ADINSTRUMENTS
making science easier

Getting Started with

# Front-end Signal Conditioners

# Safety Information

ADInstruments is conscious of the critical safety issues involved when connecting electrical devices to subjects. We invest significant resources to ensure that our products are approved to strict international safety standards, and have our systems tested by independent certification bodies. In addition, ADInstruments products are designed, manufactured and serviced under the internationally recognized ISO9001:2008 quality management system.

## Statement of Intended Use

All ADInstruments manufactured products are intended for use in teaching and research applications and environments only. ADInstruments products are NOT intended to be used as medical devices or in medical environments. That is, no product supplied by ADInstruments is intended to be used to diagnose, treat, or monitor a subject. Furthermore no product is intended for the prevention, curing or alleviation of disease, injury or handicap.

Where a product meets IEC 60601-1 it is under the principle that:

1. it is a more rigorous standard than other standards that could be adopted.
2. it provides the most appropriate safety level for subjects and operators.

The choice to meet IEC 60601-1 is in no way to be interpreted to mean that a product:

1. is a medical device.
2. may be interpreted as a medical device.
3. is safe to be used as a medical device.

## Safety and Quality Standards

When used with ADInstruments isolated front-ends, PowerLab systems are safe for connection to subjects. The Bio Amp and the Isolated Stimulator built into the ML760 PowerLab/4ST, ML860 PowerLab 4/20T, ML865 PowerLab 4/25T, ML818 PowerLab 15T, ML856 PowerLab 26T and the FE132 Bio Amp, FE135 Dual Bio Amp, FE408 Dual Bio Amp/Stimulator, FE116 GSR Amp, FE117 BP Amp and FE180 Stimulus Isolator front-ends, conform to international safety requirements. Specifically these are IEC60601-1 and its addenda (see next page), and various harmonized standards worldwide (CSA601.1 in Canada and AS/NZS 3200.1 in Australia and New Zealand). In accordance with European standards they also comply with the electromagnetic compatibility requirements under EN61326-1, which encompasses the EMC directive.

### Quality Management System ISO9001:2008z

ADInstruments manufactures products under a quality system certified as complying with ISO9001:2008 by an accredited certification body.

## BF (body protected) Symbol

This means that the input connectors are suitable for connection to humans provided there is no direct electrical connection to the heart.

## Warning Symbol

This means that the supplied documentation must be consulted for operating, cautionary or safety information before using the device.

## CE Mark

All PowerLab systems and front-end amplifiers carry the CE mark and meet the appropriate EU directives.

## UL Mark


ADInstruments isolated preamplifiers and 35 series PowerLab data acquisition units meet the standards set by Underwriters Laboratories.

## IEC Standard - International Standard - Medical Electrical Equipment

| | |
|---|---|
| IEC60601-1:1998 | General requirements for safety |
| IEC60601-1-1:1992 | Safety requirements for medical electrical systems |
| EN61326-1:2006 | Electrical equipment for measurement, control and laboratory use – EMC requirements |
| IEC61010-1ed2.0 | Safety requirements for electrical equipment for measurement, control and laboratory use. |

## UL Standard - Medical Electrical Equipment

| | |
|---|---|
| UL 60601-1 | Medical Electrical Equipment, Part 1: General Requirements for Safety - Edition 1 |
| CSA C22.2 NO. 601.1 | Medical Electrical Equipment, Part 1: General Requirements for Safety - Edition 1 |

# Contents

# Overview

Front-ends are ancillary devices connected to the PowerLab recording unit to extend the system's capabilities. They provide additional signal conditioning and other features, and extend the types of experiments that you can conduct and the data you can record.

- All ADInstruments front-ends are designed to be operated under full software control.
- Any front-end feature such as gain or filtering is combined with the appropriate features of the program and presented as a single set of software controls.
- No knobs, dials, or switches are needed, although some may be provided for reasons of convenience or safety.

The PowerLab controls front-ends through an expansion connector called the $I^2C$ ("eye-squared-see") bus. This makes it very easy to add front-ends to the system or to transfer them between PowerLabs. Many front-ends can be added to the system by connecting the $I^2C$ sockets in a simple daisy-chain arrangement. In general, each front-end requires a separate analog input channel of the PowerLab, although the Stimulus Isolator and similar front-ends use the positive analog output of the PowerLab.

The front-ends are compatible with PowerLab and MacLab hardware and require the following ADInstruments software versions or later: LabChart v6, Chart v4 or Scope v3.6.

Visit www.adinstruments.com/downloads/ for Windows and Mac operating system compatibility. For more information please contact your ADInstruments representative.

# Getting Started

Front-ends are used with PowerLabs and ADInstruments programs such as LabChart and Scope. This section describes the general setup for front-ends. Some front-ends (Isolated Stimulator, Stimulator HC) have specialized connection requirements. Refer to the Front-end Owners Guide installed with your software for further information.

## Checking the Front-end

Before connecting the front-end to anything, check it carefully for signs of physical damage.

1. Check that there are no obvious signs of damage to the outside of the front-end casing.
2. Check that there is no obvious sign of internal damage, such as rattling. Pick up the front-end, tilt it gently from side to side, and listen for anything that appears to be loose.

