Chapter 18 Planned Maintenance and Troubleshooting

This chapter describes the functional checkout procedure, maintenance and troubleshooting for the CardioLab system.

18.1 Safety

Before performing any maintenance or service procedure, read and follow all applicable safety information in 1.2 Safety information on page 25 in this manual.

The maintenance and troubleshooting procedures listed in this section may be performed by nontechnical personnel. Any other procedure must be performed by GE HealthCare authorized service personnel. Unauthorized service may void the equipment warranty.

A regular maintenance schedule is highly recommended to ensure proper equipment operation and patient safety.

WARNING

SHOCK HAZARD

Do not modify or attempt to service any system equipment. This equipment contains no user serviceable parts. Refer servicing to qualified service personnel.

WARNING

Do not open the acquisition computer when power is on. This will cause the computer to automatically shut down.

WARNING

SHOCK HAZARD

Damaged cables and loose connections present a shock hazard and could cause signal noise or impaired device operation. Ensure all cables are in good condition, protected from potential sources of damage, and securely connected before powering on equipment. Replace damaged cables immediately.

WARNING

EQUIPMENT HAZARD

Do not attempt to service the UPS or replace the battery. Doing so could result in equipment damage. Contact qualified GE HealthCare Service personnel for service or replacement.

NOTE
If the system components are not fully operational, contact GE HealthCare technical support.

18.2 Before you begin

Before performing any maintenance or service procedure, ensure the following conditions are met:

- Follow all applicable facility safety procedures when cleaning or servicing cabling or equipment that may have been exposed to bio-hazard material.
- Turn off power to the system and any applicable auxiliary equipment before connecting or disconnecting cables.
- Turn off power to the system and disconnect the power cord to the isolation transformer and any applicable auxiliary equipment before cleaning or servicing.
- When cleaning or servicing equipment, DO NOT:
  - Immerse any part of the equipment in any liquid or allow liquids to drip into equipment.
  - Use organic solvents, strong ammonia-based solutions, or abrasive cleaning agents.
  - Use cleaning solutions or solvents in any disk drive.

18.3 Functional checkout procedure

Refer to the applicable service manuals for additional information.

1. Connect a simulator to the CardioLab amplifier, which is located in the procedure room.
2. If a GE HealthCare or Bio-Tek simulator is being used, connect the P1 output to the P1 input of the amplifier.
3. Connect the P2 output to the P2 input of the amplifier. These two pressure simulations provide a realistic representation of pressure waveforms.
4. Connect the ECG lead wires.
5. Connect the simulator to the intracardiac inputs of the Catheter Input Module.
6. Turn on the isolation transformer and acquisition system (see Chapter 2 Getting Started on page 39 for additional information).
7. Log on to the custom shell as **mlcluser**.
8. Enter the appropriate password. Refer to the Mac-Lab/CardioLab Privacy and Security User Manual (PN 5222004-1EN) for additional information.
9. Launch the Mac-Lab/CardioLab application.
10. Select **CardioLab**.
11. Adjust the simulator to zero the blood pressure waveforms.
12. Readjust the simulator to simulate blood pressures. If the simulator is connected correctly, the blood pressure waveforms should be displayed.
13. Verify that the correct ECG waveforms are present at the top of the window.
14. Hook simulator ECG outputs to catheter input modules to verify intracardiac inputs.

18.4 Planned maintenance

GE HealthCare recommends performing planned maintenance. Use the following procedures when performing planned maintenance.

18.4.1 General cleaning and inspection

WARNING

SHOCK HAZARD

If liquids or foreign materials have entered a device, take it out of service and have it checked by qualified service personnel to verify safety and functionality before it is used again. Ingress of foreign substances may result in shock, fire, excess leakage current, or device failure.

WARNING

SHOCK HAZARD

Use caution when cleaning the environment near equipment. Fluid ingress may damage devices or compromise electrical safety.

General inspection

Before cleaning, inspect components, cables, and accessories. If signs of damage or degradation are present, contact a GE HealthCare representative to determine if equipment needs to be replaced.

General cleaning

See each specific equipment subsection in this portion of the manual for specific equipment cleaning and disinfection instructions. For other system components and cables, use the following:

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Do not pour or spray any liquid directly on the device, cables or leadwires or permit fluid to seep into connections or openings.
- Pay attention to mated surfaces, recessed areas, ridges and other difficult to clean features. Inspect the device to ensure the complete removal of soil from surfaces. If soil is present, clean the device again.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- Do not make patient connections until the equipment is thoroughly dry.

Cautions

- Never immerse the device in any liquid.
- Do not pour or spray any liquid directly on the device, cables or leadwires or permit fluid to seep into connections or openings.
- Mild dishwashing detergent is used for cleaning several system components.

- Never use solutions or products that contain the following ingredients:
  - Acetone
  - Ketone
  - Betadine
  - Solutions that contain wax or wax compounds
- Do not use abrasive cleaners or solvents of any kind.
- Never autoclave or steam clean the device, cables or leadwires.
- Do not make patient connections until equipment is thoroughly dry.

Avoid products that contain active ingredients and solutions similar to these products.

NOTE
Always apply the cleaner to the cleaning cloth and wring out any excess if necessary. If too much cleaner is used, it may run inside the case and cause damage.

NOTE
Automated cleaning is not available with the Mac-Lab/CardioLab system.

18.4.2 Monitors

Tools

- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent

Clean LCD Monitors

- Turn off the monitor and disconnect power before cleaning.

  NOTE
  Do not rub any part of the LCD monitor with hard or coarse material.

- Monitor Screen — Clean the LCD monitor screen (the viewing area of the screen) with a dry soft, lint-free cloth. Do not use any cleaning solution or glass cleaner.

  NOTE
  Do not apply pressure to the LCD monitor screen.

- LCD cabinet (plastic components) — Dampen a soft, lint-free cloth with a mild dishwashing detergent diluted in water, wipe the plastic surfaces and then dry with a dry, soft, lint-free cloth.
- Unpacking — use a soft cloth to gently wipe off the monitor after unpacking. A white powder may occur during the shipping of the monitor. Handle the monitor with care because darker colored plastics may scratch and show white scuff marks more than lighter-colored plastics.

  NOTE
  Many plastics are used on the surface of the cabinet. DO NOT clean with benzene, alkaline, alcohol, detergent, glass cleaner, waxes of any kind, polish cleaner, soap or Office Automation (OA) cleaner. Do not place rubber or vinyl against the cabinet for long periods. These types of fluids and fabrics can cause the paint to deteriorate, crack, or peel.

18.4.3 CardioLab amplifier

Daily	• Perform the daily cleaning of the amplifier as shown in the following sections. • Check the case for cracks or other damage. • Inspect all cords and cables for fraying or other damage. • Inspect all plugs, cables, and connectors for bent prongs or pins. • Verify that all cords and connectors are securely seated. • Inspect controls for proper operation.
Monthly	• Clean all dust and debris from the fiber optic cable connectors with a dry cotton swab.

Precautions

- Do not open the CardioLab amplifier unless instructed to do so by qualified technical personnel.
- Do not immerse any part of the amplifier in water.
- Do not use organic solvents, ammonia-based solutions, or abrasive cleaning agents that may damage equipment surfaces.

Tools

- Cotton swabs
- Multiple soft, lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution
- Isopropyl alcohol

Cleaning and disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

  NOTE
  Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.4 PDM Base Station Plus or PDM Slim Connect

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

  NOTE
  Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.5 PDM Base Station Plus or PDM Slim Connect mount

Tools

- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and Disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

NOTE
Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- The surface finish is permanently damaged by strong chemicals and solvents such as acetone or trichloroethylene.
- Never submerge or allow liquids to enter the mounting assemblies. Wipe any cleaning agents off the mounting assembly immediately using a water-dampened cloth. Dry the equipment thoroughly with a clean, dry, soft, lint-free cloth.

18.4.6 PDM

Perform the daily cleaning of the PDM as shown in the following sections.

Tools

- Multiple soft, lint-free cloths
- Cellular urethane cleaning swab
- Cotton swab, gauze pad
- Water, soap
- Mild dishwashing detergent
- Sagrotan (dilution 3:100, containing 75 mg tartaric acid per 100 ml solution).
- Sodium hypochlorite (5.2% household bleach) minimum 1:500 dilution (minimum 100 ppm free chlorine) and maximum 1:10 dilution.

Visual inspection

- Remove power and all cables before inspecting or cleaning the equipment.
- Inspect the equipment and its component carefully prior to installation, once every 12 months thereafter each time the equipment is serviced. Do not use the equipment if damage is determined. Refer damaged equipment to qualified service personal.
- Inspect the case for cracks or other physical damage.
- Inspect cables for fraying or other damage.
- Inspect all plugs and connectors for bent pins or other damage.
- Check for loose or missing screws on the mounting hardware.

