GE Healthcare

ApexPro™ Antenna Infrastructure, Transmitter, and Receiver

Technical Manual

ApexPro™
English
2028341-019 (cd)
2028340-042A (paper)

NOTE

Due to continuing product innovation, specifications in this manual are subject to change without notice.

NOTE

The information in this manual only applies to ApexPro software version 3A and later, ApexPro CH software version 1A and later, and the ApexPro, ApexPro CH, and CARESCAPE telemetry T14 transmitters hardware. It does not apply to earlier software versions. Due to continuing product innovation, specifications in this manual are subject to change without notice.

NOTE

For technical documentation purposes, the abbreviation GE is used for the legal entity name, GE Medical Systems *Information Technologies*.

Contents

1 Introduction

Manual Information

Revision history

Each page of this manual has the document part number and revision letter at the bottom of the page. The revision letter identifies the document's update level. The revision history of this document is summarized below.

Revision	Comment
A	Initial release

Purpose

This manual provides technical information for maintaining the ApexPro, ApexPro CH and CARESCAPE T14 transmitters, ApexPro receiver subsystem, ApexPro antenna infrastructure equipment and GE equipment that connects to the transmitter.

Intended audience

Users of this manual are expected to have a background in electronics, including analog and digital circuitry, RF, and microprocessor architectures. It is intended for service representatives and technical personnel who maintain, troubleshoot or repair this equipment.

Ordering manuals

A paper copy of this manual will be provided upon request. Contact your local GE representative and request the part number on the first page of the manual.

Conventions

Style	Definition
bold	Indicates hardware items such as keys, labels, or text entered by the user.
bold italic	Indicates software terms such as menu items or screen text.
+	Indicates keyboard keys to select simultaneously.
>	Indicates menu options to select consecutively.

Safety information

Intended use

The ApexPro Telemetry System is intended for use under the direct supervision of a licensed healthcare practitioner. The system is designed to acquire and monitor physiological data for ambulating adult and pediatric patients within a defined coverage area. The system processes this physiological data to detect various ECG arrhythmia events and select physiological parameter limit violations.

The ApexPro Telemetry System is intended to be installed in the hospital or clinical environment in order to provide clinicians with patient physiological data, while allowing for patient mobility. These systems are typically deployed in sub acute care areas in hospitals or clinical sites where patient mobility can enhance the effectiveness of the medical procedures administered.

The physiological parameters monitored include ECG, non-invasive blood pressure, non-invasive temperature and SpO2. The ApexPro Telemetry System is intended to provide ECG data via Ethernet to the computer platform for processing. The ApexPro is also intended to provide physiologic data over the Unity network to clinical information systems for display.

Responsibility of the manufacturer

GE is responsible for the effects of safety, reliability, and performance only if:

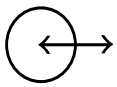
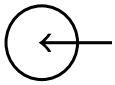
- assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE;
- the electrical installation of the relevant room complies with the requirements of the appropriate regulations; and
- the device is used in accordance with the instructions for use.

Equipment symbols

NOTE

Some symbols may not appear on all equipment.

	ATTENTION: Consult accompanying documents.
	Non-ionizing electromagnetic radiation: To indicate elevated, potentially dangerous, levels of non-ionizing radiation. Note - In case of application in a warning sign the rules according to ISO 3864-1 shall be adhered to. IEC 60878 note: See safety sign ISO 7010 - W005 “Warning, non-ionizing radiation”.

	Type CF applied part: Isolated (floating) applied part suitable for intentional external and internal application to the patient including direct cardiac application. “Paddles” outside the box indicate the applied part is defibrillator proof. [Medical Standard Definition:] F-type applied part (floating/isolated) complying with the specified requirements of IEC 60601-1/UL 60601-1/CSA 601.1 Medical Standards to provide a higher degree of protection against electric shock than that provided by type BF applied parts. **NOTE** The rating of protection against electric shock (indicated by symbol for CF) is achieved only when used with patient applied parts recommended by GE.
	TYPE B APPLIED PART: Non-isolated applied part suitable for intentional external and internal application to the patient excluding direct cardiac application. [Medical Standard Definition:] Applied part complying with the specified requirements of IEC 60601-1/UL 60601-1/CSA 601.1 Medical Standards to provide protection against electric shock, particularly regarding allowable leakage current.
	R&TTE equipment class 2 identifier: An alert sign, indicating that transmitting radio equipment operates in non-harmonized frequency bands and can cause interference.
	Equipotential
	DC In/RF Out or DC Out/RF In
	DC In or RF In
	For indoor use only.
	Power supply cable configuration. + = Power – = Return
 4P41	Medical Equipment With respect to electric shock, fire and mechanical hazards only in accordance with UL 60601-1, and CAN/CSA C22.2 NO. 601.1 and if applicable, IEC 60601-2-27, IEC 60601-2-30, and IEC 60601-2-49.
	CE mark CE-0459 indicating conformity with the provisions of the Council Directive 93/42/EEC concerning medical devices, and fulfills the essential requirements of Annex I of this directive.
	Interface Connector(s)

IPX3	Complies with IPX3 standards for water ingress
IPX7	Complies with IPX7 standards for water ingress
	This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.
 2005-08	This symbol indicates the date of manufacture of this device. The first 4 digits identify the year and the last 2 digits identify the month.
	Manufacturer name and address.
	European authorized representative.

Safety statements

Dangers

Danger statements identify an imminent hazard which, if not avoided, will result in death or serious injury. No danger statements apply to this product.

Warnings

Warning statements identify a potential hazard or unsafe practice which, if not avoided, could result in death or serious injury. The following warnings apply to this product.

WARNING
BEFORE USE —Periodically, and whenever the integrity of the device is in doubt, test all functions.

WARNING
EXPLOSION HAZARD —Do not use this equipment in the presence of flammable anesthetics, vapors or liquids.

WARNING
FALSE CALLS—False low heart rate indicators or false asystole calls may result with certain pacemakers because of electrical overshoot.

WARNING
INTERFACING WITH OTHER EQUIPMENT —Contact GE for information before connecting any devices to the equipment that are not recommended in this manual.

WARNING
LOSS OF DATA — Notify the affected users relying upon this data flow before shutting down the ApexPro™ antenna infrastructure components for any reason.

WARNING
MONITORING PACEMAKER PATIENTS —Monitoring of pacemaker patients can only occur with the pace program activated.

WARNING
PACEMAKER SPIKE —An artificial pacemaker spike is displayed in place of the actual pacemaker spike. All pacemaker spikes appear uniform. Do not diagnostically interpret pacemaker spike size and shape.

WARNING
PATIENT HAZARD —A pacemaker pulse can be counted as a QRS during asystole in either pace mode. Keep pacemaker patients under close observation.

WARNING
RATE METERS—Keep pacemaker patients under close observation. Rate meters may continue to count the pacemaker rate during cardiac arrest and some arrhythmias. Therefore, do not rely entirely on rate meter alarms.

Cautions

Caution statements identify a potential hazard or unsafe practice which, if not avoided, could result in minor personal injury or product/property damage. The following cautions apply to this product.

CAUTION
ACCESSORIES (SUPPLIES) —To ensure patient safety, use only parts and accessories manufactured or recommended by GE.

Parts and accessories used must meet the requirements of the applicable IEC 60601 series safety standards, and/or the system configuration must meet the requirements of the IEC 60601 medical electrical systems standard.

CAUTION
ACCESSORIES (EQUIPMENT) —The use of accessory equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the patient environment; and
- evidence that the safety certification of the accessory has been performed in accordance to the appropriate IEC 60601-1 and/or IEC 60601 harmonized national standard.

CAUTION
FDA POSTMARKET SAFETY ALERT—The United States FDA Center for Devices and Radiological Health issued a safety bulletin October 14, 1998. This bulletin states “that minute ventilation rate-adaptive implantable pacemakers can occasionally interact with certain cardiac monitoring and diagnostic equipment, causing the pacemakers to pace at their maximum programmed rate.”

The FDA further recommends precautions to take into consideration for patients with these types of pacemakers. These precautions include disabling the rate responsive mode and enabling an alternate pace mode. For more information contact:

Office of Surveillance and Biometrics, CDRH, FDA
1350 Piccard Drive, Mail Stop HFZ-510
Rockville, MD 20850
U.S.A.

CAUTION
POWER REQUIREMENTS —If the installation of the equipment, in the USA, uses 240V rather than 120V, the source must be a center-tapped, 240V, single-phase circuit.

CAUTION
RESTRICTED SALE —Federal law restricts this device to be sold by or on the order of a physician.

CAUTION
SUPERVISED USE —This system is intended for use under the direct supervision of a licensed health care practitioner.

Notes

Note statements provide application tips or other useful information to assure that you get the most from your equipment. The following notes apply to this product.

NOTE

ECG monitoring with patients on non-invasive transcutaneous pacemakers may not be possible due to large amounts of energy produced by these devices. Monitoring ECG with an external device may be needed.

NOTE

This device is not intended for home use.

NOTE

Patient environment is any volume in which intentional or unintentional contact can occur between patient and parts of the system or between patient and other persons touching parts of the system. (IEC 60601-1-1)

Service information

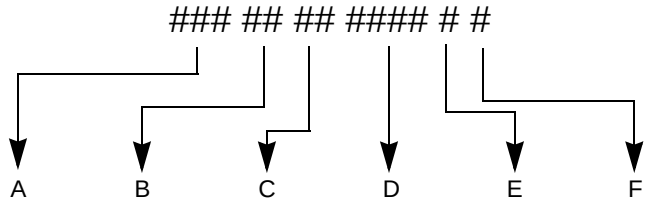
Service requirements

Follow the service requirements listed below.

- Refer equipment servicing to GE authorized service personnel only.
- Any unauthorized attempt to repair equipment under warranty voids that warranty.
- It is the user’s responsibility to report the need for service to GE or to one of their authorized agents.
- Failure on the part of the responsible individual, hospital, or institution using this equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.
- Regular maintenance, irrespective of usage, is essential to ensure that the equipment will always be functional when required.

Equipment identification

Every GE device has a unique serial number for identification. A sample of the information found on a serial number label is shown below.



	Description
A	product code[1]
B	year manufactured
C	fiscal week manufactured
D	production sequence number
E	manufacturing site
F	miscellaneous characteristic

[1]The product code is: TT for ApexPro transmitter, domestic; AM for ApexPro transmitter, international; T9 for ApexPro CH transmitter; SE3 for the CARESCAPE Telemetry T14 transmitter; RTS for US (560-614 MHz) ApexPro receiver subsystem; and RAV for international (420-474 MHz) ApexPro receiver subsystem.

2 Equipment Overview

System overview

Overview

A transmitter is directly connected to the patient and transmits monitored data via the antenna to a corresponding receiver in a one-to-one correspondence between transmitters and receivers. Up to 16 receivers (four quad receiver modules with four receivers on each) may reside in a receiver system. Up to four quad receiver modules connect to the receiver backplane PCB, which is responsible for managing communications between all connected receivers and the telemetry host application software on the PC. The communication between the PC and the receiver backplane is 10BaseT Ethernet and is called the Receiver-Exchange (RX) network. The host application software processes the patient data from the receivers and makes the patient's ECG parameter and waveform data available for display at network viewing stations or the Clinical Information Center (CIC) central station.

The ApexPro telemetry system consists of the following components:

- Patient monitoring equipment
  - Apex oximeter (optional)
  - Xpod oximeter (optional)
  - Accutracker DX noninvasive blood pressure monitor (optional)
  - DINAMAP PRO 100, 200, 300, and 400 series monitor (optional)
- Transmitter (one for each monitored patient)
  - ApexPro transmitter, or
  - ApexPro CH transmitter
- Antenna system
  - ApexPro antenna system

    Receiver antenna

    Attenuator

    Antenna splitters/combiner

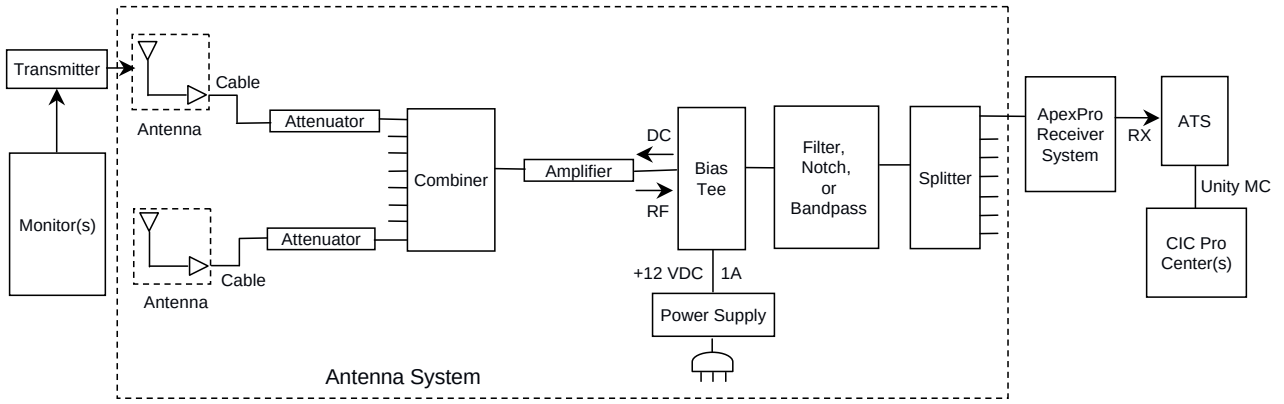
    Amplifier

    Bias tee

    Antenna filter as needed (bandpass and/or notch)

    DC power source to power the receiver antennas and antenna amplifiers
  - Enterprise Access antenna system.

    Refer to the Enterprise Access System Service Manual for more details.
- Receiver system (holds up to 4 ApexPro quad receivers)
- Unity Network
- ApexPro Telemetry Server (ATS) with ApexPro software
- PC with CIC Pro Clinical Information Center (CIC)



Power requirements

The DC power requirements for the ApexPro antenna system depend greatly on the configuration of each individual system. To ease the power requirements of the ApexPro telemetry system, the power supply for the antenna system is external to the ApexPro receiver system and separate from the antenna.

Interface with ApexPro receiver subsystem

Each receiver in the quad receiver module, located in the receiver subsystem, receives data from the transmitters. This data is processed by the receiver system and then transmitted via the dedicated Ethernet interface to a CIC Pro center for further processing and display. The quad receivers and the receiver subsystem together are known as the receiver system.

The interface between the antennas and the receiver system consists of coaxial cabling and connectors for transferring the transmitted signal. The interface uses 75-ohm cable from each antenna field and F style 75-ohm connectors as a connection medium. The preferred cable is RG-6, but for longer lengths RG-11 may be used.

Interface with multiple ApexPro receiver subsystems

To interface the antenna system with multiple ApexPro receiver systems, each antenna field in the antenna system is split into the appropriate number of tap points using combiners/splitters before connecting to each ApexPro receiver system.

Equipment

Unity Network

The Unity Network is the networking system used to transmit information from one GE product to others connected to the same Unity Network.

ApexPro antenna system

Antenna

The antenna system is used for transmission of data from the transmitter to the receiver system.

The antenna is a circularly-polarized array of sloping half-wave dipoles with an omni-directional coverage pattern. The antenna is available in two versions: active and passive. An active antenna includes an active amplifier, while a passive antenna provides no signal amplification. The receiver antenna comes with a standard drop ceiling T-bar mount.

Antenna amplifier

The antenna amplifier boosts the signal when losses from other antenna components exceed the gain of the antenna. DC power for the amplifier is obtained from the +12VDC power supply.

Coaxial cable

Coaxial cabling is used to connect the omni-directional antennas and amplifiers to the receiving equipment. Controlled-impedance cabling is used and 75-ohm, RG-6 type is recommended. Plenum- or riser-rated cable is used to meet NEC fire codes. RG-11 may be used if cable lengths become long and dB losses become excessive.

Splitters/combiner

Passive splitters/combiners split or combine the RF signal into multiple paths. The same splitter may also be used as a combiner to join multiple RF signals into one path. There are two-, four-, or eight-way splitters available that are DC-passive.

Attenuators

Attenuators lower signals and balance antenna runs. The attenuators are DC-passive and are available as 3 dB, 6 dB and 10 dB attenuators.

Power supply

A +12VDC power supply at 1A supplies power to the antenna system. Power supplies accept AC voltages between 90-270VAC. AC inputs have internal fuses that are not replaceable. The output of the supply is short circuit protected.

Bias tee

The antenna bias tee allows the injection of DC power from the antenna power supply into the antenna system cabling. The bias tee supplies RF isolation between the RF signals on the antenna cabling and the power supply. It contains a DC block that

blocks the conduction of DC power to the receiver system and associated hardware. A bias tee is used with each power supply.

Notch filter

Notch filters are frequency or TV channel specific and notch out the TV video, audio, or digital center of the band signals. Notch filters also filter pager signals or other strong RF signals that can be found in a telemetry environment.

Bandpass filter

The bandpass filter rejects frequencies outside its listed bandwidth and passes frequencies inside its listed bandwidth. It is used in place of certain notch filters to provide wide band filtering with less in-band loss than multiple notch filters.

Identify antennas

Identify the high-power and active antennas by the part number label and the GE logo only on the front (bottom). The passive antenna looks identical to the high-power antenna except it has a black cap over the LED power indicator. To visually identify the antenna type, observe the following:

- The -002, -003, -004, and -005 models have an embossed GE logo.
- The -006, -007, and -008 models have a blue GE logo.
- The -003, -005, and -006 passive antennas have a black cap over the LED power indicator.

For further identification, check the part number label.

Part number	Design frequency	Antenna type	Description	Status
2000673-002	600 MHz	ApexPro Antenna Hi-Pwr 560-614MHz	This high-power antenna operates within 560-614MHz and has filtering for out-of-band signals. It has >15dB rejection below 470MHz.	Obsolete
2000673-003	600 MHz	ApexPro Antenna Passive 560-614MHz	This passive antenna has no internal filtering or amplification, therefore requires no DC voltage. Use this antenna with notch filters, high- or low-pass filters, or a bandpass filter and an in-line amplifier. Use only when other antennas do not meet design requirements.	Obsolete
2000673-004	450 MHz	ApexPro Antenna Hi-Pwr 420-474MHz	This high-power antenna operates within 420-474MHz and has filtering for out-of-band signals. It has >15dB rejection below 320MHz.	Obsolete
2000673-005	450 MHz	ApexPro Antenna Passive 420-474MHz	This passive antenna has no internal filtering or amplification, therefore requires no DC voltage. Use this antenna with notch filters, high- or low-pass filters, or a bandpass filter and an in-line amplifier. Use only when other antennas do not meet design requirements.	Current
2000673-006	600 MHz	ApexPro Passive Antenna 560-614MHz	This passive antenna has no internal filtering or amplification, therefore requires no DC voltage. Use this antenna with notch filters, high- or low-pass filters, or bandpass filters and an in-line amplifier. Use only when the other antennas do not meet design requirements.	Current

Part number	Design frequency	Antenna type	Description	Status
2000673-007	600 MHz	ApexPro Active Antenna 608-614MHz	This active antenna operates within 608-614MHz. This antenna also has a bandpass filter element that rejects signals outside of 608-614MHz, except for signals in channels 36 and 38.	Current
2000673-008	450 MHz	ApexPro Antenna Hi-Pwr 420-474 MHz	This high-power antenna operates within 420-474MHz and has filtering for out-of-band signals. It has >15dB rejection below 320MHz.	Current

For technical specifications, see Antenna specifications on page A-13.

Enterprise Access antenna system

Refer to the Enterprise Access System Service Manual for details on the system.

ApexPro and CARESCAPE transmitters

CAUTION
UNINTENTIONAL RADIO FREQUENCY (RF) INTERFERENCE—Unintentional RF interference could degrade the reliability and performance of the wireless data link. The facility must maintain an RF environment free from unintentional interference.

The ApexPro and CARESCAPE transmitters send the patient's ECG data to the ApexPro receiver system for processing. Data is then transmitted via a dedicated Ethernet interface to the CIC Pro center for viewing. The transmitter can also send DINAMAP PRO data to the CIC Pro center via the DinaLink cable.

Additionally, the transmitter can send the patient's SpO2 and noninvasive blood pressure data when the interface connector ports are enabled and when the optional oximeter and/or Accutracker DX noninvasive blood pressure monitor are connected to it.

309C

ApexPro Transmitter

205A

ApexPro CH Transmitter

207B

CARESCAPE Telemetry T14 Transmitter

NOTE

In this manual, wherever the transmitter is shown, the ApexPro, ApexPro CH and T14 transmitter are valid, except where otherwise noted.

Transmitter battery installation

NOTE

Refer to the ApexPro Telemetry System or the CARESCAPE Telemetry T14 Transmitter Operator's Manual for further details on battery installation.

Install 2 new AA alkaline batteries in the transmitter.

1. Locate the battery cover at the bottom of the transmitter.
2. Slide the cover over to open the battery compartment.
3. Insert batteries, being careful to follow the polarity signs embossed on the lower back side of the transmitter's molded case.

220A

4. Close the battery cover.

NOTE

When the **Change Battery** LED starts flashing, the transmitter has approximately 1 hour of reserve power before the unit shuts down.

Battery functional life

CAUTION

GE recommends that you always replace both batteries at the same time. Re-using old batteries or using a combination of old and new batteries in the transmitter will compromise functionality of the transmitter and increase the risk of fire hazard.

Do not store the batteries in the transmitter when not in use. Storing the batteries in the transmitter can cause corrosion of the batteries and of the transmitter.

Be sure to insert batteries into the transmitter in the correct direction as indicated on the back of the case. Do not insert batteries in the reverse direction.

The transmitters runs on 2 AA batteries. For the ApexPro transmitter, the battery life is approximately 40 hours. For the ApexPro CH transmitter, the battery life is approximately 120 hours. For the T14 transmitter, the battery life is approximately 65 hours.

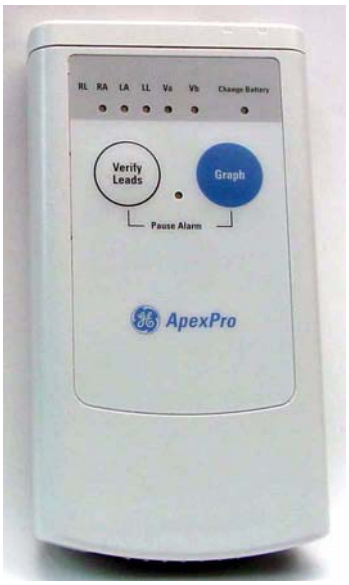
For optimum performance, follow these guidelines:

- Install 2 new alkaline batteries each time you begin monitoring a new patient or whenever the **Change Battery** LED on the transmitter is flashing.
- Do not use rechargeable batteries.
- Always change both batteries at the same time.
- Always use new batteries.

Transmitter controls, indicators and labels

Views

The transmitters have the following buttons and LEDs:



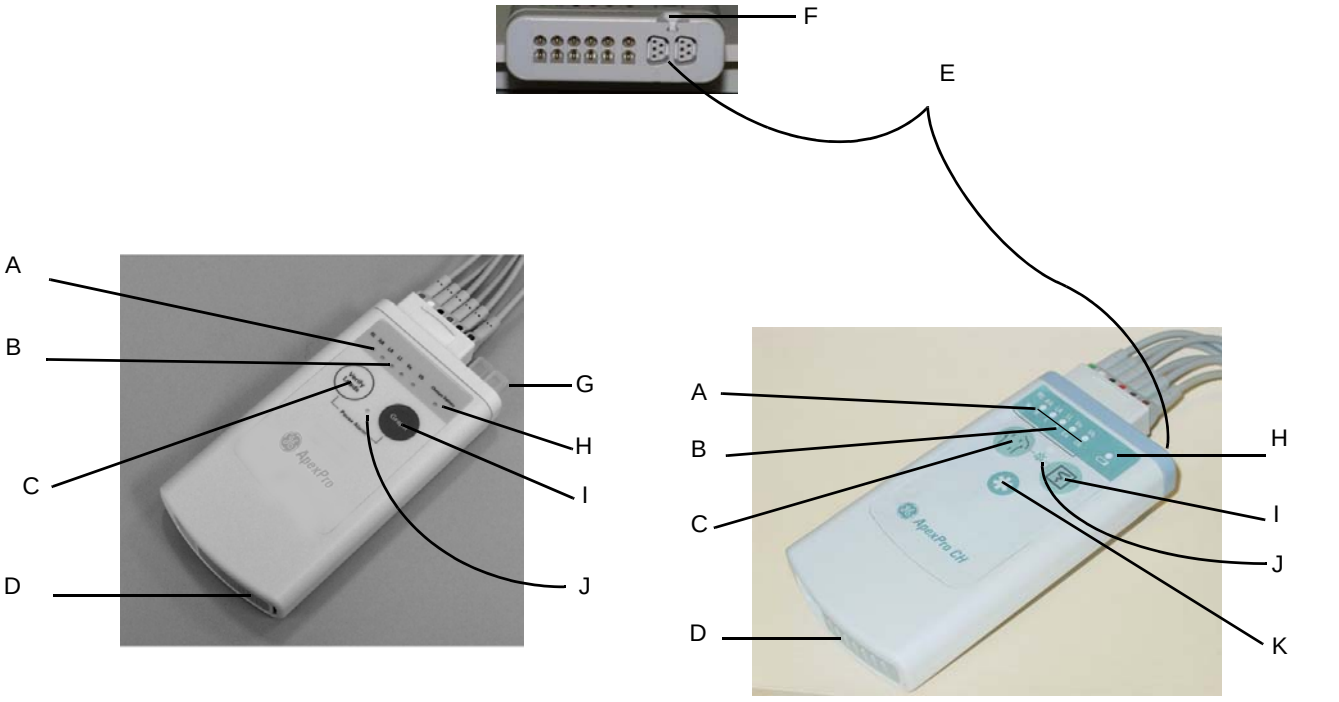
605A, 207A, 206B

ApexPro, ApexPro CH, and T14 Transmitters

ApexPro	ApexPro CH & T14	Function
RL RA LA LL Va Vb	**RL RA LA LL Va Vb** **N R L F Ca Cb**	When first powered up, the lead LEDs flash rapidly, followed by two slow flashes. The transmitter begins functioning after the two slow flashes. When any of the transmitter's buttons are pushed, the lead LEDs flash twice.
Change Battery		When the battery power is running low, the change battery LED flashes.
Verify Leads		When pressed, the lead LEDs flash twice. If a lead is valid, its LED stays lit for one minute.
Pause Alarm		When the ***Pause Alarm*** condition occurs, the pause alarm LED flashes until the condition ends.

ApexPro	ApexPro CH & T14	Function
Graph		When pressed, a 20-second graph strip is printed on the writer or printer.
(not available)		When pressed, a blue border displays around the event bed and an alarm tone sounds at the CIC Pro center. The message ***Remote Event*** displays under the ***ECG*** parameter window for approximately ten seconds.It also generates a 20-second graph and saves the event.

Controls and indicators



317A, 420B, 432A

A	**RA** LED	Used in troubleshooting (Frequent lead fail on page 5-21) and when manually viewing or programming the TTX number (Manually view/program TTX on page 3-19.)
B	Good Lead LEDs	These light when testing the verify leads function.
C	**Verify Leads** button	Checks the lead/skin preparation quality. Pressing the **Verify Leads** button enables the good lead LEDs. After pressing this button, the LEDs for good leads illuminate for 1 minute.
D	Battery compartment	Holds 2 AA alkaline batteries. The sliding cover of the compartment also functions as the on/off switch.
E	Interface connector ports	The interface connector ports (on the end of the transmitter) are used to connect the transmitter to the APEX Programming Device. The TTX number and desired reference lead are programmed using the APEX Programming Device. These interface connector ports may also be used to connect additional parameter devices to the transmitter.

F	Well for dust covers	Location for attaching the set of dust covers.
G	Dust covers	Transmitters have a set of 2 dust covers, used when the interface connectors are not being used. Markings on the covers indicate the number of the interface connector port.
H	**Change Battery** LED	The **Change Battery** LED flashes when battery power is running low and the batteries need changing.
I	**Graph** button	Initiates the printing of a graph strip. Pressing the **Graph** button initiates printing a 20-second graph strip to the writer or printer.
J	**Pause Alarm** LED	To pause the alarms for the programmed amount of time (typically 5 minutes), press the **Graph** button and the **Verify Leads** button simultaneously. The **Pause Alarm** LED flashes. "***ALARM PAUSE***" also displays in the patient's waveform window on the CIC Pro center screen. At the end of the pause time, the LED on the transmitter no longer flashes and alarms are reactivated. To reactivate the alarms before the pause time has elapsed, press both buttons simultaneously again.
K	***Event Marker*** button (Available on the ApexPro CH and T14 transmitter only.)	When pressed, displays a message on the CIC Pro center that a graph is being generated to mark an event. This function can be turned off at the CIC Pro center.

Labels

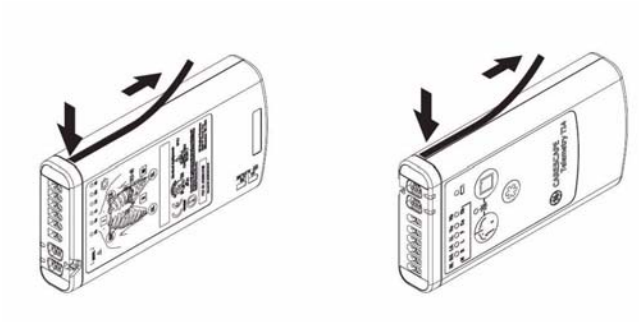
The main back label contains the ECG orientation chart, the serial number and any certification markings required for each country (FCC, UL, etc.) This label also provides the color coordination for the multi-link cables.

320A

The TTX number label corresponds to the TTX number that is programmed into the transmitter.

T14 side labels

The T14 transmitter also has side labels to distinguish it from an ApexPro CH transmitter. Additional side label kits may be ordered (See T14 on page 6-23.)



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Transmitter appearance

ApexPro transmitters have 2 user buttons: **Verify Leads** and **Graph**. They have a white endcap on the end opposite the battery compartment cover.

The ApexPro CH and T14 transmitters have 3 user buttons: **Verify Leads**, **Graph**, and ***Event Marker***. There is a blue endcap on the end opposite the battery compartment cover.

Start-up

At power-up, the transmitter LEDs flash during start-up. The following table defines the sequence.

Sequence of LED Flashes	Function
All LEDs flash quickly	Transmitter memory tests are being performed.
All LEDs flash slowly twice.	Indicates that all LEDs are functional.

Refer to the ApexPro Telemetry System or CARESCAPE Telemetry T14 Operator's Manual for further details on transmitter operation and leadwire installation.

Transmitter interfaces

ECG Multi-Link leadwire set

The ECG connector is designed to accept 3-, 5- or 6-multi-link leadwire sets. The ECG data is acquired from the patient through a set of leadwires. The signals are then amplified, processed, and transmitted.

For ApexPro, ApexPro CH and T14 transmitter, the top set of pins is the ECG signal lead. The bottom set of pins function as the signal lead shield connections. Also, the

RA shield functions as the RF antenna for the ApexPro and ApexPro CH transmitter; the T14 transmitter has an internal antenna.

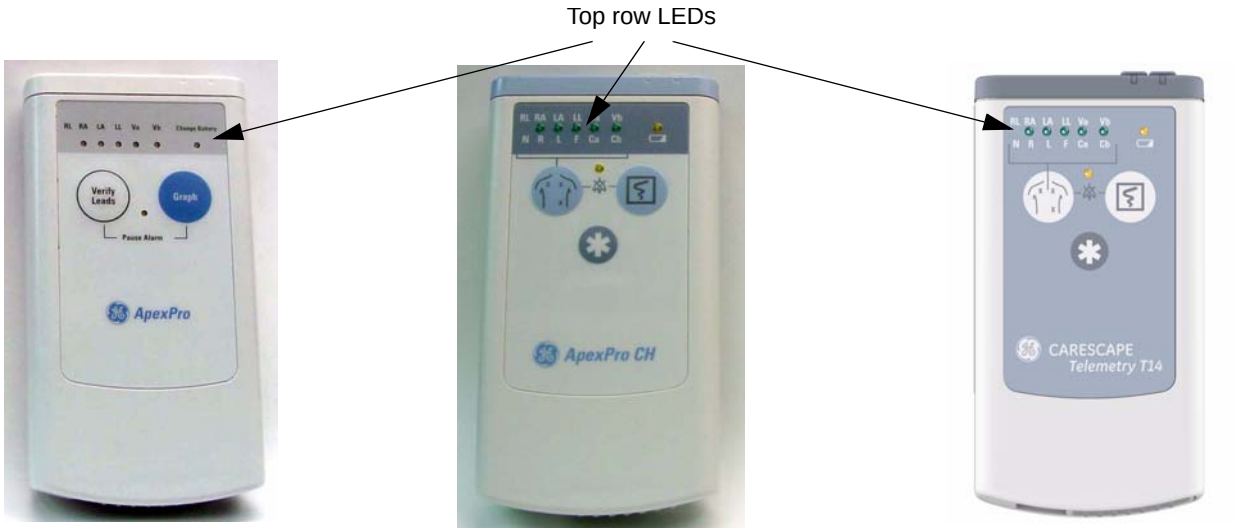
317A

Interface connector ports

When enabled, interface connector ports provide an asynchronous communication connection to other devices (NBP, SpO2, etc.) for extra monitoring or for service connection to a programming box.

Switches/LEDs

When power is applied to the transmitter, all of the LEDs should flash rapidly indicating code is being loaded. The code is done loading and executed when just the top row LEDs flash twice.



605A, 205B

While in normal application mode, pressing and releasing the **Verify Leads** button causes the LEDs to light up for 1 minute if their corresponding lead is good. Pressing and releasing the **Graph** button causes either a save or a manual graph at the CIC Pro center.

Pressing both the **Verify Leads** and the **Graph** buttons together causes an alarm pause condition for the programmed amount of time (typically 5 minutes) or until the alarm pause action is initiated again. When the transmitter is in alarm pause, the corresponding LED flashes once every second at a 1/8th duty cycle.

Upon any activation (**Verify Leads**, **Graph**, or **Alarm Pause**) the top row of LEDs flash twice. All these functions are disabled in service mode.

When the battery voltage drops below 1.9 volts for ApexPro,1.6 volts for ApexPro CH or 1.73 volts for the T14, the **Change Battery** LED flashes once every second at a 1/8 duty cycle.

RF

The RF output is transmitted through one of the shield wires on the multi-link cables. The carrier frequency can be programmed to any frequency within the allowable band.

DINAMAP PRO series monitors

The DINAMAP PRO 100, 200, 300, and 400 series monitors can be connected to the transmitter using the DinaLink™ serial cable to monitor SpO2, NBP, and temperature. Parameter data from the PRO 100–400 series monitors is displayed, trended, and stored at the CIC Pro center.

