Electrophysiology

50 Years of Experience with Researchers

From our early beginnings in 1967 working with Yale researchers, electrophysiology has been at the heart of our business. WPI amplifiers, stimulators and isolators are designed with quality components so you get a reliable, low-noise signal every time. Our time-tested designs give you affordable solutions for electrophysiology equipment, electrodes, data acquisition and accessories for applications like:

- Intracellular/Extracellular Recording
- Voltage Clamp for Ussing
- Stimulation and Isolation
- Optogenetics
- Digital Filtering
Bioamplifiers for Electrophysiology

A family of very low noise battery-operated amplifiers

Features

- Battery powered to eliminate line noise
- High pass and low pass filtering
- Single ended or differential operation
- DC/AC amplification
- Variable output positioning
- Constructed of high quality components to ensure minimal intrinsic (shot) noise
- Portable
- Rack mountable

Benefits

- Very low internal noise
- Ultra quiet DC power supply — no AC required
- Intrinsic low susceptibility to ground loops
- Small footprint
- Cost effective
- Electrostatic Discharge Protection!

Applications

- Amplifying biopotentials from metal electrodes
- Brain slice field stimulation
- EAG (Electroantennogram)
- ERG (Electroretinogram)

WPI’s DAM series amplifiers are well known as a standard of the industry for amplification of extracellular potentials. These battery powered bio-amplifiers are designed with a compact chassis profile that enables you to locate the unit closer to the preparation and thereby minimize long lead lengths which contribute to noise. Each amplifier is equipped with selectable high and low filters, and a position control to offset galvanic potentials which may develop during recording.

DAM series amplifiers can be used as stand-alone units on any tabletop or use optional clamp-mounting hardware to locate them conveniently within the work area. Alternatively, a pair of amplifiers can be mounted into a standard equipment rack with a rack mount kit (3484). A variety of hook up accessories are available to configure your application.

DAM80 Overview

DAM80, an AC amplifier only, features a very low noise active headstage probe which can be mounted in micromanipulators for up-close cortical recording, for extracellular recording from high impedance glass or metal microelectrodes. The unit also provides a gated current for tissue marking. Microelectrode holder MEH7W-XX (sold separately) is recommended for glass microelectrodes. The DAM80 is perfect for gated or manual current generation for histological marking, iontophoresis or cell stimulation. It includes a very low noise remote active headstage that is useful for very high impedance amplification utilizing glass or metal electrodes.

Included with the DAM80 is a Startup Kit containing the following accessories needed for basic metal electrode electrophysiology research:

- CBL102 (2) Cable, BNC-to-3.5 mm plug, 6 ft (2m)
- 5469 (2) Adapter, mini-banana to 0.031 socket
- 13388 (2) Adapter, mini-banana to 2mm socket
- 3294 Cable, ground clip to wire, 3 ft
- 2033 Mini-banana plug, black
- 2034 Mini-banana plug, red
- 2035 (2) Mini-banana plug solderable turret
- EP1 Ag/AgCl pellet (70 mm wire) 1 mm diam x 2.5 mm long
- M3301EH (2) Electrode Holder, 14cm
- 5470 0.031-inch jack on 12-inch wire (package of 4)

FEATURE COMPARISON

<table>
<thead>
<tr>
<th>Feature</th>
<th>DAM50</th>
<th>DAM80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Mode</td>
<td>AC/DC</td>
<td>AC</td>
</tr>
<tr>
<td>Input Configuration</td>
<td>differential/single ended</td>
<td>differential AC, 100-1K (DC)</td>
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<td>Gain Range</td>
<td>100-10K (AC), 10-1K (DC)</td>
<td>100-10K (AC)</td>
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<td>High/Low Filters</td>
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<td>Offset Position</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>Control</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Current Generator</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Remote Active Headstage</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Output Connection</td>
<td>BNC</td>
<td>3.5 mm mini phone</td>
</tr>
<tr>
<td>Standard Input Connection*</td>
<td>unterminated wire</td>
<td>mini banana</td>
</tr>
<tr>
<td>Power Supply</td>
<td>(2) 9V alkaline batteries</td>
<td>(2) 9V alkaline batteries</td>
</tr>
</tbody>
</table>

*See optional accessories for additional alternatives
DAM50 References


DAM80 References


DAM080 — with low-noise headstage DAM80P

**ORDERING INFORMATION**

**SYS-DAM50** Bio-amplifier

**SYS-DAM80** Bio-amplifier with active probe (DAM80P)

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**

**DAM80P** Replacement Probe

3072 6 Replacement Modular Cables (DAM50)

3517 2 Optional Shielded Modular Cables (DAM50)

CBL102 3.5 mm Phone plug-to-BNC Cable

2851 BNC-to-BNC Cable

2033 Black Insulated Mini-Banana Plug

2034 Red Insulated Mini-Banana Plug

2035 Uninsulated Mini-Banana Plug

2101 9V Alkaline Battery, each (2 required)

3484 Rack Mount Kit (for 1 or 2 DAM preamps)

3485 Ringstand Mounting Kit

5447 Electrode Adapter (DAM50)

5469 Metal Microelectrode Adapter for DAM80 (mini-banana plug to 0.031 in. (0.79 mm) socket)

5489 Adapter for Metal Microelectrode (DAM50)

13388 Adapter, mini-banana plug to 2mm socket

5371 Cable, Low Noise (2 mm pin to 2 mm pin)

3578 Adapter Cable for Ag/AgCl pellets (2 mm pin)

300102 Electrode Extension, 4-inch

3414 9V NiMH Battery

MEH7W-XX Microelectrode Holder- 1.0, 1.5 or 2.0 mm OD

See Cables and Connectors, page 108. See Metal Microelectrodes, page 104.

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**DAM SERIES SPECIFICATIONS**

**INPUT IMPEDANCE** 10¹Ω

**INPUT LEAKAGE CURRENT** 50 pA (typical)

**MAX. DC DIFFERENTIAL SIGNAL** ± 2.5 V (DAM 50)

**GAIN**

AC Mode: 100x, 1000x, 10000x

DC Mode: 10x, 100x, 1000x (DAM50)

**COMMON MODE REJECTION RATIO** 100 dB @ 50/60 Hz

**INPUT CAPACITANCE** 20 pF

**AC MODE NOISE**

0.4 µV RMS (2 µV p-p) 0.1-100 Hz

2.6 µV RMS (10 µV p-p) 1 Hz-10 kHz

7.5 µV RMS (30 µV p-p) 3-10 kHz

**DC MODE NOISE (DAM50)**

5489 Adapter for Metal Microelectrode (DAM50)

13388 Adapter, mini-banana plug to 2mm socket

5371 Cable, Low Noise (2 mm pin to 2 mm pin)

3578 Adapter Cable for Ag/AgCl pellets (2 mm pin)

300102 Electrode Extension, 4-inch

3414 9V NiMH Battery

MEH7W-XX Microelectrode Holder- 1.0, 1.5 or 2.0 mm OD

See Cables and Connectors, page 108. See Metal Microelectrodes, page 104.

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**BANDWIDTH FILTER SETTINGS**

AC Mode: Low frequency, 0.1, 1, 10, 300 Hz

AC Mode (DAM80): High frequency, 0.1, 1, 3, 10 kHz

DC Mode (DAM50): High frequency, 0.1, 1, 3, 10 kHz

**OUTPUT Connectors**

BNC on DAM50; 3.5 mm MiniPhone connector on DAM80

**OUTPUT VOLTAGE SWING** ±8 V

**OUTPUT IMPEDANCE** 470 Ω

**BATTERY TEST** Audible tone

**CALIBRATOR SIGNAL** 10 Hz square wave

**POSITION** Approximately 250 mV

**CURRENT SOURCE**

DAM50: DC Generator

EXTERNAL COMMAND

Input Voltage ±10 V commands

AC OR DC CURRENT WAVEFORM

±50 µA max. amplitude @ 200 kHz

**BATTERIES**

2 x 9V alkaline (included)

**DIMENSIONS**

DAM50 8 x 4 x 1.75 in. (20.3 x 10.2 x 4.4 cm)

DAM80 7 x 4 x 1.75 in. (17.8 x 10.2 x 4.4 cm)

**SHIPPING WEIGHT**

3.5 lb (1.6 kg)
Which Amplifiers is Right for You?

### AMPLIFIER COMPARISON CHART

<table>
<thead>
<tr>
<th>Amplifier</th>
<th>AC/DC</th>
<th>Differential</th>
<th>Active Headstage</th>
<th>Stimulation</th>
<th>Isolated</th>
<th>Multi-channel</th>
<th>Battery Powered</th>
<th>Connectors</th>
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<tbody>
<tr>
<td><strong>Intracellular Bioamplifiers</strong></td>
<td></td>
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<td>ISODAM8A</td>
<td>DC</td>
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<td>4 - 8</td>
<td>Mini Banana or 8-pin DIN</td>
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<tr>
<td>ISO80</td>
<td>AC</td>
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<td>Mini Banana</td>
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<tr>
<td>DAM50</td>
<td>AC/DC</td>
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<td><strong>Transducer Amplifiers</strong></td>
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<td>4 - 8</td>
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<td>8-pin DIN WPI transducers</td>
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<td><strong>Epithelial Voltage/Current Clamp Bio Amplifier</strong></td>
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<td>EVC4000</td>
<td>DC</td>
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<td>1 - 4</td>
<td>Ussing 2 mm</td>
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</table>

WPI’s Low-Noise Amplifiers Outperform Cheap Imitations

An amplifier is an electronic device that magnifies an input signal. However, the way an amplifier is designed to handle noise and bandwidth limitations greatly affects the quality and sustainability of the final output signal.

**Defining Terms**

To knowledgeably discuss amplifiers, let’s define a few common terms.

**Gain** – The gain is the multiplier defining how much the amplitude of an input signal is increased. A signal with an ×1 gain is not amplified. A ×10 gain produces an output signal ten times greater than the input signal.

**Noise** – Any unwanted signal fluctuations are called noise. While noise can also result from external sources, for the purpose of this discussion, we are primarily concerned with the noise resulting from the inner workings of the electronic device, our amplifier. This intrinsic noise is called shot (or schott) noise.

**Signal to Noise Ratio (SNR)** – The ratio of the output signal to the noise of the amplifier is called the signal to noise ratio. The smaller the shot noise signal in an amplifier in comparison with the output signal, the easier the desired signal is to discriminate. When engineering an amplifier, the SNR may be improved by boosting the first stage gain to yield a larger output signal or by using quality components to minimize the shot noise level of the amplifier.

**Output Range** – The output range determines the maximum output signal that can be generated with the amplifier. It is determined by the maximum voltage of the power supply. If the amplitude of the output signal is too large for the output range, part of the signal is cut off (clipped).

**Rail** – The upper or lower limit of the amplifier range is called a rail. Signals that exceed the rail cannot be faithfully reproduced.

**DC Offset** – DC offsets can appear in biological preparations. This offset is the amount the output signal is displaced away from a zero reference point. It is usually a result of the potential difference at the electrode’s tip.
How Amplifiers Work

Power Supply Rails Limit the Range

In a perfect world an input signal can be infinitely multiplied by the gain factor to determine the output signal. For example:

<table>
<thead>
<tr>
<th>Input Signal</th>
<th>Gain</th>
<th>Output Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mV</td>
<td>x1</td>
<td>2 mV</td>
</tr>
<tr>
<td>2 mV</td>
<td>x2</td>
<td>4 mV</td>
</tr>
<tr>
<td>2 mV</td>
<td>x10</td>
<td>20 mV</td>
</tr>
<tr>
<td>2 mV</td>
<td>x100</td>
<td>200 mV</td>
</tr>
<tr>
<td>2 mV</td>
<td>x10,000</td>
<td>20 V</td>
</tr>
</tbody>
</table>

In the real world, the power supply rails limit the possible output range of the amplifier. For example, a bio-amplifier could have a range of ±5.0V. In order for the output signal to be faithfully reproduced, the input signal times the gain factor must fall within the voltage window set by the power rails. Otherwise, the output signal goes off scale, and the input signal is not faithfully reproduced. This is called “hitting the rail.”

In our example, a 1.0 µV input signal at an ×10⁴ gain would generate a 1.0V output signal. Since the power supply is rated up to ±5.0V, this output signal is clearly visible. If the input signal in this example is greater than 5.0 µV, the output signal would be greater than ±5.0V. Since 5.0V is the top of the range that the power supply is capable of producing, the output signal hits the upper rail and gets cut off. This amplifier gives a ±5.0V DC output signal for all input signals greater than or equal to 5.0 µV. So, a smaller gain factor should be used to bring the output signal back into the dynamic output range of the amplifier.

Noise Limits Amplifier Useability

All electronic devices produce their own internal electronic noise, an unavoidable signal that can mask the output signal. For example, if the input signal is 2mV and the noise is 1 mV, the signal to noise ratio is two to one (2:1), and the output signal would be undetectable. It is nearly impossible to discern which part of this output is generated by noise and which part is the desired signal. (See figure.)

Ideally, the signal to noise ratio should be at least 50 to 1 to produce nearly impossible to discern which part of this output is generated by noise and which part is the desired signal. (See figure.)

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The amplifier that minimizes the noise is the first stage of amplification. The intrinsic noise is not amplified in the first stage. Higher gain factors used in the first stage of amplification can seriously limit the dynamic range available at output stage. Large stage one gains also limit the gain factor available in the second stage of amplification.

Stage 2 – The stage one output signal enters the second stage of amplification where both the signal and the noise from the first stage are amplified together by the second stage gain factor so that the signal is large enough to be seen on a chart recorder or data acquisition system. The second stage amplification is the gain the user controls. It does not change the signal to noise ratio.

Instead of using high gains in the first stage of amplification, a well constructed bio-amplifier that uses high quality components, like WPI’s DAM series amplifiers, minimizes the noise in the first stage of amplification so that the dynamic range is retained throughout the amplification process. Poorly designed amplifiers simply increase the gain of the first stage amplification until the desired signal to noise ratio is reached.

Boost the power rails?

Theoretically, increasing the voltage rails powering the amplifier will increase the available dynamic output range. It would seem natural to increase the power supply rails coming into the amplifier in order to provide the capability for greater first stage gains. However, most data acquisition systems are limited to a maximum input signal ranging between ±10.0V. Therefore, it is not practical to increase the power rails of bio-amplifier beyond ±10.0V. Since the industry standard limits us to ±10.0V power supply rails, the only way to improve the signal to noise ratio is to minimize the shot noise in the first stage of amplification. This is why high quality amplifier components are imperative.

Why a Signal Flatlines

Regardless of the amplifier used, biological potentials are often accompanied by a DC offset, because the electrodes polarize over time. The DC offset naturally increases over time. Since the poorly constructed amplifier that utilizes greater first stage gain has restricted its dynamic range, it has limited ability to handle this offset. As the offset continues to increase, the output signal may eventually be forced by the offset into the rail causing the flat line (clipping the signal). (See Figure.)

The amplifier that minimizes the noise in the first stage amplification offers a larger dynamic output range and handles a much greater offset value.

WPI’s Amplifiers

The purchase of a low-noise amplifier pays dividends in the end. WPI’s amplifiers were engineered for the bio-medical researcher. While 20-30 µV of noise is common in bio-amplifiers, WPI’s DAM series amplifiers generate 0.4 µV RMS (root mean squared) at 0.1-100 Hz. (That’s equal to 2 µV peak-to-peak.)
Isolated Differential Amplifier

**Excellent recording performance for extracellular nerve AP**

**Features**
- Battery powered, rechargeable
- High pass and low pass filtering
- Active remote headstage
- AC only amplification
- Electrode impedance test function
- Electrode current generation with polarity select
- Variable output positioning

**Benefits**
- Ultra quiet DC power supply
- Intrinsic low susceptibility to ground loops
- High signal to noise ratio due to remote head stage
- Small footprint
- Stimulation/histological marking current

**Applications**
- Amplifying bio-potentials using metal microelectrodes
- Brain slice field potentials
- EAG (Electroantennogram)
- ERG (Electroretinogram)
- Brain slice field potentials
- Amplifying bio-potentials using metal microelectrodes
- Use for cell marking, stimulation or electrode cleaning
- In vivo cortical recording

The ISO-80 provides low noise AC coupled amplification and offers excellent recording performance for monitoring extracellular nerve action potentials in vitro and in living animals. The ISO-80 is provided with a remote headstage (1 m cable) which incorporates an electrode impedance test function and a constant current stimulator. The constant current stimulator can be used for cell marking, stimulation or electrode cleaning. Typical applications include measuring EMG, EEG, extracellular and action potentials in vitro or in vivo. The ISO-80 system is DC isolated from the subject ground and employs state of the art electro-magnetic shielding for improved noise rejection. The amplifier employs both high pass and low pass filtering with gain from 100 to 10,000. The lowest low-pass setting is 5 Hz and the upper passband is 10 kHz.