NOTE
Damaged cables or equipment should be replaced by qualified service personnel.

Cleaning and disinfection

1. Remove power, all cables and batteries.
2. Close the battery door.
3. Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.

4. Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
5. To disinfect, wipe exterior with a soft lint-free cloth lightly dampened with any one of the permitted cleaning agents as follows:
   - Household bleach (Active ingredient: 5.2% Sodium Hypochlorite-off the shelf) Mix 1:10 with H2O.
   - Sagrotan (dilution 3:100, containing 75 mg tartaric acid per 100 ml solution).

   NOTE
   - Wring excess disinfectant from lint free cloth before using.
   - Contact of disinfectant solution with metal parts may cause corrosion.
   - Do not damage or bend connector pins when cleaning or drying.
6. Allow solution to remain on device for a minimum of one minute or per hospital guidelines.
7. Take care not to let fluid “pool” around connection pins. If this happens, blot dry with a soft, lintfree cloth or cotton swab. Shake out excess liquids from connector recesses.
8. Dry the equipment thoroughly with a clean, dry, soft, lint-free cloth after disinfecting.

NOTE
Drying times may vary based on environmental conditions.

Storage

- Remove batteries when the device is not in use, even for short period of time.
- Store in a dry, well-ventilated area.
- Hang the device using a holder if available.
- If leadwires or cables are attached, hang them straight.
- Do not coil leadwires or cables tightly around the device.

Consequences of Using Improper Cleaning Product

- Case may become brittle or may break.
- Overall system performance degradation.
- Melting, dulling or distorting the case.
- Total medical device failure requiring replacement.
- Unit malfunction.
- Void warranty.

Cleaning products to avoid

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

- Sani-cloth wipes
- Ascepti wipes
- HB Quat
- Disinfectant wipes (they do not contain bleach)

- Over the counter detergents (for example, Fantastic, Tilex and so on)

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

Expansion cover cleaning

1. Use a cellular urethane cleaning swab lightly moistened with 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.
2. Insert the cotton swab under the expansion interface to clean.

Battery compartment cleaning

Under normal operation, the battery compartment should not require cleaning. If the battery compartment does require cleaning, follow these instructions.

1. Remove the battery from the battery compartment.
2. Clean the device with a gauze pad or cloth lightly moistened with one of the following:
   - Water
   - Soap
3. Use a cloth lightly moistened with distilled water to rinse away the cleaning solution. Make sure moisture does not enter the electronics area below the battery compartment floor.
4. Dry thoroughly with a soft, lint-free cloth. Allow the battery compartment to air dry completely prior to closing the compartment door.

18.4.7 PDM bedrail and mount

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfection

1. Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents.
2. Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
3. To disinfect, wipe exterior with a soft lint-free cloth lightly dampened with any one of the permitted cleaning agents as follows:
   - Household bleach (active ingredient: 5.2% sodium hypochlorite-off the shelf) Mix 1:10 with H_2O.
   - Sagrotan (dilution 3:100, containing 75 mg tartaric acid per 100 mL solution).

NOTE

- Wring excess disinfectant from lint-free cloth before using.
- Contact of disinfectant solution with metal parts may cause corrosion.

4. Allow solution to remain on device for a minimum of one minute or per hospital guidelines.
5. Take care not to let fluid “pool” around connection pins. If this happens, blot dry with a soft, lint-free cloth or cotton swab. Shake out excess liquids from connector recesses.
6. Dry the equipment thoroughly with a clean, dry, soft, lint-free cloth after disinfecting.

NOTE
Drying times may vary based on environmental conditions.

18.4.8 RF filter box (CardioLab II Plus Amplifier only)

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

NOTE
Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.9 Analog IO box

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent

- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

  NOTE
  Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.10 Catheter input module

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfection

Remove all cables from the catheter input module.

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

  NOTE
  Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.

- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.11 System interconnect cables

System interconnect cables are cables that connect between the equipment. Examples of system interconnect cables include the following:

- Power cables
- Video cables
- Network cables
- Speaker cables
- Ethernet cables
- RMOT cables
- Grounding junction box
- USB extender, two-port

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent

Cleaning

- Remove system interconnect cables from the devices or systems before cleaning.
- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- Inspect and clean the leads of the plug on the interconnect cables with a dry cotton swab.

18.4.12 Printer planned maintenance

Tools and environment

- Cotton swabs, soft cloth, mild cleaning detergent (or equivalent)

Cleaning and inspection

Exterior cleaning

- Clean exterior surfaces of the printer with a clean damp cloth.
- Use a dry, soft, lint-free cloth to dry the printer.

NOTE
Do not use ammonia-based cleaners on or around the printer.

NOTE
While cleaning the printer, do not touch the transfer roller. Skin oils can cause print quality issues.

Visual inspection

- Check the case for cracks or other damage.
- Inspect cables for fraying or other damage.
- Inspect all plugs, cables, and connectors for bent prongs or pins.
- Ensure all cables and connectors are securely seated.

NOTE
Only qualified service personnel should replace components.

Clean printer as recommended by manufacturer

Using the printer model number, search the printer manufacturer's website for the user guide to determine the recommended printer cleaning method.

18.4.13 Uninterruptible power supply (UPS)

The uninterruptible power supply is used with the acquisition system only.

WARNING

EQUIPMENT HAZARD

Do not attempt to service the UPS or replace the battery. Doing so could result in equipment damage. Contact qualified GE HealthCare Service personnel for service or replacement.

WARNING

EXPLOSION HAZARD

Do not incinerate the battery or store at high temperature. Serious injury or death could result.

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent

Clean the uninterruptible power supply (UPS)

- Power off the UPS.
- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Clean each UPS connector port with a dry cotton swab.
- Do not pour or spray any liquid directly on the UPS or permit fluid to seep into connections or openings.

- Wipe the surfaces with a clean, dry, soft, lint-free cloth, until the equipment is thoroughly dry.

Inspect the uninterruptible power supply (UPS)

- Check the case for cracks, leaks, or other damage.
- Inspect all cords and cables for fraying or other damage.
- Inspect all plugs, cables, and connectors for bent prongs or pins.

Battery test

To test the UPS battery charge, perform the following steps monthly:

1. Ensure the acquisition system is plugged into the UPS.
2. If not already on, turn on the acquisition system.
3. Unplug the UPS so the acquisition system is powered by the UPS battery.
4. **Verify** the acquisition system stays powered for 10 seconds under battery power.
5. Plug the UPS back into the AC power outlet.

18.4.14 Mobile workstation

Tools

- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution
- 3/16" hex wrench (provided with workstand)
- 1/8" hex wrench (provided with workstand)
- Phillips screwdriver

Cleaning and disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

  NOTE
  Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- The surface finish is permanently damaged by strong chemicals and solvents such as acetone or trichloroethylene.

- Never submerge the roll stand or allow liquids to enter the mounting assemblies. Wipe any cleaning agents off the mounting assembly immediately using a water-dampened cloth. Dry the equipment thoroughly with a clean, dry, soft, lint-free cloth.

Routine maintenance

Periodically inspect all mounting hardware. Tighten or adjust as necessary for optimal operation and safety.

18.4.15 Desk

Tools

- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfection

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect the desk, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

  NOTE
  Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- The surface finish will be permanently damaged by strong chemicals and solvents such as acetone or trichloroethylene.

18.4.16 Stimulator Cable

Perform the monthly cleaning of the Stimulator Cable as shown in the following sections.

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and Disinfecting

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.

- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

NOTE
Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.17 Ablation stimulator extender cable

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfecting

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

NOTE
Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.18 Auxiliary cable

Tools

- Cotton swabs

- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- 5.25% sodium hypochlorite (household bleach) 1:10 dilution

Cleaning and disinfecting

- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.
- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- To disinfect, 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): 5.25% sodium hypochlorite (household bleach) 1:10 dilution.

NOTE
Wring excess disinfectant from lint-free cloth before using.

- Treated surfaces must remain wet for a minimum of 5 minutes.
- If surface becomes dry before contact duration time is met, re-wipe with a fresh wet cloth.
- Do not make patient connections until equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.19 Barcode scanner

Tools

- Multiple soft, dry lint-free cloths

Cleaning

- Wipe down the component with a soft, dry lint-free cloth.