The DinaLink interface cable assembly consists of a monitor adapter cable, the DinaLink adapter, and an interconnection cable. It connects the transmitter to the PRO 100–400 series monitors and provides electrical isolation. The interconnect cable connects to either of the optional interface ports on the transmitter

201A

SpO2 oximeter modules

The oximeter is an optional module that, when connected to the transmitter, allows telemetry monitoring of a patient's pulse oximetry data. The oximeter must be connected to an transmitter in order to convey SpO2 data to the CIC Pro center. Only digital data is available; no waveforms are generated or transmitted.

310C

NOTE

The telemetry system supports 2 SpO2 oximeter modules:

- Apex Oximeter
- Nonin Xpod Oximeter

Apex oximeter

Theory of operation - pulse oximetry

Pulse oximeters shine light (red and infrared) through perfused tissue and detect the fluctuating signals caused by arterial blood pressure pulses. Well-oxygenated blood is bright red, while poorly oxygenated blood is dark red. The pulse oximeter determines functional oxygen saturation of arterial hemoglobin from this color difference by measuring the ratio of absorbed red and infrared light as the blood volume fluctuates with each heart beat. Since steady conditions (steady venous blood flow, skin thickness, bone, finger nails, etc.) do not cause fluctuations, they do not affect the saturation reading.

Mathematically:

$$SpO_2 = f\left[\frac{\ln\left(\frac{min}{max}\right)\ red}{\ln\left(\frac{min}{max}\right)\ infrared}\right]$$

801

Anything that affects the intensity of the light such as thick or colored skin affects the maximum and minimum proportionally and thus the ratio minimum/maximum does not change. However, if too little light gets through, the pulse oximeter does not function.

Pulse oximeters use 2 different wavelengths of light (colors) and thus have the ability to determine 1 component of blood. Pulse oximeters are calibrated to closely approximate functional oxygen saturation values. Pulse oximeter oxygen saturation values will closely approximate laboratory instrument fractional saturation values if the dysfunctional hemoglobin saturation levels are negligible. If the dysfunctional hemoglobin is carboxyhemoglobin or methemoglobin, then the difference between the oxygen saturation value displayed by the Pulse oximeter and the oxygen saturation values determined by the laboratory instrument are greater as the dysfunctional hemoglobin levels rise approximately in accordance with the following formulas:

- SpO2 = O2Hb + COHb + MetHb
- SaO2 = 100 x O2Hb /(100 - COHb - MetHb)

Where:

- SpO2 = Pulse oximeter determined and displayed oxygen saturation in percent
- O2Hb = Fractional oxyhemoglobin saturation in percent
- COHb = Carboxyhemoglobin saturation in percent
- MetHb = Methemoglobin saturation in percent
- SaO2 = Functional oxygen saturation in percent

The following table gives examples of the oximeter readings:

Example 1	Example 2
O2Hb = 96	O2Hb = 88
COHb = 0.5	COHb = 8
MetHb = 0.6	MetHb = 2
SpO2 = 97	SpO2 = 98
SaO2 = 97.07	SaO2 = 97.78

The mathematics are fixed in the pulse oximeter hardware and software. Thus, no field calibrations are needed or are possible. There are no adjustable parts within the pulse oximeter that affect the calibration.

The function f, depends on the wavelengths of the sensor LEDs. These wavelengths are fixed by specified manufacturing processes and materials. The sensors are checked for correct operation before shipping, so no adjustment or calibration is needed or possible.

Because the pulse oximeter does all critical computations in software and there are no critical parts to drift; no re-calibration is needed.

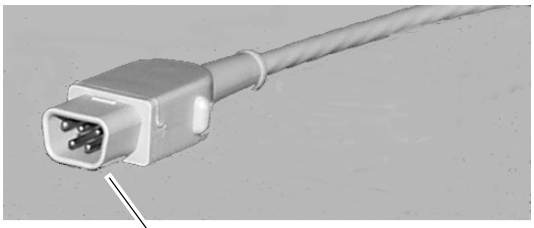
Interconnection cables

NOTE

Refer to the ApexPro Telemetry System or CARESCAPE Telemetry T14 transmitter Operator’s Manual for further details on interconnection cables.

Apex oximeter and Accutracker DX

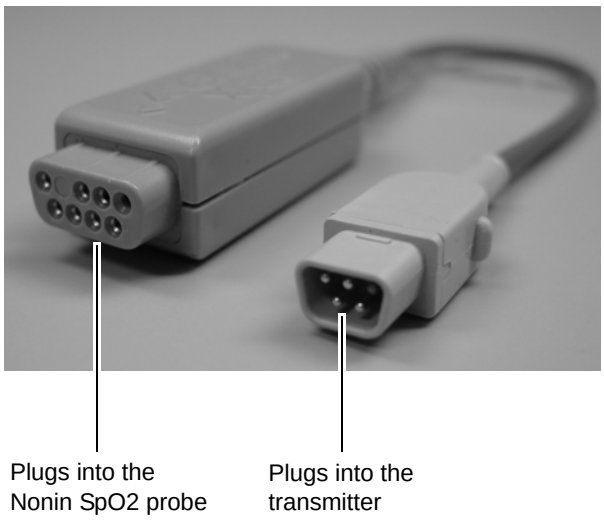
The interconnection cable used to connect the transmitter with the Apex Oximeter and/or the Accutracker DX blood pressure monitor, and/or the DinaLink serial cable.



423B

Nonin Xpod oximeter

The interconnection cables used to connect the transmitter and the SpO2 probe are a part of the oximeter module.



502A

ApexPro receiver system

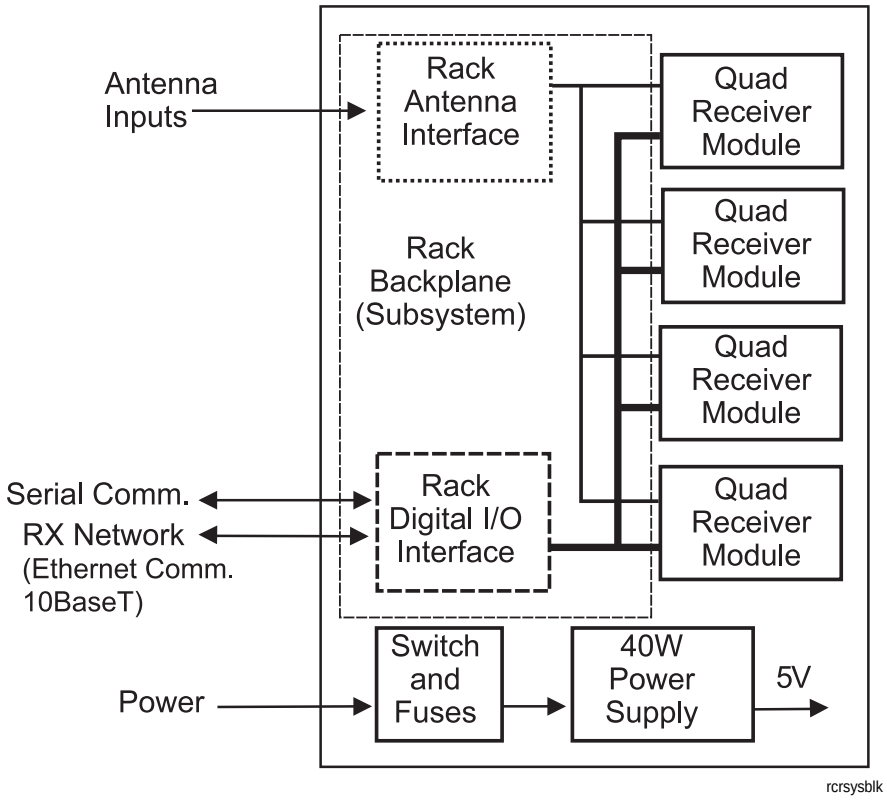
Overview

The Receiver System receives RF signals from the four antenna inputs. These inputs are for four separate, overlapping fields. The system performs the following functions:

- filters RF (backplane)
- distributes RF to quad receiver modules (backplane)
- demodulates and decodes transmitter data (quad receiver modules)
- retrieves decoded data (backplane)
- packetizes and sends data out over RX network (backplane)

The asynchronous serial communication port is for diagnostics, service and installation information.

The RX network is directly connected by a network crossover cable to an ApexPro Telemetry System. The RX network should not be tied to any other network.



Receiver System Block Diagram

Receiver subsystem (backplane)

The subsystem provides an interface between the quad receiver modules and the telemetry software running on the ApexPro Telemetry System connected via 10BaseT Ethernet. The subsystem accommodates up to four quad receiver modules. The subsystem performs the initial amplification and filtering necessary on the RF input signals from the transmitter.

Quad receiver modules

The quad receiver module receives the GMSK modulated RF signals from the transmitter through the receiver subsystem (backplane). The RF signals are mixed to an intermediate frequency, filtered, and mixed again to baseband and re-filtered. The baseband signal is separated into its in-phase and quadrature components then sampled. The DSP takes the samples, demodulates, corrects, and decodes packets of TLINK data. The information is passed on to the receiver subsystem for further processing and transport over Ethernet. Each module has four functionally identical receivers.

Input/output connectors and signals

F-Connectors, J1, J2, J3, and J4

Pin	Description
J1	Antenna A field input
J2	Antenna B field input
J3	Antenna C field input
J4	Antenna D field input

RJ-45 Ethernet port, J6

Pin	Description
1	HOST_XMIT_POS
2	HOST_XMIT_NEG
3	HOST_RCV_POS
4	N/C
5	N/C
6	HOST_RCV_NEG
7	N/C
8	N/C

RS-232 async comm port, J15

Pin	Description
1	N/C
2	TX
3	RX
4	N/C
5	DGND
6	N/C
7	N/C
8	N/C
9	N/C

Input power plug, J16

Pin	Description
1	GND
2	GND
3	GND
4	+5V
5	+5V
6	+5V

3 Installation and configuration

Infrastructure installation

Overview

This chapter provides direction for how to install specific parts and gives guidelines for specific tools to use for installation.

Install coaxial cable

Installation guidelines

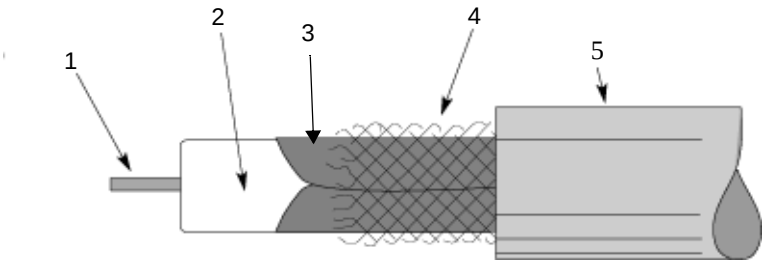
Use the hospital scaled prints and the logical antenna schematic to install the cabling. The logical antenna schematic is generated by ND&I.

Keep the following in mind when installing coax cable.

- Always follow the National Electric Code regulations.
- Always use PVC for the feed-throughs.
- Do not kink the cable. If the cable is kinked, cut out the kinked part and reattach.
- Do not pull cable over any metal edges or other abrasive surfaces.
- Do not pull cable for one room at a time. The entire cable spool should be accessible and multiple runs should be pulled at the same time into the ceiling.
- Do not lay cable on top of light fixtures.
- Lay out cable uniformly and with excess slack. The slack should consist of about 25 cm (1 foot) or so every 3 m (10 feet), both horizontally and vertically.
- Do not coil up any extra cable, but instead increase the amount of excess slack throughout the entire length of cable.

Coaxial cable preparation

These sections describe how to strip coaxial cable and crimp connectors to the cable. Below are descriptions of the components of a coaxial cable.



200A

1	Center conductor — The center-most feature of coaxial cable. It consists of solid copper or copper-clad aluminum wire.
2	Dielectric — An electrical insulation utilized to maintain position of the center conductor. It is composed of polyethylene in either solid or foam state. This insulator/positioner may also be evenly spaced solid polyethylene discs.

3	Outer conductor or foil — Either solid aluminum tube or an aluminum foil wrap. The cable size is usually derived from its outside diameter.
4	Braid — Interwoven strands of aluminum or copper mesh. It extends the conductivity of the outer conductor to the sleeve of the connector.
5	Jacket — The black polyethylene coating over the aluminum outer conductor protects it from scratches or abrasions during handling and provides a weather-tight seal. The jacket on plenum cable is made of teflon specified by fire codes.

Strippers and crimpers

Recommended tools

The following table indicates the recommended cable strippers and crimpers.

NOTE

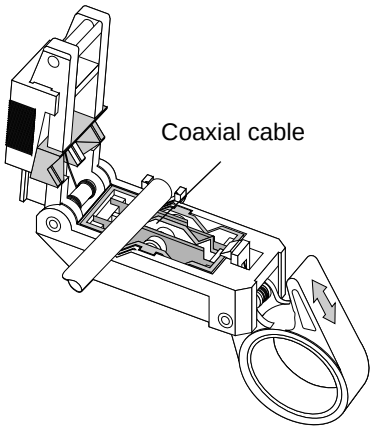
- The CT611QS will work for both RG-6 Riser and RG-11 Plenum cable.
- The current RG-11 crimper will work with the new RG-11 cable and connector.
- The old RG-6 Riser crimp tool will work for the RG-6 Plenum.
- *Italics* = preferred tool.

Following the descriptions is a section describing how to correctly strip coaxial cable. RG-6 is the recommended coaxial cable, but RG-11 cabling is used for some installations.

Connector		**Crimp tool**		**Stripper tool**
Part number and description	**Thomas & Betts (T&B)**	**Hex**	**Tool # and Manufacturer**	**Tool # and Manufacturer**
2018510-001 RG-6 Plenum (replaces 1886-008)	PL56CS	*0.260*	*HCT-659 CablePrep*	3CSK-GN Cooper/Xcelite
2018509-001 RG-6 Riser NP (replaces 1886-004)	AMF6	*0.360*	*CT611QS T&B*	3CSK-GN Cooper/Xcelite
2018511-001 RG-11 Plenum (replaces 1886-007)	PL11CS	0.470	HCT-211 CablePrep	RG11 Maxi-Corex, 360 Cooper
		0.470	*CT611QS T&B*	
2018512-001 RG-11 Riser NP (replaces 1886-003)	F11QS	0.470	HCT-211 CablePrep	RG11 Maxi-Corex, 360 Cooper
		0.470	*CT611QS T&B*	

Strippers

- For RG-6 coax cable, use Xcelite coaxial cable stripper (3CSK-GN).
- For RG-11 coax cable, use Cooper cable stripper, RG11 Maxi-Corex 360.



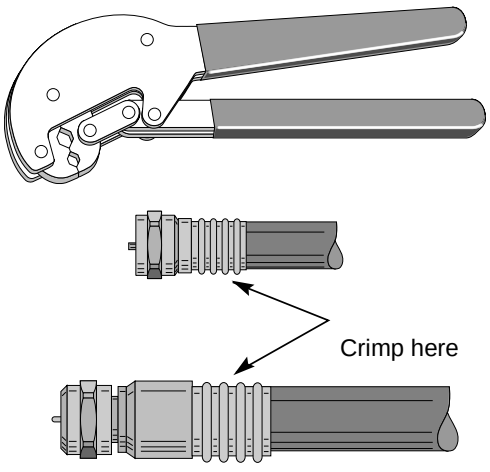
205A

Crimpers

The typical hex crimping tool is shown below. The recommended crimping tool part numbers are the following.

- For RG-6 plenum, use a HCT-659 crimper from CablePrep.
- For RG-6 riser, use a CT611QS crimper from T&B.
- For RG-11 riser and plenum, use a CT611QS crimper from T&B (recommended) or HCT-211 crimper from CablePrep.

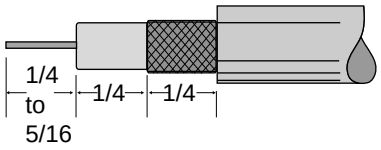
Before you crimp, check the dimensions for the specific type of coaxial cable and connector.



215A

RG-6 plenum cable preparation

Required stripping dimensions for RG-6 plenum cabling are shown below.



220A

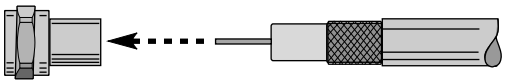
For this cable, use stripper 3CSK-GN from Cooper/Xcelite. The stripper requires 3 blades.

1. To start with a squarely-cut cable end, open the stripper and place the cable so that 1/4 – 5/16 inch of cable extends past the first blade. Then close and latch the stripper and rotate around the cable 3 – 4 times.
2. Open the stripper and adjust stripping blades until the correct dimensions are achieved as shown in the figure above. Then strip the cabling.
   a. Expose the center conductor 1/4 – 5/16 inch. Do not score the conductor.
   b. Expose the dielectric another 1/4 inch without braid.
   c. Expose the braid an additional 1/4 inch. Do not score the braid.
   d. Remove and discard excess dielectric, foil and braiding.
3. Place the connector over the prepared cable end.

   NOTE

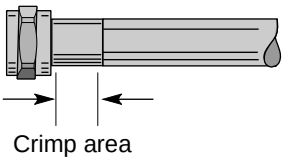
   Make sure the braid does not fold back over the jacket.

   - The connector is properly positioned when the cable dielectric end is flush with the connector post end.



221A

   - Position cable dielectric end flush with connector post.
4. Crimp the collar once in the area shown below using a 0.260 inch hex crimp tool.

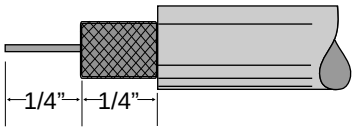


217A

5. Wrench-tighten the connector.

RG-6 riser cable preparation

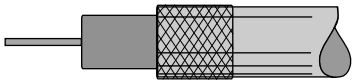
Required stripping dimensions for RG-6 riser cabling are shown below.



222A

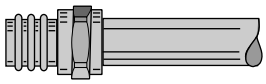
For this cable, use stripper 3CSK-GN from Cooper/Xcelite. The stripper requires 2 blades.

1. To start with a squarely-cut cable end, open the stripper and place the cable so that 1/4 – 5/16 inch of cable extends past the first blade. Then close and latch the stripper and rotate around the cable 3 – 4 times.
2. Open the stripper and adjust stripping blades until the correct dimensions are achieved as shown in the figure above. Then strip the cabling.
   a. Expose the center conductor 1/4 inch. Do not score the conductor.
   b. Expose the braid another 1/4 inch. Do not score the braid.
   c. Remove and discard excess dielectric, foil and braiding.
3. Fold the braid back over the jacket.



218A

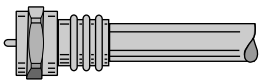
4. Place the connector, reversed as shown below, over the cable end until it bottoms against the braid.



219A

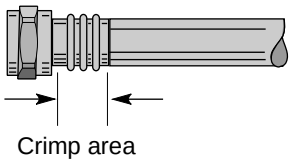
5. Remove the connector. Reverse it once more. Position the connector over the cable end as shown below. Then push and rotate the connector until it bottoms.

   The connector is properly positioned when the cable dielectric end is flush with the connector post end.



223A

6. Crimp the collar once in the area shown below using a 0.360 inch hex crimp tool

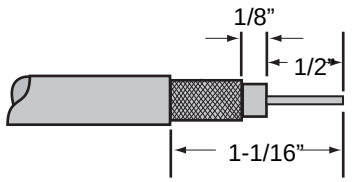


224A

7. Wrench-tighten the connector.

RG-11 plenum cable preparation

Required stripping dimensions for RG-11 plenum cabling are shown below.



225A

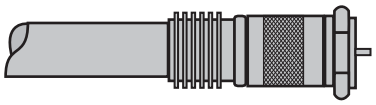
For this cable, use stripper RG11 Maxi-Corex, 360. The stripper requires 3 blades.

1. To start with a squarely-cut cable end, open the stripper and place the cable so that 1/4 – 5/16 inch of cable extends past the first blade. Then close and latch the stripper and rotate around the cable 3 – 4 times.
2. Open the stripper and adjust stripping blades until the correct dimensions are achieved as shown in the figure above.
   a. Expose the center conductor 1/2 inch. Do not score the conductor.
   b. Expose the dielectric another 1/8 inch without braid.
   c. Expose the braid an additional 7/16 inch (a total of 1-1/16 inch from the end of the center conductor.) Do not score the braid.
   d. Remove and discard excess dielectric, foil and braid.
3. Place the connector over the prepared cable end.

   NOTE

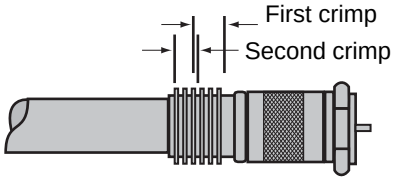
   Make sure the braid does not fold back over the jacket.

4. Push the cable center conductor into the connector until the conductor is inserted into the contact pin. A slight back-and-forth motion may be necessary to locate the entryway of the pin, however, avoid excessive twisting of the cable as the braiding is not to fold back over the jacket.



228A

5. Crimp the collar of the connector in two places, the first beginning at the furthest ring away from the cable entry end. Using an LRC tool CT611QS, crimp the first four rings using a .470 size hex. Crimp the last three rings, being careful to align the resulting hex-shaped areas together.

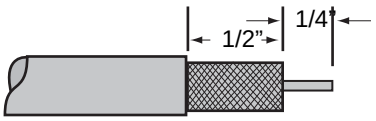


229A

6. Wrench-tighten the connector.

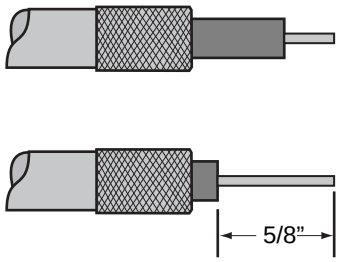
RG-11 riser cable preparation

Required stripping dimensions for the first cuts for the RG-11 riser cabling are shown below.



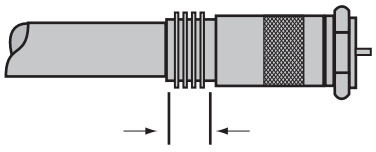
230A

1. For RG-11 riser coaxial cable, use stripper RG11 Maxi-Corex, 360.To start with a squarely-cut cable end, open the stripper and place the cable so that 1/4 – 5/16 inch of cable extends past the first blade. Then close and latch the stripper and rotate around the cable 3 – 4 times.
2. Open the stripper and adjust stripping blades until the correct dimensions are achieved as shown in the figure above.
   a. Expose the center conductor 1/4 inch. Do not score the conductor.
   b. Expose the braid an additional 1/2 inch (a total of 3/4 inch from the end of the center conductor.) Do not score the braid.
   c. Remove and discard excess dielectric, foil, braid and jacket.
3. Fold the braid back over the jacket. Then use the stripper to cut through to the center conductor an additional 3/8 inch as shown below. Do not score the conductor. Remove and discard excess dielectric and foil.



231A

4. Insert the connector post over the foil and dielectric until it bottoms.



232A

5. Crimp the collar once in the area shown above using a 0.470 inch hex crimp tool.
6. Wrench-tighten the connector.

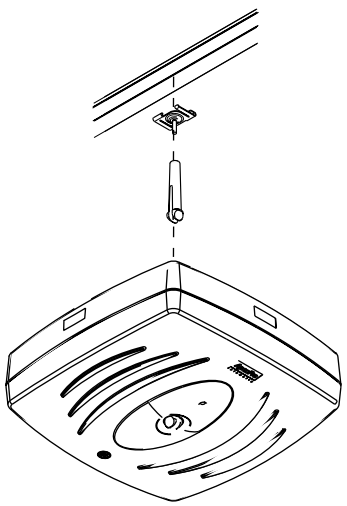
Install antennas

NOTE

Be sure that after planning and designing the antenna system, the Penetration Check test (described in the ApexPro Antenna System Installation Test Instructions) is completed. It is used to estimate the RF penetration of the hospital construction.

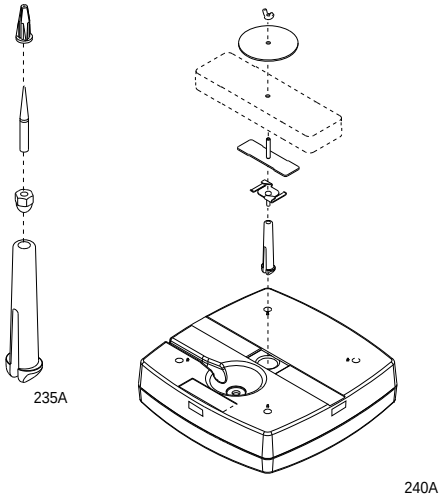
The standard installation for antennas uses a T-bar mount connected to the drop ceiling support. The retaining clip and pin come with the antenna.

For ceiling tile or dry wall mounting, see Optional antenna mounting kits on page 6-3 to order additional hardware kits necessary for these mounting options. All antenna mounting installation options and instructions are described in the ApexPro Telemetry Antenna Mounting Instructions that are included with the antenna.



233A

Standard installation



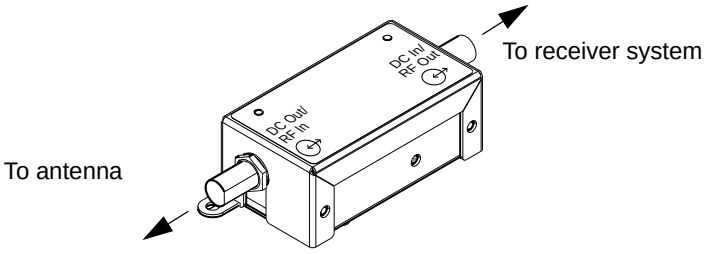
Optional dry wall mount and ceiling tile mount

NOTE

For customer site reasons, some antennas may require installation above the ceiling. Antennas cannot be mounted in a plenum air shaft, since the antenna is not plenum rated. For specific guidance on above-ceiling antenna mounting, contact the Network Design and Integration (ND&I) team.

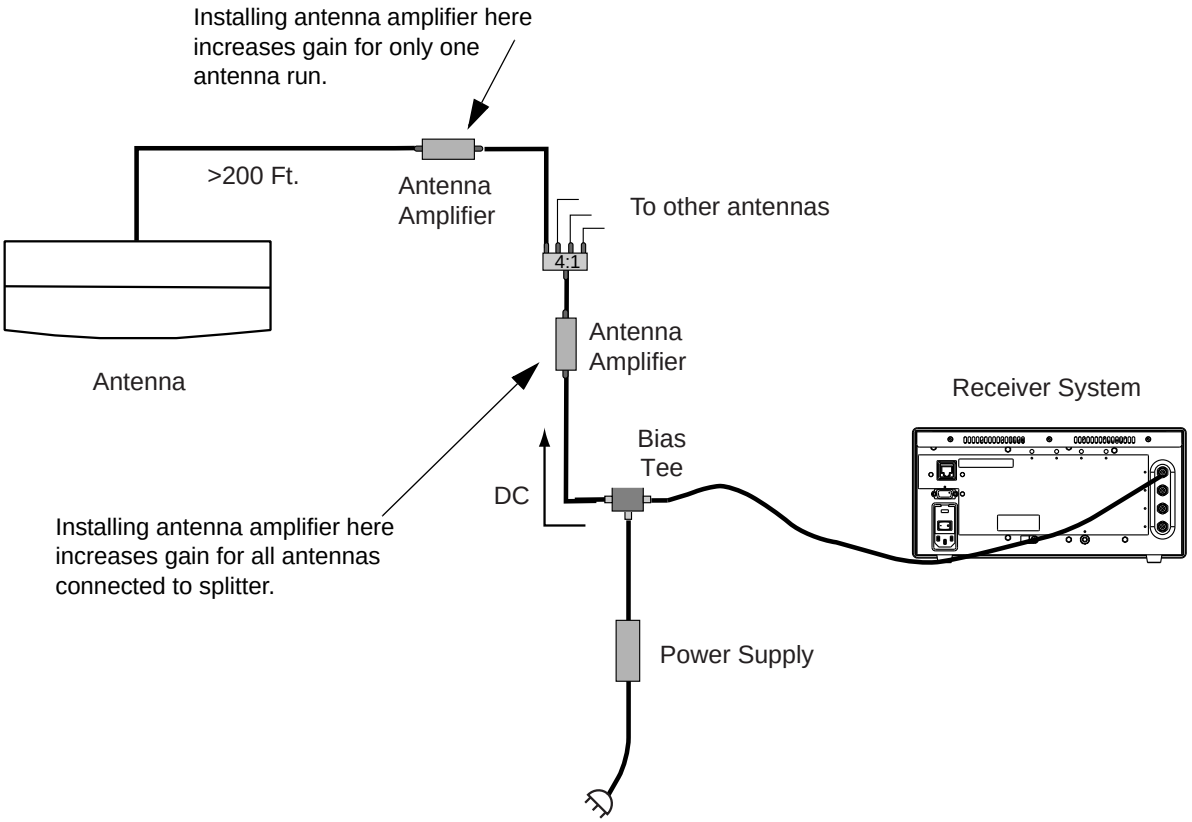
Install antenna amplifiers

Antenna amplifiers are installed to boost the signal levels from the antenna. The installation location for the antenna amplifier is generated by the ND&I team for each site installation.



245A

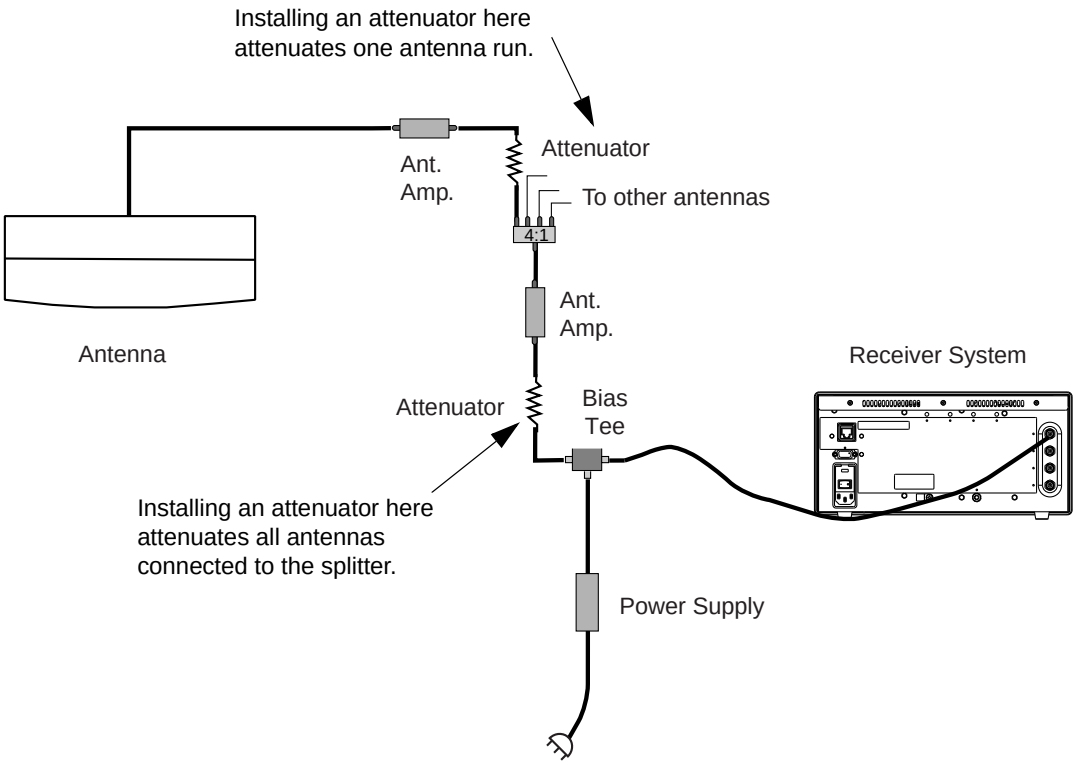
Do not install antenna amplifiers backwards. Note the markings on the amplifier for installation orientation. If connected backwards, the LED will illuminate, however the amplifier will not work correctly; there will be signal loss instead of gain.



250A

Install attenuators

Attenuators are used to attenuate the signal levels from the antennas. The locations of the attenuators and the types of attenuators used are determined by the ND&I team for each site installation.

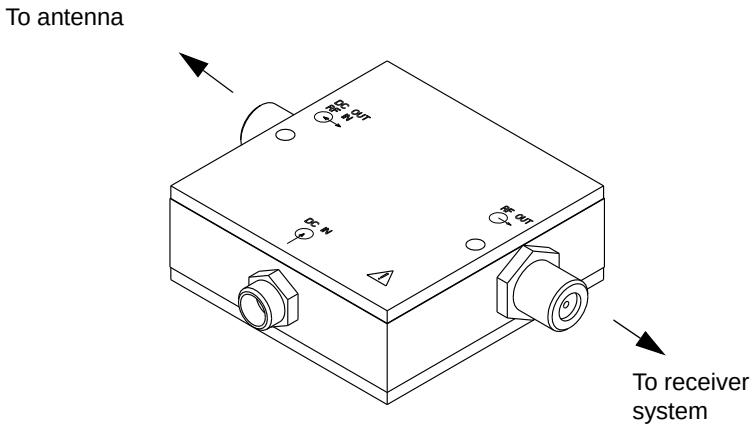


Install power supplies and bias tees

Power supplies and bias tees are used to power the active antennas and amplifiers used as part of the antenna system. The number of power supplies used and their location is determined by the ND&I team. If emergency power is available, the power supplies are installed on emergency power. Use the power supply/bias tee mounting bracket to mount both devices to the splitter board to reduce the area needed by each device.

NOTE

To mount a power supply and bias tee use the Bias Tee and Power Supply Mounting kit (pn 2010197-001)



260A

NOTE

Do not install bias tees backwards. Note the markings on the bias tee for installation orientation. If connected backwards, the LEDs on all antennas and/or amplifiers in that specific antenna field run will not illuminate. Neither the antennas nor the amplifiers will work correctly.

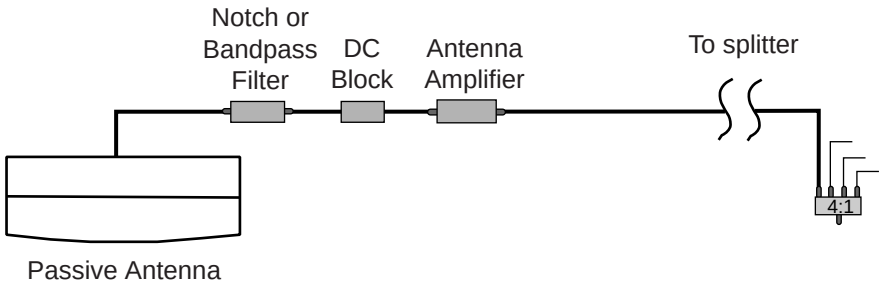
Install notch/bandpass filters

To protect the antenna system or receiver system from signal overload, notch filters are installed as determined by the site survey and the ND&I team. Multiple notch filters and bandpass filters can be used on a given antenna field. Do not install notch filters on the **DC OUT/RF IN** side of the bias tee because filter components may be damaged if DC is applied. Bandpass filters are DC passing and can be installed on either side of the bias tee.

