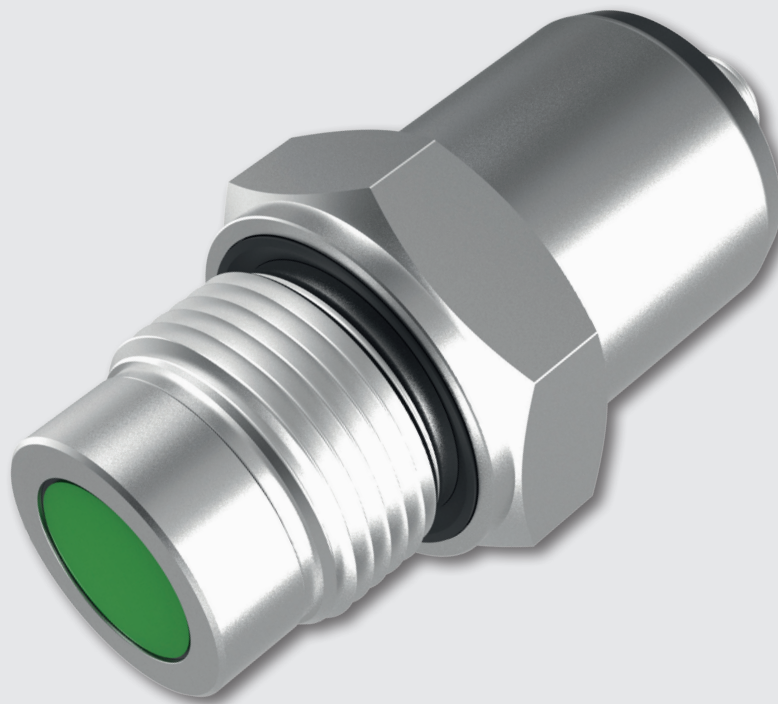# OPCom FerroS
SPCO 500-1000

## Safety and operating instructions

**Read safety and operating instructions before use**

**Note:** Representations do not always correspond exactly to the original. No legal claims arise from information provided by us in error. Subject to change.

The indicated data only serve to describe the product. Information regarding the use of this product are only examples and suggestions. Catalog specifications are no guaranteed features. The information given does not release the user from his / her own assessments and inspection.

Our products are subject to a process of natural wear and aging.

The picture on the title page shows a configuration example.
The delivered product may thus differ from the illustration.

# Contents

## 1.1    General

The OPCom FerroS measures the wear of mechanical components by detecting ferromagnetic particles. The sensor is provided with a G1" thread and can be integrated directly into a gear box or a recirculating lubrication circuit. The amount of particles is continuously detected and evaluated by an inductive measuring principle. The output is effected via digital and analog interfaces. By the early detection of wear and damage, service measures can be planned and downtimes may be minimized.

*The sensor detects the following parameters:*
> sensor temperature
> ferromagnetic particles
> ferromagnetic fragments ("chunks")

## 1.2    Checking the sensor function

The sensor is designed so that it can be exposed to specified loads over long periods of time. With fluids or applications where there is no experience base regarding the long-term stability of the sensor, the sensor should be checked in the laboratory every two years at the latest.

## 1.3    Measuring principle

The sensor detects the amount of ferromagnetic particles that accumulate at the permanent magnet of the sensor head. Here, the sensor can distinguish between fine particles in the micrometer range and coarse ferromagnetic fragments ("chunks") in the millimeter area. On the basis of the output signal from 0 to 100 %, the occupancy of the sensor surface with ferromagnetic particles or fragments can be read off. In addition, the sensor has the function to compensate the magnetic field of the permanent magnet, whereupon the particles are detached from the sensor head (automatic cleaning operation). Based on the time intervals between two cleaning operations, it is possible to deduce a change in the wear.

The individual parameters as well as other sensor functions are described below in more detail.

## 1.4    Operating hours counter

The sensor has an integrated operating hours counter whose values are still present even after power failure. After interruption, the counter restarts counting at the last stored value before the interruption.

## 1.5    Temperature Measurement

The sensor is provided with an internal temperature measurement. The measurement of the temperature takes place inside the sensor and therefore only serves as a guide for the actual oil temperature.

## 1.6.    Fine ferromagnetic particles

The detection of fine ferromagnetic particles is achieved steplessly and is output via a signal from 0 to 100 %. 0 % displays a particle-free surface, 100 %, however, means that the sensor surface has reached its preset limit. When this limit has been reached, the adhering particles are discharged back to the oil by compensation of the magnetic field, generated by the permanent magnet, and the sensor then again begins with the accumulation of particles.

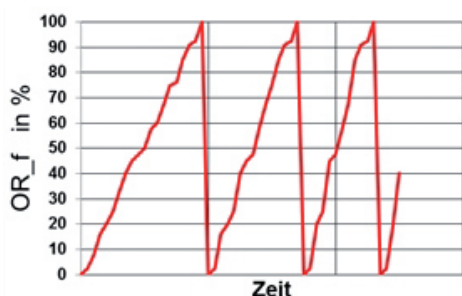The parameter, output by the sensor, is called: OR_f = OccupancyRate_fine



Figure 1.1: Example for the detection of fine particles

### 1.6.1 Coarse ferromagnetic fragments (chunks)

The detection of coarse ferromagnetic fragments (chunks) is effected by default in steps of 10 % and is output via a signal from 0 to 100 %. 0 % displays a chunkfree surface. 100 %, however, means that the sensor surface has reached the set limit value (= 10 chunks). When this limit has been reached, the adhering particles and chunks are discharged back to the oil by compensation of the magnetic field, generated by the permanent magnet, and the sensor then again begins with the accumulation of particles and chunks.

The parameter, output by the sensor, is called: $OR\_c$ = OccupancyRate_chunk
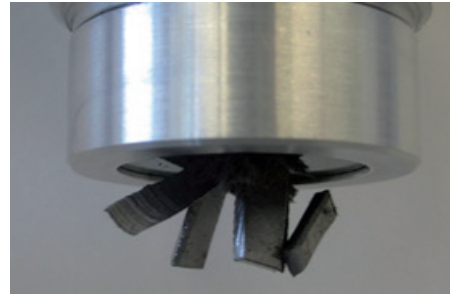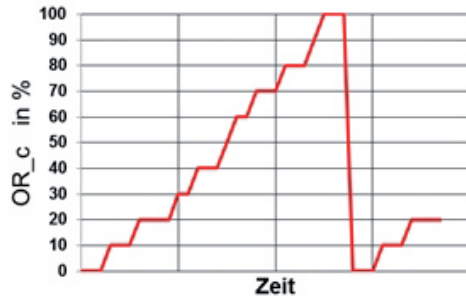


Figure 1.2: Example for the detection of chunks

### 1.6.2 Sum signal

In order to display both parameters via the analog output at the same time, the sensor calculates the sum of the occupancy rate of fine particles and "chunks". 0 % displays a free, uncontaminated sensor surface. 100 %, however, mean that the sensor surface has reached the set limit (= 100 % fine particles or 10 chunks or any combination of both). When this limit has been reached, the adhering particles and chunks are discharged back to the oil by compensation of the magnetic field, generated by the permanent magnet, and the sensor then again begins with the accumulation of particles and chunks.

