

**FLUKE®**

**Biomedical**

# MPS450 Multiparameter Simulator

## Service Manual

PN 2243361

February 2005

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# Notices

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 Service Fax: 425.446.5560  
 Internet: <http://www.flukebiomedical.com>

For additional sales or service information, contact your local Fluke Biomedical Distributor or Fluke Electronics office.

References in this manual to Bio-Tek International, Inc. and DNI Nevada, refer to companies that are now owned by Fluke Biomedical.

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## 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.

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## 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.

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## Standard Terms and Conditions

### Refunds & 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.

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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 Customer Service Department:

Customer Service  
Fluke Biomedical  
800-648-7592 (domestic) or 775-883-3400.

**Returns for service/repair/calibration:**

All returns for calibration and service repair require a Return Material Authorization (RMA) number. This number will be issued when you contact Fluke Customer Service to schedule your service. To schedule your next calibration or repair, call toll free 1-888-99F-LUKE (1-888-993-5853).

To request an RMA outside the US, email: [service.international@fluke.com](mailto:service.international@fluke.com).

Ship the instrument, freight-prepaid and fully insured, along with the applicable form, to the following address:

Fluke Biomedical  
1420 – 75<sup>th</sup> Street SW  
Everett, WA 98203

**Certification**

This instrument was thoroughly tested and inspected. It was found to meet Fluke Biomedical 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.

**Warranty****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 nonserialized 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.

In all cases, breaking the tamper-resistant Quality Seal should be avoided at all cost, as this seal is the key to your original instrument warranty. In the event that the seal must be broken to gain internal access to the instrument (e.g., in the case of a customer-installed firmware upgrade), you must first contact Fluke Biomedical's Service Department at 775-883-3400. You will be required to provide the serial number for your instrument as well as a valid reason for breaking the Quality Seal. You should break this seal only after you have received factory authorization. Do not break the Quality Seal before you have contacted us. Following these steps will help ensure that you will retain the original warranty on your instrument without interruption.

**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.

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**Manufacturing Location**

Fluke Biomedical  
6920 Seaway Blvd.  
Everett, WA 98203  
775-883-3400  
800-648-7952

# Safety Considerations

Authorized service personnel should service Fluke Biomedical's **MPS450™ Multiparameter Simulator** (hereafter referred to as the **MPS450**). For safety reasons, although the power output from the **MPS450** is not potentially dangerous, only an experienced technician should open the unit to access the inner electronics.

The following warning and informational symbols may be found on the **MPS450**:

Symbol	Description
	<b>Direct Current</b>
	<b>Caution</b> (Refer to accompanying documentation.)
	<b>ON/OFF</b> (Toggle for power connection/disconnection for operation.)

## Hazard Warnings

- ⇒ **Warning! Internal Voltage.** Always turn OFF the **MPS450** and unplug the battery eliminator before replacing the batteries or cleaning the outer surface.
- ⇒ **Warning! Liquids.** Avoid spilling liquids on the instrument; fluid seepage into internal components creates corrosion and a potential shock hazard. Do not operate the instrument if internal components are exposed to fluid.

## Precautions

- ⇒ **Caution: Environmental Conditions.** Do not expose the instrument to temperature extremes. Ambient operating temperatures should remain between 10 to 40 °C. Storage temperatures should remain between -25 to 50 °C. System performance may be adversely affected if temperatures fluctuate above or below these ranges, or if ambient humidity exceeds the maximum of 80 %.
- ⇒ **Caution: Do NOT Immerse.** Clean only with a damp, lint-free cloth. Use a mild detergent and wipe down gently.

# Abbreviations and Symbols

<b>BP</b>	blood pressure
<b>BrPM</b>	breaths per minute
<b>cc</b>	cubic centimeters
<b>DAC</b>	digital-to-analog converter
<b>°C</b>	degrees Celsius (centigrade)
<b>h</b>	hexadecimal
<b>Hg</b>	mercury
<b>Hz</b>	hertz
<b>kHz</b>	kilohertz
<b>kΩ</b>	kilohm
<b>LA</b>	left arm (lead)
<b>LCD</b>	liquid crystal display
<b>LL</b>	left leg (lead)
<b>m</b>	milli- ( $10^{-3}$ )
<b>MCU</b>	microcomputer
<b>MHz</b>	megahertz
<b>mm</b>	millimeter
<b>mV</b>	millivolt
<b>PCA</b>	printed circuit assembly (See <b>PCB</b> .)
<b>PCB</b>	printed circuit board (See <b>PCA</b> .)
<b>RA</b>	right arm (lead)
<b>RL</b>	right leg (lead)
<b>SPI</b>	Serial Peripheral Interface
<b>V</b>	volt
<b>μ</b>	micro- ( $10^{-6}$ )
<b>μV</b>	microvolt
<b>Ω</b>	ohm

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# **Chapter 1**

## **General Information**

### **Inside This Chapter**

- PURPOSE AND SCOPE
- RELATIONSHIP OF THIS MANUAL  
TO OTHER PUBLICATIONS
- EQUIPMENT DESCRIPTION
- EQUIPMENT-RELATIONSHIP  
ILLUSTRATION



## PURPOSE AND SCOPE

The purpose of this manual is to provide information that will assist a qualified technician to service Fluke Biomedical's **MPS450™ Multiparameter Simulator** (hereafter referred to as the **MPS450**).

## RELATIONSHIP OF THIS MANUAL TO OTHER PUBLICATIONS

It is assumed that the reader is familiar with the **MPS450** Operator's Manual (P/N 2243350), which provides a full description of this product along with operating instructions.

