

## Background and Value

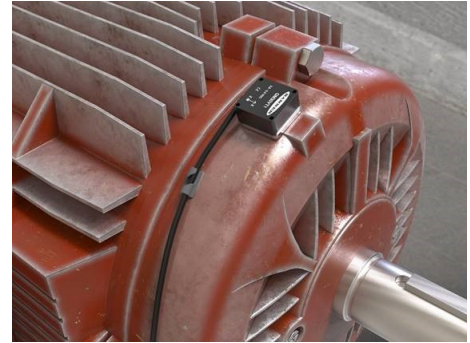
Industrial facilities have hundreds of critical rotating assets such as motors, pumps, gearboxes, and compressors. Unexpected failures result in costly down-time.

An equipment health monitoring (EHM) preventative maintenance solution uses machine learning to identify when assets exceed pre-defined parameters, resulting in:

- **Increased Uptime**—Eliminate unplanned shutdowns by continuously monitoring up to 40 assets with a single system
- **Reduced Maintenance Cost**—Repair prior to failure or extensive collateral damage
- **Effective Maintenance/Parts Scheduling**—Plan for labor and spare parts
- **Ease of Use**—Reduce installation costs and eliminate complexity of traditional data analysis
- **Improved Asset Selection**—Use data to analyze root cause and reliability
- **IIOT**—Review real-time alerts for better decision-making and remote asset management

### Vibe-IQ By Banner Engineering Corp:

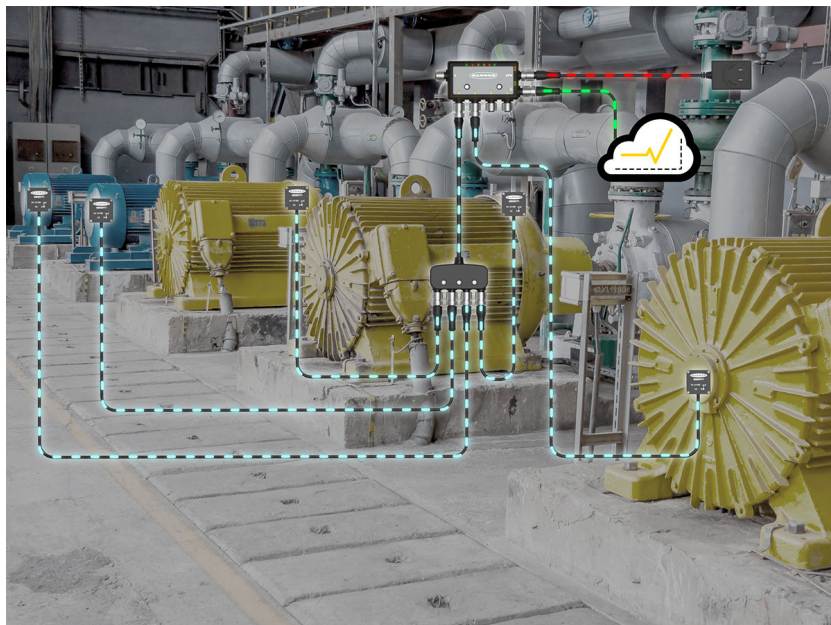
- Monitors each motor using a machine learning algorithm to baseline values and set control limits for alerts with limited end-user interaction
- Continually monitors RMS Velocity (10-1000Hz), RMS high frequency Acceleration (1000-4000Hz), and temperature on rotating equipment using Banner's Wireless vibration/temperature sensor
- Determines if motors are running or not and only uses the running data for baselining and alerting
- Collects data for trending and analysis; script defines acute verses chronic issues
- Sends data and alerts to the host control or to the cloud for IIoT connectivity



**VIBE-IQ™**

This Banner solution monitors vibration levels on rotating assets that are the result of:

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



## Application Features and Benefits

<b>CONTINUOUS VIBRATION MONITORING</b>	Monitor vibration data on up to <b>40 assets</b> sensing X and Z axis RMS Velocity and high frequency RMS Acceleration. RMS Velocity is indicative of general rotating machine health (unbalance, misalignment, looseness) and high frequency RMS Acceleration is indicative of early bearing wear.
<b>SELF-LEARNING BASELINE &amp; THRESHOLDS</b>	Prevent users from having to generate baselines or alarms by using machine learning algorithms to create an initial baseline reading and warning/alarm thresholds for each motor individually.
<b>ACUTE &amp; CHRONIC ALARMS</b>	Alarms and Warnings are generated for both acute and chronic conditions for each motor. Acute thresholds indicate a short-term condition such as a motor jam or stall which cross the threshold rapidly. Chronic thresholds use a multi-hour moving average of the vibration signals to indicate a long-term condition such as a wearing/failing bearing or motor.
<b>TEMPERATURE ALARMS</b>	Each vibration sensor will also monitor the temperature and send an alarm when the threshold is exceeded.
<b>ADVANCED DATA</b>	Additional advanced diagnostic data available such as Spectral Band Velocity data, Peak Velocity, Kurtosis, Crest factor, Peak Acceleration, etc.
<b>EMAIL ALERTS</b>	Generate email alerts based on individual warnings and/or alarms.
<b>CLOUD MONITORING</b>	Push data to a Cloud Webserver or PLC via LAN for remote viewing, alerting, logging.

