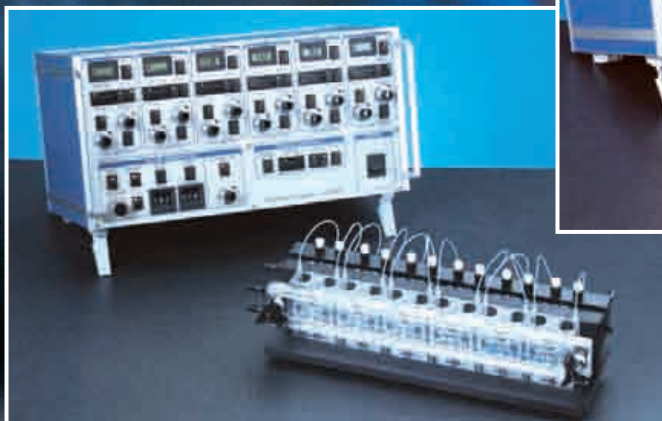
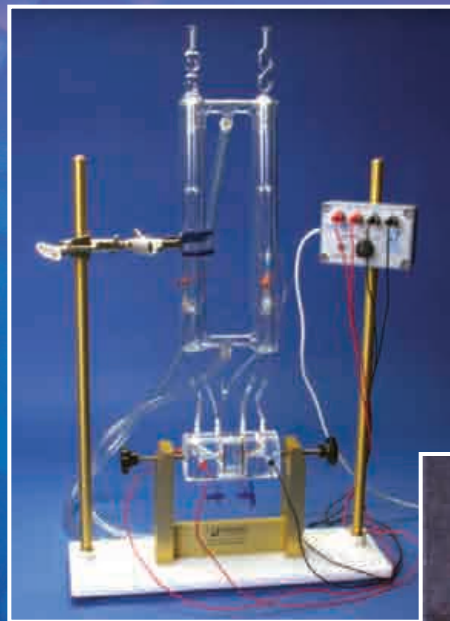


Guide to Using Chamber Systems



WARNER
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A Harvard Apparatus Company

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Overview

An Ussing System, used to measure transport across epithelial membranes, is generally comprised of a chamber and perfusion system, and, if needed, an amplifier and data acquisition system. The heart of the system lies in the chamber with the other components performing supporting roles. The 'Classic' chamber design, first introduced by the Danish physiologist Hans Ussing in the early 1950's, is still in wide use today. However, several newer designs are now available that optimize for convenience and for diffusion- or electrophysiology-based measurements.

Epithelia are polar structures possessing an apical (or mucosal) and basolateral (or serosal) side. It is the movement of electrolytes, non-electrolytes, and H_2O across this membrane that is of interest to the researcher. Ussing systems have been used to make measurements from native tissue including stomach, large and small intestine, gall and urinary bladder, skin, and trachea, as well as from tissue derived cell monolayers from various sources including renal tubes, pancreas, and salivary and sweat glands.

A well designed Ussing chamber supports an epithelia membrane or cell monolayer in such a way that each side of the membrane is isolated and faces a separate chamber-half. This configuration allows the researcher to make unique chemical and electrical adjustments to either side of the membrane with complete control.

Study Types

Ussing systems can be used for either electrophysiology or diffusion-based studies, or for a combination of both. They can also be used for radiotracer studies wherein the ionic species under transport is radiolabeled. For convenience, we will consider radiotracer studies to operate within the context of a diffusion or electrophysiology-based system.

While each approach described above makes use of a chamber and fluid handling system, an electrophysiology-based setup has the added dimension of a current and/or voltage clamp amplifier and data acquisition system. Relevant components include:

Diffusion-based system

- A chamber with perfusion system and tissue holding apparatus
- Temperature and gas control, if needed
- The ability to acquire data

Electrophysiology-based system

- A chamber with perfusion system and tissue holding apparatus
- Temperature and gas control, if needed
- Amplifier
- Data acquisition system and software

A Systems Approach

Warner instruments offers many Ussing system components embodying several different design philosophies. Fortunately, the various components are generally interchangeable with each other (i.e., all the amps are compatible with all the chambers). While this presents the potential for a great degree of flexibility and customization, it can also increase the complexity of selecting the optimum combination of Ussing system components for your needs.

The goal of this article is to outline the advantages and disadvantages associated with each Ussing chamber design with an eye towards guiding you in selecting the best components for your application.

Ussing Measurements

A basic understanding of different Ussing measurements commonly made can guide you in determining which components best fit your needs when building a system. As stated earlier, Ussing systems can be defined as being either diffusion or electrophysiology-based.

A diffusion-based system is generally focused on measuring transepithelial fluid transport and is used to follow net movement of H_2O or solute across the membrane. By itself, diffusion-based systems do not provide specific information regarding the underlying transport mechanism and are best suited towards measurements of leaky epithelia characterized by electroneutral transport.

While fluid transport can result in a volume change in the recording chamber, it is usually quantitated by measuring a corresponding change in a volume marker. Volume markers include changes in salt or dye concentration, or changes in physical characteristics such as fluid capacitance or resistance. Advantages of fluid transport measurements using a volume marker include good temporal resolution and sensitivity to small fluxes (volume changes as low as ± 1 nl/min have been reported). A disadvantage is the requirement for small volume chambers.

An electrophysiology-based system focuses on measuring transepithelial electrical responses to experimental perturbations. These systems are used to quantitate the operation of electrogenic pathways in the membrane (e.g., ion pumps, channels, etc). As such, an electrophysiology-based system carries the additional hardware requirement of a voltage and/or current clamp amplifier, a data acquisition system, and collection/analysis software.

Basic measurement parameters in electrophysiology-based Ussing systems include transmembrane voltage (V_t), epithelial membrane resistance (R_t), and short circuit current (I_{SC} ; the current required to bring V_t to 0 mV). A limitation with these systems is that non-electrogenic ion transport mechanisms such as fluid transport and electroneutral ion transport cannot be directly monitored. This limitation, however, can be addressed by employing indirect or secondary measurements such as ion replacement, transport inhibition, and the use of hormones and second messengers.

The use of radioisotope tracers is one measurement technique deserving special mention. This technique can be applied equally well to both diffusion and electrophysiology-based measurements and is usually employed to provide information regarding ion-specific transport mechanisms. For example, a diffusion-based model cannot identify the fluid being transported or if the measured volume change is the result of a hydrostatic or osmotic process. Finally, if an osmotic-driven volume change is mediated by an ionic mechanism, then the responsible ion is not identified. By comparison, a limitation with the electrophysiology-based model is that while ionic transport can be measured, the specific ion crossing the membrane is not specifically determined. This is especially true for multi-ionic salt conditions. For both cases, the use of a radiolabeled ionic species allows for directly monitoring ion-specific translocation for the two measurement systems described above.



The Components

An Ussing system is comprised of a chamber and perfusion system, and if needed, an amplifier and data acquisition package. If working at defined temperatures, then a circulating water bath is also needed for the heat jackets.

The Chamber System

While decisions need to be made for each step in assembling a complete Ussing system, the greatest complexity is associated with choosing the chamber and its associated tissue support. Once these elements have been addressed, then the task of selecting the other components (amplification, data acquisition, etc) is more or less direct.

All Ussing chamber systems have the following features in common: a means to hold the membrane while minimizing tissue damage, a means for holding and exchanging solutions, a means to facilitate precise electrode placement, and a means to control solution temperature and gas load.

Ussing chamber systems from Warner include the Classic, introduced by Ussing in the 50's, Self-Contained, incorporating the full classic setup within a small housing, and Multi-Channel systems, allowing simultaneous measurement from many epithelia in parallel. Most chamber systems, except the Classic and NaviCyte Vertical make use of inserts allowing them to accommodate various tissues as well as cultured cells on permeable supports (e.g., Snapwell, Millicell, Falcon, and Transwell) without having to purchase a separate chamber for each support.

The **Classic** is the fundamental chamber system as designed by Ussing. It is comprised of a cylindrical tissue holder to which the electrodes and plumbing attach. Tissues are mounted directly onto and are compressed between the two chamber-halves. A variety of tissue chambers are available with both round and slotted openings. The enclosed baths (apical, basolateral) are perfused via a glass circulation reservoir that mounts above the chamber. The reservoir uses a 'gas-lift' mechanism to drive circulation and to provide gas tension. Reservoirs are available in 4, 10, and 20 ml volumes.

The **Classic with Insert** chamber system is the same as the Classic system except that the tissues are supported via inserts. This system also supports cultured cells on Snapwell, Millicell, Falcon, or Transwell culture cups.

The **Self-contained** chamber systems provide all of the features of the Classic system but houses the full apparatus (chamber, electrodes, and perfusion system) within a single Lucite block. Tissues or cultured cells mount into a two piece assembly (an insert) that is easily placed into the chamber from the top. Temperature control is provided via an external circulating water bath. Self-contained chambers are available in both single and dual channel models.

The **Multi-channel** chamber systems include the NaviCyte and EasyMount designs. Both designs make use of a support assembly to hold anywhere from 2 to 24 independent chambers (depending on design) and to couple the perfusion and electronic components to the chambers. NaviCyte chambers are available in both horizontal and vertical configurations and the EasyMount chambers are only available in the vertical configuration.

- The **NaviCyte Horizontal** configuration accommodates from 1 to 6 chambers and is ideal for studying mucosal layers at an air/liquid interface. NaviCyte Horizontal chambers make use of a mounting ring or Snapwell insert to support the tissue of interest.
- The **NaviCyte Vertical** configuration is well designed for diffusion-based studies and accommodates from 1 to 24 chambers. Tissues are supported directly in the chamber block and no insert is required. However, a chamber block supporting a Snapwell insert is also available.
- The **EasyMount** configuration accommodates from 2 to 8 chambers and are well designed for electrophysiology-based measurements. EasyMount chambers are visually similar to the NaviCyte Vertical chambers but differ in that they require the use of an insert to secure and place the tissue into the chamber.

The Amplifier

An amplifier is required if making electrophysiology-based measurement. Warner offers a large selection of amplifiers, all compatible with the chamber systems described above. Available options include the EC-800 and VCC-600 single channel amplifiers, the EC-825A and VCC-MC2 dual channel amplifiers, and finally, the VCC-MC6 and VCC-MC8 six and eight channel amplifiers, respectively.

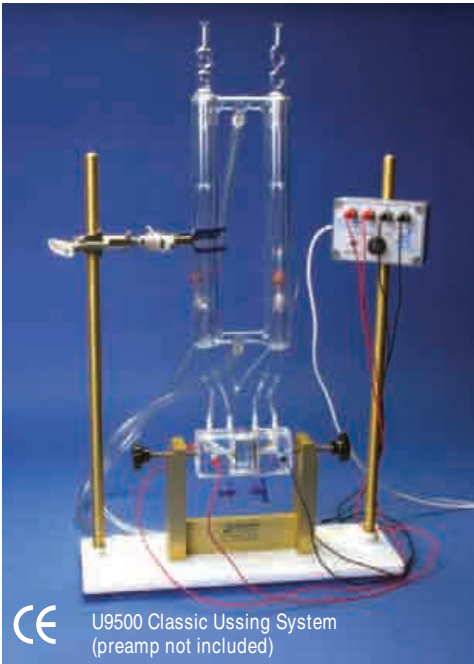
The Data Acquisition Package

Data acquisition is necessary for collecting data from the Ussing system (usually from the amplifier when making electrophysiological recordings) and processing it into a digital form for later analysis on a computer. The basic system offered for this purpose by Warner is the **Acquire and Analyze** acquisition system.

There is another option, however, that bears special mention. This is the **Computer Controlled Multi-clamp with Software**. This is a unique package that houses several amplifiers (2, 4, or 6), a computer, and the software all in a single box. As such, a separate amplifier and data acquisition system are not needed when using the Multi-clamp with Software.



The investigation of ionic transport across epithelial cells was greatly facilitated by the development of a chamber system designed by Dr. H. H. Ussing more than 40 years ago. Today this equipment bears his name. The U9500 'Classic' design presented here varies little from Dr. Ussing's original equipment which remains in wide use for the study of electrophysiological properties of epithelial tissues. A newer design, the U9520 'Classic with Inserts' allows for insertion of cell culture or tissue supports and greatly increases the functionality of the classic Ussing chamber. The low initial cost of the Classic design, coupled with the modest cost of add-on components, makes this system an ideal option for classroom instruction and in-the-field research.



U9500 Classic Ussing System
(preamp not included)

The Classic Ussing Chamber Systems

The U9500 and U9520 are complete chamber systems consisting of an Ussing chamber, chamber support stand, circulation reservoir, 3-prong clamp, air/gas fitting kit, and electrode set. Both systems are virtually identical with the difference embodied in the actual chamber

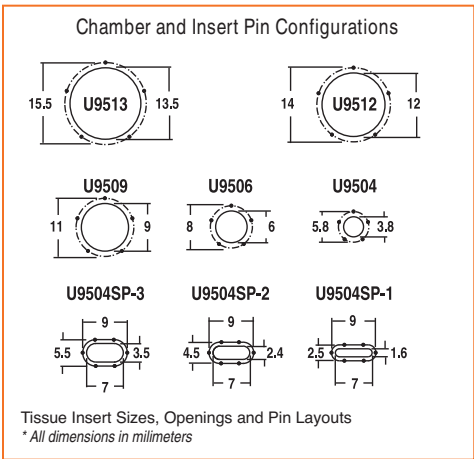
U9500 'Classic' Ussing Chambers

The U9500 'Classic' chambers are machined from solid acrylic into two halves and have vertical and horizontal ports in each half for connection to the circulation system and for making electrical connections.