## EQUIPMENT DESCRIPTION

The **MPS450** is a lightweight, portable, battery-powered unit that provides multiple physiological simulations for ECG, blood pressure, respiration, temperature, pacemaker, artifact, and arrhythmia conditions.

The **MPS450** is available in one model with four configurations: the basic multiparameter simulator, the simulator with Cardiac-Output Option, the simulator with Fetal / Maternal ECG Option, and the simulator with both options. (Options are preprogrammed at time of purchase.) The Cardiac-Output Option requires a cardiac-output adapter box (P/N 2226808).

The microprocessor control of the **MPS450**, combined with extensive digital memory, assures rapid test and verification of cardiac-monitoring medical equipment. All simulation settings are displayed on the built-in LCD, with adjustable contrast. A keypad enables the entry of functions, parameters, and codes. Tests and simulations can be selected by choosing menu selections, by using front-panel keys to enter numeric codes for actions, or by using computer control.

The right side of the **MPS450** features connections for linking to blood-pressure, cardiac-output, and temperature monitors. In addition, there is an auxiliary connection for future expansion. The bottom of the **MPS450** features an RS-232 serial port and a connection for a battery eliminator.

The left side of the **MPS450** features a full set of universal ECG jacks, enabling the connection of any 3-, 5-, or 12-lead ECG device. AHA and IEC color-coded dots run along the left side of the face of the unit as an aid in connecting the corresponding U.S. and international patient leads to the proper universal ECG jacks on the **MPS450**:

LABEL	MEANING
RA or R	Right arm
LA or L	Left arm
RL or N	Right leg (reference or ground)
LL or F	Left leg
V <sub>1</sub> , V <sub>2</sub> , V <sub>3</sub> , V <sub>4</sub> , V <sub>5</sub> , and V <sub>6</sub>	V Leads (U.S. and Canada), also referred to as <i>pericardial</i> , <i>precordial</i> , or <i>unipolar chest leads</i>
C <sub>1</sub> , C <sub>2</sub> , C <sub>3</sub> , C <sub>4</sub> , C <sub>5</sub> , and C <sub>6</sub>	Chest leads (International)

### EQUIPMENT-RELATIONSHIP ILLUSTRATION

The following diagram illustrates the relationships of the **MPS450** top-level-assembly equipment:

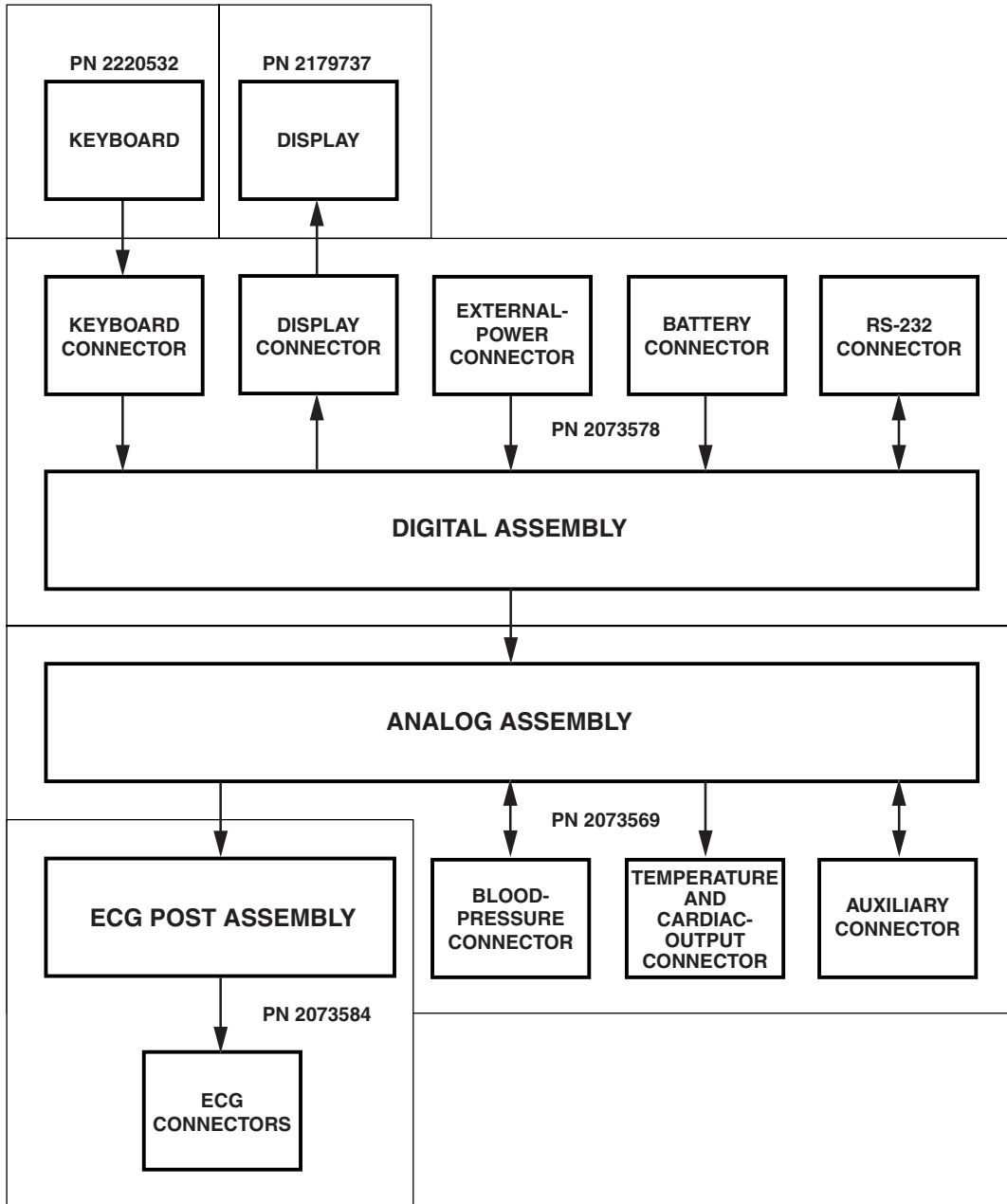


figure1.eps

## **Chapter 2**

# ***Functional Description***

### ***Inside This Chapter***

---

- ❑ THEORY OF OPERATION
- ❑ **MPS450** FUNCTIONS
- ❑ CIRCUIT DESCRIPTION

## THEORY OF OPERATION

The **MPS450** generates physiological waveforms simulating actual conditions in a patient.

### CONTROL

The **MPS450** is controlled by a microcomputer (MCU). The MCU runs its own embedded program. It obtains user input from the keyboard or serial port, writes to the display, and controls the circuits that generate patient simulations.

### ECG and RESPIRATION

The **MPS450** ECG circuits simulate signals generated by a patient's heart. They are low-level signals in the millivolt range. The MCU writes the ECG waveforms to an eight-channel digital-to-analog converter (DAC). The signals from the DAC are attenuated to the proper low levels by resistor networks.

Patient monitors measure respiration by measuring a change in impedance across the patient's chest as the patient breathes. Breathing stretches the chest and, therefore, causes the impedance to change. A monitor uses the ECG electrodes to measure this impedance at the same time that the monitor senses the ECG. The **MPS450** switches in a digital variable resistor to simulate respiration. The MCU writes the changes in impedance to the variable resistor to generate the respiration waveform.

### BLOOD PRESSURE

Patient monitors measure instantaneous blood pressure internal to the patient's heart and blood vessels by connecting to pressure transducers that are inserted physically into the area being monitored. A blood pressure transducer is a 300-ohm bridge device. The monitor supplies an excitation voltage to the bridge. The transducer then returns a signal proportional to the excitation voltage and the measured pressure. The **MPS450** circuits simulate blood pressure transducers. They contain multiplying DACs with the excitation voltage driving the DACs' reference inputs.

### TEMPERATURE

Patient monitors measure temperature by connecting to a thermistor. The **MPS450** contains precision resistors that have the same resistance as thermistors at specified temperatures.

### CARDIAC OUTPUT

Patient monitors can measure the quantity of blood pumped out of the heart. In the cardiac-output procedure, water (either "iced" or room temperature) is injected into the heart. Then, the temperature of the blood coming out of the heart is measured. The monitor uses the temperature change to determine how much blood has been pumped. The **MPS450** uses a digital variable resistor to simulate a thermistor measuring the blood temperature.

## MPS450 FUNCTIONS

The **MPS450** provides control over a wide array of testing parameters.

The variety of normal and abnormal ECG waveforms replicated by the **MPS450** can be used not only for testing arrhythmia-detection systems, but also for training medical personnel, hospital administrators, and staff. The **MPS450** enables the teaching of techniques for pulmonary/respiratory analysis and ECG-waveform interpretation, as well as techniques for CPR and defibrillation/cardioversion.

The groupings below describe the **MPS450** functions by category:

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### ECG FUNCTIONS

Normal sinus rhythm	The <b>MPS450</b> provides complete 3-, 5-, and 12-lead ECG simulation that includes seven artificial pacemaker conditions. Normal sinus rhythm is output over a range of heart rates and voltage amplitudes. The elevation of the ST segment is adjustable.
ECG rate and amplitude	
Adult / pediatric QRS	
ST-segment elevation	
ECG-artifact simulation	
Pacemaker waveforms	
Pacer amplitude and width	

---

### ARRHYTHMIA FUNCTIONS

Supraventricular arrhythmia	The <b>MPS450</b> simulates 36 types of arrhythmias, such as multifocal PVCs, bigeminy, trigeminy, tachycardia, fibrillation, flutter, and asystole. Simulated conduction defects include first-, second-, and third-degree heart block; and left- and right-bundle-branch block.
Premature arrhythmia	
Missed beat	
Ventricular arrhythmia	
Conduction defect	

---

### ECG-PERFORMANCE TESTING

Square/pulse/triangle/sine R waveforms	The <b>MPS450</b> generates square, pulse, triangle, sine, and R waveforms for performance testing. Wave amplitude is adjustable, as well as R-wave rate and width.
Wave amplitude	
R-wave rate and width	

---

### RESPIRATION

Respiration lead	Calibrated respiration rates are generated from 15 to 120 BrPM (breaths per minute), including four respiration-impedance selections, with two different lead selections (LA or LL). The output-impedance level is adjustable to 500, 1000, 1500, or 2000 ohms. The <b>MPS450</b> generates apnea pauses (0 BrPM) of 12, 22, and 32 seconds, as well as a continuous-apnea condition.
Baseline (impedance)	
Respiration rate	
Respiration amplitude	
Apnea simulation	

