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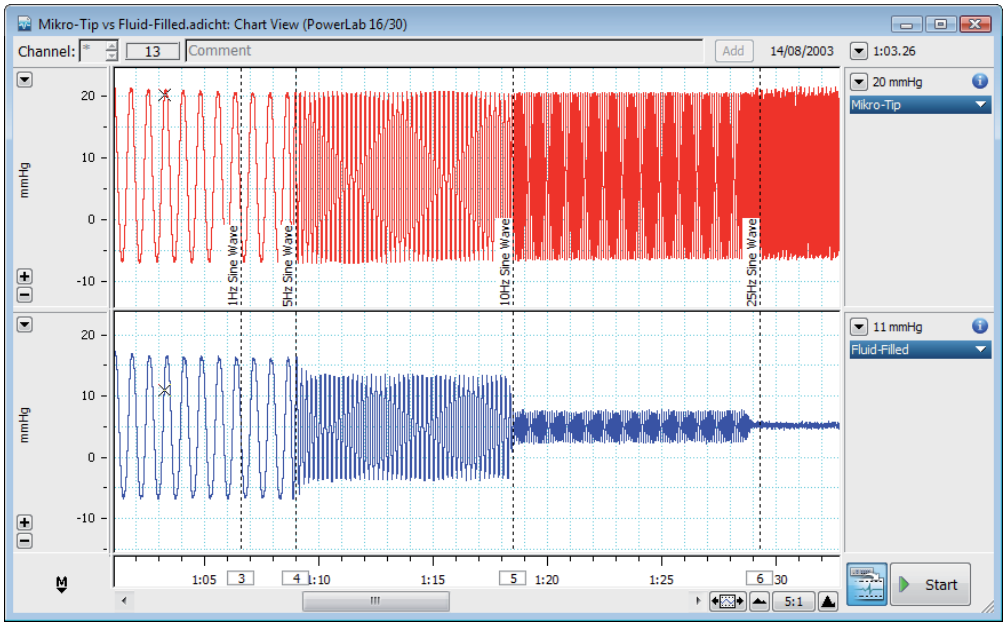
making science easier

Hemodynamic Pressure Signals

PowerLab® Systems, LabChart® Software and Mikro-Tip® Catheters



Pressure signals recorded using a PowerLab system with a Millar Instruments Mikro-Tip catheter in the top channel and a traditional fluid-filled catheter in the bottom channel.

PowerLab data acquisition systems and Mikro-Tip catheters provide researchers with leading-edge technology to record and analyze high-fidelity cardiovascular pressure and volume signals with unparalleled accuracy. With the transducer positioned at the tip of the catheter, you are able to place the sensor directly at the source of the signal.

The Mikro-Tip catheter design offers many advantages over the traditional fluid-filled catheter models. Benefits include maintained signal integrity, no signal attenuation and the elimination of artifacts due to catheter movement. The design and technology of the Mikro-Tip catheters ensure a true representation of the pressure signals and make them ideal for cardiovascular measurements in mice and rats through to rabbits and sheep.

The Pressure-Volume Systems measure ventricular pressure and volume simultaneously in small (such as mice) through to large animals. LabChart software and PowerLab systems are ideal for recording ventricular or arterial pressure and volume data. Ventricular pressure parameters can be extracted and analyzed online or offline using the Blood Pressure Module. P-V loops can be plotted in real time and a wide range of cardiovascular parameters can be extracted offline using PVAN. The complete ADInstruments solution provides fast and reliable evaluation of *in vivo* mechanical properties of the heart.

