

What is ABB MACHsense-R?

ABB MACHsense-R is a service for monitoring the condition of motors and generators which is provided by ABB Local Service Centers. It is a remote monitoring service using sensors that feed signals to a fixed Data Analysis Unit installed either on or near the motor or generator. Data is collected continuously and transmitted wirelessly to an ABB server. The service aims to identify faults at a much earlier stage than previously possible so that the findings can be integrated into preventive maintenance schedules. The customer can access the server via the internet to view the overall status of the motor or generator, trend graphs, etc.

What is the output of ABB MACHsense-R?

The measured data are analyzed to provide insight into the motor or generator's condition from the viewpoint of:

1. Rotor bar defects (for squirrel cage induction motors)
2. Installation problems (mechanical condition - unbalance, misalignment, looseness, soft foot, etc.)
3. Bearing problems - anti-friction and sleeve
4. Operating parameters
5. Cooler fouling (if winding temperature is available for measurements)

Based on the findings, a preventive maintenance strategy can be prepared for the equipment in order to increase reliability and reduce costs.

What parameters are measured?

The system collects vibration data (four channels) and temperature data (five channels). Vibration is measured using accelerometers mounted at carefully selected locations (bearing housing, body, etc.) to ensure that the necessary signals are picked up. Temperature is measured using RTDs (resistance temperature detectors); in most cases three RTDs are mounted on the winding and two in the bearings. DAU will be able to receive signals from spare RTDs. It is not be able to share the signals from RTDs such as with PLC and others.

Will I have to open the motor or generator to install RTDs on the winding?

In the case of ABB motors and generators, most customers choose to order products with RTDs installed. The necessary signals can then be directly tapped from the RTDs into the MACHsense-R Data Analysis Unit. If the motor or generator – whether supplied by ABB or another manufacturer – does not have RTDs available, it may be possible to install them in the bearings and end windings, for example. Installation in the core will not be possible.

What happens if RTDs cannot be installed?

Even without RTDs, ABB MACHsense-R will still be able to assess the condition of the motor or generator based on vibration measurements. However, without RTDs it will not be possible to detect fouling of the cooler.

How are the vibration sensors mounted?

Steel blocks are fixed to the mounting location using high quality adhesive. The blocks are then drilled and tapped to mount the accelerometers.

How does the Data Analysis Unit work?

The Data Analysis Unit is a core element of the entire service. Its Linux-based embedded processor runs the complete ABB diagnostic software suite, monitoring the motor or generator and processing the vibration and temperature data on-board. Key Condition Parameters (KCPs) are generated for each different fault, and it is these KCPs that are transmitted to the server.

What do you mean by on-board processing? What are KCPs?

The software in the unit incorporates a number of algorithms developed by ABB's Corporate Research Centers. These algorithms process the raw signals to extract useful information.

Each KCP is a measure of a typical fault. It provides a direct understanding of the fault, rather than merely reflecting the overall amplitudes of the signals. To understand the rotor bar condition, for example, the algorithm assesses the specific location of the spectrum, spacing of the sidebands at slip frequency, etc. and converts them into numerical values. This data is normalized with respect to load by the Autoscan feature, and the normalized value is the KCP indicating the rotor bar condition.

The KCPs for other faults are generated in a similar way. They include:

Rotor bar damage: rotor bar index

Eccentricity: dynamic and static eccentricity values

Operating condition: slip versus load graph, line frequency, speed

Bearing: BeAM (Bearing Asset Monitor) and BeaCon (Bearing Condition), crest, etc.

Installation: Principal Component Analysis (measures unbalance, misalignment, looseness)

Cooler fouling: temperature versus load graph

How does ABB MACHsense-R differ from other condition monitoring services?

ABB MACHsense-R is a unique tool for motor and generator analysis. Conventional remote or online condition monitoring systems transmit only raw data, which is input into a SCADA system. Trending of overall amplitude, such as vibration velocity, is computed and compared with a benchmark, usually the ISO 10816 standard. When the computed value exceeds the benchmark, an alarm or alert is activated.

With ABB MACHsense-R it is the KCPs rather than the overall values that are monitored. If an alarm is triggered then the customer is given clear information on what fault has caused the alarm. In short, when an alarm is generated there is no need to do a detailed analysis to identify the fault.

Another major strength of the service is the web portal.

How does the ABB MACHsense-R web portal work?

The KCPs generated within the Data Analysis Unit are transmitted wirelessly via GPRS or 3G to an ABB server. The ABB MACHsense-R web portal handles all data management tasks. The customer is authorized to log in to the portal to view data, trend graphs, operating parameters, health condition summaries, etc. The customer can also download reports directly from the portal.

An important advantage of this 'cloud based' model is that the customer can access the data from anywhere in the world. Corporations with activities in different locations can quickly and conveniently monitor key performance indexes for critical motors and generators, no matter where in the world they are located.

Another key function of the portal is alarm management.

How does the portal manage alarms?

If a KCP exceeds the alarm limit, this indicates that 'something is no longer all right' and action should be taken. As ABB MACHsense-R can monitor performance on a continuous basis, any small deviation of the KCPs from normal observed values will be detected immediately. To prevent false alarms, however, a delay is provided to verify whether a fixed number of KCPs in series are above the threshold values. When an alarm is activated, the Data Analysis Unit uploads all the raw data to the server. The portal immediately sends SMS or e-mail messages to the customer's registered contacts and, by default, to the nearest ABB Local Service Center (LSC). These messages contain detailed information about the motor or generator and type of KCPs which have triggered the alarm. This ensures that quick checks and, if required, corrective action can be carried out to prevent any unscheduled failure of the equipment.

