

Visual Inspection

Inspect for Damage

The following steps check for obvious damage.

- Inspect the transmitter case for cracks or other damage. Do not use a transmitter that is damaged.
- Inspect the transmitter case for damage that may affect the environmental seals (such as the unit was dropped and the case seals opened as a result of the impact). Do not use a transmitter that has seals that have been compromised.
- Inspect the membrane switch for the GRAPH and VERIFY LEADS controls. If the membrane is cracked or damaged do not use the transmitter.
- Inspect the leadwire connections for corroded or bent connector pins. Do not use a transmitter with bad leadwire connectors.
- Inspect the leadwires for cracks or other damage. Replace leadwires that are cracked, damaged, or no longer flexible.
- Open battery compartment and inspect the battery contacts. Clean them if they are dirty or corroded.
- The battery compartment is not sealed and may be exposed to moisture. If there are any visible signs of moisture within the battery, return for service.
- Inspect the dust covers before each use to verify that they are securely attached.

If a transmitter or leadwires fail any of the above inspections, immediately service or replace it.

Verify Labels

NOTE

The transmitter must be running software version 2C or later to use this feature. Refer to the APEX and ApexPro Telemetry System Programming Device Service Instructions to verify transmitter software revision.

Follow these steps:

1. Verify that the TTX label is present and the data recorded on it is accurate for the transmitter. The programmed TTX number can be determined by pressing and holding both the **Verify Leads** and **Graph** control buttons when the transmitter is powered up (batteries inserted).
2. Release both buttons when the four LEDs illuminate. The RA LED flashes the same number assigned to the most significant TTX number. The second LED flashes the number assigned to the second most significant TTX number and so on with the third and the fourth LEDs. A "0" in the transmitter number displays by flashing the corresponding LED 10 times. See example.

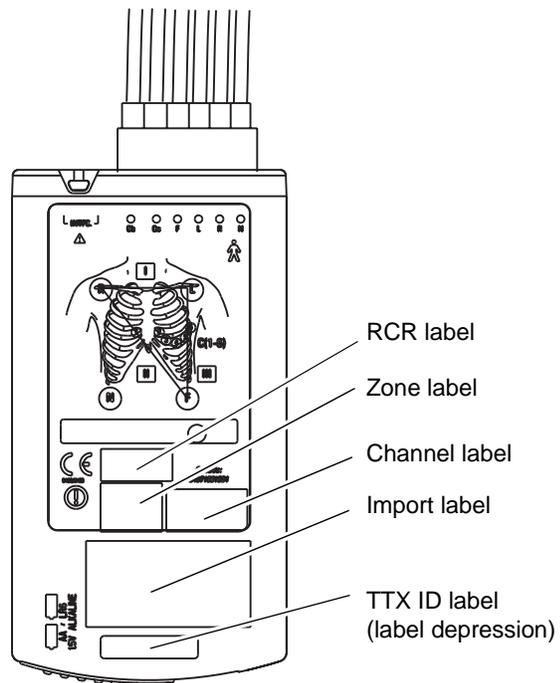
LEDs	RA O	LA O	LL O	VA O
TTX #	8	5	7	0
Transmitter Response	8-Flashes	5-Flashes	7-Flashes	10-Flashes.

NOTE

FOR JAPAN ONLY. The TTX flashed out by the transmitter is NOT the channel number. Use the charts “ApexPro (Type B devices) TTX Frequency Chart” on page 3-37 to match the TTX number with its corresponding channel number. See the programming kit instructions for more information.

CAUTION

Make sure the TTX numbers match. Failure to do so may result in the monitoring of the wrong patient.



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- Verify that the membrane switch label is securely attached to the case.

Verify Transmitter Appearance

Transmitters can have one of the following configurations. These configurations are indicated by the labels next to the interface connector ports at the top of the transmitter and by the color of the interface connector port dust covers. Use the following chart to ensure that the transmitter's appearance matches its enabled features.

