



# MicroC

*Carbon Fiber Potentiostat*



## **World Precision Instruments, Inc.**

### **USA**

International Trade Center, 175 Sarasota Center Blvd., Sarasota FL 34240-9258  
Tel: 941-371-1003 • Fax: 941-377-5428 • E-mail: sales@wpiinc.com

### **UK**

Astonbury Farm Business Centre • Aston, Stevenage, Hertfordshire SG2 7EG  
Tel: 01438-880025 • Fax: 01438-880026 • E-mail: wpiuk@wpi-europe.com

### **Germany**

Liegnitzer Str. 15, D-10999 Berlin  
Tel: 030-6188845 • Fax: 030-6188670 • E-mail: wpide@wpi-europe.com

### **Internet**

[www.wpiinc.com](http://www.wpiinc.com) • [www.wpi-medical.com](http://www.wpi-medical.com)  
[www.nitricoxide.net](http://www.nitricoxide.net) • [www.pipetter.com](http://www.pipetter.com)

www.wpiinc.com

## **INSTRUCTION MANUAL**

Serial No. \_\_\_\_\_

010405

**World Precision Instruments**

**WORLD PRECISION INSTRUMENTS, INC.**

175 Sarasota Center Boulevard

Sarasota, FL 34240-9258 USA

Telephone: (941) 371-1003 Fax: (941) 377-5428

e-mail wpi@wpiinc.com

**DECLARATION OF CONFORMITY**

We: World Precision Instruments, Inc.  
175 Sarasota Center Boulevard  
Sarasota FL 34240-9258  
USA

as the manufacturers of the apparatus listed, declare under sole responsibility that the product(s):

<b>Title: MICRO C</b>
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to which this declaration relates is/are in conformity with the following standards or other normative documents:

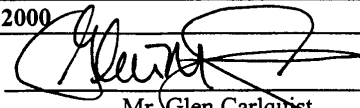
**Safety:** EN 61010-1:1993 (IEC 1010-1:1990)

**EMC:** EN 50081-1:1992  
EN 50082-1:1992

and therefore conform(s) with the protection requirements of Council Directive 89/336/EEC relating to electromagnetic compatibility and Council Directive 73/23/EEC relating to safety requirements.

<b>Issued on: 18<sup>th</sup> February 2000</b>
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Dr. Mark P. Broderick  
President and COO  
World Precision Instruments, Inc.  
175 Sarasota Center Boulevard  
Sarasota, FL 34240-9258 USA

  
Mr. Glen Carlquist  
Production Manager  
World Precision Instruments, Inc.  
175 Sarasota Center Boulevard  
Sarasota, FL 34240-9258 USA

## 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 one year\* from the date of receipt. 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 10 days after receipt of shipment. Claims for lost shipments must be made within 30 days of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim settles. 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.

- WPI cannot be held responsible for items damaged in shipment en route to us. Please enclose merchandise in its original shipping container to avoid damage from handling. We recommend that you insure merchandise when shipping. The customer is responsible for paying shipping expenses including adequate insurance on all items returned.

- Do not return any goods to WPI without obtaining prior approval and instructions (RMA#) from our returns department. Goods returned unauthorized or by collect freight may be refused. The RMA# must be clearly displayed on the outside of the box, or the package will not be accepted. Please contact the RMA department for a request form.

- Goods returned for repair must be reasonably clean and free of hazardous materials.

- A handling fee is charged for goods returned for exchange or credit. This fee may add up to 25% of the sale price depending on the condition of the item. Goods ordered in error are also subject to the handling fee.

- Equipment which was built as a special order cannot be returned.

- Always refer to the RMA# when contacting WPI to obtain a status of your returned item.

- For any other issues regarding a claim or return, please contact the RMA department.

**Warning: This equipment is not designed or intended for use on humans.**

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

## Contents

<b>Introduction .....</b>	<b>1</b>
<b>MicroC Specifications.....</b>	<b>1</b>
<b>Front Panel.....</b>	<b>2</b>
<b>General Operations.....</b>	<b>4</b>
Setting-up and Grounding/Shielding .....	4
Activating Carbon Fiber Electrodes.....	5
Electrochemical Treatment of Carbon Electrodes .....	5
Offsetting Background Current.....	5
Measuring Redox Current .....	6
Calibrating Carbon Electrodes .....	6
Adjusting Applied Potential .....	7
<b>Troubleshooting .....</b>	<b>8</b>
<b>Warranty .....</b>	<b>10</b>

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**(5)** The baseline is drifting and/or noisy.

