

4 Maintenance and checkout

Maintenance schedule

Manufacturer recommendations

To help ensure the equipment remains in proper operational and functional order, adhere to a good maintenance schedule. The manufacturer recommends that the following be performed by service personnel upon receipt of the equipment, every 12 months thereafter, and each time the unit is serviced:

- Visual Inspection
- Cleaning
- Electrical Safety Tests
- Checkout Procedure
- Clearing the Stored Patient Data Memory: Admit and discharge a test patient every 12 months to clear the monitor's stored patient data memory.

Manufacturer responsibility

WARNING

Failure on the part of all responsible individuals, hospitals or institutions, employing the use of this device, to implement the recommended maintenance schedule may cause equipment failure and possible health hazards. The manufacturer does not, in any manner, assume the responsibility for performing the recommended maintenance schedule, unless an Equipment Maintenance Agreement exists. The sole responsibility rests with the individuals, hospitals, or institutions utilizing the device.

Preventive maintenance

The message “**EC1**” will appear on the monitor to the left of the ECG parameter block after 395 days of operation. This message is a reminder that it is time to perform preventive maintenance procedures on the monitor. Perform all of the maintenance procedures listed under “Manufacturer Recommendations” above.

Visual inspection

The Solar 8000M/i patient monitor and its components should be carefully inspected prior to installation, once every 12 months thereafter, and each time the equipment is serviced.

- Carefully inspect the equipment for physical damage to the case, the display screen, and the keypad. Do not use the monitor if damage is determined. Refer damaged equipment to qualified service personnel.
- Inspect all external connections for loose connectors or frayed cables. Have any damaged connectors or cables replaced by qualified service personnel.
- Inspect the display face for marks, scratches, or other damage. Physical damage to a CRT display face may pose an implosion hazard. Have the CRT replaced by qualified service personnel if necessary.

Cleaning

Cleaning precautions

NOTE

See “Cleaning, disinfecting and storing GE ECG cables and leadwires” on page 4-5 for instructions specific to GE ECG cables and leadwires.

Use one of the following approved solutions:

- Cidex solution
- Sodium hypochlorite bleach (diluted)
- Mild soap (diluted)
- Lint-free cloth
- Dust remover (compressed air)

To avoid damage to the equipment surfaces, *never* use the following cleaning agents:

- organic solvents,
- ammonia based solutions,
- acetone solution,
- alcohol based cleaning agents,
- Betadine solution,
- a wax containing a cleaning substance, or
- abrasive cleaning agents.

Exterior cleaning

Clean the exterior surfaces with a clean, lint-free cloth and one of the cleaning solutions listed in the table above.

- Wring the excess solution from the cloth. Do not drip any liquid into open vents, switches, plugs, or connectors.
- Dry the surfaces with a clean cloth or paper towel.

Cleaning the display

To clean the display, follow the recommendations of the display’s manufacturer. In general you will need to use a soft, clean, lint-free cloth dampened with a glass cleaner.

CAUTION

To avoid getting liquid into connector openings, do not spray glass cleaning or general cleaning solutions directly onto the product’s surface.

Cleaning the Touch Screen Display

1. Turn OFF the mains power switch on the monitor and disconnect it from the power source.
2. Clean the screen with an *ammonia free* glass cleaner and lint free cloth.

CAUTION

Do not spray any glass cleaning solution or any general cleaning solutions directly onto the monitor's display surface. Always dampen the towel and then clean the screen.

Cleaning, disinfecting and storing GE ECG cables and leadwires

NOTE

These instructions supersede all cleaning/disinfecting instructions for GE ECG Cables and Leadwires. All safety statements and notes in the manual still apply.

Cleaning or disinfecting

1. Remove cables and leadwires from the handheld device or system before cleaning.
2. Use care in cleaning leadwires to prevent pulling the long wires from the connector ends. Metal connections can be pulled away from the connectors.
3. For general cleaning of cables and leadwires, wipe using a lightly moistened cloth with a mild soap and water solution. Then wipe and air dry.
4. For disinfecting the cables and leadwires, wipe exterior with a soft lint-free cloth, using the following solution as recommended in the APIC Guidelines for Selection and Use of Disinfectants (1996):
 - ◆ Sodium hypochlorite (5.2% household bleach) minimum 1:500 dilution (minimum 100 ppm free chlorine) and maximum 1:10 dilution.
 - ◆ Any sodium hypochlorite wipe product that meets the above guidelines of can be used.

NOTE

Wring excess disinfectant from wipe before using.

NOTE

Any contact of disinfectant solutions with metal parts may cause corrosion.

5. Do *not* immerse either end of a cable or leadwire connector. Immersing or “soaking” the connector ends may corrode metal contact ends and affect signal quality.
6. Wipe off cleaning solutions with a clean, lightly moistened cloth.

7. Dry thoroughly with a dry lint-free cloth and let air dry for at least 30 minutes.

NOTE

Drying times may vary based on the environmental conditions.

8. Take care not to let fluid “pool” around connection pins. If this should happen, blot dry with a soft, lint-free cloth.
9. *Do not* use excessive drying techniques, such as oven, forced heat or sun drying.

Sterilization

NOTE

EtO sterilization is *not recommended*, but may be required for cables and leadwires. Frequent sterilization will reduce the useful life of cables and leadwires.

Sterilize with ethylene oxide gas (EtO) at a maximum temperature of 50° C/122° F. After EtO sterilization, follow the recommendations from the sterilizer manufacturer for required aeration.

Cautions

- Never immerse the handheld device, cables, or leadwires in any liquid.
- Do not pour or spray any liquid directly on cables or leadwires or permit fluid to seep into connections or openings.
- Never use conductive solutions, solutions that contain chlorides, wax, or wax compounds to clean handheld devices, cables or leadwires.
- Never use solutions or products that contain the following:
 - ◆ Any type of Ammonium Chloride such as, but not limited to:
 - ◆ Dimethyl Benzyl Ammonium Chloride
 - ◆ Quaternary Ammonium Chloride solutions
 - ◆ Abrasive cleaners or solvents of any kind
 - ◆ Acetone
 - ◆ Ketone
 - ◆ Betadine
 - ◆ Alcohol-based cleaning agents
 - ◆ Sodium salts
- Never autoclave or steam clean cables or leadwires.

Storage

- Store in a dry well-ventilated area.
- Vertically hang cables and leadwires.
- Do not coil leadwires or cables tightly around any medical device.

Improper cleaning products and processes impact/results

- Product discoloration.
- Metal part corrosion.
- Brittle wires.
- Brittle and breaking connectors.
- Reduced cables and leadwires life.
- Unit malfunction.
- Void warranty.

Cleaning products to avoid

Cleaning products known to cause the types of problems listed above include, but are not limited to:

- Sani-Cloth[®] Wipes
- Ascepti[®] Wipes
- HB Quat
- Clorox[®] Wipes (they do not contain bleach).
- Over-the-counter detergents (e.g. Fantastic[®], Tilex[®], etc.).

Products that contain active ingredients and solutions similar to these products should also be avoided.

NOTE

For additional information, refer to the How to Reach Us page of the manual for contact information. Also see the GE Handheld Medical Devices Cleaning, Disinfecting, and Storage addendum.

Electrical safety tests

Recommendations

Electrical safety tests provide a method of determining if potential electrical health hazards to the patient or operator of the device exist.

GE recommends that all safety tests be performed

- upon receipt of the device,
- once a year thereafter,
- after any upgrade,
- any time the main enclosure is disassembled, or a part is repaired or replaced.

Record the date and results on the Repair Log included at the end of this chapter.

These instructions are intended for every component in the system. If the system includes a Tram-rac housing without its own power supply, it should remain connected to the monitor throughout the safety tests.

