Q: How do I calibrate my DO probe with the YSI 4010 MultiLab meter?

A: Unless otherwise specified in company or site-specific procedures, specifications, and regulations, a water vapor-air saturated calibration should be sufficient for probe calibration.

Why calibrate?

Standard Methods 5210 for Biological Oxygen Demand, 23rd Edition, states to calibrate the DO probe daily by following the manufacturer's calibration procedure. It also recommends making frequent calibration checks daily to ensure accurate DO readings.

The following will outline the calibration method options for PC-BOD and the YSI 4010 MultiLab meter. YSI recommends that to best evaluate the quality of the calibration, it is pertinent to check the quality of the calibration record as well as the accuracy of the calibration via an altitude chart.

Above all, it is pertinent that operators follow company and/or site-specific procedures, specifications, and regulations. The below information may be considered when developing appropriate operating procedures.

Calibration Methods

- Calibration in water vapour-saturated air
    o Includes reference to altitude chart

- Calibration by a comparison measurement, e.g. Winkler Titration

1. Calibration in water vapour-saturated air

Unless otherwise specified in company or site-specific procedures, specifications, and regulations, a water vapor-air saturated calibration should be sufficient for probe calibration.

This calibration method requires a 300mL BOD bottle containing ~40mL of clean water (or ~1inch of clean water in any BOD bottle). The DO probe will sit on the BOD bottle with a seal created between the bottle and the probe; the sensor must not be immersed in the water. The probe should stabilize in the bottle for approximately 15 minutes, to allow the air to be saturated with water vapour and the sensor to adapt to ambient temperature.

Once the probe is stable, complete the calibration by doing the following steps:

    a. Press <CAL> and then <ENTER>. The measured value is checked for stability. While the stability is being verified, the display will show [AR].

    b. Once the stabilization is verified, the meter will beep, and the calibration record and evaluation are displayed.

The calibration value is automatically evaluated after each calibration. For evaluation, the slope of the sensor is compared to the slope of an ideal sensor, using the following equation: $S = S_{semsor}/S_{ideal}$. An ideal sensor has a slope of 1.

There are four different classifications of the calibration evaluation, summarized in the Table 1 below:

Table 1: Calibration Evaluation

Calibration Record	Relative Slope
+++	$0.94 < S < 1.06$
++	$0.92 < S < 0.94$ or $1.06 < S < 1.08$
+	$0.90 < S < 0.92$ or $1.08 < S < 1.10$
Error	$S < 0.90$ or $S > 1.10$

(Xylem Inc. (2018). *MutliLab 4010-3W Operating Manual ba76194e 03 07/2018*. OH.)

Ideally, the calibration record will display +++, which indicates that the sensor is measuring closest to an ideal sensor. If the calibration record is displaying less than +++, recalibrate, or compare the displayed result to the altitude chart shown in Table 2. If the displayed value matches the chart's value, then the calibration is valid, however, the sensor may need replacement soon (i.e. new sensor cap or membrane). It is good practice to always compare the measured value against the attitude chart, even if the calibration record displays +++.

Table 2: Calibration Values for various atmospheric pressures and altitudes

APPENDIX B – CALIBRATION VALUES FOR VARIOUS ATMOSPHERIC PRESSURES AND ALTITUDES

This table is also used to correct mg/L for the local barometric pressure of older, box style instruments that did not report % Saturation.

Pressure				Altitude		Calibration value
Inches Hg	mm Hg	kPA	mbar	Feet	Meters	% Saturation
30.23	768	102.4	1023	-276	-84	101
29.92	760	101.3	1013	0	0	100
29.61	752	100.3	1002	278	85	99
29.33	745	99.3	993	558	170	98
29.02	737	98.3	983	841	256	97
28.74	730	97.3	973	1126	343	96
28.43	722	96.3	963	1413	431	95
28.11	714	95.2	913	1703	519	94
27.83	707	94.2	944	1995	608	93
27.52	699	93.2	932	2290	698	92
27.24	692	92.3	923	2587	789	91
26.93	684	91.2	912	2887	880	90
26.61	676	90.1	901	3190	972	89
26.34	669	89.2	892	3496	1066	88
26.02	661	88.1	881	3804	1106	87
25.75	654	87.2	872	4115	1254	86
25.43	646	86.1	861	4430	1350	85
25.12	638	85.1	851	4747	1447	84
24.84	631	84.1	841	5067	1544	83
24.53	623	83.1	831	5391	1643	82
24.25	616	82.1	821	5717	1743	81

Pressure				Altitude		Calibration value
Inches Hg	mm Hg	kPA	mbar	Feet	Meters	% Saturation
23.94	608	81.1	811	6047	1843	80
23.62	600	80.0	800	6381	1945	79
23.35	593	79.1	791	6717	2047	78
23.03	585	78.0	780	7058	2151	77
22.76	578	77.1	771	7401	2256	76
22.44	570	76.0	760	7749	2362	75
22.13	562	74.9	749	8100	2469	74
21.85	555	74.0	740	8455	2577	73
21.54	547	73.0	729	8815	2687	72
21.26	540	72.0	720	9178	2797	71
20.94	532	71.0	709	9545	2909	70
20.63	524	70.0	699	9917	3023	69
20.35	517	69.0	689	10293	3137	68
20.04	509	67.9	679	10673	3371	67
19.76	502	66.9	669	11058	3371	66

(Xylem Inc. (2018). *MutliLab 4010-3W Operating Manual ba76194e 03 07/2018*. OH.)

c. To view the measured calibration value, press <F1> to return to the DO display.

d. Press <M> to change the display mode to % Saturation. Use the chart in Table 2 to verify the measured value.
   i. If the measured value doesn't fall in the range specified in the chart, consider recalibrating or changing the sensor (i.e. change the sensor cap or membrane).

e. Press <M> again to change the display back to mg/L. **The display must be in units of mg/L to run BOD analysis.**

The internal barometer on the YSI 4010 MultiLab meter is calibrated upon manufacturing and is designed to last the lifespan of the barometer sensor. The sensor is very stable and can last many years. Standard Methods does not specify a requirement for an adjustable barometer for dissolved oxygen measurements or biological oxygen demand testing.

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2. Calibration by a comparison measurement, e.g. Winkler Titration

Unless otherwise specified in company or site-specific procedures, specifications, and regulations, a Winkler Titration calibration is not recommended. A water vapor-air saturated calibration should be sufficient for probe calibration.

This method can be used to compare and adjust the measured value of the sensor against the nominal value of a comparison solution by applying a correction factor. The current correction factor is documented in the sensor menu and calibration record as *Factor = x.xxx.*

Complete a calibration by comparison measurement using the following steps:

a. Immerse the sensor in the reference solution.

b. Start the calibration by pressing <CAL> on the meter, followed by <ENTER>.

c. The measured value is checked for stability. While the stability is being verified, the display will show [AR].

d. Once the stabilization is verified, the meter will beep, and display the current reading.

e. Use the up and down arrows to adjust the current reading to the nominal value of the reference. Press <ENTER> to apply the nominal value.

f. The meter will switch to the measured value display and [Factor] is shown on the screen to indicate that the correction factor is applied to subsequent measurements.