FLUKE®
Biomedical

MPS450

Multiparameter Simulator

Operators Manual

PN 2243350
June 2010, Rev. 2, 3/11

Warranty and Product Support

Fluke Biomedical warrants this instrument against defects in materials and workmanship for one year from the date of original purchase OR two years if at the end of your first year you send the instrument to a Fluke Biomedical service center for calibration. You will be charged our customary fee for such calibration. 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 covers the original purchaser only and is not transferable. The warranty does not apply if the product has been damaged by accident or misuse or has been serviced or modified by anyone other than an authorized Fluke Biomedical service facility. NO OTHER WARRANTIES, SUCH AS FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSED OR IMPLIED. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, ARISING FROM ANY CAUSE OR THEORY.

This warranty covers only serialized products and their accessory items that bear a distinct serial number tag. Recalibration of instruments is not covered under the warranty.

This warranty gives you specific legal rights and you may also have other rights that vary in different jurisdictions. Since some jurisdictions do not allow the exclusion or limitation of an implied warranty or of incidental or consequential damages, this limitation of liability may not apply to you. If any provision of this warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

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Notices

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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 or call 1-800- 850-4608 ext 2560 or 1-440-498-2560.

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- 850-4608 ext 2560 or 1-440-498-2560.

Repair and calibration:

To find the nearest service center, go to www.flukebiomedical.com/service, or

In the U.S.A.:
Cleveland Calibration Lab
Tel: 1-800-850-4606
Email: globalcal@flukebiomedical.com

Everett Calibration Lab
Tel: 1-888-993-5853
Email: service.status@fluke.com

In Europe, Middle East, and Africa:
Eindhoven Calibration Lab
Tel: +31-402-675300
Email: ServiceDesk@fluke.com

In Asia:
Everett Calibration Lab
Tel: +425-446-6945
Email: 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 MPS450 Multiparameter Simulator is manufactured at Fluke Biomedical, 6920 Seaway Blvd., Everett, WA, U.S.A.

Applicable Testing Standards

Fluke Biomedical's **MPS450**™ Multiparameter Simulator (hereafter referred to as the **MPS450**) has been tested by an independent laboratory and meets the requirements listed here.

Safety Requirements

USA	UL 61010-1 (2nd Edition). General requirements.
Canada	CAN/CSA C22.2 No. 61010 (2nd Edition), Safety requirements for electrical equipment for measurement, control and laboratory use.
EC Directive 2006/95/EC	IEC/EN 61010-1:2001 (2nd Edition), safety requirement for electrical equipment for measurement, control, and laboratory use.

Electromagnetic Interference and Susceptibility

EN 61326-1:2006 Emissions Class A and Immunity

FCC Class A

Warning: Changes of modifications to this unit not expressly approved by the

manufacturer could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. Like all similar equipment, this equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause interference, in which case the user will be required to correct the interference at his/her own expense.

Canadian Department of Communications Class A

This digital apparatus does not exceed Class A limits for radio emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'excède pas des bruits radioélectriques dépassant les limites applicables des appareils numériques de la Class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.

CE Based on the testing standards below, this device bears the CE mark.

EC Directive 2004/108/EC Electromagnetic Compatibility

Emissions – Class A

The system has been type tested by an independent, accredited testing laboratory and found to meet the requirements of EN 61326-1:2006 for Radiated Emissions and Line Conducted Emissions.

EN 61000-3-2 Harmonics Current Emissions

EN 61000-3-3 Voltage Fluctuations and Flicker

Immunity

The system has been type tested by an independent, accredited testing laboratory and found to meet the requirements of EN 61326-1:2006 for immunity.

EN 61000-4-2 Electrostatic Discharge
EN 61000-4-3 RF Electromagnetic Fields
EN 61000-4-4 Fast Transient/Burst
EN 61000-4-5 Surge Immunity
EN 61000-4-6 RF Common Mode Disturbance
EN 61000-4-11 Voltage Dips, Short interruptions and AC Variations

***EC Directive 2006/95/EC** Low Voltage*

User Safety

The system has been type tested by an independent testing laboratory and found to meet the requirements of EC Directive 2006/95/EC for Low Voltage. Verification of compliance was conducted to the limits and methods of the following

EN 61010-1 (2001)

Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use, Part 1:General requirements" (IEC 61010-1:2001, Mod).

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Introduction and Specifications

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Introduction

When the term “simulation” is used in connection with ECG, Respiration, Temperature, IBP or Cardiac Output, the simulation is electrical.

The MPS450 Multiparameter Simulator (the MPS450) is an electronic signal source for determining if patient monitors are performing within their operating specifications. The MPS450 provides the following function categories:

- ECG Functions
- Arrhythmia Functions
- ECG-Performance Testing
- Respiration
- Blood Pressure
- Temperature
- Cardiac Output (Optional)
- Fetal/Maternal ECG and IUP (Optional)

The MPS450 is a lightweight, battery-powered unit that is portable enough to test a patient monitor anywhere the monitor is being used. This device is not to replace clinical testing of waveform detecting devices such as patient monitors.

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 read easily on the clear, built-in LCD (liquid crystal display), with adjustable viewing “angle” (contrast). Tests and simulations can be selected quickly and easily, by choosing menu selections, by using front-panel keys to enter numeric codes for actions, or by using computer control.

A cross-referenced listing of MPS450 actions, numeric codes, and remote-entry commands is available in Chapter 4: “Remote Operations.”

MPS450 Features

The MPS450 provides control over the widest array of testing parameters, while also providing simplicity in design and user interface. A keypad enables the easy entry of functions, parameters, and codes; easy-access jacks simplify quick connection to monitoring devices.

The wide variety of 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 can be used to teach techniques for recognizing normal and abnormal conditions in the heart, lungs, and circulatory system, as well as techniques for CPR and defibrillation/cardioversion. Cardiac physiologists can learn how to interpret ECG waveforms; respiratory physiologists can learn pulmonary/respiratory analysis techniques.

The groupings in Table 1-1 list the main categories of MPS450 functions. Each of these function groupings is explained in a corresponding section.

Table 1-1. MPS450 Functions

Function Category	Function	Description
ECG Functions	Normal sinus rhythm	The MPS450 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. ST-segment elevation 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 MPS450 simulates 36 types of arrhythmias, such as PVCs, 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	The MPS450 generates square, pulse, triangle, sine, and R waveforms for performance testing. Wave amplitude is adjustable, as well as R-wave rate and width.
	R waveforms	
	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 MPS450 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	
Blood Pressure	BP sensitivity	The MPS450 simulates static and dynamic invasive pressures, providing complete blood-pressure simulation. The MPS450 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.
	BP zeroing	
	Static-pressure levels	
	Dynamic BP waveforms	
	BP respiration artifact	
	Swan-Ganz simulation	
Temperature	Temperature settings	The MPS450 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.

Table 1-1. MPS450 Functions (cont.)

Function Category	Function	Description
Cardiac Output Thermodilution method, (Option)	Injectate temperature	The **MPS450** 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 room-temperature conditions, with adjustable flow rate (in liters per minute). The **MPS450** also simulates a faulty-injectate curve, as well as a left-to-right-shunt curve which is a function of temperature (Y-axis) and time (X-axis) curve, instead of a pressure curve.
	Injectate flow	
	Faulty-injectate curve	
	Left-to-right-shunt curve	
	Calibrated pulse	
Fetal / Maternal ECG (Option)	Fixed/periodic FHR	The MPS450 simulates a combined fetal and maternal ECG occurring during labor, as well as a selection of 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	MPS450 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 MPS450 remotely in the numeric-control mode.
	RS-232 serial port	

⚠Warning

To prevent personal injury, use the Simulator in the manner specified in this manual or the protection provided by the Simulator may be impaired.

MPS450 Package Contents

Standard Equipment

- MPS450 Multiparameter Simulator

Standard Accessories

- MPS450 Operators Manual (P/N 2243350)
- Registration card
- Two 9-volt alkaline batteries (minimum 8 hours continuous use)
- Cardiac-output adapter box (P/N 2226608, standard with Cardiac-Output Option)

Optional Accessories

- Carrying case (P/N 2248623)
- Blood-pressure cables (See your local Fluke Biomedical Representative for availability)
- Temperature cables (YSI 400 Series: P/N 2391976; 700 Series: P/N 2391983)
- High-level-output cable (P/N 2226958)

- Universal injectate-temperature adapter (P/N 2226800)
- RS-232 cable (P/N 2238659)
- Service Manual (P/N 2243361)
- Battery eliminator (P/N 2720054)
  - Contains universal power supply, 9 - 264V, USA, AUS, DEN, IND, ISR, ITAL, SHK, SWZ and UK
  - For power cord order 284174 (USA), 658641 (AUS), 2200218 (DEN), 2200229 (IND), 2200241 (ISR), 2198785 (ITAL), 769422 (SHK), 769448 (SWZ) and 769455 (UK)

Date of Manufacture

The date of manufacture of the MPS450 unit appears on a label on the back of the instrument, for example, JAN-03.

Unpacking the MPS450

Unpack the MPS450 and accessories from the shipping carton and insert the batteries. Inspect the unit carefully for damage, such as cracks, dents, scratches, or bent parts. If any physical damage is apparent, please call Fluke Biomedical for assistance, and notify the carrier if the damage appears to be the result of a shipping mishap.

Storage and Maintenance

As with most electronic equipment, the MPS450 should be operated in a dry area within normal temperature limits (10 °C to 40 °C).

There are no unique storage requirements. However, when storing the unit, maintain the storage temperature between -25 °C and 50 °C. Remove the batteries if the unit will be stored for a long period.

The MPS450 should be recalibrated once a year by a qualified technician. 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.

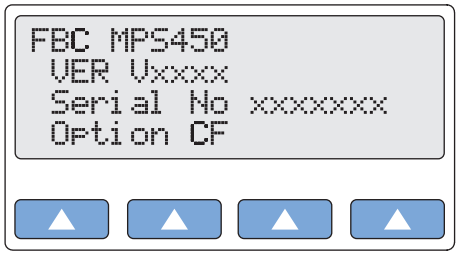
The MPS450 operates continuously for 8 or more hours on two 9-volt alkaline batteries, which should be replaced regularly. The message “Low Battery” displays on the LCD whenever the batteries need to be replaced.

Note

When the LCD screen displays a message warning that batteries are low, replace the two batteries immediately. The battery compartment is located at the back of the unit, toward the bottom. Use only two new 9-volt batteries.

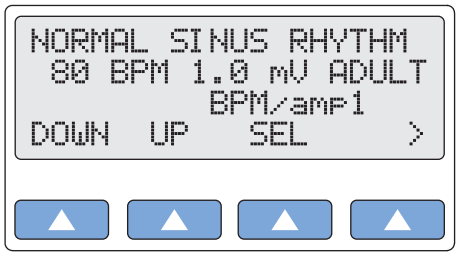
Powering Up the MPS450

1. Power up the system by pressing the power-on/off key (the green key located on the keypad of the unit, bottom/right). After one short beep, the LCD screen displays the following startup message:



gje001.eps

2. After a three-second display test, the following top menu displays:



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Note

Once you have the MPS450 up and running, please fill out the Registration Card and mail it to Fluke Biomedical.

Connection the MPS450

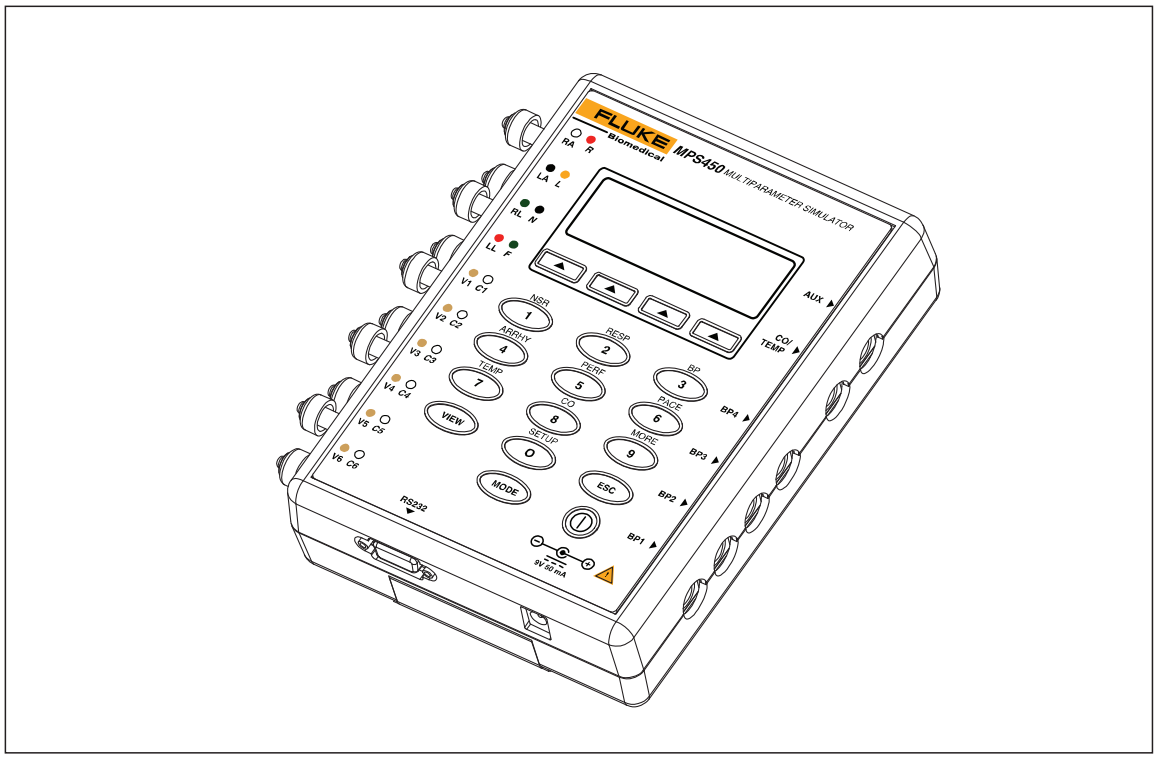

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Figure 1-1. MPS450 Patient Simulator

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. Prewired cables compatible with all major manufacturers' monitors are available for simulating functions related to blood pressure, temperature, and cardiac-output injectate. (Call your sales representative for a complete list.)

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:

Table 1-2. ECG Jack Labeling

Label	Meaning
RA or R	Right arm
LA or L	Left arm
RL or N	Right leg (reference or ground)
LL or F	Left led
V1, V2, V3, V4, V5, and V6	V Leads (U.S. and Canada). Also referred to as *pericardial*, *precordial*, or *unipolar chest leads*.
C1, C2, C3, C4, C5, and C6	Chest leads (International)

Using the MPS450

The MPS450 offers a wide array of simulations, functions, and adjustments that are easy to use. During operation, press the **MODE** key (the yellow key located on the keypad near the bottom of the unit) to enable either the menu-control or numeric-control mode. In menu mode, simply press the top-menu key for a function group (labeled in yellow just above the corresponding number key as shown in the Table 1-3), and then press one of the four function keys (the blue keys located on the keypad just beneath the LCD) to select from options displayed on the screen. In numeric mode, simply press the number keys to enter the three-digit numeric code for the desired function, and select **RUN**.

Table 1-3. MPS450 Button Description

Number Key / Key	Menu Label	Menu Functions
1	**NSR**	Adjust ECG heart rate. Adjust ECG amplitude. Set patient type (age). Adjust ST-segment elevation.
2	**RESP**	Adjust respiration rate. Adjust respiration amplitude (impedance variation). Simulate apnea.
3	**BP**	Zero all blood-pressure channels. Set static-pressure levels for BP channels. Run dynamic BP waveforms. Simulate Swan-Ganz procedure. Add respiration artifact to BP signal.
4	**ARRHY**	Run arrhythmia simulations (36).
5	**PERF**	Run ECG-performance waves. Adjust performance-wave amplitude. Adjust R-wave rate, width, and amplitude.
6	**PACE**	Run pacemaker waveform. Adjust pacemaker-spike amplitude and width.
7	**TEMP**	Adjust body temperature.
8	**CO**	Simulate cardiac-output test. Adjust injectate temperature and flow for CO test. Simulate injectate failure. Simulate left-to-right shunt. Simulate output from a calibrated pulse signal.
9	**MORE**	Simulate ECG artifact. Set fixed fetal heart rate. Simulate intrauterine-pressure (IUP) wave. Adjust IUP-wave period.

Table 1-3. MPS450 Button Description (cont.)

Number Key / Key	Menu Label	Menu Functions
0	**SETUP**	Set respiration lead and baseline (impedance). Set blood-pressure sensitivity. Adjust viewing angle (contrast) for LCD screen. Set beeper mode.
MODE		Switch between menu control and numeric control.
VIEW		View current parameters.
ESC		Return to previous or top menu.
		Select option displayed on LCD screen.

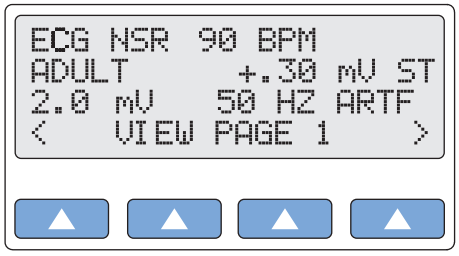
Viewing Current MPS450 Parameters

The current settings for adjustable parameters—such as heart rate and BP static-pressure levels—are available for display at any time on a series of LCD screens that are accessed by pressing the **VIEW** key.

(When the MPS450 is turned off, the parameters reset to defaults, with the exception of settings that can be stored, i.e., respiration lead and baseline, BP sensitivity, view angle, and beeper mode. Power-on default settings for functions are listed in the "Specifications" section later in this chapter.)

Action in the Menu-Control Mode

1. Press the white key labeled **VIEW** to display the VIEW PAGE 1 screen—the ECG page—which indicates current ECG settings:



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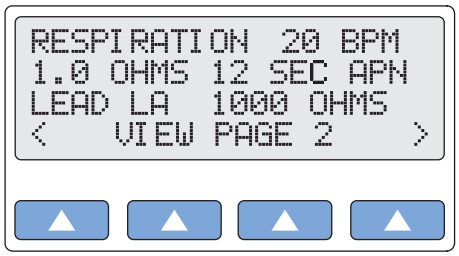
The types of parameters displayed on VIEW PAGE 1 depend on which group of ECG waves is running. In this example (the ECG-NSR-wave group), the settings displayed include NSR rate (90 BPM), patient type (ADULT), ST-segment elevation (+.30 mV), NSR amplitude (2.00 mV), and ECG artifact (50 HZ).

Four other types of ECG-wave groups display different parameter types on **VIEW PAGE 1**, and three other **VIEW PAGE** screens display parameters for respiration, blood-pressure, and temperature/cardiac-output functions. Table 1-4 lists the parameters available for viewing on the four pages:

Table 1-4. Parameter Viewing List

View Page	Wave/Function	Current Parameters Displayed
1	ECG NSR	NSR rate, patient type, ST-segment elevation, NSR amplitude, and ECG artifact.
	ECG performance	Performance wave and amplitude
	ECG R-wave detection	R-wave rate, width, and amplitude
	ECG Arrhythmia	Arrhythmia and ECG artifact
	Fetal/maternal	IUP wave, IUP period, and fetal heart rate
2	Respiration	Respiration rate, amplitude, lead, and baseline
3	Blood Pressure	BP sensitivity; and settings BP1, BP2, BP3, BP4
4	Temperature/Cardiac Output	Temperature, thermistor, cardiac-output wave, and CO-injectate temperature and flow

2. Select < or > to cycle through the other three **VIEW** pages, which display as screens similar to the following:



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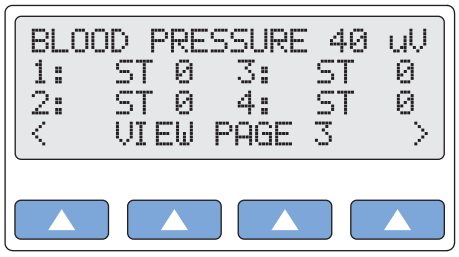
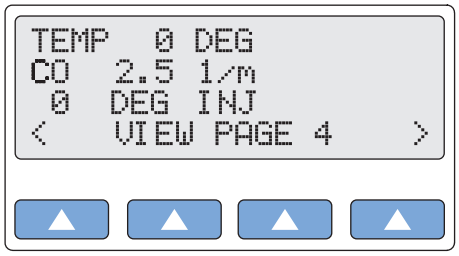


gje005.eps



gje006.eps

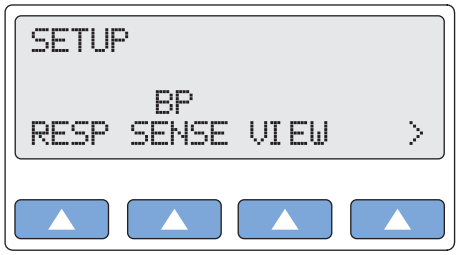
3. To exit viewing, press the **VIEW** key again, or press the **ESC** key to return to the previous control mode.
4. While viewing settings, the **MODE** key is inactive. Press the **ESC** key to exit viewing before changing modes.

Setting the MPS450 View Angle

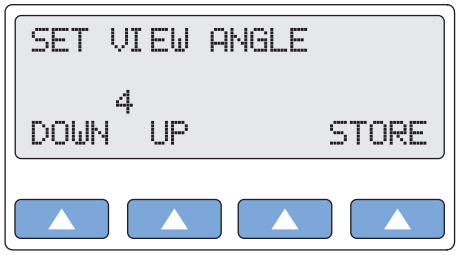
The MPS450 offers eight preconfigured settings to customize the preferred degree of contrast (brightness) for the angle at which the LCD screen is being viewed.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **SETUP** to display the LCD screen:



2. Select **VIEW** to scroll to the LCD screen **SET VIEW ANGLE**, which displays the current screen-contrast setting (in this example, 4):



3. To adjust the LCD screen's contrast, scroll to the preferred setting, from 1 (lowest) to 8 (highest). The setting is active when displayed and remains active until the setting is changed.
4. To store the contrast setting beyond the current session, select **STORE**. On the LCD screen, Storing blinks on momentarily to indicate the value is being saved.
5. Press the **ESC** key to return to the top menu SETUP.

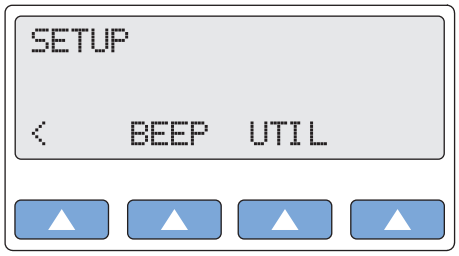
Adjusting the MPS450 Beeper

If not turned off, the MPS450 beeper sounds on power-up and whenever a key is pressed. A double-beep sounds for an invalid key.

The MPS450 offers three preconfigured settings to customize the beeper sound: off, short, or long.

