



Beetrode[®] pH Electrodes

pH electrodes with 100 μ m sensing tips

INSTRUCTION MANUAL

Serial No. _____

050514

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World Precision Instruments

OTHER POPULAR WPI PRODUCTS

Dissolved oxygen meter & oxygen electrode

Electrically isolated, the electrode can function in recording situations where ground-referred electrodes would fail

- **Measures gas and dissolved oxygen**
- **Low O₂ consumption**
- **2 mm tip**

Isolation prevents adverse interaction with other electrodes and instruments. Highly accurate and stable **ISO2** measures oxygen concentrations in aqueous solutions and in gas mixtures. Measurement modes are percent oxygen, parts per million, and oxygen reduction current in nanoamperes.

The lower detection limit (DL) for **ISO2** (in gaseous or in liquid phase) is 0.1 ppm or 0.1%. Oxygen concentration around 0.5 ppm or 0.5% and up can be routinely measured in the gaseous or in the liquid phases.

DL for a particular sensor tends to be different in gaseous and liquid phases when the baseline noise level is also different. In the case of **ISO2**, however, the baseline noise level is very close whether the electrode is immersed in solution or used in the gaseous phase, so DL for the **ISO2** remains relatively close in either phase.

The small tip size (2 mm diameter) and low oxygen consumption of the **OXELP** electrode make it ideal for measurements *in vivo* or *in vitro*. With a T-Adapter (#5399), the sensor probe can be used also for continuous-flow monitoring of oxygen in small fluid volumes. **OXELP** also features a fast response time, typically 10 seconds. Optional BNC-to-double banana adaptor (#13347) and BNC cable (#500184) allow **ISO2** to be connected directly to your chart recorder.



SYS-ISO2	Dissolved Oxygen Meter & Electrode
OXELP	Replacement Oxygen Electrode for ISO2
5378	Replacement Electrode Sleeve Kit (pkg of 4) <i>Four sleeves with membranes, plus 10 mL refill solution.</i>
7326	ISO2 Filling Solution (10 mL)
5377	Replacement ISO2 Start-up Kit <i>Includes Calibration Bottle, 10mL Refill Solution, 1 cc Syringe, 2 Replacement Membranes Sleeves, MicroFil (28 ga.)</i>
5399	T-Adapter Flow-Through Kit <i>Includes 3 female luer T's, 3 luer lock fittings, 3 2mm gaskets, 6 male luer to 1/8-in. tubing, 3 luer lock fittings</i>
13347	Chart Recorder Adapter (requires BNC cable)
500184	BNC Cable

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ABOUT THIS MANUAL

The following symbols are used in this guide:



This symbol indicates a **CAUTION**. Cautions warn against actions that can cause damage to equipment. Please read these carefully.



This symbol indicates a **WARNING**. Warnings alert you to actions that can cause personal injury or pose a physical threat. Please read these carefully.

NOTES and TIPS contain helpful information.

