

Background and Value

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

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 the 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 versus chronic issues
- Sends data and alerts to the host control or to the cloud for IIoT connectivity

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



Guide Features and Benefits

Continuous Vibration Monitoring	Monitors vibration data on up to 40 assets, 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.
Self-learning Baseline and Thresholds	Prevents users from having to manually generate baselines or alarms; machine learning algorithms create an initial baseline reading and warning/alarm thresholds for each motor individually.

Continued on page 2

Continued from page 1

Acute and Chronic Alarms	Generates alarms and warnings for both acute and chronic conditions for each motor. Acute thresholds indicate a short-term condition, such as a motor jam or stall, that 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.
Long Range and Daisy-chained Sensors	MultiHop network allows for multiple sensors to be daisy-chained to a single radio to reduce the cost per monitored point and adds the ability to use repeaters to increase the network's range.
Temperature Alarms	Each vibration sensor monitors temperature and sends an alarm when the threshold is exceeded.
Advanced Data	Additional advanced diagnostic data is available, such as Spectral Band Velocity, Peak Velocity, Kurtosis, Crest factor, Peak Acceleration, etc.
SMS Text and Email Alerts	Generates email alerts based on individual warnings and/or alarms when used with Banner Cloud Data Services.
Cloud Monitoring	View data, log trends, and send alerts remotely by pushing data to the cloud Webserver or PLC using a LAN or Cellular connection

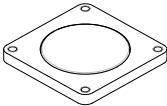
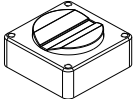
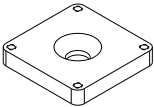
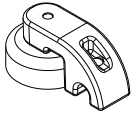
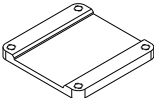
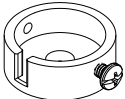
Solution Components

Model	Description
QM30VT1 or QM30VT2	Banner Vibration and Temperature Sensor
DX80DR9M-H10, DX80DR2M-H10, R70SR9MQ, or R70SR2MQ MultiHop Radio	Banner MultiHop M-H10 (use with QM30VT1) or R70SR (use with QM30VT2) Data Radio Select either the 900 MHz or 2.4 GHz ISM radio to match the DXM
DXM700-B1R2, DXM700-B1R4, DXM1000-B1R2, DXM1000-B1R4, DXM1200-B2R2, or DXM1200-B2R4 Wireless Controller	DXM700, DXM1000, or DXM1200 Wireless Controller Select either 900 MHz or 2.4 GHz ISM radio to match the MultiHop radios

Mounting Options

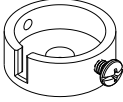
The following mounting options are listed from least effective to most effective. In all mounting options, ensure there is no sensor movement because this results in inaccurate information or changes to the time-trended data.

Follow Banner's [Vibration Monitoring Sensor Installation Guide](#) (p/n b_4471486) for proper sensor installation help.

Model	Bracket	Application Description
BWA-QM30-FMSS Flat magnet sensor bracket		Highly flexible and reusable, flat magnetic mount for larger diameter surfaces or flat surfaces.
BWA-QM30-CMAL 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.
BWA-QM30-FTAL Center mounting bracket, 1/4-28 x 1/2-inch screw mount (ships with sensor)		Flat bracket is 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
BWA-QM30CAB-MAG		Cable management bracket
BWA-QM30-CEAL		Notched aluminum bracket for curved surfaces permanently epoxied to motor and sensor screwed to bracket.
BWA-QM30-FSSSR		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.

Continued on page 3

Continued from page 2

Model	Bracket	Application Description
BWA-QM30-FSALR		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. Bind the MultiHop radio to a DXM (see ["Bind a MultiHop Radio to a DXM and Assign the Device ID" on page 3](#)).
2. Install the vibration sensor (see ["Install the Vibration Sensor" on page 4](#)).
3. Conduct a Site Survey from the DXM (see ["Conduct a Site Survey from the DXM" on page 4](#)).
4. Assign Modbus IDs to the sensors (see ["Assign Modbus IDs to the Sensors" on page 4](#)).
5. Configure the system (see ["Configure the System" on page 5](#)).
6. Save and upload the configuration file (see ["Save and Upload the Configuration File" on page 7](#)).
7. Turn on the sensors in the Local Registers (see ["Turn on the Sensors in the Local Registers" on page 7](#)).