WARNING

Failure to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards. Unless you have an Equipment Maintenance Contract, GE does not in any manner assume the responsibility for performing the recommended maintenance procedures. The sole responsibility rests with the individual or institution using the equipment. GE service personnel may, at their discretion, follow the procedures provided in this manual as a guide during visits to the equipment site.

Test conditions

Perform electrical safety tests under normal ambient conditions of temperature, humidity, and pressure.

Test equipment

The recommended test equipment required to perform electrical safety tests is listed below.

| Item | Specification |
|-----------------------------|--|
| Leakage Current Tester | Equivalent to the circuits shown |
| Digital Multimeter (DMM) | AC volts, ohms |
| Ground Bond Tester | 0 – 1 ohm |
| ECG Test Body | All leads together |
| Masimo SET SpO2 Test Body | 2006036-001 |
| Host patient monitor system | Solar 8000M or Solar 8000i |
| Acquisition device | Tram-rac with TRAM module or Patient Data Module |

Set up

Prepare the Solar 8000M or Solar 8000i patient monitor and the acquisition device for electrical safety tests.

1. Confirm that all components of the monitoring system are correctly connected as described in Chapter 3, “[Installation](#)”.
2. Verify that the power indicator illuminates on the acquisition device.

Power outlet test

Verify that the power outlet is wired correctly per the country’s electrical code standard before starting the following electrical safety tests. The results of the following tests will be inaccurate unless a properly wired power outlet is used.

Ground (earth) integrity

Listed below are two methods for checking the ground (earth) integrity, “Ground Continuity Test” and “Impedance of Protective Earth Connection.” These tests determine whether the device's exposed metal and power inlet's earth (ground) connection have a power ground fault condition.

Perform the test method below that is required by your country/local governing safety organization.

Ground continuity test

1. Disconnect the device under test from the power outlet.
2. Connect the negative (–) lead of the DMM to the protective earth terminal (ground pin in power inlet connector) or the protective earth pin in the mains plug (ground pin in power cord).
3. Set the DMM to the milliohm ($m\Omega$) range.
4. Connect the positive (+) lead of the DMM to all exposed metal surfaces on the device under test.
5. Resistance must read:
 - ◆ 0.1 ohm or less without power cord
 - ◆ 0.2 ohms or less with power cord

Impedance of protective earth connection

This test stresses the ground system by using special ground bond testers and is normally only required as a manufacturing production test to receive safety agency compliance.

Some country agencies do require this test after field equipment repairs (i.e. Germany's DIN VDE 0751 standards). Consult your country/local safety agency if in question.

Check compliance as follows:

1. A current of 25A from a current source with a frequency of 50 or 60 Hz with a no-load voltage not exceeding 6 V is passed for at least 5 seconds through the protective earth terminal or the protective earth pin in the mains plug and the equipotential stud which could become live in case of failure in basic insulation.
2. The voltage drop between the parts described is measured and the impedance determined from the current and voltage drop. It shall not exceed the values indicated.

When taking this measurement, move the unit's power cord around. There should be no fluctuations in resistance.

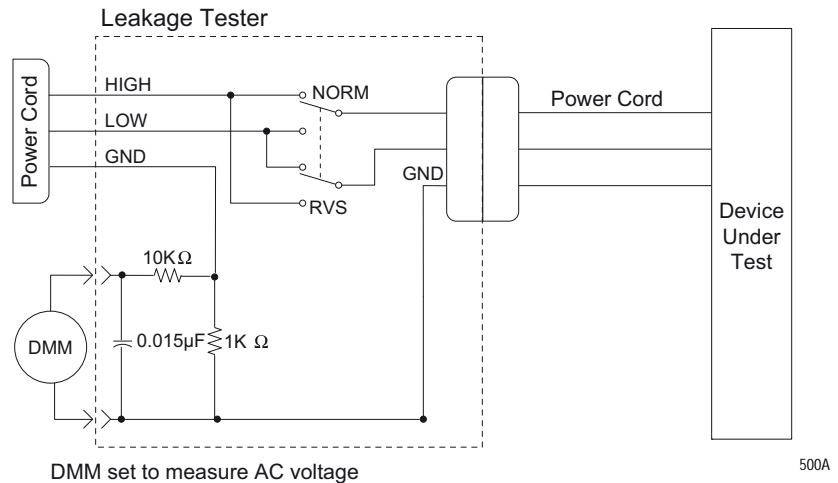
- ◆ For equipment without a power supply cord the impedance between the protective earth terminal and the ground tabs of the Video In connector which is protectively earthed shall not exceed 0.1 ohms.
- ◆ For equipment with a power supply cord the impedance between the protective earth pin in the mains plug and the ground tabs of the Video In connector which is protectively earthed shall not exceed 0.2 ohms.

Ground (earth) wire leakage current tests

Perform this test to measure current leakage through the ground (earth) wire of the equipment during normal operation.

The device under test is to be tested at its normal operating voltage.

1. Configure the leakage tester like the circuit shown below.



2. Connect the power cord of the device under test to the power receptacle on the leakage tester.
3. Set the power switch of the device under test to ON.
4. Read the current leakage indicated on DMM.
5. Set the polarity switch on the leakage tester to RVS (reverse).
6. Read the current leakage indicated on DMM.

NOTE

If either reading is greater than the appropriate specification below, the device under test fails. Contact GE Technical Support.

- ◆ 300 μ A (0.3 volts on the DMM), and the device under test is powered from 100-120 V/50-60 Hz.
- ◆ 300 μ A (0.3 volts on the DMM), and the device under test is powered from a centered-tapped 200-240 V/50-60 Hz, single phase circuit.
- ◆ 500 μ A (0.5 volts on the DMM), and the device under test is powered from a non-center-tapped, 200-240 V/50-60 Hz, single-phase circuit.

NOTE

Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and EN limits are different.

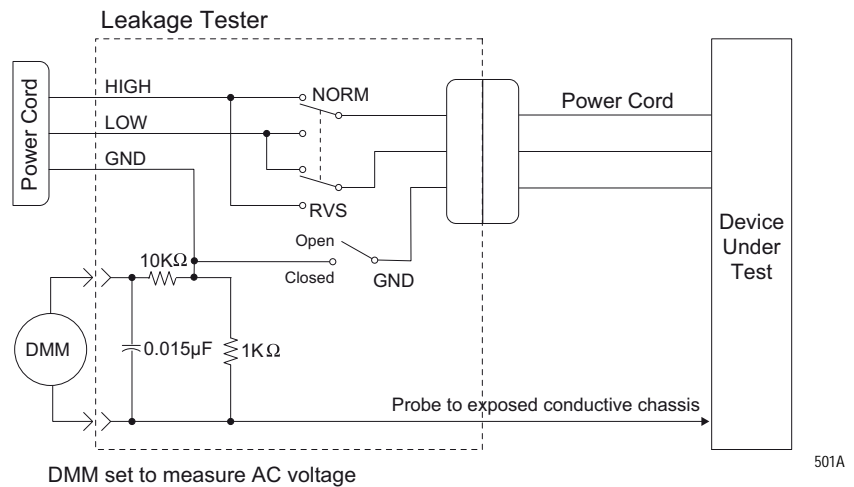
7. Set the power switch of the device under test to OFF.

Enclosure leakage current test

This test pertains to the Solar 8000M/i, part of the monitoring system.

Perform this test to measure current leakage through exposed conductive surfaces on the device under test during normal operation.

1. Configure the leakage tester like the circuit shown below with GND switch OPEN and polarity switch NORM.



2. Connect probe to an unpainted, non-anodized chassis ground on the device under test.
3. Set the power switch of the device to ON.
4. Read the current leakage indicated on DMM.

NOTE

Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and EN limits are different.

5. Set the polarity switch to RVS.
6. Read the current leakage indicated on DMM.

NOTE

If either reading is greater than the appropriate specification below, the device under test fails. Contact GE Technical Support.

