

**FLUKE**®

**Biomedical**

# **PS415**

Patient Simulator

## Operators Manual

PN 2572338

March 2006

© 2006 Fluke Corporation, All rights reserved. Printed in USA  
All product names are trademarks of their respective companies.

# ***Warranty and Product Support***

Fluke Biomedical warrants this instrument against defects in materials and workmanship for one full year from the date of original purchase. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to Fluke Biomedical. This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than Fluke Biomedical. **IN NO EVENT SHALL FLUKE BIOMEDICAL BE LIABLE FOR CONSEQUENTIAL DAMAGES.**

Only serialized products and their accessory items (those products and items bearing a distinct serial number tag) are covered under this one-year warranty. **PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY.** Items such as cables and non-serialized modules are not covered under this warranty.

Recalibration of instruments is not covered under the warranty.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country. This warranty is limited to repairing the instrument to Fluke Biomedical's specifications.

## ***Warranty Disclaimer***

Should you elect to have your instrument serviced and/or calibrated by someone other than Fluke Biomedical, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to Fluke Biomedical for factory service and calibration, especially during the original warranty period.

## ***Notices***

---

### **All Rights Reserved**

© Copyright 2006, Fluke Biomedical. No part of this publication may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language without the written permission of Fluke Biomedical.

---

### **Copyright Release**

Fluke Biomedical agrees to a limited copyright release that allows you to reproduce manuals and other printed materials for use in service training programs and other technical publications. If you would like other reproductions or distributions, submit a written request to Fluke Biomedical.

---

## Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

---

## Technical Support

For application support or answers to technical questions, either email [techservices@flukebiomedical.com](mailto:techservices@flukebiomedical.com) or call 1-800- 648-7952 or 1-425-446-6945.

---

## Claims

Our routine method of shipment is via common carrier, FOB origin. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim. If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact Fluke Biomedical or your local sales representative.

---

## Standard Terms and Conditions

### Refunds and Credits

Please note that only serialized products and their accessory items (i.e., products and items bearing a distinct serial number tag) are eligible for partial refund and/or credit. Nonserialized parts and accessory items (e.g., cables, carrying cases, auxiliary modules, etc.) are not eligible for return or refund. Only products returned within 90 days from the date of original purchase are eligible for refund/credit. In order to receive a partial refund/credit of a product purchase price on a serialized product, the product must not have been damaged by the customer or by the carrier chosen by the customer to return the goods, and the product must be returned complete (meaning with all manuals, cables, accessories, etc.) and in “as new” and resalable condition. Products not returned within 90 days of purchase, or products which are not in “as new” and resalable condition, are not eligible for credit return and will be returned to the customer. The Return Procedure (see below) must be followed to assure prompt refund/credit.

### Restocking Charges

Products returned within 30 days of original purchase are subject to a minimum restocking fee of 15 %. Products returned in excess of 30 days after purchase, but prior to 90 days, are subject to a minimum restocking fee of 20 %. Additional charges for damage and/or missing parts and accessories will be applied to all returns.

### Return Procedure

All items being returned (including all warranty-claim shipments) must be sent freight-prepaid to our factory location. When you return an instrument to Fluke Biomedical, we recommend using United Parcel Service, Federal Express, or Air Parcel Post. We also recommend that you insure your shipment for its actual replacement cost. Fluke Biomedical will not be responsible for lost shipments or instruments that are received in damaged condition due to improper packaging or handling.

Use the original carton and packaging material for shipment. If they are not available, we recommend the following guide for repackaging:

- Use a double-walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use nonabrasive material around all projecting parts.
- Use at least four inches of tightly packed, industry-approved, shock-absorbent material around the instrument.

**Returns for partial refund/credit:**

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, obtained from our Order Entry Group at 1-800-648-7952 or 1-425-446-6945.

**Repair and calibration:**

To find the nearest service center, goto [www.flukebiomedical.com/service](http://www.flukebiomedical.com/service) or

In the U.S.A.:

Cleveland Calibration Lab

Tel: 1-800-850-4606

Email: [globalcal@flukebiomedical.com](mailto:globalcal@flukebiomedical.com)

Everett Calibration Lab

Tel: 1-888-993-5853

Email: [service.status@fluke.com](mailto:service.status@fluke.com)

In Europe, Middle East, and Africa:

Eindhoven Calibration Lab

Tel: +31-402-675300

Email: [ServiceDesk@fluke.com](mailto:ServiceDesk@fluke.com)

In Asia:

Everett Calibration Lab

Tel: +425-446-6945

Email: [service.international@fluke.com](mailto:service.international@fluke.com)

---

## Certification

This instrument was thoroughly tested and inspected. It was found to meet Fluke Biomedical's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Institute of Standards and Technology (NIST). Devices for which there are no NIST calibration standards are measured against in-house performance standards using accepted test procedures.

---

## WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Fluke Biomedical will not be responsible for any injuries sustained due to unauthorized equipment modifications.

---

## Restrictions and Liabilities

Information in this document is subject to change and does not represent a commitment by Fluke Biomedical. Changes made to the information in this document will be incorporated in new editions of the publication. No responsibility is assumed by Fluke Biomedical for the use or reliability of software or equipment that is not supplied by Fluke Biomedical, or by its affiliated dealers.

---

## Manufacturing Location

The PS415 Patient Simulator is manufactured in Everett, WA, U.S.A.

