

# MPVS

## Millar Pressure-Volume Systems for Cardiovascular Research

### *Animal Use Only*



The Millar Pressure-Volume Systems (MPVS) simultaneously and continuously measure high-fidelity left ventricular pressure and relative volume from the intact beating hearts of small laboratory animals such as transgenic mice and rats.

Using the MPVS, cardiovascular pressure and volume signals can be plotted against each other in real time, generating the characteristic pressure-volume (P-V) loops that are an excellent illustration of the cardiac cycle in normal or diseased conditions of the living heart. With the MPVS, P-V loops may be captured during pharmacological, therapeutic, and hemodynamic interventions, allowing comprehensive evaluation of the fundamental mechanical properties of the heart.

The MPVS provides the least invasive, most robust means for complete hemodynamic assessment of small animals.

### Types of Study

- Baseline P-V loop analysis
- Occlusion P-V loop analysis
- Phenotyping gene manipulations
- Cardiac hypertrophy
- Cardiac failure
- Cardiovascular remodeling
- Toxicology
- Pharmacology (rapid drug screening)

### MPVS Components

- SPR-Series 1.4 to 2.0 French ultra-miniature P-V catheters
- MPVS-300 signal conditioning hardware with external data acquisition system (DAQ) or MPVS-400 signal conditioning hardware with integrated ADInstruments PowerLab® DAQ technology
- PVAN data analysis software
- Computer

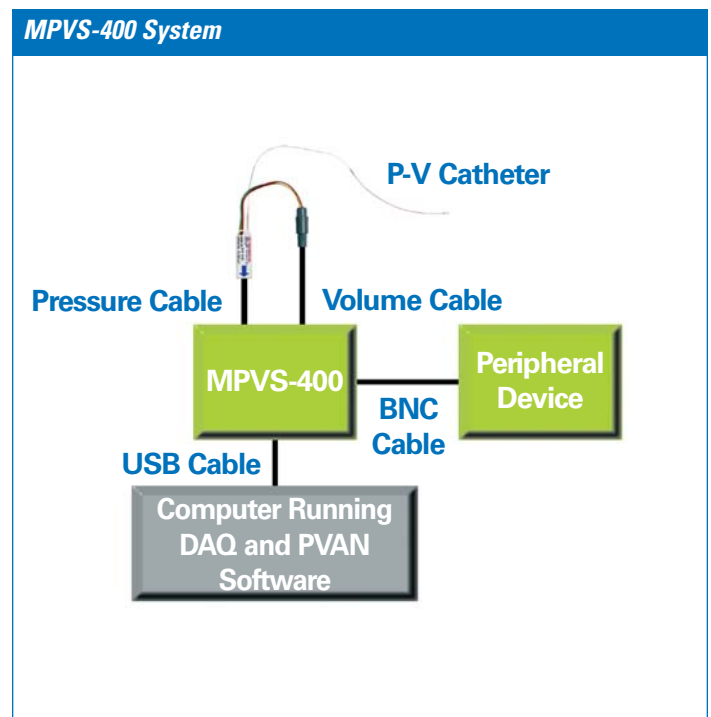
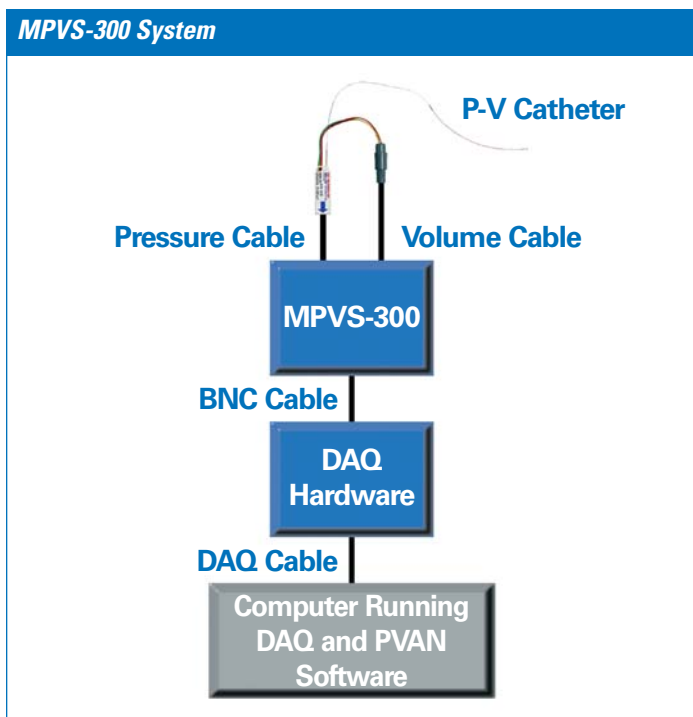
Recognizing the diverse needs of the research community, Millar offers two comprehensive and flexible solutions to investigators interested in expanding their studies to include P-V acquisition and analysis.