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## BLOOD PRESSURE

BP sensitivity	The <b>MPS450</b> simulates static and dynamic invasive pressures, providing complete blood-pressure simulation.
BP zeroing	
Static-pressure levels	The <b>MPS450</b> also provides calibrated static pressures and dynamic waveforms to simulate signals such as pulmonary-artery, left- and right-ventricle and Swan-Ganz (RA-RV-PA-PAW) pressures.
Dynamic BP waveforms	
BP respiration artifact	
Swan-Ganz simulation	

---

## TEMPERATURE

Temperature settings	The <b>MPS450</b> provides four preset temperature simulations: 0 °C, 24 °C, 37 °C, and 40 °C. All temperature simulations are compatible with Yellow Springs, Inc. (YSI) Series 400 and 700 thermistors.
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## CARDIAC OUTPUT (OPTION)

Injectate temperature	The <b>MPS450</b> simulates cardiac-output waveforms for testing the accuracy and sensitivity of cardiac-output computational devices equipped with Baxter-Edwards-type catheters. Injectate temperature can be set either to “iced” or to room-temperature conditions; blood-flow rate is selectable from three different rates (2.5, 5.0, or 10 liters-per-minute) for each of the two temperature selections. The <b>MPS450</b> also simulates a faulty-injectate curve, as well as a left-to-right-shunt curve.
Blood-flow rate	
Faulty-injectate curve	
Left-to-right-shunt curve	
Calibrated pulse	

---

## FETAL / MATERNAL ECG (OPTION)

Fixed/periodic FHR	The <b>MPS450</b> simulates a combined fetal and maternal ECG occurring during labor, as well as a selection of direct-pressure waveforms produced by uterine contractions. The contraction period is adjustable and includes a manually generated waveform.
IUP simulation	

---

## REMOTE OPERATIONS

RS-232 serial port	The <b>MPS450</b> features include a built-in RS-232 serial port that, when connected to a computer, enables instrument control through remote commands. In addition, a special command can be used to operate the <b>MPS450</b> remotely in the numeric-control mode.
Computer control	

---

## CIRCUIT DESCRIPTION

### INTRODUCTION

Refer to the Equipment-Relationship Illustration in Chapter 1, “General Information.” As shown in the illustration, the **MPS450** comprises three printed circuit assemblies (PCAs), each portrayed as a separate block on the diagram:

- Digital Assembly
- Analog Assembly
- ECG Post Assembly

Each of these circuit blocks is described below. (See also the **MPS450** PCA images, available in the section called “Top-Level Assembly” in Chapter 6, “**MPS450** Parts.”)

### DIGITAL PRINTED CIRCUIT ASSEMBLY

The Digital PCA is the location of the microcomputer that controls all instrument functions, as well as general power supplies and digital circuits:

- Power on/off control
- Power supplies  
    ± 5 V
- MicroController:
  - Microprocessor
  - RAM
  - FLASH
  - EEROM
  - Timers
  - Serial ports
- Keyboard Interface
- Display interface
- RS-232 port:
  - Level shifters
  - Transmitter/receivers
  - Digital/Analog PCA interface
- Connectors:
  - External power-source connector
  - Internal power-source (battery) connector
  - Display connector
  - Digital/Analog PCA connector (controls patient-simulation circuits)

## **ANALOG PRINTED CIRCUIT ASSEMBLY**

The Analog PCA is the location of all patient-simulation circuits, which are controlled by the microcomputer on the Digital PCA:

- ECG-wave generation
- ECG-amplitude control
- Pacer-pulse amplitude and width control
- Respiration-lead and baseline-impedance selection
- Respiration-wave generation
- Respiration-amplitude control
- Blood-pressure-sensitivity selection
- Blood-pressure-wave generation
- Blood-pressure excitation-voltage modulation
- Temperature-resistance selection
- Cardiac-output-wave generation
- Auxiliary port operation
- Connectors:
  - Digital/Analog PCA connector
  - ECG PCA Assembly connector
  - Blood-pressure channels 1 – 4 connectors

## **ECG POST PRINTED CIRCUIT ASSEMBLY**

The ECG Post PCA is the location of protection circuitry. It connects to the ECG signals from the Analog PCA and routes the signals to the ten ECG posts.



## **Chapter 3**

# ***Scheduled Maintenance***

### ***Inside This Chapter***

---

- ❑ SCHEDULED MAINTENANCE REQUIREMENTS
  
- ❑ INSTRUCTIONS FOR PERFORMING SCHEDULED MAINTENANCE

## SCHEDULED MAINTENANCE REQUIREMENTS

The following table reflects the requirements for scheduled maintenance:

INTERVAL	DESCRIPTION
Annually	Calibration
“Low Battery” message displayed	Replace the batteries immediately. The battery compartment is located at the back of the unit, toward the bottom. Use only two new 9-volt alkaline batteries. (Note that the <b>MPS450</b> operates continuously for 8 or more hours on two new 9-volt batteries.)

## INSTRUCTIONS FOR PERFORMING SCHEDULED MAINTENANCE

Refer to Chapter 4 in this manual, “Calibration.”

# **Chapter 4**

## **Calibration**

### ***Inside This Chapter***

---

- ❑ GENERAL CALIBRATION / VERIFICATION INFORMATION
- ❑ CALIBRATION INSTRUCTIONS
- ❑ VERIFICATION OF SPECS

## GENERAL CALIBRATION / VERIFICATION INFORMATION

Calibration is the procedure by which an instrument is adjusted to make its indicated values correspond as closely as possible with the actual values being measured. Verification is accomplished by comparing readings of the instrument with those of another instrument that serves as a reference or standard.

