



**HUGO SACHS
ELEKTRONIK**



The Physiology Specialists

Isolated Lung

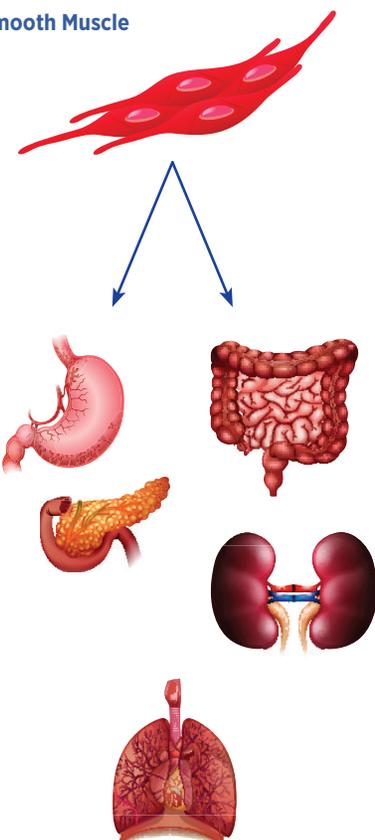
PERFUSION SYSTEMS

For Small to Large Animal Models



PERFUSION & TISSUE BATH SYSTEMS OVERVIEW

Solutions for All Aspects of Animal Physiology Research

	Organs	Systems for Organs/Applications
Smooth Muscle 	GASTROINTESTINAL TRACT <ul style="list-style-type: none"> • Esophagus • Stomach • Liver/Pancreas • Intestine 	<ul style="list-style-type: none"> • Moist Chamber—perfusion of liver, pancreas • UP-100—perfusion of liver ex vivo or in situ • PBTO—intraluminal intestine perfusion • SCP—perfusion of GI organs and tissues using peristaltic pump • IPR—perfusion of ileum peristaltic reflexes
	UROGENITAL TRACT <ul style="list-style-type: none"> • Kidney • Placenta 	<ul style="list-style-type: none"> • Moist Chamber—perfusion of kidney, uterus • UP-100—perfusion of kidney ex vivo or in situ • PBTO—intraluminal vas deferens perfusion
	VASCULAR MUSCULATURE <ul style="list-style-type: none"> • Hind Quarter • Mesenteric Bed • Coronary Vasculature 	<ul style="list-style-type: none"> • Moist Chamber with Edema Balance—simultaneous vascular and intraluminal perfusion • UP-100—perfusion of mesenteric bed, hindquarter, hind quarter ex vivo or in situ • IH-SR, IH-5, IH-9—isolated heart perfusion of small rodent, rabbit, small pig • PBTO—blood vessel perfusion
	BRONCHIAL MUSCULATURE <ul style="list-style-type: none"> • Lung 	<ul style="list-style-type: none"> • IPL-1, IPL-2, IPL-4, IPL-16—isolated lung perfusion of mouse, rat, guinea pig, rabbit, pig • PBTO—intraluminal trachea perfusion • PCLS—precision cut lung slice chamber <p>See our <i>Isolated Lung Brochure</i> for more information.</p>
Cardiac 	HEART <ul style="list-style-type: none"> • Langendorff • Working Heart • Heart-Lung Preparation 	<ul style="list-style-type: none"> • UP-100, IH-SR, IH-5, IH-9— isolated heart perfusion of small rodent, rabbit, small pig <p>See our <i>Isolated Heart Brochure</i> for more information.</p>
Skeletal Muscle 	SKELTAL MUSCULATURE <ul style="list-style-type: none"> • Intact Limb • Hindquarter 	<ul style="list-style-type: none"> • UP-100—perfusion of intact limb, hindquarter ex vivo or in situ
Nerve Bundle 	NERVOUS SYSTEM <ul style="list-style-type: none"> • Brain • Spinal Cord • Ganglion 	<p>See our <i>Tissue Baths & Perfusion Systems Selection Guide</i> for more information.</p>
Tissue	TISSUES	<p>See our <i>Tissue Baths & Perfusion Systems Selection Guide</i> for more information.</p>

Isolated Lung

PERFUSION SYSTEMS

For Small to Large Animal Models

Hugo Sachs Elektronik (HSE), part of the Harvard Bioscience family of companies, provides top-notch, fully integrated physiology research systems, including perfusion and tissue bath systems for many organ and tissue types.

Hugo Sachs' IPL Series of isolated lung perfusion systems are designed to enhance the ease of acquisition and quality of data for researchers in pulmonary physiology. These modular systems provide a full range of in-depth respiratory mechanics and are tailored for specific species from mouse to pig. Core systems can be supplemented with a comprehensive range of application-specific additions and options. Our product line is backed by an experienced technical support team of "physiology specialists".

This catalog contains all the information you need to choose an optimal isolated perfused lung system for your research. To ensure that your system is properly configured as a functional unit that meets your application needs, please contact Technical Services before placing an order.

For the US and outside of Europe, call 800-547-6766 or email support@hbiosci.com. In Europe, please call (49) 7665-9200-0 or email sales@hugo-sachs.de.



**HUGO SACHS
ELEKTRONIK**



**Harvard
Apparatus**

The Physiology Specialists

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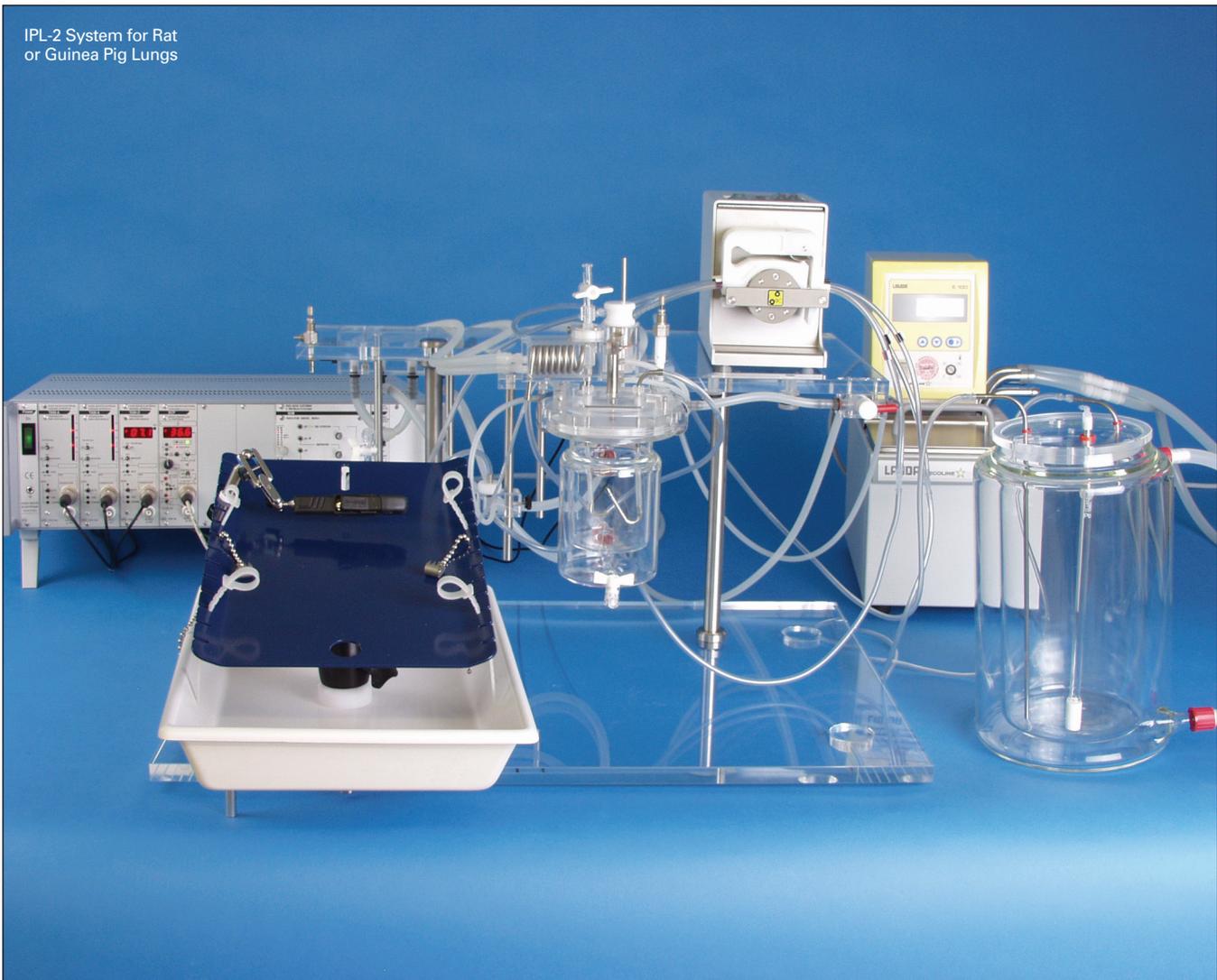
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Introduction to Isolated Lung Perfusion Systems

The Isolated Perfused Lung (IPL) method for ex vivo lung perfusion (EVLV) is an invaluable method for characterizing the non-respiratory capabilities of pulmonary tissues such as pulmonary metabolic activity as well as the activities of various components (pulmonary alveolar macrophage, alveolar tissue, endothelial tissue, etc.) in response to inhaled/airborne particulates or therapies (drug testing, toxicology testing, etc.). Isolated lung systems are equally useful for evaluating respiratory functions such as respiratory mechanics and gas exchange. The lungs, even though removed from the body, are still an intact functional organ. Unlike other in vitro methods such as tissue slices and cultures, they can continue their physiological function, now without interference from the CNS and other systems of the living organism.

IPL-2 System for Rat or Guinea Pig Lungs



INTRODUCTION TO IPL SYSTEMS



Technology Designed for the Unique Requirements of the Isolated Perfused Lung

The IPL system architecture utilizes a unique technology to enable seamless switching between positive and sub-atmospheric (negative) pressure ventilation on all models*. Sub-atmospheric pressure ventilation is the natural method of lung inflation and has been demonstrated to allow a much increased pulmonary artery flow and decreased edema formation in comparison to positive pressure ventilation. Combined with constant pressure perfusion, optimal physiologic lung function similar to in vivo can be more easily achieved.

The IPL preparation requires both the perfusion of the vascular system and the ventilation of the respiratory tract. Like all HSE perfusion systems, the IPL series utilizes a Solid State Physiological Perfusion Circuit technology, defined by the use of a solid block of material (Perspex) with precision-milled perfusion and ventilation pathways. The technology is integrated into a common architecture, appropriately scaled for species, ensuring precisely repeatable non-turbulent perfusion, minimal perfusion circuit dead space, and ventilation for the highest fidelity pressure and flow measurements. This, combined with the natural thermal properties of Perspex, creates a system that allows control, maintenance and monitoring of pulmonary parameters in a way that is more physiologically relevant than any conventional perfusion system.

Systems begin at basic perfusion and ventilation. The addition of measurement devices, signal conditioning equipment and data acquisition software provide a superior solution for virtually any study. Building your system is as simple as selecting the core system for your lung model and then adding various options to suit the particular needs of your study.

Should any questions arise, our expert team of scientists and engineers is always ready to assist you with system configuration, application support or custom design requests.

* Not available for IPL-16 systems

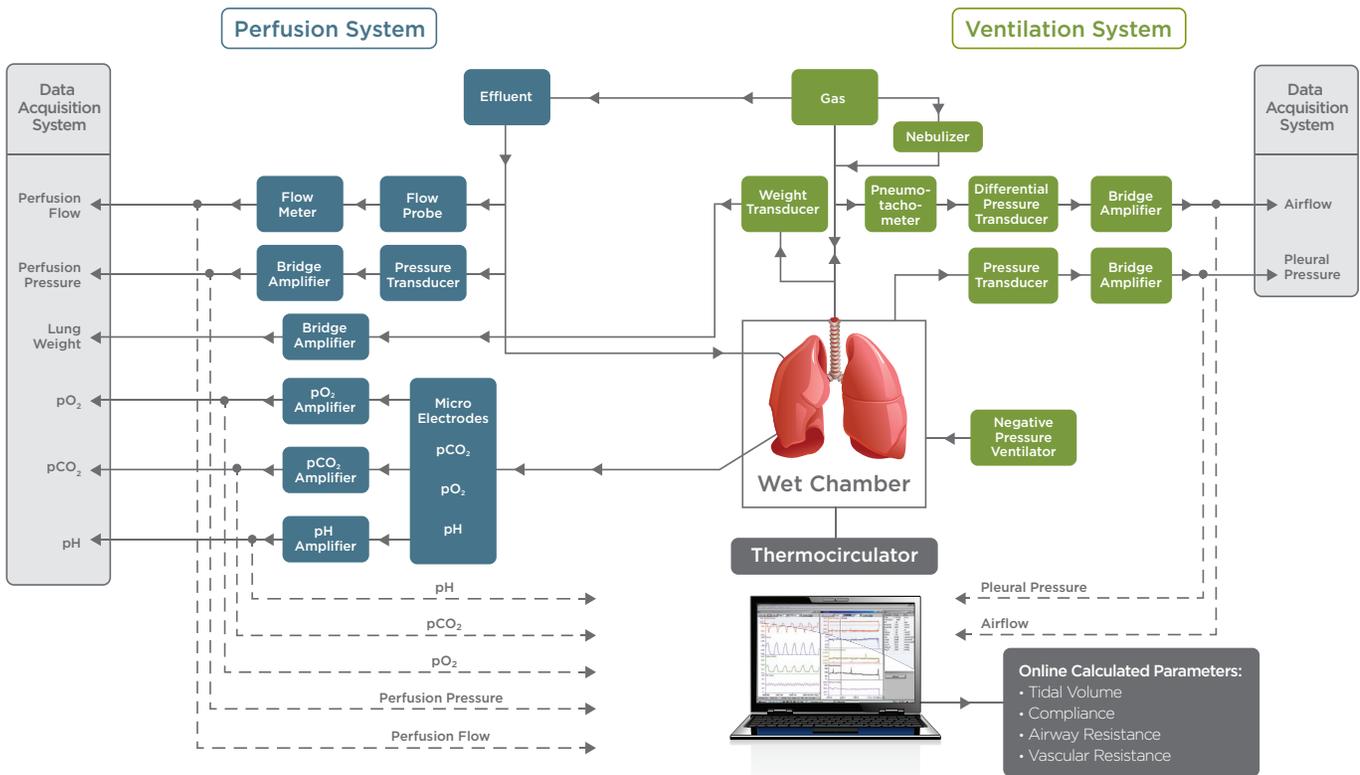
Constant Flow vs. Constant Pressure Perfusion in Lungs

Lungs can be perfused by either constant flow or constant pressure. Although constant flow perfusion may mimic the in vivo situation more closely, it has the disadvantage that in case of vasoconstriction, hydrostatic edema becomes inevitable. Since lymph drainage is not possible in perfused lungs, extravascular water will accumulate quickly. For this reason, when using constant flow perfusion, small flow rates have been used to minimize hydrostatic edema. However, small flow rates may decrease lung functions such as serotonin metabolism and protein synthesis.

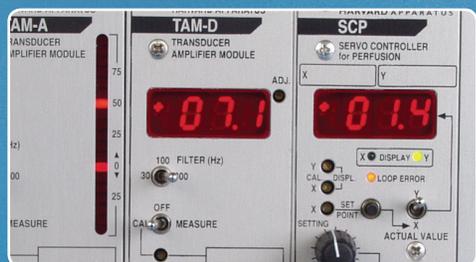
Constant pressure perfusion is a more physiologically relevant method of perfusion which helps to extend the viability of the lung. By allowing the normal regulation of vascular pressure through vasoconstriction, regional flow is regulated naturally leading to minimal hydrostatic edema, often seen with constant flow perfusion. As a result, perfusing the lungs under constant pressure conditions allows the investigator to study edema formation caused by changes in vascular permeability. If the vascular resistance is calculated, pressure and flow must be measured. In the case of flow measurement, flow can be measured directly by using an ultrasonic transit time flowmeter (PLUGSYS TTFM-2 module) or indirectly by calculating the flow rate from the peristaltic pump's speed (PLUGSYS SCP module).

All core IPL system packages are configured to include our PLUGSYS SCP control module, suitable peristaltic pump capable of external analog speed control, pressure transducer and amplifier. The pressure transducer amplifier supplies a feedback signal to the SCP module which varies the pump speed to maintain constant perfusion pressure. The output of the SCP module can be calibrated to allow measurement of the perfusion flow. A switch on the SCP module allows the user to choose or switch between either constant pressure or constant flow perfusion as needed.

Block Diagram for the Isolated Perfused Lung

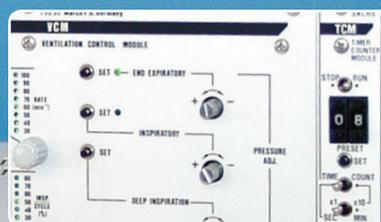


IPL-1 Isolated Perfused Lung System



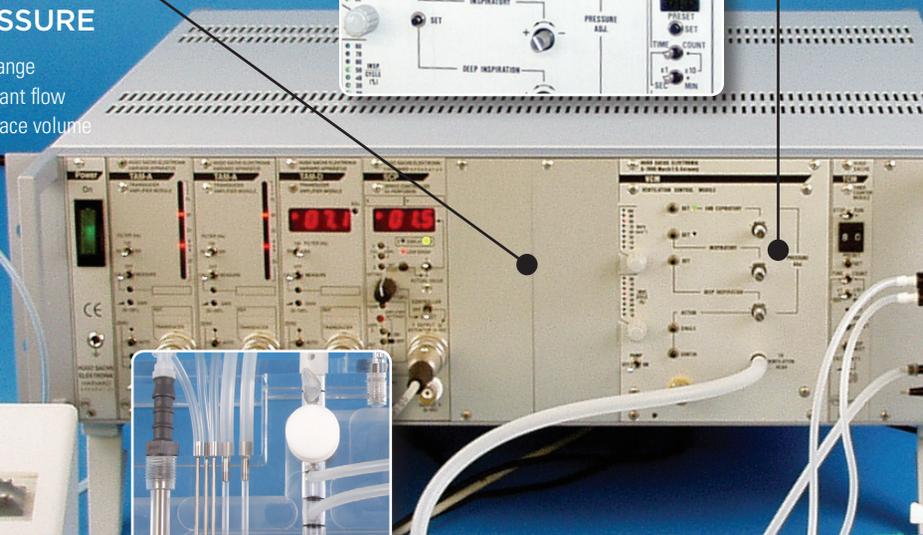
POSITIVE & SUB-ATMOSPHERIC (NEGATIVE) PRESSURE VENTILATION

- Option for positive and negative pressure ventilation with one-step switch



CONSTANT FLOW & PRESSURE

- A switch on the SCP module can rapidly change the system from constant pressure to constant flow perfusion with no change in circuit dead-space volume



RESPIRATORY PATH

- Built-in, warmed pneumotachometer for minimal dead space volume
- Milled infusion and pressure measurement paths allow access to closed chamber
- Built-in humidifier frit prevents lung drying

UNIQUE CANNULAE

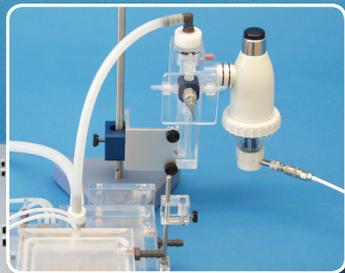
- Cannulae are matched to the size of mouse vessels
- Tip occlusion protectors and mini-ball holder system minimize the incidence of vascular occlusion
- Pulmonary artery cannula incorporates secondary bubble trap to prevent air emboli during perfusion
- Mini ball joint system secures cannulae in optimal position



IPL-1 ISOLATED PERFUSED LUNG SYSTEM FOR MOUSE

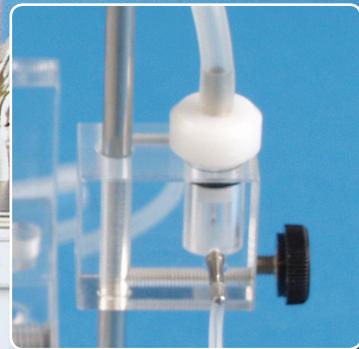
OPTIONS

- Simple add-on aerosol nebulizer
- Multi-gas for hyperoxic, hypercapnic, anesthetic or other gas mixtures



PRESSURE BALANCED

- Pressure-balancing vessel eliminates transmural pressure difference during sub-atmospheric pressure ventilation
- Allows for simulation of hypertensive cardiac afterload