## Solution Components

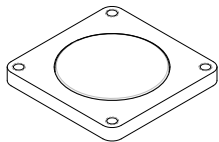
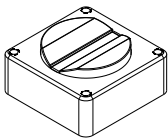
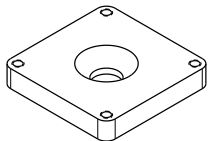
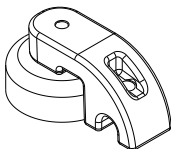
Model	Description
<b>QM30VT2</b>	Banner Vibration and Temperature Sensor with RS-485 communication
<b>DXMR90</b>	Industrial controller with four Modbus ports

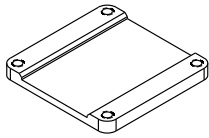
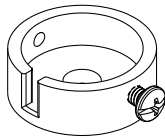
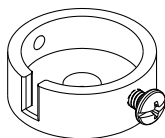
This guide demonstrates how to install the sensors, connect them to your controller, and load a preconfigured XML file and script for up to 40 vibration sensors. The XML file only requires some minor modifications to be customized for any site.

## Mounting Options

The following mounting options are listed from least effective to most effective. In all mounting options, ensure there is no sensor movement because this results in inaccurate information or changes to the time-trended data.

Follow Banner's [Vibration Monitoring Sensor Installation Guide](#) (p/n b\_4471486) for proper sensor installation help.

Model	Bracket	Application Description
<b>BWA-BK-013</b> Flat magnet sensor bracket		Highly flexible and re-usable, flat magnetic mount for larger diameter surfaces or flat surfaces.
<b>BWA-BK-019</b> Curved surface magnet bracket		Curved surface magnet mounts are best suited to smaller curved surfaces. Ensure you have positioned the sensor in the correct direction for the strongest mount. Offers flexibility for future sensor placement.
<b>BWA-BK-022</b> Center mounting bracket –M4 x 0.7 screw mount (ships with sensor)		Flat bracket permanently epoxied to the motor and the sensor is screwed to the bracket (very effective) or the flat bracket is screwed to the motor and sensor (most effective). Ensures the best sensor accuracy and frequency response. Recommend epoxy designed for accelerometer mounting: Loctite Depend 330 and 7388 activator
<b>BWA-BK-027</b>		Cable management bracket

Model	Bracket	Application Description
BWA-BK-029		Notched aluminum bracket for curved surfaces permanently epoxied to motor and sensor screwed to bracket.
BWA-BK-QM-001		Flat surface rapid release stainless steel bracket; circular with a center screw for mounting the bracket to the motor and a side set-screw for quick release mounting of the sensor to the bracket.
BWA-BK-QM-002		Flat surface rapid release aluminum bracket; circular with a center screw for mounting the bracket to the motor and a side set-screw for quick release mounting of the sensor to the bracket.

## Configuration Instructions

Follow these basic steps to configure your system.

1. Load the configuration files (see [Load the Configuration Files](#) on page 3).
2. Set the sensor's slave ID (see [Set the Sensor Slave ID](#) on page 4).
3. Install the vibration sensor (see [Install the Vibration Sensor](#) on page 4).
4. Customize the XML file (see [Customize the XML File](#) on page 5). This is an optional step that depends upon your specific network requirements.
5. Set up the Ethernet connection (see [Set Up the Ethernet Connection](#) on page 6).  
Verify that your Cloud Push Interval has been set to **None**.
6. Turn on the sensors in the local registers (see [Turn on Sensors in Local Registers](#) on page 7).
7. Save and upload the configuration file (see [Save and Upload the Configuration File](#) on page 7).
8. Configure the BannerCDS account (see [Push Information to BannerCDS](#) on page 8).

## Load the Configuration Files

To customize the system to an actual application, make some basic modification to the template files. There are two files uploaded to the DXM:

- The XML file sets the DXM's initial configuration
- The ScriptBasic file reads vibration data, performs the machine learning, sets the thresholds for warnings and alarms, and organizes the information in logical and easy to find registers in the DXM

To upload and modify these files, use Banner's DXM Configuration Software (version 4 or newer) and the Vibration Monitoring files available via in the links below.

1. Verify you have bound the radios, conducted a site survey, and set up the sensor IDs.
2. Install the sensors.  
The sensors automatically begin baselining after they are installed and connected to the DXM. Avoid unrelated vibrations from installation after you have uploaded the configuration file.
3. Download the pre-configured files from either the DXMR90 series page or QM30VT sensor series page on [www.bannerengineering.com](http://www.bannerengineering.com).
4. Extract the ZIP files into a folder on your computer. Note the location where the files were saved.
5. Connect the DXM, via the USB cable supplied with the DXM or ethernet cable, to a computer containing the DXM Configuration Software or download the software and install it on a computer.
6. Launch the software and select the correct DXM model.
7. On the DXM Configuration Software: Go to **File > Open** and select R90 VIBE-IQ XML file.
8. Connect the software to the DXM.
  - a) Go to **Device > Connection Settings**.
  - b) Select **TCP/IP**.
  - c) Enter the correct IP address of the DXM.
  - d) Click **Connect**.
9. Go to the **Settings > Scripting** screen and click **Upload file**. Select the DXMR90 VIBE-IQ script file (.sb).

- Go to **File > Save** to save the XML file. Save the XML file any time the XML has been changed. The DXM Configuration Software DOES NOT autosave.

## Set the Sensor Slave ID

Before configuring the sensors, each sensor must have a Modbus slave ID assigned to it. Sensor Modbus slave IDs must be between 1 and 40.

Each sensor slave ID corresponds to individual sensor numbers in the DXM registers. Sensor IDs don't have to be assigned in order but Banner recommends assigning your sensors in reverse order, starting with the last sensor in your system.

To assign sensor IDs through the DXM Configuration Software, follow these steps.

- Apply power to the DXMR90 Controller and connect it to your Ethernet network.
- Connect your QM30VT2 sensor to port 1 of the DXMR90 Controller.
- On your computer, launch the DXM Configuration Software and select the DXMR90x from the model drop-down list.
- Scan your network for DXMs and identify your DXMR90's IP address. Click **Connect**.

