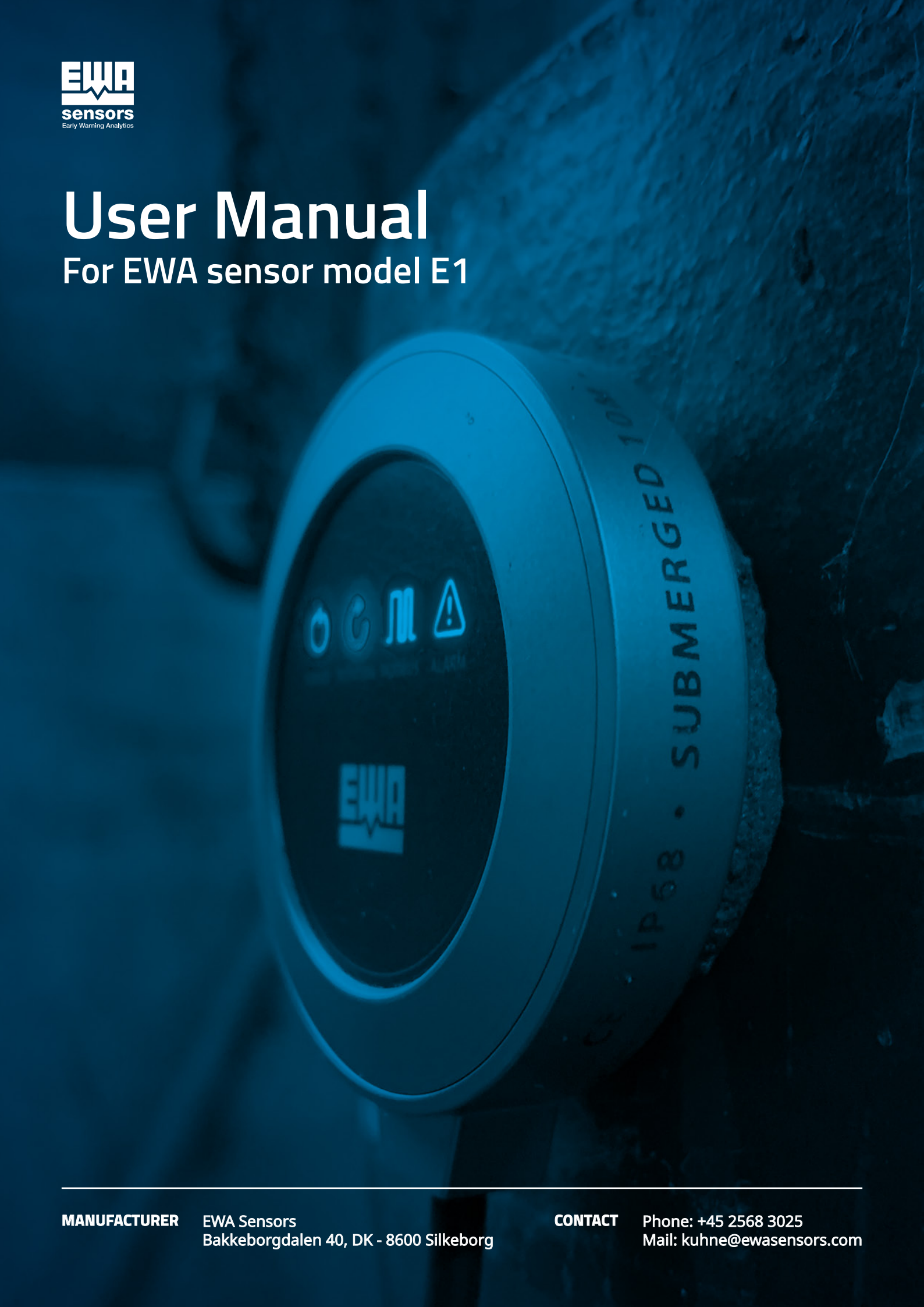
User Manual

For EWA sensor model E1



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Introduction

The sensor is for condition monitoring and health assessment for rotating machinery. The purpose of the sensor is to capture the essential operation of the machine.

