

FLUKE®

Biomedical

PS420

Multiparameter Simulator

Users Manual

PN 2631808

April 2006

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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- 648-7942 or 1-425-446-6945.

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

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

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

Returns for partial refund/credit:

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

Repair and calibration:

To find the nearest service center, 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: 1-800-850-4606

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: 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.

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Manufacturing Location

The PS420 Multiparameter Simulator is manufactured in Norway for Fluke Biomedical, 6920 Seaway Blvd., Everett, WA, U.S.A.

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PS420 Multiparameter Simulator

Introduction

The PS420 Multiparameter Simulator (hereafter called the Simulator) is a compact, lightweight, high-performance simulator for use by trained service technicians for patient monitor testing. Through settings that you manipulate, it simulates various electrocardiogram, respiration, blood pressure, temperature, and cardiac output conditions. The Simulator offers two-channel simulation.

Safety

 Warning. Read before using the Simulator.

To avoid personal injury, follow these guidelines:

- **Do not use in any manner not specified in the Users Manual. Otherwise, the protection provided by this product may be impaired.**
 - **Always press power off on the Simulator and unplug the Battery Eliminator before cleaning the outer surface.**
 - **Inspect the product. If the Simulator appears damaged or appears to operate in a manner not specified in the manual, DO NOT CONTINUE USE. Return for service.**
 - **Avoid spilling liquids on the Simulator; fluid seepage into internal components creates corrosion and a potential shock hazard. Do not operate the instrument if internal components are exposed to fluid.**
- Do not open this product. There are no user replaceable parts.**






⚠ Caution

The Simulator should be calibrated annually. Only qualified technical personnel should perform troubleshooting and service procedures on the Simulator.

Do not expose the Simulator to temperature extremes. Ambient operating temperatures should remain between 15 and 35 °C. Simulator performance may be adversely affected if temperatures fluctuate above or below this range.

Refer to Table 1 for descriptions of symbols found on the Simulator.

Table 1. Symbols

| Symbol | Description |
|---|--|
|  | See Users Manual. |
|  | Caution risk of electric shock |
|  | Manufacturer's declaration of product compliance with applicable EU directives |
|  | Battery Eliminator Port |
|  | Do not mix with solid waste stream. Dispose of using a qualified recycler or hazardous material handler. |

Specifications

General

| | |
|--|--|
| Display/Control | 16 alphanumeric display keys; two switches for Respiratory Leads LL/LA and Power ON/OFF |
| Interface | RS232 bi-directional interface. Baud rate: 9600 |
| ECG Output Connectors | 10 AHA/IEC color-coded connectors accepting ECG snaps and pins. |
| Power | 9 V alkaline battery or battery eliminator |
| Case | High impact plastic |
| Weight (w/o battery) | 0.343 kg / 12.1 oz. |
| Environmental | Indoor use |
| Temperature, Operating | 15 to 35 °C (59 to 95 °F) |
| Temperature, Storage | 0 to 50 °C (32 to 122 °F) |
| Maximum Humidity, Operating | 80 % relative humidity up to 31 °C (88 °F), decreasing linearly to 50 % relative humidity at 40 °C (104 °F). |
| Maximum Humidity, Storage | 95 % |
| Altitude | Up to 2000m |
| Dimensions | |
| Height..... | 16.0 cm (6.3 in.) |
| Width | 10.7 cm (4.2 in.) |
| Depth..... | 3.4 cm (1.4 in.) |
| Part No | PS420 Multiparameter Simulator (PN 2631290) |

Accessories

| Item | Part Number |
|---|-------------|
| Standard Accessories | |
| Users Manual CD-ROM | 2631721 |
| Users Manual (printed) | 2631808 |
| 9 VDC Battery Eliminator | 2647372 |
| Optional Accessories | |
| Cardiac Output Adapter Box | 2462200 |
| Temperature Cable | * |
| Blood Pressure Cable | * |
| Cardiac Output Cable | * |
| * Contact your local Fluke Biomedical Sales Agent for further details | |

ECG

12 Lead ECG with nine independent outputs referenced to RL

- Baseline Impedances 500, 1000, 1500 or 2000 Ohms for Leads I, II, and III
- High Level Output 1000 x (Lead II)
- Rates 30, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, and 300 BPM
- Default Rate 80 BPM.
- Rate Accuracy \pm 1% of selection

Adult or Pediatric Waveform

- ECG Amplitudes 0.5, 1.0, 1.5, and 2.0 mV
- Amplitude Accuracy \pm 2 % (Lead II)
- Superimposed Artifact 50 and 60 Hz, muscle, baseline wander, and respiration

ECG Performance

Square Wave.....0.125 and 2.0 Hz
Pulse30, 60, and 120 BPM 60 ms pulse width
Sine Wave5, 5, 10, 40, 50, 60, and 100 Hz
Triangle Wave2.0 and 2.5 Hz

ST Segment Analysis

Elevated or Depressed.....-.8 mV to +.8 mV in .1 mV steps

Pacemaker Selections

Pacer Spike Amplitude (2, 4, 6, 8, and 10 mV in Lead II)

Pacer Spike Duration (0.1, 0.5, 1.0, 1.5, and 2.0 ms)

Asynchronous Pacemaker

Pacer Non-Function

Pacer Non-Capture

Demand Occasional Sinus

Demand Frequent Sinus

AV Sequential

Arrhythmia Selections

| Base Rate of 80 BPM | |
|--|-----------------------------------|
| Sinus Arrhythmia | PVCs 24 / minute |
| Atrial (PAC) * | Frequent Multifocal PVCs |
| Missed Beat * | Bigeminy |
| Atrial Tachycardia | Trigeminy |
| Atrial Flutter | Pair PVCs * |
| Nodal (PNC) * | Run 5 PVCs * |
| Nodal Rhythm | Run 11 PVCs * |
| Supraventricular Tachycardia | Ventricular Tachycardia |
| PVC1 Left Ventricular Focus * | Ventricular Fibrillation (Coarse) |
| PVC1 Early, LV Focus * | Ventricular Fibrillation (Fine) |
| PVC1 R on T, LV Focus * | Asystole |
| PVC2 Right Ventricular Focus * | Conduction Defects |
| PVC2 Early, RV Focus * | First Degree |
| PVC2 R on T, RV Focus * | Second Degree |
| Multifocal PVCs * | Third Degree |
| Atrial Fibrillation Coarse/Fine | Right Bundle Branch Block |
| PVCs 6 / minute | Left Bundle Branch Block |
| PVCs 12 / minute | |
| * Will go to NSR ECG @ 80 BPM after completion | |

