

Physiology



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Research Grade Isometric and Isotonic Transducers

These Research Grade Isometric and Isotonic Transducers supply excitation voltage to a self-contained transducer and convert the pico-farad changes of capacitance into high level DC voltages using a patented electronic circuit (U.S. Patent #4,142,144). This circuit is extremely sensitive and stable, producing up to 5 VDC for direct connection to Standard Signal Conditioners, Data Acquisition Systems, Modular Universal Oscillographs, Student Oscillographs, Flatbed Strip Chart Servo Recorders, and X-Y Plotters. All transducers have a small external transducer element hard-wired to a small amplifier. This amplifier is hard-wired to a

wall type transformer. The transformer reduces line voltage to 12 VDC and is both UL- and CSA-listed. For 230 VAC, 50 Hz operation the transformer is VDE-listed. These Transducers are factory-calibrated to deliver 5 VDC for full rated load and are still linear for 100% overload (4 VDC). They have offset (tare) controls. The Transducer amplifier has a 3-digit backlit LCD display that shows the output voltage. A standard BNC output connector is located at the rear of the amplifier. These amplifiers can be stacked for multiple use.



Specifications

Output Impedance	10,000 Ω
Sensitivity	< 1 part in 1,000
Accuracy Output Voltage	±1%
Output Connector	Standard BNC
Linearity	±1%
Drift	Negligible after 5 min. warm-up
Amplifier Adjustments	Range selector and offset
Display	LCD, 7.6 mm (0.3 in) numbers
Weight	908 g (2 lb)
Transducer, H x W x D	32 x 45 x 32 mm (1-1/4 x 1-3/4 x 1-1/4 in)
Amplifier, H x W x D	51 x 95 x 86 mm (2 x 3-3/4 x 3-3/8 in)
Mounting Handle, OD x L:	
Model 1	12.7 x 51 mm (0.5 x 2 in)
Model 2	9.5 x 91.4 mm (0.375 x 3.6 in)

Research Grade Isometric Transducer

- Self-powered transducer and amplifier in one
- Transducers are available with three different sensitivities
- Each Transducer has two selectable ranges

This Isometric Transducer approaches the ideal of measuring isometric contraction force without motion. It is available with three different force ranges. Each Transducer has an X10 range selector switch providing two ranges.

This Transducer measures force by measuring the change in capacitance of a stiff beam between two plates. Beam deflection is measured in microns.

Two models are now available. The only difference between the models is the length and diameter of the mounting rod. Model 1 has a 12.7mm OD by 51mm long mounting rod. Model 2 has a 9.5 mm OD by 91.4mm long mounting rod.

Research Grade Isometric Force Transducer

Power		Sensitivity			
115 VAC, 60 Hz	230 VAC, 50 Hz	Deflection Per Gram Load	Selectable Force Ranges	Offset Control Max. Tare	2 VDC Output Voltage Per

Model 1 with 12.7 x 51mm (0.5 x 2in) Mounting Rod (OD x L)

BS4 72-4490 \$	BS4 72-4493	10.0 μm	0 to 0.5 g 0 to 5.0 g	0.2 g 2.5 g	0.5 g 5.0 g
BS4 72-4491 \$	BS4 72-4494	1.0 μm	0 to 5.0 g 0 to 50 g	2.5 g 25 g	5 g 50 g
BS4 72-4492 \$	BS4 72-4495	0.1 μm	0 to 50 g 0 to 500 g	25 g 250 g	50 g 500 g

Model 2 with 9.5 x 91.4mm (0.375 x 3.6in) Mounting Rod (OD x L)

BS4 72-4480 \$	BS4 72-4483	10.0 μm	0 to 0.5 g 0 to 5.0 g	0.2 g 2.5 g	0.5 g 5.0 g
BS4 72-4481 \$	BS4 72-4484	1.0 μm	0 to 5.0 g 0 to 50 g	2.5 g 25 g	5 g 50 g
BS4 72-4482 \$	BS4 72-4485	0.1 μm	0 to 50 g 0 to 500 g	25 g 250 g	50 g 500 g

Research Grade Isometric and Isotonic Transducers



Research Grade Isotonic Transducer

- $\pm 1\%$ linearity and accuracy
- High level output signal, no additional amplifier needed for most strip chart recorders and acquisition systems
- Remote sensor head can be mounted close to experimental setup

This Transducer converts rotary motion into an electrical signal. It features precision bearing for low torque requirements for recording from delicate smooth muscle preparations.

This Transducer converts picofarad changes of capacitance into high level DC voltages using a patented electronic circuit (U.S. Patent #4,142,144).

The Transducer is supplied with a wooden and aluminum lever for smooth muscle work, a calibrated lever, after loading screw, scale pan and weights for skeletal muscle (gastrocnemius) studies and a storage box with complete instructions for experimental setups.

These Research Grade Isometric and Isotonic Transducers are for direct use with:

- BS4 72-7258 Data Acquisition System for the IBM-PC with Windows and BS4 72-7259 Data Acquisition System for the Macintosh, see page 1103
- Harvard Apparatus TR2 Chart Recorder, see page 170
- Flatbed Recorder, see page 165
- Modular Universal Oscillographs, see page 166
- Student Oscillographs, see page 168

Specifications

Rotation	$\pm 15^\circ$ about center
Output	+5 VDC for +15° rotation, 0 at center, -5 VDC for -15° rotation, BNC connector
Breakaway Torque	0.05 g/cm
Accuracy	$\pm 1\%$
Linearity	$\pm 1\%$
Dimensions:	
Transducer, H x W x D	32 x 45 x 32 mm (1.25 x 1.75 x 1.25 in)
Handle, OD x L	9.7 x 127 mm (3/8 x 5 in)
Amplifier, H x W x D	51 x 95 x 86 mm (2 x 3.75 x 3-3/8 in)
Display	LCD, 7.6 mm (0.3 in) numbers
Weight	908 g (2 lb)

Catalog No.	\$	Product
BS4 72-4486		Research Grade Isotonic Transducer, 115 VAC, 60 Hz
BS4 72-4487		Research Grade Isotonic Transducer, 230 VAC, 50 Hz
BS4 52-0083		BNC to BNC Cable, pkg. of 1
BS4 60-3822		BNC to Phone Plug, Cable, pkg. of 1
BS4 60-1156		BNC to Phone Plug, Cable, pkg. of 2
BS4 52-9974		4 mm Double Banana-to-Double Banana Cable, pkg. of 2, for use with other flatbed recorders
BS4 52-9975		Double Banana to Double Banana, pkg. of 1
BS4 60-4676		Double Banana to Female BNC Adapter, pkg. of 1
BS4 60-4675		Double Banana to Female BNC Adapter, pkg. of 2
BS4 52-9983		Double Banana to BNC Cable, pkg. of 1
BS4 52-9982		Double Banana to BNC Cable, pkg. of 2

Did you know?

Harvard Apparatus manufactures the Medical Systems picoliter injector, iontophoretic injectors, and micro-incubators. See the Cell Biology Section M in this Bioscience Catalog for complete details.

HSE-HA Isometric Force Transducers F30 and F10



- Resolution of ± 2 mg
- Ultra low vertical displacement (1 $\mu\text{m/g}$)
- Suitable for small tissue samples like papillary muscle, Purkinje fibers and vessel rings
- Force Range of ± 30 grams (± 0.3 N)



- Ultra-high resolution of ± 0.5 mg
- Low vertical displacement (6 $\mu\text{m/g}$)
- Suitable for small tissue samples like papillary muscle, Purkinje fibers and vessel rings
- Force range of ± 10 grams (± 0.1 N)

HSE-HA Isometric Force Transducer F30

The HSE-HA F30 is a sensitive, reliable and rugged isometric force transducer suitable for use with very small muscle/tissue specimens. The ultra-low vertical displacement of the transducer means that true isometric measurements can be made. The low seismic sensitivity of the HSE F30 minimizes the influence of environmental vibrations on the force recordings which result in very stable baselines. The design of the unit (no internal wires suspending the transducer head) means that this transducer will stand up to years of use. This is a full resistance bridge transducer which can be connected to the HSE-HA TAM-A and TAM-D strain gauge amplifiers, see page I33. Connectors are also available for Harvard Apparatus Ltd., Grass and Gould strain gauge amplifiers.

Specifications

Force Range	± 30 g (± 0.3 N)
Linear Range	± 50 cN
Maximum Load	± 3 N
Displacement Range	± 0.03 mm
Sensitivity	0.5 mV/V g
Isometric Quotient IQ	1 $\mu\text{m/g}$
Excitation AC or DC	5 V (max. 10 V)
Full-Scale Output	± 10 mV/V, nominal
Natural Frequency	440 Hz, nominal
Bridge Resistance	1 K Ω , nominal, full resistance bridge
Hysteresis	< 0.1%
Zero Drift	< 10 mg/ $^{\circ}\text{C}$ at 20 to 40 $^{\circ}\text{C}$ < 0.03 % FS/ $^{\circ}\text{C}$
Resolution (Noise)	2 mg
Maximum Load	300%
Breaking Load	1000%
Sensitivity to Transverse Load	< 0.1%
Maximum Allowed Transverse Load	< 300%
Connection Cable	1.5 m L
Weight	200 g (7 oz)
Dimensions	22 x 22 x 70 mm (0.9 x 0.9 x 2.8 in)
Mounting Rod, OD x L	6 x 130 mm (0.25 x 5.1 in)

Catalog No. \$ Product

BS4 73-0831	Isometric Transducer F30 for PLUGSYS Amplifier
BS4 73-2657	Isometric Transducer F30 for Harvard Apparatus Transducer Amplifier
BS4 73-2658	Isometric Transducer F30 for Grass Amplifier
BS4 73-2659	Isometric Transducer F30 for Gould Series 6600 Amplifier
BS4 73-2660	Isometric Transducer F30 for Gould Series 4600 Amplifier

HSE-HA Isometric Force Transducer F10

The HSE-HA F10 isometric force transducer is a lower force range, higher resolution version of the F30 isometric force transducer on the left.

* Note: This transducer is produced under licence from DLR: Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V., D-51140 Köln.

Specifications

Force Range	± 10 g (± 0.1 N)
Linear Range	± 20 cN
Maximum Load	± 0.5 N
Displacement Range	± 60 μm
Sensitivity	3.0 mV/V g
Isometric Quotient IQ	6 $\mu\text{m/g}$
Excitation AC or DC	5 V (max. 10 V)
Full-Scale Output	± 20 mV/V, nominal
Natural Frequency	180 Hz, nominal
Bridge Resistance	1 K Ω , nominal, full ohmic bridge
Hysteresis	< 0.1%
Zero Drift	< 10 mg/ $^{\circ}\text{C}$ at 20 to 40 $^{\circ}\text{C}$ < 0.03 % FS/ $^{\circ}\text{C}$
Resolution (Noise)	0.5 mg
Maximum Load	100%
Breaking Load	300%
Connection Cable	1.5 m L with 6-pin Binder Plug (HSE System)
Peak to Peak	< 0.5 mg
Weight	200 g (7 oz)
Dimensions	22 x 22 x 70 mm (0.9 x 0.9 x 2.8 in)
Mounting Rod, OD x L	6 x 130 mm (0.25 x 5.1 in)

Catalog No. \$ Product

BS4 73-0841	Isometric Transducer F10 for PLUGSYS Amplifier
BS4 73-2661	Isometric Transducer F10 for Harvard Apparatus Transducer Amplifier
BS4 73-2662	Isometric Transducer F10 for Grass Amplifier, 6-Pin Cannon Connector
BS4 73-2663	Isometric Transducer F10 for Gould Series 6600 Amplifier
BS4 73-2664	Isometric Transducer F10 for Gould Series 4600 Amplifier

References:

Gollasch, M. et al.: Pinacidil Relaxes Porcine and Human Coronary Arteries by Activating ATP-Dependent Potassium Channels in Smooth Muscle Cells. *J. Pharmacol. Exp. Ther.*, 275, 681-691 (1995)

Force Displacement and Vernier Control Transducers



HSE-HA Force-Displacement Transducers

- Four ranges available
- Oil damping system
- Robust construction
- Application in teaching

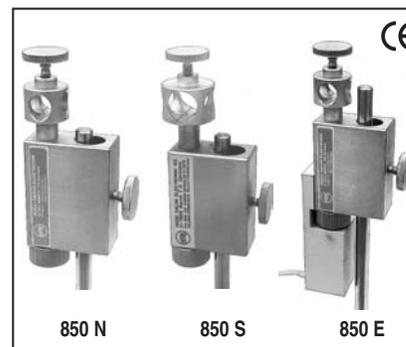
Series K force transducers are universally applicable for the measurement of force. There are 4 models, for 4 different force ranges: K30 (± 30 g-force), K100 (100 g-force), K300 (300 g-forces), and K1000 (1000 g-force). The maximum displacement at the tip of the flat spring is 4 mm. The K30 includes a damping system with oil.

Specifications

Transducer	K30	K100	K300	K1000
Force Range	± 30 g-force, ± 0.3 N	± 100 g-force, ± 1 N	± 300 g-force, ± 3 N	± 1000 g-force, ± 10 N
Displacement	± 2.5 mm	± 2 mm	± 3 mm	± 1 mm
Sensitivity (Force)	100 μ V/g-force/V	30 μ V/g-force/V	10 μ V/g-force/V	3 μ V/g-force/V
Sensitivity (Displacement)	1200 μ V/mm/V	0.7 mV/mm/V	0.8 mV/mm/V	1.2 mV/mm/V
Natural Frequency Without Load	110 Hz	170 Hz	200 Hz	400 Hz
Resolution	5 mg	15 mg	50 mg	150 mg
Input Impedance (Pins 1–5)	350 Ohm			
Output Impedance (Pins 2–4)	350 Ohm			
Supply Voltage	10 V max.			
Dimensions Without Pulley	20 x 20 x 84 mm (0.8 x 0.8 x 3.3 in)			
Height With Pulley	60 mm (2.4 in)			
Mounting Rod	6 x 130 mm (0.25 x 5.1 in), OD x L			
Weight	200 g (7 oz)			

HSE-HA Force Transducer

For Use With	Transducer Model			
	K30	K100	K300	K1000
HSE	BS4 73-0822	BS4 73-0824	BS4 73-0825	BS4 73-0826
\$				
Harvard Apparatus	BS4 73-2676	BS4 73-2677	BS4 73-2678	BS4 73-2679
\$				
Grass	BS4 73-2680	BS4 73-2681	–	BS4 73-2683
\$				
Gould 6600	BS4 73-2684	BS4 73-2685	BS4 73-2686	BS4 73-2687
\$				
Gould 4600	BS4 73-2688	BS4 73-2689	BS4 73-2690	BS4 73-2691
\$				



Vernier Control Transducers

- 3 versions available
- Robust mechanical construction with less friction
- Allows fine adjustment

The vernier control allows an exact pre-stretch of the tissue preparation in order to ensure optimum contractile force of the musculature. The S-Version is specific for the transducer with 14 mm mounting rod. The E-Version is a motorized type that is compatible with the flushing unit and microdrive controller.

Specifications

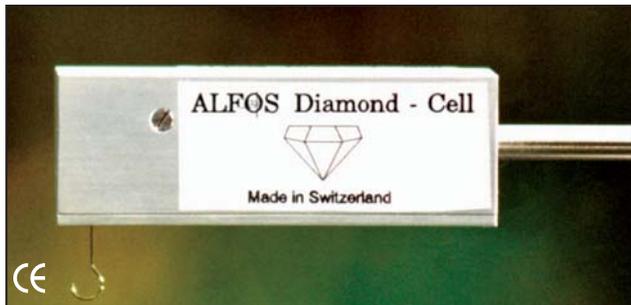
Weight:	
850 N and 850 S	0.35 kg (0.8 lb)
850 E	0.47 kg (1 lb)
Max. Dimensions:	
850 N and 850 S	115 x 50 x 20 mm (4.5 x 2 x 0.8 in)
850 E	160 x 55 x 20 mm (6.3 x 2.2 x 0.8 in)
Displacement Per Turn	0.5 mm
Max. Displacement	22 mm
Rod Mounting Hole \varnothing:	
850 N and 850 E	13 mm (0.5 in)
850 S	14 mm (0.55 in)*
Hole for Transducer Holder:	
850 N and 850 E	2 x \varnothing 10.5 mm/90°
850 S	2 x \varnothing 14.5 mm/90°*
Power Supply 850 E Only	12 V DC for connection to flushing unit

*Note: Extra large bore for GRASS force-displacement transducers

Catalog No.	\$	Product
BS4 73-0786		Vernier Control, Standard, Type 850 N
BS4 73-0787		Vernier Control, Motorized Version, Type 850 E
BS4 73-0788		Vernier Control, Special, Type 850 S

NEW

HSE-HA Isometric Force Transducers "Diamond-Cell"



- High resolution
- Low vertical displacement
- Suitable for small tissue samples like papillary muscle, Purkinje fibers and vessel rings
- 3 Force range of 0-50 cN, 0-150 cN, 0-250 cN

The HSE-HA "Diamond-Cell" is a sensitive, reliable and rugged isometric force transducer suitable for use with very small muscle/tissue specimens. The low vertical displacement of the transducer means that true isometric measurements can be made. The low seismic sensitivity of the "Diamond-Cell" minimizes the influence of environmental vibrations on the force recordings which result in very stable baselines. The design of the unit (no internal wires suspending the transducer head) means that this transducer will stand up to years of use. This is a full resistance bridge transducer which can be connected to the HSE-HA TAM-A and TAM-D strain gauge amplifiers, see page I33. Connectors are also available for HA-Ltd, Grass and Gould strain gauge amplifiers.

environmental vibrations on the force recordings which result in very stable baselines. The design of the unit (no internal wires suspending the transducer head) means that this transducer will stand up to years of use. This is a full resistance bridge transducer which can be connected to the HSE-HA TAM-A and TAM-D strain gauge amplifiers, see page I33. Connectors are also available for HA-Ltd, Grass and Gould strain gauge amplifiers.

Specifications

Force Range	0-50 cN, 0-150 cN, 0-250 cN
Linearity	<0.2 %FS
Maximum	1000 cN
Displacement Range	60 μm at 10 cN.
Excitation	DC 5 V
Full-Scale Output	10 mV/V, nominal ± 30%
Natural Frequency	300 Hz
Bridge Resistance	> 500 kOhm, full resistance bridge
Zero Drift	< ± 0.04 % FS/K
Weight	200 g (7 oz)
Dimensions	20 x 26 x 75 mm (0.8 x 1.0 x 3.0 in)
Mounting Rod, OD x L	6 x 120 mm (0.25 x 4.7 in)

HSE-HA Isometric Force Transducers "Diamond-Cell"

For use with	Transducer Range		
	0-50 cN	0-150 cN	0-250 cN
HSE	BS4 73-3538	BS4 73-3539	BS4 73-3540
Harvard Appar.	BS4 73-3541	BS4 73-3542	BS4 73-3543
Grass	BS4 73-3544	BS4 73-3545	BS4 73-3546
Gould 6600	BS4 73-3547	BS4 73-3548	BS4 73-3549
Gould 4400	BS4 73-3550	BS4 73-3551	BS4 73-3552

Force Calibration Weights



These NEWTON style calibration weights are precision weights use to calibrate force transducers. The weights are made from polished brass and have an integral hook. They are supplied in a wooden storage case. They are calibrated in Newtons at the standard acceleration of gravity $g_n = 9.80665 \text{ m/s}^2$. Nine weights are supplied. Class of accuracy M1.

Specifications

Newton	Gram-Force	Newton	Gram-Force
0.01 N	1	0.2 N	20
0.02 N (2 supplied)	2	0.5 N	50
0.05 N	5	1.0 N	100
0.1 N (2 supplied)	10		

Catalog No.	\$	Product
BS4 73-2634		Force Calibration Weights

Gram Calibration Weights



These gram calibration weights are precision weights use to calibrate preload on force transducers. The weights are made from polished brass. They are supplied in a wooden storage case with a pair of handling forceps and a cleaning brush. Nine weights are supplied. The 0.1, 0.2 and 0.5 gram size weights are flat metal pieces. The larger size weights have an integral hook. Class of accuracy M1 after OIML*.

Specifications

Weight	Tolerance ± mg	Weight	Tolerance ± mg
0.1 g	0.5 mg	2 g (2 supplied)	1.2 mg
0.2 g (2 supplied)	0.6 mg	5 g	1.5 mg
0.5 g	0.8 mg	10 g	2.0 mg
1 g	1.0 mg		

Catalog No.	\$	Product
BS4 73-2635		Gram Calibration Weights

*Note: Organisation Internationale Metrologie Légale

UF1 Series Isometric Transducer



- $\pm 1\%$ accuracy
- Temperature range from -40° to $+80^{\circ}\text{C}$ (-104° to $+176^{\circ}\text{F}$)
- Available in six force ranges

The popular UF1 Series of load cells has been adapted to be used with the above listed amplifiers and interfaces. These Transducers have an integral cable that is compatible with the following amplifiers: BS4 53-6132, BS4 50-7970, BS4 50-7996 and BS4 50-8861. They are available in six force ranges.

Specifications

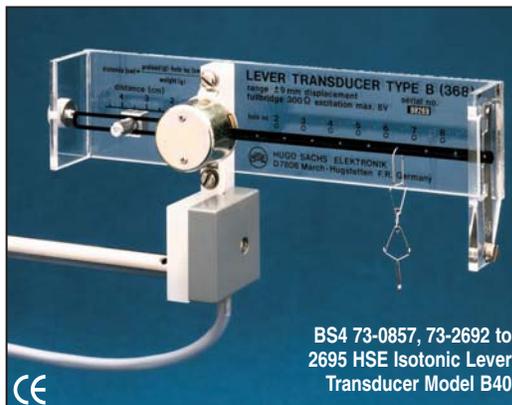
Dimensions:

Transducer, H x W x D	70 x 35 x 25 mm (2.75 x 1-3/8 x 1 in)
Mounting Rod, OD x L	6.5 x 40 mm (0.25 x 1.5 in)

UF1 Series Isometric Transducers

Catalog No.	\$	Force Range
BS4 50-7293		0 to 25 g
BS4 50-8036		0 to 55 g
BS4 50-8044		0 to 110 g
BS4 50-8051		0 to 220 g
BS4 50-8069		0 to 450 g
BS4 50-8077		0 to 1000 g

HSE-HA Isotonic Lever Transducer



- Very low friction, ideal isotonic measurement conditions
- Easy calibrating conditions
- Large linear measuring range 40 mm
- Ideal for smooth muscle preparations

BS4 73-0857, 73-2692 to 2695 HSE Isotonic Lever Transducer Model B40

This system is designed to transduce displacements during contractions and movements into proportional electric currents. The amount of force required to operate the system is exceedingly small, providing ideal isotonic measurement conditions for physiological and pharmacological research. This arrangement of a lever transducer with any bridge system (DC measuring bridge or TAM plug-in module of our PLUGSYS, see page I33) is particularly well suited to isotonic measurements in smooth muscle preparations in isolated organ and tissue baths. Values are transmitted as a result of movements of a permanent magnet within field plates.

The instrument is calibrated by locking the end of the lever into the calibration stops on the frame. These stops represent full deflections of ± 10 and ± 20 mm. If the organ preparation is attached to hole no. 10, this is equivalent to a movement of ± 20 mm (= 40 mm total), reducing for each lower hole used. The unit can be interfaced with almost any type of AC or DC bridge.

There are 3 calibration steps on the frame: ± 22 mm, 0 and -22 mm at a distance of 100 mm from the pivot measured at the arch. The calibration amplitude is reduced at the various holes as shown below.

Hole No.	10	9	8	7	6	5	4	3	2
cm from Pivot	10	9	8	7	6	5	4	3	2
Displacement (mm)	± 20	± 18	± 16	± 14	± 12	± 10	± 8	± 6	± 4

Specifications

Range/Linearity	± 20 mm (0 to 40 mm) / $\pm 2\%$ full scale
Zero Drift	$< 0.03\%$ / $^{\circ}\text{C}$ FS
Frequency Range	0 to 10 Hz
Full Bridge	4 x 300 Ω
Frictional Torque of Lever	0.1 mN cm
Output Voltage	± 10 mV, adjustable up to max. ± 40 mV, internal resistance of 300 Ω , max. output voltage represents full lever deflection and full measuring range
Power Supply	5 V DC or AC (max. 8 V)
Lever	180 x 85 x 40 mm, 3 positions to screw in support rod
Support Rod	6 mm OD x 130 mm L

Catalog No. \$ Product

BS4 73-0857	HSE-HA Isotonic Lever Transducer Model B40 for PLUGSYS System
BS4 73-2692	HSE-HA Isotonic Lever Transducer Model B40 for Harvard Apparatus Amplifier
BS4 73-2693	HSE-HA Isotonic Lever Transducer Model B40 for Grass Amplifier
BS4 73-2694	HSE-HA Isotonic Lever Transducer Model B40 for Gould 6600 Series
BS4 73-2695	HSE-HA Isotonic Lever Transducer Model B40 for Gould 4600 Series
BS4 73-0572	Thread Clip, Clamp for Fixing Thread

Harvard Apparatus Isometric and Isotonic Transducers



Harvard Apparatus Isometric Transducers

- Strain gauge type
- Available in five force ranges

Isometric muscle contraction is defined as force with zero motion. Harvard Apparatus Isometric Transducers achieve this condition by means of thinfilmed, bonded strain gauges and substantial beams. The strain gauge has four-wire closed Wheatstone bridges for long term stability and sensitivity. The stiffness of the transducer and stem prevents unwanted displacement.

To operate, these Isometric Transducers require power from the amplifier/signal conditioner to which they are connected. They are available in five force ranges and are supplied with an amplifier/signal conditioner specific, 1.8 m (6 ft) Cable. These Cables are also available separately allowing the Transducer to be connected to a different amplifier/signal conditioner simply by switching the Cable.

Specifications

Dimensions:

Transducer, H x W x D	19 x 150 x 19 mm (3/4 x 6 x 3/4 in)
Mounting Rod, OD x L	12.5 x 75 mm (1/2 x 3 in)

Harvard Isometric Transducer for Use With

Force Range	Harvard Apparatus Amplifiers	Gould Signal Conditioners
0 to 50 g	BS4 50-7905	BS4 50-7911
\$		
0 to 100 g	BS4 50-7913	BS4 50-7912
\$		
0 to 200 g	BS4 50-7921	BS4 50-7914
\$		
0 to 500 g	BS4 50-7939	BS4 50-7915
\$		
0 to 1000 g	BS4 50-7947	BS4 50-7916
\$		
Replacement Cable		
\$	BS4 50-7988	BS4 50-7990



Harvard Apparatus Battery-Powered Isotonic Transducer

This Battery-Powered Isotonic Transducer has an output shaft located in precision bearings, which carries a lever 90 mm (3.5 in) long. This lever is notched on its top surface and pierced with eight holes on either side of the lever point on a 5 mm pitch from the fulcrum. These piercings are for attachment of the preparation.

A graduated optical density vane (a light wedge), is also mounted on this shaft and moves between a miniature lamp and a silicon phototransistor which are housed in the light-proof casing.

The output of the photo transistor is linear over approximately 50° of movement of the lever. A balance control is provided on the front of the instrument to zero the output at a convenient level. A long lasting mercury battery is supplied. Output is from a pair of 4 mm sockets on the front panel.

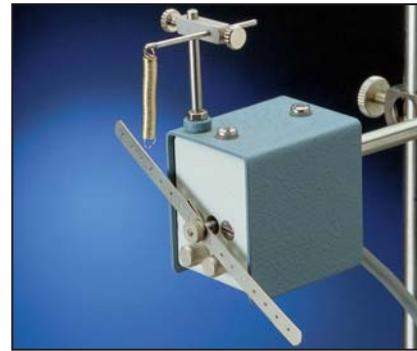
Specifications

Dimensions:

Case, H x W x D	50 x 100 x 25 mm (2 x 4 x 1 in)
Mounting Rod, OD x L	6.5 x 60 mm (1/4 x 2-1/4 in)

Catalog No. \$ Product

BS4 50-6378	Battery-Powered Isotonic Transducer
BS4 50-9257	4 mm plugs to BNC Cable; for use with Modular Universal Oscillograph, see page 166, and Student Oscillograph, see page 168
BS4 50-6364	Adapter Cable, 4 mm plugs to 14-Pin DIN connector; for use with Gould 6600 Series Amplifiers



Harvard Apparatus Isotonic Transducers

This Harvard Apparatus Isotonic Transducer is exceptionally sensitive and stable, requiring a minimum of force to produce a substantial electrical signal. It uses precision ball bearings and a graduated optical density vane that moves between an infrared source and a sensor.

The notched, pierced input lever is 90 mm (3-1/2 in) long for easy connection to muscle tissue. A spring and anchor post are supplied for converting the unit into a Transducer capable of recording frog/heart muscle tension for auxotonic applications.

This Transducer has a 2 m (6.6 ft) shielded integral cable which terminates in a specific connector for use with one of the amplifiers/signal conditioners below.

Specifications

Output	50 mV/angular degree rotation
Angle of Rotation	±25° above and below horizontal axis
Excitation Voltage	-12, 0, +12 VDC
Breakaway Torque	0.05 g/cm
Dimensions:	
Housing, H x W x D	45 x 35 x 45 mm (1.75 x 1.5 x 1.75 in)
Mounting Rod, OD x L	6.5 x 60 mm (0.25 x 2.5 in)

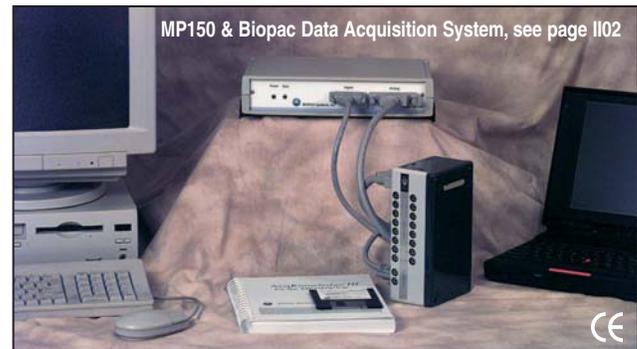
Catalog No. \$ Product

BS4 50-6360	Harvard Apparatus Isotonic Transducer for use with BS4 53-6132 Harvard Apparatus Amplifier, BS4 50-7970 and BS4 50-7996 Freestanding Transducer Interfaces, and BS4 50-8861 Modular Transducer Interface
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Harvard Apparatus now owns Hugo Sachs Elektronik. The HSE isolated organ baths set the industry standard. They can be found in the Isolated Organ and Tissue Section K in this Bioscience Catalog.

Introduction to Stimulators



Biological experiments that involve the functional study of isolated or in-situ organs or tissues such as nerves and muscles can only be examined if they are artificially induced to perform some reproducible activity. Apart from chemical stimuli, this artificial stimulation used in these experiments is mainly achieved through the use of electrical stimuli. All types of instrumentation that are used to accurately generate these electric stimuli with precise timing and repeatability can be classified as stimulators.

There are 3 basic components (functions) that are common to all stimulator systems, Timing, Signal Amplitude/Quality, and Delivery.

Timing is the basic spacing between each stimulation event (Frequency/ Rhythm) and the duration of the stimulation pulses themselves (pulse Width). Stimulation timing can be as simple as the generation of a single stimulation pulse or complex, consisting of repetitive pulses or pulse trains of varying frequency and pulse widths. Timing functions are either built into a stimulator system or are supplied from another type of instrument such as a timing generator or computer. The pulses produced by the stimulator's timing generators are usually made up of mono-polar or bipolar/bi-phasic square waves, although in some applications such as shock applications where a sinusoidal waveform is used. Other types of waveforms such as triangular and trapezoidal pulses are also employed for other specialized physiological investigations.

Amplitude of the output stimulation is the measure of stimulation energy intensity that can be provided by the **Quality** of the stimulus output. This is usually in the form of either a constant current or constant voltage but can be other type of stimuli such as magnetic stimulation. The intensity of stimulators of the constant current vari-

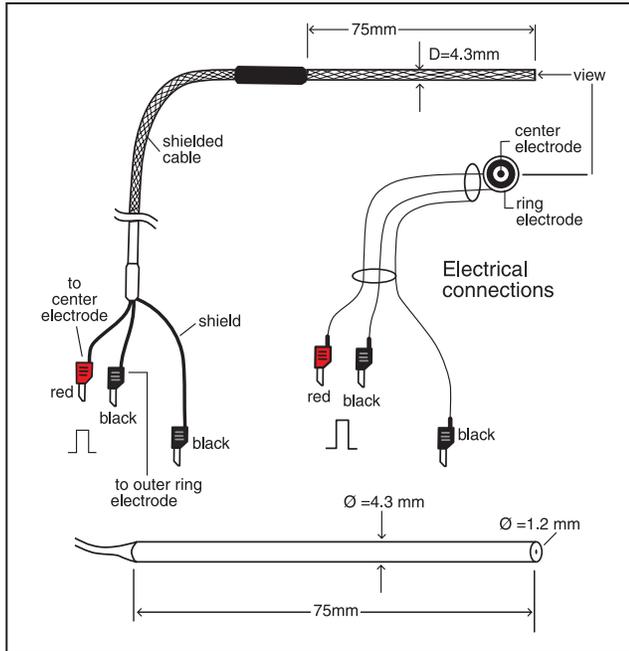
ety would adjust the amount of current measured in units typically from mA to Amps. In constant voltage systems this intensity would be measured in units from mV to hundreds of Volts. Normally the stimulation pulses are mono-polar going from 0 to either a positive or negative potential.

When minimal electrophoretic ion transfer is required to reduce the double layer of gas bubbles that form on polarized electrode, a system that generates bipolar/bi-phasic pulses is needed.

Delivery is any of the various methods used to electrically connect the stimuli to the tissue. Simplistically, the electric current travels along the cable from the stimulator into the muscle or nerve through some form of electrodes. These electrodes are made from various materials that are both conducting and tissue-compatible. Some of the preferred electrode materials are platinum, platinum/iridium, silver and stainless steel although other material such as carbon fiber are sometimes used.

Harvard Apparatus, Inc. offers a wide variety of stimulator systems including modular systems for research use, such as the Stimulator I Series and the Neurolog systems that can be configured from variety of plug in function modules or stand-alone stimulators and stimulus isolations units for dedicated benchtop use. Several models of stimulator teaching systems are also available. Stimulator functions are also available in computer controlled multipurpose physiological measurement systems such as the PLUGSYS or BIOPAC systems. There are also a range of stimulation electrodes for a wide range of applications.

Heart Stimulating Electrodes



- For electrical stimulation of the isolated perfused heart
- Reduced stray fields for more accurate recordings

Coaxial Stimulation Electrode for the Isolated Heart (Rat, Guinea-pig, Rabbit...)

Electrical stimulation of the isolated heart ensures constant heart rate. The tissue is being stimulated between the inner wire and the outer cylinder. Through the coaxial construction, the outer electrode at zero potential acts as a screen so that stray fields are reduced and interference to ECG (EG) recordings is limited. A special holder for easy positioning of the electrode on the heart surface is available as an accessory.

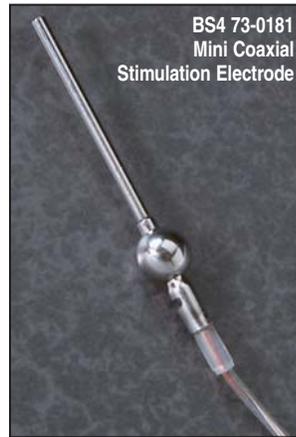
Specifications

Outside Diameter	4.3 mm
Length of Cylinder	75 mm
Cable Length	120 mm (4.7 in) ending on 4 mm MC Banana Plugs, 2-core screened cable
Weight	40 g, without holder

Catalog No.	\$	Product
BS4 73-0219		Coaxial Stimulation Electrode
BS4 73-0220		Holder with Maxi-Ball Joints for Large Stimulation Electrode. Includes 9 mm Ball with 130 mm length and 8 mm diameter Rod (BS4 73-3323), Maxi-Ball High Load Link (BS4 73-3322), and special bar with ball and thumbscrew



BS4 73-0160
Small Stimulation
Electrode Set



BS4 73-0181
Mini Coaxial
Stimulation Electrode

Small Stimulation Electrode Set (Mice)

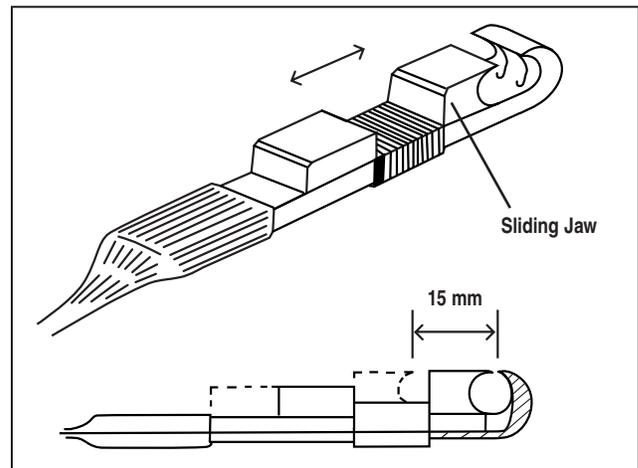
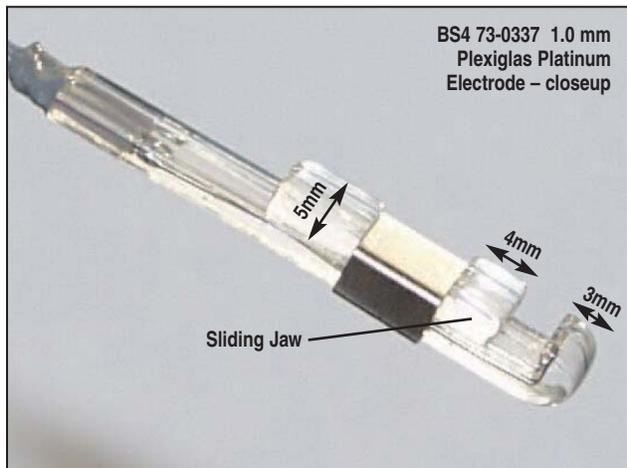
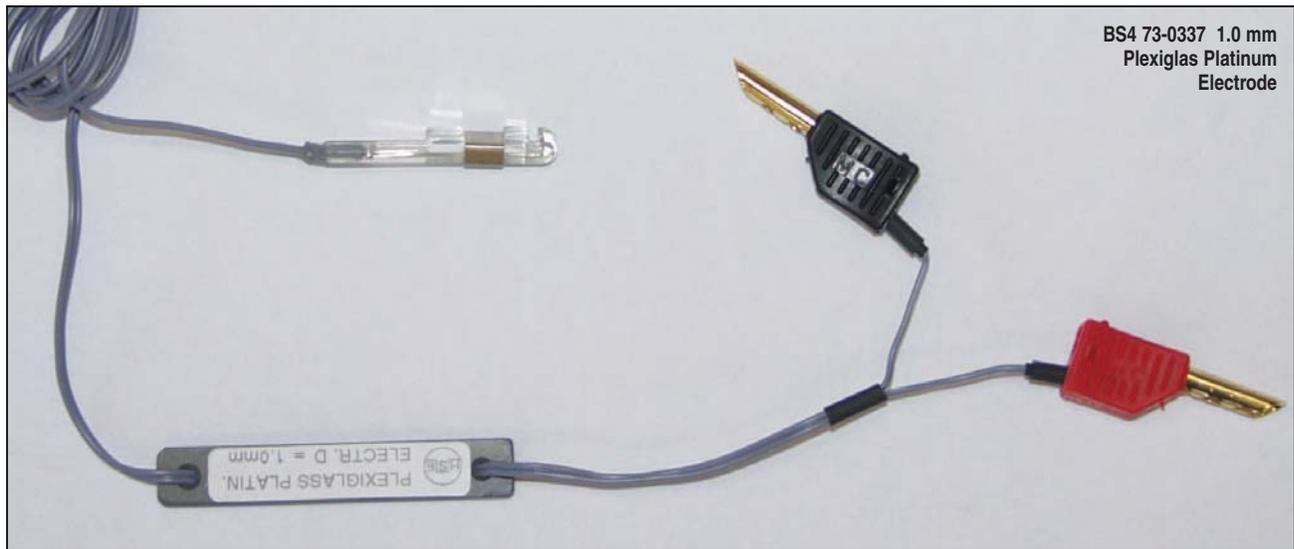
This stimulation electrode set is used for electrical stimulation of small heart or tissues. Through the coaxial construction the other electrode at zero potential acts as a screen so that stray fields are reduced and interference to recordings is limited (ECG, MAP). In combination with the mini ball joint holders a precise fixation on the myocardium is possible.

Specifications

OD	1.3 mm
Tip Length	20 mm
Cable Length	35 cm
Connector	Modified Lemo

Catalog No.	\$	Model
BS4 73-0160		Small Stimulation Electrode Set, Includes BS4 73-0181 & BS4 73-0182
BS4 73-0181		Mini Coaxial Stimulation Electrode with modified Lemo connector
BS4 73-0182		Adapter Cable - modified Lemo connector to 4 mm Banana Plugs, 2 mm Cable Length

Stimulating Electrodes



Bipolar Stimulating Electrodes for Nerves

- For in situ applications
- For stimulating or recording

The Plexiglas-platinum electrodes are used for direct stimulation of the exposed nerve in situ. The sliding jaw is opened for inserting the nerve. The diameter should fit smoothly without clamping the nerve. The surgery recess is filled with warmed liquid paraffin to prevent the nerve drying out. This offers the additional advantage of keeping blood and saline solution away from the nerve and preventing damage to it. It also prevents the bipolar electrode from short-circuiting. The electrode weighs 15 grams (0.5 oz). Those electrodes can also be used for recording (e.g., Vagus Nerve).

Catalog No.	\$	Product
BS4 73-0336		Plexiglas Platinum Electrode, ID of closed jaw 0.5 mm
BS4 73-0337		Plexiglas Platinum Electrode, ID of closed jaw 1.0 mm
BS4 73-0338		Plexiglas Platinum Electrode, ID of closed jaw 1.5 mm
BS4 73-0339		Plexiglas Platinum Electrode, ID of closed jaw 2.0 mm
BS4 73-0340		Plexiglas Platinum Electrode, ID of closed jaw 3.0 mm

HSE-HA Stimulator I



CE

- Modular rack-mountable construction
- Plug in modules for timing and control, stimulation output and specialty functions
- Configurations for up to 8 output (stimulation) channels
- Select from either constant current/constant voltage, constant voltage only and constant current only output modules

timing/control modules and the other 4 positions are used for basic, additional timing/control and/or other types of specialty function modules. The single rack configuration of the STIMULATOR I will provide one channel of basic timing controls (4 module slots) and up to 2 stimulus output modules.

There are a number of plug-in modules that will fit into the slots of the Stimulator I chassis. The two basic types of stimulator modules, one for controlling the timing (Timing and control modules) of the stimulus and the other to produce the stimulation energy as either constant current or constant voltage (output modules). Some of these modules such as the Multiple Current Output Modules and High Current Monitor require the use of 2 slots per module.

The STIMULATOR I model can be equipped with up to 2 single slot output modules or 2 dual-slot current output modules per channel. Output modules are available in one and four stimulation outputs so that up to eight (8) individual outputs of stimulus can be achieved for applications such the simultaneous stimulation of isolated tissues. With the available output modules, systems with 1,2,3,4, or 8 outputs can be configured.

HSE-HA modular, rack mountable stimulator is designed to meet the needs of almost every application that requires a controlled electrical voltage/current stimulus. This system provides a flexible platform that can be easily configured from a number of basic and specialized plug-in modules or selected from several pre-configured systems.

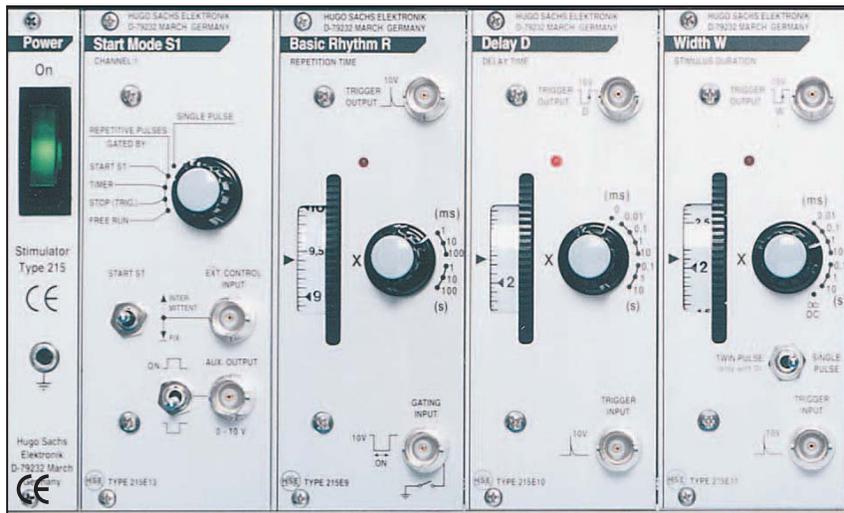
The Stimulator I system has a single row of modules consisting of 8 module slots. The first 4 of these slots are used for the basic

In addition to the basic timing and output modules (base Rhythm, Delay, Width and Timer) there are a number of modules for special applications:

- **High Current Output Module BS4 73-0086** with alternating polarity (Bi-Phasic) prevents the formation of gas bubbles and polarization of the stimulation electrodes, see page I15.
- **R-Wave Trigger Module BS4 73-0079** provides electrical stimuli that can be generated in synchronism with the cardiac rhythm, see page I18.
- **Double Stimulus Preset DP Module BS4 73-0080** permits the production of double stimuli after a pre-selected number (0 to 99) of single stimuli, see page I18.
- **Stimulus Preset SP Module BS4 73-0081** controls the number of stimulus pulses produced by an adjustable number (1 to 9999 pulses) rather than by time, see page I18.

For applications that require an isolated (ungrounded) stimulus (e.g. when applying a stimulation while simultaneously recording biological potentials), a **Universal Isolated Stimulation** benchtop unit (BS4 73-0082) can be used to convert the ungrounded stimuli into low-capacity isolated stimuli. Although stimulators are mains (AC) operated, use of the isolation unit produces the same conditions as a battery-operated instrument providing the stimuli. If you have any questions on how to configure a system for your specific applications, call our Technical Sales department for assistance.

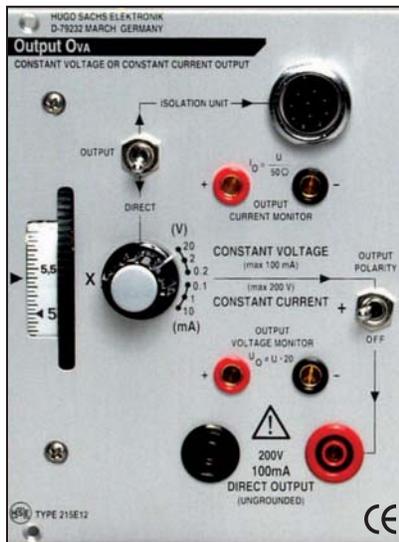
HSE-HA Stimulator I Series



To the left is an illustration of the BS4 73-0050 Stimulator I Single Channel Chassis. It includes the following timing modules:

- BS4 73-0066 Start Mode Module
- BS4 73-0068 Basic Rhythm R Module
- BS4 73-0070 Delay D Module
- BS4 73-0069 Width W Module

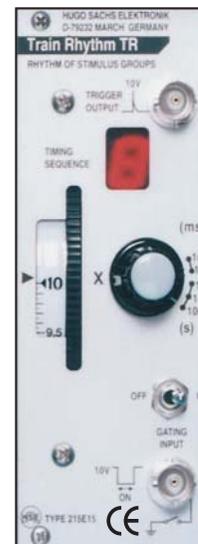
Harvard Apparatus offers five pre-configured Stimulator I systems. Each offers a selection of different modules for different stimulation applications. By combining the Stimulator I basic timing system with the various stimulator output and pulse train timing modules, multiple types of stimulator systems can be configured for a variety of applications. Additional modules are also available on pages I14 to I18.



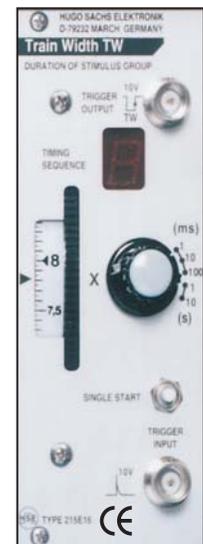
BS4 73-0084



BS4 73-0075



BS4 73-0072



BS4 73-0073

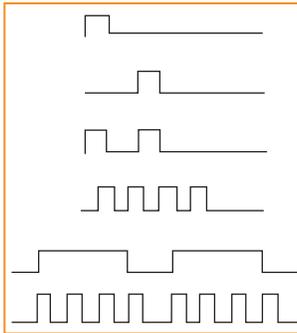
Specifications: Stimulator I Rack

Supply 220 V (15%), 50 Hz; 90 VA; can be switched to 110 V
 Dimensions, H x W x D 150 x 440 x 355 mm (5.9 x 17.3 x 14 in)
 Weight 9 kg (19.8 lb)

Stimulator I Preconfigured Systems

System Components	Catalog No.	System Catalog No.				
		BS4 73-0051	BS4 73-0052	BS4 73-0053	BS4 73-0054	BS4 73-0055
Basic Stimulator I Chassis	BS4 73-0050	1	1	1	1	1
Single Channel Output O_{VA}	BS4 73-0084	1	1	-	-	-
Train Rhythm TR	BS4 73-0072	-	1	-	-	1
Train Width TW	BS4 73-0073	-	1	-	-	1
4-Channel Voltage Output O_{4V}	BS4 73-0075	-	-	1	2	1

HSE-HA Modules for Stimulator I



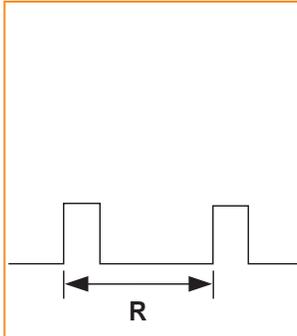
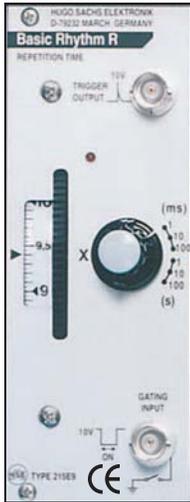
Start Mode S1

Start Mode S1 Module

For single-channel stimulators. This module is used in Stimulator I to start the stimulation in one of the following modes:

- With local switch or remote contact:
 - Single stimulus immediate
 - Single stimulus delayed
 - Twin stimulus immediate
 - Repeated stimulus while switch is pushed repeated stimulus as train
- With trigger pulse
- Free-running

Catalog No.	\$	Product
BS4 73-0066		Start Mode S1 Module



Basic Rhythm R

Basic Rhythm R Module

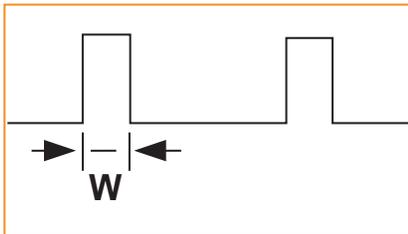
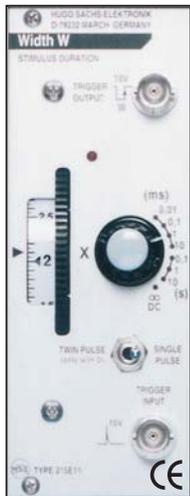
This module controls the time spacing of the repeated square-wave pulses.

Specifications

Adjustment Range	0.5 msec to 1000 sec, this corresponds to frequency range of 2000 Hz to 0.001 Hz
Trigger Output	Positive pulse of 10 V on $R_i = 1 \text{ k}\Omega$
Gate Input	Inactive +10 V, active 0 V at 10 k Ω input impedance

Catalog No.	\$	Product
BS4 73-0068		Basic Rhythm R Module

HSE-HA Timing Modules for Stimulator I



Width W

Stimulus Width W Module

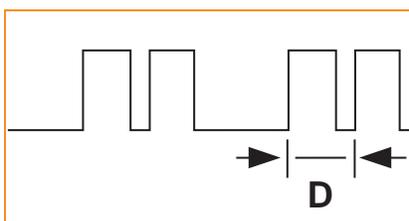
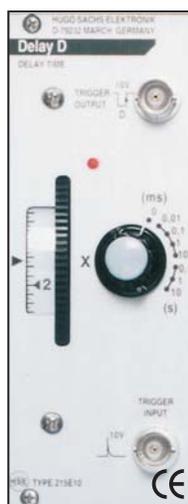
Controls the duration during which the stimulus is present.

Specifications

Adjustment Range	5 μsec to 100 sec and $\infty = \text{d.c. stimulus}$; if stimulator is fitted with delay module, it is possible to select twin stimuli; stimulus duration indicated by red signal lamp
Trigger Output	Inactive +12 V, active 0 V on 1 k Ω
Trigger Input	Positive rise to +2V on 10 k Ω input impedance

Catalog No.	\$	Product
BS4 73-0069		Stimulus Width W Module

HSE-HA Timing Modules for Stimulator I



Delay D

Delay D Module

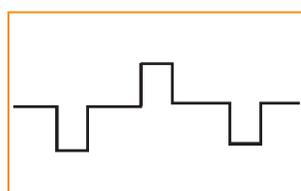
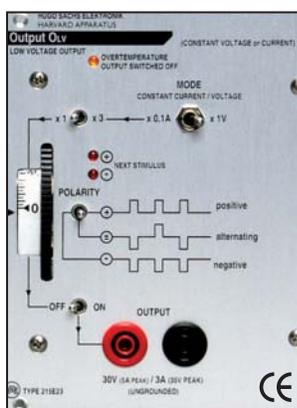
Controls the time spacing from a repeating (first) square-wave pulse to a subsequent (second) pulse.

Specifications

Adjustment Range	5 μ sec to 100 sec or 0 = no delay, delay time is indicated by red signal lamp
Trigger Output	Inactive +12 V, active 0 V, $R_i = 1 \text{ k}\Omega$
Trigger Input	Positive rise +2 V on 10 $\text{k}\Omega$ internal impedance

Catalog No.	\$	Product
BS4 73-0070		Delay D Module

HSE-HA Output Modules for Stimulator I



Module O_V

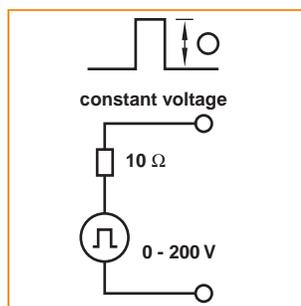
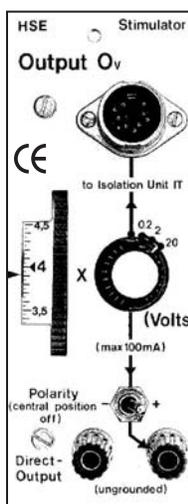
High-Current Output O_V Module

This module is used in stimulator I for field stimulation of a single isolated tissue, either at constant voltage or at constant current.

Specifications

Output Range:	
Constant Voltage	0 to 30 V in 2 ranges, 0.9 A (DC) or 5 A (pulse width 1 msec max.)
Constant Current	0 to 3 A in 2 ranges at max. voltage of 30 V
Output Characteristic	Monophasic or alternating to avoid polarization of stimulation electrodes
Output Connector	Safety female banana jacks

Catalog No.	\$	Product
BS4 73-0086		High-Current Output O_V Module



Output O_V

Output O_V Module

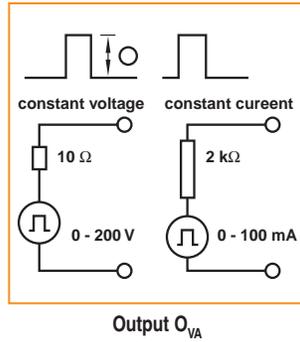
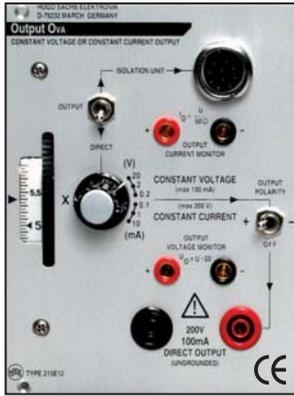
This module is a simpler version of the O_{V_A} module, which provides only a constant voltage stimulus

Specifications

Output Range	Constant voltage 0 to 200 V in 3 ranges at source resistance of less than 10 Ω , current output can be up to 100 mA (DC operation) or up to 200 mA (pulse width 1 msec max.)
Output Characteristic	Monophasic, polarity can be reversed
Output Connector	Safety female banana jacks

Catalog No.	\$	Product
BS4 73-0085		Output O_V Module

HSE-HA Output Modules for Stimulator I



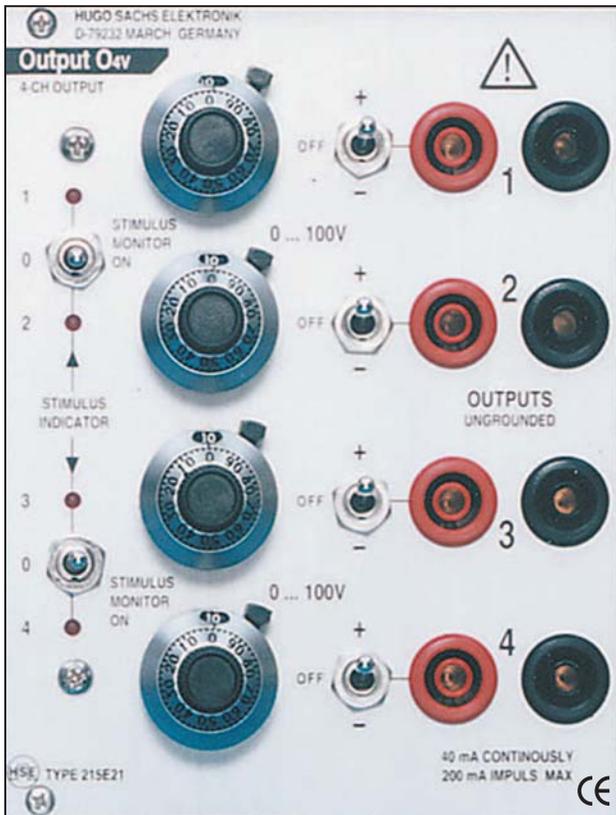
Output O_{VA} Module

This module is used in Stimulator I and controls the amplitude of the stimulus as constant voltage or constant current.

Specifications

Output Range:	
Constant Voltage	0 to 200 V in 3 ranges at internal resistance of 10 Ω currents up to 100 mA (DC) or 200 mA (pulse width 1 msec max.) are produced
Constant Current	0 to 100 mA in 3 ranges at source resistance of 100, 1000 or 10,000 kΩ depending on range, max. voltage produced is 200 V
Rise Time	Rise speed of stimulus is 10 V per μsec
Output Characteristic	Floating, capacity of 1 nF, monophasic, polarity can be reversed
Noise	50/60 Hz less than 1 μA
Current Monitor Output	$U = I_o \times 50 \Omega$
Voltage Monitor Output	$U = U_o/20$
Output Connector	Safety female banana jacks

Catalog No.	\$	Product
BS4 73-0084		Output O _{VA} Module



4-Channel Voltage Output O_{4V} Module

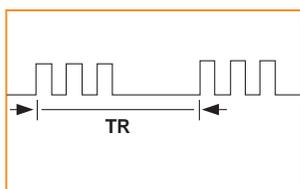
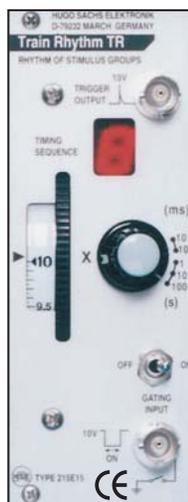
This module is used for simultaneous stimulation of 4 isolated tissues, e.g. in the Schuler or Graz organ baths. Each of the channels provides constant-voltage stimuli (0 to 100 Volt) adjustable on a 10-turn potentiometer for each channel. The channels are not isolated from each other. The large output current permits field stimulation.

Specifications

No. of Outputs	4
Output Range	Constant Voltage 0 to 100 V, max. output current is 40 mA (DC stimulation) or 200 mA (pulses 1 msec max.)
Output Characteristic	Monophasic, polarity can be reversed separately on each channel
Output Connector	Safety female banana jacks

Catalog No.	\$	Product
BS4 73-0075		4-Channel Voltage Output O _{4V} Module

HSE-HA Train Modules for Stimulator I



Train Rhythm TR

Automatic Timer Z

Consists of:

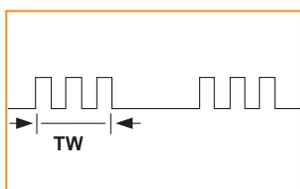
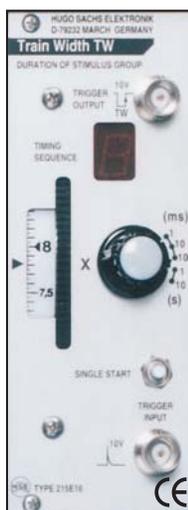
A. Train Rhythm TR Module

This module controls the time spacing of the stimulus groups. This module is used in Stimulator I.

Specifications

Adjustment Range	5 msec to 1000 sec in 5 switched ranges; single-digit display indicates time countdown; ON-OFF switch is fitted
Trigger Output	Positive pulse +10 V on $R_i = 1 \text{ k}\Omega$
Gate Input	Inactive +10 V, active 0 V, $R_i = 10 \text{ k}\Omega$

Catalog No.	\$	Product
BS4 73-0072		Train Rhythm TR Module



Train Width TW

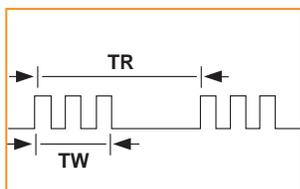
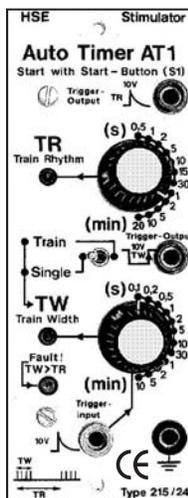
B. Train Width TW Module

This module controls the time during which the stimuli are switched on. This module is used in stimulator I.

Specifications

Adjustment Range	0.5 msec to 100 sec; single-digit display indicates time countdown; single train can be triggered by pressing key
Trigger Output	Inactive +12 V, active 0 V, $R_i = 1 \text{ k}\Omega$
Trigger Input	Positive rise to +2 V at $R_i = 10 \text{ k}\Omega$

Catalog No.	\$	Product
BS4 73-0073		Train Width (TW) Module



Auto Time AT1

C. Automatic Timer AT1 Module

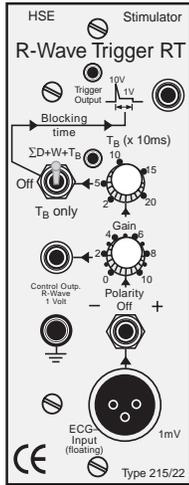
This module permits the production of stimulus groups (trains), with the times selected not continuously but in discrete steps. This module is used in Stimulator I.

Specifications

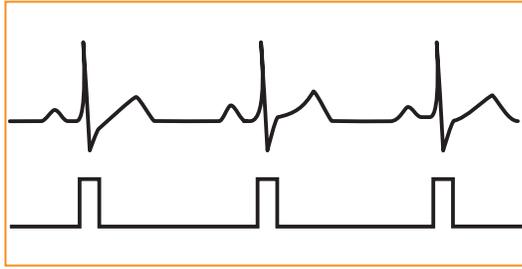
Train Rhythm (TR)	0.5/1/2/5/10/15/30 sec and 1/2/5/10/20 min
Train Width (TW)	0.1/0.2/0.5/1/2/5/10/30 sec and 1/2/5/10 min
Trigger Output	Inactive +12 V, active 0 V, $R_i = 1 \text{ k}\Omega$
Trigger Input	Positive rise to +2 V at $R_i = 10 \text{ k}\Omega$
Stimulus Trains	Single or repeated stimulus trains can be produced by operating start key

Catalog No.	\$	Product
BS4 73-0074		Automatic Time AT1 Module

HSE-HA Special Modules for Stimulator I



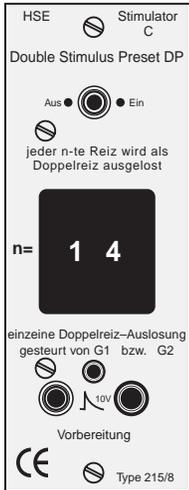
R-Wave Trigger RT Module



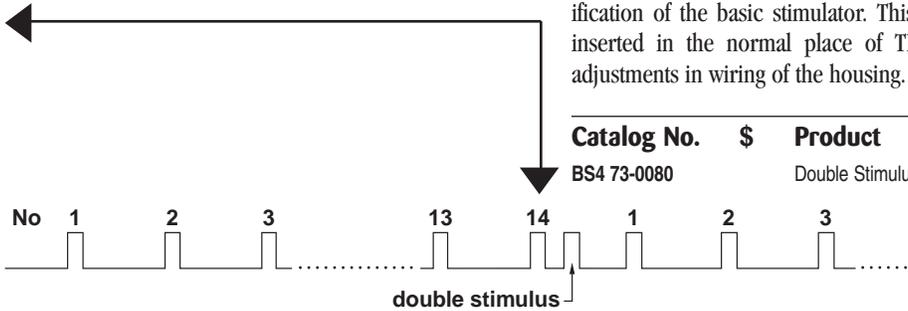
R-Wave Trigger RT Module

This module can be triggered directly from the 1 mV ECG signal. Linking the trigger output of the RT module to the trigger input of a delay module D permits e.g. synchronized stimulation of the heart; the stimulation pulses can be set at any spacing from the R-wave of the ECG, and can be placed e.g. into the vulnerable phase to produce ventricular fibrillation. This module has to be inserted in the normal place of TR or TW. Requires adjustments in wiring of the housing.

Catalog No.	\$	Product
BS4 73-0079		R-Wave Trigger RT Module



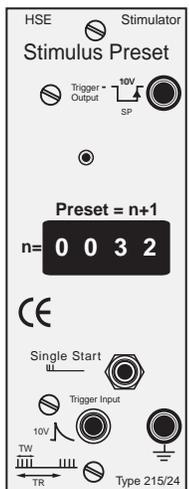
Double Stimulus Present DP Module



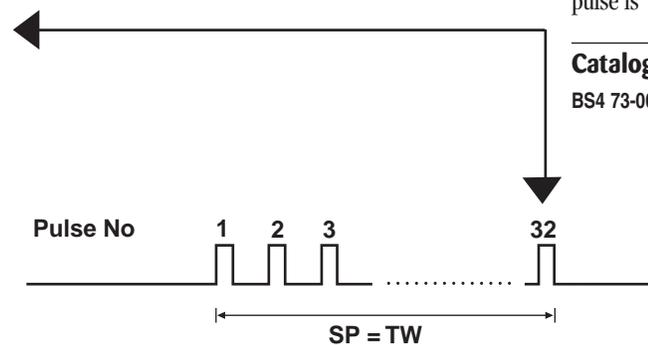
Double Stimulus Present DP Module

This module permits the triggering a second pulse (twin stimulus) after a certain number of normal single stimuli. If the counter is set to 5, for example, then an additional second and equal stimulus is produced after every fifth stimulus. The preset number can be selected between 1 and 99. Use of this module in Stimulator I requires modification of the basic stimulator. This module has to be inserted in the normal place of TR or TW. Requires adjustments in wiring of the housing.

Catalog No.	\$	Product
BS4 73-0080		Double Stimulus Present DP Module



Stimulus Preset SP Module



Stimulus Preset SP Module

This module can be used instead of the train width module TW 215/16 and controls the train by the number of pulses instead of by time (width). Pulse trains with pulse counts between 1 and 9999 can be produced. This module can be used in Stimulator I at the place of TW. It ensures that no pulse is 'cut' at the end of the timed period.

Catalog No.	\$	Product
BS4 73-0081		Stimulus Preset SP Module

HSE-HA Programmable Stimulator Module PSM for PLUGSYS System



- Combination of stimulator and measurement system in one main frame
- Up to 8 channels in one main frame
- For tissue baths applications

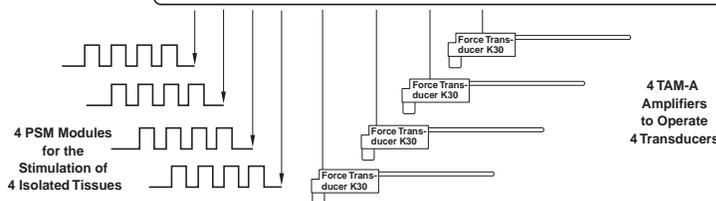
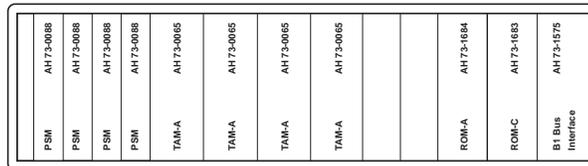
This programmable stimulator module is intended for the stimulation of isolated tissue, with operation from PC computer. An appropriate stimulation program is available. The adjustments are made from the PC and transferred to the PSM. The PSM is ideally suitable for computer-controlled tissue bath setups, e.g. for automatic refractory period determination. Up to 8 PSM modules can be mounted inside a PLUGSYS housing see page I29. For more than 4 modules an extra-large power supply is required: Option 5.

Hardware Required:

PC, PLUGSYS housing with HSE-data acquisition hardware, PLUGSYS version and DIM-D digital link.

Software Required:

HSE-HA Stimulator Control Program 'Stimulus' or HSE-HA ACAD, ISOHEART, NEURODYN, EPES with the Software module to control the PSM



Sample PLUGSYS Setup: PLUGSYS Equipment for Stimulated Isolated Tissues Module

Specifications

Trigger Modes	Continuous stimulus, trains, triggered from hardware or software; single or twin stimuli; polarity at output can be set constant or alternating
Basic Rhythm	100 msec to 10 sec
Delay	1 msec to 1 sec or 0
Width	0.5 msec to 200 msec
Output	1 mA to 25 mA or 10 mA to 250 mA, max. 40 V
Dimensions, H x W x D	27.5 x 20.2 x 220 mm (10.1 x 0.8 x 8.7 in)
PLUGSYS Width*	1 slot unit
Operation:	+5 V, 700 mA and +24 V, 500 mA
Weight	0.35 kg (0.8 lb)

*Note: For description of slot unit, see page I28.

Catalog No. \$ Product

BS4 73-0221	\$	Programmable Stimulator Module PSM for PLUGSYS System
BS4 73-3497	\$	Software "Stimulus" for PSM and PPG Control
BS4 73-0224	\$	Software Module to HSE-HA Software for PSM and PPG Control

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HSE-HA Universal Isolated Stimulator Output UIO



- Generates isolated stimuli in the range of 0 to 100 Volt
- Can be connected to any stimulator delivering a trigger signal
- Can be used in combination with a trigger output generated by a computer software as a power amplifier
- Applications:
 - Electrophysiology
 - In case of simultaneous biopotential recording

This unit is required to produce ungrounded (isolated or floating) stimuli and prevent interference in any biopotentials (ECG, EMG, EEG etc.) which are recorded simultaneously. It can be connected to virtually any type of stimulator delivering a trigger pulse with the same width as the stimulus duration. The input for the trigger impulse is a BNC socket on the back plane. It can also be connected to a TTL trigger output generated by a software on a computer as a power amplifier. A switch selects the output amplitude range (0 to 50, 0 to 100 Volt). Fine adjustment is provided by the fine control on a 10-turn Potentiometer. Stimuli produced can be either monopolar (positive or negative), or alternated. Alternated stimulation avoids electrode polarization.

Specifications

Trigger Signal	3 to 15 V, Trigger level 1.5 V, active low or active high (can be switched internally using jumper)
Trigger Input Impedance	10 kΩ
Trigger Input Width	10 μs to 10 msec defines Stimulus duration; if Trigger Signal Width exceeds 10 msec, stimuli duration is limited on 10 msec
Stimuli Output	Constant voltage, floating, isolated
Stimuli Output Voltage	Two ranges 0 to 50 V, 0 to 100 V
Stimuli Output Current	1.8 to 2 A for stimuli duration < 100 μsec, 0.5 A at 10 msec stimuli duration
Stimuli Polarity	Positive, Negative, Alternating
Dimensions, H x W x D	160 x 55 x 250 mm (6.3 x 2.2 x 8.7 in)
Weight	1.3 kg (2.9 lbs)

Catalog No. \$ Product

BS4 73-2696	\$	Universal Isolated Stimulation Unit, 110 VAC, 60 Hz
BS4 73-0504	\$	Universal Isolated Stimulation Unit, 230 VAC, 50 Hz

HSE-HA Stimulator P



- Trigger facilities
- Single or repeated stimuli
- Mono-phasic and bi-phasic pulses available
- Polarity can be reversed
- Output is floating and can be combined with other stimulator outputs
- DC stimulation is available

The Stimulator P is a simple single channel square-wave stimulator. Suitable for pacing via direct contact (i.e. nerve or heart).

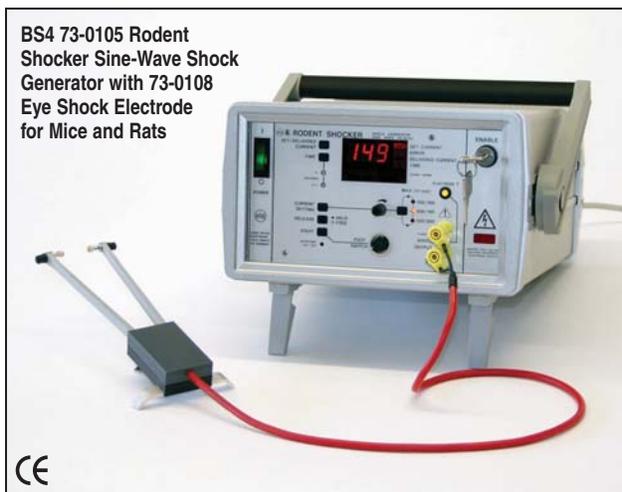
Specifications

Basic Rhythm R	Adjustable 5 msec to 10 sec, corresponding to 200 – 0.1 Hz
Width W	Adjustable 0.005 to 100 msec and infinity (=DC)
Output O	Adjustable 0.03 to 50 V in 3 coarse ranges with fine scale; output is isolated and has 500 pF capacity to ground; 50 Hz interference is of order of 0.5 μ A
Internal Resistance	1 k Ω , short-circuit current 70 mA max.
Trigger Inputs	10 V on 10 k Ω
Trigger Output	10 V on 1 k Ω
Supply	220 V 50 Hz, 16 VA, stabilized between 180 and 250 V
Dimensions	220 x 235 x 280 mm (8.6 x 9.3 x 11 in)
Weight	3.5 kg (7.7 lbs)

Catalog No. \$ Product

BS4 73-0087	Stimulator P, 115 VAC
BS4 73-0159	Stimulator P, 230 VAC

HSE-HA Rodent Shocker Sine-Wave Shock Generator



BS4 73-0105 Rodent Shocker Sine-Wave Shock Generator with 73-0108 Eye Shock Electrode for Mice and Rats

- For testing anticonvulsant drugs
- For mice and rats
- Two types of electrodes are available: for eyes or ears
- Foot Switch operation

Cerebral seizures, preferably in mice, are produced using constant sinusoidal alternating current to determine the effect of anticonvulsant drugs. For the reliable induction of seizures it is necessary to achieve satisfactory current flow. Eye electrodes and (especially in mice) ear electrodes are used for this purpose.

For complete details on the HSE-HA Rodent Shocker see page G9.