NOTE

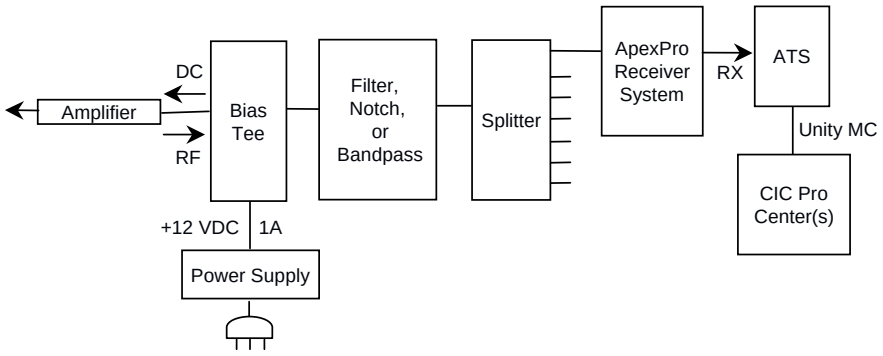
Use the two mounting holds to secure the Cavity Bandpass Filter 608-614 MHz (pn 2027458-001).

With passive antennas



265A

With active antennas



270B

ApexPro receiver installation

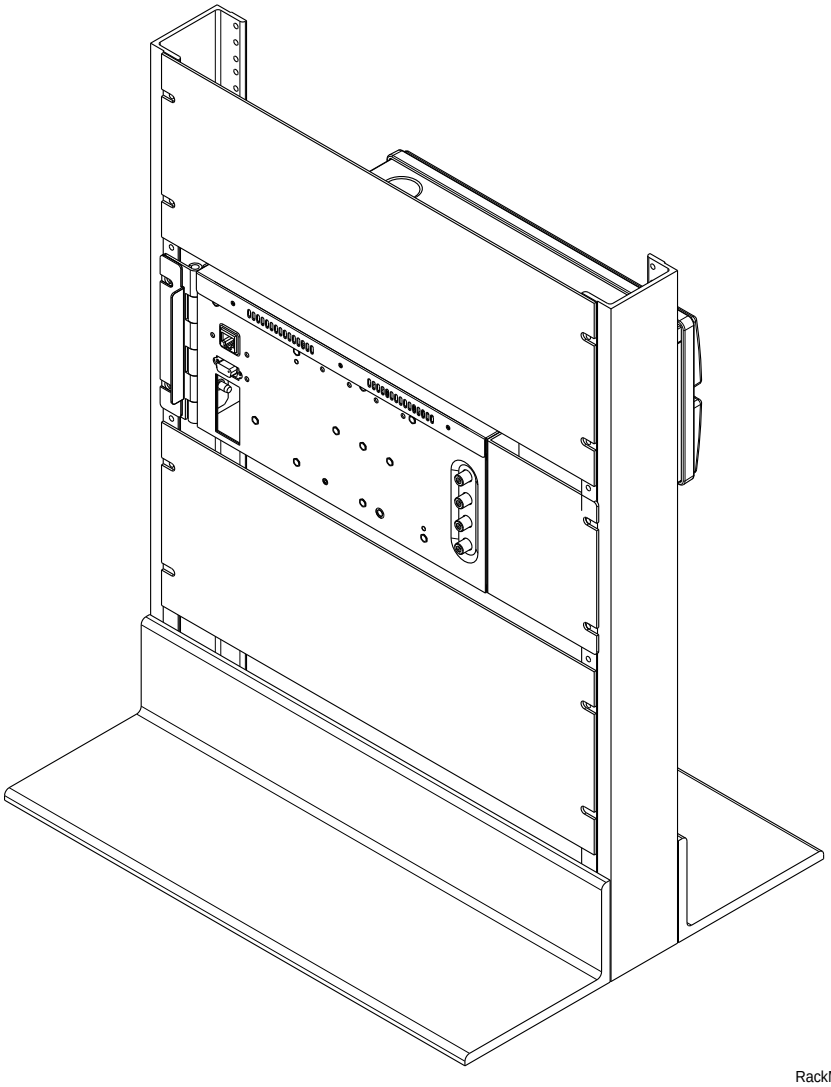
Due to the fact that frequency drift occurs even without power applied, the cailbration schedule should take into account the date the equipment was last calibrated, including equipment in storage locations and spares.

Before installation, determine and record the date of initial factory calibration of transmitters and receivers from the removable calibration sticker that ships on these devices. If the installation is not within 30 months of the date shown on the manufacturer calibration sticker, calibrate before installation. See Calibration on page 4-10.

Mounting options

The mounting options for the ApexPro Telemetry System Receiver System are:

- Standard tabletop mount (four rubber feet)
- Optional rack mount for standard 19 inch network rack system with a 4U panel height (177.8mm/7in.). (Order rack mounting kit #2004232-001 separately.)



RackMount

CAUTION

Mount the receiver system securely and away from vibration. Vibration may cause patient waveform dropout at the CIC.

NOTE

If using rack mount, route all cables to the hinge side so the receivers are accessible for service. A right angle F-connector may be helpful for the coaxial cable.

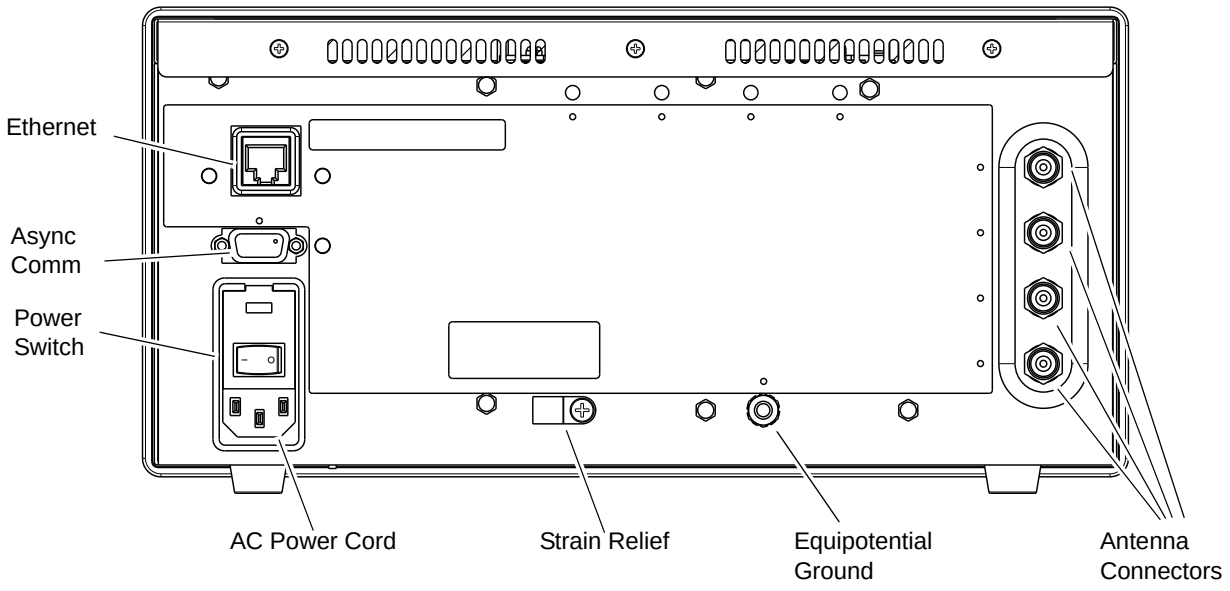
Connections

Keep the following in mind when connecting the system.

- Use a dedicated connection between the RX network and the ApexPro Telemetry System.

- If the distance between the ApexPro Telemetry System and the Receiver System is less than 100 meters (328 ft.) use point-to-point with Ethernet crossover cable connection.
- If the distance is greater than 100 meters (328 ft.) then use either an additional hub or use fiber optic cable.

1. Connect the RJ-45 (RX network) to the Ethernet port.
2. Connect the coaxial antenna cables to the antenna inputs. Unused antenna input jacks need to be terminated with a 75 Ohm F-type male terminator.
3. Connect the power cord to the AC power inlet. Secure the cord with the strain relief. Plug cord into emergency AC power outlet.
4. Indicate which ApexPro Telemetry System is directly connected by labeling the Receiver System with the ApexPro Telemetry System name. Place the label near the RX Ethernet port. If desired, this step may be omitted as the ApexPro Telemetry System can also be identified by using the Blink Rack command at the ApexPro Telemetry System.
5. Switch the power switch to **I** (on).



RearPanel

Setup antenna fields

Use the following procedure for configuring receiver subsystem so that it listens to antenna fields that are setup.

NOTE

The factory default is that all four fields are enabled.

1. Using the 9-pin, serial cable supplied with the transmitter programming kit, connect a PC to **Async Comm** (asynchronous serial communication) for setup.

2. At the PC, use a communication program such as ***HyperTerminal*** to set up the ComPort connection.

Port:	**Com1 (comm port on the PC)**
Speed:	Baud 19200
Parity:	No
Stop Bit:	1
Data Bits:	8
Flow Control:	Xon Xoff

3. Press **Enter** to get the **@>** ***Enter Service Password:*** prompt.
4. Type password, **mms_aps** (case-sensitive).
5. Press **Enter**.
6. At the **@>** prompt type **ssf**.

   The command is "**ssf x**" where x identifies which antenna field(s) to enable. Enter the "**ssf x**" command as listed below to configure the desired antenna field(s).

X	**Field D**	**Field C**	**Field B**	**Field A**
1	Disabled	Disabled	Disabled	Enabled
2	Disabled	Disabled	Enabled	Disabled
3	Disabled	Disabled	Enabled	Enabled
4	Disabled	Enabled	Disabled	Disabled
5	Disabled	Enabled	Disabled	Enabled
6	Disabled	Enabled	Enabled	Disabled
7	Disabled	Enabled	Enabled	Enabled
8	Enabled	Disabled	Disabled	Disabled
9	Enabled	Disabled	Disabled	Enabled
10	Enabled	Disabled	Enabled	Disabled
11	Enabled	Disabled	Enabled	Enabled
12	Enabled	Enabled	Disabled	Disabled
13	Enabled	Enabled	Disabled	Enabled
14	Enabled	Enabled	Enabled	Disabled
15	Enabled	Enabled	Enabled	Enabled

7. Exit the communication program, then disconnect serial cable and PC, or continue with step 6 in Setup the receiver on page 3-17.

Setup the receiver

Assuming that the ApexPro Telemetry System and all antennas have been installed and set up, the entire system is now installed and connected.

CAUTION
Equipment damage. If receiver system software needs updating, the system LED flashes yellow while software is updating. DO NOT power down the system during a software update.

1. Using the 9-pin, serial cable supplied with the transmitter programming kit, connect a PC to **Async Comm** (asynchronous serial communication) for setup.
2. At the PC, use a communication program such as ***HyperTerminal*** to set up the ComPort connection. For example:

Port:	**Com1 (comm port on the PC)**
Speed:	Baud 19200
Parity:	No
Stop Bit:	1
Data Bits:	8
Flow Control:	Xon Xoff

3. Press **Enter** to get the **@>** ***Enter Service Password:*** prompt.
4. Type password, **mms_aps** (case-sensitive).
5. Press **Enter**.
6. At the **@>** prompt type **sii**.
7. Type information for the following prompts:
   - ***Enter Installer's Name/ID (31 Characters MAX):***
   - ***Enter Installation Date (31 Characters MAX):***
   - ***Enter Rack Location (31 Characters MAX):***
8. Check the information by typing **gii** at the prompt.
9. Exit the communication program, then disconnect serial cable and PC.
10. Go to Maintenance on page 4-1 and complete the Receiver System Checkout procedures to make sure the Receiver System is working properly.

Transmitter installation

Due to the fact that frequency drift occurs even without power applied, the cailbration schedule should take into account the date the equipment was last calibrated, including equipment in storage locations and spares.

Before installation, determine and record the date of initial factory calibration of transmitters and installation calibration is not within 30 months of the date shown on the manufacturer calibration sticker, calibrate before installation.See Calibration on page 4-10.

Programming the transmitter for use

Before use, the transmitter must be programmed. The transmitter is programmed or upgraded in the field to:

- select the operating frequency and corresponding TTX number
- select the reference lead
- set the alarm pause time
- select the filter setting
- change the serial number
- download new software

Refer to the ApexPro Telemetry Frequency Chart Reference Manual for the operating frequencies and the corresponding TTX ID numbers.

Refer to the Transmitter Programming Box Programming Instructions for details.

Transmitter configuration

Program code storage

Executable program code for the main processor is stored in non-volatile programmable memory. Program code can be changed via an interface connector port using the PC-based programming box software or a HyperTerminal program and a programming box. The version of the currently stored transmitter code can be displayed using the transmitter programming box software kit. See Apex, ApexPro and ApexPro CH Transmitter Programming Instructions.

Error log

The transmitter contains an error log in its non-volatile programmable memory. When a synthesizer lock error occurs, this is logged and latched into the appropriate memory space. When a checksum error on start-up occurs, this is logged into the appropriate memory space for this as well. The error log can be viewed using the programming box PC software or a HyperTerminal program. This reports both of these errors as well as a real-time report of the synthesizer lock status.

Parameters

Using HyperTerminal or the ApexPro PC programming box software, certain transmitter parameters can be viewed and some can be changed while in service mode.

Transmitter Model(s)	Parameter	Status
ApexPro, ApexPro CH, T14	TTX / Frequency	Read / Write
ApexPro, ApexPro CH, T14	Board Version	Read
ApexPro, ApexPro CH, T14	Synthesizer Lock Error Log	Read / Clear
ApexPro, ApexPro CH, T14	EEPROM Checksum Error Log	Read / Clear
ApexPro, ApexPro CH, T14	Synthesizer Lock Status	Read
ApexPro, ApexPro CH, T14	Serial Number	Read / Write
ApexPro, ApexPro CH, T14	Reference Lead (3-lead)	Read / Write
ApexPro, ApexPro CH, T14	Alarm Pause Time	Read / Write
ApexPro, ApexPro CH, T14	Code Version (Application)	Read
ApexPro, ApexPro CH, T14	Code Version (Manufacturing / Service)	Read
ApexPro, ApexPro CH, T14	Filter	Read / Write
ApexPro	I/Q Table Version	Read
ApexPro	I/Q Table	Write
ApexPro, ApexPro CH, T14	Battery Voltage	Read
ApexPro, ApexPro CH, T14	Battery Status	Read
ApexPro, ApexPro CH, T14	Lead Status	Read
ApexPro, ApexPro CH, T14	Button Status	Read
ApexPro, ApexPro CH, T14	App Code	Write File
ApexPro, ApexPro CH, T14	Mfg Code	Write File
ApexPro CH, T14	RF Test Pattern	Read / Write
ApexPro CH, T14	Digital Potentiometers	Read / Write
ApexPro CH, T14	LED Test Pattern	Write

Manually view/program TTX

After initial programming of the TTX number using the ApexPro Program Device Kit described in Programming the transmitter for use on page 3-18, the transmitter frequency or TTX can be viewed or changed without a programming box. The transmitter always loads code on power-up.

View the TTX number

1. Power up the transmitter. This causes the application to load (indicated by all LEDs flashing).
2. Hold down the **Verify Leads** button and the **Graph** button while the transmitter loads code and before the top row of LEDs flash twice (this causes the service code to load). Continue to hold the **Verify Leads** and **Graph** buttons.This displays the TTX number using the first 4 LEDs as follows:

a. The first 4 LEDs light up indicating it is going to display the 4-digit TTX number.

b. The **RA** LED flashes a number of times corresponding to the first digit of the TTX number. The flashes are from 1 to 10, with 10 flashes representing a zero digit.

c. The **LA** LED flashes corresponding to the second TTX digit.

d. The **LL** LED corresponds to the third digit.

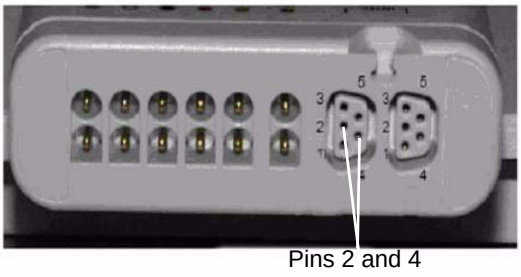
e. The **Va** LED corresponds to the fourth TTX number.

3. Write down the TTX numbers as they display.

Program the TTX number

WARNING
Choose a unique TTX number for each transmitter. Programming 2 transmitters to the same TTX number may result in monitoring the wrong patient.

1. Short connector pin 2 of either interface connector port to pin 4 of that same interface connector port.



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2. Power up the transmitter while holding down the **Verify Leads** and **Graph** buttons. This causes the service code to load.

3. The first 4 LEDs (5 on T14 transmitter) of the top row light up indicating it is in manual TTX program mode.

4. Release the **Verify Leads** and **Graph** buttons.

   The **RA** LED flashes corresponding to the number of the first digit of the TTX number.

5. Increment the first digit by pressing the **Verify Leads** button repeatedly. Each time you press the button, the current digit is increased by 1.

6. Release the **Verify Leads** button when you reach the desired number.

   At this point, the LED begins to flash again, indicating acceptance of your entry. The LED flashes the number corresponding to the new number.

7. Proceed to the next digit by pressing the **Graph** button until the next LED flashes.

8. Repeat for all 4 (5 for T14 transmitter) digits.

   The TTX number is not changed until the fourth/fifth digit is accepted by pressing the **Graph** button. The top row LEDs flash twice upon acceptance of the TTX number.

9. To exit service mode, remove the short from pins 2 and 4. The service program runs until the short is removed. Then the transmitter reloads the application code and continues to run normally at the new TTX number.

4 Maintenance

ApexPro CH Telemetry Tune-Up

Introduction

To make sure the ApexPro CH antenna infrastructure remains in proper operational and functional order, a proper maintenance schedule must be observed.

RF environment changes

Changes in the RF environment could adversely affect the output of the original design of the antenna infrastructure.

Schedule

WARNING
LOSS OF DATA—The manufacturer requires that calibration be performed by service personnel as follows:

For 1395-1400 MHz systems calibrate the following every 2 years:

- T14 transmitter
- RIM 1400
- Receiver subsystem

Due to the fact that frequency drift occurs even without power applied, the cailbration schedule should take into account the date the equipment was last calibrated, including equipment in storage locations and spares.

Determine and record the date of initial factory calibration of transmitters and receivers from the removable calibration sticker that ships on these devices. Calibrate within 30 months of the date shown on the manufacturer calibration sticker or 24 months after installation, whichever occurs first, and every 24 months thereafter.

Additionally, the manufacturer recommends that service personnel perform the following maintenance procedures upon installation of antenna infrastructure, prior to every antenna expansion, and every 12 months thereafter.

Antenna infrastructure tests

	Test
☐	Quick Antenna System Checks. See Quick antenna system checks on page 5-7.
☐	ApexPro CH Antenna System Test Instructions: Antenna System installation verification tests ☐ Out-of-Band RF Signal Test ☐ Unity Signal Gain Test with Transmitter ☐ Noise Floor Performance Test ☐ In-band Noise Test

Subsystem tests

	Test
☐	Visual inspection - General. See Visual inspection on page 4-4.
☐	Cleaning. See Cleaning on page 4-5.
☐	Receiver calibration (Systems that include T14 transmitters only. Only need to perform every two years). See Receiver calibration on page 4-15.
☐	Receiver System Checkout. See Receiver system checkout on page 7-3. ☐ LED Status Indicators ☐ Verify Connectivity ☐ Receiver Function
☐	Electrical Safety Tests. See Electrical safety tests on page 7-7.

Transmitter tests

	Test
☐	Transmitter calibration (T14 transmitters only. Only need to perform every two years). See Transmitter calibration on page 4-10.

Visual inspection

Inspect for damage

The following steps check for obvious damage.

- General
  - Inspect the equipment (transmitter, receiver, etc.) case for cracks or other physical damage. Do not use a transmitter that is damaged. Refer all damaged equipment to qualified personnel.
  - Inspect all external connections for loose connectors or frayed cables. Have any damaged connectors or cables replaced by qualified service personnel.
- Transmitter
  - Inspect the transmitter case for damage that may affect the environmental seals (such as if 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 transmitter features

The model of the transmitter is indicated by its features and appearance. Use this chart to ensure that the transmitter is as expected:

Model	Feature	Transmitter Appearance
ApexPro	User buttons	2: **Verify Leads** and **Graph**
	Port covers	Gray interface connector port covers
ApexPro CH & T14	User buttons	3: **Verify Leads**, **Graph** and ***Event Marker***
	Port covers	Blue interface connector port covers, label and endcap

Verify labels

Follow these steps to be sure that the TTX number shown on the transmitter is the same as the programmed TTX number:

1. Verify that the Switch Label is present and securely attached to the front of the case.
2. Determine the programmed TTX number. For more information, see View the TTX number on page 3-19.
3. Verify that the data recorded on the TTX label on the back of the transmitter is accurate for the transmitter.

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

Cleaning

All equipment should be cleaned on a regular basis. Comply with the policies of your institution's infection control unit and/or biomed department. The decision to disinfect or sterilize must be made per your institution's requirements with an awareness of the effect on the integrity of the transmitter and leadwire.

WARNING
Disconnect AC-powered equipment from the power line before cleaning or disinfecting its surface. Turn off the power to battery-powered equipment before cleaning or disinfecting its surface.

CAUTION
Never immerse devices, cables, or leadwires in any liquid.

CAUTION
Do not pour or spray any liquid directly on cables or leadwires or permit fluid to seep into connections or openings.

CAUTION
Never use conductive solutions, solutions that contain chlorides, wax, or wax compounds to clean devices, cables or leadwires.

CAUTION
Never use solutions or products that contain the following:

- Any type of Ammonium Chloride such as, but not limited to:
  - Dimethyl Benzyl Ammonium Chloride
  - Quaternary Ammonium Chloride solutions
- Abrasive cleaners or solvents of any kind
- Acetone
- Ketone
- Betadine
- Alcohol-based cleaning agents
- Sodium salts

CAUTION
Never autoclave or steam clean devices, cables or leadwires.

CAUTION
Do not attach the device to a patient until it is thoroughly dry.

CAUTION
IMPROPER TRANSMITTER/LEADWIRE APPLICATION — Applying a transmitter and/or leadwire that is not thoroughly dry to a patient can result in an electrically conductive path being established and a ***Leads Fail*** alarm not being provided if leadwires come off the patient.

Cleaning products to avoid

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

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

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

Transmitter/device cleaning

These instructions apply to transmitters and any other devices, such as oximeters, blood pressure monitors, etc.

Results of improper cleaning

- Appearance of waveforms when the device is not connected to a patient, causing false alarms instead of a ***Leads Fail*** alarm and may not provide a visual and/or audible ***Leads Fail*** alarm.
- Brittle and breaking device case.
- Overall system performance degradation.
- Melting, dulling, or distorting the case.
- Total handheld medical device failure requiring replacement.
- Unit malfunction.
- Void warranty.

Cleaning/disinfecting

1. Remove all batteries and leadwires.
2. Close the battery door before cleaning the device.
3. Wipe the exterior of the device with a soft lint-free cloth, using the following solution as recommended in the APIC Guidelines for Selection and Use of Disinfectants (1996):
   - Sodium hypochlorite (5.2% household bleach) minimum 1:500 dilution (minimum 100 ppm free chlorine) and maximum 1:10 dilution.
   - Any sodium hypochlorite wipe product that meets the above guidelines of can be used.

   NOTE

   Wring excess disinfectant from wipe before using.

   NOTE

   Any contact of disinfectant solutions with metal parts may cause corrosion.
4. Allow disinfectant solution to remain on device for a minimum of one minute or per hospital guidelines.
5. Wipe off cleaning solutions with a clean, moist cloth.
6. Dry thoroughly with a dry lint-free cloth and let air dry for at least 30 minutes.

   NOTE

   Drying times may vary based on the environmental conditions.
7. Take care not to let fluid pool around connection pins. If this should happen, blot dry with a soft, lint-free cloth.

Storage

- Always remove batteries when the device is not in use (even for short periods of time).
- Store in a dry well-ventilated area.

- Hang the device, use a holder if available.
- If leadwires/cables are attached, they should hang straight.
- Do not coil leadwires/cables tightly around the device.

ECG cable/leadwire cleaning

Results of improper cleaning

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

Cleaning/disinfecting

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

   NOTE

   Wring excess disinfectant from wipe before using.

   NOTE

   Any contact of disinfectant solutions with metal parts may cause corrosion.
5. Do *not* immerse either end of a cable or leadwire connector. Immersing or soaking the connector ends may corrode metal contact ends and affect signal quality.
6. Wipe off cleaning solutions with a clean, lightly moistened cloth.
7. Dry thoroughly with a dry lint-free cloth and let air dry for at least 30 minutes.

NOTE

Drying times may vary based on the environmental conditions.

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

Sterilizing

NOTE

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

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

Storage

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

Calibration

WARNING
LOSS OF DATA—The manufacturer requires that calibration be performed by service personnel as follows:

For 1395-1400 MHz systems calibrate the following every 2 years:

- T14 transmitter
- RIM 1400
- Receiver subsystem

Determine and record the date of initial factory calibration of transmitters and receivers from the removable calibration sticker that ships on these devices. Calibrate within 30 months of the date shown on the manufacturer calibration sticker or 24 months after installation, whichever occurs first, and every 24 months thereafter.

Transmitter calibration

Required equipment

- Spectrum analyzer
- Rubber duck antenna
- An external 10 MHz reference (accurate to 0.0083 ppm)
- Laptop with HyperTerminal

Determine target frequency

Using the TTX number on the back of the transmitter, look up the target frequency in the ApexPro Telemetry Frequency Chart Reference Manual and record it here:

Target frequency: _____

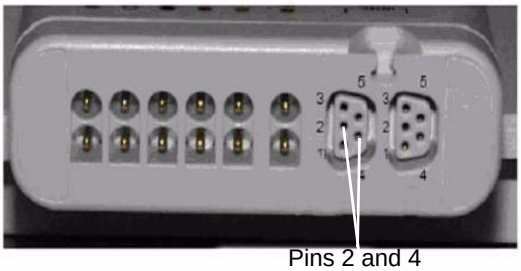
Determine frequency offset

This checks the carrier frequency to verify that it is within the frequency tolerance of the programmed value.

NOTE

The Rohde & Schwarz FSH3 spectrum analyzer is used for the following steps. If a different spectrum analyzer is being used, the detailed sub-steps may be different.

1. Connect a Rubber Duck antenna to the spectrum analyzer to view the transmitter.
2. Do one of the following:
   - Using a small paper clip, short pins 2 and 4 on either of the interface connector ports as shown.



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- Plug the programming box into one of the two serial ports.

3. Power up the transmitter.
4. Place the transmitter within one foot of the spectrum analyzer.
5. Press **PRESET**.
6. Connect the external 10 MHz reference to the **EXT TRIG IN/EXT REF IN**.

   NOTE

   The external reference must be accurate to 0.0083ppm. Ensure that you allow the external reference to warm up (See the device operators manual).

7. Set the analyzer for external 10MHz reference mode.
   a. Press **SETUP**.
   b. Press **F3**- ***HARDWARE SETUP***.
   c. Select ***BNC I/O MODE*** and press **ENTER**.
   d. Select ***EXT REF IN*** and press **ENTER**.
8. Ensure the preamplifier is on.
   a. Press **SETUP**.
   b. Press **F3 - *HARDWARE SETUP***.
   c. Select ***PREAMP*** and press **ENTER**.
   d. Select ***ON*** and press **ENTER**.
9. Set the center frequency to match the TTX number of the transmitter being tested. Refer to the ApexPro Telemetry Frequency Chart Reference Manual for TTX to frequency comparison.
   a. Press **FREQ**.
   b. Type the center frequency for the tested channel and press **ENTER**.
10. Set the reference amplitude to 0 dBm.
    a. Press **AMPT**.
    b. Type in **0**, press **dBM** and press **ENTER**.
11. Set the span to 50 kHz.

a. Press **SPAN**.

b. Type in **50**, press **kHz** and press **ENTER**.

12. Set the marker to the peak signal.

    a. Press **MARKER**.

    b. Press **F3** - ***SET MARKER***.

    c. Select ***Peak*** and press **ENTER**.

    d. The center maximum peak should be selected.

13. If necessary, set the center frequency to be the same as the marker frequency.

    a. Press **MARKER**.

    b. Press **F3** - ***SET MARKER***.

    c. Select ***CENTER=MKR FREQ*** and press **ENTER**.

14. Set span to 1 kHz.

    a. Press **SPAN**.

    b. Type **1**, press **kHz** and press **Enter**.

15. Set the resolution bandwidth to 100 Hz.

    a. Press **BW**.

    b. Press **F1** - ***MANUAL RES BW***.

    c. Type **100**, press **Hz** and press **Enter**.

16. Reset the marker to the peak signal.

    a. Press **MARKER**.

    b. Press **F3** - ***SET MARKER***.

    c. Select ***Peak*** and press **ENTER**.

    d. The center maximum peak should be selected.

17. Record the frequency of the marker:

    Measured frequency: _____

18. Subtract the transmitter target frequency (Determine target frequency on page 4-10) from the measured frequency (step 17) and record the value:

    _____ - _____ = _____

    Measured frequency - Target frequency = Frequency difference

    NOTE

    Multiply MHz by 1000000 (one followed by six zeros) to convert to Hz.

19. Follow the appropriate steps for the transmitter being calibrated.

    a. For ApexPro and ApexPro CH transmitters

i. Verify that the difference is no more than ±750Hz.

ii. If the transmitter fails this test, it must be returned for service.

iii. Remove the jumper from the interface connector port. When the jumper is removed, the transmitter resets and returns to normal operation mode.

b. For T14 transmitters:

i. If the difference is less than or equal to ±130 Hz, no adjustment is required as the transmitter is within specifications. If the difference is greater, proceed to Adjust T14 transmitter frequency.

NOTE

If the difference is more that ±1400 Hz from the target frequency, take the transmitter out of service and contact GE.

Adjust T14 transmitter frequency

WARNING
The T14 transmitter cannot be adjusted more that 1400 Hz over the lifetime of adjustments. Refer to the previously recorded adjustments to ensure that the overall total of adjustments is not or will not be more than 1400 Hz. If it greater than or equal to 1400 Hz take the T14 transmitter out of service and contact GE.

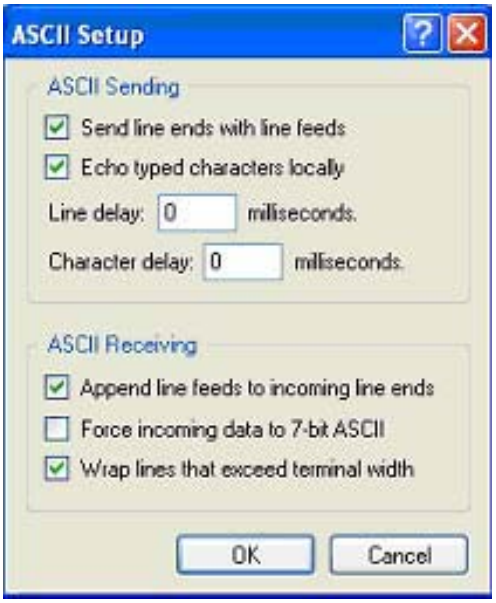
NOTE

This procedure applies to the T14 transmitters. If the ApexPro or ApexPro CH transmitter frequency needs to be adjusted, send the unit to GE for service.

1. Remove the jumper from the serial port on the transmitter. From the programming box kit, connect the programming box to the transmitter and the laptop serial port.
2. Launch ***HyperTerminal***.
3. Configure ***HyperTerminal*** to the following settings.

Baud-Rate	***9600***
Data Bits	***8***
Parity	***None***
Stop Bit	***1***
Flow Control	***None***

4. Configure the ASCII setup.
   a. Select ***File*** > ***Properties***.
   b. In the ***Settings*** tab, click ***ASCII Setup...***
   c. Verify the settings are the same as shown:



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d. Click ***OK***.

5. Identify and record the band that the transmitter is operating from the following table:

   Band: ___

T14 frequency bands		TTX range
Band 0	1395.025-1395.975	10199-10161
Band 1	1396 - 1396.975	10160-10121
Band 2	1397 - 1397.975	10120-10081
Band 3	1398 - 1398.975	10080-10041
Band 4	1399 - 1399.975	10040-10001

6. Type the command

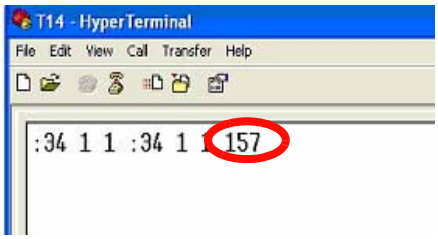
   :34<space>X<space>1

   NOTE

   X is the frequency band recorded in step 5 (e.g. **:34 1 1** for band 1)

7. Record the initial pot value shown:

   _____



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8. If the difference calculated in Determine frequency offset (step 18) is positive, *decrease* the pot value by one. If the difference is negative, *increase* the pot value by one. Type the command:

   CAUTION
   Do not move the pot setting by more than one value at a time to prevent moving the intended set point/frequency too far, which could cause signal dropout.

   :35<space>X<space>1<space>Y

   NOTE

   X is the frequency band recorded in step 5, Y is the pot value increased/ decreased by one (e.g. **:35 1 1 156**)

9. Check the frequency on the spectrum analyzer. If it is not within 130 Hz of the target frequency, repeat the steps in Adjust T14 transmitter frequency.

10. Once the measured frequency is within 130 Hz of the target frequency the calibration is complete. Record the total amount of Hz adjusted in the ApexPro Telemetry Frequency Chart Reference Manual or somewhere it can be tracked for the lifetime of the transmitter for future calibration reference.

    Record the final pot value: _____

11. Repeat step 8 to program the remaining bands to the same pot setting. (e.g. if band 1 was set to 156, bands 0,2,3, and 4 should be set to 156).

Receiver calibration

Determine target frequency

NOTE

The Rohde & Schwarz FSH3 spectrum analyzer is used for the following steps. If a different spectrum analyzer is being used, the detailed substeps may be different.

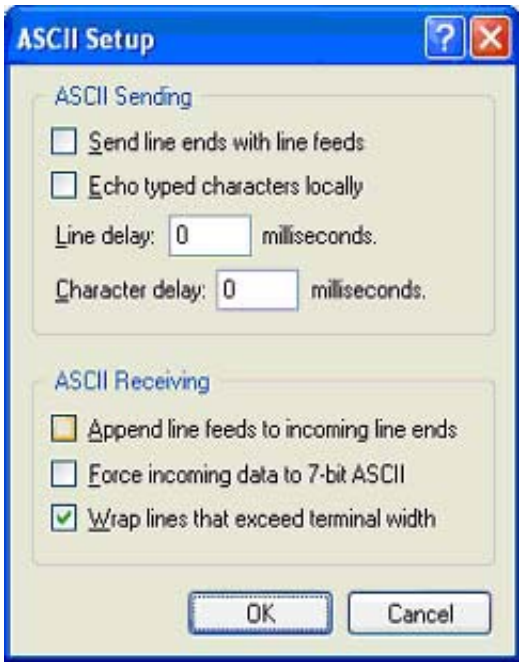
1. Connect a serial cable between a laptop and the receiver subsystem **Async Comm** connector.