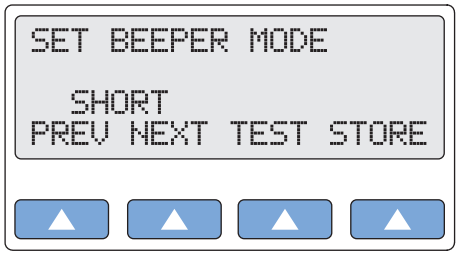
Action in the Menu-Control Mode

1. Press the top-menu key labeled **SETUP** to display the LCD screen.
2. Select **>** to display the following LCD screen:



gje009.eps

3. Select **BEEP** to scroll to the LCD screen **SET BEEPER MODE**, which displays the current setting (in this example, SHORT):



gje010.eps

4. Scroll to the desired beeper mode. The setting is active when displayed and remains active until the setting is changed.
5. To hear the audible beep as currently set, select **TEST**.
6. To store the beeper setting beyond the current session, select **STORE**. On the LCD screen, Storing blinks on momentarily to indicate the value is being saved.
7. Press the **ESC** key to return to the top menu SETUP.

Navigation in the MPS450

Press the MODE key (the yellow key located on the keypad near the bottom of the unit) to enable either the menu-control or numeric-control mode. The control mode can be switched at any time, except while viewing current parameters on a VIEW page; press the **VIEW** key to exit back to the mode you were in previously.

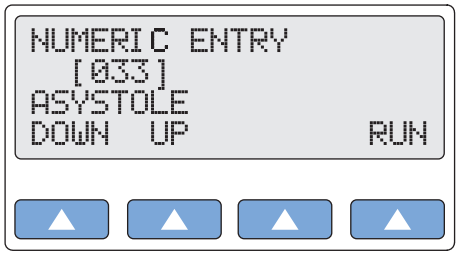
Action in the Menu-Control Mode

1. To navigate in menu-control mode, press the top-menu key for a function group, labeled in yellow just above the corresponding number key. (Available functions in each of the menu categories are listed in the "Using the MPS450" section earlier in this chapter.)
2. Press one of the four function keys (the blue keys located on the keypad just beneath the LCD) to select from options displayed on the screen.
3. To scroll through screens while in the menu mode, select **PREV** or **NEXT**. (Selecting **PREV** from the first selection—or **NEXT** from the last selection—in a menu usually results in a double-beep. Press the **ESC** key to return to the previous menu, or press another top-menu key.)
4. To scroll through the adjustment options, select **DOWN** or **UP**.
5. Some menu selections are active when displayed. For others, **RUN** must be selected to execute the option. (Instructions are provided in this manual for each function.) When selected, RUN or RUNNING flashes on the LCD screen to indicate the selection is active.

6. Some simulations run continuously until terminated; others run as one-time events and must be selected again to repeat. (Again, instructions are provided for each function.)

Action in the Numeric-Control Mode

1. To navigate in numeric-control mode, press the number keys to enter the three-digit numeric code for the desired function. (Numeric codes for functions are listed in each section after the menu-control instructions. A complete list of MPS450 numeric codes for actions, arranged by category and cross-referenced to remote-control-entry codes, is available in the "Remote Operations" Chapter.)
2. The LCD displays a screen similar to the following:



gje011.eps

3. Select **RUN**. (On the LCD screen, **RUN** does not flash while the selection is active as it does in the menu-control mode.)
4. To scroll through screens while in the numeric-control mode, select **DOWN** or **UP**; screens are available in chronological numeric order. (Inactive numeric-control codes are skipped automatically.) Alternatively, simply press the number keys for another numeric selection.
5. The screen for a numeric entry appears only after the entire numeric code is entered.
6. As the numbers for a three-digit code are entered, each number on the screen shifts one place to the left. This means that the function identifications for other key codes appear briefly on the screen during the entry process.

   For example, from the ASYSTOLE numeric screen (in the example shown in this section), if you begin to enter **382** for the PAROXYSMAL ATR TACH screen, when you press **3**, the LCD displays the screen [333] R WAVE WIDTH 150 MS; and when you press **8**, the LCD displays the screen [338] R WAVE WIDTH 200 MS. The ASYSTOLE screen does not appear until the entire code 382 is entered.

General Specifications

Power ..... Two 9-V alkaline batteries (minimum 8 hours continuous power). Optional battery eliminator: 9 Vdc, 50 mA

Size ..... 6 in x 7.5 in x 2 in (15.2 cm x 19 cm x 5 cm)

Weight ..... 1 lb 8 oz (0.7 kg)

Temperature

Storage ..... -25 °C to +50 °C

Operation ..... 10 °C to 40 °C

Maximum Humidity ..... 80 % relative humidity

Battery Replacement ..... Warning for low-battery condition. The batteries must be replaced at this time.

Detailed Specifications

Normal-Sinus-Rhythm Waveform

ECG Reference ..... The ECG amplitudes specified are for Lead II (calibration), from the baseline to the peak of the R wave. All other leads are proportional.

Normal Sinus Rhythm ..... 12-lead configuration with independent outputs referenced to right leg (RL). Output to 10 Universal ECG Jacks, color-coded to AHA and IEC Standards.

High-Level Output ..... 0.2 V/mV ±5 % of the ECG amplitude setting available on the BP3 connector.

Amplitude ..... 0.05 mV to 0.5 mV (0.05 mV steps); 0.5 mV to 5.5 mV (0.5 mV steps)

Amplitude Accuracy ..... ±2 % of setting Lead II

ECG Rate ..... 30, 40, 45, 60, 80, 90, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, and 300 BPM

Rate Accuracy ..... ±1 % of setting

ECG Waveform Selection ..... Adult (80 ms) or pediatric (40 ms) QRS duration

Superimposed Artifact ..... 50 and 60 Hz, muscle, baseline wander, respiration

ST-Segment Elevation ..... Adult mode only. -0.8 mV to +0.8 mV (0.1 mV steps) Additional steps: +0.05 mV and -0.05 mV

Power-On Default ..... 80 BPM, 1.0 mV, adult QRS, ST-segment elevation of 0 mV, and a P-R interval of 0.16 seconds

Pacemaker Waveform

Pacer-Pulse Amplitude ..... 1, 2, 5, 10 mV ±10 %

Pacer-Pulse Width ..... 0.1, 0.5, 1.0, 1.5, 2.0 ms ±5 %

Pacing Rate ..... 75 BPM
Waveforms
Atrial
Asynchronous 75 BPM
Demand with frequent sinus beats
Demand with occasional sinus beats
AV sequential
Noncapture (one time)
Nonfunction

Power-On Default ..... Amplitude 5 mV, width 1.0 ms, atrial waveform

Arrhythmia

Baseline NSR ..... 80 BPM

PVC Focus ..... Left focus, standard timing (except where specified)

Supraventricular Arrhythmia ..... Atrial fibrillation (coarse or fine); atrial flutter; sinus arrhythmia; missed beat (one time); atrial tachycardia; paroxysmal atrial tachycardia; nodal rhythm; and supraventricular tachycardia.

Premature Arrhythmia ..... (All one-time events) Premature atrial contraction (PAC); premature nodal contraction (PNC); PVC1 left ventricular; PVC1 left ventricular, early; PVC1 left ventricular, R on T; PVC2 right ventricular; PVC2 right ventricular, early; PVC2 right ventricular, R on T; and multifocal PVCs

Ventricular Arrhythmia ..... PVCs 6, 12, or 24 per minute; frequent multifocal PVCs; bigeminy; trigeminy; multiple PVCs (one-time run of 2, 5, or 11 PVCs); ventricular tachycardia; ventricular fibrillation (coarse or fine); and asystole

Conduction Defect ..... First-, second-, or third-degree heart block; and right- or left-bundle-branch block

Power-On Default ..... Atrial fibrillation (coarse); PAC; PVCs 6/minute; first-degree heart block

ECG-Performance-Testing

Amplitude ..... 0.05 to 0.5 mV (0.05 mV steps)
0.5 to 5.5 mV (0.5 mV steps)

Pulse Wave ..... 30, 60 BPM, with 60 ms pulse width

Square Wave ..... 2.0, 0.125 Hz

Triangle Wave ..... 2.0, 2.5 Hz

Sine Wave ..... 0.5, 5, 10, 40, 50, 60, 100 Hz

R-wave-Detection Waveform ..... Haver-Triangle

R-wave Rate ..... 30, 60, 80, 120, 200, and 250 BPM

R-wave Width ..... 20 to 200 ms (10 ms steps)
Additional Steps: 8, 10, and 12 ms

Rate Accuracy ..... ±1 %

Amplitude Accuracy ..... ±2 %, Lead II (Exception: ±5 % for R waves ≤20 ms)

Power-On Default ..... 1.0 mV, square wave 2.0 Hz, R-wave rate 60 BPM, R-wave width 10 ms

Respiration

Rate ..... 0 (OFF), 15, 20, 30, 40, 60, 80, 100, 120 BrPM

Impedance Variations (Δ Ω) ..... 0.2, 0.5, 1, or 3 Ω

Accuracy Delta ..... ±10 %

Baseline ..... 500, 1000, 1500, 2000 Ω, Leads I, II, III

Accuracy Baseline ..... ±5 %

Respiration Lead ..... LA or LL

Apnea Selection ..... 12, 22, or 32 seconds (one-time events), or continuous (Apnea ON = respiration OFF)

Power-On Default ..... 20 BrPM, delta 1.0 Ω, 1000-Ω baseline, left-arm lead (LA), 12-second apnea

Blood Pressure

Input/output Impedance ..... 300 Ω ±10 %

Exciter Input Range ..... 2.0 to 16.0 V rms

Exciter-Input Frequency Range ..... DC to 5000 Hz

Transducer Sensitivity ..... 5 or 40 µV/V/mmHg

Pressure Accuracy ..... ±(2 % of setting + 2 mmHg)

Static Levels, p1 ..... -10, 0, 80, 160, 240, 320, 400 mmHg

Static Levels, p2 ..... -10, 0, 50, 100, 150, 200, 240 mmHg

Static Levels, p3 ..... -5, 0, 20, 40, 60, 80, 100 mmHg

Static Levels, p4 ..... -5, 0, 20, 40, 60, 80, 100 mmHg

Dynamic Waveforms, p1 ..... Arterial: 120/80
Radial artery: 120/80
Left ventricle: 120/00
Right ventricle: 25/00

Dynamic Waveforms, p2 ..... Arterial: 120/80
Radial artery: 120/80
Left ventricle: 120/00
Right atrium (central venous or CVP): 15/10
Right ventricle: 25/00
Pulmonary artery: 25/10
Pulmonary-artery wedge: 10/2
Left atrium: 14/4

Dynamic Waveforms, p3 ..... Arterial: 120/80
Radial artery: 120/80
Left ventricle: 120/00

	Right atrium (central venous or CVP): 15/10 Right ventricle: 25/00 Pulmonary artery: 25/10 Pulmonary-artery wedge: 10/2 Left atrium: 14/4
Dynamic Waveforms, p4	Swan-Ganz sequence: Right atrium (CVP) Right ventricle RV) Pulmonary artery (PA) Pulmonary-artery wedge (PAW)
Respiration Artifact	BP delta changes from 3 to 16 mmHg
BP Output	Mini DIN 7-Pin
Power-On Default	0 mmHg, transducer sensitivity 5 µV/V/mmHg

Temperature

Temperature	0 °C (42 °F), 24 °C (75.2 °F), 37 °C (98.6 °F), and 40 °C (104 °F)
Accuracy	±0.1 °C
Compatibility	Yellow Springs, Inc. (YSI) Series 400 and 700
Output	mini DIN 7-pin
Power-On Default	0 °C (42 °F)

Cardiac Output

Catheter Type	Baxter Edwards, 93a-131-7f
Calibration Coefficient	0.542 (0 °C injectate), 0.595 (24 °C injectate)
Blood Temperature	37 °C (98.6 °F) ±2 %
Injectate Volume	10 cc
Injectate Temperature	0 °C or 24 °C ±2 % value
Cardiac Output	2.5, 5, 10 liters per minute ±5 %
Faulty-Injectate Curve	Waveform for simulation available
Left-to-Right-Shunt Curve	Waveform for simulation available
Calibrated Pulse	1.5 ° for 1 second (37 ° → 35.5 °)
Repeatability	±1 %
Power-On Default	2.5 liters per minute, 0 °C injectate

Fetal / Maternal-ECG

Fetal Heart Rate (Fixed)	60, 90, 120, 140, 150, 210, and 240 BPM
Fetal Heart Rate (IUP):	140 BPM at beginning, then varies with pressure
Intrauterine-Pressure Waveforms	Early deceleration, late deceleration, and acceleration
Wave Duration	90 seconds, bell-shaped pressure curve, from 0 to 90 mmHg and returning to 0
IUP Period	2, 3, or 5 minutes; and manual
Power-On Default	FHR 120 BPM, late deceleration, manual

Computer Setup

Port	Bidirectional (Data Communications Equipment) RS-232
Baud Rate	9600
Parity	None
Stop Bits	1
Data Bits	8

Chapter 2
Cardiac Functions

Introduction

This chapter covers the MPS450 functions that are related to the heart: ECG, Arrhythmia, ECG Testing, Blood Pressure, and Cardiac Output.

ECG Functions

An electrocardiogram (ECG) is a recording of the electrical activity of the muscles of the heart—the depolarization and repolarization of the myocardium. Wires running from an ECG machine are connected to small plastic or metal-terminated cables called leads, or electrodes. Placed on the chest, on the wrists of the right and left arms, and on the left leg at the ankle, the electrodes transmit signals to a pen that draws lines in the form of waves onto graph paper in the ECG machine, tracing the heart's electrical activity (rate) and its rhythm (beat). Each contraction of a normal heart causes a consistent waveform, referred to as the P QRS T waveform, normal sinus rhythm, or NSR.

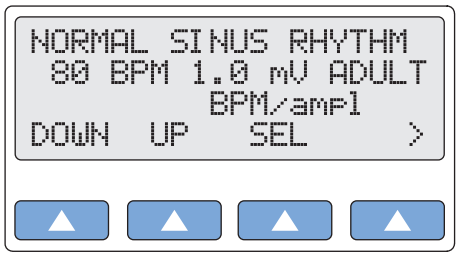
The MPS450 sets the simulated heartbeat to NSR, offering adjustable settings for heart rate, amplitude, and ST measurement.

Normal Sinus Rhythm (NSR)

The NSR heartbeat, exhibiting the P-QRS-T wave, as defined in standard ECG textbooks:

When the heartbeat is normal, with a standard QRS waveform shape and height, it is referred to as having a normal sinus rhythm. In normal sinus conditions, the SA (sinoatrial) node—which lies just in front of the opening of the superior vena cava—sends an electrical impulse through the nerves of the heart to the AV (atrioventricular) node, through the bundle of His, down the left- and right-bundle branches, and on to the fibers in the Purkinje network, where the impulse finally depolarizes in the ventricular myocardium. At rest, the heart pumps an average of approximately two ounces (59 cc) of blood per beat, or about five quarts per minute.

The MPS450 simulates NSR with a P-R interval of 0.16 seconds. Whenever the instrument is turned on, the LCD screen displays the defaults (which remain active during a session until the settings are changed) for heart rate (80 BPM), ECG amplitude on Lead II (1.0 mV), and patient type (ADULT):



gje012.eps

Beats-per-minute, ECG amplitude, and patient type are adjustable. (Adjusting the BPM rate does not affect simulations for arrhythmias, which set their own rates.)

Adjusting the ECG Heart Rate

The MPS450 offers seventeen preprogrammed settings (BPM) for heart rate: 30, 40, 45, 60, 80, 90, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, or 300.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **NSR**. (The top-menu screen for normal sinus rhythm displays automatically whenever the MPS450 is turned on.)
2. Select **SEL** to toggle to the screen for adjusting beats-per-minute (BPM/ampl), with BPM in upper-case letters.

3. The heart-rate setting identified on the LCD screen is active when displayed and remains active until the setting is changed. (Adjusting the BPM rate does not affect simulations for arrhythmias, which set their own rates.)

Alternatively, in the Numeric-Control Mode, press the number keys for a heart-rate setting according to Table 2-1, and select **RUN**:

Table 2-1. Numeric Codes for BPM Settings

BPM Setting	Numeric Code
30 BPM	165
40 BPM	166
45 BPM	250
60 BPM	167
80 BPM	168
90 BPM	251
100 BPM	169
120 BPM	170
140 BPM	171
160 BPM	172
180 BPM	173
200 BPM	174
220 BPM	175
240 BPM	176
260 BPM	177
280 BPM	178
300 BPM	179

Adjusting the ECG Amplitude

Most waveforms are sent to the ECG using the selected adjustment (QRS height) for amplitude. (ECG amplitudes are used only as a reference during arrhythmia simulations.)

The MPS450 offers a selection of twenty preprogrammed amplitude settings (Lead II): 0.05 to 0.5 mV (0.05 mV steps) and 0.5 to 5.5 mV (0.5 mV steps). This amplitude setting applies to all ECG waveforms except performance waves and R waves, each of which has its own amplitude settings.

Action in the Menu-Control Mode

1. Press the top-menu key labeled NSR. (The top-menu screen for NSR displays automatically whenever the MPS450 is turned on.)
2. Select **SEL** to toggle to the screen for adjusting ECG amplitude (bpm/AMPL), with AMPL in upper-case letters.
3. To adjust the ECG amplitude, select **DOWN** or **UP**.
4. The ECG-amplitude setting identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for an ECG-amplitude setting according to Table 2-2, and select **RUN**:

Table 2-2. Numeric Codes for ECG Amplitude Settings

Amplitude setting	Numeric code
0.05 mV	252
0.10 mV	253
0.15 mV	254
0.20 mV	255
0.25 mV	256
0.30 mV	257
0.35 mV	258
0.40 mV	259
0.45 mV	260
0.50 mV	261
1.00 mV	262
1.50 mV	263
2.00 mV	264
2.50 mV	265
3.00 mV	266
3.50 mV	267
4.00 mV	268
4.50 mV	269
5.00 mV	270
5.50 mV	271

Adult and Pediatric ECG

The MPS450 simulates an adult ECG waveform with QRS duration of 80 ms, or a pediatric waveform with QRS duration of 40 ms.

Action

1. Press the top-menu key labeled **NSR**. The LCD screen identifies the current patient type either as adult (ADULT) or as pediatric (PEDS).
2. Select **>** to move to the LCD screen PT TYPE.
3. Select **PT TYPE** to toggle to the desired patient type.
4. The patient-type setting identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for a patient-type setting according to Table 2-3, and select **RUN**:

Table 2-3. Numeric Codes for Patient-Type Settings

Patient-Type Setting	Numeric Code
ADULT	010
PEDS	011

Adjusting the ST Segment

On the ECG output, the ST segment is that portion of line between the end of the QRS complex and the T wave. The T wave is caused by the return of the ventricular mass of the heart to a state of electrical rest (repolarization). The deviation of the ST segment is indicative of a variety of conditions, with the baseline being set by the P-R segment.

The MPS450 adjusts (elevates or depresses) the ST segment for adult normal-sinus waves at or below 180 BPM. The nineteen preprogrammed settings (mV) include a range from -0.8 mV to +0.8 mV (0.1 mV steps) as well as +0.05 and -0.05. The elevation/depression amount specified is for Lead II, per millivolt of ECG amplitude, with other leads being proportional.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **NSR**.
2. Select **>** to display the LCD screen NORMAL SINUS RHYTHM ST.
3. To adjust the ST segment to the desired setting, select **DOWN** or **UP**.
4. The ST-segment setting identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for an ST-segment setting according to Table 2-4, and select **RUN**:

Table 2-4. Numeric Code for ST-Segment Settings

ST-Segment Setting	Numeric code
+0.8 mV	222
+0.7 mV	223
+0.6 mV	224
+0.5 mV	225
+0.4 mV	226
+0.3 mV	227
+0.2 mV	228
+0.1 mV	229
+0.05 mV	219
0 mV	220
-0.05 mV	221
-0.1 mV	230
-0.2 mV	231
-0.3 mV	232

Table 2-4. Numeric Code for ST-Segment Settings (cont.)

ST-Segment Setting	Numeric code
-0.4 mV	233
-0.5 mV	234
-0.6 mV	235
-0.7 mV	236
-0.8 mV	237

Simulating ECG Artifact

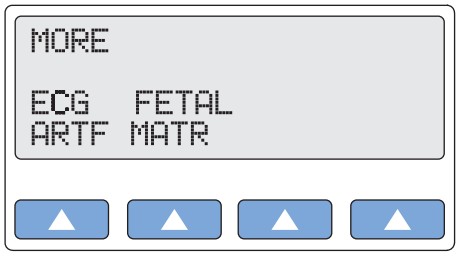
Depolarization is the process by which all muscles of the body contract, and the electrical charges generated by any muscle (electromyographic signals) can be detected to a degree by an electrocardiogram. Thus, the electrical charges associated specifically with contractions of the heart will be clear only if there is no interference by auxiliary signals from other muscles. (This is why a patient must be fully relaxed—with no skeletal muscle movement—during ECG testing.)

Electrical signals from power lines or local (in-wall) circuitry represent another kind of artifact (also called noise) that can be picked up by an ECG device. These sources can cause minute electric currents through capacitive coupling or resistive contacts. On an ECG readout, such electrical artifacts can cause a serious safety condition. Even a relatively tiny current of 60 hertz (Hz) can be fatal. Therefore, whenever line frequency in an electrocardiogram is noted, the cause of the signal should be determined at once.

The MPS450 simulates a number of different ECG artifacts that can affect the accuracy of an ECG reading. ECG-artifact simulations, which can be added to any ECG wave, include line-frequency artifacts of 60 Hz (U.S. lines) and 50 Hz (European lines), as well as separate artifacts for muscle, wandering baseline, and respiration.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **MORE** to display the following LCD screen:



gje013.eps

2. Select **ECG ARTF**. The LCD screen displays ECG ARTIFACT OFF; RUN flashes if the ECG-artifact option is turned off.
3. Scroll to the desired artifact: 60 HZ; 50 HZ; MUSCLE; WANDER; or RESPIRATION.
4. Select **RUN**. The ECG artifact remains active until another artifact selection is made.
5. To turn off the ECG-artifact option, scroll to the LCD screen displaying ECG ARTIFACT OFF, and select **RUN**.

Alternatively, in the Numeric-Control Mode, press the number keys for an ECG artifact according to Table 2-5, and select **RUN**:

Table 2-5. Numeric Code for ECG Artifact Settings

ECG-Artifact Setting	Numeric Code
ECG ARTIFACT OFF	104
60 HZ	105
50 HZ	106
MUSCLE	107
WANDER	108
RESPIRATION	109

Pacemaker Waveforms

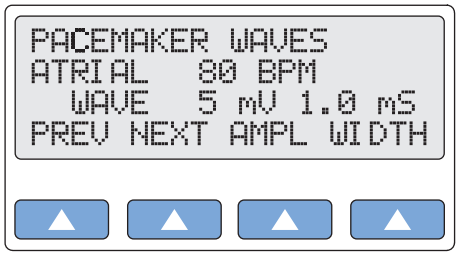
When the heart beats erratically, or not at all, it may need to be stimulated by artificial means, that is, by either an internal (permanent) or an external (temporary) artificial pacemaker. Pacemakers may operate at a fixed preset rate, or on demand.

