scisense
advancing micro-sensor technology™

STUDYING THE PV LOOP IN RODENTS

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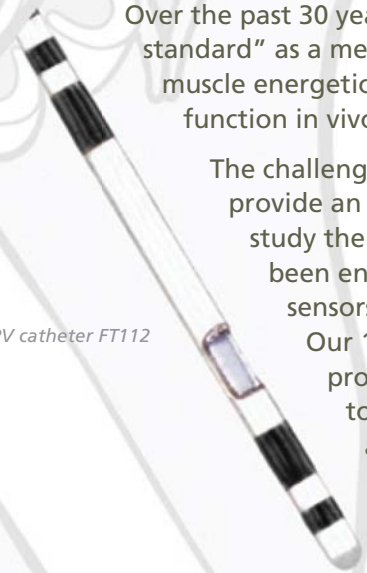
Many useful and necessary parameters are used to describe the function of a beating heart including minimum dP/dt, maximum dP/dt, developed pressure and cardiac output. However, only the pressure-volume (PV) loop properly describes the performance of the heart as a pump.

Over the past 30 years, the PV loop has steadily become the "gold standard" as a means to study myocardial contractility, compliance, muscle energetics and other important quantitative measures of function in vivo (and in certain instances, in vitro).

The challenge for medical technology companies has been to provide an accurate, reliable and minimally invasive tool to study the PV loop in mice and rats. Since 2002, Scisense has been engineering and developing a full line of catheter-based sensors to satisfy this need in the scientific community. Our 1.2F (mouse) and 1.9F (rat) pressure-volume catheters provide cardiac research scientists the unique ability to measure almost every imaginable hemodynamic and contractile index of ventricular function with a single instrument.



1.2F mouse PV catheter FT112

These catheters have been extensively tested and validated and have been endorsed by some of the most knowledgeable and well-respected authorities in the world, on solid-state pressure and conductance volume measurements.

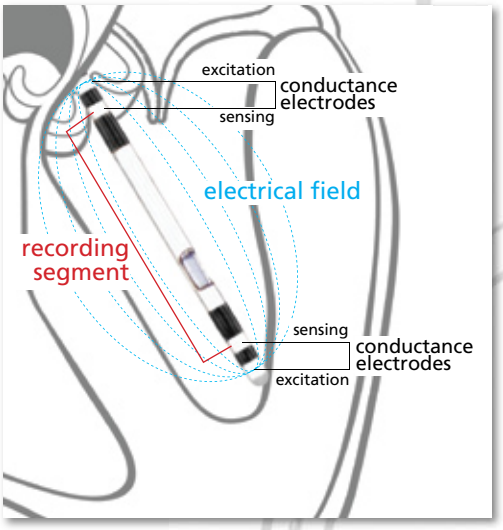
RPV-6 Mouse/Rat PV System

PRINCIPLE OF OPERATION:

Scisense PV catheters for rodents are comprised of two components: 2 pairs of conductance electrodes (outer excitation electrodes and inner sensing electrodes) and a high fidelity pressure sensor. The pairs of rings are spaced so that one set is situated at the apex and the other set at the base of the heart. Our solid-state pressure transducer is located between the 2 pairs of conductance electrodes.

The outermost conductance electrodes (distal and proximal ends of the catheter) inject a current into the heart that generates an electric field. As luminal volume in the heart changes during the cardiac cycle, the conductivity value measured between the innermost sensing electrodes will change proportionally. This conductivity value is then applied to an accepted volume formula (Baan's equation) to generate a real-time volume signal. Our state-of-the-art hardware outputs an analog voltage that is proportional to this volume change.

