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Signet 2610 Process Optical Dissolved Oxygen Sensor

3-2610.091   Rev. 4   12/18

MODBUS Manual

Power Connections

The RDO® Pro sensor may be connected to a controller or logger for communication via RS485 Modbus.

Power Connections
The red wire provides power for all system modes. Analog output is enabled by default. The 4 to 20 mA current loop output can be disabled by setting Modbus device register 49507 to 0. Set it back to 1 to re-enable the 4 to 20 mA loop.

Trim back and insulate unused wires. The shielded wire should be wired to a chassis ground or earth ground.
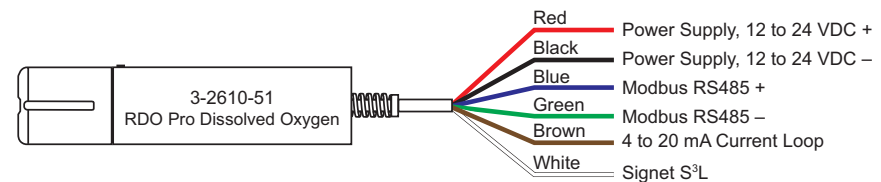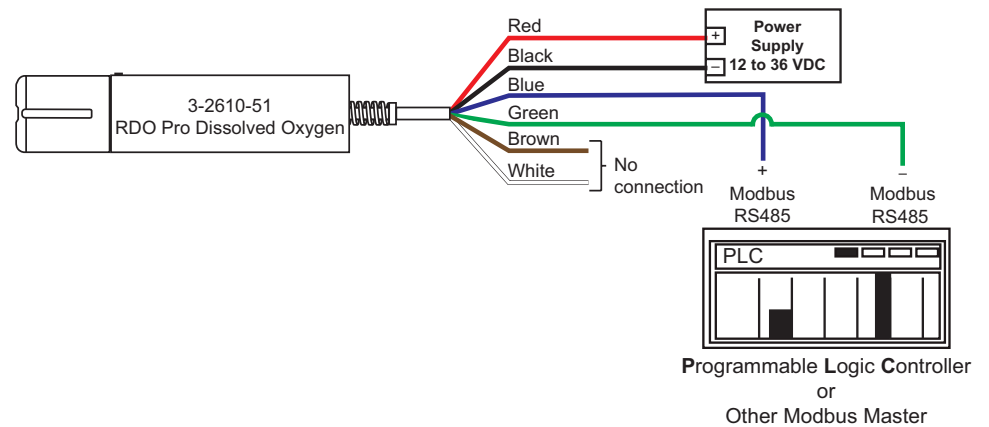
Cable length must not exceed 1220 m (4000 ft.)

Modbus Registers

Communication Control Registers

Register	Size (registers)	Mode & Access Level (R/W)	Data Type	Description
9200	1	R/W	ushort	Device Address (1-247, default = 1)
9201	1	R/W	ushort	Serial Communication Configuration
9202	1	R/W	ushort	EOM timeout (1000 – 15000 ms, default = 1000)
9203	1	R/W	ushort	EOS timeout (5000-60000 ms, default = 5000)
9204	1	R	ushort	Max allowed baud rate id (0-7)
9205	1	R	ushort	Max Message/Response size (bytes)
9206-9207	2	R/W	ulong	Good message counter
9208	1	R/W	ushort	Bad message counter
9209	1	R/W	ushort	Exception response counter

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Modbus Registers

Serial Communication Configuration Register 9201

When the Serial Configuration Register (9201) is changed the Modbus response will be sent to the Master at the current configuration (mode, baud, parity, data bits, address … etc). After the response has been sent to the Master the device will switch to the new settings.