The sensor is a hybrid sensor where robustness comes by using a multi sensor approach. All processing and analytics are executed in the sensor itself. Edge-computing, calculating a long range of parameters and sending them out on the sensor fieldbus. The sensor works continuously and in real-time, updating all parameters on the sensor fieldbus every second.

LEDs on the sensor front indicate the overall machine status, for walk-around service people.

Condition monitoring

The sensor calculates parametre, related to the machine, the motor and the process.

Motor

Electric rotation speed - RPM

The stator RPM is the rotation speed of the rotating magnetic field in the motor - also known as the synchronous speed. The rotating speed of the rotating magnetic field depends on two factors: the number of pole pairs P, and the frequency (Hz) of the power supply F, and it can be calculated as F*60/P. For a 6-pole motor @50Hz, the stator RPM = 50Hz * 60 RPM/Hz / 3 pole pairs = 1.000 RPM.

Mechanic rotation speed - RPM

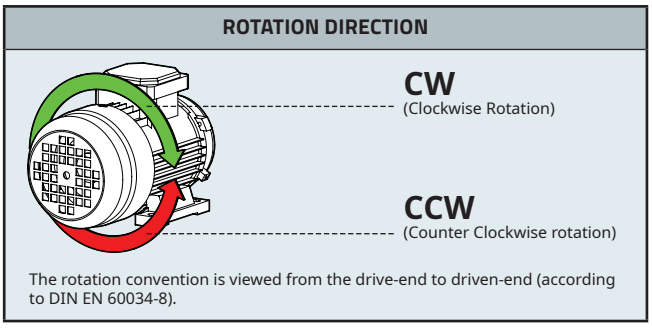
The rotor RPM is the actual rotation speed of the motor shaft - also known as the asynchronous speed. For induction motors, the rotor RPM will always be lower than the stator RPM due to the lagging of flux current in the rotor with flux current in the stator. In a permanent magnet motor, the rotor RPM will follow the stator RPM. In general - rotor RPM ≤ stator RPM

Slip Speed - RPM

Slip Speed is the difference between the electrical and mechanical rotation speed. Slip Speed increases with increasing load, as it provides a greater torque on the shaft. For permanent magnet motors, the Slip Speed is zero.

Rotation Direction

This parameter states the rotation directions of the motor - Clock Wise (CW), Counter Clock Wise (CCW) or no rotation.



System

Duty Cycle

Duty cycle express the relation between machine operation time and total observation time. The parameter is continuously calculated, stating the actual duty cycle for the last 24 hours. A duty cycle of 25% will have a machine running in total of 6 hours for the last 24 hours.

Number of start/stops

This parameter states the number of machines starts, for the last 24 hours.

Number of start/stops Total

This parameter states the accumulated number of machines starts for the lifetime of the installation.

Operation Time

This parameter states the machine operation time, for the last 24 hours.

Operation Time Total

This parameter states the accumulated machine operation time for the lifetime of the installation.

Magnetic Strength

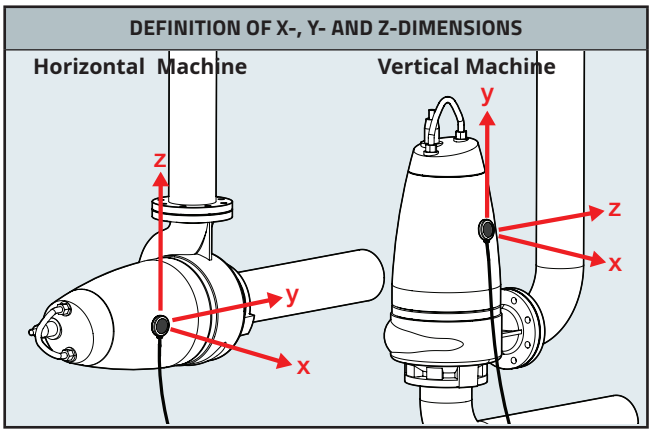
The parameter states the actual strength of the magnetic field from the motor.