The parameter, output by the sensor, is called: $OR\_s$ = OccupancyRate_sum
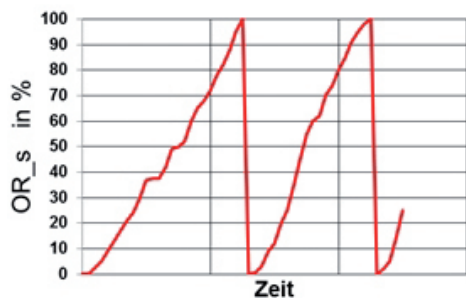


Figure 1.3: Example for the output of the sum signal

### 1.7 Derived characteristics

The following derived parameters are also calculated by the sensor and read out via the digital or analog interfaces

| Parameter abbreviations | Parameter name | Unit | Statement |
|---|---|---|---|
| chunk_cnt | Chunk Counter | - | Number of detected chunks |
| cln_cnt | Clean Counter | - | Number of automatic cleaning cycles since the last manual reset ("SONew" command) |
| cln | Cleaning | - | Cleaning process at the moment active / inactive |
| tlc | Time since last clean | h | Time since last manual reset ("SONew" command) or automatic cleaning process |
| tbc | Time between (last two cleans) | h | Time between the second last and the last automatic cleaning process |
| OAge | Oil age | h | Time since last manual reset ("SONew" command) |
| ROT | Remaining Occupancy Time | h | Estimated remaining time until OR_s reaches 100 % and the automatic cleaning process is triggered based on the current value of OR_s and last automatic cleaning |

### 1.8    Cross-influences

The sensor signal is substantially free of cross-influences, as long as there are no interfering contours or (electro)-magnetic fields in the defined detection radius.

On first operation, a minimum offset (<5%) may occur in the measurement signal due to a cross-influence of the oil (sensor is - ex works - calibrated to air). This influence, however, is automatically compensated after the first cleaning process. One possiblility for earlier compensation is by execution of the SONew command (see Chapter 5).

**2.1    General data**

| Sensor data | Size | Unit |
|---|---|---|
| **Max. operating pressure** | 20 | bar |
| **Operating conditions** | | |
| Temperature | -40 ... 85 | °C |
| Humidity [1] | 0 ... 100 | % r.H. |
| **Max. distance for attraction of fine particles (1g)** | | |
| Viscosity <100 mm²/s | ~9.0 | mm |
| Viscosity 300 mm²/s | ~7.5 | mm |
| Viscosity 500 mm²/s | ~7.0 | mm |
| **Min. required flow rate for automatic cleaning process** | 0.05 | m/s |
| **Maximum flow rate** | 1.0 | m/s |
| **Compatible liquids** | mineral oils (H, HL, HLP, HLPD, HVLP) synthetic esters (HETG, HEPG, HEES, HEPR) polyalkylene glycols (PAG) zinc and ash-free oils (ZAF) polyalphaolefines (PAO) | |
| **Wetted materials** | aluminum, polyamide (PA6 GF30), HNBR, epoxy resin | |
| **Protection class [2]** | IP67 | |
| **Power supply** | 22 ... 33 | VDC |
| **Power input** | max. 0.5 | A |
| **Output** | | |
| Output analog [3] | 4 ... 20 | mA |
| Accuracy of power output [4] | ±2 | % |
| Interface digital | RS232/CAN | |
| **Connection** | | |
| Threaded connection | G1 | inch |
| Tightening torque thread | 50 ±5 | Nm |
| Electrical connection | M12x1, 8-pole | |
| Tightening torque M12-plug | 0.1 | Nm |
| **Measuring range** | | |
| Fine particles | 0...100 | % |
| Coarse particles | 1...10 | - |
| **Measurement resolution** | | |
| Fine particles | 0.1 | % |
| Coarse particles | 1 | - |
| **Repeat accuracy** | | |
| Fine particles | ±5 | % |
| **Weight** | ~190 | g |

Table 2.1: Technical specifications OPCom FerroS

[1] Non-condensing
[2] With screwed-on connector
[3] Output is freely configurable (see Chapter 6)
[4] In relation to digital output value

## 2.2 Dimensions
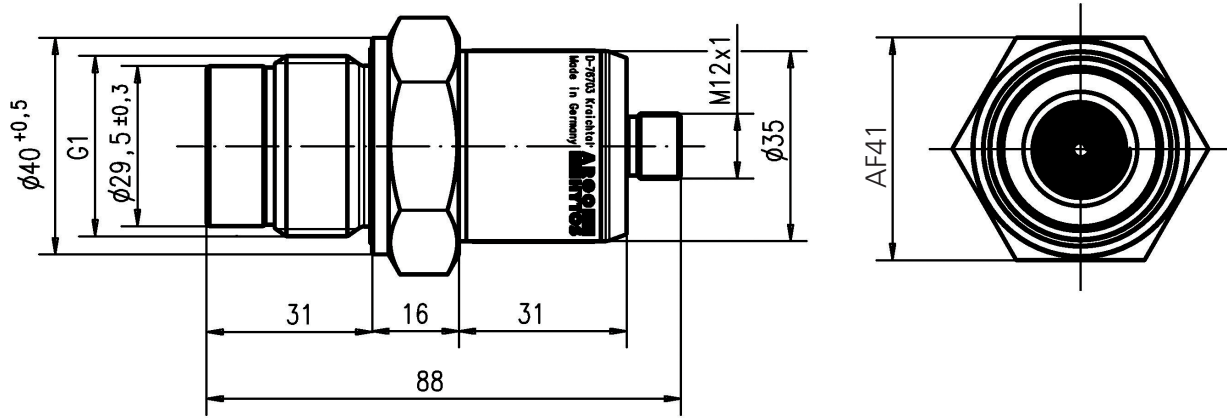


Figure 2.2.1: Dimensions OPCom FerroS

## 2.3 Permissible mechanical loads

The permissible mechanical loads for the sensors are listed in Table .

| Load | Size | Unit |
|---|---|---|
| **Max. operating pressure** | 20 | bar |
| **Max. tightening torque** | 50 ±5.0 | Nm |
| **Max. vibration in the longitudinal direction** | f: 5 - 9 | Hz |
| Test according to DIN EN 60068-2-6 | A: ±15 | mm |
| | F: 9 - 200 | HZ |
| | a: 10 | g |
| **Max. vibration in the transverse direction** | f: 5 - 9 | HZ |
| Test according to DIN EN 60068-2-6 | A: ±15 | mm |
| | f: 9 - 200 | Hz |
| | a: 10 | g |

Table 2.3.2: Permissible mechanical loads

Place the sensor at a measuring point which is characteristic for the system. There is no preferred flow direction.

Rmax = 16

41 mm
50Nm ±5

1…7 mm

min.
15 mm
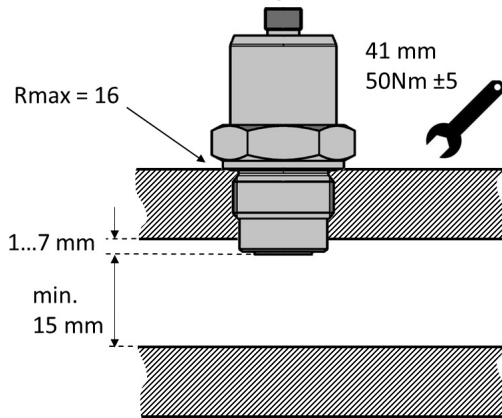
Illustration 3.1: Mounting the sensor and detection radius

To ensure proper operation, please observe the following guidelines:

› Completely cover the sensor surface with oil
› Observe the minimum and maximum flow rate. See chapter "Technical data".
› Adequate mixing of the oil
› Avoid foaming
› No installation in the immediate vicinity of motors, pumps or other hot components

| ⚠ | ▶ No interference contours and (electro) magnetic fields may be located in the area of the detection radius (r). |
| | ▶ How far the sensor tip must be immersed in the oil, may be system dependent. An inquiry at the Technical Service of ARGO-HYTOS is advisable. |
| | ▶ In order to ensure a reliable measurement, the sensor tip should not enter the flow channel deeper than stated. |

### 4.1 General information and safety note

The device must be installed by a qualified electrician. Follow the national and international regulations for the installation of electrical equipment.

Voltage supply according to EN 50178, SELV, PELV, VDE 0100-410 / A1.

