Vibration Monitoring on a Variable Speed Drive Cooling Towers

Cooling towers are a critical asset to most power, petrochemical and oil and gas industries. In order to optimize performance and to save energy, large diameter, low speed cooling towers are equipped with Variable Speed Drives (VSD), allowing the cooling tower to run at the highest possible efficiency.

Due to the construction, these large diameter cooling towers have to cope with large forces in their construction and high stress factors in their components and joints. Fatigue is therefore a serious risk for these type of cooling towers.

Fatigue due to vibration is the result of continuous displacement induced stress in the materials and components of the cooling tower, e.g. blades, gearbox, construction, foundation and joints. Therefore it is required to monitor the vibration levels and trip the installation if the risk levels are exceeded.

Vibration measurements are typically velocity measurements (mm/s), based on EN-10816, while the maximum allowable displacement value of the cooling tower is in millimeters. For fixed speed cooling towers, the velocity equivalent of the maximum displacement value can be calculated and used as a trip level. For variable speed cooling towers, a fixed velocity value to equal the maximum displacement level cannot be used, due to the influence of the speed on the velocity / displacement ratio (figure 1).

Example:
A cooling tower running at different RPM, with a maximum allowed displacement value of 1 mm, could show the following measurements (1 x RPM operational speed):

Speed:	300 RPM	150 RPM
Velocity:	10 mm/s	10 mm/s
Displacement:	**0,6 mm pk-pk**	**1,27 mm pk-pk**

Based on the example, setting a trip level to a fixed velocity value of 10 mm/s will trip the cooling tower too early at 300 RPM, but too late at 150 RPM. This clearly shows that a fixed velocity level cannot be used to monitor and trip a variable speed cooling tower.

In order to monitor a variable speed cooling tower, the monitoring system must be configurable to use different velocity values at different RPM, and must be able to measure the RPM to use the matching velocity value (adaptive monitoring).

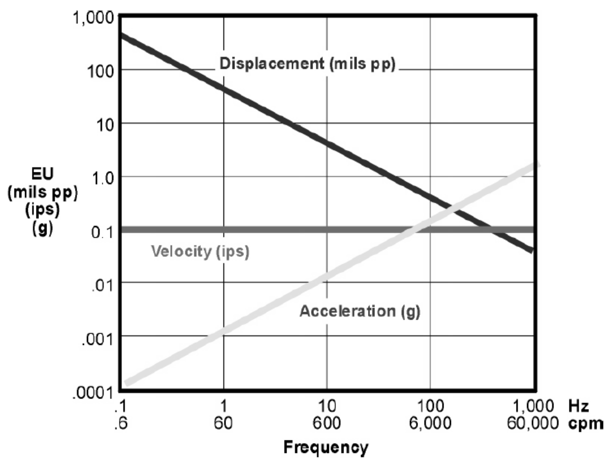

Figure 1. Relationship between displacement, velocity, and acceleration, at constant velocity with different RPM (frequency)

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How To Measure

Monitoring a variable speed cooling tower requires a system that can measure vibration and speed, and adapt the alarm and trip levels to the measured speed. The selection of the monitoring system components is critical to get the right results.

Transmitter

The ideal solution for this is the MEGGITT VibroSmart transmitter, a two channel transmitter with an additional speed input, a proven solution in variable speed cooling towers. By using its adaptive monitoring capability the VibroSmart can adjust its alarm and trip levels, based on the actual speed. Additionally, the second channel can be used to monitor the gearbox or to detect blade lift.

Sensor

Measurement of the low acceleration amplitudes at slow speeds requires special sensor designs and low noise electronics. Low frequency readings are generally expressed in terms of velocity (mm/s), or displacement (um peak to peak). Accelerometer measurements are electrically integrated or converted by software. Vibration can be measured with velocity sensors and proximity probes; however these devices lack the versatility of piezoelectric accelerometer. In many cases it is also required to be able to perform manual measurements, using the same sensor for Machine Protection and Condition Monitoring. In that case the only sensible solution is an acceleration sensor.

