

Performance Verification and Maintenance

Introduction

This chapter describes how you verify the cardiograph's performance, explains preventive maintenance, presents patient safety information, and provides a performance verification checklist.

Performance Verification

Three procedures make up performance verification: visual inspection of the cardiograph exterior, execution of Extended Self-test, and visual examination of an ECG recorded from an ECG patient simulator.

The performance verification checklist at the end of this chapter summarizes the steps you should follow to verify the cardiograph's performance. These are some suggested uses for this checklist:

- Make copies of the blank checklist, then fill out a copy each time the cardiograph is tested.
- Attach the printer test output, simulator ECG trace, and error log printout to the completed checklist and file with the cardiograph's permanent maintenance record.

Visual Inspection

Before beginning the inspection, press the **On-Standby** key to put the cardiograph in Standby, and unplug the power cord from the wall outlet. Then inspect the cardiograph for the following:

- Worn or damaged power cord
- Loose or missing hardware
- Mechanical damage
- Evidence of liquid spill
- Worn printer drive gear
- Worn printer roller
- Corroded or damaged electrodes
- Worn or damaged patient module cable
- Dirt on the thermal printhead

Replace any damaged or missing items, and clean the printhead and patient electrodes as necessary. Cleaning instructions are listed under "Preventive Maintenance" later in this chapter. Connect the cardiograph to AC power and turn on the AC switch. Observe that the AC indicator comes on. Turn the cardiograph On and observe that one or more of the battery indicators light.

Extended Self-test

The cardiograph's Extended Self-test, loaded as part of the system software, tests each major subassembly. The display tests and the printer test require visual verification of displayed or printed output.

In most cases, a test failure halts the test and a message indicating the failure appears on the keyboard display. In the case of the tests that require visual verification, visible failure symptoms appear in the printed or displayed test pattern. See Chapter 6, "Troubleshooting," for a list of self-test failure messages and failure symptoms.

To begin the Extended Self-test, press **On-Standby** to turn on the cardiograph, then quickly press and release the **Alt** and **X** keys simultaneously. The following display will appear:

```
Test: All
Select   Test       Next   Previous  ErrorLog
```

The upper line displays the test choice, while the lower line displays the softkey labels. With the softkeys you step through the test menu, select tests, and initiate testing.

Select	Selects the test displayed in the message line. Asterisks (*) appear around the test name to indicate its selection. If the test is already selected, pressing this key de-selects the test (the asterisks disappear). You can select one or more tests in any combination, but the sequence is fixed.
Test	Begins running the selected test(s).
Next	Steps forward through the test menu.
Previous	Steps backward through the test menu.
ErrorLog	Prints out the stored error log.

To stop or exit Extended Self-test, you must press **On-Standby** to place the cardiograph in **Standby**.

These are the tests available in Extended Self-test:

- Patient module and cable
- CPU assembly
- Printer
- Disk drive (M1700A and M1701A only)
- Preview display (M1700A only)
- Keyboard display
- Modem and cable (M1700A only)
- All

Each test in this list is described in more detail in the discussions that follow.

To begin running the tests you press **Test** . The test or tests that you selected then run continuously until you stop the Extended Self-test. After each successful pass through the tests, the number in the message **Selected tests passed nnnn times** . increases by one. To stop the Extended Self-test, you must place the cardiograph in **Standby**.

Patient Module and Cable Test

This test looks for failures in the patient module and patient data cable, and generates a test pattern in the patient module display.

If the patient module fails the test, the message **Patient module test failed** . appears on the keyboard display. If the cable fails the test, the message **Patient module cable test failed** . appears.

Note



The patient module test does not test the patient electrodes or leadwires. Test the patient electrodes and leadwires by recording an ECG from a patient or ECG simulator as described later in this section.

Note



The M1702A patient module does not have a display.

