5 PREVENTIVE MAINTENANCE

Equipment Maintenance Program

Recommended Maintenance Schedule

A regular equipment maintenance program helps prevent unnecessary equipment and power failures and also reduces possible health hazards. The maintenance schedule for the Tram 100-850 A and SL modules include the following:

- Inspection; Do this before each time the module is used with a patient.
- General cleaning; Do this before each time the module is used with a patient.
- Checkout procedures; Do these when you first get your module (before you use it to monitor patients), every six months thereafter, and each time you remove and replace a circuit board.
- Current leakage tests; Do these when you first get your module (before you use it to monitor patients), every six months thereafter, and each time you remove and replace a circuit board. Leakage tests verify that the equipment does not propose a health hazard.
- Hi-pot tests; Do these each time you open the acquisition module.
- NBP calibration (refer to Chapter 4: "Calibration"); Do this when you first get your module (before you use it to monitor patients), every year thereafter, and each time you remove and replace a circuit board.

Recommended Frequency

To help you establish a systematic maintenance routine, Marquette Electronics recommends that you perform all maintenance procedures presented in this chapter.

- upon receipt of the module,
- every six months thereafter,
- each time a circuit board is removed or replaced, and
- record the results on the "Preventive Maintenance Inspection Form," included at the end of this chapter.

WARNING
Failure to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards. Unless you have an Equipment Maintenance Contract, Marquette Electronics 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. Marquette Electronics service personnel may, at their discretion, follow the procedures provided in this manual as a guide during visits to the equipment site.

Inspection and Cleaning

Visual Inspection

Remove module before making an inspection or cleaning the module.

- Check the case for cracks or other damage.
- Regularly inspect cables for fraying or other damage.
- Inspect all plugs, cables, and connectors for bent prongs or pins.
- Make sure the latches work properly:
  - When you install the Tram module in a monitor, it should be latched firmly into place and should not slide out of the monitor without pressing the latch buttons.
  - When you press the latch buttons, the Tram module should slide easily out of the monitor
- Verify that all cables and connectors are securely seated. Note that replacement of components should be performed only by qualified service personnel.

Cleaning Precautions

To avoid damage to the equipment surfaces, do not use the following cleaning agents:

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

Table 5-1. Recommended Cleaning Supplies

Item	Part Number
Ammonia (diluted) or Cidex solution, or Sodium hypochlorite bleach (diluted), or Mild soap (diluted)	–
Lint-free cloth	TX609
Dust remover (compressed air)	–

Exterior Cleaning

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

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

Checkout Procedure

The following pages describe the checkout procedures for the Tram module. We provide you with these procedures so you can verify the operational performance of the Tram module. If you do not get the results listed in the procedures, your Tram module might not be working properly.

The checkout procedures consist of several tests. You should perform all of the tests applicable to your Tram module in the order in which they are listed.

Test Frequency

This procedure tests the functions of each parameter of the module. We recommend this checkout procedure be performed:

- upon receipt of the module,
- every six months thereafter, and
- each time the module is open or repaired.

Remember to record the date and results on the "Maintenance/ Repair Log" included at the end of this chapter.

Required Tools/Special Equipment

These procedures are based on the assumption that the module under test is used with known good cables and known good test equipment. It also assumes that you are at least somewhat familiar with the operation of all devices required for the procedures. For more information concerning the operation of these components, consult the appropriate operator's manuals.

The following paragraphs list the test equipment, adapters, and cables necessary to complete the checkout procedures. You can use equivalent equipment, but the procedures were written for the test equipment listed here, so you might have to slightly modify some test steps, because the values listed in the steps take into account the accuracy of the simulators, as well as the accuracy of the module. The "Technical Specifications" in Chapter 2: "General Information" for details about the module's accuracy specifications.

1. You will need a monitor to plug the Tram module into. You may use any of these monitors:
   - a Tram Critical Care monitor (a Tramscope display with a Tram-rac housing).
   - a Series 7000 or 7000RA monitor that has been modified to be Tram-compatible, or
   - a Series 7005, 7010, or 7010RA monitor.

2. You will need the simulators and cables listed below to provide waveforms and patient vital signs.

CAUTION
You should never use a patient simulator as a calibration reference because they are generally not precise enough to be trusted as a reference. Make sure that your simulator is accurate by testing it on a known-good monitor.

Table 5-2. Suggested Simulators and Cables

Item	Part Number
Multifunction Micro-Simulator	MEI PN MARQ-1
Cardiac Output Simulator II	MEI PN 900028-001
SpO_2 Simulator	MEI PN 408610-001
ECG Patient Cable	MEI compatible
ECG Leadwire Set	MEI compatible
Blood Pressure Simulator Cable	MEI PN 700095-001
Temperature Adapter	MEI PN 402015-004
Temperature Simulator Cable	MEI PN 6770031
Cardiac Output Cable Adapter	MEI PN 700092-001
MEI (Nellcor-style) SpO_2 Simulator Cable OR (Ohmeda-Style SpO_2 Simulator Cable)	MEI PN 700232-004 OR MEI PN 700232-002)

3. You can use any patient cable or leadwire set that you would usually use on patients.
4. You need these items to build an NBP test fixture:

Table 5-3. Description

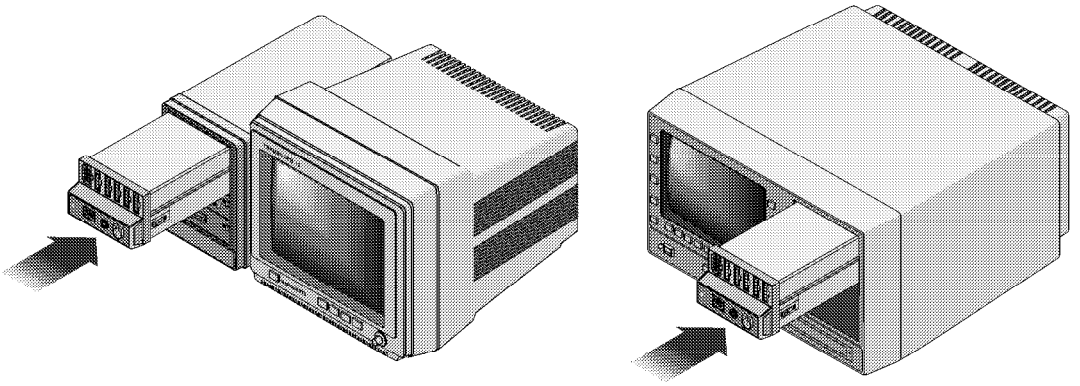
Item	Part Number	Qty
NBP Cuff Coupling	MEI PN 400787-001	1
NBP Hose Coupling	MEI PN 46100-002	1
NBP Tee	MEI PN 4745-101	1
NBP Tubing	MEI PN 401582-001	2

5. You need an accurate manometer for the NBP test. A digital one, like the Sensym PDM200M is nice, but you can use a mercury manometer, too.

6. You need an NBP tube for the NBP test:
   - If you have a Tram 100 or 200 module, you will need pn 9461-203.
   - If you have a Tram 400A module with an NBP connector that protrudes from the front of the module, you will need pn 9461-208.
   - If you have a Tram 400 A or SL module with a recessed NBP connector, or if you have a Tram 800 A or SL module, you will need pn 9461-212.
7. You need an NBP cuff for the NBP test. Any size will work. If you do not have one, order pn 9461-301.
8. You need something to wrap the cuff around during that test. PVC pipe from your local hardware store works good.
9. You need an oscilloscope for the DEFIB SYNC test. Since you will use it to view low-frequency ECG and BP waveforms, almost any kind of oscilloscope will work.
10. You need a Smart-pac transport display, or a Series 7200 Tram transport display fitted with a Smart-pac battery backpack.
11. You need a cable to connect your Tram module to the transport display. If you do not already have one, pn 403495-001 is a 3-meter (10-foot) cable.

General Test

1. Install the module in a Tram-rac 4 housing or Series 70XX-type monitor.



2. Apply power to monitor by turning the rear panel power switch to the ON position.
3. Turn the display ON by pressing the DISPLAY ON/OFF or POWER key on the front panel of the monitor.
4. Make sure the power indicators ON both the monitor and the Tram module are turned ON.
5. Connect patient cable to module.
6. Attach appropriate leads to the simulator.

Parameter Tests

Select the appropriate tests to verify all parameters of the module under test. The parameter tests are presented in the following order.

- ECG Test
- 12SL ECG Test
- Respiration Test
- BP Test
- Temperature Test
- CO Test
- SpO_2 Test
- NBP Test

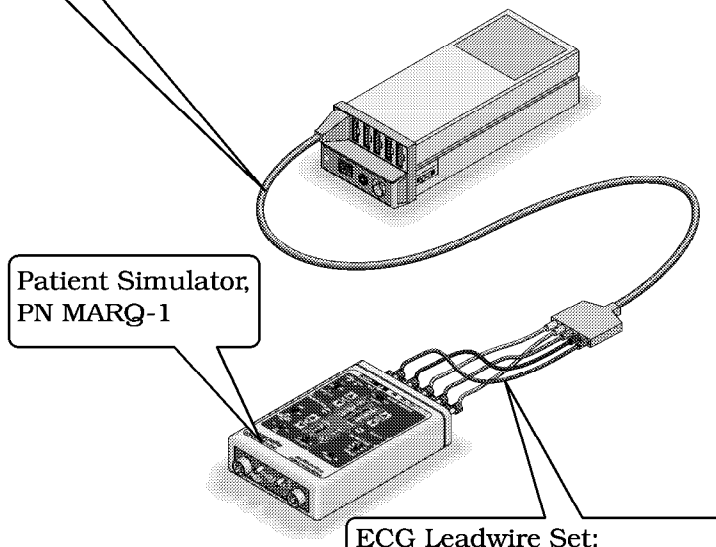
CAUTION
Make sure to test all parameters per module.