18.4.20 HD Hub

Tools

- Cotton swabs
- Multiple soft, dry lint-free cloths
- Mild dishwashing detergent
- Vacuum cleaner

Cleaning

- Power off the HD Hub.
- Vacuum the component externally to remove the dust.
- Wipe down the component with a soft, lint-free cloth lightly dampened with mild dishwashing detergent diluted in water. Wring excess fluid from lint-free cloth before using. Avoid contact with open vents, plugs, or connectors.

- Wipe the surfaces with a clean, dry, soft, lint-free cloth until the equipment is thoroughly dry.
- Clean each connector port with a dry cotton swab.
- Do not let fluid pool around connection pins. If this happens, blot dry with a soft, lint-free cloth.

18.4.21 Other GE HealthCare peripheral devices

To do the planned maintenance for the following devices/accessories, refer to the respective supplier service manual for the proper cleaning and disinfection procedure.

- Respironics Capnostat 5 CO_2 sensor (refer to the Respironics CO_2 User and Service Manual for AltiX BT22 [5222370-199])
- Respironics LoFlo CO_2 module (refer to the Respironics CO_2 User and Service Manual for AltiX BT22 [5222370-199])
- CARESCAPE
- Dash
- Solar
- Stimulator
- Innova Central Touch Screen Unit (ITU)
- Accessories
  - CardioLab leadwires and ECG cables
  - Invasive blood pressure accessories
  - Non-invasive blood pressure accessories
  - Temperature accessories
  - Pulse oximetry accessories
  - CO_2 accessories (refer to the Respironics CO_2 User and Service Manual for AltiX BT22 [5222370-199])

18.5 Database maintenance

The database maintenance job is executed on acquisition and review systems on a weekly basis to provide better performance, to check consistency and integrity errors in the databases, and to back up the data on the system. The database maintenance job is scheduled to run during off-peak hours. Based on the default schedule the database maintenance job is scheduled to run at 2 AM every Sunday. The acquisition and review system should remain powered on when the database maintenance job is scheduled to run.

The current schedule of the **Database Maintenance Job** can be accessed by the following steps:

1. Select **Start** > **Programs** > **Microsoft SQL Server Tools 17** > **Microsoft SQL Server Management Studio 17**.
2. In the window that opens, select or type the following:
   - Server Type: **Database Engine**
   - Server Name: Computer name

NOTE
To view the computer name, on the desktop, right-click **This PC** and select **Properties**. The computer name appears in the **Computer name, domain and workgroup settings** section.

- Authentication: **Windows Authentication**

3. Click **Connect**.
4. On the left in the *Object Explorer* window, expand **SQL Server Agent** > **Jobs**.
5. Right-click **Database Maintenance**, then select **Properties**.
6. In the window that opens, click **Schedules**.
7. The Schedule is visible in the Schedule list.
8. Click **Cancel**.
9. Close the **Microsoft SQL Server Management Studio**.

18.6 Troubleshooting

WARNING

SHOCK HAZARD

Damaged cables and loose connections present a shock hazard and could cause signal noise or impaired device operation. Ensure all cables are in good condition, protected from potential sources of damage, and securely connected before powering on equipment. Replace damaged cables immediately.

18.6.1 Initial inspection

NOTE
Do not disconnect or reconnect any cables while the system is powered.

Before performing any troubleshooting procedure, check the following:

- The isolation transformer is plugged in and power and ground are available at the wall outlet (also check the outlet circuit breaker).
- The isolation transformer, computer, monitors, keyboard and any optional equipment are properly connected and all connections are tight. Be sure to check for:
  - Frayed cables
  - Exposed conductors
  - Bent prongs or pins
  - Damaged cable housings
  - Loose plug screws
- The isolation transformer power switch is on.
- Computer power switch is on.
- All monitors are turned on and set to the appropriate brightness and contrast.
- Equipment housing for cracks, overheating, or other damage.

18.6.2 System locked up

WARNING

NOT A PATIENT MONITOR

The system is intended to be used as a recording system for catheterization, electrophysiology and related specialty laboratories. A defibrillator or ECG monitor should be attached for patients in need of uninterrupted ECG display. An additional means to display SpO_2 should be attached for patients in need of uninterrupted SpO_2 display. A temporary pacemaker needs to be available for patients in need of uninterrupted delivery of pacing. An additional means to display CO_2 should be attached for patients in need of uninterrupted CO_2 display.

- While recording patient information – If still able to record, contact your GE HealthCare service representative.
- Not recording patient information – Reboot the computer. Contact your GE HealthCare service representative if rebooting does not correct the problem.

18.6.3 System does not boot

1. Check to see if there is a disk in the DVD drive (if available). If a disk is in the DVD drive, remove the disk. Turn the system off and wait 10 seconds before turning the system on again.
2. Check the isolation transformer and then the other hardware for loose power and connections.

18.6.4 UPS is beeping

When the UPS battery is low, it will beep. If this happens, do not attempt to replace the battery. Contact a GE HealthCare representative.

18.6.5 Monitor not working

A monitor may not work because it has either lost signal or power.

1. Check other monitors. If all monitors are not working, check for system power.
2. Check the power light on the affected monitor. If it is off, ensure the monitor is plugged in and power is available at the outlet. Try plugging into a different outlet or using a different power cable.
3. If the power light is on, ensure the video cable is connected properly (refer to the connection diagrams in the Mac-Lab/CardioLab/Centricity Cardiology INW Service Manual [PN 5222010-1EN]) and all connections are undamaged and tight.
4. Confirm that the monitor input source is set to HDMI.
5. Plug the monitor into another system, if the monitor works, then the monitor is functional. Otherwise, use a known working monitor on the system in question.
6. Check the power light on the video splitter and video switch (if applicable).
7. Check the signal lights on the splitters to determine if a valid video input and output are present.
8. Check Windows 10 Display Settings to ensure monitor output is enabled.

18.6.6 Missing or noisy waveforms

- Ensure the desired waveform traces are on.
- Ensure blood pressure waveforms are zeroed.
- Verify the pressure gain (right-click label and select **Scale**).
- Click the **Offset** icon in the *Real-Time* window to offset the signal.
- Ensure all power lights are illuminated. Check power cords.
- If the power lights are illuminated, ensure the cables to the modules are properly connected and that all connections are undamaged and tight. Refer to the connection diagrams in the Mac-Lab/CardioLab/Centricity Cardiology INW Service Manual (PN 5222010-1EN).
- Verify sensor pads are applied to properly prepared skin. Reapply or replace if necessary.
- If the problem persists, contact your GE HealthCare Service Representative.

18.6.7 Missing Vitals (with PDM)

No vitals can be acquired from the PDM until it is registered.

If the vitals from the PDM (such as NIBP, RR, and SpO2) are missing, and the PDM was not previously registered with the CardioLab system, contact GE HealthCare Service personnel to perform the PDM registration.

18.6.8 Ablation device data

Table 18-1 Ablation device data

Issue	Resolution
The system does not appear to receive ablation device data.	Select the NULL ablation device, and then re-select the desired ablation device driver in the ablation setup screen. This resets the COM port and may resolve the ablation data reception issue.

18.6.9 Missing amplifier inputs

1. Initial checks (from within a CardioLab study):
   1.1. Highlight the label area and check the *Real-Time* window for the signal. Highlighted traces are orange.
   1.2. Ensure blood pressure waveforms are zeroed.
   1.3. Verify the pressure gain (right-click the label and select **Scale**).
2. 2. From the *Navigator* window, make sure the study is set up correctly.
   2.1. From the *Navigator* window, select **Administration** > **Study Configuration** > **Edit**. The *Study Configuration* window appears.
   2.2. Select the appropriate **Catheter Block**.
   2.3. Select the **Hardware** tab.
   2.4. Ensure the numbers on the catheter input module (CIM) that the catheter is plugged into correspond to the numbers listed in the **Input** column.

2.5. Check the gain and filter settings:

- Gain should be between 1000 and 10,000.
- Bipolar filter setting should be: high pass 30 Hz, low pass 500 Hz, or power line filter off.
- Unipolar filter setting should be: low pass 0.05 Hz, high pass 150 Hz, power line filter off.
- Select the **Display Settings** tab.
- Ensure the signal is not turned off.

3. Check the hardware.

3.1. Ensure power is on to the amplifier

3.2. If the power light is on, ensure the amplifier fiber optic cable is properly connected (refer to the connection diagrams in the Mac-Lab/CardioLab/Centricity Cardiology INW Service Manual [PN 5222010-1EN]) and all connections are undamaged and tight.

3.3. Assign an unused channel on the amplifier to the same location on the CIM and check to make sure it displays. If it does, the problem is with the channel in the amplifier.

3.4. Plug the pins from the catheter into a spot on the CIM that is confirmed to be working. If there is no display, the problem may be in the catheter connecting cable.

