FLUKE ®
Biomedical

ProSim™ 6/8

Vital Signs Simulator

Users Manual

January 2011, Rev. 2, 9/11

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

All Rights Reserved

Copyright Release

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 1-800-648-7952 or 1-425-446-6945.

Claims

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

Standard Terms and Conditions

Refunds and Credits

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

Restocking Charges

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

Return Procedure

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

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

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

Returns for partial refund/credit:

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

Repair and calibration:

To find the nearest service center, 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: 1-888-99 FLUKE (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: service.international@fluke.com

To ensure the accuracy of the Product is maintained at a high level, Fluke Biomedical recommends the product be calibrated at least once every 12 months. Calibration must be done by qualified personnel. Contact your local Fluke Biomedical representative for calibration.

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 ProSim™ 6/8 Vital Signs Simulator is manufactured at Fluke Biomedical, 6920 Seaway Blvd., Everett, WA, U.S.A.

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Introduction

The Fluke Biomedical ProSim™ 6 and ProSim™ 8 Vital Signs Simulators (hereafter the Product) are full-featured, compact, portable simulators, used to measure the performance of patient monitors. The Fluke Biomedical ProSim™ 8 is shown in all illustrations.

The Product simulates:

- ECG Functions
- Respiration
- Invasive and Non-Invasive Blood Pressure
- Temperature
- Cardiac Output

When the term simulation is used in connection with ECG, respiration, temperature, IBP, NIBP, cardiac output, or SpO2, the simulation type shown in Table 1 is used in this Product. Additionally, the Devices provide an optical signal to verify that the electronics within the pulse oximeter probe are functional.

Table 1. Simulation Types

Parameter	Simulation Type
ECG	Electrical
Respiration	Electrical
Temperature	Electrical
IBP	Electrical
NIBP	Pneumatic
Cardiac Output	Electrical
SpO2	Light Emission

Intended Use

The Product is intended to be used to test and verify the basic operation of patient monitoring devices or systems used to monitor various physiological parameters of a patient, including ECG, Respiration, Invasive blood pressure, Non-invasive blood pressure, Temperature, and Cardiac output. Additionally, the Devices provide an optical signal to verify that the electronics within the pulse oximeter probe are functional.

The intended user is a trained biomedical equipment technician who performs periodic preventative maintenance checks on patient monitors in service. Users can be associated with hospitals, clinics, original equipment manufacturers and independent service companies that repair and service medical equipment. The end user is an individual, trained in medical instrumentation technology.

This Product is intended to be used in the laboratory environment, outside of the patient care area, and is not intended for use on patients, or to test devices while connected to patients. This Product is not intended to be used to calibrate medical equipment. It is inteneded for over the counter use.

Safety Information

In this manual, a **Warning** identifies hazardous conditions and actions that could cause bodily harm or death. A **Caution** identifies conditions and actions that could damage the Product, the equipment under test, or cause permanent loss of data.

⚠⚠ Warnings

To prevent personal injury, use the Product only as specified, or the protection supplied by the Product can be compromised.

To prevent possible electrical shock, fire, or personal injury:

- **Do not use and disable the Product if it is damaged.**
- **The battery door must be closed and locked before you operate the Product.**
- **Remove all probes, test leads, and accessories that are not necessary for the measurement.**
- **Do not use the Product around explosive gas, vapor, or in damp or wet environments.**
- **Do not use the Product if it operates incorrectly.**
- **Do not connect the Product to a patient or equipment connected to a patient. The Product is intended for equipment evaluation only and should never be used in diagnostics, treatment, or any other capacity where the Product would come in contact with a patient.**
- **Read all safety Information before you use the Product.**
- **Examine the case before you use the Product. Look for cracks or missing plastic. Carefully look at the insulation around the terminals.**
- **Carefully read all instructions.**

Symbols

Table 2 describes symbols used in association with the Product.

Table 2. Symbols

Symbol	Description	Symbol	Description
⚠	Risk of danger. Important information. See manual.	⚠	Hazardous voltage. Risk of electric shock.
Li	This Product contains a Lithium-ion battery. Do not mix with solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler per local regulations. Contact your authorized Fluke Service Center for recycling information.		Do not dispose of this Product as unsorted municipal waste. Go to Fluke's website for recycling information.
⚠	Magnetic Field.	CE	Conforms to European Union directives.

Unpack the Product

Carefully unpack all items from the box and check that you have these items:

- ProSim™ 8 or ProSim™ 6
- Getting Started Manual
- Users Manual CD
- Carrying Case
- Power Cord
- AC/DC Power Supply
- USB Cable
- IBP Cable (unterminated)
- NIBP Cuff Mandrel set (adult and neonate)
- NIBP Cuff Adapters
- Ansur Demostration Disk

After you unpack and inspect the Product, fully charge the battery before the first use. Afterwards, charge the battery when the Product shows the low battery message. See the How to Maintain the Battery section in this manual.

Accessories

Available Product accessories are shown in Tables 3 and 4.

Table 3. Standard Accessories

Item		Fluke Biomedical Part Number
ProSim™ 6/8 Getting Started Manual		3984515
ProSim™ 6/8 Users Manual CD		3984526
AC/DC Power Supply		2184298
AC Power Cord	US	2201455
	Schuko	2201437
	UK	2201428
	Japan	2201419
	Australia	2201443
	Brazil	3930831
USB Cable		4034393
IBP Cable, unterminated		2392173
Carrying Case		4034597
Set of NIBP Cuff Mandrels	End blocks (2 required)	2392370
	Space blocks (3 required)	2392381
Neonatal Cuff Mandrel		2392328
Set of NIBP Cuff Adapters		2391882
Ansur Demonstration CD-ROM		2795488

Table 4. Optional Accessories

Item	Fluke Biomedical Part Number
SpO2 Finger Module with cable	3985658
SpO2 Masimo RAINBOW cable	4034609
Battery pack	4021085
NIBP Test 500 mL rigid chamber	4034611
Simulation Cables: IBP Temperature	See your Fluke Biomedical Distributor
Cardiac Output Interface Box	2392199
Upgrade kit to ProSim™ 8	3987196
USB Wireless Dongle	3341333
Mini-DIN to DIN IBP Adapter	3408564

Instrument Familiarization

Table 5 is a list of Product top-panel controls and connections shown in Figure 1.

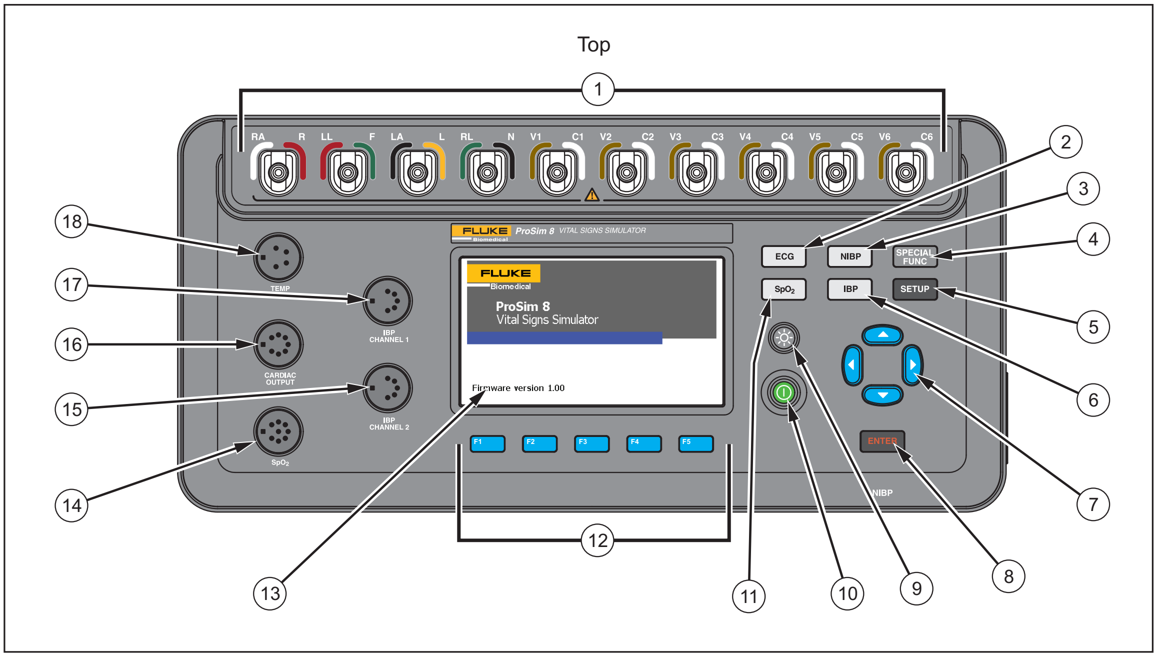

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Figure 1. Top-Panel Controls and Connections

Table 5. Top-Panel Controls and Connections

Item	Name	Description
1	ECG Posts	Connection posts for Device Under Test (DUT) ECG leads.
2	ECG Function	Accesses the ECG waveforms (adult, pediatric, and arrhythmias), and ECG test functions (performance waves, QRS detection, Tall T wave rejection, and R wave detection).
3	NIBP Button	Accesses the Non-Invasive Blood Pressure (NIBP) functions.
4	Special Functions	Accesses the temperature, respiration, cardiac output, fetal simulation, autosequences, and view memory functions.
5	SETUP Button	Accesses the setup controls.
6	IBP Button	Accesses the Invasive Blood Pressure (IBP) functions.
7	Navigation Buttons	Cursor control buttons for navigating menus and lists.
8	Enter Button	Sets the highlighted function.
9	Backlight Button	Turns the display backlight on and off.
10	Power Button	Turns the Product on and off.
11	SpO2 Button	Accesses the SpO2 functions.
12	Function Softkeys	Keys F1 through F5 are used to select from a number of selections that appear in the LCD display above each function softkey.
13	LCD Display	Color display.

Table 5. Top-Panel Controls and Connections (cont.)

Item	Name	Description
14	SpO2 Connector	Connector to the SpO2 accessory.
15	IBP Channel 2 Connector	Connector to an IBP input of the patient monitor.
16	Cardiac Output Connector	Connector to the Cardiac input of the patient monitor.
17	IBP Channel 1 Connector	Connector to the IBP input of the patient monitor.
18	Temperature Connector	Connector to the Temperature input of the patient monitor.

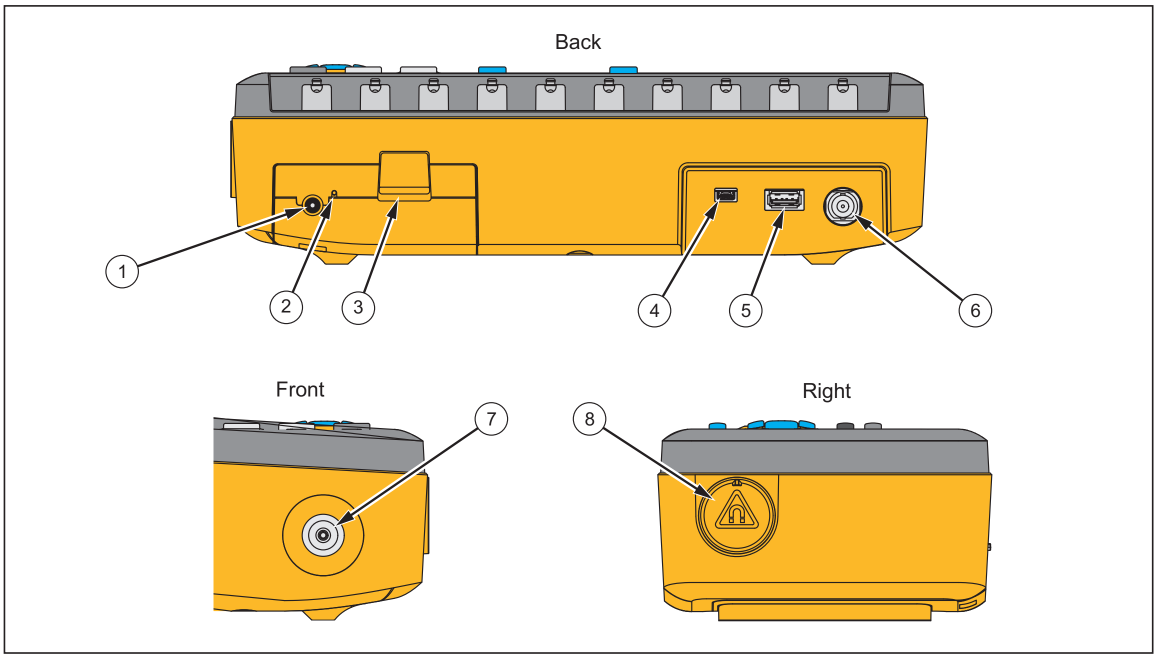

Figure 2. Back, Front, and Side-Panel Connections

Table 6. Back, Front, and Side-Panel Connections

Item	Name	Description
1	AC/DC Supply Connector	Input jack for the DC output of the AC/DC supply connector.
2	Battery Charge LED	Battery charges when LED shows red. Green shows battery charge is complete.
3	Battery Latch	Locks the battery pack into the Product. Push down to remove the battery pack.
4	Mini B USB Device Port	Used to connect to a PC for remote control or download test results data to a PC.
5	USB A Controller Port	For external keyboard, barcode reader, or printer.
6	ECG BNC Connector	High-level output of ECG signal.
7	Air Port Connector	Pressure port for NIBP cuff and monitor.
8	Magnetic Holder for SpO2 Finger Module	Holds the SpO2 Optical Emitter and Detector finger module in two orientations.

How to Turn the Product On

Push ⏻ on the front panel to turn the Product on. The screen shown in Figure 3 shows the power-up screen.

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Figure 3. Power-Up Screen

When the self test is complete and no errors are sensed, the home screen in Figure 4 shows in the display.

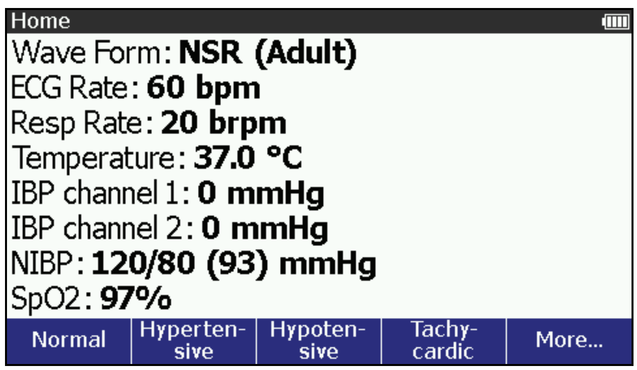

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Figure 4. Home Screen

From the home screen, a number of pre-defined patient simulations can be used to set all the simulation functions at one time. See Pre-Defined Simulations to learn more on how to use simulations. Waveform and ECG rate parameters are set through the ECG function. See the ECG Function section to learn more on how to set these variables. The respiration rate (Resp Rate), temperature parameter, cardiac output, and fetal simulation are set through the special functions menu. The two Invasive Blood Pressure (IBP) channels are set through the IBP function. The Non-Invasive Blood Pressure variables are set through the NIBP function. See the Blood Pressure Simulations and Tests section to learn more on how to set IBP and NIBP variables. The SpO2 variable is set through the SpO2 function. See the Oximeter SpO2 Optical Emitter and Detector section to learn more on how to set this variable.

How to Connect a PC to the Product

You can use a PC to store presets, auto sequences, and test results from the Product. You must use the ProSim Mini Plug-In on the PC to communicate with the Product.

Note

You must have Ansur Test Executive version 2.9.6 on your PC to communicate with the Product.

To connect the Product to a PC:

Connect a USB port on your PC or laptop to the Mini B USB device port of the Simulator.

Or

For the ProSim 8 only, plug in an XStick USB dongle to your PC USB port. See Figure 5.

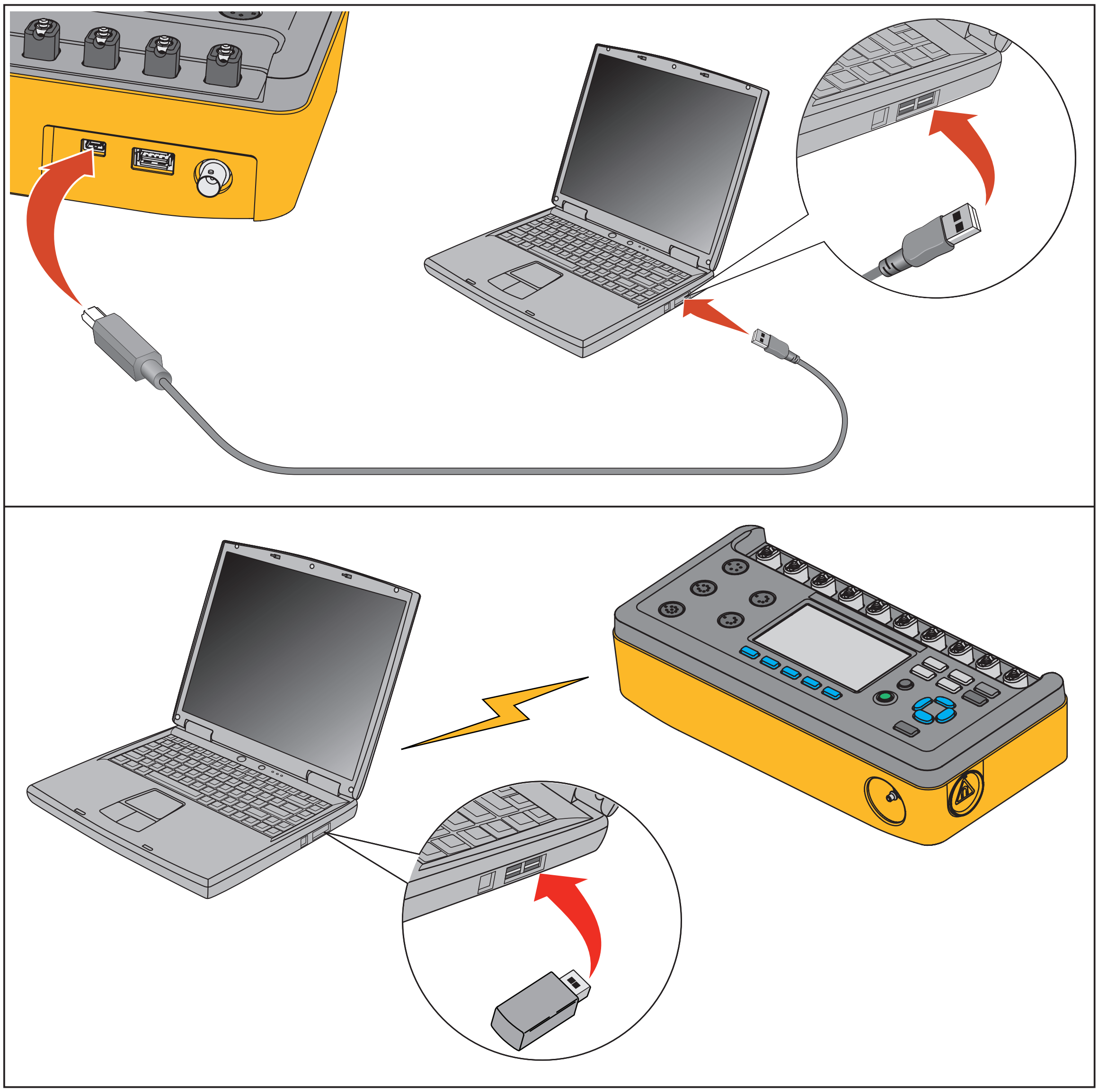

Figure 5. Laptop to PC Connection

Pre-Defined Simulations

The pre-defined simulations are set through the softkeys along the bottom of the home screen. See Figure 4. There are seven factory pre-defined simulations: normal, hypertensive, hypotensive, tachycardic, bradycardic, heart attack, and asystole. A **More** softkey shows in the display for more simulations. Table 7 lists the parameter values for each pre-defined simulation.

Table 7. Pre-Defined Patient Simulations

Simulation Name	Parameter	Pre-Set Value
Normal	Wave Form	NSR (Adult)
	ECG Rate	60 bpm
	Respiration Rate	20 brpm
	Temperature	37.0 °C
	IBP Channel 1	120/80 mmHg (Art)
	IBP Channel 2	28/15 mmHg (PA)
	NIBP	120/80 (93) mmHg
	SpO2	97 %
Hypertensive	Wave Form	NSR (Adult)
	ECG Rate	130 bpm
	Respiration Rate	40 brpm
	Temperature	37.0 °C
	IBP Channel 1	200/150 mmHg (Art)
	IBP Channel 2	45/25 mmHg (PA)
	NIBP	200/150 (166) mmHg
	SpO2	94 %
Hypotensive	Wave Form	NSR (Adult)
	ECG Rate	40 bpm
	Respiration Rate	15 brpm
	Temperature	37.0 °C
	IBP Channel 1	60/30 mmHg (Art)
	IBP Channel 2	15/10 mmHg (PA)
	NIBP	60/30 (40) mmHg
	SpO2	95 %
Tachycardia	Wave Form	NSR (Adult)
	ECG Rate	180 bpm
	Respiration Rate	50 brpm
	Temperature	40.0 °C
	IBP Channel 1	80/50 mmHg (Art)
	IBP Channel 2	25/10 mmHg (PA)
	NIBP	80/50 (60) mmHg
	SpO2	88 %

Table 7. Pre-Defined Patient Simulations (cont.)

Simulation Name	Parameter	Pre-Set Value
Bradycardic	Wave Form	NSR (Adult)
	ECG Rate	30 bpm
	Respiration Rate	15 brpm
	Temperature	35.0 °C
	IBP Channel 1	100/65 mmHg (Art)
	IBP Channel 2	25/10 mmHg (PA)
	NIBP	100/65 (77) mmHg
	SpO2	85%
Ventricular Fibrillition	Wave Form	Atrial Fibrillation (Coarse)
	ECG Rate	No bpm
	Respiration Rate	70 brpm
	Temperature	34.0 °C
	IBP Channel 1	35/15 mmHg (Art)
	IBP Channel 2	35/0 mmHg (LV)
	NIBP	35/15 (22) mmHg
	SpO2	80 %
Asystole	Wave Form	Asystole
	ECG Rate	0 bpm
	Respiration Rate	0 brpm
	Temperature	33.0 °C
	IBP Channel 1	0 mmHg
	IBP Channel 2	0 mmHg
	NIBP	0/0 mmHg
	SpO2	50 %

After you set one of the pre-defined simulations, you can change the parameters of one or all of the vital signs. Changes are not kept in the Product. The pre-defined simulation parameters can not be changed through the front panel.

There are seven custom pre-defined simulations in the Product. To set a custom simulation:

1. From the **Home** screen, push the **More** softkey.
2. Push the **Custom** softkey.

   Four custom simulation names show above the first four softkeys. The names are **Custom1**, **Custom2**, **Custom3**, and **Custom4**. To show the next three names, push the **More** softkey.
3. Push the softkey for a custom pre-defined simulation.

All the vital sign simulation parameters are set to the values contained in the pre-defined simulation.

You can customize the seven factory simulations and seven custom simulations through the Ansur functionality.

ECG Function

The Product simulates normal heart signals (ECG) as well as heart signals for a variety of arrhythmias. Heart rate (beats per minute), signal amplitude, and ST segment elevation are all controlled by the Product through the user interface. Artifacts can also be simulated.

To measure the ECG performance of a monitor, connect the Product to the monitor as shown in Figure 6. A maximum of ten ECG leads can be connected to Product.

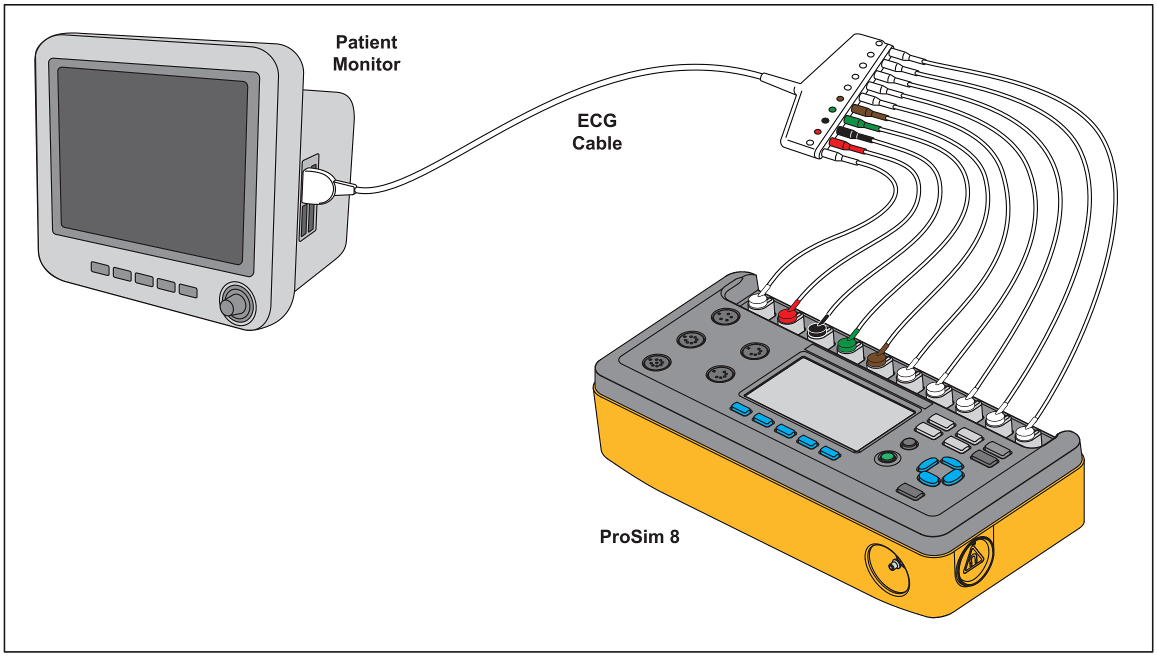

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Figure 6. ECG Connections

How to Set the ECG Parameters

Whenever the Product is turned on, the display shows the defaults for heart rate (60 BPM) with a patient type of Adult. Although not shown on the initial display, the signal amplitude is 1 mV. To set any of the ECG parameters, push ECG. The **ECG** screen shown in Figure 7 shows in the display.

