Guide to DSI's

Telemetry Devices

Continuous, real-time *In Vivo* Physiologic Monitoring Solutions for Animal Models

DSI™

a division of
Harvard Bioscience, Inc.

Implants for Rodents

- **DSI offers the broadest choice of implants for use in mice and rats**
- **Proven physiologic research partner for more than 30 years**
- **The most physiologic endpoint options, serving a global research community**

Extra-Small Implants

For use with mice and other similarly sized animals.

Model	Pressure	Biopotential	Respiratory Rate^	Temperature	Activity	Continuous Glucose	Warranted Battery Life	Implant Weight (g)	Implant Volume (cc)	Minimum Animal Weight (g)*
HD-X11	1	1	1	1	1		1	2.2	1.4	19
HD-X10	1		1	1	1		1.5	2.2	1.4	19
HD-X02		2		1	1		1.5	2.2	1.7	19
HD-XG°				1	1	1	1.5	2.2	1.4	19
PA-C10	1		1		1		1.5	1.4	1.1	17
ETA-F10		1		1	1		2	1.6	1.1	17
TA-F10				1	1		6	1.6	1.1	17

* All minimum animal weights assume subcutaneous implantation. Intraperitoneal implantation would require a larger animal.
° Sensor often functions for 6-8 weeks; warranty is 4 weeks.
^ Implants can derive respiratory rate from pleural pressure or blood pressure.

DSI's PhysioTel™ HD implants allow researchers to focus on what matters — research.

Enhance data security with *Animal ID*

- Have confidence that the data collected is from the intended animal.

Reduce study setup time with *Auto-Calibration*

- Save time and eliminate human error during manual entry of offsets.

Maximize battery life with *Battery On-Time Counter*

- Dynamic battery life updates to assist with efficient study planning and re-use of implants.

Small Implants

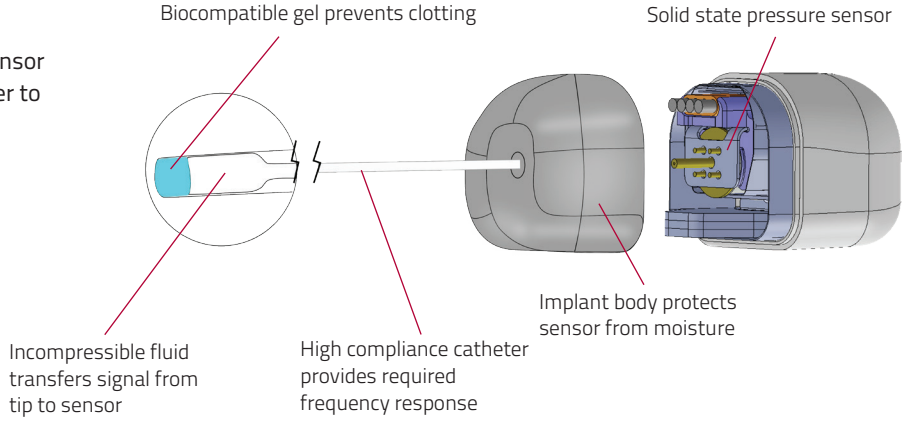
Species commonly monitored with small implants include rats, guinea-pigs, ferrets, marmosets and others.

Model	Pressure	Biopotential	Respiratory Rate^	Temperature	Activity	Continuous Glucose	Warranted Battery Life	Implant Weight (g)	Implant Volume (cc)
HD-S21	2	1	1	1	1		2	8	5.9
HD-S20	2		1	1	1		2	8	5.9
HD-S11-F0/F2**	1	1	1	1	1		2(F0)/3(F2)	8	5.9
HD-S1-F0/F2**	1		1	1	1		2(F0)/3(F2)	8	5.9
HD-S10	1		1	1	1		5	4.4	3.1
HD-S02		2	1	1	1		5	4.7	3.3
HD-XG°				1	1	1	1.5	2.2	1.4
4ET+		4	1	1	1		3	12.8	8.8
F50-EEE		3	1		1		2	11.5	5.5
CTA-F40		1	1	1	1		6	8	4.2
F40-TT				2	1		4	7.5	3.5
TA-F40*				1	1		12	7.25	3.5
F50-W-F2 (records sympathetic nerve activity)					1		2	12	5.5

**Available in two frequencies: 455 kHz (F0) and 18 MHz (F2). Pair housing capable.
° Sensor often functions for 6-8 weeks; warranty is 4 weeks.
+ Available in two frequencies: 8 MHz (F1) and 18 MHz (F2). Pair housing capable.
*Available with an external thermistor probe if desired.
^ Implants can derive respiratory rate from pleural pressure, blood pressure or diaphragmatic EMG.

