

Vibration Monitoring with a SmartSolutions StarterKit



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Chapter 1 Introduction

Industrial facilities have hundreds of critical rotating assets, such as motors, pumps, gearboxes, and compressors. Unexpected failures result in costly downtime. The SmartSolutions™ Starter Kit for Vibration Monitoring is an equipment health monitoring (EHM) and preventative maintenance solution that can automatically set a baseline for the health of an asset with machine learning embedded in the cloud software.



Value

- **Increased Uptime**—Eliminate unplanned shutdowns by continuously monitoring up to 10 assets with a single system
- **Reduced Maintenance Cost**—Repair prior to failure or extensive collateral damage
- **Effective Maintenance/Parts Scheduling**—Spare parts and labor planning
- **Ease of Use**—Reduce installation costs and eliminate complexity of traditional data analysis
- **Improved Asset Selection**—Use data to assist in root cause and reliability analysis
- **IIoT**—Real-time alerts for improved decision-making and remote asset management

Banner Solution—Monitors vibration levels on rotating assets that are the result of:

- Imbalanced/misaligned condition
- Loose or worn components
- Improperly driven or mounted components
- Over-temperature condition
- Early bearing failure



How Banner Solves

- Banner's Wireless vibration/temperature sensor continually monitors RMS velocity (10–1000 Hz), RMS high-frequency acceleration (1000–4000 Hz), and temperature on rotating equipment, but uses vibration data only when the asset is operational
- Banner Cloud Data Services uses a machine learning algorithm to baseline values and set threshold limits for alerts with limited end-user interaction. Alert thresholds can be modified as desired to create alerts and warnings for each asset.
- Data and alerts can be visualized and stored.

SmartSolutions™ StarterKit Features and Benefits

<p>Continuous Vibration Monitoring</p>	<p>Monitor vibration on up to 10 assets by sensing x- and z-axis RMS velocity and high-frequency RMS acceleration. RMS velocity indicates general rotating machine health (unbalance, misalignment, looseness) and high-frequency RMS acceleration indicates early bearing wear.</p>
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Self-Learning Baseline & Thresholds	Use machine learning algorithms to automatically create an initial baseline reading and warning/alarm thresholds for each asset individually; users do not have to manually generate baselines or alarms.
Temperature Alarms	Each vibration sensor also monitors temperature and indicates an alarm when the threshold is exceeded.
SMS Text/Email Alerts	Generate SMS text and/or email alerts based on individual warnings and/or alarms.
Cloud Monitoring	Remotely monitor assets throughout an entire organization by viewing, alerting, and logging data from anywhere that has access to a web browser.
Peel and Stick	Battery-powered devices and multiple mounting options for convenient installation.
Flexibility	Right-size the kit by easily binding Nodes to the Gateway. Configurable dashboards make it easy to assist in data-driven decisions and solutions.
Durability	IP-rated sensors, Nodes, and Gateways for harsh environments

This set-up guide demonstrates how to use any SmartSolutions™ Starter Kit for monitoring the vibration of valuable rotating assets. It is important to note that all SmartSolutions™ Starter Kits are capable of monitoring and baselining vibration characteristics after a wireless Vibration Sensor Node has been bound to the DXM Controller. The baselining feature automatically becomes available after the Vibration Sensor Node is recognized by the Banner Cloud Data Services (BannerCDS) system.

SmartSolutions™ StarterKits for Vibration Monitoring

StarterKit Model	Description
STARTERKIT91200-VIBE-A	DXM1200 Controller with ISM 900 MHz radio band and AT&T cellular module, one Q45VA-BK Vibration Node, power supply, and batteries. A 90-day prepaid cellular and cloud data services included.
STARTERKIT91200-VIBE-V	DXM1200 Controller with ISM 900 MHz radio band and Verizon cellular module, one Q45VA-BK Vibration Node, power supply, and batteries. A 90-day prepaid cellular and cloud data services included.
STARTERKIT9700-VIBE-A	DXM700 Controller with ISM 900 MHz radio band and AT&T cellular module, one Q45VA-BK Vibration Node, power supply, and batteries. A 90-day prepaid cellular and cloud data services included.
STARTERKIT9700-VIBE-V	DXM700 Controller with ISM 900 MHz radio band and Verizon cellular module, one Q45VA-BK Vibration Node, power supply, and batteries. A 90-day prepaid cellular and cloud data services included.

