DVC-1000

Dual Voltage Clamp

INSTRUCTION MANUAL

Serial No.______________________

7/97 rev

World Precision Instruments, Inc.

Table of Contents

Introduction

The DVC-1000 is a voltage clamp for the study of epithelial tissues. With this now-classic voltage clamp technique, temporal changes in membrane permeability as a function of voltage or locally applied chemical agents can be studied.

DVC-1000 is comprised of two separate and complete instruments. One clamp normally measures a test tissue sample, the second measures a control tissue sample.

In addition to the I/V clamp circuitry, a pulse generator and several on board circuits allow the instrument to be remotely controlled.

Specifications

Probes

Input Impedance	10^{12}
Leakage Current	100 pA max
Maximum Input	10 V

V Clamp

Clamp Voltage Range:

set clamp potentiometer	± 100 mV
external command	± 1 V
command factor	10 mV/mV
max clamp current	± 1 mA

Current Clamp

Clamp Current Range:

set clamp potentiometer	± 1 mA
external command	± 10 mA
command factor	1 mV/µA
compliance	± 100 V
Input Offset Range	± 130 mV
Fluid Resistance Compensation	0-1 k
Test Current	60 µA adjustable
Output Resistance	100

Timer

Range	500 ms to 500 s each side
LCD Meter	3 1/2 digits, 2000 µA or 200 mV max

Power	95-130 VAC or 190-260 VAC, switch selectable single phase, 50/60 Hz, 40 VA
Fuse	110V 0.5A slow blow; 230V 0.25A slow blow (1.24" x 0.25" diam)

Dimensions

Height	223 mm (8.75 in.) plus 16 mm (0.6 in.) removable bail
Width	432 mm (17.0 in.)
Depth	242 mm (9.5 in.) plus front/rear panel controls

Mountable in standard ANSI/EIA RS-310C 19-inch rack

Weight	9.5 kg (21 lb)

CE Certified

Controls, Indicators and Connectors

Clamp

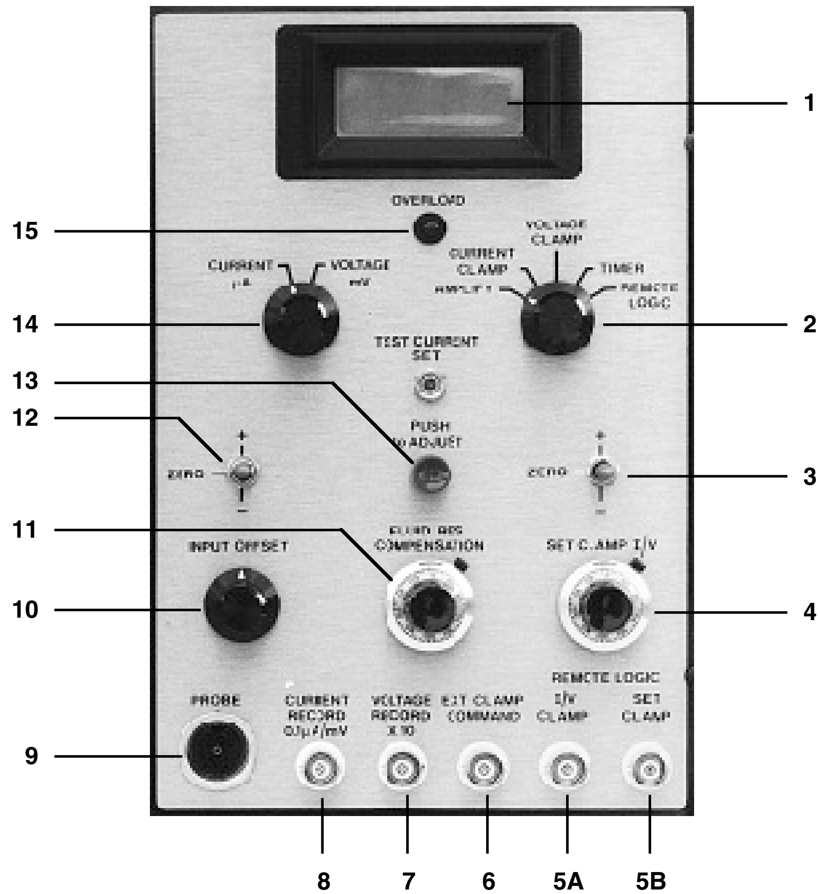


Figure 1

1. LCD Meter
2. Clamp Function Control
3. Polarity Switch For Set Clamp Pot
4. Set Clamp Potentiometer

5A. Remote Logic Input I/V

5B. Remote Logic Input Set Clamp

6. External Clamp Command
7. Voltage Record Output
8. Current Record Output
9. Probe Input
10. Input Offset Potentiometer
11. Fluid Resistance Potentiometer
12. Polarity For Input Offset
13. Fluid Resistance Test
14. Meter Function Select
15. Over Load