3.5. If the cable seems to be good, the problem may be with the catheter.

NOTE
Catheters are rarely defective. Ensure all troubleshooting options have been exhausted before pulling the catheter from the patient.

4. If the problem persists, contact your GE HealthCare Service Representative.

18.6.10 Log Entries Caused by Noise Spikes on Stim Channels

When pacing is enabled on a noisy stim channel, noise spikes on the stim channel sometimes are mistaken as pacing pulses even when they are not actually paced. This causes log entries in the S1/S2 columns if **Auto Save** is also enabled or **Manual Save** is turned on.

Recommended corrective actions:

1. Make sure the study is set up correctly.

1.1. In the *Real-Time* window, click the **Study Configuration** icon. The *Study Configuration* window appears.

1.2. Select the **Stim** tab.

1.3. Ensure the numbers on the CIM that the catheter is plugged into correspond to the numbers listed in the **Input** column.

2. Check the physical connections of the stim channels.

3. Disable pacing on the stim channels not paced.

18.6.11 Signal noise

This section identifies basic causes of signal noise and suggested solutions. Noise can be caused by a number of different factors that may interact with each other. Only GE HealthCare approved accessories and supplies should be used with the system to avoid noise issues. Contact your GE

HealthCare service representative if the noise cannot be corrected. Be sure to keep notes about the noise type and what was tried to correct the noise.

NOTE
The use of electrocautery may cause noise on waveforms.

For CardioLab, over filtered “Blocky” signals can be improved by adjusting filter settings, screen resolution, sampling rate and contrast / brightness as listed in the following:

- Select 0.05Hz or 0.5Hz for ECG signals; a high-pass filter setting too high (5Hz) will distort the waveform.
- The power line filter options are designed to remove this noise.
- Increasing sample rate from 1K to 2K can improve signal quality.

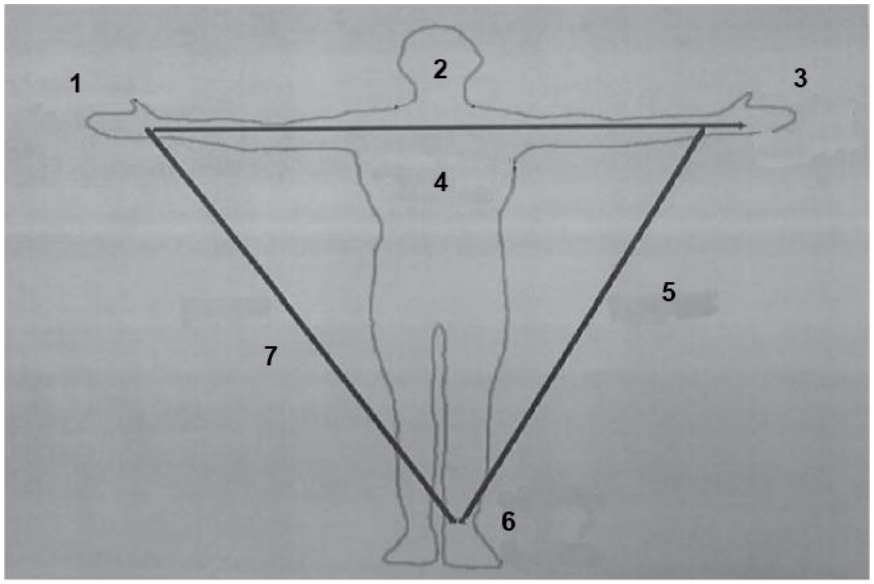
The following actions can be taken to reduce electromagnetic disturbances:

- Assess the environment of the healthcare facility for potential sources of electromagnetic interference (EMI) (for example, identify radio transmitters in and around the facility).
- Increase the distance between sources of EMI and susceptible devices.
- Lower power transmitted from electrical and electronic equipment (EMI sources) under hospital control (that is, paging systems).
- Educate healthcare facility staff (nurses and doctors) to be aware of and to recognize potential EMI-related problems.

18.6.11.1 Surface ECG Noise

Proper placement of electrodes and good skin preparation are vital to getting ECG signals free of noise. The Right Leg electrode is the reference lead of the CardioLab system and good contact with the patient is critical to all ECG and Intracardiac signals.

Surface ECG noise can appear on some traces but not others. To help troubleshoot the cause of noise, Einthoven's Theorem can be used to determine the problem electrode or lead wire.



1	Right Arm (-) Negative

2	LEAD I
3	Left Arm (+) Positive
4	Einthoven's Triangle
5	LEAD III
6	Left Leg (+) Positive
7	LEAD II

Examples of how Einthoven's Theorem can be used:

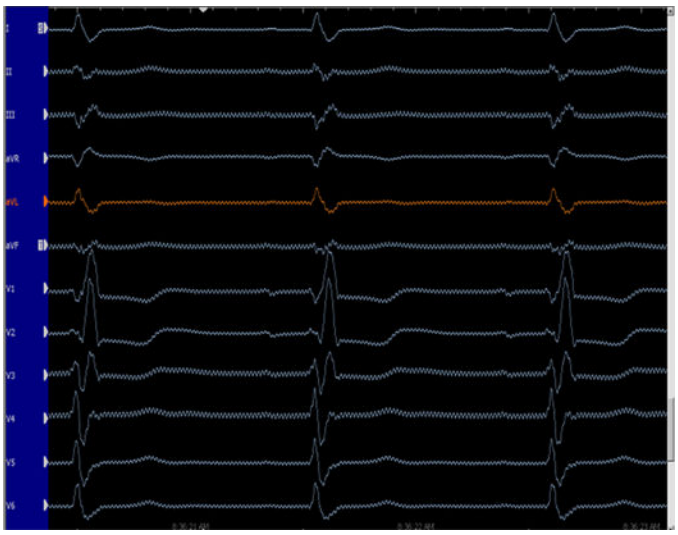
- If Lead I and II are noisy but Lead III is normal, look for a bad electrode / lead wire at Right Arm.
- If Lead I and III are noisy but Lead II is normal, look for a bad electrode / lead wire at Left Arm.
- If Lead II and III are noisy but Lead I is normal, look for a bad electrode / lead wire at Left Leg.
- If all leads are noisy, look for a bad electrode / lead wire at Right Leg (or multiple electrodes / lead wires).

ECG noise can be categorized into several different types of noise including power line frequency, baseline drift, ablation, pacing artifact, and muscle artifact.

18.6.11.1.1 Power Line Frequency Noise - ECG

The Power Line Frequency noise is the most common type of noise with traces becoming fuzzy, thick, or dull. Power Line Frequency Noise can appear on one or all ECG traces. The source of the noise is derived from the local AC power frequency, 60Hz or 50Hz. The power line frequency noise can be measured by turning up the display speed and measuring the period of corresponding sine wave (1000ms/60 = 16.7ms for 60Hz or 1000ms/50 = 20ms for 50Hz). The power line filter is designed to remove this noise.

Example of Power Line Frequency Noise - 60Hz noise on all ECG traces:



Typically, Power Line Frequency noise is the result of a difference in ECG lead wire impedance (poor connection with the patient), inducing noise on the CardioLab amplifier. Possible contributing factors of Power Line Frequency noise include:

- Power line filter turned off
- Bad lead wires

- Bad patient cables
- Poor electrode connection with the patient

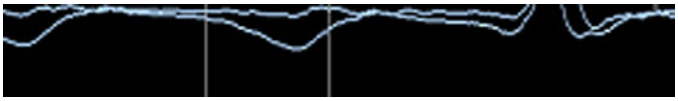
Recommended corrective actions include:

- On all ECG traces, turn on the power line filter by changing the power line filter option to **Fixed** or **Adaptive**. If noise is still present, select **Fixed+** to apply additional filtering.
- Replace bad or worn out lead wires
- Replace bad or worn out patient cables
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.

18.6.11.1.2 Baseline Drift Noise - ECG

The Baseline Drift noise appears as if the entire ECG trace is moving vertically. The frequency of this noise is a variable. The ECG trace can move with some physical movement in the lab.

Example of Baseline Drift Noise:



The Baseline Drift noise is often the result of differences in ECG lead wire impedance (poor connection with the patient) inducing noise from some physical movement near the patient. Possible contributing factors of Baseline Drift noise include:

- Bad lead wires
- Bad patient cables
- Poor electrode connection with the patient
- Electrode location susceptible to respiration movement
- Patient movement
- Patient drape movement
- Patient table not grounded properly

Recommended corrective actions include:

- Adjust the High Pass Filter to a higher setting to filter out this noise (for example, change from 0.05 Hz to 0.5 Hz).
- Replace bad or worn out lead wires.
- Replace bad or worn out patient cables.
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Limit patient movement.
- Ground the patient table with a common ground shared with the PDM Base Station Plus, PDM Slim Connect, or CardioLab amplifier.