2. Launch ***HyperTerminal***.

3. Configure ***HyperTerminal*** to the following settings.

Baud-Rate	19200
Data Bits	***8***
Parity	***None***
Stop Bit	***1***
Flow Control	***Xon Xoff***

4. Configure the ASCII setup.
   a. Select ***File*** > ***Properties***.
   b. In the ***Settings*** tab, click ***ASCII Setup...***
   c. Verify the settings are the same as shown:



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   d. Click ***OK***.
5. Press **Enter**.
6. When prompted, type the password **mms_aps** and press **Enter**.
7. At the **@>** prompt, type **ss** and press **Enter**.
8. Determine if patients are admitted to the receiver, use the following graphics for reference:
   - If the column next to FQ is all -1 values, no beds are admitted on the receiver subsystem tested. Proceed to step 9.

```
@> ss
RX  0 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  1 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  2 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  3 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  4 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  5 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  6 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  7 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  8 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX  9 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX 10 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX 11 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX 12 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX 13 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX 14 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
RX 15 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x00 RS 0x00
```

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- If the column next to FQ is displays any hertz values, each hertz value represents an admitted bed on the receiver subsystem tested. Proceed to step 10.

```
@> ss
RX  0 AP 1 FQ 567000000 VF 0x0f AF 0xff AT -1 AG   -1 TL 1 HS 0x03 RS 0x03
RX  1 AP 1 FQ 600000000 VF 0x0f AF 0xff AT -1 AG   -1 TL 1 HS 0x03 RS 0x03
RX  2 AP 1 FQ 612000000 VF 0x0f AF 0xff AT -1 AG   -1 TL 1 HS 0x03 RS 0x03
RX  3 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  4 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  5 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  6 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  7 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  8 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX  9 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX 10 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX 11 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x03 RS 0x00
RX 12 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x01 RS 0x00
RX 13 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x01 RS 0x00
RX 14 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x01 RS 0x00
RX 15 AP 0 FQ         -1 VF 0xff AF 0xff AT -1 AG   -1 TL 0 HS 0x01 RS 0x00
```

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9. If no beds are admitted, perform the following steps:

   a. Type **l<space>1<space>1** and press **Enter**.

   NOTE

   The command is lower case letter L <space> number one <space> number one. This will load application one to receiver one.

   b. Type **sf<space>1<space>600000000** to admit a reserved frequency to receiver one.

   NOTE

   The command is sf<space>number one<space> number six followed by eight zeros.

c. Type **ss** and press **Enter** to confirm settings. You should see

RX 1 AP 1 FQ 600000000

d. The target frequency when using the 600000000 Hz reserved frequency is 513.15 MHz (513150000 Hz).

e. Proceed to Determine frequency offset on page 4-18.

10. If beds are admitted, perform the following steps:

a. Choose one of the admitted beds from the list shown and use that frequency for the following.

b. Calculate and record the target frequency:

displayed frequency from the list - 86.85 MHz = target frequency

_____Hz - 86850000 Hz = _____Hz

NOTE

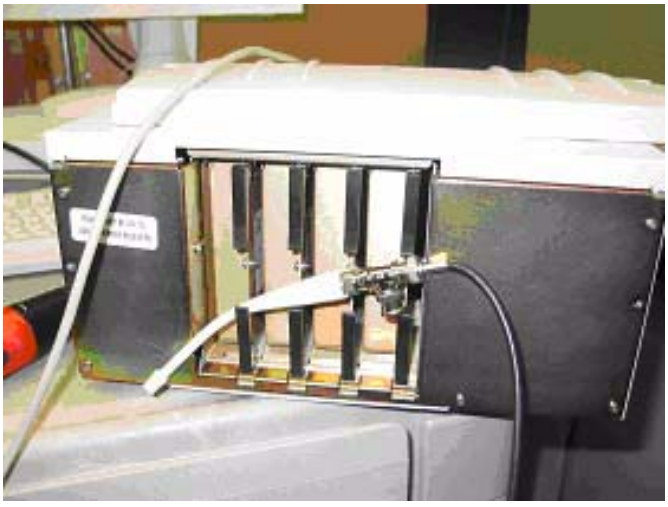
Multiply MHz by 1000000 (one followed by six zeros) to convert to Hz.

c. Proceed to Determine frequency offset on page 4-18.

Determine frequency offset

1. Connect a rubber duck antenna to the spectrum analyzer and the antenna. If desired, use a short 75 Ohm jumper cable to connect the antenna to the spectrum analyzer.

2. Remove the front cover of the receiver, as shown, and place the antenna very close to the receiver cards.



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3. On the spectrum analyzer, press **PRESET**.

4. Connect the external 10 MHz reference to the **EXT TRIG IN/EXT REF IN**.

   NOTE

   The external reference must be accurate to 0.0083ppm. Ensure that you allow the external reference to warm up (See the device operators manual).

5. Set the analyzer for external 10MHz reference mode.

   a. Press **SETUP**.

   b. Press **F3**- ***HARDWARE SETUP***.

   c. Select ***BNC I/O MODE*** and press **ENTER**.

   d. Select ***EXT REF IN*** and press **ENTER**.

6. Ensure the preamplifier is on.

   a. Press **SETUP**.

   b. Press **F3** - ***HARDWARE SETUP***.

   c. Select ***PREAMP*** and press **ENTER**.

   d. Select ***ON*** and press **ENTER**.

7. Set the center frequency to match the target frequency of the receiver subsystem being tested.

   a. Press **FREQ**.

   b. Type the target frequency, press the correct units button and press **ENTER**.

8. Set the reference amplitude to -60 dBm.

   a. Press **AMPT**.

   b. Type **-60**, press **dBm** and press **ENTER**.

9. Set the span to 1 kHz.

   a. Press **SPAN**.

   b. Type **1**, press **kHz** and press **ENTER**.

10. Set the resolution bandwidth to 100 Hz.

    a. Press **BW**.

    b. Press **F1** - ***MANUAL RES BW***.

    c. Type **100**, press **Hz** and press **Enter**.

    NOTE

    Ensure that the antenna is located as close to the back of the receiver as possible. Depending on the antenna used, the signal will be very small (–100 dBm or smaller). When positioning the antenna, do not move it too quickly as the analyzer is doing a three cycle average and the peak will build. If you do not see a signal, change the center frequency up or down by 1 kHz up to 4 kHz (signal should not be outside of this range). Ensure that the resolution bandwidth does not change while doing this.

11. Set the trace mode to a three cycle average.
    a. Press **TRACE**.
    b. Press **F1** - ***TRACE MODE***.
    c. Select ***AVERAGE*** and press **ENTER**.
    d. Type **3** and press **ENTER**.
12. Set the marker to the peak signal.
    a. Press **MARKER**.
    b. Press **F3** - ***SET MARKER***.
    c. Select ***Peak*** and press **ENTER**.
    d. The center maximum peak should be selected.
13. Record the measured frequency of the marker:

    Measured frequency: _____
14. Subtract the receiver subsystem target frequency (Determine target frequency on page 4-15) from the measured frequency (See step 13.) and record the frequency difference.

    _____ - _____ = _____

    Measured frequency - Target frequency = Frequency difference

    NOTE

    Multiply MHz by 1000000 (one followed by six zeros) to convert to Hz.
15. If the difference is less than or equal to ±10 Hz, no adjustment is required as the receiver subsystem is within specifications. If the difference is greater, proceed to Adjust frequency.

Adjust frequency

1. In ***HyperTerminal***, type **gvd** and press **Enter**.
2. Record the initial DAC value:

   _____
3. Type **svd<space>new value** (e.g. svd 162).

   NOTE

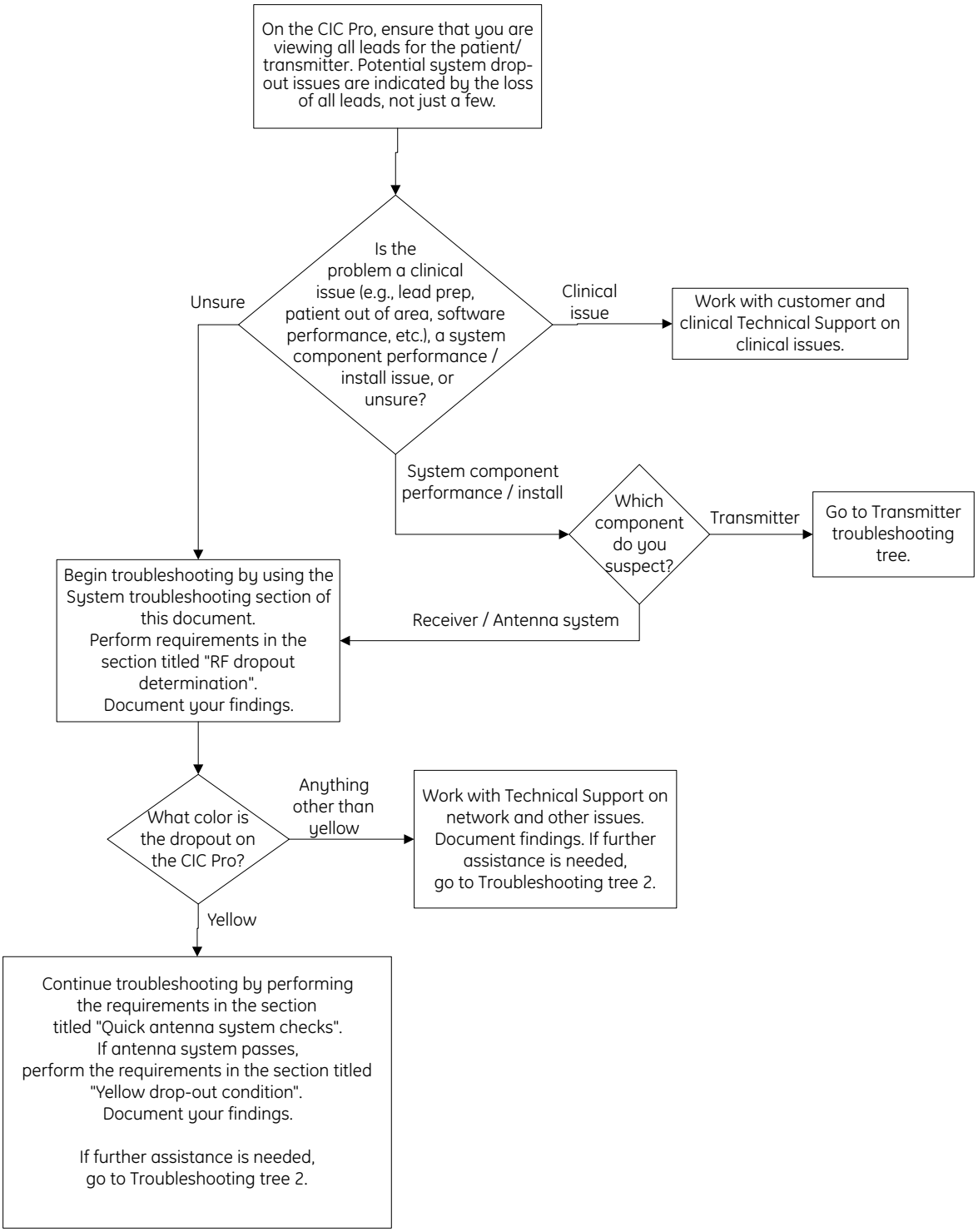
   If the difference calculated above is positive, decrease the DAC value by one. If the difference is negative, increase the DAC value by one.

   CAUTION
   Do not move the DAC setting by more than one value at a time to prevent moving the intended set point/frequency too far, which could cause signal dropout.

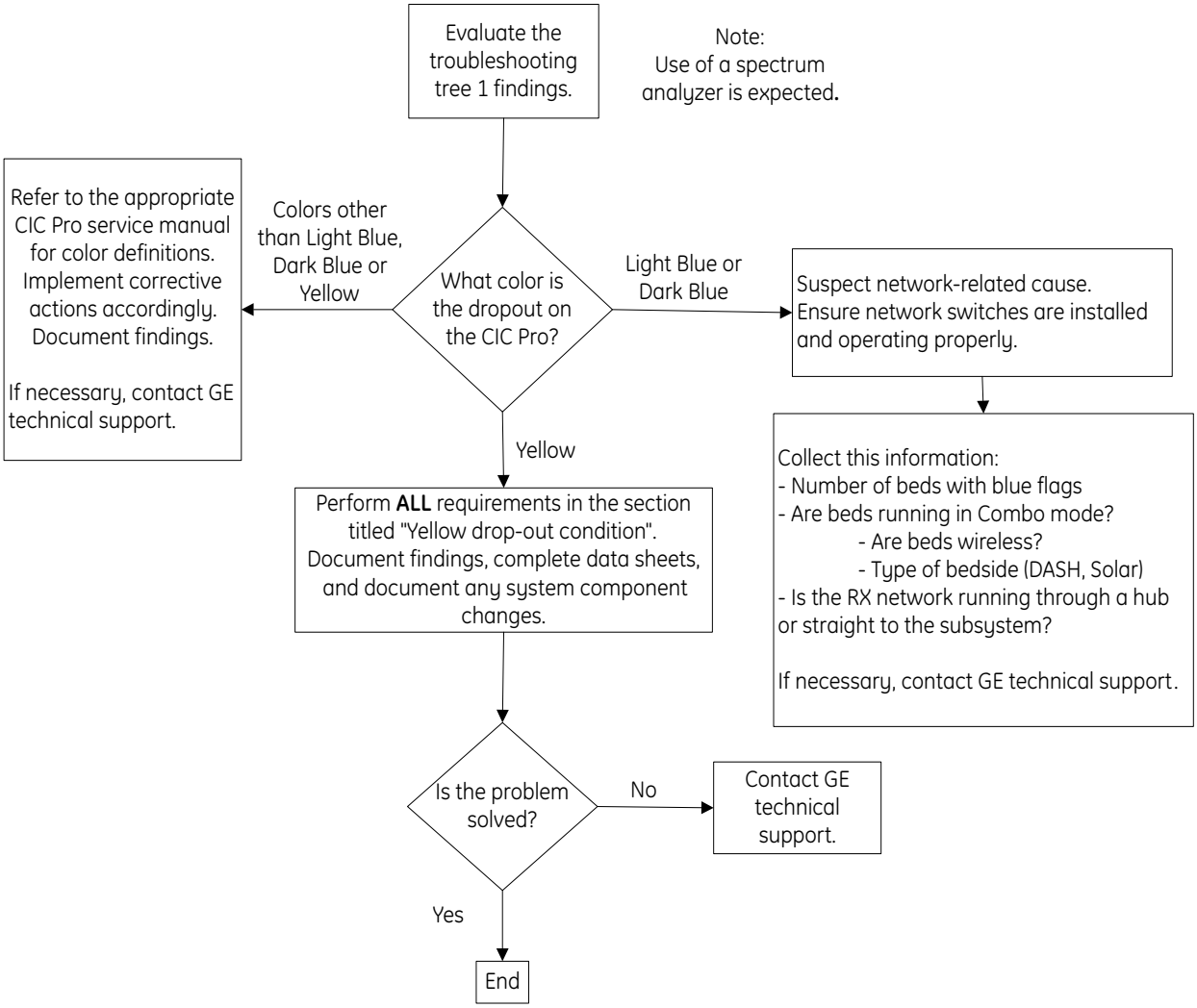
4. Check the frequency on the spectrum analyzer. If the frequency is not within 50 Hz of the target frequency, repeat by either further increasing or decreasing the DAC value by one.

5 Troubleshooting

Troubleshooting tree 1

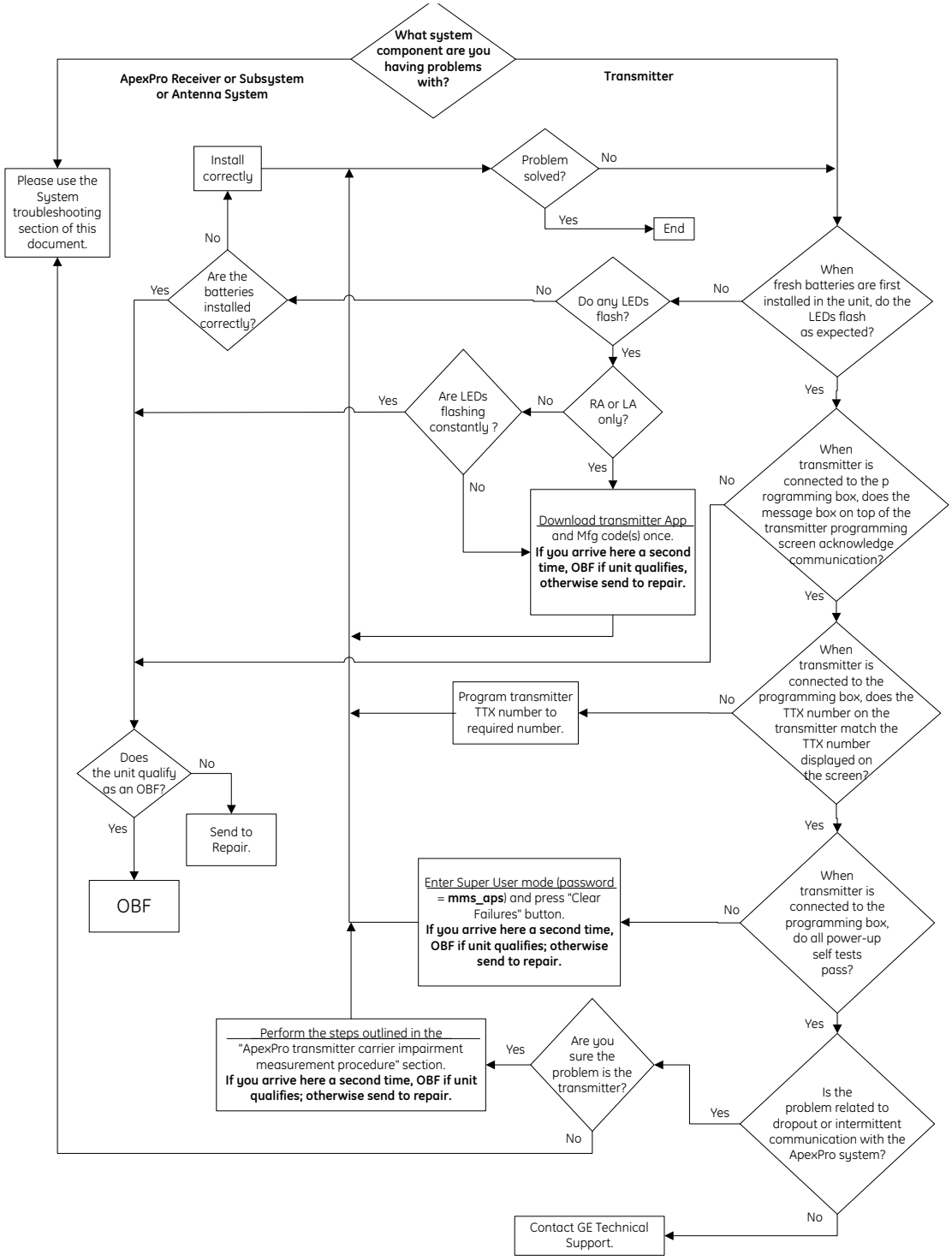


Troubleshooting tree 2



ApexPro transmitter troubleshooting tree

Use the APEX, ApexPro and ApexPro CH Transmitter Programming Box Programming Instructions to accomplish the tasks below. Programming Kit: PN 421733-xxx



System troubleshooting

RF drop-out determination

Turn on drop-out flags on the CIC Pro to check the color of any drop-out on the patient signal lead waveform at the CIC Pro patient view.

1. From the Main CIC Pro screen, select the ***Setup CIC*** button.
2. Select the ***Service Password*** tab.
3. Type the password **mms_com** and then select ***OK***. A Command prompt window is displayed.
4. Type **setflags<Space>-mark<Space>all** and press **Enter** on the keyboard to turn on drop-out flags.
   - If the color is yellow, suspect RF drop-out on the transmitter, the antenna system or the receiver system.
   - If the color is light blue or dark blue, suspect a network issue, not an RF-related drop-out.
   - If it is another color, refer to the CIC Pro Service Manual provided with your system for the cause since this indicates that it is not RF drop-out.
5. Type **setflags<Space>-mark<Space>off** and press **Enter** on the keyboard to turn off drop-out flags.
6. Close the Command prompt window and the CIC Setup window.

Yellow drop-out condition

Determine the source of the problem

1. Verify the patient/transmitter is in the coverage area. If not, the system is not at fault.
2. On the CIC Pro:
   - Ensure that you are viewing all leads for the patient/transmitter.
   - If the status is ***Leads Fail***, correct the system. Refer to the operator's manual provided with your system.

     NOTE

     If a shorted-leadwire set is used, an Asystole alarm will sound if the transmitter is admitted. This alarm can be silenced by turning off all alarms for this admitted bed.
3. Check the transmitter battery status. If the status is ***Low Batt***, correct the condition by replacing the batteries with new ones.

   NOTE

   If needed, refer to the appropriate ApexPro Telemetry Service Manual or the operator's manual provided with your system.

4. Isolate whether the drop-out is related to single or multiple patients in the same coverage area by verifying if more than one transmitter is dropping out in that coverage area.

   - If multiple transmitters drop out in the same coverage area, suspect the antenna system. See Antenna system troubleshooting on page 5-7.
   - If only one transmitter is dropping out, suspect transmitter or receiver. Follow the steps to Troubleshoot the transmitter on page 5-6 or Troubleshoot the receiver on page 5-6 for specific troubleshooting techniques.

Troubleshoot the transmitter

If the drop-out is related to only a single patient/transmitter, use the following instructions to duplicate the transmitter on another receiver.

1. From the Main CIC Pro screen, select the **Setup CIC** button.
2. Select the **Service Password** tab.
3. Type the password **mms_com** and then select ***OK***. A Command prompt window is displayed.
4. Type **setflags<Space>-dup<Space>on** and press **Enter** on the keyboard to allow duplicate transmitters.

   NOTE

   Once you select this option, you have five minutes to enter the duplicate TTX numbers. If that is not enough time, simply select this option again and continue entering TTX numbers.

5. At the CIC Pro center, admit a duplicate TTX four times. You should have the same TTX admitted five times. This will ensure that the TTX is admitted to at least two different receiver cards.
6. Type **setflags<Space>-dup<Space>off** and press **Enter** on the keyboard when you want to turn off duplicate TTX.
7. Close the Command prompt window and the **CIC Setup** window.

   - If drop-out continues on both receivers, suspect the transmitter. Swap the transmitter with a known good transmitter. Drop-out should go away.
   - If drop-out is on one receiver and not the other, See Troubleshoot the receiver on page 5-6.

Troubleshoot the receiver

If drop-out is on one receiver and not on the other, use the ApexPro Telemetry Server Service Manual provided with your system to complete the following steps.

1. Isolate which receiver subsystem is attached to the CIC Pro center you're viewing by using the service diagnostic tool ***PTSCONFIG*** at the CIC Pro center/telemetry server and the command "blink patient unit|bed*" in order to associate a care unit/bed number to a receiver in a given rack.

2. Once the receiver subsystem is known, check all LEDs for proper operation. Verify their status with the Receiver Subsystem LED status chart on page 5-13.
3. Swap the suspected receiver with a known good receiver card. Drop-out should go away.

   If drop-out does not go away, suspect an antenna coverage problem. See Antenna system troubleshooting on page 5-7.

Quick antenna system checks

1. Check all antennas:
   a. Check to see if each antenna's LED is illuminated.
   b. If any antenna's LED is not illuminated, make sure its power supply is powered. Apply power to the antenna power supply if necessary.
   c. Make sure all cables are properly connected.
   d. Replace the power supply if necessary.
   e. Replace the antenna if necessary.
2. If all antennas are okay, check the antenna amplifiers.
   a. Check to see if each antenna amplifier's LED is illuminated.
   b. Make sure the amplifier is properly oriented regarding RF In and DC Out.
   c. Make sure all cables are properly connected.
   d. Replace any faulty unit(s).

   NOTE

   If an identical replacement part cannot be found, contact the ND&I Team to ensure proper system balancing.

Antenna system troubleshooting

Perform the following steps in the listed sequence.

Refer to the ApexPro Antenna System Installation Test Instructions for test details.

1. Obtain the following test equipment and site documentation:
   - Equipment required to perform tests as listed in the ApexPro Antenna System Installation Test Instructions
   - Floor plan with antenna placement (-101)
   - Rack Diagram (-301)
   - Splitter Board Design Document (-700)
   - Loss calc spreadsheet (-430)
   - Clinical Systems Design Tool for site
2. Verify the antenna system meets the requirements of the Out-of-Band RF Signal Test.

a. Perform Out-of-Band RF Signal Test.

b. Record data in the Clinical Systems Design Tool.

c. If test passes, go to the next test.

d. If test fails:

i. Troubleshoot signal(s) to suspect antenna(s) and add appropriate filtering.

ii. Verify by repeating the test.

iii. Update documentation.

3. Verify the antenna system meets the requirements of the Unity Signal Gain Test with Transmitter.

a. Perform the Unity Signal Gain Test with Transmitter.

b. Record data in the Clinical Systems Design Tool.

c. If test passes, go to the next test.

d. If test fails:

i. Verify that the actual installation complies with the system design.

ii. Adjust components as necessary to comply with the design.

iii. Verify by repeating the test.

iv. Update documentation if appropriate.

v. If test passes, go to the next step.

vi. If test still fails, contact GE technical support.

4. Verify the antenna system noise floor.

a. Perform Noise Floor Performance Test.

b. Record data in the Clinical Systems Design Tool.

c. If test fails:

i. Contact GE technical support.

ii. Notify the Field Product Specialist and Director of Service.

d. If test passes, go to the next test.

5. Verify the antenna system meets antenna coverage requirements.

a. Perform Antenna System Coverage Test.

b. Record data in the Clinical Systems Design Tool.

c. If test passes, go to the next test.

d. If test fails:

i. Determine the location(s) of additional antennas needed.

ii. Update the antenna design documentation and resubmit it for approval.

iii. Once approved, modify the antenna system according to the approved design.

iv. Repeat the tests in the Antenna System Installation Verification Test Plan section of the ApexPro Antenna System Installation Test Instructions.

6. Verify the antenna system meets the requirements of the In-Band Noise Test.
   a. Perform the In-Band Noise Test.
   b. Record data in the Clinical Systems Design Tool.
   c. If test passes, go to the next test.
   d. If test fails:
      i. Verify that no transmitters are programmed to occupy the failed TTX number.
      ii. Change transmitter TTX numbers as required.
      iii. Verify by repeating the test.
      iv. Update the CIC Pro TTX number list and documentation.
   e. Perform step 4 again if it previously failed.
   f. If step 4 fails a second time:
      i. Complete step 7 and contact GE technical support.
      ii. Notify the Director of Service or Field Product Specialist.
7. Verify transmitter TTX numbers are valid for installed notch filters in the system.
   a. Perform the Transmitter Frequency Validation Test.
   b. If test passes, go to the next test.
   c. If test fails:
      i. Change transmitter TTX numbers as required.
      ii. Verify by repeating test.
      iii. Update the CIC Pro TTX number list and documentation.
8. If drop-out continues, contact GE technical support.

ApexPro transmitter carrier impairment measurement procedure

Rationale for test

The purpose of this test is to compare the transmitter's carrier level to the transmitter's modulated output. The transmitter's carrier level must be at least 30 dB

below the transmitter's modulated output, otherwise the signal will interfere with the modulated output and cause drop-out. This test verifies that the carrier level conforms to this requirement. This test is not required for ApexPro CH transmitters (PN 2014748-XXX).

NOTE

The ApexPro transmitter troubleshooting tree on page 5-4 references this test.

Equipment needed

- Spectrum Analyzer (Rohde & Schwarz FSH3 preferred)
- N-connector-to-BNC-connector adapter (attached)
- BNC-connector-to-F-connector adapter
- Cable with F-connectors on both ends, to connect the antenna system output to the spectrum analyzer input
- ApexPro transmitter (PN 418500-XXX)
- Rubber duck antenna

Rohde & Schwarz FSH3 test procedure

For each transmitter, perform the following test.

1. Press **POWER ON** and allow the spectrum analyzer to warm up.
2. Stand the analyzer on end with the stand on back of the analyzer.

3. Attach a rubber duck antenna to the analyzer.
4. Press **PRESET**.
5. Turn on the transmitter under test. Disconnect any attached leadwires. Wait 10 seconds for the transmitter to stop transmitting.
6. Set the center frequency of the analyzer to the frequency of the transmitter under test.
   a. Press FREQ.
   b. Press the numbers corresponding to the center frequency for the channel being tested and press ENTER.
7. Set the analyzer span to 25 kHz.

a. Press SPAN.

b. Press F1 - MANUAL SPAN.

c. Press 25.

d. Press kHz.

e. Press ENTER.

8. Set the analyzer reference amplitude to -30 dB.

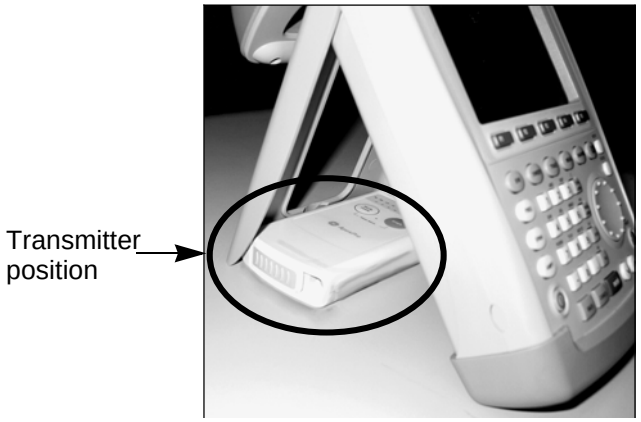
   a. Press AMPT.

   b. Press 30.

   c. Press GHz/-dBm.

   d. Press ENTER.

9. Place the transmitter face up in front of the stand. See the figure below. Make sure the placement of the transmitter is consistent.



10. Turn on **MARKER** and place it on the peak of the signal.

11. Turn on averaging to average over 10 samples.

    a. Press **TRACE**.

    b. Press **F1** - ***TRACE MODE***.

    c. Select ***AVERAGE***.

    d. Press **ENTER**.

12. Move away from the analyzer. Your body will affect the measurement, so make sure your hands are at least 3 feet away from the analyzer, antenna, and transmitter.

13. Watch the peak signal for 30 seconds and record the highest value you see.

14. Put the transmitter into Pause Alarm mode to force the transmitter to transmit an RF signal.

    To put the transmitter into Pause Alarm mode, do the following:

With transmitter powered, press **Graph** and **Verify Leads** buttons at the same time. The Pause Alarm LED will begin to blink. This mode will remain active for 5 minutes (default time) or until transmitter is powered down or is taken off Pause Alarm mode, whichever occurs first. (After 5 minutes the RF will shut off.)

15. Place the transmitter in the same position on the spectrum analyzer as in step 9.
16. Turn on a marker and place it on the peak of the signal.
17. Turn on averaging to average over 10 samples.
    a. Press **TRACE**.
    b. Press **F1** - ***TRACE MODE***.
    c. Select ***AVERAGE***.
    d. Press **ENTER**.
18. Move away from the analyzer. Your body will affect the measurement, so make sure your hands are at least 3 feet away from the analyzer, antenna, and transmitter.
19. Wait for 10 seconds and then record the peak of the signal.

NOTE

When measuring the signal, ensure that the transmitter is still in Pause Alarm mode by verifying that the no alarm LED on the front of the transmitter is blinking.

20. Repeat steps 5 through 19 for all transmitters to be tested.

We recommend the following table for data collection:

Transmitter TTX number	Transmitter serial number	Transmitter carrier level (dB) from step 13	Transmitter modulated data level (dB) from step 19

Transmitter TTX number	Transmitter serial number	Transmitter carrier level (dB) from step 13	Transmitter modulated data level (dB) from step 19

Acceptance criteria

The transmitter's carrier level should be 30 dB or more below the transmitter's modulated output. For example, if a transmitter's modulated output is -55 dB, its carrier level should be -85 dB or lower. If the carrier level is higher, the transmitter needs repair.

Receiver subsystem troubleshooting

Receiver Subsystem LED status chart

LED	Solid Green	Flashing Green	Solid Yellow	Flashing Yellow	Blank
System Status	Normal Operation	System Initialization	System Error – System Halted	Software updating or Blink rack command at CIC Pro	Power off
Receiver 1	Normal Operation	Module 1 Initialization	Module 1 Error	Single Receiver Error on Module 1 or Blink rack command at CIC Pro	Not installed
Receiver 2	Normal Operation	Module 2 Initialization	Module 2 Error	Single Receiver Error on Module 2 or Blink rack command at CIC Pro	Not installed
Receiver 3	Normal Operation	Module 3 Initialization	Module 3 Error	Single Receiver Error on Module 3 or Blink rack command at CIC Pro	Not installed
Receiver 4	Normal Operation	Module 4 Initialization	Module 4 Error	Single Receiver Error on Module 4 or Blink rack command at CIC Pro	Not installed
Link/Collision	Link Established	N/A	N/A	Ethernet Collision Occurred	Not connected to host
Transmit/ Receive	N/A	Ethernet Transmission	N/A	Ethernet Reception	No transmit or receive

General fault isolation

Visual inspection

A thorough visual inspection of the equipment can save time. Small things—disconnected cables, foreign debris on circuit boards, missing hardware, loose components—can frequently cause symptoms and equipment failures that may appear to be unrelated and difficult to track.

The following steps might seem trivial but it is highly recommended that they be performed to remove these “simple” failures as causes of problems.

NOTE

Notify the staff and move any admitted patients off the receiver system or provide for alternate monitoring before removing power from it.

- Set the ON/OFF switch to the **OFF** position and disconnect the Receiver System from its power source.
- Perform an internal visual inspection of the components.See Replaceable parts on page 6-1.

Take the time to make all the recommended visual checks (refer to the visual inspection table below) before starting any detailed troubleshooting procedures.

Area	Look for the following problems:
I/O Connectors and Interface Cables	■ Fraying or other damage ■ Bent prongs or pins ■ Cracked housing ■ Loose screws in plugs ■ Excessive cable tension or wear ■ Secure mounting hardware
Internal Harnesses and Cables	■ Excessive tension or wear ■ Loose connection ■ Strain reliefs out of place
Circuit Boards	■ Moisture, dust, or debris (top and bottom) ■ Loose or missing components ■ Burn damage or smell of over-heated components ■ Socketed components not firmly seated ■ PCB not seated properly in edge connectors ■ Solder problems: cracks, splashes on board, incomplete feedthrough, prior modifications or repairs
Ground Wires/Wiring	■ Loose wires or ground strap connections ■ Faulty wiring ■ Wires pinched or in vulnerable position
Mounting Hardware	■ Loose or missing screws or other hardware, especially fasteners used as connections to ground planes on PCBs ■ Receiver System mounted loosely or near vibration
Power Source	■ Faulty wiring, especially AC outlet ■ Circuit not dedicated to system (Power source problems can cause static discharge, resetting problems, and noise.)

