ALTA®

by MONNIT®

Remote Monitoring for Business

ALTA® Wireless Advanced Vibration Meter
USER GUIDE

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CAUTION SYMBOL EXPLANATION

⚠ The following caution symbol appears on the product. This symbol indicates caution and a potential risk of danger. Carefully read the warning attached with each symbol.

I. ABOUT THE WIRELESS ADVANCED VIBRATION METER

The ALTA® Wireless Advanced Vibration Meter (AVM) includes an accelerometer within a cube at the end of its lead. By the end of each user-defined report interval, or Heartbeat, the Advanced Vibration Meter collects at least one measurement of 256 samples to generate a report about the vibrations detected by the accelerometer housed in a sealed cube and attached to a surface. In these reports, the Advanced Vibration Meter provides data on each of three orthogonal axes about:
1. Vibrations, in terms of peak acceleration, root mean square (RMS) acceleration, RMS velocity, or peak-to-peak displacement.
2. The predominate frequency of those vibrations in Hz or RPMs.
3. The crest factor—the ratio of peak acceleration over the RMS acceleration—indicating whether non-fundamental vibrations could damage a machine to which the surface is mechanically coupled. Or whether the surface experiences greater accelerations than the sensor is configured to measure.

The Advanced Vibration Meter also reports the duty cycle—the percentage of time between reports when vibration is present—and the temperature of the electronics within the cube.

You can configure the Advanced Vibration Meter to:
- Enter an Aware State and provide an immediate text, email, or phone-call notification for an acceleration greater or less than your Critical Vibration Aware Threshold, regardless of where the sensor is in its cycle of Heartbeat reports.
- Create a buffer region around this threshold to prevent the meter from bouncing in and out of its Aware State near the threshold.
- Set a minimum acceleration below which readings will not be analyzed.
- Provide a frequency range minimum and maximum outside of which high and low pass filters suppress information, respectively.
- Measure the trade-off between resolution and the range of acceleration values.

Define the Sample Measurement
Sample rate is the speed at which individual samples are made to create a 256-sample measurement from which the vibration waveform is constructed and on which analysis is performed. Increasing the sample rate increases noise. At sample rates below 800 Hz, and depending on the configured Power Mode, however, each of the 256 samples from a given measurement may be:
- A single reading (low-power consumption and low performance)
- The average of 16 readings (medium-power consumption and performance)
- The average of up to 128 readings (high-power consumption and performance)

At and above 800 Hz, each sample within the 256 sample measurement constitutes a single reading.

As an additional control, you may define a time interval at which the 256 sample measurements are collected that is less than or equal to the Heartbeat for purposes of:
- Checking for breaches of the threshold value
- Calculating duty cycle
- Statistically enhancing report values
- Finding maxima occurring during the time between Heartbeats

You can also select from among three Data Modes to report:
- Values that only come from the last set of 256 acceleration measurements
- Mean values from all sets of 256 measurements taken between Heartbeat reports
- Maximum values from all these sets of measurements

To determine the predominate frequency of vibrations, the vibration meter performs a Fast Fourier Transform (FFT) and reports the frequency of greatest magnitude. RMS velocity and peak-to-peak displacement are also calculated in the frequency domain. A windowing function, such as a Hanning filter, may be applied to each set of 256 measurements before analysis, to prevent spectral leakage in the analysis.

The IoT Advantages
The Advanced Vibration Meter can remotely manage and collect online-accessible vibration data for a large number of industrial and commercial applications, from assembly lines to individual assets, such as fans, motors, and pumps. The sector-leading features of the vibration meter make it the right choice to realize the benefits of smart asset management, predictive maintenance, and the many other advantages of implementing the principles of Industry 4.0 and the Internet of Things (IoT).

ADVANCED VIBRATION METER FEATURES

- Three-axis measurement
- Configurable Vibration Measurement modes to report Peak Acceleration, RMS acceleration, RMS Velocity, or Peak-to-Peak Displacement
- Configurable Frequency Range
- Configurable Hanning filter
- Measure vibration frequencies up to 4200 Hz / 252,000 RPM
- Configurable Measurement Interval as low as one second
- Configurable critical Vibration Aware Threshold
- Runtime indication via Duty Cycle
- Three configurable Data Report modes (Most Recent, Average, Max)

ALTA WIRELESS FEATURES

- Wireless range of 1,200+ feet through 12+ walls[1]
- Frequency-Hopping Spread Spectrum (FHSS)
- Best-in-class interference immunity
- Best-in-class power management for longer battery life[2]
- Encrypt-RF® Security (Diffie-Hellman Key Exchange + AES-128 CBC for sensor data messages)
- Onboard data memory stores up to 3200 readings:
    - 10-minute Heartbeats = 22 days
    - 2-hour Heartbeats = 266 days
- Over-the-air updates (future proof)
- The iMonnit Premiere Cloud-Based Wireless Sensor Management & Monitoring Software is free for 45 days to configure sensors, view data, and set up alerts to be sent via SMS text, email, or call. The system will automatically default to the free iMonnit Basic version if you don't purchase an annual subscription of iMonnit Premiere.

[1] Actual range may vary depending on the environment.

[2] Battery life is determined by sensor reporting frequency and other variables. Other power options are also available.

EXAMPLE APPLICATIONS

- Vibration monitoring for nearly anything
- Motor, pump, system door, and fan monitoring
- Smart machines, structures, and materials monitoring
- Wind turbine and utility pole monitoring
- Assembly line monitoring
- Air conditioner and heat pump monitoring
- Additional applications

II. ORDER OF OPERATIONS

It's important to understand the order of operations for activating your meter. If performed out of sequence, the meter may have trouble communicating with iMonnit. Please perform the steps below in the order indicated to ensure you're performing your setup correctly.

1. Create an iMonnit account (if new user).
2. Register all meters, sensors, and gateways to a network in iMonnit.
    a. Sensors can only communicate with gateways on the same iMonnit network.
3. Connect and power on the gateway and wait until it checks into iMonnit.
4. Power on the meter and verify that it checks into iMonnit.
    a. We recommend powering the meter on near the gateway then moving it to the installation location, checking signal strength along the way.
5. Configure the meter for use. (This can be done at any point after step 2.)
6. Install the meter in the final location.

> **Note: For information on setting up iMonnit and the gateway refer to the iMonnit user guide and the gateway's user guide.**

> **Note: Specific Advanced Vibration Meter setup details are covered in the following sections.**

III. SET UP AND REGISTRATION ON IMONNIT

If this is your first time using iMonnit, you must create a new account. If you have already created an account, start by logging in. For instructions on how to register and set up your iMonnit account, please consult the iMonnit User Guide.

DO NOT INSTALL OR POWER ON YOUR DEVICE UNTIL TOLD TO DO SO IN iMONNIT.

STEP 1: ADD DEVICE

1. Add the meter in iMonnit.

Add the meter to your account by choosing **Sensors** in the left main menu. Navigate to and click the **Add Sensor** button.
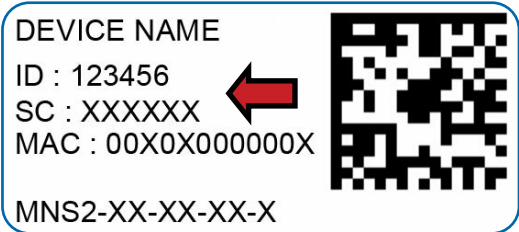
Desktop   Mobile

2. Find the Device ID
.
The Device ID (ID) and Security Code (SC) are necessary to add a sensor. These can both be located on the label on the side of your device.

