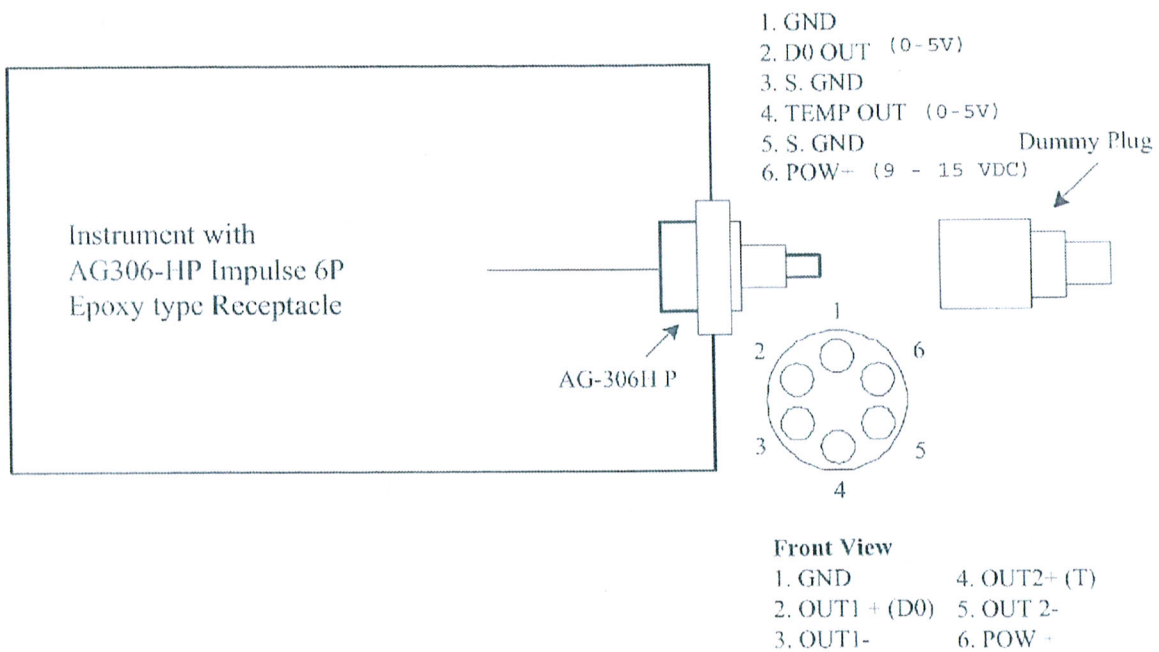
RINKO-III Pin Out



User calibration for RINKO oxygen sensor

In order to achieve the better repeatability, we highly recommend checking the RINKO output in 0 and 100%-oxygen water before and after deployment.

Materials need for the calibration

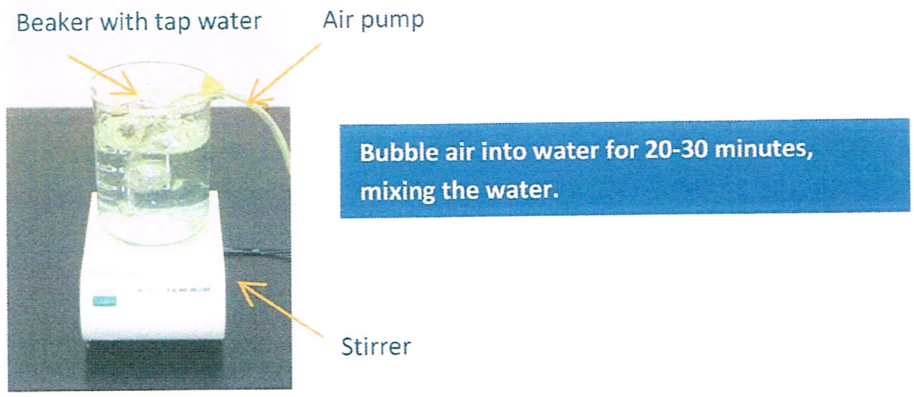
- Sodium sulfite (25g per 500ml): to make the 0% oxygen water
- 100% N_2 gas (if you do not use a sodium sulfite solution for the calibration of the 0%-oxygen.)
- Plastic bag (if you do not use a sodium sulfite solution for the calibration of the 0%-oxygen.)
- Aquarium air pump: to make the 100% (saturated) oxygen water
- Tap water
- Beaker or bucket (> 500ml)
- Stirrer
- Barometer in air
- Temperature sensor in water

Procedure

The first step is to take a test point in the 100% oxygen water. The reason is that if any residue of the sodium sulfite solution remains on the sensing surface, the 100% measurement will be inaccurate.

