WE INCREASE
UPTIME AND EFFICIENCY
IN THE REFRIGERATION INDUSTRY

Instruction manual

HBOC - OIL MANAGEMENT

For oil level control / compressor protection & control of oil returned from the oil separator

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Safety Instructions

CAUTION! Always read the instruction manual before commencing work! Heed all warnings to the letter! Installation of HBOC requires technical knowledge of both refrigeration and electronics. Only qualified personnel should work with the product. The technician must be aware of the consequences of an improperly installed sensor, and must be committed to adhering to the applicable local legislation.

If changes are made to type-approved products, this type approval becomes void. The product's input and output as well as its accessories may only be connected as shown in this guide. HB Products assumes no responsibility for damages resulting from not adhering to the above.

Explanation of the symbol for safety instructions. In this guide, the symbol below is used to point out important safety instructions for the user. It will always be found in places in the chapters where the information is relevant The safety instructions, and particularly the warnings, must always be read and adhered to.

	CAUTION! Refers to a possible limitation of functionality or risk of use. NOTE! Contains important information about the product and provides further tips. The person responsible for operation must commit to adhering to all the legislative requirements, preventing accidents, and doing everything so as to avoid damage to people and materials.

Intended use, conditions of use. HBOC level controller is made for continuous measurement and control of PAO & PEO oil levels in compressors and oil separators. It can also be used on PAG oil types if recalibration is carried out. If HBOC is to be used in a different way or with another purpose, and if the operation of the product in this function is determined to be problematic, prior approval must be obtained from HB Products

Prevention of collateral damage Make sure that qualified personnel assess any faults and take necessary precautions before attempting to make replacements or reparations, so as to avoid collateral damage.

Environmentally correct behaviour, disposal instruction: HBOC is built so that the modules can easily be removed and sorted for disposal.

Introduction

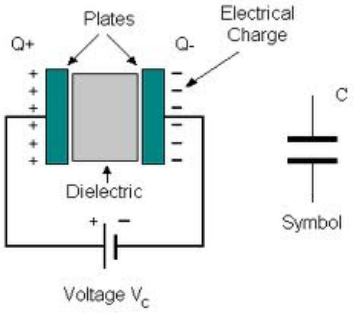
HBOC is an intelligent sensor with a built-in microprocessor. It is designed to detect and control oil levels in oil separators and compressors.
Apart from the sensor function, it also has a built-in controller.
The controller can be setup with all the parameters that are necessary to directly regulate a solenoid valve for oil level control.

The sensor is non-compatible with scroll compressors.

Measurement Principle

The sensor is a capacitative sensor. The capacitative measurement principle is based on the electrical properties in the proximity of a capacitor. A capacitor is an electrical component that is capable of building and sustaining an electrical charge

Principally, a capacitor consists of two plates. When a charge is applied to a plate, the other plate will be charged with the opposite polarity and retain the charge until it has been grounded. The magnitude of the charge (the capacitance) that can be generated depends, among other things, on what is found between the plates. The substance between the plates is referred to as a dielectric.



In front of the two plates, the sensor for level measurement is shaped as a cylindrical rod. When liquid covers the sensor, the measured capacity is changes.

The conductivity of a material can vary depending on temperature, chemical composition, and the homogeneity of the material, and therefore it can in some cases require a different factory calibration.

HB Products sensors are calibrated so that they differentiate between conductive and non-conductive liquids.
In refrigeration systems, the oil and liquid CO_2 are not regarded as conductive fluids, whereas refrigerants such as ammonia, HFCs, and brine are regarded as conductive.

Design

The sensor consists of a mechanical part and an electronic part. These are easily separated by loosening 2 grub screws, or for mechanisms with mounting tabs, by pressing the electronic part in towards the mechanical part and turning the housing counter-clockwise until a wave washer pushes it from the mounted position. The electronic part is designed in accordance with IP65 waterproof rating and to resist vibrations.
The mechanical part is produced in AISI304/PTFE and tested to withstand high pressure.

Software

The sensor is supplied with the latest firmware. The sensor is configured with a configuration tool, "HBLO Tool", using a PC. It is capable of determining on its own the current version which was delivered.
The newest version of the tool is backwards compatible.
It is not possible to update the software on a sensor which has already been delivered.

