What is VIBE-IQ®?

Banner's VIBE-IQ® machine learning algorithm simplifies the challenging task of characterizing vibration data using a condition monitoring system.

VIBE-IQ® solutions use machine learning to determine if assets are operating, establish baselines, set warning and alarm thresholds, and detect changes in vibration across each monitored axis. By continuously monitoring assets such as motors and gearboxes, VIBE-IQ can provide early fault detection without requiring specialized manual configuration or external processing, simplifying predictive maintenance and making it accessible to teams at every level of experience.

The custom baseline profiles provided by VIBE-IQ® include specific information, such as load and speed variability, asset age, and specific applications, to create unique thresholds instead of generic ones. Using VIBE-IQ solutions can dramatically reduce the time and effort required to establish a predictive maintenance system, extending asset life and reducing unexpected downtime. The automated nature of VIBE-IQ can free up maintenance teams for higher-value work instead of spending time taking vibration readings and monitoring assets that are in good condition.

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, RMS high-frequency acceleration, temperature, and other factors critical to rotating equipment using Banner's wired or wireless vibration/temperature sensors
- Determines if motors are running or not and only uses the running data for baselining and alerting
- Collects data for trending and analysis; defines acute versus chronic issues
- Sends data and alerts to the host controller or to the Cloud for IIoT connectivity

VIBE-IQ® Mode

The QM30VT3 vibration and temperature sensors have this mode built into the sensor and only require a few steps to begin the baselining process. Previously, this data had to be collected by a controller and processed at the edge or in the cloud. The configuration registers in 6007-6011 are used to set up the initial parameters that can be used for all future baselines.

Configuration registers 6007–6011

Register	Description
6007	Number of samples used to generate the baseline
6008	Sample rate for how often a new data point is used towards the baseline (seconds)
6009	Acute Fault samples, the number of consecutive running samples of vibration data after the baseline is established to trigger an acute fault when above the learned thresholds
6010	Chronic Fault samples, the number of running samples of vibration data after baseline is established that are used in a moving average to trigger a chronic fault when this moving average crosses the learned thresholds.
6011	Units (0 = Imperial, 1= Metric)

The length of the baseline is determined by how often the asset is running, the number of samples used for the baseline, and the sample rate. If you are uncertain how long to collect the baseline data, we recommend about 24 hours of running time or one full load/process cycle that this asset may go through, whichever is longer, to capture all the possible system variability.

The motor is determined to be running using certain defaults limits established by default on the sensor. These thresholds can be adjusted in registers 6012-6017 but typically only require adjustments in unique circumstances. These default parameters are very accurate at determining the running state of a motor and only require adjustment in scenarios where either the sensor is picking up a significant amount of vibration being coupled in from other vibrating sources in the surrounding area, such as a large non-isolated motor, or the sensor is being used on an asset with limited signal output, which can often be corrected by improving the mounting location. In almost all cases, place the sensor as close to the bearing on a cast surface to accurately collect vibration data trends.

After configuration parameters are established, triggering a new baseline only requires sending a value of 1 to register 6001. When the sensor is completing the baseline, the number of remaining samples can be seen in register 6003. After the baseline is finished, baseline and threshold values are placed in registers 6018–6035. This includes a baseline value, warning and alarm threshold for each of the three axes on both the RMS velocity, and high-frequency acceleration data. These values remain constant unless a new baseline is triggered and can be collected for visualizing against the raw vibration data. It is recommended to trigger a new baseline after heavy preventative maintenance or asset replacement is completed.

The VIBE-IQ mode is focused on trending the RMS Velocity and High-Frequency Acceleration levels. If these values are not increasing beyond the thresholds, nothing beyond standard maintenance should be required. When these parameters begin to trend upward, this can be an early indication of a failure mode appearing.

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The RMS Velocity is a parameter taken from the lower frequency area of the sensor's bandwidth (below 1000 Hz). RMS Velocity trending update indicates issues related to imbalance, misalignment, looseness, soft foot, eccentricity, etc.