# Table of Contents

Chapter	Title	Page
<b>1</b>	<b>General Information .....</b>	<b>1-1</b>
	Introduction .....	1-3
	Safety Considerations .....	1-3
	General Specifications .....	1-4
	ECG Waveforms .....	1-4
	Normal Sinus Rhythms .....	1-4
	ECG Performance .....	1-5
	ECG Arrhythmias .....	1-5
	Blood Pressure .....	1-5
	BP Channel 1 Waveforms .....	1-6
	BP Channel 2 Waveforms .....	1-6
	Respiration .....	1-6
	Temperature .....	1-7
	Lead Test .....	1-7
	Data Interface .....	1-7
	Instrument Familiarity .....	1-8
	Accessories .....	1-10
<b>2</b>	<b>Installation .....</b>	<b>2-1</b>
	Battery or Battery Eliminator .....	2-3
	Battery .....	2-3
	Battery Eliminator .....	2-4
	ECG Output Snaps .....	2-4
	High-Level ECG Output .....	2-5
	Blood Pressure Outputs .....	2-5
	Temperature Output .....	2-6
	RS-232 Serial Port .....	2-6
<b>3</b>	<b>Operating Instructions .....</b>	<b>3-1</b>
	Power-Up Initialization .....	3-3
	Settings .....	3-4
	ECG Waveforms .....	3-4
	Normal Sinus Rhythm .....	3-5
	ECG Performance .....	3-6
	ECG Arrhythmias .....	3-7
	ECG Amplitude .....	3-8

Blood Pressure.....	3-9
Respiration .....	3-11
Temperature .....	3-12
Lead Test.....	3-12
Serial Port Operation.....	3-13
Remote Commands .....	3-13
Waveform Commands.....	3-13
Normal Sinus Rhythm.....	3-14
ECG Performance.....	3-15
ECG Arrhythmias.....	3-16
ECG Amplitude.....	3-16
Blood Pressure Channel 1 .....	3-17
Blood Pressure Channel 2 .....	3-18
Respiration Rate .....	3-18
Respiration Amplitude .....	3-19
Respiration Apnea .....	3-19
Output Connections.....	3-20

# List of Tables

<b>Table</b>	<b>Title</b>	<b>Page</b>
1-1.	Symbols.....	1-3
1-2.	PS415 Controls and Connectors.....	1-9
1-3.	Accessories .....	1-10
3-1.	Error Codes .....	3-3
3-2.	Power-Up Simulation Settings .....	3-4
3-3.	Normal Sinus Rhythm Base Rate Settings .....	3-5
3-4.	ECG Performance Settings.....	3-6
3-5.	ECG Arrhythmia Waveform Settings .....	3-7
3-6.	ECG Amplitude Settings.....	3-8
3-7.	Blood Pressure Channel 1 Settings.....	3-9
3-8.	Blood Pressure Channel 2 Settings.....	3-10
3-9.	Respiration Rate .....	3-11
3-10.	Respiration Amplitude .....	3-12
3-11.	Respiration Apnea .....	3-12
3-12.	Normal Sinus Rhythm Commands .....	3-14
3-13.	ECG Performance Commands .....	3-15
3-14.	ECG Arrhythmia Commands .....	3-16
3-15.	ECG Amplitude Commands.....	3-16
3-16.	Blood Pressure Channel 1 Commands .....	3-17
3-17.	Blood Pressure Channel 2 Commands .....	3-18
3-18.	Respiration Rate Commands .....	3-18
3-19.	Respiration Amplitude Commands .....	3-19
3-20.	Respiration Apnea Commands .....	3-19
3-21.	Back Panel DIN Connector Pin Descriptions.....	3-20





# ***List of Figures***

<b>Figure</b>	<b>Title</b>	<b>Page</b>
1-1.	PS415 Patient Simulator.....	1-8



# **Chapter 1**

## **General Information**

<b>Contents</b>	<b>Page</b>
Introduction.....	1-3
Safety Considerations .....	1-3
General Specifications .....	1-4
ECG Waveforms .....	1-4
Normal Sinus Rhythms .....	1-4
ECG Performance .....	1-5
ECG Arrhythmias.....	1-5
Blood Pressure .....	1-5
BP Channel 1 Waveforms .....	1-6
BP Channel 2 Waveforms .....	1-6
Respiration .....	1-6
Temperature .....	1-7
Lead Test.....	1-7
Data Interface.....	1-7
Instrument Familiarity .....	1-8
Accessories .....	1-10



## Introduction


The PS415 Patient Simulator (hereafter “the Simulator”) is a high–performance patient simulator that generates the following simulations:

- ECG
- Blood Pressure
- Respiration
- Temperature

The Simulator is intended for biomedical equipment technicians or service representatives to test the basic operation of physiological monitoring and diagnostic equipment. These tests are typically conducted during routine or scheduled preventive maintenance inspections.



The Simulator also verifies calibration to the precision stated in the *Specifications* section of this manual. For the recommended inspection protocol and the required level of precision, refer to the service or maintenance manual for the actual equipment under test (EUT). The Simulator is not intended to be used as the primary signal source for the initial validation of patient–related equipment

## Safety Considerations

In this manual, a **Warning** identifies conditions and actions that pose hazards to the user. A **Caution** identifies conditions and actions that may damage the Simulator or the equipment under test. Do not proceed beyond a warning or caution until the indicated conditions are fully understood and met. The  symbol means there is information in the Operators Manual that should be referenced.

To ensure safe operation of the Simulator, observe all instructions and warnings contained in this manual.

**Table 1-1. Symbols**

	Hazardous voltage.		Risk of danger. Important information. Refer to the manual.
---	--------------------	---	---

## **General Specifications**

### **Power requirements**

<b>Battery</b> .....	9 volt battery
<b>Battery Life</b> .....	50 hours
<b>Line Power</b> .....	Battery eliminator 7.7 Vdc @ 100 mA unregulated Connector: 2.5 mm center (+)

### **Temperature Performance**

<b>Operating</b> .....	15 °C to 35 °C (59 °F to 95 °F)
<b>Storage</b> .....	0 °C to 55 °C (32 °F to 131 °F)
<b>Weight</b> .....	0.34 kg (0.75 lb)
<b>Size</b> .....	3.8 cm H x 16.0 cm L x 10.4 cm W (1.5" H x 6.3" L x 4.1" W)
<b>Display</b> .....	2-digit numeric LCD display

## **ECG Waveforms**

The Simulator generates a 12-lead ECG simulation. A single-ended signal is resistively divided to produce a 12-lead ECG simulation. These signals are referenced to the right leg (RL) electrode.