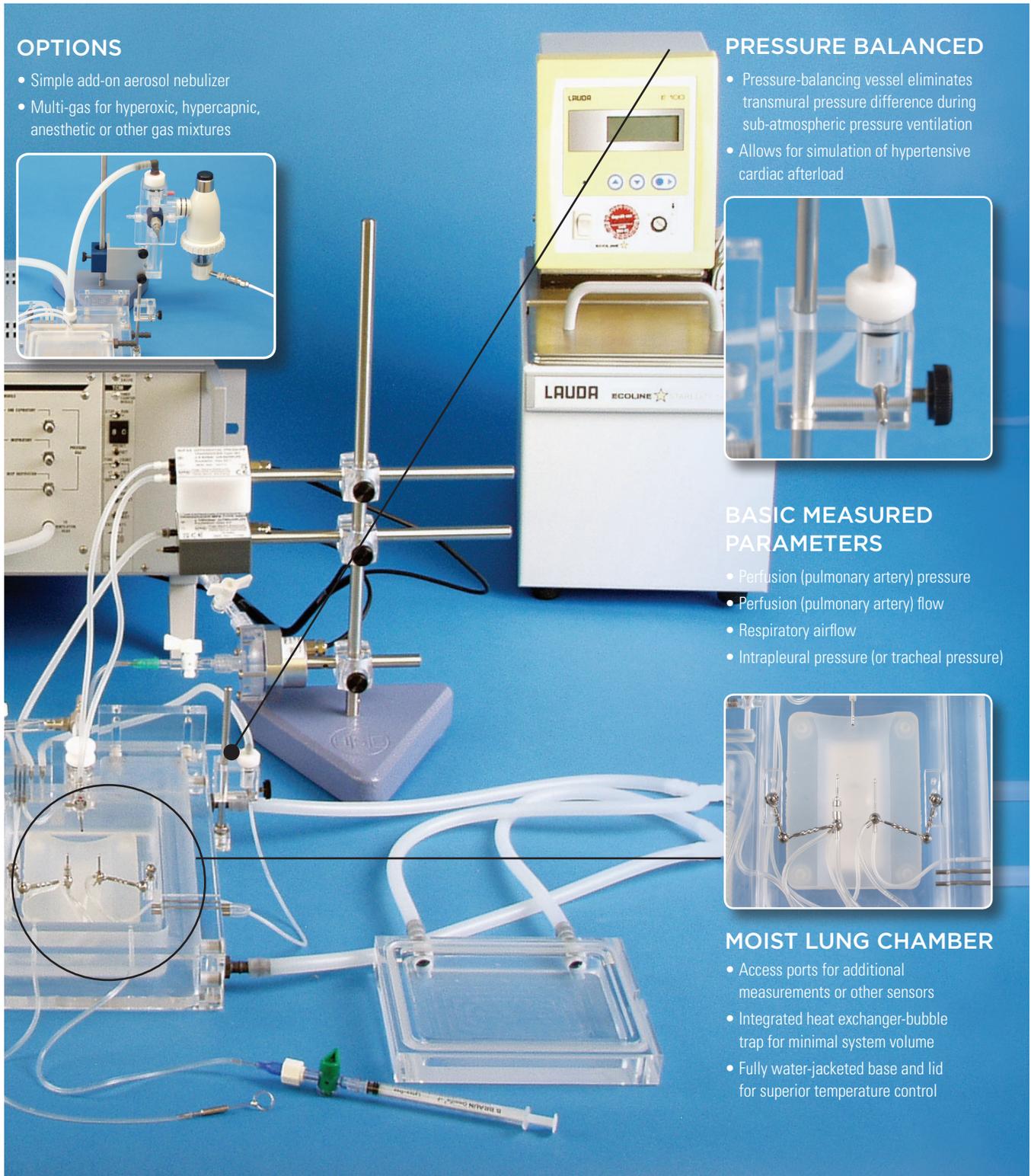
BASIC MEASURED PARAMETERS

- Perfusion (pulmonary artery) pressure
- Perfusion (pulmonary artery) flow
- Respiratory airflow
- Intrapleural pressure (or tracheal pressure)

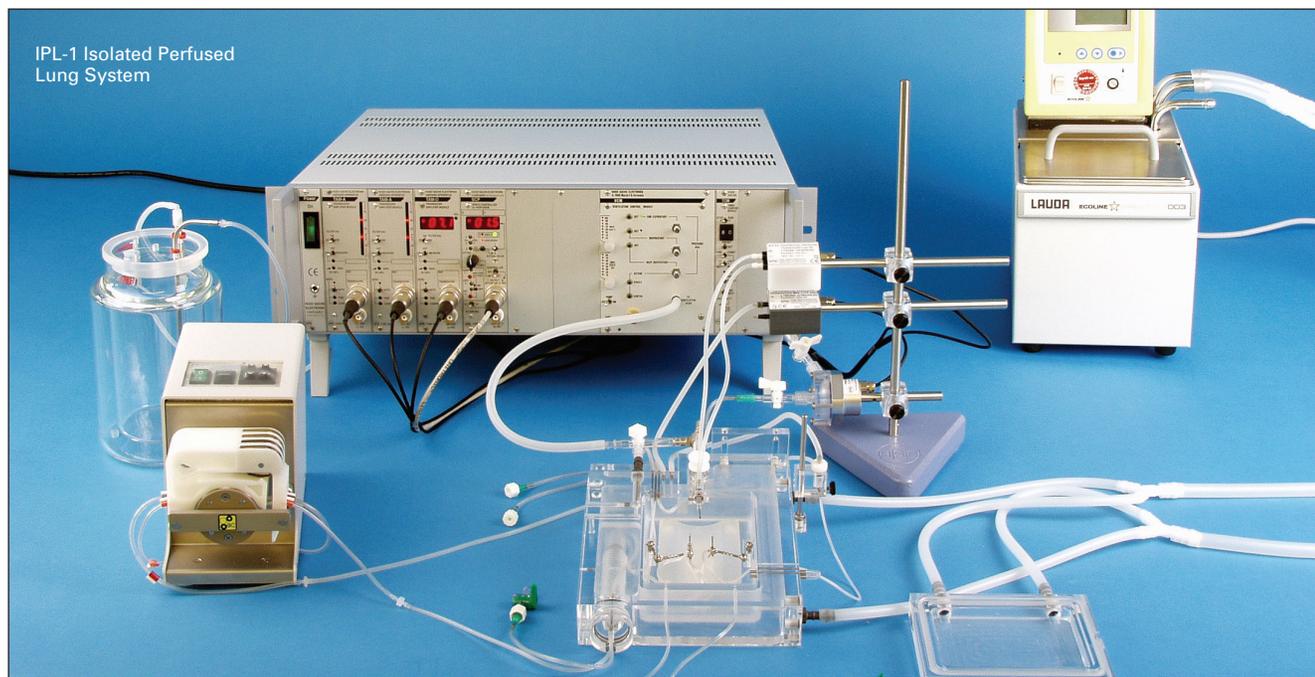


MOIST LUNG CHAMBER

- Access ports for additional measurements or other sensors
- Integrated heat exchanger-bubble trap for minimal system volume
- Fully water-jacketed base and lid for superior temperature control



IPL-1 Core System



The IPL-1 is an ex vivo lung perfusion (EVLV) system specifically engineered for the fragile mouse lung. The core system can be initially configured with various system options or upgraded later as your needs change.

The IPL-1 core system contains all the primary equipment to accomplish the basic perfusion and ventilation experiments, requiring only the addition of core options for ventilation. Application-specific upgrades and options are also available.

Advanced System Design

Due to the fragile nature of the mouse lung, its suspension from the tracheal and vascular cannulae is difficult to accomplish without the rapid occurrence of edema. In collaboration with experts in pulmonary physiology, a design was developed which allows for ventilation and perfusion with the lungs remaining in situ at a slight incline in the open thorax. This novel approach simplifies cannulation of the pulmonary artery and left atrium of the heart and dramatically reduces edema formation.

Most of the studies with isolated perfused lungs have been performed with lungs obtained from rats, guinea pigs, rabbits or dogs. The interaction of the immune system with the lung is currently an area of great interest. The mouse is the best characterized rodent species with respect to its immune system. Immunologic probes such as antibodies and cytokines are more widely available for mice versus other species. Likewise, the mouse is the most commonly used animal model in the biomedical research community due to the wealth of genetically modified variants for the species.

Ventilation

The HSE IPL systems for EVLP are the only commercially available systems that allow the investigator to select either positive or negative pressure ventilation. Positive pressure ventilation can be used in studies that seek to mimic clinical EVLP systems. Sub-atmospheric pressure ventilation, due to the substantial difference in vascular flow rates, allows one to more precisely mimic the in vivo physiological conditions. The lung is placed in the chamber and ventilated by either positive airway pressure or negative artificial thoracic pressure. It is connected through the tracheal cannula to the pneumotachometer for measurement of respiratory air flow. Using either positive or negative pressure, the respiration rate, the inspiratory pressure and the end-expiratory pressure can be adjusted with separate controls using the Ventilation Control Module (VCM). Positive only ventilation using a regular MiniVent ventilator is also possible. The surgery is always performed under positive ventilation to avoid the lung collapsing. Switching over to sub-atmospheric ventilation only requires you to attach the chamber lid and switch over a stopcock. Switching back to positive ventilation is always possible.

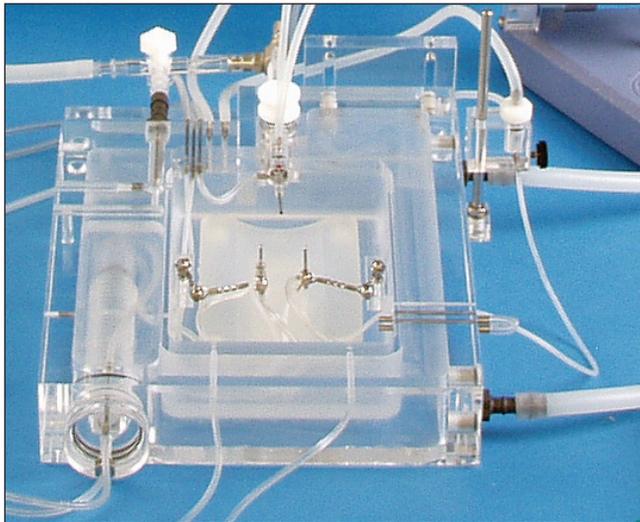
Perfusion

The pulmonary artery is cannulated to provide perfusion. The perfusate is passed by means of a roller pump at constant flow or constant pressure (using the SCP module) through the heat exchanger, through a bubble trap to the pulmonary artery and finally into the lung vascular bed. The perfusate outflow is usually provided by cannulating the left atrium of the heart. The non-functional lung remains in the thoracic cavity and allows easier cannula placement for the effluent.

IPL-1 ISOLATED PERFUSED LUNG SYSTEM FOR MOUSE

Applications

- Investigation of ventilation and perfusion in the isolated mouse lung
- Continuous measurement of respiratory mechanics (respiration rate, inspiratory and expiratory air flow, tidal volume, minute volume, dynamic airway resistance, dynamic lung compliance) and perfusion characteristics (pulmonary artery pressure, left atrium pressure, lung vascular resistance, pO_2 , pCO_2 , pH)
- Drug testing on respiration and vascular parameters



- Toxicology tests on respiration and vascular parameters
- Aerosol tests, surfactant studies, etc.

Features & Benefits

- Exclusive artificial thorax chamber for isolated lung with integrated changeover system—quick switch between simple positive-pressure ventilation and physiological sub-atmospheric (negative) pressure ventilation
- Integrated surgery table—reduces damage during preparation
- Pressure-balancing vessel—eliminates transmural pressure difference during sub-atmospheric pressure ventilation; allows for simulation of hypertensive cardiac afterload
- Built-in, warmed pneumotachometer—minimal dead space volume
- Low flow resistance and dead space volume—minimizes perfusion artifacts
- Milled infusion and pressure measurement paths—allow access to closed chamber
- Built-in humidifier frit—prevents lung drying
- Moist lung chamber has access ports for additional measurements or other sensors
- Simple add-on aerosol nebulizer
- Optional multi-gas inlet adapter for hyperoxic, hypercapnic, anesthetic or other alternative gas studies
- Drug injection pathway built directly into pulmonary perfusate stream

- Cannulae are matched to size of mouse vessel and feature tip occlusion protectors and an articulated mini ball system which allow cannulae to be precisely positioned—further reducing incidence of vascular occlusion

Measured Signals and Calculated Parameters

- Pulmonary artery (perfusion) pressure
- Respiratory airflow
- Intrapleural (artificial thorax) pressure or tracheal pressure
- Perfusion flow (calculated by the SCP from pump speed or measured directly using an integrated transit time flow probe)

The following parameters can be calculated from the raw data*:

- Respiration rate
- Peak inspiratory and expiratory airflow
- Tidal volume, minute volume
- Vascular resistance
- End-inspiratory and end-expiratory pressures
- Dynamic airway resistance and dynamic lung compliance
- Inspiratory time and expiratory time (Software Option)

* Calculations are automatic when PULMODYN Data Acquisition Software is used. See page 51.

Included Items

Included items are representative of a typical IPL-1 Core System. Individual components can be customized to your needs.

IPL-1 Core System, 230 V (73-4291) includes:		IPL-1 Core System, 115 V (73-4292) includes:	
Item #	Product Name	Item #	Product Name
73-2329	Base Unit for the Mouse Isolated Perfused Lung	73-2329	Base Unit for the Mouse Isolated Perfused Lung
73-4544	TC120 Thermocirculator, complete with 5 L stainless steel bath and lid, 220 V	73-4545	TC120 Thermocirculator, complete with 5 L stainless steel bath and lid, 120 V
73-3436	Water-Jacketed Glass Perfusate Reservoir with Oxygenating Frit, 0.5 L	73-3436	Water-Jacketed Glass Perfusate Reservoir with Oxygenating Frit, 0.5 L
73-3456	Tube Set for Jacketed Buffer Reservoir with Fluid Line Shutoff Valves	73-3456	Tube Set for Jacketed Buffer Reservoir with Fluid Line Shutoff Valves
73-0114	REGLO Analog 4-Channel Peristaltic Pump, 230 VAC, 50 Hz	73-0113	REGLO Analog 4-Channel Peristaltic Pump, 115 VAC, 60 Hz
73-1825	3-Stop Tygon® E-Lab Tubing, 0.89 mm ID, 12/pack, Orange/Orange	73-1825	3-Stop Tygon® E-Lab Tubing, 0.89 mm ID, 12/pack, Orange/Orange
73-0126	3-Stop Tygon® E-Lab Tubing, 1.22 mm ID, 12/pack, Red/Grey	73-0126	3-Stop Tygon® E-Lab Tubing, 1.22 mm ID, 12/pack, Red/Grey
73-0500	Lab Stand with Triangular Base Plate, 30 cm Rod Length (one block clamp included)	73-0500	Lab Stand with Triangular Base Plate, 30 cm Rod Length (one block clamp included)
73-0566	Block Clamp to Mount Second Transducer onto 73-0500 Stand (up to 9 mm OD)	73-0566	Block Clamp to Mount Second Transducer onto 73-0500 Stand (up to 9 mm OD)
73-0045	PLUGSYS Case, Type 603*	73-0045	PLUGSYS Case, Type 603
73-2806	Servo Controller for Perfusion (SCP)	73-2806	Servo Controller for Perfusion (SCP)
Perfusion Pressure Measurements			
73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module	73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module
73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)*	73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)
Respiratory Airflow Measurements			
73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector	73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)
Artificial Thorax or Tracheal Pressure Measurements			
73-0064	Airway/Thoracic Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector	73-0064	Airway/Thoracic Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)

*See PLUGSYS Modules & Housings on page 49–50 for information about PLUGSYS modules and optional PLUGSYS housings.

The Base Unit (73-2329) includes:

Temperature-controlled negative pressure lung chamber (artificial thorax) with cover including Venturi jet, positive pressure ventilation head, air humidifier, pneumotachometer, connectors to interface with the perfusion system, pressure equilibration vessel for venous flow and all necessary accessories (tracheal cannulae, pulmonary artery cannulae, left atrium cannulae). Optional Y adapter available for positive pressure ventilation.

Mouse Cannulae (included with Base Unit):

- Tracheal Cannula for Mouse, ID 1.0 mm, OD 1.3 mm, L 20 mm (73-4181)
- Pulmonary Artery Cannula for Mouse, Stainless Steel, ID 1.0 mm, OD 1.3/1.6 mm, L 28 mm (73-0723)
- Atrial Cannula for Mouse, ID 1.0 mm, OD 1.6 mm, L 24 mm (73-0724)

Standard Options for the Core IPL-1 System (Purchase Separately)

PULMODYN Data Acquisition Software

Online evaluation of a wide range of signals and classical respiration parameters. *See page 51.*

Note: Ponemah Data Acquisition & Analysis Software from DSI, a Harvard Bioscience Company is also suitable. See page 51.

Ordering Information

Item #	Description
73-4291	IPL-1 Core System for Isolated Perfused Mouse Lung, 230 VAC
73-4292	IPL-1 Core System for Isolated Perfused Mouse Lung, 115 VAC

Ventilation for IPL-1

For a functional unit the core system requires a suitable ventilation system. For only positive ventilation a mouse ventilator can be used. If positive and sub-atmospheric pressure ventilation is required, the Ventilation Control Module must be purchased.

Positive and Sub-Atmospheric (Negative) Pressure Ventilation with Ventilation Control Module (VCM)

- Used to control the ventilation of the isolated lung preparation. Allows for the physiological negative pressure ventilation of the lung and positive ventilation during preparation
- 30 to 100 breaths per minute
- I:E ratio can be set between 10 and 90% in 10% steps
- End-inspiratory, end-expiratory, sigh, positive and negative pressures can be individually set
- The TCM Timer Counter Module allows periodic sigh (hyperinflation) breaths to minimize edema formation
- An adapter to supply the trachea with a gas mixture different than room air during negative ventilation can be added

IPL-1 ISOLATED PERFUSED LUNG SYSTEM FOR MOUSE

Negative Pressure Ventilation Control Option with Pump for IPL-1 & 2 (73-4279) includes: Utilizes 6 slot units		Negative Pressure Ventilation Control Option with Pressure Regulator for IPL-1 (73-4293) includes: Utilizes 6 slot units	
Item #	Product Name	Item #	Product Name
73-1741	PLUGSYS Ventilation Control Module with Integral Pump (VCM-P)	73-2795	PLUGSYS Ventilation Control Module with Regulator (VCM-R)*
73-1750	PLUGSYS Time Counter Module (TCM)	73-1750	PLUGSYS Time Counter Module (TCM)
N/A	See above	73-2789	Pressure-Free Gas Supply Adapter for Alternative Gas Supply**

* Negative pressure ventilation with a pressure regulator (73-4293) built into the VCM-R requires a pressurized gas supply from a tank or house air in the range of 2 to 8 bar (29 to 116 PSI).

** The Pressure-Free Gas Supply Adapter (73-2789) is only for use during sub-atmospheric pressure ventilation with either the VCM-P or VCM-R and is used to supply alternative gas mixtures to the lungs.

Positive Pressure Ventilation Only

If only positive pressure ventilation will be used, choose an option below:

- Ventilation rate from 60 to 400 breaths per minute
- Stroke volume 30 to 350 µl, simple adjustment while running
- Compact size allows positioning close to system for minimal system volume

Positive Pressure Ventilation Option, 230 V (73-4305) includes:		Positive Pressure Ventilation Option, 115 V (73-4306) includes:	
Item #	Product Name	Item #	Product Name
73-0044	Mouse Ventilator MiniVent Type 845, 230 V	73-0043	Mouse Ventilator MiniVent Type 845, 115 V
73-2792	Y-Adapter to Connect External Respirator to IPL-1	73-2792	Y-Adapter to Connect External Respirator to IPL-1

Ordering Information

Item #	Description
73-4279	Negative Pressure Ventilation Control Option with Pump for IPL-1 and IPL-2
73-4293	Negative Pressure Ventilation Control Option with Pressure Regulator for IPL-1 and IPL-2
73-4305	Positive Pressure Ventilation Option for IPL-1, 230 V
73-4306	Positive Pressure Ventilation Option for IPL-1, 115 V
73-2789	IPL-1 Gas Inlet Adapter, including needle valve
73-2919	Multi-Gas Adapter for Minivent

Each IPL system can be custom configured and built based on your experimental requirements and design. Please contact our specialists to configure your system.

Specialized Applications & Options

Venous Pressure Measurement

Venous pressure transducer and amplifier for venous pressure measurement in an isolated perfused lung system. *See page 33.*

Perfusate Deoxygenation

For deoxygenation of blood or buffers containing proteins (e.g. albumin) or erythrocytes. *See page 34.*

pH Control

Delivers CO₂ to maintain pH when system is not deoxygenated with N₂/CO₂ gas mixture. *See page 35.*

Perfusion Solution Monitoring

Permits precise continuous or discontinuous measurement in liquid media or perfusate of these three key parameters: pO₂, pH and pCO₂. *See page 36.*

Temperature Measurement

Measures perfusate temperature in any isolated perfused organ system. *See page 36.*

Perfusate Filtration

For filtration of recirculated perfusate. *See page 34.*

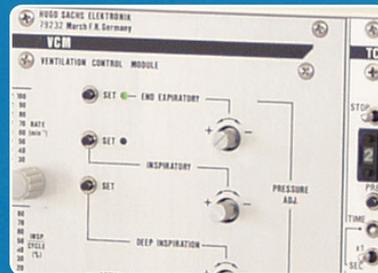
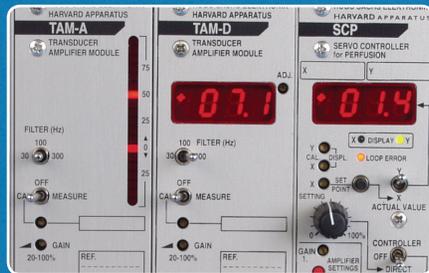
Aerosol Application

Add-on to deliver aerosols to the isolated lung. *See page 38.*

Drug Addition

For accurate drug addition using a syringe pump. Additional option for flow controlled drug addition, where flow is measured (or calculated) and a drug must be added in a certain ratio. *See page 37.*