The test patterns displayed on the patient module consist of (in this order):

- all white cells
- checkerboard cells
- all black cells
- inverse checkerboard cells
- 80 characters (displayed in 5 successive groups of 16)
- all white cells

You must observe the patient module display while the test pattern is running to ensure:

- accurate rendition of all patterns and characters
- no random lines or dots are displayed

Before and after the tests, asterisks appear in the display.

CPU Assembly Test

This test looks for failures in the following CPU assembly subsystems:

- Real-time Clock
- Printer Controller
- Read-Only Memory (ROM)
- Random Access Memory (RAM)
- Digital Signal Processor (DSP)
- DSP RAM

If the CPU assembly fails the test, the message `CPU assembly test failed.` appears on the keyboard display.

Note



The printer door must be closed to properly test the CPU assembly.

Printer Test

The printer test exercises the printhead and paper drive mechanism by printing a test pattern on the page four times, once for each printer speed. The pattern consists of a rectangular box that contains the entire character font, a column of numbers, and a black & white pattern. While the test patterns are printing, the message `Printing test pattern ...` appears in the keyboard display.

When the printout is complete, inspect it for:

- straight diagonal lines
- consistent print quality for all four patterns
- constant width for all four patterns
- visible separation between the close parallel lines
- accurate rendition of all characters
- clean black bars with no dropout in black areas
- perforation aligned with tear bar

If the printer assembly fails the test (not including the visual verification of the printout), the message `Printer test failed.` appears on the keyboard display.

Disk Drive Test (M1700A and M1701A only)

Caution



This test destroys any data previously recorded on the disk. Be sure that any data on the disk is expendable, or use a blank disk.

The disk drive test formats, writes to, and reads from a disk installed in the drive. When you select the disk drive test, the following display appears requesting confirmation of the selection:

Disk test destroys disk data. Select?	
Yes	No

- Yes Allows the test to be selected.
No Prevents the test from being selected.

Suggestion



Clearly label and set aside a test disk to help avoid the possibility of accidentally destroying valuable data.

If the disk drive fails the test, the message `Disk drive test failed.` appears on the keyboard display.

Note

The disk drive test will fail if the disk is write protected, or if the test is started when there is no disk in the drive.

Preview Display Test (M1700A Only)

The preview display test checks the preview logic board by writing data to and reading data from the board. This test also displays test patterns on the preview screen. Each of the following patterns appears on the screen for several seconds and in this order:

- checkerboard pattern
- inverse checkerboard pattern
- all black screen
- vertical white bar moving left to right
- horizontal white bar moving top to bottom
- all white screen
- horizontal black bar moving bottom to top
- vertical black bar moving right to left
- all black screen
- text characters in a white box on the black screen

The message `Displaying test pattern ...` appears on the keyboard display during the time the test pattern is on the preview screen.

You must observe the preview screen while the test pattern is running to ensure:

- accurate rendition of all characters and patterns
- no random lines or dots in the display
- no permanent patterns visible at normal contrast. Patterns may be visible at low contrast (darker screen); this is normal.
- no LCD flickering

If the preview display fails the test or if the test is run when a preview display is not installed on the M1700A, the message `Preview test failed.` appears on the keyboard display.

Note

If the M1700A is not equipped with a preview display, selecting the preview display test results in a test failure. If you have selected the "All" test choice, remove the preview display test from the selected tests to avoid an erroneous test failure.

Keyboard Display Test

The keyboard display test exercises each cell in the LCD by displaying the following patterns:

- checkerboard cells
- all black cells
- inverse checkerboard cells
- all white cells
- text characters

You must observe the keyboard display while the test pattern is running to ensure:

- accurate rendition of all characters and patterns
- no random lines or dots in the display
- no permanent patterns visible at normal contrast. Patterns may be visible at low contrast (darker screen); this is normal.
- no LCD flickering

This test relies on the visual inspection of the test patterns for detecting failures. There is no failure message for the keyboard display test.

