Non-Invasive Blood Pressure

ZOLL M Series

9650-0214-01 Rev. F

The issue date or revision level for this operation guide is shown on the front cover.
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Table of Contents

Preface

How Do I Use This Manual?

This manual insert describes the set up and use of the M Series Non-Invasive Blood Pressure option. If you already know how to use the M Series unit, start by reading the "Safety Summary", "Indications for Use" and "Introduction" sections of this insert. Familiarize yourself with all the procedures in this insert before you use the NIBP option. Consult the "Troubleshooting" section if the M Series unit fails to operate as expected.

If you do not know how to use the M Series unit, see the *M Series Operator's Guide* and the relevant inserts. Thoroughly read the Safety Considerations and Warnings sections in both the *M Series Operator's Guide* and the relevant inserts before operating your M Series product.

Place this insert in the three-ring binder along with the *M Series Operator's Guide* and all other option inserts.

Safety Summary

The following section summarizes the warnings, cautions and other safety information related to the NIBP option. Additional warnings and cautions are in the text of this insert. Read this section thoroughly before operating the NIBP Option.

General NIBP Safety

- Read the *M Series Operator's Guide* and this manual insert before use.
- Ensure that the M Series NIBP option is operated by qualified personnel only.
- Consult a physician for the proper interpretation of pressure measurements.
- Do not use the NIBP option on newborns or infants whose upper arm circumference is less than 13 cm unless the unit is an M Series CCT unit.
- Do not use on patients known to be susceptible to bruising.
- Use caution when using on elderly hypertensive patients, as such patients may be more susceptible to bruising.
- Do not use in the presence of oxygen-rich atmospheres, flammable anesthetics or other flammable agents (such as gasoline). Do not use near the site of a gasoline spill. Explosion may result.
- Route patient cabling and hoses carefully to avoid patient entanglement, strangulation or compression of hose.
- Do not select a cuff inflation pressure that exceeds the patient's expected systolic pressure by more than 30-40 mmHg (4.0-5.3 kPa). The factory-installed default cuff inflation pressure is 160 mmHg (21.3 kPa) for adult patients. On M Series CCT units, the default cuff inflation pressure is 160 mmHg (21.3 kPa) for adult patients, 120 mmHg (16.0 kPa) for pediatric patients, and 90 mmHg (12.0 kPa) for neonatal patients.
- Do not attach the cuff to a limb being used for IV infusion or SpO_2 monitoring. Cuff inflation might block the infusion, causing harm to the patient or inaccurate measurements.
- Keep patients as still as possible during measurement. Patient movement or vibrations from outside sources, particularly moving vehicles, can degrade the measurement accuracy.
- Do not touch the bed, patient, or any equipment connected to the patient during defibrillation. A severe shock to the operator can result.

- Do not allow exposed portions of the patient's body to come in contact with metal objects, such as a bed frame during defibrillation. Unwanted electrical pathways can result.
- Check patient regularly for signs of skin irritation or impaired circulation in the monitored limb.
- If an alarm occurs while the alarms are audibly disabled, audio alarms do not sound, only visual alarms display.
- If the accuracy of measurements is suspect, first check the patient's vital signs by alternate means. Then check the cuff, hose and M Series NIBP option for proper functioning.
- Do not immerse the M Series device, batteries, patient cables, sensors or airway adapters in water, solvents, or cleaning solutions.
- Do not sterilize.
- Connect the ECG-out jack and modem (if available) only to other equipment with galvanically isolated circuits.
- The cuff, hose and fitting are defibrillator proof. Using the NIBP option introduces no risk for shock due to defibrillation. The cuff and hose are non-conductive. Using the NIBP option introduces no risk for burns due to electro-surgery.

Cuff and Hose Safety

- Only use cuffs, hoses and connectors supplied or specified by ZOLL.
- Ensure that the hose is not kinked or obstructed before taking measurement.
- Do not use damaged cuffs, hoses or connectors.
- Ensure proper cuff selection and placement to avoid inaccurate measurements or patient injury.
- Position the cuff so it is level with the heart during measurement.
- Do not place the cuff on a limb with an SpO_2 sensor or an infusion line.
- Do not repeat NIBP measurements (particularly STAT measurements) at intervals less than 3-5 minutes over an extended period of time. Rapidly repeating measurement can impair circulation in the monitored limb.
- Do not sterilize or immerse the cuffs or hoses.

Indications for Use

The ZOLL M Series NIBP option is indicated for the noninvasive measurement of arterial blood pressure for resting patients in critical care and transport. The NIBP option on standard M Series units is designed to measure blood pressure for adult and pediatric patients only. The NIBP option on M Series CCT units is designed to measure blood pressure for adult, pediatric, and neonatal patients.

Contraindications for Use

Use of the ZOLL M Series NIBP option is not indicated for use on neonatal patients or infants whose upper arm circumference is less than 13 cm unless the unit is an M Series CCT unit.

SunTech CE Contact

All cuff, hose and NIBP questions with regards to the Declaration of Conformity with European Union Directives should be directed to the authorized representative for SunTech:

SunTech Medical Instruments Ltd.
Oakfield Industrial Estate
Stantom Harcourt Road
Eynsham, Witney
OX8 ITS
UK

Introduction

What Can I Do With the NIBP Option?

With the NIBP option you can do the following in Monitor, Pacer, or Defib mode:

- Take a single blood pressure measurement.
- Take a STAT measurement - as many measurements (up to ten) as possible within five minutes.
- Take repeated measurements at user-programmable intervals.
- Immediately abort any measurement in progress by pressing one button.
- Set the cuff inflation pressure to adjust automatically based on the previously measured systolic value.
- Display systolic, diastolic and mean blood pressure on the screen.
- Configure alarms to go off when the unit detects blood pressure values above or below user-programmable limits.

How Do I Use the NIBP Option?

To take safe and accurate blood pressure measurements using the M Series NIBP option, you must do all of the following:

1. Select the proper sized cuff.
2. Connect the hose to the M Series unit and to the cuff.
3. Apply the cuff to the patient.
4. Display the NIBP menu.
5. Set the cuff inflation pressure (if the current setting is not appropriate).
6. Configure alarms (if the current settings are not appropriate).
7. Take blood pressure measurement(s).
8. Read the display.

NOTE To facilitate quick reactions in emergency situations, press the NIBP button instead of completing steps 4 - 7.

Each step corresponds to a section in this chapter. Read each section carefully before you use the M Series NIBP option.

WARNING Do not use the NIBP option without proper training. Setting initial inflation pressure too high can result in serious injury to the patient. Patient movement, very low pulse volume or vibration from outside sources can influence the accuracy of blood pressure measurements.

How Does the NIBP Option Work?

The NIBP option uses the oscillometric method to measure arterial blood pressure and consists of the following parts:

- Blood pressure cuff.
- Hose.
- Pump.
- Pressure sensor and signal processing electronics/software (inside the M Series unit).