Blood Pressure

| | |
|--|------------------------|
| Input/Output Impedance | 350 Ohms |
| Exciter Input Limit | ± 10 V |
| Exciter Input Frequency Range | DC to 4000 Hz |
| Transducer Sensitivity | 5 or 40 μ V/V/mmHg |
| Level Accuracy | ± 1% ± 1 mmHg |

Static Levels

| | |
|-----------|---|
| BP 1..... | -10, 0, 80, 160, 240, 320, and 400 mmHg |
| BP 2..... | -10, 0, 50, 100, 150, 200, and 240 mmHg |

Channel Selections

| | |
|-----------------------------|--------------------------------------|
| Arterial 120/80 | Channels 1 and 2 |
| Radial Artery 120/80..... | Channels 1 and 2 |
| Left Ventricle 120/00 | Channels 1 and 2 |
| Right Ventricle 25/00 | Channels 1 and 2 |
| Central Venous 15/10..... | Channel 2 |
| Pulmonary Artery 25/10..... | Channel 2 |
| Pulmonary Wedge 10/2..... | Channel 2 |
| Left Atrium 14/4 | Channel 2 |
| Automatic Swan/Ganz..... | Every 20 seconds |
| Manual Swan/Ganz | Changes every time entry is selected |

Synchronized with all normal sinus rates
Physiologically tracks all arrhythmia selections

Cardiac Output Option

| | |
|------------------------------------|---|
| Catheter Type | Baxter-Edwards, 10 cc |
| Blood Temperature | 37 °C (98.6 °F) and 36 °C (95.9 °F) |
| CO for 2 Degrees C | 3, 5, and 7 L/Min |
| CO for 20 Degrees C | 3, 5, and 7 L/Min |
| Cal Pulse | Of 1 degree C for 1 second; of delta 402 Ohms for 4 seconds |
| Accuracy | ± 5 % |
| Computational Constant | |
| 2 Degrees C | 0.561 |
| 20 Degrees C | 0.608 |
| Left to Right Shunt * | 2 and 20 Degrees C |
| Faulty Injectate * | 2 and 20 Degrees C |

*Note: These four CO simulations are examples of defective (uncalibrated) curves.

Respiration

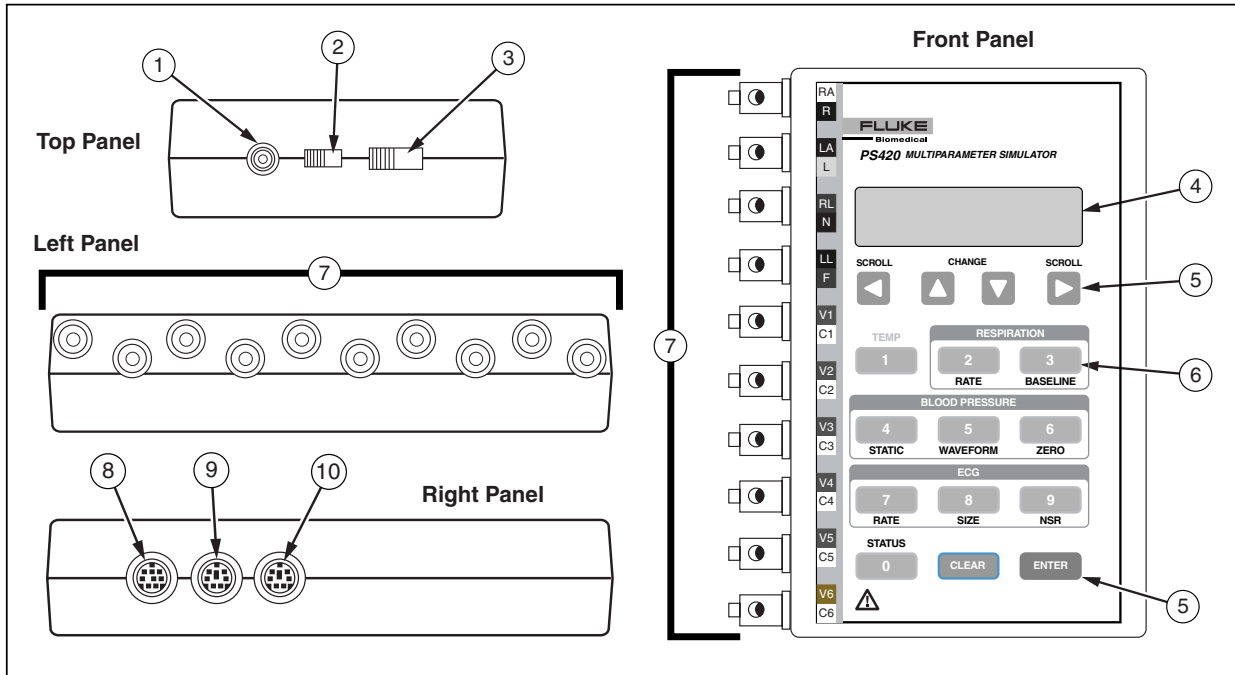
| | |
|-----------------------------------|---|
| Baseline Impedances | 500, 1000, 1500, 2000 Ohms (Leads I - III) |
| Lead Selection | LL or LA |
| Impedance Variations | 0.2, 0.5, 1.0, and 3.0 Ohms |
| Impedance Accuracy | ± 5 % |
| Rates | 0 (apnea), 15, 20, 30, 40, 60, 80, 100, 120 BPM |
| Apnea | 12 sec, 22 sec, 32 sec, and continuous |
| Rate Accuracy | ± 2 % |