Modem Test (M1700A Only)

The modem test checks the operation of the Hayes® modem and its connecting cable.

Note



The cardiograph must be connected to AC power to operate the Hayes® modem.

If the modem passes the test, the message **Modem firmware checksum: xxx.** appears. If the modem fails the test, or if the test is run when a modem is not installed on the M1700A, the message **Modem test failed.** appears on the keyboard display.

Note



If the M1700A is not equipped with a modem, selecting the modem test results in a test failure. If you have selected the “All” test choice, remove the modem test from the selected tests to avoid an erroneous test failure.

All Tests

The “All” test choice allows you to select all the tests with one keystroke. Then when you press **Test**, Extended Self-test continuously runs all of the individual tests in sequence. At the end of each successful pass through the test sequence, the number in the message **Selected tests passed nnnn times** is increased by one. If one of the selected tests fails, testing stops and the failure message for the failed test is displayed until the cardiograph is placed in **Standby** or shuts off due to a low battery.

Before you press **Test** to start the “All” selection, delete any tests that would cause a false failure indication. The tests that fall into this category are:

- the disk drive test (M1700A and M1701A only)—delete if you do not have a disk suitable for testing. Testing the disk drive with a write protected disk or without a disk installed will cause the test to fail.
- the preview display test (M1700A only)—delete if the M1700A does not have a preview display installed. The test will fail if a preview display is not installed.
- the modem test (M1700A only)—delete if the M1700A does not have a modem installed. The test will fail if a modem is not installed.

If you want to delete one or more of these tests after selecting “All,” you can move through the list and press **Select** to remove any test from those selected. When you delete a test, the asterisks disappear from around the test name in the display.

Printing the Error Log

As errors occur, they are stored in memory in the error log. Pressing the **ErrorLog** softkey prints the stored error log. While the error log is printing, the message **Printing error log ...** appears on the keyboard display. When the printout is complete, you can select another test from the Extended Self-test menu.

To understand the error printout, refer to the error lists in Chapter 6, “Troubleshooting.” Store the error log printout with the cardiograph’s permanent maintenance record.