Specifications

Stimulation Frequency	50 Hz or 60 Hz according to supply frequency
Stimulus Duration	0.1 sec to 9.9 sec in steps of 0.1 sec, selected after pressing a button, the selected time is indicated
Stimulus Energy	Up to 75 W
Output	Constant current, fully floating
Output Current	0 to 300 mA, 0 to 150 mA, 0 to 100 mA depending on maximum stimulation voltage selected, the setting is made on a 10-turn potentiometer and the selected value is shown on the digital display
Limitation of Maximum Stimulation Voltage	250 V, 500 V, 750 V in 3 steps, selected by button
Digital Display	The selected stimulation current is indicated continuously in mA, the actual current applied is shown during application and can be called up later by pushing a button, the selected stimulation time is shown on pressing the TIME button, bargraph indicates the course of the stimulation time.
Supply	110 V, 60 Hz or 220 V, 50 Hz
Dimensions, H x W x D	150 x 260 x 360 mm (5.91 x 10.2 x 14.2 in)
Weight	5 kg (11 lb)

Catalog No. \$ Product

BS4 73-0105	Rodent Shocker Sine-Wave Shock Generator with Foot Switch, 115 VAC, 60 Hz
BS4 73-0106	Rodent Shocker Sine-Wave Shock Generator with Foot Switch, 230 VAC, 50 Hz
BS4 73-0107	Ear Shock Electrodes for Mice and Rats, pair
BS4 73-0108	Eye Shock Electrode for Mice and Rats

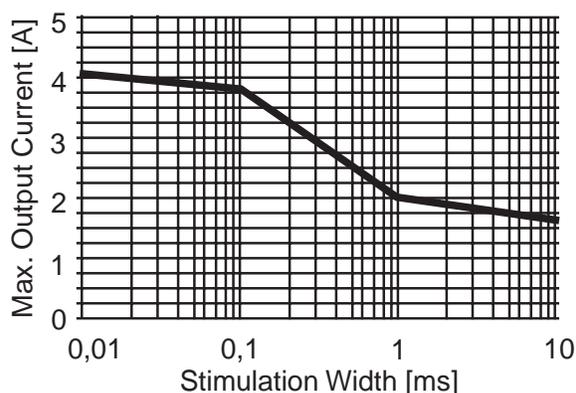
HSE-HA Stimulator CS for Isolated Cells



- Easy to use
- Constant voltage monophasic, biphasic or alternating stimulation (> 1A)
- High output impulse current
- Backup memory for timing setting
- Specially adapted for isolated cells stimulation

The stimulator CS Type 223 is a new development of an electronic stimulator for the electrical stimulation of isolated cells, e.g. myocytes. Stimulating isolated cells needs a high impulse current to trigger a maximum of cells independent of the size, shape specially in cell culture medium having a low resistance. This is of importance in experiment where the threshold voltage of cell reaction has to be determined. To reduce electrochemistry effects such as polarization of the electrodes and double layer of gas bubbles biphasic stimulation with perfect symmetry is requested. To be able to activate an action potential by depolarizing the membrane and to avoid further influence of the stimuli on the cell reaction, short and powerful impulses are required.

Simulation Mode and Timing are displayed on a LCD display and can easily be set in a step through mode using the 'Menu' button and the adjust knob. The last setting of the timing is stored in a backup memory and recalled automatically after switching on the instrument. The Stimulus Output Voltage is indicated on the built-in digital voltmeter and can be Adjusted on two potentiometers: "coarse" and "fine" with adjustment in the range of 0 to 45 V. The output is floating, not connected to earth (ungrounded). The output has a very low impedance (less than 1 Ohm). To avoid overheating of the output circuit a dynamic current limiter is built in. It limits the maximum output current relative to the Stimulation Width.



Specifications

Stimulation Mode	SINGLE/STRT single stimulus triggered by START switch or by remote contact REPEAT/STRT repeating stimulus triggered by START switch or by remote contact TRIGGER pulse (TTL, negative-going edge) starts delay circuit; START switch must be in OFF position
Timing	
Stimulation Frequency	0.05 to 100 Hz (in 29 steps) 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 Hz
Delay Time	(leading the stimuli): 2 to 50 msec (in 7 steps) 2, 5, 10, 20, 30, 40, 50 msec
Stimulus Width	10 µsec to 10 msec (in 28 steps) 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900 µsec 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 msec
Stimulus Output	1. Output voltage 0 to 50 V; Pulse Current up to 1 A at max. pulse width (10 msec) 2. Monophasic, Biphasic, Alternated 3. Output circuit floating, not connected to earth (ungrounded)
Indication	1. LCD module (4 lines of 16 characters each) to indicate stimulus parameter settings (except amplitude); 2. Digital voltmeter (DVM) to indicate output voltage setting range selectable: 0 - 19.99 V ↔ 0 - 50.0 V 3. LED for stimulus pulse 4. Beep (with each stimulus pulse), can be switched off 5. 2 LEDs for polarity of next stimulus: + or -
Trigger Input/Output:	
Input	BNC socket, input signal starts time delay, TTL level, negative active edge
Output	BNC socket, signal: delay time, open collector output (2 kΩ to +5V)
Weight	3.5 kg (7.7 lb)
Dimensions, H x W x D	110 x 300 x 250 mm (4.3 x 11.8 x 9.8 in)

Catalog No. \$ Product

BS4 73-0485	HSE-HA Stimulator CS, 220 VAC, 50 Hz
BS4 73-2667	HSE-HA Stimulator CS, 115 VAC, 60 Hz

D330 MultiStim System for Tissue Bath Stimulation

Typical System Configurations



- Versatile tissue bath stimulator
- Multiple independent channels
- Constant current or constant voltage operation
- Modular design

The D330 MultiStim System is a modular and highly versatile multi-channel stimulator designed to be used by biomedical scientists who wish to accurately stimulate a number of low impedance tissue preparations with different stimulating voltages or currents. The output channels are fully protected and galvanically isolated from ground so that a single earthing point can be chosen and loops avoided.

The system provides a choice of modules for either constant voltage stimulation (up to 100 V or 1 A) or constant current stimulation (up to 500mA from a 100 V source). The D335 - Meter can be fitted into the system to allow precise voltage or current monitoring.

A selection of timing modules are available to generate pulses, variable in frequency and width, which can be controlled as bursts using a gating waveform, variable in repetition rate and duration or pulse count. For ease of use, most modules have an error indicator to warn of incompatible settings or an overload condition. Sockets are fitted to allow full external control and synchronization if required.

The D330 MultiStim System rack/case is available in two sizes. A 19 inch rack-mountable unit that can house up to ten stimulation channels and a 'half-width' bench-top unit capable of taking up to four stimulation channels along with the Pulse Train Generator and Gating modules.

The D345 PowerStim is an extension of the D330 MultiStim System range, and provides the controlled high power stimuli from a low impedance source needed for Field Stimulation of preparations in extra low impedance baths. It provides up to 80 V at 2.5 A from each of its four overload protected channels and these outputs can be externally combined to give two 5A channels or a single 10A.

The modularity of the system allows a system to be extended or split between smaller units for two sites.

Rack and Power Supply

The Rack and Power Supply unit contains a motherboard that distributes the power, automatically connects the timing signals between the generators and the stimulators as well as routing the signals of the stimulating channels to one or more of the D335-Meter modules. They are fully enclosed to meet laboratory safety standards so that they can be used on the bench top.

NOTE: As the normal stimulating procedure is short pulses with a longer 'gap' the power supplies are rated for a duty cycle that will give at least 500mA continuous 'rack' stimulation current. That is 1 A at 50% duty cycle or 5A at 10% duty cycle for short pulses.

D337 19-inch Case

This unit can hold up to ten independently adjustable stimulation channels along with the required timing, gating and monitoring units from the range of available modules.

Catalog No.	\$	Product
BS4 65-0352		Model D337 19 in. Rack and PSU

Safety Information

To comply with laboratory safety standards, the complete D330-MultiStim System must be completely enclosed. Therefore we offer matching D330-1 and D330-2 Single and Double Blank Front Panels to complete the front panel aperture. We cannot sell a system with less than a completely filled front panel.

Catalog No.	\$	Product
BS4 65-0360		Model D330-1 One-Wide Blank
BS4 65-0361		Model D330-2 Two-Wide Blank

D330 MultiStim System for Tissue Bath Stimulation



D342 2-Channel Bi-Phasic Switcher

This 2-Channel Bi-Phasic switcher is for use with a D333H or D343 module. The unit provides the switching function required to alternate the polarity of the stimuli to each of two preparations. It provides control of stimulus polarity (Normal, Alternating or Reverse) independently for each channel as well as warning of a stimulus timing rate that is too-fast. The control and timing for the pulses is generated by selecting other modules from the D330 - MultiStim™ range.

It should be noted that the unit works with mechanical relays that require a certain time to switch their polarity. The circuitry is designed so that the changeover command is taken (independently for each channel) from the end of each stimulus timing pulse so that the relay 'moves' when no stimulus is being applied.

As with all mechanical devices, relays have a finite life. This is quoted as a minimum of 100,000,000 mechanical operations. If the relay was to 'move' whilst a stimulus was presented the contacts would wear-out much

quicker than the mechanics. Therefore, the circuit will detect and warn the user if the 'time-between' stimuli pulses is less than 5 ms. The user must ensure that this never happens.

The module connects to the outputs of a D333H or D343 via 2 mm - 2 mm leads (supplied). The D333H/343 has the functions and specifications as defined in its specification part of this manual. Each module is preset for specific channels whose outputs are to be switched. Normally, the unit will be supplied preset for channels 1 and 2 or as required when a full system is purchased. That is, the timing signals of the D333H/343 and the D342 will automatically be the same. The channels set is shown at the top of the module front panel.

Current and Voltage Monitoring

The current and output voltage of each channel can be monitored independently with the D335 METER as taken from the output of the D333H/343 stimulation module. This can show either the voltage or current of the selected channel immediately before the end of the stimulation pulse. The meter will always read a positive value irrespective of the polarity of the stimulus.

Specifications

Polarity Selector:	
Normal	Left hand blue socket will go positive with respect to associated right hand blue socket
Alt	Polarity of sockets with respect to each other reverse with each stimuli
Reverse	Right hand blue socket will go positive with respect to associated left hand blue socket
Amplitude	As set on associated D333H/D343 channel, optional D335 METER module will display current and voltage
Current	1 A max. (depends on D333H/D343)
Output	Pair of 2 mm sockets (with compliance)
Mechanical Life	100,000,000 (100 Million) operations at 10 Hz
Electrical Life	5,000,000 operations at 200 mA, 200,000 operations at 1 A Note: only applies if stimulus rate is NOT too high (< 5 ms ISI)
Indicators:	
Reverse	Amber LED indicates output pulse is 'REVERSE'
Too-Fast	Red LED illuminates if 'off' time between stimuli is < 5 msec

Catalog No.	\$	Product
BS4 65-0356		Model D342 Dual Bi-Stim module (for use with a D333H/343)

Stimulators and Monitoring

The D330-MultiStim System provides a choice of two different stimulators. Each has output channels with independent, automatically reset output protection and indication of error conditions but they differ in their capabilities.

The Meter module is a precise method of monitoring voltage or current without the need of an oscilloscope and more than one can be fitted per rack.

D333H Dual Stimulator

A double-width unit with two totally independent constant voltage stimulation channels. The D333H has an output capability allowing a maximum output of up to 1 A per channel.

D343 Dual Stimulator

Similar to the D333H but with constant current stimulation control.

D335 Meter

This module allows selection of the channel for monitoring of current or voltage. This is displayed on a 3-digit display which is 'held' until the next pulse, for ease of reading.

Specifications

D333H:	0 to 10V or 0 to 100V at 1A max per channel
Rise/Fail Time	< 5/20 µsec
D343 Dual Stimulator	0 to 50mA or 0 to 500mA from 100 V supply
D335 Meter	00.0 to 99.9 V, 0.00 to 9.99 A, 000 to 999 mA

Catalog No.	\$	Product
BS4 65-0349		Model D333H Dual Stimulator (0 to 100 V, 1 A Max.)
BS4 65-0357		Model D343 Dual Stimulator (0 to 500 mA, 100 V Max.)
BS4 65-0351		Model D335 Meter Module

D330 MultiStim System for Tissue Bath Stimulation

D332T Pulse Timing

The D330-MultiStim System provides a common timing pulse to all the stimulating channels in the system unless the D344 is used for external control of each channel. These modules provide that timing. This provides the pulse frequency and pulse width for the system. Incorporates 10-turn controls for greater accuracy.

Specifications

Frequency	0.01 to 1100 Hz
Pulse Width	0.01 to 110 msec

Catalog No.	\$	Product
BS4 65-0348		Model D332T Pulse, 10-Turn

Control and Gate

Each system must have one of these modules as they provide the routing for the timing signals and the connectors for external control and synchronization. They also contain the power switch rod and supply health indicator.

D334B Sync

This basic module is not shown but is the same as the left-hand side of the D341.

D331AT Sync & Gate

This double-width module adds the control of Gating the duration of a burst of pulses to the basic functions.

D341A Sync & Train

This module is similar to the D331AT but controls the Gating as number of pulses in a burst.

Specifications

D331AT:	
Gate Repetition	0.1 to 110 sec
Gate Duration	0.01 to 11 sec
D341A:	
Gate Repetition	0.1 to 990 sec
Number-of-Pulse in Burst	01 to 99 sec

Catalog No.	\$	Product
BS4 65-0350		Model D334B Sync Module
BS4 65-0347		Model D331AT Sync and Gate, 10-Turn
BS4 65-0355		Model D341A Sync and Train module

D340 Count & Delay

Provides the method of introducing an 'extra' stimulation pulse (or just a single stimulation pulse timing to occur) at a delay after a particular pulse within a train. This can be used for Refractory Period measurements. The D340T (not shown) is the same module but incorporates a 10-turn control for greater delay accuracy.

Specifications

Count	01 to 99
Delay	0.1 to 10 sec

Catalog No.	\$	Product
BS4 65-0354		Model D340 Count and Delay Module

D344 Remote

This module allows complete and independent control of the timing of each channel using an external timing generator.

Catalog No.	\$	Product
BS4 65-0358		Model D344 Remote Interface Module

Biphasic Isolated Stimulators



- Two independent constant current sources: use separately or biphasically
- Accepts TTL or biphasic gates
- Multi-range 70-turn amplitude controls
- ± 90 volts compliance
- Battery operated photically isolated

Biphasic Stimulus Isolator (BSI-1)

- Output waveform follows input (linear)
- Constant current and constant voltage
- ± 125 volts compliance
- Battery operated photically isolated

The Model BSI-1 Biphasic Stimulus Isolator is totally battery-powered utilizing optimum packaging design to provide maximum isolation of stimulus signals. This instrument is a truly linear

device which converts any waveform from 0 to ± 10 volts into a constant current or voltage stimulus. It has a constant current range from ± 100 nA to ± 10 mA with a compliance voltage of up to ± 125 VDC and a constant voltage range between 0 and ± 125 VDC. A 4-position front panel range switch allows optimum resolution for selecting precise stimulus amplitudes. A calibrated front panel control knob allows the investigator to apply input signal levels which can be attenuated to give continuously adjustable output levels. A separate output jack is provided for monitoring current levels through the electrode so that no connection need be made across the electrode which could interrupt the stimulus' current path. The Model BSI-1 is completely self-contained and portable with an adjustable handle for convenient placement near the preparation. It is the logical companion to the BPG-1,2 Biphasic Pulse Generators.

Biphasic Stimulus Isolator (BSI-2)

The Model BSI-2 Biphasic Stimulus Isolator has been optimized for applications requiring precise control of rectangular waveform stimuli. It is designed for use with external timing circuits which are biphasic single channel or dual channel TTL. The external timing input(s) gates each of the two photically isolated, independently battery powered, constant current sources. Because they have completely independent isolators, range controls, and output circuits, the 'A' and 'B' outputs can be used as independent monophasic stimuli which are completely isolated from each other as well as from the control input. Each output has an inversion switch and an extra binding post to facilitate installation of coupling capacitors or current monitoring resistors. The two sets of output binding posts are strategically placed so that the addition of two jumpers (provided) converts the unit instantly to biphasic or pulse pair operation.

The Model BSI-2 features high compliance, high isolation, and the same conveniently portable plastic case as the BSI-1. The main difference is that its output circuitry has been optimized for gated on-off operation rather than proportional input following. This mode of operation is inherently very low noise and eliminates the danger of applying DC currents as a result of low level offsets in the control signal between output pulses. It also permits manual fine tuning of the output level from the unit itself which can be placed near the preparation. If you need non-rectangular waveforms (e.g. sinusoids, ramps or computer D/A driving), we recommend the BSI-1, a linear biphasic stimulus isolator with a complete range of both constant current and constant voltage output levels.

Specifications

Constant Current	100 nA to 10 mA each channel with polarity inversion switch
Current Control Ranges	1,10, 100 and 1000 μ A per turn via 5 position rotary switches each channel
Output Controls	10 turn potentiometer with indicating dial each channel
Output Linearity	1% all ranges
Compliance Voltage	90 volts each channel, independent battery sources
Isolation	1000 VDC (photically isolated), < 30 pF between any two jacks
Output Connections	3-way banana binding posts, 3 each channel
Input Connections	Floating BNC jacks
Input Signal:	
A/B Biphasic	± 2.8 V mm, TTL compatible, protected to ± 15 V
B Only	± 2.8 V mm, TTL compatible, protected to ± 15 V
Power Supply	2 x 9 V lithium batteries & 4 x 45 V batteries
Battery Life	100 hrs min.
Package	Bench mount with supporting handle
Size, H x W x D	3.5 x 26 x 7.5 in (less handle)
Weight	5 lbs (shipped with batteries installed)

Specifications

Constant Current	± 100 nA to ± 10 mA
Constant Voltage	Zero to ± 125 V
Linearity	1%
Noise	0.5% of full output range
Compliance Voltage In Constant Current Mode	± 125 V
Isolation	1000 V (photically isolated)
Input Voltage Range	0 to ± 10 V (accepts any waveform)
Range Adjust	4 position switch & calibrated input attenuator knob (0 to 1.0)
Rise Time	2 μ sec w/ 1 M Ω source impedance
Slew Rate	5 V/ μ sec
Current Monitor Output	1 mV/ μ A
Power Supply	4 x 9 V lithium batteries 4 x 67.5 V batteries
Weight	5 lbs

Catalog No.	\$	Product
BS4 72-3755		BSI-1 Single-Channel Biphasic Stimulus Isolator
BS4 72-3756		Replacement Battery*, 9 V Li Ion
BS4 72-3757		Replacement Batteries*, 45 V
BS4 72-3758		Replacement Battery*, 67.5 V

* Note: Supplied in package of 2.

Catalog No.	\$	Product
BS4 72-3759		BSI-2 Dual Channel Biphasic Stimulus Isolator

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6000 Series Stimulators

The 6000 Series of stimulators are ideal units for conducting teaching and research experiments. The range, which consists of the 6002 Basic Stimulator, 6012 Dual Pulse Stimulator and the 6020 Dual Impedance Stimulator, have been designed specifically to allow complete compatibility between all 6000 series stimulators. This allows two or more systems to be connected together to make a sophisticated multi channel system.

All systems feature variable pulse frequency, 3 operating modes, variable pulse width, variable pulse amplitude, an output on or off selector, pulse indicator, gate in and gate out terminals. The 6012 and 6020 Stimulators also feature a sync output terminal. The 6020 stimulator features a delay circuit that allows the output pulse to be delayed in relation to the sync output for oscilloscope timebase to be pre-triggering.

In continuous mode, systems generate a continuous stream of pulses, at the selected frequency, amplitude and pulse width.

In single shot mode, a single pulse is generated at the selected amplitude and pulse width, whenever the single shot key is activated or when the gate in condition is met.

In gate in mode, whenever the gate in condition is met or the single shot key is activated, pulses are produced at the selected frequency, amplitude and pulse width, for as long as the condition remains met.



6002 Basic Stimulator

- Single Pulse, Single Channel
- 50 Volt Pulse Amplitude
- 6 Pulse Widths

The 6002 stimulator features a highly stable pulse generator that is continuously adjustable between 0.1Hz to 100Hz, with a variable pulse width that can be set to one of six positions and a maximum output amplitude of 50 Volts.

Specifications

Frequency Range	0.1 to 100 Hz in 3 ranges
Pulse Width Range	0.1 to 5 mS
Output Amplitude	0 to 0.5 Volts, 0 to 5 Volts or 0 to 50 Volts
Rise and Fall Time	> 5 μ sec
Gate In	Short Circuit or 12 Volt (Max) Logic Pulse (triggers on falling edge)
Connections	2 x insulated 4 mm sockets (Output) 2 x BNC Socket (Gate Connections)
Power	110-115 Volts 60 Hz or 220-230 Volts 50 Hz

Catalog No.	\$	Product
BS4 50-6002		6002 Basic Stimulator



6012 Dual Pulse Stimulator

- Dual Pulse Single Channel
- Sync Output
- 50 Volt Output Amplitude
- 6 Pulse Widths
- Produces Tetanic Train Pulses

The 6012 stimulator is similar to the 6002, however this unit has a wider frequency range of 0.1 to 1000Hz and a dual pulse function. When dual pulse mode is selected a secondary pulse is generated behind the initial pulse; a delay circuit controls the time difference between the two pulses. The 6012 is also

capable of producing Tetanic Train Pulses internally without the need to utilise any other external triggering.

Specifications

Frequency Range	0.1 to 1000 Hz in 4 ranges
Pulse Width Range	0.1 to 5mS in 6 preset steps
Dual Pulse Delay	0 to 1000 mS
Output Amplitude	0 to 0.5 Volts, 0 to 5 Volts or 0 to 50 Volts
Rise and Fall Time	> 5 μ sec
Gate In	Short Circuit or 12 Volt (Max) Logic Pulse (triggers on falling edge)
Connections	2 x insulated 4 mm sockets (Output) 3 x BNC Socket (Gate & Sync Connections)
Power	110-115 Volts 60Hz or 220-230 Volts 50Hz

Catalog No.	\$	Product
BS4 50-6012		6012 Dual Pulse Stimulator

6000 Series Stimulators



6020 Dual Impedance Stimulator

- Dual Output Impedance
- Sync Output
- 150 Volt Output Amplitude
- 9 Pulse Widths

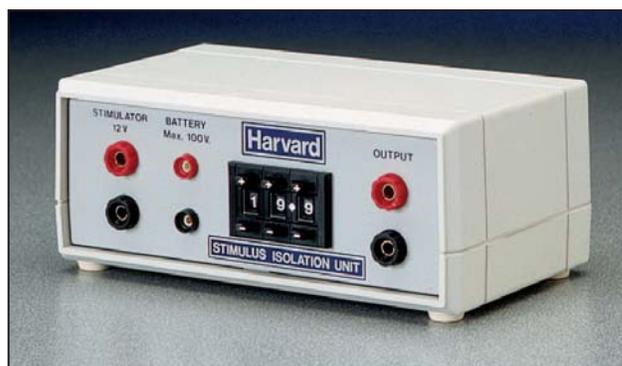
The 6020 Stimulator is similar to the 6012 stimulator, however there is no dual pulse function. Instead this unit has a fully earth isolated output amplitude of 150 Volts, which can be set at 100 ohms or 100 K Ohms impedance. The delay circuit allows

the output pulse to be delayed in relation to the sync output.

Specifications

Frequency Range	0.1 to 1000 Hz in 4 ranges
Pulse Width Range	0.1 to 50 mS in 9 preset steps
Dual Pulse Delay	0 to 1000 mS
Output Amplitude	0 to 0.15 Volts, 0 to 5 Volts or 0 to 50 Volts
Rise and Fall Time	> 5 μ sec
Gate In	Short Circuit or 12 Volt (Max) Logic Pulse (triggers on falling edge)
Connections	2 x insulated 4 mm sockets (Output) 1 x uninsulated 4mm earth connection 3 x BNC socket (Gate & Sync Connections)
Power	110-115 Volts 60 Hz or 220-230 Volts 50 Hz

Catalog No.	\$	Product
BS4 50-6020		6020 Dual Impedance Stimulator



Harvard Apparatus Stimulus Isolation Unit

- Essential safety device for experiments involving AC-powered stimulators
- Effectively isolates any stimulator having a minimum output of 12 volts
- Available with positive or negative output pulses

This Isolation Unit makes true biphasic stimulation available to the researcher at a low cost when used in conjunction with the BS4 50-6002 Harvard Apparatus Single Pulse Stimulator and BS4 50-6012 Harvard Apparatus Single/Dual Pulse Stimulator, see page I26. This self-contained, battery-powered Isolation Unit is constructed of plastic for additional isolation.

The Unit's output faithfully reproduces the pulse shape characteristics of the driving stimulator, but is optically isolated from it. The output voltage is controlled by a 3 decade digital potentiometer providing a range from zero volts to approximately 96% battery supply voltage in steps of 0.1%.

In operation, the stimulator controls are set to the required pulse width and frequency. These factors are maintained independently of the stimulator voltage. The output of the stimulator is set to 12 volts. It is then connected to the Stimulus Isolation Unit. The output of this Isolation Unit is then set to the required voltage and connected to the appropriate electrodes.

Specifications

External Power Source	12 to 100 VDC batteries
Input from Stimulator	12 V
Output Impedance	$\leq 100 \Omega$
Dimensions, H x W x D	60 x 155 x 95 mm (2.5 x 6 x 3.5 in)
Weight	225 g (1/2 lb)

Catalog No.	\$	Product
BS4 50-8275		Harvard Apparatus Stimulus Isolation Unit* with Positive Output Pulses
BS4 50-0090		Harvard Apparatus Stimulus Isolation Unit* with Negative Output Pulses

HSE-HA PLUGSYS Modular Measuring and Control System



- Universal modular measuring and controlling system for recording and data acquisition
- Wide range of modules
 - Transducer amplifiers (force, pressure, flow)
 - Biopotential amplifiers (ECG, EEG, EMG, AP)
 - Amplifiers for biochemical sensors (O₂, pH, ion selective)
 - Calculating modules (differentiator, integrator, heart rate)
 - I/O modules (trigger output, recorder output, trigger input, signal input)
 - Controlling and special function modules (ventilator module, liquid level controller, programmable stimulator module)
 - Interface to recording devices, data acquisition and controlling
- Modular structure permits multi-application platform use:
 - Hemodynamics
 - Pulmonary
 - Isolated organ
 - Biopotentials
 - Combinations (hemodynamics and pulmonary)
- Modules can be interconnected internally. There is no need for external cables which reduces clutter and confusion. The same is true for recorder and data acquisition connections, simple, clutter free connections reduce the chance of error.

General System Description

PLUGSYS is a flexible measuring and control system developed for use in physiological and pharmacological research. Its modular design accepts a wide pallet of different plug-in function modules such as bridge amplifier, differentiator, integrator, heart rate meter, ECG amplifier etc. All these modules fit directly into the PLUGSYS main frame, which is available in a 19 inch rack or as a desktop case.

The PLUGSYS main frame is the base of the measuring system. It consists of the case, the standard power supply, and the bus system. The system has 20 slots for PLUGSYS modules, but the maximum number of installable modules in practice depends on the width of the module. The PLUGSYS configuration for most applications will result in a maximum of 10 to 15 modules per case.

One of the leading features of the PLUGSYS measuring system is the slot-independent design, that means that all configuration settings are done on the plug-in modules and not on the system bus. The system can be modified or reconfigured by the using jumpers and dip switches installed on the PLUGSYS modules.

The PLUGSYS is not only a conventional modular analog measuring system, it includes specific interface modules and application software for data acquisition and analysis.

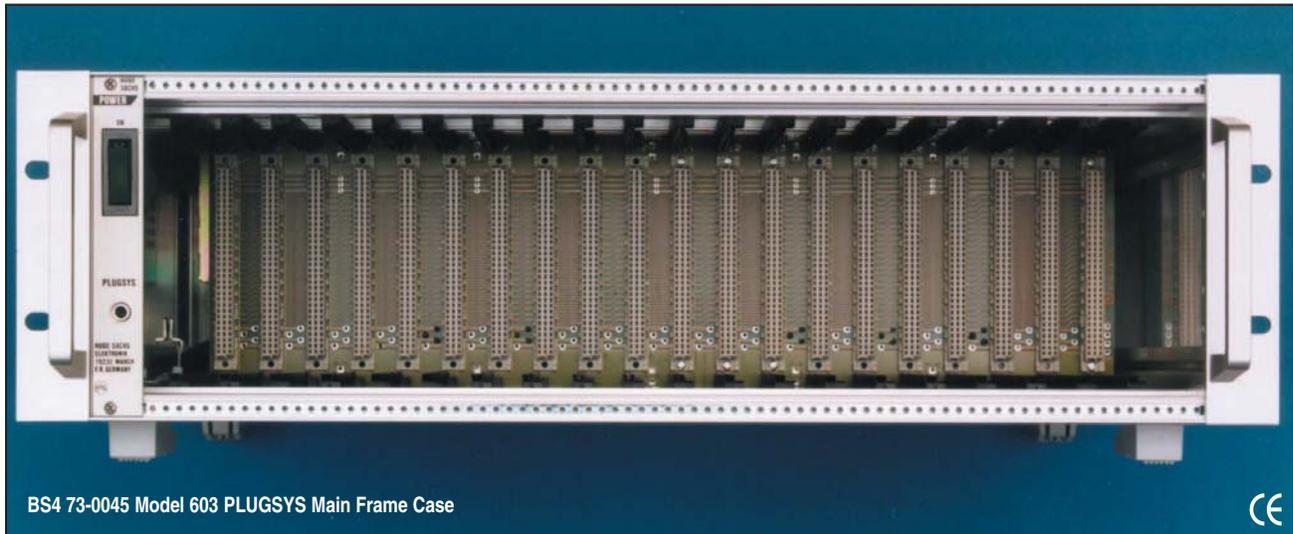
HSE-HA PLUGSYS System Cases and Minicase

The basic system cases with internal system bus are supplied completely wired and ready for use. The different models have either 6, 10 or 20 positions (slot units = SU) which accept the PLUGSYS modules. A MiniCase is also available that has 4 slot units and with an optional Case Extension that increases the number to 6 slot units.

The Type 601 cases provides a total space of 10 slot units. The Type 603 cases provides a total space of 20 slot units. The width of the function PLUGSYS modules equals either one or a multiple of it slot units. For instance, the width of the CFBA Bridge Amplifier is equal to two slot units, therefore it would occupy 2 slot spaces in the PLUGSYS case. The maximum number of PLUGSYS modules — such as a Bridge Amplifier, Differentiator, Integrator, or Heart Rate Module — which can be plugged into a unit system case depends on the number of slot units required by each module.

The MiniCase housing is a low-cost and space-saving alternative for 1 or 2 modules and allows PLUGSYS modules to be used as conventional stand-alone units. Unlike the PLUGSYS housings Type 601 and 603, the MiniCase has no system bus for power supply or signal link between the individual modules. For this reason, the MiniCase systems are supplied custom wired and configured to suit your requirements. The MiniCase is only suitable for use with certain modules or module combinations. Please contact Harvard Apparatus for more information.

HSE-HA PLUGSYS Modular Measuring and Control System



PLUGSYS Bus

Each of the PLUGSYS Mainframe cases has a series of multifunction connectors into which PLUGSYS modules are inserted. The connector pins interface with the PLUGSYS bus. The PLUGSYS bus provides the power for the PLUGSYS modules and is further subdivided into:

- A 16-line analog bus (AV1 to AV16)
- A 4-line trigger bus (TR1 to TR4)
- An 8-bit digital bus

Analog Bus

Each PLUGSYS module which produces an analog signal is assigned its own analog channel (AV1- AV16) using jumpers on the module PC board. Some modules use as their input analog signals from other modules (e.g. Differentiator module, Heart Rate module, etc.). Using jumpers on the PLUGSYS module, the input signals can be easily assigned to an AV channel without the use of cables. The following is an example of a setup which uses analog input and output signals:

- The PLUGSYS bridge amplifier module TAM-A is used to amplify and condition a left ventricular pressure signal. The TAM-A analog output is assigned by jumpers to line AV1.
- The PLUGSYS Differentiator module is used to derive dp/dt from the LVP Signal. The input is linked to the LVP signal on line AV1. The output is linked to line AV2.
- A PLUGSYS Heart Rate module is used to calculate heart rate from the LVP signal on line AV1. The input for the LVP signal is assigned to AV1 and the output for heart rate signal is assigned to line AV3, using jumpers on the Heart Rate module.

Each analog signal produced by a PLUGSYS module can be picked up from the BNC socket on the front of the module. There are two ways to acquire signals which minimize the potential for cable clutter. The first uses the BS4 73-0161 Data Acquisition Hardware, PLUGSYS Version, see page I80, along with HSE-HA* data acquisition software. The second method used to acquire data from any other data acquisition system or strip chart recorder, picks up the analog signals using the BS4 73-1684 Recording Output Standard Set, see page I51.

Trigger Bus

The trigger bus is used by some PLUGSYS modules for outgoing and incoming trigger signals (e.g. synchronization signals between master and slave modules (see example below). Jumpers on the PLUGSYS modules are used to assign trigger lines, similar to assigning analog lines. External (user) access to the trigger bus is provided by the BS4 73-1633 ROM-T PLUGSYS, see page I52. The following are examples of setups which use trigger signals:

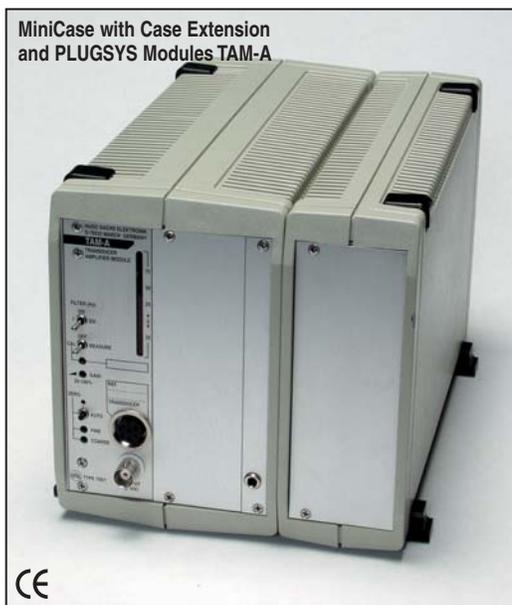
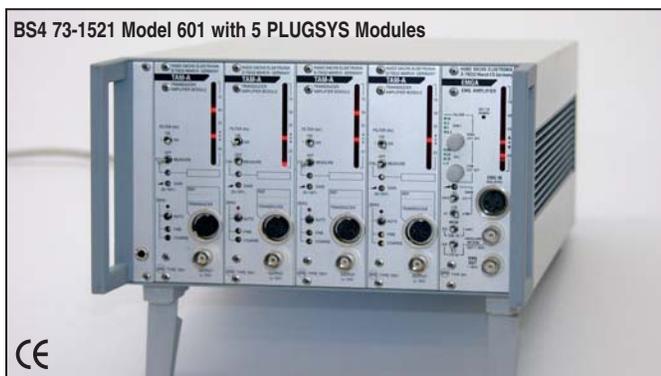
Setup for Isolated Perfused Lung, see page K6.

- The BS4 73-0021 PLUGSYS Programmable Stimulator Module PSM, see page I58, is used for electrical stimulation of isolated tissues. If a multiple channel Stimulator using several PSM modules is used, these modules can be synchronized. One module acts as a master module and the other module as the slave. The master module Synchro-Output is assigned to TR-1 and the slave module Synchro-Input is assigned to TR-1.
- The BS4 73-1741 PLUGSYS Ventilation Control Module, see page I55, is used to generate negative ventilation pressure in the thoracic chamber. A sigh breath can be inserted in the respiratory cycle using a BS4 73-1750 Timer Counter Module, see page I55, to trigger the Ventilation Control module. The output from the Timer Counter Module and the 'DEEP INSP.IN' from the Ventilation Control module are both assigned to line TR2. The Timer module is now set to trigger a Ventilation Control module sigh breath.

Digital Bus

The digital bus consists of a proprietary 8 bit parallel data bus and several handshake lines. It is used to control modules such as the BS4 73-0221 Programmable Stimulator, see page I58, or the BS4 73-1748 Plethysmograph Control Unit, see page I56, which requires control from HSE-HA* software. The BS4 73-0161 Data Acquisition Hardware, PLUGSYS Version, see page I80 with the DIM-D option are used to access the digital bus signals.

HSE-HA PLUGSYS System Cases and Minicase

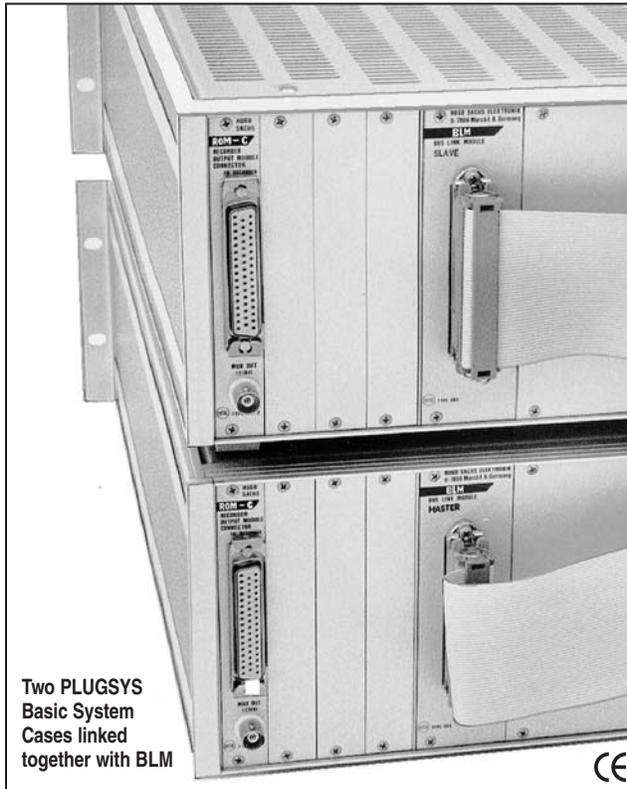


Specifications

	PLUGSYS Case Type 603	PLUGSYS Case Type 601	PLUGSYS MiniCase Type 609
Housing Construction	Metallic housing, gray plastic coated, Universal 19 inch case with pivoting feet, prepared for rack mounting	Metallic housing, gray plastic coated with pivoting feet	ABS plastics, flame-resistant to UL94V0, color RAL 7032 (stone gray), with ventilation slots at sides
Dimensions, H x W x D	132 x 483 x 435mm (5.2 x 19 x 17.1 in)	150 x 235 x 420mm (5.9 x 9.25 x 16.5 in)	160 x 160 x 250mm (6.3 x 6.3 x 9.8 in); Option 01 = 206mm (8.1 in)
Weight	6.5 kg (14.3 lbs)	4.8 kg (10.6 lbs) without PLUGSYS modules	1.4 kg (3.1 lbs) approx. without PLUGSYS modules
Power	100 to 240 VAC, 50/60 Hz, built-in line filter, 100 W max. consumption	85 to 264 VAC (40 Watts), output voltage +5 VDC (5 A) and ±12 VDC (0.5 A) for supplying PLUGSYS modules	85 to 264 VAC (40 Watts), output voltage +5 VDC (5 A) and ±12 VDC (0.5 A) for supplying PLUGSYS modules
Accessories	Line Cable, Spare Fuses, Screw driver for fitting Function Modules, Document Folder for Operating Instructions of Function Modules 3 x BNC-BNC Output lines	Line Cable, Screw driver for fitting Function Modules, Document Folder for Operating Instructions of Function Modules 3 x BNC-BNC Output lines	Mains Supply Cable and Operating Instructions 2 x BNC-BNC Output lines (3 if with case extension Option01)
Module Positions	20 slot units max.	10 slot units max.	4 slot units max. without extension case; possible to fit 6 slot units using internal straps, Option 1 case extension
Socket Combination	3-pin IEC mains with fuse and mains switch on back of housing	3-pin IEC mains with fuse and mains switch on back of housing	3-pin IEC mains with fuse and mains switch on back of housing

Catalog No.	\$	Product	Catalog No.	\$	Product
PLUGSYS Case Type 603					
BS4 73-0045		PLUGSYS Case, Type 603	BS4 73-1538		Option 2, Additional Power Supply, additional +24 V (1.6 A) output increases max. consumption to 80 W
BS4 73-1529		Additional Power Supply, Type A	BS4 73-1541		Option 4, 4 BNC Sockets on Rear, for signal inputs or outputs
PLUGSYS Case Type 601					
BS4 73-1521		PLUGSYS Case, Type 601	BS4 73-1542		Option 5, Housing without Power Supply, empty MiniCase housing without power supply and mains input, to take non-electrical PLUGSYS modules, e.g. Pressure Regulator Module PRM Type 671/3; reduces housing width to 105 mm
BS4 73-3103		Option for PLUGSYS Case Type 601, Additional Power Supply +24 Volt (1.6A)	BS4 73-3346		Option 7, 6 BNC Sockets on Rear, for Signal Inputs or Outputs
BS4 73-3082		PLUGSYS Bus Adapter to Mount Backside Modules on the Front			
PLUGSYS Minicase Type 609					
BS4 73-1523		PLUGSYS Minicase, Type 609			
BS4 73-1537		Option 1, Case Extension: Case width extension through internal straps, extra width 2 slot unit case can take front panels up to 6 slot units			

HSE-HA Bus Link Module (BLM)



- To link together 2 PLUGSYS main frame to increase module spaces

The Bus Link Module is used to increase the number of slot units available by linking two PLUGSYS mainframe together. This is necessary if the maximum number of module or the maximum power consumption of one case is exceeded. The resulting combination of two cases works as one unit. The BLM does not increase the maximum number of 16 analog (AV) or digital (DV) connection lines of the PLUGSYS bus system. The BLM itself does not need any slot space, it is installed on the rear of each PLUGSYS case.

A complete BLM connection kit consists of the following:

- 2 BLM Type 680
- 1 Connection Cable
- 1 Mounting Kit
- 1 Operating Instructions

Note: The BLM module can only be installed in the PLUGSYS basic system case, Type 603.

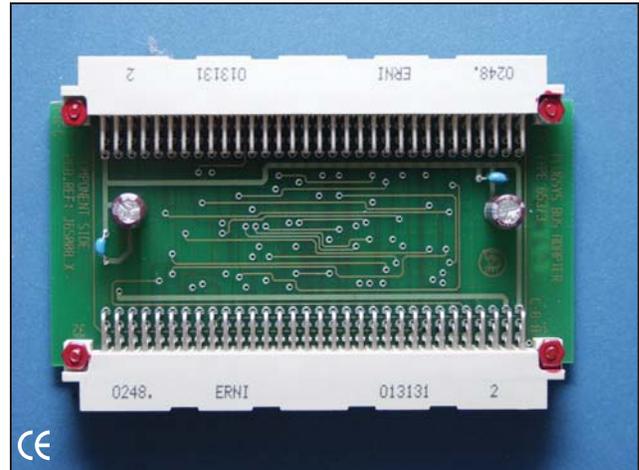
Specifications

Dimensions, H x W Rear Panel Installation Space: 128.7 x 40.5 mm
 PLUGSYS Width* 2 slot units
 Weight 800 g (set of 2 BLM and 1 connecting cable)

** Note: For description of Slot Unit, see page 128.*

Catalog No.	\$	Product
BS4 73-0163		BLM Bus Link Module

HSE-HA PLUGSYS Bus Adapter



- To mount backside modules on the front side of the system case

The PLUGSYS Bus Adapter is used to mount modules that would normally mount on the backside of the PLUGSYS system case, on the frontside. This adapter is especially required for the Type 601 Case (BS4 73-1521) to use the HSE Data Acquisition Hardware for PLUGSYS cases (BS4 73-0161).

Specifications

PLUGSYS Width* 2 slot units

** Note: For description of Slot Unit, see page 128*

Catalog No.	\$	Product
BS4 73-3082		PLUGSYS Bus Adapter

PLUGSYS Modules

HSE-HA PLUGSYS Modules



BS4 73-1602 Carrier Frequency Bridge Amplifier Module CFBA



BS4 73-0149 ECG Amplifier Module ECGA



BS4 73-0146 Transit Time Flowmeter Module TTFM



BS4 73-0210 Oxygen Partial Pressure Module

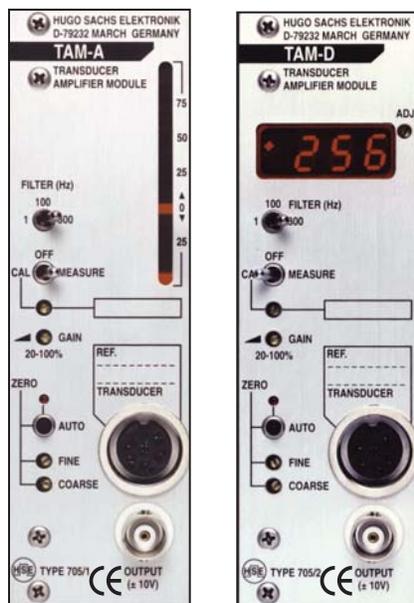
Cat. No.	\$	PLUGSYS Module Description	Page	Cat. No.	\$	PLUGSYS Module Description	Page
Amplifier Case Modification Modules				BS4 73-1587 DIF/S Differentiator Module without Max/Min Storage 149			
BS4 73-0163		BLM Bus Link Module	131	BS4 73-1583		INT Integrator Module	149
BS4 73-3082		Bus Adapter Module	131	Input/Output Modules			
Transducer Amplifiers				BS4 73-0222		EIM External Input Module (Analog Only)	150
BS4 73-0065		TAM-A Analog Transducer Amplifier Module	133	BS4 73-1601		EIM-S Suppression Module for EIM	150
BS4 73-1793		TAM-D Digital Transducer Amplifier Module	133	BS4 73-2823		DIM Data Interface Module	150
BS4 73-0907		CFAB Carrier Frequency Adapter Box	133	BS4 73-0223		DIM-D Digital Bus Link for DIM	150
BS4 73-1602		CFBA Carrier Frequency Bridge Amplifier	134	BS4 73-1683		ROM-DL Recording Output Module - Direct Link	150
Flowmeters				BS4 73-1684		ROM-A Recording Output Module - Adjustable	151
BS4 73-0146		TTFM Transit Time Ultrasonic Flowmeter Module	134	BS4 73-1639		ROM-C Recording Output Module - Connector	151
Biopotential Amplifiers				BS4 73-0166		ROM-SET Recording Output Standard Set	151
BS4 73-0149		ECGA Electrocardiogram ECG Amplifier Module	135	BS4 73-1633		ROM-T Trigger Input/Output Module	152
BS4 73-1753		RWT R-Wave Trigger Module	135	BS4 73-1631		ROM-B 8-Fold BNC Output Module, Signals 1-8	152
BS4 73-1778		EGM Einthoven Golberger Module	136	BS4 73-1632		ROM-B 8-Fold BNC Output Module, Signals 9-16	152
BS4 73-1779		WLA Wilson Lead Amplifier	136	BS4 73-1752		STOM Software Trigger Output Module STOM	152
BS4 73-0153		BPA Biopotential Amplifier Module	137	Controlling Modules			
BS4 73-1780		MAPM 6 Channel Monophasic Action Potential Module	137	BS4 73-1597		ODM Output Driver Module	153
BS4 73-3080		MAPM 3 Channel Monophasic Action Potential Module	137	BS4 73-2806		SCP Servo Controller for Perfusion	153
BS4 73-1773		MEA Microelectrode Amplifier Module	142	BS4 73-0195		PRM Pressure Regulator Module	154
BS4 73-2665		Headstage PreAmplifier	142	BS4 73-1647		GSM Gas Select Module	154
BS4 73-1766		EMGA Electromyogram EMG Amplifier Module	143	BS4 73-1741		VCM-P Ventilation Control Module using Integral Pump	155
BS4 73-1770		EEGA Electroencephalogram EEG Amplifier Module	143	BS4 73-2795		VCM-R Ventilation Control Module using Pressure Regulated Gas Source	155
BS4 73-1743		PHDA Peak Height Detector Amplifier Module	144	BS4 73-1750		TCM Timer Counter Module	155
BS4 73-1792		TCAM Thermocouple Amplifier Module	145	BS4 73-1748		PCU-1 Plethysmograph Control Unit Module	156
Amperometric and Electrometer Amplifiers				BS4 73-1749		PCU-2/4 Plethysmograph Control Unit Module	156
BS4 73-0215		pHMM pH Measurement Module	146	BS4 73-1754		PCU-3 Plethysmograph Control Unit Module	156
BS4 73-1776		pHCM pH Control Module	146	BS4 73-0046		VSM Ventilator Sequencer Module	157
BS4 73-0210		OPPM Oxygen Partial Pressure Module	147	BS4 73-0221		PSM Programmable Stimulator Module	158
BS4 73-0212		EMM Electrometer Module	147	BS4 73-3097		PPG Programmable Pulse Generator Module	158
Calculating Modules				Stand Alone Amplifiers			
BS4 73-0165		HRM Heart Rate and ECG Amplifier Module	148	BS4 73-0748		BRL-100 Laser Doppler Flowmeter	159
BS4 73-1747		RRM Respiration Rate Module	148				
BS4 73-0164		DIF Differentiator Module	149				

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11,000 Specialty Products to Enhance Your Bioresearch

PLUGSYS Transducer Amplifiers

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



The Transducer Amplifier Module is a DC amplifier with bridge. It is used to amplify physiological signals like blood pressure, contraction force and contraction displacement using transducers based on a resistive Wheatstone bridge. Transducers with a built-in pre-amplifier which have a high level DC output voltage can also be connected. Choose from two: TAM-A (analog) & TAM-D (digital)

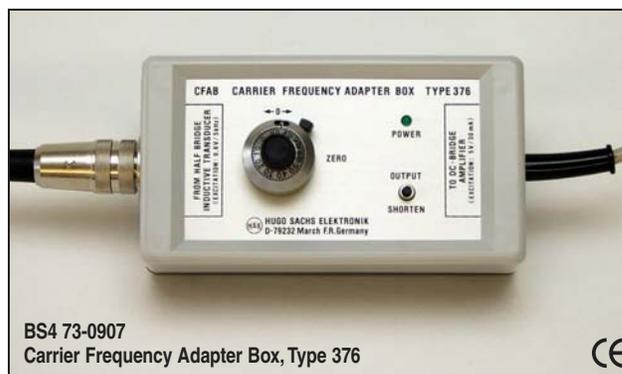
(display). The TAM-A is equipped with an analog LED bar graph signal indicator and is best suited for applications which require the monitoring of dynamic signals, e.g. blood pressure. The TAM-D has a digital numeric display and is best suited for applications with slowly changing signals, e.g. isometric or isotonic contractions, intracranial pressure or venous blood pressure.

Specifications

Bridge Supply Voltage	+5V / 50 mA max.
Transducer Input	6-pin socket with screw lock (binder, Amphenol Tuchel) Differential input circuit, input impedance $10^6 \Omega$
Gain	Selectable Ranges by Internal Jumper: 0.2 to 10, 0.4 to 20, 1 to 50, 2 to 100, 4 to 200, 10 to 500, 20 to 1000, 100 to 5000, 200 to 10000. Fine Adjustment Through 10-Turn Trimmer
Bridge Balance	Through 10-turn trimmer coarse adjustment and electronic autozero by push button (LED for error if autozero is not possible)
Signal Output	a) On front panel through BNC socket ± 10 V pulsatile filtered or mean signal output internally selectable b) Through bus connector to PLUGSYS measuring system through links ± 10 V pulsatile filtered and mean signal voltage
Output Low-Pass Filter	a) Selectable by switch on front panel for pulsatile output signal: 1, 100, 300 Hz b) Selectable by internal jumper for mean output signal: 0.1, 0.3 Hz
Analog Indication	TAM-A LED bar graph 20 LEDs (+13/-7) for visual check on the signal sensitivity approx. 1 V/LED TAM-D 3 1/2-digit LED display
Electrical Calibration	Selectable by switch on front panel: a) 0 V output signal with switch in position '0' b) Positive or negative calibration output voltage adjustable with 10-turn trimmer if switch is in position 'CAL'
Power Supply	+5 V through connector from PLUGSYS bus system
PLUGSYS Width	2 slot units

Catalog No.	\$	Product
BS4 73-0065		Transducer Amplifier Module TAM-A
BS4 73-1793		Transducer Amplifier Module TAM-D

Carrier Frequency Adapter Box, Type 376 (CFAB)



- Sine wave carrier demodulator for bridge amplifiers
- Provides a carrier frequency excitation for inductive or capacitive transducers
- Interfaces differential pressure transducers to various amplifiers

The Type 376 carrier frequency adapter box (CFAB) allows the interconnection of an inductive or capacitive transducer (half bridge system) to a DC-bridge amplifier. This adapter box can be used with most differential pressure transducers, see page F42, and with the HSE-HA lung weight transducer. A DC bridge amplifier supplies power, through a 5 volt excitation

voltage to the adapter box which in turn supplies a 0.6 volt, 5 kHz sine wave excitation signal to the transducer. The transducer signal voltage is demodulated and passed through the adapter box to the DC bridge amp. It is available with connectors for one of five different amplifiers including both PLUGSYS TAM modules, see left column.

Specifications

Power Supply	From Preamp Excitation, 5V/ 30 mA
Transducer Excitation Voltage	0.6 V, 5 kHz
Input Voltage From Transducer	0 to 50 mV
Input Resistance	40 Ω
Gain	1-fold
Thermal Zero Shift	< 0.01 mV/ $^{\circ}$ K
Thermal Gain Shift	< 0.01 %/ $^{\circ}$ K
Output Resistance	300 Ω
Frequency Range	0 to 200 Hz, $\pm 5\%$
Dimensions, H x W x D	40 x 120 x 65 mm (1.6 x 4.7 x 2.6 in)
Cable Length	1.8 m (5.9 ft)
Weight	0.2 kg (7 oz)

Catalog No.	\$	Product
BS4 73-0907		CFAB for PLUGSYS Amplifier
BS4 73-2701		CFAB for Harvard Apparatus Transducer Amplifier
BS4 73-2702		CFAB for Grass Amplifier, 6 pin Cannon Connector
BS4 73-2703		CFAB for Gould Series 6600 Amplifier, 14 pin Connector
BS4 73-2704		CFAB for Gould Series 4600 Amplifier, 12 pin Deutsch Connector

PLUGSYS Transducer Amplifiers

Carrier Frequency Bridge Amplifier Module (CFBA)



The HSE-HA Carrier Frequency Bridge Amplifier (CFBA) (5 kHz) is a plug-in module for the PLUGSYS system. Together with a suitable transducer it is designed for the electrical measurement of mechanical variables such as force, pressure, displacement, acceleration, etc. In multiple transducer applications, it is important that the carrier oscillators of the CFBA can be synchronized to eliminate interference. The CFBA is specially designed for transducers with AC excitation voltage like differential pressure transducers.

Specifications

Bridge Supply Voltage	AC excitation voltage (5 kHz sine wave) internal adj. from 3 - 5 V
Synchronization	Switch selectable master or slave (internal)
Input Voltage Range	140 mVrms (internal gain setting x10), 14 mVrms (internal gain setting x100)
Gain:	0 to 100, 0 to 1000 or 0 to 10,000, depending on various internal and external gain settings
Internal	Switch selectable x10 / x100
External	Switch selectable x1 / x10 and continuously adjustable through 10 turn trimmer from 0 to 100%
Band Width	0 to 1 kHz
Output Low-Pass Filter	11 positions 0.01 Hz to 1 kHz selected by rotary switch
Signal Input	6-pin socket with screw lock (binder, Amphenol-Tuchel)
Signal Output	1. front panel BNC socket ± 10 V (filtered output signal) 2. Through bus connector to PLUGSYS measuring system (jumper selectable) both filtered and unfiltered output signal in range of ± 10 V
Analog Indication	Through LED bar graph + 20 LED's / - 9 LED's for visual check on the measurement; sensitivity can be selected between 500 mV / LED and 50 mV / LED
Electrical Calibration 1	CAL 1 adjustable through 10-turn trimmer, negative and positive calibration voltage; calibration signal is superimposed on measurement signal by pressing CAL 1 key
Electrical Calibration 2	CAL 2 selected internally through link plugs 1. Positive calibration voltage 2. Negative calibration voltage 3. External calibration voltage from PLUGSYS measuring system Amplitude of calibration voltage is adjustable with 10-turn trimmer; calibration voltage is applied on pressing CAL 2 key; during this time measuring signal is switched off
Suppression SUP	Adjustable with 10 turn trimmer, negative and positive values; suppression can be switched on and off with switch
Signal Output MUX	After pressing MUX (MULTIPLEX) key filtered signal output of amplifier is switched for example to input of digital voltage meter module for accurate zero adjustment and calibration setting; function is self-maintained and module previously selected is switched off
Power Supply	+5 V, 1.1 A through main connector from PLUGSYS bus system
PLUGSYS Width	2 slot units
Connector	DIN 41612, 96-pin VG

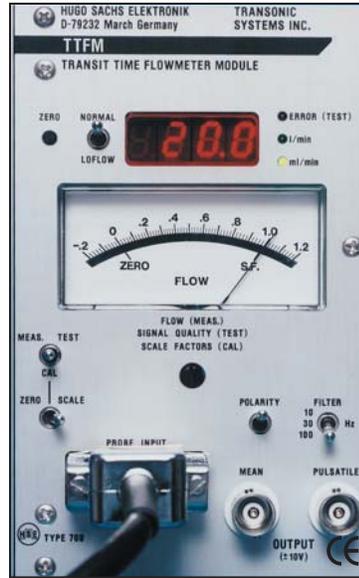
Catalog No. \$ Product

BS4 73-1602 Carrier Frequency Bridge Amplifier Module CFBA

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11,000 Specialty Products to Enhance Your Bioresearch

Transonic Transit Time Flowmeter Module (TTFM)



The Transit Time Flowmeter (TTFM) is an ultrasonic Transit Time flowmeter for animal research. It incorporates a complete 1-channel Transonic® ultrasonic transit time flowmeter. It can be used either with in-line flow probes or perivascular probes from Transonic®, see page J7.

An extensive selection of probes for vessel diameters from 0.25 to 36 mm are available for chronic and acute studies. The extracorporeal in-line-probes, ideal for isolated organ preparations, are

available in sizes from 0.5 to 22.2 mm. The module features a built-in digital display for direct reading of mean flow and an analog instrument to show flow, signal quality and scale factors. The TTFM has mean and pulsatile outputs for recording, both can be used simultaneously.

Specifications

Digital Display	Shows average flow rate in ml/min or l/min
Analog Display	For monitoring analog flow, quality of ultrasound signal and scale factors; analog display also shows flow signal in MEAS. mode, signal quality in TEST mode and scale factors in CAL mode
Normal/Loflow	Loflow scale selection for increased sensitivity (x4) on low flows
Zero Flow	Automatic zero adjustment by pressing button
MEAS/CAL/TEST	Switch to select three modes: Measure/Calibration/Test
Zero/Scale	Delivers 0 flow and scale flow signal at output for calibrating connected recorder or data acquisition systems; scale factor depends on connected probe
Flow Direction	Can be inverted by switch polarity in case flow probe mounted in wrong direction
Low-Pass Filter	Three filter positions (100/30/10 Hz) for smoothing pulsatile output; 0.1 Hz fixed for mean output
Signal Output	1. On front panel through BNC sockets ± 10 Volt FS, pulsatile and mean 2. Through bus connector to PLUGSYS measuring system (jumper selectable) ± 10 V FS, pulsatile and mean
Synchronization	For applications with two or more TTFM modules, synchronization output or input can be connected on PLUGSYS bus; selector on unit selects master or slave mode
Power Supply	5 V 0.6 A through connector from PLUGSYS bus system
PLUGSYS Width	4 slot units
Connector	DIN 41612, 96-pin VG

Catalog No. \$ Product

BS4 73-0146 Transit Time Flowmeter Module TTFM

TTFM flowmeter cannot be purchased as a stand alone flowmeter. Please call for details.

Electrocardiogram (ECG) Amplifier Module (ECGA)



This module amplifies ECG signals. A floating input circuit is used to avoid hum and grounding problems. A bar graph display permits visualization of the ECG signal. The filters are for heart rates up to 1000 beats per minute. Both outputs can be used for recording on a chart recorder or for data acquisition. A square-wave signal generator with amplitudes of 0.3 mV and 1 mV is incorporated or calibration

Specifications

Input	Floating differential input, isolated barrier internally clamped to 300 V, with protection against static discharges and 10 kHz input filter for h.f. suppression
Input Connector	5-pin binder socket with screw lock; pin connections correspond to those of standard 3-pin ECG input cable
Input Impedance	10 ¹⁰ Ω
Common Mode Rejection	106 dB
Filters:	
Low-Pass Filter	(HIGH CUT OFF) 150 Hz, 120 Hz, 100 Hz, 50 Hz
High-Pass Filter	(LOW CUT OFF) 5 Hz, 1 Hz, 0.5 Hz, 0.1 Hz
Filter Indication	By green LEDs on front panel
Gain Trimmer:	
Switch In Position x0.5	1000 to 5000
Switch In Position x1	2000 to 10000
Switch In Position x2	4000 to 20000
Display	Bar graph 0.75 V/LED
Output	BNC connector on front panel (±10 V); output voltage also available on PLUGSYS bus
Calibration	Square-wave signal generator with amplitudes of 0.3 mV and 1 mV
Recorder Output	Internal output is connected to bus system via jumpers; ECG signal is connected to recorder via Recorder Output Module (ROM); also possible to connect recorder directly to BNC connector 'ECG OUT' at front panel
Quick Start	For rapid discharge of coupling capacitors by pressing QUICK START key
Power Supply	5 V/600 mA, through connector from PLUGSYS bus system
PLUGSYS Width	2 slot units
Connector	DIN 41612, 96-pin VG

Catalog No.	\$	Product
BS4 73-0149		ECG Amplifier Module ECGA

HSE-HA R-Wave Trigger Module (RWT) for ECG Amplifier

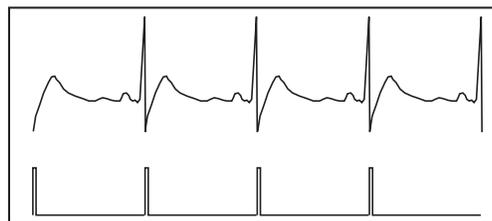


- Module to trigger an external stimulator, data acquisition, oscilloscope on ECG R-Wave

This module is especially designed to trigger (start) a stimulator or any other device with the R-wave of an ECG

signal. The ECG signal has to be measured with the PLUGSYS ECG Amplifier Type 689. The R-wave trigger module is internally connected to the ECG Amplifier and works only together with this amplifier.

The R-wave trigger module can be used (e.g., for synchronized stimulation of the heart) by triggering a delay module of a stimulator. It is possible to set the stimulation pulses delayed from the R-wave into the vulnerable phase to produce ventricular fibrillations. The trigger output of this module must be connected to the trigger input of a stimulator with a BNC cable.



Specifications

Output	BNC connector TRIGGER OUT at front panel open collector TTL signal, pull-up resistor 2.2 kΩ; jumper on board defines whether positive or negative pulses used as trigger pulses
R-Wave Indication	LED and beep to indicate R-wave; loudness of beep can be set with potentiometer
Threshold	Threshold for triggering can be set with potentiometer
Adjustable Blocking Time	Blocking time for trigger signal can be adjusted so that circuit is inactive for fixed time; time can be set with potentiometer 'BLOCKING TIME' in range from 50 msec to 500 msec; LED indicates blocking time
Power Supply	Through ECG Amplifier Type 689
Dimensions, H x W x D	128.7 x 20.2 x 100 mm (5.1 x 0.8 x 3.9 in)
PLUGSYS Width*	1 slot unit
Weight	0.2 kg (0.4 lbs)
Accessories	BNC output cable, operating instructions

* For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-1753		RWT R-Wave Trigger Module for ECGA

PLUGSYS Biopotential Amplifiers

Einthoven Goldberger Module (EGM)



The EGM module is used for capturing and amplifying ECG signals after Einthoven and Goldberger lead configuration in the PLUGSYS system. It connects to 4 electrodes. This module has isolated input amplifiers in order to avoid hum interference.

Inputs Leads:

- RA Right Arm
- LA Left Arm
- LF Left Foot
- RF Right Foot (Reference)

Output Signals: Bipolar Einthoven Extremity Leads:

- I LA(+) - RA(-)
- II LF(-) - RA(-)
- III LF(-) - LA(-)

Unipolar Goldberger Extremity Leads:

- aVR RA(+) - (LA+LF)/2(-)
- aVL LA(+) - (RA+LF)/2(-)
- aVF LF(+) - (RA+LF)/2(-)

The 6 output voltages of the different leads can be switched through jumpers to the PLUGSYS system bus. From the system bus they can be picked off by a Recorder Output Module (ROM) for direct recording or a DAQ Hardware PLUGSYS for data acquisition by computer.

Specifications

ECG Leads	Bipolar extremity leads I, II and III after Einthoven as well as unipolar extremity leads aVR, aVL and aVF after Goldberger
ECG Input	4-way inputs cable must be connected as follows: RA (right arm), LA (left arm), LF (left foot), RF (right foot)
Input Circuit	Isolated input circuit (floating input), isolating volt. 200 V DC max.
Input Impedance	10 ⁷ Ω
Filter:	
Low-Pass Filter	100 Hz, 200 Hz and 500 Hz
High-Pass Filter	0.1 Hz, fixed
Gain	Setting x0.5 - 500; Setting x1 - 1000; Setting x2 - 2000
Calibration	Square-wave signal 1 mV 2 Hz (120/min); calibration signal is activated with switch
Recorder Outputs	Outputs of 6 ECG leads are linked by jumpers to PLUGSYS bus system; link to recorder is provided by Recorder Output module (ROM) installed in PLUGSYS System
Supply	5 V 1.2 mA from PLUGSYS system bus
PLUGSYS Width	2 slot units
Connector	96-pin VG connector to DIN 41612, 8-pin RJ-45
Input Cable	(Order separately) 4-way ECG input cable with needles, or 4-way ECG input cable with banana plugs, or input box with 4 + 6 inputs for simultaneous use of WLA module Type 702 for 6 unipolar Wilson chest leads (V1 to V6)

Catalog No.	\$	Model
BS4 73-1778		Einthoven Goldberger Module EGM
BS4 73-1785		4-lead ECG Input Cable with Needles
BS4 73-1786		4-lead ECG Input Cable with Banana Plugs

Wilson Lead Amplifier Module (WLA)



The WLA module Type 702 is used for capturing and amplifying unipolar ECG chest lead potentials after Wilson lead configuration in the PLUGSYS system. Up to 6 chest electrodes (V1 to V6) can be connected.

IMPORTANT: Correct recording of the Wilson unipolar chest electrode potentials requires the central reference signal (Central Terminal Point, CTP) which is formed from the bipolar extremity leads after Einthoven. Using the WLA therefore requires the EGM module Type 701 which provides the CTP signal. The necessary link between the two modules is provided by the input box.

The WLA module has isolated input amplifiers in order to avoid hum interference. In this way the inputs are isolated electrically from the output circuits and from the housing. The 6 output voltages of the different chest leads can be switched through jumpers to the PLUGSYS system bus. From the system bus

they can be picked off by a ROM module for direct recording or a DAQ Hardware PLUGSYS for data acquisition by computer. A square-wave calibration generator with a 1 mV amplitude is incorporated for calibrating the amplitudes.

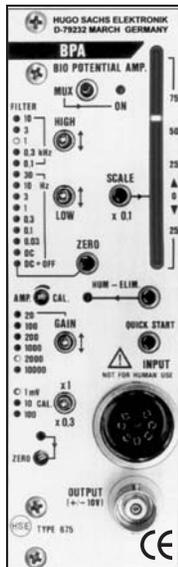
Specifications

Input Leads	V1, V2, V3, V4, V5, V6 and CTP Note: CTP = Central Terminal Point = Ref. Signal (add. output on EGM Module, Type 701)
ECG Leads	6 unipolar chest leads after Wilson; V1 to V6
Input Circuit	Isolated input circuit (floating input), isolating volt. 200 V DC max
Input Impedance	10 ⁷ Ω
Filter:	
Low-Pass Filter	100 Hz, 200 Hz and 500 Hz
High-Pass Filter	0.1 Hz, fixed
Gain	Setting x0.5 - 500; Setting x1 - 1000; Setting x2 - 2000
Calibration	Square-wave signal 1 mV 2 Hz (120/min); calibration signal is activated with switch
Recording Outputs	Output signals of 6 ECG leads are linked by jumpers to PLUGSYS bus system; link to recorder is provided by Recorder Output Module (ROM) installed in PLUGSYS system
Supply	5 V 1.2 mA from PLUGSYS system bus
PLUGSYS Width	2 slot units
Connector	96-pin VG connector to DIN 41612, 8-pin RJ-45
Input Box	(Order separately) Input box with 4 + 6 inputs for simultaneous use of WLA module Type 702, and EGM module Type 701 for 4 bipolar Einthoven extremity leads (I, II, III) and Goldberger unipolar extremity leads (aVR, aVL, aVF) with necessary internal link for CTP. See page I39 for more information.

Catalog No.	\$	Model
BS4 73-1779		Lead Amplifier Module WLA

PLUGSYS Biopotential Amplifiers

Biopotential Amplifier Module (BPA)



The Biopotential Amplifier module (BPA) is used to amplify ECG, EMG, EEG, ENG biopotentials in the PLUGSYS system. It can also be used with strain gauge transducers. The BPA amplifier module is a non-isolated amplifier. It is designed specifically for physiological and pharmacological animal experiments.

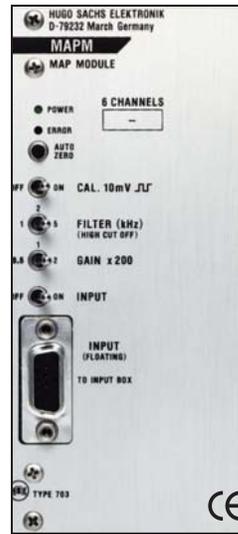
Specifications

Input	Direct for biological signals (ECG, EMG, EEG, ENG) and for strain gauge bridge transducers
Input Impedance	Higher than 100 M Ω
Input Bias Current	30 nA maximum
Input Capacity	1.5 nF
Signal Input	8-pin binder (Amphenol) socket with screw lock
Signal Output	1. Internally through system bus of PLUGSYS measuring system; signal output is assigned to connecting lines AV-1 to AV-16 through jumper 2. On front panel through BNC socket ± 10 V
Analog Indication	Through LED bar graph +13/-7 LEDs for monitoring applied signal; display sensitivity can be changed by key from +10/-5 V to +1/-0.5 V
Transducer Supply	5 V a bridge supply for transducers and supply for headstages
Gain	20x, 100x, 200x, 1000x, 2000x and 10 000x selected by switch, can be varied by multi-turn trimmer within range of 10 to 100% (based on current amplification setting)
Electrical Calibration	CAL automatic calibration steps operated by zero key, for transducer calibration and evaluation of input signal; calibration voltage 0.3, 1, 3, 10, 30, 100 mV is changed automatically to suit amplification setting
Frequency Range	DC to 10 kHz (-3 dB)
High-Pass Filter	12 settings, range 0.03 Hz to 10 kHz (-3 dB)
Low-Pass Filter	10 settings, range DC to 100 Hz (-3 dB)
Filter Indication	Settings of high-pass and low-pass filters are indicated as frequency pass band using LED line on front panel
Notch Filter	(HUM-ELIMINATION) to suppress 50 (60) Hz interference
Quick Start	Rapid discharge of coupling capacitors by pressing key
Auto Zero	Automatic zero adjustment by pressing key
Manual Zero	Manual zero adjustment for correcting high input offset voltages which exceed automatic adjustment range of Auto Zero
PLUGSYS Width	2 slot units
Connector	DIN 41612 96-pin VG (PLUGSYS system bus)
Power Supply	5 V 1.2 A from PLUGSYS system bus

Catalog No. \$ Product

BS4 73-0153	Biopotential Amplifier Module BPA
BS4 73-1643	Input Cable for Electrophysiological Signals
BS4 73-1691	Transducer Adapter Cable for BPA

Monophasic Action Potential Module (MAPM)



The MAP module Type 703 is for capturing and amplifying monophasic action potentials (MAPs) in the PLUGSYS system. It has to be connected to special MAP electrodes. This module incorporates isolated input amplifiers in order to avoid hum interference. In this way the inputs are isolated electrically from the output circuits and from the housing.

The output voltages of the amplified MAP signals can be switched with jumpers to the PLUGSYS system bus. From the system bus they can be picked off by a Recorder Output Module (ROM) for direct recording or a DAQ Hardware PLUGSYS for data acquisition by computer. A square-wave calibration generator with a 10 mV amplitude is incorporated for calibrating the amplitudes.

The output voltages of the amplified MAP signals can be switched with jumpers to the PLUGSYS system bus. From the system bus they can be picked off by a Recorder Output Module (ROM) for direct recording or a DAQ Hardware PLUGSYS for data acquisition by computer. A square-wave calibration generator with a 10 mV amplitude is incorporated for calibrating the amplitudes.

Inputs: A special connection box is required for connecting the MAP electrodes, with separate switch-off facility for the individual channels. The connection box has to be placed close to the electrodes so that the unscreened electrode leads can be kept as short as possible. The box is not part of the module and has to be ordered separately.

Specifications

Amplifier Type	DC amplifier with automatic zeroing, 6 channels
Input Circuit	Differential inputs, isolated (floating input), isolating voltage 200 V DC max.
Input Impedance	When switched on (INPUT ON): 10^{10} Ω When switched off (INPUT OFF): 5000 Ω approx.
Common Mode Rejection	Better than 1 in 50,000 at 50 Hz
Zeroing	Voltage range ± 200 mV referred to particular input resolution: 0.1 mV
Filter	Low-pass filter: 1 kHz, 2 kHz and 5 kHz
Gain	Setting x0.5 - 100; Setting x1 - 200; Setting x2 - 400
Calibration	Square-wave signal 10 mV 2 Hz
Outputs	Output signals of 6 MAP signals are linked by jumpers to PLUGSYS bus system; link to display unit is provided by Recorder Output Module (ROM) installed in PLUGSYS system
Supply	5 V 1.2 mA from PLUGSYS system bus
PLUGSYS Width	3 slot units
Connector	96-pin VG connector to DIN 41612 submin-D 15-HD
Input Box	(Order separately) input box with 6 differential inputs, sockets suitable for 2 mm dia. plug pins, including approx. 2 m connecting cable

Catalog No. \$ Product

BS4 73-1780	Monophasic Action Potential Module MAPM (6-Channel)
BS4 73-3080	Monophasic Action Potential Module MAPM (3-Channel)
BS4 73-1787	Input Box for MAPM Module
BS4 73-1788	Input Box for 2 MAPM Modules
BS4 73-1790	Input Box for EGM, WLA and MAPM Module
BS4 73-1791	Input Box for EGM, WLA and 2 MAPM Modules

PLUGSYS Biopotential Amplifiers

NEW Single Lead ECG Measurements

Lead I, II, or III depending on Electrode Location (RA, LA, RL, LL)

To do a single lead ECG measurement such as Lead I, II, or III, the HSE PLUGSYS amplifier ECGA (BS4 73-0149), BPA (BS4 73-0153) or HRM (BS4 73-0165) with a selection of different types of ECG electrodes and the matching monitoring cables are used.

