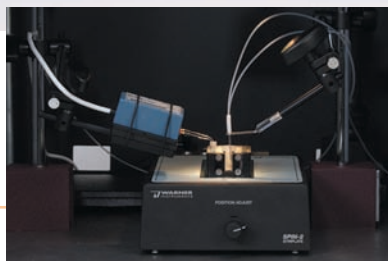


Warner Instruments LLC

2006

The Planar Lipid Bilayer Workstation

the only complete tool specifically designed for sophisticated planar lipid bilayer research



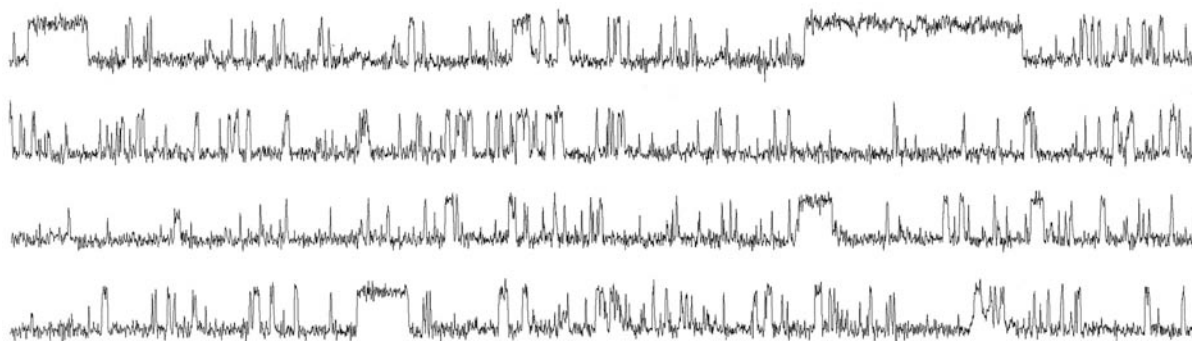
work 1. a task or duty, 2. to operate or cause to operate effectively
station 1. the place from which a service is provided or operations are directed

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The Planar Lipid Bilayer Workstation

→ designed to have you quickly up and running



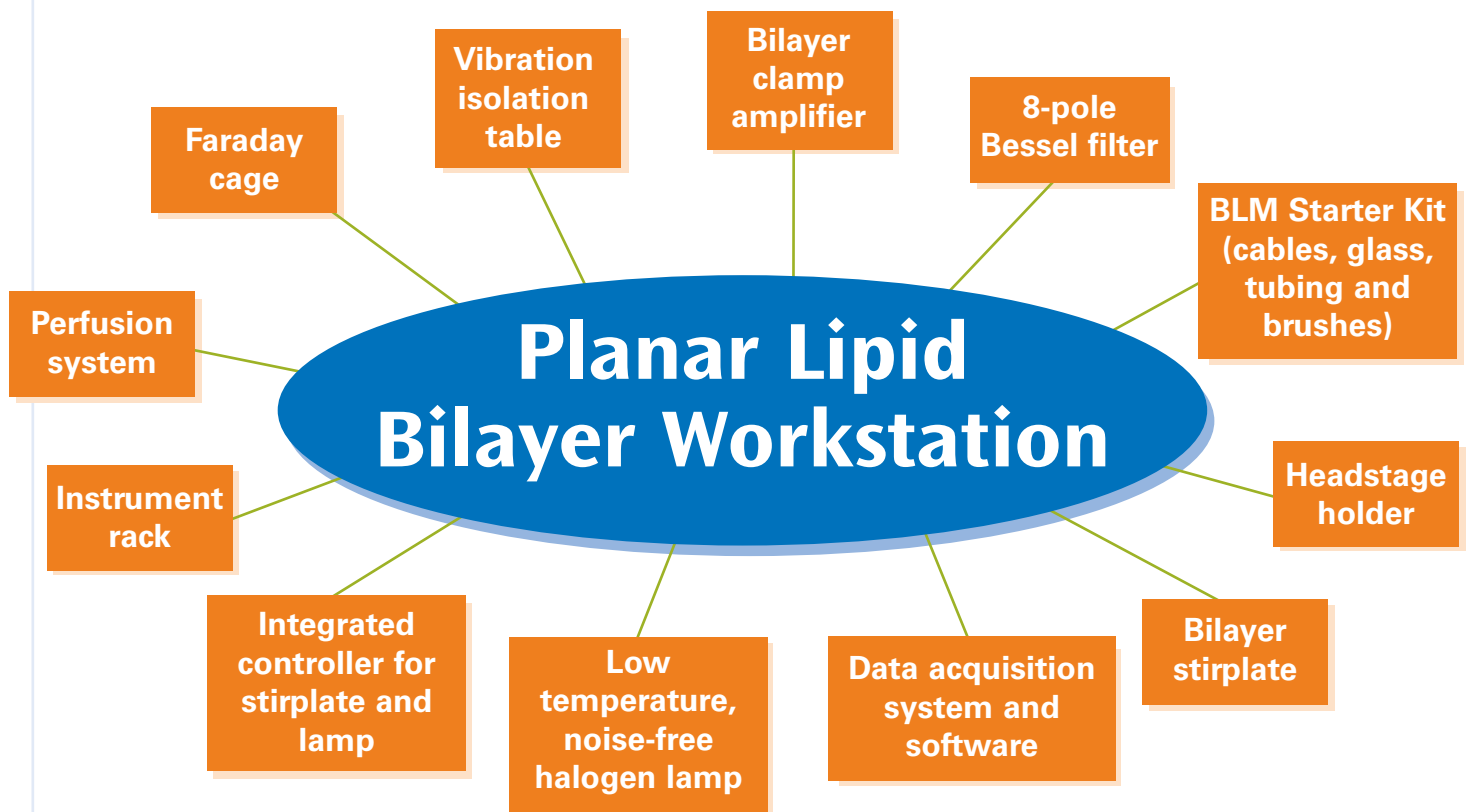
- **Integrated instrumentation for Planar Lipid Bilayer recording**
- **Simple and integrated design**
- **Complete System**
- **Optional power line conditioning**
- **Popular data acquisition packages**
- **Available on-site setup and training**

system 1. a group of interacting elements functioning as a complex whole, 2. a network, 3. method or procedure

component 1. a constituent part, 2. being or functioning as a part of

System Components

The complete Planar Lipid Bilayer Workstation includes:



Custom and advanced components are available.
Contact our Sales Department for further information.

training 1. to make or become proficient with specialized instruction and practice, 2. focus or aim

Optional On-Site Setup and Training

Investigators first entering the arena of research using the planar lipid bilayer can be overwhelmed by the wealth of design and application issues surrounding the proper assembly and use of a Bilayer Workstation. While tractable, this state of affairs can result in an investigator choosing a less effective means to achieve his or her research goals.

Warner Instruments recognizes the need to make this technology more accessible and is the only company to establish **on-site assembly and training** in the proper care and use of the Bilayer Workstation. Our senior scientist, Dr. Edmond Buck, has over 15 years experience using this powerful technology and is committed to providing extensive support for this important technique.

Dr. Buck will visit your site, assemble the Workstation and instruct you in how to use and maintain the equipment. If desired, he will also provide guidance and insight in the best way to use your acquisition and analysis software.*

It is our committed goal to quickly and efficiently optimize your Bilayer Workstation and skill set allowing you to focus your efforts on data acquisition.

*Support and warranty rights are retained by the manufacturer of the acquisition software package.

We invite you to contact Dr. Buck to discuss your needs and application.

References available.