Temperature

| | |
|--|-----------------|
| 30 °C (86 °F), 35 °C (95 °F), 37 °C (98.6 °F), 40 °C (104 °F), 42 °C (107.6 °F), compatible with YSI 400/700 series | |
| Accuracy | ± 0.25 Degree C |

Controls and Terminals

Refer to Figure 1 and Table 2 for descriptions of Simulator controls and terminals.



ebt001f.eps

Figure 1. Controls and Terminals

Table 2. Controls and Terminals

| Item | Name | Description |
|------|----------------------|---|
| ① | Battery Eliminator | <p>For use in operating the Simulator from any standard electrical outlet. To ensure safe operation, use only the Fluke Biomedical Battery Eliminator (PN 2647372).</p> <p style="text-align: center;">⚠⚠ Warning</p> <p style="text-align: center;">Caution risk of electric shock. Use only the Battery Eliminator specified in this manual or the protection provided may be impaired.</p> |
| ② | Power Switch | Switches the power on and off. |
| ③ | LA - LL Slide Switch | Selects the reference lead, either LA (left arm) or LL (left leg). The position of the switch must correspond to the type of patient monitor in use. |
| ④ | LCD Display | 15 mm x 60 mm (.58 in. x 2.37 in.) window displaying up to two lines of 20-point font. |
| ⑤ | Control Keys | |
| | ENTER | Enters the selected code line value into memory. |
| | CLEAR | Clears the code line value from the LCD window. |
| | SCROLL | Causes the code line number to increase or decrease. The display arrows indicate which SCROLL to use. The right SCROLL ► increases the code lines by 1, while the left SCROLL ◀ decreases the code lines by 1. |

Table 2. Controls and Terminals (cont.)

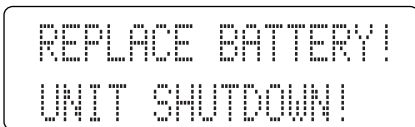
| Item | Name | Description |
|----------------|--|--|
| ⑤ | CHANGE | These keys are functional when the top line in the LCD window displays the up/down arrows ▲ ▼. They allow you to increment or decrement the current setting. The up CHANGE arrow ▲ increases the preset codes by 1, while the down CHANGE arrow ▼ decreases the preset codes by 1. |
| ⑥ | Keypad Soft Keys | These keys have two functions: numeric and one-step selection of Simulator functions. |
| | 0 / STATUS | Enters a numeric 0 to code line. Displays current parameter settings. |
| | 1 / TEMP | Enters a numeric 1 to code line. Changes temperature. |
| | 2 / RATE | Enters a numeric 2 to code line. Changes respiration rate. |
| | 3 / BASELINE | Enters a numeric 3 to code line. Changes baseline resistance. |
| | 4 / STATIC | Enters a numeric 4 to code line. Sets BP channels static levels. |
| | 5 / WAVEFORM | Enters a numeric 5 to code line. Sets BP channels to BP waveforms. |
| | 6 / ZERO | Enters a numeric 6 to code line. Sets BP channels to zero level. |
| | 7 / RATE | Enters a numeric 7 to code line. Changes ECG rate for NSR. |
| | 8 / SIZE | Enters a numeric 8 to code line. Changes ECG amplitude (lead II). |
| 9 / NSR | Enters a numeric 9 to code line. Selects Normal Sinus Rhythm (80 BPM). | |

Table 2. Controls and Terminals (cont.)

| Item | Name | Description | |
|------|-----------------|--|-----------------------------------|
| ⑦ | ECG Connectors | Ten snap and multi-banana connectors for ECG output, allowing for connection to any twelve-lead ECG. These terminals are labeled and on the top panel. The labels are AHA/IEC color-coded to aid in matching them to corresponding patient leads. Labels and their definitions are as follows: | |
| | | Label | Definition |
| | | RA / R | Right Arm |
| | | LA / L | Left Arm |
| | | RL / N | Right Leg (Reference or grounded) |
| | | LL / F | Left Leg |
| ⑧ | CO / Temp 1 & 2 | 8-pin mini-DIN plug connector for the Cardiac Output and Temperature cables. These cables are available separately from your Fluke Biomedical Sales Agent. | |
| ⑨ | BP 1 | 8-pin mini-DIN connector for BP cable plugs. | |
| ⑩ | BP 2 / RS-232 | 8-pin mini-DIN plug connector for BP cable plugs, as above, and for connecting an RS-232. | |

Powering the Simulator

The Simulator uses a 9 V alkaline battery (Duracell® MN1604 or equivalent). It is designed to use as much of the battery as possible. When it detects less than about 5.6 volts, it goes into a shutdown mode, sounds a continuous tone alarm, and displays the following message:



REPLACE BATTERY!
UNIT SHUTDOWN!

The battery is in the base of the instrument. Use a 9-volt alkaline battery (Duracell® MN1604 or equivalent). Do not use mercury, air, or carbon-zinc batteries.

⚠ Warning

The 9-volt alkaline battery provided with the Simulator may explode or leak if recharged, inserted improperly, disposed of in a fire, or mixed with different battery types. Dispose of the battery in accordance with any applicable state or local regulations.

As an alternative to a battery, you can power the Simulator with the Fluke Biomedical Battery Eliminator, PN 2647372.

⚠⚠ Warning

Caution risk of electric shock. Use only the Battery Eliminator specified in this manual or the protection provided may be impaired.

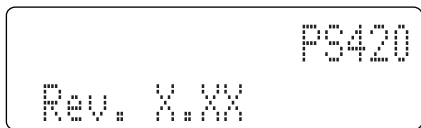
Note

Remove the battery and disconnect the Battery Eliminator if you do not intend to use the Simulator for an extended period of time.