Verify connectivity

Verify the connectivity between the ApexPro Telemetry System and the Receiver Subsystem by completing one of the following procedures:

- Ping the receiver system on page 5-15 or
- Check the ApexPro log file on page 5-16.

NOTE

Using the log file to verifying connectivity will result in approximately 10 seconds of unmonitored activity.

Ping the receiver system

To verify connectivity by pinging the Receiver System, complete the appropriate procedure below for your configuration. Follow all procedures sequentially to the end of the section for either the ApexPro application residing on a CIC on page 5-15 or for an ApexPro application residing on an ATS on page 5-16.

ApexPro application residing on a CIC

1. Query the IP address of the receiver by connecting a PC to the receiver **Async Comm** (asynchronous serial communication) port, using a 9-pin serial cable.

   NOTE

   The procedure to query the receiver via the serial port is described in Chapter 3. Use the **gip** command to get the receiver IP address.

2. At the CIC with ApexPro that is connected to the Receiver System, click ***Setup CIC***.

3. Select the ***Service Password*** tab.

4. Type the service password **mms_com** and press **Enter** to open a command prompt.

5. Type **ping 119.X.X.X** (where 119.X.X.X is the Receiver System IP address) and press **Enter**.

6. Verify that the reply reads similar to the example. Again, 119.X.X.X in the example below refers to the Receiver System IP address obtained in step 5 above.

   ```
   Pinging 119.X.X.X with 32 bytes of data:
   Reply from 119.X.X.X: 32 bytes = 32  time <10ms  TTL
   255
   Reply from 119.X.X.X: 32 bytes = 32  time <10ms  TTL
   255
   Reply from 119.X.X.X: 32 bytes = 32  time <10ms  TTL
   255
   ```

   If time out message appears, refer to Troubleshooting on page 5-1.

ApexPro application residing on an ATS

1. Query the IP address of the receiver by connecting a PC to the receiver **Async Comm** (asynchronous serial communication) port, using a 9-pin serial cable.

   NOTE

   The procedure to query the receiver via the serial port is described in Chapter 3. Use the **gip** command to get the receiver IP address.

2. Configure the laptop to the same IP addressing scheme as the ATS in order to connect to the ATS remotely within the hospital intranet (used to gain access to the ATS desktop). Refer to the ApexPro Telemetry Server service manual if additional instruction is needed to configure the IP address.

3. Start a ***Virtual Network Computing (VNC)*** session. Refer to the ApexPro Telemetry Server service manual if additional instruction is needed.

   a. Start ***Internet Explorer*** and type **http://[ApexPro Telemetry Server Unity Network IX network IP address]:5800** into the ***Address*** field and press **Enter**.

   b. When prompted, type **prism1,3,5,7** for the password and click **OK**

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   c. If the server is in sleep mode, or otherwise requires a login to start operation, click ***Ctrl-Alt-Delete*** at the top of the window.

4. Using the VNC remote connection, open a ***Command*** prompt on the ATS.

5. Type **ping 119.X.X.X** (where 119.X.X.X is the Receiver System IP address) and press **Enter**.

6. Verify that the reply reads similar to the example. Again, 119.X.X.X in the example below refers to the Receiver System IP address obtained in step 5 above.

   Pinging 119.X.X.X with 32 bytes of data:
   Reply from 119.X.X.X: 32 bytes = 32 time <10ms TTL 255
   Reply from 119.X.X.X: 32 bytes = 32 time <10ms TTL 255
   Reply from 119.X.X.X: 32 bytes = 32 time <10ms TTL 255

   If time out message appears, refer to Troubleshooting on page 5-1.

Check the ApexPro log file

To verify the connectivity between the ApexPro Telemetry System and the Receiver Subsystem by checking the ApexPro log file, complete the following procedure.

NOTE

Using the log file to verifying connectivity will result in approximately 10 seconds of unmonitored activity.

1. Unplug the receiver subsystem Ethernet cable for at least 10 seconds.
2. Reconnect the Ethernet cable and wait 30 seconds.
3. Log into ***Webmin***. Refer to the appropriate service manual (example, CIC or ATS) if additional information is needed to log into ***Webmin***.
4. If the ApexPro application is running independently of the CIC application (such as on a telemetry server), perform step 5 only. If the ApexPro application and the CIC application co-exist on the same server (Nightshade or BCM CIC), perform step 6 only.
5. View the ApexPro Telemetry System logs for today as follows:
   a. Select the ***Diagnostics*** tab.
   b. Select ***Logs*** > ***View*** using the links on the left side of the ***Webmin*** window. The main part of the ***Webmin*** window will now display a ***View Logs*** information area.
   c. From the ***ApexPro Logs*** listing, select today's log. (Logs are named using the following convention: yyyymmdd.txt.)
   d. With the desired log selected, click ***Submit*** to display the log file.
   e. Scroll to the bottom of the log and search for an entry containing a string similar to the following ***"18:47:52.312 848:8E8 Rack Master: CRackMaster::UpdateRack added receiver: 119.2.10.17:3001 in slot 1"***

      If the connection was properly established, there should be a string containing "***hh:mm:ss ... UpdateRack added receiver: 119.X.X.X...***" where hh:mm:ss reflects the time the Ethernet cable was reconnected, and 119.X.X.X reflects the IP address of the receiver.
   f. If a string such as that shown in step e above is not present, then the connection has not been properly established. See Troubleshooting on page 5-1.
6. To view today's ApexPro log on a server running both CIC and ApexPro, complete the following procedure:
   a. Select the ***System*** tab.
   b. Using the links on the left side of the Webmin window, select ***View Logs*** > ***ApexLogs***
   c. Select today's log from the list of ***ApexLogs*** and click the ***View Selected Files*** button.
   d. When the log displays, scroll to the bottom of the log and search for an entry containing a string similar to the following ***"18:47:52.312 848:8E8 Rack Master: CRackMaster::UpdateRack added receiver: 119.2.10.17:3001 in slot 1"***

If the connection was properly established, there should be a string containing "***hh:mm:ss ... UpdateRack added receiver: 119.X.X.X...***" where hh:mm:ss reflects the time the Ethernet cable was reconnected, and 119.X.X.X reflects the IP address of the receiver.

e. If a string such as that shown in step d above is not present, then the connection has not been properly established. See Troubleshooting on page 5-1.

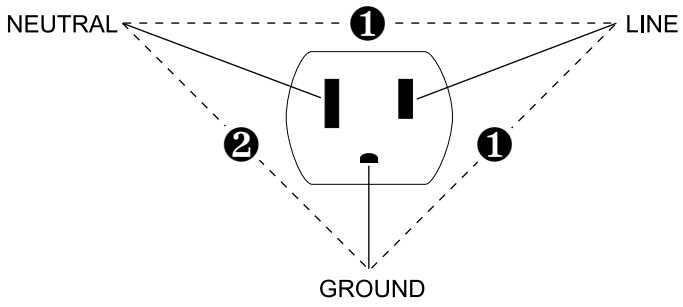
AC line voltage test

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

120 VAC, 50/60 Hz

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

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

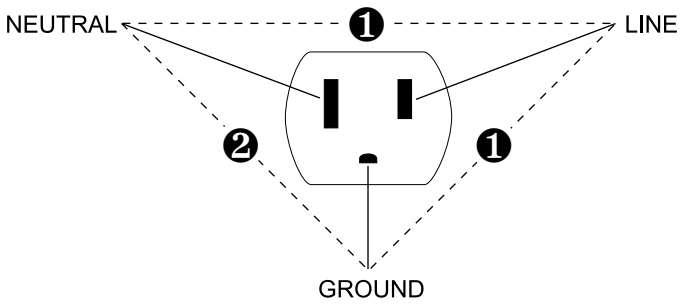


120VACplug

240 VAC, 50/60 Hz

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

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



240VACplug

Event logs

Events can be stored in two locations, the receiver system and the ApexPro host hard drive.

Receiver system event logs

Events logged to the receiver system are stored in flash memory and can be retrieved via the diagnostic service port. The system stores the events in two flash memory sectors. When the event storage maximum is reached, and a new event occurs, the flash sector with the oldest events is erased. New events are stored to that sector.

Access the receiver system event logs as follows.

1. Using the 9-pin, serial cable supplied with the transmitter programming kit, connect a PC to **Async Comm** (asynchronous serial communication).
2. At the PC, use a communication program such as ***HyperTerminal*** to set up the ComPort connection.
3. Press **Enter** to get the **@>** ***Enter Service Password:*** prompt.
4. Type password, **mms_aps** (case-sensitive).
5. Press **Enter**.

   There is no command to view how many events are stored, but typically the most recent event will be examined first. Event 1 is the first (oldest) stored event.

   Use the **del** (display error log) command with a parameter of 999 to determine the number of events stored. Since 999 is greater than the number of events that can be stored, the command errors and reports the number of events in the system.
6. At the **@>** prompt type **del 999** and press **Enter**. The following displays.

   @> del 999
   Record not present, XXX ***records stored in system.***

NOTE

"XXX" is representative of the number of events stored in the error log. It will appear on screen as an actual number.

7. At the **@>** prompt type **del XXX** (where XXX equals the number of events as indicated in the error message) and press Enter to display the most recent event.

Other commands include:

- Type **,** (comma) and press **Enter** to display the previous log entry.
- Type **.** (period) and press **Enter** to display the next log entry.
- Type **dael** and press **Enter** to dump all entries. This is useful in conjunction with the "capture-to-file" feature of Hyperterminal.

The following is an example of the information in each event log.

Record Number 244	
Date/Time:	1 January 2000 00:00
Error Code:	0x438a
Severity:	4
Error Text:	Set fields for rcvr 15 to 15
Process Name:	sysstart
Status Register:	0x9042
User Stack Pointer:	0xff0902c8
Program Counter:	0xff013a24
Super Stack Pointer:	0xffcbffe8
Heap Pointer:	0xff0c8554
Passed Parameter:	15
Error Number:	60544
Ticks:	525

The date and time are set by the ApexPro Telemetry System. If the date and time have not been updated by the time the event occurs, the time defaults to 1 January 1990 00:00.

The error text explains the error code.

The severity levels are:

- 4 = An event occurred, not an error
- 5 = A minor error
- 6 = An error that caused the system to halt
- 7 = An error that caused the system to reset

The number of ticks indicates when the event occurred relative to the last time the system was rebooted. There are 60 ticks in one second.

The ***Passed Parameter***, in most cases but not all, indicates which receiver in the system logged the event. The receivers are indexed starting with 0.

ApexPro host event logs

The receiver system also sends events to the ApexPro host. The ApexPro host stores event logs only when the receiver system is connected to the ApexPro host. Refer to the appropriate service manual (eg. CIC, ATS, etc.) for information on obtaining the logs from the ApexPro Telemetry System.

Event logs may be requested by GE tech support to help diagnose the problem. The easiest way to save the logs is to use the ApexPro Webmin module. Refer to the appropriate service manual (eg. CIC or ATS) for additional information. \

Before calling service

Before calling service on a transmitter that may appear to be operating incorrectly or may have failed, check the following.

System dropout

If you suspect any system-related dropout or if you are not sure what the problem is, consult the ApexPro System Troubleshooting Instructions or the Enterprise Access Service Manual Troubleshooting section as applicable, available to GE service personnel.

Transmitter

Frequent lead fail

- Swap the leadwire set with either a new set or a known good set. Leadwires may have hidden internal damage that can cause signal failure.
- Leadwires may become brittle or damaged after frequent cleanings. Inspect them before each use and replaced if damaged.
- Leadwires that have been wrapped around the transmitter are more likely to be damaged. Use a transmitter holder when the transmitter is not in use. Leadwires should be either laid out flat or hung up such that there are no kinks or sharp bends in the wires.
- Check the electrodes on the patient. Improper preparation can cause Lead Fail events.
- Should Lead Fail events continue to occur regularly, a call for service may be necessary.
- If, after powering up the transmitter, only the **RA** LED flashes rapidly:
  - The transmitter has lost its memory.
  - The application code contained in the EEPROM has been erased or corrupted.
  - The transmitter needs to be reprogrammed.
  - Return the transmitter to the factory for service.

- If, after powering up the transmitter, only the **LA** LED flashes rapidly:
  - The transmitter has lost its memory.
  - The manufacturing/service code contained in the EEPROM has been erased or corrupted.
  - The transmitter needs to be reprogrammed.
  - Return the transmitter to the factory for service or contact Technical Support.

Short battery life

- Install a new set of alkaline AA batteries into the transmitter and then verify battery life.
- Once used in a transmitter for any length of time, dispose of (recycle) used batteries immediately.
- Batteries must NOT be re-used for telemetry. Use batteries for only one patient. DO NOT store used batteries for use with the next patient. A battery contains a finite amount of stored energy. Each unit of time a battery is used diminishes the amount of stored energy. Installing a used battery in a transmitter results in a greatly reduced, and unpredictable, monitoring period.
- NEVER use a battery beyond the recommended expiration date for the battery. The amount of stored energy in the battery may not be sufficient for proper monitoring.
- DO NOT use rechargeable batteries. The transmitter circuitry, Apex Oximeter, and the Accutracker were designed for the power output characteristics of alkaline batteries.

  NOTE

  Rechargeable batteries DO NOT store as much energy as alkaline batteries and have very different output characteristics. The monitoring period may be greatly shortened and the specified low-battery warnings may be adversely affected or possibly not even displayed.

- If, after working through the above steps, your transmitter still has a short battery life, a call for service may be necessary.

Waveform dropout

- To determine the type of dropout, enable flags as described in RF signal integrity on page 7-16.
- If out of antenna range, position the transmitter within range of the antenna.
- Check the voltage levels of the batteries. If the voltage level is below the acceptable value as listed in Switches/LEDs on page 2-13, replace the batteries. Alternatively, you can replace the batteries and see if the waveform is displayed properly.
- For external RF interference, use the spectrum analyzer to verify the external noise and reprogram the transmitter if necessary.
- If you suspect a bad transmitter, perform checkout procedure. (See Checkout on page 7-1.) Return to service if defective.

Synthesizer lock error

If the transmitter can not operate at its programmed frequency, a synthesizer lock error occurs. For the CH and T14 transmitter, the **Change Battery** and **Va** LEDs will be lit although the transmitter halts operation. Try resetting the transmitter by sliding the battery compartment cover open and closed again. If this does not resolve the problem, return the transmitter to the factory for service.

Additional problem resolution

If you are not sure which component in the telemetry system may be operating incorrectly or may have failed or if the above information does not resolve the problem, please contact GE technical support.

Apex oximeter and Nonin Xpod oximeter

Refer to the appropriate ApexPro Telemetry System Operator's Manual for troubleshooting messages for the oximeters.

Apex oximeter short battery life

- A change battery condition is indicated by the Apex Oximeter display flashing and displaying a message at the CIC Pro center. If the batteries are not changed within 1 hour, the oximeter's display flashes dashes, the sensor LED turn off, and no data displays on the CIC Pro center.
- Install a new set of alkaline AA batteries into the oximeter and then verify battery life.
- Once used in an oximeter for any length of time, dispose of (recycle) used batteries immediately.
- Batteries must NOT be re-used. Use batteries for only one patient. DO NOT store used batteries for use with the next patient. A battery contains a finite amount of stored energy. Each unit of time a battery is used diminishes the amount of stored energy. Installing a used battery in an oximeter results in a greatly reduced, and unpredictable, monitoring period.
- NEVER use a battery beyond the recommended expiration date for the battery. The amount of stored energy in the battery may not be sufficient for proper monitoring.
- DO NOT use rechargeable batteries. The oximeter circuitry was designed for the power output characteristics of alkaline batteries.

  NOTE

  Rechargeable batteries DO NOT store as much energy as alkaline batteries and have very different output characteristics. The monitoring period may be greatly shortened and the specified low-battery warnings may be adversely affected or possibly not even displayed.

- If, after working through the above steps, your oximeter still has a short battery life, a call for service may be necessary.

Power shutdown during leads fail

ApexPro

If all leads fail for more than about 8 seconds, the digital signal processor shuts off power supplied to the RF output amplifier. This reduces the battery discharge rate when no data actually transmits.

Once the leads are reconnected, about 1 second is required for the digital signal processor to power up the RF circuitry and resume transmitting patient data.

ApexPro CH and T14

If all leads fail for more than about 8 seconds, the digital signal processor shuts off the VCO regulator causing the RF output to be turned off.

Once the leads are reconnected or if a button is pressed, about 1 second is required for the digital signal processor to power up the VCO regulator. If the leads are still bad after a button is pressed the VCO regulator will turn off again (the RF turns on for 70 seconds for **Verify Leads** button press, 15 seconds for the other buttons).

If the transmitter is reporting a synthesizer lock error the VCO regulator will be turned off.

6 Replaceable parts

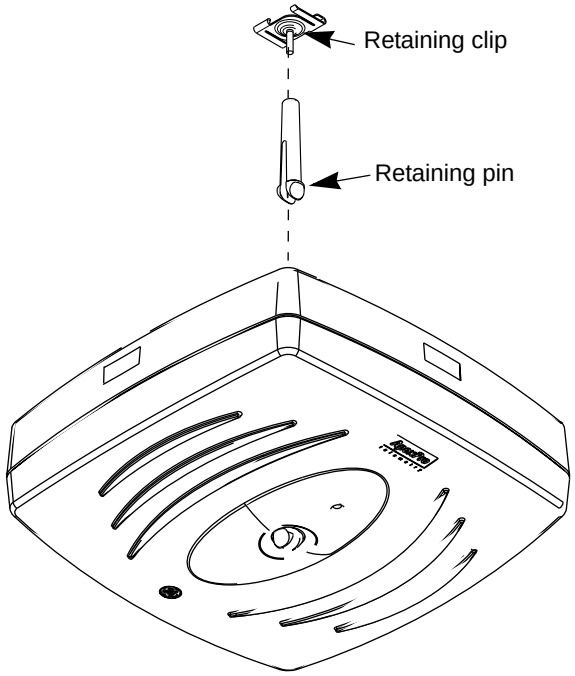
WARNING
LOSS OF DATA — Notify the affected users relying upon this data flow before shutting down the ApexPro™ antenna infrastructure components for any reason.

When replacing any component, be sure to replace it with the same part number. If a different part number is used, consult with GE ND&I to verify if any system redesign is required.

Mounting hardware and labels

The antennas described in Antenna on page 2-4 come with the following mounting hardware and labels:

Part number	Description	Status
45153-007	Ceiling Retaining Clip	Current
419524-001	Retaining Pin	Current
2001522-001	Antenna Labels	Current



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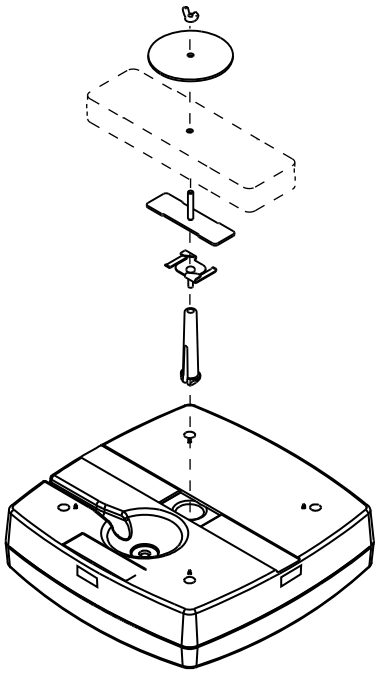
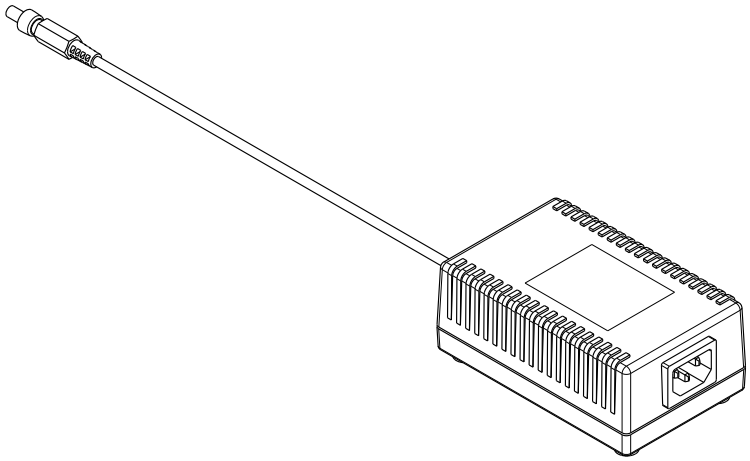
Optional antenna mounting kits

Part number	Description	Drawing
2002112-001	Optional Ceiling Tile Mounting Kit	 050A
2002112-002	Optional Drywall Mounting Kit	 045A

Power supply

Power cords must be ordered separately. See Power cords on page 6-19.



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NOTE

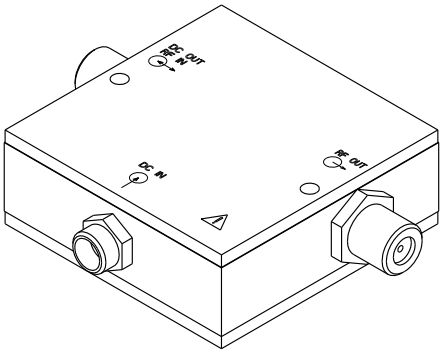
The power supply *must* be deactivated or unplugged when working with the antenna equipment.

For technical specifications, see Power supply specifications on page A-14.

Bias tee

NOTE

If using bias tee PN 2001546-001, you must use GE power supply PN 422766-001.



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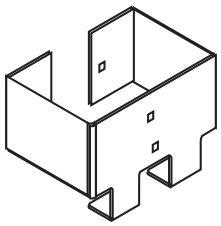
For technical specifications, see Bias tee specifications on page A-15.

Bias tee & power supply mounting kit

The mounting kit is for use with the following bias tee and power supply.

Part number	Description
422766-001	Telemetry Power Supply
2001546-001	RF Bias Tee 650MHZ 75 Ohms
2014998-001	Power supply kit with bracket and bias tee

The power supply sits inside the bracket and two screws are provided for mounting the bias tee to the front of the bracket.



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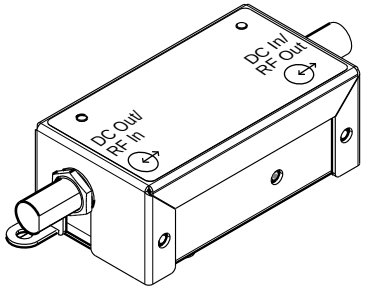
For technical specifications, see Bias tee & power supply mounting kit specifications on page A-16.

Antenna amplifier

The antenna amplifier is used to strengthen the antenna signal. A green LED on the side indicates that the amplifier is receiving power. The antenna amplifier is DC passing.

NOTE

Do not plug in backwards! Note the markings on the amplifier for installation orientation. If connected backwards, the LED will illuminate, however the amplifier will not work correctly: there will be signal loss instead of gain.



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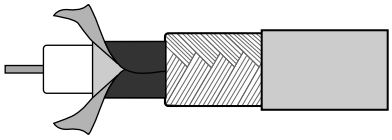
Part number	Description	Status
2001727-001	U.S. Antenna Amplifier (560–614 MHz)	Obsolete
2001727-002	International Antenna Amplifier (420-474 MHz)	Obsolete

Part number	Description	Status
2001727-004	U.S. Cable Amplifier (560–614 MHz)	Obsolete
2001727-005	International Cable Amplifier (420-474 MHz)	Obsolete
2001727-006	U.S. Cable Amplifier (560–614 MHz)	Current
2001727-007	International Cable Amplifier (420-474 MHz)	Current

For technical specifications, see Antenna amplifier specifications on page A-16.

Coaxial cabling - RG-6 and RG-11

Controlled-impedance cabling is used and 75-ohm RG-6 type is recommended. Plenum- or riser-rated cable is used to meet NEC fire codes. RG-11 may be used if cable lengths become long and dB losses become excessive.



75 Ohm Cable

075A

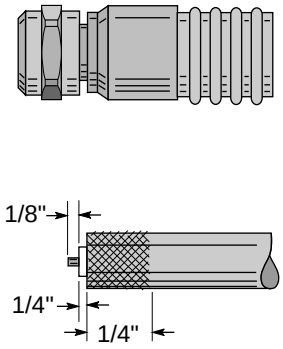
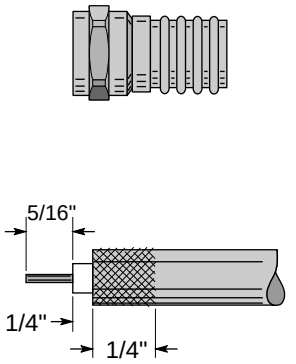
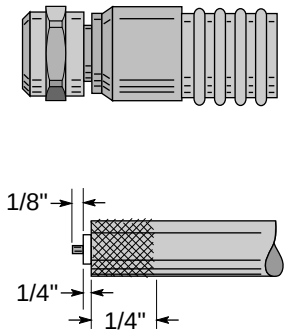
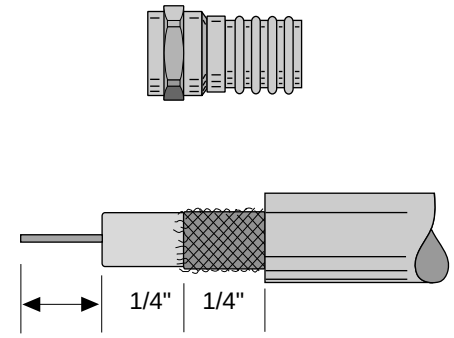
Part number	Coaxial type	dB loss/100 ft (dB loss / 30 meters) @ 200 MHz	dB loss/100 ft (dB loss / 30 meters) @ 400 MHz	dB loss/100 ft (dB loss / 30 meters) @ 600 MHz	dB loss/100 ft (dB loss / 30 meters) @1400 MHz	Ohms/1000 ft (ohms / 300 meters)	Status
4907-001	RG-6 Riser	N/A	4.0	5.1	N/A	31	Obsolete
4907-101	RG-6 Plenum	N/A	4.5	5.7	N/A	7.5	Obsolete
4908-001	RG-11 Riser	N/A	2.9	3.7	N/A	12	Obsolete
4908-101	RG-11 Plenum	N/A	3.3	4.3	N/A	12	Obsolete
2018505-001	RG-6 Riser	2.7	3.8	4.7	N/A	6.4	Current
2018506-001	RG-6 Plenum	2.9	4.4	5.5	N/A	6.5	Obsolete
2018506-002	RG-6 Plenum	N/A	4.3	5.5	8.7	6.4	Current
2018508-001	RG-11 Riser	1.8	2.6	3.2	N/A	2.6	Current
2018507-001	RG-11 Plenum	2.2	3.4	4.4	N/A	2.6	Current

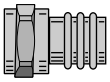
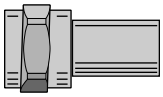
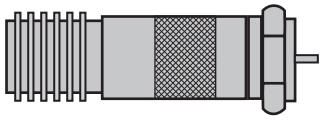
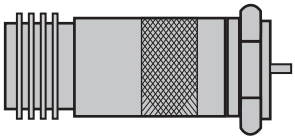
Connectors

NOTE

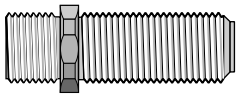
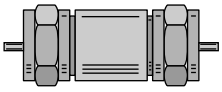
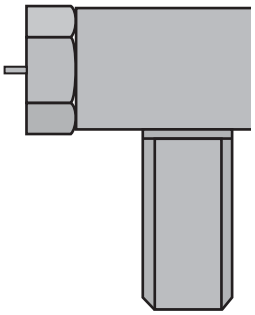
For obsolete connectors, stripping dimensions for the associated cables are shown in this section.

For current connectors, stripping dimensions for cables are shown in Installation guidelines on page 3-2.

Part number	Description	Drawing	Status
1886-003	F-Type, RG-11, Riser Male Connector		Obsolete
1886-004	F-Type, RG-6, Riser Male Connector		Obsolete
1886-007	F-Type, RG-11, Plenum Male Connector		Obsolete
1886-008	F-Type, RG-6, Plenum Male Connector		Obsolete

Part number	Description	Drawing	Status
2018509-001	F-Type, RG-6, Riser Male Connector	 100A	Current
2018510-001	F-Type, RG-6, Plenum Male Connector	 105A	Current
2018511-001	F-Type, RG-11, Plenum Male Connector	 110A	Current
2018512-001	F-Type, RG-11, Riser Male Connector	 115A	Current

Adapters

Part Number	Description	Drawing	Status
1886-401	Female F-Female F Adapter	 120A	Current
1886-601	Male F-Male F Adapter	 125A	Current
403789-001	Right Angle Female F - Male F Connector	 130A	Current

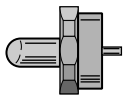
Block and terminator

75-Ohm terminator

The 75-ohm terminator is used to terminate all unused splitter/combiner and receiver ports.

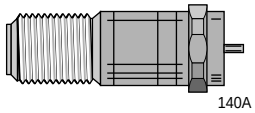
NOTE

The 75-ohm terminator must always be used with a DC power block.

Part Number	Description	Drawing	Status
17100-001	75 Ohm Terminator	 135A	Current

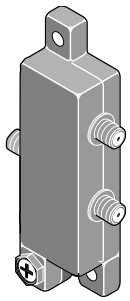
DC-power block

The DC-power block is used to isolate antenna system components that are not DC passive, such as terminations and notch filters, from DC voltage.

Part Number	Description	Drawing	Status
17102-001	DC Power Block	 140A	Current

Splitters/combiners

The splitters/combiners are used to combine antenna runs to create an antenna field or used to split an antenna field to support multiple receiver systems.

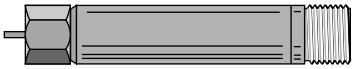


145A

Part number	Description	dB loss/gain		DC loss ohms	Status
		@ 474 MHz	@ 614 MHz		
2006947-001	2:1 Splitter/combiner	– 4.8	– 4.8	0.2	Obsolete
2006947-002	4:1 Splitter/combiner	– 8.4	– 9.1	0.2	Obsolete
2006947-003	8:1 Splitter/combiner	– 15.0	– 13.1	0.2	Obsolete
2007753-001	2:1 Splitter/combiner	– 3.5	– 3.9	0.1	Obsolete
2007753-002	4:1 Splitter/combiner	– 7.3	– 7.5	0.1	Obsolete
2007753-003	8:1 Splitter/combiner	– 10.9	– 10.5	0.1	Obsolete
2007753-014	2:1 Splitter/combiner	– 3.5	– 3.6	0.02	Current
2007753-015	4:1 Splitter/combiner	– 6.9	– 7.0	0.02	Current
2007753-016	8:1 Splitter/combiner	– 10.25	– 10.5	0.07	Current

DC passing attenuators

DC-passing attenuators are used to balance antenna runs.

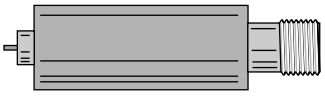


150A

Part number	Description	dB loss/gain		DC loss ohms	Status
		@ 474 MHz	@ 614 MHz		
17101-110	Passive Attenuator (10 dB loss)	10.2	10.6	0.2	Current
401240-001	Passive Attenuator (3 dB loss)	3.1	3.1	0.2	Current
401241-001	Passive Attenuator (6 dB loss)	6.2	6.4	0.2	Current

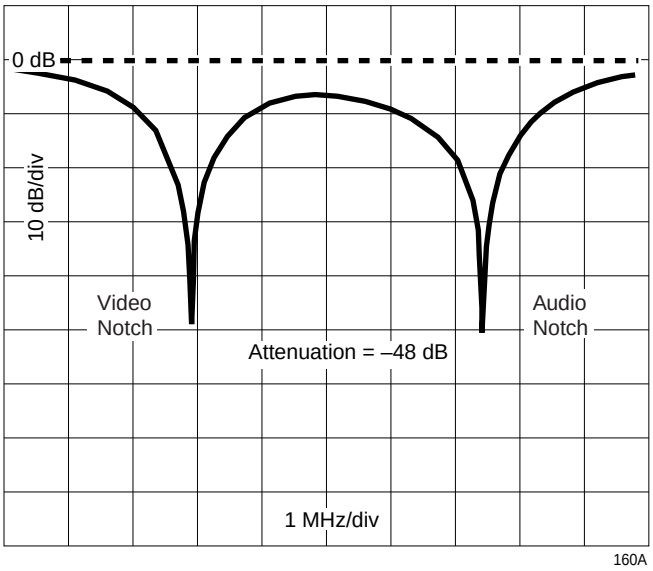
Notch filters

Notch filters are sealed filters tuned to filter specific frequencies as listed in the table below. These notch filters are passive components and should not be used with +12 volts to prevent damage to the units. The filters also do not pass DC voltages.