Technical Data

Supply:	
Voltage:	24 V DC ±10%
Current draw:	Max 30 mA
Connector:	M12 – 5 pins DIN 0627
Valve control:	
Transistor output:	PNP/NPN
Output function:	NC or NO
Potential-free relay output:	Max 1 A (24W)
Cable length:	3 m
Cable size:	3 x 0,75 mm^2
Cable connection:	Screw terminals
Cable glands:	PG7 / M8
Installation conditions:	
Ambient temperatures:	-20…+50°C
Oil temperature:	0…+80°C
Max. operational pressure:	150 bar
Waterproof rating:	IP65
Vibrations:	IEC 68-2-6 (4g)
Authorisations:	
EMC Emission:	EN61000-3-2
EMC Immunity:	EN61000-4-2
GOST R:	No 0903044

Oil type:	PAO & PEO
If re calibrated:	PAG
Mechanical specifications:	
Thread connection:	½”, ¾” & 1 1/8”
Materials – mechanical parts:	AISI304/PTFE
Materials – electronic parts:	Nylon 6 (PA)
Weight:	600 g
Housing design:	Front or angled
Configuration & indication:	
Configuration	With a PC
LED indication	LED (green, yellow, and red)
Accessories:	
Configuration tool:	HBOC Tool
Programming cable:	HBxC-USB
Magnetic valve:	V100 & V150
Flange adapter:	HBS/ADAP/FLANGE
M12 cable – 5 m:	HBxC-M12/5
M12 cable – 10 m:	HBxC-M12/10
Plug type – cable:	Angle - 90°
Cable type:	PVC-OB grey
Cable size:	5 x 0,34 mm^2
Cable glands:	PG7 / M8
Cable approval:	CSA

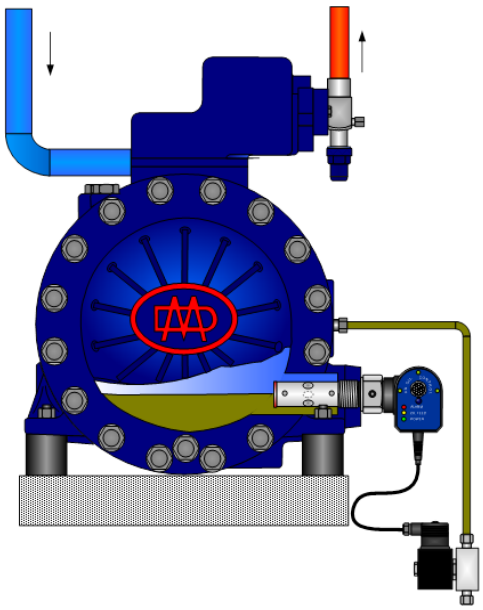
NOTE! All terminals are protected against incorrect termination with a supply voltage of up to 40V. If the supply voltage is greater than 40 V, the electronics will be damaged.

Functionality

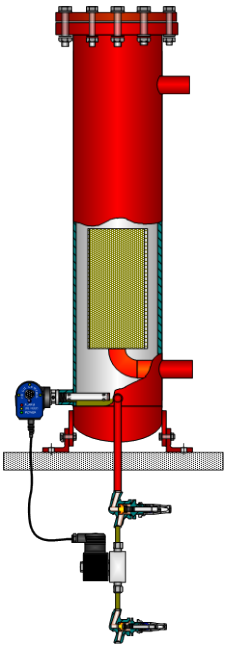
HBOC is designed for the three applications listed below:

1) Measurement/control of oil level in refrigeration compressors
2) Measurement/control of oil level in oil separators
3) Oil detection in tanks, level indicators, etc. (for special applications where calibration according to the medium is crucial for the sensor's function)

The HBOC sensor also has a built-in controller. The parameters for controlling a 24V DC magnetic motor valve can easily be set up through a configuration tool (HBOC Tool).
Control of oil level in compressors: The sensor detects if there is oil in the centre of the level where it has been installed. If the level is too low, oil is added, e.g. from an oil reservoir or a separator, according to the specified parameters. Especially in high pressure systems, it is crucial to avoid oil flooding in the crankshaft housing, and therefore the oil return valve must be precisely controlled.