Transmitter Feature Configuration	Start Up LED Sequence	Transmitter Appearance
Single Lead ECG INACTIVE interface connector ports	All LEDs, except Change Battery and RA , light on second flash.	Single Lead label. Blue interface connector port covers and label. 
Single Lead ECG ACTIVE interface connector ports	All LEDs, except RA light on second flash.	Single Lead label. Gray interface connector port covers.
Multi-Lead ECG ACTIVE interface connector ports	All LEDs light on second flash.	No labels. Gray interface connector port covers.

Cleaning

General

WARNING

Remove the battery before cleaning or disinfecting its surface.

Clean the equipment on a regular basis. (Comply with the policies of your institution's infection control unit and/or biomed department.) The exterior surfaces of the equipment may be cleaned with a dampened, lint-free cloth. Use one of the following approved solutions:

- ammonia (diluted)
- Cidex
- mild soap (diluted)
- sodium hypochlorite bleach (diluted)

NOTE

Severe corrosion may occur to any metal parts that come in contact with bleach. Do not submerge patient cable ends or leadwire ends.

To avoid damage to the equipment, follow these rules:

CAUTION

Failure to follow these rules may melt, distort, or dull the finish of the case, blur lettering on the labels, or cause equipment failures.

- Always dilute the solutions according to the manufacturer's suggestions.
- Always wipe off all the cleaning solution with a dry cloth after cleaning.
- Never use a cleaning substance containing wax.
- Never pour or spray water or any cleaning solution on the equipment.
- Never permit fluids to run behind switches, into the connectors, or into any ventilation openings in the equipment.
- Never use these cleaning agents:
 - ◆ abrasive cleaners or solvents of any kind,
 - ◆ acetone,
 - ◆ ketone,
 - ◆ alcohol-based cleaning agents, or
 - ◆ Betadine

Transmitters

These cleaning instructions apply to the ApexPro transmitter, the Apex Oximeter, the Nonin Xpod oximeter, and the Accutacker DX blood pressure monitor.

CAUTION

Do not autoclave the transmitter.

For general cleaning, wiping with mild soap and water and wiping dry is recommended.

For more intensive disinfecting or sterilization:

- Aqueous disinfectants such as glutaraldehydes (Sporicidin, etc.), 2-part sodium chloride/lactic acid mixture (i.e., Exspor and other chlorine dioxide action types), and other cold cleaning agents are acceptable. These solutions may shorten the transmitter's useful lifetime after repeated applications.
- Ethylene Oxide (ETO) is acceptable but may discolor and/or reduce the useful lifetime of the transmitter.

CAUTION

The decision to sterilize must be made per your institution's requirements with an awareness of the effect on the integrity of the transmitter.

Do not submerge the transmitters.

Leadwires

CAUTION

Do not use acetone or ketone solvents for cleaning; do not use an autoclave or steam cleaner.

For general cleaning, wipe with a lint-free cloth dampened with mild soap and water. Drying off excess cleaning solution is recommended. Leadwires should hang freely when wiping. Leadwires can be cleaned with isopropyl alcohol wipes. For more intensive disinfecting or sterilization:

- Aqueous disinfectants such as glutaraldehydes (Sporicidin, etc.), 2-part sodium chloride/lactic acid mixture (i.e., Exspor and other chlorine dioxide action types), and other cold cleaning agents are acceptable. These solutions may shorten the leadwire's useful lifetime after repeated applications.
- Ethylene Oxide (ETO) is acceptable but may discolor and/or reduce the useful lifetime of the leadwire.

CAUTION

The decision to sterilize must be made per your institution's requirements with an awareness of the effect on the integrity of the leadwire.

Do not submerge telemetry leadwires.

Transmitter and Leadwire Storage

Transmitter Holder

GE recommends storing the transmitter and leadwires in the optional transmitter holder (not pictured). This wall-mounted holder can store up to six ApexPro transmitters. The leadwires hang freely below the holder, minimizing the possibility of damage.

Storage Guidelines

If a transmitter holder is not available, follow these guidelines for storage.