Bind a MultiHop Radio to a DXM and Assign the Device ID

Separate radios by two meters when running the binding procedure. Put only one DXM MultiHop client radio into binding mode at a time to prevent binding the server radios to the wrong client radio.

1. Apply power to all the devices.
2. Enter binding mode on the DXM radio:
 - a. Use the arrow keys select the **ISM Radio** menu on the LCD and press **ENTER**.
 - b. Highlight the **Binding** menu and press **ENTER**.
3. Assign the device address to the repeater or server radios.
 - For MultiHop radios with rotary dials: Use the rotary dials to assign a valid decimal device ID (51 through 110). The left rotary dial represents the tens digit (1 through 6) and the right dial represents the ones digit (0 through 9) of the device ID.
 - For MultiHop radios without rotary dials: Use the DXM arrow keys to select the device ID to assign to the MultiHop radio about to enter binding mode. The DXM assigns this device ID to the next radio that enters binding mode. Only bind one radio at a time.
4. Start binding mode on the DXM radio by pressing **ENTER** on the DXM radio.
5. After entering binding mode on the DXM, triple-click button 2 on the MultiHop radio.
After binding is completed, the MultiHop radio automatically exits binding mode and begins operation.
6. Press **BACK** on the DXM to exit binding mode for that specific device address.
7. Label the MultiHop radio with the assigned address number for future reference.
8. Repeat these steps, changing the device address, for as many MultiHop radios as are needed for your network.
9. When you are finished binding, press **BACK** on the DXM until you return to the main menu.
All radios begin to form the network after the client radio exits binding mode.

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.

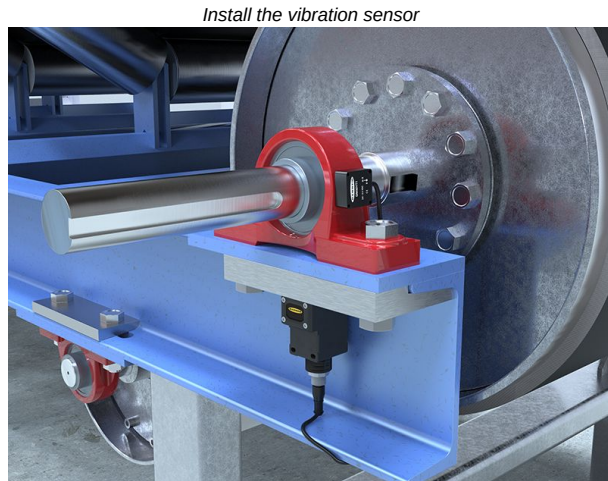
1. Align the vibration sensor's x- and z-axes.
 - The vibration sensors have an x- and z-axis indication on the face of the sensor. The z-axis goes in a plane through the sensor while the x-axis goes horizontally. The sensor can be installed flat or vertically.
 - Flat installation—Align the x-axis in 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.



Conduct a Site Survey from the DXM

Conduct a Site Survey to verify the wireless communication between the radios within your wireless network.

Conduct the site survey when the Nodes and DXM Controller are at the proposed installation sites to determine each radio's signal strength with the DXM.

1. On the DXM: Use the arrow buttons to select the **ISM Radio** menu and press **ENTER**.
2. Select the **Site Survey** menu and press **ENTER**.
3. Use the Up or Down arrows to select the device ID number and press **ENTER** to run the site survey with that radio. The site survey results display as green, yellow, red, and missed packets. Green indicates the highest signal strength, then yellow, and red. Missed packets were not received.
4. When you are finished running the Site Survey, press **Back** twice to return to the main menu and exit site survey mode.