Cavitation

Cavitation in e.g. a pump is the rapid creation and subsequent collapse of air bubbles in a fluid. In many cases, the force of cavitation is strong enough to pit metal components of the pump, like the impeller, and damage pump seals. This parameter measures the impact level of Cavitation. Cavitation is supported by baseline tracking and warning/alarm levels.

Vibration RMS

The vibration level is measured in separate directions x, y and z from 5-1.000Hz, in mm/s RMS average. All three directions are supported by baseline tracking and warning/alarm levels.



Secondary Impact

Secondary Impact is caused by vibrations acting on the bearing while in a non-rotating state. Bearings are very vulnerable to vibration, when the machine/motor is not rotating as the balls are impacting the raceways in isolated points. The Secondary Impact parameter measure the precentrices amount of vibration energy received by the bearing, while the machine was not operating against the total received energy. A level below 10% indicate a good installation, and a level above 30% indicate an installation with too stiff piping/foundation.

Temperature

Monitoring of the skin temperature. As the temperature is measured inside the sensor hours, the level will be offset by 10-15 degrees. The temperature reading is therefore more useful as a relative measure, than for an absolute measure. As an example, a change in temperature can be an indication of motor fault or pump blockage. Temperature is supported by baseline tracking and warning/alarm levels.

Machine faults

Unbalance

Unbalance is the uneven distribution of mass around a rotating axis. During rotation, the unequal mass will create a centrifugal force, resulting in force on the bearings, especially at higher speeds and can lead to damage of bearings and finally to destruction of machine. Unbalance is measured as the velocity vibration level (mm/s RMS) at the rotor rotation RPM. The Unbalance parameter is supported by baseline tracking and warning/alarm levels.

Gear Mesh Vibration

The gear mesh frequency, also called “tooth mesh frequency”, is the rate at which gear teeth mate together in a gearbox. It is equal to the number of teeth on the gear times the RPM of the gear. The vibration level of the gear mesh frequency is a tell-tale sign of gear wear, and it is measured and supported by baseline tracking and warning/alarm levels.

Bearing Fault Detection

Different kind of wear can occur in bearings, due to an improper bearing installation or due to high operation load, and they increase over time. Wear can be on inner cage, outer cage, and on the rolling bearing elements. The tell-tale sign of bearing wear is non-synonymous vibration, and this parameter measure the level of non-synonymous vibration as the severity level for bearing wear. The parameter is supported by baseline tracking and warning/alarm levels.

Machine health

Machine Health

This is an overall machine health parameter, to give a quick overview for the single machine’s health status. This is if the machine is running as intended, a warning if an issue as to be looked after and an alarm if the is a fault that needs an action.

Parameter limits and use of data information

Parameter limits

Each parameter generates its own dynamic baseline. The baseline is individual and unique for each machine, depending on the actual machine and its overall condition.

If a machine has been serviced, a new baseline is automatically calculated and used. The baseline is defining the normal / good operation area.

Warning Defines a fault level, where maintenance people have to be aware, follow the development and eventual plan service.

The Warning level is also dynamic, and default defined as 2 times the baseline.

The default level is adjustable over the Modbus

Alarm Defines a level, where service actions have to be carried out very soon.

The Alarm level is also dynamic, and default defined as 3 times the baseline.

The default level is adjustable over the Modbus

Using the data information

All data, in form of parameter information, is available on the Modbus, each second. Control system decides on how often data is collected.