**Improper connection of the device may cause damage**

For installation, disconnect the device from the power and connect the device as follows:

Top view sensor cover                              Pin / assignment    Color standard cable

| Pin / assignment | Color standard cable |
|---|---|
| 1 L+ | white |
| 2 L- | brown |
| 3 TxD, CANL | green |
| 4 RxD, CANH | yellow |
| 5 not connected | grey |
| 6 not connected | pink |
| 7 IOut | blue |
| 8 SGND | red |
| housing / shield | |
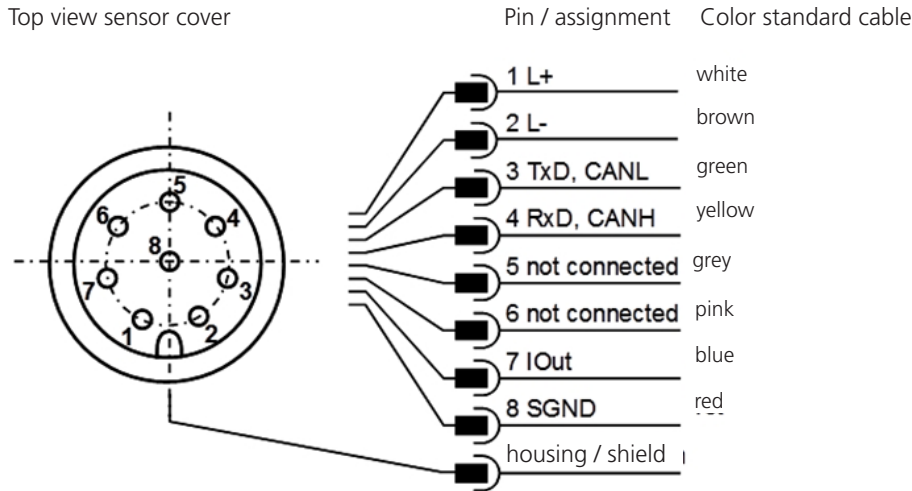
Figure 4.1: Pin assignment with top view of the sensor cover

The sensor cable is to be shielded.

In order to achieve the protection class IP67, only suitable plugs and cables may be used. The tightening torque for the plug is 0.1 Nm.

The power should be measured with a suitable ammeter or alternatively via a load resistor, and a voltage measurement according to the Figure 4.2 or 4.3. The maximum allowable load resistance is 100Ω at 12V and 400Ω at 24V.

⚠️ Please note when connecting, that the sensor must be grounded either through the shield of the cable or via the housing.

### 4.2 Analog current outputs (4 ... 20 mA) - measurement without load resistance

The current measurement should be carried out with a suitable ammeter according to the next figure.

Top view sensor cover

7 IOut

8 SGND
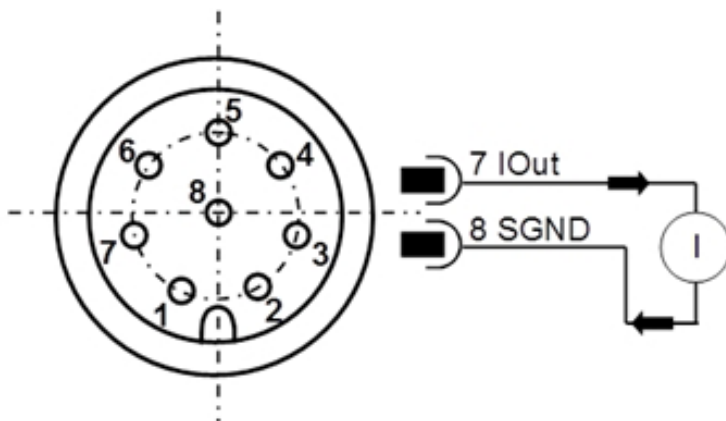
Figure 4.2: Measurement of the analog outputs 4 ... 20 mA without load resistance

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## 4.3 Analog current output (4 ... 20 mA) - measurement with load resistance

In order to measure the currents of the analog current output with a voltmeter, a load resistance must be connected to the output as shown in Figure 4.3. The load resistance should be, depending on the supply voltage, between 25 Ohm and 200 Ohm. With the use of a voltmeter, the voltage at each resistor can now be measured.

Top view sensor cover
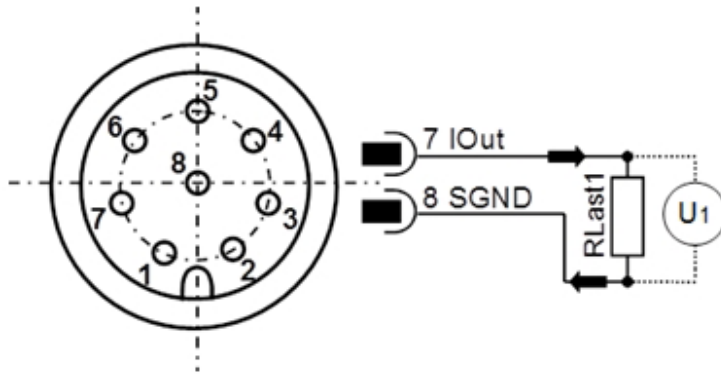


Figure 4.3: Connection of the load resistances for measuring the analog 4 ... 20 mA output

In order to determine the appropriate parameters from the present currents or from the voltage and the size of the load resistance calculated currents, the tensions must be converted according the formulas of Table 4.3.

## 4.4 Dimensioning of the load resistance

The load resistance cannot be chosen arbitrarily. It must be adjusted according to the supply voltage of the sensor. The maximum load resistance can be calculated with the formula (5-1). Alternatively, Table 4.1 is available.

$$R_{max} / \Omega = U_{supply} / V \cdot 25(\Omega/V) - 200\Omega \qquad 25\ \Omega \leq R_{max} \leq 200\ \Omega \qquad (5-1)$$

| $R_{max}$ in $\Omega$ | $U_{supply}$ in V |
|---|---|
| 350 | 22 |
| 400 | 24 |
| 450 | 26 |

Table 4.1: Determination of the load resistance as a function of the supply voltage

## 4.5 Setting of the analog current outputs

The assignment of the analog current output is set at the factory. **The default configuration is the sum of the occupancy rate of fine and coarse particles (OccupancyRate_sum).** However, the sensor has the ability to change the default output parameters. The RS232 command is: **"SAMOx [CR],"** with the corresponding number key x. Table 4.2 shows the possible parameters for the configuration of the analog outputs.

| x | Parameter name | Abbre-viation | Unit | Statement |
|---|---|---|---|---|
| 0 | Temperature | T | °C | Temperature of the sensor |
| **1** | **OccupancyRate_sum** | **OR_s** | **%** | **Default: sum signal of OR_f and OR_f** |
| 2 | OccupancyRate_fine | OR_f | % | Occupancy rate of the sensor surface with fine particles |
| 3 | OccupancyRate_chunk | OR_c | % | Occupancy rate with large particles (chunks) from 0 ... 100 % in 10 % steps |
| 10 | Clean Counter | cln_cnt | - | Number of automatic cleaning cycles since the last manual reset ("SONew" command) |
| 16 | Chunk Counter | chunk_cnt | - | Number of detected large particles (chunks) |
| 40 | Sequential output | - | - | Time-separated output of the values 0, 1, 2, 3, 10 and 16 (see Figure 4.2) |
| 100 | 4 mA | - | - | Output fixed at 4 mA |
| 101 | 12 mA | - | - | Output fixed at 12 mA |
| 102 | 20 mA | - | - | Output fixed at 20 mA |