**(a)** The carbon electrode might have been activated in too strong base solution and/or for too long.

**(b)** Check the grounding and shielding of the setup, make they are all attached to the ground of MicroC. See Figure 4.

**(6)** The Lo-Bat indicator is on in LCD meter.

**(a)** Batteries need to be replaced.

## Troubleshooting

### Problem

**(1)** The current reading is off-scale.

### Solution

**(a)** If electrode background is being read, wait a little longer.

**(b)** Make sure that **Select** is in **V** in position and **Display** is in **I**.

**(c)** Meter may not be zeroed. Remove the electrode, zero the meter and reattach the electrode.

**(d)** Make sure electrode background current has been properly zeroed by briefly submerging the electrode in the control solution.

**(e)** Switch to higher current range.

**(2)** The background current reading is negative.

**(a)** If the carbon electrode had just been activated, it is normal to observe a negative reading first, which will change to positive later. If it does not, see (b).

**(b)** Briefly remove the electrode and reattach.

**(3)** The background current cannot be zeroed (i.e., too large) or does not stabilize.

**(a)** The fiber electrode might be damaged at the tip seal — replace it.

**(b)** Wait a little longer for activation of carbon **disk** electrodes.

**(4)** The meter reading is unresponsive to attachment or removal of electrode.

**(a)** Check the ground electrode and make sure it is in your preparation.

**(b)** Probe may be damaged. To check this, attach a 1 M resistor between the probe center jack and the outer shell; if the meter reading does not change in 2  $\mu$ A range, the probe needs to be repaired.

## Introduction

WPI's MicroC™ carbon fiber potentiostat is designed for electrochemical analysis of the oxidizable biological compounds such as epinephrine, norepinephrine, serotonin, melatonin, Fe(II) and dopamine. It is a low-noise, ultra-sensitive instrument, which can be used to detect oxidation current as small as 1 picoampere and as large as 2 microamperes while holding the working electrode at a constant DC voltage. MicroC features built-in carbon fiber electrode activation, a low-pass filter and the option of supplying DC electrode voltage externally.

An output connector is provided to allow direct connection to a chart recorder, oscilloscope or computer-based data acquisition system. An economical and easy-to-use data acquisition system, WPI's **Lab-Trax-4**, designed for computer-based data recording in electrochemical studies, is highly recommended for recording the output signal from MicroC.

## MicroC Specifications

METHOD	2-electrode DC potentiostat
ELECTRODE APPLIED POTENTIAL	0.65 V (adjustable from -2.5 to 2.5 V
FIBER ELECTRODE ACTIVATION	at 1.2 V DC
CURRENT RANGES	2000 pA, 20 nA, 200 nA, 2 $\mu$ A
CURRENT/VOLTAGE CONVERSION FACTOR	from 1 pA/mV to 1 nA/mV
RISE TIME	1 millisecond
NOISE	< 1 pA (peak-peak)
DISPLAY	+/- 2 V, 3 <sup>1</sup> / <sub>2</sub> -digit LCD display
MAXIMUM RECORDER OUTPUT	4.5 V
LOW-PASS FILTER	1.67 Hz or 167 Hz
ELECTRODE PROBE/CABLE	Triax shielded, 5 feet
POWER	6 x 1.5 V batteries (included)
DIMENSIONS	8 x 4 x 1.75 in. (20 x 10 x 4 cm)
SHIPPING WEIGHT	4 lb (1.8 kg)

