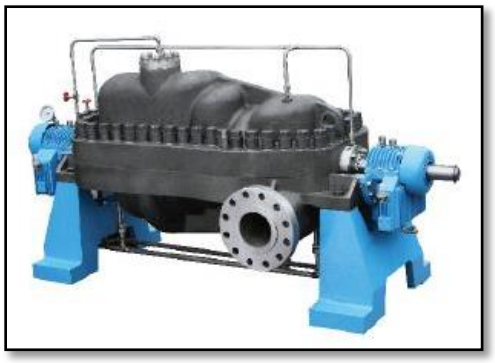
VTBNet –Vibration & Temperature Monitoring of Horizontal Multistage BB3 & BB5 Pumps



Horizontal Multistage BB3 Pump

BB3 – Axially Split Pumps

The casing of the horizontally split pump is made up of lower and upper parts which are bolted together with a number of studs located around the perimeter of the casing. The shaft and impellers are supported by bearings at the ends of the casing, i.e., between bearing (BB). Low-pressure fluid enters near one end and then flows through several impeller stages at increasing pressures. The mid-pressure fluid is led through internal passageways to the opposite end of the casing and then through several more impeller stages. High pressure fluid finally emerges near the centre of the machine.

It is mainly used in the following applications:

- Boiler feed in all industries; auxiliary feed in nuclear power
- Reverse osmosis feed
- Offshore crude oil shipping
- Refined product pipeline
- Supercritical Liquefied Petroleum Gas (LPG), Ethylene and CO_2 compressible services

Double Cased Horizontal Multistage BB5 Pump

BB5 – Double-Casing Radial Split Pumps

This type of pump – also known as barrel pumps are basically radially split pumps with an extra cylindrical casing enclosing the ring sections and holding the internal components together.

This multistage barrel pump is suitable for high pressure, high speed and high temperature services requiring reliability and long service life. It is mainly used in the following applications:

- Water injection
- Offshore crude oil shipping
- High pressure pipeline
- Boiler feed
- High pressure safety injection
- Refinery charge
- Ethylene shipping

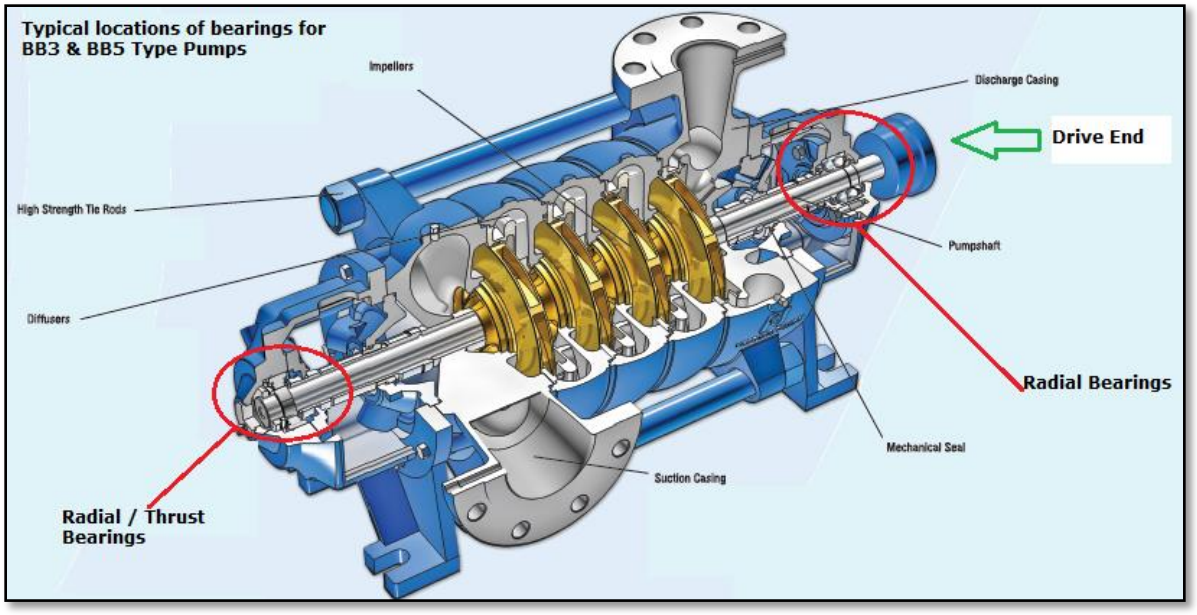
VTB-Sensor and VTB-COM

The VTB-Sensor is addressable with a smart programmable design enabling reliability engineers and maintenance professionals to have a one-size-fits-all vibration sensor. The VTB-Sensor is suitable for rotating machine applications such as motors, pumps, fans, compressors, engines, centrifuges, cooling towers as well as reciprocating compressors and pumps. The sensor provides overall vibration level outputs for the X, Y and Z axis in acceleration & velocity, and provides a temperature output.