Control of oil level in separators: The sensor detects if there is oil in the container. If there is too much oil, the valve opens to allow drainage to the compressor crankshaft housing or to an oil reservoir. The sensor is also able to raise an alarm if, during a given period, the amount of oil separated does not conform to expectations. All parameters for the use of HBOC in this function are easily set up in the configuration tool.



Installation Guide

For both applications, the following applies:

1) The sensor must be installed in a horizontal position.
2) During installation, check the sensor's length as well as its placement with the refrigeration compressor manufacturer or the oil separator producer. Oil pockets may not form around the sensor, and there must be a gap of at least 2mm between the sensor and the other mechanical parts.

CAUTION! In case of welding work on the unit, the electronic part must be removed. Welding work can damage the electronics. The sensor's mechanical parts may not be installed in a pipe stub during welding.

Accessories:

The sensor can be supplied with the following accessories:

1) USB cable for configuration - HBxC-USB
2) Supply cable with M12 plug (5 at 10m length) – HBxC-M12/5 / HBxC-M12/10
3) Solenoid-V100 - ¼" magnetic valve for opening/closing inflow or outflow of oil. The valve has a 24 VDC supply and is designed for pressures up to 100 bar. The valve has a Kv value of 1.5 l/min.
4) Solenoid-V150 - ¼" magnetic valve for opening/closing inflow or outflow of oil. The valve has a 24 VDC supply and is designed for pressures up to 150 bar. The valve has a Kv value of 1.5 l/min.
5) HBS/ADAP/FLANGE: Flange adapter that replaces sight glass for the installation of the HBOC on refrigeration compressors. There are several different flange types, which are ordered independent of the type of compressor (see the attachment with an overview of compressors and ordering codes).

Installation of the magnetic valve: So as to be able to supply the magnetic valve directly, it must be installed within 3 metres of the sensor. Oil inflow to the compressor is determined by the compressor, but most often the connection is placed above the sensor and directly into the crankshaft housing.

Flange installation: HBOC installed in a flange replaces the sight glass. The flange is sealed against the compressor housing with an o-ring, ø32.00x2.50 mm. See the guide below for the installation of the sensor.

Mounting Guide

HBOC is mounted either on a compressor or an oil separator. On a compressor, an adapter flange can be provided as an accessory. The sensor is sealed with Teflon tape or liquid gasket before installation. Dependent upon the thread type, the gasket consists of:

- NPT thread = Teflon tape or liquid gasket
- BSPP & UNEF = Gasket

Thread type	**Gasket type**
½" BSPP	Bonded seals - ø21,65/26,70 x 1,25
¾" BSPP	Bonded seals - ø27,30/32,50 x 1,25
1 1/8" UNF	Bonded seals - ø29,33/36,58 x 2,34

For installation, there is required a 2.5mm Allen key, a shifting spanner, as well as gasket material depending on the thread type.

Loosen two set screws, or for mechanisms with mounting tabs, press the electronic part in towards the mechanical part and turn the housing counter-clockwise until a wave washer pushes it from the mounted position.

Separate the electronic part from the mechanical part.

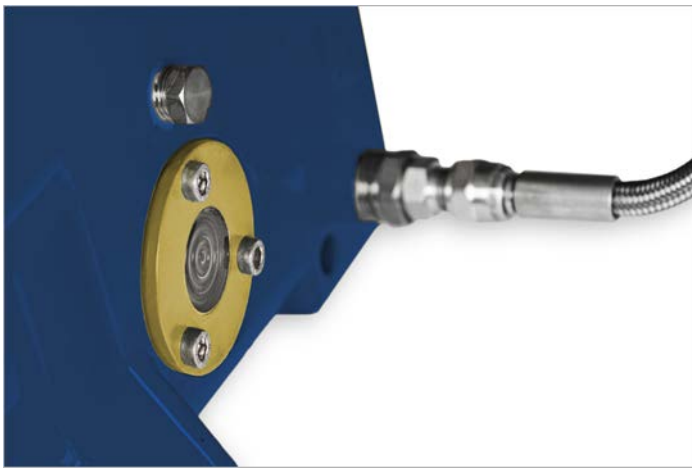
Teflon or liquid gasket is applied to the conical thread. Cylindrical thread is installed with gasket.