PhysioCath Telemetry Catheters

DSI pressure sensing implants use a solid state sensor coupled to a proprietary and biocompatible catheter to acquire high fidelity signals.



Implants for Large Animals

The trusted partner for drug discovery, safety pharmacology, toxicology and biodefense research. Scientists using DSI's reliable, high performance research tools have published data across numerous high impact journals.

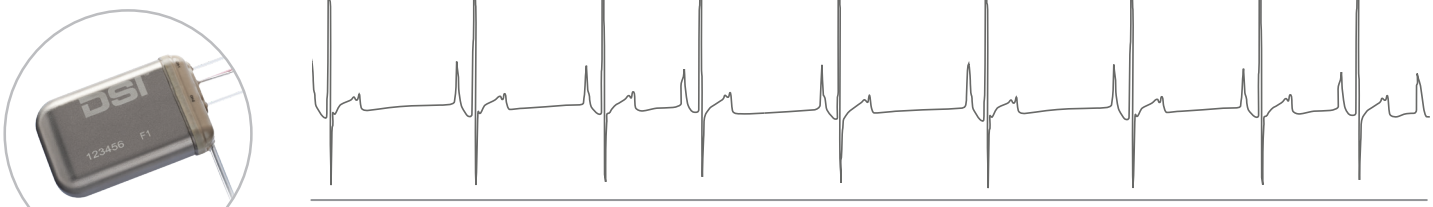
Medium & Large Implants

Designed with social housing in mind, PhysioTel™ Digital implants have a 3-5 m transmission distance.
Species commonly monitored include, but are not limited to, non-human primates, dogs, rabbits, and swine.

Model	Pressure	Biopotential	Respiratory Rate**	Temperature	Activity	Continuous Glucose	Warranted Battery Life	Implant Weight (g)	Implant Volume (cc)
M00				1	1		100 days	13.7	11
M0G*				1	1	1	95 days	13.7	11
M1G*	1		1	1	1	1	48 days	13.7	11
M01		1	1	1	1		40 days	13.7	11
M10	1		1	1	1		55 days	13.7	11
M11	1	1	1	1	1		35 days	13.7	11
L03		3	1	1	1		90 days	56	29
L04		4	1	1	1		95 days	56	29
L11	1	1	1	1	1		105 days	56	29
L11R^	1	1	1	1	1		125 days#	49	33
L21	2	1	1	1	1		84 days	56	29

* Sensor often functions for 6-8 weeks, warranty is 4 weeks.
** Implants can derive respiratory rate from pleural pressure, blood pressure or diaphragmatic EMG.
^ L11R provides respiratory volume and respiratory rate via respiratory impedance.
# LV capable version of L11R has a 110 day battery life

PhysioTel Digital Solid Tip Lead... clean, artifact-free ECG data



L series

M series

PhysioTel Digital

L series: These implants are designed for chronic physiologic monitoring research in colony animals. Implants are used in safety pharmacology studies to address core battery requirements in cardiovascular (CV), neuroscience, and respiratory applications. Core CV measurements include systemic pressure and ECG and includes LV pressure as a secondary measurement.

M series: The smaller size of M series allows PhysioTel Digital technology to be expanded into a broader range and size of species including rabbits and cats. Primary applications for M series are toxicology and biological defense, discovery, and glucose metabolism studies. Single use implants are ideal for shorter duration studies.

Telemetry Devices from DSI

Implantable Telemetry

DSI's PhysioTel™ implants are designed for acquiring data from conscious, freely moving laboratory animals, providing stress-free data collection while enhancing animal welfare. PhysioTel implants are offered in various sizes to support a range of research models, including mice, rats, dogs and non-human primates.

Physiologic signals measured include:

- **Pressures: arterial, left ventricular, ocular, bladder, intra-cranial**
- **Biopotentials: ECG, EMG, EEG, EOG**
- **Blood glucose**
- **Respiration**
- **Temperature: core and localized with thermistor**
- **Activity**
- **Sympathetic nerve activity**

External Telemetry

DSI's external telemetry includes JET™ for large animals. By jacketing subjects, multiple physiologic endpoints may be collected continuously without requiring surgery. Animals remain freely roaming and unstressed, providing high quality data for your studies.

