Philips Telemetry System

Service and Reference Guide

PHILIPS

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Notice

Proprietary Information

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Appendices

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Introducing the Philips Telemetry System

Overview

Chapter 1 provides a functional description of the Philips Telemetry System. It describes how the system works as a whole and explains the various assemblies that make up the telemetry system.

Following are the topics in this chapter.

Philips Telemetry System Compatibility

Software and hardware compatibility information provided in this document is valid at the time of publication. New revisions are likely.

Compatibility revision changes are updated regularly in Service Notes. Information in this document reflects information provided in Service Note M2600A-007G Compatibility Charts and M2600A-008G Software History. As updates occur, the last character in the service note number increments (for example, M2600A-007G, H, I). The latest Service Note is available from a Philips Medical Systems Response Center.

Warning

Philips Medical Systems has done extensive validation of the systems specified as compatible in the compatibility charts. Failure to adhere to these compatibility charts could result in a malfunction or in unspecified behavior.

Philips Telemetry System

The **Philips Telemetry System** consists of the following components. See Figure 1-1.

1. pocket sized **Transmitters** with removable Leadsets and SpO_2 Transducers
2. Philips **Receiver Mainframe**
3. Philips **Receiver Modules** (up to 8), housed in the Receiver Mainframe
4. active and passive **Antenna Components**
5. **TeleMon** (M2636B)
6. **Telemetry Configuration Tool**
7. **Telemetry** S**ervice Too**l

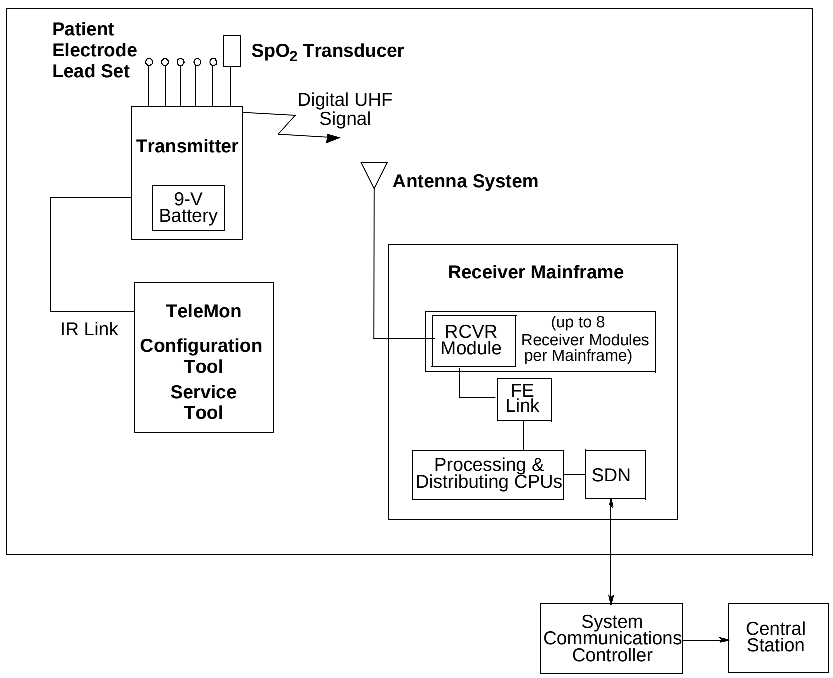


Figure 1-1 Philips Telemetry System Block Diagram

Leadsets and SpO_2 Transducer

The telemetry system provides ECG and SpO_2 monitoring of ambulatory and non-ambulatory patients. ECG and SpO_2 data are acquired by the Transmitter from the patient via **Patient Electrode Leadsets** and an **SpO_2 Transducer**.

Transmitter

The **Transmitter** processes the signals and broadcasts them via Radio Frequency (RF) to the Receiver and via infrared signals to the TeleMon.

Antenna System

The **Antenna System** is designed to create coverage areas where radio signals can be picked up. Standard band transmitters broadcast signals at characteristic frequencies between 406 and 480 MHz. These signals are received by the antenna system, which distributes them to the receiver mainframe. Inside the mainframe, they are distributed further to the receiver modules, each of which is tuned to receive from one transmitter.