Baan's Equation: $V=\frac{1}{\alpha}(\rho L^2)(G-Gp)$

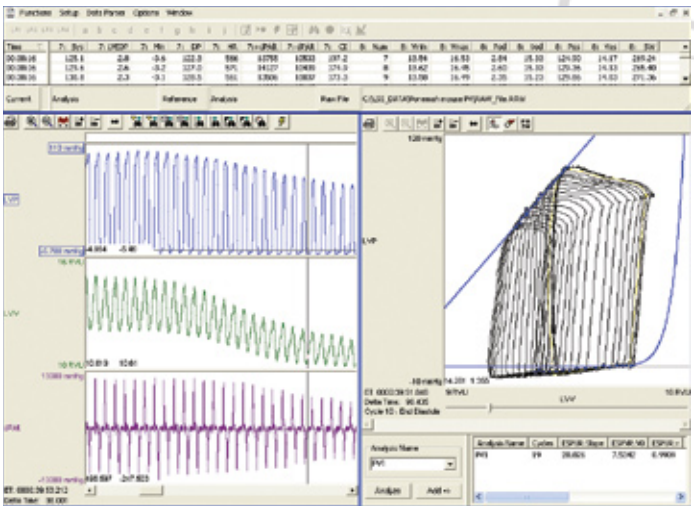


FUNCTIONAL PARAMETERS FROM SCISENSE PV SYSTEM:

VARIABLE	DESCRIPTION	VARIABLE	DESCRIPTION	VARIABLE	DESCRIPTION
HR	Heart Rate	EDV	End-Diastolic Volume	PRSW	Preload Recruitable Stroke Work
Pmax	Maximum Pressure	SV	Stroke Volume	ESPVR	End-Systolic Pressure-Volume Relationship
Pmin	Minimum Pressure	CO	Cardiac Output	EDPVR	End-Diastolic Pressure-Volume Relationship
Pdev	Developed Pressure	EF	Ejection Fraction	PVA	Pressure-Volume Area
ESP	End-Systolic Pressure	dP/dt max	Maximum dP/dt	E(t)	Time Varying Maximal Elastance
EDP	End-Diastolic Pressure	dP/dt min	Minimum dP/dt	Ees	End-Systolic Elastance
Vmax	Maximum Volume	dV/dt max	Maximum dV/dt	Ea	Arterial Elastance
Vmin	Minimum Volume	dV/dt min	Minimum dV/dt	Tau	Time Constant of Isovolumic Relaxation
ESV	End-Systolic Volume	SW	Stroke Work	CI	Contractility Index

APPLICATIONS:

- Heart Failure
- Ischemia/Reperfusion Injury
- Cardiac Hypertrophy
- Myocardial Stunning
- Cardiovascular Remodeling
- Stem Cell Research
- Phenotyping
- Pharmacology & Toxicology



Acquisition/analysis software depicting a pressure-volume loop, and left ventricular pressure, volume and dP/dt traces.

SCISENSE CATHETER DESIGN, FEATURES & BENEFITS:

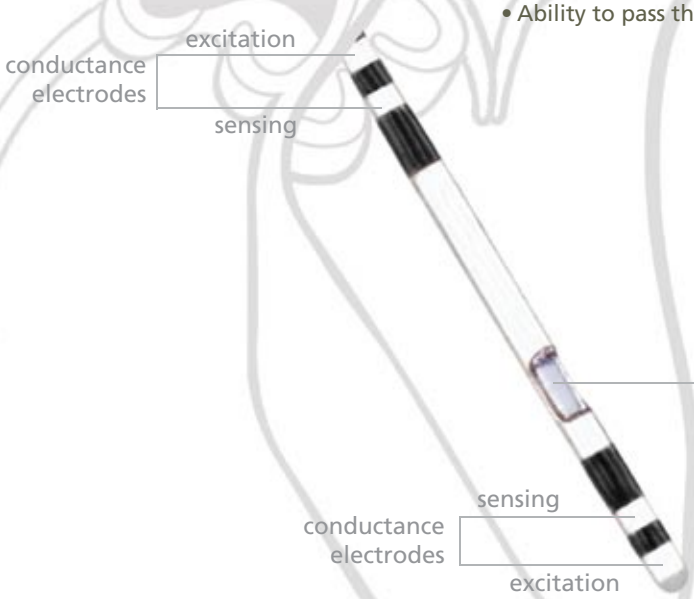
1.2F mouse PV catheter FT112

Polyimide Tubing:

- Provides ideal balance of flexibility and rigidity, ensuring easy insertion and maneuverability
- Will not fray like many other catheter materials which, over time, will irritate vascular lining and valves
- Small diameter of tubing minimizes impact on aortic flow resulting in more physiologic LV data