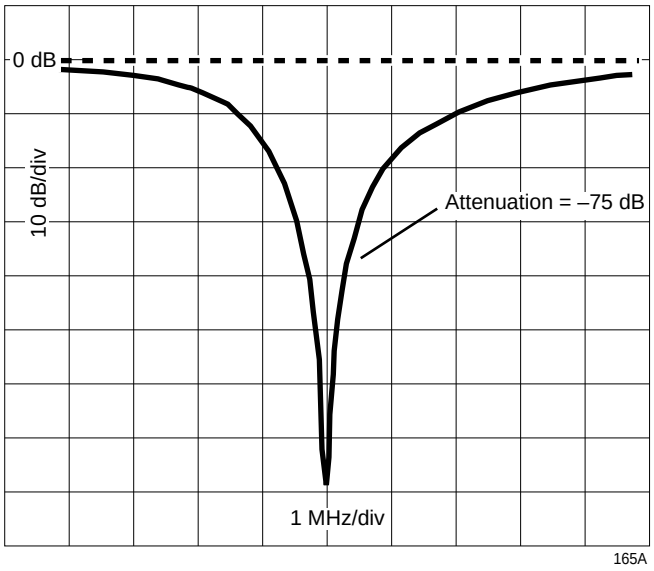


155A

Part number	Description	RF range	Notch frequencies
2005063-018	Filter High Pass 550 MHz	See High pass filter 560MHz on page 6-12.	N/A
2005063-017	Filter Low Pass 610 MHz	See Low pass filter 614MHz on page 6-12.	N/A
2005063-011	Notch Filter Channel 26 A/V	542-548	543.25/547.75
2005063-012	Notch Filter Channel 27 A/V	548-554	549.25/553.75
2005063-013	Notch Filter Channel 28 A/V	554-560	555.25/559.75
2005063-001	Notch Filter Channel 29 A/V	560-566	561.25/565.75
2005063-002	Notch Filter Channel 30 A/V	566-570	567.25/571.75
2005063-003	Notch Filter Channel 31 A/V	572-578	573.25/577.75
2005063-004	Notch Filter Channel 32 A/V	578-584	579.25/583.75
2005063-005	Notch Filter Channel 33 A/V	584-590	585.25/589.75
2005063-006	Notch Filter Channel 34 A/V	590-596	591.25/595.75
2005063-007	Notch Filter Channel 35 A/V	596-602	597.25/601.75
2005063-045	Notch Filter Channel 36 A/V	602-608	603.25/607.75
2005063-009	Notch Filter Channel 36 Video	602-608	603.25
2005063-046	Notch Filter Channel 36 Center	602-608	605
2005063-047	Notch Filter Channel 38 A/V	614-620	615.25/619.75
2005063-048	Notch Filter Channel 38 Center	614-620	617
2005063-014	Notch Filter Channel 39 A/V	620-626	621.25/625.75
2005063-015	Notch Filter Channel 40 A/V	626-632	627.25/631.75
2005063-016	Notch Filter Channel 41 A/V	632-638	633.25/637.75
2005063-021	Notch Filter 448.65 MHz	448-449	448.65
2005063-022	Notch Filter 453.75 MHz	453-454	453.75
2005063-031	Notch Filter 459.275 MHz	459-460	459.275
2005063-032	Notch Filter 454.250 MHz	454-455	454.250



Notch filter channels 26 – 41

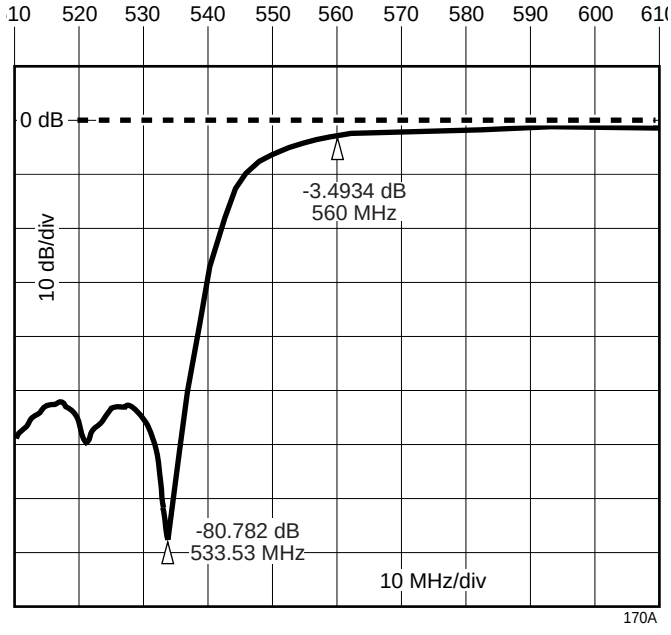


Notch filter channels 36 and 38 center

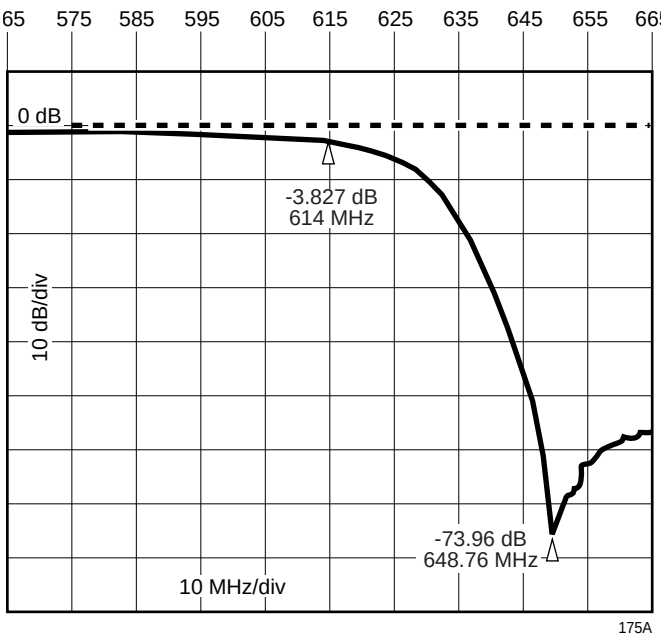
NOTE

Do *not* use the above filters with any transmitters within the specific TV channel. The entire channel is severely attenuated.

Do not have transmitters operating or programmed within 2 MHz of either side of the video and/or audio notch filter.



High pass filter 560MHz



Low pass filter 614MHz

Notch filter (audio/video) dB loss specifications

NOTE

These specifications apply to all a/v notch filters except channel 36 and channel 38.

Channel	dB loss in occupied channel
4 channels above occupied channel	1
3 channels above occupied channel	1.5
2 channels above occupied channel	3
1 channel above occupied channel	5 (top 2 MHz are not usable)
1 channel below occupied channel	8 (bottom 2 MHz are not usable)
2 channels below occupied channel	3.5
3 channels below occupied channel	2
4 channels below occupied channel	1.5

Channel 36 and 38 notch filter (audio/video) dB loss specifications

Channel	dB loss in occupied channel
36	6.25 dB max
38	5.00 dB max

Notch filter (center channel) dB loss specifications

Channel	dB loss in channel 37
36	4.75 dB max (bottom 2 MHz are not usable)
38	4.75 dB max (top 2 MHz are not usable)

High pass and low pass filter dB loss specifications

Filter	dB loss
High-Pass Filter above 560MHz	1
Low-Pass Filter below 614MHz	1

Bandpass filters

When an antenna system is designed *only* with notch filters rather than with the bandpass filter, the use of multiple notch filters can cause excessive signal loss. In addition, whenever a new TV station is activated in the vicinity, the antenna system must be redesigned and corresponding notch filters must be installed.

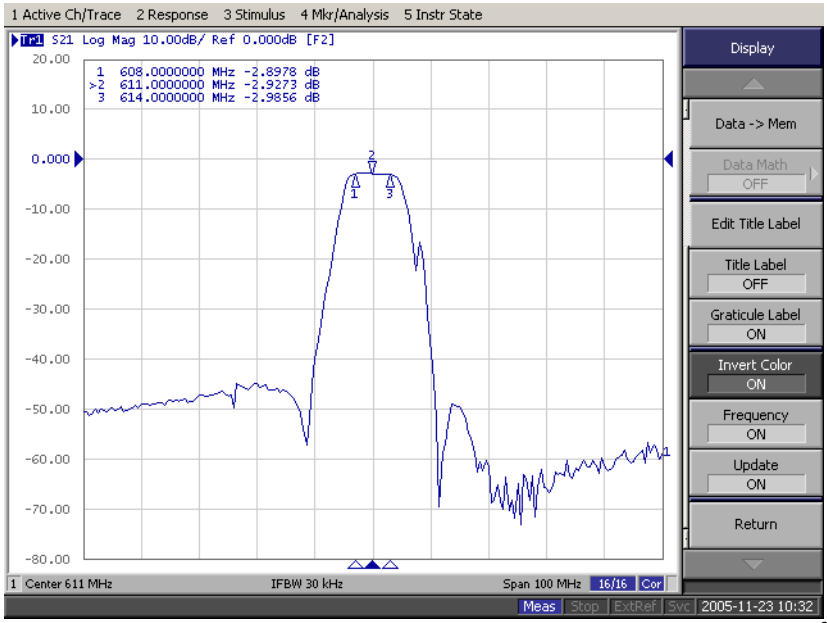
In general, bandpass filters eliminate the need for notch filters on every channel. They pass only the channel of interest and reject other channels. The result is fewer parts to install, significant reduction of signal loss in the desired channel, and no redesign of the system to accommodate new TV stations.

ApexPro bandpass filter 608-614 MHz

The 608-614 MHz bandpass filter passes channel 37 and rejects all other channels, except for portions of channels 36 and 38. Continue to use channels 36 and 38 in all systems and in older antenna systems where multiple notch filters are used.

185A

dB loss in passband	dB loss outside of passband	Status
3.2	> 30 @ 603, 620 MHz	Current



273A

ApexPro bandpass filter 608-614 MHz

The ApexPro bandpass filter 608-614 MHz replaces the following part numbers:

Part number	Description
2005063-001	Notch Filter Channel 29 A/V
2005063-002	Notch Filter Channel 30 A/V
2005063-003	Notch Filter Channel 31 A/V
2005063-004	Notch Filter Channel 32 A/V
2005063-005	Notch Filter Channel 33 A/V
2005063-006	Notch Filter Channel 34 A/V
2005063-007	Notch Filter Channel 35 A/V
2005063-011	Notch Filter Channel 26 A/V
2005063-012	Notch Filter Channel 27 A/V
2005063-013	Notch Filter Channel 28 A/V
2005063-014	Notch Filter Channel 39 A/V
2005063-015	Notch Filter Channel 40A/V
2005063-016	Notch Filter Channel 41 A/V
2005063-017	Low Pass Filter 610 MHz
2005063-018	High Pass Filter 550 MHz

The ApexPro bandpass filter 608-614 MHz does *not* replace the following part numbers:

Part number	Description
2005063-045	Notch Filter Channel 36 A/V
2005063-009	Notch Filter Channel 37 A/V
2005063-048	Notch Filter Channel 38 Center
2005063-047	Notch Filter Channel 38 A/V
2005063-046	Notch Filter Channel 36 Center

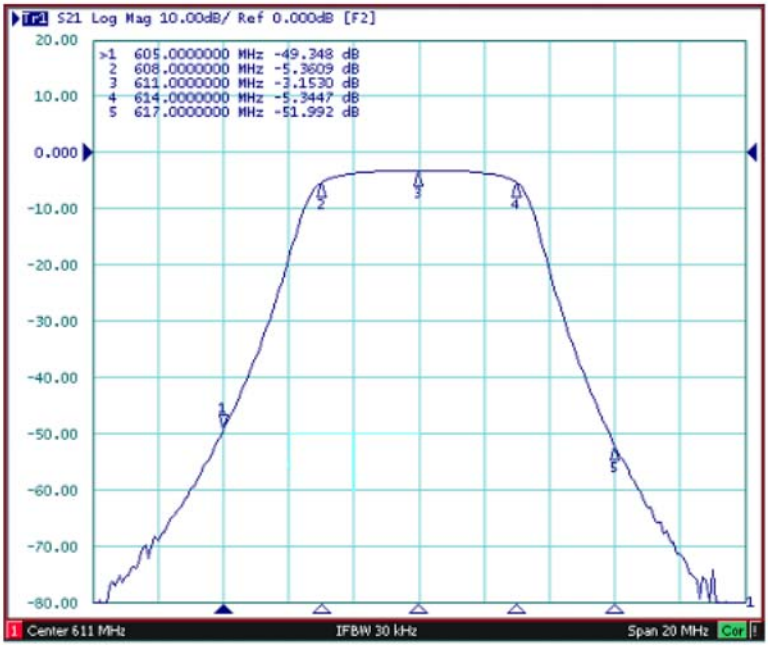
Cavity bandpass filter 608-614 MHz

The 608-614 MHz cavity bandpass filter passes channel 37 and rejects all other channels, including channels 36 and 38. No notch filters are required. The absence of notch filters results in a significant reduction of signal loss in channel 37.

274A

dB loss in passband	dB loss outside of passband	Status
3.3	>47 @ 605, 617 MHz[1]	Current

[1]605 MHz is the center of channel 36; 617 MHz is the center of channel 38.



271A

Cavity bandpass filter 608-614 MHz

The cavity bandpass filter 608-614 MHz replaces the following part numbers:

Part number	Description
2005063-001	Notch Filter Channel 29 A/V
2005063-002	Notch Filter Channel 30 A/V
2005063-003	Notch Filter Channel 31 A/V
2005063-004	Notch Filter Channel 32 A/V
2005063-005	Notch Filter Channel 33 A/V
2005063-006	Notch Filter Channel 34 A/V
2005063-007	Notch Filter Channel 35 A/V
2005063-045	Notch Filter Channel 36 A/V
2005063-048	Notch Filter Channel 38 Center
2005063-011	Notch Filter Channel 26 A/V
2005063-012	Notch Filter Channel 27 A/V
2005063-013	Notch Filter Channel 28 A/V
2005063-014	Notch Filter Channel 39 A/V
2005063-015	Notch Filter Channel 40A/V
2005063-016	Notch Filter Channel 41 A/V
2005063-017	Low Pass Filter 610 MHz

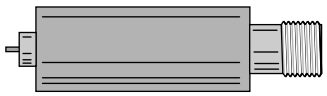
Part number	Description
2005063-018	High Pass Filter 550 MHz
2005063-047	Notch Filter Channel 38 A/V
2005063-046	Notch Filter Channel 36 Center

The cavity bandpass filter 608-614 MHz does *not* replace the following part numbers:

Part number	Description
2005063-009	Notch Filter Channel 37 A/V

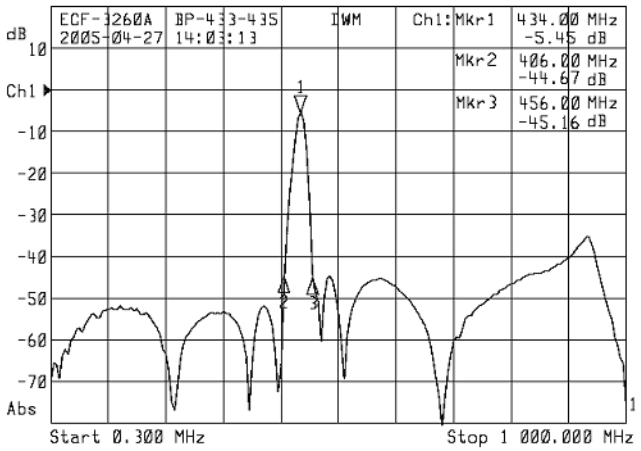
International bandpass filter 433.05-434.75 MHz

This bandpass filter passes signals in the frequency band form 433.05 MHz to 434.75 MHz. Signals outside this band are attenuated.



155A

dB loss in passband	dB loss outside of passband	Status
5.2	> 40 @ 406, 456 MHz	Current



272A

International bandpass filter 433.05 - 434.75 MHz

The international bandpass filter 433.05 - 434.75 MHz replaces the following part numbers:

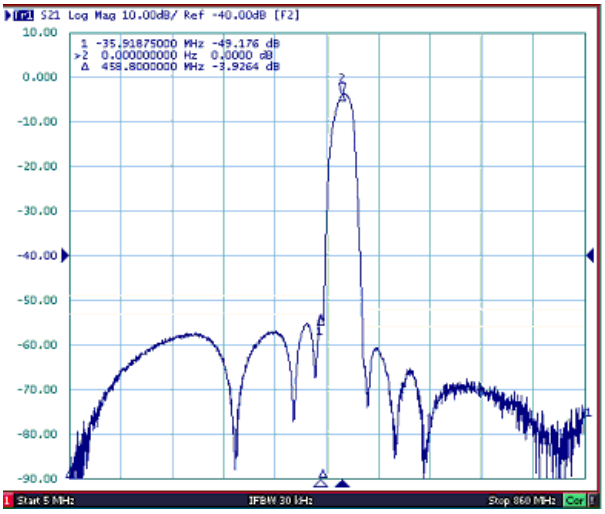
Part number	Description
2005063-021	Notch Filter UK 448.65 MHz
2005063-022	Notch Filter UK 453.75 MHz
2005063-031	Notch Filter GB 459.275 MHz
2005063-032	Notch Filter UK 454.25 MHz

International bandpass filter 458.5-459.1 MHz

This bandpass filter passes signals in the frequency band form 458.5 MHz to 459.1 MHz. Signals outside this band are attenuated.

155A

Minimum dB loss in passband	Maximum dB loss in passband	3dB bandwidth (MHz)	dB loss outside of passband 5-425 MHz	dB loss outside of passband 500-860 MHz
2	6	20-30	45	50



280A

International bandpass filter 458.5 - 459.1 MHz

Power cords

Use one power cord per power supply.

Part number	Description
405535-001	Power Cord, right angle, 125V, 12ft, 13A
80274-002	Power Cord, straight, 125V, 12ft
80274-006	Power Cord, straight, 125V, 6ft
80274-007	Power Cord, right angle cable,125V, 6ft, SE
80274-008	Power Cord, right angle cable,125V, 12ft, SE
405535-001	Power Cord, RA 125V 13A 12F
401855-001	Power Cord, Cont Euro, 10A 250V, 8ft
401855-002	Power Cord, British, 10A 250V, 8ft
401855-003	Power Cord, Italian, 10A 250V, 8ft
401855-004	Power Cord, Israeli, 10A 250V, 8ft
401855-007	Power Cord, Swiss, 10A 250V, 8ft
401855-008	Power Cord, Indian, 10A 250V, 8ft
401855-009	Power Cord, Danish, 220VAC/50HZ, stress
401855-010	Power Cord, Australian, 10A 250V, 8ft
401855-101	Power Cord, Cont Euro, 10A, 8ft, STR
405535-002	Power Cord, 125V 15A, 12ft, STR

Ordering parts

The parts lists in this chapter supply enough detail for you to order parts considered field replaceable.

If you require additional information, schematics, or troubleshooting assistance, contact GE Technical Support.

To order parts, contact Service Parts at the address or telephone number listed on the “How to Reach Us...,” page found in the front of this manual.

For the latest parts information, including substitutions, obsolescence and compatibility, please visit our Parts ID Portal website at:

egems.gemedicalsystems.com/partsiduser/gems/Welcome.jsp

Ordering parts

Field replaceable units

The following table lists transmitter field-replaceable units.

Part number	Description
APRO-CH-US-ENG-AHA-4	Transmitter - ApexPro CH (608.025 - 613.975 MHz)
TLMTX-T14-ENG-CAAXXX	Transmitter - CARESCAPE T14 (1395.025 - 1399.975 MHz)
2017569-009	Dust covers (kit)

The tables below list the most commonly replaced assemblies ordered in the service spare circuit board kits.

Item Description	Item Number
APEXPRO RCVR BKPLN 560-614 MHz (U.S.)	2017569-014
APEXPRO RCVR BKPLN 420-474 MHz (International)	2017569-015
APEXPRO RECEIVER POWER SUPPLY	2017569-016
KIT APEXPRO QUAD REC MOD ENG 560-614MHZ	2019838-002
KIT APEXPRO QUAD REC MOD ENG 420-474MHZ	2019838-003
FUSE 3AG 1A SB	2017569-018
RACK MOUNTING KIT	2004232-001

Label kits

Item Number	Item Description
2002068-001	LABEL KIT APEXPRO TLMY SUBSYSTEM ENG
2002068-002	LABEL KIT APEXPRO TLMY SUBSYSTEM GER
2002068-003	LABEL KIT APEXPRO TLMY SUBSYSTEM FRE
2002068-004	LABEL KIT APEXPRO TLMY SUBSYSTEM SWE
2002068-005	LABEL KIT APEXPRO TLMY SUBSYSTEM SPA
2002068-006	LABEL KIT APEXPRO TLMY SUBSYSTEM ITA
2002068-007	LABEL KIT APEXPRO TLMY SUBSYSTEM DUT
2002068-008	LABEL KIT APEXPRO TLMY SUBSYSTEM DAN
2002068-009	LABEL KIT APEXPRO TLMY SUBSYSTEM NOR
2002068-010	LABEL KIT APEXPRO TLMY SUBSYSTEM JAP
2002068-011	LABEL KIT APEXPRO TLMY SUBSYSTEM POR
2002068-012	LABEL KIT APEXPRO TLMY SUBSYSTEM RUS
2002068-013	LABEL KIT APEXPRO TLMY SUBSYSTEM CHI
2002068-014	LABEL KIT APEXPRO TLMY SUBSYSTEM HUN
2002068-015	LABEL KIT APEXPRO TLMY SUBSYSTEM POL

Transmitters

The versions of transmitters are:

Model	Frequency Range	Upper Level Part Number	Frequency Type
ApexPro	584 – 613.975 MHz	418500-001	USA
ApexPro	420 – 460 MHz	418500-003	International
ApexPro	420 – 460 MHz	418500-005	Japan
ApexPro CH	608.025 – 613.975 MHz	2014748-001	USA, Canada
T14	1395.025 – 1399.975 MHz	2014748-002	USA

Interconnect cables

The following table lists the interconnect cables used to connect the transmitter with other devices.

Part Number	Description
2005512-003	SpO2 interconnect cable
2002370-001	Suntech Accutracker interconnect cable
418497-002	DinaLink interconnect cable assembly

Labels

Each of these kits is a full set of TTX labels.

ApexPro

Part number	Description
2002553-001	LABEL KIT APEXPRO TLMY TRANSMITTER ENG
2002553-002	LABEL KIT APEXPRO TLMY TRANSMITTER GER
2002553-003	LABEL KIT APEXPRO TLMY TRANSMITTER FRE
2002553-004	LABEL KIT APEXPRO TLMY TRANSMITTER SWE
2002553-005	LABEL KIT APEXPRO TLMY TRANSMITTER SPA
2002553-006	LABEL KIT APEXPRO TLMY TRANSMITTER ITA
2002553-007	LABEL KIT APEXPRO TLMY TRANSMITTER DUT
2002553-008	LABEL KIT APEXPRO TLMY TRANSMITTER DAN

Part number	Description
2002553-009	LABEL KIT APEXPRO TLMY TRANSMITTER NOR
2002553-010	LABEL KIT APEXPRO TLMY TRANSMITTER JAP
2002553-011	LABEL KIT APEXPRO TLMY TRANSMITTER POR
2002553-012	LABEL KIT APEXPRO TLMY TRANSMITTER RUS
2002553-013	LABEL KIT APEXPRO TLMY TRANSMITTER CHI
2002553-014	LABEL KIT APEXPRO TLMY TRANSMITTER HUN
2002553-015	LABEL KIT APEXPRO TLMY TRANSMITTER POL

ApexPro CH

Part number	Description
2017516-001	LABEL KIT APEXPRO CH TRANSMITTER AHA

T14

Part number	Description
2009840-024	LABEL SHEET TTX CARESCAPE T14
2039001-002	CARESCAPE T14 Side Identification Labels

Optional components and accessories

There are 2 versions of the ApexPro Oximeter assembly and 1 version of the Nonin Xpod oximeter assembly. Make sure to reference the correct parts list for your version of the oximeter.

Part Number	Description
420364-001	Apex Oximeter Assembly (Domestic) (NONIN PN 2621-000)
421049-002	Apex Oximeter Assembly (International) (NONIN PN 2621-100)
2007245-001	Nonin Xpod Oximeter Assembly (NONIN Model 3013)

ApexPro CH transmitter parts list

This list is for ApexPro CH transmitter (UHF for USA and Canada) at 608.025 - 613.975 MHz.

NOTE

The ApexPro CH transmitter has no internal field-replaceable parts.

Part number	Description
APRO-CH-US-ENG-AHA-4	Transmitter - ApexPro CH
2017569-009	Dust covers (kit)

T14 transmitter parts list

This list is for CARESCAPE telemetry T14 transmitter at 1395.025 - 1399.975 MHz.

NOTE

The T14 transmitter has no internal field-replaceable parts.

Part number	Description
TLMTX-T14-ENG-CAAXXX	Transmitter - CARESCAPE T14
2017569-009	Dust covers (kit)

Receiver subsystem disassembly guidelines

General

WARNING
PATIENT MONITORING INTERRUPTION—Make sure a patient is not being monitored.

When removing the receiver subsystem pcb, use the following tools:

- 3-4 inch Phillips head screwdriver
- 12 inch Phillips head screwdriver
- 1/2 inch crescent wrench

PCB assemblies

CAUTION
Solder multilayer and surface mount PCB assemblies at your own risk! Improper repair methods can damage the PCB assemblies even further and void the warranty. Only qualified service personnel with the proper laboratory equipment should attempt to repair PCB assemblies.

Observe the following guidelines when handling all PCB assemblies.

- Take precautions against electrostatic discharge damage.
- Handle all PCB assemblies by their edges.

Hardware

- Before disassembly, note the positions of any wires or cables, marking them if necessary to ensure that they are replaced correctly.
- Gray ribbon cables have retainer clips holding them in the connector.
- Save and set aside all hardware for re-assembly.

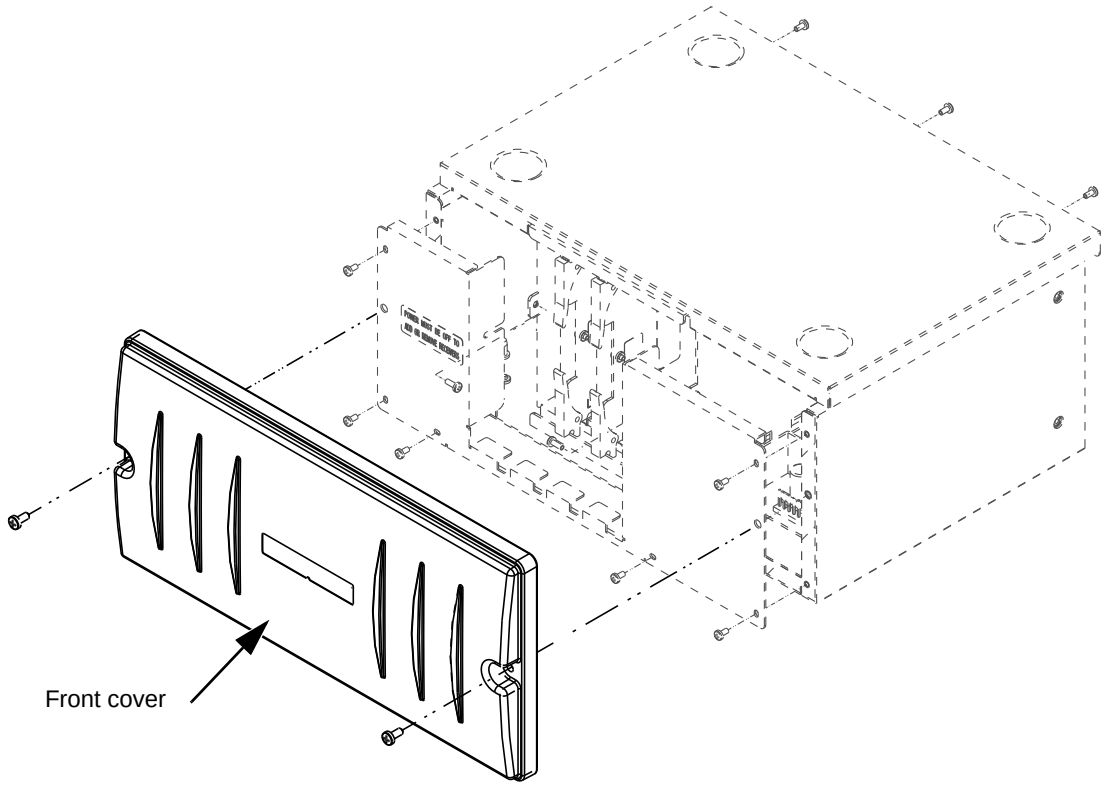
Replace the fuse

1. Open the door on the AC inlet module to access the fuse holder.
2. Remove two fuses and replace with new on each side of the holder.
3. Close the AC inlet module doors.

Open the unit

CAUTION
EQUIPMENT DAMAGE—Power must be off to add or remove any internal assemblies or circuit boards.

1. Turn the unit OFF at the rear power switch and disconnect the AC power cord and all communication cables.
2. Remove 2 screws from the front cover.
3. Remove cover and set aside.



frontcover

Remove a quad receiver module

CAUTION
EQUIPMENT DAMAGE—Do not remove or install Quad Receiver Modules with power applied.

1. Remove the front cover as described above.
2. Unseat the quad receiver module by pulling the two retaining clips away from the module.
3. Pull module straight out of chassis.

Add a quad receiver module

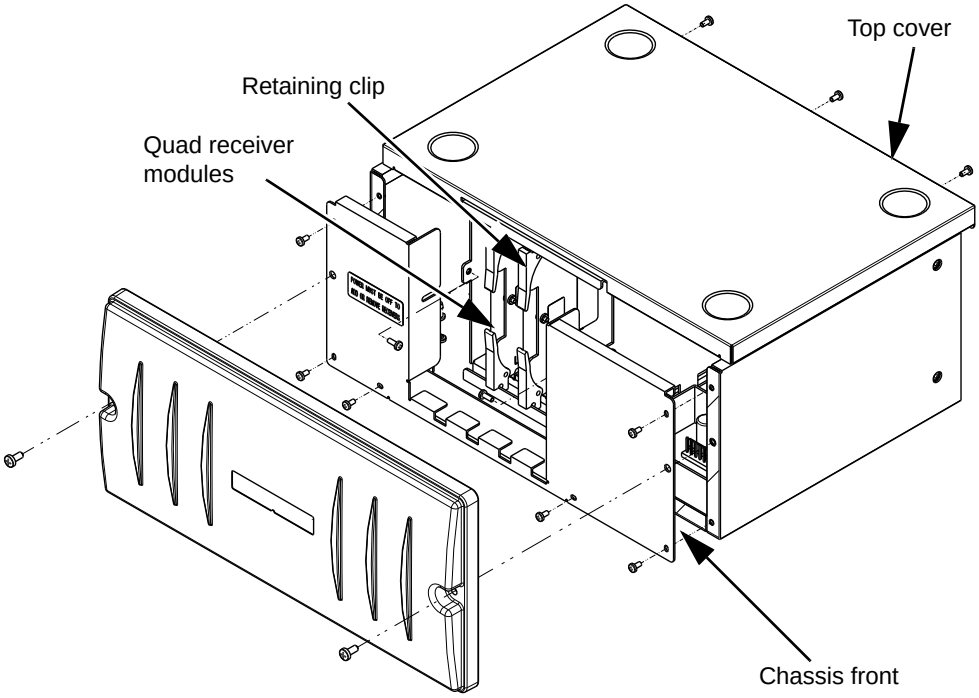
1. Remove the front cover as described above.
2. Position a quad receiver module with the protruding side (with label) facing the right side of the chassis.
3. Slide the protruding edge into the upper and lower chassis track.
4. Keep the retaining clips fully extended until the outer edges meet the receiver cage.

5. Fold the retaining clips inward, seating the module into the connector.

   NOTE

   Do not force the module or retaining clips. If it does not seat easily, the module may be upside down.

6. Replace the front cover.



disassy cover

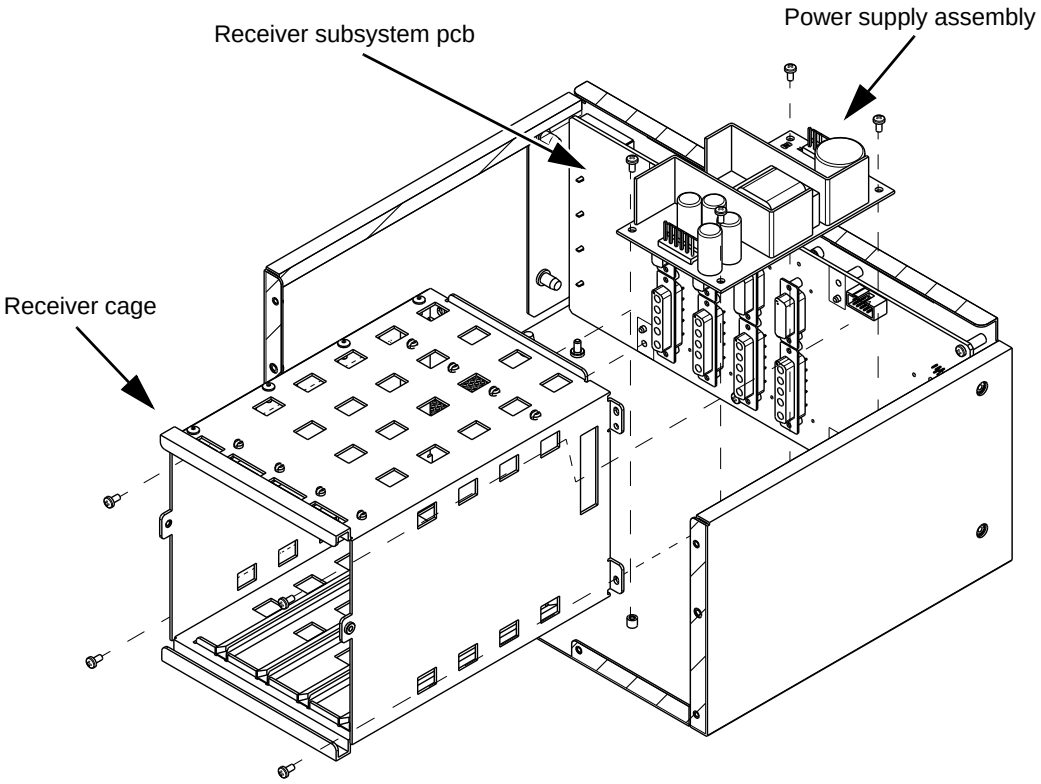
Remove/replace the power supply assembly

1. Remove the front cover as described above.
2. Remove 3 screws from the upper rear of the top cover.
3. Remove top cover.
4. Disconnect the power supply harness from the receiver subsystem pcb.
5. Remove 4 screws holding the power supply to the chassis assembly.
6. Remove power supply.
7. Reverse the above steps to install a power supply assembly.

Remove/replace receiver subsystem pcb (backplane)

1. Remove the front cover as described above.
2. Remove 3 screws from the upper rear of the top cover.
3. Remove top cover.

4. Remove all quad receiver modules.
5. Remover 6 screws from chassis front.
6. Using a short screwdriver loosen 2 screws inside the receiver cage.
7. Pull chassis front straight out.
8. Using a long screwdriver remove 4 screws holding receiver cage to receiver subsystem pcb.
9. Remove receiver cage.
10. Disconnect the power supply harness from the receiver subsystem pcb.
11. At the outside rear of the chassis assembly remove 4 hex nuts and washers.
12. Remove 7 screws holding pcb to chassis assembly.
13. Remove the receiver subsystem pcb.
14. Reverse the above steps to install a receiver subsystem pcb.



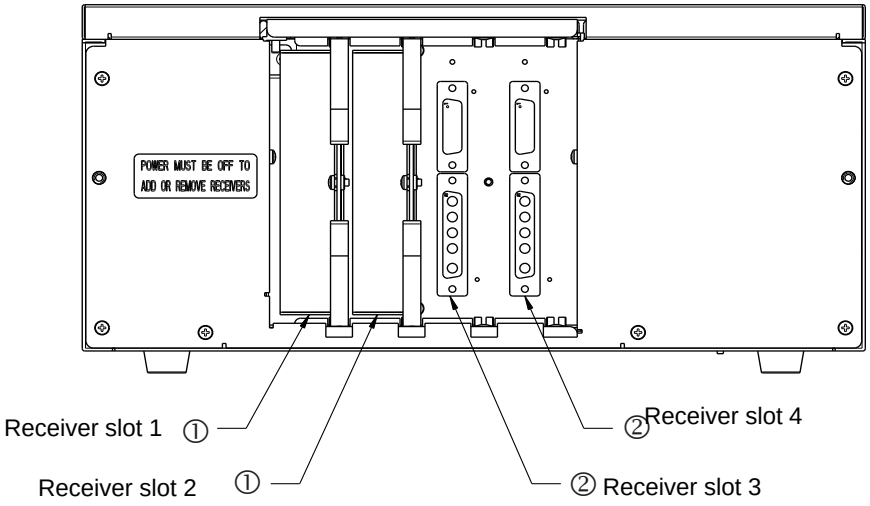
Close and reconnect unit

1. Position the front cover and install 2 screws.
2. Reconnect the power cord and all communication cables.

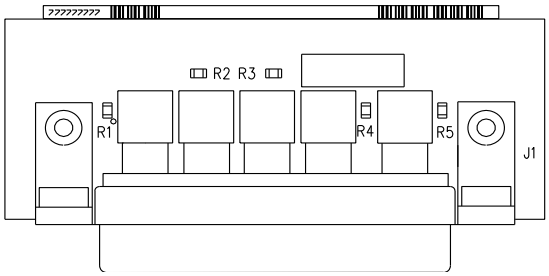
3. Perform Checkout and Electrical Safety Test procedures. See Maintenance on page 4-1.