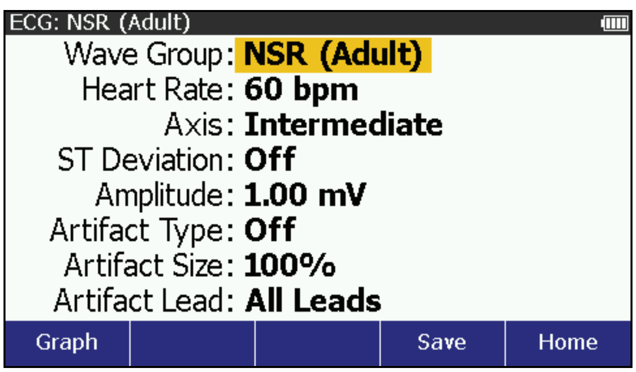

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Figure 7. ECG Screen

To change the ECG waveform:

1. Push ⏶ or ⏷ to move the highlight to the **Wave Group** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to move the highlight to a waveform group name. Table 8 is a list of the wave groups available in the Product.

Table 8. ECG Wave Groups

Wave group	
NSR (Adult)	Adult Normal Sinus Rhythm
NSR (Pediatric)	Child Normal Sinus Rhythm
Performance	Special waveforms for monitor tests. See the ECG Tests section.
R-Wave Detection (ProSim 8 only)	
QRS Detection (ProSim 8 only)	
Tall T Wave Rejection (ProSim 8 only)	
Supraventricular	Arrhythmia waveforms. See the How to Simulate Arrhythmias section.
Premature	
Ventricular	
Conduction	
TV Paced	
ACLS (ProSim 8 only)	

4. When the waveform group value is highlighted, push ENTER.

To change the heart rate:

1. Push ⏶ or ⏷ to move the highlight in the display to the **Heart Rate** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to adjust the heart rate. Each push of a key moves the heart rate one beat in the direction of the key pushed. The ProSim 8 simulates a heart rate of 10 to 360 beats/minute (BPM) set in 1 BPM intervals. The ProSim 6 simulates a heart rate of 30 to 360 beats/minute (BPM) set in 10 BPM intervals.
4. Push ENTER to set the heart rate and go back to the **ECG** screen.

To change the axis:

1. Push ⏶ or ⏷ to move the highlight to the **Axis** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Intermediate**, **Horizontal**, or **Vertical**.
4. Push ENTER.

To set the ST Deviation:

1. Push ⏶ or ⏷ to move the highlight to the ST Deviation value.
2. Push ENTER.

3. Push ⏶ or ⏷ to adjust the deviation. Each push of a key moves the deviation 0.05 or 0.1 mV in the direction of the key pushed. The deviation range is ±0.80 mV

Note

When the ST Deviation value is set to 0.00 mV, the value in **ECG** *screen will show as Off.*

4. Push ENTER to set the deviation and go back to the **ECG** screen.

To set the ECG signal amplitude:

1. Push ⏶ or ⏷ to move the highlight in the display to the **Amplitude** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to adjust the amplitude. Each push of a key increases or decreases the amplitude 0.05 mV between 0.05 and 0.50 mV and 0.25 mV above 0.50 mV to 5.00 mV in the direction of the key pushed.
4. Push ENTER to set the signal amplitude and go back to the **ECG** screen.

Table 9 shows the percentage of the signal amplitude value that is put on each ECG lead.

Table 9. ECG Lead Amplitudes

Waveform	I	II	III	V1	V2	V3	V4	V5	V6
Performance [1]	70 %	100 %	30 %	100 %	100 %	100 %	100 %	100 %	100 %
Normal Sinus	70 %	100 %	30 %	24 %	48 %	100 %	120 %	112 %	80 %
Normal Sinus, Horizontal Axis	100 %	30 %	-70 %	20 %	40 %	70 %	100 %	80 %	50 %
Normal Sinus, Vertical Axis	30 %	130 %	100 %	20 %	30 %	40 %	60 %	80 %	100 %

[1] Includes R-Wave Detection, QRS Detection, and Tall T-Wave Rejection waves.

How to View the ECG Waveform

As you adjust the ECG signal, you can see the signal in the display. To see the ECG signal, from the ECG screen, push the **Graph** softkey. The graph screen in Figure 8 shows in the display.

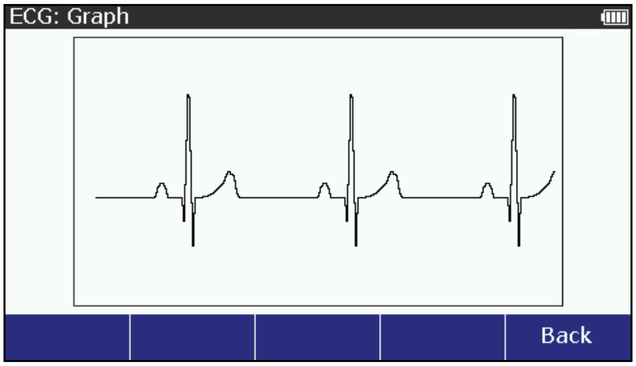

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Figure 8. ECG Graph Screen

The ECG signal is shown in the display in real time.

Push the **Back** softkey to go back to the **ECG** screen.

How to Simulate an ECG Artifact

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

All simulated ECG signals can have an artifact added to the ECG signal. To add an artifact:

1. Push ECG to show the ECG screen in Figure 9 in the display.

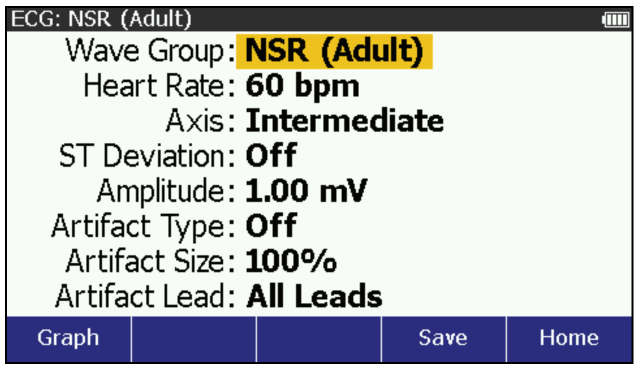

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Figure 9. ECG NSR Adult Screen

2. Push ▲ or ▼ to highlight the **Artifact Type** value.
3. Push ▲ or ▼ to highlight **50 Hz**, **60 Hz**, **Muscular**, **Baseline Wander**, or **Respiration**.
4. Push ENTER to enable the artifact and go back to the **ECG** screen.

To change the size of the artifact:

1. From the ECG screen, push ▲ or ▼ to highlight the **Artifact Size** value.
2. Push ▲ or ▼ to highlight **100%**, **50%**, or **25%**.
3. Push ENTER to set the artifact size and go back to the **ECG** screen.

The artifact signal can be made to one ECG lead or all leads. To change which lead the artifact is on:

1. From the ECG screen, push ▲ or ▼ to highlight the **Artifact Lead** value.
2. Push ▲ or ▼ to highlight **RA**, **LL**, **LA**, **V1 – V6**, or **All Leads** in the lead list.
3. Push ENTER to set the artifact lead and go back to the **ECG** screen.

How to Simulate Arrhythmias

All arrhythmia simulations are grouped into related wave groups. These arrhythmia wave groups are Supraventricular, Premature, Ventricular, Conduction, TV Paced, and ACLS. Table 10 shows all the arrhythmias the Product can simulate and identifies in which wave group they can be found. The table also identifies which model can simulate the arrhythmia.

Table 10. Arrhythmias by Wave Group

Arrhythmia	Wave Group	Available in
Asynchronous 75 BPM	TV Paced	ProSim 6 and 8
Asystole	ACLS, Ventricular	ProSim 6 and 8

Table 10. Arrhythmias by Wave Group (cont.)

Arrhythmia	Wave Group	Available in
Atr-Vent Sequential	TV Paced	ProSim 6 and 8
Atrial Fibrillation	Supraventricular	ProSim 6 and 8
Atrial Flutter	Supraventricular	ProSim 8 only
Atrial PAC	Premature	ProSim 6 and 8
Atrial Tach	Supraventricular	ProSim 8 only
Atrial 80 BPM	TV Paced	ProSim 6 and 8
Bigeminy	Ventricular	ProSim 6 and 8
Bradycardia	ACLS	ProSim 8 only
Demand Freq Sinus	TV Paced	ProSim 6 and 8
Demand Occ Sinus	TV Paced	ProSim 6 and 8
Freq Multi-focal PVCs	Ventricular	ProSim 8 only
Ischemic Chest Pain	ACLS	ProSim 8 only
Lt Bndl Branch Block	Conduction	ProSim 8 only
MIs with LBBB	ACLS	ProSim 8 only
MIs with RBBB	ACLS	ProSim 8 only
Missed Beat at 80 BPM	Supraventricular	ProSim 8 only
Missed Beat at 120 BPM	Supraventricular	ProSim 8 only
Mono V Tach	Ventricular	ProSim 6 and 8
Multi-focal PVCs	Premature	ProSim 6 and 8
Myocardial Infarctions	ACLS	ProSim 8 only
Narrow Complex Tach	ACLS	ProSim 8 only
Nodal PNC	Premature	ProSim 8 only
Nodal Rhythm	Supraventricular	ProSim 8 only
Non-Capture	TV Paced	ProSim 6 and 8
Non-Function	TV Paced	ProSim 6 and 8
Paroxysmal ATach	Supraventricular	ProSim 8 only
Poly V Tach	Ventricular	ProSim 6 and 8
Poly V Tach (unstable)	ACLS	ProSim 8 only
Pulseless Vent Tach	ACLS	ProSim 8 only
Pulseless Elect Tach	ACLS	ProSim 8 only
PVCs	Ventricular	ProSim 8 only
PVC1 Left Vent	Premature	ProSim 8 only
PVC1 LV Early	Premature	ProSim 8 only

Table 10. Arrhythmias by Wave Group (cont.)

Arrhythmia	Wave Group	Available in
PVC1 LV R on T	Premature	ProSim 8 only
PVC2 Right Vent	Premature	ProSim 8 only
PVC2 RV Early	Premature	ProSim 8 only
PVC2 RV R on T	Premature	ProSim 8 only
Rt Bndl Branch Block	Conduction	ProSim 6 and 8
Run of PVCs	Ventricular	ProSim 8 only
Sinus Arrhythmia	Supraventricular	ProSim 6 and 8
Stable Tachycardias	ACLS	ProSim 8 only
Supra VTach	Supraventricular	ProSim 8 only
Trigeminy	Ventricular	ProSim 8 only
Unstable Tachycardias	ACLS	ProSim 8 only
Ventricular Fibrillation	Ventricular	ProSim 6 and 8
Wide Complex Tach	ACLS	ProSim 8 only
1st Deg AV Block	Conduction	ProSim 8 only
2nd Deg AV Block T1	Conduction	ProSim 6 and 8
2nd Deg AV Block T2	Conduction	ProSim 8 only
3rd Deg AV Block	Conduction	ProSim 8 only

Supraventricular Arrhythmias

To set a supraventricular arrhythmia:

1. From the ECG screen, push ⏶ or ⏷ to highlight the **Wave Group** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Supraventricular** in the wave group list.
4. Push ENTER.
5. Push ⏶ or ⏷ to highlight the **Waveform** value.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight a waveform in the list.
8. Push ENTER to set the arrhythmia waveform and go back to the **ECG: Supraventricular** screen.

The amplitude of all supraventricular arrhythmia waveforms can be adjusted. See the How to Set the ECG Parameters section above. ECG signal artifacts can also be added to each arrhythmia signal. See the How to Simulate an ECG Artifact section above.

The atrial fibrillation arrhythmia has one variable not available on the other supraventricular arrhythmias. The type variable can be set to coarse or fine. To change the type variable with the atrial fibrillation waveform set:

1. Push ⏶ or ⏷ to highlight the **Type** value.
2. Push ENTER.

3. Push ⏶ or ⏷ to highlight **Coarse** or **Fine** from the list.
4. Push ENTER to set the arrhythmia type and go back to the **ECG: Supraventricular** screen.

Premature Arrhythmias

The premature wave group arrhythmias simulate premature contraction of muscle at different nodes of the heart. To do a premature arrhythmia:

1. From the ECG screen, push ⏶ or ⏷ to highlight the **Wave Group** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Premature** in the wave group list.
4. Push ENTER.
5. Push ⏶ or ⏷ to highlight the **Waveform** value.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight a waveform in the list.
8. Push ENTER to set the arrhythmia waveform and go back to the **ECG: Supraventricular** screen.

   The amplitude of all premature arrhythmia waveforms can be adjusted. See the How to Set the ECG Parameters section above. ECG signal artifacts can also be added to each arrhythmia signal. See the How to Simulate an ECG Artifact section above.

Ventricular Arrhythmias

Ventricular arrhythmias are arrhythmias in the lower chambers of the heart, or ventricles. To do a ventricular arrhythmia:

1. From the ECG screen, push ⏶ or ⏷ to highlight the **Wave Group** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Ventricular** in the wave group list.
4. Push ENTER.
5. Push ⏶ or ⏷ to highlight the **Waveform** value.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight a waveform in the list.
8. Push ENTER to set the arrhythmia waveform and go back to the **ECG: Ventricular** screen.

The amplitude of all ventricular arrhythmia waveforms can be adjusted. See the How to Set the ECG Parameters section above. ECG signal artifacts can also be added to each arrhythmia signal. See the How to Simulate an ECG Artifact section above.

The ventricular fibrillation and poly V tach arrhythmias have a variable not available on the other ventricular arrhythmias. To change the type variable for the ventricular fibrillation and poly v tach waveform set:

1. Push ⏶ or ⏷ to highlight the **Type** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Coarse** or **Fine** from the list.
4. Push ENTER to set the arrhythmia type and go back to the **ECG: Ventricular** screen.

The mono v tach arrhythmia has a heart rate variable. To change the heart rate:

1. Push ⏶ or ⏷ to highlight the **Heart Rate** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to adjust the heart rate. Each push of a key moves the heart rate one beat in the direction of the key pushed. A heart rate of 120 to 300 beats/minute (BPM) can be set in 5 BPM intervals for this arrhythmia.
4. When the heart rate is set, push ENTER to set the arrhythmia heart rate and go back to the **ECG: Ventricular** screen.

The PVCs arrhythmia has a rate variable to set the number of PVCs in a minute. To change the rate of PVCs:

1. Push ⏶ or ⏷ to highlight the **Rate** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **6/min**, **12/min**, or **24/min** in the list.
4. Push ENTER to set the arrhythmia rate and go back to the **ECG: Ventricular** screen.

The Run of PVCs arrhythmia has a number variable to set the number of PVCs in a run. To change the number of PVCs in a run:

1. Push ⏶ or ⏷ to highlight the **Number** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **2 PVCs**, **5 PVCs**, or **11 PVCs**.
4. Push ENTER to set the arrhythmia number and go back to the **ECG: Ventricular** screen.

Conduction Arrhythmias

Conduction arrhythmias are caused when conduction of electrical impulses are stopped or blocked from their usual pathways around the heart. To simulate a conduction arrhythmia:

1. From the ECG screen, push ⏶ or ⏷ to highlight the Wave Group value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Conduction** in the wave group list.
4. Push ENTER.
5. Push ⏶ or ⏷ to highlight the **Waveform** value.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight a waveform in the list.
8. Push ENTER to set the arrhythmia waveform and go back to the **ECG: Conduction** screen.

The amplitude of all conduction arrhythmia waveforms can be adjusted. See the How to Set the ECG Parameters section above. ECG signal artifacts can also be added to each arrhythmia signal. See the How to Simulate an ECG Artifact section above.

Pacemaker Waveforms

The Product can simulate ECG waveforms with a number of artificial-pacemaker conditions. Table 11 shows the simulations in the waveform list of the Product with a description of each.

Table 11. Pacemaker Waveforms

Pacemaker Waveform Label	Waveform Description
Atrial 80 bpm	Atrial pacemaker wave at 80 BPM, with a pacer pulse at the start of each P wave.
Asynchronous 75 bpm	Asynchronous pacemaker wave with continuous ventricular-paced beats (75 BPM) and no P waves
Demand Freq Sinus	A "demand" pacemaker wave with frequent sinus beats (forty normal beats followed by twenty ventricular-paced beats, repeated)
Demand Occ Sinus	A "demand" pacemaker wave with occasional sinus beats (twenty normal beats followed by forty ventricular-paced beats, repeated)
Atr-Vent Sequential	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
Non-Capture	Ventricular-paced beats, where one out of ten beats has no heart response.
Non-Function	Continuous pacer pulses at 75 BPM with no heart response.

To select a pacemaker waveform simulation:

1. From the ECG screen, push ⏶ or ⏷ to highlight the **Wave Group** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **TV Paced** in the wave group list.
4. Push ENTER.
5. Push ⏶ or ⏷ to highlight the **Waveform** value.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight a waveform in the list.
8. Push ENTER to set the arrhythmia waveform and go back to the **ECG: TV Paced** screen.

The amplitude of all TV Paced waveforms can be adjusted. See the How to Set the ECG Parameters section above. ECG signal artifacts can also be added to each arrhythmia signal. See the How to Simulate an ECG Artifact section above.

TV-Paced waveforms include the applicable pacer pulses. The pacer pulses can be changed through the front panel. All but the Atrial 80 bpm waveform have ventricle pacemaker variables that can be changed. The Atrial 80 bpm has an atrial pacemaker value. The Atr-Vent Sequential waveform has an atrial pacemaker value and a ventricle pacemaker value. To change the pacemaker values push the **Atrial Settings** or **Vent. Settings** softkey.

You can change the amplitude, width, and polarity of the pacemaker signal. To change the amplitude:

1. Push ⏶ or ⏷ to highlight the **Amplitude** value.

2. Push ENTER.
3. Push ⏶ or ⏷ to highlight an amplitude value in the list. Below is a list of the pacemaker amplitude values.

0 mV	16 mV
2 mV	18 mV
4 mV	20 mV
6 mV	50 mV
8 mV	100 mV
10 mV	200 mV
12 mV	500 mV
14 mV	700 mV

4. Push ENTER to set the amplitude and go back to the **TV Paced Settings** screen.

To change the width value:

1. Push ⏶ or ⏷ to highlight the **Width** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **0.1**, **0.2**, **0.5**, **1.0**, **1.5**, or **2.0** mV in the list.
4. Push ENTER to set the width and go back to the **TV Paced Settings** screen.

To change the polarity:

1. Push ⏶ or ⏷ to highlight the **Polarity** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **+** or **-** in the list.
4. Push ENTER to set the polarity and go back to the **TV Paced Settings** screen.

Push the **Back** softkey to go back to the **ECG: TV Paced** screen.

Advance Cardiac Life Support (ACLS) Waveforms (ProSim 8 only)

The Product can simulate Advanced Cardiac Life Support (ACLS) waveforms.

To simulate an ACLS waveform:

1. From the ECG screen, push ⏶ or ⏷ to highlight the **Wave Group** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **ACLS** in the wave group list.
4. Push ENTER.
5. Push ⏶ or ⏷ to highlight the **Waveform** value.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight a waveform in the list.
8. Push ENTER to set the waveform and go back to the **ECG: ACLS** screen.

The amplitude of all ACLS waveforms can be adjusted. See the How to Set the ECG Parameters section above. ECG signal artifacts can also be added to each arrhythmia signal. See the How to Simulate an ECG Artifact section above.

ECG Performance Tests

As well as physiological waveforms, the Product can supply signals to measure the performance of an ECG monitor. A set of performance waveforms are used to measure the frequency response (high and low), sensitivity, gain drift, internal calibration, stylus damping, paper speed, linearity, and sweep speed of an ECG monitor. Three more Product functions are used to measure R wave detection, QRS detection, and tall T wave rejection of an ECG monitor.

How to Set a Performance Wave

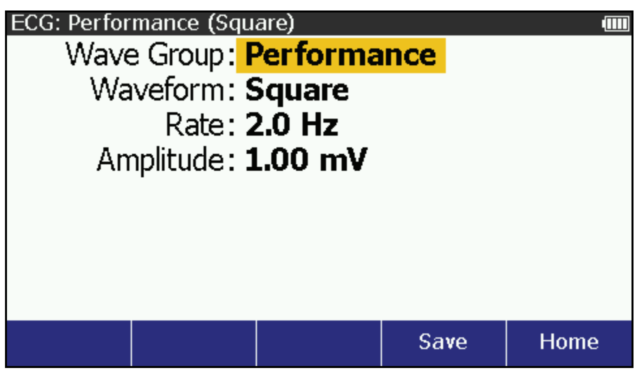
The waveforms in the performance wave group are sine, square, triangle, and pulse.

Note

When a performance wave is set on the Product, outputs for respiration, blood pressure, and temperature are disabled.

The four waveforms used for ECG performance tests are, sine, square, pulse, and triangle. The rate and amplitude of these waveforms are adjustable to preconfigured values. To output a performance wave:

1. Push ECG to show the ECG screen in the display.
2. Push ▲ or ▼ to highlight the **Wave Group** value.
3. Push ENTER.
4. Push ▲ or ▼ to highlight the **Performance** value in the wave group list.
5. Push ENTER to show the **ECG: Performance** screen in Figure 10 in the display.



glh019.bmp

Figure 10. Performance Wave Screen

To change the waveform:

1. Push ▲ or ▼ to highlight the **Waveform** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight **Square**, **Sine**, **Triangle**, or **Pulse** in the list.
4. Push ENTER to set the performance waveform and go back to the **ECG: Performance** screen.

All waveforms have the same two variables: Rate and Amplitude.

To change the rate:

1. Push ▲ or ▼ to highlight the **Rate** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight a value in the rate list. Table 12 lists the rates for each type of wave.

Table 12. Performance Wave Rates

Performance Wave	Rates
Square and Triangle	0.125, 2.0, and 2.5 Hz
Sine	0.05, 0.5, 1, 2, 5, 10, 25, 30, 40, 50, 60, 100, and 150 Hz
Pulse	30 and 60 bpm

4. Push ENTER to set the rate and go back to the **ECG: Performance** screen.

To change the amplitude:

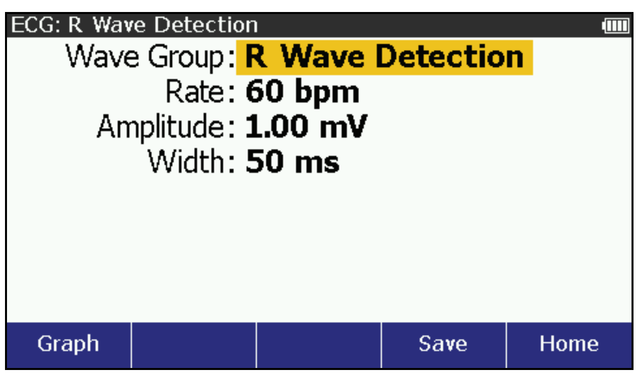
1. Push ▲ or ▼ to highlight the **Amplitude** value.
2. Push ENTER.
3. Push ▲ or ▼ to adjust the amplitude. Each push of a key increases or decreases the amplitude 0.05 mV between 0.05 and 1.00 mV and 0.25 mV above 1 mV to 5.00 mV in the direction of the key pushed.
4. Push ENTER to set the rate and go back to the **ECG: Performance** screen.

How to Set R Wave Detection Values (ProSim 8 only)

To sense a heartbeat, a monitor looks for R waves. The sensed R wave is used to calculate heart rate and other analysis. You adjust the R wave to find the range of values a heart monitor can sense a heart beat. The R wave is a simple triangular pulse.

To output a signal for an R Wave detection test:

1. Push ECG to show the ECG screen in the display.
2. Push ▲ or ▼ to highlight the **Wave Group** value.
3. Push ENTER.
4. Push ▲ or ▼ to highlight the **R Wave Detection** value in the wave group list.
5. Push ENTER to show the **ECG: R Wave Detection** screen in Figure 11 in the display.



glh020.bmp

Figure 11. R-Wave Detection Screen

The rate, amplitude, and width of the R wave can be changed. To change the rate:

1. Push ▲ or ▼ to highlight the **Rate** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight **30**, **60**, **90**, **120**, **200**, or **250 bpm** in the list.

4. Push **ENTER** to set the rate and go back to the **ECG: R Wave Detection screen**.

To change the R wave amplitude:

1. Push ▲ or ▼ to highlight the **Amplitude** value.
2. Push **ENTER**.
3. Push ▲ or ▼ to adjust the amplitude. Each push of a key increases or decreases the amplitude in the direction of the key pushed. The Product simulates a heart signal amplitude of 0.05 to 0.25 mV by 0.05 mV intervals and 0.05 to 5.00 mV that is set in 0.25 mV intervals.
4. When the amplitude is set, push **ENTER** to enter the value and go back to the **R Wave Detection** screen.

To change the width of the R Wave:

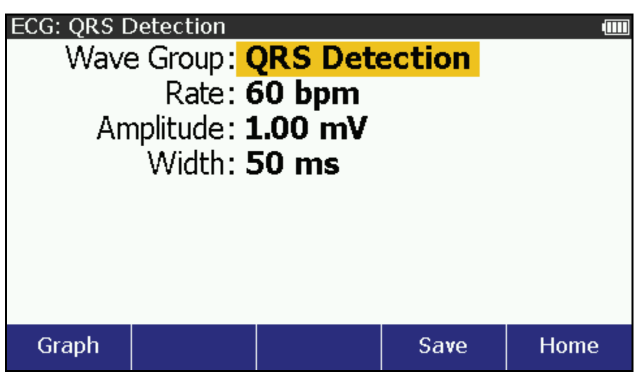
1. Push ▲ or ▼ to highlight the **Width** value.
2. Push **ENTER**.
3. Push ▲ or ▼ to adjust the width. Each push of a key increases or decreases the width 20 ms for each key push when the value is 20 ms or above and 2 ms when the value is 20 ms or less. The Product simulates an R Wave width of 8 to 200 ms.
4. When the amplitude is set, push **ENTER** to enter the value and go back to the **R Wave Detection** screen.

How to Set QRS Detection Test Values (ProSim 8 only)

The QRS Detection wave group supplies a signal that you can adjust the width of the QT interval. This QRS Detection wave includes the R and S waves with relative amplitudes as specified in EC-13. The R wave is 0.875 of the waveform amplitude and the S wave is negative at 0.125 of the waveform amplitude. The R wave up slope is 0.4375 of the waveform width. The R wave down slope is 0.5 of the waveform width. The S wave up slope is 0.0625 of the waveform width.

To generate a signal for an QRS detection test:

1. Push **ECG** to show the ECG screen in the display.
2. Push ▲ or ▼ to highlight the **Wave Group** value.
3. Push **ENTER**.
4. Push ▲ or ▼ to highlight the **QRS Detection** value in the wave group list.
5. Push **ENTER** to show the **ECG: QRS Detection** screen in Figure 12 in the display.



glh021.bmp

Figure 12. QRS Detection Screen

The rate, amplitude, and width of the QRS wave can be changed.