The MPS450 sends waveforms to simulate several artificial-pacemaker conditions:

- an atrial pacemaker wave at 80 BPM, with a pacer pulse at the start of each P wave;
- an asynchronous pacemaker wave with continuous ventricular-paced beats (75 BPM) and no P waves;
- a “demand” pacemaker wave with frequent sinus beats (forty normal beats followed by twenty ventricular-paced beats, repeated);
- a “demand” pacemaker wave with occasional sinus beats (twenty normal beats followed by forty ventricular-paced beats, repeated);
- an AV-sequential-pacemaker wave with continuous paced beats, each with an atrial pulse and a P wave followed by a ventricular-paced pulse and QRS response;
- ventricular-paced beats, where one out of every ten beats has no heart response (noncapture); or
- continuous pacer pulses at 75 BPM with no heart response (nonfunction).

Action in the Menu-Control Mode

1. Press the top-menu key labeled **PACE** to display the following LCD screen:



gje014.eps

2. Scroll to the desired pacemaker-wave type: ATRIAL 80 BPM; ASYNC 75 BPM; DEMAND FREQ SINUS; DEMAND OCC SINUS; AV SEQUENTIAL; NON-CAPTURE; or NON-FUNCTION.
3. The pacemaker wave identified on the LCD screen is active when displayed and remains active until another wave is selected.

Alternatively, in the Numeric-Control Mode, press the number keys for a pacemaker-type wave according to Table 2-6, and select **RUN**:

Table 2-6. Numeric Code for Pacemaker-Waveform Settings

Pacemaker-Waveform Setting	Numeric Code
ATRIAL 80 BPM	383
ASYNC 75 BPM	110
DEMAND FREQ SINUS	111
DEMAND OCC SINUS	112
AV SEQUENTIAL	113
NON-CAPTURE	114
NON-FUNCTION	115

Adjusting Pacemaker–Spike Amplitude

The MPS450 offers a selection of four preprogrammed settings (mV) for pacemaker-spike amplitude: 1, 2, 5, or 10.

Action in the Menu-Control Mode

1. On the LCD screen for the selected pacer-type wave, select **AMPL** repeatedly to scroll to the desired spike-amplitude setting.
2. The pacemaker amplitude identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the **Numeric-Control Mode**, press the number keys for pacemaker-spike amplitude according to Table 2-7, and select **RUN**:

Table 2-7. Numeric Codes for Pacemaker-Amplitude Settings

Pacemaker-Amplitude Setting	Numeric Code
1.0 mV	384
2.0 mV	385
5.0 mV	386
10.0 mV	387

Adjusting Pacemaker–Spike Width

The MPS450 simulates five preconfigured settings (ms) for pacemaker-spike width: 0.1, 0.5, 1.0, 1.5, or 2.0.

Action in the Menu-Control Mode

1. On the LCD screen for the selected pacer-type wave, select **WIDTH** repeatedly to scroll to the desired spike-width setting.
2. The pacemaker width identified on the LCD screen is active when displayed and remains active until the settings are changed.

Alternatively, in the Numeric-Control Mode, press the number keys for the pacemaker-width setting according to Table 2-8, and select **RUN**:

Table 2-8. Numeric Codes for Pacemaker-Width Settings

Pacemaker-Width Setting	Numeric Code
0.1 ms	243
0.5 ms	244
1.0 ms	245
1.5 ms	246
2.0 ms	247

Arrhythmia Functions

Departures from the normal height, shape, or length (of time) of the PQRST-waveform patterns suggest specific illnesses, making the ECG very valuable when used in conjunction with other diagnostic tests. ECG patterns that divulge disturbances in the blood supply to the heart muscle or abnormalities in the heartbeat (arrhythmias) may be associated with coronary artery disease.

The MPS450 simulates a wide array of arrhythmias, representing heartbeats that are too slow, too fast, or totally erratic; that have beats with abnormal timing, spacing, or waveform shapes; or that combine abnormal and normal beats in varying proportions.

Atrial Fibrillation

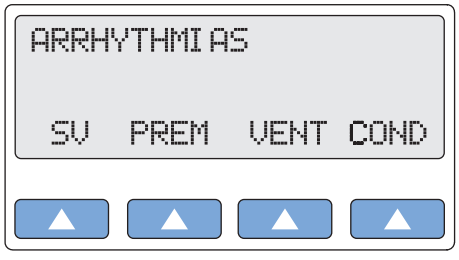
A rapid, irregular atrial signal, coarse or fine, with no real P waves; an irregular ventricular rate.

Coarse and fine atrial fibrillation occurs when the electrical signals in the atria are chaotic, and multiple, ectopic pacemakers are firing erratically. Some impulses may conduct through to the AV node to stimulate the ventricles, causing a quite-irregular and often-rapid ventricular rate. On the ECG there is an absence of P waves, with an irregular R-R interval. Atrial-fibrillation waveforms are irregularly shaped and usually rounded. The amplitude of the atrial signal is higher for coarse, and lower for fine, fibrillation.

The MPS450 simulates irregular atrial waveforms; the amplitude of the atrial signal is higher for coarse, and lower for fine, fibrillation.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY** to display the following LCD screen:



gje015.eps

2. Select SV to display the following LCD screen:

gje016.eps

3. Scroll to the LCD screen for the desired condition: ATRIAL FIB COARSE or ATRIAL FIB FINE.
4. Select **RUN**. The selected simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys for atrial-fibrillation amplitude according to Table 2-9, and select **RUN**:

Table 2-9. Numeric Codes for Atrial-Fibrillation-Amplitude Settings

Atrial-Fibrillation-Amplitude Setting	Numeric Code
ATRIAL FIB COARSE	012
ATRIAL FIB FINE	013

Atrial Flutter

A repeating sequence of large, irregular P waves at 300 BPM; an irregular ventricular response.

Atrial flutter occurs when a single, ectopic, atrial pacemaker that is non-SA (usually low, near the AV node) fires repeatedly and (usually) regularly, producing large, pointed P waves at an approximate rate of 400 BPM (between 240 and 480 BPM). Not all of the atrial impulses conduct through to the ventricles. On the ECG readout the waveform generally exhibits a “saw tooth” appearance. This type of arrhythmia can reduce cardiac output by as much as 25 %, due in many cases to the lack of an atrial “kick” and the accompanying failure of the ventricles to fill completely with blood prior to ventricle contraction.

The MPS450 simulates atrial flutter in the following (repeating) sequence: beats at a ratio of 5:1 (five atrial beats for every one ventricular beat) for twelve seconds, followed by beats at a ratio of 3:1 for six seconds, followed by beats at a 2:1 ratio for six seconds.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.
3. Scroll to the LCD screen ATRIAL FLUTTER.
4. Select **RUN**. The atrial-flutter simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **014**, and select **RUN**.

Sinus Arrhythmia

Beats that are normal, but triggered at an irregular rate, from 60 BPM to 100 BPM.

Sinus arrhythmia occurs when the SA node paces the heart irregularly. Typically, the heartbeat increases with each intake of breath and decreases with each exhalation (a

condition most commonly found in young children and the elderly).

The MPS450 simulates a sinus arrhythmia condition with normal beats triggered at an irregular rate, from 60 to 100 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.
3. Scroll to the LCD screen SINUS ARRHYTHMIA.
4. Select **RUN**. The sinus-arrhythmia simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys 015, and select **RUN.**

Missed Beat

A single missing beat, with the heart rate returning to normal.

Missed beats, often present in first-degree heart block, are symptomatic of other conditions as well.

The MPS450 simulates a random missed beat occurring as a one-time event during an otherwise normal heart rate of 80 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.
3. Scroll to the LCD screen MISSED BEAT.
4. Select **RUN**. On the LCD screen, RUN flashes to indicate that the missed-beat simulation is running as a one-time event. When the simulation completes, the command **INSRT** displays on the screen.
5. To send another missed-beat simulation, select **INSRT**.

Alternatively, in the Numeric-Control Mode, press the number keys **016**, and select **RUN**. (To send another missed-beat simulation, select **RUN** again.)

Atrial Tachycardia (AT)

Normal rhythm at a faster-than-normal rate of 160 BPM.

Atrial tachycardia occurs when an ectopic, atrial pacemaker (non-SA) fires repeatedly at a rate between 150 and 250 BPM. AT may cause cardiac output to drop significantly (in some cases by as much as 25 %), due to the inability of the ventricles to fill completely during the typically short diastole. This condition may result from an atrioventricular blockage or digitalis toxicity.

The MPS450 simulates AT at 160 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.
3. Scroll to the LCD screen ATRIAL TACH.
4. Select **RUN**. The atrial-tachycardia simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **017**, and select **RUN**.

Paroxysmal Atrial Tachycardia (PAT)

Normal rhythm at alternating rates.

When atrial tachycardia occurs as a seizure-like spasmodic event, it is called paroxysmal atrial tachycardia or PAT. PATs typically start and stop suddenly, initiated by a premature atrial contraction (PAC). PAT spasms may last for only a few seconds or for minutes or hours. A patient may experience ATs and PATs over the course of many years.

The MPS450 simulates PAT at alternating rates: 160 BPM for five seconds and 80 BPM for twelve seconds.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.
3. Scroll to the LCD screen PAROXYSMAL ATR TACH.
4. Select **RUN**. The PAT simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **382**, and select **RUN**.

Nodal Rhythm

Normal rhythm, but with a P wave that originates in the AV node, and a P-R interval that is very short.

Nodal rhythm, also referred to as junctional rhythm or junctional escape, is a condition where the predominant pacemaker is the AV node rather than the SA node.

The MPS450 simulates nodal rhythm with a very short P-R interval of 90 ms.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.
3. Scroll to the LCD screen NODAL RHYTHM.
4. Select **RUN**. The nodal-rhythm simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **018**, and select **RUN**.

Supraventricular Tachycardia

Normal rhythm at a faster-than-normal rate of 200 BPM.

Supraventricular tachycardia is a combination of a junctional tachycardia (that is, an atrial tachycardia occurring in the AV or junctional node) and an atrial tachycardia. Therefore, supraventricular tachycardia encompasses multifocal, ectopic, atrial pacemakers in and around the AV node above the bundle of His.

The MPS450 simulates a condition of supraventricular tachycardia at 200 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **SV**.

3. Scroll to the LCD screen SUPRAVENT TACH.
4. Select **RUN**. The supraventricular-tachycardia simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **019**, and select **RUN**.

Premature Atrial Contraction (PAC)

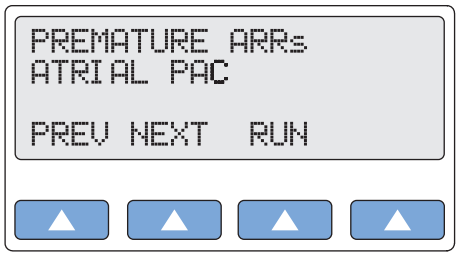
A beat that is 25 % premature but otherwise normal.

Any part of the heart can depolarize earlier than it should; the accompanying heartbeat is called extrasystole. This type of depolarization is called a premature contraction; a premature contraction that originates in the SA node is referred to as a PAC. An isolated PAC is relatively unimportant. However, frequent PACs are a concern, because they could be the precursor of more serious and potentially life-threatening conditions, including atrial flutter, atrial fibrillation, and atrial tachycardia.

The MPS450 simulates a PAC as a one-time event within an otherwise-normal rhythm at 80 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **PREM** to display the following LCD screen:



gje017.eps

3. Select **RUN**. On the LCD screen, RUN flashes to indicate that the PAC simulation is running as a one-time event. When the simulation completes, the command **INSRT** displays on the screen.
4. To send another PAC simulation, select **INSRT**.

Alternatively, in the Numeric-Control Mode, press the number keys **035**, and select **RUN**. (To repeat a PAC, select **RUN** again.)

Premature Nodal Contraction (PNC)

A nodal beat that is 25 % premature, followed by a nodal rhythm at 80 BPM.

A premature nodal contraction—also called a premature junctional contraction, a PNC, or a PJC—is an extra beat that occurs as a result of an electrical impulse sent from the atrioventricular (junctional) node. The P-R interval is shorter than normal. PNCs, which may occur in isolation or in groups, can appear sporadically for no obvious reason in an otherwise-healthy person.

The MPS450 simulates a PNC as a one-time event, followed by a normal sinus rhythm at 80 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **PREM**.

3. Scroll to the LCD screen NODAL PAC.
4. Select **RUN**. On the LCD screen, RUN flashes to indicate that the PNC simulation is running as a one-time event. When the simulation completes, the command **INSRT** displays on the screen.
5. To send another PNC simulation, select **INSRT**.

Alternatively, in the Numeric-Control Mode, press the number keys **036**, and select **RUN**. (To repeat a PNC, select **RUN** again.)

Premature Ventricular Contractions

Six PVC-type selections of focus and timing:

- a left-focus premature ventricular beat with standard timing, 20 % premature;
- a left-focus premature ventricular beat with early timing, 33 % premature;
- a left-focus premature ventricular beat with very early timing, 65 % premature, which starts during the T wave of the previous beat;
- a right-focus premature ventricular beat with standard timing, 20 % premature;
- a right-focus premature ventricular beat with early timing, 33 % premature; or
- a right-focus premature ventricular beat with very early timing, 65 % premature, which starts during the T wave of the previous beat.

A premature ventricular contraction or PVC is an extra beat consisting of an abnormally wide and unusual QRS complex originating in an ectopic pacemaker in the ventricles. Early ventricular PVCs occur close to the preceding beat. Moreover, R-on-T PVCs, which are characterized by a beat that falls on the T wave of the preceding QRS-T complex, are especially inauspicious because of their potential to cause ventricular tachycardia or ventricular fibrillation.

The six PVC selections offered by the MPS450, occurring as one-time events within a normal sinus rhythm, enable the focus or type of the simulated PVC (left or right ventricle) to be specified, as well as the timing (standard, early, or R on T). “Type 1” refers to a PVC with a left-ventricular focus and a marked left-axis deviation, while “type 2” refers to a PVC with a right-ventricular focus and a right-axis deviation. The MPS450 simulates “standard” PVCs as 20 % premature, “early” PVCs as 33 % premature, and R-on-T PVCs as 65 % premature.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **PREM**.
3. Scroll to the LCD screen for the desired PVC focus: PVC1 LEFT VENT; PVC1 LV EARLY; PVC1 LV R ON T; PVC2 RIGHT VENT; PVC2 RV EARLY; or PVC2 RV R ON T.
4. Select **RUN**. On the LCD screen, RUN flashes to indicate that the selected simulation is running as a one-time event. When the simulation completes, the command **INSRT** displays on the screen.
5. To repeat a PVC with the same focus, select **INSRT**.

Alternatively, in the Numeric-Control Mode, press the number keys for a PVC-waveform type according to Table 2-10, and select **RUN**. (To repeat the selected PVC, select **RUN** again.)

Table 2-10. Numeric Codes for PVC-Waveform Settings

PVC-Waveform Setting	Numeric Code
PVC1 LEFT VENT	037
PVC1 LV EARLY	038
PVC1 LV R ON T	039
RIGHT VENT	040
PVC2 RV EARLY	041
PVC2 RV R ON T	042

Multifocal PVCS

A sequence that includes a left-focus PVC, followed by two normal beats, followed by a right-focus PVC, followed by a normal rhythm at 80 BPM

Multifocal PVCs are premature ventricular contractions that originate in different ectopic-pacemaker sites throughout the ventricles. These PVCs, which exhibit different size and shape elements, are characterized by the absence of a P wave (due to the lack of any atrial-pacemaker activity).

To simulate a multifocal-PVC condition, the MPS450 alternates the PVCs between type 1 (left focus) and type 2 (right focus), with a sequence occurring as a one-time event: a left-focus PVC, followed by two normal beats, followed by a right-focus PVC, followed by normal rhythm at 80 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **PREM**.
3. Scroll to the LCD screen MULTIFOCAL PVCS.
4. Select **RUN**. On the LCD screen, RUN flashes to indicate that the sequence for a multifocal-PVC simulation is running as a one-time event. When the simulation completes, the command INSRT displays on the screen.
5. To repeat the sequence, select **INSRT**.

Alternatively, in the Numeric-Control Mode, press the number keys **043**, and select **RUN**. (To repeat the sequence, select **RUN** again.)

PVCS: 6, 12, or 24 Per Minute

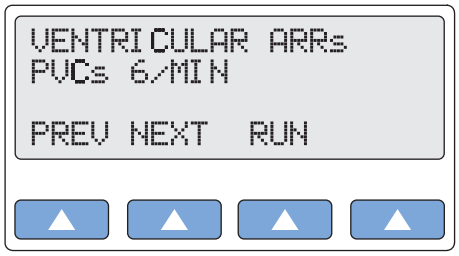
PVCs scattered among normal beats AT 80 BPM, so that PVCs take place 6, 12, or 24 times every minute.

Premature ventricular contractions may occur independently (even in healthy individuals), as well as in groups and/or for a number of times every minute.

The MPS450 sets the number of PVCs that occur per minute during an otherwise-normal sinus rhythm (80 BPM), to simulate conditions of six PVCs per minute, twelve PVCs per minute, or twenty-four PVCs per minute. In this category the MPS450 simulates all PVCs as type 1, left-ventricular focus, within a normal sinus QRS.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT** to display the following LCD screen:



gje018.eps

3. Scroll to the LCD screen for the desired PVC simulation: PVCs 6/MIN; PVCs 12/MIN; or PVCs 24/MIN.
4. Select **RUN**. The PVCs-per-minute waveform runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys for a PVCs-per-minute waveform according to Table 2-11, and select **RUN**:

Table 2-11. Numeric Codes for PVCs-Per-Minute Settings

PVCs-Per-Minute Setting	Numeric Code
PVCs 6/MIN	021
PVCs 12/MIN	022
PVCs 24/MIN	023

Frequent Multifocal PVCS

A sequence that includes a left-focus PVC followed by normal beats, alternating with a right-focus PVC followed by normal beats.

Frequent multifocal PVCs are initiated by a number of different ectopic pacemakers in the ventricles, with events occurring at least five times per minute, and usually more often.

The MPS450 simulates a continuous, repeating waveform that alternates between a type-1 (left-focus) PVC followed by three normal beats, and a type-2 (right-focus) PVC followed by three normal beats.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT**.
3. Scroll to the LCD screen FREQ MULTIFOCAL.
4. Select **RUN**. The frequent-multifocal-PVC waveform runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **024**, and select **RUN**.

Bigeminy and Trigeminy

Two sequences: a PVC followed by a normal beat, or a PVC followed by two normal beats.

Bigeminy—also called a fixed coupling or bigeminal rhythm—is a type of PVC in which a beat with a normal QRS complex alternates with a PVC; in other words, every other beat is premature. In trigeminy, which is similar to bigeminy, a PVC appears after every two normal QRS complexes.

The MPS450 simulates either bigeminy or trigeminy incorporated within a normal sinus rhythm (80 BPM), using type-1 (left-focus) PVCs.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT**.
3. Scroll to the LCD screen for the desired simulation: BIGEMINY or TRIGEMINY.
4. Select **RUN**. The bigeminy or trigeminy waveform runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys for the desired simulation according to Table 2-12, and select **RUN**:

Table 2-12. Numeric Codes for PVC-Sequence Settings

PVC-Sequence Setting	Numeric Code
BIGEMINY	025
TRIGEMINY	026

Multiple PVCS: Paired PVCS; Run 5 PVCS; Run 11 PVCS

Three series of multiple PVCs run as one-time (nonrepeating) events.

The term multiple PVCs refers to any condition where two or more PVCs occur in a row. Standard PVCs of this type include a pair of PVCs (also known as a couplet), a run of five PVCs in a row, and a run of eleven PVCs in a row.

The MPS450 simulates multiple-PVC waveforms with three sequences occurring as one-time events:

a paired-PVC condition, with a waveform that includes a normal beat followed by two type-1 (left-focus) PVCs;
a run-5-PVC condition, with a waveform that includes one normal beat followed by five type-1 (left-focus) PVCs; or
a run-11-PVC condition, with a waveform that includes one normal beat followed by ten type-1 (left-focus) PVCs plus one type-2 (right-focus) PVC.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT**.
3. Scroll to the LCD screen for the desired PVC simulation: PAIR PVCs; RUN 5 PVCs; or RUN 11 PVCs.
4. Select **RUN**. On the LCD screen, RUN flashes to indicate that the selected sequence of PVCs is running as a one-time event. When the simulation completes, the command **INSRT** displays on the screen.
5. To repeat the sequence, select **INSRT**.

Alternatively, in the Numeric-Control Mode, press the number keys for the desired simulation according to Table 2-13, and select **RUN**. (To repeat a PVC series, select **RUN** again.)

Table 2-13. Numeric Codes for Multiple-PVC Settings

Multiple-PVC Setting	Numeric Code
PAIR PVCs	027
RUN 5 PVCs	028
RUN 11 PVCs	029

Ventricular Tachycardia

A faster-than-normal rhythm of beats (160 BPM) originating in the ventricles, similar to type-1 (left-focus) PVCs.

Ventricular tachycardia is a life-threatening arrhythmia in which one or multiple, ectopic, ventricular pacemakers in the bundle branches, Purkinje network, or ventricular myocardium are firing in a heart beating more frequently than 110 times a minute. In some cases the heart will be beating at a rate above 240 BPM. Ventricular tachycardia usually occurs in cases of extreme cardiac disease and often initiates or degenerates into ventricular fibrillation. This type of tachycardia can reduce cardiac output by as much as 25 % due, in many cases, to the lack of an atrial "kick" and therefore the lack of a complete filling of the ventricles with blood prior to ventricle contraction.

The MPS450 simulates a ventricular tachycardia at 160 BPM, with beats similar to type-1 (left-focus) PVCs.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT**.
3. Scroll to the LCD screen VENTRICULAR TACH.
4. Select **RUN**. The ventricular-tachycardia simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **030**, and select **RUN**.

Ventricular Fibrillation

An irregular ventricular waveform, coarse or fine.

Coarse and fine ventricular fibrillations occur when the electrical signals in the ventricles are chaotic, and multiple, ectopic, ventricular pacemakers are firing erratically. There are no real P waves and no clear R-R interval. Ventricular fibrillation waveforms are irregularly shaped. Ventricular fibrillation is a life-threatening condition; usually in such situations a defibrillator is applied immediately to return the heart to its normal rhythm.

The MPS450 simulates irregular ventricular waveforms; the amplitude of the ventricular signal is higher for coarse, and lower for fine, fibrillation.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT**.
3. Scroll to the LCD screen for the desired simulation: VENT FIB COARSE or VENT FIB FINE.
4. Select **RUN**. The selected ventricular-fibrillation simulation runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys for the desired simulation according to Table 2-14, and select **RUN**.

Table 2-14. Numeric Codes for Ventricular-Fibrillation-Amplitude Settings

Ventricular-Fibrillation-Amplitude Setting	Numeric Code
VENT FIB COARSE	031
VENT FIB FINE	032

Asystole (Cardiac Standstill)

No ECG activity whatsoever.

Ventricular asystole is a critical condition characterized by the absence of a heartbeat either in the ventricles or in the entire heart. This condition, also referred to as cardiac standstill, is usually accompanied by loss of consciousness, apnea, and—if not treated immediately—death.