## Front Panel

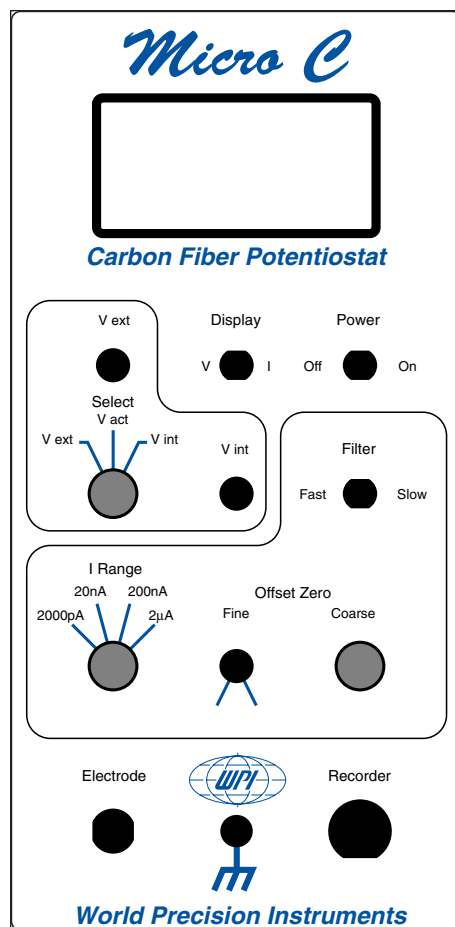


Figure 1 — MicroC Front panel

**Ground:** The black jack between the electrode and recorder connector is the circuit and chassis ground. It should normally be connected to the preparation reference electrode (Ag/AgCl half cell) as shown in Figure 2 (page 4). WPI's reference electrodes (DRI-REF™ series) are excellent for this application. In some cases, however, a smaller Ag/AgCl half cell (EP series) might fit better in very small preparation chambers.

**Probe:** The MicroC probe is made using a triaxial guard cable plus a stainless steel shield at the electrode end. This simple design is highly effective in reducing noise. WPI's carbon fiber electrodes are connected to the probe through a 0.8 mm jack in the probe. **Care should be taken not to accidentally wet this end of the probe with salt solution or any other fluids.**

The front panel of MicroC is divided into four functional blocks: input/output ports, voltage controls, current selections, voltage/current display.

**Electrode:** When connecting the probe to the electrode port on the front panel, it is important to align the red dot on the meter connector with the red dot on the probe connector.

**Recorder:** This BNC connector is provided for displaying redox current on a chart recorder, computer or oscilloscope. The conversion ratio at the recorder port is 1 pA/mV (2000 pA range); 10 pA/mV (20 nA range); 100 pA/mV (200 nA range); 1 nA/mV (2  $\mu$ A range). For example, a 5 mV output recorded using the most sensitive range (2000 pA) corresponds to 5 pA

current. However, it represents 5 nA of current in the 2  $\mu$ A range.

The calibration setup is shown in Figure 4. If a plastic magnetic stirrer is used, it should be shielded by wrapping a cover of aluminum foil around it. The foil should also be electrically connected to the ground of the MicroC meter in order to reduce the the interference of motor noise. In addition, the slow filter should be selected during the calibration procedure. It is important to note that an electrode should be reactivated for the calibration procedure if it was activated before the experiment.

It is suggested to use, in calibration, the compound of interest at concentrations evoking similar range of current responses as in your experiments. In other words, if there is some information regarding the range of concentration of the compound under investigation, then use sample solutions with the same range of concentrations to calibrate the electrode.

## Adjusting Applied Potential

Turn **Display** to **V** and **Select** to **V int**. Use a small screw driver to turn the screw on the adjustable potentiometer in the hole labelled **V int** so that the voltage reading on the LCD meter corresponds to the voltage desired.

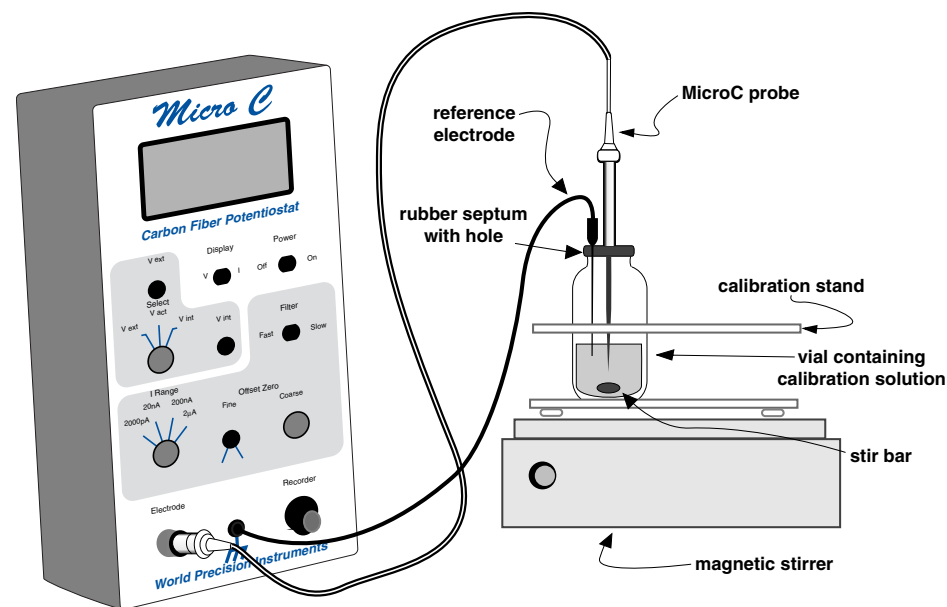


Figure 4 – Calibration setup

## Measuring Redox Current

Following activation and offset-zeroing, turn **Select** to **V int**, **I Range** to **2000 pA**, **Display** to **I** (if they are not already at these positions).