DEVICE NAME
ID : 123456
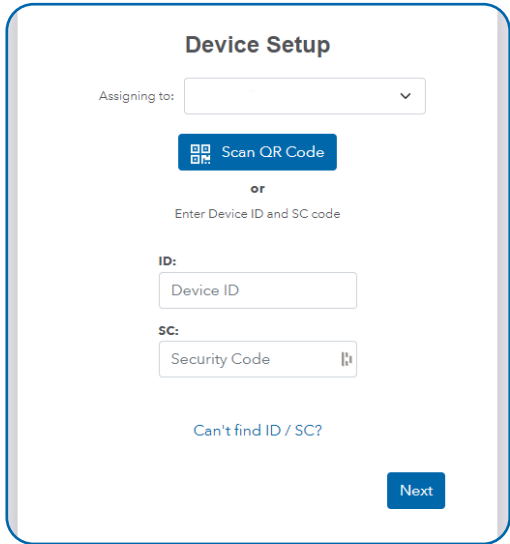SC : XXXXXX
MAC : 00X0X000000X

MNS2-XX-XX-XX-X

3. Add Your Device

Enter the **Device ID** and **Security Code** from your meter in the corresponding text boxes. Use the camera on your smartphone to scan the QR code on the meter. If you don't have a camera on your phone, or the system is not accepting the QR code, you may enter the Device ID and Security Code manually.

- The Device ID is a unique number located on the barcode label of each device.
- Next, you'll be asked to enter the Security Code from your device. A security code consists of letters and must be entered in upper case (no numbers). It can also be found on the barcode label of your device.

When completed, select the **Next** button.

Device Setup

Assigning to:

Scan QR Code

or

Enter Device ID and SC code

ID:
Device ID

SC:
Security Code

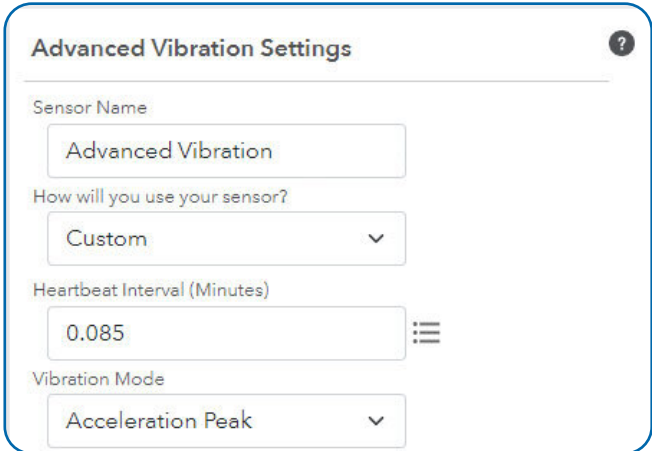Can't find ID / SC?

Next

STEP 2: SETUP

Name Your Device

Use a descriptive name for your device. The best names are memorable and unique to your monitoring application.

Select Your Use Case

The AVM doesn't come with preset use cases. Select **Custom** from the drop down.

Select the **Save** button when completed.

Note: The full range of sensor settings on this screen is covered in detail in the Sensor Overview portion of this manual. It isn't necessary to edit these settings at this time.

Advanced Vibration Settings

Sensor Name
Advanced Vibration

How will you use your sensor?
Custom

Heartbeat Interval (Minutes)
0.085

Vibration Mode
Acceleration Peak

STEP 3: VALIDATION

The Validation Checklist

The validation checklist will help you ensure your meter is communicating with the gateway properly and you have a strong signal. A green check mark will appear when each step is complete.

    Step 1. Gateway Online
    Step 2. Sensor in Gateway List
    Step 3. Insert Batteries
        Powering on the device and battery installation is covered in the next section (IV) of this manual.
    Step 4. Validate Sensor Status

Follow the on-screen instructions for each step, then press the **Next** button to continue.

Step 4 will only complete when your sensor achieves a solid connection to the gateway. Once you insert the batteries (or flip the switch on an industrial sensor) the sensor will communicate with the gateway every 30 seconds for the first few minutes.

Select the **Complete** button when step 4 is done.
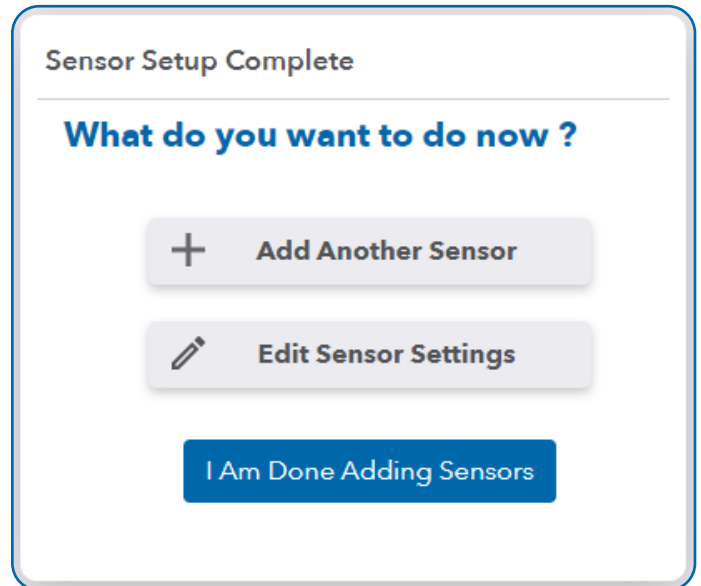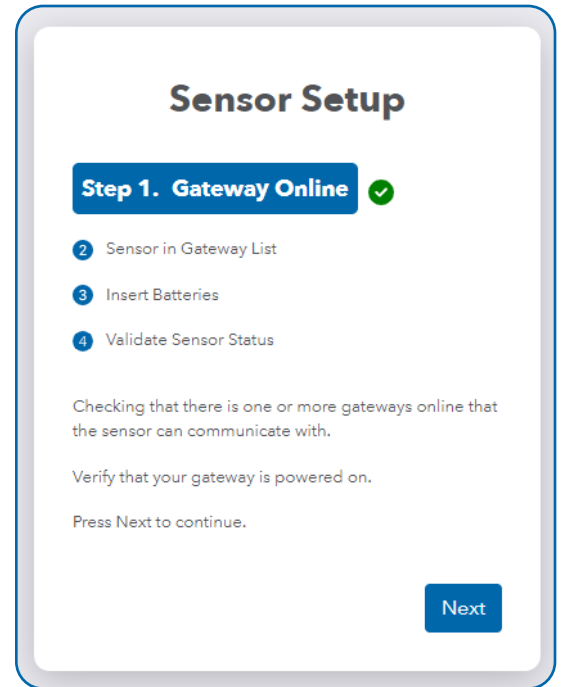
STEP 4: SETUP COMPLETE

Congratulations. Your sensor is now setup.

You now have three options available.

You can add an additional sensor to your network by pressing the **Add Another Sensor** button.

Edit the recently set up sensor settings by pressing **Edit Sensor Settings.**

Return to the iMonnit home screen by pressing **I Am Done Adding Sensors.**

IV. BATTERIES AND INSTALLATION

When you're finished adding the meter to your account, the next step is to deal with the batteries, depending on whether the meter is a commercial or industrial version.

INSTALLING/REPLACING BATTERIES

ALTA® commercial sensors and meters are powered by AA batteries. Industrial meters need a 3.6V Lithium battery supplied by Monnit or another industrial battery supplier. We encourage you to recycle all old batteries.
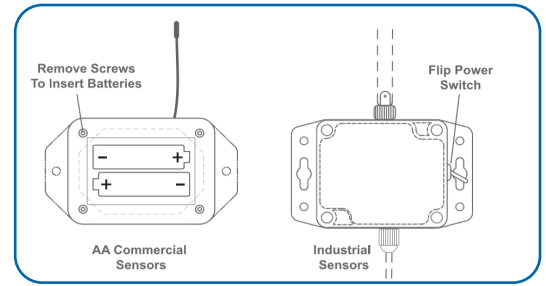
AA Batteries

Two replaceable 1.5V AA-sized batteries (included with purchase) power the standard or commercial version of this meter. The typical battery life is up to 10 years.

