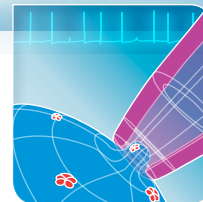**AD**INSTRUMENTS
making science easier

Data acquisition and analysis

For all aspects of physiological research

What researchers are saying about PowerLab Research Systems:

"software is powerful, easy to use... versatile functions... we have saved a lot of time and labor... record useful data immediately... intuitive features... they're very reliable"

"I became interested in ADInstruments after seeing the products shown at the Society for Neurosciences meeting. I love this company and their products. As an investigator in the neurosciences, I deal with many different vendors and many different kinds of equipment and also experience the whole gamut of product quality and customer service. My recent purchase of a PowerLab and LabChart software from ADInstruments stands out as one of the best experiences I have had buying a new product."

Associate Professor Ken Catania, Vanderbilt University, Tennessee, USA

"My research group are interested in both basic, pathophysiologically relevant research and clinical experimental research. To combine both is somewhat difficult, with an emerging need for advanced technologies. The PowerLab system has provided us with an affordable, top-technological means to detect, accurately record and analyze biomedical signals. We have studied a number of tissue types, involving smooth muscle and mucosa, together with dedicated ECG for detecting autonomic neuropathy in a number of conditions."

Piero Portincasa, MD, PhD, University of Bari Medical School, Bari, Italy

"In the MRI laboratory at Hoffmann-La Roche, PowerLab has been used since 1999. PowerLab is a central technology platform within our laboratory that performs investigations on an average of 1200 animals per year. During MRI scans the physiological state of each animal is monitored, recorded and archived. With the PowerLab system, ADInstruments has created a physiological monitoring system that stands out because of its reliability and ease of use."

Stephanie Schöppenthau, Hoffmann-La Roche Ltd

"PowerLabs are very easy to use. They're intuitive, they're simple. Because they have no moving parts and no mechanical systems, they're very robust, they're very reliable."

Dr Michael Shattock, Rayne Institute, St Thomas' Hospital, UK

"We have been using the ADInstruments PowerLab data acquisition systems, in combination with Millar PVAN Ultra and Transonic Flowmeter, in cardiovascular physiology and pharmacology since our lab was established. ADInstruments software is powerful, easy to use and is regularly updated."

Dr. Rongli Zhang, The Institute of Molecular Medicine, Peking University, China

"I have been using an eight-channel PowerLab for more than 3 years along with Millar Mikro-Tip catheters for invasive blood pressure monitoring in rodent models. It has helped me immensely in pursuing my doctoral study on diabetic cardiomyopathy. The ADInstruments software is very user friendly and easy to use even for a novice user. With customizable add-on modules like Blood Pressure and ECG Analysis it makes life science research quite easy for us. It would be my pleasure to continue using the PowerLab in my future experiments and I will certainly recommend the same to my colleagues and friends."

Sandeep Kumar, National Centre for Cell Science, India

"I like that PowerLab allows me to use all of my existing amplifiers and transducers. The intuitive interface makes life easy. I like to change gains and display settings on the fly, something the competitor's system does not allow."

Dr. Jerrel L. Wilkens, University of Calgary, Canada

About ADInstruments

Established in 1988, ADInstruments is a market-leading provider of computer-based data acquisition and analysis systems for life science. Our customers include internationally-recognized research hospitals, pharmaceuticals, biotechnology companies, contract research organizations, research institutes and 100% of the Quacquarelli Symonds Top 100 Life Sciences and Biomedical Universities in the World (2010).

Our success comes from providing life science researchers a data acquisition and analysis solution that is user friendly, ensures data integrity, is versatile, and accelerates the research process.

The ADInstruments Advantage

- **Proven track record** with installations in thousands of research institutes, universities, hospital and commercial laboratories around the world.
- **Power and flexibility** to be used in a variety of life science applications. Start with a PowerLab system and simply add an appropriate amplifier, instrument and transducer.
- **Quality and reliability** are synonymous with ADInstruments products. They are manufactured under a quality system certified by an accredited body as complying with ISO 9001:2008. The latest range of research PowerLab systems and signal conditioners are covered by a 5-year warranty to provide peace of mind.
- **Data integrity** is paramount. Our PowerLab data acquisition systems are calibrated and tested to deliver data you can trust.
- **GLP and 21 CFR Part 11 compliance** is facilitated when a PowerLab system is used with the GLP Module and GLP Server software. Together they provide the required user interface, audit trail and signing components for non-repudiation of data.
- **Being the industry leader** for data acquisition is something we're proud of. With 24 years of design and manufacturing experience, more than 38 000 installations worldwide, over 10 000 research papers we have referenced from research journals, and citations in Google Scholar exceeding 55 000, it's easy to see why our systems are the preferred choice for life science research all over the globe.
- **Intuitive and powerful software** allows researchers to concentrate on the science. With no programming required, the software is mastered quickly and provides comprehensive recording, display and analysis features.
- **Excellence in customer training and support** is what we are known for. Our staff includes Scientists, Programmers and Engineers that understand your research needs. In addition, with eleven ADInstruments offices and over forty distributors, we provide a truly global support network.
- **ADInstruments complete research systems** provide solutions for Isolated Heart, Isolated Tissue, Blood Pressure Analysis, ECG Analysis, Non-Invasive Blood Pressure, Ventricular Volume, Ventricular Pressure, Blood Flow, Nerve Activity, Cardiac Output, Biopotential, Blood Pressure and SNA Telemetry, Extracellular and Intracellular Recording. Complete research systems include equipment from Gold Standard manufacturers such as Millar Instruments, DMT and Transonic Systems.

Contents

ADInstruments Hardware `78`

Configured Research Systems and a wide range of Signal Conditioners, Instruments, Transducers and Accessories

Product List `152`

Index of products

PowerLab in Education `156`

Information on PowerLab Systems and software in life science teaching

The core of our product range is the PowerLab® data acquisition unit. When PowerLab hardware is combined with ADInstruments software, researchers have a powerful and versatile data acquisition and analysis system at their command.

PowerLab systems provide the full utility of a multi-channel, real-time chart recorder, polygraph, XY plotter, digital voltmeter and storage oscilloscope with the benefits of easy data handling, remarkable resolution, variable sampling speeds and powerful analysis options.

ADInstruments extends the use of PowerLab systems with a range of complete solutions for specific applications. Our complete research systems typically include ADInstruments signal conditioners, as well as selected specialized instruments, transducers and accessories from leading manufacturers.

ADInstruments Hardware

PowerLab 35 Series

The PowerLab 35 Series units are available in four, eight and sixteen channels and provide continuous acquisition of up to 200 K samples per second per channel (one or two channels) or an aggregate of 400 K samples per second across all channels. Online computations can be performed at the same high sampling rates and displayed in real time.

The hardware unit has no knobs or dials and absolutely no programming is required. PowerLab systems connect to Windows and Macintosh computers using USB ports. Typical research applications include:

- Blood, Atrial and Ventricular Pressure
- Blood Flow, Pulse Oximetry and Cardiac Output
- ECG and Heart Rate Variability
- Isolated Tissue
- Isolated Perfused Hearts
- Respiratory and Airway Physiology
- Exercise Physiology
- Neurophysiology/Electrophysiology
- Sleep
- Psychophysiology
- Animal Applications
- Telemetry.

See page 78 for more information.

Signal Conditioners

ADInstruments signal conditioners (preamplifiers) connect with PowerLab hardware to acquire the best signal possible for your particular application. See page 96 for more information.

Software Control and Identification — All gain and filter settings are selected using the software and saved automatically with your file. Once connected, ADInstruments signal conditioners are automatically identified and configured by ADInstruments software.

ADInstruments range of signal conditioners includes:

- Animal Bio Amp*
- Bio Amp*
- Octal Bio Amp
- Bridge Amp
- Octal Bridge Amp
- Conductivity Pod
- GSR Amp*
- Neuro Amp EX*
- pH/Temperature Amp
- Spirometer
- Stimulus Isolator*
- Thermistor Pod

- Animal Oximeter Pod
- Dual Bio Amp*
- BP Amp*
- Quad Bridge Amp
- Cardiac Output Pod
- EOG Pod
- T-type Pod
- Oximeter Pod
- Pod Expander
- Stimulator HC
- Dual Bio Amp/Stimulator*.

*Signal conditioners designed for connection to subjects are certified by external test authority to IEC 60601–1 safety requirements.

Instruments

Our instrument range provides devices from gold-standard manufacturers, for specialized physiological applications, see pages 106 to 121. Our instrument range includes:

- Multi-channel Bio Amps
- Gas Analyzers
- Stimulators
- Intracellular Amplifiers
- Wireless Neural Headstages
- Organ/Tissue Baths
- Wire Myographs
- Isolated Heart Apparatus
- NIBP Devices
- Animal Telemetry Devices
- Temperature Controllers
- Stimulus Presentation Systems.

Transducers and Accessories

ADInstruments supplies an extensive selection of specialized transducers and accessories configured to operate with our signal conditioners. We offer transducers for measuring force, displacement, blood pressure, temperature, pH, air flow, pulse, respiration and much more. For details on transducers and accessories, please see pages 122 to 151.

Complete Research Systems

To save time and allow you to concentrate on research, we have configured research systems that have just about everything you need for specific applications. Each system includes a PowerLab data acquisition unit and software, as well as signal conditioners, instruments, transducers and accessories if required.

We offer complete systems for applications including:

- Blood Pressure
- Blood/Fluid Flow
- Cardiac Output
- Exercise Physiology
- Isolated Tissue
- Working Heart
- Langendorff Heart
- Neurophysiology
- Electrophysiology
- Telemetry
- Ventricular & Atrial Pressure
- Ventricular Pressure-Volume
- Wireless Neural Recording.

There are over forty complete research systems including the Telemetry Small Animal Foundation System shown below. Please see page 91 for more details.
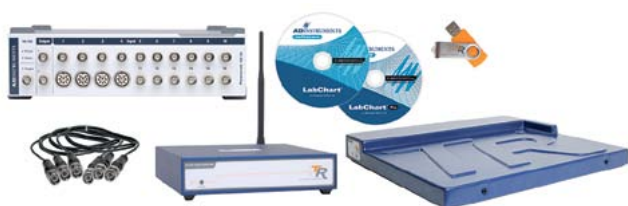
Quality and Safety Standards

All ADInstruments hardware (PowerLab data acquisition systems, signal conditioners and instruments) are manufactured under a quality system certified as complying with ISO 9001:2008 by an accredited certification body. All ADInstruments isolated signal conditioners designed for subject connection are independently certified as being approved to strict IEC 60601-1 and equivalent CSA standards (identified by the use of the following symbols).

Meets the CSA and US certified medical electrical equipment standards.

Approved for non-direct cardiac connection (BF rated).

Satisfies the requirements of the European EMC and low voltage directives.

ISO 9001:2008 Certified Quality Management System.

Intended Use

All ADInstruments manufactured products are intended for use in teaching and research. ADInstruments products are NOT intended to be used as medical devices or in medical environments and are NOT intended to be used to diagnose, treat, or monitor a subject.

Read our full intended use policy at
www.adinstruments.com/support/safetystandards/

Complete Education Solutions

ADInstruments also provides engaging, cost-effective solutions for every level of life and health science education. Our blended learning approach has improved learning outcomes in high schools, colleges and universities.

Enhance learning using student-guiding software, in class and online

LabTutor Teaching Suite is a revolutionary education tool that engages students by efficiently guiding them through interactive experiment activities. These include real-time data acquisition, data analysis, graphing and reports, all within the familiar interface of an Internet browser. **Learn more on page 156.**

ADInstruments Software

ADInstruments software for research provides comprehensive data display, recording and analysis features that are easy to use and quick to master. Software options are summarized in the table below.
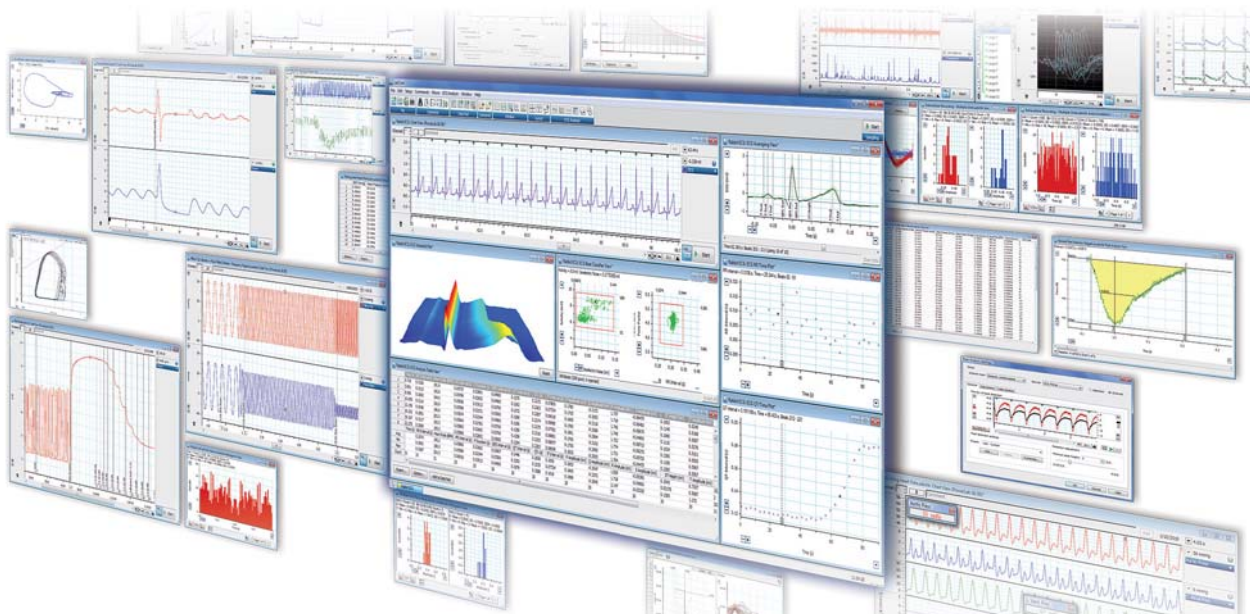
Software	Purpose
LabChart	LabChart software offers the functionality of a multi-channel chart recorder, digital oscilloscope, XY plotter and digital voltmeter. Record, display and analyze up to 32 channels of data in real time.
LabChart Pro	A software package that includes LabChart and all LabChart modules for analysis of application-specific data.
LabChart Modules	Application-specific acquisition and analysis add-on programs for LabChart software. Modules are available separately or as a collection in LabChart Pro. Examples include ECG Analysis, Blood Pressure, HRV and more.
LabChart Extensions	Available free of charge to all LabChart users. Extensions provide additional data formatting, filtering, visualization, measurement calculations and other utility features.
GLP Client and GLP Server	In conjunction with LabChart software, GLP Client and GLP Server software provide PowerLab users with an easy and reliable data acquisition solution for a GLP and 21 CFR Part 11 compliant environment.
LabChart Reader	A free program that allows scientists who do not use LabChart software to view and analyze (to a limited extent) LabChart data files. This allows PowerLab users to share data and collaborate with colleagues.

LabChart

LabChart software (supplied with all PowerLab systems for research) transforms your Windows or Macintosh computer into a digital chart recorder and oscilloscope that records and displays data in real time. You benefit from easy acquisition, graphical presentation and powerful analysis features.

LabChart lets you start, stop and adjust settings, record data with new settings and keep all this information within a single file. Additionally, any computed analysis or event information is saved within the same file. See page 42 for details.

Scope View

Scope View acts as a multi-channel oscilloscope and averages signals in real time. Pages/sweeps can be generated using data blocks, events or comments in LabChart View. Scope View can be controlled with macros and advanced scripting. There are no sampling or page limits and up to 100 pages can be overlaid.

Scope View provides a number of powerful tools to enhance analysis and display, and improve trace contrast. These include the 3D Depth Overlay feature, Scope Overlay Options dialog box and black/white background toggle. See page 53 for feature details.
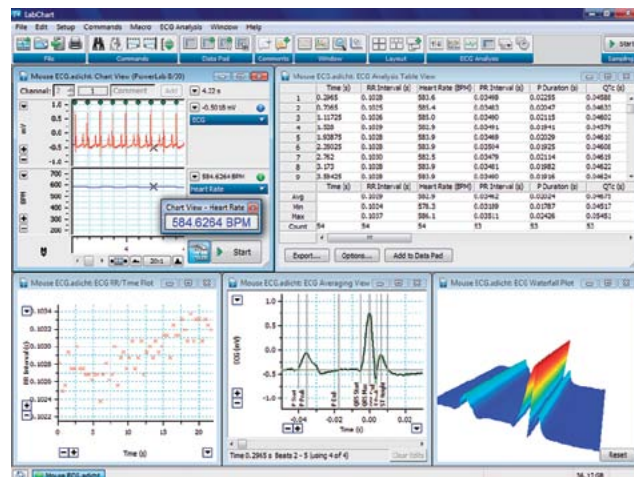
LabChart Modules

LabChart modules are software add-ons that provide comprehensive analysis and feature sets for specific applications. LabChart modules are included with the LabChart Pro package, or can be purchased individually.

Modules include:

- Blood Pressure
- Peak Analysis
- ECG Analysis
- Spike Histogram
- HRV
- Video Capture

- Cardiac Output
- DMT Normalization
- Metabolic
- Circadian Analysis
- Dose Response
- PV Loop.

See pages 62–74 for full descriptions of each module.


Data analyzed using the ECG Analysis Module.

LabChart Extensions

LabChart extensions are free software plug-ins that extend the functionality of LabChart. They fall into the following groups: File Translation, Filtering, Data Visualization, Measurement and Calibrations and Utility Features.

File translation extensions enable LabChart files to be saved in formats readable by popular packages including Axon and Igor Pro or spreadsheet packages such as Excel. See page 60 for a complete list of LabChart extensions.
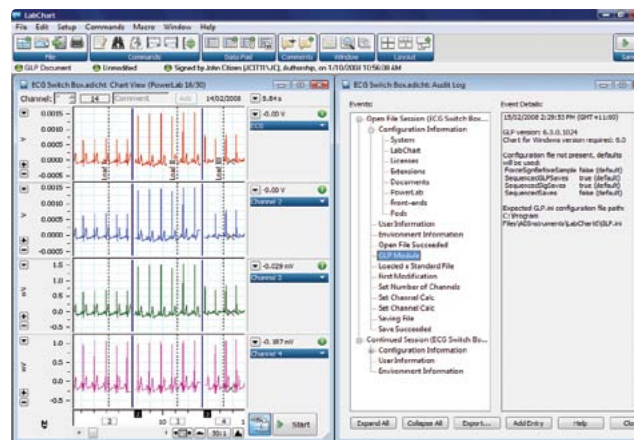
The GLP Client adds a GLP Status Bar to the LabChart application window and an Audit Log (right panel) that records the user, GLP status, configuration and recorded data information.

Good Laboratory Practice Compliance

LabChart GLP Client and GLP Server provide the user interface, audit trail and signing components that are essential to meet GLP and FDA 21 CFR Part 11 requirements. See page 76 for more information.
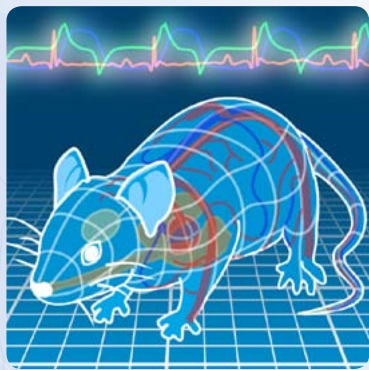
LabChart Reader

LabChart Reader is a free downloadable program that lets you share your LabChart data files with colleagues. It enables anyone to open and view LabChart files. The program includes standard LabChart analysis and display features. The advanced analysis tools from LabChart modules and extensions are only available with the full version of LabChart software with LabChart Pro. See page 61.
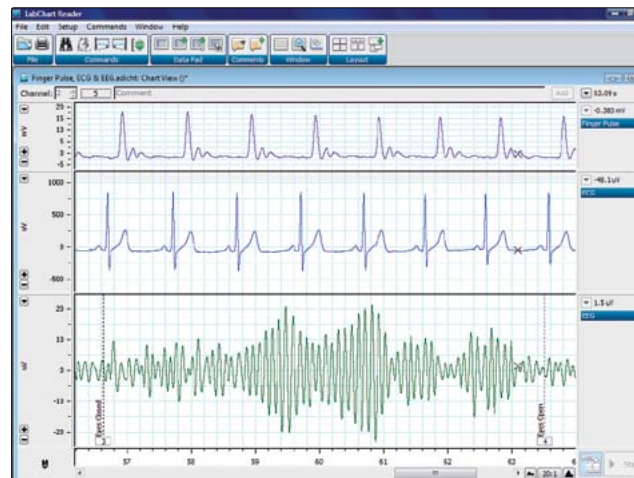
LabChart Reader, a free application, allows display and limited analysis of LabChart data on any computer.

Mouse and Rat Applications

ADInstruments provides a variety of research systems ideal for *in vivo* and *in vitro* investigation of diverse physiological parameters in mouse and rat models.

Intravascular Blood and Cardiac Pressure

The **PL3508B49 Mikro-Tip BP Foundation System** (page 88) records pressure using high-fidelity **Millar Mikro-Tip® Catheters** (page 132). Due to their small size and high-frequency response, they're suitable for use with rats and mice. For ventricular pressure-volume recordings, the **PL3516B49 MPVS Ultra Foundation System** (page 88) and **Millar Mikro-Tip Pressure-Volume Catheters** (page 132) are ideal. The **Blood Pressure Module** (page 62) and **PV Loop Module** (page 72) provide automated analysis and display of pressure and pressure-volume parameters.

Biopotential Recordings

Signals such as ECG, EMG, EEG can be recorded using **Needle Electrodes** and the **FE136 Animal Bio Amp** (page 96). To record intracardiac or transesophageal ECG, **Millar Electrophysiology Catheters** (page 126) are used with a **Bio Amp FE132, FE135, ML408 (**page 97**)**. ECG signals are analyzed using the **ECG Analysis Module** (page 68) which provides detection, averaging and analysis of ECG beats.

Cardiac Output

The **ML313C Cardiac Output Pod** (page 100) and **Cardiac Output Accessory Kit** (page 130) determine cardiac output of small animals using the thermodilution technique. The **Cardiac Output Module** (page 64) calculates cardiac output from a thermodilution curve recording. **Transonic Flowmeters** (page 107) and PowerLab systems can also be used to determine cardiac output through volumetric flow. **Millar MPVS Ultra Systems** (page 88) also provide cardiac output measurements.

Cardiac Electrophysiology

The **PL3508B36 Cardiac Electrophysiology Foundation System** (page 89) includes an 8 channel PowerLab, and the **STG3008-FA Intracardiac Electrophysiology Stimulator/Amplifier**. Using the **EPR-800, 801, 802 Millar Electrophysiology Catheters** (page 126), electrical properties of rodent atria and ventricles can be recorded.

Telemetry

ADInstruments provides **Millar Telemetry Research** equipment (page 121) for wireless, high-fidelity signal acquisition from small animals. In conjunction with

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ADInstruments Advantage

- Complete systems for monitoring parameters from mice and rats
- Software analysis modules for automated detection and extraction of parameters of interest
- Applications include BP, LVP, RVP, PV Loop Analysis, NIBP, Cardiac Output, ECG Analysis, Blood Flow, Isolated Heart and Tissue Studies
- PowerLab data acquisition systems interface with industry gold standard instruments such as Transonic Systems Flowmeters and Millar Mikro-Tip Catheters.

PowerLab systems, the solid-state wireless devices provide highly-accurate cardiovascular pressure, biopotential and temperature recordings.

Noninvasive Blood Pressure

The **IN125/M NIBP Controller** (page 108) in conjunction with a **Pulse Transducer/Tail Cuff** and PowerLab obtains noninvasive blood pressure measurements from mice and rats. A specialized tail cuff that incorporates a pulse transducer is used to intermittently measure blood pressure based on the periodic occlusion of tail blood flow.

Blood Flow and Oximetry

Blood flow can be measured invasively using **Transonic Flow Systems** (page 80). A wide range of probes for chronic and acute applications are available. Relative blood flow perfusion can be measured using the **IN191 Blood FlowMeter** (page 106). The **ML325 Animal Oximeter Pod** (page 100) is ideal for measuring pulse oximetry from the underside, base of the tail or other well-vascularized surfaces.

Isolated Organ and Tissue

A range of **Organ Bath/Tissue Systems** (page 81) and **Wire Myograph Systems** (page 83) are available for isolated muscle studies. The **Dose Response Module** (page 67) is used to automate the generation of dose response curves. To investigate cardiac function using the isolated heart preparation, **Langendorff Heart Systems** (page 84) and **Working Heart Systems** (page 86) are available in a wide range of configurations.
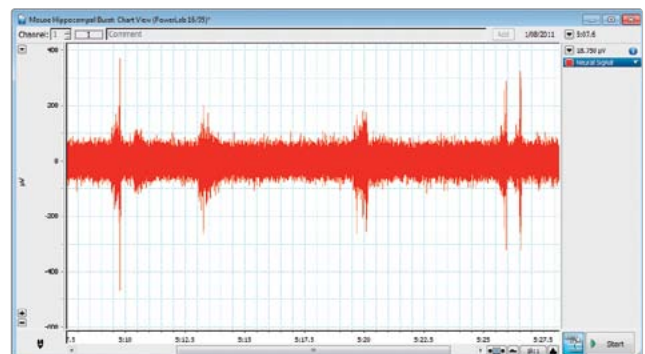
Wireless Neural Recording

5 and 15 channel **Wireless Neural Recording Systems** (page 94) are available for acquisition of action potential signals (spikes) from individual brain cells (neurons), as well as local field potential (LFP and EEG) signals in small animals such as rodents.
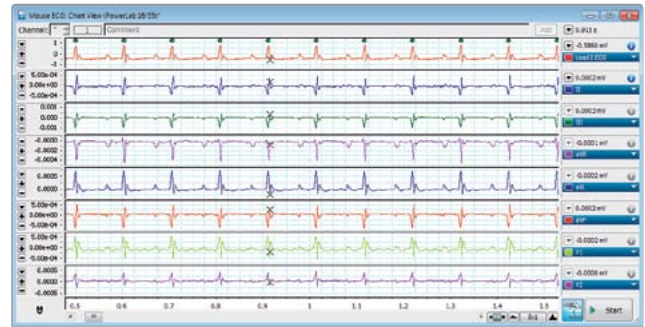
Standard eight-lead mouse ECG recording.
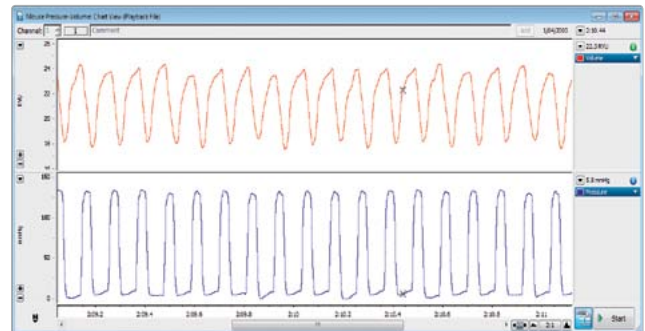
Recording of ventricular volume and pressure using a Millar Pressure-Volume Catheter and PowerLab. Data provided by Dr Pacher, National Institute of Health, NIAAA, Laboratory of Physiologic Studies, US.


Mouse hippocampal burst recorded wirelessly with ADInstruments and TBSI wireless neural systems.

Select PowerLab citations

Ho, T., Vessey, K. a., Cappai, R., Dinet, V., Mascarelli, F., Ciccotosto, G. D., & Fletcher, E. L. (2012). Amyloid Precursor Protein Is Required for Normal Function of the Rod and Cone Pathways in the Mouse Retina. (D. Vavvas, Ed.) *PLoS ONE*, 7(1), e29892. doi:10.1371/journal.pone.0029892

Wu, J., Zhang, Y., Zhang, X., Cheng, L., Lammers, W. J. E. P., Grace, A. a, Fraser, J. a, et al. (2012). Altered sino-atrial node function and intra-atrial conduction in murine gain-of-function scn5a+/delta KPQ hearts suggest and overlap syndrome. *American Journal of Physiology. Heart and Circulatory Physiology.* doi:10.1152/ajpheart.00357.2011

Search our citations database at: www.adinstruments.com/citations

Xie, Y., Wang, Y., Zhang, T., Ren, G., & Yang, Z. (2012). Effects of nanoparticle zinc oxide on spatial cognition and synaptic plasticity in mice with depressive-like behaviors. *Journal of Biomedical Science*, 19(1), 14. doi:10.1186/1423-0127-19-14

Fadel, P. J., Farias Iii, M., Gallagher, K. M., Wang, Z., & Thomas, G. D. (2012). Oxidative stress and enhanced sympathetic vasoconstriction in contracting muscles of nitrate-tolerant rats and humans. *The Journal of Physiology*, 590(2), 395-407. doi:10.1113/jphysiol.2011.218917

Xu, X., Li, Z., Yang, Z., & Zhang, T. (2012). Decrease of synaptic plasticity associated with alteration of information flow in a rat model of vascular dementia. *Neuroscience.* doi:10.1016/j.neuroscience.2011.12.050
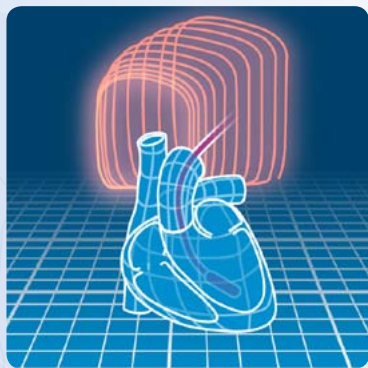
Typical Equipment

Research Systems

PL3516B49 MPVS Ultra Foundation System

PL3508B35 Mikro-Tip BP Foundation System

PL3516B109 Telemetry Small Animal Foundation System

Individual Items

PL3508/P PowerLab 8/35 (8 channels) with LabChart Pro

PL3516/P PowerLab 16/35 (16 channels) with LabChart Pro

FE221 Bridge Amp

FE224 Quad Bridge Amp

FE228 Octal Bridge Amp

FE117 BP Amp

MLT844 Physiological Pressure Transducer

MLT0380 Reusable Blood Pressure Transducer

MLT0670 Disposable BP Transducer (stopcock)

MLT0699 Disposable BP Transducer (no stopcock)

ML295 Homeothermic Controller and Pad

Software Highlights

MLS260/7 LabChart Pro

MLS370/7 Blood Pressure Module

MLS390/7 Dose Response Module

MLS380/7 Peak Analysis Module

MLS375/7 PV Loop Module

Blood, Atrial and Ventricular Pressure

Invasive Blood Pressure Measurement

ADInstruments supplies systems for invasive blood pressure measurements in a range of animal species. The systems are ideal for recording and analyzing blood pressure and related parameters in both anesthetized and conscious animals.

Mikro-Tip BP Systems

The **PL3508B35 Mikro-Tip® BP Foundation System** (page 86) offers high-fidelity pressure signal measurements with unparalleled accuracy. Advantages include:

- Precise signal resolution as the pressure sensor is located at the tip, enabling recording at the source of the signal
- No signal attenuation or drift as catheters are solid-state rather than fluid or gel-filled
- Large selection of Millar Mikro-Tip Catheters for a variety of animal species (including mice, rats, cats, dogs, pigs, sheep, cattle, horses, etc.)
- Dual pressure sensor catheters for recording two pressure signals simultaneously (i.e. atrial and ventricular pressure)
- Millar Mikro-Tip Catheters connect easily to a PowerLab system using any ADInstruments Bridge Amp and a Catheter Interface Cable.

Using **LabChart** features such as **Cyclic Measurements**, **Arithmetic** and **Data Pad** (pages 55-56), BP parameters such as systolic, diastolic and mean blood pressure, as well as heart rate, can be easily recorded and displayed in real-time. The LabChart **Blood Pressure Module** (page 62) enables beat-by-beat or signal-averaged analyses of arterial and ventricular waveforms. Thousands of individual waveforms can be analyzed in a few seconds. Extracted parameters are provided in a table and if desired, can be easily exported to other software for further statistical analysis.

Millar Mikro-Tip Pressure-Volume Systems

The **PL3516B49 MPVS Ultra Foundation System** (page 88) simultaneously and continuously measures ventricular pressure and volume with high fidelity from the intact beating hearts of animals. **Millar Pressure-Volume Catheters** (page 132) are used to measure ventricular pressure and volume using the conductance method and are suitable for use in a wide range of animals.

ADInstruments Advantage

- Complete systems for cardiovascular pressure and pressure-volume measurement in small and large animals
- The world's most accurate high fidelity pressure/pressure-volume catheters
- Blood Pressure Module for automated detection, analysis and data extraction from ventricular and arterial pressure signals
- PV Loop Module for graphical display of the pressure-volume relationship and extraction of hemodynamic parameters including pressure volume area, stroke work, and cardiac output.

applications

LabChart software allows researchers to display pressure-volume loops in real time and export parameters of interest to the Data Pad. In addition, the LabChart **PV Loop Module** (page 72) automatically plots PV loops in real time and calculates up to 30 cardiac parameters including:

- Cardiac Output
- Stroke Work
- Stroke Volume
- Preload Recruitable Stroke Work
- Max and Min dP/dt
- Max and Min dV/dt

- ESPVR and EDPVR
- Arterial Elastance
- Ejection Fraction
- Systolic & Diastolic Pressure
- Tau (τ): Isovolumetric Relaxation Time.

Measurement of mouse left ventricular pressure and volume *in vivo* after occlusion of the inferior vena cava.
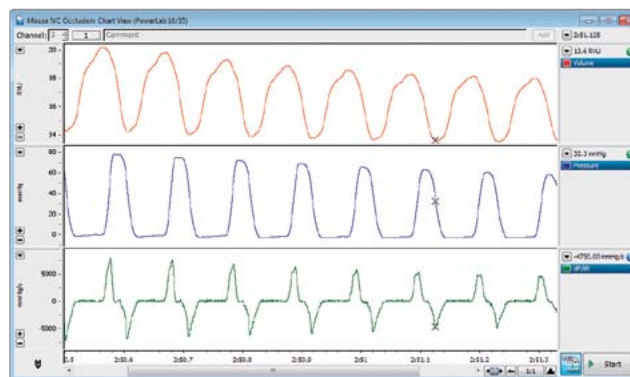
Telemetry Systems

To facilitate study in conscious, free-roaming animals, ADInstruments provides a range of **Millar Telemetry Research Systems** (page 91). Telemetry-based studies offer a realistic insight into animal physiology and how it is influenced by the sympathetic nervous system.
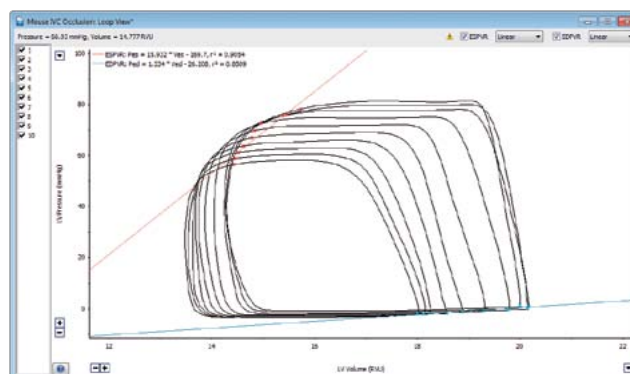
Telemetry Foundation Systems

These configured research systems enable blood pressure, biopotentials and temperature to be recorded wirelessly using a single, implanted telemeter. **Pressure, Biopotential and SNA Telemeters** (page 145) feature Millar solid-state sensors that can acquire signal frequencies of up to 2000 Hz. Telemeters are available according to the measured signals.

The innovative **SmartPad** (page 121) power supply enables simultaneous recharging of the implanted telemeter battery while recording. Each telemeter transmits data on a separate frequency, allowing animals to be housed in the same area without requiring any special shielding.

Using the PV Loop Module, ventricular pressure-volume loops can be displayed and analyzed in real time.
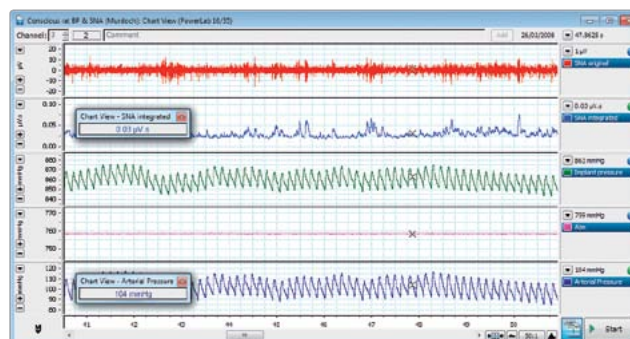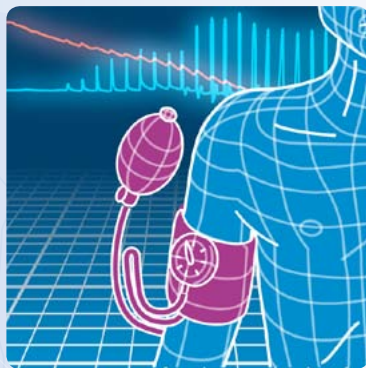

Rat telemetry recording of sympathetic nerve activity (SNA) top channel, and arterial pressure, bottom channel. Data courtesy of Dr Jackie Phillips, Murdoch University.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

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applications

Fluid-Filled Pressure Catheters

ADInstruments offers several reusable and disposable **Pressure Transducers** (page 134) for use with fluid-filled catheters and a wide range of species. The **MLT844 Physiological Pressure Transducer** is highly accurate and features an easy-to-fill dome that can be quickly coupled to the transducer, eliminating any liquid between the transducer and dome diaphragms. This gives the transducer a long life expectancy by ensuring it does not foul. Pressure signals are amplified using a **Bridge Amp** (page 99) connected to a **PowerLab data acquisition system** (page 78). The ADInstruments range of Bridge Amps includes Single, Quad and Octal models.

For measuring intravascular blood pressure in humans, the **BP Amp** (page 99) is electrically isolated and certified for human connection when used with the supplied transducer cable and a sterilized disposable blood pressure transducer. Specialized polyethylene tubing is available for catheterization of arteries in small animals.

The **Cyclic Measurements** feature (page 55) in LabChart software derives and displays (online or offline) systolic, diastolic and mean arterial pressure, as well as heart rate, from a single blood pressure signal. The **Blood Pressure Module** (page 62) for LabChart (Windows) enables online or offline analysis of arterial and ventricular waveforms.

Animal Temperature Control

The **ML295 Homeothermic Controller and Pad** (page 121) maintains body temperature in anesthetized animals during surgical procedures or during chronic *in vivo* studies. The system is configured for use with small animals including mice, rats and guinea pigs.

Noninvasive Blood Pressure Measurement

Third-party NIBP devices that provide an analog output can be interfaced with PowerLab data acquisition systems. The acquired signals can be analyzed using LabChart software online or offline.

Human Noninvasive Blood Pressure Measurement

The **MLE1054-V Finometer MIDI** (page 109) is a noninvasive blood pressure device for use with human subjects. It interfaces with PowerLab data acquisition

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ADInstruments Advantage

- Complete systems for invasive and noninvasive blood pressure measurement
- Compressed display and split bar for trend observations
- Powerful VB scripting, including event-based functions, for automation of LabChart software tasks
- Simple calibration of pressure signals into mmHg or other units
- Automated extraction of data from recordings using online **"Timed Add to Data Pad"** or offline using **"Multiple Add to Data Pad"**.

systems to provide a digital recording of the reconstructed arterial pulse-pressure waveform. The Finometer MIDI can be used alongside **ADInstruments Bio Amps** (page 97) to obtain simultaneous ECG recordings.

LabChart Pro software (page 62), which includes the **ECG Analysis** and **Blood Pressure Modules**, enables researchers to view, manipulate and analyze ECG and blood pressure signals online or offline, without losing raw data. Optional **BeatScope Easy Software** for Finometer MIDI enables cardiac output calculations to be derived from NIBP data.

Animal Noninvasive Blood Pressure Measurement

The **IN125 NIBP Controller** (page 108) is ideal for mice and rats. It connects directly to a PowerLab system and uses a specialized **Tail Cuff and Pulse Transducer** (page 140) for mice or rats, from which arterial pressure can be determined (based on the periodic occlusion of blood flow to the tail).

To ensure a reliable signal, conscious animals must be trained and properly restrained using **Rodent Restrainers** (page 140) available in a range of sizes.

Noninvasive Pulse Tonometry

The **Pulse Tonometer** (page 140) is a hand-held wand probe equipped with a Millar Mikro-Tip pressure sensor at its tip. It is designed for noninvasive recording of pulse pressure wave contours from humans and animals. The high-frequency response ensures accurate reproduction of pulsatile waveforms. The SPT-301 Millar Non-Invasive Pulse Tonometer features a 1.5 m cable and requires the AEC-10C Catheter Interface Cable for connection to ADInstruments Bridge Amps.
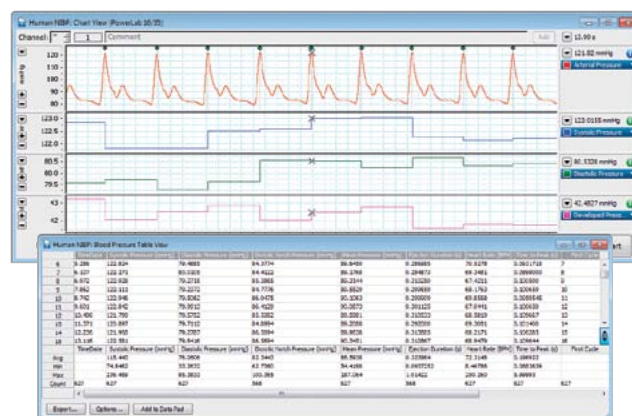
Non-invasive human blood pressure (top) recorded with the Finometer MIDI. The Blood Pressure Module's Table View (bottom) showing automatically logged parameters.
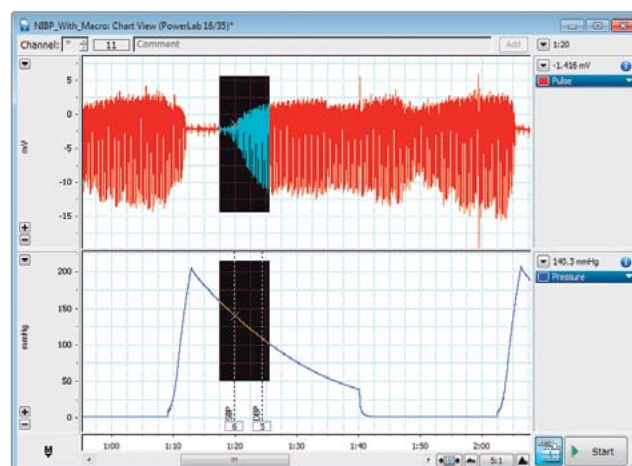
Rat pulse (channel 1) and tail-cuff pressure in mmHg (channel 2). Comments can be added during or after recording data.
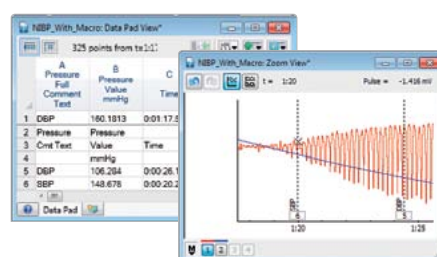
Derived systolic and diastolic pressures can be automatically extracted to the Data Pad (left). Zoom View (right) shows the detailed examination of pulse signal from the above rat NIBP recording.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

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Telemetry

Telemetry offers a number of advantages to researchers including stress-free, long-term recordings from freely moving animals. A variety of **Millar Telemetry Research Systems** used to monitor and analyze blood pressure, biopotentials (ECG, EMG, EEG), and temperature are available.

Animal Telemetry Systems

ADInstruments & Millar Telemetry Research Systems

Millar Telemetry Research Systems are ideal for wireless monitoring of blood pressure, biopotentials, SNA, temperature and tissue oxygen in rats and other animals such as guinea pigs and rabbits, weighing 200 g or more.

Features of these systems include:

- Wireless recharging of telemeter batteries *in situ* (small animals)
- Independent telemeter frequencies allow normal animal interaction
- Digital data transmission range of up to 5 meters
- Range of telemeter configurations for small animals
- Ability to record three different signals from a single implanted telemeter
- Solid-state sensors with high-sampling frequencies (up to 2000 Hz)
- Power down feature extends rechargeable battery life
- Simultaneous recording from multiple telemeters.

The **PL3516B109 Small Animal Telemetry Foundation System** (page 91) is supplied with the PowerLab 16/35 data acquisition system, LabChart Pro software, SmartPad (Receiver/Charger) and Configurator (control of the SmartPad and Telemeters). Implantable **Telemeters** (page 145) are selected separately according to the monitored signals.

The following telemeters are available to record up to 3 signals from each device:

- Biopotential and Temperature
- Dual Biopotential and Temperature
- Pressure, Biopotential and Temperature
- Pressure and Temperature
- Dual Pressure and Temperature
- Tissue Oxygen and Temperature
- SNA (sympathetic nerve activity), Pressure and Temperature.

ADInstruments Advantage

- Complete telemetry systems for small animals
- Unique *in situ* recharging and independent signal frequencies allow animal cohabitation
- 32 channels of real-time data acquisition and analysis using LabChart
- Cutting edge solid-state technology provides highly accurate signals
- LabChart Pro with Blood Pressure, ECG Analysis, Circadian Analysis, HRV and Dose Response Modules provide fast, automated analysis of recorded data.

The **SmartPad** (page 121) uses patented inductive power technology to charge the implanted telemeter *in situ*, when the animal is housed over the pad. 24-hour continuous and simultaneous recording and recharging of implanted telemeters is possible. There is no need to send telemeters for battery replacements reducing the overall cost of research and lowering the number of required animals.

The SmartPad receives the telemeter signals and outputs them as voltage to **PowerLab** (page 78) and **LabChart software** (page 40). LabChart allows real-time recording and analysis of up to 32 channels. Parameter detection, extraction and analyses are made easy with features such as Cyclic Measurements, Data Pad and Arithmetic. Powerful VB Scripting can also be used to automate recording, display and analysis tasks.

LabChart Pro (page 62), supplied with the Telemetry Foundation Systems, includes a number of specialized software modules that automate detection, extraction and analysis of parameters of interest.

LabChart Pro Modules ideal for telemetry include:
- ECG Analysis
- Blood Pressure
- Circadian Analysis
- Heart Rate Variability
- Spike Histogram
- Peak Analysis.

LabChart's ability to acquire up to 32 input channels from multiple data acquisition units to a single or multiple files provides added flexibility.
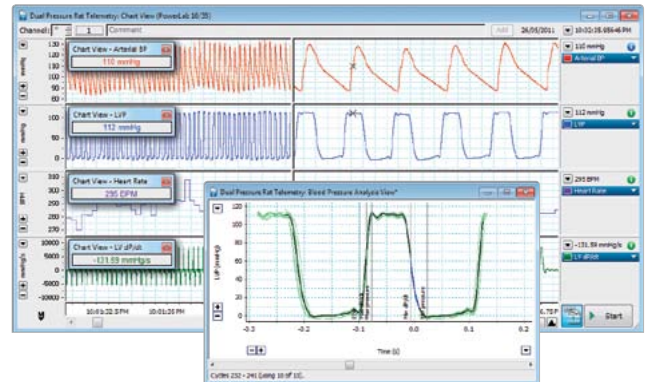
Rat arterial and left ventricular pressure recorded using ADInstruments Telemetry Systems. Channels three and four show calculated Heart Rate and dP/dT. Inset: Blood Pressure Module Analysis View showing a single cycle with marked LVP parameters.
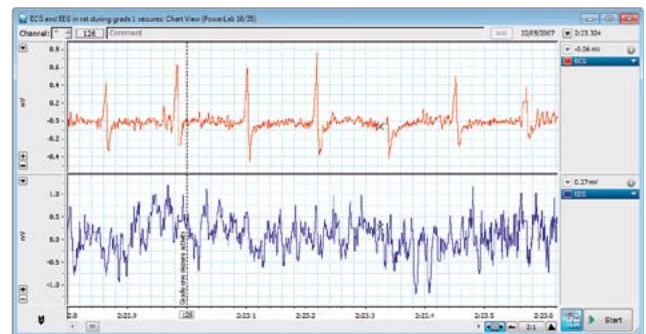
A telemetry recording of rat ECG (channel 1) and EEG (channel 2).
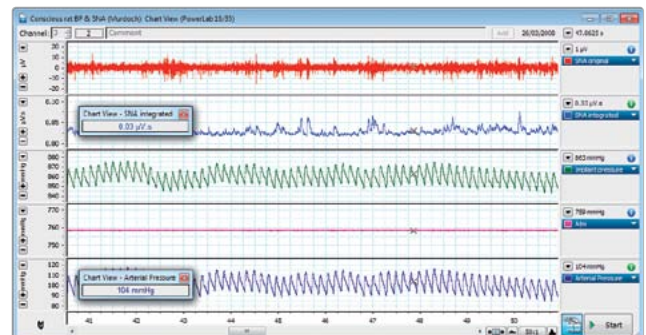
Raw and integrated (channels 1 & 2) sympathetic nerve activity, and arterial pressure (channel 5) signals acquired from a conscious, freely moving rat.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

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ECG and Heart Rate Variability

Electrocardiograms (ECG) and Heart Rate Variability (HRV) in humans and animals can easily be recorded and analyzed using PowerLab data acquisition systems and a suitable ADInstruments Bio Amp.

Human ECG

All ADInstruments **Bio Amps** (page 97) designed for human connection, provide full electrical isolation to guarantee subject safety. They feature low-noise, high-gain differential amplifiers and software-controlled low-pass, high-pass and notch filters for removal of unwanted signal frequencies.

The **FE132 Bio Amp** (page 97) is ideal for recording single channel ECG. Two or more channels of ECG or other biopotential measurements can be recorded using the **FE135 Dual Bio** or **ML138 Octal Bio Amp** (page 97). For multi-channel ECG, a Dual Bio Amp can record ECG from two standard lead configurations and LabChart can calculate the remaining four leads. Alternatively, the ADInstruments **MLA0115 ECG 12-Lead Switch Box** (page 124) provides a selection of standard ECG lead configurations using 10 standard lead wires. It supports a direct selection of leads configurations I, II, III, aVF, aVL, aVR and precordial leads V1 to V6.

The **ML408 Dual Bio Amp/Stimulator** (page 98) combines a human approved stimulator and dual bio amplifier to provide precise electrical stimulation of subjects while recording. ADInstruments also supplies the **GT205/F 8 Channel and GT201/F 16 Channel Bio Amps** (page 106).

Animal ECG

The **FE136 Animal Bio Amp** (page 96) is an isolated, high-performance, software-controlled differential amplifier used for the measurement of a wide variety of biological signals in animals and isolated tissues. It can be used with **Needle Electrodes** (page 125) for measuring biopotentials in a variety of animal species. Animal ECG can also be acquired using the **MPVS Ultra Systems** (page 88). In mice or rats, transesophageal or intracardiac electrographic recordings can be made using the **EPR-800, 801 an 802 Millar Electrophysiology Catheters** (page 126) in conjunction with a Bio Amp. Renal sympathetic nerve activity (RSNA) can be recorded using the **DP301 Single Channel Differential Extracellular Amplifier** (page 114) connected to PowerLab.

ADInstruments Advantage

- Complete software control of Bio Amps for high-quality signals
- LabChart ECG Analysis and HRV Modules for automatic detection, plotting and extraction of selected parameters
- Scope View for recording and viewing consecutive sweeps of ECG data
- ECG signals can be averaged using the LabChart for Mac SAECG Extension which calculates the averaged cycle of ECG signals
- Spectrum feature for online or offline determination of the power and frequency components of ECG.

Automated Analysis

The **ECG Analysis Module** (page 68) can be used to determine and quantify the salient components of an ECG during or after recording. The module provides powerful detection, analysis and reporting features. These include:

- Detection presets for a range of species, including human, dog, pig, rabbit, guinea pig, rat and mouse
- Presets are customizable for other species
- Extraction of 15 ECG parameters to an exportable table (can be saved as *.txt)
- Beat Classifier View for inclusion or exclusion of ECG beats in analysis
- Signal averaging and parameter plots.

Interbeat interval variation due to sympathetic/parasympathetic influences is easily identified and quantified using the **HRV Module** (page 69). Features include:

- Threshold detector to detect the R component from each ECG waveform and generate RR Interval data
- Automatic beat classification (normal, ectopic or artifact)
- Visual reporting of HRV through the Poincaré Plot, Period Histogram, ΔNN Histogram, Tachogram and LF, HF, and LF/HF parameters
- Display power spectrum of time-based Tachogram (FFT) with Spectrum View
- View limits of LF and HF regions of the Spectrum
- Text-based report including statistical analysis.

The cardiac vector can be calculated and displayed using the LabChart **Cardiac Axis Extension** (page 60). The extension automates the calculation of frontal plane electrocardiograms and the vectorcardiogram. It can also animate the instantaneous cardiac vector display. The **SAECG Extension** (page 60) calculates the averaged cycle of ECG signals. This allows for the removal of noise and unwanted waveforms.
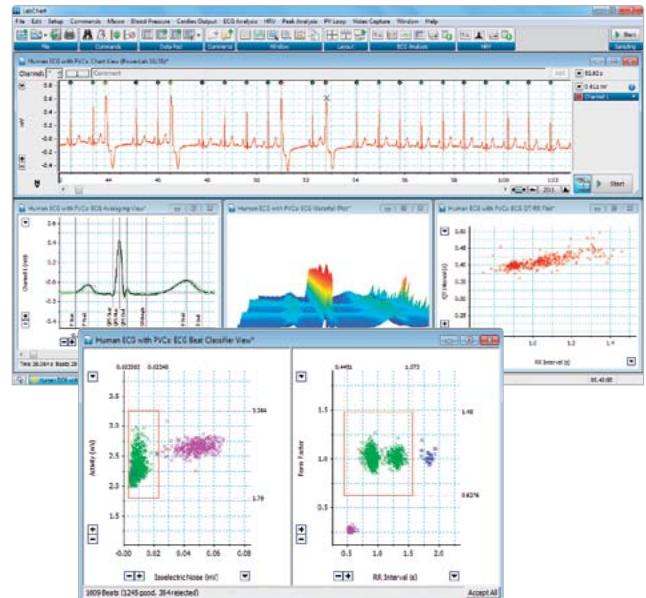
LabChart recording of Human ECG (top window) with premature ventricular contractions (PVCs). ECG Analysis Module allows classification of beats on the basis of noise, form factor and RR interval using the Beat Classifier View (bottom inset). Analysis plots including the Averaging View, Waterfall Plot and QT/RR Plot are shown above.
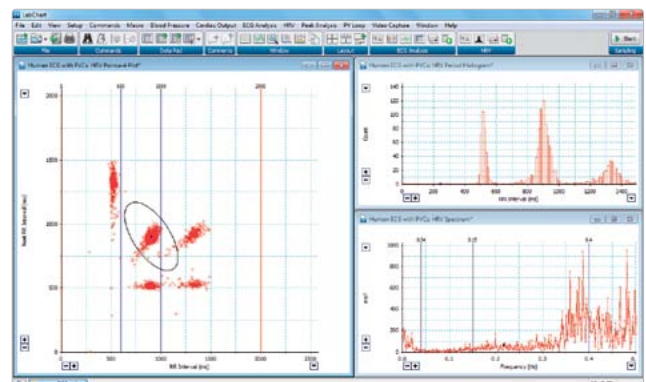
The HRV Module was used to analyze the ECG recording at top. Selected plots include the Poincaré Plot, Period Histogram and Spectrum.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

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Blood Flow, Cardiac Output and Oximetry

PowerLab data acquisition systems, in conjunction with a range of specialized instruments and transducers, allow researchers to record a number of hemodynamic parameters such as blood flow, oximetry and cardiac output.

Blood Flow

Relative Blood Perfusion

Relative blood flow measurements in tissues, organs and skin can easily be recorded using a PowerLab data acquisition system and the laser Doppler based **IN191 Blood FlowMeter** (page 106). The MRI compatible surface laser Doppler Probes are suitable for measuring blood perfusion of skin, tissue and brain. A variety of needle probes (for animal use only) are available for determining regional blood flow in tissues, organs and small vascular beds.

Perivascular and Tubing Flow Systems

Transonic Systems Flowmeters (page 107) provide accurate flow measurements for *in vivo* and *in vitro* applications. The Flowmeters use transit-time ultrasonic technology, the gold standard in volume blood flow measurement for the past two decades. This technology offers unprecedented volume flow resolution. Flowprobes and flowsensors are supplied calibrated and ready for immediate use. Complete **Perivascular and Tubing Flow Research Systems** (page 80) including PowerLab data acquisition units and LabChart Pro software are available.

A variety of **Transonic Flowprobes** (page 128) are available for continuous real-time volume flow measurements (mL/min) in conscious and anesthetized animals for acute and chronic studies. These probes are placed around the vessel and do not interfere with blood flow to the target tissues. Available in a wide range of sizes (0.5 to 35 mm) and configurations, the probes are suitable for recording in small and large vessels in a variety of species, ranging from mice through to cows.

Tubing Flowsensors (page 129) are used for volume flow measurements in tubing applications such as isolated perfused organ studies. The in-line flowsensors are easily spliced into laboratory tubing and are calibrated to measure volume flow of water, saline, buffer solutions, blood or other fluids. The four-transducer

ADInstruments Advantage

- Transonic Systems Flowmeters for accurate, gold-standard determination of volume blood flow measurement
- LabChart's Data Pad features for automatic extraction and logging of parameters of interest
- The LabChart Cardiac Output Module for extraction and calculation of cardiac output from small animals, using the thermodilution technique
- VB Scripting (Macros) in LabChart for control and automation of repetitive analysis tasks.

Cardiac Output

The **ML313C Cardiac Output Pod** (page 100) with the **MLT1402 T-type Ultra Fast Thermocouple** (page 147) is used to determine cardiac output using the thermodilution method in small animals (mice, rats, guinea pigs). Thermodilution is accurate, cost effective and superior to dye based measurements. The Cardiac Output Pod has a 'delta' temperature mode to allow a signal offset to be applied and monitor small temperature variations accurately.

The **Cardiac Output Module** (page 64) calculates cardiac output from selected thermodilution curves recorded in LabChart. Analysis parameters such as injectate temperature, volume, baseline correction and temperature tail-fitting limits are easily adjusted. The calculated data is automatically added to the Data Pad for further analysis.

The **Cardiac Output Accessory Kit** (page 130) includes an accurate syringe and dispenser, catheters, adapters, and taps, to facilitate the measurement of cardiac output.

Cardiac output can also be calculated in small and large animals with **Transonic Flowmeters** (page 107) and suitable probes, or **Millar MPVS Ultra** (page 88).