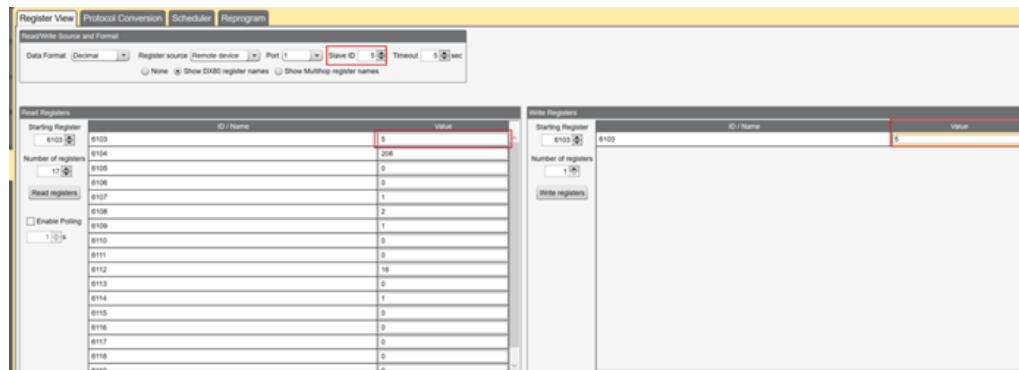
If you are installing a factory preset DXMR90, the DXM should have a fixed IP address of 192.168.0.1. You may need to directly connect your computer to the DXMR90 to configure DHCP before continuing.

- After connecting to the DXMR90, go to the **Tools > Register View** screen.
- In the **Read/Write Source and Format** section, select the following:

- Register Source: Remote Device**
- Port: 1** (or the port your sensor is connected to)
- Slave ID: 1**

Slave ID 1 is the factory default ID for the QM30VT2. If your sensor has already been re-addressed in the past, please enter the new address under Slave ID. If you don't know the Slave ID and can't find it under 1, use the Sensor configuration software directly with the sensor.

Figure 1. Set the sensor Slave ID



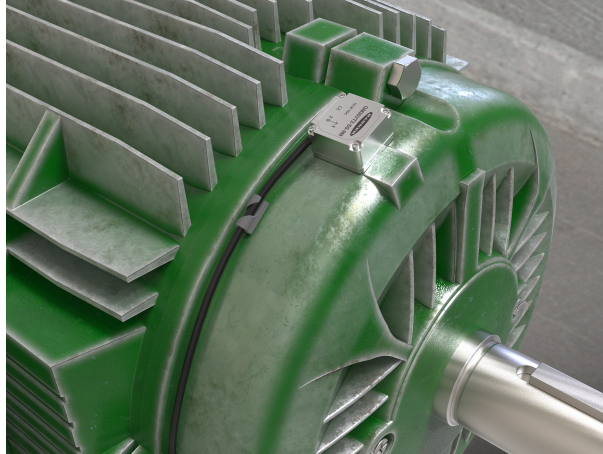
- Use the **Read Registers** section to read Register 6103 of the sensor. Register 6103 should contain a 1 by default.
- Use the **Write Registers** section to change the Sensor ID. Banner recommends you start with the last sensor in your system and work your way back to 1.

To assign the sensor's slave ID using the Sensor Configuration Software: Use the Sensor Configuration Software and the **BWA-UCT-900** cable accessory to connect the VT2 sensor to the computer. Follow the instructions in the [Sensor Configuration Software Instruction Manual](#) to assign the Sensor Modbus ID to a value between 1 through 40.

## Install the Vibration Sensor

Correctly mounting the vibration sensor on a motor is important to collect the most accurate readings. There are some considerations when it comes to installing the sensor.

Figure 2. Install the vibration sensor



1. Align the vibration sensor's x- and z-axes.

The vibration sensors have an x- and z-axis indication on the face of the sensor. The z-axis goes in a plane through the sensor while the x-axis goes horizontally. The sensor can be installed flat or vertically.

- Flat installation—Align the x-axis in line with the motor shaft or axially and the z-axis is going into/through the motor.
- Vertical installation—Align the z-axis so it is parallel with the motor shaft and x-axis is orthogonally vertical to the shaft.

2. 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 ability to detect certain vibration characteristics.

The mounting type can affect the results of the sensor.

Directly screwing or epoxying a bracket to a motor provides a permanent installation of the bracket to which the sensor can be attached. This more rigid mounting solution ensures some of the best sensor accuracy and frequency response, but is not flexible for future adjustments.

Magnets are slightly less effective but provide more flexibility for future adjustments and faster installation. Magnet mounts are susceptible to accidental rotation or change in the sensor location if an outside force bumps or moves the sensor. This can lead to a change in the sensor information that differs from the time-trended data from the previous location.

## Customize the XML File

This is an optional configuration step.

1. Within the configuration software, go to the **Local Registers > Local Registers in Use** screen.
2. Rename the registers for the monitored asset.
  - a) On the **Local Registers > Local Registers in Use** screen, go to the **Edit Register** section near the bottom of the screen.
  - b) In the **Name** field, enter the register name of your monitored asset.
  - c) Because there are five registers per monitored asset, copy and paste names for efficiency. (N1 = Sensor ID 11, N2 = Sensor ID 12, ... N40 = Sensor ID 50).



- To display the motor vibration data, warnings, and alarms on the Banner CDS website, change the **Cloud settings** to **Read** for each monitored asset's information (velocity, acceleration, alert mask, etc.) that you would like to appear on the website.