Table 4.2: Number key for the output parameters of the analog current outputs

A sequential output of the main parameters is possible via the analog interface. The sensor must be configured according to the specification in Table 4. The accordingly configured sensor displays the most important parameters in the manner shown in Figure 5:
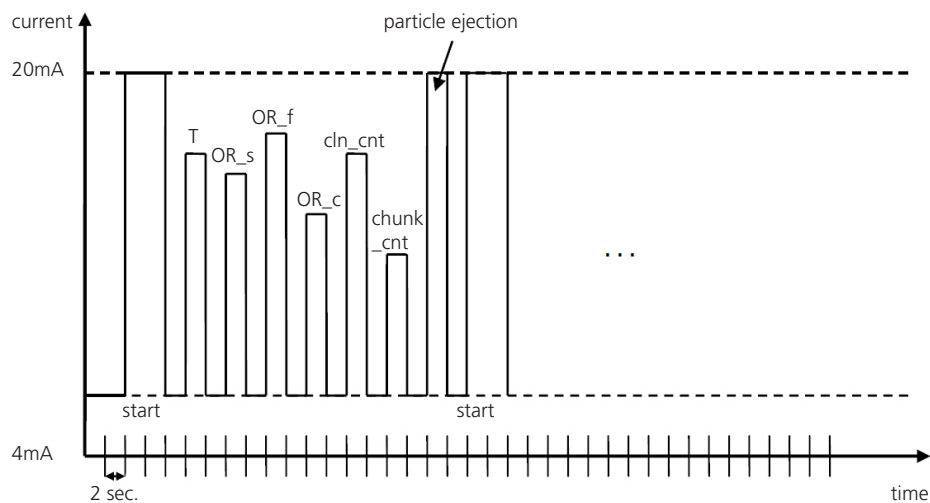


Table 4.4: Sequential output of the values via the analog interface

## 4.6    Calibration

The output values can be calibrated and calculated on the basis of the following formulas:

| Output size X | Output range | Size equation | Formula |
|---|---|---|---|
| Temperature (T) | -20 ...100 °C | $X = \dfrac{U/V}{R/\Omega} \cdot 7500\left(\dfrac{°C}{A}\right) - 50\ °C$ | (5-1) |
| **OccupancyRate_sum (OR_s)** | **0 ... 100%** | $X = \dfrac{U/V}{R/\Omega} \cdot 6250\left(\dfrac{\%}{A}\right) - 25\ \%$ | (5-2) |
| OccupancyRate_fine (OR_f) | 0 ... 100 % | $X = \dfrac{U/V}{R/\Omega} \cdot 6250\left(\dfrac{\%}{A}\right) - 25\ \%$ | (5-3) |
| OccupancyRate_chunk (OR_c) | 0 ... 100 % | $X = \dfrac{U/V}{R/\Omega} \cdot 6250\left(\dfrac{\%}{A}\right) - 25\ \%$ | (5-4) |
| Clean Counter (cln_cnt) | 0 ... 64 | $X = \dfrac{U/V}{R/\Omega} \cdot 4000\left(\dfrac{1}{A}\right) - 16$ | (5-5) |
| Chunk Counter (chunk_cnt) | 0 ...10 | $X = \dfrac{U/V}{R/\Omega} \cdot 625\left(\dfrac{1}{A}\right) - 2,5$ | (5-6) |
| Particle ejection | active or inactive | X =   4mA = inactive<br>X = 20mA = active | |

Table 4.3: Calculation of the measured values of the current

The communication with the sensor is carried out either via a serial RS232 interface, CANopen or via an analog 4 ... 20 mA output.

By default, the sensors are supplied with an activated RS232 interface. In this mode, it is very easy to carry out the configuration of the analog interface as well as the configuration of the CANopen communication parameters. If necessary, you may then switch to the CANopen interface via RS232 command (see Chapter 5.3 write commands, command "SComMode"), the change will become effective after the restart of the sensor.

**For configuration and / or operation of the sensor via PC, the on the homepage of ARGO-HYTOS available software (LubMonPClight, LubConfig) is recommended. With operation of the sensor at a PC, the software allows convenient access to the sensor data and the configuration of the sensor without help of terminal programs.**

With operation of the sensor in the CANopen mode, it may - via corresponding entry in the object directory - permanently be switched to the RS232 interface (see Chapter 6), the change will take effect after the restart of the sensor.

With operation of the sensor in the CANopen mode, it may also temporarily be switched to the RS232 interface. For this purpose, the sensor is connected to an appropriately configured RS232 interface. During startup, the hash key (#) needs to be kept pressed until the sensor reports with its ID (for example $ ARGO-HYTOS; OPComFerroS; SN. 000015; SW: 0:55:15; CRC: b). In case the sensor does not respond within 10 seconds after applying the power supply, the process must be repeated.

### 5.1    Serial interface (RS232)
The sensor is provided with a serial interface, via which it can be read and configured.
For this purpose, a PC and an appropriate terminal program or a readout software is required. Both are described in more detail in the following chapters.

First, you need to select an existing, free COM port at your computer to which you connect your sensor. An appropriate communication cable for the serial connection between sensor and computer / controller is available under order no. SCSO 100 5020 or SCSO 100 5030 (see Chapter 6).  In case the computer should not be provided with a standard COM port, it is possible to use serial interface cards or USB-to-serial converters, SCSO 100 5040 (see Chapter 6).

If the sensor is started in CAN mode, it must be reset to the RS232 mode. After connecting the sensor to the current supply,  the sensor will detect online, if it is connected to a serial interface (interface configuration see below) and if a defined character ("#") is sent, which must be present during the starting phase. If the character is not sent, the sensor will jump in the CANopen mode. If it understands the transmitted character, it will go into the communication mode via RS232. Here, by command ("ScomMode"), the RS-232 mode can be permanently activated. With restart of the sensor, it automatically will start in RS232 mode and the above process can be omitted.

### 5.2    Interface parameters

› Baud rate:        9600
› Data bits:        8
› Parity:           none
› Stop bits:        1
› Flow control:     none

### 5.3    Command list
Below, all interface commands for communication with the sensor are listed. These can be transferred to the sensor by using a terminal program such as e.g. Microsoft Windows HyperTerminal.

### 5.3.1 Read commands

| # | Instruction format | Meaning | Return format |
|---|---|---|---|
| 1 | RID[CR] | Reading the identification and subsequent checksum (CRC) | $ARGO-HYTOS;OPComFerroS; SN:xxxxx;...;CRC:x[CR][LF] |
| 2 | RVal[CR] | Reading all measurements with subsequent check sum (CRC) | $ Time:x.xxx[h];T:xx.x[°C]; ....;CRC:x[CR][LF] |
| 3 | RCon[CR] | Reading the configuration parameters and CAN configuration with subsequent check sum (CRC) | $ Time:x.xxx[h];…; CRC:x[CR][LF] |

Table 5.1: Serial communication - read commands

### 5.3.2 Write commands

| # | Instruction format | Meaning | Return format |
|---|---|---|---|
| 1 | SONew[CR] | Stores the current state as fresh oil. The oil age is set to 0 h, adhering particles are ejected | ok[CR][LF] |
| 2 | SAOx[CR] | Assignment of the current output with a corresponding measured value. (Configuration see Chapter 4.5). | SAO:x[CR][LF] |
| 3 | SChunkCntThr[CR] | Limit value, how many chunks (large particles) may be counted in the system before OR_c reaches 100 % (default: 10) | ChunkCntThr:x[CR][LF] |
| 4 | SComModex[CR] | Sets the communication mode: x = 0: CANopen X1: SAE J1939 x = 2: RS232 (default) Implementation with next restart | ComMode:x[CR][LF] |
| 5 | WCOSpdx[CR] | Sets the baud rate for CANopen mode. x = Baud rate in kbit/s The following baud rates are supported (in kbit/s): 50, 100, 125, 250 (default), 500 Implementation with next restart | COSpd:x[CR][LF] |
| 6 | WCOIDx[CR] | Sets the node ID for CANopen mode. Range x: 0 …127 (default: 100) COB-ID of the TPDO is automatically set to default values TPDO1 COB ID: 0x180 + Node-ID TPDO2 COB ID: 0x280 + Node-ID TPDO3 COB ID: 0x380 + Node-ID Implementation with next restart | COID:xxx[CR][LF] |
| 6 | WCOHBeatx[CR] | Sets the node ID for CANopen mode. Range x: 0 …127 (default: 100) COB-ID of the TPDO is automatically set to default values TPDO1 COB ID: 0x180 + Node-ID TPDO2 COB ID: 0x280 + Node-ID TPDO3 COB ID: 0x380 + Node-ID Implementation with next restart | COHBeat:x[ms] [CR][LF] |
| 7 | WTPDOyIDx[CR] | Sets TPDOy-COB-ID for CANopen mode. Range y: 1 … 3 Range x: 384 …1279 (0x180..0x4FF) Corresponds to SDO entry index: 0x180y, Sub: 1 Implementation with next restart | TPDOyID:x[CR][LF] |
| 8 | WTPDOyType [CR] | Sets TPDOy-Type for CANopen mode. Range y: 1 … 3 Range x: 1 … 240, 254, 255 Corresponds to SDO entry index: 0x180y, Sub 2 Implementation with next restart | TPDOyType:x [CR][LF] |