When taking a measurement, the M Series unit performs the following cycle:

1. Cuff inflates to preset pressure, cutting off the flow of blood through the arteries in the monitored limb.
2. Cuff deflates incrementally.
3. When the cuff pressure drops far enough, the blood flow in the patient's arteries resumes.
4. Pressure oscillations caused by the restricted blood flow travel from the cuff, through the hose, and to the M Series unit.
5. A sensor inside the M Series unit measures the pressure oscillations and calculates the corresponding systolic, diastolic, mean blood pressure and pulse rate values.
6. Blood pressure values display on the screen.

This cycle takes approximately 30 seconds. If set to do so, the M Series unit repeats the cycle at a user-selected interval.

If the sensor cannot detect systolic pressure, the M Series unit immediately increases the cuff inflation pressure and completes the measurement. If the M Series unit finds a fault, it displays a corresponding message on the screen. If after 180 seconds the M Series unit has not been able to determine systolic, diastolic or mean pressure, it aborts the measurement and deflates the cuff.

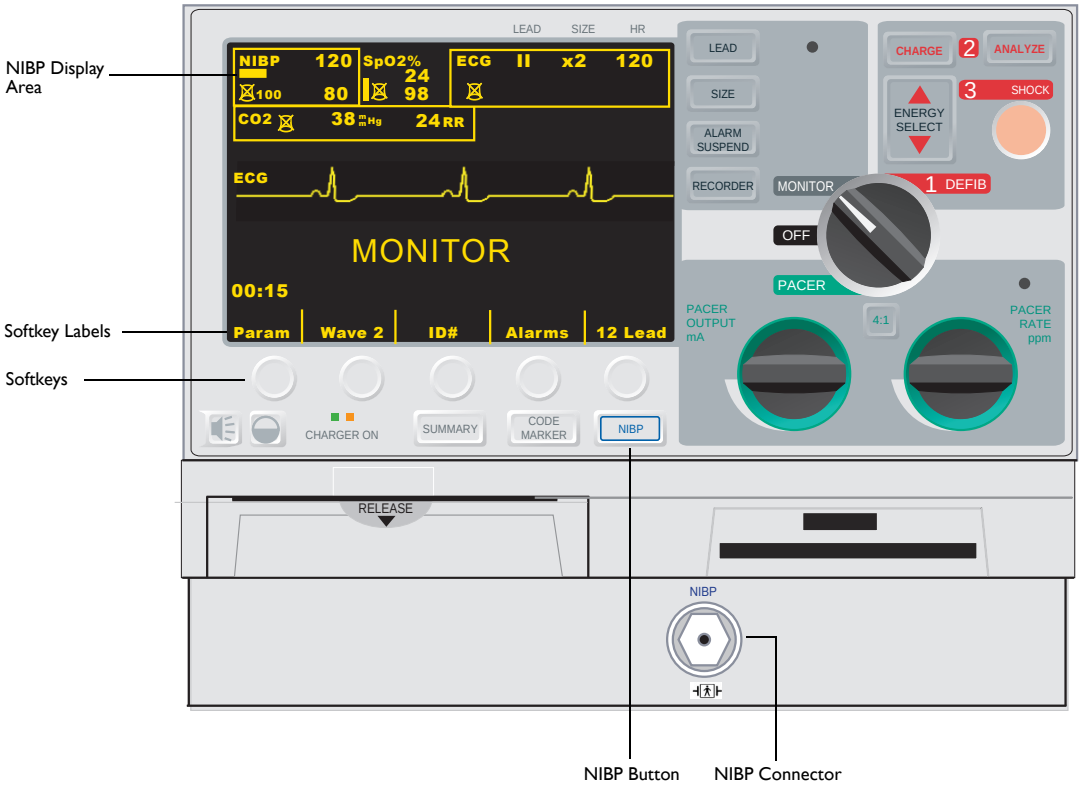
When taking automatic interval measurements, the M Series unit does not start a new measurement unless 30 seconds have elapsed since the end of the previously completed measurement cycle.

How Do I Read the Display?

After each measurement, the NIBP display area displays systolic, diastolic, and mean blood pressure values.

To access most NIBP features you must press a softkey with the appropriate softkey label. To facilitate quick reaction in emergency situations, you can control certain NIBP features by pressing the NIBP button (see the following figure):

Figure 1 M Series Front Panel with NIBP Option



NOTE Depending on the options included in your M Series unit, your front panel and display may differ slightly from the illustrations in this insert.

The NIBP display area consists of:

- Symbols that represent the status of blood pressure measurements.
- Numbers that represent the measurement values (see Figure 2 and Table 1):

Figure 2 NIBP Display Area

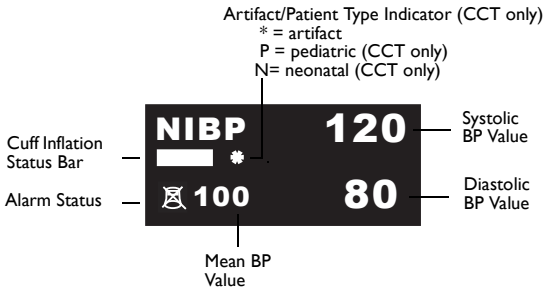


Table 1 NIBP Display Symbols

Display Symbols	Status
NIBP mmHg	Not taking any NIBP measurements
NIBP	Taking a single measurement
STAT alternating with NIBP	Taking STAT measurement
AUTO alternating with NIBP	Taking Auto measurement.
AUTO mmHg alternating with NIBP mmHg	Between Auto measurements
	Alarms enabled
	Alarms disabled

The movement of the Cuff Inflation Status Bar reflects the cuff inflation pressure. As the cuff inflates, the Cuff Inflation Status Bar lengthens. As the cuff deflates, the Cuff Inflation Status Bar shortens. When the cuff is fully deflated, the Cuff Inflation Status Bar is not displayed.

On M Series CCT units, a Patient Type indicator appears in the display area if the unit is in pediatric (“P”) or neonatal (“N”) mode. There is no Patient Type indicator if the unit is in adult patient mode (default).

The Artifact Indicator flashes when the M Series unit detects artifact in the signal. (On M Series CCT units, the Artifact Indicator alternates with the Patient Type indicator if the unit is in either pediatric or neonatal patient mode.) Under such circumstances, perform additional blood pressure measurements. If you repeatedly obtain artifact, use alternate techniques to obtain blood pressure prior to taking clinical action.

The M Series default unit of measure is millimeters of mercury (mmHg), but you can configure the M Series to display kilopascals (kPa). See the *M Series Configuration Guide* for information on configuring alternate units of measure.

Preparing to Take Measurements

Setting Up the Hose and the Cuff

Before taking NIBP measurements, select the appropriately sized cuff, connect the hose to the M Series unit and to the cuff, and apply the cuff to the patient. Additional cuffs and hoses can be ordered from ZOLL Medical Corporation. See "Ordering Accessories" on page 21 for part numbers.