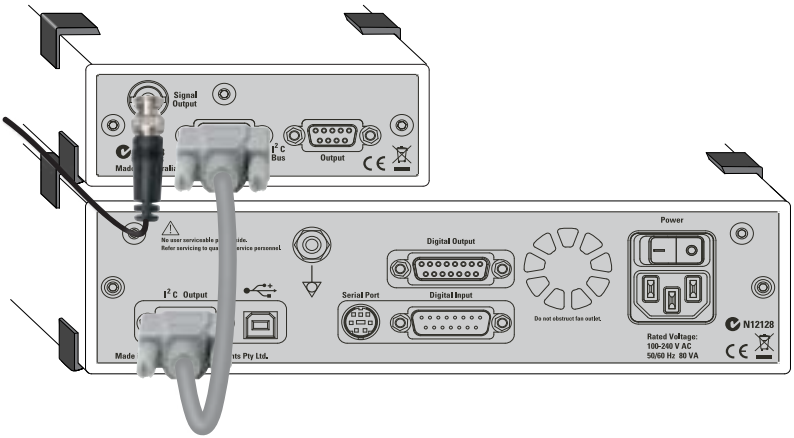
If you have found a problem, contact your ADInstruments representative and describe the problem. Arrangements can be made to replace or repair the front-end.

# Connecting to the PowerLab

To connect a front-end to the PowerLab, first ensure that the PowerLab is turned off.

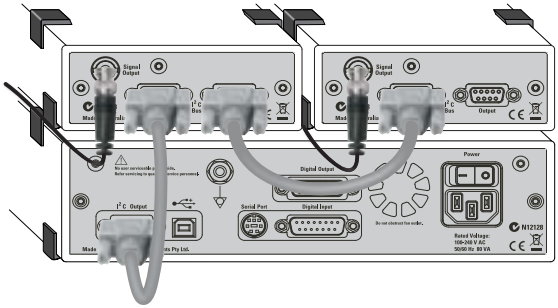
## Single Front-ends

Connect the I²C output of the PowerLab to the I²C input of the front-end using the I²C cable provided. Connect the BNC output of the front-end to an Input channel on the front of the PowerLab.



## Multiple Front-ends

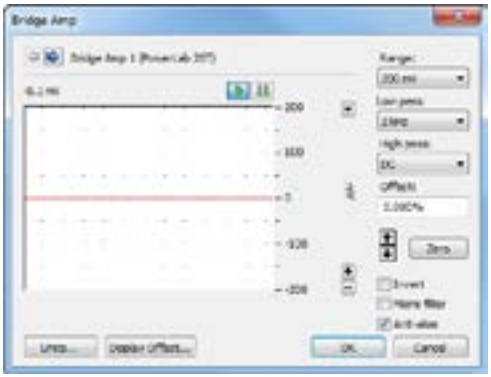
The number of normal front-ends that can be connected depends on the number of input channels on the PowerLab, since the BNC cable for each front-end is normally connected to one of the analog input channels of the PowerLab. The initial front-end should be connected with the I²C cable. The remainder are daisy-chained via I²C cables, connecting the I²C output of the last connected front-end to the I²C input of the front-end to be added.



# Software Configuration

The functions of the front-end are combined with those of the PowerLab and the program and presented as a single set of software controls, replacing the input amplifier dialogs or the Stimulator dialog depending on the front-end connected.

1. Turn on the PowerLab and start LabChart
2. Create a new document
3. Choose the front-end from the Channel Function popup menu.



# Animal Bio Amp

The Animal Bio Amp is a galvanically isolated, high performance, differential amplifier suitable for the measurement of a wide variety of biological signals in animals and isolated tissues.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

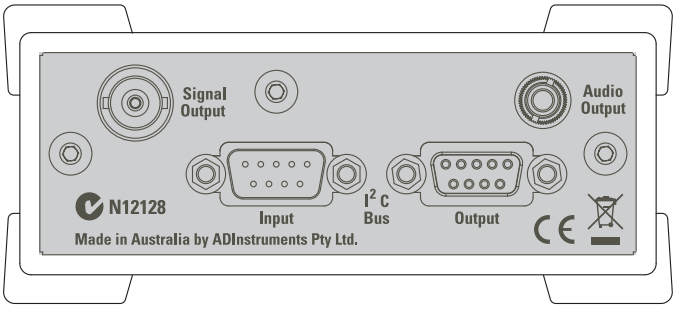

## Related Products

| | |
|---|---|
| MLA1213 | Needle Electrodes for FE136 (3 pk) |
| MLA1214 | Spring Clip Electrodes for FE136 (3 pk) |

See www.ADInstruments.com for further information.