Included with the ISO-80 is a Startup Kit containing the following accessories needed for basic metal electrode electrophysiology research:

- **CBL102**
  - Cable, BNC-to-3.5 mm plug, 6 ft (2m) (two)
- **5469**
  - Adapter, mini-banana to 0.031 skt. (two)
- **13388**
  - Adapter, mini-banana to 2mm skt. (two)
- **3294**
  - Cable, ground clip to wire, 3 ft
- **2033**
  - Mini-banana plug, black
- **2034**
  - Mini-banana plug, red
- **2035**
  - Mini-banana plug solderable current (two)
- **EP1**
  - Ag/AgCl pellet (70 mm wire) 1 mm diam x 2.5 mm long
- **M3301EH**
  - Electrode Holder, 14cm (two)
- **5470**
  - 0.031-inch jack on 12-inch wire (package of 4)

**ISO-80 SPECIFICATIONS**

- **INPUT RESISTANCE**
  - >1011 Ω, Common mode and differential
- **INPUT Leakage CURRENT**
  - 50 picoamperes, max.
- **AMPLIFICATION**
  - ×10, ×100
- **COMMON MODE REJECTION RATIO**
  - 100 dB typ. @ 50/60 Hz
- **EQUIVALENT NOISE SIGNAL INPUT**
  - 0.4 µV rms (0.1-100 Hz)
  - 2.0 µV rms (1 Hz - 10 kHz)
- **FILTER SETTINGS**
  - Low frequency
  - 5, 10, 100, 300 Hz
  - High frequency
  - 100 Hz, 1, 10 kHz
- **MAX. OUTPUT VOLTAGE SWING**
  - ±15 V
- **ELECTRODE IMPEDANCE RANGE**
  - 100 kΩ - 10 MΩ @ 300 Hz
- **MAXIMUM STIMULATION VOLTAGE**
  - ±15 V
- **MAXIMUM STIMULATION CURRENT**
  - 0 to ±20 µA (constant current)
- **DISPLAY**
  - 3½-digit LCD
- **BATTERY TEST**
  - Low battery display
- **POWER**
  - Low battery display
- **EQUIVALENT NOISE SIGNAL INPUT**
  - 0.4 µV rms (0.1-100 Hz)
  - 2.0 µV rms (1 Hz - 10 kHz)
- **INPUT RESISTANCE**
  - >1011 Ω, Common mode and differential
- **INPUT Leakage CURRENT**
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- **FILTER SETTINGS**
  - Low frequency
  - 5, 10, 100, 300 Hz
  - High frequency
  - 100 Hz, 1, 10 kHz
- **MAX. OUTPUT VOLTAGE SWING**
  - ±15 V
- **ELECTRODE IMPEDANCE RANGE**
  - 100 kΩ - 10 MΩ @ 300 Hz
- **MAXIMUM STIMULATION VOLTAGE**
  - ±15 V
- **MAXIMUM STIMULATION CURRENT**
  - 0 to ±20 µA (constant current)
- **DISPLAY**
  - 3½-digit LCD
- **BATTERY TEST**
  - Low battery display
- **POWER**
  - Low battery display
- **EQUIVALENT NOISE SIGNAL INPUT**
  - 0.4 µV rms (0.1-100 Hz)
  - 2.0 µV rms (1 Hz - 10 kHz)

**ORDERING INFORMATION**

- **ISO-80**
  - Isolated Bioamplifier w/ active probe (ISO80P)
  - Specify line voltage

- **ISO-80P**
  - Replacement ISO-80 Probe

- **CBL102**
  - 3.5 mm phone plug-to-BNC cable

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**

- **ISO-80P**: Replacement ISO-80 Probe
- **CBL102**: 3.5 mm phone plug-to-BNC cable

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**Applications**

- Amplifying bio-potentials using metal microelectrodes
- Brain slice field potentials
- EAG (Electroantennogram)
- ERG (Electroretinogram)
- Brain slice field potentials
- Amplifying bio-potentials using metal microelectrodes
- Use for cell marking, stimulation or electrode cleaning
- In vivo cortical recording
**Low Noise Modular Amplifier System**

**Isolated, low noise bio-amplifier**

**Features (Iso-DAM8A)**
- High pass and low pass filtering
- Optional active remote head stage
- AC/DC amplification
- Variable gain adjustment
- Input is optically isolated
- 50/60 Hz notch filter
- Pre-optical isolation DC offset
- Post-optical isolation zeroing
- Independent module power switch

**Benefits (Iso-DAM8A)**
- Chassis accepts combination of bioamplifiers and transducer amplifiers
- Flexible channel count (1–8) allows expandability
- Notch filter targets AC line noise sources
- Variable gain output amplitude
- Wide ±10V output range

**Applications (Iso-DAM8A)**
- Amplifying biopotentials using metal microelectrodes
- Brain slice field potentials
- EAG (Electroantennogram)
- ERG (Electroretinogram)

**Iso-DAM8A Modules Isolated Low Noise Bio-Amplifier**

The ISO-DAM8A is a compact modular standard rack-mountable DC amplifier system. Each channel is electrically isolated from the others and from ground. No current can flow from the input terminals and electrodes, thus, the instrument is intrinsically safe and cannot cause any electrical stimulus or shock to the preparation, in addition ground loop noise is minimized. Systems can be purchased with one, two, three or up to eight preamplifier modules or mixed with Bridge8 transducer amplifier modules (see next page). The user can then select an appropriate low pass filter setting, gain and offset on the channel amplifier panel. A notch filter has been added to reduce line frequency interference. An optional headstage preamplifier (10X gain) allows low noise extracellular (DC) recording with Iso-DAM8A and adds greater signal bandwidth than a shielded cable of the same length. The ISO-DAM8A amplifier and headstage configuration is optimally suited for use with our metal microelectrodes and can be easily configured for many applications. Each amplifier channel has a coaxial (BNC) connector located on the rear panel.

<table>
<thead>
<tr>
<th>ISO-DAM8A SPECIFICATIONS</th>
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<tbody>
<tr>
<td><strong>EACH CHANNEL</strong></td>
</tr>
<tr>
<td>INPUT IMPEDANCE</td>
</tr>
<tr>
<td>INPUT LEAKAGE CURRENT</td>
</tr>
<tr>
<td>INPUT DC OFFSET</td>
</tr>
<tr>
<td>GAIN</td>
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<tr>
<td>COMMON MODE REJECTION</td>
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<tr>
<td>EQUIVALENT NOISE SIGNAL INPUT</td>
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<tr>
<td>BANDWIDTH FILTER SETTINGS</td>
</tr>
<tr>
<td>High Filter (Low Pass) (kHz)</td>
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<tr>
<td>Low Filter (High Pass) (Hz)</td>
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<tr>
<td>Notch Filter (Hz)</td>
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<tr>
<td>OUTPUT VOLTAGE SWING</td>
</tr>
<tr>
<td>OUTPUT RESISTANCE</td>
</tr>
<tr>
<td>ENCLOSURE DIMENSIONS</td>
</tr>
<tr>
<td>(18 x 43 x 23 cm)</td>
</tr>
<tr>
<td>SHIPPING WEIGHT</td>
</tr>
</tbody>
</table>

**Low noise transducer amplifier**

**Features (BRIDGE8)**
- Wide range of fixed gains with independent variable gain adjustment
- Low pass filter
- Single ended or differential transducer compatibility
- Dual range output offset correction
- Independent module power switch
- Provides ± voltage excitation to transducers

**Benefits (BRIDGE8)**
- Chassis accepts combination of bioamplifiers and transducer amplifiers
- Flexible channel count (1–8) allows expandability
- Output LEDs confirm transducer output balance

**Applications (BRIDGE8)**
- WPI force transducers
- Wheatstone bridge transducers
- Muscle force measurement

**Bridge8 Modules Low Noise Transducer Amplifier**

Bridge8 is a modular, rack-mountable amplifier system. It is specifically designed for use as a signal conditioning amplifier with strain gauges and other powered transducers. Bridge8 includes differential amplifiers featuring high input impedance, high common mode rejection and low current leakage input terminals for low noise operation. It includes a half bridge switch and channel offset A wide variety of WPI transducers are available for force, temperature, pressure and light measurements. The Bridge8 amplifier is a clear choice for convenience and quality.

<table>
<thead>
<tr>
<th>BRIDGE8 SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT IMPEDANCE</td>
</tr>
<tr>
<td>AMPLIFICATION</td>
</tr>
<tr>
<td>INPUT LEAKAGE CURRENT</td>
</tr>
<tr>
<td>VOLTAGE OFFSET ADJUSTMENT</td>
</tr>
<tr>
<td>AMPLIFIER OUTPUT VOLTAGE</td>
</tr>
<tr>
<td>EXCITATION VOLTAGE</td>
</tr>
<tr>
<td>EQUIVALENT NOISE SIGNAL INPUT</td>
</tr>
<tr>
<td>LOW PASS FILTER BAND (kHz)</td>
</tr>
<tr>
<td>&quot;Wide Band&quot; R-C Butterworth 6 dB /octave</td>
</tr>
</tbody>
</table>

**ORDERING INFORMATION**

| 74020 | Iso-DAM8A Single Channel Module |
| 74030 | ISDB chassis and power supply |
| 74040 | Iso-DAM8A Active Headstage (separate) |
| BRIDGE8 | Bridge8 Transducer Amplifier Module |

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**

| 74050 | ISDB Blank panels |
| 74016 | Replacement Cable, Input bare 5-ft wire |
| 2933 | ISDB Rack Mount Kit, 5-in.-High |
| FORT10g | Force Transducer 10 g |
| FORT25 | Force Transducer 25 g |
| FORT100 | Force Transducer 100 g |
| FORT250 | Force Transducer 250 g |
| FORT1000 | Force Transducer 1000 g |
| 500184 | BNC to BNC 10 foot cable |
| 3161 | 8-pin DIN plug |
| 3718 | Package of 4, 8-pin DIN (startup kit) |
| 3491 | Extension Cable (DIN male, DIN female), 5 ft (1.5 m) |
Dual Microprobe Intracellular Amplifier
2-Channel intracellular amplifier for dual and differential studies

Features

- Two channels for differential or intracellular ISE
- Built in DC current generator with external control input
- Built in low pass filter
- Bridge balance circuit to null out electrode voltage drop
- Tickle circuit
- Built in test ports for each channel
- Dual capacitance compensations and output offset controls

Benefits

- Dual channel, single ended recording
- Differential recording
- Bridge circuit nulls electrode voltage drop
- Assign low pass filter to either channel
- Very high impedance channel can be used with intracellular ISE

Applications

- Intracellular electrophysiology using sharp micropipettes
- Brain slice intracellular recording
- In vivo intracellular recording from brain and spinal cord

For intracellular dual or differential studies, the Duo773 has separate negative capacity controls and built-in active filtering that allows the precise balancing of time constants for artifact-free differential measurement. Comes complete with two probe headstages, 10^10Ω and 10^7Ω probes to monitor signals from ion-specific micro-electrodes as well as KCl-filled electrodes.

Headstage for precise positioning

Two gold-plated, epoxy sealed miniature active probes can be positioned directly to the measurement site. Microelectrode holders containing an Ag/AgCl electrochemical half-cells plug directly into the probes. Stray capacitance can be reduced by placing the included driven guard shield over the microelectrode holder at the end of the probe.

Capacity compensation

Channel A can compensate up to 10 pF of electrode shunt capacity and Channel B can compensate up to 50 pF.

Tickler circuit for penetration

A Tickler Circuit assists in cell penetration. The frequency and amplitude of the oscillations may be varied for differences in membrane thickness or cell size. The duration of tickle can be controlled either by using the momentary switch, a foot switch, or by applying a signal to the remote tickler input.

Active filters

Low pass settings on a -40 dB/decade active filter vary the cutoff from 1 to 30 kHz. Either probe or bridge outputs may be selected for filtering.

Current injection

Channel B can eject current through the microelectrode by applying a command signal to the stimulus input connector. The resulting output from the probe will be a constant current replica of the input signal. Two ranges of current delivery are provided: 50 nA and 500 nA or by an external source. This source can be useful for delivering hyperpolarizing currents to stabilize the cell membrane potential and as a holding current for microiontophoresis.

Bridge balance

Subtracts the excess electrode voltage associated with delivering current through the recording micropipette. Electrode resistances up to 1000 MΩ can be balanced in two ranges. The balanced signal is available from x10 or x50 front panel output connectors.

Independent outputs

The Duo773 has an output for each probe independent of gain filtering or balancing. In addition the Duo773 has a 10x and a 50x output for easy integration to most data acquisition programs.
**DUO 773 SPECIFICATIONS**

**HEADSTAGE (PROBE)**
- 712P (red, port "B")
- 715P (blue, port "A")

**ACTIVE PROBE INPUT IMPEDANCE**
- 10^12 Ω
- 10^13 Ω

**GAIN**
- x1, x10
- x1

**OUTPUT RESISTANCE**
- 100 Ω
- 100 Ω

**OUTPUT VOLTAGE RANGE**
- ±10 V
- ±10 V

**MAXIMUM INPUT VOLTAGE**
- ±15 V
- ±15 V

**PROBE LEAKAGE CURRENT**
- 5 × 10^-12 A
- 10^-14 A

**DC POSITION ADJUST RANGE**
- ±300 mV
- ±300 mV

**ELECTRODE RESISTANCE TEST CURRENT**
- 1 nA
- 1 pA, 1 nA selectable

**INPUT CAPACITY COMPENSATION**
- +10 to -50 pF
- 0 to -10 pF

**NOISE**
- <50 µV p-p, 10kHz bandwidth
- <200 µV p-p, 10kHz bandwidth
- <200 µV p-p, 10kHz bandwidth

**RISE TIME**
- 10-90% direct input small signal
  - 1 µs, typical
- 10-90% through 20 MΩ
  - 25 µs, typical

**CURRENT INJECTION (712P only)**
- Internal DC Current
  - ±50 nA low range, ±500 nA high range
- Externally commanded Current
  - ±500 nA low range, ±5 µA high range
- External current command factor
  - ±500 nA low range, ±2 mV high range
- Current monitor
  - 100 mV/100 mA low range, 10 mA high range
- Compliance
  - 30V low range, 10V high range
- Bridge balance
  - 0-100 MΩ, 0-1000 MΩ
- Bridge amplifier gain
  - x10, x50

**LOW PASS FILTER**
- 40 dB/decade, continuously variable 1-30 kHz

**METER SECTION**
- Display
  - 3.5-digit LED
- Ranges
  - 200 mV, 2000 mV, 20 V, 200 nA, 2000 nA
- Accuracy and resolution
  - 1 digit

**DIMENSIONS**
- Instrument
  - 17 x 5.25 x 10 in. (43 x 13 x 25 cm)
- Probe
  - Diameter: 12 mm, Length: 34 mm
- POWER
  - 95-135 V or 220-240 V, 50/60 Hz
- SHIPPING WEIGHT
  - 15 lb (7 kg)

**CERTIFICATION**
- CE, CSA

*Although injected currents are “constant,” the maximum current in a given situation will always be limited by the system compliance of 10 V.*

**THE 712P HEADSTAGE MAY BE USED ON EITHER A OR B CHANNELS, HOWEVER CURRENT INJECTION SPECIFICATIONS DO NOT APPLY WHEN USED ON CHANNEL A. THE 715P HEADSTAGE MAY NOT BE USED ON THE B CHANNEL.**

**ORDERING INFORMATION**

**SYS-773**
- Duo 773 Electrometer
- Includes two probes (712P and 715P or two 712P) with driven guard shields and eight MEH1SF microelectrode holders for 1.0, 1.2, 1.5 or 2.0 mm glass electrodes. Specify line voltage

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**
- 712P
  - Replacement probe (includes calibration)*
- 715P
  - Replacement probe (includes calibration)*
  - *Instrument should be returned to WPI for free calibration with new probe.

**TW100F-4**
- Glass capillary with filament

**TW150F-4**
- Glass capillary with filament

---

**References**


Dual Channel Differential Electrometer

Electrochemical measurements with ion specific electrodes

Features
- Dual channel with very high input impedance
- Separate outputs for Channel A, B and A-B (Differential)
- Independent DC offset controls
- Test port
- Standby mode

Benefits
- Measure changes in intracellular ion content electrochemically
- Stable and drift free
- Excellent amplification with low noise
- Driven guard shield for reduced noise and stray capacitance
- Set probe leakage current

Applications
- Measure intracellular ion concentrations for K⁺, Ca²⁺, H⁺ and other

The FD223a electrometer was designed specifically for use with intracellular ion selective electrodes fabricated using glass micropipettes and liquid ion exchangers.

The active head stages allow the researcher to locate the probes directly at the measurement site to minimize noise that would normally be picked up by longer cable runs. Driven guard shields cover the micropipette holders to further reduce the potential for interference from external sources of electromagnetic noise.

The FD223a is equipped with a test resistance port which is used to measure and adjust each probe for minimum leakage current. Each channel has a standby mode which clamps the head stage input voltage to zero, preventing extreme saturation or possible damage to the high impedance input amplifier.

References

Liquid Ion Exchangers
Make micropipettes to record cellular concentrations

WPI's Liquid Ion Exchangers (LIX), for use with the FD223A Electrometer, allow intracellular measurements to be made for cations (hydrogen, potassium and calcium)

For more information, see "Liquid Ion Exchangers" on page 167.

When used in micropipettes to record cellular ion concentrations, consider using WPI's Duo 773 electrometer (channel A).