IPL-2 Isolated Perfused Lung System

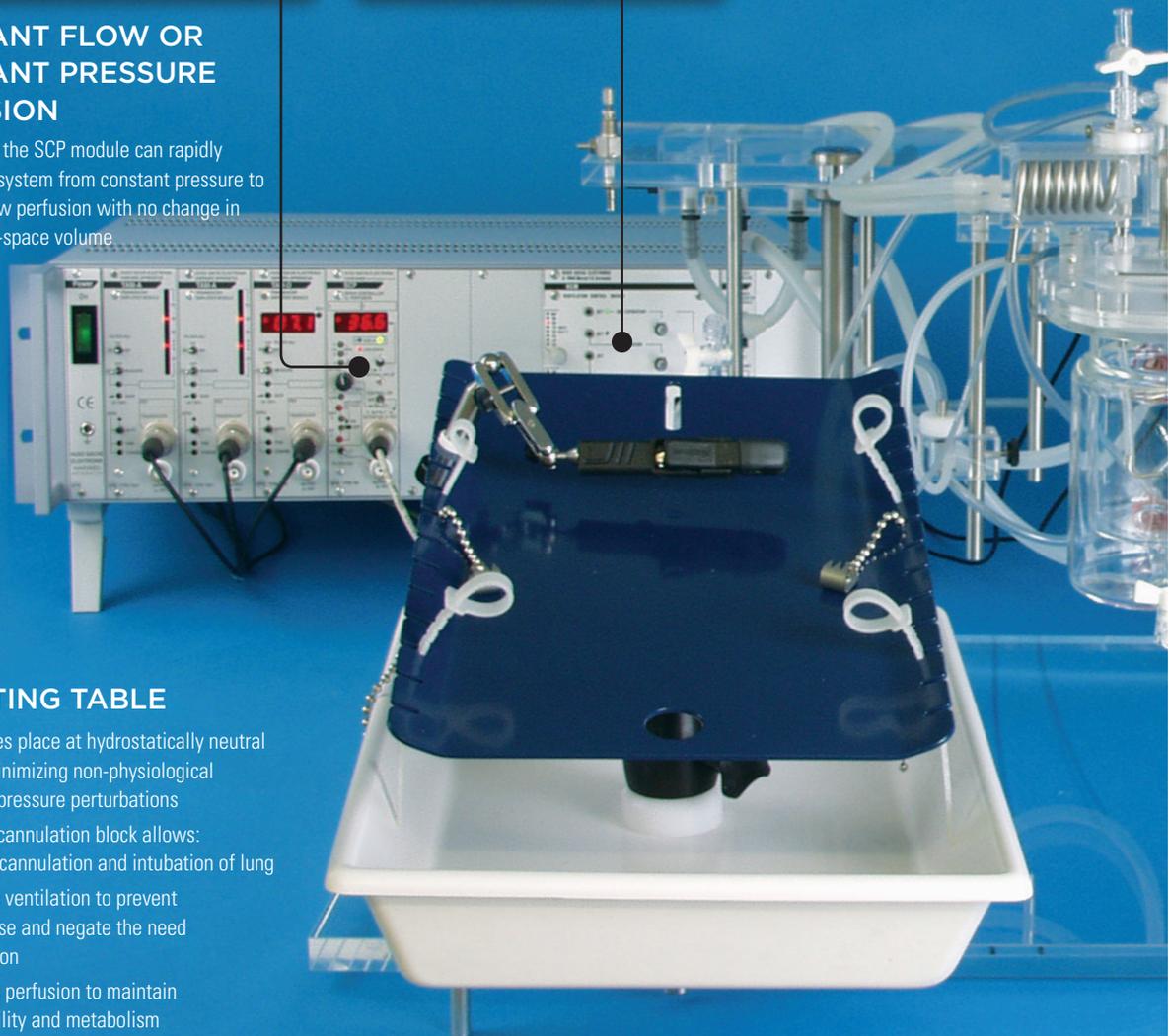


POSITIVE & SUB-ATMOSPHERIC (NEGATIVE) PRESSURE VENTILATION

- Option for positive and negative pressure ventilation with one-step switch
- Configurable periodic sigh (hyperinflation) breaths to minimize edema formation

CONSTANT FLOW OR CONSTANT PRESSURE PERFUSION

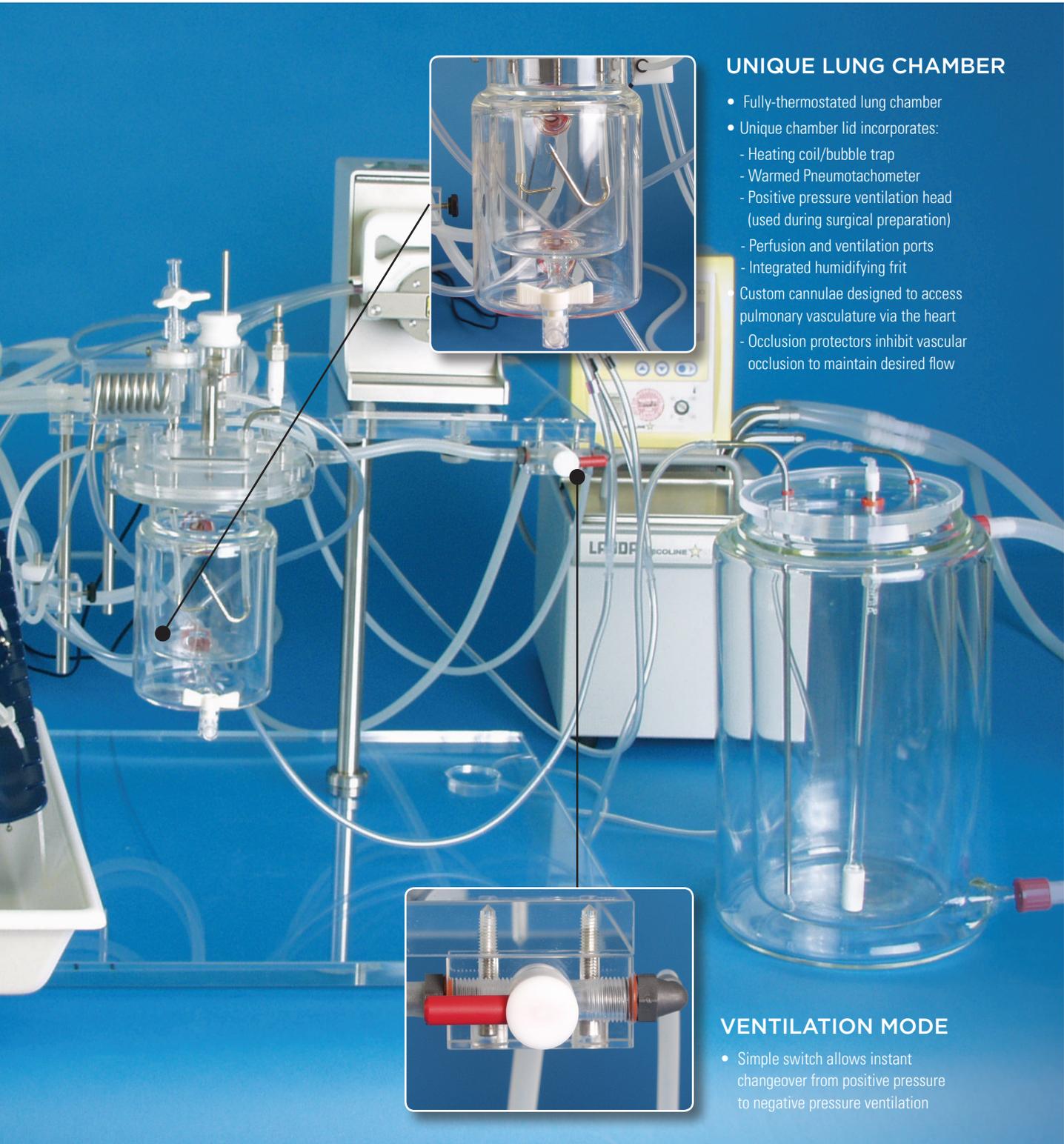
- A switch on the SCP module can rapidly change the system from constant pressure to constant flow perfusion with no change in circuit dead-space volume



OPERATING TABLE

- Surgery takes place at hydrostatically neutral elevation minimizing non-physiological hydrostatic pressure perturbations
- Removable cannulation block allows:
 - Optimized cannulation and intubation of lung
 - Continuous ventilation to prevent lung collapse and negate the need for reinflation
 - Continuous perfusion to maintain tissue viability and metabolism
- Plastic trough collects waste
- Table is easily removable for cleaning after lung is placed in chamber

IPL-2 ISOLATED PERFUSED LUNG SYSTEM FOR RAT AND GUINEA PIG



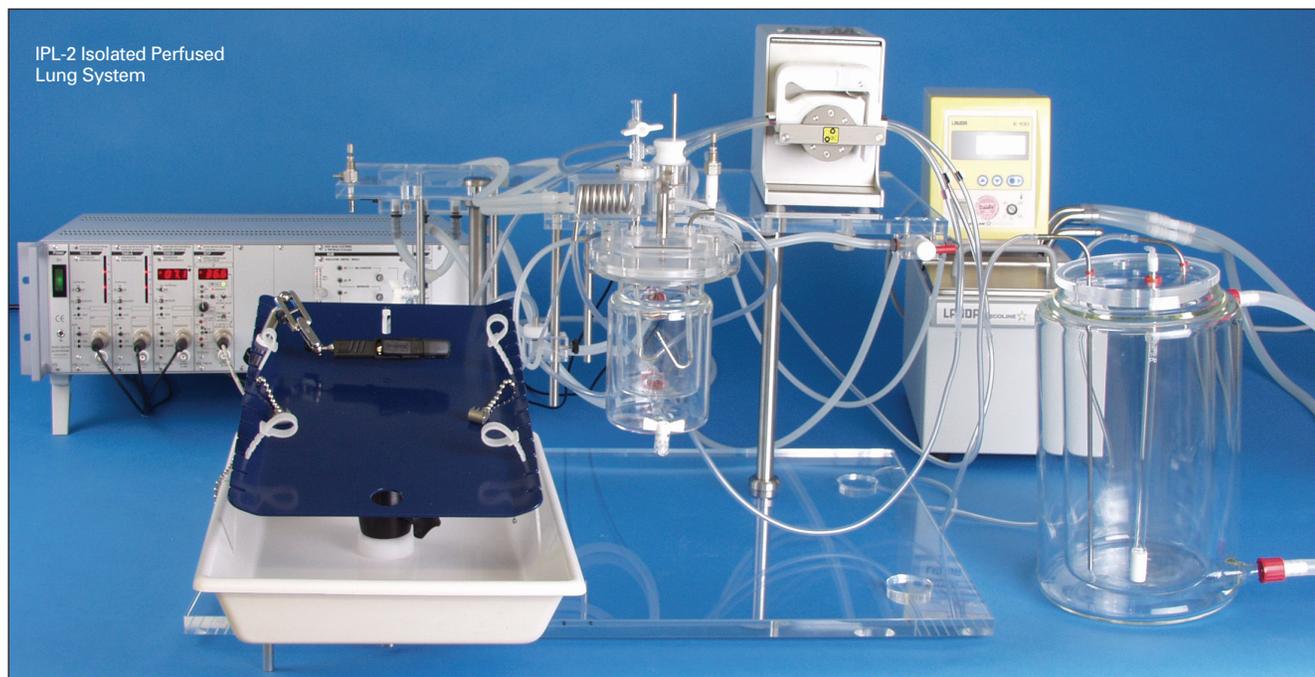
UNIQUE LUNG CHAMBER

- Fully-thermostated lung chamber
- Unique chamber lid incorporates:
 - Heating coil/bubble trap
 - Warmed Pneumotachometer
 - Positive pressure ventilation head (used during surgical preparation)
 - Perfusion and ventilation ports
 - Integrated humidifying frit
- Custom cannulae designed to access pulmonary vasculature via the heart
- Occlusion protectors inhibit vascular occlusion to maintain desired flow

VENTILATION MODE

- Simple switch allows instant changeover from positive pressure to negative pressure ventilation

IPL-2 Core System



IPL-2 Isolated Perfused Lung System

IPL-2 is an ex vivo lung perfusion (EVLV) system designed for rat and guinea pig lung. Guinea pig IPL preparations are preferred for inhalation studies while rat lungs, popular for use in pulmonary metabolism studies, are an ideal size for ease of preparation and cost-effectiveness. The system can be modified to accommodate mouse lung.

The IPL-2 core system contains all the primary equipment to accomplish basic perfusion and ventilation experiments, requiring only the addition of core options for ventilation. The core system can be initially configured with various system options or upgraded later as your needs change.

Advanced System Design

Ventilation

The lung can be ventilated with a standard positive pressure ventilator (e.g. VentElite) or with the Ventilation Control Module (VCM) which allows the researcher to do positive and sub-atmospheric pressure ventilation, to mimic the in vivo situation as closely as possible. The type of ventilation depends on the application and aim of the study.

The preparation of the lung is done in vivo under positive pressure ventilation. The tracheal cannula, the pulmonary artery cannula and the left atrium cannula are placed in situ. Also the perfusion starts in situ. The lung remains continuously ventilated during the explantation process and is transferred into the artificial lung chamber without an interruption in ventilation. A collapsed lung never would come back to the same tidal volume compared to a non-interrupted ventilation.

When the lung is placed in the artificial thoracic chamber (and the Ventilation

Control Module is used as ventilator), the lung can be ventilated by sub-atmospheric pressure using the VCM ventilator and the integrated lung chamber Venturi jet which precisely creates and controls the thoracic pressures. Respiration rate, end-inspiratory and end-expiratory pressures can be set on the Ventilation Control Module. The Ventilation Control Module also offers sigh breath in order to keep the lung in good condition and minimize edema during the perfusion.

A pneumotachometer measures the airflow in and out of the lung. From this signal the tidal volume (TV) is calculated by software (e.g. PULMODYN).

Perfusion

The lung is perfused through the cannulated pulmonary artery. The perfusate is passed by means of a roller pump at constant flow or constant pressure (using the SCP module) through a heat exchanger, a bubble trap, the pulmonary artery and finally into the lung vascular bed. For ease of cannulation, the effluent (i.e. venous) cannula is inserted through the left atrium of the heart which is surgically removed with the lung. The heart is otherwise non-functional.

Applications

- Investigation of ventilation and perfusion in the isolated rat or guinea pig lung and optionally, the mouse lung
- Drug testing on respiration and vascular parameters
- Toxicology tests on respiration and vascular parameters
- Aerosol tests, surfactant studies, etc.
- Continuous measurement of lung weight changes (edema studies)

IPL-2 ISOLATED PERFUSED LUNG SYSTEM FOR RAT AND GUINEA PIG

Features & Benefits

- Continuous measurement of respiratory mechanics (respiration rate, inspiratory and expiratory air flow, tidal volume, minute volume, dynamic airway resistance, dynamic compliance) and perfusion characteristics (pulmonary artery pressure, left atrium pressure, lung vascular resistance, pO_2 , pH)
- Optimized temperature conditions for the isolated lung; unique jacketed thoracic chamber
- Operating table for non-damaging in situ preparation
- Negative-pressure ventilation similar to in vivo condition or positive-pressure ventilation available
- Low flow resistance and dead space volume, minimize perfusion artifacts
- Unique built-in pneumotachometer and air humidifier with small dead volume
- Option for positive and negative pressure ventilation with one-step switch
- Configurable periodic sigh (hyperinflation) breaths to minimize edema formation
- Quickly change the system from constant pressure to constant flow perfusion with no change in circuit dead-space volume using a switch on the SCP module
- Drug injection pathway built directly into pulmonary perfusate stream
- Unique compensation system for vascular transmural pressure changes
- More measurement parameters than any other system

Measured Signals and Calculated Parameters

The following signals are recorded as raw data:

- Respiratory air flow
- Intrapleural (artificial thorax) pressure or tracheal pressure
- Pulmonary artery (perfusion) pressure
- Perfusion flow (calculated by the SCP from pump speed) or directly through the use of an in-line transit time flow probe.

The following parameters can be calculated from the raw data:

- Respiration rate
- Peak inspiratory and expiratory airflow
- Tidal volume, minute volume
- Vascular resistance
- End-inspiratory and end-expiratory pressures
- Dynamic airway resistance and compliance
- Inspiratory time and expiratory time (software option)

** Calculations are automatic when PULMODYN data acquisition software is used. See page 51.*

IPL-2 ISOLATED PERFUSED LUNG SYSTEM FOR RAT AND GUINEA PIG

Included Items

Included items are representative of a typical IPL-2 Core System. Individual components can be customized to your needs.

IPL-2 Core System, 230 V (73-4275) includes:		IPL-2 Core System, 115 V (73-4276) includes:	
Item #	Product Name	Item #	Product Name
73-2266	Base Unit for the Rat/Guinea Pig Isolated Perfused Lung	73-2266	Base Unit for the Rat/Guinea Pig Isolated Perfused Lung
73-4544	TC120 Thermocirculator, complete with 5 L stainless steel bath and lid, 220 V	73-4545	TC120 Thermocirculator, complete with 5 L stainless steel bath and lid, 120 V
73-3440	Jacketed Glass Reservoir for Buffer Solution, with Frit, 2.0 L	73-3440	Jacketed Glass Reservoir for Buffer Solution, with Frit, 2.0 L
73-3456	Tube Set for Jacketed Buffer Reservoir with Fluid Line Shutoff Valves	73-3456	Tube Set for Jacketed Buffer Reservoir with Fluid Line Shutoff Valves
73-0114	REGLO Analog 4-Channel Peristaltic Pump, 230 VAC, 50 Hz	73-0113	REGLO Analog 4-Channel Peristaltic Pump, 115 VAC, 60 Hz
73-0045	PLUGSYS Case, Type 603*	73-0045	PLUGSYS Case, Type 603
73-2806	Servo Controller for Perfusion (SCP)	73-2806	Servo Controller for Perfusion (SCP)
73-2488	Operating Table, Size 5	73-2488	Operating Table, Size 5
Perfusion Pressure Measurements			
73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module	73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module
73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)*	73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)
Respiratory Airflow Measurements			
73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector	73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)
Artificial Thorax or Tracheal Pressure Measurements			
73-0064	Airway/Thoracic Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector	73-0064	Airway/Thoracic Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)

See PLUGSYS Modules & Housings on page 49–50 for information about PLUGSYS Modules.

The Base Unit (73-2266) includes:

Plexiglass stand, jacketed lung chamber (artificial thorax), lid with double Perspex disk that seals the chamber and contains the connectors that interface with the perfusion system, heat exchanger, humidifier and warm up system for breathing air, pressure equilibration vessel for the venous outflow, holders for the pressure transducers and all needed accessories (pulmonary artery cannula, left atrium cannula). Tracheal cannula, must be purchased separately (different diameters available).

Pulmonary Artery and Left Atrium Cannulae (included with Base Unit):

- Large Pulmonary Artery Cannula, OD 2.0 mm, Head Diameter, 2.5 mm (73-0711)
- Left Atrial Cannula, DD 4.0 mm (73-0712)

Tracheal Cannulae and Cannulae Sets (required, purchase separately):

- Tracheal Cannula for Rat, OD 2.0 mm, L 14 mm, no Luer Connection (73-3384). Order tubing separately.
- Tracheal Cannula for Rat, OD 2.5 mm, L 17 mm, no Luer Connection (73-3557). Order tubing separately.
- Tracheal Cannula for Guinea Pig, OD 3.0 mm, L 20 mm, no Luer Connection (73-3556). Order tubing separately.
- Tracheal Cannula for Guinea Pig, OD 3.5 mm, L 24 mm (73-3555). Order tubing separately.



Tracheal Cannula Set for Rat (73-4277) includes:

- Tracheal Cannula for Rat, OD 2.0 mm, L 14 mm, no Luer Connection (73-3384)
- Tracheal Cannula for Rat, OD 2.5 mm, L 17 mm, no Luer Connection (73-3557)
- 3-Stop Tygon® E-Lab Tubing (AME 23), 2.54 mm ID, 12/pack, Purple/Orange (73-1838)
- 3-Stop Tygon® E-Lab Tubing (AME 25), 3.17 mm ID, 12/pack, Black/White (73-1839)

Tracheal Cannula Set for Guinea Pig (73-4278) includes:

- Tracheal Cannula for Guinea Pig, OD 3.0 mm, L 20 mm, no Luer Connection (73-3556)
- Tracheal Cannula for Guinea Pig, OD 3.5 mm, L 24 mm (73-3555).
- 3-Stop Tygon® E-Lab Tubing (AME 23), 2.54 mm ID, 12/pack, Purple/Orange (73-1838)
- 3-Stop Tygon® E-Lab Tubing (AME 25), 3.17 mm ID, 12/pack, Black/White (73-1839)

Note: Cannulae Sets come with the appropriate pump tubing.

If only single cannulae are ordered, also order pump tubing 73-1838 and 73-1839. A complete tube set for the perfusion circuit is available (73-3842) which includes all necessary tubing and adapters for the IL-2 perfusate circuit.

Operating Table (Included in Core System):

The operating table (73-2488) is specially designed for a stable and easy in situ preparation under most physiological conditions (e.g. stable perfusion pressure). It is attached to the Perspex stand and allows an exploration of the lung without interruption of ventilation and perfusion.

Surgery takes place at a hydrostatically neutral elevation, minimizing physiological hydrostatic pressure perturbations. An included plastic trough collects waste. The table is easily removed for cleaning after the lung is placed in the chamber. The operating table is 300 mm x 195 mm in size with four paw clamps, two thorax retractors, holder for chamber lid with heat exchanger, and ball joint for positioning.

IPL-2 ISOLATED PERFUSED LUNG SYSTEM FOR RAT AND GUINEA PIG



Size 5 Operating Table for IPL-2

Standard Options for the Core IPL-2 System (Purchase Separately)

PULMODYN Data Acquisition Software

Online evaluation of a wide range of signals and classical respiration parameters. *See page 51.*

Note: Ponemah Data Acquisition & Analysis Software from DSI, a Harvard Bioscience Company is also suitable.

Small Animal Ventilator, Type 683

Allows tidal volumes to be set from 0.5 to 5.0 cc in 0.5 cc increments. A larger cylinder allows tidal volumes of 3.0 to 30 cc in 0.3 cc increments. Respiratory rate can be set from 18 to 150 strokes per minute. Volume and rate settings can be adjusted while the ventilator is running. *See page 40.*

VentElite

Allows tidal volumes to be set from 50 µl up to 5 ml. Touchscreen display and many advanced features. *See page 39.*

Ordering Information

Item #	Description
73-4275	IPL-2 Core System for Isolated Rat or Guinea Pig Lung, 230 V
73-4276	IPL-2 Core System for Isolated Rat or Guinea Pig Lung, 115 V

Each IPL system can be custom configured and built based on your experimental requirements and design. Please contact our specialists to configure your system.

Ventilation for IPL-2

For a functional unit the core system requires a suitable ventilation system. For only positive ventilation a rat ventilator can be used (e.g., VentElite or the Small Animal Ventilator, Type 683). If positive and sub-atmospheric ventilation is needed, a special Ventilation Control Module (VCM) is required.

Positive and Sub-Atmospheric (Negative) Pressure Ventilation with Ventilation Control Module (VCM)

- Used to control the ventilation of the isolated lung preparation. Allows for the physiological negative pressure ventilation of the lung and positive ventilation during preparation

- 30 to 100 breaths per minute
- I:E ratio can be set between 10 and 90% in 10% steps
- End-inspiratory, end-expiratory, sigh, positive and negative pressures can be individually set
- The TCM Timer Counter Module allows periodic sigh (hyperinflation) breaths to minimize edema formation
- The Pressure-Free Gas Supply Adapter (73-2789) is only included with 73-4293 but can be added to 73-4279 when alternative gases need to be delivered during negative pressure ventilation.
- The adapter is used to supply the trachea with a gas mixture different from room air during negative ventilation. It includes a needle valve to adjust gas flow.