Operating the Simulator

Connect the Simulator to the device under test. Use the Simulator's alphanumeric keypad to enter the code presets. The Simulator then transmits these values to the device. The following steps walk you through a sample procedure.

1. Switch the Simulator ON. The LCD window displays the program version for about two seconds.

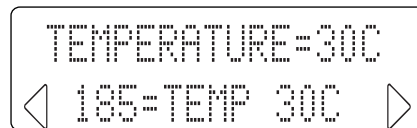


The window then displays the code entry display.

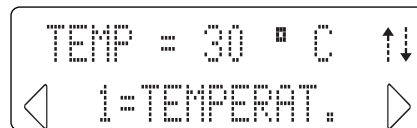


The display arrows indicate which **SCROLL** to use. The right **SCROLL** ► increases the preset codes by 1, while the left **SCROLL** ◀ decreases the preset codes by 1. For example, pressing the right **SCROLL** once will display the first preset, "0=VIEW".

2. Key in the required preset code. For example, to simulate a 30 °C (86 °F) temperature (code line 185), press menu keys 1 + 8 + 5. Then, press the **ENTER** key. This now becomes the preset temperature. Press **CLEAR** to return to the default code entry display.



3. To adjust some settings you can use the keypad's two-function alphanumeric keys. For temperature, as an example, press 1, then **ENTER**. The LCD displays the current preset.



Note the two additional up and down arrows. These indicate which way to increase or decrease the preset. Use the menu **CHANGE** arrows for scrolling through the presets. The up **CHANGE** arrow ▲ increases the preset codes by 1, while the down **CHANGE** arrow ▼ decreases the preset codes by 1. You can then advance through the temperature settings shown in Table 3.

Table 3. Temperature Settings

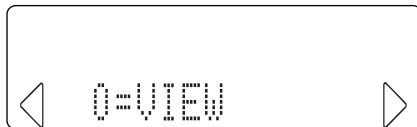
| Code | Temperature |
|------|------------------|
| 189 | 42 °C (107.6 °F) |
| 188 | 40 °C (104 °F) |
| 187 | 37 °C (98.6 °F) |
| 186 | 35 °C (95 °F) |
| 185 | 30 °C (86 °F) |

After reaching the required preset, press **ENTER**. This now becomes the active temperature. Press **CLEAR** to return to the default code entry display.

Note

*Only use the **ENTER** key when scrolling through the current settings. Using a **SCROLL** or **CHANGE** key interrupts the scrolling operation.*

At any point, you can view the Simulator's current parameter settings simply by pressing STATUS (0). The Simulator then displays "0=VIEW".



Press **ENTER**. The first parameter setting ("ECG=NSR") is then displayed. Thereafter, each time you press **ENTER**, the Simulator displays current settings in the sequence shown in Table 4.

Table 4. Current Settings

| Display | Description |
|-------------|--|
| ECG NSR | Normal sinus rhythm in BPM. |
| NSR QRS | Adult or pediatric waveform. |
| ECG AMPL | ECG amplitude in mV. |
| RESP RATE | Respiration rate in RPM. |
| R DELTA | Impedance variation in ohms. |
| BASELINE | Baseline impedance in ohms. |
| TEMPERATURE | Temperature in °C. |
| BP SENS | Transducer sensitivity in μ V. |
| BP1, BP2 | Blood pressure channel settings in mmHg. |

Simulating Functions

This section describes simulation procedures by function. If you are unfamiliar with basic Simulator operation, refer to Operating the Simulator.

Temperature

The Simulator replicates normal, hypothermic, and hyperthermic conditions with five temperature presets. All temperature outputs are compatible with YSI 400/700 series probes. Temperature can be set through direct code entry, as below, by keying the preset code and pressing **ENTER**. You can also use the **SCROLL** keys ◀ ▶ to cycle through the other presets before pressing **ENTER**.

In addition, you can select and adjust settings by first keying **1 = TEMPERAT. or 190**. If you key **1**, press **ENTER** and use the **CHANGE** keys ▲ ▼ to cycle through the presets. Then press **ENTER** to set the temperature. If you key **190**, press **ENTER** and use the **SCROLL** keys ◀ ▶ to cycle through the other presets. Then press **ENTER** to set the temperature.

| Code | Display | Selects temperature of: |
|------------|----------|-------------------------|
| 185 | TEMP 30C | 30 °C (86 °F) |
| 186 | TEMP 35C | 35 °C (95 °F) |
| 187 | TEMP 37C | 37 °C (98.6 °F) |
| 188 | TEMP 40C | 40 °C (104 °F) |
| 189 | TEMP 42C | 42 °C (107.6 °F) |

Respiration

Respiration Rate

The Simulator replicates nine rate settings. These can be set through direct code entry, as below, by keying the preset code and pressing **ENTER**. You can also use the **SCROLL** keys ◀ ▶ to cycle through the other presets before pressing **ENTER**. In addition, you can select and adjust settings by first keying **2 RATE**. If you key **2**, press **ENTER** and use the **CHANGE** keys ▲ ▼ to cycle through the other presets. Then press **ENTER** to set the rate.

| Code | Display | Selects respiration rate of: |
|------|------------|------------------------------|
| 152 | RESPPM 0 | 0 RPM |
| 153 | RESPPM 15 | 15 RPM |
| 154 | RESPPM 20 | 20 RPM |
| 155 | RESPPM 30 | 30 RPM |
| 156 | RESPPM 40 | 40 RPM |
| 157 | RESPPM 60 | 60 RPM |
| 158 | RESPPM 80 | 80 RPM |
| 159 | RESPPM 100 | 100 RPM |
| 160 | RESPPM 120 | 120 RPM |

Baseline Impedance

The baseline resistance selection of 500, 1000, 1500, and 2000 Ohms is between leads LA, RL, RA, and LL. The resistance for the V leads is 1020 Ohms between any V leads (V1-V6).