Choose **Slow Filter**, which results in low-noise recording. If, however, your interest is to study the kinetics of oxidizable compound release, then **Fast Filter** should be selected. At this speed, the potentiostat can respond with a rise time of 1 millisecond. Use a BNC cable to connect the output to your recording device (a chart recorder or computer-based data acquisition system).

The system is now ready for the measurement of oxidizable compounds such as catecholamines at the electrode poise voltage of 0.65 V (relative to Ag/AgCl). Screwdriver access is provided for the adjustment of the poise voltage (see below).

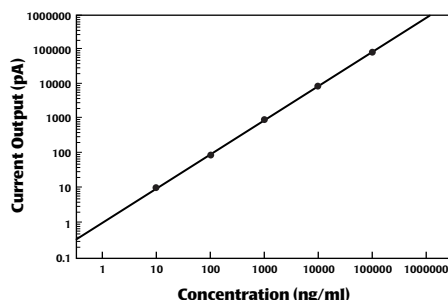
Note that if you use an external data acquisition system the output voltage observed can be easily transformed into the corresponding redox current at the electrode using the following conversion ratios:

I Range	Conversion Ratio
2000 pA	1 pA/mV
20 nA	10 pA/mV
200 nA	100 pA/mV
2 $\mu$ A	1 nA/mV

## Calibrating Carbon Electrodes

In order to achieve accurate measurement of the concentration of biological chemicals under oxidation it is imperative to calibrate carbon electrodes before or after experiments. Standard solutions containing the known concentration(s) of the compound of interest are needed for the calibration. The current responses of the standard solutions are then fitted as a straight line, **whose slope is the calibration ratio in terms of the amount of current response per unit concentration of compound of interest.** Figure 3 shows is an example of electrode calibration.

**Dopamine Concentration/Response Curve**



**Figure 3 – Excellent linearity in the response of carbon fiber electrode (CF30-500) to dopamine recorded on Micro-C. Courtesy: Drs D. Teomans and X.T Wang, University of Illinois at Chicago**

**Select: V int, V ext, V act:** This selection sets up the source of poise voltage at the carbon electrode as either **Internal (V int)**, 0.65 V-adjustable from -2.5 to 2.5 V) or **Activation (V act)**, 1.2 V-fixed, refer to “Activating Carbon Fiber Electrodes”, page 5, for more information) or **External (V ext)**, variable).

**V Int:** Access is provided for the adjustment of the electrode poise voltage in the range from -2.5 to 2.5 V using a small screw driver. In the electrochemical study of catecholamines, a poise voltage of 0.65 or 0.5 V (relative to Ag/AgCl reference) is usually used. A poise voltage of 0.65 V is preset at the factory. **CAUTION: Exceeding  $\pm 2.0$  V can damage some specialized electrodes.**

**V Ext:** A 3.5 mm stereophone jack is provided for externally supplying other than positive DC voltage. WPI's adapter cables or CBL102 can be used to connect an external voltage source.

**I Range:** Provided to record redox current in four different ranges: 2000 pA (2 nA), 20 nA, 200 nA and 2  $\mu$ A.

**Offset Zero:** The background current of carbon microelectrodes can be zeroed by using the **Coarse** and **Fine** adjustment knobs.

**Filter:** Two low-pass filter filters, **Fast** or **Slow**, which correspond to two ranges of rise time response, 1 ms (fast) or 100 ms (slow). Normally, the slow filter should be used for low noise recording. If the primary interest of your investigation is the kinetics of oxidizable compound-induced current response, the fast filter should be used.