Negative Pressure Ventilation Control Option with Pump for IPL-1 & 2 (73-4279) includes: Utilizes 6 slot units		Negative Pressure Ventilation Control Option with Pressure Regulator for IPL-1 (73-4293) includes: Utilizes 6 slot units	
Item #	Product Name	Item #	Product Name
73-1741	PLUGSYS Ventilation Control Module with Integral Pump (VCM-P)	73-2795	PLUGSYS Ventilation Control Module with Regulator (VCM-R)
73-1750	PLUGSYS Time Counter Module (TCM)	73-1750	PLUGSYS Time Counter Module (TCM)*
N/A	See above	73-2789	Pressure-Free Gas Supply Adapter for Alternative Gas Supply**

* Negative pressure ventilation with a pressure regulator (73-4293) built into the VCM-R requires a pressurized gas supply from a tank or house air in the range of 2 to 8 bar (29 to 116 PSI)

** The Pressure-Free Gas Supply Adapter (73-2789) is only for use during sub-atmospheric pressure ventilation with either the VCM-P or VCM-R and is used to supply alternative gas mixtures to the lungs.

Positive Pressure Ventilation Only

If only positive pressure ventilation will be used, choose the option below. This adapter is used with the Small Animal Ventilator, Type 683 or the VentElite. It has a side port to measure the tracheal airway pressure during positive ventilation.

Positive Pressure Ventilation Option for IPL-2 includes:

Item #	Product Name
73-3635	Adapter for Positive Pressure Ventilation on IPL-2

Ordering Information

Item #	Description
73-4279	Negative Pressure Ventilation Control Option with Pump for IPL-1 and IPL-2
73-4280	Negative Pressure Ventilation Control Option with Pressure Regulator for IPL-2
73-3635	Adapter for Positive Pressure Ventilation on IPL-2
73-3448	Alternative Gas Supply, including needle valve

IPL-2 Mouse Lung Option



Mouse Lung Upgrade to IPL-2

Add this option to run mouse perfused lung experiments on an IPL-2 system. Includes:

- Small low-volume heat exchanger
- Mouse pneumotachometer
- Tracheal, pulmonary and venous cannulae for mouse
- Pump tubing AME 09 (73-1825) and AME 014 (73-0126)
- All necessary tubing with tube adapters

Ordering Information

Item #	Description
73-4108	IPL-2 Mouse Lung Option

Specialized Applications & Options

Real-Time Flow Measurement

Direct real-time flow measurement with functional IPL-2 systems. *See page 33.*

Venous Pressure Measurement

Venous pressure transducer and amplifier for venous pressure measurement in an isolated perfused lung system. *See page 33.*

Perfusion Occlusion

Enables double occlusion or individual and venous occlusion on IPL-2. *See page 32.*



Perfusate Deoxygenation

For deoxygenation of blood or buffers containing proteins (e.g. albumin) or erythrocytes. *See page 34.*



pH Control

Delivers CO₂ to maintain pH when system is not deoxygenated with N₂/CO₂ gas mixture. *See page 35.*

IPL-2 ISOLATED PERFUSED LUNG SYSTEM FOR RAT AND GUINEA PIG

Perfusion Solution Monitoring

Permits precise continuous or discontinuous measurement in liquid media or perfusate of these three key parameters: pO_2 , pH and pCO_2 . *See page 36.*

Temperature Measurement

Measure perfusate temperature in any isolated perfused organ system. *See page 36.*

Perfusate Filtration

For filtration of recirculated perfusate. *See page 34.*

Aerosol Application

Add-on to deliver aerosols to the isolated lung. *See page 38.*



Drug Addition

For accurate drug addition using a syringe pump. Additional option for flow controlled drug addition, where flow is measured (or calculated) and a drug must be added in a certain ratio. *See page 37.*

Lung Weight Measurement (Edema Balance)

Weight measurement-edema balance option for IPL-2 core system for mouse, rat or guinea pig lungs. *See page 32.*



IPL-4 Isolated Perfused Lung System

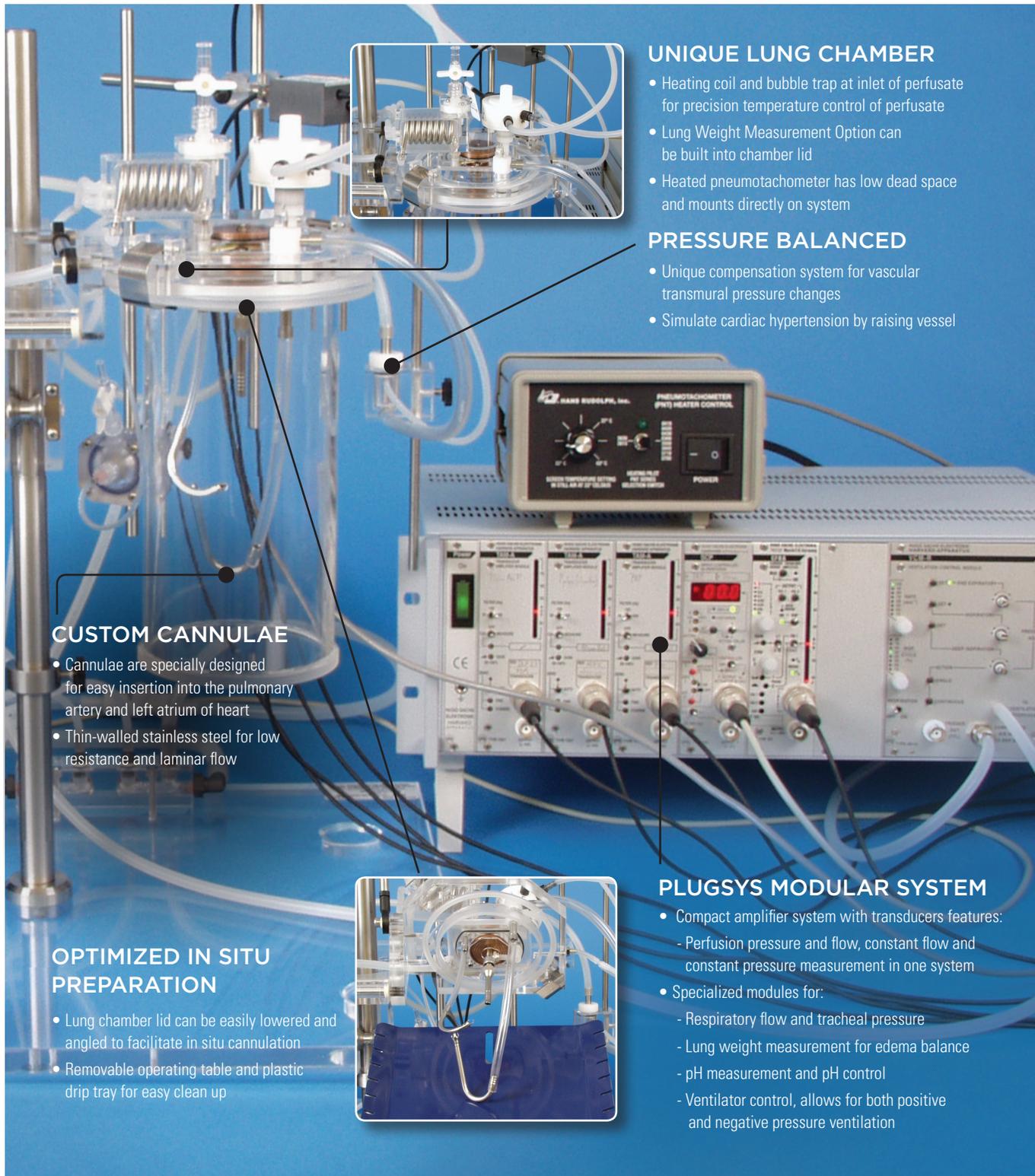
OPTIMAL DESIGN

- Fully thermostated lung chamber for superior temperature control
- Compact system for small lab spaces
- Drug injection pathway is built directly into perfusate system

HIGHER FLOW CAPACITY

- Larger analog pump and reservoir to accommodate higher flow and perfusate volumes for larger lungs (rabbit, fetal pig)

IPL-4 ISOLATED PERFUSED LUNG SYSTEM FOR RABBIT TO FETAL PIG



UNIQUE LUNG CHAMBER

- Heating coil and bubble trap at inlet of perfusate for precision temperature control of perfusate
- Lung Weight Measurement Option can be built into chamber lid
- Heated pneumotachometer has low dead space and mounts directly on system

PRESSURE BALANCED

- Unique compensation system for vascular transmural pressure changes
- Simulate cardiac hypertension by raising vessel

CUSTOM CANNULAE

- Cannulae are specially designed for easy insertion into the pulmonary artery and left atrium of heart
- Thin-walled stainless steel for low resistance and laminar flow

OPTIMIZED IN SITU PREPARATION

- Lung chamber lid can be easily lowered and angled to facilitate in situ cannulation
- Removable operating table and plastic drip tray for easy clean up

PLUGSYS MODULAR SYSTEM

- Compact amplifier system with transducers features:
 - Perfusion pressure and flow, constant flow and constant pressure measurement in one system
- Specialized modules for:
 - Respiratory flow and tracheal pressure
 - Lung weight measurement for edema balance
 - pH measurement and pH control
 - Ventilator control, allows for both positive and negative pressure ventilation

IPL-4 Core System



IPL-4 is an isolated organ perfusion system specially designed for isolated rabbit or fetal pig lung for measurement of key parameters associated with ex vivo lung perfusion (EVLV) studies.

The IPL-4 core system plus the selection of an appropriate ventilation option contains all the equipment required to perform basic perfusion and ventilation experiments. Many options are available for the IPL-4 system to further extend its capabilities.

Advanced System Design

The IPL-2 system's unique in situ cannulation system allows the researcher to align the cannulation head with the operating table while simultaneously retracting the lung chamber. No part of the system needs to be removed during cannulation.

The lung is perfused via the pulmonary artery by a roller pump. The perfusate is stored in a water-jacketed container to maintain constant temperature. Aeration is provided to keep the pH constant. A heat exchanger and a bubble trap are placed next to the pulmonary artery connection for exact adjustment of the perfusate temperature just before the thorax chamber and to prevent air bubbles entering the lung.

Positive and Sub-Atmospheric (Negative) Pressure Ventilation with the VCM-4 Module

During the surgery the lung is ventilated under positive pressure using a special ventilation head driven by the VCM-4 module. The artificial thoracic chamber includes an integrated Venturi jet that in combination with the airflow from the VCM module creates a vacuum within the chamber. The lung can then be ventilated physiologically by sub-atmospheric

pressure ventilation. The ventilation head is removed and replaced by the pneumotachometer for measurement of respiratory airflow. The ventilation medium (air or a gas mixture) is constantly flowing past the distal end of the pneumotachometer directly via the tracheal cannula into the lungs. The breathing frequency can be varied between 30 and 60 breaths/min. In addition, the inspiration/ expiration ratio as a percentage of each breath can be set between 10 and 90% in 10% steps. The end-inspiratory, end-expiratory, and deep breath (sigh or hyperinflation) negative pressure can be set individually. A deep breath (sigh) is usually induced every 5 to 20 minutes.

Constant Flow or Constant Pressure Perfusion

The lung can be perfused at constant flow or constant pressure. A switch on the SCP module allows you to quickly switch perfusion modes so that the lung can be perfused either at a constant flow rate or at constant pressure, with no change in system dead-space volume. In constant pressure mode, the SCP uses the measured perfusion pressure as a control input and through feedback circuitry adjusts the pump speed to maintain the user-specified perfusion pressure.

Lung Mechanics

Measurement of respiratory parameters up to and including full respiratory mechanics requires the measurement of thoracic pressure and airflow raw signals. The MPX transducer is used to measure the artificial thoracic pressure during negative pressure ventilation and airway pressure during positive pressure ventilation. The heated pneumotachometer along with the DLP 2.5 differential pressure transducers are used to measure airflow.

PULMODYN Data Acquisition Software can calculate respiration rate, peak inspiratory and expiratory airflow, tidal volume, minute volume, vascular resistance, end-inspiratory and end-expiratory pressures, dynamic airway resistance and dynamic lung compliance, inspiratory time and expiratory time from these raw signals in real time.

IPL-4 ISOLATED PERFUSED LUNG SYSTEM FOR RABBIT TO FETAL PIG

Applications

- Investigation of ventilation and perfusion in the isolated rabbit or fetal pig lung
- Drug testing on respiration and vascular parameters
- Toxicology tests on respiration and vascular parameters
- Aerosol tests, surfactant studies, etc.
- Continuous measurement of lung weight changes (edema studies)

Features & Benefits

- Optimized temperature conditions for the isolated lung; unique jacketed thoracic chamber
- Operating table for non-damaging in situ preparation
- Sub-atmospheric pressure ventilation similar to in vivo condition or positive pressure ventilation
- Low flow resistance and dead space volume, minimize perfusion artifacts
- Drug injection pathway built directly into pulmonary perfusate stream
- Unique compensation system for vascular transmural pressure changes during sub-atmospheric pressure ventilation
- Optimized in-situ preparation
- Sub-atmospheric pressure ventilation to mimic closely the in-vivo situation
- Regular induction of hyperinflation of the lung (sigh)
- Perfusion under constant flow or constant pressure condition using buffer solution or blood
- Continuous measurement of respiratory mechanics (respiration rate, inspiratory and expiratory air flow, tidal volume, minute volume, dynamic airway resistance, dynamic compliance) and perfusion characteristics (pulmonary artery pressure, left atrium pressure, lung vascular resistance, pO_2 , pH)
- More measurement parameters than any other system

Measured Signals and Calculated Parameters

Signals recorded as raw data:

- Respiratory flow
- Intrapleural (artificial thorax) pressure or tracheal pressure
- Pulmonary artery (perfusion) pressure
- Perfusion flow

Parameters that can be calculated from raw data*:

- Respiration rate
- Peak inspiratory and expiratory airflow
- Tidal volume, minute volume
- Vascular resistance
- End-inspiratory and end-expiratory pressures
- Dynamic airway resistance and dynamic lung compliance
- Inspiratory time and expiratory time (software option)

* Calculations are automatic when PULMODYN data acquisition software is used. See page 51.

IPL-4 ISOLATED PERFUSED LUNG SYSTEM FOR RABBIT TO FETAL PIG

Included Items

Included items are representative of a typical IPL-4 Core System. Individual components can be customized to your needs.

IPL-4 Core System, 230 V (73-4296) includes:		IPL-4 Core System, 115 V (73-4297) includes:	
Item #	Product Name	Item #	Product Name
73-4138	Base Unit for the Rabbit to Fetal Pig Isolated Perfused Lung	73-4138	Base Unit for the Rabbit to Fetal Pig Isolated Perfused Lung
73-0125	Lauda Thermostatic Circulator, Type E-103, 230 V/50 Hz, 3 L Bath Volume, Temperature Range 20 to 150°C	73-2802	Lauda Thermostatic Circulator, Type E-103, 115 V/60 Hz, 3 L Bath Volume, Temperature Range 20 to 150°C
73-0322	Jacketed Glass Reservoir for Buffer Solution, with Frit and Tubing, 6.0 L	73-0322	Jacketed Glass Reservoir for Buffer Solution, with Frit and Tubing, 6.0 L
70-7001	Harvard Peristaltic Pump P-230 (Complete with Control Box and P-230 Motor Drive)	70-7001	Harvard Peristaltic Pump P-230 (Complete with Control Box and P-230 Motor Drive)
73-1864	2-Stop Tygon® E-Lab Tubing, 3.17 mm ID, 12/pack, Black/White	73-1864	2-Stop Tygon® E-Lab Tubing, 3.17 mm ID, 12/pack, Black/White
73-0045	PLUGSYS Case, Type 603*	73-0045	PLUGSYS Case, Type 603
73-2806	Servo Controller for Perfusion (SCP)	73-2806	Servo Controller for Perfusion (SCP)
Perfusion Pressure Measurements			
73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module	73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module
73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)*	73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)
Respiratory Airflow Measurements			
59-9349	Heated Linear Pneumotachometer 0 to 10 L/min flow range	59-9349	Heated Linear Pneumotachometer 0 to 10 L/min flow range
59-9703	Heater Controller for Single Pneumotachometer 230 VAC, 50 Hz	59-9702	Heater Controller for Single Pneumotachometer 115 VAC, 60 Hz
73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector	73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)
Artificial Thorax or Tracheal Pressure Measurements			
73-0064	Differential Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector	73-0064	Differential Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)

*See PLUGSYS Modules & Housings on page 49–50 for information about PLUGSYS Modules.

The Base Unit (73-4138) includes:

Temperature-controlled negative pressure lung chamber (artificial thorax) with cover including venturi jet, positive pressure ventilation head, air humidifier, pneumotachometer, operating table, connectors to interface with the perfusion system, pressure equilibration vessel for venous flow and all necessary accessories (tracheal cannulae, pulmonary artery cannulae, left atrium cannulae)

Pulmonary Artery, Left Atrium and Tracheal Cannulae (included with Base Unit):

- Pulmonary Artery Cannula for Rabbit with Basket, OD 4.6 mm (73-4161)
- Left Atrium Cannula for Rabbit with Basket, OD 5.9 mm (73-4162)
- Tracheal Cannula for Rabbit, OD 5.0 mm (73-4163)

If additional or replacement tubing is needed, order pump tubing 73-1863 and 73-1864. Complete IPL-4 tube sets are available on request for the thermostatic circuit (22051), for ventilation (22052) and for the perfusion circuit (22054). Please inquire.

Operating Table (included with Base Unit):

The operating table (73-2487) is specially designed for a stable and easy in situ preparation under most physiological conditions (e.g. stable perfusion pressure). It is attached to the Perspex stand and allows an exploration of the lung without interruption of ventilation and perfusion.

Surgery takes place at a hydrostatically neutral elevation, minimizing physiological hydrostatic pressure perturbations. An included plastic trough collects waste. The table is easily removed for cleaning after the lung is placed in the chamber. The operating table is 300 mm x 195 mm in size and includes ball joint, plastic trough, parts for mounting the table to the acrylate stand, four paw clamps, two thorax retractors, and a holder to support tracheal cannula and positive pressure ventilation head during surgery.

Standard Options for the Core IPL-4 System (Purchase Separately)

PULMODYN Data Acquisition Software

Online evaluation of a wide range of signals and classical respiration parameters. *See page 50.*

Note: Ponemah Data Acquisition & Analysis Software from DSI, a Harvard Bioscience Company is also suitable.

Small Animal Ventilator, Type 683

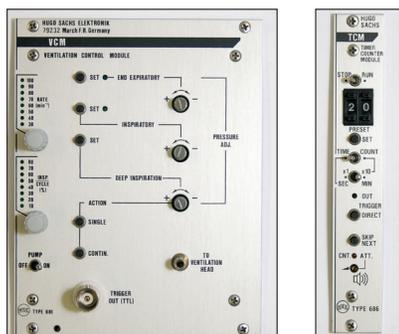
A large cylinder allows tidal volumes of 30 ml in 0.3 ml increments. Respiratory rate can be set from 18 to 150 strokes per minute. Volume and rate settings can be adjusted while the ventilator is running.

Ordering Information

Item #	Description
73-4296	IPL-4 Core System for Isolated Rabbit to Fetal Pig Lung, 230 V
73-4297	IPL-4 Core System for Isolated Rabbit to Fetal Pig Lung, 115 V

Each IPL system can be custom configured and built based on your experimental requirements and design. Please contact our specialists to configure your system.

Ventilation for IPL-4



PLUGSYS VCM-4 and TCM modules for IPL-4 Sub-Atmospheric (Negative) Pressure Ventilation

For a functional unit the core system requires a suitable ventilation system. For only positive ventilation the Small Animal Ventilator, Type 683 with a 30 ml cylinder can be used. If positive and sub-atmospheric ventilation is wanted, a special Ventilation Control Module (VCM-4) is required. (See table below).

Positive and Sub-Atmospheric (Negative) Pressure Ventilation with Ventilation Control Module (VCM-4R)

The Ventilation Control Module (VCM-4R) controls the ventilation of the isolated lung preparation. It allows for the physiological negative pressure ventilation of the lung and positive ventilation during surgery and preparation. The TCM Timer Counter Module allows periodic sigh breaths (hyperinflation) to minimize edema formation.

- 30 to 100 breaths per minute
- I:E ratio can be set between 10 and 90% in 10% steps
- End-inspiratory, end-expiratory, sigh and negative

Negative Pressure Ventilation Control Option with Pressure Regulator for IPL-4* (73-4298) includes: Utilizes 6 slot units	
Item #	Product Name
73-1755	PLUGSYS VCM-4R Ventilation Control Module with Pressure Regulator*
73-1750	PLUGSYS TCM Time Counter Module

* Negative pressure ventilation with a pressure regulator requires a pressurized gas supply from a tank or house air in the range of 2 to 8 bar (29 to 116 PSI). If the lung needs to be supplied with gas mixtures different from room air during negative ventilation the Pressure-Free Gas Supply Adapter (73-4309) is required. It must be purchased separately. (A VCM with air pump is not available for IPL-4.)

Positive Pressure Ventilation Only

If only positive pressure ventilation will be used, choose the option below. This adapter is used with the Small Animal Ventilator, Type 683 or any suitable ventilator that can support 30 ml or more. It has a side port to measure the tracheal airway pressure.