ORDERING INFORMATION
IE010 Hydrogen Ion Exchanger (0.1 mL)
IE190 Potassium Ion Exchanger (1.0 mL)
IE200 Calcium Neutral Ion Exchanger (0.1 mL)

ORDERING INFORMATION
FD223A Dual Channel Differential Electrometer
2 probes, driven guard shields and micropipette holder MEH1SF included for all glass microelectrodes O.D. 1.0, 1.2, 1.5 or 2.0 mm.

OPTIONAL ACCESSORIES/REPLACEMENT PARTS
M3301L Left-hand Micromanipulator
M3301R Right-hand Micromanipulator
M-3 80° Tilting base
RC1T Reference cell (Ag/AgCl)
2547 Driven guard shield for FD223AP Probe
MEH1SF Microelectrode holder
FD223AP Replacement probe (includes calibration)

See cables and connectors, page 108.
See microelectrode holders, page 110.
See capillary glass, page 114.

FD223A SPECIFICATIONS
- INPUT IMPEDANCE: > 10¹⁵ Ω, shunted by 0.5 pF
- INPUT CAPACITANCE: 1 pF, nominal
- LEAKAGE CURRENT: 75 fA max
- GAIN: 1.000 ± 0.1%
- OUTPUT RESISTANCE: 50 Ω
- INPUT SWING VOLTAGE: ±10 V
- RISE TIME (10 TO 90%): 5 µs, small signal
- NOISE (0.1 Hz TO 10 KHz): <100 µV p-p, input shorted
- BASELINE STABILITY: ±0.1 mV/day
- POSITION CONTROLS RANGE: ±600 mV
- PHYSICAL DIMENSIONS:
  Case: 8.8 x 21.0 x 17.5 cm (H x W x D)
  Probe: 12.7 x 65 mm (D x L), 1.8 m cable
- POWER: 90-265 VAC, 50/60 Hz, 10 VA
- PROBE HANDLE: 6.5 x 65 mm (D x L)
- SHIPPING WEIGHT: 2.5 kg

OPERATING CONDITIONS: Equipment is intended to be operated in a controlled laboratory environment. Temperature: 0-40 °C; altitude: sea level to 2000 m; relative humidity: 0-95%.
Ultra Quiet Intracellular Amplifier

High quality, intracellular amplifier perfect for students

Features
- Driven guard shield
- Test port
- Ground port
- Portable
- Remote headstage

Benefits
- Cost effective
- Battery powered
- Capacitance compensation

Applications
- Measure intracellular action potentials

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

Remote headstage
Easily mounted in any manipulator, this compact probe, containing the first stage of amplification, includes a microelectrode holder, which plugs directly into the probe input.

Battery power
Four 9V alkaline batteries (included) power the Electro 705 for approximately 500 hours giving a clean, low noise source of power, making the Electro 705 the quietest amplifier available. Batteries can be easily tested by the press of a button.

Capacitance Compensation
Corrects for loss of rise time caused by the presence of electrode capacity. Up to 50 pF of electrode shunt capacity may be neutralized.

Driven Guard Shield
Stray capacitance can be further reduced by placing the driven guard shield (included) over the microelectrode holder at the input end of the probe.

Test Features
A Tickler Circuit offers a momentary oscillation that helps achieve cell penetration. The Electro 705 provides a 1 nA electrode test current. Electrode resistance is monitored at the 1X output as a voltage (1 mV/MΩ). The Probe Test Port allows the convenience of testing the amplifier’s intrinsic noise and gain without cumbersome external test hookups. Head stage leakage current can also be adjusted with minimum effort. The Baseline Position Control adds or subtracts up to 300 mV to the headstage output, allowing artifact voltages such as liquid junction potentials to be nulled prior to recording.

Differential Output
Two Electro 705 units can be connected in tandem to create an optional differential amplifier probe system.

References

Electro 705 Specifications
- INPUT IMPEDANCE 10^12 Ω, shunted by 1 pF
- OUTPUT IMPEDANCE 100 Ω, both outputs
- GAIN X1: ±0.1%
- INPUT VOLTAGE RANGE ±5 V
- RISETIME 15 µs, 10-90%
- NOISE LEVEL 500 µV peak-to-peak*
- INPUT CAPACITANCE COMPENSATION 0-50 pF
- GATE LEAKAGE CURRENT ±10 pA, adjustable to zero
- ELECTRODE RESISTANCE TEST 1 mV/MΩ
- DC POSITIONING ± 300 mV
- COMMON MODE REJECTION >10^4 (in differential mode)
- POWER Four 9V alkaline batteries
- DIMENSIONS 8.5 x 3.5 x 2.2 in. (22 x 9 x 6 cm)
- SHIPPING WEIGHT 5 lb. (2.3 kg)

* Full bandwidth, with 20 M Ohm source

Ordering Information
- ELECTRO 705 Electrode
- Probe, driven guard shield and micropipette holder MEH1SF included for glass microelectrodes O.D. 1.0 mm, 1.2 mm, 1.5 mm, or 2.0 mm.

Optional Accessories/Replacement Parts
- M3301L Left-hand Micromanipulator
- MM3301R Right-hand Micromanipulator
- M-3 80° Tilting base
- RC1T Reference cell (Ag/AgCl)
- 25411 Driven guard shield for 705PF Probe
- MEH1SF Microelectrode holder
- 705PF Replacement probe (includes calibration)*

*Instrument must be returned to WPI for free calibration with new probe.
See cables and connectors, page 108.
See microelectrode holders, page 110.
See capillary glass, page 114.

World Precision Instruments
www.wpiinc.com
ORDER TOLL-FREE: (866) 606-1974 (U.S. only) • Tel: (941) 371-1003 • Fax: (941) 377-5428 • E-mail: sales@wpiinc.com

WORLD PRECISION INSTRUMENTS
Multi-Channel Pulse Generator
From single pulses to complex pulse trains

Features
- Variable voltage output channel
- Includes one interval generator, five pulse or train channels, two mixer channels and variable voltage output stage
- Synchronized operation or manually triggered
- Designed to drive A300 series stimulus isolators

Benefits
- Accurate timing
- TTL inputs/outputs on event generator plus five (5) channels and two (2) mix channels
- Synchronized operation or manually triggered
- Designed to drive A300 series stimulus isolators

Applications
- Neuro-electrophysiology

The A300 Pulsemaster™ is WPI’s third generation, multichannel, pulse/train generator/stimulator that incorporates the superb accuracy of digital electronics industry standard controls. The Pulsemaster™ contains an event interval generator, five pulse train channels, two mixing channels and a very quiet variable voltage output channel.

Accurate Timing
Output timing is continuously variable to 0.1% of range selection over eight orders of magnitude. Bright, three-digit LED displays timing parameters for each channel.

Synchronized Operation or Manually Triggered
The A300 Pulsemaster™ is designed for ease of use and flexibility. Each of the five channels may be triggered directly from the onboard event interval generator or by any of the other four main channels. Using the event interval generator, the five main channels can be programmed to create pulse trains that are subject to gating (windowing) by any other channel. This enables nested pulse trains to be created. Nested trains up to four iterations deep are possible. In addition to the five main channels, two mixer channels allow multiplexing of the main five channels in any combination. A variable voltage output channel is also provided, which can be triggered from one of the five main channels or either of the two mixed channels. Coupled with extremely long (>16 minutes) and short (10 µs) pulse intervals, the A300 Pulsemaster™ provides a comprehensive toolset for building stimulation protocols for Neuro-electrophysiology experiments.

The event interval generator can be manually triggered as a single shot pulse, started as a continuously running train, or triggered externally. Any of the 5 main or two mixed channels can also be triggered as single shot or from received input from an external TTL source.

References

ORDERING INFORMATION
SYS-A300 Pulsemaster™ Multi-Channel Stimulator
Specify line voltage

SPECIFICATIONS

EVENT INTERVAL CHANNEL
Operating Modes EXTERNAL SYNC, SINGLE EVENT, CONTINUOUS ON
Input EXT SYNC accepts 1 µs pulses; TTL, CMOS, RS232C compatible
Timing EVENT INTERVAL 10 µs to 999 s (100kHz - 0.001 Hz), ±0.1% of full scale, continuously variable in 0.1% of full scale increments, through three orders of magnitude, in six ranges
Output SYNC OUT pulse of 6 µs, TTL, 5V CMOS compatible
PULSE TRAIN CHANNEL
Operating Modes EXTERNAL SYNC, SELF SYNC, manual Single event, sync from Event Interval, sync from any of other four Pulse Trains, sync from one of the MIXers, off, TRAIN/PULSE
Input EXT SYNC accepts 1 µs pulses; TTL, CMOS, RS232C compatible
Timing DELAY and WIDTH 10 µs to 999s; ±0.1% of full scale, continuously variable in 0.1% of full scale increments, through three orders of magnitude, in six ranges (0.0005 Hz to 50kHz in the SELF SYNC mode)
Output OUTPUT PULSE/TRAIN of preset timing, TTL, 5V CMOS compatible, 4 mA sink and source
MIXER CHANNEL
Inputs Any combination of an EXternal pulse, the outputs of the five Pulse Train channels, and DC continuous ON/DC MOMentary EXT INPUT accepts 1 µs pulses; TTL, CMOS, RS232C compatible
Output OUTPUT, TTL, 5V CMOS compatible, 4 mA sink and source
VARIABLE CHANNEL
Inputs Output from any one PULSE TRAIN channel or one of the two MIXER channels or DC
Output 0 to +1V low range, 1 mV resolution
5 mA max sink and source
Output Impedance <1 Ω
Noise <500 µV peak @ 100 kHz bandwidth, PULSED mode
<500 µV, wide band, DC mode
Signal Ground Floating, i.e., not connected to chassis
POWER 95-135 V or 220-240 V, 50/60 Hz
BATTERIES Three 1.2 VDC, size AA, NiMH batteries
DIMENSIONS 8.5 x 19 x 8.75 in. (22 x 45 x 22 cm)
SHIPPING WEIGHT 2.1 lb. (9.5 kg)
Single Channel Pulse Generator

The accuracy of digital electronics and convenience of analog controls

Features

- Single channel pulse generator with train capability
- TTL and variable voltage output

Benefits

- Variety of pulses: continuous run, single-shot, train/burst
- Multiple outputs available: monitor, isolator, sync and variable

Applications

- Electrophysiology

The A310 pulse generator/stimulator combines the reproducibility and accuracy of digital electronics with the fine resolution and continuous adjustment possible with analog circuitry. All timing parameters are entered with high resolution, ten-turn potentiometers and six-position range switches. Timing is accurate to within 1% of the set value.

Variety of Pulses

Pulses can be created in continuous run, single-shot or train/burst modes. Duration of the train/burst is controlled using the onboard envelope generator or by using either of two external gating inputs. Used in conjunction with the A360, A365, A385 or A395, constant current pulses and trains can be created easily. A foot switch allows hands-free, manual triggering.

Multiple Outputs Available

Five separate standard BNC outputs are available on the front panel. The isolator output sends full pulse width control signals to any TTL triggered stimulus isolator, such as WPI's A360, A365 or A385 and others. The monitor output sends synchronized large scale full pulse width signals to recording or monitoring instrumentation such as a data acquisition system or oscilloscope. The sync output provides an additional synchronized 5 µs TTL pulse for triggering external instrumentation. A variable voltage output provides two separate full pulse width signals in both positive and negative polarities in two ranges for applications that require a specific output voltage other than TTL.

References


SPECIFICATIONS

<table>
<thead>
<tr>
<th>TIMING PARAMETERS</th>
<th>EVENT INTERVAL</th>
<th>100 µs to 1000 s*</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVENT DELAY</td>
<td>10 µs to 100 s</td>
<td></td>
</tr>
<tr>
<td>PULSE WIDTH</td>
<td>10 µs to 100 s</td>
<td></td>
</tr>
<tr>
<td>TRAIN DURATION</td>
<td>100 µs to 1000 s*</td>
<td></td>
</tr>
<tr>
<td>PULSE INTERVAL</td>
<td>20 µs to 100 s</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUTS</th>
<th>SYNC</th>
<th>5 µs, TTL, and 5 V CMOS compatible, 20 mA max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MONITOR</td>
<td>10-15 V, 50 mA max.</td>
</tr>
<tr>
<td></td>
<td>ISOLATOR</td>
<td>TTL &amp; 5 V CMOS compatible, 20 mA max.</td>
</tr>
<tr>
<td></td>
<td>VARIABLE (Pos or Neg)</td>
<td>LOW RANGE 0 to ±1 V, HIGH RANGE 0 to ±10 V</td>
</tr>
<tr>
<td></td>
<td>PULSED/DC Range</td>
<td>Resolution 1 mV, 10 mV</td>
</tr>
<tr>
<td></td>
<td>NOISE</td>
<td>Pulsed at 100 kHz bandwidth 500 µV, DC Wide Band 500 µV</td>
</tr>
<tr>
<td></td>
<td>OUTPUT IMPEDANCE</td>
<td>&lt;1 Ω</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>EXTERNAL SYNC</th>
<th>Accepts 1-µs minimum pulses TTL, CMOS compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXTERNAL GATE</td>
<td>Accepts 1-µs pulse to continuous TTL, CMOS compatible</td>
</tr>
<tr>
<td></td>
<td>POWER</td>
<td>95-130 V or 190-260 V, switch selectable single phase, 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>DIMENSIONS</td>
<td>17 x 5.25 x 10 in. (43 x 13 x 25 cm)</td>
</tr>
<tr>
<td></td>
<td>SHIPPING WEIGHT</td>
<td>14 lb (6.4 kg)</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION

SYS-A310 Accupulser™ Signal Generator

Specify line voltage

OPTIONAL ACCESSORIES/REPLACEMENT PARTS

- 3259 Footswitch for A310
- 2933 Rack Mount Kit, 5½ in. high

ORDER TOLL-FREE: (866) 606-1974 (U.S. only) • Tel: (941) 371-1003 • Fax: (941) 377-5428 • E-mail: sales@wpiinc.com
Constant Current Stimulus Isolator
Automated bipolar pulsing for zero net charge on biological preparations

Features
- Constant current
- Unipolar and bipolar stimulation modes
- Built-in non-compliance alarm
- Input is optically isolated
- Standard TTL triggering
- DC test mode
- Powered by 9V alkaline or rechargeable batteries

Benefits
- Compliance voltage is 100V or better
- Bipolar mode auto generates alternating positive and negative pulses from TTL input
- Test mode simplifies performance verification
- Optical isolation enhances safety of the preparation and reduces noise susceptibility

Applications
- Electrophysiology
- Brain slice stimulation
- In vivo brain and CNS stimulation

Activated by conventional logic-level commands, Model A365 can be gated by any pulse generator, stimulator, or computer output; automated bipolar pulsing for zero net charge on biological preparations.

Dual Tone Audible Alarms
A tone sounds when an open electrode circuit is detected or when system compliance is reached. A second optional tone sounds when a signal is applied to the input. A test switch is also provided to check battery charge.

Current Delivery up to 10 mA at More than 100V
Stimulus currents are set using a three-digit control knob and a three-position range switch. Output current tracks control settings to better than 1%. Output current is load independent; voltage sufficient to push the desired current through the load is automatically developed, subject only to compliance limits. Model A360LA produces up to 1 milliampere current, in three ranges, at more than 100 volts compliance.

Bipolar Output Polarity
Output polarity is determined by a push switch on the front panel. Bipolar current is toggled by the command waveform, setting alternating pulses as positive or negative.

References
High Current Stimulus Isolator

Constant current stimulus isolator with 100 mA current range

Features
- Constant current to 100 mA
- Unipolar or bipolar stimulation modes
- Built-in non-compliance alarm
- Input is optically isolated
- Standard TTL triggering
- DC test mode
- Powered by six rechargeable lead acid batteries
- 36V compliance
- Output polarity and output “on/off” switches

Benefits
- 100 mA current capability
- Bipolar mode automatically generates alternating positive and negative pulses from TTL input
- Test mode simplifies performance verification
- Optical isolation enhances safety of the preparation and reduces noise susceptibility
- Battery charge status LEDs keep the experimenter informed of battery status
- Charger included at discounted price when system is purchased as A385RC

Applications
- Muscle electrophysiology
- In vivo/in vitro muscle stimulation

The A385 is an optically isolated current source, which can generate up to 100 mA of unipolar or bipolar constant current pulses or DC. Pulse duration is controlled manually or by an external 5V command. Output current amplitude is determined by a 3-digit 10-turn potentiometer. Maximum output voltage between the stimulating electrodes is +36V.

Delivers Positive, Negative or Bipolar Currents

For bipolar delivery, the polarity of the output can be toggled to the opposite polarity state with each successive pulse presented to the input. Pulse duration is controlled by an externally applied voltage. The input connector is a standard BNC, allowing TTL signals from a data acquisition system to be used.

Excellent Accuracy and Repeatability

The output amplitude is controlled by a 3-digit, ten-turn dial as a percentage of the range selected: for example, a setting of 45.6 in the 0-10 mA range translates to 4.56 mA at the output. Accuracy and repeatability are excellent. Designed for subcutaneous stimulation, maximum output voltage at the stimulating electrodes is 36 volts, reducing the possibility of accidental transcutaneous shocks. A compliance/output alarm sounds when the 36V limit is reached. Internal circuitry ensures electrodes are short-circuited during inactive periods (“electrode exhaus” feature). The A385 is not appropriate for transcutaneous stimulation.