This meter is also available with a line-power option. The line-powered version has a barrel power connector, allowing it to be powered by a standard 3.0–3.6V power supply. The line-powered version also uses two standard 1.5V AA batteries as backup for uninterrupted operation in the event of a line-power outage.

Power options must be selected at the time of purchase, as the internal hardware of the meter must be changed to support the selected power requirements. Place batteries in the device by first taking the meter and sliding the battery door open. Insert fresh AA batteries in the carriage, then shut the battery door.

Complete the process by opening up iMonnit and selecting **Sensors** from the main navigation menu. Verify that iMonnit shows that the meter has a full-battery level. To replace the batteries in a commercial meter, ensure that removing power will not interfere with any upcoming data message. Remove the old batteries, and follow the battery installation instructions with two new, non-rechargeable, 1.5 Volt, AA batteries. As with the industrial meters or sensors, the commercial meter will pick up its old configurations from the gateway and continue to provide data at the same intervals, but beginning at the time the meter starts up anew.

WARNING: ONLY install new alkaline batteries from the same manufacturer, when replacing batteries in AA commercial sensors and meters.

Industrial Batteries

The industrial version of the meter comes with a 3.6V Lithium battery installed. The meter doesn't need to be taken apart for battery installation and the battery isn't rechargeable. The ALTA battery life for the industrial meter is up to seven years.

Open iMonnit and select **Sensors** from the main navigation menu. Verify iMonnit shows that the meter has a full-battery level. In order for the meter to function properly, you must attach the included antenna. Simply screw the antenna onto the barrel connector on the top of the device. Make sure the antenna connection is snug, but do not over tighten. When placing the meter, make sure to mount the meter with the antenna straight up (vertical) to ensure the best wireless radio signal.

Since the electronics are sealed within the meter's housing, we added an On/Off switch to the unit for your convenience. If you aren't using the meter, simply leave the button in the Off position to preserve battery life. If the meter needs to be reset for any reason, you can simply cycle the power by turning the switch to the Off position and waiting 30 seconds before powering it back up.

To replace the battery in an industrial meter, remove the old battery from the meter when the loss of power will not interfere with any upcoming data message.

WARNING: The new, replacement battery MUST be a single, new, ER14505M, 3.6 Volt, AA battery. This ER14505M can only be a RAMWAY, TITUS, or GMB POWER ER14505M battery, preferably a RAMWAY ER14505M battery. Follow the battery installation instructions above with the ER14505M battery.

MOUNTING THE SENSOR BASE

The meter base (housing the radio and microcontroller of the sensor) features mounting flanges and can be attached to most surfaces using the included mounting screws or double-sided tape. For a wooden surface, a metallic surface, or dry-wall, the included double-sided tape (use two pieces) or the two included screws may be used. For masonry, use the included double-sided tape. If the included screws are not available, use two #7, 7/16" (0.4375") screws. If the included double-sided tape is not available, use one or more pre-cut, double-sided foam squares of dimensions 1/32" x 3/4" x 3/4" available from ULINE as model number S-11695, or the like.
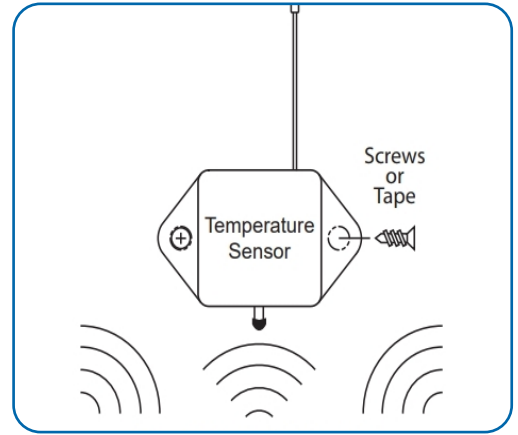

MOUNTING THE ACCELEROMETER CUBE

The leaded cube can be adhered to surfaces using a threaded stud, adhesives, double-sided tape, magnetic base, or a combination of all three. It is critically important that the cube is rigidly mounted to the system you wish to assess to ensure the sensor can accurately read the vibrations in the system. Loose or non-rigid mounting can result in signal loss, unpredictable resonant frequencies, and less accurate results. The cube includes an axis indicator label to aid in installation and improve physical understanding of data reported to iMonnit.
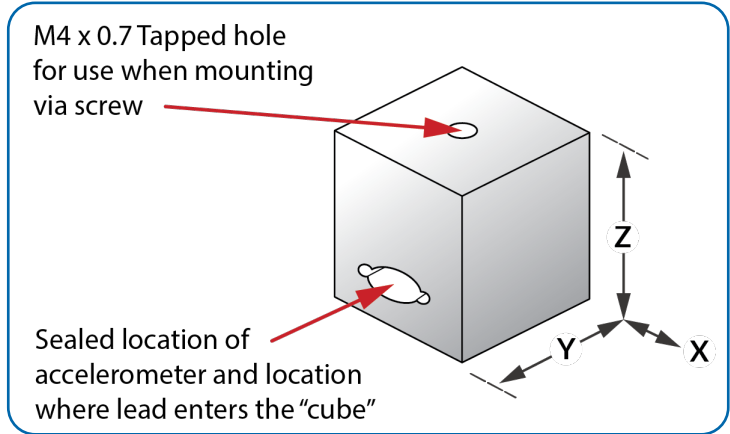
Mounting Approaches: a through d below indicate typical mounting approaches and the generalized best case frequency response associated with that mounting style. [1]
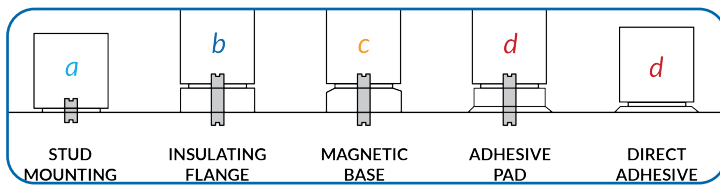
1. Monnit does not provide material for any of these mounting options, it is up to the installer to source appropriate mounting materials.
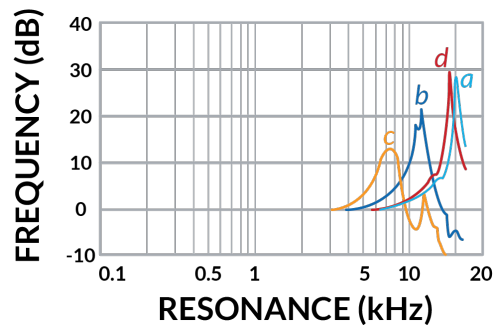
Things to Avoid: The graphic below indicates some things to avoid when mounting the cube.

