

# Exercise Physiology

## Metabolic Measurements with PowerLab® Systems and Chart™



ADInstruments provides a range of specialized products for use in cardiorespiratory and exercise physiology research. These include PowerLab data acquisition systems, respiratory gas analyzers, spirometers, oximeters, biological amplifiers, blood flow meters, pulse transducers, goniometers, force transducers, temperature sensors and more.

PowerLab data acquisition systems and all of our signal conditioners are controlled by Chart software. This provides researchers and educators with a high-grade and easy-to-use data acquisition solution. In addition, ADInstruments human-use signal conditioners are isolated and certified safe for use with human subjects.

### Exercise Physiology System

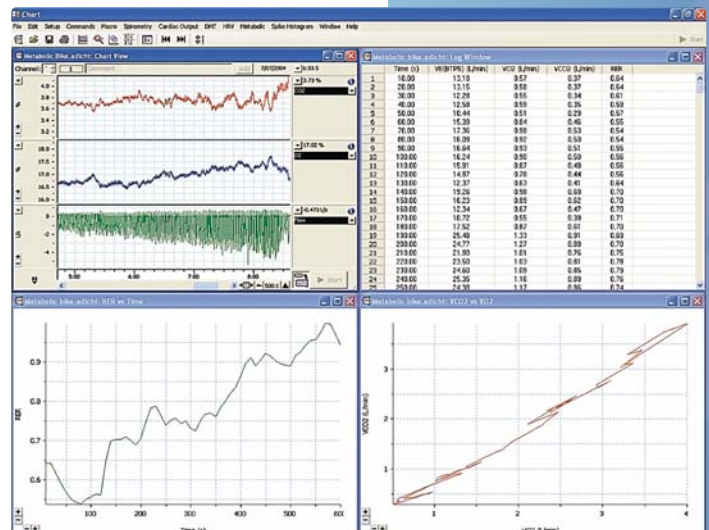
The ML870B80 Exercise Physiology System is ideal for monitoring cardiorespiratory and metabolic function in human subjects. The system includes a PowerLab data acquisition unit with Chart software, gas analysis and spirometry hardware, accessories and a specialized metabolic software module.

In conjunction with a PowerLab, Chart software records metabolic signals and provides advanced real-time or post-acquisition analysis features. The Metabolic Module for Chart (Windows® & Mac® OS) automates gas calibration procedures and the calculation of parameters such as RER,  $\dot{V}_{CO_2}$ ,  $\dot{V}_{O_2}$  and  $\dot{V}_E$ . This combination ensures accurate and efficient data analysis.

### Typical Applications

- Metabolic measurements
- Respiratory gas analysis
- Student exercise testing
- Pulmonary function analysis
- Indirect calorimetry
- Anaerobic threshold
- Biopotential measurements
- Spirometry

Below: A recording of expired airflow and gas concentrations ( $CO_2$  and  $O_2$ ), RER,  $\dot{V}_{O_2}$  and  $\dot{V}_{CO_2}$ . As expired flow and gas concentration values are collected in the Log Window, the metabolic graphs such as RER vs Time and  $\dot{V}_{O_2}$  vs  $\dot{V}_{CO_2}$  are updated in real time.



# Software

## Chart

Chart software, for Windows and Mac OS, provides control of ADInstruments hardware with interactive displays for amplifier range and filter settings. It includes a variety of analysis features such as XY plotting, differential, integral and spectral calculations. Real-time data acquisition and computations are performed on up to 16 channels, with sampling rates as fast as 200 kHz per channel (or 400 kHz aggregate).

## Metabolic Module

The MLS240 Metabolic Module for Chart is included with the ML870B80 Exercise Physiology System. You can also use the Module with any custom configuration that includes an ADInstruments Spirometer, Gas Mixing Chamber, Gas Analyzer and a PowerLab system featuring at least four BNC inputs.

Using simultaneous measurements of airflow [L/s], oxygen [%O<sub>2</sub>] and carbon dioxide [%CO<sub>2</sub>] concentrations (and accounting for environmental conditions), the module provides online or offline calculations of the following parameters:

- Expired Minute Ventilation  $\dot{V}_E$
- Oxygen Consumption  $\dot{V}_{O_2}$
- Carbon Dioxide Production  $\dot{V}_{CO_2}$
- Respiratory Exchange Ratio (RER)

The module plots these parameters against time and in relation to each other. The graphs are displayed and updated in real time during acquisition. The Metabolic Log Window provides a summary of the data in a spreadsheet format. This can be easily exported to other programs for further analysis or graphing.

## Spirometry

The Spirometry feature in Chart software uses incoming respiratory flow and volume data to calculate a number of spirometry parameters. These include peak inspiratory flow (PIF), peak expiratory flow (PEF), tidal volume (V<sub>T</sub>), expired minute ventilation ( $\dot{V}_E$ ), respiratory rate (f) and forced vital capacity (FVC).

