Condition-based maintenance functions – for maximum availability of your application

Why integrate condition-based monitoring into your maintenance strategy?

Integrating condition-based monitoring directly into your VFD system delivers clear, measurable benefits:

> Reduce unplanned downtime with early fault detection
> Lower maintenance costs by avoiding unnecessary manual inspections and external monitoring systems
> Extend equipment lifetime by continuously operating within optimal parameters
> Condition-based monitoring is no longer a luxury—it's a smart investment in uptime, efficiency, and long-term asset reliability

Built-in predictive and condition-based maintenance

Integrating predictive and condition-based maintenance, Danfoss VFDs represent a technological leap forward in VFD systems. These functions allow you to use the VFD as a smart sensor to monitor the condition of your motor, pump, sine-wave filter, and application, for early detection of potential issues, and to find solutions before they have an impact on the process.

An integral part of condition-based maintenance involves monitoring the condition of the equipment. In variable speed applications, the condition of the application often depends on speed. For example, vibration levels tend to get higher at higher speeds, although this relationship is not linear. Indeed, resonances can occur at certain speeds and then disappear when the speed is increased.

Using an independent system to monitor the condition of a variable speed application is complicated by the need for knowing the speed and the correlating monitored value with speed. Generally, external monitoring systems incur higher costs than integrated systems due to their more complex setup. This includes both the initial investment and ongoing maintenance.

VFD as a sensor

Using VFDs for condition monitoring ("VFD as a sensor" or "VFD as a sensor hub") is an advantageous solution, as the information about application speed is already present in the VFD. Additionally, information about the load/motor torque and acceleration is readily available in the VFD, and most of this analysis is conducted without sensors.

Setting up CBM

You can set various thresholds and automatically or manually determine the baseline for monitoring with different methods and according to relevant standards and guidelines, such as the ISO 13373 standard for Condition Monitoring and Diagnostics of Machines or the VDMA 24582 guideline for condition monitoring.

The condition-monitoring functions being embedded in the VFD are a unique feature. It means that the VFD can perform these functions without needing a connection to the cloud or to a PLC. Danfoss Drives' edge-based condition monitoring provides cost-optimized, patented, independent monitoring. By collecting, analyzing, and storing data within the VFD, it eliminates extra costs and monthly fees for external data collection.

However, Danfoss VFDs are also capable of cloud connectivity, and the condition monitoring data can be pushed to the cloud. Using cloud or fieldbus connection enables you to monitor a large number of conditions (such as stator winding insulation or the vibration level of the application) at plant level, or to perform in-depth cloud analytics.