## **Normal Sinus Rhythms**

<b>Rates</b> .....	30, 40, 60, 70, 80, 90, 100, 120, 140, 150, 160, 180, 200, 210, 220, 240, 270, 300, and 350 BPM.
<b>Accuracy</b> .....	± 1 %
<b>Auto</b> .....	Automatically steps through the following rates at 30-second intervals: 30, 60, 80, 120, 180, and 240 BPM.
<b>Amplitudes</b> .....	Lead II: 0.5, 1.0, 1.5, and 2.0 mV. Accuracy: ± 5% 2-Hz square wave at 1.0 mV p-p. (Lead II).
<b>Impedances</b> .....	Limb-lead impedance selections are 500 or 1000 Ω. V Leads are 1000 Ω Accuracy: ± 5%

## **ECG Performance**

**Manual Selections:**

- Pulse** ..... 4 seconds
- Square wave**..... 2 Hz
- Triangle wave** ..... 2 Hz
- Sine waves** ..... 0.5, 10, 40, 50, 60, and 100 Hz.

**Automated Sequence** ..... A series of the above-listed performance waveforms output in the following sequence: square wave; pulse; sine waves 10, 40, 50, 60, and 100 Hz; and triangle wave.

## **ECG Arrhythmias**

- Atrial fibrillation
- Second degree A–V block, type 1
- Right bundle branch block
- Premature atrial contraction
- Premature ventricular contraction, standard
- Premature ventricular contraction, early
- Premature ventricular contraction, R on T
- Multifocal PVCs
- Bigeminy
- Run of 5 PVCs
- Ventricular tachycardia
- Ventricular fibrillation
- Pacemaker
- Fetal / Maternal

## **Blood Pressure**

The specifications listed below apply to both blood pressure channels. Blood pressure channel 1 and 2 waveforms follow next.

- Input/Output Impedance** ..... 300Ω
- Exciter Input Voltage Range:**..... 2 V to 16 V
- Output Sensitivity Selections:**..... 5 or 40μV/ V/mmHg
- Output Range:**..... 0 to + 300 mmHg.  
 Accuracy: ±1% of full range + 1 mmHg

Dynamic blood pressure waveforms are specified only at 80 BPM normal sinus rhythm ECG.

- Rates:**..... All dynamic pressures track all normal sinus rates and all arrhythmias.
- Isolation:**..... Electrically isolated from the rest of the instrument.

## **BP Channel 1 Waveforms (mmHg)**

**Manual Selections:**

- Arterial (120/80)
- Left ventricle (120/0)
- Central venous pressure (15/10)
- Right ventricle (25/0)
- Pulmonary artery (25/10)
- Pulmonary artery wedge (10/2)
- Atmosphere (0)
- Static pressures: 20, 40, 80, 100, 200, 250, and 300.
- Artifact BP1/BP2

**Automated Sequence:**..... A series of blood pressure static levels output in the following sequence: atmosphere 0, 20, 40, 80, 100, 200, 250, and 300.

## **BP Channel 2 Waveforms (mmHg)**

**Manual Selections:**

- Atmosphere (0)
- Track BP1 Mode.....BP2 tracks BP1 setting to facilitate testing patient monitoring equipment with dual BP channels.
- Central venous pressure (15/10)
- Swan–Ganz: Insert
- Swan–Ganz: Inflate
- Swan–Ganz: Deflate
- Swan–Ganz: Remove

**Automated Sequence:**..... A series of blood pressure static levels output in the following sequence: atmosphere 0, 20, 40, 80, 100, 200, 250, and 300.

*Note*

*For descriptions, refer to BP Channel 2 in the Settings section of Chapter 3*

## **Respiration**

**Output Configurations:**..... Lead I, II, and RL to LL.

**Baseline Impedances:**..... 500 and 1000 Ω.  
Accuracy: ± 5 %



<b>Delta Impedances:</b> .....	0.1, 0.2, 0.5, 1.0, and 3.0 $\Omega$ . Accuracy: $\pm 10$ % of setting
<b>Normal Physiological Rates:</b> .....	0, 15, 20, 30, 40, 60, 80, 100, and 120 BrPM.
<b>Accuracy:</b> .....	$\pm 5$ %
<b>Apneas:</b> .....	12 and 32 seconds.

## **Temperature**

<b>Selections:</b> .....	30°C (86°F), 37°C (98.6°F), and 40°C (104°F). Accuracy: $\pm 0.4$ °C
<b>Probe Compatibility:</b> .....	YSI 400 series and YSI 700 series.
<b>Isolation:</b> .....	Electrically isolated from the rest of the instrument. The connector shell is to common ground.

## **Lead Test**

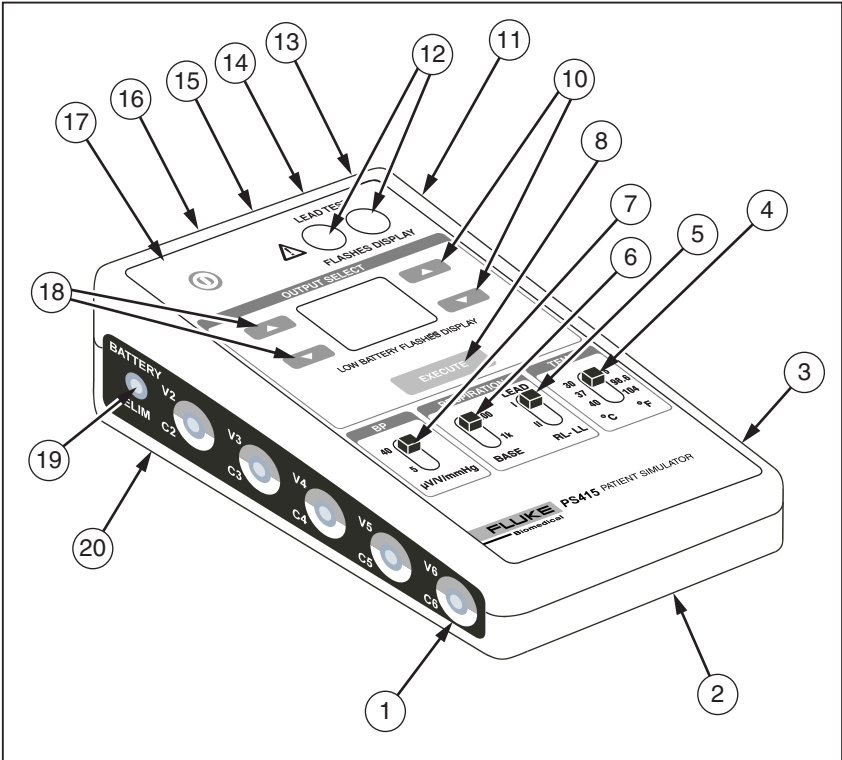
If the resistance is less than 1 k $\Omega$ , the display flashes at the rate of 4 Hz.