Receiver system drawings

Receiver assembly

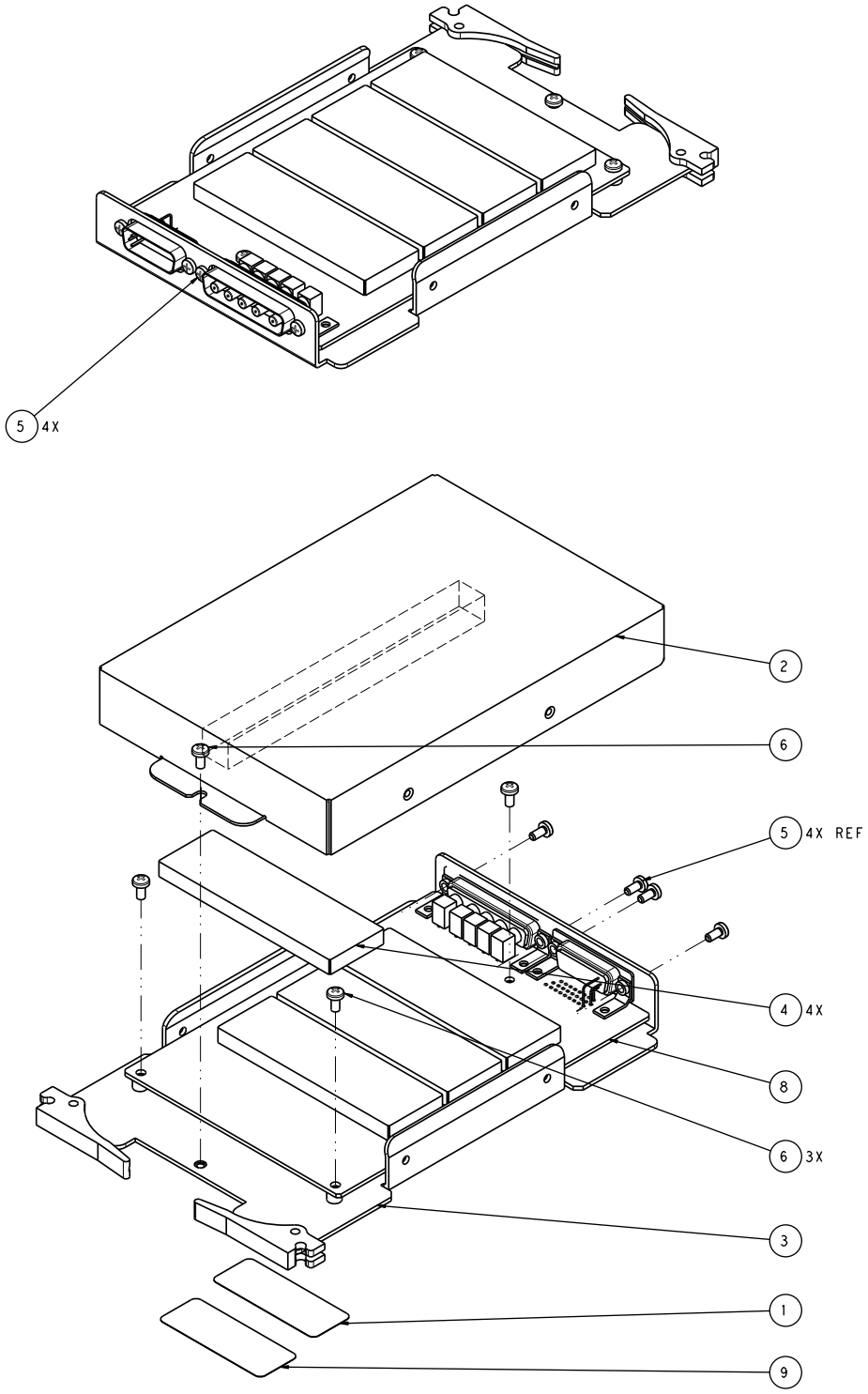


Detailed view of item 2



Item	Item Description	Qty
1	ASSY APEXPRO QUAD RCVR MOD 560-614 MHZ ASSY APEXPRO QUAD RCVR MOD 420-474 MHZ	1
2	QUAD RCVR TERMINATOR	3

Quad receiver module



7 Checkout

Antenna checkout

Procedure

1. If the antenna is active, verify that the power LED on the antenna is lit.
2. Perform visual inspection. See Visual inspection on page 4-4.
3. For the replaced antenna, perform the Unity Signal Gain Test with Transmitter from the Antenna system installation verification tests section of the ApexPro CH Antenna System Test Instructions.
4. For the field that the replaced antenna is on, perform the Out-of-Band RF Signal Test from the Antenna system installation verification tests section of the ApexPro CH Antenna System Test Instructions.

Infrastructure equipment checkout

This section applies to: power supplies, power cords, bias tees, antenna amplifiers, splitters/combiners, attenuators, filters, coaxial cables, connectors, and adapters.

Procedure

1. If replacing coaxial cables or connectors, perform a distance-to-fault or other similar test to verify continuity of the cable.
2. Perform visual inspection. See Visual inspection on page 4-4.
3. Multiple antennas may be connected to the replaced component. For each affected antenna, perform the Unity Signal Gain Test with Transmitter from the Antenna system installation verification tests section of the ApexPro CH Antenna System Test Instructions. If there are more than 10 affected antennas, it is sufficient to perform the test on only 10 of the affected antennas.
4. For the field that the replaced component is on, perform the Noise Floor Performance Test from the Antenna system installation verification tests section of the ApexPro CH Antenna System Test Instructions.
5. For the field that the replaced component is on, perform the Out-of-Band RF Signal Test from the Antenna system installation verification tests section of the ApexPro CH Antenna System Test Instructions.

Receiver subsystem checkout

Checkout procedure

1. Perform visual inspection. See Visual inspection on page 4-4.
2. Perform receiver system checkout. See Receiver system checkout on page 7-3.
3. Perform electrical safety tests. See Electrical safety tests on page 7-7.

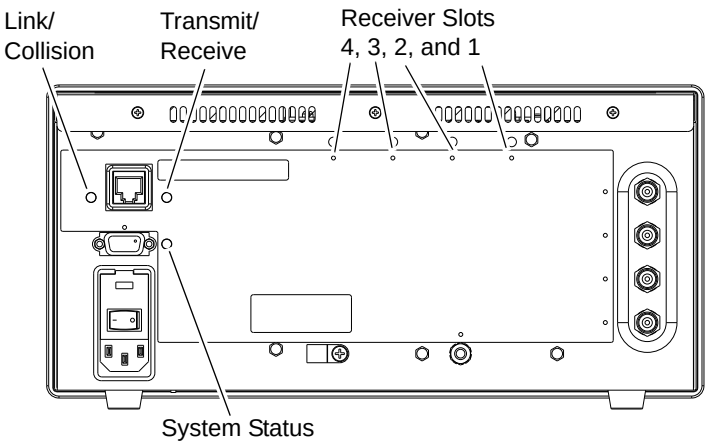
Additional system tests

Receiver system checkout

LED status indicators

Seven bi-color LEDs on the back of the Receiver System indicate the following:

LED	Solid Green	Flashing Green	Solid Yellow	Flashing Yellow	Blank
System Status	Normal Operation	System Initialization	System Error – System Halted	Software updating or Blink rack command at ApexPro Telemetry System	Power off
Receiver 1	Normal Operation	Module 1 Initialization	Module 1 Error	Single Receiver Error on Module 1 or Blink rack command at ApexPro Telemetry System	Not installed
Receiver 2	Normal Operation	Module 2 Initialization	Module 2 Error	Single Receiver Error on Module 2 or Blink rack command at ApexPro Telemetry System	Not installed
Receiver 3	Normal Operation	Module 3 Initialization	Module 3 Error	Single Receiver Error on Module 3 or Blink rack command at ApexPro Telemetry System	Not installed
Receiver 4	Normal Operation	Module 4 Initialization	Module 4 Error	Single Receiver Error on Module 4 or Blink rack command at ApexPro Telemetry System	Not installed
Link/ Collision	Link Established	N/A	N/A	Ethernet Collision Occurred	Not connected to host
Transmit/ Receive	N/A	Ethernet Transmission	N/A	Ethernet Reception	No transmit or receive



LED Locations

1. Switch power on.
2. Check that the **System Status**, **Transmit/Receive**, and appropriate receiver slot LEDs illuminate.
3. Verify that the **System Status** LED shows initialization status after power-up (flashing green).
4. Verify that all installed receivers initialize without error (**Receiver Slots** LEDs flashing green).
5. Verify that, after initialization, the **System Status** LED and all **Receiver Slots** LEDs are solid green.

> **CAUTION**
> EQUIPMENT DAMAGE —If receiver system software needs updating, the system LED flashes yellow while software is updating. DO NOT power down the system during a software update.

6. Verify **Link/Collision** LED is green.
7. Verify that the **Transmit/Receive** LED flashes yellow and green once every 5 seconds on first time setup. If patients are admitted on this Receiver System, then the receiver automatically transmits data (flashing green).

   NOTE

   After the Receiver System is powered up (power switch), it resets itself when the host connection is detected.

8. Verify that diagnostic information can be retrieved from the **Async Comm** (asynchronous serial) port via a laptop.

Receiver function

Follow all procedures sequentially to the end of this section to verify that all receivers are available and communicating with the ApexPro Telemetry System.

Open prompt

1. Connect a patient simulator to a transmitter.
2. Depending on where the ApexPro application resides, open a command prompt. See ApexPro application residing on a CIC on page 5-15. or See ApexPro application residing on an ATS on page 5-16..
3. In the MS-DOS command window type

   cd <space> C:\Program Files\Marquette\PTS\X.X> (where X.X is the current ApexPro software version)
4. Verify the prompt

   C:\Program Files\Marquette\PTS\X.X>

Determine number of admitted beds

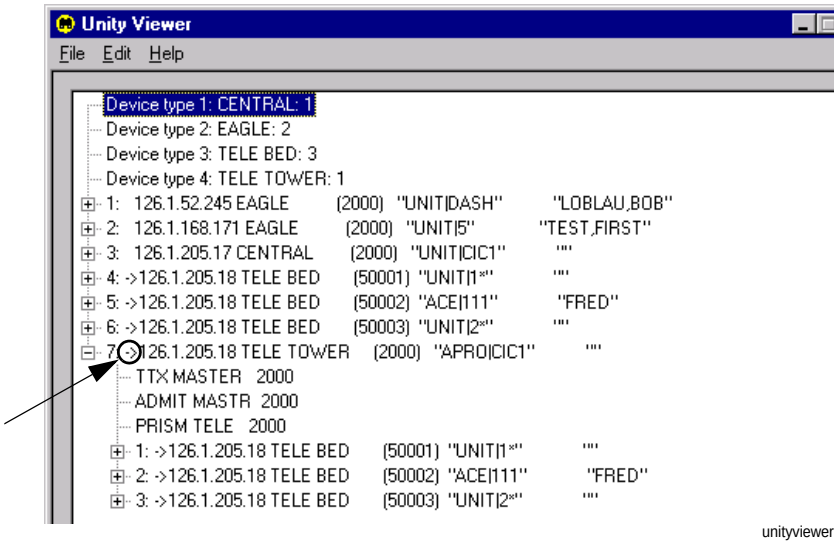
1. At the prompt type **unityviewer**.

   The Unity Viewer window opens.

   The message ***Waiting for network traffic...*** appears.
2. In the displayed information, identify the ***TELE TOWER*** with the arrow preceding the IP address and click on the **+** (on the left) to expand.

   NOTE

   The small arrow preceding the IP address identifies the tele tower (i.e. the ApexPro Telemetry System) currently being checked for connectivity. This arrow is highlighted in the following graphic.



unityviewer

3. This displays the number of beds admitted on the ApexPro Telemetry System. Note this number and close the window.

Determine number of unassigned receivers

1. In the MS-DOS window at the ***PTS\X.X*** prompt, type **ptsconfig** and press **Enter**.

NOTE

Type **help** at any time to see a list of commands.

2. Verify new prompt, Unity MC IP address of the ApexPro application, then ***C:Program Files\Marquette\PTS\X.X***.

3. Type **display receiver** and press **Enter**.

4. The number of beds correlates to the number of receivers indicated by the number of green Receiver Slots LEDs on the back of the Receiver System. Four receivers per one green Receiver Slots LED.

1 LED =	4 receivers
2 LEDs =	8 receivers
3 LEDs =	12 receivers
4 LEDs =	16 receivers

Test available receivers

1. Type **admit <space> care unit name <space> bed name <space> patient name <space> TTX# <space> patient age**, where

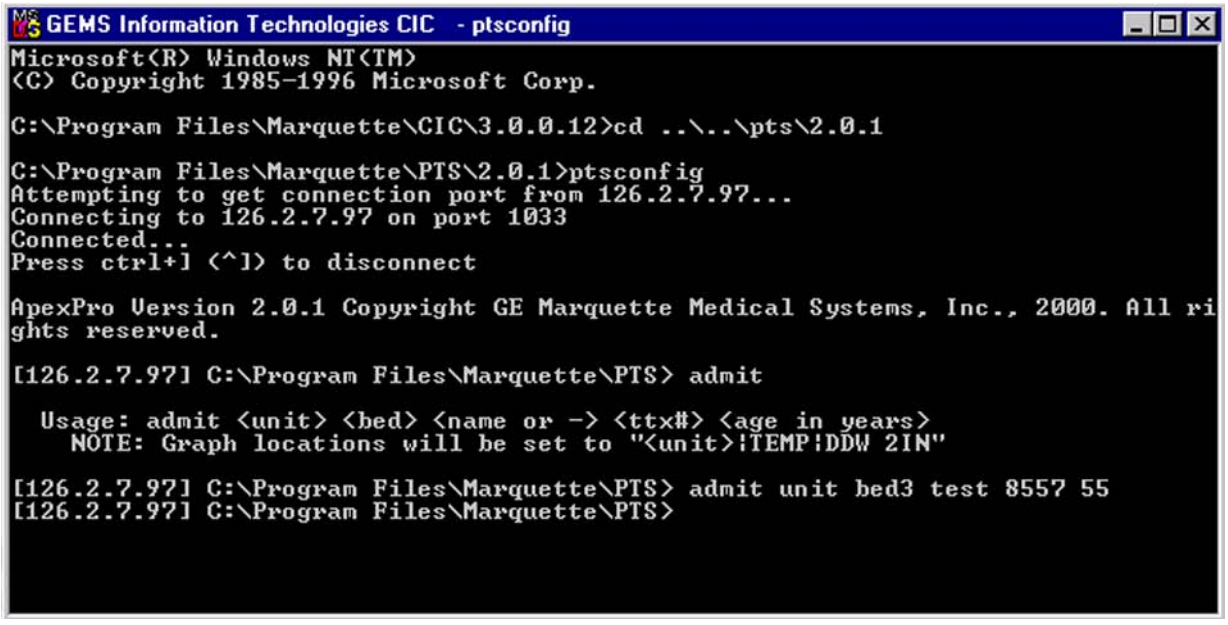
   care unit name = a temporary unique name for testing

   bed name = a temporary unique name for testing

   patient name = test

   TTX# = number of transmitter using for test (Use the number in parentheses on the transmitter label or in the CIC drop-down menu, e.g., 1071.)

   age = 55



pstconfig2

2. Press **Enter** and minimize the MS-DOS screen.
3. At a CIC, right-click on an empty available bed. Select newly admitted test bed and verify ECG waveform appears without dropout.
4. Restore the MS-DOS window either at the CIC, or return to your ApexPro Telemetry System and restore the MS-DOS window there.
5. Type **discharge <unit>|<bed>** and press **Enter**.
6. At the message, ***Are you sure you want to delete?***, type **y**.
7. Repeat these steps for all remaining receivers.

Electrical safety tests

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

Recommendations

Test conditions

Electrical safety tests may be performed under normal ambient conditions of temperature, humidity, and pressure.

Test equipment

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

Item	Specification
Leakage Current Tester	Equivalent to the circuits shown
Digital Multimeter (DMM)	AC volts, ohms
Ground Bond Tester	0 – 1 ohm
ECG Test Body	All leads together

Power outlet test

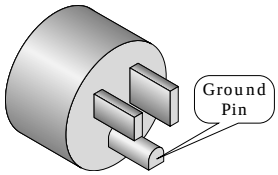
Before starting the tests, the power outlet from which the monitoring device will get electrical power must be checked. This test checks the condition of the power outlet to ensure correct results from leakage tests.

For international power outlets, refer to the internal standards agencies of that particular country. Use a digital multimeter to ensure the power outlet is wired properly.

If other than normal polarity and ground is indicated, corrective action must be taken before proceeding. The results of the following tests will be meaningless unless a properly wired power outlet is used.

Ground (earth) integrity

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



Perform the test method below that is required by your Country/Local governing safety organization.

Ground continuity test

Completion of this test is checked by the following steps:

1. Disconnect the device under test from the power outlet.
2. Connect the negative (-) lead of the DMM to the protective earth terminal (ground pin in power inlet connector) or the protective earth pin in the Mains plug (ground pin in power cord). Refer to the US 120 VAC power cord figure above.
3. Set the DMM to the milliohm (**mW**) range.
4. Connect the positive (+) lead of the DMM to all exposed metal surfaces on the device under test. If the metal surfaces are anodized or painted, scrape off a small area in a inconspicuous place for the probe to make contact with the metal.
5. Resistance must read:
   - 0.1 ohm or less without power cord
   - 0.2 ohms or less with power cord

Impedance of protective earth connection

This test, unlike a ground continuity test, will also stress the ground system by using special ground bond testers.

This test normally is only required as a manufacturing production test to receive safety agency compliance (i.e., IEC 60601-1).

Some country agencies do require this test after field equipment repairs (i.e. Germany's DIN VDE 0751 standards).

Consult your country/local safety agency if in question.

Compliance is checked by the following steps:

1. A current not less than 10A and not exceeding 25A from a current source with a frequency of 50 or 60 Hz with a no-load voltage not exceeding 6V is passed for at least 5s through the protective earth terminal or the protective earth pin in the mains plug and each accessible metal part which could become live in case of failure in basic insulation.

2. The voltage drop between the parts described is measured and the impedance determined from the current and voltage drop. It shall not exceed the values indicated.

For equipment without a power supply cord, the impedance between the protective earth terminal and any accessible metal part which is protectively earthed shall not exceed 0.1 ohms

For equipment with a power supply cord, the impedance between the protective earth pin in the mains plug and any accessible metal part which is protectively earthed shall not exceed 0.2 ohms.

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

Ground (earth) wire leakage current tests

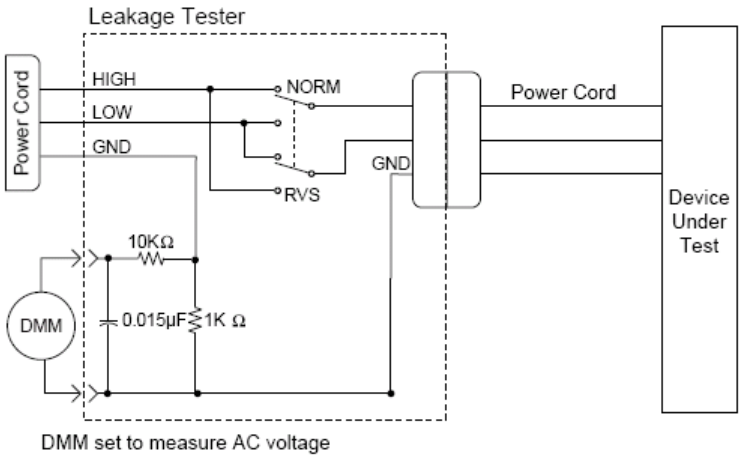
Perform this test to measure current leakage through the ground (earth) wire of the equipment during normal operation.

NOTE

The DMM plus leakage tester network shown is the circuitry defined by the UL 60601-1 standard for measuring leakage current.

The measuring devices, defined by various standard organizations (IEC, UL, etc.), produce almost identical test measurement results.

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



DMM set to measure AC voltage

GND wire leak

2. Connect the power cord of the device under test to the power receptacle on the leakage tester.
3. The device under test is to be tested at its normal operating voltage.
4. Set the power switch of the device under test to **ON**.
5. Read the current leakage indicated on DMM.
6. Set the polarity switch on the leakage tester to **RVS** (reverse).
7. Read the current leakage indicated on DMM.

NOTE

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

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

NOTE

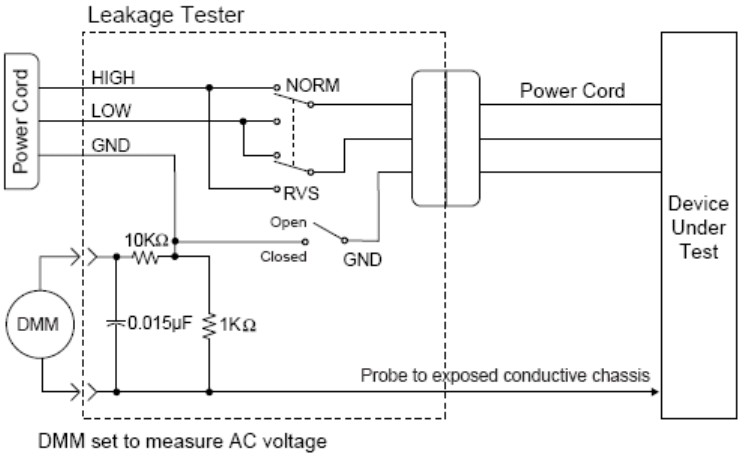
Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and IEC limits are different.

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

Enclosure leakage current test

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

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



enclosure leak

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

NOTE

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

5. Set the polarity switch to **RVS**.

6. Read the current leakage indicated on DMM.

NOTE

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

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

7. Set the **GND** switch on the leakage tester to **CLOSED**.
8. Read the current leakage indicated on DMM.
9. Set the polarity switch to **RVS**.
10. Read the current leakage indicated on DMM.

NOTE

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

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

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

Test completion

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

Transmitter checkout

Checkout procedure

NOTE

Due to IPX7 rating, the ApexPro CH and T14 Transmitters are not field repairable.

1. Perform visual inspection. See Visual inspection on page 4-4.
2. Perform the communication tests. See Communications tests on page 7-17.
3. If an oximeter is being used with the transmitter, perform the Oximeter operational tests for the applicable oximeter. See Oximeter operational tests on page 7-19.

4. If the Accutracker DX NIBP is being used with the transmitter, perform the Accutracker DX NIBP operational tests. See Accutracker DX NIBP operational tests on page 7-20.

Additional system tests

Power-up self-tests

Transmitter

The transmitter performs a limited amount of testing of the internal memory components when it powers up. The results of these tests are indicated by the LEDs on the transmitter case. Test results may also be viewed on a remote terminal or personal computer if the ApexPro transmitter programming box is connected and in use.

To start the tests, install new batteries into the transmitter. The internal digital signal processor performs the self-tests automatically.

NOTE

Any test failures are stored and appear when you view TTX information during programming of the transmitter. Stored errors can only be cleared by reprogramming the transmitter.

The following functions are performed at power-up of the transmitter.

1. First, a memory test is performed. The memory in the transmitter's digital signal processor circuit either passes or fails this test.
   - EEPROM memory is copied to RAM memory.
   - The copy is verified with a checksum test.
   - If the checksum test passes, testing continues.
   - If the checksum test fails, a checksum error is logged and the memory test is repeated. This test continues in a loop as long as the test fails and power is applied to the transmitter, indicated by all LEDs flashing rapidly then pausing repeatedly.
   - The Checksum Error status is displayed in the power-up self-test results of the Apex & ApexPro Tx Config program for programming the transmitter.
2. Next, the transmitter's frequency synthesizer is programmed with the specified customer's frequency. A test is performed to verify a successful lock of the synthesizer circuits.
   - If the synthesizer lock test passes, the transmitter starts normal operation.
   - If an error is detected, the transmitter creates a Synthesizer Lock log which indicates if the transmitter was ever unable to operate at its programmed frequency.
   - The Synthesizer Lock status is displayed in the power-up self-test results of the Apex & ApexPro Tx Config program for programming the transmitter.

During normal operation, a ROM test is executed continuously. If an error is detected, the transmitter resets itself.

Apex oximeter

The following is the Apex Oximeter power-up sequence:

1. The display reads ***888 888*** and the perfusion LED is red for approximately 1 second.
2. The display reads ***888 888*** and the perfusion LED is green for approximately 1 second.
3. The software revision level displays for 1-2 seconds and the perfusion LED is off.
4. The display goes to **- -** and there is a flashing dash in the upper left-hand corner of the SpO2 display.

If the unit functions properly, these indications occur in the specified order.

If the unit does not function properly, contact Technical Support.

Nonin Xpod oximeter

The oximeter does not contain a power supply, as it draws power from the transmitter. Consequently, there is no power-up sequence. The unit only functions when connected to the telemetry system.

Accutracker

The Accutracker error codes are translated in the software to display on the system monitor. See the operator's manual for your system for an explanation of error codes.

Transmitter operational tests

The following series of tests verify basic operation of the transmitter.

Required test equipment

The following equipment is required.

- ECG simulator
- New alkaline AA batteries and low-voltage batteries
- Digital multimeter
- Spectrum analyzer
- SpO2 simulator for optional Apex Oximeter and Nonin Xpod oximeter testing (pn 408610-001)
- Nonin simulator cable adapter for optional Apex Oximeter and Nonin Xpod oximeter testing (pn 420970-901)
- PDM200 or equivalent manometer for optional Accutraker DX NIBP operational testing

LED displays

This test verifies LED operation.

1. Attach the leadwires to an ECG source.

2. Install new batteries into the transmitter, then wait for the power-up self-tests 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.

Power-up self-tests

This test verifies completion of the power-up self-tests.

1. Remove any batteries in the transmitter.

2. Install good 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 as described in Start-up on page 2-8. Use that information to verify the features of your transmitter.

If the self-tests 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 8 seconds.

1. Connect the transmitter to an ECG source.

2. Install new batteries in the transmitter.

3. At a CIC Pro center, verify that the transmitter is sending the ECG source's signals properly.

4. Remove the leadwires from the ECG source.

   After 6 seconds, a NO TELEM signal displays at the CIC Pro center for the transmitter being tested.

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

RF test

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

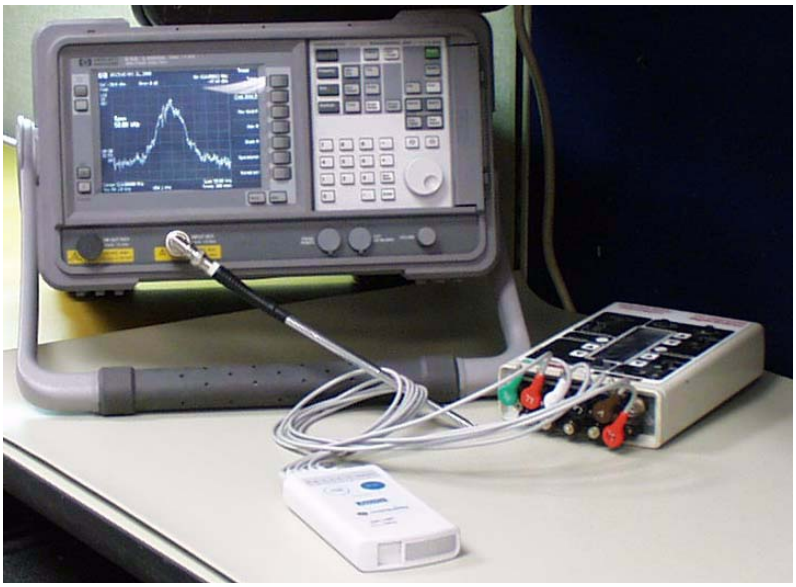
NOTE

The Rohde & Schwarz FSH3 spectrum analyzer is used for the following steps. If a different spectrum analyzer is being used, the detailed sub-steps may be different.

Power output

This test measures the power output of the transmitter. (Refer to the RF monitor operator's manual for setup information.)

1. Turn on the RF monitor and allow it to operate for at least one hour for temperature stabilization.
2. Set the center frequency to the frequency of the transmitter. Refer to the ApexPro Telemetry Frequency Chart Reference Manual.
   a. Press **FREQ**.
   b. Press the numbers corresponding to the frequency of the transmitter.
   c. Press **MHz** and press **Enter**.
3. Set the span to 500KHz (50KHz/div).
   a. Press **Span**.
   b. Press **500**.
   c. Press **KHz and press Enter**.
4. Set the reference amplitude to -10dBm at 10dB/div.
   a. Press **AMPT**.
   b. Press **10**.
   c. Press **GHz/-dBm** and press **Enter**.
5. Connect the transmitter with lead wires to a patient simulator.
6. Wrap the leadwires around the antenna of the RF monitor.



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7. Verify that a peak signal of at least -20dBm (-10dBm for T14 transmitter) 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, enable the max hold to help detect the RF peak signal strength.

a. Turn on ***MARKER*** and place it on the peak of the signal.

b. Press **Trace**.

c. Press ***F1-TRACE MODE***.

d. Select ***CLEAR/WRITE***.

e. Press **ENTER**.

8. If the transmitter fails this test, it must be returned for service.

RF signal integrity

This test verifies the integrity of the transmitter's RF signal.

1. Connect the transmitter to an ECG simulator. Position the transmitter approximately 10 to 20 feet (6 meters) from an antenna.
2. Allow duplicate transmitters:

   a. At the bottom of the CIC Pro center screen, select the ***Setup CIC*** button.

   b. Select the ***Service Password*** tab.

   c. Type the password **mms_com** and then select ***OK***. A DOS command prompt window is displayed.

   d. Type **setflags<space>-dup<space>on** and press **Enter** on the keyboard to allow duplicate transmitters.

   NOTE

   Once you select this option, you have a set time, generally 5 minutes, to enter the duplicate TTX numbers. If that is not enough time, simply select this option again and continue entering TTX numbers.

   e. Admit the transmitter to multiple receivers.

3. Type **setflags<space>-mark<space>all** and press **Enter**. This function plots many causes of dropout.

   The colored diagnostic tic marks at the bottom of each window indicate the reason for missing waveform data.

   If the diagnostic tic marks are yellow on all receivers at the same time, then either the transmitter or the antenna system (or both) may require service. Any color other than yellow indicates a system problem unrelated to the transmitter. If this is the case, please contact GE technical support.

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

Communications tests

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

Verify leads

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 Pro center. Verify that the ECG signals display at the CIC Pro center.

   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 Pro center 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 Pro center.

   NOTE

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

Graph request

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

1. Configure the CIC Pro center so that graph requests (from the transmitter) are printed at the CIC Pro 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.

Event marker

This test verifies the Event Marker feature. This feature is available only on the ApexPro CH and T14 transmitter.

1. Install batteries in the transmitter.
2. Press the ***Event Marker*** button.

3. At a CIC Pro center, verify that the ***Event Marker*** message is displayed.

Pause alarm

This test verifies that the transmitter enters into the PAUSE ALARMS condition for approximately 5 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 5 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 CIC Pro center display.

1. Connect an ECG simulator to the transmitter.
2. With the transmitter operating and ECG waveforms from the transmitter displaying on the CIC Pro center, trigger a pace pulse at the ECG simulator.
3. Verify a pace mark on the CIC Pro center. (Ensure that the PACE function is enabled on the CIC Pro 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 CIC Pro center.
3. Verify the ECG gain at the CIC Pro center is set to 1x magnification.
4. Press the **Graph** button on the transmitter to trigger a graph run.
5. Measure the graph output. Signal level should be 1 cm (2 large boxes on graph strip) for a 1 mV input.

Completion

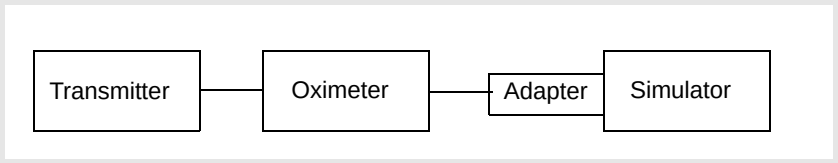
If the transmitter fails any of the above tests, return it to the factory for service.

Oximeter operational tests

Apex oximeter

This test verifies the functionality of the Apex Oximeter.

1. Record the oximeter's serial number.
2. Connect the oximeter to the transmitter.
3. Admit the transmitter to an ApexPro telemetry system.
   a. Make sure that the SpO2 parameter box comes up on the CIC Pro center.
   b. If the oximeter fails, discontinue the test.
   c. Return the oximeter after double-checking the test setup.
4. Place the oximeter in continuous display mode by pressing and holding the Display On/Off switch for 2 seconds.
5. Connect the oximeter to the pulse oximeter simulator (pn 408610-001)using the Nonin simulator cable adapter (pn 420970-901).



6. Set the simulator's selector switch to "Nellcor" and check the heart rate accuracy.

   Accuracy specification for 18 – 300 BPM is +/– 3% or +/–1, whichever is greater.
7. Adjust the RATE (BPM) switch to vary the heart rate.
   a. Set the RATE to 70 BPM.

      Accuracy at 70 BPM is +/–2.
   b. Repeat for 100 BPM (+/–3) and 160 BPM (+/–5).
8. Set the simulator to 68.4% (use the white Nellcor numbers).

   Accuracy at 68% is +/–3.

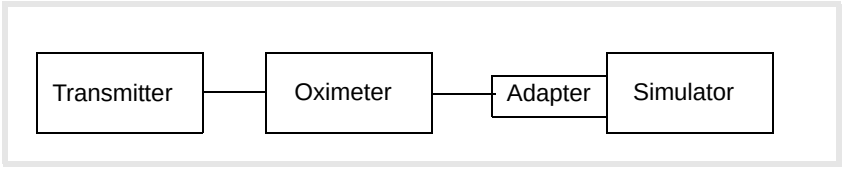
   Repeat for 90.6% (+/–3), 96% (+/–3), and 99% (+/–3).
9. Check the perfusion indication.
   a. Change the selector switch to "Ohmeda".
   b. Verify that the perfusion LED changes to yellow.
10. Disconnect the oximeter from the simulator.
    - The indicator illuminates in front of the SpO2 value on the oximeter.