For operation at extended UHF frequencies, transmitters broadcast signals in the range 590-632 MHz. These signals are received by the antenna system and sent to the Frequency Converter.

Frequency Converter

A **Frequency Converter** shifts or “converts” the signal from the antenna system to a lower frequency. The “converted” signal is then fed into the receiver mainframe, which distributes it further to the installed receivers. The receivers are tuned to the transmitter frequency less the Frequency Converter frequency. The Frequency Converter can be external to the Receiver Mainframe (Option #C07) or on a PC board internal to the Receiver Mainframe (Option #C08)

Receiver Mainframe

The **Receiver Mainframe** houses the **Receiver Modules** and converts the received signal into a format that can be sent over the network and routes the signal to the central station for display and analysis. The Receiver Mainframe can accommodate up to 8 Receiver Modules.

Analog Output Option

An **Analog Output Option** converts the SDN formatted signal back into an analog value in the mainframe and is routed to a bedside or a Holter interface.

TeleMon

The **M2636B TeleMonB** is a portable monitor display that can be docked to a transmitter via an IR link. It provides local display of 2 waves -- ECG waveforms, pleth wave or a delayed/annotated arrhythmia wave -- and numerics for heart rate, % SpO_2, and NBP. The TeleMon also transmits NBP, recording, suspend requests, and INOPs through the transmitter to a Philips Information Center simultaneously with the transmission of the Transmitter’s ECG and SpO_2 signals.

Note

Use of the TeleMon is not described in detail in this Guide. For information on the TeleMon Monitor, consult the TeleMonB Customer Documentation CD ROM (PN M2636-90035), which includes the following M2636B TeleMonB Monitor documents:

- Instructions for Use
- Service Manual
- Quick Guide

Telemetry Configuration Tool

The **Telemetry Configuration Tool** is a software application that runs on a computer that operates DOS and links to the transmitter via an IR link. It can be used to set several transmitter parameters -- operating frequency, %SpO_2 sample rate, auto shut off. For a description of the Telemetry Configuration Tool, see the Philips Telemetry System Configuration Tool Guide on the Philips Telemetry System Service and User Documentation CD ROM (PN M2600-90187).

Telemetry Service Tool

The **Telemetry Service Tool** is a software application that runs on a computer that operates Windows 98 or Windows NT. It links to transmitters via an IR link and to the Receiver Mainframe via an RS232 PC board that must be mounted in in the rear of the Mainframe. The Service Tool can be used for a variety of configuration, service, and firmware upgrading tasks. For a description of the Telemetry Configuration Tool, see the Philips Telemetry System Service Tool Guide on the Philips Telemetry System Service and User Documentation CD ROM (PN M2600-90187).

Transmitter

The **Philips Transmitter** is a battery powered (9-volt) Transmitter worn by the patient. It acquires ECG and SpO_2 data from the patient via a ECG Leadset and SpO_2 Transducer, amplifies and digitizes the data, and broadcasts them at ultra high frequency (UHF) to a Receiver Module in the Receiver Mainframe. SpO_2 processing occurs in the Transmitter. ECG processing takes place in the Receiver Mainframe, Central Station, or at the bedside (analog output).

The Transmitter consists of the following assemblies. See Figure 1-1.

- ECG Leadset
- SpO_2 Transducer
- Front-end Assembly
- Case Assembly
- ECG Printed Circuit Board (PCB)
- Main Digital PCB, which contains the following subsections:
  a. digital section
  b. RF section, including the synthesizer
  c. power supply
- SpO_2 PCB
- SpO_2 Transducer
- Battery
- Battery extender