Single Lead ECG Measurements Lead I, II, or III depending on Electrode Location (RA, LA, RL, LL)					
Type of Electrode	Reusable Electrodes			Disposable Electrodes*	
	28 Gauge Needle	Ag/AgCl Discs Unshielded Shielded		Foam Tabs	Snaps
Catalog No.	BS4 72-5740	BS4 72-3749	BS4 72-3750	BS4 72-7092	BS4 72-7090
Supplied as	Pkg. of 12	Ea.	Ea.	Pkg. of 100	Pkg. of 60
Qty. Required	1 Pkg.	1	2	1 Pkg.	1 Pkg.
Required Adapter	N/A	N/A		Alligator Clip	Pinch Clamp
Catalog No.	-	-		BS4 60-2394	BS4 73-3383
Supplied as	-	-		Pkg. of 10	Ea.
Qty. Required	-	-		1 Pkg.	3
Connection Cable					
Small Animal	BS4 73-0148	BS4 73-3357		N/A	N/A
Large Animal	BS4 73-1643	N/A		BS4 73-1643	BS4 73-1643
Amplifier - Choose only one					
ECGA, ECG Amplifier	BS4 73-0149	BS4 73-0149		BS4 73-0149	BS4 73-0149
BPA, Biopotential Amplifier	BS4 73-0153	BS4 73-0153		BS4 73-0153	BS4 73-0153
HRM, Heart Rate Monitor	BS4 73-0165	BS4 73-0165		BS4 73-0165	BS4 73-0165

* Small animals cables for disposable electrodes are not available. This type of electrode is difficult or impossible to be placed on such species. For Small Animals the total monitoring cable lengths is 2.00 m the ending leads have a length of 30 cm. For Large Animals the total monitoring cable lengths is 2.50 m the ending leads have a length of 75 cm

Catalog No.	\$	Product
Accessories for Reusable Needles		
BS4 72-1872		Needle Cleaning Kit
BS4 72-1875		Cleaning Wires for 28 to 30G Needles, Pkg. of 10
BS4 72-1880		Cleaning Concentrate, 500 ml
Accessories for Reusable Ag/AgCl Disc Electrodes		
BS4 60-1060		Double-Sided Adhesive Disk, 7.2 mm OD, 4 mm ID, Pkg. of 100
Accessories for Disposable Electrodes		
BS4 60-2395		Preparatory Pads (70% Isopropanol), Pkg. of 1000
BS4 50-8309		Electrode Gel Applicator Syringe with blunt needle
BS4 72-7365		Electrode Gel, 4 oz

Specialized Tools for Bioresearch

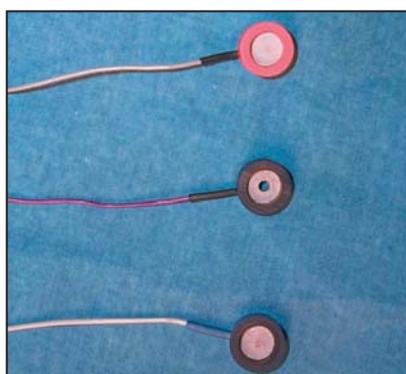
BS4 50-8309 Syringe with Blunt Needle, see page I74



Standard Hypodermic Needles, see page B18



Needle Cleaning Kit, see Pumps Section A



Reusable Ag-AgCl Disc Electrodes, see page I136



BS4 72-7093 Disposable Electrode, see page I73

BS4 72-7094 Disposable Electrode, see page I73



Electrode Accessories, see page I138



Disposable Tab Electrode, see page I73

PLUGSYS Biopotential Amplifiers

NEW Six Lead ECG Measurements

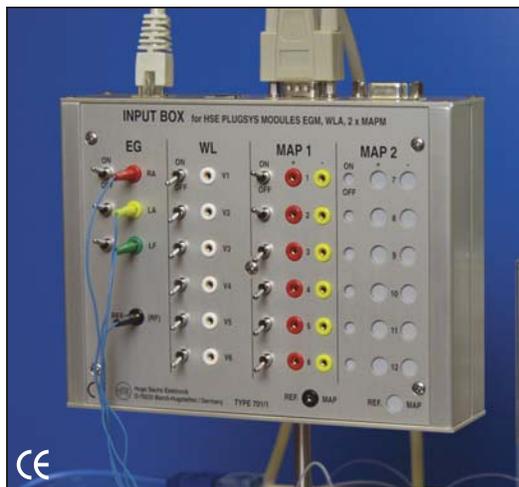
Einthoven Leads I, II, III, aVI, aVr, and aVf

To do all the Einthoven leads, the HSE PLUGSYS amplifier EGM (BS4 73-1778) with a selection of different types of ECG electrodes and the matching monitoring cable is used. As an alternative to the monitoring cable, an input box can be used. The advantage of the input box is that it can be mounted close to the animal; this reduces cable movement and allows short connections.

Six Lead ECG Measurements – Einthoven Leads I, II, aVI, aVr, and aVf					
Type of Electrode	Reusable Electrodes			Disposable Electrodes*	
	28 Gauge Needle	Ag/AgCl Discs Unshielded Shielded		FoamTabs	Snaps
Catalog No.	BS4 72-5740	BS4 72-3749	BS4 72-3750	BS4 72-7092	BS4 72-7090
Supplied as	Pkg. of 12	Ea.	Ea.	Pkg. of 100	Pkg. of 60
Qty. Required	1 Pkg.	1	3	1 Pkg.	1 Pkg.
Required Adapter	N/A	N/A		Alligator Clip	Pinch Clamp
Catalog No.	–	–		BS4 60-2394	BS4 73-3383
Supplied as	–	–		Pkg. of 10	Ea.
Qty. Required	–	–		1 Pkg.	4
Direct Connection Cable to Amplifier					
Small Animal	BS4 73-1786	BS4 73-3331		N/A	N/A
Large Animal	BS4 73-3381	N/A		BS4 73-3381	BS4 73-3381
Cable to Input Box-Alternative to Direct Connection Cable					
6-Lead ECG Only Input Box	BS4 73-1777	BS4 73-1777		BS4 73-1777	BS4 73-1777
Cable to Input Box	BS4 73-3334	BS4 73-3333		BS4 73-3334	BS4 73-3334
Amplifier					
For Einthoven Leads	BS4 73-1778	BS4 73-1778		BS4 73-1778	BS4 73-1778

* Small animals cables for disposable electrodes are not available. This type of electrode is difficult or impossible to be placed on such species.
For Small Animals the total monitoring cable lengths is 2.00 m the ending leads have a length of 30 cm.
For Large Animals the total monitoring cable lengths is 2.50 m the ending leads have a length of 75 cm

Multi-Lead ECG and MAP Using Input Box



BS4 73-1790 Input Box Type 701/3 Signal Input for 12-Lead ECG and 6 Channels of MAP

Choose the Input Box that fits current and future maximum number of signals (Leads) for ECG and Monophasic Action Potential (MAP).

NOTE: Input Boxes are NOT upgradeable.

Catalog No.	\$	Model
BS4 73-1777		Input Box Type 701/4 for up to 6-Lead (4-Wire) ECG only. Includes connection cable to EGM module
BS4 73-1789		Input Box Type 701/2 for up to 12-Lead (10-Wire) ECG only. Includes connection cables to EGM and WLA modules
BS4 73-1787		Input Box Type 703/1 for up to 6 Channels of MAP only. Includes connection cable to MAPM module
BS4 73-1788		Input Box Type 703/1 for up to 12 Channels of MAP only. Includes connection cables to MAPM modules
BS4 73-1790		Input Box Type 701/3 for up to 12-Lead ECG and up to 6 Channels of MAP. Includes connection cables to EGM, WLA, and MAPM modules
BS4 73-1791		Input Box Type 701/1 for up to 12-Lead ECG and up to 12 Channels of MAP. Includes connection cables to EGM, WLA, and MAPM modules

PLUGSYS Biopotential Amplifiers

NEW Twelve Lead ECG Measurements

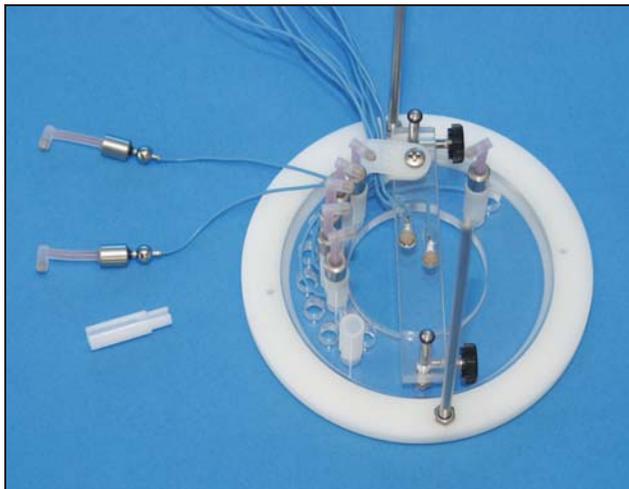
Einthoven Leads I, II, III, aVI, aVr, aVf and Wilson Chest Leads V1-V6

To do the Einthoven and the Wilson leads, the HSE PLUGSYS amplifier EGM (BS4 73-1778) and WLA (BS4 73-1779) with a selection of different types of ECG electrodes are used. The electrodes are connected to the amplifier via an input box. Different input boxes are available depending on the overall configuration (i.e., including MAP measurements or not).

Twelve Lead ECG Measurements Einthoven Leads I, II, III, aVI, aVr, aVf and Wilson Leads V1-V6					
Type of Electrode	Reusable Electrodes			Disposable Electrodes*	
	28 Gauge Needle	Ag/AgCl Discs Unshielded Shielded		FoamTabs	Snaps
Catalog No.	BS4 72-5740	BS4 72-3749	BS4 72-3750	BS4 72-7292	BS4 72-7090
Supplied as	Pkg. of 12	Ea.	Ea.	Pkg. of 100	Pkg. of 60
Qty. Required	1 Pkg.	1	9	1 Pkg.	1 Pkg.
Required Adapter	N/A	N/A		Alligator Clip	Pinch Clamp
Catalog No.	-	-	-	BS4 60-2394	BS4 73-3383
Supplied as	-	-	-	Pkg. of 10	Ea.
Qty. Required	-	-	-	1 Pkg.	10
Connection Cable					
For Einthoven Leads	BS4 73-3334	BS4 73-3333	BS4 73-3334	BS4 73-3334	BS4 73-3334
For Wilson Leads	BS4 73-3359	BS4 73-3360	BS4 73-3359	BS4 73-3359	BS4 73-3359
Amplifier					
For Einthoven Leads	BS4 73-1778	BS4 73-1778	BS4 73-1778	BS4 73-1778	BS4 73-1778
For Wilson Leads	BS4 73-1779	BS4 73-1779	BS4 73-1779	BS4 73-1779	BS4 73-1779
Input Box - Choose only one					
12-Lead ECG Only	BS4 73-1789	BS4 73-1789	BS4 73-1789	BS4 73-1789	BS4 73-1789
12-Lead ECG & 6 MAP	BS4 73-1790	BS4 73-1790	BS4 73-1790	BS4 73-1790	BS4 73-1790
12-Lead ECG & 12 MAP	BS4 73-1791	BS4 73-1791	BS4 73-1791	BS4 73-1791	BS4 73-1791

* Small animals cables for disposable electrodes are not available. This type of electrode is difficult or impossible to be placed on such species.
For Small Animals the total monitoring cable lengths is 2.00 m the ending leads have a length of 30 cm.
For Large Animals the total monitoring cable lengths is 2.50 m the ending leads have a length of 75 cm

NEW Multi-Lead ECG Recording for Isolated Heart



Mini ECG electrodes are mounted on an insert. The insert has been designed for multi-lead ECG recording on large hearts like Rabbit, it has all the features to be mounted on the IH-5, see page K4. The electrodes can individually be adjusted to be as near as possible to the heart surface. Depending on the number of electrodes installed it is possible to mimic an "EINTHOVEN" derivation as well as "WILSON" V1-V6 unipolar leads. The electrodes are connected to the input box of the EGM and WLA PLUGSYS amplifier.

Catalog No.	\$	Model
BS4 73-0550		ECG Electrode Insert for 12-Lead ECG
BS4 73-0200		Monopolar ECG Electrode for Isolated Heart

Catalog No. \$ Product

Accessories for Reusable Needles

BS4 72-1872		Needle Cleaning Kit
BS4 72-1875		Cleaning Wires for 28 to 30G Needles, Pkg. of 10
BS4 72-1880		Cleaning Concentrate, 500 ml

Accessories for Reusable Ag/AgCl Disc Electrodes

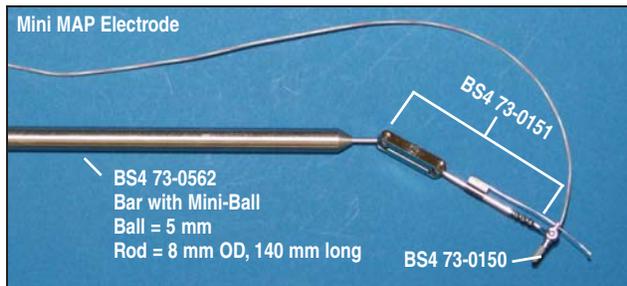
BS4 60-1060		Double-Sided Adhesive Disk, 7.2 mm OD, 4 mm ID, Pkg. of 100
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Accessories for Disposable Electrodes

BS4 60-2395		Preparatory Pads (70% Isopropanol), Pkg. of 1000
BS4 50-8309		Electrode Gel Applicator Syringe with blunt needle
BS4 72-7365		Electrode Gel, 4 oz

PLUGSYS Biopotential Amplifiers

NEW Monophasic Action Potential (MAP) Measurements



The technique used for the measurement of Monophasic Action Potentials was described by the founder of this technique Prof. Franz (Washington DC). The technique generates no injury on the heart.

The electrodes are available in two versions as “Cane type” and as “Mini type”. By using special holders they can be mounted on laboratory stands and placed close to the animal for in-vivo applications. They can also be used in conjunction with isolated hearts. For the HSE-HA isolated heart systems, specific holders are used. These are not described on these pages, see on page K23 for more information.

For multiple MAP measurements, input boxes are required. The box is chosen depending on the number of MAP wanted and if ECG measurement is also required. For input box options, see page I39.

Single Channel Monophasic Action Potential (MAP) Measurements

	Cane Version	Mini Version
Surface Connection	BS4 73-2910 (sponges)	BS4 73-2910 (sponges)
Electrode	BS4 73-0409	BS4 73-0150
Electrode Holder	BS4 73-3015	BS4 73-0562, BS4 73-0564, BS4 73-0151
Connection Cable	BS4 73-0152	BS4 73-0152
Amplifier	BS4 73-0153	BS4 73-0153
Stand		
Lab Stand	BS4 73-0499, BS4 53-2012W	BS4 73-0499, BS4 53-2012W
Micromanipulator Left H.	BS4 64-0055, BS4 73-0566, BS4 53-2012W	BS4 64-0055, BS4 73-0566, BS4 53-2012W
Micromanipulator Right H.	BS4 64-0056, BS4 73-0566, BS4 53-2012W	BS4 64-0056, BS4 73-0566, BS4 53-2012W

Multiple Channel Monophasic Action Potential (MAP) Measurements

	Cane Version	Mini Version
Surface Connection	BS4 73-2910 (sponges)	BS4 73-2910 (sponges)
Electrode	BS4 73-0409	BS4 73-0150
Quantity Needed	1-12	1-12
Electrode Holder	BS4 73-3015	BS4 73-0562, BS4 73-0564, BS4 73-0151
Quantity Needed	1-12	1-12
Stand		
Lab Stand	BS4 73-0499, BS4 53-2012W	BS4 73-0499, BS4 53-2012W
Quantity Needed	1-12	1-12
Micromanipulator Left H.	BS4 64-0055, BS4 73-0566, BS4 53-2012W	BS4 64-0055, BS4 73-0566, BS4 53-2012W
Quantity Needed	1-12	1-12
Micromanipulator Right H.	BS4 64-0056, BS4 73-0566, BS4 53-2012W	BS4 64-0056, BS4 73-0566, BS4 53-2012W
Quantity Needed	1-12	1-12
Input Box & Amplifier - Choose only one		
1-3 Channel MAP Only	BS4 73-1787, BS4 73-3080	BS4 73-1787, BS4 73-3080
4-6 Channel MAP Only	BS4 73-1787, BS4 73-1780	BS4 73-1787, BS4 73-1780
7-12 Channel MAP Only	BS4 73-1788, 2 x BS4 73-1780	BS4 73-1788, 2 x BS4 73-1780
12-Lead ECG & 1-3 MAP	BS4 73-1790, BS4 73-3080, (BS4 73-1778, BS4 73-1779)	BS4 73-1790, BS4 73-3080, (BS4 73-1778, BS4 73-1779)
12-Lead ECG & 4-6 MAP	BS4 73-1790, BS4 73-1780, (BS4 73-1778, BS4 73-1779)	BS4 73-1790, BS4 73-1780, (BS4 73-1778, BS4 73-1779)
12-Lead ECG & 7-12 MAP	BS4 73-1791, 2 x BS4 73-1780, (BS4 73-1778, BS4 73-1779)	BS4 73-1791, 2 x BS4 73-1780, (BS4 73-1778, BS4 73-1779)

PLUGSYS Biopotential Amplifiers

Microelectrode Amplifier Module (MEA)



The PLUGSYS module MEA is a universal single-channel, easily operated microelectrode amplifier for physiological and pharmacological research. With the aid of the separate preamplifier (headstage) it permits direct measurement of intracellular or extracellular potentials. The compact PLUGSYS module incorporates extensive technology and offers, in addition to its excellent amplifier performance, also all modern extra facilities such as adjustable output filter, calibration generator, audio monitor and LED bar graph for audible and visual signal monitoring, microelectrode function test (resistance measurement), adjustable buzz frequency, capacity compensation and zero balance. Optionally the MEA can be provided with special headstages.

HSE-HA Headstage Preamplifier



- Headstage for intracellular potential recording using the MEA module
- High input impedance 1 GΩ

Important Note for Ordering:

The Headstage Type 695-1G can only be used in conjunction with the BS4 73-1773 HSE-HA Microelectrode Amplifier MEA, see to left.

Specifications

Input	Through separate preamplifier (headstage) for direct intracellular or extracellular potential recording
Input Socket	8-pin binder or Amphenol-Tuchel socket with screw lock
Input Capacity Compensation	Continuously adjustable between 0 and 8 pF
Signal Output Internally	Filtered output signal ± 10 V corresponding to ± 1 V input signal (gain 10x) On PLUGSYS system bus, assigned via jumper to one of signal lines AV-1 to AV-16.
Externally	By BNC socket on front panel
Amplifier Bandwidth	DC to 30 kHz (-3dB)
Output Filter	Low-pass in 7 steps covering 30 Hz to 30 kHz (-3dB)
Gain	10x (fixed)
Zero Balance	Compensation of input offset in range ± 400 mV
Buzzer	AC feed through microelectrode to assist piercing cell membrane during microelectrode insertion; buzz frequency adjustable with 16-position switch between 10 Hz and 10 kHz to suit actual requirements
Calibration Signal	Generator for signal adjustment to computing amplifier or recorder; pressing CAL key injects complex calibration signal consisting of values 0 V, -100 mV and ± 50 mV referred to input
Analogue Indication	LED bar graph with 30 LEDs for visual monitoring of applied signal (7.5 mV per LED referred to input) For accurate zeroing bar graph range can be expanded by key (magnifier function) to 1.5 mV per LED referred to input
Audio Monitor	Audible monitoring system for measurement signal using monitoring tone whose frequency is modulated according to signal amplitude; loudness and base frequency are individually adjustable by trimmer on front panel
Microelectrode Function Test	Check of microelectrode by feeding in (via the headstage) constant current for approximate measurement of instantaneous electrode resistance; since measurement current may damage microelectrode by electrolysis, test duration automatically limited to 2 secs.
Supply	5 V 1.2 A from PLUGSYS system bus
PLUGSYS Width	3 slot units

Catalog No.	\$	Product
BS4 73-1773		MEA Microelectrode Amplifier Module, including Headstage BS4 73-2665

Specifications

Construction	Screened metal case with microelectrode holder integral and mounting rod, 2 mm socket for bath reference and screen connection for central ground; headstage is independent of MEA amplifier used and does not require adjustment
Mounting	By 8 mm dia. support rod and integral microelectrode holder suitable for mounting of conventional micromanipulators as replacement against standard microelectrode holder
Microelectrode Resistance	Suitable for microelectrodes in range of 1 to 100 MΩ
Input Circuit	Fully integrated electrometer amplifier with driven screen, boot-strapped supply and capacity compensation
Input Current	Compensated to zero
Coupling Resistor	1 GΩ
Capacity Compensation	Adjustable over 0 to 8 pF
Frequency Range	DC to 75 kHz (-3dB)
Supply	From MEA Microelectrode Amplifier Type 695
Connecting Cable	Signal and supply cable 1.95 m long with 8-pin binder or Amphenol-Tuchel plug to suit MEA microelectrode amplifier

Catalog No.	\$	Product
BS4 73-2665		Headstage Preamplifier

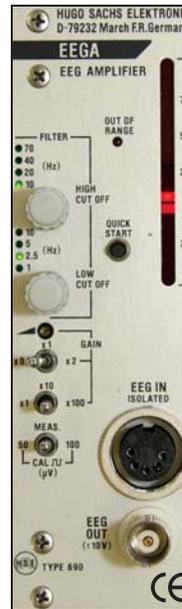
PLUGSYS Biopotential Amplifiers

Electromyogram (EMG) Amplifier Module (EMGA)



This module is to amplify EMG signals in the PLUGSYS system. A floating input circuit is used to avoid hum and grounding problems. The filters are designed for EMG signals up to 10 kHz. The analog EMG signal is available at a BNC connector on the front panel and also internally on the PLUGSYS system bus. Both outputs can be used for recording on a chart recorder or for data acquisition. A square-wave signal generator with 0.3 mV and 1 mV amplitude is incorporated for calibration. For EMG integration an envelope integration circuit is provided. This signal is also available on the front panel and on the PLUGSYS bus.

Electroencephalogram (EEG) Amplifier Module (EEGA)



This module is for amplify EEG signals. A floating input circuit is used to avoid hum and grounding problems. The filters are for EEG signals up to 70 Hz. The analog EEG signal is available at a BNC connector on the front panel and also internally on the PLUGSYS system bus. Both outputs can be used for recording on a chart recorder or for data acquisition. A square-wave signal generator with amplitudes of 50 μ V and 100 μ V is incorporated for calibration.

Specifications

Input	Floating differential input, isolated barrier internally clamped to 300 V, with protection against static discharges and 10 kHz input filter for h.f. suppression		
Input Connector	5-pin binder socket with screw lock; pin connections correspond to those of standard 3-pin EMG input cable		
Input Impedance	10 ¹⁰ Ω		
Common Mode Rejection	106 dB		
Filters:			
Low-Pass Filter	(HIGH CUT OFF) 10 kHz, 3 kHz, 1 kHz, 0.3 kHz		
High-Pass Filter	(LOW CUT OFF) 50 Hz, 25 Hz, 10 Hz, 2 Hz		
Envelope Curve	(Leakage Time Constant) 0.2 s, 0.5 s, 1 s		
Filter Indication	By green LEDs on front panel		
Gain Trimmer:			
Switch	x1	x10	x100
In Position x0.5	100 to 500	1000 to 5000	10000 to 50000
In Position x1	200 to 1000	2000 to 10000	20000 to 100000
In Position x2	400 to 2000	4000 to 20000	40000 to 200000
Display	Bar graph 0.75 V/LED		
Outputs	BNC connector on front panel for EMG and envelope signal (± 10 V) output signals also available on PLUGSYS system bus		
Calibration	Square-wave signal generator with amplitudes of 0.3 mV and 1 mV amplitude		
Recorder Output	Internal outputs are connected to bus system via jumpers; EMG signal and envelope signal are connected to recorder via Recorder Output Module (ROM); also possible to connect recorder directly to BNC connectors 'EMG OUT' and 'Envelope Integration' at front panel		
Quick Start	For rapid discharge of coupling capacitors by pressing QUICK START key		
Power Supply	5 V/600 mA, through connector from PLUGSYS bus system		
PLUGSYS Width	2 slot units		
Connector	DIN 41612, 96-pin VG		

Catalog No. \$ **Model**
BS4 73-1766 EMG Amplifier Module EMGA

Specifications

Input	Floating differential input, isolated barrier internally clamped to 300 V, with protection against static discharges and 10 kHz input filter for HF suppression		
Input Connector	5-pin binder socket with screw lock; pin connection corresponds to those of standard 3-pin EEG input cable		
Input Impedance	10 ¹⁰ Ω		
Common Mode Rejection	106 dB		
Filters			
Low-Pass Filter	(HIGH CUT OFF) 70 Hz, 40 Hz, 20 Hz, 10 Hz,		
High-Pass Filter	(LOW CUT OFF) 10 Hz, 5 Hz, 2.5 Hz, 1 Hz		
Filter Indication	By green LEDs on front panel		
Gain Trimmer:			
Switch	x1	x10	x100
In Position x0.5	100 to 500	1000 to 5000	10000 to 50000
In Position x1	200 to 1000	2000 to 10000	20000 to 100000
In Position x2	400 to 2000	4000 to 20000	40000 to 200000
Display	Bar graph 0.75 V/LED		
Output	BNC connector on front panel (± 10 V) output voltage also available on PLUGSYS bus		
Calibration	Square-wave signal generator with amplitudes of 50 μ V and 100 μ V		
Recorder Output	Internal output is connected to bus system via jumpers; EEG signal is connected to recorder via Recorder Output Module (ROM); also possible to connect recorder directly to BNC connector "EEG OUT" at front panel		
Quick Start	For rapid discharge of coupling capacitors by pressing QUICK START key		
Power Supply	5 V/600 mA, through connector from PLUGSYS bus system		
PLUGSYS Width	2 slot units		
Connector	DIN 41612, 96-pin VG		

Catalog No. \$ **Model**
BS4 73-1770 EEG Amplifier Module EEGA

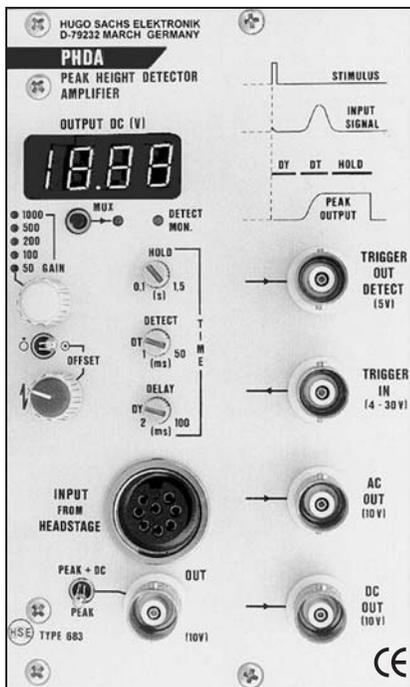
PLUGSYS Biopotential Amplifiers

HSE-HA Peak Height Detector Amplifier (PHDA) Module

- Special amplifier for recording extracellular signals from isolated sympathetic ganglia or whole nerve bundles
- Works in combination with the Marsh Chamber

The HSE-HA Peak Height Detector Amplifier PHDA Type 683 is used in conjunction with the ganglion chamber according to MARSH for measuring extracellular potentials of isolated sympathetic ganglia and whole nerve bundles of the rat.

The Peak Height Detector incorporates a variable gain, low-noise differential amplifier and a spike amplitude evaluator. This enables simultaneous monitoring of low amplitude D.C. signals and the amplitude of a selected portion of an evoked potential. The input circuit of this amplifier includes a headstage which is placed near the ganglion chamber. The peak height detector output, which can be displayed on a chart recorder, provides a single continuous record of changes in potential difference (membrane potential) and evoked potential amplitude or separate traces of the same two components, enabling high gain recording of low amplitude changes in membrane potential. An amplified signal output allows oscilloscope monitoring of the evoked potential and adjustment of the detection region for the peak detector.



PHDA Built-In PLUGSYS Case, Type 601, with Headstage Preamplifier

Literature MARSH, S.: *Extracellular Recording from rat sympathetic Ganglia and whole Nerve Bundles. BVM Biological Measuring Technique VI/89, Biomesstechnik-Verlag March GmbH, D-79232 March, Germany.*

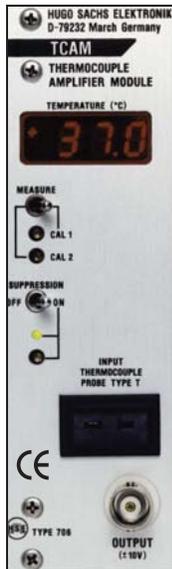
Specifications

Input from Headstage:	
Headstage	Differential input
Input impedance	$>10^{12} \Omega$
Input Capacity	20 pF
Gain	10 (only for headstage)
Noise	40 μV_{pp}
Max. Differential Input Voltage	$> 0.2 \text{ V}$
Common Mode Rejection Ratio	$>120 \text{ dB}$
Overshoot Protection	15 V constant, 100 V non-repetitive peak
Trigger IN:	
BNC Connector	4 to 30 V
Input Resistance	5 k Ω
Trigger Out Detect	Monitor output, TTL level, to control detect time with oscilloscope, BNC connector
AC Out	Output of AC voltage, BNC connector 10 V, 10 mA; output used to connect oscilloscope
DC Out	Output of DC voltage to chart recorder or oscilloscope; DC voltage shown in display; BNC connector $\pm 10 \text{ V}$, 10 mA; DC output shows membrane potential, which is slow signal in frequency range from 0 to 0.2 Hz
Out	Signal output used to connect up chart recorder or oscilloscope; it is possible to switch voltage peak height or peak height and additional DC voltage to BNC connector with switch PEAK/PEAK+DC. 10 V, 10 mA BNC connector
Gain	Switchable x50/100/200/500/1000 (including Headstage Gain 10)
Offset	Fine adjustment with 10-turn potentiometer, can be switched off
Hold	Hold time is duration of holding amplitude of peak in peak memory; time can be set from 0.1 to 1.5 seconds.
Detect	Time is on-time for detecting max. of input signal; detect time can be set in range from 1 to 50 msec
Delay	During time peak height detector is out of action, peak height detector is enabled for detect duration; delay time can be set in range from 2 to 100 msec
Frequency Range:	
AC	1.5 Hz to 40 kHz (-3 dB)
DC	0 to 0.2 Hz (-3 dB)
Signal Output MUX	After pressing MUX key, one of analog voltages (depending on switch PEAK/PEAK+DC) is switched to system bus line AM (analog multimeter), which can be switched to Digital Display Module (DM) or Digital Voltmeter Module (DVM). Function is self-maintained; module previously selected is switched off.
Power Supply	5 V/0.7 A through connector from PLUGSYS bus system
Dimensions, H x W x D	128.7 x 80.8 x 220 mm (5.1 x 3.2 x 8.7 in)
PLUGSYS Width*	4 slot units
Connector	DIN 41612, 96-pin VG
Weight	500 g
Accessories	2x BNC-BNC cable; 3x BNC-banana cable; 2x BNC-banana adapter; operating instructions

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-1743		Peak Height Detector Amplifier Module PHDA

Thermocouple Amplifier Module (TCAM)



The measurement of temperature on small structures requires probes of correspondingly small dimensions. With the TCAM Module and a suitable thermocouple, there are virtually no limitations. Thermocouples (Type T, copper-constantan) are available in a wide range of forms. From the thinnest wires with a diameter of 0.23 mm (IT-23) to the largest rectal probe with 4 mm probe diameter (RET-1); a whole range of probes in different forms and dimensions can be supplied. The temperature probes are directly interchangeable and do not require individual calibration.

The range of the TCAM module covers 0°C to 100°C. In the physiological temperature range (30 to 45°C) the basic accuracy is 0.1°C; outside this range the accuracy is 0.2°C. The built-in digital display has a resolution of 0.1°C. The TCAM module has an analogue output for connection to a recorder or data acquisition system. The recorder or acquisition system can easily be calibrated through a build-in simulation device with two adjustable temperature values. In addition, there is a zero suppression facility for recorders which permits recording temperatures within a limited range (e.g., 36 to 38°C) at a high resolution.

TCAM Module requires Thermocouple Probes. Please see pages D22 to D25 for a complete selection of Thermocouple Probes.

Specifications

Input	Floating differential input, max. isolation 1500 Vrms, transient protection to ANSI/IEEE C37.90. 1-1989, input protection to 240 VAC continuous
Input Resistance	50 MΩ
Input Connector	Thermoelement connector blue, Cu/CuNi
Range	0 to 100°C
Resolution	0.1°C
Sensitivity	0.1°C in physiologic range between 30° and 45°C; 0.2°C outside this range
Response Time	0.2 sec (90% span)
Display	3-1/2 digit LED display
Analog Output	For simultaneous recording, using BNC connector on front panel (± 10 V, output impedance 100 Ω); output voltage is also available on PLUGSYS bus system; 100 mV per 1°C = 1 V per 10°C
Calibration	2-point calibration with two freely selectable temperatures
Power Supply	+5 V/450 mA supplied via PLUGSYS system bus
PLUGSYS Width	2 slot units
Connector	DIN 41612, 64-pin VG

Catalog No.	\$	Product
BS4 73-1792		Thermocouple Amplifier Module TCAM
BS4 73-1911		Extension Cable EXT-6 for Thermocouples

pH Measurement Module (pHMM)



The HSE-HA pH Measurement module is used to measure pH with pH glass electrodes. The main application is continuously pH recording with the combination pH electrodes for measurement in biological fluids such as perfusate for isolated perfused organs. The input circuit of the module includes an isolation amplifier (potential separation between sensing electrode and circuit ground of the PLUGSYS measuring system) to avoid measurement errors due to ground loops and leakage currents.

pH Control Module (pHCM)



The pHCM module Type 694/1 is used for maintaining a constant pH in perfusion systems. It can only be used in conjunction with pHMM pH Measurement Module, see to the left, in the PLUGSYS system.

The main application is in ensuring a constant pH of biological solutions, as e.g. the perfusate of isolated organs as isolated lung, heart, liver, kidney or isolated tissues, see our Isolated Organ and Tissue Section K. To control the pH a gas (commonly CO₂) flow bubbling through the perfusion solution is switched on and off. Fine adjustment of the rate of gas flow is by a built-in needle valve. The required pH value and the permitted fluctuations (Hysteresis) can be adjusted on trimmer potentiometers and can be indicated on the corresponding pHMM module by pressing a key.

Specifications

Input	Floating single-ended input, isolated barrier internally clamped to 300 V
Input Connector	Isolated BNC connector
Input Impedance	10 ¹⁵ Ω
Input Bias Current	±300 fA
pH Range	0 to 14
Resolution	0.01 pH
Display	3 1/2 -digit LED display
Millivolt Range	±600 mV
Offset Range at pH7	±100 mV
Slope	45 mV/pH to 90 mV/pH
Output	1 V per 1 pH on BNC connector on front panel (±10 V); output voltage is also available on PLUGSYS bus
Suppression	OFF, output voltage 0 V = pH 0 and 10 V = pH 10 ON, output voltage 0 V can be adjusted to any pH in the range 0 to 14
Slope Adjustment	2 point adjustment using calibrated buffer solutions
Simulation	Physiological measuring range for calibrating recording output can be simulated using 2 corresponding push buttons; each simulated value can be adjusted in pH range of 0 to 14
Power Supply	+5 V/450 mA (2.25 W)
PLUGSYS Width	2 slot units
Connector	DIN 41612, 96-pin VG

Catalog No.	\$	Product
BS4 73-0215		pH Measurement Module pHMM

Specifications

Control Range, Setting	SET POINT is adjustable between approx. pH 6.5 and pH 8.5; set value is indicated on pHMM module by pressing DISPLAY key
Differential, HYST	Adjustable between approx. 0.05 to 1 pH units; setting is indicated on pHMM module by pressing DISPLAY key
Controlled Medium (Gas)	Depends on perfusion solution used and on control direction; when used on Krebs-Henseleit solution where pH has to be reduced: CO ₂ gas
Required Condition of Controlled Medium (Gas)	Dirt particle size 25 µm max., dry gas pressure 2 bar max.
Gas Flow	Continuously adjustable
Power Supply	From pHMM module to which it is linked
PLUGSYS Width	1 slot unit
Connector	10-way ribbon cable to pHMM module

Catalog No.	\$	Product
BS4 73-1776		pH Control Module pHCM

Oxygen Partial Pressure Module (OPPM)



The Oxygen Partial Pressure Module OPPM is a polarographic amplifier for the PLUGSYS system. It is used to measure oxygen concentrations with CLARK-style electrodes. The main application is recording of pO_2 concentrations in biological fluids e.g. perfusate or effluate of isolated perfused organs, using the corresponding electrodes e.g. Mini Oxygen Electrode Type 733 or ZABS Flow-Through O_2 Chemosensor, see our website. The digital display indicates either electrode polarization voltage, O_2 concentration as percent or mmHg or the electrode current.

The input circuit of the module includes an isolation amplifier (potential separation between sensing electrode and circuit ground of the PLUGSYS measuring system) to avoid measurement problems due to ground loops and leakage currents.

Specifications

Input	Floating single-ended input, max. isolated barrier internally clamped to 300 V
Input Connector	Isolated BNC connector
Polarization Voltage	Adjustable with trimmer between -1 and +1 V
Digital Display	3-1/2 digit LED display displays O_2 concentration in ranges 0 to 199.9% or 0 to 1999 mmHg; electrode current in range of 0 to 1.999 (ampere multiplied with gain factor) or polarization voltage in range from -1.000 V to +1.000 V can also be displayed
Resolution	\pm One least significant digit
Accuracy of Amplifier	\pm 1% (total accuracy depending on electrode)
Linearity of Amplifier	\pm 0.5%
Gain Adjustment	Input current ranges for electrode currents: 10^6A , 10^7A , 10^8A , 10^9A , $10^{10}A$ full scale
Gain Fine	For fine adjustment of gain
Zero Adjustment	Coarse zero current ranges: 10^9A , 10^8A , $10^{10}A$, $10^{11}A$, $10^{12}A$
Zero Fine	For fine adjustment of zero current
Analog Output	For simultaneous recording, using BNC connector on front panel (\pm 10 V, output impedance 100 Ω); output voltage also available on PLUGSYS bus system; signal output is assigned to internal connecting lines AV-1 to AV-16 through jumper
Simulation	Two physiological pO_2 values can be simulated for calibrating recording output; this gives advantage of easy calibration procedure for connected chart recorder or data acquisition system
Power Supply	+ 5 V/450 mA
PLUGSYS Width	2 slot units
Connector	DIN 41612, 64-pin VG

Catalog No.	\$	Product
BS4 73-0210		Oxygen Partial Pressure Module OPPM

Electrometer Module (EMM)



The HSE-HA Electrometer module is a high-impedance electrometer plug-in amplifier for the PLUGSYS measuring system. It is used to measure continuously concentrations with potentiometric electrochemical sensing electrodes. The main application is recording of pCO_2 or Na^+ , K^+ and Ca^{++} concentrations in biological fluids such as perfusate for isolated perfused organs, using the corresponding electrodes, see our website. The input circuit of the module includes an isolation amplifier (potential separation between sensing electrode and circuit ground of the PLUGSYS measuring system) to avoid measurement errors due to ground loops and leakage currents.

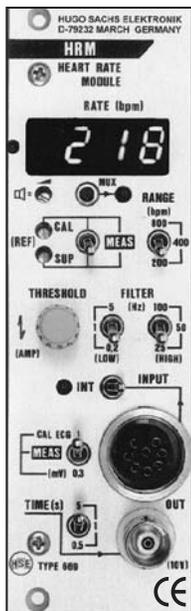
Specifications

Input	Floating single-ended input, isolated barrier internally clamped to 300 V
Input Connector	Isolated BNC connector
Input Impedance	$10^{15} \Omega$
Input Bias Current	\pm 300 fA
Resolution	\pm one least significant digit
Display	3 1/2 -digit LED display
Millivolt Range	\pm 1200 mV
Gain	x10, x20, x50, x100 set internally using jumper
Output	On BNC connector on front panel (\pm 10 V, output impedance 100 Ohm); output voltage also available on PLUGSYS bus; signal output is assigned to connecting lines AV-1 to AV-16 through jumper
Suppression	Only active on output, adjustable with 10 turn trimmer (max. \pm 10 V); suppression can be switched on and off
Simulation	Physiological measuring range for calibrating recording output can be simulated using 2 corresponding push buttons; for each simulated value can be adjusted in range of \pm 150 mV
Power Supply	+5 V/450 mA
PLUGSYS Width	2 slot units
Connector	DIN 41612, 96-pin VG

Catalog No.	\$	Product
BS4 73-0212		EMM Electrometer Module

PLUGSYS Calculating Modules

HSE-HA Heart Rate and ECG Amplifier Module (HRM)



- Heart Ratemeter with wide range 20 to 1000 beats/min
- Includes an ECG Preamplifier
- Can calculate Heart Rate from any signal (BP, LVP, ECG, etc.)
- Suitable for all species from mouse up to large animals

This module is used to calculate frequency (rate) within the range 20 to 1000 beats/min from a signal. The input signal is provided either from a PLUGSYS Preamplifier Module (e.g. TAM-A or TAM-D, see page I33, having a Blood Pressure, see pages J3 and J4, or a force Transducer, see pages I4 to I7), connected via the PLUGSYS bus system or from a PLUGSYS external preamplifier over the external input on the front panel. The module also includes an ECG-Preamplifier. An appropriate cable can

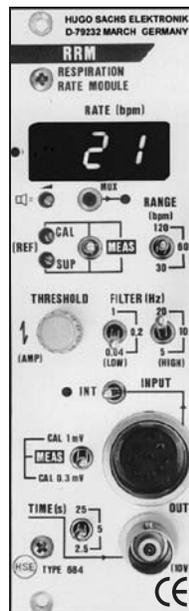
connect ECG-electrodes (Single Lead) directly to the external input for reading Heart Rate. The ECG Signal is also available for recording.

Specifications

Input	Selected by switch "INT/INPUT" (indication through LED)
Internally	"INT" signal through the 96-pin connector from the PLUGSYS bus system
Externally	"INPUT" Using ECG electrodes connected to the built-in ECG amplifier, or from an external unit
Sensitivity	5 mV to 10 V, ECG Input: 0.1 mV to 25 mV
Input Filter	Band-pass, bottom and top frequency limit selected separately within the ranges 0.2 / 1 / 5 Hz and 25 / 50 / 100 Hz
Trigger Operation	Adjustable over a wide range through 10-turn potentiometer
Range	3 ranges are available, selected by a switch:
200	20 to 250 beats/min
400	40 to 500 beats/min
800	80 to 1000 beats/min
Indication	3 1/2-digit LED display (0 to 1000 beats/min); additional trigger response check through LED in display field
Outputs	The analogue frequency signal is available at a BNC socket on the front panel (0 to 10 Volt) and through the connector on the PLUGSYS bus system. The external input signal (± 10 Volt) can also be transmitted to the PLUGSYS bus system (e.g. ECG)
Output Filter	3 positions: 0.5 sec/1 sec/5 sec, are provided for smoothing the recording
Power Supply	5 V, 450 mA, through connector from PLUGSYS bus system.
Dimensions, H x W x D	128.7 x 40.5 x 220 mm (5.1 x 1.6 x 8.7 in)
PLUGSYS Width*	2 slot units
Connector	DIN 41612, 96-pin VG
Weight	0.4 kg (0.9 lbs)
Accessories	Input Cable, Output Cable, Operating Instructions

* Note: For description of Slot Unit, see page I28.

HSE-HA Respiration Rate Module (RRM)



- Respiratory Rate Meter with a wide range: 3 breaths/min to 150 breaths/min
- Suitable for all species from mouse up to large animals

The Respiration Rate Module is used to calculate respiration frequency (rate) in the range from 3 to 150 breaths per minute from any signal reflecting it (respiratory airflow, thoracic excursion signal, nasal airflow temperature signal, etc.). The input signal is provided either from a PLUGSYS Preamplifier Module (e.g. Bridge Amplifier (TAM-A, TAM-D with respiratory belt or a Carrier Frequency Amplifier (CFBA) with a differential pressure transducer and a pneumotachometer connected) via the PLUGSYS bus system or from a PLUGSYS external preamplifier over the external input on the front panel.

Specifications

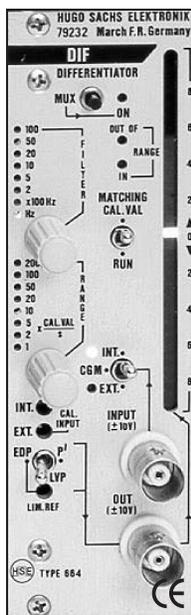
Input	Selected by switch (indication through LED)
Internally	Signal through 96-pin connector from the PLUGSYS bus system
Externally	From an external amplifier
Input Filter	Band-pass, bottom and top frequency limit selected separately within the ranges 0.04 / 0.2 / 1 Hz and 5 / 10 / 20 Hz
Trigger Operation	Adjustable over a wide range through 10-turn potentiometer
Range	3 ranges are available, selected by a switch
30	3 to 37.5 breaths/min
60	6 to 75 breaths/min
120	12 to 150 breaths/min
Indication	3 1/2-digit LED display (0 to 1000 breaths/min); additional trigger response check through LED in display field
Outputs	The analogue frequency signal is available at a BNC socket on the front panel (0 to 10V) and through the connector on the PLUGSYS bus system. The external input signal (± 10 V) can also be passed to the PLUGSYS bus system
Output Filter	Three positions: 2.5 / 5 / 25 s, are provided for smoothing the recording
Signal Output MUX	After pressing the MUX key the response signal is switched to the system bus line AM (analog multimeter) which can be switched to an optional digital Display Module DM or a Digital Voltmeter DVM. The function is self-maintained; the module previously selected is switched off.
Power Supply	5 V, 450 mA, through connector from PLUGSYS bus system
Dimensions, H x W x D	128.7 x 40.5 x 220 mm (5.1 x 1.6 x 8.7 in)
PLUGSYS Width*	2 slot units
Connector	DIN 41612, 96-pin VG
Weight	0.45 kg (1 lb)
Accessories	Input Cable Output Cable Operation Instructions

* Note: For description of Slot Unit, see page I28.

Catalog No.	\$	Product
BS4 73-0165		HRM Heart Rate Module with ECG Amplifier
BS4 73-0148		ECG Cable with Banana Plugs

Catalog No.	\$	Product
BS4 73-1747		RRM Respiration Rate Module

HSE-HA Differentiator Modules (DIF) and (DIF/S)



- Differentiator Module for recording signals such as $dLVP/dt$, dF/dt on an analogue recording device
- Includes maximum and minimum tracking

The HSE-HA Differentiator is a universal analog calculator for evaluating the rate of rise and fall of signals such as blood pressure dP/dt , force dF/dt , displacement, Intracellular Action Potential etc. The input signal is provided either from a PLUGSYS Preamplifier Module (e.g. TAM-A or TAM-D, see page I33, having a Blood Pressure, see pages J3 and J4, or a force Transducer, see page I4, connected via the PLUGSYS bus system or from a PLUGSYS external preamplifier over the external input on the front panel. Output signals available are the differentiated signal and a tracking signal of its maximas

and minimas. All the output signals are available via the PLUGSYS bus for further processing or for linking to a Chart Recorder using a Recording Output Module. The differentiated signal is also available at the auxiliary output on the front panel.

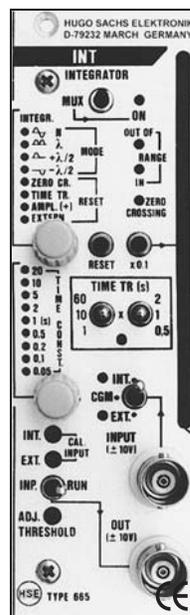
Specifications

Input	Externally through BNC socket or internally from system bus as selected by switch (± 10 V)
Range	Differentiation factor x calibration value x sec ⁻¹ (Differentiation factor = x1; x2; x5; x10; x20; x50; x100; x200) (Calibration value: e.g. 100 mmHg or 1 mN)
Overrange	Overrange of the differential stage is indicated by LEDs
Amplitude Adjustment	Through separate 10-turn trimmer, adjustable for external and internal input
Operating Mode	Selected either amplitude adjustment (Matching Cal. Val.) or differentiation (RUN)
Output Low-Pass Filter	12 positions from 2 Hz to 10 kHz, selected by rotary switch
Analog Indication	Through LED bargraph +15 LEDs/-14 LEDs for visual monitoring of the differentiated signal. The sensitivity is ± 10 V
Signal Output	a) On front panel through BNC socket (± 10 V) b) Through bus connector to PLUGSYS Measuring System through link plugs; all signals or selectively: — Differentiated signal — Maximum positive slope — Maximum negative slope — Positively limited input signal
Limit Ref	Through a 10-turn trimmer a positively limited section of the left ventricular pressure signal can be emulated which can later be recorded enlarged on the recorder without overloading the recording channel.
Power Supply	5 V, 900 mA through connector from PLUGSYS bus system
Dimensions, H x W x D	128.7 x 40.5 x 220 mm (5.1 x 1.6 x 8.7 in)
PLUGSYS Width*	2 slot units
Connector	DIN 41612, 96-pin VG
Weight	0.33 kg (0.7 lbs)

* Note: For description of Slot Unit, see page I28.

Catalog No.	\$	Product
BS4 73-0164		DIF Differentiator Module with Max/Min Storage
BS4 73-1587		DIF/S Differentiator Module without Max/Min Storage

HSE-HA Integrator Module (INT)



- Integrator Module for recording area under curve (e.g., Respiratory Tidal Volume, Cardiac Minute Volume) on an analogue recording device
- Includes maximum tracking

The Integrator Module INT is used to calculate the area under the curve of an input signal in the PLUGSYS system. The module readily provides time or stroke integration of periodic physiological signals or other time-related parameters.

Examples for Integration:

- From the Respiratory Curve
 - Respiratory Minute Volume
 - Respiratory Tidal Volume
- From the Aortic Flow Curve
 - Cardiac Minute Volume
 - Stroke Volume
 - Cardiac Output (C.O.)

The input signal is provided either from a PLUGSYS Preamplifier Module such as the Carrier Frequency Amplifier CFBA, see page I34, with a differential pressure transducer, see page F42, and a pneumotachometer, see pages F40 and F41, connected for airflow or from a Transit Time Ultrasonic Flowmeter TTFM, see page I34, for aortic flow, via the PLUGSYS bus system or from a PLUGSYS external preamplifier over the external input on the front panel. The output signal from maximum tracking is available on the system bus.

Specification

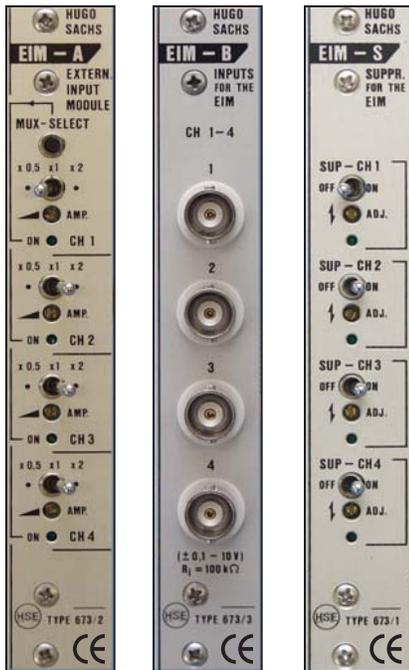
Input	Externally through BNC sockets or internally from system bus as selected by switch. Input voltage: ± 10 V
Integration Time	Selected in 6 steps: 0.05 / 0.1 / 0.2 / 0.5 / 1 / 2 / 5 / 10 / 20 sec Constant
Integration Period	Controlled through the cyclic input signal over one cycle (stroke integration). Time-controlled through a built-in timer, selected in the following steps: 0.5/1/2/5/10/20/30/60/120 sec. Controlled by a trigger signal from the bus system or by pressing (RESET key)
Polarity	Choice of input signal to be integrated, positive half-wave only or negative half-wave only or both, as selected by switch
Amplitude Adjustment	Through separate 10-turn trimmer for external and internal input
Analogue Indication	Through LED bargraph for visual monitoring of the input or output signal; sensitivity ± 10 V or ± 1 V by pressing the 'x 0.1'.
Signal Output	On the front panel through a BNC socket (± 10 V) through bus connector to PLUGSYS measuring system as selected by links: a) Current integration signal b) Maximum value of the elapsed integration period
Power Supply	5 V, 700 mA through connector from PLUGSYS bus system
Dimensions, H x W x D	128.7 x 40.5 x 220 mm (5.1 x 1.6 x 8.7 in)
PLUGSYS Width*	2 slot units
Connector	DIN 41612, 96-pin VG
Weight	0.33 kg (0.7 lbs)

* Note: For description of Slot Unit, see page I28.

Catalog No.	\$	Product
BS4 73-1583		INT Integrator Module

PLUGSYS Input/Output Modules

HSE-HA External Input Module (EIM)



- For linking external equipment to the PLUGSYS system for connection to data acquisition hardware PLUGSYS version

The External Input Module is used for feeding external analog signals into the PLUGSYS Measuring System, such as a flow signal from an external blood flowmeter, a force signal from an external bridge amplifier or distance signals measured using a sonomicrometer. The EIM consists of the two parts EIM-A (Adjust) and EIM-B (BNC).

The modules EIM-A and EIM-B normally fit in the PLUGSYS Mainframe from the front. With an optional board it is possible to install the module EIM-B on the rear to have more space on the front.

An optional suppression for the EIM module is available. This option is used to zero shift the input signal to blank out uninteresting parts of the signal or for correcting offsets of an external amplifier.

Specifications

Inputs	4 analog inputs through BNC sockets on module EIM-B
Gain	From 0.25 to 100 adjustable by 10-turn trimmer together with range switch x0.5/x1/x2, corresponding to max. input voltage range of ± 0.1 to ± 10 V
Outputs	Through links on circuit board (jumpers) signal outputs are fed directly into bus distribution board of PLUGSYS measuring system
Power Supply	5 V, 300 mA from PLUGSYS measuring system
Dimensions, H x W x D:	
EIM-A	128.7 x 20.2 x 220 mm (5.1 x 1.6 x 8.7 in)
EIM-B	128.7 x 20.2 x 50 mm (5.1 x 1.6 x 2 in)
Suppression	128.7 x 20.2 x 100 mm (5.1 x 1.6 x 4 in)
PLUGSYS Width*	3 slot units
Connector	DIN 41612, 96-pin VG
Weight	0.25 kg (0.6 lbs)
Accessories	2 BNC-BNC input cable, operating instructions

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-0222		EIM External Input Module (Contains Both EIM-A and EIM-B Modules)
BS4 73-1634		Additional Board to Mount EIM-B at Rear
BS4 73-1601		Suppression Module for EIM

Data Interface Modules (ROM-DL, DIM, DIM-D)



BS4 73-1683
ROM-DL



BS4 73-0223
DIM-D



The ROM-DL is used as a central output for the analog output signals of the modules in a PLUGSYS Mainframe. It can be used as a central output to a recording device if connected to a ROM-C. It is used instead of the ROM-A if the adjustment of the output amplitude is not required that means if the connected device can handle the ± 10 Volt signals. The ROM-DL is only a connecting board and requires a DIM or a ROM-C as connection.

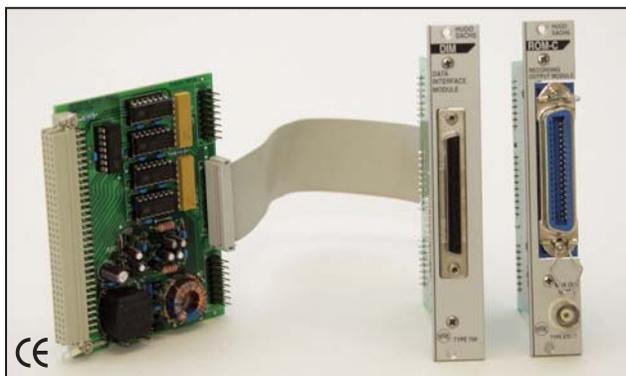
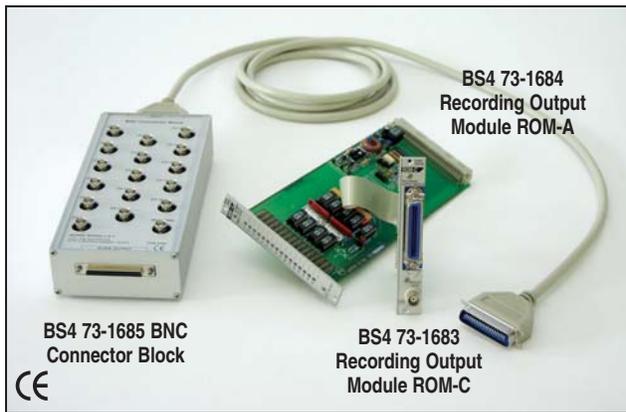
The ROM-DL is used in combination with the DIM module to realize the connection of the PLUGSYS modules to the Data Acquisition Board going with the HSE-HA software packages. This combination gives a simple single cable connecting system.

For modules which require digital control, like PSM or PPG, used in the PLUGSYS Main System Case, the DIM-D allows the digital communication between the Data Acquisition Board, HSE-HA Software and these modules.

Catalog No.	\$	Product
BS4 73-1683		ROM-DL Recording Output Module - Direct Link
BS4 73-2823		DIM Data Interface Module
BS4 73-0223		DIM-D Digital Bus Link for DIM

PLUGSYS Input/Output Modules

HSE-HA Recording Output Standard Set (ROM)



ROM DL board with DIM or ROM C. DIM is used for A/D board connection.

- Central output for all selected output signals of the modules in a PLUGSYS Main Frame
- Reduces the number of connecting wires
- Allows clear connection to any chart recorder or data acquisition system using custom cable

The Recording Output Standard Set consists of the ROM-A Type 670/1, ROM-C Type 670/ 7 and BNC Connection Block Type 670/6. This module combination is ideal for connecting a chart recorder or digital data acquisition unit to the PLUGSYS measuring system. The adjustable amplifier module ROM-A buffers all 16 internal analog lines AV1 to AV16.

The ROM-A is internally connected to the central output connector module ROM-C and has to be installed into the PLUGSYS rack from the front. The output connector ROM-C can be installed either in the front or at the rear if there is not sufficient module space on the front.

ROM-A is an attenuator for the internal analogue lines AV1 to AV16. Each channel individually adjustable from 0 to ± 10 Volt for optimum matching with the recording unit.

ROM-C is a central output connector 36 pin ribbon type. All outputs have EMI filters to reduce the electromagnetic interference from and to the PLUGSYS measuring system.

BNC Connector Block external box with 17 BNC sockets for the 16 analogue lines AV1 to AV16 with additional EMI filters and ESD protection circuit. The maximal cable length between the PLUGSYS and the BNC connector block is nominal 3 m. As a further combination it is possible to use the slave output of the BNC connector block to connect up an additional evaluation and recording unit.

If the connected system chart recorder or data acquisition system can handle the output voltages of ± 10 Volt, adjustment for each channel individually from 0 to ± 10 Volt is not required. In this case the ROM-DL can be substituted for the ROM-A module, and the ROM-C with the BNC connector box can be connected to the ROM-DL and installed either in the front or at the rear of the PLUGSYS system case if there is not sufficient module space on the front.

Specifications

ROM-A Type 670/1

Inputs	Direct from PLUGSYS system bus, all 16 analogue lines AV1 to AV16 and MUX line
Amplitude	Individually adjustable in the range from 0 to ± 10 V
Outputs	Ribbon cable connector for connecting internally the ROM-C
Dimensions, H x W x D	127.5 x 20.2 x 220 mm (5 x 0.8 x 8.7 in)
PLUGSYS Width*	1 slot unit
Weight	80 g (2.8 oz)

ROM-C Type 670/7

Construction	Output module for ROM-A or ROM-DL connected over ribbon cable to ROM-A or DL
Outputs	All AV signals and MUX output centrally through 36-pin ribbon output socket (e.g., CONEC Type CRS 36 LG (301A 10269x)); MUX output is additionally taken to BNC socket
Output Filter	EMC filter for suppressing radiated interference or interference pick-up
Dimensions, H x W x D	127.5 x 20.2 x 65 mm (5 x 0.8 x 2.6 in)
PLUGSYS Width**	1 slot unit
Weight	80 g (2.8 oz)

Accessories Fixing screws, operating instructions, connecting cable ROM-C to ROM-A or DL

Add-On One or two ROM-B modules, BNC connector options block

BNC Connector Block, Type 670/6

Construction	Natural anodized aluminium case with 36-pin ribbon input and slave output socket (e.g., CONEC Type CRS 36 LG (301A 10269x)). All PLUGSYS 16 analog outputs AV1 to AV16 and MUX-OUT available for individual connection via BNC sockets
Output Filter	EMC filter for suppressing radiated interference or interference pick-up and ESD protection circuit
Dimensions, H x W x D	55 x 105 x 245 mm (2.2 x 4.1 x 9.6 in)
Weight	0.8 kg (1.7 lbs)
Add-On	Customized cable for connecting slave output to data acquisition board

Recording Output Standard Set

Accessories Operating instructions, 5 BNC cables, connecting cable ROM-A to ROM-C (ribbon), connecting cable ROM-C to BNC connector block are included.

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-0166		Recording Output Standard Set consisting of ROM-A, ROM-C, and BNC Connector Block
BS4 73-1684		Recording Output Module ROM-A
BS4 73-1639		Recording Output Module ROM-C
BS4 73-1685		BNC Connector Block
BS4 73-1683		Recording Output Module Direct Link ROM-DL

PLUGSYS Input/Output Modules

Trigger Input/Output Module (ROM-T)



- Provides 2 trigger inputs and 2 trigger outputs to the PLUGSYS system
- For triggering external equipment like oscilloscopes or stimulators
- For synchronization of HSE-HA software with external equipment (e.g., stimulators, ventilators, etc.)

This module is used as a trigger input and output. BNC sockets 1 and 2 are used as trigger outputs, the BNC sockets 3 and 4 are used as trigger inputs.

This module is connected to the module ROM-A and mounted in the PLUGSYS Mainframe from the rear. With the trigger outputs 1 and 2 it is possible to trigger an oscilloscope from a PLUGSYS module providing this feature.

With the trigger inputs 3 and 4 it is possible to trigger a PLUGSYS module from the outside, e.g. triggering a module with an external stimulator.

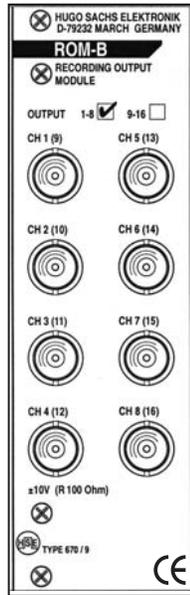
Requires a ROM-A module to connect to the PLUGSYS Bus

Specifications

Outputs	2 TTL outputs, open collector TTL signal, low activ. pull-up resistor 2.2 k Ω
Inputs	2 inputs, TTL or CMOS-signal dynamic inputs, acting on falling edge
Dimensions, H x W x D	128.7 x 20.2 x 100 mm (5.1 x 0.8 x 4.3 in)
PLUGSYS Width*	1 slot unit
Weight	150 g (5.3 oz)
Accessories	2 BNC-BNC output cables

Catalog No.	\$	Product
BS4 73-1633		ROM-T Trigger Input/Output Module

BNC Output Module (ROM-B)



- Alternative to central output ROM-C

The ROM-B module is an 8 channel BNC output of the PLUGSYS measuring system for connecting external recording or evaluation systems. The module is normally installed at the rear of a PLUGSYS rack. Either the signals AV1-8 or the signals AV9-16 are taken out via the 8 channel output connector

module ROM-B. The maximum arrangement is therefore 2 ROM-B for the 16 AV lines AV1 to AV16. The output modules ROM-C and ROM-B can be combined in any way. The outputs of ROM-C and ROM-B are then connected in parallel; there is no provision for decoupling through output amplifiers.

Note: To connect ROM-B to the module ROM-A module a ROM-C is necessary. The ROM-B module can be connected directly to ROM-DL or via a ROM-C module.

Specifications

Dimensions, H x W x D	128.7 x 40.5 x 100 mm (5.1 x 1.6 x 4.3 in)
PLUGSYS Width*	2 slot units
Weight	150 g (5.3 oz)

Catalog No.	\$	Product
BS4 73-1631		ROM-B 8-BNC Output Module (Ch 1-8)
BS4 73-1632		ROM-B 8-BNC Output Module (Ch 9-16)

Software Trigger Output Module (STOM)



- For triggering an external device from HSE-HA Software (e.g., Stimulator, Oscilloscope, etc.)

The Software Trigger Output Module STOM is used for triggering an external device (e.g. a stimulator) from a computer using HSE-HA software. This module has been specially developed for triggering stimulators, it is also possible to trigger other devices.

The data acquisition software, including HSE-HA ISOHEART, ACAD, NEURODYN and EPES, provides the STOM module via the PLUGSYS system with a trigger pulse. The module can be connected to any stimulator having the capability of trigger inputs, such as the HSE-HA Stimulators I or P.

Operation of this module requires the following components:

- Computer
- Data Acquisition Hardware, PLUGSYS version
- DIM-D Digital Bus Link for DIM Module
- HSE-HA Software (ISOHEART, ACAD, NEURODYN or EPES)

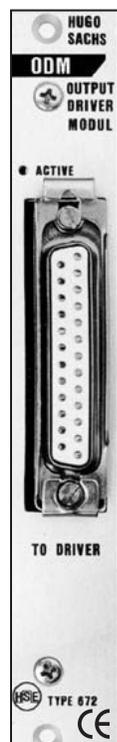
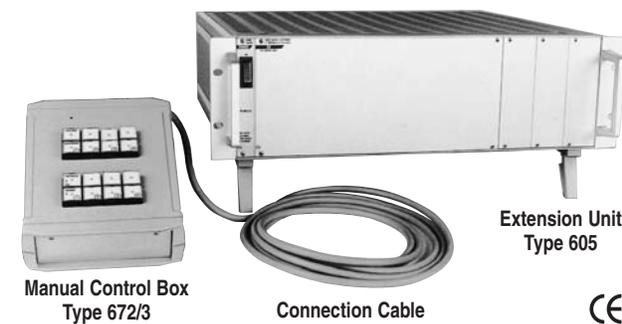
Specifications

Indication	LED indication for: 1. TTL/CMOS Level 2. Positive/Negative Trigger Pulse
Outputs	2 BNC sockets Trig1 Out and Trig2 Out, duration of trigger pulse is 20 μ sec (protected against short-circuit)
Protective Circuit	Both outputs protected against brief overvoltages up to 100 V
Supply	5 V 420 mA, supplied via PLUGSYS system bus
Dimensions, H x W x D	128.7 x 20.2 x 220 mm (5.1 x 0.8 x 8.7 in)
PLUGSYS Width*	1 slot unit
Weight	0.2 kg (0.4 lbs)
Accessories	2 BNC cables, operating instructions

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-1752		STOM Software Trigger Output Module
BS4 73-1704		Software Module to HSE-HA Software for STOM;Control

HSE-HA Output Driver Module (ODM)



- For controlling power circuits like valves or motors) from software
- Connects the extension unit 605 to the PLUGSYS system

The PLUGSYS Output Driver Module is used for the control of power circuits from a laboratory computer in automated experiments. The output driver module can control up to 6 external power switch modules each with 8 switches (a total of 48 relays). The switch board modules are installed in a PLUGSYS Extension Unit, see above.

Note: These automated experiments (e.g. on isolated tissue bath where multiple pumps and valves have to be controlled) are custom made and require several other hardware and software components. Additionally to this module the HSE-HA computer data acquisition hardware and HSE-HA software ACAD or ISOHEART is required for using the output driver module. Please ask for specific applications.

Specifications

Output	Through 25-pin connector on front panel as link between PLUGSYS system and switch board modules installed in extension unit
Control	From laboratory computer through bus of PLUGSYS measuring system
Power Supply	5 V, 400 mA through connector from PLUGSYS bus system
Dimensions, H x W x D	128.7 x 20.2 x 220 mm (5.1 x 0.8 x 8.7 in)
PLUGSYS Width*	1 slot unit
Connector	DIN 41612, 96-pin VG
Weight	0.25 kg (0.6 lbs)
Accessories	Cable, operating instructions

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-1597		ODM Output Driver Module
BS4 73-1572		PLUGSYS Extension Unit Type 649/1
BS4 73-1574		PLUGSYS Extension Unit Type 649/3
BS4 73-1600		MCB Manual Control Box Type 672/3

HSE-HA PLUGSYS Modules

Servo Controller for Perfusion (SCP) Type 704



The PLUGSYS® plug-in unit "Servo Controller for Perfusion" (SCP) is used for the perfusion of organs and tissues using a peristaltic pump in the physiological and pharmacological laboratory. It is a conventional PID controller which operates to maintain either a constant perfusion pressure or a constant perfusion flow.

For a functioning system the following additional items are required:

- Measuring system, either for perfusion pressure or for perfusion flow
- Pump suitable for external control and providing the appropriate pumping rate

Function

The pressure or flow measuring system evaluates the current perfusion pressure or perfusion flow (= actual value X); this is fed in to the "actual value" input of the SCP module (over the PLUGSYS bus). The SCP has provision for setting the required perfusion pressure (e.g. 100 mm Hg) or perfusion flow (e.g. 50 ml/min); this represents the setpoint X. From these two values the SCP module produces a control voltage (Y) for the pump so that the required perfusion pressure or perfusion flow is produced. When using a proportional-action pump (e.g. a roller pump) the pump control voltage corresponds to the perfusion flow rate. This voltage is available for further use at the Y output on the front panel. The built-in digital indication can be set to show either the actual value X, the setpoint X, or the control output signal Y.

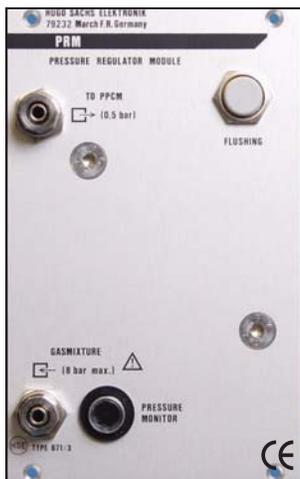
Specifications

Description	Servo Controller for Perfusion (SCP) Type 704
Function	Electronic PID Controller for Physiological and Pharmacological Research
Actual Value Input	0 - 10 V Via System Bus
Setpoint	0 - 5 V, Adjustable
Control Gain	1 - 50, Adjustable
Derivative Factor	0.1 - 100, Adjustable
Integral Factor	0.05 - 10, Adjustable
Ambient Conditions	Laboratory Indoors
Digital Indication	Range -1999 to +1999, Selectable for Actual Value, Setpoint, or Control Output Signal
Control Voltage	0 - 10 V to Operate the Pump
Recorder Output	0 - 10 V, BNC Socket
Construction	Plug-in Module for a PLUGSYS® Housing
Supply	5 V, 0.3 A from PLUGSYS® System Bus
PLUGSYS Width	2 slot units
System Connector	DIN 41612, 96-pin VG
Weight	0.3 kg
Accessories	Operating Instructions, Screwdriver, Output Cable to Pump

Catalog No.	\$	Product
BS4 73-2806		Servo Controller for Perfusion SCP

PLUGSYS Controlling Modules

Pressure Regulator Module (PRM)



- Pressure regulator 0.5 bar
- Low hysteresis

The Pressure Regulator Module PRM is a special module to provide a safe gas pressure from the high pressure of the gas cylinder to any apparatus. It is used to avoid an excessive input pressure and to prevent a dangerous overpressure on instruments, glassware, etc. It reduces the incoming gas pressure from maximum 8 bar to 0.5 bar.

Specifications

Input Pressure	8 bar max.
Output Pressure	350 mmHg (0.466 bar)
Dimensions, H x W x D	128.7 x 80.8 x 150 mm (5.1 x 3.2 x 5.9 in)
PLUGSYS Width*	4 slot units
Weight	1.2 g (2.7 lbs)

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-0195		PRM Pressure Regulator Module
BS4 73-1520		Housing for Inserting PRM and GSM

Gas Select Module (GSM)



- Used to select one of the different gas mixtures
- For hypoxic and normoxic studies on isolated organs (hearts) using pre-mixed gas tanks

The Gas Select Module GSM is used to select one of four different gases. To switch from one gas to another the stopcock of the module must be turned to the corresponding position. The GSM Module is normally used in front of the Pressure Regulator Module PRM. The GSM works under the normal high input pressure. Following the GSM, a Pressure Regulator Module PRM has to be used to avoid excessive input pressures and to prevent a dangerous overpressure on instruments.

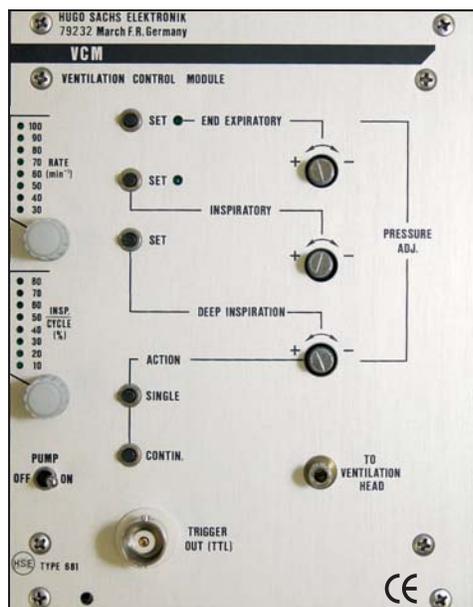
Specifications

Input Pressure	8 bar max.
Dimensions, H x W x D	128.7 x 80.8 x 150 mm (5.1 x 3.2 x 5.9 in)
PLUGSYS Width*	4 slot units
Weight	0.9 kg (2 lbs)

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-1647		GSM Gas Select Module
BS4 73-1520		Housing for Inserting PRM and GSM

Ventilation Control Module (VCM)



The Ventilation Control Module VCM has been developed especially for producing a negative pressure at a respiratory rhythm as required for operating an isolated perfused rabbits, rats, guinea-pigs, or mouse lung.

The module operates with a positive pressure. The negative pressure required for ventilation is generated by means of a venturi nozzle which is fitted externally. When used with a restrictor nozzle the module can also be employed for positive pressure ventilation during the preparation phase of the lung, a very convenient facility.

The VCM module works independently; it requires neither a vacuum nor a compressed air supply. The module consists of an electronic and a pneumatic section. A low-noise pump stores the compressed air in a small reservoir where it is stabilized electronically. The air stream which appears at the outlet connection (TO VENTILATION HEAD) passes through adjustable valves. The air is controlled electronically according to the selected respiration rate (RATE) and the selected inspiration cycle (INSP. CYCLE%). In addition one (or several) deep breaths (DEEP INSPIRATION) can be triggered by pressing a button. The output therefore consists of a rhythmically modulated air stream at a positive pressure. By connecting it to a suitable nozzle a rhythmically modulated pressure of the desired magnitude can be produced.

Specifications

Adjustment Ranges:	
Ventilation Rate	'RATE': 30, 40, 50, 60, 70, 80, 90, 100 (min ⁻¹)
Inspiration Time	'INSP. CYCLE': 10, 20, 30, 40, 50, 60, 70, 80 (%)
Airflow at Outlet	0 to 4 l/min (no back pressure)
Internal Operating Pressure	100 to 5 mmHg electronically controlled
Trigger Output (BNC Socket)	[inspiration = low level] / [expiration = high level] TTL level (open collector)
Trigger Inputs/Outputs through Internal Jumpers to PLUGSYS Bus	DEEP INSP. OUT (output TTL level open collector) EXP./INSP. OUT (output TTL level open collector) DEEP INSP.IN (input TTL load resistance 2.2 kOhm)
Power Supply	5 V 0.4 A, 24 V 0.4 A through connector from PLUGSYS bus system
PLUGSYS Width	5 slot units
Connector	DIN 41612, 96-pin VG

Catalog No.	\$	Product
BS4 73-1741		Ventilation Control Module VCM-P; uses integral pump
BS4 73-2795		Ventilation Control Module VCM-R; uses pressure regulated gas source (tank or house air): Requires gas pressure in the range of 2-8 bars.

Note: The real ventilation curve depends on the characteristics of the venturi or restrictor nozzle and the volume of the negative pressure lung chamber. All technical data refer to our isolated perfused lung setups for mouse, rat, guinea pig and rabbit.

Timer Counter Module (TCM)



The Timer Counter Module was designed to operate in conjunction with the HSE-HA Ventilation Control Module VCM used in all HSE-HA isolated lung apparatus from mice to rabbits. As a timer or event counter module it generates a signal which triggers the VCM to perform a deep inspiration cycle (sigh breath).

In order to prevent the slow collapse of the isolated lung during quiet respiration, a deep inspiration should be produced every 5 to 20 minutes. This results in an appreciable extension of the lifetime of the preparation. The VCM, see facing page, therefore has a facility for triggering such a deep inspiration by pressing the 'DIRECT' key or at the regular intervals from the HSE-HA Timer Counter Module. Other PLUGSYS modules are also capable of responding to this output signal.