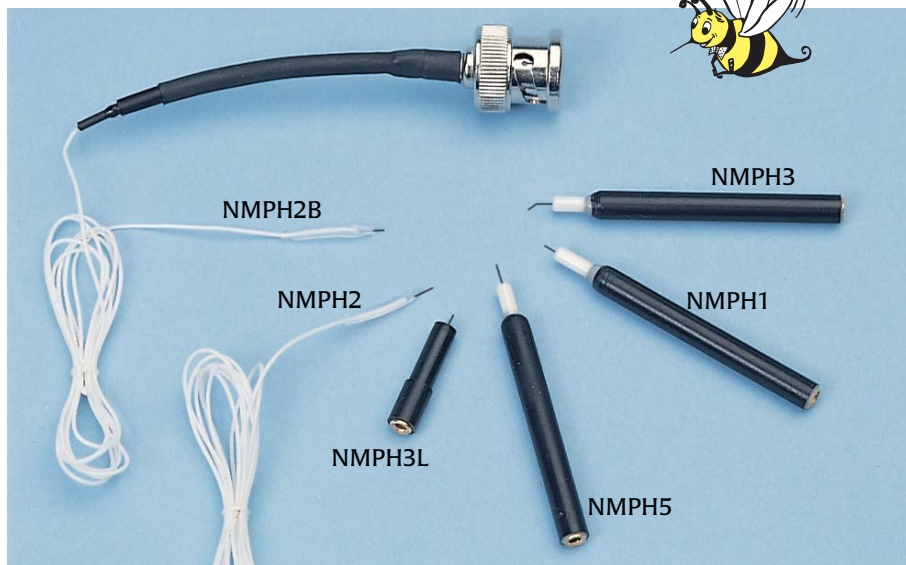



Fig. 1—A variety of Beetrode electrodes are available.


INTRODUCTION

Beetrode pH electrodes are miniature, dry-coated pH wire electrodes with 100 μ m sensing tips that make them ideal for monitoring fast pH changes in very small places. A Beetrode, due to its dry state chemistry, exhibits a larger E_0 than conventional glass electrodes. To obtain pH-scale readings on standard pH meters, a BEE-CAL™ offset device and a reference electrode (both sold separately) are used. For a choice of reference electrodes, see "Accessories" on page 8. The BEE-CAL is a small battery-operated compensator which allows you to adjust the electrode offset potential so that the Beetrode produces standard pH-scale readings.


NOTE: The DRIREF reference electrodes are designed for measurements of five minutes or less. Longer term measurements may require intermediate calibrations.


Notes and Warnings

 **CAUTION:** When not in use, rinse with distilled water and allow the Beetrode to air dry. Wiping the electrode could damage the pH sensitive coating.


 **CAUTION:** Oil on the electrode surface could affect the performance of the sensor. Do not let the electrode tip come into contact with oil. Do not touch the electrode tip, because oil from skin can also affect the Beetrode.

 **CAUTION:** Do not autoclave the Beetrode pH electrodes.

 **CAUTION:** The tip of the Beetrode pH sensor must be soaked in distilled water for **several hours** prior to use.

 **CAUTION:** Avoid wetting or immersing the electrical connector.

 **CAUTION:** Never connect the Beetrode directly to the reference electrode.

 **CAUTION:** Protect the tip of the Beetrode. It is delicate, and its pH coating can be damaged if it is allowed incidental contact with hard surfaces. If the coating chips, the electrode will not function properly.

NOTE: The Beetrode is not designed for use in blood.

Parts List

After unpacking, verify that there is no visible damage to the sensor. Verify that all items are included:

(1) Beetrode pH electrode

(1) Instruction Manual

Unpacking

Upon receipt of this electrode, make a thorough inspection of the contents and check for possible damage. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed damage should be reported at once to the carrier and an inspection requested. Please read the section entitled "Claims and Returns" on page 11 of this manual. Please contact WPI Customer Service if any parts are missing at 941.371.1003 or customerservice@wpiinc.com.

Returns: Do not return any goods to WPI without obtaining prior approval (RMA # required) and instructions from WPI's Returns Department. Goods returned (unauthorized) by collect freight may be refused. If a return shipment is necessary, use the original container, if possible. If the original container is not available, use a

suitable substitute that is rigid and of adequate size. Wrap the instrument in paper or plastic surrounded with at least 100mm (four inches) of shock absorbing material. For further details, please read the section entitled "Claims and Returns" on page 11 of this manual.

INSTRUMENT DESCRIPTION

Electrodes

The following electrodes and accessories are available.

