900A

Micropressure System

INSTRUCTION MANUAL

Serial No._____

030813

World Precision Instruments

CONTENTS

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—The 900A is a micropressure system.

INTRODUCTION

WPI's model **900A** micropressure system is designed to measure pressures from −200 to +400mmHg in small blood vessels, cells and other electrolyte-filled micro-cavities. The micropressure system includes a main electronic Control Unit, probe and an independent pressure pod or Pressure Pod, an amplifier, piezoelectric valve and a pressure transducer. The Pressure Pod is small and lightweight, so it can be mounted near the microelectrode to reduce dead space. Fluid-filled glass micropipettes (supplied by the user) pulled to an outside diameter of 2−5µm are paired with the **900A** sensing probe. A pressure source supplying up to +500mmHg of pressure and a vacuum source supplying up to −300mmHg vacuum is required, but not supplied.

Notes and Warnings

NOTE: Use fresh micropipettes each time it is to be used.

NOTE: Be sure the air pressure source provides clean, dry air.

NOTE: Use micropipettes with tips pulled to 2 to 5µm in diameter.

NOTE: Use a short tube (12˝ or less) to connect the microelectrode holder to the Pressure Pod tubing port.

CAUTION: Always pay attention to the tube between the holder and the tubing port. If you find that solution drops have been sucked into the tube, set to the **Zero Set** mode. Disconnect the tube, and use the air pressure supply to blow the solution drops out. Leaving solution in the pressure tube may damage the Pressure Pod.

CAUTION: It is important that the pressure and vacuum sources supply clean, filtered, dry air. Air that is not clean and dry damages the piezovalve, and damage of this sort is not covered under warranty.

CAUTION: If the microelectrode is connected to the Pressure Pod before the pressure and vacuum sources are connected and turned on, fluid may be pushed through the Fluid Trap and into the Pressure Pod causing damage to the piezo valve. *This damage is not covered under warranty.*

CAUTION: **Before moving the micropipette from one recording site to another, set the Loop Status switch to Zero Set.** This ensures that no pressure is applied to the micropipette while it is being moved. If this is not done, the pressure pod tries to compensate the increased tip resistance (caused by the open circuit) by applying pressure to the micropipette. This may expel the filling solution from the micropipette.

Parts List

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

Each 900A system includes the following components:
(1) **900A** Control Unit
(1) Power Cord
(1) **900A** Probe
(1) **900A** Pressure Pod
(8) Electrode Holders
(1) Fluid Trap
(2) Luer Fittings
(1) 1 ft. 3/32″ plastic tubing
(1) 4 ft. 1/8″ Tygon tubing
(1) Instruction Manual

Unpacking

Upon receipt of this instrument, 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 19 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 19 of this manual.

INSTRUMENT DESCRIPTION

System Overview

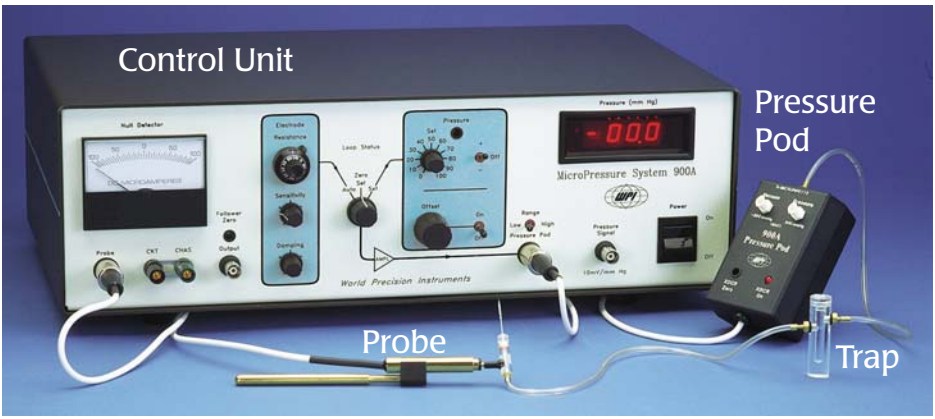


Fig. 2—The 900A system includes the control unit, pressure pod, probe and trap.