Specifications

Input and Output Trigger Signals	Connections made via jumpers to trigger lines of 96-pin VG connector from internal PLUGSYS system bus
Time Mode	Deep inspiration is produced at predetermined time intervals. Quartz-controlled timer inside TCM runs down from set time to '00' and then resets counter back to selected value; when '00' is reached, VCM is triggered to perform deep inspiration cycle.
Count Mode	Deep inspiration is produced after predetermined number of respiratory cycles of VCM. Respiration cycles are counted down on presetting counter inside TCM; when zero is reached, VCM is triggered to perform deep inspiration cycle and counter automatically resets to preset value
Preset	Time or event presetting is selected on two digit thumbwheel switch (00-99) mounted on front panel; time or count range can be altered with switch SEC/MIN or x1/x10 to select appropriate factor
Warning Function	TCM incorporates warning function which announces next triggering operation; announcement activated when internal timer or counter counts last 10 seconds or respiratory cycles; function is indicated visually on LED and audibly by built-in loudspeaker. Purpose of facility is to remind user that deep inspiration is coming shortly. This can be inhibited by pressing 'SKIP NEXT' key, if desired to avoid interference with any measurement during experiment.
Power Supply	5 V, 350 mA through connector from PLUGSYS bus system
PLUGSYS Width	1 slot unit

Catalog No.	\$	Product
BS4 73-1750		Timer Counter Module TCM

PLUGSYS Controlling Modules

HSE-HA Plethysmograph Control Unit Module (PCU)



- Control unit for switching valves, jet nebulizers, oxygen flushing in a multiple animal study using Plethysmograph Box 855
- Can be driven by the HSE-HA* Software PULMODYN 'Pennock'

This module has been developed specially for the investigation of bronchospasmolytic-active substances on the awake animal in combination with the plethysmograph box type 855 and the membrane valves in the PLUGSYS system. This type of experiment involves switching valves, nebulizer and oxygen periodically on and off in a specific sequence.

The PCU module together with the Manual Control Box (must be ordered separately) is used to automate and synchronize the switching of these valves, nebulizer etc.

On the Manual Control Box it is only necessary to select a specific state (measurement, challenge, flushing, calibration) and the PCU switches all the valves according to this state. The PCU also delivers the bias flow for the Plethysmograph box. One PCU can control two plethysmograph boxes. With an extension module it is possible to control up to four boxes. In addition the module provides for control of all four plethysmograph boxes from a computer so that a complete computerized system can be set up. This module also incorporates monitor functions. It checks whether oxygen pressure for flushing is applied and provides an appropriate warning. It also checks whether aerosol challenge is followed by flushing and if not provides a warning. The connection to the plethysmograph boxes consists of 6-way ribbon tubing with the connectors 'To Plethysmograph Box 1' and 'To Plethysmograph Box 2'. Each channel can be switched on and off separately.

Specifications

Inlet Oxygen	Receives oxygen for flushing plethysmograph box — DO NOT exceed 6 bar
Inlet Compressed Air	For switching membrane valves, driving aerosol jet nebulizer and generating bias flow in plethysmograph box via venturi jet — DO NOT exceed 6 bar
LED Oxygen Fault	Blinks and sounds beeper if no oxygen is delivered (empty cylinder or closed valve at oxygen pressure reducer)
Power Supply	5 V/600 mA, through connector from PLUGSYS bus system
Dimensions, H x W x D	128.7 x 121.9 x 220 mm (5.1 x 4.8 x 8.7 in)
PLUGSYS Width*	6 slot units
Connector	DIN 41612, 96-pin VG
Weight	0.8 kg (1.8 lbs)
Accessories	Operating instructions

* Note: For description of Slot Unit, see page 128.

Catalog No.	\$	Product
BS4 73-1748		PCU Plethysmograph Control Unit for Channel 1
BS4 73-1749		PCU Plethysmograph Control Unit Extension for Channel 2 or 4
BS4 73-1754		PCU Plethysmograph Control Unit Extension for Channel 3
BS4 73-3423		Manual Control Box to PCU Plethysmograph Control Unit

Refer to page F76 for the complete System.

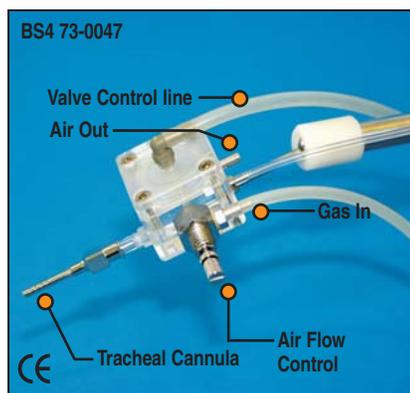
HSE-HA Multiple-Channel Ventilator for Large Rodents



BS4 73-0046



BS4 73-0048



BS4 73-0047



Set up for 4 Animals

The HSE-HA Multiple-Channel Ventilator is a modular system for ventilation of one to eight large rodents. The respiratory rate is adjustable from 30 to 100 breaths per minute. It is based on the PLUGSYS system, see Section I for a complete description of the PLUGSYS system. The primary component is the Ventilator Sequencer Module (VSM) which plugs into a PLUGSYS mainframe case and is used to set the respiratory rate, inspiratory:expiratory (I:E) ratio and the maximum inspiratory pressure (i.e. safety pressure) for all animals. The safety pressure is set by the researcher and is used to prevent over inflation of the animal's lungs. The VSM requires a compressed air supply and, using both electronic and pneumatic controls, directs the air flow to the VSM ventilation head.

One to eight ventilation heads BS4 73-0047 can be connected to the VSM. If more than one ventilation head is used, a connecting block BS4 73-0048 is required. A directional valve within the ventilation head is controlled by the VSM to regulate the inspiratory and expiratory cycle. The VSM ventilation head includes all necessary tubing.

An optional MPX pressure transducer, BS4 73-0064, can be connected to the ventilation head. This pressure transducer attached to a TAM-A transducer amplifier, BS4 73-0065, page I33, can be used to record tracheal/airway pressures. This setup is described more thoroughly in the Einthoven Anti-asthmatics system, see our website. All components must be purchased separately.

HSE-HA Ventilation Sequencer Module (VSM)

The HSE-HA Ventilation Sequencer Module (VSM) consists of an electronic and a pneumatic section and requires a compressed air supply. The VSM module with the ventilation head operates on the principle of 'intermittent constant flow ventilation'. A continuously adjustable air flow is passed by a main valve either to the animal (during inspiration) or to an overflow outlet (during expiration). The design of the main valve provides an adjustable, pressure controlled, protection against excessive pressure rise in the animal's lung. The main valve is controlled electronically according to the selected respiration rate (RATE) and the selected inspiratory cycle (INSP. CYCLE %). The safety pressure which is the maximum admitted inspiratory pressure can be adjusted on the VSM module. The timing and the safety pressure are the same for all the ventilation heads, the constant air flow during inspiration can be adjusted individually on each ventilation head.

- Ventilate up to eight rodents at the same time
- Adjust tidal volume individually
- Very small dead space volume
- For applications where multiple rodents must be ventilated simultaneously (e.g. multiple blood pressure measurement)
- For Einthoven bronchospasmolysis test on multiple animals

Specifications

Compressed Air Supply:

Minimum	4 bar (58 lbs)
Maximum	8 bar (116 lbs)

Respiratory Rate

30, 40, 50, 60, 70, 80, 90, 100 breaths/min

Inspiratory Time

10, 20, 30, 40, 50, 60, 70, 80 % of total cycle duration

Control of Ventilation Heads:

Ventilation Pressure	150 mmHg
Control Pressure	Adjustable 0 to 50 cmH ₂ O, safety pressure set at 'Max. Insp. Pressure'

Ventilator Sequencer Module (VSM)

Indication	LED lights up during inspiration
Trigger Output	BNC socket on front panel (TTL open collector; inspiration = low level; expiration = high level); trigger signal also available on PLUGSYS bus system
Power Supply	5 V 0.4 A and 24 V 0.18 A through connector from PLUGSYS bus system
Dimensions, H x W x D	1128.7 x 101.6 x 220 mm (5.1 x 4 x 8.7 in)
PLUGSYS Width	5 slot units
Connector	DIN 41612, 96-pin VG

Catalog No.	\$	Product
BS4 73-0045		PLUGSYS Basic System Case
BS4 73-1523		PLUGSYS Minicase ¹
BS4 73-1537		PLUGSYS Minicase Case Extension Option ¹
BS4 73-1538		PLUGSYS Minicase 24 V Option ¹
BS4 73-0046		Ventilator Sequencer Module (VSM) ⁴
BS4 73-0048		Connecting Block for up to 8 Ventilation Heads
BS4 73-0047		Ventilation Head Kit ²
BS4 73-0500		Stand with Triangular Plate
BS4 73-0557		Perspex X-Block ³
BS4 73-0064		MPX Pressure Transducer ³
BS4 73-0065		TAM-A Amplifier Module ⁴

1 Alternative case if pressure monitoring not used.
 2 Kit includes ventilation head, stand and block clamp.
 3 One required for each MPX transducer.
 4 For more information on VSM, MPX Transducer or TAM-A, see Section I.

PLUGSYS Controlling Modules

HSE-HA Programmable Stimulator Module (PSM)



- Combination of stimulator and measurement system in one
- Up to 8 channels in one main frame
- For applications with tissue baths

The Programmable Stimulator Module PSM is a square-wave single-channel stimulator with isolated constant-current output for the PLUGSYS system. It has been developed specially for stimulating isolated tissue in physiological and pharmacological research. The stimulator is operated through software from a PC. All the settings are performed through the control

program STIMULUS or through HSE-HA Software ACAD or ISOHEART. The system features interactive operation, i.e. all inputs are set at a special user level with window menus. The instrument settings are stored inside the computer on disk or hard disk and can at any time be loaded into the stimulator module using the control program. With automated experimental setups the stimulator can be controlled from evaluation HSE-HA software. For example, in automatically evaluating

the refractory period of an isolated guinea-pig atrium, each stimulation cycle is followed by recalculation of the interval between the first and second stimulus of the twin stimulation, and the appropriate changes are then made to the settings of the stimulator module. The unit cannot be operated by itself; it requires at least the system components listed below.

Note: In case of using more than one PSM in the basic system case, an additional power supply must be installed (option 5, 24 V DC, 100 VA). A maximum of 4 PSM modules can be installed (power consumption 100 VA).

Specifications

Construction	Programmable Stimulator Module PSM designed as module of HSE-HA PLUGSYS measuring system; occupies one slot unit
Hardware Required	Pentium computer, at least 500 MHz; HSE-HA PLUGSYS basic system case, Type 603; HSE-HA data acquisition hardware, PLUGSYS version; DIM-D Digital Bus Link for DIM
Software Required	Microsoft WINDOWS 2000/XP/NT; HSE-HA Stimulator Control Program Stimulus; HSE-HA software ACAD, ISOHEART, NEURODYN or EPES with according Software module
Operating Modes	Free-running (continuous stimulation); Trains; hardware-triggered through control signal; software-triggered through control command; single or twin stimulation; output current polarity fixed or alternating (automatic change-over after each stimulation cycle)
Basic Rhythm R	Continuously adjustable between 100 msec and 10 sec
Delay D	Spacing between stimulus 1 and stimulus 2 adjustable between 1 msec and 1 sec, or 0 for no twin stimulation
Width W	Stimulus duration adjustable between 0.5 msec and 200 msec
Output O	Output can be programmed from 1 mA to 25 mA or from 10 mA to 250 mA (manual change of current range)
Power Supply	+ 5 V/700 mA and + 24 V/1 A through connector from PLUGSYS system bus
Dimensions, H x W x D	128.7 x 20.2 x 220 mm (5.1 x 0.8 x 8.7 in)
PLUGSYS Width*	1 slot unit
Connector	DIN 41612, 96-pin VG
Weight	0.35 kg (0.8 lbs)

Catalog No. \$ Product

BS4 73-0221	PSM Programmable Stimulator Module
BS4 73-0161	HSE Data Acquisition Hardware, PLUGSYS Version
BS4 73-0223	DIM-D PLUGSYS Digital Bus Link Module Amplifier
BS4 73-3497	Software "Stimulus" for PSM and PPG Control
BS4 73-0224	Software Module to HSE-HA Software for PSM and PPG Control

NEW HSE-HA Programmable Pulse Generator (PPG)



Hardware Features:

- Microprocessor controlled
- All functions programmable via PLUGSYS I/O and MS-WIN PC
- Complementary TTL pulse output

Software Features:

- Stimulation mode free run or hardware triggered
- Single pulse or train stimulation
- Stand alone system with PPG control software
- Fully supported and controlled by HSE-HA Software.

The PPG Programmable Pulse Generator Module is a module of the HSE PLUGSYS measurement system. In combination with a MS-Windows compatible computer, additional I/O hardware and the PPG control software, the module forms a programmable stimulation pulse generator (repetition rate and pulse width). The stimulus outputs are TTL compatible and have a minimum

drive capability of 4 standard TTL inputs. The complementary output offers both active high and active low pulse signals. Therefore the PPG can direct control e.g. up to four HSE UIISO Universal Isolated Stimulator Outputs or any external stimulator output stage with TTL gating or trigger possibility.

The PPG is connected to the A/D converter and controller board of the computer via the DIM and its extension DIM-D. The DIM and the A/D board are connected by the data cable. The DIM-Module is installed on the rear side of the PLUGSYS mainframe, the A/D converter and controller board is installed in the computer.

The software installed on the control computer presents a menu to adjust the different stimulation parameters pulse width and frequency. These parameters can be stored on disk for later use. The PPG control software has to be recalled to make any changes in the stimulation parameters.

Specifications

Rise and fall time	200 nsec.
Output	2 Stimulus TTL outputs (1 POS and 1 NEG), BNC sockets on front panel
Output Resistance	50 Ohm
Supply	5 V, 350 mA max from PLUGSYS system bus
Pulses	TTL compatible
Connector	DIN 41612 96-pin VG (PLUGSYS system bus)
PLUGSYS Width	1 slot unit (20,2 mm)
Ambient Conditions:	
Operating Temperature	0 to 40°C
Humidity	20 to 80% relative humidity, no condensation
Storage Temperature	-20 to + 60°C

Catalog No. \$ Product

The following components are all required for this module.

BS4 73-3097	PPG Programmable Pulse Generator Module
BS4 73-0161	HSE Data Acquisition Hardware, PLUGSYS Version
BS4 73-0223	DIM-D Digital Bus Link for DIM
BS4 73-3497	Software "Stimulus" for PSM and PPG Control
BS4 73-0224	Software Module to HSE-HA Software for PSM and PPG Control

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11,000 Specialty Products to Enhance Your Bioresearch

NEW Laser Doppler Flowmeter BRL-100



- Small and light weight.
- Multiple types of sensors are available.
- Measuring range from small animals (i.e., mouse and rat) to large animals.
- Simple and easy to operate.
- Flexibility in applications. (acute to chronic)

Principles of Measurement

The laser light strikes the moving corpuscles in the blood and is reflected back to a receiving sensor which measures the doppler shift in the original signal. The laser light that strikes the tissue is absorbed and no light is reflected back to the receiving sensor.

The BRL-100 detects the heterodyne wave from some of the laser light. It analyzes the light signal using the Stern method. It can calculate the flow parameters by looking at the amount of the blood flow.

The BRL-100 is perfect for the monitoring of the blood circulation in small animals

Since ordinary laser flow meters are basically designed and made for human use, these flow meters exhibit several disadvantages when used on small animals, such as: extremely large sensors, heavy optical fiber cables, and a fixed number of circuits for measuring the human body not applicable to small animals.

The BRL-100 is an efficient design to reduce the cost and to simplify the operation of the laser flow meter. Light optical fiber cables and miniaturized sensors are utilized so that smaller animals may be measured.

Specifications

Type of Laser	Semiconductor Laser 780 nm
Fiber	80 μ m, GI, Quarts Fiber
Laser Output	1.5 nW (At the End of the Connector)
Gain	0–1000
CAL	100 mV
Indicator	4 digit, LED
Analog Output	1 mV Output/1 digit
Power Requirements	230 V or 120 V AC. 50/60Hz
Consumption	15 VA
Size, H x W x D	74 x 216 x 235 mm
Weight	4.18 lbs (1.9 kg)

Sensor

Plate Type (suitable for Skin, Organ Surface)

BP-8S Plate OD = 8mm, H = 0.7mm
Body OD = 4mm, H = 3mm



BP-8L Plate OD = 8mm, H = 0.7mm
Body OD = 4mm, H = 3mm



Disc Type (suitable for Brain Cortex, Organ Surface)

BD-6 Body OD = 6mm, H = 3mm



Straight Type (suitable for Brain Cortex, Organ Surface, Spinal Marrow)

BS-24 Body OD = 2.4mm, H = 10mm



Needle Type (suitable for Brain, Muscle, Organ, Spinal Marrow)

BN-11 Tip OD = 1.1mm, H = 6mm
Body OD = 2.4mm, H = 4mm



BN-05 Tip OD = 0.5mm, H = 6mm
Body OD = 1.3mm, H = 5mm



Catalog No.	\$	Model	Product
BS4 73-0748		BRI-100	Laser Doppler Flowmeter
BS4 73-1197		BP-8S	Plate Type Laser Doppler Flow Probe
BS4 73-1198		BP-8L	Plate Type Laser Doppler Flow Probe
BS4 73-1199		BD-6	Disk Type Laser Doppler Flow Probe
BS4 73-1200		BS-24	Stick Type Laser Doppler Flow Probe
BS4 73-1201		BN-11	Needle Type Laser Doppler Flow Probe
BS4 73-1202		BN-05	Needle Type Laser Doppler Flow Probe

Amplifier Interfaces



- Extremely versatile
- Two models available:
 - Modular for plugging directly into Modular Universal Oscillographs, see page I66
 - Freestanding for direct connection to Data Acquisition Systems, see pages I102 to I146, Student Oscillograph or other recording devices, see pages I65 to I70

Transducer Interface

The Modular Interface receives its power from the Modular Universal Oscillograph. The Freestanding Interface is AC powered. This interface handles six transducer types using a six-position switch, see page I66.

Transducer Types:

- Isometric** For force of muscle contraction, use with Harvard Apparatus Isometric Force Transducers, see page I8. Two series of isometric transducers are available in various load forces, see Harvard Apparatus Isometric Transducers and UF1 Series Isometric Transducers.
- Isotonic** For isotonic muscle contractions, use with BS4 50-6360 Harvard Apparatus Isotonic Transducer, see page I8. Pivoting beam of Isotonic Transducer gives electrical output proportional to angular rotation.
- Pressure** For direct blood pressure, use with the Blood Pressure Transducer, see Cardiovascular Section J. Blood Pressure Transducer features removable transparent dome, two Luer fittings, minimum volume and displacement and range of ± 300 mmHg. For indirect blood pressure, use with BS4 50-4472 Armcuff with Microphone.
- Pneumograph** For human respiratory waveform, use with BS4 50-8028 Pneumograph with Transducer. Pneumograph consists of a corrugated bellow that straps around chest and pressure transducer that transforms chest excursion into voltage suitable for recording.
- Plethysmograph** For human arterial pulse, use with BS4 50-8093 Finger Plethysmograph. Plethysmograph is practical finger transducer that responds to blood density changes produced by peripheral pulse.
- Potentiometric** In this mode, Transducer Interface responds to changing resistance from potentiometer, as found in BS4 50-1676 Student Spirometer, see page F52. Front panel DC level control permits compensation of DC component of input signal. 7-pin DIN female input connector is also located on front panel of Transducer Interface and allows connection of variety of transducers.

Specifications

Dimensions, H x W x D:	
Modular	50 x 120 x 120 mm (2 x 4.75 x 4.75 in), approx.
Freestanding	95 x 165 x 138 mm (3.75 x 6.5 x 5.25 in)
Freestanding Weight	750 g (1.7 lb)

Catalog No.	\$	Product
BS4 50-8861		Modular
BS4 50-7970		Freestanding, 115 VAC, 60 Hz
BS4 50-7996		Freestanding, 230 VAC, 50 Hz
BS4 50-9158		Replacement 7-Pin Female Input Connector for Front Panel
BS4 50-9141		7-Pin Male Connector for Mating with Front Panel Female Connector
BS4 50-9166		7-Pin Female In-Line Connector for Use in Making Extension Sets



AC/DC Preamplifier Interface

- For ECG, EMG, ENG and EOG
- High gain, low noise and drift
- Step gain switch, x10, x50, x100, x200, x500, x1000
- AC/DC selector switch
- DC level control

This is a general purpose differential Preamplifier for animal use only. There is a 6-position gain switch (x10, x50, x100, x200, x500 and x1000), an input selector for AC or DC coupled, a filter selector (3 dB at 15 Hz, 150 Hz and 15 kHz) and a DC level control giving a maximum offset range of ± 4 volts. Common mode rejection is greater than 80 dB and the maximum gain when used with a Harvard Apparatus Oscillograph is 30 $\mu\text{V}/\text{cm}$ of pen deflection. The input impedance is 4.7 M Ω . Input is via a 7-pin binder socket and output via edge connector into the Universal Oscillograph or Interface Adapter.

Catalog No.	\$	Product*
BS4 50-8879		AC/DC Preamplifier Interface
BS4 50-9836		3-Lead Surface Electrode Set
BS4 50-9802		3-Lead Animal Electrodes
BS4 50-7954		Male 3-Pin DIN Input Connector

* For Biopotential Leads and Electrodes, see pages I71 to I77.

Amplifier Modules on pages I60 to I62 are designed to interface with Harvard Apparatus's Amplifier Case, see page I69, Chart Recorders, see pages I65 to I70 and the CEPTU physiology system, see pages I65 and I64.

Amplifier Interfaces



Thermistor Interface

When used with a Harvard Apparatus thermistor or YSI series 400 Thermistor, temperature is displayed on the LCD and produced as a DC level proportional to temperature from the linear range when used with the above mentioned thermistors is 30° to 50°C. Input is via a standard phone socket and output via edge connector into the Universal Oscilloscope or Interface Adapter.

Catalog No.	\$	Product
BS4 50-8903		Thermistor Interface
BS4 50-9133		General Purpose Temperature Probe
BS4 59-9808		Rectal Probe
YSI 400		Any YSI 400 series Thermistor Probes, see pages P28 and P29



Isolator Interface

The sole purpose of this interface is to allow connection of the Harvard Apparatus range of Isolated Preamplifiers to the Universal Oscilloscope or Interface Adapter. The On/Off control is used to connect the battery power in the Isolated Preamplifier.

Catalog No.	\$	Product
BS4 50-5966		Isolator Interface



Cardiotach Interface

The Cardiotach counts repetitive events such as ECG or blood pressure wave forms and gives a DC level output proportional to rate in beats per minute. Counting is done on a beat-to-beat basis. Input is taken from the 'monitor' socket on the Harvard Apparatus Universal Oscilloscope, via a BNC lead which is supplied. There are two ranges: 17 to 250 bpm and 17 to 500 bpm. A 'Trig Level' control sets the threshold level for counting, and there is an 'Under Range' indicator to warn that no wave forms are being counted. The top panel output gives 1 volt per 100 bpm for use with the BS4 50-8960 Harvard Cardiotach Display.

Catalog No.	\$	Product
BS4 50-8895		Cardiotach Interface

Cardiotach Display

Solely for use with the BS4 50-8895 Cardiotach Interface. This Display fits into the top right hand corner of the Harvard Apparatus Universal Oscilloscope and receives its power and signal from the Cardiotach Interface via the a cable supplied. Beats per minute are displayed on the LCD.

Catalog No.	\$	Product
BS4 50-8960		Cardiotach Display

The following Harvard Apparatus Freestanding Preamplifiers are offered for use with the Harvard Student Oscilloscope, flat bed recorders and computer interfaces.

Freestanding Transducer Amplifiers

This is to give power to and amplify signals from the Harvard Apparatus range of transducers (Isotonic, Isometric, Pressure, Plethysmograph and Potentiometric chosen by 6-position selector switch). This is an Isometric Filter to reduce the effort of gas bubbles vibrating the preparation and a DC Level Control for balancing transducers to base line. Input is via a 7-pin binder socket and the output is via a BNC lead. It measures 95 x 165 mm (3.75 x 6.5 x 6.3 in) and weighs 0.75 kg. (1.65 lb). See page 160 for complete details.

Catalog No.	\$	Product
BS4 50-7970		Freestanding Transducer Amplifier, 115 VAC, 60 Hz
BS4 50-7996		Freestanding Transducer Amplifier, 230 VAC, 50 Hz



Basic Audio Amplifier

A general purpose AC coupled amplifier with a selectable modulation facility. Input is via two 4 mm tie posts/sockets. It is battery powered and has a level indicator. It measures 95 x 165 mm (3.75 x 6.5 x 6.3 in) and weighs 0.6 kg. (1.32 lb).

Catalog No.	\$	Product
BS4 50-5172		Basic Audio Amplifier

Transducer Amplifier Interface



Isolated GSR Preamplifier

- For GSR on human subjects for teaching purposes only

The front end of the preamplifier is battery powered (2 x 9 volt transistor radio batteries) while the back end receives its power from the host unit. A meter shows battery state and the batteries are connected only when linked to the host unit. There are 3 ranges (0 to 10 k Ω , 0 to 100 k Ω and 0 to 1 M Ω) and DC level control, built in audio speaker with modulation facility and a normal/differential switch. The maximum sensitivity is 50 Ω /cm of pen deflection when used with the Harvard Apparatus oscillographs. It is supplied with the BS4 50-9521 GSR Finger Electrode Set.

The BS4 50-5966 Isolator Interface is needed to connect this unit to a Universal Oscillograph or Interface Adapter, or it plugs directly into the Harvard Apparatus Student Oscillographs.

Catalog No.	\$	Product
BS4 50-9505		Isolated GSR Preamplifier
BS4 50-7954		Male 3-Pin DIN Input Connector
BS4 50-9810		GSR Palm Disposable Electrode Set, see page 172; use as an alternative to the BS4 50-9521 2-Lead Input Cable with Finger Electrodes which is included with the Amplifier



Isolated Preamplifier

- For ECG, EMG, ENG, EOG on human subject for teach purposes only

The front end of the Preamplifier is battery powered (2 x 9 volt transistor radio batteries) while the back end receives its power from the host unit. A meter shows battery state and the batteries are connected only when linked to the host unit. The input is via either the 3-pin binder socket or the row of five standard color coded 2 mm sockets (labeled LA, RA, LL, RL and C) for 5 electrode ECG measurements. A 7-position 'limb' selector allows connection of the standard ECG electrode configurations.

There is a 3-position gain switch (x10, x100 and x1000), an input selector for AC or DC coupled, a filter selector (3 dB down at 30 Hz, 150 Hz and 15 kHz) and a DC level control. Maximum gain when used with a Harvard Apparatus Oscillograph is 30 μ V/cm of pen deflection. A comprehensive range of electrodes and input leads is available.

The BS4 50-5966 Isolator Interface is needed to connect this unit to a Harvard Apparatus Universal Oscillograph or Interface Adapter. The Isolated Preamplifier will plug directly into the Harvard Apparatus Student Oscillographs, see page I68.

Catalog No.	\$	Product
BS4 50-9513		Isolated Preamplifier

* For Biopotential Leads and Electrodes, see pages 171 to 177.



AC/DC Preamplifier

This is a general purpose differential preamplifier for use on animals. It is powered by two 9 volt batteries (not supplied) and has a battery meter. Input is via a 3-pin binder socket and there is a two position gain control (x10 and x100 for DC coupled; x100 and x1000 for AC coupling). LF out (3 db down at 1, 5, 10, and 100 msec and 1 sec) and HF out (3 db down at 40 Hz, 100 Hz, 1 kHz, 10 kHz and 40 kHz) are selectable by two controls. Input impedance is 4.7 M Ω and the output is from a BNC connector. It measures 95 x 165 mm (3.75 x 6.5 x 6.3 in) and weighs 0.75 kg. (1.65 lb).

Catalog No.	\$	Product
BS4 50-5131		AC/DC Preamplifier

The Amplifier Modules on pages I60 to I62 are designed to interface with Harvard Apparatus's Amplifier Case, see page I69, Chart Recorders, see pages I65 to I70 and the CEPTU physiology system, see pages I65 and I64.

Complete Electrophysiology Teaching Unit



Harvard's Electrophysiological Teaching Unit enables students to grasp the essentials of complex electrophysiological control functions including:

- Electrocardiograms
- Electromyograms
- Simple electroencephalograms
- Other bioelectrical measurements

The Electrophysiological Teaching Unit is for investigating, displaying, and analyzing most bioelectrical phenomena of importance to nerve-muscle studies including:

- Stimulus-reaction times
- Reflexes
- Nerve transmission speed
- Nerve mapping
- Nerve-muscle preparation
- Neurological reflex

The Electrophysiology Teaching Unit has the following integral components:

- 2-Channel Oscilloscope
- 2-Channel Stimulator
- Audio Amplifier switchable between channels
- Transducer Interface (same as BS4 50-8861 Transducer Interface, see page I60)
- 2 preamplifier inputs for connection of two BS4 50-9513 Isolated AC/DC Preamplifiers supplied

A comprehensive range of accessories are also supplied including all leads and connectors necessary for most needs and a practical handbook that gives students a firm foundation in basic electrophysiology, see facing page. The inputs are totally isolated electrically from the outputs.

The Oscilloscope has a 12.7 cm (5 in) dual-trace CRT with a 10 x 8 cm (4 x 3.1 in) display. The 2-Channel Stimulator is well-suited for both teaching and research applications. The two channels share the same pulse generator but each channel has independent controls for delay, pulse width and voltage. Each channel can be used independently or the outputs can be combined to produce stepped waveforms. The Stimulator includes a sync output for the oscilloscope and trigger inputs for remote triggering of the Stimulator.

Complete Electrophysiology Teaching Unit

The two BS4 50-9513 Isolated AC/DC Preamplifiers, see page I62 for full details, are connected externally to the Electrophysiological Teaching Unit, enabling measurements such as vector cardiography. In addition, for certain experiments, two students can use the equipment at one time. The high gain, low noise and high common mode rejection make these Preamplifiers suitable for applications at the micro-volt level, which is within the range of nerve and muscle potentials, ECG, EMG and EEG signals. The Preamplifiers are optically-isolated and battery-powered for maximum safety.

The Audio Amplifier can be used to monitor the twin Preamplifiers' signal. The controls on the front panel select the modulation facility and the channel to be monitored.

The Transducer Interface has suitable bridge and amplifier circuits for use with Harvard Apparatus's complete range of transducers, see right. A multi-turn potentiometer can be used to adjust the DC level. A mode selection switch matches the input to the appropriate transducer.

Specifications

Oscilloscope:

Vertical Deflection	5 mV/div to 20 V/div
Time Base	0.5 μ sec/div to 0.2 sec/div
Input Impedance	1 M Ω // 30 pF
Input Coupling	AC/DC

Stimulator:

Frequency	0.1 to 1000 Hz
Delay	0.1 to 1000 msec
Width	0.05, 0.1, 0.5, 1, 2, or 5 msec
Voltage	0.25 to 25 V in 3 ranges
Output Impedance	22 Ω
Triggers	Oscilloscope and external

Isolated AC/DC Preamplifier:

Input	Differential, isolated
Output	Single-ended
Common Mode	
Rejection	> 70 dB
Gain	x10, x100, x1000
HF Filters	30 Hz, 150 Hz, 15 kHz
Coupling	AC/DC
Input Configuration	Simple three-lead differential or clinical with modes I, II, III, AVR, AVL, AVF, V

Audio Amplifier:

Power Output	0.1 W, max.
External Loudspeaker Load	4 Ω
Dimensions, H x W x D	43 x 53 x 33 cm (17 x 21 x 13 in)
Weight	22 kg (48 lb)

Catalog No.	\$	Product
BS4 50-8259		Complete Electrophysiological Teaching Unit, 115 VAC, 60 Hz
BS4 50-8267		Complete Electrophysiological Teaching Unit, 230 VAC, 50 Hz

Individual Components Included with Electrophysiological Teaching Unit

BS4 50-9513		Isolated AC/DC Preamplifiers, pkg. of 2
BS4 50-6360		Isotonic Transducer
BS4 50-7905		Harvard Apparatus Isometric Transducer, 0 to 50 g Force Range
BS4 50-8275		Harvard Apparatus Stimulus Isolation Unit with Positive Output Pulses
BS4 50-5271		Patella Hammer
BS4 50-5305		Stimulating Electrode with Round 1 cm (0.4 in) D Tip for Stimulating with Voltages up to 100 V
BS4 50-7004		Screened Electrode
BS4 50-7020		Nerve Conduction Chamber
BS4 50-9539		Plate Electrodes and Straps, pkg. of 4
BS4 59-8438		Disposable Foam Electrodes, 48 mm (1.9 in), pkg. of 50
BS4 50-9265		Nondisposable Ag/AgCl Cup Electrodes, pkg. of 3 Electrodes, 2 pkgs. Supplied
BS4 50-9273		Small Double-Sided Adhesive Discs to Hold Nondisposable Ag/AgCl Cup Electrodes, Roll of 100
BS4 50-5313		Electrode Gel
BS4 50-8309		Syringe with Blunt Needle
BS4 50-5321		Electrode Adhesive Tape
BS4 50-9570		4 mm Socket to Snap Fastener (Press Stud) Connector, pkg. of 5
BS4 50-9547		3-Lead Input Cable, 3-Pin DIN to Three 1 mm Plugs
BS4 50-9562		ECG Limb Cables, 2 mm Plugs to 4 mm Plugs, Color-Coded, pkg. of 5
BS4 50-7954		Male 3-Pin DIN Input Connector, pkg. of 2
BS4 50-9232		BNC to BNC Output Leads, pkg. of 5

Transducer Interface of this Teaching Unit is For Use With:

BS4 50-6360 Harvard Apparatus Isotonic Transducer, see page I8

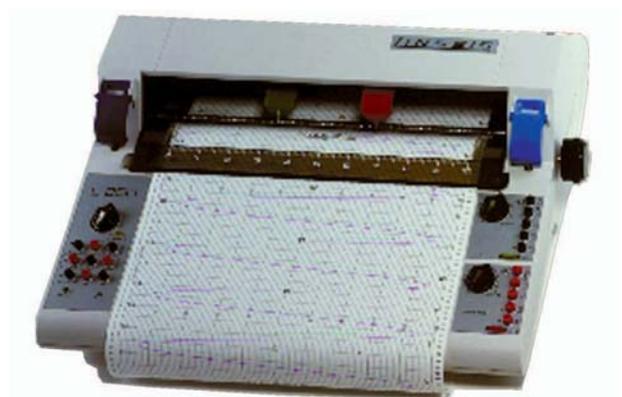
Harvard Apparatus Isometric Transducers, see page I8

BS4 50-7905	0 to 50 g
BS4 50-7913	0 to 100 g
BS4 50-7921	0 to 200 g
BS4 50-7939	0 to 500 g
BS4 50-7947	0 to 1000 g

UF1 Series Isometric Transducers, see page I7

BS4 50-7293	0 to 25 g
BS4 50-8036	0 to 55 g
BS4 50-8044	0 to 110 g
BS4 50-8051	0 to 220 g
BS4 50-8069	0 to 450 g
BS4 50-8077	0 to 900 g
BS4 50-8093	Finger Plethysmograph
BS4 50-8028	Pneumograph with Transducer

Flatbed Recorders



This series of laboratory strip chart recorders have been updated with the latest in mechanical and electrical design. Mechanical features include on board pen storage holders to extend the life of the pens, exposed feed paper for easy monitoring and loading. Electrical features include single chip hybrid technology, easy access calibration ports, easy push button design. Both the economy and deluxe series are available in three different chart sizes: 120 mm, 200 mm, 250 mm Common features on both series include; individual electric pen lift, mV and Volt ranges, 16-speed chart drive, fiber tip disposable pens, and a manual chart position knob. The deluxe series offers these additional features: external chart drive control, chart paper repeat function, chart advance to next grid, forward reverse recording, and 5 – 1000 mA recording ranges.

Flatbed Recorders				
Chart Width	Economy		Deluxe	
	1-Channel	2-Channel	1-Channel	2-Channel
120 \$	BS4 72-2982	BS4 72-2985	BS4 72-2988	BS4 72-2991
200 \$	BS4 72-2983	BS4 72-2986	BS4 72-2989	BS4 72-2992
250 \$	BS4 72-2984	BS4 72-2987	BS4 72-2990	BS4 72-2993

Catalog No.	\$	Description
BS4 72-7678		Ink Set for Flatbed Recorder, Blue, includes Filling Syringe and 30 cc Ink
BS4 72-3533		Ink Set for Flatbed Recorder, Green, includes Filling Syringe and 30 cc Ink
BS4 72-3534		Ink Set for Flatbed Recorder, Red, includes Filling Syringe and 30 cc Ink
BS4 72-3535		Ink Set for Flatbed Recorder, Black, includes Filling Syringe and 30 cc Ink
BS4 72-7679		Repl. Pens for Flatbed Recorder, Blue, pkg. of 5
BS4 72-3528		Repl. Pens for Flatbed Recorder, Green, pkg. of 5
BS4 72-3529		Repl. Pens for Flatbed Recorder, Red, pkg. of 5
BS4 72-3530		Repl. Pens for Flatbed Recorder, Black, pkg. of 5
BS4 72-2994		Replacement Paper, 120 mm, 16 M L, pkg. of 10
BS4 72-2995		Replacement Paper, 200 mm, 16 M L, pkg. of 10
BS4 72-2996		Replacement Paper, 250 mm, 16 M L, pkg. of 10
BS4 72-2997		Replacement Paper, 250 mm, 25 M L, pkg. of 10

- 15 voltage ranges 1 mV to 50 V
- Single chip hybrid technology
- 16 chart speeds 0.1 to 20 mm/sec/min
- Manual and electric paper advance/rewind
- Optional monitor input signal, counter voltage, temperature controller types

Specifications

Number of Channels	1 or 2
Chart Width	120, 200 or 250 mm
Input Ranges:	
Economy	1, 2, 6, 10, 20, 60, 100, 200 mV 0, 5, 1, 2.5, 5, 10, 25, 50 V
Deluxe	1, 2, 5, 10, 20, 50, 100, 200 mV 0.5, 1, 2.5, 5, 10, 25, 50 V 5, 10, 25, 50, 100, 250, 500, 1000 mA
Zero Setting	Chart width plus 200% suppression
Accuracy:	
Economy	0.5%
Deluxe	±0.35% or ±10 μV
Linearity:	
Economy	±0.35%
Deluxe	±0.25%
Full Scale Deflection Time	> 0.12, > 0.18 or > 0.2 sec
Input Impedance:	
DC mV Ranges	> 30 MΩ
DC V Ranges	2 MΩ
DC mA Ranges*	< 1 Ω
Source Impedance:	
Economy	< 6 KΩ
Deluxe	5 KΩ
Overload Protection	Electronic
Range Expansion	Continuously adjustable up to 250% of selected range
Cut-Off Frequency	> 3.6 Hz sine wave / -3 dB
CMRR	> 130 dB
Counter Voltage*	±100, 200, 300 and 400%
Pen-Lift	Separate for each channel
Monitor Output Signal	0 to 1 V
Chart Speeds	0.1, 0.2, 0.5, 1, 2, 5, 10, 20 mm/s and mm/min
Resolution:	
Economy	0.08 mm
Deluxe	0.05 mm
Operating Conditions	10° to 40°C
Humidity Range	< 80% relative humidity
Safety	Protection class 1, built according to VDE 0411, EMV according to DIN/VDE 0843/IEC
FCC Rating	VDE 0871 class B
Power Supply	115/230 V, 50/60 Hz, user selectable
Dimensions, W x D x H:	
L120	261 x 350 x 127 mm (10.3 x 13.8 x 5 in)
L200	340 x 350 x 127 mm (13.4 x 13.8 x 5 in)
L250	390 x 350 x 127 mm (15.4 x 13.8 x 5 in)
Weight	Approx. 3 kg
Options*	Linearized temp. input for 4 temp. controllers and Pt100 time offset compensation

* Deluxe models only.

Modular Universal Oscillographs



- Curvilinear or rectilinear recording
- Available in two sizes:
 - 2 channels for one or two writing channels
 - 4 channels for one, two, three or four writing channels
- For use with Harvard Apparatus Amplifier Interfaces, see pages I60 to I62, which plug in directly to the oscillograph
- Accept inputs from freestanding amplifiers or transducers via BNC connector (For Harvard Apparatus Research Grade Blood Pressure Transducer, see page J2, for Isotonic and Isometric Transducers, see pages I2 to I8)
- Output via BNC connectors for use with data acquisition systems, see pages I80 to I146, while simultaneously recording
- Modular, compact systems
- Ten chart speeds from a fast 100 mm/sec to a slow 0.1 mm/sec (100, 50, 25, 10, 5, 2.5, 1, 0.5, 0.25 and 0.1 mm/sec)
- Built-in event channel
- 'Monitor' socket on pen amplifier for amplified signal output to BS4 50-8895 Cardiograph Interface, see page I61, FM tape recorder, A/D converter, etc.
- Pen amplifiers and pens with disposable ink cartridges in 4 colors: black, blue, red and green
- Built-in, crystal-controlled, adjustable time channel of 1, 5, 10, 30 and 60/min
- Removable panels for interface units and meters
- Pen lifter bar
- Plastic pen guard

These oscillographs are designed around a pen amplifier module which contains the circuits to power the pen and operate the various amplifier interface modules on the following pages. The oscillographs are supplied with 2 or 4 factory-installed pen amplifier modules with either curvilinear or rectilinear writing.

Each pen amplifier has an input toggle switch which is used to select 'Direct', 'Interface' or 'Off'.

When on 'Direct', the input is taken from the 'Direct Input' BNC socket which connects to self-powered transducers such as the Harvard Apparatus Research Grade Blood Pressure Transducer, see page J2, the Harvard Apparatus Research Grade Isotonic Transducers, see page I3 and the Harvard Apparatus Research Grade Isometric Transducers, see page I2, or Freestanding Amplifiers, pages I60 to I62.

When on 'Interface', the pen amplifier input is from the plug-in Amplifier Interface, see following pages, located next to the pen amplifier.

'Off' is selected when the amplifier is not in use.

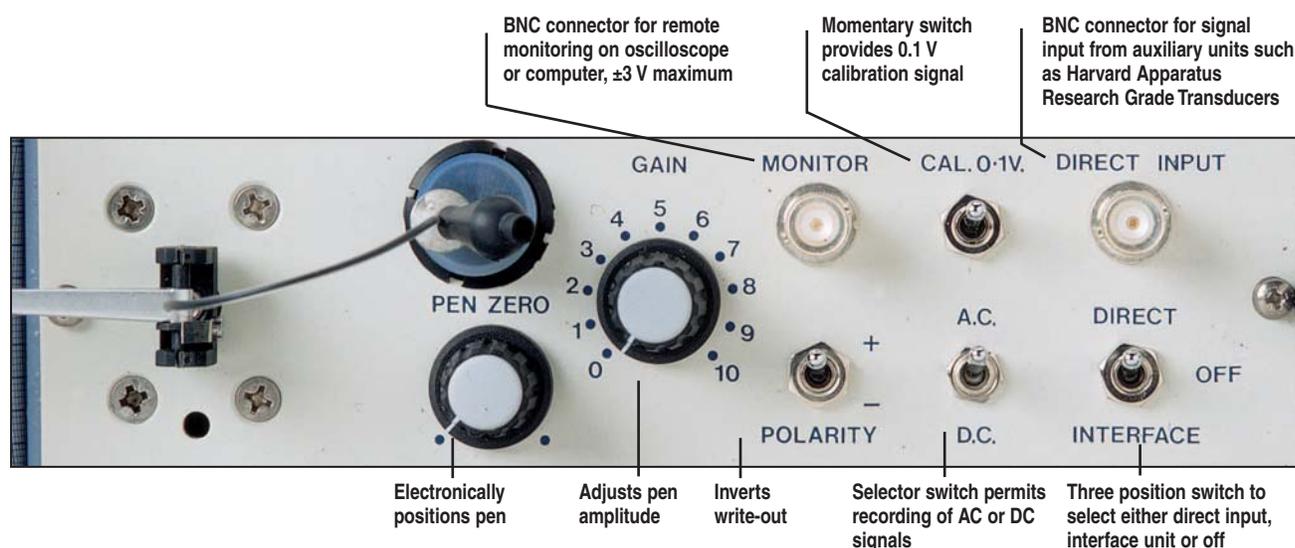
To use the amplifier, the input is selected and a selector switch is set to either AC or DC depending on the type of signal to be recorded. With the switch in the 'Off' position, the pen is then set by turning the 'Pen Zero' knob either to the center of the chart (for ECG measurements) or to the bottom of its swing (for isotonic, isometric and blood pressure measurements). 'Direct' or 'Interface' is next selected and the Gain is increased until the pen starts moving. If necessary, the pen position can be further adjusted using the DC level control on the Interface Adapter. A calibration switch provides a 0.1 volt signal. Each pen amplifier has a 'Monitor' (analog) output BNC socket.

An 'Event' button supplied with the Oscillograph is useful for noting the occurrence of drug additions, etc. When the 'Event' button is momentarily pressed and then released, a 'tick' is marked on the chart paper. When the 'Event' button is pressed for a longer period, the output signal is held constant at either the high or low side of its range.

These oscillographs are for use with Harvard Apparatus's amplifier interfaces for processing signals from transducers, electrodes, sensors, thermistors, etc. Each Interface is tailored to convert its unique input into a voltage suitable for the pen amplifier of the Modular Universal Oscillograph. These interface modules are easily inserted, removed or exchanged.

These modular oscillographs are supplied complete with dust cover, one black ink cartridge per channel, one roll of paper, remote event push-button and operating instructions.

Modular Universal Oscillographs



Oscillographic Recording Applications

Curvilinear Recording

- Higher frequency response (70 Hz); greater trace width
- Waveforms are commensurate with a curved trace
- More suitable for teaching and demonstrations

Rectilinear Recording

- Produces straight-line, pen tip travel that is easy to calibrate and measure
- Reduced frequency response; (40 Hz) and pen travel
- More suitable for analytical-type recordings, such as ECG

Specifications

Pen Amplifier Module:

Maximum Gain	30 mV/cm
Input Impedance	> 100 K Ω (Single Ended)

Frequency Response:

Curvilinear	DC to 70 Hz ± 3 dB
Rectilinear	DC to 40 Hz ± 3 dB

Trace Width:

Curvilinear	5 cm (2 in)
Rectilinear	4 cm (1.6 in)

Dimensions, H x W x D:

2-Channel Recorders	195 x 508 x 205 mm (7-1/3 x 20 x 8 in)
4-Channel Recorders	195 x 508 x 305 mm (7-1/3 x 20 x 12 in)

Weight:

2-Channel Recorders	10 kg (22 lb)
4-Channel Recorders	14.5 kg (32 lb)

Modular Universal Oscillograph

Recording Method	Power		Recording Method	
	115 VAC, 60 Hz	\$	230 VAC, 50 Hz	\$
Curvilinear				
2-Channel	BS4 50-8630		BS4 50-8622	
4-Channel	BS4 50-9315		BS4 50-9307	
Rectilinear				
2-Channel	BS4 50-8655		BS4 50-8648	
4-Channel	BS4 50-9331		BS4 50-9323	

Catalog No. \$ Product

BS4 50-8978	Pen Amplifier Module for Curvilinear Oscillograph
BS4 50-8986	Pen Amplifier Module for Rectilinear Oscillograph
BS4 50-9091	Replacement Pen for Curvilinear Oscillograph
BS4 50-9083	Replacement Pen for Rectilinear Oscillograph
BS4 50-9018	Black Ink Cartridge
BS4 50-9174	Blue Ink Cartridge
BS4 50-9182	Red Ink Cartridge
BS4 50-9190	Green Ink Cartridge
BS4 50-9034	Paper, 91 m (300 ft) for 2-Channel, Curvilinear Oscillograph
BS4 50-9026	Paper, 91 m (300 ft) for 2-Channel, Rectilinear Oscillograph
BS4 50-9372	Paper, 91 m (300 ft) for 4-Channel, Curvilinear Oscillograph
BS4 50-9364	Paper, 91 m (300 ft) for 4-Channel, Rectilinear Oscillograph

For a complete description and specifications of amplifier modules for these recorders, see pages I60 to I62.

Student Oscillographs



- Eight crystal-controlled chart speeds from 25 mm/sec down to 0.1 mm/sec
- Built-in event marker
- AC or DC switched input
- Pen amplifier gain control; pen zero control
- Gain calibration switch
- Versatile

This versatile, compact, 2-Channel Student Oscillograph is available with curvilinear or rectilinear recording and features. Unlike the Modular Universal Oscillograph, see preceding pages, which supplies power to operate its amplifier interfaces, the Student Oscillograph requires freestanding AC or battery operated amplifiers or transducers.

The Student Oscillograph furnishes power to the freestanding BS4 50-9513 Isolated AC/DC Preamplifier and BS4 50-9505 Isolated GSR Amplifier, see page I62. All other amplifiers must be self-powered. This oscillograph is supplied with chart paper, ink cartridges, pens and a plastic dust cover.

Specifications

Sensitivity	30 mV/cm
Maximum Direct Input	10 V
Chart Speeds	0.1, 0.25, 0.5, 1, 2.5, 5, 10, and 25 mm/sec
Frequency Response:	
Curvilinear	DC to 70 Hz ± 3 dB
Rectilinear	DC to 25 Hz ± 3 dB
Trace Width:	
Curvilinear	45 mm (1.75 in)
Rectilinear	37 mm (1.5 in)
Input Connectors	7-pin DIN and BNC connectors
Chart Paper, L x W	100 m x 127 mm (328 ft x 5 in) (available in curvilinear or rectilinear)
Dimensions, H x W x D	150 x 410 x 210 mm (6 x 16 x 8 in)
Weight	6 kg (13.2 lb)

Catalog No.	\$	Product
BS4 50-8168		Student Oscillograph, Curvilinear, 115 VAC, 60 Hz
BS4 50-8150		Student Oscillograph, Curvilinear, 230 VAC, 50 Hz
BS4 50-8184		Student Oscillograph, Rectilinear, 115 VAC, 60 Hz
BS4 50-8176		Student Oscillograph, Rectilinear, 230 VAC, 50 Hz

Amplifiers and Transducers for Use With Student Oscillograph

BS4 50-9513	Isolated AC/DC Preamplifier for all biological signals, ECG, EEG, EMG, including lead selector, see page I62 For appropriate Electrodes, see pages I71 to I74
BS4 50-9505	Isolated GSR Amplifier for human demonstration, see page I62
BS4 50-7970	Freestanding Transducer Interface, see page I60, for interfacing with all Harvard Apparatus Isometric and Isotonic Transducers, see pages I2 to I8
BS4 50-5131	Battery-Powered AC/DC Preamplifier for animal use, see page I62
BS4 50-6378	Battery-Powered Isotonic Transducer, see page I8
BS4 50-1676	Student Spirometer, see page F52

Did you know ?

Harvard Apparatus has nitric oxide sensors that have 100 times the sensitivity of any existing nitric oxide sensors. See pages M2 to M4 in the Cell Biology Section of this catalog for complete details.

1- and 4-Channel Interface Adapter



These Adapters have integral power supplies and allow up to four Harvard Apparatus Modular Amplifier Interfaces to be used directly with computer data acquisition systems, see pages 180 to 1146, or other recording devices.

Three Interface Adapters are available:

- The 4-Channel Interface Adapter with Signal Conditioning provides amplification and signal conditioning resulting in outputs ranging from 0 to ± 5 volts. Rotary control knobs are used to adjust the gain and offset and toggle switches to choose between positive or negative polarity, AC or DC amplification and a calibration signal of 0.1 volts
- The 4-Channel Interface Adapter without Signal Conditioning delivers analog signals in the 1 volt range via four BNC output connectors
- The 1-Channel Interface Adapter without Signal Conditioning delivers analog signals in the 1 volt range via four BNC output connectors

The same amplifiers and accessories that are used with the Modular Universal Oscillographs, see listing to right, can now be powered by these Interface Adapters. Power required is 115/230 VAC, 50/60 Hz. These Adapters are supplied with one BNC to BNC cable per channel.

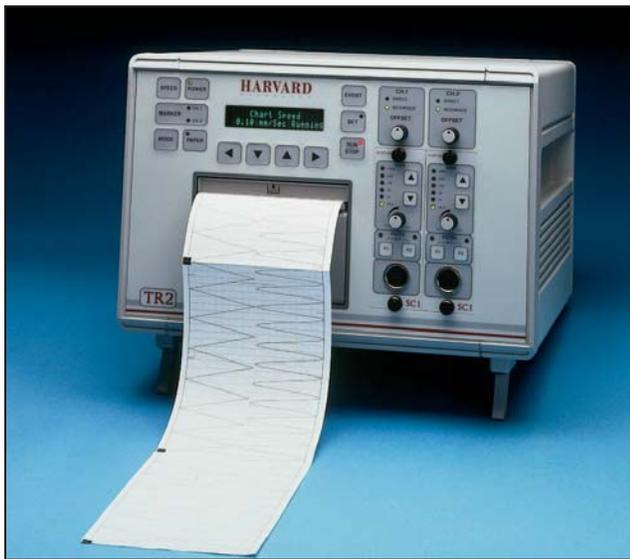
The various amplifiers and accessories that can be used with these Adapters are as follows:

Catalog No.	\$	Amplifier Interfaces*
BS4 50-8861		Transducer Interface, see page 160, for interfacing with Isotonic, Isometric, and Blood Pressure Transducers, Pneumograph with Transducer, and Finger Plethysmograph
BS4 50-8879		AC/DC Preamplifier Interface, see page 160, for ECG and EMG; Electrodes are Available as Accessories
BS4 50-8903		Thermistor Interface, see page 161; Assorted Temperature Probes are Available as Accessories, see pages D16 to D29
BS4 50-8895		Cardiotach Interface, see page 161
BS4 50-9513		Isolated AC/DC Preamplifier, see page 162; Electrodes are Available as Accessories
BS4 50-9505		Isolated GSR Amplifier with 2-Lead Finger Electrodes, see page 162
BS4 50-5966		Isolator Interface, see page 161, for Interfacing BS4 50-9505 Isolated GSR Amplifier and BS4 50-9513 Isolated AC/DC Preamplifier with the Modular Universal Oscillograph, see pages 166 and 167, and these One and Four-Channel Amplifiers

* For a complete description and specifications of these amplifier modules, see pages 160 to 162.

Interface Adapters			
Catalog No.	Interface Adapter	Dimensions, H x W x D	Weight
BS4 50-4028	4-Channel With Signal Conditioning	27.3 x 31.8 x 19.1 cm (10-3/4 x 12-1/2 x 7-1/2 in)	5.4 kg (12 lb)
BS4 50-4027	4-Channel Without Signal Conditioning	27.3 x 17.1 x 19.1 cm (10-3/4 x 6-3/4 x 7-1/2 in)	3.2 kg (7 lb)
BS4 50-9620	1-Channel Without Signal Conditioning, 115 VAC, 60 Hz	6.5 x 13.2 x 20 cm (2.6 x 5.2 x 7.9 in)	1.25 kg (2.8 lb)
BS4 50-9638	1-Channel Without Signal Conditioning, 230 VAC, 50 Hz	6.5 x 13.2 x 20 cm (2.6 x 5.2 x 7.9 in)	1.25 kg (2.8 lb)

Harvard Apparatus TR2 Chart Recorder



- Ideal for recording physiological signals
- 2 independent recording channels
- 2 event marker channels
- Accepts either direct or indirect input signals
- Clear and easy to read traces
- Easy to use

Harvard Apparatus introduces its NEW TR2 Chart Recorder. This thermal array Recorder is well suited for recording physiological signals. The rectilinear method of printing provides a precise trace of the input signal.

2 Independent Recording Channels

This Recorder has two independent channels that will accept an input signal from BS4 40-2010 and

BS4 40-2020 Signal Conditioners or directly from other devices such as our Research Grade Blood Pressure, Isometric, and Isotonic Transducers, see pages J2, I2, and I3). A simple push button control permits selection of direct or interface input. An LED indicator displays which type of input signal is being used.

2 Event Marker Channels

Each of the event marker channels may be independently set to an automatic timed marker, manual event, remote event, or no event. 14 different timed markers are available. Select from seconds or minutes. For a manual event, simply press the front panel push button. This Recorder will also accept a short circuit or 5 volt logic pulse applied to the rear event socket which will cause an event marking. If being used with a timed marker, the corresponding LED on the front panel of the Recorder will illuminate.

Clear, Easy to Read Traces

This Recorder provides clear, easy to read traces that are 50 mm wide. It uses simple fanfold thermal paper. When the Recorder runs out of paper the Paper LED will illuminate.

Variety of Chart Speeds

This Recorder provides three different speed ranges for the ultimate in versatility. Ranges available are mm/hours, mm/minute, and mm/seconds. 35 selectable speeds are provided. The minimum speed is 1 mm/hour. The maximum speed is 100 mm/sec.

Output Signal

In addition to providing a printed trace, the Recorder has 2 direct signal output sockets. These sockets permit the signal to be transferred to a data acquisition system or oscilloscope. The maximum output signal is ± 1 volt.

Simple Controls and Displays

The clear 2 line alpha numeric display is easy to read and provides detailed information. Simple LED indicators are provided for Power, Run/Stop, Set, Paper, Marker Channel, and Direct/Indirect Input. With the display, these LEDs provide information at a glance. Other parameters are set by simple push button controls. Only the offset control is via simple knobs.

Specifications

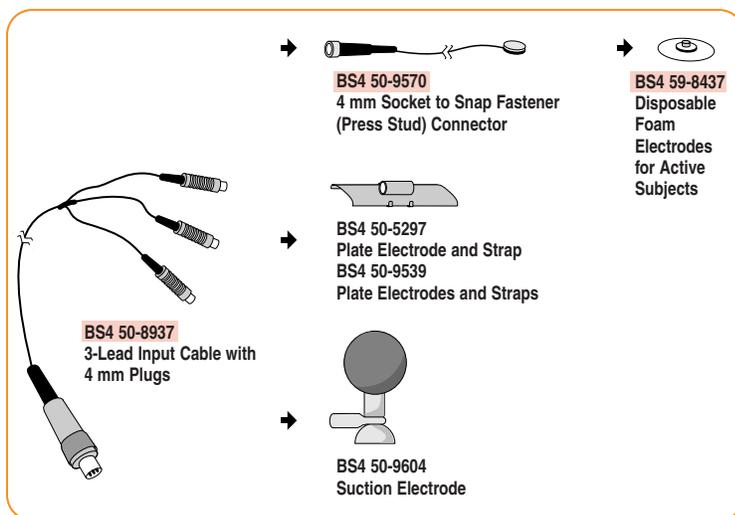
Input Channels	2
Event Channels	2, selectable in any combination of time and/or event
Channel Width	50 mm
Linearity	Better than 1% full scale
Frequency Response	Flat from DC to 40 Hz ± 3 dB
Input Types	2 analog inputs either direct or via plug in interface
Input Level	± 1 V to provide full scale trace deflection max.
Direct Input	Single ended BNC (rear panel), max. input ± 2.5 V
Rise Time	<10 msec
Gain	1:1 or dependant on signal conditioner
A/D Converter	8 bit
Chart Speeds:	35 selectable speeds, ranges: mm/hrs, mm/min, and mm/sec
Minimum	1 mm/hr
Maximum	100 mm/sec
Chart Wander	± 0.5 mm max. per 10 sec
Chart Paper, L x W	Fanfold, 150 x 110 mm
Print Head	104 mm direct thermal linear array
Resolution:	
Vertical	8 dots/mm
Horizontal	32 dots/mm for chart speeds up to 25 mm/sec 16 dots/mm for charts speeds from >25 mm/sec to 50 mm/sec 8 dots/mm for charts speeds from >50 mm/sec to 100 mm/sec
Time Markers	14 user selectable settings; 1, 5, 10, 30, 45, or 60 sec/min
Event Markers	Front panel push button or remote via BNC: either short circuit or +ve 5 V logic pulse
Power	110 or 230 VAC, 50/60 Hz, 40 W max., 1 A 20 mm fuse
Dimensions, H x W x D	225 x 313 x 350 mm (8.9 x 12.3 x 13.8 in)
Weight	8.0 kg (17.5 lb)

Catalog No.	\$	Product
BS4 40-2000		Harvard Apparatus TR2 Chart Recorder, 110/230 VAC, 50/60 Hz
BS4 40-2010		Transducer Interface for Use with Harvard Apparatus Transducers: UF1 Series Isometric, Standard Isometric, and Isotonic Transducers, see pages I7 and I8
BS4 40-2020		Isolated Interface for Use with Isolated Amplifiers to Permit Recording of GSR, ECG, EEG, and EMG Signals
BS4 40-2001		Replacement Fan Fold Chart Paper, 300 Sheets

3-Lead Input Cables and Surface Electrodes

The different size plugs connect to different types of Ag/AgCl electrodes offered, see below. To use Disposable Electrodes, BS4 50-9570 or BS4 50-9554 Snap Fastener (press stud) Connectors are required. These Input Cables and Electrodes are for use with the BS4 50-8879 AC/DC Preamplifier for animal use, see page 160, or the BS4 50-9513 Isolated Preamplifier for human or animal use, see page 162.

- For ECG, EMG, EEG, ENG/EOG and skin potentials from humans or animals
- Two 3-lead input cables are offered:
 - 3-pin DIN to three 4 mm plugs
 - 3-pin DIN to three 1 mm plugs
- Four types of surface electrodes are offered:
 - A range of disposable biopotential electrodes are offered, see pages 173 and 174
 - Small nondisposable Ag/AgCl cup electrodes
 - Plate electrodes with straps
 - Suction electrode

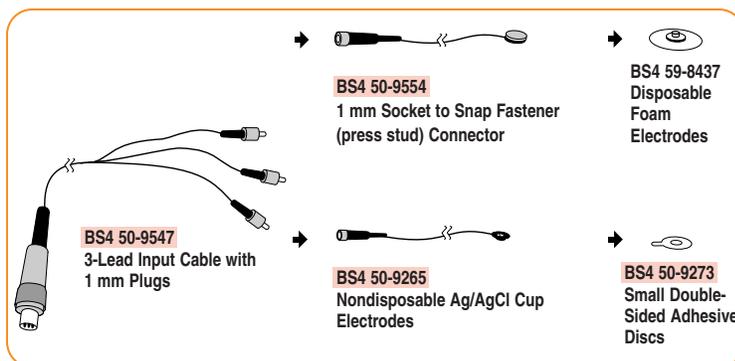


3-Lead Input Cable with 4 mm Plugs

The 4 mm plugs on this Input Cable connect to either Snap Fastener Connectors for use with Disposable Bipotential Electrodes, or directly to Plate Electrodes or Suction Electrodes.

Catalog No.	\$	Product
BS4 50-9836		3-Lead Surface Electrode Set. Consists of one of each of Cables, Connectors, Electrodes and Adhesive Discs whose catalog numbers are shaded, plus BS4 50-5313 Tube of Electrode Gel and BS4 50-8309 Syringe with Blunt Needle for applying gel
BS4 50-8937		3-Lead Input Cable with 4 mm Plugs; 3-Pin DIN to three 4 mm Plugs, 1 m (3.3 ft) long
BS4 50-9570		4 mm Socket to Snap Fastener (Press Stud) Connector, set of 5
BS4 50-5297		Plate Electrode and Strap, pkg of 1
BS4 50-9539		Plate Electrodes and Straps, set of 4
BS4 50-9604		Suction Electrode
BS4 72-7095		Disposable Foam Electrodes for Active Subjects, 38 mm (1-1/2 in), pkg of 50, (for additional Disposable Electrodes, see pages 173 and 174)

For BS4 50-8309 Syringe with Blunt Needle and BS4 50-5313 Tube of Electrode Gel, see page 174.

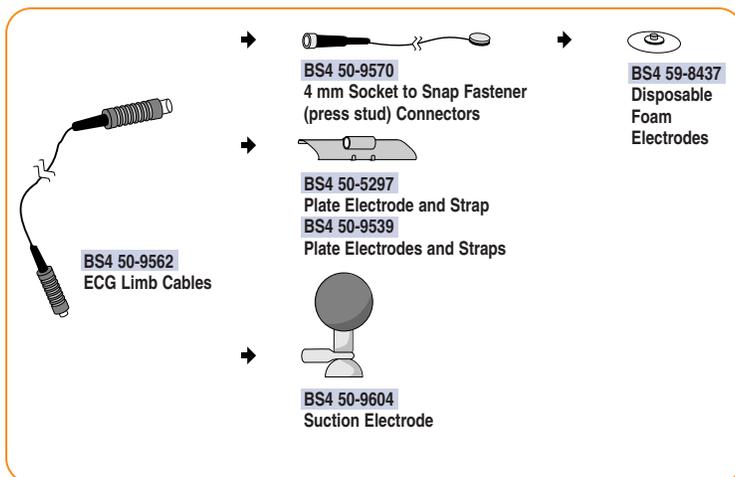


3-Lead Input Cable with 1 mm Plugs

The 1 mm plugs on this Input Cable connect to either Snap Fastener Connectors for use with Disposable Biopotential Electrodes, or directly to Small Nondisposable Cup Electrodes.

Catalog No.	\$	Product
BS4 50-9547		3-Lead Input Cable with 1 mm Plugs; 3-Pin DIN to three 1 mm Plugs, 1 m (3.3 ft) long
BS4 50-9554		1 mm Socket to Snap Fastener (Press Stud) Connector, set of 3
BS4 50-9265		Nondisposable Ag/AgCl Cup Electrodes, pkg of 3
BS4 72-7095		Disposable Foam Electrodes for Active Subjects, 38 mm (1-1/2 in), pkg of 50, (for additional Disposable Electrodes, see pages 173 to 174)
BS4 50-9273		Small Double-Sided Adhesive Discs to hold Nondisposable Ag/AgCl Cup Electrodes, roll of 100

Multi-Lead Cables and Electrodes

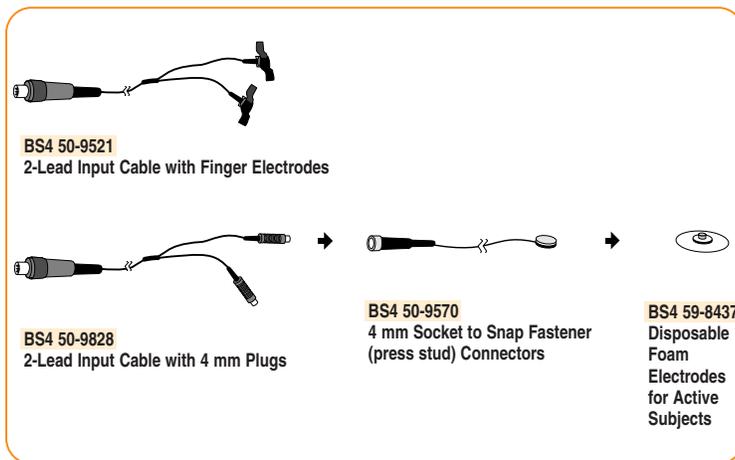


5-Lead Clinical ECG Cables and Electrodes

A Set of 5 color-coded ECG Limb Cables, labelled RA, LA, RL, LL and C, are offered. Each cable is 1 m (3.3 ft) long. One end has a 2 mm plug for connecting to the BS4 50-9513 Isolated Preamplifier, see page 162. The other end has a 4 mm plug that connects directly to Plate and Suction Electrodes or to a Snap Fastener Connector for use with Disposable Electrodes. These Electrodes, Cables and accessories are available individually or as a complete set BS4 50-9844.

- For clinical ECG measurement for human use only
- Use only with the BS4 50-9513 Isolated Preamplifier, see page 162
- Four surface electrodes are offered:
 - A range of disposable biopotential electrodes are offered, see pages 173 to 174
 - Plate electrodes with straps
 - Suction electrode

Catalog No.	\$	Product
BS4 50-9844		5-Lead Clinical ECG Electrode Set. Complete Set of all items whose catalog numbers are shaded
BS4 50-9562		ECG Limb Cables, color-coded, 1 m (3.3 ft) leads, 2 mm plug to 4 mm plug connectors, set of 5
BS4 50-9570		4 mm Socket to Snap Fastener (press stud) Connectors, set of 5
BS4 50-5297		Plate Electrode and Strap, pkg of 1
BS4 50-9539		Plate Electrodes and Straps, set of 4
BS4 50-9604		Suction Electrode
BS4 72-7095		Disposable Foam Electrodes for Active Subjects, 38 mm (1-1/2 in), pkg of 50, (for additional Disposable Electrodes, see pages 173 to 174)



GSR Palm Input Cables and Electrodes

Both Input Cables are 1 m (3.3 ft) long and have a 3-pin DIN connector for directly connecting to the BS4 50-9505 Isolated GSR Amplifier, see page I147. One BS4 50-9521 2-Lead Input Cable with Finger Electrodes is supplied with this GSR Amplifier. These GSR Electrodes, Cables and accessories are available individually or as complete GSR Palm Disposable Electrode Set BS4 50-9810.

- For recording GSR from palm of hand and from other parts of body
- Two input cables are available:
 - 2-lead cable with attached finger electrodes
 - 2-lead cable with two 4 mm plugs to attach to BS4 50-9570 Snap Fastener Connectors for use with disposable electrodes

Catalog No.	\$	Product
BS4 50-9810		GSR Palm Disposable Electrode Set. Complete set of all items whose catalog numbers are shaded
BS4 50-9521		2-Lead Input Cable with Finger Electrodes*
BS4 50-9828		2-Lead Input Cable with 4 mm Plugs*
BS4 50-9570		4 mm Socket to Snap Fastener (Press Stud) Connectors, set of 5
BS4 72-7095		Disposable Foam Electrodes for Active Subjects, 38 mm (1-1/2 in), pkg of 50, (for additional Disposable Electrodes, see pages 173 to 174)

*Note: Pin 1 and 2 internally shorted.

Disposable Electrodes



- Suitable for all types of studies
- Available in two adhesives types

NEW General Purpose Disposable Electrodes

These General Purpose Disposable EKG Electrodes are the ideal choice for cardiac monitoring and diagnostic applications. Each Electrode is designed to work in all procedures: Stress Test, Long Term Monitoring, Short Term Monitoring or Resting EKG.

These General Purpose Disposable Electrodes are available in two adhesive materials, a Solid or a Wet gel, to satisfy your preference. The adhesive Solid Gel has a specially formulated solid gel that improves adhesion and ease of application, while reducing the need for clean-up. The optional Wet Gel adhesive Electrodes are quick reading and more stable. Both electrodes are available in a 48 mm (1 7/8 in) diameter breathable tape with a stainless steel snap and are Latex-Free. They attach to an alligator clip or a standard connector lead wire.

Cat. No.	\$	Product
BS4 72-7093		Solid Gel Adhesive General Purpose Electrodes, pkg. of 60
BS4 72-7094		Wet Gel Adhesive General Purpose Electrodes, pkg. of 60
BS4 60-2394		Alligator Clip, Connects to an 4 mm Banana Plug, pkg. of 10
BS4 60-2395		Preparatory Pads, individually packaged, 5.1 x 2.5 cm (2 x 1 in) Textured Cloth Pads soaked in 70% Isopropanol Solution with Pumice, prepares skin surface to accept Electrodes, pkg. of 1000



- Ag/AgCl, high chloride, wet gel electrodes hydrate the skin and produce fast, clear traces
- Aggressive adhesive keeps electrodes on the subject, no motion artifact or repeat testing
- Hypoallergenic adhesive
- Latex Free

NEW Disposable Foam Electrodes for Active Subjects

These Disposable Foam Electrodes are ideal for withstanding the physical abuse of special procedures such as stress testing. In critical diagnostic situations, use of these electrodes insures quality readings, zero artifact and no repeat procedures. These Disposable Foam electrodes are available in two sizes, have a stainless steel metal snap, and are supplied 5 per strip and 60 per package. These electrodes attach with an Alligator Clip or standard snap connector lead wire.

Cat. No.	\$	Product
BS4 72-7095		Disposable Foam Electrode, 38 mm (1 1/2 in) diameter, pkg of 60
BS4 72-7096		Disposable Foam Electrode, 48 mm (1 7/8 in) diameter, pkg. of 60
BS4 60-2394		Alligator Clip, Connects to an 4 mm Banana Plug, pkg. of 10
BS4 60-2395		Preparatory Pads, individually packaged, 5.1 x 2.5 cm (2 x 1 in) Textured Cloth Pads soaked in 70% Isopropanol Solution with Pumice, prepares skin surface to accept Electrodes, pkg. of 1000



- Conductive adhesive gel
- Specially designed strain relief tab
- Single use (eliminates cross contamination)
- Pliable substrate conforms to body
- Solid gel requires minimal clean-up
- Ultra-low impedance (< 100 Ω) promotes rapid baseline stabilization
- Repositionable
- Packaged in convenient, re-sealable pouches

NEW Disposable Diagnostic Resting EKG Tab Electrodes

The Diagnostic Resting EKG Tab Electrode provides excellent adhesion and quality traces. The silver/silver chloride coating and conductive adhesive gel provide an electrode that meets or exceeds the AAMI standard for disposable pre-gelled EKG electrodes. The specially designed strain relief tab is pliable, allowing electrode to remain secure. They are supplied as 10 electrodes per strip in a package of 100 electrodes. Attachment requires the use of an alligator clip available below.

Cat. No.	\$	Product
BS4 72-7092		Ag/AgCl Adhesive Solid Gel Tab, pkg. of 100
BS4 60-2394		Alligator Clip, Connects to an 4 mm Banana Plug, pkg. of 10
BS4 60-2395		Preparatory Pads, individually packaged, 5.1 x 2.5 cm (2 x 1 in) Textured Cloth Pads soaked in 70% Isopropanol Solution with Pumice, prepares skin surface to accept Electrodes, pkg. of 1000

Electrodes & Cables

Disposable Electrodes and Accessories



NEW Small Disposable Electrodes

- Small size for easy placement on difficult locations
- Optional aggressive adhesive
- Solid gel is repositionable and easy clean-up
- Hypoallergenic for long term use with no irritation
- Cloth base is comfortable and conforming
- Silver/Silver Chloride sensor gives a clear signal
- Multipurpose use for EMG or EKG

These Small Disposable Cloth Electrodes are for use in EMG, NCS and EP studies and are latex-free. They meet or exceed AAMI specifications and are also suitable for use with EKG monitors. All Small Disposable Electrodes are supplied as 3 electrodes per strip with 60 electrodes per package. They attach with an alligator clip or standard connector lead wire.

The Small Disposable 2.5 cm² (1.0 in²), aggressive adhesive electrode is designed for easy placement and superior adhesion.

A specially formulated adhesive solid gel ensures full sensor contact and excellent readings.

The Small Disposable 2.2 cm² (0.88 in²) gentle adhesive electrodes are designed with a gentle adhesive for use in sensitive areas.

Catalog No.	\$	Product
BS4 72-7090		Aggressive Adhesive Small Disposable Electrode, pkg. of 60
BS4 72-7091		Gentle Adhesive Small Disposable Electrode, pkg. of 60
BS4 60-2394		Alligator Clip, Connects to an 4 mm Banana Plug, pkg. of 10
BS4 60-2395		Preparatory Pads, individually packaged, 5.1 x 2.5 cm (2 x 1 in) Textured Cloth Pads soaked in 70% Isopropanol Solution with Pumice, prepares skin surface to accept Electrodes, pkg. of 1000

Syringe with Blunt Needle

For dispensing small quantities of Electrode Gel, see below.

Catalog No.	\$	Product
BS4 50-8309		Syringe with Blunt Needle

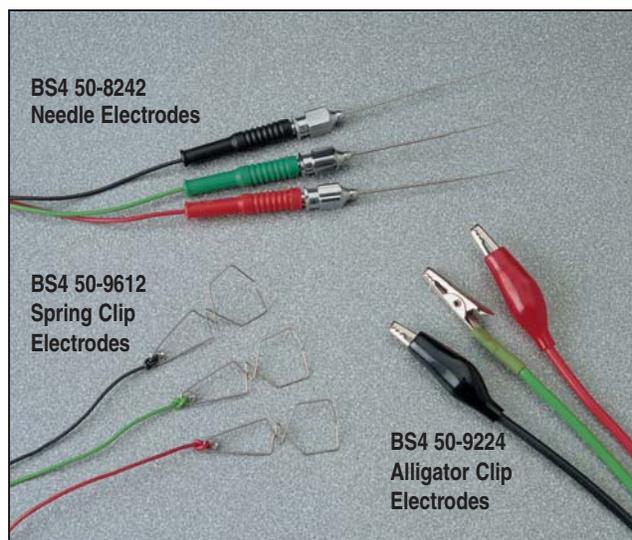


Tube of Electrode Gel

Provides good electrical contact for BS4 50-9297 Plate Electrodes, BS4 50-9604 Suction Electrodes and BS4 50-9265 Nondisposable Ag/AgCl Cup Electrodes.