UNEVEN SURFACE   ROUGH SURFACE   FLEXIBLE COUPLING
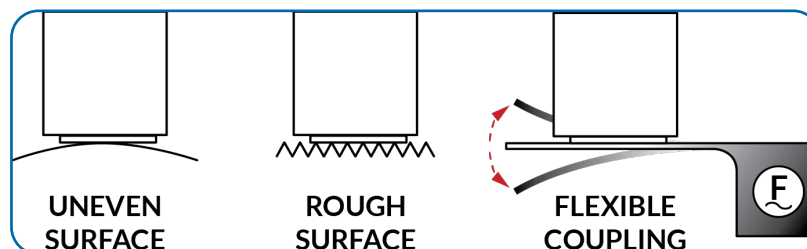
ANTENNA ORIENTATION

To get the best performance out of your ALTA device, it is important to note proper antenna orientation and device positioning. Radio performance is best when sensor and gateway antenna are pointing in the same direction and installed on the same plane. For devices installed on the same horizontal plane, this means the antenna should be pointed straight up. However, if devices are installed on the same vertical plane, antenna should be aligned on the same horizontal plane and still pointed in the same direction.
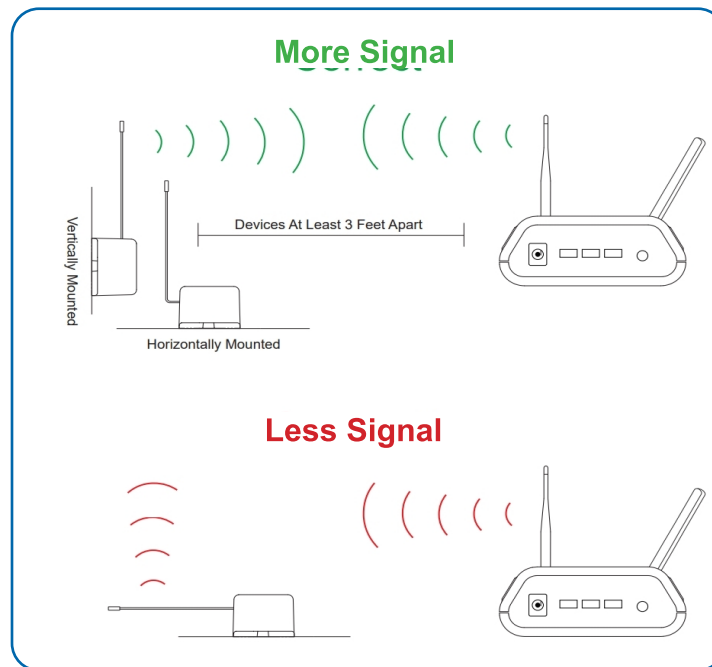
CLEANING

When needed, clean the meter with a damp, but not dripping-wet, cloth where it's installed.

V. METER OVERVIEW IN iMONNIT

Select **Sensors** from the main navigation menu in iMonnit to access the Sensor Overview page and begin to configure the settings of the Advanced Vibration Meter.

MENU SYSTEM

A. List - Lists all sensors on the chosen network

B. Details - Displays a graph of recent meter data

C. Readings - List of all past Heartbeats and readings

D. Rules - List of all Rules assigned to the meter

E. Settings - Configurable levels for a meter

F. Scale - Changes the units for the meter readings

Directly under the top horizontal tabbed menu bar is an overview of the meter. You can see the signal strength and the battery level of the selected sensor. A colored dot in the left corner of the meter icon denotes its status.

- **Green** indicates the sensor is checking in and within user-defined safe parameters.
- **Red** indicates the sensor has met or exceeded a user-defined threshold or triggered event.
- **Gray** indicates that no sensor readings are being recorded, rendering the sensor inactive.
- **Yellow** indicates that the sensor reading is out of date, due to perhaps a missed Heartbeat check-in.

Details View

The Details View will be the first page you see upon selecting which sensor or meter you want to modify or review.
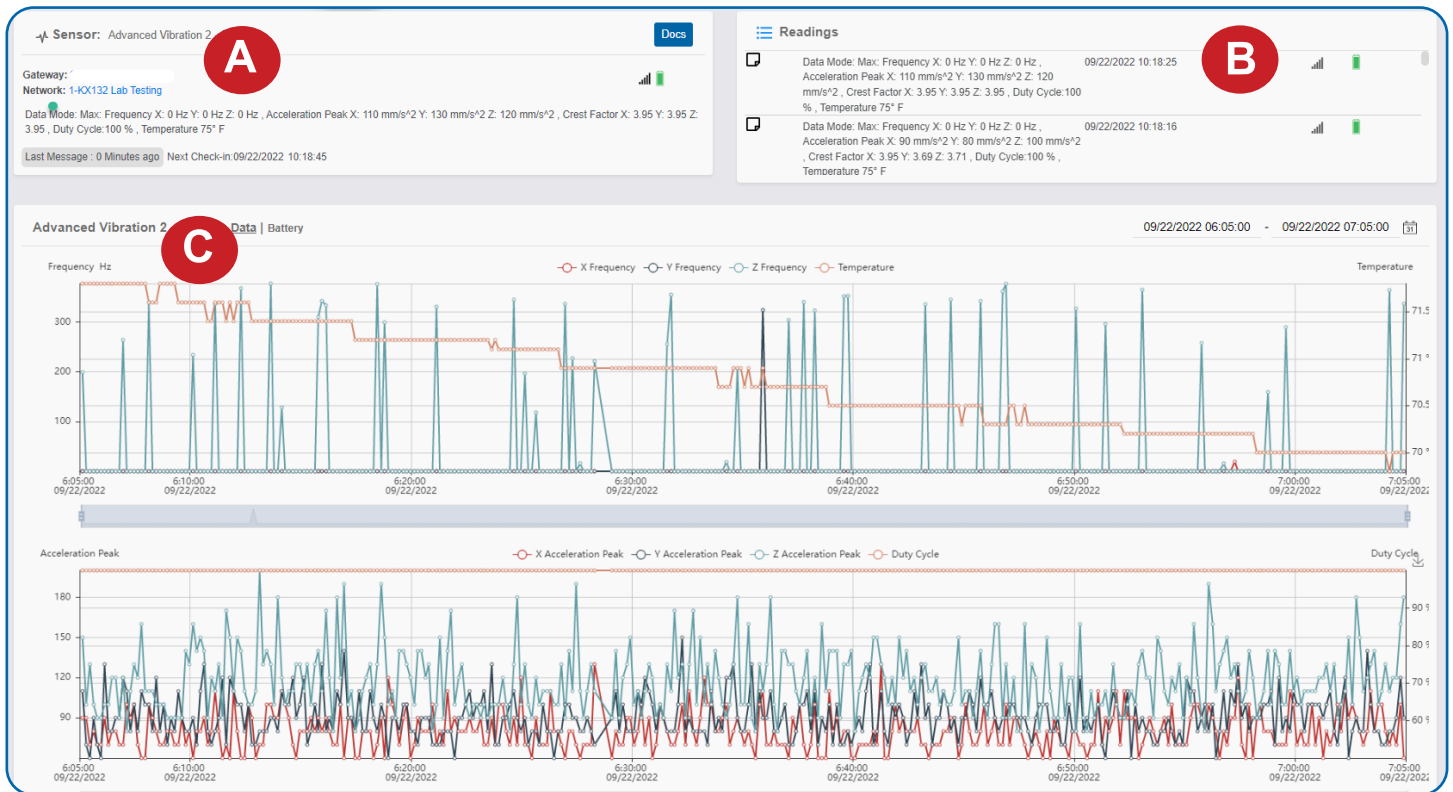
A. The Sensor Overview section will be above every page. This will consistently display the present reading, signal strength, battery level, and status.

B. The Recent Readings section below the chart shows the most recent data received from the meter or sensor.

C. The Readings Chart shows how the meter's readings fluctuate throughout a set date range. To change the date range displayed in the graph, navigate up to the top of the Readings Chart section on the right-hand corner to change the From date and To date.

Readings View

Select the **Readings Tab** within the tab bar to view the meter's data history as time-stamped data.

- On the far right of the Sensor History Data is a cloud icon. (   ) Selecting this icon will export an Excel file for the meter data into your downloads folder.

> **Note: Make sure you have the date range for the data you need input in the From and To text boxes. This will be the previous day by default. Only the first 2,500 entries in the selected date range will be exported.**

Exported Data

The exported Excel file will have the following columns of data:

MessageID: Unique identifier of the message in our database.

Sensor ID: If data of multiple sensors is exported, you can distinguish between the sensors using this number—even if the names are the same.

Sensor Name: The name you gave the sensor or meter.

Date: The date the message was transmitted from the sensor.

Value: Data presented with transformations applied, but without additional labels.

Formatted Value: Data transformed and presented as it is shown in iMonnit.

Raw Data: Raw data as it is stored from the sensor.

Sensor State: Binary field represented as an integer containing information about the state of the sensor when the message was transmitted. (See **Sensor State** explained below.)

Alert Sent: Boolean indicating if this reading triggered a notification to be sent from iMonnit.

