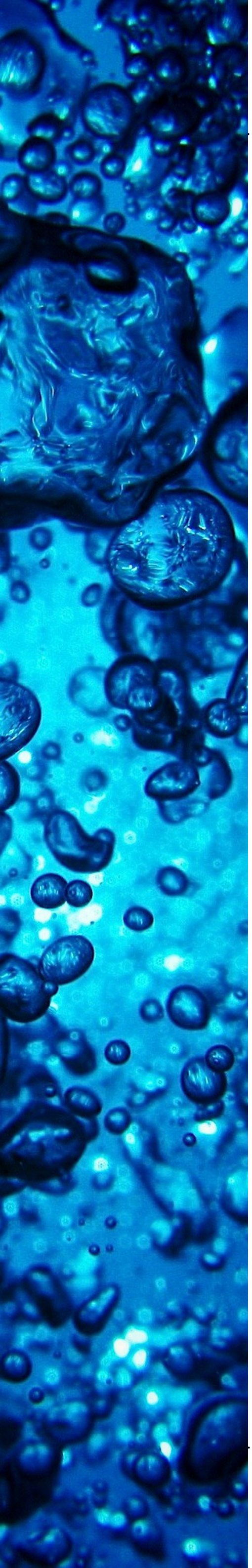

INTEGRON Poland EU
Research and Development Laboratory

USER MANUAL

Optical dissolved oxygen sensor

Model: OXY-DIOS-DSP-V2

Applications:

- wastewater treatment plants
- water intakes
- fish farms
- composting plants
- monitoring of rivers and lakes

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Szydłowiec, POLAND

Contents

Tables

Figures

1. Technical specifications

- Optical measurement of the concentration of the dissolved oxygen in the water and sewage
- High stability
  - fluorescence quenching method
  - trigonometric measurement of the phase - DSP signal analysis
- Communication: CANopen, MODBUS, USB, current loop 4-20mA
- High resistance to environmental degradation
  - housing from acid-proof titanium stainless steel
  - measuring window from sapphire glass
  - no plastic components operating in the wastewater
- Operation without a flow of water / wastewater
- Built-in pneumatic system of measuring window cleaning

Table 1. Technical specification

Parameter	Description	
Type	Dissolved oxygen sensor in water	
Model	OXY-DIOS-DSP **210105061** INTEGRON Poland EU	
Measurement method	Optical – fluorescence quenching with frequency modulation excitation light, trigonometric measurement of the phase	
Optical head	447 / 650 nm with reference channel 617 nm, replaceable	
	Measuring interval	1, 2, 5, 10 s
	The activation time fluorophore during the measurement	4 ms
Measuring window	Type	Porphyrin platinum closed in a polymer-glass matrix
	Substrate	Sapphire glass dim. ϕ12.5 mm / 1 mm
	Durability	Up to 2 year
	Chemical resistance	Methanol, ethanol, isopropanol
	No chemical resistance	Chloroform, benzene, toluene, xylene, acetone and other organic solvents
	Drift	0.2 mg/L-O_2 by a year, (20°C - water saturated with oxygen)

Parameter	Description	
Calibration	One point	0% - O_2, aqueous solution of sodium sulfite Na_2SO_3 or nitrogen 4.0
	Two point	0% / 20.946% O_2 (air - built-in barometer) or air saturated with water vapour
Minimum flow	No need for flow of water / wastewater	
Working temperature	0 to 50°C	
Storage temperature	-20 to 70°C	
Maximum depth	30 m in the front of the case	
Measured parameters	Concentration, saturation, temperature, O_2 partial pressure, air	
Measuring range O_2	Partial pressure O_2	0 to 400 mBar
	Concentration	0 to 20 mg/L
	Saturation	0 to 200%
Measurement accuracy O_2	Range 0 to 5.0 mg/L, 20°C	+/-0.10 mg/L
	Range 5.0 to 20.0 mg/L , 20°C	+/-0.20 mg/L
Measurement resolution O_2	Range 0 to 1.0 mg/L	0.001 mg/L
	Range from 1.0 mg/L	0.01 mg/L
Response time	21% O_2 to 0% O_2 (20°C - nitrogen), T_{90} < 40 s, 21% O_2 to 0% O_2 (20°C - water), T_{90} < 60 s, membrane with improved mechanical strength	
Resistance to environmental factors	H_2S, pH, K+, Na+, Mg_2+, Ca_2+,NH_4+, Al_3+, Pb_2+, Cd_2+,An_2+, Cr, Fe_2+, Fe_3+, Mn_2+, Cu_2+, Ni_2+, CO_2+, CN-, NO_3-, $SO_4$2-, S_2-, $PO_4$3-, Cl-	
Barometric pressure	Accuracy	0.3%
	Resolution	0.1 mBar
	Range	900 to 1200 mbar (absolute)
Temperature	Sensor type	Pt1000 class A
	Accuracy	+/- 0.2°C
	Resolution	0.01°C
	Range	-20 to +85°C
	Response time	T_{90} < 120 s
Stabilization of the humidity inside the sensor body	Proton pump with SPE membrane in the thermostatic chamber, chamber ventilation with ultrasonic air pump	
	Chamber working temperature	42 °C

Parameter	Description	
	Vacuum ventilation	-15 mBar
	Ventilation connections	Screw connectors 4/2.5mm pipe
	Vacuum filter	Hydrophobic 5um – SMC ZFC53
Materials	Stainless steel-titanium EN 1.4571, stainless steel EN 1.4301, sapphire glass AL_2O_3, FPM, silicone	
Dimensions	Diameter	35 mm
	Length	237 mm
Weight	1.1kg	
Mounting	Type	Thread G1, adapter G1-ϕ35 / L=60mm for welding in thin-walled pipe
	Sealing	X-ring 28.25x2.62 NBR70, recommended grease LB Loctite 8104
	Position	Minimum 30° from the vertical
Protection level	IP68	
Socket connection	Type	M12A, 8 pins, male, IP68
	Recomended plug	Conec 43-00130
Electromagnetic immunity	EN 61326 Class B	
Window cleaning system	Pneumatic - compressed gas, rotating nozzles	
	Medium	Air / Nitrogen
	Connection	Quick connector 6/4mm pipe
	Working pressure	0.7 bar + hydrostatic pressure
	Maximum pressure at the outlet nozzle	1.2 bar + hydrostatic pressure
	Maximum pressure at the input of the system	6 bar
Power	+24VDC, +/-20%	0.2A inactive current outputs
		1.2A active current outputs
	Electrical strength	max 80.0V
	Overvoltage protection	28.8V
	Under-voltage protection	18.2V
	Overcurrent protection	1.4A, electronic with auto restart

Parameter	Description	
	Battery RTC	BR1632/HFN PANASONIC
Control outputs	24V/0.5A-Source, according IEC 61131-3, short circuit protection	
MODBUS (RS485) Communication	Supply voltage	max 26V
	Mode	RTU, ASCII
	Speed (bps)	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600
	Max number of devices	64 (½ unit load)
	Parity	None, even, odd
	Terminator	Built-in 120 Ohm, attached electronically
CANOPEN (CANBUS) Communication	Supply voltage	max 26V
	Mode	SDO, PDO mapped
	Speed (kbps)	10, 20, 50, 100, 125, 250, 500, 800, 1000
	Max number of devices	112
	Suppresion	Common-mode filter
	Terminator	Built-in 120 Ohm, attached electronically
Current loop 4-20mA	Range	3.6 to 22mA, (4 to 20mA scalable)
	Resolution / Accuracy	5.5uA / 0.05%
	Supply voltage	max 28.8V
	Measurement resistance	>250 Ohm
	Galvanic isolation	1kV
	Alarm	NAMUR43 / 22mA
USB communication	Mode	USB 2.0 FS, virtual COM port, VT100 terminal emulation
	Supply voltage	4.0V to 5.8V / 500mA
Warranty	Sensor	2 years
	Measuring window	3 years
Expected lifetime	10 years for work in municipal wastewater	

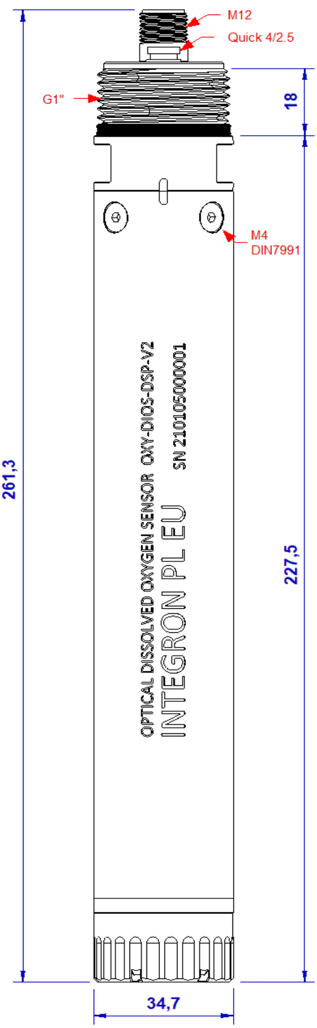
2. Sensor delivery - content of the set

The sensor is delivered in a transport box with dimensions 400x300x180mm as a set.

Table 2. Content of the set OXY-DIOS-DSP-V2

Position	Component	Quantity	Description	Code
1	Sensor	1	OXY-DIOS-DSP-V2 sensor for measuring dissolved oxygen concentration	**210105061**
2	Support adapter G1“ / Triclamp	1	G1 / Triclamp D50.5 DIN32676A titanium acid-prof stainless steel EN 1.4571	**210105062**
3	USB/M12 cable	1	USB-A/M12A cable, length 1m	**210105063**
4	Plug M12-8	1	Conec 43-00130	**210105064**
5	Sodium sulfite	6	Hydrated sodium sulfite Na_2SO_3, vial 1g	**210105065**
6	Silicone grease	1	Grease Loctite LB 8104, syringe $1cm^3$	**210105066**
7	Pneumatic quick plug	1	ϕ4mm	**210105067**
8	Flash memory / USB	1	16GB	**210105068**

3. Dimensional drawing



4. Reference drawing

1	Nut head
6	Body head
10	Sensor housing
11	4x M4x6 DIN7991
21	Sensor base
22	X-ring 28.25x2.62 NBR70
24	Pneumatic connector - cleaning system 4/2.5
27	Assembly marker housing / base
28	G1 thread mounted of the support
29	Connector M12A
30	Wrench slot 27 in the head

Figure 2. The reference drawing

5. Assembly drawing

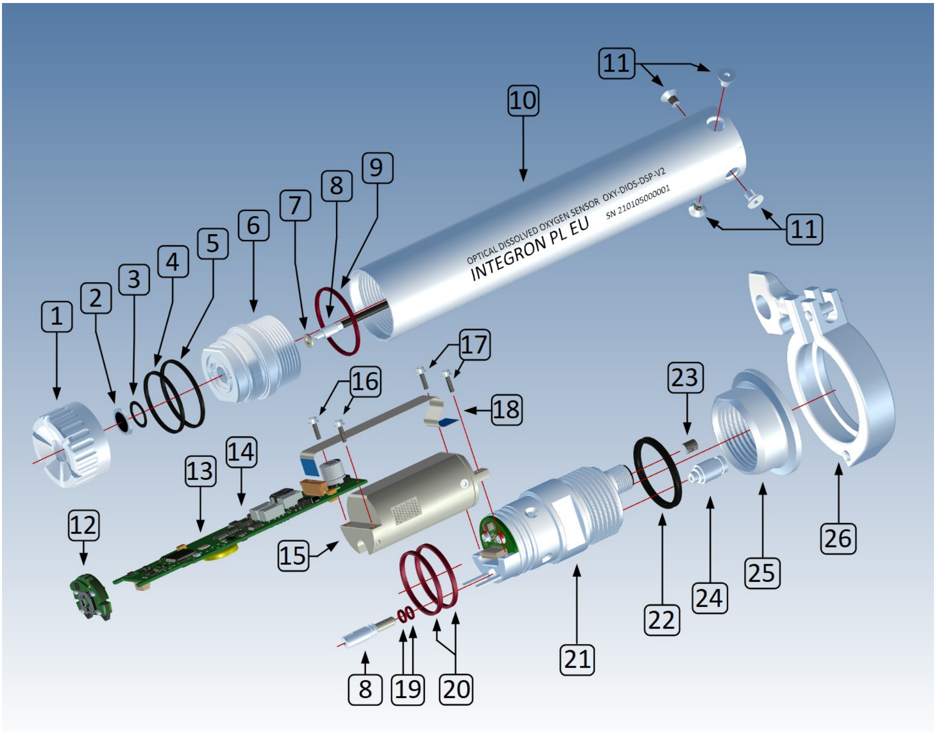


Figure 3. The assembly drawing

Table 3. List of components

No.	Description	Quantity	Type	Accessories	Code
1	Nut head	1			**210105001**
2	Measuring window	1	WPSPT4		**210105051**
3	O-ring a measuring window	1	1x10 FPM75 Viton		**210105002**
4	O-ring of a nut head 1	1	26x1.5 NBR70	Grease Loctite 8104	**210105003**
5	O-ring of a nut head 2	1	29x1.5 NBR70	Grease Loctite 8104	**210105004**
6	Head body	1		Glue Loctite 542	**210105005**
7	Pressure hose gasket	1	3.2x6.5x1 PTFE		**210105006**
8	Pressure air hose / connector	1	M3 hose 2/1.2	Glue Loctite 542	**210105007**