If the Site Survey fails (100 missed packets), verify the radios are at least 10 feet from the DXM and/or rerun the binding procedure. If you find poor signal quality, common solutions include moving the DXM to a more central location relative to the Nodes or using higher-gain antennas on the DXM. Contact your local Banner Engineering representative for assistance.

Assign Modbus IDs to the Sensors

To begin configuring the sensors, each sensor must have a Modbus Sensor ID assigned to it. Modbus Sensor IDs must be between 11 and 50.

Each Modbus Sensor ID corresponds to individual sensor numbers in the DXM registers, with ID 11 being Motor 1 (N1) and ID 50 being Motor 40 (N40). Sensor IDs don't have to be assigned in order.

IMPORTANT: You must set the NodeSelect registers in registers 7881–7920 to a 0 to turn on the sensors the system will be using. By default, only Sensor 1 (ID 11) is set to 0 to avoid long timeouts of other systems not on the system. Setting the register back to a 1 tells the system that sensor is off and data won't be collected.

To assign Modbus Sensor IDs, use either the menu system or the configuration software. To use the radio's menu system, follow these steps. For VT1 sensors, use your M-H10 radio and for VT2 sensors, use one of many radio options, such as M-H, M-H1, etc.

1. Apply power to the radio and connect one sensor at a time.
2. Push button 1 until ***DVCFG** appears, then push button 2.
3. Push button 1 until **-S ADR** appears and push button 2.
4. Push button 1 and wait for the radio to read the current sensor Modbus Sensor ID.

- A three-digit value appears with the current sensor ID with a blinking cursor.
5. Assign a unique Modbus Sensor ID value from 11 to 50. Use the left button to cycle the value from 0 to 9 and the right button to accept the value and move the cursor to the next digit right.
 6. Push and hold button 2.
The screen says SAVING.
 7. To repeat for more sensors, unplug the sensor and plug in the next sensor and repeat steps 3 through 6 with a new device ID.
 8. After you have finished, double-click button 2 to return to the main menu.
 9. Connect all sensors to be attached to that radio.

To assign the Modbus Sensor IDs using the configuration software, use the [Sensor Configuration Software](#) with a computer and either the **BWA-USB1WIRE-001** cable accessory for the VT1 sensor or the **BWA-UCT-900** cable accessory for the VT2 sensor to connect the sensor to the computer.

Follow the instructions in the [Sensor Configuration Software Instruction Manual](#) (p/n 170002) to assign the Modbus Sensor ID to a value between 11 and 50.

Configure the System

To customize the system to an actual application, some basic modification to the template files is necessary. There are two files uploaded to the DXM: the XML file sets the DXM's initial configuration, and 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.

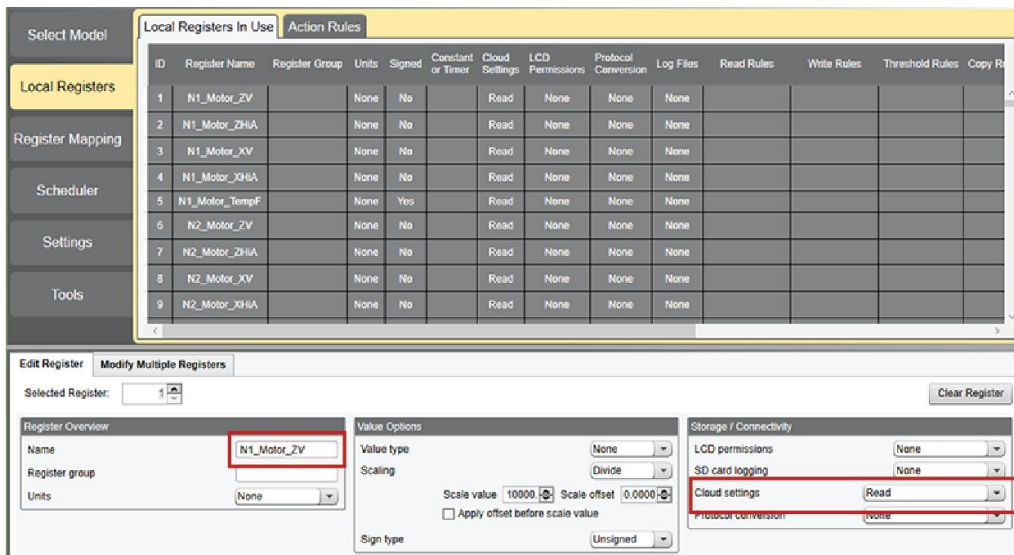
Loading these files and adjusting them requires using Banner's DXM Configuration Software (version 4 or newer) and the Vibration Monitoring files available on www.bannerengineering.com.

