



HySense® CW 100 Wear sensor Manual

MANUAL

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Read safety and operating instructions before commissioning!

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1. PERFORMANCE AND MEASUREMENT PRINCIPLES

1.1 General

The HySense® CW 100 wear sensor, hereinafter referred to as CW 100 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: $OR_f = \text{OccupancyRate_fine}$

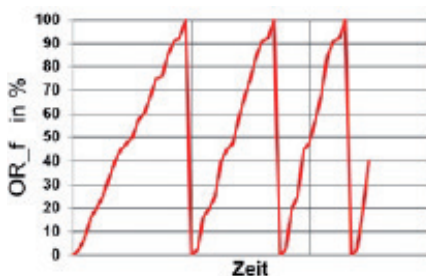


Figure 1.1: Example for the detection of fine particles

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

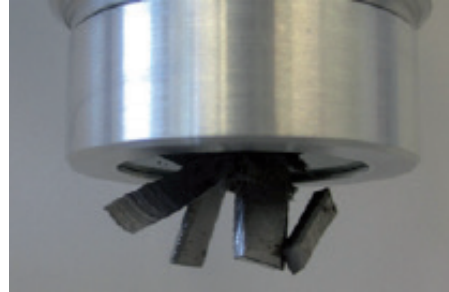
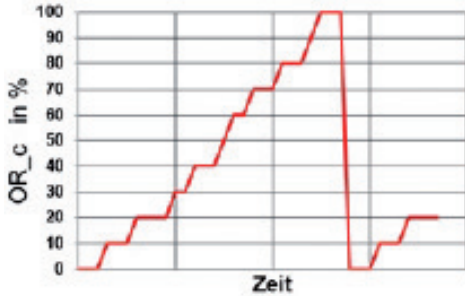


Figure 1.2: Example for the detection of chunks

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

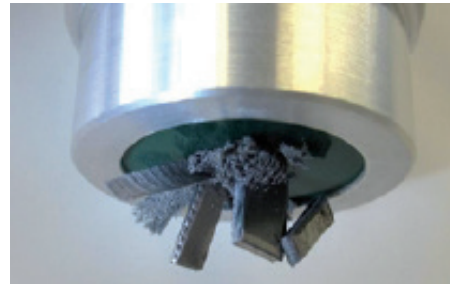
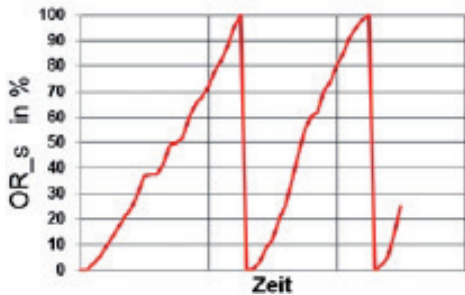


Figure 1.3: Example for the output of the sum signal

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 possibility for earlier compensation is by execution of the SONew command (see Chapter 5).

2 TECHNICAL SPECIFICATIONS

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 mm ² /s	~9.0	mm
Viscosity 300 mm ² /s	~7.5	mm
Viscosity 500 mm ² /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 ³	9 ... 33	VDC
Power input	max. 0.5	A
Output		
Output analog ⁴	4 ... 20	mA
Accuracy of power output ⁵	±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 CW100

¹ Non-condensing

² With screwed-on connector

³ Automatic switch off at U < 8 V and U > 36 V

⁴ Output is freely configurable (see Chapter 6)

