

Laboratory Equipment 2011

Muscle Physiology 2

Blood Pressure Measurement ● Stereotaxic Instruments
Animal Temperature Controller ● Microprobe Thermometers

Epithelial Physiology 18

Epithelial Voltohmmeter ● TEER Measurement ● Ussing System
Perfusion System Glass Bottom Culture Dishes

Microdissecting, Microsurgery. 30

Scissors ● Tweezers ● Ear Punches ● Vessel Clips ● Mouse
Surgery Kit ● Electrosurgical Unit ● Cautery Instruments

Animal Surgery & Support 42

EZ Systems ● Analgesia ● Stereotaxic ● Monitoring

Biosensing 62

Nitric Oxide Detection ● Ion Selective Electrodes ● Oxygen
Detection ● pH meters

Amplifiers, Electrometers 83

Intracellular ● Extracellular ● Transducer
Metal Microelectrodes ● Voltage/Current Clamps.

Stimulators. 106

Digital Stimulators ● Multi-Channel ● Linear Stimulus Isolator
● High Current Isolator

Glass, Holders, Electrodes 117

Capillary Glass ● Electrode Holders ● Metal Microelectrodes
● MicroFil Non-metallic Syringe Needles

Laboratory Supplies 130

Adhesives ● Cables & Connectors ● Metal Wire ● Luers &
Fittings ● Laboratory Bases, Rods, and Clamps

Micromanipulators, Stands 144

Manual & Motorized Micropositioners ● Magnetic Stands
● Tilting Base

Microscopes, Cameras. 160

Surgical, Stereo, and Inverted Microscopes ● Cameras
● Illuminators ● Heater Controller ● Culture Dishes

Microforges, Pullers. 174

Pullers ● Bevelers ● Microforges

Pumps, Microinjection 181

Peristaltic, Syringe, and Pneumatic Pumps ● Microprocessor
Controlled Injector

Spectroscopy 205

Spectrometers ● Sample Cells ● Light Sources ● Fiber Optic Cables
● Fiber Optic Dipping Probe

Index. 224

Ordering Information, Terms & Conditions 232

Muscle Physiology

Scientific Instruments Heidelberg, a World Precision Instruments company, offers a comprehensive line of muscle physiology products. Contact your local WPI office or distributor for more information.

Modular Systems for All Your Muscle Studies

Types of Studies

The SIH product line has solutions for cellular, tissue, and whole muscle studies, including skinned muscle fiber preparations. We also have an instrument for long-term culture/preservation of intact muscle. All common myomechanical studies in muscle can be performed, such as isometric and isotonic contractions, eccentric contractions in skeletal muscle and after-loaded contractions in cardiac muscle. In addition, optical techniques are available for measuring sarcomere spacing, intracellular calcium, and myosin ATPase activity concurrently with the mechanical studies. Automated force-pCa studies are possible, as are measurements of membrane potential and oxygen tension/consumption.

Features

SI-H systems are modular in design and easily expandable wherever your research or applications may take you. The foundations of the systems are indestructible, optical force transducer (KG series) and temperature-controlled tissue cuvette assemblies. The systems can be simple or sophisticated standalone systems. Also, there are systems that can be adapted to inverted microscopes for fiber or even single cell work. A linear motor expands the scope of mechanical studies. Optical components provide ultrastructure information on sarcomere spacing, calcium or ATPase activity in the muscle fiber. Most components are sold separately so you can customize your existing system or build your own research setup.

Overview of SI-H Research Platforms	4
Basic Muscle Tester	5
KG Optical Force Transducers	6
MKB Muscle Research System	7
OPT Muscle Research System	8
Isolated Perfused Organ System	9
Langendorff Isolated Perfused Heart System	10
Neely Isolated Working Heart System	11
Compact Langendorff	12
Vertical Tissue Bath	14
Biotester 5000 Biaxial Test System for Biomaterials	16
MicroSquisher Micro-Scale Compression System	17
MechanoCulture Strainable Substrate for Culturing Cells	17

SI-H Systems Offer Choices and Convenience

Intact muscle strips—The **Muscle Tester (MT)** is the all-round system of choice for all mechanical studies on intact muscle (skeletal, cardiac, or smooth) that do not require simultaneous optical measurements. The muscle tester allows simultaneous recording of membrane potential and signals from other electrodes or sensors in the bath. The system can come with a complete muscle data recording and analysis system (**DAS**) or a hardware adapter (**MACP**) to connect to your own data acquisition system.



Intact muscle strips and skinned muscle fibers—If you are planning to extend your research into the molecular mechanisms and biochemistry of force development on actin-myosin interaction or the study of ancillary proteins such as troponin or titin, then the **MKB Muscle Research System** is your choice. This is the most stable platform for advanced, precision and sensitive measurements. With the optional calcium gradient system (**GRDM**) and calcium photometry, you can perform very accurate force-pCA curves in very small volumes down to 500 μL . The cuvette system can also be cooled to allow accurate Q10 studies while better preserving the sarcomere ultrastructure.



If your research involves actual measurement of the ATPase activity via fluorescence or intracellular calcium in intact skeletal or cardiac muscle strips, trabeculae or papillary muscle, the **OPT Muscle Research System** is the platform of choice. This system offers an optimized light path design and special cuvettes for precision imaging and photometry

in combination with the mechanical studies in both intact and skinned fibers. Both systems are stand-alone platforms with complete data acquisition and analysis (**DAS**).

Long term culture of muscle fibers—The **Long-term Muscle Culture System (LTMT)** allows you to keep intact muscle fibers from skeletal or cardiac muscle alive and working for up to one week. The system allows all the mechanical tests and calcium imaging to be performed on the muscle in a sterile, gassed, closed, controlled environment.



Protein exchange, viral transduction and RNA interference studies on muscle are now possible in a cost-effective system. Application specialists can help you discuss what can and has been done with this system. Contact us for details and to discuss your application.

Single muscle cell studies—The combination of a very sensitive optical KG force transducer and a micro-piezo nanomotor makes studies on single muscle cells possible. In the Cell Tester, a dual remote controlled microtweezer system with special biocompatible coating allows cells to be grasped and manipulated as if they were large fibers or cell clusters. The system is meant to be integrated



on two micromanipulators and an (inverted) compound research microscope. The pair of microtweezers or microplates with tip sizes down to 20 μm , are embedded in a pN-sensitive transducer on one side of the system and piezo-based nanomotor on the other that can be moved with 20nm precision. External computer control allows you to design length change protocols and to measure optical responses such as confocal calcium or other live cell functional markers. Contact us for details and to discuss your application.

Accessorize all of our systems—The KG force transducers with different ranges are inter-exchangeable among all platform and amplifiers. All cuvette systems are heat controlled to 34-40°C or have a cooling option down to 5°C or any temperature in between.

Overview of SI-H Research Platforms

SI-H research platforms cover a broad range of muscle physiology experiments, from single cell platforms to whole organ perfusion systems. While the cost of a platform may vary dramatically depending on the options

chosen, this overview is designed to present the variety of options available. Our staff physiologists are available to discuss your specific needs and design a system with the options you need.