Sensor State

The value presented here is generated from a single byte of stored data. A byte consists of eight bits of data that we read as Boolean (True (1) / False (0)) fields.

When broken into individual bits, the State byte contains the following information: aaaabcde
STS: This value is specific to the sensor or meter profile and is often used to indicate error states and other sensor conditions.
UNUSED: This sensor does not use these bits.
AWARE: Sensors become aware when critical sensor specific conditions are met. Going aware can cause the meter or sensor to trigger and report before the Heartbeat, causing the gateway to forward the data to the server immediately or nearly immediately.
TEST: This bit is active when the sensor is first powered on or reset and remains active for the first nine messages when using default configurations.

STS Specific Codes:
  0 = No problems, sensor or meter is functioning normally
  1 = Sensor is aware due to vibration above the configurable threshold
  8 = Hardware error
  9 = Bad temperature reading
  10 = At least one accelerometer hardware error during a Heartbeat

Settings View

To edit the operational settings for the meter, choose the **Sensor** option in the main navigation menu then select the **Settings** tab to access the configuration page.
A. Sensor Name is a unique name you give the sensor to easily identify it in a list and in any notifications.

B. The **Heartbeat Interval** is how often, in minutes, the sensor communicates with the gateway if no activity is recorded.

C. Aware State Heartbeat is how often, in minutes, the sensor communicates with the gateway while in an Aware State.

Vibration Mode

Acceleration Peak ⌄

Vibration Aware Threshold (mm/s^2)

65530

Vibration Hysteresis (mm/s^2)

0

Vibration Sensitivity Threshold (g)

0

Window Function

Rectangular ⌄

Accelerometer Range

2 g ⌄

Measurement Interval (Seconds)

1

Sample Rate

12800 Hz ⌄

Frequency Range Minimum (Hz)

200.0 Hz ⌄

Frequency Range Maximum (Hz)

4250.0 Hz ⌄

Power Mode

High Performance ⌄

D. Vibration Mode determines whether the sensor reports Velocity RMS, Acceleration RMS, Acceleration Peak, or Displacement p-p.

E. The **Vibration Aware Threshold (VAT)** causes the sensor to report immediately when vibration readings cross this threshold (in either direction). This threshold works in conjunction with the Measurement Interval since the sensor can only detect a change after taking a measurement. When the sensor goes above this threshold it will report Aware. When the sensor goes below this this threshold it will report Not Aware.

F. Vibration Hysteresis (VH) is a buffer to prevent the sensor from bouncing between Standard Operation and Aware State when measurements are very close to a threshold. This feature is used in conjunction with the VAT and is only used when the sensor is already in the Aware State. In order for the sensor to go not aware when already aware, it must go below VAT - VH.

G. Vibration Sensitivity Threshold sets the lowest level of vibration to be recorded. Values below this setting are ignored. No analysis will occur and this information will not count towards Duty Cycle. Setting this to 0 will force the sensor to analyze at every opportunity and measure noise. In this situation, the Duty Cycle will always be 100 percent.

H. Window Function determines whether the measured vibration waveform is filtered prior to analysis. The Hanning filter reduces the start and end of the sampled waveform to 0 to minimize spectral leakage that can occur when the sampling of the vibration waveform does not start and end at the same point in the waveform.

I. Accelerometer Range is the maximum observable peak acceleration, in gravitational force, across which the device's 65,536 units of resolution are spread. The accelerometer range can be decreased to increase resolution at lower amplitudes or increased to capture higher amplitude vibrations with less resolution. If range is set lower than the input signal, the peaks of the vibration waveform may be clipped, distorting the data and usually resulting in a Crest Factor below 1.41.

J. Measurement Interval is how often, in seconds, the sensor takes a vibration waveform measurement comprising 256 samples.[1]

K. Sample Rate determines how fast the accelerometer reads acceleration data during a measurement. Every measurement the sensor takes is made up of 256 samples with which to reproduce the vibration waveform.

L. Frequency Range Minimum is the lowest allowable frequency to consider when measuring vibration, with frequency options varying with sample rate.

M. Frequency Range Maximum is the highest allowable frequency to consider when measuring vibration, with frequency options varying with sample rate.

N. Power Mode controls the power consumption of the accelerometer during measurements by changing the amount of oversampling performed.[2,3]

1. Timing Examples: 256 samples per measurement divided by a 25 Hz sample rate equals 10.24 seconds; and, 256 samples divided by a 12,800 Hz sample rate equals 0.02 seconds. Keep this in mind when setting the measurement interval.
2. Noise levels generally increase as the sample rate is increased and as the power mode is decreased, see Noise in the Electronic Specifications table for more details.
3. Low power averages one reading per sample and consumes the lowest power. Medium power averages 16 readings per sample and consumes mid-range power. High Performance averages up to 128 readings per sample and consumes the most power.
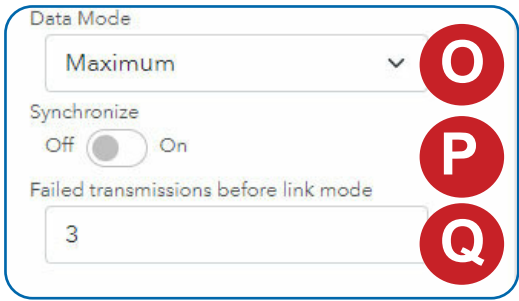
O. Data Mode controls how the data the sensor reports is computed. With Most Recent mode, the sensor reports the results of the last measurement prior to the Heartbeat only. Using Average mode, the sensor reports the mean of the frequency, vibration, and crest factor readings that occurred since the last Heartbeat. The temperature reading is just the most recent reading when in Average mode. Using Maximum mode, the sensor reports the frequency, crest factor, and the temperature associated with the largest vibration measurement in the Heartbeat.

P. Synchronize causes the sensors in a network to synchronize their communications. The default setting, off, allows the sensors to randomize their communications, thereby maximizing communication robustness.

Q. Failed Transmissions Before Link Mode is the number of transmissions the sensor sends without response from a gateway before it goes to battery saving link mode. In link mode, the sensor will scan for a new gateway and if not found will enter battery-saving sleep mode for up to 60 minutes before trying to scan again. A lower number will make the sensor enter link mode more quickly upon transmission failure. Higher numbers will better enable the sensor to remain with its current gateway in a noisy RF environment. Zero will cause the sensor to never join another gateway to find a new gateway, the battery will have to be cycled out of the sensor.

The default Heartbeat Interval is 120 minutes or two hours. It is recommended that you do not lower your Heartbeat level too much because it will drain the battery.

Finish by selecting the **Save** button.

> **Note: Be sure to select the Save button anytime you make a change to any of the meter parameters. All changes made to the meter settings will be downloaded to the meter on the next meter Heartbeat (check-in). Once a change has been made and saved, you will not be able to edit that meter's configuration again until it has downloaded the new setting.**

Scale View

Advanced Vibration Meter settings are influenced by frequency. The scale option will be available in the tab bar. To change the unit of measurement select the **Scale** tab.

Choose the text box to trigger a pop-up window allowing you to change the scale. Select the scale, or units, you prefer and push **Set**.

Press the **Save** button to complete your adjustment.
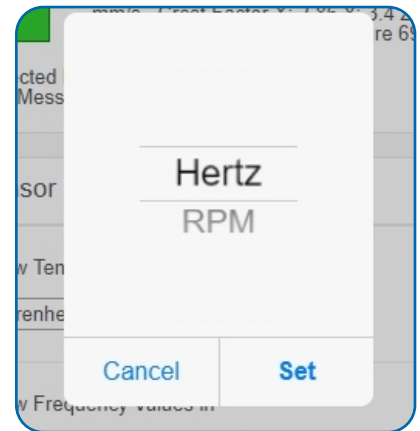
VI. USING THE SENSOR

Review the data the sensor can produce on the Advanced Vibration Meter data sheet. Also, review the configurable features of the sensor, found in this user guide and the data sheet, and determine the measurement requirements of your use case or application before deciding on the final standard configurations for the meter. Vibration analysis can be extremely complex and sometimes an expert may be required to best optimize this sensor for a specific application. With that being said, this sensor has many useful features that can be employed without the need of expert guidance. We recommend doing a little bit of research into the system to be measured and review the meter's technical documentation.