Rechargeable Battery

The 1.2 amp-hour rating of the six heavy-duty lead-acid rechargeable batteries ensures that all day experiments will not be interrupted by dead batteries when charged daily. Indicator lights and audible alarms keep the user constantly apprised of the battery charge status. The batteries are recharged by the A382 System Charger, which is designed especially for the A385, and included with the A385RC.

References

A385 SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Waveform</td>
<td>DC or current pulse</td>
</tr>
<tr>
<td>Output Current Ranges</td>
<td>1, 10, and 100 mA</td>
</tr>
<tr>
<td>Current Amplitude Error</td>
<td>0.5% of full scale, max.</td>
</tr>
<tr>
<td>Current Resolution</td>
<td>0.1% of full scale, typical</td>
</tr>
<tr>
<td>REPEATABILITY</td>
<td></td>
</tr>
<tr>
<td>Output Load Voltage</td>
<td>36 V</td>
</tr>
<tr>
<td>Excursion (Compliance)</td>
<td>5 V at 3 mA minimum, 8.5 V max.</td>
</tr>
<tr>
<td>External Command Voltage: Current</td>
<td>Reversible, manual switch, monophasic or electronically switched bipolar delivery</td>
</tr>
<tr>
<td>RISE TIME AND DELAY</td>
<td>6 μs, typical (1 KΩ load)</td>
</tr>
<tr>
<td>FALL TIME AND DELAY</td>
<td>10 μs, typical (1 KΩ load)</td>
</tr>
<tr>
<td>External Command Voltage: Output</td>
<td>2500V, rated minimum breakdown voltage</td>
</tr>
<tr>
<td>POLARITY</td>
<td>Six rechargeable lead-acid batteries</td>
</tr>
<tr>
<td>EXCURSION (COMPLIANCE)</td>
<td>(Requires companion charger A382)</td>
</tr>
<tr>
<td>OUTPUT TO GROUND RESISTANCE</td>
<td>10Ω</td>
</tr>
<tr>
<td>External Command Voltage: Optocoupler</td>
<td>8.5 x 3.5 x 5 in. (22 x 9 x 12 cm)</td>
</tr>
<tr>
<td>POWER</td>
<td>5 lb. (2.3 kg)</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION

A385RC A385 with A382 Charger
SYS-A385R High Current Isolator, rechargeable
SYS-A382 Battery Charger for A385 (see below)

Smart Battery Charger

Required for A385

An innovative three-step charger, the A382 employs fast, medium, and trickle charges at a safe, low current, greatly extending battery life. After a fast initial phase, the charger automatically switches to a constant voltage mode. When charging is complete, the charger switches to the trickle-charge mode. LED lamps indicate charging status. (For use only in charging the lead acid batteries installed in the A385.)
Stimulator/Isolator for Precise Current Delivery

Constant current stimulus isolator with integrated pulse generator

Features
- Up to 10 mA of constant current with built-in pulse generator
- Unipolar stimulation
- Built-in non-compliance alarm
- Input is optically isolated
- Manual, external sync, gating or standard TTL triggering
- DC test mode
- Output polarity/“on/off” switch
- Powered with six rechargeable lead acid batteries
- >100V compliance

Benefits
- Cost-effective for budgets which limit purchasing a separate stimulus signal generator
- Built-in free running pulse generator can be externally gated for bursts
- Test mode simplifies performance verification
- Optical isolation enhances safety of the preparation and reduces noise susceptibility
- Save on a rechargeable system when purchased as A320RC

Applications
- General purpose brain and CNS electrophysiology
- Neuro-electrophysiology teaching labs

Exceptional Timing Control
Pulse interval and width are set with single-turn continuously variable controls from 5 ms to 5.5 s in three ranges. Pulse width is continuously variable from 50 µs to 550 ms in four ranges.

Modes of Operation
In FREE RUN, Isostim™ generates continuous square waves. In EXT GATE or EXT SYNC modes, externally applied pulses can generate trains or single events. Single pulses of finite duration can be produced using a push-button on the instrument's front panel. EXT/DC mode converts Isostim™ to a passive stimulus isolator.

Dual Tone Audible Alarm
A tone sounds when an open circuit is detected or when system compliance is reached. A second tone, which sounds when a signal is applied to the input, can only be heard if the batteries have sufficient charge to operate the isolator. A violation light advises when pulse width exceeds the interval.

Precise Current Delivery
Stimulus currents up to 10 mA can be set on the front panel with a control knob and a two-position range switch. Output current is load-dependent.

Power
Isostim™ model A320D is powered by readily obtainable 9-volt alkaline batteries (included). Under average use these will last several months before replacement is required. The rechargeable A320R is supplied with a nickel metal hydride battery stack which provides 10–12 hours of operation before recharge is required. The A320 Battery Charger must be used with the A320R.
Linear Stimulus Isolator

Replicates a programmed waveform of any shape or polarity

Features
- Creates a constant current replica of analog waveforms
- Amplitude of the output current is voltage controlled
- Input voltage from -10V to +10V
- 3 current ranges from 100 µA to 10 mA
- Built-in test resistors
- Digital display shows current being delivered for non-varying currents of adequate duration
- Output offset adjustment
- ±70V compliance range

Benefits
- Amplitude of current is voltage controlled
- Built-in test resistances
- Error LEDs illuminate when current is less than commanded by control voltage

Applications
- Neuroscience

All WPI stimulus isolators are designed to supply constant current, because current threshold (not voltage) is the most quantitatively reproducible parameter for stimulation of nerve and muscle. Model A395 dispenses current reproducibly from its output terminals; the amplitude being determined by the selected current range and the input voltage. Current amplitude is “constant”, that is, load resistance independent, provided that the I x R (load) product does not exceed the available battery supply voltage. A visual indicator (the compliance LEDs) displays if current is voltage controlled.

User Defined Output Current of Various Forms

Model A395 generates a user-defined output current of wave shape; DC, AC, pulse and combinations. Battery operated, photodiode-isolated from the input voltage drive, the instrument regenerates output currents which are linearly proportional to the analog voltage waveforms provided by your D/A converter or signal generator (see diagram below). The A395 is ideally suited for data acquisition and stimulator generators.

Current Delivery for Selected Ranges

A 10 V input produces the maximum output current for the current range selected. (For example, 100 µA, 1 mA, or 10 mA). Front panel controls allow DC current to be generated. Externally applied signals can be superimposed simultaneously (DC offset). Warning lamps indicate open circuit or excessive current conditions.

Digital Meter Shows DC or Average Output

The digital display meter shows the measures DC current or the average output current. Overload lamps indicate when output voltage has reached positive or negative compliance voltage limit.

References


ORDER INFORMATION

A395 RC
A395 with Charger (A362)
SYS-A395D
Linear Stimulus Isolator
SYS-A395R
Linear Stimulus Isolator, Rechargeable
SYS-A362
Battery Charger

Specify line voltage

A362 Battery Charger

Required for A320R, A365R, A395R

Recharges the high-voltage nickel-cadmium or NiMH battery stack in the A320R, A365R or A395R.

LED lamp indicates charging status. Full charge overnight.

Dimensions: 2.8 x 4.1 x 5.6 in. (7 x 10.5 x 12.7 cm).

Shipping weight: 4 lb. (1.8 kg).
4-Channel Transducer Amplifier

**Amplify output voltage signals**

**Features**
- Use with many different types of resistive based transducers
- WPI resistive force transducers plug in directly
- Supports full resistive bridge or single ended operation
- Output offset control
- Four gain ranges from 1–1000 ×
- Provides “excitation” voltage for resistive bridge transducers

**Benefits**
- Provided with blank connectors to interface with any resistive bridge transducer
- Bridge balance LEDs provide visual cue that unloaded transducers are at zero output state

**Applications**
- Amplify signals from resistive strain gages and other resistive bridge configured transducers
- Transbridge (TBM4M) is a four-channel analog transducer manifold, specifically designed to amplify output voltage signals from pressure, force, displacement, and temperature transducers as well as a wide variety of other signal sources. Analog output signals are available from each channel for input to a data acquisition system for digital signal processing in a computer. Each channel contains a regulated 10-volt power supply (+5 and -5 volts with respect to signal ground) to provide DC power to transducers, and a precision differential amplifier with selectable power to transducers, and a precision differential amplifier with selectable
- Four gain ranges from 1–1000 ×
- Provides “excitation” voltage for resistive bridge transducers

**Dual Micro-iontophoresis Current Generator**

**Electro-iontophoresis of dyes, drugs and charged substances**

**Features**
- Dual channel
- Battery operated

**Benefits**
- Isolated due to battery power
- D’Arsonval meters indicate current level through each channel
- Channels can be operated in opposite polarity to retain iontophoresis

**Applications**
- Use electric current to inject charged dyes, drugs or other charged substances through micropipettes

**Battery Operated Impedance Measurement**

**Measure mV and MΩ impedance of metal or glass microelectrodes**

**Features**
- Battery operated

**Benefits**
- Determine impedance of electrode during micropipette beveling process for pipette reproducibility
- Measure impedance of metal or glass capillary microelectrodes

**Applications**
- Measure impedance of metal or glass capillary microelectrodes
- Omega-Tip-Z™ was created especially for measuring impedance in etched tungsten, platinum-iridium* and steel microelectrodes, as well as electrolyte-filled micropipettes. The meter's AC impedance-measuring circuit is unaffected by electrode offset or tip junction potentials. The gold-plated miniature probe lets you conveniently monitor micro-electrode impedance in electrolytes, and an electrode tip cleaning feature lets you remove buildup quickly. Omega-Tip-Z can also measure DC electrode tip potentials up to 2000 millivolts. The instrument operates for hundreds of hours without battery failure.

*See Metal Microelectrodes, page 104.

**ORDERING INFORMATION**

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2933</td>
<td>Rack Mount Kit, 5/16-in. high</td>
</tr>
<tr>
<td>711P</td>
<td>Replacement Probe</td>
</tr>
<tr>
<td>5468</td>
<td>Adapter to connect metal microelectrodes to probe, 2 mm socket to 0.31 in. receptacle</td>
</tr>
</tbody>
</table>

**Z-LITE**
- Fiber Optic Illuminator (115v, 60 Hz, beige case)
- Fiber Optic Illuminator (230v, 80 Hz, black-case)
- Bifurcated Light Guide with lenses
- Z-Lite Illuminator and bifurcated light guide

**ORDERING INFORMATION**

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS-260</td>
<td>Dual Microiontophoresis Current Generator</td>
</tr>
<tr>
<td>SYS-TBM4M</td>
<td>Transducer Amplifier</td>
</tr>
<tr>
<td>SYS-OMEGAZ</td>
<td>Omega-Tip-Z™ with Probe &amp; Holder</td>
</tr>
<tr>
<td>Z-LITE</td>
<td>Fiber Optic Illuminator</td>
</tr>
<tr>
<td>Z-LITE-Z</td>
<td>Fiber Optic Illuminator</td>
</tr>
<tr>
<td>Z-LITE-186</td>
<td>Z-Lite Illuminator and bifurcated light guide</td>
</tr>
</tbody>
</table>

**OPTIONAL ACCESSORIES**

- Fiber Optic Illuminator (230v, 80 Hz, black-case)
- Bifurcated Light Guide with lenses
- Z-Lite Illuminator and bifurcated light guide

**OPTIONAL ACCESSORIES**

- Fiber Optic Illuminator (230v, 80 Hz, black-case)
- Bifurcated Light Guide with lenses
- Z-Lite Illuminator and bifurcated light guide
Force Transducers

These rigid-lever force transducers transform applied force into proportional voltage. Using balanced strain gages, FORT transducers produce linear output voltage vs. applied force input with very little deflection. To use, clamp the handle of the FORT transducer in a horizontal position and apply the forces to be measured to a rivet or hook mounted in the hole at the end of the flat sensing leaf.

### FORT SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>FORT10g</th>
<th>FORT25</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FORCE RANGE, FULL SCALE</strong></td>
<td>0-10 g</td>
<td>0-25 g</td>
</tr>
<tr>
<td><strong>OUTPUT SENSITIVITY</strong></td>
<td>10 mV/g, nominal</td>
<td>3 mV/g, nominal</td>
</tr>
<tr>
<td><strong>INPUT &amp; OUTPUT RESISTANCE</strong></td>
<td>1500 Ω</td>
<td>1500 Ω</td>
</tr>
<tr>
<td><strong>RESOLUTION</strong></td>
<td>&lt; 1 mg</td>
<td>&lt; 2 mg</td>
</tr>
<tr>
<td><strong>LINEARITY ERROR</strong></td>
<td>&lt;0.2% of full scale</td>
<td>&lt;0.2% of full scale</td>
</tr>
<tr>
<td><strong>MAXIMUM OPERATING VOLTAGE</strong></td>
<td>10 V DC (-5V ~ +5V or 0 ~ 10V)</td>
<td>10 V DC (-5V ~ +5V or 0 ~ 10V)</td>
</tr>
<tr>
<td><strong>MAXIMUM APPLIED FORCE</strong></td>
<td>2× rated full scale force</td>
<td>3× rated full scale force</td>
</tr>
<tr>
<td><strong>DRIFT</strong></td>
<td>&lt;30 mg/hr</td>
<td>&lt;50 mg/hr</td>
</tr>
<tr>
<td><strong>DIMENSIONS</strong></td>
<td>40 x 22 x 19 mm Handle 88 mm</td>
<td>40 x 22 x 19 mm Handle 109 mm</td>
</tr>
<tr>
<td><strong>WEIGHT</strong></td>
<td>100 g</td>
<td>100 g</td>
</tr>
</tbody>
</table>

These 10 g and 25 g force transducers are reliable tools for high precision force measurement. Using balanced semiconductor strain gages, both produce linear output voltage vs. applied force input with very little deflection. The rigid lever force transducer transforms the applied force into a proportional voltage. Featuring a temperature-compensated, full-bridge configuration with four high sensitivity semiconductor strain gages, these transducers have broad dynamic measuring range and very high sensitivity.

To use, clamp the handle of the FORT10 or FORT25 transducer in a horizontal position and apply the forces to be measured to a rivet or hook mounted in the hole at the end of the flat sensing leaf.

FORT10 g

10g & 25 Force Transducers
**Metal Microelectrodes**

**Superior microelectrodes for outstanding extracellular recording — tungsten, iridium, platinum-iridium and Elgiloy®**

**Features**
- Available in Tungsten, Platinum/Iridium, Elgiloy and Pure Iridium metal, and are insulated with a thin film of vapor-deposited Parylene-C
- Four different tip profiles also available (Standard, Heat, Blunt, and Fine tips)
- High corrosion resistance offers consistent long-term performance.

**Benefits**
- Many standard types available (web) and custom
- Connecting pin fits Amphenol series 220-223 connectors.

**Applications**
- Type C: Excellent for bipolar stimulation.
- For acute and chronic recording.
- Heat treated electrodes used for penetrating tough membrane (not for chronic implantation)

<table>
<thead>
<tr>
<th>EXPOSED TIP DIMENSIONS (nominal)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Impedance</strong></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>10 kΩ</td>
</tr>
<tr>
<td>50 kΩ</td>
</tr>
<tr>
<td>0.1 MQ</td>
</tr>
<tr>
<td>0.5 MQ</td>
</tr>
<tr>
<td>1.0 MQ</td>
</tr>
<tr>
<td>2.0 MQ</td>
</tr>
<tr>
<td>5.0 MQ</td>
</tr>
</tbody>
</table>

**Heat Treated Tip** is ideal for penetrating tough membranes (not recommended for chronic implantation). This process is performed using a microforge in which the heating element is positioned in close proximity to the tip in order to melt the Parylene-C distal to the exposed metal. It provides a smooth transition and produces better adherence of the Parylene-C to the metal.

To have your electrodes heat treated, just add the suffix “H” to any of the “KT” numbers on the facing page.

* Parylene is a trade mark of Union Carbide. Kapton is a trade mark of DuPont. Elgiloy is a trade mark of Elgiloy Ltd.

**Concentric Bipolar Electrodes**

**Excellent for shielded macro recording as well as evoked potentials — especially well suited for bipolar stimulation**

The tungsten electrode is sharpened to a point and is 75 microns in diameter. The outer stainless steel conductor is insulated with Polyimide tubing to within 0.2 mm of the end of the stainless steel tube. Also available without the outer Polyimide insulation.

**Metal Exposed tip**

300102 Micromanipulator holder, 4 in., 2mm to 0.031 socket
5468 2 mm receptacle to 0.031-inch jack (for Omega-TipZ)
5469 Adapts mini banana plug (DAM80) to 0.031-inch receptacle (metal microelectrode)
5470 0.031-inch jack, 28 ga. wire, 12 inch (pkg of 4)
5482* Pins, 0.031-inch, gold-plated (pkg of 50)
5483* Sockets, 0.031-inch gold-plated (pkg of 50)

*Gold-plated pins (#5482) and sockets (#5483) may be attached to 24-, 26-, or 28-gauge wire.