Clamp

Each DVC-1000 instrument houses two identical clamp units. For the following description, please refer to Figure 1.

LCD Meter

The meter on each clamp section is a 3 1/2 digit liquid crystal (LCD) display.

Using the meter function switch (14), the output of VOLTAGE or CURRENT may be displayed by switching to voltage or current respectively.

Input Offset

INPUT OFFSET is used to zero small junction potentials often associated with the voltage recording electrodes. The dial (10) determines the magnitude of the offset compensation and the polarity switch determines the direction of voltage movement.

Set Clamp

SET CLAMP knob (4) is used to adjust DC current clamp or voltage clamp levels. The polarity control (3) is used to make the command positive (up) negative (down) or zero (center).

Fluid Resistance Compensation

Fluid resistance compensation is used to compensate for the ohmic voltage error produced by clamp currents flowing through the fluid between the voltage electrodes. This is a X10 reading (i.e., 4.1 = 410 ohms).

Inputs

Electrodes from the tissue chamber are connected to the DVC-1000 by way of probes. Probes are connected to the instrument via the PROBE input connectors (9).

EXT CLAMP COMMAND (6) can be used to command the magnitude of either clamp voltage or clamp current in a linear and proportional way. Any wave-form may be applied and will be faithfully reproduced. Maximum command to this input is 10 volts. In the voltage clamp mode 10 mV of command must be applied for each 1 mV increment of resulting voltage clamp potential. In the current clamp mode, 1 mV of command results in 1 microampere of current.

This input is active in all modes of operation except amplify.

REMOTE LOGIC (5A and 5B) inputs accept standard logic levels and allow some functions of the clamp to be remotely controlled.

REMOTE LOGIC input I/V (5A) will switch the clamp from voltage clamp to current clamp when a logic level is applied.

REMOTE LOGIC input SET CLAMP (5B) will switch the set clamp potentiometer out of the circuit when at logic level is applied. The resulting command from the set clamp potentiometer while the logic level is high will be zero. The external clamp command function will not be affected.

Both remote logic inputs operate only when the clamp function control is switched to remote logic.

Outputs

Each clamp unit has two analog recorder output terminals; one to monitor voltage across the membrane and one to monitor current.

The CURRENT RECORD (8) will display 10mV for each microampere flowing through the membrane.

The VOLTAGE RECORD (7) displays X10 the transmembrane voltage.

Both outputs operate continuously regardless of the selected operating mode of the clamp.

Clamp Function Control

The clamp function switch (2) is a five position switch which determines the operation mode of each clamp. The 5 modes are as follows:

In the AMPLIFY mode the clamp will passively record the transmembrane potential.

In the CURRENT CLAMP mode a constant current commanded either by the set clamp dial or the external command flows between the current electrodes.

In the VOLTAGE CLAMP mode a constant voltage is applied and maintained across the membrane.

In the TIMER mode the clamp automatically cycles between zero clamp (VOLTAGE or CURRENT) and a set-clamp value.

In the REMOTE LOGIC mode positive logic commands to the REMOTE LOGIC I/V input will switch the clamp from voltage clamp to current clamp and positive logic commands to REMOTE LOGIC SET CLAMP input will switch the set clamp potentiometer out of the circuit.