The face of one chamber-half is imbedded with sharp stainless-steel pins which mate with corresponding holes in the other chamber-half face. These pins allow for puncturing and positioning of an epithelium membrane within the chamber. Chambers are available in a variety of sizes and pin configurations. In the 'Classic' design, a separate chamber must be purchased for each different desired pin configuration. This is a good choice if you intend to study a single tissue type as the assembly is direct and simple.

U9520 'Classic with Inserts' Ussing Chambers

The U9520 'Classic with Inserts' chamber is functionally similar to the U9500 except that it makes use of low-cost adapters (inserts) to position and support tissues or cultured cells within the chamber body. Inserts are interchangeable and permit the researcher to investigate a variety of tissues without having to purchase a separate chamber for each different tissue. The U9520 'Classic with Inserts' chamber is mounted in the standard support stand and procedures for experimentation are the same as with the 'Classic' system.



Chamber Configurations

U9500 chambers are available with pinned openings in diameters from 3.8 to 13.5 mm and in slot widths from 1.6 to 3.5 mm to accommodate a variety of tissue dimensions. The choice of pin configuration depends on the epithelia under study. The specified diameter designates the main opening to which the buffer makes contact with the membrane.

U9520 chamber inserts are available with openings in diameters from 3.8 to 13.5 mm. Inserts are also available for culture cups from Falcon, Millicell, Snapwell, and Transwell.

Both U9500 and U9520 chambers are available with and without drains.

Circulation Reservoirs, 3 Volumes

Available in 4, 10, and 20 ml capacities, circulation reservoirs are two sided, hand-blown apparatus made from borosilicate glass. Each side has two outlets at the base for connection to the perfusion fittings on the associated Ussing chamber-half. Each side also has a separate air/gas inlet to drive the circulation system. Gas, commonly a 95% O₂/5% CO₂ mixture, is forced under low pressure into these inlets and allowed to come into contact with the buffer solution. The rising bubbles drive circulation and oxygenate the buffer. This method is commonly referred to as a 'gas-lift' perfusion system.

Each horizontal reservoir arm has either an inlet or outlet port for access to the water jacket. Water at the desired temperature is pumped through the jacket and allowing thermoregulation of the perfusion solutions. Glass condensers are provided to minimize evaporative solution losses from the top. Reservoirs are.

Electrode Sets and Agar Bridge Fittings

Each chamber is supplied with a U9975A Electrode Set comprised of 4 electrodes, 2 Ag-AgCl pellet electrodes (for voltage) and 2 Ag wire electrodes (for current). Electrodes include 1 meter (3 feet) of wire and a connector to plug into the amplifier headstage.

Also supplied are Luer taper fittings that screw onto the electrodes to provide an agar salt bridge connection into the chamber. Fittings can be filled with agar either before or after assembly onto the electrodes.



How to Order:

- **Select Base Assembly with desired reservoir size.** Systems include support stand with rods, circulation reservoir, 3-prong clamp, U9303 Air/Gas Fitting Kit, U9975A Electrode Set, and U9965EP Electrode Bridge Fitting Kit
- **Select chamber.** Choices are 'Classic' or 'Classic with Insert'. Both available with or without drains
- Finally, if using Classic with Insert', **select desired insert**

Base Assembly

Order #	Model	Description
64-0500-R4	U95004R	Classic Ussing base assembly with 4 ml circulation reservoir
64-0500-R10	U950010R	Classic Ussing base assembly with 10 ml circulation reservoir
64-0500-R20	U950020R	Classic Ussing base assembly with 20 ml circulation reservoir

'Classic' Chambers

Model	Description	Order #	
		Without Drains	With Drains
U9504	'Classic' chamber with 3.8 mm D round opening	64-0504	64-0512
U9506	'Classic' chamber with 6.0 mm D round opening	64-0505	64-0513
U9509	'Classic' chamber with 9.0 mm D round opening	64-0506	64-0514
U9512	'Classic' chamber with 12.0 mm D round opening	64-0507	64-0515
U9513	'Classic' chamber with 13.5 mm D round opening	64-0508	64-0516
U9504SP-1	'Classic' chamber with 1.5 x 7.0 mm slotted opening	64-0509	64-0517
U9504SP-2	'Classic' chamber with 2.5 x 7.0 mm slotted opening	64-0510	64-0518
U9504SP-3	'Classic' chamber with 3.5 x 7.0 mm slotted opening	64-0511	64-0519

'Classic with Insert' Chamber

Model	Description	Order #	
		Without Drains	With Drains
U9521	'Classic with Insert' chamber, no insert	64-0532	64-0533

Classic with Inserts' Chambers Inserts

Order #	Model	Description	Working Area
Inserts with pins			
64-0539	U9524B-04	3.8 mm round insert with 5 pins	11.3 mm ²
64-0540	U9524B-06	6.0 mm round insert with 5 pins	28.3 mm ²
64-0541	U9524B-09	9.0 mm round insert with 5 pins	63.6 mm ²
64-0542	U9524B-12	12.0 mm round insert with 5 pins	113.2 mm ²
64-0543	U9524B-13	13.5 mm round insert with 5 pins	143.1 mm ²
Inserts with o-rings			
64-0534	U9524A-04	3.8 mm round insert with o-ring	11.3 mm ²
64-0535	U9524A-06	6.0 mm round insert with o-ring	28.3 mm ²
64-0536	U9524A-09	9.0 mm round insert with o-ring	63.6 mm ²
64-0537	U9524A-12	12.0 mm round insert with o-ring	113.2 mm ²
64-0538	U9524A-13	13.5 mm round insert with o-ring	143.1 mm ²

Inserts for Culture Cups

Order #	Model	Description
64-0549	U9524S	Snapwell™ adapter
64-0544	U9524F-09	Falcon® adapter, 9 mm dia
64-0545	U9524F-12	Falcon® adapter, 12 mm dia
64-0546	U9524F-25	Falcon® adapter, 25 mm dia
64-0547	U9524M-12	Millicell® adapter, 12 mm dia
64-0548	U9524M-30	Millicell® adapter, 30 mm dia
64-0550	U9524T-06	Transwell® adapter, 6.5 mm dia
64-0551	U9524T-12	Transwell® adapter, 12 mm dia
64-0552	U9524T-24	Transwell® adapter 24 mm dia

How to Order: (continued)

Accessories and Replacement Parts

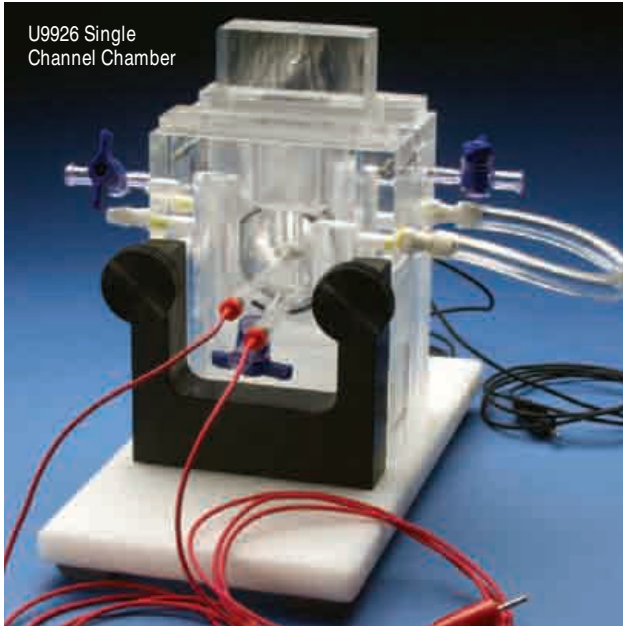
Order #	Model	Description
64-0553	U9565EP	Electrode bridge fittings, pkg. of 12, and adapters, pkg. of 6
64-0554	U9975A	Electrode set, 2 Ag/AgCl pellet, 2 Ag wire
64-0555	U9985	Bridge fitting adapters, pkg. of 6
64-0560-4ml	U9302-4	Condenser set for 4 ml circulation reservoir, set of 2
64-0560-10ml	U9302-10	Condenser set for 10 ml circulation reservoir, set of 2
64-0560-20ml	U9302-20	Condenser set for 20 ml circulation reservoir, set of 2
64-0561	U9303	Air/Gas connection kit
64-0562	U9403	Support stand with one stand rod
64-0563	U9403R	Support stand rod
64-0564	U9404	3-Prong clamp
64-0165	SL-6	Stopcocks, pkg. of 6



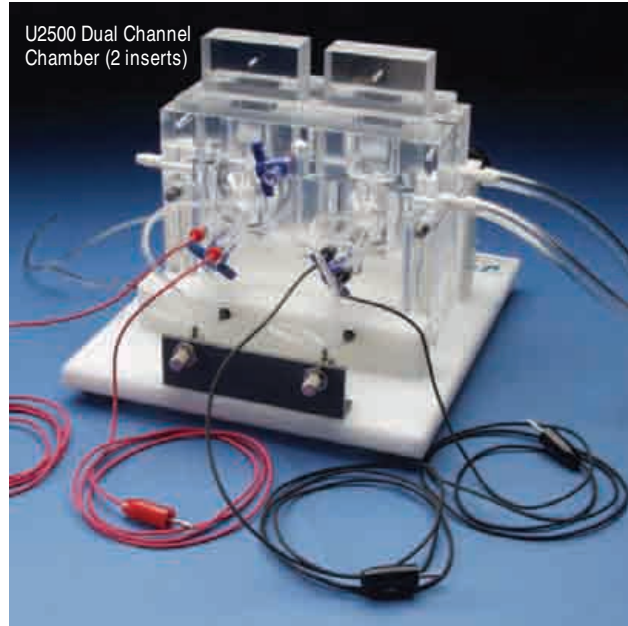
Self-Contained Ussing Chambers

U9926 & U2500

The U9926 and U2500 Self-Contained Ussing chambers improve on the Classic design by bringing the solution reservoir into the chamber housing. This dramatically reduces the size of the apparatus and increases the ease-of-use of the system.

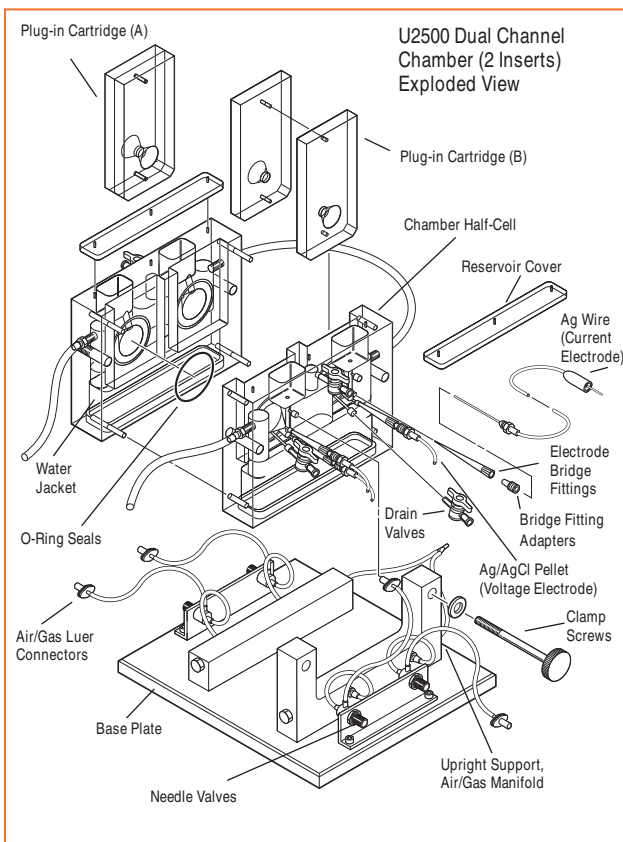


U9926 Single Channel Chamber



U2500 Dual Channel Chamber (2 inserts)

GUIDE TO USSING CHAMBER SYSTEMS



The Self-Contained Ussing Chamber Systems

The Self-Contained Ussing Chambers systems come in single- and dual-channel models and offer many advantages over the Classic design. The single-channel **U9926** and dual-channel **U2500** are shown above. Both systems make use of inserts to secure and position the tissue or culture cup

Chamber bodies (single- and dual-chamber models) consist of chamber-halves which clamp around the insert(s). Each chamber-half has four ports that enter into its respective bath compartment: a voltage electrode port, a current electrode port, an air/gas port, and a solution drain port. Solution warming is provided by pumping heated water through each chamber-half and there are no delicate glass heat exchangers to be broken. The dual-chamber U2500 has the additional feature of including four needle valves for adjusting the air/gas mixture into each individual chamber-half.

Inserts can be easily exchanged between experiments. Solutions are removed from the chambers through the drain valves and the halves unclamped from each other. The insert is then simply replaced. Inserts are available to support a variety of tissue sizes and culture cups.

Standard Accessories Supplied with U9926 and U2500

The U9926 (single-channel chamber) is supplied with 1 electrode set (consisting of 2 voltage and 2 current electrodes), 12 bridge fittings with adapters; and a tubing/ fitting kit. The U2500 (dual channel) chamber is supplied with two each of the above described accessories. Chamber inserts are ordered separately.