No.	Description	Quantity	Type	Accessories	Code
9	O-ring of a nut head 3	1	29x1.5 FPM80 Viton	Grease Krytox LVP	**210105008**
10	Sensor housing	1			**210105009**
11	Fixing screws the housing to a base	4	M4x6 DIN7991 A4	Wrench 2.5	**210105010**
12	Optical head	1	HS21B447R617		**210105011**
13	Micro-switch S1 of an emergency mode of downloading firmware				
14	Mainboard	1			**210105012**
15	Moisture absorber cartridge	1	POM-C / Silica gel		**210105013**
16	Fixing screws of a mainboard to an absorber cartridge	2	M2x8 DIN912 / DIN125 A2		**210105014**
17	Fixing screw of an absorber cartridge mainboard to a sensor base	2	M2x8 DIN912 / DIN125 A2		**210105014**
18	FPC tape – electrical connection mainboard / base of sensor	1			**210105019**
19	O-rings of a air pressure connector	2	4.5x1 FPM75 Viton	Grease Krytox LVP	**210105020**
20	O-rings of a housing / base	2	26.7x1.78 FPM75 Viton	Grease Krytox LVP	**210105021**
21	Base of a sensor	1			**210105022**
22	X-ring base / handle	1	28.25x2.62 NBR70	Grease Loctite 8104	**210105023**
23	Locking screw of the barometric pressure sensor	1	M5x6 DIN913 A2		**210105024**
24	Pneumatic connector of the cleaning system	1	4/2.5 M5 A2	Glue Loctite 542	**210105027**
25	Adapter G1“ / Triclamp	1	G1 / Triclamp D50.5		**210105028**
26	Triclamp		Triclamp D50.5 DIN32676A 316L		**210105029**
27	Mounting marker base / housing	1			
28	G1 thread base / support	1		Grease Loctite 8104	
29	M12A connector	1		Grease Loctite 8104	
30	Wrench slot (27) in a sensor base	1	Size 27		

6. Electrical connection

6.1. M12 connector

The M12 connector of the sensor enables to connect it to the **CANopen/CANBUS**, **MODBUS/RS485** communication buses or a **current loop 4-20mA**. The interface outputs are multiplexed at the 4/5 connector contacts.
A type of the connected bus is determined during a configuration of a sensor in the terminal mode. The sensor switches automatically to the terminal-USB mode after applying a voltage of +5V on the contact of the 8. pin of the M12 connector.

Before connecting the sensor to the PLC controller, set the apropriate type of the communication bus !
The maximum voltage for the RS485RS485/MODBUS is 12V, for CANBUS/CANopen 26V, for 4-20mA loop 28,8V. If signal lines are connected to too high voltage, the sensor can be damaged.

Figure 4 shows a front view of the M12 socket. M12A 8pin coding.

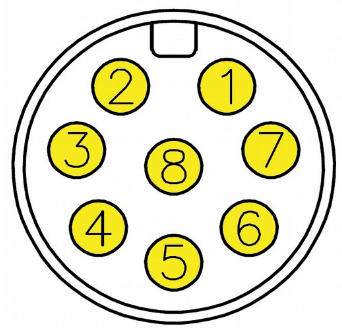


Figure 4. Socket M12A – connector front view.

Table 4. The description of the M12 socket signals

Pin	Name	Description
1	+24VDC	Power supply / Firmware loading activation
2	GND POWER	Power ground

Pin	Name	Description
3	GND FIELDBUS	Fieldbus ground (shielding)
4	CANH / RS485B / LOOP+ / USB+	Fieldbus line 1
5	CANL / RS485A / LOOP- / USB-	Fieldbus line 2
6	OXYGEN CONTROL	Air blower control output +24V/0.5A
7	AIRBLAST / CLEANING	Control output of a cleaning window system +24V/0.5A
8	+5VDC USB POWER	Power supply +5V/0.5A from USB. Applying voltage >4.0V switches a sensor in the USB-Terminal mode. Voltage +5V connected to the terminal 8 and terminal 1 activates the firmware loading mode.

6.2. Connecting the control outputs

Figure 5 shows how to connect the sensor to the cleaning and control air blower systems.

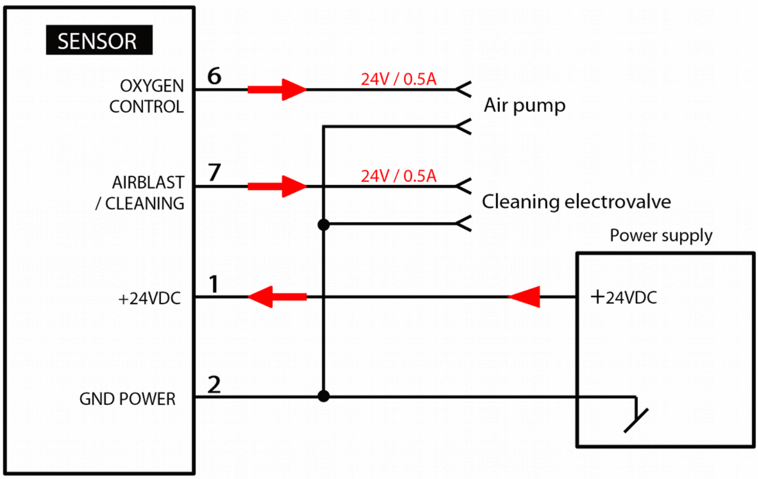


Figure 5. Connecting the control outputs

6.3. Connecting the CANopen / MODBUS fieldbuses

Figure 6 shows how to connect the sensor to **CANopen** i **MODBUS** fieldbuses. If the sensor works as the fieldbus end-device, it is necessary to connect a terminator. The sensor is equipped with the 120 Ohm built-in terminator that can be enabled during a configuration of the device.

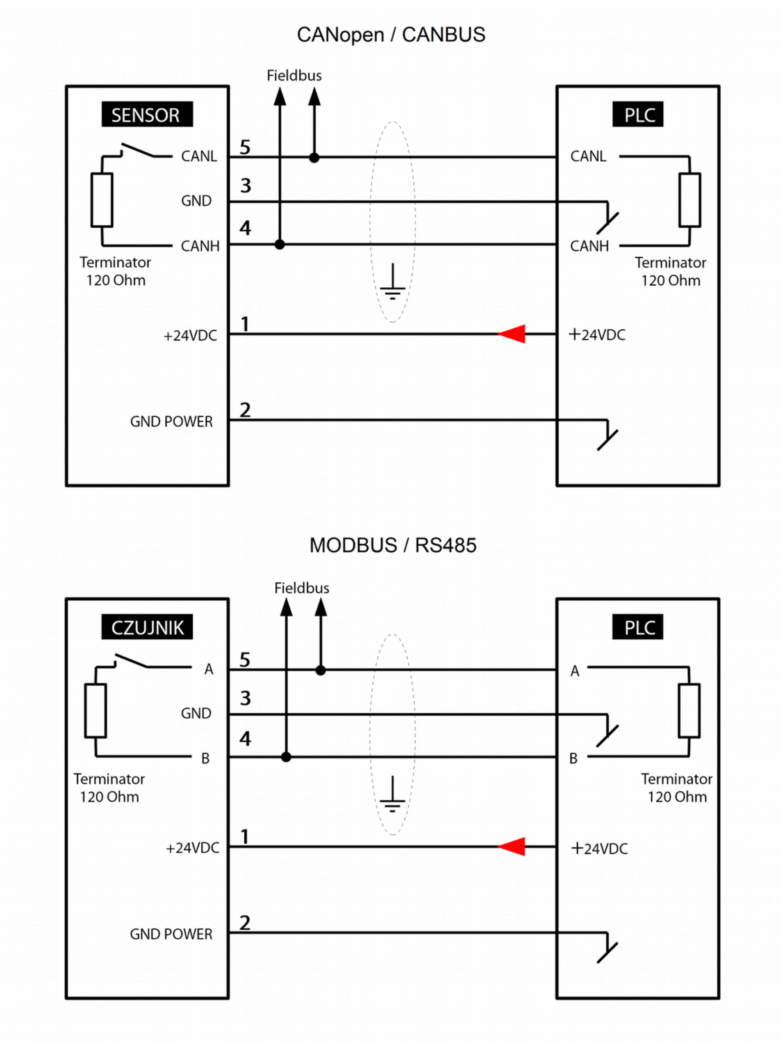


Figure 6. Connectiong the CANopen/MODBUS fieldbus

6.4. Connecting the current loop 4-20mA

The current loop circuits is electrically isolated from the sensor measurement systems.
Figure 7 shows how to connect a 3-wire cabling without galvanic isolation, and 4-wire with isolation. The recommended value of the standard resistor 500 Ohm.

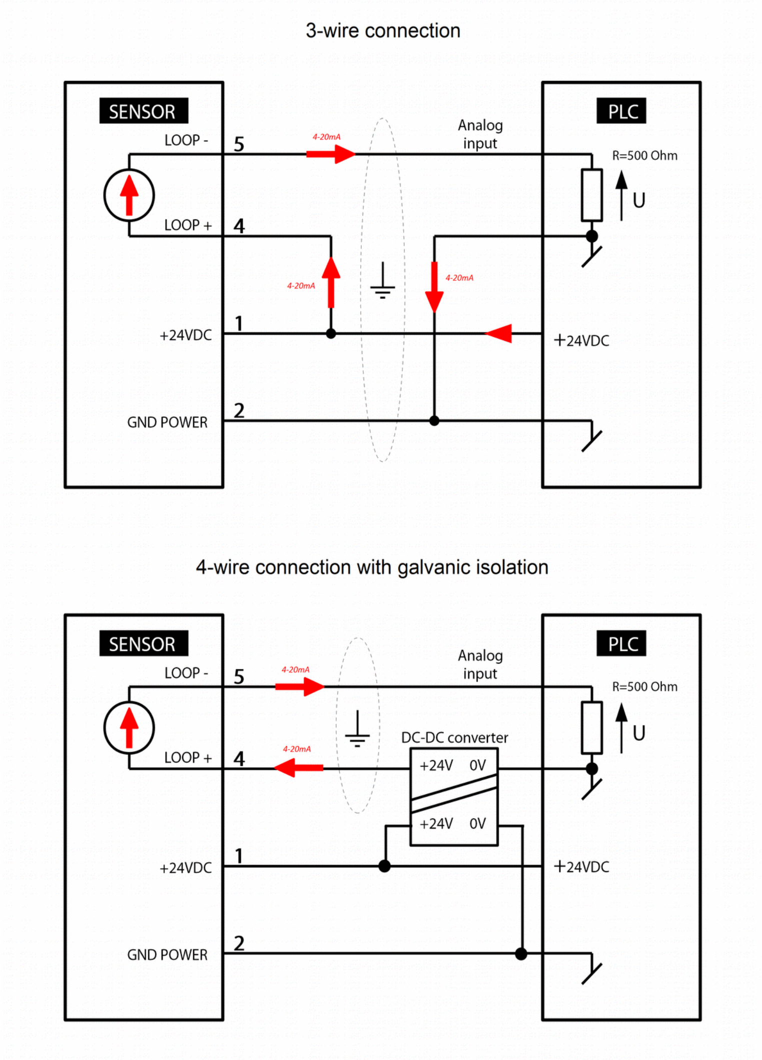


Figure 7. Connectiong the current loop 4-20mA

7. Disassembly / assembly of a sensor housing

An disassembly/assembly of a sensor housing should be performed only by a trained service technician. The incorrectly performed assembly may result in a mechanical damage of its optical head.
Figure No. 2 (page 11) and **Figure No. 3** (page 12) present the sensor structure.
The disassembly/assembly of the sensor housing is necessary when the optical head, seals are replaced or the firmware is downloaded.