SI-MT Basic Muscle Tester Platform (choose from one of three cuvettes)

The systems include: Base plate with force transducer holder, force transducer with tissue mounting supports and calibration stand, bridge amplifier with temperature control, microscope with mounts, cuvette with stand, oxygenation and vacuum systems, digital micrometer

Part Number	System Description	Variations	Optional Kits
SI-MT-L	Muscle tester long bath - For recording isometric contractions from intact muscles, muscle fibers and muscle rings	Includes long cuvette	<ul style="list-style-type: none"> Muscle perturbation studies with linear motor an motor control units Sarcomere length detection
SI-MT-S	Muscle tester short bath/recirculating - For recording isometric contractions from intact muscles, muscle fibers and muscle rings	Includes short cuvette	<ul style="list-style-type: none"> Small-volume cuvette with recirculation feature Data acquisition
SI-MT-O	Muscle tester optical cuvette bath - For recording isometric contractions from intact muscles, muscle fibers and muscle rings	Includes optical cuvette (with window)	<ul style="list-style-type: none"> Field stimulation Linear motor action control panel

SI-MKB Standard Muscle Research Platforms with Micrometer

The systems include: Base plate with force transducer holder and microscope stand, cuvette table, cuvette and vacuum system, digital micrometer and stand, force transducer with tissue mounting supports, bridge amplifier with temperature control, microscope and stand

Part Number	System Description	Variations	Optional Kits
SI-MKB-OXY	System for intact muscles and fibers with heated cuvette, digital micrometer	Includes standard cuvette	<ul style="list-style-type: none"> Data acquisition Field stimulation
SI-MKB-WIND	System for intact muscles and fibers with heated optical cuvette (with window), digital micrometer	Includes optical cuvette (with window)	<ul style="list-style-type: none"> Sarcomere length detection (SI-MKB-WIND only)

SI-MKBM Standard Muscle Research Platforms with Linear Motor

The systems include: Base plate with force transducer holder and microscope stand, cuvette table, cuvette and vacuum system, motor holder, force transducer with tissue mounting supports, bridge amplifier with temperature control, microscope and stand, linear motor, anti-oscillation unit and stand, motor control unit

Part Number	System Description	Variations	Optional Kits
SI-MKBM-OXY	Myomechanical study of intact muscles and fibers with heated cuvette, linear motor	Includes the standard cuvette	
SI-MKBM-WIND	Optical study of intact muscles and fibers with heated optical cuvette (with window) for sarcomere length studies	Includes optical cuvette (with window)	<ul style="list-style-type: none"> Data acquisition
SI-MKBM-LLCUV	System for intact or skinned fibers in a laser level cuvette with linear motor	Includes the laser level cuvette	<ul style="list-style-type: none"> Field stimulation Sarcomere length detection (SI-MKBM-WIND only)
SI-MKBM-CUVA/B	System for skinned fibers in multiple vessels with linear motor	Includes Teflon cuvette inserts and a circulating water bath	<ul style="list-style-type: none"> pCa-Force Measurements with Automated Gradient method (SI-MKBM-LLCUV only)
SI-MKBM-DUO	Semi-rapid system for temperature jump studies of intact muscles and fibers, with 2 cuvettes (1 heated, 1 cooled) and linear motor	Includes a Peltier cooling circuit	
SI-MKBM-TJUMP	Rapid System for Skinned Fibers at Different Temperatures with Linear Motor (Rapid, < 250ms temperature jumps)	Includes a Peltier cooling circuit	

SI-MB Tissue / Organ Bath Systems

The systems include: Base plate and frame, tissue chamber assemblies, buffer reservoir assemblies, single plane manipulators, tissue holders and vascular ring hooks, force transducers and bridge amplifiers

Part Number	System Description	Variations	Optional Kits
SI-MB4	4 Chamber Modular Tissue Bath System		<ul style="list-style-type: none"> Data acquisition
SI-MB8	8 Chamber Modular Tissue Bath System	System comprised of two SI-MB4 systems	<ul style="list-style-type: none"> Circulating water bath Stimulator

SI-LANG Isolated Perfused Organ Systems

The systems, except for the SI-LANGC, include: Table with base plate, shelf, sink, console, perfusion buffer column, glass overflow tube, Teflon tap valve, pressure sensor holders (2), oxygenation bubbler set, oxygenation pressure equalizer set, peristaltic pumps (2), circulating water bath, pressure transducer cables, latex balloons

Part Number	System Description	Variations	Optional Kits
SI-LANGWH	Perfused Working Heart (Langendorff Neely)	Includes heart suspension unit, heart chamber, lung column, elastic chambers (2), cannulas, afterload regulation adapter, basic analog flow meter	<ul style="list-style-type: none"> Unipolar or bipolar manipulator Temperature probe Monopolar action potential sensor
SI-LANG1	Langendorff Isolated Perfused Heart, Retrograde perfusion, single buffer column	Includes heart suspension unit, heart chamber, a heater, spindle syringe (cannula, tube, syringe)	<ul style="list-style-type: none"> Data acquisition
SI-LANG2	Langendorff Isolated Perfused Heart System, dual buffer column	Includes heart suspension unit, heart chamber, a heater, spindle syringe (cannula, tube, syringe)	<ul style="list-style-type: none"> Inline flow sensor and meter Pressure transducer and temp probe amplifier
SI-LANGC	Compact Langendorff & Isolated Heart System, compact buffer reservoirs	Includes Compact system with constant pressure controller and temperature controller, peristaltic pumps, pressure transducer with cables, latex balloons.	<ul style="list-style-type: none"> Force transducer and amplifier Biopotential amplifier Stimulator
SI-IOPKIDNEY	Isolated Perfused Organ (Kidney) System	Includes temperature controller	<ul style="list-style-type: none"> Data acquisition Inline flow sensor and meter Perfusion Bath for liver of mesentery

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

Basic Muscle Tester

The Muscle Tester is a convenient platform for all standard mechanical experiments on intact muscle preparations. The system can be equipped with any one of five different **KG optical force transducers** over ranges that are as high as 0–2N and sensitivities as low as to 1 μ N. Transducers come with interchangeable tissue holders designed for general or specific applications on skeletal, cardiac or smooth muscle, with or without tendons attached. The bridge amplifier (**SI-BAM21LC**) has integrated heat control for one of three possible perfusion cuvettes. The basic system can be used for isometric force measurement with direct point stimulation of the muscle through the transducer and mounting supports. Field stimulation is also possible. A very fast linear motor (**SI-MOTTEST**) can be added to replace the standard digital micrometer. When the motor is used in combination with one of the available motor control units, various studies can be performed on muscles that include:

- **Isotonic contractions**
- **Constant load**
- **Force-velocity**
- **Isometric contractions**
- **Length-tension**
- **Slack test**
- **Quick stretch-release**
- **Constant velocity**
- **Afterload**
- **Vibrations (sinusoidal/muscle stiffness).**

The Muscle Tester can be equipped with a complete data acquisition and analysis package (**SI-DAS**) for muscle physiology and mechanics. Alternatively, a hardware control device (**SI-MACP**) allows you to perform all tests while recording the data on your own data acquisition system. The Muscle Tester can also be equipped with either of two laser based detectors for determining sarcomere spacing (**SI-SARCSCR** or **SI-SARCCAM**).

The MT system is a stable platform for conducting mechanical muscle studies. It is a complete turnkey system with a modular design that is constructed with corrosion-free materials (stainless steel, anodized aluminum, plastic).