⁵ In relation to digital output value

2.2 Dimensions

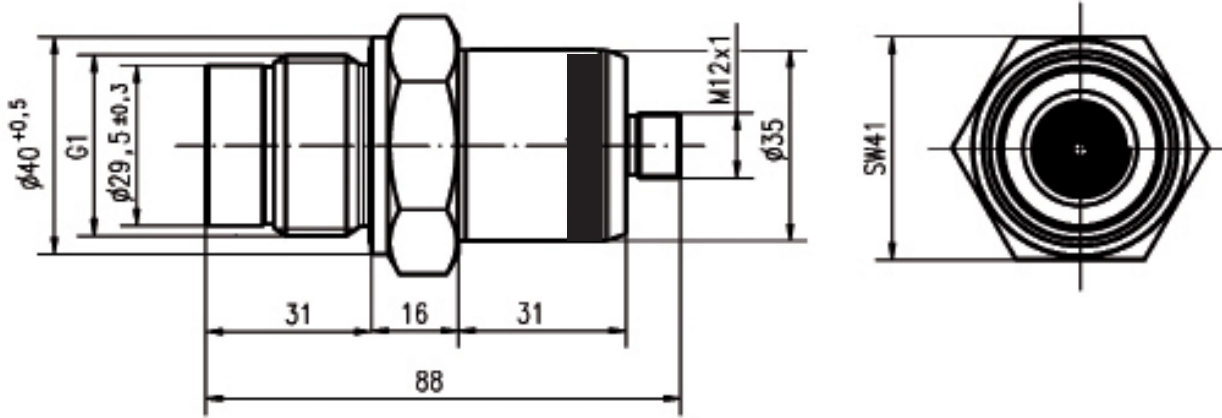


Figure 2.2.1: Dimensions CW100

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 \pm 5.0	Nm
Max. vibration in the longitudinal direction Test according to DIN EN 60068-2-6	f: 5 - 9	Hz
	A: \pm 15	mm
	F: 9 - 200	HZ
Max. vibration in the transverse direction Test according to DIN EN 60068-2-6	a: 10	g
	f: 5 - 9	HZ
	A: \pm 15	mm
	f: 9 - 200	Hz

Table 2.3.2: Permissible mechanical loads

3 MOUNTING

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

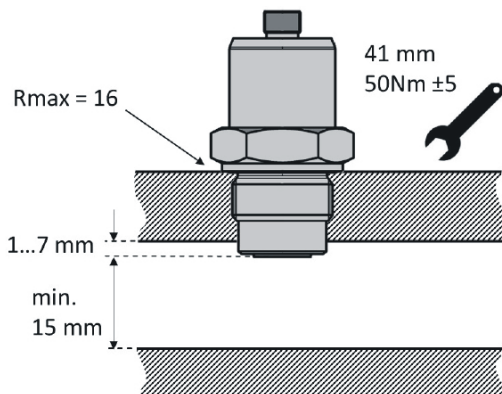


Figure 3.1: Mounting the sensor and detection radius

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 Hydrotechnik is advisable.
- ▶ In order to ensure a reliable measurement, the sensor tip should not enter the flow channel deeper than stated.

4 ELECTRICAL CONNECTION

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.

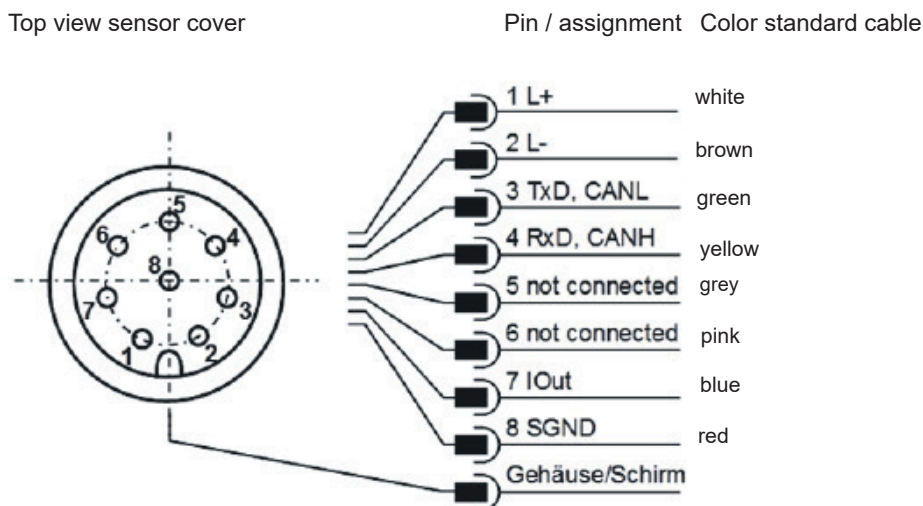


Figure 4.1: Pin assignment with top view of the sensor cover

The operating voltage must be between 9-33 VDC. 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.