Features & Benefits

- Excellent signal frequency response
- Extremely sensitive and accurate
- No motion artifacts or signal attenuation
- Transducer positioned at the source of the signal
- Catheter sizes starting at 1F - the smallest available in the market
- Electrode spacing on Pressure-Volume catheters available as close as 3 mm
- MPVS Ultra system can be used with small and large animals
- Powerful online and offline calculations and analyses with easy-to-use PowerLab systems

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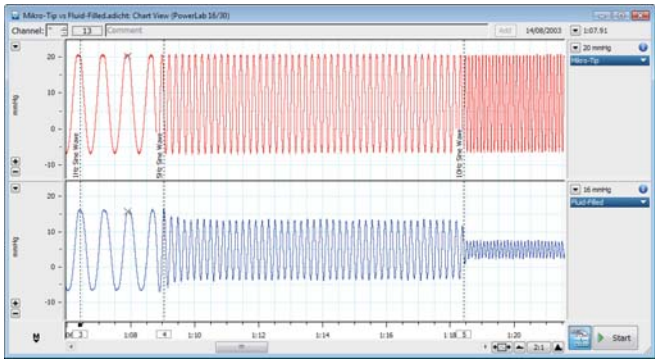
The Mikro-Tip Advantage

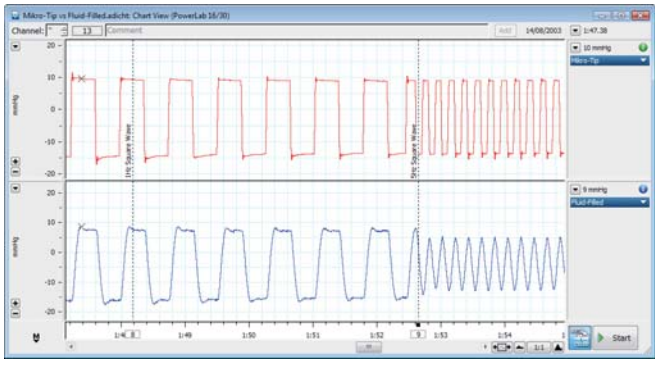
Frequency Response

Mikro-Tip catheters have a high bandwidth and respond to pressures at different frequencies without losing information. The LabChart recording on the right compares a pressure signal measured from a common source using both a fluid-filled and a Mikro-Tip catheter. The signal recorded with the Mikro-Tip catheter is unaffected by the signal frequency. In contrast, the signal recorded from a fluid-filled catheter is attenuated above 5 Hz (typical rat heart rate) and distorted further at higher frequencies such as 10 Hz (typical mouse heart rate).



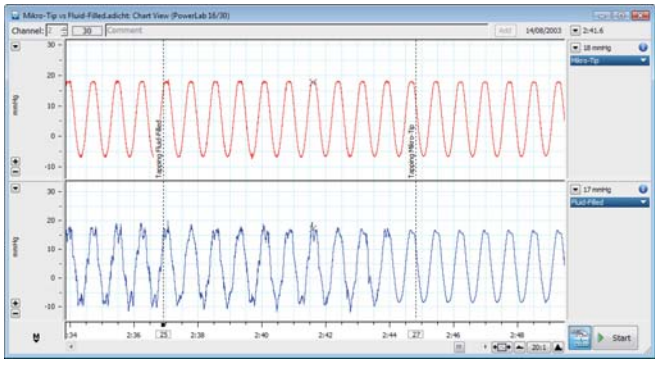
Signal Integrity

The data on the right illustrates how poor frequency response of a transducer can affect signal integrity. Using a square wave produced by a signal generator, you can see that the Mikro-Tip catheter signal (top channel) reflects the true waveform as displayed at 1 and 5 Hz. The same signal waveform detected using a fluid-filled transducer is distorted at 1 Hz and its original characteristics are completely lost at 5 Hz.



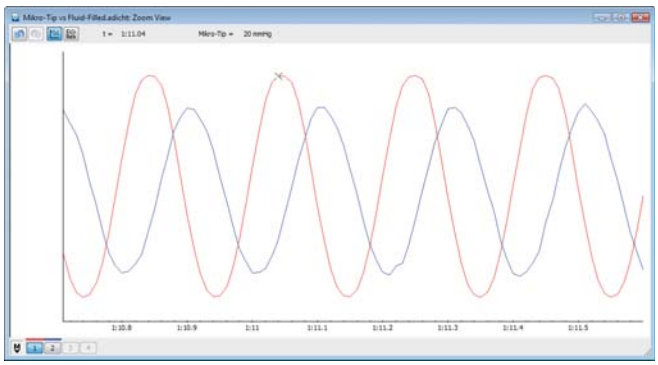
Signal Artifacts

Signals from fluid-filled catheters are susceptible to interference due to air-bubble dampening, catheter movement, catheter blockage, sensor positioning and the distance of the transducer from the signal source. Effects of tapping both the Mikro-Tip and the fluid-filled catheter are illustrated on the right. The signal from the Mikro-Tip catheter is unaffected, while the signal from the fluid-filled catheter is distorted.