To change the rate:

1. Push ▲ or ▼ to highlight the **Rate** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight **30**, **60**, **90**, **120**, **200**, or **250 bpm** in the list.
4. Push ENTER to set the rate and go back to the **ECG: QRS Detection** screen.

To change the QRS Wave amplitude:

1. Push ▲ or ▼ to highlight the **Amplitude** value.
2. Push ENTER.
3. Push ▲ or ▼ to adjust the amplitude. Each push of a key increases or decreases the amplitude in the direction of the key pushed. The Product simulates a heart signal amplitude of 0.05 to 0.25 mV by 0.05 mV intervals and 0.50 to 5.00 mV that is set in 0.25 mV intervals.
4. Push ENTER to set the amplitude and go back to the **ECG: QRS Detection** screen.

To change the width of the QT interval:

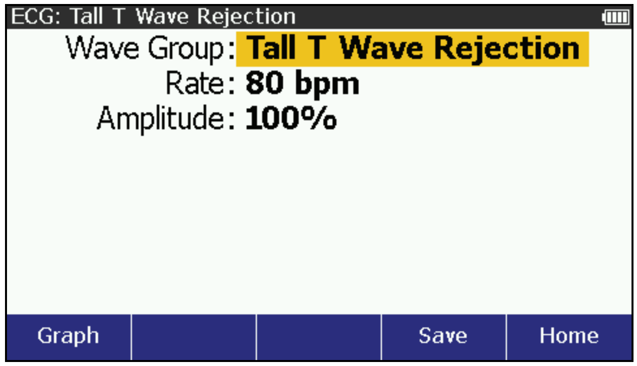
1. Push ▲ or ▼ to highlight the **Width** value.

5. Push ENTER.
6. Push ▲ or ▼ to adjust the width. Each push of a key increases or decreases the width 10 ms for each key push when the value is 20 ms or above and 2 ms when the value is 20 ms or less. The Product simulates a QT width of 8 to 200 ms.
7. When the width is set, push ENTER to enter the value and go back to the **ECG: QRS Detection** screen.

How to Set Tall T Wave Rejection Test Values (ProSim 8 only)

An ECG monitor must sense and reject a large T wave when it calculates the heart rate. Use the Tall T Wave Rejection waveform for this test. This wave includes the QRS wave per EC-13 with a 100 ms width and QT interval of 350 ms. The T wave has a sinusoidal shape, 180 ms wide, and can be adjusted in amplitude to 0 to 150 % of the overall waveform amplitude. The rate is set at 80 bpm. To output a tall T wave signal:

1. Push ECG to show the ECG screen in the display.
2. Push ▲ or ▼ to highlight the **Wave Group** value.
3. Push ENTER.
4. Push ▲ or ▼ to highlight the **Tall T Wave Rejection** value in the wave group list.
5. Push ENTER to show the **ECG: Tall T Wave Rejection** in Figure 13 in the display.



glh022.bmp

Figure 13. Tall T Wave Rejection Screen

The amplitude of the T Wave can be changed. To change the amplitude:

1. Push ▲ or ▼ to highlight the **Amplitude** value.
2. Push ENTER.
3. Push ▲ or ▼ to increase or decrease the T Wave amplitude. The amplitude is set as a percentage of the voltage on the reference lead. The range is 0 to 150 % in 10 % steps.
4. Push ENTER to enter the value and go back to the **ECG: Tall T Wave Rejection** screen.

Fetal Simulation (ProSim 8 only)

The Product simulates a mixed fetal and maternal electrocardiogram (ECG) that occurs during labor, as well as a selection of pressure waveforms made by uterine contractions. The contraction period can be changed. There is also a manual contraction.

Note

The maternal heart rate is always a normal sinus rhythm at 80 beats/minute.

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

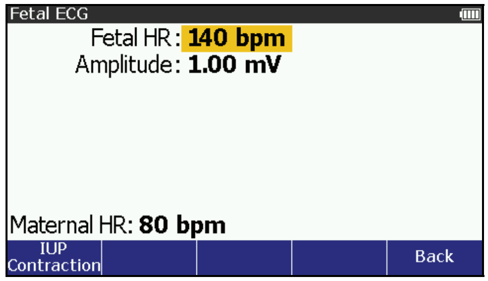
- Variable decelerations
- Sinusoidal pattern
- Reactive tracing
- Variations in FHR variability
- Tachysystole

How to Set Fetal Heart Values

The Product simulates the fetal/maternal ECG on its regular ECG leads. The maternal signal is a P-QRS-T wave at half the set ECG amplitude. The fetal signal is a narrow R wave at full amplitude. Fetal and maternal signals are summed to make a composite signal.

To do a fetal simulation:

1. Push SPECIAL FUNC..
2. Push ▲, ▼, ▶, or ◀ to highlight **Fetal Simulation** and then push ENTER to show the **Fetal ECG** screen in the display. See Figure 14.



glh025.bmp

Figure 14. Fetal ECG Screen

Push the softkey labeled **Back** to go back to the **Special Functions** screen.

To change the fetal heart rate:

1. Push ▲ or ▼ to highlight the **Fetal HR** value.
2. Push **ENTER**.
3. Push ▲ or ▼ to change the heart rate value in 1 bpm steps between 60 and 240 bpm.

Note

When you hold down the direction key, the step size will change to 10 bpm until the key is released.

4. Push **ENTER** to set the heart rate and go back to the **Fetal ECG** screen.

To change the amplitude of the fetal waveform:

1. Push ▲ or ▼ to highlight the **Amplitude** value.
2. Push ▲ or ▼ to adjust the amplitude. Each push of a key increases or decreases the amplitude in the direction of the key pushed. The Product simulates a fetal heart signal amplitude of 0.05 to 0.25 mV by 0.05 mV intervals and 0.50 to 5.00 mV that is set in 0.25 mV intervals.
3. Push **ENTER** to set the amplitude and go back to the **Fetal ECG** screen.

How to Simulate Intrauterine Pressure (IUP)

The simulated intrauterine-pressure (IUP) waveform shows a measurement read by an intra-amniotic catheter connected to a pressure transducer. The Product simulates the IUP on IBP channel 1, with a 5 or 40 µV/V/mmHg sensitivity (as has been setup for blood pressure).

The Product sends waveforms to simulate intrauterine pressure during a contraction of the uterus in childbirth. Each IUP wave goes for 90 seconds with a bellshaped pressure curve that increases from zero to 90 mmHg and goes back to zero. In an IUP-wave simulation, the fetal heart rate (which always begins at 140 BPM, regardless of the fetal ECG rate.) changes with the blood pressure. The fetal heart rate and blood pressure shows in the display.

The IUP period is adjustable to four preconfigured values: a manually started contraction, and contractions that start at 2, 3, or 5 minute intervals.

To do an Intrauterine pressure simulation, connect the fetal monitor to the Product as shown in Figure 15.

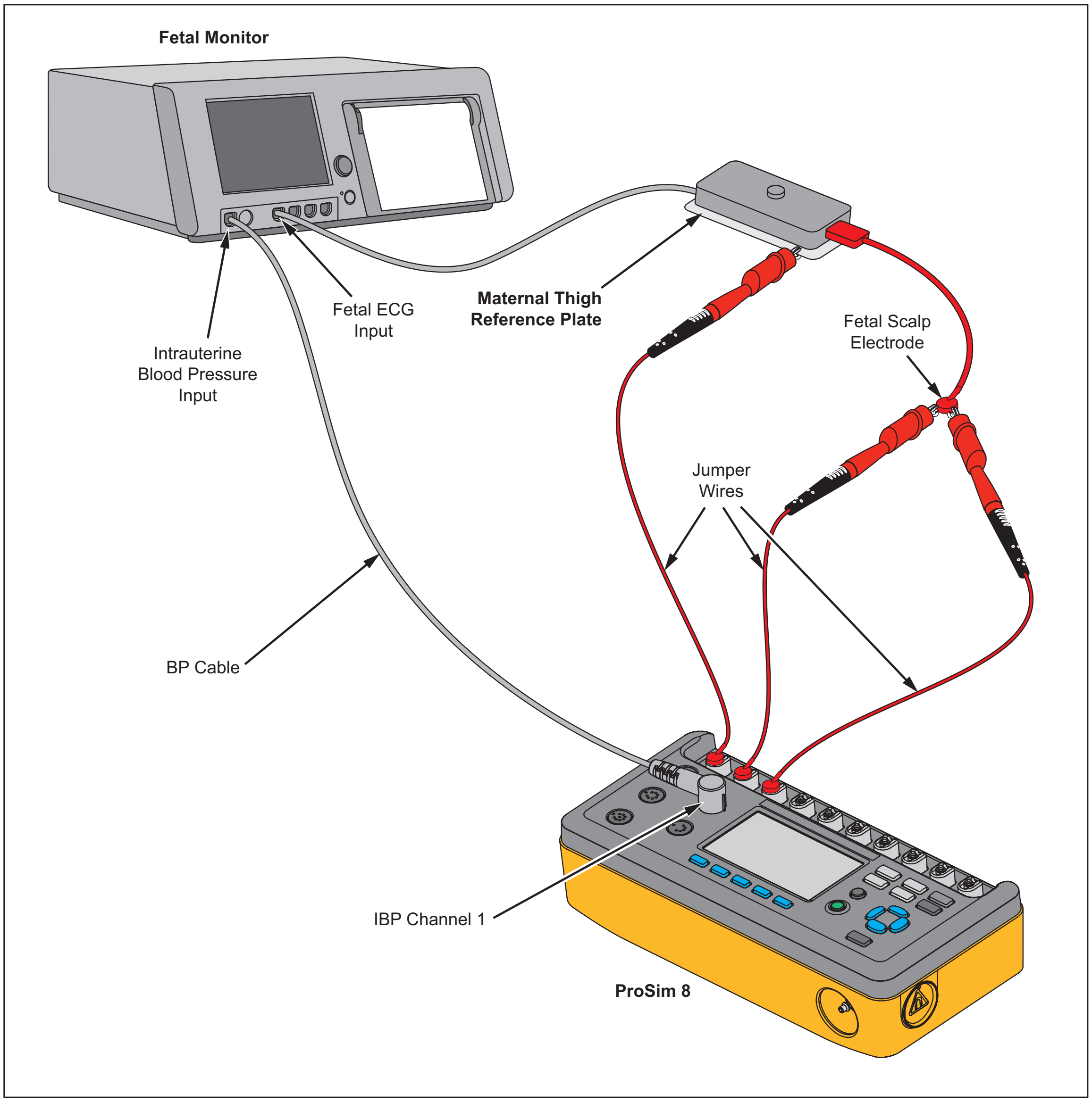
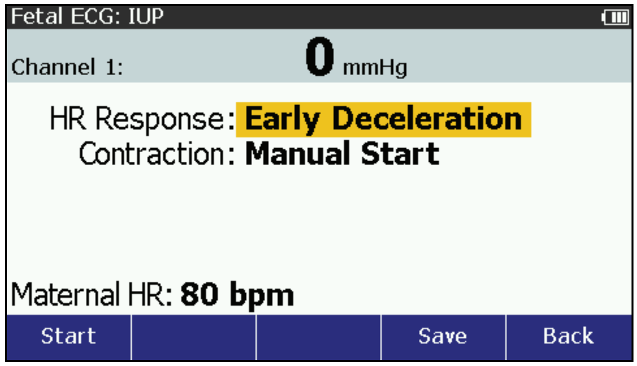


Figure 15. Fetal Monitor Connections for Intrauterine Pressure Simulation

Note

The maternal thigh reference plate is an accessory provided by fetal monitor OEM, not by Fluke Biomedical, for internal FHR and FECG recording. The 3-lead leg plate employs a single skin electrode as a reference, positioned on the mother's thigh.

To simulate intrauterine pressure contractions push the **IUP Contraction** softkey to show the Fetal ECG: IUP screen in the display. See Figure 16.



glh026.bmp

Figure 16. Intrauterine Pressure Contractions Screen

How to Set the Fetal Heart Rate Response

The Product simulates three types of preconfigured waveforms for a periodic fetal heart rate 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). The fetal heart rate starts at 140 BPM, slows to 100 BPM at intrauterine-pressure peak, and then goes back to 140 BPM as the IUP falls back to zero.

With late deceleration, the change in fetal heart rate starts when IUP pressure is at its peak and lags the change in intrauterine pressure by 45 seconds. The fetal heart rate starts at 140 BPM, slows to 100 BPM, and then goes back to 140 BPM.

With acceleration, the change in fetal heart rate lags the change in intrauterine pressure by 30 seconds. The fetal heart rate starts at 140 BPM, increases to 175 BPM, and then goes back 140 BPM.

To set the fetal heart rate response:

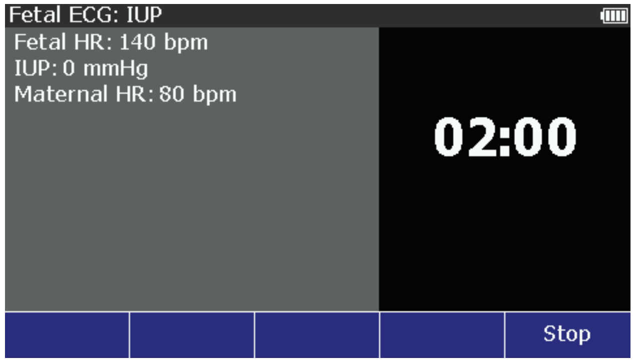
1. Push ⏶ or ⏷ to highlight the **HR Response** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Early Deceleration**, **Late Deceleration**, or **Acceleration**.
4. Push ENTER to set the response value and go back to the **Fetal ECG: IUP** screen.

How to Set the Intrauterine Contraction Simulation

The IUP (Intrauterine Pressure) period is adjustable to four preconfigured values. These are contractions that start manually or at 2, 3, or 5 minute intervals.

To set the contractions:

1. Push ⏶ or ⏷ to highlight the **Contraction** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Manual Start**, **2**, **3**, or **5 minutes**.
4. Push ENTER to set the contraction value and go back to the **Fetal ECG: IUP** screen.
5. To start a contraction, push the **Start** softkey. The screen below shows in the display and updates with real-time simulation data. The time until the contraction ends is also shown in the display. See Figure 17.



glh027.bmp

Figure 17. Fetal ECG Intrauterine Pressure Screen

If the contraction value is set to **Manual Start**, only one contraction cycle is simulated.

The timer shows the time until the contraction ends and the subsequent contraction starts.

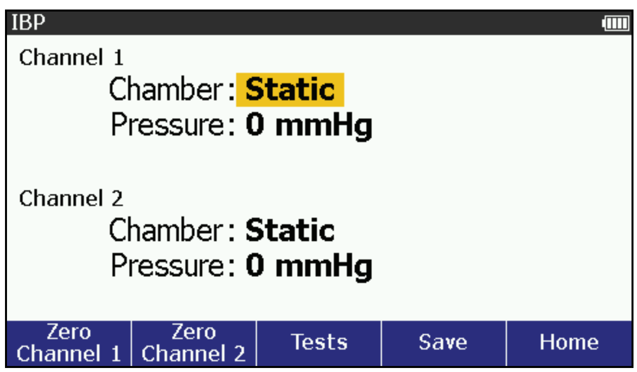
Push the **Stop** softkey to stop contractions and go back to the **Fetal ECG: IUP** screen.

Invasive Blood Pressure Simulation and Tests

The Product simulates blood pressure for Invasive blood pressure monitors. Each blood pressure variable can be set through the front-panel controls. The Product also simulations Swan-Ganz and cardiac catheterization procedures.

How to Set the Invasive Blood Pressure Variables

The Product can simulate two invasive blood pressure transducers at one time. The blood pressure variables are set separately for each channel. To set these variables, push IBP to show the IBP screen in Figure 18 in the display.



glh009.bmp

Figure 18. Invasive Blood Pressure Screen

To set the chamber:

1. Push ▲ or ▼ to highlight the **Chamber** value on channel 1 or channel 2.
2. Push ENTER.
3. Push ▲ or ▼ to highlight a value in the chamber list. Below is a list of chamber values in the Product.

Static	Right Ventricle
Arterial	Pulmonary Artery
Radial Artery	PA Wedge
Left Ventricle	Right Atrium (CVP)
Left Atrium	

4. Push ENTER to set the chamber and go back to the **IBP** screen.

You must first zero the patient monitor when you connect to a new IBP transducer or patient simulator. To set a channel to 0 mmHg and Static chamber, push the **Zero Channel 1** or **Zero Channel 2** softkey. After you zero the product, do the zero function on the patient monitor.

To set the pressure:

1. Push ⏶ or ⏷ to highlight the **Pressure** value on channel 1 or channel 2.
2. Push ENTER.

   Systolic and diastolic pressures are set separately.

Note

If the chamber is set to static, only one pressure is set.

3. Push ⏴ or ⏵ to highlight the systolic or diastolic pressure value.
4. Push ⏶ or ⏷ to increase or decrease the pressure value in 1 mmHg steps. The range is -10 to +300 mmHg.

Note

When you hold down the direction key, the step size will change to 10 mmHg until the key is released.

5. Push ENTER to set the pressure and go back to the **IBP** screen.

When the Chamber parameter is set to a value other than Static, the artifact parameter is added to the display as shown in Figure 19.

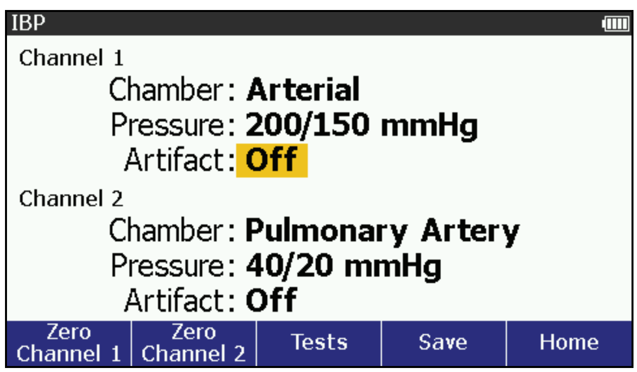


Figure 19. IBP with Chambers Screen

To set the artifact:

Note

Artifact value is not available when the chamber value is set to static.

1. Push ⏶ or ⏷ to highlight the **Artifact** value on channel 1 or channel 2.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **5%** or **10%** if the chamber parameter is set to Arterial, Radial Artery, or Left Ventricle. Highlight **5 mmHg** or **10 mmHg** for all other chamber values. Highlight **Off** to turn off the artifact function

Note

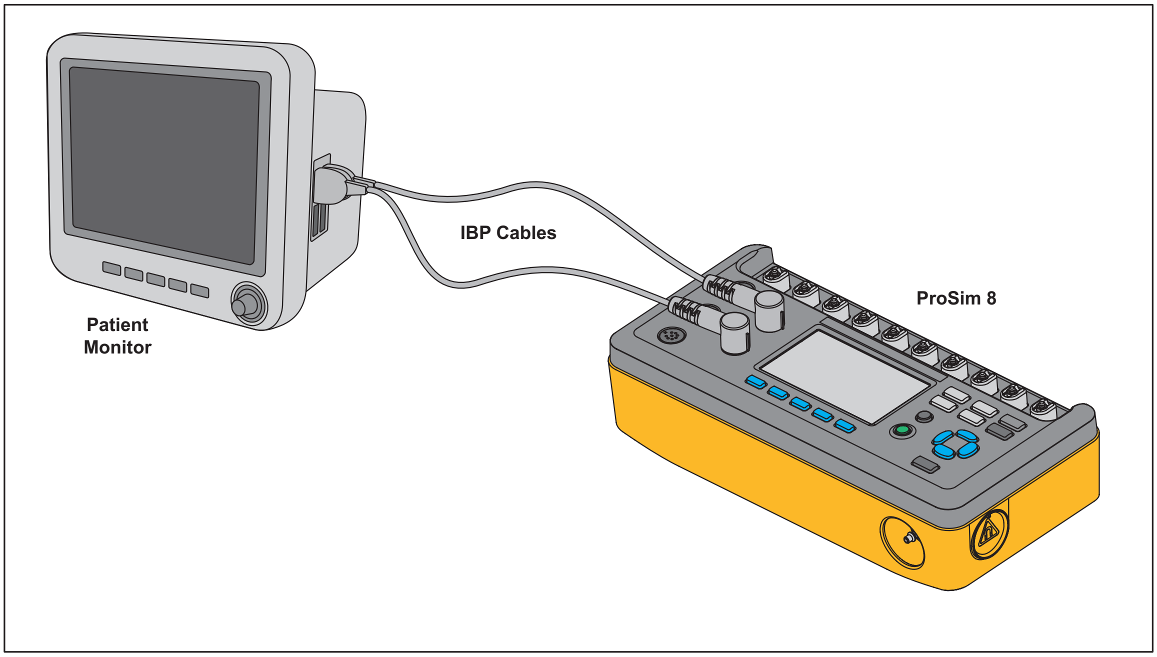
The artifact values in the list can be in percent (%) or in mmHg. These units are set by the chamber value.

4. Push ENTER to set the artifact value and go back to the **IBP** screen.

The IBP screen reappears in the display with the new artifact selection.

How to Simulate Invasive Blood Pressure Tests

The Product can simulate pressures that occur during a Swan-Ganz or Cardiac Catheterization procedure. Figure 20 shows a monitor connected to the two IBP channel jacks on the Product.



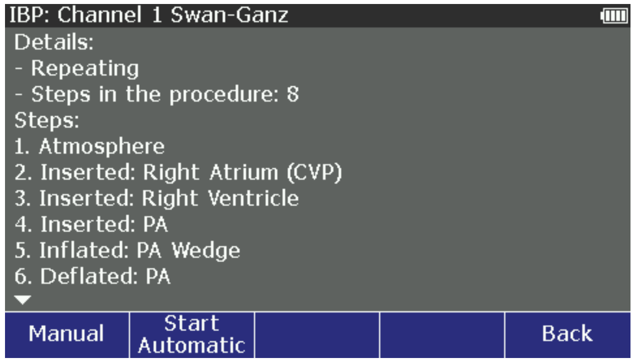
glh028.eps

Figure 20. Invasive Blood Pressure Connections

How to Simulate a Swan-Ganz Procedure

To simulate IBP during a Swan-Ganz procedure:

1. Push the **Tests** softkey in the IBP screen.
2. Push ⏶ or ⏷ to highlight **Swan-Ganz – Channel 1** or **Swan-Ganz – Channel 2**.
3. Push ENTER. The details and steps in the procedure shown in Figure 21 are shown in the display.



glh012.bmp

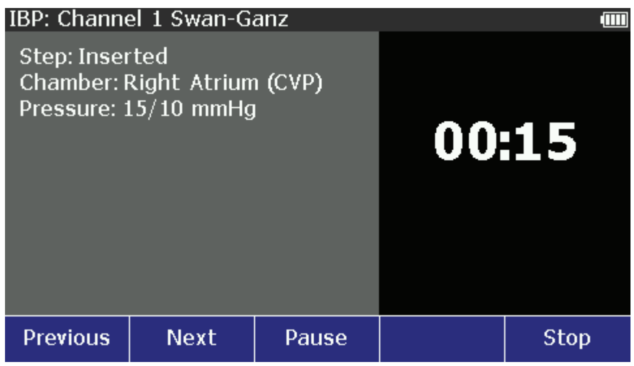
Figure 21. Initial Swan-Ganz Procedure Simulation Screen

You can do the Swan-Ganz procedure manually or automatically.

To step through the procedure manually, push the **Manual** softkey. Each procedure step is shown in the display. To move to the subsequent step push the **Next** softkey.

After the first step, you push the **Previous** softkey to go back a step. You stop the procedure when you push the **Stop** softkey.

To do the steps automatically, push the **Start Automatic** softkey. The display in Figure 22 shows the Inserted (Right Atrium) step for the Swan-Ganz procedure.



glh014.bmp

Figure 22. Insert Step in Swan-Ganz Procedure Simulation

There is a 15 second period between steps. The remaining time for each step shows in the right part of the display. You can push the **Pause** softkey to stop the countdown to the subsequent step while the Product continues the patient simulation for that step. **Continue** replaces **Pause** when the procedure step is paused. Push **Continue** to continue the step.

You can go back a step when you push the **Previous** softkey. The Product simulates that step for a full 15 seconds before it does the subsequent step. When you push the **Previous** softkey while paused, the Product goes back a step, but stays paused and sets the time to 15 seconds.

When you push the **Stop** softkey, the procedure simulation is stopped and the initial test screen shown in Figure 21 shows in the display.

How to Simulate a Cardiac Catheterization Procedure (ProSim 8 only)

Note

The Cardiac Catheterization procedure is only available in the ProSim 8.

The Product simulates blood pressure measurements on both sides of a heart valve. The pressure difference, or gradient across the valve is used to determine heart valve condition.

To simulate a Cardiac Catheterization procedure:

1. Push the **Tests** softkey in the **IBP** screen.
2. Push ▲ or ▼ to highlight **Cardiac Catheterization**.
3. Push ENTER. The valve selection is shown in the display.

To change the valve value:

1. Push ENTER.
2. Push ▲ or ▼ to highlight **Aortic**, **Pulmonary**, or **Mitral**.
3. Push ENTER to go back to the **IBP: Cardiac Catheterization** screen.

To start the procedure simulation:

1. Push the **Start** softkey.

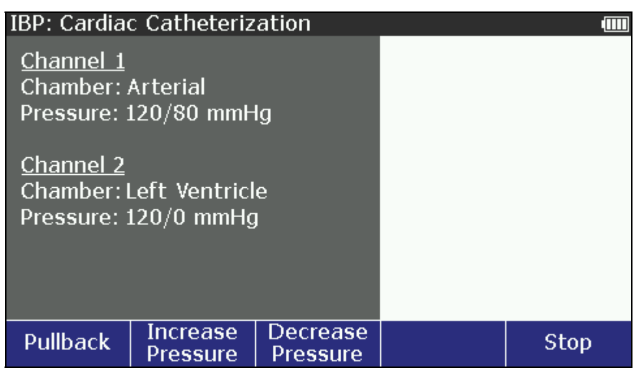
   All the procedure steps are done manually.
2. Push the **Insert** softkey for the next step.
3. You simulate an increase and decrease of simulated pressure when you push the **Increase Pressure** or **Decrease Pressure** softkeys.
4. Push the **Pullback** softkey to simulate the pressures when the catheter is pulled back.

Push the **Stop** softkey to stop the procedure and go back to the **IBP: Cardiac Catheterization** screen.

Aortic Valve Catheterization Simulation

The aortic valve controls flow from the left ventricle (LV) to the aorta (atrial pressure) and prevents flow in the reverse direction. Both IBP channels are set the Arterial 120/80. IBP channel 1 stays at arterial 120/80 for reference throughout the simulation.