7.1. Disassembly

1. Unscrew bolts 11 which attach the housing 10 to the sensor base 24. Use a 2.5 hex wrench.
2. Eject the sensor base 24 from the housing 10. Do not use excessive force. If the gaskets 23 are blocking the housing tightly, turn it relative to sensor base 2 degrees.

7.2. Assembly

1. Always replace the O-rings 22 i 23 with a new ones during assembly. Use silicone lubricant.

Body assembly requires o-rings
210105020 4.5x1 FPM75 and 210105021 26x2 FPM80
for new ones.

2. Insert the sensor base 24 to the housing 10 for a depth of 10mm. Adjust position markers 33. They must be positioned linearly. The pressure hose connector must hit the connection hole in the sensor base.
3. Insert the sensor base 24 to the housing 10 so that there is no aperture between them.

If you use excessive force during installation, the optical head of the sensor can be damaged!

4. Screw bolts 11 whitch attach the housing.

8. Replacing the measuring window

The measuring window contains a fluorescent dye trapped in a gas-permeable membrane. The window is an operating element and it should be replaced for a new one on average once per three years.

Figure No. 9 (page 21) and **Figure No. 10** (page 21) present how the window is instaled in the head.

Figure 8. The measuring window

8.1. Window disassembly

1. Dry the head using lint-free wipes.
2. Unscrew the head nut **1**.
3. Dry the head socket with a lint-free wipe.
4. Remove the measuring window **2**. Use forceps. Hold the window by its metal ring.

Do not touch the measuring window!
The upper black layer is covered with a gas-permeable membrane

5. Remove the O-ring of the nut **3**.

Do not touch the lens with the sharp objects in the measuring cavity !

8.2. Window assembly

1. Wipe the head socket with a lint-free wipes soaked in IPA alcohol.
2. Wipe the lens with a lint-free wipes soaked in IPA alcohol.

Do not touch the lens with the sharp objects in the measuring cavity !

3. Assembly the **new** window O-ring **3**. Do not lubricte the O-ring.

Installation of the measuring window requires an absolute replacement of the window o-ring 210105002 1x10 FPM75 with a new one !

4. Insert the measurement window into the socket **2**. Use forceps. Hold the window by its metal ring.

Do not touch a surface of the measuring window!

5. Lubricate the O-rings **4** and **5** with a thin layer of silicone grease. If they have visible damage, replace them to new ones.
6. Assembly the head nut **1**.

8.3. View of the measuring window in the head

Figure 9. The measuring window assembled in the head

Figure 10. The window socket and the optical head lens

9. Mounting the sensor at the tube support

The sensor body is adapted to assembling at the tube support with the G1 thread. The attached equipment includes the G1-ϕ35mm adapter to be welded into the acid-proof stainless thin-walled tube.
Figure No. 2 (page 11) and **Figure No. 3** (page 12) present the sensor structure. **Figure No. 12** (page 23) show a structure of the support.

Figure 11. Installation of cables

Assembly procedure:

1. Pull from the support tube the electric wire M12, pneumatic hose 6/4 and two ventilation 4/2.5 hoses.
2. Unscrew the comresson nut of the 6/4 pneumatic connector **29**. Slide it onto the pneumatic hose. Slide the hose onto the conncetor end. Tighten the compression end. Do not use excessive force. If the cleaning option will not be used blind-weld the end of the pneumatic hose. This will prevent water form flooding the tube support.

Blanked off the other end of the 6/4 hose if the cleaning system will not be connected !
Otherwise, the connectors will be flooded with water.

3. Unscrew the comresson nut of the 4/2.5 ventilation connector **27**. Slide it onto the ventilation hose. Slide the hose onto the conncetor end. Tighten the compression end. Do not use excessive force. Do the same with the second connector.

Connecting the ventilation hoses is necessary for the correct operation of the device !

4. Connect the M12 plug to the connector **34** in the sensor.

Tighten the M12 plug so that its body does not rotate relative to the socket!
Otherwise the connector will be damaged !

5. Inspect the O-ring **25**. If they are fractured or torn, exchange them. Use silicone lubricant.
6. Screw manually the sensor into the G1 thread of the support. Be careful with the position of the wiring insife the tube. While screwing the wires should turn freely inside the tube.
7. Tighten the sensor suing the 27 wrench. Put the wrench on the socket at the sensor base **36**.
8. Install the filter block in the control box **36**. Connect the ventilation hoses to the quick connectors **31**.

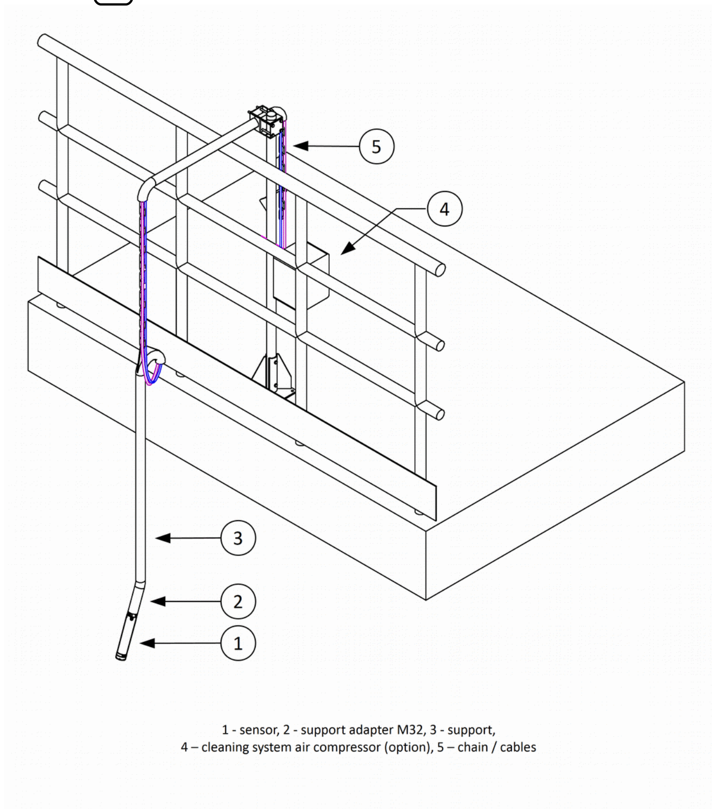


Figure 12. Example of mounting the sensor on the support

10. Theory of operation

The OXY-DIOS-DSP sensor operates on the basis of the phenomenon of luminescence **quenching**.

Luminescence or “cold light” is an emission of light waves through certain bodies called luminophores (phosphors), inducted by the other cause than warming them up to high temperatures. Luminescence is characterised by a finite lighting time, i.e. it does not fade immediately after the excitation is stopped. A special case of luminescence is photoluminescence, inducted by an absorption of electromagnetic radiation from ultraviolet and visible light spectrum. This excitation is connected with jumping by an electron to an excited singlet state, and then, after it returns to a ground state, an emission of an excess energy amount as a photon flux. A wavelength of this radiation is higher than an absorbed wavelength because during the thermic and non-radiative transitions, a partial energy degradation occurs. Many substances exhibit photoluminescence. For measurements of oxygen concentrations mostly complex compounds of ruthenium and platinum porphyrins are applicable. This is due to a relatively long time of lighting: 5 - 60us and high quantum efficiency – luminosity brightness.

The fluorescence **quenching** phenomenon occurs during a collision of a quencher molecule with a “charged” fluorophore molecule. After the collision quencher molecules get rid of adopted energy in a form of thermal radiation. The small dimensions and a neutral charge of the oxygen molecules stimulate a diffusion speed, and in consequence it significantly increases a probability of collisions. Oxygen is a relatively good quencher of fluorescence. With the increase of the quencher concentration, increases effectiveness of the quenching process. The more oxygen molecules in the solution, the lower luminescence brightness of fluorophore and the shorter the decay time of the emission. **Figure 13** presents the mechanism of fluorescence quenching.

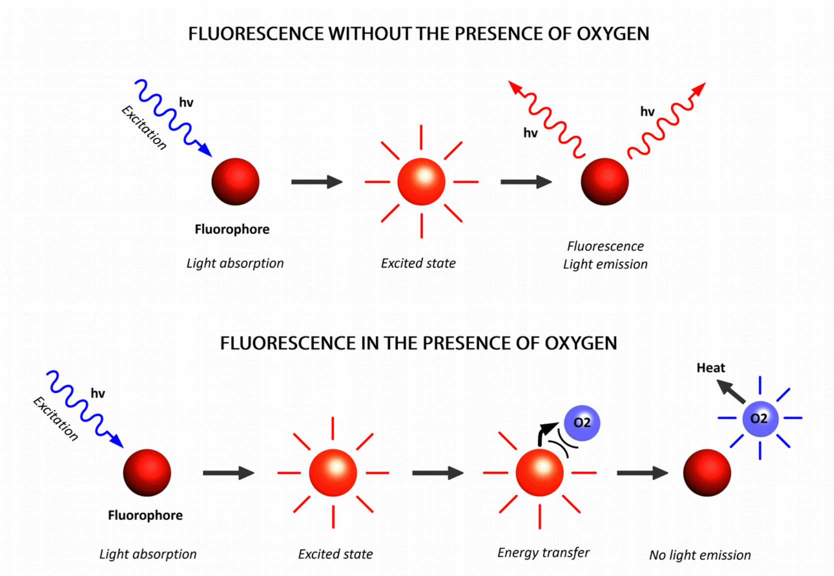


Figure 13. The mechanism of fluorescence quenching

There is a wide range of the measuring techniques connected with the fluorescence phenomenon. The simplest one consists in a measurement of the emission intensity in the presence of a quencher. Unfortunately due to the temperature changes and a degradation of fluorophores during their excitation, it is also the least accurate method. A specific feature of the excitation phenomenon is an exponential fading of light emission after the excitation is stopped. A slope of the curve depends on the quencher concentration, but independent from an excitation level and an emission level. **Figure 14** shows an emission fading as a function of time.

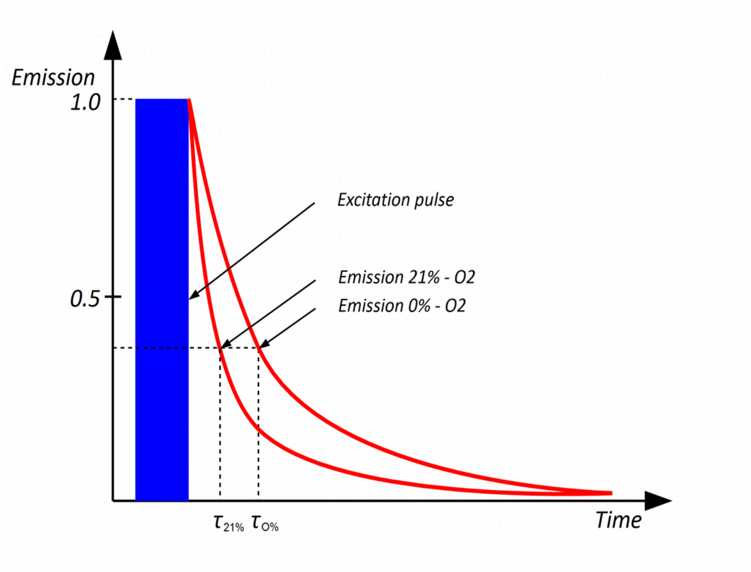


Figure 14. The fluorescense, decay emission.