Oximetry

The **ML320 Oximeter Pod** (page 100) is suitable for measuring blood oxygen saturation (SpO$_2$) in humans. It connects directly to a PowerLab unit and is supplied with either a Finger Clip or Ear Clip sensor. The Oximeter Pod provides SpO$_2$ readings in the range of 70 to 100%. SpO$_2$ measurement in animals is also available using the **ML325 Animal Oximeter Pod** (page 100).

sensor design offers precision measurements for flows of less than 1 mL/min up to 100 L/min.
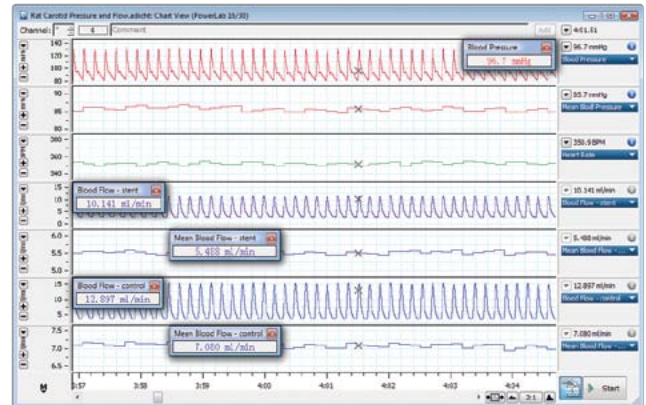
Recording of normal and thrombolytic induced occlusion of blood flow in rat carotid arteries using Transonic Systems flowmeter and probes. Data courtesy of Assoc. Prof. Christine Wright, University of Melbourne, Australia.
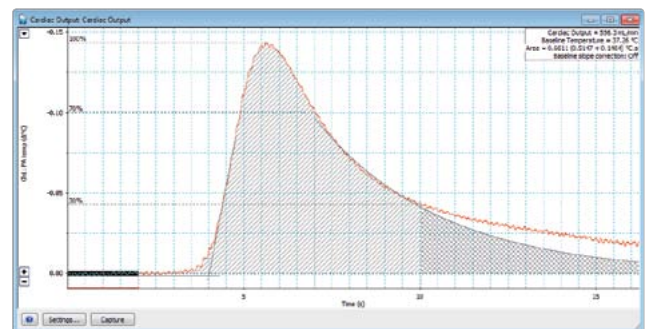
A thermodilution curve and parameters using the Cardiac Output Module.
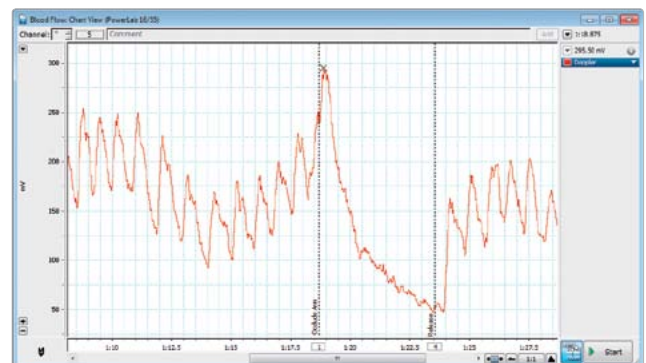
Changes in human blood flow before and after occlusion of the radial artery. Recording made using the IN191 Blood FlowMeter.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

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Respiratory and Airway

In vivo or *in vitro* respiratory and airway research data can be recorded and analyzed using ADInstruments PowerLab data acquisition systems and a range of specialized instruments and transducers.

Frequently recorded parameters include:
- Lung volumes and flow rates
- O_2 and CO_2 analysis
- Respiratory rate
- Lung sounds
- Intrathoracic pressure
- Bronchial/tracheal ring contraction (see Isolated Tissue application, page 32)
- Allergen/inflammation studies.

Spirometry

The spirometry technique is commonly used to assess lung function. It measures the amount (volume) and/or speed (flow) of air that is inhaled and exhaled.

The ADInstruments **FE141 Spirometer** (page 103) is a differential pressure transducer that can be used with a variety of **Respiratory Flow Heads** (page 142) for airway and flow studies from small to large animals and humans. For human respiratory studies where minimization of condensation is crucial, the **MLT3813H-V Heated Pneumotach** (Hans Rudolph) 800 L/min flow head with **Heater Controller** (page 142) is ideal.

Real-time respiratory flow and volume measurements are easily made in LabChart with the **Spirometry Extension**. The extension provides:
- Automated calibration of respiratory flow and volume recordings
- Advanced analysis functions
- Generation of flow-volume plots
- Calculation of tidal volume and respiratory rate
- Calculation of minute ventilation, peak inspiratory and expiratory flow.

Typical Equipment Used

PL3508/P PowerLab 8/35 (8 channels) with LabChart Pro

PL3516/P PowerLab 16/35 (16 channels) with LabChart Pro

FE141 Spirometer

Respiratory Flow Heads

ML206 Gas Analyzer

MLA246 Gas Mixing Chamber

MLT1132 Respiratory Belt Transducer

MLT844 Physiological Pressure Transducer

FE224 Quad Bridge Amp

MLT208 Digital Stethoscope

Software Highlights

MLS260/7 LabChart Pro

MLS380/7 Peak Analysis Module

Spirometry Extension

XY View

Spectrum

ADInstruments Advantage

- LabChart easily records spirometric flow and volume signals
- The Spirometry Extension processes the raw flow signal and displays respiratory parameters such as tidal volume, minute ventilation, respiratory rate, PIF, PEF, FVC, FEV_1
- Flow/volume or pressure/flow loops can be displayed online with the XY View in LabChart
- Lung sounds can be easily correlated with breathing cycles. The Spectrum feature can be used to easily analyze lung sound frequencies.

Respiratory Gas Analysis

The ADInstruments **ML206 Gas Analyzer** (page 119) in conjunction with a **PowerLab data acquisition system** can be used to measure and display concentrations of O_2 and CO_2 in real-time. The fast response time of the Gas Analyzer's transducers enables accurate respiratory gas analysis from humans. The instrument features a sampling flow control, making it suitable for use in mammalian studies.

Respiratory Rate

The **MLT1132 Respiratory Belt Transducer** (page 144) or **MLT415/A Nasal Temperature Probe** (page 148) are recommended for recording respiratory rate in humans. The Respiratory Belt Transducer plugs directly into a PowerLab input and can also be used in large animals such as dogs and pigs. The **MLT1010 Finger Pulse Transducer** (page 141) can be used for recording respiratory rate in small animals. The **Cyclic Variables** (page 55) feature in LabChart software can quickly and accurately detect periodic cyclical events and calculate rates from the signal.

Lung Sounds

Lung sounds can be recorded with the **MLT208 Digital Stethoscope** (page 131) using a high-frequency pulmonary setting. The Digital Stethoscope is a high-sensitivity microphone-based cardiac auscultation transducer. It allows distinction of audible heart sounds while simultaneously recording representative cardiac traces. The stethoscope can be connected directly to a PowerLab BNC input. Lung sounds and respiratory cycles can be easily correlated by recording the signals on separate channels and using the overlay feature in LabChart.
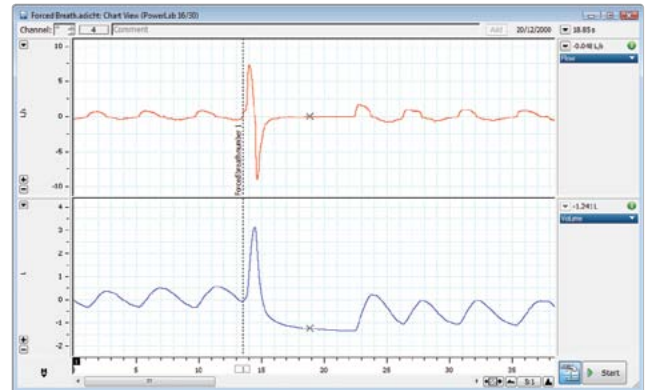
A flow volume recording of a forced expiration.
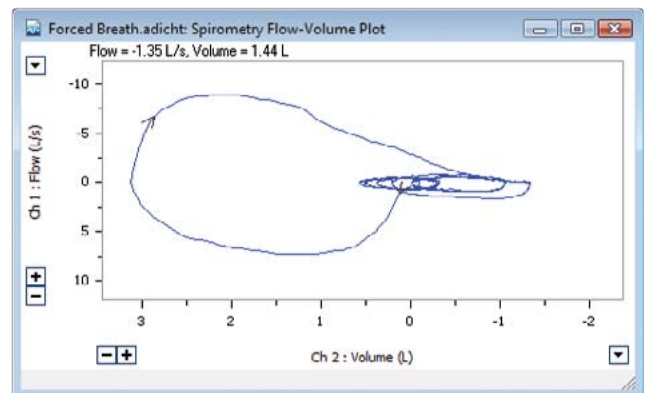
A flow-volume loop generated using LabChart's Spirometry Extension.
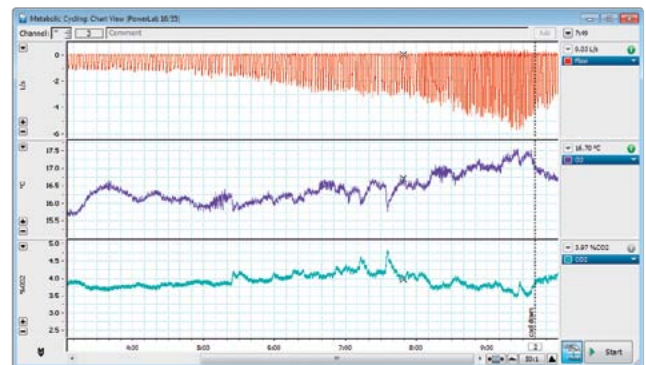
LabChart recording of respiratory gas concentrations and airflow.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

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Typical Equipment Used

Research Systems

PL3508B80 Exercise Physiology System

Individual Items

PL3508/P PowerLab 8/35 (8 channels) with LabChart Pro

PL3516/P PowerLab 16/35 (16 channels) with LabChart Pro

ML206 Gas Analyzer

MLA246 Gas Mixing Chamber

FE141 Spirometer

MLA240 Exercise Physiology Accessory Kit

FE135 Dual Bio Amp

MLT1132 Respiratory Belt Transducer

ML309 Thermistor Pod

Software highlights

MLS260/7 LabChart Pro

MLS240/7 Metabolic Module

MIS360/7 ECG analysis Module

MLS370/7 Blood Pressure Module

MLS310/7 Heart Rate Variability Module

MLS380/7 Peak Analysis Module

Spirometry Extension

XY View

Exercise Physiology

PowerLab systems provide both power and versatility for exercise/sports physiology applications. The PowerLab, in combination with LabChart Pro, records and analyzes a wide range of parameters. These include:

- Cardiopulmonary signals
- Respiration flow and volume
- Oxygen and carbon dioxide concentrations and rates
- Blood flow
- Heart performance (ECG, heart rate, R-R interval)
- Muscle activity (EMG)
- Reaction times.

Metabolic Studies

The **PL3508B80 Exercise Physiology System** (page 90) is ideal for studying cardiorespiratory and metabolic function in humans. The system includes a PowerLab 8/35 (8-channel data recording unit with LabChart software), single-channel Bio Amp, Respiratory Gas Analyzer, 4.7 L Gas Mixing Chamber, Spirometer, Thermistor Pod, Metabolic Accessory Kit and the LabChart Pro software suite including the **Metabolic Module** (page 70).

Airflow and gas concentration of expired air (%O_2 and %CO_2), are measured using the **FE141 Spirometer** (page 101) and the **ML206 Gas Analyzer** (page 119). Continuous real-time measurements of $\dot{V}_{CO_2}$, $\dot{V}_{O_2}$, $\dot{V}_E$ and the Respiratory Exchange Ratio (RER) are easily and automatically calculated and displayed in a number of plots and tables by the Metabolic Module.

For heavy exercise where minimization of condensation is crucial, the **MLT3813H-V Heated Pneumotach** (Hans Rudolph) 800 L/min flow head with Heater Controller (page 142) is recommended.

Biopotential recording such as ECG and EMG can be made with PowerLab and any of the ADInstruments **Bio Amps** for human use (page 97). Heart rate can be easily calculated in LabChart from an ECG using Cyclic Measurements.

The Exercise Physiology System is supplied with **LabChart Pro software** (page 62) which includes a number of application specific analysis modules.

ADInstruments Advantage

- The LabChart Metabolic Module calculates and displays ventilatory parameters such as $\dot{V}_{CO_2}$, $\dot{V}_{O_2}$, $\dot{V}_E$ and RER online from measurements of %O_2, %CO_2 and air flow
- Construct flow-volume loops online or offline with the Spirometry Extension
- Accurate O_2 and CO_2 respiratory gas analysis
- Transfer data easily to word processing or spreadsheet programs for further analysis and publication-quality reports
- Annotate data files with comments about experimental conditions.

LabChart Pro modules useful in exercise physiology studies include:

- Metabolic
- ECG Analysis
- Blood Pressure
- HRV
- Peak Analysis
- Video Capture

ECG signals can be averaged and analyzed using the **ECG Analysis Module** (page 68). The module automatically detects, analyzes and reports PQRST onset, amplitude and intervals online or offline. The **HRV Module** (page 69) can analyze the heart rate variability of the recorded ECG, again online or offline. **Video Capture** (page 74) can be used to record and synchronize a video recording with a LabChart data file recording. **Peak Analysis** (page 71) offers automatic detection and analysis of non-overlapping peaks in a recording.

NIBP Measurement

The **MLE1054-V Finometer MIDI** (page 109) can be used for noninvasive blood pressure measurements. It can be connected to a PowerLab to record, display and analyze the brachial arterial pressure and beat to beat values of systolic, diastolic and mean pressure. The **Blood Pressure Module** (page 62) for LabChart for Windows can be used to automatically extract arterial pressure parameters online or offline. Cardiac output can also be calculated with the additional purchase of MLE1055 BeatScope Easy or MLE1056 BeatScope 1.1a software.

Other instruments and transducers that can be interfaced with a PowerLab in exercise physiology studies include **oximeters** (page 100), **blood flowmeters** (page 106), **pulse transducers** (page 141), **goniometers** (page 131), **force transducers** (page 130), and **temperature sensors** (page 146).
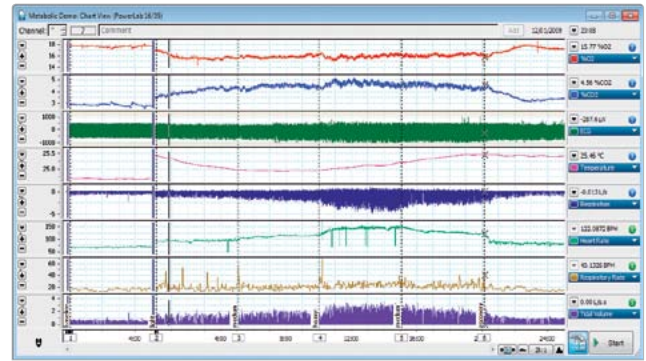
A recording of expired airflow and gas concentrations (CO_2 and O_2). Calculations of $\dot{V}_{CO_2}$, $\dot{V}_{O_2}$ and RER. As expired flow and gas concentration values are tabulated and displayed in the Log Window, the metabolic graphs such as RER vs Time and $\dot{V}_{O_2}$ vs $\dot{V}_{CO_2}$ are updated in real time.
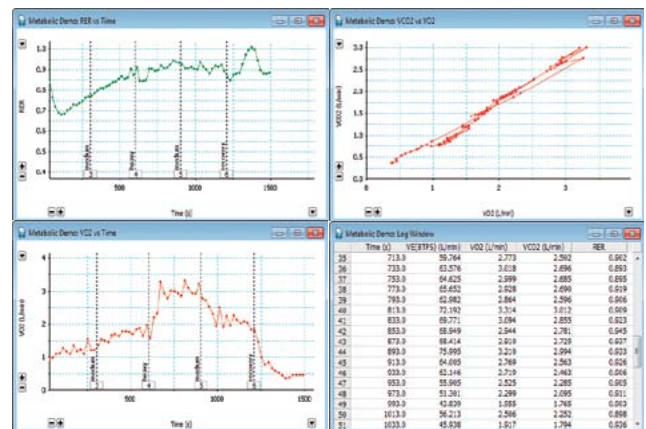
Graphs such as RER and $\dot{V}_{CO_2}$ versus Time are automatically generated using the Metabolic Module and displayed in real time.
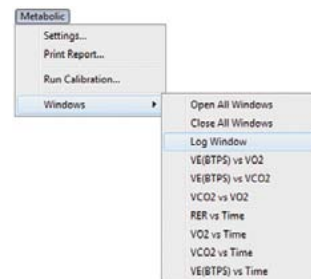
The Metabolic Module's Windows menu showing the list of available analysis plots.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

Lucas, S. J. E., Ainslie, P. N., Murrell, C. J., Thomas, K. N., Franz, E. a., & Cotter, J. D. (2012). Effect of age on exercise-induced alterations in cognitive executive function: Relationship to cerebral perfusion. *Experimental Gerontology*, article in. Elsevier B.V. doi:10.1016/j.exger.2011.12.002

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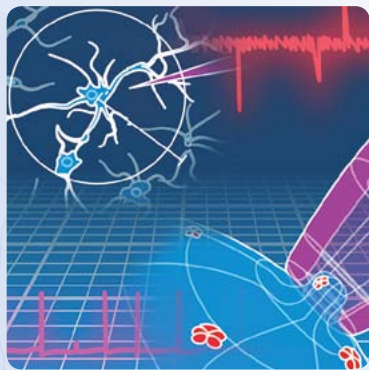
Typical Equipment Used

Research Systems

PL3508B73 Extracellular Recording System

PL3508B74-V Intracellular Recording System

PL3508B75-V Two Electrode Voltage Clamp Recording System

PL3508B76-V Oocyte Clamp Workstation

PL3508B77-V Single Channel Epithelial Voltage Clamp System

PL3508B78-V Dual Channel Epithelial Voltage Clamp System

PL3508B79/8-V Patch Clamp Recording System with 5101–100M Headstage

PL3508B79/9-V Patch Clamp Recording System with 5101–01G Headstage

PL3508B79/10-V Patch Clamp Recording System with 5101–10G Headstage

Individual Items

PL3508/P PowerLab 8/35 (8 channels) with LabChart Pro

FE185 Neuro Amp EX

DP-311 Differential Amplifier with Active Headstage

IE-210-V Intracellular Electrometer Amplifier

OC-725C-V Oocyte Clamp Amplifier

PC-501A Patch Clamp Amplifier

EC-800-V Epithelial Voltage Clamp

EC-825A-V Dual Channel Epithelial Voltage Clamp

Single and Dual Ussing Chambers

Intra/Extracellular and Clamp Headstages

Software Highlights

MLS062/7 Spike Histogram Module

MLS380/7 Peak Analysis Module

Scope View

Event Manager Extension

Telegraph Extension

Electrophysiology

ADInstruments Electrophysiology/Neurophysiology Research Systems include a PowerLab data acquisition system, LabChart Pro software and specialized amplifiers with accessories to record, analyze and display data from extracellular and intracellular studies.

Extracellular Recording

The **FE185 Neuro Amp EX** (page 102), an extracellular amplifier with extremely low noise, is used to record from single cells or groups of cells in humans or animals using a metal microelectrode. Approved for human use, it is ideal for microneurography studies. The **PL3508B73 Extracellular Recording System** (page 91) is used for recording signals with an AC/DC preamplifier and headstage with glass or metal microelectrodes. It has excellent CMRR specifications and high DC tolerance. It is best suited for recording of extracellular activity, ECG and EMG in animals.

Intracellular Recording

The **PL3508B74-V Intracellular Recording System** (page 92) is a low-noise amplifier with low drift and fast response time for recording from high-impedance fluid-filled glass electrodes. Current injection circuitry permits simultaneous stimulation and recording from a single electrode. These features and the lightweight headstage make it ideal for easy and accurate intracellular recording and current injection.

The **PL3508B75-V Two Electrode Voltage Clamp Recording System** (page 92) and **PL3508B76 Oocyte Clamp Workstation System** (page 93) are used for clamping large cells and cell structures such as Xenopus Oocytes and squid axons.

Patch Clamp Recording

Several **Patch Clamp Recording Systems** (page 93) with varying headstage sensitivities are available for measuring current levels passing through whole cells or individual ion channels using a blunt electrode.

Epithelial Voltage Clamp Recording

Epithelial Voltage Clamp Systems (page 92) are available for studies of epithelial transport and the electrical properties of tissue or cell layers held in **Ussing Chambers** (available separately).

ADInstruments Advantage

- Sample up to 200,000 Hz in a single channel (up to 400,000 Hz aggregate)
- Spike Histogram Module for discrimination and analysis of extracellular data
- Smoothing, Absolute Value, Integration and RMS Arithmetic calculations for data processing
- Scope View for spike-triggered averaging and the overlay of evoked responses
- Peak Analysis Module for analysis of non-overlapping peaks
- Telegraph Extension for correct scale display of data after a gain change.

Stimulators

A PowerLab dual analog output stimulator can be used to stimulate isolated tissue directly or trigger and control other high-powered stimulators. The **STG Stimulator series** (page 120) is ideal for neurophysiology applications. Features include optically isolated channels and voltage or current stimulation modes with impressive resolution.

Data Analysis

A wide range of electrophysiological signals can be analyzed using LabChart software. **LabChart's Scope View** (page 53) is a useful tool for averaging signals on multiple channels in real time. Scope View is of particular use in analysis of EEG, spike-triggered averaging and in evoked potential studies, where signal averaging is often required to extract evoked responses from background signal.

The **Spike Histogram Module** (page 73) can be used to perform real-time or offline discrimination and analysis of extracellular neural spike activity. Key features include:

- Freeform discriminating and fast template matching
- Selection of 6 customizable analysis histograms
- Removal of unwanted units from multi-unit recordings.

The **Peak Analysis Module** (page 71) provides a number of features that automate analysis of peaks. These include:

- Real time or offline analysis of peak parameters from action potentials, evoked responses and spikes
- Extracting parameters in a tabular format that can be exported to other programs for further analysis.

The **LabChart Telegraph Extension** (page 60) makes use of the gain-telegraph output from electrophysiological amplifiers for the continuous display of data at the correct scale after a gain change. LabChart can also save data as ABF (Axon binary format), which can be read by the pClamp software.
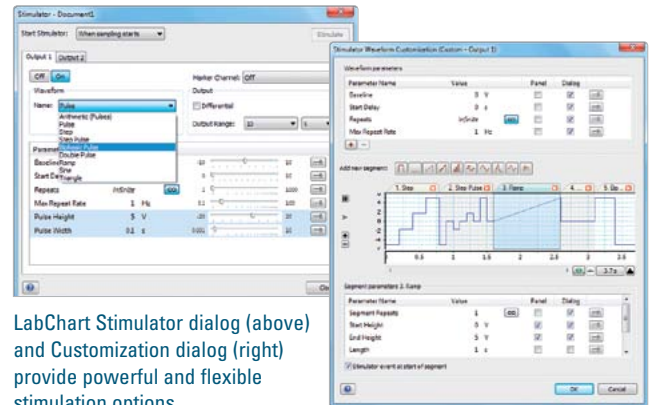
LabChart Stimulator dialog (above) and Customization dialog (right) provide powerful and flexible stimulation options.
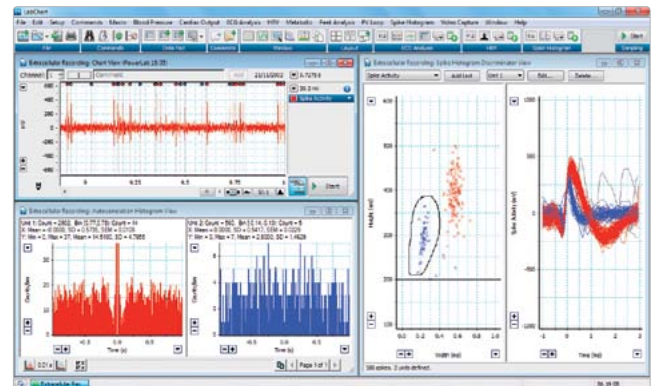
Analysis of extracellular spike data using the Spike Histogram Module.
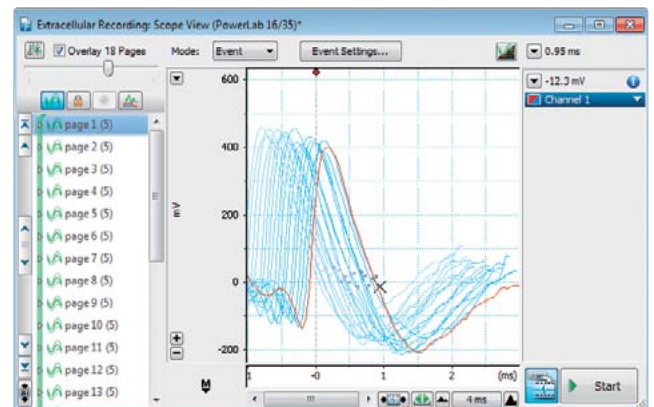
Defined spike units can be recorded as sweeps and averaged in LabChart's Scope View.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

Gill, J. K., Dhankher, P., Sheppard, T. D., Sher, E., & Millar, N. S. (2012). A Series of α7 Nicotinic Acetylcholine Receptor Allosteric Modulators with Close Chemical Similarity but Diverse Pharmacological Properties. *Molecular Pharmacology*. doi:10.1124/mol.111.076026

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Sleep

PowerLab data acquisition systems provide sleep researchers with a powerful, yet easy-to-use tool for acquiring and analyzing an extensive range of physiological parameters relating to cardiovascular function, sleep disordered breathing, restless leg syndrome and sudden infant death syndrome, in both animal and human subjects.

PowerLab systems (page 78) can record and display up to 32 channels of data simultaneously in LabChart. Variable sampling rates enable synchronous recording of low frequency signals (for example, temperature and respiration) and high frequency signals (for example, EEG and EMG), while ensuring manageable data file sizes. Commonly recorded parameters in sleep studies include:

- Electroencephalogram (EEG/ECoG)
- Electrooculogram (EOG)
- Electromyogram (EMG)
- Electrocardiogram (ECG)
- Respiratory rate, airflow and pressure
- Oxygen saturation
- Intravascular and surface blood flow
- Invasive and noninvasive blood pressure
- Skin and rectal temperature.

Biopotential Recordings

The **ML138 Octal Bio Amp** (page 97) and **GT201/F 16 Channel Bio Amp** (page 106) are ideal for recording multiple potentials from a single subject. ADInstruments **Bio Amps** (page 97) interface with **Flat EEG/EMG Electrodes, ECG Clip Electrodes** or the **Unshielded Lead Wires with Snap-On Connectors** (page 125). Alternatively, the **EEG Electro-cap Systems** (page 127) can be used for human subjects. For animal studies, **Alligator Clip Lead Wires** or **Needle Electrodes** are available (page 125).

LabChart (page 40) offers numerous features and advanced modules for analysis of sleep data. The **Blood Pressure** (page 62), **ECG Analysis** (page 68) and **HRV** (page 69) **Modules** quickly and easily analyze cardiovascular data. The **Circadian Analysis Module** (page 65) can be used to determine patterns over unlimited durations, and the Spectrum feature allows spectral frequency analysis of signals such as EEG.

Typical Equipment Used

PL3508/P PowerLab 8/35 (8 channels)
   with LabChart Pro

PL3516/P PowerLab 16/35 (16 channels)
   with LabChart Pro

ML138 Octal Bio Amp

GT201/F 16 Channel Bio Amp

MLE1054-V Finometer

IN191 Blood Flowmeter

MSP100XP Standard Surface Probe

ML309 Thermistor Pod

MLT422/A Skin Temperature Probe

MLT1132 Respiratory Belt Transducer

MLAEC1 or 2 EEG Electro-cap Systems

ML320 Oximeter Pod

MLAWBT9 EEG Flat Electrodes

MLA410 Physiology Accessory Kit

MLA1010 Disposable ECG Electrodes

Software Highlights

MLS260/7 LabChart Pro

MIS360/7 ECG Analysis Module

MLS370/7 Blood Pressure Module

MLS310/7 Heart Rate Variability Module

MLS395/7 Circadian Analysis Module

MLS380/7 Peak Analysis Module

MLS320/7 Video Capture Module

Spectrum

Scope View

ADInstruments Advantage

- Spectral frequency (FFT) analysis of EEG, EMG and snoring sounds with LabChart's Spectrum View
- A selection of digital filters including high, low and band-pass/stop options
- Heart rate variability analysis using the HRV Module
- Circadian Analysis Module for recordings over unlimited durations
- Synchronized video/data recording of the subject with Video Capture Module
- Sampling control and Scope View for stimulus control and the overlay and averaging of responses.

Respiration and Oxygenation

Respiratory Belt Transducers, **Spirometer and Flow Heads** and **Pressure Transducers** are available (page 142 onward) to record respiratory rate, airflow and pressures in both animal and human subjects. LabChart's **Cyclic Measurements** feature (page 56) and **Peak Analysis Module** (page 71) provide extensive analysis options for cyclical waveforms (see Respiratory and Airway application pages for further information). The **ML320 Oximeter Pod** (page 100) and a respiratory **Gas Analyzer** (page 119) are also available for measuring SpO_2 and concentration of O_2 and CO_2, respectively.

Blood Pressure and Flow

Continuous, noninvasive blood pressure in humans can be easily measured using the **MLE1054-V Finometer MIDI** (page 109) with a variety of finger cuff sizes. The **Blood Pressure Module** (page 62) automatically extracts arterial pressure measurements online or offline, while noninvasive cardiac output can be calculated using **BeatScope software**.

Relative blood flow (in perfusion units) can be measured invasively (needle electrodes) or noninvasively using the **IN191 Blood Flowmeter** (page 106), while calibrated (mL/min) measurements can be performed using **Transonic Blood Flow Systems** (page 80) with customizable flowprobes sized appropriately for mice to large animals.

Wireless Animal Recordings

The **Telemetry Foundation System** (page 91) provides wireless recordings of biopotential, nerve, blood pressure and temperature of an animal during sleep. The systems allow long-term experimental protocols required for analysis of circadian rhythms using the **Circadian Analysis Module** (page 65). See Telemetry application pages for further information (page 14).
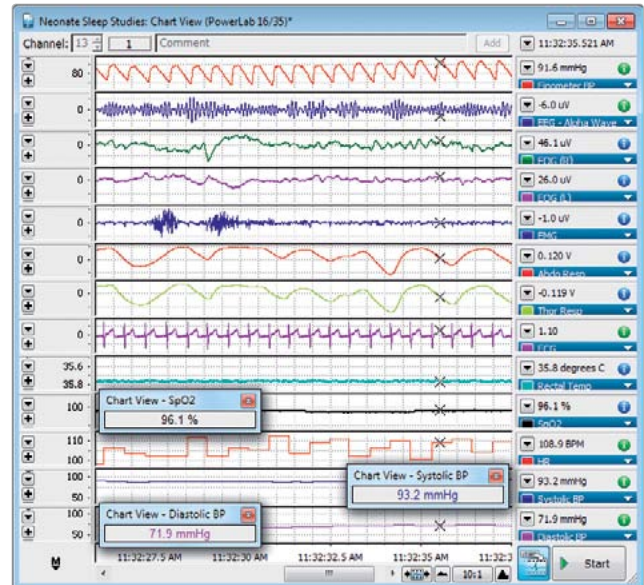
Chart View shows a 13 Channel polysomnic recording from a human Neonate during quiet sleep. Data include blood pressure, ECG, EEG, EMG, EOG, respiration, heart rate, temperature and oxygen saturation. Data provided by Dr. R. S.C. Horne, The Richie Centre for Baby Health Research, Monash University, Australia.
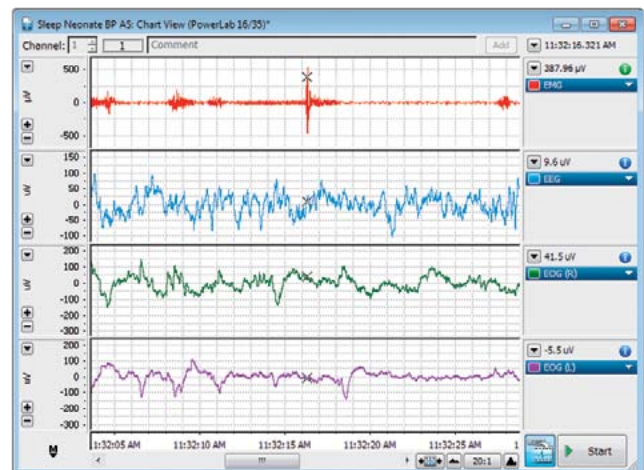
Recording of EMG, EEG and EOG from a human neonate during quiet sleep. Data provided by Dr R. S. C Horne, Monash University.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

Witcombe N, Yiallourou S, Sands S, Walker A, Horne R. Preterm birth alters the maturation of baroreflex sensitivity in sleeping infants. *Pediatrics*, 129(1), e89-e96, 2012

Nanduri J, Makarenko V, Reddy V, Yuan G, Pawar A, Wang N, Khan S, Zhang X, Kinsman B, Peng Y, Kumar G, Fox A, Godley L, Semenza G, Prabhakar N. Epigenetic regulation of hypoxic sensing disrupts cardiorespiratory homeostasis. *Proceedings of the National Academy of Sciences*, doi:10.1073/pnas.1120600109, 1–6, 2012

Walter LM, Nixon GM, Davey MJ, O. Sleep disturbance in pre-school children with obstructive sleep apnoea syndrome. *Sleep Medicine*, 12, 880–886, 2011

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Psychophysiology

PowerLab data acquisition systems are widely used for researching the psychological basis of physiological processes including autonomic nervous system function, cardiorespiratory control, cortical function, pain and more. Typical research applications include:

- Skin conductance responses (GSR/SCR/EDR)
- Electrocardiography (ECG)
- Heart Rate Variability (HRV)
  - Sympathovagal tone (LF/HF)
- Evoked potentials
  - Visual (VEP)
  - Auditory (AEP)
  - Event-related brain potentials (ERPs)
- Electroencephalography (EEG)
- Reaction time and reflexes
- Stimulus presentation (using systems such as E-Prime and SuperLab)
- Blood pressure
- Skin temperature
- Respiratory analysis
  - Spirometry
  - Respiration rate
- Polygraphy.

Skin Conductance (GSR/EDR)

Skin conductance can be used to measure a subject's anxiety and emotional state. Using **FE116 GSR Amp** (page 102) and a PowerLab data acquisition unit with LabChart software, skin conductance measurements can be easily recorded and analyzed. The fully isolated and certified safe-for-human-use **GSR Amp** comes supplied with **MLT116F GSR Finger Electrodes** (page 128). The **MLT117F GSR Finger Electrodes** variant provides the option for use with MRI equipment. Extended cable length can be supplied on request.

Typical Equipment Used

PL3508/P PowerLab 8/35 (8 channels) with LabChart Pro

ML408 Dual Bio Amp/Stimulator

ML138 Octal Bio Amp

FE116 GSR Amp

MLE1054-V Finometer MIDI

SPT-301 Millar Non-Invasive Pulse Tonometer

ML309 Thermistor Pod

MLT409 Skin Temperature Probe

MLT1100 Sphygmomanometer

MLT201 Cardio Microphone

MLA92/D Push Button Switch

MLT1132/D Respiratory Belt Transducer

ML317 EOG Pod

MLAC34 E-Prime Interface Cable

MLE1300 StimTracker Universal Marker Interface

RB Series Response Pads

MLT1601/ST Response Meter

IN191 Blood FlowMeter

MLT422/A Skin Temperature Probe

MLT1010 Piezo Electric Pulse Transducer

Software Highlights

MLS260/7 LabChart Pro

MLS395/7 Circadian Analysis Module

MLS370/7 Blood Pressure Module

MLS380/7 Peak Analysis Module

MLS310/7 Heart Rate Variability Module

MLS320/7 Video Capture Module

VB Scripting (LabChart Macros)

Peak Parameters Extension

ADInstruments Advantage

- Spectral frequency (FFT) analysis of ECG, EEG and EMG with LabChart's Spectrum View
- Heart rate variability analysis using the LabChart's HRV Module
- Synchronized video and data with LabChart's Video Capture Module
- PowerLab and LabChart can be interfaced with stimulus presentation software and hardware packages such as SuperLab and E-Prime
- Event Manager Extension for defining and controlling events in LabChart.
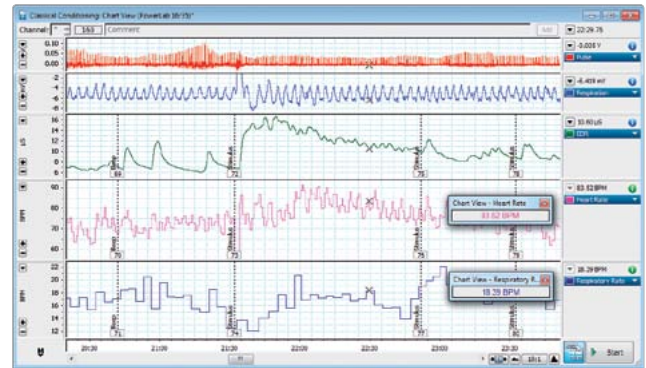
Biopotential Recordings

Biopotential signals are recorded using a PowerLab and an ADInstruments **Bio Amp** (page 94). The choice of the Bio Amp model depends on the number of recording channels required for the application. For ECG and HRV analysis, the **FE135 Dual Bio Amp, ML138 Octal Bio Amp** or **GT201/F 16 Channel Bio Amp** (pages 97 & 106) are recommended.

Automated analysis of ECG is possible with the **ECG Analysis Module** (page 68). Used to determine and quantify components of an ECG, the module provides powerful detection, analysis and reporting features. These include:

- Detection presets for a range of species (human, dog, pig, rabbit, guinea pig, rat and mouse)
- Preset customization for any species
- Beat Classifier for inclusion/exclusion of ECG beats
- Signal averaging and graphical plots
- Automatic extraction of 15 ECG parameters.

When combined with spectral analysis, HRV provides quantitative information about the relative influence of the sympathetic and parasympathetic nervous systems. The **HRV Module** (page 69) is a comprehensive tool for calculating and analyzing a subject's HRV online or offline. Inter-beat interval variation can be automatically identified and quantified. Both visual and text based reports are available through the Poincaré Plot, Period Histogram, Delta NN Histogram, Tachogram and Spectrum (FFT) windows (sympathovagal tone) and a statistical report.

For EEG recording, LabChart's **Spectrum View** (page 53) provides spectral analysis allowing quantification of the frequency and power components of the subject's EEG.

Pulse, respiration, electrodermal response and heart rate recorded during successive stimuli presented in a classical conditioning experiment.
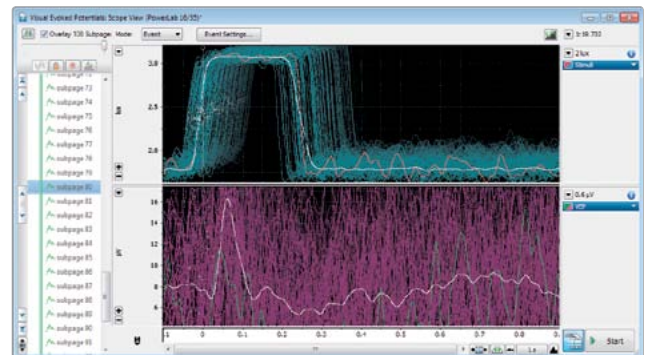
Recording of the evoked potential from the visual cortex of a human (channel 2). Averaging removes typical noise in such a recording. Channel one indicates changes in the visual stimuli patterns.
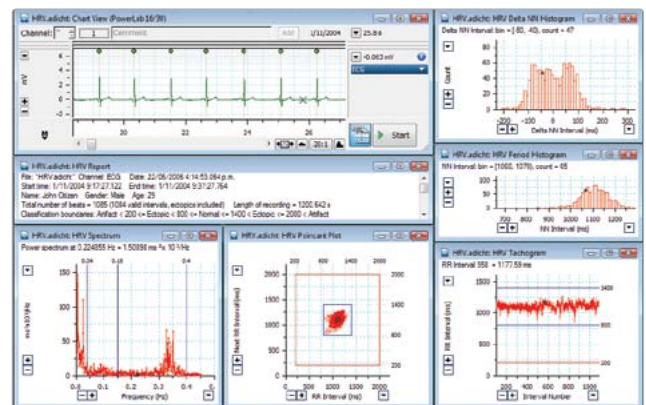
The Heart Rate Variability Module showing a variety of histograms, plots and statistics.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

McFadden K, Healy K, Hoversten K, Ito T, Hernández T. Efficacy of acupressure for non-pharmacological stress reduction in college students. *Complementary Therapies in Medicine*, doi:10.1016/j.ctim.2011.12.003, 2012

Melville G, Chang D, Colagiuri B, Marshall P, Cheema B. Fifteen Minutes of Chair-Based Yoga Postures or Guided Meditation Performed in the Office Can Elicit a Relaxation Response. *Evidence-Based Complementary and Alternative Medicine*, 10.1155/2012/501986, 1–9, 2012

LaCount LT, Barbieri R, Park K, Kim J, Brown EN, Kuo B, Napadow V. Aviation, Static and dynamic autonomic response with increasing nausea perception. *Space and Environmental Medicine*, 82(4), 424–433, 2011

C Staunton, S Hammond. An Investigation of the Guilty Knowledge Test Polygraph Examination. *Journal of Criminal Psychology*, 1, 1–14, 2011

McAndrew, A., Jones, F. W., McLaren, R. P., & McLaren, I. P. L. (2012). Dissociating expectancy of shock and changes in skin conductance: An investigation of the Perruchet effect using an electrodermal paradigm. *Journal of Experimental Psychology. Animal behavior processes.* doi:10.1037/a0026718

Visual Stimulation and Reaction Times

PowerLab systems can be easily interfaced with stimulus presentation software and hardware. **SuperLab** stimulus presentation software (page 116) enables the presentation, recording and analysis of reaction times to visual and auditory stimuli. Using the **MLE1300 StimTracker** (page 118) reaction times to stimuli presented in SuperLab can be synchronized with physiological signals acquired and analyzed in real time using a PowerLab data acquisition and analysis system.

RB Series Response Pads (page 151) can be interfaced directly with a PowerLab via a Response Pad to PowerLab Cable or indirectly via the StimTracker. Response Pads are available with 5, 7 and 8-Buttons.

The **MLAC34 E-Prime Interface Cable** (page 151) allows the PST (Psychology Software Tools) serial response box to connect to the digital inputs on a PowerLab. Eight active keys from the PST Box can be used to trigger Digital Inputs 1–8 (on a suitable PowerLab) and insert Preset Comments into LabChart while recording.

Continuous varying responses to stimuli can be recorded in LabChart using ADInstruments **MLT1601/ST Response Meter** (page 151). This can be used where discrete responses are not warranted.

The **Event Manager Extension** (page 60) for LabChart for Windows allows users to define and monitor events online and perform a variety of user-defined actions. The **Scope View** (page 53) feature provides signal-averaging techniques to investigate visual and auditory-evoked potentials in signals such as EEG.

Cardiorespiratory Effects

PowerLab Systems enable psychophysiologists to monitor cardiorespiratory parameters such as blood pressure, skin temperature, respiratory rate, pulse, and blood perfusion in skin. The **MLT1100 Sphygmomanometer** (page 140) and **MLT201 Cardio Microphone** (page 131) can be used to obtain discrete, noninvasive blood pressure measurements using oscillometry or auscultation.

Continuous, noninvasive blood pressure (NIBP) can be recorded and simultaneously analyzed using the **MLE1054-V Finometer MIDI** (page 109), **PowerLab** and **BP Analysis Module** (page 62). Changes in skin blood perfusion can be obtained using the **IN191 Blood FlowMeter** (page 106) and a standard Surface Probe. Skin temperature can be recorded using a **ML309 Thermistor Pod** (page 105) and a skin temperature probe.

ADInstruments Advantage

- Third-party instruments, such as audio generators, can be interfaced with PowerLab using analog (TTL) or digital outputs
- Ability to add searchable comments/annotations to the data trace
- LabChart ECG Module for automated detection, averaging, and parameter extraction of ECG waveforms and PQRST components
- Cyclic Measurements in LabChart for detection, calculation and analysis of waveforms with a cyclical nature.

Polygraphy

Polygraphy combines several physiological measures used by researchers to distinguish between truth and deception. Typical physiological measures include:

- Skin conductance
- Skin temperature
- Respiration rate
- Heart rate (derived via Channel Calculations on either pulse or ECG signal).

Skin conductance can be recorded with the use of the **GSR Amp** (page 102) and a PowerLab. A **Thermistor** (page 148) with the **ML309 Thermistor Pod** (page 105) can acquire accurate physiological temperature readings. The respiratory rate can be efficiently recorded using the **MLT1132/D Respiratory Belt Transducer** (page 144). Heart rate can be derived from a pulse recording using the **MLT1010 Pulse Transducer** or an ECG recording using an ADInstruments **Bio Amp** (page 97).

Data and Video Synchronization

Data acquisition can be synchronized with live video recording using the **Video Capture Module** (page 74). Videos are recorded (typically using USB based web cameras) simultaneously with physiological data. Video analysis allows psychophysiologists to correlate a subject's behavior (i.e. facial expression) with physiological data (i.e. heart rate variability).
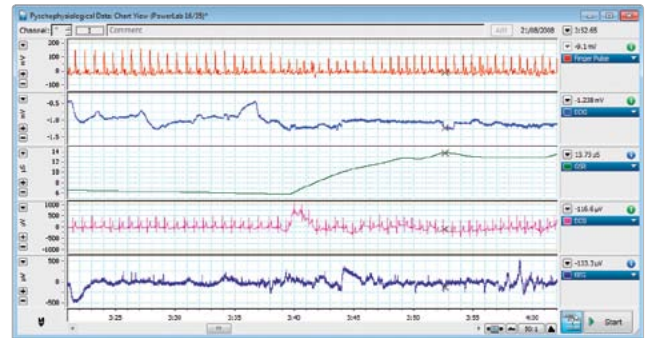
A recording of data from a human subject during stimulus presentation. Data acquired include finger pulse, EOG, GSR, ECG and EEG.
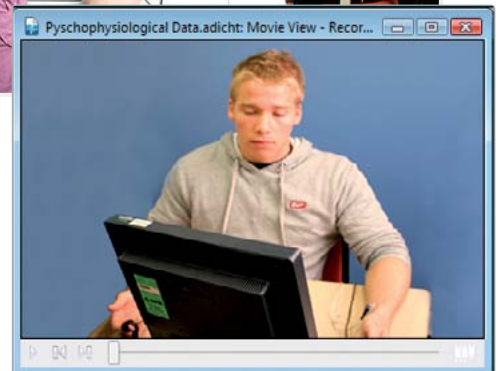
The Video Capture Module allows synchronization of visual data in video format (i.e. subject behavior, activity and facial expression) with physiological data recorded with LabChart software.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

Eye contact and arousal: The effects of stimulus duration. Helminen T.M., Kaasinen SM, Hietanen JK., *Biological Psychology*, 88, 124–130, 2011

Physiological responses to simulated and on-road driving. Johnson M. J., Chahal T, Stinchcombe A, Mullen N, Weaver B, Bédard M., International *Journal of Psychophysiology*, 81, 203–208, 2011

An Investigation of the Guilty Knowledge Test Polygraph Examination. Staunton C & Hammond S. *Journal of Criminal Psychology*, 1(1), 1–14, 2011

Static and dynamic autonomic response with increasing nausea perception. LaCount LT, Barbieri R, Park K, Kim J, Brown EN, Kuo B, Napadow V, *Aviation Space and Environmental Medicine*, 82(4), 424–433, 2011

Effects of emotional excitement on heart rate and blood pressure dynamics in patients with coronary artery disease. Piira O., Huikuri HV, Tulppo MP. *Autonomic Neuroscience: Basic and Clinical*, 160, 107–114, 2011

The Effect of Associative and Dissociative Attentional Focus Strategies on Muscle Activity and Heart Rate During a Weight Training Exercise. Neumann D. L. and Heng S. *Journal of Psychophysiology*, 25 (1), 1–8, 2011

Isolated Tissue

PowerLab systems are well suited to recording physiological and pharmacological properties of isolated tissue including skeletal, cardiac, and smooth muscle.

Tissue-Organ Bath Systems

Complete **Isolated Tissue Research Systems** (pages 81 to 83) featuring organ bath systems with four, eight or sixteen tissue chambers are available in compact and modular styles.

Compact Encased Tissue-Organ Bath Systems

The compact, all-in-one organ baths from Panlab allow automatic filling and emptying of tissue chambers. In addition they feature:

- Immersion of all tissue chambers and perfusate warming coils in a single temperature controlled bath
- Individual or simultaneous filling and emptying of tissue chambers
- Compact design to save on bench space
- Bath capacity options between 5 and 50 mL.

Modular Tissue-Organ Bath Systems

The modular systems (**PL3508B60, PL3508B61, PL3516B62**) include a PowerLab, a Radnoti tissue-organ bath, a bridge amplifier and isometric transducers. They offer:

- Traditional, glassware-on-stand design
- Water-jacketed reservoirs and tubing for perfusate temperature stability
- Easy addition and substitution of components
- Modular design for easy customization of glassware
- Bath capacity options between 5 and 300 mL.

Myograph based systems are also available for recording tension in:

- Small isolated blood vessels (>60 μm)
- Large isolated blood vessels (>500 μm)
- Large isolated vessels/tubular structures (<10 mm)
- Isolated muscle strip preparations <15 mm).

For more information on myograph systems see overleaf and pages 83 and 112 of the hardware section.

ADInstruments Advantage

- Complete research systems for isolated tissue experiments
- Dose Response Module for investigating responses to agonists/antagonists
- Data Pad for automated extraction of experimental data
- LabChart software can control stimulation frequency and timing of pulse trains using an external stimulator
- GLP Client for data acquisition and analysis in a 21 CFR Part 11 compliant environment.

Bridge Amplifiers and Transducers

ADInstruments **Single, Quad or Octal Bridge Amps** (page 99) are software-controlled preamplifiers, providing a range of filter and amplification settings for isometric or isotonic transducers. Once connected, the bridge amplifiers are automatically identified by the PowerLab system and all user-configured settings are stored when the data file is saved. A range of **Isometric and Isotonic Transducers** (page 130) of varying specifications is available.

## Stimulators & Stimulating Electrodes

The PowerLab analog output can be used directly as a stimulator or as a trigger to control the frequency and pulse duration of an external stimulator. ADInstruments also supplies a variety of powerful **external stimulators** (pages 103 and 119) that supply voltage and/or current stimulation and feature extensive programming options. A range of **Stimulating Electrodes** (page 149) for various types of tissues and experimental studies are also available (including single/double ring stainless steel or platinum, straight, zig-zag, coil, flat, and L-shaped electrodes).

PowerLab systems can also control perfusion pumps, syringe pumps or auto-injectors via eight TTL compatible digital outputs. The **Event Manager Extension** (page 60) is ideal for controlling user-defined events.

Software Modules

The **Dose Response Module** (page 67) provides quick and flexible tools for investigating the relationship between drug concentration and tissue response. The module automatically identifies minimum and maximum response ranges and generates a non-linear fit to the response data for the calculation of EC_{50} and Hill Slopes.

The **Peak Analysis Module** (page 71) provides automatic detection and analysis of multiple, but not overlapping, signal peaks in acquired waveforms.
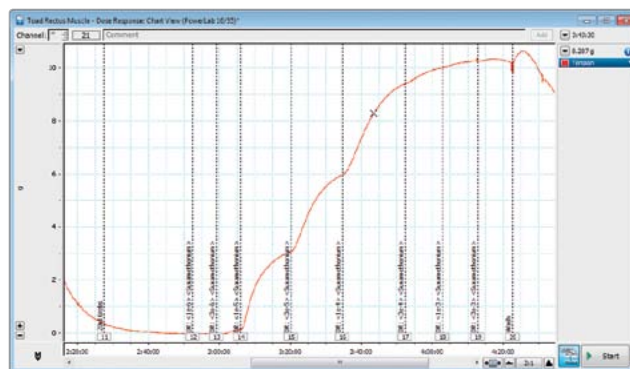
Toad rectus muscle response to increased doses of Suxamethonium.
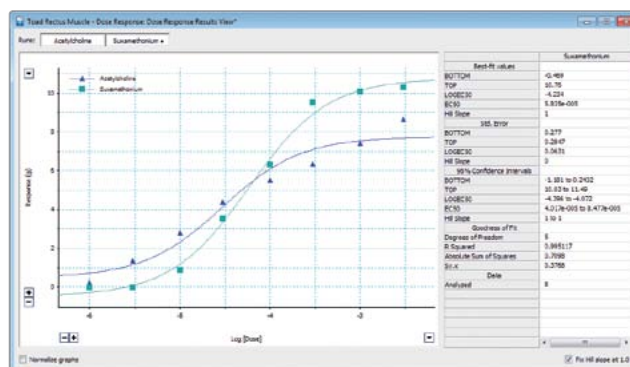
Dose Response Module Results View showing fitted response curves to increasing doses of Suxamethonium and Acetylcholine.
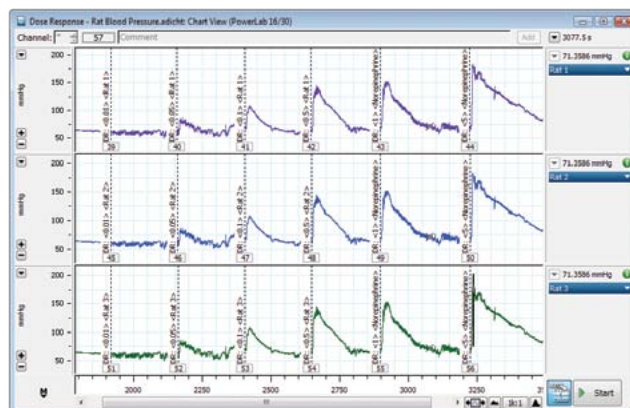
Recording of rat aortic blood pressure with cumulative drug responses. Data were digitally filtered to show only the average pressure per beat.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

Kang, Y. H., & Shin, H. M. (2012). Cinnamomi ramulus Ethanol Extract Exerts Vasorelaxation through Inhibition of Ca Influx and Ca Release in Rat Aorta. *Evidence-based complementary and alternative medicine: eCAM*, 2012, 513068. doi:10.1155/2012/513068

Lau, Y.-S., Machha, A., Achike, F. I., Murugan, D., & Mustafa, M. R. (2012). The aporphine alkaloid boldine improves endothelial function in spontaneously hypertensive rats. *Experimental Biology and Medicine* (Maywood, N.J.), 237(1), 93–8. doi:10.1258/ebm.2011.011145

Shing, C. M., Fassett, R. G., Brown, L., & Coombes, J. S. (2012). The effects of immunosuppressants on vascular function, systemic oxidative stress and inflammation in rats. *Transplant International: Official Journal of the European Society for Organ Transplantation*, 1-10. doi:10.1111/j.1432-2277.2011.01420.x

Kawakami, T., Puri, N., Sodhi, K., Bellner, L., Takahashi, T., Morita, K., Rezzani, R., et al. (2012). Reciprocal Effects of Oxidative Stress on Heme Oxygenase Expression and Activity Contributes to Reno-Vascular Abnormalities in EC-SOD Knockout Mice. *International Journal of Hypertension*, 1–11. doi:10.1155/2012/740203

Mollica, J. P., Dutka, T. L., Merry, T., Lamboley, C., McConell, G. K., McKenna, M. J., Murphy, R. M., et al. (2012). S-glutathionylation of Troponin I (fast) increases contractile apparatusCa2+-sensitivity in fast-twitch muscle fibres of rats and humans. *The Journal of Physiology*, 1–51. doi:10.1113/jphysiol.2011.224535

Myography

Wire myographs are ideal for *in vitro* investigations of smooth muscle structure and function in tubular tissues >60 μm in diameter (i.e. vein, artery, bronchi, vas deferens and similar).

Myographs are available individually in single, dual, four-chamber and laser scanning confocal microscopy models. They are also available as part of the complete **Myograph Research Systems** (page 83) (**PL3508B21, PL3508B22, PL3508B23, PL3508B24/TS, PL3508B25**) that include a PowerLab data acquisition system, DMT Wire Myograph, LabChart Pro software with the DMT Normalization Module.

Features and benefits include:

- Stainless steel jaws for easy mounting of the tissue
- Small bath volume (5 to 10 mL) to conserve reagents
- Individually heated and aerated chambers to optimize tissue conditions
- Automated control of the micropositioners to determine passive length-tension relationships (DMT510A Auto Dual Wire Myograph only)
- Force measurements easily calibrated into mN using Units Conversion.

The **Confocal Wire Myograph** (page 113) combines Laser Scanning Confocal Microscopy with myography to allow simultaneous measurements of isometric force and fluorescence (confocal microscope not supplied). Example applications include studies that correlate isometric contractions in isolated, mounted blood vessels and intracellular Ca^{2+} measurements within the vascular smooth muscle cells.

Tissue Normalization

Normalization takes into account the amount of contractile tissue to determine the optimal pretension conditions for each tissue being investigated. Setting the pretension according to these parameters reduces inter- and intra-variability of tissue responses in the preparations. The ADInstruments **DMT Normalization Module** (page 66) provides the user with the ability to easily and accurately determine and set the optimal pretension parameters for each piece of tissue investigated. The algorithms used in this software module are based on previously validated and published research by Professor Michael Mulvaney (University of Aarhus, Denmark).

ADInstruments Advantage

- Fast data extraction and analysis with Dose Response, DMT Normalization and Peak Analysis Modules, as well as LabChart features such as Timed Add to Data Pad and Multiple Add to Data Pad
- Data Pad mini-windows for easy display of current values of measurements or calculations set up in the Data Pad
- The LabChart GLP Client and GLP Server software offers a comprehensive audit trail, secure signing and a centralized user authorization system required for GLP and 21 CFR Part 11 (FDA) compliant environments.

Multi Chamber Myographs

ADInstruments supplies **Multi Chamber Myographs** (pages 112-113) that feature four bath chamber units for simultaneous tension measurements. They are available in several configurations including:

- **DMT620M Multi Chamber Myograph w/Touch Screen** (also available as part of the **PL3508B24/TS** research system) for microvessels greater than 60 µm diameter

- **DMT720MO Tissue Bath System w/Touch Screen** for large isolated blood vessels (>500 µm) and other large vessels or tubular structures (up to 10 mm), such as trachea or gut mounted as large ring preparation

- **DMT820MS Muscle Strip Myograph w/Touch Screen** for isolated skeletal or other muscle preparations, mounted as a strip (15 mm in length) between clamp supports.

Features of the multi chamber myographs include:

- A graphical color touch screen menu

- Easy interchange of bath chamber type, enabling customized bath configurations

- A built-in temperature control unit

- High-resolution force transducers and micrometers

- Acid-resistant stainless steel chamber

- Individually controlled gas inflow and solution suction in each chamber insert unit

- Analog outputs which can be connected directly to PowerLab for data recording and analysis.