SI-MT-L	Muscle Tester — Long Cuvette
SI-MT-S	Muscle Tester — Short Cuvette
SI-MT-O	Muscle Tester — Cuvette with Optical Window
System includes: Base platform, transducer holder, digital micrometer, peristaltic pump, one KG force transducer, a set of tissue mounting supports, bridge amplifier, temperature controller, binocular scope, oxygenation/vacuum system and choice of a long (L), short (S) or optical (O) cuvette with a window (for use with the laser-detection system)	
OPTIONAL COMPONENTS	
SI-MOTTEST	Linear motor with power amplifier
SI-AOSU	Anti-oscillation unit (Eliminates resonance frequency from measurement)
SI-LCU	Length control unit for slack test, quick stretch/release, constant velocity
SI-COLU	Constant load unit, isotonic contractions
SI-ERG	Ergometer unit for after loaded contractions (e.g., heart muscle)
SI-VIBU	Vibration Unit (vibration, stiffness and sinusoidal studies)
SI-DAS	Data acquisition/analysis system (controls stimulator and all length devices)
SI-MACP	Motor Action Control Panel (motor control when using your own DAQ)
SI-SARCSCR	Laser based sarcomere spacing, manual
SI-SARCCAM	Laser based sarcomere spacing with linear camera, electronic >250Hz



**Modular
Flexible
Expandable**

Key Experiments

- **Measure isotonic force and the effects of constant load**
- **Measure Isometric force and myomechanical properties**
- **Analyze twitch kinetics and determine parameters like time to peak, half-maximal velocities, Starling curves**
- **Control stretch and release velocities to perform slack, quick stretch-release, constant velocity, and eccentric contraction tests**
- **Measure afterloaded contractions from cardiac muscles**
- **Conduct vibrational studies to simulate unloaded muscle shortening**
- **Determine sarcomere length and spacing using a laser-based system**

MUSCLE TESTER SPECIFICATIONS

FORCE	0-10, 20, 50, 500mN, 2N
MOTOR	7mm range, 200 μ m/s speed 1.5N pull force indefinitely, 100N for 20ms
MICROSCOPE	4.5-45x (specify objective) Binocular or Trinocular scope

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

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KG Optical Force Transducers

— lifetime warranty

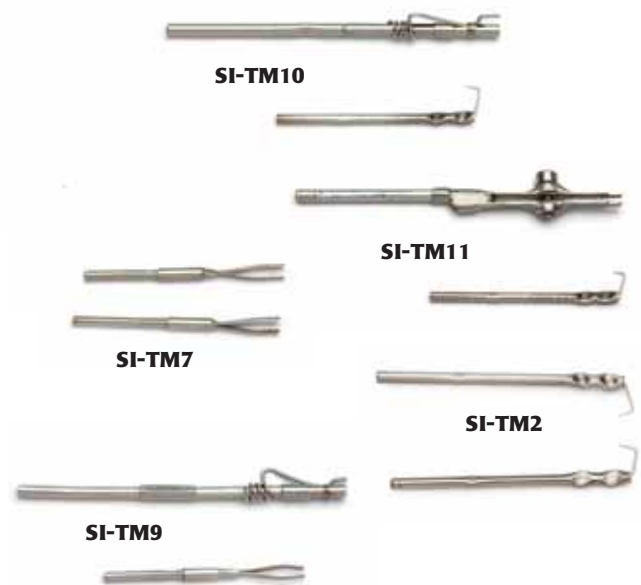
- A force transducer series with a range and sensitivity from the pN to tens of newton range
- Nearly insensitive to temperature and light
- Extremely linear
- Virtually indestructible with normal use

Different transducer bodies can be exchanged and set and zeroed to the same bridge amplifier at the touch of a button. After a simple calibration with an appropriate weight, the system is ready for use.

TRANSDUCER SPECIFICATIONS

Unloaded transducer without tissue mounting support

	Force Range	Range	Noise	Compliance (nm/mN)	Resonance Frequency
SI-KG2	0-2 N	0-200 g	250 μ N	150	1.3 kHz
SI-KG2A	0-0.5 N	0-50 g	300 μ N		
SI-KG4	0-50 mN	0-5 g	15 μ N	0.5	1.2 kHz
SI-KG4A	0-20 mN	0-2 g	4 μ N	1	1.2 kHz
SI-KG7	0-5 mN	0-0.5 g	0.2 μ N	10	250 Hz
SI-KG7A	0-5 mN	0-0.5 g	0.4 μ N	5	500 Hz
SI-KG7B	0-10 mN	0-1.0 g	1 μ N	1.5	550 Hz
SI-KG20	0-0.2 N	0-20 g	80 μ N		590 Hz
SI-KGxx	contact us for specialty transducers with different ranges.				



Mounting Supports include a choice of hooks, baskets, tweezers for general purpose, skeletal (with/without tendon), smooth muscle and cardiac muscle (papillary/trabeculae) fibers. Contact WPI for a list of current supports.

Optical Force Transducer Amplifier



SI-BAM21-LC Optical Transducer Amplifier, Single Channel
MT/MKB/OPT/MB/LANG



BAM21-LC SPECIFICATIONS

INPUT CONFIGURATION	Current to voltage converter
GAIN	1x, 2x, 5x, 10x — Switch selectable
OUTPUT IMPEDANCE	100 Ω
POWER	12 VDC at 3 A (wall adaptor)
OUTPUT RANGE	0-10 V

The BAM21-LC is also available as a module for the new Signal Conditioning Amplifier System — see page 94.

MKB Muscle Research System

The **MKB** is the standard muscle research system designed for use primarily on intact living muscle preparations. The system combines the versatility of the sensitive KG optical transducer series with a solid platform on which mechanical and optical measurements can be performed. The MKB system can also be used for skinned muscle fiber preparations held at different temperatures or concentrations of buffers for various periods of time. The MKB platform can be equipped to span nearly the entire muscle physiology field and its wide range of applications that include quickly moving intact or skinned fibers between different solutions or temperatures. It can be equipped with a single optical device, like a photometer or a laser diode, and a linear motor and controller.

Like the MT and the OPT systems, the MKB system MKB is complete turnkey system with a modular design that is constructed with corrosion-free materials (stainless steel, anodized aluminum, plastic).

MKB systems include: Base platform, transducer holder, motor holder, cuvette table, cuvette(s), microscope holder, and vacuum system. (Does not include: transducer, bridge amplifier, microscope, temperature controller, linear motor, motor control unit, or data recording system).



FOR INTACT MUSCLE PREPARATIONS

SI-MKBM-OXY	System with Heated Cuvette & Motor
SI-MKBM-WIND	System with Heated, Optical Cuvette & Motor
SI-MKBM-DUO	System with Two Cuvettes (one heated, one cooled) & Motor
SI-MKB-OXY	System with Heated Cuvette & Micrometers
SI-MKB-WIND	System with Heated, Optical Cuvette & Micrometers

FOR SKINNED MUSCLE FIBER PREPARATIONS

SI-MKBM-CUVA/B	System with multiple heated cuvette wells & Motor
SI-MKBM-TJUMP	System with multiple cuvette wells at three different temperatures & Motor
SI-MKBM-LLCUV	System with laser leveled cuvette for sensitive force measurements or calcium gradients & Motor

MKB systems use some of the same components that are used on MT systems: Linear motor with power amplifier (**SI-MOTTEST**); anti-oscillation unit (**SI-AOSU**); motor control units (**LSI-CU**, **SI-COLU**, **SI-ERG**, **SI-VIBU**); laser-based sarcomere spacing unit (**SI-SARCSR**, **SI-SARCCAM**); data acquisition unit and software (**SI-DAS** & **SI-MUSCLEDATA**); motor action control panel (**SI-MACP**).

KEY EXPERIMENTS

- Measure intact muscle responses to electrical stimulation, including tetanizing frequencies.
- Measure myomechanical properties of contracting and relaxing muscle strips.
- Measure isotonic force and the effects of constant load
- Measure and analyze twitch amplitude and kinetics, including: time to peak, half maximal contraction and relaxation times and velocities, startling curves, and diastolic force development.
- Control stretch and release velocities to perform slack, quick stretch-release, constant velocity, and eccentric contraction tests
- Measure afterloaded contractions from cardiac muscles
- Conduct vibrational studies to simulate unloaded muscle shortening
- Conduct quick temperature-change experiments on skinned and intact muscle fibers
- Determine sarcomere length using laser diode diffraction as muscle force is also being measured.
- Conduct force-pCA studies and acquire background information with a automated calcium gradient maker (GRDM). These determinations can be combined with calcium measurement.