Applying a time method in the case of fluorophores used to measuring a concentration of oxygen requires a significant sampling frequencies in the track of the emission measurement. This problem can be solved by transferring a signal detection from a time domain to a frequency domain. If the excitation light is modulated by a sinusoidal signal with a certain frequency, the emission light will have the same frequency, but a phase shift between the excitation and emission signal will be dependent only on the oxygen partial pressure. **Figure 15** presents the phase detection of the oxygen concentration.

In the frequency method a fluorescence decay time is described by the following equation:

$$\tau = \frac{\tan(\phi)}{2 \cdot \pi \cdot f_{mod}} \quad (10\ 1)$$

gdzie:

- **τ** - fluorescense decay time [s]
- **ϕ** - phase shift between the excitation and emission signal [°]
- **f_{mod}** - frequency of the excitation signal [Hz]

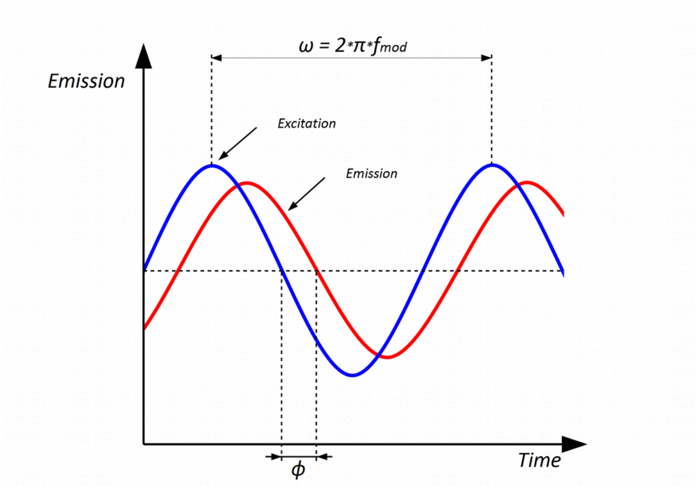


Figure 15. The phase detection of oxygen concentration

In order to eliminate a temperature influence on the electronic systems of the sensor its optical head is equipped with two light sources. Blue light stimulates fluorophore to the emission and the red one is used for measuring a phase shift introduced by the electronic systems. **Figure 16** presents the structure of the optical head of the sensor.

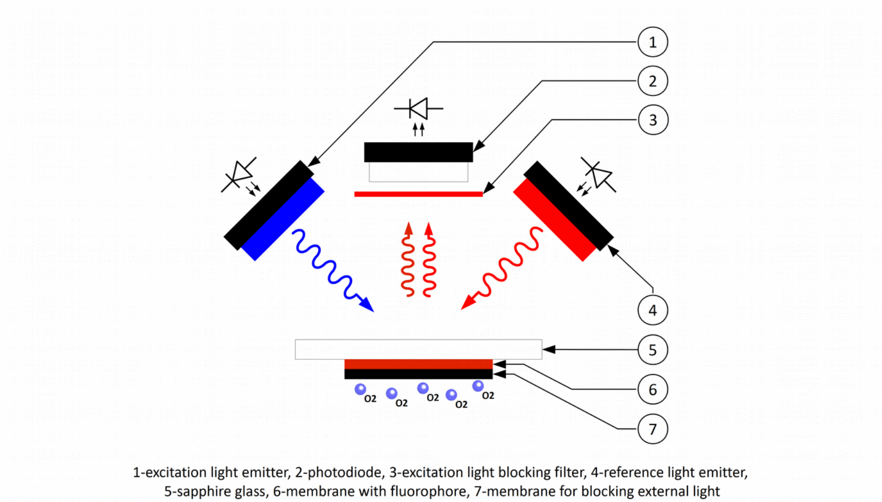


Figure 16. The optical head structure

The phenomenon of fluorescence quenching delivers information about kinetic energy of the oxygen molecules which surround a fluorophore, i.e. a partial concentration. A dependence between a fluorescence decay time and a partial pressure is described by the following formula:

$$\frac{\tau_0[T]}{\tau}=1+K_{SV}[T]\cdot pO_2 \quad (10\ 2)$$

where:

- **τ_0**[T] - fluorescence decay time as a function of temperature (in the absence of quencher) [s]
- **τ** - decay time in the presence of quencher [s]
- **K_{SV}**[T] - *Stern-Volmer-a* constant as a function of temperature
- **pO_2** - oxygen artial pressure [Bar]
- **T** - temperature [°C]

Due to the properties of the membrane in which are placed the fluorophore molecules, in order to calculate a partial pressure the modified *Stern-Volmer* equation is applied. The equation is based on an assumption, that an activation of the fluorophore inside the membrane is non-linear. The **f** fraction describes an active party, and the **1-f** fraction the non-active one.

$$\frac{\tau_0[T]}{\tau}=\left(\frac{f}{1+K_{SV1}[T]\cdot pO_2}+\frac{1-f}{1+K_{SV2}[T]\cdot pO_2}\right)^{-1} \quad (10\ 3)$$

where:

- **τ_0**[T] - fluorescence decay time as a function of temp. (in the absence of quencher) [s]
- **τ** - decay time in the presence of quencher [s]
- **K_{SV1}**[T] - quenching constant fraction **f** as a function of temperature
- **K_{SV2}**[T] - quenching constant fraction **1-f** as a function of temperature
- **f** - fractional coefficient
- **pO_2** - oxygen partial pressure [Bar]
- **T** - temperature [°C]

Temperature changes have a direct impact on the parameters of the measuring window. An increase of the temperature shortens a fluorescence decay time and decreases an amplitude of the dye emission. This dependency is heavily non-linear. The **τ_0**, **K_{SV1}**, **K_{SV2}** are a subject of an offset. The calibration curve of the **τ_0** coefficient as a function of temperature has a form of the following second degree multinomial:

$$\tau_0[T]=a_{\tau_0}\cdot T^2+b_{\tau_0}\cdot T+c_{\tau_0} \quad (10\ 4)$$

where:

- **τ_0[T]** - fluorescence decay time as a function of temp. (in the absence ofquencher) [s]
- **T** - temperature [°C]
- **$a_{\tau 0}$, $b_{\tau 0}$, $c_{\tau 0}$** - calibration coefficients a_{tau0}, b_{tau0}, c_{tau0}

The calibration curves of the **K_{SV1}**, **K_{SV2}** coefficients as a function of temperature have a form of the Arrhenius equation:

$$K_{SV1,2}[T]=K'_{SV1,2}\cdot e^{-\frac{EK_{SV1,2}}{R(T+273.15)}} \quad (10\ 5)$$

where:

- **$K_{SV1,2}[T]$** - quenching constant as a function of temperature
- **$K'_{SV1,2}$** - calibration coefficients of quenching constants
- **$EK_{SV1,2}$** - calibration coefficients sum of the activation energy of the membrane and the fluorophore
- **R** - gas constant 8.314459848 [J/(mol*K)]
- **T** - temperature [°C]

An application of the *Henry's law* allows for determining a weight concentration of the oxygen dissolved in water. The equation describes a dependency between an oxygen partial pressure and its concentration:

$$c_{O_2}=\frac{pO_2}{p_N}\cdot 20.946\cdot\alpha[T]\cdot 1000\cdot\frac{M[O_2]}{V_m} \quad (10\ 6)$$

where:

- **cO_2** - weight concentration of oxygen [mg/L]
- **pO_2** - oxygen partial pressure [Bar]
- **p_N** - normal atmospheric pressure 1.013 [Bar]
- **α**[T] - *Bunsen* gas solubility coefficient as a function of temperature
- **M**$[O_2]$ - oxygen molar mass 32 [g/mol]
- **V_m** - molar volume 22.414 [L/mol]

A saturation of water with oxygen is described by the following equation:

$$s_{O_2}=\frac{c_{O2}}{c_{O2}max[T]}\cdot\frac{p_N}{p_{atm}-p_W}\cdot 100 \quad (10\ 7)$$

where:

- **sO_2** - saturation of water with oxygen [%]
- **cO_2** - oxygen concentration in the water [mg/L]
- **cO_2max[T]** - the oxygen concentration at full saturation of water durring the measurement temperature and atmospheric pressure 1.013Bar [mg/L] **Table21** (page60)
- **p_N** - normal atmospheric pressure 1.013 [Bar]
- **p_{atm}** - atmospheric pressure for dry air [Bar]
- **p_W** - partial pressure of water vapor contained in the air [Bar]

11. Sensor calibration methodology

During a production process the sensor is a subject to a 30-point calibration of the partial pressure as a function of the fluorescence decay time **τ** and a temperature. The measured data set is used to generate the following calibration coefficients: **f**, $\mathbf{K'_{SV1}}$, $\mathbf{EK_{SV1}}$, $\mathbf{K'_{SV2}}$, $\mathbf{EK_{SV2}}$. These coefficients are determined using a non-linear regression on the basis of the modified *Stern-Volmer* equation (10 3).
The sensor is a highly stabile device however the membrane of the measuring window, similarly as every element of the measuring system, is a subject to the slow physical and chemical changes. Due to this during an installation of the sensor one should verify its indications. If they do not fall into the tolerance range of the device, it is necessary to perform a simplified calibration procedure. The simplified calibration procedure assumes a linear adjustment of the modified *Stern-Volmer* curve (10 3) to the two reference points: *0%-O_2 and 20.95%-O_2* at the foreseen operating temperature. This adjustment is of linear nature:

Offset:

$$tau_0[T]_{odczyt} = tau_0[T]_{pomiar} + cal_{tau_0} \quad (11\ 1)$$

Linearity:

$$pO_{2\ odczyt} = cal_{pO_2} \cdot pO_{2\ pomiar} \quad (11\ 2)$$

A correction of a zero fluorescence decay time $\boldsymbol{\tau_0}$ with a value of the calibration **cal**$\boldsymbol{\tau_0}$ is a modification of the offset of the sensor indications in the zero anaerobic point. This correction describes a drift of the fluorescent dye due to its thermal ageing and a phenomenon of photo-bleaching. A determination of the **cal**$\boldsymbol{\tau_0}$ coefficient is a basic calibration operation and it has a fundamental impact on an accuracy of indications within the entire range of the oxygen concentrations. The most accurate method is a calibration in pure nitrogen 4.0 or an aqueous solution of sodium sulfite Na_2SO_3. For calibration of the low reference point is used the **/ 6.1 Low point, 0% O2** menu option. This procedure has been described in the sub-chapter 12.6.6 (page 51).
A correction of the indications of the oxygen partial pressure by means of the **calp**$\mathbf{O_2}$ calibration coefficient has a nature of the proportional adjustment of the *Stern-Volmer*'s curve slope to a value of the second calibration point. An impact of the **calp**$\mathbf{O_2}$ coefficient on the accuracy of the sensor indications increases linearly as the oxygen partial pressure growth. If the sensor operates in the deoxygenated water with the oxygen content below 1mg/L conducting the two-point calibration is not required because it increases an accuracy to the small degree. For calibration of the high reference point is used the **/ 6.3 High point, 20.95% O2 in air** menu option. This procedure has been described in the sub-chapter 12.6.6 (page 51).
A drift of the sensor indicator is of the complex nature. It depends on the operating temperature, frequency of thermic cycles, a level of condensation of dissolved oxygen and a water contamination with organic solvents. The smallest drift is related to an operation at the operation temperatures from 10°C to 30°C, in the pure water with an oxygen content from 1.0mg/L to 12mg/L.. The drift increases by a few times while operating at the temperatures below 5°C, in deoxygenated water and solvent contaminated water. In the first case the calibration should be conducted once a year, in the latter several times a year. The drift is of the increasing nature, the indications of the oxygen concentration are overestimated.

12. Configuration software

12.1. Drivers instalation

The **OXY-DIOS-DSP-V2** sensor communicates with a computer by means of the USB interface and the *HyperTerminal* terminal software.