The **Planar Lipid Bilayer (BLM) Workstation** from Warner Instruments integrates every significant component required for the use of a working BLM rig. This unique device allows the user to quickly get up to speed in performing research using this powerful technology.

The BLM Workstation is comprised of an **FC Series** Faraday cage, a **BenchMate** vibration isolation table from Kinetic Systems, our **BC-535** bilayer clamp amplifier and **LPF-8** 8-pole Bessel filter, a **SUN-1** halogen lamp, a **SPIN-2** bilayer stirplate, the **SUNStir** integrated controller (for the stirrer and lamp), and the **BPS-2** perfusion system. The **HST-1** headstage holder with magnetic base rounds out the package. Also included is a **RAC-14** table top rack and the **BLM-ST** starter kit which includes red sable artist dotting brushes, glass capillary tubing for lipid application, BNC's and grounding cables, spare stirbars for bilayer cups and chambers, and rubber matting for traction control of the bilayer chamber.

Optional components include the **ON-750** power line conditioner and a stereo zoom microscope for viewing the membrane. We also supply accessories useful for bilayer work. These include the **CM-3** (variable) and **CM-1** (fixed value) single channel simulators.

Additional items required for a complete Workstation include our popular **BCH-13A** or **BCH-22A** bilayer cups and chambers, acquisition hardware/software and a computer.

The BLM workstation supports the use of either pClamp (Axon Instruments, Union City, CA) or Pulse (Instrutech, Port Washington, NY) for data acquisition. You may purchase your acquisition system directly from the vendor or **from us at no additional charge**. (Technical support and warranty are through the manufacturer.) Call Warner Instruments or visit our website for details.

The complete system from Warner includes everything you need *(except the computer)* **to begin collecting data.**

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Bilayer Clamp Amplifier

Model BC-535

The **BC-535** is the newest version of our popular bilayer clamp amplifier. Warner Instruments is the only company to supply an instrument specifically designed for research using planar lipid bilayer technology and this device forms an integral component of the BLM Workstation.

Major improvements in this model include:

- Reduced noise and wider bandwidth
- Improved stability with gains to 1000 mV/pA
- Digital hold potential
- AutoZero function
- Digital readout of membrane capacitance
- Multi-step 4-pole Bessel filter
- Hold potentials to 1400 mV; currents to 20 nA

Resistive Feedback Headstage

BC-535 sports an advanced, resistive feedback headstage which provides high bandwidth and low noise recording. The switchable headstage resistance is automatically selected based on the gain selection. The low current mode provides up to 100 pA of current carrying capability, while the high current mode provides up to 20 nA of current capacity!

Hold Control

The hold control for the BC-535 has been redesigned to function entirely within the digital domain. This unique approach allows the user to make holding potential adjustments in highly reproducible and discrete steps of 1 and 10 mV, up to ± 400 mV. Hold potentials up to ± 1000 mV or step sizes greater than 10 mV can be applied at the Command Input BNC's located on the front and rear panels of the instrument.

AutoZero

The large currents flowing through the low resistance aperture prior to bilayer formation saturates the amplifier input. Under these conditions, junction potential offsets can be easily nullified by using the new AutoZero function. Once armed, the AutoZero cycle measures and compensates for any offset potentials in the conducting pathway. Traditional manual controls remain for making small corrections or for resetting the offset potential without re-activating the AutoZero cycle.



Audio Output

The BC-535 now sports a VCO circuit providing auditory feedback during membrane formation. This feature is selectable from the front panel and an internal speaker is included. An external speaker output is provided on the instrument rear panel.

Capacitance Test

This test circuit has been completely redesigned and is used to monitor the formation of the bilayer membrane. A triangle waveform is applied to the command input and the amplitude of the resulting square wave is proportional to the membrane capacitance. When selected, the membrane capacitance is read directly from the meter.

4-Pole Bessel Filter

The filtering capacity if the instrument has been expanded to include a low pass, 4-pole Bessel filter ranging from 0.05 to 20 kHz in 1-2-5 steps. The internal filter can be bypassed for use with external filtering apparatus and allows realization of the instrument's full 75 kHz bandwidth.

Capacitance Compensation

Large capacitance transients are cancelled using both fast (0-10 μ s) and slow (0-2 ms) controls. Each control provides separate adjustment of both amplitude and time constant. Maximum capacitance compensation is 500 pF.

I/O

Input and output BNC's have been duplicated or moved to the instrument rear panel except for those requiring user interaction. Front panel BNC's include Command Input, $V_c \times 10$ and I_m Output. Rear panel BNC's include the headstage connector, I_m Output, Cap Sync, Command In, and Gain and Filter telegraphs. A speaker output is also available on the rear panel.

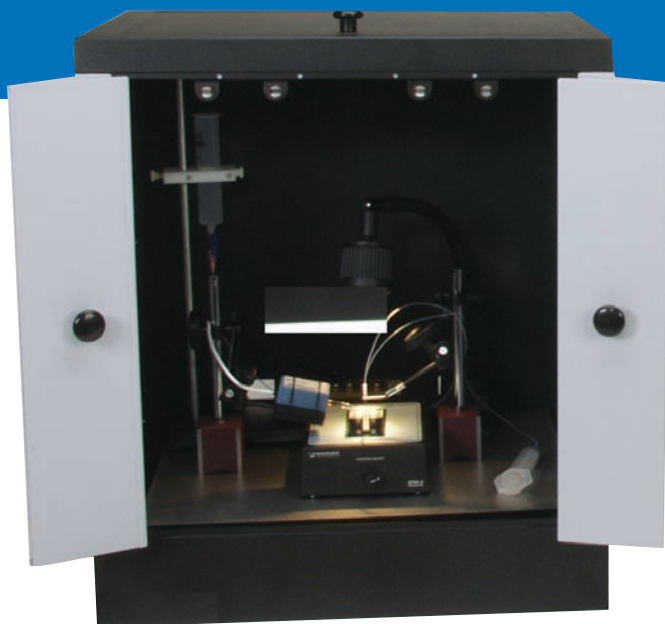
BC-535 Specifications

Noise	Measured with 8-pole Bessel filter at specified cutoff frequency	
	Frequency range	Open input 100 pF at input
	DC to 1 kHz	0.060 pA RMS 0.82 pA RMS
	DC to 100 Hz	0.009 pA RMS 0.28 pA RMS
Bandwidth	75 kHz	
Input commands	Internal Hold Command In	Digital; 1 or 10 mV steps to ± 400 mV maximum Front and rear external input, 10 V/V (applied voltage is attenuated by 10/100/1000 at the command electrode)
Junction zero	AutoZero or manual adjust. AutoZero lockout feature. Cycle time 1.5 s. Correction to ± 120 mV.	
Audio	VCO with off switch and volume control. Internal speaker and external speaker output.	
Capacitance test	Triangle wave applied to command electrode. Derived membrane capacitance read from meter up to 1000 pF. Calibrated (1 mV/pF) square wave available at I_m output. Cap Sync (rear panel) synchronized with input triangle wave.	
Gain	Membrane current gain selectable from 0.5 to 1000 mV/pA in 1-2-5 steps	
Filter	4-pole Bessel selectable from 0.05 to 20 kHz in 1-2-5 steps, or bypassed for full amplifier bandwidth	
Capacity compensation	Fast (0-10 μ s) and slow (0-2 ms) with adjustment of amplitude and time constant for each range. Maximum compensation 500 pF.	
Headstage	Switching	
	Low Current Mode	50 gigohm feedback, 100 pA maximum current
	High Current Mode	500 megohm feedback, 20 nA maximum current
I/O	Front panel:	
	Command Input	BNC input up to 10 V. Attenuated by 10, 100 or 1000
	I_m Output	Membrane current scaled by amplifier gain setting
	$V_c \times 10$ Output	Applied command voltage $\times 10$
	Rear panel:	
	I_m Output	Membrane current scaled by amplifier gain setting
	Cap Sync	TTL compatible
	Cap Out	Reports calculated membrane capacitance scaled to 1 mV/pF
	Command Input	BNC input up to 10 V. Attenuated by 10, 100 or 1000
	Gain Telegraph	Stepped DC voltage 0.5 to 5.5 V in 0.5 V steps for gain settings of 0.5 to 1000 mV/pA. Telegraphed value of 0.0 V for bypass.
Filter Telegraph	Stepped DC voltage 0.5 to 4.5 V in 0.5 V steps for filter settings of 0.05 to 20 kHz. Telegraph value of 5.0 V for full bypass.	
External Speaker	Standard RCA jack	
Digital meter	3.5 digit LED	± 1999 mV full scale
	Junction offset	± 120 mV full scale
	Cap Test	0 to 1999 pF
	V_c	± 1999 mV full scale
	I_m	± 1999 pA full scale
Power	100-125 or 220-240 VAC, 50/60 Hz	
Dimensions	H x W x D	
	Case	9 x 42 x 25 cm (3.5" x 16.5" x 10")
	Headstage	2.3 x 2.8 x 5.8 cm (0.9" x 1.1" x 2.25")
		1.8 m connecting cable