dP/dt Measurements

The parameter dP/dt is commonly used as an index of cardiac contractility. It represents the change in left ventricular pressure as a function of time and is determined from the slope of the ventricular pressure waveform during systole. Maximum dP/dt is used as an index of the initial velocity of myocardial contraction. If you use a fluid-filled catheter and transducer (blue signal), the recorded signal may be misrepresented and will result in inaccurate dP/dt values.

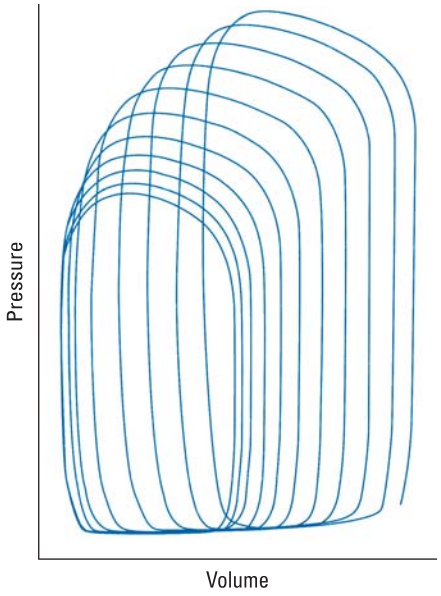


Only Millar catheters provide:

- Ultra minature catheters from 1F size - the world's smallest pressure and pressure-volume sensor catheters
- Electrode spacing from 3.0 mm on pressure-volume catheters - ideal for mice as small as 16 grams
- No risk of artificial volume changes caused by flexing of the catheter

Cardiovascular Pressure-Volume Systems

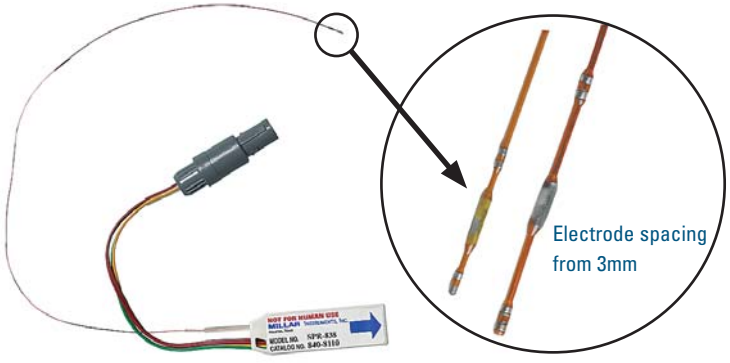
Millar Instruments produced the world's first commercially available pressure-volume (P-V) system for use in small animals. Now with the MPVS Ultra system, researchers are able to measure pressure and volume in small through to large animal hearts with a single system. A single catheter with a high-fidelity pressure sensor and electrodes is used to simultaneously measure left ventricular pressure (LVP) and volume from *in vivo* beating hearts. Ultra-miniature catheters are ideal for use in studies using transgenic mice as small as 16 grams, with multi-segmented catheters available for large domestic animals.



The MPVS Ultra unit in conjunction with PowerLab and LabChart allow you to measure, analyze and plot pressure and volume signals against each other in real time. P-V loops are easily generated and can be used to compare cardiac cycles in normal and diseased hearts. P-V loops can be continuously recorded during drug and hemodynamic interventions allowing the user to monitor and evaluate the mechanical properties of the heart.