Correct Storage

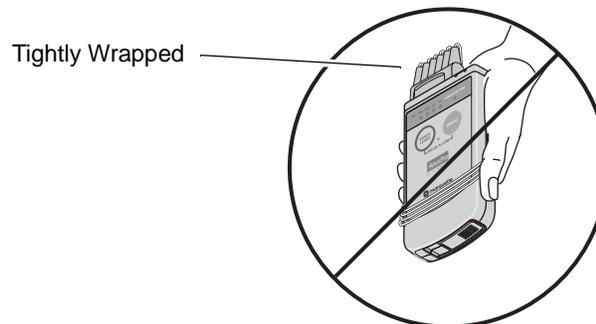
The proper way to store the transmitter is to wrap the leadwires around the transmitter, allowing the top of the leadwires to remain loose. Leadwires should NOT be stretched tightly during storage.



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Incorrect Storage

Do NOT bend or stretch leadwires tightly before wrapping around the transmitter. Improper storage will cause damage and shorten the leadwires' useful lifetime.



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Checkout Procedure

This procedure describes a series of performance tests for the ApexPro Transmitter and optional Apex Oximeter and Nonin Xpod oximeter.

Required Test Equipment

The following equipment is required.

- ECG simulator
- New alkaline “AA” batteries and low-voltage batteries
- Digital multimeter
- RF service monitor or equivalent spectrum analyzer
- SpO₂ simulator, pn 408610-001 for optional Apex Oximeter and Nonin Xpod oximeter testing
- Nonin simulator cable adapter, pn 420970-001 for optional Apex Oximeter and Nonin Xpod oximeter testing

Transmitter Operational Tests

LED Displays

This test verifies LED operation.

1. Attach the leadwires to an ECG source.
2. Install batteries into the transmitter, then wait for the powerup selftests to be completed.
3. Press the VERIFY LEADS and GRAPH buttons simultaneously. The LEAD STATUS and CHANGE BATTERY LEDs flash twice to acknowledge the switch was pressed. Then the PAUSE ALARM LED starts flashing.

Powerup Selftests

This test verifies completion of the powerup selftests.

1. Remove any batteries in the transmitter.
2. Replace the batteries in the transmitter.

The transmitter then performs the following tests:

- ◆ memory (RAM and EEPROM)
- ◆ frequency synthesizer
- ◆ displays installed options through the LED start up sequence. Please refer to “Start Up” on page 2-6 to verify the features of your transmitter.

If the selftests are successful, the transmitter begins normal operation.

RF Power Shutdown

This test verifies that the transmitter reduces its output when an all-leads-fail condition lasts more than six seconds.

1. Connect the transmitter to an ECG source.
2. Install batteries in the transmitter.
3. At a Clinical Information Center, verify that the transmitter is sending the ECG source's signals properly.
4. Remove the leadwires from the ECG source.

After six seconds a NO TELEM signal displays for the transmitter being tested (at the Clinical Information Center).

This test could also be done using the RF monitor to measure the decrease in RF output under a LEADS FAIL condition.

Change Battery LED

This test verifies that the transmitter and the Clinical Information Center indicate a low battery condition if the transmitter battery voltage drops below 1.9V.

1. Remove batteries from transmitter.
2. Install low-voltage batteries.
3. Verify that the transmitter powers up successfully and performs the self-tests.

The transmitter minimum start-up voltage is 2.3V, so when performing this test, start above 2.3V to start the transmitter. The transmitter shuts down at 1.5 voltage.

4. Verify that the CHANGE BATTERY LED starts flashing when the power supply is adjusted to 1.9V.
5. Admit the transmitter to the Clinical Information Center and verify that the *Change Battery* message appears at the CIC and the CHANGE BATTERY LED flashes on the transmitter.

RF Test

The following series of tests verify operation of the transmitter's RF circuitry.

Power Output

This test measures the power output of the transmitter. Prepare the RF monitor as shown in the following diagram.



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Reference the RF monitor operator's manual for setup information. Allow the RF monitor to operate for at least 15 minutes for temperature stabilization.

Configure the RF monitor as follows:

1. Set the center frequency to the frequency of the transmitter. Refer to the chapter 3, Installation for a TTX cross-reference list.
2. Set the span to 500KHz (50KHz/div).
3. Set the amplitude to -10dBm at 10dB/div.
4. Connect the transmitter with lead wires to a patient simulator as shown in above diagram.