A container or compressor is screwed onto the mechanical part. Tighten thread, depending on thread type.

The electronic part is installed on the mechanical part and secured with 2 screws.

Bayonet version:
Press the electronic part in towards the mechanical part and turning the housing clockwise. The type with bayonet fixating has the possibility to be placed in different positions.

Installation on Flange



HBOC can be installed on the compressor housing directly where the sight glass is installed.

Remove sight glass and clean surface.

Install flange on the compressor housing. Use o-ring Ø32x2.5 as gasket (not included with flange).

Tighten screws (depending on the quality of the screws).

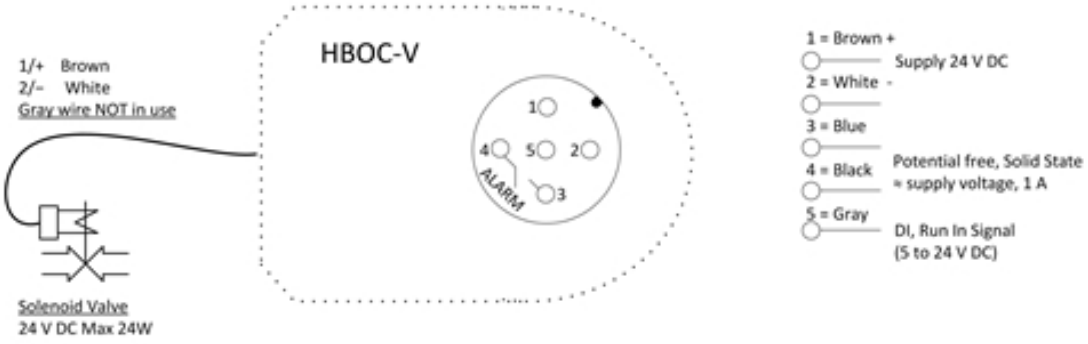
Teflon or liquid gasket is applied to the mechanical part of the sensor and it is secured to the interior thread of the flange.

The sensor housing is re-installed, either via a mounting tab or it is secured with 2 grub screws.

***Bayonet version**:*
Press the electronic part in towards the mechanical part and turning the housing clockwise. The type with bayonet fixating has the possibility to be placed in different positions.

Electrical connection

HBOC can be supplied with direct control of the magnetic valve, or it can be connected to the central control via the sensor's control/alarm output. See the diagram below.



The sensor has a control function and regulates the flow of oil independent of other parts of the system. The function starts to work when the supply is connected. The control function can be activated/deactivated via an external run signal with "Run in" (clamp 5) and -24 V (clamp 2).

LED Indication & Calibration

LED indication:

1) 3 x green LEDs indicate oil level
2) Green Power LED indicates 24 V DC supply; blinks during operation. If "run-in" is not used, this function must be deactivated in the tool.
3) Yellow LED indicates supply is open to magnetic valve
4) Red LED indicates ALARM

LED signal	ON/OFF/Frequency	Functionality
Green (3x)	ON	Oil detected
	Flash	Turbulence in the compressor housing
	OFF	Oil is not detected
Green POWER	ON	Supply
	Flash	In operation or when the sensor is connected to HBOC Tool. (Red and yellow LED also blink)
	OFF	No supply
Yellow	ON	Activation/supply to the magnetic valve
	OFF	Magnetic valve is not being supplied
Red	ON	Alarm. Activated automatically according to a calculated time span if oil has not been detected (oil cycle x alarm counter = Time before alarm goes off). Output relay (pin 3 & 4) is activated.
	OFF	Oil level reached in accordance with the calculated time span / number of oil cycles.

Calibration:

"R" for factory reset and calibration:

Alarm is reset by pressing "R" for 5 seconds.

Calibration instructions:

HBOC is pre-calibrated upon delivery. If one uses common lubricating oils in the refrigeration compressor, calibration is normally not necessary. If the sensor is too sensitive or does not register oil at all, calibration should be carried out.