Additional Components	Description
DX80N9Q45VA	Wireless Q45VA Node with Integrated Vibration and Temperature Sensor (900 MHz)
DX80N9Q45VA-BK	Wireless Q45VA Node with Integrated Vibration and Temperature Sensor (900 MHz), includes mounting brackets BWA-BK-009 and BWA-BK-010
DX80N9Q45VTP	Wireless Q45VTP Vibration and Temperature Node with 1-wire Serial Interface (900 MHz)
QM30VT1	Vibration and Temperature Sensor (1-wire Serial Interface, 2.09 m length) for use with Q45VTP Node

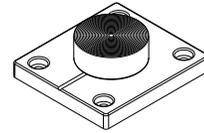
Mounting Brackets

The following mounting options are for use with the **Q45VA All-in-One Vibration and Temperature Sensor Node**. These brackets can be purchased separately or are included in the **Q45VA-BK All-in-One Vibration and Temperature Sensor Kit**. In all mounting options, ensure there is no sensor movement as this could lead to inaccurate information or changes to the time-trended data. Please visit www.bannerengineering.com/starterkitsupport and watch the **Q45VA Mounting Tutorial** video for more instructions for mounting these devices.

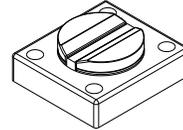
Mounting options for the Q45VA All-in-One Vibration and Temperature Sensor

BWA-Q45VA-FESS

- Mounts the device to a surface using two-part epoxy
- Alignment mark indicates the front of the device
- Includes a base plate, two screw retainers, four mounting screws, a set screw, and a mounting disc
- 44.5 mm × 49.5 mm
- **For installation instructions, see Q45VA Bracket Assembly Quick Start Guide (p/n 208986)**

**BWA-Q45VA-CMSS**

- Includes a magnetic mounting bracket and four mounting screws
- 44.5 mm × 49.5 mm
- SmCo magnet with a 40 lb pull strength
- For use on flat or curved surfaces

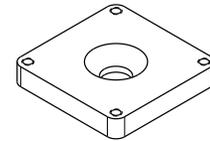


The following mounting options are for use with the **QM30VT1 1-Wire Serial Sensor**. This is a sensor that is tethered to the Q45VTP transmitter by an M12 quick disconnect cable. These brackets are listed from least effective to most effective. In all mounting options, ensure there is no sensor movement as this could lead to inaccurate information or changes to the time-trended data.

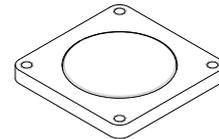
Mounting options for the QM30VT1 1-Wire Serial Sensor

BWA-QM30-FTAL

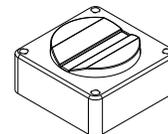
- Use when measuring high-frequency vibrations or when mounting the sensor to curved surfaces
- Includes aluminum bracket, four mounting screws, one 1/4-28 × 1/2 screw mount, and one piece of 3M™ thermally conductive adhesive transfer tape
- 30 mm × 30 mm
- **Refer to the Bracket Assembly Quick Start Guide for installation instructions (p/n 213323)**

**BWA-QM30-FMSS**

- Includes magnetic mounting bracket and four mounting screws (two sets of mounting screws for both the aluminum and stainless steel models)
- 30 mm × 30 mm
- **Refer to the Bracket Assembly Quick Start Guide for installation instructions (p/n 213323)**

**BWA-QM30-CMAL**

- Magnet mount for curved surfaces
- 30 mm × 30 mm, 14.4 mm thick
- Includes four M2.5 × 16 mm socket head cap screws
- **Refer to the Bracket Assembly Quick Start Guide for installation instructions (p/n 213323)**



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Chapter 2 Quick Start Guide

Set Up the SmartSolutions™ Starter Kit

The starter kit set-up process is specially designed to allow a user to push data to the cloud software with visual tools of the data and default alarms in less than an hour.

Go to www.bannerengineering.com/starterkitsupport to view the three tutorial videos describing the configuration process. The following steps are described in more detail in the [SmartSolutions™ Starter Kit Setup Guide](#) (p/n 218675).