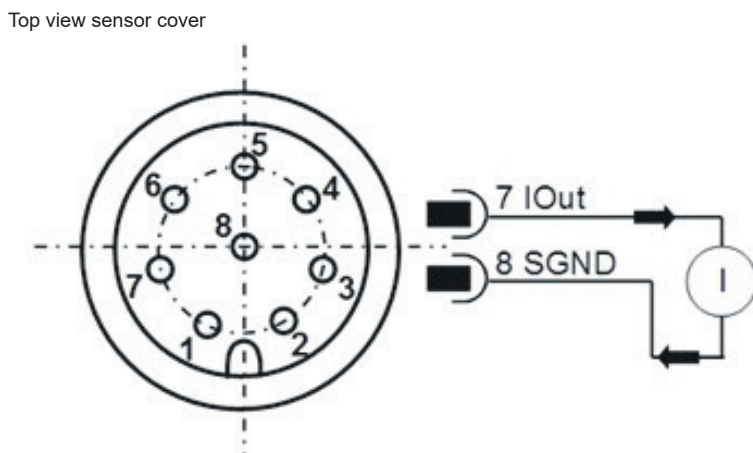


Figure 4.2: Measurement of the analog outputs 4 ... 20 mA without load resistance

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

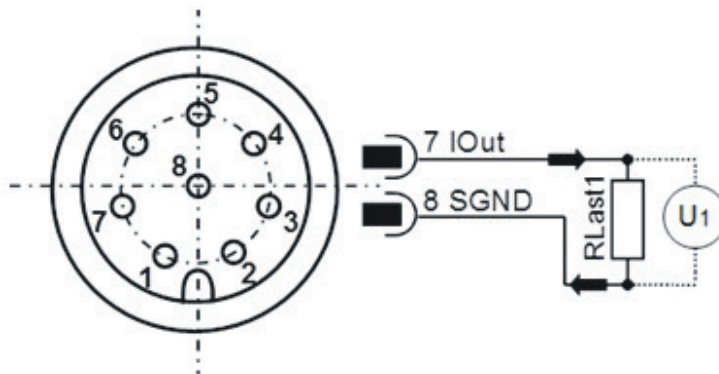


Figure 4.3: Connection of the load resistances for measuring the analog 4 ... 20 mA output

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 (4-1). Alternatively, Table 4.1 is available.

$$R_{max} / \Omega = U_{supply} / V * 25(\Omega/V) - 200\Omega \quad 25 \Omega \leq R_{max} \leq 200 \Omega \quad (4-1)$$

R _{max} in Ω	U _{supply} in V
25	9
50	10
100	12
150	14
200	16

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	Abbreviation	Unit	Statement
0	Temperature	T	°C	Temperature of the sensor
1	OccupancyRate_sum	OR_s	%	Default: sum signal of OR_f and OR_c
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)

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 4.4:

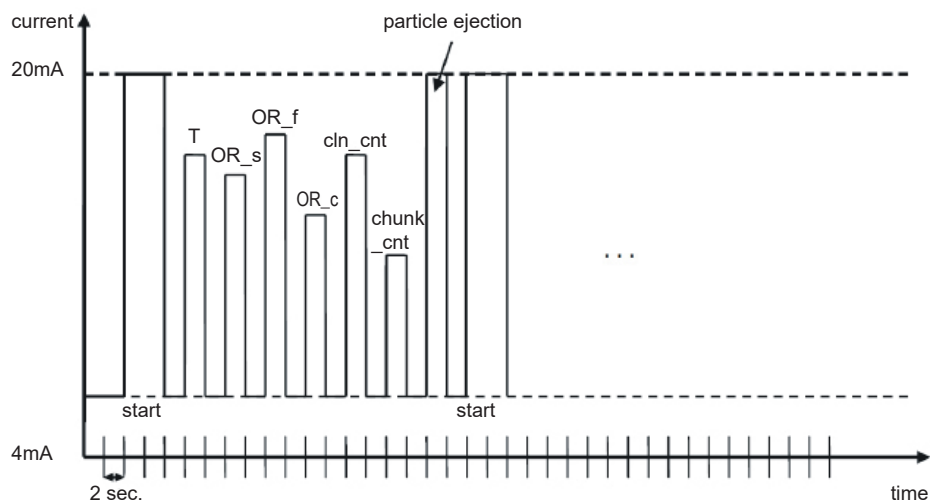


Table 4.4: Sequential output of the values via the analog interface

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	$X = \frac{U / V}{R / \Omega} \cdot 7500 \left(\frac{^{\circ}\text{C}}{\text{A}} \right) - 50^{\circ}\text{C}$	(4-2)
OccupancyRate_sum (OR_s)	0 ... 100%	$X = \frac{U / V}{R / \Omega} \cdot 6250 \left(\frac{\%}{\text{A}} \right) - 25\%$	(4-3)
OccupancyRate_fine (OR_f)	0 ... 100 %	$X = \frac{U / V}{R / \Omega} \cdot 6250 \left(\frac{\%}{\text{A}} \right) - 25\%$	(4-4)
OccupancyRate_chunk (OR_c)	0 ... 100 %	$X = \frac{U / V}{R / \Omega} \cdot 6250 \left(\frac{\%}{\text{A}} \right) - 25\%$	(4-5)
Clean Counter (cln_cnt)	0 ... 64	$X = \frac{U / V}{R / \Omega} \cdot 4000 \left(\frac{1}{\text{A}} \right) - 16$	(4-6)
Chunk Counter (chunk_cnt)	0 ... 10	$X = \frac{U / V}{R / \Omega} \cdot 625 \left(\frac{1}{\text{A}} \right) - 2,5$	(4-7)
Particle ejection	active or inactive	$X = 4\text{mA} = \text{inactive}$ $X = 20\text{mA} = \text{active}$	

Table 4.3: Calculation of the measured values of the current

5. RS232 COMMUNICATION

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.

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 \$HYDROTECHNIK;CW100;SN;000015;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. 8824-T7-00.00 , 8808-50-01.03 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, 8812-00-00.36.

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)	\$HYDROTECHNIK;CW100;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]

#	Instruction format	Meaning	Return format
9	WTPDOyTimern [CR]	Sets TPDOy timer for CANopen mode. Range y: 1 ... 3 Range x: 0 ... 10000ms, resolution: 50ms If x = 0, heartbeat is turned off Corresponds to SDO entry index: 0x1017 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 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	-	-	HYDROTECHNIK (manufacturer)
2	-	-	CW100 (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

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“).

6 CANopen communication

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 dienen dem Schreib- und Lesezugriff auf das Objektverzeichnis des Sensors. Die SDOs werden jeweils quittiert und die Übertragung findet immer nur zwischen zwei Teilnehmern statt, ein sogenanntes Client/Server-Model (vgl.: Abbildung 6.1).

Der Sensor kann ausschließlich als Server funktionieren, beantwortet also nur SDO-Nachrichten und schickt von sich aus keine Anfragen an andere Teilnehmer. Die SDO-Nachrichten vom Sensor an Client haben als ID die NodeID+0x580. Bei Anfragen vom Client an den Sensor (Server) wird bei der SDO-Nachricht als ID die NodeID+0x600 erwartet.

Das Standardprotokoll für SDO-Transfer, benötigt 4 Byte um die Senderichtung, Datentyp, den Index und den Subindex zu kodieren. Somit bleiben noch 4 Byte von den 8 Byte eines CAN-Datenfeldes für den Dateninhalt. Für Objekte, deren Dateninhalt größer als 4 Byte ist, gibt es zwei weitere Protokolle für sogenannten fragmentierten oder segmentierten SDO-Transfer.

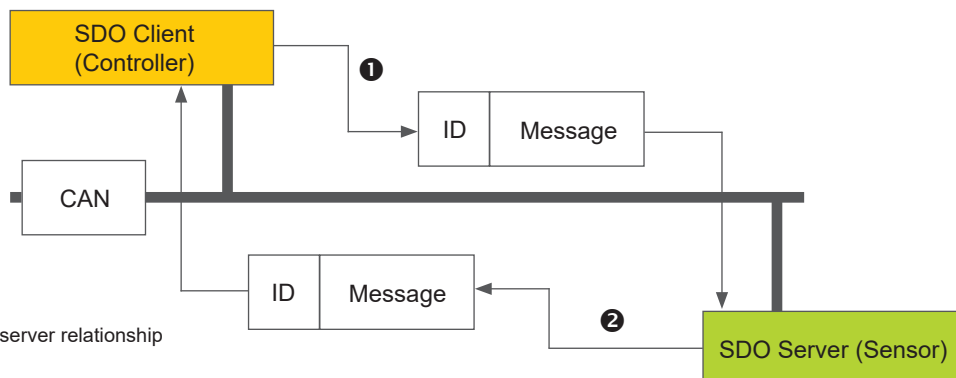


Figure 6.1: SDO client / server relationship

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 TPDOs are freely selectable
- › The TPDOs 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.