The impedance can be set through direct code entry, as below, by keying the preset code and pressing **ENTER**. You can also use the **SCROLL** keys ◀ ▶ to cycle through the other presets before pressing **ENTER**.

In addition, you can select and adjust settings by first keying **3 = BASELINE**. If you key **3**, press **ENTER** and use the **CHANGE** keys ▲ ▼ to cycle through the other presets. Then press **ENTER** to set the impedance.

| Code | Display | Selects baseline resistance of: |
|------|------------|---------------------------------|
| 166 | BASEL 500 | 500 Ohms |
| 167 | BASEL 1000 | 1000 Ohms |
| 168 | BASEL 1500 | 1500 Ohms |
| 169 | BASEL 2000 | 2000 Ohms |

Note

When you switch the Simulator on, the baseline impedance is set at 1000 Ohms. If changed, some monitors check lead impedance and, if too high (e.g., 2000 Ohms), may revert to their inoperative modes.

Impedance Variations

The Simulator replicates impedance variations of 0.2, 0.5, 1.0, 2.0, and 3.0 and 2000 delta Ohms. Use the LA/LL switch on the top panel to select which lead will have the respiration signal on it. This will not affect the baseline operation.

The variation can be set through direct code entry, as below, by keying the preset code and pressing **ENTER**. You can also use the **SCROLL** keys ◀ ▶ to cycle through the other presets before pressing **ENTER**.

| Code | Display | Selects respiration delta Ohms: |
|-------------|----------------|--|
| 161 | R DELTA .2 | 0.2 Ohms |
| 162 | R DELTA .5 | 0.5 Ohms |
| 163 | R DELTA 1 | 1.0 Ohms |
| 164 | R DELTA 2 | 2.0 Ohms |
| 165 | R DELTA 3 | 3.0 Ohms |

Apnea

The Simulator replicates the general apnea types by duration only: continuous; and 12, 22, and 32 seconds. Apnea can be set through direct code entry, as below, by keying the preset code and pressing **ENTER**. You can use the **SCROLL** keys ◀ ▶ to cycle through the other presets before pressing **ENTER**.

| Code | Display | Selects respiration apnea: |
|-------------|----------------|---|
| 144 | APNEA ON | ON. Respiration rate of 0 RPM. |
| 145 | APNEA OFF | OFF. Respiration reverts to previously selected respiration rate. |
| 146 | 12 SEC APN | For 12 seconds. |
| 147 | 22 SEC APN | For 22 seconds. |
| 148 | 32 SEC APN | For 32 seconds. |

Blood Pressure

The Simulator synchronizes dynamic blood pressure waveforms with all NSR rates and tracks all arrhythmia selections. Both blood pressure channels (BP-1 and 2) can be controlled. Each channel can act independently or can be set together for universal settings.

The Simulator will set the blood pressure channels to a zero level on power up. This is to allow you to set up the monitoring equipment under test.

Transducer Sensitivity (All Channels)

Before simulation can begin, blood pressure transducer sensitivity must be set to correlate with the monitor manufacturer's specifications: 40 $\mu\text{V/V/mmHg}$ (code 76) or 5 $\mu\text{V/V/mmHg}$ (code 77). Simulator accuracy is $\pm 1\%$, ± 1 mmHg.

The sensitivity is set through direct code entry by keying the preset code and pressing **ENTER**.

Waveform (All Channels)

The Simulator can set a single waveform for all blood pressure channels. This is set by first selecting **5 = WAVEFORM**. After selecting **5**, press **ENTER**. The LCD will display BP CHANNELS SET. The waveforms will appear only during ECG waveforms where blood

pressure waveforms occur (e.g., during the asystole selection, all pressure channels drop to 0 level).

Blood Pressure Artifact (All Channels)

You can insert a respiratory artifact, as required, into any waveform over all channels. Insert artifacts by keying **84**, then pressing **ENTER**. Stop insertion by keying **85**, and then pressing **ENTER**.

BP Static Levels (All Channels)

The blood pressure static level can be set through direct code entry, as below, or selected and adjusted through first selecting **4 = STATIC**. After selecting **4**, press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets.

BP Static Levels, Channels 1 and 2

BP Static Levels, Channels 1 and 2 can be set through direct code entry, as below, or selected and adjusted through first selecting **94 = P1,2 STAT**. After selecting **94**, press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets. Note that this will affect all pressure channels, and the Simulator will not display the levels for BP channels 1 and 2.

| Code | Display | Sets |
|------|------------|---|
| 207 | BP STAT L0 | BP channel to static level 0. P1= -10 P2= -10 P3= -5 P4= -5 |
| 208 | BP STAT L1 | BP channel to static level 0. P1=0 P2=0 P3=0 P4=0 |
| 209 | BP STAT L2 | BP channel to static level 0. P1=80 P2=50 P3=20 P4=20 |
| 210 | BP STAT L3 | BP channel to static level 0. P1=160 P2=100 P3=40 P4=40 |
| 211 | BP STAT L4 | BP channel to static level 0. P1=240 P2=150 P3=60 P4=60 |
| 212 | BP STAT L5 | BP channel to static level 0. P1=320 P2=200 P3=80 P4=80 |
| 213 | BP STAT L6 | BP channel to static level 0. P1=400 P2=240 P3=100 P4=100 |

Channel BP-1

| Code | Display | Selects: |
|------|------------|----------------------------------|
| 78 | P1 ARTERIA | Arterial waveform, 120/80. |
| 79 | P1 RADIAL | Radial waveform, 120/80. |
| 80 | P1 LVNT | Left ventricle waveform, 120/00. |
| 81 | P1 RVNT | Right ventricle waveform, 25/00 |

Channel BP-2

| Code | Display | Selects: |
|------|------------|--|
| 86 | P2 ARTERIA | Arterial waveform, 120/80. |
| 87 | P2 RADIAL | Radial waveform, 120/80. |
| 88 | P2 LVENT | Left ventricle waveform, 120/00. |
| 89 | P2 RVNT | Right ventricle waveform, 25/00. |
| 90 | P2 PULAR | Pulmonary arterial waveform, 25/10. |
| 91 | P2 PULWDG | Pulmonary wedge waveform, 10/2. |
| 92 | P2 L ATRIU | Left atrium waveform, 14/4. |
| 93 | P2 CVP | Central venous waveform (right atrium), 15/10. |

ECG/Arrhythmia

The Simulator replicates 37 different types of arrhythmias, from inconsequential types of PNCs to asystole. In addition, the Simulator can send waveforms to test any electrocardiograph, and can accommodate twelve-lead configurations with independent outputs for each signal lead referenced to the right leg (RL).