TIMER

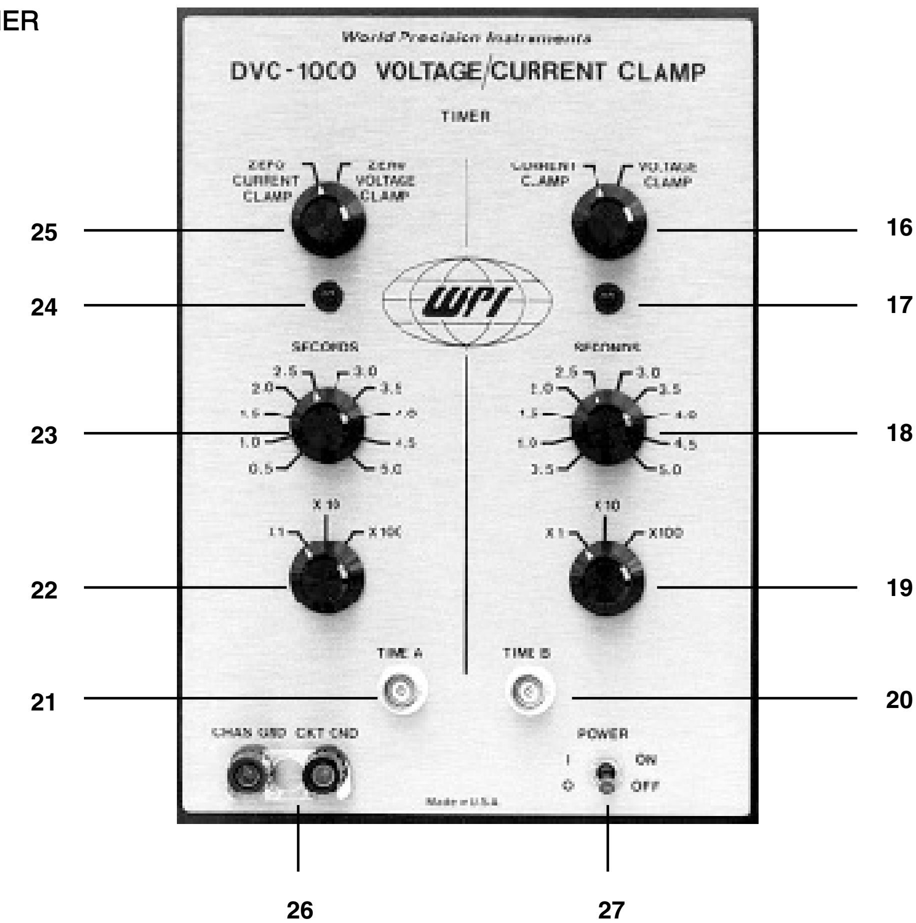


Figure 2

16. Function Switch For Right Side Timer
17. Indicator LED Right Side Timer
18. Time Select
19. Time Multiplier
20. Time B Output
21. Time A Output
22. Time Multiplier
23. Time Select
24. Indicator LED
25. Function Switch For Left Side Timer
26. System Ground Posts
27. Power Switch

Timer Figure 2

The DVC-l000's timer is physically and functionally divided into two halves. Each side of the timer has a time duration control (18, 23), a time multiplier (l9, 22) and a function switch (l6, 25).

Function Switch

Each section of the timer has a function switch (16, 25) that determines whether the clamp will will be in voltage clamp or current clamp mode during that particular time interval.

Timer Control

Each TIMER has a time duration control which is continuously variable from 0.5 to 5 seconds. These set values are multiplied by 1, 10 or 100 by the time multiplier switch.

Probes

Each clamp unit of DVC-1000 is supplied with a probe box. Probes contain the first stage of amplification and interface the instrument with preparation. The probes are specifically calibrated to work with the proper clamp unit.

Electrode Connection

Each probe has four input connectors; two for voltage electrodes designated V_1 and V_2 and two for current delivery designated I_1 and I_2. These inputs accept standard 2 mm pin plugs. Subscripts 1 and 2 in connection with V_1, V_2, I_1 and I_2 signify that electrodes with the same subscript must be connected the same side of the membrane chamber.

Operate/Ground Switch

The input connectors of each probe may be arbitrarily grounded by switching the two position OPERATE/GROUND switch to the GROUND position. In the OPERATE mode, the probe amplifier is connected to the electrodes.

Dummy Membrane (DVC-2)

The DVC-2 Dummy Membrane may be connected to either probe by pluging the output connector into the 9-pin receptacle marked TEST in the center of the probe face plate.

The dummy membrane provided with the DVC-1000 is designed to mimic the electrical actions of a tissue sample in a fluid filled chamber. It may be used to familiarize the user with the instrument before working on live tissue. It may be also used to check the proper functioning of each clamp. See the *Maintenance* section of this manual.