The **900A** uses a salt concentration gradient at the tip of the sensing electrode to measure pressure. The internal pressure of the microelectrode is continuously adjusted to equal the pressure outside the tip, to keep the salt concentration gradient in dynamic equilibrium. The amount of pressure required to maintain equilibrium is digitally displayed on the front panel. The voltage proportional to this reading can be sent to a recording device via the **Pressure Signal** output connector.

To equilibrate the salt gradient, the piezoelectric pressure pod actively regulates air flow in and out of a small pressure chamber. A vacuum source connected to the chamber outlet removes air to reduce pressure. A piezoelectric valve at the inlet admits pressurized air to increase the pressure. This in turn regulates the pressure inside the micropipette electrode so that it equals the pressures outside the tip.

The response rate of the piezoelectric valve (from fully closed to fully open) is 0.5ms. The response rate of the overall system, when properly configured, is typically less than 10ms. This figure is affected, however, by the pressure chamber's residual volume, which includes the micropipette, fluid trap, connecting tubing and the pressure transducer piezoelectric valve outlet. Long lengths of tubing add dead space, which slows overall system response. Keeping the residual volume low by mounting the Pressure Pod close to the microelectrode and using short lengths of small-bore tubing minimizes dead space and contributes to a rapid system response.

Microelectrode Resistance

When the value set by **Electrode Resistance** dial is greater than the intrinsic value, the concentration gradient interface is shifted inside the pipette tip. (For example, the value obtained by adjusting electrode resistance. See "Adjusting Electrode

Resistance" on page 13.) This can affect the rate of response to an externally applied, stepped pressure, but this is not significant for most applications. When the interface is shifted inside the electrode, the tip opening contains a solution that is more ionically compatible with the fluid outside the tip. This gives a longer diffusion path from the pool of high concentration electrolyte to the outside, which may be advantageous.

The shape of the microelectrode tip significantly affects the **900A**'s response. Shorter tipped microelectrodes that do not have an excessively long taper work best.

All electrode resistance and potential measurements are referenced to ground. Ground should be established through an appropriate salt solution and reference half cell such as WPI's **DriRef-2** or **DriRef-5**.

Using Sensitivity and Damping to Correct Oscillations

All feedback control systems tend to become unstable and oscillate under certain conditions. The **900A** provides two controls for combatting instability and oscillation—**Sensitivity** and **Damping**. Decreasing **Sensitivity** or increasing **Damping** often reduces or stops oscillations. The proper settings for both controls depends on the particular application.

Keep the **Sensitivity** knob as high as possible to provide close matching and following of the external pressure by the internal pressure in the micropipette. We recommend starting at half of a full rotation, then adjusting in a counterclockwise direction, as needed. Generally, to maintain proper response, **Sensitivity** should not be set below one-third of the full rotation.

The **Damping** knob adjusts the amplitude of feedback. Turning the damping control clockwise reduces the amplitude of the feedback. Turning the damping control counter-clockwise increases the amplitude of the feedback. One-third to one-half rotation typically produces a stable, quiet baseline.

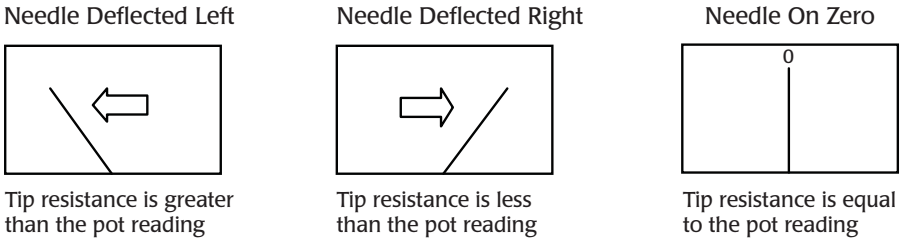


Fig. 3—The Null Detector Meter deflection points to the actual value of the tip resistance.

*When the **Null Detector** meter needle is deflected left*, it indicates that the tip resistance is greater than the resistance dial setting on the **900A** front panel. *If the needle deflected right*, the pipette tip resistance is less than the value shown on the **900A** resistance dial setting. When the null detector is at zero, the resistance of the pipette is the value that appears on the 10-turn potentiometer.

NOTE: Use an oscilloscope or recorder to monitor the pressure output signal to gain better control of oscillations. The digital pressure meter on the **900A** front panel tends to average oscillations, especially those with higher frequencies. For this reason, the digital display may give a constant reading, when in fact almost full-scale oscillations may be occurring.