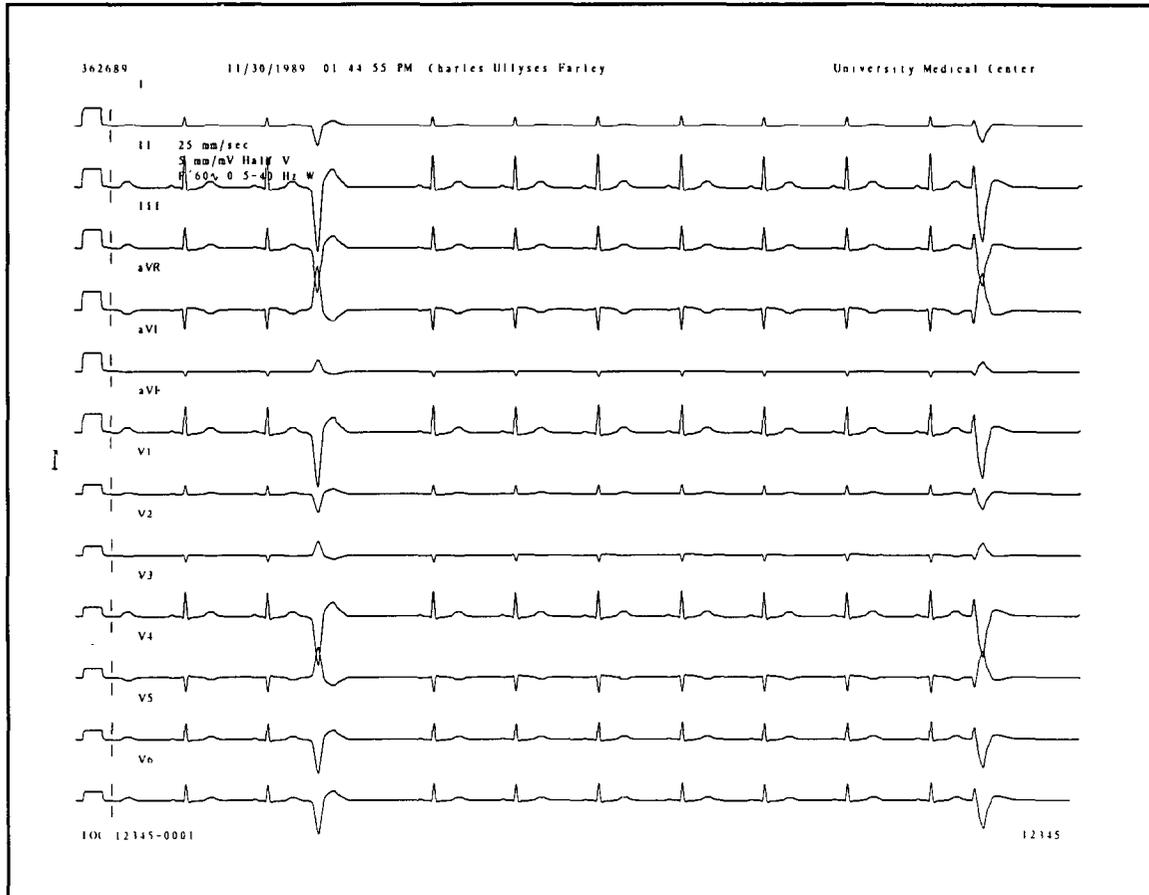


Figure 4-1. 12-Lead ECG from ECG Simulator.

ECG Simulation Taking an ECG using a 12-lead ECG simulator allows you to verify areas of operation that Extended Self-test cannot test:

- the integrity of the patient module leadwires
- the accuracy of the paper speed
- the accuracy of the gain settings

The recorded ECG trace should look similar to the one shown in Figure 4-1, although there will probably be differences in the trace you record. The trace differences result from differences in simulators, simulator settings, and, more importantly, from differences in configuration and control settings on the cardiograph. To make a recording similar to the one in Figure 4-1:

1. Connect the patient module leadwires to the simulator. Check the display on the patient module to verify that all leadwires are connected and signal quality is adequate. Gently pull each leadwire taut and look for excessive noise on the patient module display.
2. On an M1700A with preview display, check that all twelve leads are displayed. The leads will be displayed in groups of three.

3. Select a Manual format on the front panel display (preferably 12 lead).
4. Press **Manual** on the cardiograph front panel (or press \diamond on the patient module) to start the recording.

When the recording is complete:

- Verify trace activity for all 12 leads. This assures integrity of all patient electrodes and leadwires. Noise should measure less than 1 mm, and there should be no baseline wander.
- Verify no gross distortion of complexes or calibration pulses (no overshoot, etc.).
- Verify that calibration pulses are of proper duration. This assures the correct paper speed. With the cardiograph set to record at 25 mm/sec, the calibration pulse should measure 5 mm (calibration pulse duration is 200 ms).
- Verify that calibration pulse amplitude is correct. This assures the correct gain. With the cardiograph gain set at 10 mm/mV, the calibration pulse should measure 10 mm (calibration pulse amplitude is 1 mV).

Note



An arrhythmia simulator is not an acceptable tool for verifying computerized ECG analysis. The analysis software is biased to process human ECG data.

Note



SAECG verification should not be required in addition to standard ECG simulation. However, you can use an ECG simulator to determine that the SAECG is functional. All leadwires should be connected to the simulator (though you do not need to connect specific leadwires to specific outputs). See Appendix B for more information.

**Preventive
Maintenance**

Routine maintenance for the cardiograph consists mainly of cleaning and inspection.

Caution



The cardiograph does not require any kind of lubrication. Lubricating any part of the cardiograph could damage it or diminish its performance.