NOTE

The transmitter does not radiate RF energy when in a leads fail condition.

5. Wrap the leadwires around the antenna of the RF monitor and verify that a peak signal of at least -20dBm can be obtained. It may be necessary to move the transmitter and leadwires around to obtain this peak signal.

NOTE

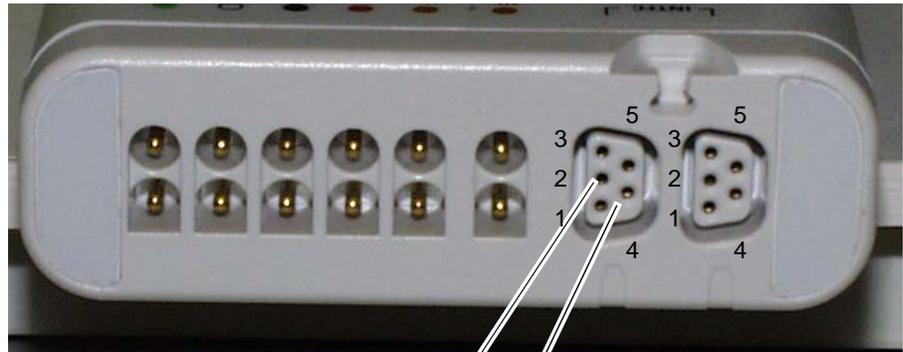
If the RF Monitor has a Max Hold function, then enable the max hold to help detect the RF peak signal strength.

Carrier Frequency Error

This test checks the carrier frequency to verify that it is within the programmed range. Refer to the RF monitor operator's manual for the setup information.

1. Use the same setting on the RF Monitor as described in step 1 above except change the span to 1KHz.
2. To measure the center frequency of the ApexPro transmitter, use the manufacturing code.
 - ◆ Short pins 2 and 4 on either one of the interface connector ports.
 - ◆ Power up the transmitter.

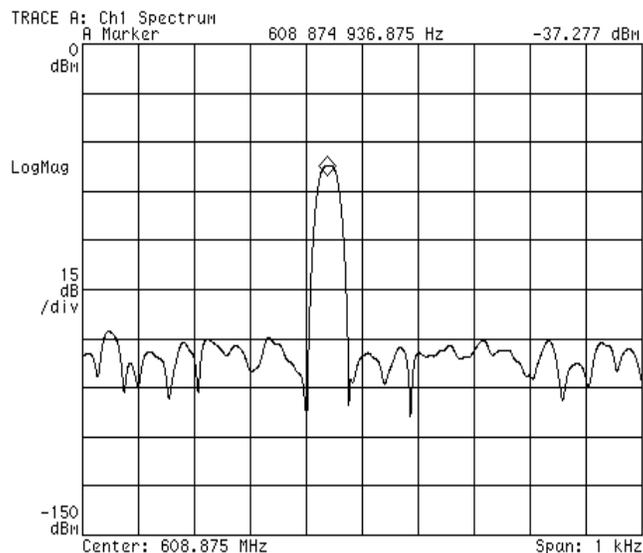
This forces the transmitter to run the manufacturing code, which outputs a test pattern that can be measured accurately for center frequency.



Pins 2 and 4

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3. Verify that the peak signal is $\pm 650\text{Hz}$ from the assigned center frequency as shown in the diagram below.



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4. If the transmitter fails either the Power Output test or the Carrier Frequency error test, then return to factory for service.

This completes the RF checkout. Remove the jumper from the interface connector port. When the jumper is removed the transmitter resets and returns to normal operation mode.

RF Signal Integrity

This test verifies the RF output of the transmitter.

1. Connect the transmitter to an ECG simulator. Position the transmitter approximately 10 to 20 feet (6 meters) from an antenna.
2. At the CIC, click *Setup CIC*.
3. Click the *Service Password* tab.
4. Type password, **mms_com** and press **Enter**.
5. Type in the command, **setflags -dup on** and press **Enter**. This allows a duplicate TTX for 5 minutes.
6. At the MS DOS prompt, type **setflags -mark ttx** and press **Enter**. This function plots many causes of dropout.