Pressure and Vacuum Sources

The maximum pressure that should be applied to the pressure pod is +500mmHg. The maximum recommended vacuum is −300mmHg. In the **Auto** mode, the system can compensate for small fluctuations in the supply pressures, but large supply pressure changes may cause a pressure reading error. If possible, therefore, both pressure and vacuum sources should be stable.

If your experiment involves pressure measurements consistently lower than the rated maximum, you can use lower supply pressure and vacuum. For example, if pressure readings at the pressure measuring site are fairly consistent and slow-changing at approximately 150 to 200mmHg, a positive supply pressure of +300mmHg would suffice.

To keep the pressure gradient high and ensure a quick, accurate response, plan to provide positive/negative pressures at least 50mmHg greater that the maximum positive/negative pressure to be measured. Pressure differentials of less than 50mmHg are inadequate to move air quickly, causing response times to increase considerably.

CAUTION: It is important that the pressure and vacuum sources supply clean, filtered, dry air. Air that is not clean and dry damages the piezo valve, and damage of this sort is not covered under warranty.

Alarm

An alarm sounds when the pressure pod valve is completely open to indicate that maximum pressure has been reached. The alarm also sounds when electrical continuity is broken for any reason. For example, if the microelectrode comes out of the solution, the filling solution level drops below the Ag/AgCl pellet, the ground reference is disconnected, etc. or the tip is blocked.

Circuit Discussion

The **900A** consists of an oscillator, head stage, phase detector, buffer amplifier, pressure transducer and pressure pod.

OSCILLATOR: A Wein bridge oscillator generates a 1000Hz sinusoidal voltage. This is amplitude stabilized by internal negative feedback transistors in the bridge circuit.

HEAD STAGE (or FOLLOWER): A 1000Hz carrier constant current is injected through the microelectrode. The resulting voltage drop is compensated in the follower circuit by advancing the **Electrode Resistance** dial so that balance null is achieved.

The microelectrode resistance is then read directly in MΩ from the dial. If the microelectrode resistance changes, a 1000Hz imbalance signal is amplified and detected by a phase detector.

PHASE DETECTOR: This is a synchronously switched detector in a single integrated circuit package. The resulting detected signal is filtered and is available at the output of the amplifier.

BUFFER AMPLIFIER: The buffer amplifier lies between the detector and the pressure pod driver. It compensates the detector signal with output from the pressure transducer in order to compensate for the inherent lag in propagating the pressure changes transmitted to the micropipette tip. The lag would normally cause the system to oscillate. The **Damping** knob sets the amplitude of the buffer amplifier. Insufficient damping (For example, the **Damping** knob is turned too far counter clockwise) causes the system to oscillate at higher frequencies. Too much damping (For example, the **Damping** knob is turned too far clockwise) can result in a slow rate of response and low frequency oscillations.

PRESSURE TRANSDUCER: The pressure transducer is a silicon strain gauge resistance bridge device. Its volume and pressure displacement are small and sensitivity is high. The bridge output is amplified, scaled and displayed on the digital meter. The meter has a resolution of 0.1mmHg from +199.9 to –199.9mmHg. Pressures outside this range can be viewed by toggling the **Range** switch to **High**. The pressure output can also be monitored via the BNC connector marked **Output** on the front panel. The output level of this signal is 10mV/mmHg.

PRESSURE POD: The pressure pod consists of a driver circuit to operate the piezoelectric controller and an alarm circuit to warn when the maximum pressure of the controller has been reached.

Setup for Testing

See Fig. 2 when setting up the **900A** micropressure system. Be sure the setup is complete before you turn on the power.

1. Connect the seven-pin cable on the Pressure Pod to the connector labeled **Pressure Pod** on the front panel of the Control Unit.
2. Connect the **900A** active probe to the connector labeled **Probe** on the front panel of the Control Unit. Connect the tip of the **900A** active probe to ground using a banana to 2mm pin adapter (WPI **#13776**). Use the **CKT** and **CHAS** ground connections, which should be electrcally connected with a metal strap.
3. Connect the power cord to the receptacle on the rear panel of the Control Unit. Plug into the wall socket.
4. Connect the reference electrode from the **CAL900A** or the experiment to the circuit ground terminal marked **CKT** on the front panel of the Control Unit.
5. Place the **Loop Status** in the **Zero Set** position. This maintains a pressure of 0mmHg in the pressure chamber.