## **Data Interface**

<b>Serial Port:</b> .....	RS-232 compatible.  5-pin mini DIN female connector.  Bi-directional port for controlling the instrument.  Baud Rate: 2400
---------------------------	---

## **Instrument Familiarity**

Table 1-1 identifies the controls and connectors of the PS415 Simulator called out in Figure 1-1.



ehe1.eps

**Figure 1-1. PS415 Patient Simulator**

**Table 1-2. PS415 Controls and Connectors**

<b>Item</b>	<b>Description</b>
①	ECG Snaps: V6, V5, V4, V3, and V2.
②	Pullout Card
③	ECG Snaps: RL, RA, LA, LL, and V1.
④	Temperature Select Switch
⑤	Respiration Lead Select Switch
⑥	Respiration Baseline Impedance Select Switch
⑦	Blood Pressure Sensitivity Select Switch
⑧	Execute Key
⑨	Right Selector Keys (Increment/decrement right display character.)
⑩	Two-Character Display
⑪	High-Level ECG Output
⑫	Lead Test Terminals
⑬	Blood Pressure Channel 1 Output
⑭	Blood Pressure Channel 2 Output
⑮	RS-232 Serial Port
⑯	Temperature Output
⑰	Power-On/Off Key
⑱	Left Selector Keys (Increment/decrement left display character.)
⑲	Battery Eliminator Input
⑳	Battery Compartment

**Accessories****Table 1-3. Accessories**

<b>Item</b>	<b>Fluke Part #</b>
<b>Standard</b>	
Operators Manual	2572338
Battery Eliminator (90 – 264 Vac, 9 V, IEC-320/C6 inlet)	2183983
Battery, 9-volt alkaline (Duracell MN1604 or equiv.)	614487
Power Cord	See Note 1
ECG Electrode Adapter	2242609
Carrying Case	2248505
<b>Optional</b>	
Calibration Manual	2577812
Cable, High Level ECG (3.5 mm phone to BNC)	2200116
RS-232 Interface Cable 5-pin mini DIN to D9F	2225362
Temperature Cable for YSI 400 series	2391976
Temperature Cable for YSI 700 series	2391983
Blood Pressure Cable, unterminated	2392010
Blood Pressure Cables, prewired for selected patient monitors.	See Note 1
[1] See a current Fluke Biomedical Price List for availability, part number, and price.	

# **Chapter 2**

## **Installation**

<b>Contents</b>	<b>Page</b>
Battery or Battery Eliminator.....	2-3
Battery .....	2-3
Battery Eliminator .....	2-4
ECG Output Snaps.....	2-4
High-Level ECG Output.....	2-5
Blood Pressure Outputs .....	2-5
Temperature Output.....	2-6
RS-232 Serial Port .....	2-6



## **Battery or Battery Eliminator**

The Simulator operates with an internal 9-volt battery or an external battery eliminator. Make sure you have the correct battery eliminator.

You can power up the Simulator after you install the 9-volt battery that shipped with it or after you connect the Simulator to the battery eliminator. Step-by-step installation and connection instructions follow in the next two sections.

### **Battery**

Install or replace the battery as explained below:

1. Turn the Simulator over so you are looking at the pullout card. Grasp the pullout card where you see the words “*ECG: Amplitude* mV LEAD II”. Now slide the pullout card away from the Simulator.
2. Locate the rectangular (approximately 1 in x 2 in) battery compartment cover. Next locate the half-inch rectangular notch on the one-inch side of the cover.
3. Put a small screwdriver into this notch and push toward the cover a sixteenth of an inch to release the latch\*. Lift the cover away from the battery compartment and set it aside.

*Note*

*Do not push the latch more than a sixteenth of an inch; otherwise, the latch weakens and it may break.*

4. Lift out the two-terminal snap connector. Attach this keyed connector to the 9-volt alkaline battery (Duracell MN1604 or equivalent\*). If the connector won't attach easily, rotate the battery 180 degrees and try again.

*Note*

*Do not use a mercury, air, or carbon-zinc battery.*

5. Put the battery and its attached wires into the battery compartment. Make sure the attached-wires end of the battery is on the side of the compartment where the cover latches.
6. Pick up the cover and hold the latch a half inch above its receptacle. With the cover held at this angle, insert the small

rectangular tab on the cover's opposite end into the indent in the compartment.

7. Push down on the latch side of the cover until it clicks shut. Slide the pullout card back into place.

If the cover bulges up and blocks movement of the pullout card, first remove the cover from the battery compartment as explained in step 3. Next lift the battery out and reorganize the wires. Finally, follow steps 5 through 7.

*Note*

*If the battery is low, the Simulator detects this and flashes the display at a rate of 1 Hz.*

## **Battery Eliminator**

Insert the battery eliminator plug into the "BATTERY ELIM" receptacle on the power-switch side of the Simulator. Plug the battery eliminator box into a mains outlet. Make sure you have the correct battery eliminator for the outlet you are using. Eliminator input is 7.7 to 9.0 Vdc, 100 mA, unregulated. The connector is 2.5mm, center (+).

*Note*

*Refer to the Accessories section in the General Information chapter and to the current Fluke Biomedical Price List for availability, part number information, and price.*

## **ECG Output Snaps**

Ten ECG snaps are located along the right and the left sides of the Simulator. Adapter kits for 3.2- or 4-mm electrodes are available from Fluke Biomedical. Output snaps are color-coded with both AHA (American Heart Association) and IEC (International Electrotechnical Commission) standards.