Optical Measurements from Muscles using SI-H Research Systems

Sarcomere Length and Spacing

Two options, SARCSCR or SARCCAM:

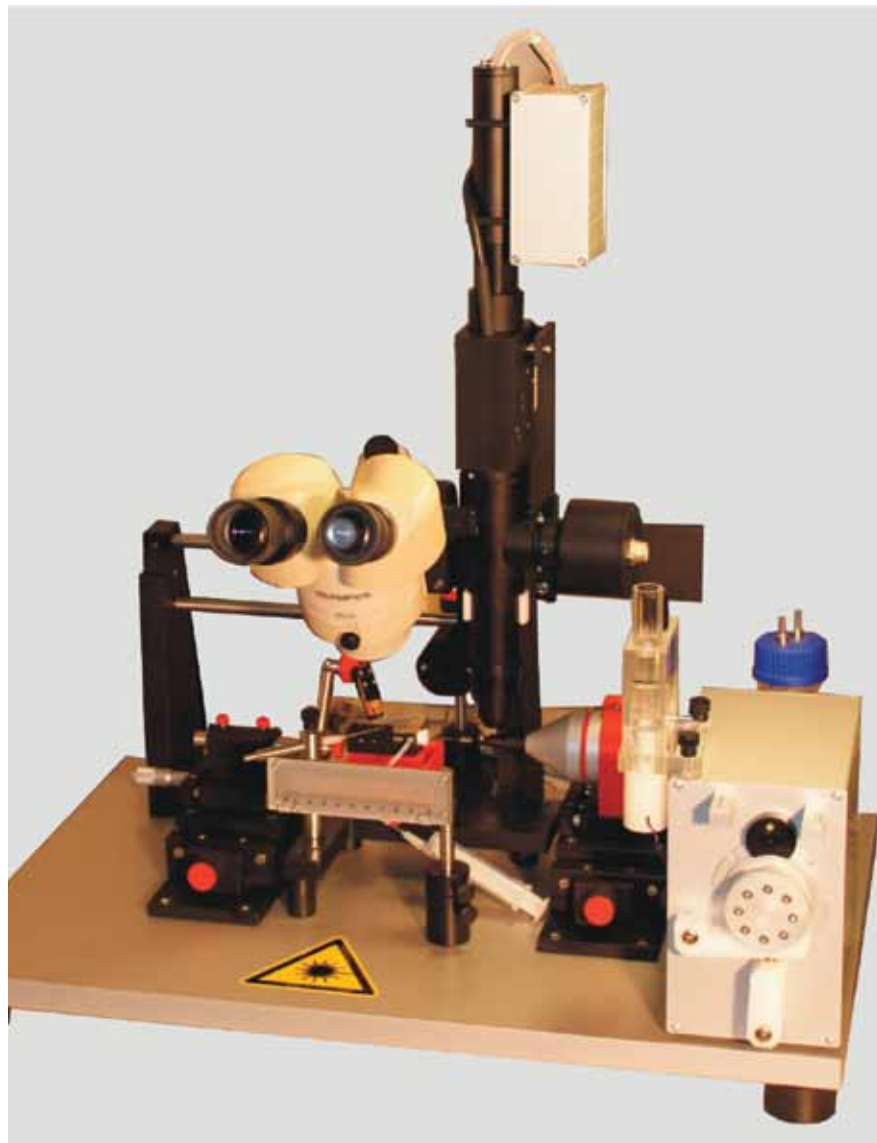
- Use either with MT, MKB, or OPT muscle systems on intact muscle fibers
- Use either with MKB or OPT muscle systems on skinned muscle fibers.
- Use either with any system while myomechanical parameters are measured.
- Use either with MKB or OPT system while doing calcium imaging .
- SARCSCR system uses a screen to display and measure the diffraction pattern of the light.
- SARCCAM system uses a linear diode array detector and a calibrated controller to detect the laser diffraction pattern.
- SARCCAM with optional PICO unit stores and records the Gaussian distribution of sarcomere lengths.
- Pico unit recommended when measuring changes in calcium concentration at temperatures above 5°C.

ATPase Activity

- Used on skinned muscle fibers.
- Measures the increase in ATPase activity by measuring the decrease in fluorescence of NADH with a photometer. NADH is a component involved in the binding and release of crossbridges in the myofibrils.
- ATPase activity system includes: the UV light source; photometer; and a cuvette of the appropriate size for the skinned fibers being examined.
- Optional automatic gradient maker for conducting pCa-ATPase and pCa-force studies can be added to the system.

Intracellular Calcium Concentration

- Used on intact muscle fibers.
- Measures the change in the intracellular calcium concentration in muscle fibers that occurs when the sarcoplasmic reticulum releases calcium that is required for the binding of myosin and actin in myofibrils.
- SIH calcium imaging system compensates for the concentration and distribution of dye in the cells.
- Uses quickly (<75us) alternating wavelengths of incident light.
- Can easily be adapted for use on ZEISS or OLYMPUS inverted microscopes.



OPT Muscle Research System

The **OPT Muscle Research System** is primarily designed for advanced optical measurements on intact and skinned muscle fibers under precise mechanical control. The system has excellent mechanical stability and can be equipped with multiple optical devices, like photometers and laser diodes, and linear motors and ultra-sensitive force transducers. The system is also versatile enough to be used for intact muscle studies. It is recommended that this system be placed on a vibration isolation table or very stable platform.

The OPT system is a complete turnkey system with a modular design that is constructed with corrosion-free materials (stainless steel, anodized aluminum, plastic).

For information on system configurations and pricing, please contact our staff physiologists.

Isolated Perfused Organ System



The Isolated Perfused Organ (IPO) system is designed as a perfusion system for isolated, small mammalian organs like the kidney, liver or mesenteric bed.

The **SI-IPOKIDNEY** system is designed for *in vitro* investigations of the perfused kidney of small laboratory animals like mice, rats, hamsters, guinea pigs and rabbits. An optional perfusion chamber for liver and mesenteric bed (gut) is also available.

During experiments, the artery of the organ is cannulated and perfused with a buffer solutions using either constant pressure or constant flow mode. Then, you can measure the changes in the perfusion pressure. If desired, the effluents can be collected for biochemical analysis.

Features

- Constant flow and constant pressure modes
- Can be equipped to measure perfusion pressure, arterial flow and buffer temperature
- Perfusion pressure up to 120mmHg
- Maintain buffer temperature with water-jacketed reservoir
- Lubricant-free Teflon taps
- External circulating water bath for the buffer reservoir

- Internal heater/controller for the organ bath
- Supplementary thermostat in the organ bath
- Constant oxygenation of the buffer

Perfusion Chamber

Each perfusion chamber has an organ holder, water bath, heater, vaporizer, perfusion inlet and outlet, thermosensor port, supplementary thermostat, mesh organ fastener, acrylic lid, and blood vessels and ureter ports.