| # | Instruction format | Meaning | Return format |
|---|---|---|---|
| 9 | WTPDOyTimern [CR] | Sets TPDOy timer for CANopen mode.<br>Range y: 1 ... 3<br>Range x: 0 ...10000ms, resolution: 50ms<br>If x = 0, heartbeat is turned off<br>Corresponds to SDO entry index: 0x1017<br>Implementation with next restart | TPDOyTimer:x[ms] [CR][LF] |
| 10 | STrAu[CR] | Switches off automatic transmission of measured values (x = 0) or (x = 1 ... 60), every x minutes, transfer corresponds to the response to command RVal<br>Default value x: 0 | TrAu:x[min][CR][LF] |

Table 5.2: Serial communication - write commands

*Note:*
[CR] = [Carriage Return (0xD)]
[LF] = [Linefeed (0xA)]

## 5.4 Overview on output parameters for individual commands

The sensor supports commands for reading the identification, measurement values and configuration. The responses to individual commands are listed in the following tables. Depending on the version of the sensor firmware, the order or the content of the issues may differ.

| # | Parameter name | Unit | Statement |
|---|---|---|---|
| 1 | - | - | ARGO-HYTOS (manufacturer) |
| 2 | - | - | OPCom FerroS (product name) |
| 3 | SN | - | Serial number |
| 4 | SW | - | Software version (firmware) of the sensor |

Table 6.3: Response to the command "RID"

| # | Parameter name | Unit | Statement |
|---|---|---|---|
| 1 | Time | h | Operating hours counter of the sensor |
| 2 | T | °C | Temperature of the sensor |
| 3 | OR_s | % | Occupancy rate sum: occupancy rate - sum of OR_f and OR_c |
| 4 | OR_f | % | Occupancy rate fine: occupancy rate of the sensor surface with fine particles |
| 5 | OR_c | % | Occupancy rate chunk: occupancy rate with large particles (chunks) from 0 ... 100 % in 10 % steps (detection of max. 10 chunks) |
| 6 | chunk_cnt | - | Number of detected large particles |
| 7 | cln_cnt | - | Number of automatic ejections since the last manual reset ("SONew" command) |
| 8 | cln | - | Ejection process currently active / inactive |
| 9 | tlc | h | Time since last manual reset ("SONew" command) or automatic ejection |
| 10 | tbc | h | Time between the second last and last automatic ejection |
| 11 | OAge | h | Time since last manual reset ("SONew" command) |
| 12 | ROT | h | Remaining Occupancy Time, expected time remaining until OR has reached 100 % and the automatic cleaning process is triggered, based on the current value of OR_s and last automatic cleaning |

Table 6.4: Response to the command "RVal"

| # | Parameter name | Unit | Statement |
|---|---|---|---|
| 1 | Time | h | Operating hours counter of the sensor |
| 2 | ChunkDetThr | % | Limit value for detection of large particles (chunks) |
| 3 | TrAu | min | Periodic transmission of the data set as this is issued at RVal command in intervals of specified minutes (range 1 ... 60 minutes, at setting 0 the automatic transmission is turned off) |
| 4 | AO | - | Setting for the analog output (also see Chapter 5) |
| 5 | ChunkCntThr | - | Number of chunks that are required for achieving the 100 % limit |
| 6 | TimeOFF | ms | Time for turning off the automatic ejection (a multiple of 250 ms) |
| 7 | TimeON | ms | Time for switching on the automatic ejection (a multiple of 250 ms) |
| 8 | pThr | % | Limit  value for proximity signal |
| 9 | fThr | % | Threshold for frequency signal |
| 10 | ComMode | - | Communication mode (RS232, CANopen or SAE J1939) |
| 11 | COID | - | CANopen node ID of the sensor |
| 12 | COSpd | kBit/s | Speed (baud rate) of the CANopen bus |
| 13 | TPDO1Type | - | TPDO 1 Type for CANopen |
| 14 | TPDO2Type | - | TPDO 2 Type for CANopen |
| 15 | TPDO3Type | - | TPDO 3 Type for CANopen |
| 16 | TPDO1Timer | ms | TPDO 1 Timer for CANopen |
| 17 | TPDO2Timer | ms | TPDO 2 Timer for CANopen |
| 18 | TPDO3Timer | ms | TPDO 3 Timer for CANopen |
| 19 | TPDO1ID | - | TPDO 1 COB-ID for CANopen |
| 20 | TPDO2ID | - | TPDO 2 COB-ID for CANopen |
| 21 | TPDO3ID | - | TPDO 3 COB-ID for CANopen |
| 22 | COHBeat | ms | CANopen Heartbeat of the sensor |
| 23 | J1939ID | - | SAE J1939 ID of the sensor |
| 24 | J1939BR | kBit/s | Speed (baud rate) of the SAE J1939 bus |
| 25 | J1939ti | - | SAE J1939 Timer |
| 26 | Verb | - | Switching between clear and substantive response for RVal command |

Table 5.5: Response to the command "RCon"

## 5.5    Communication with a terminal program

If the sensor is connected to a PC and is supplied with power, you may communicate with it, using an arbitrary program. On the internet, different terminal programs are offered as freeware. The simplest way is to use the "HyperTerminal", included in the scope of delivery of Microsoft Windows XP. As standard, this program is to be found under **Start / Programs / Accessories / Communications.**

## 5.6    Output trigger

The output of measured values via the RS232 interface can in principle be effected in two different ways, time-triggered or command-triggered (see command: "StrAu").

## 5.7    Software

ARGO-HYTOS offers various programs (drivers, LabVIEW tools and utilities) for the field of sensor technology. These can be downloaded from **www.argo-hytos.com**.

## 6.1 CAN interface

The CAN interface corresponds to the "CAN 2.0B Active Specification". The sensor supports a limited number of transmission speeds on the CAN bus (see Table 6.1).

| By CiA recommended and by the sensor supported data rates | | | |
|---|---|---|---|
| Data rate | Supported | CiA Draft 301 | Bus length (CiA Draft Standard 301) |
| 1 Mbit/s | no | yes | 25 m |
| 800 kbit/s | no | yes | 50 m |
| 500 kbit/s | yes | yes | 100 m |
| 250 kbit/s | yes | yes | 250 m |
| 125 kbit/s | yes | yes | 500 m |
| 100 kbit/s | yes | no | 750 m |
| 50 kbit/s | yes | yes | 1000 m |
| 20 kbit/s | no | yes | 2500 m |
| 10 kbit/s | no | yes | 5000 m |

Table 6.1: Supported bus speeds with CANopen communication and associated cable lengths

The electrical parameters of the CAN interface are listed in Table 6.2.

| Parameter | Size | Unit |
|---|---|---|
| Typ. response time to SDO requests | <10 | ms |
| Max. response time to SDO requests | 150 | ms |
| Supply voltage CAN transceiver | 3,3 | V |
| Integrated scheduling | No | - |

Table 6.2: Electrical parameters of the CAN interface

## 6.2 SDO communication

Service Data Objects allow read and write access to the object directory of the sensor. The SDOs are acknowledged and the transmission always takes place only between two participants, a so-called client / server model (see Figure 6.1).

The sensor can only function as a server, thus only answers to SDO messages and does not send requests to other participants by itself. The SDO messages from the sensor to a client need the NodeID + 0x580 as ID. For inquiries from the client to the sensor (Server), the NodeID + 0x600 is expected as ID in the SDO message.

