Machinery health monitoring using displacement sensors

PC420DPP-40, 4-20 mA displacement sensor

2008

Wilcoxon
SENSING TECHNOLOGIES

PC420DPP-40 displacement sensor

- Added to Wilcoxon's successful line of 4-20 mA vibration transmitter sensors in April 2008
- Completes the choice selection for the customer
  - 4-20 mA acceleration
  - 4-20 mA velocity
  - 4-20 mA displacement

- Optimized for displacement measurements on rotating machinery
- Ideal for simplified, real-time and continuous 24/7 vibration monitoring when connected to a PLC, DCS or SCADA system

PC420DPP-40 displacement sensor

PC	420	D	PP	- 40

- **PC**: Designed to work with an existing process control system for machinery health and process monitoring
- **420**: Outputs a value between 4 and 20 mA that represents the overall vibration at the monitoring point

- **D**: The vibration is integrated to displacement to detect faults at the 1x running speed
- **PP**: Displacement is measured “peak-to-peak” – the farthest displacement from either side of center is combined for total displacement

- 40: Full scale displacement measured by the sensor is 40 mils, which is equal to .04” (English) or 1.0mm (metric)

Why measure vibration displacement

- Displacement is an easily understood parameter
  - Machine movement can be seen
  - Machine displacement has been the traditional way of monitoring a machine when no vibration sensors are available
  - Users want a ‘number’ to associate with the motion they feel when they touch a machine
- Balance specifications are given in mils displacement
- Before machine failure, imbalance level will increase
  - Monitoring displacement on a 24/7 basis will alert staff when the level increases
  - Unsafe levels can be established from guidance charts
  - Displacement level can be tied to alarms such as the iT401 vibration alarm

How does displacement relate to machine condition

- A machine's vibration level is established by the force generated by the rotating component
  - This force is transmitted to the outside case through the rotor containment method, usually the bearings
  - This force is related to acceleration by the following equation:
    - **Force = mass x acceleration**
  - The acceleration signal will emphasize high frequency vibrations (vibrations greater than 10 times the running speed)
  - Integrating the acceleration signal to displacement (double integration) provides a means of emphasizing the lower speed components of the machine such as 1x running speed
  - Running speed is associated with the machine balance condition, a desired quantity to know

What do the bearings do to the force generated by the rotating component

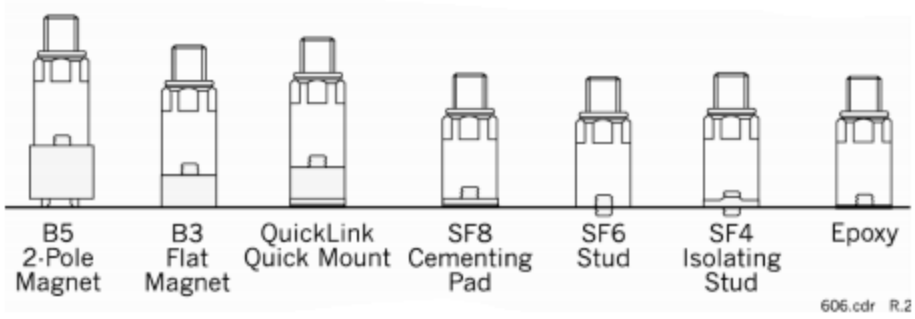
- Bearing are the mechanical interface between the rotating component and the machine outer case
  - Bearings can be roller element (ball or roller) or sleeve (babbitt)
    - Roller element bearing holds the rotating shaft firmly in place
      - Ball bearings offer maximum strength with the best axial and radial load characteristics
      - Roller bearings offer stronger side loading characteristics
  - Sleeve bearings are monitored using a different kind of sensor, a displacement probe
- The energy of the rotating shaft is transferred to the outer frame of the motor through the bearings
  - Bearing has a frequency dependent component known as stiffness
  - Stiffness can amplify or attenuate the force from the rotating component

Displacement measurements focus on balance and alignment conditions

- Capitalizing on the natural attenuation of high frequency components, the PC420DPP-40 sensor will best sense the 1x running speed of motors in the 900 to 3,600 rpm range
- As wear occurs in a machine, the imbalance level will increase as failure approaches
- Misalignment of shafts, often seen at 1x shaft speed, especially in the axial direction, will cause an increase in the imbalance
- It can be mounted on the end of a shaft rider to record its movement, documenting the balance condition of a sleeve bearing shaft

Mounting considerations

- The PC420DPP-40 should be treated like any other vibration sensor and be mounted as close as possible to the source of vibration
- It can be mounted in any orientation, horizontal, vertical or axial
- Stud mounting is preferred, but magnet mounting is acceptable
- Permanent mount installations should always use stud mounting



What type of output signal comes from the PC420DPP-40

- Output is a 4-20 mA signal
- Output is proportional to the peak-to-peak displacement level
- Full scale output (20mA) can be interpreted as 40 mils (peak-to-peak, English) or 1.0 mm (peak-to-peak, SI)

$$\text{Vibration level in mils} = \frac{(\text{reading in mA} - 4\text{ mA})}{16\text{ mA}} \times \text{Full scale vibration in mils}$$

$$\text{Vibration level in mm} = \frac{(\text{reading in mA} - 4\text{ mA})}{16\text{ mA}} \times \text{Full scale vibration in mm}$$