VTB-COM is a communication gateway which monitors the VTBSensors via the CAN bus network. This communications gateway logs information from the VTB-Sensors and communicate the information to control systems (PLC, DCS, SCADA) or remote monitoring stations using a variety of communications methods, e.g., Ethernet, Modbus and USB. Additional connection options are available such as: wireless and cellular (GSM).

The VTB-COM has four independent CAN bus ports and each port is controlled by a dedicated microcontroller chip. Each CAN bus channel can communicate with up to twenty-four daisy chained VTB-Sensors, i.e., this makes it possible to have up to ninety-six VTB-Sensors (monitoring points) connected to one VTB-COM communication gateway

BB3 & BB5 Pumps - VTBNet Application



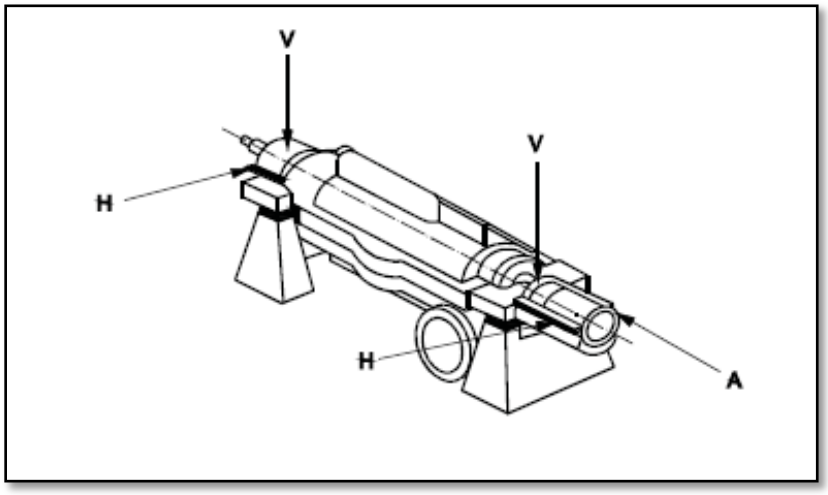
The centrifugal pump operates at relatively high speeds and is generally driven by an electric motor. Having no reciprocating parts, these pumps are inherently balanced. The centrifugal pump can be arranged according to the following features:

- Number of stages: single or multistage
- Position of the shaft: horizontal or vertical
- Bearing design: sleeve / Kingsbury, sleeve / rolling element, or rolling element / rolling element

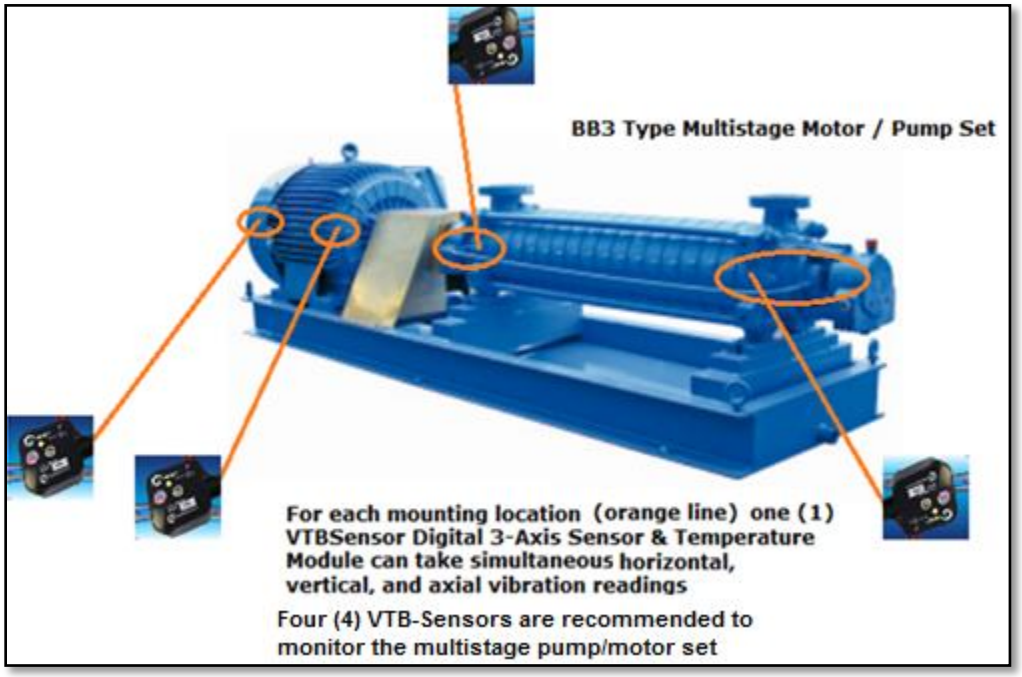
Pumps that contain sleeve or fluid film bearings have damping and stiffness characteristics that do not adequately transmit shaft vibration to the machine's casing. For these types of machines, a proximity probe system is recommended to directly detect and monitor the vibratory motion of a machine's rotating shaft.

