



Electro705

Battery operated low-noise wide-band electrometer preamplifier for intracellular voltage measurement

INSTRUCTION MANUAL

Serial No. _____

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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—Electro705 System. Two 705's can be linked together to form a high impedance differential electrometer pair.

INTRODUCTION

Electro 705, a battery operated, low noise, wide band electrometer preamplifier, is designed for intracellular voltage measurement. Two 705's can be linked together to form a high impedance differential electrometer pair. Each instrument includes a miniature gold plated active probe to which a microelectrode can be attached using the miniature WPI microelectrode holder supplied.

Features

Model 705 includes:

- An on-board probe test port
- Tickler oscillator
- Negative capacity control
- Electrode resistance test
- Audible push button test
- Differential amplifier

Notes and Warnings



CAUTION: The miniature active probe can be damaged by static electricity discharged at its tip. To reduce this danger, keep the probe tip connected to an electrical ground when the instrument is not in use.



CAUTION: To conserve battery life, remember to turn power off when the instrument is not in use.

Parts List

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

- (1) Electro 705
- (1) Miniature gold plated active probe
- (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 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

Front Panel Controls

R & GND: Test jacks into which the active probe can be inserted to adjust Leakage Current and Zero position respectively.

Leak Adjust: Screwdriver zero adjustment of active probe leakage current.

Tickler: Push button initiates probe oscillation for cell impalement.

Tickler Adjust: Screwdriver adjustment to vary amplitude of tickler oscillation.

Negative Capacity: Electrode shunt capacity neutralization control. Over compensation or oscillation can occur if this knob is rotated clockwise too far.

Electrode Test: 1 nanoampere of DC current injected through electrode (electrode +) results in baseline voltage deflection of 1 millivolt per $M\Omega$ of electrode resistance.

Battery Test: Push button elicits short warbling tone if battery voltage is adequate for normal operation of the instrument.

Power: The instrument power switch should be turned Off when the instrument is not in use to preserve battery life.

Output: The electrometer output signal is linear over a range of $\pm 5V$.

Position: A ten-turn knob with a baseline positioning range of about $\pm 400mV$.

Differential: The output of another active probe can be applied at Noninvert Input. The resulting signal at Differential Output will be the difference between this instrument's probe voltage and the external signal.

Brief Instrument Test

With the aid of an oscilloscope, Electro 705 can be quickly tested as follows:

1. Plug the tip of the active probe into the GND (ground) test port
2. Insert the probe cable plug into the Probe receptacle on the front panel.
3. Connect the Output BNC connector to an oscilloscope input with an appropriate coaxial cable.
4. Turn the Power switch On
5. Push the Battery Test button. An audible pulsating tone lasting for 1 or 2 seconds will occur. This indicates that the instrument's batteries are operative.
6. View the oscilloscope trace. Adjusting the Position control of the 705 will move the oscilloscope trace smoothly over a range of $\pm 300mV$.
7. Adjust the Position control to bring the oscilloscope trace to zero.

8. Turn the Negative Capacity control to its minimum position (counter clockwise).
9. Pull the probe out of the GND port and insert it into the R (100M Ω) port. The oscilloscope trace may move from 0.0mV, because of the small leakage current flowing from the probe tip.
10. Using a small screwdriver, readjust the leakage current to 0.0 with the Leak Adjust by moving the oscilloscope trace to 0.0mV. The system is ready for use.

OPERATING INSTRUCTIONS

Measuring and recording Potential

In the brief test above, the on-board 100M Ω resistor, located in the R port, simulates a fluid filled micropipette electrode. In a live experiment, two immediate differences become apparent as compared to the artificial test above:

A potential will usually exist between the top of the electrode and the reference "ground" electrode in fluid. This potential should be a few millivolts and can be easily compensated by displacing the Position knob so that the recorder or oscilloscope trace returns to zero.

Interference from the power line voltage is very easily induced on the tip of the active probe, because of the very high impedance of the electrode. You must reduce this interfering noise amplitude to acceptable levels where recorded signals are not seriously degraded. Fluorescent lights are often a particularly strong source of electrical interference and should be turned off. Electrical equipment located too near the recording site may induce AC line noise. Electrostatic shielding may be necessary in unusually bad recording locations. Shielding can be a grounded Faraday cage completely surrounding the preparation, probe and preamplifier or in some cases a small wound spring can be slipped over the probe tip (WPI #2541) to serve as a "driven guard" and electrode shield. Since model 705 is battery powered, it generates virtually no power line electrical noise. For this reason the instrument can be located very close to the site of recording. If your recording apparatus is located too far for the probe cable to easily reach the recording site, the output coaxial cable can be extended as needed. Do not attempt to add to the length of the probe cable for this purpose.

Electrodes

The primary task of the intracellular voltmeter is the accurate and stable measurement of potential in fluid electrolyte media. Usually, reference half cells such as Calomel or silver/silver chloride are used to connect an electrolyte filled micropipette to the preparation. The electrode holder supplied with this instrument contains a Ag/AgCl half cell in a medium containing chloride ions. (WPI provides a variety of half cell reference electrodes and half-cell micropipette holders.)