The RMS High-Frequency Acceleration is a parameter taken from the higher frequency area of the sensor's bandwidth (above 1000 Hz). This parameter and associated faults are indications of early bearing wear, lubrication issues, gear faults in a gearbox, cavitation on a pump, etc.

Temperature is also a critical component of motor monitoring and although the Vibe-IQ algorithm does not provide baselining or automatic threshold generation, there are registers available for users to set their own thresholds. When the temperature rises above these thresholds, the alert flags will be set for indication.

There are two registers dedicated to providing alert status: 6038 and 6039. These are bit-packed registers where each bit is an indication of a different level or type of fault. There is a warning and alarm level for both RMS Velocity and RMS High-Frequency Acceleration across two types of faults: Acute or Chronic.

Acute faults are triggered when the raw vibration sample data of a running motor rises above the warning or alarm level for multiple samples in a row. The number of samples in a row is based on the user setting in register 6008 (default of 5). An acute fault can be an indication of a quicker developing fault such as a machine jam, belt slip, etc., but due to the volatile nature of vibration signals, some demodulation is necessary to avoid nuisance fault indication. To avoid nuisance fault indications, adjust the acute fault samples register.

The Chronic faults are based on a 10VI0-point moving average of running samples. When that trend rises above the warning or alarm thresholds, the chronic alert bits trigger. This type of fault indicates a much longer growing trend upward from asset age/fatigue, spalling within the bearing, etc. A chronic fault could also be an indication that an acute fault was left in that state long enough and it was unable to clear itself.

Typically, an acute fault triggers first, but this isn't always the case if the data is bouncing above and below the threshold because each sample below the threshold restarts the acute sample consecutive count. The bit maps for the different alerts in registers 6038 and 6039 are as follows:

Alert bitmaps for registers 6038 and 6039

Modbus Address	Description	IO Range Min	IO Range Max	Holding Register Min	Holding Register Max	Default Value	Scale (exp)
46038	Vibe IQ Runtime Flags Low Word (Bitwise Warning/ Alarm)	0	65535	0	65535		
46038.0	X-Axis Velocity Acute Warning	0	1				
46038.1	X-Axis Velocity Acute Alarm	0	1				
46038.2	X-Axis Velocity Chronic Warning	0	1				
46038.3	X-Axis Velocity Chronic Alarm	0	1				
46038.4	X-Axis High-Frequency Acceleration Acute Warning	0	1				
46038.5	X-Axis High-Frequency Acceleration Acute Alarm	0	1				
46038.6	X-Axis High-Frequency Acceleration Chronic Warning	0	1				
46038.7	X-Axis High-Frequency Acceleration Chronic Alarm	0	1				
46038.8	Y-Axis Velocity Acute Warning	0	1				
46038.9	Y-Axis Velocity Acute Alarm	0	1				
46038.A	Y-Axis Velocity Chronic Warning	0	1				
46038.B	Y-Axis Velocity Chronic Alarm	0	1				
46038.C	Y-Axis High-Frequency Acceleration Acute Warning	0	1				
46038.D	Y-Axis High-Frequency Acceleration Acute Alarm	0	1				
46038.E	Y-Axis High-Frequency Acceleration Chronic Warning	0	1				
46038.F	Y-Axis High-Frequency Acceleration Chronic Alarm	0	1				
46039	Vibe IQ Runtime Flags High Word (Bitwise Warning/ Alarm)	0	65535	0	65535		
46039.0	Z-Axis Velocity Acute Warning	0	1				
46039.1	Z-Axis Velocity Acute Alarm	0	1				
46039.2	Z-Axis Velocity Chronic Warning	0	1				
46039.3	Z-Axis Velocity Chronic Alarm	0	1				
46039.4	Z-Axis High-Frequency Acceleration Acute Warning	0	1				
46039.5	Z-Axis High-Frequency Acceleration Acute Alarm	0	1				
46039.6	Z-Axis High-Frequency Acceleration Chronic Warning	0	1				
46039.7	Z-Axis High-Frequency Acceleration Chronic Alarm	0	1				
46039.8	Temperature Warning	0	1				
46039.9	Temperature Alarm	0	1				