The standard protocol for SDO transfer requires 4 bytes to encode the transmit direction, the data type, the index and the sub-index. Thus, 4 bytes of the 8 bytes of a CAN data field remain for the data content. For objects, whose data content is larger than 4 bytes, there are two other protocols for the so-called fragmented or segmented SDO transfer.
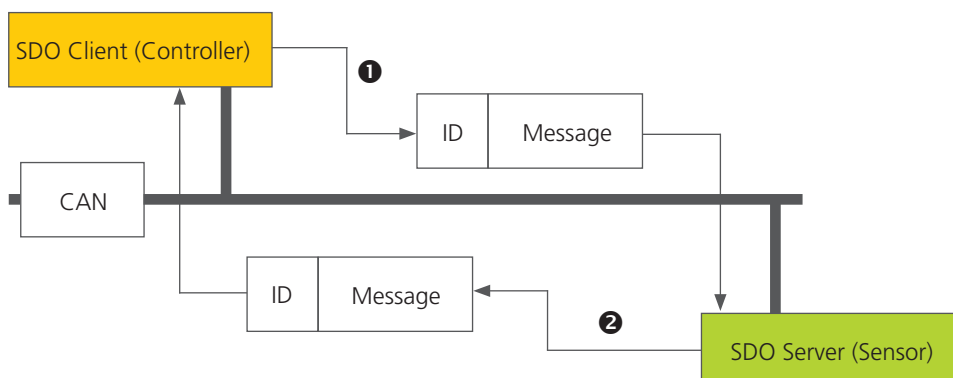


Figure 6.1: SDO client / server relationship

SDOs are intended to configure the sensor via access to the object directory, to request rarely used data or configuration values or to download large amounts of data.

## 6.3    PDO communication

PDOs are one or more records, that are reflected from the object dictionary in the up to 8 bytes of a CAN message, to transfer data quickly and with the least possible expenditure of time from a "Producer" to one or more "Consumers" (see Figure 7.4). Each PDO has a unique COB-ID (Communication Object Identifier), is sent by a single node, but may be received from a plurality of nodes and does not need to be acknowledged / confirmed.

PDOs are ideally suited for the transfer of sensor data to the controller or from the controller to actuators.
The PDO attributes of the sensor at a glance:

› The sensor supports three TPDOs, no RPDOs
› The mapping of the data in PDOs is fixed and cannot be changed
› The COB IDs for the three TODOs are freely selectable
› The TODOs  can be transferred event- / timer-triggered or cyclically to SYNCH triggered and can be set individually.

The sensor supports two different PDO transmission methods.

› In the event or timer-triggered method, the transmission is initiated by a sensor internal timer or event.
› In the SYNC-triggered method, the transfer takes place in response to a SYNC message.
  (CAN message by a SYNC producer without user data). The answer with PDO is carried out either with each received SYNCH or set to all n-received SYNC messages.
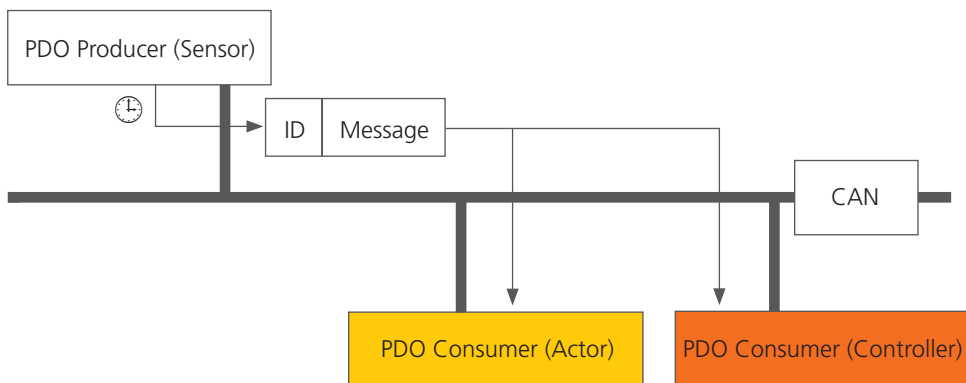


Figure: 7.2: PDO consumer / producer relationship

The sensor supports three transmit PDOs (TPDO)  to allow a most efficient operation of the CAN bus. The sensor does not support dynamic mapping of PDOs, the mapping parameters in the OD are therefore only readable but not writable.

The sensor supports certain types of TPDOs (see Table 11), which can be entered for the respective communication parameters of the TPDOs.

| By sensor supported TPDO types | | | | | |
|---|---|---|---|---|---|
| Type | supported | cyclically | not cyclically | synchronous | asynchronous |
| 0 | yes | | X | X | |
| 1-240 | yes | X | | X | |
| 241-253 | no | | | | |
| 254 | yes | | | | X |
| 255 | yes | | | | X |

Table 6.3: Description of the TPDO types

## 6.4    CANopen object directory

The complete object dictionary of the sensor is shown in Table 6.4 and Table 6.5. In Table 6.4, the communication-related part of the object directory is displayed. The here possible settings correspond, with a few exceptions, to the CANopen standard as described in DS 301. There are some restrictions regarding the communication due to the used hardware platform. The setting procedure for "heartbeat time" (Index 1017h), "TPDO1 event timer" (Index 1800h, Sub-index 5), "TPDO2 event timer" (Index 1801h, Sub-index 5), "TPDO3 event timer" (Index 1802h, Sub-index 5) are limited to 10 ms instead of the intended 1 ms. This means that these objects can be set, for example, to 0 ms, 20 ms, 280 ms, but not to 33 ms or 125 ms, etc.

An appropriate EDS file for the sensor is available on the website of ARGO-HYTOS.

| Communication Profile Area | | | | | | |
|---|---|---|---|---|---|---|
| Idx | Sub | Name | Type | Attr. | Default | Notes |
| **1000h** | **0** | **Device type** | **u32** | **ro** | **194h** | **Sensor, see D S404** |
| **1001h** | **0** | **Error register** | **u8** | **ro** | **00h** | **Mandatory, see DS301** |
| **1017h** | **0** | **Producer heartbeat time** | **u16** | **rw** | **1388h** | **Heartbeat time in ms, range: 0 ... 65535** |
| **1018h** | | Identity object | record | ro | | |
| | 0 | Number of entries | u8 | ro | 04h | Largest sub index |
| | 1 | Vendor ID | u32 | ro | 000000E6h | ARGO-HYTOS |
| | 2 | Product Code | u32 | ro | 00005014h | OPCom FerroS |
| | 3 | Revision Number | u32 | ro | 1000 | Device dependent |
| | 4 | Serial Number | u32 | ro | | Device dependent |
| **1800h** | | Transmit PDO1 Parameter | record | | | |
| | 0 | Number of entries | u8 | ro | 05h | Largest sub index |
| | 1 | COB-ID | u32 | rw | 180h+NodeID | COB-ID used by PDO, range: 181h ...1FFh, can be changed while not operational |
| | 2 | Transmission type | u8 | rw | FFh | Cyclic + synchronous, asynchronous values: 1-240, 254, 255 |
| | 5 | Event timer | u16 | rw | 1F4h | Event timer in ms for asynchronous TPDO1 range: 0 ....65000 |
| **1801h** | | Transmit PDO2 Parameter | record | | | |
| | 0 | Number of entries | u8 | ro | 05h | Largest sub index |
| | 1 | COB-ID | u32 | rw | 280h+NodeID | COB-ID used by PDO, range: 281h ... 2FFh, can be changed while not operational |
| | 2 | Transmission type | u8 | rw | FFh | Cyclic + synchronous, asynchronous values: 1-240, 254, 255 |
| | 5 | Event timer | u16 | rw | 1F4h | Event timer in ms for asynchronous TPDO2 range: 0 ... 65000 |
| **1802h** | | Transmit PD03 Parameter | record | | | |
| | 0 | Number of entries | u8 | ro | 05h | Largest sub index |
| | 1 | COB-ID | u32 | rw | 380h+NodeID | COB-ID used by PDO, range: 381h ... 3FFh, can be changed while not operational |
| | 2 | Transmission type | u8 | rw | FFh | Cyclic + synchronous, asynchronous values: 1-240, 254, 255 |
| | 5 | Event timer | u16 | rw | 1F4h | Event timer in ms for asynchronous TPDO3 range: 0 ... 65000 |
| **1A00h** | | TPD01 Mapping Parameter | record | | | |
| | 0 | Number of entries | u8 | ro | 07h | Largest sub index |
| | 1 | PDO Mapping for 1st app obj. to be mapped | u32 | co | 0x20000608 | Occupancy Rate s-Signal |
| | 2 | PDO Mapping for 2nd app obj. to be mapped | u32 | co | 0x20000308 | Occupancy Rate f-Signal |
| | 3 | PDO Mapping for 3rd app obj. to be mapped | u32 | co | 0x20000508 | Occupancy Rate c-Signal |
| | 4 | PDO Mapping for 4th app obj. to be mapped | u32 | co | 0x20020108 | Temperature |
| | 5 | PDO Mapping for 5th app obj. to be mapped | u32 | co | 0x20020b08 | Cleaning Counter |