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FC Series Faraday Cages



- Convenient benchtop design
- Enclosed vibration isolation table
- Passive or active support mechanisms
- Large access doors
- Magnetic closures
- Solid brass grounding block
- Durable powder coat finish

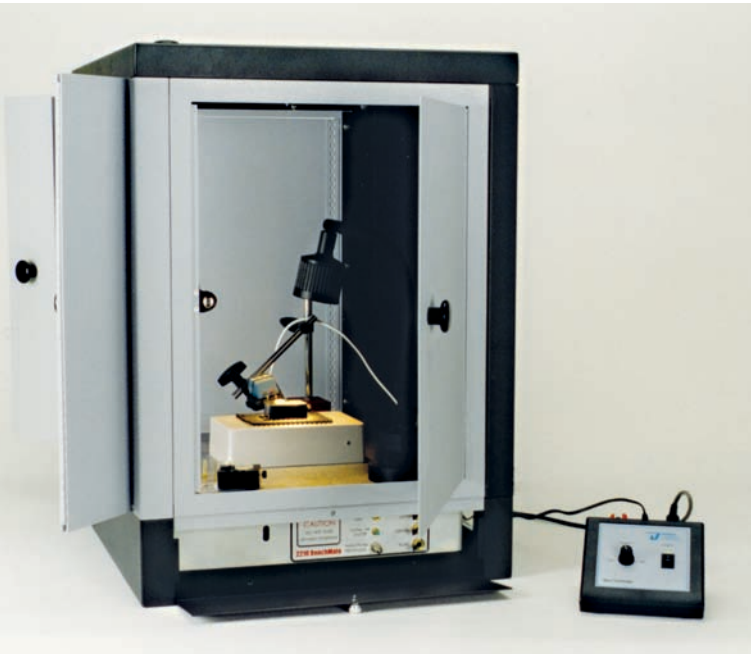
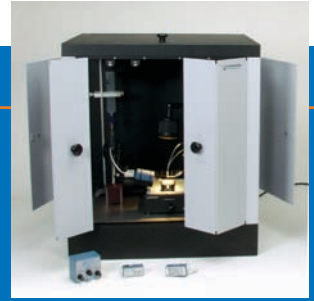
The Faraday cage provides critical shielding of electromagnetic interference from outside sources and is an integral component of the Bilyer Workstation. FC Series Faraday cages from Warner include the vibration isolation table and are designed to optimize the user's experience.

The Cage

The Faraday cage is a critical component in the Bilyer Workstation since it functions to shield the sensitive electronics contained therein from externally generated electrical interference. Without such, the ability to make single channel measurements would be mitigated.

FC Series cages from Warner Instruments are designed to be conveniently placed on a sturdy workbench and are supplied with a choice of active or passive vibration isolation table. A version of the cage without a table is also available.

Large access doors allow entry into the cage from all sides and the fan-fold front doors are designed to be placed out of the way when open. Doors along the base of each side allow access to table controls. There are also ports on the rear panel for entry of electronic cabling into the cage enclosure.



The Table

The cage is shipped with a custom 16" x 19" table manufactured for Warner Instruments by Kinetic Systems, Inc. When installed, the table is entirely contained within the cage enclosure and this design successfully isolates the tabletop from external acoustic and mechanical noise sources. The table has a steel top allowing the attachment of magnetically coupled devices to its surface.

Faraday Cage Specifications

Dimensions	25" x 22" x 18" (H x W x D)
Materials	Aluminum with durable powder coat finish. Solid brass grounding block.
Design	Electrically continuous cage with solid wall construction. Cage base accommodates 16" x 19" vibration isolation table (either passive or active support) manufactured by Kinetic Systems, Inc. Table top forms cage floor. Large panel doors with magnetic closures. Dual fan-fold front doors. Large panel doors on top and sides. Cage base has wing doors for access to vibration isolation table controls. Access ports on back panel for electrical connection to cage contents.
Table	Specifications are supplied by Kinetic Systems, Inc. Contact our offices or Kinetic Systems for a copy of the table specifications.
Model	
FC-2	Faraday cage with active pneumatic vibration isolation table
FC-1	Faraday cage with passive pneumatic vibration isolation table, includes hand pump
FC-0	Faraday cage without vibration isolation table. This model has a shallow (1.5"), weighted base for improved access and stability in the absence of the enclosed table.

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Bilayer Chambers and Cuvettes

Since the pioneering work on black lipid membranes by Paul Mueller and co-workers in the early '60s, several generations of membrane biologists have exploited this model membrane for biophysical and reconstitution studies. The planar bilayer formed by painting lipids across a small aperture in a partition is one of the simplest techniques available to the novice and expert alike, and the cup/chamber system has been used to reconstitute and record the single-channel behavior of a wide variety of ion channel proteins from diverse tissues.



Classic design

- Polystyrene, polysulfone or Delrin cuvettes
- Precision machined apertures of 150, 200 or 250 μm
- *cis* and *trans* stirbar wells
- Stirbar included with each cup and chamber
- Viewing window
- Shipments from stock



Perfusion design

- Polystyrene or Delrin cuvettes
- Precision machined apertures of 150, 200 or 250 μm
- *cis* and *trans* stirbar wells
- Stirbar included with each cup and chamber
- Maintains fixed volume
- Dedicated perfusion line ports
- Unique aspiration shelf

The Basics

Cups and chambers from Warner Instruments are designed such that addition of equal volumes to the *cis* and *trans* sides results in a balanced solution height, thus minimizing mechanical gradients across the bilayer membrane.

Bilayer Cuvettes

Polystyrene has been a favored material for cuvettes for several years. The physical properties of this material make for a high quality membrane support. However, its poor resistance to organic solvents can lead to degradation of the aperture. Cuvettes have also been made from Delrin (acetyl resin) and many users report good membrane formation as well as easier maintenance. It should be noted, however, that Delrin cuvettes do not work equally well in all applications and with all users.

Warner Instruments now offers bilayer cups made from polysulfone. This material has many of the mechanical properties of polystyrene coupled with enhanced solvent resistance. The choice of material will depend on your application.