*Note*

*Refer to the Accessories section in the General Information chapter and to the current Fluke Biomedical Price List for availability, part number information, and price.*

## **High-Level ECG Output**

This output connects to high-level patient monitors. It is labeled “HI-LEVEL ECG” and is located on the right-side panel .

*Note*

*A generic or standard test lead, obtainable from any of several suppliers of industrial equipment, can be used for this connection.*

The connector is a 3.5-mm phone jack with a Lead II waveform at 0.5 V/mV of the low-level Lead II signal.

*Note*

*If Lead II is set to 1 mV, the high-level output will be 0.5 V.*

## **Blood Pressure Outputs**

The blood pressure outputs, located on the top panel of the Simulator, are two 6-pin mini DIN female connectors labeled “BP1” and “BP2”. Cables prewired for many monitors\* and an un-terminated cable\*\* are available from Fluke Biomedical to connect to these outputs.

*Note*

*Refer to the current Fluke Biomedical Price List for availability, part number information, and price.*

*Note*

*See table on page 3-20 for the pin-outs of Blood Pressure connectors and refer to the section in the General Information chapter.*

## **Temperature Output**

This output is labeled “TEMP” and is a 8-pin mini DIN female connector, also on the top panel of the Simulator. Temperature cables\* are available from Fluke Biomedical. The type of probe simulated—either the 400 or 700 series YSI—determines the type of cable to use.

### *Note*

*Refer to the Accessories section in the General Information chapter and to the current Fluke Biomedical Price List for availability, part number information, and price.*

## **RS-232 Serial Port**

The RS-232 serial port can control all test functions except switch settings when used with a personal computer or a compatible terminal device. An RS-232 interface cable\*, available from Fluke Biomedical, connects to a 5-pin mini DIN female connector labeled “RS-232” on the top panel of the instrument.

### *Note*

*Refer to the Accessories section in the General Information chapter and to the current Fluke Biomedical Price List for availability, part number information, and price.*

# Chapter 3

## Operating Instructions

Contents	Page
Power-Up Initialization.....	3-3
Settings .....	3-4
ECG Waveforms.....	3-4
Normal Sinus Rhythm.....	3-5
ECG Performance .....	3-6
ECG Arrhythmias.....	3-7
ECG Amplitude.....	3-8
Blood Pressure .....	3-9
Respiration.....	3-11
Temperature.....	3-12
Lead Test.....	3-12
Serial Port Operation .....	3-13
Remote Commands.....	3-13
Waveform Commands .....	3-13
Normal Sinus Rhythm.....	3-14
ECG Performance .....	3-15
ECG Arrhythmias.....	3-16
ECG Amplitude.....	3-16
Blood Pressure Channel 1 .....	3-17
Blood Pressure Channel 2 .....	3-18
Respiration Rate.....	3-18
Respiration Amplitude .....	3-19
Respiration Apnea.....	3-19
Output Connections .....	3-20



## Power-Up Initialization

The Simulator operates with an internal 9-volt battery or an external battery eliminator. Before you power it up, make sure you’ve installed the supplied battery or connected the correct battery eliminator for the mains outlet you are using.

*Note*

*For battery eliminator connection instructions, refer to the Battery Eliminator section in the preceding chapter, Installation. For battery installation or replacement instructions, refer to the Battery section in preceding chapter, Installation.*

1. Locate the “POWER” switch on the Simulator’s front panel in the upper left corner. Press it once to power up the instrument.

*Note*

*If the battery is low, the Simulator detects this and flashes the display at the rate of 1 Hz. Upon power-up, the Simulator performs a self-test. After the self-test, one of the error codes listed below may show on the display.*

**Table 3-1. Error Codes**

Error Code	Explanation
E1	RAM has failed
E2	EPROM or EEPROM checksum is in error
E3	RAM has failed and EPROM or EEPROM checksum is in error
E4	Illegal interrupt

2. During the first couple of seconds after power-up, the display shows either *a)* the error code for one second; then the number “34” or *b)* the firmware version for one second; then the number “34”.
3. The number 34 showing on the display indicates one of the simulation settings present at power-up: ECG normal sinus rhythm at 80 BPM. Listed below, by simulation type, is each simulation setting present at power-up.

Table 3-2. Power-Up Simulation Settings

Simulation Setting	Simulation Type
ECG	<i>Waveform:</i> Normal sinus rhythm <i>Baseline BPM:</i> 80 <i>Amplitude:</i> 1 mV, Lead II
Blood Pressure	<i>BP channels 1 and 2:</i> Atmosphere
Respiration	<i>Waveform:</i> Normal <i>Rate:</i> 20 BrPM <i>Delta impedance:</i> 1.0 $\Omega$

*Note*

*The simulations and their two-character settings are listed on the pullout card at the bottom of the instrument as well as in the Settings section on page 3-5.*

Anytime while the instrument is running, you can review current settings by incrementing the left digit on the display.

- When the left digit has a corresponding right digit showing on the display, the two digits indicate the currently running simulation.
- When a left digit has no corresponding right digit showing (i.e., the right display is blank), no simulation in that group is running.

## Settings

Choose a setting by pressing the left and right selector keys until the two-character setting you want appears on the display. Press the <EXECUTE> key to start outputting this setting's simulation.

The two-character settings and their associated output simulations are listed in the sections that follow.

## ECG Waveforms

The following sections describe how to set up the various waveforms of the Simulator.

## Normal Sinus Rhythm

The following settings set the normal sinus rhythm baseline rate and cancel the prior settings.

**Table 3-3. Normal Sinus Rhythm Base Rate Settings**

Setting	Rate	Simulation
30	30 BPM	Normal sinus rhythm at 30 BPM
31	40 BPM	Normal sinus rhythm at 40 BPM
32	60 BPM	Normal sinus rhythm at 60 BPM
33	70 BPM	Normal sinus rhythm at 70 BPM
34	80 BPM	Normal sinus rhythm at 80 BPM
35	90 BPM	Normal sinus rhythm at 90 BPM
36	100 BPM	Normal sinus rhythm at 100 BPM
37	120 BPM	Normal sinus rhythm at 120 BPM
38	140 BPM	Normal sinus rhythm at 140 BPM
39	150 BPM	Normal sinus rhythm at 150 BPM
40	160 BPM	Normal sinus rhythm at 160 BPM
41	180 BPM	Normal sinus rhythm at 180 BPM
42	200 BPM	Normal sinus rhythm at 200 BPM
43	210 BPM	Normal sinus rhythm at 210 BPM
44	220 BPM	Normal sinus rhythm at 220 BPM
45	240 BPM	Normal sinus rhythm at 240 BPM
46	270 BPM	Normal sinus rhythm at 270 BPM
47	300 BPM	Normal sinus rhythm at 300 BPM
48	350 BPM	Normal sinus rhythm at 350 BPM
49	Auto	Automated sequence: each segment runs for 30 seconds in this order 30, 60, 80, 120, 180, and 240 BPM; then repeats.