The MPS450 simulates a condition of asystole by sending to the ECG a flatline signal, which is completely devoid of P waves, P-R or R-R intervals, and QRS complexes.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **VENT**.
3. Scroll to the LCD screen ASYSTOLE.
4. Select **RUN**. The asystole-condition waveform runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys **033**, and select **RUN**.

Heart Block: First, Second, and Third Degree

Three heart-block simulations, running as repeating sequences.

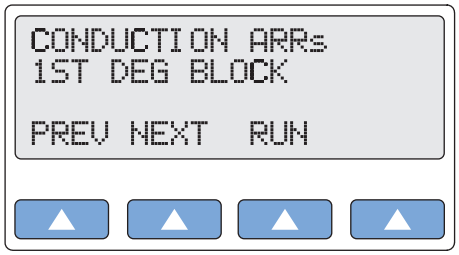
A heart block is a condition wherein the signal generated by the SA node is delayed or is blocked (partially or completely) in its journey to the ventricles. Because this condition typically occurs at the AV (atrioventicular) junction, a more precise term for heart block is atrioventricular block. When the conduction time from the atria to the ventricles becomes delayed (usually resulting in a P-R interval greater than 0.20 seconds), it is referred to as a first-degree block. When impulses from the atria occasionally do not reach the ventricles, the block is considered partial or incomplete and is referred to as a second-degree block. Finally, when no impulses whatsoever are able to enter the ventricles from the atria, the heart block is complete and is referred to as a third-degree block. As a consequence of a third-degree block, the atria and the ventricles beat at their own separate rates.

The MPS450 simulates waveforms for all three heart-block conditions:

- first-degree-block waveforms, with normal beats (80 BPM), but with a long P-R interval of 250 ms;
- second-degree-block waveforms, with normal beats, but with a P-R interval that increases every beat for four beats (from 160 to 220 to 400 to 470 ms), followed by a P wave only with no QRS response (the Wenckebach phenomenon); or
- third-degree-block waveforms, with normal beats, but with a P-wave rate of 80 BPM and a QRS rate of 30 BPM, running independently.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **COND** to display the following LCDC screen:



gje019.eps

3. Scroll to the LCD screen for the desired heart-block simulation: 1ST DEG BLOCK; 2ND DEG BLOCK; or 3RD DEG BLOCK.
4. Select **RUN**. The selected heart-block waveform runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys for the desired heart-block simulation according to Table 2-15, and select **RUN**:

Table 2-15. Numeric Code for Heart-Block Settings

Heart-Block Setting	Numeric Code
1ST DEG BLOCK	046
2ND DEG BLOCK	047
3RD DEG BLOCK	048

Bundle-Branch Block

Blockage in the right- or left-bundle branches, with beats exhibiting a wide QRS and a P-R interval of 160 ms.

Bundle-branch blockage—also referred to as intraventricular conduction defect, BBB or IVCD—is a form of heart block in which there is a conduction delay or failure from one of the branches of the bundle of His (which start about a centimeter below the bundle of His) to the Purkinje network. The blockage may be complete or incomplete, transient, intermittent, or permanent. In most cases, the electrical impulse travels through the normal bundle branch to stimulate one ventricle and then passes through the cardiac septum to stimulate the other, resulting in one ventricle's depolarizing later than the other. (Both anatomically and functionally, the septum separates the heart into its left and right halves.)

The MPS450 simulates a right- or left-bundle-branch block, with waveforms that contain normal P waves. P-R intervals are 0.16 seconds; QRS complexes are wide.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **ARRHY**.
2. Select **COND**.
3. Scroll to the LCD screen for the desired simulation: R BNDL BR BLOCK; or L BNDL BR BLOCK.
4. Select **RUN**. The selected bundle-branch-block waveform runs continuously (repeats) until another arrhythmia selection is made.

Alternatively, in the Numeric-Control Mode, press the number keys for the bundle-branch-block simulation according to Table 2-16, and select **RUN**:

Table 2-16. Numeric Code for Bundle Branch-Block Settings

Bundle Branch-Block Setting	Numeric Code
R BNDL BR BLOCK	049
L BNDL BR BLOCK	050

ECG Testing

The MPS450 sends a number of ECG waveforms to test and verify an ECG machine and monitor. Performance waveforms can be used to test frequency response (both high and low), sensitivity, gain drift, internal calibration, stylus damping, paper speed, linearity, sweep speed, and more.

For square, pulse, sine, triangle, and R waves, both rate and amplitude are adjustable to a wide range of preconfigured settings. R-wave width is also adjustable.

While running any performance waveform, outputs for respiration and blood pressure are disabled; they are reactivated when a physiological waveform—such as normal sinus rhythm—is selected.

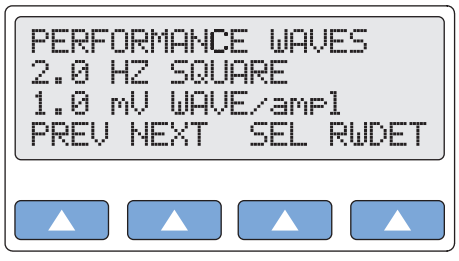
Running a Performance Wave

The MPS450 offers a selection of preconfigured-rate settings for square, pulse, sine, and triangle waves:

- **Square waveform**s—available at 2 or 0.125 Hz—are used most frequently to test linearity, amplitude, and frequency response.
- **Pulse waveforms**—available at 30 or 60 BPM with a 60 ms pulse width—are especially useful in measuring and calibrating paper speed, internal calibration signal (as compared with the MPS450 calibration), sweep speed, stylus damping, sensitivity, gain and drift.
- **Sine waveforms**—available at 0.5, 5, 10, 40, 50, 60, or 100 Hz—are used for a variety of tests, including ECG sensitivity, frequency response (high and low), and accuracy.
- **Triangle waveforms**—available at 2 or 2.5 Hz—are an important tool for testing the linearity of an ECG unit.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **PERF** to display the following LCD screen:



gje020.eps

2. Select **SEL** to toggle to the screen for adjusting performance-wave type (WAVE/ampl), with WAVE in upper-case letters.
3. Select **PREV** or **NEXT** to scroll to the desired performance-wave type.

4. The performance wave identified on the LCD screen is active when displayed and remains active until another wave is selected.

Alternatively, in the Numeric-Control Mode, press the number keys for a performance wave according to Table 2-17, and select **RUN**:

Table 2-17. Numeric Codes for Wave/Rate Settings

Wave/Rate Setting	Numeric Code
2 HZ SQUARE	120
0.125 HZ SQUARE	121
2.0 HZ TRIANGLE	122
2.5 HZ TRIANGLE	123
30 BPM PULSE	124
60 BPM PULSE	125
0.5 HZ SINE	207
5 HZ SINE	208
10 HZ SINE	209
40 HZ SINE	210
50 HZ SINE	211
60 HZ SINE	212
100 HZ SINE	213

Adjusting Performance-Wave Amplitude

The MPS450 offers a selection of twenty preconfigured settings (mV) for performance-wave amplitude (on Lead II): 0.05 to 0.50 (in 0.05 steps) and 0.50 to 5.50 (in 0.50 steps).

Action in the Menu-Control Mode

1. Press the top-menu key labeled **PERF**.
2. Select **SEL** to toggle to the screen for adjusting performance-wave amplitude (wave/AMPL), with AMPL in upper-case letters.
3. Select **DOWN** or **UP** to scroll to the desired performance-wave amplitude.
4. The amplitude identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for performance-wave amplitude according to Table 2-18, and select **RUN**:

Table 2-18. Numeric Code for Wave Amplitude Settings

Wave Amplitude Setting	Numeric Code
0.05 mV	272
0.10 mV	273
0.15 mV	274
0.20 mV	275

Table 2-18. Numeric Code for Wave Amplitude Settings (cont.)

Wave Amplitude Setting	Numeric Code
0.25 mV	276
0.30 mV	277
0.35 mV	278
0.40 mV	279
0.45 mV	280
0.50 mV	281
1.00 mV	282
1.50 mV	283
2.00 mV	284
2.50 mV	285
3.00 mV	286
3.50 mV	287
4.00 mV	288
4.50 mV	289
5.00 mV	290
5.50 mV	291

R-Wave Detection

In order to detect a heartbeat, a heart monitor looks for R waves; the detected beat is annunciated and used for rate calculations and other analysis. By adjusting the R wave, the range of settings can be determined for which a given heart monitor will detect a beat.

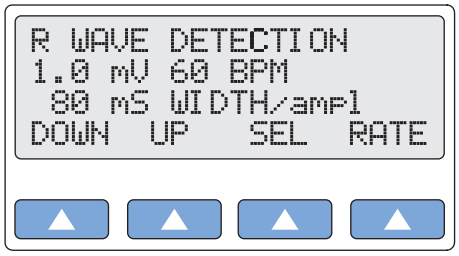
The MPS450 simulates an R wave that is adjustable to a wide range of preconfigured settings for rate, width, and amplitude.

Setting R-Wave Rate

The MPS450 offers six preconfigured settings (BPM) for R-wave rate: 30, 60, 80, 120, 200, or 250.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **PERF**.
2. Select **RWDET** to display the LCD screen R WAVE DETECTION:



gje021.eps

3. Select **RATE** to scroll to a different R-wave rate. The rate identified on the LCD

screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for R-wave rate according to Table 2-19, and select **RUN**:

Table 2-19. Numeric Codes for R-Wave-Rate Settings

R-Wave-Rate Setting	Numeric Code
30 BPM	312
60 BPM	313
80 BPM	314
120 BPM	315
200 BPM	316
250 BPM	317

Setting R-Wave Width

The MPS450 offers twenty-two preconfigured settings (ms) for R-wave width: nineteen settings ranging from 20 to 200 ms (10 ms steps), plus three settings at 8, 10, or 12 ms.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **PERF**.
2. Select **RWDET**.
3. Select **SEL** to toggle to the screen for adjusting R-wave width (WIDTH/ampl), with WIDTH in upper-case letters.
4. Select **DOWN** or **UP** to scroll to the desired R-wave width.
5. The width identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for R-wave width according to Table 2-20, and select **RUN**:

Table 2-20. Numeric Code R-Wave Width Settings

R-Wave-Width Setting	Numeric Code
8 ms	318
10 ms	319
12 ms	320
20 ms	321
30 ms	322
40 ms	323
50 ms	324
60 ms	325
70 ms	326
80 ms	327
90 ms	328

Table 2-20. Numeric Code R-Wave Width Settings (cont.)

R-Wave-Width Setting	Numeric Code
100 ms	329
110 ms	330
120 ms	331
130 ms	332
140 ms	333
150 ms	334
160 ms	335
170 ms	336
180 ms	337
190 ms	338
200 ms	339

Setting R-Wave Amplitude

The MPS450 offers twenty preconfigured settings (mV) for R-wave amplitude on Lead II: 0.05 to 0.50 (0.05 steps) and 0.50 to 5.50 (0.50 steps).

Action in the Menu-Control Mode

1. Press the top-menu key labeled **PERF**.
2. Select **RWDET**.
3. Select **SEL** to toggle to the screen for adjusting R-wave amplitude (width/AMPL), with AMPL in upper-case letters.
4. Select **DOWN** or **UP** to scroll to the desired R-wave amplitude.
5. The amplitude identified on the LCD screen is active when displayed and remains active until another wave is selected.

Alternatively, in the Numeric-Control Mode, press the number keys for R-wave amplitude according to Table 2-21, and select **RUN**:

Table 2-21. Numeric Codes for R-Wave-Amplitude Settings

R-Wave-Amplitude Setting	Numeric Code
0.05 mV	292
0.10 mV	293
0.15 mV	294
0.20 mV	295
0.25 mV	296
0.30 mV	297
0.35 mV	298
0.40 mV	299
0.45 mV	300

Table 2-21. Numeric Codes for R-Wave-Amplitude Settings (cont.)

R-Wave-Amplitude Setting	Numeric Code
0.50 mV	301
1.00 mV	302
1.50 mV	303
2.00 mV	304
2.50 mV	305
3.00 mV	306
3.50 mV	307
4.00 mV	308
4.50 mV	309
5.00 mV	310
5.50 mV	311

Blood Pressure Function

Blood pressure (BP) is the force of the blood exerted on the artery walls, as measured in millimeters of mercury (mmHg). Contraction (referred to as systole) produces the highest pressure, while relaxation (referred to as diastole) produces the lowest; blood pressure at or near 120 mmHg over 80 mmHg (120/80) is considered healthy.

The MPS450 simulates dynamic BP waveforms that synchronize with all normal sinus rhythm rates and track all arrhythmia selections. Settings are controlled independently for the four MPS450 invasive BP channels—P1, P2, P3, and P4—each of which simulates a bridge pressure transducer. Also, respiration artifact can be injected into any BP waveform for each of the channels.

Cables (available from Fluke Biomedical) to attach to the BP connectors of the MPS450 are available both prewired and unterminated, for both types of monitors.

Before beginning BP simulation, the MPS450 BP-transducer sensitivity must be set to match the monitor manufacturer's requirements. (See the section in this chapter called “SETTING BP SENSITIVITY.”)

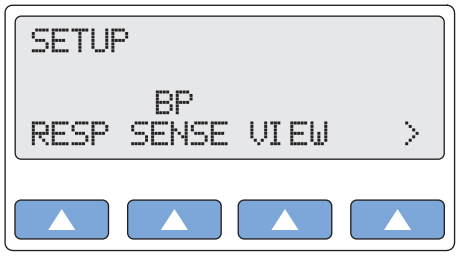
In addition, before testing, all BP channels should be set to zero. (See the “Zeroing BP Channels” section later in this chapter.)

Setting BP Sensitivity

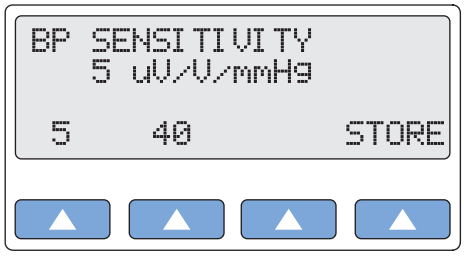
Depending on the manufacturer's requirements for the monitor being tested, set the MPS450 blood-pressure-transducer sensitivity to either 40 µV/V/mmHg or 5 µV/V/mmHg (the default). For convenience, either value can be stored as a permanent power-on default.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **SETUP** to display the following LCD screen:



2. Select **BP SENSE** to display the BP SENSITIVITY screen. If the setting has not been changed, the LCD screen displays the default BP-sensitivity setting (5 µV/V/mmHg):



3. To change the BP-sensitivity setting, select 40. The setting identified on the LCD screen is active when displayed and remains active until the setting is changed. (This setting does not persist beyond the current session unless it is stored specifically.)
4. To store the displayed value as the power-on default, select **STORE**. On the LCD screen Storing blinks on momentarily to indicate the value is being saved.
5. Press the **ESC** key to return to the top menu SETUP.

Alternatively, in the Numeric-Control Mode, press the number keys for a BP-sensitivity setting according to Table 2-22, and select **RUN**:

Table 2-22. Numeric Codes for BP-Sensitivity Settings

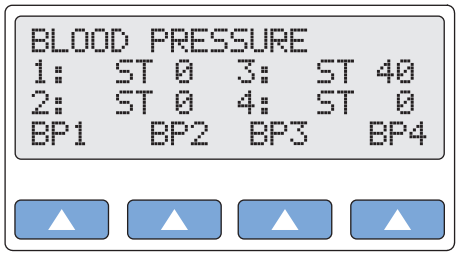
BP-Sensitivity Setting	Numeric Code
40 uV/V	068
40 uV/V STORE	133
5 uV/V	069
5 uV/V STORE	132

Zeroing BP Channels

Before testing or simulation, each of the four BP channels should be reset to zero mmHg.

Action in the Menu-Control Mode

1. To display the active pressure setting for each of the four channels, press the top-menu key labeled **BP**. (In this example, the active setting for BP channel 3 has been set to 40 mmHg.)



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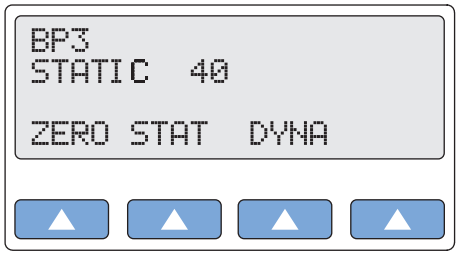
2. To display the screen for BP channel 3, select **BP3**:



gje028.eps

3. To reset BP channel 3 to zero, select **ZERO**.
4. Press the **ESC** key to return to the top menu BLOOD PRESSURE.
5. For each channel, select its screen from the top menu, and then select **ZERO**, until the top menu BLOOD PRESSURE displays 0 as the active setting for all four channels.

Alternatively, in the Numeric-Control Mode, to zero all four BP channels simultaneously, press the number keys **007**, and select **RUN**.

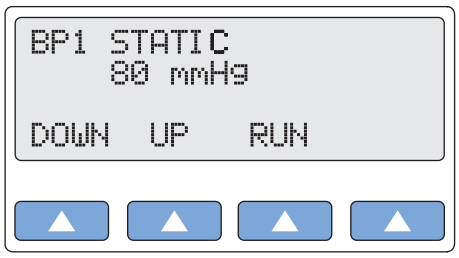
Setting Static-Pressure Levels

The MPS450 offers seven preconfigured static-pressure-level settings (mmHg) for each BP channel, with each channel controlled independently:

- Set BP channel 1 to -10, 0, 80, 160, 240, 320, or 400.
- Set BP channel 2 to -10, 0, 50, 100, 150, 200, or 240.
- Set each of BP channels 3 and 4 to -5, 0, 20, 40, 60, 80, or 100.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **BP**.
2. Select **BP1, BP2, BP3,** or **BP4** to display the channel's screen.
3. Select **STAT** to display the STATIC screen for the selected channel (in this example, BP channel 1 with an active setting of 80 mmHg):



gje029.eps

4. On the LCD screen, RUN flashes, because the displayed setting is active.

5. Select **DOWN** or **UP** to scroll to a different static-level setting.
6. Select **RUN**. On the LCD screen, RUN flashes to indicate the setting is active. This value remains active until the setting is changed.
7. Press the **ESC** key to return to the previous screen.
8. Press the **ESC** key again to return to the top menu BLOOD PRESSURE.

Alternatively, in the Numeric-Control Mode, press the number keys for a static-pressure-level setting according to Table 2-23, and select **RUN**:

Table 2-23. Numeric Codes for Static-Pressure-Level Settings

Static-Pressure-Level Setting	Numeric Code
BP1 -10 mmHg	342
BP1 Zero	343
BP1 80 mmHg	344
BP1 160 mmHg	345
BP1 240 mmHg	346
BP1 320 mmHg	347
BP1 400 mmHg	348
BP2 -10 mmHg	351
BP2 Zero	352
BP2 50 mmHg	353
BP2 100 mmHg	354
BP2 150 mmHg	355
BP2 200 mmHg	356
BP2 240 mmHg	357
BP3 -5 mmHg	360
BP3 Zero	361
BP3 20 mmHg	362
BP3 40 mmHg	363
BP3 60 mmHg	364
BP3 80 mmHg	365
BP3 100 mmHg	366
BP4 -5 mmHg	369
BP4 Zero	370
BP4 20 mmHg	371
BP4 40 mmHg	372
BP4 60 mmHg	373
BP4 80 mmHg	374
BP4 100 mmHg	375

Running a Dynamic Waveform

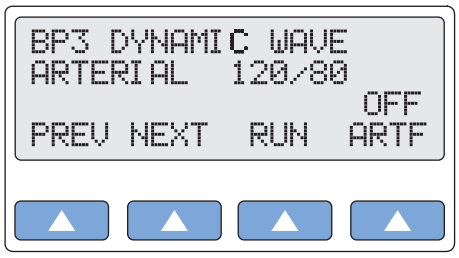
The MPS450 simulates dynamic waves to represent the pressures in various places in the heart or blood vessels. Waves are specified for a normal sinus rhythm at 80 BPM, with systolic pressure over diastolic pressure, e.g., 120/80, etc. Available dynamic waves (not all available on all channels) are listed Table 2-24. (For information about the Swan-Ganz simulation—a serial simulation available only on BP4, in both manual and automatic modes—see the "Simulating the Swan-Ganz Procedure" section in this chapter.

Table 2-24. Dynamic Waveform Availability by BP Channel

DYNAMIC WAVE		BP1	BP2	BP3	BP4	
ARTERIAL	120/80	√	√	√		
RADIAL ARTERY	120/80	√	√	√		
LEFT VENTRICLE	120/00	√	√	√		
LEFT ATRIUM	14/4		√	√		
RIGHT ATRIUM (CVP)	15/10		√	√	√	IN SWANZ-GANZ PROCEDURE
RIGHT VENTRICLE	25/00	√	√	√	√	
PULMONARY ARTERY	25/10		√	√	√	
PULMONARY WEDGE	10/2		√	√	√	

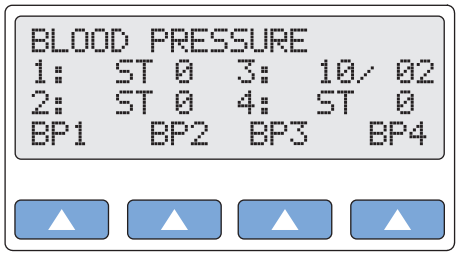
Action in the Menu-Control Mode

1. Press the top-menu key labeled **BP**.
2. Select **BP1, BP2, BP3**, or **BP4** to display the screen for a specific channel.
3. Select **DYNA** to display the DYNAMIC WAVE screen for the selected channel (in this example, BP3):



gje030.eps

4. Scroll to the desired dynamic waveform, for example, PULM WEDGE 10/2.
5. Select **RUN**. On the LCD screen, RUN flashes to indicate the identified waveform is running. The simulation runs continuously (repeats) until another selection is made.
6. Press the **ESC** key to return to the screen for the selected BP channel. The screen identifies the selected waveform.
7. Press the **ESC** key again to return to the top menu BLOOD PRESSURE. The LCD screen indicates the waveform running on the selected channel:



gje031.eps

Alternatively, in the Numeric-Control Mode, press the number keys for a dynamic-wave setting according to Table 2-25, and select **RUN**:

Table 2-25. Numeric Codes for Dynamic-Wave Settings

Dynamic-Wave Setting	NumericCode
BP1 Arterial 120/80	060
BP1 Radial Art 120/80	061
BP1 Left Vent 120/00	062
BP1 Right Vent 25/00	063
BP2 Arterial 120/80	070
BP2 Radial Art 120/80	071
BP2 Left Vent 120/00	072
BP2 Right Vent 25/00	073
BP2 Pulmonary Art 25/10	074
BP2 Pulm Art Wedge 10/2	075
BP2 Left Atrium 14/4	076
BP2 Right Atrium CVP 15/10	077
BP3 Arterial 120/80	080
BP3 Radial Art 120/80	081
BP3 Left Vent 120/00	082
BP3 Right Atrium CVP 15/10	083
BP3 Pulmonary Art 25/10	084
BP3 Pulm Art Wedge 10/2	085
BP3 Left Atrium 14/4	086
BP3 Right Vent 25/00	087

Adding Respiration Artifact to the BP Signal

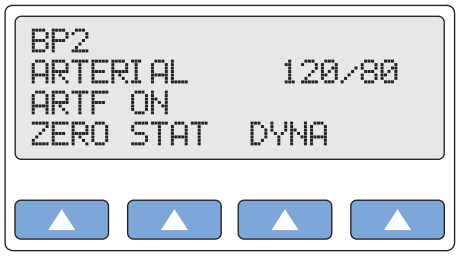
The MPS450 adds respiration artifact to any BP-channel dynamic wave, including the Swan-Ganz-wave series. The artifact is turned on separately for each of the four BP channels.