1. Push the **Insert** softkey to simulate the insertion of IBP channel 2 catheter into the left ventricle at 120/0. Figure 23 shows the screen for the aortic valve catheterization simulation.



glh054.bmp

Figure 23. Aortic Valve Catheterization Simulation Screen

For a normal valve, when the heart beat starts, the LV pressure increases to 80 mmHg. Then, as the valve opens, both pressures increase to the systolic peak. Next, the pressures fall until the valve opens. The LV pressure goes back down, but the arterial stays at 80 mmHg.

2. Push the **Increase Pressure** or **Decrease Pressure** to simulate a bad aortic valve. There are six pressure values between 120 and 180 mmHg. Each push of the increase softkey sets the left ventricle pressure to 126 (+5 %), 132 (+10 %), 138

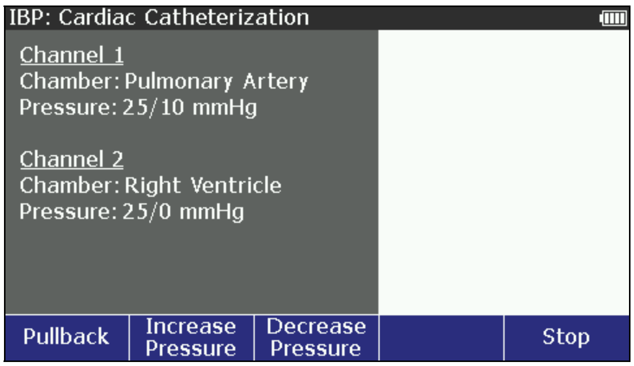
(+15 %), 144 (+20 %), and 180 (+50 %). Each push of the decrease softkey sets the pressure down from 180 to 120 mmHg with the same pressure steps.

3. Push the **Pullback** softkey to simulate the pull back of the IBP channel 2 catheter to the left ventricle.

Pulmonary Valve Catheterization Simulation

The pulmonary valve controls flow from the right ventricle (RV) to the pulmonary artery (PA) and prevents flow in the reverse direction. Both IBP channels are set to PA 25/10. IBP channel 1 stays at PA 25/10 for reference throughout the simulation.

1. Push the **Insert** softkey to simulate the insertion of the IBP channel 2 catheter into the right ventricle at 25/0.



glh055.bmp

Figure 24. Pulmonary Valve Catheterization Simulation Screen

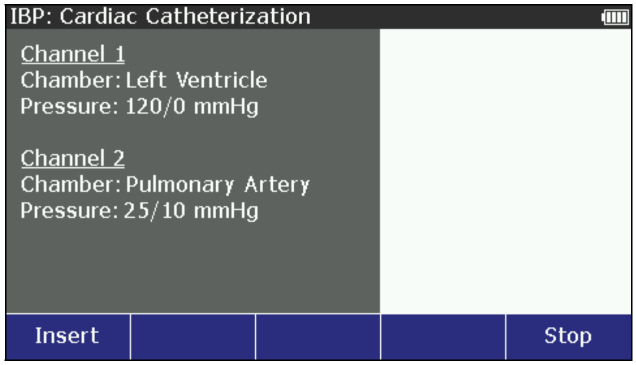
For a normal valve, when the heart beat starts, the RV pressure increases to 10 mmHg. Then, as the valve opens, both pressures increase to the systolic peak. Next, the pressures fall until the valve opens. The RV pressure goes back down, but the pulmonary artery stays at 10 mmHg.

2. Push the **Increase Pressure** or **Decrease Pressure** to simulate a bad pulmonary valve. There are six pressure values between 25 and 38 mmHg. Each push of the increase softkey sets the left ventricle pressure to 26 (+5 %), 28 (+10 %), 29 (+15 %), 30 (+20 %), and 38 (+50 %). Each push of the decrease softkey sets the pressure down from 38 to 25 mmHg with the same pressure steps.
3. Push the **Pullback** softkey to simulate the pull back of the IBP channel 2 catheter to the right ventricle.

Mitral Valve Cahteterization Simulation

The mitral valve controls flow from the left atrium (LA) to the left ventricle (LV) and prevents flow in the reverse direction. A mitral valve test is done indirectly with pressure measurements in the pulmonary artery (PA). There are two measurements: normal and wedged. A wedged measurement is done with a inflated ballon (PAW) in the pulmonary artery to measure the back pressure from the left ventricle through the left atrium and the lungs. At the start of the procedure, IBP channel 1 is set to LV 120/0 and channel 2 is set to pulmonary artery (PA) 25/10/. IBP channel 1 stays at LV 120/0 for reference throughout the simulation.

1. Push the **Insert** softkey to simulate a change in IBP channel 2 catheter pressure to the pulmonary artery wedge pressure (PAW) of 10/2.



glh056.bmp

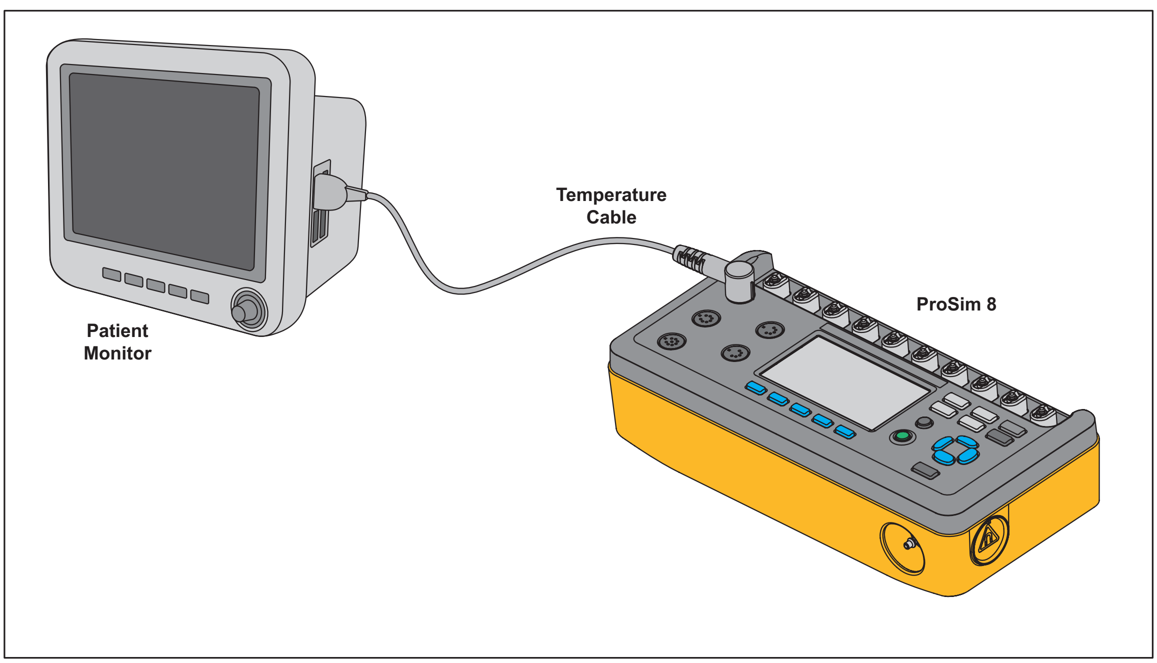
Figure 25. Mitral Valve Catheterization Simulation Screen

For a normal valve, the PAW pressure stays low because there is little back pressure from the left ventricle through the left atrium and the lungs.

2. Push the **Increase Pressure** or **Decrease Pressure** to simulate a bad mitral valve. There are six pressure values between 10/2 and 36/24 mmHg. Each push of the increase softkey sets the left ventricle pressure to 26/18, 29/19, 31/21, 34/22, and 36/24. Each push of the decrease softkey sets the pressure down from 36/24 to 10/2 mmHg with the same pressure steps.
3. Push the **Pullback** softkey to simulate the pulmonary artery wedge (PAW) balloon deflation. This changes IBP channel 2 back to the pulmonary artery.

How to Simulate Temperature

Temperatures simulated by the Product are compatible with Yellow Springs, Inc. (YSI) Series 400 and 700 probes. The type of cable connected to the temperature jack sets the type of temperature probe simulated. Connect the temperature input of the UUT to the Temperature jack as shown in Figure 26.



glh038.eps

Figure 26. Temperature Simulation Connection

To set the simulated temperature:

1. Push SPECIAL FUNC..
2. Push ▲, ▼, ►, or ◄ to highlight the **Temperature** selection then push ENTER to show the set temperature in the display.
3. Push ENTER.
4. Push ▲ or ▼ to change the temperature in 0.5 °C steps between 30.0 and 42.0 °C.

Note

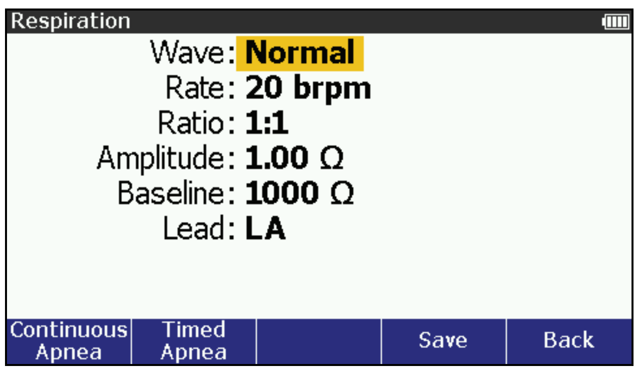
When you hold down the direction key, the step size will change to 1.0 °C until the key is released.

5. Push ENTER to set the temperature and go back to the **Temperature** screen.

How to Simulate Respiration

Respiration variables are set through the special functions. To set respiration:

1. Push SPECIAL FUNC..
2. Push ▲, ▼, ◄, or ► to highlight **Respiration**.
3. Push ENTER. The Respiration screen in Figure 27, shows in the display.



glh013.bmp

Figure 27. Respiration Screen

You can choose between a normal or ventilated respiration waveform and change the respiration rate. The respiration signal can be set to the left arm (LA) or left leg (LL) ECG lead. The baseline impedance between the leads and the amplitude of impedance variation (respiration amplitude) are set though the front panel as well. To set respiration between normal and ventilated:

1. Push ▲ or ▼ to highlight the **Wave** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight **Normal** or **Ventilated**.
4. Push ENTER to set the wave and go back to the **Respiration** screen.

To set the respiration rate:

1. Push ▲ or ▼ to highlight the **Rate** value.
2. Push ENTER.
3. Push ▲ or ▼ to increase or decrease the rate of respiration in 1 brpm steps between 10 and 150 brpm.
4. Push ENTER to set the respiration rate and go back to the **Respiration** screen.

To set the respiration ratio:

1. Push ⏶ or ⏷ to highlight the **Ratio** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **1:1**, **1:2**, **1:3**, **1:4**, or **1:5**.
4. Push ENTER to set the respiration ratio and go back to the **Respiration** screen.

To set the respiration amplitude:

1. Push ⏶ or ⏷ to highlight the **Amplitude** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to change the amplitude in 0.05 Ω steps between 0.00 and 5.00 Ω.
4. Push ENTER to set the amplitude and go back to the **Respiration** screen.

To set the baseline resistance:

1. Push ⏶ or ⏷ to highlight the **Baseline** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **500**, **1000**, **1500**, or **2000** Ω in the list.
4. Push ENTER to set the baseline impedance and go back to the **Respiration** screen. The baseline impedance is kept in memory and is non-volatile.

Note

Baseline value is kept in memory and is non-volatile.

To set the respiration lead:

1. Push ⏶ or ⏷ to highlight the **Respiration** lead.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **LA** or **LL** in the list.
4. Push ENTER to set the respiration lead and go back to the **Respiration** screen. The respiration lead is kept in memory and is non-volatile.

Note

Respiration lead value is kept in memory and is non-volatile.

How to Set Apnea Simulation

You can simulate an apnea period manually or for a specified time period. To control an apnea period manually, push the **Continuous Apnea** softkey from the respiration screen. The display shows a timer which shows the time since the apnea period started. The respiration simulation is stopped when the **Stop** softkey is pushed.

To do a timed apnea period:

1. Push the **Timed Apnea** softkey from the respiration screen.
2. Push ⏶ or ⏷ to highlight **12**, **22**, or **32 seconds**.
3. Push ENTER.

The display shows a timer that counts down the apnea period. When the timer counts down to zero, the apnea period ends and the display shows the respiration screen. Push the Stop softkey to abort the apnea function.

How to Simulate Cardiac Output

The Cardiac Output function electronically simulates the dynamic temperature changes in the blood of the patient during a thermal dilution cardiac output measurement.

Thermal dilution cardiac output measurements are given by the heat interchange between the blood of the patient and a known volume of chilled saline put into the heart. Cardiac output is expressed in liters per minute (L/min) and ranges between 3 L/min and 7 L/min in normal adults.

Current cardiac output measurement devices can make sure you get the most accurate measurements. This includes an average of a series of measurements to prevent variations because of artifacts. This rejects measurements because of clinician technique or the underlying cardiovascular disease in a patient.

Note

Cardiac output measurement devices that use different techniques (such as Fick dye injection, Doppler ultrasonography and bioimpedance) are not addressed or intended for this Product.

To simulate cardiac output, a CI-3 module/jack is necessary and connects to the cardiac output jack of the Product. This module has connections for the cardiac output measurement under test and simulates the injectate temperature (IT) thermistors at 0 °C or 24 °C. Of the two connectors on the CI-3 module/cable, the smaller 3-pin connector is for catheter blood temperature (BT) and is standard on most monitors.

Note

This 3-pin catheter BT connector is compatible with the standard Baxter (Edwards) BT catheter and equivalent catheters available from other manufacturers such as Viggo-SpectraMed and Abbott (Sorenson).

The larger 4-pin connector supplies the simulated injectate temperature. The 10-turn 100 kΩ potentiometer enables adjustment of the injectate temperature to 0 or 24 °C.

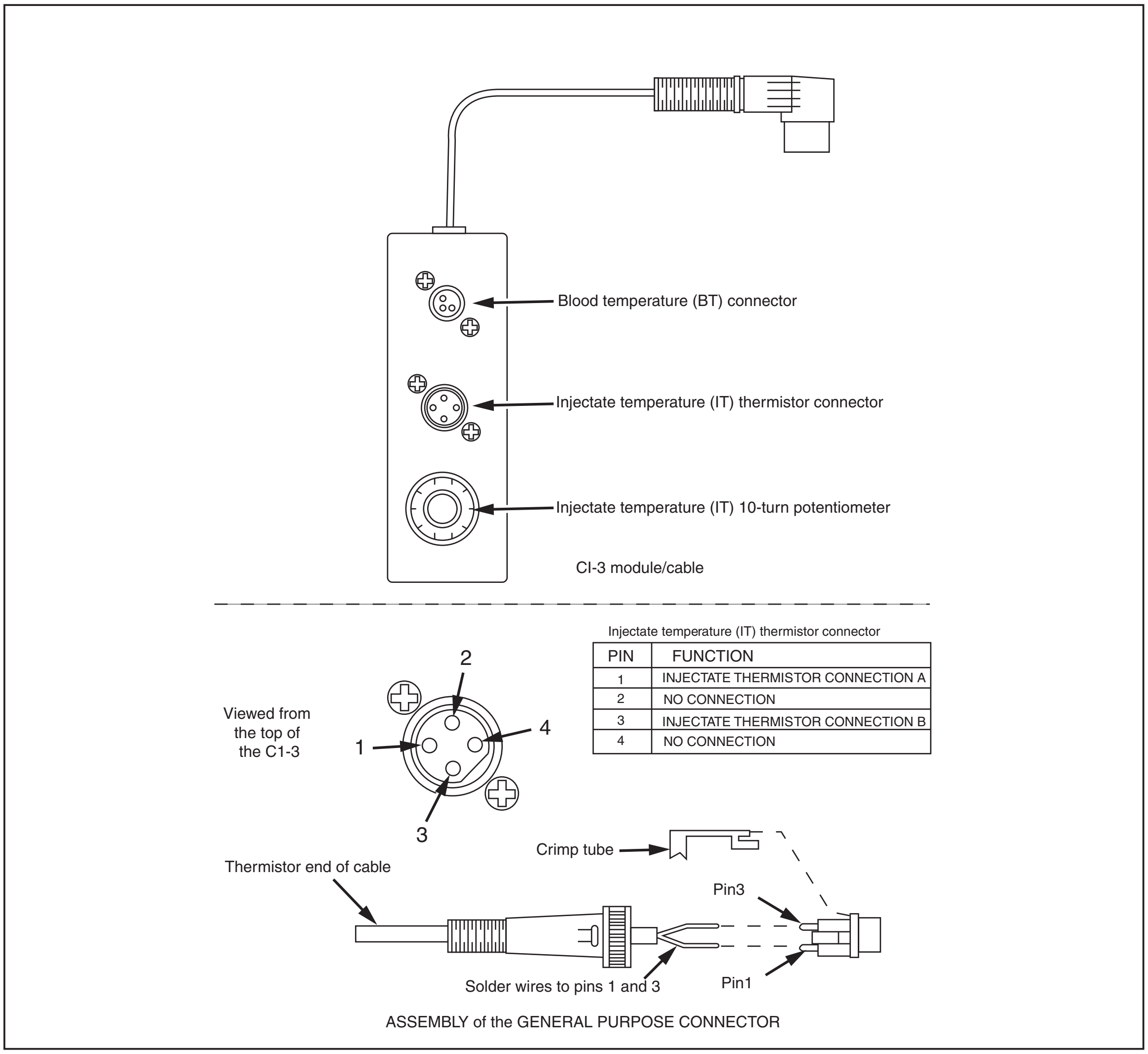
Although this 100 kΩ range of resistance has proven adequate to simulate the 0 or 24 °C temperature for most brands of cardiac output measurement devices, the 4-pin IT thermistors connector is not standard on all monitors. A general function connector that you can connect to the device under test (DUT) injectate cable is also supplied.

Figure 28 shows the general-purpose connector assembly. Note that the injectate temperature thermistor has to be cut off the EUT cable to install the general-purpose connector.

Note

A DUT cardiac output cable changed for this test must not be used in a clinical application.

If the DUT cardiac output cable includes an interconnection (or plug-in) for the injectate temperature bath probe assembly, change the plug-in cable only.



Injectate temperature (IT) thermistor connector

PIN	FUNCTION
1	INJECTATE THERMISTOR CONNECTION A
2	NO CONNECTION
3	INJECTATE THERMISTOR CONNECTION B
4	NO CONNECTION

eic224.eps

Figure 28. Cardiac Output Injectate Cable Modification

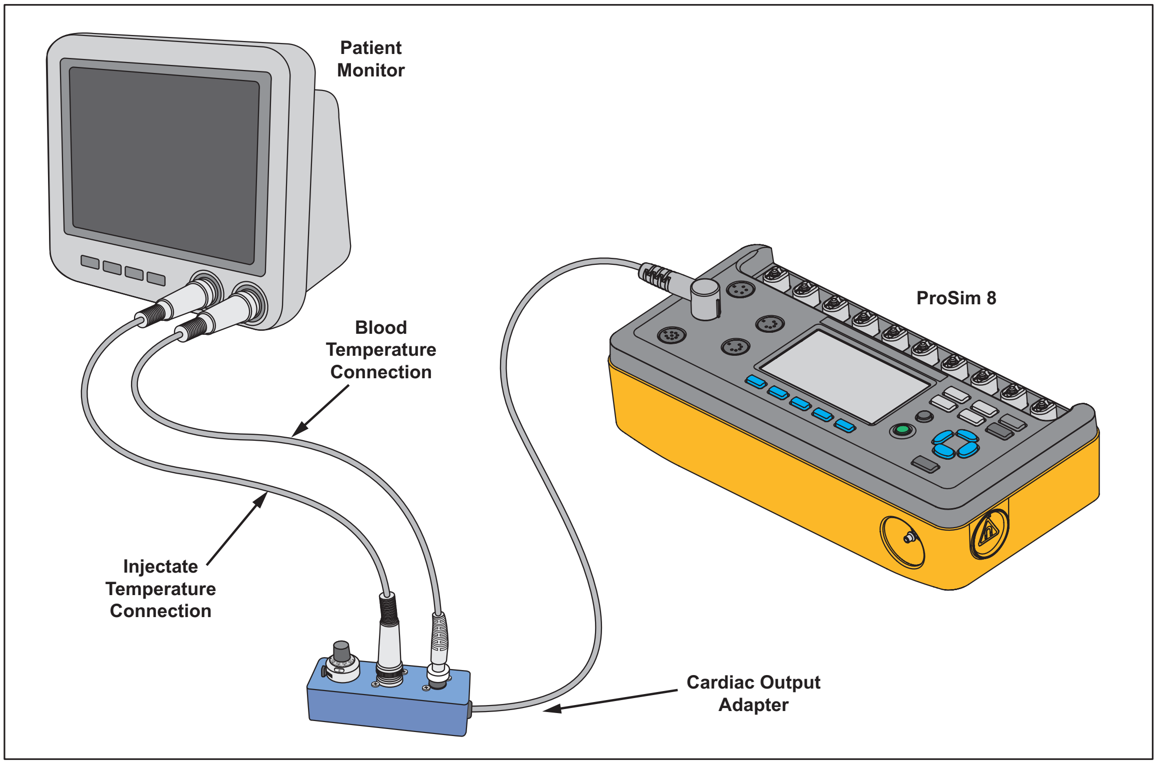
Note

Fluke Biomedical offers optional adapter cables to connect the Product to specified brands of cardiac output measurement devices.

- *To examine Hewlett Packard Merlin systems, a cardiac output adapter and a temperature adapter are necessary.*
- *A special adapter is necessary for Gould/SpectraMed Models SP1445 and SP1465 cardiac output devices.*

Contact Fluke Biomedical for availability, price, and part number.

For cardiac output simulation, use the supplied CI-3 module/cable to connect the Product to the DUT. (see Figure 29). If necessary, use the general-purpose connector.



glh057.eps

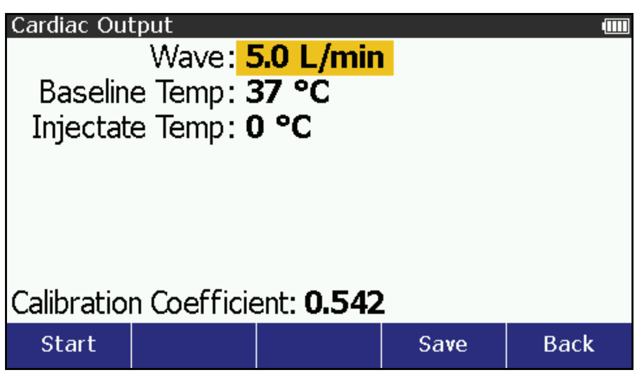
Figure 29. Cardiac Output Connections

Setup the DUT for the simulated parameters that follow:

- Catheter Size: 7 F
- Injectate Volume: 10 cc
- Computational Constant: 0.542 or 0.595, based on the injectate temperature.

To set the Product for a cardiac output test:

1. Push SPECIAL FUNC..
2. Push ⏶, ⏷, ⏵, or ⏴ to highlight **Cardiac Output** and then push ENTER to show the cardiac output parameters in the display. See Figure 30.



glh017.bmp

Figure 30. Cardiac Output Screen

Push the softkey labeled **Back** to go back to the **Special Functions** screen,

How to Set the Cardiac Output Waveform

To set the cardiac output waveform:

1. In the **Cardiac Output** screen, use ⏶ or ⏷ to highlight the wave parameter.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight a waveform name in the list of waveforms.

Table 13 shows the cardiac output waveforms for the Product.

Table 13. Cardiac Output Waveforms

Waveform	Description
2.5 L/min	Normal waveform with accuracy of 2.5 L/min
5.0 L/min	Normal waveform with accuracy of 5.0 L/min
10.0 L/min	Normal waveform with accuracy of 10.0 L/min
Interrupted Injectable	Interrupted injection waveform
LR Shunt	Left to right ventricular shunt
Calibrated Pulse	Calibrated square wave pulse

4. Push ENTER to set the wave and go back to the **Cardiac Output** screen.

How to Set the Baseline Temperature

To set the baseline temperature:

1. In the cardiac output screen, if not already highlighted, use ⏶ or ⏷ to highlight the baseline temperature value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **36 °C**, **37 °C**, or **38 °C**.
4. Push ENTER to set the baseline temperature and go back to the **Cardiac Output** screen.

How to Set Injectate Temperature

To set the injectate temperature:

1. In the cardiac output screen, use ⏶ or ⏷ to highlight the injectate temperature value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **0 °C** or **24 °C**.
4. Push ENTER to set the temperature and go back to the **Cardiac Output** screen.

As you change the injectate temperature, the calibration coefficient necessary for the monitor is shown in the display.

How to Start a Cardiac Output Simulation

After you set the parameters for a cardiac output simulation, push the **Start** softkey. The simulation completes automatically. To stop the simulation, push the **Stop** softkey.

Non-Invasive Blood Pressure Simulation and Tests

The Product simulates blood pressure for Non-Invasive blood pressure monitors. Each blood pressure variable can be set through the front-panel controls. The Product also does leak, pressure source, and pressure relief tests. The manometer function sets the Product to measure static pressure and shows the pressure in the display.

How to Set the Non-Invasive Blood Pressure Variables

For non-invasive blood pressure tests, connect the Product to the BP cuff and monitor as shown in Figure 31.