VIBE-IQ® Settings

Modbus Address	Description	IO Range Min	IO Range Max	Holding Register Min	Holding Register Max	Default Value	Scale (exp)
46001	Start Baseline	0	1	0	1		
46002	Baseline Acquisition Status (0 = Idle, 1 = Start, 2 = Samples Acquiring, 3 = Processing, 4 = Active)	0	4	0	4		
46003	Baseline Samples remaining	0	65535	0	65535		
46004	Velocity Threshold Compare (0 = "or", 1 = "and" comparison with axis)	0	1	0	1		
46005	Accel Threshold for Compare (0 = "or", 1 = "and" comparison with axis)	0	1	0	1		
46006	Accel Velocity or and Threshold Exceed for Baseline (0 = No, 1 = Yes)	0	1	0	1		
46007	Number of Samples for baseline	0	300	0	300	300	
46008	Sample Rate in seconds for baseline	0	65535	0	65535	300	
46009	Acute Fault Settings (# of consecutive samples)	0	65535	0	65535	5	
46010	Chronic Fault Settings (# of samples used for rolling average)	0	65535	0	65535	100	
46011	Units (0 = Imperial, 1 = Metric)	0	1	0	1	0	
46012	X RMS Velocity Running Threshold (Scale dependent on units)	-1	32767	0	32767	-1	
46013	Y RMS Velocity Running Threshold (Scale dependent on units)	-1	32767	0	32767	-1	
46014	Z RMS Velocity Running Threshold (Scale dependent on units)	-1	32767	0	32767	-1	
46015	X RMS HF Acceleration Running Threshold	-1	32767	0	32767	-1	-3
46016	Y RMS HF Acceleration Running Threshold	-1	32767	0	32767	-1	-3
46017	Z RMS HF Acceleration Running Threshold	-1	32767	0	32767	-1	-3
46018	X RMS Velocity Threshold for Baseline Value (Scale dependent on units)			0	65535		
46019	Y RMS Velocity Threshold for Baseline Value (Scale dependent on units)			0	65535		
46020	Z RMS Velocity Threshold for Baseline Value (Scale dependent on units)			0	65535		
46021	X RMS HF Acceleration Threshold for Baseline Value	0	65.535	0	65535		-3
46022	Y RMS HF Acceleration Threshold for Baseline Value	0	65.535	0	65535		-3
46023	Z RMS HF Acceleration Threshold for Baseline Value	0	65.535	0	65535		-3
46024	X RMS Velocity Warning Threshold Value			0	65535		
46025	Y RMS Velocity Warning Threshold Value			0	65535		
46026	Z RMS Velocity Warning Threshold Value			0	65535		
46027	X RMS HF Acceleration Warning Threshold Value	0	65.535	0	65535		-3
46028	Y RMS HF Acceleration Warning Threshold Value	0	65.535	0	65535		-3
46029	Z RMS HF Acceleration Warning Threshold Value	0	65.535	0	65535		-3
46030	X RMS Velocity Alarm Threshold Value			0	65535		
46031	Y RMS Velocity Alarm Threshold Value			0	65535		
46032	Z RMS Velocity Alarm Threshold Value			0	65535		
46033	X RMS HF Acceleration Alarm Threshold Value	0	65.535	0	65535		-3
46034	Y RMS HF Acceleration Alarm Threshold Value	0	65.535	0	65535		-3
46035	Z RMS HF Acceleration Alarm Threshold Value	0	65.535	0	65535		-3
46036	Temperature Warning Threshold			-32768	32767		
46037	Temperature Alarm Threshold			-32768	32767		