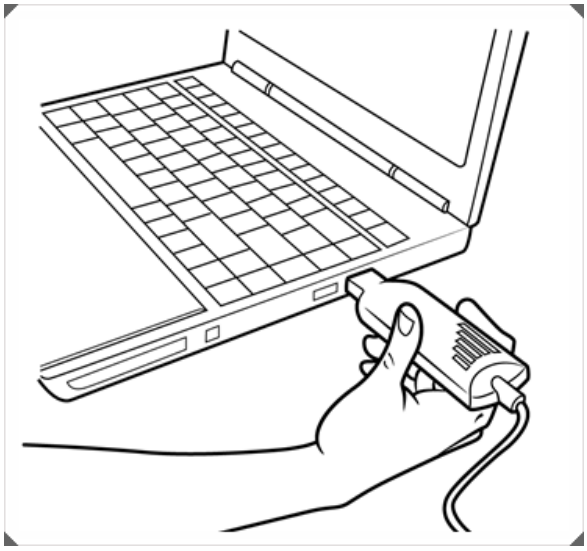
Calibration can only be carried out if the function "Calibration" is set to ON in HBOC Tool. It is carried out during normal system operation.

The sensor is calibrated by pressing "R" 5 times.

Calibration can alternatively be carried out before start-up or during fault detection, by having an extra mechanism. Without stoppages or loss of pressure.
The electronics are installed on the extra mechanism and calibrated when vertically submerged to 50% in the same type of oil that is used in the compressor housing. The electronics can then be re-installed in the system.
After final calibration, one should consider setting "Calibration" to OFF

Installation of HBOC Configuration Tool

NOTE! To be able to change the control parameters, it is necessary to have a special USB/M12 configuration cable as well as a configuration tool installed on a PC.



1) The tool can be downloaded for free. Request access to download the tool by sending an email to support@hbproducts.dk

   Instructions for installation are sent together with the password.

2) Download HBOC Tool and install it on a PC. System requirements: Windows-based PC with Java installed. If Java is not installed, it is possible to do this in connection with the installation of the HBOC tool. An internet connection is required to download it. Minimum screen resolution is 1366x768

3) Follow the instructions during setup of the program.

4) Connect the USB cable, HBxC-USB, to the PC. Give Windows a moment to find a driver for the USB cable; for this to happen automatically an internet connection is required, otherwise follow the instructions on the installation of drivers in the program "Configurations Instructions".

5) Search for USB com port. Select USB COM port in the window below. For example COM3. In the lowermost bar, one can see that the USB com port is selected and open for communication with the sensor. The bar changes colour from red to green when there is a connection between the program and the USB cable.

6) Connect the cable to the sensor. The software program records the current version (see SW xx.x.xx).

7) Connection to the sensor is complete when the green, yellow, and red sensors blink in a set pattern.

8) The sensor's current setup can be retrieved by pressing (Show current configuration).

9) The sensor's factory settings can be reset by pressing (Reset to default).

