



Electro705

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



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INSTRUCTION MANUAL

Serial No. _____

042804

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DECLARATION OF CONFORMITY

We: World Precision Instruments, Inc.
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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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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. Model 705 includes an on-board probe test port, tickler oscillator, negative capacity control and an electrode resistance test feature. Also included are an audible push button test and a differential amplifier.

Important Operating Notes

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

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 advanced too far in the clockwise direction.

Electrode Test: 1 nanoampere of DC current injected through electrode (electrode +) results in baseline voltage deflection of 1 millivolt per Megohm 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 ± 5 volts.

Position: A ten-turn knob with a baseline positioning range of ± 400 millivolts approximately.

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:

Plug the tip of the active probe into the GND (ground) test port and probe cable plug into the Probe receptacle on the front panel. Connect the Output BNC connector to an oscilloscope input with an appropriate coaxial cable. Turn the Power switch On and 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. View the oscilloscope trace. Adjusting the Position control of the 705 will move the oscilloscope trace smoothly over a range of plus and minus 300 millivolts. Adjust the Position control so as to bring the oscilloscope trace to zero. Turn the Negative Capacity control to its minimum position (counter clockwise). Pull the probe out of the GND port

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.*

Specifications

Probe Input Resistance.	$10^{12} \Omega$
Probe Input Leakage Current	\pm pA, adjustable to 0
Input Capacitance Compensation	0 to 50 pF
Stepped Voltage Rise Time	$<25 \mu\text{s}$, 10–90%, through $20 \text{ M}\Omega^*$
Voltage Gain	$\times 1 \pm 0.1\%$
Voltage Range	± 5 volts
Position Range	± 300 mV
Electrode R Test	1 mV per MegOhm
Common Mode Rejection	adj. $> 10^4:1$, paired operation
Power	Four 9V alkaline cells, supplied
Dimensions	21.6 x 8.9 x 14.3 cm (8.5 x 3.5 x 5.6 in.)

* *Dependent on measuring technique.*

and insert it into the R (100 Megohms) port. The oscilloscope trace may move from zero millivolts because of the small leakage current flowing from the probe tip. Using a small screwdriver, readjust the leakage current to zero with the Leak Adjust by moving the oscilloscope trace to zero millivolts. The adjustment is ready for use.

Operation

Measuring and Recording Potential

In the brief test above, the on-board 100 MOhm 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. This interfering noise amplitude must be reduced by the user to levels below which is seriously degrades the recorded signals. Fluorescent lights are often a particularly strong source of electrical interference and should be turned off if necessary. Electrical equipment located too near the recording site also often results in strong power line frequency interference. 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 part number **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. Should the user’s recording apparatus be located too far for the probe cable to easily reach the recording site, the output coaxial cable can be extended as far as is necessary. *The user should 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. (*A variety of half cell reference electrodes and half cell micropipette holders are manufactured by WPI.)

Electrode Resistance Test

Pushing the Electrode Test button on the front panel of the instrument causes a DC current of 1 nanoampere (electrode positive) to flow through the electrode to preparation ground. This will cause the Output voltage to displace 1 millivolt for each Megohm of electrode resistance. The user 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 mV (the test resistor is only approximately 100 Megohm) will occur.

Negative Capacity

Electrode shunt capacity increases the response time of the microelectrode. It is estimated that 1 picofarad 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". Care must be used when adjusting negative capacity because (a) excessive negative capacity adjustment will cause the probe to oscillate and (b) increasing negative capacity also increases the random electrical noise level. Several possible methods can be used with Electro 705 to adjust the Negative Capacity control:

- a) Rotate the control 10 to 20 degrees up from the minimum (ccw) position of the knob.
- b) Rotate the control so that the baseline just begins to get a little noisier.
- c) 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 tip 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 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 2 mm 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 of your WPI representative for repairs. Electro 705 uses four nine-volt alkaline transistor batteries which should all be replaced at the same time. Batteries should be replaced annually or as needed.

To replace batteries, *turn off the power switch*, unscrew the four screws on the bottom of the instrument case. Withdraw the internal instrument assembly and remove and replace the four batteries taking care to match male and female battery terminals so as to insure the proper battery polarity.

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