### MPVS-300 System

The MPVS-300 is the ideal system solution for customers who prefer to couple Millar's P-V signal conditioning hardware with any commercially available stand-alone DAQ system.

### MPVS-400 System

With the MPVS-400 system, Millar's P-V signal conditioning hardware is fully integrated with DAQ technology to create a single, space-saving unit.



## SPR-Series 1.4 to 2.0 French P-V Catheters

The introduction of Millar's Mikro-Tip® SPR-Series 1.4 to 2.0 French P-V catheters revolutionized the possibilities for cardiovascular research in small animals. These ultra-miniature catheters are the only devices in the world capable of measuring both left ventricular pressure and volume simultaneously from the intact, beating hearts of mice and rats. They may be used in either closed-chest or open-chest surgical procedures, as well as in isolated working heart studies.

### P-V Catheter Features

- Ultra-miniature 1.4F-2.0F (0.47-0.67 mm outer diameter) pressure sensors
- Four electrodes (spaced for either mice or rats)
- Pressure and volume measurement from a single instrument
- Flexible, durable, small-diameter catheter material
- High frequency response
- Pressure measurement at the source
- No motion artifact or damping of pressure signal



### SPR-Series 1.4 to 2.0 French P-V Catheter Models

| Features                    | SPR-838                       | SPR-839                       | SPR-869                       |
|-----------------------------|-------------------------------|-------------------------------|-------------------------------|
| Part Number                 | 840-8110                      | 840-8111                      | 840-8136                      |
| Animal Type                 | Normal/large rat              | Mouse                         | Small rat                     |
| Catheter Material           | Polyimide                     | Polyimide                     | Polyimide                     |
| Effective Length            | 12.5 cm                       | 3.5 cm                        | 12.5 cm                       |
| French Size                 | 2.0                           | 1.4                           | 2.0                           |
| Number of Pressure Sensors  | 1                             | 1                             | 1                             |
| Sensor Location from Tip    | Centered in electrode segment | Centered in electrode segment | Centered in electrode segment |
| Electrodes (0.5 mm)         | 4                             | 4                             | 4                             |
| Pin-to-Electrode Resistance | < 15 ohms                     | < 15 ohms                     | < 15 ohms                     |
| Electrode Spacing           | 9.0 mm segment                | 4.5 mm segment                | 6.0 mm segment                |
| Electrode Connector         | Redel                         | Redel                         | Redel                         |
| Pressure Sensor Connector   | Low profile                   | Low profile                   | Low profile                   |
| Reusable                    | Yes                           | Yes                           | Yes                           |
| Repairable                  | Yes                           | Yes                           | Yes                           |

## MPVS-300/400 Signal Conditioning Hardware

The MPVS signal conditioning hardware provides digital and/or analog outputs of the time-varying left ventricular pressure and volume signals for data acquisition. The combined pressure and volume signals generate pressure-volume loops that allow calculation and analysis of a wide array of hemodynamic parameters in small animals.