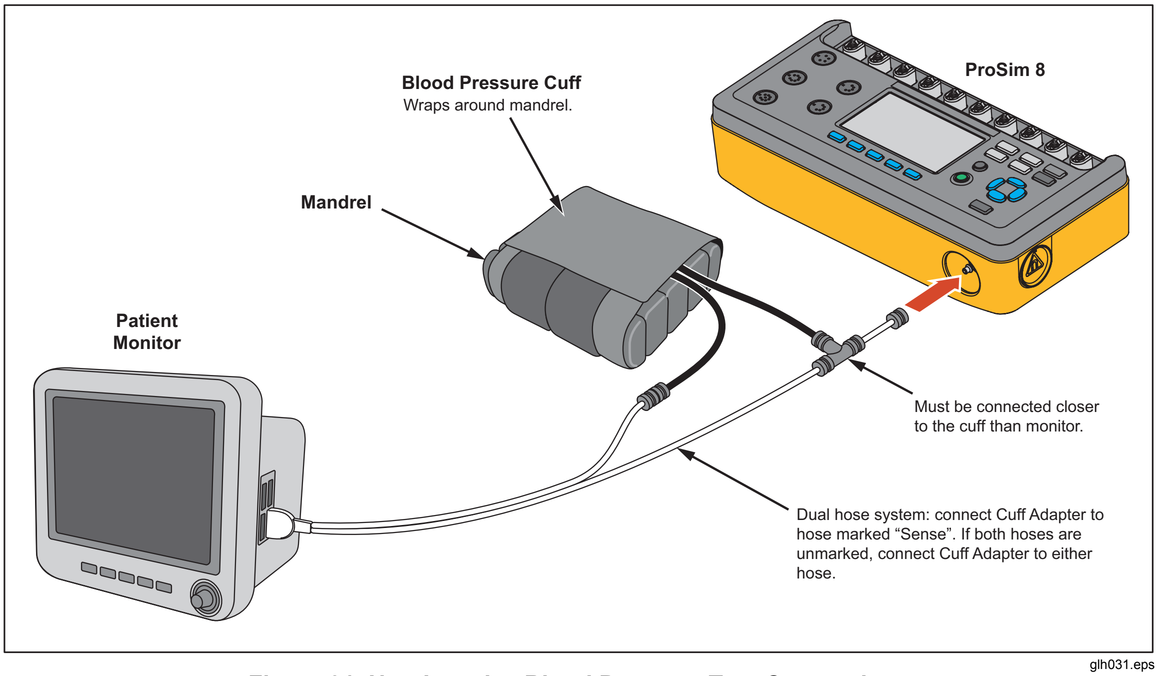


Figure 31. Non-Invasive Blood Pressure Test Connections

There are two blood pressure cuff mandrels that are used with the Product: Adult and Neonatal. Figure 32 shows the parts of an adult mandrel and how to assemble it for different sizes.

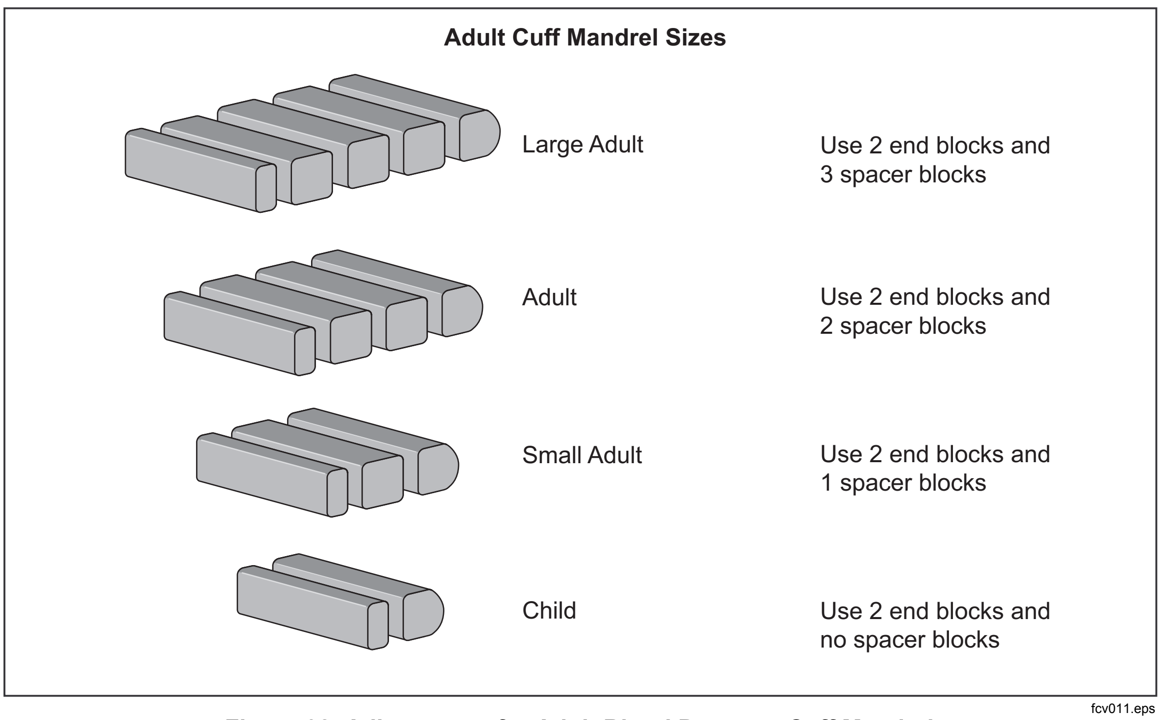


Figure 32. Adjustments for Adult Blood Pressure Cuff Mandrel

Figure 33 shows the neonatal blood pressure cuff mandrel.

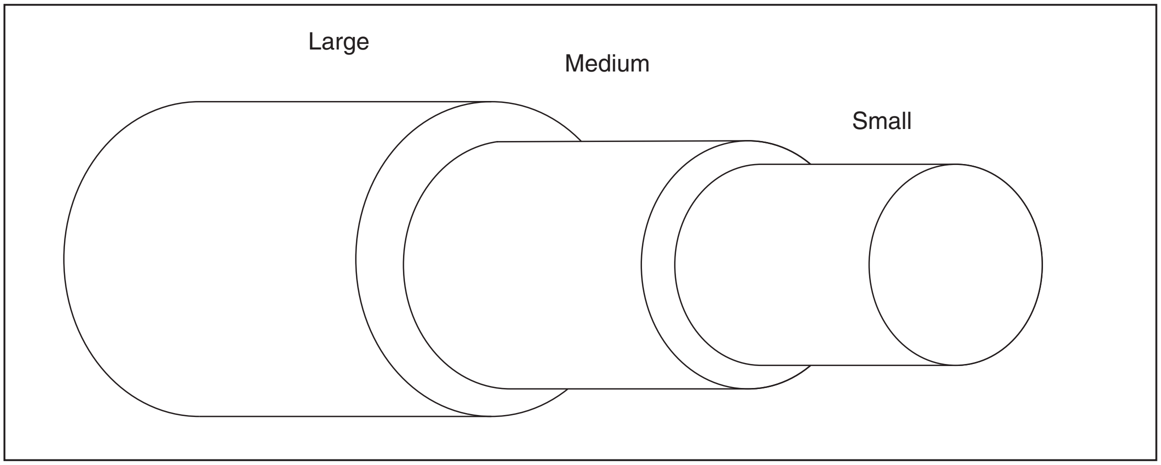


Figure 33. Neonatal Blood Pressure Cuff Mandrel

To set the blood pressure simulation, push NIBP to show the **NIBP** screen in Figure 34 in the display.

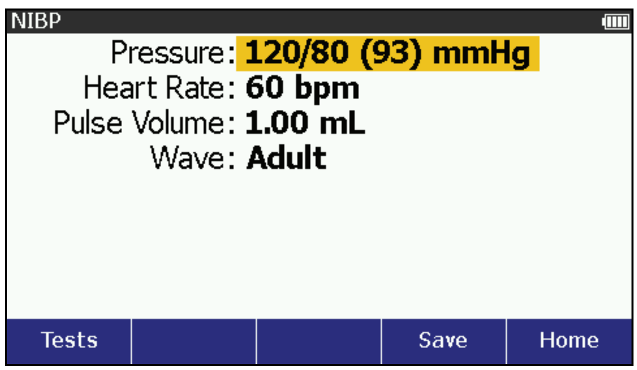


Figure 34. Non-Invasive Blood Pressure Screen

Pressure, heart rate, pulse volume, brand, and wave are set through the front-panel controls to simulate different patient conditions. Arrhythmia waveforms are also simulated in the NIBP simulation (set through ECG). To set the Blood Pressure:

1. Push ⏶ or ⏷ to highlight the **Pressure** variable.
2. Push ENTER.

   Systolic and diastolic pressures are set separately.
3. Push ⏴ or ⏵ to highlight the systolic or diastolic pressure value.
4. Push ⏶ or ⏷ to increase or decrease the pressure value in 1 mmHg steps.

Note

When you hold down the direction key, the step size will change to 10 mmHg until the key is released.

5. Push ENTER to set the pressure and go back to the **NIBP** screen.

Note

Heart Rate may not be shown in the NIBP screen if an arrhythmia or performance waveform is set.

To set the heart rate:

1. Push ⏶ or ⏷ to highlight the **Heart Rate** variable.
2. Push ENTER.
3. Push ⏶ or ⏷ to increase or decrease the heart rate in 1 bpm steps. The range is 30 to 240 bpm.

Note

When you hold down the direction key, the step size will change to 10 bpm until the key is released.

4. Push ENTER to set the heart rate and go back to the **NIBP** screen.

Note

***Arrhythmia** may show in the display instead of **Heart Rate** when an arrhythmia or performance waveform is set under the ECG function. The Mono VTach waveform is the one exception. You can only change the heart beat to normal sinus rhythm in the NIBP screen.*

To set the heart beat waveform to normal sinus rhythm:

1. Push ⏶ or ⏷ to highlight the **Arrhythmia** variable.
2. Push ENTER.
3. Push ⏶ or ⏷ to increase or decrease the heart rate.
4. Push ENTER to set the heart rate and go back to the **NIBP** screen.

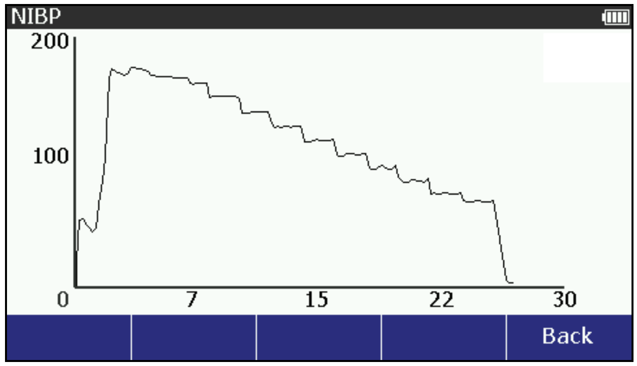
To set the pulse volume:

1. Push ⏶ or ⏷ to highlight the **Pulse Volume** variable.
2. Push ENTER.
3. Push ⏶ or ⏷ to increase or decrease the pulse volume in 0.05 mL steps. The pulse volume range is 0.10 to 1.25 mL.
4. Push ENTER to set the pulse volume and go back to the **NIBP** screen.

You can set the wave variable to Adult or Neonatal simulation. When set, the pulse volume is set to the default for that simulation: 1.0 ml for Adult, 0.5 ml for Neonatal. Afterwards, the pulse volume can be changed with its own control (see above). To set the wave variable:

1. Push ⏶ or ⏷ to highlight the **Wave** variable.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Adult** or **Neonatal**.
4. Push ENTER to set the wave and go back to the **NIBP** screen.

When the NIBP monitor starts the blood pressure measurement cycle, the Product keeps the measured parameters of the measurement cycle. If the NIBP screen is shown in the display when the measurement cycle starts, a graph of pressure versus time shows in the display. See Figure 35.



glh005.bmp

Figure 35. Blood Pressure Measurement Graph

Note

The Summary and Graph softkeys show in the NIBP screen after you do an NIBP simulation.

To see the measured parameters of the last blood pressure measurement cycle, push the **Summary** softkey in the NIBP screen. To see the graph of the last NIBP simulation, push the **Graph** softkey in the NIBP screen,

How to Do an NIBP Monitor Test

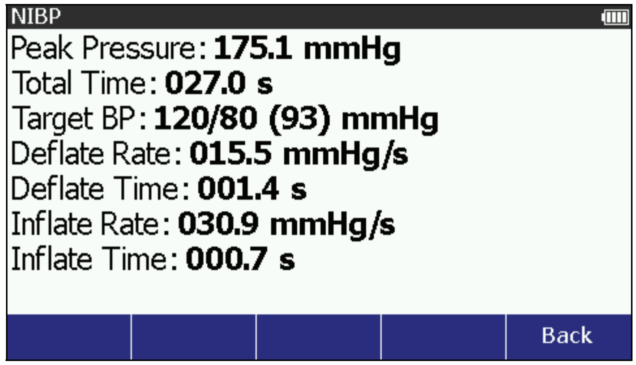
To do an accuracy test on an NIBP monitor:

1. Connect the NIBP monitor to the Product as shown in Figure 37.
2. Start an NIBP pressure cycle on the monitor. Refer to the monitor manual as necessary. After you start the blood pressure measurement cycle:
   - The blood pressure cuff inflates around the mandrel.
   - The Product starts the peripheral pulse simulation and shows the blood pressure measurement graph in the display.

   Note

   The graph shows in the display automatically only when the blood pressure measurement cycle starts when the NIBP screen shows in the display.

   - The Product starts blood pressure simulation when the pressure is 10 mmHg. Heart beat simulation starts when the pressure equals the diastolic pressure set into the Product.
   - The Product stops the simulation when the pressure is 2 mmHg or below.
   - The NIBP monitor interprets and shows the measured blood pressure values and heart rate when the test stops.
3. Push the **Summary** softkey to show the blood pressure measurements in Figure 36 in the display.



glh053.bmp

Figure 36. NIBP Summary Screen

4. Compare the NIBP monitor values with the target values shown in the Product display.

How to Do a Pressure Leak Test

The leak test measures leaks in a non-invasive blood pressure monitor, the hoses connected to the monitor, and the pressure cuff.

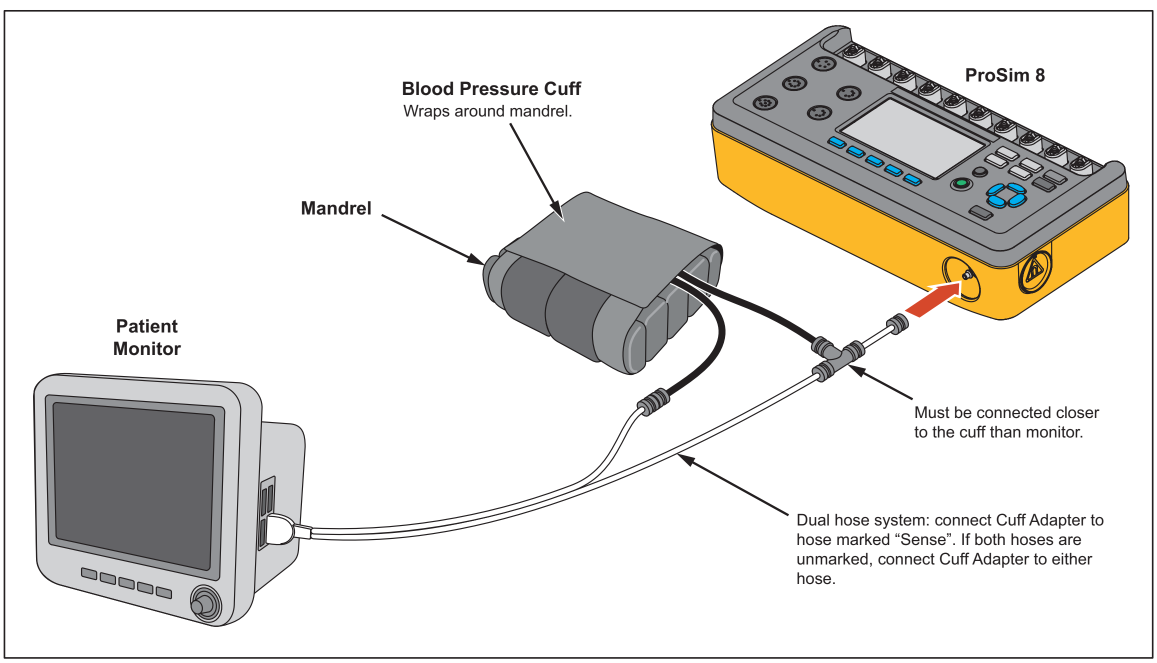
Note

Before you do a pressure leak test on a monitor, do the pressure leak test without the monitor to identify the leak rate of the Product. Use this leak rate to offset the rate of the full system with the monitor connected.

Note

Put the NIBP monitor in "calibrate" or "service" mode to close the vent valve, so the Product can inflate the pneumatic system. Refer to the service manual for the NIBP monitor.

Connect the Product to the monitor and cuff as shown in Figure 37.



glh008.bmp

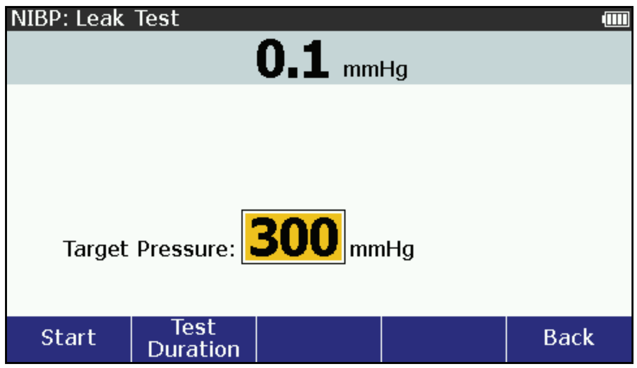
Figure 37. Pressure Leak Test Connections

Note

If the NIBP device has an internal system leak test or one that vents the cuff inflation pneumatic circuit to the atmosphere when idle, do not use the Leak Test. Rather, do a Manometer check to test for internal system leaks. Refer to the NIBP monitor operators manual for the recommended test protocol.

To perform a leak test:

1. Push NIBP to show the NIBP screen.
2. Push the **Tests** softkey.
3. Push ⏶ or ⏷ to highlight **Leak Test**.
4. Push ENTER to show the **NIBP: Leak Test** screen in Figure 38 in the display.



glh024.bmp

Figure 38. Leak Test Screen

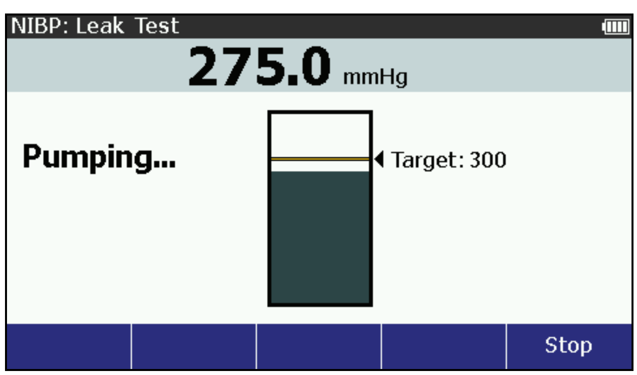
The default target pressure is 300 mmHg. The target pressure can be set between 20 and 400 mmHg. To change the target pressure, push ⏶ or ⏷ to increase or decrease the pressure value in 1 mmHg steps.

Note

When you hold down the direction key, the step size will change to 10 mmHg until the key is released.

5. Push the **Start** softkey to start the leak test.

   The Product pressurizes the pneumatic system to the target pressure. While the Product pumps air into the pneumatic system, the pressure and a graph of the pressure is shown in the display. See Figure 39.



glh006.bmp

Figure 39. Leak Test Pumping Screen

The pump stops when the measured pressure is the same as the target pressure. The Product waits for a time to let the pressure to become stable. Then the Product starts to measure and monitor the pressure for the test period.

When the test is done, the test results are shown in the display. An example pressure test result is shown in Figure 40.

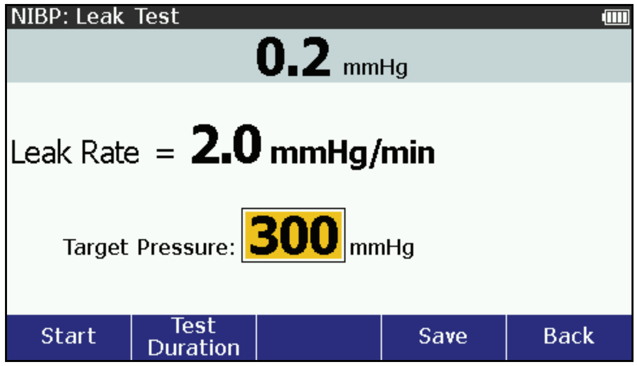


Figure 40. Example Leak Test Result Screen

To set how long the test will run:

1. Push the **Test Duration** softkey.
2. Push ⏶ or ⏷ to adjust the time between 30 seconds and 5 minutes in 30 second steps. The default time is 1 minute.
3. Push **ENTER** to set the test duration and go back to the **NIBP: Leak Test** screen.

How to Do a Pressure Relief Test

The pressure relief test pressurizes a pneumatic system until the Product senses a drop in pressure, as occurs when the relief valve opens. Or the test stops if the pressure gets to the target pressure and no relief is sensed.

Note

Put the NIBP monitor in "calibrate" or "service" mode to close the vent valve, so the Product can inflate the pneumatic system. Refer to the service manual for the NIBP monitor.

To test the relief valve:

1. From the NIBP screen, push the **Tests** softkey.
2. Push ⏶ or ⏷ to highlight **Pressure Relief Test**.
3. Push **ENTER**.
4. Push ⏶ or ⏷ to increase or decrease the target pressure between 100 and 400 mmHg in 1 mmHg steps.

Note

When you hold down the direction key, the step size will change to 10 mmHg until the key is released.

5. Push the **Start** softkey to begin the test.

The Product pressurizes the pneumatic system to the target pressure with the pressure measurement and a graph of the pressure shown in the display. See Figure 39. When the Product senses the pressure valve has opened, the test stops and the results are shown in the display. See Figure 41. It is recommended you do three pressure relief tests in case the relief valve is intermittent.

If there is no drop in pressure and the pressure climbs to the target pressure, the pump stops and **Not Tripped** shows in the display.

Note

Some NIPB monitors do not let you access a "Service" mode. If you can not close the vent valve, the system can not be pressurized by an external pump. It is possible to start a blood pressure measurement with the monitor (this closes the valve), then start the Pressure Relief tests, so that two pumps inflate the system. The results can change, but the monitor usually opens a relief valve at some high pressure.

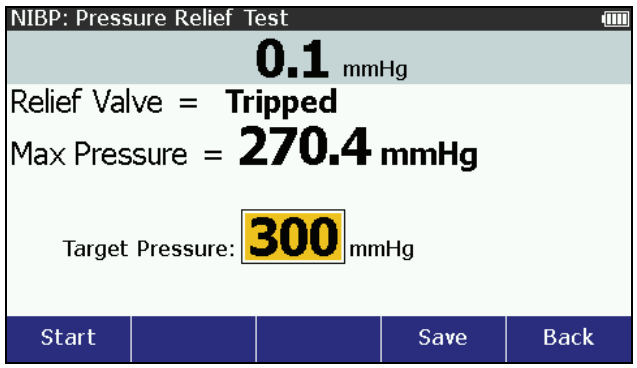


Figure 41. Pressure Relief Valve Test Results Screen

See the How to Save Test Results section to learn more on how to save your test results data.

How to Do a Pressure Source Test

The pressure source test is used to pressurize a pneumatic system while it measures the pressure. This can be used for static calibration of non-invasive blood pressure measurement systems, sphygmomanometer checks, and other devices that measure pressure.

To do a pressure source test:

1. Connect the pressure port to pressure system as shown in Figure 42.

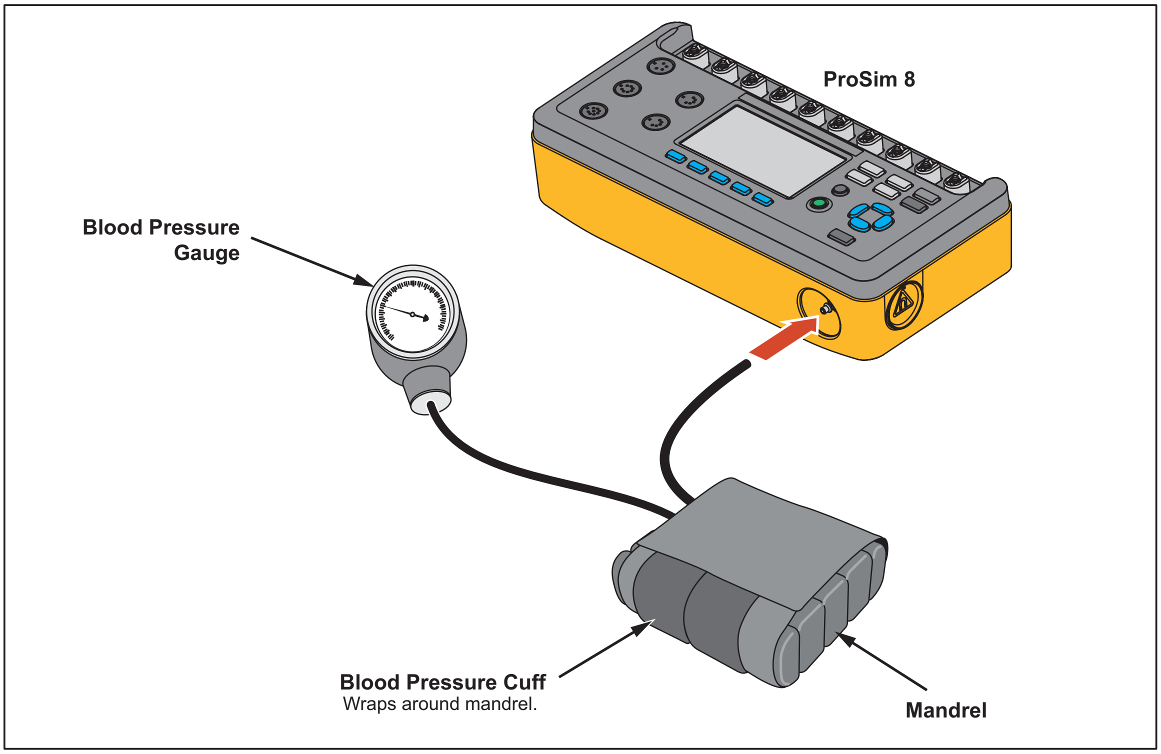


Figure 42. Pressure Source Connection

2. From the NIBP screen, push the **Tests** softkey.
3. Push ⏶ or ⏷ to highlight **Pressure Source**.
4. Push **ENTER**.
5. Push ⏶ or ⏷ to increase or decrease the target pressure between 20 and 400 mmHg in 1 mmHg steps.

Note

When you hold down the direction key, the step size will change to 10 mmHg until the key is released.

6. Push the **Start** softkey to begin the test.

The Product pressurizes the pneumatic system to the target pressure. While the Product pumps air into the pneumatic system, the pressure measurement and a graph of the pressure is shown in the display. See Figure 43.