Advantages of Telemetry

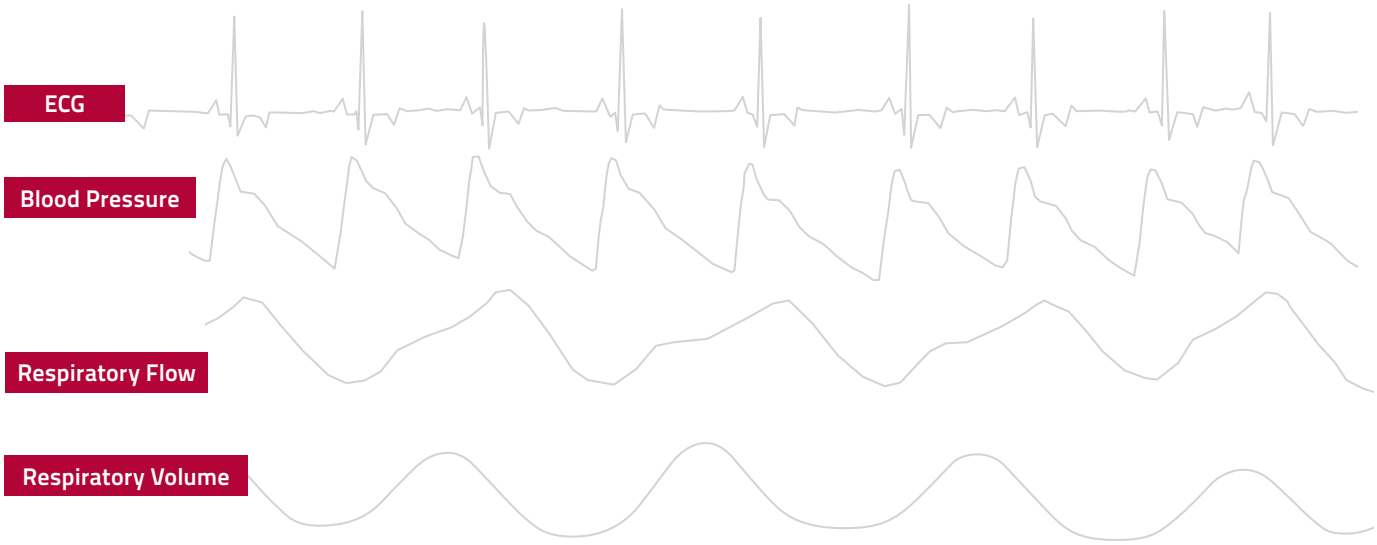
- Animals can be chronically instrumented and used sequentially as their own control or in multiple studies to reduce the number of animals.
- Stress artifact induced by handling is avoided.
- Physiologic measurements can be obtained around the clock with no lab personnel present.
- Decreases the costs of many protocols by reducing the number of animals and maintenance required.

External Telemetry

For toxicology, repeat dose, and other high-throughput studies, less invasive physiologic monitoring may be desired. Collect accurate, continuous physiologic data from jacketed animals.

Species	Device	ECG Vectors	ECG Vectors with Respiratory Impedance Plethysmography (RIP)	Blood Pressure Add-on^	Temperature	Activity	Battery
Large Animals	JET-EA-BP	1	NA	Yes	No	Yes	Rechargeable 27-hr life
	JET-3ETA-BP	7	1	Yes	Yes	Yes	
	JET-5ETA-BP	9	7	Yes	Yes	Yes	
Small Animals	CA-EXT	1	NA	No	No	Yes	6 months

Collect multiple endpoints with JET™



About Data Sciences International

DSI provides a complete preclinical platform to assess physiological data for research ranging from basic, to drug discovery, and drug development. DSI is the leading provider of telemetry systems, pulmonary solutions, associated software platforms, and services.

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datasci.com

Headquarters and North American Sales:
1-800-262-9687 (U.S.)
1-651-481-7400 (International)
sales@datasci.com

European Sales:
Tel: 31-13-5479356
europe-sales@datasci.com

Asia Pacific Sales:
Tel: 86-21-50793177
apac-sales@datasci.com

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Elevate your research with proven technology.

DSI has the tools you need for your respiratory research. All Buxco® respiratory products are compatible with the powerful, easy-to-use, FinePointe software for collecting, analyzing, and reporting data.

Non-invasive airway mechanics

Whole body plethysmography

Acute Respiratory Disorders

Disorders of the respiratory system can be grouped into different categories. Example categories include obstructive versus restrictive, or acute versus chronic. Many disorders have similar causes, symptoms, and effects. As such, animal models (and hardware solutions) are often used to study more than one particular disease at a time.