How to Order:

- **Select Base Assembly.** Each system includes one or two U9975A Electrode Set(s) and U9965EP Electrode Bridge Fitting Kit(s)
- **Select Insert.** Order 1 if using the U9926 and order 2 if using the U2500

Base Assembly

Order #	Model	Description
64-0568S	U9926	Single-channel Ussing chamber base assembly, does not include insert
64-0575S	U2500	Dual-channel Ussing chamber base assembly, does not include inserts

Inserts for U9926 & U2500 Base Assembly

Inserts for tissue, with o-rings

Order #	Model	Description	Working Area
64-0582	U9924A-04	Round insert, 3.8 mm, with o-ring	11.3 mm ²
64-0583	U9924A-06	Round insert, 6.0 mm, with o-ring	28.3 mm ²
64-0584	U9924A-09	Round insert, 9.0 mm, with o-ring	63.6 mm ²
64-0585	U9924A-12	Round insert, 12.0 mm, with o-ring	113.1 mm ²
64-0586	U9924A-13	Round insert, 13.5 mm, with o-ring	143.1 mm ²

Inserts for tissue, with pins

64-0587	U9924B-04	Round insert, 3.8 mm, with 5 pins	11.3 mm ²
64-0588	U9924B-06	Round insert, 6.0 mm, with 5 pins	28.3 mm ²
64-0589	U9924B-09	Round insert, 9.0 mm, with 5 pins	63.6 mm ²
64-0590	U9924B-12	Round insert, 12.0 mm, with 5 pins	113.1 mm ²
64-0591	U9924B-13	Round insert, 13.5 mm, with 5 pins	143.1 mm ²
64-0592	U9924C-03	Slotted insert, 1.6 x 7.0 mm, with 6 pins	10.7 mm ²
64-0593	U9924C-04	Slotted insert, 2.4 x 7.0 mm, with 6 pins	15.6 mm ²
64-0594	U9924C-05	Slotted insert, 3.5 x 7.0 mm, with 6 pins	21.9 mm ²

Inserts for U9926 & U2500 Base Assembly

Order #	Model	Description
Inserts for culture cups		
64-0595	U9924F-09	Falcon® adapter, 9 mm dia
64-0596	U9924F-12	Falcon® adapter, 12 mm dia
64-0597	U9924F-25	Falcon® adapter, 25 mm dia
64-0598	1U9924M-12	Millicell® adapter, 12 mm dia
64-0599	U9924M-30	Millicell® adapter, 30 mm dia
64-0600	U9924S	Snapwell™ adapter, 12mm dia
64-0601	U9924T-06	Transwell® adapter, 6.5 mm dia
64-0602	U9924T-12	Transwell® adapter, 12 mm dia
64-0603	U9924T-24	Transwell® adapter, 24 mm dia

Replacement Parts

Order #	Model	Description
64-0565	U9406	Tubing/Fitting Kit; Includes 3/16 in x 10 ft (ID x L) Tygon Tubing, 1/16 in x 10 ft (ID x L) Tygon Tubing, Eighteen 1/16 in Fittings (six each of straight, Y and Luer Fittings)
64-1521	U9565SC	Electrode Bridge Fitting Kit; Includes twelve Bridge Fittings, six Bridge Fitting Adapters
64-0554	U9975A	Electrode Set; Includes two Ag-AgCl Pellet Voltage Electrode, two Ag Wire Current Electrode
64-0555	U9985	Bridge Fitting Adapters, pkg. of 6
64-0604	U9605	Replacement o-rings, pkg. of 4

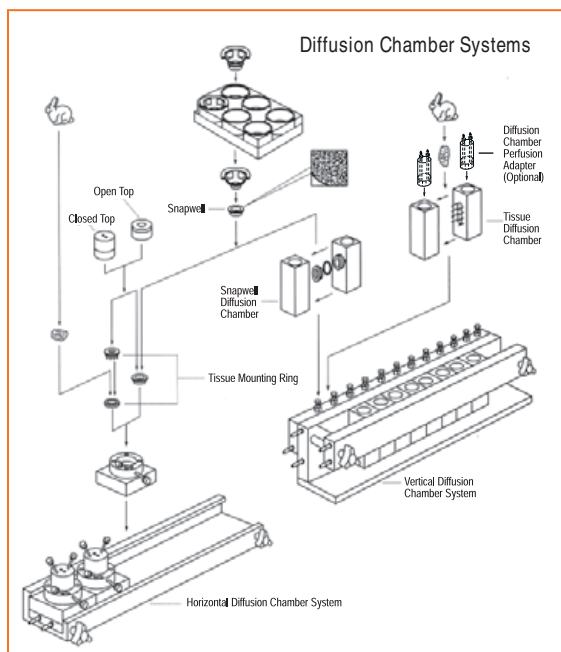
Warner Instruments offers three multichannel Ussing chamber systems capable of supporting up to 24 independent chambers, all operating in parallel. Two systems position the membrane vertically and one positions the membrane horizontally. All three multichannel chamber systems embody the self-contained design and are fully capable of supporting either membranes or cell culture cups. The differences between these systems are explained below.



NaviCyte Horizontal and Vertical Chamber Systems

The Harvard/NaviCyte patented line of horizontal and vertical diffusion chambers is designed for the study of transport across cultured cell monolayers or excised tissue under dynamic conditions. The basic system architecture shown here demonstrates the fundamental design of both the horizontal and vertical diffusion chamber systems.

These systems are extremely well suited for non-electrical applications, however, the introduction of electrodes can provide the ability to make electrophysiological measurements. For larger applications, electrical manifolds can be employed to organize and simplify the connections to our various voltage/current clamps. NaviCyte chamber systems are manufactured from acrylic and can be temperature controlled.

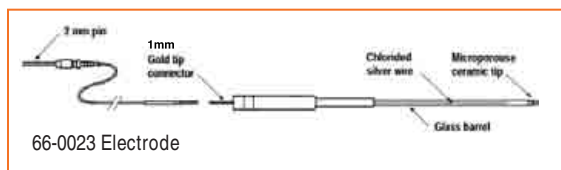


The **NaviCyte Horizontal** chamber system is designed for transport and toxicology studies using cells or tissue exposed to an air interface such as occurs in the *in vivo* environment (e.g., nasal, pulmonary, corneal, or dermal cells). The chambers create an environment wherein the apical surface can be exposed to liquids, semi-solid compounds, or to gases while the basolateral surface remains perfused with medium. NaviCyte Horizontal chambers accept either tissue mounting rings or Snapwell™ cell culture cups and can be used in either open or closed configurations. In the closed configuration, electrodes can be brought to bear to make electrophysiological membrane resistance measurements. Accepts from 1 to 6 chambers.

Similar to the NaviCyte Horizontal, the **NaviCyte Vertical** chamber system is designed for transport studies on filter grown cell monolayers or excised tissue sections. This system differs, however, in that membranes are mounted vertically and the chamber blocks do not use inserts to secure tissues. Instead, tissue is affixed between the opposing faces of the chamber-halves using a series of pins surrounding the opening. Chambers are available with both circular and oblong openings, depending on the tissue type under study, and can also accommodate Snapwell™ culture cups. Several low volume chambers that reduce the amount of compound required to conduct permeability studies are also available. Accepts from 1 to 24 chambers.

NaviCyte Electrodes

The NaviCyte electrodes can be used with either the NaviCyte horizontal or vertical chamber systems and provide the ability to make electrophysiological recordings. Electrodes are terminated with a 2 mm pin connector and are compatible with the NaviCyte electric manifolds (used to connect chambers to our current/voltage clamps). The Ag/AgCl reference electrode is contained in a glass barrel that terminates in a micro-porous ceramic tip. The barrel is filled with a suitable electrolyte solution, usually the buffer used for the external media or 3M KCl, and is refillable.

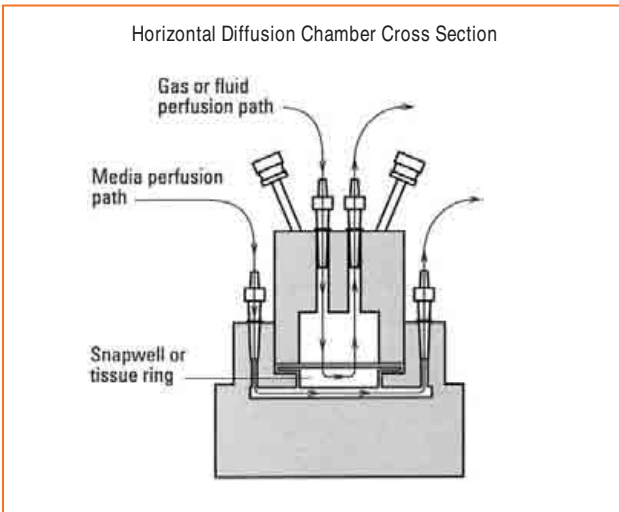


EasyMount

EasyMount Vertical Chamber Systems

The EasyMount Vertical chamber systems are ideal for studies requiring electrophysiological measurement of transmembrane resistance. While visually similar to the NaviCyte Vertical chambers, EasyMount chambers are different in that they use inserts to position and secure tissues or culture cups within the chamber body. Inserts can be easily exchanged without removing the chamber from its support assembly or disturbing the electrodes. Chambers come in standard and low volume designs with a variety of inserts available for each. All chambers, however, mount into the same support assembly. Accepts from 2 to 8 chambers.

This system features the ability to run up to six chambers simultaneously and is optimized for transport studies on cells and tissues exposed to an air interface. The included heater block permits temperature control, with the use of a circulating water bath, for these chambers in both open and closed configurations. While optimized for diffusion-based studies, the use of optional electrodes permits electrophysiological membrane resistance measurements.



The NaviCyte Horizontal chamber system consists of a heater/support block and up to six horizontal chambers. Chambers require the use of a supplied open or closed chamber cap into which either a Snapwell™ culture cup or a tissue mounting ring may be fitted. Culture cups or tissues are mounted on a horizontal plane. Chambers have basolateral and apical inputs for attachment to perfusion lines, and in the closed configuration chambers can accept electrodes.

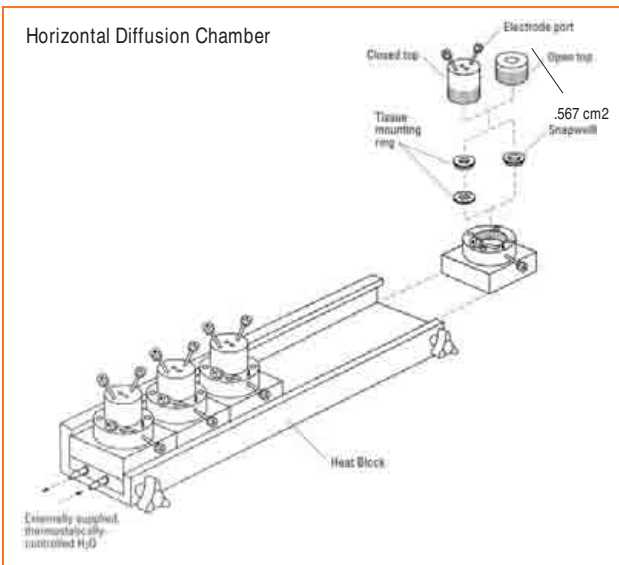
Single or Multichannel Setups

Chambers can be used singly as a stand-alone entity, or can be mounted into the heater/support block in sets of up to six chambers per block. The heater/support block provides chamber heating and is recommended even if using a single chamber. Inserts are easily exchanged in mounted chambers. The compact footprint (38.1 x 8.9 x 10.2 cm) of the heater/support block conserves lab bench space.

Open and Closed Configurations

Open and closed chamber configurations are defined by the use of an open or closed chamber cap. Either cap completes the chamber and holds the culture cup or tissue ring into place. Both an open and closed cap is supplied with each chamber.

In the open configuration, the upper surface (usually the apical side) of the membrane is directly accessible, making the system suitable for drug transport studies or cytotoxicity testing of liquids or semi-solid materials. In the closed configuration, the membrane can be exposed to solutions, exposed to gases, perfused with gas, or perfused with liquid.