Selecting the Cuff

The NIBP option comes with a cuff that inflates to cut off the patient's blood flow and then deflates slowly to allow the blood flow to gradually resume. To take accurate measurements, you must use the proper sized cuff. Bladder length should be at least 80 percent of the limb circumference, while the cuff width should be equal to 40 percent of the limb circumference.

Select the appropriate size cuff for the patient from the following table:

Table 2 Cuff Selection

Limb Circumference	Cuff
34.3 to 48.2 cm	Large Adult
25.4 to 42.0 cm	Adult Plus
25.4 to 34.3 cm	Adult
21.1 to 26.6 cm	Small Adult
16.0 to 21.8 cm	Pediatric
12.0 to 16.5 cm	Small Pediatric*
8.0 cm to 15.0 cm	Neonate #5*
7.0 to 13.0 cm	Neonate #4*
6.0 to 11.0 cm	Neonate #3*
4.0 to 8.0 cm	Neonate #2*
3.0 to 6.0 cm	Neonate #1*

* Neonatal and pediatric NIBP modes available on M Series CCT units only.

You can now connect the hose to the M Series unit and the cuff.

Connecting the Hose

The NIBP option comes with a hose that has a plastic connector on one end and a metal connector on the other end. Attach this hose to both the M Series unit and the cuff before taking a measurement. The cuff has its own short length of hose with a connector on the end. This connector fits into the end of the hose that is not connected to the M Series unit.

To connect the hose:

1. Insert the metal connector into the NIBP connector at the front of the M Series unit and push the connector until it snaps into place.
2. Insert the plastic connector into the cuff connector and twist the connectors until they lock into place.

You can now apply the cuff to the patient.

Applying the Cuff to the Patient

Using a cuff that is too small or is loosely applied results in values higher than the patient's actual blood pressure. Using a cuff that is too large results in values lower than the patient's actual blood pressure.

To apply the cuff to the patient:

1. Ensure the patient is sitting or lying down with the limb relaxed, extended and placed on a smooth surface for support.
2. Place the cuff 2 to 5 cm above the elbow crease or 5 to 10 cm above the knee crease.

CAUTION Do not place the NIBP cuff on the same arm/leg as an SpO_2 sensor. Inflation of the cuff will cause the SpO_2 monitor to read incorrectly.

CAUTION Ensure that the cuff is at the same level as the heart. If the cuff is located below the patient's heart, the blood pressure measurements display false high readings. If the cuff is located above the patient's heart, the blood pressure measurements display false low readings.

3. Adjust the cuff so that the artery marker on the cuff is over the artery, pointing to the hand or foot.
4. Check that the cuff ends between the Range lines marked on the cuff. If they do not line up, use a different sized cuff.
5. Wrap the deflated cuff snugly around the limb without impeding blood flow.
6. Ensure that the hose is routed to avoid kinking or compression.

You can now access the NIBP features.

Accessing NIBP Features

Unless you are sure that the NIBP cuff inflation and alarm settings are appropriate for the patient, display the NIBP menu before you take a blood pressure measurement. When you first turn on the M Series unit, the NIBP settings are at their default values.

While the factory-installed default settings are appropriate for most patients, do not assume the settings are at their default. NIBP settings may not be at their factory-installed defaults because a previous user may have:

- Changed the settings (if you did not turn on the M Series unit).
- Reconfigured the default settings.

Use the default settings unless they are clearly inappropriate for the patient. Any changes to these settings remain in effect until either the settings are changed or 10 seconds after the M Series unit is turned off. If you have not received training on setting NIBP features, do not use the NIBP option.

To facilitate quick reaction during emergency situations, you can directly access many NIBP features without displaying the NIBP menu (see the following table).

WARNING Do not start NIBP measurements unless you are sure that the cuff inflation and alarm settings are appropriate for the patient. Incorrect settings can result in patient injury or inaccurate measurements.

Table 3 Accessing NIBP Features

Task	Action
Taking a single measurement.	Press the **NIBP** button.
Taking STAT measurements.	Press and hold the **NIBP** button for two seconds.
Taking automatic measurements.	See "Displaying the NIBP Menu" on page 7.
Aborting measurement in progress.	Press the **NIBP** button.
Changing NIBP settings.	See "Displaying the NIBP Menu" on page 7.

Displaying the NIBP Menu

Unless it is an emergency situation where quick reaction is essential, you should always check that the cuff inflation and alarm settings are set properly before taking a measurement. You can access all NIBP features through the NIBP menu (see Figure 1 on page 3). You can display the NIBP menu without leaving Monitor, Defib or Pacer mode. AEDs must be in manual override mode to display the NIBP menu.

Displaying the NIBP Menu

To display the NIBP menu:

1. Press the **Param** softkey. If the **Param** softkey label is not displayed, press the **Return** softkey until “Param” displays.

   The M Series unit displays the Parameter menu (see the following figure):

   Figure 3 Parameter Menu

2. Press the **Select** softkey until “NIBP” highlights.
3. Press the **Enter** softkey.

   The M Series unit displays the NIBP menu:

   Figure 4 NIBP Menu

   On M Series CCT units, the following NIBP menu appears:

   Figure 5 NIBP Menu (CCT only)

NOTE The following procedures assume that you are already in the NIBP menu.

Selecting the Patient Type (CCT units only)

On M Series CCT units, you can select a patient type for NIBP measurements: adult, pediatric, or neonate. The patient type setting determines the default cuff inflation pressure, as well as alarm limits for high/low systolic, diastolic and mean blood pressure values.

Unless configured otherwise, the M Series CCT unit defaults to adult patient mode when initially powered on. See the *M Series Configuration Guide* for more information.

NOTE When you change the patient type setting, the unit clears any currently displayed NIBP values from the LCD. You must reinitiate NIBP measurement to display new blood pressure values.

To change the Patient Type setting:

1. Press the **NIBP PT. Type** softkey from the NIBP menu. If the **NIBP PT. Type** softkey label is not displayed, see "Displaying the NIBP Menu" on page 7.

   The M Series displays the NIBP Patient menu:

   Figure 6 NIBP Patient Menu

2. Press the **NIBP Adult**, **NIBP Ped**, or **NIBP Neonate** softkey to select the appropriate patient type setting.

   The M Series CCT unit displays a Patient Type indicator in the NIBP display area (“P” for pediatric mode, or “N” for neonatal mode), and automatically updates the default cuff inflation pressure and default alarm settings accordingly.

NOTE If you press the **Return** softkey, the M Series CCT unit returns to the NIBP menu without changing the patient type setting.

WARNING Do not begin NIBP measurements unless the patient mode setting is appropriate for the patient. Taking NIBP measurements on a pediatric or neonatal patient while the unit is in adult mode can result in inaccurate measurements and injury to the patient. Taking NIBP measurements on an adult patient while in pediatric or neonatal mode can result in inaccurate measurements.