Electrode	Description
NMPH1¹	Beetrode—2mm tip length, 2mm receptacle
NMPH2	Beetrode with cable—2mm tip length (1 m cable terminates in bare wire)
NMPH2B²	Beetrode with BNC cable, 2mm tip length, 1 m cable
NMPH3¹	Dental Beetrode, 45° Bend, 2mm receptacle
NMPH3L¹	Dental Beetrode with 2.5mm loop, 2mm receptacle
NMPH5¹	Beetrode, 5mm tip length, 2mm receptacle
BEECAL	Beetrode Offset Device with male 2mm pin
ZBEECAL	Beetrode Offset Device with BNC input
3508	BNC-to-US Standard Adapter
1358	BNC-to-2mm Pin Adapter

¹ Requires BEE-CAL or 1358 BNC-to-2mm Pin Cable (4-ft) for connection to a pH meter.

² Requires Z BEE-CAL.

BEE-CAL and ZBEECAL

The Bee-Cal Offset Device provides offset potentials ranging from 0 to -850mV. The 2mm male pin coming from the Bee-Cal plugs directly into Beetrode electrodes. For Z-Bee-Cal, the female BNC input connector can be connected directly with the male BNC connector of the NMPH2B pH electrodes. If other Beetrode electrodes are used with the Z-Bee-Cal, an optional adapter cable (WPI #**1358**) converts the input from BNC to 2mm pin.

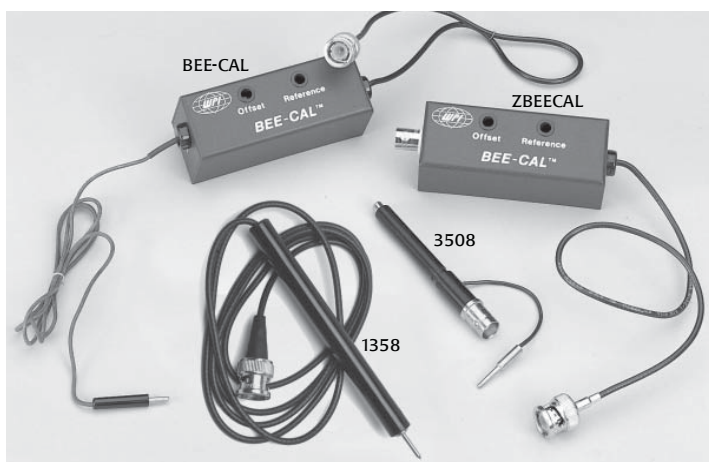


Fig. 2—Beetrode accessories

Setup

Connect Beetrode, Bee-Cal, and your pH meter as shown in Fig. 3 below.

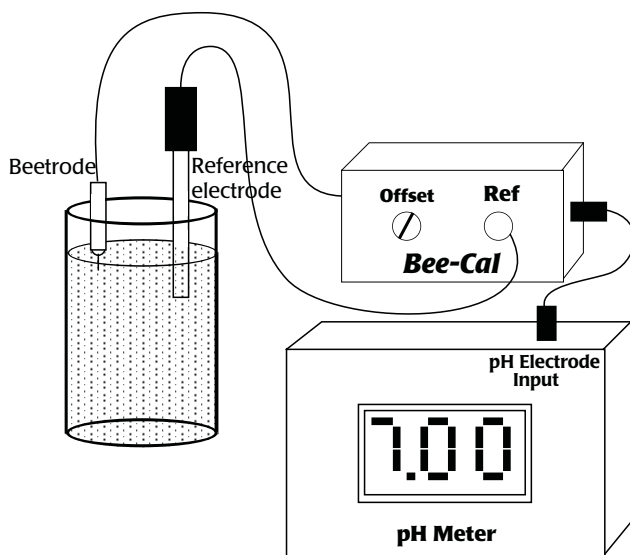


Fig. 3—Typical Beetrode setup

1. Connect the 2mm jack (female) on the Bee-Cal with a reference electrode (like WPI's Drifref series). The reference electrode should be a Calomel or a liquid junction Ag/AgCl electrode.

2. Connect the coaxial BNC output with a pH meter that has a BNC input.

NOTE: A BNC-to-US Standard adaptor (WPI #3058) may be used for pH meters with a US Standard input receptacle.