Adult and Pediatric NSR QRS

An adult NSR with a QRS width of 80 ms, or a pediatric NSR with a QRS width of 40 ms, can be set. These will remain in effect throughout ECG and arrhythmia selections until changed by reentering the below codes and pressing **ENTER**.

| Code | Display | Selects: |
|-------------|----------------|--|
| 11 | PEDIATRIC | Pediatric NSR with QRS width of 40 ms. |
| 12 | ADULT | Adult NSR with QRS width of 80 ms. |

NSR

The Simulator replicates fifteen normal sinus rhythms, or NSRs. These NSRs can be set through direct code entry, as below, or selected and adjusted through first selecting

9 = NSR. After selecting **9**, press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets.

| Code | Display | Selects NSR rate of: |
|-------------|----------------|-----------------------------|
| 170 | NSR 30BPM | 30 BPM |
| 171 | NSR 40BPM | 40 BPM |
| 172 | NSR 60BPM | 60 BPM |
| 173 | NSR 80BPM | 80 BPM |
| 174 | NSR 100BPM | 100 BPM |
| 175 | NSR 120BPM | 120 BPM |
| 176 | NSR 140BPM | 140 BPM |
| 177 | NSR 160BPM | 160 BPM |
| 178 | NSR 180BPM | 180 BPM |
| 179 | NSR 200BPM | 200 BPM |
| 180 | NSR 220BPM | 220 BPM |
| 181 | NSR 240BPM | 240 BPM |
| 182 | NSR 260BPM | 260 BPM |
| 183 | NSR 280BPM | 280 BPM |
| 184 | NSR 300BPM | 300 BPM |

Arrhythmias: Premature Beats

| Code | Display | Selects: |
|------|------------|---|
| 13 | PVC1 LVF | PVC with left ventricle focus. The Simulator then assumes NSR at 80 BPM. |
| 14 | PVC1 E LVF | Early PVC with left ventricle focus. The Simulator then assumes NSR at 80 BPM. |
| 15 | R ON T LVF | R on T PVC with left ventricle focus. The Simulator then assumes NSR at 80 BPM. |
| 16 | PVC2 RVF | PVC with right ventricle focus. The Simulator then assumes NSR at 80 BPM. |
| 17 | PVC2 E RVF | Early PVC with right ventricle focus. The Simulator then assumes NSR at 80 BPM. |

| Code | Display | Selects: |
|------|------------|--|
| 18 | R ON T RVF | R on T PVC with right ventricle focus. The Simulator then assumes NSR at 80 BPM. |
| 19 | MULTIFOCAL | Multifocal PVCs. The Simulator then assumes NSR at 80 BPM. |
| 20 | ATRIAL PAC | Atrial premature contraction. The Simulator then assumes NSR at 80 BPM. |
| 21 | NODAL PNC | Nodal premature contraction. The Simulator then assumes NSR at 80 BPM. |

Arrhythmias: Ventricular

| Code | Display | Selects: |
|-------------|----------------|---|
| 24 | PAIR PVCS | Pair of PVCs. The Simulator then assumes NSR at 80 BPM. |
| 25 | RUN 5 PVCS | Run of 5 PVCs. The Simulator then assumes NSR at 80 BPM. |
| 26 | RUN 11 PVC | Run of 11 PVCs. The Simulator then assumes NSR at 80 BPM. |
| 27 | BIGEMINY | Bigeminy rhythm. |
| 28 | TRIGEMINY | Trigeminy rhythm. |
| 29 | PVCS 6/M | 6 PVCs per minute. |
| 30 | PVCS 12/M | 12 PVCs per minute. |
| 31 | PVCS 24/M | 24 PVCs per minute. |
| 32 | FREQ MULTI | Frequent multifocal rhythm. |
| 33 | VENT TACHY | Ventricular tachycardia. |
| 34 | VENT FIB 1 | Ventricular fibrillation. |
| 35 | VENT FIB 2 | Ventricular fibrillation at 1/2. |
| 36 | ASYSTOLE | Asystole. No ECG. |

Arrhythmias: Atrial

| Code | Display | Selects: |
|-------------|----------------|--|
| 38 | ATRL FIB1 | Atrial fibrillation. |
| 39 | ATRL FIB2 | Atrial fibrillation 1/2 value. |
| 40 | ATRIAL FLT | Atrial flutter. |
| 41 | SINUS ARRH | NSR with irregular rate. |
| 42 | MISSED | Missed beat. The Simulator then assumes NSR at 80 BPM. |
| 43 | ATRL TACHY | Atrial tachycardia. |
| 44 | NODAL RHYT | Nodal rhythm. |
| 45 | SUPRAVENT | Supraventricular tachycardia. |

Arrhythmias: Conduction Defects

| Code | Display | Selects: |
|------|------------|-----------------------------------|
| 47 | RT BNDL BB | Right bundle branch block rhythm. |
| 48 | LT BNDL BB | Left bundle branch block rhythm. |
| 49 | 1ST DEG BL | 1st degree heart block rhythm. |
| 50 | 2ND DEG BL | 2nd degree heart block rhythm. |
| 51 | 3RD DEG BL | 3rd degree heart block rhythm. |