**Display I or V:** Choose display of either current response (**I**) or poise (activation) voltage (**V**).

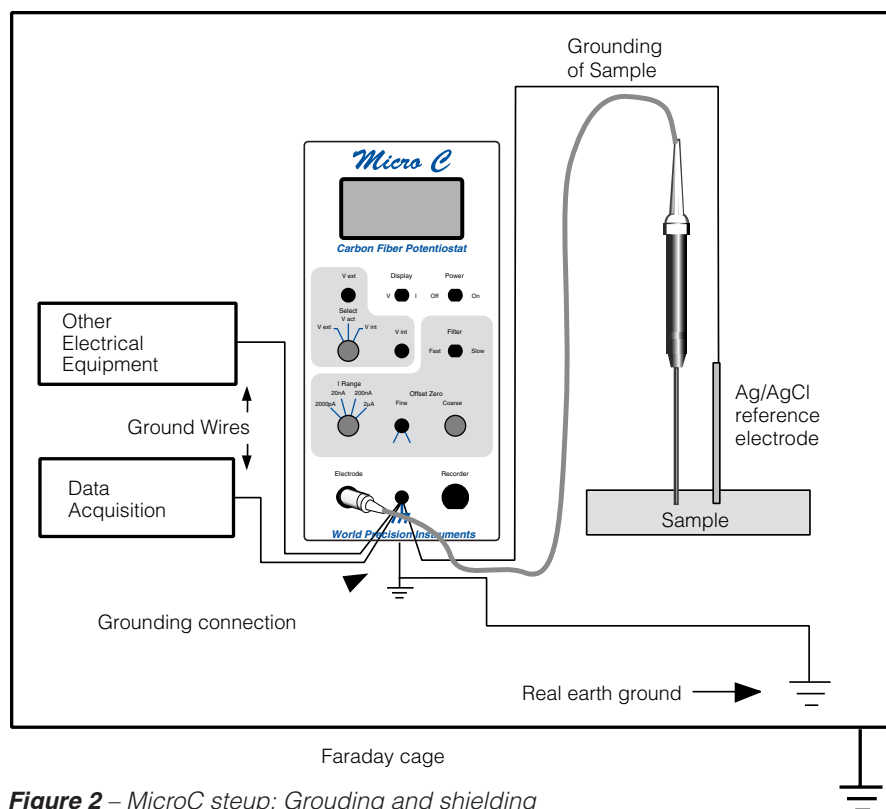


Figure 2 – MicroC setup: Grounding and shielding

## General Operations

### Setting-up and Grounding/Shielding

The general setup of the MicroC carbon fiber potentiostat is illustrated in Figure 2.

MicroC measures concentrations of oxidizable compounds amperometrically. In order to measure redox current in picoamperes (pA), proper grounding and shielding of the MicroC based recording system is often critical to the success of the measurements. It is recommended that at least the experimental preparation, probe and grounding electrode of the preparation chamber be enclosed in a Faraday cage (a metal shielded cage), which should be connected to the ground of the MicroC meter.

With proper grounding and shielding, the equivalent noise at the output recorder of MicroC, using WPI's carbon fiber electrodes, can be reduced to 1 pA (peak-peak) (**Fast Filter** selected).

### Activating Carbon Fiber Electrodes

Carbon fiber electrode activation has been found to be necessary in electrochemical studies of oxidizable compounds. For more information, refer to the instruction manual accompanying WPI's carbon microelectrodes.

To activate a fiber electrode, turn the **Power On**, turn **Select** knob to **V act**, and turn the **Display** toggle switch to **V**. A voltage close to 1200 mV should be displayed. Connect the carbon fiber electrode to the probe and submerge it in a pH 9-9.5 salt solution for 5-10 minutes. (Reference Ag/AgCl halfcell should also be placed in the solution.) **Do not activate the electrodes for more than 5-10 minutes. The seal cannot withstand the base solution for extensive periods of time.** If an obvious increase in the noise level is observed following activation, a weaker base solution and shorter period of activation time are suggested.

### Electrochemical Treatment of Carbon Electrodes

Electrochemical pretreatment has been used to activate carbon electrodes to improve their response. The sensitivity, selectivity, as well as stability (repeatability) of carbon electrodes can be significantly improved through electrochemical activation. Numerous techniques have been proposed for such activation/pretreatment, although the precise working mechanism(s) of these treatments are mostly unknown.

To treat the carbon fiber electrodes on WPI's potentiostat, MicroC, turn the Select knob to V-ext and I-Range to 2 uA, then apply the required waveform (from an external source) or DC potential (from either an external source or the MicroC, Select should be to V-int in the latter case) to the V-Ext phone jack (3.5 mm).

For more information on procedures of treatments to achieve selective detection of catecholamines, indolamines or ascorbic acid, please refer to WPI's *Application Notes: Carbon Fiber Microelectrodes* or the instruction manual accompanying WPI's carbon microelectrodes.

### Offsetting Background Current

After activation of carbon electrodes following one of the two procedures above, turn **Select** to **V int**, **I Range** to **2000 pA**, and **Display** to **I**. Attach the electrode and position it in an experimental preparation. It is normal to observe a large current reading initially, which drops quickly at first and slows down gradually. Wait for about five minutes for the stabilization of background current. If the carbon electrode was activated, wait a little longer. Use **Fine** knob to zero the background current, which should not exceed 500 pA for all WPI carbon electrodes.