ECG Test

1. Set up the simulator like this:
   - Set heart rate to 80 bpm.
   - Set ECG amplitude to 1.0 mV.
2. Attach a patient cable and leadwires between the ECG connector on the Tram module and the leadwire connectors on the top of the patient simulator.

ECG Patient Cable:

Lead-Wires	AHA Colors Part Number	IEC Colors Part Number
3	408026-001	408026-002
5	403061-001	403061-002
10	401280-001	401280-002

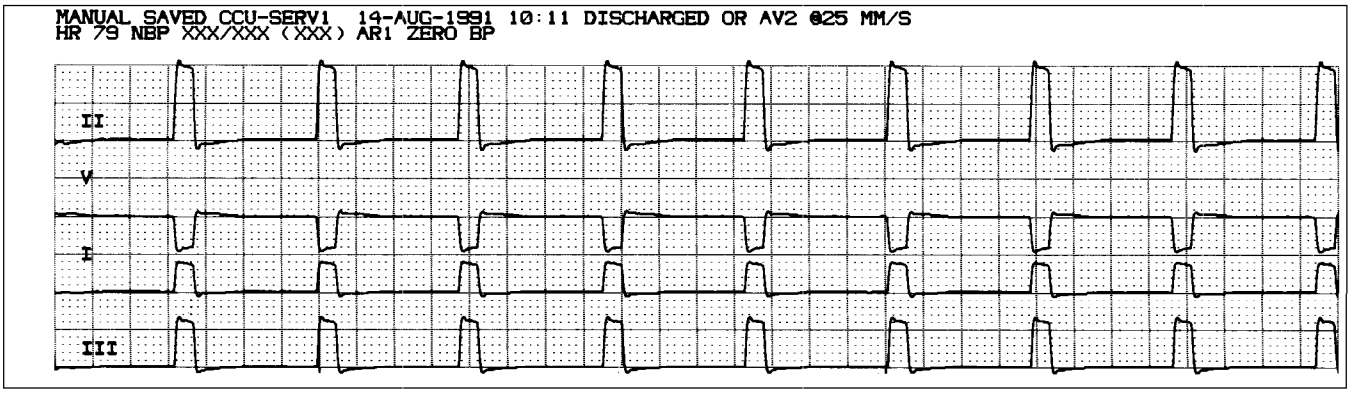


ECG Leadwire Set:

Lead-Wires	AHA Colors Part Number	IEC Colors Part Number
3	408029-001	408029-002
5	403067-005	403067-006
10	Not Available	Not Available

3. Admit a patient into system.
4. Make sure the following conditions are true:
   - The monitor displays ECG lead II, and it is noise-free.
   - The monitor displays an 80 ±1 bpm heart rate.
   - If the monitor has QRS tones are turned ON, an audible tone sounds with each QRS complex.
5. Make sure all seven ECG leads are available for display and they are noise-free.
6. Set DETECT PACE to NORMAL.
7. Inject a VP2 pacemaker pulse with the simulator.

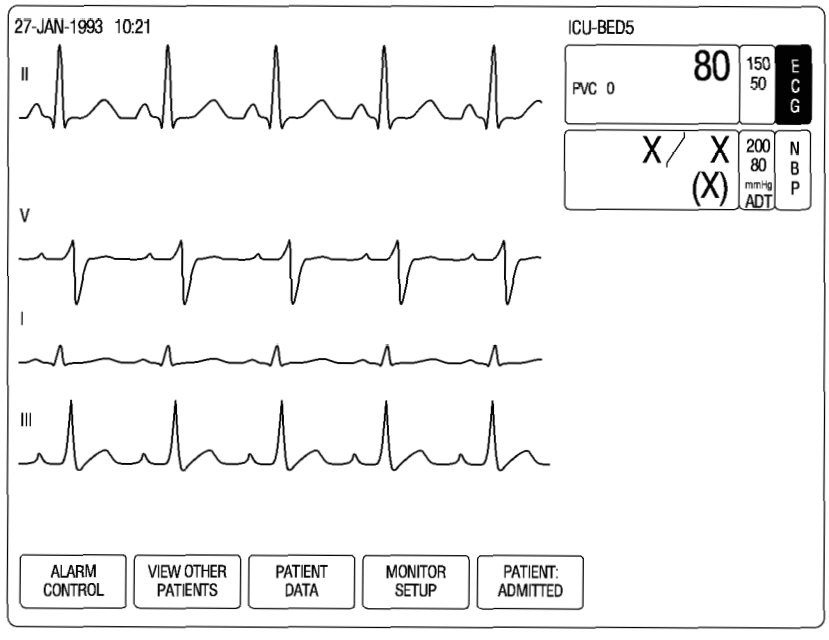
8. Observe following with leads II, III, aVR, aVF, and V:
   - On the monitor, a P appears above the PVC count to denote pacemaker mode.
   - The monitor still shows an 80 ±1 bpm heart rate.
9. Remove the pacemaker pulse input and return the simulator to these conditions:
   - Set heart rate to 80 bpm.
   - Set amplitude to 1.0 mV.
10. Select lead II for display in the top trace position.
11. Remove the RA leadwire from the patient cable.
12. Observe following:
    - The monitor displays an RA FAIL message.
    - The monitor displays lead III in place of lead II.
13. Replace the RA leadwire.
14. Inject a 1-millivolt calibration pulse with the simulator and start a manual graph.
15. Observe that the calibration pulses are properly displayed and graphed, like in the example below.



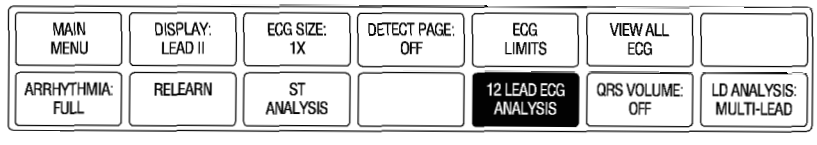
12SL ECG Test

This test is only necessary for SL-type Tram modules. It requires that the Tram module use version 7 (or later) software, and that the monitor uses a Tramscope 12 or 12C display with version 7 or 17 (or later), Series 7030 software.

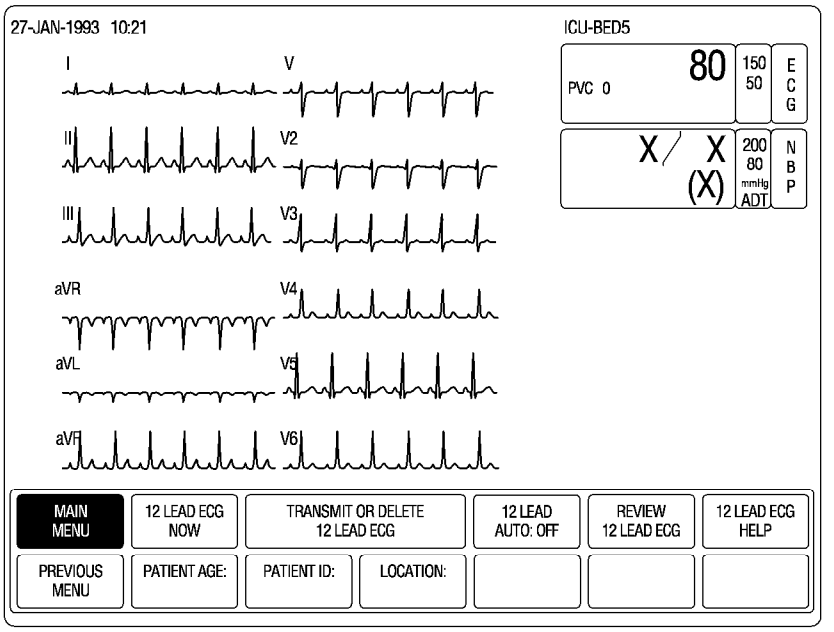
1. At the monitor, return to the Main Menu.
2. Turn the Trim Knob control to highlight the ECG parameter box, and press the Trim Knob control to select it.



3. At the ECG menu, rotate the Trim Knob control to highlight 12 LEAD ECG ANALYSIS, and then press the Trim Knob control to select it.