## Specifications

| | | |
|---|---|---|
| Product: | FE136 Animal Bio Amp | |
| Safety: | Approved to IEC 60601-1 Standard (BF rating) | |
| EMC: | EN61326-1:2006 | |
| Connection type: | Three shrouded 1.5 mm male pin sockets | |
| Configuration: | Isolated differential channel with isolated ground reference | |
| Input range: | ± 5 µV to ± 100 mV full scale in 14 steps (combined PowerLab and Bio Amp) | |
| Input impedance: | 200 MΩ differential | |
| Input leakage current: | < 3 $\mu A_{rms}$ @ 240 V, 50 Hz | |
| | < 2 $\mu A_{rms}$ @ 120 V, 60 Hz | |
| CMRR: | > 85 dB (typically, 1–60 Hz) | |
| IMRR: | > 130 dB (to true earth, 50–60 Hz) | |
| Noise: | 1 Hz to 5 kHz | < 1.3 $\mu V_{rms}$ (< 8 µV peak-to-peak) |
| | 0.3 Hz to 1 kHz | < 0.6 $\mu V_{rms}$ |
| | 0.1 Hz to 100 Hz | < 0.35 $\mu V_{rms}$ (@ 200 samples/second) |
| Accuracy: | ± 1.5% (all ranges, within Bio Amp) | |
| Non-linearity: | < 0.2% within range | |
| DC blocking: | ± 1 V | |
| Baseline restore: | Automatic | |



# Bio Amp

The Bio Amp is a galvanically isolated, high-performance differential bio amplifier optimized for the measurement of a wide variety of biological signals such as ECG, EEG and EMG recordings. It is certified and approved for human connection.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

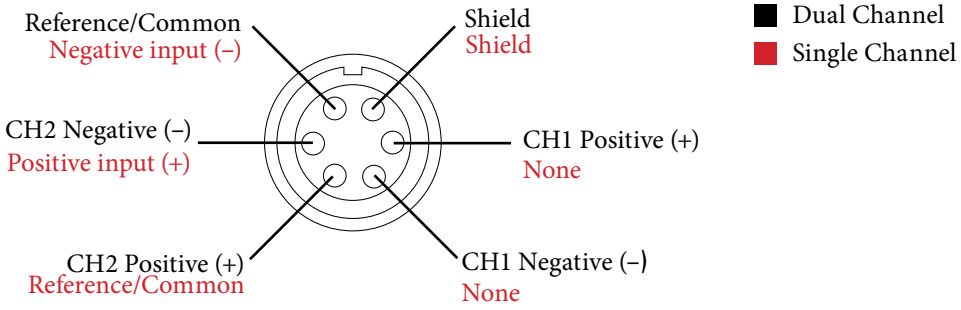
## Related Products

| | |
|---|---|
| MLA700 | Reusable ECG Electrodes |
| MLA710 | Chest ECG Electrodes |
| MLAWBT9 | EEG Flat Electrodes |
| MLA1605 | Shielded Lead Wires (5 alligator clip, 25 cm) |
| MLA1610 | Shielded Lead Wires (5 Micro-Hooks) |
| MLA1203 | Needle Electrodes (5) 29 gauge |
| MLAEC1 | EEG Electro-Cap System 1 (medium cap) |
| MLAEC2 | EEG Electro-cap System 2 (large & medium cap) |
| MLAC14 | Adapter Pack (2 mm pin to SAF, 5 pk) |

See www.ADInstruments.com for further information.

## Specifications

| | | |
|---|---|---|
| Product: | FE132/FE135 Bio Amp | |
| Safety: | Approved to IEC 60601-1 Standard (BF rating) | |
| EMC: | EN61326-1:2006 | |
| Connection type: | Six-pin DIN/MS socket to fit 3-lead (FE132) Bio Amp cable (Tronomed D-1340) or 5-Lead (FE135) Bio Amp Cable (Tronomed D-1540) | |
| Configuration: | Isolated differential channel with isolated ground reference | |
| Input range: | ± 5 µV to ± 100 mV full scale in 14 steps (combined PowerLab and Bio Amp) | |
| Input impedance: | 200 MΩ differential | |
| Input leakage current: | < 3 $\mu A_{rms}$ @ 240 V, 50 Hz | |
| | < 2 $\mu A_{rms}$ @ 120 V, 60 Hz | |
| CMRR: | > 85 dB (typically, 1–60 Hz) | |
| IMRR: | > 130 dB (to true earth, 50–60 Hz) | |
| Noise: | 1 Hz to 5 kHz | < 1.3 $\mu V_{rms}$ (< 8 µV peak-to-peak) |
| | 0.3 Hz to 1 kHz | < 0.6 $\mu V_{rms}$ |
| | 0.1 Hz to 100 Hz | < 0.35 $\mu V_{rms}$ (@ 200 samples/second) |
| Accuracy: | ± 1.5% (all ranges, within Bio Amp) | |
| Non-linearity: | < 0.2% within range | |
| DC blocking: | ± 1 V | |
| Baseline restore: | Automatic | |
| Input pin diagram: | | |



# BP Amp

The BP Amp is a galvanically isolated blood pressure amplifier that provides pressure measurements from human and animals using suitable BP transducers. It is certified and approved for human connection.