What type of equipment is the PC420DPP-40 suited to monitor

- Ideal for rotating equipment with a fundamental running speed between 300 rpm (5 Hz) and 3,600 rpm (60 Hz)
- Responsive to frequencies as high as 60,000 rpm (1,000 Hz), but displacement may “roll off” at high frequencies
- Fundamental belt frequencies are lower than the slowest shaft they are connected to and often are in the ideal frequency range
- Attaching the PC420D to a shaft rider allows shaft vibration to be recorded directly

4-20 mA process control products

Many facilities want to monitor machinery vibration, but don't want an expensive vibration program. 4-20 mA products keep track of vibration levels so that maintenance professionals can take action on machines that start trending upward (higher vibration).

- Output signals fed to a process control computer (PLC/DCS/SCADA) or directly to an alarm module
- No trained analyst needed
- ISO 10816 offers guidance on vibration limits for rotating machinery

4-20 mA transducers - LPS™

Wilcoxon offers the largest selection of 4-20 mA vibration sensors available

Loop powered sensors - LPS

- An accelerometer and signal conditioner in one transducer
- Average the overall signal:
  - Acceleration, velocity or displacement
- Output is r.m.s., true peak, pseudo-peak or peak-to-peak
- Loop powered
- Top exist, side exit, integral cable, instrinsically safe and explosion proof models available

Sensor networks: cables, mounting accessories and hardware

Wilcoxon manufacturers a full line of cables, mounting accessories, power supplies and boxes to provide customers with a complete sensor network

A full spectrum of custom cables

Wilcoxon builds cables to your specifications and our exacting standards

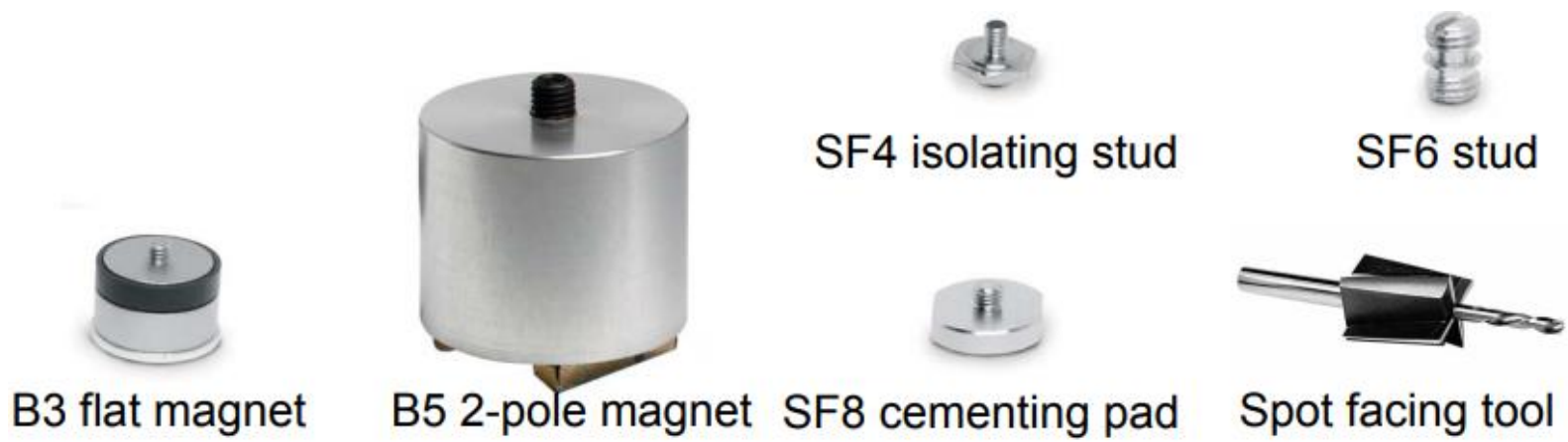
Wilcoxon offers a variety of cables and connectors to meet your vibration monitoring needs and beyond

- Select your cable
- Select your connector
- Extensive cable protection and environmental resistance options
  - Jacket options include Teflon® and spiral wrapped cable armor
  - Cables rated to 260°C
  - Ingress protection ratings to IP68
- Custom cable orders are usually built in less than a week
- Many standard cables ship the same day

Mounting accessories

When using piezoelectric sensors to measure vibration, the sensor must directly contact the machine surface. The more intimate and stiff the contact between the sensor and the machine, the better the ability to couple and measure high frequency signals.

Wilcoxon offers mounting options to fit virtually every machine and application. Below is a sampling of Wilcoxon's most popular mounting accessories:



Network connections

Junction boxes simplify taking route data by making multiple channels of vibration output available at one source for the fastest walk around data collection

- Terminal boxes
- Junction boxes
- Switchable/multi-channel junction boxes
- Switch boxes
- Expandable switchable junction boxes

Wilcoxon products

Precisely what you need

For more information, please contact Wilcoxon's sales and customer service team:

✆ +1 (301) 330 8811
✉ info@wilcoxon.com
💻 www.wilcoxon.com