A) 100%-oxygen water

1) Put 500ml water into a beaker or a bucket.
2) Mix the water well using a stirrer.
3) Bubble air into the water for around 20-30 minutes using an air pump.



4) Put the sensor into the water and record the data. And measure the atmospheric pressure and water temperature during the oxygen measurement.

- **This is a sample image of the calibration with a RINKO-I (Self-recording model).**
- **Keep the optical window away from the bottom of the beaker.**
- **When RINKO-III (analog model) is calibrated, it must be connected into a CTD to record the data and supply the power.**

5) Calculate the oxygen saturation level (O_{sat}) in the water:

$$O_{sat}\,[\%] = \frac{p - p_v}{1013.25 - p_v} \times 100 \qquad (1)$$

where p and p_v indicates the atmospheric pressure and the saturation vapor pressure [hPa]. p_v can be calculated as follows:

$$p_v = 6.11 \times 10^{\frac{7.5 \times t}{237.3 + t}} \qquad (2)$$

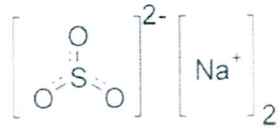
where t shows the water temperature in C degree in the water.

B) 0% -oxygen water or N_2 gas

The user can select to use a sodium sulfite solution or 100%-N_2 gas for the 0%-oxygen calibration.

(a) 0%-oxygen sodium sulfite solution

1) Put 500ml water into a beaker or a bucket.
2) Input 25g- sodium sulfite and mix well.
3) Put the sensor into the water and record the data.



After putting sodium sulfite (25g per 500ml-water) into the water, dissolve it well.

(b) 0%-oxygen (100%-N_2) gas

1) Cover the sensing head by a plastic bag.
2) Start recording.
3) Inject and substitute 100%-N_2 gas for air in the bag. Continue to record for a couple of minute, because the substitution of 100%- N_2 gas requires time.

C) Calculations of the calibration coefficients

Rinko calculates oxygen concentrations with 8-coefficients (please look at the calibration sheet, coefficients of A to H). Both coefficients of "G" and "H" (default values are 0 and 1) are used to correct the output drift.

A sample of the coefficients (A to H) described in RINKO calibration sheet.
Default values of "G" and "H" are "0" and "1".

A値= -44.8522
B値= 148.888
C値= -0.653942
D値= 0.0058
E値= 0.0035
F値= 0.150
G値= 0.00
H値= 1.00

Film No= 131002A

Here are the procedures to obtain the new coefficients of "G" and "H".

$$G = \frac{G' - P_0}{P_1 - P_0} \times O_{sat} \qquad (3)$$

where G', P_1, P_0 shows the current coefficient of "G", the output value at 100%-oxygen water and the output value at 0%-oxygen water, respectively.

$$H = \frac{O_{sat}}{P_1 - P_0} \times H' \qquad (4)$$

P_1 and P_0 must be physical values with a unit of "%". If you use RINKO-III (analog model), recorded data in the section (A) and (B) are not physical values but "voltage" values. **Obtain P_1 and P_0 with %-unit using the conversion software or the Matlab code provide by JFE ALEC.**

D) Input "new" calibration coefficients on the software

Both new coefficients of "G" and "H" are required to correct the output drift. Use the new "G" and "H" values in the software.

If you use:

- "DO converter" software, change "G" and "H" in the coefficient matrix. Please look at the software manual.
- Matlab code, use the new "G" and "H" to calculation DO concentrations.

List of symbols

Symbol	Unit	
A to H		Calibration coefficients for the oxygen calculations
G'		Current "G" coefficient (default value is 0)
H'		Current "H" coefficient (default value is 1)
P_0	%	Sensor output in 0%-oxygen water or N_2 gas
P_1	%	Sensor output in 100%-oxygen water
p	hPa	Atmospheric pressure when 100%-oxygen water is measured
p_v	hPa	Saturation vapor pressure when 100%-oxygen water is measured
t	°C	Water temperature when 100%-oxygen water is measured
O_{sat}	%	Oxygen saturation level when 100%-oxygen water is measured

Maintenance

1. Check RINKO outputs in 0 and 100% -oxygen water before and after deployment.

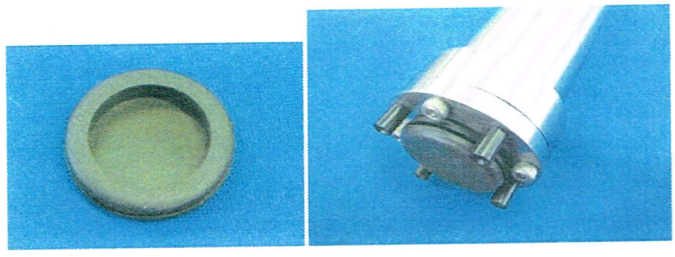
2. Power off the sensor whenever it in not used.