P-V Catheter Features

- Ultra-miniature 1F to large 7F catheters
- Pressure and volume recordings from a single instrument
- High-frequency pressure response
- Measure pressure and volume at signal source
- No motion artifact or dampening of the signal
- Multi-segmented platinum electrodes for variable heart ventricle sizes



Applications

- Baseline P-V loop analysis
- Occlusion P-V loop analysis
- Phenotyping gene manipulations
- Monitoring of cardiac failure or hypertrophy
- Cardiovascular remodeling
- Pharmacology and toxicology

MPVS-400

The MPVS-400 pressure-volume signal conditioning hardware has a four-channel PowerLab data acquisition system integrated in the unit. The MPVS-400 is supplied with LabChart software for pressure and volume data acquisition and analysis. This unit comes with adjustable gain settings for use in *ex vivo* studies involving solutions with varying conductivity values.

MPVS Ultra System

The MPVS Ultra™ unit simultaneously and continuously measures high-fidelity left ventricular pressure and volume from the intact beating hearts of animals, from transgenic mice through to domestic livestock. The MPVS Ultra provides analog outputs for two pressure signals and selectable volume outputs to easily integrate with PowerLab and LabChart. The unit is controlled by a computer interface and the Rho cuvette enables easy conversion of conductance measurements to true volume units.

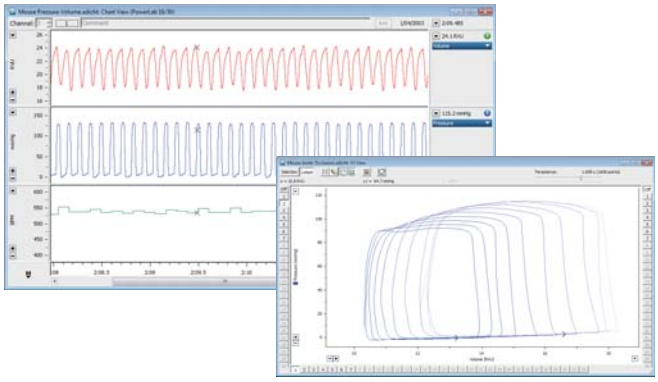
- State-of-the-art technology
- Can be used with small and large animals
- Flexible volume determination using selectable catheter segments
- Built-in volume calibration technique using Rho cuvette and Baan's equation
- Software-controlled user interface
- Adjustable gain settings to allow both *in vivo* and *in vitro* studies
- Dual pressure inputs
- Seamless integration with PowerLab and LabChart
- Compatible with all Millar Mikro-Tip P-V Catheters

Data Acquisition and Analysis

PowerLab Systems

PowerLab data acquisition systems (comprising an analog to digital hardware unit and LabChart software) are ideal for monitoring cardiovascular signals. With recording and computation speeds of up to 200 kHz per channel (400 kHz aggregate), you can record, calculate and display up to 32 channels simultaneously in real time. These may include left ventricular pressure and volume, heart rate, systolic and end-diastolic pressure, rate of pressure change (dP/dt), rate of volume change (dV/dt) and more.

The flexible display allows the user to zoom in or out on different sections of the trace while acquiring data. Recording channels can be easily calibrated into meaningful units such as mmHg or mL.



Volume and pressure signals were recorded using a PowerLab, LabChart software and Pressure-Volume system. Heart rate was calculated from the pressure signal in real time. Pressure-Volume loops were generated and displayed in real time using LabChart's XY View feature

Blood Pressure Module

The optional Blood Pressure Module for LabChart (for Windows) automatically detects, analyzes and reports a set of cardiovascular parameters from arterial or ventricular pressure signals, including the left ventricular pressure signal measured by Millar pressure-volume systems. The module can analyze recordings both online and offline, and calculate parameters including maximum, minimum and end-diastolic pressure, and dP/dt.