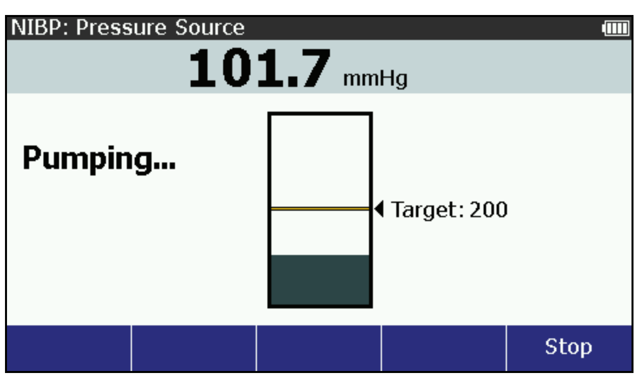


Figure 43. Pressure Source Pumping Screen

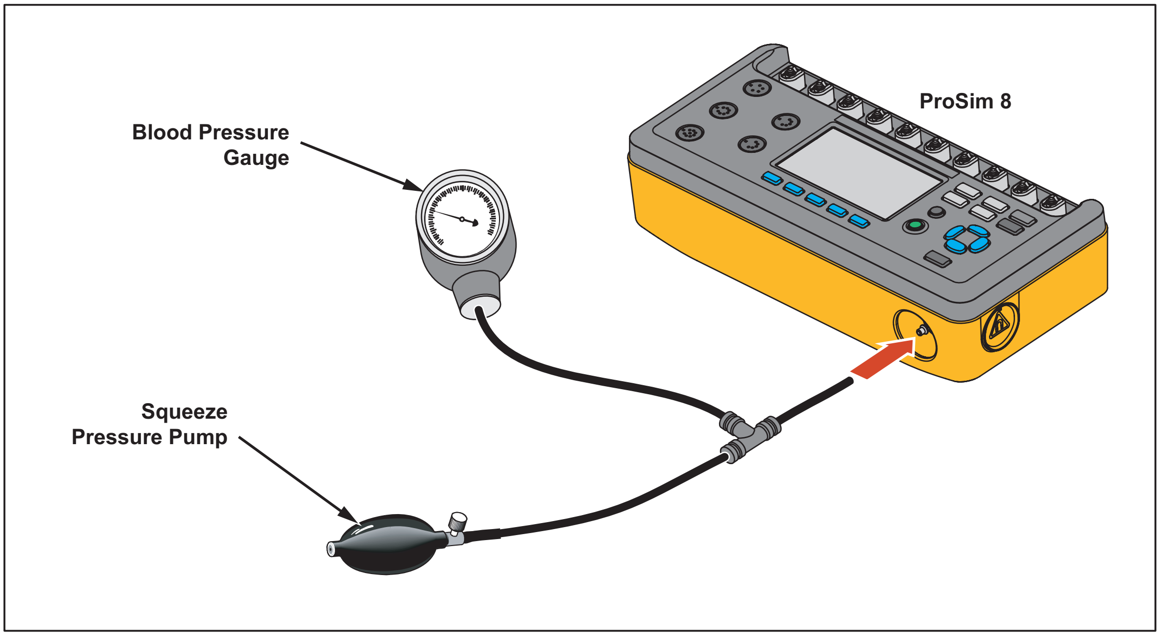
Push the **Stop** softkey to stop the test. This will cause a **Vent** softkey to show in the display. The pressure will remain at the level it was when the **Stop** softkey was pushed. Either push the **Vent** softkey to vent the pressure system or change the pressure and push the **Start** softkey to do another test.

How to Check a Manometer

The manometer function sets the Product up as a pressure gauge to measure pressure supplied by an external source.

To measure pressure:

1. Connect the pressure port to a pneumatic system as shown in Figure 44.

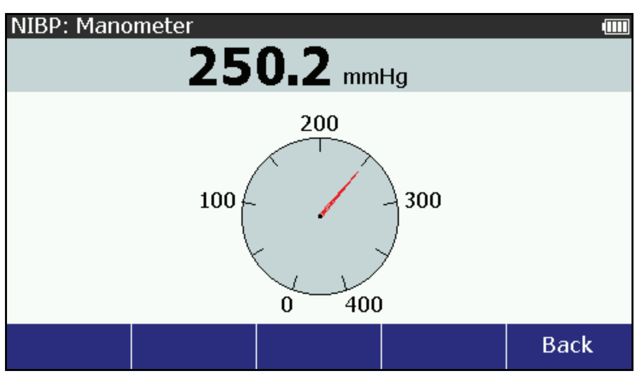


glh050.eps

Figure 44. Manometer Connections

2. From the NIBP screen, push the **Tests** softkey.
3. Push ⏶ or ⏷ to highlight **Manometer**.
4. Push ENTER.

The digital pressure screen in Figure 45 is shown in the display.



glh011.bmp

Figure 45. Manometer Screen

As the external generator increases the pressure, the digital and analog pressure values in the display shows the current pressure.

Oximeter SpO2 Optical Emitter and Detector

The subject device provides Oximeter SpO2 optical emitter and detector capability, which is solely intended to generate an optical signal to verify that the electronics within the pulse oximeter probe are functional. The subject device presents pulse oximeter equipment with a signal having a predictable value of ratio so that the operator can observe the resulting displayed value of SpO2, and compare it to the expected value derived from the calibration curve for that particular pulse oximeter equipment.

⚠ Warning

The pulse oximeter component of the device is not intended to validate the SpO2 accuracy of pulse oximeter equipment.

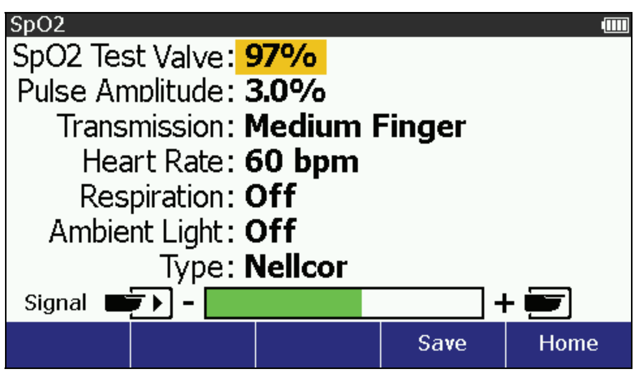
The pulse oximeter component of this device is not intended to confirm the SpO2 accuracy of the calibration curve of the pulse oximeter monitor or to assess the optical characteristics of representative pulse oximeter probes to determine their proper calibration.

Not all functional testers and pulse oximeter equipment are compatible. Functional testers can vary in pulse methods, pulse contours, and amplitude. A functional tester might not accurately reproduce the calibration of the pulse oximeter equipment and can yield different results between pulse oximeter equipment.

Note

When the Type value is set to Masimo Rainbow, there will be more SpO2 parameters shown in the display than other types of sensors. See the How to Test a Masimo Rainbow SpO2 section to learn about these parameters.

To set oximeter SpO2 optical emitter and detector parameters, push SpO2 to show the screen in Figure 46 in the display.



glh018.bmp

Figure 46. Oximeter SpO2 Optical Emitter and Detector Screen

Connect the SpO2 artificial finger to the SpO2 jack on the front panel as shown in Figure 47.

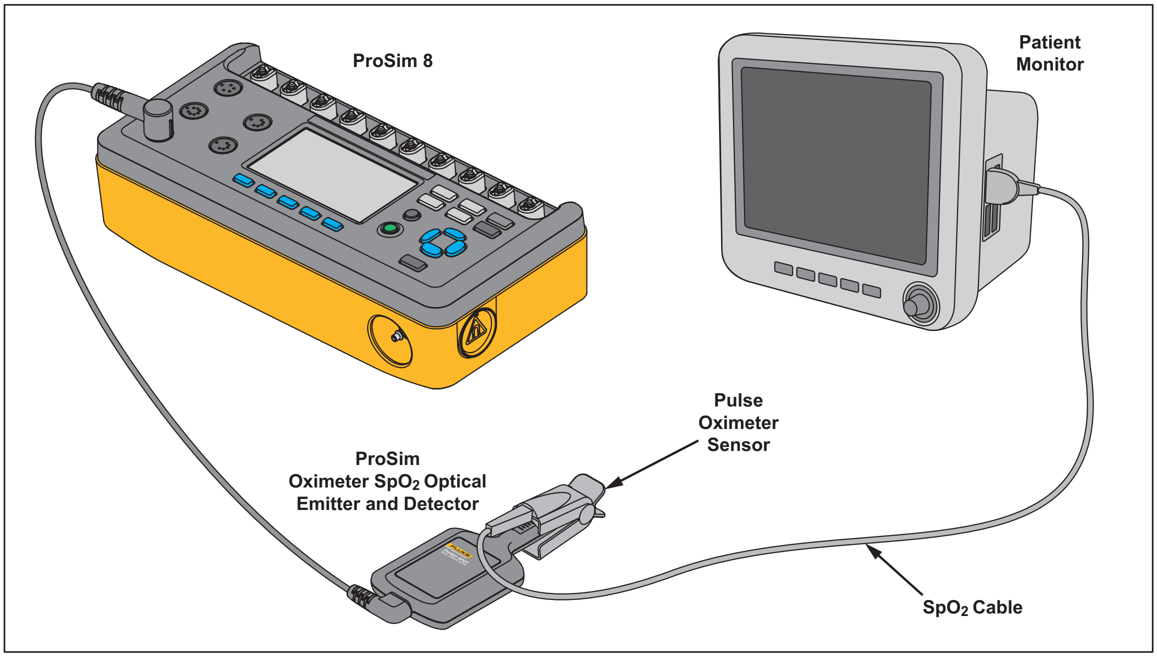


Figure 47. Oximeter SpO2 Optical Emitter and Detector Connections

Note

When you put the oximeter sensor on the artificial finger, make sure the red LEDs (light emitting diodes) are on the bottom.

Put the SpO2 sensor on the artificial finger as shown in Figure 48. Place the sensor with the LEDs on the bottom of the artificial finger. While you put the sensor on the artifical finger, monitor the signal indicator along the bottom of the Product display. Adjust the sensor on the finger for maximum signal strength.

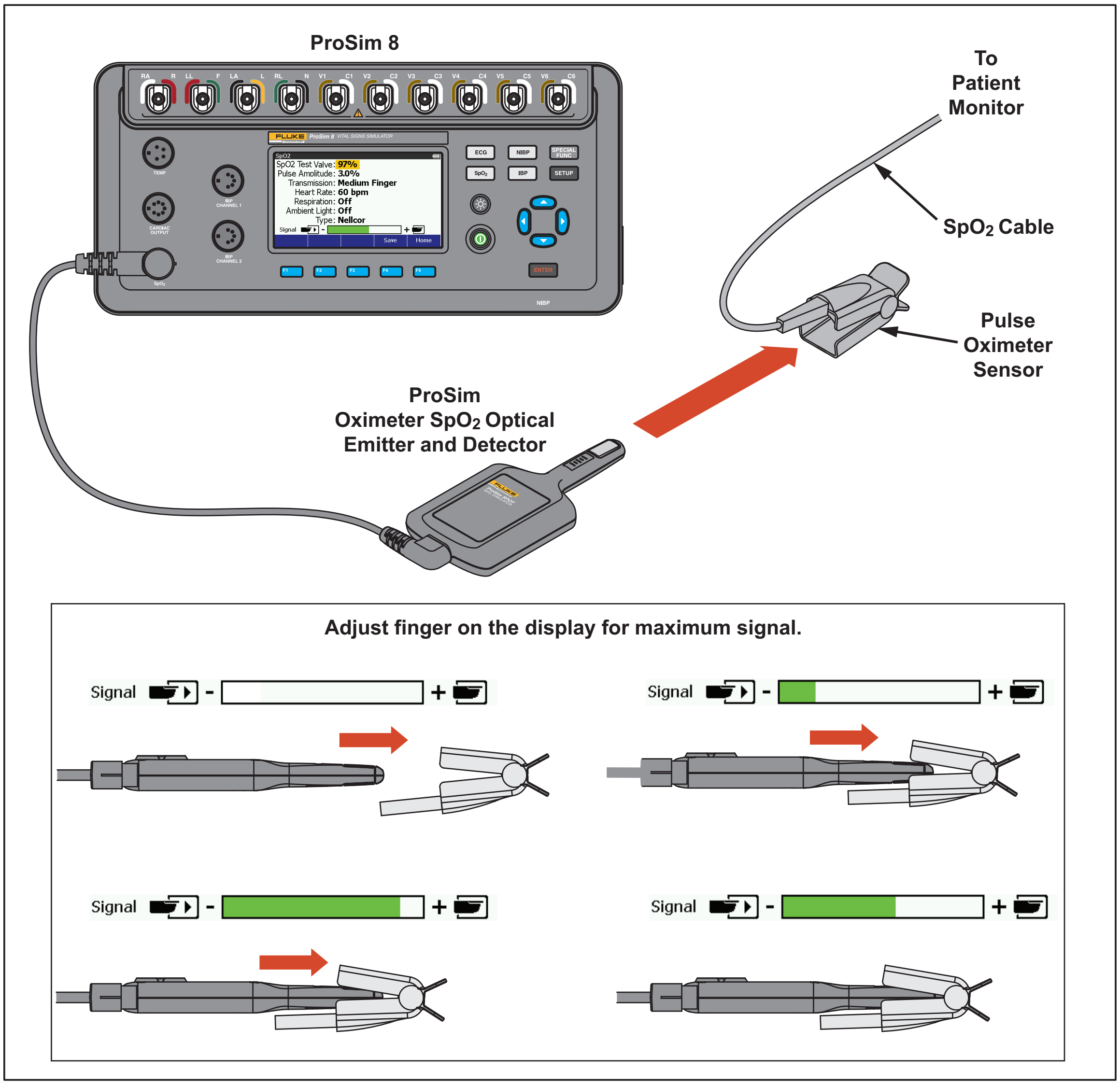
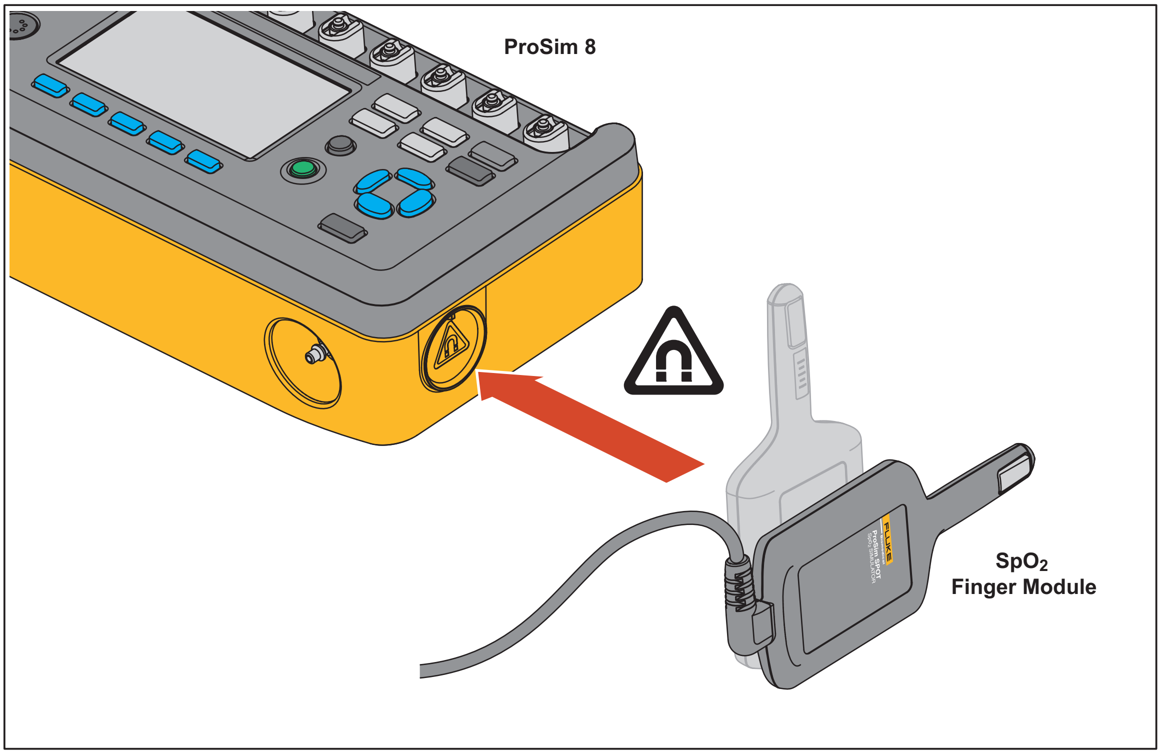


Figure 48. SpO2 Sensor Placement

Attach the artificial finger to the magnetic holder on the right side of the Product as shown in Figure 49.



glh045.eps

Figure 49. Magnetic Holder for SpO2 Artificial Finger

How to Set the SpO2 Parameters

You can raise or lower the degree of oxygen saturation. To change the SpO2 value:

1. Push ⏶ or ⏷ to highlight the **SpO2** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to increase or decrease the SpO2 value in 1 % steps between 30 and 100 %.
4. Push ENTER to set that SpO2 value and go back to the **SpO2** screen.

To change the pulse amplitude value:

1. Push ⏶ or ⏷ to highlight the **Pulse Amplitude** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to change the pulse amplitude value between 0 and 20 %. Each push of a key changes the value 0.01 % between 0 and 1 % in the direction of the key pushed. The value changes 0.1 % between 1 and 10 %. The value changes 1 % between 10 and 20 %.
4. Push ENTER to set the pulse amplitude value and go back to the **SpO2** screen.

To change the transmission value:

1. From the **SpO2** screen, push ⏶ or ⏷ to highlight the **Transmission** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Dark, Thick Finger**, **Medium Finger**, **Light, Thin Finger**, and **Neonatal Foot**.
4. Push ENTER to set that transmission value and go back to the **SpO2** screen.

You can change the simulated heart rate of the Product from the **SpO2** screen. To change the heart rate:

1. Push ▲ or ▼ to highlight the **Heart Rate** value.
2. Push ENTER.
3. Push ▲ or ▼ to adjust the heart rate. Each push of a key moves the heart rate one beat in the direction of the key pushed. The range is 10 to 300 beats/minute (BPM).
4. Push ENTER to go back to the **SpO2** screen.

To change SpO2 respiration:

1. From the **SpO2** screen, push the ▲ or ▼ to highlight the **Respiration** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight **1%, 2%, 3%, 4%, 5%** or **off**.
4. Push ENTER to set the respiration and go back to the **SpO2** screen.

You can test SpO2 under different ambient light conditions. To change the ambient light value:

1. From the SpO2 screen, push the ▲ or ▼ to highlight the **Ambient Light** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight an ambient light value. Below is the list of ambient light values in the Product.

Sunlight	Indoor – 4 kHz
Indoor – DC	Indoor – 5 kHz
Indoor – 50 Hz	Indoor – 6 kHz
Indoor – 60 Hz	Indoor – 7 kHz
Indoor – 1 kHz	Indoor – 8 kHz
Indoor – 2 kHz	Indoor – 9 kHz
Indoor – 3 kHz	Indoor – 10 kHz

4. Push ENTER to go back to the **SpO2** screen with the new ambient light value.

The manufacturer must be known before you do a pulse oximeter test, optically through an artificial finger. For Masimo, you need to know if the sensor is a 2 wavelength or Rainbow sensor. You can configure the Product for the make of pulse oximeter(s) used for the test. You change variables for each of the pulse oximeters through the type variable. To change the oximeter sensor type:

1. From the SpO2 screen, push the ▲ or ▼ to highlight the **Type** value.
2. Push ENTER.

3. Push ⏶ or ⏷ to highlight a type value in the list. Below is the list of types in the Product.

Nellcor	Philips
Masimo	Hihon Khoden
Masimo Rainbow	Mindray
Nonin	BCI
GE/Ohmeda	

4. Push ENTER to set the type value and go back to the **SpO2** screen.

To test other manufacturer types of oximeters, you must download R-Curve data into the Product through the USB Port. Oximeter R-Curve design and data download is done through the Ansur functionality.

How to Test a Masimo Rainbow SpO2

When you set the SpO2 type parameter to Masimo Rainbow, you must connect the Product to the monitor with the optional SpO2 Masimo Rainbow cable. See the Optional Accessories table for a part number. The **SpO2** screen shows three more parameters than what is shown for other types of sensors: SpMet, SpCO, and SpHb.

SpMet, SpCO, and SpHb can not be set through the Product. The special Masimo Rainbow cable sets them based on the measured SpO2 percent. At 100 %, SpMet = 0 %, SpCO = 0 %, and SpHb = 25 g/dl. A -1 % change in SpO2 changes SpMet +0.3 %, SpCO by +0.7 %, and SpHb by -0.5 %. SpHb does not change for values of SpO2 above 90 %.

Note

The ProSim 8 tests Masimo Rainbow technology with an optional adapter supplied by Masimo that allows the ProSim two-wavelength to test the Rainbow multiple wavelength system.

Note

Since a special Masimo testing sensor is required to connect the ProSim 8 to Masimo Rainbow Oximeter, the ProSim 8 only validates performance of Oximeter, not the Masimo Rainbow sensor (the SpHb, SpCO and SpMet values from the Masimo technology are generated based on the SpO2 value provided to the test sensor and are not able to be changed independently).

How to Perform an Oximeter Limits Test

Most oximeters have alarms that can be set for the parameters it measures. The Product can be used to trip the alarm as a test. Connect the Oximeter to the Product as shown in Figure 47.

Oxygen Limits Test

You do a sensitivity test on an oximeter through SpO2 value adjustments. To do an oxygen limits test:

1. Set the oxygen alarm limit value(s) on the oximeter.
2. From the **SpO2** screen, push ⏶ or ⏷ to highlight the **SpO2** value.
3. Push ENTER.
4. Push ⏶ to increase the oxygen saturation until the oximeter alarm sounds.
5. Push ⏷ to decrease the oxygen saturation until the oximeter alarm sounds.

Pulse Rate Test

You can simulate different patient conditions while you monitor the effect of different pulse rates on the SpO2 measurement. To do a pulse rate test:

1. Set the pulse rate alarm limit value(s) on the oximeter.
2. From the **SpO2** screen, push ▲ or ▼ to highlight the **Heart Rate** value.
3. Push ENTER.
4. Push ▲ to increase the heart rate until the alarm sounds.
5. Push ▼ to decrease the heart rate until the alarm sounds.

   You can decrease the heart rate to 0 bpm to simulate asystole or no pulse.

Pulse Amplitude Test

The peak-to-peak amplitude of the blood pressure wave tested by the Product can be increased or decreased. You can decrease the amplitude to find where the oximeter fails to sense a pulse. To do a pulse amplitude test:

1. From the **SpO2** screen, push ▲ or ▼ to highlight the **Pulse Amplitude** value.
2. Push ENTER.
3. Push ▼ to decrease the pulse amplitude value until the oximeter no longer shows a pulse or the oximeter alarm sounds.

Autosequences

Autosequences are a series of steps that change the output of the Product automatically. For example, to do a temperature test on a monitor, you must change the temperature of the temperature simulation a number of times for a specified time period. To do this manually, you can go to the temperature function, push ENTER and then push ▲ or ▼ to change the temperature and then push ENTER again. After some time period, you do these same steps for the subsequent temperature change. The Temperature autosequence does these changes for you automatically. Each step of the temperature autosequence sets the temperature and after the allotted time period, it does the subsequent step.

Table 14 is a list of autosequences that are built into the Product.

Table 14. Autosequences

Autosequence	Sequence Steps	Run Time
Monitor Testing	ECG 200 BPM, IBP1 (Arterial, 200/150), IBP2 (PA, 45/25), SpO2 100 %, NIBP 200/150, Respiration 80 brpm and Temperature 42 °C	01:30
	ECG 80 BPM, IBP1 (Arterial, 120/80), IBP2 (PA, 28/15), SpO2 97 %, NIBP 120/80, Respiration 20 brpm and Temperature 37 °C	01:30
	ECG 30 BPM, IBP1 (Arterial, 60/30), IBP2 (PA, 20/10), SpO2 85 %, NIBP 60/30, Respiration 10 brpm and Temperature 32 °C	01:30
	STOP	Total Time 04:30

Table 14. Autosequences (cont.)

Autosequence	Sequence Steps	Run Time
Medical Training	ECG 80 bpm, IBP1 120/80 (Art), IBP2 120/0 (LV), SpO2 98 %, NIBP 120/80, Respiration 20 brpm, and Temperature 37 °C	01:00
	ECG 120 bpm, IBP1 250/150 (Art), IBP2 200/0 (LV), SpO2 85 %, NIBP 200/150, Respiration 60 brpm, and Temperature 40 °C	01:00
	ECG 30 bpm, IBP1 60/30 (Art), IBP2 60/0 (LV), SpO2 50 %, NIBP 60/30, Respiration 10 brpm, and Temperature 34 °C	01:00
	REPEAT	Total Time 03:00
Oximeter Testing	SpO2 100 %, Pulse Amplitude 20 %, Transmissivity: normal adult, heart rate 60BPM	00:45
	SpO2 95 %, Pulse Amplitude 15 %, Transmissivity: normal adult, heart rate 60BPM	00:45
	SpO2 90 %, Pulse Amplitude 10 %, Transmissivity: dark/thick adult, heart rate 120BPM	00:45
	SpO2 85 %, Pulse Amplitude 7 %, Transmissivity: dark/thick adult, heart rate 30BPM	00:45
	SpO2 84 %, Pulse Amplitude 5 %, Transmissivity: normal adult, heart rate 60BPM	00:45
	SpO2 83 %, Pulse Amplitude 4 %, Transmissivity: normal adult, heart rate 60BPM	00:45
	SpO2 82 %, Pulse Amplitude 3 %, Transmissivity: dark/thick adult, heart rate 120BPM	00:45
	SpO2 81 %, Pulse Amplitude 2 %, Transmissivity: dark/thick adult, heart rate 30BPM	00:45
	SpO2 80 %, Pulse Amplitude 1 %, Transmissivity: normal adult, heart rate 60BPM	00:45
	SpO2 79 %, Pulse Amplitude 0.5 %, Transmissivity: normal adult, heart rate 60BPM	00.45
	STOP	Total time 07:30
Cardiac Failure	NSR (Adult) 80 BPM	00:45
	Premature PVC1 Left Vent	00:30
	Ventricular Mono VTach	00:30
	Ventricular Ventricular Fibrillation	00:30
	Ventricular Asystole	00:25
	STOP	Total Time 02:30

Table 14. Autosequences (cont.)