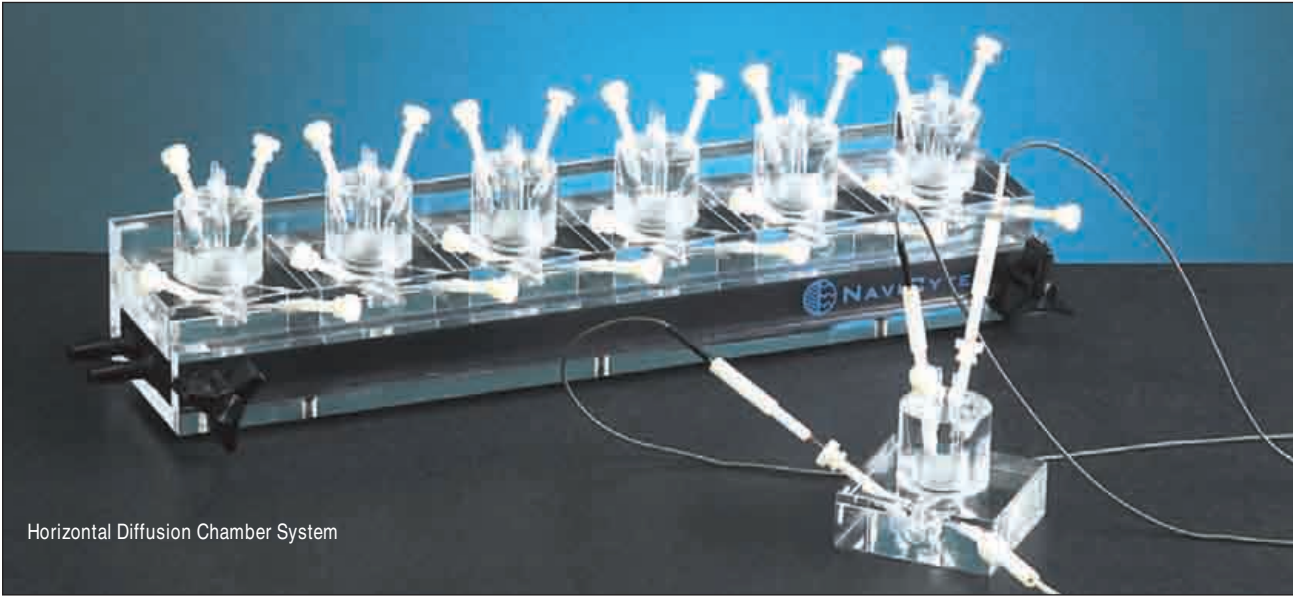


NaviCyte Electrodes and Manifolds

While optimized for diffusion-based assays, NaviCyte electrodes are available for making electrophysiology-based measurements from NaviCyte chambers. Electrodes can only be used with the NaviCyte Horizontal chamber in its closed configuration.

Electrical manifolds are available to organize the multiple connections between the amplifiers and the electrodes when making electrophysiology-based measurements using multiple chambers. Two electrical manifolds are available, one compatible with the VCC amplifiers and the other compatible with the 'Computer Controlled Multi-Clamp with Software' package. See the associated amplifiers for these required components.

An optional gas manifold is also available to manage gas connections to the chambers. Note that a gas and electrical manifold cannot be used simultaneously with NaviCyte Horizontal system.



Horizontal Diffusion Chamber System

How to Order:

- **Select Base Assembly.** This is the heater block and is needed only if using more than one chamber or if heating
- **Select Chambers.** Order from 1 to 6 per heater block. Each chamber includes both open and closed caps, and electrode port screws (for perfusion-only applications)
- **Order a tissue mounting ring** if not using Snapwell. Order one per chamber
- **Order electrodes, glass barrels, and open screws** if making electrophysiological recordings

Base Assembly

Order #	Description
66-0017	Base assembly/heater block for horizontal chambers

NaviCyte Horizontal Chambers

Order #	Description
66-0016	Single NaviCyte horizontal diffusion chamber
66-0022	Tissue mounting ring, 9 mm round aperture

Electrode Components

Order #	Description
66-0023	Ag/AgCl electrodes with KCl, pkg. of 4
66-0024	Glass barrel for electrode, with ceramic tip, pkg. of 8
66-0058	Open screw (straight hole) and o-rings, serves as an electrode holder, pkg. of 24

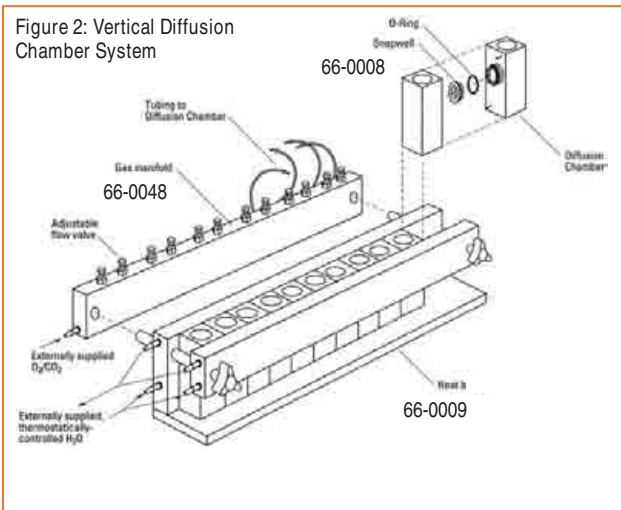
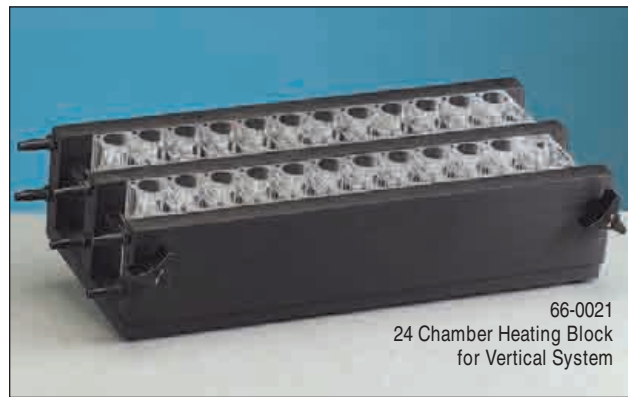
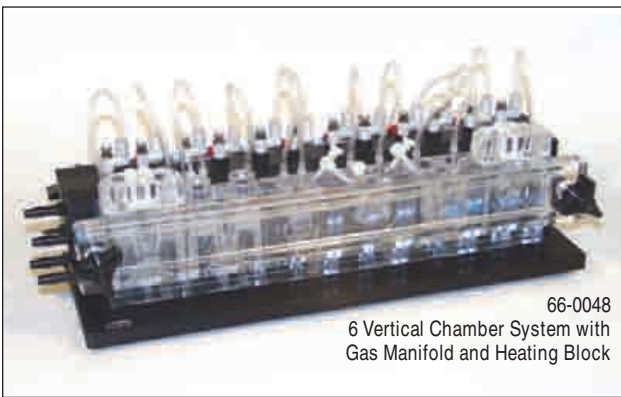
Accessories and Replacements Parts

Order #	Description
66-0054	Closed caps for horizontal chambers
66-0055	Open caps for horizontal chambers
66-0053	Closed screws, used when perfusion is not needed, pkg. of 24
66-0056	Male Luer fitting - 3/32 bar, pkg. of 24
66-0057	Small o-rings for electrodes, pkg. of 24
66-0048	6-Channel gas manifold (includes air lines to chamber)

6-Channel System

Order #	Description
66-0005	6-Channel NaviCyte Horizontal Chamber System - Includes base assembly and six horizontal chambers

This system features the capacity of running up to 24 chambers simultaneously and is optimized for transport studies on both filter grown cell monolayers and surgically excised tissue sections. 14 different chamber types are currently available. The standard support assembly holds 6 chambers and the included 12 channel gas manifold provides air regulation to both sides of each chamber. An included heater block allows for temperature control with the use of a circulating water bath. While optimized for diffusion-based studies, the use of optional electrodes allows for electrophysiological membrane resistance measurements.



The NaviCyte Vertical chamber system consists of up to six vertical chambers, a gas manifold, and a heater block. The system can be extended to 24 channels by the use of an available 24 channel heater block. NaviCyte Vertical chambers do not use inserts, except for the Snapwell chamber, and 14 different chambers are currently available. Chambers are described in detail below.

Single or Multichannel Setups

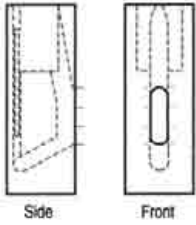
Chambers can be used singly as a stand-alone entity, or can be mounted in quantity into the heater/support blocks. The heater/support blocks provide chamber heating. The standard heater block and associated gas manifold allows up to six experiments to be run in parallel. The compact design (38.1 x 10.2 x 12.7 cm) of this setup conserves valuable bench space.

Heater Blocks

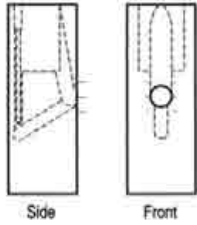
The standard heater block of the NaviCyte Vertical chamber system provides efficient and precise temperature control of chambers. Temperature is regulated by use of an external, user supplied circulating water bath. An optional 24 channel heat block (shown above) allows a greater number of simultaneous measurements to be made.

Gas Manifold

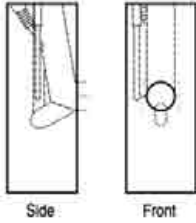
The 6-chamber (12-channel) gas manifold distributes gas to the chambers where media circulation is generated by the previously described gas-lift process. Gas manifolds can be ganged to accommodate the 24 chamber heater block.



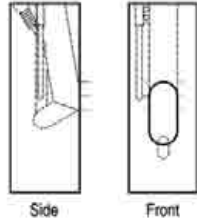
Standard Diffusion Chamber
66-0013,0032,0038,0046



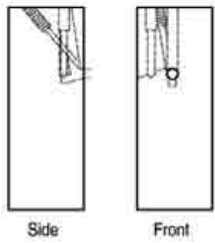
Standard Diffusion Chamber
66-0014, 0036



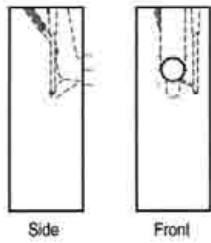
Low Volume Diffusion Chamber
66-0027



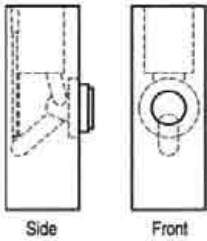
Low Volume Diffusion Chamber
66-0034, 0042



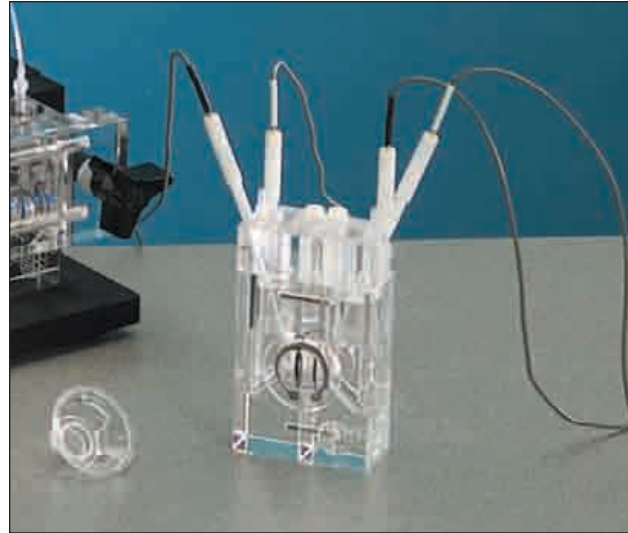
Low Volume Diffusion Chamber
66-0026, 0040



Low Volume Diffusion Chamber
66-0015



Snapwell™ Diffusion Chamber
66-0008



NaviCyte Vertical Chambers

NaviCyte Vertical chambers are primarily designed for work with excised tissue segments. Chambers are two piece assemblies held together by a high spring-tension retaining ring to insure leak free operation. Tissue is affixed between the opposing faces of two half-chambers using a series of pins that surround the opening. Chambers are available with both circular and oblong openings of various sizes.

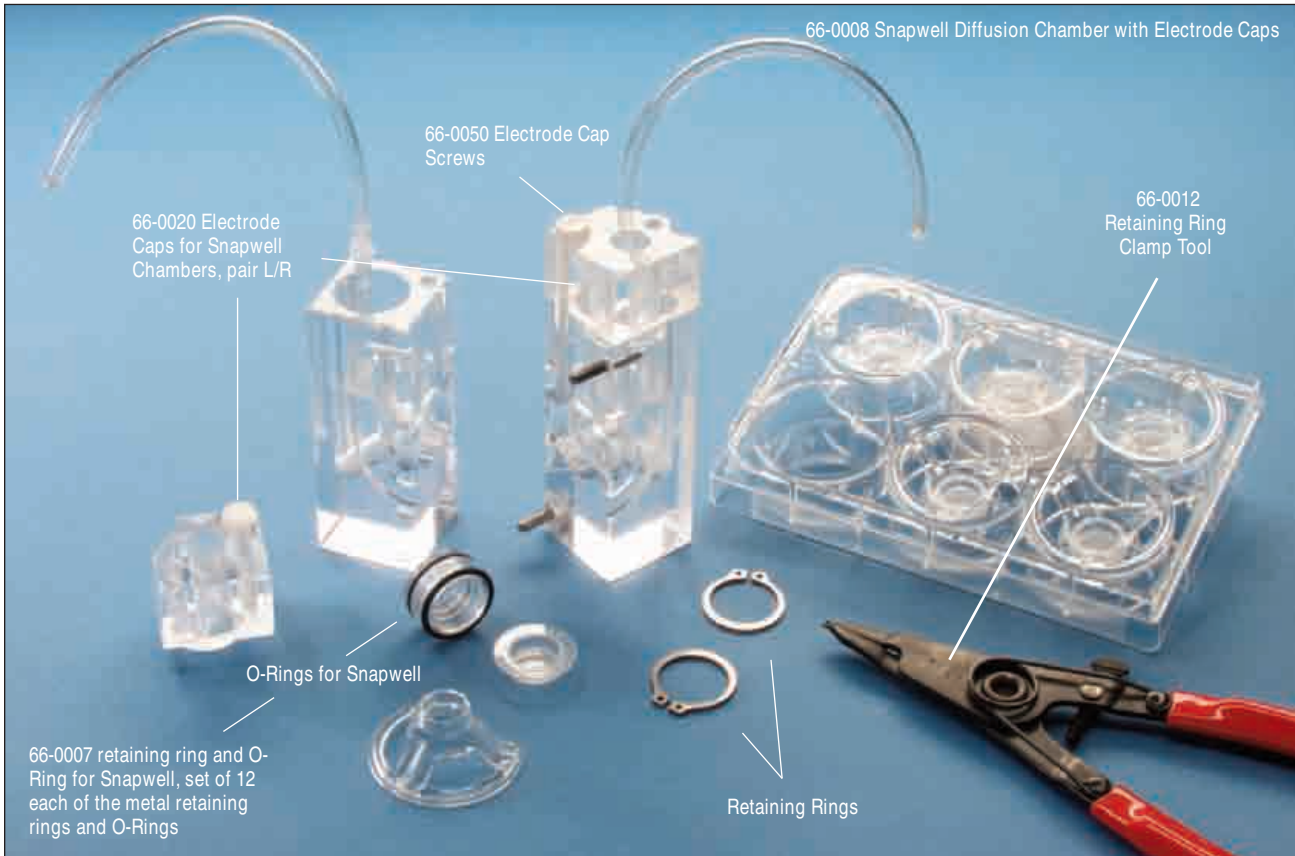
The optimal choice of opening will depend on the size and type of tissue under study. For example, an oblong opening can increase the effective sample surface area for an intestinal tissue.