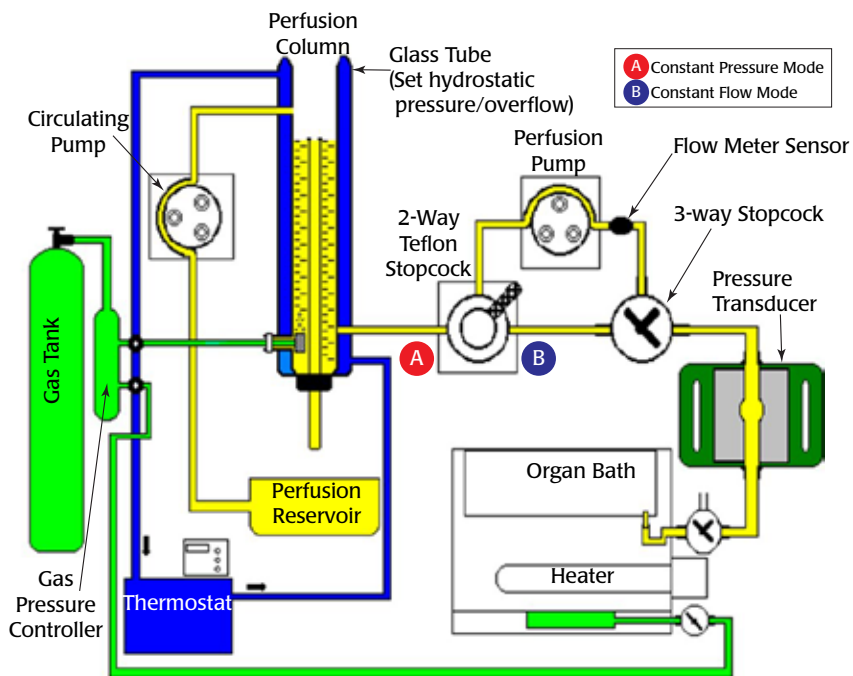


The perfusion chamber, the most critical part of the system, has autonomic thermoregulation. The system is equipped with a kidney chamber. A liver/mesenteric bed chamber is optional.

Optional Accessories

The following accessories may be added to complete your system:

- Pressure transducer
- Temperature probe
- Bridge amplifier
- Flow sensor and monitor
- Ball-mounted stimulating and recording electrodes
- Data acquisition system
- Stimulator
- Peristaltic pump
- Circulating water bath
- Liver/gut perfusion chamber



ISOLATED PERFUSED ORGAN SYSTEM

SI-IPOKIDNEY Isolated Perfused Organ (Kidney) System

Included: Heated tissue bath • Table with base plate • Console • Perfusion buffer column • Glass overflow tube • Pressure sensor holder • Oxygenation bubbler set • Oxygenation pressure equalizer set • Silicone tubing set, cables, accessories • Peristaltic pumps (2) • Circulating water bath • Pressure transducer with cable

Requires two channels of Bridge/Transducer amplification

OPTIONAL COMPONENTS

SI-LF-05-01-IPO Alternate Tissue Bath for Liver or Mesenteric Bed

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

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Langendorff

Isolated perfused heart system



The **SI-LANG1** and **SI-LANG2** isolated perfused heart systems were developed for *in vitro* investigations of the hearts of small animals according to the methods originated by Oscar Langendorff. The system can be configured easily to perform many of the common methods used to study isolated hearts. Supplementary devices, like a special ECG sensor or a constant flow/pressure device, can easily be added to the system.

Features

- Retrograde perfusion of isolated hearts from mouse, rat, guinea pig, hamster and rabbit
- Measurements in constant pressure or constant flow mode on the same device
- Equipped with two columns for using different buffers
- Capable of recording aortic pressures as high as 120mmHg
- Equipped for measuring left ventricular pressure (LVP)
- Ports in the system are available for measuring pressure, flow, temperature and surface potentials, and for the infusion or injection of drugs
- Continuous filling of buffer columns with use of a pump
- Continuous oxygenation of buffers
- Water-jacketed system for precise temperature control

The Langendorff system is designed as a perfusion system for isolated, small mammalian hearts. Some special features of this system include the stainless steel sink, the small reeling pump and specially designed two-way Teflon taps.



LANGENDORF SPECIFICATIONS

WIDTH	600 mm
LENGTH	800 mm
HEIGHT	2550 mm
WEIGHT	80 kg

LANGENDORF SYSTEMS

SI-LANG1	Langendorff Isolated Perfused Heart System, Single Buffer Column
SI-LANG2	Langendorff Isolated Perfused Heart System, Dual Buffer Column

Included: Table with base plate, shelf, sink • Console • Perfusion buffer column • Glass overflow tube
Teflon tap set • Heart suspension unit • Heart chamber • Spindle syringe • Pressure sensor holders (2) • Oxygenation bubbler set • Oxygenation pressure equalizer set • Latex pressure balloons for left ventricular pressure (LVP) catheter • PeriStar Pro 2-channel peristaltic pumps (2) • Circulating water bath • Pressure transducers with cables (2)

Requires two channels of Bridge/Transducer amplification

OPTIONAL COMPONENTS

SI-SEN12AM4E-U	Manipulator with Removable Head (Unipolar)
SI-SEN12AM4E-B	Manipulator with Removable Head (Bipolar)
SI-SEN07RTH2	Buffer Temperature Sensor
SI-SEN13MAP	Monopolar Action Potential Sensor

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

Neely

Isolated working heart system



The **SI-LANGWH** isolated working heart system was developed for *in vitro* measurements of the mechanical activity and work performed by hearts from small animals according to the methods devised by J. R. Neely, *et al.* This system is designed with a combination of features from both the classic Langendorff (non-working) and the Neely (working) systems.

Features

- For use on small mammalian hearts (mouse, rat, guinea pig, hamster and rabbit)
- Working (Neely) and non-working (Langendorff) options in the same device
- Control of the left ventricular diastolic pressure (LVDP), coronary flow and cardiac output by variation of the left atrial filling pressure and the hydrostatic pressure in the aorta
- Measurement of the heart rate, atrial and ventricular pressure and cardiac output
- Ports for drug administration
- Pacing of the heart is possible
- Special ECG sensor available
- Tissue easily removed for biochemical investigations

The Neely system is designed as a perfusion system for isolated, small mammalian hearts. Some special features of this system include the stainless steel sink, the small reeling pump and specially designed two-way Teflon taps.

NEELY SPECIFICATIONS

WIDTH	600 mm
LENGTH	800 mm
HEIGHT	2550 mm
WEIGHT	80 kg

NEELY SYSTEM

SI-LANGWH Langendorff Neely Perfused Working Heart System

Included: Table with base plate, shelf, sink • Console • Perfusion buffer column • Glass overflow tube • Lung column • Elastic chambers (2) • Teflon tap valve • Heart suspension unit w/cannulas • Heart chamber • Pressure sensor (2) • Oxygenation bubbler set • Oxygenation pressure equalizer set • After load regulation adapter • Basic analog flow meter • PeriStar Pro 2-channel Peristaltic Pumps • Circulating Water Bath • Pressure Transducers with Cables (2)