4. Make sure that all 12 ECG traces are noise-free, and they are displayed clearly.

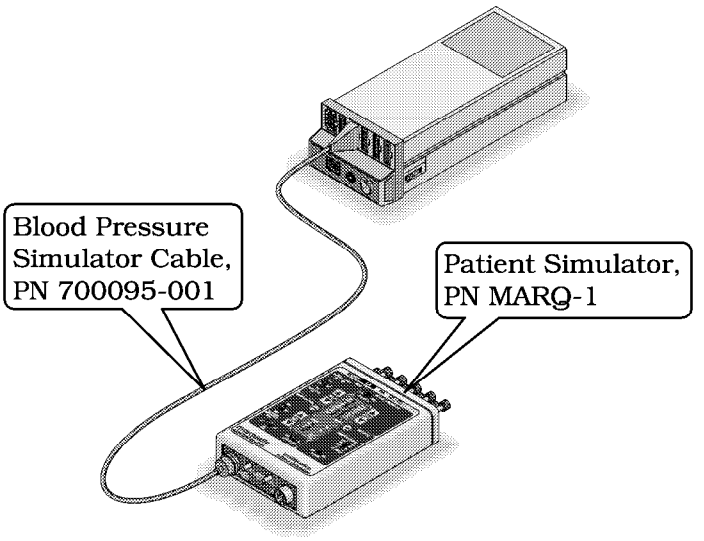


Respiration Test

1. Set up simulator like this:
   - Set baseline impedance to 750Ω.
   - Set ΔR to 0.5Ω.
   - Set lead select to I & II.
   - Set respiration rate to 30 breaths per minute.
2. Set up the monitor like this:
   - Turn the respiration waveform 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 and observe the same conditions as in step 3.

Blood Pressure Test

1. Set up simulator like this:
   - Set polarity to POS.
   - Set output to 0 mmHg.
2. Connect a cable from the BLOOD PRESSURE 1 connector of the simulator to the left most BP connector (BP1) of the Tram module.

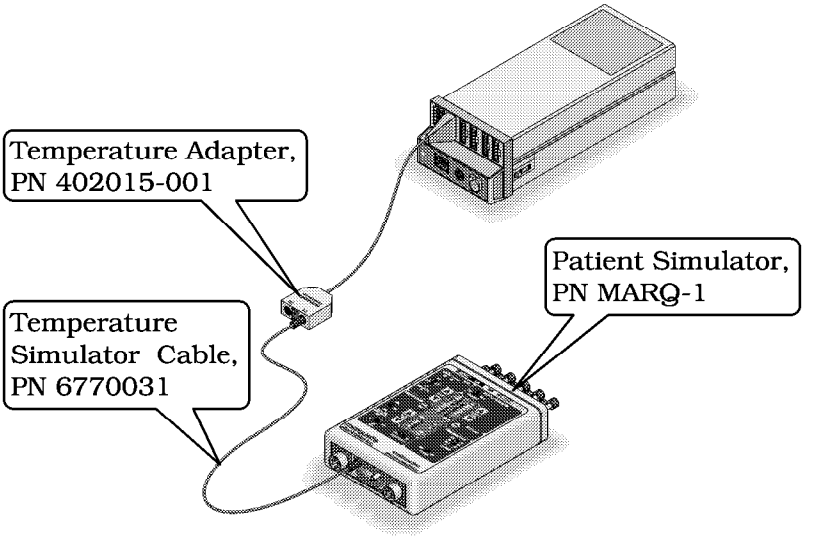


3. Observe an AR1 label and graticules on the monitor.
4. Zero the AR1 waveform.
5. Set the simulator to output 200 mmHg.
6. Observe a reading of 200/200 (200) ± 4 mmHg on the monitor.
7. Set the simulator to WAVE output.
8. Set the waveform gain on the monitor to auto.
9. Observe a distortion free waveform and a blood pressure reading of approximately 120/80 (93) on the monitor.
10. Remove the cable from the BP1 connector of the Tram module and insert it into the BP2 connector.
11. Observe a PA2 label and graticules on the monitor.
12. Set the simulator to output 0 mmHg.
13. Zero the PA2 waveform.
14. Repeat steps 5 through 9 of this test.
15. If you are testing a Tram 100A, 200A, or 200SL module, proceed to the TEMP Test.
16. Remove the cable from the BP1 connector of the Tram module and insert it into the BP3 connector.
17. Observe a CVP label and graticules on the monitor.
18. Set the simulator to output 0 mmHg.
19. Zero the CVP waveform.
20. Repeat steps 5 through 9 of this test.

21. If you are testing a Tram 400A or 400SL module, proceed to the TEMP Test.
22. Remove the cable from the BP1 connector of the Tram module and insert it into the BP4 connector.
23. Observe an LA label and graticules on the monitor.
24. Set the simulator to output 0 mmHg.
25. Zero the LA waveform.
26. Repeat steps 5 through 9 of this test.

Temperature Test

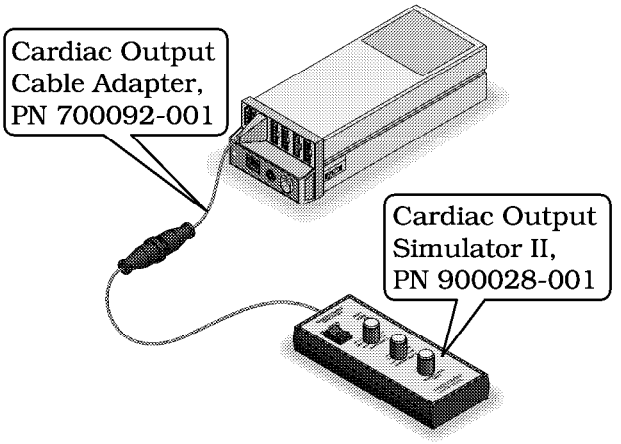
1. Set up the simulator for a 37°C temperature output.
2. Attach a temperature sensor adaptor to the TEMP/CO connector of the Tram module.



3. Set the switch on the adaptor to the 400 position.
4. Attach a cable from the SERIES 400 TEMPERATURE OUTPUT connector of simulator to the T1 connector of the temperature sensor adaptor.
5. Observe that a T1 reading appears on the display with reading between 36.6 and 37.4.
6. Move cable from the T1 connector of the temperature sensor adaptor to the T2 connector.
7. Observe that a T2 reading appears on the display with reading between 36.6 and 37.4.
8. Remove the temperature sensor adaptor and temperature cable from the Tram module and the simulator.

Cardiac Output Test

1. Connect a cardiac output cable adapter to the TEMP/CO connector of the Tram module and connect the CO adaptor to a cardiac output simulator II.



2. Set the cardiac output simulator to output the BT (blood temperature) readings in the following table and observe the correct readings on the monitor:

Table 5-4. Simulator Output Blood Temperature Settings

Simulator BT Setting	Monitor BT Reading Range
30.3˚C	30.1 – 30.5
35.1˚C	34.9 – 35.3
36.0˚C	35.8 – 36.2
37.0˚C	36.8 – 37.2
41.7˚C	41.5 – 41.9

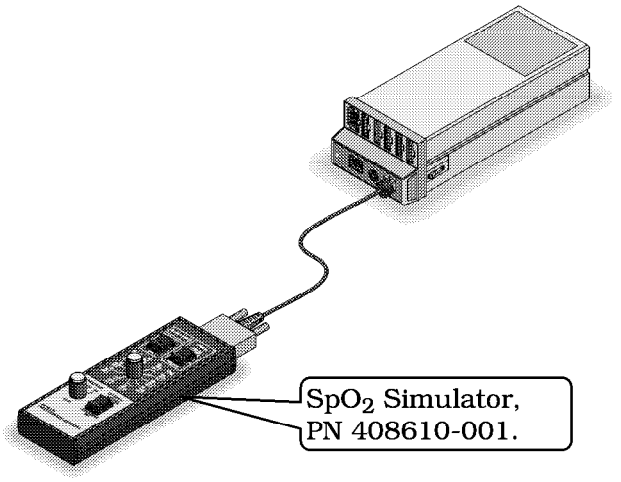
3. Set the cardiac output simulator to output the IT (injectate temperature) readings in the following table and observe the correct readings on the monitor:

Table 5-5. Simulator Injectate Temperature Settings

Simulator BT Setting	Monitor BT Reading Range
0.0˚C	–0.3 – +0.3
8.0˚C	7.7 – 8.3
15.0˚C	14.7 – 15.3
24.0˚C	23.7 – 24.3
29.6˚C	29.3 – 29.9

SpO_2 Test

1. Turn the SpO_2 simulator power switch OFF.
2. Connect the simulator to the Tram module simulator cable. For Tram X50 modules, use the MEI or Nellcor square-style SpO_2 simulator cable, pn 700232-004, and for the Tram X00 modules, use the Ohmeda round-style SpO_2 simulator cable, pn 700323-002.



3. Set the simulator as follows:
   - Set the MODE to your type of probe (NELLCOR or OHMEDA).

   NOTE
   On the simulator, use the gold-colored values for OHMEDA and the white-colored values for NELLCOR. The OHMEDA values are presented in parentheses in this procedure.

   - Set the SpO_2% to 99.
   - Set the PRR to 100 beats/min.
   - Turn the power ON.
4. Verify the following are displayed at the monitor:
   - A sinusoidal waveform with an SpO_2 label.
   - An SpO_2% reading between 97 – 100% (97 and 102%).
   - A PRR reading between 97 and 103 beats per minute (it might be necessary to turn SpO_2 ON).
5. Test the accuracy of these SPO_2% settings.