Rear Panel

Connector	A polarized, 3-conductor, cable, terminated with a NEMA 5-15P connector is used for line (mains) power input to the instrument. An alternate cordset may be supplied when local circumstances dictate different mains voltages and connections.
Fuseholder	Used for protective fuse in series with the high side (brown or black wire) of the mains. Holder accepts 1/4 by 1-1/4 inch (6.35mm by 31.8mm) fuses of the type indicated on the rear panel.

Operating Directions

General

Preliminary Test

Before the DVC-1000 is initially placed in operation, it is recommended that the instrument is operated under simulated conditions. For this purpose, a procedure is provided in the *Maintenance* section of this manual that effectively tests the instrument and familiarizes the user with typical operations.

Connect to the Chamber*

Assemble the test chamber with electrodes in place without the membrane. Fill the chamber with electrolyte. With the probe grounded, connect the electrodes to the probe. Set the clamp function control to AMPLIFY. Next, switch the probe to operate.

**See, for example, WPI's USS voltage clamp chambers.*

Adjust Voltage Offset

Zero out any electrode junction potential difference using the input offset controls.

Compensate Fluid Resistance

Depress the FLUID RESISTANCE test button. At the same time, advance the FLUID RESISTANCE COMPENSATION potentiometer until the panel meter reads zero. Disassemble the chamber, install the tissue, reassemble and refill with electrolyte. Set up is now complete.

Voltage Clamp

Use SET CLAMP potentiometer and polarity switch to set the desired polarity and magnitude for clamp voltage. The set clamp pot can adjust clamp voltage up to ± l00mV (one turn/l0mV) if the user requires larger clamp voltages the external clamp command input must be used. This will allow clamp voltages up to ± lV.

Switch the clamp function switch to VOLTAGE CLAMP. The digital panel meter should now display the desired clamp voltage exactly. The membrane is now voltage clamped.

Change the meter function switch to current (µA). The meter will now display clamp current required to maintain the clamp.

Both clamp current and clamp voltage are continuously available at the current record and voltage record respectively.

Current Clamp

Use set clamp potentiometer and polarity switch to set the desired polarity and magnitude for clamp current. The set clamp pot can dial currents up to ± lmA (one turn/l00µA). If the user requires larger clamp currents, the external clamp command can be used to obtain current to 4mA. Factory modification of the DVC-l000 can extend the range of the clamp command to ±10mA.

Switch the clamp function switch to current clamp. The digital panel meter will now display the desired clamp current exactly. The membrane is now current clamped.

Change the meter function switch to voltage (mV). The meter will now display the transmembrane potential difference.

Both clamp current and clamp voltage are continuously available at the current record and voltage record respectively.

Timer

The timer is divided into two sections: the left side designated "Time A", is that period of time during which the membrane is clamped to zero. The timer function for "Time A" determines whether the membrane is clamped to zero volts or zero current. The timer duration potentiometer and multiplier switch determine theduration of Time A.

The right side designated "Time B" is that period of time during which the membrane is clamped to some preset value. The timer function switch for "Time B" determines whether the preset value is a current or a voltage. The timer duration potentiometer and multiplier switch determine the length of "Time B".

Use of the timer is illustrated by the following example.

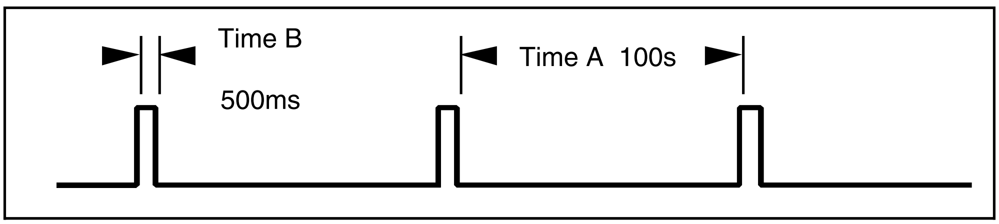


Figure 3

To produce Figure 3, use the set clamp potentiometer and polarity switch to dial in the clamp current of l00µA.

Set the timer function switch for "Time A" to "zero current" adjust timer duration potentiometer and multiplier switch such that "Time A" is 100 seconds long.

Set the timer function switch for "Time B" to current clamp. Adjust the timer duration potentiometer and multiplierswitch such that "Time B" is 500ms long.

Switch the clamp function switch to timer mode. The clamp will now begin to cycle from l00µA (500ms) to zero µA (l00s).