## ECG Performance

Table 3-4 lists the ECG performance settings available on the Simulator. During ECG performance simulations, the blood pressure and respiration simulations are turned off.

**Table 3-4. ECG Performance Settings**

Setting	Simulation
70	Pulse at 4 seconds, square
71	Square wave at 2 Hz
72	Triangle wave at 2 Hz
73	Sine wave at 0.5 Hz
74	Sine wave at 10 Hz
75	Sine wave at 40 Hz
76	Sine wave at 50 Hz
77	Sine wave at 60 Hz
78	Sine wave at 100 Hz
79	<p>Automated performance sequence.</p> <p>The 2-Hz square wave outputs continuously.</p> <p>To advance, press the &lt;EXECUTE&gt; key.</p> <p>Next, the pulse outputs for 4 seconds; then the sequence automatically advances.</p> <p>The following sine waves output for 2 seconds each: 10, 40, 50, 60, and 100 Hz; then the sequence automatically advances.</p> <p>The triangle wave outputs continuously until you press the &lt;EXECUTE&gt; key; then the 2-Hz square wave outputs continuously.</p>

### Note

*All ECG performance simulations are referenced to Lead II. The amplitude of Lead II continues at its most recent setting. If you haven't set the amplitude, it will be 1 mV (its setting at power-up.)*

At anytime, you can change the amplitude of Lead II by entering one of the two-character settings listed in the ECG Amplitude section on page 3-8.



## ECG Arrhythmias

Table 3-5 lists the ECG Arrhythmia Settings available on the Simulator. The following selections that contain normal beats have an 80–BPM rate. Unless otherwise stated, the PR interval is 0.16 seconds.

When an arrhythmia contains one or more abnormal beats within a series of normal beats, the abnormal beat is the second beat of the total series starting after one normal beat.

**Table 3-5. ECG Arrhythmia Waveform Settings**

Setting	Waveform	Simulation
50	AFIB	Atrial fibrillation. Rapid irregular atrial signal with no real P–waves. Irregular ventricular rate.
51	2° BLOCK I	Second–degree AV block, type I. Waveform similar to right bundle branch block except PR interval is 0.25 seconds. Eighteen beats at 80 BPM followed by two missed beats; then repeats.
52	RBB BLOCK	Right bundle branch block. Wide QRS complexes. An 80–BPM rate with a PR interval of 0.16 seconds.
53	PAC	Premature atrial contraction. Normal sinus rhythm except every tenth beat is premature by 25%.
54	PVC Std	Premature ventricular contraction, standard—25% premature.
55	PVC Early	Premature ventricular contraction, early—33% premature.
56	PVC R on T	Premature ventricular contraction, R on T—65% premature (260 ms after R wave).
57	Multifocal PVCs	Normal sinus rhythm except two of every fifteen beats are PVCs of two different types.
58	Bigeminy	Bigeminy. Normal beat followed by a PVC; then repeats.

**Table 3-5, ECG Arrhythmia Waveform Settings (cont)**

Setting	Waveform	Simulation
59	Run of 5 PVCs	Five PVCs together in a series with eight normal beats; then repeats.
60	VTACH	Ventricular tachycardia. Similar to left focus PVCs at 180 BPM.
61	VFIB	Ventricular fibrillation. Irregular ventricular waveform.
62	Paced	Series of paced beats at 75 BPM.
63	Fetal/Maternal	Maternal ECG with fetal ECG added.

### *ECG Amplitude*

At anytime, you can set the amplitude of Lead II using the settings below. The ECG amplitude setting affects all ECG waveform simulations. At power-up, this setting returns to 1 mV.

**Table 3-6. ECG Amplitude Settings**

Setting	Simulation
A0	Lead II: 0.5 mV
A1	Lead II: 1.0 mV
A2	Lead II: 1.5 mV
A3	Lead II: 2.0 mV

#### *Note*

*Instructions for connecting the Simulator to a high-level patient monitor are in the High-Level ECG Output section on page 2-5.*

The high-level output is approximately 0.5 V/mV of the low-level output. For instance, if Lead II is set to 1 mV, the high-level output will be 0.5 V.

## Blood Pressure

There are two blood pressure channels. Each channel can be programmed separately or channel two can be set to track channel one.

*Note*

*Refer to the Blood Pressure Outputs section on page 3-20 for information about connecting to these outputs.*

1. Set the blood pressure sensitivity switch to match the patient monitor's input sensitivity—either 5 or 40  $\mu\text{V/V/mmHg}$ .
2. The dynamic blood pressures are specified for their systolic and diastolic values for rates of 80 BPM or less. For higher rates, the systolic pressure stays the same but the diastolic pressure increases as the rate increases.
3. All dynamic pressures are synchronized with all normal sinus rhythm rates and physiologically track all arrhythmias.
4. Choose a blood pressure setting from Table 3-7 and Table 3-8 below.