The following peak-to-peak changes (mmHg) are caused by the respiration wave, with values independent of the programmed respiration amplitude:

- for BP channel 1, a delta change from 0 to 16;
- for BP channel 2, a delta change from 0 to 12;
- for BP channel 3, a delta change from 0 to 5; and
- for BP channel 4, a delta change from 0 to 3.

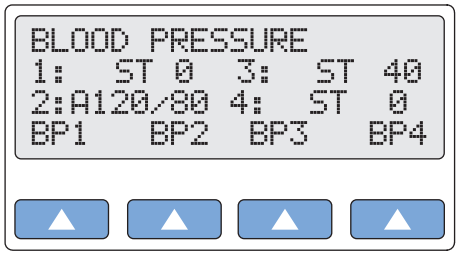
Action in the Menu-Control Mode

1. Press the top-menu key labeled **BP**.
2. Select **BP1, BP2, BP3,** or **BP4** to display the channel's screen.
3. Select **DYNA** to display the DYNAMIC WAVE screen for the selected channel.
4. Select **ARTF**. On the LCD screen, OFF toggles to ON.
5. Select **RUN**. On the LCD screen, RUN flashes to indicate the identified waveform is running with the artifact applied.
6. Press the **ESC** key to return to the selected BP channel screen. The LCD screen identifies the waveform that is running and indicates if the artifact is active (ARTF ON):



gje032.eps

7. Press the **ESC** key again to return to the top menu BLOOD PRESSURE. The LCD screen indicates that the selected waveform (in the following example, 120/80) on the selected channel (2) is running with a respiration artifact (A prefixed to 120/80):



gje033.eps

Alternatively, in the Numeric-Control Mode, press the number keys for a respiration-artifact setting according to Table 2-26, and select **RUN**:

Table 2-26. Numeric Codes for Respiration-Artifact Settings

Respiration-Artifact Setting	Numeric Code
BP1 Respiration Artifact Off	349
BP1 Respiration Artifact On	350
BP2 Respiration Artifact Off	358
BP2 Respiration Artifact On	359
BP3 Respiration Artifact Off	367

Table 2-26. Numeric Codes for Respiration-Artifact Settings (cont.)

Respiration-Artifact Setting	Numeric Code
BP3 Respiration Artifact On	368
BP4 Respiration Artifact Off	376
BP4 Respiration Artifact On	377

Simulating the Swan-Ganz Procedure

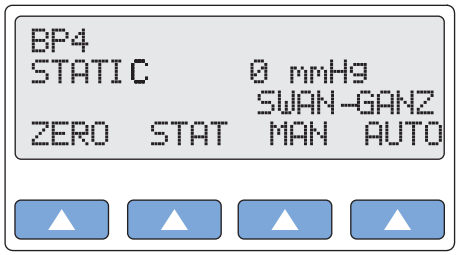
The MPS450 reserves BP channel 4 exclusively for simulating the effect on the blood pressure of a Swan-Ganz procedure. The Swan-Ganz simulation is available in both automatic and manual modes.

The Swan-Ganz catheter is a soft, balloon-tipped instrument that is used for measuring pulmonary-arterial pressure; right-atrial pressure; and reflected, left-ventricular, end-diastolic pressure. After insertion into a vein (usually the basilic vein of the forearm), the catheter is gently guided by the flow of the blood into the pulmonary artery. A monitor attached to the distal lumen port supplies a reading of pulmonary-artery pressure (PAP). Pulmonary-capillary-wedge pressure (PCWP) is determined by inflating the balloon, which becomes wedged; when this wedge blocks blood flow, it provides a reading of the pressure in the left side of the heart.

The MPS450 simulates the full effects of the insertion of the catheter into the heart, the inflation of the balloon tip, the deflation of the tip, and the removal of the catheter from the heart and body. The Swan-Ganz simulation runs as a continuous, serial cycle of four dynamic waves, with a different wave type generated every fifteen seconds: right-atrium CVP (central venous pressure) 15/10; followed by right ventricular 25/00; followed by pulmonary artery 25/10; followed by pulmonary-arterial wedge 10/2. The simulation then continues by reversing through the cycle of waves.

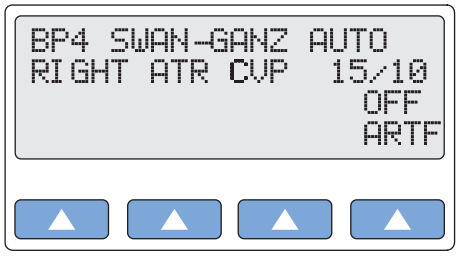
Action in the Menu-Control Mode

1. Press the top-menu key labeled **BP**.
2. Select **BP4** to display the channel's screen:



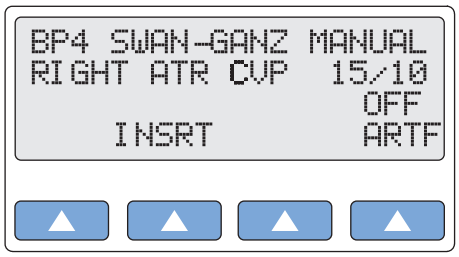
gje034.eps

3. To generate the complete Swan-Ganz cycle automatically, select **AUTO**. As the automatic simulation begins, the LCD screen BP4 SWAN-GANZ AUTO displays:



gje035.eps

4. As the automatic simulation proceeds, the LCD screen continues to indicate which wave in the cycle is currently running: RIGHT ATR CVP 15/10; RIGHT VENT 25/00; PULM ARTERY 25/10; or PULM WEDGE 10/2.
5. To terminate the automatic Swan-Ganz simulation, press the **ESC** key.
6. To generate the complete Swan-Ganz cycle manually, select **MAN** from the screen for the BP4 channel to display the screen for BP4 SWAN-GANZ MANUAL:



gje036.eps

7. The manual simulation begins with a right-atrium CVP 15/10 dynamic wave. Select **INSRT** to start the Swan-Ganz procedure with the simulated insertion of the catheter into the heart.
8. To complete the Swan-Ganz procedure manually, select **INSRT** again. Next, select **INFL** (simulating balloon inflation), then **DEFL** (simulating balloon inflation). Finally, select **PLBK** (simulating pullback, that is, the withdrawal of the catheter), then **PLBK** again.
9. At each point in the procedure, the LCD screen identifies which dynamic wave in the cycle of four is currently running.
10. Press the **ESC** key to return to the BP4 screen.
11. Press the **ESC** key again to return to the top menu.

Alternatively, in the Numeric-Control Mode, press the number keys for a Swan-Ganz simulation according to Table 2-27, and select **RUN**:

Table 2-27. Numeric Codes for Swan-Ganz-Simulation Settings

Swan-Ganz-Simulation Setting	Numeric Code
Swan-Ganz Auto	088
BP4 Right Atrium CVP 15/10	378
BP4 Right Vent 25/00	379
BP4 Pulmonary Art 25/10	380
BP4 Pulm Art Wedge 10/2	381
Swan-Ganz Manual	416
Insert (in Swan-Ganz Manual)	417
Inflate (in Swan-Ganz Manual)	418
Deflate (in Swan-Ganz Manual)	419
Pull Back (in Swan-Ganz Manual)	420

Cardiac Output

Cardiac output is a term encompassing blood flow, pulse rate, and other vascular-related elements. Of the entire circulatory system, cardiac output is arguably the most important single factor for health since it controls the degree of blood being received by every other tissue in the body. Diseases of the heart can cause a decrease of cardiac output, leading to a condition of insufficient nutrition for the body cells. Cardiac output is expressed as the measure of blood pumped out of the heart each minute, also called the heart-minute volume (HMV).

One method of determining cardiac output is to measure the transference of heat in the blood through a method called thermodilution. Thermodilution is the measurement of the temperature change caused by the injection into the heart of a series of cold or room-temperature solutions (such as a saline solution) into the heart. A thermistor (as integrated into the distal lumen port of a Swan-Ganz catheter) measures the average change in blood temperature. From this information, a determination can be made as to ventricular blood volume and cardiac output.

The MPS450 simulates blood cooling, as the result of an injectate, to below-normal temperatures. On most monitors, the blood temperature curve is in the positive direction, even though the blood is cooling. Following the simulated cardiac-output test, ECG reverts to normal sinus rhythm at 80 BPM.

To simulate cardiac output, use the cardiac-output adapter box, which is supplied as part of the cardiac-output option. (See the section in the "Setting Up for a Cardiac-Output Test" section later in this chapter.)

Setting Up For a Cardiac-Output Test

Action

1. Configure the cardiac-output monitor to the settings listed in Table 2-28, which are compatible with the MPS450 simulation:

Table 2-28. Cardiac-Output Monitor Settings

Variable	Setting
CATHETER TYPE / SIZE:	Baxter Edwards, 93a-131-7f
CALIBRATION COEFFICIENT:	0.542 for 0 °C injectate; 0.595 for 24 °C injectate
INJECTATE VOLUME:	10 cc
INJECTATE TEMPERATURE:	0 °C or 24 °C

2. Connect the cardiac-output adapter box to the CO/TEMP connector on the right-side panel of the MPS450.
3. Connect the BT thermistor cable from the cardiac-output monitor to the smaller 4-pin connector on the cardiac-output adapter box. This is the blood-temperature-simulation line directly wired to the MPS450.
4. Connect the injectate-temperature cable from the cardiac-output monitor to the bigger 4-pin switchcraft connector on the cardiac-output adapter box. This line is wired to the trimpot on the front panel of the CO adapter box, enabling the resistance to be set correctly to either 0 °C or 24 °C, as displayed on the CO monitor.
5. With the MPS450 turned on, the blood-temperature indicator on the CO monitor should read approximately 37 °C.
6. Turn the trimpot on the CO adapter box until the injectate-temperature (IT) sensor

reads “0” or “24” on the CO monitor. (To get a reading, the trimpot may have to be turned all the way in one direction.)

Note

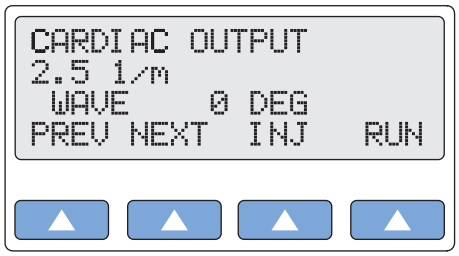
Fluke Biomedical supplies adapters to connect to some nonstandard catheters. (Please consult the cable price list.) For manufacturers that are not listed, a “pigtail” may be ordered and wired to cut-off catheters.

Simulating a Cardiac-Output Test

The MPS450 simulates two separate injectate temperatures (an iced solution of 0 °C / 32 °F or a room-temperature solution of 24 °C / 75.2 °F), each flowing at three different rates (2.5, 5.0, or 10 liters per minute).

Action in the Menu-Control Mode

1. Press the top-menu key labeled CO to display the following LCD screen:



gje038.eps

2. To set the injectate temperature to 0 °C or 24 °C, select **INJ** to toggle to the desired setting.
3. To adjust the flow rate, select **PREV** or **NEXT** to scroll to the desired setting.
4. Select **RUN**. On the LCD screen, RUNNING flashes while the simulation is active. To repeat a simulation, select **RUN** again.
5. To terminate a cardiac-output simulation, select **END**.

Alternatively, in the Numeric-Control Mode, press the number keys for a combined temperature/flow setting listed in Table 2-29, and select **RUN**:

Table 2-29. Numeric Codes for Temperature/Flow Settings

Temperature/Flow Setting	Numeric Code
CO OFF	090
CO 0 DEG 2.5 L/M	091
CO 0 DEG 5.0 L/M	092
CO 0 DEG 10.0 L/M	093
CO 24 DEG 2.5 L/M	094
CO 24 DEG 5.0 L/M	095
CO 24 DEG 10.0 L/M	096

Injectate Failure and Left-To-Right Shunt

Injectate failure occurs, for example, when an injector fails to release an injectate in a continuous manner, a situation caused most often by the human factor of hesitation.

A physiological condition called a left-to-right shunt occurs when the blood detours from

the systemic (body) circulation to the pulmonary (lung-related) circulation. In other words, the blood has been shunted from the left side of the heart to the right side, through an abnormal aperture, such as a defect in the septum of the heart, or patient ductus arteriosus (the persistence after birth of the open lumen between the aorta and the pulmonary artery).

The MPS450 simulates both injectate-failure and left-to-right-shunt curves at either 0 °C or 24 °C.

Action in the Menu-Control Mode

1. To simulate a cardiac-output test involving either a faulty injectate (as if the injectate alternately stops and starts), or a left-to-right-shunt condition, press the top-menu key labeled **CO**.
2. To set the injectate temperature to 0 °C or 24 °C, select **INJ** to toggle to the desired setting.
3. Scroll to the FAULTY INJ screen, or to the L/R SHUNT screen.
4. Select **RUN**. On the LCD screen, RUNNING flashes while the simulation is active. To repeat a simulation, select **RUN** again.
5. To terminate a cardiac-output simulation, select **END**.

Alternatively, in the Numeric-Control Mode, press the number keys for a combined condition/temperature simulation listed in Table 2-30, and select **RUN**:

Table 2-30. Numeric Code for Condition/Temperature Setting

Condition/Temperature Setting	Numeric Code
FAULTY INJ 0 DEG	097
FAULTY INJ 24 DEG	099
L TO R SHUNT 0 DEG	098
L TO R SHUNT 24 DEG	100

Simulating Output From a Calibrated Pulse Signal

The MPS450 sends a waveform to test the calibration of a cardiac-output monitor, simulating an injectate temperature of either 0 °C or 24 °C and a step change of 1.5 °C for 1 second.

Action in the Menu-Control Mode

1. Press the top-menu key labeled CO.
2. To set the injectate temperature to 0 °C or 24 °C, select **INJ** to toggle to the desired setting.
3. Select **PREV** or **NEXT** to scroll to the CAL PULSE screen.
4. Select **RUN**. On the LCD screen, RUNNING flashes while the simulation is active. To repeat the simulation, select **RUN** again.
5. To terminate the simulation, select **END**.

Alternatively, in the Numeric-Control Mode, press the number keys for a calibration setting listed in Table 2-31, and select **RUN**:

Table 2-31. Numeric Code for Calibration Setting

Calibration Setting	Numeric Code
CAL PULSE 0 DEG	101
CAL PULSE 24 DEG	102

Fetal / Maternal ECG (Option)

The MPS450 simulates a combined fetal and maternal electrocardiogram (ECG) occurring during labor, as well as a selection of pressure waveforms produced by uterine contractions. The contraction period is adjustable and includes a manually generated waveform.

The maternal ECG is always a normal sinus rhythm with a heart rate of 80 BPM; the fetal heart rate is either fixed (to a selection from seven settings), or periodic, which is interactive with uterine contractions. The simulated fetal heart rate represents a measurement from a fetal scalp electrode, while the simulated maternal heart rate represents a measurement from an electrode on the mother's thigh.

The MPS450 simulates the fetal / maternal ECG on its regular ECG leads. The maternal signal is a P-QRS-T wave fixed at 80 BPM, at half the selected ECG amplitude; the fetal signal is a narrow R wave at full amplitude. Fetal and maternal signals are summed to make a composite signal.

The simulated intrauterine-pressure (IUP) waveform represents a measurement taken by an intra-amniotic catheter connected to a pressure transducer. The MPS450 simulates the IUP on its BP4 blood-pressure channel, the same as if it were a blood-pressure transducer, either at 5 or 40 µV/V/mmHg sensitivity (as has been set up for blood pressure).

The MPS450 does not provide simulations for all types of fetal heart rate tracings and contraction patterns. A few examples of simulation not provided are:

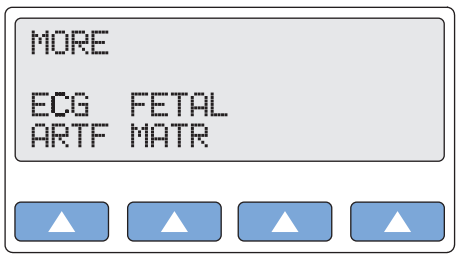
- Variable decelerations
- Sinusoidal pattern
- Reactive tracing
- Variations in FHR variability
- Tachysystole

Simulating a Fixed Fetal Heart Rate (Fhr)

The MPS450 simulates seven preconfigured settings (BPM) for a fetal heart rate that is fixed: 60, 90, 120, 140, 150, 210, or 240.

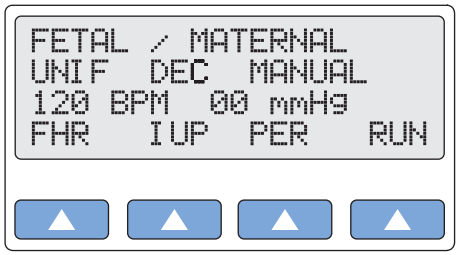
Action in the Menu-Control Mode

1. Press the top-menu key labeled **MORE** to display the following LCD screen:



gje039.eps

2. Select **FETAL MATR** to display the following LCD screen:



gje040.eps

3. Select **FHR** repeatedly to scroll to a different fetal heart rate. The FHR setting identified on the LCD screen is active when displayed and remains active until the setting is changed. (Fixed settings do not affect IUP simulations, since they set their own rates.)

Alternatively, in the Numeric-Control Mode, press the number keys for a fixed fetal-heart-rate setting listed in Table 2-32, and select **RUN**:

Table 2-32. Numeric Codes for Heart-Rate Settings

FHR Setting	Numeric Code
60 BPM	409
90 BPM	410
120 BPM	411
140 BPM	412
150 BPM	413
210 BPM	414
240 BPM	415

Simulating a Periodic FHR With Intrauterine Pressure (IUP)

The MPS450 sends waveforms to simulate intrauterine pressure during a contraction of the uterus in childbirth. The duration of each IUP wave is 90 seconds, generating a bell-shaped pressure curve that rises from zero to 90 mmHg and returns back to zero. During an IUP-wave simulation, the fetal heart rate (which always begins at 140 BPM) varies with the blood pressure; the LCD screen displays both values as they change.

The IUP period is adjustable to four preconfigured settings, including a single contraction that is triggered manually, as well as waveforms that automatically simulate a contraction generated once every 2, 3, or 5 minutes.

The MPS450 simulates three types of preconfigured waveforms for a periodic FHR that is interactive with uterine contractions: early deceleration; late deceleration; or acceleration:

- With **early deceleration**, the fetal heart rate follows the intrauterine pressure (no lag). FHR starts at 140 BPM, slows to 100 BPM at intrauterine-pressure peak, and returns to 140 BPM as the IUP falls back to zero.
- With **late deceleration**, the change in fetal heart rate begins when IUP pressure is at its peak and lags the change in intrauterine pressure by 45 seconds. FHR starts at 140 BPM, slows to 100 BPM, and returns to 140 BPM.
- With **acceleration**, the change in fetal heart rate lags the change in intrauterine pressure by 30 seconds. FHR starts at 140 BPM, increases to 175 BPM, and returns 140 BPM.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **MORE**.
2. Select **FETAL MATR**.
3. Select **PER** to scroll to a different contraction-period setting.
4. Select **IUP** to scroll to the desired wave simulation: EARLY DEC (early deceleration); LATE DEC (late deceleration); or ACC (acceleration).
5. Select **RUN**. On the LCD screen, RUNNING flashes while the simulation is active.
6. A manually generated IUP ends after one contraction. To repeat the simulation, select **RUN** again.
7. Periodically generated IUPs repeat at the selected period. To terminate a periodic-IUP simulation, select **END**.

Alternatively, in the Numeric-Control Mode, press the number keys for an IUP-wave simulation using one of the codes in Table 2-33, and select **RUN**. (The selected IUP is generated according to the specific period that was last selected, whether manual, or once every 2, 3, or 5 minutes.)

Table 2-33. Numeric Codes for IUP Wave Settings

IUP Wave Setting	Numeric Code
IUP OFF	400
IUP EDEC (early deceleration)	402
IUP LDEC (late deceleration)	403
IUP UACC (acceleration)	404

To select a contraction period in the Numeric-Control Mode, press the number keys for one of the settings found in Table 2-34, and select **RUN**. (The selected period is applied to a run of the specific IUP-wave simulation that was last selected, whether early deceleration, late deceleration, or acceleration.)

Table 2-34. Numeric Codes for IUP Contraction Period Settings

IUP Contraction Period Setting	Numeric Code
IUP MANUAL	405
IUP 2 MIN	406
IUP 3 MIN	407
IUP 5 MIN	408

Chapter 3
Other Functions

Introduction

The MPS450 also simulates to other bodily functions: Respiration and Temperature. This chapter explains how to simulate these functions through the front-panel controls and Numeric-Control mode.

Respiration

The MPS450 sets the respiration lead as either left arm or left leg. Respiration rate, baseline (impedance, between two limb leads), and amplitude (impedance variation) are adjustable to preconfigured settings. Values for respiration lead and baseline are storable. The MPS450 also offers a selection of preconfigured apnea simulations.

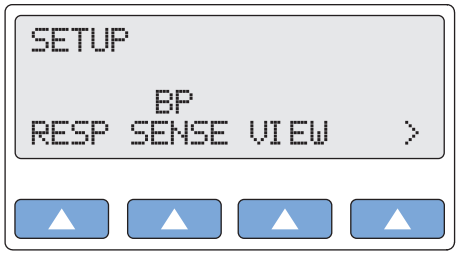
Setting the Respiration Lead and Baseline

The MPS450 sends the respiration signal to the lead for either the left arm (LA, the default) or left leg (LL). If the setting for left leg is stored, it becomes the new power-on default.

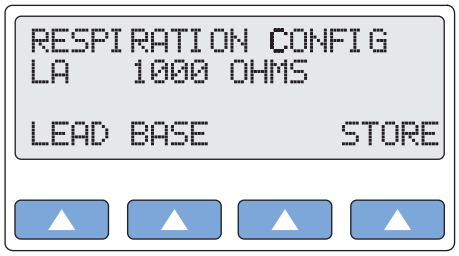
For baseline impedance, the MPS450 simulates four preconfigured settings (ohms): 500; 1000 (the default); 1500; or 2000. Optionally, any of these settings can be stored to become the new power-on default.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **SETUP** to display the LCD screen:



2. Select **RESP** to scroll to the LCD screen RESPIRATION CONFIG. If the settings for respiration lead and baseline impedance have not been changed, the screen displays the default settings (LA and 1000 OHMS):



3. To change the respiration lead, select **LEAD**.
4. To adjust the respiration base, select **BASE** to scroll to the desired setting.
5. The values identified on the LCD screen are active when displayed and remain active until the settings are changed. (Settings other than defaults do not persist beyond the current session unless they have been stored specifically.)
6. To store the settings for respiration lead and baseline, select **STORE**. On the LCD screen, Storing blinks for a moment to indicate the selected values are being saved.