**MPVS-300 Rear Panel**



**MPVS-400 Rear Panel**

## MPVS Signal Conditioning Hardware Features and Benefits

- Combined pressure and volume signal conditioning provides increased ease of use.
- High signal-to-noise ratio allows use of low excitation currents that are significantly below fibrillation thresholds.
- Built-in Pressure and Relative Volume Unit (RVU) calibration provides quick and easy-to-use calibration reference points.
- Visual LED indicators of pressure and volume signal output provide real-time assurance of system functionality.
- Compact and stackable design saves laboratory space.
- Two pressure sensor channels.
- Compatible with six-electrode “selectable segment” catheters.
- Universal power supply.
- High-resolution signal output.
- Fixed signal gain and frequency preserve calibration accuracy and data integrity.
- Compatible with commercially available data acquisition systems.
- Universally compatible with all single- and dual-sensor Millar pressure catheters (with appropriate interface cables).
- Integrated data acquisition with digital USB output (MPVS-400 only).
- Additional channel of analog signal input to accommodate peripheral measuring devices, i.e., temperature, flow, pH, etc. (MPVS-400 only).

## PVAN Data Analysis Software

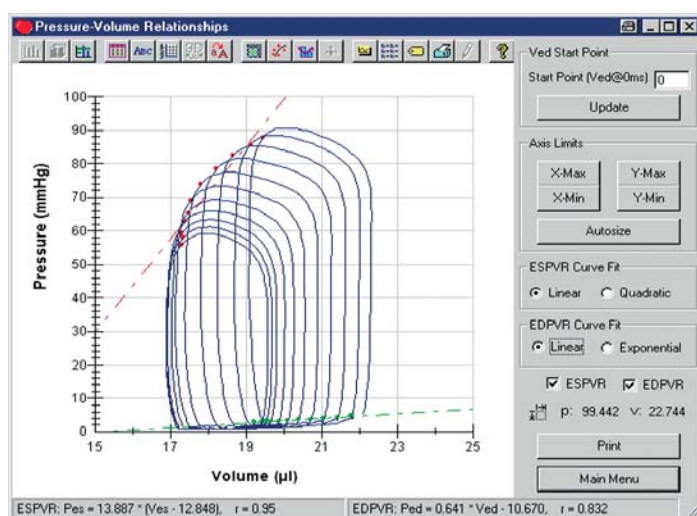
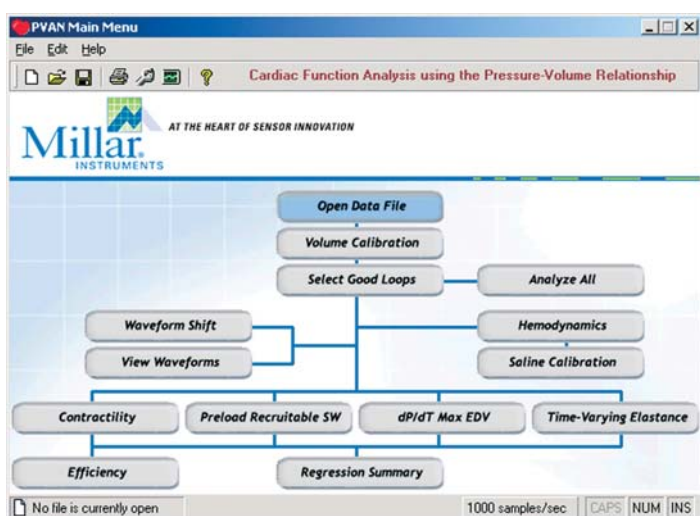
Millar's PVAN software provides a powerful, easy-to-use method for investigators to calculate the hemodynamic parameters of the P-V data generated by the MPVS hardware.

PVAN opens the text files generated by the data acquisition software and applies a variety of algorithms to the P-V data to calculate over thirty hemodynamic parameters.

The calculated hemodynamic parameters serve as indicators of cardiovascular performance in response to different interventions (genetic mutations, drugs, occlusions, etc.). PVAN offers the investigator the opportunity to convert data to units of true volume if the data are recorded in RVUs.