**Table 3-7. Blood Pressure Channel 1 Settings**

Setting	Waveform	Simulation
00	ART	Arterial at 120/80 mmHg
01	LV	Left ventricle at 120/0 mmHg
02	CVP	Central venous pressure at 15/10 mmHg
03	RV	Right ventricle at 25/0 mmHg
04	PA	Pulmonary artery at 25/10 mmHg
05	PAW	Pulmonary artery wedge at 10/2 mmHg
10	ATM	Atmosphere (0 mmHg)
11	20	Static pressure: 20 mmHg
12	40	Static pressure: 40 mmHg
13	80	Static pressure: 80 mmHg
14	100	Static pressure: 100 mmHg
15	200	Static pressure: 200 mmHg

**Table 3-7. Blood Pressure Channel 1 Settings (cont)**

<b>Setting</b>	<b>Waveform</b>	<b>Simulation</b>
16	250	Static pressure: 250 mmHg
17	300	Static pressure: 300 mmHg
18	Auto	Automated sequence: each segment runs for 12 seconds in this order atmosphere (0), 20, 40, 80, 100, 200, 250, and 300; then repeats.
19 <sup>[1]</sup>	Artifact BP1/BP2	Respiration artifact is superimposed onto any blood pressure waveform. Arterial and left ventricular waveforms are modulated by 5%; all others have a respiration artifact of 5 mmHg added to them.  To turn this setting on and off, ensure that “19” shows on the display, then press <EXECUTE>.
[1] You can change blood pressure, normal sinus rhythm rate (BPM), or ECG arrhythmia settings before or after you select setting “19”.		

**Table 3-8. Blood Pressure Channel 2 Settings**

<b>Setting</b>	<b>Waveform</b>	<b>Simulation</b>
20	ATM	Atmosphere (0 mmHg)
21	Auto	Automated sequence: each segment runs for 12 seconds in this order atmosphere (0), 20, 40, 80, 100, 200, 250, and 300; then repeats.
22	Track BP1	Tracks BP Channel 1 setting.
23	CVP	Central venous pressure at 15/10 mmHg
24	Insert <sup>[1]</sup>	Swan–Ganz: Insert. The catheter tip advances automatically from atmosphere (ATM) to central venous pressure (CVP), then to right ventricle (RV) pressure, and then to the pulmonary artery (PA). Runs each waveform for 8 seconds.
25	Inflate <sup>[1]</sup>	Swan–Ganz: Inflate. The balloon in the catheter inflates to measure the pulmonary artery wedge (PAW) pressure.
26	Deflate <sup>[1]</sup>	Swan–Ganz: Deflate. The balloon in the catheter deflates and measures the earlier pulmonary artery (PA) pressure.

**Table 3-8. Blood Pressure Channel 2 Settings (cont)**

Setting	Waveform	Simulation
27	Remove <sup>[1]</sup>	Swan–Ganz: Remove. With the balloon deflated, the catheter is removed and vented to atmosphere.
<p>[1] <b>Description of the Swan–Ganz Clinical Procedure:</b> The Swan–Ganz sequence begins with the Swan–Ganz catheter tip vented to atmosphere, proceeds through the venous side of the circulatory system, and terminates in a distal branch of the pulmonary artery. At this time, the balloon in the catheter inflates to measure the pulmonary artery wedge pressure. The balloon can be either deflated or reinflated, and the catheter can be removed as desired.</p> <p>Swan–Ganz simulations operate only at 80 BPM. Starting the Swan–Ganz simulation forces the ECG waveform simulation to 80 BPM.</p>		

## Respiration

The respiration signal is output across the ECG leads.

Set the respiration lead select switch, “LEAD”, to the lead configuration expected by the patient monitor: I, II, or RL to LL.

Use the respiration baseline impedance select switch, “BASE”, to set the impedance between two limb leads: 500 Ω or 1 kΩ.

Select your settings from the charts below.

**Table 3-9. Respiration Rate**

Setting	Simulation
80	0 BrPM
81	15 BrPM
82	20 BrPM
83	30 BrPM
84	40 BrPM
85	60 BrPM
86	80 BrPM
87	100 BrPM
88	120 BrPM

Table 3-10. Respiration Amplitude

Setting	Simulation
90	0.1 $\Omega$
91	0.2 $\Omega$
92	0.5 $\Omega$
93	1.0 $\Omega$
94	3.0 $\Omega$

Table 3-11. Respiration Apnea

Setting	Simulation
95	Generates 12 seconds of apnea every time it is selected.
96	Generates 32 seconds of apnea every time it is selected.

## Temperature

Temperature simulation is set using either the Celsius or Fahrenheit scale with the temperature select switch on the front-panel.

### Note

*To connect to the patient monitor, see the Temperature Output section on page 3-20.*

## Lead Test

Connect each end of the lead to be tested\* to each lead test terminal. The display flashes at a rate of 4 Hz if the lead is good.

### Note

*The lead test connectors are compatible with the older-style electrodes that have the exposed metal pin (1.5-mm [0.06-inch]) and the disposable ECG snaps. To test the newer insulated "safety-touch proof" type of electrode, use the included adapter to make the connection to the Simulator.*

## **⚠ ⚠ Warning**

**Use the ECG Electrode Adapter for testing purposes only. It is not intended for clinical use with either ECG or apnea monitoring devices.**

## Serial Port Operation

You can control remotely all functions except switch settings via RS-232 serial port operation. Use the remote commands to control the *Simulator* from a personal computer or other serial device.

### Note

*Specialized cables, available from Fluke Biomedical, are required for RS-232 remote control. Refer to the Accessories section on page 1-10 for the part numbers.*

Baud rate is 2400, parity is off, and there is one stop bit.

## Remote Commands

Remote commands can be sent in lower case or in upper case letters and all command strings must be terminated with a carriage return [CR] and/or a line feed [LF]; that is, [command][CR][LF], [command][CR], or [command][LF].

Illegal entries return the error message “WHAT [CR][LF]”, legal entries return “OK [CR][LF]”, and the entry [CR][LF] alone returns “?[CR][LF]”. The process can take up to one second during which time all other inputs are ignored.

To prevent functional inconsistencies, some commands can cause changes in certain parameters: for example, starting Swan-Ganz sets ECG to normal sinus rhythm at 80 BPM.

## Waveform Commands

The following remote commands simply turn on the specified waveform; they do not enter a special mode. All of these commands return “OK [CR][LF]”.

### Note

*Each command must be followed by a carriage return [CR] and/or a line feed [LF].*

## Normal Sinus Rhythm

Table 3-12 lists the remote commands for setting the Simulator to normal sinus rhythms.