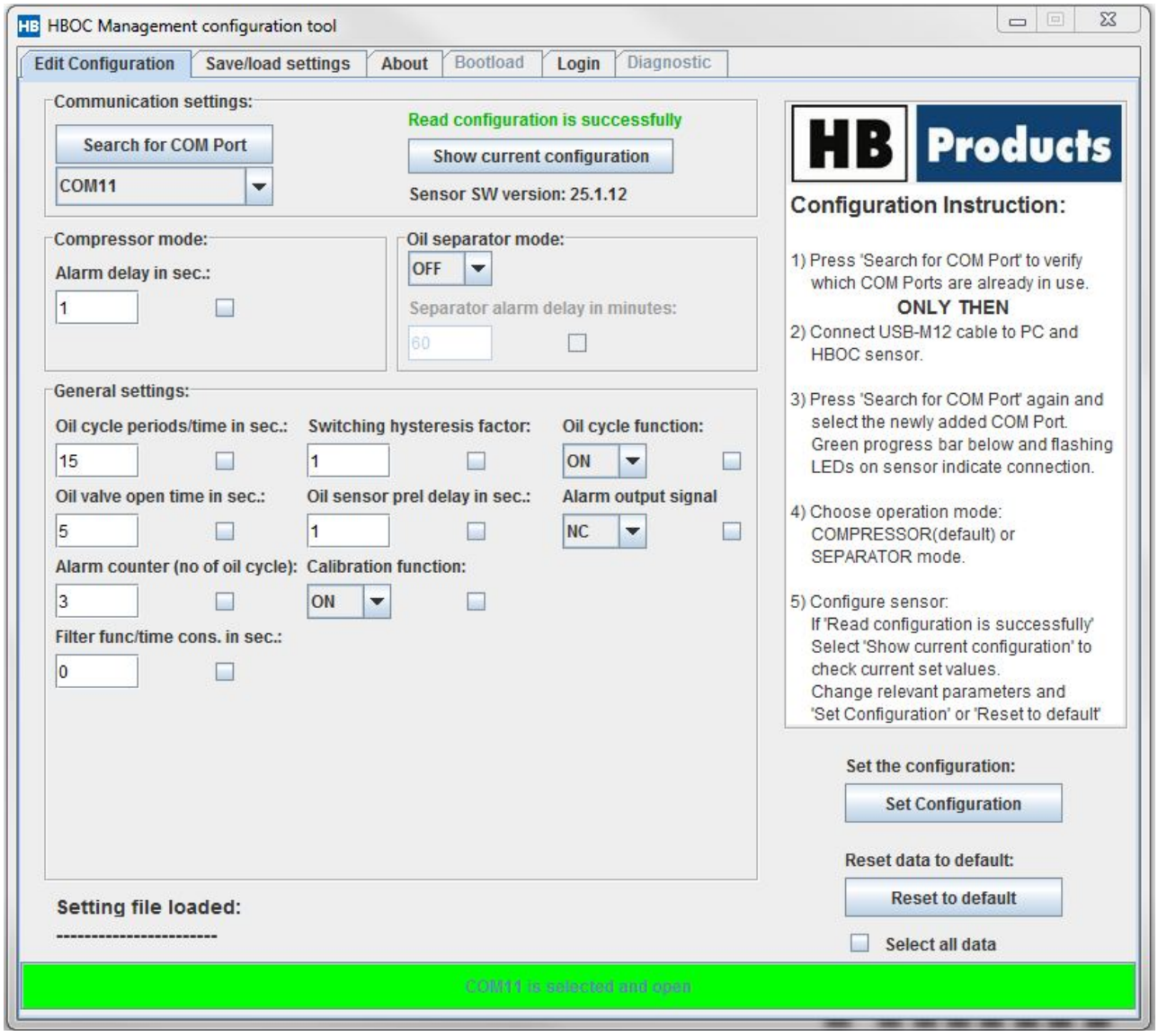
10) All parameters can now be input. After the final selection, press "Set configuration". The selected parameters are transferred and saved in the sensor. When this transfer is complete, an image of the sensor appears with a message that the transfer was successful. Press OK to complete the process.

PC Configuration

The sensor is supplied with the following configuration options and factory settings:

Compressor mode	Configuration options	Factory settings
Alarm delay	0…3600 s	5 s
Alarm output signal	NO/NC	NC
Oil separator mode		
Oil separator mode	ON/OFF	OFF
Output signal, oil feed	NO/NC	NO
Alarm delay (separator mode)	10…10.000 min	60 min
General settings		
Oil cycle periods/time	1…300 s	60 s
Oil valve open time	1…300 s	10 s
Oil feed, switching hysteresis	1….10 mm	5 mm
Alarm counter (no of oil cycles)	1…100	30
Oil sensor dwell	1…30 s	10 s
Calibration function	ON / OFF	OFF
Oil cycle function	ON/OFF	ON

CAUTION! Factory settings do not guarantee safe operation, since the configuration parameters depend on the type of compressor/separator.



HBOC Tool version 2.10.0

NOTE! If the program is shut down and started up again, the cable to the sensor must be disconnected (M12 plug) and reconnected.

Function description – setup parameters

The sensor can be set up for two different functions

- Oil level control in compressors "compressor mode"
- Oil level control in separators "separator mode"

Compressor mode

Setup for compressor mode: The compressor mode is set to default in the menu.

When "Oil separator mode" is set to OFF, the sensor is set to "compressor mode".

Alarm delay in sec:
Indicates the time that elapses before the alarm is activated (red LED and signal on pin 3 on the plug).
See example of calculation of alarm delay below

Oil cycle periods/time in sec:
The time for the frequency at which the sensor checks for oil. Typically, one wants a certain period between when the oil-return-valve releases oil into the crankshaft housing and for how long the level is accepted to be lower.
If the period is (too) short, oil will be filled up more frequently.