The same procedure for a voltage clamping application can be followed by changing only the timer functioning switches ("Time A" and "Time B") to voltage clamp.

Potentiometers for adjusting the duration of "Time A" and "Time B" are accurate to 5% of full scale. For more precise timing, outputs are provided on each side of the TIMER labelled TIME A and TIME B. They can be used with an oscilloscope or chart recorder to set more accurate timing.

These outputs can also be used to gate or drive other devices whose functioning the user may wish to synchronize with the clamping process.

Remote Logic Mode

The remote logic mode enables the user to control the clamp with a computer or other automatic device.

This is accomplished through the use of the following inputs:

I. The external clamp command.

2. The remote logic I/V input.

3. The remote logic set clamp input.

The remote logic I/V input will change the clamp from voltage clamp to current clamp when a positive logic level (1) is presented. When a low logic level (0) is presented, as would occur with no connection at all or if the input were grounded, the clamp remains in voltage clamp. Refer to Figure 4.

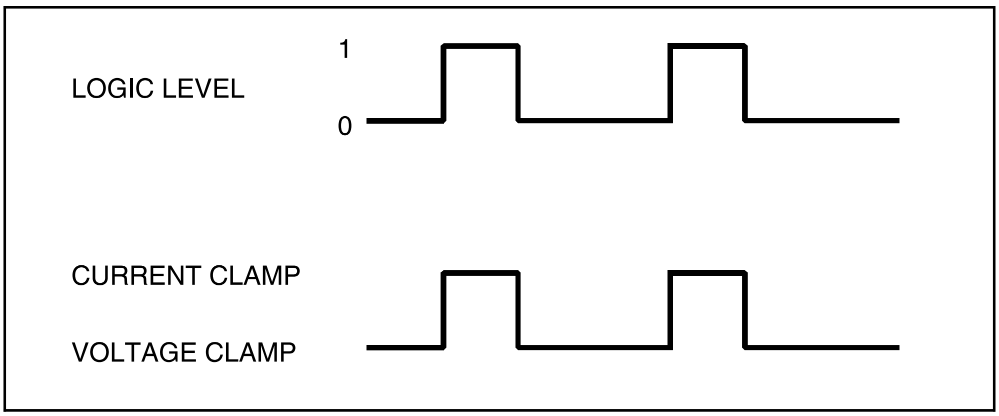


Figure 4

The REMOTE LOGIC SET INPUT input works in a manner similar to the REMOTE LOGIC I/V input. When a logical high is presented, the set clamp potentiometer is switched out of the circuit making the effective DC command 0.

Both remote logic inputs will only operate when the clamp function control switch is in the remote logic position.

External Clamp Command

Voltages presented to the external clamp command input produce proportional clamp voltages or clamp currents depending on the mode of operation of the particular clamp. This input is active in all modes of clamp operation (voltage clamp, current clamp, timer, and remote logic); including “Time A” in the timer mode. External commands will always sum algebraically with any command on the set clamp potentiometer.

Inputs to external clamp may be AC or DC. However, clamp circuitry will not follow commands faster than l5-20Hz. Clamp levels to the external clamp command input may be determined by using the following factors.

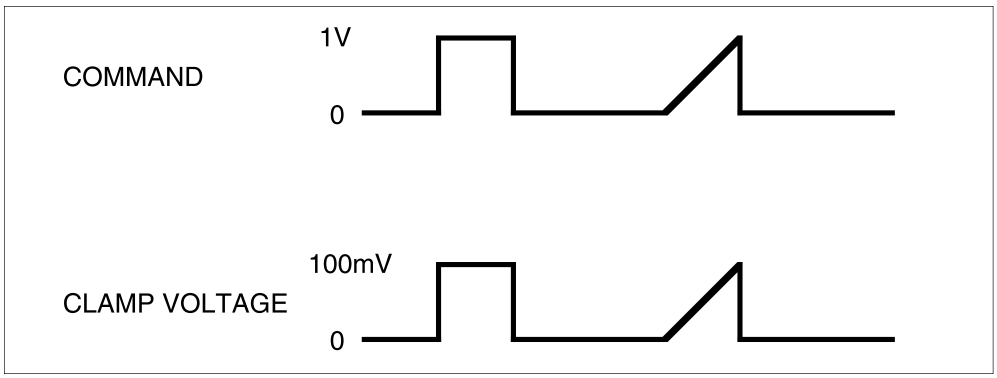


Figure 5. For voltage, each l0mV of command results in lmV of clamp voltage.