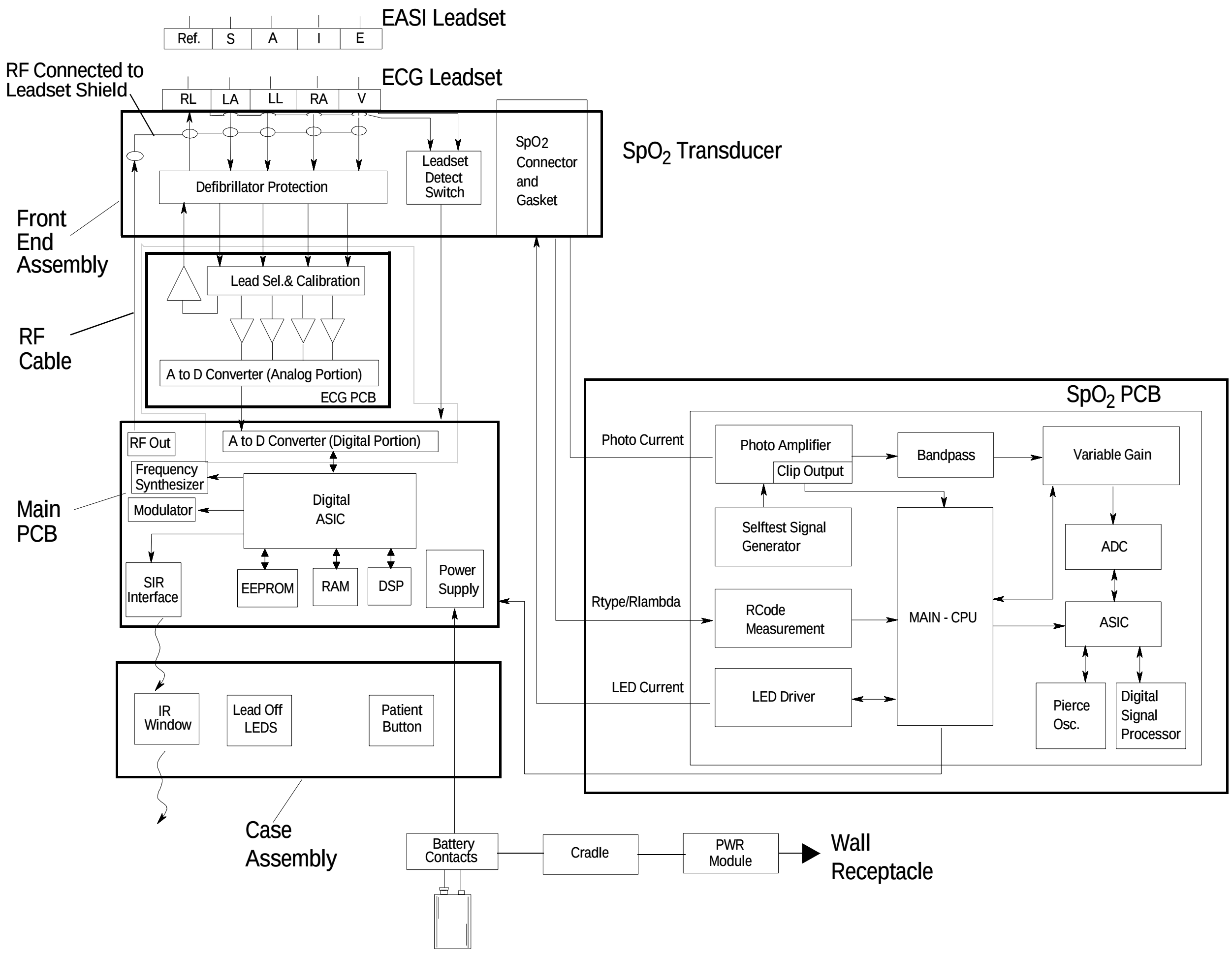


Figure 1-2 Block Diagram of Philips Transmitter

Leadsets

The standard ECG system supports two leadset configurations: 3-wire and 5-wire. With a 3-wire leadset, only 1 lead is transmitted (lead II is the default), and leads I, II, or III can be selected if the transmitter is configured for 3-wire leadset selection. For EASI, a 5-wire leadset is required.

The ECG leadset provides connection from the inputs of the transmitter to the electrodes on the patient. Each lead has its own front end circuitry in the transmitter that routes the signal from each lead to the transmitter's processing circuits. The transmitter sources an active lead for each connection. Each signal is then combined to generate the transmitted leads.