Low Volume Chambers

Several low volume tissue chambers are offered and are designed to reduce the amount of compound required for permeability studies.

Snapwell™ Chamber

The Snapwell™ chamber is specifically designed for use with Snapwell™ culture inserts from Corning Costar. This chamber accepts the lower section of the insert, which contains the cultured cell monolayer.



Perfusion Caps

Perfusion caps provide perfusion capability to the standard volume Snapwell™, 8 x 24 mm oblong, and 9 mm round chambers. They are not needed for, and cannot be used with, the other standard volume or any of the low volume chambers. The use of a perfusion cap places a chamber into its 'closed' configuration.

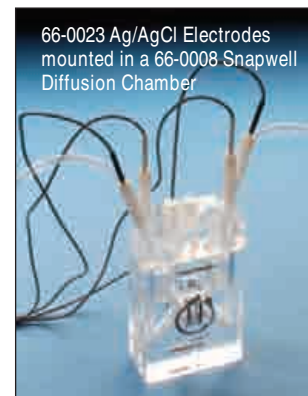
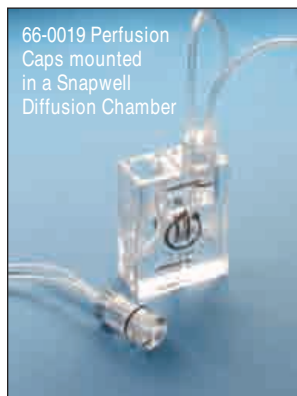
Electrode Caps

Electrode caps provide electrode placement, if making electrophysiological measurements, within the standard volume Snapwell™, 8 x 24 mm oblong, and 9 mm round chambers. They are not needed for, and cannot be used with, the other standard volume or any of the low volume chambers. The use of an electrode cap places a chamber into its 'closed' configuration. You do not need to use a perfusion cap if using an electrode cap.

NaviCyte Electrodes and Manifold

While optimized for diffusion-based assays, NaviCyte electrodes are available for making electrophysiology-based measurements with NaviCyte chambers. Electrodes can be used with NaviCyte Horizontal chambers in both their open and closed configurations. Snapwell™, 8 x 24 mm oblong, and 9 mm round chambers (standard volume) require the use of electrode caps for proper electrode placement.

Electrical manifolds are available to organize the multiple connections between the amplifiers and the electrodes when making electrophysiology-based measurements using multiple chambers. Two manifolds are available, one compatible with the VCC amplifiers and the other compatible with the 'Computer Controlled Multi-Clamp with Software' package. See the associated amplifiers for these components.



References

- 1) Grass, G.M. and Sweetana, S.A., "In vitro measurement of gastrointestinal tissue permeability using a new diffusion cell", *Pharm. Res.* 5:372-76 (1988)
- 2) Hidalgo, I.J., Hilgren, K.M., Grass, G.M., and Borchardt, R.T., "Characterization of the unstirred water layer in Caco-2 cell monolayers using a novel diffusion apparatus", *Pharm. Res.* 8:222-227 (1991)

For additional references, please visit our website.

How to Order:

- **Select Base Assembly.** Only needed if using more than one chamber or if heating.
- **Select Chambers.** Order from 1 to 6.
- **Order Perfusion Caps.** Only needed if perfusing in the standard volume Snapwell, 8 x 24 mm oblong, and 9 mm round chambers. Not needed if using electrode cap. One set per chamber.
- **Order electrodes and glass barrels** if making electrophysiological recordings. One set per chamber.
- **Order electrode caps and electrode cap screws** if making electrophysiological recordings in the standard volume Snapwell, 8 x 24 mm oblong, and 9 mm round chambers. One set per chamber.

Base Assembly

Order #	Description
66-0075	6-Chamber heater block assembly - System includes 6-Chamber heating block, 6-chamber air/gas manifold, clear front panel, and retaining ring clamp tool.

NaviCyte Vertical Chambers

Order #	Chamber Type	Exposed Tissue Area	Working Reservoir Vol	Requires Perfusion or Electrode Caps (not include)
Standard Volume				
66-0014	9 mm round	0.64 cm ²	5 to 7 ml	yes
66-0036	4 mm round	0.12 cm ²	5 to 7 ml	
66-0013	8 x 24 mm oblong	1.78 cm ²	5 to 7 ml	yes
66-0032	4 x 8 mm oblong	0.29 cm ²	5 to 7 ml	
66-0038	6 x 9 mm oblong	0.46 cm ²	5 to 7 ml	
66-0046	5 x 24 mm oblong	1.15 cm ²	5 to 7 ml	
Low Volume				
66-0026	5 mm round	0.20 cm ²	0.2 to 0.4 ml	
66-0015	9 mm round	0.64 cm ²	1 to 2 ml	
66-0027	12 mm round	1.13 cm ²	2 to 4 ml	
66-0040	3 mm round	0.07 cm ²	1 to 2 ml	
66-0034	2 x 10 mm oblong	0.10 cm ²	2 to 4 ml	
66-0042	4 x 8 mm oblong	0.28 cm ²	2 to 4 ml	
Specialty				
66-0008	Snapwell™	1.13 cm ²	4 to 6 ml	yes

Perfusion

Order #	Description
66-0019	Tissue Chamber Perfusion Cap, pkg. of 2

Electrodes

Order #	Description
66-0018	Electrode Cap for chambers, pair L/R
66-0020	Electrode Cap for Snapwell Chambers, pair L/R
66-0050	Electrode Cap Screws, pkg. of 12
66-0023	Ag/AgCl Electrodes with KCl, pkg. of 4, with O-rings
66-0024	Glass Barrel for Electrode with Ceramic Tip, pkg. of 8
66-0049	Open Screws (with step) and O-rings, pkg. of 12. Serves as Electrode Holders for Low Volume Chambers.
66-0057	Small O-rings for Electrodes, pkg. of 24

How to Order: (continued)

Accessories and Replacement Parts

Order #	Description
66-0009	6-Chamber Heating Block
66-0048	6-Channel gas manifold (includes air lines to chambers)
66-0021	24-Chamber Heating Block
66-0010	Clear Front Panel
66-0007	Retaining Ring and O-Ring, pkg. of 12
66-0012	Retaining Ring Clamp Tool
66-0006	Replacement Air Line for Air\Gas Manifold, 6 inch long, pkg. of 12
7507-023	Replacement Air Line for Air\Gas Manifold, 6 inch long, 1 ea.
7507-028	Replacement Air Line for Air\Gas Manifold, 36 inch long, 1 ea.

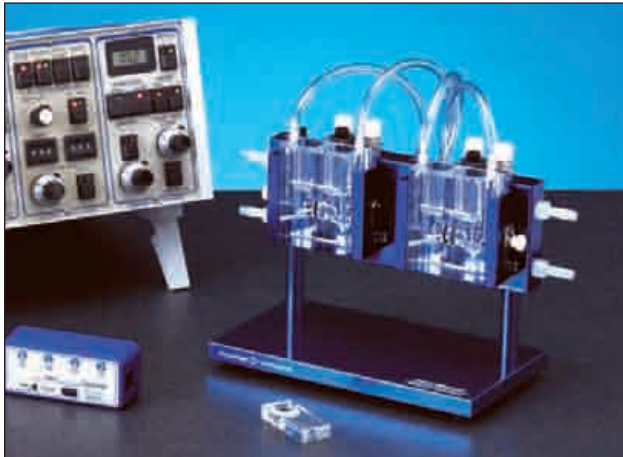
Package Systems (Where needed, perfusion or electrode caps not included)

Order #	Description
Standard Volume Systems	
66-0003	NaviCyte Vertical Chamber System - Includes Base Assembly and six 9 mm round (66-0014) chambers
66-0037	NaviCyte Vertical Chamber System - Includes Base Assembly and six 4 mm round (66-0036) chambers
66-0002	NaviCyte Vertical Chamber System - Includes Base Assembly and six 8x24 mm oblong (66-0013) chambers
66-0033	NaviCyte Vertical Chamber System - Includes Base Assembly and six 4x8 mm oblong (66-0032) chambers
66-0039	NaviCyte Vertical Chamber System - Includes Base Assembly and six 6x9 mm oblong (66-0038) chambers
66-0047	NaviCyte Vertical Chamber System - Includes Base Assembly and six 5x24 mm oblong (66-0046) chambers
Low Volume Systems	
66-0028	Low Volume NaviCyte Vertical Chamber System - Includes Base Assembly and six 5 mm round (66-0026) chambers
66-0004	Low Volume NaviCyte Vertical Chamber System - Includes Base Assembly and six 9 mm round (66-0015) chambers
66-0029	Low Volume NaviCyte Vertical Chamber System - Includes Base Assembly and six 12 mm round (66-0027) chambers
66-0041	Volume NaviCyte Vertical Chamber System - Includes Base Assembly and six 3 mm round (66-0040) chambers
66-0035	Volume NaviCyte Vertical Chamber System - Includes Base Assembly and six 2x10 mm oblong (66-0034) chambers
66-0043	Volume NaviCyte Vertical Chamber System - Includes Base Assembly and six 4x8 mm oblong (66-0042) chambers
Specialty Systems	
66-0001	NaviCyte Vertical Chamber System - Includes Base Assembly and six Snapwell (66-0008) chambers



The EasyMount chamber systems are ideal for studies requiring electrophysiological measurement of transmembrane resistance. While visually similar to the NaviCyte Vertical chambers, EasyMount chambers are different in that they use inserts to position and secure tissues or culture cups within the chamber body.

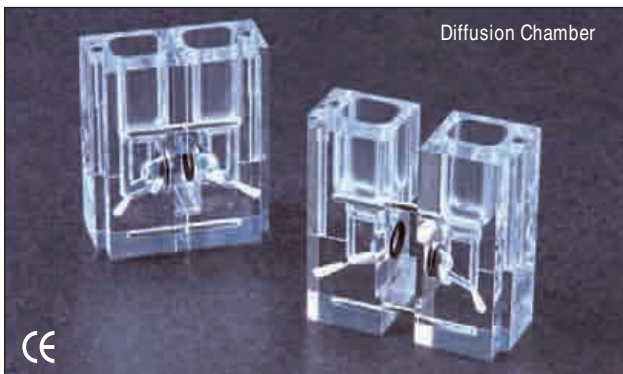
EasyMount



The EasyMount chamber systems consist of 2 to 8 vertical Ussing chambers, a heater block/support stand, needle valves for adjustment of gas flow (for oxygenation and gas lift stirring), and Ag/AgCl voltage/current electrodes for measuring transepithelial voltage and for passing current. Tissue specific inserts are ordered separately.

Multichannel Setups

All EasyMount chambers (P2300 and P2400,) use the same stands and electrodes. Stands are available to support 2, 4, 6, or 8 chambers and can be readily ganged to allow for higher count applications. Stands have an incorporated heater block that warms all chambers to the same temperature. A needle valve assembly (one set per chamber) is mounted on the rear of the heater block for regulation of the gas flow.



EasyMount Chambers

EasyMount chambers are a two piece assembly using an insert to secure and position tissues or culture cups. Tissues are placed in the chamber by loosening a thumbscrew, sliding the tissue holding insert into the space between the chamber halves, and retightening the thumbscrew. Chambers do not need to be removed from the heater block, nor are the electrodes disturbed, when placing an insert. This easy and rapid replacement process makes the EasyMount system an excellent choice for high-throughput applications.

Chambers are available in two styles; the P2300 is the standard chamber and accommodates a large variety of inserts and the P2400 is designed for low-volume applications. The P2300 has chamber caps available for sealing the chamber when radioligands or toxic chemicals are used.



EasyMount Inserts

EasyMount inserts are available to mount a variety of tissues and can also accommodate cell culture cups. Each chamber type has its own supporting family of inserts.

The P2300 Series inserts are available to accommodate Snapwell, Millicell, Nunc, and Transwell culture cups. Inserts are also available with pins or o-rings in both oblong and round formats.

P2400 Series inserts do not support culture cups but are available with pins or o-rings in both oblong and round formats.