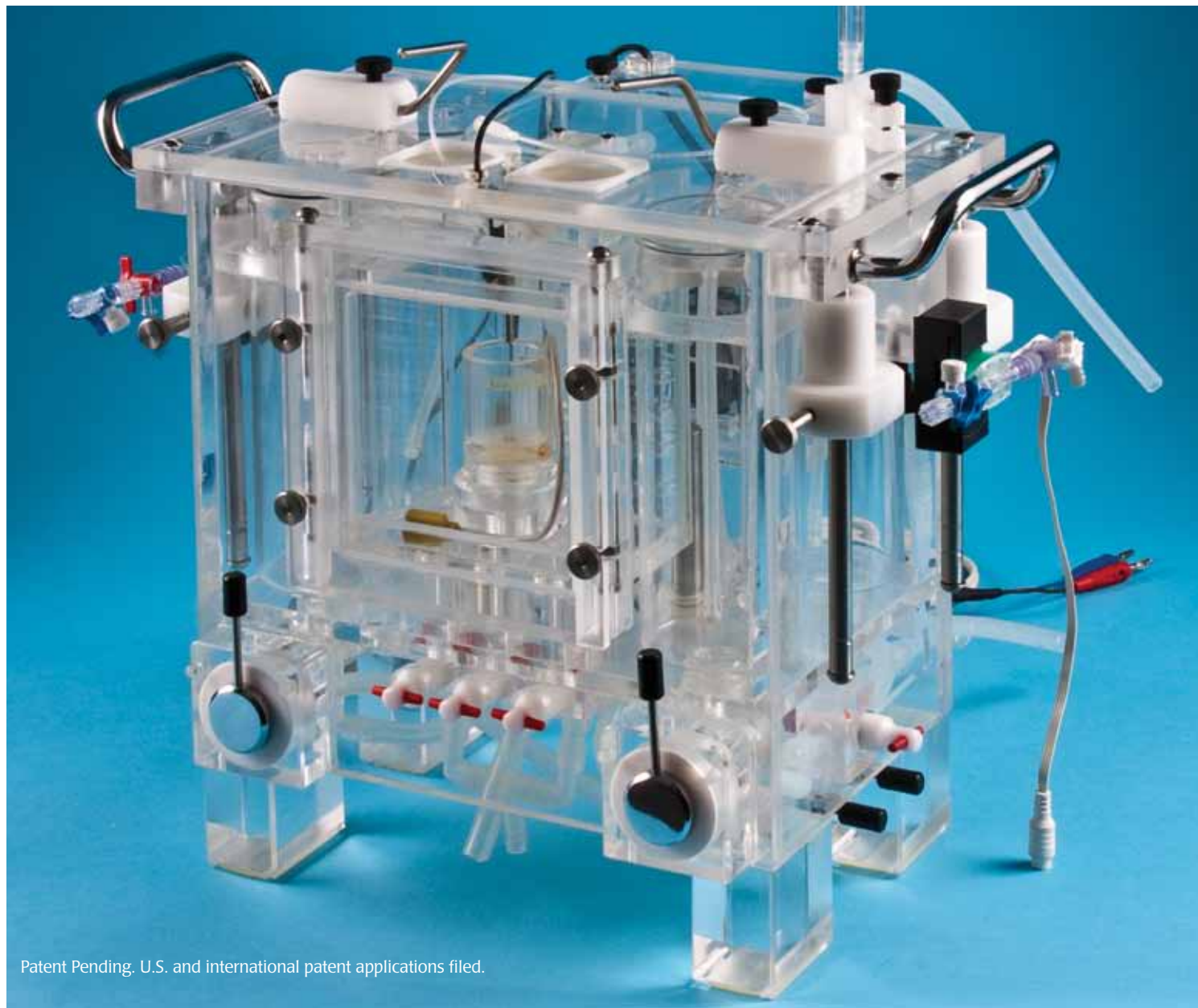
Requires two channels of Bridge/Transducer amplification

OPTIONAL COMPONENTS

SI-SEN12AM4E-U	Manipulator with Removable Head (Unipolar)
SI-SEN12AM4E-B	Manipulator with Removable Head (Bipolar)
SI-SEN07RTH2	Buffer Temperature Sensor
SI-SEN13MAP	Monopolar Action Potential Sensor

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

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Patent Pending. U.S. and international patent applications filed.

Compact Langendorff

Miniature system for isolated, perfused heart/ischemia reperfusion studies

The Compact Langendorff system was developed for *in vitro* investigations of the hearts of small animals in constant pressure and/or flow modes. Even though the system occupies a small amount of bench space, it contains all the features of non-working (Langendorff) and working perfusion systems in a single, compact, thermostatically-controlled unit.

The system contains four perfusate reservoirs that can store 500mL of preheated and oxygenated buffer each. Through a system of valves, the reservoirs can be connected to create one large (2L), two medium (1L each) or four small (500 mL) volumes. This flexibility allows you to test different doses of a drug consecutively, or combinations of drugs concurrently.

The system also has a unique heart suspension module that permits easy attachment of the heart to the system, as well as the concise placement of the heart within a 12-lead muscle action potential (MAP) sensor.

The integrated temperature control system lets you set the temperature in 0.1 °C degrees increments. Also, heat transfer between the device and the surrounding air is very low, establishing a stable environment for the heart preparations.

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Features

- Fluid columns are replaced by electronically adjusted flow control to keep the pressure at desired values from 0–500mmHg
- Langendorff and working heart perfusion modes
- Real-time calcium imaging ready
- Compact, all-in-one unit thermostatically controlled to 0.1°C degree
- Four 500mL saline reservoirs which can easily be connected to create 2L and 1L volumes
- Special heart suspension module

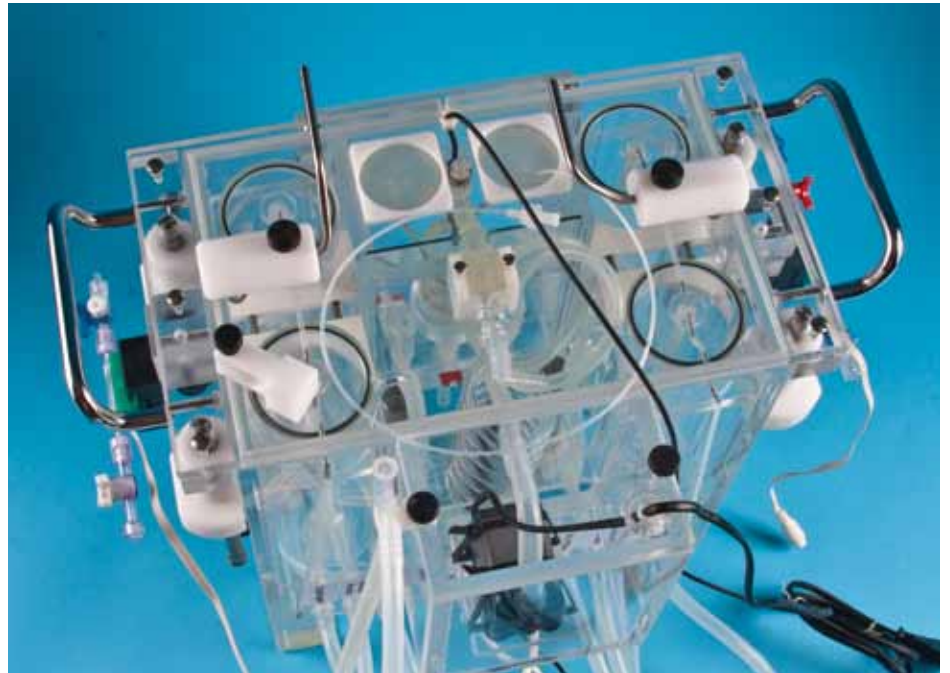


- Muscle action potential (MAP) sensors sized for mouse, rat, guinea-pig and rabbit hearts
- Capability to measure the following parameters: muscle action potentials (MAP), left ventricular pressure (LVP), perfusion pressure, coronary flow, buffer temperature, heart rate (HR), ECG, surface potentials, muscular tone and force with force-displacement method
- Capability of pacing and stimulation can be added

Real Time Calcium Imaging

If you're interested in calcium imaging, you no longer need a dedicated room to accommodate the 2.5m height of the standard Langendorff with columns. This ingenious Langendorff system was engineered using a pressure clamp apparatus to replace the bulky columns so that the entire system is small enough to fit into a dark box for imaging.

Everything you need to begin calcium imaging is available now through SI-Heidelberg.



COMPACT LANGENDORF SYSTEM

SI-LANGC Compact Langendorff Working Heart System

Included: Reservoirs, taps, central heater, heart suspension unit, oxygenation system • Constant Pressure Controller • Temperature Controller • Latex pressure balloons for left ventricular pressure (LVP) catheter • PeriStar Pro 2-channel high output Peristaltic Pumps (2) • Pressure transducers with cables (2) for aortic and left ventricular/atrial pressures

Requires two channels of Bridge/Transducer amplification

OPTIONAL COMPONENTS

SI-SEN12AM4E-U Manipulator with Removable Head (Unipolar)

SI-SEN12AM4E-B Manipulator with Removable Head (Bipolar)

SI-SEN07RTH2 Buffer Temperature Sensor

SI-SEN13MAP Monopolar Action Potential Sensor



Vertical Tissue Bath

**Multi-chamber tissue
bath system**



The SI-MB4 vertical tissue bath is shown with all four channels.