18.6.11.1.3 Muscle Artifact Noise - ECG

The Muscle Artifact noise is a variable noise riding on a trace or multiple traces. This noise can be traced to movement of the patient such as shivering or snoring. The Muscle Artifact noise is often the result of a difference in ECG lead wire impedance (poor connection with the patient).

Example of Muscle Artifact Noise:

Possible contributing factors of Muscle Artifact noise include:

- Bad lead wires
- Bad patient cables
- Poor electrode connection with the patient
- Electrode location
- Patient movement caused by patient being cold, reaction to medications, or snoring

Recommended corrective actions include:

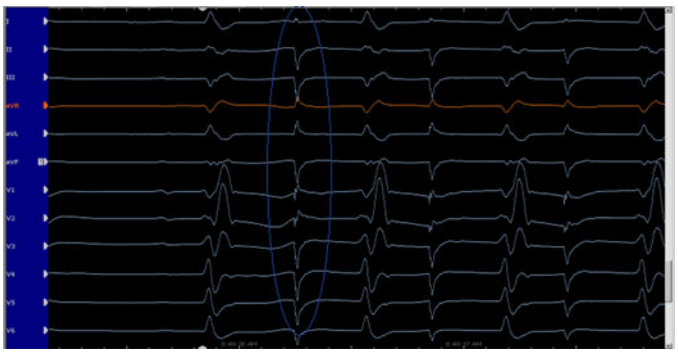
- Replace bad or worn out lead wires
- Replace bad or worn out patient cables
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Limit patient movement.

18.6.11.1.4 Pacing Artifact Noise - ECG

The Pacing Artifact noise occurs while the pace generator (stimulator) is actively pacing the heart and disappears after the pacing pulses are turned off. Generally, the higher the pacing current, the higher the amplitude of noise will be generated on the ECG trace. Some pacing artifact is considered normal operation.

NOTE
Stimulators are constant current sources. If the resistance is higher than the normal due to bad or corroded cables/connections, the voltage delivered by the stimulator will be higher and therefore more likely to generate larger spikes/artifact. To help troubleshoot a possible problem, the CardioLab amplifier can be bypassed using the direct stimulator connection on the CIM module.

Example of Pacing Artifact Noise:



Possible contributing factors of Pacing Artifact noise include:

- Excessively high pacing current settings on the stimulator (“milliamp” output and “duration” settings).
- Bad stimulator cables.
- Loose fitting or bad stimulator connections.
- Stimulator Isolation / Interface box (low batteries).
- Pacing for long periods of time causing a charge build-up on the pacing poles of the catheter. This will lead to a natural occurring event of a long decay back to baseline after each pacing spike.

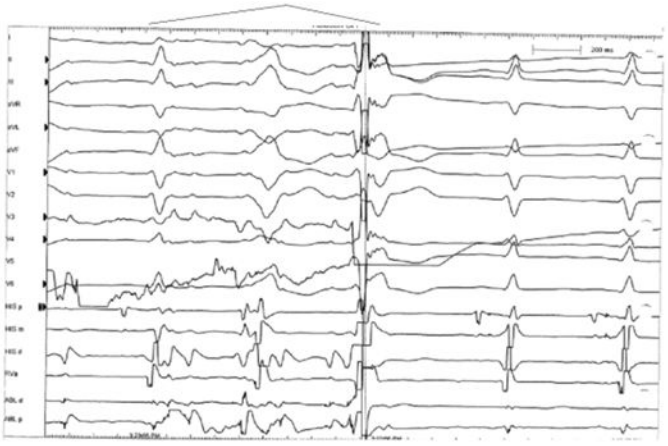
Recommended corrective actions include:

- Reduce the pacing current (Common settings: 1-5mA @ 2.0ms)
- Replace bad or worn out stimulator cables
- Replace batteries present in Stimulator Isolation / Interface box
- Use a bi-phasic stimulator

18.6.11.1.5 Ablation Noise - ECG

The Ablation noise occurs while the RF generator is actively ablating the heart and disappears after the generator is turned off. A large spike on the waveform may occur at the time the RF generator changes its power output (turned on or turned off). This spike could be confused with a pacing spike.

Example of Ablation Noise - With RF Generator On:



Possible contributing factors of Ablation noise include:

- Bad lead wires
- Bad patient cables
- Poor electrode connections with the patient
- Bad ablation grounding pad
- Proximity of electrodes / lead wires to RF source
- Grounding of equipment

Recommended corrective actions include:

- Replace bad or worn out lead wires.

- Replace bad or worn out patient cables.
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Replace bad or worn out grounding pad.
- Ground the Ablation Device (RF Generator) and patient table with a common ground shared with the CardioLab amplifier.

18.6.11.2 Intracardiac Signal Noise

Proper placement of catheters and good electrical contact are vital to maintaining Intracardiac signals free of noise. The Right Leg electrode is the reference lead of the CardioLab system, and good contact with the patient is critical to all ECG and Intracardiac signals.

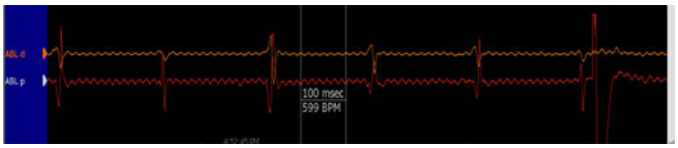
When troubleshooting Intracardiac signal noise issues, it is possible to configure a new channel of the amplifier and move the poles of the catheter to different poles of the CIM module. If the same noise is seen on two identical channels of the CardioLab amplifier, the problem is likely not the amplifier but the signal or ground wiring.

Intracardiac signal noise can be categorized into several different types of noise including power line frequency, baseline drift, pacing artifact, ablation, unipolar high frequency, and mapping systems.

18.6.11.2.1 Power Line Frequency Noise - Intracardiac

The Power Line Frequency noise is the most common type of noise (when not ablating) with traces becoming fuzzy, thick, or dull. Power Line Frequency Noise can appear on one or all Intracardiac traces. The source of the noise is derived from the local AC power frequency, 60Hz or 50Hz. The power line frequency noise can be measured by turning up the display speed and measuring the period of corresponding sine wave (1000ms/60 = 16.7ms for 60Hz or 1000ms/50 = 20ms for 50Hz). The power line filter is designed to remove this noise.

Example of Power Line Frequency Noise - 60Hz noise on all Intracardiac traces:



Possible contributing factors of Power Line Frequency noise include:

- Grounding of devices (bad electrical grounds: power outlets at the patient table / wall outlet, power strips, equipment in the lab, power cords)
- Bad Ablation Device cabling (Personality module/wires)
- Poor routing of wires / cables around other equipment
- Poor electrode connection with the patient - Right Leg lead
- High Gain (>5000) will amplify signal as well as noise

Recommended corrective actions include:

- Ground the Ablation Device (RF Generator) and patient table with a common ground shared with the CardioLab amplifier
- Replace Ablation Device cabling (personality module/wires)

- Improve routing of wires / cables away from other equipment
- Replace bad or worn out lead wires
- Replace bad or worn out patient cables
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- On the impacted channels, apply 1 of the 5 power line filter options: **Fixed**, **Fixed+, Adaptive**, **AUTO**, or **Off**.
    - **Fixed**: Use this filter for channels that are pacing, ablating, or experience frequent railing.
      The **Fixed** filter implements a hardware power line notch filter on the specified channel to remove power line noise at the configured frequency (50 Hz or 60 Hz).
    - **Fixed+**: Use this filter for channels if noise is still present after applying the **Fixed** or **Adaptive** power line filters.
      The **Fixed+** filter applies either a 50 Hz or 60 Hz fixed power line filter as well as the filters for the 2nd through 5th harmonics of the power line frequency.
    - **Adaptive**: Use this filter for channels that are not pacing or ablating, or experience frequent railing.
      The **Adaptive** filter learns the pattern of a good signal and then eliminates power line noise from the configured frequency (50 Hz or 60 Hz).
    - **AUTO**: This filter is recommended for channels that are not ablating or experience frequent railing.
      The **AUTO** filter implements the **Fixed** filter when the channel becomes a **Pace & Record** channel type. If the channel is not a **Pace & Record** channel, then this option implements the **Adaptive** filter.
    - **Off**: Use this option when no power line filtering is desired. No power line filter is active on the signal.