- ◆ 300 μ A (0.3 volts on the DMM), and the device under test is powered from 100-120 V/50-60 Hz.
- ◆ 300 μ A (0.3 volts on the DMM), and the device under test is powered from a centered-tapped 200-240 V/50-60 Hz, single phase circuit.
- ◆ 500 μ A (0.5 volts on the DMM), and the device under test is powered from a non-center-tapped, 200-240 V/50-60 Hz, single-phase circuit.

7. Set the GND switch on the leakage tester to CLOSED.
8. Read the current leakage indicated on DMM.

9. Set the polarity switch to RVS.
10. Read the current leakage indicated on DMM.

NOTE

If the reading is greater than the specification below, and the device under test is powered from 100-240 V/50-60 Hz, the device under test fails. Contact GE Technical Support.

- ◆ 100 microamperes (0.1 volts on the DMM), and the device under test is powered from 100-240 V/50-60 Hz.

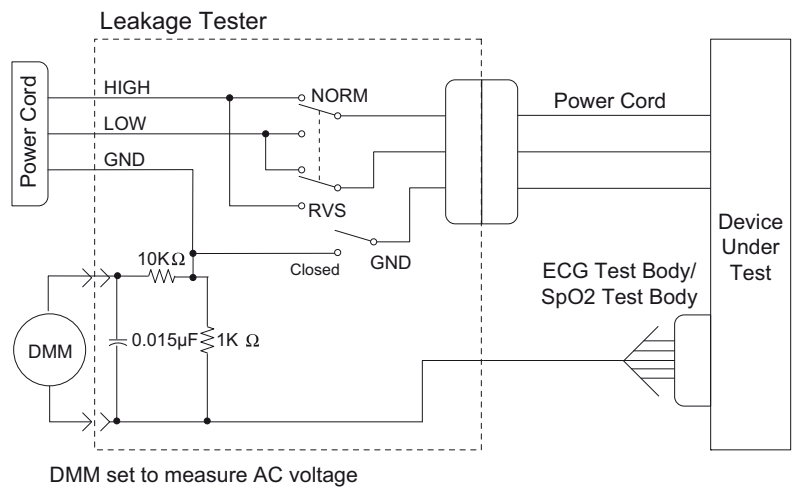
11. Set the power switch of the device under test to OFF.

Patient (source) leakage current test

This test pertains to the Solar 8000M/i, part of the monitoring system.

This procedure only applies to Class I (grounded/earthed) equipment, and measures the leakage current from the ECG/RESP connector then the SpO2 connector of the device to ground.

1. Configure the leakage tester like the circuit shown below with GND switch OPEN and polarity switch NORM.



2. Connect an ECG test body to the ECG/RESP connector of the device under test.
3. Set the power switch of the device to ON.
4. Read the leakage current indicated on the DMM.
5. Change the leakage tester polarity switch to the RVS position.
6. Read the leakage current indicated on the DMM.

NOTE

If either reading is greater than 50 μ A (0.05 volts on the DMM), the device fails this test. Contact GE Technical Support.

7. Change the GND switch to the closed position.
8. Read the leakage current indicated on the DMM.

9. Change the leakage current switch to the RVS position.
10. Read the leakage current indicated on the DMM.

NOTE

If either reading is greater than $10\ \mu\text{A}$ (0.01 volts on the DMM), the device fails this test. Contact GE Technical Support.

11. Set the power switch of the device to OFF.

NOTE

The AAMI and EN single fault condition (ground open) is $50\ \mu\text{A}$, whereas the normal condition (ground closed) is less.

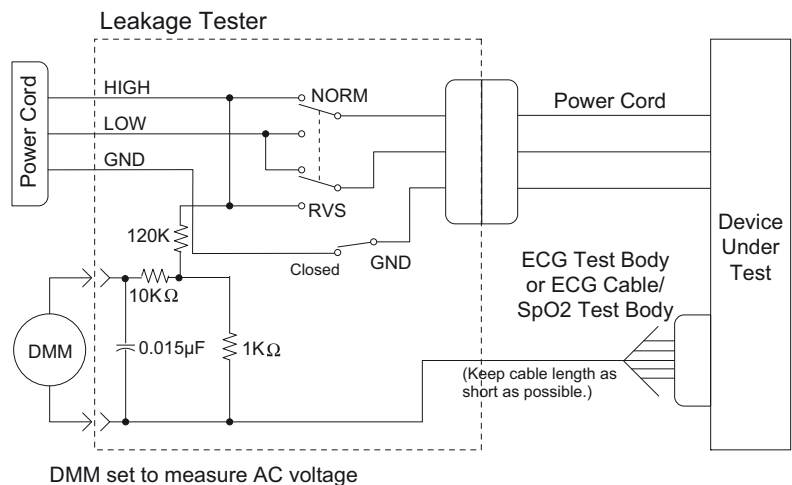
12. Repeat the steps in this procedure using the appropriate SpO₂ Test Body. Connect the SpO₂ Test Body to the blue SpO₂ connector of the device under test.

Patient (sink) leakage current test

This test pertains to the Solar 8000M/i, part of the monitoring system.

This procedure only applies to Class I (grounded/earthed) equipment, and measures the leakage current from a mains voltage source into the ECG/RESP connector then the SpO₂ connector.

1. Configure the leakage tester like the circuit shown below with GND switch CLOSED and polarity switch NORM.

**WARNING**

Shock hazard. The following step causes high voltage at the test body. Do not touch the test body.

2. Set power switch on the device to ON.
3. Read leakage current indicated on DMM.
4. Change the leakage tester polarity switch to the RVS position.
5. Read the leakage current indicated on the DMM.

NOTE

If either reading is greater than the appropriate specification below, the device under test fails. Contact GE Technical Support.

- ◆ 10 μA (0.01 volts on the DMM) at 120 VAC using the test body.
- ◆ 20 μA (0.02 volts on the DMM) at 240 VAC using the test body.
- ◆ 50 μA (0.05 volts on the DMM) at 120-240 VAC using the ECG cable.

NOTE

The 10 and 20 μA limits are based on internal design standards. The 50 μA limit is common to all standards. AAMI ES-1 standard requires using the patient cable.

6. Set the power switch on the device to OFF.
7. Repeat the steps in this procedure using the appropriate SpO₂ Test Body. Connect the SpO₂ Test Body to the blue SpO₂ connector of the device under test.

Test completion

1. Disconnect the leakage tester from the power outlet.
2. Disconnect all test equipment from the device.
3. Disconnect the device power cord from the leakage tester.

Checkout procedure

General

These procedures test the functions of the patient monitor, Tram-rac housing or Patient Data Module and associated communication networks. For other input modules checkout procedures, refer to their appropriate service manual.

GE recommends that all checkout procedures be performed

- upon receipt of the device,
- once a year thereafter,
- after any upgrade,
- any time the main enclosure is disassembled, or a part is repaired or replaced.

Record the date and results on the Repair Log included at the end of this chapter.

Required tools and equipment

NOTE

Be sure test equipment is maintained according to manufacturer's maintenance schedule to ensure accuracy.