Autosequence	Sequence Steps	Run Time
Arrhythmia Sequences	NSR (Adult) 80 bpm	00:20
	NSR (Adult) 120 bpm	00:20
	Supraventricular Supra VTach	00:20
	Ventricular Bigeminy	00:20
	TV Paced Asynchornous 75 bpm	00:15
	Ventricular Asystole	00:15
	Conduction Lt Bndl Branch Block	00:15
	Ventricular Run of PVCs	00:30
	Supraventricular Atrial Fibrillation	00:15
	Ventricular Ventricular Fibrillation	00:15
	REPEAT	Total Time 03:05
Exercise	NSR (Adult) 50 bpm	00:30
	NSR (Adult) 90 bpm	00:30
	NSR (Adult) 120 bpm	00:30
	NSR (Adult) 150 bpm	00:30
	NSR (Adult) 90 bpm	00:30
	NSR (Adult) 70 bpm	00:30
	REPEAT	Total Time 03:00
Respiration Sequence	Respiration 110 brpm	00:30
	Respiration 60 brpm	00:30
	Respiration 20 brpm	00:30
	Respiration 0 brpm	00:12
	REPEAT	Total Time 01:42
NIBP Sequence	Waveform: Square; Rate: 2.0 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 0.05 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 0.5 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 1 Hz; Amplitude: 1.0 mV	00:05
	Waveform; Sine; Rate: 10 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 50 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 60 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 100 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Sine; Rate: 150 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Triangle; Rate: 0.125 Hz; Amplitude: 1.0 mV	00:05

Table 14. Autosequences (cont.)

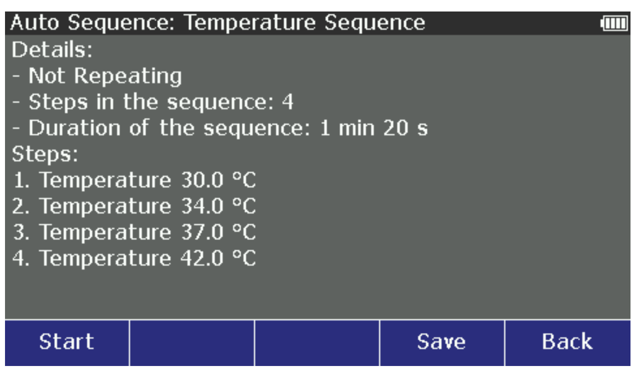
Autosequence	Sequence Steps	Run Time
NIBP Sequence (cont.)	Waveform: Triangle; Rate: 2.0 Hz; Amplitude: 1.0 mV	00:05
	Waveform: Pulse; Rate: 60 bpm; Amplitude: 1.0 mV	00:05
	REPEAT	Total time 01:10
IBP Sequence	IBP 1: 120/80 mmHg (Art), 2: 120/0 mmHg (LV)	01:00
	IBP 1: 25/0 mmHg (RV), 2: 120/80 mmHg (Art)	01:00
	IBP 1: 25/10 mmHg (PA), 2: 10/2 mmHg (PAW)	01:00
	REPEAT	Total Time 03:00
Temperature Sequence	Temperature 30.0 °C	00:20
	Temperature 34.0 °C	00:20
	Temperature 37.0 °C	00:20
	Temperature 42.0 °C	00:20
	STOP	Total Time 01:20

How to View the Steps of an Autosequence

To view an autosequence:

1. Push SPECIAL FUNC.
2. Push ▲, ▼, ◄, or ► to highlight **Autosquences**.
3. Push ENTER.
4. Push ▲ or ▼ to highlight an autosequence in the list. See Table 14.
5. Push ENTER.

The screen shown in Figure 50 is the Temperature Sequence in the autosequence list.



glh032.eps

Figure 50. Autosequence Start Screen

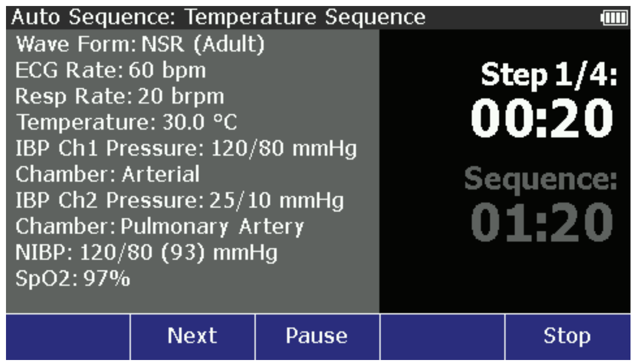
The details of the autosequence shows the sequence does each of the four steps and stops. Although this example does not repeat, some autosequences do. The screen also shows the four-step sequence will complete in 1 minute and 20 seconds.

Each sequence step is shown in the display. When there are more steps than can be shown in one display screen, push ▼ or ▲ to go to the next or previous screen.

How to Do an Autosequence

To do an autosequence:

1. Push [SPECIAL FUNC.].
2. Push ▲, ▼, ◄, or ► to highlight **Autosquences**.
3. Push [ENTER].
4. Push ▲ or ▼ to highlight an autosequence in the list.
5. Push the **Start** softkey. The autosequence screen in Figure 51 shows in the display.



glh033.bmp

Figure 51. Autosequence Step Screen

The autosequence screen shows all the simulation parameters which are updated as the Product steps through the sequence. The right part of the screen shows which step the sequence is on and how much time is left to complete the step. The length of time left to complete all steps of the autosequence is also shown in the display.

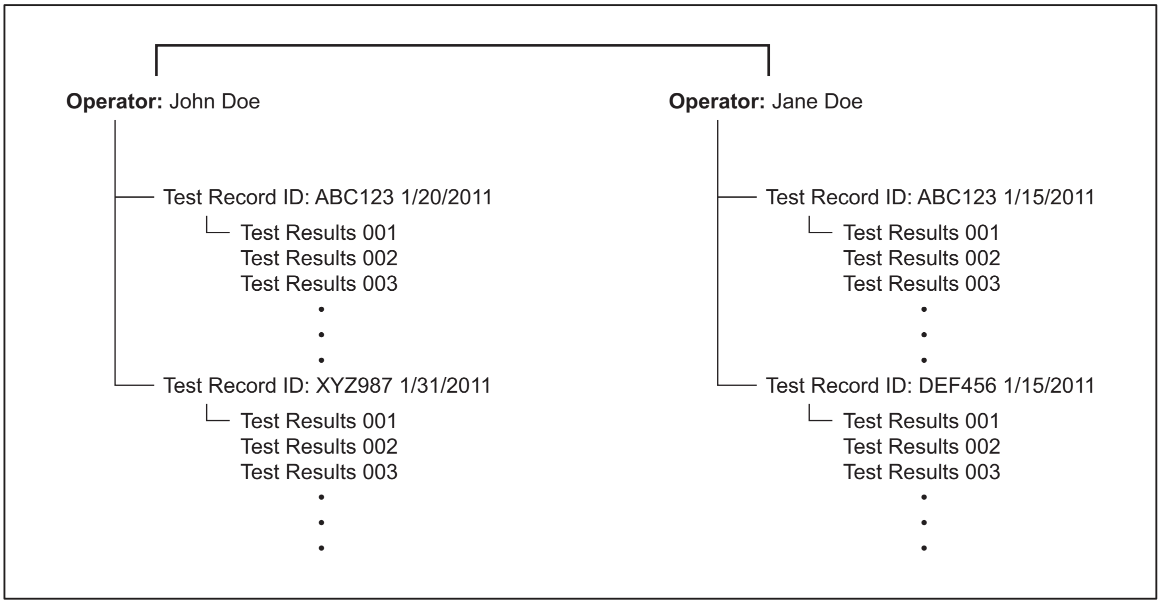
Push the **Next** softkey to abort the step and move to the subsequent step. When the autosequence has moved to step two, a **Previous** softkey shows in the display. Push the **Pause** softkey to pause the step. A **Continue** softkey shows in the display when the auto sequence is paused. Push the **Continue** softkey to continue the step for the time left when the step was paused.

To abort the autosequence, push the **Stop** softkey and go back to the **Autosequence** view screen.

You can not change a pre-defined autosequence or rename it. But, you can use the Ansur functionality to copy an autosequence, make changes, and then put it into the Product as a new custom autosequence. You can change each step of the new autosequence and add more steps as necessary.

How to Save and View Test Results (ProSim 8 only)

The data of test results can be saved in and recalled from the Product. Test results are organized in memory first by operator ID, then by a test record ID, and then individual test results. Figure 52 shows the memory organization of test results data.



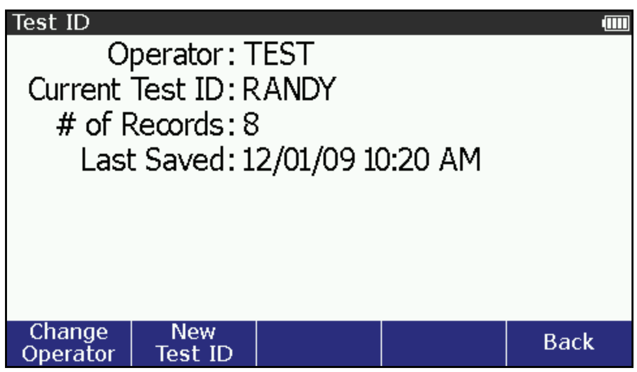
glh044.eps

Figure 52. Memory Organization of Test Results

How to Make an Operator ID

Test results are kept in memory by an operator ID. To make a new operator ID:

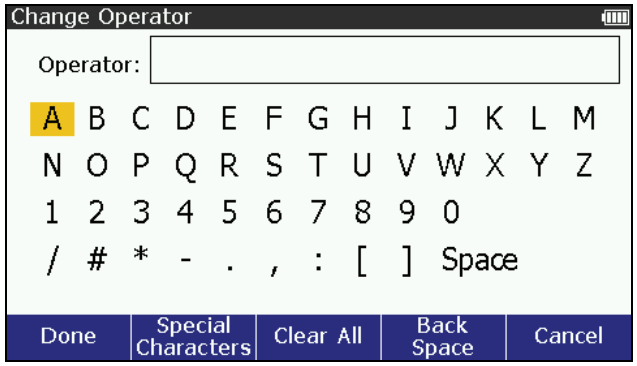
1. Push SETUP.
2. Push ⏶ or ⏷ to highlight **Test Record ID** in the list.
3. Push ENTER to open the **Test ID** screen shown in Figure 53.



glh036.bmp

Figure 53. Operator ID Screen

4. Push the **Change Operator** softkey to open the change operator screen shown in Figure 54.



glh037.bmp

Figure 54. Change Operator ID Screen

5. Push ◀, ▶, ▲, and ▼ to highlight a character for the operator ID.
6. Push ENTER to add the highlighted character to the operator ID.
7. Do steps 5 and 6 for each character in the operator ID. You can have the maximum number of characters that fit in the test ID field in the display. If you use more of the narrow characters like I and 1, you can have more characters in the operator ID than when wider characters are used.
8. Push the **Done** softkey when you have all the characters in the operator ID.

Note

If this is a new operator ID, the ID won't exist until you save the first test result.

Do these same steps when you change the operator ID to an ID that is already in memory. After you type the ID in as it already is in memory, all saved results data are added to that operator ID.

How to Make a Test ID

As shown in Figure 52, test results data is related to a Test Record ID. This test record ID could identify the device under test. Some examples could be its model number, its serial number, or its asset number. After you input the new Test ID, all results data saved after that point is kept with that test ID until you change the test ID.

Note

When you type in a new test ID, the test ID that was open before is closed and no more test results data can be added to that test ID. You can use the same test ID name as one that is already in memory, but a date and time stamp will always be appended to the name and its own test ID.

To make a test ID:

Note

These instructions use the setup function to make a test ID. You can also make a test ID when a ***Save*** *softkey label shows in the display. The* ***New Test ID*** *softkey always shows in the display when you push the* ***Save*** *softkey.*

1. Push SETUP.
2. Push ▲ or ▼ to highlight **Test Record ID** in the list.
3. Push ENTER to open the **Test ID** screen.
4. Push the New Test ID softkey.

5. Push ◀, ▶, ▲, and ▼ to highlight a character for the test ID.
6. Push ENTER to add the highlighted character to the test ID.
7. Do steps 5 and 6 for each character in the test ID. You can have the maximum number of characters that fit in the test ID field in the display. If you use more of the narrow characters like I and 1, you can have more characters in the test ID than when wider characters are used.

   Additional characters are available when you push the **Special Characters** softkey. To go back to the normal characters, push the **Back** Softkey.

   Note

   If you make a mistake, push the **Back Space** *softkey to remove the last character added. A* **Clear All** *softkey removes all characters in the test ID field of the display.*

8. Push the **Done** softkey when you have all the characters in the test ID.

How to Save Test Results

Note

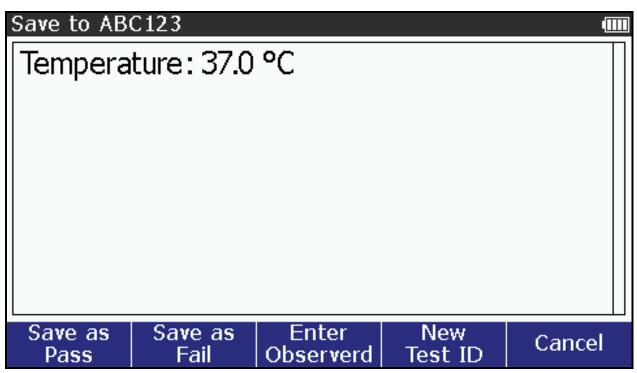
Before you save test results, make sure the operator ID and test ID are set correctly.

Each function of the Product lets you save test results data through a **Save** softkey. To save test results:

Note

If the **Save** *softkey label is not shown in the display, it means you can not save data at this point.*

1. Push the **Save** softkey to show the **Save** screen. The screen in Figure 55 is the save screen for the temperature simulation function.



glh039.bmp

Figure 55. Save Screen

Note

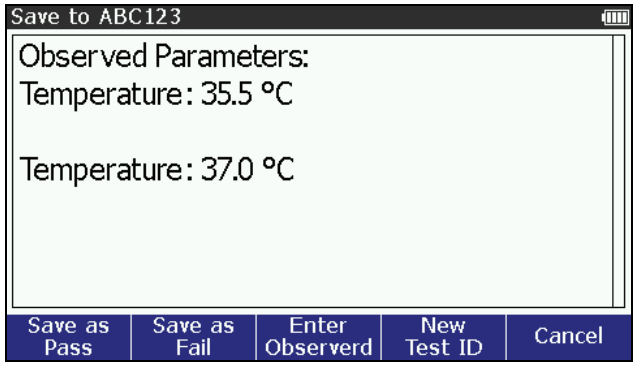
The next step is valid only when the Enter Observed softkey appears in the display.

2. To add measurements shown in the UUT display to the test results record, push the **Enter Observed** softkey.

   Note

   If there is more than one simulation parameter, you have to highlight a parameter and push ENTER *before the next step.*

3. Push ▲ or ▼ to set the parameter to the value observed on the UUT.
4. Push ENTER to set the observed value and show the save screen shown below in the display.



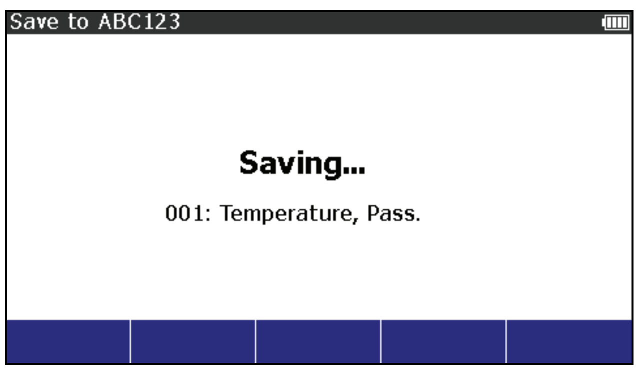
glh049.bmp

Figure 56. Observed Results Screen

Note

If the observed value is incorrect at this point, you can push the **Enter Observed** *softkey and change the observed parameter.*

5. Test results are saved with a Pass or Fail prefix in their label. Push the **Save as Pass** or the **Save as Fail** softkey. The saving screen in Figure 57 shows in the display.



glh040.bmp

Figure 57. Saving Screen

The three-digit number is the test result ID. Within the test ID, each saved test results is assigned a number in sequence. When the save operation completes, the display goes back to the screen for the function you just saved. In the case of this example, the display goes back to the temperature screen.

How to View Test Results

To view the test results in memory:

1. Push SPECIAL FUNC.
2. Push ◄, ►, ▲, and ▼ to highlight **View Memory**.
3. Push ENTER.

Note

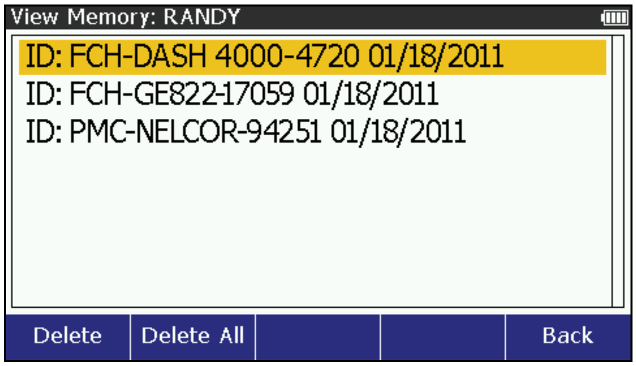
If no test results data is saved to memory, an error message shows in the display when you push ENTER.

4. Push ⏶ or ⏷ to highlight an operator.
5. Push **ENTER**.

Note

If there is only one operator, the operator list does not show in the display and the Product skips steps 4 and 5.

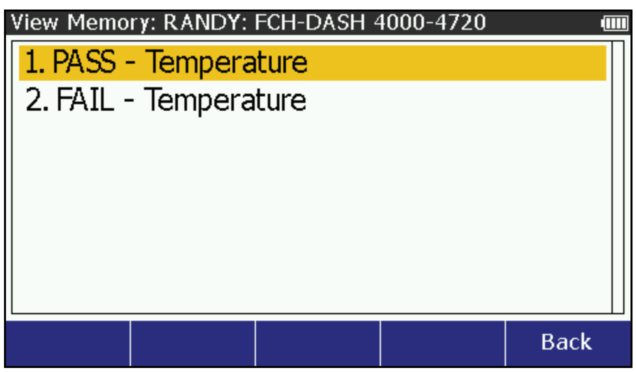
6. The list of test IDs shows in the display. Figure 58 shows an example list of test IDs.



glh041.bmp

Figure 58. Test ID Screen

7. Push ⏶ or ⏷ to highlight a test ID record.
8. Push **ENTER** to show the test results data saved for the test ID. See Figure 59.



glh042.bmp

Figure 59. Test Results Screen

9. Push ⏶ or ⏷ to highlight a test results file.
10. Push **ENTER** to show the test results data shown in Figure 60.

glh043.bmp

Figure 60. Test Results Data Screen

How to Print Test Results

With a PCL5 compatible printer connected to the USB A Controller Port, you can print a test results record.

Note

A compatible printer must be connected to the Product before the **Print** *softkey appears in the view screen of a test results record.*

1. Do the steps in the How to View Test Results section to show a test results record in the display.
2. Push the **Print** softkey.

The data in the test results record shown in the display is transmitted through the printer port.

How to Delete Saved Data

Removal of data from memory is done through the View Memory feature. You can only delete test ID records. When the test ID record is deleted, all saved test results data connected to that test ID is deleted from memory. To remove a test ID record:

1. Push SPECIAL FUNC..
2. Push ◀, ▶, ▲, and ▼ to highlight **View Memory**.
3. Push ENTER.
4. Push ▲ or ▼ to highlight an operator.
5. Push ENTER.

Note

If there is only one operator, the operator list does not show in the display and the Product skips steps 4 and 5.

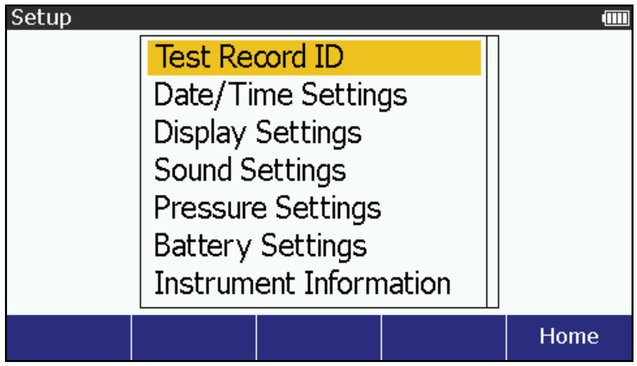
6. Push ▲ or ▼ to highlight a test ID record.
7. Push the **Delete** softkey to delete the test ID record.

   A **Confirm Delete** screen shows in the display with a “Delete Record?” message. When you push the **Yes** softkey, the test ID record is deleted from memory and the display goes back to the **View Memory** screen. Push the **No** softkey to abort the delete.

The **Delete All** softkey will delete all the test ID records associated with the operator. A Confirm Delete screen shows in the screen with a “Delete ALL records for this operator?” message.

Setup Features

The Product has several functions that are accessed through the **SETUP** key. Push SETUP to show the setup variables shown below in the display.



glh016.bmp

Figure 61. Setup Screen

The setup parameters are kept in memory and are non-volatile.

How to Set the Time and Date

The date and time can be set as well as the format in which they show in the display. From the **Setup** screen, push ▲ or ▼ to highlight **Date/Time Settings** and then push ENTER. To go back to the **Setup** screen, push the **Back** softkey.

To set the date:

1. Push ▲ or ▼ to highlight the **Date** value.
2. Push ENTER.
3. Push ◀ or ▶ to move to the month, day, or year.
4. Push ▲ or ▼ to increase or decrease the value.
5. Push ENTER to set the date and go back to the **Date/Time Settings** screen.

To set the time:

1. Push ▲ or ▼ to highlight the **Time** value.
2. Push ENTER.
3. Push ◀ or ▶ to move to the hour, minute, or second value.
4. Push ▲ or ▼ to increase or decrease the value.
5. Push ENTER to set the time and go back to the **Date/Time Settings** screen.

To set the date format:

1. Push ▲ or ▼ to highlight the **Date Format** value.
2. Push ENTER.
3. Push ▲ or ▼ to highlight the **Date Format** value.
4. Push ENTER to set the date and go back to the **Date/Time Settings** screen.

To set the time format:

1. Push ▲ or ▼ to highlight the **Time Format** value.
2. Push ENTER.

3. Push ⏶ or ⏷ to highlight the **Time Format** value.
4. Push ENTER to set the format and go back to the **Date/Time Settings** screen.

How to Set the Backlight Intensity

The backlight on the Product has two intensity levels: Low and High. Each intensity can be set separately. From the **Setup** screen, push ⏶ or ⏷ to highlight **Display Settings** and push ENTER. To go back to the **Setup** screen, push the **Back** softkey.

To set the backlight intensity:

1. Push ENTER.
2. Push ⏶ or ⏷ to highlight a backlight value.
3. Push ⏶ or ⏷ to increase or decrease the backlight intensity.
4. Push ENTER to set the backlight intensity and go back to the **Display Settings** screen.

How to Set the Beeper

The Product beeper can be turned on and off and its volume set. From the **Setup** screen, push ⏶ or ⏷ to highlight **Sound Settings** and push ENTER. To go back to the **Setup** screen, push the **Back** softkey.

5. Push ENTER.
6. Push ENTER.
7. Push ⏶ or ⏷ to highlight **On** or **Off**.

When the beeper is set to on, two more variables appear in the Sound Settings screen.

To set the beeper type:

1. Push ⏶ or ⏷ to highlight the **Beep Type** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight the **Beeper Type** value.

   The beeper can be set to beep at each key press or to beep only when an error occurs.
4. Push ENTER to go back to the **Sound Settings** screen.

To set the beeper volume:

1. Push ⏶ or ⏷ to highlight the **Volume** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight the **Volume** value.
4. Push ENTER to set the volume and go back to the **Sound Settings** screen.

How to Set the Pressure Units and IBP Sensitivity

The units of measure for pressure (IBP and NIBP) values and IBP sensitivity to simulate are set through the pressure Settings. From the **Setup** screen, push ⏶ or ⏷ to highlight **IBP Settings** in the setup list and push ENTER. To go back to the **Setup** screen, push the **Back** softkey.

To set the IBP sensitivity:

1. Push ⏶ or ⏷ to highlight the **IBP Sensitivity** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight a sensitivity value.

4. Push ENTER to set the sensitivity and go back to the **Pressure Settings** screen.

To set the Pressure units:

1. Push ⏶ or ⏷ to highlight the **Units** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **mmHg** or **kPa**.
4. Push ENTER to set the units and go back to the **IBP Settings** screen.

How to Set Battery Settings

To help save battery life, the Product can be set to power down (Auto power off) when no buttons are sensed as pushed for a set period of time. You can also set whether or not the battery charges in the Product. From the **Setup** screen, push ⏶ or ⏷ to highlight **Battery Settings** and push ENTER. To go back to the **Setup** screen, push the **Back** softkey.

To set auto power off:

1. Push ⏶ or ⏷ to highlight the **Auto Power Off** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight an auto power off value.

   When enabled, auto power of can be set to 10, 30, or 60 minutes.
4. Push ENTER to set auto power and go back to the **Battery Settings** screen.

To set the battery charger:

1. Push ⏶ or ⏷ to highlight the **Charge Battery** value.
2. Push ENTER.
3. Push ⏶ or ⏷ to highlight **Yes** or **No**.
4. Push ENTER to set the charger value and go back to the **Battery Settings** screen.

Note

A 1-minute warning message will show in the display before the Product turns off.

How to Set the Display Language

The Product can be set to show text and messages in the display in many different languages. To set the language, push ⏶ or ⏷ to highlight **Instrument Information** in the **Setup** screen and push ENTER. To go back to the **Setup** screen, push the **Back** softkey.

The language already set in the Product, shows in the display. To change the language:

1. Push ENTER.
2. Push ⏶ or ⏷ to highlight a language in the list. Below is a list of the display languages.

English	Spanish
French	Japanese
Italian	Chinese
German	

3. Push ENTER.

How to Control the Product Remotely

Ansur test automation systems uses a solutions-based procedure for medical device tests. Ansur helps you make standard work through test templates and/or sequences that use your written test procedure. All test results are then integrated into one test report that can be printed or archived. Ansur manages your test procedures through manual and visual automated test sequences.

The software works hand-in-hand with Fluke Biomedical analyzers and simulators, that integrates:

- Visual inspections
- Preventive maintenance
- Work procedures
- Performance tests
- Safety tests

Ansur software uses plug-in modules to interface with a wide array of Fluke Biomedical instruments. The plug-in module is a software interface to the Ansur test program. Plug-ins supply test elements used by Ansur Executive that use the same user interface for all analyzers and simulators supported by an Ansur plug-in.

When you purchase a new Fluke Biomedical analyzer or simulator, you can update your existing Ansur software by installing a new plug-in. Each plug-in module allows you to work only with the options and capabilities you need for the instrument you are testing.

Maintenance

The Product is a calibrated measurement instrument. Try to prevent mechanical abuse that could change the calibrated values. The Product has no internal user-serviceable parts.