The SI-MB4 and SI-MB8 isolated tissue bath systems were developed for *in vitro* investigation on isolated smooth, cardiac or skeletal muscle preparations.

The SIH vertical tissue bath systems offers easy control of the inflow and outflow of buffer, oxygenation and stimulation. Simple tissue installation, calibration of the chamber volume and temperature maintenance are also important features.

High quality, calibrated tissue bath chambers with fitted tissue holders allow for low bath volumes. Sensitive, optical-based force transducers come with a LIFETIME warranty. Removable tissue holders ensure ease of tissue mounting and installation into the chambers.

Features

- Unique optical force transducers with LIFETIME warranty
- Test tissue strips or rings
- 5, 10 and 20mL calibrated chamber volumes
- Oxygen delivery and control integrated into each chamber bath
- Field (or point) stimulation electrodes built into each tissue holder
- Water jacketed reservoirs with built-in oxygenators



Oxygenation frit may be easily moved while tissue and holder are in the bath, to prevent bubbles from impacting the tissue.

SYSTEM SPECIFICATIONS

	SI-MB4	SI-MB8
Width	500mm	500mm
Length	1000mm	2000mm
Height	1050mm	1050mm
Weight	30kg	60kg

BATH SPECIFICATIONS

	Height*	ID
5mL	65mm	14mm
10mL	65mm	18mm
20mL	65mm	20mm

*Inside height is measured between the outflow port at the bottom and the overflow port at the top.

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

Tissue Baths

Tissue baths come as small as 5mL, for your most delicate applications. All the SI-H tissue baths are precisely calibrated, so that when your tissue holder is installed, you can accurately calculate your solution concentration.

Oxygenation

SI-H re-engineered the standard oxygen frit (shown below) to avoid the disturbances to the tissue sample that tiny bubbles can cause. The repositionable SI-H frit is installed on a small wire attached to the tissue mounts. You can choose the depth and direction of the bubble stream that will cause the least disruption to your tissue. Because the frit is a removable part, it can be easily replaced without the need to order a new tissue bath.

Tissue Holders

All tissue holders are made of Teflon to prevent the contamination of the tissue buffer by trace metals. The tissue holders are designed to:

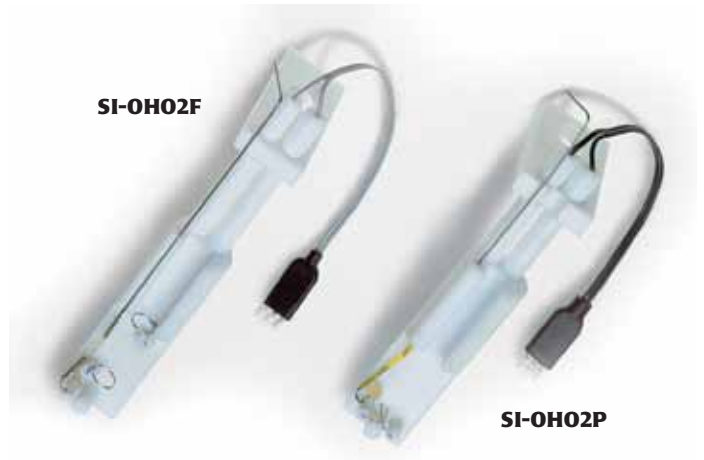
- Tissue mounts for strips with field and point stimulation and ring with field stimulation are included with all systems
- Allows for the attachment of the tissue on the holder before it is positioned in the chamber.
- Effectively oxygenate the buffer in the vicinity of the tissue.
- Position the field (or point) electrodes for efficient stimulation.
- Permit easy calibration of the chamber volume.

Two tissue holder styles are available for testing tissue.

- **SI-OHO2F**—tissue strips with field stimulation. This can also be used with the included tissue mounts for tissue rings.
- **SI-OHO2P**—tissue strips with point stimulation



The mounting for each tissue bath provides solid support as well as ports for oxygenation control and fluid handling.



Tissue holders are designed for simple and accurate preparation mounting. As the tissue holder slides into the tissue bath, its size significantly lowers the volume of liquid in the tissue bath.



Tissue mounts for vascular rings (**SI-OVO2F**) can be used with either holder. Upon request, custom electrode shapes and positions can be manufactured.

VERTICAL TISSUE BATH

- SI-MB4** 4-Chamber Vertical Tissue Bath
- SI-MB8** 8-Chamber Vertical Tissue Bath

OPTIONAL COMPONENTS

- 503843** Water Bath, Circulating (110 V)
- 503844** Water Bath, Circulating (220 V)
- LAB-TRAX-4** 4-Channel Data Acquisition System
- WPI-118** High Performance Digital Data Recorder

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BioTester 5000

Biaxial Test System for Biomaterials



The **BioTester5000** offers you a complete system for testing small biological specimens and analyzing the test results. Skin, ligaments, blood vessels, heart valves, sclera, membranes, scaffolds– **BioTester5000** can examine any planar biological or replacement tissue. Easy to use, yet powerful image tracking and analysis software delivers synchronized data, image and video management. Data can be exported to spreadsheets or analysis software.

- Quick and easy sample mounting of test samples as small as 5mm x 5mm.
- High Resolution (integrated) CCD camera provides synchronized video tracking for live images (up to 60 frames/sec) and real-time analysis
- Image tracking and analysis software included.
- Precision measurement of small samples (3mm-50mm square)
- Uniaxial or biaxial tension tests of planar tissues
- Multi-modal cyclic, simple and relaxation testing
- Simple USB interface offers a quick connect to a control computer with the included image and marker tracking software.
- User-friendly, comprehensive software package offers live data graphing and imaging to confirm the quality of the data collected.

Sample Mounting

The unique tungsten BioRakes (shown at right) easily pierce the toughest and most delicate soft tissue samples and provide distributed attachment sites across the geometry of the sample for uniform attachment and deformation across the edge of the sample. The sharp rakes will not damage fragile samples.

Software

The software features a user-friendly interface with live data graphing and imaging. The menu-driven setup offers a virtually limitless number of test stages and duration combinations. Previously used tests and templates can be easily edited for quick test designs. Live test status and data graphing provides real-time data monitoring. Analysis data can be easily exported to spreadsheets or other scientific modeling software.