The most common mistake to use an industry standard sensor (typical 100 mv/g) and have the transmitter integrate this to velocity. 100 mV/g sensors are not real low frequency sensors. To achieve true low noise low frequency measurements, a sensor with a larger sensitivity is required (500 mV/g). These sensors have a higher reaction mass and therefore are more sensitive. Using a more sensitive sensor reduces the need for amplification and increase the signal to noise ratio. When integrating the signal to velocity, noise influences will create a phenomena called ski slope in the measurement, which may lead to the registration of high velocity levels, unrelated to the machine. The suggested sensor for a variable speed cooling tower is the MEGGITT 797L acceleration sensor.

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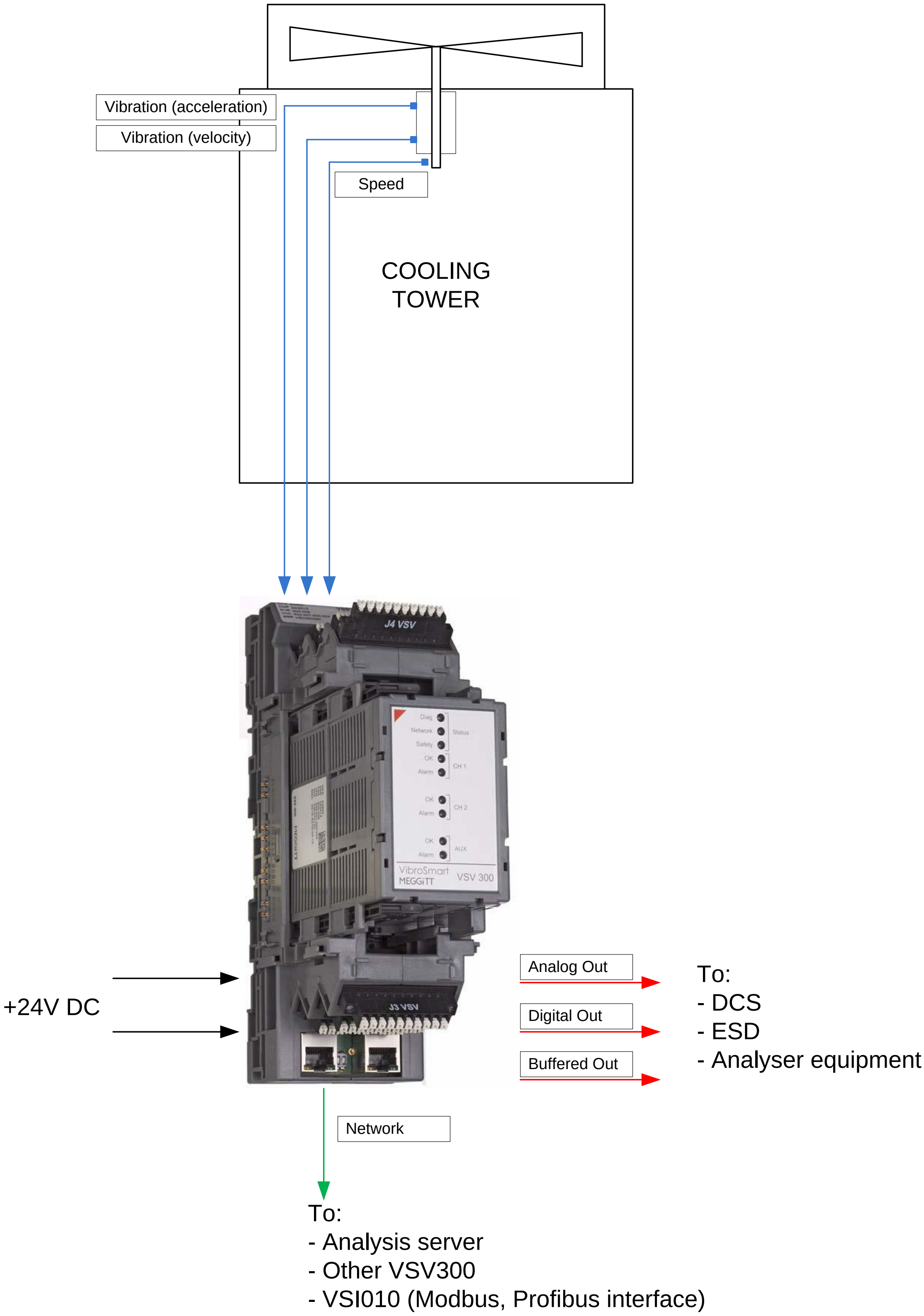

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