DETERMINING A BASELINE
One of the most critical steps, prior to setting final configurations on this sensor, is gathering baseline readings. A baseline is a set of average readings measured by the sensor while the machine, equipment, or system is in a known good working state. Before determining this baseline, it's important to determine the typical operating frequency (or RPMs) for your system. If this is not clear from the system's technical literature, this can be determined experimentally with the meter.

Find the typical operating frequency experimentally:
1. Set the Vibration Mode to Acceleration RMS, Power Mode to High Performance, and Accelerometer Range to 16 G.
2. Set the Sample Rate and the Frequency Range Min/Max settings on the meter with consideration for what you think the operating frequency of the system might be (where the assumed operating frequency falls just below the middle of the Frequency Range settings).
3. Observe the readings of the sensor while the system is running. It's best to gather several readings to get a more robust picture of the typical operating frequency.
4. Adjust Sample Rate up and down and repeat Step 3, looking for what frequency produces the greatest Acceleration RMS readings. **Note**: Setting the Data Mode to Maximum and Measurement Interval to about 10x less than the Heartbeat can help speed up this process.
5. Once you determine what frequency produces the greatest Acceleration RMS readings, you have found the typical or fundamental operating frequency.

Now, adjust the Sample Rate so the typical operating frequency falls within the lower third of the Frequency Range. This is desirable since harmonics (multiples of the typical operating frequency) may start to appear when system health starts to degrade. With the typical frequency in the lower third, this leaves better bandwidth at the upper end of the Frequency Range to be able to see harmonics as they appear.

With an appropriate frequency setting found, all that is left is determining the preferred Vibration Mode. Which mode is ideal, is typically determined by the Frequency Range of interest.

Select a Vibration Mode:
1. **Acceleration:** Best for higher frequencies where frequencies of interest are above 1 KHz (60,000 RPM).
2. **Velocity:** Best for medium frequencies where frequencies of interest fall between 10 Hz and 1 KHz (600 RPM to 60000 RPM).
3. **Displacement:** Best for low frequencies where frequencies of interest fall below 20 Hz (1200 RPM).

With Vibration Mode and Frequency settings applied now, we can determine the baseline. Take an appropriate number of measurements while the system is running and using a combination of Average and Maximum Data modes to determine the baseline.

USING THE BASELINE
With the baseline determined, set the meter with the desired configurations and Vibration Thresholds. Once the meter is set with it's final permanent configurations, set up Rules in iMonnit to be notified of readings that significantly deviate from the baseline values. Even without expert analysis, deviation from the baseline can be interpreted as a change in your system that may require further attention. This may be an appropriate time to contact a technician or expert to assess the system more closely for potential issues. The value of using this sensor and this approach is that the system can be assessed, and often times problems addressed, long before it becomes a much more expensive repair, preventing unscheduled downtime and more extensive system damage.

THINGS TO CONSIDER
If you wish to measure using multiple modes and frequency ranges at the same time, multiple meters can be installed in or on a single system. The only real limiting factor here is surface area available for mounting.

DIRECT ANALYSIS
If you're looking for a specific vibration aspect, or several aspects, of the system, the meter's settings can be changed at anytime to help assess different vibration measurements. This may involve changing settings several times within an hour to get more refined measurements. The beauty of Monnit Remote Monitoring Solutions is that setting changes and related analysis can be conducted from anywhere you have Internet access, saving significant time and expense on travel.

VII.TROUBLESHOOTING

Symptoms	Detailed Problem Description	Solution
Not Checking into iMonnit	The meter lost the radio link to the gateway or never connected to the gateway.	Power cycle the meter by turning the switch off for 60 seconds then toggling it on. 1. Ensure the network is set up correctly in iMonnit (sensor and gateway are on the same network). Press the utility button on the gateway. 2. If the network is set up correctly, reform the gateway. 3. Move the meter ~10 feet from the gateway. 4. Move the meter progressively further from the gateway ensuring at least two signal bars are showing. Keep in mind the signal bars represent the signal from the previous message, not the current message. We recommend taking two readings to verify signal strength. 5. Check the antenna position on the gateway.
Low Signal	The radio signal strength in iMonnit is lower than expected.	1. Ensure the gateway antenna is properly connected. 2. Ensure the gateway antenna is optimally oriented with respect to the position of the sensor. (See Antenna Orientation guide in the Setup and Installation section).
"Hardware Error" is Reported in iMonnit	The sensor base can't communicate with the measurement circuitry in the cube. STS is set to 8 or 9.	If this condition occurs all the time, try setting default configurations. If a hardware error occurs occasionally, try routing the cable away from significant noise producing items (heavy machinery, high-current power cables, transformers, etc.). If the problem persists, contact Monnit technical support for further guidance. Persistent hardware errors not addressable by the above directions usually require repair by a technician.
Unexpected Vibration Readings	Vibration levels do not appear to be accurate.	1. Verify the cube is rigidly mounted to the system to ensure the cube moves exactly as the system moves. Refer to the Mounting guide section of this document for additional mounting instructions. 2. Verify the meter's configurations in iMonnit align with your application requirements. For more information on configurations refer to the Sensor Features table in the data sheet and the Settings View section in this user guide. 3. If the Sensitivity Threshold (ST) is set at low or 0 the sensor can produce readings from a combination of electronic and environmental conditions. To filter this noise increase the ST. 4. Refer to the data sheet for a detailed description of how each data point is generated to better understand how the measurements are produced and verify this aligns with your application. 5. Refer to the data sheet for vibration and frequency specification to determine if the meter is reading within expected tolerances.

Symptoms	Detailed Problem Description	Solution
Unexpected Crest Factor (CF) Readings	Crest Factor readings are below 1.41 or much higher than expected.	1. CF readings can be below 1.41 if the Accelerometer Range setting is lower than the vibration signal. The value is lower than 1.41 due to clipping of the signal. Address this by increasing the Accelerometer Range. 2. If the meter is experiencing high noise or harmonic signals, then it is very likely that the CF level will be relatively high (2.5+). If there is noise, the high CF is usually accompanied by lower, inconsistent vibration readings. If there are harmonics, the CF will usually be accompanied by consistent normal or higher than normal vibration readings. In this case, it may be an indication of poor machine health, not a meter problem, and you should have your system evaluated by a technician or expert.
Duty Cycle always 0 or 100%	Duty Cycle always reports 0 or 100%	1. If Duty Cycle is always 0%, the Vibration Sensitivity Level (VST) is probably too high. 2. If the Duty Cycle is always 100%, the VST is probably too low or 0.

VIII. SUPPORT

For technical support and troubleshooting tips, please visit our support library at monnit.com/support/. If you are unable to solve your issue using our online support, email Monnit Support at support@monnit.com with your contact information and a description of the problem. A support representative will call you within one business day.

For error reporting, please email a full description of the error to support@monnit.com.

IX. MONNIT DATA SECURITY

Monnit ALTA Wireless, PoE•X (Power over Ethernet), and MoWi (Wi-Fi) Sensors have been designed and built to securely manage data. Monnit works to ensure your data security is handled with the utmost care. The same methods of financial institutions to transmit data are also used in Monnit's security infrastructure. Security features from sensors to gateways include tamper-proof network interfaces, data encryption, and bank-grade security.

Monnit's proprietary sensor protocol uses low power and specialized radio equipment to transmit application data. Wireless devices listening on open communication protocols can't eavesdrop on sensors. Packet-level encryption and verification is key to ensuring data traffic isn't altered between sensors and gateways. Paired with a best-in-class range and power consumption protocol, all data is transmitted securely from your devices, ensuring a smooth, worry-free experience.