6. Set the **Damping** and **Sensitivity** controls to the 12:00 position.
7. Set the **Electrode Resistance** dial fully counterclockwise to zero.
8. Set the **Offset** switch to the **Off** position.
9. Set the **Pressure** switch to **Off** position.
6. Turn the power on and let the system warm up for 15 minutes.

Zeroing the Pressure Pod

1. Complete the setup procedure described on above. Verify that the **Loop Status** is set to **Zero Set** and the system has warmed up for 15 minutes.
4. In the **Zero Set** mode, ***applying no pressure or vacuum*** to the pressure pod, insert a screwdriver into the recess on the pressure pod marked **XDCR Zero** and turn clockwise or counterclockwise until the digital meter on the **900A** reads 0.00mmHg.

Re-zeroing after Pressure and Vacuum is Applied

1. Remain in **Zero Set** mode.
2. Regulate the source of pressure and vacuum for the **900A** pressure pod to approximately +350mmHg for the pressure, and −150mmHg for the vacuum. If you are using a pressure manometer (WPI #**PM015**) to monitor the pressure, use port **B** on the meter for measurement.

   NOTE: The pressure and vacuum sources may be regulated to pressures other than those suggested here, however, IT IS CRUCIAL THAT THE PRESSURE SIDE ALWAYS BE OF A GREATER ABSOLUTE VALUE THAN THE VACUUM SIDE, AND THAT THERE IS A MINIMUM OF 75mmHg DIFFERENCE BETWEEN THE PRESSURE AND VACUUM SOURCES.
3. Connect these regulated pressure and vacuum sources to their respective input ports on the pressure pod.
4. Block the **To Micropipette** port on the pressure pod. A finger can be used for this operation if it's held firmly against the port opening.
5. Keeping the **To Micropipette** port blocked, insert a screwdriver into the recess marked **Pressure** on the **900A** front panel, and turn clockwise or counterclockwise until the digital meter reads 0.00mmHg. If the unit has been properly re-zeroed, very little change occurs when the tubing port is opened.

Testing the Microelectrode and Micropressure System

1. Setup the system as describe on page 7. Zero the Pressure Pod as described above. Then, prepare two stock solutions: 1M KCl and 0.1M KCL.
2. Put 0.1M KCl into the **CAL900A** Pressure Calibration Chamber. The level should be enough to cover the Ag/AgCl pellet. This accessory is sold separately
3. Connect the blue ground (Ag/AgCl pellet) connection of the CAL900A test chamber to the ground connection on the 900A using a banana to 2mm pin adapter (WPI #**13776**).

4. Prepare a micropipette holder and glass capillary. Using **Microfil**, fill up the glass capillary with 1M KCl. It helps to soak the tip of the capillary in KCl before filling the rest of the capillary. Separately fill the micropipette holder with 1M KCl, and then install the capillary in the holder. NO air bubbles may exist in the pathway between the tip of the glass capillary and the Ag/AgCl pellet in the holder.
5. Install the holder/capillary assembly into the **CAL900A** cap, and secure the cap by screwing it onto the base of the **CAL900A** for a good pressure seal.

   NOTE: Be careful not to break the pipette tip when inserting it into the cap or in the **CAL900A**. Be mindful that the tip of the micropipette can strike the ground electrode or the **CAL900A** chamber wall.
6. Connect the micropipette holder to the liquid trap and the liquid trap to the **900A** Pressure pod.
7. Remove the **900A** probe from the ground location and connect it to the micropipette holder.

   The **Null Detector** needle goes to a hard left position.
8. Begin turning the **Electrode Resistance** dial clockwise. The needle of the **Null Detector** display eventually moves from the left to right. Adjust the dial until the **Null Detector** needle is in the zero position.
9. Take note of the resistance reading on the 10–turn resistance adjustment potentiometer. This is the actual resistance of the pipette tip in proper equilibrium. Each full turn is 1000KΩ of resistance. The correct electrode resistance should be between 250KΩ to 400KΩ.

   TIP: If the electrode resistance is more than 400KΩ, it is likely that there is an air bubble somewhere in the pipette between the tip and the Ag/AgCl pellet. If the resistance is less than 250KΩ, it is likely that the pipette tip inside diameter is greater than 5µm. This may happen if the tip is broken.