Alternatively, in the Numeric-Control Mode, press the number keys for a respiration-lead setting according to Table 3-1, and select **RUN**:

Table 3-1. Numeric Codes for Respiration-Lead Settings

Respiration-Lead Setting	Numeric Code
RESP LEAD LA	389
RESP LEAD LA STORED	390
RESP LEAD LL	391
RESP LEAD LL STORED	392

For baseline impedance, press the number keys for a respiration-baseline setting according to Table 3-2, and select **RUN**:

Table 3-2. Numeric Codes for Respiration-Baseline Settings

Respiration-Baseline Setting	Numeric Code
RESP BASE 500 OHM	180
RESP BASE 500 STRD	393
RESP BASE 1000 OHM	181
RESP BASE 1000 STRD	394
RESP BASE 1500 OHM	182
RESP BASE 1500 STRD	395
RESP BASE 2000 OHM	183
RESP BASE 2000 STRD	396

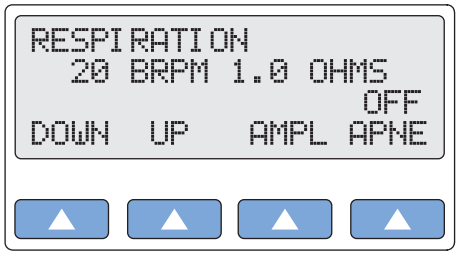
Adjusting the Respiration Rate

Respiration rate is measured by the number of times per minute the lungs inflate (inspiration) and deflate (expiration), expressed as breaths-per-minute (BrPM). Pediatric respiration rates are two or three times higher than adult rates. Newborn babies, for example, breathe from forty to fifty times per minute, while adults typically breathe approximately fifteen times per minute.

The MPS450 simulates nine preconfigured respiration rates (BrPM): 15, 20, 30, 40, 60, 80, 100, and 120, plus a respiration-off condition.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **RESP**. If the respiration-rate setting has not been changed, the screen displays the default setting (20 BRPM):



gje024.eps

2. To adjust the respiration rate, select **DOWN** or **UP**. The rate identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for a respiration-rate setting according to Table 3-3, and select **RUN**:

Table 3-3. Numeric Codes for Respiration-Rate Settings

Respiration-Rate Setting	Numeric Code
0 BrPM	156
15 BrPM	157
20 BrPM	158
30 BrPM	159
40 BrPM	160
60 BrPM	161
80 BrPM	162
100 BrPM	163
120 BrPM	164

Adjusting the Respiration Amplitude (Impedance Variation)

The MPS450 offers four preconfigured settings (ohms) for respiration amplitude: 0.2, 0.5, 1.0, or 3.0.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **RESP**. If the respiration-amplitude setting has not been changed, the screen displays the default setting (1.0 OHMS).
2. To adjust the respiration amplitude, select **AMPL** repeatedly to scroll to the desired setting. The amplitude identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for a respiration-amplitude setting according to Table 3-4, and select **RUN**:

Table 3-4. Numeric Codes for Respiration-Amplitude Settings

Respiration Amplitude Setting	Numeric Code
0.2 ohms	195
0.5 ohms	196
1.0 ohms	197
3.0 ohms	198

Simulating Apnea (Respiration Standstill)

Apnea is described as the cessation of breathing. In general there are three types of apnea: central (often seen in infants, when there is no diaphragm movement and no air flow); obstructive (where an object, such as food, is lodged in the trachea); and mixed (where central apnea is followed immediately by obstructive apnea).

The MPS450 offers four apnea simulations that differ from each other only by simulation length, not by waveform. These four simulations are available as pre-configured, one-time events (with apnea lasting for a duration of 12, 22, or 32 seconds), plus a continuous user-controlled apnea.

Action in the Menu-Control Mode

1. Press the top-menu key labeled **RESP**. If the apnea on/off setting has not been changed, the LCD screen indicates the default condition with apnea turned off (OFF APNE).
2. Select **APNE** to display the LCD screen RESPIRATION APNEA.
3. If the apnea setting has not been changed, the LCD screen references the default apnea simulation (12 SECONDS). To simulate a one-time event of 12-second apnea, select **RUN**. On the LCD screen, ON flashes while the MPS450 counts down and displays the seconds remaining in the simulation. To repeat the simulation, select **RUN** again.
4. For a one-time event of 22-second or 32-second apnea, or for a continuous-apnea simulation, select **PREV** or **NEXT** to scroll to the LCD screen displaying the desired condition, and select **RUN**.
5. To terminate a running simulation of apnea at any time (including continuous apnea), select **END**.
6. To return to the top menu RESPIRATION, press the **ESC** key.

Alternatively, in the Numeric-Control Mode, press the number keys for an apnea condition according to Table 3-5, and select **RUN**:

Table 3-5. Numeric Codes for Apnea Simulation Settings

Apnea Simulation Setting	Numeric Code
APNEA ON CONTINUOUS	150
APNEA OFF	151
APNEA 12 SECONDS	152
APNEA 22 SECONDS	153
APNEA 32 SECONDS	154

Temperature (Adjusting Body Temperature)

All temperatures output by the MPS450 are compatible with Yellow Springs, Inc. (YSI) Series 400 and 700 probes. The type of probe simulated is based on the type of cable connected to the MPS450 and/or the input used. (Cables for connection to the 400 or 700 are available directly from Fluke Biomedical.)

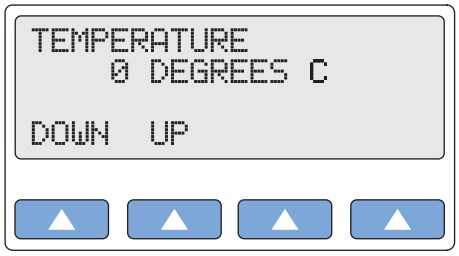
The MPS450 simulates four preconfigured body temperatures, which can be applied at any time while operating the instrument.

The MPS450 simulates four preconfigured temperatures of the human body, accurate to

within ±0.40 °C: freezing (0 °C / 32 °F); hypothermic (24 °C / 75.2 °F); normal (37 °C / 98.6 °F); or pyretic (40 °C / 104 °F).

Action in the Menu-Control Mode

1. Press the top-menu key labeled **TEMP** to display the following LCD screen:



gje037.eps

2. To adjust the simulated temperature to the desired setting, select **DOWN** or **UP**.
3. The temperature setting identified on the LCD screen is active when displayed and remains active until the setting is changed.

Alternatively, in the Numeric-Control Mode, press the number keys for a Celsius-temperature setting according to Table 3-6, and select **RUN**:

Table 3-6. Numeric Codes for Temperature-Celsius Settings

Temperature-Celsius Setting	Numeric Code
0 DEG	189
24 DEG	190
37 DEG	191
40 DEG	192

Chapter 4
Remote Operations

Introduction

MPS450 features include a built-in RS-232 serial port running at 9600 baud—configured so that it can be connected to a standard PC serial port with a straight-through cable—that enables instrument control through remote commands. (See the "Entering Remote Commands" section later in this chapter.)

Remote Connection

The serial-port connector is a 9-pin female D-SUB, configured as Data Communications Equipment (DCE) and intended to connect straight through to Data Terminal Equipment (DTE). Table 4-1 lists the pins of the remote connector and their signal name and function:

Table 4-1. Remote Connector Signal Pin-Out

Pin	Signal Name	Direction DCE	Function
1	(not used)		
2	RX	Output	Data received by DTE (transmitted by MPS450/DCE)
3	TX	Input	Data transmitted by DTE (received by MPS450/DCE)
4	(not used)		
5	Ground		Signal common
6	DSR	Output	Handshake line indicates MPS450/DCE ready, always ON
7	RTS	Input	Handshake line from DTE says MPS450/DCE can send data
8	CTS	Output	Hand Handshake line tells DTE it is OK to send data to MPS450/DCE
9	(not used)		

For serial communications to work properly, the RTS handshake line must be connected and functioning. Normally, when connecting to a PC serial port, that requirement is met. The PC serial port may need to be configured in order to turn on RTS/CTS handshaking.

Entering Remote Commands

In addition to using the MPS450 keypad (in either the menu-control or numeric-control mode), the instrument can be controlled by sending remote commands to its serial port. For example, the following remote-entry command sets blood-pressure sensitivity to 40 µV/V/mmHg:

```
BPSNS40
```

A complete list of the remote-entry commands, which set up MPS450 parameters and return standard operational responses, is arranged by category is in the "Codes and Actions" section later in this chapter.

The following guidelines apply to entering remote commands:

- The MPS450 executes a command upon a carriage return and/or a line feed.
- Alphabetic characters in commands are case-insensitive.
- When entering commands, the BACKSPACE key operates normally (that is, deletes the previously recorded character).
- When entering commands, the ESCAPE key discards the entire command.
- When a command is completed, a message is sent back (usually "OK").

Using Remote Entry to Operate In Numeric-Control Mode

In addition to using remote commands to set up wave parameters, one specific remote-entry command can be used to operate the MPS450 in the numeric-control mode from a peripheral device:

`NUMENT=num` (where `num` is a numeric-control code)

For example, entering the remote command `NUMENT=017` runs a simulation of atrial tachycardia—just as if the MPS450 was being operated in the numeric-control mode, the number keys **017** were pressed on the MPS450 keypad, and **RUN** was selected.

A list of numeric-control codes—cross-referenced both to actions and to remote-entry commands—is available in the "Codes and Actions" section later in this chapter.

General Remote Commands

The general remote commands are listed in Table 4-2:

Table 4-2. General Remote Commands

Remote Command	Action
IDENT	Identifies the instrument. Returns "MPS450; version; options," where version is the version of the firmware program and options equal "C" for Cardiac Output, and/or "F" for Fetal / Maternal.
VER	Returns the firmware version.
NUMENT=num	Executes a numerical entry function, where num equals the 3-digit number to execute.

Error Messages

Invalid commands return error messages, including the following:

- "ERR=00, NO COMMANDS ALLOWED AT THIS TIME"
- "ERR=001, UNKNOWN COMMAND"
- "ERR=02, ILLEGAL COMMAND"
- "ERR=03, ILLEGAL PARAMETER"
- "ERR=04, DATA CORRUPTED"
- "ERR=05, UNKNOWN ERROR"
- "ERR=06, OPTION NOT INSTALLED"
- "ERR=20, INVALID NUMERIC ENTRY"
- "ERR=21, ILLEGAL SWAN-GANZ COMMAND"

Codes and Actions

This section lists the code numbers for controlling MPS450 actions, including both numeric-mode and remote-control-entry codes. (See the Table of Contents for this chapter to locate a specific action.)

The code numbers used in the numeric-control mode range from 000 to 420, with most of the numbers from 0 through 247 matching the numbers used previously by the Lionheart 3. Both active and inactive numeric-control codes are listed; when operating in the numeric-control mode, selecting **DOWN** or **UP** on the LCD screen automatically skips the inactive codes.

For more information about using the remote-control-entry codes (including how to use one specific remote-control command to operate the MPS450 in the numeric-control mode), see the "Remote Operations" section.

ECG Functions

The ECG functions category consist of Normal-Sinus ECG, ECG Amplitude, Adult/Pediatric, STE Elevation, ECG Artifact simulation, Pacemaker Waveform, Pacemaker Amplitude, and Pacemaker Width

Normal-Sinus ECG

Table 4-3 lists the numeric control codes for the normal-sinus ECG functions.

Table 4-3. Numeric Codes for Normal Sinus ECG Actions

Numeric Control Code	Action	Remote Control Entry
165	Run normal sinus ECG at 30 BPM.	NSR30
166	Run normal sinus ECG at 40 BPM.	NSR40
250	Run normal sinus ECG at 45 BPM.	NSR45
167	Run normal sinus ECG at 60 BPM.	NSR60
168	Run normal sinus ECG at 80 BPM.	NSR80
251	Run normal sinus ECG at 90 BPM.	NSR90
169	Run normal sinus ECG at 100 BPM.	NSR100
170	Run normal sinus ECG at 120 BPM.	NSR120
171	Run normal sinus ECG at 140 BPM.	NSR140
172	Run normal sinus ECG at 160 BPM.	NSR160
173	Run normal sinus ECG at 180 BPM.	NSR180
174	Run normal sinus ECG at 200 BPM.	NSR200
175	Run normal sinus ECG at 220 BPM.	NSR220
176	Run normal sinus ECG at 240 BPM.	NSR240
177	Run normal sinus ECG at 260 BPM.	NSR260
178	Run normal sinus ECG at 280 BPM.	NSR280
179	Run normal sinus ECG at 300 BPM.	NSR300

ECG Amplitude

Table 4-4 lists the numeric control codes for the ECG amplitude functions.

Table 4-4. Numeric Codes for ECG Amplitude Actions

Numeric Control Code	Action	Remote Control Entry
252	Set ECG amplitude to 0.05 mV.	NSA0.05

Table 4-4. Numeric Codes for ECG Amplitude Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
253	Set ECG amplitude to 0.10 mV.	NSA0.10
254	Set ECG amplitude to 0.15 mV.	NSA0.15
255	Set ECG amplitude to 0.20 mV.	NSA0.20
256	Set ECG amplitude to 0.25 mV.	NSA0.25
257	Set ECG amplitude to 0.30 mV.	NSA0.30
258	Set ECG amplitude to 0.35 mV.	NSA0.35
259	Set ECG amplitude to 0.40 mV.	NSA0.40
260	Set ECG amplitude to 0.45 mV.	NSA0.45
261	Set ECG amplitude to 0.50 mV.	NSA0.50
262	Set ECG amplitude to 1.00 mV.	NSA1.00
263	Set ECG amplitude to 1.50 mV.	NSA1.50
264	Set ECG amplitude to 2.00 mV.	NSA2.00
265	Set ECG amplitude to 2.50 mV.	NSA2.50
266	Set ECG amplitude to 3.00 mV.	NSA3.00
267	Set ECG amplitude to 3.50 mV.	NSA3.50
268	Set ECG amplitude to 4.00 mV.	NSA4.00
269	Set ECG amplitude to 4.50 mV.	NSA4.50
270	Set ECG amplitude to 5.00 mV.	NSA5.00
271	Set ECG amplitude to 5.50 mV.	NSA5.50

Adult / Pediatric

Table 4-5 list the numeric control codes for the adult / pediatric functions.

Table 4-5. Numeric Codes for Adult / Pediatric Actions

Numeric Control Code	Action	Remote Control Entry
010	Set patient type to Adult.	ADULT
011	Set patient type to Pediatric.	PEDS

STE Elevation

Table 4-6 lists the numeric control codes for the STE elevation functions.

Table 4-6. Numeric Codes for STE Elevation Actions

Numeric Control Code	Action	Remote Control Entry
237	Set ST elevation to -0.8 mV.	STD-0.8

Table 4-6. Numeric Codes for STE Elevation Action (cont.)

Numeric Control Code	Action	Remote Control Entry
236	Set ST elevation to -0.7 mV.	STD-0.7
235	Set ST elevation to -0.6 mV.	STD-0.6
234	Set ST elevation to -0.5 mV.	STD-0.5
233	Set ST elevation to -0.4 mV.	STD-0.4
232	Set ST elevation to -0.3 mV.	STD-0.3
231	Set ST elevation to -0.2 mV.	STD-0.2
230	Set ST elevation to -0.1 mV.	STD-0.1
221	Set ST elevation to -0.05 mV.	STD-0.05
220	Set ST elevation to 0.	STD0
219	Set ST elevation to +0.05 mV.	STD+0.05
229	Set ST elevation to +0.1 mV.	STD+0.1
228	Set ST elevation to +0.2 mV.	STD+0.2
227	Set ST elevation to +0.3 mV.	STD+0.3
226	Set ST elevation to +0.4 mV.	STD+0.4
225	Set ST elevation to +0.5 mV.	STD+0.5
224	Set ST elevation to +0.6 mV.	STD+0.6
223	Set ST elevation to +0.7 mV.	STD+0.7
222	Set ST elevation to +0.8 mV.	STD+0.8

ECG Artifact Stimulation

Table 4-7 lists the numeric control codes for the ECG artifact Stimulation functions.

Table 4-7. Numeric Codes for ECG Artifact Stimulation Actions

Numeric Control Code	Action	Remote Control Entry
104	Set ECG artifact to off.	EAOFF
105	Set ECG artifact to 50 Hz sine.	EA50
106	Set ECG artifact to 60 Hz sine.	EA60
107	Set ECG artifact to muscle.	EAMSC
108	Set ECG artifact to wandering baseline.	EAWNDR
109	Set ECG artifact to respiration.	EARESP

Pacemaker Waveform

Table 4-8 lists the numeric control codes for the pacemaker waveform functions.

Table 4-8. Numeric Codes for Pacemaker Waveform Actions

Numeric Control Code	Action	Remote Control Entry
383	Run atrial pacer wave.	ATR
110	Run asynchronous pacer wave.	ASN
111	Run demand frequent sinus pacer wave.	DFS
112	Run demand occasional sinus pacer wave.	DOS
113	Run AV sequential pacer wave.	AVS
114	Run noncapture pacer wave.	NCA
115	Run nonfunction pacer wave.	NFU

Pacemaker Amplitude

Table 4-9 lists the numeric control codes for the pacemaker amplitude functions.

Table 4-9. Numeric Codes for Pacemaker Amplitude Actions

Numeric Control Code	Action	Remote Control Entry
384	Set pacer amplitude to 1 mV.	PA1
385	Set pacer amplitude to 2 mV.	PA2
386	Set pacer amplitude to 5 mV.	PA5
242, 387	Set pacer amplitude to 10 mV.	PA10

Pacemaker Width

Table 4-10 lists the numeric control codes for the pacemaker width functions.

Table 4-10. Numeric Codes for Pacemaker Width Actions

Numeric Control Code	Action	Remote Control Entry
243	Set pacer width to 0.1 ms.	PW0.1
244	Set pacer width to 0.5 ms.	PW0.5
245	Set pacer width to 1.0 ms.	PW1.0
246	Set pacer width to 1.5 ms.	PW1.5
247	Set pacer width to 2.0 ms.	PW2.0

Arrhythmia Functions

The Arrhythmia Functions category consists of Supraventricular Arrhythmia, Premature Arrhythmia, Ventricular Arrhythmia, and Conduction Defect.

Supraventricular Arrhythmia

Table 4-11 lists the numeric control codes for the supraventricular arrhythmia functions.

Table 4-11. Numeric Codes for Supraventricular Arrhythmia Actions

Numeric Control Code	Action	Remote Control Entry
012	Run atrial fibrillation, coarse.	AF1
013	Run atrial fibrillation, fine.	AF2
014	Run atrial flutter.	AFL
015	Run sinus arrhythmia.	SINA
016	Run missed beat.	MB80
017	Run atrial tachycardia.	ATC
382	Run paroxysmal atrial tachycardia.	PAT
018	Run nodal rhythm.	NOD
019	Run supraventricular tachycardia.	SVT

Premature Arrhythmia

Table 4-12 lists the numeric control codes for the premature arrhythmia functions.

Table 4-12. Numeric Codes for Premature Arrhythmia Actions

Numeric Control Code	Action	Remote Control Entry
035	Run premature atrial contraction.	PAC
036	Run premature nodal contraction.	PNC
037	Run premature vent contraction left (PVC1), standard.	PVC1S
038	Run premature vent contraction left (PVC1), early.	PVC1E
039	Run premature vent contraction left (PVC1), R on T.	PVC1R
040	Run premature vent contraction right (PVC2), standard.	PVC2S
041	Run premature vent contraction right (PVC2), early.	PVC2E
042	Run premature vent contraction right (PVC2), R on T.	PVC2R
043	Run multifocal PVCs.	MF

Ventricular Arrhythmia

Table 4-13 lists the numeric control codes for the ventricular arrhythmia functions.

Table 4-13. Numeric Codes for Ventricular Arrhythmia Actions

Numeric Control Code	Action	Remote Control Entry
021	Run PVCs 6 per minute.	PVC6
022	Run PVCs 12 per minute.	PVC12
023	Run PVCs 24 per minute.	PVC24
024	Run frequent multifocal PVCs.	FMF
025	Run bigeminy.	BIG
026	Run trigeminy.	TRG
027	Run pair of PVCs.	PAIR
028	Run 5 PVCs.	RUN5
029	Run11 PVCs.	RUN11
030	Run ventricular tachycardia.	VTC
031	Run ventricular fibrillation, coarse.	VFB1
032	Run ventricular fibrillation, fine.	VFB2
033	Run asystole.	ASY

Conduction Defect

Table 4-14 lists the numeric control codes for the conduction defect functions.

Table 4-14. Numeric Codes for Conduction Defect Actions

Numeric Control Code	Action	Remote Control Entry
046	Run first-degree block.	1DB
047	Run second-degree block.	2DB1
048	Run third-degree block.	3DB
049	Run right-bundle-branch block.	RBB
050	Run left-bundle-branch block.	LBB

ECG Testing

ECG Testing category consists of Performance Waves, Performance Wave Amplitude, R-Wave Rate, R-Wave Width, and R-Wave Amplitude.

Performance Waves

Table 4-15 lists the numeric control codes for the performance waves functions.

Table 4-15. Numeric Codes for Performance Waves Actions

Numeric Control Code	Action	Remote Control Entry
120	Run 2 Hz square performance wave.	SQU2
121	Run .125 Hz square performance wave.	SQU.125

Table 4-15. Numeric Codes for Performance Waves Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
122	Run 2 Hz triangle performance wave.	TRI2
123	Run 2.5 Hz triangle performance wave.	TRI2.5
124	Run 30 BPM pulse performance wave.	PUL30
125	Run 60 BPM pulse performance wave.	PUL60
207	Run 0.5 Hz sine performance wave.	SIN0.5
208	Run 5 Hz sine performance wave.	SIN5
209	Run 10 Hz sine performance wave.	SIN10
210	Run 40 Hz sine performance wave.	SIN40
211	Run 50 Hz sine performance wave.	SIN50
212	Run 60 Hz sine performance wave.	SIN60
213	Run 100 Hz sine performance wave.	SIN100

Performance Wave Amplitude

Table 4-16 lists the numeric control codes for the performance wave amplitude functions.

Table 4-16. Numeric Codes for Performance Wave Amplitude Actions

Numeric Control Code	Action	Remote Control Entry
272	Set performance amplitude to 0.05 mV.	PFA0.05
273	Set performance amplitude to 0.10 mV.	PFA0.10
274	Set performance amplitude to 0.15 mV.	PFA0.15
275	Set performance amplitude to 0.20 mV.	PFA0.20
276	Set performance amplitude to 0.25 mV.	PFA0.25
277	Set performance amplitude to 0.30 mV.	PFA0.30
278	Set performance amplitude to 0.35 mV.	PFA0.35
279	Set performance amplitude to 0.40 mV.	PFA0.40
280	Set performance amplitude to 0.45 mV.	PFA0.45

Table 4-16. Numeric Codes for Performance Wave Amplitude Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
281	Set performance amplitude to 0.50 mV.	PFA0.50
282	Set performance amplitude to 1.00 mV.	PFA1.00
283	Set performance amplitude to 1.50 mV.	PFA1.50
284	Set performance amplitude to 2.00 mV.	PFA2.00
285	Set performance amplitude to 2.50 mV.	PFA2.50
286	Set performance amplitude to 3.00 mV.	PFA3.00
287	Set performance amplitude to 3.50 mV.	PFA3.50
288	Set performance amplitude to 4.00 mV.	PFA4.00
289	Set performance amplitude to 4.50 mV.	PFA4.50
290	Set performance amplitude to 5.00 mV.	PFA5.00
291	Set performance amplitude to 5.50 mV.	PFA5.50

R-Wave Rate

Table 4-17 lists the numeric control codes for the R-wave rate functions.