Selecting Cuff Inflation Settings

Before taking a measurement, ensure that the cuff inflation settings are appropriate for the patient. To measure a patient’s blood pressure, the cuff must begin the measurement cycle by inflating to a pressure higher than the patient’s systolic blood pressure. This value is called the cuff inflation pressure. During a NIBP measurement, the M Series unit may increase the cuff inflation pressure over the initial value to obtain a systolic reading.

By default, the cuff inflation pressure for the first measurement after power-up is set as follows:

- 160 mmHg (21.3 kPa) for adult mode
- 120 mmHg (16.0 kPa) for pediatric mode (CCT units only)
- 90 mmHg (12.0 kPa) for neonatal mode (CCT units only)

Use the default settings unless they are clearly inappropriate. Any changes to these settings remain in effect until either the settings are changed or 10 seconds after the M Series unit is turned off (returning the settings to their defaults). See the *M Series Configuration Guide* for information on reconfiguring the cuff inflation pressure default setting.

As a safety feature, the cuff can never be inflated to more than 300 mmHg (40.0 kPa). On M Series CCT units, the cuff can never be inflated to more than 300 mmHg (40.0 kPa) in adult or pediatric mode, and never more than 150 mmHg (20.0 kPa) in neonatal mode.

Auto Adjust

The M Series unit automatically adjusts the cuff inflation pressure for all subsequent measurements to 30 mmHg (4.0 kPa) greater than the systolic value of the previous measurement. This default setting is called Auto Adjust. For example, the cuff inflates to 160 mmHg for the first measurement and the unit obtains a systolic reading of 110 mmHg. For the next measurement, the cuff inflates to 140 mmHg (i.e., 110 + 30 = 140).

If the Auto Adjust feature is set to “OFF”, the selected cuff inflation pressure is used for all measurements. If the Auto Adjust feature is set to “ON”, the selected cuff inflation pressure is used for the first measurement only. After the first measurement, the cuff inflation pressure automatically adjusts to 30 mmHg (4.0 kPa) greater than the systolic value of the previous measurement.

Setting Cuff Inflation Pressure

Before taking a measurement, check that the cuff inflation pressure is appropriate for the patient. The cuff inflation pressure options are:.

Adult	**Pediatric***	**Neonatal***
120 mmHg (16.0 kPa)	80 mmHg (10.7 kPa)	60 mmHg (8.0 kPa)
140 mmHg (18.7 kPa)	90 mmHg (12.0 kPa)	70 mmHg (9.3 kPa)
160 mmHg (21.3 kPa)	100 mmHg (13.3 kPa)	80 mmHg (10.7 kPa)
180 mmHg (24.0 kPa)	110 mmHg (14.7 kPa)	90 mmHg (12.0 kPa)
200 mmHg (26.7 kPa)	120 mmHg (16.0 kPa)	100 mmHg (13.3 kPa)
220 mmHg (29.3 kPa)	130 mmHg (17.3 kPa)	110 mmHg (14.7 kPa)
240 mmHg (32.0 kPa)	140 mmHg (18.7 kPa)	120 mmHg (16.0 kPa)
260 mmHg (34.7 kPa)	150 mmHg (20.0 kPa)	130 mmHg (17.3 kPa)

* Neonatal and pediatric NIBP modes available on M Series CCT units only.

See the *M Series Configuration Guide* for information on reconfiguring the cuff inflation pressure default setting.

WARNING Do not set cuff inflation pressure too high, particularly for pediatric, neonatal, or frail patients. Serious injury can result.

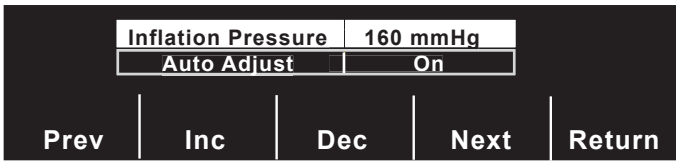
To set the cuff inflation pressure:

1. Press the **Cuff Inflation** softkey from the NIBP menu. If the **Cuff Inflation** softkey is not displayed, see "Displaying the NIBP Menu" on page 7.

NOTE On M Series CCT units, you access the **Cuff Inflation** softkey from the NIBP Settings menu. Press the **Settings** softkey from the NIBP menu, then press the **Cuff Inflation** softkey. If the **Settings** softkey is not displayed, see "Displaying the NIBP Menu" on page 7.

The M Series unit displays the Cuff Inflation menu.

Figure 7 Cuff Inflation Menu



On M Series CCT units, the “Inflation Pressure” field is labeled “Adult Inflation Pressure”, “Pediatric Inflation Pressure”, or “Neonatal Inflation Pressure” if the Patient Type is set to Adult, Pediatric, or Neonatal respectively.

2. Press the **Next** softkey if “Inflation Pressure” is not highlighted.
3. Press the **Inc** or the **Dec** softkey to select cuff inflation pressure.
4. Press the **Return** softkey (twice on M Series CCT units) to return to the NIBP menu.

   The cuff inflation pressure is set.

Turning Off Auto Adjust

You should turn off the Auto Adjust feature in situations where the M Series unit might inflate the cuff to levels that can cause discomfort or harm to the patient. For example:

- Patient is being transported over a very bumpy road.
- Patient is moving the monitored arm.
- Patient is a small child or infant.

When you turn the Auto Adjust feature off, the M Series unit repeats the same cuff inflation pressure for every measurement. Because this method does not readjust to the patient’s previously measured blood pressure, do not use fixed cuff inflation pressures unless you have received the proper training.

To turn off Auto Adjust:

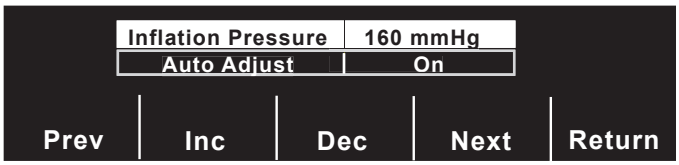
1. Press the **Cuff Inflation** softkey from the NIBP menu. If the **Cuff Inflation** softkey is not displayed, see "Displaying the NIBP Menu" on page 7.

NOTE

On M Series CCT units, you access the **Cuff Inflation** softkey from the NIBP Settings menu. Press the **Settings** softkey from the NIBP menu, then press the **Cuff Inflation** softkey. If the **Settings** softkey is not displayed, see "Displaying the NIBP Menu" on page 7.

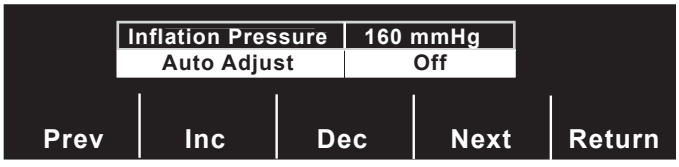
The M Series unit displays the Cuff Inflation menu.