Respiratory Disorders

- Respiratory depression
- Respiratory syncytial virus (RSV)
- Acute respiratory distress syndrome (ARDS)
- Mucociliary clearance and dysfunction
- Pneumonia
- Cough
- Tuberculosis (TB)
- Bronchiolitis
- Bronchitis

Applicable Hardware

- Head out plethysmography
- Whole body plethysmography
- Non-invasive airway mechanics (double chamber)
- Resistance and compliance
- Pulmonary function testing
- Inhalation/exposure systems

Asthma

Asthma affects 8% of the world's population, and there is no cure. There are several risk factors for developing asthma, such as inhaled substances and particles that provide allergic reactions or irritate the airways. Other factors include genetic predisposition, environmental allergens, and dietary factors. Rodents are the typical species used when studying asthma. Ovalbumin (OVA) derived from chicken egg is a frequently used allergen that induces a robust, allergic pulmonary inflammation in laboratory rodents. Airway Hyperresponsiveness (AHR) is assessed using a muscarinic receptor (Methacholine). Primary endpoints of interest include respiratory rate, peak flows, and resistance; all are contributors to determining levels of bronchoconstriction.

Applicable Hardware

- Resistance and compliance
- Whole body plethysmography
- Non-invasive airway mechanics
- Pulmonary function testing

Resistance and compliance

COPD

COPD (chronic obstructive pulmonary disease) is a progressive disease that makes it hard to breathe. The primary contributor to COPD is cigarette smoke. COPD is the third leading cause of death in the U.S., and there is no cure. The two primary conditions are emphysema and chronic bronchitis. Rodents are the typical species used when studying COPD. Recent publications suggest that cigarette smoke exposure to animals, using a smoke generating device, is the best approximation to human COPD. Other approaches include long-term lipopolysaccharide (LPS) exposure and the use of genetically modified models. Primary endpoints of interest include static and dynamic compliance and lung volumes.

Applicable Hardware

- Smoke generator
- Resistance and compliance
- Pulmonary function testing

Smoke generator and inhalation tower

Pulmonary function test

Applicable Hardware

- Resistance and compliance
- Pulmonary function testing

Lung Fibrosis

Pulmonary Fibrosis (PF): a disease which affects over 5 million people worldwide, and there is no cure. Mice are the most common species used when studying; however, several animal models of lung fibrosis exist, ranging from mice to primates.

Bleomycin is a commonly used chemotherapeutic agent that causes an acute lung injury response, followed by lung fibrosis. Other approaches include asbestosis and instillation of silica.

Cystic Fibrosis (CF): an incurable and inherited disorder affecting multiple organ systems, including the lungs. Animal models used to study CF typically focus on the use of mice with absent or mutant forms of the CFTR protein. Species including ferrets and pigs are also considered.

Pulmonary fibrosis and cystic fibrosis are two very different diseases. As such, the disease model studied often dictates the endpoints of interest. Although compliance and resistance are two commonly collected parameters, many supplemental endpoints can be calculated at the same time.

Plethysmographs

Safety Assessment

Lung function endpoints are commonly obtained when conducting disease-related pharmacology studies (fibrosis, asthma, etc.). However, similar endpoints are desired in safety pharmacology and toxicology groups as well. Safety pharmacology and toxicology studies have to be performed in compliance with the GLP Principles. The ICH guideline S7A requires safety pharmacology tests including measurements of pulmonary function. Respiratory toxicology studies are performed on pharmaceuticals or chemicals when inhalation is the primary route of exposure or when the airways are the focus of interest.

Most studies are performed in rodents; rats are the primary choice. When warranted, other species are considered. Although respiratory rate and tidal volume are the typical endpoints desired, many additional derived parameters and supplemental pulmonary function measurements are available.

Applicable Hardware

- Whole body plethysmography
- Head out plethysmography
- Resistance and compliance
- Non-invasive airway mechanics

DSI's Scientific Services: Data, Surgery, Technical, and Validation

Streamline your research by leveraging expertise you can rely on. Our Scientific Services teams can assist you with making better informed decisions, achieving greater surgical success, summarizing study data, executing preclinical in vivo studies, and meeting GLP validation requirements.

Contact Us: datasci.com

North America
1-800-262-9687 (U.S.)
+ 1-651-481-7400 (International)
sales@datasci.com

Europe
+ 1-651-481-7400
europe-sales@datasci.com

Asia
+ 86-21-50793177
apacsales@datasci.com

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