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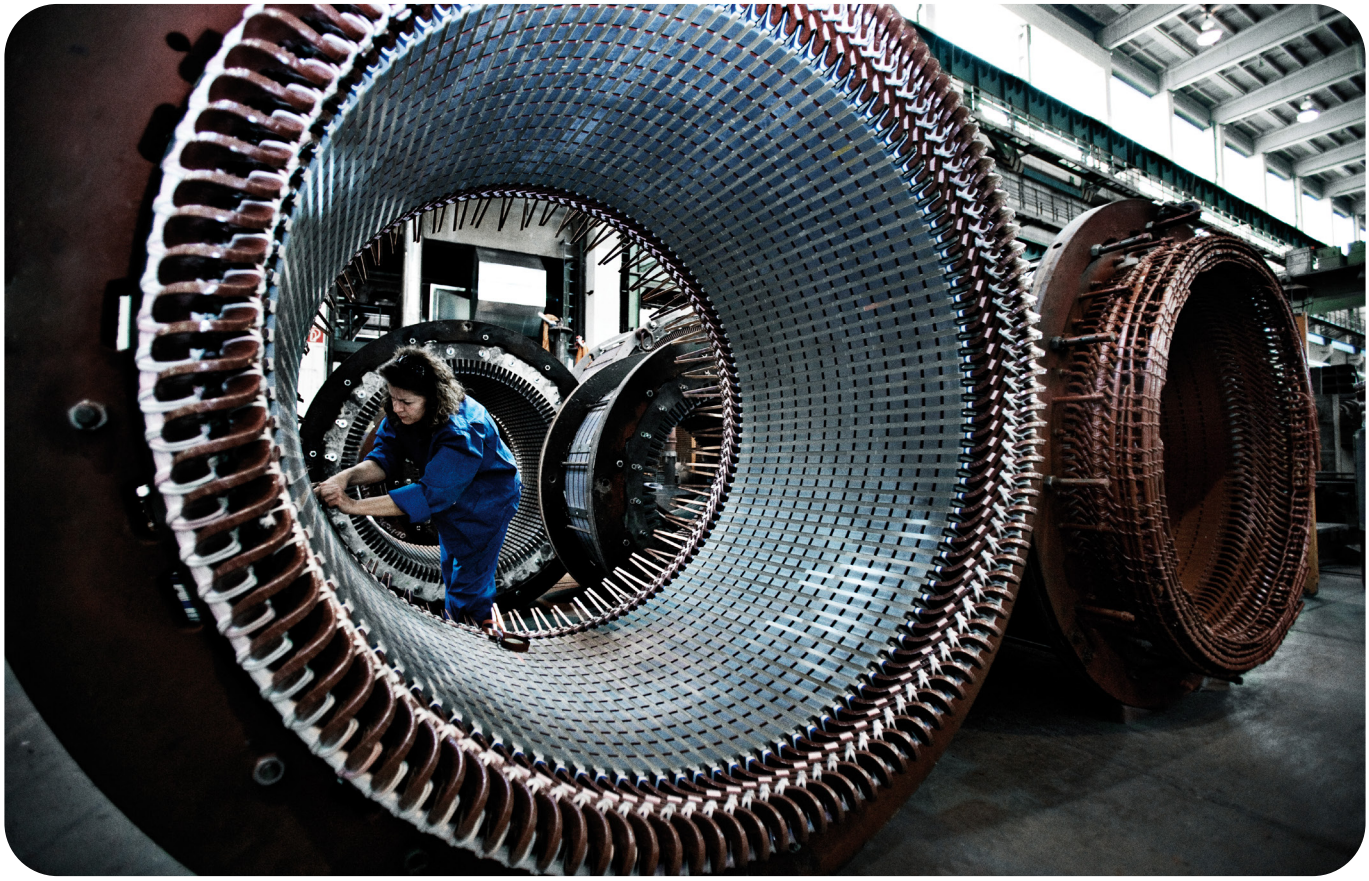
The integrated condition monitoring function helps us enormously with maintenance... In effect, the CBM capability acts as an invisible safety net protecting the system from within.

- Troels Nim Andersen,
Project Manager at Universe Science Park

Motor-stator-winding condition monitoring

Motor-winding failures do not occur suddenly; they develop over time. They start with a small single-turn short- circuit fault which causes additional heating. The damage then spreads to a level where the overcurrent protection is activated and the operation is stopped, causing unwanted downtime.

The unique and sensorless Danfoss Drives winding condition monitoring function allows you to shift from corrective maintenance of faulty motors to detecting motor isolation faults at an early stage and dealing with them during scheduled maintenance. In this way, unwanted and potentially costly machine downtime caused by ‘burned’ motors can be avoided.



↑ Unplanned shutdowns caused by winding failures can be prevented. Danfoss Drives’ advanced monitoring detects early insulation issues, so you can act before minor faults become major breakdowns.

Vibration monitoring in the VFD enables early detection of mechanical wear, using real-time data correlated with load and speed to prevent damage to your system's critical components.

VFDs from Danfoss continuously monitor sine-wave filter capacitors, detecting degradation over time. When preset thresholds are reached, warnings allow you to take corrective actions before failure.

Mechanical-vibration monitoring

The accelerated wearing out of mechanical parts of a VFD system can be avoided by using the Danfoss VFD together with a sensor – an external vibration transducer – to monitor the vibration level in a motor or application.

The available functions are baseline measurement, broadband trending, vibration during acceleration and deceleration and transient-vibration trending.

Vibration monitoring is performed using standardized methods and threshold levels given in standards such as ISO13373 for Condition Monitoring and Diagnostics of Machines or ISO10816/20816 for Measurement and Classification of Mechanical Vibration.