The screenshot shows the Banner CDS web interface. The top section is titled 'Local Registers In Use' and contains a table with columns: ID, Register Name, Register Group, Units, Signed, Constant or Timer, Cloud Settings, LCD Permissions, Protocol Conversion, Log Files, Read Rules, Write Rules, Threshold Rules, and Copy R. The table lists 9 registers, including N1\_Motor\_ZV, N1\_Motor\_ZHA, N1\_Motor\_XV, N1\_Motor\_XHA, N1\_Motor\_TempF, N2\_Motor\_ZV, N2\_Motor\_ZHA, N2\_Motor\_XV, and N2\_Motor\_XHA. Below the table is the 'Edit Register' section, which is currently set to 'Modify Multiple Registers'. It shows a 'Selected Register' of 'N1\_Motor\_ZV'. The 'Value Options' section shows 'Value type' as 'None', 'Scaling' as 'Divide', 'Scale value' as '10000', and 'Scale offset' as '0.0000'. The 'Storage / Connectivity' section shows 'LCD permissions' as 'None', 'SD card logging' as 'None', 'Cloud settings' as 'Read', and 'Protocol conversion' as 'None'. Red boxes highlight the 'N1\_Motor\_ZV' register name and the 'Cloud settings' dropdown menu.

- The most common registers to be sent to the cloud already have their cloud permissions set. To send additional registers or reduce the number of registers being sent if you are using less than 40 sensors, change the cloud permissions.
  - On the **Modify Multiple Registers** screen, select **Set** in the drop-down list next to **Cloud settings**.
  - In the **Cloud settings** drop-down, select **Read** or **None** to turn the register off.
  - Set the **Starting Register** and the **Ending Register** for the group of registers that need to be changed.
  - Click **Modify Registers** to complete the modification.

Standard register cloud permissions are shown in the Local Registers table at the end of this document.

## Set Up the Ethernet Connection

The DXMR90 is designed to push data to a webserver and/or send emails via an Ethernet push. Follow these steps to set up the Ethernet connection to the cloud services.

- On the **Local Registers in Use** screen, set the **Value Type** of register 844 to **Constant** and a value of 1 to enable the data push.
- If the DXM will text, email, or push to the cloud webserver, set up the push interface.
  - Go to the **Settings > Cloud Services** screen.
  - From the **Network Interface** drop-down list, select **Ethernet**.
- Set the **Cloud Push Interval** to **None**.

The script associated with this file defines the five-minute push interval internally so that it occurs immediately after the sample of the sensors. If you define the **Cloud Push Interval** here as well, you will be pushing too much information to your account.

Figure 3. Mail Server Settings and Email Recipients screen

**Mail Server Settings**

SMTP server:

SMTP server port:

☒ No encryption  
☐ Situational encryption

☒ Enable SMTP authentication

User name:

Password:

**E-mail Recipients**

Recipient	Address
E-mail Recipient 1	<input type="text" value="person1@gmail.com"/>
E-mail Recipient 2	<input type="text" value="person2@gmail.com"/>
E-mail Recipient 3	<input type="text"/>
E-mail Recipient 4	<input type="text"/>
E-mail Recipient 5	<input type="text"/>
E-mail Recipient 6	<input type="text"/>
E-mail Recipient 7	<input type="text"/>
E-mail Recipient 8	<input type="text"/>
E-mail Recipient 9	<input type="text"/>
E-mail Recipient 10	<input type="text"/>

**SMS Recipients**

Name	Number	Message
Person1	<input type="text" value="2125555555"/>	<input type="text" value="Vibration Alert"/>
Person2	<input type="text" value="2125551234"/>	<input type="text" value="Vibration Alert"/>
SMS Recipient 3	<input type="text"/>	<input type="text"/>
SMS Recipient 4	<input type="text"/>	<input type="text"/>

## Turn on Sensors in Local Registers

To turn on the sensors, set the NodeSelect registers (7881–7920) to the DXMR90 Port Number of the sensor. By default, only Sensor 1 (ID 1) is set to a 1 to avoid long timeouts of other systems not on the system. Setting the register back to 0 tells the system the sensor is OFF and data won't be collected.

For example, if you have five sensors connected to port 1 of the DXMR90 and five sensors connected to port 2 of the DXMR90, set registers 7881–7885 to 1 and registers 7886–7890 to 2. Set all other registers to 0 to indicate those sensors are not used in the system.

These registers also indicate to the Vibe-IQ application which sensors should be pushed to the BannerCDS cloud. The application uses group pushing to optimize bandwidth and avoid pushing blank registers for unused sensors in the system. Because of register constraints, sensors 31–35 and 36–40 are grouped together. If you have 36 sensors, you will push registers for all 40. The Banner CDS application automatically hides empty registers. The registers can be written to from a PLC.

Repeat these steps any time a sensor is added or removed from the system.

1. After the DXM reboot, wait one to two minutes.
2. From the DXM Configuration Software: Go to the **Tools > Register View** screen.
3. In the **Write Registers** section, set the starting register to a value between 7881 and 7920 to turn on the sensors used in the system. Set the **Number of Registers** to 40 to see them all at once.
4. Enter a 0 to turn a sensor off and enter the DXMR90 port number of the sensor (1, 2, 3, or 4) to turn it on.
5. Click **Write registers** to write your changes to the DXM.

## Save and Upload the Configuration File

After making any changes to the configuration, you must save the configuration files to your computer, then upload it to the device.

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 4. Status indicator bar

Connected 192.168.0.1	VibelQ_DXR90_V2.xml	Application Status	
Connected 192.168.0.1	VibelQ_DXR90_V2.xml	Application Status	
Not Connected	VibelQ_DXR90_V2.xml	Application Status	

- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the cable and reconnect the DXM to the software.
  - If the Application Status indicator is green, the file upload is complete.
  - If the Application Status indicator is gray and the green status bar is in motion, the file transfer is in progress.
- After the file transfer is complete, the device reboots and begins running the new configuration.