1. Unbox the kit and apply power to all devices.
2. Bind the Wireless Q45 Vibration and Temperature Sensor Node(s) to the DXM Controller.
Up to 10 Wireless Sensor Nodes can be bound to a DXM with the baselining capability available for each Vibration Node added to the system.
3. Perform a site survey with the DXM and Node near their respective locations within your application to ensure sufficient wireless communication.
4. Using a web browser, navigate to the Banner Cellular Data Plans portal to create an account and activate the cellular device within the DXM Controller.
5. Using a web browser, navigate to the Banner Cloud Data Services (BannerCDS) platform to create an account and add the gateway to the software. After a push from the gateway (DXM) is detected by the system, the default dashboards and alarms automatically generate for each wireless Node bound to the DXM Controller.

For more information about the features and capabilities of Banner's Cloud Data Services, please consult the [Banner Cloud Data Services Instruction Manual](#) (p/n 178337) at www.bannerengineering.com. You may also contact an engineer from the website or by calling 555-555-555.

Installing the Vibration Sensor

Mount and install the vibration sensors appropriately on a motor to get the most accurate readings. Sensors can be mounted using magnetic brackets, thermal transfer dual-sided tape, standard brackets epoxied directly to the motor, or standard brackets bolted directly to the motor.

The vibration sensors have an x-axis and z-axis indication on the face of the sensor. Direct the z-axis in a plane through the sensor and the x-axis horizontally. For the SmartSolutions™ Starter Kits, there are two types of Vibration Nodes that can be used with the system: Q45VA Sensor Nodes and the Q45VTP Node with a QM30VT Sensor.

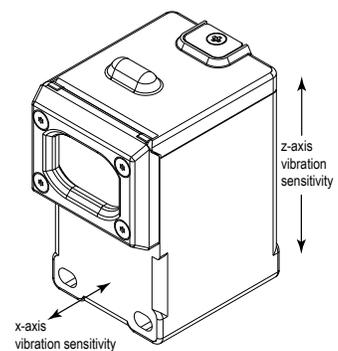
For help installing the **Q45VA Sensor Node**, please view the Q45VA Mounting Tutorial video at the [SmartSolution™ Starter Kit Setup and Installation](#) landing page on www.bannerengineering.com.

The **Q45VA Vibration Sensor Nodes** have an x- and z-axis indication on the face of the sensor.

- Install the x-axis in line with the shaft of the motor or axially.
- Install the z-axis to go into or through the motor or radial.

For the best results, install the sensor as close to the motor bearing as possible. If this is not possible, install the sensor on a surface that is in rigid connection with vibration characteristics of the motor. Using a cover shroud or other flexible mounting location may result in reduced accuracy or reduced ability to detect certain vibration characteristics.

The Q45VA body can be affixed to the motor using Loctite 330 and 7387 Activator or similar two-part epoxy. For information about optional brackets, see .



Install the **Q45VTP Node** and **QM30VT Sensor** so that the x-axis line is aligned with the rotating shaft of the motor, or axially and the z-axis is directed through the motor. If sensor is placed vertically on an asset for easy installation, the axis orientations can be reversed so that the x-axis goes through the motor and the z-axis is aligned with the rotating shaft. Install the sensor as close to the bearing of the motor as possible. Using a cover shroud or location far from the bearing may result in reduced accuracy or a reduced ability to detect certain vibration characteristics.



Calculating a Vibration Baseline with Banner CDS

Banner Engineering designed a machine learning algorithm into Banner Cloud Data Services that automatically generates baselines and standard deviations as alarm thresholds by recognizing when a motor is running and collecting data.