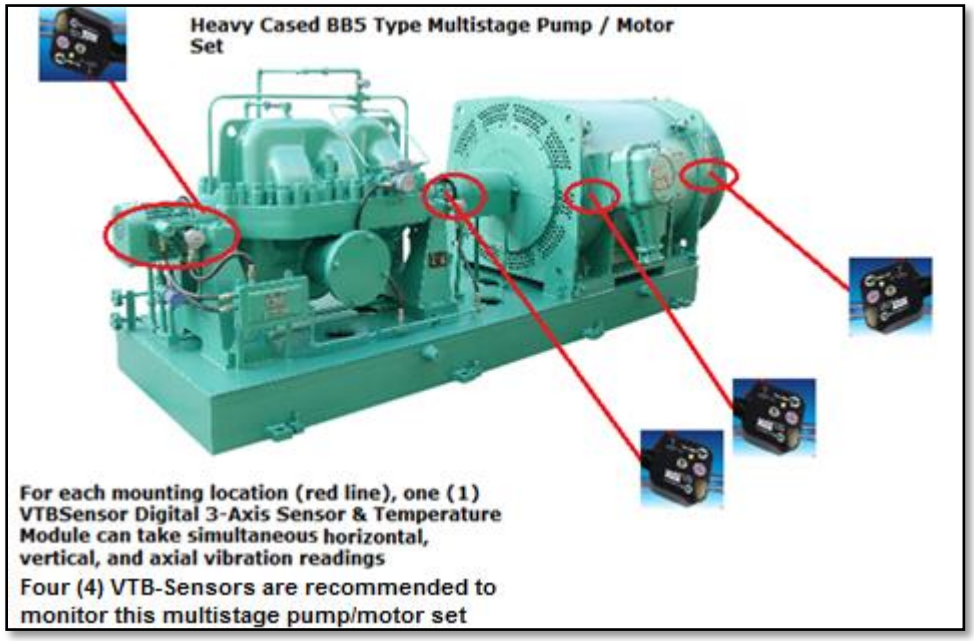
Pumps that use rolling element bearings (ball, spherical, cylindrical, needle, and taper) will propagate internal machine vibrations to the machine's casing. Case mounted vibration sensors like the VTB-Sensor, 3-axis digital sensor and temperature sensor is the practical and reliable way to monitor for bearing defects and high temperatures. The lower frequency sensor can be used so that 1X, 2X, 3X frequencies (imbalance, misalignment, and loose foot) can clearly be identified. Similar to case mounted sensors, the VTB-Sensor must be mounted on the bearings cap or near the outer race of the bearings. VTB-Sensor conforms to the intent of API670 standard and can be used on pumps that combine rolling element and sleeve bearing designs.

API610 Standard – Locations for Taking Vibration Readings on BB type of Pumps



Recommended Mounting Locations for VTB-Sensor





The dual 3-Axis sensor provides a unique vibration signature for each monitoring point that can be compared to other similarly located machines to insure optimal machine performance and plant wide reliability.

To provide the best machine casing location and sensor mounting procedure for the VTB-Sensors, please let our reliability team aware of the drive & driver components, and the existing environmental conditions.

Suggested Vibration Trip Levels

You can monitor the vibration levels in three simultaneous planes (X,Y, and Z) and in two vibration measurands, but, the velocity measurand is best for most balance of plant process equipment. This is because the velocity (ips) measurement is constant over a wide range of speeds and frequencies.

The suggested trip levels in the table below (blue text) are starting points but the recommendations provided by the most current API610 standard should be followed.

The table below provides some common machine vibration and temperature faults.