## Push Information to BannerCDS

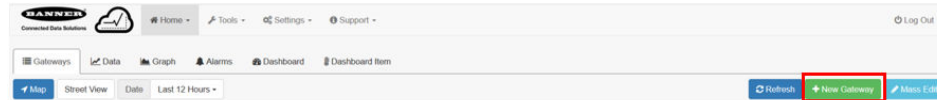
The DXM Wireless Controller can connect to the Web via Ethernet or an internal cell module. The controller pushes data from the DXM to be stored and displayed on a website.

The Banner website for storing and monitoring the system's data is <https://bannercds.com>. The Banner Cloud Data Services website automatically generates dashboard icons and graphs for the application that is populated onto the Dashboard. Email alerts can be configured using the Alarms screen.

### Create a New Gateway

After you log into the Banner Cloud Data Services website, the **Gateway** screen displays. Follow these steps to create a new monitoring site.

1. Click on **+New Gateway**.  
Create a new Gateway/site for each device that will be sending data to the web server.



A **Create New Gateway** prompt appears.

2. Verify **Traditional** is selected for the **Configuration**.
3. Enter a site name.
4. Click **Create**.  
The Gateway/Site appears in the listing of devices on the Gateways screen.
5. Click **Edit Gateway** (pencil icon) next to your Gateway/Site name.  
The Gateway detail window appears.
6. Copy the **Site ID** number located at the top of this window.  
The Site ID number created by the web server is a required parameter in the configuration of the DXM. The Site ID is the address the webserver uses to store the data pushed from the DXM.
7. Click **Save**.

### Configure the DXM to Push Information to the Cloud



**Important:** Do not adjust the Cloud Push Interval. The push frequency is controlled by the script. Adjusting the cloud push interval through this configuration may result in excessive amounts of data being pushed to Banner CDS.

1. Within the DXM Configuration Software, go to the **Settings > Cloud Services** screen.
2. Set the **Server name/IP** to push.bannercds.com.
3. In the **Web Server** section, keep the **Gateway ID is** drop-down selection as **GUID**.
4. Use the **File > Save** menu to save the XML file to your hard drive.
5. Send the updated XML to the DXM Controller using the **DXM > Send XML Configuration to DXM** menu.

### Upload the XML Configuration File to the Website

To upload an XML configuration file to the website, follow these instructions.

1. At the webserver, select the **Home** screen.

Options	CompanyName	Gateway	Last Push	Alarms
 2 updates pending	Technical Demo	VKIT	11/13/2019 04:24 pm	Connectivity Critical
	Demo Company	Vibration Monitoring Solutions	04/07/2020 03:25 pm	7 Register Alarms
	Sandbox	Vibration	04/07/2020 03:26 pm	Clear

2. On the row displaying your new site, click the **Edit Gateway** (pencil) icon.
3. Select **Update XML**.



- Click **Choose File** and select the file that was just updated to the DXM and click **Save**.

Figure 5. Example file selection screen that may not represent your specific kit

The screenshot shows a configuration window titled 'VKIT' with a unique ID '52df5c36-50f9-40a6-b67f-a6d43f294826'. It contains several input fields and buttons:
 

- Company:** A dropdown menu currently showing 'Technical Demo'.
- Gateway Name:** A text field containing 'VKIT'.
- Update XML:** A button labeled 'Choose File' next to the text 'No file chosen'.
- XML History:** A text field showing 'vibekitworkingcell.xml - 11/20/2019 11:34 am' with a 'Get' button.
- Script File:** A checkbox that is currently unchecked, with the text 'Disabled' and a 'Get' button.
- Authentication:** A checkbox that is currently unchecked.
- Bottom Bar:** Includes a red 'Delete Gateway' button, a 'Close' button, and a green 'Save' button.

After the XML file is loaded into the webserver, the webserver uses the register names and configurations defined in the configuration file.

- Click on the **Site Name** link to go to the configured registers to see the values uploaded by the DXM. The same XML configuration files is now loaded on both the DXM and the Website. After some time, the data should be seen on the website.

Completing these steps creates continuity between the site created on the website with the DXM used in the field. The DXM pushes data to the website, which can be viewed at any time.

Refer to the [Banner Cloud Data Services Instruction Manual](#) (p/n 178337) to review all the features available for monitoring, comparing data, and establishing warnings/alarms on the website.

## Additional Information

### Baselining a Motor

The script included with this guide uses the first 300 running data points (user adjustable by changing register 852) of a motor to generate a baseline and the statistics for determining warning and alarm threshold levels.

Create a new baseline when significant changes are made to the motor or vibration sensor, including performing heavy maintenance, moving the sensor, installing a new motor, etc. This ensures that the system is running as accurately as possible. Re-baselining a motor can be done from the DXM Configuration Software, from the Banner CDS website, or from a connected host system.

#### Baseline a Motor Using the DXM Configuration Software

- Go to the **Local Registers > Local Registers in Use** screen.
- Use the arrows to select **Registers**.  
The registers are labeled **NX\_Baseline** (where X is the sensor number you want to baseline).
- Select the appropriate register to reset and click **Enter**.
- Change the value to 1, then click **Enter** three times.  
The reset register value automatically returns to zero after the baseline is complete.

#### Baseline a Motor from the Banner CDS Website

- On the **Dashboard Items** screen, select the appropriate motor from the **Dashboard Item** drop-down list.
- Click the **Baseline** switch to on.  
The switch automatically turns off when the baseline is complete.
- Repeat steps 1 and 2 for each sensor that needs to be baselined.

#### Baseline a Motor from a Connected Host System

Example host systems may be a PLC or HMI.

Write a value of 1 to register 320 + X where X is the sensor number 1–40 (sensor ID 11-50) to be re-baselined.

### Sensor Connection Status

The system tracks the connection status of a sensor. If a sensor times out, the sensor is put into a “status error” state and is only checked once every four hours until after the system receives a good reading during one of the four-hour intervals.