Table 5-6. Accuracy of SpO_2 Settings

Simulator Setting	Displayed SpO_2 Value
99% (Both types)	97 – 100% (97 – 102%)
80.3% (84%)	78 – 82% (81 – 87%)
49.7 (63%)	48 – 52% (61 – 65%)

6. Test the accuracy of these PPR settings:

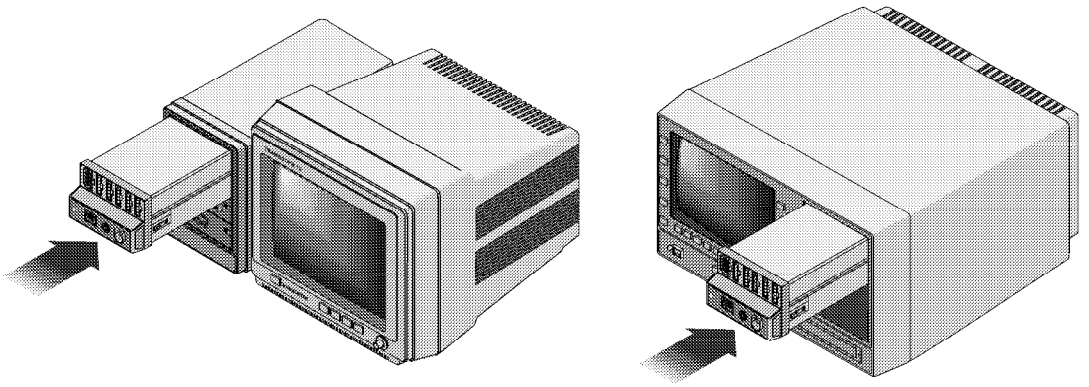
Table 5-7. Accuracy of PPR Settings

Simulator Setting	Displayed PPR Value
70	68 – 72
100	97 – 103
160	156 – 164

7. Return the simulator to these conditions:
   - Set the SpO_2% to 99.
   - Set the PPR to 100 beats/min.
8. Press the NOISE TEST button ON the simulator for 30 seconds.
9. Make sure the monitor still displays an SpO_2 value between 97 and 100% (97 and 102%), or an interference detection message is displayed.
10. Set these alarms on the monitor:
    - Set SpO_2% LO to 90.
    - Set PPR HI to 150.
11. Set PPR on the simulator to 160.
12. Make sure the PPR value on the monitor flashes, and it sounds an alarm.
13. Return PPR on the simulator to 100.
14. Set SpO_2% on the simulator to 80.3% (84%).
15. Make sure the SpO_2% value on the monitor flashes, and it sounds an alarm.
16. Turn the simulator OFF.
17. Make sure the monitor shows a CHECK PROBE message.
18. Disconnect the simulator cable from the Tram module.

NBP Tests

Insert the module in the top slot of a Tram-rac 4 housing or Series 70XX-type.

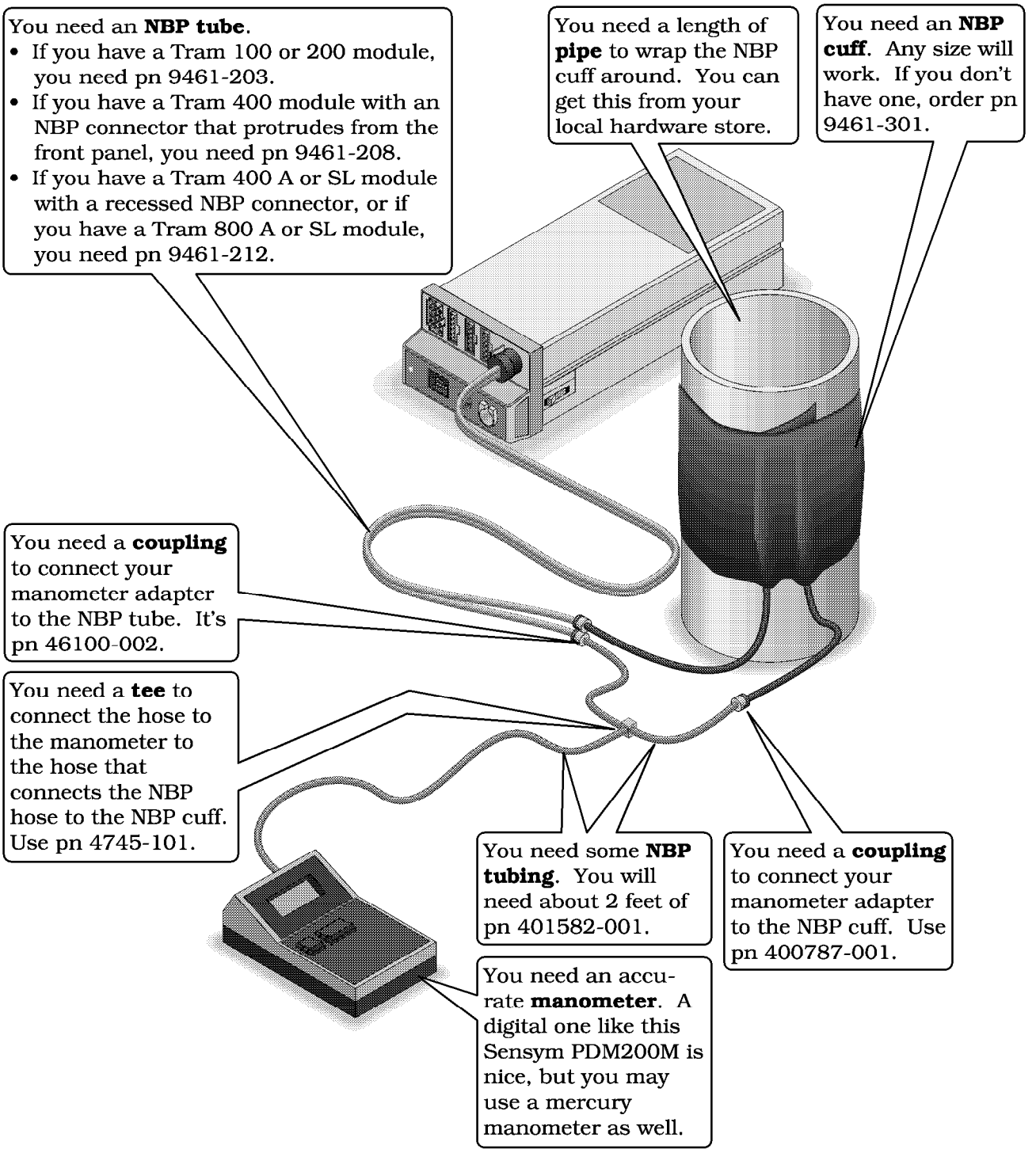


1. Disconnect all parameter cables
2. Apply power to the monitor. If your Tram-rac housing has its own power supply, apply power to it, too.
3. Enure POWER indicator on the Tram module's front panel is turned ON.

There are two different NBP calibration procedures: one for Tram modules used with Tram Critical Care monitors (Tramscope or Solar displays with Tram-rac housings), and one for Tram modules used with Series 70XX-type (7000, 7000RA, 7005, 7010, and 7010RA) monitors.

WARNING
When the NBP cuff is used in this procedure, it must be tightly wrapped around a tube. Never put the cuff around your arm during the calibration procedures. If you do put the cuff around your arm during this procedure, you will injure yourself.

1. Connect a manometer and NBP cuff to the NBP connector on the front of the Tram module as shown below.

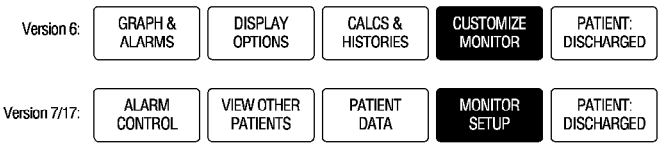


2. Turn the manometer ON, and set its range switch to the 1000 mmHg setting.

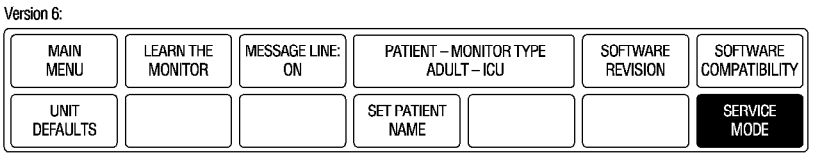
NBP Test for Tram Critical Care Monitors

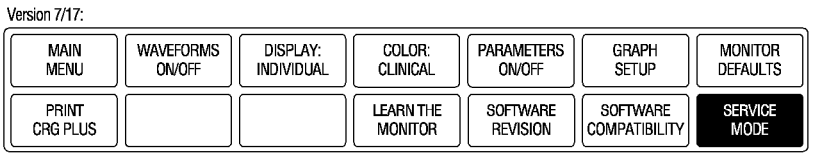
Perform this test if you are using the Tram module with a Tram Critical Care monitor (Tramscope or Solar monitor). This procedure assumes you have either version 6, 7, or 17 software in your Tramscope/Solar display, Tram-rac housing, and Tram module.

1. From the Tramscope display's main menu, rotate the Trim Knob control to highlight CUSTOMIZE MONITOR (with version 6), or MONITOR SETUP (with version 7/17) and then press the Trim Knob control to select it.