Procedure of installation in the "Windows 10" operating system:

1. Connect the sensor to the computer. Use the included USB/M12 cable.
2. The operational system will detect a mass storage device: "*INTEGRON MemoryDisk XXXX USB Device*" and a serial port device: VCOMXXXX (Win7) or "Communications Port *(COMXX)*" (Win10). A virtual disc contains drivers, the *HyperTerminal* terminal software and an operating manual.
3. The system will ask to enter a path to the driver files. Indicate the detected USB disc.
4. If the system fails to install the VCOM device automatically, do it manually by means of the Windows *"Device Manager"*.
5. In the "*Other devices"* tab, select the "*VCOMXXXX*" device and an option: "*Update the … driver software.*".
6. When a window of the driver update creator appears, select *"Search and install a driver software manually".*
7. Indicate the USB disc in the "*Search a driver software in this location*" field.
8. If during an installation appears the window: "*Windows System Security*" and the following message: "*System Windows cannot verify this driver software;, select the option: "Despite this install a driver software".*
9. The following message: "*System Windows successfully installed/updated a software of the "INTEGRON USB VCOM*" driver" means a correct end of the installation.

The HyperTerminal software installed on the USB disc of the sensor has been pre-configured in the factory to enable communication with the COM8 port in the emulation mode of the VT100 terminal. If a number of the configured VCOM port is other than COM8 it is necessary to make a change in the system or in the settings of the *HyperTerminal.*

Procedure of changing a port number in the "Windows 10" operating system:

1. In the list of devices of the "*Device Manager*" search a section "*Ports (COM and LPT)*", and then the "*INTEGRON USB VCOM (COMX)*" device.
2. Find the "*Properties*" > "*Port settings*" > "Advanced" option.
3. In the "*COM port number*" field select the COM8 port.

Procedure of changing the VCOM port in the *HyperTerminal*:

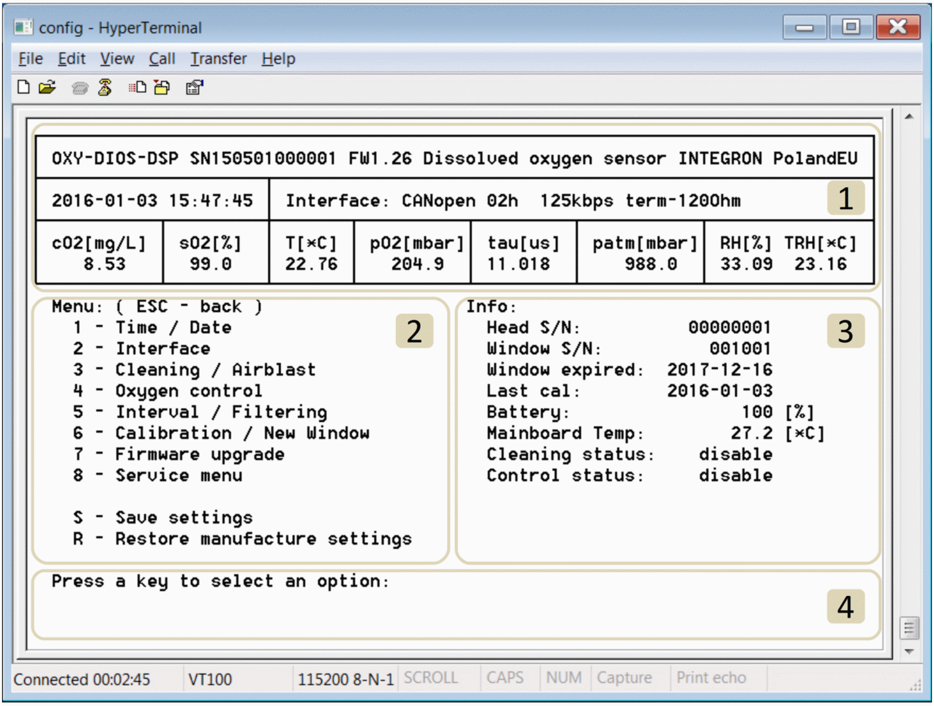
1. Launch the *HyperTerminal* from the USB by activating the "*OXY-DIOS-DSP.bat*" file.
2. In the "*File/Properties*" menu, in the "*Connecting using*" field select a port number. The port number can be read after starting the "*Device Manager*" Windows. In the device list, in the *"Ports (COM and LPT)*" section find the "*INTEGRON USB VCOM (COMx)*" device. A device name includes a proper port number.
3. In the "*Call*" menu select the "*Call*" option. It will be established a connection with the sensor.
4. *WARNING!* After disconnecting the sensor from the computer the fabric pre-settings of the *HyperTerminal* will be recovered. If a permanent change is needed, the *HyperTerminal* must be installed in the computer hard disc.

12.2. Application

The sensor communicates with the computer by means of the USB interface. The included USB/M12 wire is intended for providing a connection. Communication is provided in VT100 terminal mode by means of the *HyperTerminal* application.
In order to launch this terminal with predefined factory settings, one should activate the "*OXY-DIOS-DSP.bat*" file. The file is in the USB virtual disc available directly after connecting the sensor to the system.

12.3. Main screen

After the sensor is started up in the terminal mode the main screen of the application is available:



The application screen is divided into four parts:

- **1** information field which displays measurement values and main system settings,
- **2** "Menu" with options to be selected,
- **3** "Info" which displays additional parameters linked to an active menu,

- **4** status line and two lines intended for entering data.

The numerical and letter keys are for navigating between menu options.
The "**ESC**" key enables to return to the master menu.
The "**/**" key enables to return to the main menu.

In the case of the options which require to enter numerical data, a status line includes a tip with regard to format of entering and a permitted range. A parameter can be of an integral nature, e.g. 12345, a floating-point nature, e.g. 123.45 or of a scientific nature, e.g. -123E-6. Lowercases and uppercases are allowed.

Table 5 contains a description of the fields of the information box.

Table 5. Info box

Pole				Znaczenie
OXY-DIOS-DSP				Device name
SNXXXXXXXXXXXX				Device serial number
FWX.XX				Firmware version
Dissolved oxygen sensor				Device description - Optical dissolved oxygen sensor
RRRR-MM-DD HH:MM:SS				Date and time
INTEGRON PolandEU				Manufacturer
Interface				Settings communication interface
	Loop 4-20mA			Current loop 4-20mA
		Source		
			cO_2	Dissolved oxygen concentration
			sO_2	Saturation
			pO_2	Partial pressure
			tau	Fluorescence quenching time
			Temperature	Head temperature
		Alarm		Namur43 on / off
			Namur43	Alarm on
			no	Alarm off
	CANopen			CANopen fieldbus
		XXh		Sensor slave address

			XXXkbps	Transmission speed
			no term	Termination off
			term-120Ohm	Termination on
		MODBUS		MODBUS fieldbus
			XXh	Sensor slave address
			XXXXXXbps	Transmission speed
			RTU / ASCII	Transmission mode
			XYZ	X - number of data bits, Y - parity **N**-none, **E**-even, **O**-odd), Z - number of stop bits
			no term	Termination off
			term-120Ohm	Termination on
cO_2	*mg/L*	Dissolved oxygen concentration		
sO_2	*%*	The oxygen saturation [%] (in relative to dry air at atmospheric pressure)		
T	*°C*	Head temperature		
sO_2	*mBar*	Oxygen partial pressure		
tau	*us*	Fluorescence quenching time		
patm	*mBar*	Absolute atmospheric pressure during calibration or hydrostatic pressure at immersion in water		
RH	*%*	Relative humidity of ambient air during calibration or humidity inside the sensor during operation (leaks detection)		
TRH	*°C*	Humidity sensor temperature		

12.4. Activating the factory measuring window

The new sensor delivered by its manufacturer requires a one-time activation of the factory-made measuring window. During the first start-up of the terminal there is available only one menu option:

/1 Activate window An activation of the factory-made measuring window. This option requires entering a current date. An activation process adjusts physical and chemical changes which have been performer in the measuring window within a period between a production end and the first start-up of the sensor.

Enter the correct current date during activation of the factory-made measurement window !
If the date is not set correctly its subsequent correction will not be possible! The sensor will report wearing of the measuring window.

12.5. Menu structure

The keyboard shortcuts provide a quick access to the menu functions.
Example: The "**/2.1**" shortcut - press key "**/**", press key "**2**", press key "**1**".

Table 6. The menu structure

Option name	Keyboard shortcut	Page
1 – Time / Date	**/1**	41
2 – Interface	**/2**	41
1 – Loop 4-20mA	**/2.1**	41
1 – Source	**/2.1.1**	42
1 – cO2	**/2.1.1.1**	42
2 – sO2	**/2.1.1.2**	42
3 – pO2	**/2.1.1.3**	42
4 – tau	**/2.1.1.4**	42
5 – Temperature	**/2.1.1.5**	42
2 – Range	**/2.1.2**	42
1 – cO2	**/2.1.2.1**	42
2 – sO2	**/2.1.2.2**	42
3 – pO2	**/2.1.2.3**	42
3 – Alarm	**/2.1.3**	42
1 – Namur43 – 22mA	**/2.1.3.1**	42
2 – no alarm	**/2.1.3.2**	42
2 – CANopen	**/2.2**	42
1 - Node ID	**/2.2.1**	44
2 – Speed	**/2.2.2**	44
1 – 10 kbps	**/2.2.2.1**	44
2 – 20 kbps	**/2.2.2.2**	45
3 – 50 kbps	**/2.2.2.3**	45
4 – 100 kbps	**/2.2.2.4**	45
5 – 125 kbps	**/2.2.2.5**	45

6 – 250 kbps	**/2.2.2.6**	45
7 – 500 kbps	**/2.2.2.7**	45
8 – 800 kbps	**/2.2.2.8**	45
9 – 1000 kbps	**/2.2.2.9**	45
3 – Termination	**/2.2.3**	45
1 – No termination	**/2.2.3.1**	45
2 – 120 Ohm termination	**/2.2.3.1**	45
3 – MODBUS	**/2.3**	45
1 – Address	**/2.3.1**	47
2 – Speed	**/2.3.2**	47
1 – 1200 bps	**/2.3.2.1**	47
2 – 2400 bps	**/2.3.2.2**	47
3 – 4800 bps	**/2.3.2.3**	47
4 – 9600 bps	**/2.3.2.4**	47
5 – 19200 bps	**/2.3.2.5**	47
6 – 38400 bps	**/2.3.2.6**	47
7 – 57600 bps	**/2.3.2.7**	47
8 – 115200 bps	**/2.3.2.8**	47
9 – 230400 bps	**/2.3.2.9**	47
A – 460800 bps	**/2.3.2.A**	47
B – 921600 bps	**/2.3.2.B**	47
3 – Mode	**/2.3.3**	47
1 – RTU	**/2.3.3.1**	47
2 – ASCII	**/2.3.3.2**	47
4 – Parity	**/2.3.4**	47
1 – None	**/2.3.4.1**	47
2 – Even	**/2.3.4.2**	47
3 – Odd	**/2.3.4.3**	47
5 – Termination	**/2.3.5**	47
1 - No termination	**/2.3.5.1**	47
2 – 120 Ohm termination	**/2.3.5.2**	47

12.6. Description of menu functions

Table 7. The main menu - Info box

Information fields		Meaning	
Head S/N		Head serial number	
Window S/N		Window serial number	
Window expired		Expected date of exchange of measuring window	
Last cal		Date of last calibration	
Battery	*%*	Battery level of real-time clock	
Mainboard Temp	*°C*	Motherboard temperature	
Cleaning status		Status of the cleaning system of measuring window	
		cleaning	Cleaning operations are in progress
		waiting	Waiting for cleaning
		disable	Cleaning system off
Control status		Status of the control system of air blower	
		running	Blower on
		waiting	Waiting for air blowing
		disable	Control system off

12.6.1. Date and time

/1 Time / Date Settings of time and date of the RTC clock.
A change is saved directly in the clock memory, a record of the sensor configuration is not required. It is possible to change a date format YYYY-MM-DD (year-month-date) or DD-MM-YYYY (day-month-year). The possible formats of time: HH:MM:SS (hour : minutes : seconds) or HH:MM (hour : minutes). Date and time can be entered simultaneously, you are just to separate them with a space character. The order of entering does not matter.

12.6.2. Loop 4-20mA, CANopen, MODBUS communication interfaces

/2 Interface Settings of a current loop communication 4-20mA and the CANopen, MODBUS fieldbuses.

/2.1 Loop 4-20mA Current loop 4-20mA.