All cuvettes have a 0.5 mm well milled into their base to confine the motion of stirbars and to reduce mechanical noise artifacts. A 2 x 5 mm or 2 x 7 mm Teflon-coated stirbar is supplied with each cuvette. Standard available aperture diameters are 150, 200 or 250 μm . Contact our offices for custom aperture sizes. The wall thickness at the aperture is 250 μm .

Bilayer Chambers

Chambers are made from black Delrin and also have a 0.5 mm recessed well milled into the floor of the non-cup side to confine the motion of stirbars and

Bilayer Chambers and Cuvettes

to reduce mechanical noise artifacts. A 2 x 5 mm or 2 x 7 mm Teflon-coated stirbar is supplied with each chamber.

Polyethylene centrifuge tubes (supplied) serve as intermediate wells for electrical connections between the headstage electrodes and the cup or chamber. Chambers include a nylon screw and rubber plug to secure the cups during use. The classic model has a window for viewing the aperture during membrane formation.

Classic Models BCH-13A and BCH-22A

Two classic models are offered: The BCH-13A is a small volume chamber (1.0 ml) with a 13 mm (1/2") diameter cuvette. The BCH-22A is a larger volume chamber with (3.0 ml) chamber with a 22 mm (7/8") diameter cuvette.

Perfusion Model BCH-P

The Perfusion Bilayer Chamber is designed to simplify the exchange of solutions in both the cup and chamber. This new model incorporates unique features which can improve your perfusion success rate.

The simple design of the BCH-P has two features not found in our classic cup and chamber. First, ports have been permanently milled into both the chamber and cup body for attachment of perfusion lines. The input port is routed to the bottom of the cup (or chamber) while the output port collects solution from the top of the cup (or chamber).

A second improvement is the incorporation of an aspiration shelf in both the cup and chamber. This shelf provides two advantages. First, the aspiration line can remain attached to the chamber without introducing noise artifacts into the bath. Second, the fixed height of the shelf, coupled with rapid aspiration of overflow solutions, helps maintain the working volume.

Connection between your PE perfusion lines and the perfusion ports is conveniently made via standard 200 μ l pipette tips. Alternatively, PE-90 tubing can be attached directly to the cup (or chamber) to minimize dead volume.

The BCH-P chamber is machined from black Delrin and has a working volume of 1 ml. Cups are available in either white Delrin or polystyrene and have a working volume of 1 ml.

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Lamp, Stirplate and Dual Function Controller

The **SUNStir-3 System** is comprised of the **SUNStir** controller, a **SUN-1** lamp and a **SPIN-2** stirplate. This convenient, rack-mountable system is designed to provide simultaneous control for both the **SUN-1** lamp and the **SPIN-2** stirplate.

Controller

The **SUNStir** controller is a rack-mountable instrument designed to provide quiet and efficient control of the **SUN-1** Lamp and **SPIN-2** Stirrer.



SUNStir controller

Lamp

- Dichroic reflector
- Noise-free electronics
- Halogen bulb
- Adjustable spotlight intensity with external control device
- Magnetic base with gooseneck and swivel-head lamp

The **SUN-1** is an externally controlled, noise-free halogen light source suitable for inclusion in a shielded enclosure. The magnetic base attaches securely to any steel tabletop and the lamp swivel-head allows projection of the beam in virtually any direction. Modifications to the design of the reflector result in significant improvements in the lamp's performance.



SUN-1 halogen lamp

The lamp is comprised of a magnetic base with 12" gooseneck for accurate positioning of the illumination spot. A jointed swivel-head at the end of the gooseneck allows the beam to easily subtend a solid angle of 2π steradians (half of a sphere).

Beam intensity is adjustable to one of eight levels via the rack-mount controller. The lamp electronics are well isolated to prevent the introduction of external EMF into the Faraday cage enclosure and allows recording of data even while the lamp is on.

A dichroic reflector reduces much of the projected heat from the lamp and allows longer illumination times without significant warming the object under study.

Stirrer

Bilayer work often requires stirring of contents on both sides of a bilayer membrane. The SPIN-2 Bilayer Stirplate achieves this task by providing two spinning dipoles in a mechanically quiet apparatus.

- **Very low noise!**

- Stir while recording!
- Independent *cis/trans* dipoles
- Minimized magnetic flux through bilayer membrane
- Magnetic steel side panels

Stirring of solutions in a bilayer cup and chamber has traditionally been achieved using a commercial stirplate. Unfortunately, these devices are not designed for use in a bilayer rig and present a single rotating magnetic dipole to the bilayer chamber. A result of these characteristics is that it is impossible to simultaneously stir both wells since the stirbars will be drawn to a common rotational axis defined by the stirplate magnet. The resulting collisions between the stirbars and the bilayer cup introduces a noise artifact into the acquired data. Many researchers avoid this problem by not stirring while recording, which is an undesirable state of affairs.

The **SPIN-2** stirplate from Warner Instruments is designed to specifically address these problems experienced by researchers in the field.

First, it has two separate spinning dipoles, one each for the *cis* and *trans* wells. This design allows the stirbars within each well to be independently controlled which virtually abolishes cup/stirbar collisions. The relative separation between the two dipoles is adjustable allowing the apparatus to be used with bilayer cups and chambers of different sizes.



SPIN-2 bilayer stirplate

Second, the rotation characteristics (speed and phase) of the two spinning dipoles is digitally controlled. This allows the device to present the *minimum magnetic flux* to the bilayer membrane. A liquid crystal display allows the researcher to view the rotating dipoles in real-time.

Third, the apparatus is both electrically isolated and mechanically quiet. In addition, steel strips are provided on each side of the liquid crystal window for attachment of magnetic holders and the like. This provides a convenient method of positioning a perfusion head.

Taken together, these features allow the **SPIN-2** to be used *while acquiring data*.

Specifications

Lamp, Stirplate and Dual Function Controller

SUNStir Controller Specifications

SUNStir	Master power switch, Power on LED
Lamp control	Eight position intensity selection with on/off switch, Power on LED
Stirrer control	Continuously variable speed control with on/off switch, Power on LED
Power requirements	20 W-12 V internal, 100-125 VAC, 60 Hz external
Dimensions	1.75 x 16.5 x 8 in (H x W x D)

SUN-1 Lamp Specifications

Lamp	High impact polyamide housing; swivel head; spot reflector; clear lens Halogen bulb, dichroic reflector; 20 W-12 V
Gooseneck	1.4 cm diameter x 30.5 cm length; with PVC sleeve

SPIN-2 Stirplate Specifications

Controls	
Controller	Power on/off switch, Speed rotary control
Stirplate	Position adjust (rotary)
Display	
Controller	LED; flashes once per complete rotation
Stirplate	Magnetic field display; passive LCD
Speed range	300 to 600 RPM
Rotor	
Synchronization	Counter-rotating with magnets repelling
Position adjustment range (center-to-center)	0.4 to 2.5 inches
Dimensions	
Stirplate	5.5 x 8.0 x 2.3 in (W x D x H)
Weight	
Stirplate	3.0 lb