Note: For human application the transducer must be cold sterilized prior to use.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

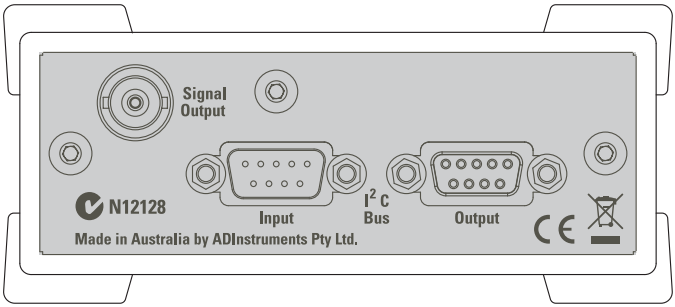

## Related Products

| | |
|---|---|
| MLT0699 | Disposable BP Transducer (no stopcock) |
| MLT0670 | Disposable BP Transducer (stopcock) |

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE117 BP Amp |
| Safety: | Approved to IEC 60601-1 Standard (BF rating) |
| EMC: | EN61326-1:2006 |
| Connection type: | 6-pin socket to fit 6-pin Utah Medical 650-208 transducer cable with a 4-pin transducer connection cable |
| Configuration: | Isolated AC Bridge |
| Input range: | 50 to 250 mmHg full scale in 3 steps (combined PowerLab and BP Amp) |
| Sensitivity: | Correct for 5 µV/V/mmHg transducer standard (~350 Ω bridge) |
| Input impedance: | > 10 kΩ at 400 Hz AC |
| Input leakage current: | < 3 $\mu A_{rms}$ at 240 V, 50 Hz<br>< 2 $\mu A_{rms}$ at 120 V, 60 Hz |
| Frequency response: | –3 dB at 50 Hz |
| Accuracy: | ± 2% (± 0.2 mmHg) all points, after zero correction |
| Zeroing and offset: | Automatic software-controlled fast zeroing, controlled by internal 12-bit DAC; resolution = ± 0.2 mmHg (with supplied transducer) |
| Excitation: | 5 $V_{rms}$ AC at 400 Hz ± 5% |



# Bridge Amp

The Bridge Amp is a non-isolated bridge amplifier, which provides strain gauge measurements from most DC bridge transducers, including force transducers, displacement transducers, pressure transducers and temperature probes. The Bridge Amp is available in single- (FE221), four- (FE224) or eight-channel (FE228) models.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

## Related Products

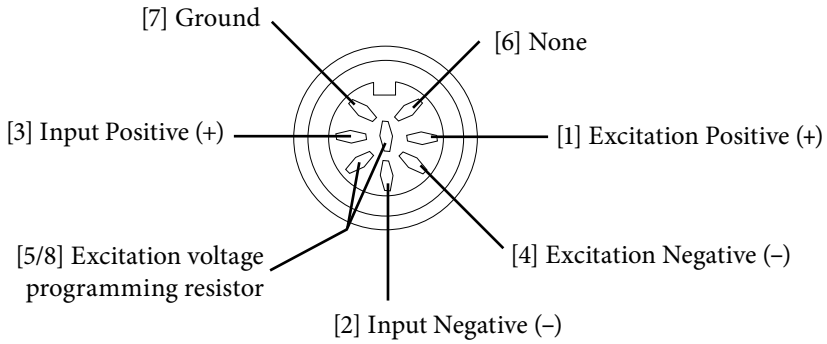
| | |
|---|---|
| MLT0420 | Force Transducer (20 g) |
| MLT0402 | Force Transducer (2 g) |
| MLT0015 | High Grade Isotonic Transducer |
| MLT422/D | Skin Temperature Probe (DIN, 2 m) |
| SPR-320 | Pressure Catheter (2F, Single, Straight, 140 cm, PU) |

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE221/FE224/FE228 Bridge Amp |
| EMC: | EN61326-1:2006 |
| Connection type: | 8-pin DIN socket |
| Configuration: | Differential |
| Input range: | ± 200 µV to ± 5 V full scale in 14 steps (combined PowerLab and Bridge Amp) |
| Input impedance: | 2 × 1 MΩ (single-ended) 2 MΩ (differential) |
| CMRR (differential): | 100 dB @ 50 Hz (typical) |
| Noise: | < 1 $\mu V_{rms}$ referred to input at highest gain |
| Frequency response: | –3 dB, 2 kHz maximum at all gains with the low-pass filter off |
| Accuracy: | ± 0.5% (combined PowerLab and Bridge Amp) |
| Maximum input voltage: | ± 10 V |
| Zeroing circuitry: | Software-controlled, either manual or automatic |
| Internal offsetting range: | ± 10 V (1–5 V range)<br>± 1 V (100–500 mV range)<br>± 100 mV (0.2–50 mV range) |
| Internal offset resolution: | 16-bit (internal DAC) ± 32 000 steps about 0 V |
| Excitation voltage range: | 0–20 V DC (± 10 V referred to ground), adjusted by external resistor |
| Transducer drive current: | ± 45 mA maximum |

Input pin diagram:



# GSR Amp

The Galvanic Skin Response amplifier with suitable electrodes is designed to measure the electrical conductance of the skin, which is used as an indication of psychological or physiological response. It is galvanically isolated for subject safety, and certified and approved for human connection.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