Figure 8 Cuff Inflation Menu



2. Press the **Next** softkey until “Auto Adjust” highlights.
3. Press the **Inc** softkey until “OFF” displays.

Figure 9 Auto Adjust Menu



4. Press the **Return** softkey (twice on M Series CCT units) to return to NIBP menu.

   The M Series unit repeats the selected cuff inflation pressure for every measurement.

Setting Alarms

Before taking a measurement, ensure that all the NIBP alarms settings are appropriate for the situation. See the *M Series Operator's Guide* for instructions on setting alarms. When an NIBP or heart rate alarm is triggered, the unit automatically initiates a single blood pressure measurement. See the *M Series Configuration Guide* for instructions on how to enable/disable this automatic measurement.

The M Series NIBP option includes blood pressure alarms for the following measurements:

Table 4 Alarm Limit Settings and Defaults

Patient Type	Alarm Parameter		Default Setting	Range (increments of 5)
Adult	Systolic	High	160 mmHg (21.3 kPa)	80-260 mmHg (10.7-34.7 kPa)
		Low	90 mmHg (12.0 kPa)	40-140 mmHg (5.3-18.7 kPa)
	Diastolic	High	110 mmHg (14.7 kPa)	50-200 mmHg (6.7-26.7 kPa)
		Low	50 mmHg (6.7 kPa)	25-100 mmHg (3.3-13.3 kPa)
	Mean	High	130 mmHg (17.3 kPa)	60-220 mmHg (8.0-29.3 kPa)
		Low	60 mmHg (8.0 kPa)	30-120 mmHg (4.0-16.0 kPa)
Pediatric*	Systolic	High	145 mmHg (19.3 kPa)	80-160 mmHg (10.7-21.3 kPa)
		Low	75 mmHg (10.0 kPa)	35-140 mmHg (4.7-18.7 kPa)
	Diastolic	High	100 mmHg (13.3 kPa)	50-130 mmHg (6.7-17.3 kPa)
		Low	35 mmHg (4.7 kPa)	20-100 mmHg (2.7-13.3 kPa)
	Mean	High	110 mmHg (14.7 kPa)	60-140 mmHg (8.0-18.7 kPa)
		Low	50 mmHg (6.7 kPa)	20-120 mmHg (2.7-16.0 kPa)
Neonate*	Systolic	High	100 mmHg (13.3 kPa)	60-130 mmHg (8.0-17.3 kPa)
		Low	50 mmHg (6.7 kPa)	25-120 mmHg (3.3-16.0 kPa)
	Diastolic	High	70 mmHg (9.3 kPa)	30-105 mmHg (4.0-14.0 kPa)
		Low	30 mmHg (4.0 kPa)	20-100 mmHg (2.7-13.3 kPa)
	Mean	High	80 mmHg (10.7 kPa)	35-110 mmHg (4.7-14.7 kPa)
		Low	35 mmHg (4.7 kPa)	20-105 mmHg (2.7-14.0 kPa)

* Neonatal and pediatric NIBP modes available on M Series CCT units only.

When the M Series unit is turned on, all alarm functions are disabled and the alarm limits are set to their default values. Any changes to these settings remain in effect until either the settings are changed or 10 seconds after the M Series unit is turned off. On M Series CCT units, you can configure the default alarm limits at power-up according to patient type; see the *M Series Configuration Guide* for more information.

Setting Alarm Limits

You can change all the alarm limits using standard M Series procedures. See the *M Series Operator's Guide* for instructions on setting alarm limits.

You can set the alarm limits using the Auto function, or you can choose your own limits (see Table 4 on page 11). The Auto function sets the high limit to 30 mmHg (4.0 kPa) above and the low limit to 20 mmHg (2.7 kPa) below the last measurement.

Enabling, Disabling, and Suspending Alarms

You can activate, deactivate and audibly disable all NIBP alarms using standard M Series procedures. See the *M Series Operator's Guide* for instructions on activating, deactivating, and audibly disabling alarms.

Changing the status of one NIBP alarm automatically sets all the other NIBP alarms to the same status. For example, if you enable the systolic alarm, all other NIBP alarms are automatically activated. Similarly, if you deactivate the diastolic alarm, all other NIBP alarms are automatically deactivated. Activating, deactivating or audibly disabling NIBP alarms does not affect the status of other M Series alarms.

Suspending an NIBP alarm audibly disables the audio alarm until after the completion of the next measurement. All visual alarms remain active.

Triggering NIBP Measurements

You can configure the M Series unit to take a single NIBP measurement after the Heart Rate alarm is triggered and/or the NIBP alarm is triggered. See the *M Series Configuration Guide* for further details.

Taking Measurements

With the NIBP option you can take:

- A single measurement.
- A STAT measurement - as many measurements (up to ten) as possible within five minutes.
- Automatic measurements at user-set intervals.

Each type of measurement corresponds to a section below. You can take any type of measurement whether you are in Monitor, Defib or Pacer mode unless the:

- defibrillator is charged or charging, or
- previous measurement has occurred within 30 seconds in automatic interval measurement mode.

WARNING Do not begin NIBP measurements unless you are sure that the cuff inflation and alarms settings are appropriate for the patient. Incorrect settings can result in patient injury or inappropriate alarms.

To immediately abort any measurement in progress and deflate the cuff, press the NIBP button. As a safety feature, the M Series unit does not take measurements within 30 seconds of another completed measurement when in automatic interval measurement mode.

If the M Series unit finds a fault, a message displays on the screen. See "Troubleshooting" on page 23 for a list of NIBP display messages and their corresponding corrective action.

If the M Series unit cannot detect the systolic blood pressure value, it immediately increases the cuff inflation pressure by 30 mmHg (4.0 kPa) and completes the measurement. If, after 180 seconds, the M Series unit has not been able to determine all three blood pressure values or find a fault, it aborts the measurement cycle and deflates the cuff.

WARNING If the M Series unit takes a measurement but indicates the presence of artifact in the signal (denoted by "*" in the NIBP Display area), the measurement may not be accurate. Under such circumstances, perform additional blood pressure measurements. If you repeatedly obtain artifact, use alternate techniques to obtain blood pressure prior to taking clinical action.

As a safety feature, the cuff can never be inflated to more 300 mmHg (40.0 kPa). On M Series CCT units, the cuff can never be inflated to more 300 mmHg (40.0 kPa) in adult or pediatric mode, and never more than 150 mmHg (20.0 kPa) in neonatal mode. Blood pressure measurements abort and the cuff deflates when the defibrillator begins charging.

WARNING On M Series CCT units, do not begin NIBP measurements unless the patient mode setting is appropriate for the patient. Taking NIBP measurements on a pediatric or neonatal patient while the unit is in adult mode can result in inaccurate measurements and injury to the patient. Taking NIBP measurements on an adult patient while in pediatric or neonatal mode can result in inaccurate measurements.