OPERATING INSTRUCTIONS

Adjusting the Offset of the Bee-Cal/Z-Bee-Cal



CAUTION: The tip of the Beetrode pH sensor must be soaked in distilled water for **several hours** prior to use.



CAUTION: Avoid wetting or immersing the electrical connector.

1. Setup your experiment as describe in "Setup" on page 4.
2. Immerse the tips of the Beetrode and the reference electrode in a pH 7 buffer solution.
3. Set pH meter to measure pH, and adjust the meter's calibration knob to the mid-position.
4. Using a small flat-head screwdriver or potentiometer adjustment tool (WPI #13661), adjust the Offset control screw on Bee-Cal until the pH meter displays a 7.0pH reading.

NOTE: The Offset calibrator is a 10-turn potentiometer.



Fig. 4—Use a potentiometer adjustment tool to turn the Offset control screw until the pH meter displays 7.0pH.

The pH meter is now ready to be calibrated with the Beetrode electrode. This calibration is performed by adjusting the slope on your pH meter.

NOTE: The Beetrode may not work properly with some auto-calibration meters. Please refer to your pH meter manual.

Calibrating the Beetrode

1. Setup your experiment as describe in “Setup” on page 4.
2. Set the pH meter to the millivolt mode.
3. Immerse the tips of the Beetrode and the reference electrode in a solution with a pH of 7.0, wait a few minutes to obtain a stable reading, and then record the pH meter measurement.
4. Repeat step 3 with a solution of pH 4.0.

NOTE: If the difference between the two readings is less than 150mV, your Beetrode does not have enough dynamic range (resolution), and it needs to be replaced.

5. Adjust the slope on the pH meter to 4.0
6. Repeat step 3 with a solution of pH 10.0.
7. Plot your results with the mV reading on the y-axis and the pH readings on the x-axis. A linear Nernstian plot (**Fig. 5**) should be obtained. The correlation should equal about 59.2mV/pH unit.

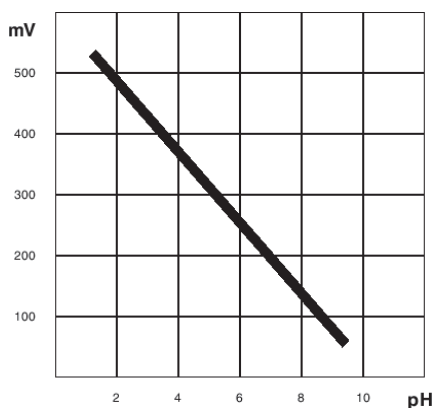


Fig. 5—A sample Beetrode calibration plot is shown. Once the values are plotted, the slope of the line can be adjusted on the pH meter to achieve the desired scale.

Once calibrated this electrode is ready for use. Electrode calibration should be checked routinely, because baseline drift may occur as the electrode ages.



CAUTION: Never connect the Beetrode directly to the reference electrode.

MAINTENANCE

BEE-Cal Battery Replacement

The internal electronic circuit is continuously operational. The battery operates for about one year. To replace the battery, you will need a small flat head screwdriver and a 1/4" nut driver.

1. Remove the two screws on the bottom of BEE-CAL case and remove the cover.
2. Using the nut driver, remove the two hex standoffs.



Fig. 6—Use a nut driver to remove the hex standoffs.

3. Turn the printed circuit board to one side and remove the 1.5-volt AAA alkaline battery.



Fig. 7—The battery is located under the circuit board.

4. Replace the battery with a new one. Install it according to the polarity markings on the battery bracket.
5. Reinstall the circuit board and the cover. Secure it with the two screws.

Cleaning



CAUTION: Do not autoclave the Beetrode pH electrodes.

To remove any protein buildup, soak the Beetrode in Enzol (WPI #7363-4) for 20 minutes.

Sterilizing

To sterilize the Beetrode, soak it in 70/30 alcohol for 20 minutes or use Cidex (WPI # 7364) according to the manufacturer’s recommendations. Rinse with distilled water before use.