| | | Communication Profile Area | | | | |
|---|---|---|---|---|---|---|
| Idx | Sub | Name | Type | Attr. | Default | Notes |
| | | **TPD01 Mapping Parameter** | **record** | | | |
| 1A00h | 6 | PDO Mapping for 6th app obj. to be mapped | u32 | co | 0x20020c08 | Chunk Counter |
| | 7 | PDO Mapping for 7th app obj. to be mapped | u32 | co | 0x20020a01 | Cleaning in Progress |
| | | **TPDO2 Mapping Parameter** | **record** | | | |
| 1A01h | 0 | Number of entries | u8 | ro | 02h | largest sub index |
| | 1 | PDO Mapping for 1st app obj. to be mapped | u32 | co | 0x20010120 | Sensor On Time / s |
| | 2 | PDO Mapping for 2nd app obj. to be mapped | u32 | co | 0x10180420 | Serial Number |
| | | **TPDO3 Mapping Parameter** | **record** | | | |
| 1A02h | 0 | Number of entries | u8 | ro | 02h | largest sub index |
| | 1 | PDO Mapping for 1st app obj. to be mapped | u32 | co | 0x20010210 | Oil age in hours |
| | 2 | PDO Mapping for 2nd app obj. to be mapped | u32 | co | 0x20010520 | Remaining Occupancy Time (ROT) |

Table 6.4: Communication related object dictionary

All sensor related objects are placed in the object directory from Index 2000h onwards and shown in Table 6.5. This part of the object directory is sensor specific. Furthermore, several configuration options are supported.

| Manufacturer-specific Profile Area | | | | | | |
|---|---|---|---|---|---|---|
| ldx | Sub | Name | Type | Attr. | Default | Notes |
| | | **OccupancyRate Parameters** | **record** | | | |
| **2000h** | 0 | Number of entries | u8 | ro | 06h | largest sub index |
| | 1 | Reserved | u8 | ro | | Reserved |
| | 2 | Reserved | u8 | ro | | Reserved |
| | 3 | OccupancyRate_fine (OR_f) | u8 | ro | | Occupancy rate of the sensor surface with fine particles (multiplied by 2) |
| | 4 | Reserved | u8 | ro | | Reserved |
| | 5 | OccupancyRate_chunk (OR_c) | u8 | ro | | Occupancy rate of the sensor surface with big particels (chunks) (multiplied by 2) OR_c = 100 / chunk_cnt_thr + chunk_cnt |
| | 6 | OccupancyRate_sum (OR_s) | u8 | ro | | Sum signal of OR_f and OR_c (multiplied by 2) OR_s = OR_c + OR_f |
| | | **Time Parameters** | **record** | | | |
| **2001h** | 0 | Number of entries | u8 | ro | 05h | largest sub index |
| | 1 | Sensor On Time / s | u32 | ro | | Sensor on time / s |
| | 2 | Oil Age / h | u16 | ro | | Time since last SONew / h |
| | 3 | Time since last cleaning (tlc) / h | u16 | ro | | Time since last SONew or automatic particle releasew / flush / h |
| | 4 | Time between two last cleanings (tbc) / h | u16 | ro | | Time between the last but one and the last particle release/flush |
| | 5 | Remaining Occupancy Time (ROT) / h | u32 | ro | | Time until OR_s reaches 100 %, based on current OR_s value und time since last particle release/flush / h |
| | | **Measured and Preprocessed Values** | **record** | | | |
| **2002h** | 0 | Number of entries | u8 | ro | 0Ch | largest sub index |
| | 1 | Temperature (T) °C | s8 | ro | | Sensor temperature in °C |
| | 2 | Reserved | u16 | ro | | - |
| | 3 | Reserved | s16 | ro | | - |
| | 4 | Reserved | u8 | ro | | - |
| | 5 | Reserved | u8 | ro | | - |
| | 6 | Reserved | u32 | ro | | - |
| | 7 | Reserved | s16 | ro | | - |
| | 8 | Reserved | u8 | ro | | - |
| | 9 | Reserved | u8 | ro | | - |
| | 10 | Cleaning in Progress | boolean | ro | | Particle release/flushing currently active/ inactive (1/0) |
| | 11 | Cleaning Counter (cln_cnt) | u8 | ro | | Amount of automatic particle releases / flushs since last SONew |
| | 12 | Chunk Counter (chunk_cnt) | u8 | ro | | Amount of detected chunks |

| Manufacturer-specific Profile Area | | | | | | |
|---|---|---|---|---|---|---|
| Idx | Sub | Name | Type | Attr. | Default | Notes |
| | | **Customer Settings** | **record** | | | |
| **2030h** | 0 | Number of entries | u8 | ro | 08h | Largest sub index |
| | 1 | Analog output type | u8 | rw | 1 | 0 = Temperature<br>1 = OR_s<br>2 = OR_f<br>3 = OR_c<br>10 = Clean Counter (0..64 counts)<br>16 = Chunk Counter (0…10 counts)<br>40 = sequential output<br>100 = 4mA<br>101 = 12mA<br>102 = 20mA |
| | 2 | Chunk counter threshold | u8 | rw | | Amount of big particles (chunks) required to reach OR_c 100% |
| | 3 | Set new oil | u8 | wo | | Reset sensor, release / flush particles, get th current state as fresh oil state<br>(correspods SONew-command) |
| | | **Service Settings** | **record** | | | |
| **2031h** | 0 | Number of entries | u8 | ro | 7h | largest sub index |
| | 1 | Reserved | u8 | rw | | - |
| | 2 | Reserved | u8 | rw | | - |
| | 3 | Reserved | u8 | rw | | - |
| | 4 | Reserved | s8 | rw | | - |
| | 5 | Reserved | s8 | rw | | - |
| | 6 | Reserved | s8 | rw | | - |
| | 7 | Maximum Temperature / °C | s8 | ro | | Highest seen temperature on the device / °C |
| | | **Device Settings** | **record** | | | |
| **2032h** | 0 | Number of entries | u8 | ro | 4h | largest sub index |
| | 1 | CANopen Start Mode | u8 | rw | 0 | 0 = Network with NMT Master (Init => PreOp => Start_Remote_Node => Operational<br>>0 = Network without NMT Master<br>(Init => Operational) |
| | 2 | CANopen Node ID | u8 | rw | | Node ID of CANopen-Bus |
| | 3 | CANopen Baudrate | u8 | rw | 1h | 0 = 500 Kbit/s<br>1 = 250 Kbit/s (default)<br>2 = 125 Kbit/s<br>3 = 100 Kbit/s<br>4 =  50 Kbit/s |
| | 4 | Communication Type | u8 | rw | 2h | 0 = CANopen<br>1 = J1939<br>2 = RS232 |

Table 6.5: Sensor-related part of the CANopen communication profile (0.64.16)