When reading the blood pressure values on the display, keep in mind that the following conditions can influence NIBP measurements:

- Position of the patient.
- Position of the cuff relative to the patient's heart.
- Physical condition of the patient.
- Patient limb movements.
- Convulsions or tremors.
- Very low pulse volumes.
- Premature ventricular beats.
- Vibrations in the cuff caused by moving vehicles.
- Improper cuff size or application.

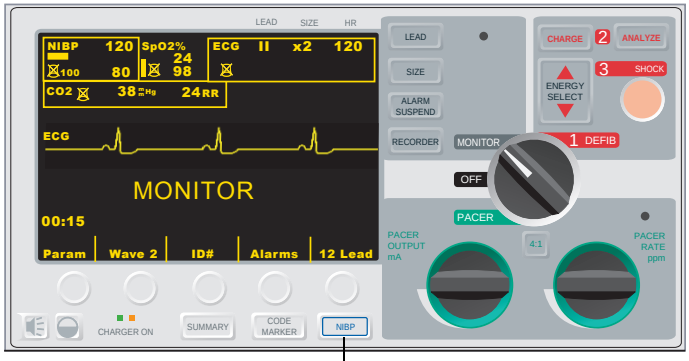
Taking a Single Measurement

You can take a single measurement at any time by pressing the NIBP button, unless the M Series unit is charged or charging.

CAUTION Make sure that no measurement is being taken when you start a new measurement. If you press the NIBP button while the M Series unit is taking a measurement, the measurement aborts immediately and the cuff deflates.

To take a single measurement:

- Press the **NIBP** button on the M Series front panel.



NIBP button

The M Series unit takes one blood pressure measurement.

Taking STAT Measurements

You can set the M Series unit to take a STAT measurement, which consists of the unit taking as many blood pressure measurements as possible (up to ten) in five minutes. When the M Series unit finishes taking a measurement and the cuff deflates, it immediately starts another measurement. Whenever practical, allow several minutes between STAT measurement sequences to restore full circulation to the monitored limb.

WARNING Repeated use of STAT measurements on the same patient over a short time interval can affect blood pressure readings, limit circulation to the limb, and cause injury to the patient.

You cannot set the M Series unit to take STAT measurements while the defibrillator is charged or charging. Charging the defibrillator aborts all STAT measurements and deflates the cuff.

Starting STAT Measurements

To start STAT measurements, either:

- Press the **NIBP** button and hold for two seconds, or
- Press the **NIBP Stat** softkey. If the NIBP Stat softkey label is not displayed, see "Displaying the NIBP Menu" on page 7.

The M Series unit takes as many measurements as possible in 5 minutes. If the M Series unit is configured to automatically generate strips, it will print a history of these STAT measurements at the end of the five-minute period.

Aborting STAT Measurements

You can abort STAT measurements at any time. Doing so terminates the current measurement and all subsequent measurements.

To abort STAT measurements, either:

- Press the **NIBP** button, or
- Press the **NIBP Stat** softkey. If the NIBP Stat softkey label is not displayed, see "Displaying the NIBP Menu" on page 7.

The M Series unit immediately aborts all measurements, and the cuff deflates.

Taking Automatic Measurements

You can set the M Series unit to automatically take a series of measurements at selected intervals. For example, if you set the M Series unit to take an automatic measurement with an interval of 15 minutes, it will immediately take a measurement, wait 15 minutes, take another measurement, wait another 15 minutes, and so on.

The M Series unit continues taking automatic measurements until you press the **NIBP Auto** softkey, or the unit is turned off for more than 10 seconds. If the M Series unit is turned off for less than 10 seconds, it resumes automatic measurements as scheduled. You can take an additional measurement between automatic measurements, by pressing the **NIBP** button.

If the defibrillator is charged or charging when the M Series unit is about to take an automatic measurement, it aborts the blood pressure measurement. All subsequent automatic measurements take place at their scheduled time.

To take automatic measurements at set intervals:

1. Set the measurement interval (if not set to desired value).
2. Start automatic measurements.

Setting the Measurement Interval

Before setting the M Series unit to take automatic measurements, ensure that the measurement interval is properly set. The measurement interval is the time period between when one measurement starts and the next measurement starts. The measurement interval options (in minutes) are: 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 45, 60, 90, and 120.

When you turn on the M Series unit, the measurement interval is set to the default value. The factory-installed default measurement interval is 30 minutes, but you can configure the M Series unit to use a different default. See the *M Series Configuration Guide* for information on reconfiguring the measurement interval.

To set measurements intervals:

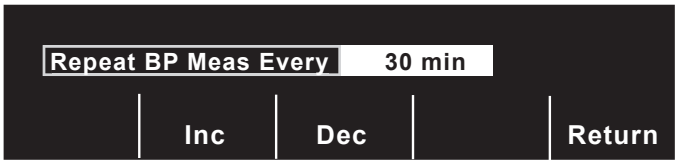
1. Press the **Auto Interval** softkey from the NIBP menu. If the **Auto Interval** softkey is not displayed, see "Displaying the NIBP Menu" on page 7.

NOTE

On M Series CCT units, you access the **Auto Interval** softkey from the NIBP Settings menu. Press the **Settings** softkey from the NIBP menu, then press the **Auto Interval** softkey. If the **Settings** softkey is not displayed, see "Displaying the NIBP Menu" on page 7.

The M Series unit displays the Auto Interval menu.

Figure 10 Auto Interval Menu



2. Press the **Dec** or the **Inc** softkey to select measurement interval.
3. Press the **Return** softkey (twice on M Series CCT units) to return to NIBP menu.

The measurement interval sets and remains until 10 seconds after the M Series unit is turned off or the value is reset.

Starting Automatic Measurements

When you start automatic measurements, the M Series unit takes an immediate measurement and repeats subsequent measurements at the selected interval.

To start automatic measurements:

- Press the **NIBP Auto** softkey. If the **NIBP Auto** softkey label is not displayed, see "Displaying the NIBP Menu" on page 7.

The M Series unit takes a measurement. After each measurement, the M Series unit repeats subsequent measurements at the selected interval.

Taking an Additional Measurement

You can take an immediate measurement between the automatic measurements unless the:

- M Series unit is currently taking a measurement, or
- defibrillator is charged or charging.

If you press the **NIBP** button during a measurement, the current measurement is aborted. All subsequent measurements continue at the selected interval.

If you press the **NIBP** button at any other time (unless the defibrillator is charged or charging), the M Series unit takes an extra measurement without altering the timing of the other automatic measurements.

The M Series unit does not start a new automatic measurement unless 30 seconds have elapsed since the end of the previous completed measurement cycle. In this case, the M Series unit omits the scheduled measurement.

To take an additional measurement:

- Press the **NIBP** button.

The M Series unit takes an extra measurement without altering the timing of the other measurements.