   NOTE: If the needle of the **Null Detector** meter is deflected to the left of zero, then the pipette tip resistance is in fact greater than the value indicated on the **Electrode Resistance** dial. Conversely, if the **Null Detector** needle is deflected to the right of zero, the pipette tip resistance is less than that indicated on the **Electrode Resistance** dial.
10. Turn the **Electrode Resistance** potentiometer clockwise gradually. The **Null Detector** meter moves to the right. Adjust the potentiometer until the reading is about 75.
11. Switch the **Loop Status** switch to **Auto.** The needle moves back to approximately the zero position, but should be slightly negative (about –1 to –3mmHg).
12. View the signal continuously on an oscilloscope or data acquisition system. The pressure signal oscillates. Use the **Damping** and **Sensitivity** controls to reduce oscillation to lowest level possible. Generally, the **Sensitivity** control should be adjusted first, and it should be adjusted counter-clockwise to decrease the sensitivity. As the sensitivity is reduced, the oscillation should become smaller.

    TIP: If the sensitivity is continuously reduced, at some point the signal becomes unstable. This results in the signal going off-scale in the positive or negative

direction. When this happens, the PLL amplifier will lose its "lock" and the carrier signal will be lost, causing the control signal to the Pressure Pod to go to its extreme limit. If this happens, quickly turn the sensitivity control back in a CLOCKWISE direction to regain control of the signal and re-establish stability. By experimenting with this process a few times, an adjustment for minimum level of oscillation can be achieved while still maintaining control of the signal. See "Using Sensitivity and Damping to Correct Oscillations" on page 5.

During this process a vacuum may be applied to the Pressure Pod, which could draw liquid into the tube going to the Pressure Pod.

NOTE: A liquid trap is provided with the **900A** and should be installed between the micropipette holder and the **900A** Pressure Pod to prevent intrusion of liquid into the pressure pod.

CAUTION: Unfortunately, the control valve within the Pressure Pod is very sensitive to salt water. If salt water gets into the valve, there is a high probability of irreparably damage. This is the most expensive component in the Pressure Pod. Make sure the liquid trap is in place, and that it is positioned upright. It's a good idea during the setup process to pay attention to the possibility for migration of liquid into the pressure pod! Damage caused by water intrusion is not covered under warranty.

13. Once the signal is stabilized, switch on the **Offset** control and adjust the dial to remove any offset voltage displayed on the digital pressure meter. The offset control affects the meter only, not the pressure signal. If you are recording the signal, as most people are, the meter offset is inconsequential.

CAUTION: When measurements are not being made, switch the **Loop Status** control to **Zero Set** mode. This is the safest way to leave the system when you must step away.

OPERATING INSTRUCTIONS

Zero Adjust

1. Disconnect the vacuum and pressure sources and the tubing to the microelectrode from the Pressure Pod, so that the Pressure Pod is open to atmosphere. Turn the Control Unit on, and let it warm up for 15 minutes.
2. The digital meter should read 0mmHg. If the reading is incorrect, insert a small screwdriver into the recess marked **XDCR Zero** on the front of the Pressure Pod, and turn clockwise or counterclockwise to bring the digital meter reading to 0mmHg.

Fig. 4—XDCR zero adjust is pointed out in this image.

3. Connect the pressure and vacuum sources to the Pressure Pod. Make sure that the pressure source supplies clean, dry air. Turn the pressure and vacuum sources on.
4. Block the micropipette output on the Pressure Pod by placing one finger over the tubing port. The digital meter should read 0mmHg. If the reading is incorrect, insert a screwdriver into the **Pressure** recess on the front panel of the **900A** and turn clockwise or counterclockwise to bring the digital reading to 0mmHg.

   NOTE: If you are unable to get a 0 reading, turn off and disconnect the pressure and vacuum supplies and repeat the previous step.
5. Now open the pipette output by removing your finger. The panel pressure meter should remain at 0mmHg.