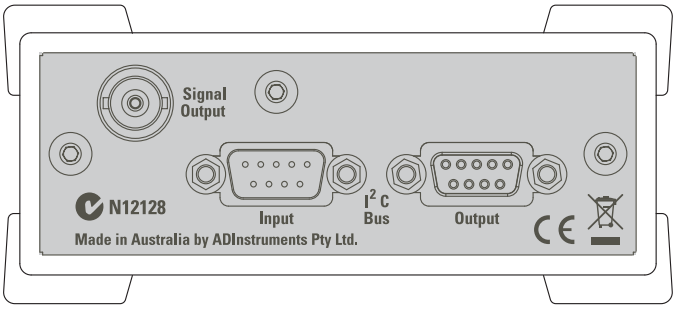

## Related Products

| | |
|---|---|
| MLT116F | GSR Finger Electrodes |
| MLT117F | MRI Safe Bipolar Finger Electrodes (5 m) |

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE116 GSR Amp |
| Safety: | Approved to IEC 60601-1 Standard (BF rating) |
| EMC: | EN61326-1:2006 |
| Connection type: | 2 × 4 mm shrouded sockets. Custom cable with two shrouded banana plugs and terminated with two dry, bright-plated, bipolar electrodes with Velcro attachment strap suitable for adult fingers |
| Configuration: | Transformer isolation (AC bridge operation) |
| Input range: | 1 to 40 µS full scale in 6 steps (combined PowerLab and GSR Amp) |
| Input leakage current: | < 3 $\mu A_{rms}$ at 240 V, 50 Hz<br>< 2 $\mu A_{rms}$ at 120 V, 60 Hz |
| Frequency response: | –3 dB at 1 Hz |
| Accuracy: | ± 5% |
| Zeroing and offset: | Automatic software-controlled fast zeroing, controlled by internal 12-bit DAC; ± 0.2 µS resolution |
| Excitation: | Constant-voltage AC excitation (22 $mV_{rms}$ @75 Hz) |
| Current density: | ≤0.5 µA $cm^{-2}$ |



# Neuro Amp EX

The Neuro Amp EX is a galvanically isolated, low noise and high gain amplifier (supplied with headstage), which is ideal for extracellular recordings requiring a wide bandpass (0.1–5 kHz) and a high signal to noise ratio, especially in microneurography. The device is certified safe for human connection.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

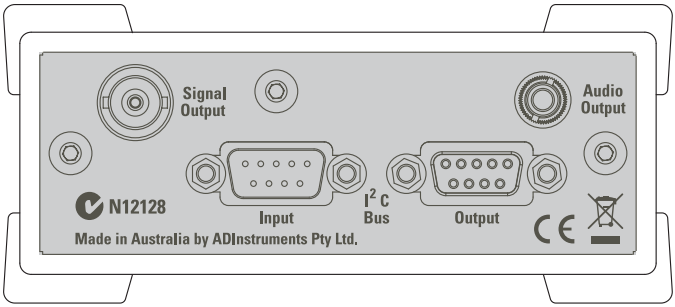

## Related Products

MLT185 Neuro Amp EX Headstage

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE185 Neuro Amp EX |
| Safety: | Approved to IEC 60601-1 Standard (BF rating) |
| EMC: | EN61326-1:2006 |
| Connection type: | Five-pin Redel connector |
| Configuration: | One isolated differential channel with isolated ground reference |
| Input range: | ± 20 µV to ± 1 mV full scale in 6 steps (combined PowerLab, Neuro Amp EX front-end and headstage) |
| Input impedance: | 100 MΩ |
| Low-pass filtering: | Fourth-order Bessel filter, ± 3% accuracy.<br>Frequencies software-selectable: 1 kHz, 2 kHz, 5 kHz |
| High-pass filtering: | First-order filter, ± 0.25% accuracy.<br>Frequencies software-selectable: 100 Hz, 300 Hz, 500 Hz |
| Notch filter: | Second-order filter, –32 dB attenuation; 50 or 60 Hz frequency (automatic sensing) |



# pH Amp

The pH Amp is a non-isolated dual front-end suitable for use with pH, ion-selective and potentiometric redox electrodes. It can provide pH measurements in the range 0–14, electrode voltages to 2.0 V and temperature ranging from 0 to 100 °C. It can also be used for temperature compensated measurements or as an independent temperature sensor.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.


## Related Products

| | |
|---|---|
| MLA060 | Redox Electrode |
| MLA042 | pH Electrode |
| MLT5733 | pH Electrode - Tuff tip for student use |

See www.ADInstruments.com for further information.