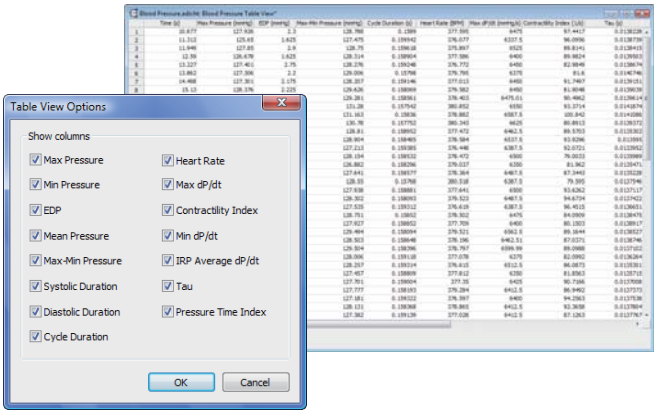
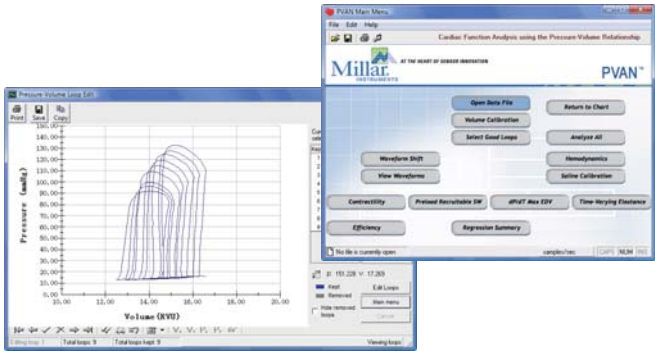


Table View Options for Ventricular Pressure and a Blood Pressure Table View generated by the Blood Pressure Module for LabChart.

PVAN Software

LabChart data is seamlessly imported into the Millar PVAN software using the ADInstruments PVAN Extension. PVAN uses highly specialized algorithms to derive over 30 hemodynamic parameters. The parameters can assess cardiovascular performance in response to interventions such as genetic manipulation, vascular occlusions or drug administration.

A saline calibration feature allows you to determine a value for the parallel conductance in volume determination. Data recorded in Relative Volume Units can be converted into calibrated volume units and easily exported to spreadsheets, or statistical analysis, graphing and/or presentation programs.



PVAN displaying pressure-volume loops following aortic occlusion in a mouse. Source: Millar Instruments, Inc.

Parameters Calculated by PVAN Software

- Heart rate
- Maximum and minimum volume
- End-systolic volume
- End-diastolic volume
- Maximum and minimum pressure
- End-systolic pressure
- End-diastolic pressure
- End-systolic elastance
- Arterial elastance
- Cardiac output
- Stroke work (SW)
- Stroke volume
- Ejection fraction
- Preload recruitable SW
- Maximum and minimum dP/dt
- Maximum and minimum dV/dt
- Pressure at dP/dt Max and dV/dt Max
- Volume at dP/dt Max and dP/dt Min
- Tau-Weiss method
- Tau-Glantz method
- Tau-Logistic method

Pressure Only and Pressure–Volume Catheters

The following is a selection of Mikro-Tip Catheters. For more options or to discuss your particular application contact your nearest ADInstruments representative.