A sensor may have a status error if the radio signal has diminished and needs to be corrected or if the radio's power source has failed (such as needing a new battery). After the issue has been corrected, send a 1 to the Sensor Discovery Local Register to force the system to check all sensors that are in the system. The system immediately checks all sensors without having to wait for the next four-hour interval. The registers for status and sensor discovery are:

- Sensor Connection Status—Local Registers 281 through 320

- Sensor Discovery—Local Register 832 (changes to 0 when complete, but can take 10 to 20 seconds)

## Viewing Run Flags

The vibration monitoring solution also tracks when a motor is running. This feature can use additional action rules to track on/off count or approximate motor run time. To view this information on the web, change the cloud reporting and permissions.

The following registers are used to show if a sample has determined that the motor was running or not.

- Motor Run Flag On/Off (0/1)—Local Registers 241 through 280

## Adjusting the Sample Rate

The DXMR90 is a wired solution that can support more rapid sampling rates than a wireless solution. The default sample rate for the R90 solution is 300 seconds (5 minutes). The sample rate is controlled by register 857. For the best performance:

- Do not set a sample rate for less than 5 seconds, no matter how few sensors are in your network.
- Set your sample rate for two seconds for each sensor in your system, up to 35 seconds or 15 sensors.
- For more than 15 sensors, use a 35 second minimum sample rate.

## Advanced Diagnostic Vibration Data

The MultiHop Vibration monitoring system includes access to additional advanced diagnostic data is available that is not available with the Performance radio system. The added characteristics are based in the two large frequency bands from 10 Hz to 1000 Hz and 1000 Hz to 4000 Hz and include Peak Acceleration (1000–4000 Hz), Peak Velocity Frequency Component(10–1000 Hz), RMS Low Frequency Acceleration(10–1000 Hz), Kurtosis (1000–4000 Hz) and Crest Factor (1000–4000 Hz).

There are five additional characteristics from each axis for a total of 10 total registers per sensor. This data is available in registers 6141–6540 as shown in [Local Registers](#) on page 12.

In addition to the additional large band registers above, the system may collect Spectral Band data: RMS Velocity, Peak Velocity, and Velocity Peak Frequency components from each of three bands that are generated from Speed Inputs. The three bands center around the 1x, 2x, and 3x-10x running speeds entered in Hz into the DXM Local Registers 6581–6620 (one register for each sensor). NOTE: Speed cannot be entered any faster than once per hour to these registers.

To view the Spectral Band data, enable register 858 (change the value from 0 to 1) then view floating-point registers 1001–2440 (36 registers per sensor). For more information, see [Local Registers](#) on page 12.

For more information about the Spectral Band information, refer to the VT2 Vibration Spectral Band Configuration technical note (p/n [b\\_4510565](#)).

## Adjusting Warning and Alarm Thresholds

These values are stored in non-volatile local registers so they remain through a power outage.

**Temperature**—The default temperature settings are 158 °F (70 °C) for warnings and 176 °F (80 °C) for alarms. Temperature thresholds may be changed from the DXM Configuration Software, from the Banner CDS website, or from a connected host system.

**Vibration**—After baselining is complete, warning and alarm thresholds are set for each vibration characteristic on each axis automatically. To view those values, check registers 5181–5660 (12 registers per sensor). To adjust those thresholds, use registers 7001–7320 (8 registers per sensor). Triggering a new baseline returns these user-defined registers to zero.

### Adjust the Thresholds Using the Configuration Software

1. Using the DXM Configuration Software, connect to the DXM Controller running the Vibration Application Guide.
2. Go to the **Tools > Register View** screen.
  - **Temperature**—The temperature warning and alarm thresholds are in registers 7681–7760 and are labeled **NX\_TempW** or **NX\_TempA**, where X is the sensor number 1–40 (sensor ID 11–50).
  - **Vibration**—The vibration warning and alarm thresholds are in registers 7001–7320 and are labeled **User\_NX\_XVel\_Warning** or **User\_NX\_XVel\_Alarm**, etc., where X is the sensor number 1–40 (sensor ID 11–50).
3. Use the right column and enter the starting register to change and the value to write to the register.
4. Click **Write Registers**.
5. Repeat steps 3 and 4 for any additional thresholds to change.
6. To modify up to 40 thresholds at a time, adjust the **Number of registers** underneath the starting register. Enter a value for each register and click **Write Registers** when you are finished.
7. To return to using an original baseline value for a particular sensor:
  - **Vibration**—Set the user-defined register (7001–7320) back to 0.

### Adjust the Threshold from the Banner CDS Website

1. On the **Dashboard Items** screen, select the appropriate motor from the **Dashboard Item** drop-down list.
2. Below the graphs, enter the values for the thresholds and click **Update**.  
The Banner CDS updates the system's settings the next time the Controller pushes to the cloud.
3. Repeat steps 1 and 2 for each sensor threshold.
4. For the vibration thresholds, set the threshold back to 0 to return to using the original baseline values for a particular sensor.

## Adjust the Thresholds from a Connected Host System

Example host systems may be a PLC or HMI.

- Write the appropriate value into the register where x is the sensor number 1–40 (sensor ID 11–50) .
  - Temperature**—Value in °F or °C to registers 7680 + x for the temperature warning or 7720 + x for the temperature alarm.
  - Vibration**—Write to the following registers.

Register	Description	Register	Description
$7000 + (x - 1) \times 8$	X-Axis Velocity Warning	$7004 + (x - 1) \times 8$	X-Axis Acceleration Warning
$7001 + (x - 1) \times 8$	X-Axis Velocity Alarm	$7005 + (x - 1) \times 8$	X-Axis Acceleration Alarm
$7002 + (x - 1) \times 8$	Z-Axis Velocity Warning	$7006 + (x - 1) \times 8$	Z-Axis Acceleration Warning
$7003 + (x - 1) \times 8$	Z-Axis Velocity Alarm	$7007 + (x - 1) \times 8$	Z-Axis Acceleration Alarm

- For the Vibration values, to return to using an original baseline value for a sensor, set the user-defined register (7001–7320) back to 0.