The **DMT100192 Automated Buffer Filler System 2** (page 113) provides an easy and automatic means of replacing buffer in the bath chambers.
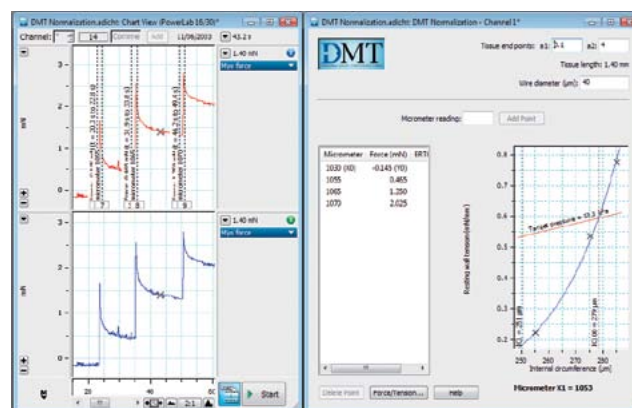
DMT Normalization window with stepwise distension of the tissue using the micrometer and the developed force measured. The graph on the right is automatically generated from the calculated internal circumference and resting wall tension.
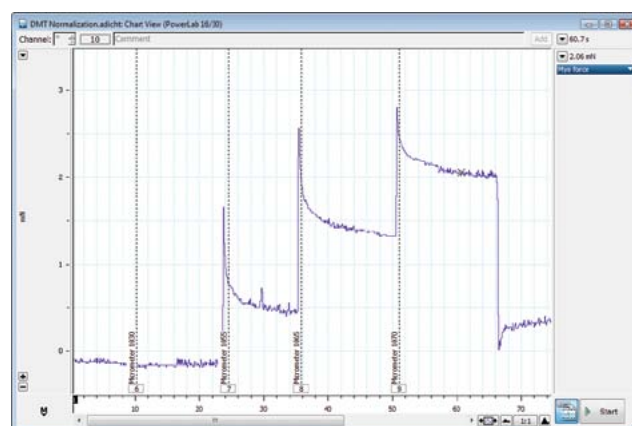
Data recorded with LabChart software and PowerLab showing step-wise distension and force measurement of the tissue.
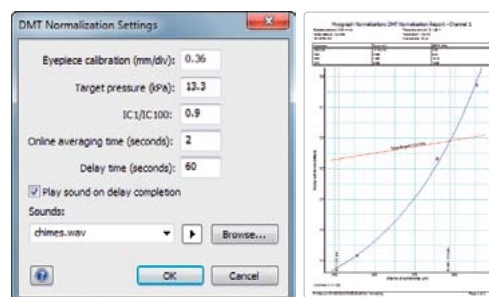
Left: DMT Normalization settings window, Right: DMT Normalization Report.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

González-Forero D, Montero F, García-Morales V, Domínguez G, Gómez-Pérez L, García-Verdugo JM, Moreno-López B. Endogenous rho-kinase signaling maintains synaptic strength by stabilizing the size of the readily releasable pool of synaptic vesicles. *Journal of Neuroscience*, 32(1), 68–84, 2012

Chadha, P. S., Zunke, F., Davis, A. J., Jepps, T. a, Linders, J. T. M., Schwake, M., Towart, R., et al. (2012). Pharmacological dissection of K(v) 7.1 channels in systemic and pulmonary arteries. *British Journal of Pharmacology*. doi:10.1111/j.1476-5381.2012.01863.x

Fryer, R. M., Muthukumarana, A., Chen, R. R., Smith, J. D., Mazurek, S. N., Harrington, K. E., Dinallo, R. M., et al. (2012). Mitigation of off-target adrenergic binding and effects on cardiovascular function in the discovery of novel ribosomal s6 kinase 2 inhibitors. *The Journal of Pharmacology and Experimental Therapeutics*, 340(3), 492–500. doi:10.1124/jpet.111.189365

Kawakami, T., Puri, N., Sodhi, K., Bellner, L., Takahashi, T., Morita, K., Rezzani, R., et al. (2012). Reciprocal Effects of Oxidative Stress on Heme Oxygenase Expression and Activity Contributes to Reno-Vascular Abnormalities in EC-SOD Knockout Mice. *International Journal of Hypertension*, 1–11. doi:10.1155/2012/740203

Maekawa, T., Komori, K., Kajikuri, J., & Itoh, T. (2012). Characteristics of the actions by which 5-hydroxytryptamine affects electrical and mechanical activities in rabbit jugular-vein graft. *British Journal of Pharmacology*. doi:10.1111/j.1476-5381.2012.01867.x

Typical Equipment Used

Research Systems

PL3508B2-V Langendorff System
(Constant Pressure or Flow)

PL3508B1-V Langendorff System for Mice
(Constant Pressure)

PL3508B3-V Langendorff System for Rats
(Constant Flow)

PL3508B4-V Langendorff System for Rats
(Constant Pressure)

Individual Items

PL3508/P PowerLab 8/35 (8 channels)
with LabChart Pro

ML176 Langendorff Apparatus

ML172 Minipuls Peristaltic Pump

IN175 STH Pump Controller

FE221 Bridge Amp

MLT844 Physiological Pressure
Transducer

MLT0420 Force Transducer (20 g)

ML312 T-type Pod

MLT1401 T-type Thermocouple Probe

FE136 Animal Bio Amp

MLA1214 Spring Clip Electrodes

Software Highlights

MLS370/7 Blood Pressure Module

MLS340/7 Cardiac Output Module

MLS390/7 Dose Response Module

MLS360/7 ECG Analysis Module

MLS310/7 Heart Rate Variability Module

MLS380/7 Peak Analysis Module

MLS320/7 Video Capture Module

Isolated Perfused Hearts

PowerLab data acquisition systems are ideal for acquisition and analysis of data from isolated whole-organ perfusion including heart, liver, lung, kidney or mesenteric bed.

Langendorff Heart Preparation

The Langendorff heart technique allows for the examination of cardiac contractile strength (inotropic effects), heart rate (chronotropic effects) and vascular effects without neuronal and hormonal influences. Pressure in the perfusate line is typically monitored using a pressure transducer and bridge amplifier connected to a PowerLab data acquisition system.

To monitor ventricular developed pressure, a fluid-filled balloon-tipped catheter is inserted into the left ventricle and connected to a second pressure transducer and bridge amplifier. The Langendorff Heart preparation can be investigated under conditions of constant perfusate flow or constant perfusate pressure.

ADInstruments provides several Langendorff Systems that include PowerLab data acquisition systems, glassware, amplifiers and transducers. These systems provide:
- Real-time and offline data extraction and analysis capabilities
- Stable environment maintenance for the heart
- Measurement of parameters including:
  - Perfusion pressure
  - Perfusion flow rate
  - Left ventricular developed pressure
  - Maximum and minimum dP/dt
  - Temperature
  - Heart rate
  - Cardiac electrical activity.

Compact Langendorff Heart System

The **PL3508B2-V Langendorff System** (page 84) provides a complete solution for the perfusion and performance monitoring of small animal hearts (mice or rats). The Langendorff Apparatus is a thermostatically controlled unit with two separate perfusate reservoirs that are continually oxygenated and kept at a constant temperature. Constant recirculation of both chambers allows for a quick change

ADInstruments Advantage

- Online calculations of heart rate, systolic and diastolic parameters, dP/dt can be performed using the Arithmetic and Cyclic Measurements features of LabChart software
- Data Pad facilitates automatic or manual extraction of experimental data
- LabChart software can be used to control stimulation frequency and timing of pulse trains using an external stimulator.

of perfusate and prevents the formation of air bubbles or entry of air into the heart when switching reservoirs.

The heated junction block above the heart chamber ensures the perfusate is maintained at a constant temperature prior to entering the heart.

The system incorporates the **IN175 STH Pump Controller** (page 111) which, when used in conjunction with the **ML172 Peristaltic Pump** (page 110), removes the need for cumbersome elevated pressure reservoirs and expensive flowmeters. It also allows the user to switch between constant flow and constant pressure modes at the press of a button.

Traditional Langendorff Heart System

ADInstruments provides traditional, glassware-style modular **Langendorff Systems** (page 85). These include:

- **PL3508B1-V Langendorff System for Mice (Constant Pressure)**
- **PL3508B3-V Langendorff System for Rats (Constant Flow)**
- **PL3508B4-V Langendorff System for Rats (Constant Pressure)**.

The modular design allows the user to select and change from a wide range of glassware. This allows various custom and application-specific configurations. Further features of these systems include:

- Complete water-jacketed glassware and tubing to maintain constant system temperature
- Perfusate and heart temperature monitoring using a T-type Pod and T-type Thermocouple Probe
- Recording cardiac electrical activity using the Animal Bio Amp and Spring Clip Electrodes
- Pacing of the heart by an external stimulator (available separately) controlled via the PowerLab analog outputs
- Option for recirculating the perfusate (excluding Langendorff systems for rats).
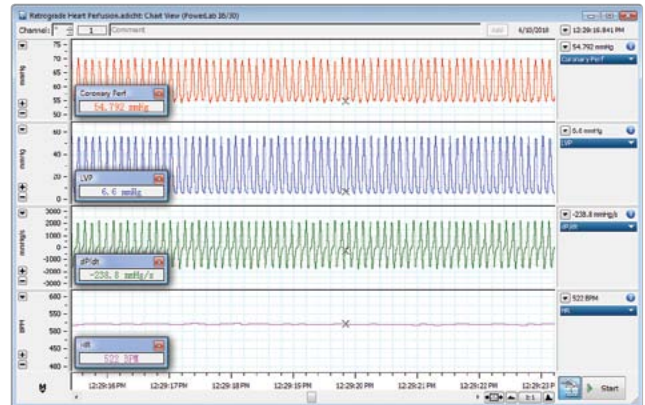
Langendorff rat heart experiment with recordings of coronary perfusion pressure, LVP, dP/dt and heart rate. Data courtesy of Dr W. Noonan, Genome Center, University of Cincinnati, US.

The Analysis Table View generated using the Blood Pressure Module.
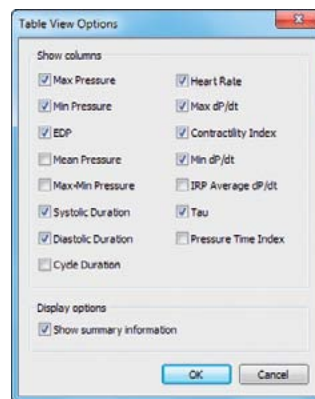
The Analysis Table View Options dialog listing the available parameters that can be selected for automatic extraction and logging by the Blood Pressure Module.

Select PowerLab citations

Cordwell, S. J., Edwards, A. V. G., Liddy, K. A, Moshkanbaryans, L., Solis, N., Parker, B. L., Yong, A. S. C., et al. (2012). Release of tissue-specific proteins into coronary perfusate as a model for biomarker discovery in myocardial ischemia / reperfusion injury. *Journal of Proteome Research*. doi:10.1021/pr2006928

Diwan, V., Poudyal, H., & Brown, L. (2011). Piperine Attenuates Cardiovascular, Liver and Metabolic Changes in High Carbohydrate, High Fat-Fed Rats. *Cell Biochemistry and Biophysics*, Doi:10.10. doi:10.1007/s12013-011-9306-1

He, L., Liu, B., Dai, Z., Zhang, H.-F., Zhang, Y.-S., Luo, X.-J., Ma, Q.-L., et al. (2012). Alpha lipoic acid protects heart against myocardial ischemia-reperfusion injury through a mechanism involving aldehyde dehydrogenase 2 activation. *European Journal of Pharmacology*. Elsevier B.V. doi:10.1016/j.ejphar.2011.12.042

Lee, H.-L., Chen, C.-L., Yeh, S. T., Zweier, J. L., & Chen, Y.-R. (2012). Biphasic Modulation of the Mitochondrial Electron Transport Chain in Myocardial Ischemia and Reperfusion. *American Journal of Physiology. Heart and Circulatory Physiology*. doi:10.1152/ajpheart.00731.2011

Loch, D., Hoey, A., Morisseau, C., Hammock, B. O., & Brown, L. (2007). Prevention of hypertension in DOCA-salt rats by an inhibitor of soluble epoxide hydrolase. *Cell Biochemistry And Biophysics*, 47(1), 87–98.

Working Heart Preparation

The working heart preparation enables the investigation of cardiac function in an isolated heart perfused via the normal circulatory pathway. The atrial pressure (preload) and aortic resistance (afterload) are regulated experimentally as the heart circulates perfusate. The aortic and coronary flows can be monitored and the resulting cardiac output calculated. ADInstruments supplies a number of complete research systems featuring all items required for a working heart preparation. Customized options are also available.

Complete Working Heart Research Systems

The four **Working Heart Systems** (page 86) supplied by ADInstruments provide options based on the species of the animal (heart size) and the parameters of interest to be recorded. They are available as a standard system for measuring key working heart parameters or as the ultimate system that enables additional measurements such as flow and cardiac output. These include:

- **PL3508B55-V Working Heart System for Mice**
- **PL3516B56-V Working Heart Ultimate System for Mice**
- **PL3508B50/X-V Working Heart System for Rats/Rabbits**
- **PL3516B51/S-V Working Heart Ultimate System for Rats.**

All Working Heart systems include a PowerLab, Radnoti Working Heart Apparatus, Bridge Amps, Animal Bio Amp, Physiological Pressure Transducers, T-type Pod and T-type Thermocouple Probe.

Features and Benefits

- Real-time and offline data acquisition, extraction and analysis with PowerLab data acquisition systems and LabChart Pro software
- Measurements including left ventricular pressure, cardiac electrical activity, heart rate, cardiac output, flow and temperature
- Configurations to suit a variety of experimental models
- Stable environment maintenance for the heart
- Modular hi-tech glassware that allows easy customization
- Single-pass perfusion or recirculation modes.

Typical Equipment Used

Research Systems

PL3508B55-V Working Heart System for Mice

PL3516B56-V Working Heart Ultimate System for Mice

PL3508B50/X-V Working Heart System for Rats/Rabbits

PL3516B51/S-V Working Heart Ultimate System for Rats

Individual Items

PL3508/P PowerLab 8/35 (8 channels) with LabChart Pro

PL3516/P PowerLab 16/35 (16 channels) with LabChart Pro

120101bEZ/X-V Radnoti Working Heart Apparatus for Rats/Rabbits

130101EZ-V Radnoti Working Heart Apparatus for Mice

140101EZ-V Radnoti Working Heart Apparatus for Porcine

FE221 Bridge Amp

MLT844 Physiological Pressure Transducer

ML312 T-type Pod

MLT1401 T-type Thermocouple Probe

FE136 Animal Bio Amp

Software Highlights

MLS260/7 LabChart Pro

MLS370/7 Blood Pressure Module

MLS340/7 Cardiac Output Module

MLS390/7 Dose Response Module

MLS360/7 ECG Analysis Module

MLS310/7 Heart Rate Variability Module

MLS380/7 Peak Analysis Module

MLS320/7 Video Capture Module

ADInstruments Advantage

- Complete research systems for the maintenance and monitoring of working hearts and analysis of recorded data
- Real-time measurements of pressure, cardiac electrical activity, heart rate, cardiac output, flow and temperature
- Data Pad facilitates automatic or manual extraction of experimental data
- LabChart software can be used to control stimulation frequency and timing of pulse trains using an external stimulator.

Working Heart Apparatus

The Radnoti Working Heart Apparatus is ideal for investigating and assessing isolated perfused hearts. Its features include:

- Complete water-jacketing glassware and tubing to maintain a constant temperature and controlled environment
- A threaded lid with access ports for insertion of cannulae, pressure catheters, electrodes and/or temperature probes
- A variety of available glassware sizes and types to suit different applications and animal hearts (such as the heart chamber).

Parameters Recorded

Parameters that can be recorded and analyzed using the Standard Working Heart systems include:

- Left atrial pressure
- Aortic pressure
- Systolic and diastolic pressure from the aortic line
- Heart rate
- Temperature
- Cardiac electrical activity.

Additional parameters recorded and analyzed using the Ultimate Working Heart systems include:

- Atrial inflow, aortic outflow and coronary flow
- Stroke volume and cardiac output
- Left atrial volume
- Left ventricular pressure (LVP)
- Aortic pressure & cardiac contractility
- pH
- Oxygen concentration
- Pacing/electrical stimulation.
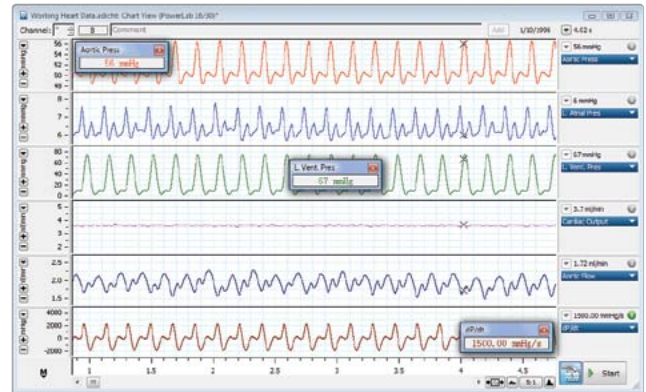
LabChart recording of mouse isolated working heart parameters. Data courtesy of Prof. John Headrick, Heart Foundation Research Centre, Griffith University.
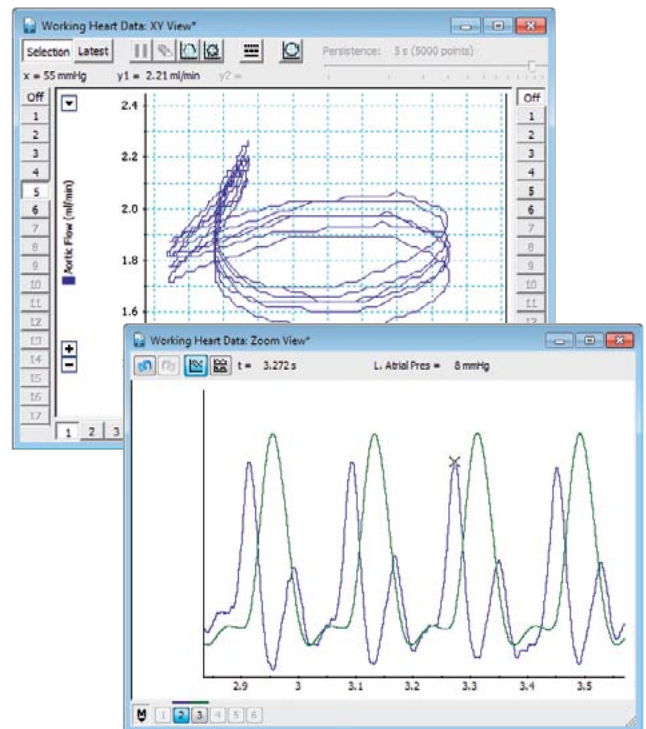
The XY View (above) has been used to create a pressure-flow plot. The Zoom View (right) displays in "Overlay" mode left atrial and left ventricular pressure waveforms.

Select PowerLab citations

Search our citations database at: www.adinstruments.com/citations

Mesripour, A., Iyer, A., & Brown, L. (2012). Mineralocorticoid Receptors Mediate Cardiac Remodeling in Morphine-Dependent Rats. *Basic & Clinical Pharmacology & Toxicology.* doi:10.1111/j.1742-7843.2012.00860.x

Panchal, S. K., & Brown, L. (2011). Cardioprotective and hepatoprotective effects of ellagitannins from European oak bark (Quercus petraea L.) extract in rats. *European Journal of Nutrition.* doi:10.1007/s00394-011-0277-1

Peart, J. N., See Hoe, L., Pepe, S., Johnson, P., & Headrick, J. P. (2012). Opposing Effects of Age and Calorie Restriction on Molecular Determinants of Myocardial Ischemic Tolerance. *Rejuvenation Research*, 15(1). doi:10.1089/rej.2011.1226

Ramos, G. C., Dalbó, S., Leite, D. P., Goldfeder, E., Carvalho, C. R., Vaz, N. M., & Assreuy, J. (2012). The autoimmune nature of post-infarct myocardial healing: oral tolerance to cardiac antigens as a novel strategy to improve cardiac healing. *Autoimmunity*, 9491(ext 216), 1–1.

Sakamoto, A., Hongo, M., Furuta, K., Saito, K., Nagai, R., & Ishizaka, N. (2012). Pioglitazone ameliorates systolic and diastolic cardiac dysfunction in rat model of angiotensin II-induced hypertension. *International Journal of Cardiology.* Elsevier Ireland Ltd. doi:10.1016/j.ijcard.2012.01.007

ADInstruments Research Software Overview

Building on over 25 years of program development, ADInstruments continues to set the standard for life science data acquisition and analysis software.
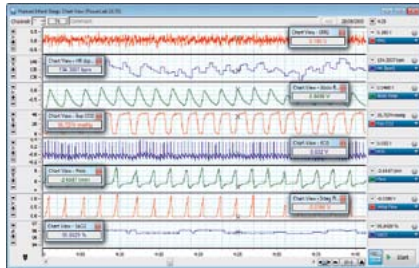
LabChart (Chart View)
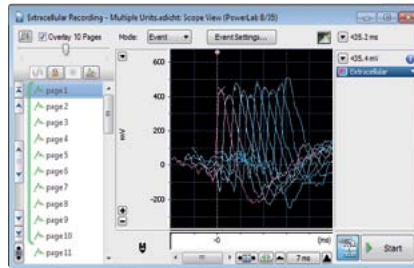
LabChart (Scope View)
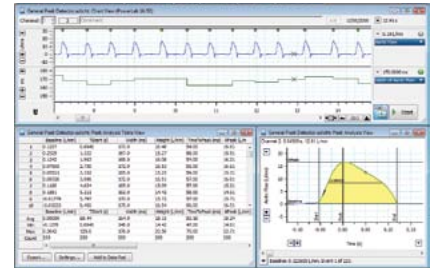
Peak Analysis Module

Software	Purpose	More Details
LabChart	LabChart software offers the functionality of a multi-channel chart recorder, digital oscilloscope, XY plotter and digital voltmeter. Record, display and analyze up to 32 channels of raw data in real time.	Page 42
LabChart Extensions	LabChart extensions are available free of charge to all LabChart users. They provide additional data formatting, filtering, visualization, measurement calculations and other utility features.	Page 60
LabChart Reader	LabChart Reader allows scientists that do not own LabChart software to view and analyze (to a limited extent) LabChart data files. PowerLab users can share data files with their colleagues.	Page 61
LabChart Modules	LabChart modules are application-specific acquisition and analysis add-on programs for LabChart software. Modules are available separately or as a collection in LabChart Pro.	Page 62
LabChart Pro	A software package that includes LabChart and all LabChart modules. See list below for individual LabChart module descriptions.	Page 62
■ Blood Pressure Module	Detects, analyzes, displays and reports a set of cardiovascular parameters from arterial or ventricular pressure signals. It can be used online or offline.	Page 62
■ Cardiac Output Module	Derives Cardiac Output parameters from LabChart thermodilution curves in small animals.	Page 64
■ Circadian Analysis Module	Analyzes data that have an inherent daily pattern. It generates graphical and tabular views of the raw and averaged data.	Page 65
■ DMT Normalization Module	Calculates the optimal pretension conditions for microvessels prior to commencing experiments using DMT wire myographs.	Page 66
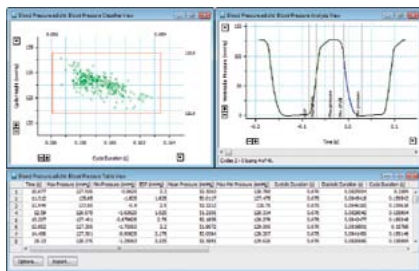
Blood Pressure Module
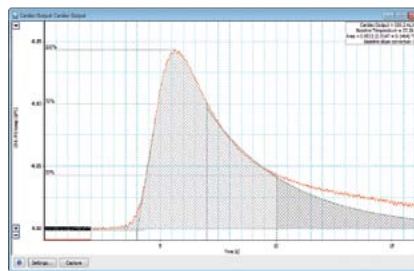
Cardiac Output Module
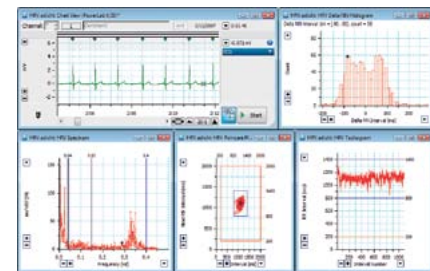
HRV Module
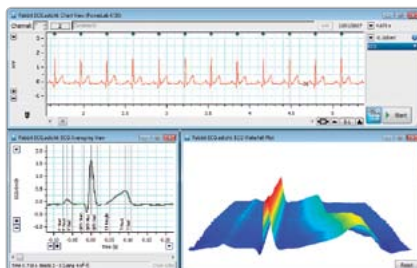
ECG Analysis Module
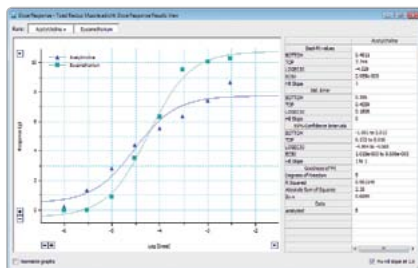
Dose Response Module
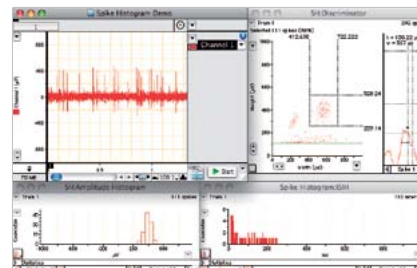
Spike Histogram Module

software

Software	Purpose	More Details
■ Dose Response Module	Generates dose response curves and calculated values such as EC_{50} and Hill Slopes from LabChart data. It can be used online or offline.	Page 67
■ ECG Analysis Module	Detects ECG components online or offline providing statistical and graphical analyses. It features ECG presets to suit human and animal subjects.	Page 68
■ HRV Module	Analyzes variability in ECG or arterial pulse recordings. A variety of parameters, graphs, and a report can be generated online or offline.	Page 69
■ Metabolic Module	Enables real-time acquisition and analysis of human metabolic parameters such as RER, $\dot{V}_{CO_2}$, $\dot{V}_{O_2}$ and $\dot{V}_E$ online or offline.	Page 70
■ Peak Analysis Module	Provides automatic detection and analysis of multiple non-overlapping signal peaks in acquired waveforms. The module can be used online or offline.	Page 71
■ PV Loop Module	Records and analyzes left ventricular pressure and volume data for hemodynamic research in animals.	Page 72
■ Spike Histogram Module	Detects, discriminates and analyzes extracellular neural spike activity online or offline.	Page 73
■ Video Capture Module	Synchronizes a video recording with a LabChart data file, and allows simultaneous playback and correlation between data and video recorded events.	Page 74
GLP Client and GLP Server	In conjunction with LabChart software, GLP Client and GLP Server software provide PowerLab users with an easy and reliable data acquisition solution for a GLP and 21 CFR Part 11 compliant environment.	Page 76
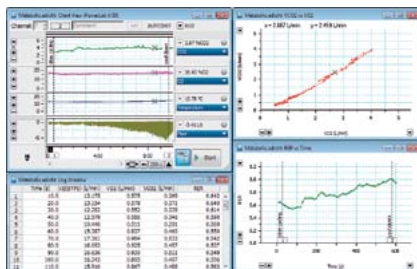
Metabolic Module
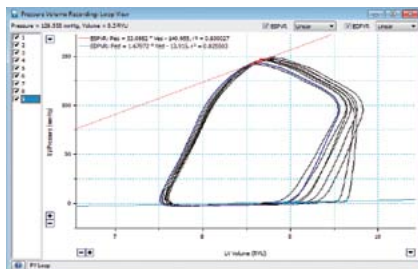
PV Loop Module

Video Capture Module

41
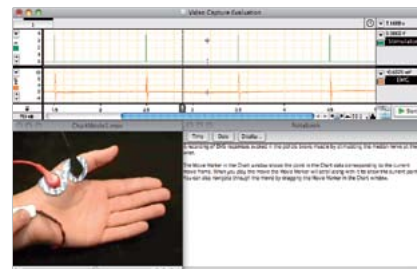
Key LabChart Features

Invaluable features used by thousands of researchers since 1988

2 Multiple Block Sampling

7 DVM

6 Channel Calculations

5 Customizable Comments

4 Split Bar

3 Input Amplifier

1 Software-Controlled Settings

1 Software-Controlled Settings: Set and adjust PowerLab hardware acquisition settings in LabChart.

2 Multiple Block Sampling: Record multiple data blocks with different sampling rates, filters and amplification within a single file.

3 Input Amplifier: Adjust amplification, filtering and units conversion, and preview the result in real-time.

4 Split Bar: Split the Chart View to compare data recorded earlier with data being recorded in real-time.

5 Customizable Comments: Add comments to data during or after recording. Find, edit, move and delete comments after recording.

6 Channel Calculations: Perform calculations on signals during or after recording without losing raw data.

7 DVM Windows: Monitor a signal's amplitude, sampling rate or calculated value, as a changing number in a standalone mini-window that can be displayed numerically or graphically (trend data).

9 Edit Macros

8 LabChart Modules & Extensions

12 Data Pad

11 Find and Select **13** XY View **10** Cyclic Measurements

14 Zoom View **16** Right Clicking

15 Marker Tool
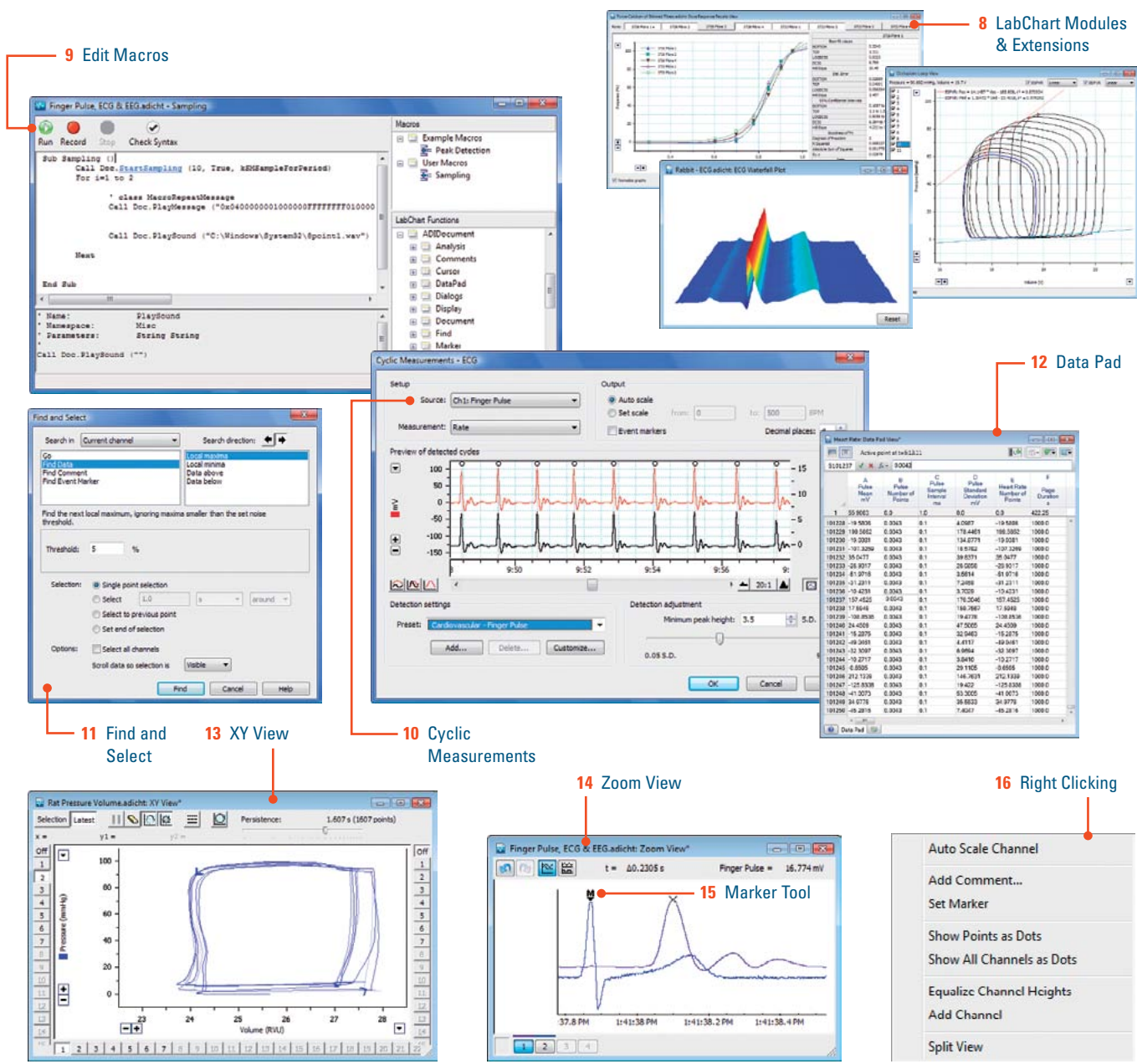
8 **LabChart Modules & Extensions:** Choose from a wide range of specialized software add-ons to speed up and enhance acquisition and analysis of discrete data sets.

9 **Editable Macros (VB Scripting):** Automate recording, analysis and event protocols with macros. Edit macros with advanced scripting options.

10 **Cyclic Measurements:** Analyze signals using a range of statistics and functions online and offline.

11 **Find & Select:** Locate data of interest quickly and accurately.

12 **Data Pad:** Extract, log and analyze large amounts of data in a spreadsheet — manually or automatically. Link Data Pad to OLE programs including Microsoft Excel.

13 **XY View:** Plot variables against each other and observe their relationship as XY or XYY displays.

14 **Zoom View:** Magnify data for a detailed view.

15 **Marker Tool:** Mark a reference point on your recorded data to obtain differential measurements relative to the cursor position.

16 **Right Clicking:** Access features in a LabChart channel with a single click.

Key LabChart Features continued...

17 32 Channels with variable sampling rates

18 Sample from multiple devices

19 Scope View

20 Spectrum View

21 Feature Manager

22 Welcome Center

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17 Acquire 32 Channels of data with Variable Sampling Rates: Record and analyze up to 32 channels of data. Choose different sampling rates for each channel.

18 Sample from Multiple PowerLabs: Sample data from multiple PowerLab systems (or compatible devices) simultaneously to one or more LabChart files on the same computer.

19 Average Signals on Multiple Channels with Scope View: Turn your computer into a digital oscilloscope to record and display data as sweeps.

20 Display & Analyze Signal Frequencies with Spectrum View: View a signal's component frequencies as Spectrogram and Power Spectral Density plots.

21 Browse & Install Software Add-ons from LabChart: Use the Feature Manager in LabChart to search for and obtain relevant tools in LabChart extensions or modules.

22 Access Recent Files & LabChart Resources: The Welcome Center provides one-click access to recent data files, settings files, sample files, technical help and a number of online resources.

23 Stimulus Outputs

24 Analysis Manager

28 Export and open file types

27 Shortcut Key Manager

116.31 mmHg

26 Guide Lines

25 Continuous Auto Scale

23 **Generate Two Independent Stimulus Outputs:** Generate two completely customized stimulus waveforms from the analog outputs of a research PowerLab (/SP, /30, and /35 series and later).

24 **Save & Recall Analysis Settings:** Use the Analysis Manager to recall the data selected for analysis in Chart and Scope View. Save and recall settings when using popular LabChart Modules.

25 **Continuously Auto Scale Chart View:** Continuously and automatically adjust the vertical scale of data channels in Chart View so you can see the entire waveform at all times.

26 **Add Guide Lines to the Chart View:** Easily view waveform data crossing threshold values by adding shaded guidelines to any data channel.

27 **Manage Shortcut Keys:** Use the Shortcut Key Manager to view all preset shortcuts and/or customize your own.

28 **Open & Export Many File Types:** Use LabChart to view and analyze data recorded in other applications, or save LabChart data in a range of formats for analysis in other applications.

LabChart

In conjunction with a PowerLab data acquisition unit, LabChart software provides the data integrity, display and analysis features needed for today's science. LabChart offers easy selection of hardware settings, powerful online and offline analysis options, procedure automation, seamless extraction of experimental data and clever display options.

You can extend LabChart's acquisition and analysis functions to suit specialized areas with LabChart Extensions and LabChart Modules, as well as share data with your colleagues using LabChart Reader.

LabChart can:

- Quickly and easily configure hardware and software settings
- Record, display and analyze 32 channels of data
- Analyze data online or offline
- Display data in specialized Views including Scope, Spectrum, Zoom and XY
- Automatically export recorded values to other graphical or statistical packages
- Ensure compliance with Good Laboratory Practice guidelines and FDA 21 CFR Part 11 regulations when used with GLP Client and GLP Server software.

This section describes a wide range of LabChart's comprehensive features. Please note that feature availability may vary between Windows and Mac OS versions of LabChart.

ADInstruments' large software team continuously develops LabChart. We regularly release new versions and add functions to ensure LabChart is compatible with the latest operating systems and hardware technology.

For the latest version of LabChart and new features, visit www.adinstruments.com/LabChart/

Set Up and Start Recording

Experiment optimization

Set up experiments easily in the Input Amplifier dialog:

- Preview and optimize the incoming signal
- Select an appropriate recording range
- Alter the vertical axis to optimize display
- Remove drift and noise with high- and low-pass filters
- Invert the signal and view any signal offset.

Change channel settings in seconds

Set recording and display parameters for every channel in one location. In the Channel Settings dialog you can:

- Rename channels
- Turn channels and channel separators on or off
- Adjust the signal input range
- Select filters and sampling rates for each channel
- Perform units conversion
- Change the color or style of the data trace
- Select and set channel calculations.

Convert raw data into familiar units

Convert the input voltage signal to familiar units (such as %, mmHg, pH, g, or any custom defined unit) by performing a linear calibration with the Units Conversion dialog. The raw data is retained and available for recall at any time.

For non-linear sensors, perform multipoint calibration of up to twelve points using the Multipoint Calibration Extension.

Access recent files & settings

Access recently opened data files and a variety of Quick Links (for technical help and software updates) with LabChart's Welcome Center.

Use the Recent Files panel to search and open up to 100 of your recent LabChart files or clone their settings for a new LabChart file. You can configure the Welcome Center to include:

- LabChart settings files — use settings files to repeat experiments with the same recording parameters
- LabChart data files — quickly access files from previous experiments for reference or to clone settings
- The ADIPak files (Windows only) — easily pack and install LabChart files and supporting documents (including PDFs, *.txt files and more)
- LabChart Getting Started Tutorials — learn about LabChart using HTML tutorials and sample data files.
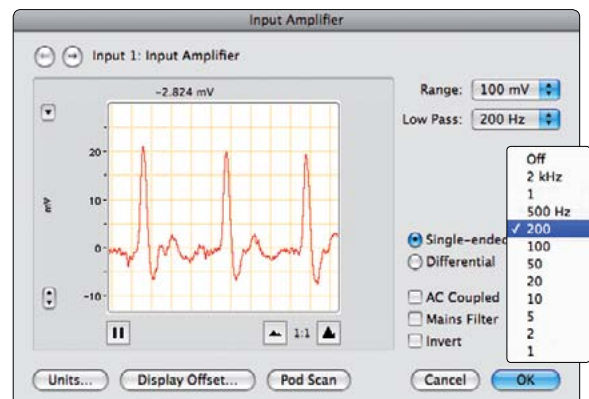
Optimize the signal using the Input Amplifier dialog.

Quickly set up channel parameters in the Channel Settings dialog.
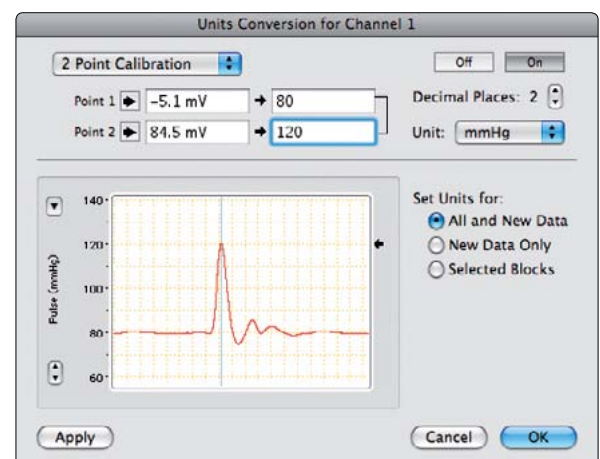
Convert signals from millivolts to a meaningful unit.

LabChart

Record Accurate Data with Powerful and Flexible Software

Record from multiple devices

With LabChart you can use one data file to record up to 32 channels of raw data from multiple PowerLab units or other devices. You can also record from multiple PowerLabs and devices into separate data files on the same computer (Windows only).

Annotate data with comments

Record relevant information at specific points in your LabChart data as text comments. Add comments:
- Manually by typing into the Comment field during or after recording, or
- Automatically by assigning relevant phrases to specific function keys or trigger events.

You can also:
- View a list of all comments
- Search for comments using a text filter
- Display the date and time of the comment
- Modify, edit, delete or move any comment in the Comments window (Mac: Comments and Exclusions)
- Automatically go to the location of a comment in the recording.

Select independent sampling rates for every channel (single file)

Choose the optimal sampling rate for each channel to ensure acquisition of accurate data as well as minimizing file size.

Record multiple data blocks (single file)

Record, save and analyze data from any number of experiments in a single LabChart file. LabChart saves continuous data as a Data Block. As well as indicating breaks in recording, each Data Block retains information specific to that block, including:
- Recording range, sampling rate and number of samples
- Channel number and Data Block number
- Filters used
- Date and time of block record.
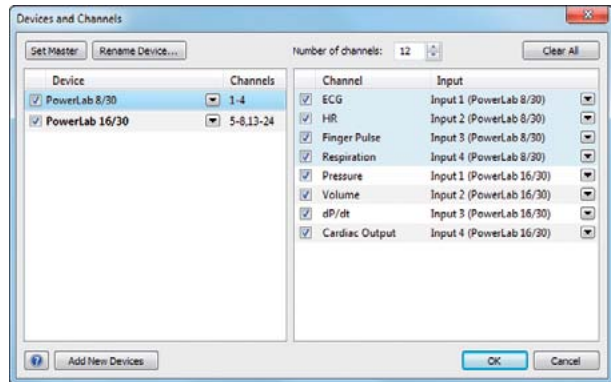
Setting up recording from two PowerLab units.
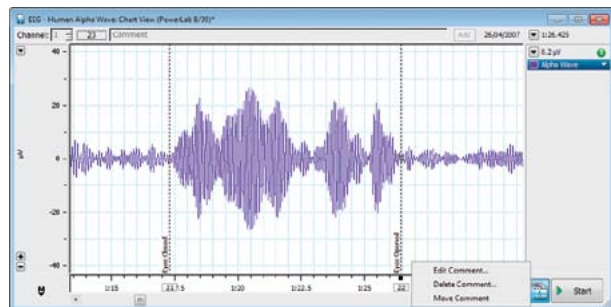
Right-click on a comment to edit, delete or move comments.
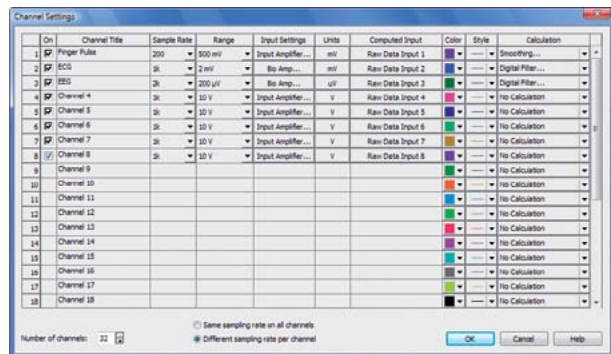
Select multiple sampling rates in the Channel Settings dialog.
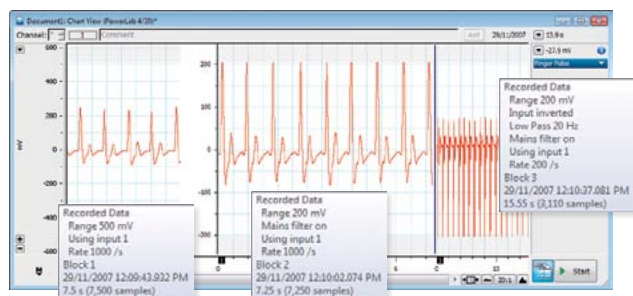
Multiple recordings and corresponding Data Block information.

Keep text notes with your data file

Annotate experiments using LabChart's Notebook — before, during or after recording. Notebook keeps your notes as part of the data file. They can be recalled with the file at any time, so cannot be misplaced.

Recall recording information

Retain and recall recording parameters and experiment settings for future reference. LabChart's sophisticated data file structure automatically:

- Stores experimental and analysis settings, computations and comments in each file
- Retains raw data at all times
- Allows data files to be appended
- Protects your data with disk buffering (allows data recall in the event of power failure etc.).

Subject and experiment setup details can be recorded in Notebook.

Generate Custom Stimulus Outputs

Use LabChart's stimulator to generate custom stimulus or series of stimuli from PowerLab's analog outputs (or an isolated stimulator). You can generate two independent stimulus outputs simultaneously with research PowerLab units from the /SP, /30, and /35 series and later (Windows only).

Quickly select stimulation settings

Use the intuitive Stimulator dialog to select the pattern, frequency, duration and output range of a stimulatory waveform. You can also select the types of output waveforms in continuous or discrete waveform mode.

Preconfigured stimulus waveforms include:

- Pulse
- Step
- Ramp
- Sine
- Triangle

Windows only:

- Double pulse
- Arithmetic
- Step Pulse
- Biphasic pulse

Stimulator dialog showing preconfigured stimulus waveforms in the drop down menu.
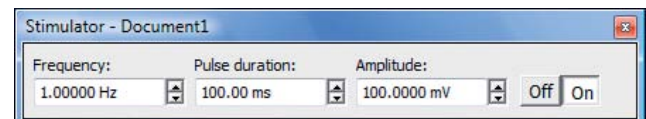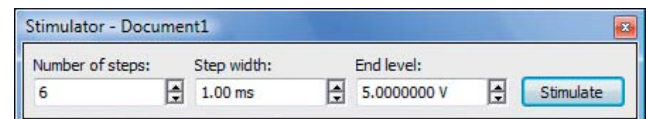
Stimulator Panels for discrete (top) and continuous (bottom) stimulation.

LabChart

Customize stimulator waveforms

Generate a variety of customized stimulus waveforms by selecting and configuring any number and combination of stimulus segments. All customized stimulation waveforms can be saved and recalled for future use (Windows only).

Start, stop and adjust stimuli online

Easily start or stop the stimulation and change the stimulation settings while sampling, using the Stimulator Panel mini-window.

The Stimulator Panel mini-window floats in front of the active Chart View and can be moved around the screen, providing quick and easy control of stimulation parameters such as frequency, duration and amplitude.

Automate Tasks

Use triggers to start & stop recording

Use LabChart to start or stop recording without manual intervention. Determine how and when LabChart starts and stops recording with the Sampling dialog. You can set the type of trigger event, any delay before recording, how many times to repeat the trigger and how multiple blocks in Scope View are handled.

You can start and stop a recording using an external trigger signal or stimulator, or by setting a threshold voltage to trigger from one of the recording channels. Pre-triggering and post-triggering options are also available.

Program timed events

Create a list of actions to be performed during a recording, and LabChart will perform the actions at the times you have specified (Windows: Event Manager Extension, Mac: Timed Events). This is useful in long recordings with repetitive events.

Choose from three event types:
- Set a PowerLab output voltage
- Add a comment
- Apply a digital output configuration that can turn switches (e.g. auto-injectors) on or off.
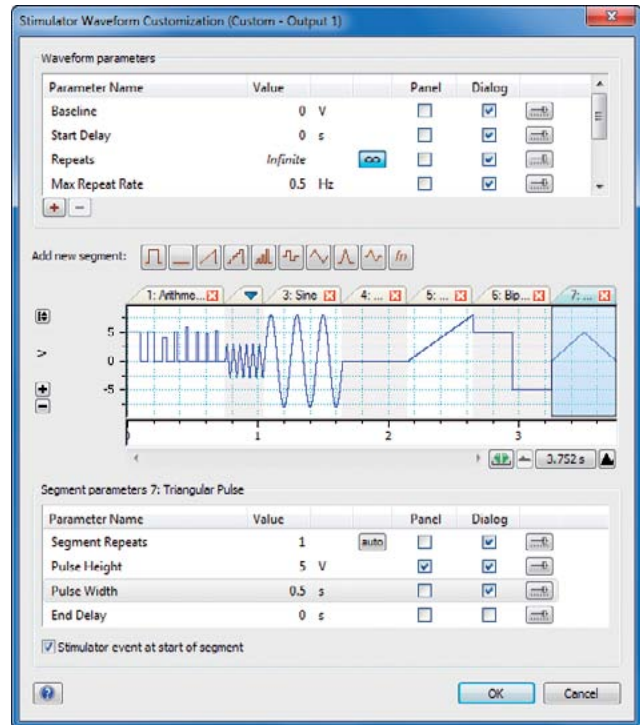
Customize stimulator output by selecting and configuring any number and combination of stimulus segments.
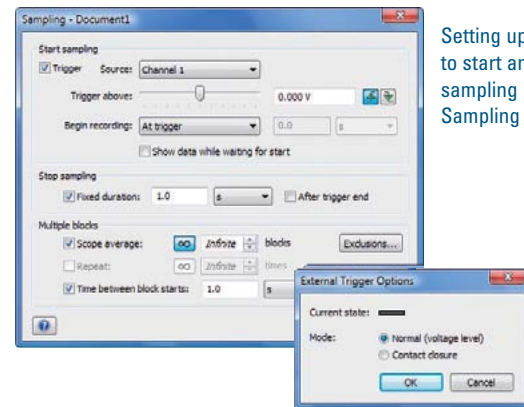
Setting up triggers to start and stop sampling in the Sampling dialog.
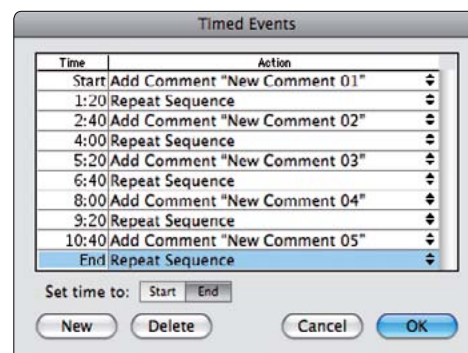
Timed Events dialog showing a list of selected actions.

Record & edit Macros

Automate repetitive tasks, such as recording, event detection and analysis using customizable Macros. LabChart captures your actions as you record the Macro and you can replay your recorded Macro at any time. Commands available for selection during the recording of a Macro include:

- Wait…
- Message…
- Begin Repeat
- End Repeat
- Play Sound…
- Set units conversion… and more!

Event based Macros

Event-driven scripting allows a script to operate continuously, responding efficiently to events as they occur in LabChart.

Events supported include:

- When sampling starts or finishes
- As samples arrive
- When event data arrives
- On LabChart Selection or digital input change
- On external trigger
- On stimulus occurred... and more!

Manage Macros

Manage your macro library using the Manage Macros and Macro Properties dialogs. You can:

- Create, run and delete macros
- Edit macros using VB Scripting (Windows only)
- View macro properties
- Import macros (Windows only)
- Place a recorded macro in the menu or toolbar.

Macro script (top), Commands (middle) and Sampling dialog (bottom).
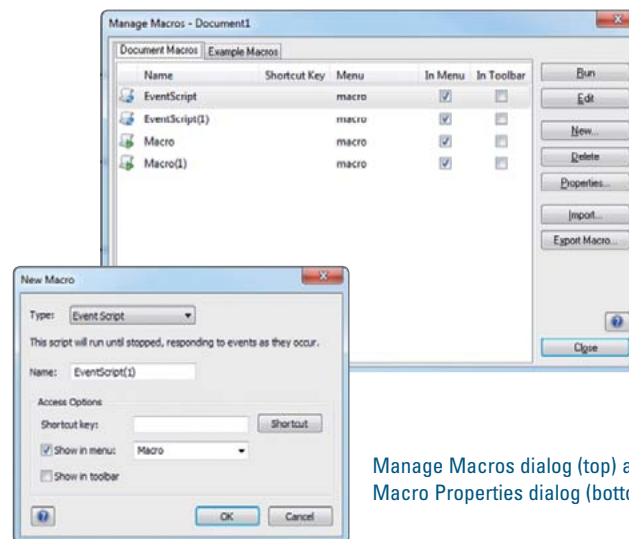
Manage Macros dialog (top) and Macro Properties dialog (bottom).

Customize Chart View Display

LabChart's default display mode, Chart View, displays data as continuous waveforms. You can adjust and optimize Chart View to suit your recordings and experiment protocols.

Continuously auto scale data channels

LabChart can dynamically adjust the vertical scale of data channels in Chart View. Continuous Auto Scale allows a detailed and scaled view of all signals without having to make repeated manual adjustments. This is particularly useful for recordings that show large changes in signal amplitude, or those with a shifting baseline.

Right click, or use the shortcut button to select continuous auto-scale

LabChart

Monitor signal values easily with DVM windows

Visually monitor incoming signal values as numbers and graphical trends with DVM (digital voltmeter) windows. Online DVM windows show the incoming signal value, and after recording, they display the data value at the cursor position.

DVM windows float in front of the Chart View, and can be resized to almost full screen so you can monitor values from a distance. The DVM windows change color when used with Guide Lines and you can navigate backwards and forward through the DVM to see signal trends and values that flank the data point of interest.

Compare data using the Split Bar

Divide the data display area vertically with the Split Bar to compare sections of previously recorded data with incoming signals. You can use the Scroll buttons in both panes to review saved or live data.

Make discrete & relative waveform measurements

Place the Waveform Cursor over data to determine:
- Rate/Time — shows the time at the cursor location
- Range/Amplitude — shows the waveform's amplitude at the cursor location.

Drag and lock the Marker Tool on a waveform to make measurements relative to its position. As you move the cursor along the waveform, the time and amplitude difference (relative to the Marker position) is displayed. The Marker Tool can also be used in the Zoom View.

Monitor threshold crossings with Guide Lines

Provide a clear visual indication of any threshold crossing with the Guide Lines tool. Manually set the position of two horizontal guidelines across a data channel to highlight particular value ranges of data. You can also set up customized shading of each defined value range.
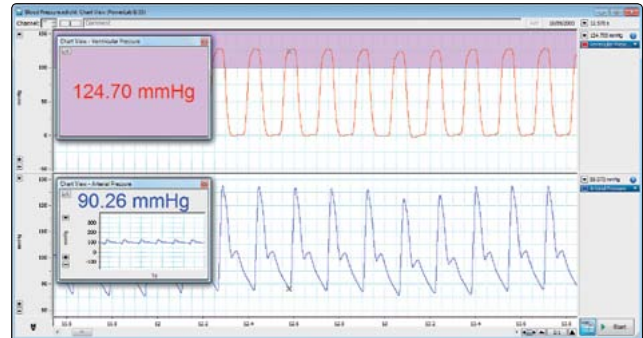
Resizable DVM windows provide live values and graphical trends for easy viewing of numerical data.
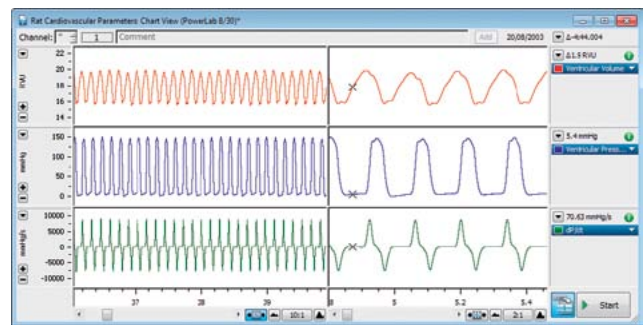
Dividing the Chart View display area by dragging the Split Bar.
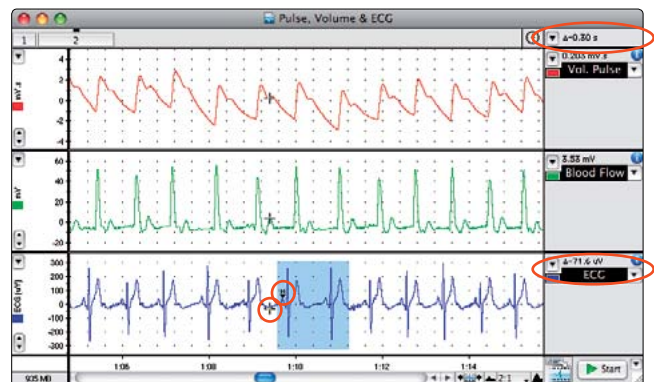
The difference between the amplitudes of the cursor and Marker positions (in the ECG channel) is displayed in the top right corner of the Chart View.
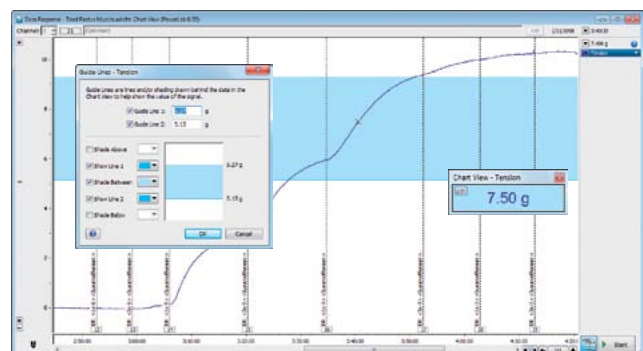
The Guide Lines feature is accessed in Chart View and provides a customizable and easy way to visualize threshold crossings.

Use Multiple Data Display Modes

LabChart

In addition to Chart View's continuous waveform display of up to 32 channels of raw and/or calculated data, LabChart includes additional data display modes that allow you to extract and visualize your data in versatile ways.

Average signals in Scope View

Turn your computer into a digital oscilloscope with Scope View (Windows only). Using this window you can:

- Average signals on multiple channels in real time
- Record each sweep on a different page to average and overlay during analysis
- Record simultaneously in Scope and Chart Views
- Extract data from Scope View into Data Pad
- Apply Channel Calculations
- Optimize display using 3D Depth, overlay trace color, color saturation and black/white background toggle
- Remove periodic recurring signals using Background Subtraction.

You can generate Scope View pages based on data blocks, Event Markers or Comments.

Analyze frequency in Spectrum View

Convert data from time to frequency domain in Spectrum View (Windows only). With Spectrum View you can:

- Observe and differentiate the component frequencies of a signal (in stacked or overlaid mode)
- Estimate the main frequency component of your signal
- Remove unwanted signal frequencies and background
- Display spectral parameters as continuous waveforms in overlaid or stacked mode
- Export spectral parameters to the Data Pad.

Power Spectral Density — overlays data from multiple channels to display the power of the input signal over a selected frequency range. Single or multiple signals can be analyzed. Using the Spectrum View settings data window you can select the FFT size, type of data window, the extent of window overlap and amplitude zeroing of the first frequency component. PSD display modes include amplitude, power, power density and power attenuation (in decibels).

Spectrogram — a color-coded plot of signal spectral power against time and frequency is displayed in each selected channel. You can customize the Spectrogram's color scale, and save the Spectrogram matrix for each channel as a text file.
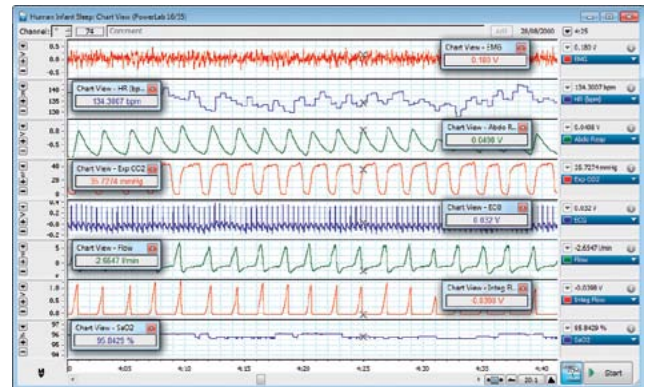
Display up to 32 channels of raw and/or calculated data in Chart View. Above, the EMG, HR, expired carbon dioxide, ECG, blood flow, integral flow and partial oxygen concentration of a sleeping neonate are shown.
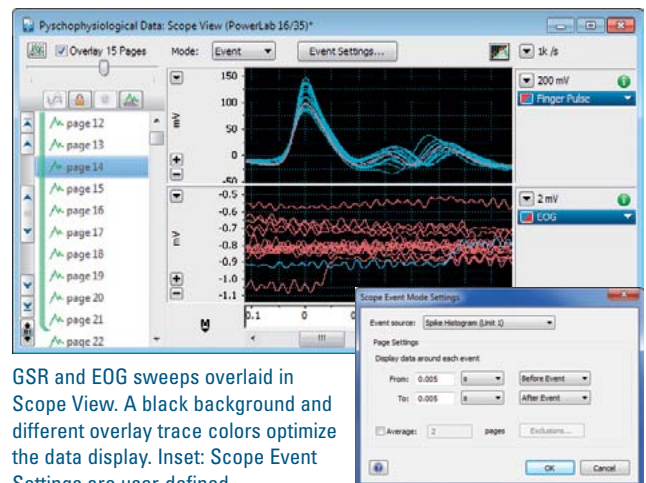
GSR and EOG sweeps overlaid in Scope View. A black background and different overlay trace colors optimize the data display. Inset: Scope Event Settings are user-defined.
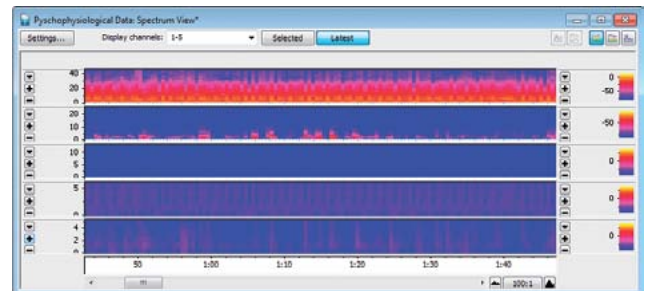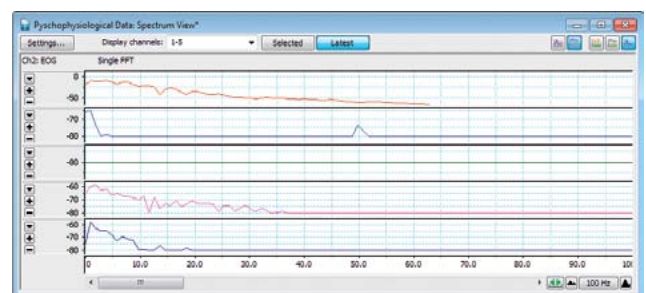
Spectrum View's PSD Plot (top) and Spectrogram (bottom). The PSD Plot uses color-coding to overlay data from multiple channels and traces can be viewed in stacked mode (shown above) or as overlaid traces.

LabChart

Magnify data in Zoom View

Enlarge and display data selections for closer examination. The Zoom View can overlay and stack data from any number of channels. You can repeatedly zoom in on the data by making repeated selections and navigate back and forth between multiple zooms using the undo and redo buttons.