Smooth Profile:

- Reduces potential damage to endothelial lining during catheterization
- Allows for easy passage through aortic valve (can be inserted and withdrawn repeatedly)
- Ability to pass through remodeled arteries



High-fidelity Pressure Sensor:

- High frequency response maintains signal integrity and prevents damping or attenuation of signal
- No motion artifact or overshoot as with conventional fluid-filled catheters
- 10μV/V/mmHg sensitivity provides higher measurement resolution than any other sensor on the market
- Pressure membrane recessed for protection
- Vented to atmosphere to correct for barometric pressure
- Pressure and volume at the source from a single instrument

SCISENSE PRESSURE-VOLUME CATHETERS ARE COMPATIBLE WITH ALL OTHER COMMERCIALLY AVAILABLE RODENT PRESSURE-VOLUME SYSTEMS!

FV896 **PRESSURE-VOLUME** CONTROL BOX:

Scisense PV catheters connect to a state-of-the-art control box with signal conditioning and amplification circuitry. The PV control box outputs amplified analog signals for collection and analysis by any commercially available computer acquisition and analysis system.

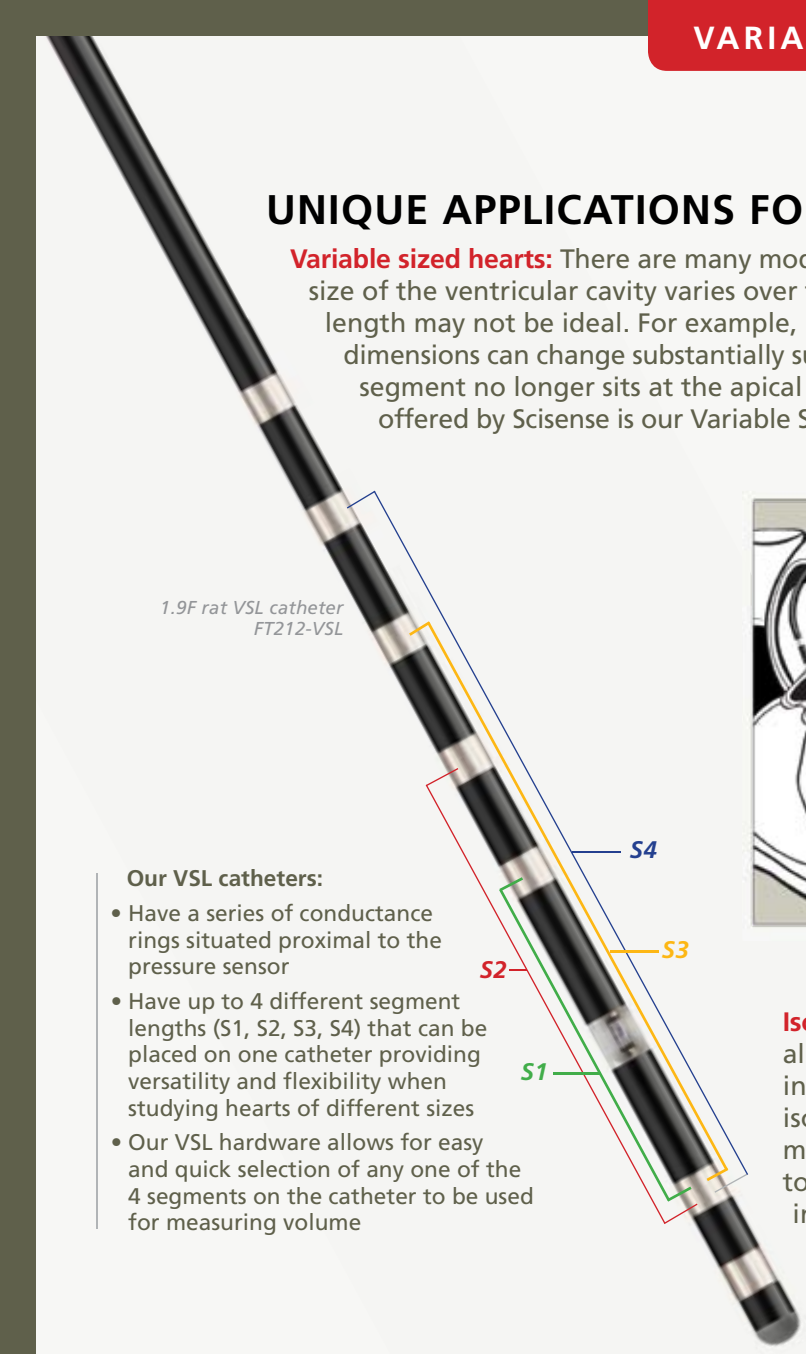
Pressure-volume control box FV896

FEATURES/BENEFITS – PV HARDWARE:

- LED display for pressure and conductance voltage output
- 2-point electronic calibration with balance control for pressure
- Separate electronic conductance calibration for mouse and rat volumes
- Controls mounted on 15 degree angle for easy user access
- Pressure output > 2 V/100 mmHg (no additional amplifier needed)

UNIQUE APPLICATIONS FOR VSL TECHNOLOGY:

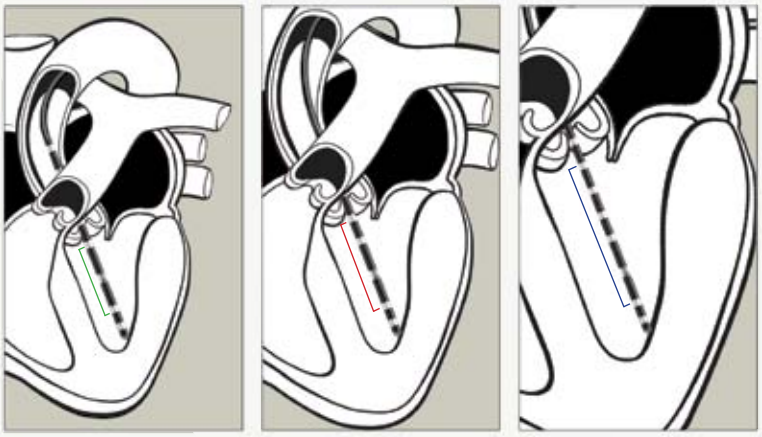