18.6.11.2.2 Baseline Drift Noise - Intracardiac

The Baseline Drift noise appears as if the entire trace is moving vertically. The frequency of this noise is a variable but low, similar to Baseline Drift Noise - ECG.

Possible contributing factors of Baseline Drift noise include:

- Bad lead wires
- Bad patient cables
- Poor electrode connection with the patient
- Electrode location susceptible to respiration movement
- Patient movement
- Patient drape movement
- Patient table not grounded properly

Recommended corrective actions include:

- Adjust the High Pass Filter to a higher setting to filter out this noise (for example, normal setting: 30 Hz for Intracardiac signal)
- Replace bad or worn out lead wires

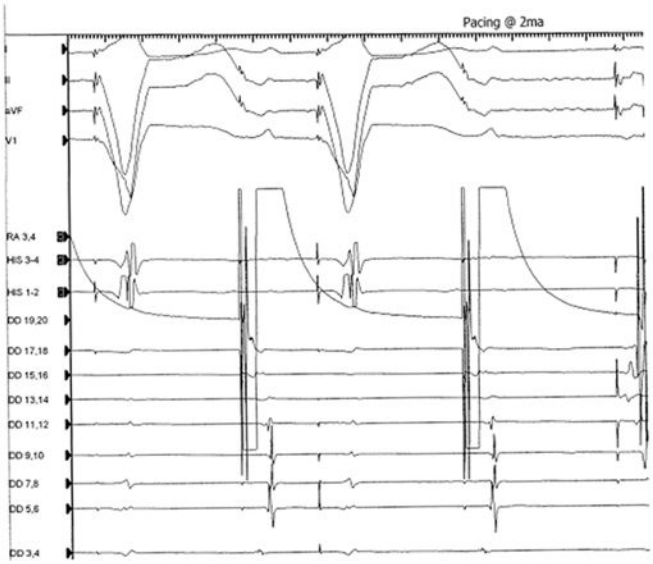
- Replace bad or worn out patient cables
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Limit patient movement
- Ground the patient table with a common ground shared with the CardioLab amplifier

18.6.11.2.3 Pacing Artifact Noise - Intracardiac

The Pacing Artifact noise occurs while the pace generator (stimulator) is actively pacing the heart and disappears after the pacing pulses are turned off. Generally, the higher the pacing current, the higher the amplitude of noise will be generated on the trace.

NOTE
Stimulators are constant current sources. If the resistance is higher than the normal due to bad or corroded cables/connections, the voltage delivered by the stimulator will be higher and therefore more likely to generate larger spikes/artifact. To help troubleshoot a possible problem, the CardioLab amplifier can be bypassed using the direct stimulator connection on the CIM module.

Example of Pacing Artifact Noise:



Possible contributing factors of Pacing Artifact noise include:

- Excessively high pacing current settings on the stimulator (“milliamp” output and “duration” settings)
- Bad stimulator cables
- Loose fitting or bad stimulator connections
- Stimulator Isolation / Interface box (low batteries)
- Pacing for long periods of time causing a charge build-up on the pacing poles of the catheter. This will lead to a natural occurring event of a long decay back to baseline after each pacing spike.

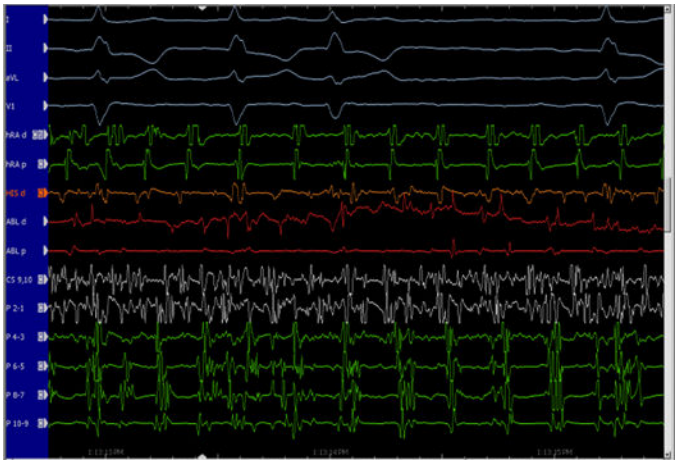
Recommended corrective actions include:

- Reduce the pacing current (Common settings: 1-5mA @ 2.0ms)
- Replace bad or worn out stimulator cables
- Replace batteries present in Stimulator Isolation / Interface box
- Use a bi-phasic stimulator

18.6.11.2.4 Ablation Noise - Intracardiac

The ablation noise occurs while the RF generator is actively ablating the heart and disappears after the generator is turned off. Generally, the higher the power setting of the RF generator, the higher the amplitude of noise. Noise on the **Ablation Distal** signal is the most difficult noise to eliminate. With power settings above 35W, noise is expected on the **Ablation Distal** signal. Using the pacing enabled RF filter box kit (PN 2082432-001) will help filter out the ablation noise.

Example of ablation noise:



Possible contributing factors of ablation noise include:

- Poor electrode connections with the patient
- Bad ablation grounding pad
- Proximity of electrodes or lead wires to RF source
- Grounding of equipment
- Old versions of EPT personality module are not designed for **Ablate and Record** capability
- No pacing enable RF filter box kit in use

Recommended corrective actions include:

- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Replace bad or worn out grounding pad.
- Ground the ablation device (RF generator) and patient table with a common ground that is shared with the CardioLab amplifier.
- Replace **Ablate and Record** personality module and associated cables.
- Use the pacing enabled RF filter box kit.

18.6.11.2.5 Unipolar High Frequency Noise - Intracardiac

The Unipolar High Frequency noise is the result of a difference in noise level on the catheter pole and the channel reference (either the surface Intracardiac Wilson Central Terminal (WCT) or Auxiliary Reference). Unipolar signals are more susceptible to noise because a catheter pole and a channel reference affect the common mode rejection of the system.

Possible contributing factors of Unipolar High Frequency noise include:

- Bad lead wires
- Bad patient cables
- Poor electrode connection with the patient
- Placement of Intracardiac cable near the other devices (when WCT is used as channel reference)

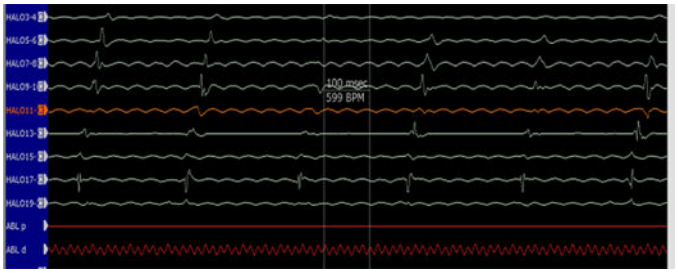
Recommended corrective actions include:

- Adjust the Low Pass Filter to a lower setting to filter out this noise (for example, change from 1000Hz to 150Hz)
- Replace bad or worn out lead wires
- Replace bad or worn out patient cables
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Route the Intracardiac cable away from other electrical devices

18.6.11.2.6 Mapping System Noise - Intracardiac

Mapping System noise is typically associated with power line frequency noise or magnet generated noise. The power line frequency noise can be measured by turning up the display speed and measuring the period of corresponding sine wave (1000ms/60 = 16.7ms for 60Hz or 1000ms/50 = 20ms for 50Hz). The power line filter is designed to remove this noise.

Example of Mapping System Noise:



Possible contributing factors of Mapping System noise include:

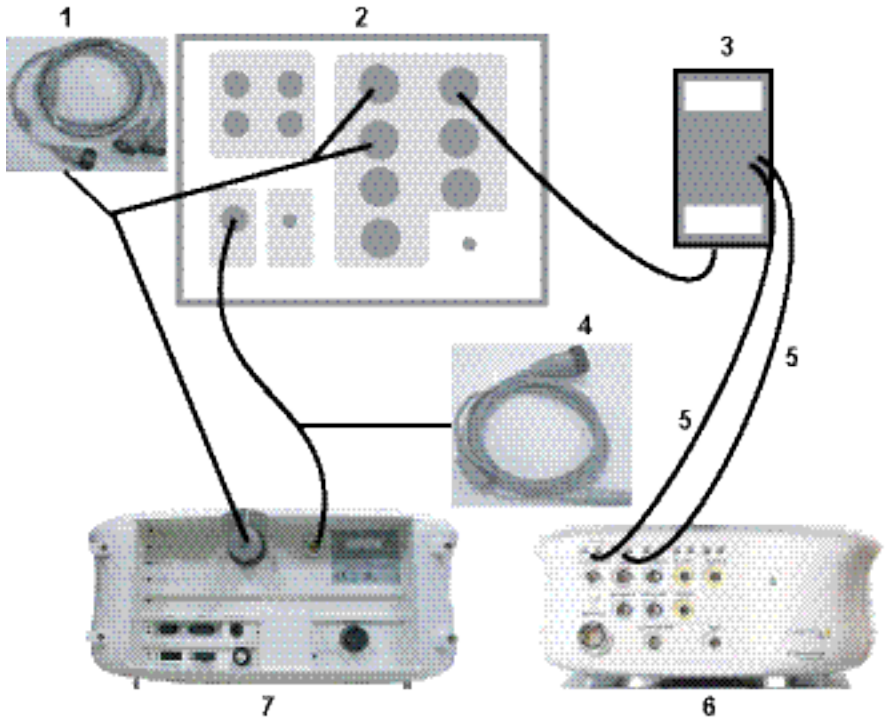
- Poor electrode connections with the patient
- Grounding of equipment
- Magnet interference
- 5.6KHz End Guide Signal (a signal emitted from the top of the ESI catheter used for catheter location)