Plot signal relationships in XY View

Plot data in one channel against data from one or two other channels, and establish the relationship between two parameters at the same time in the XY View.

Plotting periodical signals against one another may result in loops. Loop features in the XY View include:
- Direction arrows — to show the direction of the loops
- Fade mode — to fade previous loops
- Loop analysis — to calculate the area of the loop (Windows only).

Analyze Data Online and Offline

Apply built-in Channel Calculations

Convert raw data from one channel to computed data displayed in a new channel with Channel Calculations. You can use Channel Calculations both online and offline, and your raw data is always retained for further analysis.

LabChart's Channel Calculations include:

- **Arithmetic** — mathematically manipulate data using algebraic, trigonometric, logarithmic, noise and filtering functions
- **Cyclic Measurements** — see overleaf for details
- **Derivative** — display the first and second derivative
- **Digital Filter** — select from six filter types: low-pass, high-pass, notch, narrow band-pass, band-pass and band-stop
- **Integral** — measure areas under waveforms
- **Smoothing** — remove unwanted high frequencies and noise from a waveform
- **Shift** — shift data in a channel backwards or forwards in the time domain
- **Spectrum** — display Total Power, Percentage Total Power, Maximum and Minimum Power, Maximum and Minimum Power Frequency, Mean Power Frequency, Median Power Frequency, Standard Deviation Frequency and Spectral Edge Frequency (Windows only).
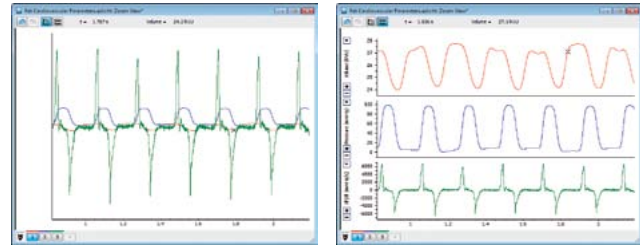
Selection from multiple channels in the Zoom View. Zoom displayed as an overlay (left) and stack (right).
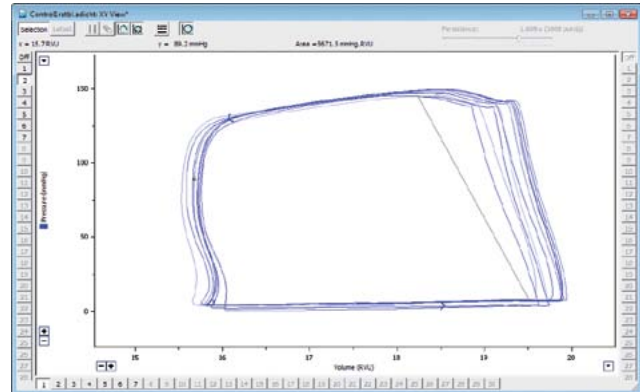
XY View with ventricular volume versus pressure.

Dialogs of some of the calculation functions available in every channel.

LabChart

Process periodic signals with Cyclic Measurements

LabChart can process periodic waveform signals, detect cycles and perform calculations with Cyclic Measurements channel calculations.

Cyclic Measurements calculations include:

- **Rate** — calculate rates e.g. heart rate from ECG or pulse
- **Period** — measure time taken to complete a cycle
- **Frequency** — calculate event frequencies
- **Count** — count number of events or cycles
- **Mean** — derive the mean of a cyclic waveform
- **Min, Max, 1/3 Max + 2/3 Min** — calculate min and max values such as diastolic, systolic and mean BP from a blood pressure trace
- **Height** — calculate maximum minus minimum height
- **Integral** — measure areas under waveforms
- **Variance** — detect variance of values within a given cycle of a waveform
- **Min and Max Derivative** — calculate minimum and maximum derivatives in a given cycle of a waveform
- **Unit Spikes at Events** — place markers on a second channel where a peak occurs on the input channel.

Analyze numerical data with Data Pad

LabChart's Data Pad features parallel processing and full Unicode support to provide a high-capacity rapid-response data logging system. You can log raw signal points or calculated values from any channel, or perform calculations on exported data.

You can set up unlimited rows in Data Pad to tabulate data and apply different calculations and formulas. Data Pad's built-in calculation and analysis functions include:

- **Statistics** — calculate the mean, SD, RMS, max and min value, time at max and min values and number of points
- **Selection & Active Point** — obtain the start time, end time, duration and number of points
- **Comments** — list comment time, comment number, the full comment text or extract numbers from the comment text
- **Slope** — get the average slope value, max and min slope or time at max and min slopes
- **Integral** — calculate time integrals online or offline
- **Block Information** — obtain the range, sample interval, block number, block duration, samples in block, start time, start date and sampling rate.
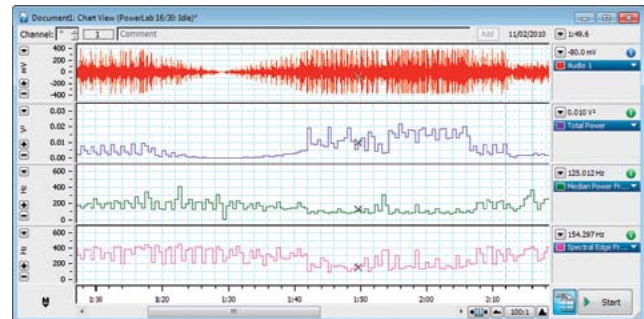
Spectral parameters of audio data in Channel 1 displayed as continuous waveforms in Chart View using Channel Calculations.
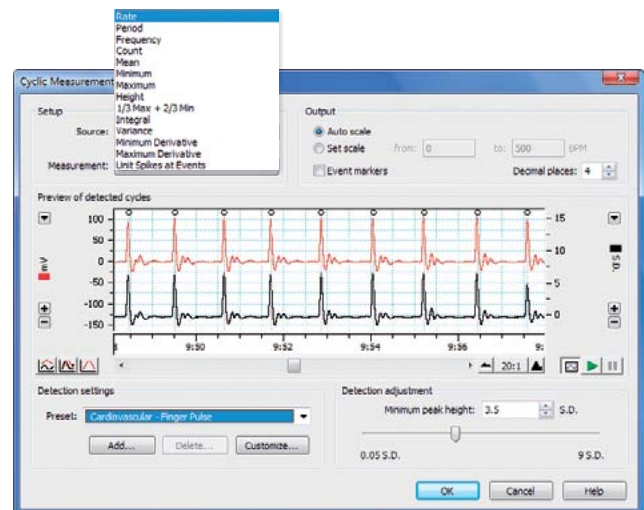
Cyclic Measurements dialog. The channel is being set up to display heart rate derived from a finger pulse recording.
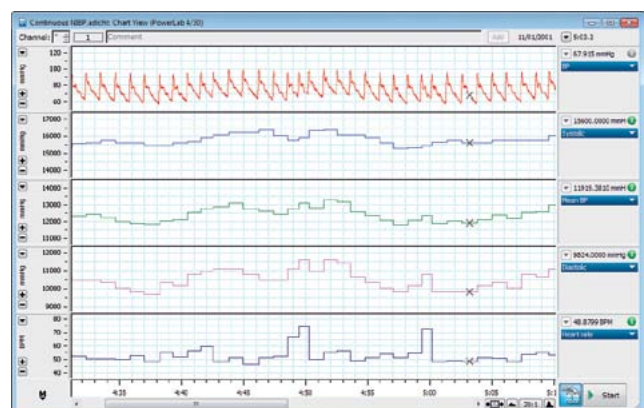
Blood pressure recording in Chart View. From the raw BP data in Channel 1, Channel Calculations have been used to calculate and display systolic, diastolic and mean BP, as well as heart rate in additional channels.

software

LabChart

- **Cyclic Measurements**—calculate or extract periodic parameters from waveforms including frequency, rate, mean, min and max, 1/3 max + 2/3 min, height, integral, variance, min and max derivatives
- **XY Loop Calculations**— using the loop created in the XY View, calculate the area inside the loop, x or y value and slope at the reference point in loop, minimum and maximum x or y value, time at minimum and maximum x or y value, and mean of x or y value
- **Scope**— obtain page number, page duration and page start time containing the active point or selection from Scope View (Windows only)
- **Spectrum**— display maximum power, maximum power frequency, mean power frequency, median power frequency, minimum power, minimum power frequency, percentage total power, spectral edge frequency, SD frequency and total power (Windows only).

You can add values to Data Pad:
- Automatically, by configuring the **'Timed Add to Data Pad'** feature prior to recording
- Manually, by selecting data of interest after recording and choosing the **'Add to Data Pad'** command. Use the **'Multiple Add to Data Pad'** command to repeatedly extract values from recorded data.

Data Pad contents can be saved as a text file or copied into other programs. Using OLE you can also export incoming values to Microsoft Excel in real time, allowing live updates of Microsoft Excel graphs.

Find and select data

Quickly find specific points of interest within a data file using the Find and Select feature. Search and make selections on any number of channels based on your desired criteria. Available commands are:
- **Go**— go to a specific location on the data such as data block boundaries
- **Find Data**— find the peaks or troughs in the waveform
- **Find Comment**— search for specified comments
- **Find Event Marker**— search for Markers (Windows only).
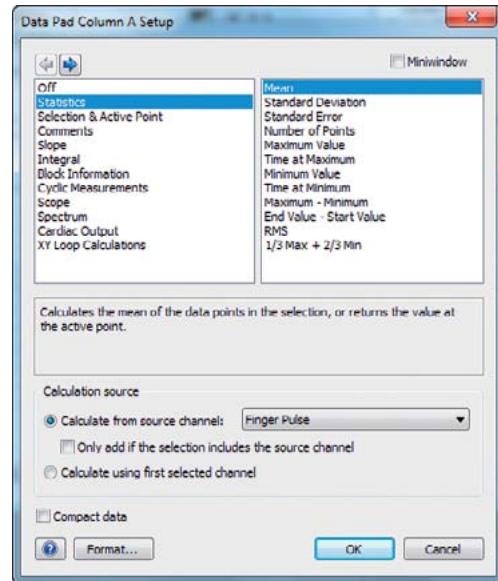
Data Pad Column Setup dialog showing Spectrum calculation options.

Frequency parameters displayed in Data Pad.
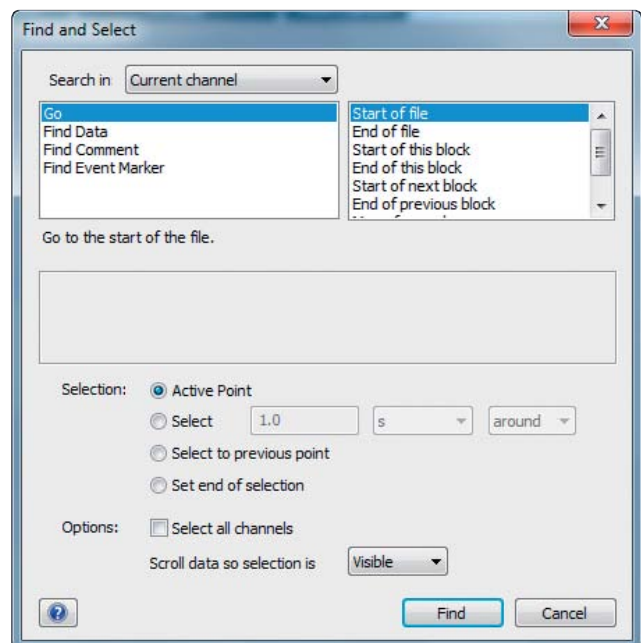
Find and Select Data dialog.

Save and recall analysis settings

Use Analysis Manager to save and recall selections of data and/or active points in both Chart and Scope View.

You can also use Analysis Manager with popular LabChart Modules to save the module settings associated with one or more analyses. This enables analysis of separate data regions within a file and multiple analyses of the same or different regions. The results of each analysis can be saved and recalled.

The Analysis Manager dialog showing multiple analyses of data recorded from two subjects in one data file.

Import and Export Data Easily

Copy and paste data: numbers or images

Transfer data between files and applications with LabChart's copy and paste functions. You can:

- Copy and paste a data selection (from Chart View or Data Pad) directly into another LabChart file or a different application
- Illustrate reports and presentations quickly — copy Chart, Scope, XY, Zoom or Spectrum Views and paste as an image into a different application

Selecting data region to copy using the Copy dialog.

Export data dynamically to Excel

Export incoming or previously recorded data into Microsoft Excel for numerical analysis and graphing. OLE technology links LabChart and Excel so any changes in the LabChart data are automatically updated in Excel.

You can export into Excel from Chart View, Scope View and Data Pad. Use LabChart's **'Timed Add to Data Pad'** feature to plot XY curves in Excel as you record.

Export data to other applications

Export LabChart data for display and analysis in a range of popular software applications. File format options include:

- *.pxp for IGOR Pro software
- *.mat for MATLAB software
- Axon Binary Format (*.abf) for pCLAMP software
- *.wav (uncompressed audio) for a range of applications
- *.edf for European Data Format applications
- *.adidat for earlier versions of LabChart
- LabChart Binary File (*.adibin).

OLE linking allows data to be acquired and exported online or offline into other programs such as Excel.

LabChart

Export LabChart data as *.txt files for use in applications, such as Excel, that accepts tab-delimited text format data. Configure the data you would like to save in the Export dialog.

Options include:
- Export specific channels or include comments and Event Markers in a *.txt file
- Export Data Pad contents as a *.txt file or Unicode text file
- Export Spectrogram or Spectrum PSD data as *.txt files
- Export Scope View page data as a *.txt file.

Import data from other applications

Use LabChart to view and analyze data recorded in other applications. Options include:
- Data recorded in BIOPAC AcqKnowledge software
- Data recorded in Axon pCLAMP software
- WinDAQ data files
- WAV uncompressed audio files (*.wav format)
- EDF (European Data File format) data files
- LabChart Binary File (*.adibin).

Get Help and Find New Features

Access LabChart's Help Center

Browse, search or navigate through hundreds of Help topics in LabChart's Help Center (Windows). Accessed through the main Menu and Chart View menu bar, the Help Center covers LabChart, as well as all extensions and modules. There are also links to our website, software forum and worldwide distribution and support network.

Browse, install & manage software from the Feature Manager

Browse and manage all ADInstruments software modules and extensions in one location. Feature Manager categorizes all available modules and extensions, making it easy to find an add-on that suits your application. You can also search for relevant software using key terms.

You can use Feature Manager to quickly turn LabChart extensions and modules on or off on start up. LabChart will then only load the features you request.

Feature Manager also performs manual or automatic software update checks to ensure you have the latest version of LabChart software and plug-ins.
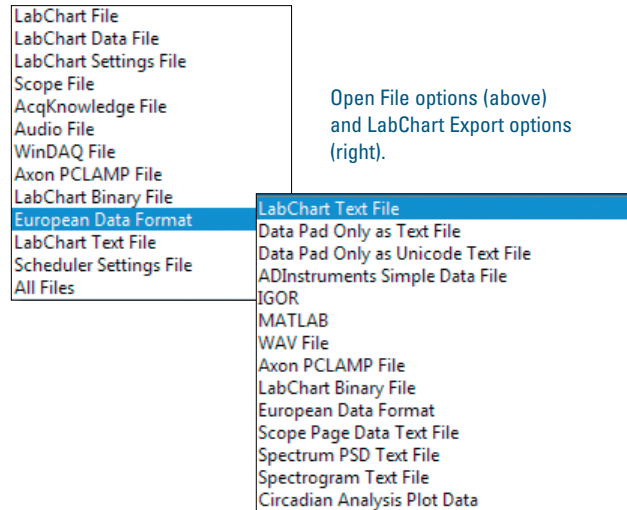
Open File options (above) and LabChart Export options (right).
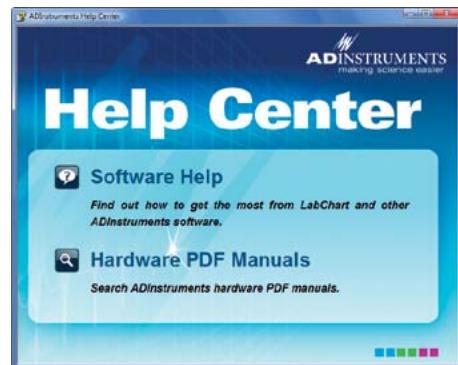
LabChart Help dialog.
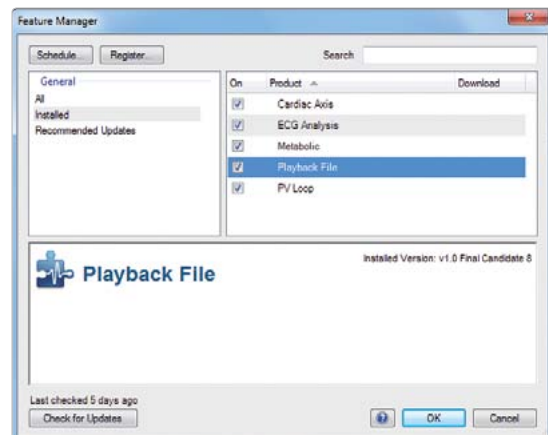
Feature Manager allows users to choose which of the installed modules and extensions to load at the next launch of LabChart.

LabChart

LabChart Welcome Center

Gain access to LabChart resources and materials within one interface. Open your LabChart files, access all ADInstruments documents (including demo files and supporting documents) and clone document settings easily, as well as access and search up to 100 recently opened files. A collection of Quick Links provides one-click access to popular LabChart features and support.
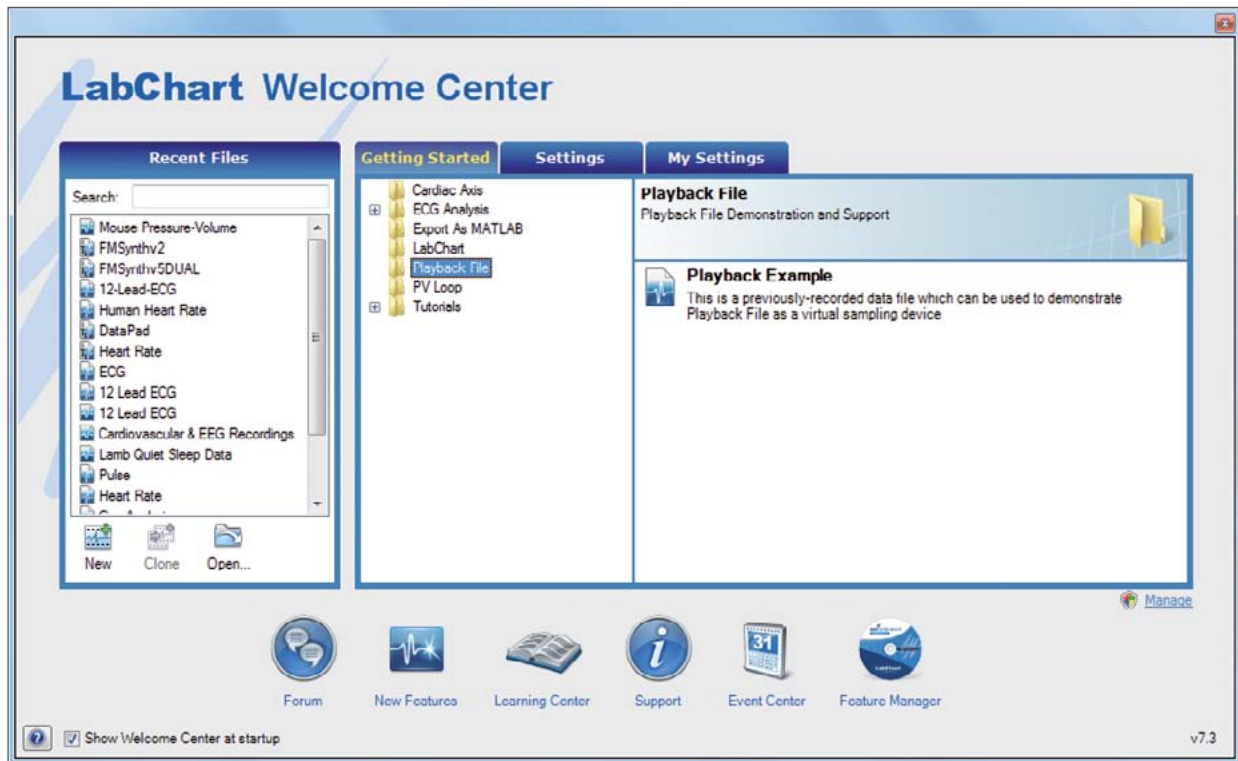
Included with the Welcome Center Quick Links are:

- **ADInstruments Forum**
  Keep abreast of developments in the scientific community, and connect with peers, technical specialists and ADInstruments product developers.

- **Support**
  View PDF and HTML help documents, or request one-on-one technical assistance from ADInstruments scientists and engineers.

- **New Features**
  Read about the latest developments in LabChart software, modules and extensions that enhance your experiments and analysis.

- **Feature Manager**
  Browse, install and update software quickly and conveniently.

- **Event Center**
  Browse upcoming training and workshop opportunities worldwide.

- **Learning Center**
  Access training videos, web seminars, software tips, technical documents, manuals and brochures.

Neurophysiology:
RMS & Noise
Evoked Response
Fast Response Output
Telegraph
Template

Filtering:
RMS & Noise
Savitzky-Golay
Signal Averaged ECG (SAECG)

Cardio-respiratory:
Spirometry
Signal Averaged ECG (SAECG)
Cardiac Axis
Ventricular Pressure

Utility:
Audio Output
Event Manager
Export QuickTime
Fast Response Output
Playback File
Scheduler
Telegraph
Template

Data Visualization:
Amplitude Histogram
Spectral Temporal Mapping (STM)
Telegraph
Peak Parameters

Measurements & Calibrations:
Multipoint Calibration
Absorbance
Evoked Response
Spirometry
Ventricular Pressure
Template

Chemistry:
Absorbance
Multipoint Calibration
Curve Fit
pH Measurement

Analysis Windows:
Amplitude Histogram
Curve Fit
Spectral Temporal Mapping (STM)

LabChart Extensions

LabChart Extensions add specific features and functionality to LabChart software and are free to all LabChart users*. Use LabChart's Feature Manager to browse and install extensions, or visit our website for a complete list.

- **Absorbance** — convert spectrophotometer outputs from Transmittance to Absorbance
- **Amplitude Histogram** — display and analyze a signal's amplitude distribution (define bin width and analyze mean, standard deviation and standard error)
- **Audio Output** — play recorded LabChart data as sound
- **Cardiac Axis** — automate the calculation of frontal plane ECGs and vector cardiograms and display the instantaneous cardiac vector
- **Curve Fit** — perform non-linear, least squares fitting of built-in and user-defined equations to data that has been recorded as a function of time
- **Event Manager** — monitor user-defined events online using numerous criteria and perform a variety of user-defined actions
- **Evoked Response** — analyze physiological responses to a stimulus; parameters include value, latency, peak height, half-width, latency to peak
- **Export QuickTime** — save LabChart data files as QuickTime movies
- **Fast Response Output** — generate rapid responses from digital outputs of the PowerLab (old model PowerLabs are not supported)
- **Function Generator** — create data using mathematical functions
- **Multipoint Calibration** — perform linear and non-linear multipoint calibration of transducers, sensors, and other devices
- **Peak Parameters** — determine parameters including peak height, width and individual peak slope. Useful for action potentials (cardiac, EPSP and IPSP)
- **pH Measurement** — calibrate pH and ion selective electrodes using single or double point methods
- **Playback File** — record data from a saved LabChart or audio file into a live LabChart file, as if sampling from a PowerLab
- **RMS & Noise** — determine a signal's power content (RMS gives total power content, including the DC component; Noise gives the AC component only)
- **Savitzky-Golay** — perform offline least-squares smoothing, especially suited to removing noise from data such as ECG and differential calculations
- **Scheduler** — schedule recording across one or more LabChart data files using external scheduling devices such as the TR Scheduler Pod
- **Signal Averaged ECG** — use SAECG to analyze ECG signals and display an averaged cycle to remove noise and unwanted signal components
- **Spirometry** — process pneumotachometer signals and display respiratory parameters (e.g. $\dot{V}_E$, V_T, Frequency, PIF, PEF, FVC, FEV_1). Generate flow volume plots and spirometry reports
- **STM** — display the amplitude of a signal's frequency components as a function of time (a spectral-temporal map)
- **Telegraph** — use the gain-telegraph output from an electrophysiological amplifier to display data at the correct scale after a gain change
- **Template** — match a data template with similar occurrences in a larger data set. Choice of three algorithms — RMS Error, Correlation or Convolution
- **Ventricular Pressure** — analyze recordings of cardiac ventricular pressure.

*Not all extensions are available for both Windows and Mac operating systems and some extension features may differ between computer platforms.

LabChart Reader

LabChart Reader is a free program that allows anyone to view LabChart data files. The program includes standard LabChart display features and some analyses. LabChart Reader is available for Windows and Mac operating systems from our website.

Use LabChart Reader to:

- Easily collaborate with other scientists
- Ask students to view and analyze real experimental/research data
- Make data files available on/to download from your website.

Same display and analysis features as LabChart

Apply Cyclic Measurements to recorded data

Recording button disabled — you cannot acquire data with LabChart Reader

Magnify data in the Zoom View

Extract and analyze data in the Data Pad

With LabChart Reader you can:

- Open LabChart data files and view recorded data
- Perform some calculations and analyses
- Analyze data (limited)
- Print data
- Import other file formats
- Install the Cardiac Axis & Spirometry Extensions.

A full version of LabChart is required to:

- Record new data
- Save data
- Use our advanced analysis extensions and modules.

LabChart Pro and LabChart Modules

LabChart Modules provide highly specialized data acquisition and analysis features for specific applications. Modules are available for purchase as a complete set in LabChart Pro or individually. LabChart Pro users are entitled to free software upgrades for five (5) years, conveniently available to download from the ADInstruments website.

LabChart™ Pro

LabChart Software plus:

Blood Pressure	HRV
Cardiac Output	Metabolic
Circadian Analysis	Peak Analysis
DMT Normalization	PV Loop
Dose Response	Spike Histogram
ECG Analysis	Video Capture

Blood Pressure   Windows

Identify and analyze various parameters of arterial and ventricular pressure online or offline with the Blood Pressure Module.

Customize analysis settings

Analysis settings can be set prior to (for online analysis) or after recording (for offline analysis). In the Blood Pressure Settings dialog you can select:

- The pressure signal to be analyzed (atrial or ventricular)
- Cycle detection parameters
- Cycle averaging options
- End diastole and Tau fitting options (ventricular pressure only).

For ventricular pressure signals, the end of diastole can be identified using either the pressure signal, or an ECG signal that is synchronized with the pressure signal. The time constant (Tau) provides a measure of the isovolumetric relaxation of the heart.

Once the detection and analysis settings are selected:

- Pressure cycles are automatically identified and marked in the pressure channel
- Marked cycles contain information such as cycle time, number, duration and height.
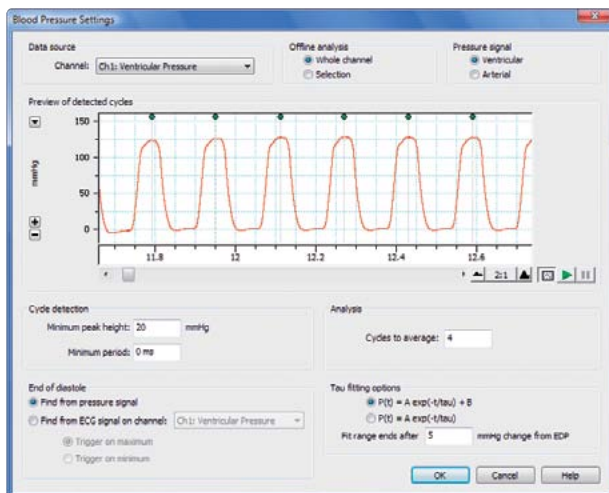
Blood Pressure Settings dialog.
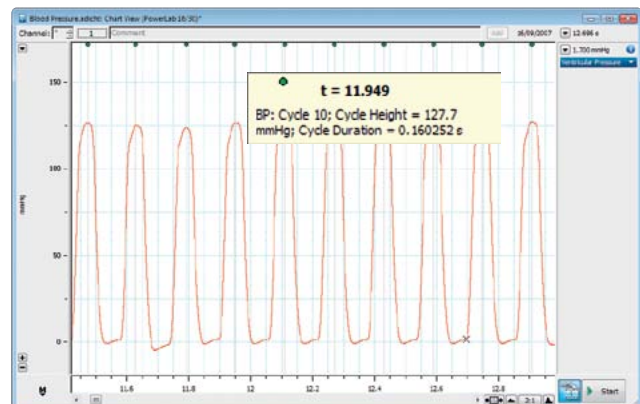
Chart View of a ventricular pressure recording.
Note: Cycle Markers above the trace and cycle information pop up.

Classify, include or exclude cycles

Use the Classifier View to identify cycles that differ in duration or height, and to include or exclude any cycle groups from the analysis.
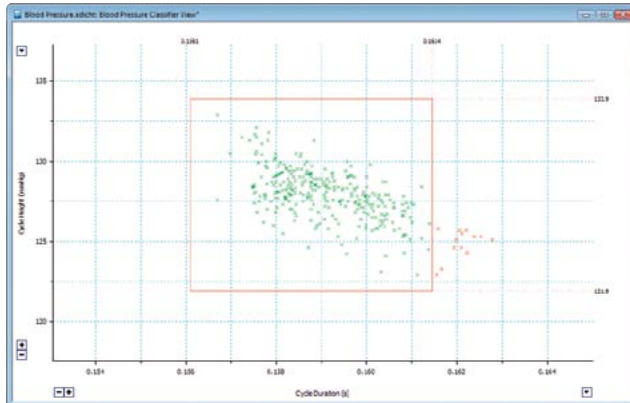
Blood Pressure Classifier View. Points outside the cycle height and duration limits (red crosses) are not included in the analysis.

Analyze averaged signals

The Analysis View displays groups of averaged cycles and highlights key parameters calculated by the module. Cycle averaging is a more accurate representation of the blood pressure waveform in the presence of noise or interference.
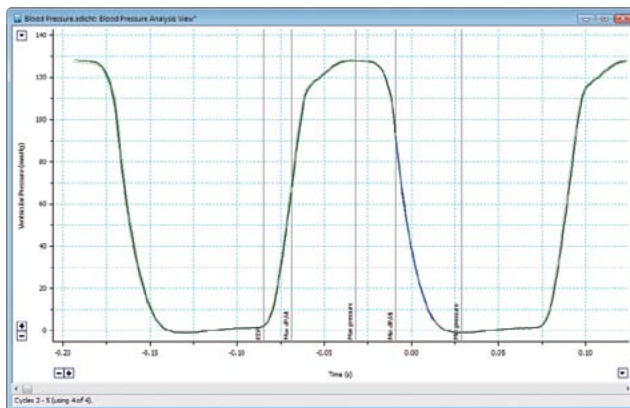
Blood Pressure Analysis View displaying a ventricular pressure cycle.

Ventricular cycle parameters marked include:
- End diastolic pressure
- Maximum dP/dt
- Maximum pressure
- Minimum dP/dt
- Minimum pressure
- Tau.

Arterial cycle parameters marked include:
- Diastolic pressure
- Systolic pressure
- Dicrotic notch.

Analyze calculated parameters

The Table View displays a wide range of calculated parameters for each averaged cycle. The individual parameters available for selection in the Table View Options dialog vary depending on whether arterial or ventricular signals are being analyzed. The contents of the Table View can be exported for further analysis.
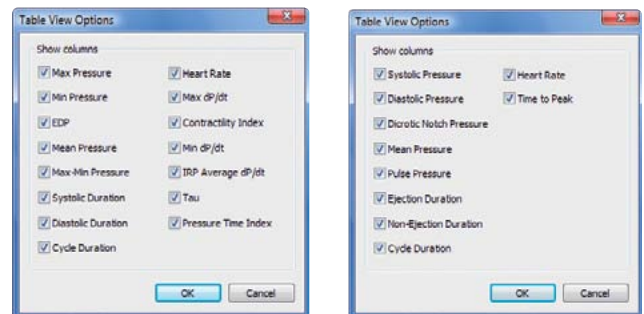
Blood Pressure Table View Options Dialog for ventricular (left) and arterial signals (right).

Display calculated parameters in separate channels

You can display parameters calculated by the Blood Pressure Module as continuous data on separate channels in Chart View. This provides online analysis of blood pressure parameters.
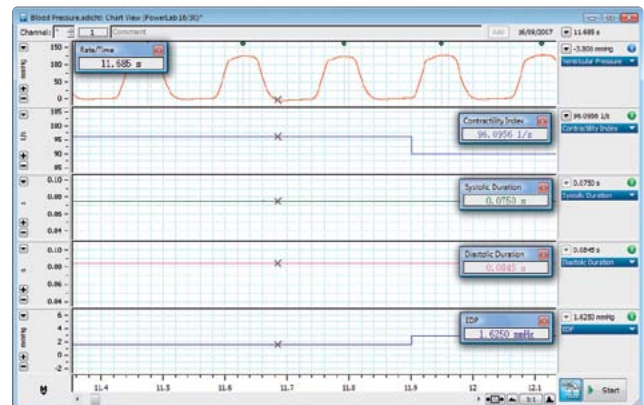
Selected ventricular pressure parameters displayed on separate channels in real time.

Blood Pressure Applications:

- Mouse and Rat (page 8)
- Blood, Atrial and Ventricular Pressure (Page 10)
- Telemetry (page 14)
- Psychophysiology (page 30)

Cardiac Output

Windows

Determine the cardiac output from a recorded thermo-dilution curve measured in small animals.

With the Cardiac Output Module's analysis tools you can:
- Set experimental and calculation parameters
- Automatically calculate and display cardiac output from recorded thermodilution curves
- Extract and export cardiac output values to other programs for further statistical analyses.

The cardiac output calculation is based on the area under the thermodilution curve and takes account of baseline drift and prolongation of the decay curve due to recirculation of the injectate.

The module calculates cardiac output in mL/min and generates a graphical display featuring the area under the curve. Analysis parameters are quickly and easily selected in the Cardiac Output Settings dialog.

Correct for temperature & baseline drift

The module's settings include a user-defined correction factor option to account for warming of the injectate as it is injected through the catheter, or any other correction factor related to the experimental conditions.

Extrapolate curves to baseline

Depending on the injectate temperature, there may be some permanent cooling of the blood. As the cooled fluid is recirculated, the thermodilution curve does not return to its baseline value. The Tail Fitting range allows the user to define a portion of the downslope of the recorded thermodilution curve, from which an exponential curve is calculated and extrapolated to a baseline. The portion of the downslope used in this calculation is specified as a percentage of the curve full height.
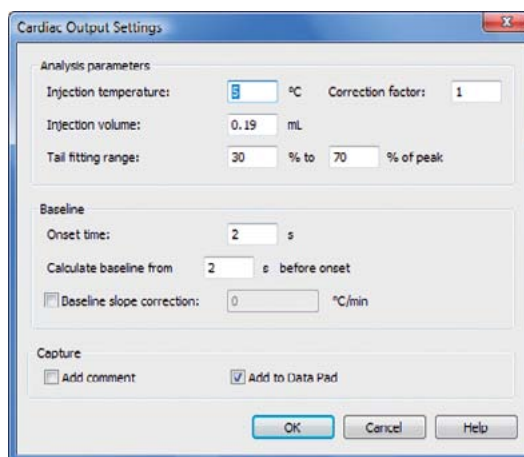
Define the parameters used to calculate cardiac output in the Cardiac Output Settings dialog.

Tabulate calculated values

The Capture option in the settings dialog allows the addition of a comment and the resulting cardiac output values on the selected thermodilution curve.

Selecting **'Add to Data Pad'** automatically transfers calculated values to the Data Pad spreadsheet.
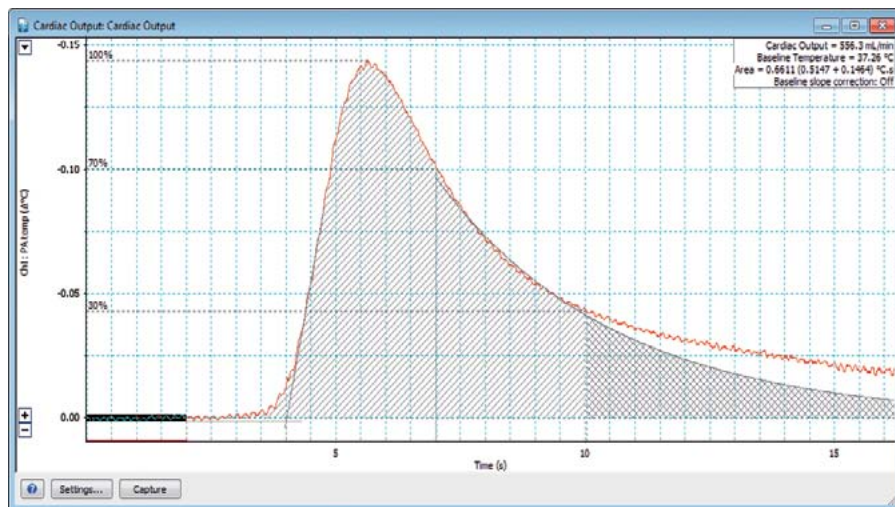
A thermodilution curve showing baseline determination (red line), area under the curve (shaded region) and cardiac output values (top right-hand corner) calculated using the Cardiac Output Module.

Each cardiac output determination uses a baseline temperature calculated for each thermodilution curve. Any baseline drift can be corrected by selecting baseline data and choosing **'Set Baseline Correction'** from the Cardiac Output Settings dialog.

Cardiac Output Applications:
- Mouse and Rat (page 8)
- Blood Flow, Cardiac Output, Oximetry (page 19)

Circadian Analysis

Windows

Analyze long term recordings with an inherent daily pattern and generate graphical and tabular views of the daily and averaged data with the Circadian Analysis Module.

Each period's recording is split into a user-determined number of intervals. Interval data are averaged, plotted, displayed numerically and analyzed to determine variables including the minimum, maximum and mean value for each day, as well as the average period.

LabChart Window displaying Chart View (top left), Circadian Analysis Averaging View (top right) and Circadian Analysis Table View (bottom).

Features and benefits include:

- Day-by-day analysis of data over multiple channels
- Analysis of continuous, intermittent or calculated data
- Customizable circadian period start time and length
- Optional data exclusion filter.

Customize analysis settings

In the Circadian Analysis Settings dialog you can:

- Select the number of channels to be analyzed
- Choose to analyze the whole channel or a selection
- Adjust time settings including the circadian period (day length), day start time and averaging interval
- Enable and configure data exclusion filter to ignore data outside preset limits for calculating averages
- Adjust the light on/off shading feature to represent day and night in the Averaging View.

Circadian Analysis Table View.

View, analyze & export calculated data

The Circadian Analysis Table View automatically calculates and displays the following parameters for each day, as well as determining an average day:

- Maximum
- Minimum
- Mean
- Time at maximum
- Time at minimum
- Maximum–minimum.

You can export Circadian Analysis Table View data as a tab delimited file into other programs (such as Microsoft Excel).

Display averaged daily data

The Circadian Analysis Averaging View displays and plots the averaged interval data for single or multiple channels. You can choose to:

- View the automatically calculated average daily data
- Show all days as an overlay on top of the average day
- Select a specific day from the highlight drop-down list or by clicking on its trace
- View the values for any specific point in time obtained by hovering over the trace
- View each channel's data separately, or show multiple channels in the same view.
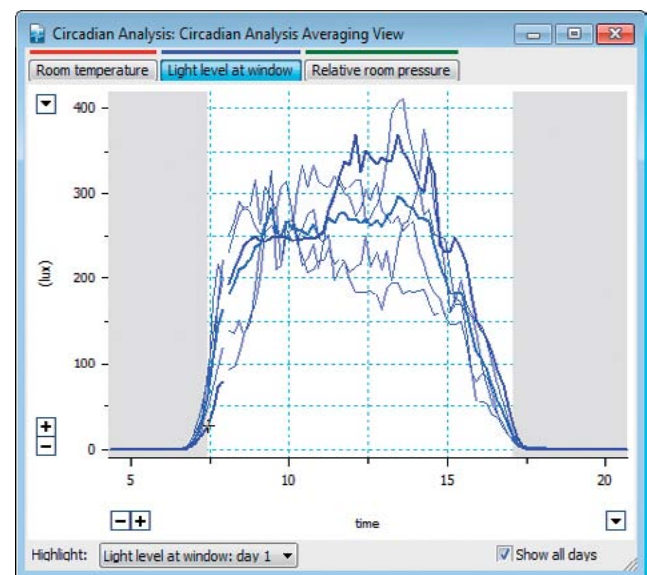
Circadian Analysis Averaging View.

Circadian Analysis Applications:

- Blood, Atrial and Ventricular Pressure (page 10)
- Telemetry (page 14)
- Psychophysiology (page 30)
- Sleep Studies (page 26)

DMT Normalization

Windows Mac OS

Calculate optimal pretension conditions for microvascular and other small tubular tissue experiments with the DMT Normalization Module. The module provides a standardized and validated method for use with PowerLab and DMT Wire Myographs.

The DMT Normalization Module:
- Provides online and offline determination of tissue effective pressure
- Calculates the optimal pretension (micrometer setting) for each piece of tissue prior to experimentation.

Standardize tissue tension

As pretension can affect smooth muscle function, it is important to standardize the tension placed on individual tissues before conducting an experiment.

The normalization procedure determines the optimal internal circumference at which each tissue would be relaxed under a transmural pressure of 100 mmHg (denoted as the IC100 index).

In the Normalization Settings dialog you can customize microscopic calibration, target pressure, IC1/IC100 ratio, online averaging time and the delay time between micrometer changes. This ensures the most accurate measurement of resting wall tension.
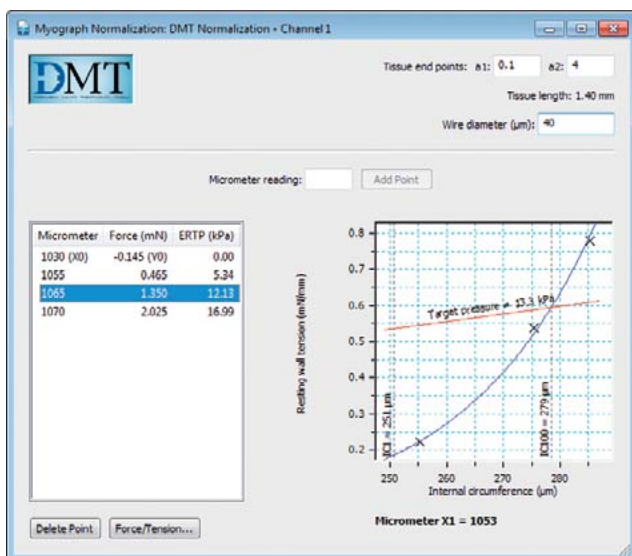
DMT Normalization window with stepwise distension of tissue using the micrometer and the developed force measured. The graph on the right is automatically generated from the calculated internal circumference and resting wall tension.

Collect data during experiments

The module calculates IC100 for each tissue mounted on the wire myograph, and takes into account the tissue's size and contractile components. You can specify wire diameter and tissue end points (for determination of tissue length) in each LabChart channel's Normalization window.

When micrometer values and force measurements are entered (either online or offline) the module graphs the measured internal circumference versus the vessel's resting wall tension, from which the IC100 and IC1 are then calculated.

The module uses these values to calculate the final micrometer setting for uniform and accurate pretension conditions for each tissue being studied prior to the experiment.
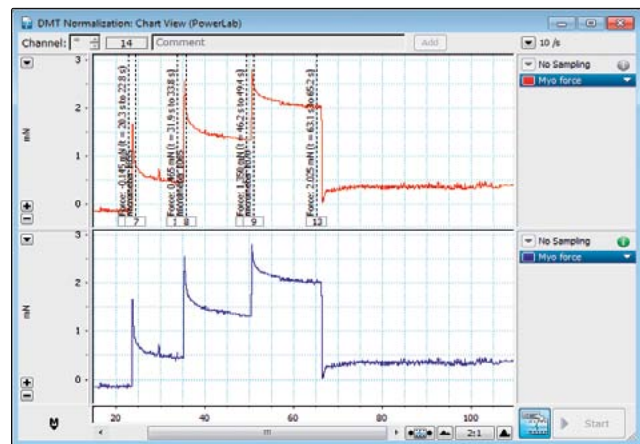
LabChart file (above) showing stepwise distension and force measurement of the tissue, and the Normalization Settings dialog
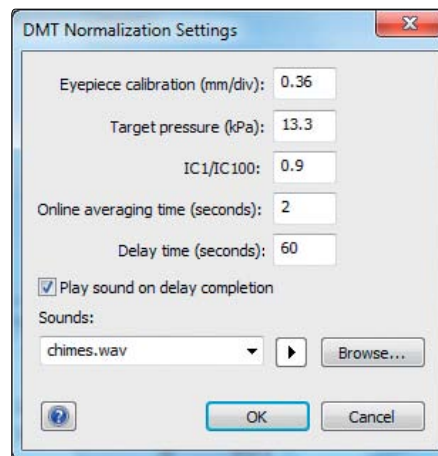
DMT Normalization Applications:

- Mouse and Rat (page 8)
- Isolated Tissue (page 32)

Dose Response

Extract and analyze data from *in vivo* and *in vitro* experiments with the Dose Response Module.

The Dose Response Module is ideal in the analysis of responses to chemical, electrical or physical agonists or antagonists. Applications include:

- Isolated muscle preparations
  - smooth
  - skeletal
  - cardiac
- Cardiovascular studies
  - blood pressure
  - heart rate
- Neurophysiology
  - membrane potentials
  - nerve activity.
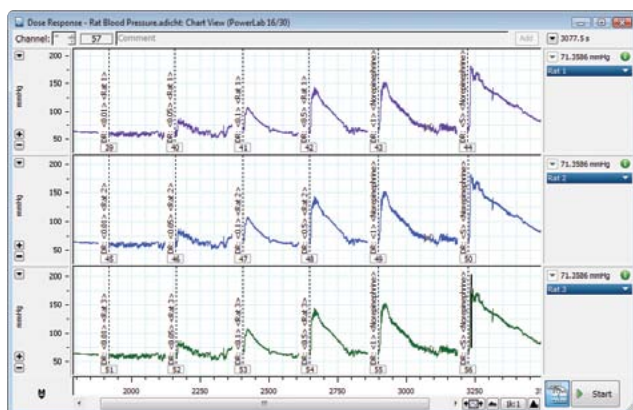
Rat aortic blood pressure recording. Agonist injection times were marked during recording. Data were digitally filtered to show only the average pressure per beat.

The Dose Response Module:
- Calculates dose and response parameters including average, maximum, maximum-minimum (Response Height), integral (area) and minimum
- Tabulates the results automatically or manually
- Generates instantaneous Hill curves
- Displays single or multiple response curves
- Calculates EC_{50} and Hill slopes
- Exports results in XML and tab-delimited text format.

Dose Comments for quick analysis

Uses comments to identify changes in doses when analyzing data. Predetermined comments can be easily set up and used during experiment protocols. Comments that are not in the correct dose format can be easily converted using the convert comments dialog. Comments can also be used to specify which parameters to analyze and for how long.

Display Tabulated Data & Dose Response Curves

The Dose Response Table View tabulates response parameters. The value of each response in the Table View is linked with the corresponding display in the Dose Response Analysis View and Chart View. The results change automatically when different analysis selections are made.
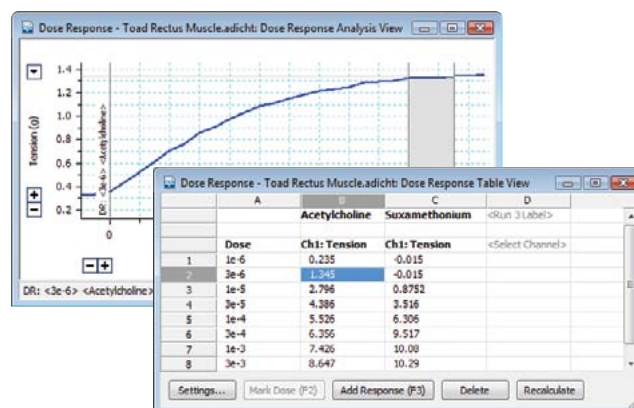
Dose Response Analysis and Table View. The highlighted dose in the Table View corresponds to the result highlighted in the Analysis View.

The Dose Response Results View displays the plotted dose response curves and calculated parameters such as EC_{50} and Hill slopes with their respective standard errors. The Results View provides options for normalizing the curves and changing the units on the x-axis.
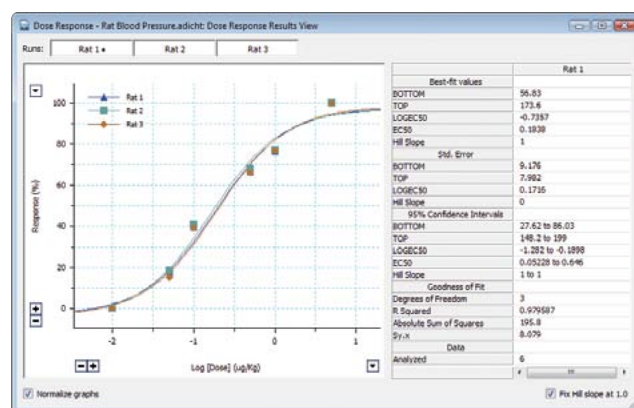
Dose Response Module Results View showing fitted response curves to increasing doses of norepinephrine in a rat blood pressure recording. Fitting parameters for a selected curve are shown on the right.

Dose Response Applications:

- Blood, Atrial and Ventricular Pressure (page 10)
- Mouse and Rat (page 8)
- Isolated Tissue (page 32)
- Isolated Perfused Hearts (page 36)

ECG Analysis

Windows

Automatically detect and analyze ECG signals from any species with the ECG Analysis Module. The module:

- Analyzes ECG signals both online and offline
- Automatically detects and averages ECG cycles
- Includes preset detection parameters for humans, pigs, dogs, rabbits, guinea pigs, rats and mice
- Leaves raw data unaltered for future analysis
- Links between Chart, ECG Analysis and Table Views for quick navigation to points of interest.
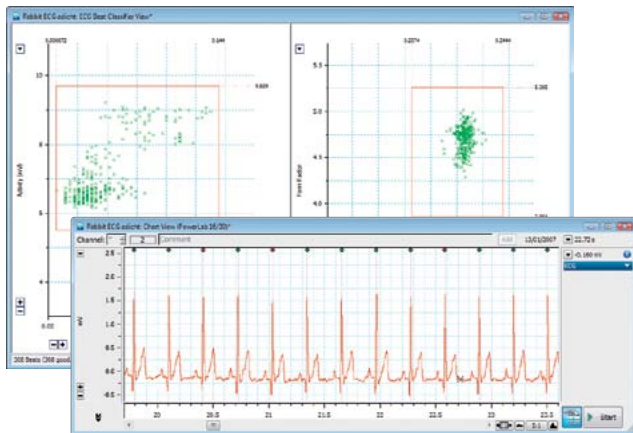
Top: Classifier View. Bottom: In Chart View, Beat Markers show beats included (green) and excluded (red) from analysis.

Detect and remove unwanted beats

In the module's Classifier View, you can exclude beats with excessive noise (such as muscle activity) in the left panel, while the right panel identifies beats with altered QRS shape.

Display the average beat

The Averaging View displays each beat along with the average as determined in the Settings dialog.
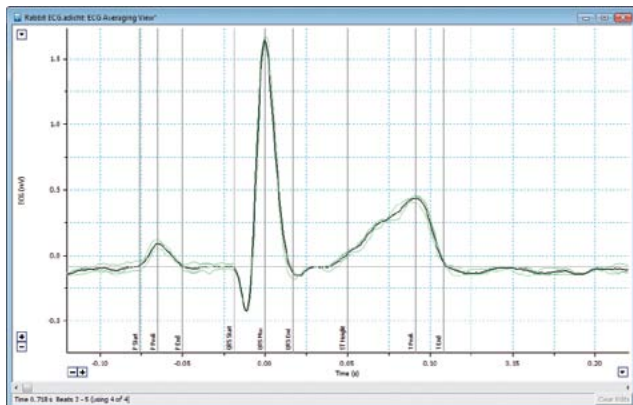
ECG Averaging View shows the average waveform (black) and labels specific ECG components.

Automatically tabulate ECG variables

The Table View logs variables for each average including:

- P, Q, R, S, T amplitudes
- Time intervals such as RR, PR, JT, QT and QTc.

ECG Table View.

View analysis plots online and offline

For quick analysis of ECG recordings, the module generates analysis plots (online and offline) including:

- QT/RR Plot (QT Interval versus RR Interval)
- QT/Time Plot
- RR/Time Plot
- Waterfall Plot.

You can also display each ECG parameter calculated by the module in a separate channel in Chart View.
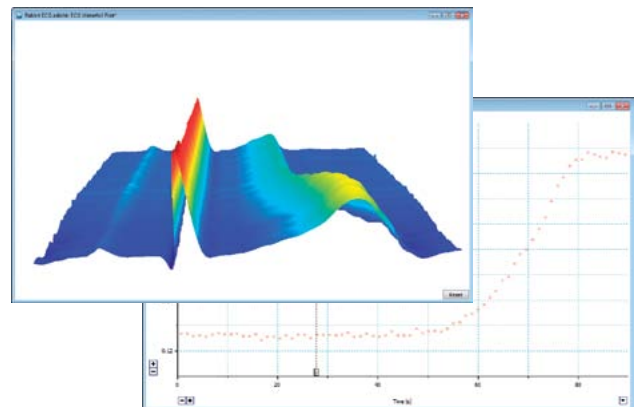
The QT interval versus Time plot is ideal for illustrating the effect of dofetilide on the ECG's QT interval in a rabbit. The ECG Waterfall Plot displays a 3D plot of averaged beats, with obvious QT prolongation.

ECG Analysis Applications:

- Mouse and Rat (page 8)
- ECG and Heart Rate Variability (page 16)
- Telemetry (page 14)

HRV

Analyze ECG or pulse signals for variations in the interval between heartbeats with the HRV (Heart Rate Variability) Module.

ECG signal recorded in LabChart and HRV Report providing subject details and heart rate variability statistics.

The HRV Module uses a threshold detector to detect the R component from each raw ECG waveform and generate RR Interval data. The module automatically distinguishes and classifies beats into three groups; normal, ectopic or artifact. With the HRV Module you can:

- Adjust artifact/ectopic interval classification limits
- Exclude artifacts or include beats in the analysis on an individual basis
- Delete short artifact groups or add RR intervals
- Adjust the histogram bin size.
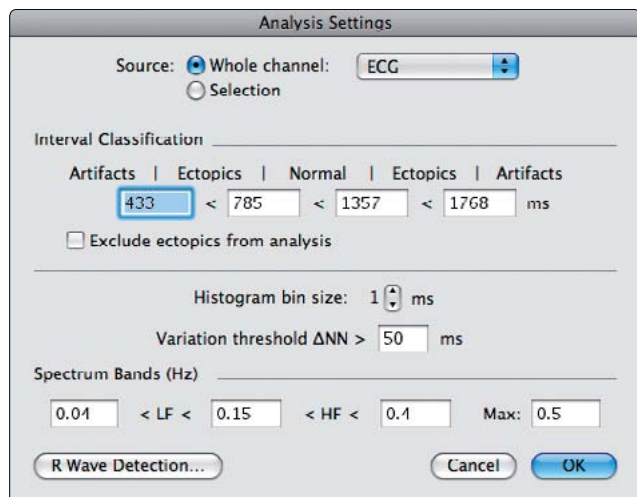
The Analysis Settings dialog.

Display data as graphs & statistics

The HRV Module uses the RR interval data to generate displays including: Poincaré Plot, Period Histogram, Delta RR Histogram, Tachogram and Spectrum. It also generates a Report featuring subject data and HRV statistical measures.
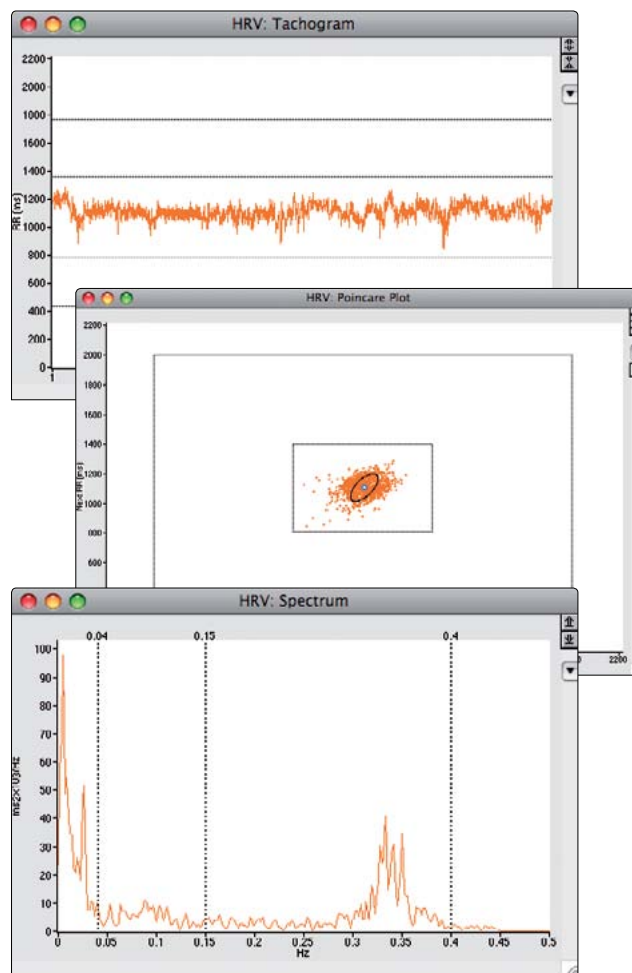
Top: The Tachogram window plots the RR duration against the corresponding beat number.

Middle: The Poincaré Plot plots each RR interval against the preceding RR interval. Simply adjust the interval classification limits to change the classification boundaries.

Bottom: The Spectrum window plots a power spectrum of the RR intervals.

HRV Applications:

- Exercise Physiology (page 22)
- ECG and Heart Rate Variability (page 16)
- Telemetry (page 14)
- Psychophysiology (page 30)
- Sleep Studies (page 26)

Metabolic

Windows
Mac OS

Determine cardiorespiratory function and exercise physiology measurements online and offline with the Metabolic Module.

The module provides a comprehensive set of features for metabolic data acquisition and analysis from human subjects, and is ideal for use with the ADInstruments Exercise Physiology System (see page 90).

The Metabolic Module and Exercise Physiology System are used together in applications including:

- Continuous measurements of metabolic parameters
- Respiratory gas analysis
- Pulmonary function analysis
- Indirect calorimetry
- Spirometry
- Biopotential measurements.

The module uses simultaneous measurements of respiratory gas concentrations and airflow to calculate and display metabolic variables.

Customize experiment settings

The Metabolic Module allows you to:

- Set averaging time (data logging) and recording time (duration of experiment)
- Enter subject details (such as name, age, weight, height and gender)
- Specify environmental settings (such as atmosphere or air conditions)
- Calibrate your data: settings for automated first and second gas calibrations
- Customize reports generated by the module.
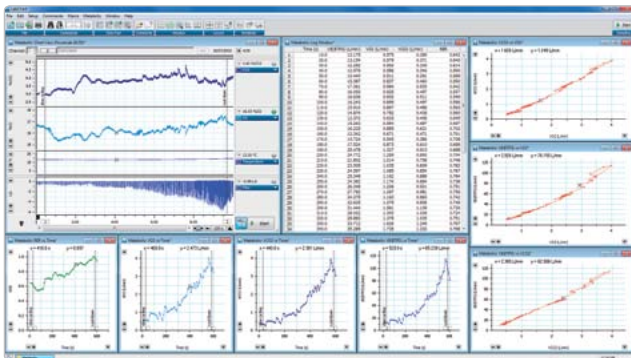
Chart View (top left) with measurements of $\%CO_2$, $\%O_2$ and airflow, Metabolic Module Log Window (top centre) and various plots.

Automatically generate variables and graphs

The Metabolic Module automatically calculates and tabulates the following variables in the Log Window:

- $\dot{V}_E$ expired minute volume (L/min)
- $\dot{V}_{O_2}$ oxygen consumption (L/min)
- $\dot{V}_{CO_2}$ carbon dioxide production (L/min)
- RER respiratory gas ratio.