Positive Pressure Ventilation Option for IPL-4 includes:	
Item #	Product Name
73-4312	Adapter for Positive Pressure Ventilation on IPL-4

Ordering Information

Item #	Description
73-4298	Negative Pressure Ventilation Control Option with Pressure Regulator for IPL-4
73-4312	Adapter for Positive Pressure Ventilation on IPL-4
73-4309	Alternative Pressure-Free Gas Supply for IPL-4: To supply the trachea with gas mixture different from room air during negative ventilation

Specialized Applications & Options

Real-Time Flow Measurement

Direct real-time flow measurement with a functional IPL-4 systems. *See page 33.*

Venous Pressure Measurement

Venous pressure transducer and amplifier for venous pressure measurement in an isolated perfused lung system. *See page 33.*

Perfusion Occlusion

Enables double occlusion or individual and venous occlusion. *See page 32.*

Perfusate Deoxygenation

For deoxygenation of blood or buffers containing proteins (e.g. albumin) or erythrocytes. *See page 34.*

pH Control

Delivers CO₂ to maintain pH when system is not deoxygenated with N₂/CO₂ gas mixture. *See page 35.*

Perfusion Solution Monitoring

Permits precise continuous or discontinuous measurement in liquid media or perfusate of these three key parameters: pO₂, pH and pCO₂. *See page 36.*

Temperature Measurement

Measure perfusate temperature in any isolated perfused organ system. *See page 36.*

Perfusate Filtration

For filtration of recirculated perfusate. *See page 34.*

Aerosol Application

Nebulizer setup for delivery of aerosols to the isolated lung. *See page 38.*

Drug Addition

For accurate drug addition using a syringe pump. Additional option for flow controlled drug addition, where flow is measured (or calculated) and a drug must be added in a certain ratio. *See page 37.*

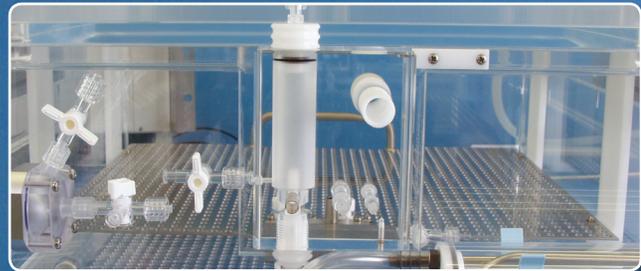
Lung Weight Measurement (Edema Balance)

Weight measurement-edema balance option for IPL-4 core system rat or guinea pig lungs. *See page 32.*

IPL-16 Isolated Perfused Lung System

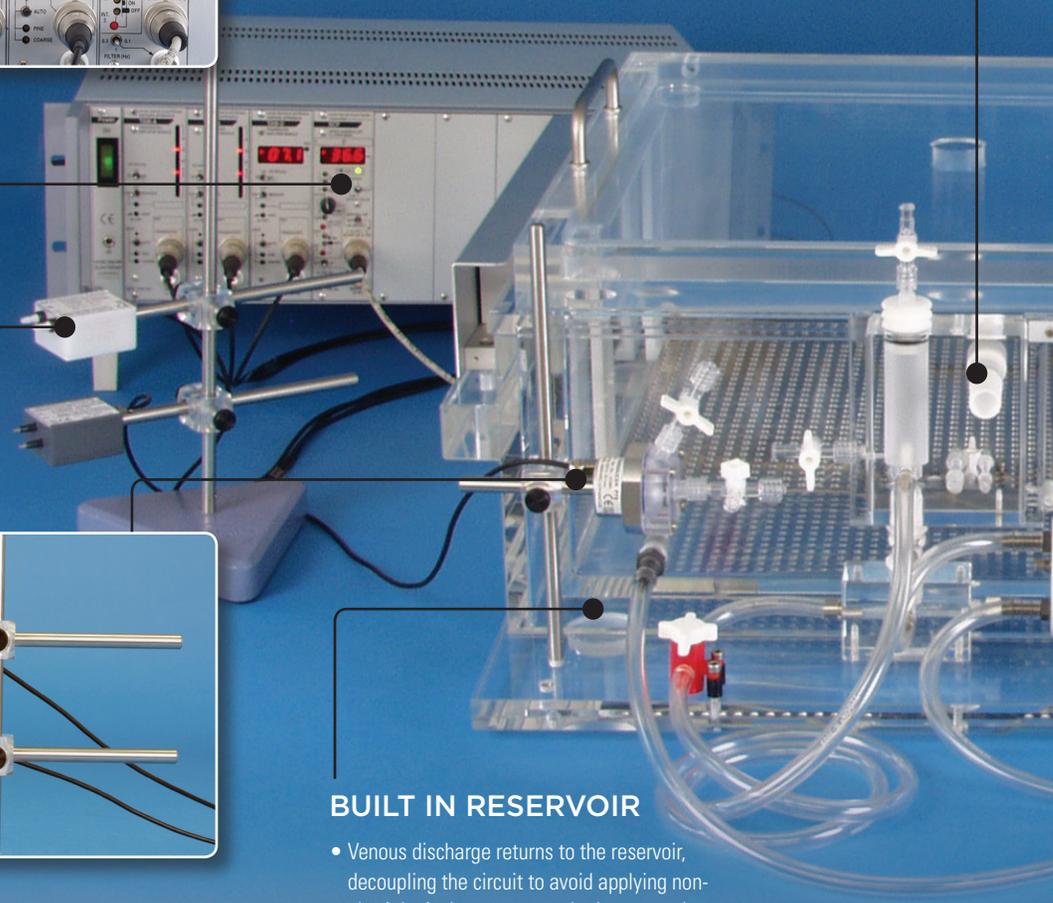
CONSTANT FLOW & PRESSURE

- A switch on the SCP module can rapidly change the system from constant pressure to constant flow perfusion with no change in circuit dead-space volume



REMOVABLE SURGERY CANNULATION PLATFORM

- Allows continuous ventilation and perfusion during surgery



SENSORS

- Mounted conveniently on the system

BUILT IN RESERVOIR

- Venous discharge returns to the reservoir, decoupling the circuit to avoid applying non-physiological pressures to the lung vasculature

IPL-16 ISOLATED PERFUSED LUNG SYSTEM FOR PIG

FULLY THERMOSTATED LUNG CHAMBER

- Keeps lungs warm and moist
- Large dimensions 400 x 500 x 300 mm
- Short connecting tubing and cannulae result in small dead volume and thermal stability

INTEGRATED LUNG WEIGHT MEASUREMENT

- Allows calculation of filtration coefficient
- Track edema formation



OXYGENATOR

- Oxygenator holders for common heart-lung heater/oxygenators available

SECONDARY HEAT EXCHANGER

- Due to heat loss through the tubing after leaving the heater/oxygenator, perfusate is reheated by a heat exchanger located proximal to the pulmonary artery cannula

IPL-16 Core System for Pig



IPL-16 Isolated Perfused Lung System

The IPL-16 system is designed for whole lung or single lung lobe perfusion of pig of species lung of similar size.

The IPL-16 core system contains all the primary equipment to accomplish basic perfusion and ventilation experiments, requiring only the addition of ventilation equipment. The basic system can be easily upgraded with options such as aerosol delivery, real-time flow measurement and many others.

Advanced System Design

The lung chamber and lid are both water jacketed and when connected with a heating or heating/coiling thermocirculator ensure accurate maintenance of organ temperature. A traditional heating thermocirculator is typically used with studies that are physiologically isothermic and heating/coiling thermocirculators with integrated chillers are used for studies replicating organ transplantation conditions. The unique cannulation system allows the researcher to remove the cannulation block and the lung platform to cannulate the vasculature and trachea outside of the main chamber while maintaining physiological pulmonary artery pressure and continuous ventilation.

The lung in this system can be only positive-pressure ventilated. A clinical ventilator or our Model 613 Large Animal Ventilator can be used. The space below the lung platform is used as integrated reservoir designed for recirculating perfusate. A single lobe or the full lung can be perfused through one or more pulmonary arteries. The base lung chamber has an integrated lung weight sensor which when connected to the required TAM-A amplifier provides continuous monitoring of lung weight and tracking of edema formation.

When the lung is placed in the chamber and ventilated a pneumotachometer for measurement of respiratory airflow is connected. PULMODYN software can calculate the tidal volume and other respiration parameters from the airflow. Ponemah Data Acquisition & Analysis Software from DSI is also suitable.

Constant Flow or Constant Pressure Perfusion

The lung can be perfused at a constant flow rate or under constant pressure. The SCP module controls and regulates the perfusion pressure in the pulmonary artery. Pump selection is often based on the composition of the perfusate. For acellular media, a peristaltic pump can be used. If blood or blood-doped perfusion solutions are to be used, a centrifugal pump can be used.

For acellular media and a configuration including a peristaltic pump, the system is typically configured with a pressure transducer, amplifier and the PLUGSYS SCP module that receives the pressure signal from the amplifier and controls the pump speed. A switch on the SCP allows the user to change between either constant flow or constant pressure perfusion. Flow rate based on tubing ID and pump speed can be calibrated and recorded from the SCP module.

For cell-based media and use of a centrifugal pump, the user must specify a setup for either constant pressure or constant flow perfusion. Constant pressure perfusion is achieved as described above when a centrifugal pump is selected. Constant flow perfusion with a centrifugal pump is also possible by selecting a suitable in-line flow probe and flow meter which provides a precise flow feedback signal to the SCP for constant flow perfusion.

IPL-16 ISOLATED PERFUSED LUNG SYSTEM FOR PIG

Lung Mechanics

The tracheal pressure is measured with an MPX pressure transducer. Airflow is determined with a heated pneumotachometer connected to a DLP2.5 differential pressure transducer. PULMODYN Data Acquisition Software (or other suitable DAQ system such as DSI Ponemah) acquires the raw airflow and airway pressure signals and derives a variety of respiratory parameters such as tidal volume, respiratory rate and other values for respiratory mechanics from these. See the list "Measured Signals and Calculated Parameters" on the next page.

Applications

- Investigation of ventilation and perfusion in the isolated pig lung
- Drug testing on respiration and vascular parameters
- Aerosol tests, surfactant studies, etc.
- Continuous measurement of lung weight changes (edema studies)

Features & Benefits

- Only Positive Pressure Ventilation (a ventilator for human use must be used)
- Optimized temperature conditions for the isolated lung
- Unique jacketed chamber
- Continuous measurement of lung weight to monitor edema formation
- Drug injection pathway built directly into pulmonary perfusate stream for precision compound dosing
- Optimized preparation
- Perfusion under constant flow or constant pressure condition using buffer solution, heparinized blood or erythrocyte-containing solutions
- Continuous measurement of respiratory mechanics (respiration rate, inspiratory and expiratory air flow, tidal volume, minute volume, dynamic airway resistance, dynamic compliance) and perfusion characteristics (pulmonary artery pressure, left atrium pressure, lung vascular resistance, pO_2 , pCO_2 , pH)
- More measurement parameters with greater precision than any other system

Measured Signals and Calculated Parameters

Signals recorded as raw data:

- Respiratory airflow
- Tracheal pressure
- Pulmonary artery (perfusion) pressure
- Perfusion flow

Parameters that can be calculated from raw data*:

- Respiration rate
- Peak inspiratory and expiratory airflow
- Tidal volume, minute volume
- Vascular resistance
- End-inspiratory and end-expiratory pressures
- Dynamic airway resistance and compliance
- Inspiratory time and expiratory time (software option)

* Calculations are automatic when PULMODYN data acquisition software is used. See page 51.

Included Items

Included items are representative of a typical IPL-16 Core System. Individual components can be customized to your needs.

IPL-16 Core System, 230 V (73-4301) includes:		IPL-16 Core System, 115 V (73-4302) includes:	
Item #	Product Name	Item #	Product Name
73-4726	Base Unit for the Pig Isolated Perfused Lung	73-4726	Base Unit for the Pig Isolated Perfused Lung
73-0125	Lauda Thermostatic Circulator, Type E-103, 230 V/60 Hz, 3 L Bath Volume, Temperature Range 20 to 150°C	73-2802	Lauda Thermostatic Circulator, Type E-103, 115 V/60 Hz, 3 L Bath Volume, Temperature Range 20 to 150°C
73-0045	PLUGSYS Case, Type 603*	73-0045	PLUGSYS Case, Type 603
73-2806	Servo Controller for Perfusion (SCP)	73-2806	Servo Controller for Perfusion (SCP)
Perfusion Pressure Measurements			
73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module	73-0020	Low Range Blood Pressure Transducer P75 for PLUGSYS Module
73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)	73-1793	PLUGSYS Transducer Amplifier Module (TAM-D)
Respiratory Airflow Measurements			
72-6310	Heated Linear Pneumotachometer with Luer side port for airway pressure, 0 to 160 L/min flow rate, dead space 13.87 ml. Port OD = 22 mm, ID = 15 mm. Opposite port: OD = 15 mm, ID = 13.2 mm. Requires heater controller.	72-6310	Heated Linear Pneumotachometer with Luer side port for airway pressure, 0 to 160 L/min flow rate, dead space 13.87 ml. Port OD = 22 mm, ID = 15 mm. Opposite port: OD = 15 mm, ID = 13.2 mm. Requires heater controller.
59-9703	Heater Controller for Single Pneumotachometer 230 VAC, 50 Hz	59-9702	Heater Controller for Single Pneumotachometer 115 VAC, 60 Hz
73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector	73-3882	Differential Low Pressure Transducer DLP2.5, Range +2.5 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)
Tracheal Pressure Measurements			
73-0064	Differential Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector	73-0064	Differential Pressure Transducer MPX, Range +100 cmH ₂ O, HSE Connector
73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)	73-0065	PLUGSYS Transducer Amplifier Module (TAM-A)

* If your chosen options require more than 20 slot units you will need to add a case extension. See page 49–50.

The Base Unit (73-4138) includes:

chamber consisting of a jacketed Plexiglass box and a jacketed cover. The chamber itself acts as the reservoir. The box is divided in two compartments by a platform receiving the organ. The platform is attached to the weighing system. The lower compartment is the perfusate reservoir. The chamber has connections for ventilation and perfusion. Perfusion cannula depend on application and must be purchased separately. Inside dimensions: 400 x 400 x 155 mm. Height for organ between platform and cover: 123 mm. Outer dimensions of chamber: 590 x 590 x 232 mm. Note: A 6 L jacketed reservoir can be added in case the perfusate cannot be recirculated.

Standard Options for the Core IPL-16 System (Purchase Separately)

Cannulae

Although cannulae are included with other IPL systems, they are not included with the IPL-16. Cannula are chosen by the researcher.

If a lung lobe is perfused standard Luer cannulae can be used:

- Tracheal Cannula for Rabbit/Cat, OD 6.0, L 40 mm (73-3319)
- Tracheal Cannula for Rabbit, OD 5.0, L 35 mm (73-0037)
- Tracheal Cannula for Rat/Guinea Pig/Rabbit, OD 4.0, L 32 mm (73-0036)
- Aortic Metal Cannula with Luer, OD 4.0 mm (73-2872)

If a complete lung is being perfused, larger Tygon tubing can be used directly as cannulae.

Pumps

Either a peristaltic or centrifugal pump can be used, depending on the perfusate used.

Peristaltic Pump

The Harvard Apparatus Peristaltic Pump consists of a control unit, a motor drive, a tubing cassette and some sample tubing. The pump can deliver solutions over a range of flow rates from 0.001 to 230 ml/min. Tracheal pressure can be doubled by using two tubes in parallel. See page 46.

- Complete with Control Box and P-230 Motor Drive (70-7001)

Centrifugal Pump

The Centrifugal Pump is specifically designed for pumping blood and/or erythrocyte suspension solutions. It consists of the pump drive BVP-ZX and a centrifugal pump head which can be replaced without tools. See page 47.

- Centrifugal Pump Drive (BVP-ZX), 230 VAC (73-2470)
- Centrifugal Blood Pump Head (BP-80) (73-2807)

PULMODYN Data Acquisition Software

Online evaluation of a wide range of signals and classical respiration parameters. *See page 51.*

Note: Ponemah Data Acquisition & Analysis Software from DSI, a Harvard Bioscience Company is also suitable.

Ordering Information

Item #	Description
73-4301	IPL-16 Core System for Isolated Pig Lung, 230 V
73-4302	IPL-16 Core System for Isolated Pig Lung, 115 V

Each IPL system can be custom configured and built based on your experimental requirements and design. Please contact our specialists to configure your system.

Ventilation for IPL-16

The Large Animal Volume-Controlled Ventilator, Model 613 is suitable for ventilating a pig lung lobe. An alternative to the 613 ventilator is a suitable clinical ventilator.

The Model 613 has adjustable tidal volume from 30 to 700 ml/stroke and an adjustable respiratory rate from 7 to 50 breaths/minute. *See page 41.*

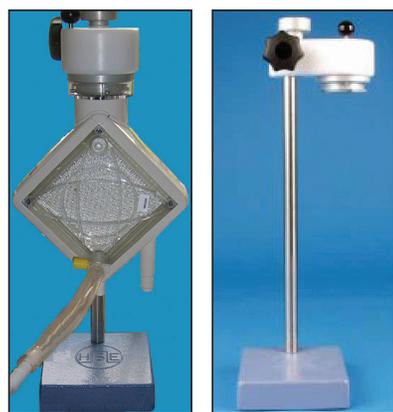


Large Animal Volume-Controlled Ventilator

Deoxygenation for IPL-16

While Hugo Sachs does not supply the oxygenator/deoxygenator for the IPL-16 system, researchers can use readily available oxygenators used in the heart-lung machines of their affiliated hospital or institute.

We offer two custom oxygenator holders (platforms) for use with the IPL-16 system. The platform receives the mounting parts for either the Medtronic or Terumo oxygenator. It is equipped with a rotameter for controlling the gas flow through the oxygenator.



Base Platform for the Medtronic Oxygenator
Base Platform for the Terumo Oxygenator

Ordering Information

Item #	Description
73-4313	Base Platform for Metronic Carmeda Affinity NT Oxygenator
73-2805	Base Platform for Terumo Capiox CX 210 Oxygenator

Specialized Applications & Options

Real-Time Flow Measurement

Direct real-time flow measurement with a functional IPL-16 systems. *See page 33.*

Venous Pressure Measurement

Venous pressure transducer and amplifier for venous pressure measurement in an isolated perfused lung system. *See page 33.*

Perfusate Deoxygenation

Hugo Sachs does not supply a deoxygenator suitable for the IPL-16 system. Researchers can use readily available oxygenators used in the heart-lung machines of their affiliated institution. *See page 34.*

pH Control

Delivers CO₂ to maintain pH when system is not deoxygenated with N₂/CO₂ gas mixture. *See page 35.*

Temperature Measurement

Measures perfusate temperature in any isolated perfused organ system. *See page 36.*

Perfusion Solution Monitoring

Permits precise continuous or discontinuous measurement in liquid media or perfusate of these three key parameters: pO₂, pH and pCO₂. *See page 36.*

Lung Weight Measurement Option



The weight measurement-edema balance option can be added to an IPL-2 or IPL-4 core system for mouse, rat, guinea pig or rabbit lungs. It requires the the 73-4626 PLUGSYS Edema Balance Module (EBM), which includes the sensor.

- Continuously monitor and measure edema formation over time
- Raw data is weight; calculated value is weight change over time (dW/dT)
- Assess vascular permeability by calculating the filtration coefficient derived from weight changes induced by increasing and decreasing perfusion pressure
- Range of ± 10 or ± 22 g; displacement 23 m/gm
- Measure changes of less than 20 mg

Includes: HSE Weight Measurement Transducer integrated into an alternative lung chamber cover (lid). EBM module must be purchased separately.

Ordering Information

Item #	Description
73-4626	EBM Edema Balance Module (EBM) with Sensor
73-4604	HSE Weight Measurement System V.2 without Sensor for IPL-2, Range 0 to 22 g, for Rat or Guinea Pig Lungs
73-4710	HSE Weight Measurement System V.2 without Sensor for IPL-2, Range 0 to 10 g, for Mouse Lungs
73-4709	HSE Weight Measurement System V.2 without Sensor for IPL-4, Range 0 to 80 g, for Rabbit Lungs

Perfusion Occlusion Option



The perfusion occlusion option for IPL-2 allows double occlusion for:

- Measurement of segmental vascular resistances (precapillary and post-capillary resistance)
- Measurement of microvascular pressure

Allows individual arterial and venous occlusion for:

- Determination of large and small artery resistances
- Determination of large and small vein resistances
- Determination of vascular compliance

Includes: Stand, two pinch valves and controller for perfusion occlusion.

Note: A peristaltic pump with external ON/OFF control is required.

Ordering Information

Item #	Description
73-4322	Perfusion Occlusion System Option for IPL-2

Real-Time Flow Measurement Option



PLUGSYS TTFM-2 Module for Real-Time Flow Measurement

Direct real-time flow measurement can be done with functional IPL-2, IPL-4 and IPL-16 systems using the PLUGSYS TTFM-2 module. (Utilizes 5 slot units.) The included custom-built flow-through probe allows visualization of trapped air bubbles that could interfere with measurement. (Note: With the IPL-1 system, because of the low flow rate, flow measurement is calculated with the SCP Pressure Controller.)

Flow Measurement for IPL-2 (73-4339) includes:

Item #	Product Name
73-4617	PLUGSYS Transit Time Flowmeter Module (TTFM-2)
73-4754	Inline Flow Probe Type 2N, 2 mm ID

Flow Measurement for IPL-4 (73-4281) includes:

Item #	Product Name
73-4617	PLUGSYS Transit Time Flowmeter Module (TTFM-2)
73-7555	Inline Flow Probe Type 4N, 4 mm ID

Flow Measurement for IPL-16 (73-4303) includes:

Item #	Product Name
73-4617	PLUGSY Transit Time Flowmeter Module (TTFM-2)
73-4656	MA8PSB Flow probe for HSE TTFM-2 or TS420 module, back exit, 100 cm cable, CRA 10 connector
73-4266	Inline Adapter for Flow Probe 8SB (Flow probe 73-4656 is supplied integrated into this adapter, connection steel tubes ID = 8 mm, OD = 10 mm)

Ordering Information

Item #	Description
73-4339	Real Time Flow Measurement Option to IPL-2 Core System
73-4281	Real Time Flow Measurement Option to IPL-4 Core System
73-4303	Real Time Flow Measurement Option to IPL-16 Core System

Venous Pressure Measurement Option



Venous Pressure Measurement Option

This option provides a venous pressure transducer and amplifier for venous pressure measurement in an isolated perfused lung system. Amplifier module requires suitable PLUGSYS housing.

Includes: P75 Blood Pressure Transducer (73-0020), PLUGSYS Transducer Amplifier Module (TAM-A) (73-0065), Perspex block clamp (73-0566), suitable tubing and T-piece to connect P75 to venous outflow tubing

Ordering Information

Item #	Description
73-4295	Venous Pressure Measurement Option for all IPL Systems

Perfusate Deoxygenation Option



Add this option to IPL-1, IPL-2 and IPL-4 to deoxygenate blood or buffers containing proteins (e.g. albumin) or erythrocytes. See page 44 for detailed information about the Fiber Oxygenators.