Pressure Catheters	
SPR-1000*	Pressure Catheter (1F Polyimide)
SPR-1000/2*	Pressure Catheter (1F Polyimide), 2 pack
SPR-671	Pressure Catheter (1.1F Nylon)
SPR-671NR*	Pressure Catheter (1.1F Nylon)
SPR-407	Pressure Catheter (1.5F Nylon, 140 cm)
SPR-407NR*	Pressure Catheter (1.5F Nylon)
SPR-320	Pressure Catheter (2F Polyurethane, 140 cm)
SPR-320NR*	Pressure Catheter (2F Polyurethane)
SPR-249	Pressure Catheter (2.2F Nylon, 140 cm)
SPR-249A	Pressure Catheter (2.2F Nylon, 60 cm)
SPR-882	Pressure Catheter (2.2F)
SPR-524*	Pressure Catheter (2.3F Nylon , 100 cm)
SPR-330	Pressure Catheter (3F Polyimide Nylon, 65 cm)
SPR-330A	Pressure Catheter (3F Polyimide Nylon, 130 cm)
SPR-340	Pressure Catheter (4F Polyurethane/Woven Dacron, curve)
SPR-340S	Pressure Catheter (4F Polyurethane/Woven Dacron, straight)
SPR-350	Pressure Catheter (5F Polyurethane/Woven Dacron, curve)
SPR-350S	Pressure Catheter (5F Polyurethane/Woven Dacron, straight)
MPR-500*	Pressure Catheter (5F Polyurethane, 50 cm)
SPR-360	Pressure Catheter (6F Polyurethane/Woven Dacron, curve)
SPR-360S	Pressure Catheter (6F Polyurethane/Woven Dacron, straight)
SPR-370	Pressure Catheter (7F Polyurethane/Woven Dacron, curve)
SPR-370S	Pressure Catheter (7F Polyurethane/Woven Dacron, straight)
SPR-721	Dual Pressure Catheter (2.5F Polyurethane, 135 cm)
Implantable Pressure Catheters	
SPR-407I	Pressure Catheter (2F Nylon, Implantable length 28 cm, Proximal 30 cm)
SPR-407I-2	Pressure Catheter (2F Nylon, Implantable length 13 cm, Proximal 153 cm)
SPR-524I	Pressure Catheter (3.5F Nylon, Implantable length 10 cm, Proximal 245 cm)
SPR-524I-2	Pressure Catheter (3.5F Nylon, Implantable length 25 cm, Proximal 100 cm)
SPR-671I	Pressure Catheter (1.4F Nylon, Implantable length 15 cm, Proximal 15 cm)
SPR-671I-2	Pressure Catheter (1.4F Nylon, Implantable length 7.5 cm, Proximal 60 cm)
Mouse Pressure-Volume Catheters (For use with MPVS-400 and MPVS-Ultra)	
PVR-1030*	Mouse PV Catheter (1F, 4E, 3.0 mm)
PVR-1035*	Mouse PV Catheter (1F, 4E, 3.5 mm)
PVR-1045*	Mouse PV Catheter (1F, 4E, 4.5 mm)
SPR-839	Mouse PV Catheter (1.4F, 4E, 4.5 mm)
SPR-839NR*	Mouse PV Catheter (1.4F, 4E, 4.5 mm)
SPR-848	Mouse Dual PV Catheter (1.4F, 2P, 4E, 4.5 mm Apical)
SPR-853	Mouse PV Catheter (1.4F, 4E, 4.0 mm Taper)
SPR-864	Mouse Dual PV Catheter (1.4F, 2P, 4E, 4.5 mm Carotid)
SPR-819	Rat/Mouse Selectable Seg PV Catheter (1.4F, 6E, 9 mm/14 mm)
SPR-866	Rat/Mouse Selectable Seg PV Catheter (1.4F, 6E, 4 mm/6 mm)
Rat Pressure-Volume Catheters (For use with MPVS-400 and MPVS-Ultra)	
SPR-901	Rat Dual PV Catheter (2F, 2P, 12 mm, 4E, 9 mm Carotid)
SPR-902	Rat Dual PV Catheter (2F, 2P, 12 mm, 4E, 9 mm Apical)
SPR-838	Rat PV Catheter (2F, 4E, 9 mm)
SPR-838NR*	Rat PV Catheter (2F, 4E, 9 mm)
SPR-847	Rat PV Catheter (1.4F, 4E, 9 mm)
SPR-858	Rat PV Catheter (2F, 4E, 14 mm)
SPR-869	Rat PV Catheter (2F, 4E, 6 mm)
SPR-869NR*	Rat PV Catheter (2F, 4E, 6 mm)
SPR-878	Rat PV Catheter (2F, 4E, 12 mm)
SPR-851	Rat PV Catheter (3F, 4E, 20 mm)
Multi-Segmented Pressure Volume Catheters (For use with MPVS-400 and MPVS-Ultra)	
Recommended for rabbits	
SPR-550-1	Multi-Seg PV Catheter (5F, 12E Dual Field, 7 mm, Straight, 125 cm)
SPR-550-2	Multi-Seg PV Catheter (5F, 12E Dual Field, 9 mm, Pigtail, 125 cm)
SPR-550-5	Multi-Seg PV Catheter (5F, 12E Dual Field, 7 mm, Pigtail, 125 cm)
SPR-550-7	Multi-Seg PV Catheter (5F, 12E Dual Field, 10 mm, Pigtail, 125 cm)
SPR-550-8	Multi-Seg PV Catheter (5F, 10E Single Field, 7 mm, Pigtail, 125 cm)
SPR-562-1	Multi-Seg Dual PV Catheter (6F, 2P, 12E Dual Field, 7 mm, 125 cm)
Recommended for dogs and pigs	
SPR-889	Multi-Seg PV Catheter (3F, 10E Single Field, 3 mm, U-tip, 80 cm)
SPR-894	Multi-Seg PV Catheter (3F, 10E Dual Field, 4 mm, U-tip, 80 cm)
SPR-845	Multi-Seg PV Catheter (3F, 8E Single Field, 3 mm, U-tip, 120 cm)
SPR-855	Multi-Seg PV Catheter (3F, 10E Dual Field, 4 mm, Straight, 120 cm)
SPR-856	Multi-Seg PV Catheter (3F, 10E Single Field, 4.5 mm, Straight, 120 cm)
SPR-877	Multi-Seg PV Catheter (3F, 10E Dual Field, 2.5 mm, Straight, 120 cm)
Electrophysiology	
EPR-800	Ultra-Miniature Electrophysiology Catheter