Electrodes and Accessories

Electrodes are available in sets comprised of two sintered Ag/AgCl pellet electrodes for voltage sensing (black), two Ag wire electrodes for current passing (white), and eight electrode tips. The number of sets provided is dependent on the system purchased, however, one electrode set is required for each chamber.

Replacement current and voltage electrodes are available, as are electrode tips. Additional accessories include electrode lead sets and chamber filling needles.

How to Order:

- **Select Chamber Assembly.** Each assembly includes heater block/stand, chambers, needle valves, and electrodes.
- **Select Chamber Inserts.** Select from P2300 or P2400 Series depending on volume of system assembly chosen.
- **Select FN15 filling needles and extra electrode tips.**
- **Select P23000 Chamber Caps** (if using radioligands or toxic chemicals with these chambers)

EasyMount Chamber Assembly

Order #	Model	Description
P2300 Chamber Systems, No Inserts (Standard Volume)		
69-1070	CSYS-2HA	P2300 EasyMount system with 2 chambers
69-1071	CSYS-4HA	P2300 EasyMount system with 4 chambers
69-1072	CSYS-6HA	P2300 EasyMount system with 6 chambers
69-1073	CSYS-8HA	P2300 EasyMount system with 8 chambers
P2400 Chamber Systems, No Inserts (Low Volume)		
69-1074	LVSYS-2HA	P2400 EasyMount system with 2 chambers
69-1075	LVSYS-4HA	P2400 EasyMount system with 4 chambers
69-1076	LVSYS-6HA	P2400 EasyMount system with 6 chambers
69-1077	LVSYS-8HA	P2400 EasyMount system with 8 chambers

Chamber Inserts

Order #	Model	Aperture	Working Area	Description
Fits P2300 Chamber Systems				
69-0956	P2302	12 mm round	1.12 cm ²	For Snapwell cell culture cups
69-1081	P2302M	8.75 mm round	0.60 cm ²	For Millicell cell culture cups
69-1082	P2302N	8.0 mm round	0.50 cm ²	For Nunc/Anopore cell culture cups
69-1083	P2302T	6.5 mm round	0.33 cm ²	For Costar Transwell cell culture cups
69-1084	P2303	2.8 x 4.5 mm	0.10 cm ²	For juvenile mouse intestine
69-1085	P2303A	2.8 x 4.5 mm	0.10 cm ²	For juvenile mouse intestine or bladder, with pins
69-0957	P2304	2.8 x 11.0 mm	0.30 cm ²	For mouse intestine, with pins
69-0958	P2305	4.5 x 11.2 mm	0.50 cm ²	For rat and larger animal intestine, with pins
69-0959	P2306	2.8 x 1.5 mm	0.036 cm ²	For mouse trachea and similar tissue
69-0960	P2307	2.0 mm round	0.031 cm ²	For small tissues (e.g., biopsies)
69-1086	P2308	1.0 mm round	0.008 cm ²	For very small, thin tissues (e.g., lower mouse trachea)
69-0961	P2310	5.0 mm round	0.20 cm ²	With pins
69-0962	P2311	6.2 mm round	0.30 cm ²	With pins
69-1087	P2311A	5.7 mm round	0.26 cm ²	With pins
69-0963	P2312	8.0 mm round	0.50 cm ²	With pins
69-0964	P2313	9.5 mm round	0.71 cm ²	With pins
69-0965	P2314	11.3 mm round	1.00 cm ²	With pins
69-0966	P2315	12.7 mm round	1.26 cm ²	With pins
69-1088	P2316	5.0 mm round	0.20 cm ²	For skin, with o-ring
69-1089	P2317	10.8 mm round	0.93 cm ²	For synthetic membranes, with o-ring
69-1090	P2318	11.3 mm round	1.00 cm ²	For frog skin, with o-ring
69-1091	P2319	12.7 mm round	1.26 cm ²	For studying mucus layer, with spacer ring
Fits P2400 Chamber Systems				
69-1092	P2403	2.8 x 4.5 mm	0.10 cm ²	For small tissue specimens
69-0969	P2404	2.8 x 9.2 mm	0.25 cm ²	For mouse intestine
69-0970	P2405	4.5 x 9.2 mm	0.40 cm ²	For rat and larger animal intestine
69-0971	P2406	2.8 x 1.5 mm	0.04 cm ²	For mouse trachea
69-0972	P2407	2.0 mm round	0.031 cm ²	For biopsies
69-1093	P2408	0.8 mm round	0.005 cm ²	For biopsies
69-1094	P2408A	0.5 mm round	0.002 cm ²	For biopsies
69-1095	P2408B	1.0 mm round	0.008 cm ²	For biopsies
69-0973	P2410	5.0 mm round	0.20 cm ²	With pins
69-0975	P2412	8.0 mm round	0.50 cm ²	With pins
69-0976	P2413	9.5 mm round	0.71 cm ²	With pins

How to Order: (continued)

Accessories

Order #	Model	Description
69-0990	P2023-20	Electrode tips - 20 pack
69-0991	P2023-50	Electrode tips - 50 pack
69-0992	P2023-100	Electrode tips - 100 pack
69-1097	FNS15-2	Two syringes with filling needles
69-1098	FN15	Replacement filling needle
69-1096	P2300-CAP	Chamber caps for P2300 chamber - set of 2

Replacement Parts

Order #	Model	Description
69-0993	P2300	EasyMount Chamber - Standard volume (chamber only)
69-0995	P2400	EasyMount Chamber - Low volume (chamber only)
69-1099	P2060	Air control valve assembly, mounts on stand, fits one chamber
69-0987	P2020-S	Electrode Set (2 current, 2 voltage, 8 tips)
69-0988	P2020-IS	Electrode Set (4 current, 8 tips)
69-0989	P2020-VS	Electrode Set (4 voltage, 8 tips)
69-0998	P2024	Electrode leads (7 in, pk 4)
69-3147	P2024-36	Electrode leads (36 in, pk 4)



Single & Dual Channel Epithelial Voltage Clamps

EC-800 & EC-825A

The EC-800 and EC-825A are specifically designed for studies of epithelial transport and the electrical properties of tissue. They feature high common mode rejection, clamp speed selection, membrane resistance measurement circuitry, and a watertight headstage with model membrane.



GUIDETO USSING CHAMBER SYSTEMS

Single Channel EC-800 and Dual Channel EC-825A

Epithelial voltage clamps from Warner Instruments provide accurate measurements of transepithelial voltage, short circuit current, and membrane resistance. Important features include fluid resistance compensation, membrane resistance readout, choice of voltage compliance, and small water-tight preamp headstages. Operating modes include voltage clamp, current clamp, voltmeter, and resistance. The dual channel model includes an internal timer.

The **EC-800** and **EC-825A** are state-of-the-art instruments with several unique and important design features offering more reliable recording and operator convenience.

High CMR

Differential voltage recordings are made with very high common mode rejection providing accurate measurements free from the effects of common mode potential changes of a noisy environment.

Membrane Resistance Measurement

Accurate resistance measurements are made with the membrane mounted in the chamber. This measurement is made using a low frequency 2 Hz bipolar signal to avoid polarization of the membrane (ideal for monolayers). Resistances up to 200 k Ω are displayed on the meter with push-button convenience.

Clamp Speed Selection

Three clamp speeds provide optimum recording conditions for a variety of applications. In Fast mode, preparations with low access resistance (small tissues or monolayers) can be clamped with speeds as fast as 10 sec. Typical Ussing chambers with larger tissues will use Medium or Slow modes for stable, oscillation free clamping.

Commands

Internal DC Command (Hold) control for both Voltage clamp and Current clamp modes.

Watertight Headstage with Model Membrane

The small compact headstage can be located close to the measurement site to keep input leads short for reduced noise pick-up. The model membrane circuit simulates a preparation to provide convenient operational checks of the clamp. Internal circuits are protected against the invasion of corrosive saline solutions by a watertight seal.

Choice of Voltage Compliance

The EC-800 has a voltage compliance of ± 120 V and the EC-825A has a voltage compliance of ± 50 V. The high voltage compliance of these instruments are important for studies of low resistance (leaky) epithelial cells and in applications in which long agar leads in the current passing circuit produce large voltage drops (which must be compensated). Additionally, the high compliance helps in charging large membrane capacitances typical of epithelial tissues, resulting in faster settling times and improved overall clamp performance.

External Control

The clamp can be operated by an external programmer, lab timer or computer. Logic control of clamp mode and clamp command levels is possible as well as simultaneous mixing of external linear commands.

Onboard Timer Controller

The dual channel EC-825A includes event timers (2) to provide cycle times and clamp durations up to 2000 seconds. Times are set with 2 digit thumbwheel switches and 4 position range switches. Once set, the timer will free run, eliminating the need for a computer or other external device to control the experiment.

Model EC-800LV ± 15 Volt Compliance

Studies with small tissue samples or monolayers in set-ups with low access resistance may not require high compliance. For these applications, models EC-800LV offers both a lower cost and a safer environment for the membrane.

Single & Dual Channel Epithelial Voltage Clamps

EC-800 & EC-825A (continued)



EC-825A

Specifications

Headstage:

Input Impedance	10^{10}
Input Voltage	± 1.5 V maximum
Common Mode Voltage	± 13 V maximum
Common Mode Rejection	100 dB at 60 Hz
Leakage Current	20 pA maximum
Offset Voltage Range	± 120 mV

Voltage Clamp Ranges:

Int. Clamp Potentiometer	± 100 mV with 10-turn control
Ext. Command	± 1 V
Ext. Command Factor	1 mV/10 mV applied

Current Clamp Ranges:

Clamp Potentiometer	± 1 mA
External Command	± 10 mA
Command Factor	1 μ A/10 mV applied
Speed	10 μ s measured with model membrane

Resistance:

Fluid Resistance	0-100 Ω standard
Compensation Range	0-1 k Ω optional
Membrane Resistance Measurement	made with 2 Hz bipolar constant current square wave

Ranges	0-2 k Ω , injected current = 10 nA 0-200 k Ω , injected current = 1 nA
Membrane Resistance	0-2 k Ω , 1 mV/ Ω
Output (EC-825A)	0-200 k Ω , 10 mV/ Ω
Panel Meter EC-800	3-1/2 digit LCD; Voltage Range: 200 mV max; Current Range: 2000 μ A max
Panel Meter EC-825A	3-1/2 digit LED; Voltage Range: 200 mV max; Current Range: 2000 μ A max

Specifications (continued)

Outputs:

Voltage Monitor	x10
Current Monitor	10 mV/ μ A

Compliance:

EC-800	± 120 V
EC-800LV	± 15 V
EC-825A	± 50 V

Timers (A & B) EC-825A:

Range	10 ms to 1000 s, set with 2 digit resolution and 4 ranges (each channel)
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Power Requirements

100-130 VAC or
220-240 VAC,
50/60 Hz, 15 VA

Physical Dimensions, H x W x D:

EC-800, EC-800LV,	
EC-825A	8.9 x 43.2 x 30.5 cm
Headstage	7.7 x 7.7 x 5 cm

Shipping Weight:

EC-800 & EC-800LV	6.4 kg
EC-825A	9.1 kg
Warranty	Two years, parts & labor

EC-800 and EC-825A Epithelial Voltage Clamps

Order #	Model	Description
64-0035	EC-800	Single Channel Voltage Clamp with ± 120 V Compliance*
64-0036	EC-800LV	Single Channel Voltage Clamp with ± 15 V Compliance*
64-1605	EC-825A	Dual Channel Voltage Clamp with ± 50 V Compliance*

*Supplied with rack mount hardware.

The VCC-600 is a single channel voltage/current clamp for epithelial tissue. It is the most versatile instrument in the VCC series. Basic features include 10-turn dials for electrode offset and fluid (series) resistance compensation, user selectable current gain and response frequency.



69-0930 Single Channel Voltage/Current Clamp

The VCC-600 epithelial clamp amplifier is a versatile single channel instrument. In addition to its basic features, a clamp level control allows the holding voltage or current to be set while a built-in pulse generator provides unipolar or bipolar step changes from the holding level for tissue conductance/resistance measurements.

Voltages and currents can be monitored via recorder outputs on the front panel and by a bright 3.5 digit LED digital panel meter. An interface connector, for remote instrument control and data acquisition, is provided on the rear panel. A high voltage option is also available to increase the output compliance voltage to ± 35 V DC for certain types of experiments.

The VCC-600 also has special features making it a popular instrument for electrophysiological studies of epithelia. These features include an active headstage that incorporates a virtual grounding amplifier for current measurement and an extra level of current gain to measure currents in the nA range. This allows the instrument to be used for studies on very small tissues such as isolated renal tubules and single isolated colonic crypts. A switch and buffer amplifier in the headstage allows selection and continuous measurement of the potential on either side of the epithelium. The output on the rear of the instrument can be used as a reference for microelectrode experiments so that the intracellular voltage can be directly measured across either apical or basolateral membranes regardless of side of impalement. Similarly, it can be used as the reference voltage in pH stat experiments, thereby eliminating a problem with some combination electrodes and pH meters in which a fraction of the transepithelial current may be shunted to ground.