1. Install the sensors and radios after binding, testing the radio signal (site survey), and assigning sensor IDs. Sensors automatically begin to establish their baseline after they connect to the DXM to avoid recording vibrations generated during installation.
2. Download the preconfigured files from either the DXM series page or VT sensor series page on bannerengineering.com.
3. Extract the ZIP files into a folder on your computer. Note the location where the files were saved
4. Connect the DXM, using the USB cable supplied with the DXM or an ethernet cable, to a computer containing the [DXM Configuration Software v4](#) or download the software and install it on a computer.
5. Launch the software and connect the software to the DXM.
 - a. In the **Configuration Mode** drop-down list, select **Traditional**.
 - b. Select **Serial** and then select the COM port that the USB cable is plugged into or select **TCP/IP** and enter the correct IP address of the DXM.
 - c. In the **Select DXM Model** drop-down list, select your DXM model.
 - d. Click **Connect**. If you are unsure which COM port to select and multiple ports are listed, attempt to connect to each one of them until you are successful.
6. Load the configuration file by going to **File > Open** and choosing the MultiHop Vibration Monitoring XML file.
7. Go to the **Settings > Scripting** screen. Click **Upload file** and select the MultiHop Vibration Monitoring script file (.sb).
8. Go to the **File > Save** menu to save the file. Save the XML file any time the XML has been changed because the software DOES NOT autosave.

Optional Configuration Steps

Customize the XML File

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, to go 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.
3. 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.



4. 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.
 - a. On the **Modify Multiple Registers** screen, select **Set** in the drop-down list next to **Cloud settings**.
 - b. In the **Cloud settings** drop-down, select **Read** or **None** to turn the register off.
 - c. Set the **Starting Register** and the **Ending Register** for the group of registers that need to be changed.
 - d. Click **Modify Registers** to complete the modification.

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

5. For systems with up to 40 sensors, warnings and alarms are contained within a single register for each sensor, in Local Registers 201–240.

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 can be up to 18 warnings or alarms for each sensor. Velocity alerts are indicative of low frequency motor issues such as unbalance, misalignment, soft foot, looseness, etc. High Frequency Acceleration alerts are indicative of early bearing failure, cavitation, and high side gear mesh, etc. Acute alerts are indicative of a quickly happening issues as they occur after five consecutive (adjustable in register 853) running samples above the thresholds. Chronic alerts are indicative of a long term failure and are 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	$(0/1) \times 2^{14}$

Continued on page 7

Continued from page 6

Bit	Description	Binary Mask
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)	$(0/1) \times 2^{17}$

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.

Set Up the Ethernet or Cellular Connection

By default, the DXM with an Ethernet Push interface is configured to push the data registers to a web server. The DXM can also be configured to use a cellular push if the DXM Controller contains a cellular module and data plan. This section is only necessary if you want to receive or display information to more than the DXM Controller's LCD.

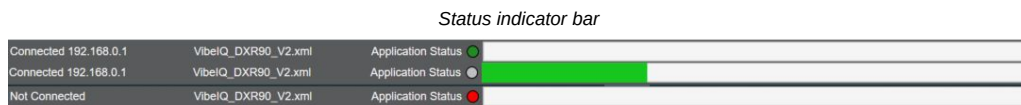
1. On the **Local Registers in Use** screen, set the **Value Type** of register 844 to **Constant** and a value of 1 to enable the data push.
2. If the DXM will push to the cloud web server, set up the push interface.
 - a. Go to the **Settings > Cloud Services** screen.
 - b. From the **Network Interface** drop-down list, select either **Ethernet** or **Cell**. Selecting **Cell** requires a cellular module be installed in the DXM Controller and a wireless plan be set up for sending data.
3. Set the **Cloud Push Interval** to **None**. The script associated with this file establishes the five-minute push interval internally so that it occurs immediately after the sample of the sensors.