**ORDERING INFORMATION**

**MICROELECTRODES**

**ELECTROPHYSIOLOGY**

**WORLD PRECISION INSTRUMENTS**

UK: +44 (0)1462 424700 • wpiuk@wpi-europe.com • www.wpi-europe.com
Germany: +49 (0)30 61 88845 • wpide@wpi-europe.com • www.wpi-europe.com
Brazil: 011 55 13 40629703 • info@brazil.wpiinc.com • www.wpiinc.com
China: +86 21 6888 5517 • chinasales@china.wpiinc.com • www.wpiinc.cn

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### INTRODUCTORY ASSORTMENTS ORDERING INFORMATION

Each of these assortment kits includes electrodes with different impedance within each style. Use an assortment kit to determine which electrode you need for your experiment. Ten electrodes per box, no mixing.

<table>
<thead>
<tr>
<th>Item</th>
<th>Contains the following electrode impedances by quantity (pkg of 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM33A10KT</td>
<td>TM33A10 (3), TM33A20 (3), TM31A50 (2)</td>
</tr>
<tr>
<td>TM33B20KT</td>
<td>TM33B20KT (3), TM33B20KT (2)</td>
</tr>
<tr>
<td>TM33B30KT</td>
<td>TM33B30KT (3), TM33B30KT (2)</td>
</tr>
<tr>
<td>TST33AxKT</td>
<td>TST33A05KT (3), TST33A30KT (3)</td>
</tr>
</tbody>
</table>

### CONCENTRIC ELECTRODES* ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Item</th>
<th>Metal Core</th>
<th>Length</th>
<th>Imp</th>
<th>Probe Outer Diameter (total)</th>
<th>Tip Diam.</th>
<th>Core diam.</th>
<th>Y dim.</th>
<th>X dim. w/ polyimide (pkg of 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM33CCNON</td>
<td>Tungsten</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.356 mm</td>
<td>2.0 MΩ</td>
<td>1-2 µm</td>
<td>Greater selectivity - small cells</td>
<td></td>
</tr>
<tr>
<td>TM33CCINS</td>
<td>Tungsten</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.216 mm</td>
<td>1.0 MΩ</td>
<td>1 µm</td>
<td>Greater selectivity - small cells</td>
<td></td>
</tr>
<tr>
<td>TM33CCNON</td>
<td>Tungsten</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.180 mm</td>
<td>3.0 MΩ</td>
<td>1-2 µm</td>
<td>Greater selectivity - small cells</td>
<td></td>
</tr>
<tr>
<td>TM33CCINS</td>
<td>Tungsten</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.127 mm</td>
<td>2.0 MΩ</td>
<td>1 µm</td>
<td>Greater selectivity - small cells</td>
<td></td>
</tr>
<tr>
<td>TST33CCNON</td>
<td>Pt/ir</td>
<td>50 mm</td>
<td>3 µm</td>
<td>0.180 mm</td>
<td>2.5 MΩ</td>
<td>1-2 µm</td>
<td>Greater selectivity - small cells</td>
<td></td>
</tr>
<tr>
<td>TST33CCINS</td>
<td>Pt/ir</td>
<td>50 mm</td>
<td>3 µm</td>
<td>0.106 mm</td>
<td>1.5 MΩ</td>
<td>1-2 µm</td>
<td>Greater selectivity - small cells</td>
<td></td>
</tr>
</tbody>
</table>

*All have a stainless steel outer shaft.

### METAL ELECTRODES ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Item</th>
<th>Length</th>
<th>Insul. Thick</th>
<th>Shaft Diam.</th>
<th>Nominal Impedance (± 20%)</th>
<th>Tip Diam.</th>
<th>Typical Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tungsten — Profile A</td>
<td>Package of 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TM33A10</td>
<td>76 mm</td>
<td>1 µm</td>
<td>0.127 mm</td>
<td>1.0 MΩ</td>
<td>1 µm</td>
<td>Multi unit and single unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33A20</td>
<td>76 mm</td>
<td>1 µm</td>
<td>0.127 mm</td>
<td>2.0 MΩ</td>
<td>1 µm</td>
<td>Multi unit and single unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33C05</td>
<td>76 mm</td>
<td>1 µm</td>
<td>0.085 mm</td>
<td>2.0 MΩ</td>
<td>1 µm</td>
<td>Recording from small tightly packed cells</td>
</tr>
<tr>
<td>TM33A05</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.127 mm</td>
<td>0.5 MΩ</td>
<td>1 µm</td>
<td>Multi unit and single unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33A10</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.127 mm</td>
<td>1.0 MΩ</td>
<td>1 µm</td>
<td>Multi unit and single unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33A20</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.127 mm</td>
<td>2.0 MΩ</td>
<td>1 µm</td>
<td>Multi unit and single unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33B01</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.254 mm</td>
<td>0.1 MΩ</td>
<td>1-2 µm</td>
<td>Single and multi unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33B05</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.254 mm</td>
<td>0.5 MΩ</td>
<td>1-2 µm</td>
<td>Single and multi unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33B10</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.254 mm</td>
<td>1.0 MΩ</td>
<td>1-2 µm</td>
<td>Single and multi unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33B20</td>
<td>76 mm</td>
<td>3 µm</td>
<td>0.254 mm</td>
<td>2.0 MΩ</td>
<td>1-2 µm</td>
<td>Single and multi unit recording and microstimulation</td>
</tr>
<tr>
<td>TM33C05</td>
<td>76 mm</td>
<td>1 µm</td>
<td>0.085 mm</td>
<td>1.0 MΩ</td>
<td>1 µm</td>
<td>Single unit and stim / chronic use</td>
</tr>
<tr>
<td>TM33C10</td>
<td>76 mm</td>
<td>1 µm</td>
<td>0.085 mm</td>
<td>1.0 MΩ</td>
<td>1 µm</td>
<td>Single unit and stim / chronic use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tungsten — Profile C</th>
<th>Package of 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>TST33AxKT</td>
<td>TST33A05KT (2), TST33A10KT (3), TST33A20KT (3)</td>
</tr>
<tr>
<td>TST33AxKT</td>
<td>TST33A05KT (3), TST33A10KT (4), TST33A20KT (3)</td>
</tr>
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<table>
<thead>
<tr>
<th>Tungsten — Profile B</th>
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<tbody>
<tr>
<td>TST33AxKT</td>
<td>TST33A05KT (2), TST33A10KT (3), TST33A20KT (3)</td>
</tr>
<tr>
<td>TST33AxKT</td>
<td>TST33A05KT (3), TST33A10KT (4), TST33A20KT (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pure Iridium — Profile A</th>
<th>Package of 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRM23E10</td>
<td>50 mm</td>
</tr>
<tr>
<td>IRM23E15</td>
<td>50 mm</td>
</tr>
<tr>
<td>IRM23E25</td>
<td>50 mm</td>
</tr>
<tr>
<td>IRM23E30</td>
<td>50 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pure Iridium — Profile C</th>
<th>Package of 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRM23E10KT</td>
<td>50 mm</td>
</tr>
<tr>
<td>IRM23E20KT</td>
<td>50 mm</td>
</tr>
<tr>
<td>IRM23E25KT</td>
<td>50 mm</td>
</tr>
<tr>
<td>IRM23E30KT</td>
<td>50 mm</td>
</tr>
</tbody>
</table>

All Metal Microelectrodes are available in custom lengths, blunt or heat treaded (extra charge).

Ordering:
- Add the B suffix where blunt electrodes are desired. (For example, an IRM123A10KT ordered as a blunt will be IRM123A10KTB.)
- Add the H suffix where heat treated electrodes are desired. (For example, an IRM123A10KT ordered as with heat treatment will be IRM123A10KTH.)

Additional metal microelectrodes available on website: www.wpiinc.com
**Ag/AgCl Half-Cells**

*Sintering pellets with low resistance and high strength*

New, improved sintered pellets with lower resistance and high strength. Stable and well balanced in the presence of current, these small and inexpensive half-cells are easy to work with as bath electrodes.

### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC1</td>
<td>Reference Cell with 1.5 m lead</td>
</tr>
<tr>
<td>RC1T</td>
<td>Reference Cell, 1.5 m lead, 2 mm pin</td>
</tr>
<tr>
<td>RC2</td>
<td>Reference Cell with 2.0 mm pin</td>
</tr>
<tr>
<td>RC2F</td>
<td>Reference Cell with female connector</td>
</tr>
<tr>
<td>RC3</td>
<td>Reference Cell with epoxy body, 4.5 mm diam x 50 mm</td>
</tr>
<tr>
<td>RC6</td>
<td>Reference Cell with glass body, 1.5 mm diam x 50 mm</td>
</tr>
<tr>
<td>EP05</td>
<td>Ag/AgCl Electrode 0.5 mm diam x 20 mm</td>
</tr>
<tr>
<td>EP08</td>
<td>Ag/AgCl Electrode 0.8 mm diam x 20 mm</td>
</tr>
<tr>
<td>EP1</td>
<td>Ag/AgCl Electrode 1.0 mm diam x 3 mm</td>
</tr>
<tr>
<td>EP2</td>
<td>Ag/AgCl Electrode 2.0 mm diam x 4 mm</td>
</tr>
<tr>
<td>EP4</td>
<td>Ag/AgCl Electrode 4.0 mm diam x 1 mm</td>
</tr>
<tr>
<td>EP8</td>
<td>Ag/AgCl Electrode 6.0 mm diam x 1 mm</td>
</tr>
<tr>
<td>EP12</td>
<td>Ag/AgCl Electrode 12.0 mm diam x 1 mm</td>
</tr>
<tr>
<td>3578</td>
<td>Adapter Cable for Ag/AgCl Pellets</td>
</tr>
</tbody>
</table>
Precious Metal and Specialty Wire

Bare and coated metal wire for most laboratory applications

Micro coaxial cables (MAXxxxx) are ideal for microelectrode fabrication and construction of similar research tools. The dual shielding eliminates electrical interference caused by radio frequencies (RF), electrostatic and microphonics (e.g., bending and vibration. Available with single or dual (twin) conductors.

Teflon-coated stainless steel (type 304) wire (SSTxxxx) is available in 25-ft and 50-ft lengths. The Teflon coating is 150 micro-in. thick (4 µm). The Teflon coating is designed to reduce surface friction, only. It is not insulation.

Carbon wire (C3005) is a single 30-micron fiber of electrochemically activated carbon. This fiber is especially useful in micro-electrode experiments.

Platinum/iridium wire — uncoated (PTPxxxx) and Teflon-coated (PTTxxxx) — is an alloy of 90% platinum and 10% iridium, giving excellent tensile strength and corrosion resistance. Uncoated pure platinum wire (PTPxxxx) is 99.95% pure. Iridium wire (N1003) is 99.99% pure, with a melting point of 164.4°C.

Annealed silver wire (AGWxxxx), 99.99% pure, is available in five diameters; three of those sizes are also available with a Teflon coating (AGTxxxx).

Tungsten wire (TGWxxxx), available in three diameters, is 99.95% pure. Gold wire (AUWxxxx) is 99.99% pure. Stainless steel wire (SSxxxxx) is type 316.

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>Metal</th>
<th>Coating</th>
<th>AWG*</th>
<th>Diameter</th>
<th>Precut Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGT0510</td>
<td>Silver</td>
<td>Teflon</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGT0525</td>
<td>Silver</td>
<td>Teflon</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>25 ft (7.6 m)</td>
</tr>
<tr>
<td>AGT05100</td>
<td>Silver</td>
<td>Teflon</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>100 ft (30 m)</td>
</tr>
<tr>
<td>AGT1010</td>
<td>Silver</td>
<td>Teflon</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGT1025</td>
<td>Silver</td>
<td>Teflon</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>25 ft (7.6 m)</td>
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<tr>
<td>AGT10100</td>
<td>Silver</td>
<td>Teflon</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>100 ft (30 m)</td>
</tr>
<tr>
<td>AGT1510</td>
<td>Silver</td>
<td>Teflon</td>
<td>26-27</td>
<td>0.015 in. (0.38 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGT1530</td>
<td>Silver</td>
<td>Teflon</td>
<td>26-27</td>
<td>0.015 in. (0.38 mm)</td>
<td>30 ft (9.1 m)</td>
</tr>
<tr>
<td>AGW0510</td>
<td>Silver</td>
<td>—</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGW0530</td>
<td>Silver</td>
<td>—</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>30 ft (9.1 m)</td>
</tr>
<tr>
<td>AGW1010</td>
<td>Silver</td>
<td>—</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGW1030</td>
<td>Silver</td>
<td>—</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>30 ft (9.1 m)</td>
</tr>
<tr>
<td>AGW1510</td>
<td>Silver</td>
<td>—</td>
<td>26-27</td>
<td>0.015 in. (0.38 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGW1530</td>
<td>Silver</td>
<td>—</td>
<td>26-27</td>
<td>0.015 in. (0.38 mm)</td>
<td>30 ft (9.1 m)</td>
</tr>
<tr>
<td>AGW2010</td>
<td>Silver</td>
<td>—</td>
<td>24</td>
<td>0.020 in. (0.5 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AGW2030</td>
<td>Silver</td>
<td>—</td>
<td>24</td>
<td>0.020 in. (0.5 mm)</td>
<td>30 ft (9.1 m)</td>
</tr>
<tr>
<td>AGW4010</td>
<td>Silver</td>
<td>—</td>
<td>18</td>
<td>0.040 in. (1.0 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>AUW0170</td>
<td>Gold</td>
<td>—</td>
<td>50</td>
<td>0.001 in. (0.025 mm)</td>
<td>70 ft (21 m)</td>
</tr>
<tr>
<td>AUW201</td>
<td>Gold</td>
<td>—</td>
<td>24</td>
<td>0.020 in. (0.5 mm)</td>
<td>1 ft (30 cm)</td>
</tr>
<tr>
<td>C3005</td>
<td>Carbon</td>
<td>—</td>
<td>49</td>
<td>0.0012 in. (30 µm)</td>
<td>5 ft (1.5 m)</td>
</tr>
<tr>
<td>PT1002</td>
<td>Platinum/Iridium</td>
<td>—</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>2 ft (61 cm)</td>
</tr>
<tr>
<td>PT0402</td>
<td>Platinum/Iridium</td>
<td>—</td>
<td>38</td>
<td>0.004 in. (0.102 mm)</td>
<td>2 ft (61 cm)</td>
</tr>
<tr>
<td>PT0203</td>
<td>Platinum/Iridium</td>
<td>—</td>
<td>44</td>
<td>0.002 in. (0.051 mm)</td>
<td>3 ft (91 cm)</td>
</tr>
<tr>
<td>PT0110</td>
<td>Platinum/Iridium</td>
<td>—</td>
<td>50</td>
<td>0.001 in. (0.025 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>PTP101</td>
<td>Platinum</td>
<td>—</td>
<td>30</td>
<td>0.010 in. (0.25 mm)</td>
<td>1 ft (30 cm)</td>
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<tr>
<td>PTP201</td>
<td>Platinum</td>
<td>—</td>
<td>24</td>
<td>0.020 in. (0.5 mm)</td>
<td>1 ft (30 cm)</td>
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<tr>
<td>PTP401</td>
<td>Platinum</td>
<td>—</td>
<td>18</td>
<td>0.039 in. (1.0 mm)</td>
<td>1 ft (30 cm)</td>
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<tr>
<td>PTP406</td>
<td>Platinum</td>
<td>—</td>
<td>18</td>
<td>0.039 in. (1.0 mm)</td>
<td>0.5 ft (15.2 cm)</td>
</tr>
<tr>
<td>PT0502</td>
<td>Platinum/Iridium</td>
<td>—</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>2 ft (61 cm)</td>
</tr>
<tr>
<td>PT0203</td>
<td>Platinum/Iridium</td>
<td>—</td>
<td>44</td>
<td>0.002 in. (0.051 mm)</td>
<td>3 ft (91 cm)</td>
</tr>
<tr>
<td>PT0110</td>
<td>Stainless Steel</td>
<td>—</td>
<td>50</td>
<td>0.001 in. (0.025 mm)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>SS31605</td>
<td>Stainless Steel</td>
<td>—</td>
<td>36</td>
<td>0.005 in. (0.125 mm)</td>
<td>50 ft (15.2 m)</td>
</tr>
<tr>
<td>SS31614</td>
<td>Stainless Steel</td>
<td>—</td>
<td>27</td>
<td>0.014 in. (0.36 mm)</td>
<td>30 ft (9.1 m)</td>
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<tr>
<td>SST30407-25</td>
<td>Stainless Steel</td>
<td>—</td>
<td>33</td>
<td>0.007 in. (0.18 mm)</td>
<td>25 ft (7.6 m)</td>
</tr>
<tr>
<td>SST30407-50</td>
<td>Stainless Steel</td>
<td>—</td>
<td>33</td>
<td>0.007 in. (0.18 mm)</td>
<td>50 ft (15.2 m)</td>
</tr>
<tr>
<td>TGW0325</td>
<td>Tungsten</td>
<td>—</td>
<td>40</td>
<td>0.003 in. (0.07 mm)</td>
<td>25 ft (7.6 m)</td>
</tr>
<tr>
<td>TGW0515</td>
<td>Tungsten</td>
<td>—</td>
<td>36</td>
<td>0.005 in. (0.13 mm)</td>
<td>15 ft (4.6 m)</td>
</tr>
<tr>
<td>TGW1510</td>
<td>Tungsten</td>
<td>—</td>
<td>26-27</td>
<td>0.015 in. (0.38 mm)</td>
<td>10 ft (3 m)</td>
</tr>
</tbody>
</table>