Aborting a Single Measurement

When the M Series unit is taking automatic measurements, you can stop a single blood pressure measurement. The M Series unit continues taking all subsequent measurements at the selected intervals. If you press the **NIBP** button while the M Series unit is not taking a measurement, it takes a new measurement.

To stop a single measurement:

- Press the **NIBP** button.

The M Series unit immediately stops taking the measurement and deflates the cuff, but takes all subsequent automatic measurements at their selected interval.

Stopping all automatic measurements

You can stop all upcoming blood pressure measurements by pressing the **NIBP Auto** softkey. If the M Series unit is taking a measurement, it completes the current measurement but does not take any subsequent measurements.

To stop automatic measurements:

- Press the **NIBP Auto** softkey. If the **NIBP Auto** softkey label is not displayed, see "Displaying the NIBP Menu" on page 7.

The M Series unit stops all upcoming measurements.

Aborting Measurements

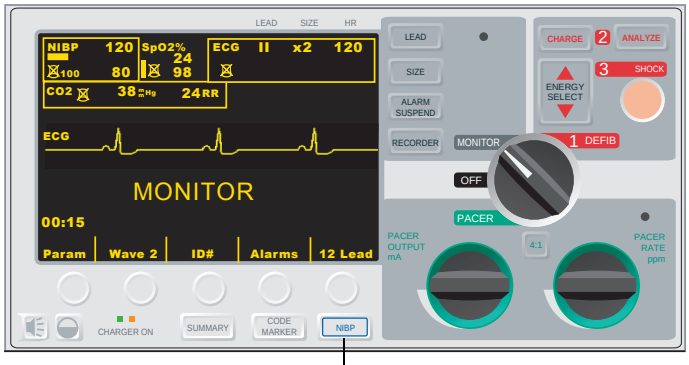
You can immediately abort a blood pressure measurement at any time by pressing the **NIBP** button. You can abort a measurement whether you are in Monitor, Defib or Pacer mode. If you press the **NIBP** button while taking a STAT measurement, the M Series unit terminates all measurements.

If you press the **NIBP** button while the M Series unit is taking an automatic measurement, it aborts the current measurement, deflates the cuff, and continues all subsequent measurements at the set interval. See "Taking an Additional Measurement" on page 15 for further details on the use of the **NIBP** button while the M Series unit is set to take automatic measurements.

CAUTION Make sure that a measurement has already started before attempting to abort. If you press the **NIBP** button while a measurement is not being taken, the M Series unit starts a new measurement.

To abort the current measurement:

- Press the **NIBP** button on the M Series front panel.



NIBP button

The M Series unit immediately stops taking the measurement, displays the “NIBP MEAS ABORTED” message, and deflates the cuff.

Printing Data

See the “Recorder Operation” section of the *M Series Operator’s Guide* for instructions on how to record data. If you have already taken NIBP measurements, press the **RECORDER** button to print a strip chart that includes the following values for the currently displayed measurement:

- Systolic blood pressure
- Diastolic blood pressure
- Mean blood pressure
- Pulse rate
- Time of measurement

Maintaining the NIBP Option

See the *M Series Service Manual* for instructions on maintaining the NIBP option. Calibrate the pressure transducers and perform leak tests yearly.

Performing the Daily Checkout Procedure

Perform the following checkout procedure daily to ensure that the NIBP option is functioning properly. This daily checkout procedure also ensures that medical personnel maintain familiarity with the proper use of the NIBP option.

For more specific instructions on how to accomplish each step listed below, refer to the related section in this manual.

To perform the daily checkout procedure:

1. Select the proper sized cuff.
2. Connect the hose to the M Series unit and to the cuff.
3. Apply the cuff to a human test subject.
4. Display the NIBP menu.
5. Set the cuff inflation pressure (if current setting is not appropriate).
6. Take blood pressure measurement.
7. During cuff inflation, inspect cuff, hoses, and connectors for air leakage (if leak is present, correct, replace or service item).
8. Ensure no errors display.
9. Verify the measurements values are appropriate.
10. Visually inspect hose, hose connector and cuffs for signs of damage (if damaged, replace).

Cleaning the Hose

Clean the hose when it appears dirty.

To clean the hose:

1. Clean the outside surface of hose with a damp cloth.
2. Disinfect with a mild disinfectant solution.
3. Blow dry air through hose.

The hose is now ready for use.

Cleaning Reusable Cuffs

Clean cuffs when they appear dirty.

To clean reusable cuffs:

1. Clean surface with a damp cloth.
2. Disinfect with a mild disinfectant solution.
3. Dry before use.

The cuffs are now ready for use.

Specifications

Table 5 General Specifications

Principle of Operation	Oscillometric
Warm up Time	Operational in less than 10 seconds
Size	8.2" (20.8 cm) high x 10.1" (25.7 cm) wide x 8.0" (20.3 cm) deep
Regulatory Standards	ANSI/AAMI SP10-1992; EN 1060-1: 1996 Specification for Non-invasive sphygmomanometers; EN 1060-3: 1997; IEC60601-2-30: 1999

Table 6 NIBP Measurement Specifications

Range	
Systolic	Adult: 40 – 260 mmHg; 5.3 – 34.7 kPa Pediatric: 35 – 160 mmHg; 4.7 – 21.3 kPa* Neonatal: 25 – 130 mmHg; 3.3 – 17.3 kPa*
Diastolic	Adult: 20 – 200 mmHg; 2.7 – 26.7 kPa Pediatric: 20 – 130 mmHg; 2.7 – 17.3 kPa* Neonatal: 20 – 105 mmHg; 2.7 – 14.0 kPa*
Mean	Adult: 20 – 220 mmHg; 2.7 – 29.3 kPa Pediatric: 20 – 140 mmHg; 2.7 – 18.7 kPa* Neonatal: 20 – 110 mmHg; 2.7 – 14.7 kPa*
Accuracy	Per AAMI SP10 +/- 5 mmHg (0.7 kPa) mean difference; 8 mmHg (1.1 kPa) standard deviation[a]
Resolution	1 mmHg; 0.13 kPa
Measurement Cycle Time	Typical: 30 seconds Worst Case: 180 seconds

* Neonatal and pediatric NIBP modes available on M Series CCT units only.

[a] Blood pressure measurements determined with this device are equivalent to those obtained by a trained observer using the cuff/stethoscope auscultation method, within the limits prescribed by the American National Standard, Electronic or automated sphygmomanometers (AAMI SP10). To receive a copy of the report containing the AAMI SP10 test results, contact ZOLL Technical Support at (800) 348-9011 or (978) 421-9655.

Table 7 Pulse Rate Measurement Specifications

Range	35 – 220 pulses per minute
Resolution	1 pulse per minute

Table 8 Battery Operating Time Specifications

For a new, fully charged battery pack at 20°C with NIBP, $EtCO_2$ and SpO_2 Options	35 defibrillator discharges at maximum energy (360J), or 1.25 hours minimum of continuous ECG monitoring and blood pressure measurements once every 5 minutes, or 0.75 hour of continuous ECG monitoring/pacing at 60 mA, 70 beats/min.