Care and Cleaning

The cardiograph and its accessories are chemically resistant to common cleaning solutions and non-caustic detergents. The following are some approved cleaning solutions for all of the outside surfaces of the cardiograph, the patient module, and the cart.

- Mild soap and water
- Chlorine Bleach (30ml/l water)
- 90% Isopropyl Alcohol

If the keyboard requires cleaning, you can remove it from the cardiograph and immerse it in lukewarm water.

Cleaning the Cardiograph and Patient Module

1. Unplug the power cord and ensure that the cardiograph is set to **Standby** at the front panel.
2. Wipe the external surfaces of the cardiograph, the patient module, and reusable electrodes with a soft cloth dampened in any of the approved cleaning solutions listed above. Avoid the leadwire inputs and cable connections.

Caution



Do not use any strong solvents or abrasive cleaning materials.

Do not spill any liquids on the surface of the cardiograph.

Do not immerse the patient module.

Do not use any of the following to clean the cardiograph:

- Ammonia-based cleaners
 - Acetone
 - Iodine-based cleaners
 - Phenol-based cleaners
 - Ethylene oxide sterilization (ETO)
 - Autoclave
-

Cleaning the Keyboard

1. Carefully insert a small flat-bladed screwdriver into the notches at the top or bottom edge of the keyboard and pry the keyboard up.
2. Rinse off the keyboard and thoroughly dry it.
3. Snap it back into the cardiograph.

Caution



Do not wash the keyboard in hot water. **Do not** attempt to clean the keyboard in a dishwasher.

Cleaning the Printhead and Paper Sensor

If you use Hewlett-Packard recording paper, you should not have to clean the printhead for the life of the product. Should you decide to do so, this is the procedure to follow. These are the materials required:

- Foam swabs—Hewlett-Packard part number 9310-0468 or 9300-0767
- 90% Isopropyl Alcohol—Hewlett-Packard part number 8500-0559 or equivalent
- Dry, lint-free tissue—Kimwipes® or Hewlett-Packard lint-free wipes (Hewlett-Packard part number 92193W)

To clean the printhead:

1. From the front of the cardiograph, unlatch and open the paper door. The printhead is to the right under the paper blade, behind the ESD brush (see Figure 4-2).
2. Scrub the printhead with a foam swab moistened with isopropyl alcohol.
3. Dry the printhead with a lint-free tissue.

To clean the paper sensor lens:

1. From the front of the cardiograph, unlatch and open the paper door. The paper sensor lens is to the right under the printhead (see Figure 4-2).
2. Lightly wipe the paper dust off of the paper sensor lens with a dry foam swab.

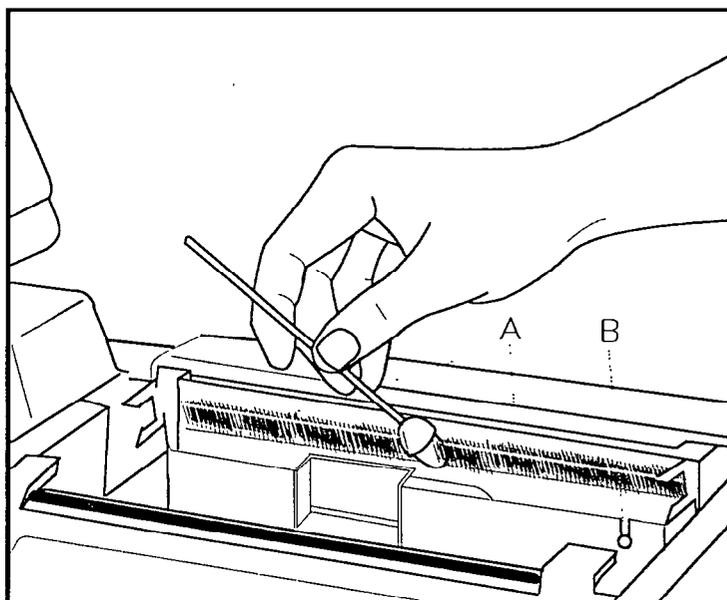


Figure 4-2. Cleaning the Digital Array Printhead.