PVAN contains an intuitive user menu that offers easy access to a variety of displays and calculation tables for several cardiovascular parameters. A saline calibration feature allows the user to obtain a value for the parallel volume contribution of the myocardium.

Data may be easily exported to spreadsheets or text files, and graphical information can be placed into presentations or papers for publication.



## Parameters Calculated by PVAN Software

| Parameter | Description            | Parameter | Description                    | Parameter      | Description           |
|-----------|------------------------|-----------|--------------------------------|----------------|-----------------------|
| HR        | Heart Rate             | Ea        | Arterial Elastance             | dP/dt min      | Minimum dP/dt         |
| Vmax      | Maximum Volume         | CO        | Cardiac Output                 | dV/dt max      | Maximum dV/dt         |
| Vmin      | Minimum Volume         | SW        | Stroke Work                    | dV/dt min      | Minimum dV/dt         |
| Ves       | End-Systolic Volume    | SV        | Stroke Volume                  | P@dP/dt max    | Pressure at dP/dt Max |
| Ved       | End-Diastolic Volume   | EF        | Ejection Fraction              | P@dV/dt max    | Pressure at dV/dt Max |
| Pmax      | Maximum Pressure       | PRSW      | Preload Recrutable SW          | V@dP/dt max    | Volume at dP/dt Max   |
| Pmin      | Minimum Pressure       | ESPVR     | End-Systolic P-V Relationship  | V@dP/dt min    | Volume at dP/dt Min   |
| Pes       | End-Systolic Pressure  | EDPVR     | End-Diastolic P-V Relationship | Tau (Weiss)    | Tau-Weiss Method      |
| Ped       | End-Diastolic Pressure | E(t)      | Time Varying Max. Elastance    | Tau (Glantz)   | Tau-Glantz Method     |
| Ees       | End-Systolic Elastance | dP/dt max | Maximum dP/dt                  | Tau (Logistic) | Tau-Logistic Method   |

## Computer

The MPVS utilizes either a desktop or a laptop computer with a Microsoft® Windows® operating system and Microsoft Office software. The computer can be supplied by the end user or by Millar Instruments with the purchase of turnkey MPVS package solutions.

## Data Acquisition System (DAQ)

Integral parts of the complete MPVS package are the data acquisition hardware and software. They are standard with the MPVS-400 system; and they can be purchased separately for the MPVS-300 system. Key features include:

- Customizable graphical user interface
- Four to eight channels of analog input (stand-alone DAQ hardware only)
- USB output
- Compatibility with peripheral measuring devices
- Scrolling strip chart display of pressure and volume waveforms
- Real-time display of P-V loops
- Real-time calculations using raw data (mean, max, min, derivatives, etc.)
- Digital indicators (pressure, volume, heart rate, etc.)
- Multi-point calibration
- Adjustable sampling rates
- Event marking

## MPVS-300/400 Hardware Specifications

|                                   | MPVS-300                           | MPVS-400                           |
|-----------------------------------|------------------------------------|------------------------------------|
| Part Number                       | 753-2057                           | 753-2058                           |
| Integrated Data Acquisition       | No                                 | Yes                                |
| Pressure Channels                 | 2                                  | 2                                  |
| Volume Channels                   | 1                                  | 1                                  |
| Additional Analog Inputs          | 0                                  | 1                                  |
| Maximum Input Voltage             | N/A                                | 15 V                               |
| Catheter Input Connectors         | Redel                              | Redel                              |
| Input Configuration               | Single-ended                       | Single-ended                       |
| Conductance Excitation Frequency  | 20 kHz                             | 20 kHz                             |
| Conductance Output                | +/-10 V                            | +/-10 V                            |
| Pressure Output                   | 1 V / 100 mm Hg                    | 1 V / 100 mm Hg                    |
| Input Impedance                   | N/A                                | 1 megohm                           |
| Frequency Response – Pressure     | 600 Hz                             | 600 Hz                             |
| Frequency Response – Volume       | 460 Hz                             | 460 Hz                             |
| Sampling Resolution               | N/A                                | 100 kS/s max, selectable           |
| Analog Output                     | 3 BNC Connectors                   | DIN Connector                      |
| Digital Output                    | N/A                                | USB                                |
| Dimensions (w x h x d)            | 200 mm x 65 mm x 265 mm            | 200 mm x 65 mm x 265 mm            |
| Weight                            | 1.90 kg (4.2 lb)                   | 2.18 kg (4.8 lb)                   |
| Integrated Universal Power Supply | Yes                                | Yes                                |
| Operating Voltage                 | 220-240 V or 110-120 V (universal) | 220-240 V or 110-120 V (universal) |
| Operating Temperature             | 10 to 35°C (50 to 95°F)            | 10 to 35°C (50 to 95°F)            |