Catalog No.	\$	Product
BS4 50-5313		Tube of Electrode Gel

3-Lead Surface Electrodes



3-Lead Surface Electrodes

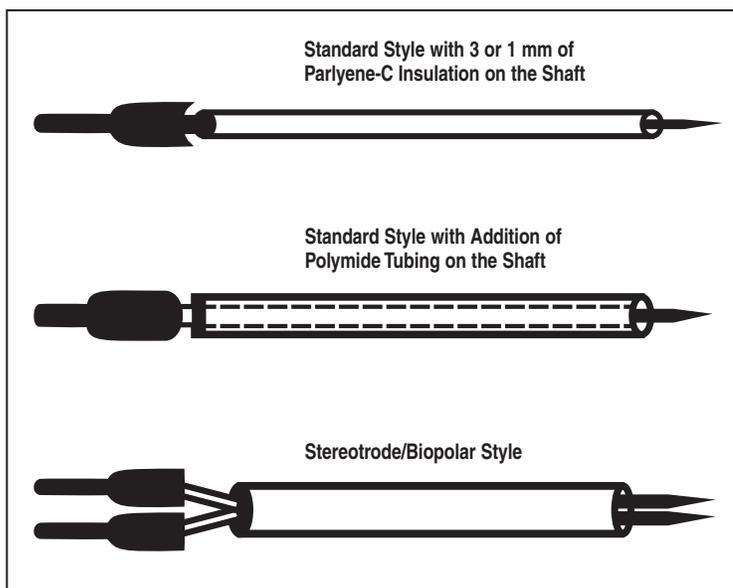
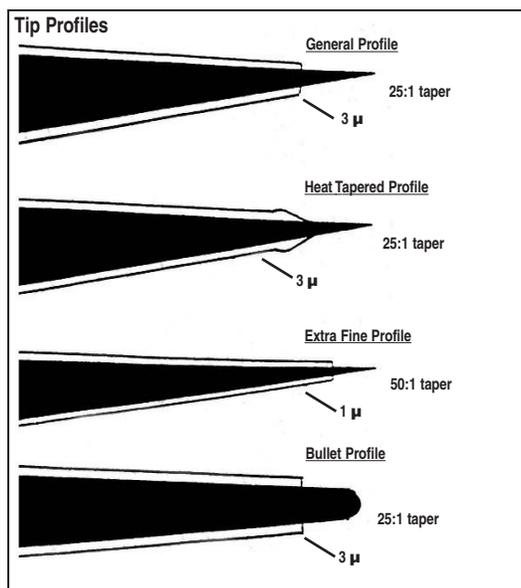
- For ECG, EMG and EEG from a variety of animals including frogs, rats, mice, guinea pigs, rabbits, cats and dogs
- For ECG, EMG and EEG from humans, use any of the Spring Clip Electrodes or BS4 50-9224 Alligator Clip Electrodes to hold Disposable ECG Electrodes, see page 173

Three different types of 3-Lead Electrodes are offered: Alligator Clip, Spring Clip and Needle Electrodes. These can either be purchased individually or together as a complete 3-Lead Electrode Set. The 22 G Needle Electrodes are for inserting into tissues and are removable from the lead for sterilizing. The Alligator Clip Electrodes will securely grip the snap fastener of a Disposable

Biopotential Electrode or the tab on BS4 72-7092 Electrodes for Resting Subjects, see page 173. The Spring Clip Electrode can attach directly to the skin or tissue for rapid, low resistance applications such as stimulation, ECG, EEG and EMG. The electrodes have a 1 m (3-1/4 ft) cable. The electrodes with a 3-pin DIN connector plug directly into either the BS4 50-8879 AC/DC Pre-amplifier for animal use, see page 162, or the BS4 50-9513 Isolated Pre-amplifier for human or animal use, see page 162. The Spring Clip Electrode is also available with a 14-pin DIN connector for use with other equipment. A third version has three separate Spring Clips with plain wire connectors for use with the BS4 50-6002 and BS4 50-6012 Stimulators, see page 126.

Catalog No.	\$	Product
BS4 50-8242		3-Lead Surface Electrode with Needle Electrodes and 3-Pin DIN Connector
BS4 50-9224		3-Lead Surface Electrode with Alligator Clip Electrodes and 3-Pin DIN Connector
BS4 50-9612		With Spring Clip Electrodes with 3-Pin DIN Connector
BS4 50-9613		With Spring Clip Electrodes with 14-Pin DIN Connector
BS4 50-6808		With Spring Clip Electrodes with 3 Separate Spring Clips with 3 Plain Wires
BS4 50-9802		3-Lead Electrode Set, Consists of one each of BS4 50-9224 Alligator Clip, BS4 50-9612 Spring Clip and BS4 50-8242 Needle Electrodes

Macro and Micro Metal Electrodes



Metal Macro Electrodes

- Excellent for stimulation, lesions, and recording evoked responses
- Parylene-C insulation makes these Electrodes ideal for chronic applications
- Select from tungsten or stainless steel metals

These Macro Electrodes are similar in construction to our Metal Micro Electrodes except they are larger in size. Their shaft diameters range from 0.009 inches (229 μm) to 0.02 inches (508 μm). The same unique manufacturing process is used to create these electrode tips so they provide consistent, repeatable, superior performance. They are 3 inches (76.2 μm) long and are constructed of either stainless steel (elgiloy) or Tungsten. The electrode shaft has a 3 mm coating of Parylene-C insulation. They are supplied in a box of 10.

Metal Macro Electrodes			
Catalog No.	\$	Shaft OD in (mm)	Impedance at 1 kHz
Stainless Steel (Elgiloy)			
BS4 72-0416		0.009 (229)	0.1 μm
BS4 72-0417		0.009 (229)	0.25 μm
Tungsten			
BS4 72-0418		0.010 (254)	0.1 μm
BS4 72-0419		0.010 (254)	0.25 μm
BS4 72-0420		0.020 (508)	0.1 μm
BS4 72-0421		0.020 (508)	0.25 μm

Note: Concentric Electrodes available, please call for details.

Metal Microelectrodes

These Metal Micro Electrodes are ideal for a multitude of applications including single- and multi-unit studies, stimulation, lesioning, and evoked response studies. Four metals are available depending on the application:

- Tungsten
- Stainless Steel (Elgiloy metal)
- Platinum/Iridium Mix (80/20%)
- Pure Iridium

- Outstanding for extracellular recording and micro-stimulation
- Unique, precision manufacturing process provides consistent repeatable tip profiles for superior performance
- Select from 4 metals, 3 styles, and 4 tip profiles to meet almost any application
- Gold-plated connector pins for superior electrical connections
- Custom made probes readily available

Tungsten is the most versatile and widely used type of probe. It is ideal for demanding recording situations and most stimulation protocols.

The **Stainless Steel (Elgiloy)** Electrodes are widely used as the primary component for the 'vibrating probe' electrode. It is vibrated at a fairly high frequency and is used to record very small DC potentials. It is also used for Prussian blue staining around the tip by passing a small anodal current.

The **Platinum/Iridium** mix Electrodes have a lower concomitant impedance value than tungsten or stainless steel for the same exposure, therefore they are ideal for recording. They are also superior for stimulation studies because they are less likely to erode during intense stimulation protocols. This metal mixture is also excellent for chronic implants because it is very biocompatible.

The **Pure Iridium** Electrodes are ideal for improved stimulation and recording. Pure Iridium is extremely stiff and has a much lower concomitant tip impedance than any other noble metal. It is extremely inert and very resistant to corrosion. Consequently, it is much less likely to erode during stimulation and can be activated using cyclic voltametry for increased charge storage capacity to lower tip impedance values.

Macro and Micro Metal Electrodes

Three Electrode Styles are Available:

- Standard style with 3 mm or 1 mm of Parylene-C insulation on the metal shaft.
- Standard style with the addition of polyimide tubing on the shaft which provides additional reinforcement for easy electrode insertion. The additional insulation also minimizes signal attenuation making this an ideal electrode for deep brain penetrations.
- Stereotrode/Bipolar style for micro bipolar stimulation. These Electrodes are ideal where the current injection needs to be confined to a small, localized part of the nervous system. They are also used for enhanced isolation of single neural elements by simultaneously recording from multiple units of two closely spaced microelectrodes.

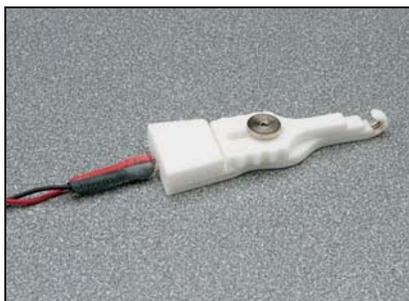
All of the Microelectrodes are sharpened electrochemically and their tips are individually exposed under a microscope. Each is inspected to assure reproducible tip exposures and profile. Four different tip profiles are created using a unique process to remove the insulation from the electrode tip:

- **General Profile** with a 25:1 taper ending in a sharp point which is good for most applications.
- **Heat Tapered Profile** with a 25:1 taper ending in a sharp point with “toughened” Parylene-C near the exposed tip providing more rigidity. This tip is ideal for penetrating tough tissues.
- **Extra Fine Profile** with a 50:1 taper ending in a sharp point which is good for small cells and near surface work. This profile only has 1 mm of Parylene-C insulation on the metal shaft.
- **Bullet Profile** with a 25:1 taper ending in a rounded point which is ideal for stimulation due to reduced neuron penetration.

These Electrodes are supplied in a box of 10.

Metal Micro Electrodes							
Catalog No.	\$	Electrode Style	Length	Insulation	Tip Profile Tip Imped.	Shaft Diameter	Tungsten
BS4 72-0375		Stereotrode/Bipolar	127 mm (5 in)	3 µm	1	General	127 µm
BS4 72-0376		Stereotrode/Bipolar	127 mm (5 in)	3 µm	1.5	General	127 µm
BS4 72-0377		Stereotrode/Bipolar	127 mm (5 in)	3 µm	0.5	General	127 µm
BS4 72-0378		Additional Polyimide	127 mm (5 in)	3 µm	2	General	127 µm
BS4 72-0379		Additional Polyimide	127 mm (5 in)	3 µm	1	General	127 µm
BS4 72-0380		Parylene Coated	127 mm (5 in)	3 µm	2	Tapered	127 µm
BS4 72-0381		Parylene Coated	127 mm (5 in)	3 µm	2	General	127 µm
BS4 72-0382		Parylene Coated	127 mm (5 in)	3 µm	1	Tapered	127 µm
BS4 72-0383		Parylene Coated	127 mm (5 in)	3 µm	1	Bullet	127 µm
BS4 72-0384		Parylene Coated	127 mm (5 in)	3 µm	1	General	127 µm
BS4 72-0385		Parylene Coated	127 mm (5 in)	3 µm	1	General	127 µm
BS4 72-0386		Parylene Coated	127 mm (5 in)	3 µm	0.5	Bullet	127 µm
BS4 72-0387		Parylene Coated	127 mm (5 in)	3 µm	0.5	General	127 µm
BS4 72-0388		Parylene Coated	127 mm (5 in)	3 µm	0.5	General	127 µm
BS4 72-0389		Stereotrode/Bipolar	76 mm (3 in)	3 µm	1	General	127 µm
BS4 72-0390		Stereotrode/Bipolar	76 mm (3 in)	3 µm	0.5	General	127 µm
BS4 72-0391		Additional Polyimide	76 mm (3 in)	3 µm	2	General	127 µm
BS4 72-0392		Additional Polyimide	76 mm (3 in)	3 µm	1	General	127 µm
BS4 72-0393		Additional Polyimide	76 mm (3 in)	1 µm	5	X-Fine	127 µm
BS4 72-0394		Parylene Coated	76 mm (3 in)	3 µm	2	General	127 µm
BS4 72-0395		Parylene Coated	76 mm (3 in)	3 µm	2	General	127 µm
BS4 72-0396		Parylene Coated	76 mm (3 in)	3 µm	1.5	General	127 µm
BS4 72-0397		Parylene Coated	76 mm (3 in)	3 µm	1	General	254 µm
BS4 72-0398		Parylene Coated	76 mm (3 in)	3 µm	1	General	127 µm
BS4 72-0399		Parylene Coated	76 mm (3 in)	3 µm	0.5	General	254 µm
BS4 72-0400		Parylene Coated	76 mm (3 in)	3 µm	0.5	General	127 µm
BS4 72-0401		Parylene Coated	76 mm (3 in)	3 µm	0.1	General	254 µm
BS4 72-0402		Parylene Coated	76 mm (3 in)	1 µm	5	X-Fine	127 µm
BS4 72-0403		Parylene Coated	76 mm (3 in)	1 µm	2	X-Fine	127 µm
BS4 72-0404		Parylene Coated	76 mm (3 in)	1 µm	1	X-Fine	127 µm
Stainless Steel							
BS4 72-0405		Parylene Coated	76 mm (3 in)	3 µm	7	General	127 µm
BS4 72-0406		Parylene Coated	76 mm (3 in)	3 µm	2	General	127 µm
BS4 72-0407		Parylene Coated	76 mm (3 in)	3 µm	1	General	127 µm
Platinum/20% Iridium							
BS4 72-0408		Additional Polyimide	51 mm (2 in)	3 µm	2	General	127 µm
BS4 72-0409		Additional Polyimide	51 mm (2 in)	3 µm	1	General	127 µm
BS4 72-0410		Parylene Coated	51 mm (2 in)	3 µm	2	General	127 µm
BS4 72-0411		Parylene Coated	51 mm (2 in)	3 µm	1	General	127 µm
BS4 72-0412		Parylene Coated	51 mm (2 in)	3 µm	0.5	General	127 µm
Iridium (Pure)							
BS4 72-0413		Additional Polyimide	76 mm (3 in)	3 µm	2	General	127 µm
BS4 72-0414		Additional Polyimide	76 mm (3 in)	3 µm	1	General	127 µm
BS4 72-0415		Additional Polyimide	76 mm (3 in)	3 µm	0.5	General	127 µm

Nerve Electrodes and Accessories



Dastre Electrode

- For reaching deep-seated nerves through a small incision

The end of the white plastic Electrode body is curved into a 5 x 6.5 mm (3/16 x 1/4 in) hook, which forms the nerve grip. The two pole wires are exposed within the hook radius. A white plastic plunger can be forced down into the inside of the hook, so that the desired securing tension can be brought on the tissue. The plunger can be locked in place by a knurled screw. Plain wire connector.

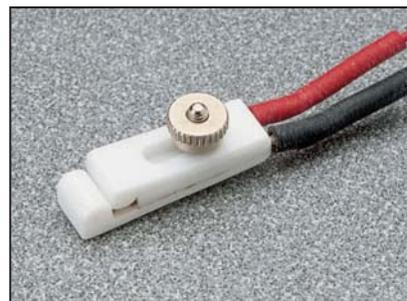
Catalog No.	\$	Product
BS4 50-6873		Dastre Electrode



Subminiature Electrode

The inside jaw grip of this miniature Electrode is a half-circle, 2 mm (1/16 in) in diameter. The two wires of the stimulating circuit are brought down through the Electrode shank and exposed in the half-circle base. A plunger holds the nerve tightly against the Electrode and can be locked in place. The end of the Electrode has an over-all dimension of 2 x 6.5 mm (1/16 x 1/4 in). This size is maintained for 20 mm (3/4 in) before it enlarges into the regular electrode shank. Plain wire connector.

Catalog No.	\$	Product
BS4 50-1650		Subminiature Electrode



Miniature Electrode

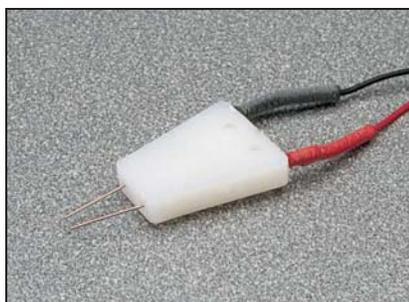
The two Electrode pole wires are set in a channel cut through a white plastic block, 6.5 mm (1/4 in) wide and high. A plastic locking clamp is adjusted over the nerve or tissue. The proper gripping tension is applied with a knurled head screw. This electrode has plain wire connectors.

Catalog No.	\$	Product
BS4 50-6865		Miniature Electrode

Bipolar Electrode Set

Contains one each of BS4 50-4118 Dastre Electrode and BS4 50-4119 Subminiature Electrode.

Catalog No.	\$	Product
BS4 50-6881		Bipolar Electrode Set



Simple Electrode

The stainless steel wire poles are fed back through a plastic molding and are secured to the leads.

Catalog No.	\$	Product
BS4 50-6824		Simple Electrode



Bipolar Electrode

Two 9.5 mm (3/8 in) stainless steel Electrodes are attached to two sheathed, stout brass wires. The wires are bound together for 92.1 mm (3-5/8 in) and then split into two leads each of which is fitted with a terminal. Each terminal has a small hole and thumb-screw that permits a wire to pass through and be secured for connection to a stimulator.

Catalog No.	\$	Product
BS4 50-6816		Bipolar Electrode



Finkelman Electrode for Phrenic Nerve

The pole wires of this Electrode are sealed into a clear plastic, 6.5 mm (1/4 in) diameter, 15 cm (6 in) rod. At the end of the rod, each pole wire is formed into a small coil of three turns. These coils are seated in a 6.5 mm (1/4 in) plastic knob. The plastic surrounding the coils, as well as the coils themselves, is pierced by a 2 mm (0.08 in) hole that exposes the wires. The nerve is passed through the hole and brought in contact with the electrodes.

Catalog No.	\$	Product
BS4 50-6857		Finkelman Electrode

Nerve Electrodes and Accessories



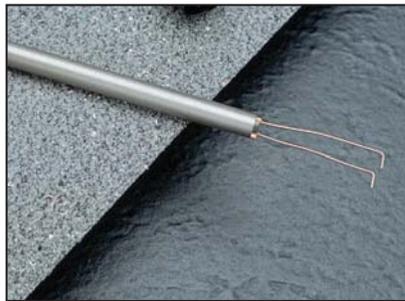
Phrenic Nerve Electrode

- Available with or without oxygen bubbler
- For use primarily with rat diaphragm preparations

The short horizontal foot of this plastic body Electrode, to which the costal segment is attached, carries a single-pole wire. A stainless steel latch is pivoted on the end of the foot and clamps the costal segment against the indirect-stimulation electrode wire. The latch is secured by a knurled screw located at the end of the Electrode body. The diaphragm tendon is connected to the transducer or writing lever by a piece of fine stainless steel wire, which then acts as the second electrode for direct stimulation.

The nerve grip, located on the Electrode shank, consists of a plunger and a U-shaped piece of plastic. The plunger pushes down and locks the nerve ending against the two electrode wires that are exposed in the base of the "U". Once set, the plunger can be locked in place. The entire nerve holder can be moved along a 25 mm (1 in) portion of the Electrode to maintain proper tension on the nerve. Once adjusted, the entire unit can be locked in place. The Electrode assembly is mounted on a 6.5 mm (1/4 in) diameter rod. This electrode is available with and without an oxygen bubbler. The Electrode with Oxygen Bubbler.

Catalog No.	\$	Product
BS4 50-0561		Phrenic Nerve Electrode with Oxygen Bubbler
BS4 50-6972		Phrenic Nerve Electrode without Oxygen Bubbler



Screened Electrode

- Double poles

This Electrode has a 6.5 mm (0.25 in) diameter, 17.5 cm (6.9 in) nickel-plated brass tube that carries two 0.5 mm (0.02 in) diameter, 4 cm (1.5 in) silver wires. The electrode has 1 m (3.3 ft) screened leads (screening connects to the outer metal tube) and terminate in a 3-pin DIN for connection to the BS4 50-8259 Electrophysiological Teaching Unit, see pages I63 and I64, and the BS4 50-5131 Battery-Powered AC/DC Pre-amplifier, see page I62.

Catalog No.	\$	Product
BS4 50-7004		Screened Electrode



Electrode Holder

The two spring clips on this Electrode Holder hold electrodes with diameters up to 6.5 mm (1/4 in). The 12.7 mm (1/2 in) long Electrode Holder head can be swiveled until the electrode is in the desired position. A friction device passes through the 9.5 mm (3/8 in) diameter, 132 mm (5.2 in) handle of the Holder and is operated by a knurled knob at the end. When the knob is rotated a half-turn, the ball and socket joint is locked and the electrode is held securely in place.

Catalog No.	\$	Product
BS4 50-1643		Electrode Holder



Nerve Conduction Chamber

- For the measurement of the speed of electrical impulses in an isolated nerve preparation

This unit consists of a clear plastic chamber, electrodes and a plastic cover. Fifteen electrode wires extend from side-to-side. All are 5 mm (0.2 in) apart and may be used for stimulation and for receiving impulses. Each electrode terminates in a socket for use with 2 mm plugs. The inside dimensions of the chamber are, H x W x D, 2.5 x 7.9 x 3.2 cm (1 x 3-1/8 x 1.25 in). The Chamber has a 6.5 mm (0.25 in) diameter, 10 cm (4 in) stainless steel mounting handle.

Catalog No.	\$	Product
BS4 50-7020		Nerve Conduction Chamber



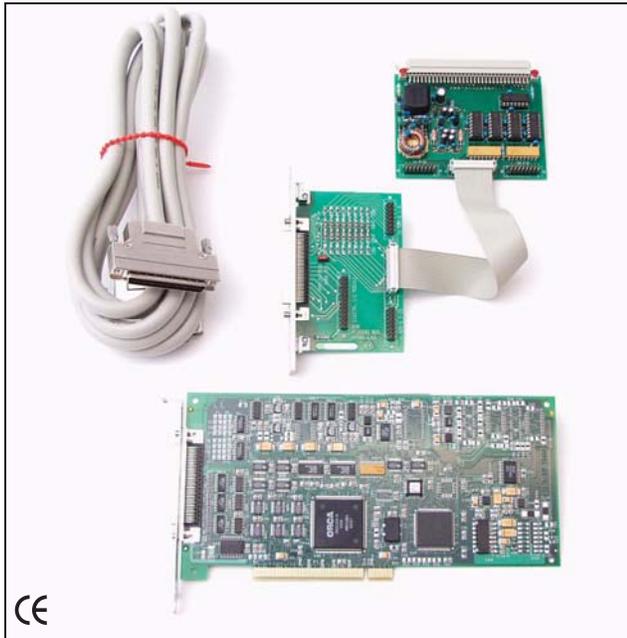
Electrode Clamp

See photo above. This ball and socket Clamp permits the precise positioning of electrodes with diameters up to 6.5 mm (0.25 in). The electrode snaps into two spring clips which are mounted on a ball that is precisely positioned and locked in a socket by a knurled screw. This clamp can be mounted either vertically or horizontally on a standard 9.5 mm (3/8 in) rod.

Catalog No.	\$	Product
BS4 50-4530		Electrode Clamp

Data Acquisition Hardware

HSE-HA Data Acquisition Hardware for HSE-HA Software



BS4 73-0161 Data Acquisition Hardware, PLUGSYS Version



BS4 73-0235 Data Acquisition Hardware, Stand Alone Version



BS4 73-3330 Data Acquisition Hardware, USB Stand Alone

Data Acquisition Hardware, PLUGSYS Version

In this version, the 16 signals of the PLUGSYS bus system are connected to the PCI A/D converter board via the module ROM-DL (Recording Output - Direct Link) a built-in board, the DIM (Data Interface Module) and an appropriate cable. The ROM-DL and the DIM Modules are installed on the rear side of the PLUGSYS Mainframe. The PCI A/D board is installed in the computer. The DIM and the A/D board are connected by the data cable. If controlling modules such as the PSM or PPCM are requested, the DIM must be extended with the DIM-D Option.

Data Acquisition Hardware, Stand Alone Version

This version is used to connect any amplifier, flowmeter or other instruments of several different manufacturers to the HSE-HA software. Up to 16 signals can be connected to the BNC connector block. The connector block is connected to the PCI A/D converter board. The A/D board is installed in the computer.

- Data Acquisition Hardware, PLUGSYS Version: Central connection for output signals of PLUGSYS modules to data acquisition board installed in computer
- Data Acquisition Hardware, Stand Alone Version: To connect input signals from any instrument to the data acquisition board installed in the computer for using HSE-HA software
- Suitable for all HSE-HA data acquisition software

Data Acquisition Hardware, USB Stand Alone Version

In this version, any Windows NT / 2000 / or XP based computer or laptop with a USB port can connect to any amplifier, flowmeter, or other instrument to run HSE-HA Software. Up to 16 input signals can be connected to the USB Input Box from the PLUGSYS system case or independent manufactures via BNC cables. The USB Input Box is connected to the USB port on the desktop or laptop computer.

Catalog No.	\$	Product
BS4 73-0161		HSE-HA Data Acquisition Hardware, PLUGSYS Version
BS4 73-0235		HSE-HA Data Acquisition Hardware, Stand Alone Version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version

HSE-HA Data Acquisition Software Packages

All Software packages have a maximum of 16 channels allowing acquisition of up to 16 different raw signals. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. Prior to the experiment, the user chooses the available signals to acquire and display, which of the possible parameters to evaluate and display, enter the experimental protocol and finally calibrate the instruments. All packages include storage of raw data with the possibility for replay. Complete experiments can be replayed. An indication of the measured signals and parameters occurs online in numerical tabular form or graphical detail and trend windows. Monitoring

of the experimental sequence is done by placing event markers and/or concentration information. Very easy graphical selection of specific data points by markers for evaluation, data reduction, and export. Raw data can be easily exported in ASCII delimited format.

Hardware Requirements:

Computer	PENTIUM III PC, 500 MHz or more with one free PCI-slot
RAM	128 MB or more of RAM
Operating System	Windows NT 4.0, WIN 2000 or XP
Hard Disk Space	at least 20 GB
Floppy Drive	1.44 MB
CD-ROM Drive	Required
Monitor	Color SVGA graphic board with 19" standard or 17 - 18" flat panel monitor
Backup Media	CD burner or DVD RAM/RW

Catalog No. \$ Product

BDAS Basic Data Acquisition Software

BS4 73-1712 For analyzing smooth, slow moving signals such as mean pressure, mean flow, temperature, pH, pO_2 , pCO_2 , pK+ and smooth muscle contractions. Software calculates maximum, minimum, and mean values for: Pressure, Flow, Tension (force), Displacement, Temperature, Concentrations, pO_2 , pCO_2 , and pH

ACAD® Isolated Tissue Data Acquisition

BS4 73-1688 For isolated tissue studies such as smooth muscle, and beating or electrically stimulated tissues. Can control electrical stimulation, pre-tension adjustment and flushing. Evaluates isometric or isotonic tissue contractions. Software calculates Resting Tension for smooth muscles

Optional software modules are available for calculating specific values:

BS4 73-1715 **Option to ACAD® Software for evaluation of free Beating Tissues**
Amplitude, Rate, $\pm dF/dt$

BS4 73-1703 **Option to ACAD® Software for Advanced Evaluation of Stimulated Beating Tissues**
Amplitude, Rate, $\pm dF/dt$, Contraction time, Relaxation time, Response duration, Peak duration, Latency period

BS4 73-2900 Strip Chart Print Option for HSE-HA DAQ Software

ISOHEART® Isolated Heart Data Acquisition

BS4 73-0162 For Isolated Heart Studies. Evaluates online most of the standard parameters in Isolated Heart experiments such as left ventricular pressure, blood pressure, blood flow, pO_2 , pCO_2 , pH and length measurement. Software calculates the following parameters online:

From LVP signal LVPsys, LVPdia, LVPEDP, dLVP/dtmin, dLVP/dtmax, heart rate, mean pressure

From all PRESSURES Systolic, diastolic, mean pressure, heart rate

From all FLOWS Mean, maximum, minimum flow

From DISTANCE Maximum, minimum, amplitude (max - min)

From ELECTROGRAM Heart rate

From pO_2 , pCO_2 , & pH Mean value

Optional software modules are available for calculating specific values:

BS4 73-0237 **LVP Advanced Module**
Tau, Time to Peak, Relaxation Time, Contractility Index $CI = dp/dtmax/P$, Ejection Time

BS4 73-0238 **Flow Advanced Module**
End Systolic Flow, End Diastolic Flow

BS4 73-2715 **Monophasic Action Potential (MAP)**
Module Max, Min, Plateau, Amp, Rate, $\pm dv/dt$, duration at 10% of MAP

BS4 73-2716 **Dimensions Module**
End-systolic length, end-diastolic length, $+dL/dt$, $-dL/dt$

BS4 73-2799 **PV-Loop Module**
Conductance Signal, LVP Signal: Acquire and view PV loops real time and during experiment replay. Select and export PV loop segments to Millar PVAN software for further analysis.

BS4 73-2900 Strip Chart Print Option for HSE-HA DAQ Software

Catalog No. \$ Product

PULMODYN® Pulmonary Mechanics Data Acquisition

BS4 73-1692 For Respiratory Studies. Evaluates online most of the standard respiratory parameters such as airflow, intrapleural pressure, blood pressure and flow signals, tidal volume, respiration rate, resistance, and compliance. Software calculates the following parameters online:

From PULMONARY AIR FLOW Respiration Rate, maximum Inspiratory Flow, maximum Expiratory Flow, Tidal Volume, dynamic Resistance, Conductance, dynamic Compliance

From all PULMONARY PRESSURES Maximum, minimum, mean pressure

From BLOOD PRESSURE Systolic, diastolic, mean/pressure, non-pulsatile mean, Heart Rate

From PERFUSION FLOW Maximum, minimum, mean flow, non-pulsatile mean

From pO_2 , pCO_2 , pH & TEMPERATURE Mean value

Optional software modules are available for calculating specific values:

BS4 73-2705 **Advanced Pulmonary Flow Module**
Inspiratory time, Expiratory time, Apnea time, Total Time

BS4 73-2706 **ECG Advanced Module**
RR-I, HR

HAEMODYN® Cardiovascular Data Acquisition

BS4 73-1690 For Cardiovascular Studies. Evaluates online most of the standard Hemodynamic parameters such as left ventricular pressure, blood pressure, blood flow, pO_2 , pCO_2 , pH and distance signals. Software calculates the following parameters online:

From LVP signal LVPsys, LVPdia, LVPEDP, dLVP/dtmin, dLVP/dtmax, heart rate, mean pressure

From all PRESSURES Systolic, diastolic, mean pressure, heart rate

From all FLOWS Mean, maximum, minimum flow

From DISTANCE Maximum, minimum, amplitude (max - min)

From ELECTROGRAM Heart rate

From pO_2 , pCO_2 , & pH Mean value

Optional software modules are available for calculating specific values:

BS4 73-0237 **LVP Advanced Module**
Tau, Time to Peak, Relaxation Time, Contractility Index $CI = dp/dtmax/P$, Ejection Time

BS4 73-0238 **Flow Advanced Module**
End Systolic Flow, End Diastolic Flow

BS4 73-0239 **Respiration Module**
Respiration Rate, maximum Inspiratory Flow, maximum Expiratory Flow, Tidal Volume

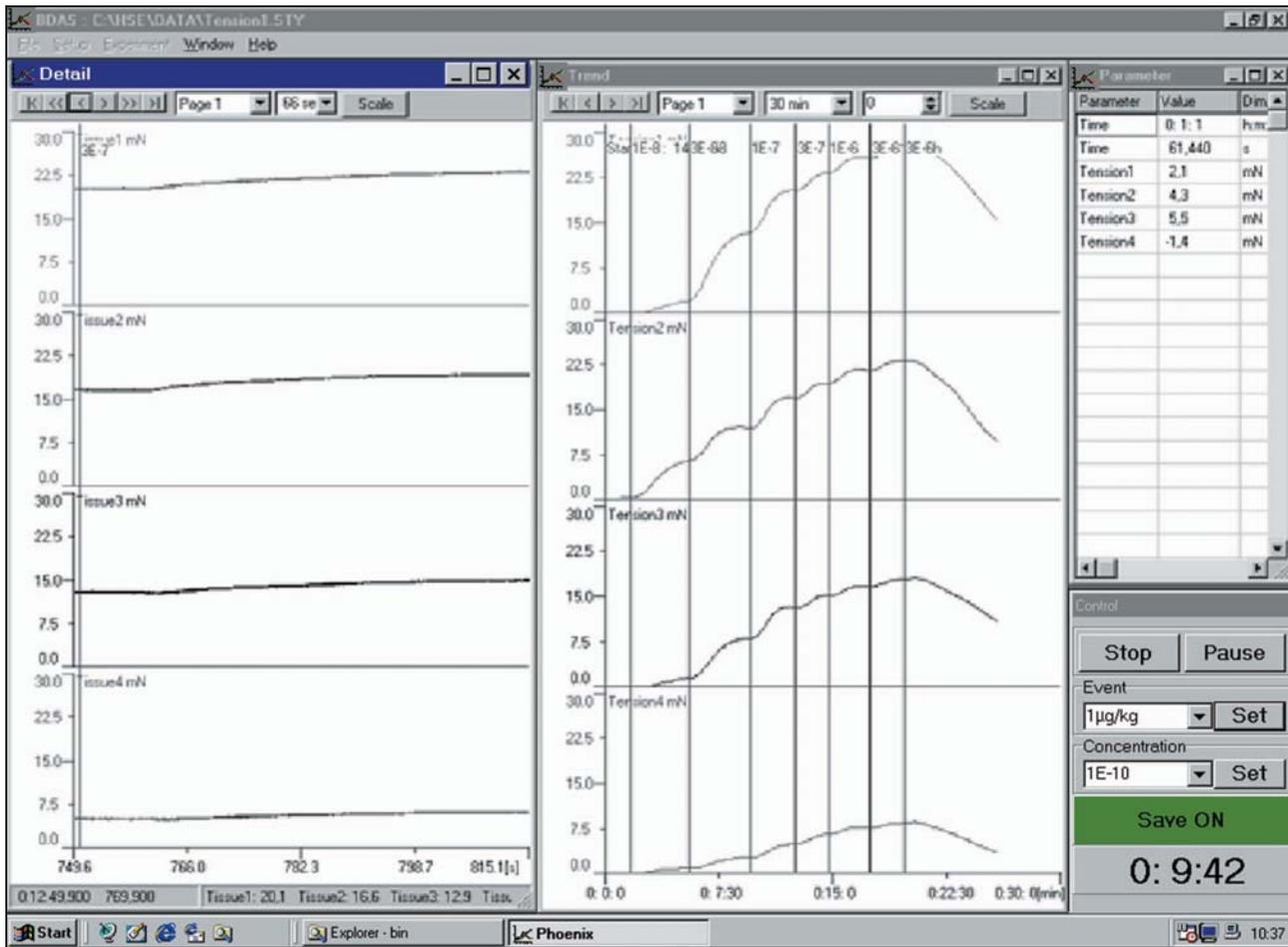
BS4 73-2715 **Monophasic Action Potential (MAP) Module**
Max, Min, Plateau, Amp, Rate, $\pm dv/dt$, duration at 10% of MAP

BS4 73-2716 **Dimensions Module**
End-systolic length, end-diastolic length, $+dL/dt$, $-dL/dt$

BS4 73-2799 **PV-Loop Module**
Conductance Signal, LVP Signal: Acquire and view PV loops real time and during experiment replay. Select and export PV loop segments to Millar PVAN software for further analysis.

BS4 73-2900 Strip Chart Print Option for HSE-HA DAQ Software

HSE-HA BDAS W for Data Acquisition



- 16-channels basic data acquisition software
- For Windows® NT, 2000, and XP
- To measure slow signals such as: mean perfusion pressures or flows, smooth muscle contractions, pO₂, pCO₂, pH, temperature etc.
- Easy to use, reduced settings by using configuration files
- Storage of raw data with possibility for replay; complete experiments can be replayed
- Indication of the measured signals and parameters online in numerical tabular form or graphical detail and trend windows
- Data exchange interface by converting the data into the ASCII delimited format
- Monitoring of the experimental sequence by placing event markers and concentration information
- Very easy graphical selection of specific data points by cursors for evaluation, data reduction and export
- Export of a raw data sequence into ASCII delimited format

The HSE-HA-BDAS software is an easy data acquisition software for measuring relatively slow moving signals where only a mean value is of interest such as temperature, pH, pO₂, pCO₂, pK⁺, mean flow, mean pressure, smooth muscle contraction... under Microsoft® Windows® NT/2000/ or XP operating system. The software is very flexible and user-friendly. It saves the digitized raw signals on the hard disk and calculates online the mean values of these signals.

The HSE-HA BDAS software can be adapted to virtually any experimental investigation where slow signals are measured, eg. measuring oxygen consumption of cells in a cell chamber with a Clark electrode, measuring of up to 16 temperatures, measuring up to 16 pH values, measuring pH, pO₂, pCO₂, K⁺ concentrations in isolated organ experiments, measuring of static pressures, measuring contraction forces of smooth muscles... During data acquisition all acquired signals and derived parameters are displayed on the screen.

The configuration of the system is defined in configuration files to reduce the amount of necessary settings and to ensure a stable and secure system. The user only has to calibrate the signals and to fix the graphics scaling, all the hardware definitions and the algorithms used are defined in these configuration files. This reduces the amount of information necessary in the SOP's and the possibilities of wrong settings. The configuration files can of course be changed and the software can be used in combination with a set of different configuration files to match the different experiments.

*BDAS - Basic Data Acquisition System

HSE-HA BDAS W for Data Acquisition

The HSE-HA-BDAS software has a maximum of 16 channels, i.e. up to 16 different raw signals can be handled. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and the algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. The user has only to set up which of the available signals he wants to acquire and display, which of the possible parameters he wants to evaluate and display; to enter the experimental protocol and finally to calibrate before he starts the data acquisition.

The HSE-HA Data Acquisition Hardware for BDAS Software is available in three versions:

- **PLUGSYS Version BS4 73-0161**

This version consists of the PCI A/D board DT301, ROM-DL, DIM and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28.

- **Stand Alone Version BS4 73-0235**

This version consists of the PCI A/D board DT301, cable and a BNC input box where signals from external amplifiers can be connected.

- **Stand Alone USB Version BS4 73-3330**

Hardware Requirements for BDAS:

Both the PLUGSYS and Stand Alone versions require the following computer hardware:

Computer	PC Pentium at least 500 MHz with one free PCI-slot
RAM	128 MB of RAM
Operating System	Windows NT/2000/XP or 64 MB RAM Windows NT
Hard Disk Space	At least 3.2 Gigabytes
Floppy Drive	1.44 MB
CD-ROM Drive	Required
Monitor	17 or 19 in
Backup Media	MO drive, CD recorder or ZIP drive

Signals processed by BDAS:

P	Pressure
FI	Flow
F	Tension (force)
D	Displacement
T	Temperature
K	Concentrations
pO₂	Oxygen partial pressure
pCO₂	Carbon dioxide partial pressure
pH	pH

BDAS is able to calculate from these signals the following parameter. The standard version includes:

maximum, minimum, mean value

Additionally, formulas can be defined to calculate new parameters from the parameters above

Data Acquisition Software

HSE-HA BDAS W for Data Acquisition

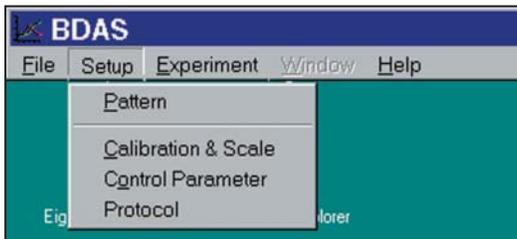
Menu Description

The BDAS software has an intuitive pull-down menu. The main menu has five items with the corresponding pull-down sub-menus.



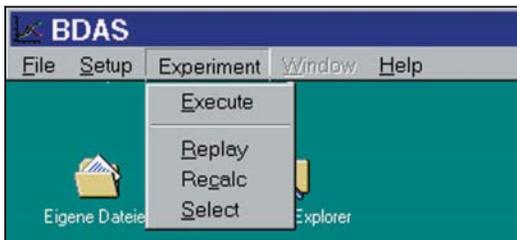
Menu 'File'

Allows you to select an experiment, define a new one, convert and export data into different formats, and print data and protocol.



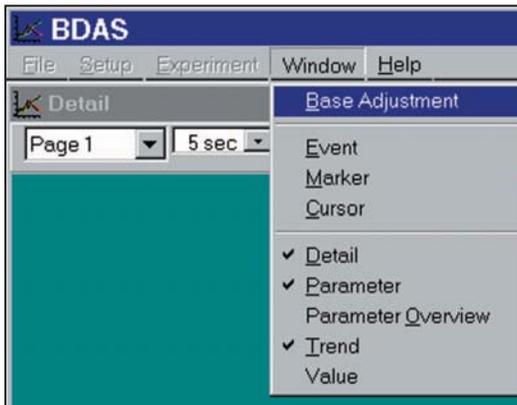
Menu 'Setup'

For calibrating the system, setting up the screens and defining the experimental protocol and all the parameters necessary for controlling the experiment.



Menu 'Experiment'

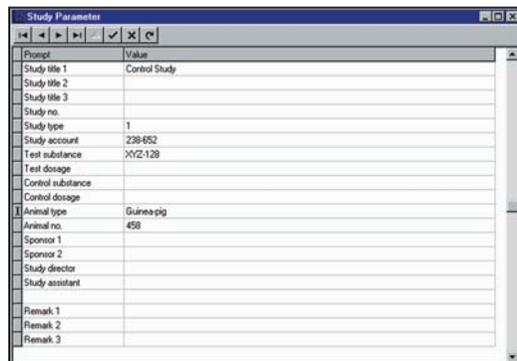
Starts the data acquisition according to the selected settings, and is used to replay an experiment stored on disk, recalculate all the parameters of a stored experiment, to view and select data.



Menu 'Window' and 'Help'

In this menu the user can define the different windows used (details, trend, parameters...) and set the arrangement.

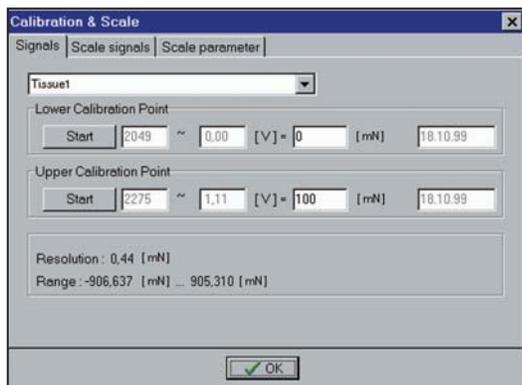
If the user selects the 'Help' menu, the software automatically launches Adobe Acrobat which displays the user's manual.



Protocol

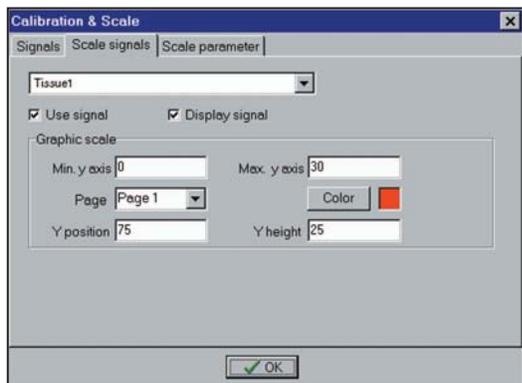
The user can enter several experimental protocol parameters such as experimenter's name, drug used, type of animal used, experiment numbers, SOP number... The set of parameters to enter is defined in a configuration file.

HSE-HA BDAS W for Data Acquisition



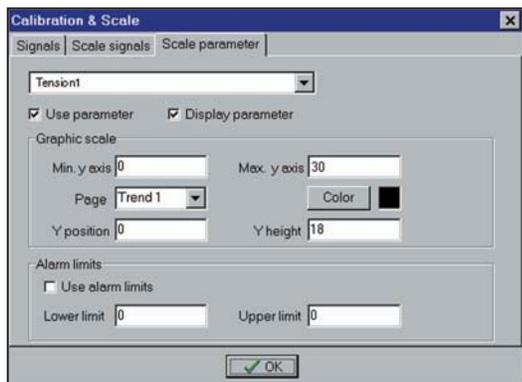
Signal Calibration

For each signal a two-point calibration must be performed. After reading of the lower and upper calibration value, the software automatically calculates the resolution and the available measuring range in physiological units.



Signal Scaling

For each signal the user can define whether the signal is used, displayed, on which graphic page it is displayed, the position on the page, the color and the scaling (scaling can be modified during acquisition).



Parameter Scaling

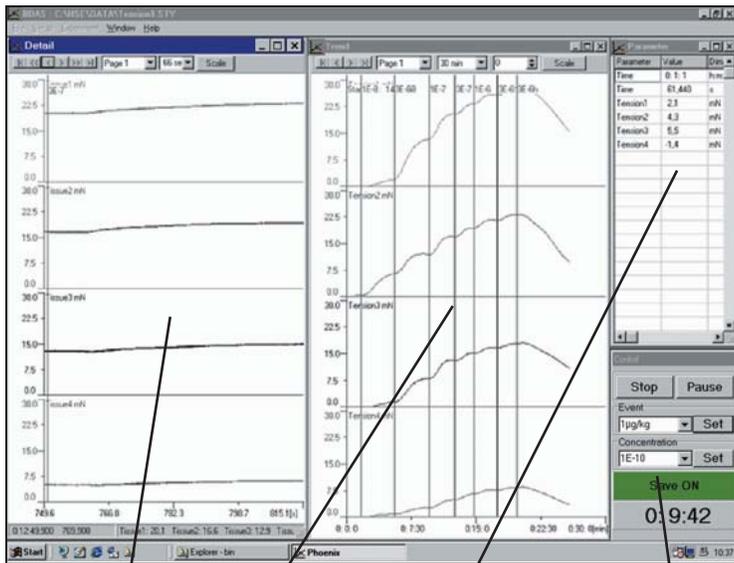
Similar to the signal presentation, the user can define whether a parameter is evaluated, displayed, on which graphic page it is displayed, the position on the page, the color and the scaling (scaling can be modified during acquisition). An alarm condition can also be defined.

Marker	Prompt	Value
Marker 1		Equilibration
Marker 2		Agonist
Marker 3		
Marker 4		
Marker 5		
Marker 6		
Marker 7		
Marker 8		
Marker 9		
Marker 10		
Marker 11		
Marker 12		
Marker 13		
Marker 14		
Marker 15		
Marker 16		
Marker 17		
Marker 18		
Marker 19		
Marker 20		

General Settings

Here the user can enter definitions for events, concentrations, cursors and markers. Events and concentrations are used for marking the data recording during the experiment to report the procedure and to simplify the data reduction after the experiment. Cursors are used to measure times and amplitudes in the detail screen. Markers are used for evaluation to select specific points (maxima, minima) in the trend window.

HSE-HA BDAS W for Data Acquisition



Detail Screen Trend Screen Parameter Screen Control Screen

Data Acquisition Mode

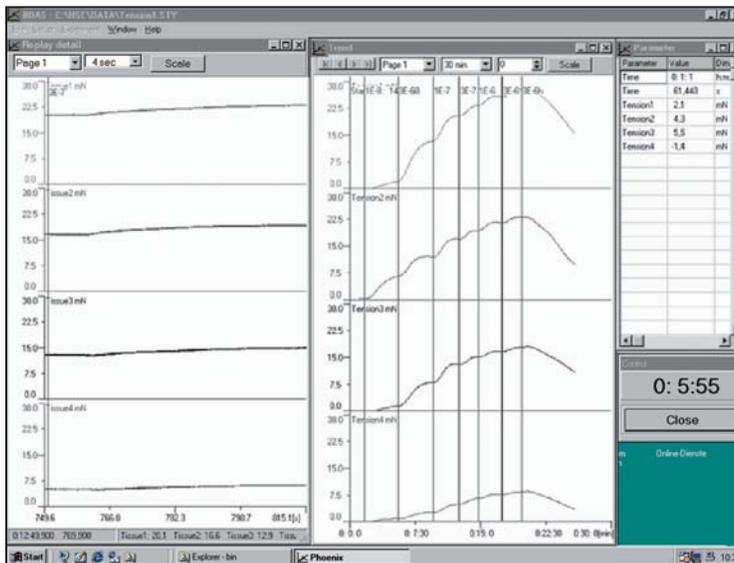
This is a typical window arrangement for data acquisition. This screen configuration appears if the user selects “base adjustment” in the menu ‘Window’. This screen shoot is representative for an experiment measuring force contraction on smooth muscles.

The **Detail screen** displays the raw signals for the contraction force.

The **Trend screen** shows the evolution of the mean contractile force. In this screen we can also see the event lines which are set before each test drug injection.

The **Parameter screen** reproduces the actual measured values in numerical form.

In the **Control screen** the data acquisition can be held (paused) or stopped, and the event markers and concentration markers can be set.



Possible screen configuration during replay.

Replay Mode

After the experiment the stored signals can be replayed to analyze single portions of the experiment using cursors or markers. Cursors can be placed in the detail screen.

Markers can be placed in the trend screen. Here the markers can be used to permit an easy data reduction e.g. for dose response curves several markers are set (control value, dose1, dose2 ...). The calculated values at these markers can be exported. Data reduction can therefore be performed very easily.

If a marker is placed, the detail screen shows the raw signal for the corresponding time point. This permits checking the raw signal for a specific event in the trend graph and correlating both for a better analysis. It is easy to verify whether an event in the trend graph correlates with the real drug action or with any artifact.

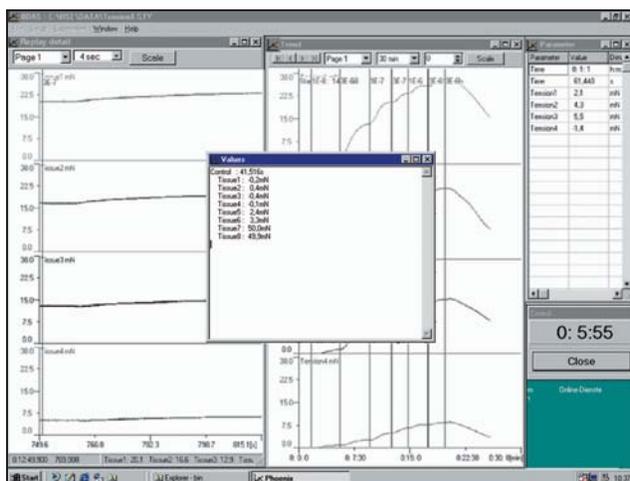
The screen configuration during replay is the same as during data acquisition, except the control screen which is not displayed. Due to the Windows operating system it is possible to create an individual arrangement.

HSE-HA BDAS W for Data Acquisition

Events, Concentrations, Cursors and Markers

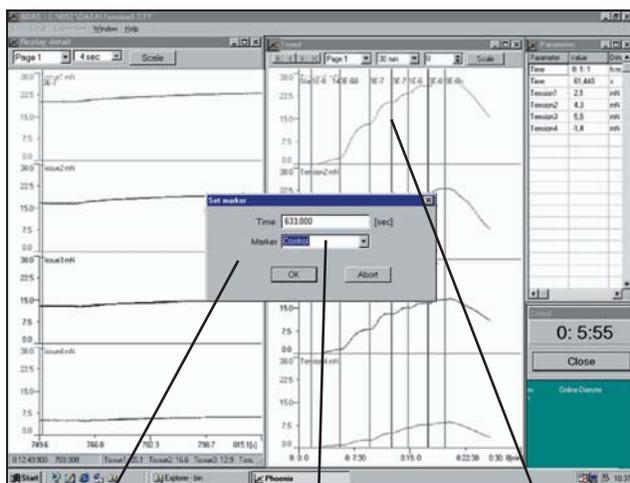
Events and concentration information can be set during the experiment for documentation. To measure manually specific levels or time values on the raw signals, cursors can be placed in the detail screen. Markers can be placed in the trend screen for data reduction. For example, if a dose response experiment has to be evaluated, at least a control value and one value per concentration are necessary. By setting markers in the trend screen the specific points of interest can be marked very quickly and easily e.g. one control value and the maximum effect of each concentration. For further statistical evaluation the

values at these marker lines can be exported into an ASCII file which is suitable for any statistical software or spreadsheet program like EXCEL[®] or Quattro Pro[®], Origin[®] or GraphPad[®]. If a preset marker is selected, the detail screen shows the raw signal at the same instant. This permits checking the raw signal for each marker in the trend graph to correlate both for better analysis. Because of this feature it is easy to verify if a marker in the trend graph correlates with the real drug action or with any artifact.



Using Cursors in the Detail Screen

In the screen shown to the left a cursor has been placed. The time and the values of all acquired signals at the cursor point are displayed in the small window in the centre. These values also can be exported and stored in a separate data file. In the trend screen on the right side the events set during the experiment before a test substance has been added can be seen.



A new window is opened. It shows the exact time where the marker will be placed.

The marker type to place is selected or a new one is defined by typing in the text on the keyboard.

The mouse cursor is placed in the trend screen exactly on the location where the marker should be located and the left mouse button is pressed.

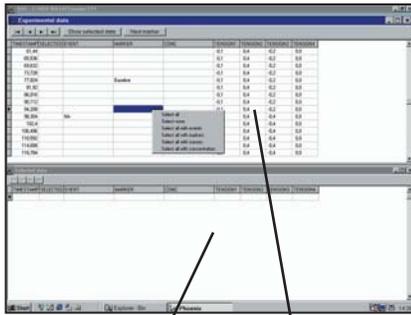
Data Reduction or 'How to Get the Important Data Lines Out of the Long Data File'

The main feature of this software is the possibility of data reduction by placing markers in the replay trend screen. There are two different marker types available: markers for line selections and markers for evaluation.

Markers for Line Selection: The marker is placed in the trend screen. By selecting 'Experiment' 'Selection' 'select all with markers' each data line associated to such a marker is transferred to the selected data set. This allows to define graphically a reduced data set consisting only of the data lines marked by line selection markers.

Markers for Evaluation: A set of evaluation marker pairs (Start and End) for Mean, Maximum and Minimum evaluation are available. A marker pair defines an area in which the evaluation will take place for mean, maximum or minimum depending on the pair selected. The result is a data line containing for each parameter the mean, maximum or minimum in the defined area. This allows to analyze non synchronized parameters.

HSE-HA* BDAS W for Data Acquisition



All selected lines will be transferred into the new table.

Selection window

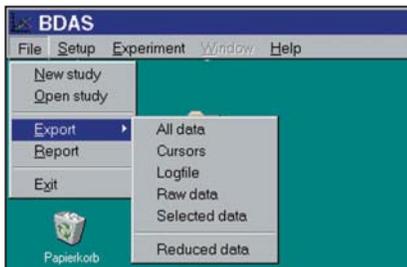
How to Perform the Data Reduction

In the menu items 'Experiment Select' all parameters are displayed in tabular form in the Window 'Experiment Data'. With specific commands it is possible to jump in the data set to a specific marker or time point and select data lines manually. The lines are selected in the 'Experimental Data' window and automatically transferred to the lower 'Selected Data' window which only contains the pre-selected data lines. The more common data reduction is realized by selecting the lines having a marker which have been placed in the trend screen in the replay mode. By pressing the right mouse button a new window opens. If you choose 'Select markers' the data lines where the predefined markers are set will be added to the 'Selected data' window. The selected data lines can be exported to spreadsheet software, graphics or statistical software and are processed there.

Available Selection Commands:

- Select All** All data lines are selected
- Select None** All data lines in the 'Selected data' Window are erased
- Select all With Events** All data lines containing an event are selected
- Select all With Markers** All data lines at the instants where markers have been placed in the trend window are picked out and displayed in the selected data window
- Select all With Concentrations** All data lines where concentration markers have been set are transferred and displayed in the selected data window

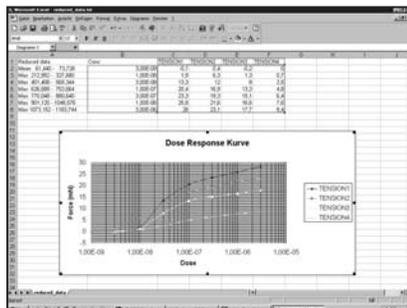
All selected data lines can be exported for evaluation into statistical programs or spreadsheet programs such as EXCEL®, Quattro Pro®, Origin® or GraphPad®.



Exporting Data

To export experiment data several possibilities are provided using the menu item 'File' 'Export'

- All Data** On selecting 'Export' 'All data' all data lines of the experiment with the defined logging rate are exported into an ASCII file. You are asked for the file name and the folder where you would like to store your data file.
- Selected Data** Using menu item 'Export' 'Selected data' converts all data lines of the experiment selected under menu 'Experiment' 'Select' into a ASCII file. You are asked for the file name and the folder where you would like to store your data file.
- Reduced Data** Using menu item 'Export' 'Reduced data' converts all data lines of the experiment selected by the Mean, Maximum and Minimum evaluation into a ASCII file. You are asked for the file name and the folder where you would like to store your data file.
- Cursors** Using menu item 'Export' 'Cursors' converts all data at the timepoint where a cursor is set in the detail window into a ASCII file. You are asked for the file name and the folder where you would like to store your data file. This works only on cursors set in the detail window.
- Logfile** Exports the logfile with the timepoints where markers, concentration markers and cursors have been set into an ASCII file. You are asked for the file name and the folder where you would like to store your data file
- Raw Data** This menu item exports a segment of the raw data file into an ASCII file, for example if you intend to export five cardiac beats. Before you use this menu item you have to set two cursors named 'Start_raw' and 'End_raw' at the beginning and at the end of your segment in the replay mode in the detail screen.



Example of exported data to Excel

Printout

As in all WINDOWS programs each window can be captured and imported into any text editor for further documentation and printout. It is also possible to print the experimental protocol together with the selected data lines

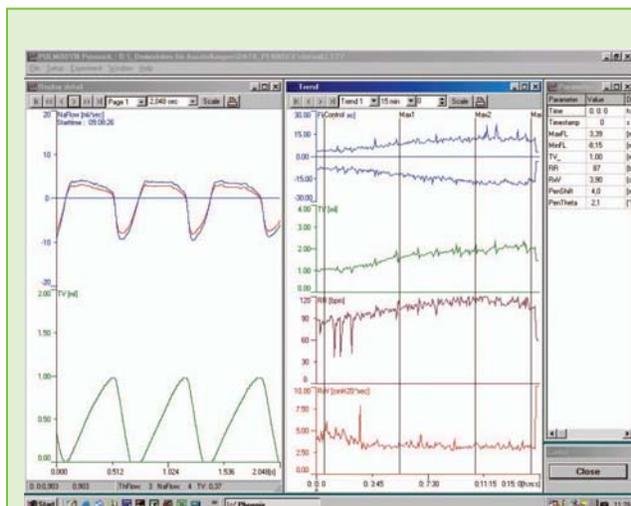
Generating a Report

To generate a report use the menu item 'File' 'Report'. The report is generated as an HTML file, the Internet explorer is automatically opened. The report contains the experimental protocol and the selected data.

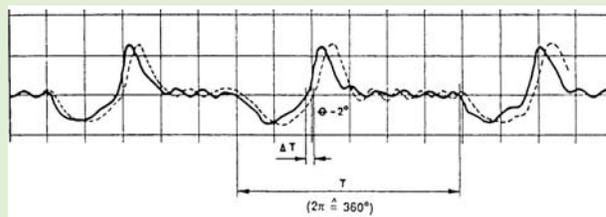
Catalog No. \$ Product

- BS4 73-0161 HSE Data Acquisition Hardware PLUGSYS Version
- BS4 73-0235 HSE Data Acquisition Hardware Stand Alone Version
- BS4 73-3330 HSE-HA Data Acquisition Hardware, USB Stand Alone Version
- BS4 73-1712 Software HSE-HA BDAS

PULMODYN® Pennock W



Data acquisition software for the investigation of bronchospasmodically active substances on conscious animals in the double chamber plethysmograph box, type 855.



The formula according to Pennock et al. (1979) is as follows:

$$\tan \Theta = \omega \times R \times C$$

Θ = Phase Displacement

$\omega = 2\pi \times \text{Respiration Rate } f$

$R \times C$ = Time Constant of the Respiratory System

$C = V/p = \text{Thoracic Gas Volume (V)} / (P_{\text{atm}} - 47 \text{ mmHg})$

The specific airway resistance is therefore obtained as:

$$R \times V = (P_{\text{atm}} - 47) \times 13.6 \times \frac{\tan \Theta}{\omega} [\text{mmH}_2\text{O} \times \text{s}]$$

The phase displacement is measured at the end of inspiration on the steep change over to the expiratory phase.

This software was especially developed for the investigation of bronchospasmodically active substances on conscious animals. In this experiment the awake animal is placed into a double chamber plethysmograph box Type 855 (see page F75) and is restricted so that the head protrudes into the front chamber. The neck is sealed with a soft diaphragm. The nasal air flow is measured in the front chamber, the thoracic respiratory flow in the rear chamber. Both measurements are made with wire-mesh measuring screens and differential pressure transducers. There is a phase shift between the two respiratory flows from which the PULMODYN PENNOCK software calculates the specific airway resistance according to PENNOCK. Data acquisition covers the following signals: pulmonary air flow in the nasal chamber, pulmonary air flow in the thoracic chamber. From the flow signal of the thoracic chamber the following parameters are calculated: respiration rate, tidal volume, maximal inspiratory flow, maximal expiratory flow.

From the phase shift between nasal and thoracic flow the following parameters are calculated: phase shift and specific airway resistance. During data acquisition all acquired signals and derived parameters can be displayed on the screen.

The system covers eight channels. This makes it possible to experiment simultaneously on 4 plethysmograph boxes. All 8 signals are sampled at 1 kHz. This means that each channel is measured 1000 times per second, or measurements on each channel are made once every millisecond. This permits measuring phase shifts of some milliseconds and calculate from this delay the specific airway resistance.

The Software Receives the Following Signals from up to 4 Plethysmograph Boxes:

- Airflow from the Nasal Chamber
- Airflow from the Thoracic Chamber

Optional:

- Blood Pressure
- ECG

From these signals the software calculates the following parameters online:

From the Pulmonary Air Flow signals:

- Respiration Rate (RR)
- Peak Inspiratory Flow (PIF), Peak Expiratory Flow (PEF)
- Tidal Volume (TV)

Optional:

- IT (Inspiratory Time), ET (Expiratory Time), AT (Apnea Time), TT (Total Time), TB (Time of brake), TP (Time of pause), Airflow at 0.5VT

From the Phase Shift between Nasal and Thoracic Airflow:

- Phasic Shift in msec (PenSift)
- Specific Airway Resistance (Res)

Optionally from Blood Pressures:

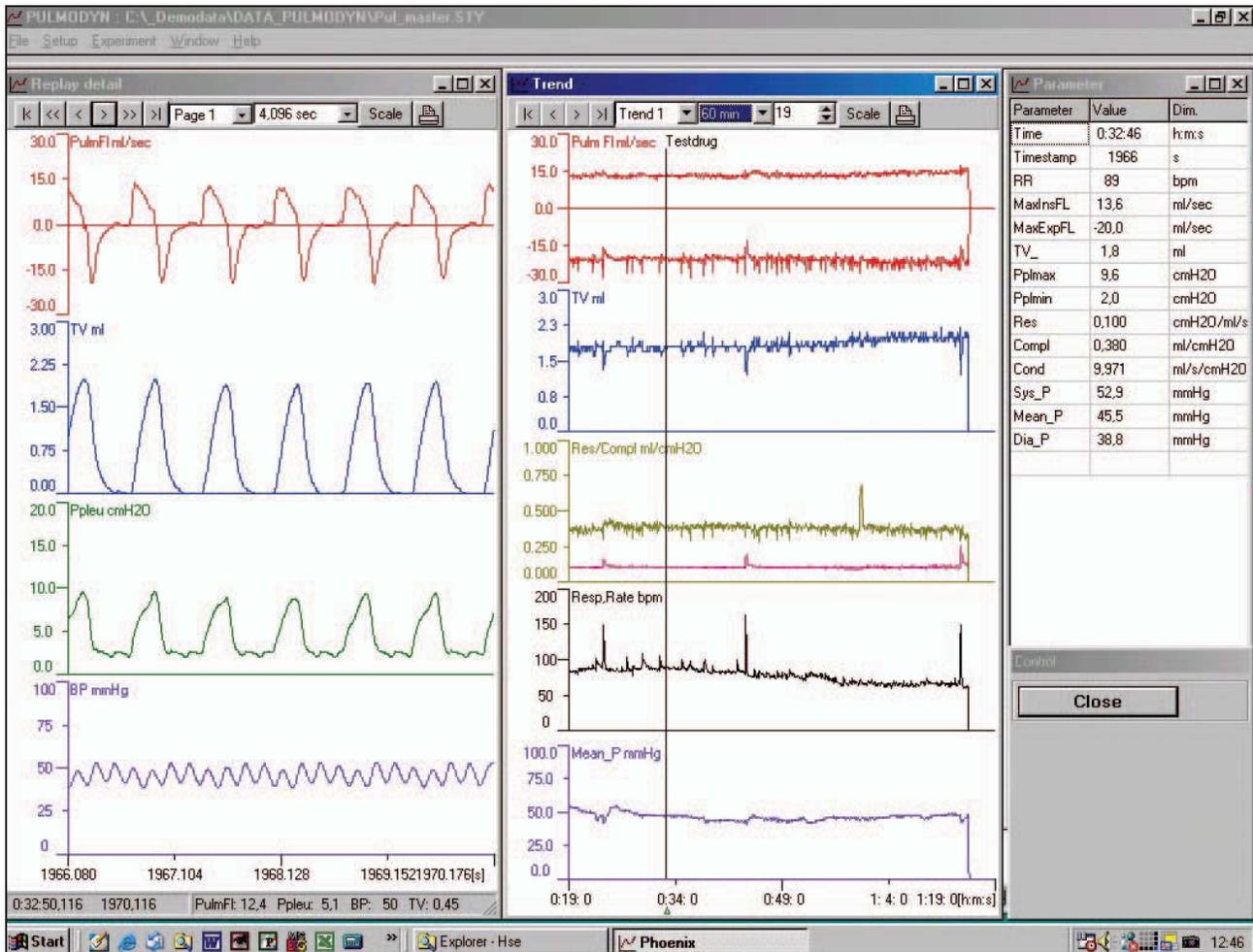
- Systolic, Diastolic, Mean Pressure
- Heart Rate

Optionally from the ECG:

- Heart Rate
- RR-I

Catalog No.	\$	Product
BS4 73-1702		Software PULMODYN 'PENNOCK'
BS4 73-0161		HSE Data Acquisition Hardware PLUGSYS Version
BS4 73-0235		HSE Data Acquisition Hardware Stand Alone Version
BS4 73-2705		Algorithm Advanced Pulmonary Flow IT, ET, AT, TT
BS4 73-2706		Algorithm ECG RR-I, HR
BS4 73-3409		Option Blood Pressure Module

HSE-HA PULMODYN® W for Respiratory Studies



- 16 channel data acquisition software for in vivo or in vitro respiration experiments
- For Windows® 98, ME, 2000, XP and NT
- Derives and presents online the standard parameters for respiratory studies (TV, Resp. Rate, Resistance, Conductance, Compliance)
- possibility of combination with circulatory signals (e.g. LVP, aortic pressure, aortic flow)
- In vivo:
 - Bronchodilation test and bronchospasmolytic test on anesthetized animals
 - Antiasthmatics test according to Konzett-Roessler (bronchial overflow measurement) or according to Einthoven (tracheal pressure measurement)
 - Pulmonary air flow
 - Tracheal pressure or esophageal pressure
 - Arterial pressure or venous pressure
 - pO₂, pCO₂, pH, temperature etc.
- In vitro:
 - Bronchodilation test and bronchospasmolytic test on the isolated lung
 - Pulmonary-vascular studies on the isolated lung

The HSE-HA PULMODYN W software can be adapted to virtually any experimental investigation in respiratory experiments. Acquisition can cover signals such as pulmonary air flow, tracheal pressure or oesophageal pressure, arterial pressure or venous pressure, pO₂, pCO₂, pH, temperature etc. Various parameters can be derived from these signals, e.g. tidal volume, respiration rate, peak inspiratory flow, peak expiratory flow, maximal and minimal tracheal pressure, resistance, compliance, systolic, diastolic and mean values for pressures, etc. During data acquisition all acquired signals and derived parameters can be displayed on the screen.

The HSE-PULMODYN software is available in a basic version which includes the minimal necessary algorithms for pulmonary mechanics evaluation. It can be upgraded to a more complex system including all the available algorithms. The configuration of the system is defined in configuration files to reduce the amount of settings necessary and to ensure a stable and secure system. The user has only to calibrate the signals and to fix the graphics scaling, all the hardware definitions and the algorithms used are defined in the configuration files. This reduces the amount of information necessary in the SOP's and the possibilities of wrong settings. The configuration files can of course be changed and the software can be used in combination with a set of different configuration files to match the different experiments. PULMODYN is a menu-controlled software and employs special algorithms to calculate the standard pulmonary mechanics parameters.

HSE-HA PULMODYN® W for Respiratory Studies

The HSE-HA PULMODYN software has a maximum of 16 input channels, i.e. up to 16 different raw signals can be handled. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and the algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. The user has only to set up which of the available signals he wants to acquire and display, which of the possible parameters he wants to evaluate and display; to enter the experimental protocol and finally to calibrate before he starts the data acquisition.

The HSE-HA Data Acquisition Hardware for PULMODYN W Software is available in two versions:

- **PLUGSYS Version BS4 73-0161**
This version consists of the PCI A/D board DT301 and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28
- **Stand Alone Version BS4 73-0235**
This version consists of the PCI A/D board DT301 and a BNC input box where signals from external amplifiers can be connected.
- **Stand Alone USB Version BS4 73-3330**

Hardware Requirements for PULMODYN:

Both the PLUGSYS and Stand Alone versions require the following computer hardware:

Computer	Pentium PC at least 500 MHz with one free PCI-slot,
RAM	128 MB of RAM
Operating System	Windows 2000/XP or Windows NT
Hard Disk Space	With at least 3.2 GB
Floppy Drive	1.44 MB
CD-ROM Drive	Required
Monitor	17-19"
Backup Media	MO drive, CD recorder or ZIP drive

Commonly Used Signals for In-Vivo Respiratory Experiments are:

- Pulmonary Air Flow
- Intrapleural Pressure
- Tracheal Pressure or Oesophageal Pressure
- Arterial Blood Pressure or Venous Blood Pressure (option)
- ECG (option)
- Temperature

Signals in Isolated Lung Experiments are:

- Pulmonary Air Flow
- Intrapleural Pressure
- Perfusion Pressure, venous pressure
- Perfusion Flow
- pO₂, pCO₂, pH
- Temperature
- Lung Weight

The Basic PULMODYN Calculates the Following Parameters On-Line:

From Pulmonary Air Flow	RespRate, maxInspFI, maxExpFI, TV, dynResistance, Conductance, dynCompl.
From all Pulmonary Pressures	Maximum, minimum, mean pressure
From Blood Pressures	Systolic, diastolic, mean pressure, nprmn, Heart Rate
From Perfusion Flows	Maximum, minimum, mean flow, nprmn
From the Pulmonary airflow	Inspiratory time, Expiratory time, Apnea time, Total time
From pO ₂ , pCO ₂ , pH	Mean value
From Temperature & Lung Weight	Mean value

Note: nprmn = non pulsatile mean

It is also possible to calculate specific values from these parameters by writing a formula e.g. the difference between the oesophageal and the tracheal pressure.

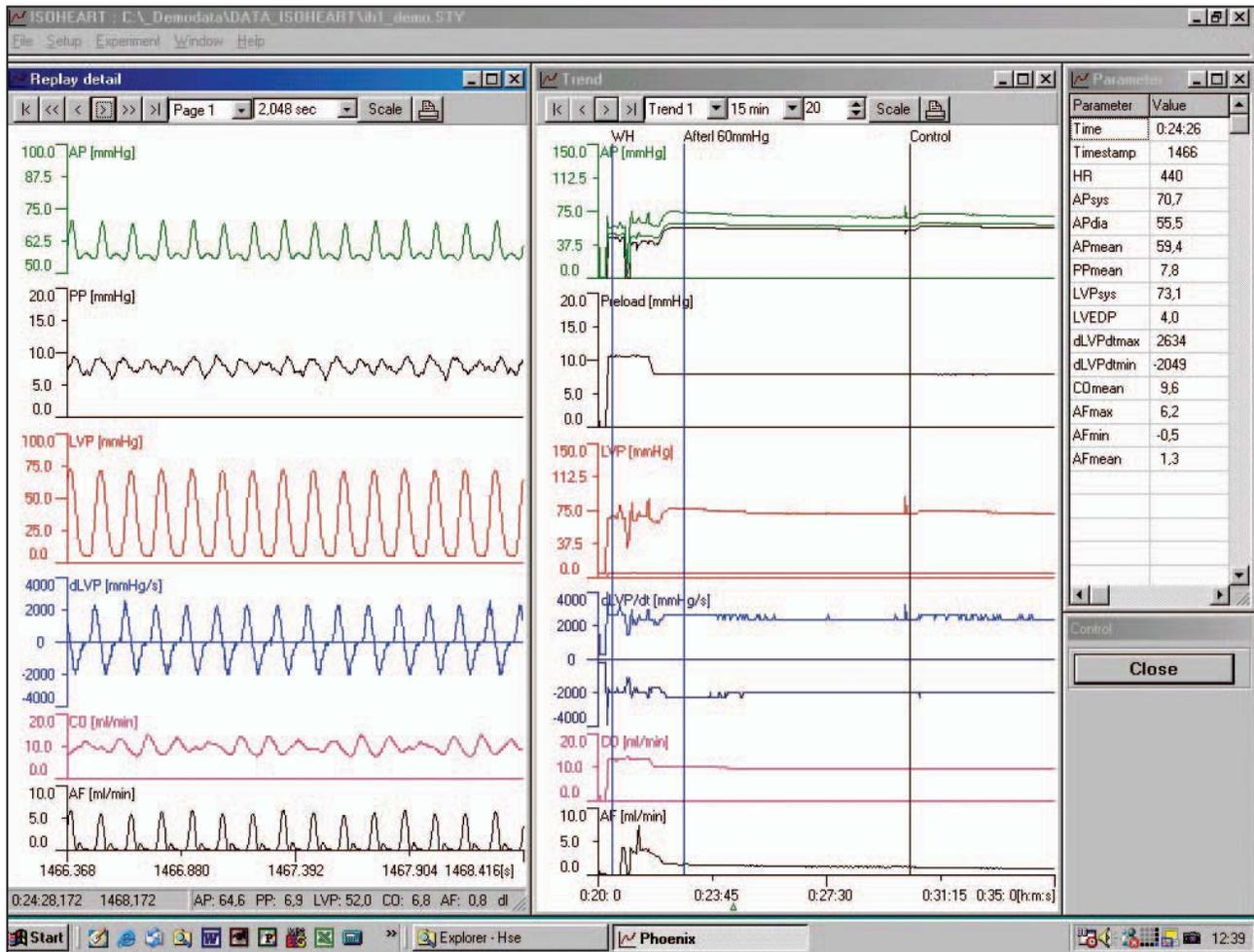
Additional Software Modules:

Algorithm Advanced Pulm Flow	IT (inspiratory time), ET (expiratory time), AT (apnea time), TT (total time), TB (Time of brake), TP (Time of pause), Airflow at 0.5VT
Module for Blood Pressure	Systolic, diastolic, mean pressure, nprmn, Heart Rate
Module for LVP	LVPsys, LVPpedp, dP/dtmax, dP/dtmin, heart rate
Algorithm ECG	RR-I, HR

Specific parameters which are not mentioned in this list are available upon request.

Catalog No.	\$	Product
BS4 73-1692		Software HSE-HA PULMODYN W
BS4 73-0161		HSE Data Acquisition Hardware PLUGSYS Version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version
BS4 73-0235		HSE Data Acquisition Hardware Stand Alone Version
BS4 73-2705		Option Advanced Pulmonary Flow Module
BS4 73-3409		Option Blood Pressure Module
BS4 73-3462		Option LVP Module
BS4 73-2706		Option ECG Module

HSE-HA ISOHEART® W for Isolated Heart Studies



- 16 channel data acquisition software for isolated heart experiments
- For Windows® NT, 2000, and XP
- To measure signals such as: perfusion pressure, perfusion flow, left ventricular isovolumetric pressure, aortic pressure, aortic flow, atrial pressure, atrial flow, coronary flow, length measurement, pO₂, pCO₂, pH, temperature, etc.
- Easy to use, reduced settings by using configuration files
- Storage of raw data with possibility for replay. Complete experiments can be replayed
- Indication of the measured signals and parameters online in numerical tabular form or graphical detail and trend windows
- Data exchange interface by converting the data into the ASCII delimited format
- Monitoring of the experimental sequence by placing event markers and concentration information
- Very easy graphical selection of specific data points by cursors for evaluation, data reduction and export
- Export of a raw data sequence into ASCII delimited format

The HSE-HA ISOHEART software for Windows can be adapted to virtually any experimental investigation of isolated hearts (according to Langendorff or Working Heart). Acquisition can cover signals such as perfusion pressure, perfusion flow, left ventricular pressure, aortic pressure, aortic flow, atrial pressure, atrial flow, coronary flow, segment length or wall thickness measurement, pO₂, pCO₂, pH, temperature, etc. Various parameters can be derived from these signals, (e.g., systolic, diastolic, mean and rate (frequency) values for pressures); dP/dt; contractility index CI; minimal, maximal, and mean flows, etc. During data acquisition all acquired signals and derived parameters are stored on the hard disk and can be displayed on the screen.