The module generates seven graphs that plot metabolic variables against time or each other. The plots are constructed from time-averaged data points (tabulated in the Log Window).

Top: The Log Window. Bottom (left to right): $\dot{V}_{CO_2}$ vs. time, $\dot{V}_{O_2}$ vs. time and RER vs. time.

Metabolic calculations are displayed as:

- $\dot{V}_E$(BTPS) vs. $\dot{V}_{O_2}$
- $\dot{V}_E$(BTPS) vs. $\dot{V}_{CO_2}$
- $\dot{V}_{CO_2}$, vs. $\dot{V}_{O_2}$
- RER vs. Time
- $\dot{V}_{O_2}$ vs. Time
- $\dot{V}_E$ (BTPS) or $\dot{V}_I$ (ATPS) vs. Time
- RER vs. Time.

The plots and the Log Window are updated in real time and can be printed or exported. Metabolic graphs and calculations are compiled into a report that can be printed or exported to other programs for further analysis.

Metabolic Applications:

- Exercise Physiology (page 22)

Peak Analysis

Windows

Automatically detect and analyze single or multiple (non-overlapping) peaks in periodic signals with the Peak Analysis Module.

Use the Peak Analysis Module to:
- Automatically detect peaks within an entire channel or data selection
- Automatically tabulate extracted peak parameters for export to other applications
- Detect positive or negative peaks
- Display calculated parameters as continuous signals in LabChart channels
- Navigate between the Chart, Peak Analysis and Table Views.
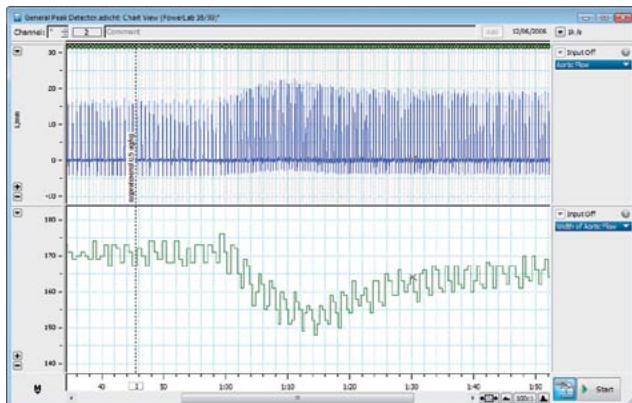
Chart View with detected peaks in the top channel and calculated peak width displayed as a continuous signal in the bottom channel.

Choose from default settings for different applications

The Peak Analysis Module can enhance waveform analysis across a wide range of applications. To make analysis setup simple, you can choose between default settings options including:

- **Action Potentials** — for intracellular neuronal action potentials
- **Cardiac Action Potentials** — for monophasic intracellular and extracellular cardiac action potentials
- **Evoked Responses** — for monophasic peaks that follow a stimulus
- **General Unstimulated** — general-purpose detector of unstimulated peaks (offers a wide range of customized options)
- **Population Spikes** — for extracellular evoked responses
- **Synaptic** — for synaptic measurements.

You can further customize the settings and baseline detection options to suit your specific signals and experiments.

Calculate and log selected peak parameters
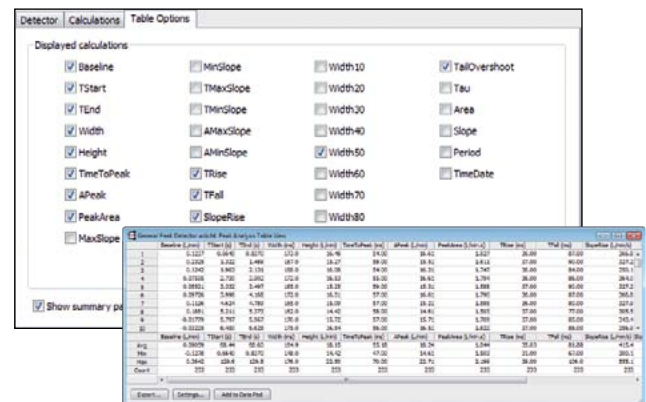
The Table View displays calculated variables chosen in Table Options for all detected peaks. Values can be exported as a text file or easily added to Data Pad.
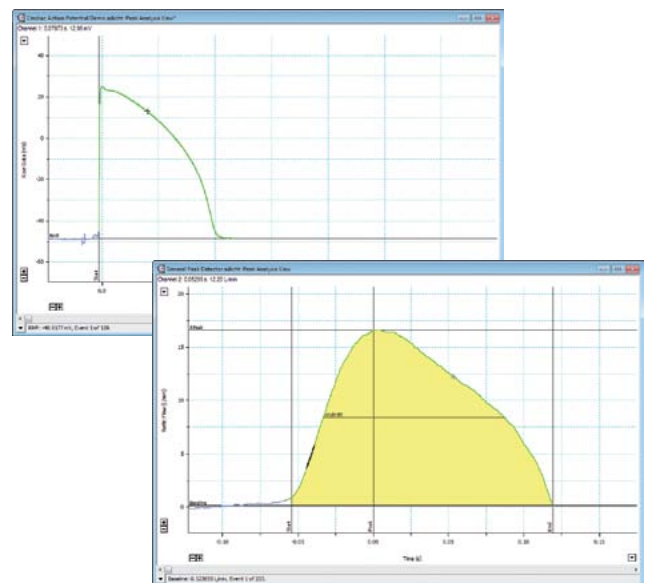
Analysis View provides the visual analysis of each peak and its parameters. Examples here show Peak of an aortic flow signal (top left) and a cardiac action potential (bottom right).

Peak Analysis Applications:

- Blood, Atrial and Ventricular Pressure (page 10)
- Mouse and Rat (page 8)
- Blood Flow, Cardiac Output and Oximetry (page 19)
- Isolated Tissue (page 32)
- ECG and Heart Rate Variability (page 16)
- Telemetry (page 14)
- Psychophysiology (page 30)
- Sleep Studies (page 26)
- Isolated Perfused Hearts (page 36)

PV Loop

Windows

Record and analyze left ventricular pressure and volume data for hemodynamic research in animals with the PV Loop Module.

You can calculate the area of a loop, as well as a wide range of hemodynamic parameters both online and offline.
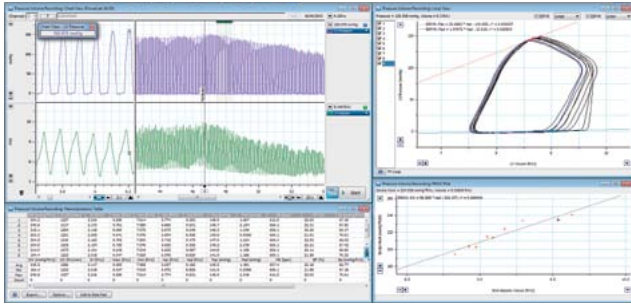
LabChart window showing pressure-volume data (clockwise from top left) recorded in Chart View, displayed in Loop View, plotted as PRSW and dP/dT Max vs. EDV plots and tabulated as hemodynamic parameters.

Display and analyze PV Loops

In addition to displaying pressure-volume loops in the Loop View you can:

- Examine individual loops
- Choose individual loops to include or exclude from your analysis
- Automatically calculate and display end-systolic and end-diastolic PV relationships (ESPVR and EDPVR) using linear, quadratic or exponential regression fit.
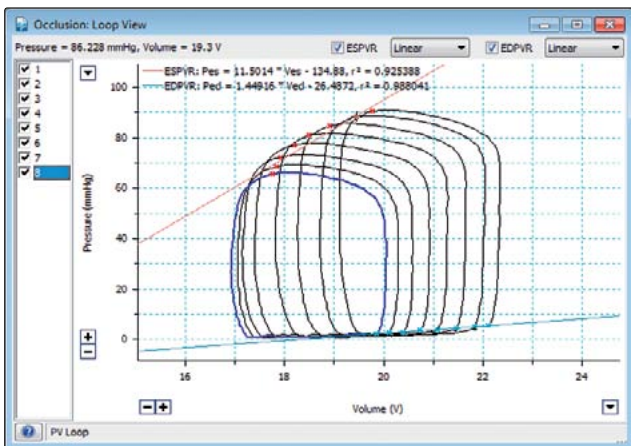
Loop View: Examine individual loops or select a group of loops for analysis.

Calibrate volume data

Use the module to:

- Convert data to absolute volumes using **Cuvette Calibration** — settings files with known volumes of common cuvettes are supplied

- Correct for parallel conductance using saline calibration — calculates and applies the parallel conductance volume correction factor to the volume channel.
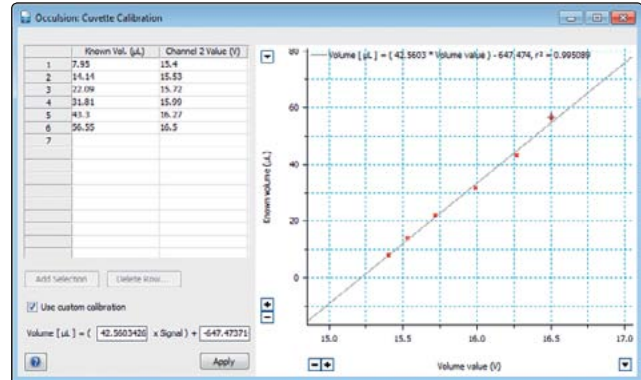
Data calibrated using the cuvette calibration dialog.

Calculate hemodynamic variables

The module's Hemodynamics Table calculates and logs a wide range of variables including pressure-volume area, stroke work, and cardiac output. You can:

- Calculate and display parameters cycle-by-cycle
- Include or exclude parameters from the table.

The Hemodynamics Table.

Plot linear regression

Display linear regression information on four plots including

1 dP/dt max vs. EDV
2 PVA vs. ESP
3 PVA vs. EDV
4 Preload-Recruitable Stroke Work (PRSW).
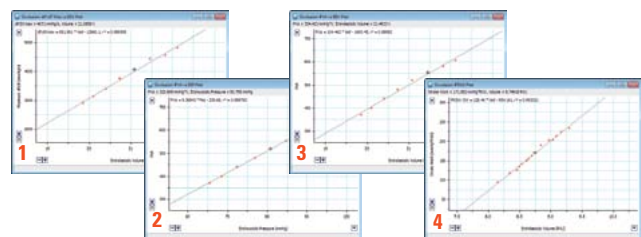
Linear regression information can be displayed on 4 plots.

PV Loop Applications:

- Ventricular Pressure and Volume (page 10)

Spike Histogram

Windows
Mac OS

Analyze extracellular recordings sampled at high rates with the Spike Histogram Module. The module provides a variety of statistical analyses and discriminates online or offline between different units.

Two discrimination methods available

The Spike Discriminator View Window features two powerful discrimination methods for reliable discrimination between units in multi-unit recordings:
- Fast and easy template matching
- Freehand height and width discrimination for precise spike selections.
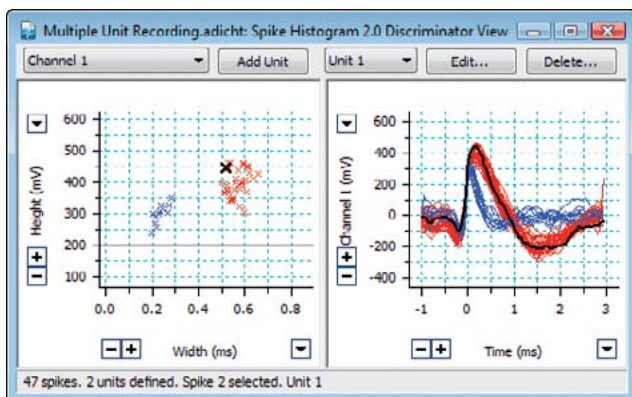
Spike Discriminator View showing some of its many interactive controls. Scatter Plot of spikes organized by height and width (left) and Spike Display pane showing waveform of individual spike (right).

Integrate with Scope View

The Spike Histogram Module integrates seamlessly with LabChart's Scope View. Spike units defined in the discriminator window are automatically updated in Scope View Event Mode allowing spike shapes to be individually reviewed.
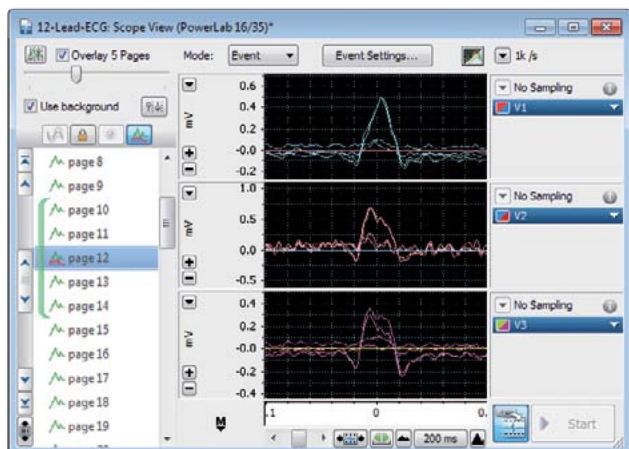
Spike units defined in Spike Histogram Discriminator Window can be used as an Event source in LabChart Scope View.

Generate histograms and display parameters

The module generates analysis graphs from the analyzed spike selection including:
- **Amplitude Histogram** — displays a histogram of amplitudes
- **Interspike interval Histogram** — displays a histogram of interval distribution
- **Peristimulus Time Histogram** — displays the frequency and timing of spike relative to a stimulus or event
- **Ratemeter** — plots the firing rate against time
- **Autocorrelation Histogram** — detects periodicity in an individual unit
- **Cross-correlation Histogram** — detects the temporal dependence of two physiological parameters.

The module calculates and exports 13 parameters for each Histogram Window into LabChart's Data Pad (including bin size, mean X, SD X, SEM X, mean Y and more).
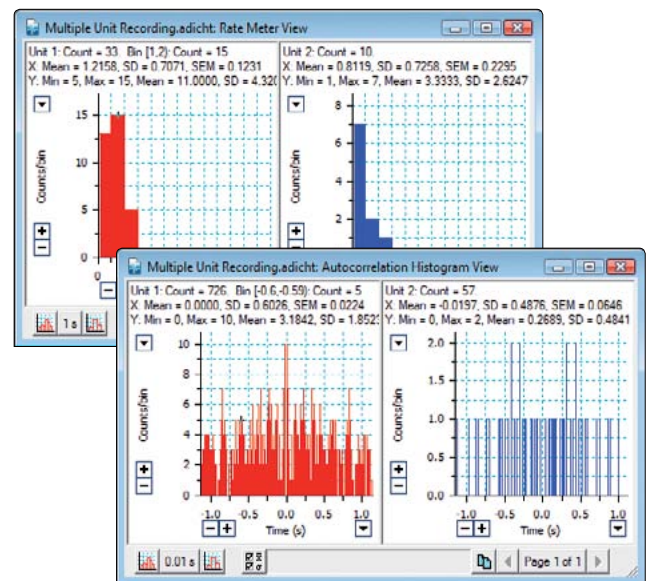
Spike Histogram Rate Meter Window (top) and Autocorrelation Histogram Window (bottom).

Analyze data with NeuroExplorer

Using the Spike Histogram Module for Windows, you can save data as a *.nex file and open it in NeuroExplorer for extensive spike train analysis options including Poincaré plots, burst and spectral analysis, and more.

Spike Histogram Applications:
- Neurophysiology and Electrophysiology (page 24)

Video Capture

The Video Capture Module adds audio and video capability to LabChart. The module allows the synchronized recording and playback of a Windows Media Video or QuickTime movie with a correlating LabChart data file.

The Video Capture Module records in Windows Media Video or QuickTime movie formats and supports most video cameras with USB connections or input from any frame capture cards supported by DirectShow.
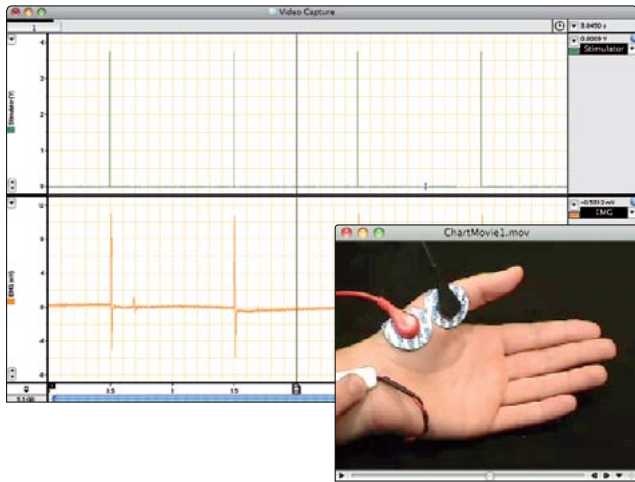
Simultaneous LabChart (left) and QuickTime (below) recording of EMG activity of the abductor pollicis brevis muscle following stimulation of the median nerve. Note: The Movie Marker in Chart View and the Progress Marker in QuickTime correspond to the same time in the synchronized recordings.

In the Video Capture Settings dialog you can select:
- Video and/or audio recordings
- Start/stop recording controls
- Quality of recording
- Video/audio instrument settings
- Synchronization settings of recording devices with LabChart to allow frame-accurate video/data recordings
- Hard disk space allocation.

Play video in synchronization with LabChart files

After recording is finished, the recorded movie can be viewed by clicking on the Movie View dialog box. The movie is played back in tandem with the LabChart data file. When the Movie View is open, the Movie Marker can be used to show the point in the LabChart data file corresponding to the current movie frame. This is useful when trying to find the exact data point corresponding to a particular event, or vice versa.
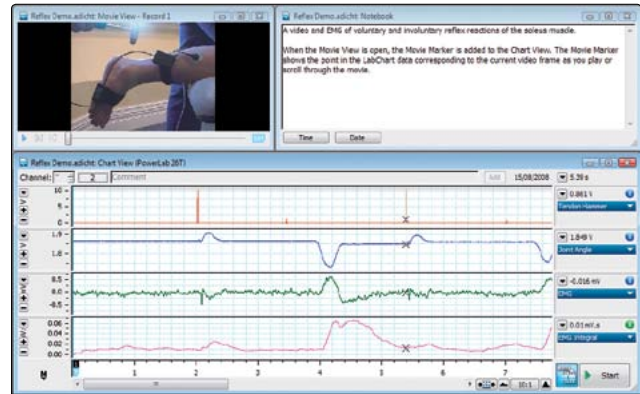
A synchronized recording of LabChart data (EMG, Joint Angle and Tendon Hammer Strikes) with a *.wmv movie of the experiment.

Match video events with data points

You can navigate through data or movie frames by dragging the Movie Marker in LabChart. Alternatively, scroll within the movie and correlate each point in the movie with the corresponding point in the data file. LabChart data files and associated movies are automatically saved in the same file location.
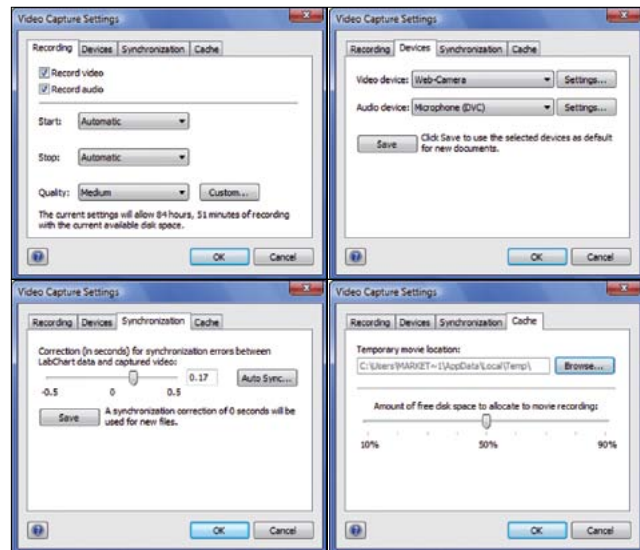
Recording, Devices Synchronization and Cache tabs in the Video Capture Settings dialog.

The Video Capture Module for Windows includes a tutorial to guide users through video recording set up in LabChart, including hardware connection, settings, synchronization, recording and analysis.

Video Capture Applications:
- Psychophysiology (page 30)
- Sleep studies (page 26)
- Telemetry (page 14)
- Exercise Physiology (page 22)

LabChart Specifications

	Windows	Mac
Minimum system requirements	■ Windows Vista or Windows 7 (32-bit & 64-bit editions) Windows XP ■ 100 MB free hard disk space ■ Display with 1024 x 768 resolution ■ USB interface for operation with PowerLab	■ Mac OS X 10.4 or later ■ 100 MB free hard disk space ■ Display with 1024 x 768 resolution ■ USB interface for operation with PowerLab
Printers	Windows compatible	Mac compatible
Export formats	Binary, Axon, IGOR, MATLAB, QuickTime, Wav, Text, PVAN, EDF	IGOR, MATLAB, QuickTime, Text
Display mode	Chart, Zoom, XY View, Scope, Movie (Video Capture Module)	Chart, Zoom, XY Plot, Movie (Video Capture Module)
Maximum storage limits	Limited by available computer disk space	Limited by available computer disk space
Channels supported	32 channels	32 channels
Maximum throughput Maximum sampling speed	400 kHz aggregate (one PowerLab 35 Series unit) 800 kHz aggregate (two PowerLab 35 Series units) Up to 200 kHz per channel (PowerLab 35 Series hardware)	400 kHz aggregate (PowerLab 35 Series hardware) Up to 200 kHz per channel (PowerLab 35 Series hardware)
Recording modes	Continuous to memory (RAM) or disk	Continuous to memory (RAM) or disk
Trigger sources	User, external trigger input, internal timer or channel voltage level	User, external trigger input, internal timer or channel voltage level
Trigger modes	Post-trigger, pre-trigger and event trigger	Post-trigger, pre-trigger and event trigger
Statistics	Statistics — mean, standard deviation, standard error, maximum value, time at maximum, minimum value, time at minimum, maximum – minimum, number of points, RMS, 1/3 Max + 2/3 Min Selection Information — time, date, value, start, end, duration, number of points Comments — comment time, comment number, full comment, comment numbers only Slope — average, maximum, time at maximum slope, minimum, time at minimum slope Integral — integral, integral from minimum, integral from start, integral from baseline Block Information — range, sample interval, sampling rate, block number, block duration, samples, start time, start date Cyclic Measurements — event count, cycle count, average cyclic frequency, rate, period, minimum/maximum cyclic period, average cyclic minimum, average cyclic maximum, average cyclic height, average 1/3 Max + 2/3 Min Scope — page number, page duration and page start time containing the active point or selection from Scope View XY Loop Calculations — calculates the area inside the XY loop, x or y value and slope at the reference point in XY loop, minimum and maximum x or y value, time at minimum and maximum x or y value, and mean of x or y value in XY loop in the XY View Spectrum — display maximum power, maximum power frequency, mean power frequency, median power frequency, minimum power, minimum power frequency,% total power, spectral edge frequency, SD frequency and total power	Statistics — mean, standard deviation, standard error, maximum value, time at maximum, minimum value, time at minimum, max – min, number of points, integral, integral from minimum, integral from start, integral from baseline, RMS, 1/3 Max + 2/3 Min Selection Information — start, end, duration, number of points Cursor and comments — time, value, comment full, comment numbers only, comment number, comment time, comment duration Slope — average, maximum, time at maximum slope, minimum, time at minimum slope Block Information — range, sample interval, sampling rate, block number, block duration, samples, start time, start date Cyclic Measurements — event count, cycle count, frequency, rate, period, minimum period, maximum period, average minimum, average maximum, average peak-to-peak, average 1/3 Max + 2/3 Min
Online calculations	Arithmetic, Cyclic Measurements, Derivative, Digital Filter, Integral, Shift, Smoothing	Online calculations: Arithmetic, Integral Offline calculations: Cyclic Measurements, Derivative, Digital Filter, Shift, Smoothing
Further analysis	Additional extensions and modules are available to increase the functionality and analysis capabilities of LabChart	

All care has been taken to provide correct specifications at the time of printing. Specifications are subject to change. See our website for the latest information.

GLP Client & Server Windows

GLP is the recognized standard for performing non-clinical testing of pharmaceuticals. ADInstruments offers an easy and reliable data acquisition solution for a GLP and 21 CFR Part 11 compliant environment.

Features and benefits include:
- Data acquisition systems that are compliant with GLP and 21 CFR Part 11 regulations
- Centralized authorization system that supports an unlimited number of users
- System that does not allow unauthorized access or tampering of files
- Public-key, private-key user validation to guarantee user authentication
- Easy installation, administration, maintenance and record keeping
- User-friendly system that does not hinder research.

GLP Client

The GLP Client provides the user interface, audit trail and signing components required to meet GLP and 21 CFR Part 11 requirements.

GLP Client features include:
- Securely signed data files to avoid tampering
- Non-editable audit trail
- Preservation of raw data
- Data and audit trail in a single file
- Visual indication of file validity
- Date and time stamping.
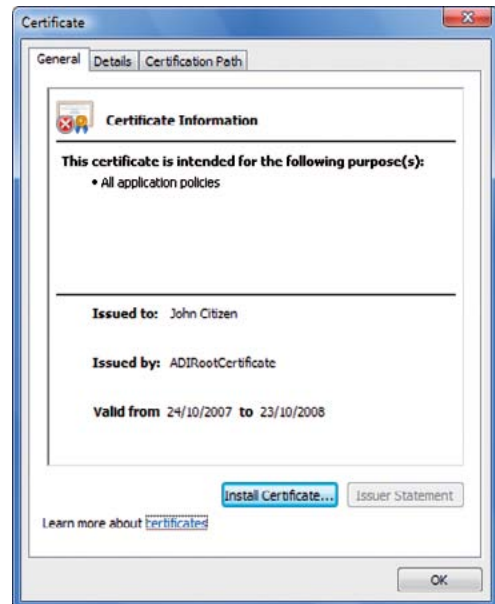
The GLP Certificate dialog containing ownership and validity information.
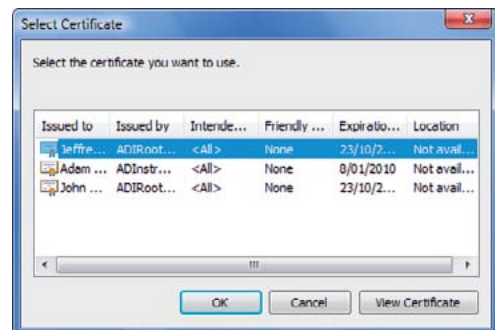
The Select Certificate dialog allows selection of the appropriate certificate.

The Sign Document window is where LabChart Documents are signed and verified.

LabChart application window with GLP Status Bar. Recorded data is seen on the left screen with the GLP Audit Log on the right.

GLP Server

The GLP Server works together with the GLP Client to provide centralized authorization for signing LabChart files, as well as the means to check validity of signatures. At the administration level, it determines which users are permitted to create, modify or sign GLP documents.
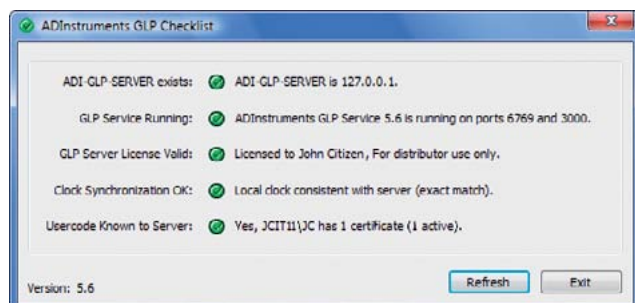
The configuration Checklist provides a quick way to check the server and user status.

GLP Server provides:
- Verification of signature validity when files are opened
- Users with authority to sign files upon saving
- Access to remote configuration
- Licenses for an unlimited number of users
- Extensive and customizable logging.
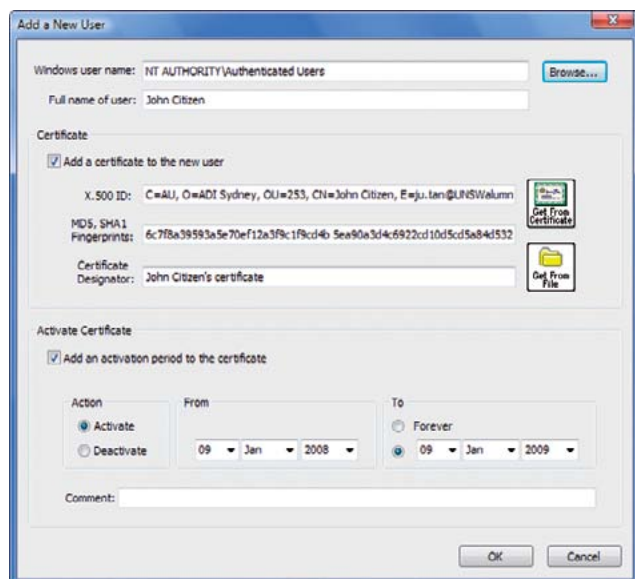
When adding a new user a specified GLP certificate and activation period must be selected.
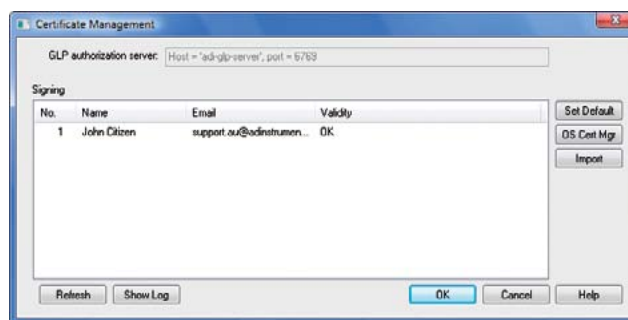
The Certificate Management dialog allows you to import and manage installed certificates.
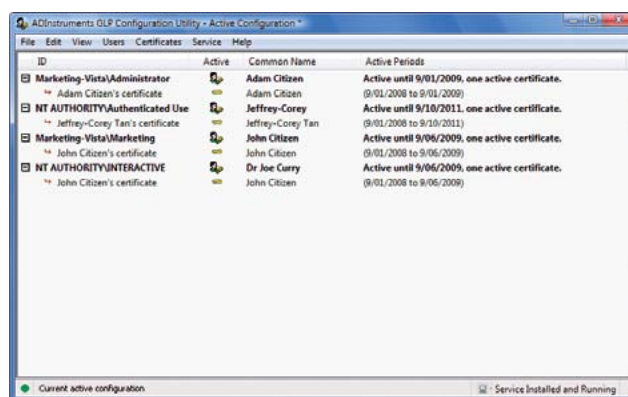
The GLP Configuration Utility allows the system administrator to add, delete or change user privileges.

Training and Certification

Introducing a GLP system can present challenges. With this in mind ADInstruments provides on-site installation, training and user certification services.

Calibration Service

ADInstruments can provide periodic calibration of your PowerLab hardware to confirm the system is working within specifications. Calibration can be organized within your GLP time frame and includes a calibration certificate. Ask your ADInstruments representative for more information or see the Support section of our website.

PowerLab Data Acquisition Systems

Full specifications are listed in the Products section of our website: www.ADInstruments.com. Specifications listed in the hardware section are as tested at the time of printing and are subject to change.

PowerLab 35 Series

The PowerLab 35 series models are high performance data acquisition units. A single unit is capable of recording at speeds of up to 400 kHz aggregate and up to 200 kHz per channel, continuously to disk. They are suitable for recording data from an extensive range of life science applications and are compatible with all signal conditioners, instruments and transducers supplied by ADInstruments as well as third party amplifiers that have analog outputs.

The PowerLab 35 series models are supplied with LabChart software and associated manuals and cables. Also available are PowerLab systems featuring LabChart Pro software. LabChart Pro includes all ADInstruments LabChart Modules and five years of free software upgrades.

PL3504 PowerLab 4/35 – 4 channels
PL3508 PowerLab 8/35 – 8 channels
PL3516 PowerLab 16/35 – 16 channels

Highlights

- Fast recording speed — up to 200 000 samples per channel (400 kHz aggregate)
- Integrated Pod inputs (differential inputs, DC power) for a wide range of transducers
- Independently selectable input sensitivities
- High speed USB
- High-pass, low-pass and anti-aliasing filters
- 16-bit resolution
- Independent analog outputs providing stimulation and DC control.

Analog Outputs (BNC)

General-purpose analog inputs (BNC)

External trigger input (BNC)

Pod inputs (8-pin DIN)

Front-end expansion

Earth equipment post

Digital I/O connections

USB 2.0 connection

90–250 VAC
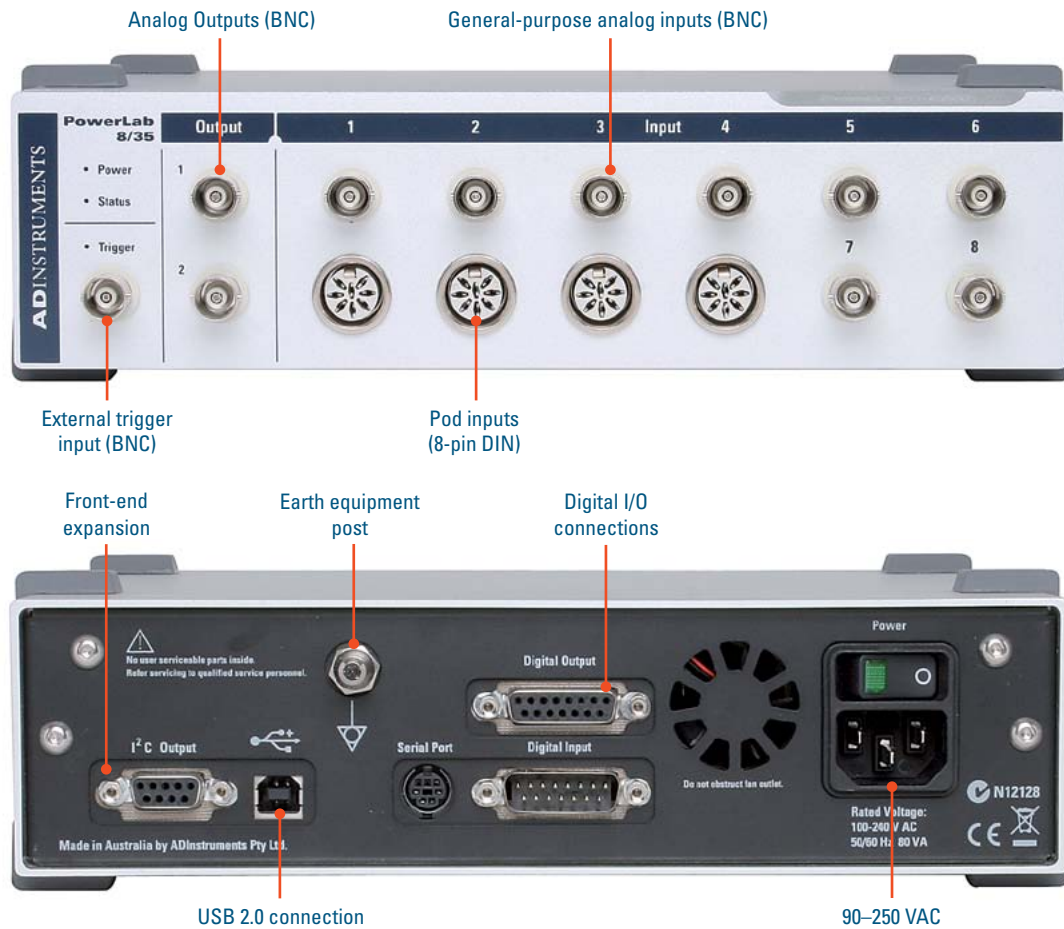
Specifications

Input Amplifiers

Analog inputs:	4/35 – 4 inputs (4 single ended or 4 differential Pod)
	8/35 – 8 inputs (8 single ended or 4 differential Pod and 4 single ended)
	16/35 – 16 inputs (16 single ended or 4 differential Pod and 12 single ended)
Input impedance:	~ 1 MΩ ‖ 100 pF
Input ranges:	±2 mV to ±10 V in 12 steps
Input coupling:	DC or 0.15 Hz (software-selectable)
Low-pass filters:	1 Hz to 1 kHz or 2:5:10 steps; 2 kHz, 25 kHz

Stimulator Output

Analog output:	2 independent output channels
Output ranges:	±200 mV to ±10 V in 6 steps
Maximum output current:	±50 mA

External Trigger

Trigger mode:	TTL level or contact closure, software selectable

System

ADC resolution:	16-bit (313 μV resolution on 10 V range, ~ 62 nV on 2 mV range)
Maximum throughput:	400 ksps aggregate
Maximum sampling speed:	200 kHz on one or two inputs 100 kHz on 3 or 4 inputs (independent sampling rates on each channel)
Digital inputs/outputs:	8 TTL inputs and 8 TTL outputs
Amplifier/Pod support:	PowerLab 4/35 four single ended or four differential Pod ports
	PowerLab 8/35 eight single ended or four single ended and four differential Pod ports
	PowerLab 16/35 sixteen single ended or twelve single ended and four differential Pod ports

Mechanical

Size:	240 × 260 × 70 mm (9.4" × 10.2" × 2.8") (W × D × H)
Power supply:	90–250 VAC, 50/60 Hz
Enclosure:	Aluminium and steel construction

Research Systems

ADInstruments Research Systems provide a range of complete solutions for diverse research applications. They typically consist of a PowerLab system, software, signal conditioners, specialized instruments and transducers. Research Systems are available for a variety of applications including Isolated Heart, Isolated Tissue, Blood Pressure, Exercise Physiology, Neurophysiology and more. For custom options please contact your ADInstruments representative.

Blood and Fluid Flow

In vivo and *in vitro* flow measurements are accurately recorded, displayed and analyzed using PowerLab data acquisition systems and Transonic Systems® patented ultrasonic transit-time flowmeters.

ADInstruments supplies two types of systems for the measurement of blood and fluid flow. Perivascular systems measure flow in a variety of animal blood vessels by placing a flowprobe external to the vessel. Tubing systems measure the flow of solutions such as water, saline, buffer solutions or blood. High-precision flowsensors in the systems can record flows of less than 1 mL/minute up to 100 L/minute without contact with the fluid.

The systems are suitable for a range of applications including cardiac output, cardiovascular dynamics, renal hypertension, ischemia/reperfusion, extracorporeal shunts and cannulae, as well as studies of artificial heart and pulse duplication/heart valves, isolated perfused organs and hind limbs.

A variety of calibrated ready-to-use flowprobes and flowsensors are available separately (page 128) to provide simple, versatile and extremely accurate measurements for flow applications.

PL3508B11 One Channel Perivascular System

- PL3508/P — PowerLab 8/35 with LabChart Pro Software
- T402-PB — One Channel Perivascular Flowmeter
- MLAC01 — BNC to BNC Cable (1 m)

PL3508B12 One Channel Tubing Flow System

- PL3508/P — PowerLab 8/35 with LabChart Pro Software
- T402-TB — One Channel Tubing Flowmeter
- MLAC01 — BNC to BNC Cable (1 m)

PL3508B13 Two Channel Perivascular System

- PL3508/P — PowerLab 8/35 with LabChart Pro Software
- T402-PP — Two Channel Perivascular Flowmeter
- MLAC01 — BNC to BNC Cable (1 m) (2)

PL3508B14 Two Channel Tubing Flow System

- PL3508/P — PowerLab 8/35 with LabChart Pro Software
- T402-TT — Two Channel Tubing Flowmeter
- MLAC01 — BNC to BNC Cable (1 m) (2)

PL3508B15 Two Channel Perivascular / Tubing Flow System

- PL3508/P — PowerLab 8/35 with LabChart Pro Software
- T402-PT — Two Channel Perivascular/Tubing Flowmeter
- MLAC01 — BNC to BNC Cable (1 m) (2)

Isolated Tissue

PowerLab systems are widely used to record and analyze data from experiments involving isolated tissues. A range of hardware units to accompany these systems (such as multiple chamber organ baths, bridge amplifiers and isometric/isotonic transducers) are also supplied by ADInstruments. The most popular configurations of organ bath systems are listed below.

Radnoti Tissue-Organ Bath Systems

ADInstruments, in conjunction with Radnoti Glass Technology, provides a range of modular organ bath research systems for multiple isolated tissue studies. Radnoti's highly experienced craftsmen use quality borosilicate glass in their manufacturing process to produce world-class glassware. Supplied with a PowerLab unit, the Tissue-Organ Bath Systems are available in 4, 8 or 16 chamber models and include a temperature bath/circulator, bridge amplifiers and force transducers. Stimulating electrodes for specific tissue types are also available separately (see page 148).

Radnoti systems include innovative High-Tech Tissue-Organ Baths that are available in 5, 10, 25, 50, 100, 200 and 300 mL sizes. A pre-heating coil in the water-jacketed walls of the chamber maintain optimal solution temperature. The bath solution can quickly be drained via a stopcock at the base of the chamber (single-pass mode). The tissue-organ bath can also be used in a recirculating flow mode. Each chamber is supplied with a glass hook tissue support and Teflon needle valve to control oxygenation, and the tissue pretension can easily be adjusted using the transducer positioner.

PL3508B60/C-V†* Radnoti Tissue–Organ Bath System (4 chamber)
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE224   Quad Bridge Amp
- MLT0420/RAD   Force Transducer (20 g) (4)
- 159920-X1/C†   Radnoti 4 Chamber Tissue-Organ Bath
- 170051B-V*   Radnoti Thermal Circulator Pump

PL3508B61/C-V†* Radnoti Tissue–Organ Bath System (8 chamber)
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE228   Octal Bridge Amp
- MLT0420/RAD   Force Transducer (20 g) (8)
- 159920-X1/C†   Radnoti 4 Chamber Tissue-Organ Bath (2)
- 170051B-V*   Radnoti Thermal Circulator Pump
- 120140-C   Radnoti 4 to 8 Chamber Conversion Kit

PL3516B62/C-V†* Radnoti Tissue–Organ Bath System (16 chamber)
- PL3516/P   PowerLab 16/35 with LabChart Pro Software
- FE228   Octal Bridge Amp (2)
- MLT0420/RAD   Force Transducer (20 g) (16)
- 159920-X1/C†   Radnoti 4 Chamber Tissue-Organ Bath (4)
- 170051B-V*   Radnoti Thermal Circulator Pump (2)
- 120140-C   Radnoti 4 to 8 Chamber Conversion Kit (2)

† Specify chamber size: C = 5, 10, 25, 50, 100, 200, 300 mL

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

hardware
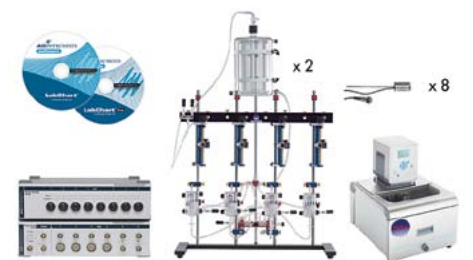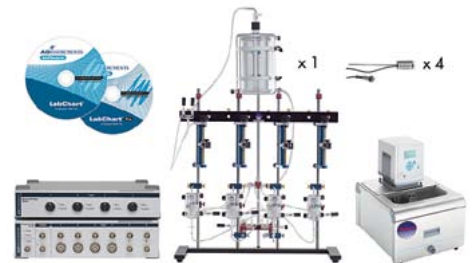
Panlab Tissue-Organ Baths

ADInstruments supplied a range of compact all-in-one design organ baths from Panlab. They feature automatic filling and emptying of tissue chambers and include reservoir coils, gas diffusers, tissue holders, water pump, thermostat controller and micropositioners. The micropositioner mounting holes can accommodate most force and displacement transducers. Tissue chambers of 25 mL volume are standard, with 5, 10 or 50 mL capacity chambers available on request. A variety of platinum or stainless steel stimulating electrodes (page 149) can also be fitted as optional extras.

PL3508B5/C-V§* Organ Bath System (4 chamber)

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE224   Quad Bridge Amp
- MLT0420   Force Transducer (20 g) (4)
- ML0146/C-V§*   4 Chamber Organ Bath†

PL3508B6/C-V§* Organ Bath System (8 chamber)

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE228   Octal Bridge Amp
- MLT0420   Force Transducer (20 g) (8)
- ML0186/C-V§*   8 Chamber Organ Bath†

PL3516B7/C-V§* Organ Bath System (16 chamber)

- PL3516/P   PowerLab 16/35 with LabChart Pro Software
- FE228   Octal Bridge Amp (2)
- MLT0420   Force Transducer (20 g) (16)
- ML0186/C-V§*   8 Chamber Organ Bath† (2)

† Includes SP3785-V* Thermostat Controller

§ Specify chamber size: C = 5, 10, 25 or 50 mL

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Wire Myograph Systems

The combination of DMT wire myographs and PowerLab data acquisition systems provides a complete solution for pharmacological investigations of smooth muscle reactivity and morphology of small tubular tissues (>60 μm). Single, dual and four-chamber myographs are available, all featuring in-built temperature control, oxygen and suction ports.

The myographs are supplied with a control unit, an in-built high-resolution transducer and micrometer. The high-quality manual or automatic micropositioners provide precise tension control, and the DMT Normalization Module for LabChart software, included with LabChart Pro, allows easy calculation of optimal pretension conditions.

PL3508B21 Single Wire Myograph System
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- DMT310A   Single Wire Myograph

PL3508B22 Dual Wire Myograph System
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- DMT410A   Dual Wire Myograph

PL3508B23 Auto Dual Wire Myograph System
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- DMT510A   Auto Dual Wire Myograph

PL3508B24/TS Multi Chamber Myograph w/Touch Screen System
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- DMT620M   Multi-Chamber Myograph

PL3508B25 Confocal Wire Myograph System
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- DMT120CW   Confocal Wire Myograph

hardware

Isolated Heart

ADInstruments systems provide an easy way to monitor the performance of an isolated heart in response to the effects of drugs, electrical stimulation and other factors such as pressure, flow and temperature changes. ADInstruments supplies complete Working Heart and Langendorff systems that include a PowerLab unit, LabChart Pro software and all the necessary glassware, signal conditioners, transducers and accessories.

Panlab Langendorff System

ADInstruments and Panlab provide a compact design Langendorff System to study the hemodynamic performance of small mammalian isolated hearts (mice, rats and guinea pigs). The Langendorff system maintains the heart in a temperature controlled organ chamber whilst the coronary arteries are perfused with a nutrient solution, allowing evaluation under conditions of constant perfusate flow or constant pressure.

Switching between constant perfusate flow and pressure is easy using the Minipuls™3 Peristaltic Pump and the STH Pump Controller. The controller eliminates the need for elevated reservoirs and records the flow rate continuously without the additional cost of a flowmeter.

PL3508B2-V* Langendorff System (Constant Pressure or Flow)

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- ML176   Langendorff Apparatus and Thermostat Controller
- ML172   Minipuls™ 3 Peristaltic Pump
- IN175   STH Pump Controller
- FE221   Bridge Amp (2)
- MLT844   Physiological Pressure Transducer (2)
- MLT1401   T-type Implantable Thermocouple Probe
- ML312   T-type Pod
- FE136   Animal Bio Amp
- MLA1214   Spring Clip Electrodes for FE136 (3 pk)
- MLA2001   Langendorff Transducer Accessory Kit

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Radnoti Langendorff Systems

ADInstruments, in conjunction with Radnoti Glass Technology, provides a range of Langendorff research systems to study the performance of an isolated mammalian heart. They include constant perfusion pressure Langendorff systems, where changes in coronary resistance are indicated by changes in flow, and constant perfusion flow Langendorff systems, where changes in coronary resistance are indicated by changes in pressure.

The systems include water-jacketed interconnecting tubing and are supplied complete with lab stand, glassware and tubing, as well as associated clamp hardware. The "quick disconnect" fittings and modular nature of the systems allow easy modification of experimental setup.

All Radnoti Langendorff Systems include:
- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE221   Bridge Amps (2)
- MLT844   Physiological Pressure Transducer (2)
- ML312   T-type Pod
- MLT1401   T-type Implantable Thermocouple Probe
- FE136   Animal Bio Amp
- MLA1214   Spring Clip Electrodes for FE136 (3 pk)
- MLAC16   BNC-BNC Cable (6 m)
- MLAC17   Front-End Extension Cable Kit
- SP2881   Transducer Brackets (2)

PL3508B1-V* Langendorff System for Mice (Constant Pressure)
- 130102EZ   Radnoti Langendorff Constant Pressure Recirculating Apparatus[†]

PL3508B3-V* Langendorff System for Rats (Constant Flow)
- 120103EZ   Radnoti Langendorff Constant Flow Non-Recirculating Apparatus[†]
- 170403   Latex Balloons (Size 3, 10 pack)
- 170423   Flexible Balloon Catheter (for Size 3 & 4 Balloons)

PL3508B4-V* Langendorff System for Rats (Constant Pressure)
- 120105EZ   Radnoti Langendorff Constant Pressure Non-Recirculating Apparatus[†]
- 170403   Latex Balloons (Size 3, 10 pack)
- 170423   Flexible Balloon Catheter (for Size 3 & 4 Balloons)

† Includes 170051B-V* Radnoti Thermal Circulator Pump

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

hardware
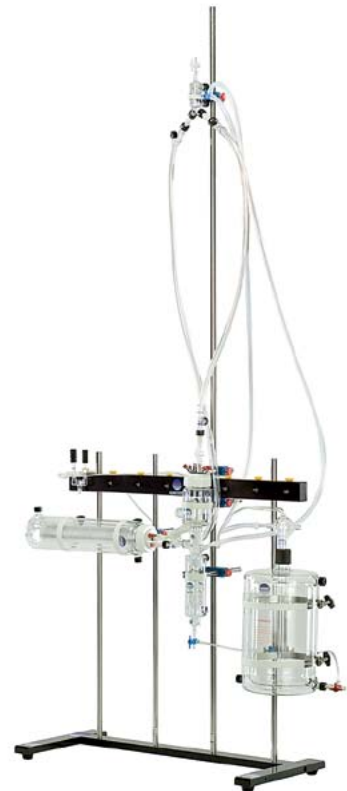
Radnoti Working Heart Systems

Radnoti Working Heart Systems allow evaluation of isolated mammalian hearts of most sizes (from mice to pigs) while the heart is perfused via the normal circulatory pathway. The researcher can cannulate both the aorta and pulmonary vein to measure left atrial and ventricular function.

All Radnoti Working Heart Systems can be used in single-pass perfusion or recirculation modes. Each system includes water-jacketed interconnecting tubing and features a high-tech heart chamber to maintain a constant temperature environment. Locking ports in the heart chamber provide easy access for cannulae and additional instrumentation or electrodes. Optional Millar Mikro-Tip Pressure Catheters are available (see page 132).

All Radnoti Working Heart Systems include:

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE221   Bridge Amp (2)
- MLT844   Physiological Pressure Transducer (2)
- ML312   T-type Pod
- MLT1401   T-type Implantable Thermocouple Probe
- FE136   Animal Bio Amp
- MLA1214   Spring Clip Electrodes for FE136 (3 pk)
- MLAC17   Front-End Extension Cable Kit
- SP2881   Transducer Brackets (2)

PL3508B50/X-V*§ Working Heart System for Rats/Rabbits

- 120101BEZ   Working Heart Apparatus for Rats/Rabbits†

PL3508B55/V* Working Heart System for Mice

- 130101EZ-V   Working Heart Apparatus for Mice†

† Includes 170051B-V* Radnoti Thermal Circulator Pump

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

§ Specify heart chamber: X = S (rat, guinea pig), M (cat, rabbit), L (pig)
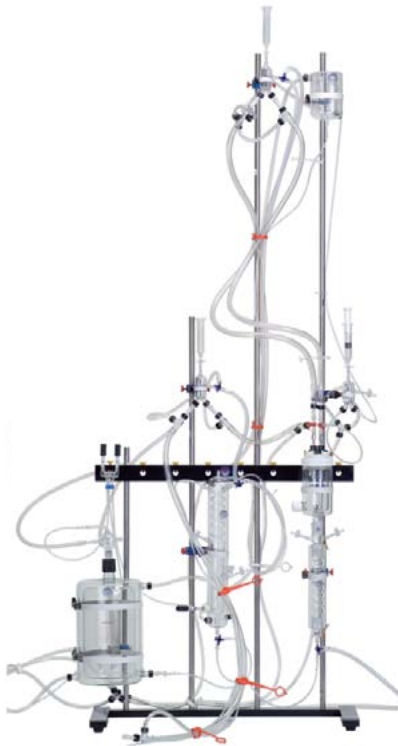
120101BEZ

Radnoti Working Heart Ultimate Systems include:

- PL3516/P   PowerLab 16/35 with LabChart Pro Software
- FE224   Quad Bridge Amp
- MLT844   Physiological Pressure Transducers (2)
- SP2881   Transducer Brackets (2)
- ML312   T-type Pod
- MLT1401   T-type Implantable Thermocouple Probe
- FE136   Animal Bio Amp
- MLA1214   Spring Clip Electrodes for FE136 (3 pk)
- FE180   Stimulus Isolator
- MLA260/L   Stimulator Cable (4 mm shrouded to Alligator clip, 2 m)
- ML165   pH Amplifier
- MI-405   Miniature Glass Electrode for pH measurement
- MI-409   Miniature Reference Electrode
- SPR-671   Millar Pressure Catheter (1.1F) (2)
- AEC-10D   Catheter Interface Cable (Low Profile)
- MLT1120   Micro-Oxygen Electrode
- MLT1122   Analog Adapter (for Micro-Oxygen Electrode)
- T402-TT   Two Channel Tubing Flowmeter
- MLAC16   BNC Extension Cable Kit
- MLAC17   Front-End Extension Cable Kit
- SP0169   Teflon Insulated Platinum Wire (3 m)

PL3516B56-V* Working Heart Ultimate System for Mice

- 130101EZ   Working Heart Apparatus for Mice†
- ME1PXN   PXN-Series Inline Flowprobe – 1.2 mm (2)

PL3516B51/S-V* Working Heart Ultimate System for Rats

- 120101BEZ/S   Radnoti Working Heart System for Rats†
- ME3PXN   PXN Inline Flowprobe – 2.4 mm (2)
- 170403   Latex Balloon (Size 3, 10 pack)
- 170423   Flexible Balloon Catheter (for Size 3 & 4 Balloons)

† Includes 170051B-V* Radnoti Thermal Circulator Pump

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

hardware

Cardiovascular Pressure

PowerLab data acquisition systems and Millar Mikro-Tip catheters provide leading-edge technology to record and analyze high-fidelity cardiovascular pressure signals with unparalleled accuracy. Mikro-Tip catheters offer many advantages over traditional fluid-filled catheters including signal integrity, no signal attenuation and elimination of movement artifact. Due to the catheter configuration, the sensor can be placed directly at the source of the signal, such as the left ventricle of the heart. Though the sensors are robust and some are repairable, it is recommended that extreme care be exercised when using these catheters to prevent irreversible damage.

Please note: Catheters for Dog/Pig/Sheep, Rabbits/Cats and Mice/Rats are available separately (see page 132). For more information or assistance please contact your ADInstruments representative.

PL3508B35 Mikro-Tip BP Foundation System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- FE221   Bridge Amp
- AEC-10C   Catheter Interface Cable (Viking)
- AEC-10D   Catheter Interface Cable (Low-profile)

Ventricular Pressure-Volume

In vivo ventricular pressure and volume can be simultaneously recorded in small (mouse, rat) through to large animals (dog, sheep, pig) with a PowerLab and a suitable Millar Pressure-Volume System. Using the MPVS Ultra, a suitable pressure-volume catheter and PowerLab, pressure and volume can be recorded and displayed with LabChart software in real time. All systems are provided with LabChart Pro including the PV Loop Module for analysis of hemodynamic parameters including maximum and minimum pressure/volume, end-systolic and end-diastolic pressure/volume, cardiac output and stroke work/volume.

The MPVS Ultra Single-Segment systems record PV measurements from mice and rats only. Single-Segment systems can be upgraded to the MPVS Ultra Foundation system with the 880–0168U Software Upgrade.

Please note: A variety of pressure-volume catheters for Dog/Pig/Sheep, Rabbits/Cats, and Mice/Rats are available separately (see page 132).

PL3516B49 MPVS Ultra Foundation System

- PL3516/P   PowerLab 16/35 with LabChart Pro Software
- 880-0168   Millar MPVS Ultra (large and small animals)
- 910-1060   Rho Calibration Cuvette Kit
- 880-0169   MPVS Ultra Cable pack (10 ft)
- 880-0172   MPVS Ultra BNC Cable Pack

PL3508B48/M MPVS Ultra Single Segment Foundation System for Mice

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- 880-0168SS   Millar MPVS Ultra Single Segment
- 880-0170 BNC MPVS Ultra Single Segment Cable Pack
  - 880–0170 MPVS Ultra Cable Kit
  - MLAC01 BNC to BNC Cable (3)
- 910-1049   Volume Calibration Cuvette (1.5 to 4 mm)

PL3508B48/R MPVS Ultra Single Segment Foundation System for Rats

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- 880-0168SS   Millar MPVS Ultra Single Segment
- 880-0170BNC   MPVS Ultra Single Segment Cable Pack
  - 880–0170 MPVS Ultra Cable Kit
  - MLAC01 BNC to BNC Cable (1 m) (3)
- 910-1048   Volume Calibration Cuvette (2 to 15 mm)

Cardiac Electrophysiology System

ADInstruments provides a cardiac electrophysiology system for determining the electrical properties of the atrium and ventricle in small animals (ideal for mice and rats). Parameters measured include conduction times, refractory periods, His potentials, sinus and atrioventricular nodal properties and inducibility of abnormal heartbeats.

Please Note: Electrophysiology catheters used to perform pacing and recording protocols from inside the heart (intracardiac) or through the esophagus (transesophageal) are available separately .

PL3508B36 Cardiac Electrophysiology Foundation System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- STG3008-FA   Intracardiac Electrophysiology Stimulator/Amplifier
- C-BNC-Lemo Intracardiac Electrophysiology Stimulator/Amplifier Output Cable (Lemo to BNC) (8)

hardware

hardware

Exercise Physiology

ADInstruments provides complete recording and analysis systems for both pure and applied exercise physiology research.

Exercise Physiology System

The complete Exercise Physiology System records and displays continuous real-time measurements of metabolic parameters such as CO_2 and O_2 concentrations, airflow, airflow temperature, and ECG or EMG. The supplied Metabolic Module provides continuous real-time measurements (tabular and graphical) of $\dot{V}_{CO_2}$, $\dot{V}_{O_2}$ and RER.

PL3508B80 Exercise Physiology System

- PL3508/P PowerLab 8/35 with LabChart Pro Software
- FE132 Bio Amp
- ML206 Gas Analyzer
  - MLA0343 Drying Tube
  - MLA0110 In-line Filters (10pk)
- MLA246 Gas Mixing Chamber
- FE141 Spirometer
- ML309 Thermistor Pod
- MLA240 Exercise Physiology Accessory Kit includes:
  - MLT1000L Respiratory Flow Head (1000 L/min)
  - MLA1029 Face Mask Kit (Adult, Small and Medium)
  - MLA1081 Flow Head Adapter
  - MLA1013 35 mm I.D. Adapter
  - MLA1015 Breathing Tube
  - MLA6024 Desiccant Cartridge
  - MLA0343 Drying Tube
  - MLT415/M Thermistor Temperature Sensor

Telemetry

ADInstruments offers telemetry systems to record and transfer information from a wireless system, expanding the range of monitoring capabilities available to researchers. By removing the need for tethers, the systems facilitate stress-reduced, long-term recordings from freely-moving animals.

Telemetry System

ADInstruments and Millar have combined the latest data acquisition and telemetry technologies to create a world-leading system that wirelessly monitors the physiological parameters of small animals. The foundation system can be used with a variety of telemeters to record signals, such as intravascular or intralumenal pressure signals, SNA and pressure signals, or ECG, EMG, EOG or EEG signals, or dissolved oxygen. Body temperature can also be recorded from any telemeter.

The SmartPad (TR180) receives data and charges the telemeters, while the Configurator (TR190) is used to configure and control telemeters and SmartPads. Each telemeter sends data on a separate frequency, allowing animals to be co-housed without shielding. A variety of telemeters are available separately (page 145).

PL3516B109 Telemetry Small Animal Foundation System

- PL3516/P   PowerLab 16/35 with LabChart Pro Software
- MLE0180   SmartPad (TR180)
- MLE0190   Configurator (TR190)

Neurophysiology

Due to their high sampling rates, PowerLab systems are ideal for use in electrophysiology and neurophysiology studies. ADInstruments offers a selection of extracellular, intracellular, two electrode voltage clamps, patch clamps and epithelial voltage clamps.