This interface handles a system of the NAMUR43 alarms. A level of current below 3.6 mA means no supply power or a sensor failure. A level of 22 mA means a measurement error, e.g. a total wearing of the measuring window.

The available sources of the signal is a **cO2** concentration, a **sO2** saturation, an oxygen partial pressure **pO2**, a luminescence quenching time **tau,** a temperature. For the measuring values of the **cO2**, **sO2** and **pO2** it is possible to set a mapping of the measurement range for the current range of the loop. Therefore it is possible to increase a measurement resolution at the result conversion from the digital to the analogue value.

Example. If a value of the condensation fluctuates within a scope of 7 mg/L and for a concerned operation environment it does not exceed 10 mg/L then setting the range to 10 mg/L instead of the default 20 mg/L allows for a two-fold increase of the resolution.

- **/2.1.1 Source** Selection of a signal source for a current loop.
  - **/2.1.1.1 cO2** Concentration ,
  - **/2.1.1.2 sO2** Saturation,
  - **/2.1.1.3 pO2** Partial pressure,
  - **/2.1.1.4 tau** Fluorescence quenching time,
  - **/2.1.1.1 temperature** Temperature.
- **/2.1.2 Range** Range of measuring value mapping for a current range of the loop.
  - **/2.1.2.1 cO2** Range from 10 to 40 mg/L,
  - **/2.1.2.2 sO2** Range from 100 to 400 %,
  - **/2.1.2.3 pO2** Range from 200 to 1000 mbar.
- **/2.1.3 Alarm** Turning on / off of the Namur43 alarm.
  - **/2.1.3.1 Namur43 – 22mA**
  - **/2.1.3.2 no alarm**

/2.2 CANopen The interface of the CANopen (CANBUS) fieldbus.

The sensor operates according to the **DS-301** standard, handles the **SDO** and **PDO** transmission. Maximally there are available eight configurable **PDO** rounds. Each round may include four mapped measuring values. The sensor supervises **Heartbeat, Nodeguard** and **NMT** states.

When power supply is turned on, the sensor is in the **NMT PREOPERATIONAL** mode and sends a message **NMT Boot-up** to the fieldbus. The **PDO** transmission starts its operations after switching the sensor to the **NMT OPERATIONAL** mode. A transition to the **NMT STOP** mode stops the **PDO** transmission.

The **Heartbeat** function launches its operations when a value of the register of the *Heartbeat time (1017h, 00h)* is higher than 0. The sensor's USB disk has an **EDS** file for automatically configuring the PLC controller.

A detailed description of the CANopen fieldbus operation is available at http://www.can-cia.org.

The sensor has a built-in 120 ohm terminator connected electronically to the fieldbus.

If the sensor operates as an end-device it is possible to turn on an internal terminator and give up mounting a resistor in the M12 plug.

Time of the RTC clock is recorded in the UNIX format (4 bytes) in seconds from the beginning of the era, i.e. from 1st January 1970.

Table 8. Addressing the CANopen

Index	Subindex	Description	Unit	Type	R/W	Size (bytes)	Default value
1000h	00h	Device Type		Unsigned32	R	4	00000000h
1017h	00h	Heartbeat time	*ms*	Unsigned16	R/W	2	0000h
1018h	01h	Vendor ID		Unsigned32	R	4	00000000h
1018h	02h	Product code		Unsigned32	R	4	4F585944h OXYD
1200h	01h	SDO RX COB-ID		Unsigned32	R	4	600h
1200h	02h	SDO TX COB-ID		Unsigned32	R	4	580h
2000h	00h	Sensor status		Unsigned32	R	4	-
2001h	00h	Sensor parameters NrOfObjects		Unsigned8	R	1	15h
2001h	01h	**cO2** concentration	*mg/L*	Real32	R	4	-
2001h	02h	**sO2** saturation	*%*	Real32	R	4	-
2001h	03h	Head temperature	*°C*	Real32	R	4	-
2001h	04h	**pO2** O_2 partial pressure	*bar*	Real32	R	4	-
2001h	05h	**Tau** fluorescence decay time	*us*	Real32	R	4	-
2001h	06h	Atmospheric pressure	*bar*	Real32	R	4	-
2001h	07h	Relative humidity inside the sensor	*%*	Real32	R	4	-
2001h	08h	Temperature of humidity sensor	*°C*	Real32	R	4	-
2001h	09h	Salinity	*ppt*	Real32	R	4	-
2001h	0Ah	Mainboard temperature	*°C*	Real32	R	4	-
2001h	0Bh	Sensor serial number		Unsigned64	R	8	-
2001h	0Ch	Date and time	*s*	Unsigned32	R	4	-

Index	Subindex	Description	Unit	Type	R/W	Size (bytes)	Default value
2001h	0Dh	Measuring window serial number		Unsigned16	R	2	-
2001h	0Eh	Expected date of exchange measuring window	*s*	Unsigned32	R	4	-
2001h	0Fh	Date of last calibration	*s*	Unsigned32	R	4	-
2001h	10h	RTC battery level	*%*	Unsigned16	R	2	-
2001h	11h	Supply power +24V	*V*	Real32	R	4	-
2001h	12h	**cO2** concentration	*0,01mg/L*	Unsigned16	R	2	-
2001h	13h	**sO2** saturation	*0,01%*	Unsigned16	R	2	-
2001h	14h	Head temperature	*0,01°C*	Unsigned16	R	2	-
2001h	15h	Time to(+)/from(-) expired measuring window	*days*	Signed16	R	2	-

Table 9. CANOpen Status register (2000h, 00h)

Bit	Description	State "0"	State "1"
0	Correctness of indications	Incorrect	Correct
1	Range error	Range ok	Range exceeded
2	Measuring window status	Need to replace	Correct
3	Cleaning	Waiting	Cleaning in progress
4	Maintaining values after cleaning "**holding time**"	Real current value	Saved value
5	Output status **OXYGEN CONTROL**	Correct	Short circuit
6	Output status **AIRBLAST CLEANING**	Correct	Short circuit
7	Dehumidity system status	Failure	Correct

/2.2.1 Node ID CANopen slave address of the sensor. Range from 0 to 127.

/2.2.2 Speed Transmission speed.

/2.2.2.1 10 kbps 10 kbit/s.

/2.2.2.2 20 kbps 20 kbit/s.

/2.2.2.3 50 kbps 50 kbit/s.

/2.2.2.4 100 kbps 100 kbit/s.

/2.2.2.5 125 kbps 125 kbit/s.

/2.2.2.6 250 kbps 250 kbit/s.

/2.2.2.7 500 kbps 500 kbit/s.

/2.2.2.8 800 kbps 800 kbit/s.

/2.2.2.9 1000 kbps 1000 kbit/s.

/2.2.3 Termination 120 Ohm terminator. Enabled electronically.

/2.2.3.1 No termination Disconnecting the terminator.

/2.2.3.2 120 Ohm termination Connecting the 120 ohm terminator.

/2.3 MODBUS The interface of the MODBUS (RS485) fieldbus.

A communication protocol is compatible with the **MODICON** format. The sensor handles both the **RTU** and **ASCII** mode. The registers are placed in the Holding Register (4XXXX) space with a shift of 1 000 addresses, i.e. from the 41000 address.

In the MODBUS protocol in the RTU mode, a character frame has always a length of 11 bits. Therefore the frame contains one bit of the stop if a parity is in the **even** mode or **odd** mode, or 2 bits of a stop if a parity is off.

In the ASCII mode, the frame lengths is always 10 bits. If a parity is set to **even** or **odd**, so a frame contains 1 bit of a stop, if a parity is turned off, the frame includes 2 bits of a stop.

The sensor has a built-in 120 ohm terminator connected electronically to the fieldbus.

If the sensor operates as an end-device it is possible to turn on an internal terminator and give up mounting a resistor in the M12 plug.

Table 10. Addressing the MODBUS

Address	Description	Unit	Type	R/W	Size (bytes)
41000	Sensor status		Long unsigned int	R	4
41002	**cO2** concentration	*mg/L*	Float	R	4
41004	**sO2** saturation	*%*	Float	R	4
41006	Head temperature	*°C*	Float	R	4
41008	**pO2** O_2 partial pressure	*bar*	Float	R	4

Address	Description	Unit	Type	R/W	Size (bytes)
41010	Tau fluorescence decay time	*us*	Float	R	4
41012	Atmospheric pressure / hydrostatic	*bar*	Float	R	4
41014	Relative humidity inside the sensor	*%*	Float	R	4
41016	Humidity sensor temperature	*°C*	Float	R	4
41018	Salinity	*ppt*	Float	R	4
41020	Mainboard temperature	*°C*	Float	R	4
41022	Sensor serial number		Long long unsigned int	R	8
41026	Date and time	*s*	Long unsigned int	R	4
41028	Window serial number		Unsigned word	R	2
41029	Expected date of exchange measuring window	*s*	Long unsigned int	R	4
41031	Date of last calibration	*s*	Long unsigned int	R	4
41033	RTC battery level	*%*	Unsigned word	R	2
41034	Supply power +24V	*V*	Float	R	4
41036	**cO2** concentration	*0.01mg/L*	Unsigned word	R	2
41037	**sO2** saturation	*0.01%*	Unsigned word	R	2
41038	Head temperature	*0.01°C*	Unsigned word	R	2
41039	Time to(+)/from(-) expired measuring window	*days*	Signed word	R	2

Table 11. MODBUS Status register (41000)

Bit	Description	State "0"	State "1"
0	Correctness of indications	Incorrect	Correct
1	Range error	Range ok	Range exceeded
2	Measuring window status	Correct	Must be replaced
3	Cleaning	Waiting	Cleaning in progress
4	Maintaining values after cleaning "**holding time**"	Real current value	Saved value
5	Output status **OXYGEN CONTROL**	Correct	Short circuit
6	Output status **AIRBLAST CLEANING**	Correct	Short circuit

7	Dehumidity system status	Failure	Correct

/2.3.1 Address Sensor slave address. Range 1 to 247.

/2.3.2 Speed Transmission speed.

- **/2.3.2.1 1200 bps** 1200 bit/s.
- **/2.3.2.2 2400 bps** 2400 bit/s.
- **/2.3.2.3 4800 bps** 4800 bit/s.
- **/2.3.2.4 9600 bps** 9600 bit/s.
- **/2.3.2.5 19200 bps** 19200 bit/s.
- **/2.3.2.6 38400 bps** 38400 bit/s.
- **/2.3.2.7 57600 bps** 57600 bit/s.
- **/2.3.2.8 115200 bps** 115200 bit/s.
- **/2.3.2.9 230400 bps** 230400 bit/s.
- **/2.3.2.A 460800 bps** 460800 bit/s.
- **/2.3.2.B 921600 bps** 921600 bit/s.

/2.3.3 Mode Fieldbus operation mode.

- **/2.3.3.1 RTU** Binary RTU.
- **/2.3.3.2 ASCII** Text ASCII.

/2.3.4 Parity Parity.

- **/2.3.4.1 None**
- **/2.3.4.2 Even**
- **/2.3.4.3 Odd**

/2.3.5 Termination 120 Ohm terminator. Turned on electronically.

- **/2.3.5.1 No termination** Disconnecting the terminator.
- **/2.3.5.2 120 Ohm termination** Connecting the 120 ohm terminator.

/2.3.6 Watchdog MODBUS Watchdog. Exceeding the time between frames addressed to the sensor restarts the interface/sensor.

Table 12. The **Watchdog** menu - Info box

Information fields	Meaning

Watchdog		Watchdog state	
		enabled	On
		disable	Off
Reset type		Reboot type	
		interface	Reboot of fieldbus interface
		sensor	Reboot of sensor
Time	*s*	The maximum time between frames addressed to sensor.	

/2.3.6.1 Watchdog enable/disable Enable/Disable.

/2.3.6.2 Reset type Typ restartu.

/2.3.6.2.1 Reset interface Interface reboot.

/2.3.6.2.2 Reset sensor Sensor reboot.

/2.3.6.3 Time *[s]* Maximum time between the MODBUS frames addressed to the sensor. Range from 3 to 600 seconds. Exceeding reboots the interface/sensor.