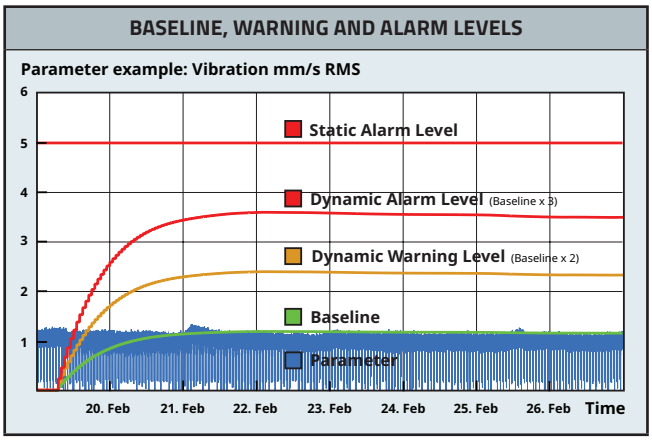
Trend curves

Parameter status can be logged, showing the actual parameter trend curve over time. This gives a good overview on how fast a fault develop over time, and is important information in the actual service planning.

When the trend curves are plotted in curves, together with the parameter information limits, it creates a quick overview over the parameter development over time.

Warning Log and Alarm Log

When a parameter exceeds the Warning or the Alarm limit, it generates a Warning respectively an Alarm.
This information is available and can be in a log-file, used for service and maintenance planning.



Installation process

This installation guide takes you through a 4 step installation process, to secure a fast and correct installation of the EWA sensors.

To succefully install the EWA Sensor you must use the recommended adhesive or similar, and the electrical installation must be carried out by a professional electrician.

The LEDs on the sensor will provide information during the installation process.

To complete the installation succesfully all 4 steps of the installation process must be followed in numerical order.

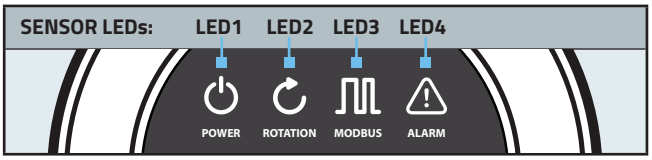
1. **Electrical sensor installation**
2. **Mounting position**
3. **Sensor mounting**
4. **Final check**

Sensor removal

The sensor can be detached, if relevant.

Sensor LEDs

The sensor has four LEDs:



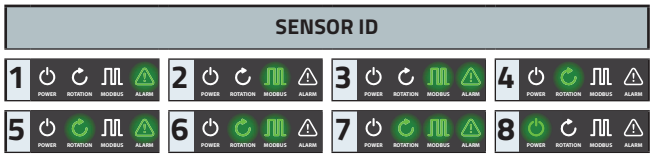
LED1	Power
Green	when power on sensor.
Red	when sensor monitoring signals exceed the dynamic range.
No light	when there is no power on sensor

LED2	Rotation Direction
Green	when CW rotation direction.
Red	when CCW rotation direction.
No light	when there is no rotation.

LED3	Modbus
Green	when there is communication on the Modbus line.
Red	when there is a communication error.
No light	when there is no communication on the Modbus line.

LED4	Machine Health
Green	when the asset is healthy, with no faults.
Red flashing	When there is one or more warnings
Red	when there is one or more alarms/faults, where action is needed.

Identification of sensor ID no.



When the sensor is powered-up, the sensor LEDs will indicate the actual sensor ID no.

- The sensor is powered-on / power resetted
- The sensor LED will light-up with GREEN light, indicating the binary sensor ID number (read from right).

- This light will be on for 2 sec., the return to READY STATE, indicating LED1 as GREEN.

1. Electrical sensor installation

1.1 The sensor cable is electrical connected to the PLC / control system (the Master)

This secures power consumption to the sensor and establishes the Modbus communication with the control system.

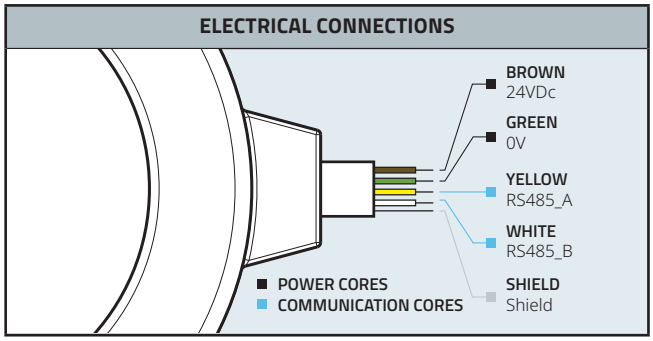
1.2 Sensor interfacing:

1.2.1 Two wires are used for sensor power supply (brown/green).

1.2.2 Two wires are used for Modbus fieldbus communication (white/yellow)

1.3 Check power to the sensor

When the power is supplied to the sensor, the LEDs will indicate the actual sensor ID for two seconds (see section **Sensor LEDs**), and the LED1 indicates fixed GREEN light.