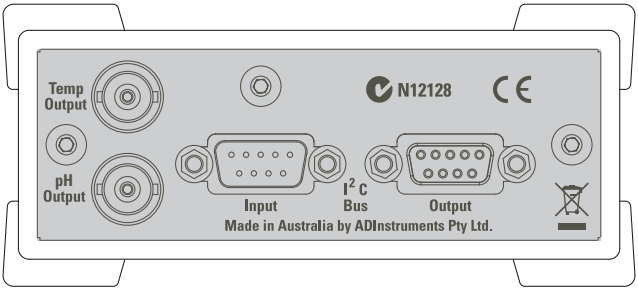
## Specifications

| | |
|---|---|
| Product: | FE165 pH Amp |
| **pH Section** | |
| Connection type: | Insulated BNC socket |
| Configuration: | High impedance, electrometer type |
| Input Range: | ± 200 µV to ± 2 V full scale in 13 steps (combined PowerLab and pH Amp) |
| Input impedance: | $10^{13}$ Ω typical |
| Noise: | < 1 $\mu V_{rms}$ (< 4 µV p–p) with a bandwidth of DC – 10 Hz |
| Low pass filter: | 10 Hz. (–3 dB frequency) |
| Low pass filter accuracy: | ± 3.0% |
| Low pass filter type: | Bessel (2 pole) |
| **Temperature Section** | |
| Connection type: | 3 pin mini-audio jack |
| Configuration | 100 Ω platinum RTD (Resistance Temperature Detector) |

Output ranges:

| Range | Temperature °C | Resolution °C |
|---|---|---|
| ± 10 V | ± 200 | 0.1 |
| ± 5 V | ± 100 | 0.05 |
| ± 2 V | ± 40 | 0.02 |
| ± 1 V | ± 20 | 0.01 |
| ± 500 mV | ± 10 | 0.01 |

| | |
|---|---|
| Amplifier output: | 0 V @ 0 °C, 50 mV/°C (factory set) |
| Accuracy: | ± 0.2 °C |



# Spirometer

The Spirometer is a precision differential pressure transducer that measures the respiration flow rates from humans or animals (using suitable flow head sizes). The Spirometer and attached flow head function together as a pneumotachometer, with an output signal proportional to airflow.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

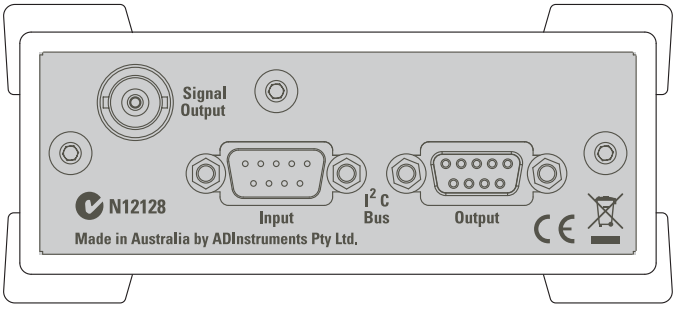

## Related Products

| | |
|---|---|
| MLT1000L | Respiratory Flow Head 1000 L |
| MLT300L | Respiratory Flow Head 300 L |
| MLT10L | Respiratory Flow Head 10 L |
| MLT1L | Respiratory Flow Head 1 L |
| MLA5530 | Calibration Syringe |

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE141 Spirometer |
| EMC: | EN61326-1:2006 |
| Connection type: | Two female Luer fittings to enable connection to Flow Head via male Luer fittings and suitable tubing. |
| Configuration: | Differential pressure input, ± 1" (2.5 cm) $H_2O$ (1.9 mmHg, 249 Pa) |
| Input range: | ± 20 mV to ± 500 mV full scale in 5 steps (combined PowerLab and Spirometer) |
| Pressure sensitivity: | 0.5 V per inch (1.27 V per cm) $H_2O$ |
| Amplifier noise: | < 150 $\mu V_{rms}$ @ 100 Hz<br>< 50 $\mu V_{rms}$ @ 10 Hz<br>< 35 $\mu V_{rms}$ @ 1 Hz |
| Temperature drift: | 0.05% of full scale per °C |
| Warm-up time: | ~ 2 minutes |
| Maximum input pressure: | ± 28.1" $H_2O$ (7 kPa) |
| Response time: | 1 ms (10–90% full scale) at maximum bandwidth |
| Linearity: | ± 0.5% full scale |
| Low-pass filtering: | 1, 10 or 100 Hz (software-selectable) using fourth-order Bessel filter |
| Max zero pressure offset: | < 1% full scale, software removable |
| Zero offset correction: | Software removed (up to ± 10% full scale) |



# Stimulus Isolator

The Stimulus Isolator is a galvanically isolated constant-current stimulator providing a range of pulse width from 10 µs to 2.56 ms with a maximum current of 10 mA. The unit provides adjustable pulse amplitude, width, and frequency. It is certified and approved for human connection.