### WARRANTY DISCLAIMER

The **MPS450** should be calibrated once a year by a qualified technician. It is recommended that the instrument be sent to Fluke Biomedical for factory calibration and service. However, if you choose to calibrate the **MPS450**, it is important to be aware that the warranty on the unit becomes void if the tamper-resistant Quality Seal on the rear panel is broken – Step # 3 in the calibration-setup instructions below – without proper factory authorization. (Refer to “Warranty Disclaimer” on Page ii.)

---

**NOTE:** When returning the unit for calibration, repair, or service, be sure to follow the “Return Procedure” in “Standard Terms and Conditions” in the section in this manual called “Notices.”

---

### REQUIRED EQUIPMENT

The following equipment is required for calibration/verification:

General equipment:

- DMM, 6.5 digit, Keithley 2000 or equivalent
- Power supply, 10 V DC, 33 mA
- Battery eliminator – optional (P/N 2184298)

Hand tools:

- Phillips screwdriver
- ESD wrist strap

Test fixtures:

- MPS450** BP calibration cable (P/N 2201618)
- MPS450** temp/CO cable (P/N 2201607)

## CALIBRATION INSTRUCTIONS

### SETUP FOR CALIBRATION

Following are setup instructions for calibrating the **MPS450**.

(References to function keys – **[F1]**, **[F2]**, **[F3]**, and **[F4]** – refer to the 4 blue keys located on the keypad just beneath the LCD.)

1. Warm up the DMM and power supply for 20 minutes.
2. Put on the ESD wrist strip, and ensure that it is functional.
3. Remove the tamper-resistant Quality Seal from the rear panel. (**Note that breaking the tamper seal voids the factory calibration.**)
4. Connect the battery eliminator, or install fresh batteries.
5. Turn on the **MPS450** by depressing the green button.
6. Wait until the power-up sequence has completed (6 seconds).
7. Press the **SETUP** key (labeled in yellow just above the corresponding **0** number key).
8. Select **>** by pressing the **[F4]** key.
9. Select **UTIL** by pressing the **[F3]** key.
10. Locate the CAL SWITCH through the hole in the rear panel. While holding the CAL SWITCH depressed (using a pencil or similar item), select **CAL** by pressing the **[F1]** key.
11. The display reads **Start w/raw constants?** If the unit has not been calibrated before, or if the microprocessor has been changed, select **YES** by pressing the **[F1]** key. If the unit has been calibrated before, select **NO** by pressing the **[F2]** key.

### CALIBRATION PROCEDURE

Following are calibration instructions for the **MPS450**. (Instructions to “Zero the DMM” refer to pressing the button [on the DMM] that nulls the reading.)

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**NOTE:** The following step numbers match the calibration step numbers displayed on the LCD screen of the **MPS450** during the calibration procedure.

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#### 1) ECG High-Range Reference:

- Connect the +DMM to the RA post, and connect the –DMM to the LL post.
- Set the DMM to read 100 mV DC.

- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

## 2) ECG High-Range Gain:

- Note the words that appear on the LCD screen above the function keys:
  - DOWN** (the **[F1]** key) decreases the calibration setting.
  - UP** (the **[F2]** key) increases the calibration setting.
  - PREV** (the **[F3]** key) returns to the previous calibration step.
  - NEXT** (the **[F4]** key) advances to the next calibration step.

(The display also indicates the DMM connections, the name of the step, and the required DMM reading.)

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $5.0 \pm 0.005$  mV.
- Select **NEXT** by pressing the **[F4]** key.
- 

## 3) ECG Low-Range Reference:

- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

## 4) ECG Low-Range Gain:

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $0.5 \pm 0.0005$  mV.
- Select **NEXT** by pressing the **[F4]** key.

## 5) ECG PACER Gain:

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $10 \pm 1$  mV.
- Select **NEXT** by pressing the **[F4]** key.

## 6) RESPIRATION Reference:

- Change the DMM setting to read 30  $\Omega$ .
- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

## 7) RESPIRATION Gain:

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $3 \pm 0.03$   $\Omega$ .
- Select **NEXT** by pressing the **[F4]** key.

**8) BLOOD PRESSURE 1 — 5  $\mu$ V Reference:**

- Disconnect the DMM from the ECG posts.
- Connect the **MPS450** BP calibration cable to BP1.
- Connect the +power supply to the brown wire, and the –power supply to the yellow wire.
- Connect the +DMM to the brown wire, and connect the –DMM to the yellow wire.
- Change the DMM setting to read 30 V DC with Null off.
- Adjust the power supply (NOT the **MPS450**) for  $10 \pm 0.01$  V. (Note that this is the only adjustment that is not made on the **MPS450**.)
- Move the +DMM connection to the orange wire, and the –DMM connection to the blue wire.
- Change the DMM setting to read 3 V DC.
- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**9) BLOOD PRESSURE 1 — 5  $\mu$ V 400 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $20 \pm 0.02$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**10) BLOOD PRESSURE 1 — 40  $\mu$ V Reference:**

- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**11) BLOOD PRESSURE 1 — 40  $\mu$ V 400 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $160 \pm 0.16$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**12) BLOOD PRESSURE 2 — 5  $\mu$ V Reference:**

- Move the **MPS450** BP calibration cable to BP2. Keep the power supply and DMM connections the same.
- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**13) BLOOD PRESSURE 2 — 5  $\mu$ V 240 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $12 \pm 0.012$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**14) BLOOD PRESSURE 2 — 40  $\mu$ V Reference:**

- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**15) BLOOD PRESSURE 2 — 40  $\mu$ V 240 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $96 \pm 0.96$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**16) BLOOD PRESSURE 3 — 5  $\mu$ V Reference:**

- Move the **MPS450** BP calibration cable to BP3. Keep the power supply and DMM connections the same.
- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**17) BLOOD PRESSURE 3 — 5  $\mu$ V 120 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $6 \pm 0.006$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**18) BLOOD PRESSURE 3 — 40  $\mu$ V Reference:**

- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**19) BLOOD PRESSURE 3 — 40  $\mu$ V 120 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $48 \pm 0.048$  mV.
- Select **NEXT** by pressing the **[F4]** key.