1F= 0.33 mm
E= Electrode Numbers
P= Pressure transducer number

*= Non-repairable NR= Non-repairable option
Note: Catheter interface cables are required for connection to ADInstruments Bridge Amplifiers

Ordering Information

ADInstruments Foundation Systems

ADInstruments provides a Pressure and a Pressure-Volume Foundation System. Due to a wide range of species and applications, the Mikro-Tip Catheters need to be selected separately. If you need assistance with selecting the appropriate catheters for your application please do not hesitate to contact us. Customized systems are also available.

ML870B35 Mikro-Tip Blood Pressure Foundation System

1 x ML870/P PowerLab 8/30 with LabChart and Scope (Win & Mac) includes LabChart Pro software

1 x ML221 Bridge Amp

1 x AEC-10C Catheter Interface Cable

1 x AEC-10D Catheter Interface Cable

MPVS Ultra Hardware Unit

ML880B46 MPVS-Ultra Foundation System

1 x ML880/P PowerLab 16/30 with LabChart and Scope (Win & Mac) includes LabChart Pro software

1 x 880-0168 MPVS-Ultra Pressure-Volume Unit (large and small animals)

1 x 910-1060 Rho Calibration Cuvette kit

1 x 880-0169 MPVS-Ultra Cable pack (3 m) required for connecting PV catheters to the MPVS-Ultra Pressure-Volume Unit

Includes:

- 1x CEC-10E PV Extension Cable (3 m) for pressure and volume measurement
- 1x PEC-10D Pressure Extension Cable (3 m) for 2nd sensor pressure measurement
- 1 x 880-0172 MPVS-Ultra BNC Cable pack required for connecting the MPVS-Ultra Pressure-Volume Unit to the PowerLab. Includes:
  - BNC-BNC 22.9 cm cables (10)
  - BNC-BNC 91.4 cm cables (2)
  - BNC-BNC 30.5 cm cable (1)
- 1 x 001-1056 PVAN Ultra Analysis Software

Software

MLS060/7 LabChart (Win and Mac)

MLS330/7 GLP Client and MLS335 GLP Server (Win)

MLS260/7 LabChart Pro (Includes the modules listed below. Modules are also available for individual purchase.)

MLS390/7 Dose Response	(Win)	MLS310/7 Heart Rate Variability	(Win and Mac)	MLS340/7 Cardiac Output	(Win)
MLS065/7 DMT Normalization	(Win and Mac)	MLS240/7 Metabolic	(Win and Mac)	MLS320/7 Video Capture	(Win and Mac)
MLS370/7 Blood Pressure	(Win)	MLS062/7 Spike Histogram	(Win and Mac)	MLS395/7 Circadian Analysis	(Win)
MLS360/7 ECG Analysis	(Win)	MLS380/7 Peak Analysis	(Win)		

ADInstruments also offers solutions for researchers working in GLP and 21 CFR Part 11 environments. Please contact your ADInstruments representative for more information.

Share your data with colleagues. Free LabChart Reader – download to view and analyze LabChart data.

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