If your work requires highly accurate readings, re-calibrate the instrument:

1. Connect the pressure and vacuum sources to the Pressure Pod.

2. Using a "T" fitting, connect the pressure source (supplying clean, dry air) to the microelectrode outlet port and to a WPI **PM Series** pressure manometer or other accurate pressure-measuring device. This pressure source must supply pressures of the same order of magnitude as the pressures to be measured in your application.
3. Turn the pressure source on. The pressure reading on the **900A** should match that given on the reference meter.
4. If the reading is not correct, insert a screwdriver into the recess on the back of the Pressure Pod, and turn clockwise or counterclockwise until the correct reading is displayed on the **900A**.

Since the system gain has now been changed it is necessary to repeat the Zero Adjust procedure, possibly several times, until all zero adjusts are correct and the pressure input is measured accurately.

Preparing the Microelectrode Holder and Pipette

Use a micropipette pulled to a tip diameter of 2–5µm. Prepare a KCl or NaCl filling solution with a concentration of 1M (molar) or higher. A high concentration is important in order to maintain a large concentration gradient between the microelectrode's internal salt solution and the solution outside the tip.

1. Immerse the pipette tip into the 1M solution and fill the tip by allowing the solution to wick up.
2. Backfill the shank of the micropipette. (**MicroFil™**, WPI's flexible syringe needle, works particularly well for this application.) Do not allow air bubbles to remain in the pipette.
3. Fill the electrode holder, making sure that no air bubbles remain in the holder, and that the filling solution covers the Ag/AgCl pellet.
4. Insert the pipette into the holder and tighten the cap.
5. Check again to be sure that no air bubbles remain in the pipette or the holder. If fluid leaks from the microelectrode tip or if it becomes necessary to purge the tip, make sure to avoid an open circuit, that the level of the filling solution is high enough to maintain contact with the Ag/AgCl pellet.
6. Insert the holder onto the probe tip. Connect a 12-inch or shorter (30cm or shorter) length of small-bore tubing to the pressure port on the electrode holder.
7. ***Do not connect this tube to the Pressure Pod yet!*** First connect the pressure and vacuum supply tubes to the Pressure Pod, and turn them on.

CAUTION: If the microelectrode is connected to the Pressure Pod before the pressure and vacuum sources are connected and turned on, fluid may be pushed through the Fluid Trap and into the Pressure Pod causing damage to the piezo valve. *This damage is not covered under warranty.*

8. Referring to Fig. 5, connect the pipette holder to the fluid trap.

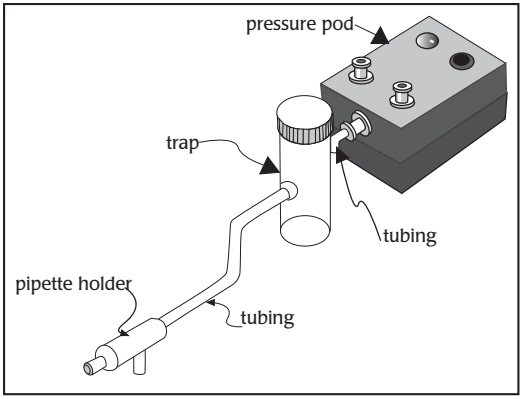


Fig. 5—The pipette assembly is attached to pressure pod.

9. Check that the pressure and vacuum sources are connected to the Pressure Pod and that both are turned on. Connect the microelectrode/holder assembly to the micropipette outlet port.

Adjusting Electrode Resistance

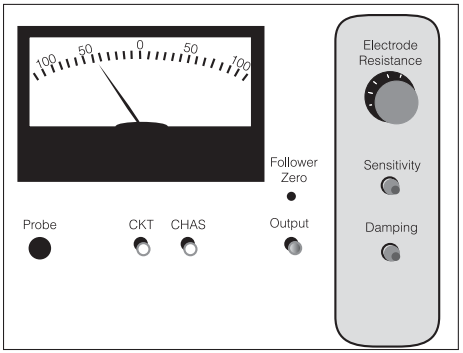


Fig. 6—Rotate the electrode resistance knob clockwise or counterclockwise until the null detector meter reads 0µA DC.

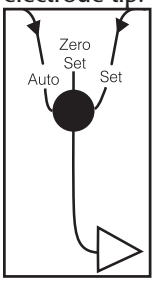
1. If everything is correct, the **900A** adjusts the pressure in the tubing to maintain 0mmHg at the microelectrode tip. Turn the **Damping** and the **Sensitivity** knobs to about 1/2 of a full rotation.
2. Immerse the pipette tip into a dilute electrolyte solution — for example, 0.1M concentration of the filling solution.
3. Place a ground reference electrode into the solution.
4. Connect the ground reference electrode to the circuit ground on the front panel, marked **CKT**. Use WPI's **Dri-Ref2** or **Dri-Ref5** or another Ag/AgCl wire reference electrode.