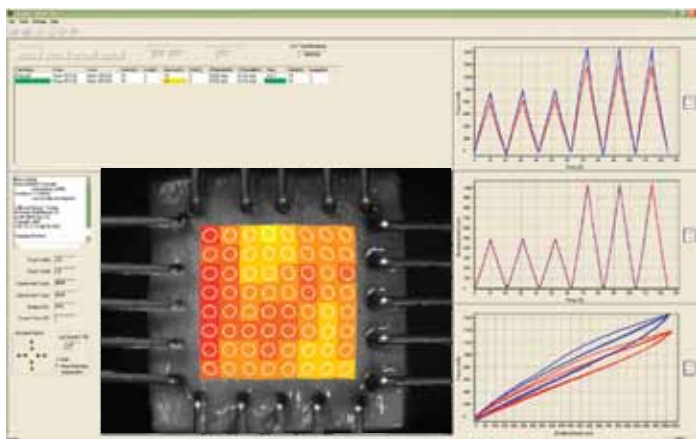
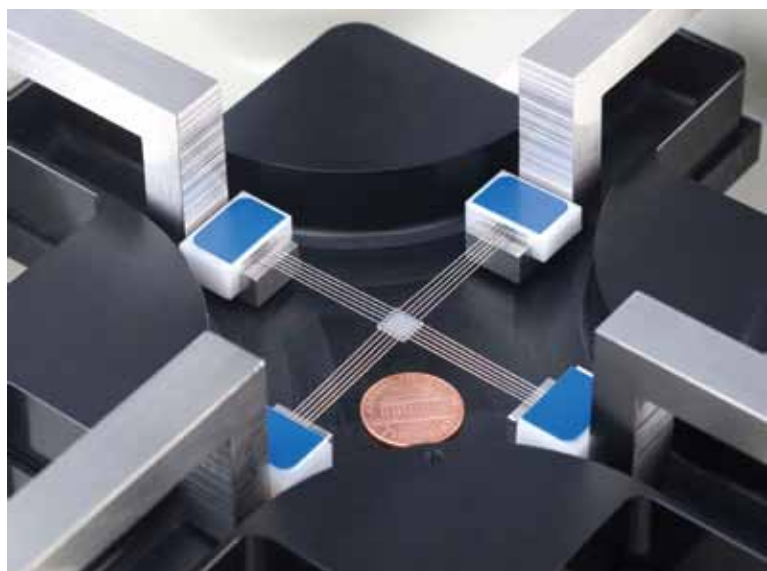


Image analysis software is provided with the BioTester5000 to deliver synchronized data, image and video management. Image features are easily tracked and synchronized to measured data and export to spreadsheets or other scientific analysis software. Images are available as JPG or AVI files for presentation and import into other image processing applications.



BIOTESTER 5000 SPECIFICATIONS

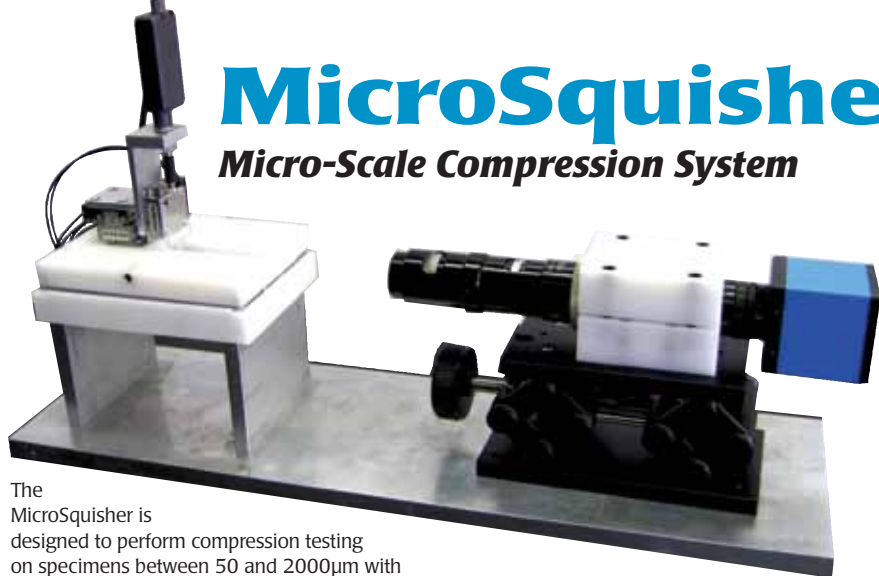
FORCE CAPACITY.....	500, 100, 2500, 5000 mN, 10 N, 23 N
FORCE RESOLUTION.....	>0.02% of full scale
FORCE ACCURACY.....	0.2% of full scale
SPATIAL RESOLUTION (ACTUATOR).....	>0.1 μm
SPATIAL ACCURACY (ACTUATOR).....	10 μm
SPATIAL RESOLUTION (IMAGE ANALYSIS).....	1/8 pixel
FORCE DATA RATE.....	≤100 Hz
IMAGE RATE.....	1280x960 - 15 Hz 1024x768 - 30 Hz 640x480 - 60 Hz
DEFORMATION RATE.....	≤100 mm/s (17 mm/s optional)

CS-BIOTESTER5000	Biaxial Biomaterial Tester
CS-BIOTESTER5000	Uniaxial Biomaterial Tester

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

MicroSquisher

Micro-Scale Compression System



The MicroSquisher is designed to perform compression testing on specimens between 50 and 2000µm with force resolutions as small as 0.05 µN. Forces are determined from the deflection of a flexible cantilever beam to which one compression plate is attached. Displacement control is achieved by manipulating the base of that beam using a motorized piezo stage.

The specimen can be tested in ambient air or in a temperature-controlled fluid bath. An integrated camera system allows synchronized imaging at up to 5Hz.

MICROSQUISHER SPECIFICATIONS

SPECIMEN SIZE	50–2000 µm
FORCE RESOLUTION	<0.05 µN
SAMPLING RATE	Up to 5 Hz

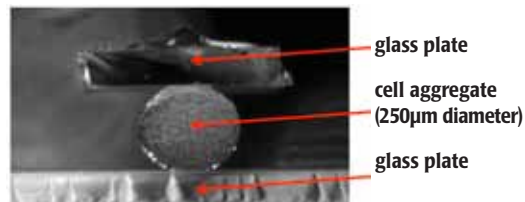
Micro-Scale Material Characterization

The MicroSquisher can be used to determine the compressive stress-strain properties of a variety of materials (hydrogels, small tissue samples, etc.) with peak forces ranging from 1µN to 1mN.

The device can perform displacement-controlled compression and stress relaxation testing.

Cell Aggregate Compression

The interface tensions that exist play an important role in the organization of cells within aggregates. These properties can be determined by analyzing the force-time curve and test images from a parallel plate compression test.



The MicroSquisher image analysis module quantifies the aggregate profile, allowing cell-cell and cell-medium interface tensions to be calculated.



CS-MICROSQUISHER Micro-Scale Compression System

MechanoCulture

Strainable Substrate for Culturing Cells

The MechanoCulture system was developed to allow researchers to culture cells on flat, strainable silicone membranes. Uniform strains up to 25% are possible and up to six, 20mm-diameter wells can be stretched simultaneously using a single, inexpensive base unit.



The MechanoCulture Base Unit has three silicone membranes



Base Unit

The MechanoCulture base unit has eight synchronous motor-driven pins that move radially so as to stretch a specially designed silicone membrane that includes a 20mm-diameter by 5mm deep well with cover plate. The Base Unit is 110mm X 130mm X 70mm and it can stretch up to 6 membranes at one time. Strain rates ranging from 10% per second to 0.01% per hour can be specified as can peak equi-biaxial strains ranging from 1% to 25%. Tests can be as simple as a single stretch cycle or they can be so complex and long that they take weeks to run.

The base unit posts move radially to stretch a silicone membrane from 1–25%.

disconnected from its power source without losing track of its position in the protocol.

Computer Control

The base unit is programmed using a graphical user interface (GUI) that runs on a PC and a USB cable. Once it is programmed, it can be disconnected from the PC and transferred to an incubator where it is connected to a 12V power supply. A run/pause button is used to initiate, pause and stop the test. An LED display indicates the state of the unit, including the number of cycles remaining in the original protocol. The base unit can be stopped and

Carrier

A special carrier allows membranes to be removed from the MechanoCulture base whenever it is paused or stopped. Thus, cultured cells can be observed and imaged on an inverted microscope in their original or deformed state.

The system is designed to be scalable and cost effective. Each base unit operates independently so that different strain-time protocols can be run simultaneously. Individual base units can be moved from one incubator to another or from one lab to another, thus providing maximum flexibility.

CS-MECHANOCULTURE Strainable Substrate for Culturing Cells

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