Included Items : IPL-1 (73-4307) and IPL-2 (73-4290)	
Item #	Product Name
73-3762	Fiber Oxygenator, Type D150, Pkg. of 5
73-3765	Connection Kit for D150 Fiber Oxygenator
73-3759	Mounting Kit for D150 Fiber Oxygenator on Holders
73-3058	Stand-Alone Oxygenator Holder (Not included with 73-4290)
73-0500	Stand with Triangular Base and Block Clamp

Included Items : IPL-4 (73-4311)	
Item #	Product Name
73-4993	Fiber Oxygenator, Type DP07HE, Pkg. of 5
73-3765	Connection Kit for Fiber Oxygenator
73-3760	Mounting Kit for Fiber Oxygenator on Holders
73-3058	Stand-Alone Oxygenator Holder (Note included with 73-4290)
73-0500	Stand with Triangular Base and Box Clamp

Ordering Information

Item #	Description
73-4307	Deoxygenation Unit for IPL-1 System
73-4290	Deoxygenation Unit for IPL-2 System
73-4311	Deoxygenation Unit for IPL-4 System

Perfusate Filtration Option



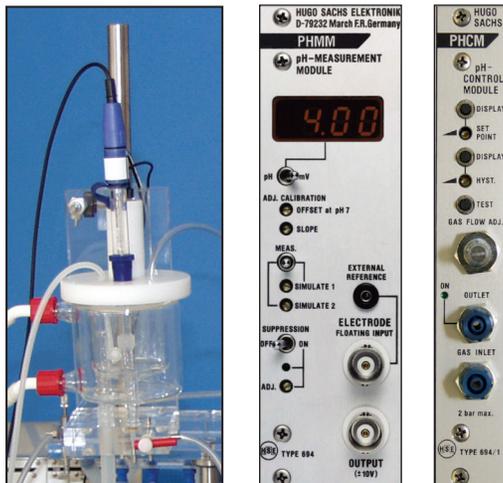
This option enables filtration of recirculated perfusate in any isolated organ system. Includes:

- In-line holder for disc particle filter, diameter = 47 mm
- Polypropylene particle filter, 45 µm, diameter = 47 mm (pack of 100)
- Filters with other pore sizes are available:

Ordering Information

Item #	Description
73-4423	Addition of Filtration of Recirculated Perfusate, Includes polypropylene particle filter, 25 µm, 47 mm diameter, pkg. of 100 (73-2047) and nylon particle filter, 10 µm, 47 mm diameter, pkg of 100 (73-4956)}

pH Control Option for IPL-1 and IPL-2



PLUGSYS pHMM and pHCM Modules

This option controls and regulates the pH in the buffer solution by carefully bubbling it with CO₂. Delivery of CO₂ maintains pH when the system is not deoxygenated with a N₂/CO₂ gas mixture.

The pH is controlled by a feedback system which regulates CO₂ gas bubbling into a dedicated small volume reservoir for minimizing foaming of perfusate. The pH is measured with a pH sensor. The pH control module (pHCM) allows setting to a desired pH, e.g. to 7.4.

A certain amount of CO₂ is necessary to hold the pH constant in a physiological range. For example, in order to keep the pH in a buffer solution at 7.4 (e.g. in a Krebs-Henseleit buffer), 5% CO₂ is necessary. If the measured pH is above this value (e.g. 7.4), a small valve opens so that CO₂ from a tank goes to a frit in the reservoir. The CO₂ changes the pH to a lower value. As soon the pH of 7.4 is reached the CO₂ valve is closed. This acts in a closed loop and regulates the pH by bubbling with CO₂. This is only necessary for perfusates which are CO₂-dependent buffered.

Note: Available by special order for IPL-4. Please inquire.

Features & Benefits

- Minimizes foaming of perfusates due to minimal gassing of 100% gas to maintain pH

pH Control Unit for IPL-1 (73-4308) includes:	
Item #	Product Name
69-0072	Foodtrode™ Protein Resistant pH Electrode
69-0075	Protelyte™ Reference Electrolyte Solution, 100 ml
69-0077	Electrode Connecting Cable, BNC to AS7, 1 m (3.3 ft)
73-1784	BNC-BNC Connecting Cable
73-0215	PLUGSYS pH Measurement Module (pHMM)*
73-1776	PLUGSYS pH Control Module (pHCM)*
N/A	Modified Cover to 0.5 L Reservoir

pH Control Unit for IPL-2, 230 V, (73-4282) includes:

Item #	Product Name
73-2269	Jacketed Glass Container to Isolated Lung*
73-0114	REGLO Analog 4 Channel MS-4/8-100, 230 VAC, 50 Hz
73-0155	3-Stop Tygon® E-Lab Tubing, 2.79 mm ID, 12/pack, Purple/White
69-0072	Foodtrode™ Protein Resistant pH Electrode
69-0075	Protelyte™ Reference Electrolyte Solution, 100 ml
69-0077	Electrode Connecting Cable, BNC to AS7, 1 m (3.3 ft)
73-1784	BNC-BNC Connecting Cable
73-0215	PLUGSYS pH Measurement Module (pHMM)
73-1776	PLUGSYS pH Control Module (pHCM)
73-2811	Mixer for IPL-2 Buffer Reservoir

pH Control Unit for IPL-2, 115 V, (73-4283) includes:

Item #	Product Name
73-2269	Jacketed Glass Container to Isolated Lung*
73-0113	REGLO Analog 4 Channel MS-4/8-100, 115 VAC, 60 Hz
73-0155	3-Stop Tygon® E-Lab Tubing, 2.79 mm ID, 12/pack, Purple/White
69-0072	Foodtrode™ Protein Resistant pH Electrode
69-0075	Protelyte™ Reference Electrolyte Solution, 100 ml
69-0077	Electrode Connecting Cable, BNC to AS7, 1 m (3.3 ft)
73-1784	BNC-BNC Connecting Cable
73-0215	PLUGSYS pH Measurement Module (pHMM)
73-1776	PLUGSYS pH Control Module (pHCM)
73-2811	Mixer for IPL-2 Buffer Reservoir

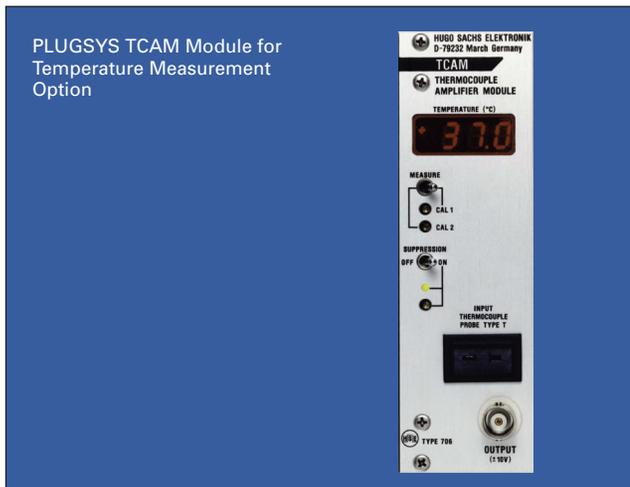
* With overflow to maintain constant perfusion solution level

PLUGSYS modules use a total of 4 slot units. Magnetic stirrer and stir bar sold separately.

Ordering Information

Item #	Description
73-4308	pH Control Option for IPL-1 System
73-4282	pH Control Option to IPL-2 System, 230 V
73-4283	pH Control Option to IPL-2 System, 115 V

Temperature Measurement Option



Perfusate temperature can be measured in one of two ways: with the PLUGSYS Thermocouple Amplifier Module (TCAM) or using a handheld thermometer with a digital readout. The perfusate temperature is measured by inserting a thermocouple probe directly into the perfusion line (into the tubing.) All IPL systems are accurately thermostated. Temperature measurement is only necessary on studies using different temperatures, such as transplantation studies.

- Temperature measurement with TCAM (73-1792) provides an analog output to record temperature changes with any data acquisition (DAQ) system.
- Temperature measurement with a handheld thermometer (73-4945) provides measurement on a digital display.

Choose either of the options above and add:

- Copper Constantan Thermocouple Flexible Implantable Probe (52-1732)
- Extension Cable for Thermocouples, 6 ft (73-1911)
- Tuohy Borst Adapter for inserting tip catheter, small temperature probe or PE catheter into left ventricle via aortic cannula (73-4193)

Ordering Information

Item #	Description
73-1792	Thermocouple Amplifier Module (TCAM)
73-4945	Handheld Thermometer for Thermocouple Probes
52-1732	Copper Constantan Thermocouple Flexible Implantable Probe, 0.6 mm Tip Diameter
73-1911	Extension Cable EXT-6 for Thermocouple Probes, 6 feet long (ca. 1.80 m)
73-4193	Tuohy Borst Adapter

Perfusion Solution Monitoring



This addition permits precise continuous monitoring and measurement of three key parameters, pO_2 , pH and pCO_2 , in liquid media or perfusate. Monitoring is accomplished using ion-sensitive, chemosensor-based, flow-through electrodes. The electrodes require a dedicated pulsation-free peristaltic pump to deliver a constant flow of perfusate through the electrode at flow rates in the range of 0.5 to 2 ml/min.

Because of the high impedance of these sensors, screening or shielding of the measuring circuit is required to protect against electrostatic discharges and other electrical disturbances.

Continuous measuring pH, pO_2 and pCO_2 of the perfusion solution in an isolated organ system allows the user to control these parameters over the course of the experiment. It is especially important to monitor these parameters throughout the course of drug studies as any change in these values indicates a significant effect of the drug being tested.

Applications

- Measurement of organ O_2 consumption, CO_2 production and/or pH changes

Features & Benefits

- Enables continuous measurement of pH, pO_2 , and pCO_2 in perfusate
- Smooth side stream flow through electrodes with use of peristaltic pump
- Noise-free design (when used with the Shielding Case)
- Measure parameters in the reservoir (pre-organ) and in the effluent (post-organ) allowing measurement of O_2 exchange, CO_2 production and pH change

Drug Addition Option

System Components (purchase separately)

- Shielding Case and Mounting Plate
- Electrodes, associated amplifiers, adapters and related components*
- Dedicated peristaltic pump (such as REGLO Analog Pump 73-0114 or 73-0113) and appropriate pump tubing (73-0206)

*Various microelectrodes and associated components are available. Not all options listed. Please contact us to discuss your application so that we can assist you with the best possible solution.

Ordering Information

Item #	Description
Shielding Cases	
73-4195	Microelectrode Shielding Case for Three Electrodes (pH, pO ₂ , pCO ₂)
73-0207	Mounting Plate for Three-Electrode Shielding Case
73-4196	Microelectrode Shielding Case for Single Electrode (pO ₂ or pCO ₂)
73-3000	Mounting Base for Single Electrode Shielding Case
Sensors for pO₂ Measurement	
73-4189	Mini Flow-Through Oxygen Electrode, 1/16" Fittings, for use with OPPM
66-0100	O ₂ Flow Through Electrode, 1/16" Fittings for O ₂ Adapter
Sensors for pCO₂ Measurement	
73-4191	pH Flow Through Electrode, 1/16" Fittings
Sensors for pH Measurement	
73-4190	pH Flow Through Electrode, 1/16" Fittings
73-4197	pH Mini Flow Through Electrode Set, 1/16" fittings. Includes: flow through electrode, solid state reference system and cable to pHMM
73-2998	Leak Free pH Flow Through Reference Electrode Set for Millivolt Adapter
Amplifiers & Adapters	
73-0210	PLUGSYS Oxygen Partial Pressure Module (OPPM)*
73-0212	PLUGSYS Electrometer Module (EMM)*
73-0215	PLUGSYS pH Measurement Module (pHMM)*
75-1672	O ₂ Adapter 100, Lemo to ADI DIN
75-1672	Millivolt Adapter, Lemo to ADI DIN (for pCO ₂ or pH electrodes)



Pump 11 Elite

These options for drug addition can be added to any isolated organ system where flow is measured or calculated and a drug must be added in a certain ratio.

There are two options:

- **Perfusion drug addition with syringe pump:** allows drug addition at a set flow rate without software control.
- **Perfusion flow-controlled drug addition with syringe pump:** allows a drug addition proportional to the measured flow in order to maintain a stable drug concentration at any flow rate under constant pressure. Requires HSE software to read and calculate the flow to control the syringe pump flow.

Drug Addition Option (73-4041) includes:		Flow-Controlled Drug Addition Option (73-4042) includes:	
Item #	Product Name	Item #	Product Name
70-4504	Pump 11 Elite Infusion/Withdrawal Programmable Single Syringe	70-4504	Pump 11 Elite Infusion/Withdrawal Programmable Single Syringe
73-4193	Tuohy Borst Adapter	73-4193	Tuohy Borst Adapter
73-3941	Luer cannula, shorted 1.2 mm, L = 25 mm	73-3941	Luer cannula, shorted 1.2 mm, L = 25 mm
73-1866	Tygon Tubing, OD = 2.86 mm, ID = 1.14 mm, L = 1 m	73-1866	Tygon Tubing, OD = 2.86 mm, ID = 1.14 mm, L = 1 m
		73-3819	HSE DAQ Flow-Controlled Drug Addition Software

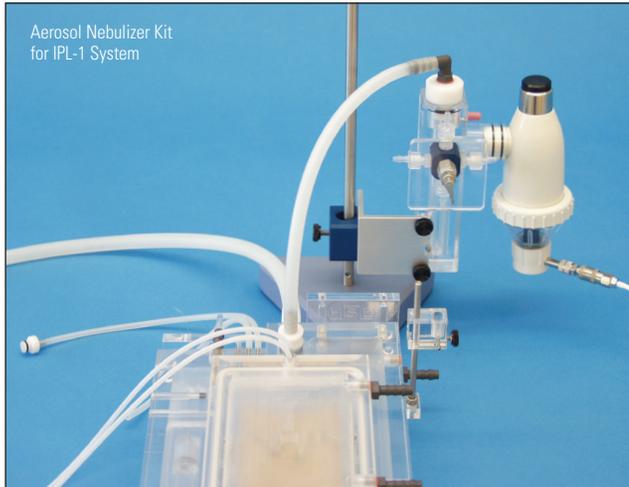
For either option, a syringe with Luer taper must be purchased separately.

Ordering Information

Item #	Description
73-4041	Drug Addition Option
73-4042	Flow Controlled Drug Addition Option*

* This option is available on request. Please contact Technical Support.

Aerosol Nebulizer Options for IPL-1, IPL-2 and IPL-4



The Aerosol Jet Nebulizer can be used for any fluid (water-like) drug. It is recommended for nebulizing drugs sensitive to ultrasonic cavitation. If a drug can be diluted in fluid and nebulized in a jet nebulizer, it must be clarified first. The viscosity of the fluid must be water-like.

The throughput of this nebulizer compared to the inhaled air of a small lung is very high. The nominal flow for the nebulizer is 5.0 L/min at a pressure of 1.42 bar. By using a 0.9% NaCl solution at a pressure of 1.42 bar the total output rate of NaCl solution is 130 mg/min.

This jet nebulizer is driven by compressed air. The aerosol is transported by the compressed air and the air stream through the jet. A compressed air source at an operating pressure of approximately 1.5 bar (22 psi) is required. 100% of the particles are below 10 µm, 60% below 2.5 µm.

Convenient Aerosol Nebulizer Kits contain the nebulizer and all the parts to connect it to the IPL System.

Features & Benefits

- Low particle sizes (60% of the particles are below 2.5 µm; 100% of the particles are below 10 µm).
- No solution warming required
- Recommended for drug sensitive to ultrasonics
- Aerosol is automatically transported by the air stream

Ordering Information

Item #	Description
73-1963	Aerosol Nebulizer only
73-3300	Tubing Connection Kit for Aerosol Nebulizer
73-2919	Multi-Gas Inlet Adapter for MiniVent with Nebulizer Port: Required if positive ventilation with MiniVent on an IPL-1 system is used. Nebulizer 73-1963 and Connection kit 73-3300 must be ordered separately.
73-3433	Universal Aerosol Generator and Multi-Gas Adapter Kit: Includes all necessary parts to adapt a nebulizer 73-1963 to a ventilator. Includes holder for nebulizer with stand, tubing, exhaust tubing. Nebulizer 73-1963 and connection kit 73-3300 is also included.
73-4294	Aerosol Nebulizer Kit to IPL-1: Includes all necessary parts, one jet nebulizer, multi-gas adapter, aerosol filter, alternative gas supply and all the necessary tubing, connectors and mounting hardware to connect the nebulizer to the IPL-1 system. This kit is used for aerosol application during negative ventilation. If the Aerosol should be applied during positive ventilation a MiniVent with 73-2919, 73-3300 and 73-1963 must be used.
73-2111	Aerosol Nebulizer Kit to IPL-2: Includes all necessary parts, one jet nebulizer, aerosol filter, ON/OFF switch for compressed air (to be mounted on IPL-2 base unit), and all the necessary tubing, connectors and mounting hardware to connect the nebulizer to the IPL-2 system. This kit is used for aerosol application during negative ventilation. If the Aerosol should be applied during positive ventilation a suitable ventilator and the 73-3433 Universal Aerosol Generator and multi gas adapter kit must be used.
73-2112	Aerosol Nebulizer Kit to Add Second Nebulizer to IPL-2: Includes one nebulizer, aerosol filter, tubing, and necessary parts to hold the second nebulizer onto the IL-2 system. This is only required if two substances should be nebulized after each other.
73-4310	Aerosol Nebulizer Kit to IPL-4: Includes all necessary parts, one jet nebulizer, aerosol filter and all the necessary tubing, connectors and mounting hardware to connect the nebulizer to the IPL-4 system. This kit is used for aerosol application during negative ventilation. If the Aerosol should be applied during positive ventilation a suitable ventilator and the 73-3433 Universal Aerosol Generator and multi gas adapter kit must be used.

VENTILATORS

VentElite Small Animal Ventilator



The VentElite Small Animal Ventilator was designed for animal research applications and is intended for use on subjects ranging in size from 20 g to 1 kg. The goal in designing this ventilator was to maintain versatility and ease of use while fostering safe and physiologically accurate mechanical ventilation conditions.

Features & Benefits

- Tidal volumes from 50 μ l up to 5 ml
- Real time graphical display of tracheal pressure
- Easy to use color touchscreen
- Interchangeable between volume and pressure modes
- Internal pressure monitoring for detection of over and under pressure conditions
- Manual or programmable sigh
- Inspiratory or expiratory hold
- Adjustable I:E

The VentElite utilizes advanced technologies to precisely control respiration profiles. It has two operating modes, Volume Control and Pressure Control, and allows users to easily toggle between these two modes via the Settings button on the large touch screen. The Volume Control mode delivers the desired tidal volume to the subject by precisely controlling the stroke of the piston. Since the actual stroke length, and therefore tidal volume, may be modified for a given stroke, sigh breaths are supported. Similarly, since stroke speed is precisely controllable during inspiration and expiration, variable inspiration-to-expiration (I:E) ratios are also supported. A pressure sensor continuously monitors the airway pressure to alert the user of over- and under-pressure conditions.

The Pressure Control mode of the VentElite allows the user to set the peak inspiratory pressure (PIP) value and the positive end expiratory pressure (PEEP). Flow rates are automatically adjusted by changing the tidal volume while keeping the respiration rate constant. Manual adjustment of the inspiratory flow rate is not required. The VentElite offers built-in Positive End Expiratory Pressure (PEEP) capability, allowing a PEEP setting via the touch screen user interface of up to 10 cmH_2O . Another feature of the VentElite is the ability to perform Inspiratory or Expiratory Hold. The user can enter the desired hold time and initiate inspiratory or expiratory hold by simply pressing the Insp. Hold/Exp. Hold button on the user interface.

Ordering Information

Item #	Description
55-7040	VentElite Ventilator for Small Rodents
73-4872	Connection Kit for VentElite for Pressurized Gas or Isoflurane Anesthesia

Note: To connect the VentElite to an IPL-1 or IPL-2 system, special adapters are required. Please inquire with our support specialists.

VENTILATORS

Harvard Apparatus Small Animal Ventilator (Model 683)



Model 683 Small Animal Ventilator

The Model 683 Small Animal Ventilator comes standard with two piston and cylinder assemblies. The smaller piston (which comes installed) allows tidal volumes to be set from 0.5 to 5.0 cc in 0.5 cc increments and the larger cylinder allows tidal volumes of 3.0 to 30 cc in 0.3 cc increments. Setting the cylinder stroke between gradations it is possible to achieve finer resolution in tidal volume settings.

Features & Benefits

- For single small animals from 250 g to 10 kg (22 lb) e.g. rats, hamsters, rabbits, cats, monkeys, small dogs
- Volume controlled

The 683 Ventilator features a numerical LED to display the respiratory rate which can be set from 18 to 150 strokes/minute. Volume and rate settings can be adjusted while the ventilator is running. It has four ports: supply gas in, gas out (to animal), gas return (from animal) and ventilator exhaust. The ventilator exhaust can be attached to a column of water to achieve PEEP (positive end expiratory pressure).

Overhaul kits are available and are specific for the type of cylinder used. They include complete instructions and replacement parts.

Ordering Information

Item #	Description
55-0000	Harvard Small Animal Ventilator Model 683
55-0006	Retrofit Model 683, for Models pre-2008
73-3076	Ventilation Connection Kit for 683 Small Animal Ventilator for Isoflurane Anesthesia
55-5282	Overhaul Kit for 683 Ventilator with 5 cc Cylinder
55-5283	Overhaul Kit for 683 Ventilator with 30 cc Cylinder

MiniVent Ventilator for Mice (Model 845)



Model 845 MiniVent Ventilator

The MiniVent Model 845 Ventilator is a quiet, compact and light weight ventilator designed specifically for mice. It is a constant-volume respiration pump operating on the Starling principle. It can be used for positive only ventilation with the IPL-1 system. It can be used for other animals (e.g. birds and perinatal rats) which requires tidal volumes in the range of 30 to 350 μ l and respiratory rates of 60 to 400 breaths per minute.

Features & Benefits

- Ideal ventilator for mice
- Stroke volume range from 30 to 350 μ l
- Ventilation rate from 60 to 400 breaths/minute
- Simple adjustment of stroke volume while running
- Valveless piston pump, no valves to clog
- Very small instrument/circuit dead space volume
- Compact construction, easy to install close to animal
- No vibrations, very low noise

Unlike conventional units for larger animals, the MiniVent employs a rotary plunger and has no valves. During each ventilation cycle, the plunger performs a synchronized forward and rotating movement. Cleverly arranged bores and channels in the cylinder and plunger control inspiration and expiration during each stroke of the plunger.

The extremely light weight and compact construction, in addition to the convenient rod clamp, allow the MiniVent ventilator to be positioned directly next to the animal. With the MiniVent, the tidal volume error due to system compliance is reduced to +/- 3 μ l.

VENTILATORS

Tidal volume and respiration rate can be set exactly to the values required for mouse ventilation. The level of precision and control available to the investigator minimizes the danger of hyperventilation or hypoventilation.