SENSOR COMMUNICATION SECURITY

Monnit's sensor-to-gateway, secure wireless tunnel, Encrypt-RF™, is generated using ECDH-256 (Elliptic Curve Diffie-Hellman) public key exchange that creates a unique symmetric key between each pair of devices. Sensors and gateways use this link-specific key to process packet-level data with hardware-accelerated 128-bit AES encryption, which minimizes power consumption to provide better battery life. Thanks to this combination, Monnit proudly offers robust bank-grade security at every level.

How Monnit Encrypt-RF™ Works

DATA SECURITY ON THE GATEWAY

ALTA Gateways are designed to prevent prying eyes from accessing the data that is stored on the sensors. Gateways don't run on an off-the-shelf, multi-function operating system. Instead, they run on a purpose-specific, real-time, and embedded state machine that can't be hacked to run malicious processes. There are also no active interface listeners that can be used to gain access to the device over the network. The fortified gateway secures your data from attackers and can't become a relay for malicious programs.

More information on Ethernet Gateway Security https://monnit.blob.core.windows.net/site/documents/other/ethernet-gateway-security-brief.pdf

iMONNIT SECURITY

The iMonnit™ system is the online or on-premises software and central hub for configuring your device settings. All data is secured on dedicated servers operating Microsoft SQL Server. Access is granted through the iMonnit user interface that requires Two-Factor Authentication (2FA), or an Application Programming Interface (API) safeguarded by 256-bit Transport Layer Security (TLS 1.2) encryption. The TLS encryption is a blanket of protection to protect all data exchanged between iMonnit and you. The same encryption is available to you whether you are a Basic or Premiere user of iMonnit. You can rest assured that your data is safe with iMonnit.

OPTIONAL DATA AUTHENTICATION

SensorPrints™ is the industry's only end-to-end Internet of Things (IoT) data authentication platform for low-power wireless sensors. SensorPrints authenticates data by issuing a unique fingerprint for each device within the IoT. Data is secured from the point of generation to the point of consumption. Easy to install and use, SensorPrints is is the definitive IoT security solution for any enterprise.

SensorPrints authenticates data at both the point of generation and consumption, creating trust between the sensor and server levels. Implementing 256-bit SHA 3 authentication, SensorPrints creates a "fingerprint" for a Monnit Wireless Sensor that contains an authenticated sensor message. When data is transmitted from the sensor, it is accompanied by a generated authentication token. Upon receipt by the application, the token is evaluated via cryptographic hash function against a unique per sensor secret key. This step provides an unprecedented level of full-coverage security for any Monnit user wishing to secure their IoT devices and data. More information can be found at https://www.monnit.com/products/software/sensorprints-data-authentication/.
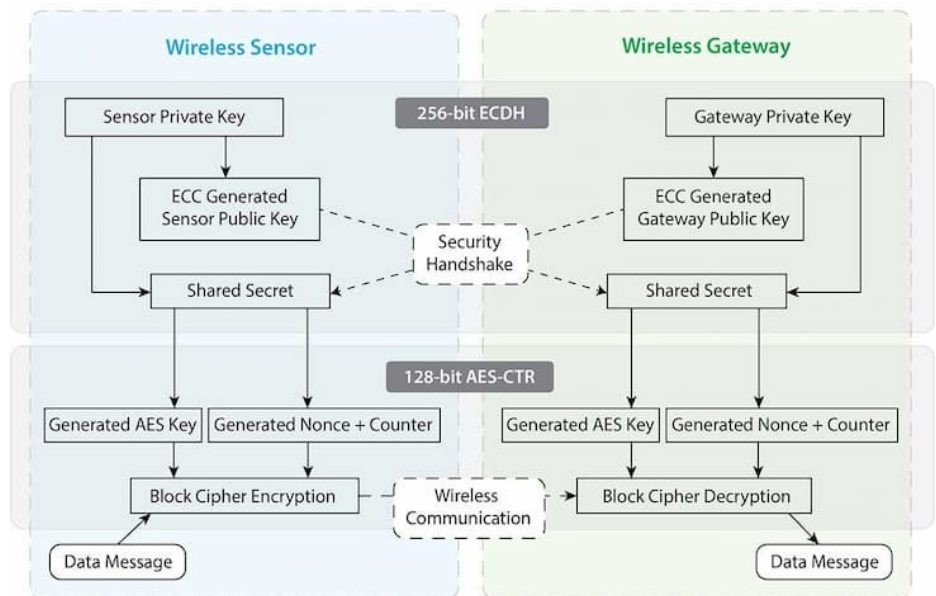
X. WARRANTY

(a) Monnit warrants that Monnit-branded products (Products) will be free from defects in materials and workmanship for a period of one (1) year from the date the Products arrive at the Customer's shipping address with respect to hardware and will materially conform to their published specifications for a period of one (1) year with respect to software. Monnit may resell sensors manufactured by other entities and are subject to their individual Warranties; Monnit will not enhance or extend those Warranties. Monnit does not warrant that the software or any portion thereof is error-free. Monnit will have no Warranty obligation with respect to Products subjected to abuse, misuse, negligence, or accident. If any software or firmware incorporated in any Product fails to conform to the Warranty set forth in this Section, Monnit shall provide a bug fix or software patch correcting such non-conformance within a reasonable period. Monnit shall provide the fix or patch after Monnit receives from the Customer (i) notice of such non-conformance, and (ii) sufficient information regarding such non-conformance so as to permit Monnit to create such bug fix or software patch. If any hardware component of any Product fails to conform to the Warranty in this Section, Monnit shall, at its option, refund the purchase price less any discounts, or repair or replace nonconforming Products with conforming Products or Products having substantially identical form, fit, and function. Monnit will then deliver the repaired or replacement Product to a carrier for land shipment to the Customer within a reasonable period after Monnit receives from the Customer (i) notice of such non-conformance, and (ii) the non-conforming Product provided; however, if, in its opinion, Monnit cannot repair or replace on commercially reasonable terms, it may choose to refund the purchase price. Repair parts and replacement Products may be reconditioned or new. All replacement Products and parts become the property of Monnit. Repaired or replacement Products shall be subject to the Warranty, if any remains, originally applicable to the Product repaired or replaced. The Customer must obtain from Monnit a Return Material Authorization (RMA) number prior to returning any Products to Monnit. Products returned under this Warranty must be unmodified.

The Customer may return all Products for repair or replacement due to defects in original materials and workmanship, if Monnit is notified within one year of the Customer's receipt of the Product. Monnit reserves the right to repair or replace Products at its own and complete discretion. Products returned under this Warranty must be unmodified and in original packaging. Monnit reserves the right to refuse Warranty repairs or replacements for any Products that are damaged or not in original form. For Products outside the one-year Warranty period, repair services are available at Monnit at standard labor rates for a period of one year from the Customer's original date of receipt.

(b) As a condition to Monnit's obligations under the immediately preceding paragraphs, Customer shall return Products to be examined and replaced to Monnit's facilities, in shipping cartons which clearly display a valid RMA number provided by Monnit. The Customer acknowledges that replacement Products may be repaired, refurbished or tested, and found to be complying. The Customer shall bear the risk of loss for such return shipment and shall bear all shipping costs. Monnit shall deliver replacements for Products determined by Monnit to be properly returned, shall bear the risk of loss and such costs of shipment of repaired Products or replacements, and shall credit a Customer's reasonable costs of shipping such returned Products against future purchases.

(c) Monnit's sole obligation under the Warranty described or set forth here shall be to repair or replace non-conforming products as set forth in the immediately preceding paragraph, or to refund the documented purchase price for non-conforming Products to the Customer. Monnit's Warranty obligations shall run solely to a Customer, and Monnit shall have no obligation to the customers of a Customer or other users of the Products.