Variable sized hearts: There are many models of cardiac dysfunction (mouse, rat, rabbit) where the size of the ventricular cavity varies over time and using a volume catheter with a fixed segment length may not be ideal. For example, in heart failure mice and diabetic rats, intraventricular dimensions can change substantially such that the standard ring spacing for the conductance segment no longer sits at the apical and basal limits of the chamber. An innovative solution offered by Scisense is our Variable Segment Length (VSL) Technology.



1.9F rat VSL catheter FT212-VSL

Our VSL catheters:

- Have a series of conductance rings situated proximal to the pressure sensor
- Have up to 4 different segment lengths (S1, S2, S3, S4) that can be placed on one catheter providing versatility and flexibility when studying hearts of different sizes
- Our VSL hardware allows for easy and quick selection of any one of the 4 segments on the catheter to be used for measuring volume



Small heart, S1 *Normal heart, S2 or S3* *Enlarged heart, S3 or S4*

Isolated working heart studies: Isolated heart preparations allow for measurement of cardiac function without the influence of neurohormonal factors. Furthermore, the isolated heart model eliminates any impact anesthetics may have on function. For some time, it has been possible to study function in the isolated *working* rat heart and in recent years, more literature is being published citing the use of an isolated *working* murine heart. Until now, because of the resistivity values of blood replacement solutions, it has not been possible to use conductance technology to derive volume in the isolated heart model. The FV898 VSL control box addresses this research segment.

FV898 **VSL PRESSURE-VOLUME** CONTROL BOX:

Scisense VSL catheters connect to an enhanced signal conditioning and amplification hardware unit. Controls allow for the selection of which recording electrode segment is to be used for volume determination and also manual adjustment of the output voltage range.