**20) BLOOD PRESSURE 4 — 5  $\mu$ V Reference:**

- Move the **MPS450** BP calibration cable to BP4. Keep the power supply and DMM connections the same.
- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**21) BLOOD PRESSURE 4 — 5  $\mu$ V 100 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $5 \pm 0.005$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**22) BLOOD PRESSURE 4 — 40  $\mu$ V Reference:**

- Zero the DMM.
- Select **NEXT** by pressing the **[F4]** key.

**23) BLOOD PRESSURE 4 — 40  $\mu$ V 100 mm:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $40 \pm 0.04$  mV.
- Select **NEXT** by pressing the **[F4]** key.

**24) CARDIAC-OUTPUT Baseline:**

- Disconnect the **MPS450** BP calibration cable.
- Connect the **MPS450** temp/CO Cable to CO/TEMP.
- Connect the +DMM to the brown wire, and connect the –DMM to the blue wire.
- Set the DMM to read 30 k $\Omega$  with Null off.
- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $14.004 \pm 0.014$  k $\Omega$ .
- Select **NEXT** by pressing the **[F4]** key.

**25) CARDIAC-OUTPUT Peak:**

- Select **UP** or **DOWN** (by pressing the **[F2]** or **[F1]** keys) to adjust the **MPS450** so that the DMM reads  $14.794 \pm 0.015$  k $\Omega$ .
- Select **NEXT** by pressing the **[F4]** key.

**CALIBRATION-PROCEDURE END:**

- To save the new calibration, select **YES** by pressing the **[F1]** key. To discard it and return to the previous settings, select **NO** by pressing the **[F2]** key.
- Turn off the **MPS450**.
- Disconnect the **MPS450** temp/CO calibration cable.

**VERIFICATION OF SPECS****SETUP FOR VERIFICATION**

Following are setup instructions for verifying the specifications of the **MPS450**.

1. Warm up the DMM and power supply for 20 minutes.
2. Connect the battery eliminator, or install fresh batteries.
3. Turn on the **MPS450** by depressing the green button.
4. Wait until the power-up sequence has completed (6 seconds).

**VERIFICATION PROCEDURE**

The following tables comprise verification procedures for the **MPS450**, using the terms below:

<b>TERM</b>	<b>REFERENCE</b>
Connections	Refers to the connections to the DMM, such as "RA-RL"
DMM setting	Refers to the function and range to which the DMM should be set
Display	Refers to the displayed value or name for the specified test
DMM reading	Refers to the expected reading and the required tolerance
Zero the DMM	Refers to pressing the button on the DMM that nulls the reading

**VERIFICATION OF RESPIRATION-BASELINE SPECS**

## SETUP

1. Press the **SETUP** key.
2. Select **RESP**.
3. Select **BASE** to select baseline impedance for the following steps.

## STEPS

VERIFICATION STEP	CONNECTIONS	DMM SETTING	DISPLAY	DMM READING
<b>RESPIRATION-BASELINE IMPEDANCE</b>				
RA-RL IMPEDANCE	RA-RL	3000 $\Omega$	500	475 - 525
			1000	950 - 1050
			1500	1425 - 1575
			2000	1900 - 2100
LA-RL IMPEDANCE	LA-RL		500	475 - 525
			1000	950 - 1050
			1500	1425 - 1575
			2000	1900 - 2100
LL-RL IMPEDANCE	LL-RL		500	475 - 525
			1000	950 - 1050
			1500	1425 - 1575
			2000	1900 - 2100
V1-RL IMPEDANCE	V1-RL		500	713 - 787
V2-RL IMPEDANCE	V2-RL		500	713 - 787
V3-RL IMPEDANCE	V3-RL		500	713 - 787
V4-RL IMPEDANCE	V4-RL		500	713 - 787
V5-RL IMPEDANCE	V5-RL		500	713 - 787
V6-RL IMPEDANCE	V6-RL		500	713 - 787

**VERIFICATION OF ECG-AMPLITUDE SPECS**

## SETUP

1. Press the **SETUP** key.
2. Select **>**.
3. Select **UTIL**.
4. Select **DIAG**.
5. Select **PREV** or **NEXT** until the LCD reads **CAL TEST**.

6. Select **EXE**. The unit is now in a special calibration-test mode. The second line on the display shows the test name.
7. Select **PREV** or **NEXT** to scroll through the tests, and then select **EXE** to execute the test displayed on the LCD screen.
8. To exit a test, press the **ESC** key.

---

**NOTE:** For some ECG-amplitude-specification tests, all that is required is to zero the DMM, while other tests show a DMM reading and a tolerance.