Limitation of Warranty and Remedies

THE WARRANTY SET FORTH HEREIN IS THE ONLY WARRANTY APPLICABLE TO PRODUCTS PURCHASED BY THE CUSTOMER. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. MONNIT'S LIABILITY WHETHER IN CONTRACT, IN TORT, UNDER ANY WARRANTY, IN NEGLIGENCE, OR OTHERWISE SHALL NOT EXCEED THE PURCHASE PRICE PAID BY A CUSTOMER FOR THE PRODUCT. UNDER NO CIRCUMSTANCES SHALL MONNIT BE LIABLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES. THE PRICE STATED FOR THE PRODUCTS IS A CONSIDERATION IN LIMITING MONNIT'S LIABILITY. NO ACTION, REGARDLESS OF FORM, ARISING OUT OF THIS AGREEMENT MAY BE BROUGHT BY A CUSTOMER MORE THAN ONE YEAR AFTER THE CAUSE OF ACTION HAS ACCRUED.

IN ADDITION TO THE WARRANTIES DISCLAIMED ABOVE, MONNIT SPECIFICALLY DISCLAIMS ANY AND ALL LIABILITY AND WARRANTIES, IMPLIED OR EXPRESSED, FOR USES REQUIRING FAIL-SAFE PERFORMANCE IN WHICH FAILURE OF A PRODUCT COULD LEAD TO DEATH, SERIOUS PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE SUCH AS, BUT NOT LIMITED TO, LIFE SUPPORT OR MEDICAL DEVICES, OR NUCLEAR APPLICATIONS. PRODUCTS ARE NOT DESIGNED FOR AND SHOULD NOT BE USED IN ANY OF THESE APPLICATIONS.

XI. CERTIFICATIONS

United States FCC

This equipment has been tested and found to comply with the limits for Class B digital devices, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from the one the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

Warning: *Changes or modifications not expressly approved by Monnit could void the user's authority to operate the equipment.*

RF Exposure

⚠️   **WARNING**: To satisfy FCC RF exposure requirements for mobile transmitting devices, the antenna used for this transmitter must not be co-located in conjunction with any antenna or transmitter.

Monnit and ALTA Wireless Sensors, Wireless Sensor Adapters and Ethernet Gateways:

This equipment complies with the radiation exposure limits prescribed for an uncontrolled environment for fixed and mobile use conditions. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and the body of the user or nearby persons.

All ALTA Wireless Sensors and Gateways Contain FCC ID: ZTL-G2SC1.

Approved Antennas

ALTA devices have been designed to operate with an approved antenna listed below, and having a maximum gain of 14 dBi. Antennas having a gain greater than 14 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

- *Xianzi XQZ-900E (5 dBi Dipole Omnidirectional)*
- *HyperLink HG908U-PRO (8 dBi Fiberglass Omnidirectional)*
- *HyperLink HG8909P (9 dBd Flat Panel Antenna)*
- *HyperLink HG914YE-NF (14 dBd Yagi)*
- *Specialized Manufacturing MC-ANT-20/4.0C (1 dBi 4" whip)*

Monnit ALTA IoT Gateway models starting with MNG2-9-CME-CCE also contain module: FCC ID: XMR202007BG95M6

The system antenna(s) used with the device must not exceed the following levels:

- *4 dBi in 700 MHz, i.e. LTE FDD-12 band*
- *4 dBi in 850 MHz, i.e. LTE FDD-5 band*
- *7 dBi in 1700 MHz, i.e. LTE FDD-4 band*
- *7 dBi in 1900 MHz, i.e. LTE FDD-2 band*

Canada (IC)

English

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the Equivalent Isotropically Radiated Power (E.I.R.P.) is not more than that necessary for successful communication.

The radio transmitters (IC: 9794A-G2SC1, IC: 10224A-2020BG95M6) have been approved by Industry Canada to operate with the antenna types listed on previous page with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la Puissance Isotrope Rayonnée Èquivalente (P.I.R.È) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteurs radio (IC: 9794A-G2SC1, IC: 10224A-2020BG95M6) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne figurant sur la page précédente et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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

UK / CE

There is no restriction for the commercialization of Monnit ALTA 868MHz and 433MHz wireless products in all the countries of the European Union. The European Community provides specific directives for the electronic equipment introduced on the market. All the relevant information is available on the European Community websites.

ALTA wireless products comply with the specific harmonized standards, regulations, instruments, and directives listed in the table below. For more information on product compliance, please contact Monnit Sales or Support and request a copy of the manufactures Declaration of Confirmatory (DoC) for the relevant product(s).

Directive / Instrument / Regulation	Part	Harmonized Standard(s) / Standard(s)
Low Voltage Directive (LVD) (2014/35/EC) **Electrical Equipment (Safety) Regulations 2016** (S.I. 2016/1101)	All parts	**EN 61010-1**:2010 IEC 61010-1:2010/ AMD1:2016
ElectroMagnetic Compatibility Directive (EMCD) (2014/30/EU) **Electromagnetic Compatibility Regulations 2016**	Emissions Requirement	**EN 55032**:2015/ A11:2020
	Immunity Requirement	**EN 55035**:2017/ A11:2020
Radio Equipment Directive (RED) (2014/53/EU) **Radio Equipment Regulations 2017** (S.I. 2017/1206)	Electrical Safety Article 3.1(a)	**EN 61010-1**:2010 IEC 61010-1:2010/ AMD1:2016
	EMC Article 3.1(b)	**ETSI EN 301 489-3** V2.2.0
	RF Spectrum Efficiency Article	**ETSI EN 300 220** V3.2.1 (2018-06)
	Internet of Things Cybersecurity Article 3.3(d)-(f)	EU 2022/30 **ETSI EN 303 645** V2.1.1 (2020-06)
Restriction of Hazardous Substances (2011/65/EU) **Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic**	RoHS II and RoHS III	**IEC 63000**:2016/ AMD1:2022
Registration, Evaluation, and Authorization of CHemicals (REACH) Regulation 1907/2006	Article 33	**SVHC 224** (June 10, 2022)

XII. USER SAFETY REQUIREMENTS

⚠ **WARNING**: It is the responsibility of the user to enforce the country regulation and the specific environment regulation.

⚠ **WARNING**: This product is not certified for use in hazardous locations (HAZLOC) where there is a risk of explosions.

⚠ **WARNING**: IF THE SENSOR IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED. *Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of this user guide for correct setup and use of the product. Please handle the product with care, avoiding any dropping and contact with the internal circuit board as electrostatic discharges may damage the product.*

⚠ **WARNING**: The device has a mechanical stress rating of **IK06**, meaning its housing and/or its readings could be compromised by an impact with greater energy than one Joule.

Justification of a mechanical impact rating less than five Joules exists by: (1) a documented Risk Analysis performed and maintained by Monnit; (2) installation of the sensor in locations that cannot easily be touched by unauthorized persons or the general public; (3) the equipment being only accessible in normal use for occasional operations such as adjustment, programming, or maintenance.

⚠ **WARNING**: **DO NOT** rely solely on the sensor system to prevent: (1) one or more fatalities; (2) disabling injury or illness; (3) chemical release with acute or public health impact; (4) chemical release with temporary environmental or public health impact; (5) system or facility loss; and/or, (6) major subsystem loss.

Note: Every device has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed with care in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (23 cm). In case this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

Industrial-Grade Products | Type 1, 2, 4, 4X, 12, and 13 NEMA-Rated Enclosure

Industrial products are enclosed in reliable, weatherproof NEMA-rated enclosures. Our NEMA-rated enclosures are constructed for both indoor or outdoor use and protect the circuitry against the ingress of solid foreign objects like dust and the damaging effects of water.

- Safe from falling dirt
- Protects against wind-blown dust
- Protects against rain, sleet, snow, splashing water, and hose-directed water
- Increased level of corrosion resistance
- Remains undamaged by ice formation on the enclosure

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