The following table lists the test equipment, adapters, and cables necessary to complete the checkout procedures. Equivalent equipment may be substituted

| |
|---|
| Acquisition device: <ul style="list-style-type: none"> ■ Tram 100-851 module (Any GE Tram 100-851 module) ■ Patient Data Module (Any GE Patient Data Module) |
| Multifunctional patient simulator (MARQ III or equivalent) |
| Patient cables (Multi-link ECG 12-lead patient cable and ECG leadwire set) |
| Tram-rac housing test: <ul style="list-style-type: none"> ■ Tram-rac (Any GE Tram-rac) ■ BP module (Any GE BP module) ■ Digital multimeter (AC volts, ohms) |
| M-Port test: <ul style="list-style-type: none"> ■ Port Checkout DIDCA (420915-031) ■ Cable, category 5 (418335-002) ■ AutoPort to M-Port Adapter (2001973-001) |
| Blood pressure test: <ul style="list-style-type: none"> ■ Blood pressure simulator cable (700095-001) |

| |
|--|
| <p>Temperature test:</p> <ul style="list-style-type: none"> ■ 700/400 series dual temperature adapter (402015-004) ■ Temperature simulator cable for use with Marq III |
| <p>Cardiac output test:</p> <ul style="list-style-type: none"> ■ Cardiac output simulator II (900028-001) (no longer available for ordering) ■ Cardiac output cable adapter (700092-001) |
| <p>SpO2 test:</p> <ul style="list-style-type: none"> ■ Masimo SpO2 Test Kit includes Masimo Tester and SpO2 Sensor Adapter Cable (2021087-001) ■ Nellcor pulse oximeter tester model SRC-2 (2007650-001) ■ Dual BP adapter cable (2005772-001) ■ Nellcor OxiMax pulse oximeter functional tester model SRC-MAX (2007650-002) |
| <p>NBP test:</p> <ul style="list-style-type: none"> ■ NBP cuff coupling (400787-001) ■ NBP hose coupling (46100-0020) ■ NBP tee (4745-101) ■ NBP tubing 2 feet (401582-001) ■ Manometer, digital or mercury (Meriam Instrument Smart Manometer model 350 DM2000 or equivalent) ■ NBP tube (414873-001) ■ NBP cuff (9461-301) ■ Pipe, PVC |
| <p>DEFIB sync test:</p> <ul style="list-style-type: none"> ■ Unterminated cable assembly (2017842-001) ■ Oscilloscope |

Set up

Complete the following steps in the order presented. Failure to attain any of the listed results indicates a malfunction.

1. Confirm that all components of the monitoring system are correctly connected as described in Chapter 3, “Installation”.
 - ◆ For Patient Data Module, connect using the ePort host interface cable.
 - ◆ For Tram, place the Tram module into the top two slots of the Tram-rac housing.
2. Verify that the power indicator illuminates on the acquisition device.
3. Using the patient simulator and patient cables, configure the monitor display with as many waveforms as possible. Refer to the appropriate patient monitor operator's manual, if necessary.
4. The waveforms should look clean (no noise).

Procedures

PDM admit/discharge cycle

Prior to patient use, perform an admit/discharge cycle on the PDM to clear all patient data.

Follow these steps to do an admit/discharge cycle when the monitor is set for Adult-ICU or Neonatal-ICU mode.

1. With the PDM connected to the monitor, select **MORE MENUS > ADMIT MENU > ADMIT PATIENT** to admit. The **ADMIT PATIENT** option will change to **DISCHARGE PATIENT** once a patient has been admitted to the monitor.
2. Select the **DISCHARGE PATIENT** option from the Admit menu. A popup menu opens.
3. Select **DISCHARGE** from the popup menu. The message “**DISCHARGED**” appears at the top of the display and all data is cleared from the system.

Follow these steps to do an admit/discharge cycle when the monitor is set for Operating Room mode.

1. With the PDM connected to the monitor, select **MORE MENUS > NEW CASE SETUP > NEW CASE**. This is a direct action menu option that performs both a discharge and an immediate admit. All patient data from the previous patient is erased, the screen blanks for a few seconds, and the monitor is then ready to monitor the next patient.

NOTE

For more information about admitting and discharging, refer to the monitor operator’s manual.

Solar 8000M/i CPU

Verify that the power cord is securely connected and that it is routed through the retaining clip. Verify that the clip is not damaged or broken, and that it is securely attached to the CPU. Refer to “[Back panel connections](#)” on page 3-2.

Solar 8000M/i Unity View display

NOTE

For Solar 8000M, the Unity View display was only sold with product code **3S** and **3T**.

Refer to the specific manufacturer’s documentation.

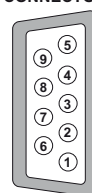
Touchscreen

Verify that touching a parameter box displays the screen information for that parameter.

Tram-rac housing

1. Verify that the power LED is ON at the Tram-rac housing.
2. Disconnect and reconnect the Tram-rac housing communication cable. Verify the recovery of the waveforms.
3. If the Tram-rac housing has additional slots for input modules, insert a BP module. Connect simulator and verify communication to the monitor. Repeat for each slot.
4. If the Tram-rac housing has an optional power supply, check the following on the **TRAM-NET** connector.

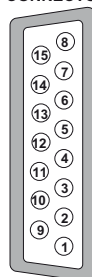
REAR VIEW
TRAM-RAC 4 & 4A
TRAM-NET
CONNECTOR



018B

- ◆ Verify +16.5V is *not* present at pin 5 of the **TRAM-NET** connector with respect to pin 9.
 - ◆ Verify +16.5V is *not* present at pin 5 with respect to chassis ground of the Tram-rac housing.
 - ◆ Verify that the power cord is securely connected and routed through the retaining clip. Verify that the clip is not damaged or broken, and that it is securely attached. Refer to “**Back panel connections**” on page 3-2.
5. The following step does not apply for a Tram-rac 2 housing. Check the analog output connector (yellow) using an oscilloscope. Observe a signal at the appropriate pins found in the next table. The output signal is dependent upon which Tram and input module functions are activated at the monitor.

REAR VIEW
TRAM-RAC 4A
ANALOG OUTPUT
CONNECTOR



019B

| Analog output signals | | |
|---------------------------|--|--|
| Pins for D-type connector | Signal source | Tram-rac 4A bezel number for BP output |
| Pin 1 | Signal GND for Tram Waveforms | – |
| Pin 2 | Trace I (ECG II ¹) | Tram ¹ |
| Pin3 | Tram BP3 or SPO ₂ Value | Tram ¹ |
| Pin 4 | Reserved for Future Use | – |
| Pin 5 | Tram ART 1 or BP1 | Tram |
| Pin 6 | Slot 3 Series 7000 Waveform A (Right Side or Module) | Parameter 6 |
| Pin 7 | Slot 4 Series 7000 Waveform A (Right Side or Module) | Parameter 8 |
| Pin 8 | Signal GND for Series 7000 Waveforms | – |
| Pin 9 | Tram ECG II | Tram ¹ |
| Pin 10 | Tram ECG V | Tram ¹ |
| Pin 11 | Tram BP4 or RESP | Tram ¹ |
| Pin 12 | Reserved for Future Use | – |
| Pin 13 | Tram BP2 or SPO ₂ Waveform | Tram |
| Pin 14 | Slot 3 Series 7000 Waveform B (Left Side or Module) | Parameter 5 |
| Pin 15 | Slot 4 Series 7000 Waveform B (Left Side or Module) | Parameter 7 |

1. The top displayed trace on the monitor is present unless AVR, AVL, or AVF leads are used, then lead II is output.

M-Port

1. Insert the AutoPort to M-Port adapter into the Port Checkout DIDCA.
2. Connect the M-Port side of the AutoPort to M-Port adapter to one of the M-Ports using the category 5 cable.
3. Verify that the M-Port status LED illuminates green. (LED remains illuminated for a short time after the cable is removed.)
4. Repeat the above steps for all available M-Ports.

If an LED is anything but steady green, refer to Chapter 5, [“Troubleshooting”](#).

TRAM-NET interface or communication

Interface

1. Connect the TRAM-NET interface assembly and device. (Use the appropriate TRAM-NET interface assembly manual and device manual for interconnection directions.)

Or,

Connect the Patient Data Module between the ePort connector and the **TRAM-NET 2/ePort** connector on the Solar.

2. Observe correct type of device identified at the monitor.
3. Simulate and observe waveform on monitor.

Communication

1. Connect the Tram-rac housing cable into each of the two TRAM-NET connectors.

Or,

Connect the Patient Data Module between the ePort connector and the **TRAM-NET 2/ePort** connector on the Solar.