The MiniVent is supplied with 1 x AC power supply (115 V or 220 V); 2 x silicone tubing (1.5 mm ID, 3.0 mm OD, 14 cm long); 1 x 1.3 mm OD tracheotomy cannula (73-2730) and 1 x 1.2 mm OD intubation cannula (73-2844). A multi-gas inlet adapter is available for the MiniVent so that alternate gas mixtures and nebulized substances can be delivered to the MiniVent inlet port at atmospheric pressure.

Ordering Information

Item #	Description
73-0043	Mouse Ventilator MiniVent Type 845, 115 V, Power Supply with US Connector
73-0044	Mouse Ventilator MiniVent Type 845, 230 V, European Power Supply with EU Connector

Note: The Model 849 MidiVent Ventilator for Large Mice and Small Rats and Model 687 Mouse and Perinatal Rat Ventilator may be used for investigators who wish to study ventilator-induced lung injury.

Harvard Apparatus Large Animal Ventilator (Model 613)



Model 613 Large Animal Ventilator

The Harvard Apparatus Large Animal Volume-Controlled Ventilator is suitable for ventilating a single animal from 1.5 to 50 kg. It can be used for ventilating a pig lung lobe with the IPL-16 system.

Features & Benefits

- For animals from 1.5 to 50 kg (3.3 to 110 lb) in weight
- Adjustable volume adjustable from 30 to 750 cc/stroke
- Adjustable respiratory rate from 7 to 50 breaths/minute.
- Variable inspiratory: expiratory ratio

Volume adjustment is made on the piston shaft. Therefore accurate volume adjustment cannot be made while the ventilator is running. However, the rate and the I:E% can be varied while the ventilator is running. Includes separate ports for gas inlet, gas outlet (to animal), gas return (from animal) and ventilator exhaust.

The gas inlet can be used to supply air or any non-flammable gas supply. Like the other Harvard mechanical ventilators, attachment of the ventilator exhaust to a column of water can be used to produce a positive end-expiratory pressure (PEEP).

Ordering Information

Item #	Description
55-0715	Harvard Large Animal Ventilator, Model 613, 115 VAC
55-0723	Harvard Large Animal Ventilator, Model 613, 230 VAC
55-0731	Overhaul Kit for Harvard Apparatus Large Animal Ventilator: Contains O-rings, Valve Springs, Lubricants, etc. to Overhaul Ventilator* *Overhaul Kit does not include replacement cylinder

THERMOCIRCULATORS

Lauda Thermocirculators



E-103 Thermocirculator RE-207 Thermocirculator

Lauda Bath/Immersion Thermostats (E-103)

Economical, high quality stainless steel baths that provide temperature-controlled circulating water from 20°C to 150°C.

Features & Benefits

- User-friendly menu guidance, operation with three keys
- Over-temperature cut off
- Visual alarm
- High-powered, speed-selectable, five-speed pump with electronic control heats the thermocirculator up quickly
- Can be switched between internal and external circulation

Lauda Low-Temp Thermostats (RE 207)

Powerful, low-temperature thermostats with microprocessor technology. Environmentally-friendly and energy-saving refrigeration system.

Features & Benefits

- Clear 2-line LCD display with numbers and symbols
- Parallel display of actual and set temperature
- Messages for the various operating states in plain language
- Audible alarm for low level and over temperature
- Facility for remote fault indication through floating contact

Ordering Information

Item #	Description
73-2481	Lauda Low Temperature Thermostatic Circulator RE 207, 6 L Bath Volume, 230 VAC/ 50Hz, Temperature Range -35 to +200°C
73-0125	Lauda Thermostatic Circulator, Type E-103, 230 V/50 Hz, 3 L Bath Volume, Temperature Range 20 to 150°C
73-2802	Lauda Thermostatic Circulator, Type E-103, 115 V/60 Hz, 3 L Bath Volume, Temperature Range 20 to 150°C
73-2968	Tube Set for Lauda Thermocirculators

LT ecocool Refrigerated / Heating Circulating Baths



LT ecocool Circulating Baths

Powerful cooling and heating in an eco-friendly bath. Up to 80% energy savings compared to standard compressor units. The two models offered come as complete kits with hosing, clips and connectors.

Features & Benefits

- Temperature range -20°C to 100°C or -25°C to 150°C (model dependent)
- Active cooling through whole temperature range
- Thermostat and chiller work simultaneously, eliminating the danger of overheating or freezing
- Single front switch for user convenience

Ordering Information

Item #	Description
75-0310	LT ecocool 100, 120 V, -20 to 100°C
75-0311	LT ecocool 100, 230 V, -20 to 100°C
75-0312	LT ecocool 150, 120 V, -25 to 150°C
75-0313	LT ecocool 150, 230 V, -25 to 150°C

TC120 Series Heated Circulating Bath



TC120 Thermocirculator with Stainless Steel Bath

This easily programmable thermocirculator allow for high precision temperature control from 0 to 120°C. The powerful pump makes these circulators ideal for both routine and sensitive procedures.

Features & Benefits

- Digital control unit with four digit display
- Rotor dial for simple temperature setting
- Low liquid protection
- Over temperature cut out
- Integral pump with max flow rate 16 L/min
- Visual alarm

Operation at low temperatures

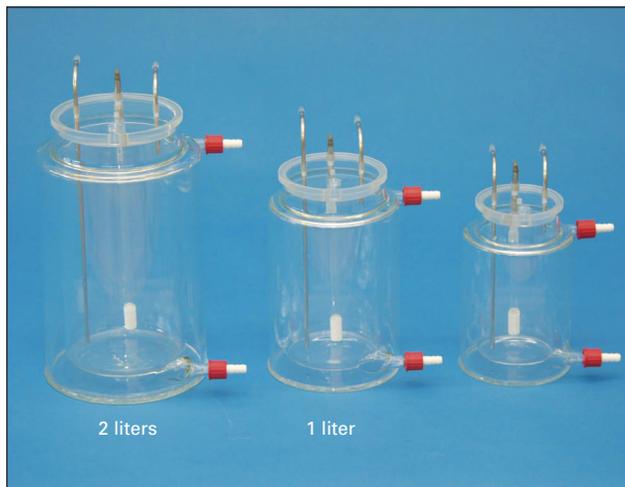
Accessory cooling is required for controlled operation at or below ambient temperature. The minimum working temperature without accessory cooling depends on the size of the bath. The small baths, P5 and ST5, have a minimum working temperature of approximately 10°C above ambient without a lid and 15°C above ambient with a lid. Other bath sizes can be used at a temperature of 5°C above ambient.

These TC120 Thermocirculators are supplied complete with the thermocirculator itself, stainless steel or plastic bath and lid.

Ordering Information

Item #	Description
73-4544	TC120 Thermocirculator, complete with 5 L stainless steel bath and lid, 220 V
72-4945	TC120 Thermocirculator, complete with 5 L stainless steel bath and lid, 120 V
72-4924	TC120 Thermocirculator, complete with 5 L plastic bath and lid, 120 V
72-4921	TC120 Thermocirculator, complete with 5 L plastic bath and lid, 220 V

Jacketed Glass Perfusate Reservoirs



These jacketed glass reservoirs are used in conjunction with a peristaltic pump to deliver warmed perfusate to the target organ. They interface with a thermocirculator to stabilize the temperature of the reservoir through ports that accept 5 mm ID tubing.

These reservoirs are available in multiple sizes and styles:

- Standard and sealed styles – the peristaltic pump is connected to the longer stainless steel tube via a Luer connector and tubing.
- Bottom drain type – the perfusate outlet is the drain port, which can be connected to 5 mm ID tubing or via a Luer adapter to the stopcock (included with the reservoirs with bottom drain).
- All styles – a return flow can be connected to the short stainless steel tube with the included Luer to barded tubing connector.

Each reservoir is supplied with a frit to aerate the perfusate. Tubing sets for interfacing with a thermocirculator must be purchased separately.

Jacketed Glass Perfusate Reservoirs

(continued)

Ordering Information

Item #	Description
Jacketed Glass Reservoirs	
73-3440	Jacketed Glass Reservoir for Buffer Solution, with Frit, 2.0 L
73-3438	Jacketed Glass Reservoir for Buffer Solution, with Frit, 1.0 L
73-3436	Jacketed Glass Reservoir for Buffer Solution, with Frit, 0.5 L
73-0322	Jacketed Glass Reservoir for Buffer Solution, with Frit, 6.0 L
73-3496	JJacketed Glass Reservoir for Enzyme Solution, with Cover, 100 ml
Jacketed Glass Reservoirs with Bottom Drain	
73-3441	Jacketed Reservoir for Buffer Solution with Frit and Bottom Drain, 2.0 L
73-3439	Jacketed Reservoir for Buffer Solution with Frit and Bottom Drain, 1.0 L
73-3437	Jacketed Reservoir for Buffer Solution with Frit and Bottom Drain, 0.5 L
Sealed Jacketed Glass Reservoirs	
73-4734	Sealed Jacketed Glass Reservoir, 2.0 L, with Tubing Oxygenator
73-4808	Sealed Jacketed Glass Reservoir, 220 ml, with Tubing Oxygenator
73-4954	Sealed Jacketed Glass Reservoir with Autoclavable Lid, 2 L (no tubing)
73-4952	Sealed Jacketed Glass Reservoir with Autoclavable Lid, 220 ml (no tubing)
Accessories & Replacement Parts	
73-3566	Frit for 2.0 L Jacketed Buffer Reservoir
73-3565	Frit for 1.0 L Jacketed Buffer Reservoir
73-3564	Frit for 0.5 L Jacketed Buffer Reservoir
73-3455	Tube Set for Jacketed Buffer Reservoir
73-3456	Tube Set for Jacketed Buffer Reservoir with Fluid Line Shutoff Valves
73T17140	Return Tube for Glass Reservoir, stainless steel, D = 4 x 0.25 mm, L = 70 mm
73T17141	Suction Tube for 0.5 L Glass Reservoir, stainless steel, D = 4 x 0.25 mm, L = 190 mm
73T17142	Suction Tube for 1.0 L Glass Reservoir, stainless steel, D = 4 x 0.25 mm, L = 220 mm

Fiber Oxygenators



Fiber Oxygenator



Stand Alone Oxygenator Holder, shown with Needle Valve



Universal Mounting Kit

The fiber (or membrane) oxygenator is an alternative to glass frit or bulb oxygenators. This oxygenator is used for blood, blood/perfusate mix, or perfusate that contains protein (to prevent foaming).

Oxygenator holders are available separately. Mounting rods are not included. Mounting kits are specific for either the D150 or DP07HE oxygenator. They include two ring clamps to hold the oxygenator, tubing adapters, and silicone and Tygon® tubing.

Features

- Hollow fiber oxygenator in two sizes D150 or DP07HE
- MediSulfone® membrane material
- 18/49 ml total priming volume
- 0.22/0.7 m₂ active oxygenating surface area
- Can be used 3 to 10 times
- Selection of different holders available

Ordering Information

Item #	Description
73-3757	Fiber (Membrane) Oxygenator Type D150, pkg. of 1
73-3762	Fiber (Membrane) Oxygenator Type D150, pkg. of 5
73-4993	Fiber (Membrane) Oxygenator Type DP07HE, pkg. of 1
73-4995	Fiber (Membrane) Oxygenator Type DP07HE, pkg. of 5
73-3061	Holder for Oxygenators for UP-100 and IH-SR
73-3057	Holder for Oxygenators for PSCI
73-3058	Stand Alone Holder for Fiber (Membrane) Oxygenators with Needle Valve
73-3759	Mounting Kit for D150 Fiber Oxygenator on Holder
73-3760	Mounting Kit for DP07HE or DP07HE Fiber Oxygenators on Holder
73-3765	Connection Kit for Fiber Oxygenator: Consisting of 5 sets of tubing connectors for perfusate and gas to the oxygenator

REGLO Analog & Digital Peristaltic Pumps



REGLO Peristaltic Pump

The REGLO peristaltic pump is available in either analog or digital models. The analog pump has a variable speed drive with start/stop, speed, and direction functions. The digital version features a dispense mode with variable flow rates and also dispenses by volume or time intervals. The digital readout facilitates programming.

Features

- Included snap-on MS/CA Click 'n' Go Cassettes makes these pumps very easy to use

While the REGLO digital is suitable for constant flow perfusion, the analog is necessary when utilizing the SCP module for constant pressure perfusion.

Ordering Information

Item #	Description
73-0113	REGLO Analog Peristaltic Pump, 4-channel MS-4/8, 115 VAC, 60 Hz
73-0114	REGLO Analog Peristaltic Pump, 4-channel MS-4/8, 230 VAC, 50 Hz
73-2915	REGLO Digital Peristaltic Pump, 4-channel MS-4/8, 115 VAC, 60 Hz
73-0100	REGLO Digital Peristaltic Pump, 4-channel MS-4/8, 230 VAC, 50 Hz
3-Stop Collared Tubing	
Item #	AME# Description
73-1828	12 3-Stop Collared TYGON E-Lab Tubing, 1.09 mm ID, pkg. of 12
73-0126	14 3-stop Collared TYGON E-Lab Tubing, 1.22 mm ID, pkg. of 12
73-1831	16 3-stop Collared TYGON E-Lab Tubing, 1.42 mm ID, pkg. of 12
73-1836	21 3-stop Collared TYGON E-Lab Tubing, 2.06 mm ID
73-1838	23 3-stop Collared TYGON E-Lab Tubing, 2.54 mm ID
73-1839	25 3-stop Collared TYGON E-Lab Tubing, 3.1 mm ID

Harvard Apparatus Peristaltic Pump

Harvard Peristaltic Pump with P-70 motor drive



The Harvard Peristaltic Pump provides unparalleled accuracy, reproducibility, and ease of use over a broad range of flow rates. It consists of a control unit, a motor drive, a tubing cassette and some sample tubing. The P70 drive allows for flow rates of 1 $\mu\text{m}/\text{min}$ to 70 ml/min, depending on tubing size used.

Features

- Ability to separate the motor drive from the controller to facilitate use and save space in incubators and fume hoods
- Library of tubing sizes is stored in the pump's memory minimizing set up time
- Custom tubing can be used allowing complete flexibility
- Connectivity to a wide range of external input or output devices is easily accomplished.
- Easy to calibrate just by sampling a small amount of fluid over time.

All settings can easily be saved as user-generated methods in the pump's memory. The method can be easily recalled and run very quickly, saving researchers valuable time.

The pump will automatically rotate at the proper rpm for the tube selection and flow rate chosen. To further increase the accuracy, Harvard Peristaltic Pumps offer a rapid calibration routine to further optimize flow accuracy by entering a measured volume of fluid collected.

Note: Connecting this pump to the SCP pressure controller requires a special cable (73-4619) which must be ordered separately.

Harvard Apparatus Peristaltic Pump

(continued)

Specifications	
Type	8 rollers, 5 channels
Accuracy	±1.0%
TTL Connector	15-pin D-sub
Computer Interface	USB Type 'B'
Pump-To-Pump	IEEE 1394
Back Pressure Maximum	15 psi (-1.0 bar)
Tubing ID	0.13 to 2.79 mm
Flow Rate Range	0.001 to 70 ml/min
Dimensions, Control Box	207 x 130 x 96 mm
Dimensions, Pump Head	115 x 254 x 118 mm
Weight	4.7 kg
Pump Voltage	30 VDC, 1.67 A
Power Supply	100-250 VAC, 50/60 Hz

Ordering Information

Item #	Description
70-7000	Harvard Peristaltic Pump with P-70 Motor Drive
70-2215	Footswitch
72-0604	Replacement Cartridge/Cassette for P-70
72-0643	3-stop Collared Silicone Tubing, 1.29 mm ID
72-0649	3-stop Collared Silicone Tubing, 2.05 mm ID
72-0651	3-stop Collared Silicone Tubing, 2.54 mm ID
72-0652	3-stop Collared Silicone Tubing, 2.79 mm ID

Ecoline Microprocessor Controlled Peristaltic Pumps

Ecoline Roller Pump, VC-MS/CA4-12



The Ecoline pumps are economical and compact and offer a wider flow rate range than both the Harvard Peristaltic Pump and the REGLO Analog and Digital Pumps. They are ideal for complex pumping applications such as recirculating organ perfusion system.

The Ecoline pumps accept 3-stop collared tubing and utilize the MS/CA Click 'n' Go Cassettes.

Features & Benefits

- Economical and powerful
- Stackable pumps for dosing and filling applications requiring variable flow rates
- MS/CA Click 'n' Go Cassettes included
- Uses 3-stop collared tubing
- Differential pressure 1.0 bar
- Analog interface
- Robust stainless steel housing

Note: Connecting this pump to the SCP pressure controller requires a special cable (73-4619) which must be ordered separately.

Ordering Information

Item #	Description
72-6434	Ecoline Roller Pump, VC-MS/CA4-12, 4 Channels, 230 VAC, 50 Hz
72-6435	Ecoline Roller Pump, VC-MS/CA4-12, 4 Channels, 115 VAC, 60 Hz
72-6432	Ecoline Roller Pump, VC-MS/CA8-6, 8 Channels, 230 VAC, 50 Hz
72-6422	Ecoline Roller Pump, VC-MS/CA8-6, 8 Channels, 115 VAC, 60 Hz

3-Stop Collared Tubing		
Item #	AME#	Description
73-0126	14	3-stop Collared TYGON E-Lab Tubing, 1.22 mm ID
73-1836	21	3-stop Collared TYGON E-Lab Tubing, 2.06 mm ID
73-1838	23	3-stop Collared TYGON E-Lab Tubing, 2.54 mm ID
73-1839	25	3-stop Collared TYGON E-Lab Tubing, 3.1 mm ID

Centrifugal Pump



Centrifugal Blood Pump

The centrifugal pump is specifically designed for pumping blood and/or erythrocyte suspension solutions in the physiological or pharmacological laboratory. It consists of the pump drive BVP-ZX and a centrifugal pump head which can be replaced without tools. Pump heads are hermetically sealed. The coupling to the motor of the pump drive is carried out via magnetic force; there is no axle.

Features & Benefits

- Low hemolysis
- Flow rates up to 16 L/min
- No or only low pulsation
- Smooth run, producing only low noise
- Pump heads interchangeable without tool
- Speed setting by a digital switch in 0.1% steps
- "Max Speed" button for quick fill or ventilate
- Robust construction for long life time
- Analog interface for remote control, e.g. via SCP pressure controller

The pump speed is set using a 3-digit potentiometer switch (000 to 999) or via an analog interface. The drive is very robust and suitable for continuous speed selection operation.

The pump drive and pump heads must be purchased separately. The pump heads are interchangeable and do not require tools to change.

Ordering Information

Item #	Description
73-2963	Centrifugal Pump Drive (BVP-ZX), 115 VAC, 50/60 Hz
73-2470	Centrifugal Pump Drive (BVP-ZX), 230 VAC
73-2807	Centrifugal Blood Pump Head (BP-80)

Blood Pressure Transducer (APT300)



APT300 Pressure Transducer

The APT300 Transducer is an inexpensive pressure transducer which can be used to measure arterial blood pressures in all species, even on mice with a high heart rate. This transducer is typically used for arterial pressure measurement in vivo, perfusion pressures in isolated perfused organs such as heart or kidney, Isovolumetric Left Ventricular (using a balloon) pressures in isolated hearts from mice up to rabbits or pigs.

Features & Benefits

- Inexpensive, reliable and accurate
- Low volume displacement
- Suitable for virtually all arterial pressure applications
- Easy to fill
- Stopcocks Included
- Simple holder for rod mounting

The APT300 Transducer consists of a contact plate with cable and the exchangeable transducer head, which can easily be replaced. Contact plates with cables for different amplifiers are available. Please visit www.harvardapparatus.com for detailed specifications.

Ordering Information

Item #	Description
73-3862	APT300 Pressure Transducer for PLUGSYS Module
73-3866	APT300 Pressure Transducer for ADInstruments
73-3860	Replacement Cable with Contact Plate for PLUGSYS TAM Amplifier
73-3861	Replacement Transducer Head for APT300 Transducer
73-3868	Holder for APT300 Transducer, 8 mm Rod, Length 160 mm
73-3869	Holder for APT300 Transducer, 8 mm Rod, Length 75 mm
73-0566	Plexiglass Block Clamp for mounting Mini-Ball Bar onto Lab Stand
73-0500	Lab Stand with Triangular Base Plate, 30 cm Rod Length (one block clamp included)
73-4479	Manual Pressure Calibrator, Range 0 to 300 mmHg

PRESSURE TRANSDUCERS

Venous Pressure Transducer (P75)



P75 Blood Pressure Transducer

This rugged low pressure transducer is highly sensitive for research and surgical applications involving liquids or gases.

- For low pressure applications with liquids and gases +/-75 mmHg
- Excellent sensitivity and baseline stability
- Applications include:
 - Venous blood pressure
 - Esophageal pressure with fluid filled catheter
 - Perfusion pressure in isolated lung and liver
 - Perfusion pressure on perfused hollow organs, such as the esophagus
- Robust construction with a removable Macrolon® dome, easy to fill, bubble free
- Transducer is a metal housing with ceramic pressure sensor giving the P75 excellent resistance to a variety of media

The P75 has a removable Macrolon® dome with a pressure connection and a vent connection at the side, so that it can be filled free of air bubbles. The dome connections have a male Luer taper so that suitable stopcocks can be attached. The transducer has a metal housing. The actual pressure sensor inside is made from ceramic and therefore has excellent resistance to different media.

The transducer's rugged construction can withstand pressure overloads up to 4000 mmHg without damage. It works together with any DC bridge amplifier (e.g., PLUGSYS TAM-A). Please visit www.harvardapparatus.com for detailed specifications and accessories.

Ordering Information

Item #	Description
73-0020	Blood Pressure Transducer P75 for PLUGSYS Module
73-3738	Blood Pressure Transducer P75 for ADInstruments Bridge Amp
73-0025	Replacement Dome for P75

Differential Low Pressure Transducer (DLP2.5)



DLP2.5 Differential Pressure Transducer

This Differential Pressure Transducer is designed for very low differential pressure measurements. They are especially suitable for airflow measurement in respiration studies using pneumotachs. They are used in combination with plethysmographic boxes, isolated lung systems and all types of pneumotachs. This transducer is included in all IPL systems for respiratory air flow measurements.

The transducer element is temperature compensated over a large temperature range. It has small internal volume and a very low volumetric displacement to achieve good frequency response. It can be connected to a standard strain gauge amplifier like a PLUGSYS Module TAM-A.