Specifications

Input Resistance	$10^9 \Omega$, differential, $\geq 10^{12} \Omega$ available as option
Common Mode Rejection	≥ 100 dB
Frequency Response	4-stage adjustment via internal switch
Clamp Output	± 13 V standard, ± 35 V optional high voltage
Display:	3.5 digit, 1/2 in red LED
Transepithelial Voltage	± 199.9 mV
Transepithelial Current	$\pm 1.990, \pm 19.90, \pm 199.9, \pm 1999 \mu\text{A}$, jumper-selectable
Switches	Subminiature toggle
Grounding	Signal (circuit) ground is isolated from chassis and power grounds; binding posts on rear panel allow connection of circuit to chassis ground
Power	100/125 VAC, 60 Hz or 200/250 VAC, 50 Hz, user selectable
Meter	Selects current or voltage to be displayed on panel meter

Specifications (continued)

Function:	Three position rotary switch
Zero	Standby mode, voltage inputs are internally grounded
Open	Open circuit, voltage inputs are connected to sensing electrodes
Clamp	Feedback loop is closed to control either current or voltage
Mode:	Two switches select operating modes
Voltage/Current (I/V)	Selects transepithelial voltage or current to be controlled when function is on Clamp
Local/Remote	Selects control to be from front panel switches or from remote interface
Offset Potential	± 10 mV, set via precision 10-turn dial
Fluid Resistance	Push-button current injection, compensation set by precision 10-turn dial, jumper selectable ranges
On/Off	'On' sends pulse output to clamp, red indicator light
Polarity	Selects +, - or bipolar pulses to be generated
Single Pulse	Injects single pulse during interval between pulses
Reset	Initializes interval timer and injects pulse
Amplitude	0 to 10 mV in 1 mV steps at X1 gain; 0 to 100 mV in 10 mV steps at X10 gain
Period	0.1 to 99.9 sec time period between pulses; set by 3-decade thumbwheel switch
Duration	0.01 to 9.99 sec duration of each pulse; set by 3-decade thumbwheel switch
DC Clamp Level:	Sets DC holding voltage or current
Voltage Clamp	± 100 mV and ± 300 mV via 10-turn dial
Current Clamp	Current gain dependent, 50% and 150% of max. displayed current
Headstage	Active input stage for sensing voltage and current near preparation, cable length 6 ft
Reference Buffer	Switch selectable to send V1 or V2 inputs to buffer amplifier in headstage; allows monitoring of bath potential on either side of epithelium; output via rear panel permits microelectrode impalements or pH electrodes to be referenced to either V1 or V2

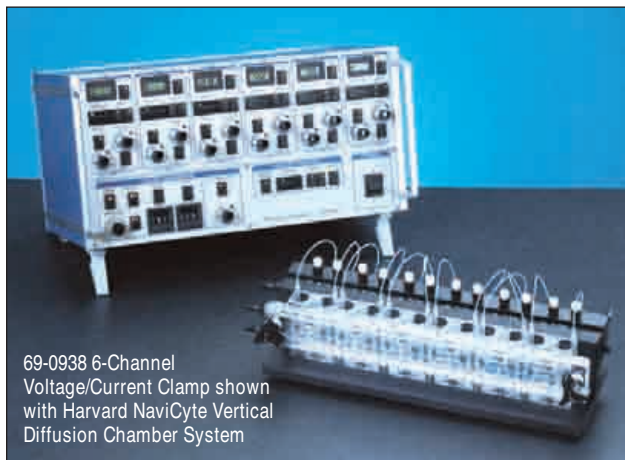
I/O Connection Specifications

Electrode Inputs	Banana jacks on headstage
Recorder Output Voltage	10 mV/mV, x10 transepithelial voltage
Recorder Output Current	Jumper selectable, 1, 10, 100 or 1000 mV/ μA
Pulse Generator	0 to ± 100 mV and 0 to ± 1 V
External Input	Allows arbitrary analog input signal to be clamped
Remote Interface	9 pin DB connector

VCC-600 Epithelial Voltage Clamps

Order #	Model	Description
69-0930	VCC-600	Single Channel Voltage/Current Clamp
69-0931	VCC-600HV	Single Channel Voltage/Current Clamp with High Voltage Option

The VCC-MC family of epithelial voltage/current clamps are ideal instruments for use with the multichannel chamber systems described earlier. Configurations range from 2 to 8 amplifiers and these systems integrate fully with the Acquire and Analyze software package.



69-0938 6-Channel Voltage/Current Clamp shown with Harvard NaviCyte Vertical Diffusion Chamber System

The **VCC-MC** family of voltage/current clamps and accessories have been designed to be flexible tools for studying ion transport across epithelial tissue.

The VCC-MC family is of particular benefit in high throughput, multi-channel applications and where laboratory bench space is limited. All models in this family provide similar capabilities and specifications as the VCC-600 single channel clamp to control the voltage or the current across the epithelium. However, unlike the VCC-600, these clamps are modular in design.

The **VCC-MC2** contains two voltage/current clamp modules, a pulse generator, and a computer interface in a compact 9.5 inch chassis.

The VCC-MC2 is best suited for small scale applications and for student laboratories. The VCC-MC2 is compatible with all chamber systems offered by Warner. Each VCC-MC2 comes complete with two single channel input modules (DM MC6) for connection to electrodes.

The **VCC-MC6** and **VCC-MC8** are multichannel chassis that can be configured with 2 to 8 voltage/current clamp channels, depending on model. These instruments are ideally suited for experiments where multiple specimens are sampled in parallel. They offer the distinct advantage of expandability within the same instrument chassis.

A useful feature built into the VCC-MC6 and VCC-MC8 instruments is a master control section. This section enables the investigator to quickly change the function, mode, and meter settings on each clamp module from a single switch bank. This markedly simplifies the use of the instrument and removes some of the tedium associated with continually having to change multiple, identically placed switches (e.g., changing the meter switch to display current instead of voltage on eight channels).

The VCC-MC Multichannel clamps are well suited for the NaviCyte and EasyMount systems. For use with the NaviCyte systems, a special 24-lead input module (EP-MC6) replaces the individual DM-MC6 input modules for making electrode connections. The EP-MC6 mounts between the heat block and air manifold on the NaviCyte system and must be ordered separately.

Specifications

Input Resistance	≥ 10 ⁹ Ω, differential
Common Mode Rejection	≥ 100 dB
Frequency Response	4-stage adjustment via internal switch
Display:	3.5 digit, ½ in LCD with green backlight for each channel
Transepithelial Voltage	±199.9 mV
Transepithelial Current	±19.90, ±199.9, ±1999 μA, jumper selectable
Switches	Push button, digital switching with LED indicators
Power	100/125 VAC, 60 Hz or 200/250 VAC, 50 Hz, user selectable
Meter	Selects current or voltage to be displayed on panel meter
Function:	Three position switch with LED indicator of state
Zero	Standby mode, voltage inputs are internally grounded
Open	Open circuit, voltage inputs are connected to sensing electrodes
Clamp	Feedback loop is closed to control either current or voltage
Mode:	Two switches select operating modes
Voltage/Current (I/V)	Selects transepithelial voltage or current to be controlled when Function is on Clamp
Remote (REM)	Selects control to be from front panel switches or from remote interface
Offset Potential	±10 or ±100 mV, set via precision 10-turn dial, jumper selectable ranges and lighted polarity switch
Fluid Resistance	Push-button current injection, compensation set by precision 10-turn dial, jumper selectable ranges
On/Off	'On' sends pulse output to clamp, red indicator light
Polarity	Selects +, - or bipolar pulses to be generated
Single Pulse	Injects single pulse during interval between pulses
Reset	Initializes interval timer and injects pulse
Amplitude	0 to 10 mV in 1 mV steps at X1 gain; 0 to 100 mV in 10 mV steps at X10 gain
Period	0.1 to 99.9 sec time period between pulses; set by 3-decade thumbwheel switch
Duration	0.01 to 9.99 sec duration of each pulse; set by 3-decade thumbwheel switch

Specifications (continued)

DC Clamp Level:	Sets DC holding voltage or current
Voltage Clamp	±100 mV via 10-turn dial, lighted polarity switch
Current Clamp	Current gain dependent, 50% of max. displayed current
Master Override	Permits control of function, mode, and meter features on all installed clamp channels

I/O Connection Specifications

Electrode Inputs	2 mm pin tip via DM-MC6 single channel input module, 1 per channel (VCC-MC6 and VCC-MC8) 2 mm pin tip via electrode panel (EP-MC6) for Harvard/Navicyte chamber system (VCC-MC6)
Recorder Output Voltage	10 mV/mV, x10 transepithelial voltage
Recorder Output Current	Jumper selectable, 1, 10 or 100 mV/μA
Pulse Generator	0 to ±100 mV and 0 to ±1 V
External Input	Allows arbitrary analog input signal to be clamped
Remote Interface	9-pin DB connector, 1 per channel (VCC-MC2) 25-pin DB connector (all others)

VCC Amplifiers

with DM-MC6 Input Module (for EasyMount)	with EP-MC6 Input Module (for NaviCyte)	with DM-MC6-HV Input Module (High Voltage) (for EasyMount)	with EP-MC6-HV Input Module (High Voltage) (for NaviCyte)	VCC Series Amplifier
69-0933	—	69-0934	—	VCC-MC2
VCC-MC6				
69-0946	69-0944	69-0947	69-0945	2-Channel
69-0942	69-0940	69-0943	69-0941	4-Channel
69-0938	69-0936	69-0939	69-0937	6-Channel
VCC-MC8				
69-1003	—	69-1001	—	8-Channel

VCC Amplifiers (CE Version)

with DM-MC6 Input Module (for EasyMount)	with EP-MC6 Input Module (for NaviCyte)	with DM-MC6-HV Input Module (High Voltage) (for EasyMount)	with EP-MC6-HV Input Module (High Voltage) (for NaviCyte)	VCC Series Amplifier
69-0933CE	—	69-0934CE	—	VCC-MC2
VCC-MC6				
69-0946CE	69-0944CE	69-0947CE	69-0945CE	2-Channel
69-0942CE	69-0940CE	69-0943CE	69-0941CE	4-Channel
69-0938CE	69-0936CE	69-0939CE	69-0937CE	6-Channel
VCC-MC8				
69-1003CE	—	69-1001CE	—	8-Channel

Input Manifolds & Dummy Membranes

DM-MC6, EP-MC6, DM-660 & DM-6



The **VCC-MC** family of amplifiers utilizes standard 2 mm pin-tip jacks for connection to electrode leads. Connections are facilitated by the use of input modules. The necessary modules are supplied with the VCC amplifiers, and each clamp channel/Ussing chamber required a unit. Input modules are compatible with both EasyMount and Harvard/Navicyte chambers.

The **DM-MC6** is a single channel input module that can be mounted close to individual chambers. It connects to modular plugs on the rear of the VCC-MC instruments via a shielded cable. The module also contains an integral dummy membrane that is activated by an integral slide switch.

The **EP-MC6** is 6-channel (24 pin-tip jacks) electrode input manifold designed specifically for use with the Harvard/Navicyte vertical diffusion chamber system. The EP-MC6 mounts directly behind the heat block and in front of the valve manifold to provide clean, organized connection to the electrode leads. Connection between the EP-MC6 and VCC-MC6 is by means of an included



Dummy Membranes

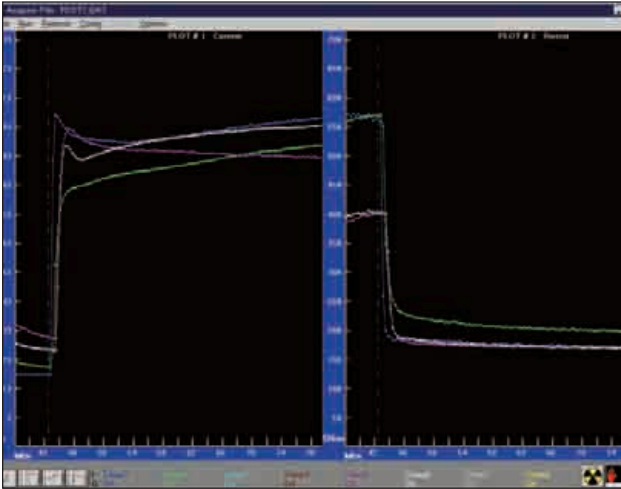
Dummy membranes are useful both for quickly verifying the operating status of the instrument and as a learning aid for students.

The **DM-660** is a single channel dummy membrane for use with the VCC-600. A similar dummy membrane is built into the DM-MC6 input module for the multi-channel clamps

The **DM-6** is a 6-channel dummy membrane for the VCCMC6 and VCC-MC8 amplifiers. Each dummy membrane may be individually manipulated. The DM-6 connects to the VCC-MC6 and VCC-MC-8 via an EP-MC6 flat cable assembly.

Order #	Model	Description
69-0950	DM-MC6	Single channel electrode input module and dummy membrane
69-0951	EP-MC6	Electrode input panel for VCC-MC6
69-0932	DM-660	Single channel dummy membrane
69-0952	DM-6	6-Channel dummy membrane for VCC-MC6

Acquire & Analyze is a comprehensive data acquisition and analysis package designed specifically for recording transepithelial electrophysiological data from epithelia mounted in Ussing chambers. The system consists of data acquisition hardware and software used to record current, voltage and conductance/resistance from up to 8 tissues as well as analysis software that enables one to quickly extract selected data and output it to summary spreadsheets.



Unlike general-purpose data acquisition packages, Acquire & Analyze is written specifically for the study of epithelial tissues.

For example, say you want to measure the dose/response curve of an agent on the I_{sc} and G_t by progressive additions in eight tissue samples. To do this you monitor the I_{sc} and G_t on the computer until stable basal readings are attained. You then place an event mark in the file and make the first addition to all 8 tissues. When the current reaches a new stable level (or a specified time has passed) you place another event mark and make the second addition. This process is repeated until all additions have been made.