2. Verify that the waveforms recover on the monitor display each time the cable is reconnected.
3. Verify that the waveforms recover on the monitor display each time the adapter is reconnected.

Unity Network MC network

1. Disconnect the patient cable from the Tram module and verify alarms at the central station.
2. From the MAIN menu, select **MORE MENUS > VIEW OTHER PATIENTS > SELECT A BED TO VIEW**. Verify that the list includes beds other than your own.
3. Select another bed and verify that the selected bed's data is displayed.

Keypad/remote control

1. Plug the keypad or remote control into an M-port.
2. Check all functions of the **TRIM KNOB** control and 18 hard keys. Verify a response at the monitor display.
3. Check that the backlight is on and lights the keys evenly.
4. Activate Boot Code as follows:
 - ◆ Hold down **NBP Go/Stop** and **Zero All**.
 - ◆ Press and release the **TRIM KNOB** control.
 - ◆ Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.

5. Select **Tools Menu**.
6. Use password “**mei^**” to open **Service and Diagnostic Tools Menu**.
7. Select **M-Port Tools > Show M-Port #X Serial Incoming Data**. (Where X = the M-Port number.)
8. If the message, “**No incoming data read**” appears, nothing is connected to the **M-Port**. Connect the keypad or remote control or choose the correct **M-Port**.
9. As the columns of numbers scroll, press the keys and **TRIM KNOB** control. Verify that the numbers change as keys are pressed.
10. Exit Boot Code.

Unity Network ID

Unity Network ID connectivity device checkout procedures, see the Unity Network Interface Device (ID) service manual.

Printer

Press **Graph Go/Stop** and verify that the printer responds correctly.

Parameter tests

ECG functions

These procedures test the following:

- Lead and heart rate information displays properly.
 - QRS tone sounds.
 - Pacemaker mode displays in ECG parameter box.
 - Calibration pulses display with correct amplitude.
1. Set up the simulator:
 - ◆ Heart rate to 80 bpm.
 - ◆ ECG amplitude to 1.0 mV.
 2. Attach the patient cable and leadwires between the ECG connector on the acquisition device and the leadwire connectors on the patient simulator.
 3. Set up the patient monitor:
 - a. Go to **MORE MENUS > MONITOR SETUP > PARAMETERS ON/OFF** and turn off all parameters except **ECG**.
 - b. In **MONITOR SETUP** select **WAVEFORMS ON/OFF** and set leads in the following order:
 - ◆ Waveform 1 = **II**
 - ◆ Waveform 2 = **I**
 - ◆ Waveform 3 = **III**
 - ◆ Waveform 4 = **V1**

- ◆ Waveform 5 = *AVL*
 - ◆ Waveform 6 = *AVF*
 - c. From the *ECG* Menu, select *MORE ECG, QRS VOLUME:* and set to the desired volume percentage.
4. Admit a patient into patient monitor. (*MORE MENUS > ADMIT MENU > ADMIT PATIENT*)
 5. Check that the following conditions are true:
 - ◆ The monitor displays ECG lead II, and it is noise-free.
 - ◆ The patient monitor displays an 80 ±1 bpm heart rate.
 - ◆ The patient monitor QRS audible tone sounds with each QRS complex.
 6. Make sure all six ECG leads are available for display and are noise-free.
 7. At the patient monitor, select the ECG parameter window to display the ECG menu at the bottom of the screen.
 8. Select *PACE 1:* or *PACE 2:*.
 9. Inject an asynchronous pacemaker pulse with the simulator.
 10. Observe the following with leads *II, III, aVR, aVF,* and *V:*
 - ◆ On the patient monitor, the pacemaker icon with asterisk appears in the ECG parameter box to denote pacemaker mode.
 - ◆ The patient monitor still displays an 80 ±1 bpm heart rate.
 11. Remove the pacemaker pulse input and return the simulator to these conditions:
 - ◆ Heart rate to 80 bpm.
 - ◆ Amplitude to 1.0 mV.
 12. Select lead *II* for display in the top trace position if not already there.
 13. Remove the **RA** leadwire from the patient cable.
 14. Observe the following:
 - ◆ The monitor displays an *RA FAIL* message.
 - ◆ The monitor displays lead *III* in place of lead *II*.
 15. Replace the **RA** leadwire. Observe lead *II* in the top trace position again.
 16. Print out a graph of ECG 1, lead *II*.
 17. Observe that the waveform pulses are 1mV in amplitude both on the printout and patient monitor display.

12SL™ ECG analysis program functions

1. Connect a 12-lead patient cable to the patient monitor and simulator.
2. At the patient monitor, select the *ECG* parameter box.
3. At the *ECG* menu, select *12 LEAD ECG ANALYSIS*.
4. Check that all 12 ECG waveforms display clearly, are noise-free, and display an amplitude equal to the input voltage.

Respiration functions

1. Set up simulator:
 - ◆ Set baseline impedance to 750Ω (or 1000Ω if using Marq II).
 - ◆ Set Δ (delta) R to 0.5Ω
 - ◆ Set lead select to **I** and **II** (or **LL** if using Marq II).
 - ◆ Set respiration rate to 30 breaths per minute.
2. Set up the monitor:
 - ◆ Turn the respiration waveform **RR ON**.
 - ◆ Set the respiration waveform to lead **II**.
3. Observe these conditions:
 - ◆ The monitor displays a distortion-free respiration waveform.
 - ◆ The monitor displays a respiration rate reading of 30 ± 2 breaths per minute.
4. Set the respiration waveform to lead **I** at the monitor, **LA** at the simulator, and observe the same conditions as in step 3.

Invasive blood pressure functions

1. Set up simulator:
 - ◆ Go to **BP** functions, select **BP1**, then **0**.
 - ◆ Set output to **0 mmHg**.
2. Connect the IP simulator cable from the **BP1** connector of the simulator to the corresponding **IP** connection of the acquisition device.
3. Observe an **ART1** label and graticules on the patient monitor.
4. Zero the **ART1** waveform by pressing the Zero All button on the Patient Data Module, Solar keypad or remote.
5. Set the simulator to output **240 mmHg**. (**BP1 > STAT > UP > RUN**)
6. Observe a reading of 240 ± 4 mmHg on the patient monitor.
7. Set the simulator to BP dynamic waveform output. (**BP1 > DYNA > RUN**)
8. Set the patient monitor **ART1 SCALES** to **AUTO**.
9. Observe a distortion-free waveform and a blood pressure reading of approximately 120/80 (93) on the patient monitor.
10. Repeat these tests with each **IP/BP** connector selecting **BP2**, **BP3**, etc.

NOTE

Use the Dual IP Adapter Cable to test the third and fourth IP functionality for each IP/BP connection.

Temperature functions

1. Go to **TEMP** functions on the simulator and set a 37°C temperature output.
2. Connect a temperature sensor adaptor to the **TEMP/CO** connector of the acquisition device.
3. Set the switch on the adaptor to the **400** position.
4. Connect the temperature simulator cable from the temperature output connector of simulator to the **T1** connector of the temperature sensor adaptor.
5. Observe that the **T1** reading on the patient monitor is between 36.6 and 37.4.
6. Move the cable from the **T1** connector of the temperature sensor adaptor to the **T2** connector.
7. Observe that the **T2** reading appears on the patient monitor is between 36.6 and 37.4.
8. Disconnect the temperature sensor adaptor and temperature cable from the acquisition device and the simulator.

Cardiac output functions

1. Connect the cardiac output cable adapter to the **Temp/CO** connector of the acquisition device.
2. Connect the cardiac output adapter to the cardiac output cable adapter and to the simulator.
3. At the patient monitor, go to **MENUS** ⇒ **CO**.
4. Set up the monitor:
 - ◆ Set **AUTO MODE:** to **ON**
 - ◆ Set **INJECT TEMP:** to **BATH**
 - ◆ Set **SIZE:** to **7**
 - ◆ Set **INJECT VOL:** to **10CC**
 - ◆ Set **COMPUTATIONAL CONSTANT:** to **0.540**
5. Select cardiac output menu corresponding to the injectate temperature. (**CO**)
6. Set the adapter and simulator to **0°**. Verify that the IT value on the lower left of the display matches the input.