Extracellular Recording System

Record extracellular, EEG and ECG potentials using the DP-311 Differential Amplifier with glass or metal microelectrodes. The low-noise amplifier features excellent common mode rejection, high input impedance, high gain, high DC tolerance and internal calibration signal to test amplifier gain and operation.

PL3508B73 Extracellular Recording System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- PLA190   19" Rack Adapter
- DP-311   Differential Amplifier with Active Headstage
- ESW-F15N   E Series Electrode Holder (Str, Ag Wire 1.5 mm)

hardware

Intracellular Recording System

Designed specifically for intracellular studies, this research system is supplied with PowerLab and a Warner Instruments high-impedance microelectrode amplifier allowing simultaneous current injection stimulation and recording. The system features three output gains (×10, ×20 and ×50) with balance controls, capacitance compensation up to 50 pF, low noise, low drift and fast response time.

PL3508B74-V* Intracellular Recording System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- PLA190   19" Rack Adapter
- IE-210-V   Intracellular Electrometer Amplifier with Headstage
- ESP/W-F15N   E Series Electrode Holder (Str, Ag-AgCl Pellet & Wire, 1.5 mm)

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Epithelial Voltage Clamp System

Two Epithelial Voltage Clamp Systems are provided for the study of epithelial transport and the electrical properties of tissue. The system features high common-mode rejection, independent voltage and current commands, clamp speed selection, membrane resistance measurement circuitry and headstage with model membrane.

PL3508B77-V Single Channel Epithelial Voltage Clamp System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- PLA190   19" Rack Adapter
- EC-800-V   Epithelial Voltage Clamp (120 V compliance)

PL3508B78-V Dual Channel Epithelial Voltage Clamp System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- PLA190   19" Rack Adapter
- EC-825A-V   Dual Channel Epithelial Voltage Clamp (50 V compliance)

Two Electrode Voltage Clamp Recording Systems

ADInstruments provides two research solutions with Warner Instruments amplifiers designed for two-electrode, whole-cell voltage clamping of Xenopus Oocytes. The amplifiers are ideal for clamping large cells and cell structures. They feature accurate measurements of bath current, high compliance voltage, low noise, two clamp speeds and fast, stable voltage clamping with extended current measuring range.

PL3508B75-V* Two Electrode Voltage Clamp Recording System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- PLA190   19" Rack Adapter
- OC-725C-V   Oocyte Clamp Amplifier
  - 7250V   Voltage Headstage
  - 7251I   Bath Clamp Headstage
  - 7259C   Current Electrode CableV
  - 725MC   Oocyte Model Cell
- ESW-F15V   E Series Electrode Holder (Str, Vent, Ag Wire, 1.5 mm)
- E45W-F15VH   E Series Electrode Holder (45°, Vent, Handle, Ag Wire, 1.5 mm)

PL3508B76-V* Oocyte Clamp Workstation System

Components of PL3508B75-V as listed above as well as items listed below.

- RC-3Z   Oocyte Recording Chamber
- MM-33L   Left Micro-Manipulator
- MM-33R   Right Micro-Manipulator
- MB/B   Magnetic Base (2)

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Patch Clamp Recording System

ADInstruments supplies three Patch Clamp Recording Systems that include the PC-501A multi-purpose patch clamp amplifier. The amplifier features independent V-hold and I-hold circuitry, a 4-pole low-pass Bessel filter, internally generated test signals, variable duration zap circuit and compensation controls.

All Patch Clamp Recording Systems include:

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- PLA190   19" Rack Adapter
- QSW-A15P   Q Series Electrode Holder (Str, Port, Ag Wire, 1.5 mm)

PL3508B79/10-V* Patch Clamp Recording System with 5101-10G Headstage

The system is used for the recording of single channel currents up to ±1 nA.

- PC-501A/10-V Patch Clamp Amplifier with 5101-10G Headstage (10 GΩ)
- MC-10G   Model Cell for 5101-10G Headstage (10 GΩ)

PL3508B79/9-V* Patch Clamp Recording System with 5101-01G Headstage

The system is used for the recording of whole cell studies with currents up to ±10 nA.

- PC-501A/9-V   Patch Clamp Amplifier with 5101-01G Headstage (1 GΩ)
- MC-01G   Model Cell for 5101-01G Headstage (1 GΩ)

PL3508B79/8-V* Patch Clamp System with 5101–100M Headstage

The system is used for the recording of whole cell experiments with currents up to ±100 nA.

- PC-501A/8-V   Patch Clamp with 5101-100M Headstage (100 MΩ)
- MC-100M   Model Cell for 5101-100M Headstage (100 MΩ)
- QSW-A15P   Q Series Electrode Holder (Str, Port, Ag Wire, 1.5 mm)

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

hardware

Wireless Neural Signals from small animals with TBSI

In partnership with Triangle BioSystems International Inc. (TBSI), ADInstruments offers industry leading research systems ideal for acquisition of neurological signals from freely moving small animals. TBSI provide small, lightweight headstages with an integrated, rechargeable battery.

PL3508B82/F 5 Channel Wireless Neural Recording System

- PL3508/P   PowerLab 8/35 with LabChart Pro Software
- TB5469/F   TBSI 5 Channel Wireless Neural Headstage Receiver Set
  - TB5663/F TBSI 5 Channel Wireless Neural Receiver
  - TB5653/F TBSI 5 Channel Wireless Neural Headstage (see page 146)
  - Accessories
  - Power supply
- MLAC55   TBSI Receiver to PowerLab Interface Cable (5 Ch)
- MLAC51   TBSI 5 Channel Headstage Testing Cable

PL3516B83/F 15 Channel Wireless Neural Recording System

- PL3516/P   PowerLab 16/35 with LabChart Pro Software
- TB5470/F   TBSI 15 Channel Wireless Neural Headstage Receiver Set
  - TB5664/F TBSI 15 Channel Wireless Neural Receiver
  - TB5656/F TBSI 15 Channel Wireless Neural Headstage (see page 146)
  - Accessories
  - Power supply
- MLAC56   TBSI Receiver to PowerLab Interface Cable (15 Ch)
- MLAC52   TBSI 15 Channel Headstage Testing Cable

Psychophysiology

ADInstruments provides complete all-in-one systems for psychophysiology research (including SuperLab software), which are ideal for experiments based on stimulus presentation and evoked response.

Stimulus Presentation Systems

ADInstruments and Cedrus Corporation provide several flexible stimulus presentation systems for psychophysiology research. These systems are ideal for conducting a range of stimulus presentation and evoked response experiments using two computers (one for stimulus presentation and the other for recording). All stimulus inputs and reaction times are monitored and synchronized to physiological parameters (such as autonomic nervous system activity (EDR), ECG, EEG, EMG or EOG, and heart rate) via TTL event markers to any PowerLab data acquisition unit with digital inputs.

All Stimulus Presentation Systems include:

- **MLE1320**   SuperLab (Win/Mac, 1 pack) and StimTracker
  - MLE1302 SuperLab Pro (Win/Mac, 1 pack)
  - MLE1300 StimTracker Universal Marker Interface
- **FE116**   GSR Amp
  - MLT116F GSR Finger Electrodes
- **MLA410**   Physiology Accessory Kit
  - MLT004/ST Grip Force Transducer
  - MLA92 Push Button Switch
  - MLT1132 Respiratory Belt Transducer
  - MLT1010 Finger Pulse Transducer
  - MLA700 Reusable ECG Electrodes (3)
  - MLAYDG Dry Earth Strap
  - MLAWBT9 EEG Flat Electrodes (5)
  - MLA1090 Electrode Cream
  - MLA1095 Electrode Paste (3 pack)
  - MLA1010 Disposable ECG Electrodes (100)
  - MLA1093 Abrasive Gel

PL3508B110 Stimulus Presentation Foundation System

- **PL3508/P**   PowerLab 8/35 with LabChart Pro Software
- **FE135**   Dual Bio Amp
  - MLA2540 5 Lead Shielded Bio Amp Cable
  - MLA2505 Shielded Lead Wires (5 snap-on)

PL3516B111 Stimulus Presentation Ultimate System

- **PL3516/P**   PowerLab 16/35 with LabChart Pro Software
- **ML138**   Octal Bio Amp
  - MLA0310 Lead Wires (1.8 m, 10 snap-on) (2)
- **MLE1307**   Response Pad (7-Buttons)
- **MLE1312**   SV-1 Smart Voice Key
- **MLT1601/ST**   Response Meter (6 m)
- **MLAC38**   Response Pad to PowerLab Cable (2 m)
- **ML309**   Thermistor Pod
- **MLT422/A**   Skin Temperature Probe (2 m)

Signal Conditioners

ADInstruments signal conditioners are software-controlled amplifiers that operate with PowerLab systems. They extend the recording capabilities of the PowerLab system into specialized fields and applications by accepting inputs from a wide variety of transducers and electrodes. Once connected, our signal conditioners are automatically identified and can be configured by LabChart software.

Software settings allow fast and accurate equipment and protocol setup. Settings are automatically stored when you save the file. Experiment protocols can be repeated with a click of a mouse.

The ADInstruments range of signal conditioners consists of two types:
Amps—connection to PowerLab unit via I^{2}C ports
Pods—connection to PowerLab unit via 8-pin DIN ports or ML305 Pod Expander

The ADInstruments range of signal conditioners includes:

- Animal Bio Amp
- Bio Amp
- Dual Bio Amp
- Octal Bio Amp
- EOG Pod
- Dual Bio Amp/ Stimulator
- Bridge Amp
- Quad Bridge Amp
- Octal Bridge Amp
- BP Amp
- Cardiac Output Pod
- Oximeter Pod
- Animal Oximeter Pod
- Conductivity Pod
- pH/Temperature Amp
- GSR Amp
- Pod Expander
- Neuro Amp
- Spirometer
- Stimulator HC
- Stimulus Isolator
- T-type Pod
- Thermistor Pod.

Biopotentials

FE136 Animal Bio Amp

The Animal Bio Amp is a galvanically isolated, high performance, differential amplifier suitable for the measurement of a wide variety of biological signals in animals and isolated tissues. Supplied with a set of 3 electrode cables with micro-hooks. Recommended for animal use only.

Specifications

Safety:	Approved to IEC 60601-1 Standard (BF rating)
EMC:	EN61326-1:2006
Connection type:	Three shrouded 1.5 mm male pin sockets
Configuration:	Isolated differential channel with isolated ground reference
Input range:	± 5 µV to ± 100 mV full scale in 14 steps (combined PowerLab and Bio Amp)
Input impedance:	200 MΩ differential
Input leakage current:	< 3 µA$_{rms}$ @ 240 V, 50 Hz < 2 µA$_{rms}$ @ 120 V, 60 Hz
CMRR:	> 85 dB (typically, 1 to 60 Hz)
IMRR:	> 130 dB (to true earth, 50 to 60 Hz)
Noise:	1 Hz to 5 kHz < 1.3 µV$_{rms}$ (< 8 µV peak-to-peak) 0.3 Hz to 1 kHz < 0.6 µV$_{rms}$ 0.1 Hz to 100 Hz < 0.35 µV$_{rms}$ (@ 200 samples/second)
Accuracy:	± 1.5% (all ranges, within Bio Amp)
Non-linearity:	< 0.2% within range
DC blocking:	± 1 V
Baseline restore:	Automatic

FE132 Bio Amp and FE135 Dual Bio Amp

The FE132 Bio Amp and FE135 Dual Bio Amp are fully isolated, high-performance differential amplifiers with filter settings optimized for the measurement of a wide variety of biological signals including EEG, ECG and EMG. They are supplied with a Shielded Bio Amp Cable and Shielded Lead Wires approved for human connection.

Specifications

Safety:	Approved to IEC 60601-1 Standard (BF rating)
EMC:	EN61326-1:2006
Connection type:	Six-pin DIN/MS socket to fit 3-lead (FE132) Bio Amp cable or 5-Lead (FE135) Bio Amp Cable
Configuration:	Isolated differential channel with isolated ground reference
Input range:	$\pm$ 5 µV to $\pm$ 100 mV full scale in 14 steps (combined PowerLab and Bio Amp)
Input impedance:	200 MΩ differential
Input leakage current:	< 3 µA$_{rms}$ @ 240 V, 50 Hz
	< 2 µA$_{rms}$ @ 120 V, 60 Hz
CMRR:	> 85 dB (typically, 1 to 60 Hz)
IMRR:	> 130 dB (to true earth, 50 to 60 Hz)
Noise:	1 Hz to 5 kHz < 1.3 µV$_{rms}$ (< 8 µV peak-to-peak)
	0.3 Hz to 1 kHz < 0.6 µV$_{rms}$
	0.1 Hz to 100 Hz < 0.35 µV$_{rms}$ (@ 200 samples/second)
Accuracy:	$\pm$ 1.5% (all ranges, within Bio Amp)
Non-linearity:	< 0.2% within range
DC blocking:	$\pm$ 1 V
Baseline restore:	Automatic

ML138 Octal Bio Amp

The ML138 Octal Bio Amp consists of eight electrically isolated, high-performance differential input AC amplifiers with a shared ground connector and separate inputs. It is ideal for many bilateral low-level signals including EEG, ECG, EMG, sensory nerve action potentials and smooth muscle studies and is recommended for use where multiple biopotentials are being recorded from a single subject rather than 'daisy-chaining' multiple Bio Amps. The ML138 features an audio output for headphones or powered speakers and includes all the necessary cables as well as MLA0310 Lead Wires (1.8 m), 10 snap on.

Specifications

Safety:	Tested to IEC60601–1:1988
Inputs:	Eight differential channels, common isolated ground
Input ranges:	$\pm$5 µV to $\pm$100 mV in 14 steps
Input impedance:	200 MΩ differential, 30 pF to isolated ground (no cable),
Isolation:	4 kV$_{rms}$ at 50 Hz for 1 minute (IEC 60601-1)
DC blocking:	$\pm$1 V
IMRR:	> 135 dB (to true earth, 50 – 100 Hz)
Low-pass filter:	Fourth-order Bessel filter, $\pm$3 % accuracy
Low-pass options:	50, 100, 200, 500, 1k and 5k Hz
	(EEG mode: 3, 10, 30, 60 and 120 Hz)
High-pass filter:	First-order filter, $\pm$0.25% accuracy
High-pass options:	0.02, 0.1, 0.3, 1, 3, 10 Hz (EEG mode: 0.03, 0.1, 0.3, 1 sec)
Frequency response:	0.02 to 5000 Hz
Notch filter:	50 or 60 Hz (auto-sensing)
Noise:	<1.3 µV$_{rms}$ at 5k Hz
Baseline restore:	Automatic
Input connector:	17 × 1.5 mm pin shrouded male socket to suit single pin 1.5 mm
Audio output:	Stereo jack with mono output, $\pm$200 mV FS, current limited to $\pm$5 mA (Suitable for headphones or powered speakers)

hardware

ML317 EOG Pod

The EOG Pod can be used to measure eye movement. The Pod is DC coupled and comes supplied with snap-on shielded lead wires. A front-panel zeroing control allows for manual adjustment of baseline levels.

Specifications

Amplification ranges:	±2 mV, ±1 mV, ±500 µV, ±200 µV, ±100 µV
Frequency response:	DC to 500 Hz
Low-pass filter:	500 Hz fixed, 2nd order Butterworth
Temperature drift:	±3 mV/° C
CMRR:	> 80 dB
IMRR:	> 110 dB
Input impedance:	< 100 MΩ
Front-panel control:	Offset knob for initial zeroing of device
Input bias (maximum):	±10 nA at 25° C
Input connector:	3 shielded lead wire connectors
Isolation rating:	4 kV$_{rms}$ at 50 Hz for 1 minute

ML408 Dual Bio Amp/Stimulator

Consisting of two fully-isolated, differential amplifiers with an integrated isolated stimulator suitable for human use, the ML408 is optimized for a wide variety of biological signals including ECG and EMG. It is particularly appropriate for studies requiring bilateral measurements and integrated stimulation. The stimulator and dual bio amplifier are both independently electrically isolated. Approved for human connection as a body protected (BF rated) instrument.

Dual Bio Amp Input

Safety:	Approved to IEC 60601-1 Standard (BF rating)
Connection type:	Six-pin DIN/MS socket to fit 5-Lead Bio Amp Cable
Configuration:	2 differential channels with common isolated ground reference
Input range:	± 20 µV to ± 50 mV full scale in 11 steps (combined Bio Amp and PowerLab)
Input impedance:	100 MΩ to ground
Input leakage current:	< 6 µA$_{rms}$ @ 240 V, 50 Hz
	< 4 µA$_{rms}$ @ 120 V, 60 Hz
CMRR:	> 75 dB (DC to 100 Hz) > 60 dB (@ 1 kHz)
IMRR:	> 130 dB (@ 50 to 60 Hz)
Noise:	0.1 Hz to 5 kHz 1.95 µV 0.1 Hz to 50 Hz 0.5 µV
	0.1 Hz to 1 kHz 1.25 µV 0.1 Hz to 20 Hz 0.2 µV
Accuracy:	± 1.5% (all ranges, within Bio Amp)
Non-linearity:	< 1% of full scale
DC blocking:	± 0.5 V
Baseline restore:	Automatic

Isolated Stimulator Output

Safety:	Approved to IEC 60601-1 Standard (BF rating)
Connection type:	Two shrouded 4 mm sockets
Configuration:	Isolated constant-current stimulator with hardware-limited repetition rate
Output range:	0 to 20 mA in 0.1 mA steps (software-selectable)
Compliance voltage:	100 to 110 V typical
Pulse rate:	Software-selectable, but hardware-limited to a maximum of 20 Hz for safety
Safety indicators:	A single multi-color indicator displays the isolated stimulator status. A green flash indicates delivery of a valid stimulus. A yellow flash indicates an out-of-compliance condition
Safety switch:	Isolating On-off switch flicks down to disconnect quickly

Blood Pressure, Force and Displacement

FE221 Bridge Amp, FE224 Quad and FE228 Octal Bridge Amps

The Bridge Amps are non-isolated bridge amplifiers for use with force, pressure, displacement and other strain gauge or semiconductor bridge based transducers. They are suitable for cardiac and smooth muscle contraction, animal arterial or venous pressures, force and displacement, and some respiratory applications. DIN input is standard, for transducers with Grass connectors the MLAC11 Grass to DIN Adapter Cable can be used. The FE224 Quad and FE228 Octal Bridge Amps are ideal for use with multiple chamber organ bath systems.

Specifications

EMC:	EN61326-1:2006
Connection type:	8-pin DIN socket
Configuration:	Differential
Input range:	± 200 µV to ± 5 V full scale in 14 steps (combined PowerLab and Bridge Amp)
Input impedance:	2 × 1 MΩ (single-ended) 2 MΩ (differential)
CMRR (differential):	100 dB @ 50 Hz (typical)
Noise:	< 1 µV$_{rms}$ referred to input at highest gain
Frequency response:	−3 dB, 2 kHz maximum at all gains with the low-pass filter off
Accuracy:	± 0.5% (combined PowerLab and Bridge Amp)
Maximum input voltage:	± 10 V
Zeroing circuitry:	Software-controlled, either manual or automatic
Internal offsetting range:	± 10 V (1 to 5 V range)
	± 1 V (100 to 500 mV range)
	± 100 mV (0.2 to 50 mV range)
Internal offset resolution:	16-bit (internal DAC) ± 32 000 steps about 0 V
Excitation voltage range:	0 to 20 V DC (± 10 V referred to ground), adjusted by external resistor
Transducer drive current:	± 45 mA maximum

FE117 BP Amp

The FE117 is a fully isolated blood pressure amplifier that operates with standard disposable BP transducers. The unit has an offset for sub-ranges and venous (negative-inclusive) ranges. The BP Amp is approved for direct connection (BF rated) and is suitable for invasive arterial, venous and ventricular pressure measurements in humans and animals. The FE117 BP Amp includes the MLAC05 Cable and MLT0670 Disposable BP Transducer.

Specifications

Safety:	Approved to IEC 60601-1 Standard (BF rating)
EMC:	EN61326-1:2006
Connection type:	6-pin socket to fit 6-pin Utah Medical 650–208 transducer cable with a 4-pin transducer connection cable
Configuration:	Isolated AC Bridge
Input range:	50 to 250 mmHg full scale in 3 steps (combined PowerLab and BP Amp)
Sensitivity:	Correct for 5 µV/V/mmHg transducer standard (~350 Ω bridge)
Input impedance:	> 10 kΩ at 400 Hz AC
Input leakage current:	< 3 µA$_{rms}$ at 240 V, 50 Hz
	< 2 µA$_{rms}$ at 120 V, 60 Hz
Frequency response:	−3 dB at 50 Hz
Accuracy:	± 2% (± 0.2 mmHg) all points, after zero correction
Zeroing and offset:	Automatic software-controlled fast zeroing, controlled by internal 12-bit DAC; resolution = ± 0.2 mmHg (with supplied transducer)
Excitation:	5 V$_{rms}$ AC at 400 Hz ± 5 %

Blood Flow and Pulse Oximetry
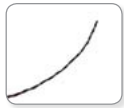
ML313C Cardiac Output Pod

The Cardiac Output Pod is used with fast response time T-type thermocouples making it ideal for the determination of cardiac output. It is supplied with a MLT1402 T-type Ultrafast Thermocouple Probe, the MLA313 Cardiac Output Accessory Kit and MLS340 Cardiac Output Module, which provides easy calculation and extraction of cardiac output values using LabChart software. **Not suitable for human use.**

Tip detail

Specifications

Probe type:	T-type thermocouple (tip maximum outside diameter 0.009")
Ranges:	20° C or 50° C
ΔT ranges:	±1, ±2, ±5, ±10, ±20, ±50 Δ° C
Offset range (ΔT):	25 to 50° C (Abs)
Output:	0 mV = 0° C, 10 mV/° C
Temperature accuracy:	< 0.2° C at 35 to 40° C
Temperature resolution:	< 0.001° C at ±20 Δ° C range or less
DC drift:	2 μV/° C
Response time (@30 Hz):	13 ms (10 to 90 % rise time on square wave input)
Input connector:	Miniature T-type

ML320 Oximeter Pod

The ML320 is a laser diode-based signal conditioner suitable for the measurement of human blood oxygen saturation in the range of 70 to 100%. The Oximeter Pod uses the patented Nonin SpO_2 technology and comes supplied with the MLT321 SpO_2 Finger Clip (ML320/F) or the MLT322 SpO_2 Ear Clip (ML320/E).

Specifications

Operating principle:	Non-invasive blood oxygen saturation (SpO_2 determination using red and infrared light passed through pulsating blood in vascular tissue)
Saturation range:	70 to 100%
Accuracy:	±2% for adults using Finger clip sensor ±4% of full scale using Ear clip sensor
Measurement wavelength:	Red (660 nm) and Infrared (910 nm)
Measurement rate:	1 reading per second
Resolution:	1% steps
SpO_2 acquisition time:	~10 s

ML325 Animal Oximeter Pod

The ML325 is a laser diode-based signal conditioner suitable for the measurement of oxygen saturation in the range of 70 to 100%. The Oximeter Pod uses the patented Nonin SpO_2 technology and comes supplied with the MLT323 Animal-Clip (ML325/AC), MLT324 Wrap Sensor (ML325/AW) or MLT325 Base Sensor (ML325/BS).

MLT323 Animal Clip

MLT324 Wrap Sensor

MLT325 Base Sensor

Specifications

Operating principle:	Non-invasive blood oxygen saturation (SpO_2 determination using red and infrared light passed through pulsating blood in vascular tissue)
Saturation range:	70 to 100%
Measurement wavelength:	Red (660 nm) and Infrared (910 nm)
Measurement rate:	1 reading per second
Resolution:	1% steps
SpO_2 acquisition time:	~10 s

Chemistry and Biochemistry

ML307 Conductivity Pod

CE

The Conductivity Pod is suitable for monitoring solution conductance and resistance with appropriate conductivity cells. The Pod measures the alternating current across a suitable conductivity cell by applying an AC potential across the pair of platinum plate electrodes. It can be used with any of our conductivity electrodes (see page 123).

Specifications

Input ranges:	10 μS/V, 100 μS/V, 1 mS/V, 10 mS/V
Error:	< 1% of input range at ≥ 1 mS/V (after user calibration)
AC waveform amplitude:	20 mV p-p
AC waveform shape:	Triangular
AC waveform frequency:	1300 Hz (approx)
Low-pass filter:	200 Hz, 2nd order Butterworth
Bandwidth:	DC to 20 Hz
Noise:	0.008% full scale
Electrode connector:	BNC

ML165 pH/Temperature Amp

CE

The ML165 pH/Temperature Amp is a signal conditioner suitable for use with pH, ion-selective and potentiometric redox electrodes. The MLT404 RTD Temperature Probe is included and can be used for temperature compensated measurements or as an independent temperature sensor.

Specifications

Input ranges:	±200 μV to ±2 V in 13 steps
Output channels:	2
Input impedance:	10^{13} Ω typical
Electrode connector:	BNC
Reference connector:	4 mm socket
Temperature probe:	RTD – 100 Ω type (supplied with unit)
Temperature range:	±100° C
Temperature accuracy:	±0.2° C
Resolution:	±0.1° C
Low-pass filter:	10 Hz, (-3 dB frequency)
Low-pass filter accuracy:	±3%
Unfiltered response:	> 2 kHz

hardware

Galvanic Skin Response
FE116 GSR Amp

The FE116 GSR Amp is a fully isolated, skin conductance response amplifier with low voltage, 75 Hz AC excitation and automatic zeroing. The low level AC excitation reduces electrode polarization artifact found in DC systems. The GSR Amp is galvanically isolated and approved to the IEC 60601-1 standard for human connection as a body protected (BF rated) instrument. It is supplied with MLT116F Finger Electrodes and is suitable for human galvanic skin response studies. MRI compatible Finger Electrodes (MLT117F) are available separately.

Specifications

Safety:	Approved to IEC 60601-1 Standard (BF rating)
EMC:	EN61326-1:2006
Connection type:	2 × 4 mm shrouded sockets. Custom cable with two shrouded banana plugs and terminated with two dry, stainless steel, bipolar electrodes with Velcro attachment strap suitable for adult fingers
Configuration:	Transformer isolation (AC bridge operation)
Input range:	1 to 40 μS full scale in 6 steps (combined PowerLab and GSR Amp)
Input leakage current:	< 3 μA_{rms} at 240 V, 50 Hz < 2 μA_{rms} at 120 V, 60 Hz
Frequency response:	−3 dB at 1 Hz
Accuracy:	± 5%
Zeroing and offset:	Automatic software-controlled fast zeroing, controlled by internal 12-bit DAC; ± 0.2 μS resolution
Excitation:	Constant-voltage AC excitation (22 mV_{rms} @75 Hz)
Current density:	≤0.5 $\mu A\ cm^{-2}$

Neurophysiology/Electrophysiology
FE185 Neuro Amp EX

The FE185 Neuro Amp EX is a low-noise and high-gain device suitable for recording signals requiring a wide bandpass (100 Hz to 5 kHz) and a high signal to noise ratio. When used with the supplied MLT185 Neuro Amp EX Headstage, it is certified safe for human connection. The Neuro Amp can be used for extracellular recordings from single cells or groups of cells and single nerve fiber recordings.

Specifications

Safety:	Approved to IEC 60601-1 Standard (BF rating)
EMC:	EN61326-1:2006
Connection type:	Five-pin Redel connector
Configuration:	one isolated differential channel with isolated ground reference
Input range:	± 20 μV to ± 1 mV full scale in 6 steps (combined PowerLab, Neuro Amp EX front-end and headstage)
Input impedance:	100 MΩ
Low-pass filtering:	Fourth-order Bessel filter, ± 3% accuracy.
Frequencies:	1 kHz, 2 kHz, 5 kHz (software selectable)
High-pass filtering:	First-order filter, ± 0.25% accuracy.
Frequencies:	100 Hz, 300 Hz, 500 Hz (software-selectable)
Notch filter:	Second-order filter, −32 dB attenuation; 50 or 60 Hz frequency (automatic sensing)

Headstage

Gain:	×100
Input leakage current:	~1 pA

Respiration

FE141 Spirometer CE

The FE141 Spirometer is a precision differential pressure amplifier for measurements of respiratory flow rates with a pneumotach flow head. It is used with the Spirometry Extension, which processes signals from pneumotachs. It displays and calculates respiratory parameters such as tidal volume, minute ventilation, respiratory rate, PIF, PEF, FVC and FEV1. By selecting a suitably sized flow head, the Spirometer can be used with small animals such as mice and rats or large animals and humans.

Specifications

EMC:	EN61326-1:2006
Connection type:	Two female Luer fittings to enable connection to Flow Head via male Luer fittings and suitable tubing.
Configuration:	Differential pressure input, ± 1" (2.5 cm) H_2O (1.9 mmHg, 249 Pa)
Input range:	± 20 mV to ± 500 mV full scale in 5 steps (combined PowerLab and Spirometer)
Pressure sensitivity:	0.5 V per inch (1.27 V per cm) H_2O
Amplifier noise:	< 150 μV_{rms} @ 100 Hz
	< 50 μV_{rms} @ 10 Hz
	< 35 μV_{rms} @ 1 Hz
Temperature drift:	0.05% of full scale per° C
Warm-up time:	~ 2 minutes
Maximum input pressure:	± 28.1" H_2O (7 kPa)
Response time:	1 ms (10 to 90% full scale) at maximum bandwidth
Linearity:	± 0.5% full scale
Low-pass filtering:	1, 10 or 100 Hz (software-selectable) using fourth-order Bessel
Max zero pressure offset:	< 1% full scale, software removable
Zero offset correction:	Software removed (up to ± 10% full scale)

Stimulation

FE155 Stimulator HC CE

The FE155 Stimulator HC is a software-controlled, constant-current stimulator with 100 V compliance designed for use *in vitro* with isolated nerve, muscle or tissue samples. The unit uses the analog output from the PowerLab to produce isolation and software adjustable constant-current pulses of 10 microseconds to 4 milliseconds duration, of 0.1 to 30 Hz pulse frequency and 1, 10 or 100 mA pulse amplitude. It is supplied with MLAC36 Stimulator HC Leads (2 m).

Specifications

Safety:	Not for human connection
EMC:	EN61326-1:2006
Connection type:	Two 2 mm touch-proof safety sockets
Configuration:	Constant-current stimulator with hardware limited repetition rate
Output range:	1 mA, 10 mA, 100 mA full scale
Resolution:	1% of full scale (10 μA, 100 μA, or 1 mA)
Compliance voltage:	100 V fixed
Pulse duration range:	0.02 to 5.12 ms in 0.02 ms steps
Duration accuracy:	± 0.01% +5/−0 μs
Repetition rate:	Up to 30 Hz
Safety indicators:	A single, multi-color indicator displays the Stimulator HC status. A green flash indicates delivery of a valid stimulus. A yellow flash indicates an out-of-compliance condition (OOC).
Safety switch:	Isolating On-Off switch flicks down to disconnect quickly.

FE180 Stimulus Isolator

The FE180 Stimulus Isolator uses the PowerLab analog output to produce isolated constant current pulses. The unit provides adjustable pulse amplitude, width and frequency. For use with *in vivo* stimulation applications, the FE180 is electrically isolated and suitable for human connection as a body protected (BF rated) instrument.

Specifications

Safety:	Tested to IEC 60601-1 Standard (BF rating)
EMC:	EN61326-1:2006
Connection type:	Two shrouded 4 mm sockets
Configuration:	Constant-current stimulator with hardware-limited repetition rate
Output range:	100 µA, 1 mA, or 10 mA full scale
Resolution:	1% of full scale (1 µA, 10 µA, or 100 µA)
Compliance voltage:	100 V fixed
Pulse duration range:	0.01 to 2.56 ms in 0.01 ms steps
Duration accuracy:	± 0.01% +5/−0 µS
Repetition rate:	Up to 2000 Hz
Safety indicators:	A single, multi-color indicator displays the isolated stimulator status. A green flash indicates delivery of a valid stimulus. A yellow flash indicates an out-of-compliance condition (OOC)
Safety switch:	Isolating On-Off switch flicks down to disconnect quickly

Temperature

ML312 T-type Pod

Suitable for general temperature measurements between 0 to 50° C using standard T-type thermocouples. Compatible transducers include the MLT1400 General-purpose Thermocouple Probe and others listed on page 146 and 147.

Specifications

Temperature range:	0 to 20° C or 0 to 50° C	
Output voltage:	10 mV/° C (0 V = 0° C) non-linearized	
Calibration:	Ice point reference calibration provided	
Temperature accuracy:	±0.2° C	35 to 40° C
	±0.5° C	0 to 45° C
	±1° C	0 to 50° C
DC drift:	2 µV/° C	
Response time:	~ 40 ms (10 to 90% of range)	
Input impedance:	~ 1 kΩ	
Input connector:	Miniature T-type	

ML309 Thermistor Pod

Suitable for measurements such as skin and nasal temperature as well as respiratory detection, the Thermistor Pod has an operating range between 5 and 45° C and supports both absolute and relative temperature measurements. Suitable transducers include the MLT409 Skin Temperature Probe and the MLT415 Nasal Temperature Probe.

Specifications

Thermistor type:	10 kΩ at 25° C
Temperature range:	5 to 45° C in absolute mode
	Δ 1° C to Δ 20° C in five ranges with Delta Temp on
Temperature accuracy:	±0.2° C absolute (25 to 45° C)
DC drift:	3 µV/° C
Temperature offset range:	50° C over all (−5° C to 45° C absolute)
Response time:	~ 200 ms (for full scale change in temperature)
	Overall response will depend on the thermal response of the thermistor probe
Input connector:	3-pin Mini-Audio

hardware

Instruments

Our range of Instruments includes devices for specialized fields of research such as organ bath experiments, CO_2 and O_2 analysis, blood flow measurements and neuro/electrophysiology. All feature an analog output suitable for connection to PowerLab data acquisition systems.

The Instruments range includes:

- Biological Amplifiers
- Blood and Tubing Flow Meters
- Organ Baths and Wire Myographs
- Invasive and Noninvasive Pressure
- Langendorff and Working Heart Apparatus
- Neuro/Electrophysiological Amplifiers

- Gas Analyzer
- Peristaltic Pumps
- Stimulators
- Stimulus Response Devices
- Telemetry Devices
- Temperature Devices.

Biopotential Measurements
GT201/F and GT205/F Multi-Channel Bio Amps

The 8 Channel (GT205) and 16 Channel (GT201) Bio Amps are fully isolated biological amplifiers used for measuring multiple biopotentials (EEG, ECG, EMG etc.) in a single subject. Each unit features 2 independent grounds.

Specifications

Mode of operation:	1 to 16 unipolar/bipolar channels
Input:	Safety sockets for bio-signal electrodes
Output:	±5 V via 25 pin Sub-D with BNC connectors
Sensitivity:	500 µV and 5 mV DIP-Switch selectable*
Low-pass filters:	100 Hz and 1 kHz DIP-Switch selectable*
High-pass filters:	0.5 Hz and 2 Hz DIP-Switch selectable*
Notch filters:	50 or 60 Hz; on/off switchable

* Further adjustment of the range/sensitivity and filter settings is applied using LabChart.

Blood Pressure and Flow
IN191 Blood FlowMeter

The IN191 provides continuous measurement of blood cell perfusion in skin and other tissues/organs. For use with PowerLab systems and suitable needle and surface laser Doppler probes (see page 128).

Specifications

Mode of operation:	Continuous laser Doppler flowmetry (1 channel)
Primary measured:	Microvascular blood profusion (Relative RBC Flux)
LDF units:	Relative units (0 to 5000 Blood Perfusion Units, corresponding to 0 to 5 V output)
BSC units:	Relative units (0 to 100% corresponding to 0 to 5 V output)
Laser power:	< 0.5 mW from probe
Linearity:	Up to 0.35% moving scatters by volume
Flow response time:	< 0.2 s
Reading stability:	5% (measured with standard motility solution)

Transsonic Flowmeters

T402 Dual Channel Console and T403 Triple Channel Console

The multi-channel consoles (T402 and T403) provide a housing case for flowmeter modules allowing 'mix and match' capabilities to fit individual application requirements. Consoles are supplied with card guides, proprietary backplane with power supply and terminal block analog outputs for data collection. In addition, the console features carrying handles and adjustable feet for easy portability.

T402 Models:

- T402 — Dual Channel Console (Blank)
- T402-PB — One Channel Perivascular Flowmeter
- T402-TB — One Channel Tubing Flowmeter
- T402-PP — Two Channel Perivascular Flowmeter
- T402-TT — Two Channel Tubing Flowmeter
- T402-PT — Two Channel Perivascular/Tubing Flowmeter

T403 Models:

- T403 — Triple Channel Console (Blank)
- T403-PBB — Three Channel 1 Perivascular/2 Blank Flowmeter
- T403-PPB — Three Channel 2 Perivascular/1 Blank Flowmeter
- T403-PPP — Three Channel Perivascular Flowmeter
- T403-PPT — Three Channel 2 Perivascular/1 Tubing Flowmeter
- T403-PTB — Three Channel 1 Perivascular/1 Tubing/1 Blank Flowmeter
- T403-PTT — Three Channel 1 Perivascular/2 Tubing Flowmeter
- T403-TBB — Three Channel 1 Tubing/2 Blank Flowmeter
- T403-TTB — Three Channel 2 Tubing/1 Blank Flowmeter
- T403-TTT — Three Channel Tubing Flowmeter

Specifications

Dimensions:	5.21" × 9.25" × 12" (h × w × d)(T402)
	132.3 mm × 234.9 mm × 304.8 mm (h × w × d)
	5.21" × 13.46" × 12" (h × w × d) (T403)
	132.3 mm × 341.9 mm × 304.8 mm (h × w × d)
Weight:	5.8 lbs. (T402)
	7.6 lbs (T403)
Leakage current:	>50 microamperes
AC input:	100 to 240 VAC; 50 to 60 Hz, 50 watts
Fuses:	0.8 Amp fast-blow, mfg bussman # GMA0.8, 250 VAC
T402 module capacity:	Accepts 2 wide flowmeter modules of 20 HP width or 4 narrow flowmeter modules of 10 HP width or a combination of wide and narrow modules
T403 module capacity:	Accepts 3 wide flowmeter modules of 20 HP width or 3 narrow flowmeter modules of 10 HP width or a combination of wide and narrow modules

hardware

TS420 Perivascular Flowmeter Module

When used with suitable perivascular flowprobes (PS-Series, PR-Series, PAX-Series), the Perivascular Flowmeter Module measures flow for a range of *in vivo* applications including cardiac output and cardiovascular dynamics, renal hypertension, ischemia/reperfusion, portal hypertension and hind limb studies. For instantaneous measurement of flow and volume in animal arteries, veins or ducts, a variety of perivascular flowprobes (page 128) are available.

Specifications

Flow Gain:	By a factor of 4 in Low Range mode
Filters:	0.1, 10, 40 Hz Butterworth filters
Frequency range:	Ultrasonic 600 kHz – 14.4 MHz
Bandwidth:	160 Hz (accurately characterize flow dynamics at high heart rates, such as mice)
Display:	Analog meter displaying voltage proportional to flow. Easy access front panel for chronic probe calibration keys

TS410 Tubing Flowmeter Module

The TS410 Flowmeter Module together with sterile inline tubing flowsensors (PXL-Series) provide unparalleled volume flow measurements in tubing circuits, flow chambers and isolated organ apparatus. It is suitable for a variety of applications including extracorporeal shunts and cannulae, artificial heart and Ventricular Assist Device (VAD) performance, pulse duplication/heart valve studies and isolated perfused organ studies. The module automatically identifies the size and scale of the connected flowsensors.

Specifications

Flow Gain:	By a factor of 4 in Low Range mode
Filters:	0.1, 10, 40 Hz Butterworth filters
Frequency range:	Ultrasonic 600 kHz - 14.4 MHz
Output:	0 to 1 V (can be calibrated to external recording devices)
Display:	Polarity inversion of analog outputs & flow
Calibration:	Programmable calibration and for different fluid/temperatures
Alarms:	Programmable alarms that include low/high flow and received signal threshold alarm

Noninvasive Blood Pressure
IN125 NIBP Controller (mice and rats)

The IN125 NIBP Controller noninvasively measures intermittent blood pressure in mice and rats by monitoring periodic occlusion of tail blood flow. The IN125 is powered by the PowerLab system and is supplied with a tail cuff and transducer (specify /R for rat or /M for mouse). Animal holders of various sizes are available separately (see page 140).

Specifications

Maximum cuff pressure:	200 or 280 mmHg
Measurement cycle time:	~ 20 to 45 seconds (depending on pulse range used)
Accuracy:	±1%
Measurement cycle:	Voltage or switch triggered (software controlled)
Pulse signal/filter range:	0.7 to 10 Hz
Pressure output sensitivity:	0 to 1 V full scale represents 0 to 300 mmHg

MLE1054-V* Finometer® MIDI

The MLE1054-V* Finometer MIDI noninvasively and continuously measures brachial arterial pressure via the finger arterial pressure. The Finometer MIDI reconstructs finger arterial pressure waveform to obtain brachial arterial pressure, making it ideal for research investigating trends of systolic, diastolic and mean blood pressure.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Specifications

Finger cuff pressure:	300 mmHg (maximum)
Accuracy:	±3 mmHg
Height sensing range:	±128 mmHg
Analog signal:	I/O connector 1 input, 4 output, 15 pin male, D-type, ±5 V max. (Outputs are brachial pressure, finger cuff pressure, ECG & marker)

Invasive Blood Pressure

TC-510 Millar Pressure Control Unit

The TC-510 Millar Pressure Control Unit (CE approved) passively interfaces the Millar pressure catheter with a strain gauge amplifier. It features an internal calibration circuit (to provide an electrical zero as well as a 100 mmHg calibration signal) and is supplied with a monitor cable for connection to ADInstruments Bridge Amps. For connection to Millar pressure catheters with Viking or low-profile connectors. Catheter interface cables are required and available separately (see page 133).

Specifications

Number of Channels:	1
Input Connector Type:	Viking
Output Connector Type:	9 pin sub-D

PCU-2000 Millar Pressure Signal Conditioner

The PCU-2000 Millar Pressure Signal Conditioner is a two-channel amplifier/interface unit for the connection of one or two Millar Mikro-Tip catheters to a CE-approved pressure monitor and PowerLab. Each channel features an electrically isolated input safe for human connection. To connect to PowerLab, two MLAC12 BNC to Audio plugs (6.5 mm connector, 2 m cable) are required and can be purchased separately.

Specifications

Equipment classifications:	II (USA and Canada) and IIb (EU)
Signal input resistance:	50 MΩ, nominal
Pressure Transducer Characteristics	
Transducer sensitivity:	5 mV/V/mmHg, nominal
Bridge excitation load resistance:	1000 Ω, nominal
	300 Ω, minimum
Bridge excitation:	5.0 VDC, nominal
Pressure Outputs	
Sensitivity:	1 V/100 mmHg, nominal
Accuracy error band:	±1 mmHg or 1% of reading
Frequency response:	DC to 1000 Hz (−3 dB), minimum
Output resistance:	1000 Ω, nominal
Noise:	<0.3 mmHg peak-to-peak
Zero-offset temperature coefficient:	<0.15 mmHg/°C
Gain temperature coefficient:	<0.1%/°C
Balance adjustment range:	±140 mmHg, nominal

hardware

Isolated Perfused Organs

Radnoti Working Heart Apparatus

Radnoti Working Heart Apparatus are ideal for working, constant flow or constant pressure isolated heart preparations. The reservoir, heart chamber, bubble traps and interconnecting tubes are all water-jacketed to maintain constant perfusate temperature, with the water temperature and flow controlled by the 170051B-V* Radnoti Thermal Circulator Pump.

The apparatus includes a High-Tech Heart Chamber for mice or rats, with special access ports for cannulae and electrodes. Compliance chambers are included to ensure air bubbles are removed from the system. For 120101bEZ specify heart chamber size: S (rat, guinea pig), M (rabbit, cat) or L (pig).

Models:
- 120101bEZ/X-V* Radnoti Working Heart Apparatus for Rats/Rabbits
- 130101EZ-V* Radnoti Working Heart Apparatus for Mice
- 140101EZ-V* Radnoti Working Heart Apparatus for Pigs

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Radnoti Langendorff Apparatus

Radnoti Langendorff Apparatus are ideal for constant pressure or constant flow isolated heart preparations in either recirculating or non-recirculating mode. The system uses a 2 L water-jacketed reservoir to maintain and gas the perfusion solution. A peristaltic pump perfuses the heart and a water-jacketed bubble trap removes bubbles from the flow. With additional equipment, left ventricular pressure, apical force (using the in-built pulley system) and coronary resistance can be measured.

Models:
- 120103EZ-V* Radnoti Langendorff constant flow non-recirculating
- 120105EZ-V* Radnoti Langendorff constant pressure non-recirculating
- 130102EZ-V* Radnoti Mouse Langendorff constant pressure recirculating

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

ML176-V* Langendorff Apparatus & Thermostat Controller

The Langendorff Apparatus unit is a thermostatically controlled self-contained unit ideal for the perfusion of small animal hearts (such as mice, rats, guinea pigs). Two separate perfusate reservoirs are constantly oxygenated in the temperature-controlled water bath and a Thermostat Controller is included.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

ML172 Minipuls™3 Peristaltic Pump

The Minipuls 3 Peristaltic Pump is a reliable pulse-free pump that provides ultra-smooth flow. The pump is easily integrated with any system and can be controlled via the digital keypad, or remotely using the IN175 STH Pump Controller (available separately). The pump is supplied with a two-channel head for flow rates between 0.05 to 45 mL/minute (dependent on tubing size).

IN175 STH Pump Controller

The IN175 STH Pump Controller allows switching between constant flow and constant pressure conditions when used with a suitable peristaltic pump and pressure transducer. It is ideal for controlling the flow of solution in Langendorff or other isolated perfused organ experiments.

The IN175 connects to a Bridge Amp and Pressure Transducer and uses a negative feedback control circuit to alter the flow rate to maintain constant pressure in the perfusate line (typically within ±1 mmHg). It can also be set to a fixed flow rate when constant flow is required.

The ML172 and IN175 are designed for use with Langendorff Systems only.

Isolated Tissue

159920-X1 Radnoti 4 Chamber Tissue-Organ Bath

This four-chamber modular bath includes a 2 L water-jacketed reservoir, support stand, oxygenating bubblers and transducer positioners. The tissue-organ chambers are available in 5, 10, 25, 50, 100, 200 or 300 mL capacity. All chambers contain a preheating coil within a thick, water-jacketed wall in order to maintain solution at a constant temperature.

The organ baths are provided with a glass hook tissue support, a removable oxygen disperser tube, and a Teflon needle for accurate gas adjustment. Multiple 4-chamber units can be added to form 8 and 16 bath systems. The 159920-X1 is supplied with a 170051B-V* Radnoti Thermal Circulator Pump.

170051B-V* Radnoti Thermal Circulator Pump Bath

This bench-top temperature bath/circulator features a high wattage heater for rapid warming of the water bath. The stainless steel corrosion resistant 17 L reservoir has excellent fluid compatibility, a low reservoir liquid level safety shutoff and a bath temperature LED display. In addition, it is easy to clean.

* Specify mains power: *V = 115* for 110–115 V or *V = 220* for 220–240 V

Specifications

Reservoir volume:	17 L (4.5 Gallons)
Temperature range:	+12° C to +200° C
Temperature stability:	± 0.01° C
Pump flow rate:	15 L/min (Max)

ML0126, ML0146, ML0186 Tissue/Organ Baths

ADInstruments supplies Panlab organ baths in two, four and eight-chamber configurations. Each organ bath includes tissue chambers, preheating reservoir coils, gas diffusers, tissue holders, micropositioners, water pump and thermostat controller. The emptying and filling of tissue chambers is automated by electrovalves. A variety of tissue chamber volumes are available (5, 10, 25 and 50 mL).

Models:
- ML0126/C-V   Two Chamber Organ Bath
- ML0146/C-V   Four Chamber Organ Bath
- ML0186/C-V   Eight Chamber Organ Bath

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

hardware

hardware

DMT310A, DMT410A, DMT510A Wire Myographs

DMT Wire Myographs are used in studies of vascular reactivity in vessels and muscle strips (>60 µm). The units are available in single or dual configurations with in-built heating, solution draining and gas ports. The auto model (DMT510A) provides automatic control of micropositioners through a controller unit that connects directly to PowerLab via the analog outputs.

Models:
- DMT310A   Single Wire Myograph
- DMT410A   Dual Wire Myograph
- DMT510A   Auto Dual Wire Myograph

Specifications

Diameter:	>60 µm
Chamber volumes:	10 mL maximum
Force range:	±200 mN
Force resolution:	±0.01 mN
Temperature range:	0 to 50° C
Temperature resolution:	0.1° C

DMT620M Multi Chamber Myograph w/Touch Screen

The DMT620M is a self contained myograph ideal for investigating the reactivity of up to four separate vessels at once. The vascular tissue can be placed in jaw or pin supports attached to the force transducer and micropositioner. Each chamber has individually-controlled gas inflow and suction (as well as in-built heating). Ideal for drug screening, this system increases throughput and features a graphical color touch-display for easy reading and navigation of menu options.

Specifications

Vessel size:	>60 µm (up to 10 mm with pins)
Force range:	Selectable at ±200, ±400, ±800 and ±1600 mN
Force resolution:	±0.01 mN
Temperature range:	0 to 44° C
Temperature resolution:	0.1° C
Chamber volume:	6 mL maximum

DMT720MO Tissue Bath System w/Touch Screen

This myograph is ideal for simultaneous measurement of tension in up to four isolated blood vessels (>500 µm) and other large circular tissue preparations (such as trachea or gut mounted as ring preparations up to 10 mm). It is supplied with pin supports for tissue mounting and a graphical color touch-display allows easy reading and navigation of menu options. Each chamber has individually-controlled gas inflow and suction, in-built heating and a high-resolution force transducer.

Specifications

Diameter:	>500 µm (up to 10 mm with pins)
Force range:	Selectable at ±200, ±400, ±800 and ±1600 mN
Force resolution:	±0.01 mN
Temperature range:	0 to 44° C
Temperature resolution:	0.1° C
Chamber volume:	8 mL maximum

DMT820MS Muscle Strip Myograph w/Touch Screen

The DMT820MS is a state-of-the-art four-channel myograph system for studying muscle strips of up 15 mm in length. Up to four isolated skeletal or other muscle preparations can be measured simultaneously when mounted as a strip between clamp supports. Several types of mounting supports are available to suit user requirements. Each chamber has individually-controlled gas inflow and suction, in-built heating and a graphical color touch-display for easy reading and navigation of menu options.

Specifications

Tissue length:	>3 mm to 15 mm
Force range:	Selectable at ±200, ±400, ±800 and ±1600 mN
Force resolution:	±0.01 mN
Temperature range:	0 to 44° C
Temperature resolution:	0.1° C
Chamber volume:	4 mL maximum

DMT120CW Confocal Wire Myograph

The Confocal Wire Myograph combines Laser Scanning Confocal Microscopy with artery myography to allow simultaneous measurements of isometric force and fluorescence (confocal microscope not supplied). Example applications include studies that correlate isometric contractions in isolated, mounted blood vessels and intracellular Ca^{2+} measurements. The DMT120CW includes a control unit with temperature control, in-built high-resolution force transducer, and micrometer and analog output for direct connection to a PowerLab.

Specifications

Vessel size:	>60 μm
Force range:	±200 mN
Force resolution:	±0.01 mN
Temperature range:	0 to 50° C
Temperature resolution:	0.1° C
Chamber volume:	8 mL maximum

DMT100192 Automated Buffer Filler System 2 (625FS)

This Automated Buffer Filler System 2 (625FS) provides an automatic, reliable and consistent way to replace buffer in the bath chambers of any DMT four channel myograph (DMT620M, DMT720MO and DMT820MS). It attaches easily and fills a selected chamber or all 4 bath chambers simultaneously with buffer by a single touch of a button. Two standard volumes (6 mL and 8 mL) of buffer can be applied. Other volumes are available on request at the time of purchase.

hardware

Neurophysiology

Differential Extracellular Amplifiers

The DP-311 is an AC/DC differential amplifier suitable for recording extracellular, ECG and EEG signals using glass or metal microelectrodes. The amplifier has a high common mode rejection ratio (CMRR) to minimize electrical interference, and the amplifier's high input resistance ensures the high CMRR is not degraded by differences in source impedance at the input. The system is supplied with an active headstage that can be easily mounted in micromanipulators.

The DP-301 Single Channel Differential Amplifier and DP-304-V* Four Channel Differential Amplifier are additional options that can be used for extracellular recording.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Specifications for DP-311

Voltage gain:	×100, ×1000 and ×10000
Input resistance:	1 TΩ typical
Leakage current:	50 pA typical
Common mode rejection ratio:	100 dB min (100000:1) at 60 Hz
Noise, input shorted:	10 µV p-p, 1 Hz to 10 kHz
Low frequency filter (high pass):	0.1, 1.0, 10 and 300 Hz
High frequency filter (low pass):	0.1, 1.0, 3.0 and 10 kHz
Max. common mode signal:	±3 V
Output voltage swing:	±10 V
Output resistance:	220 Ω

Specifications for DP-301 and DP-304-V*

Voltage Gain:	×10, ×100, ×1000 & ×10000
Input Resistance:	1 TΩ typical
Leakage Current:	1.0 pA typical
Common Mode Rejection:	120 dB min (1000000:1) at 60 Hz
Noise, Input Shorted:	8 µV p-p, 1 Hz to 10 kHz typical
Low Frequency Filter Settings (high pass):	DC, 0.1, 1.0, 10 & 300 Hz
High Frequency Filter Settings (low pass):	0.1, 0.3, 1.0, 3.0, 10 & 50 kHz
Offset Control Range:	±600 mV min at output, any gain set
Max. Common Mode Signal:	±2 V
Output Voltage Swing:	±10 V (±5 V in gain of 10)
Output Resistance:	50 Ω

Intracellular Amplifier

The IE-210-V* Intracellular Electrometer is an intracellular microelectrode amplifier that measures voltage and/or current across a cell membrane. The low noise, low drift and fast response time result in easy, accurate and reliable recordings. The current injection feature permits simultaneous stimulation and recording with a single electrode, while the high input impedance ensures accurate measurements. The amplifier is supplied with the 2100W headstage and electrode probe.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Specifications

Input Impedance:	500 GΩ
Output Resistance:	100 Ω
Gain:	×1 ±0.1%

Probe Input Range:	±10 V
Risetime (10 to 90%):	25 μsec, measured through 20 MΩ
Noise Level:	25 μV p-p input shorted (0.1 Hz to 10 kHz) at ×1 output;
	250 μV p-p, 20 MΩ at input
Capacitance Compensation:	0 to 50 pF
Leakage Current:	1 pA typical, adjustable to zero
Input Offset:	±200 mV, referred to input
Buzz:	Amplitude variable 0 to 15 V
	Frequency variable 100 Hz to 10 kHz

Two Electrode Voltage Clamp Amplifier

The OC-725C-V Oocyte Clamp Amplifier is designed for two-electrode, whole-cell voltage clamping of Xenopus oocytes. Features such as the high compliance voltage (±180 V) and unique bath clamp circuitry make the OC-725C ideal for clamping large cells and cell structures such as squid axons.

Specifications for OC-725C-V*

O/Input Impedance:	500 GΩ, 1 pF
Output Resistance:	100 Ω
DC Offset:	±200 mV at input. Variations from zero with 10 turn control (20 mV/turn).
Noise:	(0 to 10 kHz) 3 μV RMS with input grounded
	20 μV RMS with model cell
Meter Range:	±199.9 mV full scale
Capacitance Compensation:	0 to 90 pF

Complete Oocyte Clamp Workstation

The TEV700-V* Complete Oocyte Clamp Workstation provides many of the necessary components typically used with the OC-725C-V* Oocyte Clamp Amplifier for research involving oocytes.

Workstation includes:

- OC-725C-V* Oocyte Clamp Amplifier, which includes:
  - 7250V Voltage Headstage for OC-725C-V
  - 7251I Bath Clamp Headstage for OC-725C-V
  - 7259C Current Electrode Cable for OC-725C-V
  - 725MC Oocyte Model Cell for OC-725C-V
- RC-3Z Oocyte Recording Chamber for OC-725C-V
- MM-33L Left Micro-Manipulator
- MM-33R Right Micro-Manipulator
- MB/B Magnetic Base (2)

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

hardware

Patch Clamp Amplifier

The PC-501A is a multipurpose patch clamp amplifier suitable for both whole cell measurements and single channel studies. Simple modifications such as increasing the holding voltage potential and external voltage signal make the patch clamp amplifier suitable for voltammetric measurements. Installation of internal switches allows transition between normal (patch) and voltammetry operation.

Different headstages are available for measuring currents up to ±1 nA (PC-501A/10-V*), ±10 nA (PC-501A/9-V*) or ±100 nA (PC-501A/8-V*).

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Specifications

Headstage:	10 GΩ resistor with maximum current ±1 nA (5101-10G)
	1 GΩ resistor with maximum current ±10 nA (5101-01G)
	100 MΩ resistor with maximum current ±100 nA (5101-100M)
Noise:	Measured with an 8-pole Bessel filter and 10 GΩ headstage
	0.06 pA RMS (DC to 1 kHz)
	0.20 pA RMS (DC to 5 kHz)
	0.40 pA RMS (DC to 10 kHz)
Zap:	1.5 V pulse (0.1 to 10 msec)
Series resistance compensation:	0 to 100 MΩ (read from 10 turn digital dial)
Capacity compensation:	Three ranges with amplitude and time constant adjustment:
	Fast (0 to 5 μsec)
	Medium (0 to 2 msec)
	Slow (0 to 20 msec)
Leak subtract:	Adjustable to 10 GΩ (10 GΩ headstage), 1 GΩ (1 GΩ headstage) or 100 MΩ (100 MΩ headstage)
Im output:	Four-pole Bessel filter with –3 dB frequencies at 0.1, 0.2, 0.5, 1, 2, 5 kHz

Epithelial Voltage Clamp Amplifiers

For studies of epithelial transport and the electrical properties of tissue, the epithelial voltage clamp amplifiers give accurate measurements of transepithelial voltage, short circuit current and membrane resistance. Various operating modes such as voltage clamp, current clamp, voltmeter, and resistance are available. The high CMRR provides measurements free from the effects of common mode potential changes in a noisy environment. Models include:

- EC-800-V*   Epithelial Voltage Clamp (120 V compliance)
- EC-800LV-V*   Epithelial Voltage Clamp (15 V compliance)
- EC-825A-V*   Dual Channel Epithelial Voltage Clamp (50 V compliance)

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Specifications

|	
Input impedance:	10 MΩ
Input voltage:	±1.5 V maximum
Common mode voltage:	±13 V maximum
Common mode rejection ratio (CMRR):	100 dB at 60 Hz
Leakage current:	20 pA maximum
Offset voltage range:	±120 mV
Int. clamp potentiometer voltage clamp range:	±100 mV with 10-turn control
Current clamp potentiometer range:	±1 mA
Compliance:	±120 V (for EC-800); ±15 V (for EC-800LV); ±50 V (for EC-825A)

Ussing Chambers

Ussing chambers are used to measure epithelial ion transport in both native tissue and cell monolayers grown on permeable supports. The modular design allows individual inserts (available separately to support a variety of tissue sizes and culture cups) to be easily switched between experiments. Combining the solution reservoir with the chamber housing reduces the size of the apparatus while increasing the system's ease of use. Ussing chambers are available in single (U9926) or dual-channel (U2500) models.