ST Elevation and Depression Waves

These can be set through direct code entry, as below, or adjusted and set through first selecting **52 = ST WAVES** or **142 = ST WAVES**. After selecting **52** or **142**, press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets.

| Code | Display | Selects ST wave of: |
|------|------------|---------------------|
| 236 | ST +.8 mV | + .8 mV elevation |
| 237 | ST +.7 mV | + .7 mV elevation |
| 238 | ST +.6 mV | + .6 mV elevation |
| 239 | ST +.5 mV | + .5 mV elevation |
| 240 | ST +.4 mV | + .4 mV elevation |
| 241 | ST +.3 mV | + .3 mV elevation |
| 242 | ST +.2 mV | + .2 mV elevation |
| 243 | ST +.1 mV | + .1 mV elevation |
| 244 | ST - .1 mV | - .1 mV depression |
| 245 | ST - .2 mV | - .2 mV depression |
| 246 | ST - .3 mV | - .3 mV depression |
| 247 | ST - .4 mV | - .4 mV depression |
| 248 | ST - .5 mV | - .5 mV depression |
| 249 | ST - .6 mV | - .6 mV depression |
| 250 | ST - .7 mV | - .7 mV depression |
| 251 | ST - .8 mV | - .8 mV depression |

ECG Waveform

The Simulator replicates four ECG waveform amplitudes, with a $\pm 2\%$ accuracy of selection (Lead II). The Simulator uses them as references only during arrhythmia simulations. They are set through direct code entry, as below, or selected and adjusted through first selecting **8 = ECG AMPL.** After selecting **8**, press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets. Then, press **ENTER** to set the amplitude. This setting remains in effect until changed, or until you switch the Simulator off.

| Code | Display | Selects ECG amplitude of: |
|------|------------|---------------------------|
| 191 | ECGSEN .5 | 0.5 mV |
| 192 | ECGSEN 1 | 1.0 mV |
| 193 | ECGSEN 1.5 | 1.5 mV |
| 194 | ECGSEN 2 | 2.0 mV |

ECG Rate

The Simulator replicates fifteen heart rates, with a $\pm 1\%$ accuracy of selection. These are set by selecting **7 = RATE.** After selecting **7** and pressing **ENTER**, use the **CHANGE** keys **▲ ▼** to scroll to the available presets. Then press **ENTER** to set the rate.

| Code | Display | Selects ECG rate of: |
|------|--------------|----------------------|
| 170 | ECG = 30BPM | 30 BPM |
| 171 | ECG = 40BPM | 40 BPM |
| 172 | ECG = 60BPM | 60 BPM |
| 173 | ECG = 80BPM | 80 BPM |
| 174 | ECG = 100BPM | 100 BPM |
| 175 | ECG = 120BPM | 120 BPM |
| 176 | ECG = 140BPM | 140 BPM |
| 177 | ECG = 160BPM | 160 BPM |
| 178 | ECG = 180BPM | 180 BPM |
| 179 | ECG = 200BPM | 200 BPM |
| 180 | ECG = 220BPM | 220 BPM |
| 181 | ECG = 240BPM | 240 BPM |
| 182 | ECG = 260BPM | 260 BPM |
| 183 | ECG = 280BPM | 280 BPM |
| 184 | ECG = 300BPM | 300 BPM |

Superimposed Artifacts

The Simulator replicates five different artifacts. Their purpose is to evaluate the effect of these type artifacts on ECG accuracy. After selecting the artifact, press **ENTER** to transmit it to the ECG. The Simulator deactivates the artifact when you make another ECG or arrhythmia selection.

| Code | Display | Selects: |
|-------------|----------------|----------------------------------|
| 53 | 50 HZ ARTI | 50 Hz artifact (European lines). |
| 54 | 60 HZ ARTI | 60 Hz artifact (US lines). |
| 55 | MUSCLE ART | Muscle artifact. |
| 56 | BASE WANDR | Baseline wandering. |
| 57 | RESP ARTIF | Respiration artifact. |

Pacemaker

The Simulator replicates six paced rhythms/signals. After selecting the required rhythm, press **ENTER**. Use the **CHANGE** keys ▲ ▼ to scroll through the available rhythms.

| Code | Display | Selects: |
|-------------|----------------|--|
| 58 | ASYNCHRONO | Asynchronous pacemaker rhythm. |
| 59 | DEMND FSIN | Pacemaker rhythm with frequent sinus beats. |
| 60 | DEMND OSIN | Pacemaker rhythm with occasional sinus beats. |
| 61 | AV SEQUENT | Atrial ventricular pacemaker rhythm. |
| 62 | NONCAPTURE | Noncapture event. The Simulator then assumes asynchronous pacemaker. |
| 63 | NON FUNCT | Non-function pacemaker rhythm. |

Pacemaker Pulse Amplitudes, Lead II

When you select any pacemaker waveform, you can adjust and set pulse amplitudes in Lead II. These can be set through direct code entry, as below, or selected and adjusted through first selecting **64 = PACE AMP**. After selecting **64**, press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets.

| Code | Display | Sets pacemaker pulse amplitude (Lead II) of: |
|-------------|----------------|---|
| 224 | PACE 2 mV | 2 mV |
| 225 | PACE 4 mV | 4 mV |
| 226 | PACE 6 mV | 6 mV |
| 227 | PACE 8 mV | 8 mV |
| 228 | PACE 10 mV | 10 mV |

Pacemaker Pulse Width

When you select any pacemaker waveform, you can adjust and set pulse width. These can be set through direct code entry, as below, or selected and adjusted through first selecting **65 = PACE WIDTH**. After selecting **65** press **ENTER**, and then use the **CHANGE** keys **▲ ▼** to scroll to the available presets.

| Code | Display | Sets pacemaker pulse width of: |
|-------------|----------------|---------------------------------------|
| 229 | PACE 0.1mS | 0.1 ms |
| 230 | PACE 0.5mS | 0.5 ms |
| 231 | PACE 1 mS | 1.0 ms |
| 232 | PACE 1.5mS | 1.5 ms |
| 233 | PACE 2 mS | 2.0 ms |

Cardiac Output

The software detects the cardiac output option when you connect the Simulator to the patient monitor's cardiac-output computer using the available accessories. Refer to your local Fluke Biomedical representative regarding the available optional Cardiac Output Adapter Box and cables.