When computing is complete, the **CO** reading on the patient monitor should read approximately ±5% of simulated value.
7. Repeat this test with the adapter and simulator set to **24°** and the **COMPUTATIONAL CONSTANT:** set to **0.595**.

The computed output should be ±5% of simulated value.

SpO₂ functions (Masimo)

1. Connect the Masimo SpO₂ tester cable to the SpO₂ sensor adapter cable.
2. Connect the SpO₂ adapter cable to the SpO₂ connector on the acquisition device.
3. Turn the patient monitor on.
4. Verify the following are displayed at the patient monitor: (It might be necessary to turn the SpO₂ parameter on.)
 - ◆ A waveform with an SpO₂ label.
 - ◆ An SpO₂% reading between 78- 84%.
 - ◆ A PRR reading between 60 and 62 beats per minute.
5. Disconnect the simulator cable from the acquisition device.

SpO₂ functions (Nellcor OxiMax)

1. Verify that 2 AA alkaline batteries are installed in the NELLCOR SRC-MAX Pulse Oximetry functional tester.
2. Connect the SRC-MAX to the **SpO₂** connector on the module.
3. On the SRC-MAX, verify that the **IR** and **RED** LED indicators are both lit.
4. Verify the SRC-MAX default indicators are as follows:
 - ◆ Heart rate = 60 bpm
 - ◆ Light = LOW
 - ◆ MOD = LOW
5. Verify the following SpO₂ readings for saturation and pulse rate:
 - ◆ Saturation (%): 75 ± 2
 - ◆ Rate (bpm): 60 ± 2
6. Press and release the heart rate button on the SRC-MAX. Verify default indicators are lit as follows:
 - ◆ Heart rate = 200 bpm
 - ◆ Light = LOW
 - ◆ %SpO₂ = 75
 - ◆ MOD = LOW
7. Verify the following SpO₂ readings for saturation and pulse rate:
 - ◆ Saturation (%): 75 ± 2
 - ◆ Rate (bpm): 200 ± 3 (194 to 206)
8. Press and release the light button on the SRC-MAX. Verify default indicators are lit as follows:
 - ◆ Heart rate = 200 bpm
 - ◆ Light = HIGH

- ◆ %SpO₂ = 75
 - ◆ MOD = LOW
9. Verify the following SpO₂ readings for saturation and pulse rate:
- ◆ -Saturation (%): 75 ± 2
 - ◆ -Rate (bpm): 200 ± 3 (194 to 206)
10. Press and release the %SpO₂ button on the SRC-MAX. Verify default indicators are lit as follows:
- ◆ Heart rate = 200 bpm
 - ◆ Light = HIGH
 - ◆ %SpO₂ = 90
 - ◆ MOD = LOW
11. Verify the following SpO₂ readings for saturation and pulse rate:
- ◆ Saturation (%): 90 ± 2
 - ◆ Rate (bpm): 200 ± 3 (194 to 206)
12. Press and release the **MOD** button on the SRC-MAX. Verify default indicators are lit as follows:
- ◆ Heart rate = 200 bpm
 - ◆ Light = HIGH
 - ◆ %SpO₂ = 90
 - ◆ MOD = HIGH
13. Verify the following SpO₂ readings for saturation and pulse rate:
- ◆ Saturation (%): 90 ± 2
 - ◆ Rate (bpm): 200 ± 3 (194 to 206)

SpO₂ functions (Nellcor OxiSmart, Tram only)

1. Connect the Nellcor pulse oximeter SRC-2 to the sensor connector.
2. Make sure that the SRC-2 **IR** and **RED** LED drive indicators are both lit.
3. Set the **RCAL/MODE** switch to **RCAL 63/LOCAL**.
4. Set the **LIGHT** and **MODULATION** switches as follows:
 - ◆ Set the **LIGHT** switch to **HIGH 1**.
 - ◆ Set the **MODULATION** switch to **HIGH**.
 - ◆ Set the **RATE** switch to **112**.Allow the Tram a few seconds to obtain a steady reading.
5. Verify the following SpO₂ readings for saturation and pulse rate:
 - ◆ Saturation (%): 81 ± 2
 - ◆ Rate (bpm): 112 ± 2% (110 to 114)

6. Set the **LIGHT** and **MODULATION** switches as follows:
 - ◆ Set the **LIGHT** switch to **LOW**.
 - ◆ Set the **MODULATION** switch to **LOW**.
 - ◆ Set the **RATE** switch to **201**.
7. Verify the following SpO₂ readings for saturation and pulse rate:
 - ◆ Saturation (%): 81 ± 2
 - ◆ Rate (bpm): $201 \pm 3\%$ (195 to 207)
8. Set the **LIGHT** and **MODULATION** switches as follows:
 - ◆ Set the **LIGHT** switch to **HIGH 2**.
 - ◆ Set the **MODULATION** switch to **LOW**.
 - ◆ Set the **RATE** switch to **38**.
9. Verify the following SpO₂ readings for saturation and pulse rate:
 - ◆ Saturation (%): 81 ± 2
 - ◆ Rate (bpm): $38 \pm 2\%$ (37 to 39)
10. Set the **LIGHT** and **MODULATION** switches as follows:
 - ◆ Set the **LIGHT** switch to **LOW**.
 - ◆ Set the **MODULATION** switch to **HIGH**.
 - ◆ Set the **RATE** switch to **201**.
11. Verify the following SpO₂ readings for saturation and pulse rate:
 - ◆ Saturation (%): 81 ± 2
 - ◆ Rate (bpm): $201 \pm 3\%$ (195 to 207)

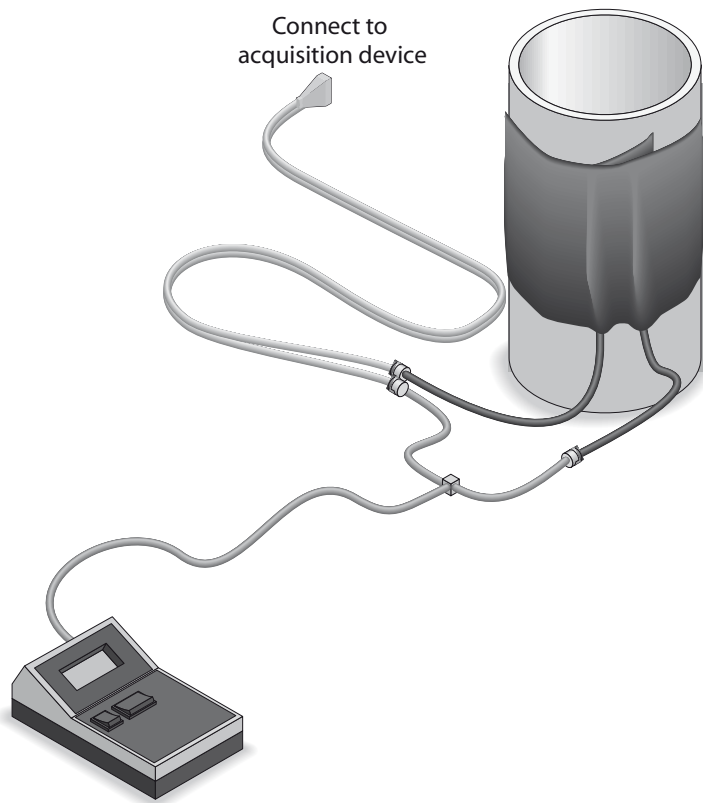
NBP calibration check

1. Connect the acquisition device to the patient monitor.
2. Disconnect all parameter cables.
3. Apply power to the patient monitor.
4. Make sure the power indicator on the acquisition device's front panel is ON (green).