- A. Printhead
- B. Paper Sensor

Maintaining the Flexible Disk Drive

Follow these rules to keep your flexible disks and their stored files in good condition.

- **Never** manually open the silver shutter on the disk.
- **Do not** expose the disk to direct sunlight, extremes of temperature or humidity, magnetic fields, or dust.
- Place the disk in a protective cover when the disk is not inside the drive.
- Store disks in a clean, dry place.
- Clean the disk drive with a wet-dry cleaning kit regularly. Wet-dry cleaning kits are available from local computer stores.
 - Clean the disk drive every six months unless the working environment is particularly dusty or dirty. Clean the drive more often in dusty or dirty environments.
 - TraceMaster ECG Management System users:
 - If you transfer ECGs to the TraceMaster System by disk, clean the TraceMaster drive every six months unless the working environment is particularly dusty or dirty. Clean the drive more often in dusty or dirty environments.
- Replace disks regularly. The recommended replacement interval is every three months. If the disks are used for more than 50 ECGs per day, replace the disks more frequently.
- For best results, use only Hewlett-Packard recommended disks. (HP part number M1700-89004)
- For more information, contact your Hewlett-Packard service representative.

Cleaning the Electrodes, Leadwires, and Patient Data Cable

Clean the electrodes, leadwires, and patient data cable with a soft cloth moistened with soapy water. You also can use a disinfectant or cleaning agent such as Cetylcide[®], Cidex[®], Lysol[®], Wescodyne[®], or Ves-phene[®]. Wring any excess moisture from the cloth before cleaning.

Caution



-
- Do not autoclave cable or use ultrasonic cleaners.
 - The leadwires and patient module cable are not immersible.
 - Do not use abrasive materials to clean metal surfaces—scratches on electrodes cause artifacts.
-

Safety Tests

The safety tests listed below are performed at the time of manufacture to assure compliance with these standards: IEC 601-1, IEC 62D (CO)17, UL 544, and CSA 22.2 No. 125.

- Chassis-to-ground resistance
- Ground wire leakage current
- Enclosure leakage current
- Patient lead leakage current (source leakage) to ground
- Leakage current between patient leads
- Patient lead leakage current (sink current) with line voltage applied

Perform these tests as part of your preventive maintenance program, and after any corrective maintenance to assure compliance with the named standards.

To perform these tests, use a safety tester or analyzer designed specifically for this purpose. Follow the manufacturer's operating instructions.

PageWriter XL Performance Verification Checklist

Model number _____
Serial number _____
Test date _____
Test technician _____

Visual Inspection

Disconnect the cardiograph from AC power and inspect for the following:

- Loose or missing hardware
- Frayed or damaged wiring
- Mechanical damage
- Evidence of liquid spill
- Printer drive gear wear
- Printer roller wear
- Wear or damage to power cord and associated strain relief
- Corroded or damaged electrodes
- Damaged leadwires or patient module cable
- Dirt on the thermal printhead

Connect the cardiograph to AC power and turn on the AC switch. Verify the following:

- The AC indicator is lit.
- One or more green battery indicators are lit when **On-Standby** is pressed to turn on the cardiograph.

Extended Self-test

Run Extended Self-test, select "All" menu choice, and verify that each test passes with no errors.

- Patient module and cable
- CPU assembly
- Printer
- Disk drive (writable disk must be in drive, M1700A and M1701A only)
- Preview display (M1700A only—de-select test if not installed)
- Keyboard display
- Modem (M1700A only—de-select test if not installed)

Print out the error log. Store the printout with the cardiograph's permanent maintenance record.