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.



- 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.

Turn on the Sensors in the Local Registers

Set the **NodeSelect** registers (7881–7920) to 0 to turn on the sensors the system will be using. By default, only Sensor 1 (ID 11) is turned on to avoid the long timeouts of other sensors that are not in the system.

Set a register to 1 to tell the system that the sensor is off and data won't be collected. A PLC may write to the registers, or you can use the configuration software. To configure the sensors using the DXM Configuration Software, follow these steps.

1. After the DXM has rebooted, wait one to two minutes.
2. In 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 that will be used in the system. Set the **Number of Registers** to 40 to see all the registers. The selected registers display.
4. In the **Value** field, enter a 0 to turn a sensor on and a 1 to turn a sensor off.
5. Click **Write Registers**.
6. Repeat these steps when a sensor is added or removed from the system.

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

To push data to the cloud, change register 844 to one (1).

For more information on creating accounts on and using the Banner Cloud Data Services (CDS) system, please refer to the Banner CDS Quick Start Guide (p/n 201126).

Create a New Gateway

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

1. Click on **New Gateway** (top right corner of the **Overview** screen).
Create a new Gateway for each DXM Controller that sends data to the web server.
A **New Gateway** prompt appears.
2. Verify **Traditional** is selected for the **Gateway Type**.
3. Enter a **Gateway Name**.
4. Select the **Company** from the drop-down list.
5. Copy the **Gateway ID** number located within the prompt window to your computer's clipboard.
The **Gateway ID** number created by the web server is a required parameter in the configuration of the DXM. The **Gateway ID** is the address the webserver uses to store the data pushed from the DXM.
6. Click **Submit** to close the prompt window.

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 **Local Registers in Use** screen.
2. Set the **Value Type** of register 844 to **Constant** and a value of 1 to enable the data push.
3. Go to the **Settings > Cloud Services** screen.
4. Set the **Server name/IP** to `push.bannercds.com`.
5. In the **Web Server** section, paste the **Gateway ID** copied from the BannerCDS configuration screen into the appropriate field.
6. Use the **File > Save** menu to save the XML file to your hard drive.
7. 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. On the BannerCDS website, select **Gateways** on the **Overview** screen.
2. On the row displaying your **Gateway**, click the **Details** under **View**.
3. Select **Edit Gateway**.
The **Edit Gateway** prompt appears.
4. Click **Select File** under **Update XML**.
5. Select the file that was just updated to the DXM and click **Open**.
After the XML file is loaded into the webserver, the webserver uses the register names and configurations defined in the configuration file. The same XML configuration file is now loaded on both the DXM and the Website. After some time, the data should be seen on the website.
6. To view the data from the Gateway's screen, click on the **Details** link for each **Gateway**.
The Gateway **Details** screen lists the **Sensor** objects and default **Alarms** for that gateway. You may view the individual register information by selecting **Registers**.

Completing these steps creates continuity between the **Gateway** 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.

Additional Information

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

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 11.

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.