NB. The sensor shield must be connected to the system Common.

2. Mounting postition

The sensor has to be mounted in a position with both good vibration signal and a good magnetic field signal. The sensor will aid you to identify the optimal position.

2.1 Turn on power to the sensor
Power is on, when sensor LED1 shows fixed GREEN light.

2.2 Identify the mounting position - horizontal machine
The motor must be running during the following steps:

2.2.1 Stand behind the machine, in the driver/motor end.

2.2.2 Mount the sensor on the right side of the machine, when looking from the motor end, with the sensor cable pointing towards the floor.
If LED1 indicates red, the position is bad, and you must move the sensor slightly until it shows green.

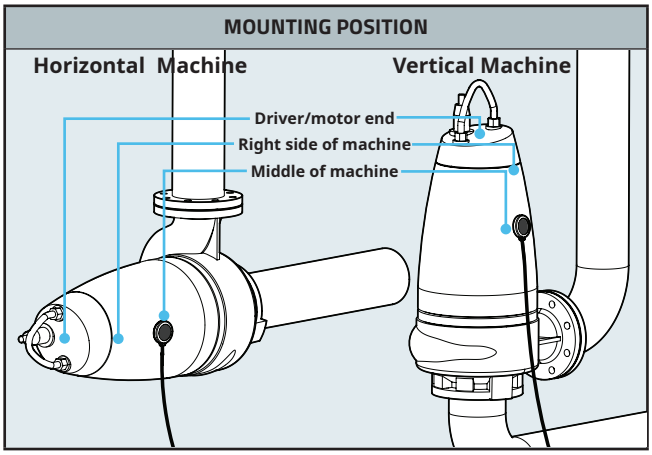
2.2.3 The sensor should be mounted on the middle of the machine with good mecanical contact to the machine.

2.2.4 If the motor is running clockwise this should result in LED2 showing a green light, for CW rotation.
If the motor is running counterclockwise, LED2 shows a red light.

2.2.5 If there is no light in LED2, and the motor machine is running, move the sensor in either vertical or horizontal direction, until the led shows rotation light.

2.2.5 When good mounting position is identified, the sensor can be final mounted.

2.3 Mounting position - vertical machine
If it is a vertical machine, and you stand in front of it, imagine that the machine is tilted and lies in a horizontal position.
Then follow the instructions outlined in section 2.2.
Mounting the sensor as described in section 2.2.1 – 2.2.3., secures a green light for CW rotation.



3. Sensor mounting

The sensor can be mounted in different ways, as long as it has good mechanical contact with the machine, e.g.:

3.1 Non-invasive using any kind of glue
3.2 On magnetic machines, a magnet can be glued to the sensor

Different kinds of glue can be used. EWA can recommend Loctite EA 3463 (epoxy glue), or similar.

3.1.1 Prepare adhesive amount

- Use ¼ stick of Loctite EA3463, for mounting on a machine with smooth surface
- Use ½ stick, for mounting on motor cooling grill
- Use 1 stick, for mounting on submerged machine