Recommended corrective actions include:

- Adjust the Low Pass Filter to 150 Hz to filter out magnet interference or 5.6 KHz End Guide signal interference.
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient.
- Ground the Mapping System and patient table with a common ground shared with the CardioLab amplifier.
- On the impacted channels, apply 1 of the 5 power line filter options: **Fixed**, **Fixed+, Adaptive**, **AUTO**, or **Off**.
    - **Fixed**: Use this filter for channels that are pacing, ablating, or experience frequent railing.
      The **Fixed** filter implements a hardware power line notch filter on the specified channel to remove power line noise at the configured frequency (50 Hz or 60 Hz).
    - **Fixed+**: Use this filter for channels if noise is still present after applying the **Fixed** or **Adaptive** power line filters.
      The **Fixed+** filter applies either a 50 Hz or 60 Hz fixed power line filter as well as the filters for the 2nd through 5th harmonics of the power line frequency.
    - **Adaptive**: Use this filter for channels that are not pacing or ablating, or experience frequent railing.
      The **Adaptive** filter learns the pattern of a good signal and then eliminates power line noise from the configured frequency (50 Hz or 60 Hz).
    - **AUTO**: This filter is recommended for channels that are not ablating or experience frequent railing.
      The **AUTO** filter implements the **Fixed** filter when the channel becomes a **Pace & Record** channel type. If the channel is not a **Pace & Record** channel, then this option implements the **Adaptive** filter.
    - **Off**: Use this option when no power line filtering is desired. No power line filter is active on the signal.

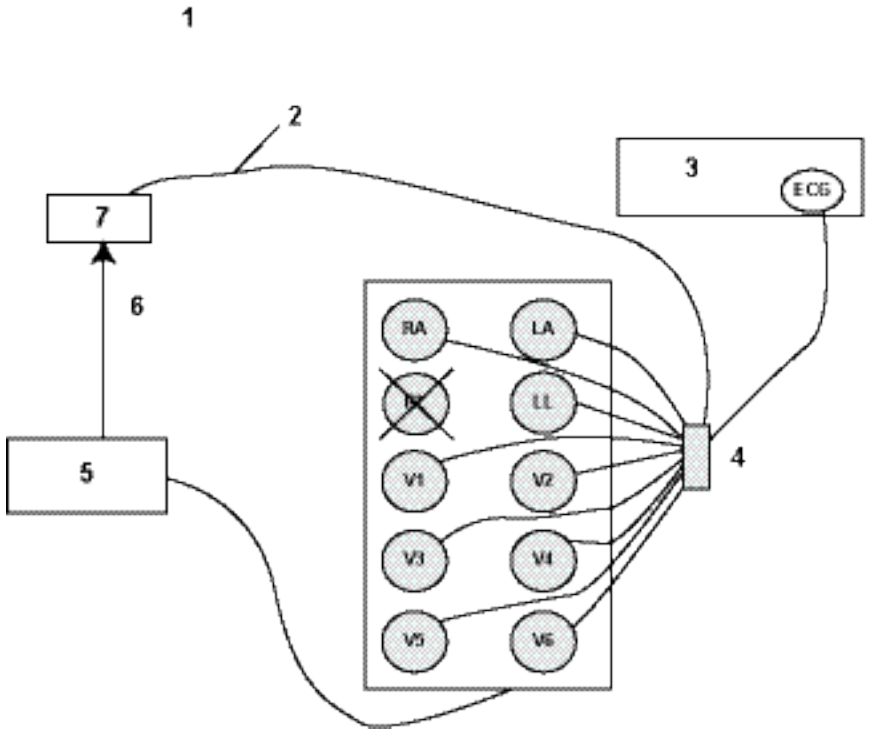
18.6.11.3 CARTO 3 Signal Noise

With the CARTO 3, the CardioLab's Surface ECG lead wires are commonly routed through the CARTO PIU box then to the CardioLab amplifier. This CARTO PIU box will filter out the noise from the magnet used with the CARTO system.



1	ICEG connectivity cable
2	CardioLab amplifier
3	Catheter input module
4	ECG connectivity cable
5	Stimulation cables
6	CARTO 3 PIU front
7	CARTO 3 PIU back

The mapping company representative may route signals through their junction box for additional processing. Below is a diagram that shows the use of the ECG junction box in line with the CardioLab amplifier.



1	CARTO ECG out connection unit CardioLab right leg lead direct connect
2	Right leg lead from CardioLab connected directly to patient
3	CardioLab amplifier
4	CardioLab ECG patient cable
5	CARTO patient interface box
6	CARTO ECG cable
7	Patient

18.6.11.3.1 Mapping System Noise - Surface

The Power Line Frequency and magnet noise is the most common type of noise with traces becoming fuzzy, thick, or dull. Power Line Frequency and magnet noise can appear on one or all ECG traces. The source of the noise is derived from the local AC power frequency, 60Hz or 50Hz.

The Power Line Frequency noise can be measured by turning up the display speed and measuring the period of the corresponding sine wave with the time calipers (1000ms/60 = 16.7ms for 60Hz or 1000ms/50 = 20ms for 50Hz). The power line filter is designed to remove this noise..

Recommended corrective actions include:

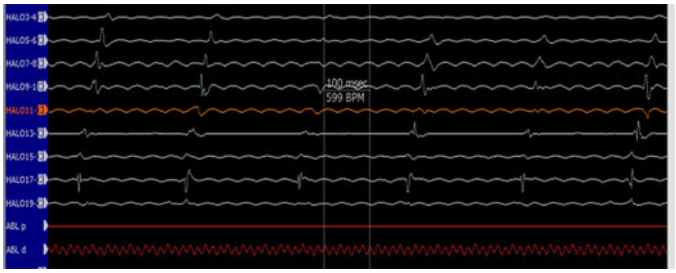
- Use a direct connection from the CardioLab ECG Cable Right Leg Lead to the patient to improve surface signals with the CARTO 3 when using the ECG connection box. This requires a double patch for the right leg only.
- Ground the mapping system and patient table with a common ground shared with the CardioLab amplifier. The connection would be made to the equipotential plug.

- Use the lowest gains possible when performing a case. Recommended setting is 2500 or lower. The standard is 1000.
- Some mapping systems do not allow for a direct connection of the Right Leg Lead. In this case, GE HealthCare recommends not using the junction box provided by the mapping system and connecting both sets of ECGs separately. (Contact BioSense/Webster for the correct connection system to allow only having to connect the Right Leg Lead twice.)

18.6.11.3.2 Mapping System Noise - Intracardiac

Mapping System Noise is typically associated with Power Line Frequency noise or magnet generated noise. The Power Line Frequency noise can be measured by turning up the display speed and measuring the period of corresponding sine wave (1000ms/60 = 16.7ms for 60Hz or 1000ms/50 = 20ms for 50Hz). The power line filter is designed to remove this noise.

Example of Mapping System Noise:



Possible contributing factors of Mapping System Noise include:

- Poor electrode connections with the patient.
- Grounding of equipment.
- Magnet interference.
- 5.6KHz End Guide Signal (a signal emitted from the top of the ESI catheter used for catheter location). Refer to manufacturer's documentation.

Recommended corrective actions include:

- Adjust the Low Pass Filter to 150 Hz to filter out magnet interference or 5.6 KHz End Guide signal interference.
- Ensure electrodes have been placed in the correct location where the skin was properly prepared. Typically, this noise source improves with no intervention after 10 minutes of contact with the patient. Patch resistance can occur when patients use body lotion prior to the procedure. Removing the body lotion prior to patch placement is an important part of the patch placement technique.
- Ground the Mapping System and patient table with a common ground shared with the CardioLab amplifier. The connection would be made to the equipotential plug.
- Use CardioLab calipers to determine if noise source is 60 Hz (16 ms time base peak to peak) or from the mapping magnet.
- Request mapping company representative for help with troubleshooting cases.
- Use a direct connection from the CardioLab ECG Cable Right Leg Lead to the patient to improve surface signals with the CARTO 3 when using the ECG connection box.This requires a double patch for the right leg only.