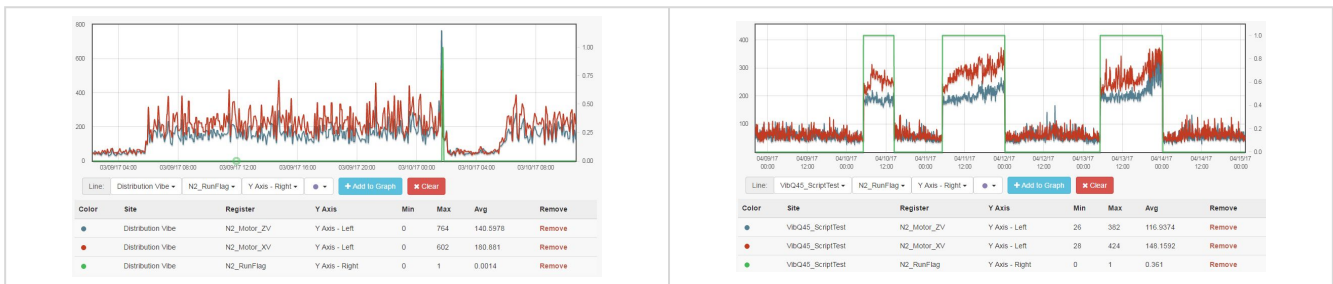
To view the Spectral Band data, enable register 857 (change the value from 0 to 1) then view floating-point registers 1001–2440 (36 registers per sensor). For more information, see "Local Registers" on page 11.

For more information about the Spectral Band information, refer to the VT2 Vibration Spectral Band Configuration technical note (p/n [b_4510565](#)).

Adjust the Velocity Thresholds for the Run Flag

The script included in this application guide automatically generates baselines and standard deviations by recognizing when a motor is running and collecting data.

If a motor has a very low RMS velocity and acceleration when running, it can be very difficult to distinguish. To ensure the system is working properly, look at the Run Flag and X/Z RMS velocity over time. The data graphics show when a motor is running or off. If the Run Flag doesn't turn on (1) when the motor turns on, decrease the Running Motor RMS Velocity threshold. To determine this, look at the data over time.



On the left, sensor 2 is between 150 and 425 for RMS velocity when the motor is running and below 100 when the motor is not running. The Run Flag (green line) indicates the motor is running at one point in time when the velocity has a spike. In comparison, if we look at the RMS velocities for sensor 2 on the right, we can see the Run Flag (green line) clearly indicates when the motor is running and not running even if the velocities are low. This means the acceleration is high enough to distinguish when the motor is running.

To adjust for this, reduce the Running RMS Velocity Thresholds for the X and Z axis to a level that is above the off state but below the lowest data collected while the motor was running. In this case a value of 100 would be the appropriate value. This value varies depending on the motor and should be assessed for each motor. To change the Run Velocity thresholds, follow these steps.

1. On the DXM Configuration Software, go to the **Local Registers > Local Registers in Use** screen.
2. Click on the X Velocity Run threshold in registers 661–700 (labeled **NX_RunThres_XV** and where X is the motor ID number) and change the value in the **Constant** field to a more accurate value for that motor.
3. Click on the Z Velocity Run threshold in registers 701–740 (labeled **NX_RunThres_ZV** and where X is the motor ID number) and change **Constant** to a more accurate value for that motor.
4. If you are configuring other similar motors, use the **Modify Multiple Registers** screen to save time.
5. After you have configured these thresholds for each motor, see ["Save and Upload the Configuration File" on page 7](#).
6. Re-baseline your motor (see ["Baselining a Motor" on page 10](#)).

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

1. Go to the **Local Registers > Local Registers in Use** screen.
2. Use the arrows to select **Registers**.
The registers are labeled **NX_Baseline** (where X is the sensor number you want to baseline).
3. Select the appropriate register to reset and click **Enter**.
4. 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

1. On the **Dashboard** screen, select the appropriate **Dashboard** that was automatically created for your gateway.
2. Within the **Dashboard**, click on the appropriate motor icon for the asset you would like to baseline.
3. Click **View Item** within the prompt that appears.
4. Scroll down within the tray that appears at the bottom of the screen, then click the **Baseline** switch to **ON**.
This automatically turns off after the baseline is complete.
5. Repeat these steps 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.

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

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 ID.
 - **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 ID.
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** screen, select the appropriate **Dashboard** that was automatically created for your gateway.
2. Within the **Dashboard**, click on the appropriate motor icon for the asset you would like to adjust thresholds.
3. Click **View Item** within the prompt that appears.
4. 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.
5. Scroll down within the tray that appears at the bottom of the screen and enter your desired values for the thresholds into the respective numeric fields.
6. Click **Update**.
Banner CDS updates the system settings the next time the gateway controller pushes to the cloud.
7. Repeat these steps for each sensor threshold.
8. 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.