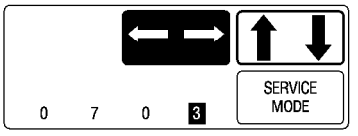


2. Rotate the Trim Knob control to highlight SERVICE MODE, and then press the Trim Knob control to select it.





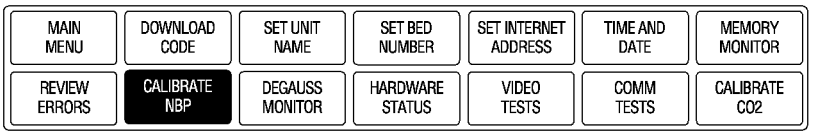
3. You have to enter a password to get into the service mode. The first two digits of the password are the day of the month, and the second two digits are the month. For example, on 7 March, the password would be 0703.
   - Rotate the Trim Knob control to highlight a password digit.
   - Press the Trim Knob control to select the password digit.
   - Rotate the Trim Knob control to change the value of the password digit.
   - Rotate the Trim Knob control to enter the password digit.
   - Repeat the steps above until all of the digits are entered.
   - Rotate the Trim Knob control to hilite SERVICE MODE from the menu.
   - Press the Trim Knob control to enter the service mode.



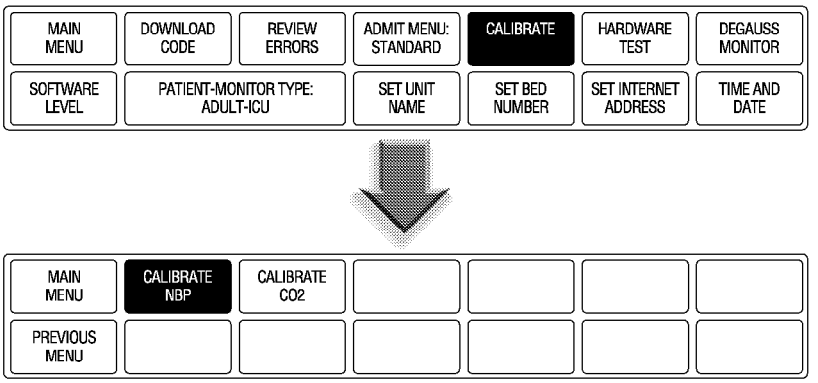
4. If you have version 6 software, rotate the Trim Knob control to highlight CALIBRATE NBP, and then press the Trim Knob control to select it.

   If you have version 7/17 software, rotate the Trim Knob control to highlight CALIBRATE, and press the Trim Knob control to select it. Then rotate the Trim Knob control to highlight CALIBRATE NBP, and press the Trim Knob control to select it.

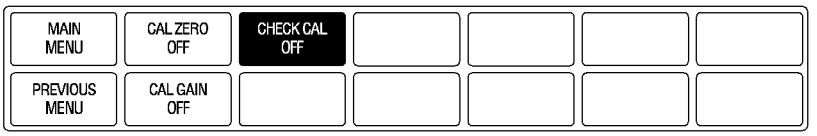
Version 6:



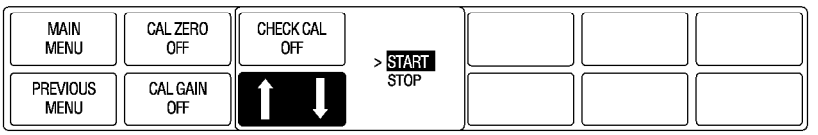
Version 7/17:



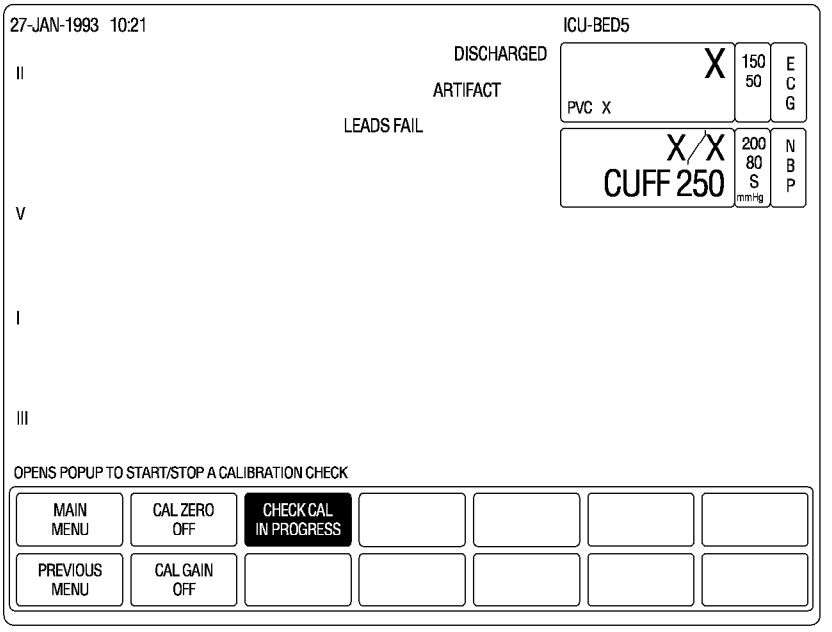
5. Rotate the Trim Knob control to highlight CHECK CAL OFF, and then press the Trim Knob control to select it.



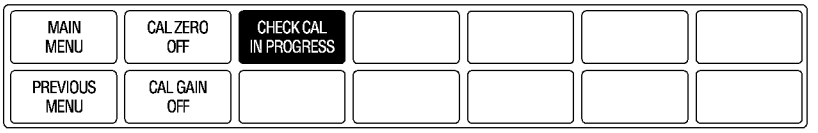
6. Rotate the Trim Knob control to highlight START, and then press the Trim Knob control to select it.



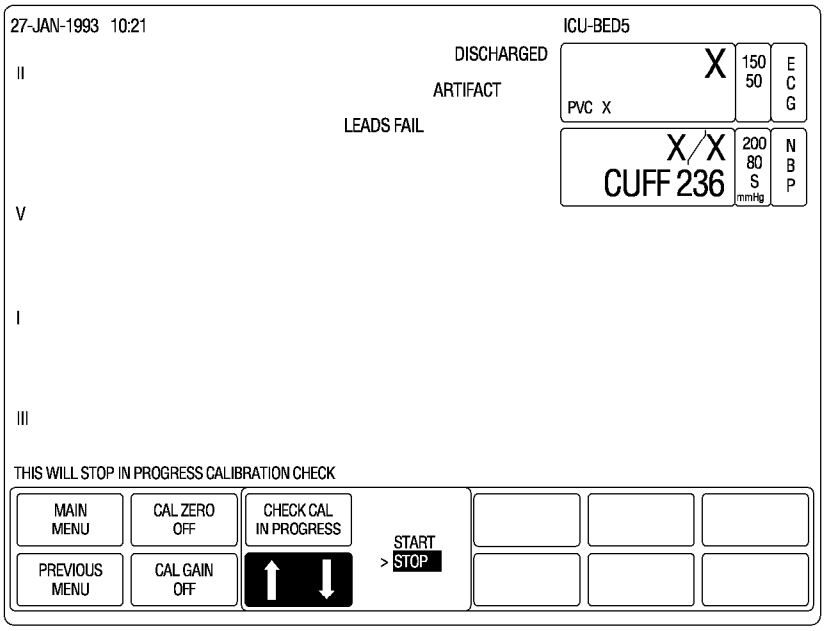
7. The text on the menu item will change from CHECK CAL OFF to CHECK CAL IN PROGRESS. Make sure that the pressure readings (shown as CUFF in the NBP parameter box) on the Tramscope display and manometer are equal (± 1 mmHg) for at least one full minute. If they are not equal, it means that you must calibrate the NBP parameter. Refer to "NBP Calibration" in Chapter 4: "Calibration."



8. Rotate the Trim Knob control to highlight CHECK CAL IN PROGRESS, and then press the Trim Knob control to select it.



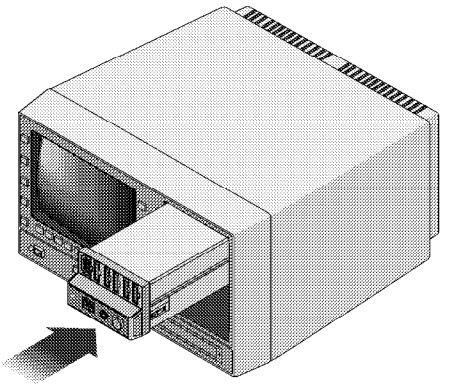
9. Rotate the Trim Knob control to highlight STOP, and then press the Trim Knob control to select it. The module then releases pressure in the bulb or cuff.



This completes the NBP calibration procedure. Remove the cuff and manometer from the Tram module.

NBP Test for Series 70XX Monitors

You should run this test if you use your Tram module with a Series 70XX-type monitor (Series 7000, 7000RA, 7005, 7010, or 7010RA monitors).

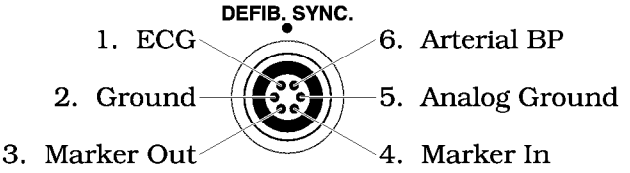


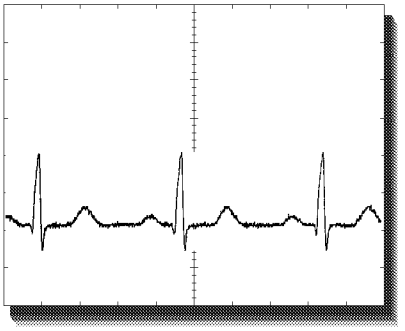
1. Press the SYSTEM key on the monitor.
2. Press the MONITOR SETUP, MONITOR SERVICE, and then CALIBRATE NBP soft keys. Soft keys are the unlabeled keys under the display. The function of each key appears on the display, just above the key.
3. If an NBP cuff is attached to the Tram module, remove it.
4. Press the YES soft key.
5. Press the TEST CAL soft key and verify that the pressure readings on the monitor and manometer are equal (± 1 mmHg) for at least one minute. If they are not equal, it means that you must calibrate NBP (that procedure starts on page 36).
6. Press the TEST CAL soft key to stop the test.
7. Press the CLEAR key.