The system easily generates Spirometry reports and flow-volume plots and these can be printed or exported. The Spirometry feature also allows users to quickly and easily calibrate respiratory flow heads.

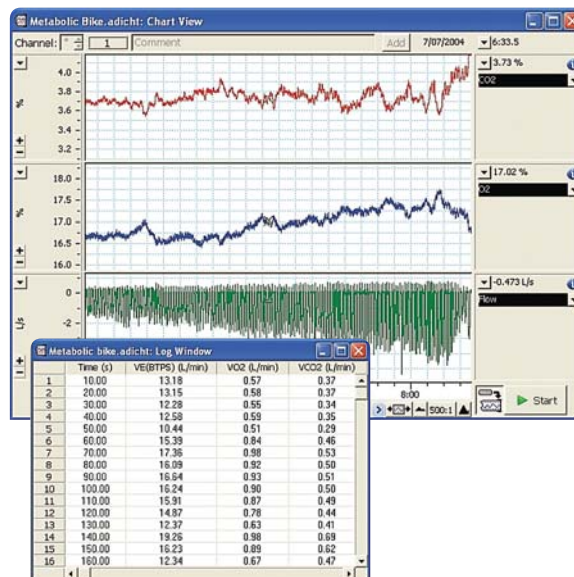
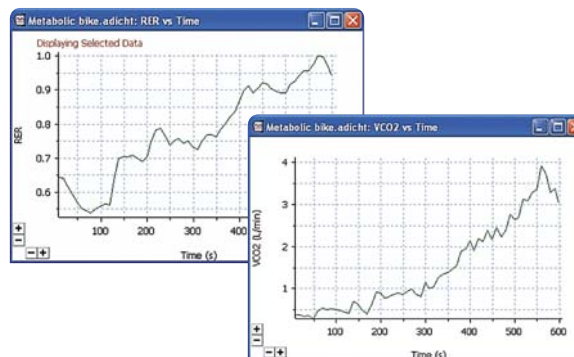
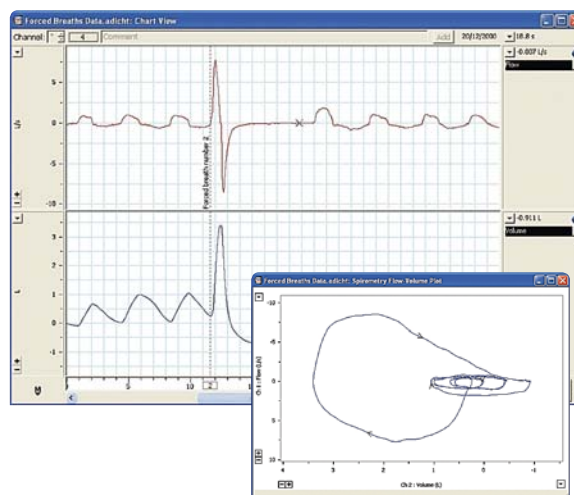


Chart recording of respiratory gas concentrations and airflow. The Log Window displays real-time averaged ventilation and gas calculations.



Graphs such as RER and  $\dot{V}_{CO_2}$  versus Time are automatically generated using the Metabolic Module and displayed in real time.



A flow volume recording of a forced expiration. The inset shows a flow-volume loop generated using Chart's spirometry feature.

# Hardware

## Exercise Physiology System

The ADInstruments ML870B80 Exercise Physiology System has been configured for measuring metabolic function during exercise in humans. The package includes a PowerLab 8/30 (8-channel data recording unit with Chart software), single-channel Bio Amp, Respiratory Gas Analyzer, 4.7 L Gas Mixing Chamber, Spirometer, Thermistor Pod, Metabolic Accessory Kit and Metabolic Module for Chart software.

The MLA240 Exercise Physiology Accessory Kit includes a Respiratory Flow Head (1000 L/min), Face Mask (two-way non-rebreathing), Tubing Adapters, Breathing Tube, Desiccant Cartridge, Drying Tube, Silicon Tubing with Connectors, and Thermistor Temperature Sensor.

The Gas Analyzer measures CO<sub>2</sub> and O<sub>2</sub> concentrations from expired air sampled from the Gas Mixing Chamber, while the Spirometer monitors airflow. The Bio Amp is used for recording biopotentials such as ECG or EMG and the Thermistor Pod monitors temperature of the respired air. Chart software records all of these signals on your Windows or Macintosh computer.

The Metabolic Module uses the acquired respiratory gas concentration and flow data for online and offline calculation and reporting of metabolic parameters.