Storage

Beetrodes

Disconnect the Beetrode from the BEECAL, rinse it in distilled water and allow it to dry. Then, store it in the original packaging to protect the delicate tip.

NOTE: Use care when removing the Beetrode from the packaging tube.

DriRefs

DriRef electrodes must be stored in 3M KCl. Exposure to air should be minimized.



CAUTION: DRIREF ELECTRODES CAN DRY OUT AND BECOME UNUSABLE IF THEY ARE EXPOSED TO AIR FOR MORE THAN A FEW MINUTES AT A TIME.

ACCESSORIES

Table 1: Accessories

Part Number	Description
7363	Enzol
7364-4	CIDEX sterilizing solution, 1 gallon
BEECAL	Beetrode Offset Device with male 2mm pin
ZBEECAL	Beetrode Offset Device with BNC (for use with NMPH2B)
DRIREF-2	Reference electrode, 2mm diameter
DRIREF-2SH	Reference electrode, 2mm diameter, short
DRIREF-5	Reference electrode, 4.7mm diameter
DRIREF-5SH	Reference electrode, 4.7mm diameter, short
DRIREF-450	Reference electrode, 450µm diameter

TROUBLESHOOTING

Issue	Possible Cause	Solution
Instability	Beetrode electrode is broken or the coating is chipped	Examine the tip under a microscope with 10X or 50X objective. If you see damage to the tip, the Beetrode must be replaced.
	The DriRef reference electrode has dried out	Soak the DriRef electrode in 3M KCl overnight. If that doesn't correct the issue, replace it.
PH reading too low when BEECAL is in pH 7 buffer	Offset of the BEECAL is set too low	Readjust the offset. See "Adjusting the Offset of the Bee-Cal/Z-Bee-Cal" on page 5.
	Electrode pair are not working	Verify that the raw voltage in a pH 7 buffer and compare it with the factory calibration sheet that came with your BEECAL.
	BEECAL battery is old	Replace the battery. See "BEE-Cal Battery Replacement" on page 7
Excessive drift (>2.5mV in 5 minutes.)	Electrodes may be dry	Presoak the electrodes for 1 hour.
	Metallic coating of the Beetrode may be damaged	Examine the tip under a microscope with 10X or 50X objective. If you see damage to the tip, the Beetrode must be replaced.

NOTE: If you have a problem/issue with that falls outside the definitions of this troubleshooting section, contact the WPI Technical Support team at 941.371.1003 or technicalsupport@wpiinc.com.

SPECIFICATIONS

The **Beetrodes** conforms to the following specifications:

Tip Diameter	100µm (0.1 mm)
Tip Length	~2mm, except NMPH3L ~2.5mm and NMPH5 ~5mm
Response Time	1 sec (90%) typical
pH Range	0-14
Slope	Nernstian
Resistance	100kΩ(max)
Selectivity	No significant interference by K ⁺ , Na ⁺ , Ca ⁺⁺ in 0.1–1M solutions

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WARRANTY

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of 30 days* from the date of receipt. (BEE-CAL and Z-BEE-CAL are warranted for one year from the date of purchase.) WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within ten (10) days after receipt of shipment. Claims for lost shipments must be made within thirty (30) days of receipt of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim is settled. In some instances, photographic documentation may be required. Some items are time-sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container.

Do not return any goods to us without obtaining prior approval and instructions from our Returns Department. Goods returned (unauthorized) by collect freight may be refused. Goods accepted for restocking will be exchanged or credited to your WPI account. Goods returned which were ordered by customers in error are subject to a 25% restocking charge. Equipment which was built as a special order cannot be returned.

Repairs

Contact our Customer Service Department for assistance in the repair of apparatus. Do not return goods until instructions have been received. Returned items must be securely packed to prevent further damage in transit. The Customer is responsible for paying shipping expenses, including adequate insurance on all items returned for repairs. Identification of the item(s) by model number, name, as well as complete description of the difficulties experienced should be written on the repair purchase order and on a tag attached to the item.

** Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.*



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