Oil valve open time in sec:
Number of seconds during which the supply voltage to the oil-return-valve is open.
Should be aligned to the system pressure, pipe dimension, and size of valve.

Alarm counter:
Number of cycles (oil cycle periods) during which there is a lack of oil needed to trigger the alarm.
See example of the calculation of the alarm time below

Filter func/time cons in sec:
An average measurement is made in programmed seconds. Can be increased in case of unstable measurement.

Switching hysteresis factor:
Hysteresis for the contact function. Hysteresis indicates how many mm the oil can drop before the contact function ceases. Popularly called a type of "lag" in the system.

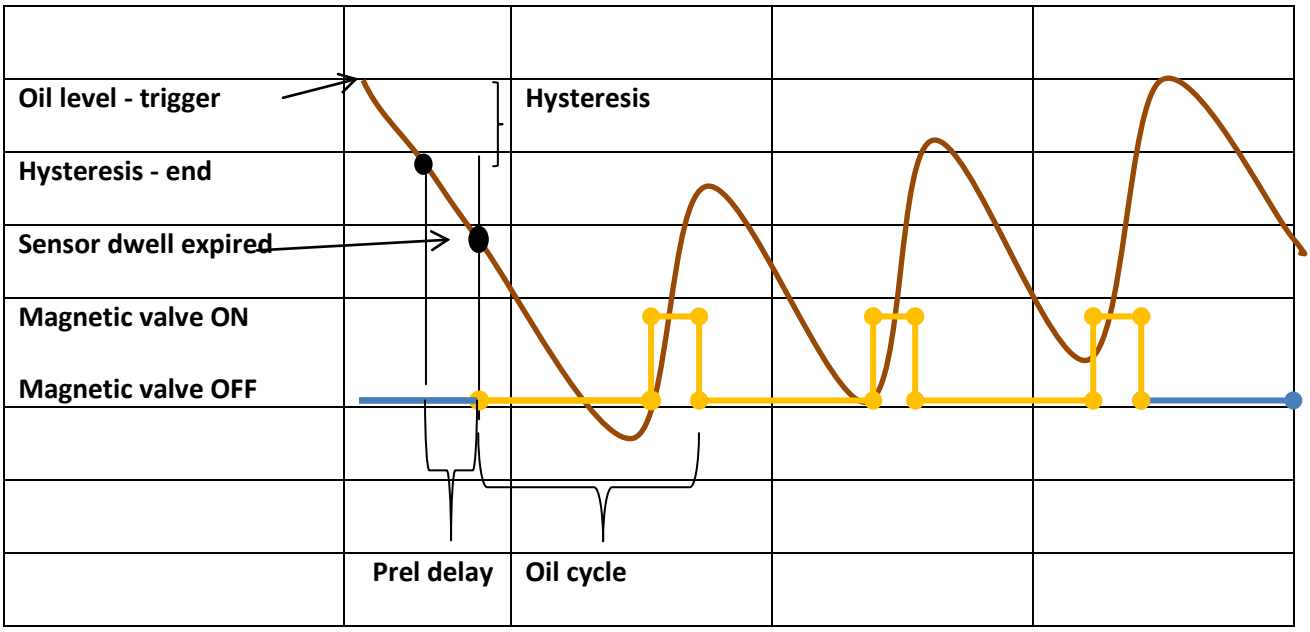
Oil sensor dwell:
Indicates the time from the end of hysteresis to the start of the oil cycle period.

Calibration function:
Must be connected if one wants to re-calibrate the sensor.
Following calibration, one can switch back to OFF by connecting the tool again.
The sensor is factory calibrated in PAG68. If a different oil type is used, it may need to be calibrated.

Oil cycle function:
Can be turned on (ON) or off (OFF) depending on whether the sensor should have oil level control activated or deactivated.

Alarm output signal:
Is selected depending on whether the magnetic valve has the contact function NC or NO (Normally closed/Normally open)

Functionality diagram



Calculation of alarm delay
The alarm is first activated following an interval that depends upon the values of "alarm counter" and "oil cycle period".
Example for calculation of the alarm time when there is a constant lack of oil:
If alarm counter is set to 3 and oil cycle period is set to 15 seconds and alarm delay is set to 1 second, the alarm is activated after (3 x 15) + 1 sec = 46 sec.