To set up the cardiac output procedure while using the Cardiac Output Adapter Box, you must match the computational constant for the injectate temperature required. You must then adjust the injectate temperature pot to the required value for the model used. Use the following procedure:

1. Set the computational constant on your monitor under test to 0.561 for 2 °C, or 0.608 for 20 °C injectate temperature.
2. Connect the cable from the Cardiac Output Adapter Box to the **CO/Temp1&2** port on the right side of the Simulator.
3. Connect the cable for the injectate temperature into the **INJEC. TEMP.** port on the Cardiac Output Adapter Box.
4. Connect the cable for the blood temperature into the **BLOOD TEMP.** port on the Cardiac Output Adapter Box.
5. You may also connect other temperature probes through the **TEMP. 1&2** port on the Cardiac Output Adapter Box.
6. Rotate the **INJEC. TEMP.** dial on the face of the Cardiac Output Adapter Box until the monitor under test indicates the proper injectate temperature. This will be either 2 °C or 20 °C.

Note

*The number value on the **INJEC. TEMP.** dial is a relative setting for obtaining the same value on identical monitors. It does not indicate a numerical temperature value.*

Once you have the injectate temperature set to either 2 °C or 20 °C, you are ready to run the appropriate simulation from the Simulator. Select the appropriate test code and then press **ENTER**.

| Code | Display | Selects: |
|-------------|----------------|--|
| 107 | 3L/M @ 2C | Cardiac output wave of 3 L/min for 2 degrees. Computational constant is 0.561. |
| 108 | 5L/M @ 2C | Cardiac output wave of 5 L/min for 2 degrees. Computational constant is 0.561. |
| 109 | 7L/M @ 2C | Cardiac output wave of 7 L/min for 2 degrees. Computational constant is 0.561. |
| 110 | 3L/M @ 20C | Cardiac output wave of 3 L/min for 20 degrees. Computational constant is 0.608. |
| 111 | 5L/M @ 20C | Cardiac output wave of 3 L/min for 20 degrees. Computational constant is 0.608. |

| Code | Display | Selects: |
|-------------|----------------|---|
| 112 | 7L/M @ 20C | Cardiac output wave of 3 L/min for 20 degrees. Computational constant is 0.608. |
| 113 | FLT INJ 2 | Faulty injection cardiac output wave for 2 degrees. Computational constant is 0.561. |
| 114 | L- T SHT 2 | Left to right shunt cardiac output wave for 2 degrees. Computational constant is 0.561. |
| 115 | FLT INJ 20 | Faulty injection cardiac output wave for 20 degrees. Computational constant is 0.608. |
| 116 | L- R SHT 20 | Left to right shunt cardiac output wave for 20 degrees. Computational constant is 0.608. |

| Code | Display | Selects: |
|------|------------|--|
| 117 | CAL WAVES | Calibrated cardiac output waves. |
| 118 | NONCAL WVE | Uncalibrated cardiac output waves. Gives 4 different values per 3, 5, and 7 L/min waves. |
| 119 | CAL 1 SEC | Calibration pulse of 1 degree for 1 second. |
| 120 | CAL 4 SEC | Calibration pulse of a delta of 402 Ohms for 4 seconds. |
| 121 | SET BT 37C | 37 °C (98.6 °F) |
| 122 | SET BT 36C | 36 °C (95.9 °F) |

When the monitor under test indicates that it is ready to perform a Cardiac Output calculation, press **ENTER** on the Simulator to generate a test. The 4-second calibration pulse provides a delta change of 402 Ohms. This provides a standard for testing cardiac output units.

If you select any cardiac output waveform key a second time while a waveform is proceeding, the selected waveform will stop. The blood temperature will return to 37 °C (98.6 °F.)

ECG Performance Testing

Square Wave

| Code | Display | Selects: |
|------|------------|---------------------------|
| 128 | 2 Hz SQR | 2.0 Hz square waveform. |
| 129 | .125 Hz SQ | 0.125 Hz square waveform. |

Triangle Wave

| Code | Display | Selects: |
|------|------------|---------------------------|
| 130 | 2 Hz TRIAN | 2.0 Hz triangle waveform. |
| 131 | 2.5 Hz TRI | 2.5 Hz triangle waveform |

Pulse Wave

| Code | Display | Selects: |
|------|----------|----------------------------------|
| 132 | PULSE 30 | Pulse of 30 BPM, width of 60 ms. |
| 133 | PULSE 60 | Pulse of 60 BPM, width of 60 ms. |

Sine Wave

| Code | Display | Selects: |
|-------------|----------------|---------------------|
| 135 | SINE .5 Hz | 0.5 Hz sine wave. |
| 136 | SINE 5 Hz | 5.0 Hz sine wave. |
| 137 | SINE 10 Hz | 10.0 Hz sine wave. |
| 138 | SINE 40 Hz | 40.0 Hz sine wave. |
| 139 | SINE 50 Hz | 50.0 Hz sine wave. |
| 140 | SINE 60 Hz | 60.0 Hz sine wave. |
| 141 | SINE 100Hz | 100.0 Hz sine wave. |

Cleaning

Clean only with a damp, lint-free cloth, using mild detergent, and wipe down gently.

⚠ Caution

Do not pour fluid onto the Simulator surface; fluid seepage into the electrical circuitry may cause Simulator failure.

⚠ Caution

Do not use spray cleaners on the Simulator; such action may force cleaning fluid into the Simulator and damage electronic components.