Vibration Severity Per ISO 10816-1

Machine		Class I	Class II	Class III	Class IV	
Vibration Velocity Vrms	in/s	Small Machines	Medium Machines	Large Rigid Foundation	Large Soft Foundation	
	mm/s					
	0.01	0.28				
	0.02	0.45				
	0.03	0.71		good		
	0.04	1.12				
	0.07	1.80				
	0.11	2.80		satisfactory		
	0.18	4.50				
	0.28	7.10		unsatisfactory		
	0.44	11.2				
	0.70	18.0				
	1.10	28.0		unacceptable		
1.77	45.9					

Shaft Speed Less than 2,000 RPM			Shaft Speed Greater than 2,000 RPM		
Mounting	Drive	Class	Mounting	Drive	Class
Rigid	Rigid	I	Rigid	Rigid	II
	Flex	II		Flex	III
Flexible	Rigid	II	Flexible	Rigid	III
	Flex	III		Flex	IV

The Sensor Nodes take a data sample every five minutes and Banner CDS uses the raw data to detect whether an asset is running, creates a baseline of the four vibration characteristics [RMS Velocity (10-1000 Hz) and RMS High Frequency Acceleration (1000-4000 Hz) on z- and x-axis], and generates warning and alarm thresholds for those characteristics.

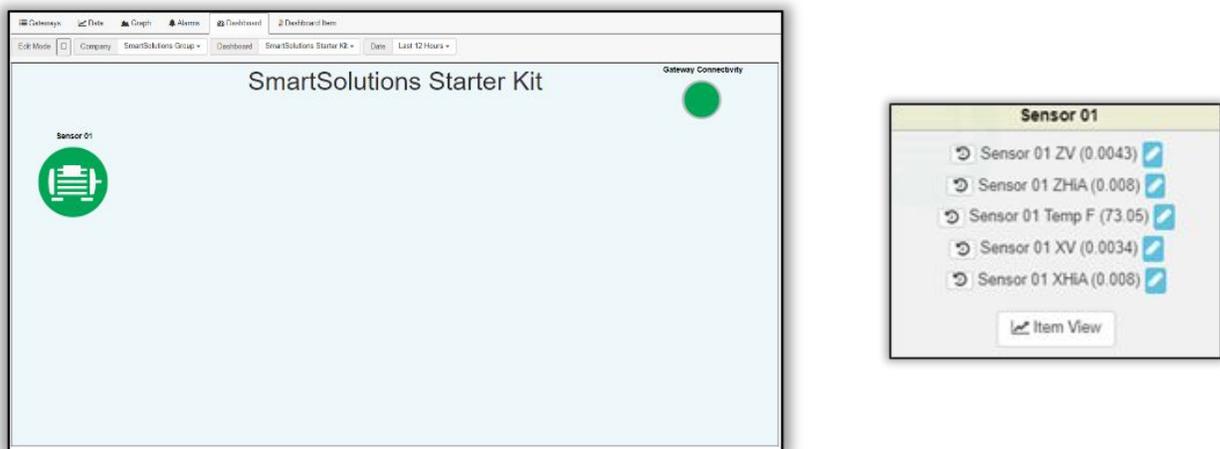
Only data from an operational asset is used to create the baselines or thresholds and only that data is used to trigger warnings or alarms. Data from assets that are not operational appear on the graphs but are not used in the analysis.

RMS Velocity identifies motor imbalance, misalignment, looseness, and other low-frequency machine issues. **RMS high-frequency acceleration** is used to indicate early bearing wear issues.

Default Dashboard Icon and Alarms

A SmartSolutions™ Starter Kit will detect a wireless Vibration Node after it has been bound to the DXM and a data push from the DXM is received by BannerCDS. A dashboard icon representing the vibration sensor is automatically created along with default alarms.

Click on the sensor icon and a small window appears that indicates the associated default alarms for the velocity and high acceleration measurements of both the z-axis and x-axis. A default alarm for the temperature in Fahrenheit is also indicated. These default alarm thresholds can be edited at any time to meet the needs of your application.



Edit an Alarm

Follow these steps to edit an alarm threshold.



1. Go to the **Alarms** screen.
2. Click on the  (Edit) button next to the alarm you'd like to edit.

The **Edit Alarm** pop-up window shows the parameters that can be modified.

- To edit the alarm thresholds, use the drop-down list to change the comparison operator (**Operation**) as needed.
- Enter your limit for velocity measurement (in/sec) or acceleration measurement (G) into the **Critical Value** field (red). If desired, enter a **Warning Value** limit (yellow).
- Entering a **Duration** (in minutes) provides an entry field for the time that the argument specified in the **Operation** must be true before the alarm will trigger.