---

STEPS

VERIFICATION STEP	CONNECTIONS	DMM SETTING	DISPLAY	DMM READING
<b>ECG AMPLITUDE, HIGH RANGE</b>				
RA-RL HIGH RANGE	RA-RL	300 mV DC	HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	-3.8 – 4.2
LA-RL HIGH RANGE	LA-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	0.95 – 1.05
LL-RL HIGH RANGE	LL-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	2.85 – 3.15
V1-RL HIGH RANGE	V1-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	-3.8 – 4.2
V2-RL HIGH RANGE	V2-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	-2.85 – -3.15
V3-RL HIGH RANGE	V3-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	2.85 – 3.15
V4-RL HIGH RANGE	V4-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	3.8 – 4.2
V5-RL HIGH RANGE	V5-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	-6.3 – -5.7
V6-RL HIGH RANGE	V6-RL		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	7.6 – 8.4
<b>PACER AMPLITUDE</b>				
LEAD II PACER	RA-LL	300 mV DC	HIGH RANGE BASE	Zero the DMM.
			PACER PEAK	9.0 – 10.0

RESPIRATION				
LEAD II RESPIRATION	RA-LL	1 kΩ	HIGH RANGE BASE	Zero the DMM.
			RESP HIGH PEAK	2.7 – 3.3
LEAD I RESPIRATION	LA-RA		LOW RANGE BASE	Zero the DMM.
			RESP LOW PEAK	0.45 – 0.55

**VERIFICATION OF BLOOD-PRESSURE SPECS**

SETUP

1. Connect the MPS450 BP calibration cable to BP1.
2. Connect the +power supply to the brown wire, and the –power supply to the yellow wire.
3. Connect the +DMM to the brown wire, and connect the –DMM to the yellow wire.
4. Change the DMM setting to read 30 V DC with Null off.
5. Adjust the power supply (NOT the **MPS450**) for  $10 \pm 0.01$  V.
6. Move the +DMM connection to the orange wire, and the –DMM connection to the blue wire.
7. Maintain the DMM and power-supply connections for all blood-pressure measurements.

---

**NOTE:** For some blood-pressure-specification tests, all that is required is to zero the DMM, while other tests show a DMM reading and a tolerance.

---

STEPS

VERIFICATION STEP	CONNECTIONS	DMM SETTING	DISPLAY	DMM READING
<b>BLOOD PRESSURE</b>				
BP1 40 μV/V/mmHg	BP1	300 mV DC	HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	156 – 164
BP1 5 μV/V/mmHg	BP1		LOW RANGE BASE	Zero the DMM.
			LOW RANGE PEAK	19.5 – 20.5
BP2 40 μV/V/mmHg	Move the BP cal cable to BP2.		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	92.8 – 98.8
BP2 5 μV/V/mmHg	BP2		LOW RANGE BASE	Zero the DMM.
			LOW RANGE PEAK	11.66 – 12.34

VERIFICATION STEP	CONNECTIONS	DMM SETTING	DISPLAY	DMM READING
<b>BLOOD PRESSURE (Continued)</b>				
BP3 40 $\mu\text{V}/\text{V}/\text{mmHg}$	Move the BP cal cable to BP3.	300 mV DC	HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	46.8 – 49.2
BP3 5 $\mu\text{V}/\text{V}/\text{mmHg}$	BP3		LOW RANGE BASE	Zero the DMM.
			LOW RANGE PEAK	5.85 – 6.15
BP4 40 $\mu\text{V}/\text{V}/\text{mmHg}$	Move the BP cal cable to BP4.		HIGH RANGE BASE	Zero the DMM.
			HIGH RANGE PEAK	39 – 41
BP4 5 $\mu\text{V}/\text{V}/\text{mmHg}$	BP4		LOW RANGE BASE	Zero the DMM.
			LOW RANGE PEAK	4.87 – 5.13

### VERIFICATION OF CARDIAC-OUTPUT SPECS

#### SETUP

1. Connect the **MPS450** temp/CO cable to CO/TEMP.
2. Connect the +DMM to the brown wire, and connect the –DMM to the blue wire.

#### STEPS

VERIFICATION STEP	CONNECTIONS	DMM SETTING	DISPLAY	DMM READING
<b>CARDIAC OUTPUT</b>				
CO RESISTANCE	(See SETUP, # 2.)	30 k $\Omega$	HIGH RANGE BASE	13.990 – 14.018
			HIGH RANGE PEAK	14.779 – 14.809

**VERIFICATION OF TEMPERATURE SPECS**

SETUP

1. To exit the special calibration mode, press the **ESC** key several times.
2. To access the TEMPERATURE MENU, press the **TEMP** key.
3. Connect the **MPS450** temp/CO cable to CO/TEMP.
4. Select **UP** or **DOWN** to set the temperature as indicated in the following steps.

STEPS

VERIFICATION STEP	CONNECTIONS	DMM SETTING	DISPLAY	DMM READING
<b>TEMPERATURE</b>				
TEMPERATURE 400	+DMM – red wire -DMM – violet wire	30 kΩ	0	7.313 – 7.393
			24	2.343 – 2.364
			37	1.349 – 1.360
			40	1.195 – 1.205
TEMPERATURE 700 T1	+DMM – grey wire -DMM – violet wire		0	19.400 – 19.800
			24	6.216 – 6.327
			37	3.580 – 3.640
			40	3.171 – 3.222
TEMPERATURE 700 T2	+DMM – green wire -DMM – violet wire	300 kΩ	0	94.045 – 95.930
			24	31.030 – 31.590
			37	18.065 – 18.358
			40	16.020 – 16.280

# **Chapter 5**

## **Troubleshooting**

### *Inside This Chapter*

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- ❑ TROUBLESHOOTING TIPS



**TROUBLESHOOTING TIPS****FUNCTION: ECG**

**Symptom:** The amplitude for Lead II is not correct.

*Suggestion 1:* The problem may be related to the monitor filters. Note that there will be a slight loss of amplitude when simulating normal sinus rhythm. Use a pulse wave to verify the amplitude more accurately.