Table 9 Environmental Specifications

Operating Temperature	0° to 50° C
Storage and Shipping Temperature	-20° to 70° C
Electromagnetic Immunity	AAMI DF-2: 1996, EN 61000-4-3: 1996, 20 V/m
Humidity	5 to 95% relative humidity, non-condensing
Operating Pressure	594 to 1060 mBar

Table 10 Alarm Limits Specifications

Systolic	Adult	High 80 – 260 mmHg; Low 40 – 140 mmHg;	High 10.7 – 34.7 kPa Low 5.3 – 18.7 kPa
	Pediatric*	High 80 – 160 mmHg; Low 35 – 140 mmHg;	High 10.7 – 21.3 kPa Low 4.7 – 18.7 kPa
	Neonatal*	High 60 – 130 mmHg; Low 25 – 120 mmHg;	High 8.0 – 17.3 kPa Low 3.3 – 16.0 kPa
Diastolic	Adult	High 50 – 200 mmHg; Low 25 – 100 mmHg;	High 6.7 – 26.7 kPa Low 3.3 – 13.3 kPa
	Pediatric*	High 50 – 130 mmHg; Low 20 – 100 mmHg;	High 6.7 – 17.3 kPa Low 2.7 – 13.3 kPa
	Neonatal*	High 30 – 105 mmHg; Low 20 – 100 mmHg;	High 4.0 – 14.0 kPa Low 2.7 – 13.3 kPa
Mean	Adult	High 60 – 220 mmHg; Low 30 – 120 mmHg;	High 8.0 – 29.3 kPa Low 4.0 – 16.0 kPa
	Pediatric*	High 60 – 140 mmHg; Low 20 – 120 mmHg;	High 8.0 – 18.7 kPa Low 2.7 – 16.0 kPa
	Neonatal*	High 35 –110 mmHg; Low 20 – 105 mmHg;	High 4.7 – 14.7 kPa Low 2.7 – 14.0 kPa

* Neonatal and pediatric NIBP modes available on M Series CCT units only.

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Ordering Accessories

To order accessories for the M Series NIBP option call ZOLL Customer Service at 1-800-348-9011. International customers should call the nearest authorized ZOLL Medical Corporation distributor. The following tables list optional accessories that can be used with the M Series NIBP option:

Table 11 NIBP Cuff Accessories

Cuffs	Limb Circumference (cm)	Part Number
Large Adult (Reusable)	34.3 to 48.2	8000-0654
Adult Plus (Reusable)	25.4 to 42.0	8000-0653
Adult (Reusable)	25.4 to 34.3	8000-0652
Small Adult (Reusable)	21.1 to 26.6	8000-0651
Pediatric (Reusable)	16.0 to 21.8	8000-0650
Small Pediatric (Disposable)*	12.0 to 16.5	8000-0645
Neonate #5 (Disposable)*	8.0 cm to 15.0 cm	8000-0644
Neonate #4 (Disposable)*	7.0 to 13.0 cm	8000-0643
Neonate #3 (Disposable)*	6.0 to 11.0 cm	8000-0642
Neonate #2 (Disposable)*	4.0 to 8.0 cm	8000-0641
Neonate #1 (Disposable)*	3.0 to 6.0 cm	8000-0640

* Neonatal and pediatric NIBP modes available on M Series CCT units only.

Table 12 NIBP Hose Accessories

Hoses	Length (m)	Part Number
Air Hose with pneumatic fittings	3	8000-0662
Air Hose with pneumatic fittings	1.5	8000-0655

Table 13 NIBP Cuff Connector Accessories

Connectors	Part Number
Cuff hose connector (male)	0310-0016
Cuff hose connector (female)	0310-0026

Troubleshooting

The following table lists the NIBP messages, the problem each message indicates, and the associated corrective action(s). Read this section carefully before monitoring patients. For further assistance, call ZOLL Technical Service at 1-800-348-9011. International customers should call the nearest authorized ZOLL Medical Corporation distributor.

Message/Symptom	Problem	User Action
CALIBRATE NIBP	NIBP calibration incomplete or failed	Recalibrate NIBP. (See *M Series Service Manual* for details).
NIBP COMM ERROR	Communication problem with the NIBP module.	Cycle power and retry. If problem persists, return for service.
NIBP FAULT	No communication from the NIBP module. NIBP module failed self-test.	Cycle power and retry. If problem persists, return for service.
NIBP MEAS ABORTED	Cuff inflation pressure set too high for attached cuff. Inflation too fast. M Series unable to find systolic value for 180 seconds. Defibrillator charged or charging. User-initiated abort.	Confirm Defib was not charging. Verify that you are using proper sized cuff. Check for cuff and hose blockages. If problem persists, return for service.
NIBP NOT READY	Defib charged or charging in progress. NIBP module performing self-test after power-up.	Wait until Defib discharges or dumps before taking the next measurement. Wait for more than 10 seconds after power up before taking blood pressure measurements.
NIBP OUT OF RANGE	The data from the NIBP module is out of range.	Measure patient's blood pressure with other equipment. Check cuff fit and positioning. Switch cuff to other arm. If problem persists, return for service.
REPEAT NIBP MEAS	Exceeded maximum number of inflation attempts. Exceeded 180-second measurement time limit.	Check cuff and hose. Repeat NIBP measurement.
REPEAT NIBP MEAS alternating with CHECK CUFF/HOSE	Blood pressure cuff or hose not installed correctly. Faulty cuff or hose. Hose kinked or disconnected. Inflation rate too fast or too slow.	Check cuff connection to hose. Check hose connection to unit. Check for kinked hose or air leaks in hose. If problem persists, replace cuff then hose.
REPEAT NIBP MEAS alternating with NIBP ARTIFACT	Unable to detect systolic, diastolic or mean blood pressure due to excessive motion or vibration.	Take a single blood pressure measurement. Keep patient as still as possible. Insulate patient and cuff from outside vibrations as much as possible.

Message/Symptom	Problem	User Action
REPEAT NIBP MEAS alternating with NIBP SIGNAL WEAK	Weak or no oscillometric signal.	Check cuff fit and positioning. Check hose connection to unit. Check for kinked hose. Increase cuff inflation pressure if clinically appropriate.
SYSTEM FAULT	Communication problem with the NIBP module.	Cycle power and retry. If problem persists, return for service.
False high reading	Cuff too small. Cuff not centered over brachial artery. Cuff too loose. Patient's limb below level of heart.	Select larger cuff. Readjust cuff. Reapply cuff or select smaller cuff. Raise patient's limb to heart level.
False low reading	Cuff too large. Limb above level of heart.	Select smaller cuff Lower patient's limb to heart level.

Index

N

O

P

R

S

T

W