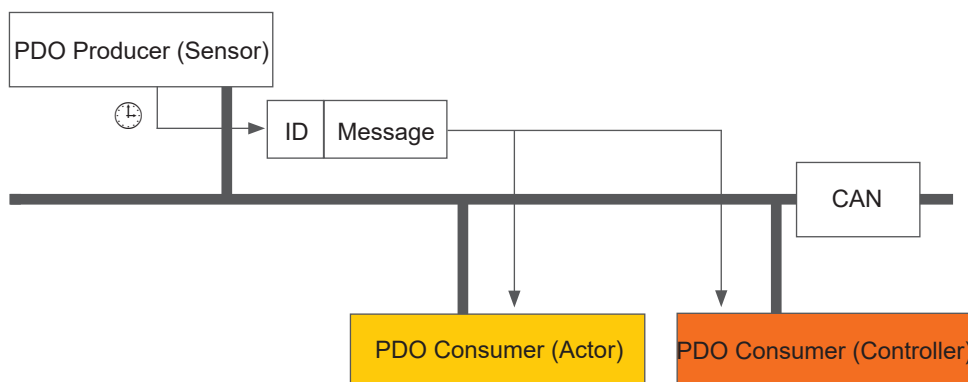


Figure: 6.2: PDO consumer / producer relationship

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 6.3), which can be entered for the respective communication parameters of the TPDOs.

Type	supported	By sensor supported TPDO types			
		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.

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	0000001C0	HYDROTECHNIK
	2	Product Code	u32	ro	00005014h	CW100
	3	Revision Number	u32	ro	1000	Device dependent
	4	Serial Number	u32	ro		Device dependent
		Transmit PDO1 Parameter	record			
1800h	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
		Transmit PDO2 Parameter	record			
1801h	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
		Transmit PD03 Parameter	record			
1802h	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
		TPD01 Mapping Parameter	record			
1A00h	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	0x20010520	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						
Idx	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 particles (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 release/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	Analogue Output Type	u8	rw	1	0 = Temperature 1 = OR_s 2 = OR_f 3 = OR_c 10 = Clean Counter (0..64 counts) 16 = Chunk Counter (0...10 counts) 40 = sequentielle Ausgabe 100 = 4mA 101 = 12mA 102 = 20mA
	2	Chunk Counter Threshold	u8	rw		Amount of big particles (chunks) required to reach OR_c 100%
	3	Set new oil	boolean	wo		Reset sensor, release / flush particles, get th current state as fresh oil state (corresponds 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	boolean	rw	0	0 = Network with NMT Master (Init => PreOp => Start_Remote_Node => Operational) >0 = Network without NMT Master (Init => Operational)
	2	CANopen Node ID	u8	rw		Node ID des CANopen-Busses
	3	CANopen Baudrate	u8	rw	1h	0 = 500 Kbit/s 1 = 250 Kbit/s (default) 2 = 125 Kbit/s 3 = 100 Kbit/s 4 = 50 Kbit/s
	4	Communication Type	u8	rw	2h	0 = CANopen 1 = J1939 2 = RS232

Tabelle 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)
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

Table 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.

7 ACCESSORIES

7.1 Wear sensor

Part	Order number	Comment
CW 100	3402-CW-G326C0-000	

7.2 Accessories and spare parts

Order number	Description	Comment
8812-00-00.36	Power supply M12x1; 8 pol Socket, with Countries plug adapter	power supply
8824-T1-00.00	Measuring cable M12x1; 8 pin Socket / open end	CAN connection cable
8824-T6-00.00	Measuring cable M12x1; 8 pol Plug / 8 pol. Socket	CAN connection cable MS 4010/ MS 5060+. MS5070
8808-50-01.03	Y-distribution M12 8-pol Socket, plug, Socket	Required to use power supply and CAN / RS232 at the same time
8824-T7-00.00	Interface cable M12 Plug, 8 pol. on D-SUB socket, 9 pol	Required to use serial interface with power supply
8824-T2-00.00	CAN connection cable M12x1; 8 pol Socket	Commitment with Y-distribution 8808-50-01.03

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