12.6.3. Automatic cleaning of the measuring window

/3 Cleaning / Airblast Managing a system of the pneumatic window cleaning.

Table 13. The **Cleaning** / **Air blast** menu - Info box

Information fields		**Meaning**	
State		State of the cleaning system	
		enabled	On
		disable	Off
Start time	*hh:mm*	Enabling time	
Interval	*hh*	Time between starts of cleaning	
Duration	*s*	Duration of cleaning operation	
Holding time	*s*	Hold time of valid measurement values during cleaning	
Status		Status of cleaning system	
		waiting	Waiting for start cleaning
		cleaning	Cleaning in progress

Output state	Output state **AIRBALST / CLEANING**	
	off	Inactive
	on	Active
Output diagnostic	Output diagnostic **AIRBALST / CLEANING**	
	ok	Proper operating
	error	Short circuit

/3.1 Cleaning enable/disable On/off cleaning.

/3.2 Start time *[hh:mm] Start-up time.*

/3.3 Interval *[hh]* Time between start-ups. Range from 1 to 24 hrs.

/3.4 Duration *[s]* Duration of the cleaning operation. Range from 10 to 600 seconds. A default value is of 120 seconds.

/3.5 Holding time *[s]* Holding time of the correct measurement values during the cleaning. The cleaning with the compressed gas results in obtaining false indications of the sensor. In order to prevent against the improper operating of the PLC drivers connected to the fieldbus, the sensor maintains in the MODBUS/CANopen registers the latest valid measurement values. Holding time allows for stabilising the sensor indications after cleaning is finished. Default value 60 seconds.

/3.6 Output manual enable/disable Cleaning output on/off. It allows for checking up a correctness of the system operating.

12.6.4. Control of air blower

/4 Oxygen control Managing a control system of the external air blower. It is a two-status control with a hysteresis system. The control output enables the air blower if an oxygen concentration is lower than the **Target – Hysteresis** value. The pump operates until the oxygen concentration reaches the **Target + Hysteresis** value. The pump is disabled until the concentration reaches the **Target – Hysteresis** value again.

Table 14. Menu **Oxygen control** - Info box

Information fields		Meaning	
State		State of blowing system	
		enabled	On
		disabled	Off
Target	*mg/L*	Target value of the dissolved oxygen concentration	
Hysteresis	*mg/L*	System hysteresis	

Status	Status control system	
	waiting	Air blowing off
	running	Air blowing on
Output state	Output state **OXYGEN CONTROL**	
	off	Inactive
	on	Active
Output diagnostic	Output diagnostic **OXYGEN CONTROL**	
	ok	Correct operating
	error	Short circuit

/4.1 Oxygen control enable/disable Control system on/off.

/4.2 Target A target value of the dissolved oxygen concentration.Range from 0 to 20mg/L.

/4.3 Hysteresis A system hysteresis. Range from 0 to 4mg/L.

/4.4 Output manual enable/disable Control output on/off.
Enables to check up a correctness of system operations.

12.6.5. Measuring interval and the averaging filter

/5 Interval / Filtering Measuring frequency / Size of the averaging filter.

Table 15. The **Interval / Filtering** menu - Info box

Information fields		**Meaning**
Interval	*s*	Measuring interval
Filter size	*samples*	Averaging filter size

/1 Measurement interval Changing a measurement frequency. Performing a measurement is connected with charging dye molecules to the high-energy state. In this state the dye is strongly reactive. It partially combines with the oxygen molecules, and partially with the matrix molecules. It is a so called “**photo-bleaching**” phenomenon which decreases an ability of the fluorophore emission what in consequence results in a measurement drift. An increase of the interval between measurement decreases the sensor drift, but increases a reaction time for a change of the oxygen concentration.

/1 1s (default) Measurement every second. Default value.

/2 2s Measurement every 2 seconds.

/3 5s Measurement every 5 seconds.

/4 10s (low drift) Measurement every 10 seconds.

/2 Filter size A size of the averaging filter. The filter operates on the basis of the FIR digital model. With an increase of the filter size, a stability of the readouts is higher, but a reaction time of the sensor for a change of the oxygen concentration decreases.

/1 5 samples Average from 5 measurements.

/2 10 samples Average from 10 measurements.

/3 15 samples (default) Average from 15 measurements Default value.

/4 30 samples Average from 30 measurements.

12.6.6. Calibration and installation of the new measuring window

/6 Calibration / New Window Sensor calibration, an installation of the new measuring window.

Table 16. The **Calibration** / **New Window** menu - Info box

Information fields		Meaning
Window S/N		Measuring window serial number
Window expired		Expected date of exchange measuring window
Last cal		Date of last calibration
tau0-temperature	*us*	tau_0 coefficient after temperature compensation
ppH2O	*mBar*	Partial pressure of water vapor contained in the atmospheric air (during a calibration after removing the measuring window)
ppO2-ambient	*mBar*	Partial pressure of oxygen in the air
ppO2-saved	*mBar*	*ppO2* pressure in the air saved during calibration
Salinity	*ppt*	Correction of CO_2 caused by salinization
photobleach tau0	*ns*	Correction values tau0 caused by photo-bleaching
cal-pO2		Slope of calibration curve
cal-tau0	*us*	Coefficient of offset calibration curve

Calibration Linear calibration, one-point and two-point calibration.

/6.1 Low point, 0% O2 Calibration of the measurement curve offset, a reset of the indications. The low calibration point.

Procedure:

1. Prepare a calibration solution of sodium sulphite. Add 1g sodium sulphite Na_2SO_3 from the test-tube, included in the set, to 500ml of demineralised water. Mix a solution until crystals are totally solved.
2. Place the sensor in the prepared solution.
3. Choose the **/6.1 Low point, 0% O2** menu option.
4. Wait 10 minutes until the sensor and solution temperatures are equal.
5. Check-up if on the surface of the measuring window are any air bubbles. If so, please incline the sensor so that they are removed.
6. Wait 5 minutes until an indication of cO_2 stops decreasing.
7. Press „**Y”**. The calibration will be finished. The indications of **cO_2**, **sO_2** and **pO_2** will be reset.
8. Save the configuration using the following menu: **/S Save settings**.

/6.2 High point, 20.95% O2 in air Calibration of the inclination of the measurement curve.

The high calibration point. The reference – partial oxygen pressure in the atmospheric air. It requires an external humidity meter.

Procedure:

1. Perform a calibration of the low point - **/6.1 Low point, 0%O2** menu.
2. Put the sensor in the place where the body temperature will be similar to the air temperature. Wait 10 minutes.
3. Measure air humidity and temperature with an external meter.
4. Select **/6.2 High point, 20.95% O2 in air** menu. Enter the measured value of air humidity and temperature.
5. Save the configuration using the following menu: **/S Save settings**.

/6.3 High point, saturated air Calibration of the inclination of the measurement curve.

The high calibration point. The reference – partial oxygen pressure in the atmospheric air. It does require: plastic bag 80x120mm, cellulose sponge 12cm^3, rubber bend 50mm, deionized water.

Procedure:

1. Perform a calibration of the low point - menu **/6.1 Low point, 0%O2** and save a configuration.
2. Pour 3cm^3 of deionized water into a cellulose sponge. Put the sponge in a plastic bag with a volume of 80x120mm. Put the bag on the sensor head and seal it with a rubber band so that water vapor does not escape.
3. Select **/6.3 High point, saturated air** menu.
4. Wait 10 minutes until the air inside the bag will saturate with the vapour.

The temperature of the sensor head and air in the bag must be equal.

5. Press „**Y**”. The calibration will be finished.
6. Save the configuration using the following menu: **/S Save settings**.

/6.4 High point, ppO2 manualy Calibration of the inclination of the measurement curve.

The high calibration point. The reference – partial oxygen pressure entered manually.

Procedure:

1. Perform a calibration of the low point - **/6.1 Low point, 0%O2** menu.
2. Place the sensor in the calibration environment. Wait 10 minutes, until the body temperature will be equal to the environment temperature.
3. Select **/6.4 High point, ppO2 manually** menu. Enter the value of the real oxygen partial pressure. The calibration will be finished.
4. Save the configuration using the following menu: **/S Save settings**.

/6.5 Salinity Salinity level. Range from 0 to 100 ppt.

A correction of salinity is related only to a measurement of cO_2. Salinity can be determined on the basis of the conductivity measurement using a conductometer. **Table 20** (page 59) allows for recalculating values.

New Window/Dye Installation of the measuring window.

Besides a mechanical exchange of the window it is necessary to enter calibration coefficients to the sensor. Every window is calibrated individually during a manufacturing process.

/6.6 Coding from file Installation of the window from the calibration file.

Procedure:

1. Check-up a time and date set in the sensor. If they are not valid enter new settings.

If during an installation of the measuring window a date is set incorrectly its subsequent correction will not be possible! The sensor will report wearing of the window.

2. **Select "/6.6 Coding from file**" menu. A virtual USB disc will switch itself from the read-only mode to the read/save mode. **Do not delete any files**.
3. Copy the "*WindowXXXXXX.wdw*" file attached to the measuring window to the "Data" catalogue.
4. Press "Y". The window will be installed.

After a correctly performed procedure of the window installation, the sensor will automatically save all setting to the non-volatile memory, removing the previous configuration.

/6.7 Coding manualy Installation of the window by means of the calibration

codes.
This option allows for a manual entering calibration coefficients using the text codes. A set of the codes consist of twelve items in the following format: 0-123456789. The codes can be entered manually or all at one time separating them by space characters. Dana comprise checksums. It is impossible to enter incorrect values.

Table 17. Menu **Coding manually** - Info box

Information fields	Meaning	
Code completeness	Status introduced calibration codes	
	+	Code entered correctly
	-	No-code or entered incorrectly

/6.9 Coefficients change Modification of calibration coefficients.
Options intended for a precise calibration performer in the laboratories. The sensor is based on the two-side activation of the luminophor. The modified *Stern-Volmer* equation has the following form:

$$\frac{tau_0[T]}{tau}=\left(\frac{f}{1+K_{SV1}[T]\cdot pO_2}\cdot\frac{1-f}{1+K_{KSV2}[T]\cdot pO_2}\right)^{-1} \quad (12.6\ 1)$$

Calibration curves of the K_{SV1} , K_{SV2} coefficients as a function of temperature have the following form:

$$K_{SV1,2}[T]=K'_{SV1,2}\cdot e^{-\frac{EK_{SV1,2}}{R(T+273.15)}} \quad (12.6\ 2)$$

Calibration curve of the tau_0 coefficient as a function of temperature have the following form:

$$tau_0[T]=a_{tau_0}\cdot T^2+b_{tau_0}\cdot T+c_{tau_0} \quad (12.6\ 3)$$

Non-linear regression allows for selecting the proper values of the coefficients.

The two-point calibration performer by a user is based on the linear adjustment of the *Stern-Volmer* curve to the *0%-O_2* and *20.95%-O_2* reference points.

$$pO_{2\ odczyt}=cal_{pO_2}\cdot pO_{2\ pomiar} \quad (12.6\ 4)$$

$$tau_0[T]_{odczyt} = tau_0[T]_{pomiar} + cal_{tau_0} \quad (12.6\ 5)$$

Table 18. Menu **Coefficients change** - Info box

Information fields		Meaning
Window S/N		Measuring window serial number
tau0-a		*a* coefficient of temperature calibration tau_0
tau0-b		*b* coefficient of temperature calibration tau_0
tau0-c	*s*	*c* coefficient of temperature calibration tau_0
f		*f* coefficient, two-side model *Stern-Volmer* equation
K'sv1		K'_{SV1} coefficient
EKsv1		EK_{SV1} energy activation coefficient
K'sv2		K'_{SV2} coefficient
EKsv2		EK_{SV2} energy activation coefficient
pbleach	m^2/W	Photo-bleaching correction coefficient
cal-pO2		Coefficient of inclination of linear calibration
cal-tau0	*s*	Coefficient of offset of linear calibration

/6.8.1 tau0-a	a_{tau0} coefficient modification
/6.8.1 tau0-b	b_{tau0} coefficient modification
/6.8.1 tau0-c	c_{tau0} coefficient modification
/6.8.1 f	*f* coefficient modification
/6.8.1 K'sv1	K'_{SV1} coefficient modification
/6.8.1 EKsv1	EK_{SV1} coefficient modification
/6.8.1 K'sv2	K'_{SV2} coefficient modification
/6.8.1 EKsv2	EK_{SV2} coefficient modification
/6.8.1 pbleach	*pbleach* coefficient modification
/6.8.1 cal-pO2	cal_{pO2} coefficient modification
/6.8.1 cal-tau0	cal_{tau0} coefficient modification

12.6.7. Downloading firmware

/7 Firmware upgrade Firmware installation.