**MICROCOAXIAL CABLES**

| MAX3820     | Tinned Cu Alloy | Coaxial | 0.0175 in. (0.44 mm) | 20 ft (6 m) |
| MAX4020     | Tinned Cu Alloy | Twin Coaxial | 0.0158x0.024 in. (0.4x0.61 mm) | 20 ft (6 m) |

*Brown & Sharpe

1 Plus 0.002 in. for Teflon coating
2 Teflon adds 0.00015 in. (4 µm) to diameter
3 Impedance: 50 ohm; capacitance: 95 pF/m; resistance: 5 ohm/m
4 Impedance: 100 ohm; capacitance: 54 pF/m; resistance: 1.9 ohm/m
Cables & Connectors
For wiring any laboratory setup

BNC Cables
2851 (6 ft)
500184 (10 ft)
500257 (6 in.)
500258 (12 in.)
500259 (18 in.)
### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part #</th>
<th>Application/Description</th>
<th>Connector A</th>
<th>Connector B</th>
<th>Cable Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1358</td>
<td>Beetrodes</td>
<td>BNC (male)</td>
<td>2 mm pin</td>
<td>3 ft. (0.9 m)</td>
</tr>
<tr>
<td>2026-10</td>
<td>2 mm socket, unwired (pkg of 10) (Not Shown)</td>
<td>2 mm socket</td>
<td>unwired none</td>
<td></td>
</tr>
<tr>
<td>2851</td>
<td>Standard BNC cable</td>
<td>BNC (male)</td>
<td>BNC (male)</td>
<td>6 ft. (1.8 m)</td>
</tr>
<tr>
<td>3142</td>
<td>Mini-Banana Adapter</td>
<td>Screw Terminals</td>
<td>Dual Mini-Banana</td>
<td>none</td>
</tr>
<tr>
<td>3161</td>
<td>Connector for input to TBM4M and BP-1</td>
<td>DIN (male)</td>
<td>unwired none</td>
<td></td>
</tr>
<tr>
<td>3294</td>
<td>Ground wire for DAM80 probe</td>
<td>Clip</td>
<td>none</td>
<td>3 ft. (0.9 m)</td>
</tr>
<tr>
<td>3417-10</td>
<td>2 mm plug, unwired (pkg of 10)</td>
<td>2 mm pin</td>
<td>unwired none</td>
<td></td>
</tr>
<tr>
<td>3491</td>
<td>Extension for any 8-pin DIN</td>
<td>DIN (male)</td>
<td>DIN (female)</td>
<td>5 ft. (1.5 m)</td>
</tr>
<tr>
<td>3492</td>
<td>Connector, adapts WPI transducers to non-WPI equipment</td>
<td>DIN (female)</td>
<td>unwired none</td>
<td></td>
</tr>
<tr>
<td>3508</td>
<td>Adapts BNC pH electrode to pH meter with “U.S. Standard” input</td>
<td>BNC (male)</td>
<td>US Standard none</td>
<td></td>
</tr>
<tr>
<td>3517</td>
<td>DAM50, DAM60, DAM70, shielded (two cables/pkg)</td>
<td>Modular phone plug, 4 wire none</td>
<td>3 ft. (0.9 m)</td>
<td></td>
</tr>
<tr>
<td>3578</td>
<td>Adapter cable for Ag/AgCl pellets</td>
<td>2 mm pin</td>
<td>none</td>
<td>5 ft. (1.5 m)</td>
</tr>
<tr>
<td>3670</td>
<td>Double banana plug with solder turret terminals</td>
<td>Dual Banana (male)</td>
<td>Dual Banana (female)</td>
<td>none</td>
</tr>
<tr>
<td>5371</td>
<td>Low-noise cable for microelectrode holders</td>
<td>2 mm gold pin/jack</td>
<td>2 mm gold pin/jack</td>
<td>2 ft. (0.6 m)</td>
</tr>
<tr>
<td>5372</td>
<td>Low-noise cable for microelectrode holders</td>
<td>2 mm gold pin/jack</td>
<td>2 mm gold pin</td>
<td>4 ft. (1.2 m)</td>
</tr>
<tr>
<td>5373</td>
<td>Low-noise cable for microelectrode holders</td>
<td>2 mm gold pin/jack</td>
<td>2 mm gold pin/jack</td>
<td>4 ft. (1.2 m)</td>
</tr>
<tr>
<td>5375</td>
<td>Low-noise cable for microelectrode holders</td>
<td>2 mm gold jack</td>
<td>none none</td>
<td></td>
</tr>
<tr>
<td>5385</td>
<td>Cable, shielded transducer stock</td>
<td>none</td>
<td>none</td>
<td>25 ft. (7.6 m)</td>
</tr>
<tr>
<td>13324</td>
<td>Adapter</td>
<td>Double-banana (female)</td>
<td>BNC (male) none</td>
<td></td>
</tr>
<tr>
<td>13347</td>
<td>ISO2 (chart recorder adapter)</td>
<td>Double-banana (male)</td>
<td>BNC (female) none</td>
<td></td>
</tr>
<tr>
<td>13388</td>
<td>Electrode adapter for DAM probes</td>
<td>Miniature banana (male)</td>
<td>2 mm jack</td>
<td>none</td>
</tr>
<tr>
<td>13451</td>
<td>Adapter: Iso-DAM, Iso-DAM8</td>
<td>BNC (female)</td>
<td>two 2 mm pins</td>
<td>6 in. (15 cm)</td>
</tr>
<tr>
<td>13555</td>
<td>Serial Cable (not shown)</td>
<td>DB9 (male)</td>
<td>DB9 (female)</td>
<td>6 ft. (1.8 m)</td>
</tr>
<tr>
<td>13620</td>
<td>Low-noise cable for microelectrode holders</td>
<td>2 mm gold pin</td>
<td>2 mm gold jack</td>
<td>2 ft. (0.6 m)</td>
</tr>
<tr>
<td>13685</td>
<td>SP Series pump-to-pump linking cable</td>
<td>Modular phone plug</td>
<td>Modular phone plug</td>
<td>7 ft. (2.1 m)</td>
</tr>
<tr>
<td>13776</td>
<td>Adapts reference electrode to VF4 ground jack</td>
<td>Banana (male)</td>
<td>2 mm jack</td>
<td>none</td>
</tr>
<tr>
<td>13854</td>
<td>BNC T-connector, male to:</td>
<td>BNC (female)</td>
<td>BNC (female)</td>
<td>none</td>
</tr>
<tr>
<td>14254</td>
<td>BNC Straight Adapter</td>
<td>BNC (female)</td>
<td>BNC (female)</td>
<td>none</td>
</tr>
<tr>
<td>15623</td>
<td>Serial cable and adapter, SP Series pump</td>
<td>SP Pump</td>
<td>IBM 9-pin “D” connector</td>
<td>5 ft. (1.5 m)</td>
</tr>
<tr>
<td>15975</td>
<td>Adapter</td>
<td>2 mm socket</td>
<td>1 mm pin</td>
<td>none</td>
</tr>
<tr>
<td>15976</td>
<td>Adapter</td>
<td>1 mm socket</td>
<td>2 mm pin</td>
<td>none</td>
</tr>
<tr>
<td>300040</td>
<td>Adapter Extension</td>
<td>2 mm socket</td>
<td>2 mm socket</td>
<td>4 in. (10 cm)</td>
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<tr>
<td>500184</td>
<td>Standard BNC Cable</td>
<td>BNC (male)</td>
<td>BNC (male)</td>
<td>10 ft. (3 m)</td>
</tr>
<tr>
<td>500256</td>
<td>BNC Right Angle Adapter</td>
<td>BNC (male)</td>
<td>BNC (female)</td>
<td>none</td>
</tr>
<tr>
<td>500257</td>
<td>Standard BNC Cable</td>
<td>BNC (male)</td>
<td>BNC (male)</td>
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Micropipette Holders & Half-Cells

**Couple fluid filled glass micropipettes to high input impedance amplifiers**

### Features
- **Connector pin, jack, luer ports, Ag/AgCl half-cells, wire selections available**
- **Optional handles (for some varieties) allow for easy manipulation. Handles are sold separately.**
- **Screw cap for tight fitting of glass electrode to avoid drifting of electrode**

### Benefits
- **Available for 1.0, 1.2, 1.5 and 2.0 mm OD glass electrodes**
- **Spare gaskets available**
- **Optional handles available in two different sizes for some holders**

### Applications
- **Microinjection**
- **Electrophysiology recording**
- **Fluid handling**

◆ denotes holder manufactured for you as custom orders. Call for price.

The most popular micropipette holders are stock items. Custom holders (designated by ◆) can be manufactured on demand but require an additional setup fee. Call for a quote. See all the options at www.wpiinc.com/MEH

WPI's microelectrode holder-half-cells couple fluid-filled glass micropipettes to high input impedance amplifiers. A Ag/AgCl pellet (or a silver wire) molded into the holder body provides stable potential. Electrical connection is made via male 2 mm pins or female 2 mm sockets. The pipette may be mounted axially or at right angles to the holder.

Pipettes are held with screw-caps or rubber gaskets (without caps). Filling WPI microelectrode holders with electrolytes containing chloride results in stable electrode potential. Suitable electrolytes include KCl, NaCl and CaCl₂. Holders are supplied for standard WPI single capillary tubing of 1.0, 1.2, 1.5 and 2.0 mm outside diameters. (Call WPI regarding custom designs for other glass diameters.) The holder style you select will depend on your experimental application, space, and instrumentation.

### Hints for selecting and ordering micropipette holders
1. Determine the required electrical connection on the holder: for example, if you wish to connect the holder to a 2 mm pin you should select a holder equipped with a 2 mm jack. Most WPI probes require a holder equipped with a 2 mm jack.
2. Decide on the required alignment of the electrical connection: either in-line with the glass pipette, or at a right angle to it. Space considerations in your experimental setup and requirements imposed by other pieces of equipment typically determine which alignment is appropriate.
3. Determine if you want to hold the glass pipette by a rubber gasket (e.g., MEH1S) or a screw-cap (e.g., MEH3S). Rubber gaskets offer easier insertion and removal of glass pipettes whereas screw-caps provide more secure mounts for micropipettes.
4. Choose a holder with either a silver wire or a silver/silver chloride pellet for the metal/liquid coupling. Silver/silver chloride pellets provide a more stable low-noise baseline which is important for low-noise DC recording. Pellets require the glass pipette and holder to be free of air bubbles to achieve a good connection. Silver wire holders are durable and are easier to use when the holder is equipped with a pressure port because the fluid in the pipette does not have to be filled to the top of the pipette to achieve a good electrical connection.
5. Choose a holder equipped with a pressure port only when you want to pressure inject liquid from the pipette. Two types of ports are available: 2.0 mm O.D. and standard “syringe-style” Luer. The Luer port is often recommended because it makes assembly and disassembly much easier. Quick-connect Luer fittings for four common sizes of tubing (1/16", 1/8", 5/32", 1/4") are included with each Luer-equipped holder.
6. Some non-WPI preamplifiers or headstages cannot be mounted to Ag Wire

---

**Electrophysiology**

**World Precision Instruments**

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Germany: +49 (0)30 61 88845 • wpide@wpi-europe.com • www.wpi-europe.com

Brazil: 011 55 13 40629703 • info@brazil.wpiinc.com • www.wpiinc.com

China: +86 21 6888 5517 • chinasales@china.wpiinc.com • www.wpiinc.cn

**Microinjection**

**Electrophysiology recording**

**Fluid handling**

● Connector pin, jack, luer ports, Ag/AgCl half-cells, wire selections available

● Optional handles (for some varieties) allow for easy manipulation. Handles are sold separately.

● Screw cap for tight fitting of glass electrode to avoid drifting of electrode

**Benefits**

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- Spare gaskets available
- Optional handles available in two different sizes for some holders

**Applications**

- Microinjection
- Electrophysiology recording
- Fluid handling

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The most popular micropipette holders are stock items. Custom holders (designated by ◆) can be manufactured on demand but require an additional setup fee. Call for a quote. See all the options at www.wpiinc.com/MEH

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6. Some non-WPI preamplifiers or headstages cannot be mounted to Ag Wire
(e.g., MEH8) permits the holder to be conveniently mounted on a micromanipulator.

7. Finally, remember to specify the O.D. of the glass you will be using when you place your order.

MEH6RF/SF is designed primarily for use with the Model 900A Micropressure System; EHB1 for use in electrode beveling; and MEH3SW for microtitration of chloride with a silver wire as the electrode and a solution of silver nitrate filling the holder. MPH models do not contain Ag/AgCl half-cells and are used for pressure injection of substances through microelectrodes. PicoNozzle, used for pressure injection with PV800 Series PicoPumps, includes an MPH6S holder — which may also be used to couple a micropipette to a syringe.

◆ denotes holder manufactured for you as custom orders. Call for price.
Micropipette Holders & Half-Cells

Couple fluid filled glass micropipettes to high input impedance amplifiers

◆ denotes holder sizes manufactured for you as custom orders. Call for price.
Our Microelectrode Holders Ordering Information:}

**Order Number**

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<th>Connector</th>
<th>Half-Cell</th>
<th>Pressure Port</th>
<th>Screw Cap</th>
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</table>

* Specify O.D. of glass (1.0, 1.2, 1.5 or 2.0 mm) by replacing XX in the Order Number with 10, 12, 15 or 20.

**Optional Accessories/Replacement Parts**

- **Handle 2505** is for use with WPI manipulators. The smaller diameter handle **5444** is required for use with Narishige and Zeiss manipulators.

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<th>Description</th>
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<td>1/8-in (6.3 mm) diameter handle</td>
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<tr>
<td>5444</td>
<td>3/16-in (4.8 mm) diameter handle</td>
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<tr>
<td>GO1-100</td>
<td>Replacement gasket 1.0 mm, Package of 100</td>
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<tr>
<td>GO2-100</td>
<td>Replacement gasket 1.2 mm, Package of 100</td>
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<tr>
<td>GO3-100</td>
<td>Replacement gasket 1.5 mm, Package of 100</td>
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<tr>
<td>GO4-100</td>
<td>Replacement gasket 2.0 mm, Package of 100</td>
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<tr>
<td>1571</td>
<td>Clear Silicone Rubber Sealant (4.7 oz)</td>
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</table>

**Contact Information**

- **Order Toll-Free:** (866) 606-1974 (U.S. only) • **Tel:** (941) 371-1003 • **Fax:** (941) 377-5428 • **E-mail:** sales@wpiinc.com

**Website:** www.wpiinc.com

**Address:**

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2000 W. Bell Road

Clearwater, FL 33761 USA

(941) 371-1003 • www.wpiinc.com

For more information please visit our website.
Glass Capillaries

Quality glass, superior prices for microinjection/microelectrodes

Features
- Quality borosilicate glass capillaries
- Large variety available, including fire polished, filaments, thin wall, specialty glass and multi-barrel

Benefits
- Superior pricing
- Most glass orders ship within 48 hours

Applications
- Microinjection
- Electrophysiology
- Patch clamp
- Fluid Handling

Fire Polishing
Fire-Polished glass capillaries are easier to insert into microelectrode holders without damaging the gasket. More importantly, fire-polished glass won’t scratch the chloridized wire used in a recording electrode. Fire-polishing does not affect the glass’s mechanical or electrical properties.

Making Uniform, Reproducable Microelectrodes
Borosilicate glass capillaries: Close dimensional tolerances assure microelectrode uniformity and reproducibility. Capillaries are available in 1, 2, 3, 5 and 7-barrel configurations, complete range of single barrel thin-wall sizes and a variety of special configurations. Capillaries with filaments contain a solid filament fused to the inner wall, which speeds filling of electrodes. Capillaries with or without inner filaments are available for making microelectrodes in a wide range of diameters.

Filament Glass Capillaries
Single Barrel standard wall thickness capillaries are offered either with or without inner filaments for quick filling in a variety of lengths and diameters.

Thin Wall Glass Capillaries
Thin Wall single barrel capillaries are offered both with or without inner filaments. Specialty glass is also available. See page 115.

ORDERING INFORMATION

<table>
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<td>0.68</td>
<td>✓</td>
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<td>1.12</td>
<td>✓</td>
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<td>2.0</td>
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</table>
Multi-Barrel Glass Capillaries

Multi-barrel configurations are designed especially for microinjection. Because the capillaries are fused together during manufacturing, you will not need to twist them while pulling to seal the tips together. An inner filament in each barrel makes filling easy and fast.