## FREQUENTLY ASKED QUESTIONS

### Why Use MPVS?

With hundreds of P-V systems installed across the globe in pharmaceutical companies, biotech firms, research organizations, hospitals and universities, Millar has a proven track record in the rapidly expanding field of small animal hemodynamic research. The MPVS is the newest generation of Millar's groundbreaking cardiovascular research systems.

Designed specifically for use with transgenic mice and rats, the MPVS allows beat-by-beat monitoring of ventricular performance. It enables pressure-volume studies using a single ultra-miniature catheter coupled with data acquisition and analysis tools. It is the least invasive, highest precision, most comprehensive and cost-effective solution available on the market today.

### How Does the MPVS Link Genetics and Hemodynamic Research?

By allowing continuous assessment of left ventricular pressure and volume from the intact beating hearts of transgenic mice, the MPVS provides the first link between molecular biology, biochemistry, and the physiological phenotype. Using the system, investigators have the power to study the physiological expression of a specific gene manipulation. By studying pressure and volume changes in intact circulation, researchers can evaluate the genetics of heart disease and the importance of individual genes in normal physiology.

### Why Use Mice and Rats?

Over the past few decades there has been a dramatic increase in the use of mice and rats for cardiovascular research. Many investigators are scaling down from their large animal research models to mice and rats because of their small size, low maintenance, rapid gestation, highly characterized genome, and similarities to the human cardiovascular system.

Characterizing the cardiac phenotype through the left ventricular P-V analysis of transgenic mice and rats had been problematic due to the small size of their hearts and rapid heart rates. By developing the MPVS, Millar solved the problem and has provided the research community with the miniature tools necessary to comprehensively assess hemodynamic parameters and cardiac function in extremely small animal models.

## World Headquarters

### Millar Instruments, Inc.

6001-A Gulf Freeway

Houston, Texas 77023-5417 USA

Phone: 832-667-7000

Toll free: 800-669-2343 (in the USA)

Fax: 832-667-7001

Email: [info@millarmail.com](mailto:info@millarmail.com)

Web site: [www.millarinstruments.com](http://www.millarinstruments.com)

## Millar Worldwide Distribution

Millar Instruments, Inc. has a network of Authorized Distributors in most countries around the world. For information on the Millar distributor in your country, please contact the Millar Customer Service Department at our headquarters in Houston.

## European Authorized Representative

### FMI Föhr Medical Instruments GmbH

In der Grube 13

D-64342 Seeheim/Ober-Beerbach

Germany

Telephone: +49 (0) 62 57-96 22 60

Fax: +49 (0) 62 57-96 22 62+8 20 17

Email: [info@fmigmbh.de](mailto:info@fmigmbh.de)



*Sensors.Systems.Solutions.®*

© 2004, 2007 Millar Instruments, Inc. All rights reserved.

Millar, Mikro-Tip, and Sensors.Systems.Solutions. are registered trademarks of Millar Instruments, Inc.

Products and company names used are the trademarks or trade names of their respective companies.

Models referred to herein are protected by USA and International patents.

M.I. P/N 005-1030 Rev. A