/7.Y Enable USB disk drive device Enabling an upload mode of firmware.

/7.N Exit Exit from menu.

The sensor is constructed so that it is possible to upgrade the firmware from the level of the factory functions of the internal processor. Due to this it is impossible to damage permanently the device if an operation of the firmware update has been unsuccessful. The procedure can be initiated by two means:

Procedure 1: Activation of the firmware download from the level of the terminal application.

1. Select **/7.Y Enable USB disk drive device** menu. After choosing this option, the sensor will switch from the terminal mode to the firmware download mode. A virtual USB disc named "**CRP DISABLD"** with the "**firmware.bin"** file will appear in the operational system of the computer.
2. Remove the "**firmware.bin"** file.
3. Copy the file with the proper firmware to the **"CRP DISABLD"** disc. It is impossible to overwrite "**firmware.bin"**. It will appear a message that there is no space.
4. Disconnect the sensor from the power supply for 5 seconds.

Procedure 2: Hardware activation of the firmware download mode.

1. Connect the M12 connector terminals 1 and 8 together. Connect the USB cable to the computer.
2. The device will switch to the firmware download mode. A virtual USB disc named "**CRP DISABLD"** with the "**firmware.bin"** file will appear in the operational system of the computer.
3. Remove the "**firmware.bin"** file.
4. Copy the file with the proper firmware to the **"CRP DISABLD"** disc. It is impossible to overwrite "**firmware.bin"**. It will appear a message that there is no space.
5. Disconnect the USB cable. Disconnect tarminal 1 and 8.

Procedure 3: Emergency activation of the firmware download mode.

6. Disassemble the sensor housing.
7. Find the **S1** button marked as **USBBOOT**.
8. Press the **S1** button and while holding it connect the USB wire to the computer. The device will switch to the firmware download mode. A virtual USB disc named "**CRP DISABLD"** with the "**firmware.bin"** file will appear in the operational system of the computer.
9. Remove the "**firmware.bin"** file.
10. Copy the file with the proper firmware to the **"CRP DISABLD"** disc. It is impossible to overwrite "**firmware.bin"**. It will appear a message that there is no space.
11. Disconnect the sensor from the power supply for 5 seconds.

12.6.8. Service options

/8 Service menu Service options are available only to the authorised technicians.

12.6.9. Saving system settings

/S Save settings Saving system settings in the non-volatile memory of the sensor.

The changes of the sensor configurations in the terminal mode are of temporary nature. Every time after finishing the configuration it is necessary to save it manually to the NVM. Power outage without saving the configuration results in restoring the previously saved settings. An operation of the installation of the new measuring window is the only exception to this rule.

After a correctly performed procedure of the window installation, the sensor will automatically save all setting to the non-volatile memory, removing the previous configuration.

12.6.10. Restore manufacture settings

/R Restore manufacture settings Restoring manufacture settings. This option restores a manufacture configuration and initial coefficients of the installed measuring window.

- **/R.Y Restore manufacture settings** Restores the fabric settings.
- **/R.N Exit** Exit from a menu.

13. Annex

Table 19. Water vapor partial pressure, humidity 100%

Temperature [°C]	Pressure [mBar]	Temperature [°C]	Pressure [mBar]	Temperature [°C]	Pressure [mBar]
0,00	6,15	**14,00**	16,06	**28,00**	37,97
0,50	6,38	**14,50**	16,59	**28,50**	39,09
1,00	6,61	**15,00**	17,14	**29,00**	40,24
1,50	6,85	**15,50**	17,69	**29,50**	41,42
2,00	7,10	**16,00**	18,27	**30,00**	42,62
2,50	7,36	**16,50**	18,86	**30,50**	43,86
3,00	7,62	**17,00**	19,47	**31,00**	45,13
3,50	7,90	**17,50**	20,09	**31,50**	46,43
4,00	8,18	**18,00**	20,74	**32,00**	47,76
4,50	8,47	**18,50**	21,40	**32,50**	49,13
5,00	8,77	**19,00**	22,08	**33,00**	50,53
5,50	9,08	**19,50**	22,77	**33,50**	51,97
6,00	9,40	**20,00**	23,49	**34,00**	53,44
6,50	9,73	**20,50**	24,23	**34,50**	54,94
7,00	10,07	**21,00**	24,98	**35,00**	56,48
7,50	10,42	**21,50**	25,76	**35,50**	58,06
8,00	10,79	**22,00**	26,56	**36,00**	59,68
8,50	11,16	**22,50**	27,38	**36,50**	61,34
9,00	11,54	**23,00**	28,22	**37,00**	63,03
9,50	11,94	**23,50**	29,09	**37,50**	64,77
10,00	12,34	**24,00**	29,98	**38,00**	66,55
10,50	12,76	**24,50**	30,89	**38,50**	68,37
11,00	13,19	**25,00**	31,82	**39,00**	70,23
11,10	13,64	**25,50**	32,78	**39,50**	72.14

Temperature [°C]	Pressure [mBar]	Temperature [°C]	Pressure [mBar]	Temperature [°C]	Pressure [mBar]
12,00	14,10	**26,00**	33,77	**40,00**	74,09
12,50	14,58	**26,50**	34,78	**40,50**	76,08
13,00	15,05	**27,00**	35,82	**41,00**	78,13
13,50	15,55	**27,50**	36,88	**41,50**	82,36

Table 20. Conductivity - salinity, temperature 20°C

Conductivity [ms/cm]	Salinity [ppt]	Conductivity [ms/cm]	Salinity [ppt]	Conductivity [ms/cm]	Salinity [ppt]
1	0,55	**21**	14,08	**41**	29,41
2	1,14	**22**	14,81	**42**	30,21
3	1,74	**23**	15,55	**43**	31,01
4	2,36	**24**	16,29	**44**	31,82
5	3,00	**25**	17,03	**45**	32,62
6	3,64	**26**	17,78	**46**	33,44
7	4,30	**27**	18,53	**47**	34,25
8	4,96	**28**	19,29	**48**	35,07
9	5,62	**29**	20,05	**49**	35,89
10	6,30	**30**	20,81	**50**	36,72
11	6,98	**31**	21,57	**51**	37,55
12	7,67	**32**	22,34	**52**	38,38
13	8,36	**33**	23,11	**53**	39,21
14	9,06	**34**	23,89	**54**	40,05
15	9,76	**35**	24,67	**55**	40,89
16	10,47	**36**	25,45	**56**	41,73
17	11,18	**37**	26,24	**57**	42,57
18	11,90	**38**	27,02	**58**	43,42
19	12,62	**39**	27,81	**59**	44,27
20	13,35	**40**	28,61	**60**	45,13

Table 21. Oxygen concentration (**cO_2**) in the water, saturation, p_{atm} 1.013 Bar

Temperature [°C]	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	14,64	14,60	14,55	14,51	14,47	14,43	14,39	14,35	14,31	14,27
1	14,23	14,19	14,15	14,10	14,06	14,03	13,99	13,95	13,91	13,87
2	13,83	13,79	13,75	13,71	13,68	13,64	13,60	13,56	13,52	13,49
3	13,45	13,41	13,38	13,34	13,30	13,27	13,23	13,20	13,16	13,12
4	13,09	13,05	13,02	12,98	12,95	12,92	12,88	12,85	12,81	12,78
5	12,75	12,71	12,68	12,65	12,61	12,58	12,55	12,52	12,48	12,45
6	12,42	12,39	12,36	12,32	12,29	12,26	12,23	12,20	12,17	12,14
7	12,11	12,08	12,05	12,02	11,99	11,96	11,93	11,90	11,87	11,84
8	11,81	11,78	11,75	11,72	11,69	11,67	11,64	11,61	11,58	11,55
9	11,53	11,50	11,47	11,44	11,42	11,39	11,36	11,33	11,31	11,28
10	11,25	11,23	11,20	11,18	11,15	11,12	11,10	11,07	11,05	11,02
11	10,99	10,97	10,94	10,92	10,89	10,87	10,84	10,82	10,79	10,77
12	10,75	10,72	10,70	10,67	10,65	10,63	10,60	10,58	10,55	10,53
13	10,51	10,48	10,46	10,44	10,41	10,39	10,37	10,35	10,32	10,30
14	10,28	10,26	10,23	10,21	10,19	10,17	10,15	10,12	10,10	10,08
15	10,06	10,04	10,02	9,99	9,97	9,95	9,93	9,91	9,89	9,87
16	9,85	9,83	9,81	9,78	9,76	9,74	9,72	9,70	9,68	9,66
17	9,64	9,62	9,60	9,58	9,56	9,54	9,53	9,51	9,49	9,47
18	9,45	9,43	9,41	9,39	9,37	9,35	9,33	9,31	9,30	9,28
19	9,26	9,24	9,22	9,20	9,19	9,17	9,15	9,13	9,11	9,09
20	9,08	9,06	9,04	9,02	9,01	8,99	8,97	8,95	8,94	8,92
21	8,90	8,88	8,87	8,85	8,83	8,82	8,80	8,78	8,76	8,75
22	8,73	8,71	8,70	8,68	8,66	8,65	8,63	8,62	8,60	8,58
23	8,57	8,55	8,53	8,52	8,50	8,49	8,47	8,46	8,44	8,42
24	8,41	8,39	8,38	8,36	8,35	8,33	8,32	8,30	8,28	8,27
25	8,25	8,24	8,22	8,21	8,19	8,18	8,16	8,15	8,14	8,12
26	8,11	8,09	8,08	8,06	8,05	8,03	8,02	8,00	7,99	7,98
27	7,96	7,95	7,93	7,92	7,90	7,89	7,88	7,86	7,85	7,83

Temperature [°C]	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
28	7,82	7,81	7,79	7,78	7,77	7,75	7,74	7,73	7,71	7,70
29	7,69	7,67	7,66	7,65	7,63	7,62	7,61	7,59	7,58	7,57
30	7,55	7,54	7,53	7,51	7,50	7,49	7,48	7,46	7,45	7,44
31	7,42	7,41	7,40	7,39	7,37	7,36	7,35	7,34	7,32	7,31
32	7,30	7,29	7,28	7,26	7,25	7,24	7,23	7,21	7,20	7,19
33	7,18	7,17	7,15	7,14	7,13	7,12	7,11	7,09	7,08	7,07
34	7,06	7,05	7,04	7,02	7,01	7,00	6,99	6,98	6,97	6,96
35	6,94	6,93	6,92	6,91	6,90	6,89	6,88	6,87	6,85	6,83
36	6,83	6,82	6,81	6,80	6,79	6,78	6,77	6,75	6,74	6,73
37	6,72	6,71	6,70	6,69	6,68	6,67	6,66	6,65	6,64	6,63
38	6,61	6,60	6,59	6,58	6,57	6,56	6,55	6,54	6,53	6,52
39	6,51	6,50	6,49	6,48	6,47	6,46	6,45	6,44	6,43	6,42
40	6,41	6,40	6,39	6,38	6,37	6,36	6,35	6,34	6,33	6,32

14. Declaration of conformity CE

DECLARATION OF CONFORMITY

Product: OXY-DIOS-DSP-V2 optical dissolved oxygen sensor

Product description: *The optical-fluorescent sensor for measuring a concentration of dissolved oxygen in water and wastewater.*

Manufacturer: INTEGRON Research and Development Laboratory
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The product is compatible with European Union Directives:
2004/108/WE (EMC Directive), 2006/95/WE (LVD Low Voltage Directive)

The product is intended for use in industrial environments and is compliant with the following standards:
EN50081-2, EN50081-2, EN 61326-1

Szydłowiec, POLAND 22.05.2019
Karol Antonkiewicz, Main constructor

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http://www.sensor.integron.pl