Also see PolyFil for a novel way to connect multi-barrel pipettes

### Multi-Barrel Borosilicate Glass Tubing with Filaments

<table>
<thead>
<tr>
<th>Length</th>
<th>Description</th>
<th>OD/ID (mm)</th>
<th>Filament Qty Item</th>
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<tr>
<td>6” (152mm)</td>
<td>3-Barrel</td>
<td>1.2/0.68</td>
<td>✔ 100 3B120F-6</td>
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<td>5-Barrel</td>
<td>1.2/0.68</td>
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<tr>
<td>6” (152mm)</td>
<td>7-Barrel</td>
<td>1.0/0.58</td>
<td>✔ 60 7B100F-6</td>
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</table>

### Special Configuration Glass Capillaries

#### Septum Theta

Septum Theta offers superior cell impalement. The natural bevel resulting from the prominent spear-like projection of the septum gives microelectrodes a sharp, spear-point tip. This style has low resistance for use as a single microelectrode, and it can be used to make superior double-tipped microelectrodes with low trans-tip coupling. The natural bevel of Septum Theta also significantly increases the effective tip cross-section. As supplied, the width of the septum is approximately 0.2 mm; wall thickness is approximately 0.2 mm.

#### Piggyback

Piggyback glass consists of a pair of borosilicate capillaries fused together during manufacturing. One barrel is larger than the other, and both have inner filaments for quick filling. Piggyback glass makes it simple to fabricate two-barrel electrodes with a significant tip diameter differential.

### Special Configuration Borosilicate Glass Tubing

<table>
<thead>
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<td>Piggyback</td>
<td>1.51/0.84 0.75/0.35</td>
<td>6 in. (152 mm) 50 PB150F-6</td>
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</table>

### Multi-barrel pipette coupling kit

**Securely couple multi-barrel pipettes to a pressure source**

#### Features

- Complete kit (all in one) for making multi-barrel pipettes
- Secure coupling of multi-barrel micropipettes to a pressure source

#### Benefits

- Allows for microinjection to multi-barrel micropipette independently for one pressure source
- Pressure safe and convenient luer lock connections

#### Applications

- Multi-port microinjection

PolyFil™ allows easy and secure coupling of a multi-barrel micropipette to a pressure source. Coupling is achieved by bonding temperature-resistant and flexible MicroFil to the capillary tube with hot melt adhesive. The luer end of each MicroFil is connected to PVC tubing (200 PSI rated). Kits also include a five-port manifold that allows use of a single PV800 Series PicoPump to drive up to six micropipette barrels independently by switching on only the barrels to be injected. All connections are locking luers — pressure safe and convenient.

### PolyFil™ Multi-Barrel Micropipette Coupling Kit

Includes: 1 pipette holder/handle, plastic; 7 pieces MF28G MicroFil; 7-pieces tubing with male luer lock fittings; 1 flow-thru manifold with five luer lock ports; 1 hot melt glue gun (110V only); 3 glue sticks.

### ORDERING INFORMATION

#### PolyFil™ Multi-Barrel Micropipette Coupling Kit

<table>
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<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
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<td>Glass Rod</td>
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### ORDERING INFORMATION

**5440** PolyFil™ Multi-Barrel Micropipette Coupling Kit

Includes: 1 pipette holder/handle, plastic; 7 pieces MF28G MicroFil; 7-pieces tubing with male luer lock fittings; 1 flow-thru manifold with five luer lock ports; 1 hot melt glue gun (110V only); 3 glue sticks.

**13316** Mini Glue Gun and (3) glue sticks
Patch Clamp Capillary Glass

*Evaluated for best softening temperature, electrical properties, sealability, leachable components*

**PG52151-4** and **PG52165-4** are prepared from Schott #8250 glass (equivalent to Corning #7052), one of the most widely used patch clamping glasses. This is a specially formulated borosilicate glass with a softening temperature that is 110°C lower than regular borosilicate glass (Corning 7740, or Pyrex). It has excellent sealing properties for most cells. Electrical properties are also very good.

**PG10150-4** and **PG10165-4** are composed of Corning #0010 glass, a high lead content (22% PbO) glass. Its thermal and electrical performance is between the Schott #8250 and Corning #8161 glasses described above. It is much more economical than Corning #8161 glass. It has been found that this glass causes much less alteration in channel behavior than Corning #8161 and Schott #8250 glass (Furman and Tanaka, Biophys. J. 53, p287, 1988).

*Patch clamp capillaries do not have microfilaments.*

**ORDERING INFORMATION**

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**Glass Handling Forceps**

*Firmly hold your capillary glass without risk of breaking it*

Ever had difficulty picking up a glass capillary? Special tips on these forceps solve the problem, holding glass firmly without risk of breakage. They also keep the glass clean and avoid contamination from skin oils.
Borosilicate Glass Micropipettes

Eliminate the cost and trouble of making your own micropipettes

Features
- Schott Duran borosilicate glass
- 0.5 µm and smaller ID micropipettes include internal glass fiber for easy filling
- Tip inner diameter tolerance ±20%
- Short taper yields high strength
- Nominal length = 50 mm
- OD:ID = 1.33:1
- Standard capillary outer diameters are 1.0 mm (thin-wall) or 1.14 mm
- Every pipette individually tested and inspected
- Vacuum packed

Benefits
- Plain Shank or Luer Fittings
- Injection of dyes or proteins into cells, oocytes or other biomedical laboratory applications
- Male luer fitting makes connecting to pumps quick and easy.
- The incorporated standard female luer fitting makes connecting to existing experimental plumbing quick and easy.

Applications
- Injection of dyes or proteins into cells, oocytes or other biomedical laboratory applications
- Schott Duran borosilicate glass
- 0.5 µm and smaller ID micropipettes include internal glass fiber for easy filling
- Tip inner diameter tolerance ±20%
- Short taper yields high strength
- Nominal length = 50 mm
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- Every pipette individually tested and inspected
- Vacuum packed

Micro Cannula

Quickly connect to existing experimental plumbing

Features
- 0.4 mm O.D., 0.2 mm I.D. tubing
- Autoclavable
- Biocompatible Perfluorocarbon tubing material

Benefits
- May be used with a pressure transducer (BLPR2) or a micro syringe injection system (UMP3 or MMP)

Applications
- Cannula for carotid or femoral arteries of rodents and small animal blood vessels

This micro cannula is ideal for placement in the carotid or femoral artery of mice, rats, and other small animal blood vessels. It can be used with a pressure transducer (WPI’s BLPR2) for blood pressure measurement, or in conjunction with a micro-syringe injection system (like WPI’s UMP3 or MMP pumps). The incorporated standard female luer fitting makes connecting to existing experimental plumbing quick and easy. The cannula is provided with a contoured-tip stainless steel stylet (trocar) to facilitate placement using established techniques. A movable “shoulder” ring provides a tie-in point to prevent accidental removal. The cannula may be left in place for 2 hours or more, and with proper care and cleaning, may be re-used multiple times. Instructions for use included.

Micro Cannula

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Microelectrode Puller

A compact, versatile and reliable workhorse

Features
- Program sequences up to four steps
- Produce micropipettes with a tip diameter less than 0.1 µm or greater than 10 µm
- Store up to 95 programs in memory for easy recall
- Two factory programs installed
- Supplied with a vial of capillary glass

Benefits
- Tempered glass cover to reduce the effects of humidity on puller reproducibility
- Switchable power supply ensures that line voltage fluctuations don’t affect reproducibility

Applications
- Pull your own microelectrodes and micropipettes

PUL-1000 is a microprocessor controlled horizontal puller for making glass micropipettes or microelectrodes used in intracellular recording, patch clamp studies, microperfusion or microinjection. The puller was designed with tight mechanical specifications and precision electronics for complete control of the pulling process and accurate reproducibility. It offers programmable sequences of up to four steps with heating, force, movement and cooling time. This allows graduated cycles for applications like patch clamp recording. This puller is a reasonably priced, compact, versatile and reliable workhorse. The microprocessor, combined with the LCD display, makes the PUL-1000 easy to use.

Tempered Glass Cover
The cover of pulling chamber is made with tempered glass to minimize the humidity effect on the reproducibility of pulled pipettes.

Switchable Power Supply
PUL-1000 has a high quality switching power supply for use anywhere in the world without worry about the line voltage differences. Pulling reproducibility is unaffected by line voltage fluctuation. Heating voltage can be controlled to within 0.1% accuracy even when line voltage fluctuates from 90 to 240 VAC.

References

PUL-1000 SPECIFICATIONS

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<tr>
<td>PULLING FORCE</td>
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<tr>
<td>MAXIMUM CAPILLARY LENGTH</td>
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<tr>
<td>POWER</td>
<td>90–240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>34 x 24 x 12 cm</td>
</tr>
<tr>
<td>SHIPPING WEIGHT</td>
<td>15 lb.</td>
</tr>
<tr>
<td>REPLACEMENT FILAMENTS</td>
<td>2.5 mm Square Box Filament, 2.5 mm wide (13834)</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION
PUL-1000 Micropipette Puller
13834 Replacement Filaments
Programmable Multipipette Puller

Pneumatic pressure (no gravity or magnetic fields) for consistent pulling force

Features

● Produces two identical pipettes every time
● 25 saved programmable sequences
● Optical-digital measurement
● 22 manufacturer preset sequences

Benefits

● Exclusive optical-digital taper measurements that applies precise taper length settings and offers real-time measurement
● Computerized real-time heater control to dynamically adjust power to match your setpoint
● Programmable, savable sequences with 18 steps so you can store your favorite tip pulling programs

Applications

● Pull patch clamping pipettes, intracellular electrodes, injection micropipettes and micro-needles

The microprocessor-controlled PMP-102 is designed to pull a pipette horizontally, producing two identical micropipettes. Different kinds of pipettes can be pulled repeatedly using the preset program sequences. You can create your own patch clamp electrodes, intracellular electrodes, injection micropipette and micro-needles using preset sequences.

Exclusive Optical-Digital Taper Measurement

Instead of the mechanical tip length setting like other pipette pullers, there is an exclusive optical-digital ruler in the PMP-102 to apply precise taper length settings, and for real-time measurement and control. With this feature, you can handle taper pulling precisely and easily. Equipped with a powerful computerize tip sensing function, the puller can automatically finish the tip pulling. You can pull the ideal tip every time.

Computerize Real-Time Feedback Heater Control

The PMP-102 includes an advanced microcontroller to perform real-time heater monitoring and control. When you select a heating level, the microcontroller measures the actual heating power applied during a pull. The real-time measurement is displayed, and the feedback to the control unit dynamically adjusts the power to match your setpoint. As a result, the puller always provides precise heating power, despite variables like thermal/electrical changes. When the heating level is set to AUTO, the heater automatically determines the melting point for different glass pipettes. The microcomputer control ensures smart, reliable heating.

Programmable, Savable Sequences

There are 25 manufacturer/user programmable pulling sequences with 18 steps in each sequence. You may easily program different pipette tip sizes, tip lengths and tip shapes in different sequences for a variety of applications. Time and length count, heat level, heat control and action parameters can be individually set in each step.

Pneumatic Pulling Force and Compact Size

The PMP-102 applies precisely controlled pneumatic pressure as the pulling force, providing control plus even and consistent dragging characteristics. The device is compact, requiring little bench space. And it precisely and automatically performs multi-step pulling without manual interruption. A simple keypad and LCD display let you easily control and monitor the pulling parameters. Parameters include sequences, steps, time, timing, heater level, heater control, tip length and actions. The heater power control and action time count up or down in real-time on the display.

With the versatility of the intelligent PMP-102, pulling an ideal micropipette is no longer an uncertainty of hand skill, but a reproducible, automatic process.

ORDERING INFORMATION

| PMP-107 | Programmable Multipipette Puller (110 V) |
| PMP-107Z | Programmable Multipipette Puller (240 V) |
| PMP-102 | Pneumatic Programmable Multipipette Puller (110 V) |
| PMP-102Z | Pneumatic Programmable Multipipette Puller (240 V) |
Digital Microforge

Microforging, Micropipette Calibration and Microinjection — in a single device!

Features

- Microprocessor-controlled microforge
- Digital signal processor technology precisely controls the polish heating time
- Unique digital pneumatic pressure feature polishes the tip without changing the size
- W305-LED Microscope (Optional)

Benefits

- Digital Signal Processor (DSP) technology
- Complete system package available
- Kohler illuminator and Abbe condenser for less glare and sharper images.
- Pneumatic pressure polishing that allows the preparation of blunt tips without change of tip ID
- Heating filament is attached to the microscope objective so they move together
- Pipette holder sits on the microscope stage to simplify the locating and polishing of the pipette

Applications

- Polishing patch pipettes
- Microforging holding pipettes
- Microforging beveled injection pipettes
- Pipette tip calibration and microinjection

The DMF1000 is a microprocessor-controlled microforge offering unmatched performance. Designed for fabrication of both small patch clamp glass pipettes and larger injection pipettes, the DMF1000 should find many uses in the laboratory. The DMF1000 is based on a design similar to that first used in WPI's extremely popular microforge model, the MF200. The extensive improvements incorporated into the DMF1000 greatly increase its versatility and performance, making it one of the most powerful microforges on the market.

Digital Signal Processor (DSP) Technology

The DMF1000 is powered by the latest digital signal processor (DSP) technology. A digital timer is used to precisely control the polish heating time. Ten memories can be used to store settings of the heating power and heating duration. All of the settings are controlled and displayed digitally for better accuracy and reproducibility. Two different operating modes are provided: Manual and Auto. In the Manual mode, the DSP will memorize the duration of the time that is used to achieve a desired polishing. In Auto mode, the heat will be applied for the duration of the timer setting.

Complete System Available

The DMF1000 system includes a specially configured WPI model W305-LED research grade compound microscope (optional) equipped with a high quality metallurgic 40x long-working distance objective and a pair of 10x eyepieces. The long working distance objective reduces the danger of damage to the objective lens during the heating process.

Kohler Illuminator and Abbe Condenser

Other benefits of the DMF1000 design include the use of a Kohler illuminator and Abbe condenser, which provide the reduced glare and sharper image contrast necessary when polishing pipettes as small as half a micron (0.5 µm) in diameter.

Pressure Polishing

The DMF1000 incorporates a unique digital pneumatic pressure feature that enables pressurized air to be delivered through the pipette during fire polishing. In the fabrication of patch pipettes, the pressurized air can be used to blunt the taper at the pipette tip without changing the size of the tip opening. This reduces electrical resistance of the tip, leading to lower noise during patch-clamp recordings (Goodman & Lockery, 2000).

The Heating Filament

With a conventional microforge often the most difficult and time-consuming part of using a high magnification objective is being able to move both the heating filament and the pipette into the same viewing area. Finding and moving both the heating filament and the pipette without collision can be a challenge. However, this difficulty is eliminated with the DMF1000 because the heating filament is directly attached to the...
microscope’s objective. Hence it can be easily adjusted to any position within the viewing area. The low heat capacity and low thermal coefficient of linear expansion of the filaments are key design features. The low heat capacity of the filament allows it to reach fire-polishing temperatures without excessive heat. This permits you to bring the pipette tip close to the filament during polishing without fear of collapsing the pipette tip. Low heat capacity eliminates the need for an auxiliary air-cooling system. The low coefficient of expansion characteristic of the filament ensures minimal displacement of the filament during heating. This feature eliminates much of the guesswork out of tip placement in relation to the filament.

Two different heating filaments are provided to accommodate various applications. The H5 filament is large gauge and can be reformed into a “U” for fabrication of pipettes, air forming of patch pipettes and other applications. The H4 is a smaller gauge filament and is ideal for polishing patch clamp pipettes.

Pipette Holder Sits on the Microscope Stage

The pipette rests on a specially designed holder that sits on top of the microscope stage. The position of the pipette, relative to the heating filament, is controlled by the (X, Y, Z) adjustment of the stage. This unique design makes locating and polishing the pipette extremely easy. The stage of the microscope has a high-quality rail that gives precise, smooth and stable control of the pipette’s movement. This configuration also eliminates the need and expense of an additional micromanipulator to control pipette movement.

Typical applications of the DMF1000

Polishing the Patch Pipettes

Proper fire polishing of patch pipettes is the single most important factor for forming a stable giga-seal in patch clamp recording. This is even more important than the type of glass capillary used. Difficulties often arise in forming giga-seals because the polishing of patch pipettes using a conventional low magnification microforge is inadequate. However, the DMF1000 uses a 40X long-working distance objective. Pipette polishing is much more accurately controlled. Both whole cell patch pipettes and single channel patch pipettes can be conveniently polished to the highest quality and reproducibility achievable with any microforge.

Microforging Holding Pipettes

A holding pipette with a large blunt tip and a small opening is used to hold a floating cell in place prior to microinjection by applying suction to the rear of the pipette. The procedure for making holding pipettes involves three steps: squaring off, large bore flame polishing and tip reducing. These steps are accomplished with a larger heating filament.

Microforging Beveled Injection Pipettes

Occasionally, a beveled large bore pipette is not sharp enough to penetrate a cell without damaging the area around the pipette. With the DMF1000 and the large heating filament, a sharp point can be formed on the beveled tip to assist the penetration of the cell. This process is referred to as contact stretching.

Pipette Tip Calibration & Microinjection

The integrated digital pneumatic pressure system can be used to calibrate the precise diameter (I.D.) of a micropipette tip, based on a technique described previously (Hagag & Randolph 1990, Bowman & Ruknudin 1999). The pressure system can also be used separately as a simple but highly accurate controller for microinjection applications.

References

Analog Microforge

Sometimes the simplest designs work best

Features

● Simple, reliable and economically priced
● Analog temperature controller
● W30S-LED microscope (optional)

Benefits

● Includes 40x long-working distance objective and 10x eyepiece
● Kohler illuminator and Abbe condenser for less glare and sharper images.