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Perfusion System

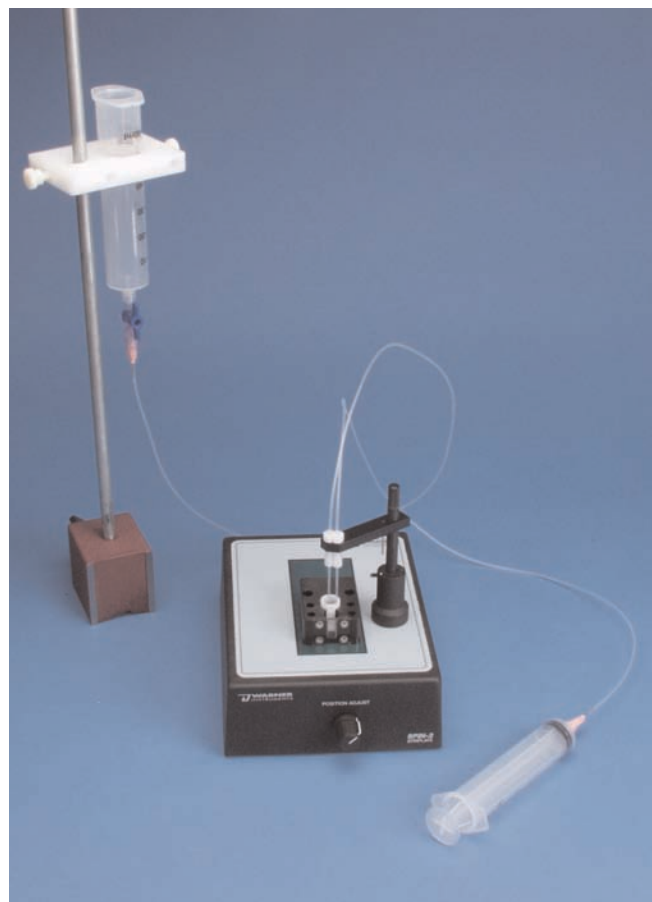
Model BPS-2

A perfusion system is a critical component of a Bilayer Workstation. The ability to exchange solutions on both sides of the bilayer membrane is important if complicated experimental protocols are to be performed. Warner Instruments recommends the use of a gravity-driven system as this is the best way to remove biological and chemical materials with a minimum of noise.

- Complete gravity-feed system
- Quiet operation
- High volume flow rates possible
- Includes everything shown (except for the cup, chamber, and stirplate)

The **BPS-2** Bilayer Perfusion System from Warner Instruments provides a simple and quiet way to exchange solutions in either the bilayer cup or the chamber. The magnetic base holds the perfusion head ready for quick insertion to your solution when expedited solution exchange is necessary.

The gravity-feed mechanism allows the device to support flow rates of up to 10 ml/min without breaking the bilayer membrane. The commonly available syringe reservoirs are easily replaced to reduce cross-contamination between different reservoir solutions.



BPS-2 perfusion head



8-Pole Bessel Filter

Model LPF-8

The LPF-8 is a signal conditioner combining an 8-pole low-pass Bessel filter and DC amplifier. Special features include digital frequency readout, visual input offset indicator, clipping indicator, and gain telegraph outputs.

- 8-Pole low-pass Bessel filter with cutoff frequencies from 0.1 Hz to 20 kHz.
- Differential amplifier gains to x200
- Frequency selection with single control
- Input offset adjustment
- Digital frequency readout
- Rack mountable

The **LPF-8** is the premier low-pass Bessel filter from Warner Instruments and provides superior control of analog signal filtering. This instrument incorporates low-pass signal filtering and output gains from 1 to 200. Selectable dual signal inputs allow the instrument to be configured to operate in normal, inverted or differential modes.

This instrument features optically encoded circuitry which permits frequency selection with a single control. Since the set frequency control is not a physical part of the filtering circuit, adjustments to the instrument do not introduce noise artifacts into the output signal. This unique design uses no mechanical switching and ensures long term instrument reliability.

LPF-8 Specifications

Input	DC differential
Input impedance	1 M Ω each channel
Input range	± 10 V
Input offset	2 Ranges, ± 100 mV and ± 1 V, variable from 0 with 10-turn control
Offset indicator	20 LED display
Low frequency range	0.1 to 199.9 Hz
Low range resolution	0.1 Hz
High frequency range	10 to 19.99 kHz
High range resolution	10 Hz
Gains	x1, x2, x5, x10, x20, x50, x100 and x200
Output impedance	50 Ω
Power requirements	100-130 VAC or 200-250 VAC, 50/60 Hz

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Additional Components

RAC-14

An instrument rack provides an organizing influence on the electronics and facilitates the tabletop design of the Workstation.

The RAC-14 is a 14" tabletop rack and comes with all the hardware needed to mount your amplifier, filter, stirring-illumination controller and A/D board into one integrated unit. A ground point is provided for attachment to the Power Line Conditioner. Powder black finish.



RAC-14

HST-1 Headstage Holder Kit

- Shock mounting for headstage
- Non-conducting surface
- Flexible headstage attachment
- Magnetic base with on/off switch

The HST-1 is designed as a shock mount positioning device for the bilayer headstage. The non-conducting neoprene pad, mounted onto a poly-carbonate base, serves as a stable platform for the headstage. Two medium elasticity rubber bands are used to fix the headstage to the pad and provide a secure but flexible attachment.

Convenient positioning of the HST-1 Headstage Holder is provided by an MB/B magnetic base. The base contains a magnet with on/off switch for easy re-positioning of the assembly within your application.



HST-1 Headstage Holder Kit

BLM Starter Kit

Warner Instruments has put together a Starter Kit to aid you in completing your Bilayer Workstation. The kit includes 3 BNC cables, grounding cables, Red Sable artist's dotting brushes, glass capillary tubing, PE tubing for your perfusion system, and one replacement pack of stirbars (2 x 5 mm or 2 x 7 mm).

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Accessories

Acquisition Hardware and Software

pClamp Package from Molecular Devices

The pClamp package (comprised of Molecular Devices' Digidata 1440 computer interface and pClamp 10 software) represents a state-of-the-art acquisition system from Molecular Devices Corporation.

Digidata 1440A Low-noise Data Acquisition System

Molecular Devices presents the latest **Digidata 1440A** digitizer for low-noise experiments. This high-resolution 16-bit data acquisition system is self-contained and communicates with the host computer via a USB 2.0 interface, which means extremely easy installation and setup. Designed for ease-of-use and fast results, the Digidata 1440A comes with versatile AxoScope for Windows software and is ready to take data immediately after installation. Absolutely no programming is necessary.



The Digidata 1440A has a maximum sampling rate of 250 kHz per channel, with an outstanding total data throughput rate of 4 megasamples per second. Both the inherent digitizer noise and channel crosstalk noise are rated at less than ± 1 mV average p-p at 10 kHz, within a ± 10 V input range. The front panel is well laid out with sixteen analog input channels and four analog output channels, eight general digital outputs, one dedicated digital output to trigger devices such as oscilloscopes, trigger inputs to start acquisition and to tag data. The back panel has four additional analog instrument telegraph inputs, as well as a DB-25 connector for the digital outputs.

Designed to support continuous data acquisition within a multitasking operating system, the Digidata 1440A digitizer is fully supported by our AxoScope 10 for Windows and pCLAMP 10 for Windows electrophysiology software.

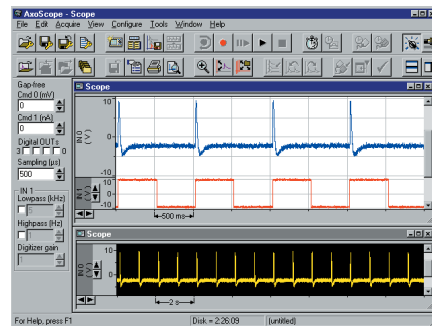
With its USB 2.0 interface, you can easily connect the Digidata 1440A to a laptop computer without the need for a peripheral PC card.

pClamp 10 Analysis Software

The **pCLAMP 10** software suite fulfills many different experimental needs, such as synchronized stimulation, event detection, and online analysis. It is the most widely-used data acquisition and analysis program for the control and recording of voltage-clamp, current-clamp, and patch-clamp experiments. Three separate programs are included: Clampex 10, AxoScope 10, Clampfit 10.