The alarm is also notified to ABB's Regional Technical Center, which will generate a detailed report on the condition of the motor or generator and send it to the LSC. The customer will be approached by the LSC with the detailed report containing an analysis of the situation and a suggested action plan.

Alarms are also provided if there is a 'system fault' ie, if data is not getting captured due to either cable, connector or sensor failure.

What are the key benefits of the ABB MACHsense-R web portal?

The ABB MACHsense-R web portal provides the following key benefits:

1. Customers can access all information via the internet at any time.
2. Easy-to-use, web based tool providing all the available information on the health of the motor or generator.
3. Displays available in the portal include:
 - Summarized condition (for plants where multiple motors or generators are monitored)
 - Overall vibration (velocity, acceleration and displacement)
 - Line frequency and speed
 - Slip versus load curve
 - KCPs
4. Complete back up support available at time of alarm generation.

How are the alarms set for the KCPs?

ABB's MACHsense solution treats each motor or generator as an individual unit. It therefore follows that common benchmark values provided in standards like ISO 10816 cannot hold good for all products. For this reason ABB MACHsense-R 'starts from scratch' to generate alarm levels for each motor or generator.

In addition, it is essential to know the operating slip parameter to analyze typical problems like rotor bar damage, eccentricity, etc. Conventional methods utilize nameplate slip, which introduces false positives and negatives into the analysis. To avoid these types of problem, when the ABB MACHsense-R hardware is installed an ABB engineer will use ABB MACHsense-P to perform measurements on the motor or generator in its operating condition.

During installation, measurements are performed with ABB MACHsense-P to determine:

1. Actual operating slip
2. Operating load
3. Operating speed and line frequency
4. Relationship between load and slip
5. Operating level of each KCP

The above results are used during configuration of the Data Analysis Unit and setting of the KCP alarm levels.

Slip is calculated for every measurement and compared to the slip versus load curve. Deviations are immediately detected. Any variation in slip indicates a variation in load. This is used along with temperature measurements to determine whether cooler fouling has occurred.

What about security? How safe is the web portal?

The portal is hosted on an ABB owned server with secure VPN (virtual private network) access and it is well protected from viruses, bugs, spam and other unauthorized interference. Only authorized personnel can access the portal, and each customer is given access only to the equipment in their own plant. This means that no-one is able to view any information on other customers' equipment or plants.

What methods are available for transferring data to the server?

The Data Analysis Unit supports various options for transferring data to the web portal. The recommended transfer method is GPRS or 3G by means of a SIM card installed in the unit. Data communication costs can be kept to a minimum as only the KCPs are transferred and the amount of data involved is very low. Another benefit of this method is that it avoids the need for data to pass through firewalls at the customer site.

For those cases (expected to be fairly rare) where network coverage is not available, the hardware supports other options:

1. WiFi – transfer via WiFi to an internet-connected computer, which transfers data to the portal
2. Ethernet cable – transfer via ethernet cable to an internet-connected computer.

In both of these cases permission is required from the local IS team to allow data through firewalls.

How does the analysis performed by ABB's software compare with conventional methods?

1. Conventional methods use nameplate information for calculating slip. ABB's solution estimates the actual operating slip from measured data.
2. In the case of rotor bar defects, the operating load is taken into account to normalize the data before the severity is determined.
3. Better signal processing techniques help to correctly locate the sideband amplitude and frequency.
4. Vibration data effectively confirm any mechanical issues.
5. Unique bearing analysis algorithms help to detect any impending faults well in advance.
6. The slip versus load curve helps to determine any abnormalities in the functioning of the cooler.

How is cooler fouling identified?

Initial measurements taken with ABB MACHsense-P effectively determine the relationship between slip and load (kW). Any change in the operating load is identified from the calculated slip. When the load increases, accompanying increases will be seen in the temperature. If the temperature increases with no change in the load, however, this could indicate a cooling problem.

How does ABB MACHsense-R assess bearing problems?

ABB MACHsense-R uses two special algorithms - BeAM (Bearing Asset Monitor) and BeaCon (Bearing Condition) - to analyze the condition of the bearings. The algorithms are based on the demodulation method. Special processing methods are also used to reduce noise and identify those signals that are likely to be from the bearing only, filtering out

the rest. Various other parameters - such as Crest, Kurtosis, HF RMS, HF Pk-Pk - are also calculated to assess bearing condition. These methods ensure that the condition of the bearings is understood correctly and any impending fault is diagnosed early.

Does the software contain a complete bearing database?

Yes. SKF and FAG bearing information, especially related to the fault frequencies of different bearing components, is built into the software. The user simply has to input the bearing number and the software will automatically recognize the related bearing information.

Is ABB MACHsense-R limited to specific types or sizes of motor or generator?

ABB MACHsense-R provides full functionality for any type or size of motor or generator. ABB manufactures a wide range of motors and generators and its corporate research centers have undertaken extensive research to identify fault patterns for different types of electrical motors and generators. The results of this work have been incorporated into the ABB MACHsense-R Data Analysis Unit. Any new findings and the algorithms subsequently developed can easily be added in the form of patches from the web portal. Upgrading is therefore a continuous process, as work is on-going to refine and fine-tune the algorithms. ABB MACHsense-R already has the capability to analyze VFD driven motors and special algorithms enable it to assess the condition of generators, including detection of damage to the magnetic slot wedges. Additional sensors are being developed to enable ABB MACHsense-R to monitor the condition of the carbon brushes in DC and slip ring motors.

ABB MACHsense-R can therefore be used on any type, size, or make of rotating electrical motor or generator.