## Alarm Masks

Warnings and alarms within the system are contained in a register for each sensor (up to 40 sensors) in local registers 201–240.

These alarm masks are automatically recognized by Banner CDS, making it straightforward to create alerts based on the alarm mask. However a complete breakdown is provided here for using this data in an PLC or other cloud system. The registers are labeled NXX VibMask where XX is the sensor number. The register value is a decimal form of an 18-bit binary number with a value of 0 or 1 because there could be up to 18 warnings or alarms for each sensor.

- Velocity alerts**—Indicate low frequency motor issues such as unbalance, misalignment, soft foot, looseness, etc.
- High Frequency Acceleration alerts**—Indicate early bearing failure, cavitation, and high side gear mesh, etc.
- Acute alerts**—Indicate quickly happening issues that occur after five consecutive (adjustable in register 853) running samples above the thresholds.
- Chronic alerts**—Indicate a long-term failure based on a 100-point moving average of running samples above the thresholds.

The 18-bit binary masks are broken out as follows:

Bit	Description	Binary Mask
0	Warning – X-Axis – Acute Velocity	$(0/1) \times 2^0$
1	Warning – X-Axis – Acute Acceleration (Hi Freq)	$(0/1) \times 2^1$
2	Warning – Z-Axis – Acute Velocity	$(0/1) \times 2^2$
3	Warning – Z-Axis – Acute Acceleration (Hi Freq)	$(0/1) \times 2^3$
4	Alarm – X-Axis – Acute Velocity	$(0/1) \times 2^4$
5	Alarm – X-Axis – Acute Acceleration (Hi Freq)	$(0/1) \times 2^5$
6	Alarm – Z-Axis – Acute Velocity	$(0/1) \times 2^6$
7	Alarm – Z-Axis – Acute Acceleration (Hi Freq)	$(0/1) \times 2^7$
8	Warning – X-Axis – Chronic Velocity	$(0/1) \times 2^8$
9	Warning – X-Axis – Chronic Acceleration (Hi Freq)	$(0/1) \times 2^9$
10	Warning – Z-Axis – Chronic Velocity	$(0/1) \times 2^{10}$
11	Warning – Z-Axis – Chronic Acceleration (Hi Freq)	$(0/1) \times 2^{11}$
12	Alarm – X-Axis – Chronic Velocity	$(0/1) \times 2^{12}$
13	Alarm – X-Axis – Chronic Acceleration (Hi Freq)	$(0/1) \times 2^{13}$
14	Alarm – Z-Axis – Chronic Velocity	$(0/1) \times 2^{14}$
15	Alarm – Z-Axis – Chronic Acceleration (Hi Freq)	$(0/1) \times 2^{15}$
16	Warning Temperature ( > 158°F or 70°C )	$(0/1) \times 2^{16}$
17	Alarm Temperature ( > 176°F or 80°C )	$(0/1) \times 2^{17}$

Table 1: 18-bit register binary mask

Acute X-Vel Warn	Acute X-Accel Warn	Acute Z-Vel Warn	Acute Z-Accel Warn	Acute X-Vel Alarm	Acute X-Accel Alarm	Acute Z-Vel Alarm	Acute Z-Accel Alarm	Chronic X-Vel Warn	Chronic X-Accel Warn	Chronic Z-Vel Warn	Chronic Z-Accel Warn	Chronic X-Vel Alarm	Chronic X-Accel Alarm	Chronic Z-Vel Alarm	Chronic Z-Accel Alarm	Temp Warning	Temp Alarm
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The Vibe Mask Registers display in decimal form and are the sum of the calculations shown in the right column for each Sensor's mask register. Note that any value greater than zero in registers 201 through 240 indicates a warning or alarm for that particular sensor.

To know the exact warning or alarm, calculate the binary value from the decimal value, which can be done on the Banner CDS site or can be done with a PLC or HMI. Multiple warnings and alarms may trigger on an event depending on severity.

## Local Registers

The Applications Guide files are shared by Banner Solutions Kits. Some registers described as Solutions Kit functionality are only relevant for systems using the Banner Solutions Kits that use an HMI screen. The variable N represents the slave ID/sensor number 1–40.

Name	Register	Range	Description	Cloud Push Default
Vibration Data	$1 + (N - 1) \times 5$	1–200	Z-axis velocity	✓
	$2 + (N - 1) \times 5$		Z-axis high frequency acceleration	✓
	$3 + (N - 1) \times 5$		X-axis velocity	✓
	$4 + (N - 1) \times 5$		X-axis high frequency acceleration	✓
	$5 + (N - 1) \times 5$		Temperature	✓
Vibration Mask	$201 + (N - 1)$	201–240	Bit-packed alarm message	✓
Run Flag	$241 + (N - 1)$	241–280	Motor running flag (0/1)	
Sensor Status	$281 + (N - 1)$	281–320	Connection status of sensor (128 = Connected)	✓
Baseline	$321 + (N - 1)$	321–360	Trigger to re-baseline a sensor (0/1)	Read/Write
Raw Register Data	$1 + (N - 1) \times 5$	361–560	Placeholder registers for script	
	$2 + (N - 1) \times 5$			
	$3 + (N - 1) \times 5$			
	$4 + (N - 1) \times 5$			
	$5 + (N - 1) \times 5$			
Warning/Alarm Masks		561–574	OR'd Alarm registers	
Temp OR		575–576		
Status Radio OR		577–578		
Temperature Warning	$581 + (N - 1)$	581–620	Individual temperature warning registers (0/1)	
Temperature Alarm	$621 + (N - 1)$	621–660	Individual temperature alarm registers (0/1)	
Run Thresholds Constants	$661 + (N - 1)$	661–700	Threshold constant for motor run determination	
	$701 + (N - 1)$	701–740		
	$741 + (N - 1)$	741–780		
	$781 + (N - 1)$	781–820		
Alert Warning Lights		825–830	Solutions Kit functionality	
Sample Count		831		
Sensor Discovery		832		
Network Reformation		833		
Sample Time		834		
Push Count		835		
Sensors 1-10 Status		836		
Sensors 11-20 Status		837		
Sensors 21-30 Status		838		
Sensors 31-40 Status		839		
Fast Sample Trigger		843		
Cloud Push Enable		844		Enable or disable cloud pushing
First Run		851		Solutions Kit functionality (0/1, set to 0 to reinitialize settings)
Baseline samples		852		Set number of samples for a baseline (default 300)
Acute Sample		853		Number of samples in a row for acute fault (default 5)
N/A		854	N/A	