This completes the NBP calibration procedure. Remove the cuff and manometer from the Tram module.

DEFIB SYNC Test

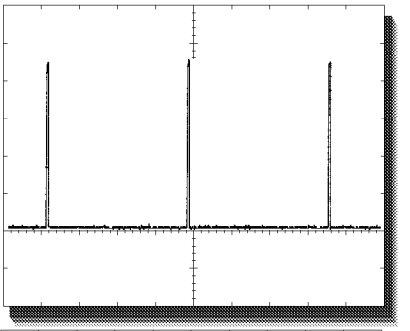
1. Connect an oscilloscope to the DEFIB SYNC connector on the front panel of the Tram module.
2. Test the ECG, Arterial BP, and Marker Out signals from the DEFIB SYNC connector. They should closely resemble the waveforms in the figure below. Note that there are two Marker Out traces shown. The top trace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

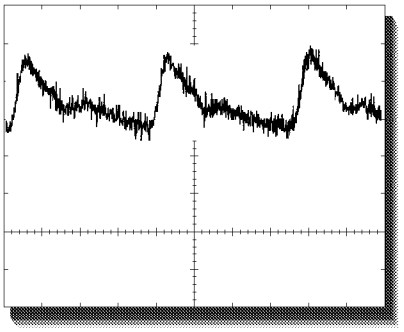




ECG
Signal Pin:1
Ground Pin:5
Probe Type:
x10
Time/
Division:0.2S
Volts/
Division:0.5V

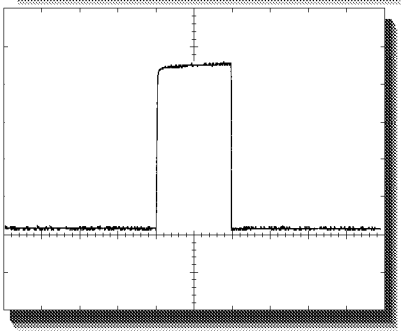
Marker Out
Signal Pin:3
Ground Pin:2
Probe Type:
x10
Time/
Division:0.2S
Volts/
Division:1V



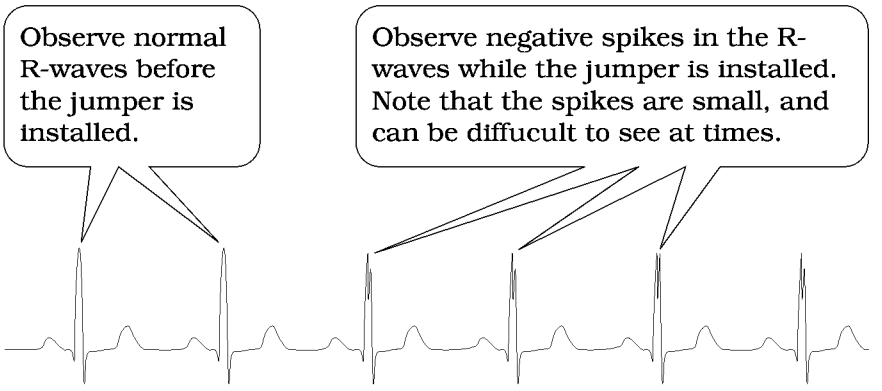


Arterial BP
Signal Pin:6
Ground Pin:5
Probe Type:
x10
Time/
Division:0.2S

Marker Out
Signal Pin:3
Ground Pin:2
Probe Type:
x10
Time/



3. Attach a jumper between pin 3 (Marker Out) and pin 4 (Marker In) of the DEFIB SYNC connector and observe negative spikes in the R-waves of the displayed ECG waveforms.



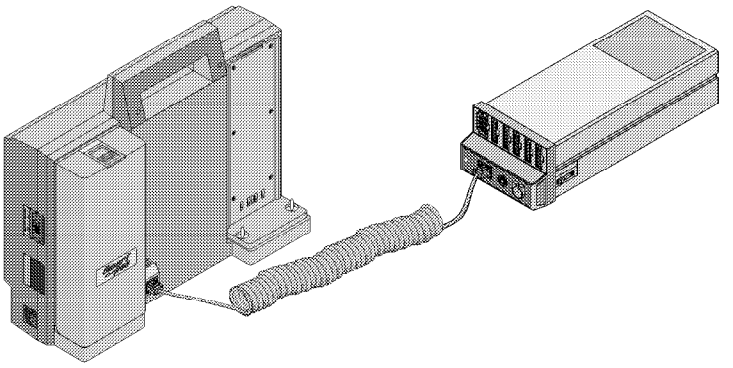
4. Remove the jumper.

Fan Test

Listen for the fan. The fan should be running whenever the Tram module is installed in a bedside monitor.

Transport Test

1. Connect the Tram module to a transport display. Make sure there are batteries on the rear of the display, and that the batteries are sufficiently charged.



2. Remove the Tram module from the bedside monitor.
3. Set up simulator like this:
   - Set heart rate to 80 bpm.
   - Set amplitude to 1.0 mV.
4. Observe the following:
   - No error messages are shown on the transport display.
   - The transport display shows ECG lead II, and it is noise-free.
   - The transport display shows a heart rate of 80 ±1 bpm.
   - If the QRS tones are turned ON, an audible tone sounds with each QRS complex.
5. Make sure that you can display all of the available ECG leads.

Completion

1. Turn all test equipment OFF.
2. Remove all test cabling from the Tram module.

Domestic Electrical Safety Tests

Test Frequency

We recommend electrical safety tests be performed:

- upon receipt of the module,
- every six months thereafter, and
- each time the module is open or repaired.

Remember to record the date and results on the "Maintenance/ Repair Log" included at the end of this chapter.

WARNING
Failure to perform leakage tests may cause undue equipment failure and possible health hazards. Marquette Electronics, Inc does not in any manner, unless an Equipment Maintenance Contract exists, assume the responsibility for performing this recommended safety test. The sole responsibility rests with the individual or institution using the equipment. Marquette service personnel may, at their discretion, use this procedure as a helpful guide during visits to the equipment site.

Required Tests

To help you establish a systematic maintenance routine, Marquette Electronics recommends that you perform all safety tests presented in this chapter

These instructions are intended for every module in the system. If the Tram-rac housing does not have its own power supply, it should remain connected to the monitor during the safety tests. Listed below are the safety tests.

- AC Line Voltage Test; This test verifies that the domestic wall outlet supplying power to the equipment is properly wired.
- Ground Continuity Test; This test verifies continuity between all the exposed metal surfaces of the monitor and the ground prong on the mains AC power cord.
- Hi-Pot Tests; These tests are mandatory when a module is opened or repaired.
- Leakage Current Tests; These tests are performed after the hi-pot tests.

If a module under test fails the leakage tests, do not allow the unit to return to service. Call Tech Support for assistance. (Refer to "How to Reach Us" in Chapter 1: "Introduction."

Test Conditions

All electrical safety test may be performed under normal ambient temperature, humidity, and pressure conditions.

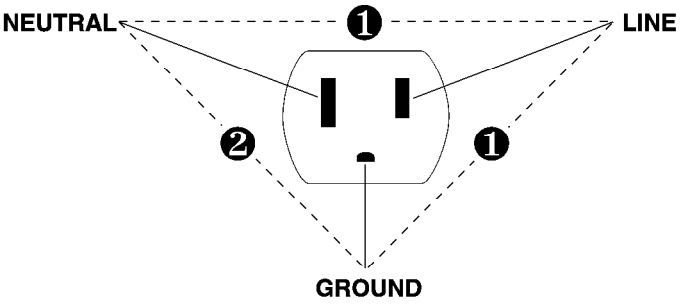
AC Line Voltage Test

This test verifies that the domestic wall outlet supplying power to the equipment is properly wired. For international wiring tests, refer to the internal standards agencies of that particular country.

120 VAC, 50/60 Hz

Use a digital voltmeter to check the voltages of the 120-volt AC wall outlet (dedicated circuit recommended). If the measurements are significantly out of range, have a qualified electrician repair the outlet. The voltage measurements should be as follows:

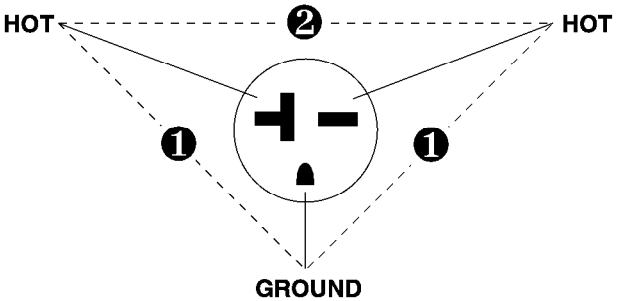
1. 120 VAC (± 10 VAC) between the line contact and neutral and between the line contact and ground.
2. Less than 3 VAC between neutral and ground.