WARNING

Do not put the NBP cuff around a human limb during the checkout procedure due to the potential for injury. When the NBP cuff is used in this procedure, it must be tightly wrapped around a rigid cylinder or pipe.

5. Connect a manometer and NBP cuff to the NBP connector on the front of the acquisition device.



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6. Turn the manometer **ON**, and set its range switch to the **1000 mmHg** setting.
7. From the patient monitor Main Menu, select **MONITOR SETUP > SERVICE MODE**.
8. Enter the username and password to get into the service mode. The first two digits of the password are the day of the month, and the second two digits are the month. Select **SERVICE MODE**.
9. Select **CALIBRATE**.
10. Select **CALIBRATE NBP**.
11. Select **CHECK CAL OFF**.
12. Select **START**.
13. The text in the menu field changes to **CHECK CAL IN PROGRESS**. Verify that the pressure readings on the patient monitor (shown as **CUFF** in the **NBP** parameter box) and the manometer are equal (± 1 mmHg) for at least one full minute.
14. If they are equal, the device is properly calibrated.
If they are not equal, the device requires calibration. Complete this section, then continue with “**NBP calibration**” below.
15. Select **CHECK CAL IN PROGRESS**.
16. Select **STOP**. The module then releases pressure in the cuff.
17. Disconnect the NBP cuff and manometer from the acquisition device.

NBP calibration

1. From the monitor's main menu, select **MONITOR SETUP**.
2. Select **SERVICE MODE**.
3. Enter the password to get into the service mode.
 - ◆ The first two digits of the password are the day of the month, and the second two digits are the month. For example, on 7 March, the password would be 0703.
 - ◆ Select **SERVICE MODE**
4. Select **CALIBRATE NBP**.
5. Select **CAL ZERO OFF**.
6. Select **START**. The **CAL ZERO** menu item shows that it is **IN PROGRESS**, and when it is done it displays **OFF** again.
7. Reconnect the cuff and manometer to the acquisition device.
8. Select **CAL GAIN OFF**.
9. Select **START**.

The second line of text on the **CAL GAIN** menu item changes to **INFLATING**. Then, the acquisition device starts pumping up the pressure bulb or cuff displayed pressures increase on both the monitor display and the manometer.

The pump shuts off at about 250 mmHg, and the pressure drops slowly to about 240 mmHg before stabilizing. The second line of text on the **CAL GAIN** menu item changes from **INFLATING** to **HOLDING**

NOTE

If the pressure continues to drop at a rate of 1 mmHg or more for every five seconds, there is a leak in the NBP plumbing. If there is a leak in the NBP plumbing, correct the problem and restart this calibration procedure.

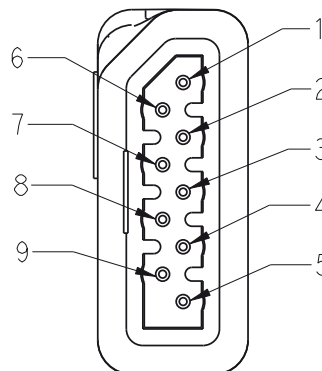
10. Select **ENTER CAL PRESSURE**.
11. An **ENTER CAL PRESSURE** popup window appears. Use the **Trim Knob** control to select a pressure value that is 1 mmHg lower than the current manometer reading.
12. When the manometer falls to exactly the value that you selected in the popup window, press the **Trim Knob** control to enter the value. Select **PREVIOUS MENU** to return to the **MAIN MENU** button.
13. Select **CHECK CAL OFF**.
14. Select **START**.
15. The text on the menu item changes from **CHECK CAL OFF** to **CHECK CAL IN PROGRESS**. Make sure that the pressure readings (shown as **CUFF** in the NBP parameter box) on the monitor display and manometer are equal (± 1 mmHg) for at least one full minute.
16. Select **CHECK CAL IN PROGRESS**.

17. Select **STOP**. The module then releases pressure in the bulb or cuff.
18. Remove the cuff and manometer from the acquisition device.

Defib/sync and analog output test

Patient Data Module

1. Connect the unterminated cable assembly to the **Defib/Sync** connector on the front of the Patient Data Module.
2. Set up the simulator:
 - ◆ Heart rate = 80 bpm
 - ◆ Amplitude to 1.0 mV
3. Test the ECG, Arterial BP, and Marker Out signals from the **DEFIB SYNC** connector using an oscilloscope to connect to the appropriate wire on the test cable (shown below). They should resemble the waveforms in the following figures. Note that there are two Marker Out traces shown. The top trace shows the frequency of the pulses; the bottom trace shows the pulse width.



450B

Test Cable Plug and Pinout

| Pin | Wire Color | Signal Name |
|-----|------------|-----------------------|
| 1 | Brown | ECG_ANALOG_OUT |
| 2 | Red | BP_ANALOG_OUT |
| 3 | Orange | NO_CONNECTION |
| 4 | Yellow | MARKER_RETURN |
| 5 | Shield | DRAIN WIRE |
| 6 | Green | ANALOG_RETURN |
| 7 | Blue | NO_CONNECTION |
| 8 | Violet | DEFIB_SYNC_MARKER_IN |
| 9 | Gray | DEFIB_SYNC_MARKER_OUT |

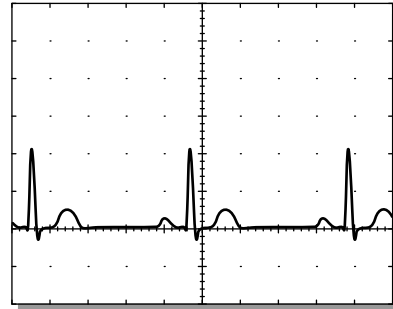
ECG

Signal pin: 1 Brown wire

Ground pin: 6 Green wire

Time/division: 0.2s

Volts/division: 0.5v



023A

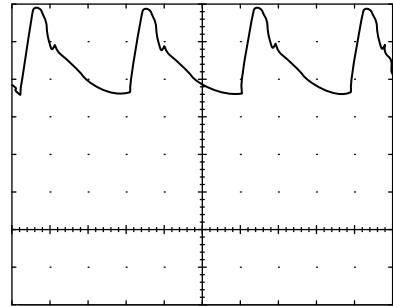
Arterial BP

Signal pin: 2 Red wire

Ground pin: 6 Green wire

Time/division: 0.2s

Volts/division: 0.2v



024A

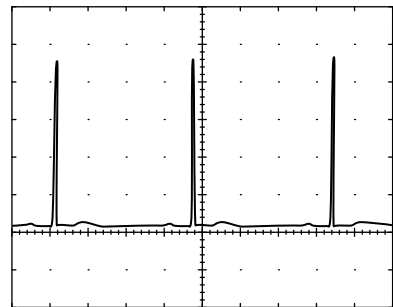
Marker Out (Frequency)

Signal pin: 9 Gray wire

Ground pin: 4 Yellow wire

Time/division: 10ms

Volts/division: 0.5v



025A

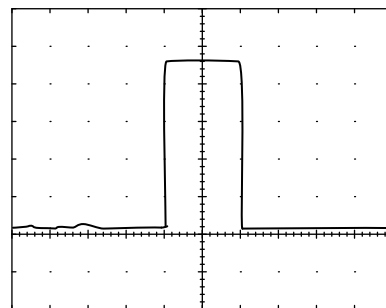
Marker Out (Pulse Width)

Signal pin: 9 Gray wire

Ground pin: 4 Yellow wire

Time/division: 5ms

Volts/division: 1v

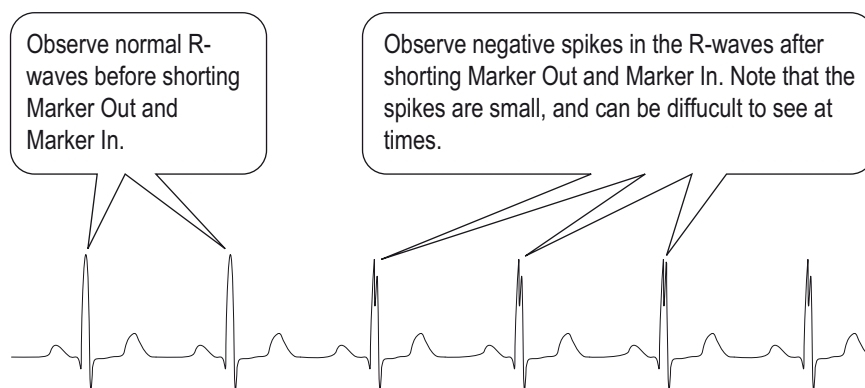


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NOTE

The Marker Out amplitude and pulse width are configured at 10v and 10ms respectively from the factory.