Ordering Information

Item #	Description
73-3882	Differential Low Pressure Transducer DLP2.5, range +/- 2.5 cmH ₂ O, HSE Connector
73-3999	Differential Low Pressure Transducer DLP2.5, range +/- 2.5 cmH ₂ O, ADI ML110, ML112 or News Versions Connector

Airway/Artificial Thoracic Pressure Transducer (MPX)



This MPX Differential Pressure Transducer can be used with most research animals to measure tracheal, esophageal or trans-diaphragmatic pressures with air-filled catheter.

It is ideal for use with mouse, hamster, rat, guinea pig, rabbit, ferret, cat and dog. It is included with IPL systems used to measure artificial thorax pressure and tracheal or airway pressures.

Ordering Information

Item #	Description
73-0064	Differential Pressure Transducer MPX, Range +/-100 cmH ₂ O, HSE Connector
73-3744	Differential Pressure Transducer MPX, Range +/-100 cmH ₂ O, for ADI Amplifier

PLUGSYS Modules & Housings



PLUGSYS TAM-A and TAM-D Modules

PLUGSYS Minicase Type 609



PLUGSYS is a flexible measuring and control system for amplifying, capturing, monitoring and recording physiological data. Its modular structure permits multi-application platform use in areas such as hemodynamics, pulmonary studies, isolated organ studies, biopotentials and combination studies.

A wide range of available modules (bridge amplifiers, ECG, EEG, EMG amplifiers, flowmeters etc. can easily be interconnected and interfaced to PC data acquisition and other recording systems. All PLUGSYS modules fit directly into slots in a PLUGSYS main frame. In addition to being a conventional modular analog measuring system, the PLUGSYS includes specific interface modules and application software for data acquisition and analysis. For more details about PLUGSYS, please visit www.harvardapparatus.com.

PLUGSYS Modules for IPL Systems

Transducer Amplifier Modules (TAM-A and TAM-D)

Universal DC bridge amplifiers used to amplify physiological signals such as blood pressure, contraction force or contraction displacement.

- **TAM-A (analog):** The TAM-A is equipped with an analog LED bar graph signal indicator and is best suited for applications which require the monitoring of dynamic signals, e.g. pulsatile blood pressures, respiratory airflow, airway pressures, contraction force or contraction displacement on tissue studies.
- **TAM-D (digital display):** The TAM-D has a digital numeric display and is best suited for applications with slowly changing low pulsatile signals, e.g. constant blood pressures, perfusion pressures, slow isometric or isotonic contractions, intracranial pressure or venous blood pressures.

Servo Controller for Perfusion Module (SCP)

A PID pressure controller intended for perfusion control of isolated organ perfusions using a peristaltic pump. It works together with PLUGSYS bridge amplifiers TAM-A and TAM-D. It can operate in constant flow perfusion mode, in which the SCP controls the pump speed, or constant pressure mode, in

PLUGSYS Modules & Housings

(continued)

PLUGSYS Housing Type 601 with Five PLUGSYS Modules



which the speed of the pump is automatically adjusted to maintain a constant pressure. It also calculates the flow rate from the pump speed (indirect flow measurement).

pH Measurement Module (pHMM)

Used to continuously measure pH with pH glass electrodes, primarily in biological fluids such as perfusate for isolated perfused organs.

pH Control Module (pHCM)

Used for maintaining a constant pH of biological solutions in perfusion systems. Used in conjunction with the pHMM.

Oxygen Partial Pressure Module (OPPM)

Used to measure oxygen concentrations with CLARK-style electrodes in biological fluids of isolated perfused organs

Electrometer Module (EMM)

Used to measure CO₂ concentration or ion concentrations in biological fluids such as perfusate for isolated perfused organs, using appropriate electrodes

Transit Time Flowmeter Module (TTFM-2)

An ultrasonic transit time flowmeter module used to measure blood flow in vivo or flow rates of any perfusion solution in isolated organ systems (direct flow measurement). It incorporates a complete 1-channel Transonic® ultrasonic transit time flowmeter. It can be used either with HSE in-line flow probes or perivascular probes.

Thermocouple Amplifier Module (TCAM)

Use to measure temperature accurately and record temperature continuously with thermocouple probes.

Edema Balance Module (EBM)

For lung weight measurement (edema balance).

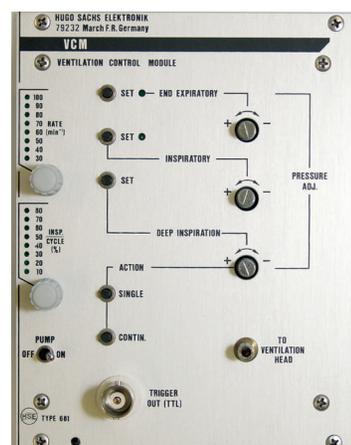
Ventilation Control Modules (VCM-P and VCM-R)

Produces a negative pressure at a respiratory rhythm as required for operating an isolated perfused rabbit, rat, guinea pig, or mouse lung. VCM-P uses an integral pump. VCM-R uses a pressure regulated gas source (tank or house air) in the range of 2 to 8 bars.

Servo Controller for Perfusion (SCP)



Ventilation Control Module (VCM-P)



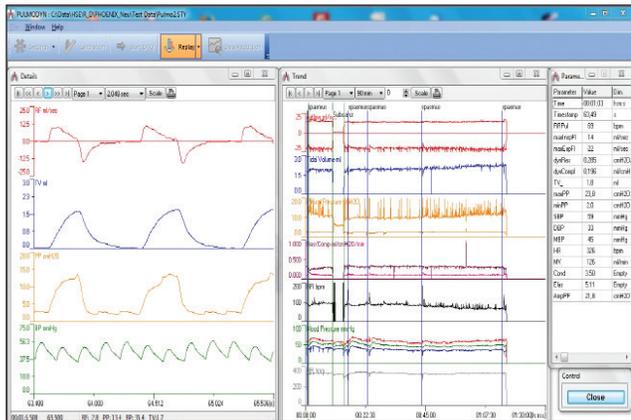
Time Counter Module (TCM)

Designed to operate in conjunction with the VCM modules. As a timer or event counter module it generates a signal which triggers the VCM to perform a deep inspiration cycle (sigh breath).

Ordering Information

Item #	Description	PLUGSYS Slots Required
73-0065	Transducer Amplifier Module, Analog (TAM-A)	2
73-1793	Transducer Amplifier Module, Digital (TAM-D)	2
73-2806	Servo Controller for Perfusion (SCP)	2
73-0215	pH Measurement Module (pHMM)	2
73-1776	pH Control Module (pHCM)	1
73-0210	Oxygen Partial Pressure Module (OPPM)	2
73-0212	Electrometer Module (EMM)	2
73-4617	Transit Time Flowmeter Module (TTFM-2)	5
73-1792	Thermocouple Amplifier Module (TCAM)	2
73-4626	Edema Balance Module (EBM)	3
73-1741	Ventilation Control Module (VCM-P)	5
73-2795	Ventilation Control Module (VCM-R)	5
73-1750	Timer Counter Module	1

PULMODYN Data Acquisition Software



PULMODYN Screenshot

PULMODYN data acquisition and monitoring software can be adapted to virtually any respiration study experiment, e.g. isolated lungs, or airflow and pressure measurements with free breathing or anesthetized animals. Acquisition can cover signals such as pulmonary air flow, tracheal pressure, and esophageal pressure. Any blood pressure, ECG or other signals such as temperature, pH and pO₂ can also be recorded.

Easy to Use

- Choose available signals to acquire and display.
- Choose from possible parameters to evaluate and display.
- Enter experimental protocol.
- Calibrate. (Calibration can be taken from previous experiment.)
- Start data acquisition.
- Data reduction and evaluation.

Measured Parameters

Calculated respiration parameters include respiration rate, max inspiratory flow, max expiratory flow, tidal volume, resistance and compliance/conductance. User defined parameters can be created by formulas.

All acquired signals and all calculated parameters can be displayed in two graphic windows (Detail and Trend) according to the settings of the user. Complete raw data of experiment are stored on hard disk and can be replayed any time later after experiment. Includes graphic selection of trend data points for easy data reduction.

PUMODYN software is available in a basic version which includes the minimal necessary algorithms. Optional software modules are available to upgrade to a more complex system that includes all the available algorithms.

Functionality

The configuration of the system can be defined by the user in the menu. Predefined templates are coming with the software if it was purchased with a system. The user only needs to calibrate the signals and fix the graphics scaling. All the hardware definitions and algorithms can be defined by the user. The configuration files can be changed according to the needs and used in combination with a set of different configuration files to match the different experiments.

PULMODYN software can acquire a maximum of 8 or 16 channels (depending on hardware used: 73-3330 (16 ch), 73-4817 (8 ch), 73-4818 (16 ch) or 73-0161 (16 ch), i.e. up to 16 different raw signals can be handled.

During data acquisition, all acquired signals and derived parameters are displayed on screen. All raw data and trend data are stored. Data reduction tools are included. Export of data to any statistical package are possible.

Ordering Information

Item #	Description
73-4788	PULMODYN Data Acquisition Software for Respiratory Studies for Windows
73-2705	Advanced Pulmonary Flow Software Module calculates Inspiratory Time, Expiratory Time, Apnea Time, Total time, EF50, TimeBreak, TimePause
73-1710	Advanced Respiration 2 Software Module calculates Inspiratory Time, Expiratory Time, Apnea Time

Ponemah Data Acquisition & Analysis Software

Ponemah is a complete physiologic data acquisition and analysis software platform used to confidently collect, accurately analyze, and quickly summarize study data. Version available for GLP labs.

Available from DSI, a Harvard Bioscience Company.

Visit www.datasci.com/products/software/ponemah.

TUBING CONNECTORS

Barbed Connector Kits



These kits allow you to customize or expand the functionality and species range of your perfusion system. Many researchers add a compound of interest to a second or even a third reservoir rather than use a syringe pump for drug additions. Also common is the use of the system for multiple species, which requires that different tube sets be adapted to the existing tubing.

These barbed connector kits come in three different size ranges:

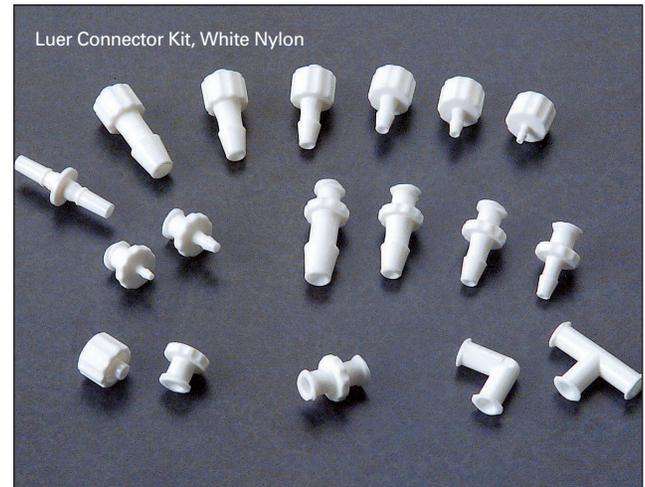
- Small fittings for 1/16-, 3/32- and 1/8-inch ID tubing (10 pieces of each component)
- Medium fittings for 1/4-, 5/16- and 3/8-inch ID tubing (10 pieces of each component)
- Large fittings 1/2- and 5/8-inch ID tubing (5 pieces of each component)

Kit components include tube to tube connectors, tube to tube reducing adapters, Y-, T- and L-connectors and Y-, T- and L-reducing adapters and tubing plugs. Connectors join tubing of similar size while reducing adapters join tubing of different sizes. Nylon and Kynar® connectors can be autoclaved.

Ordering Information

Item #	Description
72-1409	Barbed Connector Kit, Small, Nylon
72-1412	Barbed Connector Kit, Medium, Nylon
72-1415	Barbed Connector Kit, Large, Nylon

Luer to Tube Connector Kits



The Luer connection kits contain a selection of Luer fittings to interconnect Luer connectors (e.g. syringes, stopcocks and needles) with one another and with tubing.

Fittings include:

- Luer to barb connectors, Male Luer Lock (MLL) and Female Luer Lock (FLL) to barbed connector sizes 1/16-, 3/32-, 1/8-, 5/32-, 3/16- and 1/4-inch ID
- Luer to Luer connectors: MLT (Male Luer Taper) to MLT, RMLL (Rotating Male Luer Lock) to RMLL, FLL to FLL, FLL to FLL elbow, 3 x FLL 'T' connector, FLL to MLT and both MLL and FLL caps.

Each kit is supplied in a convenient box. All kit components are also sold separately with convenient bin reorder part numbers located inside each kit lid. The Male Luer Taper kit contains various MLT fittings to barbed connectors as well as MLT to MLT fittings. The kit also contains color coded rotating Luer lock rings that securely snap onto the MLT side of each connector.

Ordering Information

Item #	Description
72-1406	Luer Connector Kit, White Nylon, 10 pieces
72-2738	Male Luer Taper Kit, White Nylon, 10 pieces

Note: White nylon fittings can be autoclaved at 121°C.

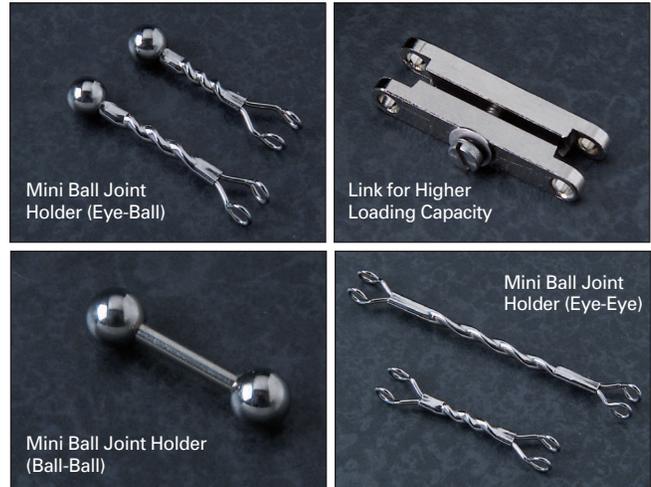
STOPCOCKS | BALL JOINT HOLDERS



The Luer Stopcock includes a collection of 1-, 3- and 4-way stopcocks. Fittings include MLL (male Luer lock), FLL (female Luer lock), MLT (male Luer taper), and barbed tubing connectors.

Ordering Information

Item #	Description
72-1664	Luer Stopcock Kit , includes 1-, 3- and 4-way MLL and FLL (non-rotating and rotating) and Male Luer Slips



Mini ball joint holders are linking elements ideal for use inside small organ chambers where space is extremely limited, such as those used for mouse hearts. They are also useful for mounting small flow probes in open chest experiments in mice or rats, and mounting cannulas on isolated hearts.

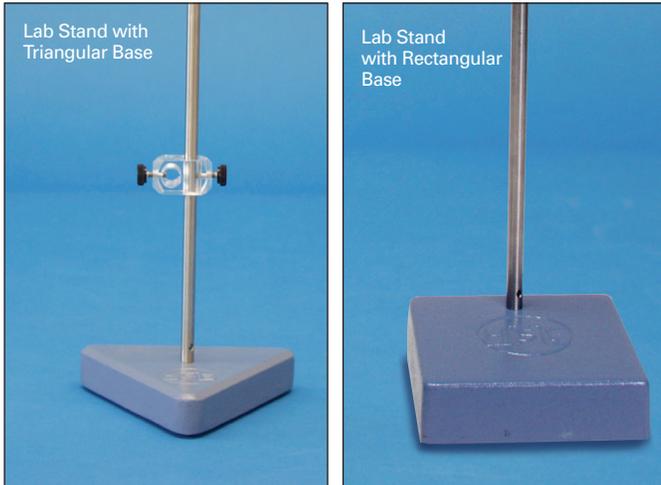
All holder elements are made from stainless steel. The special design of the ball joint ensures minimum size and permits perfectly smooth operation without any trace of spring-back. Mini holders remain rigid while carrying weights up to a few grams and are suitable for supporting tubing and small components.

High Load Link (73-0564) provides very stable positioning with a high amount of tension when used with Mini Ball Joint Holders. They receive 5 mm Mini Balls for length extension and increased positioning possibilities.

Ordering Information

Item #	Description
73-0174	Mini Ball Joint Holder, Eye-Eye, 23 mm long, pkg. of 1
73-0175	Mini Ball Joint Holder, Eye-Eye, 42 mm long, pkg. of 1
73-0176	Mini Ball Joint Holder, Eye-Ball, 18 mm long, pkg. of 1
73-0177	Mini Ball Joint Holder, Eye-Ball, 23 mm long, pkg. of 1
73-3321	Mini Ball Joint Holder, Eye-Ball, 35 mm long, pkg. of 1
73-0563	Mini Ball Joint Holder, Ball-Ball, 18 mm long, pkg. of 1
73-0564	Link for Higher Loading Capacity, for Two Arms with 5 mm Mini Balls, pkg. of 1
73-0562	Bar with Ball for Mounting on a Stand, D = 8 mm, L = 140 mm, Ball Size = 5 mm
73-0566	Plexiglass Block Clamp for mounting 73-0562 Bar onto Stand
53-2012W	Closed Connector, White

Laboratory Stands



These rugged laboratory stands have a stainless steel upright rod and heavy base plate. The stainless steel rod is threaded and may be removed if desired. The stand with triangular base is supplied with an acrylate block clamp.

Ordering Information

Item #	Description
73-0499	Lab Stand with Rectangular Base Plate
73-0500	Lab Stand with Triangular Base Plate with 300 mm Rod
73-4140	Lab Stand with Triangular Base Plate with 160 mm Rod
73-0566	Plexiglass Block Clamp for mounting 73-0562 Bar onto Stand
53-2012W	Closed Connector, White*

Specifications		
	Stand with Triangular Base	Stand with Rectangular Base
Rod Mounting	Center	End
Base Plate Dimensions	130 x 130 x 130 mm	150 x 150 x 50 mm
Rod Diameter	8 mm	12 mm
Rod Length	300 or 160 mm	510 mm
Weight	1.6 kg	6.75 kg

* Closed Connector also available in Red. For ordering, use "R" in place of "W"

Surgical Kits



Full line of precise, high quality surgical tools made from certified surgical grade German steel.

Ordering Information

Item #	Description
72-8996	Rat/Guinea Pig Isolated Organ Surgical Kit <ul style="list-style-type: none"> • Suture without Needle, Silk Black Braid, 4-0, 100 yards • Operating Scissors, 13.0 cm, Sharp/Sharp, Straight • Dressing Forceps, 13.0 cm, Sharp, Slender • Eye Scissors, 11.5 cm, Straight • Graefe Iris Forceps, Serrated, 7.0 cm, Curved, Points 1.0 mm, pkg. of 2 • Halsted Mosquito Hemostatic Forceps, 14.0 cm, Straight • Hartmann Hemostatic Forceps, 10.0 cm, Curved
72-8997	Mouse Isolated Organ Surgical Kit <ul style="list-style-type: none"> • Suture without Needle, Silk Black Braid, 5-0, 100 yards • Graefe Iris Forceps, Serrated, 10.0 cm, Straight, Points 0.7 mm • Eye Scissors, 11.5 cm, Straight, Special Cut • Micro Mosquito Hemostatic Forceps, 10.0 cm, Curved • Halsted Mosquito Hemostatic Forceps, 12.5 cm, Straight • Vannas Eye Scissors, Spring Action Model Tübingen, 8.5 cm, Straight • Graefe Iris Forceps, Serrated, 7.0 cm, Curved Points 0.5 mm

Operating Table Parts & Accessories

Replacements parts and accessories for the size 5 operating tables supplied with the IPL-2 and IPL-2 Core Systems.

Ordering Information

Item #	Description
73-3512	Replacement Paw Holders, Pkg. of 5
73-3822	Thorax Retractors with Ball Chain, 1 pair
73-3945	Small Holder Link for Higher Loads
73-4775	Replacement Holder for Chamber Cover for IL-2

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ISOLATED PERFUSED LUNG SYSTEM CHECKLIST

Configure Your Ideal Isolated Organ System

Please use this checklist as a guide to help you define the specific components of an Isolated Perfused Lung System suitable for your research needs. Then contact Technical Services for assistance with any questions and to obtain a quotation.

Species

- Mouse
- Guinea pig
- Rat
- Rabbit
- Pig

If others please specify:

Ventilation Mode

- Subatmospheric (negative) pressure ventilation*
- Alternative gas supply (not room air)
- Positive pressure ventilation

* Negative pressure ventilation is accomplished by drawing air from the lung chamber creating a negative pressure in the chamber so that the lung draws air rather than having a set volume of air forced into the lungs (positive pressure). Negative pressure ventilation is the most physiological and slows edema formation.

Perfusion Mode (check all that apply):

- Constant flow perfusion
- Constant pressure perfusion

Perfusion Solutions (check all that apply):

- Krebs-Henseleit Solution
- Erythrocyte-containing solution
- Blood

If others please specify:

- pH maintained by CO₂ control
- Desoxygenation (Typically nitrogen gas)

Drug Application

- Aerosol generator for drug nebulization
- Drug application via syringe pump

Measurement System

- Respiratory air flow
- Artificial thorax pressure, intrapleural pressure
- Tracheal pressure
- Perfusion pressure / pulmonary artery pressure
- Venous pressure
- Perfusion flow
- Lung weight

Others:

- Temperature

Gas Concentration:

- pO₂
- pCO₂
- pH

Data Acquisition (Computer):

- Desktop
- Laptop

Data Analysis (for Software needed):

- From Pulmonary Air Flow:**
RespRate, maxInspFI, maxExpFI, TV, dynResistance, Conductance, dynCompliance
- From all Pulmonary Pressures:**
Maximum, minimum, mean pressure
- From Temperature:**
Mean value (Note: npmn = non pulsatile mean)
- Inspiratory time, expiratory time, apnea time, total time, time of brake, time of pause, airflow at 0.5 TV (Advanced Module Required)
- Systolic, diastolic, mean pressure, npmn, heart rate (Advanced Module Required)
- P-V loops (Advanced Module Required)
- LVPsys, LVPedp, dP/dtmax, dP/dtmin, heart rate (Advanced Module Required)
- ECG RR-I, HR (Advanced Module Required)



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Isolated Lung

PERFUSION SYSTEMS

For Small to Large Animal Models