Electrode Resistance Test

Pushing the Electrode Test button on the front panel of the instrument causes a DC current of 1nA (electrode positive) to flow through the electrode to the preparation ground. This will cause the Output voltage to displace 1mv/M Ω of electrode resistance. You may confirm this by pushing the Electrode Test button while the probe is in R port. A displacement of the recording level of approximately $-100\text{mV} \pm 1\text{mV}$ (the test resistor is only approximately 100M Ω) will occur.

Negative Capacity

Electrode shunt capacity increases the response time of the microelectrode. It is estimated that 1 pF of shunt capacitance is added for each millimeter of electrode immersion in fluid electrolyte. This shunt capacitance can be compensated for by adding “negative capacity.” Be careful when adjusting negative capacity, because:

- Excessive negative capacity adjustment will cause the probe to oscillate and
- Increasing negative capacity increases the random electrical noise level.

Several possible methods can be used with Electro 705 to adjust the Negative Capacity control:

- Rotate the control 10 to 20 degrees up from the minimum (ccw) position of the knob.
- Rotate the control so that the baseline just begins to get a little noisier.
- With the electrode tip in a grounded solution, press the Electrode Test button repeatedly and observe the deflection of the trace on the oscilloscope as the Negative Capacity control is advanced. Advance the Negative Capacity control so as to “square” the rising edge of the wave without excessive overshoot.

Tickling

Many investigators succeed in penetrating living cells by causing a brief electrical oscillation of the probe top while the microelectrode tip is gently pressing on the outside of the cell. WPI calls this procedure “tickling.” The effect is believed to be piezoelectric. When the Tickler button is pushed briefly, an oscillation is created in the probe preamplifier. If the electrode tip is deeply immersed and the user does not observe a large oscillation at the Output when the Tickler button is pushed, adjust the Tickler Adjust control on the instrument front panel with a screwdriver.

Paired Differential Operation

Two Electro 705 amplifiers can be operated together as a differential amplifier. If the **Output** of one instrument, for example A channel, is connected with a coaxial cable to the **Noninvert Input** of a second 705 amplifier, B Channel, the **Differential Output** connector of the second instrument will display the difference potential, A-B, of input potential to the two active probes. The A Channel **Position** control can move the differential output recording trace.

Grounding

Proper connection of the experimental preparation to ground is essential in order to record signals with minimal interference from power line induction. A silver/silver chloride electrode and salt bridge connected to the GND (ground) terminal of the 705 will provide a stable electrochemical potential with reference to the electrolyte normally bathing or wetting the preparation. A lead wire with a 2mm pin is provided for this purpose.

Keep the probe tip connected to ground when not in use to prevent accidental destruction of sensitive probe transistors by static electricity.

Battery Replacement

If the Battery Test button produces an audible “battery OK” signal, but the instrument appears to be malfunctioning, try a new set of batteries before contacting the factory or your WPI representative for repairs. The Electro 705 uses four 9V alkaline transistor batteries which should all be replaced at the same time. Batteries should be replaced annually or as needed.

To replace batteries:

1. Turn off the power switch.
2. Unscrew the four screws on the bottom of the instrument case.
3. Withdraw the internal instrument assembly.
4. Remove and replace the four batteries taking care to match male and female battery terminals so as to insure the proper battery polarity.
5. Reinstall the internal instrument assembly and the four screws.

Remember to turn off power when equipment is not being used to increase battery life.

SPECIFICATIONS

| | |
|-------------------------------------|----------------------------------------------|
| Probe Input Resistance | $10^{12}\Omega$ |
| Probe Input Leakage Current..... | \pm pA, adjustable to 0 |
| Input Capacitance Compensation..... | 0 to 50pF |
| Stepped Voltage Rise Time..... | <25 μ s, 10–90%, through 20 M Ω * |
| Voltage Gain..... | x1 \pm 0.1% |
| Voltage Range..... | \pm 5V |
| Position Range..... | \pm 300mV |
| Electrode R Test | 1 mV/M Ω |
| Common Mode Rejection | adj. > 104:1, paired operation |
| Power | Four 9V alkaline cells, supplied |
| Dimensions | 21.6 x 8.9 x 14.3cm (8.5 x 3.5 x 5.6") |

* Dependent on measuring technique.



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: 705

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.

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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 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.

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

1 Hunting Gate, Hitchin, Hertfordshire SG4 0TJ
Tel: 44 (0)1462 424700 • Fax: 44 (0)1462 424701 • E-mail: wpiuk@wpi-europe.com

Germany

Zossener Str. 55, 10961 Berlin
Tel: 030-6188845 • Fax: 030-6188670 • E-mail: wpide@wpi-europe.com

China & Hong Kong

WPI Shanghai Trading Co., Ltd.
Rm 20a, No8 Dong Fang Rd., Lu Jia Zui Financial District, Shanghai PRC
Tel: +86 688 85517 • E-mail: chinasales@china.wpiinc.com

Internet

www.wpiinc.com