- A CHECK PROBE message appears on the CIC Pro center.

Nonin Xpod

This test verifies the functionality of the Nonin Xpod oximeter.

1. Record the oximeter's serial number.
2. Connect the oximeter to the transmitter.
3. Admit the transmitter to an ApexPro telemetry system.
   a. Make sure that the SpO2 parameter box comes up on the CIC Pro center.
   b. If the oximeter fails, discontinue the test.
   c. Return the oximeter after double-checking the test setup.
4. Connect the oximeter to the pulse oximeter simulator (pn 408610-001)using the Nonin simulator cable adapter (pn 420970-901).



5. Set the simulator's selector switch to "Nellcor" and check the heart rate accuracy.

   Accuracy specification for 18 – 321 BPM is ± 3 digits with no motion, and for 40-240 BPM is ± 5 digits for high motion.
6. Adjust the RATE (BPM) switch to vary the heart rate.
   a. Set the RATE to 70 BPM.

      Accuracy at 70 BPM is +/–2.
   b. Repeat for 100 BPM (+/–3) and 160 BPM (+/–5).
7. Set the simulator to 68.4% (use the white Nellcor numbers).

   Accuracy at 68% is +/–3.

   Repeat for 90.6% (+/–3), 96% (+/–3), and 99% (+/–3).
8. Disconnect the oximeter from the simulator.

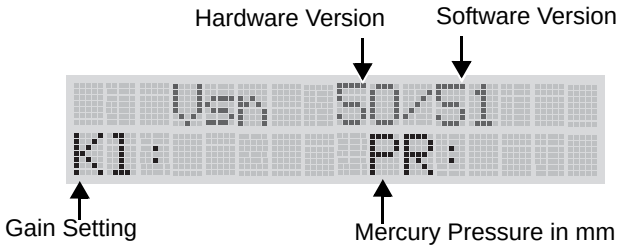
   A PROBE message appears on the CIC Pro center.

Accutracker DX NIBP operational tests

GE recommends performing the Accutracker DX NIBP operational tests when you receive the Accutracker and every 12 months thereafter. If the Accutracker fails any test, return the unit to GE Service and Supplies.

Display

Press and hold the ◁ button while turning the switch on. This display includes hardware and software version, the Gain Setting for the mic, and the pressure setting (mmHg).



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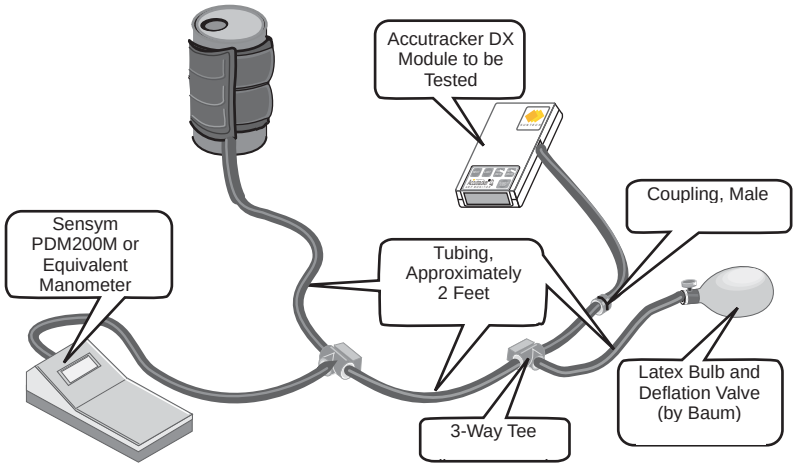
Pressure calibration check

The following test ensures the functionality of the Accutracker DX Noninvasive Blood Pressure monitor.

1. Connect the PDM200 or Mercury manometer to the patient cable/cuff connection.



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Sample test setup

NOTE

Make sure no external pressure is applied to the Accutracker when you turn it on.

2. Press and hold the ◁ button and turn the Accutracker on. The unit is now in Technical Calibrate mode and valve #1 is closed.

3. Apply pressures to the Accutracker between 0 mmHg and 250 mmHg in increments of 50 mmHg. Make sure there is no more than a +/–2 mmHg difference between the mercury column or PDM200 display and the Accutracker display value.

4. Turn off the Accutracker.
5. After 5 seconds (to prevent the unit from “locking up”), press and hold the ◁ button and turn the Accutracker on.
6. Press the ▽ button twice; then press the ▷ button to force the Accutracker to activate the pump and valve circuitry. The unit goes through a diagnostic self-test. If the unit passes the test, TEST PASSED displays briefly.
7. When OFFICE SELF TEST displays, immediately press the  button to discontinue the reading in progress. This step is necessary to identify that a reading can be aborted, if necessary, during a test in case there is a problem (i.e., the cuff slips down the arm, an electrode becomes detached, etc.).
8. Turn the Accutracker off to exit this mode.

Over-pressure release check

The Over-Pressure release occurs whenever a pressure of 285 mmHg (+/–20 mmHg) is applied to the Accutracker pressure transducer. The Over-Pressure release forces the pump to stop and valve #1 to open.

1. Press and hold the ◁ button and turn the Accutracker on.

   NOTE

   Make sure no external pressure is applied to the Accutracker when you turn it on.

2. Apply a pressure of 285 mmHg (+/–20 mmHg) to the Accutracker. Valve #1 immediately opens and allows the applied pressure to release.
3. Once the Over-Pressure circuit is tripped, valve #1 and the pump are disabled until “Analog Power” (+/–Vana) is removed from the circuit. Turn the Accutracker off to reset the circuit.

Hardware time-out and system leak check

1. Press and hold the ◁ button and turn the Accutracker on.

   NOTE

   Make sure no external pressure is applied to the Accutracker when you turn it on.

2. Apply 200 mmHg pressure to the Accutracker pressure circuit and start a timer to clock the Hardware Time-Out circuit.
3. The Hardware Time-Out occurs in 3 minutes (+/–45 seconds). Valve #1 opens and dumps pressure once the time-out is finished. As you monitor the Time-Out, monitor the pressure (in mmHg) displayed on the Accutracker LCD. The Accutracker should leak no more than 2 mmHg per minute.

Communication test

This procedure verifies that the telemetry system transmits and receives the data correctly from the Accutracker.

1. Attach the Accutracker to the ApexPro Telemetry system.

   NOTE

   You must have ECG leads with a shorting cable or simulator attached to the ApexPro Telemetry system for this test to work.

   CAUTION
   Refer to the ApexPro operator's manual for proper operation guidelines and cuff/microphone placement.

2. Place blood pressure cuff on the arm.
3. Turn the Accutracker on and press the  button.
4. When the display appears on the system screen, verify that the Accutracker display numbers match the display numbers.
5. Turn Accutracker off.

Repair log

Unit Serial Number: Institution Name:		
Date	**Maintenance/Repair**	**Technician**

Unit Serial Number: Institution Name:		
Date	**Maintenance/Repair**	**Technician**

A Technical specifications

Below are the technical specifications for the ApexPro telemetry system.

NOTE

Due to continual product innovation, GE designs and specifications are subject to change without notice. Contact your sales/service representative for the most current information.

ApexPro and ApexPro CH transmitter

Performance specifications

Power requirements

Battery type:	ANSI/NEDA 15A, 1.5 V AA alkaline (2 required)
Battery life:	■ ApexPro model: 40 hours typical ■ ApexPro CH model: 120 hours typical
Polarity:	Electronic reverse polarity protection

Alarms and controls

Battery integrity:	Transmitted and indicated via LED
Lead fail indication:	Transmitted and indicated via LED

Transmission

Channel spacing:	25 kHz
Frequency stability:	± 0.0001% of assigned channel frequency
Bit rate:	10 kb/sec
Antenna:	Formed by leadwire shield

ECG

Multi-channel (5- or 6-leadwire) configuration:	I, II, III, Va, Vb, aVR, aVL, aVF
Leads analyzed simultaneously:	Four (I, II, III and V)
Single-channel (3-leadwire) configuration:	I, II or III, programmable
Heart rate detection range:	30 to 300 beats/minute

QRS detection range:	0.5 to 5 mV
Frequency response:	up to 40 Hz (–3dB)

Environmental specifications

Operating conditions

Ambient temperature:	0°C to 50°C (32°F to 122°F)
Relative humidity:	15% to 95% (non-condensing)

Transport and storage conditions

Temperature:	–40°C to 70°C (-40°F to 158°F)
Relative humidity:	5% to 95% (non-condensing)
Pressure:	475 to 1200 hPa

Device specifications

Water resistance:	■ ApexPro model: IEC 60529 IPX3 rating (spray and wipe only) ■ ApexPro CH model: IEC 60529 IPX7 rating (can survive inadvertent submersion)
Frequency range:	■ ApexPro model: (The frequency range depends on the PCB installed.) ◆ 420–460 MHz or ◆ 584–613.975 MHz (programmable synthesizer) ■ ApexPro CH model: ◆ 608.025–613.975 MHz
Power output:	■ ApexPro model: (Meets FCC requirements for Parts 15 and 95.) ◆ 0.64mW @ 420–460 ◆ 0.5mW @ 584-614 MHz ■ ApexPro CH model: (Meets FCC requirements for Part 95.) ◆ 0.5mW @ 608.025–613.975 MHz
Bandwidth	■ ApexPro model: 9.5 KHz ■ ApexPro CH model: 9.7 KHz
Modulation:	■ ApexPro model: GMSK ■ ApexPro CH model: GFSK
Alarm Pause:	Transmitted and indicated via LED

Graph request:	Transmitted
Event Marker:	Transmitted (ApexPro CH model only)
Dynamic range:	± 5 mV (RTI)
Input offset:	± 300 mV (RTI)
Input impedance:	15 Megohm min differential at 10 Hz
ECG gain selection:	5, 10, 20, 40 mm/mV (RTI)
Gain accuracy:	± 5% at 15 Hz
Common mode rejection:	100 dB min at 60 Hz
Defibrillator protection:	± 5000 VDC, 360 joules into 100 ohm load
Defibrillation recovery time:	Defibrillation recovery time: Limited only by electrode recovery time. Transmitter recovers within 5 sec.
Pacemaker detection:	■ ApexPro model: ± 2 mV to ± 700 mV (RTI); 100 µsec to 2 msec; either polarity ■ ApexPro CH model: ± 2 mV to ± 700 mV (RTI); 100 µsec to 2 msec; either polarity Multi-vector: Detection on 2 separate ECG vectors (leads **LL** and **Va**)
Power on/off:	Battery insertion/removal
Lead fail detection:	DC type; indicates leadwire failed (i.e., RA, LA, LL, Va, or Vb)
Serial communications:	2 – 9600 baud asynchronous (Note: **Does not apply to units configured with inactive interface connector ports.)**

Analog/digital

A/D converter resolution:	10 bits, 9.76 µV (RTI)
Sample rate:	240 samples/sec

Physical specifications

Height:	13.7 cm (5.4 in)
Width:	7.3 cm (2.9 in)
Depth:	2.3 cm (0.9 in)
Weight:	141.8 g (5 oz) Weight excludes batteries and leadwire assembly.

Certifications

ApexPro transmitter

420-460 MHz – R&TTE

584 – 613.975 MHz – FCC Part 15 and 95

CE marking for the 93/42/EEC Medical Device Directive

ApexPro CH transmitter

608.025 – 613.975 MHz – FCC Part 95

T14 transmitter

Performance specifications

Power requirements

Battery type	ANSI/NEDA 15 A, 1.5V AA alkaline (2 required)
Battery life	65 hours
Polarity	Electronic reverse polarity protection

Alarms and controls

Battery integrity	Transmitted and indicated via LED
Leads Fail indication	Transmitted and indicated via LED

Transmission

Channel spacing	25 kHz
Frequency stability	± 0.0001% of assigned channel frequency
Bit rate	10 kbps
Antenna	Internal Inverted F Antenna (IFA)

ECG

Multi-channel configuration (5- or 6- leadwire)	I, II, III, Va, Vb, aVR, aVL, aVF
Leads analyzed simultaneously	Four (I, II, III, V)
Single-channel (3-leadwire) configuration	I, II or III, configurable
Heart rate detection	30 to 300 BPM
QRS detection range	0.5 to 5 mV
Frequency response	up to 38Hz (-3 dB)
A/D converter resolution	10 bits, 9.75 µV (RTI)
Sample rate	240 samples/seconds

Environmental specifications

Operating conditions

Temperature	5 to 40° C
Relative humidity	15 to 95% (non-condensing)

Transport and storage conditions

Temperature	-40 to 70° C
Relative humidity	15 to 95% (non-condensing)
Pressure	475 to 1200 hPa

Device specifications

Water resistance	IEC 60529 IPX7 rating (can survive inadvertent submersion)
Input configuration	3, 5 or 6 electrodes
Frequency range	1395.025 - 1399.975 MHz
Power output:	5mW (Meets FCC requirements for Part 95.)
Bandwidth	11.9 KHz
Modulation	GFSK
Serial I/O ports	2
Alarm pause	Transmitted and indicated via LED

Graph request	Transmitted
Event Marker	Transmitted
Maximum transmitters	199 active within WTMS at a single facility
Dynamic range	± 5 mV (RTI)
Input offset	± 300 mV (RTI)
Input impedance	15 M ohm minimum differential @ 10 Hz
ECG gain selection	5, 10, 20, 40 mm/mV (RTI)
ECG gain accuracy	± 5% @ 15 Hz
Common mode rejection	100 dB minimum @ 60 Hz
Defibrillator protection	± 5000 VDC, 360 joules into 100 ohm
Defibrillator recovery time	Transmitter recovers within 5 seconds
Pacemaker detection	± 2 mV to ± 700 mV (RTI); 100 µsec to 2 msec; either polarity; on multiple leads
Patient leakage current	Meets UL/IEC 60601-1
Serial communications	2 ports at 9600 baud asynchronous

Physical specifications

Height	13.7 cm (5.38 in)
Width	7.3 cm (2.875 in)
Depth	2.3 cm (0.91 in)
Weight	141.8 g (0.275 lb) without battery; 170.1 g (0.375 lb) with battery

FCC compliance information

This device complies with Part 95 of the FCC Rules.

Operation of this equipment requires the prior coordination with a frequency coordinator designated by the FCC for the Wireless Medical Telemetry Service.

Certifications

- UL/IEC/EN 60601-1
- IEC/EN 60601-1-1
- IEC/EN 60601-1-2
- IEC/EN 60601-1-4
- IEC/EN 60601-2-27
- IEC/EN 60601-2-49
- 1395.025 to 1399.975 MHz - FCC Part 95

Apex oximeter

Performance specifications

Battery Type:	ANSI/NEDA 15A, 1.5V AA alkaline (2 required)
Battery Life:	30 hrs. typical with display on continuously; 60 hrs. typical with display off
Polarity:	Electronic reverse polarity protection
Water resistant with sensor in place:	IEC 60529 IPX3 rating (spray and wipe only)
Controls and Indicators	
Power on/off:	Button switch
Display on/off:	Button switch
LED indicator:	Numerical SpO2 value; numerical HR value; signal quality indicator
SpO2 sensors:	Full line of Nonin qualified reusable and disposable sensors
Processing	
Saturation range:	0 to 100%
Saturation accuracy:	70 to 100% ± 3 digits (± 1 S.D.)
Pulse rate range:	18 to 300 BPM
Pulse rate accuracy:	± 3 % or 1 BPM, whichever is greater
CIC Pro center	
Messages:	Check probe, Low signal quality, Probe off patient
Numerical display:	SpO2 (% value), HR (bpm)
Alarms:	SpO2 high/low, HR high/low

Physical specifications

Height:	12.7 cm (5.0 in)
Depth:	2.0 cm (0.8 in)
Width:	6.9 cm (2.7 in)
Weight:	113.4 g (4.0 oz) Weight excludes batteries and SpO2 probe

Certification

UL 60601-1 CE marking for the 93/42/EEC Medical Device Directive.

Nonin Xpod oximeter

Performance specifications

The Nonin Xpod oximeter is manufactured for GE by Nonin Medical, Inc. It is recommended for use with Nonin sensors only.

Water resistant with sensor in place:	IEC 60529 IPX2 rating (spray and wipe only)
Controls and Indicators	
SpO2 sensors:	Refer to ApexPro CH Telemetry System Additional Product Information addendum for a list of approved sensors and specifications.
CIC Pro center	
Messages:	Refer to the ApexPro Telemetry System Operator's Manual for a list of messages.
Numerical display:	SpO2 (% value), HR (bpm)
Alarms:	SpO2 high/low, HR high/low

Physical specifications

Height:	5.3 cm (2.1 in)
Depth:	2.0 cm (0.8 in)
Width:	1.5 cm (0.6 in)
Weight:	75.0 g (2.7 oz) including 1.8 m (6.0 ft) of cable and connector

Certification

UL 60601-1 CE marking for the 93/42/EEC Medical Device Directive.

Accutracker DX noninvasive blood pressure monitor

Performance specifications

Technique:	Ausculatory. Diastolic pressure is determined from Phase 5 Korotkoff sounds.
Accuracy:	Blood pressure measurements determined with this device are equivalent to those obtained by a trained observer using the cuff/stethoscope auscultation method, within the limits prescribed by the American National Standard, Electronic or automated sphygmomanometers.

Pressure:	Dynamic or fixed programmable. Dynamic pressure configuration maximizes patient comfort by limiting cuff inflation to 30 mmHg greater than the previous systolic pressure, without exceeding configurable limits.
Pressure Range:	0 to 250 mmHg
Maximum pressure programmable limits:	100 to 250 mmHg, increments of 10 mmHg
Minimum pressure programmable limits:	10 to 100 mmHg, increments of 10 mmHg
Auto retry:	Automatically initiates an additional reading in the event a reading fails to satisfy any of the programmable criteria.
Blood Pressure Range	*Contact technical support for information on setting these limits.
Systolic:	10 to 250 mmHg
Upper auto-retry programmable limits:	50 to 240 mmHg, increments of 10 mmHg*
Lower auto-retry programmable limits:	50 to 150 mmHg, increments of 10 mmHg*
Systolic change (delta) limits:	30 to 100 mmHg, increments of 10 mmHg*
Diastolic:	10 to 250 mmHg
Upper auto-retry programmable limits:	50 to 150 mmHg, increments of 10 mmHg*
Lower auto-retry programmable limits:	30 to 100 mmHg, increments of 10 mmHg*
Diastolic change (delta) limits:	20 to 100 mmHg, increments of 10 mmHg*
Pulse Pressure	
Upper auto-retry programmable limits:	40 to 150 mmHg, increments of 10 mmHg*
Lower auto-retry programmable limits:	10 to 100 mmHg, increments of 10 mmHg*
Pulse pressure change (delta) limits:	30 to 100 mmHg, increments of 10 mmHg*
Deflation rate:	True linear deflation according to AHA guidelines. Programmable for 2, 3, 4, 5, or 6 mmHg per second.
Display:	32 character LCD (16 characters per row) provides a clear view of data and message prompts.
Sample quantity:	Over 250 samples per set of 4 new batteries.
Sample periods:	Manual and interval programmable. Intervals of 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 90, 120 or 240 minutes can be selected/programmed.

Start key:	Allows the patient or caregiver to initiate readings on demand.
Power source:	Four 1.5 (AA) alkaline batteries. Rechargeable batteries are not recommended (sample quantity with rechargeable batteries typically limited to 25 samples/measurements vs. 250 samples/measurements with new alkaline batteries).

Environmental specifications

Operating conditions

Temperature:	+10°C to 40°C (50°F to 104°F)
Relative Humidity:	<95%

Transport and storage conditions

Temperature:	-20°C to +50°C (-4°F to +122°F)
Relative Humidity:	<95%
Power:	6 Vdc, 4 1.5V AA Alkaline batteries.

Physical specifications

Length:	12.7 cm (5.0 in)
Width:	8.25 cm (3.25 in)
Thickness:	3.3 cm (1.30 in)
Weight:	357.2 g (12.6 oz)

Certification

UL60601 Medical Equipment with respect to electric shock, fire and mechanical hazards only in accordance with UL 60601-1, and CAN/CSA C22.2 No. 601.1, and IEC 60601-1

ApexPro receiver

Performance specifications

Quad receiver module

Type	GMSK or GFSK digitally demodulated
Frequency range	560.025MHz to 613.975MHz (U.S.) 420MHz to 474MHz (international)
Frequency step resolution	Frequency synthesized tuning to any transmitter. 25 KHz spacing.
Frequency stability	±0.00015% of assigned channel frequency
Demodulation	GMSK (ApexPro series), GFSK (PT series)
Bit rate	10 kb/sec (ApexPro series), 7.5 kb/sec (PT series)
Sensitivity	8.7 µV (–90 dBm) minimum for 1 bit error/1 million bits received

Receiver Subsystem

Capacity	1 to 4 quad receiver modules (4 to 16 receivers)
System status indicators	7 bicolor LEDs (green and yellow)
Network	IEEE 802.3 compatible, physical connector via 10BaseT
Serial diagnostics	19200 baud, 1 stop bit, 8 data bits, no parity, XON/XOFF flow control

Power requirements

Power requirements	100 to 240 VAC, 50 to 60 Hz
Power consumption	25 watts max with 4 quad receiver modules (85.3 BTU/hr.)
Cooling	Free convection

Environmental specifications

Operating conditions

Temperature	0°C to 40° C (32°F to 104°F)
Relative humidity	10% to 90% (non condensing)

Transport and storage conditions

Temperature	–40°C to 70°C (–40°F to 158°F)
Relative humidity	15% to 95% (non condensing)

Physical specifications

Subsystem

Height	170 mm (6.7 in)
Width	325 mm (12.8 in)
Depth	250 mm (9.8 in)
Weight	6.4 kg (14 lb) with 4 quad receiver modules

Certification

Receiver Unit

420-474 MHz – R&TTE

560 – 614 MHz – FCC Part 15, Subpart B Class B (U.S. only)

Subsystem

UL 60601-1 Classified. IEC 60601-1 and IEC 60601-1-2 Certified. CE marked per the Medical Devices Directive 93/42/EEC. Yakuji (Japanese Ministry of Health, Labour and Welfare).

Antenna specifications

Performance specifications

Type	Hi-Pwr (-002, -004)	Passive (-003, -005, -006)	Active (-007)	Active (-008)
Voltage range	7.0 – 12.6 V	N/A	8.0 - 12.6 V	8.0 - 12.6 V
Minimum voltage	7.0 V	N/A	8.0 V	8.0 V
Current draw	55 mA	N/A	115 mA	52 mA
Gain	17 dB	–5dB	28.5 dB	15 dB

Environmental specifications

Operating conditions

Ambient temperature	0°C to 50°C (32°F to 122°F)
Relative humidity	25% to 85% (non condensing)

Storage conditions

Temperature	–40°C to 70°C (–40°F to 158°F)
Relative humidity	15% to 95% (non condensing)
Pressure	500 hPa to 1060 hPa

Physical specifications

Height	11 in.
Width	11 in.
Depth	3.5 in.

Warranty information

Standard warranty is one year. Other options are available.

Power supply specifications

Power requirements

Input	100-250Vac, 50 - 60Hz, male power inlet, 3 conductor, IEC 320
Output	12Vdc ±5%,2.5A, short circuit and overload protection

Environmental specifications

Operating environment

Temperature	0 – 40°C (32°F to 104°F)
Humidity	20 - 95% non-condensing

Storage environment

Temperature	-40 – 75°C (–40°F to 158°F)
Humidity	10 -95% non-condensing

Device specifications

Isolation	Meets IEC 60601, classification BF, UL544 patient care, CSA 125 risk class 2G
Overall regulation	< 5% no minimum load required
Maximum ripple	< 100mVp-p
Cord length	305mm (12 in.)
Safety	Approved to UL 544/2601.1, cUL (CSA) 22.2 #125/601.1, TUV EN60601.1 and CE LVD
EMC	Meets level B requirements of FCC part 15, CISPR11 (EN55011).

Bias tee specifications

Environmental specifications

Temperature	0 - 50° C (32°F to 122°F)

Device specifications

Frequency	400-650MHz
Insertion loss	0.5dB, max
Isolation ■ DC OUT/RF IN port to DC IN port ■ RF OUT port to DC IN port	20dB, min
VSWR	1.3.1, max
DC voltage	30 Volts, max
DC current	1 Amp, max
RF power	+20dBm, max
DC resistance	0.1 ohms

Bias tee & power supply mounting kit specifications

Physical specifications

Material	Aluminum alloy
Length	76.6 mm (3 in)
Width	51.75 mm (2 in)
Height	60 mm (2.4 in)

Antenna amplifier specifications

Environmental specifications

Temperature	0 - 50°C (32°F to 122°F)

Device specifications

Part numbers	**2001727-001 2001727-002**	**2001727-004 2001727-005**	**2001727-006**	**2001727-007**
Gain	22.0 dB		20.0 dB	
Current draw	50mA	55mA		
DC resistance	0.5 ohms max.			
Operating voltage	6 V min.	7 V min.	6 V min	

B Electromagnetic compatibility

ApexPro and CARESCAPE transmitters

Electromagnetic compatibility (EMC)

Changes or modifications to this system not expressly approved by GE could cause EMC issues with this or other equipment. This system is designed and tested to comply with applicable regulation regarding EMC and needs to be installed and put into service according to the EMC information stated in this appendix.

CAUTION
Use of portable phones or other radio frequency (RF) emitting equipment near the system may cause unexpected or adverse operation.

CAUTION
The equipment or system should not be used adjacent to, or stacked with, other equipment. If adjacent or stacked use is necessary, the equipment or system should be tested to verify normal operation in the configuration in which it is being used.

Guidance and manufacturer's declaration – electromagnetic emissions

The ApexPro Telemetry Transmitter is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the ApexPro Telemetry Transmitter is used in such an environment.

Emissions test	Compliance	Electromagnetic environment – guidance
RF Emissions (radiated) EN 55011	Group 1 Class A	The device intentionally transmits energy in the 420-460, 584-614, or 608-614MHz range. Nearby electronic equipment may be affected. Outside the range of intentional transmission, the device emissions are very low and are not likely to cause any interference. The equipment is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
RF Emissions (conducted) EN 55011	Group 1 Class A	
Harmonic Emissions EN 61000-3-2	Not applicable	NO AC input.
Voltage Fluctuations/ Flicker Emissions EN 61000-3-3	Not applicable	

Guidance and manufacturer's declaration – electromagnetic immunity

The ApexPro and CARESCAPE Telemetry Transmitter is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the ApexPro Telemetry Transmitter is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
Electrostatic Discharge (ESD) EN 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical Fast Transient/ Burst EN 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	Not applicable	No AC input
Surge EN 61000-4-5	± 1 kV differential mode ± 2 kV common mode	Not applicable	No AC input
Voltage dips, short interruptions and voltage variations on power supply input lines EN 61000-4-11	<5% U_t (>95% dip in U_t) for 0.5 cycles <40% U_t (>60% dip in U_t) for 5 cycles <70% U_t (>30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 s	Not applicable	No AC input
Power Frequency (50/60 Hz) Magnetic Field EN 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

NOTE

U_t is the AC mains voltage prior to application of the test level.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
			Portable and mobile RF communications equipment should not be used closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance**
Conducted RF EN 61000-4-6	3 Vrms 150 KHz to 80 MHz	0.3 V rms[c]	$d = 11.6\sqrt{P}$
Radiated RF EN 61000-4-3	3 V/m 80 MHz to 2.5 GHz	0.3 V/m[c]	$d = 11.6\sqrt{P}$ 80 MHz to 800 MHz $d = 23.3\sqrt{P}$ 800 MHz to 2.5 GHz where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer, and *d* is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a], should be less than the compliance level in each frequency range[b]. Interference may occur in the vicinity of equipment marked with the following symbol: 

Note 1: At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by reflection from structures, objects, and people.

[a]Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the equipment.

[b]Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 0.3 V/m.

[c] The low power design does not allow the use of high dynamic range operational amplifiers. To further reduce size, the ECG section utilizes single supply topology, and unshielded Flex assemblies. The result of the above mentioned design choices results in a design that provides acceptable performance in the clinical environment.

Recommended separation distances

The following table provides the recommended separation distances (in meters) between portable and mobile RF communications equipment and the ApexPro Telemetry Transmitter.

The ApexPro and CARESCAPE Telemetry Transmitter is intended for use in the electromagnetic environment on which radiated RF disturbances are controlled. The customer or the user of the ApexPro Telemetry Transmitter can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the ApexPro and CARESCAPE Telemetry Transmitter as recommended below, according to the maximum output power of the communications equipment.

	Separation distance in meters (m) according to frequency of transmitter		
Rated maximum output power of transmitter in watts	**150 kHz to 80 MHz[a]** $d = 11.6\sqrt{P}$	**80 MHz to 800 MHz [a]** $d = 11.6\sqrt{P}$	**800 MHz to 2.5 GHz[a]** $d = 23.3\sqrt{P}$
0.01	1.16	1.16	2.33
0.1	3.67	3.67	7.37
1	11.6	11.6	23.3
10	36.7	36.7	73.7
100	116	116	233
[a]At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.			

For transmitters rated at a maximum output power not listed above, the recommended separation distance [*d*] in meters (m) can be estimated using the equitation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE

These guidelines may not apply in all instances. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Compliant cables and accessories

WARNING
The use of accessories, transducers and cables other than those specified may result in increased emissions or decreased immunity performance of the equipment or system.

The table below lists cables with which GE claims EMC compliance.

NOTE

Any supplied accessories that do not affect EMC compliance are not included.

Description	Maximum length
ECG multi-link leadwire sets	
Multi-Link Ldwr Set, 6-Lead, Snap, AHA	74 cm / 29 in
Multi-Link Ldwr Set, 6-Lead, Snap, IEC	74 cm / 29 in
Multi-Link Ldwr Set, 6-Lead, Grabber, AHA	74 cm / 29 in
Multi-Link Ldwr Set, 6-Lead, Grabber, IEC	74 cm / 29 in
SpO_2/Oximetry	
Nonin Xpod	27 cm / 10.5 in
Nonin **SpO_2** Sensor Adult Reusable Finger Clip	N/A
Nonin **SpO_2** Sensor Adult Reusable Ear Clip	N/A
Nonin **SpO_2** Sensor Adult Disposable	N/A
Nonin **SpO_2** Sensor Pediatric Reusable Finger Clip	N/A
Nonin **SpO_2** Sensor Pediatric Disposable	N/A

ApexPro receiver

Electromagnetic compatibility (EMC)

Changes or modifications to this system not expressly approved by GE could cause EMC issues with this or other equipment. This system is designed and tested to comply with applicable regulation regarding EMC and needs to be installed and put into service according to the EMC information stated in this appendix.

CAUTION
Use of portable phones or other radio frequency (RF) emitting equipment near the system may cause unexpected or adverse operation.

CAUTION
The equipment or system should not be used adjacent to, or stacked with, other equipment. If adjacent or stacked use is necessary, the equipment or system should be tested to verify normal operation in the configuration in which it is being used.

Guidance and manufacturer's declaration

Electromagnetic emissions

The ApexPro receiver is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the ApexPro receiver is used in such an environment.

Emissions test	Compliance	Electromagnetic environment – guidance
RF Emissions EN 55011 [Radiated]	Group 1	The equipment uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF Emissions EN 55011 [Conducted]	Class A	
Harmonic Emissions IEC 61000-3-2	Class A	The equipment is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Voltage Fluctuations/ Flicker Emissions IEC 61000-3-3	Complies	

Electromagnetic immunity

The ApexPro receiver is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the ApexPro receiver is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
Electrostatic Discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical Fast Transient/ Burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines	Mains power should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV differential mode ± 2 kV common mode	± 1 kV differential mode ± 2 kV common mode	Mains power should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5% U_t (>95% dip in U_t) for 0.5 cycles <40% U_t (>60% dip in U_t) for 5 cycles <70% U_t (>30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 s	<5% U_t (>95% dip in U_t) for 0.5 cycles <40% U_t (>60% dip in U_t) for 5 cycles <70% U_t (>30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 s	Mains power should be that of a typical commercial or hospital environment. If the user of the equipment requires continued operation during power mains interruptions, it is recommended that the equipment be powered from an uninterruptable power supply or a battery.
Power Frequency (50/60 Hz) Magnetic Field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

NOTE

U_t is the AC mains voltage prior to application of the test level.

Guidance and Manufacturer's declaration - electromagnetic immunity

The ApexPro receiver is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the ApexPro receiver is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
Conducted RF IEC 61000-4-6 Radiated RF IEC 61000-4-3	3 Vrms 150 KHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	3 V rms 3 V/m	Portable and mobile RF communications equipment should not be used closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance** $d = 1.2\sqrt{P}$ $d = 1.2\sqrt{P}$ 80 MHz to 800 MHz $d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer, and *d* is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a], should be less than the compliance level in each frequency range[b]. Interference may occur in the vicinity of equipment marked with the following symbol: 

Note 1: At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by reflection from structures, objects, and people.

[a]Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the equipment.

[b]Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 3 V/m.

Recommended separation distances

The following table provides the recommended separation distances (in meters) between portable and mobile RF communications equipment and the ApexPro receiver.

The ApexPro receiver is intended for use in the electromagnetic environment on which radiated RF disturbances are controlled. The customer or the user of the ApexPro receiver can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the ApexPro receiver as recommended below, according to the maximum output power of the communications equipment.

	Separation distance in meters (m) according to frequency of transmitter		
Rated maximum output power of transmitter in watts	**150 kHz to 80 MHz[a]** $d = 1.2\sqrt{P}$	**80 MHz to 800 MHz [a]** $d = 1.2\sqrt{P}$	**800 MHz to 2.5 GHz[a]** $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23
[a]At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.			

For transmitters rated at a maximum output power not listed above, the recommended separation distance [*d*] in meters (m) can be estimated using the equitation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE

These guidelines may not apply in all instances. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Compliant cables and accessories

CAUTION
The use of accessories, transducers and cables other than those specified may result in increased emissions or decreased immunity performance of the equipment or system.

The table below lists cables, transducers, and other applicable accessories with which GE Medical Systems claims EMC compliance.

NOTE

Any supplied accessories that do not affect EMC compliance are not included.

Description	Maximum lengths
RJ45 - Cat Cables	100m / 328 ft.

GE Medical Systems
Information Technologies, Inc.
8200 West Tower Avenue
Milwaukee, WI 53223 USA
Tel: + 1 414 355 5000
1 800 558 5120 (US only)
Fax: + 1 414 355 3790

EC REP
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Information Technologies GmbH
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Fax: + 49 761 45 43 - 233

Asia Headquarters

GE Medical Systems
Information Technologies Asia; GE (China) Co., Ltd.
24th Floor, Shanghai MAXDO Center,
8 Xing Yi Road, Hong Qiao Development Zone
Shanghai 200336, P.R. China
Tel: + 86 21 5257 4650
Fax: + 86 21 5208 2008

GE Medical Systems *Information Technologies*, a General Electric Company, going to market as GE Healthcare.
www.gehealthcare.com