Name	Register	Range	Description	Cloud Push Default
Slave Starting Number		855	Slave address starting number (default 11)	
Status Wait Time for Dropout		856	Samples before re-checking a slave that dropped out of the system (default 48)	
Sample Rate		857	Rate, in seconds, for system to sample each sensor (default 300)	
Spectral Banding On/Off		858	Enable or disable spectral banding	
Spectral Band Information (Floating Point Registers)	$1001 + (N - 1) \times 36$	1001–2440	Z-axis velocity 1x band	
	$1003 + (N - 1) \times 36$		Z-axis peak velocity 1x band	
	$1005 + (N - 1) \times 36$		Z-axis velocity peak frequency 1x band	
	$1007 + (N - 1) \times 36$		Z-axis velocity 2x band	
	$1009 + (N - 1) \times 36$		Z-axis peak velocity 2x band	
	$1011 + (N - 1) \times 36$		Z-axis velocity peak frequency 2x band	
	$1013 + (N - 1) \times 36$		Z-axis velocity 3x-10x band	
	$1015 + (N - 1) \times 36$		Z-axis peak velocity 3x-10x band	
	$1017 + (N - 1) \times 36$		Z-axis velocity peak frequency 3x-10x band	
	$1019 + (N - 1) \times 36$		X-axis velocity 1x band	
	$1021 + (N - 1) \times 36$		X-axis peak velocity 1x band	
	$1023 + (N - 1) \times 36$		X-axis velocity peak frequency 1x band	
	$1025 + (N - 1) \times 36$		X-axis velocity 2x band	
	$1027 + (N - 1) \times 36$		X-axis peak velocity 2x band	
	$1029 + (N - 1) \times 36$		X-axis velocity peak frequency 2x band	
	$1031 + (N - 1) \times 36$		X-axis velocity 3x-10x band	
	$1033 + (N - 1) \times 36$		X-axis peak velocity 3x-10x band	
	$1035 + (N - 1) \times 36$		X-axis velocity peak frequency 3x-10x band	
Site Survey		5001–5005	Solutions Kit registers for site survey	
Binding		5006–5007	Solutions Kit registers for binding	
Chronic Fault Trends 100 Point Moving Average	$5021 + (N - 1) \times 4$	5021–5180	Z velocity trend	
	$5022 + (N - 1) \times 4$		Z acceleration trend	
	$5023 + (N - 1) \times 4$		X velocity trend	
	$5024 + (N - 1) \times 4$		X acceleration trend	
Visible Baseline and Alarms	$5181 + (N - 1) \times 12$	5181–5660	Thresholds being used for alarms (Selected from learned or user-defined)	Push once a day at UTC 00:00
Learned Thresholds	$5661 + (N - 1) \times 8$	5661–5980	Thresholds from algorithm (used in 5181-5660 if equivalent user thresholds in 7001-7320 are set to 0)	
Scaled Temp Reading	$5981 + (N - 1)$	5981–6020	Placeholder registers for script	
Additional Vibration Registers	$6141 + (N - 1) \times 10$	6141–6540	Z-axis peak acceleration	
	$6142 + (N - 1) \times 10$		X-axis peak acceleration	
	$6143 + (N - 1) \times 10$		Z-axis peak velocity frequency component	
	$6144 + (N - 1) \times 10$		X-axis peak velocity frequency component	
	$6145 + (N - 1) \times 10$		Z-axis RMS low acceleration	
	$6146 + (N - 1) \times 10$		X-axis RMS low acceleration	
	$6147 + (N - 1) \times 10$		Z-axis kurtosis	
	$6148 + (N - 1) \times 10$		X-axis kurtosis	
	$6149 + (N - 1) \times 10$		Z-axis crest factor	
	$6150 + (N - 1) \times 10$		X-axis crest factor	
Speed Input (Hz)	$6581 + (N - 1)$	6581–6620	Speed input in Hz for spectral banding registers	
User Defined Thresholds	$7001 + (N - 1) \times 8$	7001–7320	User-defined vibration thresholds (will override learned thresholds)	
Saved Count/Mean/StdDev	$7321 + (N - 1) \times 9$	7321–7680	Solutions Kit functionality	
Temp Warn Thresholds	$7681 + (N - 1)$	7681–7720	User-defined temperature warning thresholds	Push once a day at UTC 00:00 / Write



Name	Register	Range	Description	Cloud Push Default
Temp Alarm Thresholds	7721 + (N – 1)	7721–7760	User-defined temperature alarm thresholds	
DXMR90 Port Numbering	7881 + (N – 1)	7881–7920	Default to zero, meaning no sensor. Set to 1–4 to indicate the port number of the sensor attached. Used to keep timeouts low, reducing slave IDs talked to by the system.	