Table 4-17. Numeric Codes for R-Wave Rate Actions

Numeric Control Code	Action	Remote Control Entry
312	Run R wave at 30 BPM.	RWR30
313	Run R wave at 60 BPM.	RWR60
314	Run R wave at 80 BPM.	RWR80
315	Run R wave at 120 BPM.	RWR120
316	Run R wave at 200 BPM.	RWR200
317	Run R wave at 250 BPM.	RWR250

R-Wave Width

Table 4-18 lists the numeric control codes for the R-wave width functions.

Table 4-18. Numeric Codes for R-Wave Width Actions

Numeric Control Code	Action	Remote Control Entry
318	Set R-wave width to 8 ms.	RWW8
319	Set R-wave width to 10 ms	RWW10
320	Set R-wave width to 12 ms	RWW12
321	Set R-wave width to 20 ms	RWW20
322	Set R-wave width to 30 ms	RWW30

Table 4-18. Numeric Codes for R-Wave Width Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
323	Set R-wave width to 40 ms	RWW40
324	Set R-wave width to 50 ms	RWW50
325	Set R-wave width to 60 ms	RWW60
326	Set R-wave width to 70 ms	RWW70
327	Set R-wave width to 80 ms	RWW80
328	Set R-wave width to 90 ms	RWW90
329	Set R-wave width to 100 ms	RWW100
330	Set R-wave width to 110 ms	RWW110
331	Set R-wave width to 120 ms	RWW120
332	Set R-wave width to 130 ms.	RWW130
333	Set R-wave width to 140 ms.	RWW140
334	Set R-wave width to 150 ms.	RWW150
335	Set R-wave width to 160 ms.	RWW160
336	Set R-wave width to 170 ms.	RWW170
337	Set R-wave width to 180 ms.	RWW180
338	Set R-wave width to 190 ms.	RWW190
339	Set R wave width to 200 ms.	RWW200

R-Wave Amplitude

Table 4-19 lists the numeric control codes for the R-wave amplitude functions.

Table 4-19. Numeric Codes for R-Wave Amplitude Actions

Numeric Control Code	Action	Remote Control Entry
292	Set R-wave amplitude to 0.05 mV.	RWA0.05
293	Set R-wave amplitude to 0.15 mV.	RWA0.10
294	Set R-wave amplitude to 0.15 mV.	RWA0.15
295	Set R-wave amplitude to 0.05 mV.	RWA0.20
296	Set R-wave amplitude to 0.25 mV.	RWA0.25
297	Set R-wave amplitude to 0.05 mV.	RWA0.30
298	Set R-wave amplitude to 0.35 mV.	RWA0.35
299	Set R-wave amplitude to 0.05 mV.	RWA0.40
300	Set R-wave amplitude to 0.45 mV.	RWA0.45
301	Set R-wave amplitude to 0.05 mV.	RWA0.50

Table 4-19. Numeric Codes for R-Wave Amplitude Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
302	Set R-wave amplitude to 1.00 mV.	RWA1.00
303	Set R-wave amplitude to 1.50 mV.	RWA1.50
304	Set R-wave amplitude to 2 mV.	RWA2.00
305	Set R-wave amplitude to 2.50 mV.	RWA2.50
306	Set R-wave amplitude to 3.00 mV.	RWA3.00
307	Set R-wave amplitude to 3.50 mV.	RWA3.50
308	Set R-wave amplitude to 4.00 mV.	RWA4.00
309	Set R-wave amplitude to 4.50 mV.	RWA4.50
310	Set R-wave amplitude to 5.00 mV.	RWA5.00
311	Set R-wave amplitude to 5.50 mV.	RWA5.50

Respiration Functions

The Respiration Functions category consists of Respiration Lead, Respiration Baseline (Impedance), Respiration Rate, Respiration Amplitude, and Apnea Simulation.

Respiration Lead

Table 4-20 lists the numeric control codes for the respiration lead functions.

Table 4-20. Numeric Codes for Respiration Lead Actions

Numeric Control Code	Action	Remote Control Entry
(N/A)	Store the respiration lead.	RLSTORE
389	Set respiration lead to LA.	RLLA
391	Set respiration lead to LL.	RLLL
390	Store LA respiration lead.	(N/A)
392	Store LL respiration lead.	(N/A)

Respiration Baseline (Impedance)

Table 4-21 lists the numeric control codes for the respiration baseline (impedance) functions.

Table 4-21. Numeric Codes for Respiration Baseline (Impedance) Actions

Numeric Control Code	Action	Remote Control Entry
180	Set respiration base to 500 ohms.	RB500
181	Set respiration base to 1000 ohms.	RB1000
182	Set respiration base to 1500 ohms.	RB1500
183	Set respiration base to 2000 ohms.	RB2000

Table 4-21. Numeric Codes for Respiration Baseline (Impedance) Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
393	Store respiration base 500 ohms.	(N/A)
394	Store respiration base 1000 ohms.	(N/A)
395	Store respiration base 1500 ohms.	(N/A)
396	Store respiration base 2000 ohms.	(N/A)
(N/A)	Store the respiration base.	RBSTORE

Respiration Rate

Table 4-22 lists the numeric control codes for the respiration rate functions.

Table 4-22. Numeric Codes for Respiration Rate Actions

Numeric Control Code	Action	Remote Control Entry
156	Set respiration rate to 0 BrPM.	RR0
157	Set respiration rate to 15 BrPM.	RR15
158	Set respiration rate to 20 BrPM.	RR20
159	Set respiration rate to 30 BrPM.	RR30
160	Set respiration rate to 40 BrPM.	RR40
161	Set respiration rate to 60 BrPM.	RR60
162	Set respiration rate to 80 BrPM.	RR80
163	Set respiration rate to 100 BrPM.	RR100
164	Set respiration rate to 120 BrPM.	RR120

Respiration Amplitude

Table 4-23 lists the numeric control codes for the respiration amplitude functions.

Table 4-23. Numeric Codes for Respiration Amplitude Actions

Numeric Control Code	Action	Remote Control Entry
195	Set respiration amplitude to 0.2 ohms.	RO0.2
196	Set respiration amplitude to 0.5 ohms.	RO0.5
197	Set respiration amplitude to 1.0 ohms.	RO1.0
198	Set respiration amplitude to 3.0 ohms.	RO3.0

Apnea Simulation

Table 4-24 lists the numeric control codes for the apnea simulation functions.

Table 4-24. Numeric Codes for Apnea Simulation Actions

Numeric Control Code	Action	Remote Control Entry
152	Start apnea for 12 seconds.	A12
153	Start apnea for 22 seconds.	A22
154	Start apnea for 32 seconds.	A32
150	Turn on apnea continuously.	AON
151	Turn off apnea.	AOFF

Blood Pressure Functions

The Blood Pressure Functions consists of Blood-Pressure Sensitivity, Blood Pressure Zeroing, BP Channel 1: Static-Pressure Levels, BP Channel 2: Static-Pressure Levels, BP Channel 3: Static-Pressure Levels, BP Channel 4: Static-Pressure Levels, BP Channel 1: Dynamic Waveforms, BP Channel 2: Dynamic Waveforms, BP Channel 3: Dynamic Waveforms, BP Channel 4: Dynamic Waveforms, BP Channel 1: Respiration Artifact, BP Channel 2: Respiration Artifact, BP Channel 3: Respiration Artifact, and BP Channel 4: Respiration Artifact.

Blood-Pressure Sensitivity

Table 4-25 lists the numeric control codes for the blood-pressure sensitivity functions.

Table 4-25. Numeric Codes for Blood-Pressure Sensitivity Actions

Numeric Control Code	Action	Remote Control Entry
069	Set blood-pressure sensitivity to 5 µV/V/mmHg.	BPSNS5
068	Set Set blood-pressure sensitivity to 40 µV/V/mmHg.	BPSNS40
132	Store blood-pressure sensitivity at 5 µV/V/mmHg.	(N/A)
133	Store blood-pressure sensitivity to 40 µV/V/mmHg.	(N/A)
(N/A)	Store the blood-pressure sensitivity	BPSNSSTORE

Blood Pressure Zeroing

Table 4-26 lists the numeric control codes for the blood-pressure zeroing functions.

Table 4-26. Numeric Codes for Blood-Pressure Zeroing Actions

Numeric Control Code	Action	Remote Control Entry
007	Zero all four blood pressure channels.	ZALL

BP Channel 1: Static-Pressure Levels

Table 4-27 lists the numeric control codes for the BP channel 1: static-pressure levels functions.

Table 4-27. Numeric Codes for BP Channel 1: Static-Pressure Levels Actions

Numeric Control Code	Action	Remote Control Entry
342	Set BP1 to -10 mmHg static.	P1S-10
343	Set BP1 to zero.	P1S0
344	Set BP1 to 80 mmHg static.	P1S80
345	Set BP1 to 160 mmHg static.	P1S160
346	Set BP1 to 240 mmHg static.	P1S240
347	Set BP1 to 320 mmHg static.	P1S320
348	Set BP1 to 400 mmHg static.	P1S400

BP Channel 2: Static-Pressure Levels

Table 4-28 lists the numeric control codes for the BP channel 2: static-pressure levels functions.

Table 4-28. Numeric Codes for BP Channel 2: Static-Pressure Levels Actions

Numeric Control Code	Action	Remote Control Entry
351	Set BP2 to -10 mmHg static.	P2S-10
352	Set BP2 to zero.	P2S0
353	Set BP2 to 50 mmHg static.	P2S50
354	Set BP2 to 100 mmHg static.	P2S100
355	Set BP2 to 150 mmHg static.	P2S150
356	Set BP2 to 200 mmHg static.	P2S200
357	Set BP2 to 240 mmHg static.	P2S240

BP Channel 3: Static-Pressure Levels

Table 4-29 lists the numeric control codes for the BP channel 3: static-pressure levels functions.

Table 4-29. Numeric Codes for BP Channel 3: Static-Pressure Levels Actions

Numeric Control Code	Action	Remote Control Entry
360	Set BP3 to -5 mmHg static.	P3S-5
361	Set BP3 to zero.	P3S0
362	Set BP3 to 20 mmHg static.	P3S20
363	Set BP3 to 40 mmHg static.	P3S40

Table 4-29. Numeric Codes for BP Channel 3: Static-Pressure Levels Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
364	Set BP3 to 60 mmHg static.	P3S60
365	Set BP3 to 80 mmHg static.	P3S80
366	Set BP3 to 100 mmHg static.	P3S100

BP Channel 4: Static-Pressure Levels

Table 4-30 lists the numeric control codes for the BP channel 4: static-pressure levels functions.

Table 4-30. Numeric Codes for BP Channel 4: Static-Pressure Levels Actions

Numeric Control Code	Action	Remote Control Entry
369	Set BP4 to -5 mmHg static.	P4S-5
370	Set BP4 to zero.	P4S0
371	Set BP4 to 20 mmHg static.	P4S20
372	Set BP4 to 40 mmHg static.	P4S40
373	Set BP4 to 60 mmHg static.	P4S60
374	Set BP4 to 80 mmHg static.	P4S80
375	Set BP4 to 100 mmHg static.	P4S100

BP Channel 1: Dynamic Waveforms

Table 4-31 lists the numeric control codes for the BP channel 1: dynamic waveforms functions.

Table 4-31. Numeric Codes for BP Channel 1: Dynamic Waveforms Actions

Numeric Control Code	Action	Remote Control Entry
060	Run BP1 arterial dynamic wave 120/80.	P1ART
061	Run BP1 radial art dynamic wave 120/80.	P1RART
062	Run BP1 left vent dynamic wave 120/0.	P1LV
063	Run BP1 right vent dynamic wave 25/0.	P1RV

BP Channel 2: Dynamic Waveforms

Table 4-32 lists the numeric control codes for the BP channel 2: dynamic waveforms functions.

Table 4-32. Numeric Codes for BP Channel 2: Dynamic Waveforms Actions

Numeric Control Code	Action	Remote Control Entry
070	Run BP2 arterial dynamic wave 120/80.	P2ART
071	Run BP2 radial art dynamic wave 120/80.	P2RART
072	Run BP2 left vent dynamic wave 120/0.	P2LV
073	Run BP2 right vent dynamic wave 25/0.	P2RV
074	Run BP2 pulmonary art dynamic wave 25/10.	P2PA
075	Run BP2 pulm art wedge dynamic wave 10/2.	P2W
076	Run BP2 left atrium dynamic wave 14/4.	P2LA
077	Run BP2 right atrium CVP dynamic wave 15/10.	P2CVP

BP Channel 3: Dynamic Waveforms

Table 4-33 lists the numeric control codes for the BP channel 3: dynamic waveforms functions.

Table 4-33. Numeric Codes for BP Channel 3: Dynamic Waveforms Actions

Numeric Control Code	Action	Remote Control Entry
080	Run BP3 arterial dynamic wave 120/80.	P3ART
081	Run BP3 radial art dynamic wave 120/80.	P3RART
082	Run BP3 left vent dynamic wave 120/0.	P3LV
083	Run BP3 right atrium CVP dynamic wave 15/10.	P3CVP
084	Run BP3 pulmonary art dynamic wave 25/10.	P3PA
085	Run BP3 pulm art wedge dynamic wave 10/2.	P3W
086	Run BP3 left atrium dynamic wave 14/4.	P3LA
087	Run BP3 right vent dynamic wave 25/0.	P3RV
	BP CHANNEL 4: DYNAMIC WAVEFORMS	
378	Run BP4 right atrium CVP dynamic wave 15/10.	P4CVP
379	Run BP4 right vent dynamic wave 25/0.	P4RV
380	Run BP4 pulmonary art dynamic wave 25/10.	P4PA
381	Run BP4 pulm art wedge dynamic wave 10/2.	P4W
088	Start Swan-Ganz auto.	STSGAUTO
416	Start Swan-Ganz manual.	STSG
417	Insert (in Swan-Ganz manual).	INS
418	Inflate (in Swan-Ganz manual).	INF
419	Deflate (in Swan-Ganz manual).	DEF
420	Pull Back (in Swan-Ganz manual).	PLBK

BP Channel 4: Dynamic Waveforms

Table 4-34 lists the numeric control codes for the BP channel 4: dynamic waveforms functions.

Table 4-34. Numeric Codes for BP Channel 4: Dynamic Waveforms Actions

Numeric Control Code	Action	Remote Control Entry
080	Run BP3 arterial dynamic wave 120/80.	P3ART
081	Run BP3 radial art dynamic wave 120/80.	P3RART
082	Run BP3 left vent dynamic wave 120/0.	P3LV
083	Run BP3 right atrium CVP dynamic wave 15/10.	P3CVP
084	Run BP3 pulmonary art dynamic wave 25/10.	P3PA
085	Run BP3 pulm art wedge dynamic wave 10/2.	P3W
086	Run BP3 left atrium dynamic wave 14/4.	P3LA
087	Run BP3 right vent dynamic wave 25/0.	P3RV
	BP CHANNEL 4: DYNAMIC WAVEFORMS	
378	Run BP4 right atrium CVP dynamic wave 15/10.	P4CVP
379	Run BP4 right vent dynamic wave 25/0.	P4RV
380	Run BP4 pulmonary art dynamic wave 25/10.	P4PA
381	Run BP4 pulm art wedge dynamic wave 10/2.	P4W
088	Start Swan-Ganz auto.	STSGAUTO
416	Start Swan-Ganz manual.	STSG
417	Insert (in Swan-Ganz manual).	INS
418	Inflate (in Swan-Ganz manual).	INF
419	Deflate (in Swan-Ganz manual).	DEF
420	Pull Back (in Swan-Ganz manual).	PLBK

BP Channel 1: Respiration Artifact

Table 4-35 lists the numeric control codes for the BP channel 1: respiration artifact functions.

Table 4-35. Numeric Codes for BP Channel 1: Respiration Artifact Actions

Numeric Control Code	Action	Remote Control Entry
349	Set BP1 respiration artifact off.	P1AOFF
350	Set BP1 respiration artifact on.	P1AON

BP Channel 2: Respiration Artifact

Table 4-36 lists the numeric control codes for the BP channel 2: respiration artifact functions.

Table 4-36. Numeric Codes for BP Channel 2: Respiration Artifact Actions

Numeric Control Code	Action	Remote Control Entry
358	Set BP2 respiration artifact off.	P2AOFF
359	Set BP2 respiration artifact on.	P2AON

BP Channel 3: Respiration Artifact

Table 4-37 lists the numeric control codes for the BP channel 3: respiration artifact functions.

Table 4-37. Numeric Codes for BP Channel 3: Respiration Artifact Actions

Numeric Control Code	Action	Remote Control Entry
367	Set BP3 respiration artifact off.	P3AOFF
368	Set BP3 respiration artifact on.	P3AON

BP Channel 4: Respiration Artifact

Table 4-38 lists the numeric control codes for the BP channel 4: respiration artifact functions.

Table 4-38. Numeric Codes for BP Channel 4: Respiration Artifact Actions

Numeric Control Code	Action	Remote Control Entry
376	Set BP4 respiration artifact off.	P4AOFF
377	Set BP4 respiration artifact on.	P4AON

Other Functions

The Other Functions category consists of Temperature, Cardiac-Output Wave/Injectate, FHR Rate (Fixed), Intrauterine-Pressure (-) Wave, Intrauterine-Pressure (IUP) Period, View Angle, and Beeper.

Temperature

Table 4-39 lists the numeric control codes for the temperature functions.

Table 4-39. Numeric Codes for Temperature Actions

Numeric Control Code	Action	Remote Control Entry
189	Set temperature to 0 degrees C.	T0
190	Set temperature to 24 degrees C.	T24
191	Set temperature to 37 degrees C.	T37
192	Set temperature to 40 degrees C.	T40

Cardiac-Output Wave / Injectate

Table 4-40 lists the numeric control codes for the BP cardiac-output wave / injectate functions.

Table 4-40. Numeric Codes for Cardiac-Output Wave / Injectate Actions

Numeric Control Code	Action	Remote Control Entry
(N/A)	Run CO wave 2.5 l/min.	COW2.5
(N/A)	Run CO wave 5.0 l/min.	COW5.0
(N/A)	Run CO wave 10.0 l/min.	COW10.0
(N/A)	Run CO wave faulty injectate.	COWFLT
(N/A)	Run CO wave left/right shunt.	COWLRS
(N/A)	Run CO wave cal pulse.	COWCAL
(N/A)	Set CO injectate to 0 degrees C.	COI0
(N/A)	Set CO injectate to 24 degrees C.	COI24
090	Turn CO wave off.	CRSET
091	Run CO wave 0 degrees C at 2.5 l/min.	(N/A)
092	Run CO wave 0 degrees C at 5.0 l/min.	(N/A)
093	Run CO wave 0 degrees C at 10.0 l/min.	(N/A)
094	Run CO wave 24 degrees C at 2.5 l/min.	(N/A)
095	Run CO wave 24 degrees C at 5.0 l/min.	(N/A)
096	Run CO wave 24 degrees C at 10.0 l/min.	(N/A)
097	Run CO wave faulty injectate 0 degrees C.	(N/A)
099	Run CO wave faulty injectate 24 degrees C.	(N/A)
098	Run CO wave left/right shunt 0 degrees C.	(N/A)
100	Run CO wave left/right shunt 24 degrees C.	(N/A)
101	Run CO wave cal pulse 0 degrees C.	(N/A)
102	Run CO wave cal pulse 24 degrees C.	(N/A)

FHR Rate (Fixed)

Table 4-41 lists the numeric control codes for the FHR rate (fixed) functions.

Table 4-41. Numeric Codes for FHR Rate (Fixed) Actions

Numeric Control Code	Action	Remote Control Entry
409	Run fetal ECG at 60 BPM.	F60
410	Run fetal ECG at 90 BPM.	F90
411	Run fetal ECG at 120 BPM.	F120
412	Run fetal ECG at 140 BPM.	F140

Table 4-41. Numeric Codes for FHR Rate (Fixed) Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
413	Run fetal ECG at 150 BPM.	F150
414	Run fetal ECG at 210 BPM.	F210
415	Run fetal ECG at 240 BPM.	F240

Intrauterine-Pressure (-) Wave

Table 4-42 lists the numeric control codes for the intrauterine-pressure (-) wave functions.

Table 4-42. Numeric Codes for Intrauterine-Pressure (-) Wave Actions

Numeric Control Code	Action	Remote Control Entry
400	Turn IUP wave off.	IUPOFF
402	Run IUP early-deceleration wave.	FEDEC
403	Run IUP late-deceleration wave.	FLDEC
404	Run IUP acceleration wave.	FUACC

Intrauterine-Pressure (IUP) Period

Table 4-43 lists the numeric control codes for the intrauterine-pressure (IUP) period functions.

Table 4-43. Numeric Codes for Intrauterine-Pressure (IUP) Period Actions

Numeric Control Code	Action	Remote Control Entry
405	Run IUP wave once (manual).	IUP1
406	Run IUP waves at 2 minute period.	IUP2M
407	Run IUP waves at 3 minute period.	IUP3M
408	Run IUP waves at 5 minute period.	IUP5M

View Angle

Table 4-44 lists the numeric control codes for the view angle functions.

Table 4-44. Numeric Codes for View Angle Actions

Numeric Control Code	Action	Remote Control Entry
(N/A)	Set view angle to 1.	V1
(N/A)	Set view angle to 2.	V2
(N/A)	Set view angle to 3.	V3
(N/A)	Set view angle to 4.	V4
(N/A)	Set view angle to 5.	V5

Table 4-44. Numeric Codes for View Angle Actions (cont.)

Numeric Control Code	Action	Remote Control Entry
(N/A)	Set view angle to 6.	V6
(N/A)	Set view angle to 7.	V7
(N/A)	Set view angle to 8.	V8
(N/A)	Store view angle.	VSTORE

Beeper

Table 4-45 lists the numeric control codes for the beeper functions.

Table 4-45. Numeric Codes for Beeper Actions

Numeric Control Code	Action	Remote Control Entry
(N/A)	Beep the beeper.	BEEP
(N/A)	Set beeper to off.	BEEPOFF
(N/A)	Set beeper to short.	BEEPSHORT
(N/A)	Set beeper to long.	BEEPLONG
(N/A)	Store beeper.	BEEPSTORE

Appendix A
Troubleshooting

Introduction

Table A-1 lists some possible problems and their solution for repair.