The HSE-HA ISOHEART software is available in a basic version which includes the minimal necessary algorithms. It can be upgraded to a more complex system including all the available algorithms. The configuration of the system is defined in configuration files to reduce the amount of settings necessary and to ensure a stable and secure system. The user has only to calibrate the signals and to fix the graphics scaling. All the hardware definitions and the algorithms used are defined in the configuration files. This reduces the amount of information necessary in the SOP's and the possibilities of wrong settings. The configuration files can of course be changed and the software can be used in combination with a set of different configuration files to match the different experiments. ISOHEART is a menu-controlled software and employs special algorithms to calculate the standard parameters.

HSE-HA ISOHEART® W for Isolated Heart Studies

The HSE-HA ISOHEART W software has a maximum of 16 channels, i.e. up to 16 different raw signals can be handled. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and the algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. The user has only to set up which of the available signals he wants to acquire and display, which of the possible parameters he wants to evaluate and display; to enter the experimental protocol and finally to calibrate before he starts the data acquisition.

HSE-HA Data Acquisition Hardware for ISOHEART Software is available in three versions:

- **PLUGSYS Version BS4 73-0161**
This version consists of the PCI A/D board DT301 and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28.
- **Stand Alone Version BS4 73-0235**
This version consists of the PCI A/D board DT301 and a BNC input box where signals from external amplifiers can be connected.
- **Stand Alone USB Version BS4 73-3330**

Hardware Requirements for ISOHEART:

Both the PLUGSYS and Stand Alone Versions require the following computer hardware:

Computer	Pentium PC at least 500 MHz with one free PCI-slot,
RAM	128 MB of RAM
Operating System	Windows 2000/XP or Windows NT
Hard Disk Space	With at least 3.2 GB
Floppy Drive	1.44 MB
CD-ROM Drive	Required
Monitor	17-19"
Backup Media	MO drive, CD recorder or ZIP drive

Commonly Used Signals for Langendorff Preparation are:

LVP	isovolumetric LVP or contraction force
PP	perfusion pressure
CF	coronary flow
WT	wall thickness or left ventricle diameter
EG	electrogram
pO ₂ a / e	oxygen partial pressure in the affluent / effluent
pH	pH in the effluent

Commonly Used Signals for Working Heart Preparation are:

PrP	preload pressure
AoP	aortic pressure (afterload)
LVP	left Ventricular Pressure, measured with tip catheter
AF	aortic flow
CO	cardiac output (flow into left atrium)
WT	wall thickness or left ventricle diameter
EG	electrogram
pO ₂ a / e	oxygen partial pressure in the affluent / effluent
pH	pH in the effluent

It is also possible to acquire other signals (e.g., temperature); maximum is 16 signals.

Standard ISOHEART Software is able to Calculate Following Parameters Online:

From LVP signal:	LVP _{sys} , LVP _{dia} , LVP _{EDP} , dLVP/dt _{min} , dLVP/dt _{max} , heart rate, mean pressure
From all pressures:	systolic, diastolic and mean pressure
From all flows:	mean, maximum and minimum flow
From distance:	maximum, minimum and amplitude (max - min)
From electrogram:	heart rate
From pO ₂ , pCO ₂ and pH:	mean value

For Specific Applications, Software Modules with More Parameters are available:

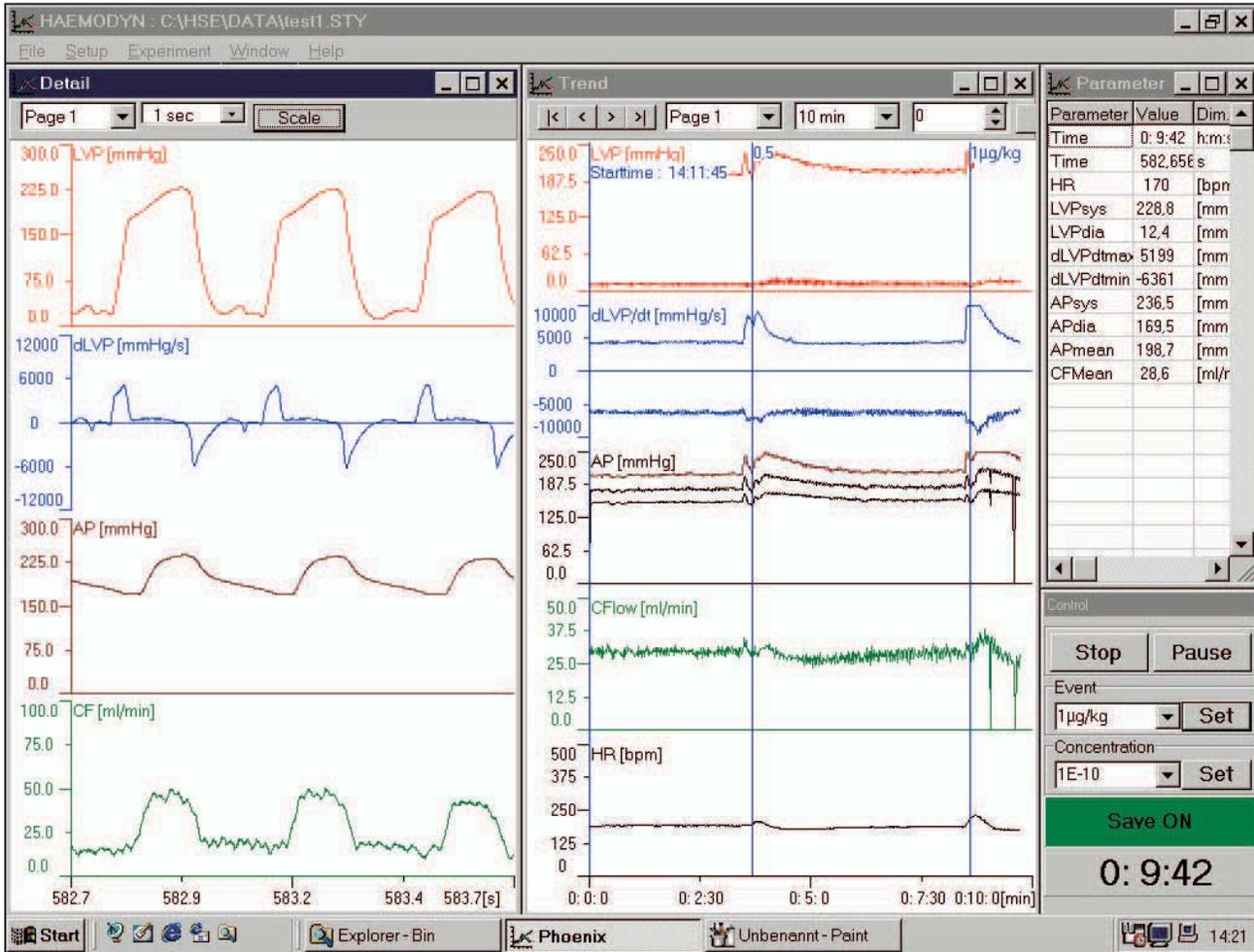
Advanced LVP:	Tau, Time to Peak, Relaxation Time, Contractility Index CI=dP/dt _{max} /P, Ejection Time
Advanced flow:	End Systolic Flow ESFL, End Diastolic Flow EDFL
MAP module:	Max, Min, Plateau, Amp, Rate, ±dv/dt, duration at 10% of monophasic action potentials
Dimension module:	end-systolic length ESL, end-diastolic length EDL, +dL/dt, -dL/dt

Software Options for Controlling External Devices:

Control of programmable stimulator PSM
Control of pretention using electrical controlled verniers
Triggering of an external stimulator

Catalog No.	\$	Product
BS4 73-0161		HSE-HA Data Acquisition Hardware PLUGSYS version
BS4 73-0235		HSE-HA Data Acquisition Hardware Stand Alone version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version
BS4 73-0162		Software HSE-HA ISOHEART W
BS4 73-0237		Option LVP Advanced Module
BS4 73-0238		Option Flow Advanced Module
BS4 73-2715		Option Monophasic Action Potential Module
BS4 73-2716		Option Dimensions Module
BS4 73-0224		Option Stimulator Control Module
BS4 73-2799		PV-Loop Module Conductance Signal, LVP Signal: Acquire and view PV loops real time and during experiment replay. Select and export PV loop segments to Millar PVAN software for further analysis.
BS4 73-2900		Strip Chart Print Option for HSE-HA DAQ Software

HSE-HA HAEMODYN® W for Haemodynamic Studies



- 16-channel data acquisition software for haemodynamic experiments
- For Windows® NT, 2000, and XP
- To measure signals such as left ventricular pressure, aortic pressure, aortic flow, atrial pressure, atrial flow, coronary flow, length measurement, pO₂, pCO₂, pH, temperature, etc.
- Easy to use, reduced settings by using configuration files
- Storage of raw data with possibility for replay — complete experiments can be replayed
- Indication of the measured signals and parameters online in numerical tabular form or graphical detail and trend windows
- Allows data exchange interface by converting the data into the ASCII delimited format
- Monitors the experimental sequence by placing event markers and concentration information
- Very easy graphical selection of specific data points by cursors for evaluation, data reduction and export
- Export of a raw data sequence into ASCII delimited format

The HSE-HA HAEMODYN software can be adapted to virtually any experimental investigation for haemodynamic experiments. Acquisition can cover signals such as left ventricular pressure, aortic pressure, aortic flow, atrial pressure, atrial flow, coronary flow, segment length and wall thickness measurement, pO₂, pCO₂, pH, temperature, etc. Various parameters can be derived from these signals, e.g. systolic, diastolic, mean and rate (frequency) values for pressures, dp/dt, contractility index CI, minimal, maximal, and mean flows, etc. During data acquisition, all acquired signals and derived parameters are stored on the hard disc and can be displayed on the screen.

The HSE-HA HAEMODYN software is available in a basic version which includes the minimal necessary algorithms that can be upgraded to a more complex system including all the available algorithms. The configuration of the system is defined in configuration files to reduce the amount of settings necessary and to ensure a stable and secure system. The user only needs to calibrate the signals and fix the graphics scaling. All the hardware definitions and algorithms used are defined in the configuration files. This reduces the amount of information necessary in the SOP's and the possibility of wrong settings. The configuration files can be changed and the software used in combination with a set of different configuration files to match the different experiments.

HSE-HA HAEMODYN® W for Haemodynamic Studies

HAEMODYN is a menu-controlled software and employs special algorithms to calculate the standard haemodynamic parameters.

The HSE-HA HAEMODYN software has a maximum of 16 channels, i.e. up to 16 different raw signals can be handled. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and the algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. The user has only to set up which of the available signals he wants to acquire and display, which of the possible parameters he wants to evaluate and display, enter the experimental protocol, and finally calibrate before he starts the data acquisition.

The HSE-HA Data Acquisition Hardware for HAEMODYN W software is available in two versions:

- **PLUGSYS Version BS4 73-0161**
This version consists of the PCI A/D board DT301 and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28.
- **Stand Alone Version BS4 73-0235**
This version consists of the PCI A/D board DT301 and a BNC input box where signals from external amplifiers can be connected.
- **Stand Alone USB Version BS4 73-3330**

Hardware requirements for HAEMODYN:

Both the PLUGSYS and stand alone versions require the following computer hardware:

Computer	Pentium PC at least 500 MHz with one free PCI-slot,
RAM	128 MB of RAM
Operating System	Windows 2000/XP or Windows NT
Hard Disk Space	With at least 3.2 GB
Floppy Drive	1.44 MB
CD-ROM Drive	Required
Monitor	17-19 in
Backup Media	MO drive, CD recorder or ZIP drive

Commonly used signals on haemodynamic experiments are:

LVP	Left Ventricular Pressure
AP	Arterial Pressure
VP	Venous Pressure
CF	Coronary Flow
AF	Arterial Flow
WT	Wall Thickness or Left Ventricle Diameter
ECG	Electrocardiogram
pO ₂	Oxygen Partial Pressure
pCO ₂	Carbon Dioxide Partial Pressure pH

It is also possible to acquire other signals such as temperature. The maximum number of signals is 16.

The basic version of HAEMODYN calculates the following parameters online:

From LVP Signal	LVP _{sys} , LVP _{dia} , LVP _{EDP} , dP/dt _{min} , dP/dt _{max} , Heart Rate, Mean Pressure
From All Pressures	Systolic, Diastolic and Mean Pressure, Heart Rate
From All Flows	Mean, Max. and Min. Flow
From Distance	Max., Min. and Amplitude (Max-Min)
From Electrogram	Only the Heart Rate
From pO ₂ Signals	Mean Value
From pCO ₂ Signals	Mean Value
From pH Signals	Mean Value

It is also possible to calculate specific values from these parameters by writing a formula (e.g., the ratio of dP/dt_{min} / dP/dt_{max} or LVP_{EDP} / heart weight, etc.).

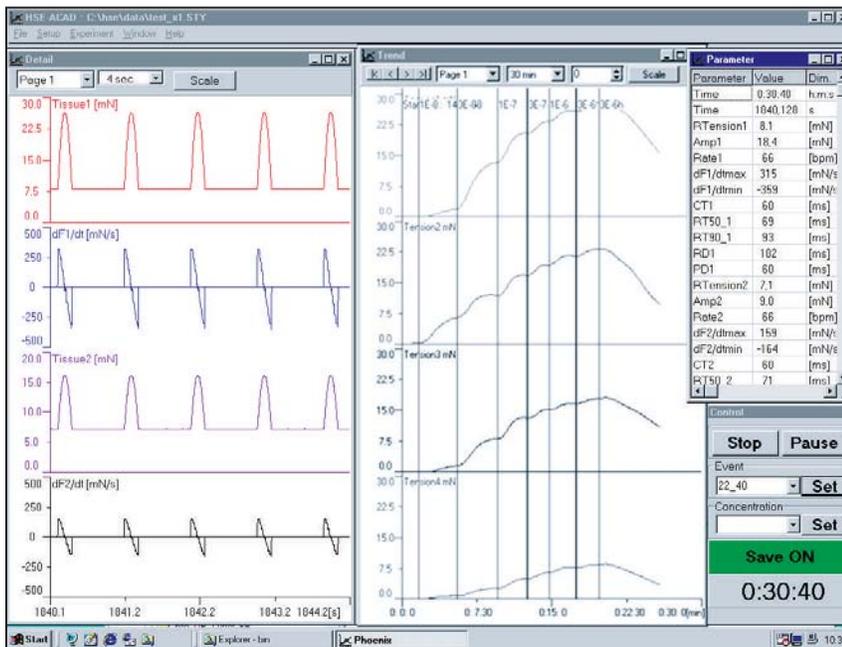
Optional software modules are available for:

LVP Advanced	Tau, Time to Peak (Contractility Time), Relaxation Time and Contractility Index $CI = dP/dt_{max} / P$
Flow Advanced	Endsystolic Flow, Enddiastolic Flow
Respiration Module	Respiratory Rate, Max. Inspiratory Flow, Max. Expiratory Flow, Tidal Volume
MAP Module	Max, Min, Plateau, Amp, Rate, ±dv/dt, duration at 10% of MAP
Dimensions Module	End-systolic length, end-diastolic length, +dL/dt, -dL/dt

Specific parameters which are not mentioned in this list are available by special order. Please call Harvard Apparatus Technical Customer Service for more details.

Catalog No.	\$	Product
BS4 73-1690		Software HSE-HA HAEMODYN W
BS4 73-0161		HSE-HA Data Acquisition Hardware PLUGSYS Version
BS4 73-0235		HSE-HA Data Acquisition Hardware Stand Alone Version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version
BS4 73-0237		Optional LVP Advanced Software Module
BS4 73-0238		Optional Flow Advanced Software Module
BS4 73-0239		Optional Respiration Software Module
BS4 73-2715		Monophasic Action Potential (MAP) Module Max, Min, Plateau, Amp, Rate, ±dv/dt, duration at 10% of MAP
BS4 73-2716		Dimensions Module End-systolic length, end-diastolic length, +dL/dt, -dL/dt
BS4 73-2799		PV-Loop Module Conductance Signal, LVP Signal: Acquire and view PV loops real time and during experiment replay. Select and export PV loop segments to Millar PVAN software for further analysis.
BS4 73-2900		Strip Chart Print Option for HSE-HA DAQ Software

HSE-HA ACAD® W for Isolated Tissue Studies



- 16-channel data acquisition software for isolated tissue studies
- For Windows® NT, 2000, XP
- To measure isometric or isotonic tissue contractions
- Can handle smooth muscle as well as beating or electrically stimulated muscle
- Possibilities of controlling electrical stimulation, pretension adjustment and flushing
- Easy to use, reduced settings by using configuration files
- Storage of raw data with possibility for replay; complete experiments can be replayed
- Indication of the measured signals and parameters online in numerical tabular form or graphical detail and trend windows
- Data exchange interface by converting the data into the ASCII delimited format
- Monitoring of the experimental sequence by placing event markers and concentration information
- Very easy graphical selection of specific data points by cursors for evaluation, data reduction and export
- Export of a raw data sequence into ASCII delimited format

The HSE-HA ACAD software can be adapted to virtually any experimental investigation in tissue bath experiments. It is possible to acquire signals from isotonic (displacement) or isometric (force) measurements. The isotonic displacement measurement is used on smooth muscles, for example on ileum, ductus deferens, lung strips, also bladder... Isometric force measurement is used with tracheal muscle, atrium, papillary muscle, aortic rings, veins or other vessel rings. Experiments on spontaneously beating or electrically stimulated tissues are also possible. Various parameters can be derived from these signals depending on the model used. During data acquisition all acquired signals and derived parameters are stored on the hard disc and can be displayed graphically on the screen.

The HSE-HA ACAD software is available in a basic version which includes the minimal necessary algorithms to evaluate the resting tension. This version can be upgraded to a more complex system including all the available algorithms. The configuration of the system is defined in configuration files to reduce the settings necessary and to ensure a stable and secure system. The user has only to calibrate the signals and to fix the graphics scaling, all the hardware definitions and the algorithms used are defined in the configuration files. This reduces the amount of information necessary in the standard operating procedures and the possibilities of wrong settings. The configuration files can of course be changed and the software can be used in combination with a set of different configuration files to match the different experiments.

The ACAD software can control preload adjustment and flushing as well as data acquisition and calculation. It was developed for use with our universal setup for isolated organ studies. It can also be used with any existing manually-operated tissue bath setup. It is possible to use ACAD only for data acquisition without controlling or with full controlling in order to automate all routine operations and provide full processing and printing facilities for the results.

The HSE-HA ACAD software has a maximum of 16 channels, i.e. up to 16 different raw signals can be handled. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and the algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. The user has only to set up which of the available signals he wants to acquire and display, which of the possible parameters he wants to evaluate and display; to enter the experimental protocol and finally to calibrate before he starts the data acquisition. The ACAD software operates with the PLUGSYS hardware only!

The HSE-HA Data Acquisition Hardware for ACAD Software is available in three versions:

• PLUGSYS Version

This version consists of the PCI A/D board DT301 and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28

• Stand Alone Version

This version consists of the PCI A/D board DT301 and a BNC input box where signals from external amplifiers can be connected

• USB Stand Alone Version

This version consists of the 16 channel USB A/D converter box with BNC inputs and USB cable

HSE-HA ACAD[®] W for Isolated Tissue Studies

Hardware Requirements for ACAD:

Both the PLUGSYS and Stand Alone versions require the following computer hardware:

Computer	PC Pentium, at least 500 MHz with one free PCI-slot
RAM	128 MB of RAM
Operating System	Windows 2000/XP, 64 MB RAM NT
Hard Disk Space	At least 3.2 GB
Floppy Drive	1.44 MB
CD-ROM Drive	Required
Monitor	17-19"
Backup Media	MO drive, CD recorder or ZIP drive

For computer-controlled applications it is necessary to have a PLUGSYS Maincase and the PLUGSYS Version of the Data Acquisition Hardware with DIM-D extension. The PLUGSYS Maincase can receive the Transducer Amplifiers TAM-A. The housing takes also the Programmable Stimulator Modules PSM or the PPG Module for triggering an external Stimulator. In addition to these modules an Output Driver Module ODM is used to control the pumps and valves via an Extension Unit. This Extension Unit contains the electronics to switch pumps, valves and automatic vernier controls.

- Manual Control Box MCB for manual draining or refilling of the organ bath or to adjust preload manually
- HSE-HA Flushing Unit with pumps and valves to drain and refill the organ bath
- Motor Vernier Control Type 850/E for isometric measurements for each organ can be used to set preload automatically

The basic version of HSE-ACAD for smooth muscles calculates the following parameter:

- Resting tension

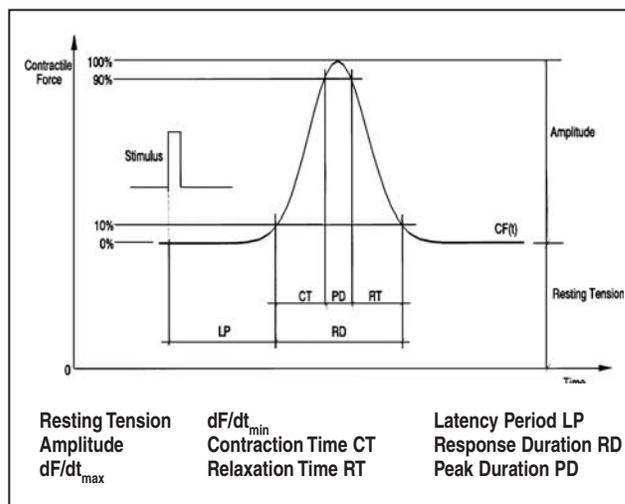
The option for beating tissues additionally calculates the following parameters:

- Amplitude, Rate, $\pm dF/dt$

The advanced version for stimulated beating tissues additionally calculates the following parameters:

- Amplitude, Rate, $\pm dF/dt$, Contraction time CT, Relaxation time RT, Response duration RD, Peak duration PD, Latency period LP

This version can be used for beating tissues and stimulated beating tissues such as atrium or papillary muscle. To calculate the Latency Period computer-controlled stimulation of the tissue is necessary. It is possible to use the HSE-HA Programmable Stimulator PSM or to trigger an external stimulator using a PPG module.



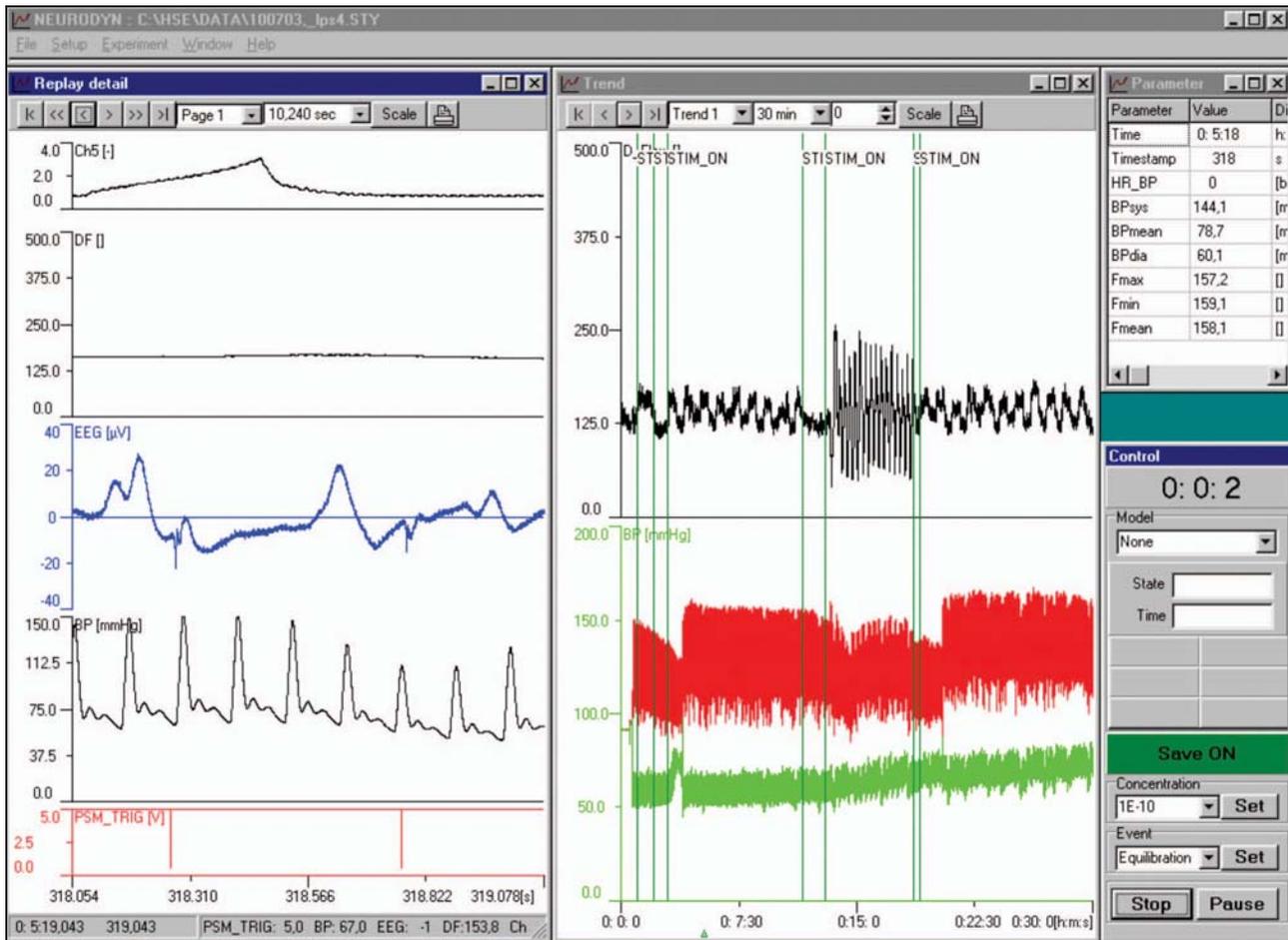
Resting Tension
Amplitude
 dF/dt_{\min}
 dF/dt_{\max}

dF/dt_{\min}
Contraction Time CT
Relaxation Time RT

Latency Period LP
Response Duration RD
Peak Duration PD

Catalog No.	\$	Product
BS4 73-0161		HSE-HA Data Acquisition Hardware PLUGSYS Version
BS4 73-0235		HSE-HA Data Acquisition Hardware Stand Alone Version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version
BS4 73-1688		Software HSE-HA ACAD W
BS4 73-1715		Option Beating Tissue Module
BS4 73-1703		Option Beating and Stimulated Tissue Module
BS4 73-0224		Software Module to HSE-HA Software for PSM and PPG Control
BS4 73-1705		Option Resting Tension (Preload) Module
BS4 73-1687		Option Flushing Control Module

NEW HSE-HA NEURODYN for Neurologic Studies



- 16-channel data acquisition software for Neurologic experiments For Windows®
- To measure and evaluate signals such as EEG, aortic and venous blood pressure, aortic blood flow, pO₂, pCO₂, pH, temperature, etc.
- Can be extended to other haemodynamic and respiratory parameters
- Analysis of somatosensory evoked potentials and cerebral autoregulation as option available
- Easy to use, reduced settings by using configuration files
- Storage of raw data with possibility for replay — complete experiments can be replayed
- Indication of the measured signals and parameters online in numerical tabular form or graphical detail and trend windows
- Allows data exchange interface by converting the data into the ASCII delimited format
- Monitors the experimental sequence by placing event markers and concentration information
- Very easy graphical selection of specific data points by cursors for evaluation, data reduction and export
- Export of a raw data sequence into ASCII delimited format

Description

The HSE-HA NEURODYN software can be adapted to virtually any experimental investigation for neurologic experiments. Acquisition can cover signals such as EEG, aortic and venous blood pressure, aortic flow, pO₂, pCO₂, pH, temperature, etc. It can be extended to many other circulation or respiratory signals. Various parameters can be derived from these signals, e.g. systolic, diastolic, mean and heart rate, minimal, maximal, and mean flows, etc. During data acquisition, all acquired signals and derived parameters are stored on the hard disc and can be displayed on the screen. EEG analysis using FFT is done in the replay mode.

Dedicated options for controlling and evaluating somatosensory evoked potentials as well as cerebral autoregulation (or both) are available.

The HSE-HA NEURODYN software is available in a basic version which includes the minimal necessary algorithms that can be upgraded to a more complex system including all the available algorithms. The configuration of the system is defined in configuration files to reduce the amount of settings necessary and to ensure a stable and secure system. The user only needs to calibrate the signals and fix the graphics scaling. All the hardware definitions and algorithms used are defined in the configuration files. This reduces the amount of information necessary in the SOP's and the possibility of wrong settings. The configuration files can be changed and the software used in combination with a set of different configuration files to match the different experiments.

HSE-HA NEURODYN for Neurologic Studies

NEURODYN is a menu-controlled software and employs special algorithms to calculate the standard parameters. The HSE-HA NEURODYN software has a maximum of 16 channels, i.e. up to 16 different raw signals can be handled. The assignment of the signals to the individual channels is determined in the configuration files. The sample rate, the type of signals and the algorithm used for analysis are also defined in the configuration file. The arrangement of the graphic detail (raw signals) and trend (calculated parameters) is defined in the menu. The user has only to set up which of the available signals he wants to acquire and display, which of the possible parameters he wants to evaluate and display, enter the experimental protocol, and finally calibrate before he starts the data acquisition.

The HSE-HA Data Acquisition Hardware for NEURODYN software is available in two versions:

- **PLUGSYS Version BS4 73-0161**
This version consists of the PCI A/D board DT301 and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28
- **Stand Alone Version BS4 73-0235**
This version consists of the PCI A/D board DT301 and a BNC input box where signals from external amplifiers can be connected.
- **Stand Alone USB Version BS4 73-3330**

Hardware requirements for NEURODYN:

Both the PLUGSYS and stand alone versions require the following computer hardware:

- PENTIUM III PC, 500 MHz or more with one free PCI slot
- RAM 128 MB or better 256 Mbytes
- Hard disk space – at least 20 GB
- 19 inch standard monitor or 17-18 inch flat panel monitor
- Floppy Drive 1.44 Mbytes, CD-ROM drive
- Operating System Windows® NT/2000 or XP
- For data backup a CD-recorder (burner)

Commonly used signals on neurologic experiments are:

- EEG Electroencephalogram
- AP Arterial Pressure
- VP Venous Pressure
- AF Arterial Blood Flow

It is also possible to acquire other signals such as temperature. The maximum number of signals is 16.

The basic version of NEURODYN calculates the following parameters:

online:

- From All Pressure signals: Systolic, Diastolic and Mean Pressure, Heart Rate
- From All Flows signals: Mean, Max. and Min. Flow

After the experiment in replay mode:

- From EEG:
 - FFT evaluation with power spectrum

- Bandpass Filter display and evaluation for Alpha, Beta, Theta and Delta wave activity

Optional software modules are available for:

- Somatosensory stimulation control and evaluation
- Cerebral autoregulation control and evaluation
- Other cardiovascular signals
 - IVP module: IVPsys, IVPdia, IVPEDP, dP/dtmin, dP/dtmax, Heart Rate, Mean Pressure
 - IVP Advanced module: Tau, Time to Peak (Contractility Time), Relaxation Time and Contractility Index $CI = dP/dtmax / P$
 - Flow Advanced module: Endsystolic Flow, Enddiastolic Flow
- Respiration Module: Respiratory Rate, Max. Inspiratory Flow, Max. Expiratory Flow, Tidal Volume

Specific parameters which are not mentioned in this list are available by special order. Please call Harvard Apparatus Technical Customer Service for more details.

Catalog No.	\$	Product
BS4 73-3004		Software HSE-HA NEURODYN
BS4 73-0161		HSE-HA Data Acquisition Hardware PLUGSYS Version
BS4 73-0235		HSE-HA Data Acquisition Hardware Stand Alone Version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version
BS4 73-3526		Optional SEP Control and Evaluation Module
BS4 73-3527		Optional Cerebral Autoregulation Control and Evaluation Module
BS4 73-3462		Optional LVP Module
BS4 73-0237		Optional LVP Advanced Software Module
BS4 73-0238		Optional Flow Advanced Software Module
BS4 73-0239		Optional Respiration Software Module

NEW EPES Electrophysiology Evaluation Software



Two channel data acquisition software for electrophysiologic studies on papillary muscles or purkinje fibres in a horizontal tissue bath (e.g. HSE Steiert papillary bath).

The HSE-HA Data Acquisition Hardware for EPES software is available in three versions:

- **PLUGSYS Version BS4 73-0161**
This version consists of the PCI A/D board DT301 and the cable for connecting to a DIM Data Interface Module installed in the PLUGSYS basic system case, see page I28
- **Stand Alone Version BS4 73-0235**
This version consists of the PCI A/D board DT301 and a BNC input box where signals from external amplifiers can be connected.
- **Stand Alone USB Version BS4 73-3330**

Hardware requirements for EPES:

Both the PLUGSYS and stand alone versions require the following computer hardware:

- PENTIUM III PC, 500 MHz or more with one free PCI slot
- RAM 128 MB or better 256 Mbytes
- Hard disk space – at least 20 GB
- 19 inch standard monitor or 17-18 inch flat panel monitor
- Floppy Drive 1.44 Mbytes, CD-ROM drive
- Operating System Windows® NT/2000 or XP
- For data backup a CD-recorder (burner)

Acquired signals: Intracellular Action Potential, Contraction Force.

Various parameters can be derived from these signals:

Calculated Parameters from AP:

- CT Conduction Time
- TOP Take Off Potential
- AMP amplitude, dV/dtmax maximum rate of depolarisation
- EOP Potential after the end of action potential
- APD90, APD75, APD50, APD25, APD10 (Signal duration @ 90, 75, 50, 25, 10%)

Calculated parameters from contraction force are:

- LP Latency period
- RT Resting Tension
- DevF Developed Force
- dF /dtmax and dF/dtmin
- RD Response Duration

Stimulator control can be added

Catalog No.	\$	Product
BS4 73-3004		Software HSE-HA NEURODYN
BS4 73-0161		HSE-HA Data Acquisition Hardware PLUGSYS Version
BS4 73-0235		HSE-HA Data Acquisition Hardware Stand Alone Version
BS4 73-3330		HSE-HA Data Acquisition Hardware, USB Stand Alone Version
BS4 73-3318		HSE-HA EPES Software
BS4 73-3497		Software STIMULUS for PSM and PPG Control (requires Hardware extension)

MEA Module, see page I42, and Steiert Bath, see page K14, are required for a complete system.

Data Acquisition Systems—RatPaak

NEW RatPaak Biotelemetry System



- Monitors EEG, EMG, ECG, EOG or PSG in small rodents
- Wireless 50 ft range allows animals to remain unteathered during data acquisition
- Monitors animals during activities such as treadmill, metabolic cages and rota-rods
- Self-contained system with steel spring strain reliefs/cable protectors – no special cages needed
- Submicrovolt noise level is excellent for EEG

The RatPaak is a new low noise two-channel wireless data acquisition system used to monitor physiological parameters such as electroencephalogram (EEG), electromyogram (EMG), electrocardiogram (ECG), electrooculogram (EOG), or polysomnography (PSG) in small laboratory animals that weigh 100 grams or more.

The system consists of a small compact integrated transmitter with a form factor that it can be used on rats and other small animals. The device, which includes a state-of-the-art analog to digital (A/D) converter, miniature

MicroSynth™ RF radio transmitter, and a microprocessor, weighs about one-quarter of an ounce and can transmit signals to a nearby receiver up to a distance of 50 feet.

The receiver provides real-time viewing of signal data by sending data to a receiver attached to the serial port of a personal computer. Data can be viewed using BioCapture software and simultaneously saved to the PC hard drive. ASCII conversion tools can be utilized to provide data analysis in software packages such as MATLAB®, LabVIEW™, and Excel.

The RatPaak biotelemetry system can take advantage of multiple sensor technologies to monitor up to two channels of EEG, EMG, and ECG, or EOG. **Please specify which signals you desire to monitor.** Programmability at the time of manufacture allows various applications to be integrated into one system, allowing for customization for the number of input channels, sampling rates, filters, gains and RF frequencies according to your research needs.

The RatPaak's submicrovolt noise level allows accurate EEG recording. The radio transmitter means that your animals no longer need to be tethered. This allows behaviors such as feeding, nesting, sleeping, and sexual activity to be observed, without having the animal wired to a cage.

The 50 foot range allows animals to be in larger cages that more closely resemble their natural environment. The remote monitoring and real-time data viewing capabilities of the RatPaak offer new opportunities for researchers and scientists in the wireless monitoring of lab animals. A flexible research tool by design, the RatPaak offers a new, low cost monitoring solution for unrestrained animals, simplifying traditional monitoring applications.

Specifications

Weight (all parts & accessories)	34 g (1.2 oz)
Data Transmission Range	Stationary: ~up to 15 m (50 feet)
Operating Conditions:	
Humidity	25% to 95% (non-condensing)
Temperature	10 to 50 °C (50 to 122 °F)
Rodent Vest	Nylon-lycra
Receiver:	
Dimensions, (without antenna)	8.9 x 5.1 x 2.4 cm (3.5 x 2.0 x 1.0 in)
Weight	77 g (2.7 oz)
Antenna	7.6 cm (3.0 in) flexible
Power Supply	2 pin AC/DC adapter plug, 6 ft cord length -or- 9 V Alkaline Battery
Power Consumption	52 mA @ 9.0 V
Cable Interface	9-pin jack connects directly to PC RS232 port via serial cable
Case Material	ABS
Receiver Cable	3 ft 9-pin serial port cable

Transmitter:

Dimensions, (without antenna)	3.3 x 2.3 x 0.76 cm (1.3 x 0.9 x 0.3 in)
Weight, (without batteries)	12 g (0.42 oz)
Number of Input Channels	2
Resolution	12 bits
Noise	< 1 µV RMS
Sampling Rate	960 Samples per second on each channel
Transmitter RF Band	902 to 928 MHz (ISM band)
Transmitter Power	≤ 1 mW
Power Source	Batteries (see Battery Choice)
Power Consumption	~15 mA @ 3.0 V
Input Impedance	10 MΩ
Case Material	Silicone

Input Selection:

Application	Range	Bandwidth
EEG	±1 mV	0.1 to 70 Hz
EKG	±5 mV	0.1 to 150 Hz
EMG	±50 mV	1.0 to 480 Hz

Battery Choice:

Battery	Type	Hours	Size (OD x L)	Weight
CR2	Lithium	~ 33	~ 1.6 x 3.2 cm	11.0 g
PR3355	Zinc-Air	~ 35	~ 3.3 x 0.64 cm	14.8 g
675 (3 cells)	Zinc-Air	~ 14	~ 2.9 x 0.48 cm	5.1 g
NH 500	Nickel	~ 8	~ 3.5 x 0.64 cm	19.4 g

Software:

Compatibility	PC with Pentium/MMX 200 MHz or higher processor (or equivalent); requires RS-232 serial port, Microsoft Windows 95, 98, NT, Me, 2000 or XP (32 MB installed memory), 50 MB free hard disk space (100 MB recommended)
Estimated Recorded File	~172.8 KB/min/channel

RatPaak Components

The RatPaak System includes the following components: Transmitter, Receiver, Software, User Guide, Battery (Coin Cell 1.4 V 600 mAh), 9 V Battery Adapter, 3 ft Serial Data Cable, 6 ft Serial Extension Cable, AC Power Adapter, Rodent Vest/Harness, 9 Volt Battery and Configuration File.

Catalog No.	\$	Product
BS4 72-7160		RatPaak Biotelemetry System

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Data Acquisition Systems - Biopac

Which system is best for you?

The NEW MP150 High-speed data acquisition system utilizes the very latest in Ethernet technology. The MP150 is compliant with any Ethernet (DLC) ready PC or Macintosh. This next generation product takes full advantage of cutting edge technology. Access multiple MP150 devices located on a local area network and record data to any computer connected to the same LAN. Record and analyze your data at an aggregate sample rate of 400,000 samples per second. Use variable sample rates to maximize storage efficiency and to guarantee you won't miss a thing. See what the MP150 and AcqKnowledge software can do for you!

Function	Performance	
	MP150 system	MP100 System
Recording Speed	High	Medium
Aggregate Sampling Rate	10kHz or greater	10kHz or less
Cardio-Pulmonary Measurements	Excellent	Excellent
Neuro-Physiology Measurements	Excellent	Good (contact BIOPAC for details)
Direct LAN Operation	Yes (Ethernet)	No (USB)
Interactive Measurements during recording	Excellent	Good (contact BIOPAC for details)
Running multiple applications	Excellent	Excellent
On-line Analysis	Excellent	Excellent
Macintosh OS	8.6 or better	8.6 or better
Windows OS	98, 98SE, NT 4.0, 2000	98, 98SE, 2000

NEW MP150 Starter System



The new MP150 offers Ethernet-ready data acquisition and analysis. Record multiple channels with differing sample rates. Record at speeds up to 400kHz (aggregate). Place one or more MP150 Systems in a local area network (LAN). Use any PC in the LAN to record from any MP150 System in the LAN. Includes:

- MP150ACE
- ETHSW1
- AC150A
- UIM100C
- CBLETH1 (2) ACKv3.7 for PC (Windows) or Macintosh

Recommended configuration: MP150 System and local network connected to the computer's Ethernet port via the ETHSW1 Ethernet Switch. This configuration provides optimal performance when connecting both an MP150 System and a network to the computer. In cases where the computer has no Ethernet port, an industry standard PCI Ethernet card or adapter is required.

Specifications

Analog Inputs:

Number of Channels	16
Input Voltage Range	±10 V
A/D Resolution	16 Bits
Accuracy (% of FSR)	±0.003
Input Impedance	1.0 MΩ

Analog Outputs:

Number of Channels	2
Output Voltage Range	±10 V
D/A Resolution	MP150: 16 bits, MP100: 12 Bits
Accuracy (% of FSR)	MP150: ±0.003, MP100: ±0.02
Output Drive Current	±5 mA maximum
Output Impedance	100 Ω

Device Specific Specs MP150

Max Sample Rate:

MP Internal Memory	200K samples/sec (400K aggregate)
PC Memory/Disk	200K samples/sec (400K aggregate)

Internal Buffer Size	6M samples
Serial Interface Type/Rate	Ethernet: DLC type II (10M bits/sec)
Transmission Type	Ethernet (10/100 Base T)
Maximum Cable Length	100 m (Ethernet cable)
Power Requirements	12 VDC @ 2 amp (uses AC150A)
Dimensions	10 x 11 x 19 cm
Weight	1.0 kg
Compatibility:	Ethernet Interface
Mac	System 8.6 or better
PC	Windows 98, 98SE, 2000, NT 4.0

Catalog No.	\$	Model	Product
BS4 72-3732		MP150WSW	MP150 Systems for PC
BS4 72-3733		MP150WS	MP150 Systems for Macintosh

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11,000 Specialty Products to Enhance Your Bioresearch

AcqKnowledge Software & Site Licenses for MP Systems

One copy of AcqKnowledge software is included with each MP Starter System. The software can be used with other programs and includes extensive on-screen help. The Site License program permits the purchase of a Site License for a specified number of software copies. Each Site License includes one software operations manual and software media. Purchase of a BIOPAC Site License does not obviate the requirement to purchase the appropriate software package for each computer on which BIOPAC hardware is installed. For network installations, the relevant number of copies required is the number of machines upon which the software will be used. The Site License program is for educational institutions only and is subject for qualification.

Use the AcqKnowledge software to analyze and display data recorded from third-party data acquisition products. Open the data in a Text format, set the horizontal axis to the desired units and analyze your results.

Site Licenses Quantities Available:

- 2-9
- 10-24
- 25-99
- 100-249

Please call for current pricing on site licenses.

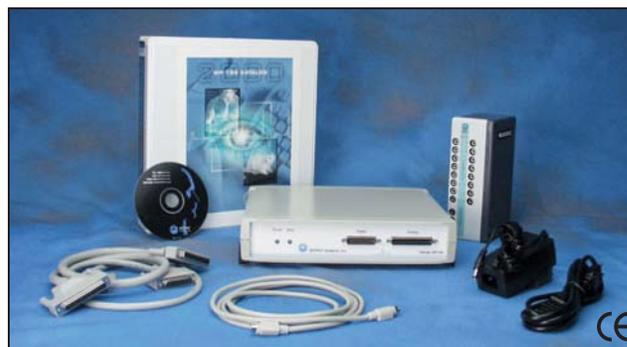
Specifications

Operational Accuracy	20 digit double precision real
Storage Accuracy	16 digit double precision real
Storage Formats	AcqKnowledge, text (ASCII), PICT (Macintosh), WMF (Windows)
Digital Filters:	
Post-Processing Mode	FIR or IIR based
Real-Time Mode	IIR based
Window Functions	Rectangular, Bartlett, Hamming, Hanning, Kaiser-Bessel
Maximum File Length	Limited only by available space
Number of Channels Displayed	60 maximum
Memory Requirements	64 MB RAM recommended minimum
System Requirements	
PC	Windows 98, 98SE, 2000 Workstation, NT4.0 Workstation
Mac	System 8.6 or better

Catalog No.	\$	Model	Product
BS4 72-3731		ACK100W	AcqKnowledge Software for PC *
BS4 72-3730		ACK100M	AcqKnowledge Software for Macintosh*
BS4 72-7415		ACK100W-9	AcqKnowledge Software for PC*
BS4 72-7416		ACK100M-9	AcqKnowledge Software for Macintosh*
BS4 72-7417		ACK100W-24	AcqKnowledge Software for PC*
BS4 72-7418		ACK100M-24	AcqKnowledge Software for Macintosh*
BS4 72-7419		ACK100W-99	AcqKnowledge Software for PC*
BS4 72-7420		ACK100M-99	AcqKnowledge Software for Macintosh*
BS4 72-7421		ACK100W-249	AcqKnowledge Software for PC*
BS4 72-7422		ACK100M-249	AcqKnowledge Software for Macintosh*

*Note: If Purchased Separately from MP150 and MP100 Starter Systems

MP100 Starter System



The MP100 system offers USB-ready data acquisition and analysis. Record multiple channels with differing sample rates. Record at speeds up to 70 kHz (one-shot) or 16 kHz (aggregate to disk). Includes:

- MP100ACE
- USB1W (PC) or USB1M (Mac)
- UIM100C
- CBLSERA
- CBL5100
- ACKv3.7 for PC (Windows) or Macintosh
- AC100A

Recommended configuration: MP100 System connected to the computer's USB port via the USB1W (PC) or USB1M (Macintosh) Adapter. In cases where the computer has no USB port, an industry standard USB card or adapter is required.

Specifications

Digital I/O	
Number of Channels	16
Voltage Levels	TTL, CMOS
Output Drive Current	±20 mA (max)
External Trigger Input	TTL, CMOS compatible
Time Base	
Min Sample Rate	2 samples/hour
Trigger Options	Internal, External or Signal Level
Power	
Amplifier Module Isolation	Provided by the MP data acquisition unit
CE Marking	EC Low Voltage and EMC Directives
Leakage Current	<8 µA (Normal), <400 µA (Single Fault)
Fuse	2A (fast blow)

Device Specific Specs MP100

Max Sample Rate:	
MP Internal Memory	70 K samples/sec (70 K aggregate)
PC Memory/Disk	11 K samples/sec (16 K aggregate)
Internal Buffer Size	16K samples
Serial Interface Type/Rate	SERIAL: RS422 (800K bits/sec)
Transmission Type	USB (via USB1W or USB1M)
Maximum Cable Length	7 m (USB + SERIAL cable)
Power Requirements	12 VDC @ 1 amp (uses AC100A)
Dimensions	7 x 29 x 25 cm
Weight	1.8 kg
Compatibility:	
Mac	System 8.6 or better
PC	Windows 98, 98SE, 2000

Catalog No.	\$	Model	Product
BS4 72-7258		MP100WSW	MP100 Systems for PC
BS4 72-7259		MP100WS	MP100 Systems for Macintosh

Data Acquisition Systems - Biopac

Universal Interface Module UIM100C



The UIM100C is used to connect 100-series amplifier modules and signal cables to the system and is included in the MP Starter System. Sixteen analog input channels plus 2 analog output channels are provided via standard 3.5mm phone jacks on the front panel. The back panel provides access to 16 digital I/O lines and an external trigger input via screw terminals. Amplifier modules snap onto the side of the UIM100C for signal routing to the MP data acquisition unit. The output of any amplifier module snapped to the UIM100C can be monitored, during acquisition, via the corresponding 3.5mm analog channel phone jack. The UIM100C also provides a direct link to the analog and digital I/O lines of the MP device when collecting or sending data to external equipment. See page 88 for cables to interface your equipment to the UIM100C.

IMPORTANT USAGE NOTE

Mains powered external laboratory equipment should be connected to an MP System through Signal Isolators when the system also connects to electrodes attached to humans. For analog signals, use the INISO or OUTISO isolator (with the HLT100C) to couple external equipment to an MP System. For digital signals, use the STP100 (with the UIM100C) to couple external equipment to an MP System. Contact BIOPAC for details.

Specifications

Analog I/O Access	16 channels (front panel) – 3.5mm phone jacks
D/A Outputs	2 channels (front panel) – 3.5mm phone jacks
Digital I/O Access	16 channels (back panel) – screw terminals
Ext. Trigger Access	1 channel (back panel) – screw terminal
Isolated Power Access	±12 V, +5 V @ 100 ma (back panel) – screw terminals
Weight	520 g
Dimensions, H x W x D	19 x 7 x 11 cm

Catalog No.	\$	Model	Product
BS4 72-7260		UIM100C	Universal Interface Module UIM100C (if purchased separately)

Isolated Power Supply Module IPS100C



Not for use with an MP data acquisition module.

The IPS100C is used to operate 100-series amplifier modules independent of an MP data acquisition unit. The IPS100C module couples the 100-series amplifier outputs directly to any other data acquisition system, oscilloscope or chart recorder. Amplifier modules snap onto the side of the IPS100C to receive the necessary isolated power and to direct the modules' output to the front panel of the IPS100C. The IPS100C allows you to operate up to 16 amplifiers on a stand-alone basis. The analog channel outputs are provided via 3.5mm phone jacks on the front panel. The IPS100C is generally used with animal or tissue preparations. When collecting data from electrodes attached to humans, use the HLT100C module with INISO and OUTISO signal isolators to couple signals to mains powered external laboratory equipment.

IMPORTANT USAGE NOTE

Do not use the IPS100C with an MP based system. For a fully isolated recording system using the IPS100C, couple signal inputs and outputs through the HLT100C module and INISO and OUTISO adapters, respectively. Contact BIOPAC for details. Includes In-line Transformer (AC100A) and MP System Guide. Specify USA or EURO power cord.

Specifications

Amplifier Output Access	16 channels (front panel) – 3.5mm phone jacks
Isolated Power Access	±12 V, +5 V @ 100 ma (back panel) – screw terminals
Weight	610 g
Dimensions, H x W x D	19 x 7 x 11 cm
Power Source	12VDC @ 1 amp (uses AC100A transformer)

Catalog No.	\$	Model	Product
BS4 72-7261		IPS100C	Isolated Power Supply Module IPS100C

High Level Transducer Module HLT100C



- To provide the maximum in subject safety and isolation, use signal isolators to connect mains powered external equipment (i.e. chart recorders, oscilloscopes, etc.) to the MP System. Use the INISO isolator to connect to MP analog system inputs and the OUTISO isolator to connect to analog system outputs.

All high level output transducers interface to an MP System via the HLT100C module. Up to 16 transducers can be connected to a single HLT100C. The HLT100C is similar in function to the UIM100C, but also provides power to the transducer when making a connection.

Alternatively, the HLT100C module can be used to connect mains powered external laboratory equipment to the MP System when the system also connects to electrodes attached to humans.

High level output transducers and adapters connect to the HLT100C via standard 6-pin RJ11 type connectors. Transducers and adapters that presently require the HLT100C module are:

- TSD109C/F - Tri-axial Accelerometers
- TSD150A/B - Active Electrodes
- TSD111 - Heel/Toe Strike Transducer
- INISO - Input Signal Isolator
- OUTISO - Output Signal Isolator
- TSD115 - Variable Assessment Transducer

Specifications

Transducer Inputs	16 channels (front panel) – RJ11 jacks
System D/A Outputs	2 channels (front panel) – RJ11 jacks
Isolated Power Access	±12 V, +5 V @ 100 ma (via all RJ11 jacks)
Weight	540 g
Dimensions (W x D x H)	7 x 11 x 19 cm

Catalog No.	\$	Model	Product
BS4 72-7262		HLT100C	High Level Transducer Module HLT100C

Signal Isolators

- For digital (TTL compatible) isolation to the MP digital I/O ports, use the STP100 optical interface (see page 1115).
- If the MP System does not electrically connect to human subjects, signal connections to external laboratory equipment can be made through the UIM100C module and the respective analog or digital connection cable (see pages 1138 and 1140).

These analog signal isolators are used to connect mains powered external laboratory equipment to the MP System when the system also connects to electrodes attached to humans. Use the INISO to connect external equipment outputs to MP analog input channels. Use the OUTISO to connect MP analog signal outputs (amplifier and D/A) to external equipment inputs. Each signal isolator comes with an RJ11 cable for connection to the HLT100C module.

Input Signal Isolated Adapter - INISO

The INISO plugs directly into any of the 16 input channels on the HLT100C module and incorporates a 3.5mm phone jack for signal input connections. Select the appropriate analog connection cable (see page 1140) to connect to your external equipment's output.

Output Signal Isolated Adapter - OUTISO

The OUTISO plugs directly into any of the 16 signal output channels, plus the two D/A outputs, on the HLT100C module and incorporates a 3.5mm phone jack for signal output connections. The OUTISO is very useful when the biopotential amplifier output signal requires routing to external laboratory equipment while being sampled by the MP System. Select the appropriate analog connection cable (see page 1140) to connect to your external equipment's input.

Specifications

Isolator Type	Analog	Isolation Capacitance	30 pF
Bandwidth	DC to 50 kHz	Input Connector	INISO: 3.5 mm mono phone jack
Input/Output Range	±10 V	Output Connector	OUTISO: 3.5 mm mono phone jack
Input Resistance	200 KΩ	Weight	50 g
Output Resistance	120 Ω	Dimensions, H x W x L	2.6 x 2.6 x 7.6 cm
Output Current	±5 mA	Included Cable	2.1 m (straight thru, M/M, 6 pin, RJ11)
Offset Voltage	±20 mV (nominal)	Interface	HLT100C—see left
Temperature Drift	200 μV/°C (nominal)		
Noise	2.5 mV (rms)		
Isolation Voltage	1500 VDC		

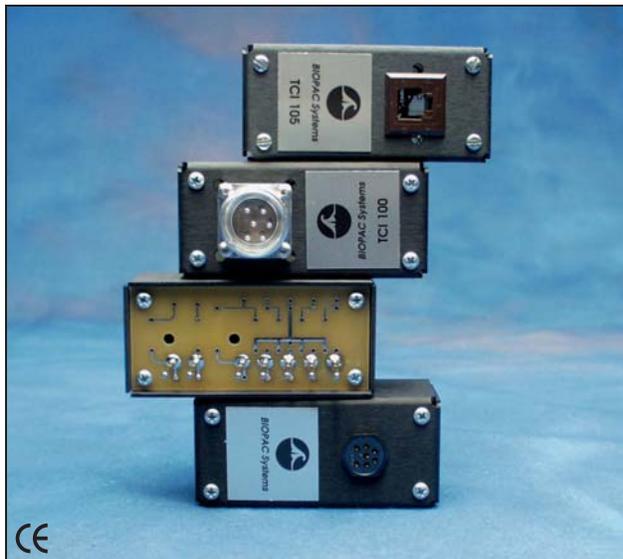
Catalog No.	\$	Model	Product
BS4 72-7263		INISO	Input Signal Isolated Adapter
BS4 72-7264		OUTISO	Output Signal Isolated Adapter

Data Acquisition Systems - Biopac

General-Purpose Transducer Amplifier DA100C



Transducer Connector Interfaces



The DA100C is a very low noise and drift differential bridge amplifier that will operate with a wide variety of transducers, including: pressure, force, strain, displacement, thermocouples, piezo sensors, light sensors, microphones and nearly any other active or passive sensor or transducer. The DA100C provides variable gain settings, offset control for baseline zeroing and adjustable voltage references for activating passive transducers (see pages I121 to I132).

The transducer connector interfaces (TCIs) adapt a variety of transducer types to the DA100C module. The TCIs match the DA100C to the transducer brands listed. If no existing connector matches your equipment, we will build a special TCI for you, or you can use the TCIIKIT. Please call or write BIOPAC with your specific needs.

Compatible Transducers		
Model	Description	Page No.
TSD104A	Precision Pressure	Page I121
TSD105A	Variable Range Force	Page I121
TSD107B	High Flow Pneumotach	Page I122
TSD108	Physiological Microphone	Page I122
TSD117	Medium Flow Pneumotach	Page I125
TSD120	Noninvasive BP Cuff	Page I125
TSD121C	Hand Dynamometer	Page I126
TSD125	Fixed Range Force	Page I127
TSD127	Low Flow Pneumotach	Page I128
TSD130	Goniometers	Page I128
TSD137	Very Low Flow Pneumotach	Page I129
TSD160	Differential Pressure	Page I132

Catalog No.	\$	Model	Product
BS4 60-1036		DA100C	General Purpose Transducer Amplifier

Catalog No.	\$	Model	Product
BS4 72-3679		TCI113	Hugo Sachs Transducer
BS4 60-1073		TCI100	Grass/Astromed transducers – 6 pin
BS4 60-3777		TCI101	Beckman transducers – 5 pin
BS4 60-3778		TCI102	World Precision Instrument transducers – 8 pin
BS4 60-1070		TCI103	Lafayette Instrument transducers – 9 pin
BS4 60-3779		TCI104	Honeywell transducers – 6 pin
BS4 60-3780		TCI105	Modular phone jack connector – 4 pin
BS4 60-3781		TCI106	Beckman transducers – 12 pin
BS4 60-3782		TCI107	Nihon Kodens transducers – 5 pin
BS4 60-3783		TCI108	Narco transducers – 7 pin
BS4 60-3784		TCI109	Fukuda transducers – 8 pin
BS4 60-3785		TCI110	Gould transducers – 12 pin
BS4 72-7265		TCI111	Liquid metal transducers – two 2mm sockets
BS4 72-7266		TCI112	Hokansen transducers – 4 pin
BS4 72-7267		TCIPPG1	Geer photo-electric (IR) for PPG100C only – 7 pin

Create a custom interface with the TCIIKIT (page I107) or check out www.foggsystem.com for additional interface options.

Custom Interface Kit



Build your own customized adapter to the DA100C. The do-it-yourself TCI kit includes housing, PC board with 7 attached PIN plugs (2mm) and instructions. Mount your connector to the housing and solder wires to the pins.

Specifications

Gain	50, 200, 1000, or 5000
Output Range	±10 V (analog)
Low Pass Filter	10 Hz, 300 Hz, 5000 Hz
High Pass Filter	DC, 0.05 Hz
Input Voltage (max)	±200 mV (protected)
Noise Voltage	0.11 μ V rms - (0.05 – 10 Hz)
Temperature Drift	0.3 μ V/°C
Z (input)	2 M Ω (Differential)
CMRR	90 dB min
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Voltage Reference	-10 to +10 V infinitely adjustable @ 20ma (max) (Factory preset to 2 volts excitation)
Signal Source	Variety of transducers
Weight	350 g
Dimensions, H x W x D	19 x 11 x 4 cm
Input Voltage Range:	
Gain	Vin (mV)
50	±200
200	±50
1000	±10
5000	±2

Catalog No.	\$	Model	Product
BS4 60-3786		TCIKIT	Custom Interface Kit

Reference Calibrator for the DA100C

Used to check and adjust the DA100C's reference voltage used for transducer excitation. The REFCAL plugs directly into the DA100C and operates with the DA100C Gain set to 50. The exact reference voltage setting will be indicated on the DA100C output. The REFCAL makes it very easy to adjust the reference voltage of the DA100C to suit your transducer.

Catalog No.	\$	Model	Product
BS4 72-268		REFCAL	Reference Calibrator for the DA100C

Calibration Cables for the DA100C or 100B-Series Amplifiers



Used to verify the signal calibration of the DA100C. This cable (1.8m) connects between the DA100C input and the UIM100C D/A output 0 or 1. To verify the DA100C's frequency response and gain settings, create a stimulus signal with AcqKnowledge and monitor the DA100C's output. The CBLCAL incorporates a precision 1/1000 signal attenuator. You can also use the CBLCAL for 100B-series Biopotential amplifier calibration. (Amplifier specification tests are performed at the factory before shipping, but your own Calibration Cable can ensure peace of mind by permitting precise frequency response and gain calibrations for exact measurements.)

Catalog No.	\$	Model	Product
BS4 72-269		CBLCAL	Calibration Cables for the DA100C or 100B Series Amplifiers

Calibration Cable for Biopotential Amplifiers

Used to verify the calibration of any of the 100C-series Biopotential amplifiers. This cable (1.8m) connects between the amplifier input and the UIM100C D/A output 0 or 1. Create a stimulus signal using AcqKnowledge and monitor the output of the amplifier connected to the Calibration Cable. This procedure can verify the amplifier's frequency response and gain settings. The Calibration Cable incorporates a precision 1/1000 signal attenuator. (Amplifier specification tests are performed at the factory before shipping, but your own Calibration Cable can ensure peace of mind by permitting precise frequency response and gain calibrations for exact measurements.)

Catalog No.	\$	Model	Product
BS4 72-270		CBLCALC	Calibration Cables for Biopotential Amplifiers

Additional DA100C Interface Cables

For CBL106, see page I40.

For CBL202, see page I38.

For JUMP100, see page I39.

Electrocardiogram Amplifier



The ECG100C records electrical activity generated by the heart and will reliably record ECG from humans, animals and isolated organ preparations. The amplifier output can be switched between normal ECG output and R-wave detection. The R-wave mode outputs a smoothed pulse with the occurrence of each R-wave. The exact timing of the R-wave is detected even under conditions of extreme signal artifact. The amplifier also includes a user-switchable baseline stabilizer.

Specifications

Gain	500, 1000, 2000, 5000
Output Selection	Normal, R-wave indicator
Output Range	±10 V (analog)
Low Pass Filter	35 Hz, 150 Hz
High Pass Filter	0.05 Hz, 1.0 Hz
Notch Filter	50 dB rejection @ 50/60 Hz
Noise Voltage	0.1 µV rms (0.05 – 35 Hz)
Z (input)	2 MΩ (Differential) 1000 MΩ (Common mode)
CMRR	110 dB min (50/60 Hz)
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Input Voltage Range:	
Gain	Vin (mV)
500	±20
1000	±10
2000	±5
5000	±2

Catalog No.	\$	Model	Product
BS4 60-1037		ECG100C	Electrocardiogram Amplifier

Electroencephalogram Amplifier

The EEG100C amplifies bio-electric potentials associated with neuronal activity of the brain and can be used to perform unipolar or bipolar EEG measurements. The amplifier output can be switched between normal EEG output and Alpha wave detection. The Alpha detection mode outputs a smoothed wave with a peak indicating maximal alpha activity (signal energy in the 8-13 Hz frequency range).

Specifications

Gain	5000, 10000, 20000, 50000
Output Selection	Normal, Alpha Wave indicator
Output Range	±10 V (analog)
Low Pass Filter	35 Hz, 100 Hz
High Pass Filter	0.1 Hz, 1.0 Hz
Notch Filter	50 dB rejection @ 50/60 Hz
Noise Voltage	0.1 µV rms - (0.1 – 35 Hz)
Z (input)	2 MΩ (Differential) 1000 MΩ (Common mode)
CMRR	110 dB min (50/60 Hz)
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Input Voltage Range:	
Gain	Vin (mV)
5000	±2
10000	±1
20000	±0.5
50000	±0.2

Catalog No.	\$	Model	Product
BS4 60-1038		EEG100C	Electroencephalogram Amplifier

Electrogastrogram Amplifier

The EGG100C amplifies the electrical signal resulting from stomach and intestinal smooth muscle activity. The amplifier monitors the DC potential on the skin surrounding, or surface of, the intestine and stomach, which is indicative of the degree of slow wave contraction. The amplifier permits DC coupling to electrodes for signal amplification and presentation without discernible decay.

Specifications

Gain	500, 1000, 2000, 5000
Output Range	±10 V (analog)
Low Pass Filter	0.1 Hz, 1 Hz
High Pass Filter	DC, 0.005 Hz, 0.05 Hz
Notch Filter	50 dB rejection @ 50/60 Hz
Noise Voltage	0.1 µV rms - (0.005 - 1.0 Hz)
Z (input)	2 MΩ (Differential) 1000 MΩ (Common mode)
CMRR	110 dB min (50/60 Hz)
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Input Voltage Range:	
Gain	Vin (mV)
500	±20
1000	±10
2000	±5
5000	±2

Catalog No.	\$	Model	Product
BS4 72-7271		EGG100C	Electrogastrogram Amplifier

Electromyogram Amplifier

The EMG100C amplifies general and skeletal muscle electrical activity. The amplifier functions directly with AcqKnowledge to perform real-time EMG integration and, as it incorporates fast response and settling time characteristics, can also be used to monitor single-fiber EMG, motor unit and peripheral nerve action potentials.

Specifications

Gain	500, 1000, 2000, 5000
Output Range	±10 V (analog)
Low Pass Filter	500 Hz, 5000 Hz
High Pass Filter	1.0 Hz, 10 Hz, 100 Hz
Notch Filter	50 dB rejection @ 50/60 Hz
Noise Voltage	0.2 µV rms (10 – 500 Hz)
Z (input)	2 MΩ (Differential) 1000 MΩ (Common mode)
CMRR	110 dB min (50/60 Hz)
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Input Voltage Range:	
Gain	Vin (mV)
500	±20
1000	±10
2000	±5
5000	±2

Catalog No.	\$	Model	Product
BS4 60-1039		EMG100C	Electromyogram Amplifier

Electrooculogram Amplifier

The EOG100C amplifies the corneal-retinal potential. The amplifier monitors the DC potential on the skin surrounding the eyes, which is proportional to the degree of eye movement in any direction. The amplifier output can be switched between normal EOG output and Derivative of EOG. In Derivative mode, the amplifier outputs the measured velocity of eye movement, which is useful for saccade and nystagmus investigations. The amplifier permits DC coupling to electrodes for X/Y graphing of eye movement without discernible decay.

Specifications

Gain	500, 1000, 2000, 5000
Output Selection	Normal, Derivative output
Output Range	± 10 V (analog)
Low Pass Filter	35 Hz, 100 Hz
High Pass Filter	DC, 0.05 Hz
Notch Filter	50 dB rejection @ 50/60 Hz
Noise Voltage	0.1 µV rms (0.05 – 35 Hz)
Z (input)	2 MΩ (Differential) 1000 MΩ (Common mode)
CMRR	110 dB min (50/60 Hz)
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Input Voltage Range:	
Gain	Vin (mV)
500	±20
1000	±10
2000	±5
5000	±2

Catalog No.	\$	Model	Product
BS4 60-1040		EOG100C	Electrooculogram Amplifier

Evoked Response Amplifier

The ERS100C is an extremely low noise differential amplifier that accurately amplifies very small potentials, such as those associated with stimulus/response, signal-averaged recordings. Selectable gain and bandwidth options make the module useful for a variety of evoked response testing modes. The ERS100C is intended for use in applications such as auditory brainstem response, startle response, somatosensory evoked response or nerve conduction velocity recording.

Specifications

Gain	5000, 10000, 20000, 50000
Output Range	±10 V (analog)
Low Pass Filter	3 kHz, 10 kHz
High Pass Filter	1.0 Hz, 20 Hz, 100 Hz
Notch Filter	50 dB rejection @ 50/60 Hz
Noise Voltage	0.5 µV rms (100 - 3000 Hz)
Z (input)	2 MΩ (Differential) 1000 MΩ (Common mode)
CMRR	110 dB min (50/60 Hz)
CMIV	±10 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Input Voltage Range:	
Gain	Vin (mV)
5000	±2
10000	±1
20000	±0.5
50000	±0.2

Catalog No.	\$	Model	Product
BS4 60-1063		ERS100C	Evoked Response Amplifier

Biopotential 100C Interface Cables

The Biopotential amplifiers connect to unshielded or shielded electrode leads terminating with Safelead®/Touchproof (1.5mm) sockets. For best performance, use two shielded electrode leads and one unshielded electrode lead per amplifier. See the extensive selection of electrode leads on page I135. For additional electrode lead distance, see the Module Extension Cables on page I139.

All Biopotential Amplifier Specifications

Signal Source	Electrodes (three electrode leads required)
Dimensions	4 cm (wide) x 11 cm (deep) x 19 cm (high)
Weight	350 g

For CBL200, see page I138.

For CBL204, see page I138.

For JUMP100C, see page I139.

Electrodermal Response and Photoplethsmogram Amplifier



The Transducer amplifiers work with specific BIOPAC transducers, as indicated in the descriptions.

Use any BIOPAC amplifier as a stand alone device with the NEW IPS100C shown on page I104.

Photoplethsmogram Amplifier

The PPG100C records the pulse pressure wave and, for providing an indication of blood pressure, blood density or vasoconstriction. The PPG100C couples to the TSD200 pulse transducer to measure changes in infrared reflectance resulting from varying blood flow. Front panel controls allow selection of either absolute or relative plethysmographic measurements. Each PPG100C requires one TSD200 photo-electric pulse plethysmogram transducer, shown on page I133.

Electrodermal Response Amplifier

The GSR100C measures both the skin conductance level (SCL) and response (SCR) as they vary with sweat gland (eccrine) activity due to stress, arousal or emotional excitement. The GSR100C uses a constant voltage technique to measure skin conductance. The controls allow selection of absolute (SCL+SCR) or relative (SCR) skin conductance measurements. Each GSR100C amplifier requires one TSD203 electrodermal response transducer (see page I134). For alternative body placement, use two of the EL258 lead electrodes (instead of the TSD203) with the GSR100C. Also required is GEL101 electrode gel (see page I138) or your preferred isotonic recording gel.

Specifications

Gain	10, 20, 50, or 100
Output Range	±10 V (analog)
Low Pass Filter	3 Hz, 10 Hz
High Pass Filter	DC, 0.05 Hz, 0.5 Hz
Noise Voltage	0.5 µV rms – amplifier contribution
Excitation	6V
Signal Source:	TSD200 Pulse Transducer
Weight	350 g
Dimensions, H x W x D	19 x 4 x 11 cm

Catalog No.	\$	Model	Product
BS4 60-1042		PPG100C	Photoplethysmogram Amplifier

Specifications

Gain	20, 10, 5, 2 micro-mhos/volt (i.e. micro-siemens/volt)
Output Range	±10 V (analog)
Low Pass Filter	1 Hz, 10 Hz
High Pass Filter	DC, 0.05 Hz, 0.5 Hz
Sensitivity	0.7 nano-mhos - with MP System
Excitation	Vex = 0.5 VDC (Constant Voltage)
Signal Source	TSD203
Weight	350 g
Dimensions, H x W x D	19 x 4 x 11 cm
Input Signal Range:	
Gain	Range (µmhos)
20	0-200
10	0-100
5	0-50
2	0-20

Catalog No.	\$	Model	Product
BS4 60-1041		GSR100C	Electrodermal Response Amplifier

To interface with a photo-electric Geer gauge, see TCIPPG1 on page I106.

Respiration Pneumogram Amplifier

The RSP100C is designed for direct physical measurement of respiratory effort. The RSP100C works with the TSD201 transducer to measure abdominal or thoracic expansion and contraction while breathing. The RSP100C permits DC coupling to the TSD201 for the recording of respiratory effort signals of arbitrarily low frequency. Front panel controls allow selection of absolute or relative expansion/contraction measurements. Each RSP100C amplifier requires one TSD201 respiratory effort transducer, shown on page I133.

Specifications

Gain	10, 20, 50, 100
Output Range	±10 V (analog)
Low Pass Filter	1 Hz, 10 Hz
High Pass Filter	DC, 0.05 Hz, 0.5 Hz
Noise Voltage	0.2 µV rms – amplifier contribution
Signal Source	TSD201
Weight	350 g
Dimensions, H x W x D	19 x 4 x 11 cm

Catalog No.	\$	Model	Product
BS4 60-1043		RSP100C	Respiration Pneumogram Amplifier

Temperature Amplifier

The SKT100C measures surface, core or air temperature. The SKT100C, with a TSD202 series temperature probe, can record temperature changes to 0.0001°C resolution. Front panel controls allow selection for either absolute or relative temperature measurements. The SKT100C operating temperature range is 40°F to 140°F (5°C to 60°C). Use the AcqKnowledge software to calibrate the SKT100C's output in °F or °C. Each SKT100C amplifier will need one TSD202 series temperature probe, shown on page I134. By using CBL203 (see page 86), the SKT100C is also compatible with any YSI® 400 series biomedical temperature probe.

Specifications

Gain	5, 2, 1, 0.5 °F/Volt— can also calibrate in °C	
Output Range	±10 V (analog)	
Low Pass Filter	1 Hz, 10 Hz	
High Pass Filter	DC, 0.05 Hz, 0.5 Hz	
Sensitivity	180 micro °F (100 micro °C)— with MP System	
Signal Source	TSD202 Series Temperature Probe	
Weight	350 g	
Dimensions, H x W x D	19 x 4 x 11 cm	

Input Signal Range:

Gain	Range (°F)	Range (°C)
5	40-140	5-60
2	70-110	22-43
1	80-100	27-37
0.5	85-95	30-35

Catalog No.	\$	Model	Product
BS4 60-1044		SKT100C	Temperature Amplifier

Transducer 100C Interface Cables

For YSI® 400 Probe Interface (for SKT100C), see CLB203, page I138.

2mm pin to Touchproof Socket Conversion, see CLB200, page I138.

For additional transducer lead distance, use a Module Extension Cable, see page I139.

You can also record these signals remotely, using the TEL100C shown on page I118.

Electrical Bioimpedance Amplifier



The EBI100C records the parameters associated with cardiac output measurements, thoracic impedance changes as a function of respiration or any kind of biological impedance monitoring. The EBI100C incorporates a precision high frequency current source, which injects a very small (100 μ A) current through the measurement tissue volume defined by the placement of a set of current source electrodes. A separate set of monitoring electrodes then measures the voltage developed across the tissue volume. Because the current is constant, the voltage measured is proportional to the characteristics of the biological impedance of the tissue volume. The EBI100C measures both impedance magnitude and phase simultaneously. Impedance can be recorded at four different measurement frequencies, from 12.5kHz to 100kHz. For operation, the EBI100C connects to four unshielded electrode leads terminating in Touchproof sockets. The EBI100C is typically used with EL500 paired disposable electrodes, but can function with spot or ring electrodes, reusable electrodes, or needle electrodes. For injecting current and averaging voltage at four paired-electrode sites (required for cardiac output measurements), use four CBL204 Touchproof "Y" electrode lead adapters (see page I138) and eight LEAD110 electrode leads (see page I135) with each EBI100C.