5. Rotate the **Electrode Resistance** knob on the **900A** front panel until the Null Detector meter reads 0µA DC. (0 is at the center of the scale.) The dial setting of the **Electrode Resistance** knob, which ranges from 0 to 10MΩ (one full turn per MΩ), now directly indicates microelectrode resistance. Electrode resistance typically ranges from 100KΩ to 1MΩ, depending on tip diameter and filling solution concentration. The ideal tip diameter, from 2 to 5µm, produces resistance of 150 to 250KΩ.

Operating the 900A

1. Set the **Loop Status** switch at **Zero Set**.
2. Advance the **Electrode Resistance** knob to the right until the **Null Detector** reads from 50 to 100µA. The resistance value will be about twice that of the actual resistance of the microelectrode as obtained above.
3. Turn the **Loop Status** switch to **Auto**. In this operating mode, the electronic feedback system automatically adjusts the microelectrode tip resistance to the higher value of resistance selected by drawing some of the external dilute solution into the tip. When the proper resistance is reached, the **Null Detector** needle returns to 0µA.

   The instrument is now ready for use. The pressure reading should be slightly negative. This is because the height of the filling solution exerts pressure on the electrode tip.



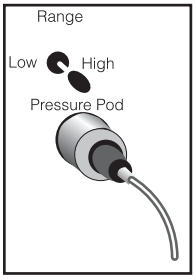


Fig. 7—(Left) Loop status switch

Fig. 8—(Right) Pressure Pod range switch

4. To compensate this slight negative pressure, turn on the **Pressure Offset** toggle switch and adjust the **Pressure Offset** knob until the meter reads 0mmHg.

   NOTE: Adjusting the **Pressure Offset** adjusts only the meter reading and does not affect the recorder output value.

   To view pressures greater than ±199.9mmHg, toggle the **Range** switch above the Pressure Pod connector to **High**.

CAUTION: The pressure transducer in the Pressure Pod has a maximum pressure rating of 500mmHg. Great care should be taken not to apply pressures greater than 500mmHg to avoid damaging the transducer.

Moving the System

CAUTION: **Before moving the micropipette from one recording site to another, set the Loop Status switch to Zero Set.** This ensures that no pressure is applied to the micropipette while it is being moved. If this is not done, the pressure pod tries to compensate the increased tip resistance (caused by the open circuit) by applying pressure to the micropipette. This may expel the filling solution from the micropipette.

Once the micropipette is placed in the desired recording site, check the electrode resistance.

1. If the **Null Detector** needle is deflected completely to the left, the tip resistance has increased. Turn the **Electrode Resistance** knob clockwise until the needle begins to move to the right. The needle does not need to reach 0, but must only move from the maximum left position in order to confirm that the open circuit has been closed.
2. Turn the **Loop Status** switch to **Auto**. The **900A** controls the pressure in the micropipette to generate the tip resistance preset on the **Electrode Resistance** dial. The **Null Detector** should return to 0.
   - If the **Null Detector** reading or the pressure reading is unsteady, adjust the **DAMPING** and/or **SENSITIVITY**. If this does not correct the instability, there may be air bubbles in the micropipette/holder system.
   - If the **Null Detector** pointer fails to move when the **Electrode Resistance** dial is adjusted, one of two situations may have occurred:
     - The external pressure applied to the micropipette was large enough to force an excessive amount of dilute solution into the tip, resulting in a resistance greater than 10MΩ. To correct this, turn the **Electrode Resistance** dial down to the original setting, as described above. Turn the **Loop Status** switch to **Auto.** The **900A** will then adjust the pressure inside the micropipette to expel the dilute electrolyte and decrease the tip resistance to its original value. Another method of purging the micropipette tip is to follow the procedure described below in "Set pressure."
     - The microelectrode is not making contact with the electrolyte solution, or the reference electrode is not connected. In either case, the problem is an open circuit. Adjusting the **Electrode Resistance** dial or changing the loop status switch to auto has no effect. Check the placement of the micropipette, the reference electrode, the liquid level in the micropipette, as well as all connections. **Take care not to leave the Loop Status switch on Auto, to avoid discharging the contents of the microelectrode.**

Setting Pressure Mode

Set Pressure mode allows you to preset the internal pressure of the micropipette. This is useful for:

- applying positive pressure to flush the tip
- applying negative pressure to draw solution into the tip.