It is important to understand that the DXM in a SmartSolutions™ Starter Kit pushes to the cloud once every ten minutes. Therefore, your duration alarms must be no less than twenty minutes because the system will need to compare the status of two data points to calculate the duration of alarm state. For example, using the argument shown in the above image:

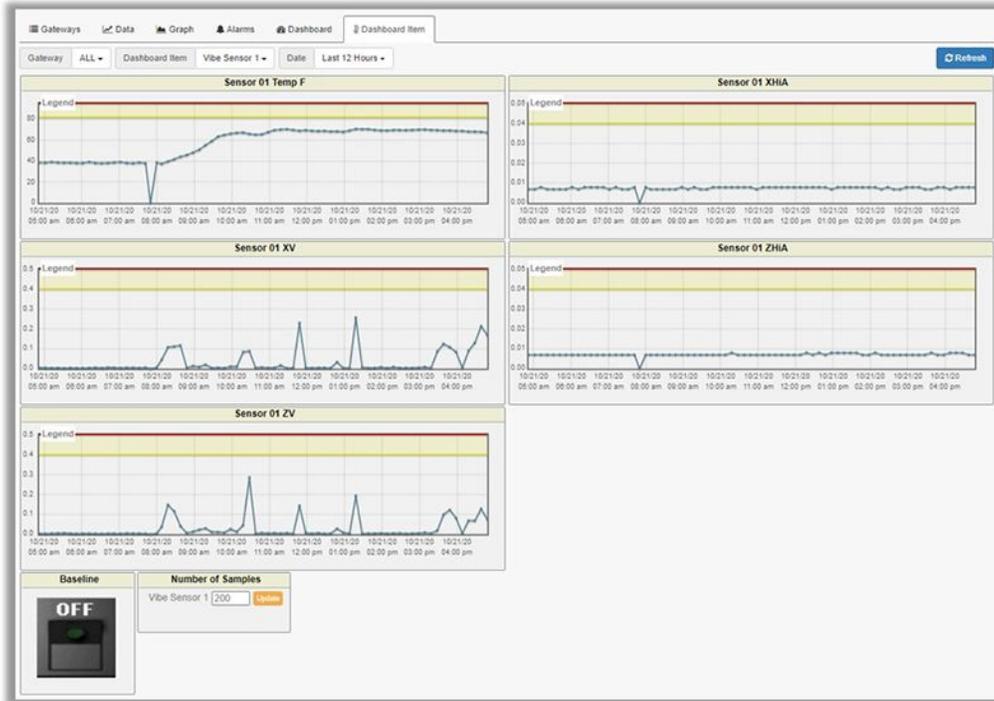
- If the measured value is greater than 0.4 in/sec for 20 minutes, then trigger the Warning alarm.
 - Similarly, if the measured value is greater than 0.5 in/sec for 20 minutes, then trigger the Critical alarm.
 - Deselecting **Duration** causes the alarms to trigger immediately after a push from the DXM indicates an alarm state.
- Select **Manual Clear** to require that a user logs into the BannerCDS system and clicks the **Clear** button on the **Alarms** screen to acknowledge the alarm.
The alarm returns to normal (Clear) state. Deselect **Manual Clear** to allow the alarm to return to normal (Clear) state without action from the user.
 - Use the **Email** drop-down list to select to be notified of alarms on **All State Changes** or **On Escalation**. By default, there are no email or notifications associated with the alarms.
 - **All State Changes**—Notifications will be sent for any state change of alarm, including return to normal (Clear) state changes.
 - **On Escalation**—Notifications will be sent for any state change of alarm except for return to normal (Clear) state changes.

After selecting the type of notification, an entry field for an email or email-to-text contact appears.

- Enter the email contact of the individual responsible for addressing the alarms for this system. To send a text message, use the following **email-to-text** formats to receive SMS alerts.
 - AT&T--[insert 10-digit number]@txt.att.net
 - Verizon--[insert 10-digit number]@vtext.com
 - T-Mobile--[insert 10-digit number]@tmomail.net
 - Sprint--[insert 10-digit number]@messaging.sprintpcs.com
 - Bell Canada--[insert 10-digit number]@txt.bellmobility.ca
 - Telus--[insert 10-digit number]@msg.telus.com
- To add additional recipients to the same alert, click the **+** button and populate the entry fields with more contacts.
- Click **Save** to store all changes.
A successful save is indicated or a prompt to correct errors appears.