The U9926 is supplied with the following accessories (×2 for U2500):
- U9975A   Ussing Electrode Set (2 Ag-AgCl pellets and 2 Ag wires)
- U9565SC   Ussing Electrode Bridge Fitting Kit (12 pk 6 adapters)
- U9406   Tubing Kit (Hose & Luer Fittings) for Ussing Chambers

Models:
- U9926/A   Single Ussing Chamber with O-Ring Insert 3.8 mm
- U9926/B   Single Ussing Chamber with Pin Insert 3.8 mm
- U9926/C   Single Ussing Chamber with Slotted Insert 1.6 × 7 mm 6 Pins
- U9926/M   Single Ussing Chamber with Millicell Insert 12 mm
- U9926/S   Single Ussing Chamber with Snapwell Insert 12 mm
- U9926/T   Single Ussing Chamber with Transwell Insert 6.5 mm
- U2500/A   Dual Ussing Chamber with O-Ring Insert 3.8 mm
- U2500/B   Dual Ussing Chamber with Pin Insert 3.8 mm
- U2500/C   Dual Ussing Chamber with Slotted Insert 1.6 × 7 mm Six Pins
- U2500/M   Dual Ussing Chamber with Millicell Insert 12 mm
- U2500/S   Dual Ussing Chamber with Snapwell Insert 12 mm
- U2500/T   Dual Ussing Chamber with Transwell Insert 6.5 mm
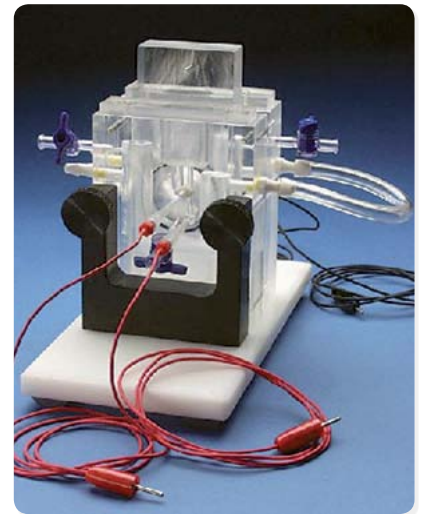
Wireless Neural Receivers

The TBSI Wireless Neural Receivers receive and process signals from any corresponding frequency TBSI headstage (see page 146). They are used for monitoring and recording action and field potentials from freely roaming animals. The receiver connects to the PowerLab data acquisition system via the TBSI Receiver to PowerLab Interface Cable. Wireless Neural Receivers are available in 5 or 15 channels.

Models:
- TB5663/F 5 Channel Wireless Neural Receiver
- TB5664/F 15 Channel Wireless Neural Receiver

Specifications

Transmission frequency:	3.05 GHz with +/-100 MHz FM bandwidth
Maximum range:	4 m maximum range between headstage transmitter and receiver (assuming Plexiglass cage)
Front-end gain:	60 dB
Intermediate gain:	10 to 20 dB
Input referred noise:	typical 4 μV_{rms}
Input voltage range:	+/− 0.5V
DC offset:	< 100 μVdc
Phase delay type:	30 μsec at 10 kHz

hardware

Psychophysiology

MLE1320 SuperLab (Win.Mac, 1 pk) and StimTracker

SuperLab is stimulus presentation software used for experiments requiring visual stimuli on the screen or auditory stimuli via speakers. It also controls synchronization with the PowerLab data acquisition unit. Recorded responses, including reaction times, are saved as text-only format and can be read by most spreadsheet or statistical software.

The StimTracker Interface is designed to synchronize data between the stimulus presentation system and the PowerLab. It monitors signals from a range of inputs (including the stimulus presentation computer) and sends TTL event markers to any PowerLab with digital inputs. It connects to a PowerLab data acquisition system via MLE1301 Interface Cable (StimTracker to PowerLab).

Please note: Typical experimental setup requires two computers, one for stimulus presentation and the other for recording. StimTracker synchronizes data between the two computers.

Pressure-Volume

The Millar MPVS Ultra monitors ventricular pressure and volume in small (mouse, rat) through to large animals (dog, sheep, pig). The 880–0168SS Millar MPVS Ultra Single Segment is limited to rats or mice only, however can be updated to the Millar MPVS Ultra by purchasing the 880–0168U Software Upgrade. The MPVS Ultra connects directly to a PowerLab data acquisition unit using BNC-BNC cables.

Models:
- 880-0168   Millar MPVS Ultra (large & small animals)
- 880-0168SS   Millar MPVS Ultra Single Segment

Specifications

Pressure Outputs

Sensitivity:	1 V/100 mmHg, nominal
Frequency response:	DC to 400 Hz (3 dB)
Noise:	<0.3 mmHg peak-to-peak

Volume/Conductance Outputs

Sensitivity:	Seven gain settings with maximal conductance inputs of 5, 25, 50, 100, 250 and 500 mS/segment
Frequency response:	400 Hz
Noise:	< 75 mVpp

Temperature Measurement

Range:	24 to 43° C (75 to 110° F)
Output accuracy:	±0.03° C (±0.05° F)

ECG

Gain:	2000 ×
Frequency response:	0.5 Hz to 30 Hz (−3 dB attenuation). Software enabled/disabled 60 Hz notch filter

Respiratory Gas Analysis

ML206 Gas Analyzer

The ML206 Gas Analyzer is used for measurement of respiratory gas concentration from small animals, such as rats, through to large animals and humans. It contains an infrared carbon dioxide sensor and optical oxygen detector fed from a damped micro vacuum sampling pump. The analyzer samples expired gas from a mixing chamber. The Flow Control dial on the front of the unit enables variable flow rates of 35 to 200 mL/min (maximum values may vary for different sized and lengths of tubing). The ability to vary the flow rates of the vacuum pump makes the unit ideal for human and animal research.

Specifications

Sampling flow range: 35 to 200 mL/minute (Rates vary due to size of tubing)
Oxygen analyzer channel
Operating range: 0 to 100% corresponding to 0 to 1 V
Resolution: 0.01%
10 to 90% response time: 440 ms (200 mL/minute)*
Carbon dioxide analyzer channel
Operating range: 0 to 10% corresponding to 0 to 1 V
Resolution: 0.1%
10 to 90% response time: 430 ms (200 mL/minute)*

* Response times tested with in-line filter and drying tube attached.

Stimulators

ML1001 Electronic Stimulator and ML1101 Stimulus Isolator

The ML1001 Electronic Stimulator is used for electrical stimulation in physiological and pharmacological research experiments. The Electronic Stimulator provides options for single pulse, paired pulse, pulse train, repeat pulse and biphasic stimuli operation using either constant voltage or current. It is equipped with a booster amplifier for a maximum field stimulation output of 50 V and input terminals for signal mixing and modulation (with an external signal). When used with the ML1101 Stimulus Isolator, the output from the Electronic Stimulator can be insulated from ground to minimize the stimulation area, ensuring greater precision and less artifact.

Specifications

Input pulse: ±3.5 V or over, 10 µs or over
Input impedance: 10 kΩ or over
External trigger level: 0 to +10 V continuous variable
Input voltage range: +10 V
Stimulation: Direct Stimulation = ±10 V or ±10 mA
                            Field Stimulation = ±50 V or ±400 mA
                            Isolated Stimulation = ±10 V or ±10 mA (connected to ML1101 Stimulus Isolator)
Frequency: 50/60 Hz
Power: AC 110 V, 220 V or 240 V ±10%

BSI-950 Biphasic Stimulus Isolator

The BSI-950 is an economical analog input-analog output stimulus isolation unit for use with externally generated stimulation signals. The AC powered stages are photo isolated from the battery powered output stage.

Specifications

Input:	Analog ±10 V (10 V input = full range output)
Output current:	±0.05, ±0.5, ±1, ±5, ±10 mA full scale ranges
Output voltage:	±0.5, ±1, ±5, ±10, ±50, ±100 V full scale ranges
Linearity:	< 1% deviation over entire output range
Rise and fall times:	8 μs, 1 mA through to 10 kΩ load
Source resistance:	10 kΩ, 1% tolerance (in voltage mode)
Power supply:	External AC supply, isolated power source, 9 V transistor batteries

Combined Pulse/Train Stimulator (4 channels)

The CS200 Combined Pulse/Train Stimulator is a four channel pulse/train current stimulator (0 to 200 mA) for *in vitro* muscle stimulation in tissue/organ bath systems, especially myograph systems requiring current stimulation. There are a variety of stimulation modes including single, continuous and frequency regulated steps. Programmed stimulation protocols can easily be stored and reloaded in one of the five internal program memories. Myograph field stimulation studies will require special chamber covers (available separately) to place the electrodes.

Specifications

Pulse Generator		Train Generator	
Frequency:	0.1 to 256 Hz	Mode 1:	Off
Pulse duration:	0.03 to 500 ms	Mode 2:	Single
Current:	0 to 100 mA	Mode 3:	Continues
Compliance:	50 Volts	Mode 4:	Frequency step
Rise/Fall time:	1.5 ms	Train Duration:	0.1 to 3600 s
Output:	Mono / Bipolar	Train Delay:	0.1 to 3600 s

STG4004 4 Channel Stimulus Generator and STG4008 8 Channel Stimulus Generator

Stimulus Generators are available in optically isolated four and eight channel configurations for the integrated stimulation of independent output channels. These units serve a wide variety of applications including *in vitro* and *in vivo* neurophysiology, as well as short term and long term stimulations. The stimulus generators are general-purpose stimulators that can be triggered directly from PowerLab, and are supplied with the MC Stimulus II software for Windows (XP and Vista compatible) to create complex current and voltage stimulus waveforms.

Specifications

Current output range:	−1.6 mA to +1.6 mA with 100 nA resolution
Maximum compliance voltage:	120 V
Voltage output range:	−8 V to + 8 V with 1 mV resolution
Maximum output current:	±20 mA
Trigger (TTL) input:	Four for STG4004 and eight for STG4008 (BNC connector)
Trigger (TTL) output:	Four for STG4004 and eight for STG4008 (BNC connector)
Time resolution:	20 μs
Power:	110 or 240 VAC (specify destination country when ordering)

STG3008-FA Stimulator

The BSI-950 is an economical analog input-analog output stimulus isolation unit for use with externally generated stimulation signals. The AC powered stages are photo isolated from the battery powered output stage.

Specifications

Input:	Analog ±10 V (10 V input = full range output)
Output current:	±0.05, ±0.5, ±1, ±5, ±10 mA full scale ranges
Output voltage:	±0.5, ±1, ±5, ±10, ±50, ±100 V full scale ranges
Linearity:	< 1% deviation over entire output range
Rise and fall times:	8 μs, 1 mA through to 10 kΩ load
Source resistance:	10 kΩ, 1% tolerance (in voltage mode)
Power supply:	External AC supply, isolated power source, 9 V transistor batteries
Rise and fall times:	8 μs, 1 mA through to 10 kΩ load
Source resistance:	10 kΩ, 1% tolerance (in voltage mode)

Telemetry Products

Configurator and SmartPad

The Configurator and software are used to control the SmartPad and Telemeters. It is easy to configure the channel frequency, acquire diagnostic information, switch off the Telemeter and control the charging field of the SmartPad. Each SmartPad unit acquires signal and/or charges one Telemeter. The receiving range is up to 5 meters and one SmartPad is required for each Telemeter.

Telemetry Instruments include:

- MLE0180 SmartPad (TR180)
- MLE0190 Configurator (TR190)

Temperature Control

ML290-V* Thermometer for T-type Thermocouples

The ML290-V* is a battery operated thermometer for use with T-type Thermocouples. It features highly accurate fast readings, with automatic correction for ambient temperature. It is supplied with a stand and a cable for connection to a PowerLab.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Specifications:

Temperature Range:	−100° C to +200° C
Resolution:	0.1° C
Accuracy:	0.1° C ±1 digit between 0 to 50° C, 0.1% ±1 digit over full range
Compensation:	Auto-compensated to 0.1° C from 0° C to 50° C
Analog Output:	Approximately 10 mV per ° C
Size:	5" × 2 1/2" × 6" (127 mm × 63.5 mm × 152.4 mm)

ML295 Homeothermic Controller and Pad

The ML295 includes a heating pad for mice, rats or guinea pigs (102 × 152 mm) and a dual set point control circuit as a safety measure to prevent overshooting the set temperature. The ML295/R is supplied with a MLT1403 Rectal Probe for Rats and the ML295/M is supplied with a MLT1404 Rectal Probe for Mice.

hardware

Transducers and Accessories

ADInstruments supplies a wide range of transducers that are configured to operate with PowerLab front-end signal conditioners or Pods. No wiring is required—you simply plug them in and use them. The range includes transducers for measuring force, displacement, blood pressure, temperature, heart rate, pH, airflow and more.

ADInstruments supplies transducers for:

- Biochemistry
- Biopotential
- Blood and Fluid Flow
- Cardiac Output
- Event Markers and Headphones
- Force and Displacement
- Galvanic Skin Response
- Heart Sounds
- Invasive Blood Pressure
- Langendorff
- Neurophysiology

- Noninvasive Blood Pressure
- Organ Bath Stimulating Electrodes
- Psychophysiology
- Pulse and Plethysmography
- Pulse Oximetry
- Respiration
- Stimulator Accessories
- Telemetry
- Temperature
- Wireless Neural Recordings.

When ordering transducers, please be aware of different connector options, as some transducers offer more than one. For example, when ordering the MLT1020 Plethysmograph, specify MLT1020/PPG for Velcro strap, MLT1020/FC for finger clip, or MLT1020/EC for ear clip option.

Biochemistry

MLT1120 Micro-Oxygen Electrode

Used to detect oxygen concentration in small volume samples, this electrode is supplied with a MLT1121 Membrane Housing Kit that contains 6 replacement Teflon® membranes, a bottle of electrolyte solution, a bulb pipette and 5 polishing pads. The MLT1122 Analog Adapter (ordered separately) is required to connect the electrode to a PowerLab.

MLT1123 Micro-Oxygen Electrode (Flow-Through)

Ideal for detecting oxygen in a continuous flow (such as water, blood, urine or physiological fluid), this electrode features low oxygen consumption, fast response (<20 s) and requires less than a drop of liquid. It is supplied with a MLT1124 Membrane Housing Kit that contains 6 T-membranes and a bottle of electrolyte solution. The MLT1122 Analog Adapter (ordered separately) is required to connect the electrode to a PowerLab.

MLT1122 Analog Adapter

Allows connection of MLT1120 Micro-Oxygen Electrode or MLT1123 Micro-Oxygen Electrode (Flow-Through) to a PowerLab.

MLT1121 Membrane Housing Kit (for MLT1120)

Used with the MLT1120 Micro-Oxygen Electrode, this kit includes 6 replacement Teflon® membranes, a bottle of electrolyte solution, a bulb pipette and 5 polishing pads.

MLT1124 Membrane Housing Kit (for MLT1123)

Used with the MLT1123 Micro-Oxygen Electrode (Flow-Through), this kit includes 6 T-membranes and a bottle of electrolyte solution.

MLT1115 Galvanic Oxygen Electrode

Used to detect oxygen concentration in an aqueous solution, this electrode connects to PowerLab BNC inputs. The output, in air-saturated deionized water, is typically between 20 to 35 mV at 25° C with oxygen consumption of 3.45×10 to 13 mol O_2/s per mV of signal.

MLA042 pH Electrode

Suitable for operation between 0 and 60° C and 0 and 14 pH, the combination pH Electrode has a double junction which is easily cleaned and ideal for low ionic strength and biological samples. Appropriate for use with the ML165 pH Amp.

MLA060 Redox Electrode

Used to detect the redox potential of an aqueous solution between 0 and 60° C, this electrode is suitable for use with the ML165 pH Amp. The double junction is easily cleaned, making it suitable for biological samples.

MLT915 Dip-In Conductivity Electrode

Used to monitor the conductivity of samples such as water, urine and other physiological fluids, the MLT915 is 14.6 cm long, with an outer diameter of 3.2 mm and immersion depth of 5 mm. The cell constant is approximately 1. The electrode is used with the ML307 Conductivity Pod.

MLT908 Flow-Thru Conductivity Electrode

Used to monitor the conductance of continuous streams of water, urine and other physiological fluids. It has a cell volume of 0.093 mL and attaches to tubing with an internal diameter of 3.2 mm (1/8"). The electrode is used with the ML307 Conductivity Pod.

MLT916 Flow-Thru Conductivity Electrode

Used to monitor the conductance of continuous streams of water, urine and other physiological fluids. It has a cell volume of 0.017 mL and attaches to tubing with an internal diameter of 1.6 mm (1/16"). The electrode is used with the ML307 Conductivity Pod.

hardware

MLT226 Reflective Drop Counter

The MLT226 Reflective Drop Counter sensor features a high-power infrared emitting diode and a phototransistor for counting drops. The counter is suitable for titration experiments (using a burette) or measurement of physiological fluids collected from rodents (such as such as urine and gastric juices). A background correction circuit removes ambient light interference at the detector. It connects directly to a PowerLab Pod port.

MI-405 Miniature Glass Electrode for pH

The MI-405 Miniature Glass Electrode for pH can be used in many general-purpose analysis applications and microchemical studies. The electrode is used with the ML165 pH Amp and an external reference electrode (such as the MI-409 Miniature Reference Electrode).

MI-409 Miniature Reference Electrode

Used with the ML165 pH Amp and any pH or ion selective electrodes, this reference electrode has an internal Ag-AgCl reference electrode with KCl filling solution, and is supplied with two reference barrels and a bottle of 3 M KCl.

Biopotential

MLA0115 ECG 12 Lead Switch Box

The MLA0115 allows for the mechanical selection of standard lead configurations using 10 standard lead wires. It supports the direct selection of type I, II, III, aVF, aVL, aVR, and V1 to V6 lead configurations. The Switch Box is supplied with MLA0311 Lead Wires (1 m, 10 snap on). The MLA0115/S is suitable for use with the FE132 Bio Amp and PL3508B80 Exercise Physiology System, as well as the FE135 Dual Bio Amp or ML408 Bio Amp/Stimulator.

Shielded Bio Amp Cables and Lead Wires

MLA2340 3-Lead Shielded Bio Amp Cable connects to MLA2503 Shielded Lead Wires (3 snap on) for use with the FE132 Bio Amp.

MLA2540 5-Lead Shielded Bio Amp Cable connects to MLA2505 Shielded Lead Wires (5 snap on) for use with the FE135 Dual Bio Amp or ML408 Dual Bio Amp/Stimulator.

MLA1605 Shielded Lead Wires (5 Alligator Clip, 25 cm) are for use with the MLA2540 5-Lead Shielded Bio Amp Cable

MLA1615 Shielded Lead Wires (5 Alligator Clip, 100 cm) are for use with MLA2340 or MLA2540 Shielded Bio Amp cables.

MLA1610 Shielded Lead Wires (5 Micro-Hooks) are for use with the MLA2540 5-Lead Shielded Bio Amp Cable. The Micro-Hooks are constructed of molded nylon with a stainless steel spring and gold-plated beryllium copper hooks.

Unshielded Bio Amp Cables and Lead Wires

MLA1340 3-Lead Bio Amp Cable connects to MLA0313 Lead Wires (3 snap on) for use with the FE132 Bio Amp.

MLA1540 5-Lead Bio Amp Cable connects to MLA0315 Lead Wires (5 snap on) for use with the FE135 Dual Bio Amp or ML408 Dual Bio Amp/Stimulator.

10-pack of Unshielded Lead Wires suitable for use with any ADInstruments ECG Lead Switch Box are available in lengths of 1 m (**MLA0311**) and 1.8 m (**MLA0310**).

MLA1505 Lead Wires (5 Alligator Clip) are used with the MLA1540 5-Lead Bio Amp Cable.

MLAC29 Octal Bio Linking Cable

Links the negative inputs of the ML138 Octal Bio Amp for 12-lead ECG recordings. It has seven 1.5 mm shrouded female plugs and one 1.5 mm shrouded male connector.

MLA1212 Micro-Hook Electrodes for FE136 (3 pk)

Supplied with FE136 Animal Bio Amp, the Micro-Hooks are made of molded nylon with a stainless steel spring and gold-plated beryllium copper hooks.

MLA1213 Needle Electrodes for FE136 (3 pk)

Surgical steel needle electrodes (29 gauge, 12 mm length) for the FE136 Animal Bio Amp.

MLA1214 Spring Clip Electrodes for FE136 (3 pk)

Gold-plated spring clip electrodes for use with the FE136 Animal Bio Amp are ideal for measuring cardiac electrical activity in isolated heart preparations.

MLA1515 Bio Cable - Animal Use Only

Used for measuring biopotentials such as EMG and ECG in animals, the MLA1515 Bio Cable (Dual Bio to 5 Alligator clips, 1 m) has a 6-pin plug to 5 alligator clips and connects to the FE135 Dual Bio Amp or ML408 Dual Bio Amp/Stimulator.

EEG Electrodes

MLAWBT9 EEG Flat Electrodes: set of five gold-plated, hat-shaped disk recording electrodes suitable for EEG and EMG measurements. The electrodes have a diameter of 9 mm, cable length of 185 cm, and feature a cavity in the top for electrolyte injection.

MLAIME EEG Clip Electrodes: set of two silver ear clip electrodes, 9.5 mm wide with 190 cm long leads. Suitable for EEG and EMG recordings, the leads from these electrodes connect directly into any ADInstruments Bio Amp Cable (MLA2540, MLA2340, MLA1340 or MLA1540).

The MLAWBT9 and MLAIME electrodes can also be used with the ML138 Octal Bio Amp, GT205 8 Channel and GT201 16 Channel Bio Amps.

hardware

MLA700 Reusable ECG Electrodes

A pack of 3 reusable clamp electrodes (8 cm) with a 24 cm² area to maximize skin contact. Suitable for attachment to the wrists or ankles (with MLA1090 Electrode Cream), these electrodes can be connected to any Bio Amp Cable with snap-connect Lead Wires (MLA2503 or MLA2505).

MLA710 Chest ECG Electrodes (suction)

A set of 3 suction electrodes 30 mm in diameter. They can be connected to any ADInstruments Bio Amp Cable using snap-on Lead Wires providing good contact and low noise.

MLADDB30 Recording Bar Electrode

The Recording Bar Electrode is used in EMG experiments. It has concave 9 mm contacts with 30 mm spacing and is fitted with shrouded 1.6 mm connectors suitable for connection to Shielded Bio Amp Cables MLA2340 and MLA2540.

MLAYDG Dry Earth Strap

Suitable for use in biopotential measurements and human nerve conduction, this strap does not require a conductive solution. It is suitable for attachment to limbs up to 100 mm in diameter (approximately 315 mm circumference) and is fitted with a snap button suitable for connection to both shielded and unshielded lead wires.

Millar Electrophysiology Catheters

These catheters are used with the STG3008-FA Intracardiac Electrophysiology Stimulator/Amplifier to determine the electrical properties of the atrium and ventricle in rats or mice. They can also be used with any ADInstruments Bio Amps via the EPC-5A EPR Catheter Interface Cable (ordered separately) for recording cardiac electrical potentials only. These catheters are non-repairable.

Millar Electrophysiology Catheters include:
- EPR-800 Millar Electrophysiology Catheter (1.1F, 8E, 1.0 mm, 4.5 cm)
- EPR-801 Millar Electrophysiology Catheter (1.1F, 8E, 1.0 mm, 4.5 cm Lumen)
- EPR-802 Millar Electrophysiology Catheter (1.6F, 8E, 1.0 mm, 12.5 cm)

EPC-5A EPR Catheter Interface Cable (5 ft)

The EPC-5A Catheter Interface Cable (5 ft) has a Redel connector to eight 1.5 mm shrouded sockets and includes a pack of ten 2 mm adaptors for connection to the FE136 Animal Bio Amp. It connects the Electrophysiology Catheters to any ADInstruments Bio Amp.

MLE2002 Model 1089 MK III Checktrode®

The Model 1089 MK III Checktrode® provides rapid and easy evaluation of total electrode contact impedance and offset voltage between two applied electrodes. Because EEG recordings are easily contaminated by noise and interference due to high contact impedance, this model assists in reducing electrode contact impedance with the skin before recording data.

EEG Electro-cap System

The MLAEC EEG Electro-cap System is available in medium and large sizes. Included in both systems is an electrode adapter (suits MLA2540 Shielded Bio Amp Cable and Multi-Channel Bio Amps), body harness, quick insert electrode, ear electrodes (1 pair), disposable sponge disks (×100), needle/syringe kit, electro-gel (16 oz), head measuring tape, ivory cleaning liquid and manual. Specify MLAEC1 for the medium cap only system, or MLAEC2 for the large and medium cap system.

Biopotential Consumables

MLA415 Biopotential Accessory Kit

A selection of items used for the preparation of sites prior to biopotential measurements such as EEG, EOG, EMG and ECG. The kit includes MLA1090 Electrode Cream (3×), MLA1095 Electrode Paste (3pk), MLA1010B ECG Electrodes (1000pk), MLA1093B Abrasive Gel (3pk) and MLA1094 Alcohol Swabs (1000pk).

MLA1090 and MLA1090B Electrode Cream

MLA1090 Electrode Cream (150 mL) provides improved contact for MLA700 Reusable ECG Electrodes. A bulk pack of 12 bottles is also available (MLA1090B).

MLA1092 and MLA1092B Abrasive Pads— Non-sterile

MLA1092 Abrasive Pads (2 sheets) are two 115 × 155 mm abrasive pads (single use only) used to prepare skin prior to the application of electrodes. A bulk pack of 20 (155 × 230 mm) sheets of abrasive pads is also available (MLA1092B).

MLA1093 and MLA1093B Abrasive Gel

MLA1093 Abrasive Gel is a single (4 oz) tube containing microbeads to prepare skin prior to attaching electrodes for biopotential measurements. A bulk pack of 3 tubes is also available (MLA1093B).

MLA1094 Alcohol Swabs (1000)

Individually wrapped isopropyl alcohol (70%) swabs, ideal for preparation of sites used for biopotential measurements (EEG, ECG, EOG and EMG).

MLA1095 and MLA1095B Electrode Paste

MLA1095 Electrode Paste (3 Pack) is a pack of three 120 mL tubes for use with MLAWBT9 EEG Flat Electrodes. It provides improved contact when recording biopotentials. A bulk pack of 6 tubes is also available (MLA1095B).

MLA1010 and MLA1010B Disposable ECG Electrodes

MLA1010 is a pack of 100 disposable ECG electrodes that measure ECG or other bioelectric potentials with snap-connect lead wires. A bulk pack of 1000 Disposable ECG Electrodes (MLA1010B) is also available.

hardware

Galvanic Skin Response

MLT116F and MLT117F GSR Finger Electrodes

These bipolar finger electrodes are ideal for detecting galvanic skin response. Both MLT116F and MLT117F are suitable for connection to the FE116 GSR Amp, however only the MLT117F model is MRI compatible.

Blood Flow

Laser Doppler Probes

A variety of surface and needle laser Doppler probes are available for measuring cutaneous organ or tissue microvascular blood flow.

Available probes include:
- MNP100XP Standard Pencil Probe (surface limited access)
- MNP110XP Fine Needle Probe (tissue insertion)
- MNP150XP Bent Tip Pencil Probe (oral surface and nasal areas)
- MSP100XP Standard Surface Probe (cutaneous blood perfusion)
- MSP110XP Digit Probe (skin blood perfusion of the digits)
- MSP300XP Miniature Surface Probe (surface monitoring, suturable)
- MSP310XP Miniature Surface Probe (surface monitoring, adhesive; MRI Compatible)

Transonic Perivascular Flowprobes and Flowsensors

Perivascular flowprobes from Transonic are ideal for acute and chronic measurements of flow in both small and large animal blood vessels. Available in a variety of configurations, the probes do not interfere with flow to target tissues, as they are placed external to the vessel.

Tubing flowsensors are used for the measurement of flow volume in non-aerated liquids including saline, buffer solutions, blood, water and other organic fluids with high resolution and low offset. Flowsensors are available in a variety of tubing sizes and can be calibrated and programmed for up to 4 different fluid/temperature/tubing combinations.

For further assistance or advice in selecting flowprobes and flowsensors for a specific application, please consult your ADInstruments representative.

- **PS and PR Series Perivascular Flowprobes**
  The PS and PR series include the 0.5 to 0.7 mm nanoprobes for mice and 1 to 20 mm precision probes for any vessel, making them the smallest probes available. They are easily stabilized under the microscope with a micromanipulator for experiments in anesthetized rodents. In addition, precision probes are available as MA (standard acute use) or MC (custom implantable configuration).

- **PAU Series COnfidence™ Perivascular Flowprobes**
  These 8 to 28 mm perivascular flowprobes are designed to measure chronic and acute cardiac output in large animal models with accuracy, enhanced reliability and ease of use. Supplied with form-fitting Ultrafit Liner cushions for safe and easy placement, the liner encircles the vessel and slips into the transducer shell to stay in place without a clip.

- **PMP Series Perivascular Flowprobes**

  These 2 to 14 mm flowprobes are designed with handles for intraoperative measurements in preclinical animal trials where devices that match those used in clinical surgical settings are preferred.

- **V Series Perivascular Flowprobes**

  This original flowprobe series includes 0.5 to 0.7 mm microcirculation probes for acute flow measurements in small vessels (<0.7 mm). These flowprobes have mirrored ultrasonic illumination and a stabilizing handle. They will also require more acoustic coupling gel than the PS and PR series nanoprobes.

- **PXL Series Clamp-on Flowsensors**

  These precision flowsensors clip on the outside of standard laboratory or extracorporeal tubing and apply ultrasound energy through the tubing to monitor instantaneous and average volume flow. The flowsensors maintain total physical and ele 0.046 to 1.0 f. Highly sensitive, they are ideal for measurements in low flow applications, such as bench-top perfused isolated organ preparations.

MLA191 Calibration Kit for IN191

The Calibration Kit contains a positioning device, to which the probe and cable can be attached, providing probe stability during calibration. Also included is a bottle of Motility Standard (a colloidal solution of suspended latex spheres, which are of a standard size and concentration).

MSP140AR Adhesive Rings for Probes (200)

Used to secure laser Doppler surface probes to a subject.

Pulse Oximetry

MLT321 and MLT322 Oximetry Transducers (Human)

The MLT321 and MLT322 measure human blood oxygen saturation in the range of 70% to 100%. Short pulses of light at two different frequencies are transmitted through the tissue with the intensity scaled to read in % SpO_2.

The MLT321 SpO_2 Finger Clip Sensor is supplied with the ML320/F Oximeter Pod (Finger clip) and the MLT322 SpO_2 Ear Clip Sensor is supplied with the ML320/E Oximeter Pod (Ear clip).

hardware

MLT323, MLT324 and MLT325 Oximetry Transducers (Animal)

The MLT323, MLT324 and MLT325 are used to measure blood oxygen saturation (SpO_2) in animals. The transducers are designed for animal applications where little transducer motion is expected. The MLT323 SpO_2 Animal Clip is an ultra-sensitive clip-on sensor for use on tongue, paw pad or tail. The MLT324 SpO_2 Wrap Sensor is a flexible wrap sensor that can be placed on the toe (large animal) or base of the tail (small animal). The MLT325 SpO_2 Base Sensor Transducer is a transflectance sensor that allows convenient sensor placement on the underside, base of the tail or other well-vascularized surfaces of the animal.

Cardiac Output
MLA313 Cardiac Output Accessory Kit

The MLA313 Cardiac Output Accessory Kit provides accurate and reproducible injection solution volumes for the determination of cardiac output. The kit can be used with the ML313C Cardiac Output Pod (with thermocouple) or ML313 Cardiac Output Pod (no thermocouple). It includes a Hamilton glass syringe (250 µl) and repeating dispenser, polyethylene tubing, 6 Luer needle hubs, 4 three-way stopcocks and 2 Touhy Borst Adapters.

Force and Displacement
MLT0201 Force Transducer (5 mg to 25 g)

The MLT0201 is an isometric transducer with a range of 5 mg to 25 g with a resolution of ±2 mg using a 360 Ω strain gauge. It is ideal for isolated tissue studies and operates with the ADInstruments range of tissue and organ bath models, as well as any ADInstruments Bridge Amp. Specify MLT0201/RAD if using with Radnoti Tissue-Organ Baths.

MLT0202 Sensitive Force Transducer (0 to 25 g)

The MLT0202 is a high-sensitivity isometric force transducer with a range of 0 to 25 g, using a 624 Ω strain gauge. It is ideal for isolated tissue studies and operates with our range of tissue and organ bath models, as well as any ADInstruments Bridge Amp.

MLT0402 Force Transducer (2 g)

The MLT0402 is a sensitive isometric force transducer suitable for measuring small forces. It is ideal for isolated tissue and organ bath studies where forces up to 2 g are expected. The transducer is suitable for connection to any ADInstruments Bridge Amp.

MLT0420 Force Transducer (20 g)

The MLT0420 is a sensitive isometric force transducer ideal for measuring force during isolated tissue and organ bath studies where small forces up to 20 g are expected. The transducer is suitable for connection to any ADInstruments Bridge Amp.

MLT0015 High Grade Isotonic Transducer

The MLT0015 is a high-performance isotonic transducer suitable for the measurement of displacements with preadjusted loads in the range of ±15°. Recommended for use with our range of organ bath models, it is suitable for connection to the FE221 Bridge Amp, FE224 Quad Bridge Amp and FE228 Octal Bridge Amp.

MLT1030 Wide Range Force Transducer (10 mg to 1 kg)

The MLT1030 is a semi-isometric 10 mg to 1 kg force transducer ideal for measuring muscle contractions and general force measurements requiring a wide dynamic range. Consisting of five blades, the rigidity of the transducer can be adjusted for the required sensitivity. Supplied with either audio connector (MLT1030/A) or an 8-pin DIN connector (MLT1030/D).

MLTS700 Goniometer

The MLTS700 Goniometer (Joint Angle Sensor) measures the angle of single degree of freedom joints such as the knee and elbow via a light sensor. Angle is determined by the amount of light passing through a pair of optic fibers along the length of the cantilever. The sensor plugs directly into a PowerLab Pod port.

MLTS720 Miniature Goniometer

The MLTS720 Miniature Goniometer (Joint Angle Sensor) measures the angle of single degree of freedom in small joints (including fingers and toes) and connects directly to a PowerLab Pod port. The sensor can be attached to a subject with a reusable and flexible adhesive polymer directly on the skin, or a glove/bio-compatible tape that allows easy adjustments along the natural axis of the joint.

159901A-V* Force Transducer with Amplifier

The 159901A-V* Force Transducer is supplied with an amplifier and output for connection to PowerLab and converts picofarad capacitance into an amplified DC output voltage. Transducer linearity is within +1% with a high DC voltage output and freedom from drift.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Heart Sounds

MLT208 Digital Stethoscope

The MLT208 Digital Stethoscope provides unsurpassed natural sound quality and can be connected directly to a PowerLab BNC input. It allows the user to listen to heart sounds while simultaneously recording representative cardiac traces.

MLT201 Cardio Microphone

The Cardio Microphone converts heart sounds into electrical signals. The MLT201 records heart sounds in the frequency range of 10 to 600 Hz and is suitable for direct connection to PowerLab Pod ports.

hardware

SPR-671

SPR-407

Invasive Blood Pressure

Millar Mikro-Tip® Blood Pressure Catheters

Millar Mikro-Tip Pressure Catheters are used for blood or cardiac pressure measurements in animal research ONLY. The micro pressure sensors provide accurate pressure measurements at the source of the signal. These catheters connect to any ADInstruments Bridge Amplifier via AEC-10C or AEC-10D Catheter Interface Cables (depending on the catheter connector type). ADInstruments supplies a range of nylon (Ny), polyimide (PI), polyurethane (PU) and woven Dacron (WD) catheters ranging from 1F (small animals) to 7F (large animals).

- SPR-1000   Pressure Catheter (1F, Single, Straight, PI, 20 cm)*
- SPR-671   Pressure Catheter (1.4F, Single, Straight, Ny, 15 cm)
- SPR-407   Pressure Catheter (2F, Single, Straight, Ny, 140 cm)
- SPR-320   Pressure Catheter (2F, Single, Straight, PU, 140 cm)
- SPR-882   Pressure Catheter (3F, Single, Straight, Ny, 140 cm)
- SPR-721   Pressure Catheter (2.5F, Dual, Straight, PU, 135 cm)
- SPR-524   Pressure Catheter (3.5F, Single, Straight, Ny, 100 cm)*
- MPR-500   Pressure Catheter (5F, Single, PU, 70 cm)*
- SPR-350   Pressure Catheter (5F, Single, Curved, PU/W, 120 cm)

Millar Mikro-Tip® Pressure-Volume Catheters

Designed for use in large and small animals, the Mikro-Tip ultra-miniature PV catheters can simultaneously measure ventricular pressure and volume from a continuously-beating intact heart, without affecting normal heart function. These catheters connect any 880–0168SS Millar MPVS Ultra Single Segment or 880–0168 Millar MPVS Ultra (large and small animals) via the 880–0169 MPVS Ultra Cable Pack (10 ft). PV catheters are available in a range of sizes and configurations from 1 to 6 French.

Mouse Pressure-Volume Catheters
- PVR-1030   Mouse PV Catheter (1F, 4E, 3.0 mm, 4.5 cm, PI)*
- PVR-1035   Mouse PV Catheter (1F, 4E, 3.5 mm, 4.5 cm, PI)*
- PVR-1045   Mouse PV Catheter (1F, 4E, 4.5 mm, 4.5 cm, PI)*
- SPR-839   Mouse PV Catheter (1.4F, 4E, 4.5 mm, 4.5 cm, PI)
- SPR-853   Mouse PV Catheter (1.4F, 4E, 4 mm, Taper)
- SPR-864   Mouse PV Catheter (1.4F, 2P, 4E, 4.5 mm, Carotid)
- SPR-848   Mouse PV Catheter (1.4F, 2P, 4E, 4.5 mm, Apical)
- SPR-866   Mouse PV Catheter (1.4F, 6E, Selectable Seg, 4 mm/6 mm)

Rat Pressure-Volume Catheters
- SPR-847   Rat PV Catheter (1.4F, 4E, 9 mm, PI, 15 cm)
- SPR-869   Rat PV Catheter (2F, 4E, 6 mm, PI, 15 cm)
- SPR-838   Rat PV Catheter (2F, 4E, 9 mm, PI, 15 cm)
- SPR-878   Rat PV Catheter (2F, 4E, 12 mm, PI, 15 cm)
- SPR-858   Rat PV Catheter (2F, 4E, 14 mm, PI, 15 cm)
- SPR-901   Rat PV Catheter (2F, 2P, 4E, 9 mm, Carotid, 15 cm)
- SPR-902   Rat PV Catheter (2F, 2P, 4E, 9 mm, Apical, 15 cm)
- SPR-819   Rat PV Catheter (1.4F, 6E, Selectable Seg, 9 mm/14 mm)

PVR-1045

SPR-839

SPR-869

SPR-838

Multi-Segmented Pressure Volume Catheters

- SPR-877   PV Catheter (3F, 10E, 2.5 mm, DField, 120 cm)
- SPR-889   PV Catheter (3F, 10E, 3 mm, SField, U-tip, 80 cm)
- SPR-894   PV Catheter (3F, 10E, 4 mm, DField, U-tip, 80 cm)

Millar Ventri-Cath™ Pressure-Volume Catheters

The Ventri-Cath™ multi segment pressure-volume catheter offers economical real-time pressure, volume and internal ECG measurements for large animal models. These catheters connect to any 880–0168 Millar MPVS Ultra (large and small animals) via the CEC-10PV PV Extension Cable (VC to MPVS Ultra, 10 ft).

Mikro-Tip Ventri-Cath™ P-V Catheters — Dog/Pig/Sheep

- VENTRI-CATH-507 PVCatheter (5F, 12E, 7 mm, DField, Pigtail, 122 cm)
- VENTRI-CATH-507S PVCatheter (5F, 12E, 7 mm, DField, Straight, 122 cm)
- VENTRI-CATH-510 PVCatheter (5F, 12E, 10 mm, DField, Pigtail, 122 cm)
- VENTRI-CATH-510S PVCatheter (5F, 12E, 10 mm, DField, Straight, 122 cm)
- VENTRI-CATH-512 PVCatheter (5F, 12E, 12 mm, DField, Pigtail, 122 cm)
- VENTRI-CATH-512S PVCatheter (5F, 12E, 12 mm, DField, Straight, 122 cm)
- VENTRI-CATH-515 PVCatheter (5F, 12E, 15 mm, DField, Pigtail, 122 cm)
- VENTRI-CATH-515S Catheter (5F, 12E, 15 mm, DField, Straight, 122 cm)
- SPR-562–1 PV Catheter (6F, 2P, 12E, 7 mm, DField, Pigtail, PU, 125 cm)*

1F = 0.33 mm
E = Electrode number
P = Pressure transducer number
* = Non-repairable
Note: Catheter interface cables are required for connection to ADInstruments Bridge Amplifiers.
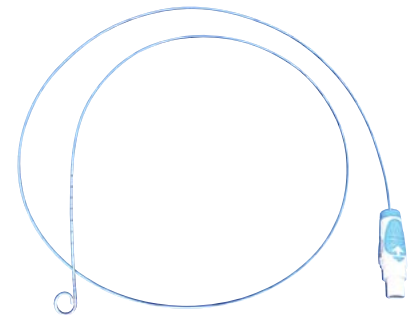
Catheter Interface Cables

A variety of catheter interface cables are available for connecting Millar catheters to any ADInstruments Bridge Amp, TC-510 Pressure Control Unit or PCU-2000 Pressure Signal Conditioner. Catheter interface cables are also available for connection to the MPVS Ultra Pressure-Volume Unit.

- **For ADInstruments Bridge Amps**
  - AEC-10C Catheter Interface Cable (Viking to DIN 8, 10 ft)
  - AEC-10D Catheter Interface Cable (Low Profile to DIN 8, 10 ft)
- **For TC-510 Pressure Control Unit**
  - TEC-10C Catheter Interface Cable (Viking to TC-510, 10 ft)
  - TEC-10D Catheter Interface Cable (Low Profile to TC-510, 10 ft)
- **For PCU-2000 Pressure Signal Conditioner**
  - PEC-10C Catheter Interface Cable (Viking to PCU-2000, 10 ft)
  - PEC-10D Catheter Interface Cable (Low Profile to PCU-2000, 10 ft)
- **For MPVS Ultra Pressure-Volume Unit**
  - 880–0169 MPVS Ultra Cable Pack (10 ft)
  - CEC-10PV PV Extension Cable (VC to MPVS Ultra, 10 ft)

hardware

MLT844 Physiological Pressure Transducer

A highly accurate piezo-resistive transducer (-20 to 300 mmHg with accuracy of ±0.5%) for recording arterial and venous blood pressure, as well as intracranial, gastric and intrauterine pressures, and urodynamic parameters (by catheterization). Designed for animal use only, maximum excitation of 15 V DC or AC can be applied to the transducer. A transducer holder, three disposable clip-on domes and 4-pin to DIN connector cable are supplied with the transducer, which is suitable for use with the FE221 Bridge Amp, FE224 Quad Bridge Amps or FE228 Octal Bridge Amp. To mount the MLT844, the MLA845 Transducer Bracket (featuring a retort stand) can be purchased separately.

MLA844 Disposable Clip-On BP Domes

Set of ten disposable clip-on domes for use with the MLT844 Physiological Pressure Transducer can be purchased as spare parts.

MLT0670 Disposable BP Transducer (stopcock)

The MLT0670 Disposable BP Transducer is a lightweight transducer for consistent and accurate readings of arterial and venous blood pressure in humans and animals. With an operating range of –50 to +300 mmHg (with an accuracy of ±2% in the range of –50 to +200 mmHg), it requires 2 to 10 V DC or 5 V_{rms} AC excitation. ADInstruments does not guarantee the sterility of the transducer, therefore it MUST be gas sterilized prior to use with human subjects. It is used with the FE117 BP Amp and the MLAC05 BP Amp to Deltran II Cable.

MLA1052 Pressure Gauge

The MLA1052 Pressure Gauge and accessories are suitable for the calibration of conventional fluid-filled or Millar Mikro-Tip pressure transducers. It is supplied with three 20 mL syringes, three Touhy Borst adaptors, three 4-way stopcocks, sphygmomanometer and silicon tubing (1 m and 2 × 0.5 m).

MLT0380/D Reusable BP Transducer

The MLT0380/D is for direct measurement of arterial and venous blood pressure in large animals. For animal use only, a maximum excitation of 6 V DC can be applied to the transducer. It can be cold sterilized and is suitable for use with the FE221 Bridge Amp, FE224 Quad Bridge Amps and FE228 Octal Bridge Amp. An 8-pin DIN connector is supplied standard.

MLT0699 Disposable BP Transducer (no stopcock)

The MLT0699 Disposable BP Transducer is a low-cost, lightweight blood pressure transducer that provides consistent and accurate readings of arterial and venous blood pressure in animals of all sizes. For animal use only, it has an operating range of –50 to +300 mmHg and requires 2 to 10 V DC or 5 V_{rms} AC excitation. The MLT0699 Blood Pressure Transducer connects to a Bridge Amp with the MLAC06 Adapter Cable.

MLT1199 Disposable BP Transducer/Cable Kit

For animal use only, the MLT1199 combines the MLT0699 Disposable Blood Pressure Transducer and MLAC06 Adapter Cable for direct measurement of

blood pressure (–50 to +300 mmHg). The transducer is suitable for connection to the FE221 Bridge Amp, FE224 Quad Bridge Amp or FE228 Octal Bridge Amp.

MLAC06 DIN (8) to MLT0699 or MLT0670 Cable

The MLAC06 adapter cable is used with the MLT0699 or MLT0670 Disposable BP Transducers for connection to the FE221 Bridge Amp, FE224 Quad Bridge Amp or FE228 Octal Bridge Amp.

910–1060 Rho Calibration Cuvette Kit

The Rho Calibration Cuvette kit is used for calibrating Pressure-Volume catheters and the Millar MPVS Ultra unit. Supplied with the PL3516B46 MPVS Ultra Foundation System, it can also be used for measuring cardiac output.

910–1048 Volume Calibration Cuvette (Rat P-V Catheters)

The 910–1048 Volume Calibration Cuvette features 2 to 15 mm wells for the calibration of rat single segment Pressure-Volume Catheters and the Millar MPVS Ultra unit. The cuvette is supplied with the PL3508B47/R MPVS Ultra Single Segment Foundation System for Rats.

910–1049 Volume Calibration Cuvette (Mouse P-V Catheters)

Supplied with the PL3508B47/M MPVS Ultra Single Segment Foundation System for Mice, the 910–1049 Volume Calibration Cuvette features 1.5 to 4.0 mm wells for the calibration of mouse single segment Pressure-Volume Catheters and the Millar MPVS Ultra unit.

Langendorff

MLA2001 Langendorff Transducer Accessory Kit

For use with ADInstruments Langendorff System, the MLA2001 Langendorff Transducer Accessory Kit contains four Male Luer plugs, four 4-way Luer stopcocks, two 300 mm Extension Tubings, two Male Luer connectors and an SP2881 Transducer Bracket.

170403 Latex Balloons (size 3 for rats, 10 pk)

The 170403 Latex Balloons are used in the measurement of isovolumetric pressures in isolated hearts of rats weighing between 100 to 200 g. Balloons are 3 × 7 mm with an approximate volume of 0.03 mL and supplied in a pack of 10. For use with the 174023 Flexible Balloon Catheter connected to the MLT844 Physiological Pressure Transducer and Bridge Amp.

170423 Flexible Balloon Catheter (for sizes 3 & 4)

The 170423 Flexible Balloon Catheter is a single flexible Teflon catheter used in the measurement of left ventricular pressure in the isolated rat heart preparation. For use with the 170403 Latex Balloons.

hardware

Neurophysiology

IC-2S and IC-4M Input Cable Sets

The IC-2S provides two BNC input cables for use with the DP-301 and DP-304 amplifiers. The IC-2S cables do not terminate at the outboard end, while the optional IC-4M cables terminate with a 2 mm pin and alligator clip.

Electrode Holder E Series

The Electrode Holder E Series is suitable for applications including extracellular, intracellular and two electrode voltage clamp recordings. The holders are made from vapor polished annealed acrylic and are available with different glass capillary diameters.

- **Differential Amplifier Electrode Holders (For use with DP-311 Differential Amplifier)**
  - ESW-F10N E Series Electrode Holder (Str, Ag Wire, 1.0 mm)
  - ESW-F12N E Series Electrode Holder (Str, Ag Wire, 1.2 mm)
  - ESW-F15N E Series Electrode Holder (Str, Ag Wire, 1.5 mm)
  - ESW-F20N E Series Electrode Holder (Str, Ag Wire, 2.0 mm)

- **Intracellular Electrometer Amplifier Electrode Holders (for use with the IE-210 and IE-251A Intracellular Electrometers)**
  - ESP-F10N E Series Electrode Holder (Str, Ag-AgCl Pellet, 1.0 mm)
  - ESP-F12N E Series Electrode Holder (Str, Ag-AgCl Pellet, 1.2 mm)
  - ESP-F15N E Series Electrode Holder (Str, Ag-AgCl Pellet, 1.5 mm)
  - ESP-F20N E Series Electrode Holder (Str, Ag-AgCl Pellet, 2.0 mm)
  - ESP/W-F10N E Series Electrode Holder (Str, Ag-AgCl Pellet & Wire, 1.0 mm)
  - ESP/W-F12N E Series Electrode Holder (Str, Ag-AgCl Pellet & Wire, 1.2 mm)
  - ESP/W-F15N E Series Electrode Holder (Str, Ag-AgCl Pellet & Wire, 1.5 mm)
  - ESP/W-F20N E Series Electrode Holder (Str, Ag-AgCl Pellet & Wire, 2.0 mm)

- **Two Electrode Voltage Clamp Amplifier Electrode Holders (for use with the OC-725C Oocyte Clamp Amplifier and voltage headstage)**
  - ESW-F10V E Series Electrode Holder (Str, Vent, Ag Wire, 1.0 mm)
  - ESW-F12V E Series Electrode Holder (Str, Vent, Ag Wire, 1.2 mm)
  - ESW-F15V E Series Electrode Holder (Str, Vent, Ag Wire, 1.5 mm)
  - ESW-F20V E Series Electrode Holder (Str, Vent, Ag Wire, 2.0 mm)

- **For use with current electrodes**
  - E45W-F10VH E Series Electrode Holder (45°, Vent, Handle, Ag Wire, 1.0 mm)
  - E45W-F12VH E Series Electrode Holder (45°, Vent, Handle, Ag Wire, 1.2 mm)
  - E45W-F15VH E Series Electrode Holder (45°, Vent, Handle, Ag Wire, 1.5 mm)
  - E45W-F20VH E Series Electrode Holder (45°, Vent, Handle, Ag Wire, 2.0 mm)

Electrode Holder Q Series

The Electrode Holder Q Series is designed for patch clamp amplifiers. Vents in the holder prevent cell damage due to pressure build-up inside the electrode. Holders are made from polycarbonate that reduces noise level during recording. The connector pins are gold-plated with Teflon or polycarbonate insulators.

- QSW-A10P Q Series Electrode Holder (Str, Port, Ag Wire, 1.0 mm)
- QSW-A12P Q Series Electrode Holder (Str, Port, Ag Wire, 1.2 mm)
- QSW-A15P Q Series Electrode Holder (Str, Port, Ag Wire, 1.5 mm)
- QSW-A17P Q Series Electrode Holder (Str, Port, Ag Wire, 1.7 mm)
- QSW-A20P Q Series Electrode Holder (Str, Port, Ag Wire, 2.0 mm)
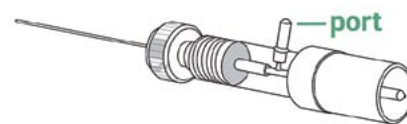
PJ2–5 2 mm Jack, Uninsulated (pack of 5)

The PJ2–5 is a pack of 5 uninsulated Jacks for use with the Electrode Holder E Series and DP-311 Differential Amplifier.

2100W Headstage for IE-210-V

The 2100W Headstage for Intracellular Electrometer features high impedance and capacitance compensation for use in intracellular recording. The 2100 W Headstage is for use with the IE-210 Intracellular Electrometer.

3110W Headstage for DP-311

The 3110W Headstage for DP-311 features high impedance and capacitance compensation for extracellular studies. The 3110W Headstage is for use with the DP-311 Differential Amplifier.

BB-15 Breakaway Box for IE-210-V

The BB-15 connects to the IE-210 Intracellular Electrometer allowing large voltages to be applied to the electrode for iontophoretic injection of dyes or drugs. Voltages up to ±200 V may be applied without damage to the probe input.

RB-1 Remote Buzz control for IE-210-V

The RB-1 Remote Buzz control provides convenient remote operation of the Buzz voltage with variable frequency and amplitude to facilitate cell impalement. It is for use with the IE-210 Intracellular Electrometer and supplied with a 3 m length cable.

725MC Oocyte Model Cell for OC-725C-V

The 725MC Oocyte Model Cell is for use with the OC-725C Oocyte Clamp Amplifier. The model cell can be used for calibration purposes or to test the accuracy of the amplifier. It connects the voltage/current probes to the bath clamp allowing all aspects of the amplifier's function to be tested.

7251I Bath Clamp Headstage for OC-725C-V

The 7251I Bath Clamp Headstage clamps the bath potential at zero and creates a virtual ground potential to provide accurate bath current measurement. The large current measuring range allows smaller currents to be amplified and larger currents to be recorded without output saturation and the headstage eliminates series resistance compensation.

hardware

RC-3Z Oocyte Recording Chamber for OC-725C-V

The RC-3Z chamber is suitable for the study of oocytes and other large cell structures when using the OC-725C Oocyte Clamp Amplifier. The chamber consists of a narrow bath allowing rapid solution exchange and a wider bath for easy electrode access. It is included in the TEV700 Complete Oocyte Clamp Workstation and PL3508B76 Oocyte Clamp Workstation System.

7250V Voltage Headstage for OC-725C-V

The 7250V Voltage Headstage is supplied with the OC-725C and features a small size, single-ended and high-impedance probe. It is supplied with a convenient mounting rod and a 2 m cable for easy attachment to the micropositioner.

7255DI Differential Headstage for OC-725C-V

The 7255DI Differential Headstage is designed for dual oocyte studies where two oocytes are clamped in a common bath. It is longer than the 7250V probe with two additional inputs. The differential headstage subtracts the voltage drop across the series resistance in the bath.

7259C Current Electrode Cable for OC-725C-V

The 7259C Current Electrode Cable is a 2 m shielded cable that connects to an electrode holder with a 2 mm pin jack (supplied) and the OC-725C-V Oocyte Clamp Amplifier with a 3-pin connector (also supplied).

WA10–5 1 mm Pin with Bare Silver Wire (100 mm L, 0.25 mm D, 2 pk)

The WA10-5 consists of two 1 mm pins attached to a bare silver wire (100 mm long and 0.25 mm diameter). It is supplied with the OC-725C Oocyte Clamp Amplifier.

WA30–5 26 1 mm Pin with Insulated Wire (300 mm L, 26 Gauge, 3 pk)

The WA30-5 consists of three 1 mm pins attached to a 26 gauge, 30 cm long insulated wire. It is for use with the OC-725C Oocyte Clamp Amplifier for grounding, shielding, and other electrical connections.

5101 Headstages for PC-501A

The 5101 Headstage features a high-impedance solid-state current to voltage converter for use with PC-501A Patch Clamp Amplifier. Different headstages are available for each amplifier, including:

- 5101-10G Headstage for PC-501A/10-V (10 GΩ)
- 5101-01G Headstage for PC-501A/9-V (1 GΩ)
- 5101-100M Headstage for PC-501A/8-V (100 MΩ)

Model Cells for PC-501A

For convenient and accurate cell simulations (system testing purposes) three varieties of model cell are available for use with the PC-501A Patch Clamp Amplifier:

- MC-10G 10 GΩ Model Cell for PC-501A/10-V
- MC-01G 1 GΩ Model Cell for PC-501A/9-V
- MC-100M 100 MΩ Model Cell for PC-501A/8-V

U9406 Tubing Kit (Hose & Luer Fittings) for Ussing Chambers

For use with single or dual Ussing Chambers.

U9565SC Electrode Bridge Fitting Kit (12 Fittings & 6 Adapters)

For use with single or dual Ussing Chambers.

U9605 O-rings for Ussing Chambers (4 pk)

A four pack of O-rings for use with the single and dual Ussing Chambers.

U9924 Tissue Insert and Culture Cups for Ussing Chambers

For use with single or dual Ussing Chambers, the U9924 tissue insert adapters and culture cups available are:

- U9924A-04 Round Tissue Insert (3.8 mm) with O-ring
- U9924B-04 Round Tissue Insert (3.8 mm) with 5 Pins
- U9924C-03 Slotted Tissue Insert (1.6 × 7 mm) with 6 Pins
- U9924F-09 Falcon Culture Cup Insert (9.0 mm)
- U9924M-12 Millicell Culture Cup Insert (12 mm)
- U9924S Snapwell Culture Cup Insert (12 mm)
- U9924T-06 Transwell Culture Cup Insert (6.5 mm)

U9975A Ussing Electrode Set (2 Ag-AgCl Pellets and 2 Ag Wires)

This set comprises four electrodes, two Ag-AgCl pellet electrodes (for voltage), two Ag wire electrodes (for current), a 1 m wire and an amplifier to headstage connector cable.

U9985 Bridge Fitting Adapters for Ussing Chambers (6 pk)

The U9985 Bridge Fitting Adapters for Ussing Chambers (6 pk) are for use with single or dual Ussing Chambers.

hardware

Noninvasive Blood Pressure

MLT1100 Sphygmomanometer

The MLT1100 is for measuring systolic blood pressure in human subjects. The unit is coupled to a pressure transducer and is supplied with both an adult and child-sized cuff. The transducer gives stable readings in the range of –50 to +300 mmHg and requires 2 to 10 V DC or 5 V_{rms} AC excitation. The MLT1100/A Sphygmomanometer is supplied with an audio connector for connection to the ML301 Bridge Pod and the MLT1100/D Sphygmomanometer is supplied with an 8-pin DIN connector for use with any ADInstruments Bridge Amp.

MLT125M and MLT125R Pulse Transducer/ Pressure Cuff for NIBP

The MLT125M (mouse) and MLT125R (rat) Pulse Transducer/Pressure Cuffs are used with the IN125 NIBP System. They are specialized pressure cuffs and pulse transducers for intermittent measurement of blood pressure based on periodic occlusion of tail blood flow in mice and rats. For animal use only.

Rodent Restrainers

The rodent restrainers are constructed with Perspex and come in six sizes. The space inside the chamber can be adjusted by the slide piston. Slots and holes are provided for ventilation and drug administration. The rodent restrainers can be used with the rodent MLA5030 Rodent Tail Cuff Holder base to secure the rat or mouse tail transducer and cuff.

- MLA5016 Rodent Restrainer for Mice (up to 35 g)
- MLA5018 Rodent Restrainer for Mice (up to 50 g)
- MLA5020 Rodent Restrainer for Rats (80 to 200 g)
- MLA5022 Rodent Restrainer for Rats (180 to 320 g)
- MLA5024 Rodent Restrainer for Rats (300 to 440 g)
- MLA5025 Rodent Restrainer for Rats (440 to 550 g)

MLA5030 Rodent Tail Cuff Holder

The MLA5030 Rodent Tail Cuff Holder secures the MLT125 Pulse Transducer/ Pressure Cuff for NIBP when attached to a mouse or rat tail. The holder can also be used with all ADInstruments rodent restrainers.

SPT-301 Non-Invasive Pulse Tonometer

For noninvasive recording of pulse pressure wave contour, the SPT-301 Non-Invasive Pulse Tonometer is equipped with a Mikro-Tip pressure sensor. The hand-held wand probe is constructed of stainless steel with a diameter of 6.35 mm (0.25"), length of 152.4 mm (6") and a cable length of 150 cm (79"). It requires an AEC-10C Catheter Interface Cable for connection to an ADInstruments Bridge Amps. For human and animal use.

FMS Finger Cuffs

The FMS finger-cuffs are used with the MLE1054-V Finometer MIDI. Finger Cuffs are available in 3 sizes: MLE1057 FMS Finger Cuffs (small), MLE1058 FMS Finger Cuffs (medium) and MLE1059 FMS Finger Cuffs (large).

MLE1060 FMS Height Correction Unit

MLE1060 is used to correct hydrostatic blood pressure changes caused by movement of the hand away from heart level. It is a liquid filled tube with sensors at both ends to measure their relative vertical distance. The FMS Height Correction Unit is used with the MLE1054-V Finometer MIDI.

MLE1061 FMS RS 232 Cable

The MLE1061 connects the MLE1054-V Finometer MIDI to a PC RS232 (COM) port. It allows online recording and remote control of the device using BeatScope Easy software.

MLE1062 FMS ECG module

The MLE1062 has three leads that acquire an analog ECG signal for simultaneous recording and storage with a blood pressure waveform originating from the MLE1054-V Finometer MIDI.