CAUTION: **Extreme care must be taken when using negative pressures not to force fluid through the fluid trap and into the Pressure Pod.** Disconnect the microelectrode holder, and attach the pressure tubing to a manometer to check the calibration of the 900A pressure transducer against an external standard.

To enter the **Set Pressure** mode:

1. Toggle the ± switch to the center or off position, and rotate the **Set** knob to 0.
2. Switch the **Loop Status** control to **Set**.
3. Select + for positive or – for negative pressure, using the toggle switch. A selected pressure can be applied to the inside of the micropipette.
4. Turn the **Set** knob to select the magnitude of the pressure. The selected internal micropipette pressure is displayed in mmHg on the digital meter.

Set Pressure mode can be used to purge the micropipette tip when too much dilute solution has diffused into the microelectrode. Applying a few mmHg of positive pressure gently expels filling solution from the shank of the micropipette into the tip. The tip resistance can be monitored by watching the **Null Detector**.

- If the tip resistance is greater than the dial setting, the needle points left.
- If the tip resistance is less than the dial setting, the needle points right.

Measuring DC Potential

Although the primary function of the **900A** is to measure pressures, it can also be used to measure DC potential at the microelectrode site.

1. Connect a recording device to the follower **Output**.
2. To offset background current from the amplifier, insert a small screwdriver into the recess labeled **Follower Zero**.
3. Turn clockwise or counterclockwise until the recording device reads 0V. Excursion in this mode is limited. You can, of course, provide additional offset correction externally, for example, at the reference electrode or the recording device.

MAINTENANCE

Cleaning

Carefully wash the holder, beaker and syringes with distilled water before and after use.

CAUTION: Always pay attention to the tube between the holder and the tubing port. If you find that solution drops have been sucked into the tube, set to the **Zero Set** mode. Disconnect the tube, and use the air pressure supply to blow the solution drops out. Leaving solution in the pressure tube may damage the Pressure Pod.

Replacing the Fuse

You can easily replace the fuse in Control Unit. The part numbers for replacement fuses are:

#3822 for 110V line power
#6408 for 220 V line power

Service

Contact World Precision Instruments, Inc. at 941.371.1003 or TechnicalSupport@wpiinc.com for all service needs.

ACCESSORIES

Table 1: Accessories

Part Number	Description
2851	BNC-to-BNC cable
2933	Rack mounting hardware
13776	Banana to 2mm pin adapter
MEH6RF*	Electrode Holders
MEH6SF*	Electrode Holders
CAL900A	Pressure Calibration Chamber

*Electrode holders may be ordered to accommodate any of the following glass sizes: 1.0, 1.2, 1.5 and 2.0mm diameter.

SPECIFICATIONS

This unit conforms to the following specifications:

Pressure Range ..... +500 to −300mmHg
Linearity ..... < ±0.5% from a straight line
Stability ..... +/- 0.1mmHg up to 1 hour or more
Accuracy ..... ±0.5% of full scale
Risetime ..... >10ms (10-90%), depending on residual volume
Output (“Pressure Signal”) 10mV/mmHg
Amplifier Probe ..... Input Resistance >$10^{10}\Omega$, Voltage Gain 1.0
Dimensions
  Main Frame ..... 17x5.25x10 in. (43.2x13.3x25.4cm)
  Pressure Pod ..... 3.7x1x2.25 in. (9.4x2.5x5.7cm)
Power ..... 110 VAC/220 VAC

DECLARATION OF CONFORMITY

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):

Title: 900A Micropressure System

to which this declaration relates is/are in conformity with the following standards or other normative documents:

EN 55011:1991 – Class B
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.

Issued on: 22nd December 1999

Dr. Mark P. Broderick
President and COO
World Precision Instruments, Inc.
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Sarasota, FL 34240-9258 USA

Mr. Glen Carlquist
Production Manager
World Precision Instruments, Inc.
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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 30 days* 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 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.*

World Precision Instruments, Inc.

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