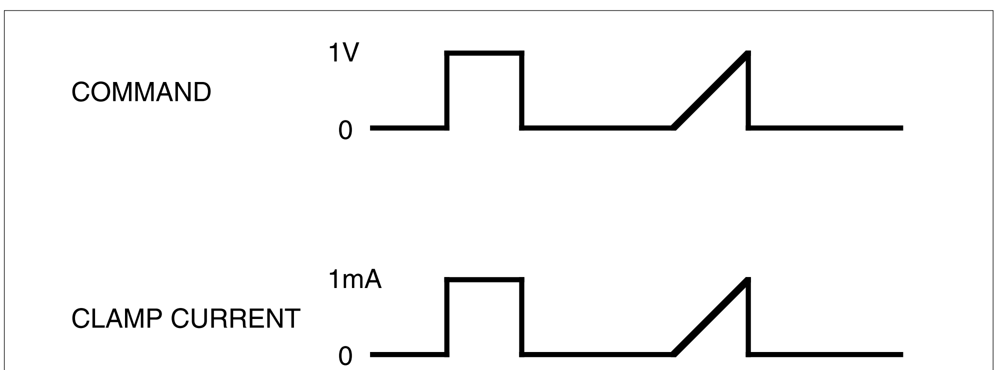


Figure 6. For current, each mV of command results in lµA of clamp current.

Special Topics

Hook-Up to the Chamber*

Electrical connections to the clamp chamber are usually made by using a short length of plastic tubing filled with an agar-salt (2% agar, salt solution compatible with chamber ionic composition) solution. A silver wire is inserted into the instrument end of the plastic tube for perhaps an inch into the agar filled tubing.

Agar is used to prevent the diffusion of metal from the wire into the membrane chamber. The use of salt bridges of this type results in a significant electrical resistance in series with the clamp current pathway. On the upper (V_1, I_1, see Figure 7) half of the membrane, excessive resistance (more than 50 k ohms) might require a voltage swing in excess of the clamp amplifiers's capability. On the lower (V_2, I_2) side of the membrane, resistance of the salt bridge in excess of about 10 k ohms may result in allowing the membrane to rise in potential above ground by more than 10 volts. If this were to occur, the differential amplifier which measures the membrane potential difference might begin to operate erratically. *Thus it is strongly recommended that a large diameter and short length of tubing for the lower salt bridge is used.** Electrodes which measure V_1 and V_2 the transmembrane potential difference, should be placed in close proximity to the membrane surface so as to keep the fluid resistance error as small as possible.

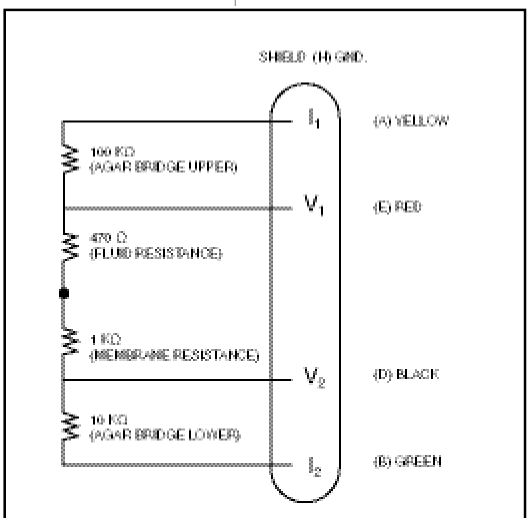


Figure 7

Bipolar Current Delivery

In certain applications, it is desirable to pass a bipolar current or voltage across the membrane. This can be accomplished using DVC-l000 in conjunction with WPI's A310 Accupulser™. The procedure is as follows:

Switch the clamp section to the TIMER mode.

Connect a BNC terminated cable from the TIME B output of the TIMER to the EXT VOLTAGE GATE input of the A310 or other stimulator with TTL outputs.

Connect the +VARIABLE OUTPUT of the A310 to the EXT CLAMP COMMAND.

*See "Update", page 18.

Adjust the timer controls to suit the experimental design.

Determine the peak to peak amplitude of the bipolar wave form. Set the A310 AMPLITUDE control for this value. Dial in l/2 of this amount on the SET CLAMP potentiometer. Select (-) polarity. This will offset the square wave generated by the A310 so that it is bipolar.