240 VAC, 50/60 Hz

Use a digital voltmeter, set to measure at least 300 VAC, to check the voltages of the NEMA 6-20R, AC wall outlet (dedicated circuit recommended). If the measurements are significantly out of range, have a qualified electrician repair the outlet. The voltage measurements should be as follows:

1. 120 VAC (± 10 VAC) between either "hot" contact and ground.
2. 210 to 230 VAC between the two "hot" contacts.



Ground Continuity Test

This test verifies continuity (less than 100 mΩ resistance) between all the exposed metal surfaces, which have the potential to become energized, and the ground prong on the mains AC power cord. If the metal surfaces are anodized or painted, scrape off a small area in an inconspicuous area for the probe to make contact with the metal.

You will require a digital multimeter (DMM) to check all the metal surfaces of the unit. Make adjustments for any resistance from the test leads.

Do the following steps in the order given.

1. Disconnect each monitor and, if applicable, Tram-rac housing with its own power supply from all power sources. A Tram-rac housing without its own power supply should remain connected to the monitor.
2. Connect the negative lead of the DMM to the ground prong of the power cord plug.
3. Set the DMM to the milli-ohm range.
4. Connect the positive lead of the DMM to any exposed metal surface on the unit under test.
5. The reading should be less than 100 milli-ohms.

   If the readings are not less than 100 milli-ohms, the unit has failed this test.

   - Check for breaks in the power cord or in the internal connections within the monitor.
   - Perform repairs and retest before using the unit on a patient.

Current Leakage Tests

Preparation

The leakage current tests are safety tests to ensure that the equipment poses no electrical health hazards. It is recommended after performing the hi-pot tests.

WARNING
Failure to perform leakage tests may cause undue equipment failure and possible health hazards. Marquette Electronics, Inc does not in any manner, unless an Equipment Maintenance Contract exists, assume the responsibility for performing this recommended safety test. The sole responsibility rests with the individual or institution using the equipment.

Required Tools/ Equipment

You will need the special tools and items listed below. Equivalent equipment may be substituted if necessary.

Table 5-8. Required Tools/Equipment

Item	Manufacturer	Part Number
Leakage current tester 120 V (or equivalent) 240 V (or equivalent)	MEI	MT-1216-01 MT-1216-02
Digital multimeter (DMM)	Fluke	8060A
ECG test body	MEI	97516-100
SpO_2	MEI	MT-4366

NOTE
The accuracy of the leakage tests depends on a properly-wired wall outlet. Do not proceed until you verify the integrity of the power source.

Current Limits

Use the table below to determine the maximum allowable leakage currents. For international leakage limits, refer to the internal standards agencies of that particular country.

Table 5-9. Maximum Allowable Leakage Currents

	Test	Maximum Current
1	Patient-Cable-Leakage-to-Ground Ground closed, normal & reverse polarity	10 µA for 120 V 10 µA for 240 V
2	Patient-Cable-Leakage-into-Patient Leads Ground closed, normal & reverse polarity	10 µA for 120 V 50 µA for 240 V

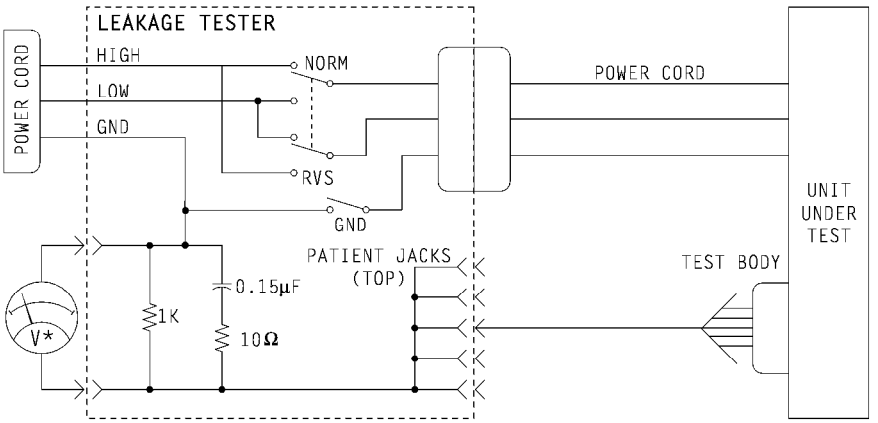
Patient-Cable-Leakage to-Ground Test

This test checks leakage current from the patient cable connector of the module to ground.

1. Install the module in a a Tram-rac 4 housing or Series 70XX-type monitor.
2. Connect the monitor power cord to the power outlet on the leakage tester.
3. With the power switch of the leakage tester off, connect the power cord of the leakage tester to a correctly wired and properly grounded ac power outlet.
4. Set leakage tester switches as follows:
   a. Set the selector knob to 3.
   b. Set the GND switch to GND OPEN.
   c. Set the polarity switch to NORM.
   d. Set the power switch to OFF.
5. Connect an appropriate test body to the connector of the module.
6. Connect a short length of cable between the test body installed in the last step and the jacks on the top of the leakage tester.
7. Set the leakage tester's power switch to ON.
8. Set the monitor's rear panel power switch to ON.
9. Read the leakage current indicated on the DMM.

If the reading is greater than 10 microamperes (10 millivolts on the DMM), the module fails this test and should be repaired and tested again.

Partial Schematic Diagram



10. Change the leakage tester polarity switch to the RVS position.
11. Read the leakage current indicated on the DMM.

    If the reading is greater than 10 microamperes (10 millivolts on the DMM), your module fails this test and should be repaired and tested again.

12. Change the GND switch to the CLOSED position.
13. Read the leakage current indicated on the DMM.

    If the reading is greater than 10 microamperes (10 millivolts on the DMM), your module fails this test and should be repaired and tested again.

14. Change the leakage tester polarity switch to the RVS position.
15. Read the leakage current indicated on the DMM.

    If the reading is greater than 10 microamperes (10 millivolts on the DMM), your module fails this test and should be repaired and tested again.

16. For Tram X50 modules, repeat steps 4 through 15 with the SpO_2 test body int he blue SpO_2 connector.
17. Set the power switch of the leakage tester to OFF.

Patient-Cable-Leakage-into-Patient Leads Test

This tests the patient cable leakage current from a 115 or 220V AC source into the connector of the module.

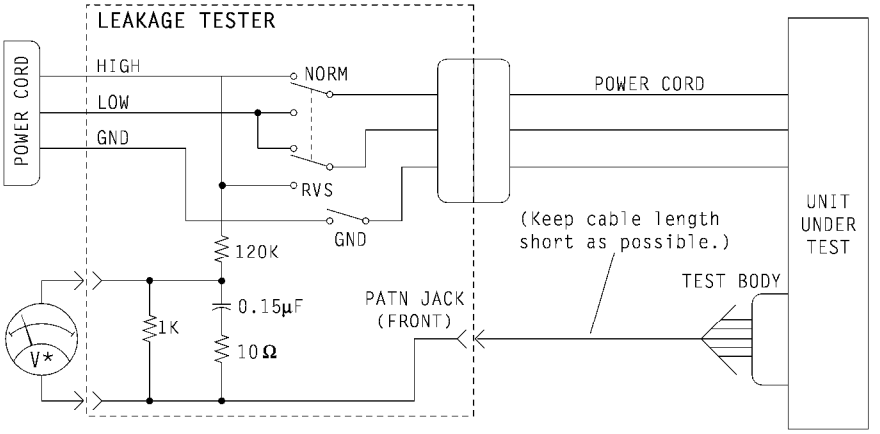
1. Set the leakage tester switches like this:
   a. Set the selector knob to 5.
   b. Leave the GND switch set to CLOSED.
   c. Set the polarity switch to NORM.
2. Disconnect the cable between the leakage tester and the test body, and reconnect it between the test body and the PATN JACK connector on the front panel of the leakage tester.

WARNING
The following step will cause high voltage to appear at the PATN JACK on the leakage tester.

3. Set power switch on the leakage tester to ON.
4. Read leakage current indicated on DMM.
   - For 115 V/60 Hz power: 10 microamperes (10 millivolts on the DMM)
   - For 220 V/50 Hz power: 50 microamperes (50 millivolts on the DMM)

   If your module fails this test, it should be repaired and tested again.

Partial Schematic Diagram



1-mV meter reading = 1-µA leakage current

5. Change the leakage tester polarity switch to the RVS position.
6. Read the leakage current indicated on the DMM.

   If the reading is greater than the following, your module fails this test and should be repaired and tested again.

   - For 115 V/60 Hz power: 10 microamperes (10 millivolts on the DMM)
   - For 220 V/50 Hz power: 50 microamperes (50 millivolts on the DMM)
7. For Tram X50 modules, repeat steps 1 through 6 with the SpO_2 test body int he blue SpO_2 connector.

Completion

1. Set the power switch on the leakage tester to OFF and disconnect all test equipment from the module.
2. Disconnect the monitor power cord from leakage tester.
3. Disconnect the tester from the power outlet.

Hi-Pot Tests

Preparation

Hi-pot (high-potential) tests protect the patient from possible electrical health hazards. They are recommended for any patient-connected devices that are repaired to ensure patient isolation after the repair.