3.1.2 Prepare adhesive

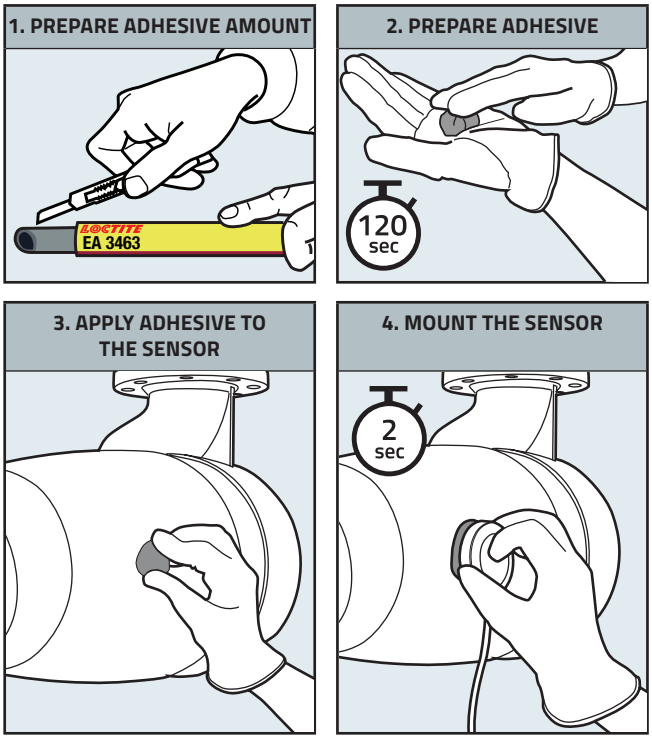
While wearing gloves, take a small amount of the adhesive. Knead it with your hands, until the two-component adhesive is mixed, (about 120 sec.), and form a ball.

3.1.3 Apply adhesive to the sensor

The adhesive ball is applied to the machine on the identified sensor mounting position. Apply small pressure.

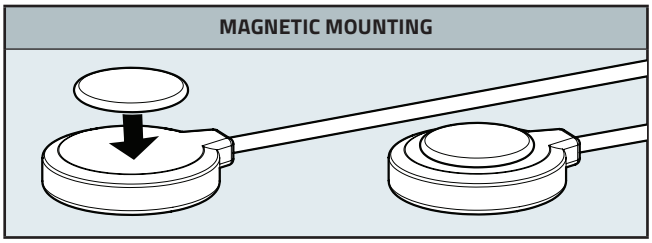
3.1.4 Mount the sensor

The sensor should be mounted immediately to the adhesive, as the adhesive will be hard within a few minutes. Apply pressure on to the sensor for a few seconds.



3. Sensor mounting - continued

3.2 Magnetic mounting
Magnetic mounting can be used, if the machine is magnetic.
A magnetic element can be glued on the sensor.



4. Final check

The sensor is now mounted on the asset, and power is supplied to the sensor. During the final check, the machine must be running.

4.1 Sensor powered (LED1)
LED1 will show fixed GREEN light, indicating that the sensor is power supplied. If the LED indicates red light, the measured signals from the machine is too strong and the sensor must be moved to a position where the light shows green.

4.2 Machine rotation direction (LED2)
Start the machine, or wait until the machine is running. LED2 indicates the asset rotation direction, and will either show fixed GREEN or fixed RED, depending on the rotation direction – both indications are approved.

4.3 Communication control (LED3)
Communication of data on the field bus will take place on request from the Master – both when the asset is running and when it is stopped. Requests can be e.g. once per second, which will be indicated by a visual fixed GREEN light at LED3.

4.4 Asset health status (LED4)
Fixed GREEN light at LED4 indicates a healthy asset. Flashing red indicates a warning, and a continous red indicates an alarm.

4.5 Forced sensor reset
The sensor starts calculating the baselines after power-up, and any impact during the installation procedure could offset these levels. Good practice is therefore to reset the sensor (Forced Device Reset, Modbus address 40 032) after completing the sensor installation, to obtain a clean and uninterrupted baseline period.