Specifications

Number of Channels	2 – Magnitude (MAG) and Phase (PHS)
Outputs	MAG of Impedance (0-1000 Ω) PHS of Impedance (0 to 90°)
Output Range	± 10 V (analog)
MAG Gain Range	100, 20, 5, 1 Ω /volt
MAG LP Filter	10 Hz, 100 Hz
MAG HP Filter	DC, 0.05 Hz
MAG Sensitivity	0.001 Ω @ 10Hz bandwidth
PHS Gain	90°/10 v
PHS LP Filter	100 Hz
PHS HP Filter	DC coupled
PHS Sensitivity	0.0025 deg @ 10 Hz bandwidth
CMIV	± 10 V (referenced to amplifier ground) ± 1500 VDC (referenced to mains ground)
Operational Frequencies	12.5, 25, 50, 100 kHz
Current Output	100 μ A (rms)— constant sinusoidal current
Signal Source	Electrodes (four electrode leads required)
Weight	370 g
Dimensions, H x W x D	19 x 4 x 11 cm

Catalog No.	\$	Model	Product
BS4 72-7272		EBI100C	Electrical Bioimpedance Amplifier

Laser Doppler Flow Module

The LDF100C is a laser Doppler tissue perfusion monitor for measuring micro-vascular blood flow in tissue. The LDF100C module delivers a low power beam of laser light down an optical fiber to the tissue being studied; typically, the volume of tissue sampled by the light is in the order of 1mm³. The LDF100C module analyzes the Doppler shift created by moving red blood cells and outputs a channel indicating blood flow expressed in Blood Perfusion Units (BPU). On a second channel the LDF100C simultaneously outputs the tissue remittance (Backscatter) from 0 to 100%. Up to four LDF100C modules can be used with a single MP System. See the extensive range of TSD140 series laser Doppler flow probes on page I131. If probes are shipped with the LDF100C, they are factory-calibrated to the module (except Disposable probes). Otherwise, probes are shipped uncalibrated. The LDF100C requires a Blood Perfusion Unit standard (LDFCAL) when (re)calibrating new or existing probes. Includes In-line Transformer (AC101). Specify USA or EURO power cord.

Specifications

Primary Measure	Microvascular blood flow
Outputs	Laser Doppler Flow (0-9999 BPU) Tissue Remittance (0-100%)
Output Range	0 to 5 V (analog)
Laser Type	Laser Diode (Class 1) (Peltier Temperature Stabilized)
Laser Wavelength	780 nm ± 10 nm
Laser Power	0.5 to 1.0 mW (probe dependent)
Doppler Update Rate	187.5 Hz
Processing Bandwidth	10 Hz - 22 kHz
Dynamic Range	116 dB
Linearity	0.35% of full scale
Response Time	100 msec
Stability	1.5% of full scale
Calibration	User set via motility standard of 1000 BPU (LDFCAL)
Probe ID	Cal factors automatically stored
Signal Source	TSD140 Series Laser Doppler Probe
Operating Temperature	15°C to 30°C
Weight:	790 g
Dimensions, L x W x H	11 x 7 x 19 cm
Power Source	± 12 , +5 VDC @ 1 amp (uses AC101A transformer)

The module utilizes Oxford Optronix, Ltd. technology for Laser Doppler signal processing.

Catalog No.	\$	Model	Product
BS4 72-3688		LDF100C	Electrical Bioimpedance Amplifier

For calibration, see LDFCAL on page I140.

NEW Micro-electrode Amplifier

The MCE100C is an extremely high input impedance, low noise differential amplifier that accurately amplifies signals derived from micro-electrodes. A number of selectable options make the module useful for general-purpose recording of cortical, muscle and nerve action/resting potentials or cellular recordings with the optional use of input capacity compensation and a current clamp.

Cable shield drives for input signals can be configured for voltage following (for reduced input capacitance) or simply grounded (for low feedback noise). The MCE100C includes manual controls for input capacity compensation ($\pm 100\text{pF}$) and clamp current zeroing. In addition, the MCE100C incorporates an external voltage control to vary the clamp current proportionally to the control voltage (100mV/nA). An MP150 D/A output channel can drive this external voltage control to change clamp currents automatically during recording. The MCE100C also includes a clamp current monitor output so the clamp current can easily be recorded by another MP150 input channel.

For general-purpose recording, without input capacity compensation or a current clamp, use standard shielded or unshielded electrode leads terminating in Touchproof sockets. Add input capacity compensation and current clamp control by connecting the respective signal ports to the [Vin+] input of the MCE100C using the JUMP100C jumper connectors. For the best performance and shielding, use the MCEKITC to interface your micro-electrode lead cable to the MCE100C.

IMPORTANT USAGE NOTE

Although the MCE100C will function with an MP100 System, an MP150 system is recommended due to the module's wide operational bandwidth. Contact BIOPAC for details.

Specifications

Gain	10, 50, 200, 1000
Output Range	$\pm 10\text{ V}$ (analog)
Low Pass Filter	3 kHz, 30 kHz
High Pass Filter	DC, 0.5 Hz, 100 Hz
CMRR	92 dB typical
CMIV	$\pm 10\text{ V}$ (referenced to isolated ground) $\pm 1500\text{ VDC}$ (referenced to mains ground)
Notch Filter	50 dB rejection (50/60 Hz)
Noise Voltage	2.1 μV rms - (DC-3000 Hz)
Noise Current	0.1 fA/ $\sqrt{\text{Hz}}$
Z (input)	10 E15 Ω (Differential) 10 E15 Ω (Common mode)
Cap Comp (Neg)	Input capacitance compensation (0-100 pF) – manual control
Current Clamp	Adjustable ($\pm 100\text{ nA}$) – voltage control
I Clamp Control	Input - 3.5 mm phone jack (100 mV/nA)
I Clamp Monitor	Output - 3.5 mm phone jack (100 mV/nA)
Signal Source	Micro-electrodes
Weight	350 g
Dimensions W x D x H	4 x 11 x 19 cm
Input Voltage Range	
Gain	Vin (mV)
10	± 1000
50	± 200
200	± 50
1000	± 10

Catalog No.	\$	Model	Product
BS4 72-7273		MCE100C	Micro-electrode Amplifier

Pulse Oximeter Module

The OXY100C measures beat-by-beat, blood oxygen saturation (SpO_2) level in a noninvasive fashion. The OXY100C outputs four signals simultaneously: SpO_2 , pulse waveform, pulse rate and module status. These signals are directed to a switchable block of four different MP System input channels. Up to four OXY100C modules can be used with a single MP System. The OXY100C has built-in calibration for a simplified setup procedure. Each OXY100C module includes a 3-meter transducer extension cable and requires one of the TSD123 series SpO_2 transducers, shown on page I126.

Specifications

Outputs	SpO_2 , Pulse Rate, Pulse Waveform & Module Status
Output Range	0 to 5 V (analog)
SpO_2 Range	0-100%
SpO_2 Accuracy	80-100% $\pm 2\%$, 60-79% $\pm 2.5\%$, 0-59% unspecified
SpO_2 Resolution	1%
Pulse Rate Range	30-250 BPM
Pulse rate Accuracy	1% of full scale
Pulse Rate Resolution	1 BPM
Method of Operation	Lambert-Beers law employing dual wavelengths
Optical Transmission	Red (660 nm) and IR (940 nm)
Signal Source	TSD123 Series SpO_2 Transducer
Weight	460 g
Dimensions, W x D x H	4 x 11 x 19 cm
Algorithm Type	The OXY100C employs Novamatrix Medical Systems, Inc. artifact rejection and averaging algorithms, which utilize an eight second history of the pulse signal. Abnormal data in this history buffer (amplitudes and periods) is rejected. Acceptable data is passed along to an averaging algorithm and is updated on a beat-by-beat basis.

Catalog No.	\$	Model	Product
BS4 72-3691		OXY100C	Pulse Oximeter Module

Build a customized adapter to a Micro-electrode Shielded Cable — MCEKITC, page I140.

CO₂ and O₂ Measurement Module



CO₂ Measurement Module

The CO2100C module records quickly varying carbon dioxide concentration levels. This fast response analyzer is ideal for monitoring time-averaged CO₂ levels using mixing chambers or real-time CO₂ levels for breath-by-breath measurements. The CO2100C module interfaces (via the AFT20 gas sampling interface kit) with the AFT15A and AFT15B mixing chambers, the AFT21 and AFT22 non-rebreathing T valves or the AFT25 mask with integral non-rebreathing T valve.

The CO2100C module is equipped with a variable speed pump to adjust the flow over a wide range of sampling conditions. The module employs a single beam, infrared, single wavelength, measurement technique. Sampling line connections for input and output flow are readily accessible on the front panel of the module.

Includes In-line Transformer (AC100A); specify USA or EURO power cord.

Specifications

CO₂ Range	0-10% CO ₂
Gain	1, 2, 5, 10 (%CO ₂ /V)
Output Range	0-10 V
Repeatability	0.03% CO ₂
Resolution	0.1% CO ₂
Linearity	0.1% CO ₂
Zero Stability	0.1% CO ₂ /24 hours
Response Time	90 msec (T10-T90) @ 200 ml/min 100 msec (T10-T90) @ 100 ml/min (factory preset) 130 msec (T10-T90) @ 50 ml/min
Flow Range	50-200 ml/min
Temp Range	10-45°C
Zero Drift	0.01% CO ₂ /°C
Span Drift	0.02% CO ₂ /°C
Warm Up Time	5 minutes @ 25°C
Sampling Port	Male Luer
Weight	740 g
Dimensions, W x D x H	7 x 11 x 19 cm
Power Source	12 VDC @ 1 amp (uses AC100A transformer)

The module measures the partial pressure of CO₂ so the module output is a function of the pressure in the sample cell. Gas sampled must be free of any liquid or condensable vapors. Gas should be filtered to 5 microns or better. The module utilizes Servomex, Inc. technology for CO₂ concentration signal processing.

Catalog No.	\$	Model	Product
BS4 72-7274		CO2100C	CO ₂ Measurement Module

O₂ Measurement Module

The O2100C module records quickly varying oxygen concentration levels. This fast response analyzer is ideal for monitoring time-averaged O₂ levels using mixing chambers or real-time O₂ levels for breath-by-breath measurements. The O2100C module interfaces (via the AFT20 gas sampling interface kit) with the AFT15A and AFT15B mixing chambers, the AFT21 and AFT22 non-rebreathing T valves or the AFT25 mask with integral non-rebreathing T valve.

The O2100C module is equipped with a variable speed pump to adjust the flow over a wide range of sampling conditions. The module employs an analysis technique based on the parametric oxygen measurement principle. Sampling line connections for input and output flow are readily accessible on the front panel of the module.

Includes In-line Transformer (AC100A); specify USA or EURO power cord.

Specifications

O₂ Range	0-100% O ₂
Gain	10, 20, 50, 100 (%O ₂ /V)
Output Range	0-10 V
Repeatability	±0.1% O ₂
Resolution	0.1% O ₂
Linearity	±0.2% O ₂
Zero Stability	±0.01% O ₂ /hr
Response Time	160 msec (T10-T90) @ 200 ml/min 500 msec (T10-T90) @ 100 ml/min (factory preset) 1000 msec (T10-T90) @ 50 ml/min
Flow Range	50-200 ml/min
Temp Range	5-50°C
Zero Drift	±0.05% O ₂ /°C
Span Drift	±0.25% O ₂ /°C
Sampling Port	Male Luer
Weight	990 g
Dimensions, W x D x H	7 x 11 x 19 cm
Power Source	12 VDC @ 1 amp (uses AC100A transformer)

The module measures the partial pressure of O₂ so the module output is proportional to the pressure in the sample cell. Gas sampled must be free of any liquid or condensable vapors. Gas should be filtered to 5 microns or better. The module utilizes Servomex, Inc. technology for O₂ concentration signal processing.

Catalog No.	\$	Model	Product
BS4 72-7275		O2100C	O ₂ Measurement Module

NEW **Stimulus Presentation System (SuperLab™)**



The STP100W is a stand-alone system that measures subject responses to visual or auditory stimuli. It can present visual stimuli on a computer screen, or auditory stimuli via headphones or speakers, and simultaneously (1ms resolution) send trigger signals to an MP System for data synchronization and collection purposes. The STP100W includes a six-pushbutton response box for performing accurate (1 ms resolution) reaction time measurements. For measuring physiological responses to stimuli, the STP100W includes an optically isolated interface, permitting up to eight synchronization signals (input or output) between the STP100W and the MP System.

The SuperLab™ software can be used to change the placement of visual stimuli on the screen, change the screen's background color, choose from a variety of input and timing options, and provide feedback to subjects based on either response or reaction time. Different trigger channels can be paired to different visual or auditory stimuli to perform sophisticated evoked response averaging tests (e.g. P300).

NOTE: Second PC required— The synchronization signal(s) coming from the STP100W can be directed to an MP System running on a Macintosh or PC, but it's not possible to run the STP100W on the same computer as the MP System. The STP100W requires that the SuperLab™ software and a Digital I/O card (PCI slot required) be placed on a PC running Windows 95, 98, or 98SE.

The STP100W system includes:

- SuperLab™ Software (Windows 95, 98, or 98SE)
- Support Pack for Digital I/O Card (Windows 95, 98, or 98SE)
- Digital I/O Card (PCI slot required)
- Six-Pushbutton Response Box
- Pushbutton Keycap Color Change Kit
- STP100 Optical Interface to UIM100C (includes 3-meter ribbon cable)

Catalog No.	\$	Model	Product
BS4 72-7276		STP100W	Stimulus Presentation System (SuperLab™)

NEW **Isolated Digital Interface for the UIM100C**



If you already have the SuperLab™ and the Digital I/O card with the Support Pack, you can interface to the MP System using the STP100 optical interface. The STP100 interface connects between the SuperLab™ Digital I/O card and the UIM100C module.

The STP100 module can also be used to connect digital signals (TTL compatible) from any mains powered external equipment to the MP System when the system also connects to electrodes attached to humans. The STP100 provides 8 lines for digital data inputs and 8 lines for digital data outputs. All lines are optically isolated to 1500 VDC compliance. The STP100 module comes equipped with a 3-meter ribbon cable (37 pin F/F) for easy system interfacing.

Catalog No.	\$	Model	Product
BS4 72-7277		STP100	Isolated Digital Interface for the UIM100C

Stimulator Module



The STM100C module provides pulse and waveform stimulus outputs for nerve conduction, evoked response (e.g. ABR studies), audio stimulus-response (e.g. startle response) and somatosensory response studies. The Stimulator setup in AcqKnowledge provides easy-to-modify single-, double- or multiple-pulse sequence outputs of any polarity. The Stimulator setup screen also provides standard sine, triangular and square wave outputs for other kinds of physiological tests. Create an arbitrary waveform by modifying an existing wave or reading in a sequence of user-specified numbers (text file). Stimulus duration, repetition, onset and amplitude are completely programmable. For interactive changes during recording, stimulus amplitude levels can also be controlled manually. Overload and pulse stimulus indicators are positioned on the module's front panel for easy viewing. The 50 Ω output port can simultaneously output a trigger or analog signal to piezo transducers, recorders, oscilloscopes, meters, etc. The External Stimulus output port on the STM100C can be used to drive headphones or tube phones directly.

In addition to providing computer control of stimulus waveforms, the STM100C can also buffer signals from any Biopotential or Transducer module that has its output directed to the STM100C input during recording.

- OUT100 headphones allows the STM100C module to provide tone or click output (e.g. startle response) or can be used to listen to signals from other module outputs during acquisition (e.g. EMG or heart sounds signals).
- OUT101 ear tube phone allows the STM100C to output a series of clicks or tone pips for auditory brainstem response (ABR) testing.
- OUT102 piezo transducer allows the STM100C to provide an audible indicator, or alarm, when signal levels cross pre-defined thresholds.
- STMISO series stimulus isolation adapters allows the STM100C to provide high voltage or constant current stimulus output for nerve conduction, somatosensory and other types of stimulus response studies.
- CBL105 and CBL202 allows the STM100C to drive a low voltage ($\pm 10V$) nerve conduction chamber directly (without a STMISO).

Electrical Stimulus Isolation Accessories

Stimulus Isolation Adapter (Voltage and Current)

The STMISOC can stimulate with pulse, sinusoidal or arbitrary waveforms and is ideal for nerve conduction, muscle twitch, somatosensory stimulation, or other response studies requiring a stimulus. It plugs into the STM100C to provide either an isolated voltage or constant current stimulus and incorporates a selectable linear voltage multiplier to amplify the voltage signal from the STM100C. Voltage stimulation can be unipolar or bipolar, with a maximum voltage output of 200 volts. Current stimulation is unipolar only, with a maximum compliance of 200 volts; 12 preset constant current levels are provided.

Specifications

Stimulus Pulse Width	50 μ sec to 2 msec (voltage and current)
Stimulus Sine Wave Range	100 Hz to 5 kHz (voltage only)
Step Up Voltage Ratio	Selectable: (1:5) or (1:10)
Maximum Output Voltage	200 V (p-p) into 5 k Ω load
Constant Current Range	0.01, 0.02, 0.05, 0.0, 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, 20.0, 50.0 ma (unipolar only)
Current Source Compliance	200 V maximum
Isolation Capacitance	120 pf
Isolation Voltage	1500 VDC (from amplifier ground)
Cable Length	1.8 m
Weight	190 g
Dimensions (W x D x H)	10 x 5 x 4.5 cm
Interface	STM100C—see above

Catalog No.	\$	Model	Product
BS4 72-3683		STMISOC	Stimulus Isolation Adapter

Specifications

Stimulus Output Voltage	20 V (p-p) maximum	Attenuation Resolution	1dB
Current Output Drive	50 Ω Output: ± 100 mA (3.5 mm phone jack) Ext Stim Output: ± 1.0 amp [6.3 mm (1/4") phone jack]	LED Indicators	Pulse, Current Limit
External Stimulus Z (out)	Less than 0.1 Ω	Uniphasic Pulse Width	10 μ s (min) with 5 μ s resolution
Input Sources	DA0, DA1, PULSE (DIG I/O 15), CH 16 (Analog)	Biphasic Pulse Width	MP100: 50 μ s (min), MP150: 20 μ s (min)
Polarity Control	Manual or digital control (DIG I/O 7)	Biphasic Pulse Resolution	MP100: 25 μ s, MP150: 10 μ s
Attenuation Control	Manual or digital control	Arbitrary Wave Resolution	MP100: 25 μ s, MP150: 10 μ s
Attenuation Control Range	128 dB (Digital I/O 0-6, LSB-MSB)	Weight	380 grams
		Dimensions (W x D x H)	4 x 11 x 19 cm

Catalog No.	\$	Model	Product
BS4 60-1064		STM100C	Stimulator Module

Stimulus Isolation Adapters (Voltage Only)

The STMISOD and STMISOE can stimulate with pulse, sinusoidal or arbitrary waveforms and are suitable for nerve conduction, muscle twitch, somatosensory stimulation, or other response studies requiring a voltage stimulus.

The STMISOD and STMISOE plug into the STM100C to provide an isolated voltage stimulus. These stimulus isolation adapters incorporate a linear voltage multiplier to amplify the voltage signal from the STM100C. Voltage stimulation can be unipolar or bipolar, with a maximum voltage output of 100 volts for the STMISOD and 200 volts for the STMISOE.

Specifications

Stimulus Pulse Width	50 μ sec to 2 msec (voltage only)
Stimulus Sine Wave Range	100 Hz to 5k Hz (voltage only)
Step Up Voltage Ratio	STMISOD (1:5) STMISOE (1:10)
Maximum Output Voltage	STMISOD 100 V (p-p) into 5k Ω load STMISOE 200 V (p-p) into 5k Ω load
Isolation Capacitance	120 pf
Isolation Voltage	1500 VDC (from amplifier ground)
Cable Length	1.8 m
Weight	140 g
Dimensions (W x D x H)	6.5 x 5 x 4.8 cm
Interface	STM100C—see page I116

Catalog No.	\$	Model	Product
BS4 72-7278		STMISOD	Stimulus Isolation Adapter (100V max)
BS4 72-7279		STMISOE	Stimulus Isolation Adapter (200V max)

See pages I135 to I138 for a wide range of electrode options.

Additional STM Series Interface Cables:

For CBL200 and CBL204, see page I138.

For CBL102, CBL105 and CBL106, see page I140.

Auditory Stimulus Accessories



Headphones

These monaural headphones can be used with the STM100C stimulator module to deliver a tone signal while recording data for startle response or other stimulus-response studies. The headphones can also be used to listen to raw signals

(such as EMG), piped through the STM100C from an amplifier output. The OUT100 is a wide response, high efficiency headphone, weighing 85 grams and is equipped with a 1.8 meter cord terminated in a 6.3mm (1/4") phone plug.

Tubeophone Set

Use the OUT101 tubeophone with a STM100C stimulator module to deliver clicks and tones in auditory evoked response applications (i.e. ABR). The Tubeophone design consists of a monaural acoustic transducer attached to a short, flexible, plastic tube, which fits into the subject's ear with the aid of a foam tip. Use of the Tubeophone reduces ambient noise and bone conduction problems, which can interfere with auditory response recordings. Furthermore, because the Tubeophone provides a 1 msec acoustic signal delay (due to plastic tube), it automatically separates true response from electromagnetic artifact resulting from speaker activation. The OUT101 measures 3.8cm (wide) x 5cm (high) x 1cm (thick), includes a clip for attachment to fabric or fixtures and comes equipped with a 1.8m cable terminated in a 6.3mm (1/4") phone plug. The OUT101 Tubeophone Set includes one Tubeophone, plastic tube and 50 foam ear inserts. The OUT101 response compares to TDH-39, 49 or 50 audiometric headphones.

NEW Piezo Audio Transducer

The OUT102 piezo transducer is typically connected directly to the STM100C stimulator module. When the stimulator module output rises above 1.5 volts, the piezo indicator will emit a constant audible signal (3.0 kHz @ 80dB). Accordingly, the device is very useful for providing an audible stimulus, or alarm, when a physiological signal passes a certain threshold. As such, the OUT102 makes an excellent audible BPM indicator for ECG, blood pressure or respiration signals. The device can also be used to indicate when temperature or another slowly moving variable (e.g. electrodermal response) passes a certain threshold. The threshold for the OUT102 is determined by adjusting the amplitude control on the STM100C module. The specific Biopotential or Transducer amplifier signal monitored can be recorded while simultaneously directed through the STM100C module. The OUT102 also connects directly to the UIM100C digital I/O ports for operation with Control Channel outputs. The OUT102 measures 2.5cm (dia) x 1cm (high) and comes equipped with a 1.8m cable terminated in a 3.5mm phone plug. An adapter is included for connecting the OUT102 to the UIM100C digital I/O ports.

Catalog No.	\$	Model	Product
BS4 72-7280		OUT100	Headphones
BS4 72-7281		OUT101	Tubeophone Set
BS4 72-7282		OUT101T	Replacement Plastic Tubes: pkg. of 4
BS4 72-7283		OUT101E	Replacement Foam Ear Inserts, pkg. of 50
BS4 72-7284		OUT102	Piezo Audio Transducer

Remote Monitoring Module Set



The TEL100C system offers a way to record data while subjects are mobile and/or physically distant (up to 60 meters) from the recording system. The TEL100C system includes a portable amplifier/transmitter, which converts up to four channels of data into a modulated data stream. This data stream travels over a single lightweight coaxial cable to the receiver module. The receiver module demodulates the data and sends it to the MP System for recording and analysis.

In keeping with the modular design, the TEL100C will work with your current MP System and any other standard 100-series amplifiers. Up to four TEL100C module sets can be used with a single MP System.

Each channel incorporates a switchable, non-distorting 50/60 Hz interference filter. Gain and bandwidth can be adjusted independently for each channel.

The TEL100C system includes:

- 1 - TEL100D-C receiver module
- 1 - TEL100M-C portable amplifier/transmitter
- 1 - CBL117 10-meter connection cable
- TEL100C system

Four Channel Receiver Module

The TEL100D-C four-channel receiver module connects directly to an MP System and is included in the TEL100C remote monitoring module set. The receiver incorporates independent filtering controls for each recording channel. Up to four TEL100D-C modules can be used with any MP System. A combination of other 100-series amplifiers, plus one or more TEL100D-Cs, can be used together for a maximum of 16 channels. The TEL100D-C requires a TEL100M-C amplifier/transmitter plus CBL117 or CBL118 for operation.

Four Channel Amplifier/Transmitter Module

The TEL100M-C amplifies and transmits up to four data channels to the TEL100D-C and is included in the TEL100C remote monitoring module set. The transmitter includes independent filtering, offset and gain controls for each recording channel. The transmitter measures 9cm x 15cm x 3.3cm and needs 5cm clearance on each side for electrode or transducer attachment. A belt clip is attached to the back of the module so it can be worn at the subject's waist. The "Smart Sensor" electrodes and transducers listed on page I119 plug into four 9-pin connectors (two on each side of the transmitter). Excitation voltages present on each input channel provide power for transducers.

The TEL100M-C requires one 9V alkaline battery (included) for operation. Expected battery life is approximately 24 hours of continuous operation. A low battery indicator light will flash when the battery needs to be replaced.

Connection Cables

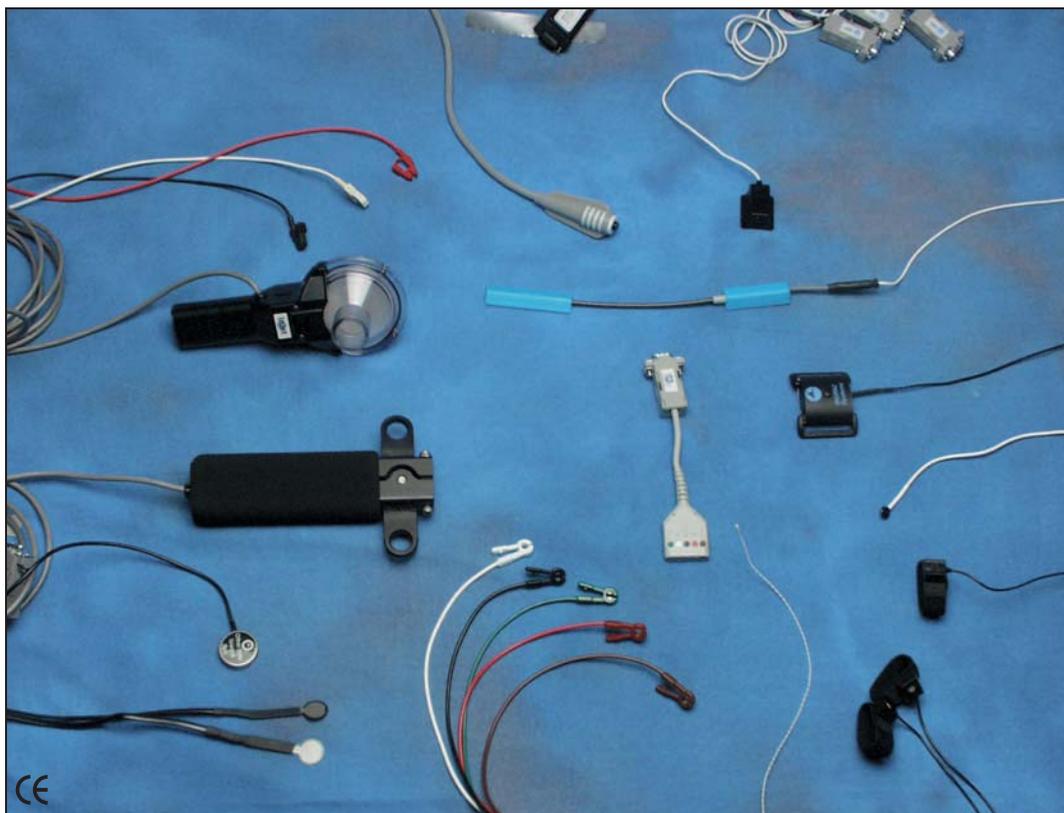
These cables connect the TEL100D-C receiver to the TEL100M-C transmitter. The lightweight coaxial cables minimize hindrance caused by multiple heavy cables. The CBL117 is included with the TEL100C set. For increased operating distance, use CBL118.

Specifications

Number of Channels	4
Low Pass Filter	30 Hz, 500 Hz
High Pass Filter	DC, 0.05 Hz and 0.5 Hz
Channel Gain Control	10 levels: x50 to x50,000
Output Range	±9 V (analog)
Offset Control	Yes
Input Impedance	2 MΩ (differential)
CMRR	110 dB min (50/60Hz)
CMII	1000 MΩ min (50/60Hz)
CMIV	±7 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Noise Voltage	0.1 μV rms (0.05-30 Hz)
Transducer Excitation	±5 V (10 V pk) @ 10 ma (max)
Signal/Crosstalk Ratio	(0.05-500 Hz) 65 dB min
Signal/Noise Ratio	(0.05-30 Hz) 75 dB min, (0.05-500 Hz) 65 dB min
Encoding	TDM-DSB/LC
Signal Transmission Range	≤ 60 m via coaxial cable
TEL100M Weight	290 g (with battery)
TEL100M Dimensions, W x L x H	9 x 15 x 3.3 cm
TEL100D Weight	370 g
TEL100D Dimensions, W x D x H	4 x 11 x 19 cm
TEL100M Power Source	9 V alkaline battery (24 hrs nominal)

Catalog No.	\$	Model	Product
BS4 72-7286		TEL100C	Remote Monitoring Set
BS4 72-7287		TEL100D-C	Four Channel Receiver Module
BS4 72-7288		TEL100M-C	Four Channel Amplifier/Transmitter Module
BS4 72-7289		CBL117	Connection Cable, 10 meter
BS4 72-7290		CBL118	Connection Cable, 60 meter

Electrodes and Transducers for the TEL100C Module Set



Smart Sensor (SS) electrodes and transducers connect to the TEL100M-C amplifier/transmitter. Any Smart Sensor electrode or transducer can be plugged into any TEL100M-C input. The following SS series transducers connect to the TEL100C system. The transduc-

er specifications mirror the characteristics of the respective "TSD" types listed. Generally, biopotentials and other signals can be recorded for up to 24 hours. All transducers come with a 1.8-meter cable unless otherwise specified.

No.	Catalog No.	\$	Model	Description	TSD Type	Page
1.	BS4 72-7290		SS1A	Unshielded Touchproof Electrode Adapter (10 cm)	—	—
2.	BS4 72-7291		SS2	Shielded Electrode Lead Assembly (1 meter)	—	—
3.	BS4 72-7292		SS3A	Electrodermal Response Transducer	see TSD203	Page I134
4.	BS4 72-7293		SS4A	Pulse Plethysmogram Transducer	see TSD200	Page I133
5.	BS4 72-7294		SS5B	Respiratory Effort Transducer	see TSD201	Page I133
6.	BS4 72-7331		SS6	Fast Response Temperature Probe	see TSD202A	Page I134
7.	BS4 72-7332		SS7	Skin Surface Temperature Probe	see TSD202B	Page I134
8.	BS4 72-7295		SS10	Hand Switch	see TSD116A	Page I124
9.	BS4 72-7296		SS11A	Air Flow (medium) Transducer	see TSD117	Page I125
10.	BS4 72-7297		SS17	Physiological Sounds Microphone	see TSD108	Page I122
11.	BS4 72-7298		SS20	Twin Axis Goniometer, 110mm (requires 2 channels)	see TSD130A	Page I128
12.	BS4 72-7299		SS21	Twin Axis Goniometer, 180mm (requires 2 channels)	see TSD130B	Page I128
13.	BS4 72-7300		SS22	Single Axis Torsiometer, 110mm	see TSD130C	Page I128
14.	BS4 72-7301		SS23	Single Axis Torsiometer, 180mm	see TSD130D	Page I128
15.	BS4 72-7302		SS24	Finger Goniometer, 35mm	see TSD130E	Page I128
16.	BS4 72-7303		SS25	Hand Dynamometer	see TSD121C	Page I126
17.	BS4 72-7304		SS26	Tri-Axial Accelerometer 5G (requires 3 channels)	see TSD109C	Page I123
18.	BS4 72-7305		SS27	Tri-Axial Accelerometer 50G (requires 3 channels)	see TSD109F	Page I123
19.	BS4 72-7306		SS28	Heel/Toe Strike Transducer	see TSD111	Page I123
20.	BS4 72-7307		SS29	Multi-lead ECG Cable (requires 3 channels)	see TSD155C	Page I132

NEW Continuous Noninvasive Blood Pressure Measurement System



The NIBP100A is a stand-alone system for continuous noninvasive real-time measurement of human blood pressure. The system employs a tonometric technique, which records intra-arterial pulse pressure. The tonometric sensor is placed just distal of the styloid process with the aid of an included wrist brace. The NIBP100A also incorporates a built-in oscillometric cuff measurement system to calibrate the relative intra-arterial pressure readings to absolute values.

The NIBP100A system outputs a continuous analog waveform representative of the blood pressure. The oscillometric measurement is performed at user defined intervals to insure the accuracy of the blood pressure waveform generated by the NIBP100A. The MP System can collect this waveform and AcqKnowledge can be used to extract the systolic, diastolic and mean blood pressure values on a beat-by-beat basis. The NIBP100A includes a cable and the INISO signal isolator to connect to the HLT100C or UIM100C module.

IMPORTANT USAGE NOTE: When using the MP System to record biopotentials and NIBP from a human subject, use an HLT100C with the included INISO adapter to connect the NIBP100A to the MP System.

The NIBP100A includes:

- Continuous Noninvasive Blood Pressure Monitor
- Tonometric Sensor
- Oscillometric Cuffs (large adult, adult, small adult)
- Cuff Hose
- Wrist Brace
- CBLNIBP1 (9-pin male DSUB to 3.5mm phone plug — 1 meter)
- INISO Signal Isolator for HLT100C module
- Hospital Grade Power Cord (US plug)
- Operation Manual

IMPORTANT USAGE NOTE: The 100 watt, linear voltage converter is required when operating the NIBP100A with 240 VAC @ 50 Hz mains power. Euro power cord included.

Specifications

NIBP100A

BP Waveform Output	1 channel (0-500 mmHg)
Output Range	0 – 5 V (analog)
Pressure Ranges	60 – 250 mmHg (Systolic) 45 – 235 mmHg (Mean) 40 – 220 mmHg (Diastolic)
Pulse Rate Range	30 – 180 BPM
Operating Temperature	10 to 40 °C
Storage Temperature	-10 to +60 °C
Weight	7.4 kg
Dimensions, W x D x H	28 x 29 x 14 cm
Protective Class	IEC Class I
Power Consumption	85 VA
Interface	HLT100C—see page I105 UIM100C—see page I104

TSD105A

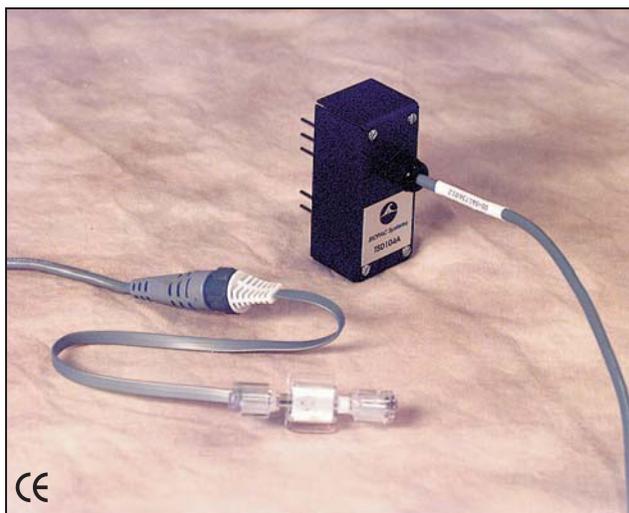
Rated Output	1 mV/V (normalized to 1 V excitation)
Ranges	50, 100, 200, 500, 1000 g
Noise (rms)	(Range/50) mg @ 10 V excitation, 1 Hz bandwidth
Nonlinearity	<±0.025% FSR
Hysteresis	<±0.05% FSR
Nonrepeatability	<±0.05% FSR
30 minute creep	<±0.05% FSR
Temperature Range	-10°C to 70°C
Thermal Zero Shift	<±0.03% FSR/°C
Thermal Range Shift	<0.03% Reading/°C
Maximum Excitation	10 VDC
Mounting Rod	9.5 mm (dia) – variable orientation
Weight	300 g (with mounting rod)
Dimensions	19 mm (wide), 25 mm (thick), 190 mm (long)
Cable Length	3 m
Interface	DA100C—see page I106

Catalog No.	\$	Model	Product
BS4 72-7308		NIBP100A	Continuous Noninvasive Blood Pressure Measurement System

For a low-cost alternative to measure non-continuous, indirect blood pressure, see the TSD120 on page I124.

For invasive blood pressure, see TSD104A on page I121.

Precision Pressure Transducer



The TSD104A measures direct arterial or venous blood pressure in animals or records pressure changes within an in-vitro circuit (e.g. Langendorff heart preparation). The TSD104A connects to tubing via standard Luer Lok fittings. The transducer is small and lightweight and the slotted base, with integral Velcro® strap, permits easy mounting. The TSD104A interfaces with the DA100C general-purpose transducer amplifier. The transducer is supplied non-sterile but can be cold sterilized. Replacement transducers (RX104A) can be purchased without the cable, making the TSD104A a very economical solution for pressure sensing applications.

Specifications

Operational Pressure	-50 to 300 mmHg
Overpressure	-400 to +4000 mmHg
Dynamic Response	100 Hz
Transducer Dimensions	67 mm long, 25 mm wide
Weight	11.5 g
MRI compatible	Yes (no ferrous parts)
Unbalance	50 mmHg max
Connection Ports	Male Luer (2)
8-hour Drift	1mm Hg after 5 minute warm-up
Isolation	≤5 μA leakage at 120 VAC/60 Hz
Defibrillation	Withstands 5 discharges of 400 joules in 5 minutes across a load
Operating Temperature	+15 to +40 °C
Storage Temperature	-30 to +60 °C
Combined Effects of Sensitivity, Linearity & Hysteresis	1mm Hg (nominal)
Output	5 μV/mmHg (normalized to 1 V excitation)
Cable Length	3 m
Interface	DA100C—see page I106

Catalog No.	\$	Model	Product
BS4 72-3704		TSD104A	Transducer and Cable
BS4 72-3705		RX104A	Replacement Element

Variable Range Force Transducer



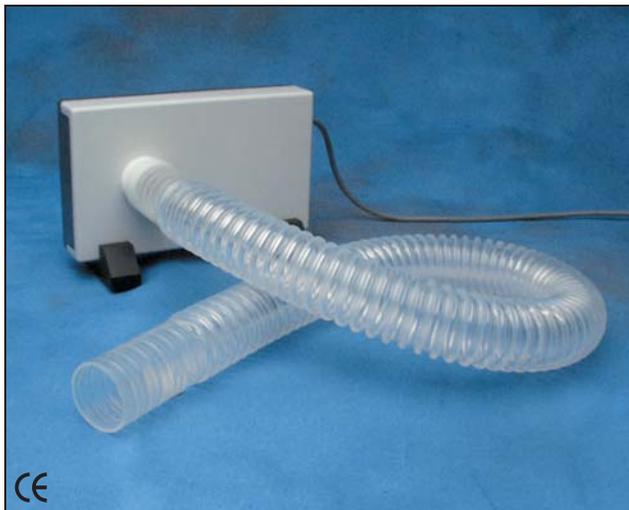
The TSD105A interfaces with the DA100C general-purpose transducer amplifier to measure a wide range of forces (1mg to 1000g) in a variety of applications, including very fine in-vitro tissue bath work as well as larger in-vivo applications. Forces are conveyed to the strain beam via an adjustable pivot, five-position, precision lever arm to insure accurate measurements. The transducer comes with a versatile mounting rod assembly to support multiple orientations. When fine tension and position adjustments are required, the mounting rod can be clamped to an HDW100A.

Catalog No.	\$	Model	Product
BS4 72-3715		TSD105A	Variable Range Force Transducer

For HDW100A Force Transducer Tension Adjuster, see page I127.

For TSD125 Series Fixed Range Force Transducer, see page I127.

Pneumotach Air Flow Transducer (High Flow)



The TSD107B is a highly linear, wide range, air flow transducer that can be used to perform a variety of high performance tests relating to air flow, lung volume and expired gas analysis. The TSD107B is ideal for applications that have large flow requirements (e.g. exercise physiology). The TSD107B consists of a high performance pneumotach coupled with an internal, precision differential pressure transducer that converts the differential pressure generated across the pneumotach into a proportional voltage signal. The TSD107B interfaces with the DA100C general-purpose transducer amplifier. All connections can be performed with AFT7 (35mm ID) smooth bore tubing (see page I141) and AFT11 series couplers (see page I142).

- For air flow and lung volume measurements, use the TSD107B with the AFT21 non-rebreathing T valve and the AFT9 mouthpiece with the AFT4 bacterial filter.
- For exercise physiology measurements, use the TSD107B with the AFT25 facemask (includes integral non-rebreathing T valve) and the AFT15A or AFT15B mixing chambers.

Specifications

Pneumotach Type	Hans Rudolf® #4813 with integral differential pressure transducer
Calibrated Flow Range	±800 L/min
Dead Space Volume	87.8 ml
Nominal Output	45 µV/[liters/sec] (normalized to 1 V excitation)
Dimensions, D x H x W	4 x 11 x 19 cm
Weight	690 g
Connection Ports	35 mm OD
Cable Length	3 m

Catalog No.	\$	Model	Product
BS4 72-7309		TSD107B	Pneumotach Air Flow Transducer (High Flow)

Physiological Sounds Microphone



The TSD108 interfaces with the DA100C general-purpose transducer amplifier to measure a wide array of physiological sounds. Most commonly, the TSD108 is used to measure heart sounds or Korotkoff sounds. When the TSD108 signal is recorded along with the TSD120 blood pressure cuff signal, the Korotkoff sounds vividly mark the systolic and diastolic blood pressure. The TSD108 can also record the sounds associated with rubbing or grinding (e.g., Bruxism). To listen to the physiological sounds with headphones as they are recorded, pipe the TSD108 signal through the STM100C stimulator module. The acoustical transducer element is a piezo-electric ceramic disk, which is bonded to the interior of a metallic circular housing.

Specifications

Frequency Response	35 Hz to 3500 Hz
Housing	Stainless Steel
MRI Compatible	Yes (no ferrous parts)
Sterilizable	Yes (contact BIOPAC for details)
Noise	5 µV rms - (500-3500 Hz)
Output	2V (p-p) maximum
Weight	9 g
Dimensions	29 mm diameter, 6 mm thick
Cable Length	3 m
Interface	DA100C—see page I106
TEL100C Compatibility	SS17—see page I119

Catalog No.	\$	Model	Product
BS4 72-7310		TSD108	Physiological Sounds Microphone

For additional air flow transducers, see TSD117 (page I125), TSD127 (page I128), TSD137 (page I129), and for Accessories, see AFT Accessories (pages I141 to I143).

Tri-Axial Accelerometers



The Tri-Axial Accelerometers are high level output transducers that connect directly to the HLT100C High Level Transducer module. The TSD109 series accelerometers provide three outputs, simultaneously measuring acceleration along the X, Y and Z axes. The TSD109C is optimal for measuring accelerations when performing slow movements, such as walking and hand tremor. The TSD109F is more suitable for quick movements, such as swinging a tennis racket. The transducers are the same size and can be used on any part of the body or attached to external equipment. The pliable and unobtrusive design conforms readily to body contours. They come with a Velcro® strap for easy attachment.

The accelerometers' frequency response extends from DC to 500Hz. They are extremely accurate and can easily be checked for calibration by changing their orientation in three-dimensional space, so that gravity ($G=1$) acts only upon the desired axis.

Specifications

Channels	3 - (X, Y, and Z axes)
Range (Output)	TSD109C: ± 5 G (250 mV/G) TSD109F: ± 50 G (38 mV/G)
Noise	TSD109C: 225 $\mu\text{G}/\sqrt{\text{Hz}}$ rms TSD109F: 1.0 $\text{mG}/\sqrt{\text{Hz}}$ rms
Bandwidth	DC - 500 Hz (-3 dB)
Nonlinearity	0.2% of Full Scale
Transverse Axis Sensitivity	$\pm 2\%$
Alignment Error	$\pm 1^\circ$
Package	Compliant silicone housing
Weight	17 g
Dimensions, L x W x H	33 x 28 x 19 mm
Power	+5V @ 9 mA (via HLT100C)
Sterilizable	Yes (contact BIOPAC for details)
Cable Length	3 m
Interface	HLT100C—see page I105
TEL100C Compatibility	SS26 (5G) and SS27 (50G)—see page I119

Catalog No.	\$	Model	Product
BS4 72-7311		TSD109C	Tri-Axial Accelerometer, ± 5 G Range
BS4 72-7312		TSD109F	Tri-Axial Accelerometer, ± 50 G Range

NEW Heel/Toe Strike Transducer



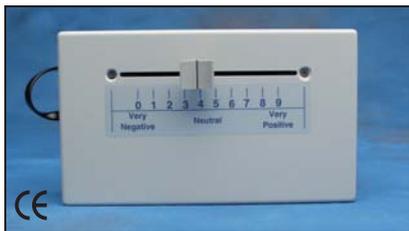
Each TSD111 heel/toe strike transducer incorporates two force sensitive resistor (FSR) sensors designed for attachment to the sole of a shoe. Typically, one FSR is placed (taped) under the heel and the other is placed under the toe. The FSRs indicate the precise moment of pressure placed on the heel and toe as the subject walks. The heel/toe strike data is encoded onto a single analog channel; the heel strike results in a [-1V] signal and the toe strike results in a [+1V] signal. If heel and toe strike timing is required for both feet, two TSD111 transducers are required. The TSD111 comes equipped with a 7.6-meter cable and is designed for direct connection to the HLT100C module.

Specifications

Nominal Output Range	-1 to +1 V
Nominal Contact Force	200 g to indicate heel/toe strike
Attachment	TAPE1, TAPE2, vinyl electrical or duct tape
FSR Dimensions	18.3 mm (dia) x 0.36 mm (thick) and 30 cm pigtail lead
FSR Active Area	12.7 mm (dia)
Cable Length	7.6 m
Interface	HLT100C—see page I105
TEL100C compatibility	SS28—see page I119

Catalog No.	\$	Model	Product
BS4 72-7313		TSD111	Heel/Toe Strike Transducer

NEW Variable Assessment Transducer



The TSD115 incorporates a slide control with graduated scale that allows users to gauge their subjective response to a variety of stimuli. Multiple TSD115 transducers can be used simultaneously, allowing several people to answer the same question or

otherwise respond to stimuli. The transducer is lightweight and fits easily into the subject's hand or lap. The TSD115 comes equipped with a 7.6-meter cable and is designed for direct connection to the HLT100C module.

Specifications

Scale Output Range	0-5 V
Scale Resolution	Infinitely adjustable
Slide Control Length	10 cm
Dimensions (H x D x W)	4 x 11 x 19 cm
Weight	230 g
Cable Length	7.6 m
Interface	HLT100C—see page I105

Catalog No.	\$	Model	Product
BS4 72-7314		TSD115	Variable Assessment Transducer

Noninvasive Blood Pressure Cuff Transducer



The TSD120 can measure systolic and diastolic blood pressure by the oscillometric or auscultatory (Korotkoff sounds) technique. The TSD120 includes an adjustable cuff (standard adult cuff: RX120D), pump bulb, pressure gauge and pressure transducer. The pressure transducer is attached to the cuff and connects to the DA100C

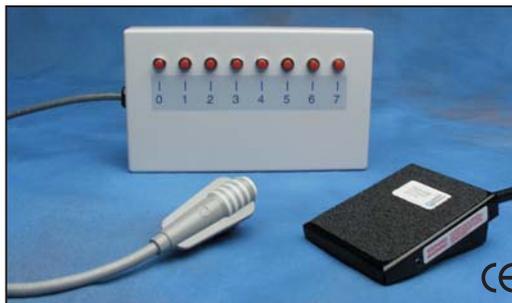
general-purpose transducer amplifier. To visually identify Korotkoff sounds during cuff deflation, use the TSD108 physiological sounds microphone. For indication of relative blood pressure changes without cycling the cuff pressure, inflate the cuff to a pressure between systolic and diastolic.

Specifications

Cuff Circumference Range	25.4 cm to 40.6 cm (RX120D cuff)
Cuff Dimensions	14.5 cm (wide) x 54 cm (long)
Pressure Range	20 mmHg to 300 mmHg
Manometer Accuracy	±3 mmHg
Output	5 µV/mmHg (normalized to 1 V excitation)
Weight	350 g
Cable Length	3 m
Interface	DA100C—see page I106

Catalog No.	\$	Model	Product
BS4 72-7315		TSD120	Noninvasive Blood Pressure Cuff Transducer

NEW Switches and Markers



The TSD116 series is used for externally triggering data acquisition, remote event marking, or psychophysiological response tests. The switches connect to the UIM100C digital I/O ports and can be monitored as input channels. The TSD116 series incorporate momentary ON operation (switch is ON only when pressed). The TSD116A is a single channel hand switch, the TSD116B is a single channel foot switch and the new TSD116C is a compact eight channel digital marker box. The TSD116C allows the user to independently mark events, or provide responses, on up to eight channels simultaneously. Because digital channels can be interleaved with analog channels, when using AcqKnowledge, it's easy to assign separate digital channels as event markers for individual analog input channels.

Specifications

Switch Type	Pushbutton: (ON) – OFF
Dimensions	TSD116A: 19 mm (dia), 63 mm (long) TSD116B: 69 mm (wide), 90 mm (long), 26 mm (high) TSD116C: 19 cm (wide), 11 cm (deep), 4 cm (high)
Cable Length	TSD116A and TSD116B: 1.8 m, TSD116C: 3 m
Connector Type	TSD116A and TSD116B: 2 mm pin plugs TSD116C: Stripped and tinned wires
MRI Compatible	Yes (no ferrous parts) - TSD116A hand switch only
Interface	UIM100C—see page I104
TEL100C Compatibility	SS10 (Hand Switch)—see page I119

Catalog No.	\$	Model	Product
BS4 72-7316		TSD116A	Single Channel Hand Switch
BS4 72-7317		TSD116B	Single Channel Foot Switch
BS4 72-7318		TSD116C	Compact Eight-Channel Digital Marker Box

For absolute and continuous measurement of noninvasive blood pressure, use the NIBP100A; see page I120.

Pneumotach Air Flow Transducer (Medium Flow)



The TSD117 can be used to perform a variety of tests relating to air flow, lung volume and expired gas analysis. The transducer includes a removable head (RX117) for easy cleaning and sterilization. The TSD117 is intended for human use and is ideal for classroom situations. The TSD117 interfaces with the DA100C general-purpose transducer amplifier. All connections can be performed with AFT12 (22mm ID) tubing and AFT11 series couplers. See pages I141 to I143 for the AFT Series.

- For air flow and lung volume measurements, use the TSD117 with the AFT2 mouthpiece and the AFT1 bacterial filter.
- For measurements of expired gases, use the TSD117 with the AFT22 non-rebreathing T valve with AFT10 facemask and the AFT15A or AFT15B mixing chambers.

Replacement Head

The RX117 is a sterilizable air flow head for the TSD117 pneumotach transducer. Multiple RX117 heads help eliminate equipment downtime during cleaning procedures. To reduce the cost of disposable items, use the RX117 with the AFT8 sterilizable mouthpiece. (22mm ID/30mm OD)

Specifications

Flow Rate	±300 L/min
Dead Space	93 ml
Nominal Output	60 μ V/[liters/sec] (normalized to 1 V excitation)
Flow Head Dimensions	82.5 mm (dia) x 101.5 mm (long)
Flow Head Weight	80 g
MRI Compatible	Yes (no ferrous parts)
Handle Dimensions	127 mm (long) x 23 mm (thick) x 35 mm (wide)
Handle Weight	85 g
Connection Ports	22 mm ID/30 mm OD
Cable Length	3 m
Interface	DA100C—see page I106
TEL100C Compatibility	SS11A—see page I119

Catalog No.	\$	Model	Product
BS4 72-7319		TSD117	Pneumotach Air Flow Transducer (Medium Flow)
BS4 72-7320		RX117	Replacement Head

Blood Pressure Cuffs for the TSD120



The RX120 series are optional blood pressure cuffs, of varying sizes, which can be quickly and easily swapped in and out of the TSD120 noninvasive blood pressure cuff transducer. Use a single TSD120 and substitute one cuff for another to accommodate a wide range in limb circumferences.

Specifications

Cuff	Circumference Range (cm)	Width (cm)	Length (cm)
RX120A	9.5-13.5	5.2	18.5
RX120B	13.0-19.0	7.5	26.1
RX120C	18.4-26.7	10.5	34.2
RX120D	25.4-40.6	14.5	54
RX120E	34.3-50.8	17.6	63.3
RX120F	40.6-66	21	82.5

Catalog No.	\$	Model	Product
BS4 72-7321		RX120A	Blood Pressure Cuff
BS4 72-7322		RX120B	Blood Pressure Cuff
BS4 72-7323		RX120C	Blood Pressure Cuff
BS4 72-7324		RX120D	Blood Pressure Cuff
BS4 72-7325		RX120E	Blood Pressure Cuff
BS4 72-7326		RX120F	Blood Pressure Cuff

General-purpose Hand Dynamometer



The TSD121C is an isometric dynamometer that measures a variety of gripping or pulling strengths for multiple muscle groups. The isometric design improves experiment repeatability and accuracy. Hand grip strength is easily recorded in pounds or kilograms force. Using the

Dynagrips option, the pulling strength of single or multiple muscle groups can be measured. To measure arm, leg, torso or neck strength, mount the TSD121C against a wall or floor and pull the free end directly (or redirect with a pulley). For in-depth studies of muscular activity, combine TSD121C force recordings with EMG recordings. The TSD121C has a 3-meter cable terminated in a connector that interfaces with the DA100C general-purpose transducer amplifier. The ergonomic soft handle design and simple calibration procedure make this device very easy to use.

Specifications

Isometric Range	0-100 kg
Nominal Output	13.2 μ V/kg (normalized to 1V excitation)
Weight	315 g
Dimensions (L x W x T)	185 x 42 x 30 mm
Cable Length	3 m
Interface	DA100C—see page I106
TEL100C Compatibility	SS25—see page I119

Catalog No.	\$	Model	Product
BS4 72-7327		TSD121C	Hand Dynamometer
BS4 72-7330		DYNAGRIPS	Dynagrips Option

Oxygen Saturation (SpO₂) Transducers



The TSD123 series transducers connect to the OXY100C pulse oximeter module to provide continuous readings for SpO₂, pulse rate and pulse waveform. The TSD123A transducer is a comfortable and easy to use finger clip, ideal for short-term monitoring. The TSD123B transducer attaches to fingers, toes and ears with adhesive patches (included) and is well suited for long-term monitoring.

Specifications

Optical Transmission	Red (660 nm) and IR (940 nm)
MRI Compatible	Yes (no ferrous parts)
Weight	TSD123A: 23 g, TSD123B: 6 g
Dimensions (L x W x H)	TSD123A: 62 x 23 x 26 mm, TSD123B: 12 x 12 x 12 mm
Sterilizable	Yes (contact BIOPAC for details)
Cable Length	1 m
Interface	OXY100C—see page I113

Catalog No.	\$	Model	Product
BS4 72-3721		TSD123A	Finger Clip
BS4 72-3722		TSD123B	Universal Adhesive

Stroboscope



The TSD122 stroboscope connects directly to the UIM100C or STM100C module for single pass or averaging type visual evoked response applications. The stroboscope can be set up to either generate or respond to a TTL synchronizing signal for data acquisition. The TSD122 is battery-operated and will operate from zero to 12,000 flashes a minute. Cables are included for interfacing with the MP System.

Specifications

Display	Digital LCD
Battery	Built-in, rechargeable
Battery Life	60 hours at 100 strobes/sec
Flash Duration	30 μ sec
Flash Energy	180 mJoule
External TTL	Sync/Trigger
Weight	1.1 kg
Body Dimensions (W x H x L)	9.3 9 x 23 cm
Reflector Housing	12.2 cm (dia)
Handle	10.8 cm (long)
I/O Ports	TTL (Sync input and output) - 3.5mm phone jacks
Cables	CBL102 and CBL106
Interface	UIM100C—see page I104 STM100C—see page I116

Catalog No.	\$	Model	Product
BS4 72-7328		TSD122A	Stroboscope, 120/60Hz
BS4 72-7329		TSD122B	Stroboscope, 240/50Hz

Precision Fixed Range Force Transducers



The TSD125 series force transducers interface with the DA100C general-purpose transducer amplifier. The TSD125 series have been designed for in-vitro tissue bath studies, in-vivo force measurements and other applications where low noise, accuracy and repeatability are critical. The most sensitive units are ideal for use with small preparations such as aortic rings. The TSD125 series utilizes a precision strain gauge element, which has superb low noise characteristics and excellent linearity. The transducers come with a versatile mounting rod assembly to support a variety of orientations. When fine tension and position adjustments are required, clamp the mounting rod to an HDW100A (see right).

Specifications

Full Scale Output	1mV/V (normalized to 1V excitation)	
Range	TSD125C	50 gram
	TSD125D	100 gram
	TSD125E	200 gram
	TSD125F	500 gram
Noise (rms)	TSD125C	1mg
[10 volts Excitation]	TSD125D	2mg
[1 Hz Bandwidth]	TSD125E	4mg
	TSD125F	10mg
Nonlinearity	<±0.025% FSR	
Hysteresis	<±0.05% FSR	
Nonrepeatability	<±0.05% FSR	
30 Minute Creep	<±0.05% FSR	
Temperature Range	-10°C to 70°C	
Thermal Zero Shift	<±0.03% FSR/°C	
Thermal Range Shift	<0.03% Reading/°C	
Maximum Excitation	10 VDC	
Mounting Rod	9.5 mm (dia) – variable orientation	
Weight	250 g	
Dimensions (L x W x H)	100 x 19 x 25 mm	
Cable Length	3 m	
Interface	DA100C—see page I106	

Catalog No.	\$	Model	Product
BS4 72-7330		TSD125C	Precision Fixed Range Force Transducer, 50 gram
BS4 72-7331		TSD125D	Precision Fixed Range Force Transducer, 100 gram
BS4 72-7332		TSD125E	Precision Fixed Range Force Transducer, 200 gram
BS4 72-7333		TSD125F	Precision Fixed Range Force Transducer, 500 gram

NEW Force Transducer Tension Adjuster



The HDW100A tension adjuster operates with the TSD105A and TSD125 series force transducers. The rugged design and stability of the mounting allow for fine position control. The position adjuster is located on the top for easy access and smooth operation. Vertical scales are provided for both metric and English units. The HDW100A slides directly onto vertical rod laboratory stands and force transducers are clamped into the unit horizontally.

Specifications

Travel Range:	25 mm
Resolution	0.0025 mm per degree rotation
Stand Clamp	13.25 mm ID
Transducer Clamp	11 mm ID
Weight	140 g
Dimensions (H x T x D)	93 x 19 x 74 mm

Catalog No.	\$	Model	Product
BS4 72-7334		HDW100A	Force Transducer Tension Adjuster

See the Variable Range TSD105A Force Transducer on page I121.

Data Acquisition Systems - Biopac

NEW Pneumotach Air Flow Transducer (Low Flow)



The TSD127 can perform a variety of pulmonary measurements relating to air flow, lung volume and expired gas analysis. The transducer includes a detachable flow head (RX127) for easy cleaning and sterilization. The TSD127 is intended for animal use and consists of a low flow, pneumotach air flow head (RX127) coupled to a precision, highly sensitive, differential pressure transducer (TSD160A). The TSD127 will connect directly to a breathing circuit or plethysmogram chamber.

- For air flow and lung volume measurements, connect a short air flow cannula to the TSD127.
- For measurements of expired gases, use the TSD127 with the AFT22 non-rebreathing valve.

All connections can be performed with AFT11 series couplers (see page I142).

Replacement Air Flow Head for the TSD127

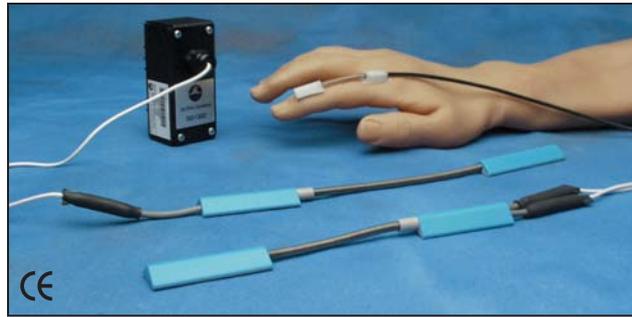
The RX127 is the replacement low air flow head for the TSD127 pneumotach transducer. Multiple RX127 heads help eliminate equipment downtime during cleaning procedures. (11mm ID/15mm OD).

Specifications

Range	± 90 L/min
Nominal Output	500 µV/[liters/sec] (normalized to 1V excitation)
Dead Space	11 cc
MRI Compatible	Yes (no metal parts) – air flow head
Weight	11 g – air flow head
Dimensions	5.7 cm (long) – air flow head
Ports	15 mm OD / 11 mm ID
Tubing Length	1.8 m (to DA100C)
Interface	DA100C—see page I106

Catalog No.	\$	Model	Product
BS4 72-3709		TSD127	Pneumotach Air Flow Transducer (Low Flow)
BS4 72-3710		RX127	Replacement Air Flow Head

Goniometers



The TSD130 series goniometers measure limb angular movement. Goniometers attach to the body using TAPE2 medical adhesive tape. The units have a telescopic endblock that compensates for changes in distance between the two mounting points as the limb moves. The gauge mechanism allows for accurate measurement of polycentric joints. A DA100C is required for each output channel; accordingly, the twin-axis goniometers require two DA100C amplifiers to measure both axes simultaneously.

- The TSD130A and TSD130B are dual output devices used for simultaneous measurements around two orthogonal rotational axes (e.g., wrist flexion/extension and radial/ulnar deviations).
- The TSD130C and TSD130D are single output devices used to measure axial rotation about a single plane (e.g., forearm pronation/supination).
- The TSD130E (single-axis goniometer) is used to measure finger joint movement.

TSD130 Specifications

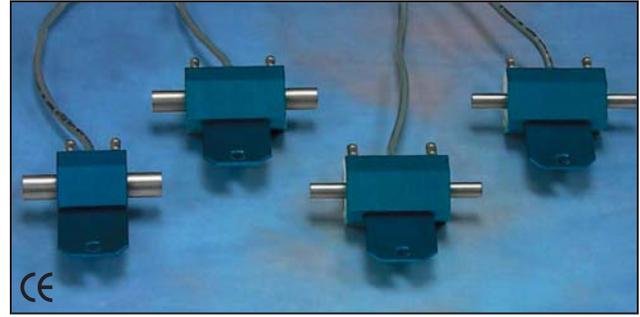
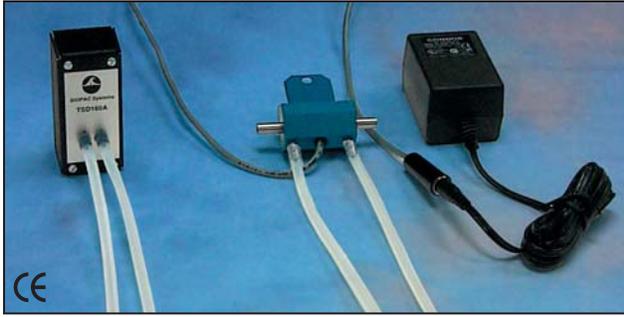
Model	Type	Channels	Max Length	Min Length	Range	Weight
TSD130A	Goniometer	2	110mm	75mm	± 180°	17g
TSD130B	Goniometer	2	180mm	130mm	± 180°	19g
TSD130C	Torsiometer	1	110mm	75mm	± 90°	17g
TSD130D	Torsiometer	1	180mm	130mm	± 90°	19g
TSD130E	Goniometer	1	35mm	30mm	± 180°	8g

Specifications

Nominal Output	5 µV/degree (normalized to 1 V excitation)
Cable Length	3 m
Interface	DA100C—see page I106
TEL100C	
Compatibility	SS20 thru SS24—see page I119

Catalog No.	\$	Model	Product
BS4 72-7335		TSD130A	Goniometer
BS4 72-7336		TSD130B	Goniometer
BS4 72-7337		TSD130C	Torsiometer
BS4 72-7338		TSD130D	Torsiometer
BS4 72-7339		TSD130E	Goniometer

NEW Pneumotach Air Flow Transducers (Very Low Flow)



The TSD137 series pneumotachs can perform a variety of small animal pulmonary measurements relating to air flow, lung volume and expired gas analysis. Each TSD137 transducer type consists of a low flow, pneumotach head coupled to a precision, highly sensitive, differential pressure transducer. The TSD137 series pneumotachs will connect directly to a breathing circuit or plethysmogram chamber. For air flow and lung volume measurements, connect a short air flow cannula to the TSD137 series flow head. For switchable or replacement head options, see the RX137 Series below. All of the TSD137 series pneumotachs come equipped with an internal heating element that can be optionally attached to the AC137A 6-volt power supply (see page I146).

Replacement Air Flow Heads for the TSD137 Series Pneumotachs

The RX137 series are low air flow heads for the TSD137 series pneumotach transducers. The RX137 heads can be mixed and matched with any of the TSD137 series pneumotachs. A wide range in flows can be accommodated by switching one head for another when using a single TSD137 pneumotach. RX137 heads connect to the TSD160A differential pressure transducer via standard 4mm ID tubing. Multiple RX137 heads help eliminate equipment downtime during cleaning procedures.

Catalog No.	\$	Model	Product
BS4 72-7340		TSD137A	Pneumotach Air Flow Transducer (Very Low Flow)
BS4 72-7341		TSD137B	Pneumotach Air Flow Transducer (Very Low Flow)
BS4 72-7342		TSD137C	Pneumotach Air Flow Transducer (Very Low Flow)
BS4 72-7343		TSD137D	Pneumotach Air Flow Transducer (Very Low Flow)
BS4 72-7344		TSD137E	Pneumotach Air Flow Transducer (Very Low Flow)
BS4 72-7345		RX137A	Replacement Air Flow Head
BS4 72-7346		RX137B	Replacement Air Flow Head
BS4 72-7347		RX137C	Replacement Air Flow Head
BS4 72-7348		RX137D	Replacement Air Flow Head
BS4 72-7349		RX137E	Replacement Air Flow Head

Pneumotach Air Flow Transducer (Very Low Flow) Specifications

Pneumotach	Range (ml/sec)	Dead Space (cc)	Output ($\mu\text{V}/[\text{ml}/\text{sec}]$)	Flow Ports (OD-mm)	Animal (size)	Animal (weight)
TSD137A	± 12	0.1	25.700	7	Small Mouse	30.0 grams
TSD137B	± 20	0.8	15.400	7	Mouse	50.0 grams
TSD137C	± 60	0.9	5.780	7	Rat/Guinea Pig	350.0 grams
TSD137D	± 150	2.0	2.100	10	Cat/Rabbit	750.0 grams
TSD137E	± 350	4.0	0.924	11	Small Dog	5.5 kg

Specifications

TSD137 Series

Nominal Output	Normalized to 1 V excitation
Tubing Length	1.8 m (to TSD160A)
Interface	DA100C—see page I106

Replacement Air Flow Heads Specifications

Head	Range (ml/sec)	Dead Space (cc)	Length (mm)	Flow Ports ID	Flow Ports OD (mm)	Weight (grams)
RX137A	± 12	0.1	75	1.35	7	100
RX137B	± 20	0.8	75	6.00	7	90
RX137C	± 60	0.9	75	6.00	7	90
RX137D	± 150	2.0	75	9.00	10	100
RX137E	± 350	4.0	60	10.00	11	60

Laser Doppler Flow Probes

The following probes interface to the LDF100C laser Doppler flow module. Interface: LDF100C—see page I112



Surface Probes

The TSD140 series surface probes are designed for skin and exposed tissue blood flow monitoring. All surface probes are made from black Delrin®. The signal delivery fiber intersects the probe body at a right angle, making the probes easy to secure to the skin or tissue surface. Surface probes are non-suturable, unless otherwise indicated. All surface probes are MRI compatible (no metal parts) and come with a 2-meter cable for connection to the LDF100C module.

TSD140

This robust and easy to handle probe is ideal for taking measurements of cutaneous blood flow anywhere on the skin surface.

TSD141

This thin and lightweight surface probe applies negligible pressure to the underlying tissue. The probe's low profile geometry has particular applications in chronic wound healing studies where it can be applied under compression bandages.

TSD142

This probe was specially developed for measuring micro-vascular skin blood flow in the digits; the curved geometry of these probes makes them ideal for studying conditions such as Raynaud's disease.

TSD143

This suturable probe is particularly suitable for small animal work including various post-operative monitoring applications such as reconstructive surgery. A non-suturable version, TSD146, is also available.

TSD146

This miniature, lightweight surface probe is particularly useful for small animal work and general tissue surface monitoring.



Needle Probes

The TSD140 series needle probes are designed for invasive and endoscopic blood flow monitoring of tissue. The signal delivery fiber terminates straight into the top of the needle, making the probes easy to insert into tissue. All needle probes are MRI compatible (made from medical grade stainless steel – no ferrous parts) and come with a 2-meter cable for connection to the LDF100C module.

TSD144

This needle probe is used when making microvascular blood flow measurements in relatively inaccessible areas with limited clearance. Typically, they are positioned using a micromanipulator clamp over soft tissues such as brain and muscle.

TSD145

This micro-needle probe has been developed for direct insertion and is frequently used for measuring either micro-vessel or micro-vascular blood flow within skin, muscle, tumor and organ tissues. The fine diameters of these probes facilitate blood flow measurements from only a small number of capillaries.

Specifications

Surface Probes

Probe Body Dimensions (H x D):

TSD140	8 x 17 mm
TSD141	6 x 17 mm
TSD142	10 x 17 mm
TSD143	5 x 10 mm
TSD146	5 x 5 mm

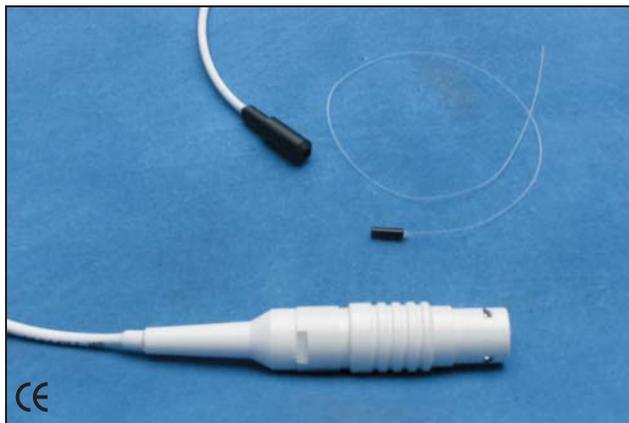
Needle Probes

Probe Body Dimensions (H x D):

TSD144	25 x 1 mm
TSD145	25 mm x 1 µm

Catalog No.	\$	Model	Product
Surface Probes			
BS4 72-3700		TSD140	Surface Probe
BS4 72-3726		TSD141	Surface Probe
BS4 72-3701		TSD142	Surface Probe
BS4 72-3699		TSD143	Surface Probe
BS4 72-3711		TSD146	Surface Probe
Needle Probes			
BS4 72-3703		TSD144	Needle Probe
BS4 72-3702		TSD145	Needle Probe

NEW Disposable Fiber Probes



The TSD140 series disposable single fiber probes are designed for safe, continuous, invasive microvascular blood flow monitoring. The probes are thin flexible plastic fibers composed of a polymethyl methacrylate core and a tough fluorinated polymer cladding. All disposable probes are MRI compatible (no metal parts) and incorporate a coupling bead to interface with the TSD148 single fiber driver for connection to the LDF100C module.

TSD147A- Insertable Single Fiber Probe

This 0.5mm diameter disposable, insertable, single fiber probe comes in two standard lengths (TSD147A - 30cm, TSD147AL - 100cm) and is supplied in a pack of two. (TSD147A is pre-sterilized.) Particularly useful for making blood flow measurements under the skin, this single fiber probe can be directly inserted into tissue using a standard 22G ID cannula. Longer probe lengths are available upon request. Shorter lengths are possible by cutting the fiber with a sharp blade at a right angle to the fiber length.

Requires the TSD148 Single Fiber Driver for operation with the LDF100C.

TSD147B- Surface Single Fiber Probe

This 0.5mm diameter disposable, surface mounted, single fiber probe has a standard length of 33cm and is supplied ready-to-use in a pre-sterilized pack. The TSD147B was primarily developed for making measurements of cortical blood flow on the surface of the brain during surgery. The probe consists of a single fiber bonded for right-angle delivery through a flexible PharmElast™ strip.

Requires the TSD148 Single Fiber Driver for operation with the LDF100C.

TSD148- Single Fiber Driver

The TSD148 is a precision-machined coupling system for interfacing the TSD147 series single fiber probes to the LDF100C. The TSD148 consists of a compact laser driver housed in a non-metallic Delrin® housing (MRI compatible), terminated with a 2-meter cable for connection to the LDF100C module.

Specifications

TSD147A

Probe Body
Dimensions (L x D) 30 cm x 0.5 mm
Tissue Mounting Inserted via 22G ID Cannula

TSD147AL

Probe Body
Dimensions (L x D) 100 cm x 0.5 mm
Tissue Mounting Inserted via 22G ID Cannula

TSD147B

Probe Body
Dimensions (L x D) 33 cm x 0.5 mm
Skin and Tissue Mounting Yes (attach via PharmElast™ strip)

TSD148

Fiber Driver
Dimensions (L x D) 28 cm x 8 mm
Connection Type In-line single fiber connector
Cable Length 2 m

Catalog No.	\$	Model	Product
BS4 72-7350		TSD147A	Insertable Single Fiber Probe, pkg. of 2
BS4 72-7351		TSD147AL	Insertable Single Fiber Probe, pkg. of 2
BS4 72-3713		TSD147B	Surface Single Fiber Probe, pkg. of 1
BS4 72-3714		TSD148	Single Fiber Driver

PROBE CALIBRATION

If probes are shipped with the LDF100C, they are factory-calibrated to the module (except Disposable probes). Otherwise, probes are shipped uncalibrated and must be calibrated with an LDF100C module using the LDFCAL motility standard (see page I140).

Active Electrodes



The TSD150 series active electrodes are designed for multiple-channel surface EMG measurements. The units incorporate a built-in high-gain amplifier with an integral 500 Hz lowpass filter. The unique design allows you to easily convert the surface contact electrodes to wire needle electrodes for intricate sub-dermal procedures. The TSD150 series active electrodes connect directly to the MP System via the HLT100C high-level transducer module. The TSD150 series are very easy to use—locate the position and hold in place with TAPE1 surgical tape. A single ground lead (CBL201 and LEAD110A with EL503 electrode) to the UIM100C is required when using one or more TSD150 series active electrodes.

Specifications

Gain	350 (nominal)	Weight	9.5 g
Fine Wire Attachments	Screw Springs	Dimensions (W x L x H)	17.4 x 51 x 6.4 mm
Input Impedance	100 MΩ	Cable Length:	3 m
CMRR	95 dB (nominal)	Interface:	HLT100C—see page 1105
Bandwidth	12 Hz – 500 Hz		
Electrode Diameter	11.4 mm		

Catalog No.	\$	Model	Product
BS4 72-7352		TSD150A	Wide electrode placement (35mm apart)
BS4 72-7353		TSD150B	Narrow electrode placement (20mm apart)

NEW Multi-lead ECG Cable



The TSD155C multi-lead ECG cable is used for performing a standard 12-lead ECG recording using only 3 ECG100C amplifiers. The TSD155C permits simultaneous recording of Leads I, II, III, aVR, aVL,

aVF and one (movable) precordial lead [V1, V2, V3, V4, V5 or V6]. The TSD155C is 3-meters long and incorporates a built-in Wilson Terminal. For full simultaneous 12-lead ECG, see the WT100C Wilson Terminal on page I139.

Specifications

Interface	ECG100C (see page I108)
TEL100C Compatibility	SS29 (see page I119)

Catalog No.	\$	Model	Product
BS4 72-7354		TSD155C	Multi-Lead ECG Cable

NEW High Sensitivity Differential Pressure Transducers



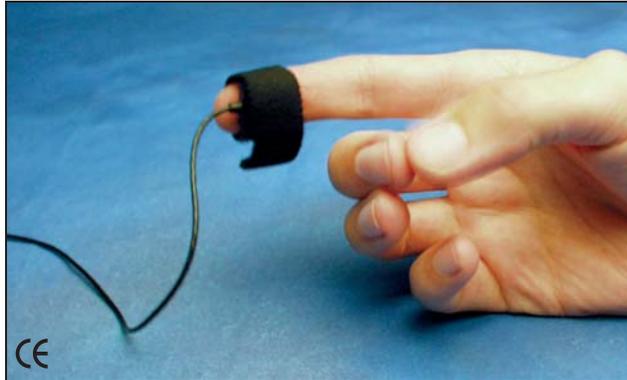
The TSD160 series differential pressure transducers are designed for low range pressure monitoring. The transducers plug directly into the DA100C general-purpose differential amplifier. The differential pressure ports are located on the front of the transducers and are easily connected to breathing circuits, pneumotachs or plethysmograph boxes. These transducers are very useful for interfacing a variety of small animal pneumotachs or plethysmographs to the MP System. The transducers are extremely sensitive and come in three ranges to suit a number of different applications. RX137 flow heads (see page I129) connect to the TSD160A differential pressure transducer via standard 4mm ID tubing.