Applications

● Patch pipette tip polishing
● Micropipette tip size reduction
● Contact stretching in vitro fertilization pipette production

The MF200 Microforge is a versatile instrument designed specifically for the fabrication of glass micropipettes and other related tools. The system was developed in collaboration with Dr. Ming Li of the Department of Pharmacology, University of South Alabama. The MF200 is simple, reliable and priced economically.

40x LWD Objective Included

The MF200 system includes: An easy to use analog temperature controller, a specially configured WPI model W30S-LED research grade compound microscope (optional), 40x long-working distance objective and 10x eyepiece. 40x magnification is essential when polishing pipettes as small as half a micron (0.5 µm) in diameter. Compared to a conventional 40x objective, the long working distance objective reduces the danger of damage to the pipette and/or objective lens during the polishing process.

Kohler Illuminator

It is the only commercial microforge using the Kohler illuminator and Abbe condenser for illumination. This provides less glare and sharper image of the pipette than the frosted glass illuminator, which is used on other commercial microforges.

References


FEATURE COMPARISON

<table>
<thead>
<tr>
<th>Feature</th>
<th>MF200</th>
<th>DMF1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>W30S-LED Microscope</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>40x Long Working Distance Objective</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Analog Controller</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Digital Controller</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Pressurized Air Control</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Micromanipulation Capability</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Optional Foot Switch</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Memory</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Auto-sense of filament type</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Digital Temperature Control</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION

MF200-1 Microforge System w. W30S-LED Microscope (110 V)
MF200-2 Microforge System w W30S-LED Microscope (220 V)
MF200-M1 MF 200 without microscope (110 V)
MF200-M2 MF 200 without microscope (220 V)

*Above MF200 microforges include 40x long working distance objective

OPTIONAL ACCESSORIES/REPLACEMENT PARTS

500292 Optional 15× Eyepieces (pair)
500329 Optional Filament Cable
500529 25× Long-Working Distance Objective (fits most microscopes with a 160 mm Focal Length)
13142 Optional foot switch
MF200-H2 Replacement heating filament (large gauge)
MF200-H3 Replacement heating filament (medium gauge)
MF200-H4 Replacement heating filament (small gauge)
75090 Filament Adjustment Assembly, 22mm OD Objectives
75050 Replacement Micropipette Slide
75040 Replacement Filament Cable

WORLD PRECISION INSTRUMENTS

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China: +86 21 6888 5517 • chinasales@china.wpiinc.com • www.wpiinc.cn

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Microbeveler System with Guided Light!

*Bevel micropipette tips larger than 1 µm, for applications like microinjection*

**Features**
- Pipette tip illuminated internally via fiber optics
- Tool holder on microscope keeps pipette in focus during beveling
- Steel base for solid support of beveler & magnetic stands
- Includes stereo zoom microscope up to 90X
- Variable speed, reversible

**Benefits**
- Abrasive surface easily replaced by Diamond and Alumina Lapping Film
- Produce sharp tips in a short time – smooth 5400 RPM with a completely flat beveling surface

**Applications**
- Polishing patch pipettes
- Pipette tip calibration and microinjection

**Replaceable Abrasive Beveling Surface**
WPi’s MicroBeveler, unlike other solid-surface bevelers, has an abrasive surface that is easily refreshed. Instead of using a conventional, solid abrasive disk, the MicroBeveler abrasive surface is made of a high quality lapping film, widely used in the fiber optics industry. When the surface is damaged or loaded with glass particles, simply replace the abrasive film.

**Produce Sharp Tips Rapidly**
The solid polishing surface of WPi’s new MicroBeveler, turning at 5,400 rpm, provides sufficient cutting force for a very sharp tip in a very short time. The cutting surface is completely flat and turns smoothly, ensuring an undamaged tip.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEVELING SURFACE</td>
<td>3.5 inch diameter disk</td>
</tr>
<tr>
<td>ABRASIVE MATERIAL</td>
<td>alumina, diamond</td>
</tr>
<tr>
<td>SPEED OF ROTATION</td>
<td>100 to 5,400 rpm</td>
</tr>
<tr>
<td>MOTOR</td>
<td>Reversible Direction</td>
</tr>
<tr>
<td>POWER REQUIREMENTS</td>
<td>120 V, 60 Hz or 240 V, 50 Hz, 20 VA to supplied power supply</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td></td>
</tr>
<tr>
<td>BASE PLATE</td>
<td>8.7 × 11 × 0.4 in. (22 × 28 × 1 cm)</td>
</tr>
<tr>
<td>OVERALL HEIGHT</td>
<td>3 in. (8 cm)</td>
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<tr>
<td>SHIPPING WEIGHT (48000)</td>
<td>16 lb. (7.6 kg.)</td>
</tr>
<tr>
<td>SHIPPING WEIGHT (MBS)</td>
<td>35 lbs. (16 Kg.)</td>
</tr>
</tbody>
</table>

**ORDERING INFORMATION**

MBS  MicroBeveler System
Includes 48000 MicroBeveler, Z-LITE illuminator, fiber optic cable, PZMIII Stereo Zoom Microscope with tilting base especially adapted for use with MicroBeveler, two clear 20x eyepieces, one 20x eyepiece with reticle, tool holder and pipette holder F0IMPH.

SYS-48000  MicroBeveler

Beveling Surface: 3.5” diameter disk  Abrasive Material: alumina, diamond  Specify line voltage.

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>48015-03</td>
<td>Lapping Film, Alumina, 0.3 micron (50-pack)</td>
</tr>
<tr>
<td>48015-10</td>
<td>Lapping Film, Alumina, 1 micron (50-pack)</td>
</tr>
<tr>
<td>48015-30</td>
<td>Lapping Film, Alumina, 3 microns (50-pack)</td>
</tr>
<tr>
<td>48014-01</td>
<td>Lapping Film, Diamond, 0.1 micron (3-pack)</td>
</tr>
<tr>
<td>48014-10</td>
<td>Lapping Film, Diamond, 1 micron (3-pack)</td>
</tr>
<tr>
<td>48014-30</td>
<td>Lapping Film, Diamond, 3 microns (3-pack)</td>
</tr>
<tr>
<td>48025</td>
<td>Fiber Optic Cable for Pipette Illumination</td>
</tr>
<tr>
<td>15934</td>
<td>Replacement Beveler Disk Plate</td>
</tr>
<tr>
<td>48300</td>
<td>Tilt Base Assembly for PZMIII binocular head</td>
</tr>
<tr>
<td>48200</td>
<td>PZM Tool Holder</td>
</tr>
</tbody>
</table>
Glass Micropipette Beveler

Easier cell impalement results in less damage and longer cell life

**Features**
- Bevel tips on glass microelectrodes of one micron or smaller
- Mounted on precision magnetic plate
- Start-up kit includes 0.05 µm alumina abrasive powder 3531, “O” ring, wick electrode, and wick support.

**Benefits**
- Ease cell impalement and improve an electrode’s linearity
- Micropositioner is an option

**Applications**
- Produce sharply beveled tips on fluid-filled glass microelectrodes of 1 µm or less.

An optically-flat mirrored glass disk, wetted with an abrasive slurry, spins at 60 rpm (120 V), producing sharply beveled tips on fluid-filled glass microelectrodes of one micron or smaller.

**Ease Cell Impalement/Improve Linearity**
This eases cell impalement and improves the electrode’s linearity. The microelectrode's resistance can be monitored during beveling with WPI's Omega-Tip-Z™ megohm meter.

The beveler is permanently mounted on a precision magnetic plate that gives stable support for the optional 1350 M Micropositioner shown.

**Optional Micropositioner Available**
Model 1350M Micropositioner (shown with beveler above) is sold separately and includes WPI’s M3301R Manipulator and an M10 magnetic stand. The stand-manipulator assembly mounts directly onto the beveler baseplate, allowing convenient positioning of electrodes onto the beveling surface. Three axes of adjustment, including coarse and fine control in the axis of the electrode.

**ORDERING INFORMATION**
SYS-1300M Microelectrode Beveler & Start-Up Kit
MES includes: 1300 M Microelectrode Beveler; 1350 M Micropositioner & Magnetic Stand; Omega-Z; 5052 Steel Base Plate; 5468 Adapter; 3485 Ringstand Mount. Shipping Weight: 59 lb (27 kg) (micropositioner not included). Specify line voltage.

**OPTIONAL ACCESSORIES/REPLACEMENT PARTS**
2478 Replacement Mirrored Disk
3531 Alumina Abrasive, 0.05 µm (5 g) fine
3551 Alumina Abrasive, 0.30 µm (5 g)
2479 Replacement “O” Ring
SYS-Omegaz Omega-Tip-Z with Probe & Holder
1350M Micropositioner (M3301R) and M10 Magnetic Stand
711p Replacement Probe
5468 Adapter to connect metal microelectrodes to probe, 2 mm socket to .031 in. receptacle
Z-LITE Z-Lite Fiber Optic Illuminator (115 V, 60 Hz, beige case)
Z-LITE-Z Z-Lite Fiber Optic Illuminator (230 V, 50 Hz, black case)
500186 Bifurcated Light Guide with lenses
Z-LITE-Z186 Z-Lite Illuminator & Bifurcated Light Guide
MES Microelectrode Beveler System

**1300 M SPECIFICATIONS**

<table>
<thead>
<tr>
<th>BEVELING SURFACE</th>
<th>7.8 cm diameter, optically flat reflective glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM BEVEL</td>
<td>0.5 µm, I.D.</td>
</tr>
<tr>
<td>ALUMINA ABRASIVE</td>
<td>0.05 µm size supplied (0.3 µm also available)</td>
</tr>
<tr>
<td>RPM</td>
<td>60 rpm at 120 V, 60 Hz; 50 rpm at 240 V, 50 Hz</td>
</tr>
<tr>
<td>MOTOR</td>
<td>AC synchronous</td>
</tr>
<tr>
<td>POWER REQUIREMENTS</td>
<td>95-135 V or 220-240 V, 50/60 Hz</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>Steel base plate: 8.5 x 11 x 0.375 in. (22 x 28 x 1 cm)</td>
</tr>
<tr>
<td></td>
<td>Overall height: 4 in. (10 cm)</td>
</tr>
<tr>
<td></td>
<td>Height of abrasive surface: 2.75 in. (7 cm) above base plate</td>
</tr>
<tr>
<td>SHIPPING WEIGHT</td>
<td>20 lb (9.1 kg)</td>
</tr>
</tbody>
</table>
Micropressure System

Measure hydrostatic pressure in small vessels and oocytes

Features

- Utilizes a liquid filled micropipette (2–5 µm tip opening) for sensing pressure
- Pressure range from 1–100 mmHg (pressure range to 350 mmHg is available)
- Lower limit 1 mmHg (133 Pa)
- Includes calibration/test chamber
- Tubing and fittings for interconnecting system subcomponents are provided
- Pressure in the pipette can be manually set to positive or negative relative to the outside
- Probe holder for mounting on micromanipulator is included
- 10 pre-pulled pipettes are included

Benefits

- Measures biological pressures in very small liquid (aqueous) filled spaces
- Pre-configured pipettes are available for convenience

Applications

- Pressure in kidney tubules
- Embryonic blood pressure
- Intracellular pressure
- Mouse intracocular pressure

The 900A system is designed to measure liquid pressures dynamically in aqueous biological micro-environments, such as in kidney tubules or intracellular pressures. A liquid filled micropipette is used as a pressure probe, and pressure external to the pipette is measured at the tip. The outside diameter of the micropipette tip typically measures between 2–7µm. Pressure measurement is achieved by monitoring the pipette’s electrical resistance. The resistance changes according to changes in the pressure outside the pipette tip via displacement of an electrolyte concentration gradient. As the position of the concentration gradient changes, the resistance of the pipette changes. The resistance signal from the pipette is used as feedback to control a pressure source that applies pressure to the inside of the pipette to counterbalance pressure from the outside. The feedback loop forces the gradient to a neutral balance point, which is user-defined at atmospheric pressure beforehand. The internal pressure required to equally balance the external pressure to the neutral point is readily measured, and it is converted into an analog voltage available at the pressure output BNC and displayed numerically on the LED meter.

System Requirements:

The 900A requires stable sources of both pressure and vacuum, which are essential for the system to rapidly counteract changing pressures encountered at the pipette tip. Pressure and vacuum sources are not provided with the 900A instrument because some labs are already equipped with suitable sources of pressure and vacuum. For researchers who do not possess pressure or vacuum sources, a cylinder of compressed air or inert gas with a dual stage regulator serves very well as a pressure source. Vacuum must be very stable. It is often best supplied by a quality vacuum pump. WPI offers a very quiet continuous duty vacuum pump well suited for use with the system. In addition, a vacuum regulation kit is recommended to fine tune the vacuum source to the ideal level (900A-VAC).

A manometer or meter for independent pressure measurement is necessary to calibrate the pressure and vacuum sources, as well as for validation of the performance of the 900A system prior to experimental use. A pressure measurement device capable of measuring within a range of +300 mmHg and -150 mmHg is recommended (PM015D or PM015R).

For system performance validation at pressures well below 100 mmHg, the PM01D or PM01R is recommended, because it provides higher resolution at low pressure.

For transient response performance evaluation, a rapid burst of air or water pressure is required. WPI’s PV830 or PV820 series PicoPumps provide this capability. Rapidly occurring transient pressure measurements are typically captured on a data acquisition system. For details about testing and measurement of rapidly occurring pressure phenomena, contact a WPI sales representative for additional information.

References


SPECIFICATIONS

<table>
<thead>
<tr>
<th>PRESSURE RANGE</th>
<th>0–100 mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINEARITY</td>
<td>&lt; ±0.5% from a straight line</td>
</tr>
<tr>
<td>STABILITY</td>
<td>±0.1 mmHg up to 1 hour or more</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>±0.5% of full scale</td>
</tr>
<tr>
<td>RISE TIME</td>
<td>&gt;10 ms (10–90%), depending on residual volume</td>
</tr>
<tr>
<td>OUTPUT (“Pressure Signal”)</td>
<td>10 mV/mmHg</td>
</tr>
<tr>
<td>AMPLIFIER PROBE</td>
<td>Input Resistance &gt;1010Ω, Voltage Gain 1.0</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>17 x 5.25 x 10 in. (43.2 x 13.3 x 25.4cm)</td>
</tr>
<tr>
<td>Main Frame</td>
<td>3.7 x 1 x 2.25 in. (9.4 x 2.5 x 5.7cm)</td>
</tr>
<tr>
<td>POWER</td>
<td>110 VAC/220 VAC</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION

SYS-900A Micropressure System

System price includes a one-day technical training session at WPI in Sarasota, Florida. Specify line voltage

OPTIONAL ACCESSORIES/REPLACEMENT PARTS

900AP Replacement Probe
CAL900A Pressure Calibration Chamber
3491 Probe Extension Cable
2933 Rack Mount Kit
5332 Replacement Liquid Trap
MEH6RF Micropipette Holder (1.0, 1.2, 1.5 or 2.0 mm — Specify O.D.)
TIPTW900A Pre-pulled Micropipette for 900A (1 mm thin-wall, 2 µTip) (pkg of 10)
900APP Replacement Pressure Pod
SYS-PM015D Pressure Manometer (15 psi)
SYS-PM011D Pressure Manometer (1 psi)
801566 Vacuum Pump, 110V
801963 Vacuum Pump, 220V
900A-VAC Vacuum Pump Regulation Kit
Pressure Manometer
For measuring hydrostatic pressures

Features
- Measure vacuum and pressure in gases
- Ranges available: ±1 PSI, ±15 PSI, ±100 PSI
- Measure in PSI or kPa on the 100 PSI unit or PSI and mmHg on the 15 PSI unit
- Battery powered
- Includes tubing and mini-phone to BNC cable

Benefits
- Easy and accurate measurements

Applications
- Measure pressure of non-corrosive gases

Hand-held and battery operated, PM Series pressure manometers monitor vacuum and pressure in non-corrosive gases. An integral transducer and digital display allow easy and accurate pressure readings. Three versions measure pressures in the range of ±1 PSI, ±15 PSI or ±100 PSI. A range switch allows measurement in units of PSI or kPa for the 100 PSI version, and PSI or mmHg for the 15 PSI version. Pressure can be read on the built-in LCD display or relayed to a chart recorder, oscilloscope, or computer.

PM Series pressure manometers come with 4 feet of 1/8-inch ID soft vinyl tubing. A mini-phone-to-BNC cable for the recorder output is also available (CBL102). Standard versions are equipped with a nine-volt alkaline battery.

<table>
<thead>
<tr>
<th>PRESSURE MANOMETER SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM01</td>
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<tr>
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ORDERING INFORMATION
- SYS-PM01D Pressure Manometer (1 psi)
- SYS-PM01R Pressure Manometer (1 psi), Rechargeable*
- SYS-PM015D Pressure Manometer (15 psi)
- SYS-PM015R Pressure Manometer (15 psi), Rechargeable*
- SYS-PM100D Pressure Manometer (100 psi)
- SYS-PM100R Pressure Manometer (100 psi), Rechargeable*
- CBL102 Mini-Phone-to-BNC Cable

*Rechargeable versions come with nickel/cadmium battery and charger