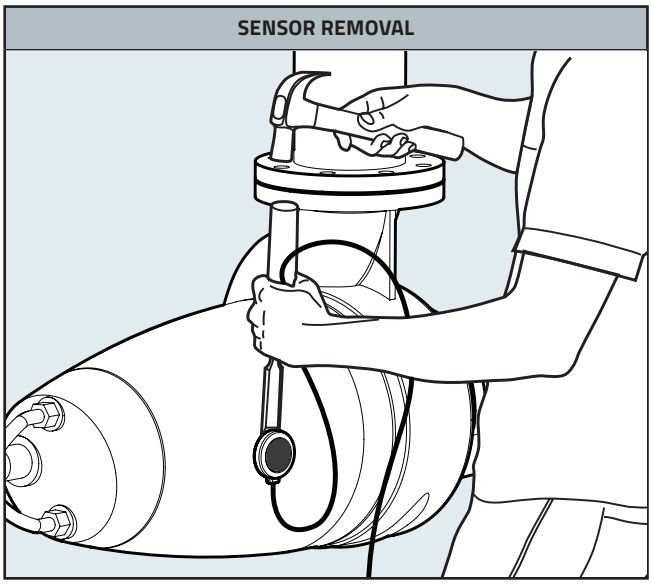
5. Sensor removal

A mounted sensor can easily be removed, if needed.
This can be for sensor installation on antoher machines.
Follow these steps to safely remove the sensor:

1. Use a paring chisel, or similar. Hold this parallel with the machine, pointing on the hard adhesive.

2. Give a quick knock on the paring chisel, with a hammer or similar. **Hold on the sensor cable** (to protect the sensor at removal).

3. The sensor and the adhesive will now be removed from the machine



Sensor mounting guidance

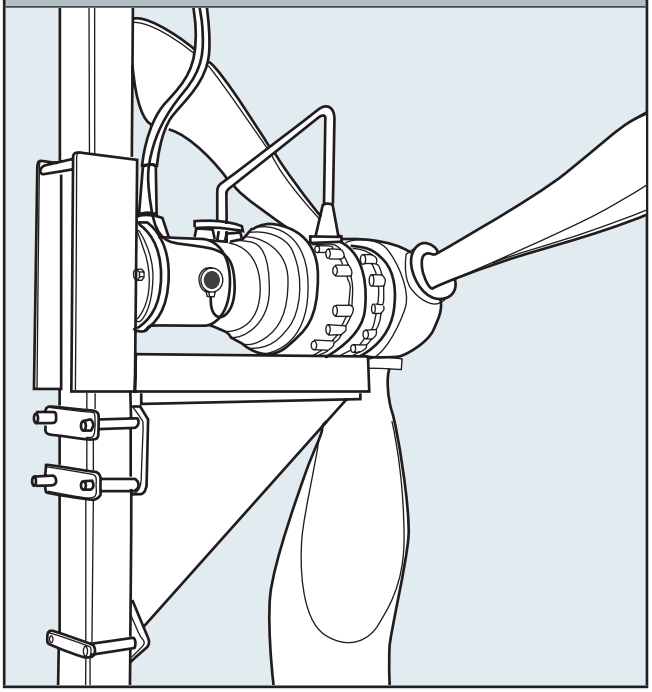
The EWA sensor is a relative sensor for stating the actual machine operation and the machine health.

One EWA sensor mounted on a machine can monitor and calculate a long list of machine insights and machine health parameters.

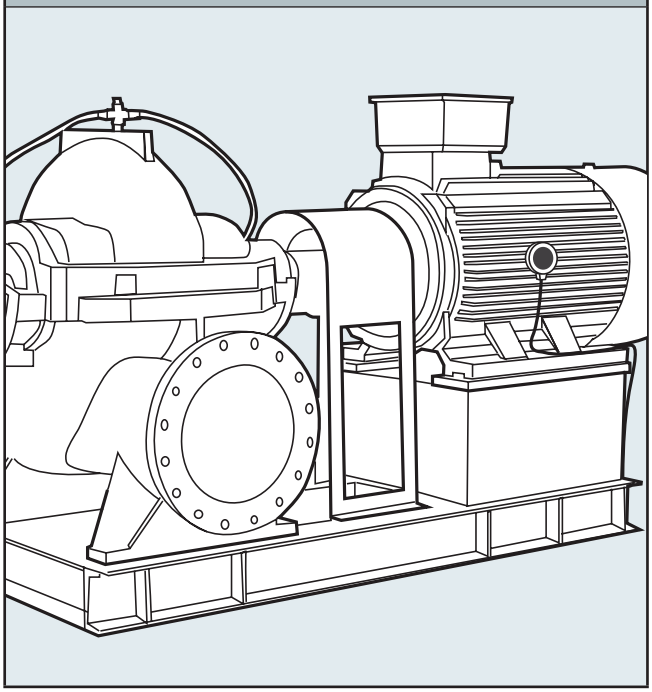
The sensor is primary for rotating machinery, driven by an electrical motor. The sensor robustness is due to analytics using both the rotating centrifugal force (in 3D) and the rotating magnetic field (in 3D). The sensor mounting position must ensure that both the vibration forces and the magnetic field are captured.