To summarize the effect of the additions, use Analyze to graph the data for all 8 tissues. Begin by displaying the movable data bar and positioning it over the basal currents just to the left of the first event mark. Right-click the mouse to save the mean values of current, conductance and voltage to a spreadsheet. Simply repeat the mouse movements and clicks to obtain the data for each subsequent addition. The spreadsheet thus created can be saved and imported directly into Excel for further analysis.

Data Acquisition and Analysis Capabilities

Acquire & Analyze runs under Windows and includes a data acquisition card, input/output cables, and software. The system can measure currents and voltages from up to 8 voltage-current clamp channels.

- Activate/deactivate acquisition on individual clamp units
- Setup and toggle between fast and slow acquisition speeds to capture transient events; speeds can be set by user and can be changed at any time during experiment
- Place time marks into file to indicate when experimental manipulations (e.g., drug additions) have been made; marks can be predefined and selected from menu or be entered from keyboard
- Graphically display current, voltage, conductance, resistance, calculated open circuit voltage and calculated I_{sc} during data acquisition in multiple formats
- Graphical/digital readout of current, voltage or conductance vs. time
- Plot raw or area corrected data
- User definable x, y scaling; zoom all, in, out, or previous; pan left, right, up or down
- Extract data under movable, adjustable width time bar in file format compatible with spreadsheet files
- Extracted data may be individual points or mean values
- Extracted data may be imported into commercial graphics packages to produce publication quality graphs
- Linear regression analysis of conductance vs. current can be performed on data within time bar to estimate pericellular pathway conductance

Order #	Model	Description
69-3145	Acquire & Analyze II	Data acquisition and analysis software
69-0954	Mod 08/A	Interface cable for VCC 600 and VCC MC2 amps
69-1005	DB9EC800	Interface cable for EC-800 amp
69-1009	DB15EC825	Interface cable for EC-825A amp



69-3130 HAI 118 Data Acquisition System

The HAI-118 includes hardware from iWorx and the popular LabScribe® software package. This system offers 8 analog input channels, 8 digital outputs, 4 digital inputs and 2 DACs. The hardware connects to PC compatible computers via USB, so setup is plug-and-play easy.

DACs

The HAI-118 offers two $\pm 0V$ DACs. Each DAC is independently programmable and can be synchronized with one another. Basic stimulus parameters for each DAC, such as pulse width, frequency, and amplitude can be changed on the fly using handy controls located in the LabScribe software tool bar. Standard protocols include pulse, train, and step waveform. Each standard protocol allows the quiescent state to be a holding voltage thereby making it ideal for voltage clamping applications.

Resolution

A 16 bit A/D converter is used to sample data over the full input range. Typical noise on any input is less than 1 mV. This allows the recording of signals from 10 mV to 10 V without the need for additional external gain.

Digital Input/Output

Eight digital output lines are available and the digital output connectors are industry standard BNC, eliminating the need for custom cables. Programming output lines is point-and-click and no complicated scripting language is required. Four digital input lines are also provided. One digital input line can be configured as an external trigger.

Speed

The HAI-118 can collect 16 bit samples at 10kHz bandwidth on a single or up to eight channels simultaneously.

USB Connection

Connection to the computer is accomplished over the popular USB port. This eliminates the need to install special interface cards and makes the HAI 118 compatible with notebook computers. The HAI 118 has a small footprint and in combination with a notebook requires very little bench space.

Software Included

Powerful LabScribe® software is included with each HAI 118. LabScribe is provided with a site license at no additional charge and upgrades are free forever. The program will actually upgrade itself on any Internet connected machine.

Supported Applications

Epithelial Studies - Output from Warner's EC-800 and EC-825A, as well as the VCC Series epithelial voltage clamps can be fed directly into the HAI-118. The voltage clamp protocol in the LabScribe program's stimulator section makes recording of data of four to six epithelial channels possible.

Oocyte Studies - LabScribe's gain telegraph feature automatically calibrates the software to Warner's Oocyte Clamp so that the main display reads in current and voltage. The on-board stimulator includes a flexible voltage clamp protocol so an external stimulator is not required. Finally, the digital output capability of the HAI-118 also adds the ability to automate your oocyte rig. **Organ and Tissue Bath Studies** - LabScribe's smooth data recording interface and available 8 channels area perfect fit for tissue and organ bath studies. Real-time displays of force in grams as well as real-time annotations are ideal for these types of studies. In addition, the on board stimulator and digital outputs make automation of tasks like filling and draining baths or delivering drugs very straightforward. An available 8 channel high voltage field stimulator is directly controlled by the HAI-118 and LabScribe software.

Supported Applications (continued)

Electrophysiology Studies - The high speed nature of the HAI-118 make it perfect for studies involving blood pressure and sympathetic nerve activity as well as all types of cardiac electrophysiology, even in rapid heartrate animals such as mice where extra speed is required.

LabScribe Data Acquisition Software The cornerstone of the HAI-118 data acquisition system is the LabScribe software. A single program, LabScribe detects what hardware it is connected to and self-configures. LabScribe is, by far, the easiest to use data recording and analysis solution available. It strikes the ideal balance between flexibility and simplicity. Just push the "Start" button, then use the AutoScale feature to center and expand your data; and you're recording! The 'click and play' approach of the software extends to a useful assortment of analyses, such as rate, integral, and conversion to real units. And, of course, built-in online help is always available.

LabScribe Software Features:

Simplified User Interface

- Only two mouse-clicks are required to record most data
- Only one mouse-click is required for most online functions
- Use of screen-time makes time calculations quick and simple

AutoScale

- Automatically ensures the optimal scaling of displayed data
- A simple click centers and expands the data in the display window to fill the available space
- You can toggle between Best View and a preset viewing range or you can zoom the time base or y axis scaling with a single click

Fast Scrolling

- LabScribe's display can smoothly scroll data at any speed
- Useful when high resolution data is compressed on the time axis to create a data overview.

Real Units

- LabScribe software allows you to calibrate the displayed data in any units that you choose
- Reading your data in mm Hg or grams or μA takes the guesswork out of analysis

Real-time Annotation

- Keyboard input from the user may be time locked to the data to indicate drug delivery or stimulus points
- You can search and "Go To Annotations" anywhere in the data

Real-time Functions

- LabScribe currently supports 17 functions that are calculated and displayed in real-time, each is called from a single click in the Main window
- These include Periodic (rate, freq., period, max, min, mean), dV/dt , integral, Channel Math, Cardiac, EEG and

Spirometry

- Functions can be applied to raw data in real-time or they can be called after the data has been recorded

Volt Meter Panel

- LabScribe can display a voltmeter status panel
- Values recorded on each channel are displayed in large type, easily visible from across the room
- Display DAC output on any channel. for iwx114, iwx214 and iwx118
- Ability to revert back to Raw Data at any time
- LabScribe reports can

Journal

- LabScribe reports can be prepared and edited, all within the program's own Journal.
- No need to export to word processor or spreadsheet programs.
- The onboard journal also serves as a collecting place for the various measurements made in the Analysis window.
- The journal saves automatically with the file in .rjf format, which can be opened by any word processor.

Offline Functions

- Twenty-six offline calculations are also supported. These operate on a selection of data and return a value. While more are being added all the time, the current list includes area under the curve, max-min, slope at a point, slope of the line of best fit and the mean.

XY Plot

- In the Analysis window you can choose to overlay selected portions of your data or you can plot different channels against one another in an XY style plot.
- In XY mode, the available measurement functions adjust to the xy mode.

Export

- Recorded data may be exported in text (.txt), pictures (.png) or MatLab (.mat) format.
- This is ideal for post analysis in programs like Excel or MatLab and export picture formats make reports or poster presentations easy to create.
- Of course, you can always print data from any window in the program.

The Stimulator

- LabScribe has full support for the analog outputs on HAI hardware.
- The user can specify simple pulses or complex protocols involving trains and stepped voltage patterns.
- When used with HAI 118 hardware, LabScribe supports two simultaneous outputs.

LabScribe Software Features: (continued)

Digital I/O

- When used with the HAI 118 the LabScribe software allows the user to configure eight digital inputs or outputs.
- Digital inputs can show frequency, period, duty cycle, time on or raw data
- Digital outputs can be assembled into control protocols for external devices

Settings

- Settings or templates for various experiments are stored in the program's settings menu
- This makes changing program settings to accommodate different experiments point-and-click easy

Broadcast

- A version (LS/16MC) of LabScribe is available that transmits recorded data in real-time over your local area network!
- Ideal for teaching or student labs where everyone can not get data first hand, this feature allows the network to share what the broadcast version sees

Gain Telegraph

- LabScribe will automatically calibrate and display the output of Warner Instrument Voltage/Patch Clamp amplifiers
- This feature takes into account the changes in gain that may be applied from the voltage clamp

Software license allows copying on all departmental and student computers.

Specifications

Input:

Number of Analog Inputs	8 single ended BNC
Input Impedance	1 M Ω
Input Range	± 10 V
Noise	1 mV typical
Gain Telegraph	Software or hardware 8 bit

A/D Converter:

Sample Speed	1 sample/sec - 100k sample/sec
Resolution	16 bit
Interface	USB
Trigger or Digital Input Lines	4, TTL

Output:

Digital Output Lines	8 TTL
Digital Output Connector	BNC

DAC Performance:

Number of DACs	2
DAC Resolution	12 bit
DAC Speed	100k sample/sec, Independent of sample speed
DAC Output Range	± 10 V
DAC Modes	Pulse, Train, Step, DC, Custom
Pulse Width	0.01 ms to 6500 ms (pulse mode)
Frequency	0.2 Hz to 50kHz (pulse Mode)

Trigger Modes

External Trigger, Data Threshold Trigger, User Trigger

Display

Real time user definable screen independent of sample rate. User definable scale units: Auto Scale, Full Scale or User Scale

Enclosure	Aluminum
Power	120/220 VAC, 60/50 HZ, CE compliant

Order #	Model	Description
69-3130	IX118	Data acquisition system with hardware and Labscribe® software



Computer Controlled Multi-Clamp with Software

DATA ACQUISITION & ANALYSIS SYSTEM

This unique package integrates the amplifiers, data acquisition system, and analysis software all into one convenient box! The system provides individual data acquisition and control for 2, 4 or 6 chambers and is fully compatible with the NaviCyte horizontal/vertical diffusion chamber systems. Windows 95/98/2000/XP compatible.



The Computer Controlled Multi-Clamp with Software is a combined voltage/current clamp and data acquisition system in one compact microcomputer controlled unit. In its full configuration it can be used to control and collect electrophysiological data from up to six NaviCyte horizontal or vertical diffusion chambers.

The system provides independent chamber control in three different modes: voltage clamp, current clamp, and open circuit. A change between these modes is possible during the experiment at each time point.

The Multi-Clamp is available in 2-, 4- or 6-channel configurations and is fully compatible with both NaviCyte Ussing chamber systems. The clamp provides a separate A/D converter and isolated current source for each chamber, and current and voltage electrodes from each half-cell are connected to the Multi-Clamp via an electrode manifold. Data exchange between the PC and the Multi-Clamp is via standard COM ports, and depending on the number of ports available, a single PC can handle several clamps.

An interesting option consists of the incorporation of a gas delivery system into a NaviCyte/Multi-Clamp system. This gas delivery system consists of 12 precision gas flow meters mounted to a stabilizing base and connect to a 6-channel NaviCyte vertical or horizontal chamber systems. The 600 x 400 mm stabilizing base also houses an electrode manifold for connecting each Ag/AgCl electrodes to their respective half-cells.

Software

The Multi-Clamp system comes complete with an easy to use Windows 95/98/2000/XP based control and data acquisition software package that allows for the individual control and monitoring of each chamber.

Software Features Includes:

- Automatic compensation of fluid resistance and electrode potential during the experiment
- Individual voltage clamp, current clamp or open circuit control for each chamber
- Overlay of uni- or bipolar current pulses with variable parameters for dynamic definition of G_t/R_t
- I/V and V/I curves with freely adjustable parameters
- Minimum pulse duration 200 ms, max. amplitude $\pm 250 \mu\text{A}$ for dynamic definition of G_t/R_t
- Ability to input marker and comments and save with data file
- Printout of parameters in variable timetable
- Data format compatible to Excel
- Continuous graphics display
- Experiment time up to 8 hours

Specifications

Channels	2, 4 or 6
A/D Subsystem for Analog Data Acquisition	13 Bit
Current Source by D/A	12 Bit, isolated
Serial Connection to PC	COM1/COM2 for bi-directional data transfer
Case Dimensions	24.5 x 11.4 x 19.7 cm (9.6 x 4.5 x 7.8 in)
Power	100/230 VAC, 50/60 Hz
Input Resistance	$> 10^9 \Omega$ differential
Input Current	$< 100 \text{ pA}$
Input Voltage	$\pm 400 \text{ mV}$, 0.1 mV step
Current Output	$\pm 2000 \mu\text{A}$, 1 μA step
Product of Current and External Resistance Max	13 V

Order #	Description
69-0300	2-Channel voltage/current clamp system with software
69-0301	4-Channel voltage/current clamp system with software
69-0302	6-Channel voltage/current clamp system with software
66-0025	6-Channel electrode manifold for NaviCyte chamber systems
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