MLE1063 FMS Analog I/O box

The MLE1063 FMS Analog I/O box allows up to four analog signals from the MLE1054-V Finometer MIDI to be recorded using a PowerLab. Signals include finger pressure, reconstructed brachial artery pressure and ECG (available only when used with MLE1062 FMS ECG Module).

Pulse and Plethysmography

MLT1010 Piezo Electric Pulse Transducer

This small, durable piezo-electric device records changes in peripheral pulse pressure by converting force from the finger blood pressure pulse into an electrical signal. Applications include measurement of pulse rate or small animal respiratory activity. The unit does not require excitation and can be connected directly to a PowerLab BNC input (MLE1010) or 8-pin DIN Input (MLT1010/D).

Infrared Plethysmographs

Infrared (IR) photoelectric sensors are used to record pulsatile blood flow changes in the finger or ear. The IR plethysmographs require 6 V to 9 V DC excitation and connect directly to a PowerLab Pod port, ADInstruments Bridge Amp or ML142 GP Amp. IR plethysmographs include:

- MLT1020EC IR Plethysmograph – Ear Clip
- MLT1020FC IR Plethysmograph – Finger Clip
- MLT1020PPG IR Plethysmograph – Velcro Strap

hardware

Respiration

MLT3813H-V* Heated Pneumotach 800 L and Heater Controller

The MLT3813H-V* features a Hans Rudolph 800 L/min flowhead with heat controller. It is used in experiments involving continuously exercising humans to minimize the distortion effects of condensation on the flow head. Recommended for use with the FE141 Spirometer. It requires MLA1011A Clean Bore Tubing & Flow Head Adapter.

* Specify mains power: V = 115 for 110–115 V or V = 220 for 220–240 V

Respiratory Flow Heads

Used for measurements such as pulmonary function, respiration, airflow and exercise tests, the following flow heads can be used with the FE141 Spirometer or ML311 Spirometer Pod (which has a differential pressure transducer to measure airflow):

- MLT1L   ±1 L for mice and rats
- MLT10L   ±10 L for rabbits
- MLT300L   ±300 L for humans (at rest)
- MLT1000L   ±1000 L for humans (during exercise or lung function tests)

Calibration Syringes

The Hans Rudolph calibration syringes provide an easy and reliable method of calibrating respiratory measurement equipment. Volumes ranging from 100 mL to 3 L are stocked. Larger volumes up to 7 L are available on request.

- MLA5510A Calibration Syringe (0.1 L, Small Outlet)
- MLA5510B Calibration Syringe (0.1 L, Large Outlet)
- MLA5550 Calibration Syringe (0.5 L)
- MLA5540 Calibration Syringe (1 L)
- MLA5530 Calibration Syringe (3 L)

MLA246 Gas Mixing Chamber

The MLA246 Gas Mixing Chamber has a capacity of 4.7 L to collect, mix and sample expired respiratory gases. It is suitable for use with the ML206 Gas Analyzer and is included in the PL3508B80 Exercise Physiology System. Three 2 mm (0.08") male luer lock connectors allow sampling lines to be connected to the unit and 35 mm (1.4") inlet and exhaust ports are provided.

MLA140 Spirometer Kit

A number of disposable items for use in a respiratory laboratory. The Spirometer Kit contains: MLA1026 Reusable Mouthpieces (10), MLA1008 Nose Clips (50), MLA304 Disposable Filters (50), MLA1011A Clean Bore Tubing (25 cm × 35 mm ID), Flow Head Adapter (connects to the MLT300L), MLT1000L Respiratory Flow Heads and MLT3813H-V (individual components may be purchased separately).

MLA1028 Face Mask (adult medium)

The MLA1028 Face Mask with head strap features a two-way non-rebreathing valve to separate inspired and expired gases. The MLA1028 is ideal for use in exercise testing and respiratory research.

MLA1029 Face Mask Kit (adult small and medium)

The MLA1028 Face Mask Kit features a head strap, Y-shaped two-way non-rebreathing valve (to separate inspired and expired air) and an interchangeable Adult Face Mask (medium or small). The MLA1029 is ideal for use in exercise testing and respiratory research.

MLA0343 Drying Tube

The Drying Tube is a 30 cm length of 1.3 diameter Nafion tubing. It is used for drying gas streams (to atmospheric conditions) in respiratory experiments. It is suitable for use with the ML206 Gas Analyzer and the MLA6024 Desiccant Cartridge if used in a humid environment.

MLA0110 In-line Filters

The MLA0110 is a pack of 10 filters that feature hydrophobic membranes (0.45 µm pore-size, disc size of 17 mm). Male/female luer connectors connect to the MLA0343 Drying Tube and sampling port of the ML206 Gas Analyzer to protect the transducers from moisture and damaging particulates. It is supplied with the ML206 Gas Analyzer.

MLA304 Disposable Filters

The MLA304 is a pack of 50 disposable droplet filters that remove water droplets from the airstream and prevent cross-contamination without impairing airflow. They can be used with the MLA1026 Reusable Mouthpieces and MLA1011A Clean Bore Tubing & Flow Head Adapter.

MLA1008 Nose Clips

The MLA1008 is a pack of 50 disposable nose clips that prevents nasal breathing during respiratory measurements.

MLA1015 Breathing Tube

The MLA1015 is a smooth bore tubing with the dimensions of 183 cm (6') length of 35 mm (1.4") internal diameter. It features integral fittings for connection to the MLA246 Gas Mixing Chamber and MLA1028 Face Mask.

MLA1013 Tubing Adapter (35 mm ID)

The MLA1013 Tubing Adaptor (5 cm long, internal diameter 35 mm) connects the MLT1000L to the MLA246 Gas Mixing Chamber outlet port. The Tubing Adapter is included with the PTK20 Exercise Breathing Kit.

hardware

MLA1011A Clean-bore Tubing & Tubing Adapter

The MLA1011A tube (25 cm long, inner diameter 35 mm) connects the MLA304 Disposable Filters to the MLT300L, MLT1000 and MLT3813H-V. The MLA1011A is included with the PTK20 Exercise Breathing Kit.

MLA1081 Flow Head Adapter

The MLA1081 Flow Head Adapter connects the MLA1011 Clean Bore Tubing to MLT300L, MLT1000L and MLT3813H-V. It is included in the PTK20 Exercise Breathing Kit.

MLA1026 Reusable Mouthpieces (10 pk)

A pack of 10 vinyl mouthpieces that can be cold sterilized for reuse. They are used with MLA304 Disposable Filters and are ideal for use in the respiratory classroom.

MLA6024 Desiccant Cartridge

The MLA6024 Desiccant Cartridge is reusable and contains Nafion tubing and desiccant material (to remove moisture from a gas stream). The desiccant material indicates expiration by changing from blue to pink in color and can be replaced with MLA6026 Desiccant Refill (available separately). The cartridge is ideal for use in exercise/sports physiology studies.

MLT1132 Piezo Respiratory Belt Transducer

The MLT1132 is a respiratory belt transducer based on a piezo-electric device that requires no excitation. Connecting directly to a PowerLab BNC input, the transducer produces a voltage when there is a change in thoracic or abdominal circumference due to respiration proportional to changes in length. It is suitable for large animal or human use.

MLA240 Exercise Physiology Accessory Kit

Included with the PL3508B80 Exercise Physiology System, this kit contains a MLT1000L Respiratory Flow Head 1000 L, MLA1029 Face Mask Kit, MLA1081 Flow Head Adapter, MLA1013 Tubing Adapter (35 mm ID), MLA6024 Desiccant Cartridge, MLA1015 Breathing Tube, MLA0343 Drying Tubing, MLT415/M Thermistor Temperature Sensor and two 1 mm Silicon Tubes (1 mm ID, 30 cm length) with Luers.

Telemetry

Telemeters measure, process and transmit high-fidelity pressure, sympathetic nerve activity (SNA), biopotential (i.e., ECG, EMG, EEG) and tissue oxygenation via telemetry from within the animal. The telemeters recharge wirelessly *in vivo* and can operate for approximately 4 hours between recharging. The telemeters are made of biocompatible silicone and weigh approximately 12 gm. The telemeter is programmed via the MLE0190 Telemetry Configurator (TR190) with one of 16 independent transmission frequencies. They have a transmission range of up to 5 m.

Pressure Telemeter

■ **MLE0054P TR/Millar Pressure Telemeter (TRM54P)**

The MLE0054P Pressure Telemeter (TRM54P) measures intravascular/ intralumenal pressure (−20 to 300 ±2 mmHg) and temperature in small animals weighing ≥ 200 g.

Dual Pressure Telemeter

■ **MLE0054PP TR/Millar Dual Pressure Telemeter (TRM54PP)**

The MLE0054PP Dual Pressure Telemeter (TRM54PP) measures two intravascular or intralumenal pressures (−20 to 300 ±2 mmHg) and temperature in small animals weighing ≥ 200 g.

Pressure and Biopotential Telemeter

■ **MLE0054PB TR/Millar Pressure Biopotential Telemeter (TRM54PB)**

The MLE0054PB Pressure Biopotential Telemeter (TRM54PB) measures two intravascular or intralumenal pressures (−20 to 300 ± 2 mmHg), biopotentials (such as ECG, EEG, EOG or EMG) and temperature in small animals ≥ 200 g.

Biopotential Telemeter

■ **MLE0050B Biopotential Telemeter (TRM50B)**

The MLE0050B Biopotential Telemeter (TRM50B) measures biopotentials (such as ECG, EEG, EOG or EMG) and temperature in small animals weighing ≥ 200 g.

Dual Biopotential Telemeter

■ **MLE0050BB Dual Biopotential Telemeter (TRM50BB)**

The MLE0050BB Dual Biopotential Telemeter (TRM50BB) measures biopotentials (such as ECG, EEG, EOG or EMG) and temperature in small animals weighing ≥ 200 g.

Tissue Oxygen Telemeter

■ **MLE0057Y Tissue Oxygen Telemeter (TR57Y)**

The MLE0057Y Tissue Oxygen Telemeter (TR57Y) is an implantable potentiostat for measuring tissue oxygen concentration. The unit is approximately 12 g in weight and is suitable for small animals weighing ≥ 200 g.

SNA and Pressure Transmitter

■ **MLE0056SP TR/Millar SNA Pressure Telemeter (TRM56SP)**

The MLE0056SP TR/Millar SNA Pressure Telemeter (TRM56SP) measures Sympathetic Nerve Activity, intravascular or intralumenal pressure (−20 to 300 ± 2 mmHg) and temperature in small animals weighing ≥200 g.

hardware

Wireless Neural Recordings

Headstages

5 or 15 Channel Wireless Neural Headstages record signals (Local Field Potentials or LFPs, EEGs, single unit or spike data) from an animal and transmits them to the Wireless Neural Receiver on the corresponding frequency. Attached to the headstage is an Omnetics female connector to facilitate connection to the microelectrodes. ADInstruments does NOT provide any microelectrodes or the mounting accessories.

The wireless headstages are supplied standard as Dipped. Covered options are available but must be specified at the time of purchase.

Headstage models include:
- **TB5653/F – 5 Channel Wireless Neural Headstage**
- **TB5656/F – 15 Channel Wireless Neural Headstage**
- **TB5662/COL – TBSI Headstage LED Option**
- **B5658/F – 15 Channel Wireless Neural Headstage w/24 Hr Battery**
- **TB5654/F – 5 Channel Wireless Neural Headstage w/5 Hr Battery**
- **TB5655/F – 5 Channel Wireless Neural Headstage w/24 Hr Battery**

TBSI to PowerLab Interface Cables

Connects the Wireless Neural Receiver and a PowerLab data acquisition system and is available for either 5 (MLAC55) or 15 (MLAC56) channels. It consists of an analog output mating connector (DB37) at one end and either 5 or 15 BNC connectors at the other end. Multiple received signals (Local Field Potentials or LFPs, single unit or spike data) processed by the receiver can be transferred directly and recorded by the PowerLab data acquisition system.

TBSI Headstage Test Cables

The MLAC52 TBSI 15 Channel Headstage Test Cable or MLAC51 TBSI 5 Channel Headstage Test Cable provides the ability to test the transmission of either 15 or 5 Channel Wireless Neural Headstages with the corresponding Wireless Neural Receiver. A PowerLab data acquisition unit and LabChart software are required to generate the appropriate test waveforms.

Temperature

MLT1400 General-purpose Thermocouple Probe

A T-type temperature probe suitable for use in liquids, gases and semi-solids to a maximum of 400° C. The MLT1400 is supplied with a 2-pin T-type connector for use with the ML312 T-type Pod or ML290-V Thermometer for T-type Thermocouples.

MLT1401 T-type Implantable Thermocouple Probe

A flexible T-type microprobe for temperature measurements in liquids and semi-solids, as well as tissue (needle supplied). It is suitable for temperature measurements up to 150° C. The MLT1401 is used in the ADInstruments Langendorff System and is MRI compatible. The MLT1401 is supplied with a 2-pin T-type connector for use with the ML312 T-type Pod or ML290-V Thermometer for T-type Thermocouples.
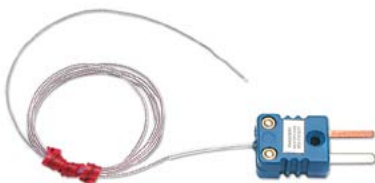
MLT1402 T-type Ultra Fast Thermocouple Probe

A tissue implantable T-type microprobe with an ultra fast response time of 5 ms for temperatures up to 150° C. The diameter tip of the thermocouple is 0.76 mm and is inserted into the tissue with a supplied 23 gauge hypodermic needle. The MLT1402 is supplied with a 2-pin T-type connector for use with the ML312 T-type Pod, ML290-V Thermometer for T-type Thermocouples or ML313B Cardiac Output Pod.

MLT1405 T-type Implantable Thermocouple Probe

The MLT1405 is a flexible T-type microprobe for temperature measurements in liquids and semi-solids. It can be inserted into tissue with the supplied needle and is also suitable for measuring rectal temperature in small animals. It has a time constant of 0.08 seconds with a temperature measurement threshold of 150° C. The MLT1405 is supplied with a 2-pin T-type connector for use with the ML312 T-type Pod, ML313B Cardiac Output Pod or ML290-V Thermometer (for T-type Thermocouples).

MLT1406 Needle Microprobe Thermocouple

The MLT1406 is a fast-response needle thermocouple probe for temperature measurements in tissues, semi-solids and liquids. It is suitable for very small specimens and can measure temperature up to 200° C with a 1.5 m lead probe and a 1 cm long 29 gauge needle. The MLT1406 is supplied with a 2-pin T-type connector for use with the ML312 T-type Pod or ML290-V Thermometer for T-type Thermocouples.

MLT1403 Rectal Probe for Rats

The MLT1403 is suitable for measuring small animal (such as rat and guinea pig) rectal temperature and is functional in the range of −273° C to 125° C. The probe consists of a 25.4 mm stainless steel shaft with a smooth ball tip (3.2 mm diameter). The MLT1403 is supplied with the ML295/R Homeothermic Controller and Plate (for rats) and a 2-pin T-type connector for use with the ML312 T-type Pod or ML290-V Thermometer for T-type Thermocouples.

MLT1404 Rectal Probe for Mice

Suitable for measuring rectal temperature in small animals such as mice, hamsters or rat pups, this probe consists of a 19 mm stainless steel shaft with a smooth ball tip (1.7 mm diameter). The MLT1404 is supplied with the ML295/M Homeothermic Controller and Plate (for mice) and a 2-pin T-type connector for use with the ML312 T-type Pod or ML290-V Thermometer for T-type Thermocouples.

MLT1407 Large Animal Rectal Probe

A flexible, vinyl covered and soft tipped isolated rectal probe which measures temperature up to 90° C with a time constant of 5.0 seconds and a 1.5 m lead. It is suitable for use with rabbits and larger animals. The MLT1407 is supplied with a 2-pin T-type connector for use with the ML312 T-type Pod or ML290-V Thermometer for T-type Thermocouples.

MLT422 Skin Temperature Probe (2 m)

The Skin Temperature Probe operates between 0°C and 50°C for continuous skin temperature monitoring as an indicator of body temperature. It is suitable in applications such as biomedical temperature monitoring requiring high sensitivity and rapid response. It is supplied with an audio connector (MLT422/A) for use with the ML309 Thermistor Pod or an 8-pin DIN connector (MLT422/D) for use with any ADInstruments Bridge Amp or ML142 GP Amp.

MLT415 Nasal Temperature Probe

The Nasal Temperature Probe is ideal for measuring nasal air temperature as an indicator of respiration. Supplied with the standard lead length (9 m), the MLT415 operates between 0°C and 50°C and can be cold sterilized between subjects. It is supplied with an audio connector (MLT415/A) for use with the ML309 Thermistor Pod or an 8-pin DIN connector (MLT415/D) for use with any ADInstruments Bridge Amp or ML142 GP Amp. For a unit with a lead length of 10 m, please order either MLT415/AL (for connection to ML309) or MLT415/DL (for connection to an ADInstruments Bridge Amp or ML142).
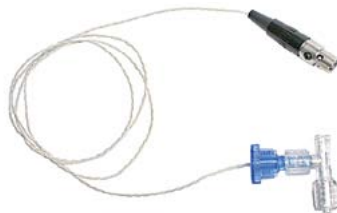
MLT415/M Thermistor Temperature Sensor

Ideal for measuring air temperature from a gas mixing chamber by providing a relative large change in resistance as a function of temperature (~4%/°C). It operates between 0°C and 50°C and is suitable for connection to the ML309 Thermistor Pod. Included as part of the MLA240 Metabolic Accessory Kit, the MLT415/M can be attached to the MLA246 Gas Mixing Chamber and ML206 Gas Analyzer for CO_2 and O_2 analysis in metabolic studies.

MLT1101 Thermocouple/Analog Converter

The MLT1101 Thermocouple/Analog Converter converts a thermocouple input signal to an amplified analog output for use with Digital Multimeters, recorders and dataloggers. It is supplied with the MLAC09 BNC to 4 mm Banana Plug Adapter for connection to PowerLab BNC input.
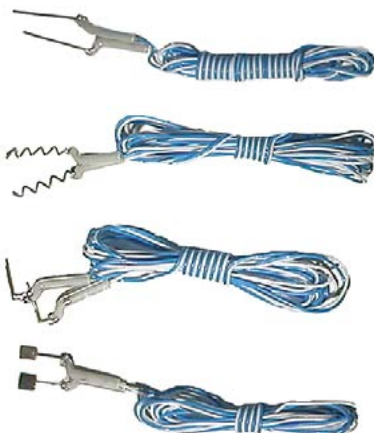
Tissue-Organ Bath Stimulating Electrodes

Stimulating Platinum Electrodes for Radnoti Tissue-Organ Baths

Several combinations of interchangeable tissue supports and stimulating electrode inserts are available for ≥ 10 mL Radnoti tissue-organ baths. This design provides both vertical and horizontal adjustment of electrodes for precise electrode placement.

Electrodes include:
- 160152–11 Universal Holder with Straight Electrode
- 160152–12 Universal Holder with Zig-Zag Electrode
- 160152–14 Universal Holder with L-Shaped Electrode
- 160152–15 Universal Holder with Flat Electrode

Field Stimulating Electrodes for Radnoti Tissue-Organ Baths

Constructed of platinum wire sealed in glass, these electrodes feature a dual vertical spiral coil design with a 1 cm gap that generates a large, uniform electrical field surrounding the tissue. They are ideal for stimulating sections of blood vessels, and other smooth or skeletal muscle preparations or any type of tissue that requires field stimulation.

Electrodes include:
- 158812 Platinum Field Stimulating Electrode (5 to 10 mL)
- 158814 Platinum Field Stimulating Electrode (25 to 50 mL)

Stimulating Electrodes with Tissue Support for Radnoti Tissue-Organ Baths

Several stimulating electrodes combined with a tissue support are available for isolated tissue research. They are designed for both the 5 to 10 mL and the 25 to 50 mL Radnoti tissue-organ baths.

Electrodes include:
- 160121 L-Type Stimulating Electrode with Tissue Support
- 160131 Ring Type Stimulating Electrode with Tissue Support
- 160151 "ZZ" Type Stimulating Electrode with Tissue Support

Stimulating Electrodes for Panlab Tissue-Organ Baths

Type of Electrode	Platinum	Stainless Steel
A) Single Ring*	MLA0301/ID	MLA0305/ID
B) Double Ring (20 mm between poles)*	MLA0302/ID	MLA0306/ID
C) 3 mm Length Pole	MLA0303	MLA0307
D) Double Ring (15 mm between poles)	MLA0304	MLA0308

* ID = 6.5, 8 or 10 mm inner diameter

Event Markers

MLA91 Foot Switch

Used as a triggering device, the MLA91 Foot Switch can either be connected to the PowerLab trigger input (to provide triggering signals) or one of the channel inputs (for inserting comments). The foot switch has normally open contact that gives a TTL output (momentary action) when depressed.

MLA92 Push Button Switch

For triggering, timing or marking when connected to any PowerLab BNC input. (Normally open contact.)

MLA93 Tendon Hammer

For mechanical triggering in human reflex studies. It can connect to any PowerLab BNC input channel to provide triggering, timer or marker signals. The sensor within the head provides a momentary pulse when a surface is struck. Pulse strength is proportional to the striking force.

hardware

Headphones

MLA1250 Headphones

With a high-fidelity and high-impedance stereo headphone, the MLA1250 is suitable for connection to the audio output of the FE132 Bio Amp, FE135 Dual Bio Amp and ML408 Dual Bio Amp/Stimulator.

Stimulator Accessories

MLA250 Stimulator Cable (BNC to Alligator clip)

The MLA250 cable with two male BNC connectors to three alligator clip is suitable for use as a stimulator cable. It connects to the stimulator output on PowerLabs.

MLA260 Stimulator Cable (4 mm shrouded to Alligator clip, 50 cm)

A 50 cm cable with two shrouded 4 mm connectors to two alligator clips suitable for stimulation. It can be connected to any PowerLab with in-built isolated stimulators, the FE180 Stimulus Isolator or the ML408 Dual Bio Amp/Stimulator. If a longer cable is required the MLA260/L Stimulator Cable (2 m) is also available.

MLA265 Stimulator Rod with Cable

Suitable for deep nerve stimulation experiments in humans, the MLA265 Stimulator Rod with cable can be used with any PowerLab with in-built isolated stimulators, or the FE180 Isolated Stimulator or the ML408 Dual Bio Amp/Stimulator.

MLA270 Stimulator Cable (BNC to Micro-Hooks)

The MLA270 Stimulator Cable is supplied with two male BNC connectors to three Micro-Hooks (molded nylon with a stainless steel spring), and gold-plated beryllium copper hooks.

MLA0320 Animal Nerve Stimulating Electrode

Suitable for nerve and muscle stimulation in animals, the MLA320 consists of two exposed gold-plated brass rounded tip electrodes that are separated by 3 mm. The rod has a 200 mm plastic handle allowing easy handling and precise positioning using a suitable positioning clamp.

MLADDF30 Stimulating Bar Electrode

Suitable for use in conduction experiments. The MLADDF30 has flat 9 mm contacts with 30 mm spacing and is fitted with shrouded 4 mm connectors suitable for connection to the FE180 Stimulus Isolator or ML408 Dual Bio Amp/Stimulator.

Psychophysiology

MLT1601/ST Response Meter (6 m)

The slide control, with a 10-point Likert scale, provides the subject with the ability to quantify their response to a range of stimuli. The Response Meter connects directly to a Pod input of a PowerLab data acquisition unit and the response is recorded by LabChart software. Several Response Meters can be connected to the PowerLab, which allows multiple subjects to respond simultaneously to the same stimuli.

MLAC34 E-Prime Interface Cable (2 m)

The MLAC34 is a 25 pin D-type (M) to 15 pin D-type (F) adapter cable (2 m) that can be used to connect a PST serial response box to the digital inputs on a PowerLab. Eight active keys (D0-D7) from the PST Box can be used to trigger Digital Inputs 1 to 8 (on a suitable PowerLab) for LabChart's preset comments.

Response Pad

High quality, ergonomic design and removable key tops make this pad ideal for response experiments. The pad is compatible with a number of stimulus presentation packages including SuperLab, E-Prime, Inquisit and Medex.

The Response Pad can be connected directly to the digital input of the PowerLab data acquisition unit using the MLAC38 Response Pad to PowerLab Cable (2 m).

Models include:
- MLE1305 Response Pad (5-Buttons)
- MLE1307 Response Pad (7-Buttons)
- MLE1308 Response Pad (8-Buttons, Comfort)
- MLE1309 Response Pad (8-Buttons, Large)

MLE1312 SV-1 Smart Voice Key

Ideal for experiments requiring a vocal response, the SV-1 Smart Voice Key monitors the participant's voice level and reports when it rises above a user specified threshold. A USB-serial adapter can be purchased separately if connection is required using the computers USB port.

hardware

product list

Product area		Page
PowerLab Data Acquisition Systems		
PL3504	PowerLab 4/35 – 4 channels	78
PL3508	PowerLab 8/35 – 8 channels	78
PL3516	PowerLab 16/35 – 16 channels	78
Research Systems		
Blood and Fluid Flow		
PL3508B11	One Channel Perivascular System	80
PL3508B12	One Channel Tubing Flow System	80
PL3508B13	Two Channel Perivascular System	80
PL3508B14	Two Channel Tubing Flow System	80
PL3508B15	Two Channel Perivascular / Tubing Flow System	80
Isolated Tissue		
PL3508B60/C-V†*	Radnoti Tissue–Organ Bath System (4 chamber)	81
PL3508B61/C-V†*	Radnoti Tissue–Organ Bath System (8 chamber)	81
PL3516B62/C-V†*	Radnoti Tissue–Organ Bath System (16 chamber)	81
PL3508B5/C-V§*	Organ Bath System (4 chamber)	82
PL3508B6/C-V§*	Organ Bath System (8 chamber)	82
PL3516B7/C-V§*	Organ Bath System (16 chamber)	82
PL3508B21	Single Wire Myograph System	83
PL3508B22	Dual Wire Myograph System	83
PL3508B23	Auto Dual Wire Myograph System	83
PL3508B24/TS	Multi Chamber Myograph w/Touch Screen System	83
PL3508B25	Confocal Wire Myograph System	83
Isolated Heart		
PL3508B2-V*	Langendorff System (Constant Pressure or Flow)	84
PL3508B1-V*	Langendorff System for Mice (Constant Pressure)	85
PL3508B3-V*	Langendorff System for Rats (Constant Flow)	85
PL3508B4-V*	Langendorff System for Rats (Constant Pressure)	85
PL3508B50/X-V*§	Working Heart System for Rats/Rabbits	86
PL3508B55/V*	Working Heart System for Mice	86
PL3516B56-V*	Working Heart Ultimate System for Mice	87
PL3516B51/S-V*	Working Heart Ultimate System for Rats	87
Cardiovascular Pressure		
PL3508B35	Mikro-Tip BP Foundation System	88
Ventricular Pressure-Volume		
PL3516B49	MPVS-Ultra Foundation System	88
PL3508B48/M	MPVS-Ultra Single Segment Foundation System for Mice	89
PL3508B48/R	MPVS-Ultra Single Segment Foundation System for Rats	89
Exercise Physiology		
PL3508B80	Exercise Physiology System	90
Telemetry		
PL3516B109	Telemetry Small Animal Foundation System	91

Product area		Page
Neurophysiology		
PL3508B73	Extracellular Recording System	91
PL3508B74-V*	Intracellular Recording System	92
PL3508B77-V	Single Channel Epithelial Voltage Clamp System	92
PL3508B78-V	Dual Channel Epithelial Voltage Clamp System	92
PL3508B75-V*	Two Electrode Voltage Clamp Recording System	92
PL3508B76-V*	Oocyte Clamp Workstation System	93
PL3508B79/10-V*	Patch Clamp Recording System with 5101-10G Headstage	93
PL3508B79/9-V*	Patch Clamp Recording System with 5101-01G Headstage	93
PL3508B79/8-V*	Patch Clamp System with 5101-100M Headstage	93
PL3508B82/F	5 Channel Wireless Neural Recording System	94
PL3516B83/F	15 Channel Wireless Neural Recording System	94
Psychophysiology		
PL3508B110	Stimulus Presentation Foundation System	95
PL3516B111	Stimulus Presentation Ultimate System	95
Signal Conditioners		
Biopotentials		
FE136	Animal Bio Amp	96
FE132	Bio Amp	97
FE135	Dual Bio Amp	97
ML138	Octal Bio Amp	97
ML317	EOG Pod	98
ML408	Dual Bio Amp/Stimulator	98
Blood Pressure, Force and Displacement		
FE221	Bridge Amp	99
FE224	Quad Bridge Amps	99
FE228	Octal Bridge Amps	99
FE117	BP Amp	99
Blood Flow and Pulse Oximetry		
ML313C	Cardiac Output Pod	100
ML320	Oximeter Pod	100
ML325	Animal Oximeter Pod	100
Chemistry and Biochemistry		
ML307	Conductivity Pod	101
FE165	pH/Temperature Amp	101
Galvanic Skin Response		
FE116	GSR Amp	102
Neurophysiolgy/Electrophysiology		
FE185	Neuro Amp EX	103
Respiration		
FE141	Spirometer	103
Stimulation		
FE155	Stimulator HC	103
FE180	Stimulus Isolator	104
Temperature		
ML312	T-type Pod	104

152

product list

153

product list

product list

155

introducing education systems

ADInstruments Solutions for Education

ADInstruments provides engaging and cost-effective solutions for every level of life and health science education. Our innovative approach has improved learning outcomes in high schools, colleges and universities. Teaching systems are available for a range of disciplines including:

Life Science
- Human physiology
- Pharmacology
- Animal physiology

Bioengineering
- Sports science
- Psychophysiology
- Biochemistry

Health Science
- Medicine
- Nursing
- Allied health

At the core of our education product range are PowerLab data acquisition systems. The hardware is supplied with LabTutor and/or LabChart Teaching Suites to provide a powerful, flexible and easy-to-use solution for education.

LabTutor Teaching Suite

Enhance learning with self-guided software, in class & online

LabTutor Teaching Suite is a revolutionary education tool that uses blended education techniques to improve learning outcomes. The software engages students in class by efficiently guiding them through interactive experiment activities, including real-time data acquisition, data analysis, graphing and reports.

When the class ends, LabTutor Online gives students the ability to continue learning outside the lab. Using Internet-connected computers and smart devices (including the iPad), students can access their experiment content for post-lab evaluation or report completion, and to prepare for the next lab.

Teach, customize, manage and provide online access with LabTutor Teaching Suite

The LabTutor Teaching Suite comprises the following features:

LabTutor Experiments — Over 100 experiments and 500 exercises. Collections include Human Physiology, Animal Physiology, Exercise Physiology, Biology, Pharmacology, Psychophysiology, Medical Laboratories, and Applied Nursing. A typical experiment features extensive scientific background, objectives and equipment setup, real data acquisition, data analysis and a report section, all in a single browser-based interface. Applied Nursing and Medical Laboratories collections additionally include real patient case studies including HD videos, medical test data and expert diagnoses.

LabTutor Server — Enables management of courses, classes, students and experiments from a single computer.

LabAuthor — An easy-to-use tool for editing or creating LabTutor experiments including multimedia components.

LabTutor Online — Enables students to access experiments for lab preparation and report completion/submission. It also allows educators to check individual student progress and review reports anytime, anywhere. LabTutor Online users get exclusive access to a range of quality science video documentaries.

LabTutor citation: *Martina Zimmermann and Gunter P. Eckert, Advan in Physiol Edu 34: 1–10, 2010*
LabTutor was introduced by Goethe University, Germany when the Dept of Pharmacology switched from lecture-based teaching to an active learning course. The outcome was better exam results in the independent state-wide exam and more satisfied students.
"significantly higher marks were reached, thus suggesting that the subjective positive evaluation of the practical orientation of the course was accompanied by objectively assessable learning success" page 9.

Resources for educators

www.adinstruments.com

The ADInstruments website has a wealth of resources to help with your life science laboratory courses. Browse through the latest equipment and software options, download ready-to-use experiments, read and view PowerLab teaching case studies and see how your peers are using our systems.

www.adinstruments.com/forum

The ADInstruments Software Forum is an interactive online environment where PowerLab users and ADInstruments application specialists can share their knowledge and expertise. It is a great place to ask questions, make suggestions, share ideas, tips and experiments. Members get direct support from programmers as well as education and research application scientists.

LabChart Teaching Suite

Advanced learning using versatile research-grade software

LabChart (for Windows or Mac OS) is research-grade software with a powerful and flexible interface that makes it ideal for introductory through to advanced courses and post-graduate projects. The software is well-suited for applications where students will require an understanding of detailed data acquisition principles and extensive analysis options.

LabChart's depth of features allows students to grow. They are able to access and utilize more features as their knowledge of the software and science increases. (See extensive LabChart features on pages 40–75.)

Choice of teaching experiments and materials

Our collection of LabChart educator support materials includes over 50 configured experiments for Human Physiology, Animal Physiology, General Biology and Psychophysiology. Each experiment includes Instructor Guides, Settings Files and Student Protocols. Each component can be edited to suit your curriculum or equipment setup.

More LabChart software options

LabChart Reader — A free application that allows you, your colleagues and students to share, view and conduct limited analyses of LabChart data, without the need for a PowerLab system.

Modules — LabChart software add-ons that provide highly specialized data acquisition, display and analysis features for specific applications. The modules speed up software setup for experimental protocols and automate analysis of data. Examples of LabChart modules include: ECG Analysis, Blood Pressure, Heart Rate Variability, Peak Analysis, Metabolic, Spike Histogram, Video Capture and more.

LabChart citation: *G. Casotti, L. Rieser-Danner & M. T. Knabb, Advan in Physiol Edu 32:286–296, 2008*
PowerLab with LabChart was introduced by West Chester University, USA to implement an inquiry-based learning approach in physiology labs. The goal was to improve students' critical and analytical-thinking skills. Assessment of all aspects was positive.

"These changes were made possible with the purchase of PowerLab, a powerful computerized data-acquisition system that enabled students to collect and analyze data easily."

education

introducing education systems

PowerLab hardware: safe and reliable

ADInstruments PowerLab data acquisition systems are powerful, flexible and easy-to-use. Available in two or four channel systems (some featuring an in-built dual bio amp and isolated stimulator), there is a PowerLab data acquisition unit suitable to cover the experimental requirements of any life science education class.

Manufactured under the ISO9001:2008 quality system and approved for human connection, PowerLab data acquisition units for teaching are safe, reliable, and are provided with a three year warranty for peace-of-mind.

PowerLab Teaching Systems allow students to develop an understanding of physiology by recording and analyzing their own data. They are suitable for use in a wide range of life science education disciplines, from basic animal biology to undergraduate medical courses.

ADInstruments Teaching Systems: complete or customized

We understand that not all life science courses are the same. Our range of teaching systems and resources cater to the different requirements of today's student laboratory, providing educators with tools for a wide range of applications and course levels.

ADInstruments Teaching Systems

Our systems include all the hardware and software your students will need to perform life science experiments. Speak to your ADInstruments representative about your curriculum requirements. We will help you find a system that meets your requirements, whether that means choosing one of our configured teaching systems, or working with you to put together a custom solution.

PTK10 Human Respiratory Kit

Extend your experiment range with Teaching Kits

Increase the number and type of experiments students can complete with your existing ADInstruments Teaching Systems by adding Teaching Kits. Teaching Kits provide the additional amplifiers, transducers and accessories for investigations in specific subject areas.

Teaching Kits available:

- Human Respiratory Kit
- Nerve and Muscle Kits
- Pharmacology Kit
- Reflex Kit
- Biochemistry Kit
- Wireless Heart Rate Kit
- EOG Kit
- Exercise Breathing Kit
- Pharmacology Kit
- Stimulus Presentation Kit

PTK11 Nerve and Muscle Kit II

LabTutor experiments

Revolutionizing life science teaching and learning

All LabTutor experiments include background information, detailed experimental setup and exercises, as well as easy-to-follow data acquisition, analysis and reporting protocols.

The experiments listed below have been configured for use with the PowerLab LabTutor Teaching Systems. If you require further information or advice please contact your ADInstruments representative.

The experiment list includes two recent additions: Medical Laboratories and Applied Nursing collections, both of which help students to connect bioscience theory with clinical practise. These two collections bring real patients into the lab with HD video interviews and real medical test results.

Human Physiology

Blood Pressure
Breathing
Cardiorespiratory Effects of Exercise
Cardiovascular Effects of Exercise
ECG & Heart Sounds
ECG & Peripheral Circulation
Electroencephalography (EEG)
Electromyography (EMG)
Electro-oculography (EOG)
Gut Absorption
Mechanics of Ventilation
Muscle
Reflexes and Reaction Times
Respiratory Air Flow and Volume
Sensory Illusions
Sensory Physiology
The Diving Response
The Stroop Test
Water Balance

Exercise Physiology

Aerobic Fitness Testing
Anaerobic Fitness Testing
Energy Expenditure & Exercise
Energy Metabolism
Introduction to Fitness Testing
Respiratory Gas Analysis Procedure

Animal Physiology

Cockroach Sensory Nerve
Cockroach Ventral Nerve Cord
Earthworm Action Potentials
Earthworm Smooth Muscle
Frog Heart
Frog Neuromuscular Junction
Frog Skeletal Muscle
Frog Nerve
Gin Trap Closure Reflex

Insect Metabolism
Intracellular Action Potentials
Mammalian Blood Pressure - Reflex Regulation
Mammalian Blood Pressure & Blood Flow
Mammalian Respiration - Nerve Effects
Mammalian Respiration - O2 & CO2 Effects

Pharmacology

Airways Resistance
Chick Biventer Cervicis
Mammalian Atria
Mammalian Blood Pressure - Drug Effects
Mammalian Diaphragm
Mammalian Heart
Mammalian Jejunum
Mammalian Uterus
Stimulated Ileum
Stimulated Rat Vas Deferens
Toad Rectus Abdominis
Unstimulated Ileum
Unstimulated Rat Vas Deferens
Vascular Resistance
Vascular Smooth Muscle

Psychophysiology

EDR & Classical Conditioning
Electrodermal Response (EDR)
Introduction to Psychophysiology Methods
Perception & The Size-Weight Illusion
Visual Evoked Potential (VEP)

General Biology

Acid-Base Titration
Biological Membranes
Cellular Respiration
Introduction to Spectrophotometry
Photosynthesis - Carbon Dioxide Fixation
Photosynthesis - Oxygen Production
Temperature Effects on Enzyme Performance

Medical Laboratories

Autonomic Nervous System
Blood Pressure
Body Temperature
Brain Structure and Reflexes
Glucose Metabolism
Heart and Circulation
Heart and Electrocardiography
Heart Sounds
Kidney and Urine
Lung Function
Muscle and Fatigue
Muscle Function
Peripheral Nerve Function
Sensory Physiology
Vision

Applied Nursing

Autonomic Nervous System
Blood Pressure
Body Temperature
Brain Structure and Reflexes
Childbirth
Glucose Metabolism
Heart and Circulation
Heart and Electrocardiography
Heart Sounds
Kidney & Urine
Lung Function
Muscle and Fatigue
Muscle Function
Peripheral Nerve Function
Pregnancy

Guided PBL

Guided PBL - Blood Pressure
Guided PBL - ECG & Pulse
Guided PBL - Electromyography (EMG)
Guided PBL - Respiratory Air Flow and Volume

Check regularly to download new and updated teaching experiments:
www.adinstruments.com/solutions/experiments/

education

A selection of ADInstruments user sites:

Audio Prototypes, August Krogh Institute, Austin and Repatriation Medical Centre, Austin Hospital, Australian Defense Force Academy, Baker Medical Research Institute, Ball State University, Ballarat University, Bangor University, Baroda Government Medical College, BASF Corp., Bath University, Bayer Cropscience, Baylor College of Medicine, BC Research Inc., Beijing Medical University, Beth Israel Deaconess Medical Center, Bethel University, BHP Research, "Biomedical Resarch Models, Inc", Birjand University, Bispebjerg Hospital, Blease Medical, "BMSI, Jinnah Post-Graduate Medical Center", Bob Jones University, Boehringer Ingelheim Pharmaceuticals, Bolton Institute, Boot's Healthcare England, Boryung Pharm, Boston Biomedical Research Institute, Boston College, Boston Medical Center, Boston University, Bowdoin College, Bowling Green State University, Bowman Research UK, Boy's Town Hospital, BPS International PLC, Brain Imaging Research Centre, Brigham and Women's Hospital Harvard, Brigham Young University, Bristol Myers Squibb Co., Bristol Royal Infirmary, Bristol University, British Columbia Institute of Women's and Children's Health, Broadgreen Hospital England, Brown Surgical• Brown University, Bryn Mawr College, Bufalini Hospital, Busan National University, Butler University, California Institute of Technology, Cambridge University, Canadian Blood Services, Capital Medical University, Cardiff School of Biosciences, Cardiff University, Cardinal Stritch University, Cardio Technologies Inc., Cardiome Pharma Corp., Carleton University, Carnegie Mellon University, Carpenter Special Products Corp., Carroll College, Case Western Reserve University, Caserta Medical Center, CEA Laboratoire Jean Metz, Celal Bayar University, Celltech R&D Ltd, Centenary College, Center for Addiction and Mental Health Toronto, "Center of Excellence in Molecular Biology, University of Punjab", Central Michigan University, Centre for Human Science DERA, Centro Residenziale Clinica S. Lucia, Chaim Sheba Medical Center, Chandka Medical College, Chang Gung Memorial Hospital, Chapman University, Charles River Laboratories, Charles Sturt University, Charles University, Chelsea and Westminster Hospital, Chesapeake Biological Lab University of Maryland, Chestnut Hill College, Chiang Mai University, Chief Dull Knife College, Chiesi Farmaceutici s.p.a., Children's Hospital and Regional Medical Center Seattle, China Medical College, Chinese University of Hong Kong, Chirurgische Klinik Großhadern München, Chon Pook National University, Choongang University, Choongwae Pharma Co., Choseon Pharmaceutical & trading Co., Christian Brothers University, Christopher Newport University, Chulabhorn Research Institute, Chulalongkorn University, Cincinnati Children's Hospital, City College of New York, CJ Corporation R&D Center for Pharmaceuticals, Clarkson University, Clemente Medical Center, Cleveland Clinic Foundation, Cloud County Community College, CMRC, Cobalt Refinery Company Inc., Colby College, Colgate University, College Misericordia, College of Marin, Colorado College, Columbia University, Comenius University, Concord Hospital, Concordia University, Converge Medical Inc., Copenhagen Center for Clinical & Basic Research, Cornell Medical College, Cornell University, Coronado High School Colorado Springs, County College of Morris, Credit Landing Medical Center, Creighton University Medical College, CRSSA, "Cryocor, Inc", CSIRO Division of Chemicals and Polymers, CSIRO Livestock Industries, Cubist Pharmaceuticals Inc., Curis Inc., Curtin University of Technology, CV Technologies Inc., CV Therapeutics, Cytokinetics Inc., "Cytologic, Inc", Dalhousie University, Danish Institute of Agricultural Sciences, Daresbury Laboratory, Dartmouth Medical School, Davao Medical School Foundation, Davidson College, De La Salle University, De Montford University, Deaconess Health Center, Deakin University, Defence Evaluation Research Agency DERA, "Deltagen, Inc", Denison University, Des Moines University, DeSales University, DNA Sherwood (Pty) Limited, Dokuz Eylul University, Dong Wha Pharm Co. Ltd, Dow International Medical College, Dow University of Health Sciences, Dowling College, Dr. Panjwani Center for Molecular Medicine and Drug Research, Drake University, Drexel University, Drug Applied Research Center of Tabriz, Dryburn Hospital England, DSTA – DMRI, Dubai Medical College for Girl, Dublin City University, Duke University, Duquesne University, Durham Technical Community College, Dynogen Pharmaceuticals Inc., Earlham College, East Carolina School of Medicine, East Stroudsburg University, East Tennessee State University, Eastern Connecticut State University, Eastern Illinois University, Eastern Washington University, Ebrahim M. Almana & Bros. Co., ECSS Trinity College, Edith Cowan University, Ege University, Elan Pharmaceutical Technologies, Elbion, Eli Lilly and Co., Elmira College, Elon University, Emory University, "Endovx, Inc", Enhance Biotech, Enobia Pharma, EntreMed Inc., Environmental, County Medical Center, Escola Paulista de Medicina, Extremadura University, Faculdade de Farmacia da Universidade do Porto, Federico II University, Ferris State University, "Fibrogen, Inc", Finch University of Health Sciences Chicago Medical School, Flinders Medical Centre, Florida A&M University, Florida Technical Institute, Fluid Power Products, FMC Corporation, Fordham University, Forschungsgruppe für Osteoporose des UKBF Berlin, Frauenklinik der Universität Gießen, Front Range Community College, Fu Jen Catholic University, Fudan University, Furman University, Gannon University, Gardiner Institute, Garvan Institute of Medical Research, Gazi University, Gaziantep University, Gene Logic Inc., Genentech Inc., George Washington University, Georgetown College, Georgia Southern University, Gettysburg College, Ghulam Mohammad Mehar Medical Collge, Gilson Medical Electronics, GKSS Forschungsinstitut Geesthacht, Gladstone Institute of Cardiovascular Disease, Glasgow Caledonian University, Glasgow Royal Infirmary, GlaxoSmithKline, Glenfield Hospital England, Global Information Solutions, Glostrup Hospital, GM Laboratories, Gonzaga University, Good Samaritan Hospital, Gordon College, Goucher College, Government College University, Grand Canyon University, Griffith University, Grinnell College, Grossmont College, GSF (Gesellschaft für Strahlenforschung) München, Guidant Corp., Guilford Pharmaceuticals, Gujarat State Research & Development Centre, Guju Pharma Co. Ltd, Gumma University, Guy's Hospital, H Lundbeck A/S, Hacettepe University, Hadassah-Hebrew University Medical Center, Haerbin Medical University, Hail University, Hamamatsu University School of Medicine, Hamline University, Hanoi Medical University, Hanoi University of Technology, Harefield Hospital, Hartwick College, Harvard Medical School, Harvard School of Public Health, Harvard University, Haskins Laboratories Inc., Hatter Institute University College Hospital, Haukeland Sykehus, Heart Research Institute, Hebrew University, HEJ Research Institute of Chemistry, Hendrix College, Henry Ford Hospital, Heriot Watt University, Herzzentrum Leipzig, HIB Institute, High Point University, Hiroshima Prefectural Women's University, Hobart and William Smith Colleges, Hoffmann-La Roche, Hong Kong Baptist University, Hope College, Hope Hospital, Hopital Cochin, Hopital Erasme, Hopital Grenoble, Hopital Tenon, Hopkins Marine Station, Houston Community College, Howard Florey Research Institute, Howard University, Huddinge Hospital, Human Genome Sciences Inc., Human Medical University, Humanbiologisches Institut der TU München, Humboldt State University, Huntingdon Research Centre Limited, Huons Co. Ltd, HUSAT, HV Technologies Inc., Ibaraki Prefectural University of Health Science, Ibn Sina Medical College (private), Icagen Inc., ICGEB Trieste, ICOS Corp., ICSM Hammersmith, Idrottshogskolan in Sweden, Idun Pharmaceuticals Inc, Ila Università degli Studi di Napoli, Ildong Pharmaceutical Co.Ltd, Illinois Institute of Technology, Imperial College, Indian Veterinary Research Institute, Indiana Institute for Medical Research, Indiana State University, Indiana University, Indiana Wesleyan University, Inotek Pharmaceuticals Inc, INRA, INSERM U171 & URA 1195, INSERM U390, INSERM U533, Institut de recherches cliniques de Montréal, Institute of Child Health London, Instituto Butantã, Instrument Solutions, Insulent, Insulent Corp., Intellicardia Inc., InterMune Pharmaceuticals, International Islamic University, InterPhases Research, Intersurgical Ltd, Iowa State University, "IPS Pharma, Inc", Irvine Valley College, Isfahan University, Isra University, Istanbul University, "IUSM, Roma", Jagiellonian University Krakow, James Black Institute, James Cook University, Janssen Pharmaceutica N.V., Jaume I University, Jichi Medical University, Jilin University of TCM, Jilin Tianyao Company, Jizan University, John B. Pierce Lab, John Hunter Hospital, John P. Robarts Research Institute, Johns Hopkins Asthma & Allergy Center, Johnson and Johnson, Joliet Junior College, Joslin Diabetes Center, Judge Baker Children's Center, Kadir Has University, Kagawa Prefectual College of Health Science, Kandang Kerbau Hospital, Kangwon National University, Kansas City Community College, Kansas State University, Kaohsiung Medical University, Karachi Medical and Dental College, Kardiologische Klinik der Universität Münster, Karolinska Institute, Kasetsart University, Kawasaki University of Medical Welfare, Kennesaw State University, Kent & Canterbury Hospitals NHS Trust, Kent State University, Kielanowski Institute of Animal Physiology & Nutrition, Killingbeck Hospital, Kinderklinik der LMU München, King Abdulaziz Medical City, King Edward Medical College, King Fahd Medical City, King Faisal Specialist Hospital, King Khalid University, King Mongkut Medical College, King Saud University, King's College, Kirikkale University, Kitazawa University, Klinik für Augenheilkunde der Universität Würzburg, Knoll Pharmaceuticals, Kobenhavens Amts Sygehus, Kobenhavns Universitet, Kogakkan University, Kosan Biosciences Inc., Krakow Medical College, Kumetrix Inc., "Kumetrix, Inc", Kuwait University, Kyung Dong Pharmaceutical Co. Ltd., Kyunghee University, KyungPook National University, Kyungsung National University, La Sierra University, La Trobe University, Laboratory Testing Inc., Lafayette College, Lake Erie College of Osteopathic Medicine, Lanzhou University, Las Positas Community College, LaSalle University, Laurentian University, Laval University, Leeds Metropolitan University, Lehigh University, Lehman College, Lewis and Clark College, Liaquat University of Medical and Health Sciences, Lily Research Centre Ltd, Limburgs University Centre, Lincoln Land Community College, Lincoln University, Loma Linda University, London Health Science, Malmo University, Manchester Metropolitan University, Mariano Galvez University Medical School, Marlboro College, Marmara University School of Medicine, Marquette University, Marty Technologie, Mary Baldwin College, Massachusetts General Hospital, Massey University, Mater Children's Hospital, Maternite Regionale A Pinard, Max-Planck-Institut für Experimentelle Kardiologie Bad Nauheim, Mayo Clinic, Mayo General Hospital, McDaniel College, McDonald Research Laboratories, McGill University, McKendree College, McMaster University, MD Anderson Cancer Center, MDIS, MDS PanLabs Pharmaceutical Ltd, MDS Pharma Service, Medical Academy Bialystok, Medical College of Georgia, Medical University of Copenhagen, Medizinische Klinik der Universität Heidelberg (Kardiologie), Medtronic Physio-Control, Memorial University of Newfoundland, Menarini Pharmaceuticals, Merck & Company Inc., Merck Frostt, Merrimack College, Messiah College, Metropolitan Community College, Miami Children's Hospital, Miami University Ohio, Michigan State University, Micro-Informatique Conseil, Mid-Plains Community College, Midwestern University, Millennium Pharmaceuticals Inc., Millersville University, Minerva Institute, Minnesota Medical Research Center, Mississippi State University, Missouri Southern State College, Mohawk Valley Community College, Molecular Research Institute, Monash Medical Centre, Monash University, Monmouth College, Montreal Children's Hospital, "Mordiglia Service, C. N. R.", Morehouse School of Medicine, Morningside College, Moscow State University, Mount Sinai Medical Center, "MPI Research, Inc", MRC Collaborative Centre`, MRC Human Genetics Unit, MRC Reproductive Biology Unit, MTA/BTA-Schule Hilden, Mugla University, Murdoch University, "Myogen, Inc", Nagoya City University, Najran University, Nanjing TCM University, Naresuan University, NASA AMES Research Center, Natal Technikon, National Defence Research Establishment Sweden, Naval Medical Research Institute, Naval Research Laboratory, Nazareth College, Nebraska Wesleyan University, Nepean Hospital, Nephros Inc., Neurocrine Biosciences Inc., Neurosearch, New College of Florida, New England College of Optometry, New Mexico State University, New York Institute of Technology, Newcastle General Hospital, Ngee Ann Polytechnic, Ninewells Hospital, Nitromed Inc., Nokia Research Centre, Norrbacka Huset, North Carolina State University, North Georgia College & State University, Northeastern Illinois University, Northern Arizona University, Northwest Missouri State University, Norwegian University of Science & Technology, Norwich University, Notre Dame de Namur University, Novartis, NTNU, Odense University, Oglethorpe University, Ohio State University, Ohio Wesleyan University, Ohlone College, Oklahoma State University, Olivet Nazarene University, Onassis Cardiac Surgery Centre, Ondokuz Mayis University, Onkologische Forschungsgruppe der Universität Düsseldorf, Open University, Oregon Health Sciences University, Oregon Regional Primate Research Center, Oregon State University, Orotta School of Medicine, Ortho-McNeil Pharmaceutical Corp., Otsuka Maryland Medicinal Laboratories, Ottawa Hospital, Oxford University, OxoN Medica Inc., Pacesetter AB, Palomar College, Pamantasan ng Lungsod ng Maynila, Pamukkale University, Panum Institute, Park University, Parker Technologies, PCSIR Laboratories, Pediatric Academic Association Inc., Pennsylvania State University, People's Medical College, Pepperdine University, Pfizer Central Research Ltd, Pfizer Inc., Pfizer Spa, "Pfizer, Inc", Pharmacia Inc., Pharmacy College of Saudi Arabia, Pharmagene Laboratories Ltd, Pharmakologisches Institut der Humbold Universität Berlin, Philadelphia College of Osteopathic Medicine, Physiologie Intestinale Uer Pharmaceutiques Paris, Plattsburgh State University, Plymouth State College, Polartechnics, Polish Academy of Sciences, Pomona College, Pontificia Universidad Católica de Chile, Porteia & Co S.A., Portland State University, Prague Institute for Clinical and Experimental Medicine, Price Lab School University of Northern Iowa, Prince Henry Institute of Medical Research, Prince of Wales Medical Research Institute, Princess Alexandra Hospital, Procter & Gamble, Punjab Medical College, Purdue University, Queen Elizabeth Hospital, Queen's University, Queens Medical Center, Queens University of Belfast, Queensland University, Johnson Pharmaceutical Research Institute, Ranbaxy Laboratories, Rayne Institute St Thomas Hospital, Rees Stealy Research Foundation, Rehabilitationszentrum des Klinkums Kladow, Rensselaer Polytechnic Institute, Research Fund of SUNY, Resonance Technology Inc., Rhone Poulenc Rorer, Riley Children's Research Hospital, Rinat Neuroscience Corp., River Valley Farms, RMIT University, Robert Wood Johnson School of Medicine, Roche Pharmaceuticals, Roche Spa, Rockefeller University, Roussel UCLAF, Royal Adelaide Hospital, Royal Airforce Institute of Aviation Medicine, Royal Brisbane Hospital, Royal College of Surgeons in Ireland, Royal Danish School of Pharmacy, Royal Edinburgh Hospital, Royal Hallamshire Hospital, Royal Melbourne Hospital, Royal North Shore Hospital, Royal Perth Hospital, Royal Prince Alfred Hospital, Royal Veterinary and Agricultural University Denmark, Royal Victoria Hospital, Rush Medical College, Rush University, Russian State Medical University, Rutgers University, RWTH Aachen, Sahand University of Technology, Sahlgrenska University Hospital, Saida, Salem State College, Salisbury State University, Samuel Lunenfeld Research Institute, San Diego Mesa College, San Pablo-CEU University, Sanofi Winthrop s.p.A., Sanofi-Aventis, Santa Ana College, Santa Clara Valley Medical Center, Sarghoda University, Savannah State University, Scanmed Medical, Schering-Plough Research Institute, SCION Pharmaceuticals, Scios Inc., Scottish School of Sport Studies, Seattle Institute for Biomedical & Clinical Research, Seattle Pacific University, Seoul National University, Services Institute of Medical Sciences, Seton Hall University, Shandong University Medical College, Shanghai #2 Medical University, Shanti Yoga and Meditation Center, Sharif University of Technology, Sheikh Zaid Medical College, Shippensburg University, Shiraz University, Shriner's Hospital for Children, Signal Pharmaceuticals Inc., Silesian Medical Academy, Sindh Medical College, Singapore General Hospital Clinical Research Labs, Sintef Unimed, Sir Charles Gairdner Hospital, Sir John Moores' University, Sir Syed University of Engineering and Technology, Skidmore College, Sligo Institute of Technology, Slippery Rock University, SNBL USA Ltd., Songklanakarin University, Sonoma State University, Sophia Children's Hospital, Southern Arkansas University, Southwestern College, Space Physics Research Laboratory at the University of Michigan, SRI International, Srinakharinwirot University, St George's Hospital Medical School, St James's Hospital, St Thomas' Hospital Medical School, St Vincent's Hospital, St. Cloud State University, St. John's University, St. Lawrence University, St. Louis University, St. Luke's Roosevelt Hospital, St. Luke's College of Medicine, St. Mary's University, St. Paul's Hospital, St. Vincent College, Stanford School of Medicine, Stockholm University, Sun Pharmaceuticals, Sunshine Coast University, Suntory Pharmaceutical Research Laboratories, SUNY Buffalo, SUNY Downstate Medical Center, SUNY New Paltz, SUNY Old Westbury, SUNY Potsdam, SUNY Stony Brook, SUNY Upstate Medical Center, Sussex Centre for Neuroscience, Suven Pharma, Suzuka University of Medical Science, Swarthmore College, Swiss Cancer Institute for Experimental Research, Syntex Research Centre, Tabuk University, Taibah University, Taichung Veterans General Hospital, Taif Univeristy, Taipei Medical University, Taiwan Development Center for Biotechnology, Taiwan National Defense Medical Center, Takeda Chemical Industries, TargeGen Inc., Tata Institute of Fundamental Research, Tawam Medical Campus, Technological University of Athens, Tehran University, Temasek Polytechnic, Temple University, Texas A&M University, Texas Woman's University, Thammasat University, The Alfred Hospital, The Jackson Laboratory, The University of Nairobi, Thomas Jefferson University, Thomas Swann & Co Ltd, Tierarztpraxis Dr. Brandes Northeim, Tierklinik Abt. Andrologie der LMU München, Tohoku University, Tokyo Medical University, Tokyo University, Tongji Medical University, Toronto SSK Children's Hospital, Torrent Pharmaceuticals, Torrent Research Center, Towson University, Trinity College, Tripler Army Medical Center, Trondheim University Hospital, Tsurumi University, Tufts University, Tulane University School of Medicine, Tunghai University, U.A.B. Barcelona, U.S. Army, U.S. Department of Energy, U.S. Navy, U.S.A. Medical Research Institute of Infectious Disease, U.S.D.A. Agricultural Research Services, UCLA Brain Research Institute, UMIST, Umm Al Qura University, Umweltforschungszentrum Magdeburg, Uniformed Services University of Health Sciences, "Unimed Pharm, Inc", Union College, United Arab Emirates University, Universidad Andrés Bello, Università degli Studi dell'Aquila, Unizyme Labs, Urmia University, Urologische Klinik der Medizinischen Hochschule Hannover, Ursinus College, Ursuline College, Utah State University, V.A. Boston Healthcare, V.A. Medical Center Boise, V.A. West Haven Medical Center, Valencia Community College, Vall d´Hebrón Hospital, Vallabhbhai Patel Chest Institute, Valley Research Group, Vaxis Therapeutics Corp., Vertex Pharmaceuticals, Veteran's Medical Research Foundation Virginia Commonwealth University, Victoria University, Victorian College of Pharmacy, Villanova University, Vinh University, Virginia Commonwealth University, Vollum Institute Oregon Health and Sciences University, Vrije University, Wabash College, Wadsworth Center New York Department of Health, Wake Forest University, Warsaw Agricultural University, Warsaw Medical University, Wartburg College, Washburn University, Washington & Jefferson College, Waters Corp., Wayne Community College, Wayne State University, WeiFang Medical College, Wellcome/CRC Institute, Wellesley College, Wellington School of Medicine, Wesleyan College, West Chester University, West China Medical University, West Georgia College, West Valley College, West Virginia University, Western General Hospital, Western Maryland University, Westf. 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