Set the A310 into the appropriately timed pulsed mode. See the A310 manual for further information.

Switch the A310 into the EXT GATES mode.

The A310 can provide a variable square wave with frequency varying between .001Hz and 10 KHz. Adjust the A310 to give the longest possible pulses within the current delivery period (“Time B”) without exceeding “Time B”. For example, if the current delivery is 500 ms, the A310 must be set to 2 Hz so that one complete bipolar wave will be complete in 500 ms.

The system will now cycle between zero current and a bipolar current wave of set amplitude.

Maintenance

Cleaning

CAUTION: Do not use alcohol, aromatic hydrocarbons or chlorinated solvents for cleaning. They may adversely react with plastic materials used to manufacture the instrument.

The exterior of this instrument may be cleaned periodically to remove dust, grease and other contamination. There is no need to clean the inside. Use a soft cloth dampened with a mild solution of detergent and water. Do not use abrasive cleaners.

Test

The Dummy Membrane (DVC-2) provided with the DVC-1000 is designed to mimic the electrical actions of a tissue sample in a fluid filled chamber. It may be used to familiarize the user with the instrument before working on live tissue. It may be also used to check the proper functioning of each clamp.

Successful completion of the following test is an excellent indication that the machine has no electronic faults. Test each probe/clamp in the following way.

Hook-Up

Connect power cord and leave power turned off. Set the function switches on both DVC-3s to the GND (ground) position. Plug one DVC-3 into the PROBE port on the left side of the DVC-1000 front panel; plug the other DVC-3 into the PROBE port on the right side of the DVC-1000 front panel.

Connect the Dummy Membrane (DVC-2) to a DVC-3 using the 9-pin connector. The DVC-2 control switch should be in the OFF position.

Panel Control Settings

Set panel meter function switch to VOLTAGE (mV) position. Set clamp function switch to AMPLIFY position. Place the polarity switches for INPUT OFFSET *and* SET CLAMP I/V functions in their zero or central positions.

Checking Input Offset

Place DVC-1000 power switch to ON. At this point, the clamp digital voltmeters should show a potential close to zero volts. Switch the DVC-3 to ON position. Zero any reading which now appears on the LCD meter using the INPUT OFFSET adjustment control, switching from ZERO to + or - as needed.

Fluid Resistance Compensation

Switch the DVC-2 to the FLUID RESISTANCE position. Press the FLUID RESISTANCE test button; the LCD meter should displace to a non-zero value. While holding the test button down, advance the fluid resistance potentiometer until the meter again reads zero. The 10-turn dial on the potentiometer should read 470O hms ± 5% (the value of the dummy fluid resistor).

The amplitude of the fluid resistance test current is factory set a 60 µA. Certain preparations may require more or less current.

The amplitude may be adjusted in the following manner:

1) Turn meter function switch to CURRENT µA.

2) Press the FLUID RESISTANCE test button, while holding the button, adjust the TEST CURRENT SET screw adjustment to desired current level as indicated on the LCD meter. Adjustment is complete.

Monitoring Dummy Membrane Voltage

Turn FLUID RESISTANCE potentiometer fully counter-clockwise. Switch meter function switch to VOLTAGE mV. Switch the DVC-2 Dummy Membrane to VOLTAGE MEMBRANE. The open circuit membrane potential should be displayed on the panel meter. Note that this voltage can be varied by rotating the VOLTAGE MEMBRANE ADJUST knob on the Dummy Membrane.

Checking Zero Voltage Clamp

Change the clamp function switch to VOLTAGE CLAMP. The panel meter will read near zero volts (the CLAMP SET should still be OFF). The membrane is now clamped to zero volts.

Reading Clamp Current on the Meter

To read clamp current, switch the meter function switch to the CURRENT (µA) position. The panel meter now reads the clamp current necessary to clamp the membrane to zero volts.

Checking Set Clamp Controls

Return the meter function switch to VOLTAGE position. It should still read near zero volts. If the set clamp toggle switch is moved up or down (+ or -), the 10-turn dial will now command the voltage clamp to the membrane at voltages other than zero volts. These new clamping voltages should be displayed on the panel meter.