Table A-1. Problem vs. Solution

Problem	Probable Cause	Solution
ECG		
Lead II amplitude not correct	Monitor filters	There will be a slight loss of amplitude when simulating NSR. Use a pulse wave to verify amplitude more accurately.
	Lead setting on monitor incorrect	Check monitor lead select switch. Set to Lead II.
	Leads not connected properly	Check color-coded ECG jacks.
Blood Pressure		
No BP or wrong output	MPS450 transducer sensitivity not set correctly	Check monitor manufacturer's BP-sensitivity requirements. Reset the MPS450 either to 5 μV/V/mmHg or to 40 μV/V/mmHg.
	Wrong BP cable	Many manufacturers use plugs and configurations with wiring differences. Check the MPS450 BP-wiring diagram and match with monitor specification.
	Monitor not zeroed	Zero the MPS450 BP channel. Next, zero the monitor.
	Monitor sensitivity (scaling) not correct	Adjust scaling on monitor, near range simulated (i.e., 120 mmHg).
	Performance waveform currently output (which turns off BP)	Select normal physiological waveform.

Table A-1. Problem vs. Solution (cont.)

Problem	Probable Cause	Solution
Respiration		
No respiration signal	Respiration lead not selected correctly	Check monitor respiration-lead detection and switch accordingly on the MPS450.
	Leads not connected properly	Verify that the color code is correct for U.S. or International ECG leads.
	Performance waveform currently output (which turns off respiration)	Select normal physiological waveform.
Temperature		
No temperature reading	Wrong series temperature cable used	Check manufacturer's series for thermistor used. Choose the correct Fluke Biomedical temperature cable for 700 or 400 Series.
Cardiac Output		
Expected values not correct, or no values	Selected Injectate temperature not set correctly	Injectate temperature must match expected temperature: 24 °C or 0 °C. Use optional cardiac-output box for setting injectate temperature.
	Incorrect setting for injectate volume on cardiac output computer	Set to 10 cc.
	Incorrect setting for catheter size on cardiac output computer	Set to 7f.
	Correct constant not set on monitor	Set correct constant to .542 or .595. See chapter on Cardiac Output.
Injectate temperature not displayed on monitor		Turn on injectate-temperature pot. (Zero the box until reading displayed is 0 °C or 24 °C.)

Appendix B
Remote Commands

Introduction

Table B-1 lists the remote commands for the MPS450 Analyzer in numerical order.

Table B-1. Remote Commands

Number	Selection
000	
001	NORMAL SINUS RHYTHM
002	
003	
004	
005	
006	
007	BP ZERO
008	
009	
010	ADULT ECG
011	PEDIATRIC ECG
012	ATRIAL FIB COARSE
013	ATRIAL FIB FINE
014	ATRIAL FLUTTER
015	SINUS ARRHYTHMIA
016	MISSED BEAT
017	ATRIAL TACH
018	NODAL RHYTHM

Table B-1. Remote Commands (cont.)

Number	Selection
019	SUPRAVENT TACH
020	
021	PVCs 6/MIN
022	PVCs 12/MIN
023	PVCs 24/MIN
024	FREQ MULTIFOCAL
025	BIGEMINY
026	TRIGEMINY
027	PAIRED PVCs
028	RUN 5 PVCs
029	RUN 11 PVCs
030	VENTRICULAR TACH
031	VENT FIB COARSE
032	VENT FIB FINE
033	ASYSTOLE
034	
035	ATRIAL PAC
036	NODAL PNC
037	PVC1 LV FOCUS
038	PVC1 LV FOCUS EARLY
039	PVC1 LV FOCUS R ON T
040	PVC2 RV FOCUS
041	PVC2 RV FOCUS EARLY
042	PVC2 RV FOCUS R ON T
043	MULTIFOCAL PVCs
044	
045	
046	1ST DEG BLOCK
047	2ND DEG BLOCK
048	3RD DEG BLOCK
049	RIGHT BB BLOCK
050	LEFT BB BLOCK
051	

Table B-1. Remote Commands (cont.)

Number	Selection
052	
053	
054	
055	
056	
057	
058	
059	
060	P1 ART 120/80
061	P1 RAD 120/80
062	P1 L VENT 120/ 0
063	P1 R VENT 25/10
064	
065	
066	
067	
068	BP SENSE 40 uV/V
069	BP SENSE 5 uV/V
070	P2 ART 120/80
071	P2 RAD 120/80
072	P2 L VENT 120/ 0
073	P2 R VENT 25/ 0
074	P2 PUL AR 25/10
075	P2 PUL WDG 10/2
076	P2 L ATR 14/4
077	P2 CVP 15/10
078	
079	
080	P3 ART 120/80
081	P3 RAD 120/80
082	P3 L VENT 120/0
083	P3 CVP 15/10
084	P3 PUL ART 25/10

Table B-1. Remote Commands (cont.)

Number	Selection
085	P3 PUL WDG 10/2
086	P3 L ATR 14/4
087	P3 R VENT 25/0
088	P4 SWAN-GANZ AUTO
089	
090	CO OFF
091	CO 0 DEG 2.5 L/M
092	CO 0 DEG 5 L/M
093	CO 0 DEG 10 L/M
094	CO 24 DEG 2.5 L/M
095	CO 24 DEG 5 L/M
096	CO 24 DEG 10 L/M
097	FAULTY INJ 0 DEG
098	L TO R SHUNT 0 DEG
099	FAULTY INJ 24 DEG
100	L TO R SHUNT 24 DEG
101	CO 0 DEG CAL
102	CO 24 DEG CAL
103	
104	ECG ARTF OFF
105	ECG ARTF 50 HZ
106	ECG ARTF 60 HZ
107	ECG ARTF MUSCLE
108	ECG ARTF BASELINE
109	ECG ARTF RESPIRATION
110	PACER ASYNC
111	PACER DEMAND FREQ
112	PACER DEMAND OCC
113	PACER AV SEQ
114	PACER NON-CAPTURE
115	PACER NON-FUNCTION
116	
117	

Table B-1. Remote Commands (cont.)

Number	Selection
118	
119	
120	PERF 2 HZ SQUARE
121	PERF 0.125 HZ SQUARE
122	PERF 2 HZ TRIANGLE
123	PERF 2.5 HZ TRIANGLE
124	PERF 30 BPM PULSE
125	PERF 60 BPM PULSE
126	
127	
128	
129	
130	
131	
132	BP SENSE 5 uV/V STR
133	BP SENSE 40 uV/V STR
134	
135	
136	
137	
138	
139	
140	
141	
142	
143	
144	
145	
146	
147	
148	
149	
150	APNEA ON CONTINUOUS

Table B-1. Remote Commands (cont.)

Number	Selection
151	APNEA OFF
152	APNEA 12 SECONDS
153	APNEA 22 SECONDS
154	APNEA 32 SECONDS
155	
156	RESP RATE 0 BRPM
157	RESP RATE 15 BRPM
158	RESP RATE 20 BRPM
159	RESP RATE 30 BRPM
160	RESP RATE 40 BRPM
161	RESP RATE 60 BRPM
162	RESP RATE 80 BRPM
163	RESP RATE 100 BRPM
164	RESP RATE 120 BRPM
165	NSR RATE 30 BPM
166	NSR RATE 40 BPM
167	NSR RATE 60 BPM
168	NSR RATE 80 BPM
169	NSR RATE 100 BPM
170	NSR RATE 120 BPM
171	NSR RATE 140 BPM
172	NSR RATE 160 BPM
173	NSR RATE 180 BPM
174	NSR RATE 200 BPM
175	NSR RATE 220 BPM
176	NSR RATE 240 BPM
177	NSR RATE 260 BPM
178	NSR RATE 280 BPM
179	NSR RATE 300 BPM
180	RESP BASE 500 OHMS
181	RESP BASE 1000 OHMS
182	RESP BASE 1500 OHMS
183	RESP BASE 2000 OHMS

Table B-1. Remote Commands (cont.)

Number	Selection
184	ECG AMPL 0.5 MV
185	ECG AMPL 1.0 MV
186	ECG AMPL 1.5 MV
187	ECG AMPL 2.0 MV
188	
189	TEMP 0 DEG
190	TEMP 24 DEG
191	TEMP 37 DEG
192	TEMP 40 DEG
193	
194	
195	RESP AMPL 0.2 OHM
196	RESP AMPL 0.5 OHM
197	RESP AMPL 1.0 OHM
198	RESP AMPL 3.0 OHM
199	
200	
201	
202	
203	
204	
205	
206	
207	PERF SINE 0.5 HZ
208	PERF SINE 5 HZ
209	PERF SINE 10 HZ
210	PERF SINE 40 HZ
211	PERF SINE 50 HZ
212	PERF SINE 60 HZ
213	PERF SINE 100 HZ
214	
215	
216	

Table B-1. Remote Commands (cont.)

Number	Selection
217	
218	
219	ST +0.05 MV
220	ST 0 MV
221	ST -0.05 MV
222	ST +0.8 MV
223	ST +0.7 MV
224	ST +0.6 MV
225	ST +0.5 MV
226	ST +0.4 MV
227	ST +0.3 MV
228	ST +0.2 MV
229	ST +0.1 MV
230	ST -0.1 MV
231	ST -0.2 MV
232	ST -0.3 MV
233	ST -0.4 MV
234	ST -0.5 MV
235	ST -0.6 MV
236	ST -0.7 MV
237	ST -0.8 MV
238	PACER AMPL 2 MV
239	
240	
241	
242	PACER AMPL 10 MV
243	PACER WIDTH 0.1 mS
244	PACER WIDTH 0.5 mS
245	PACER WIDTH 1.0 mS
246	PACER WIDTH 1.5 mS
247	PACER WIDTH 2.0 mS
248	
249	

Table B-1. Remote Commands (cont.)

Number	Selection
250	**NSR RATE 45 BPM**
251	NSR RATE 90 BPM
252	ECG AMPL 0.05 MV
253	ECG AMPL 0.10 MV
254	ECG AMPL 0.15 MV
255	ECG AMPL 0.20 MV
256	ECG AMPL 0.25 MV
257	ECG AMPL 0.30 MV
258	ECG AMPL 0.35 MV
259	ECG AMPL 0.40 MV
260	ECG AMPL 0.45 MV
261	ECG AMPL 0.50 MV
262	ECG AMPL 1.00 MV
263	ECG AMPL 1.50 MV
264	ECG AMPL 2.00 MV
265	ECG AMPL 2.50 MV
266	ECG AMPL 3.00 MV
267	ECG AMPL 3.50 MV
268	ECG AMPL 4.00 MV
269	ECG AMPL 4.50 MV
270	ECG AMPL 5.00 MV
271	ECG AMPL 5.50 MV
272	PERF AMPL 0.05 MV
273	PERF AMPL 0.10 MV
274	PERF AMPL 0.15 MV
275	PERF AMPL 0.20 MV
276	PERF AMPL 0.25 MV
277	PERF AMPL 0.30 MV
278	PERF AMPL 0.35 MV
279	PERF AMPL 0.40 MV
280	PERF AMPL 0.45 MV
281	PERF AMPL 0.50 MV
282	PERF AMPL 1.00 MV

Table B-1. Remote Commands (cont.)

Number	Selection
283	PERF AMPL 1.50 MV
284	PERF AMPL 2.00 MV
285	PERF AMPL 2.50 MV
286	PERF AMPL 3.00 MV
287	PERF AMPL 3.50 MV
288	PERF AMPL 4.00 MV
289	PERF AMPL 4.50 MV
290	PERF AMPL 5.00 MV
291	PERF AMPL 5.50 MV
292	R WAVE AMPL 0.05 MV
293	R WAVE AMPL 0.10 MV
294	R WAVE AMPL 0.15 MV
295	R WAVE AMPL 0.20 MV
296	R WAVE AMPL 0.25 MV
297	R WAVE AMPL 0.30 MV
298	R WAVE AMPL 0.35 MV
299	R WAVE AMPL 0.40 MV
300	R WAVE AMPL 0.45 MV
301	R WAVE AMPL 0.50 MV
302	R WAVE AMPL 1.00 MV
303	R WAVE AMPL 1.50 MV
304	R WAVE AMPL 2.00 MV
305	R WAVE AMPL 2.50 MV
306	R WAVE AMPL 3.00 MV
307	R WAVE AMPL 3.50 MV
308	R WAVE AMPL 4.00 MV
309	R WAVE AMPL 4.50 MV
310	R WAVE AMPL 5.00 MV
311	R WAVE AMPL 5.50 MV
312	R WAVE RATE 30 BPM
313	R WAVE RATE 60 BPM
314	R WAVE RATE 80 BPM
315	R WAVE RATE 120 BPM

Table B-1. Remote Commands (cont.)

Number	Selection
316	R WAVE RATE 200 BPM
317	R WAVE RATE 250 BPM
318	R WAVE WIDTH 8 MS
319	R WAVE WIDTH 10 MS
320	R WAVE WIDTH 12 MS
321	R WAVE WIDTH 20 MS
322	R WAVE WIDTH 30MS
323	R WAVE WIDTH 40MS
324	R WAVE WIDTH 50MS
325	R WAVE WIDTH 60MS
326	R WAVE WIDTH 70MS
327	R WAVE WIDTH 80MS
328	R WAVE WIDTH 90MS
329	R WAVE WIDTH 100MS
330	R WAVE WIDTH 110MS
331	R WAVE WIDTH 120MS
332	R WAVE WIDTH 130MS
333	R WAVE WIDTH 140MS
334	R WAVE WIDTH 150MS
335	R WAVE WIDTH 160MS
336	R WAVE WIDTH 170MS
337	R WAVE WIDTH 180MS
338	R WAVE WIDTH 190MS
339	R WAVE WIDTH 200MS
340	
341	
342	P1 ST -10 MMHG
343	P1 ST 0 MMHG
344	P1 ST 80 MMHG
345	P1 ST 160 MMHG
346	P1 ST 240 MMHG
347	P1 ST 320 MMHG
348	P1 ST 400 MMHG

Table B-1. Remote Commands (cont.)

Number	Selection
349	P1 ARTF OFF
350	P1 ARTF ON
351	P2 ST -10 MMHG
352	P2 ST 0 MMHG
353	P2 ST 50 MMHG
354	P2 ST 100 MMHG
355	P2 ST 150 MMHG
356	P2 ST 200 MMHG
357	P2 ST 240 MMHG
358	P2 ARTF OFF
359	P2 ARTF ON
360	P3 ST -5 MMHG
361	P3 ST 0 MMHG
362	P3 ST 20 MMHG
363	P3 ST 40 MMHG
364	P3 ST 60 MMHG
365	P3 ST 80 MMHG
366	P3 ST 100 MMHG
367	P3 ARTF OFF
368	P3 ARTF ON
369	P4 ST -5 MMHG
370	P4 ST 0 MMHG
371	P4 ST 20 MMHG
372	P4 ST 40 MMHG
373	P4 ST 60 MMHG
374	P4 ST 80 MMHG
375	P4 ST 100 MMHG
376	P4 ARTF OFF
377	P4 ARTF ON
378	P4 RIGHT ART CVP 15/10
379	P4 RIGHT VENT 25/0
380	P4 PULM ARTERY 25/10
381	P4 PULM WEDGE 10/2

Table B-1. Remote Commands (cont.)

Number	Selection
382	PAROXYSMAL ATR TACH
383	PACER ATRIAL
384	PACER AMPL 1 MV
385	PACER AMPL 2 MV
386	PACER AMPL 5 MV
387	PACER AMPL 10 MV
388	
389	RESP LEAD LA
390	RESP LEAD LA STORED
391	RESP LEAD LL
392	RESP LEAD LL STORED
393	RESP BASE 500 STRD
394	RESP BASE 1000 STRD
395	RESP BASE 1500 STRD
396	RESP BASE 2000 STRD
397	
398	
399	
400	IUP OFF
401	IUP UDEC
402	IUP EDEC
403	IUP LDEC
404	IUP UACC
405	IUP MANUAL
406	IUP 2 MIN
407	IUP 3 MIN
408	IUP 5 MIN
409	FETAL RATE 60
410	FETAL RATE 90
411	FETAL RATE 120
412	FETAL RATE 140
413	FETAL RATE 150
414	FETAL RATE 210

Table B-1. Remote Commands (cont.)

Number	Selection
415	FETAL RATE 240
416	P4 SWAN-GANZ MAN
417	P4 S-G INSERT
418	P4 S-G INFLATE
419	P4 S-G DEFLATE
420	P4 S-G PULLBACK

Appendix C
Glossary

Introduction

This glossary presents certain medical, electronic, and MPS450-specific terms, the understanding of which may aid in operating the instrument. Words that appear in **boldface** in a definition are themselves defined elsewhere in this glossary.

Table C-1. Glossary

Term	Definition
AAMI	Acronym for the Association for the Advancement of Medical Instrumentation. A group of physicians, biomedical and clinical engineers, nurses, manufacturers, and government representatives who set industry guidelines for the performance and safety of biomedical instrumentation.
AMPERE	A unit of steady electrical current which, when flowing in straight parallel wires of infinite length and negligible cross section, separated by a distance of one **meter** in free space, produces a force between the wires of 2 × 107 newtons per meter of length.
AORTA	The main trunk of the systemic **arteries**, carrying blood from the left side of the heart to the arteries of all limbs and organs except the lungs.
ARTERY	Any of a branching system of muscular tubes that carry blood away from the heart.
ARTIFACT	An abnormal signal or structure produced by an external medium, such as a muscle or electrical wiring. Artifacts are sometimes referred to as noise.
ASYNCHRONOUS	Signals sent to a computer at irregular intervals. Data is transmitted at irregular intervals by preceding each character with a start bit and following it with a stop bit. Asynchronous transmission allows a character to be sent at random after the preceding character has been sent, without regard to any timing device.
ATRIUM	(1) One of the two upper chambers of the heart. (2) Any chamber allowing entrance to another structure or organ.

Table C-1. Glossary (cont.)

Term	Definition
AV JUNCTION	A junction consisting of the **AV node** and the **bundle of His**. Conducts the electrical impulse sent from the **SA node** from the **atria** into the **ventricles**.
AV NODE	Also called the atrioventricular node. Located in the right **atrium** near the septum. Conducts the electrical impulse in the heart to the **bundle of His**, which passes it on to the left- and right-bundle branches.
BAUD	A unit of measurement that denotes the number of discrete signal elements, such as bits, that can be transmitted per second. Bits-per-second (bps) means the number of binary digits transmitted in one second.
BLOOD PRESSURE	The pressure of the blood within the arteries, primarily maintained by contraction of the left **ventricle**.
BPM	Beats per minute. *SEE* **pulse**.
BUNDLE OF HIS	A collection of nerves (about 1 cm in length) that lies just below the **AV node** in the heart. Part of the heart's electrical conduction system. With the AV node, forms the **AV junction**. Below the bundle, the nerves divide into left and right branches.
COMPUTATIONAL CONSTANT	Pertaining to cardiac output. Sometimes called calibration coefficient.
CARDIAC	Of, near, or pertaining to the heart.
CARDIOVASCULAR	Of, pertaining to, or involving the heart and the blood vessels.
CAPILLARY	One of the minute blood vessels that connect the **arteries** and veins.
GRAM	A metric unit of mass and weight, equal to one-thousandth of a **kilogram**, about 0.035 ounces.
HERTZ	A unit of frequency equal to one cycle per second. Used to measure electrical current and light, especially ultraviolet radiation (as in fluorescent light).
IMPEDANCE	A measure of the total opposition to current in a circuit.
INFRARED	Of, pertaining to, or being electromagnetic radiation having **wavelengths** greater than those of visible light and shorter than those of microwaves.
JOULE	A unit of energy, equal to the work done when a current of one **ampere** is passed through a **resistance** of one **ohm** for one second.
KILOGRAM	The fundamental unit of mass in the International System, about 2.2046 pounds.
LCD	Liquid crystal display. A digital display consisting of a liquid crystal material between sheets of glass that becomes readable in the presence of an applied voltage.
METER	The fundamental unit of length, equivalent to 39.37 inches, in the metric system.

Table C-1. Glossary (cont.)

Term	Definition
MILLIVOLT	One-thousandth of a **volt**.
MYOCARDIUM	The thick muscular layer of the heart, located between the endocardium at the inside and the epicardium at the outside walls of the heart.
NANOMETER	One-billionth (109) of a **meter**.
NANOSECOND	One billionth (109) of a second (one thousand-millionth of a second). Electricity travels approximately one foot per nanosecond.
NONINVASIVE	Not tending to spread; especially, not tending to invade healthy tissue.
OHM	A unit of electrical **resistance** equal to that of a conductor in which a current of one **ampere** is produced by a potential of one **volt** across its terminals.
PAP	Pulmonary arterial pressure.
PATIENT LEADS	Cables that connect a patient directly with the monitor. Sometimes called applied parts.
PCWP	Pulmonary capillary wedge pressure. Also known as PAW.
PULSE	The rhythmical throbbing of **arteries** produced by regular contractions of the heart.
PURKINJE NETWORK	The dense collection of Purkinje fibers, which are dispersed throughout the **myocardium** and which represent the terminal portion of the heart's electrical conduction system.
PVCS	Premature ventricular contractions.
QRS COMPLEX	The part of the P-QRS-T wave that records ventricular depolarization and contraction.
RESISTANCE	The opposition to electric current that is characteristic of a medium, substance, or circuit element.
RS-232	A method for connecting peripheral devices to computers using either a 25-pin connector or a 9-pin connector. There are two types of RS-232 interfaces: the data terminal equipment interface (DTE) and the data communication equipment interface (DCE). Personal computers are DTE devices, and peripherals (printers, mice, modems, the MPS450, etc.) are DCE devices. SEE **serial port**.
SA NODE	The dominant pacemaker site in the heart, responsible for setting the heart rate. Positioned in the right **atrium** near the inlet of the superior vena cava.
SERIAL PORT	An **asynchronous** COMmunication port/address to which a peripheral—such as a printer, a mouse or the MPS450—is connected to a computer or other device. *SEE* **RS-232**.
SWAN-GANZ	A soft, balloon-tipped catheter used for measuring blood pressure and cardiac output. The catheter is guided by blood flow into the pulmonary **artery**. A monitor near the tip of the catheter detects **PAP**, **PCWP**, and **thermodilution**.

Table C-1. Glossary (cont.)

Term	Definition
THERMODILUTION	The measuring of temperature change, enabled by the injection of a cold or room-temperature solution (such as saline) into the right **atrium** by means of a **Swan-Ganz** procedure.
VENOUS	(1) Of or pertaining to a vein or veins. (2) Returning to the heart through the great veins.
VENTRICLE	A small anatomical cavity or chamber, as of the brain or heart, especially (1) the chamber on the left side of the heart that receives arterial blood from the left **atrium** and contracts to drive it into the **aorta**, and (2) the chamber on the right side of the heart that receives venous blood from the right atrium and drives it into the pulmonary **artery**.
VOLT	The International System unit of electric potential and electromotive force, equal to the difference of electric potential between two points on a conducting wire carrying a constant current of one **ampere** when the power dissipated between the points is one watt.
WAVEFORM	(1) The mathematical representation of a wave, especially a graph of deviation at a fixed point (baseline) versus time. (2) On an ECG tracing or output, the size, shape, and distance (in milliseconds) of a P-QRS-T complex.
WAVELENGTH	In a periodic wave, the distance between two points of corresponding phase in consecutive cycles.