The advantage of performing this kind of monitoring in the VFD is the possibility to correlate data with the actual operating conditions, such as steady-state running/ramping, load condition or speed.

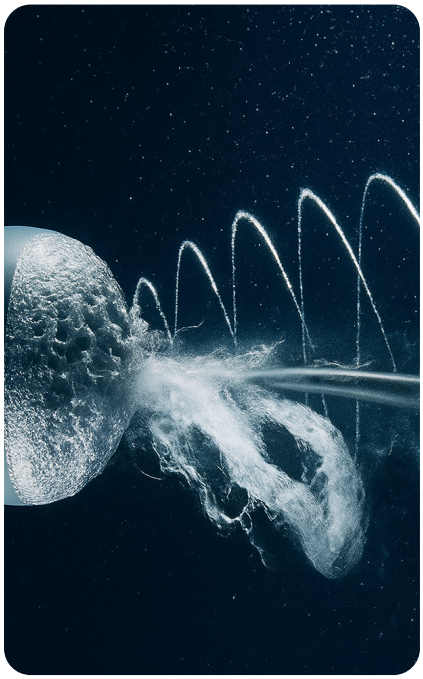
Sine-wave filter monitoring

Sine-wave filters are often part of critical applications which rely on optimal control from the VFD. The sine-wave filter monitoring function measures and supervises capacitor degradation using internal sensors in the VFD. The advanced control generates a specific excitation and reads the resulting signature from the current and voltage signals. Using this method, the Danfoss VFD determines changes in capacitance by comparing the present value to a baseline value recorded during the initial operational life.

After the initial baseline measurement, the monitoring phase starts by which the capacitors in the sine-wave filter are measured every two days.

If a trigger point is exceeded, a warning or alarm will be raised, and corrective action can be planned.

Changes in load behavior indicate developing faults. Load-envelope monitoring identifies deviations caused by wear or blockages — helping you plan maintenance early, avoid downtime, and optimize energy use.



Cavitation creates noise, vibration, and heat — warning signs of pump stress. Our sensorless monitoring detects cavitation early and automatically adjusts speed to protect equipment and performance.

Integrated g-peak sensors detect early bearing wear by measuring vibration levels, helping you take timely action before costly damage occurs. The same sensor also supports cavitation detection and speed control in pump applications.

Load-envelope monitoring

By comparing the actual load curve to the initial values determined during commissioning, the VFD allows you to detect unexpected operating conditions, for example leakage in an HVAC system. Other instances of issues in applications include pumps which have become fouled or sanded, or fans where the air filters have become clogged. This is done without sensors.

When a part has worn out, the load curve changes compared to the initial baseline, and a maintenance warning is triggered allowing you to quickly and effectively remedy the issue. This can also help you to save energy by keeping the equipment running in optimal conditions.

Cavitation and control monitoring

Cavitation is a major threat to pump performance, leading to costly damage and downtime. Cavitation generates turbulence, resulting in audible noise, vibration and increasing temperature. Danfoss sensorless cavitation detection utilizes advanced current measurements and sophisticated condition-based monitoring algorithms to identify this cavitation. The system compares the real-time cavitation measurements against user-defined thresholds at baseline. When these thresholds are exceeded for a specified duration, the system flags that pump is cavitating.

When cavitation is detected, the system can continuously change pump speed to re-establish an optimized pressure/flow relationship. This eliminates cavitation. Once the issue causing cavitation is resolved, the system can automatically return to the user-defined set point. The VFD reports when pump speed is changed to avoid cavitation.

Bearing wear-out monitoring

Thanks to g-peak sensors, Danfoss VFDs can detect and notify early bearing wear. G-peak sensors measure vibration levels indicative of bearing wear, allowing for proactive maintenance and preventing costly failures. The VFD generates an alarm signal or sends a notification when potential issues are detected.

The same sensor can be used for pump cavitation detection. By precisely controlling pump speed, the VFD can minimize conditions that lead to cavitation. This is ideal for applications in water treatment plants, irrigation systems, and industrial cooling.

It's important to note that these functions don't provide diagnostics or root cause analysis.