Clampex 10 expands the range and quality of your data acquisition experiments. These improvements should prove useful for a wide variety of applications, allowing more flexibility in your experimental protocols.

AxoScope 10 provides a convenient way to produce background recordings with the included MiniDigi 2-channel digitizer. You can monitor cells during intra-sweep periods, or create an overview of the entire day's activities including voice tags.



Clampfit 10 is a powerful solution for analyzing, graphing and layout of all of your Clampex and AxoScope data. Clampfit includes an extensive array of filtering and fitting routines. Functionality includes I-V graphs, power spectrums, and special "linked data views" for threshold (AP), template (minis) and single-channel modes of event detection and analysis.

Warner Instruments is pleased to include the following information detailing compatible acquisition systems from Molecular Devices and Instrutech. We provide this information and these products as a service to our customers and make it available as an optional component of the Warner Instruments Planar Lipid Bilayer Workstation. All product warranty and support rights for this acquisition package are retained by Molecular Devices and Instrutech.

Please contact the vendor directly if you require additional information.

Accessories

Acquisition Hardware and Software

Pulse Package from Instrutech

The WinClamp package (comprised of Instrutech's ITC-18/USB computer interface and HEKA's Pulse and PulseFit software) represents a state-of-the-art acquisition system from Instrutech Corporation.

ITC-18/USB Computer interface

The **ITC-18/USB** is a second-generation A/D converter from Instrutech Corporation. This powerful hardware/software package utilizes a USB interface to connect the hardware with the computer allowing for simple and direct product installation. A PCI based version of the hardware is also available.

The ITC-18/USB is supplied with a large 1024 kilo-sample FIFO memory for input and output data, allowing uninterrupted continuous high speed acquisition with today's multitasking operating systems. The ITC-18

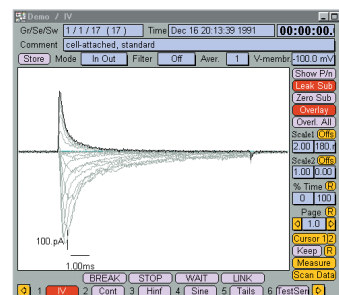


provides eight analog input channels. Each input channel uses an 18-bit A/D converter preceded by a programmable gain stage. Each A/D input can be programmed with a full scale range of +1, +2, +5, or +10 Volts. This gain stage reduces the need for external signal amplifiers before the ITC-18. Using separate A/D converters for each analog input channel also has advantages. One benefit gained by using separate A/D converters is reduced crosstalk between channels. The ITC-18 provides four 18-bit instrumentation grade D/A converters featuring high accuracy with less than 1 bit (~300 mV) of noise. This extremely low noise allows for the observation of least significant bit transitions.

The D/A circuitry used in the ITC-18 is temperature stabilized and de-glitched for ideal performance. The ITC-18 uses a sequence RAM to control the sampling order of both the analog and digital channels. This provides the ability to update individual channels at different rates. This arrangement optimizes the acquisition of signals with dissimilar bandwidth. The ITC-18 provides sixteen digital inputs, thirty-two digital outputs, seven sequence RAM trigger outputs and fourteen asynchronous non-isolated digital outputs. The digital input channels feature level-sensitive or latched modes. For maximum versatility the inputs can be inverted, allowing rising or falling edge triggering. Thirty-two digital output channels in two banks of sixteen, with fourteen channels paralleled with current sink circuitry for driving perfusion valves, solenoids, or other devices directly. Seven programmable trigger outputs for triggering from any location in the scanning sequence RAM and fourteen asynchronous auxiliary digital outputs that can be updated at any time regardless of the ITC-18's acquisition state are available.

Acquisition and analysis software

The software package from Instrutech is comprised of **Pulse** and **PulseFit** from HEKA Elektronik.



The Pulse and PulseFit package has been developed with the help of leading laboratories worldwide to meet the requirements of the scientific community and thus provides the optimal solution for data acquisition and evaluation.

Together, Pulse and PulseFit constitute the perfect combination of simple operation and comprehensive functionality. For the beginner, the operation can be limited to the essential functions. Intuitive operation and uncompromising simplification of complicated adjustments quickly enable the user to perform more complex experiments and evaluations. The experienced patch clamp investigator will be fascinated by the versatility of the program and logical structure of the functions. The outstanding user interface of the program with virtual control keys can be defined by the user to meet his requirements. From the very first day you can record data from your experiments with Pulse.

Up-to-date product information and specifications on the ITC-18/USB, as well as the Pulse/PulseFit software package can be found on the Instrutech web site.

system 1. a group of interacting elements functioning as a complex whole, 2. a network, 3. method or procedure

component 1. a constituent part, 2. being or functioning as a part of

Accessories

Stirbars

Replacement stirbars (magnetic fleas) are available for the BCH Series bilayer chambers. Stirbars are Teflon coated and are available in two sizes. Stirbars are sold in packages of 5 each and come in 2 x 7 mm and the more difficult to find 2 x 5 mm sizes.

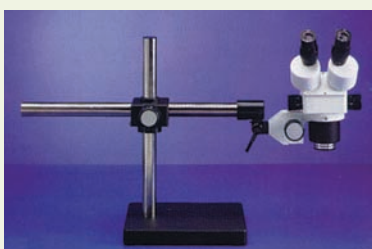
Glass Capillary Tubing

Glass capillary tubing has gained favor among bilayerologists as the preferred tool for applying lipids to the aperture in the bilayer cup. The advantages of this approach (as compared to Sable hair brushes) are durability and the ability to sterilize the applicator between uses. Glass tubing from Warner Instruments has been chosen with dimensions that facilitate this use. The 1.5 mm OD and 15 cm length of this thick-walled tubing make for good quality glass applicators.

Stereo Zoom Microscope

The ZM-186 Stereo Zoom Microscope, when used in conjunction with the Planar Lipid Bilayer Workstation, is an ideal instrument for viewing the formation of bilayer membranes. The included boom stand permits the device to be positioned in the cage during use and then swung out of the way after the membrane has stabilized. The microscope can be mounted both vertically or horizontally for diverse applications.

The rugged boom stand features a 15.4" chrome steel vertical post and a 21" horizontal bar. The 10.3" x 9.5" rectangle metal base assures positive stability. A locking collar prevents



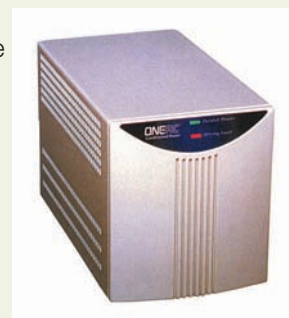
accidental slippage on the vertical pole. The universal arm with the standard 5/8" diameter knuckle mounts directly to the end of the horizontal bar.

The ZM-186 has a drift free focusing range of 3.5 cm.

Power Line Conditioning

An often overlooked source of noise in electro-physiological recording is that introduced by fluctuations in the power circuit supplying the apparatus. Many labs are placed on upper floors in large research facilities where the power circuit is shared by many other labs. While most instrumentation used in BLM work are designed to compensate for variances in the power circuit, these effects cannot be completely abolished in a distributed network of components.

An elegant solution to this problem is provided by the use of an isolation transformer to supply power to the entire Workstation. The ON-750 Power Line Conditioner is a two-sided device wherein one side connects to the institutionally supplied power and the other, isolated, side connects to the BLM



Workstation. This configuration results in the presentation of a stable power source to the Workstation which abolishes noise artifacts introduced from varying loads on the "house circuit."