- Short the gray wire (Marker Out) to the violet wire (Marker In) and observe negative spikes in the R-waves of the displayed ECG waveforms.

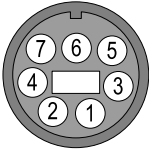


432B

Tram module

- Connect an oscilloscope to the **DEFIB SYNC** connector on the front panel of the Tram module.
- Test the ECG, Arterial BP, and Marker Out signals from the **DEFIB SYNC** connector. They should resemble the waveforms in the following figure. Note that there are two Marker Out traces shown. The top trace shows the frequency of the pulses; the bottom trace shows the pulse width.

| Defibrillator Synchronization connector J2 | | |
|--|-------------------|---|
| Pin | Name | Descriptions |
| 1 | DEFIB_MARKER_OUT | Digital defibrillator output synchronization signal |
| 2 | DEFIB_MARKER_IN | Digital defibrillator input signal |
| 3 | AGND1 | Signal Ground |
| 4 | DGND | Signal Ground |
| 5 | AGND2 | Signal Ground |
| 6 | BP_ANALOG_OUTPUT | Analog BP/OUTPUT |
| 7 | ECG_ANALOG_OUTPUT | Analog ECG output signal |

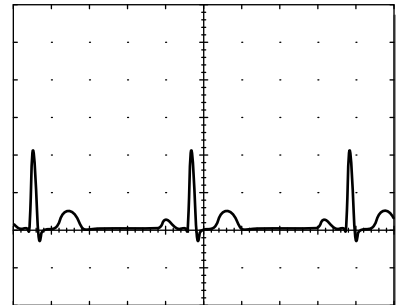


Front View of Module

039A

ECG

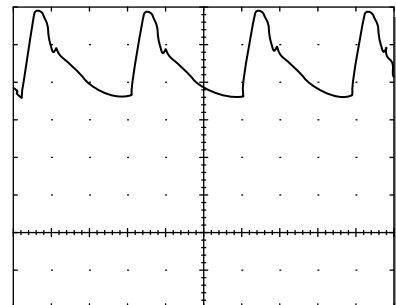
Signal Pin: **7**
 Ground Pin: **3**
 Probe Type: **x10**
 Time/Division: **0.2S**
 Volts/Division: **0.5V**



023A

Arterial BP

Signal Pin: **6**
 Ground Pin: **5**
 Probe Type: **x10**
 Time/Division: **0.2S**
 Volts/Division: **0.2V**



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NOTE

The Marker Out amplitude and pulse width are configured at 5V and 10ms respectively from the factory. To change these settings refer to the Calibration chapter of your TRAM modules service manual.

Marker Out (Frequency)

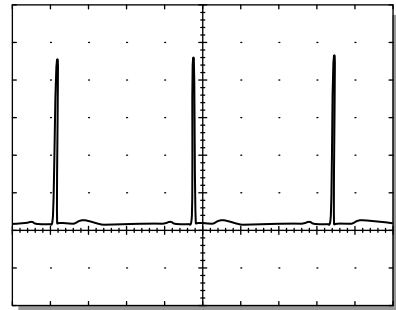
Signal Pin: 1

Ground Pin: 4

Probe Type: x10

Time/Division: 0.2S

Volts/Division: 1V



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Marker Out (Pulse Width)

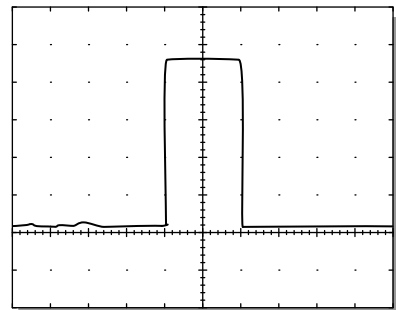
Signal Pin: 1

Ground Pin: 4

Probe Type: x10

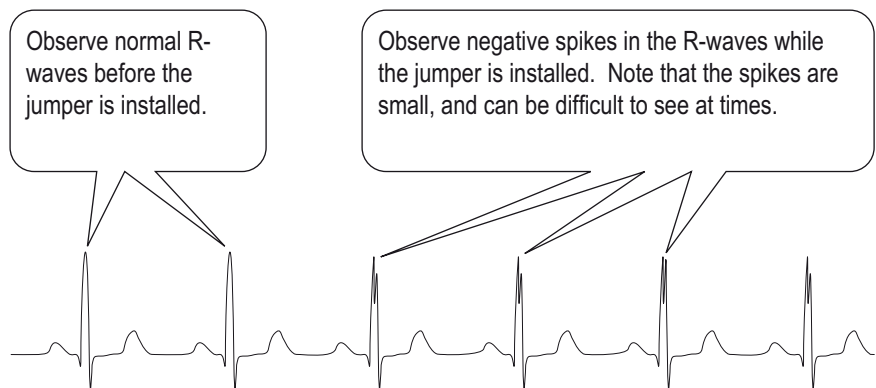
Time/Division: 5mS

Volts/Division: 1V



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3. Attach a jumper between pin 1 (Marker Out) and pin 2 (Marker In) of the **DEFIB SYNC** connector and observe negative spikes in the R-waves of the displayed ECG waveforms.



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4. Remove the jumper.

Completion

- Test additional modules using procedures found in the service manual that accompanied the module.
- Disconnect all test equipment.
- Return the monitor and acquisition device to service.

Maintenance Checklist

Use the following checklist to ensure maintenance completion.

“Visual inspection” on page 4-3

1. General
2. Connectors
3. Display

“Cleaning” on page 4-4

1. Exterior cleaning
2. Cleaning the display
3. Cleaning the touch screen display
4. Cleaning disinfecting and storing GE ECG cables and leadwires

“Electrical safety tests” on page 4-8

1. Power outlet test
2. Ground (earth) integrity
3. Ground (earth) wire leakage current tests
4. Enclosure leakage current test
5. Patient (source) leakage current test
6. Patient (sink) leakage current test

“Checkout procedure” on page 4-16

1. Solar 8000M/i Unity View display
2. Touchscreen
3. Tram-rac housing
4. M-Port
5. TRAM-NET interface or communication
6. Unity Network MC network
7. Keypad/remote control
8. Unity Network ID
9. Printer

“Parameter tests” on page 4-22

1. ___ ECG functions
2. ___ 12SL™ ECG analysis program functions
3. ___ Respiration functions
4. ___ Invasive blood pressure functions
5. ___ Temperature functions
6. ___ Cardiac output functions
7. ___ SpO2 functions (Masimo)
___ SpO2 functions (Nellcor OxiMax)
___ SpO2 functions (Nellcor OxiSmart, Tram only)
8. ___ NBP calibration check
9. ___ Defib/sync and analog output test (Patient Data Module)
___ Defib/sync and analog output test (Tram Module)

Repair Log

Unit serial number:
Institution name:

| Date | Maintenance or repair | Technician |
|------|-----------------------|------------|
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