3. Don't submit the sensor to high temperatures. Place the sensor into a water bath when it is not in use during field observations, e.g. don't let the sensor sit on deck unprotected.

4. Don't expose the optical window to direct sunlight. Keep the unit in a case or water bath.

5. Cover the optical window with the black lubber cap whenever possible, e.g.
   - during the period between profiles, if the sensor is left on the deck over 1-hour.
   - if the sensor is stored for a long period.

The lubber cap and how to cover the optical window.



CALIBRATION SHEET

Name	:	RINKO-Ⅲ
Model	:	ARO-CAV
Serial No.	:	84
Parameter		Temperature Dissolved Oxygen

JFE

JFE Advantech Co., Ltd.

Ocean and River Instruments Division

Kobe Sales Department
7-2-3 Ibukidai-higashi, Nishi-ku, Kobe 651-2242, Japan.
TEL:+81-78-997-8686 FAX:+81-78997-8609
URL:http://www.jfe-advantech.co.jp/eng/

Temperature

MODEL : ARO-CAV

SERIAL : 84

DATE : October 21, 2011

Loaction : Calibration office of manfacture department at Kobe

Method : The instrument is calibrated in a constant temperature water tank.
5 outputs in n-value corresponding to 5 water temperature ranging from 3 to 31 degrees C are computed by least square method.
(To make the tank temperature constant, water is stirred. The reference temperature is measured by a thermometer)

Reference : Platinum thermometer (certified by JCSS)

Temperature : Temperature (℃) $=A+B\times N+C\times N^2+D\times N^3$

A = -5.556716E+00
B = 1.6795156E+01
C = -2.237491E+00
D = 4.7879874E-01

Reference [℃]	Output [V]	Calculated [℃]	Error [℃]
3.631	0.58729	3.632	0.001
10.020	1.03908	10.016	-0.004
17.495	1.59640	17.501	0.006
24.058	2.08353	24.054	-0.004
31.330	2.59532	31.331	0.001

Criteria for acceptability : 1. The errors in above form must be within ±0.02℃
2. After writing the calibration coefficients into instrument, one point check at any temperature must agree with the accuracy declared by the instrument.

Output Check :

Reference [℃]	Calculated [℃]	Error [℃]
22.696	22.704	0.008

Judgement : **Good**

Calibration group,

Manufacture department at Kobe

JFE Advantech Co., LTD

Dissolved Oxygen

MODEL : ARO-CAV

SERIAL : 84

DATE : October 21, 2011

Loaction : Calibration office of manfacture department at Kobe

Method : 2 points calibration of span and zero is carried out with 100% saturation water and nigrogen gas. Calibration should be done after making the instruments accustomed in the water and keeping saturation with air-bubbling. Outputs in saturated water and nitr

Film No= 160004A

A =	-44.0512	E =	0.0052
B =	141.534	F =	0.00
C =	-0.09589	G =	0.00
D =	0.0123	H =	1.00

Results :

Temperature at calibration[℃]	25
Air pressure at calibration[hPa]	1003.2
Air saturation at calibration[%]	99.0

	Span output [%]	zero output [%]	Span Error [%]	Zero Error [%]
1st	99.5	-0.1	0.5	-0.1
2nd	99.4	-0.1	0.4	-0.1
3rd	99.5	-0.1	0.5	-0.1

Judgement : **Good**

Calibration group,

Manufacture department at Kobe

JFE Advantech Co., LTD

JFE ALEC CO., LTD.

7-2-3 IBUKIDAI-HIGASHI, NISHI-KU, KOBE 651-2242, JAPAN.
Tel : 078-997-8686 Fax : 078-997-8609 info@jfe-alec.co.jp

Feb. 12, 2010

RINKO III Correction method on Temperature and Pressure

RINKO III is an optical dissolved oxygen (Hereafter DO) sensor with analog output that makes it easy to be integrated to other observational platform. The film sensing the water is affected by environment temperature and pressure at the depth where it is deployed. Based on experiments, an empirical algorithm as following is used to correct data dissolved oxygen.

$$P' = \frac{A}{1 + D(t - 25)} + \frac{B}{(N - F)[1 + D(t - 25)] + C + F} \quad (1)$$

$$P = G + H \times P' \quad (2)$$

Here, N is instrument output, the A, B, C, D, F, G, H are the parameters provided by manufacture and t is temperature in Celsius degree ^{o}C.

The above P is DO value in % without consideration on the effect by pressure, which can be corrected as,

$$P_d = P(1 + E \times d) \quad (3)$$

Here d is pressure in MPa and E is a parameter provided by manufacture. Then, P_d is DO in percentage with correction on temperature and pressure.