Oscilloscope

An oscilloscope is a useful device for viewing an acquisition signal before it is processed by the A/D board. This permits verification of the veracity of the software and hardware. An oscilloscope can also be an invaluable aid in troubleshooting your setup. Warner Instruments features the HM-507 Dual Channel, 50 MHz Oscilloscope. This scope features high bandwidth capability in both analog and digital modes, which is unique in its price range. The user can select between the advantages of analog or digital by a single pushbutton. The high resolution CRT display offers unsurpassed signal display quality in combination with an unmatched display update rate.

Single Channel Simulators

CM-3 Variable Channel Model

The CM-3 is a continuously variable single channel simulator which models an actively gating ion channel. Gating transitions from the closed to the open, or from the open to the closed state are randomly induced within the constraints imposed by the mean open and mean close time settings. This unique device provides the researcher with a means to generate well-defined ion channel gating kinetics allowing critical analysis of data acquisition hardware and software and data analysis software. The instrument is also an ideal teaching aid.

- Independent selection of open and close time constants via calibrated rotary dial
- Selection of unitary channel conductance via calibrated rotary dial
- Available in 10 and 100 pF membranes
- Small dimensions allow easy attachment to the amplifier headstage within the Faraday cage enclosure
- Battery operated

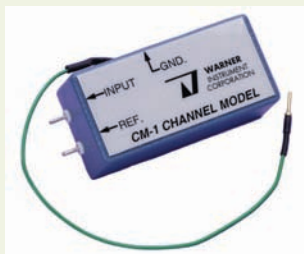


CM-3 Variable Channel Model

A special adapter cable is needed to connect the CM-3 and CM-1 simulators to non-Warner Amplifiers. See ordering information for details.

CM-1 Fixed Channel Model

The CM-1 is a fixed variable single channel model which simulates an actively gating ion channel. Gating transitions from the closed to the open, and from the open to the closed state, are randomly induced within the constraints imposed by the mean open and mean close time settings. Attaches directly to the headstage.



CM-1 Fixed Channel Model

Single Channel Specifications

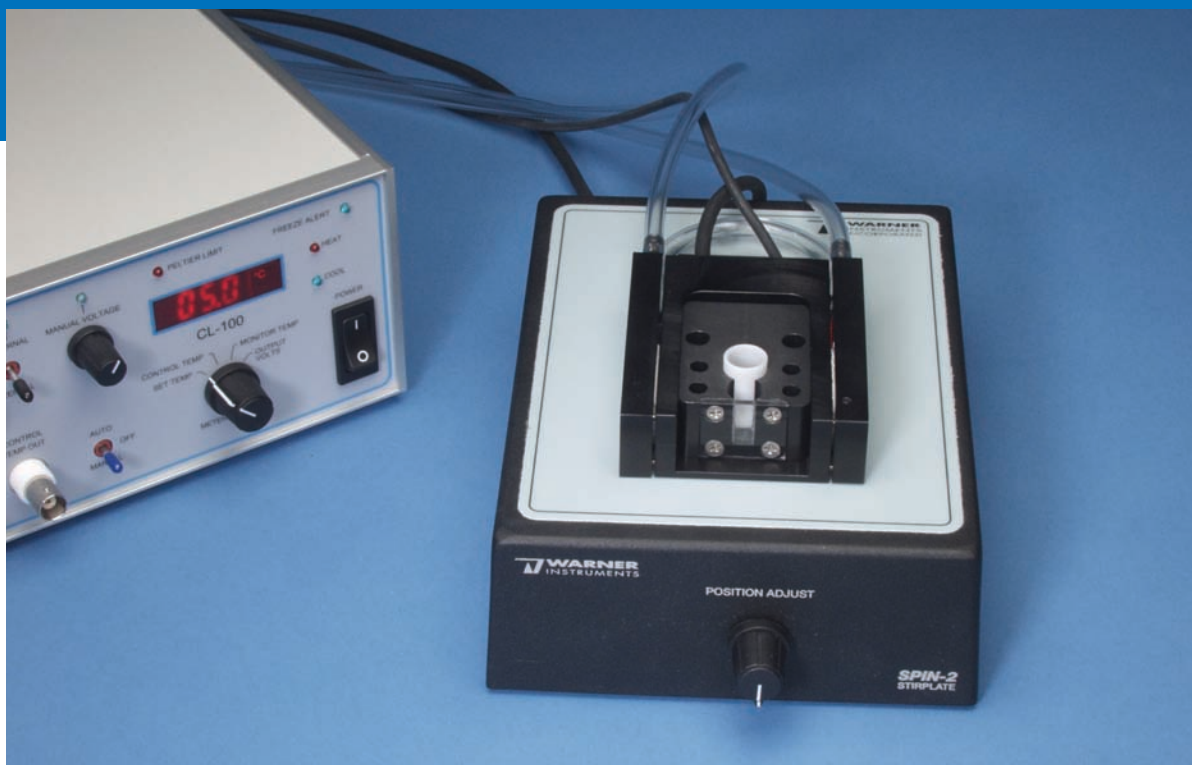
CM-3

Mean time constants	Individually adjustable from 1-200 ms
Conductance	Continuously variable from 0-750 pS
Battery	9 V, 3 years of continuous operation
Dimensions	6.6 x 7.6 x 4.2 cm (H x W x D)

CM-1

Mean time constants	Open and closed factory set to 10 ms
Conductance	20 and 200 pS for patch and bilayer models, respectively
Battery	3 V lithium, 3 years of continuous operation
Dimensions	2.8 x 5.7 x 2.2 cm (H x W x D)

BLM-TC Planar Lipid Bilayer Thermocycler



Finally, there's temperature control for the bilayer!

- Peltier driven
- Cools to 5 °C
- Heats to 50 °C
- Heats and cools at 3 °C/min.
- Stable to 0.2 °C

The new BLM-TC from Warner Instruments uses Peltier technology to cool, heat or thermocycle a planar lipid bilayer membrane.

The tight and reproducible temperature control provided by this unique device can facilitate the measurement of single channel events at physiologic temperatures, or at any temperature between 5 °C and 50 °C.

The device heats and cools at an average rate of 3 °C/min when transitioning between 40 °C to 10 °C. More importantly, the BLM-TC can maintain a temperature to within 0.2 °C of the set temperature.

The **BLM-TC** system is comprised of a Peltier-driven bilayer platform (compatible with Warner's SPIN 2 bilayer stirplate), a CL-100 bipolar temperature controller, and a reservoir/pump assembly (for the water jacket).

The purchase of a **BCH-M13** or **BCH-M22** thermally conductive bilayer chamber and a standard bilayer cup completes the package.

Note: *If you will be primarily working at temperatures above ambient, then we recommend using the larger BCH-M22 chamber to reduce the impact of evaporative losses in the system during use.*

work 1. a task or duty, 2. to operate or cause to operate effectively

station 1. the place from which a service is provided or operations are directed

Ordering Information

Order number	Model number	Product description
64-0452A	BLM-WS-A	Bilayer Workstation with Active Vibraton Isolation Table
64-0452P	BLM-WS-P	Bilayer Workstation with Passive Vibraton Isolation Table

BLM-WS System is comprised of:

FC-Series Cage	Faraday cage with vibration isolation table
BC-535	Bilayer clamp amplifier
LPF-8	Bessel filter
SUNStir-3	Dual function rack mountable controller with SUN-1 lamp and SPIN-2 stirrer
BPS-2	Basic Bilayer Perfusion System
RAC-14	Instrument rack
HST-1	Headstage holder with magnetic base
BLM-ST	Bilayer Starter Kit

Purchase of a bilayer cup and chamber, and a data acquisition system are needed to complete the system.
A legacy BLM-WS System which uses the Capacitive Feedback BC-525D amplifier is available: call for pricing.