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

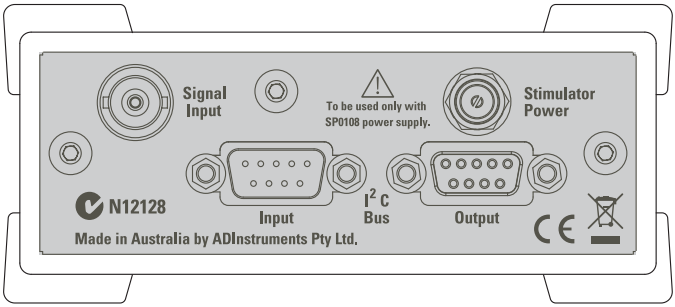

## Related Products

| | |
|---|---|
| MLADDB30 | Recording Bar Electrode |
| MLA265 | Stimulator Rod with Cable |
| MLA260 | Stimulator Cable (4 mm shrouded to Alligator clip, 50 cm) |
| MLA260/L | Stimulator Cable (4 mm shrouded to Alligator clip, 2 m) |
| SP0105 | Shrouded Connectors (10 red, 10 black) |

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE180 Stimulus Isolator |
| Safety: | Approved to IEC 60601-1 Standard (BF rating) |
| EMC: | EN61326-1:2006 |
| Connection type: | Two shrouded 4 mm sockets |
| Configuration: | Constant-current stimulator with hardware-limited repetition rate |
| Output range: | 100 µA, 1 mA, or 10 mA full scale |
| Resolution: | 1% of full scale (1 µA, 10 µA, or 100 µA) |
| Compliance voltage: | 100 V fixed |
| Pulse duration range: | 0.01 to 2.56 ms in 0.01 ms steps |
| Duration accuracy: | ± 0.01% +5/–0 µs |
| Repetition rate: | up to 2000 Hz |
| Safety indicators: | A single, multi-color indicator displays the isolated stimulator status. A green flash indicates delivery of a valid stimulus. A yellow flash indicates an out-of-compliance condition (OOC) |
| Safety switch: | Isolating On-Off switch flicks down to disconnect quickly |



# Stimulator HC

The Stimulator HC is an isolated constant-current stimulator with 100 V compliance designed to stimulate in vitro isolated nerve, muscle or tissue samples. It provides adjustable constant-current pulses of 10 microsecond to 4 milliseconds duration, of 0.1 to 30 Hz pulse frequency and up to 100 mA pulse amplitude. It is NOT approved for live subject connection!

For full usage and specification information see the Front-end Owners Guide installed with LabChart or available from www.ADInstruments.com.

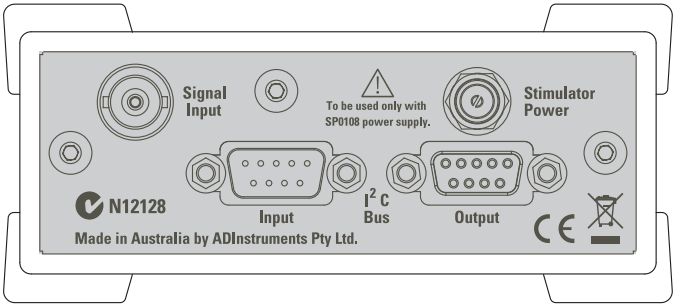

## Related Products

| | |
|---|---|
| MLAC36 | Stimulator HC Leads (2 m) |
| PTK13 | Pharmacology Kit |
| ML0146/C-V | Panlab Four Chamber Organ Bath & Thermostat Controller |
| ML0186/C-V | Panlab Eight Chamber Organ Bath & Thermostat Controller |
| 159920-X1/C | Radnoti 4 Chamber Tissue-Organ Bath |

See www.ADInstruments.com for further information.

## Specifications

| | |
|---|---|
| Product: | FE155 Stimulator HC |
| Safety: | Not For Human Connection |
| EMC: | EN61326-1:2006 |
| Connection type: | Two 2 mm touch-proof safety sockets |
| Configuration: | Constant-current stimulator with hardware limited repetition rate |
| Output range: | 1 mA, 10 mA, 100 mA full scale |
| Resolution: | 1% of full scale (10 µA, 100 µA, or 1 mA) |
| Compliance voltage: | 100 V fixed |
| Pulse duration range: | 0.02 to 5.12 ms in 0.02 ms steps |
| Duration accuracy: | ± 0.01% +5/–0 µs |
| Repetition rate: | up to 30 Hz |
| Safety indicators: | A single, multi-color indicator displays the Stimulator HC status. A green flash indicates delivery of a valid stimulus. A yellow flash indicates an out-of-compliance condition (OOC). |
| Safety switch: | Isolating On-Off switch flicks down to disconnect quickly. |



# Warranty & License Agreement

**Extent**

This Agreement is between ADInstruments Pty Ltd ['ADI'] and the purchaser ['the Purchaser'] of any ADI product — software, hardware or both — and covers all obligations and liabilities on the part of ADI, the Purchaser, and other users of the product. The Purchaser (or any user) accepts the terms of this Agreement by using the product. Any changes to this Agreement must be recorded in writing and have ADI's and the Purchaser's consent.

**Responsibilities**

The Purchaser and any others using any ADI product agree to use it in a sensible manner for purposes for which it is suited, and agree to take responsibility for their actions and the results of their actions. If problems arise with an ADI product, ADI will make all reasonable efforts to rectify them. This service may incur a charge, depending on the nature of the problems, and is subject to the other conditions in this Agreement.

**Statement of Intended Use**

All ADInstruments manufactured products are intended for use in teaching and research applications and environments only. ADInstruments products are NOT intended to be used as medical devices or in medical environments. That is, no product supplied by ADInstruments is intended to be used to diagnose, treat, or monitor a subject. Furthermore no product is intended for the prevention, curing or alleviation of disease, injury or handicap.