First Start-up – Compressor Mode

After installation and configuration of the sensor, oil is filled into the compressor until the sensor signals that the correct oil level has been reached (3 x green LED). Then the system is started. While running-in the system, the oil return is adjusted/optimised for optimal balance of the oil circulation. Among other things this depends on oil filling, compressor size, system pressure, pipe dimensions, and magnetic valve.

Oil separator mode

Setup for oil separator mode: Oil separator mode set to ON.

Separator alarm delay in minutes:
Time that elapses before the sensor triggers the alarm for low oil level.
During normal system operation, the oil will be released in the separator; if this does not occur, it is likely

that the oil has accumulated in other areas of the system. Therefore one wants the alarm to trigger when a certain amount of oil has not been separated within a defined period.

Oil cycle periods/time in sec:
The time for the frequency with which the sensor checks for oil. Typically, one wants a certain period between when the oil-return-valve lets oil into the crankshaft housing and how long the level is accepted under.
If the period is (too) short, oil will be filled up more frequently.

Oil valve open time in sec:
Number of seconds during which the supply voltage to the oil-return-valve is open.
This should be aligned to the system pressure, pipe dimension, and size of valve.

Filter func/time cons in sec:
An average measurement is made in programmed seconds. Can be increased in case of unstable measurement.

Switching hysteresis factor:
Hysteresis for the contact function. Hysteresis indicates how many mm of oil can drop before the contact function ceases. Popularly called a type of "backlash" in the system.

Oil sensor dwell:
Indicates the time from the end of hysteresis to the start of the oil cycle period.

Calibration function:
Must be connected if one wants to re-calibrate the sensor.
Following calibration, one can switch back to OFF by connecting the tool again.
The sensor is factory calibrated in PAG68. If a different oil type is used, it may need to calibrated.

Oil cycle function:
Can be turned on (ON) or off (OFF) depending on whether the sensor should have oil level control activated or deactivated.

Alarm output signal:
Is selected depending on whether the magnetic valve has the contact function NC or NO (Normally closed/Normally open)

Fault Detection

General:

NOTE! Fault detection on the electronics and/or replacement of the electronics can be carried out without releasing pressure on the system or removing the mechanical part of the sensor

Fault Detection

Fault	Reason	Correction of fault
No LED is on.	No supply to the sensor or defective cable/plug	Check and find faults in the power supply. Change the supply cable.
Sensor does not trigger even though there is oil.	Quality/type of oil is different from that used during factory calibration.	Recalibrate the sensor.
Red alarm	Oil level has not been attained during a number of oil cycles.	Check system oil return. Check oil filter and magnetic valve if necessary.
3 x Green blinks	There is oil turbulence in the compressor housing.	Change "prel delay" to a higher value.
No output (3 x green LED are on, but the output signal is not active)	Check the setup of the parameters/which contact function has been selected, NC or NO (Normally closed/Normally open)	Change the setup using the tool.
Delay in sensor activation	May be caused by gas and foam bubbles in the system.	Check if the sensor is placed optimally.
No detection	Fault in the electronics	Send the sensor to be repaired.

Sensor Repair

The sensor electronics are completely embedded and can therefore not be repaired.
In case of faults with the sensor, it will typically only be necessary to replace the electronics.

Complaint cases are handled by the HB Products dealers/distributors.
Their complain procedures must be followed before returning the sensor.

Further Information

For further information, please visit our website, www.hbproducts.dk, or send an email to: support@hbproducts.dk.

Declaration of Conformity

We, **HB Products A/S**

Hereby confirm under oath, however with full responsibility that the product:

Category:	**Instrumentation.**
Type:	**Level switch type HBOC.**
Description:	**Level sensor based on the capacitative measurement principle.**
Manufactured:	**Developed and manufactured by HB Products A/S.**

This declaration confirms that the product adheres to the standards outlined below:

EN 61000-6-2: 2005	**EMC General Immunity Requirements Industrial Environment**
EN 61000-6-4: 2007	**EMC General Emission Requirements Industrial Environment**

According to the European directive:

EMC directive.....2004/108/EC

Hasselager, May 1, 2012

Michael Elstrøm
Managing Director & Technical Manager