The color diagnostic tic marks at the bottom of each window indicate the reason for missing waveform data. The following table lists the colors and their indication.

Color	Indication
Yellow	Missing data from the transmitter
Dark Green	Missing data from the receiver
Magenta	Missing data from the receiver system
Orange	Missing data from the hardware manager
Light Gray	Invalid telemetry data

7. On the admitted beds, observe the simultaneous ECG waveforms for signal integrity. There should be no ECG signal breakup (dropout) on any of the waveforms.

If an ECG signal breakup is observed on more than one receiver the transmitter may require service.

Communications Tests

The following series of tests verify that the transmitter is operating properly with the receiving system and the monitoring network. A Clinical Information Center that has access to the receiver system is required.

Lead(s) Fail

This test verifies that the transmitter can test for, and indicate, good lead signals.

1. Attach the leadwires to an ECG source and to the transmitter.
2. Install batteries in the transmitter.
3. Admit the transmitter to an available receiver at the CIC. Verify that the ECG signals display at the CIC.

NOTE

It takes approximately 10 seconds for the transmitter to display waveforms for a 3-lead cable.

4. Press the **Verify Leads** button. The **Lead Status** and **Change Battery** LEDs flash twice to acknowledge that the button was pressed. The lead status displays for approximately 1 minute. Lead status LEDs for good leads remain illuminated for the time period.
5. Verify, both at the CIC and on the transmitter, Lead Status each time with a different lead wire removed from the ECG source. The LED associated with the disconnected leadwire should not remain illuminated and the associated lead should show lead fail at the CIC.

NOTE

In 3-lead mode, the reference lead is always displayed as “Good” during the “verify leads” test.

NOTE

If a multi-lead cable is used on a “single-lead only” transmitter, the LEDs for connected V leads flash once per second during the “verify leads” period.

Verify Graph Request

This test verifies that pressing the **Graph** button results in a graph run at the assigned printer device.

1. Configure the Clinical Information Center so that graph requests (from the transmitter) are printed at the Clinical Information Center.
2. Press the **Graph** button. The Lead Status and **Change Battery** LEDs flash twice to acknowledge that the switch was pressed.
3. Verify that a graph run occurs at the printer.

Pause Alarm

This test verifies that the transmitter enters into the PAUSE ALARMS condition for approximately five minutes.

1. With the transmitter operating, press the **Graph** and **Verify Leads** buttons simultaneously. The LEAD STATUS and **Change Battery** LEDs flash twice to acknowledge the switch was pressed.
2. Once the transmitter enters the PAUSE ALARMS condition the **Pause Alarm** LED begins flashing, and flashes for the programmed period. (Typically five minutes but this value can be changed by reprogramming the transmitter.)
3. At the end of the period the **Pause Alarm** LED stops flashing.
4. Terminate the PAUSE ALARMS condition by pressing the **Verify Leads** and **Graph** buttons simultaneously. The **Pause Alarm** LED stops flashing.

Pacemaker Transmission

This test verifies detection of a pace pulse and transmission to the Clinical Information Center display.

1. Connect an ECG simulator to the transmitter.
2. With the transmitter operating and ECG waveforms from the transmitter displaying on the Clinical Information Center, trigger a pace pulse at the ECG simulator.
3. Verify a pace mark on the Clinical Information Center. (Ensure that the PACE function is enabled on the Clinical Information Center.)

ECG Waveform Transmission

This test measures the gain through the transmitter/receiver system.

1. Connect the ECG simulator to the transmitter.
2. Verify that ECG signals from the transmitter display at the Clinical Information Center.
3. Verify the ECG gain at the Clinical Information Center is set to 1X.
4. Trigger a Graph run at the transmitter.
5. Measure the graph output. Signal level should be 1 cm (two large boxes on graph strip) for a 1 mV input.

Completion

If the transmitter fails any of the above tests, return it to GE for repair.