### 6.5 Commissioning with CAN interface

By default, the sensor is supplied with an activated RS232 and deactivated CAN interface. For permanent activation of the CAN interface, the sensor must be configured via RS232 interface (command "WCOEN", see Chapter 5.3)

On delivery, the CANopen interface of the sensor is configured according to Table 6.6.

| Parameter | Set value | RS232 command |
|---|---|---|
| Communication mode | 2 (RS232 activated / disabled CAN) To activate CANopen, communication mode must be set to 0. | SComMode |
| Node-ID | 0x64 (dez: 100) | WCOID |
| CAN baud rate | 250 kBit/s | WCOSpd |
| Heart Beat - Timer | 500 ms | WCOHBeat |
| TPDO1 ID | Node ID + 0x180 = 0x1E4 (dez: 484) | WTPDO1ID |
| TPDO2 ID | Node ID + 0x280 = 0x2E4 (dez: 740) | WTPDO2ID |
| TPDO3 ID | Node ID + 0x380 = 0x3E4 (dez: 996) | WTPDO3ID |
| TPDO1 Type | 254 | WTPDO1Type |
| TPDO2 Type | 254 | WTPDO2Type |
| TPDO3 Type | 254 | WTPDO3Type |
| TPDO1 Timer | 1000 ms | WTPDO1Timer |
| TPDO2 Timer | 1000 ms | WTPDO2Timer |
| TPDO3 Timer | 1000 ms | WTPDO3Timer |

Tabelle 6.6: CANopen default configuration

After configuration of the CAN interface in accordance with the existing CANopen network, the CAN interface of the sensor can be activated and the sensor can be connected to the CANopen network.

How to communicate with the sensor via RS232 interface, despite of the activated CAN communication, is described in Chapter 5.

### 6.6 CAN SAE J1939

For more information see www.argo-hytos.com

| Description | Order number |
|---|---|
| **Data cable for computer connection** | SCSO 100-5030 |
| › Side 1: M12 8-pole, 90° angled, IP67<br>› Side 2: D-Sub-plug 9-pole with additional coaxial power connector for power supply<br>› Length: 5m, shielded<br>› Temperature area -25°C…90°C<br>› Oil-resistant | |
| **Data cable with open ends** | SCSO 100-5020 |
| › Side 1: M12 8-pole, 90° angled, IP67<br>› Side 2: open<br>› Length: 5m, shielded<br>› Temperature area -25°C…90°C<br>› Oil-resistant | |
| **Sensor connectors** | SCSO 100-5010 |
| › M12 8-pole, straight, IP67<br>› Suitable for cable diameter 6…8 mm<br>› Temperature area -20°C … 85°C | |
| **Adapter USB - RS232 serial** | PPCO 100-5420 |
| › Side 1 (PC): USB A plug<br>› Side 2 (Periphery): D-Sub-plug 9-pole<br>› Length: 1,8m<br>› Incl. driver CD for windows 98 / ME / 2000 / XP / Win 7 / Win 8 | |
| Universal power supply | SCSO 100-5080 |
| › Supply range: 100…240VAC 50/60Hz<br>› Output voltage: 24VDC / max. 0,63A / 15W<br>› Operating temperature range: 0…40°C<br>› Suitable for data cable SCSO 100-5030<br>› Supply line: Euro power cable 2-pole, 1,5m | |
| Ethernet - RS232 Gateway | SCSO 100-5100 |
| › Side 1: D-Sub-plug 9-pole<br>› Side 2: RJ45<br>› 10/100 Mbps<br>› Temperature range: 0…55°C<br>› Power supply: 12…48VDC<br>› Windows 95 / 98 / ME / NT / 2000 / XP / Vista / 7 / 8 | |
| Display and storage device LubMon Visu | SCSO 900-1000 |
| › Suitable for installation in control cabinets<br>› Visual display of measurement data via a display<br>› Data logger with up to 1500 records<br>› SD Card and USB Type B | |

| Page | Changes |
|------|---------|
| 6 | › Power supply: 22...33 |
| | › Remove footnote 3 |
| 9 | › Remove the sentence "The operating voltage must be between 9-33 VDC." |
| 10 | › Table 4.4 $R_{max}$ and U changed |
| 19 | › 1A01h Sub1 Default 0x20010520 |
| 21 | › 2030h Sub3: New type: u8 |
| | › 2032h Sub1: New type: u8 |
| 23 | › Table Accessories processed |
| 24 | › New chapter No. 8 / Changes |

# EU - Konformitätserklärung
EU - Declaration of Conformity

$C\epsilon$

**ARGO HYTOS**

**ARGO-HYTOS GMBH**
Industriestraße 9
76703 Kraichtal-Menzingen

Tel.: +49 72 50 / 76 0
Fax: +49 72 50 / 76 199
www.argo-hytos.com

| | |
|---|---|
| Die EU - Konformitätserklärung gilt für folgendes Gerät: | The EU - Declaration of Conformity applies to the following unit: |
| Verschleißsensor | Wear Sensor |

## OPCom FerroS
SPCO 500-1000

| | |
|---|---|
| Wir bestätigen die Übereinstimmung mit den wesentlichen Anforderungen der europäischen Richtlinie(n): | We confirm the conformity according to the essential requirements of the European directive(s): |
| **2014/30/EU (EMV)** | **2014/30/EU (EMC)** |
| **2011/65/EU (RoHS)** | **2011/65/EU (RoHS)** |
| Folgende Norm(en) wurde(n) angewandt: | The following standard(s) was (were) applied: |

**EN 13309: 2010**
**ISO 13766: 2006**
**ISO 7637-2 Edition 2: 2004 (partly)**
**ISO 7637-3 Edition 2: 2007 (partly)**

| | |
|---|---|
| Die Beurteilung und Prüfung des Gerätes erfolgte durch das EMV-Prüflabor: | The evaluation and testing of the device was carried out by the EMC testing laboratory: |

**TÜV SÜD Product Service GmbH**
**Äußere Frühlingstraße 45**
**94315 Straubing / Germany**

Kraichtal, 31.08.2020

(Ort und Datum der Ausstellung)

(Place and date of issue)

i.V.

(Unterschrift) Matthias Knebel
Dokumentenverantwortlicher

(Signature) Matthias Knebel
Responsible for documents

(Unterschrift) Jörg Stech
Managing Director O&A

(Signature) Jörg Stech
Managing Director O&A

www.argo-hytos.com



A Voith Company

# ARGO-HYTOS worldwide

| | | |
|---|---|---|
| Benelux | ARGO-HYTOS B.V. | info.benelux@argo-hytos.com |
| Brazil | ARGO-HYTOS Fluid Power Systems Ltda. | info.br@argo-hytos.com |
| China | ARGO-HYTOS Fluid Power Systems | info.cn@argo-hytos.com |
| Czech Republic | ARGO-HYTOS s.r.o | info.cz@argo-hytos.com |
| | ARGO-HYTOS Protech s.r.o | info.protech@argo-hytos.com |
| France | ARGO-HYTOS SAS | info.fr@argo-hytos.com |
| Germany | ARGO-HYTOS GMBH | info.de@argo-hytos.com |
| Great Britain | ARGO-HYTOS Ltd. | info.uk@argo-hytos.com |
| Hong Kong | ARGO-HYTOS Hong Kong Ltd. | info.hk@argo-hytos.com |
| India | ARGO-HYTOS PVT. LTD. | info.in@argo-hytos.com |
| Italy | ARGO-HYTOS S.r.l. | info.it@argo-hytos.com |
| Poland | ARGO-HYTOS Polska spz o.o. | info.pl@argo-hytos.com |
| Sweden | ARGO-HYTOS Nordic AB | info.se@argo-hytos.com |
| Turkey | ARGO-HYTOS Hidrolik Ekip. San. ve Tic. Ltd. Şti. | info.tr@argo-hytos.com |
| USA | ARGO-HYTOS Inc. | info.us@argo-hytos.com |