- If possible, try using the electrical ground of the patient table as common ground for all devices connected to the patient.
- Avoid using power strips. Power strips tend to degrade the earth grounding of the equipment.
- Use the lowest gains possible when performing a case. Recommended setting is 2500 or lower. The standard is 1000.
- Power line noise is mainly found on Abl ds signal. Do not confuse power line noise with magnet interference.
- If noise exists on unfiltered ECG channels, then that suggests a noisy lab environment, and improvement opportunities are available to address noise, such as following the suggestions above.
- On the impacted channels, apply 1 of the 5 power line filter options: **Fixed**, **Fixed+, Adaptive**, **AUTO**, or **Off**.
    - **Fixed**: Use this filter for channels that are pacing, ablating, or experience frequent railing. The **Fixed** filter implements a hardware power line notch filter on the specified channel to remove power line noise at the configured frequency (50 Hz or 60 Hz).
    - **Fixed+**: Use this filter for channels if noise is still present after applying the **Fixed** or **Adaptive** power line filters.
      The **Fixed+** filter applies either a 50 Hz or 60 Hz fixed power line filter as well as the filters for the 2nd through 5th harmonics of the power line frequency.
    - **Adaptive**: Use this filter for channels that are not pacing or ablating, or experience frequent railing.
      The **Adaptive** filter learns the pattern of a good signal and then eliminates power line noise from the configured frequency (50 Hz or 60 Hz).
    - **AUTO**: This filter is recommended for channels that are not ablating or experience frequent railing.
      The **AUTO** filter implements the **Fixed** filter when the channel becomes a **Pace & Record** channel type. If the channel is not a **Pace & Record** channel, then this option implements the **Adaptive** filter.
    - **Off**: Use this option when no power line filtering is desired. No power line filter is active on the signal.

18.6.12 Lab suggestions for noise reduction

18.6.12.1 Daily Inspections

ECG Cables

- Examine the lead clasp for dirt, blood, contrast, presence of brass clip.
- Operate the clasp for performance.
- Examine the cables for frays, breakage or wear.

ECG Harness

- Examine the lead connection within the harness.
- Examine the cable for fray, breakage, or wear.

- Examine the harness connection to the amplifier for security.

CIM Blocks

- Examine the overall cleanliness of the block.
- Examine the inputs and ensure they are free of blood, dust, or contrast.
- Examine the cable connection at the amplifier for security.

18.6.12.2 Table Preparation

ECG Stickers

- ONLY clean, fresh leads should be used.
- Use smaller packs of leads to avoid wasting those not used within a 72 hour period.

ECG Cables

- Untangle and stage ECG cables to lie alongside the left side of the patient.
- Upper Limb leads (RA, LA, V1 and V2) should approach patient from the superior aspect.
- Remaining V-leads (V3, V4, V5 and V6) should approach from inferior aspect.
- Lower limb leads (RL, and LL) should approach from the left side of the patient.

CIM Blocks

- Position the blocks as needed.
- Design a flat carrier to hold the CIM blocks fast and attached to the table side, to prevent the pulling of the blocks upon the EP catheters.

Connection Cables for the EP Catheter

- The preferred method is to use new connection cables for each case.
- Establish a counting system for the amount of sterilizations the catheter has undergone and discard them after the number of sterilizations recommended by the manufacturer. (A counting system example is to use small Zip Ties applied after each use.)

18.6.12.3 Patient Preparation

Skin Preparation

- Skin preparation should consist of an alcohol cleanse of the skin for each lead position, unless patient has allergy to ETOH. This is followed by a light abrasion to the site with a 2x2 or 4x4 gauze.
- Remove non-mechanical watches.
- Assess patient for the presence of electrical implants such as nerve stimulators.

18.6.12.4 Room standards

Electrical

- Ensure the proper power cables are used with all equipment. Refer to the manufacturer’s specifications.
- Dedicated electrical circuit for the room (preferred).

- Universal earth (common) grounds for all equipment to which the patient is attached (amplifier, RF generator, flow pumps, PDM Base Station Plus or PDM Slim Connect, 3D mapping systems, warmers, etc.).
- Unplug any electrical device within the room that does not have a grounding post in its plug (DC chargers, electric shavers, etc.).

Power cable maintenance

- Avoid power strips.
- Remove unused power cables.
- Reduce cables to only those essential to case performance.
- Avoid binding electrical cables in circles. This creates a magnetic field that will cause interference.
- Always use the shortest electrical cable needed.

Lighting

- Use LED lighting for the room (preferred).
- Avoid fluorescent lighting due to EMI (electromagnetic interference) from ballasts.

Flooring

- Use non-conductive flooring.
- Use no wax flooring and remove wax if present. If the removal of the floor wax is not possible, use anti-static floor mats in the areas around the procedure table. This prevents the build-up of static charge, which can be coupled to the patient causing noise.
- Avoid plastic style shoes for the staff to avoid static.
- Electrical routing – have dual passage ways for the video and electrical cabling.

Amplifier

- Raise the amplifier from the floor to avoid housekeeping accidents.
- Locate the amplifier more than 4 feet away from any RF generator or isolation transformer to avoid the generated EMI or magnetic field.

Environmental Conditions

The Mac-Lab/CardioLab system operating conditions should be within the following range:

- Ambient temperature range of + 15 °C to + 30 °C
- Relative humidity range of 30% to 70%
- Atmospheric pressure range of 70 kPa to 106 kPa

18.6.13 Clear studies stuck in the system catalog on networked acquisition systems

Studies in the system catalog automatically move to the INW server after 10 minutes if they contain signal data and after eight hours if they do not. If the study fails to move to the INW server after this time frame, the study is marked and the server does not attempt to move it again until the mark is cleared. Both **Continue Study** and **Create Backup** fail on marked studies.

This procedure clears the mark on the study so the INW server can attempt to move the study again and **Continue Study** and **Create Backup** work for that study.

1. Select the study to review by highlighting the patient's name in the *Navigator* window.
2. Click the **Review Study** icon or select **Study** > **Review**.

   The selected study opens for review.
3. Close the study.

Once the study is closed, the mark on the study is removed. **Continue Study** and **Create Backup** should work immediately. If no further action is taken on the study, it moves to the INW server after 10 minutes or eight hours, depending on the presence of signal data in the study.

If studies remain in the system catalog for several days after clearing the marks as described above, contact GE HealthCare technical support.

18.6.14 Data export failures

If you initiate a data export command and a failure occurs either creating or sending the HL7 file and attachments, then the system displays a notification. The data export `audit.log` file also records information about the specific failure that occurred. You may be able to resolve this error if you retry the export operation.

- In a networked environment, retry the export operation when the network is in a working state.
- If the system is configured to export data on study close, open the study in review mode and then close it to initiate a data export operation and send the HL7 file and attachments to the configured destinations.
- You can also initiate a data export operation from within a study. Open the study in review mode and select **Study** > **Export Data**.

If consistent data export failures persist, contact GE HealthCare technical support.

18.6.15 Missing desktop icons (tablet mode)

Windows 10 can run on devices that function as both a laptop computer and a tablet. For example, if you have a laptop with a detachable keyboard, Windows 10 can run in the standard configuration when the keyboard is attached and automatically switch to tablet mode when the keyboard is disconnected. You may also manually configure your computer to run in tablet mode.

Tablet mode is intended for use on devices with a touchscreen display. In this mode, Windows adjusts the user interface to optimize for a tablet display, which includes:

- Hide the desktop and all icons
- Spread out content like the **Start** menu to simplify touchscreen access
- Show only one application at a time

The Mac-Lab/CardioLab application was not designed for use on tablet computers. All instructions provided in this manual assume that the Mac-Lab/CardioLab application is running in the standard configuration.

If the Mac-Lab/CardioLab is accidentally configured to run in tablet mode, do the following to switch the system back to the standard configuration:

1. On the Windows taskbar, select the **Action Center** icon on the far right.
2. In the *ACTION CENTER* window, select the **Tablet mode** button at the bottom.

18.6.16 Force restart the app

1. Power on and login to the system.
2. Start the Mac-Lab/CardioLab application.
3. Continue the study that was in progress.
4. Zero the pressures.
5. Zero the CO2.
6. Zero the IBP.
7. The NIBP starts automatically.

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