Bits	Description
0	Modbus Transmission Mode
	0 = RTU (default)
	1 = ASCII
1, 2, & 3	Baud Rate ID
	0 = 9600 (mandatory)
	1 = 19200 (default)
	2 = 38400
	3 = 57600
	4 = 115200
	5 = 128000
	6 = 230400
	7 = 256000

Bits	Description
4	Data Bits
	0 = 7 data bits
	1 = 8 data bits (default)
5, 6	Parity Bits
	0 = Even (default)
	1 = Odd
	2 = None
7	Stop Bits
	0 = 1 Stop Bit (default)
	1 = 2 Stop Bits
9 – 15	Unassigned

Device Specific Measurement Registers

Register	Size (registers)	Mode & Access Level (R/W)	Data Type	Description
Dissolved Oxygen Concentration				
40038	2	R1	float	Measured value, C_0
40040	1	R1	ushort	Parameter ID = 20
40041	1	R1/W2	ushort	Units ID 117 = mg/L (default) 118 = µg/L
40042	1	R1	ushort	Data Quality ID
40043	2	R1/W3	float	Off line sentinel value (default = 0.0)
40045	1	R1	16 bits	Available Units = 0x0030 (48)
Temperature				
40046	2	R1	float	Measured value
40048	1	R1	ushort	Parameter ID = 1
40049	1	R1/W2	ushort	Units ID 1 = °C (default) 2 = °F
40050	1	R1	ushort	Data Quality ID
40051	2	R1/W3	float	Off line sentinel value (default = 0.0)
40053	1	R1	16 bits	Available Units = 0x0003 (3)
Dissolved Oxygen %Saturation				
40054	2	R1	float	Measured value
40056	1	R1/W2	ushort	Parameter ID = 21
40057	1	R1/W2	ushort	Units ID 177 = percent saturation (default)
40058	1	R1	ushort	Data Quality ID
40059	2	R1/W3	float	Off line sentinel value (default = 0.0)
40061	1	R1	16 bits	Available Units = 0x0001 (1
Oxygen Partial Pressure				
40062	2	R1	float	Measured value
40064	1	R1	ushort	Parameter ID = 2 (pressure)
40065	1	R1/W2	ushort	Units ID 26 = torr (default)
40066	1	R1	ushort	Data Quality ID
40067	2	R1/W3	float	Off line sentinel value (default = 0.0)
40069	1	R1	16 bits	Available Units = 0x0200 (512)

Modbus Registers

Calibration Registers

Register	Size (registers)	Mode & Access Level (R/W)	Data Type	Description
40118	2	R1/W3	float	Live salinity value (PSU)
40120	2	R1/W3	float	Default salinity value (PSU, default = 0.0)
40122	2	R1/W3	float	Live barometric pressure (mbar)
40124	2	R1/W3	float	Default barometric pressure (mbar, default = 1013.25)
40126	2	R1/W3	float	100% saturation calibration reading (mg/L)
40128	2	R1/W3	float	100% saturation temperature reading (°C)
40130	2	R1/W3	float	100% saturation salinity value (PSU)
40132	2	R1/W3	float	100% saturation barometric pressure (mbar)
40134	2	R1/W3	float	0% saturation calibration reading (mg/L)
40136	2	R1/W3	float	0% saturation temperature reading (°C)
40138	2	R1/W3	float	Calibration slope (default = 1.0)
40140	2	R1/W3	float	Calibration offset (default = 0.0)

Live Salinity Value

The live salinity value is used to correct the oxygen concentration value for salinity. Values must be written in Practical Salinity Units (PSU) in the range 0 to 42 PSU. This is not a measured parameter.

Default Salinity Value

The default salinity value is loaded into the live salinity value register when power is first applied to the probe. The default salinity value is used in calculations until a live salinity value is written. This is not a measured parameter.

Live Barometric Pressure

The live barometric pressure is used in the calculation of percent saturation and to determine the theoretical saturation point during calibration. Values must be written in millibars in the range 506.625 to 1114.675 mbar. This is not a measured parameter.

Default Barometric Pressure

The default barometric pressure is loaded into the live barometric pressure register when power is applied to the probe. The default barometric pressure is used in calculations until a live barometric pressure is written. This is not a measured parameter.

100% Saturation Calibration Values

These values represent the sensor conditions while the probe is in a 100% saturation calibration environment. These are not measured values, they are written by the controller during the calibration process.