⚠⚠ Warnings

For safe operation and maintenance of the Product:

- **Do not keep cells or batteries in a container where the terminals can be shorted.**
- **Connect the battery charger to the mains power outlet before the Product.**
- **Repair the Product before use if the battery leaks.**
- **Remove batteries to prevent battery leakage and damage to the Product if it is not used for an extended period.**
- **Keep cells and battery packs clean and dry. Clean dirty connectors with a dry, clean cloth.**
- **Do not short the battery terminals together.**
- **Use only Fluke Biomedical approved power adapters to charge the battery.**

To prevent personal injury:

- **Do not disassemble the battery.**
- **Batteries contain hazardous chemicals that can cause burns or explode. If exposure to chemicals occurs, clean with water and get medical aid.**

- **Do not put battery cells and battery packs near heat or fire. Do not put in sunlight.**
- **Do not disassemble or crush battery cells and battery packs.**

To prevent possible electrical shock, fire, or personal injury:

- **Remove the input signals before you clean the Product.**
- **Use only specified replacement parts.**
- **Have an approved technician repair the Product.**

How to Clean the Product

⚠ Caution

Do not pour fluid onto the Product surface; fluid seepage into the electrical circuitry may cause the Product to fail.

⚠ Caution

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

Clean the Product occasionally with a damp cloth and mild detergent. Try to prevent the entrance of liquids.

Clean the adapter cables with the same precautions. Examine them for damage and deterioration of the insulation. Examine the connections for integrity. Keep the transducer adapter clean and dry.

Battery Maintenance

For peak battery performance, charge the Product to maximum charge once a month. If the Product is not to be used for more than a month, keep it connected to the charger.

Note

To get the specified performance, use the specified battery charger that comes with this Product.

When the battery gets low, a low battery message shows in the display.

When the battery discharges to 3 % of full charge, a different message shows and the NIBP function is disabled.

How to Charge the Battery

The battery charge level is shown in the upper-right corner of the display when the battery pack is installed in the Product. If the Product is plugged in, ⊖-◐-⊕ shows in the upper right corner of the display. When the battery charges, the status is updated in **Battery** setting under SETUP. With the AC/DC power supply removed from the Product, the battery icon shows the charge level.

The battery can be charged while it is in or out of the Product. The charge rate is slower when the Product is energized and the battery charger is on. To charge the battery:

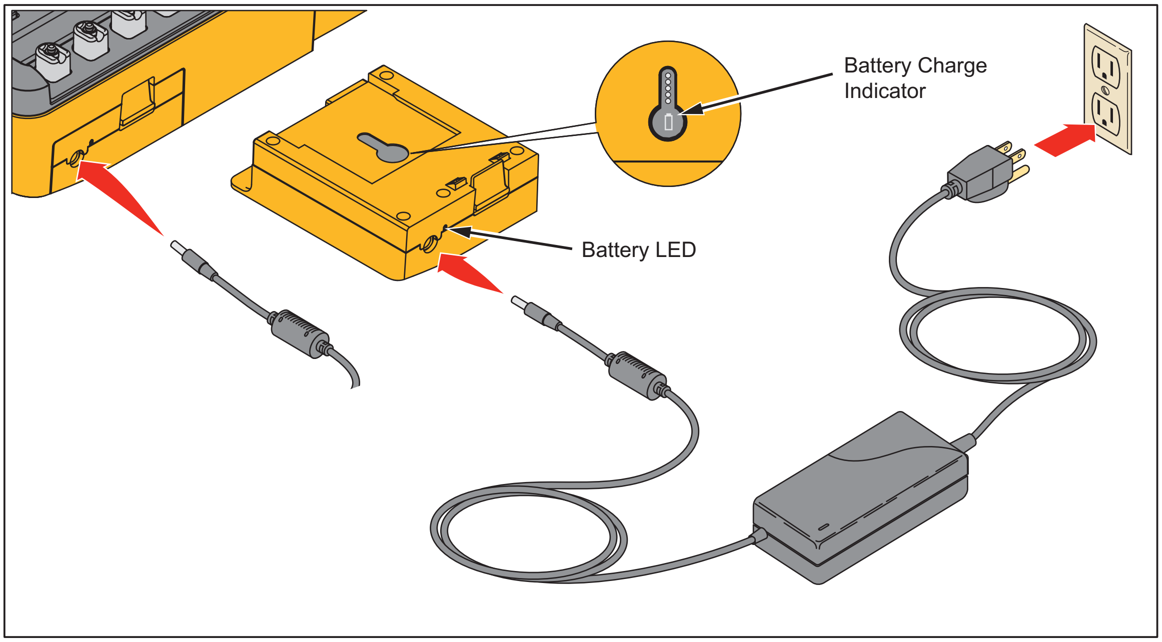
1. As shown in Figure 62, connect the AC/DC power supply to the power connector on the battery pack.
2. Connect the AC/DC power supply to a power source.

Note

When the battery pack is installed in the Product, ensure the battery charger is enabled. See the How to Set Battery Settings section earlier in the manual to enable and disable the battery charger.

The battery charge LED on the battery pack shows red or green when the battery charges. When the LED is green, the battery is charged.

When you have two or more battery packs, you can charge one battery externally while you use the other to energize the Product.



glh047.eps

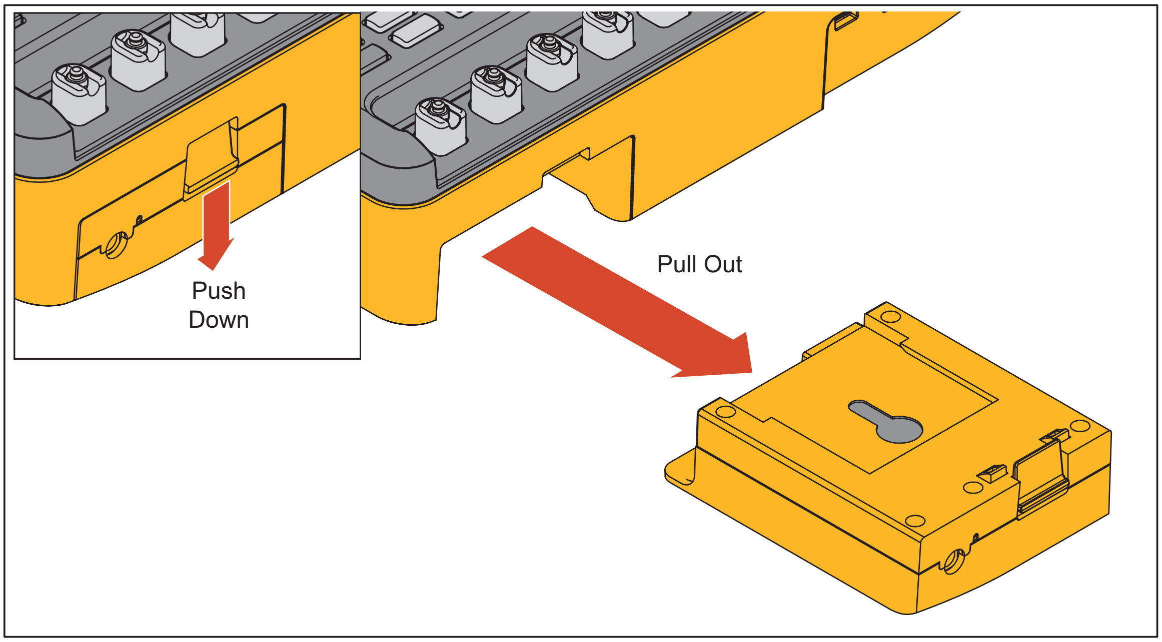
Figure 62. External Battery Charging Connections

When the battery pack is removed from the Product, push the button below the charge level indicators to see the battery charge level. See Figure 62.

Battery Removal

The battery pack is easy to remove and replace. To remove the battery pack:

1. Push down on the battery pack latch as shown in Figure 63.
2. Remove the battery pack from the Product.



glh046.eps

Figure 63. Battery Removal

To put the battery pack into the Product, align the battery pack with the guides on the Product and push it into the Product until the latch locks.

The ProSim 6/8 battery is not compatible with the ProSim 4.

General Specifications

Temperature	
Operating	10 °C to 40 °C (50 °F to 104 °F)
Storage	-20 °C to +60 °C (-4 °F to +140 °F)
Humidity	10 % to 90 % non-condensing
Altitude	3,000 meters (9,843 ft)
Size (L x W x H)	30.22 cm x 14.48 cm x 8.64 cm (11.9 in x 5.7 in x 3.4 in)
Display	LCD Color Display
Communication	
USB Device Upstream Port	Mini-B connector for control by a computer
USB Host Controller Port	Type A, 5 V output, 0.5 A max load. Connector for keyboard, barcode reader, and printer
Wireless (ProSim8 Only)	IEEE 802.15.4 for control by a computer
USB Device Virtual COM Port Settings	
Baud Rate	115,200 bps
Data bits	8 data bits
Stop Bits	1 stop bit
Flow Control	Hardware (RTS/CTS)
Power	Lithium-Ion rechargeable, 7.2 V, 31 Wh battery, 4300 mAh
Battery Charger	100 to 240 V, 50/60 Hz input, 15 V/2.0 A output. For best performance, the battery charger should be connected to a properly grounded ac receptacle
Battery Life	9 hours (minimum), 100 NIBP cycles typical
Weight	1.81 kg (4 lb)
Safety Standards	EN/IEC 61010-1:2001
Certifications	CE, CSA C US, N10140
Electromagnetic Compatibility (EMC)	EN 61326-1:2006

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 .... 0.5 V/mV ±5 % of the ECG amplitude setting available on a BNC connector.

Amplitude .... 0.05 mV to 0.5 mV (0.05 mV steps); 0.5 mV to 5.0 mV (0.25 mV steps). Other leads are proportional to Lead II (reference lead) in percentage per:

- Lead I 70
- Lead II 100
- Lead III 30
- Lead V1 24
- Lead V2 48
- Lead V3 100
- Lead V4 120
- Lead V5 112
- Lead V6 80

Amplitude Accuracy .... ±(2 % of setting + 0.05 mV)

ECG Rate

- ProSim 8 .... 10 to 360 BPM in 1 BPM steps
- ProSim 6 .... 30 to 360 BPM in 10 BPM steps

Rate Accuracy .... ±1 % of setting

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

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 .... 60 BPM, 1.0 mV, adult QRS and ST-segment elevation of 0 mV

Pacemaker Waveform

Pacer-Pulse

Amplitude .... 0 (off), ±2, ±4, ±6, ±8, ±10, ±12, ±14, ±16, ±18, ±20, ±50, ±100, ±200, ±500, and ±700 mV for lead II (reference lead)

Accuracy

- Reference lead II .... ±(5 % setting + 0.2 mV)
- All other leads .... ±(10 % setting + 0.4 mV)

Pacer-Pulse Width .... 0.1, 0.2, 0.5, 1.0, and 2.0 ms ±5 %

Paced Arrhythmias .... Atrial 80 BPM
Asynchronous 75 BPM
Demand with frequent sinus beats
Demand with occasional sinus beats
Atrio-Ventricular sequential
Noncapture (one time)
Nonfunction

Power-On Default .... Amplitude 10 mV, width 1.0 ms, atrial waveform

Arrhythmia

Baseline NSR .... 80 BPM

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

Supraventricular Arrhythmia

- ProSim 8 .... Atrial fibrillation (coarse or fine); atrial flutter; sinus arrhythmia; missed beat (one time); atrial tachycardia; paroxysmal atrial tachycardia; nodal rhythm; and supraventricular tachycardia.
- ProSim 6 .... Atrial fibrillation (coarse or fine) and sinus arrhythmia

Premature Arrhythmia

ProSim 8 .... 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

ProSim 6 .... Premature atrial contraction (PAC) and multifocal PVCs

Ventricular Arrhythmia

ProSim 8 .... PVCs 6, 12, or 24 per minute; frequent multifocal PVCs; bigeminy; trigeminy; multiple PVCs (one-time run of 2, 5, or 11 PVCs); mono-ventricular tachycardia (120 to 300 BPM in 5 BPM steps); poly-ventricular tachycardia (5 types); ventricular fibrillation (coarse or fine); and Asystole

ProSim 6 .... Bigeminy; mono-ventricular tachycardia (120 to 300 BPM in 5 BPM steps); poly-ventricular tachycardia (5 types); ventricular fibrillation (coarse or fine); and Asystole

Conduction Defect

ProSim 8 .... First-, second-, or third-degree heart block; and right- or left-bundle-branch block

ProSim 6 .... Second-degree heart block, type 1, and right-bundle-branch block

Advanced Cardiac Life Support (ProSim 8 only)

Shockable Pulseless Arrest Rhythms .... Ventricular fibrillation (coarse), ventricular fibrillation (fine), unstable polymorphic ventricular tachycardia

Non Shockable Pulseless Arrest Rhythms .... Asystole

Symptomatic Bradycardia .... Sinus Bradycardia (<60 BPM)
2nd Degree AV Block, Mobitz Type I
2nd Degree AV Block, Mobitz Type II
Complete/3rd Degree AV Block
Right Bundle Branch Block
Left Bundle Branch Block

Symptomatic Tachycardia

Regular Narrow-complex Tachycardias (QRS <0.12 seconds)

Sinus Tachycardia .... >150 BPM

Supraventircular Tachycardia .... SVT

Regular Wide-complex Tachycardias (QRS ≥0.12 seconds)

Sinus Tachycardia .... >150 BPM

Supraventircular Tachycardia .... SVT with aberrancy

Irregular Tachycardia .... Atrial Fibrillation (Coarse and fine), Atrial Flutter, unstable monomorphic ventricular tachycardia (120 to 300 BPM), Torsade De Pointes/Polymorphic ventricular tachycardia (long QT interval)

ECG-Performance-Testing

Amplitude (peak-to-peak) .... 0.05 to 0.5 mV (0.05 mV steps)
0.5 to 5.0 mV (0.25 mV steps)
Other leads are proportional to Lead II (reference lead) in percentage per:

Lead I 70

Lead II 100

Lead III 30

Lead V1 through V6 100

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

Square Wave .... 0.125, 2.0, 2.5 Hz

Triangle Wave .... 0.125, 2.0, 2.5 Hz

Sine Wave .... 0.05, 0.5, 1, 2, 5, 10, 25, 30, 40, 50, 60, 100, and 150 Hz

R-wave Detection (ProSim 8 only)

Waveform .... Triangular pulse

Rate .... 30, 60, 80, 120, 200, and 250 BPM

Width .... 8 to 20 ms in 2 ms steps, and 20 to 200 ms in 10 ms steps

Width Accuracy .... ±(1 % of setting + 1 ms)

QRS Detection (ProSim 8 only)

Widths .... 8 to 20 ms in 2 ms steps and 20 to 200 ms in 10 ms steps

Width Accuracy .... ±(1 % of setting + 1 ms)

Rate	30, 60, 80, 120, 200, and 250 BPM
R-Wave up slope	0.875 amplitude, 0.4375 x width
R-Wave down slope	Full amplitude, 0.5 x width
S-Wave up slope	0.125 amplitude, 0.0625 x width
Tall T-Wave Rejection (ProSim 8 only)	
Waveform	
QT Interval	350 ms
T-Wave width	180 ms
T-Wave Shape	½ sinewave
Amplitude	0 to 150 % reference lead amplitude in 10 % steps
Rate	80 BPM
Rate Accuracy	±1 % of setting
Amplitude Accuracy	±(2 % of setting + 0.05 mV)

ECG Artifact

Type	50 Hz, 60 Hz, muscular, baseline wander, respiration
Size	25, 50, 100 % of the normal sinus R-Wave for each lead
Lead Select	All, RA, LL, LA, V1, V2, V3, V4, V5, V6

Fetal / Maternal-ECG (ProSim 8 only)

Fetal Heart Rate (Fixed)	60 to 240 BPM in 1 BPM steps
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
Default Settings	FHR 140 BPM, early deceleration wave, manual

Invasive Blood Pressure

Channels	2, each independently settable with identical parameters and are individually electrically isolated from all other signals
Input/output Impedance	300 Ω ±10 %
Exciter Input Range	2.0 to 16.0 V peak
Exciter-Input Frequency Range	DC to 5000 Hz
Transducer Sensitivity	5 (default) or 40 µV/V/mmHg
Pressure Accuracy	±(1 % of setting + 1 mmHg) Accuracy guaranteed for DC excitation only
Static Pressure	-10 to +300 mmHg in 1 mmHg steps
Pressure Units	mmHg or Kpa
Dynamic Waveforms	
Types (default pressures)	Arterial (120/80) Radial artery (120/80) Left ventricle (120/00) Right ventricle (25/00) Pulmonary artery (25/10) Pulmonary-artery wedge (10/2) Right atrium (central venous or CVP) (15/10)
Pressure Variability	Systolic and diastolic pressures are independently variable in 1 mmHg steps.
Swan-Ganz Sequence	Right atrium, right ventrical (RV), pulmonary artery (PA), pulmonary artery wedge (PAW)
Cardiac Catheterization (ProSim 8 only)	
Chambers	Aortic, Pulmonary valve, and Mitral valve
Respiration Artifact	
Arterial, radial artery, and left ventricle	5 to 10 % multiplication
Other	5 or 10 mmHg
BP Output	Circular DIN 5-Pin
Power-On Default	0 mmHg

Respiration

Rate .... 0 (OFF), 10 to 150 BrPM in 1 BrPM steps
Waves .... Normal or ventilated
Ratio (inspiration:expiration)
Normal 1:1, 1:2, 1:3, 1:4, 1:5
Ventilated 1:1
Impedance Variations (Δ Ω) .... 0.00 to 1.00 Ω in 0.05 Ω steps and 1.00 to 5.00 Ω in 0.25 Ω steps
Delta Accuracy .... ±(5 % of setting + 0.1 Ω)
Baseline .... 500, 1000 (default), 1500, 2000 Ω, Leads I, II, III
Baseline Accuracy .... ±5 %
Respiration Lead .... LA or LL (default)
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

Temperature

Temperature .... 30.0 °C to 42.0 °C in 0.5 °C steps
Accuracy .... ±0.4 °C
Compatibility .... Yellow Springs, Inc. (YSI) Series 400 and 700
Output .... Circular DIN 4-pin

Cardiac Output

Catheter Type .... Baxter Edwards, 93a-131-7f
Calibration Coefficient .... 0.542 (0 °C injectate), 0.595 (24 °C injectate)
Blood Temperature .... 36 °C (98.6 °F) to 38 °C (100.4 °F) ±0.2 °C in 1 °C steps
Injectate Volume .... 10 cc
Injectate Temperature .... 0 °C or 24 °C
Cardiac Output .... 2.5, 5, 10 liters per minute ±7.5 %
Faulty-Injectate Curve .... Waveform for simulation available
Left-to-Right-Shunt Curve .... Waveform for simulation available
Calibrated Pulse .... 1.5 ° for 1 second
Connector .... Circular DIN 7 pin
Power-On Default .... 5 liters per minute, 0 °C injectate, 37 °C blood temperature

Non-Invasive Blood Pressure

Pressure Units .... mmHg or kPa
Manometer (Pressure Meter)
Range .... 10 to 400 mmHg
Resolution .... 0.1 mmHg
Accuracy
ProSim 8 .... ±(0.5 % reading +0.5 mmHg)
ProSim 6 .... ±(1 % reading +1 mmHg)
Pressure Source
Target Pressure Range .... 20 to 400 mmHg
Resolution .... 1 mmHg
NIBP Simulations
Pulse .... 2 mmHg max into 500 ml NIBP system
Volume of air moved .... 1.25 ml max
Simulations .... Systolic/diastolic (MAP)
Adult .... 60/30 (40), 80/50 (60), 100/65 (77); 120/80 (93); 150/100 (117); and 200/150 (167) and 255/195 (215)
Neonatal .... 35/15 (22); 60/30 (40); 80/50 (60);100/65 (77);120/80 (93) and 150/100 (117)
Pressure variability .... Systolic and diastolic pressures are variable by 1 mmHg
Repeatability .... Within ±2 mmHg (at maximum pulse size independent of device under test)

Synchronization

Normal Sinus heart rates .... 30 to 240 BPM

Maximum rate at 1 ml .... 240 BPM achievable with pulses up to 1 ml

Maximum rate at 1.25 ml .... 180 BPM

Arrhythmias.. Premature atrial contraction (PAC), Premature ventricular contraction (PVC), atrial fibrillation, and missed beat.

Leak Test

Target Pressure .... 20 to 400 mmHg

Elapsed time .... 0:30 to 5:00 minutes:seconds in 30 second steps

Range .... 0 to 200 mmHg/minute

Internal Leak rate .... <2 mmHg/min into 500 ml rigid volume

Pressure Relief Test Range .... 100 to 400 mmHg

Oximeter SpO2 Optical Emitter and Detector (optional)

% O2

Range .... 30 to 100 %

Resolution .... 1 %

Accuracy

With oximeter manufacturer's R-curve

Saturation within UUT specific range.......... ±(1 count + specified accuracy of the UUT)

Saturation outside UUT specific range .... monotonic with unspecified accuracy

With Fluke Biomedical R-curves

91 to 100 %.. ±(3 counts + specified accuracy of the UUT)

81 to 90 %.. ±(5 counts + specified accuracy of the UUT)

71 to 80 %.. ±(7 counts + specified accuracy of the UUT)

Below 71 %.. monotonic with unspecified accuracy

Heart Rate

Range .... 30 to 300 BPM in 1 BPM steps. Oximeter SpO2 Optical Emitter and Detector is synchronized with ECG rate delayed by 150 ms.

Accuracy .... ±1 % of setting

Transmission (Ratio of detector current to LED current, expressed in parts per million (ppm))

Range .... 0 to 300.00 ppm

Resolution .... 0.01 ppm

Accuracy .... +50 %/-30 % for compatible monitors, unspecified for others. Selected by finger size and color: Dark, thick finger, medium finger, light, thin finger, neonatal foot.

Pulse Amplitude

Range .... 0 to 20.00 %

Resolution .... 0.01 %

Artifact

Respiration

Range .... 0 to 5 % of transmission

Resolution .... 1 %

Rate .... all ProSim respiration simulation settings

Ambient Light

Range .... 0 to 5X transmitted light

Resolution 1X

Frequency .... DC, 50 Hz, 60 Hz, and 1 to 10 kHz in 1 kHz steps

Masimo Rainbow Technology .... Masimo Rainbow technology with an optional adapter supplied by Masimo that allows the ProSim two wavelength to test the Rainbow multiple wavelength system

Compatible Manufacturer Products

With manufacturer R-curve................................ Nellcor, Masimo, Nonin, and Nihon Kohden

With Fluke Biomedical R-curve.......................... Mindray, GE-Ohmeda, Philips/HP, and BCI

Pre-Defined Simulations

Normal
Hypertensive
Hypotensive
Tachycardic
Bradycardic
Ventricular Fibrillation
Asystole

Autosequences (default)

Monitor testing sequence
Medical training sequence
Oximeter testing sequence
Cardiac failure sequence
Arrhythmia sequence
Exercise sequence
Respiration sequence
Performance Wave Test
IBP testing sequence
Temperature sequence

Appendix A
Glossary

Introduction

The words in this glossary are common words used in this manual that may need further explanation. Words in italics are words that are defined in this glossary.

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.

AC component

The *pulse* factors of the blood measured by oximetry.

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 2×10^{-7} 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.

Apnea

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).

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.

An *ECG* artifact can be caused by depolarization or contraction of the muscle which depends on an electrical charge. These electrical charges can be detected by an electrocardiogram. The electrical charges associated with the contractions of the heart will be clear only if there is not interference by auxiliary signals from other muscle movement. 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

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.

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.

Atrial Fibrillation

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

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.

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.

Atrium

(1) One of the two upper chambers of the heart. (2) Any chamber allowing entrance to another structure or organ.

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-persecond (bps) means the number of binary digits transmitted in one second.

Bigeminy

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.

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-Branch Block

Blockage in the right- or left-bundle branches, with beats exhibiting a wide QRS and a PR 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.)

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.

DC component

See R-Value

ECG

An electrocardiogram (ECG) records the electrical signals of the muscles of the heart—the depolarization and repolarization of the *myocardium*. Wires from an ECG machine are connected to small plastic or metal cables called leads, or electrodes. Put on the chest, the wrists of the right and left arms, and the left leg at the ankle, these electrodes transmit signals to a recorder. The recorder makes lines in the shape of waves on graph paper in the ECG machine, follow the heart's electrical activity (rate) and its rhythm (beat). Each contraction of a normal heart causes a normal sinus rhythm (NSR) *waveform*, also referred to as the P QRS T waveform.

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.

Gram

A metric unit of mass and weight, equal to one-thousandth of a *kilogram*, about 0.035 ounces.

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.

Hemoglobin

The oxygen-bearing, iron-containing conjugated protein in vertebrate red blood cells, consisting of about 6 per cent **heme** and 94 per cent **globin**.

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.

Millivolt

One-thousandth of a *volt*.

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.

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).

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.

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 (10^{-9}) of a *meter*.

Nanosecond

One billionth (10^{-9}) of a second (one thousand-millionth of a second). Electricity travels approximately one foot per nanosecond.

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*.

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.

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.

PCWP

Pulmonary *capillary* wedge pressure. Also known as PAW.

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*.

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.

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*.

Pulse

The rhythmical throbbing of arteries produced by regular contractions of the heart.

Pulse Oximeter

A *non-invasive*, arterial, oxygen-saturation monitor that measures the ratio of two principle forms of *hemoglobin* in the blood.

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.

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.

QRS Complex
The part of the P-QRS-T wave that records ventricular depolarization and contraction.

R-Value
The non-pulsating components of tissue, specifically the tissue bed, the *venous* blood, the *capillary* blood, and nonpulsatile arterial blood. Also referred to as the DC component.

Resistance
The opposition to electric current that is characteristic of a medium, substance, or circuit element.

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.

SaO2
Abbreviation for saturated oxygen, SaO2 is the ratio of the concentration of oxyhemoglobin (cHbO2) to the concentration of the two principle types of blood *hemoglobin*: saturated hemoglobin (HbO2) plus reduced hemoglobin (Hb).

Serial Port
An *asynchronous* COMmunication port/address to which a peripheral—such as a printer or a mouse—is connected to a computer or other device. SEE RS-232.

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).

SpO2
The type of saturated oxygen measured with a *pulse oximeter*.

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*.

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*.

Swan-Ganz Procedure
After insertion of a Swanz-Ganz catheter 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.

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.

Trigeminy
A PVC appears after every two normal *QRS complexes*.

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*.

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.

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.

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.