### Gas Analyzer Specifications:

Analyzers	O <sub>2</sub>	CO <sub>2</sub>
Type	Visible Optical	Infrared Optical
Range	0 to 100%	0 to 10%
Resolution	0.01%	0.1%
Linearity	0.2%	0.1%

## PTK14 Exercise Physiology Kit

With the addition of a PowerLab data acquisition system, the PTK14 Exercise Physiology Kit allows investigation of respiratory function. This makes it ideal for classroom teaching experiments. To use the PTK14, you need a PowerLab data acquisition system with at least four BNC input connections. The PTK14 includes the Gas Analyzer, Gas Mixing Chamber, Respiratory Flow Head, Face Mask, Desiccant Cartridge, Tubing and Metabolic Module Software.



MLA240 Exercise Physiology Accessory Kit

ML870B80 Exercise Physiology System



PTK14 Exercise Physiology Kit

# Relevant Application Software

## Heart Rate Variability Module

The MLS310 HRV Module provides users with the ability to analyze beat-to-beat interval variation. Features include:

- Analysis such as Poincaré, Period Histogram, Delta NN Histogram and Tachogram
- Easy threshold detectors
- Beat classification: normal, ectopic or artifact
- Power spectrum analysis

## ECG Analysis Module

The MLS360 ECG Analysis Module automatically detects and reports PQRST onset, amplitude and intervals online or offline. Features include:

- Online or offline beat detection and analysis
- Easy to use Beat Classifier
- Graphical representation and tabular reports of QT, PT and QRS Intervals, P, R and T amplitudes
- ECG signal averaging

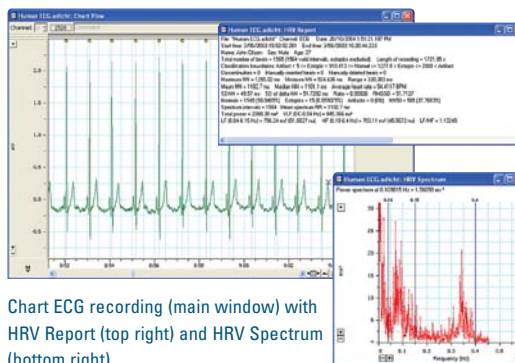
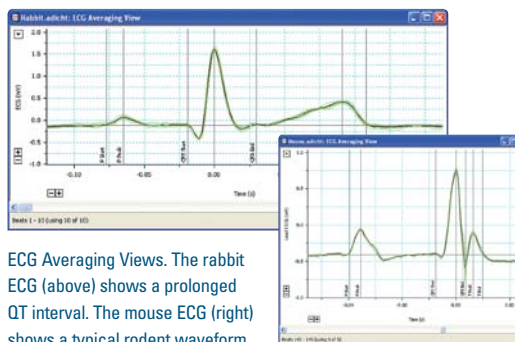


Chart ECG recording (main window) with HRV Report (top right) and HRV Spectrum (bottom right).



ECG Averaging Views. The rabbit ECG (above) shows a prolonged QT interval. The mouse ECG (right) shows a typical rodent waveform.

## Ordering Information

ML870B80 Exercise Physiology System	PTK14 Exercise Physiology Kit
1 x ML870 PowerLab 8/30 (8 channel data acquisition system)	1 x ML206 Gas Analyzer
1 x ML132 Bio Amp	1 x MLA246 Gas Mixing Chamber
1 x ML206 Gas Analyzer	1 x MLT1000L Respiratory Flow Head
1 x MLA246 Gas Mixing Chamber	1 x ML141 Spirometer
1 x ML141 Spirometer	1 x MLA1028 Face Mask
1 x ML309 Thermistor Pod	1 x MLA1081 Flow Head Adapter
1 x MLS240 Metabolic Module	1 x MLA6024 Desiccant Cartridge
1 x MLA240 Exercise Physiology Accessory Kit: 1 x MLT1000L Respiratory Flow Head 1 x MLA1028 Face Mask 1 x MLA1081 Flow Head Adapter 1 x MLA1013 35 mm (ID) Adapter 1 x MLA1015 Breathing Tube 1 x MLA6024 Desiccant Cartridge 1 x MLA0343 Drying Tube 1 x Thermistor Temperature Sensor 2 x Silicon Tube with Luers	1 x MLA1013 35 mm (ID) Adapter 1 x MLA1015 Breathing Tube 1 x MLS240 Metabolic Module
	Chart Software Modules
	MLS240 Metabolic Module (Windows® & Mac®)
	MLS310 Heart Rate Variability Module (Windows® & Mac®)
	MLS360 ECG Analysis Module (Windows®)

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PowerLab systems and signal conditioners meet the European EMC directive. ADInstruments signal conditioners for human use are approved to the IEC60601-1 patient safety standard and meet the CSA C22.2 No. 601.1-M90 and UL Std No. 2601-1 safety of medical electrical equipment standards.



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