Common Machine Vibration and Temperature Faults

Machine Component/Fault	Frequency Order	Measurement Plane	Vibration Measurand	Comments
Motor/Imbalance	1X, 2X Motor RPM	Radial	Velocity, in/sec, rms	Small amplitudes of axial vibration can occur. Imbalance can be intensified by mechanical resonance. 1X Motor RPM vibration can also be caused by Soft Foot.
Motor/Bent Shaft	1X, 2X Motor RPM	Axial	Velocity, in/sec,.rms	Bent shaft can cause roller bearings misalignment.
Motor/Mechanical Looseness	1/2X,1/3X,1/4X,1X,2X, Motor RPM	Radial (Vertical)	Velocity, in/sec, rms	There may be some vibration levels on the horizontal plane, but, the amplitudes will be highest near the mechanical fault. Excessive coupling wear can lead to mechanical looseness.
Motor/Rotor Bar and Stator Defects	1X,2X,3XMotor RPM 2X Line Frequency	Radial	Velocity, in/sec, rms	Rotor Bar Passing Frequency (F_{RBPF}) = Motor RPM X No. of Rotor Bars. Broken rotor bars are common faults that cause electrical imbalance. Small amplitudes of axial vibration can occur.
Motor/Shaft/Coupling Misalignment	1X,2X,3X 4X,5X,6X, Low Level Harmonics	Axial and/or Radial	Velocity, in/sec, rms	Shaft/Coupling Misalignment may involve both Angular (Axial) and Parallel Offset (Radial) Misalignment. Misalignment can occur under the following conditions: 1. Machine alignment and installations errors; 2. worn roller bearings; 3. settling of bases, foundations, and tower structure; 4. shift of relative position of machines after installation.
Motor/Resonance	Less Than, Equal to, or Greater Than Motor/Fan RPM	Radial, Axial	Velocity, in/sec, rms	Resonance appears when a source frequency coincides with the natural frequency of the support structure, base foundation, piping, or mechanical component, e.g., rotor, gearbox, or belt driven systems. Resonance can be confirmed by verifying that a small change in speed causes the 1X Motor RPM vibration levels to change greatly.
BB3 & BB5 Centrifugal Pump	Number of Impeller Vanes X RPM	Radial Axial	Velocity, in/sec, rms	Cavitation can be caused by improper supply of process fluid. Mount the VTB-Sensor near the pump inlet (suction) area to monitor for cavitation. An impeller vane filled with foreign material or impeller erosion can lead to machine imbalance or misalignment. Turbulence – is induced when the fluid is forced to make abrupt changes in direction such as sharp bends in discharge piping. The dominant peaks occur at less than 1X RPM. Recirculation - may occur when the fluid flow of the pump is reduced by throttling the discharge valve. Mount the VTB-Sensor near the pump discharge area to monitor for this condition that can be caused by excessive throttling.
Starting points for overall vibration warning levels – defined as levels at which abnormal wear is occurring. Vibration analysis is recommended at this level. **0.0707 to 0.2121 in/sec, rms**				

Rolling Bearing Defects with Visible Damage to the Bearings	1X to 10X 10X to 50X	Radial	Velocity, in/sec, rms	The vibration frequencies begin to manifest themselves in the 5 KHz to 15 KHz range. As the roller bearing wear increases and approaches failure, there will be an increase in overall vibration levels in the 500 Hz to 2500 Hz range. For bearing defects within 1X to 50X Machine RPM, s**chedule a machine repair as soon as possible and inspect the roller bearings. If required, replace the roller bearings and find the fault(s) causing the bearing defects,** e.g., imbalance, misalignment, improper bearing loads, excessive bearing temperature, contaminated lubrication, or, insufficient bearing lubrication.
AC Motor Windings and Roller Bearings Gearbox Roller Bearings (Overheating)	1X Motor RPM	Radial Axial	Velocity, in/sec, rms	VTB-Sensor can detect and monitor for excessive machine heat that causes rapid deterioration of motor winding insulation and roller bearing damage that can lead to AC motor failure. Overheating in the AC motor bearings is generally lubricant-related. Normal motor bearing operating temperatures range from 140°F (60°C) to 160°F (71°C). Roller bearings in gear drives normally operate at 160° (71°C)-180°F (82°C). Overheating in motors and gearboxes can be caused by increased bearing loads due to machine imbalance or misalignment. Contamination of the roller bearings lubricant by solid particles, water, and other fluids can reduce the life of the bearings. Improper lubrication generally causes overheating or excessive wear in the roller bearings. These conditions can result from insufficient or excessive lubrication, improper lubricants, e.g., viscosity is the load bearing component of the lubricant. Too thin, then the bearings cannot properly carry the load; and too thick, then the amount of friction will generate heat.
				

Conclusion

With a combination of best practice techniques, correct setting of vibration and temperature alarm settings, and interpretation of vibration spectra, your BB3 and BB5 process pumps can be protected against rising motor and pump vibration and bearing temperatures. These machine faults can cause complete machine failure which cause plant processes to stop running. This technical note has practical suggestions to assist you in your vibration monitoring and protection application. While our product will not detect every vibration and temperature fault, we understand that every application requires practical machinery vibration expertise and involvement so that we can provide a customer focused solution. We want to support you with a reliable vibration and temperature product that successfully and consistently detects, monitors, and protects your equipment investment. Our team can provide vibration monitoring solutions and benefits for your present application and extend their vibration expertise and new technology to your entire balance of plant. Product and application information is available at www.machinesaver.com

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