Where a product meets IEC 60601-1 it is under the principle that:

1. it is a more rigorous standard than other standards that could be adopted and
2. it provides the most appropriate safety level for subjects and operators.

The choice to meet IEC 60601-1 is in no way to be interpreted to mean that a product:

1. is a medical device;
2. may be interpreted as a medical device;
3. is safe to be used as a medical device

**General Limitations**

ADI products are produced to high standards, and should perform as described in the supplied documentation. There is a limited hardware warranty, and technical support is provided for all products. Nevertheless, since ADI products could be affected by external factors (for instance, the computer system on which they run), absolute performance and reliability cannot be guaranteed. No warranty, either expressed or implied or statutory, other than that contained in this Agreement, is made in respect to ADI products. The Purchaser therefore assumes all risks as to the performance and reliability of the products, and the results gained using them. ADI is not responsible for any problems with the computer system not directly related to ADI products. ADI neither assumes or authorizes any person to assume on its behalf any liability in connection with the sale, installation, service or use of its products. ADI shall not be held responsible for special, consequential or punitive damages of any kind arising out of sale, installation service or use of its products.

**Hardware Warranty**

ADI warrants that PowerLab Data Acquisition Units (PL prefix)1 and Front-ends (FE prefix)2 shall be free from defects in materials and workmanship for five (5) years from the date of purchase. Other PowerLab Data Acquisition Units3, Front-ends4 and Pods5 shall be free of defects in material and workmanship for three (3) years from their date of purchase. ADI also warrants that ADI Specialized Data Recorders6 and Instruments7 shall be free of defects in material and workmanship for one (1) year from their date of purchase. If there is such a defect, ADI will repair or replace the equipment as appropriate, and the duration of the warranty shall be extended by the length of time needed for repair or replacement.

To obtain service under this warranty, the Purchaser must notify the nearest ADI office, or Authorized Representative, of the defect before the warranty expires. The ADI or Representative office will advise the Purchaser of the nearest service center address to which the Purchaser must ship the defective product at his or her own expense. The product should be packed safely, preferably in its original packaging. ADI will pay return shipping costs.

**Hardware Warranty Limitations**

This warranty applies only to the hardware specified in this document and used under normal operating conditions and within specification. Consumables, electrodes and accessories are not covered by this warranty. Third party equipment is covered by the manufacturer's warranty. It does not cover hardware modified in any way, subjected to unusual physical, electrical or environmental stress, used with incorrectly wired or substandard connectors or cables, or with the original identification marks altered. Tampering with or breaking of the Warranty Seal will also void the warranty. ADI does not warrant that equipment is suitable for any specific purpose, other than that explicitly stated by ADI.

**Product Types & Warranty Term**

**ADI manufactured products covered by five (5) year warranty**

[1] Data Acquisition Units: PowerLab 35 series with PL prefix

[2] Front-ends: ADI Front-end Signal Conditioners with FE prefix.

**ADI manufactured products covered by three (3) year warranty**

[3] Data Acquisition Units: PowerLab 26 series with ML prefix

[4] Front-ends: ADI Front-end Signal Conditioners with ML prefix.

[5] Pods: The entire range of ADI Pod Signal Conditioners.

**ADI manufactured products covered by one (1) year warranty**

[6] Specialized Data Recorders: Metabolic Systems (e.g. ML240 PowerLab/8M Metabolic System)

[7] Instruments: Blood FlowMeter, Gas Analyzers, NIBP System (excluding transducers), STH Pump Controller.

**Third Party Products (Including Transducers)**
Products not manufactured by ADI are covered by the manufacturer's warranty.

**Accessories and Consumables**
Accessories and Consumables are not covered by any type of warranty.

**Software License**
The Purchaser has the non-exclusive right to use the supplied ADI software. (The Purchaser's employees or students, for instance, are entitled to use it, provided they adhere to this Agreement.) The Purchaser is permitted to make one backup copy of ADI software. Each separate purchase of a software program, allows the Purchaser to install the software on up to three computers for use with one PowerLab data acquisition unit or an Authorized Recording Device. That is, the software can be used for analysis purposes on three separate computers, however a single license can only be used with one PowerLab unit or an Authorized Recording Device to perform data acquisition at any one time. Departmental (multiple-user) licenses allow the Department to use the program on all computers situated within the Department, even if only one CD is provided. See the accompanied Software License document for more information.

**Controlling Law and Severability**
This license shall be governed by the laws of the territory into which the software is sold, or if sold into the United States of America, by the laws of the State of California.

**Technical Support**
The Purchaser is entitled to free technical support for any ADI product for one year from its date of purchase. Our technical support staff can provide advice concerning installation and operation of ADI products. Services outside of this may incur a charge. Technical support staff will not provide experimental protocols or procedural instructions for conducting experiments. However, information of this type may be provided in the supplied product documentation, or on ADI web sites.

**Inquiries**
For additional information or service inquiries please contact the nearest ADInstruments office or Authorized Distributor. For contact details see www.ADInstruments.com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