Accessories

Order number	Model number	Product description
Classic cups and chambers, 1 ml working volume		
64-0400	BCH-13A	Bilayer chamber without cuvette
64-0410	CD13A-150	13 mm Delrin cuvette with 150 µm aperture
64-0409	CD13A-200	13 mm Delrin cuvette with 200 µm aperture
64-0408	CD13A-250	13 mm Delrin cuvette with 250 µm aperture
64-0404	CP13A-150	13 mm polystyrene cuvette with 150 µm aperture
64-0403	CP13A-200	13 mm polystyrene cuvette with 200 µm aperture
64-0402	CP13A-250	13 mm polystyrene cuvette with 250 µm aperture
64-0416	CF13A-150	13 mm polysulfone cuvette with 150 µm aperture
64-0415	CF13A-200	13 mm polysulfone cuvette with 200 µm aperture
64-0414	CF13A-250	13 mm polysulfone cuvette with 250 µm aperture
Classic cups and chambers, 3 ml working volume		
64-0401	BCH-22A	Bilayer chamber without cuvette
64-0413	CD22A-150	22 mm Delrin cuvette with 150 µm aperture
64-0412	CD22A-200	22 mm Delrin cuvette with 200 µm aperture

Ordering Information

Order number Model number Product description

Classic cups and chambers, 3 ml working volume (continued from previous page)

64-0411	CD22A-250	22 mm Delrin cuvette with 250 μ m aperture
64-0407	CP22A-150	22 mm polystyrene cuvette with 150 μ m aperture
64-0406	CP22A-200	22 mm polystyrene cuvette with 200 μ m aperture
64-0405	CP22A-250	22 mm polystyrene cuvette with 250 μ m aperture
64-0419	CF22A-150	22 mm polysulfone cuvette with 150 μ m aperture
64-0418	CF22A-200	22 mm polysulfone cuvette with 200 μ m aperture
64-0417	CF22A-250	22 mm polysulfone cuvette with 250 μ m aperture

Perfusion cups and chambers, 1 ml working volume

64-0423	BCH-P	Perfusion bilayer chamber without cup
64-0427	CD-P100	1 ml Delrin perfusion cup with 150 μ m aperture
64-0428	CD-P200	1 ml Delrin perfusion cup with 200 μ m aperture
64-0429	CD-P250	1 ml Delrin perfusion cup with 250 μ m aperture
64-0424	CP-P150	1 ml polystyrene perfusion cup with 150 μ m aperture
64-0425	CP-P200	1 ml polystyrene perfusion cup with 200 μ m aperture
64-0426	CP-P250	1 ml polystyrene perfusion cup with 250 μ m aperture

Data acquisition systems

64-0436	DIGI	Molecular Devices A/D package: Digidata 1440/pClamp 10
64-0078	ITC	Instrutech A/D package: ITC-1600/Pulse+PulseFit

Optional items

	OST-1	On-site setup and training – daily fee (add travel expenses)
64-0450	BLM-TC	Bilayer Thermocycler System (requires BCH-M13 chamber)
64-0451	BCH-M13	Chamber for bilayer thermocycler, 1 ml (cup purchased separately)
64-0453	BCH-M22	Chamber for bilayer thermocycler, 3 ml (cup purchased separately)
64-0069	ON-750A-US	6.5 A power line conditioner for 120 VAC/60Hz
64-0073	ON-750A-EU	6.5 A power line conditioner for 220 VAC/50Hz
64-0027	CM-3/100	Single Channel Variable Simulator, 100 pF membrane
64-0026	CM-3/10	Single Channel Variable Simulator, 10 pF membrane
64-0025	CM-1/100	Single Channel Simulator, Fixed values, 100 pF membrane
64-0024	CM-1/10	Single Channel Simulator, Fixed values, 10 pF membrane
64-1618	CM-Cable	CM-3/CM-1 Command Cable
64-0071	ZM-186	Stereo microscope with boom stand
64-0080	HM-507	Oscilloscope, 50 MHz, dual channel



Order number Model number Product description

Optional items (continued)

72-2992		2-Channel chart recorder, 200 mm wide paper path
72-2989		1-Channel chart recorder, 200 mm wide paper path
72-2995		Chart recorder paper, 200 mm wide, 10 pack
72-3530		Chart recorder pens, black, 5 pack
72-3529		Chart recorder pens, red, 5 pack

Replacement parts

64-0772	G150-4	Glass capillary tubes
64-1327	WA10-5	Silver wire electrodes, 1 mm pin, 10 cm length, 0.25 mm diameter
64-0755	PE-160/10	PE-160 tubing, 10 meter
64-0420	MAG-13	Stir bars 2x5 mm for 13 mm cuvettes, pack of 5
64-0421	MAG-22	Stir bars 2x7 mm for 22 mm cuvettes, pack of 5
64-0061	SUN-1	Low temperature halogen lamp with tabletop controller
64-0065	SUN-DCH	Replacement 20 W dichroic halogen bulb for SUN-1 lamp
64-0074	SPIN-2	Dual dipole stirplate with tabletop controller
64-0075	SUNStir controller	Controller for SUN-1 lamp and SPIN-2 stirplate, rack mountable
64-0422	HH-1	Headstage holder for bilayer headstage
64-0060	MB/B	Magnetic base
64-0062	FC-0	Faraday cage without table, shallow base
64-0085	FC-3	Faraday cage without table, deep base
64-0081	KS-1	Vibration isolation table for Bilayer Workstation - passive support
64-0082	KS-2	Vibration isolation table for Bilayer Workstation - active support
64-0022	BC-525D	Bilayer clamp amplifier, capacitive feedback
64-0352	CL-100	Bipolar temperature controller

Workstation component pricing

64-0432	BC-535	Bilayer clamp amplifier, resistive feedback
64-0063	FC-1	Faraday cage with passive isolation table
64-0064	FC-2	Faraday cage with active isolation table
64-0050	LPF-8	Low pass 8-pole Bessel filter
64-0076	SUNStir-3	SPIN-2, SUN-1, SUNStir controller bundle
64-0431	BPS-2	Bilayer perfusion system
64-0435	HST-1	Headstage holder system
64-0070	RAC-14	14" tabletop instrument rack
64-0067	BLM-ST	Bilayer starter kit

Domestic orders, technical support and ordering information

Domestic orders and technical support

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(508) 893-8999
Fax: (508) 429-5732
E-mail: bioscience@harvardapparatus.com

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Terms and conditions

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If unsatisfied with a product purchased from Harvard Apparatus you may return the item for credit or replacement. You must contact us within thirty days of receipt of your shipment to obtain a Return Authorization Number and instructions to facilitate the return process. All returned products are subject to inspection and approval by Harvard Apparatus prior to issuing credit or replacement. Products must be in original manufacturer's packaging and include all instructions, manuals, and inserts. Products returned in new condition will be charged a 15% restocking fee or a minimum of \$30.00. Products not in saleable condition will be returned to the customer or assessed a refurbishment fee.

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1. Items not supplied in accordance with your order
2. Items that are defective at the time of receipt

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4. Product(s) that have been exposed to harmful, toxic or hazardous substances

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2. \$150 per hour for labor with a \$150 minimum labor charge
3. All repairs are performed on a first in/first out basis, only after receipt of a valid purchase order
4. Estimates available upon request
5. Some older products may not be repairable due to component obsolescence

Minimum Orders

We appreciate all orders and therefore have no minimum order requirement, however, a small handling fee of \$10 will be added to orders below \$75.

Notes



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