Writes to these registers are only accepted if the probe is in the calibration mode. The probe will return exception 0x85 (invalid device command sequence) if an attempt is made to write these registers when the calibration mode is off.

0% Saturation Calibration Values

These values represent the sensor conditions while the probe is in a 0% saturation calibration environment. These are not measured values, they are written by the controller during the calibration process.

Writes to these registers are only accepted if the probe is in the calibration mode. The probe will return exception 0x85 (invalid device command sequence) if an attempt is made to write these registers when the calibration mode is off.

Calibration Slope and Offset

These values represent the slope and offset that will be applied to the raw concentration reading from the sensor to generate the final values reported by the sensor parameters. These registers may be written independently of the normal internal calibration procedure.

Entering Calibration Registers

IMPORTANT Calibration is not required. The sensor cap is factory calibrated to 2% accuracy. This is valid for the life of the sensor cap, one year from first reading.

Calibrate the sensor using the following procedure:

1. **Optional:** Read the Sensor Data Cache Timeout register 49463 and store the value.

2. Write the Sensor Data Cache Timeout register 49463 to a value less than your intended sample rate and greater than 1000 milliseconds. This will ensure that you get new sensor readings during the stabilization process.

3. **Optional:** Read the temperature units register 40049 and saturation units register 40041 and store their values.

4. Write the temperature units register 40049 to its default value (1) and write the saturation units register 40041 to its default value (117).

5. Write the Calibration Mode On command (0xE000) to the sensor command register 49305.

6. Update the live salinity and barometric pressure registers if necessary.

7. Prompt the user to place the probe in a 100% saturation environment.

8. Read the oxygen concentration and temperature parameters. When these values have reached equilibrium, record them in their respective 100% saturation calibration registers. Write the current live salinity and barometric pressure readings to their respective calibration registers.

9. Prompt the user to place the sensor in a 0% saturation environment. When these registers have reached equilibrium, record them in their respective 0% saturation calibration registers. If a zero calibration is not to be performed, these registers can be set to zero or left at their previous values. Note: If you have a version of RDO PRO firmware that is earlier than 1.15 and you are not doing the zero calibration, you must set the 0% calibration registers to zero.

10. Write the Calibration Update command (0xE001) to the sensor command register. The sensor will calculate a new slope and offset, write the current time to the last user calibration time register, and set the next user calibration time register to zero (disabled). If the concentrations at 100% and 0% saturation are equal, the probe will return an exception response with code 0x97 (invalid calibration) and not attempt to compute a new slope and offset due to possible division by zero. If the slope does not calculate between 0.85 and 1.20 inclusive, or the offset does not calculate between -0.2 and +0.2 inclusive, the probe will return an exception response with code 0x97 (invalid calibration).The slope and offset will be available for read but will not be committed to flash.

11. **Optional:** Read the last user calibration time register, add the next calibration interval, and write the result to the next user calibration time register.

12. Write the Calibration Mode Off command (0xE002) to the sensor command register to place the sensor in normal operation. If the calibration mode is turned off without a calibration update command, or the calibration command returned an exception, the previous calibration shall be restored.

13. **Optional:** If you saved the temperature and saturation parameter units at the start of the process, write the original values back.

14. **Optional:** If you saved the Sensor Data Cache Timeout register 49463 at the start of the process, write the original value back.

Calibration Calculations

Calibrated oxygen reading:

$O_{2RC} = C_0 + C_1 \times O_{2RU}$

Where:

$C_1 = (O_2100\%Sat)/(O_{2RUS} \times O_{2RUZ})$

$C_0 = -C_1 \times O_{2RUZ}$

Where:

$O_2100\%Sat$ is the theoretical 100% saturation point

O_{2RUS} is the uncalibrated reading at 100% saturation

O_{2RUZ} is the uncalibrated reading at 0% saturation

References:
Standard Methods for the Examination of Water and Wastewater, 20th Ed, 2008. 4500-0 C. Azide Modification.
American Public Health Association. USA.