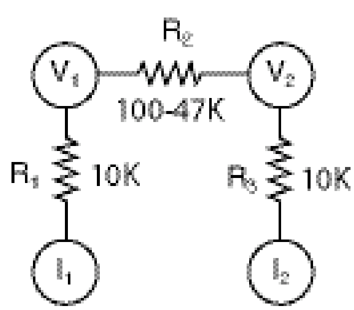
The successful completion of the above procedure proves that the voltage clamp is operational and in working order.

Testing the Right Channel

Place function switch on DVC-3L in GND position. Disconnect DVC-2.

To test the right channel of the DVC-1000, repeat entire procedure from “Hook-Up” on page 16, with DVC-2 plugged into DVC-3R.

External Calibration



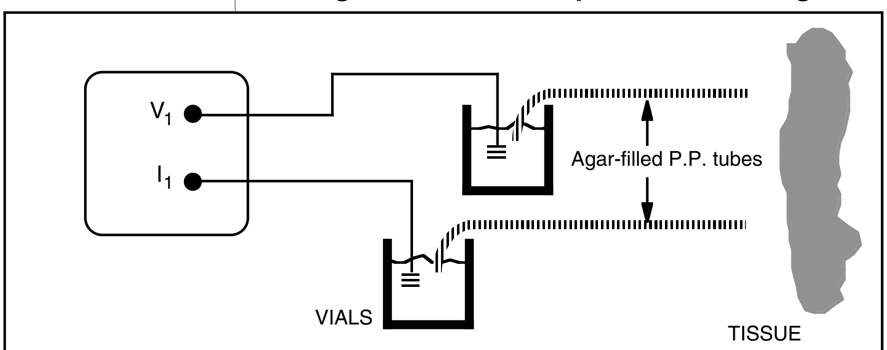
Resistors R1, R3 mimic typical agar bridge resistances while a variable R2 resistor range of 100 ohms to 50K ohms mimics the tissue resistance. This setup can be used to verify measurements and linearity. Use 0.1% resistors for accuracy.

DVC-1000 Update

Each channel of the DVC-1000 has four input connectors located on the face front panel of the DVC3 preamplifier box. The input connectors are labeled I_1, I_2 and V_1, V_2. Connectors labeled “I” source or sink current, connectors labeled “V” measure voltage across the experimental tissue. Connectors labeled with the same subscript connect to the same side of the tissue chamber.

Two methods can be used to access the tissue chamber:

1. Agar-KCl filled plastic tubing



Bridges of polyethylene tubing filled with KCl saturated agar (2%) can be used to make electrical contact between the tissue chamber electrolyte and a pool of electrolyte in a beaker. The pool is then connected to the amplifier input via Ag/AgCl or Hg/HgCl (calomel) halfcells for membrane potential recording and heavy Ag AgCl electrodes for current flow. Please refer to the block diagram below for hook-up particulars.

Helpful hints

1) Fill a syringe with hot KCl saturated agar and squirt it through a length of P.E. tubing. Once cooled, the agar-filled tube can be cut into sections.

2) If your experiment requires that you pass large currents (500 µA or more) it may be necessary to increase the size of the Ag/AgCl electrodes in the electrolyte pools as deplating of silver or over chloridization may result. The latter of these will cause an increase in the resistance of the halfcells; this should be avoided. It will be good practise therefore to interchange the current electrodes periodically. With the passage of large currents the DVC-1000 output may saturate if the halfcell resistance is too high. Special care should also be taken with the agar-filled tube connecting I2 to the chamber. This leg of the circuit functions as the ground return for the DVC-1000. Large resistances here will cause the DVC-1000 output to saturate. Resistance of the agar tube can be reduced by using shorter lengths or larger diameters of tubing and more saturated KCl solutions in preparation of the agar.

3) Finally, any asymmetry potential between the halfcells used to measure the transepithelial potential can be nullified by immersing both V electrodes in an electrolyte bath and shorting their leads for several hours.

2. WPI cartridge electrodes

With the advent of Agar filled cartridge electrodes, EKC and EKV, the difficulty inherent in paragraph 1, above, is eliminated.

These electrodes are easily filled with Agar-electrolyte solution and insert directly into WPI's Ussing chamber.

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.

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

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

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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: DVC1000
(with Probe Preamplifier Type DVC3 and Dummy Membrane Type DVC2)

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.

Issued on: **18th February 2000**

Dr. Mark P. Broderick	Mr. Glen Carlquist
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