Specifications

	TSD160A	TSD160B	TSD160C
Operational Pressure	±2.5 cm H ₂ O	±12.5 cm H ₂ O	±25 cm H ₂ O
Overpressure (max)	±250 cm H ₂ O	±375 cm H ₂ O	±375 cm H ₂ O
Voltage Output (normalized to 1 volt excitation)	330 μV/cm H ₂ O	130 μV/cm H ₂ O	65 μV/cm H ₂ O
Warm-up Drift	±50 μV		
Stability	±100 μV		
Combined Linearity and Hysteresis Error	±0.05%		
Dynamic Response	100 Hz		
Connection Ports:	Accepts 3 mm to 4.5 mm ID tubing		
Dimensions (H x W x D)	8.3 x 3.8 x 3.2 cm		
Weight	76 g		
Operating Temperature	0 to +50 °C (compensated)		
Storage Temperature	-40 to +125 °C		
Interface	DA100C—see page I106		

Catalog No.	\$	Model	Product
BS4 72-3706		TSD160A	High Sensitivity Differential Pressure Transducer (±2.5cm H ₂ O)
BS4 72-3707		TSD160B	High Sensitivity Differential Pressure Transducer (±12.5cm H ₂ O)
BS4 72-3708		TSD160C	High Sensitivity Differential Pressure Transducer (±25cm H ₂ O)

Photo-Electric Pulse Plethysmogram Transducer



This transducer operates with the PPG100C amplifier to record the pulse pressure waveform. The TSD200 consists of a matched infrared emitter and photo diode, which transmits changes in infrared reflectance resulting from varying blood flow. The ergonomic housing design improves contact with the subject and helps reduce motion artifact. The TSD200 is primarily designed for finger attachment, but can be taped to other body locations. The TSD200 comes with a shielded 3-meter cable.

Specifications

Emitter/Detector Wavelength	860 nm ± 60 nm
Optical Lowpass Filter	800 nm
Weight	4.5 g
Dimensions (L x W x H)	16 x 17 x 8 mm
Attachment	Velcro® strap
MRI Compatible	Yes (no ferrous parts)
Sterilizable	Yes (see BIOPAC for details)
Nominal Output	20 mV (p-p)
Power	6 VDC Excitation @ 5 mA
Cable Length	3 m (shielded)
Interface	PPG100C—see page 58
TEL100C compatibility	SS4—see page I119

Catalog No.	\$	Model	Product
BS4 60-1045		TSD200	Photo-Electric Pulse Plethysmogram Transducer

Respiratory Effort Transducer



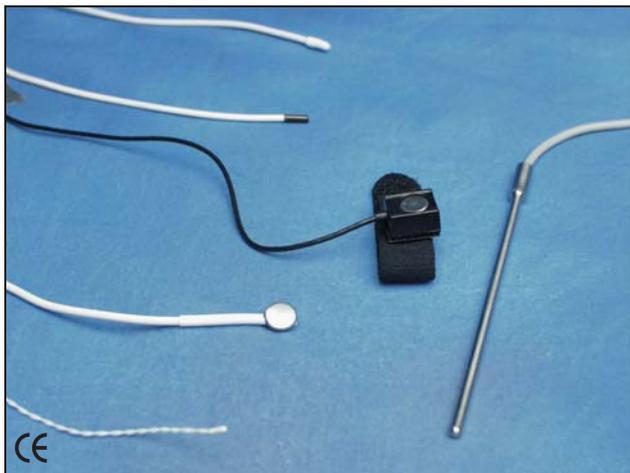
The TSD201 connects to the RSP100C Respiration Amplifier to record respiratory effort. The transducer measures the changes in thoracic or abdominal circumference that occur as the subject breathes. The design presents minimal resistance to movement and is extremely unobtrusive. Due to its novel construction, the TSD201 can measure arbitrarily slow to very fast respiration patterns with no loss in signal amplitude, while maintaining excellent linearity and minimal hysteresis. The transducer comes with a shielded 3-meter cable and an adjustable Velcro® strap to fit a wide range of subjects.

Specifications

True DC Response	Yes
Circumference Range	15 cm x 150 cm (increased with a longer strap)
Sensor Dimensions (L x W x T)	66 x 40 x 15 mm
Sensor Weight	18 g
Attachment	Velcro® strap (adjustable length)
MRI compatible	Yes (no ferrous parts)
Sterilizable	Yes (contact BIOPAC for details)
Variable Resistance Output	5-125 KΩ
Cable Length	3 m (shielded)
Interface	RSP100C—see page I111
TEL100C compatibility	SS5B—see page I119

Catalog No.	\$	Model	Product
BS4 72-3967		TSD201	Respiratory Effort Transducer

Temperature Transducers



Fast Response Probe

The TSD202A is a very small, fast response temperature probe appropriate for use in locations where temperature changes rapidly, as with the temperature changes of inspired/expired breath. TAPE1 is recommended to secure the TSD202A in place.

- **Response time** 0.6 sec
- **Dimensions (D x L)** 1.7 x 5 mm

Surface Banjo Probe

The TSD202B is used to record skin temperature on a variety of body locations. The stainless steel banjo design insures rapid and uniform recording of skin surface temperatures. Use TAPE1 to secure the transducer to the skin surface.

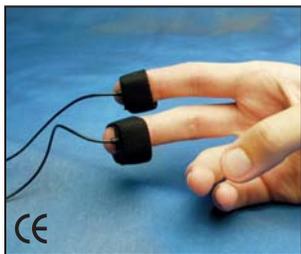
- **Response time** 1.1 sec
- **Dimensions (D x H)** 9.8 x 3.3 mm

Liquid Immersion Probe

The TSD202C is a stainless steel, extremely durable, tubular probe designed for dry or wet bath temperature measurements.

- **Response time** 3.6 sec
- **Dimensions (D x L)** 4 x 115 mm

Electrodermal Response Transducer



The TSD203 connects to the GSR100C amplifier for the purpose of skin conductance recording. Two Ag-AgCl, unpolarizable electrodes are mounted in individual, ergonomically-designed, polyurethane housings for improved contact. The electrodes are attached to the

fingers by Velcro® straps. The electrodes have a 6mm (dia) contact area with a 1.6mm cavity to accommodate electrode gel (GEL101). The TSD203 comes with a shielded 3-meter cable to minimize noise interference and improve recordings.

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Digit Surface Probe

The TSD202D records skin temperature of the fingers or toes. The probe contains a surface temperature sensing element encased in a polyurethane housing that conforms to curved skin surfaces and includes a stretchy Velcro® strap for easy attachment.

- **Response time** 1.1 sec
- **Dimensions (L x H x W)** 16 x 8 x 17 mm

NEW General-purpose Probe

The TSD202E is a small, general-purpose probe, encased in a mylar sheath for ruggedness and durability without sacrificing response time.

- **Response time** 0.9 sec
- **Dimensions (L x D)** 9.8 x 3.3 mm

NEW Waterproof Vinyl Probe

The TSD202F is a small, waterproof, vinyl encased probe for core (oral, rectal) temperature recording.

- **Response time** 1.1 sec
- **Dimensions (L x D)** 9.8 x 3.3 mm

Specifications

Nominal Resistance	2252 Ω @ 25°C
Maximum Operating Temperature	60°C (when used with STK100C)
Accuracy and Interchangeability	±0.2°C
MRI Compatible	Yes (no ferrous parts)
Cable Length	3 m
Transducer Compatibility	YSI® 400 series temperature probes
Sterilizable	YES (contact BIOPAC for details)
Interface	SKT100C—see page I111
TEL100C Compatibility	SS6 (Fast Response) and SS7 (Banjo)—see page I119

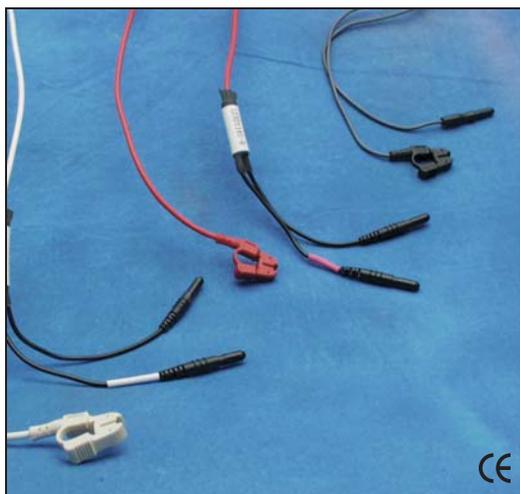
Catalog No.	\$	Model	Product
BS4 72-5306		TSD202A	Fast Response Probe
BS4 72-5307		TSD202B	Surface Banjo Probe
BS4 72-7355		TSD202C	Liquid Immersion Probe
BS4 72-5309		TSD202D	Digit Surface Probe
BS4 72-7356		TSD202E	General-purpose Probe
BS4 72-5311		TSD202F	Waterproof Vinyl Probe

Specifications

Electrode Type	Ag-AgCl (unpolarizable)
Contact Area	6 mm (dia)
Dimensions (L x W x H)	16 x 17 x 8 mm (each electrode)
Weight	4.5 g (each electrode)
Attachment	Integral Velcro® straps
MRI Compatible	Yes (no ferrous parts)
Sterilizable	Yes (contact BIOPAC for details)
Cable Length	3 m (shielded)
Interface	GSR100C—see page I110
TEL100C Compatibility	SS3A—see page I119

Catalog No.	\$	Model	Product
BS4 72-5312		TSD203	Electrodermal Response Transducer

Electrode Leads



These electrode leads are used with the EL500 series disposable snap electrodes. The LEAD110 series electrode leads have no ferrous parts. The leads include a pinch connector for easy application and terminate in standard Touchproof connectors for interfacing to 100C-series Biopotential amplifiers or Module Extension Cables (see page I139).

Use shielded leads with recording electrodes for minimal noise interference. The unshielded leads work best with ground or reference electrodes. Generally, for each Biopotential amplifier module, one each of LEAD110S-W, LEAD110S-R and LEAD110 are required.

Catalog No.	\$	Model	Product
BS4 72-3736		LEAD110	Unshielded, 1 m lead, black
BS4 72-7357		LEAD110A	Unshielded, 3 m lead, black
BS4 72-3737		LEAD110S-W	Shielded, 1 m lead, white
BS4 72-3738		LEAD110S-R	Shielded, 1 m lead, red

Disposable Ag-AgCl Snap Electrodes



These snap electrodes provide the same signal transmission as reusable electrodes, with added convenience and hygiene. Each peel-and-stick electrode is pre-gelled and designed for one use only. Use disposable snap electrodes with the LEAD110 series electrode leads (shown above). For best performance, use the LEAD110S shielded leads for your recording electrodes and the LEAD110 unshielded lead for your ground or reference electrodes.

Paired (Dual) Electrodes

These fixed spacing, paired electrodes are primarily used for peripheral stimulation and recording for nerve conduction measurements. These paired electrodes are also useful for cardiac output, electrical bioimpedance and general-purpose EMG measurements. The pre-gelled electrode pairs are placed 41mm apart (center to center) on 41mm x 82mm x 1.5mm thick foam.

Small Stress Test Electrodes

These flexible, foam-backed, strong-adhesive electrodes are most appropriate for short-term recording applications where the subject may be in motion. The 38mm diameter allows closely placed electrodes which may be necessary for multi-channel ECG, EGG, EMG or EOG recordings. Electrodes are pre-gelled and mounted on 1.5mm thick foam.

Long-term Recording Electrodes

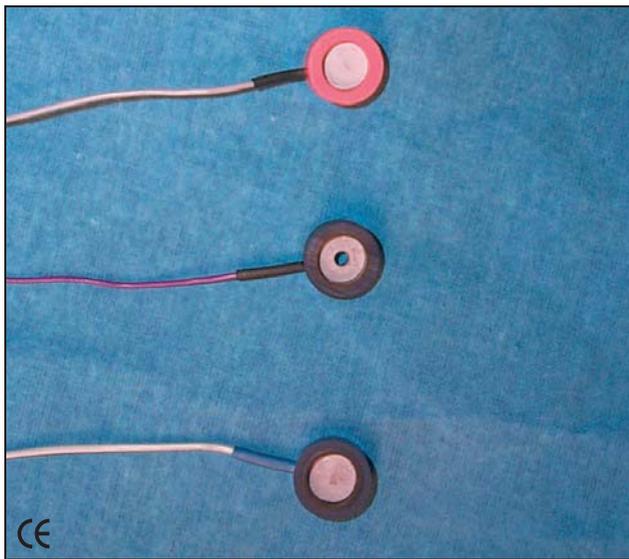
Most appropriate for long-term biopotential measurement recording sessions, these pre-gelled electrodes incorporate a small (41mm) diameter backing that resists moisture. The electrodes include an adhesive solid gel that adheres well to the skin but leaves no residue when removed.

General-purpose Electrodes

These economical, pre-gelled electrodes are most suitable for short-term recordings. The small (35mm) diameter backing allows close electrode placement where necessary, and a slightly less firm adhesive allows "ouchless" removal. The electrodes incorporate liquid gel and are high chloride for quick, accurate readings.

Catalog No.	\$	Model	Product
BS4 60-3791		EL500	Paired Electrodes, pkg. of 25 pairs
BS4 60-3792		EL501	Small Stress Test Electrodes, pkg. of 50
BS4 60-3793		EL502	Long-term Recording Electrodes, pkg. of 50
BS4 60-1192		EL503	General-purpose Electrodes, pkg. of 100
BS4 72-7358		EL503-10	General-purpose Electrodes, pkg. of 1000

Reusable Ag-AgCl Electrodes



Silver-silver chloride (Ag-AgCl) electrodes provide accurate and clear transmission of surface biopotentials. Reusable electrodes are permanently connected to robust and pliable lead wires (1mm OD). The lead wires terminate in standard Touchproof connectors for interfacing to 100C-series Biopotential modules or Module Extension Cables. Unshielded electrodes terminate in a single Touchproof connector. Shielded electrodes terminate in two Touchproof connectors, one connects to the Ag-AgCl disk and the other connects to the lead wire shield.

For best signal performance use shielded electrodes (EL254S or EL258S) as recording electrodes and unshielded electrodes (EL254 or EL258) as ground or reference electrodes. For ease of gel injection, use the EL258H for both recording and reference electrodes (useful for EEG monitoring). When recording from subjects in MRI or X-ray based environments use the EL254RT or EL258RT for the recording and reference electrodes. These electrodes are non-ferrous and employ carbon fiber lead wire for superior radio-translucent performance.

All reusable electrodes require ADD200 series adhesive collars and recording gel (see page I138). Generally, for each Biopotential amplifier module, two EL254S or EL258S and one EL254 or EL258 are required. For radio-translucent requirements, use three of the EL254RT or EL258RT with each Biopotential module.

Small Reusable Ag-AgCl Electrodes

Use these lead electrodes when closely spaced biopotentials are required. The EL254 is unshielded and the EL254S is shielded. The EL254RT is a radio-translucent version of the EL254. Fill the electrode cavity with GEL100 and use ADD204 adhesive collars to secure these electrodes to the skin surface.

General-purpose Reusable Ag-AgCl Electrodes

These lead electrodes are suitable for most applications (ECG, EEG, EGG, EMG, EOG and ERS recordings). The EL258 is unshielded and the EL258S is shielded. The EL258H is a low-profile version of the EL258 and includes a 2mm center hole for injecting gel after the electrode is attached to the subject. The EL258RT is a radio-translucent version of the EL258. Fill the electrode cavity with GEL100 and use ADD208 adhesive collars to secure these electrodes to the skin surface.

Specifications

EL254 – Unshielded

Dimensions (Outer D x Recording D x H) 7.2 x 4 x 6 mm
Lead Length 1 m

EL254S – Shielded

Dimensions (Outer D x Recording D x H) 7.2 x 4 x 6 mm
Lead Length 1 m

NEW EL254RT – Unshielded, Radio-translucent

Dimensions (Outer D x Recording D x H) 7.2 x 4 x 6 mm
Lead Length 1.5 m

EL258 – Unshielded

Dimensions (Outer D x Recording D x H) 12.5 x 8 x 6 mm
Lead Length 1 m

EL258S – Shielded

Dimensions (Outer D x Recording D x H) 12.5 x 8 x 6 mm
Lead Length 1 m

NEW EL258H – Unshielded, Low-profile

Dimensions (Outer D x Recording D x H) 12.5 x 8 x 6 mm
Lead Length 4 m

NEW EL258RT – Unshielded, Radio-translucent

Dimensions (Outer D x Recording D x H) 12.5 x 8 x 4 mm
Lead Length 1 m

Catalog No.	\$	Model	Product
BS4 72-3749		EL254	Small Reusable Ag-AgCl Electrode
BS4 72-3750		EL254S	Small Reusable Ag-AgCl Electrode
BS4 72-7359		EL254RT	Small Reusable Ag-AgCl Electrode
BS4 72-5313		EL258	General-purpose Reusable Ag-AgCl Electrode
BS4 72-5314		EL258S	General-purpose Reusable Ag-AgCl Electrode
BS4 72-7360		EL258H	General-purpose Reusable Ag-AgCl Electrode
BS4 72-7361		EL258RT	General-purpose Reusable Ag-AgCl Electrode

Extend your electrode leads by 3-meters with the MEC100 Series, see page I139.

Use RT (radio-translucent) electrodes for MRI applications.

Use H (hole) electrodes to syringe electrode gel into the electrode cavity after placement.

EEG Electrode Cap



For reduced set up time and increased subject comfort, use the CAP100C when recording multiple EEG channels. The Lycra® stretch cap holds nineteen imbedded tin electrodes closely to the subject's head. Electrodes are pre-positioned in the international 10/20 montage, so even novice EEG researchers can minimize electrode placement errors. A ribbon cable (100 cm) fans out in the cap to connect to each electrode. The other end of the ribbon cable has a connector that plugs into a mating cable (25 cm) which terminates in 19 Touchproof sockets. The connector arrangement permits the electrode cap to be easily disconnected from the recording amplifiers, allowing the cap to be fitted in one location and used in another. When the electrode cap is in place, EEG recording gel is injected into each electrode (via a central gel access hole) with a blunt-tipped syringe.

When using the CAP100C, up to 16 channels of EEG data can be acquired by the MP System, when outfitted with 16 EEG100C amplifiers. Various configurations of unipolar and bipolar setups can be achieved by using JUMP100C jumper connectors with the EEG100C amplifiers.

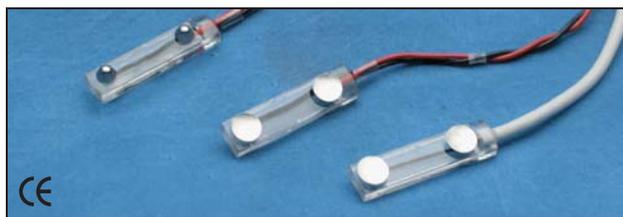
The CAP100C includes a medium cap, two earclip reference electrodes, mating ribbon cable with Touchproof connectors, blunt-tipped syringe, EEG recording gel, chest harness (to hold cap in place), and liquid soap (to wash cap after use).

Additional Electrode Caps are available in four sizes:

- Infant** 45-50 cm
- Small** 50-54 cm
- Medium** 54-58 cm (general size, fits most people from age 5 to adult)
- Large** 58-62 cm

Catalog No.	\$	Model	Product
BS4 60-3790		CAP100C	EEG Electrode Cap Kit (Kit includes MEDIUM cap)
BS4 72-3692		CAP-INFANT	EEG Electrode Cap, infant, cap only
BS4 72-3693		CAP-SMALL	EEG Electrode Cap, small, cap only
BS4 72-7333		CAP-MEDIUM	EEG Electrode Cap, medium, cap only
BS4 72-3694		CAP-LARGE	EEG Electrode Cap, large, cap only

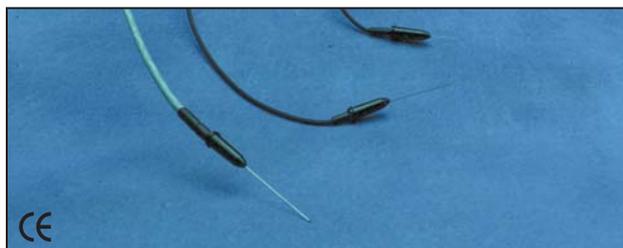
Bar Electrodes



All bar electrodes are non-ferrous and consist of two tin electrodes placed 30mm apart in a watertight acrylic bar. The bar configuration permits easy electrode placement without disturbing electrode to electrode spacing. Bar electrodes are recommended for use when applying a stimulus, or recording a signal, during nerve conduction, somatosensory or muscle twitch recordings. When using bar electrodes for signal recording, a single ground lead (LEAD110 with EL503) is required. The leads (61cm long) terminate in standard Touchproof connectors, which connect to any 100C-series Biopotential amplifier or stimulus isolation adapter (STMISOC/D/E).

Catalog No.	\$	Model	Product
BS4 72-7362		EL350	Bar lead electrode (concave), use for stimulating or recording
BS4 72-7363		EL350S	Shielded bar lead electrode (concave), use for recording
BS4 72-7364		EL351	Bar lead electrode (convex), use for stimulating

Needle Electrodes



Use needle electrodes for stimulation or recording in animal subjects and tissue preparations. These non-ferrous, 28-gauge stainless steel, needle electrodes are equipped with a flexible lead terminating in standard Touchproof connectors. Use one EL451 electrode, plus one EL452 ground electrode, when recording from a single site (e.g. studies of individual muscle fibers). Use a pair of EL450 or EL452 electrodes, plus one EL452 ground electrode, for general-purpose recording (e.g. ECG). For stimulation, use a pair of EL450 or EL452 electrodes. Teflon® coated needle electrodes are fully insulated, with a clear Teflon® overcoat, except for the conductive needle tip. Needle electrodes are shipped non-sterile, so pre-sterilization is required.

Catalog No.	\$	Model	Product
BS4 72-3740		EL450	Unipolar Needle, 300µm (dia), 2.5cm (long), Teflon® coated, 61cm lead
BS4 72-3741		EL451	Concentric Bipolar Needle, 460µm (dia), 3.7cm (long), Teflon® coated, 61cm lead
BS4 72-3742		EL452	Unipolar Needle, 300µm (dia), 1.5cm (long), uncoated, 61cm lead

Electrode Accessories



Electrode Site Preparation Pad

To remove non-conductive skin cells and sensitize skin for optimal contact during recording, this 2.5cm x 5cm abrasive pad can be rubbed lightly across the skin before applying an electrode. Each ELPAD package contains 10 abrasive pads.

Electrode Gel

GEL100 non-irritating gel is used as a conductant with the EL250 series reusable electrodes. Each tube contains 8 ounces of gel.

NEW GEL101 non-irritating, isotonic, gel is primarily used as a conductant for the TSD203 electrodermal response transducers (page I134).

Adhesive Collars

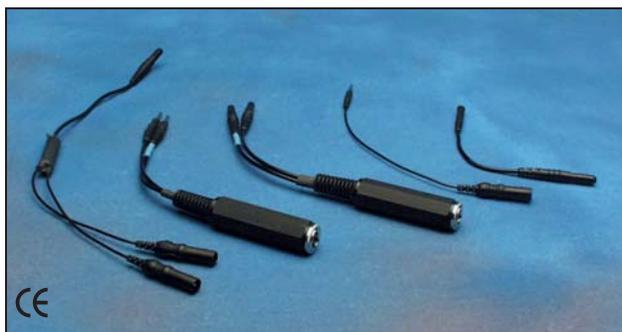
These double-sided adhesive collars are used to hold the EL250 series reusable electrodes firmly on the skin surface. Use the ADD204 (19mm OD, 4mm ID) with the EL254, EL254S and EL254RT electrodes; use the ADD208 (22mm OD, 8mm ID) with the EL258, EL258S, EL258H and EL258RT electrodes.

Tape Series

Adhesive tape for attaching transducers or electrodes to the skin surface. Use TAPE1 (single sided tape) for securing Active Electrodes or other devices and use TAPE2 (double-sided tape) for attaching Goniometers to the skin surface.

Catalog No.	\$	Model	Product
BS4 60-1191		ELPAD	Electrode Site Preparation Pad, pkg. of 10
BS4 72-7365		GEL101	Electrode Gel, 4 ounces
BS4 60-1060		ADD204	Adhesive Collars, pkg. of 100
BS4 60-1061		ADD208	Adhesive Collars, pkg. of 100
BS4 60-1261		TAPE1	Tape Series, single-sided
BS4 72-7366		TAPE2	Tape Series, double-sided

Lead Connector Conversion Cables



CBL200

This extension (10cm) is required when converting an old-style 2mm pin electrode or transducer lead to a Touchproof socket (1.5mm ID) for connection to any of the 100C-series Biopotential or Transducer amplifier modules. Use one CBL200 per Touchproof socket. To connect a Touchproof electrode or transducer to an older 100B-series module with 2mm input sockets, use the CBL201.

CBL201

Required when converting a Touchproof (1.5mm ID) socket electrode or transducer lead to an old-style 2mm pin, for connection to any of the 100B-series Biopotential or Transducer amplifier modules. Also used to connect a ground electrode lead (e.g. LEAD110A) to the UIM100C module (required when using the TSD150 active electrodes). One CBL201 (10cm long) is required for each Touchproof socket.

CBL202

This is a multi-purpose adapter to connect a phone cable to the digital I/O lines on the UIM100C or to the input of the DA100C. Also connects the STM100C to nerve conduction chambers (CBL105 required). The CBL202 is 10cm long and consists of a 6.3mm (1/4") phone socket leading to a pair of 2mm plugs.

CBL203

The CBL203 is primarily designed to connect YSI® 400 series biomedical temperature probes to the SKT100C temperature amplifier, but it can also be used to connect certain 6.3mm (1/4") mono phone plug terminated cables or transducers to the 100C-series Transducer or Biopotential amplifiers. The CBL203 is 10cm long and consists of a 6.3mm (1/4") phone socket leading to a pair of Touchproof sockets.

CBL204

This Touchproof "Y" electrode lead adapter (25cm long) is required when multiple electrode sites are to be connected to a single amplifier input or stimulator output. The CBL204 plugs into any 100C-series Biopotential amplifier input or STMISO series output and provides two plugs to connect to electrode leads terminating in Touchproof sockets. Multiple CBL204s can be plugged together to reference 3 or more electrode leads to the same input or output.

Catalog No.	\$	Model	Product
BS4 72-5300		CBL200	Lead Connector Conversion Cable
BS4 72-5301		CBL201	Lead Connector Conversion Cable
BS4 72-5302		CBL202	Lead Connector Conversion Cable
BS4 72-3744		CBL203	Lead Connector Conversion Cable
BS4 72-5304		CBL204	Lead Connector Conversion Cable

Module Extension Cables



These module extension cables are used to increase the distance between subject and recording system, allowing increased subject movement and comfort. Each extension cable attaches to one amplifier; electrodes and transducers plug into the extension cable's molded plastic input plug. The 3-meter long extension includes a clip for attaching to a subject's belt loop or clothing. The MEC series extension cables contain no ferrous parts (less the removable clothing clip). The MEC100C is designed for Transducer amplifiers. The MEC110C and MEC111C are designed for Biopotential amplifiers. Use the MEC100C or MEC110C when you simply need to increase the lead length to the amplifier. The MEC111C is required for the protection of your MP System and Biopotential amplifiers when electrocautery or defibrillation equipment is used while recording data.

Catalog No.	\$	Model	Product
100C-Series Extensions			
BS4 72-7367		MEC100C	100C-series Transducer amplifiers to Touchproof inputs
BS4 72-7368		MEC110C	100C-series Biopotential amplifiers to Touchproof inputs
BS4 72-7369		MEC111C	100C-series Biopotential amplifiers to Touchproof inputs— Protected
Other Extensions			
BS4 60-1167		MEC100	DA100C or 100B-series Biopotential or Transducer amplifiers to 2mm socket inputs
BS4 72-7370		MEC110	100B-series Biopotential or Transducer amplifiers to Touchproof inputs
BS4 72-7371		MEC111	100B-series Biopotential amplifiers to Touchproof inputs—Protected

NEW Wilson Terminal



The WT100C is used to create a virtual reference electrode when measuring the transverse plane (i.e. precordial) ECG components [V1, V2, V3, V4, V5, and V6]. The virtual reference is created by the summation of the Right Arm (RA), Left Arm (LA) and Left Leg (LL) electrode leads. To measure all six transverse plane components, six ECG100C amplifiers are required. Use five of the JUMP100C jumper connectors to tie together the reference (Vin-) inputs of these amplifiers. This common reference connects to the virtual reference created by the WT100C.

For full, simultaneous, 12-lead ECG recording, a total of 8 ECG100C amplifiers are required. Two of the ECG100C are used to generate Leads I, II, III, aVR, aVL and aVF, while the remaining six ECG100C are used to generate the six precordial leads.

For an economical alternative, use the TSD155C moveable chest lead (page 80). The TSD155C requires three ECG100C amplifiers and incorporates a built-in Wilson Terminal.

Catalog No.	\$	Model	Product
BS4 72-7372		WT100C	Wilson Terminal

Jumper Connectors



These jumper connectors (10 cm long) are used to create a common reference between Biopotential amplifier modules. Link one reference electrode to multiple amplifier inputs using one jumper connector per amplifier. Jumper connectors are required when connecting the same reference electrode lead to two or more amplifiers, as in multi-lead ECG or unipolar EEG measurements.

Catalog No.	\$	Model	Product
BS4 72-3697		JUMP100	For all connections between 100B-series Biopotential amplifiers)
BS4 72-5305		JUMP100C	For all connections between 100C-series Biopotential amplifiers)

Analog Connection Cables



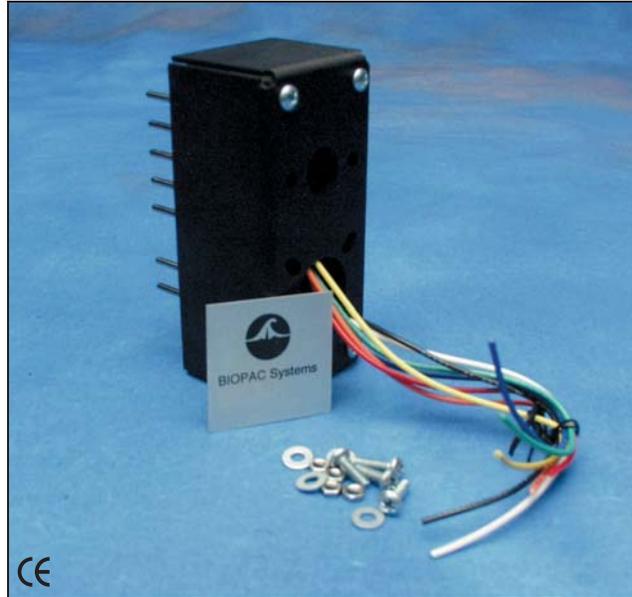
These cables connect stand-alone laboratory equipment to an MP System. Analog outputs from chart recorders, preamplifiers, oscilloscopes, force plates, chromatographs, etc. can be connected to the UIM100C module. It's also possible to use these cables to connect amplifier outputs or D/A outputs to external equipment inputs. When signal isolation is required, use the INISO or OUTISO adapter with the cable. The other end of the isolation adapter connects to the appropriate MP System channel via the HLT100C module. Select the cable number with the plug corresponding to your equipment's output or input jack. Use one cable per recording channel.

The CBL106 is a multi-purpose adapter used in conjunction with the CBL102 to connect a BNC cable to the digital I/O lines on the UIM100C or to the input of the DA100C. It also connects the STM100C to nerve conduction chambers (CBL102 required).

Catalog No.	\$	Model	Product
BS4 60-1053		CBL100	2m, 3.5mm phone plug to same
BS4 60-3801		CBL101	2m, 3.5mm phone plug to male RCA
BS4 60-3822		CBL102	2m, 3.5mm phone plug to male BNC
BS4 60-3803		CBL105	2m, 3.5mm phone plug to 6.3mm (1/4 in) phone plug
BS4 72-3696		CBL106	10cm, female BNC connector to a pair of 2mm plugs (requires CBL102)
BS4 60-3800		CBL107	10m, 3.5mm phone plug to same
BS4 72-7373		CBL108	60m, 3.5mm phone plug to same

NEW

Connector Kit for MCE100C Micro-electrode Amplifier



Build your own customized adapter to a micro-electrode shielded cable. Cable shields can be tied to a voltage follower drive or simply grounded. Input capacity compensation and clamp current options can be independently added to or removed from your cable configuration. The MCEKITC comes with seven attached Touchproof sockets and instructions; mount your interface connector to the housing and solder wires to the sockets. See the MCE100C on page I139.

Catalog No.	\$	Model	Product
BS4 72-7374		MCEKITC	Connector Kit for MCE100C Micro-electrode Amplifier

Calibration Standard for LDF100C

The LDFCAL is a specially prepared colloidal solution of suspended latex spheres undergoing Brownian motion. The LDFCAL provides a standard calibration value of 1000 BPU $\pm 5\%$ @ 21°C. Probes are calibrated to a specific LDF100C module by placing the probe in the LDFCAL solution and pressing the CAL button on the LDF100C front panel. A small clamp is provided with the LDFCAL to hold probes securely in the solution. The LDFCAL has a limited lifetime, so it's best to order it only when required. See the LDF100C on page I112.

Catalog No.	\$	Model	Product
BS4 72-7375		LDFCAL	Calibration Standard for LDF100C

Air Flow & Gas Analysis Accessories



AFT1 Disposable Bacterial Filter (22mm)

These filters remove airborne bacteria. For use with the TSD117 and other 22mm breathing circuits. One side has a 22mm ID port, the other side has a 22mm OD, 15mm ID port.

AFT2 Disposable Mouthpiece

These mouthpieces connect to the TSD117 and other 22mm breathing circuits. Connects directly to the AFT1 bacterial filter, AFT22 non-rebreathing T valve (via AFT11C) and the TSD117 air flow transducer. (22mm OD)

AFT3 Disposable Noseclip

These noseclips gently squeeze the nostrils shut to remove errors when using mouth-breathing circuits.

AFT4 Disposable Bacterial Filter (35mm)

These filters remove airborne bacteria. For use with the TSD107B and other 35mm breathing circuits. One side has a 35mm ID port, the other side has a 35mm OD port.

AFT6 Calibration Syringe

Medium pump syringe used for injecting a precise volume of air (600ml) through the TSD107B, TSD117 and TSD127 air flow transducers for precise calibration. The AFT6 comes equipped with a 22mm OD, 15mm ID coupler for direct connection to the TSD117 and TSD127. To calibrate the TSD107B, the AFT11E coupler and AFT7 tubing are required.

AFT7 Smooth Bore Tubing (35mm)

For use in TSD107B and other 35mm breathing circuits. (1 meter length, 35mm ID, 38mm OD)

AFT8 Autoclavable Mouthpiece

This autoclavable mouthpiece connects directly to the TSD117 air flow transducer and reduces the cost of disposable parts. (30mm ID)

AFT9 Reusable Mouthpiece

These mouthpieces connect to the TSD107B and other 35mm breathing circuits. Connects directly to the AFT4 bacterial filter or the AFT21 non-rebreathing T valve. (35mm ID)

NEW AFT10 Disposable Adult Facemasks

This facemask connects to 22mm breathing circuits. Connects directly to the AFT1, AFT22 non-rebreathing T valve or TSD117 air flow transducer (via AFT11B coupler). Includes hook-ring to secure AFT10S adjustable head strap. (22mm ID/25mm OD).

NEW AFT10S Adjustable Head Strap

This fully adjustable latex head strap holds the AFT10 disposable facemask securely to the subject's head. Use one or more straps to securely fasten the mask.

AFT12 Tubing (22mm)

For use in 22mm breathing circuits. (1.8 meter length, 22mm ID, 25mm OD)

Catalog No.	\$	Model	Product
BS4 60-1193		AFT1	Disposable Bacterial Filter (22m), pkg. of 10
BS4 72-7376		AFT1-250	Disposable Bacterial Filter (22m), pkg. of 250
BS4 60-1268		AFT2	Disposable Mouthpiece, pkg. of 10
BS4 72-7377		AFT2-250	Disposable Mouthpiece, pkg. of 250
BS4 60-1269		AFT3	Disposable Noseclip, pkg. of 10
BS4 72-7378		AFT3-250	Disposable Noseclip, pkg. of 250
BS4 72-7379		AFT4	Disposable Bacterial Filter (35mm), pkg. of 10
BS4 72-7380		AFT6	Calibration Syringe
BS4 72-7381		AFT7	Smooth Bore Tubing (35mm)
BS4 72-7382		AFT8	Autoclavable Mouthpiece
BS4 72-7383		AFT8-10	Autoclavable Mouthpiece, pkg. of 10
BS4 72-7384		AFT9	Reusable Mouthpiece
BS4 72-7385		AFT9-10	Reusable Mouthpiece, pkg. of 10
BS4 72-7386		AFT10	Disposable Adult Facemasks
BS4 72-7387		AFT10S	Adjustable Head Strap, pkg. of 30
BS4 72-7388		AFT12	Tubing (22mm)

Data Acquisition Systems - Biopac

NEW Mixing Chambers



AFT15A (5 Liter)

The AFT15A is designed for demanding expired gas analysis measurements (e.g. VO₂ or RER measurements). The AFT15A incorporates dual baffles and flexible connection ports capable of interfacing with 35mm or 22mm breathing circuits. Two female Luer connection ports are provided between the baffles for simultaneous monitoring of O₂ and CO₂ concentrations.

AFT15B (8 Liter)

The AFT15B is designed for very high volume and rate expired gas analysis measurements (e.g. VO₂ or RER measurements). The AFT15B incorporates dual baffles and flexible connection ports capable of interfacing with 35mm or 22mm breathing circuits. Two female Luer connection ports are provided between the baffles for simultaneous monitoring of O₂ and CO₂ concentrations.

Specifications

AFT15A

Dimensions (D X L) 13 x 47 cm
Coupling Ports 35 mm OD, 25 mm ID

AFT15B

Dimensions (D X L) 13 x 73 cm
Coupling Ports 35 mm OD, 25 mm ID

Catalog No.	\$	Model	Product
BS4 72-7389		AFT15A	Mixing Chamber, 5 liter
BS4 72-7390		AFT15B	Mixing Chamber, 8 liter

NEW AFT11 Series Couplers



These couplers are very useful for connecting a variety of air flow port IDs and ODs to transducers, tubing and calibration syringes.

AFT11 Series Coupler Guide

Pick the AFT11 Series coupler that matches the port sizes you want to interface.

Item 1		Item 2		BIOPAC Coupler
15 mm	OD	22 mm	ID	AFT11B
20 mm	OD	22 mm	ID	AFT11B
22 mm	ID	15 mm	OD	AFT11B
		20 mm	OD	AFT11B
		22 mm	ID	AFT11B
22 mm	OD	22 mm	OD	AFT11C
		25 mm	ID	AFT11C
22-25 mm	OD	22-25 mm	OD	AFT11E
		35-38 mm	ID	AFT11E
25 mm	ID	25 mm	ID	AFT11C
25-30 mm	OD	25-30 mm	OD	AFT11A
		28-35 mm	ID	AFT11A
28-35 mm	ID	25-30 mm	OD	AFT11A
		35 mm	ID	AFT11A
35 mm	ID	28-35 mm	ID	AFT11A
		38 mm	ID	AFT11E
35-38 mm	ID	22-25 mm	OD	AFT11E
35-38 mm	OD	35-38 mm	OD	AFT11D

Catalog No.	\$	Model	Product
BS4 72-7391		AFT11A	Flexible Coupler
BS4 72-7392		AFT11B	Rigid Coupler
BS4 72-7393		AFT11C	Rigid Coupler
BS4 72-7394		AFT11D	Flexible Coupler
BS4 72-7395		AFT11E	Flexible Coupler

Gas Sampling Interface Kit



For connecting the CO2100C or O2100C module with a variety of air flow breathing circuits. Use with the AFT25 facemask, AFT15A or AFT15B mixing chambers and AFT21 or AFT22 non-rebreathing T valves. Use one AFT20 kit for each gas analysis module connected.

Includes:

- 1.8 meters of 1.5mm diameter polyethylene tubing with M/F Luer connector
- 30cm Nafion® water vapor permeable tubing with M/F Luer connector
- 5 micron filter with M/F Luer connector
- M/F Luer to female Luer "Y" connector

Catalog No.	\$	Model	Product
BS4 72-3690		AFT20	Gas Sampling Interface Kit

Non-Rebreathing T Valves

AFT21 (35mm)

This non-rebreathing T valve is a high performance, very low dead space, low air flow resistance valve; suitable for high air flow applications (e.g. exercise physiology). The AFT21 incorporates a gas sampling port (female Luer) for interfacing with the AFT20 gas sampling kit. For breathing directly into the valve, use the AFT9 mouthpiece, AFT3 noseclip and (optionally) the AFT24 head support. All ports are 35mm OD, 30mm ID.

AFT22 (22mm)

This non-rebreathing T valve is a very low dead space valve; suitable for low to medium air flow applications. The AFT22 incorporates a gas sampling port (male Luer) for interfacing with the AFT20 gas sampling kit. For breathing directly into the valve, use the AFT2 mouthpiece (via AFT11C coupler) with the AFT3 noseclip or use the AFT10 facemask. All ports are 22mm OD. The common port also incorporates a 15mm ID port connection.

Catalog No.	\$	Model	Product
BS4 72-7396		AFT21	Non-Rebreathing T Valves, 35 mm
BS4 72-7397		AFT22	Non-Rebreathing T Valves, 22 mm

NEW AFT24 Head Support



The AFT24 head support is useful when breathing directly into the AFT21 non-rebreathing T valve for exercise physiology measurements. The AFT21 is secured directly in front of the subject and minimizes the strain associated with the weight of valves and tubing.

Catalog No.	\$	Model	Product
BS4 72-7398		AFT24	Head Support

NEW AFT25 Facemask with Valve



This adult facemask with integral non-rebreathing T valve is a high performance, very low dead space, low air flow resistance mask and valve; suitable for high air flow applications (e.g. exercise physiology). The AFT25 incorporates two gas sampling ports (female Luer) for interfacing with the AFT20 gas sampling kit. All ports are 35mm OD, 28mm ID.

Catalog No.	\$	Model	Product
BS4 72-7399		AFT25	Facemask with Valve

Data Acquisition Systems - Biopac

Change to Macintosh



PLAT100M1

MP100 Platform change from Macintosh (Serial) or PC (Windows) to Macintosh (USB). Includes:

- USB1M
- CBLSERA
- ACKv3.7 for Macintosh

PLAT150M

MP150 Platform change from PC (Windows) to Macintosh. Includes:

- ACKv3.7 for Macintosh

Catalog No.	\$	Model	Product
BS4 72-7400		PLAT100M1	MP100 Platform change from Macintosh (Serial) or PC (Windows) to Macintosh (USB)
BS4 72-7401		PLAT150M	MP150 Platform change from PC (Windows) to Macintosh.

Change to PC USB—Windows



PLAT100W1

MP100 Platform change from Macintosh or PC (ISA/PCMCIA—Windows) to PC (USB—Windows). Includes:

- USB1W
- CBLSERA
- ACKv3.7 for PC (Windows)

PLAT150W

MP150 Platform change from Macintosh to PC (Windows). Includes:

- ACKv3.7 for PC (Windows)

Catalog No.	\$	Model	Product
BS4 72-7402		PLAT100W1	MP100 Platform change from Macintosh or PC (ISA/PCMCIA—Windows) to PC (USB—Windows)
BS4 72-7403		PLAT150W	MP150 Platform change from Macintosh to PC (Windows)

Computer Interface Cables



CBLSERA

One CBLSERA cable comes with each MP100 System. Connects the MP100 to your MAC or PC via the USB1M or USB1W. The CBLSERA is 2.5 meters long.

CBLEXT

Use this 3.6 meter extension cable to increase the distance between the MP100 System and your computer. The CBLEXT is used to extend the length of CBLSERA (use only one CBLEXT per MP100 System).

NEW CBLETH1

Two CBLETH1 cables come with each MP150 system. The cables connect between the ETHSW1 switch and the MP150 and the computer. Each CBLETH1 is 2 meters long.

Catalog No.	\$	Model	Product
BS4 72-7404		CBLSERA	Computer Interface Cable
BS4 72-7405		CBLEXT	Computer Interface Cable
BS4 72-7406		CBLETH1	Computer Interface Cable

NEW Interface Options



Move your MP System between PC and Macintosh with a platform change. All BIOPAC amplifiers will work with both PC and Macintosh systems. Amplifier modules are optimized for specific signals, and will work with an MP100 or an MP150.

Ethernet Switch

The ETHSW1 is an Ethernet switch included with the MP150 system. The ETHSW1 is required when a computer has a network connection operating simultaneously with operation of an MP150 system. The ETHSW1 is an intelligent switch that eliminates external packet transfers not directed at the MP150 or the computer to provide optimal data acquisition performance. Setup is very simple, just connect your computer, MP150 system and network to the ETHSW1 and the ETHSW1 automatically directs the packets. Specify USA or EURO power cord.

USB1M

One USB1M USB adapter comes with each MP100 System for the Macintosh. Use the USB1M to connect the MP100 unit (via CBLSERA) to the USB port on your computer. The USB1M comes with an integral USB cable.

USB1W

One USB1W USB adapter comes with each MP100 System for the PC running Windows. Use the USB1W to connect the MP100 unit (via CBLSERA) to the USB port on your computer. The USB1W comes with an integral USB cable. The USB1W is compatible with Windows 98, 98SE and 2000.

Catalog No.	\$	Model	Product
BS4 72-7407		ETHSW1	Ethernet Switch
BS4 72-7408		USB1M	USB adapter for Macintosh
BS4 72-7409		USB1W	USB adapter for Windows

Data Acquisition Systems - Biopac

In-Line Power Transformers

All AC series in-line power transformers are CE marked for the EC Low Voltage Directive and EMC Directive. All transformers have UL and TUV approval. The units have standard IEC power input plugs and operate over mains power ratings of 100-240 VAC, 50-60Hz.

AC100A

This in-line switching transformer (+12 volt, 1 amp) connects the MP100 System, IPS100C, CO2100C or O2100C to the AC mains wall outlet. One transformer is included with each MP100 Starter System, IPS100C, CO2100C or O2100C module.

Specify USA or EURO power cord.

AC101A

This in-line switching transformer (± 12 volt, +5 volt, 1 amp) connects the LDF100C to the AC mains wall outlet. One transformer is included with each LDF100C module.

Specify USA or EURO power cord.

AC137A

This in-line switching transformer (+6 volt, 1.5 amp) powers the heating element for any of the TSD137 series pneumotachs.

Specify USA or EURO power cord.

AC150A

This in-line switching transformer (+12 volt, 2.5 amp) connects the MP150 system to the AC mains wall outlet. One transformer is included with each MP150 Starter system.

Specify USA or EURO power cord.

Catalog No.	\$	Model	Product
BS4 72-7410		AC100A	In-line switching transformer, +12 volt, 1 amp
BS4 72-7411		AC101A	In-line switching transformer, +12 volt, +5 volt, 1 amp
BS4 72-7412		AC137A	In-line switching transformer, +6 volt, 1.5 amp
BS4 72-7413		AC150A	In-line switching transformer, +12 volt, 2.5 amp

Battery Pack/Recharger Unit



For portability, use this rechargeable battery pack and charger with your MP System. The maintenance-free battery pack is built into a carrying case with a shoulder strap. The fully charged battery will operate an MP System for a minimum of 16 hours. The BAT100 includes battery pack, universal recharger and all necessary cables.

Specify USA or EURO power cord.

Specifications

Battery Pack

Output Capacity	12 V @ 13 amp-hours
Operating Time	MP100 with 4 modules: 26 hours nominal MP150 with 4 modules: 16 hours nominal
Charge Time	15 hrs
Recharge Cycles	500 (typical)
Weight	5.6 kg
Dimensions (H x W x D)	22 x 8 x 24 cm
Temperature Range	Operation: -60° to 60°C Recharge: -20° to 50°C

Recharger

Output	12 V @ 1.0 amps
Input	120/240 VAC @ 50/60 Hz
Weight	1.8 kg
Dimensions (H x W x L)	8 x 13 x 15 cm

Catalog No.	\$	Model	Product
BS4 72-7414		BAT100	Battery Pack/Recharger Unit

See the Isolated Power Supply IPS100 on page I104.

Universal Kymographs



BS4 50-7368 Harvard Apparatus
Universal Kymograph
with Integral Stimulator

Universal Kymograph Assembly

This Assembly includes the Universal Kymograph with Stimulator plus a comprehensive set of accessories with a 165 page Applications Manual with detailed instructions for over 30 experiments. Some of the possible experiments include:

Frog Heart In Situ Preparation:

- Recording of cardiac activity
- Effect of stimulation of the heart (refractory period compensatory pause)
- Demonstration of conduction path (stimulus ligatures)
- Effects of stimulating the vagus nerve (cardiac inhibition)
- Effect of drugs

Muscle-Nerve Preparation:

- Effect of stimulating voltage (simple muscle twitch)
- Effect of stimulation frequency (tetanus)
- Staircase phenomenon (Treppe)
- Effect of repeated stimulation (fatigue)
- Effects of drugs on muscles
- Effect of pre- and after-loading on muscle efficiency

For locust work, a special cork mounting block is supplied, which wedges vertically in the muscle chamber. The accessories for the Kymograph are listed on the following pages.

Catalog No.	\$	Product
BS4 50-7384		Universal Kymograph Assembly, 115 VAC, 60 Hz
BS4 50-7392		Universal Kymograph Assembly, 230 VAC, 50 Hz

Universal Kymograph with Stimulator

The Kymograph is the same as described above. The built-in square wave stimulator has a maximum output of 25 volts with less than 25 Ω impedance. The frequency range is continuously variable from 0 to 100 Hz. There are six preset pulse widths. The output has three selections: continuous, single pulse by push button, and external trigger via the contact arms on the Kymograph spindle. All the controls are located on the front panel.

Specifications

Kymograph	Same as Universal Kymograph
Stimulator Specifications:	
Output Voltage	0 to 25 V, continuously variable in 3 ranges, 0 to 250 mV, 0 to 2.5 V and 0 to 25 V
Sockets	2 x 4 mm sockets
Impedance	< 25 Ω at max. output current of 250 mA
Pulse Width	6 preset widths of 0.05, 0.1, 0.5, 1.2 and 5 ms
Frequency	0.1 to 100 Hz continuously variable in 3 ranges, 0.1 to 1.0 Hz, 1 to 10 Hz and 10 to 100 Hz
Mode Selection	Continuous, single and trigger via contact arms on spindle
Cylinders	Not included, see next page
Base Dimensions	460 x 230 x 220 mm (18.1 x 9 x 8.7 in), H x W x D
Weight	7.5 kg (16.5 lb)

Catalog No.	\$	Product
BS4 50-7368		Universal Kymograph with Stimulator, 115 VAC, 60 Hz
BS4 50-7376		Universal Kymograph with Stimulator, 230 VAC, 50 Hz

Universal Kymograph

- Two fully adjustable support arms each with a 9.5 mm OD upright rod for mounting accessories
- Adjustable, double contact arms are fitted to the spindle base for external trigger applications (e.g. stimulators)

The Universal Kymograph has a spindle 320 x 19 mm OD (12-1/2 x 3/4 in OD) for mounting a cylinder (not included). The speed range, dependent on circumference of cylinder chosen, is infinitely variable by use of two controls. A manually operated stop is provided to allow the spindle to revolve either continuously or for a single

revolution. The Kymograph is supplied without cylinder or stimulator.

Specifications

Speed Range	Infinitely variable from 0.006 to 625 mm/sec with 500 mm circumference cylinder; 0.012 to 1250 mm/sec with 1000 mm circumference cylinder, cylinder not supplied
Spindle Rotation	Either continuous or single revolution using manual start/stop control
Contact Arms	Two fully variable 'opto-triggering' producing a short circuit across 'contract' sockets
Writing Medium	Smoke or ink, dependent on recording cylinder chosen
Cylinders	Not included, see next page
Base Dimensions, H x W x D	460 x 230 x 220 mm (18.1 x 9 x 8.7 in)
Weight	7 kg (15.4 lb)

Catalog No.	\$	Product
BS4 50-7343		Universal Kymograph, 115 VAC, 60 Hz
BS4 50-7350		Kymograph, 230 VAC, 50 Hz

Kymograph Accessories



Kerosene Smoking Burner

This Smoking Burner provides a dense black smoke for even distribution on the Kymograph Cylinder. This Smoking Burner has a reservoir that holds 100 ml of kerosene or other hydrocarbon. The heavy wick is 3 mm (1/8 in) thick, 125 mm (5 in) long and 75 mm (3 in) wide. The burner has a heavy, positive acting wick adjustment knob. Replacement wicks can be cut from standard heater wicks. This must be used in a fume cupboard. Not for use with plastic cylinders.

Catalog No.	\$	Product
BS4 50-5768		Kerosene Smoking Burner

Kymograph Cylinders

These Kymograph Cylinders are for use with the 19 mm (3/4 in) diameter spindles of the Harvard Apparatus Universal Kymographs. Each Cylinder has 2 mounting plates for fitting it concentrically onto the Kymograph spindle. A lockable split ring fixes the Cylinder to the spindle at the desired height. Four different Cylinders are available. Plastic Cylinders are for ink writing only. Metal Cylinders are for ink or smoke writing.

Catalog No.	\$	Material	Circumference	Height
BS4 50-5560		Plastic	500 mm (19.7 in)	200 mm (7.9 in)
BS4 50-5511		Metal	500 mm (19.7 in)	150 mm (5.9 in)

Printed Kymograph Paper Sheets

This high quality Kymograph Paper has a special glaze for ink recording. Each Sheet has an additional 15 mm wide strip that is gummed for mounting the Sheet onto a 500 mm (19.7 in) circumference Kymograph Cylinder. Each vertical ruling represents 1/100 second when the Kymograph speed is set at 5, i.e. 625 mm per second, which is the appropriate speed to record a simple muscle twitch. Available in two heights for 500 mm (19.7 in) circumference Kymograph Cylinders only. Supplied in a package of 100 sheets. There are no Printed Sheets for the 1000 mm (39.4 in) circumference Cylinders. For paper, see Unprinted Kymograph Paper Sheets to the right.

Catalog No.	\$	Circumference	Paper Height
BS4 50-5396		500 mm (19.7 in)	150 mm (5.9 in)
BS4 50-5362		500 mm (19.7 in)	200 mm (7.9 in)

- Available for ink or smoke record

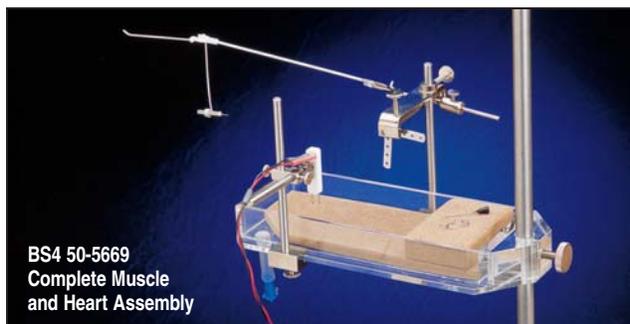
Unprinted Kymograph Paper Sheets

This high quality plain Paper is specially glazed for either ink recording or smoke recording. Each Sheet has an additional 15 mm wide strip that is gummed for mounting the Sheet on the Kymograph Cylinder. Supplied in a package of 100 sheets.

Unprinted Kymograph Paper Sheets

Kymograph Cylinder, Circumference x H	For Ink Recording	\$	For Smoke Recording	\$
500 x 150 mm	BS4 50-5578		BS4 50-5685	
1000 x 150 mm	BS4 50-5594		BS4 50-5701	
1000 x 300 mm	BS4 50-5602			

Kymograph Accessories



BS4 50-5669
Complete Muscle
and Heart Assembly

Muscle and Heart Bath

- Available as bath only or as complete assembly with electrode and lever

The Complete Assembly mounts on the upright of the Harvard Apparatus Universal Kymograph, and permits a wide range of experiments with muscle-nerves and frog hearts. The apparatus is made up of three parts: the bath, the electrode and the lever and pen assembly.

Bath

This clear plastic Bath has internal dimensions of 55 x 150 x 90 mm (2-1/8 x 6 x 3/4 in). At one end of the bath is a solid mounting block with a hole and locking screw for securing the bath to a Kymograph upright. A metal spring extends from the bath to the upright for grounding. Muscle preparations can be secured to the base of the bath by passing a pin through the muscle and into the hole situated at one end of the bath. The larger of two flat cork plates supplied can lay in the bottom of the bath and has a hole to allow a pin to be located easily. The smaller piece of flat cork fits vertically into one end of the bath and is used for the locust tibia extensor (levator) muscle preparation. The bottom of the bath has a mounting ledge along the length of each side, providing mounting locations for the electrode and recording lever. The bath has a drain hold, tubing and plug.

Electrode

The Electrode has its own upright and clamp for mounting to one ledge of the bath giving total freedom of placement. It has two fixed J-shaped stainless steel wires for stimulation and two leads for connection to a stimulator.

Lever and Pen Assembly

The Lever and Pen Assembly has its own upright and clamp allowing vertical adjustment and lateral positioning at any point along the ledge of the bath. The assembly has an L-shaped lever to one side and a pen arm with counter-balance weight to the other. The lever and pen arm is pivoted with needle bearings in a mounting bracket so that the lever is positioned in the center of the bath. Each leg of the L-lever has four holes at 5 mm centers for attaching preparations by thread. One leg is horizontal and the other vertical. A thumb screw can be adjusted to limit the downward movement of the lever. Ink or smoke writing can be achieved with the pen arm. The complete assembly is supplied with: Bath, Lever Assembly and Pen, two cork plates, heart clip, fixing pin and drain plug. The Bath Only is supplied with: Bath, two cork plates, fixing pin and drain plug.

Catalog No.	\$	Product
BS4 50-5669		Complete Muscle and Heart Bath
BS4 50-5677		Muscle and Heart Bath Only



BS4 50-3573
Myograph Board with
Lever Assembly

Myograph Board

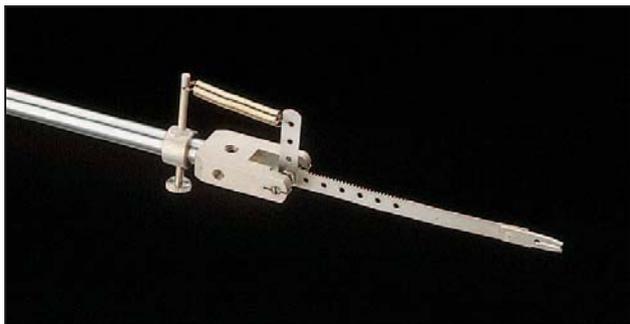
- Available with or without crank lever assembly

The Myograph Board has a 6 mm thick cork plate cemented to an acrylic bloc measuring 87 x 139 mm (3.4 x 5.5 in). At one end and one side there are 9.5 mm mounting clamps with locking screws for securing the board to a kymograph upright or suitable stand. At the other end there is a fork fitting for the crank lever. The crank lever has a threaded shank flattened on two sides that slide into the fork fitting and is secured by two knurled thumb nuts. The nut can move along the entire length of the shaft giving 38.1 mm (1.5 in) vertical adjustment. The L-shaped lever extends 72 mm (2.83 in) horizontally from the fulcrum and 20 mm (0.78 in) vertically. The horizontal arm has 8 holes and the vertical arm 3 holes for tying thread. A thumb screw can be adjusted to limit the downward movement of the lever. The board without the lever only has one mounting clip.

Catalog No.	\$	Product
BS4 50-3573		Myograph Board with Lever
BS4 50-3565		Board Only

Kymographs & Accessories

Kymograph Accessories



Brodie Universal Heart Lever

The head of this Lever is drilled and tapped so that it can be mounted on the stem in any of four ways. The horizontal bar is pierced with 6 holes on 5 mm (1/5 in) pitch from the fulcrum point. The spring tension can be adjusted by moving the anchor arm backward and forward on the Lever stem. The 6.5 mm (1/4 in) diameter stem is 12.5 cm (5 in) long. Supplied with a BS4 50-0686 Ink Pen, see page I152.

Catalog No.	\$	Product
BS4 50-0678		Brodie Universal Heart Lever



BS4 50-6766
Pendulum Auxotonic Lever

Pendulum Auxotonic Lever

The Pendulum Auxotonic Lever is mainly for study of the extensibility of tissue under the action of drugs. This Lever is supplied with one pair each of 5, 10, and 20 gram weights. As the preparation moves, these weights move in relation to the fulcrum and exert varying pressure on the preparation. Two lever arms are supplied, both pierced and notched. Frontal Writing Point, BS4 50-6451 (supplied) is attached to one lever arm to hold a BS4 50-7681 Ink Pen (not supplied). The lever frame is drilled with four holes that accept the stem permitting four different mounting positions. The mounting stem is 6.5 mm (1/4 in) OD x 12.5 cm (5 in).

Catalog No.	\$	Product
BS4 50-6766		Pendulum Auxotonic Lever



BS4 50-6550
Gimbal Lever with
Ink Pen and Reservoir

Gimbal Lever

- Available with or without ink pen with reservoir

This Gimbal Lever has a fulcrum frame that can be mounted on the stem in either of two directions. The stem is 6.5 mm OD x 125 mm

(1/4 x 5 in). The fulcrum frame carries a 73 mm (2-7/8 in) lever pierced with 4 holes in front of the fulcrum and 6 holes behind the fulcrum.

This Lever is available separately for smoke writing or with a BS4 50-3524 Ink Pen with Reservoir. The 2 ml ink reservoir is attached to the mounting rod. Miniature tubing leads ink from the reservoir to the 15.2 cm (6 in) stainless steel lever. Fixed to the end of the small bore tubing lever is a tiny ink writing nib. The ink is not supplied, see below.

Catalog No.	\$	Product
BS4 50-6550		Lever with Ink Pen with Reservoir
BS4 50-6543		Lever Only for Smoke Writing
BS4 50-0728		Writing Ink, 30 ml



Starling Heart Lever

This Starling Heart Lever has an arm that is pierced with six holes of 5 mm (1/5 in) pitch from the fulcrum point. The spring tension is also adjustable. The Lever can be mounted on any standard 9.5 mm (3/8 in) diameter rod. The Lever is supplied with a BS4 50-0686 Ink Pen.

Catalog No.	\$	Product
BS4 50-0660		Starling Heart Lever

Kymograph Accessories



Complete Simple Lever and Frontal Writing Point

This Complete Simple Lever Assembly consists of a BS4 50-6519 Simple Lever, BS4 50-6477 Frontal Writing Point with Aluminum Stem and BS4 50-7681 Ink Pen. The Lever has a 6.5 mm (1/4 in) OD, 10 cm (4 in) long mounting rod. The fulcrum of the lever is held in an adjustable needle bearing with stout jaws. The 22.5 cm (9 in) aluminum stem of the Writing Point is held by the Lever. The Frontal Writing Point consists of a plastic yoke that fits on the end of the mounting stem. The yoke carries an aluminum wire (pen holder) that wraps around and holds the BS4 50-7681 Ink Pen. The individual components are also available separately.

Catalog No.	\$	Product
BS4 50-0652		Simple Lever and Frontal Writing Point
BS4 50-6519		Replacement Simple Lever
BS4 50-6477		Replacement Frontal Writing Point with Aluminum Stem
BS4 50-7681		Replacement Ink Pen
BS4 50-6485		Replacement Frontal Writing Point, Aluminum Stem and Ink Pen



Strawholder Lever

The frame of this Lever is drilled with four holes so that the mounting stem can be positioned vertically or in three directions on the horizontal plane. The 6.5 mm (1/4 in) OD stem is 12.5 cm (5 in) long. A spring-loaded metal ring slides on the fulcrum, exposing a 4 mm (0.16 in) hole when the spring is compressed. The end of a straw or other light lever is placed in the hole and is secured when the spring expands, pushing the ring against the lever.

Catalog No.	\$	Product
BS4 50-6535		Strawholder Lever



Oxford Isometric Lever

This Lever consists of a heavy C-shaped universal frame and three easily interchangeable isometric levers of different strengths. The isometric lever is held between the two arms of the frame and can be interchanged by loosening a locking screw. Each isometric lever has four holes behind the fulcrum and one in front of it, all on 4 mm (0.15 in) pitch. The three isometric levers are supplied with wires measuring 1.02, 0.71 and 0.56 mm OD (0.04, 0.028 and 0.022 in). The Levers have a split fork for attaching the BS4 50-0686 Ink Pen (supplied). The holding frame can be mounted on any standard 9.5 mm (3/8 in) diameter rod such as those supplied with the Universal Kymograph.

Catalog No.	\$	Product
BS4 50-6733		Oxford Isometric Lever



Student Isometric Lever

The Student Isometric Lever consists of a wire spring with lever held in a C-shaped frame with mounting rod. The wire is locked securely at one end by a large wing nut with the opposite end pivoting freely. The length of rod that parallels the wire spring is adjustable, providing the desired tension on the spring. The rod is then locked in place. Lever is securely fixed to the wire spring, and then pierced with six holes in front of the fulcrum and two holes behind it. Holes are 5 mm (0.2 in) pitch from fulcrum point. Front of arm has a split fork arrangement for fixing BS4 50-0686 Ink Pen (supplied).

Catalog No.	\$	Product
BS4 50-6741		Student Isometric Lever

Kymograph Accessories



Piston Recorders

These high quality Piston Recorders are precisely manufactured. The glass cylinders are made of specially drawn and annealed glass tubing, which has been ground true. The aluminum alloy pistons are individually matched to the cylinders. The Recorders are extremely flexible and adjustable. The glass cylinder is mounted in a metal base and has a rifled tubing connector at the bottom. The cylinder is held in a split bushing operated by a large knurled knob and can be vertically adjusted. The aluminum alloy piston has a rocker arm that can be connected to any of 9 holes in the writing lever arm. The holes are spaced on 4 mm pitch from the fulcrum. The writing lever arm has an adjustable counterpoise weight. The entire cylinder and piston assembly can be moved in and out of the hollow stem for horizontal adjustment, and locked securely in place when adjusted. In this manner, the amplitude of the writing lever can be adjusted. The writing lever terminates in a connector for a writing point. A pressure transducer can be used in place of the pen. The stem is 9.5 mm (3/8 in) in diameter.

Catalog No.	\$	Product
BS4 50-6063		Piston Recorder, 5 ml
BS4 50-6071		Piston Recorder, 15 ml
BS4 50-6089		Piston Recorder, 45 ml



Ink Pen

This Ink Pen has a very small ink writing nib set in the sealed end. The reservoir holds several drops of ink for tracings. The pen and reservoir are mounted on the end of a 100 mm (4 in) aluminum stem with a split fork mount for mating with levers. Supplied with a stilette wire to draw the ink through the nib. The BS4 50-0736 Pen Filler, available separately, is used to fill the pen, see below. Some ink should flow through the pen while it is filled to keep an air lock from forming that would impede ink flow.

Catalog No.	\$	Product
BS4 50-0686		Ink Pen

Writing Ink

This specially prepared ink is for use with fine capillary tubing and fine writing styli. Available in two sizes.

Catalog No.	\$	Product
BS4 50-0728		Writing Ink, 30 ml, plastic bottle
BS4 50-5933		Writing Ink, 250 ml, glass bottle



Pen Filler

This Pen Filler is a small plastic syringe with a capacity of 1 ml, graduated by 0.1 ml increments. It is used to fill the pen supplied with the writing points.

Catalog No.	\$	Product
BS4 50-0736		Pen Filler

Kymograph Accessories



Tambours

- Two sizes available:
 - 40 mm (1.6 in) diameter diaphragm
 - 75 mm (3 in) diameter diaphragm

These tambours are for gas displacement indication measurements. A rubber diaphragm is stretched over a cylinder and held in place by a rubber O-ring (supplied) which slips on and beds itself in a groove along the edge of the cylinder.

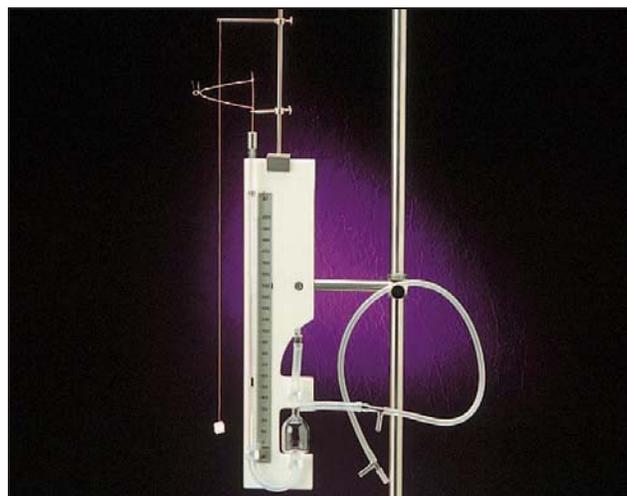
At the base of cylinder is an inlet/outlet port for 6.5 mm ID (0.26 in) tubing (not included). As volume change occurs, the rubber diaphragm moves causing a rise or fall of the metal plate which moves the lever. Available in two sizes, the medium tambour has a 40 mm long (1.6 in) diaphragm and 6 mm OD x 120 mm long (0.25 x 4.7 in) mounting stem. Large tambour has a 75 mm (3 in) diaphragm and 9.5 mm OD x 120 mm long (3/8 x 4.7 in) mounting stem and is used with instruments such as the BS4 50-6154 Pneumograph. Amplitude is adjusted by moving fulcrum along mounting stem.

Catalog No.	\$	Product
BS4 50-6022		Medium Tambour
BS4 50-6030		Large Tambour
BS4 50-6048		Replacement Tambour Rubber, 1,000 cm ² Sheet of Best Quality, Pure Dam Rubber for Replacing Damaged Tambour Diaphragms

Weight Sets

These Weight Sets consist of a hook/weight pan and nine pierced disk weights. The assembly hangs from the hook when the weights are in place. Three sets are available with total weights of 10, 50 and 100 grams. The 10 Gram Set has a 1 gram hook/weight pan with nine 1 gram disk weights. The 50 Gram Set has a 5 gram hook/weight pan with nine 5 gram disk weights. The 100 Gram Set has a 10 gram hook/weight pan with nine 10 gram disk weights.

Catalog No.	\$	Product
BS4 50-2468		Weight Set, 10 g
BS4 50-2476		Weight Set, 50 g
BS4 50-2484		Weight Set, 100 g



Condon's Sensitive Manometer

- For recording the blood pressure of rats and other small animals

This Manometer is twice as sensitive as the normal U-shaped tube Standard Mercury Manometer. It will accurately sense pressures from 0 to 200 mmHg. It has a 280

mm (11 in) glass tube with a 2.5 mm (0.1 in) bore. The glass tube is connected by tubing to a 25 mm (1 in) diameter mercury reservoir. Very small changes in the mercury level in the reservoir cause large changes in the glass tube. The scale is calibrated to compensate for the multiplying effect, so that very accurate pressure readings can be taken. A small cylindrical float is fixed to fine stainless steel tubing and is kept vertical in the tube by a guide rod. An ink writing point is attached to the steel tube and is held against the Kymograph Cylinder by a suspension wire and a guide weight. Mounts on a standard 9.5 mm (3/8 in) diameter rod. Supplied without mercury.

Catalog No.	\$	Product
BS4 50-5974		Condon's Sensitive Manometer

Standard Mercury Manometer

The glass U-shaped tube of this Manometer is 300 mm (12 in) long and has a bore of 5 mm (0.2 in). The scale is movable for zero adjustment, and is calibrated from 0 to 250 mm in 10 mm increments. The Manometer mounts on a standard 9.5 mm (3/8 in) diameter rod. Supplied without mercury.

Catalog No.	\$	Product
BS4 50-5982		Standard Mercury Manometer

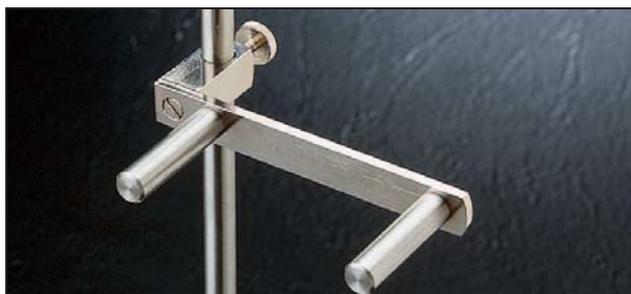
Sensitive Water Manometer

For recording very sensitive movements such as venous pressure. The U-shaped glass tube is 350 mm (14 in) long and has a large 9 mm (0.35 in) bore. The scale is movable for zero adjustment and is calibrated from 0 to 250 mm in 10 mm increments. The Manometer mounts on a standard 9.5 mm (3/8 in) diameter rod.

Catalog No.	\$	Product
BS4 50-5990		Sensitive Water Manometer

Kymographs & Accessories

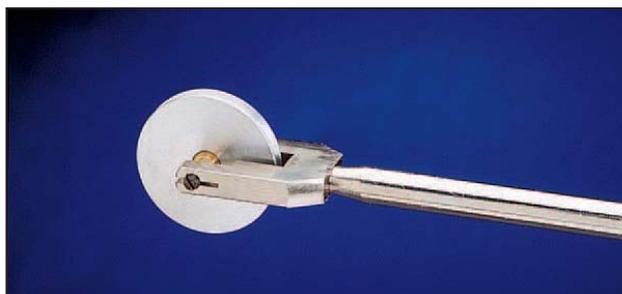
Kymograph Accessories



Double Pulley Holder

Mounts on the standard 9.5 mm (3/8 in) diameter rod.

Catalog No.	\$	Product
BS4 50-0702		Double Pulley Holder



Stem Mount Pulley

Grooved 25 mm (1 in) diameter wheel mounted in needle bearings.

Catalog No.	\$	Product
BS4 50-2666		Stem Mount Pulley



Aluminum Lever with Point

This Light Aluminum Lever is 22.5 cm (9 in) long and has a plastic point.

Catalog No.	\$	Product
BS4 50-6436		Aluminum Lever with Point



BS4 50-6006
Round Edge Cup Receiver

Fixed Mount Pulley

Light weight plastic wheel with deep groove. Negligible friction since pulley runs on hard steel spindles. Mounts on standard 9.5 mm (3/8 in) rod.

Catalog No.	\$	Product
BS4 50-0710		Fixed Mount Pulley, 25 mm

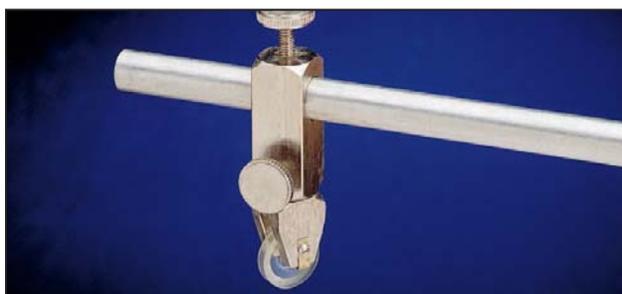


BS4 50-6006
Round Edge Cup Receiver

Cup Receivers

These moulded plastic cup receivers are for recording the pulse from an artery. The cup receiver is pressed over the limb at artery site and small changes in volume in the cup are transmitted through flexible tubing to a read-out device, such as a Tambour, see page I153. The rifled tube connector on back has an inside diameter of 3 mm (1/8 in). The cup is 45 mm (1-3/4 in) diameter and 6.5 mm (1/4 in) deep. It is available in two shapes: round and with a flattened edge for getting into hard-to-reach spots.

Catalog No.	\$	Product
BS4 50-6006		Cup Receiver, Round
BS4 50-6014		Cup Receiver, Flat Edge



Swivel Mount Pulleys

Light weight plastic wheel with deep groove. Swivels Negligible friction since the Pulley runs on hard steel spindles. Mounts on standard 9.5 mm (3/8 in) diameter rod. Available in three sizes.

Catalog No.	\$	Product
BS4 50-2708		Swivel Mount Pulley, 15 mm (5/8 in)
BS4 50-2716		Swivel Mount Pulley, 25 mm (1 in)
BS4 50-2724		Swivel Mount Pulley, 35 mm (1-1/2 in)