**Table 3-12. Normal Sinus Rhythm Commands**

Remote Command	Description
30	30 BPM
31	40 BPM
32	60 BPM
33	70 BPM
34	80 BPM
35	90 BPM
36	100 BPM
37	120 BPM
38	140 BPM
39	150 BPM
40	160 BPM
41	180 BPM
42	200 BPM
43	210 BPM
44	220 BPM
45	240 BPM
46	270 BPM
47	300 BPM
48	350 BPM
49	Automated sequence <sup>[1]</sup>
[1] For a description of the automated sequence, see the Normal Sinus Rhythm section earlier in this chapter.	



**ECG Performance**

**Table 3-13. ECG Performance Commands**

Remote Command	Description
70	Pulse: 4 seconds
71	Square: 2 Hz
72	Triangle: 2 Hz
73	Sine: 0.5 Hz
74	Sine: 10 Hz
75	Sine: 40 Hz
76	Sine: 50 Hz
77	Sine: 60 Hz
78	Sine: 100 Hz
79	Automated performance sequence <sup>[1]</sup>
A9	Execute <sup>[2]</sup> <i>Simulates the &lt;EXECUTE&gt; key when using command</i>
<p>[1] For a description of the automated sequence, see the <i>ECG Performance</i> section in this chapter.</p> <p>[2] The 2-Hz square wave outputs continuously until the remote command "A9" is received. At this point the ECG performance simulations sequence automatically until the triangle wave. The triangle wave will output continuously until the remote command "A9" is again received; the cycle then starts again with the 2-Hz square wave outputting continuously.</p>	

**ECG Arrhythmias**

Table 3-14 lists the Remote Commands to set the Simulator's ECG Arrhythmias.

**Table 3-14. ECG Arrhythmia Commands**

<b>Remote Command</b>	<b>Description</b>
50	Atrial fibrillation
51	Second-degree AV block, type I
52	Right bundle branch block
53	Premature atrial contraction
54	PVC, standard
55	PVC, early
56	PVC, R on T
57	Multifocal PVCs
58	Bigeminy
59	Run of 5 PVCs
60	Ventricular tachycardia
61	Ventricular fibrillation
62	Paced
63	Fetal/Maternal

**ECG Amplitude**

Table 3-15 lists the Remote Commands for setting the Simulator's ECG Amplitude.

**Table 3-15. ECG Amplitude Commands**

<b>Remote Command</b>	<b>Description</b>
A0	Lead II: 0.5 mV
A1	Lead II: 1.0 mV
A2	Lead II: 1.5 mV
A3	Lead II: 2.0 mV

## Blood Pressure Channel 1 (mmHg)

Table 3-16 lists the Remote Commands for setting the Simulator's Blood Pressure Channel 1 parameters.

**Table 3-16. Blood Pressure Channel 1 Commands**

Remote Command	Description
00	Arterial (120/80)
01	Left ventricle (120/0)
02	Central venous pressure (15/10)
03	Right ventricle (25/0)
04	Pulmonary artery (25/10)
05	Pulmonary artery wedge (10/2)
10	Atmosphere (0)
11	Static pressure: 20 mmHg
12	Static pressure: 40 mmHg
13	Static pressure: 80 mmHg
14	Static pressure: 100 mmHg
15	Static pressure: 200 mmHg
16	Static pressure: 250 mmHg
17	Static pressure: 300 mmHg
18	Automated sequence <sup>[1]</sup>
19	Artifact BP1/BP2

[1] For a description of the automated sequence, see the *BP Channel 1* section in this chapter.

## Blood Pressure Channel 2 (mmHg)

Table 3-17 lists the Remote Commands for setting the Simulator's Blood Pressure Channel 2 parameters.

**Table 3-17. Blood Pressure Channel 2 Commands**

Remote Command	Description
20	Atmosphere (0)
21	Automated sequence <sup>[1]</sup>
22	Track BP1 <sup>[1]</sup>
23	Central venous pressure (15/10)
24	Swan-Ganz: Insert <sup>[1]</sup>
25	Swan-Ganz: Inflate <sup>[1]</sup>
26	Swan-Ganz: Deflate <sup>[1]</sup>
27	Swan-Ganz: Remove <sup>[1]</sup>
[1] For descriptions, see the <i>BP Channel 2</i> section earlier in this chapter	

## Respiration Rate

Table 3-18 lists the Remote Commands for setting the Simulator's Respiration Rate.

**Table 3-18. Respiration Rate Commands**

Remote Command	Description
80	0 BrPM
81	15 BrPM
82	20 BrPM
83	30 BrPM
84	40 BrPM
85	60 BrPM
86	80 BrPM
87	100 BrPM
88	120 BrPM

### **Respiration Amplitude**

Table 3-19 lists the Remote Commands for setting the Simulator’s Respiration Amplitude.

**Table 3-19. Respiration Amplitude Commands**

Remote Command	Description
90	0.1 Ω
91	0.2 Ω
92	0.5 Ω
93	1.0 Ω
94	3.0 Ω

### **Respiration Apnea**

Table 3-20 lists the Remote Commands for setting the Simulator’s Respiration Apnea parameters.

**Table 3-20. Respiration Apnea Commands**

Remote Command	Description
95	12 seconds
96	32 seconds

## Output Connections

**Table 3-21. Back Panel DIN Connector Pin Descriptions**

BP1 – BP2		RS-232		Temperature	
<p><b>BP1 - BP2</b></p>		<p><b>RS-232</b></p>		<p><b>Temperature</b></p>	
<b>6</b>	-Output	<b>1</b>	N/C	<b>6</b>	N/C
<b>3</b>	+Output	<b>2</b>	Reference	<b>4</b>	N/C
<b>1</b>	+Excitation	<b>3</b>	N/C	<b>7</b>	Common Temp.
<b>4</b>	-Excitation	<b>4</b>	Transmit	<b>2</b>	T1 400 Series
<b>2</b>	N/C	<b>5</b>	Receive	<b>8</b>	T1 700 Series
<b>5</b>	N/C			<b>5</b>	T2 700 Series
				<b>3</b>	N/C
				<b>1</b>	N/C