Test Frequency

This test is required each time a module is opened or repaired.

WARNING
Failure to perform hi-pot tests may cause undue equipment failure and possible health hazards. Marquette Electronics, Inc does not in any manner, unless an Equipment Maintenance Contract exists, assume the responsibility for performing this recommended safety test. The sole responsibility rests with the individual or institution using the equipment.

Required Tools/ Equipment

Equipment required to perform the test is listed below. Equivalent equipment may be substituted if necessary.

Table 5-10. Required Tools/Equipment

Item	Manufacturer	Part Number
AC/DC hi-pot generator	Hipotronics	AD125
ECG test body	MEI	97516-100
Hi-pot cable	MEI	97516-101
Bendix connector (used to make test connector)	MEI	1866-030

Generator Setup

Follow these steps in the same order in which they are listed.

1. Set up the AC/DC hi-pot generator:
   a. Turn the power switch to ON.
   b. Set the VOLTAGE RANGE selector to MEDIUM.
   c. Set the RAISE VOLTAGE selector to 0 volts.
   d. Set the OUTPUT & CURRENT selector to the 5 mA range.
   e. Allow the unit to warm up for 15 minutes before proceeding with this test.
2. If the module to be tested is installed in a monitor, remove it from the monitor.

Ground Connection

Connect all of the ground pins at the rear panel connector on the module to the GROUND of the AC/DC hi-pot generator using the hi-pot cable.

1. A grounding test connector must be made to connect all pins at the rear connector of the module together. Use test connector, pn 1886-030, to fabricate a grounding test connector.
2. Securely attach ground clip from AC/DC Hi-Pt Generator to grounding test connector.

High Voltage Connection

The module parameter determines the test body used. Install ECG test body to connector at the front of the module.

AC Hi-Pot Test

Perform this test on the ECG input of the Tram module. Never attempt to perform this test on any of the other connectors.

WARNING
Never attempt to perform this test on any of the other connectors.

1. Install the ECG test body into the connector of the module.
2. Connect one end of a high voltage lead to the exposed lead of the test body.
3. Connect the other end of the high voltage lead to the AC OUT connector of the AC/DC hi-pot generator.

WARNING
In the following step, high voltage appears at the test body.

4. Set the HIGH VOLTAGE switch to ON. The high voltage indicator light should illuminate.

WARNING
During test, watch that the analog meter to ensure current never exceeds 1 mA. If it does, the unit has failed the test.

5. Slowly turn the RAISE VOLTAGE selector to 3000 volts.
6. Wait for 10 seconds. If the breakdown warning lamp or buzzer activate before the time expires, then the unit has failed the test.
7. Slowly turn the RAISE VOLTAGE selector to 0 volts.
8. Set the HIGH VOLTAGE switch to OFF. The high voltage indicator should turn off.
9. If your module fails this test, make the necessary repairs and test it again.
10. Perform the DC hi-pot test.

DC Hi-Pot Test

The following procedure should only be performed on the ECG connector. Follow these steps in the order listed.

1. Set the AC/DC hi-pot generator OUTPUT & CURRENT selector to the x 100 DC range.
2. Remove the high voltage lead from the AC OUT connector and connect it to DC OUT connector.

WARNING
In the following step, high voltage appears at the test body.

3. Set the HIGH VOLTAGE switch to ON. The high voltage indicator should glow.
4. Slowly turn the RAISE VOLTAGE selector to 6000V dc.
5. Wait for 1 second. If the breakdown warning lamp or buzzer activates before the time expires, then the unit has failed the test.
6. Slowly turn the RAISE VOLTAGE selector to 0 volts.
7. Set the HIGH VOLTAGE switch to OFF. The high voltage indicator should turn off.
8. If your Tram module passed the test, disconnect all cables and perform the Current Leakage Tests, listed earlier in this chapter.
9. If your Tram module failed the test, make the necessary repairs and test it again.

Repair Log/PM Inspection Form

Unit Serial Number:

Institution Name:

Date	Maintenance/Repair	Technician

Tram 100 - 850 A/SL Modules

MPMFRM-002D
31 JUL 1995

Preventive Maintenance Inspection Form

(See Service Manual p/n 404422-001 Tram 100 - 600, p/n 404422-065 Tram 100 - 850 A and SL for Details)

Customer _____ Customer Number _____ Date _____

FE _____ FE ID _____ Call Number _____

Equipment Serial Number _____ Software Revision _____

Module Type

- ❑ Tram 100
- ❑ Tram 200
- ❑ Tram 250
- ❑ Tram 300
- ❑ Tram 400
- ❑ Tram 450
- ❑ Tram 500
- ❑ Tram 600
- ❑ Tram 650
- ❑ Tram 800
- ❑ Tram 850
- ❑ "A" Series
- ❑ "SL" Series

Tools Required

- Leakage tester
- Multimeter
- Oscilloscope
- CO simulator II
- Marq1 simulator
- Manometer
- NIBP cuff
- SpO_2 simulator
- Nicolay adapter cables
- Standard hand tools
- Anti-static mat and strap

Visual Inspection

Inspect the following for excess wear and /or any visual signs of damage

- ❑ General
- ❑ Latches
- ❑ Connectors
- ❑ Cable insulation
- ❑ Reseat socketed components / connectors

Calibration

- ❑ NIBP

Electrical Safety Tests

❑ Customer will perform Electrical Safety tests

		Open		Closed	
		Normal	Reversed	Normal	Reversed
ECG	Patient Source Risk leakage (<10µA)	____µA	____µA	____µA	____µA
	Patient Sink Risk leakage (<10µA without patient cable)	N/A	N/A	____µA	____µA
SpO_2 (for X50 series modules only)	Patient Source Risk leakage (<10µA)	____µA	____µA	____µA	____µA
	Patient Sink Risk leakage (<10µA without patient cable)	N/A	N/A	____µA	____µA

Checkout Procedure

ECG

- ❑ Rate (±1)
- ❑ All leads noise free
- ❑ Pace
- ❑ Leads fail
- ❑ Amplitude
- ❑ 3 Lead(A and SL Series)

RESP Base line of 750Ω - ΔR 0.5Ω - 30 breaths per minute

- ❑ Rate lead II (± 2)
- ❑ Noise free lead II
- ❑ Rate lead I (± 2)
- ❑ Noise free lead I

BP (2% or ±1mmHg whichever is greater)

- ❑ Static BP1
- ❑ Dynamic BP1
- ❑ Noise free BP1
- ❑ Static BP2
- ❑ Dynamic BP2
- ❑ Noise free BP2
- ❑ Static BP3
- ❑ Dynamic BP3
- ❑ Noise free BP3
- ❑ Static BP4
- ❑ Dynamic BP4
- ❑ Noise free BP4

Tram 100 - 850 A/SL Modules

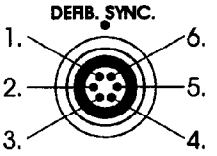
Checkout Procedure Cont.

TEMP / CO The temperature tolerance for all Tram 100-850 A and SL Series modules is ±0.1°C. Tolerances for Tram 100-600 modules are specified below.
[❑ T1 ⟷ ❑ T2] (YSI 400, 1% or ±0.3°C whichever is greater)
❑ BT range (± 0.2°C) ❑ IT range (± 0.3°C)

SpO_2 ❑ %SpO_2 range (90 - 100, 2.5%), (80 - 89.9, 3.1%), (60 - 79.9, 3.4%)
❑ PPR range (2.7%) ❑ Noise

NIBP ❑ Pump (Inflate an Adult Cuff with the bladder folded in half in <30 Sec.)
❑ Leak (<1mmHg per 4 Sec.) ❑ Static (±1 mmHg)

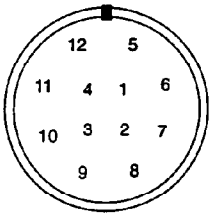
Analog Output Use Pin 2 for Marker Out ground and Pin 5 for Analog ground



❑ Pin 1 ECG ❑ Pin 6 Arterial BP ❑ Pin 3 Defib Sync
❑ Marker In (Short Pin 3 to Pin 4 Look for negative pulse on the R wave.)

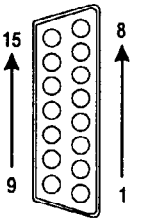
To test Analog Output from the rear connector of a Tram 100 - 800 module check the following waveforms at a Tram RAC.

Pin 8 Ground



Rac 3 / Rac 4

Pin 1 Ground



Rac 4A

❑ ECG II	Pin 1	Pin 9
❑ Trace 1	Pin 2	Pin 2
❑ ECG V	Pin 3	Pin 10
❑ ART (or BP1)	Pin 4	Pin 5
❑ BP 2 (or SpO_2 Wave)	Pin 5	Pin 13
❑ BP 3 (or SpO_2 Value)	Pin 6	Pin 3
❑ BP 4 (or Resp)	Pin 7	Pin 11

General ❑ Transport test ❑ No LCD error messages
❑ Fan

Comments

Please comment on any other environmental conditions (Static, Temperature, AC Power, Etc..) that may affect operation or reliability.

_____

_____

Briefly describe all repairs / adjustments made and list all parts replaced.

_____

_____

_____

Customer Signature _____ FE Signature _____

Marquette Electronics, Inc Service and Supplies Division Jupiter,FL 33468-9100