Vibration Baseline Details

To view more detail about the data signals measured by the vibration sensor and to access the baseline feature, click on the **Item View** button within the window that appears after clicking on the node icon from the dashboard.



You may also select the **Dashboard Item** tab to view the same information. The **Dashboard Item** screen shows a graph for all signals from the selected Node over the selected time period.

When a vibration sensor is initially bound to the DXM, the baseline algorithm automatically begins its process for each Node immediately after Banner CDS recognizes the Node and receives data from the DXM. The **Baseline** toggle icon is on when the baseline is calculating and off after the baseline has been calculated.

Any changes made to the default alarms while the baseline process is running are overwritten by the values calculated by the algorithm after it completes.

To cancel a baseline calculation in process, click the baseline toggle icon OFF. To start a new baseline process, click the baseline toggle icon ON. If a process is cancelled, the system reverts to the previous baseline or default parameters.

Number of Baseline Samples

By default, each Vibration Sensor Node is set to record 150 samples of an asset in operational mode. An asset is determined to be operational when the measurement exceeds the minimum threshold.

The minimum thresholds are shown for each data signal on the **Data** screen and can be edited by clicking **Update Register**.

The time for calculating the baseline depends on the number of operational samples recorded for your needs and the frequency at which the asset is determined as operational (150 operational samples × 10-minute push rate = 1500 minutes = 25 hours for a continuously operational asset). The time for the baseline calculation increases as the operational frequency of the asset decreases.

To adjust the number of samples for each Vibration Node using the **Data** screen:

1. Locate the **Number of Baseline Samples** register for the specific Node that you want to modify.
2. Click the **Update** icon next to that register.
3. Enter the desired number of samples for that Node.
4. Click **Save**.

To adjust the number of samples for each Vibration Node, using the **Dashboard Item** screen:

1. Go to the **Dashboard Item** screen.
2. Select the desired Node from the **Dashboard Item** drop-down list.

3. Enter the new number of samples into the text field of the **Number of Samples** widget near the bottom of the screen.
4. Click **Update**.

Baseline Data

To view the baseline data, go to the **Dashboard Item** screen. This screen displays a graph for all signals from the selected Node over the selected time period.

The vibration signal data is represented on these graphs along with the **Warning Threshold** band (yellow) and the **Critical Limit** (red).

Another, more detailed, location for viewing the baseline data is on the **Data** screen. Here you will find the list of the parameters identified during the baseline calculation for each Node. The baselines (blue), warnings (yellow), and critical limits (red) are marked.

<input type="checkbox"/>	Number of Baseline Samples	100
<input type="checkbox"/>	Sensor 01 Baselining	0
<input type="checkbox"/>	Sensor 01 ZX Exclude	0.05
<input type="checkbox"/>	Sensor 01 ZHIA Exclude	0.02
<input type="checkbox"/>	Sensor 01 XV Exclude	0.05
<input type="checkbox"/>	Sensor 01 XHIA Exclude	0.02
<input type="checkbox"/>	Sensor 01 ZX Baseline	0.0648
<input type="checkbox"/>	Sensor 01 ZHIA Baseline	0.0085
<input type="checkbox"/>	Sensor 01 XV Baseline	0.0836
<input type="checkbox"/>	Sensor 01 XHIA Baseline	0.0087
<input type="checkbox"/>	Sensor 01 ZX Warning	0.07
<input type="checkbox"/>	Sensor 01 ZHIA Warning	0.0132
<input type="checkbox"/>	Sensor 01 XV Warning	0.0858
<input type="checkbox"/>	Sensor 01 XHIA Warning	0.0142
<input type="checkbox"/>	Sensor 01 ZX Error	0.0726
<input type="checkbox"/>	Sensor 01 ZHIA Error	0.0155
<input type="checkbox"/>	Sensor 01 XV Error	0.0869
<input type="checkbox"/>	Sensor 01 XHIA Error	0.017

See also ["Default Dashboard Icon and Alarms"](#) on page 8.