The vibration is captured when the sensor is mounted on the fixed, stationary part of the machine structure, the chassis. The magnetic field must be caught from the motor, in a near distance. Therefore, a good mounting position is on the motor, or maximum ½-1 m from the motor.

MOUNTING ON MIXER



DIRECT MOTOR MOUNTING



EC Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of EWA Sensors ApS. The product satisfies the provision for CE-marking according to the following directive(s):

RoHS Directive 2011/65/EC	on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
WEEE Directive 2012/19/EC	on waste electrical and electronic equipment (WEEE).
EMC Directive 2014/30/EC	relating to electromagnetic compatibility.

Silkeborg, 02/05/2023

Signature

Eva Kühne
CEO, EWA Sensors ApS

This section describes important WRITE functionality, where the user can write to the EWA sensor, to set/adjust parameters and perform actions.

IMPORTANT machine settings:

The EWA sensor is generic and will identify itself the number of motor poles and the machine orientation (horizontal or vertical). If the motor magnetic field is not homogeneous, the sensor might state these important parameters wrongly.

Therefore, it is ***highly important*** to check and eventually adjust these parameters, to be sure the machine rotation speed (RPM) is correctly calculated. This is to be done:
- first time the sensor is installed on a machine,
- if the sensor is moved and installed a new machine.

FEATURE	MODBUS ADDRESS	DESCRIPTION
Motor pole number	40 016	The actual count of motor magnetic north and south poles. This is always an even number (2, 4, 6, etc.)
Motor orientation	40 019	This is either horizontal or vertical.

Settings for gear:

For gears, some gear information must be performed.

Spur Gear:

FEATURE	MODBUS ADDRESS	DESCRIPTION
Gear ratio	40 201 40 202	The gear factor is typically stated on the name plate
Spur gear, teeth number (gear A)	40 203	Add, if known. The sensor will calculate, if not stated.
Spur gear, teeth number (gear B)	40 204	Add, if known. The sensor will calculate, if not stated.

Planetary Gear:

FEATURE	MODBUS ADDRESS	DESCRIPTION
Gear ratio	41 044 41 045	The gear factor is typically stated on the name plate
Teeth number (Sun gear)	41 046	State the teeth number for the central sun gear, driving the orbiting.
Teeth number (Planet gear)	41 047	State the teeth number for the carrier planet gear.
Teeth number (Ring gear)	41 048	State the teeth number for the outer ring gear.

Gearbox:
This is gear with unknown design and data; therefore, no data can be entered.

Operational parameters:

The parameters below can be used during normal operation, if either a ***software*** (sensor reset) or a ***hardware*** (sensor board) reset is desired/requested.

FEATURE	MODBUS ADDRESS	DESCRIPTION
Sensor reset	40 032	This ***software reset*** is used when: • The sensor is installed on a new machine • If new baselines are to be calculated The reset will start calculating new baselines, for all the machine health parameters.
Sensor board reset	40 035	Perform a power-cycle of the sensor.

Warning/alarm levels:

The warning and alarm levels for machine fault parameters are preset in the sensor, as specified in the EWA - Modbus Interfacing Guide. It is possible to adjust the individual warning/alarm levels and the static alarm, if desired. This can e.g. be adjusted to higher levels for an older machine, where higher vibration levels are accepted.