*Suggestion 2:* The lead setting on the monitor may be incorrect. Check the monitor lead-select switch to ensure that it is set to Lead II.

*Suggestion 3:* The leads may not be connected properly. Check the connections to the color-coded ECG jacks.

**FUNCTION: BLOOD PRESSURE**

**Symptom:** There is no blood-pressure reading, or the reading is not as expected.

*Suggestion 1:* The **MPS450** transducer sensitivity may not be set correctly. Check the monitor manufacturer's BP-sensitivity requirements. Reset the **MPS450** either to 5  $\mu\text{V}/\text{V}/\text{mmHg}$  or to 40  $\mu\text{V}/\text{V}/\text{mmHg}$ .

*Suggestion 2:* An incorrect blood-pressure cable may be in use. Note that many manufacturers use plugs and/or configurations with wiring differences. Check the **MPS450** BP-wiring diagram, and compare it with the monitor specification.

*Suggestion 3:* The monitor may not be zeroed. Zero the **MPS450** BP channel. Then, zero the monitor.

*Suggestion 4:* The monitor sensitivity (scaling) may not be correct. Adjust scaling on the monitor, near the range simulated (e.g., 120 mmHg, etc.).

*Suggestion 5:* The performance waveform may be output currently, which turns off blood pressure. Select the normal physiological waveform.

**FUNCTION: RESPIRATION**

**Symptom:** There is no respiration signal.

*Suggestion 1:* The correct respiration lead may not be selected. Check the respiration-lead detection on the monitor, and switch accordingly on the **MPS450**.

*Suggestion 2:* The leads may not be connected properly. Verify that the color code is correct for U.S. or International ECG leads.

*Suggestion 3:* The performance waveform may be output currently, which turns off respiration. Select the normal physiological waveform.

**FUNCTION: TEMPERATURE**

**Symptom:** There is no temperature reading.

*Suggestion 1:* A temperature cable from the incorrect series may be in use. Check the manufacturer's series for the thermistor used. Choose the correct Fluke Biomedical temperature cable for either the YSI 400 or 700 Series.

**FUNCTION: CARDIAC OUTPUT**

**Symptom:** There are no cardiac-output values, or the values are not as expected.

*Suggestion 1:* The correct injectate temperature may not be selected. Note that the injectate-temperature setting must match the expected temperature: 24 °C or 0 °C. Check that the injectate-temperature cable from the cardiac-output monitor is connected to the bigger 4-pin switchcraft connector on the optional cardiac-output adapter box. Then, turn the trimpot on the front panel of the CO adapter box until the injectate temperature (IT) sensor on the CO monitor reads "0" or "24."

*Suggestion 2:* The setting on the cardiac-output computer for injectate volume may be incorrect. Set the volume to 10 cc.

*Suggestion 3:* The setting on the cardiac-output computer for catheter size may be incorrect. Set the size to 7f.

*Suggestion 4:* The constant set on the monitor may not be correct. Set the constant to either .542 (chilled) or .595 (room temperature).

**Symptom:** The injectate temperature is not displayed on the monitor.

*Suggestion 1:* Adjust the injectate-temperature trimpot. Rotate the knob slowly until the desired reading (0 °C or 24 °C) is displayed.

# **Chapter 6**

## **MPS450 Parts**

### *Inside This Chapter*

- PARTS LIST

## PARTS LIST

Following is the parts list for the top assembly of the **MPS450** Multiparameter Simulator:

PART NAME / DESCRIPTION	PART NUMBER	QTY
DISPLAY LCD 20 X 4 LINE	2179737	1
CONN HEADER 1X14 CES-114-01-S	2194494	1
LUG LOCK TERM #6	2194989	1
WIRE #16 GRN/YEL PVC UL CSA	2198520	1
<b>MPS450</b> BATTERY CABLE ASSY	2201338	1
SCRW 2-56 X 3/16 STL PPH	272906	8
SCRW PPH 4-40 X 1/4	129890	1
SCRW PPH #6 X 1/4	152140	5
SCRW SHT METAL #4 X 1/2	2211199	6
NUT, KEP 6-32 x 1/4	559039	16
SPACER #4 RD .562L ALUM	2214782	1
SPACER M/F 1/4 HEX #6 X .375 SS	2072924	5
SPACER #2 3/16 HEX X 3/8 SS	2215380	4
FOOT RUBBER GREY	2215487	4
<b>MPS450</b> ECG POST #6-32 X .4 THD	2215951	10
<b>MPS450</b> MEMBRANE KEYBOARD	2220532	1
FBC DATE OF MANUFACTURE LABEL	2220559	1
<b>MPS450</b> BATT INSTALL LABEL	2220567	1
ETL MARKING LABEL	2220604	1
INSERT MOLDED	2222831	10
<b>MPS450</b> FLEXIBLE SHIELD	2224841	1
<b>MPS450</b> ECG POST PCA ASSY	2073584	1
<b>MPS450</b> ANALOG PCA ASSY	2073569	1
<b>MPS450</b> DIGITAL PCA ASSY	2073578	1
<b>MPS450</b> ENCLOSURE MODIF	2230998	1
ECG POST CAP	2231336	10
ECG POST SPRING	2231349	10
TAG S/N WITH CE MARK	2239211	1
WASHER FLAT #6	2081287	10
CAL VOID LABEL	2219713	1