VSL pressure-volume control box FV898

FEATURES/BENEFITS – VSL HARDWARE:

- For use with standard PV and VSL catheters
- Can be used with solutions of different conductivity to blood (e.g. KREBS)
- Able to measure high values without saturating signal at high end of voltage output scale
- Has adjustable gains and offset to be used with ANY conductive medium with various-sized rodent hearts
- Analog output for compatibility with other data acquisition systems

PRESSURE-VOLUME (PV) CATHETER SPECIFICATIONS

CATHETER MODEL	ANIMAL	MATERIAL	OVERALL LENGTH	OUTER DIAMETER	ELECTRODE SEGMENT LENGTHS	NUMBER OF PRESSURE SENSORS
FT112	Mouse	Polyimide	18" (45 cm)	1.2F (0.39 mm)	4.5 mm	1
FT114	Mouse	Polyimide	18" (45 cm)	1.2F (0.39 mm)	4.5 mm	2
FT212	Rat	Polyimide	18" (45 cm)	1.9F (0.63 mm)	8.0 mm	1
FT214	Rat	Polyimide	18" (45 cm)	1.9F (0.63 mm)	8.0 mm	2

VARIABLE SEGMENT LENGTH (VSL) PRESSURE-VOLUME CATHETER SPECIFICATIONS

CATHETER MODEL	ANIMAL	MATERIAL	OVERALL LENGTH	OUTER DIAMETER	ELECTRODE SEGMENT LENGTHS
FT212-VSL-6/8/10/12	Rat	Polyimide	18" (45 cm)	1.9F (0.63 mm)	6/8/10/12 mm
FT312-VSL-11/14/17/20	Rabbit	Polyimide	24" (60 cm)	3.0F (1.00 mm)	11/14/17/20 mm

HARDWARE/SOFTWARE BUNDLES

PRESSURE-VOLUME SYSTEM		VSL PRESSURE-VOLUME SYSTEM	
RPV-6 MOUSE PV SYSTEM	**RPV-6 RAT PV SYSTEM**	**VSLPV-6 RAT PV SYSTEM**	**VSLPV-6 RABBIT PV SYSTEM**
HARDWARE:			
(2) 1.2F Mouse Pressure-Volume Catheters	(2) 1.9F Rat Pressure-Volume Catheters	(2) 1.9F Rat VSL Pressure-Volume Catheter with 6/8/10/12 mm Segment Length Options *custom spacings available	(2) 3F Rabbit VSL Pressure-Volume Catheters with 11/14/17/20 mm Segment Length Options *custom spacings available
Pressure-Volume Control Box	Pressure-Volume Control Box	VSL Pressure-Volume Control Box	VSL Pressure-Volume Control Box
Scisense Catheter Cable	Scisense Catheter Cable	Scisense Catheter Cable	Scisense Catheter Cable
(2) BNC Connector Cables	(2) BNC Connector Cables	(2) BNC Connector Cables	(2) BNC Connector Cables
Power Supply	Power Supply	Power Supply	Power Supply
Mouse Calibration Cuvette	Rat Calibration Cuvette	VSL Calibration Cuvette	VSL Calibration Cuvette
SOFTWARE:			
Analog-to-Digital (A/D) Converter with Interface Box	Analog-to-Digital (A/D) Converter with Interface Box	Analog-to-Digital (A/D) Converter with Interface Box	Analog-to-Digital (A/D) Converter with Interface Box
Real-time Acquisition/Analysis Software	Real-time Acquisition/Analysis Software	Real-time Acquisition/Analysis Software	Real-time Acquisition/Analysis Software
Pressure-Volume Loop Analysis Module	Pressure-Volume Loop Analysis Module	Pressure-Volume Loop Analysis Module	Pressure-Volume Loop Analysis Module

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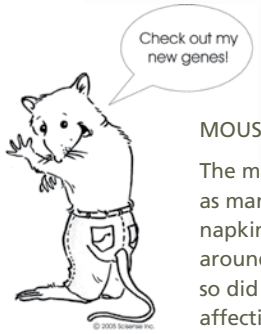

MOUSE'N GENES

The mouse'n genes was conceived, as many great ideas, on a restaurant napkin. As a serious discussion around transgenic mice evolved, so did Sammy Scisense, as he is affectionately known today.

FOR ANIMAL USE ONLY