1. Write the appropriate value into the register where x is the Sensor ID.
 - **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) × 8	X-Axis Velocity Warning	7004 + (x - 1) × 8	X-Axis Acceleration Warning
7001 + (x - 1) × 8	X-Axis Velocity Alarm	7005 + (x - 1) × 8	X-Axis Acceleration Alarm
7002 + (x - 1) × 8	Z-Axis Velocity Warning	7006 + (x - 1) × 8	Z-Axis Acceleration Warning
7003 + (x - 1) × 8	Z-Axis Velocity Alarm	7007 + (x - 1) × 8	Z-Axis Acceleration Alarm

2. 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.

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 sensor number 1–40 (equivalent to sensor ID 11–50).

Name	Register	Range	Description	Cloud Push Default
Vibration Data	1 + (N - 1) × 5	1–200	Z-axis velocity	✓
	2 + (N - 1) × 5		Z-axis high-frequency acceleration	✓
	3 + (N - 1) × 5		X-axis velocity	✓
	4 + (N - 1) × 5		X-axis high-frequency acceleration	✓
	5 + (N - 1) × 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) × 5	361–560	Placeholder registers for script	
	2 + (N - 1) × 5			
	3 + (N - 1) × 5			
	4 + (N - 1) × 5			
	5 + (N - 1) × 5			
Warning/Alarm Masks		561–574	OR'd Alarm registers	
Temp OR		575–576		

Continued on page 12

Continued from page 11

Name	Register	Range	Description	Cloud Push Default	
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		
Server Starting Number		855	Server address starting number (default 11)		
Status Wait Time for Dropout		856	Samples before re-checking a server that dropped out of the system (default 48)		
Enabling Spectral Band		857	Enables Spectral Band readings; reads take longer so battery life is reduced slightly		
Spectral Band Information (Floating Point Registers)	1001 + (N – 1) × 36	1001–2440	Z-axis velocity 1x band		
	1003 + (N – 1) × 36		Z-axis peak velocity 1x band		
	1005 + (N – 1) × 36		Z-axis velocity peak frequency 1x band		
	1007 + (N – 1) × 36		Z-axis velocity 2x band		
	1009 + (N – 1) × 36		Z-axis peak velocity 2x band		
	1011 + (N – 1) × 36		Z-axis velocity peak frequency 2x band		
	1013 + (N – 1) × 36		Z-axis velocity 3x-10x band		
	1015 + (N – 1) × 36		Z-axis peak velocity 3x-10x band		
	1017 + (N – 1) × 36		Z-axis velocity peak frequency 3x-10x band		
	1019 + (N – 1) × 36		X-axis velocity 1x band		
	1021 + (N – 1) × 36		X-axis peak velocity 1x band		
	1023 + (N – 1) × 36		X-axis velocity peak frequency 1x band		
	1025 + (N – 1) × 36		X-axis velocity 2x band		
	1027 + (N – 1) × 36		X-axis peak velocity 2x band		
	1029 + (N – 1) × 36		X-axis velocity peak frequency 2x band		
	1031 + (N – 1) × 36		X-axis velocity 3x-10x band		
	1033 + (N – 1) × 36		X-axis peak velocity 3x-10x band		
1035 + (N – 1) × 36	X-axis velocity peak frequency 3x-10x band				

Continued on page 13

Continued from page 12

Name	Register	Range	Description	Cloud Push Default
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	
Radio ID	$6541 + (N - 1)$	6541–6580	Radio ID associated with each sensor	
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 thresholds	Push once a day at UTC 00:00 / Write
Temp Alarm Thresholds	$7721 + (N - 1)$	7721–7760		
User Selected Sensors	$7881 + (N - 1)$	7881–7920	Solutions Kit functionality (0/1 with 0 = sensor in system, 1 = no sensor) Used to keep timeouts low, reducing Modbus IDs talked to by the system.	

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