3-Wire Leadset (Standard ECG)

The 3-wire leadset broadcasts one lead (lead II is the default) of ECG for display at the Central Station. The selection of leads for display using the 3-wire leadset are determined by whether the **lead selection** function is enabled (Yes) or disabled (No - factory default) in the transmitter configuration.

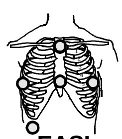
Lead Selection Enabled - With lead selection enabled, the cardiotach lead, which is broadcast, can be selected using the Telemetry Service Tool or Wave Viewer. In this mode, the broadcast lead can be selected from Leads I, II, or III. The lead label is automatically changed at the Central Station when the lead is changed.

Lead Selection Disabled (Factory Default) - When lead selection is disabled, the broadcast lead is set at Lead II. The only way the lead can be changed is by changing the electrode placement on the patient to a non-standard configuration. When doing this, place the leads that normally monitor lead II over the limb lead to be monitored. This means that Leads I, II, III, or MCL can be monitored; however, the central station will still display Lead II. The lead label must also be changed at the Central Station to the lead being broadcast.

5-Wire Leadset (Standard ECG)

With the 5-wire leadset, 3 leads are broadcast: II, III, and MCL. From these 3 leads, the software in the receiver mainframe can reconstruct the remaining 5 leads: I, aVR, aVL, aVF, and a true V lead. The leads to view can be selected at the Central Station.

5-Wire Leadset (EASI ECG)



EASI

When the transmitter is configured for monitoring the 12-lead EASI ECG, a 5-wire leadset must be used. The 3 directly acquired or “raw” EASI leads (AI, AS, ES) are broadcast by the transmitter. Software in the Philips Information Center mathematically reconstructs the following leads: I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6, and will perform arrhythmia analysis on 2 of the leads and ST analysis on all 12.

If monitoring is attempted with a 3-wire leadset attached to an EASI ECG transmitter, the system will report an INVALID LEADSET inoperative message (INOP) at the central station.

SpO_2 Transducer

When SpO_2 is monitored, the data are received via a **SpO_2 Transducer**, processed by a dedicated SpO_2 circuit within the transmitter, and the parameter values are sent as part of the broadcast.

Front End Assembly

The **Front End Assembly** the Transmitter is where the ECG Leadset and the SpO_2 Transducer plug in. It contains the following features:

1. **Leadset detect switches** that identify which leadset (3- or 5-lead) is connected to the transmitter and sends the information to the digital ASIC on the Main PCB. The leadset detect switches are positioned next to the RL and V lead wires in the standard ECG configuration, or next to the Reference and E lead wires in the EASI configuration (the two connector cutouts are rectangular not square).
2. **High impedance resistors** that provide defibrillator protection to the signal acquisition circuits on the ECG PCB.
3. **Radio Frequency (RF) cable connection** to the leadset shield that allows the RF signal to be transmitted through the leadset, which acts as an antenna.

Case Assembly

The **Case Assembly** provides protection to the internal electronics of the transmitter. It also contains the nurse-call button and the leads-off Light Emitting Diodes (LEDs).

Transmitter Button

The **Transmitter Button** is a membrane switch that toggles a bit in the transmitted message to ON when the switch is pressed. Electrically, the transmitter button has two positions:

OFF (not pressed)

ON (pressed)

The Transmitter Button can be configured in the receiver mainframe to perform the following actions when it is pressed:

1. generate a yellow-level nurse call alarm at the central station
2. generate a recording at the central station
3. generate both a nurse call alarm and a recording at the central station
4. do nothing

Once the alarm or recording has been started, it can only be stopped at the central station. Pressing the button on the transmitter again does not affect the alarm or the recording.

Manual SpO_2 Measurements

Even if the transmitter button is configured for DISABLED or if the button is turned OFF at the central station, **Manual SpO_2 Measurements** using the Transmitter button are still possible.

If a transmitter is set for intermittent SpO_2 measurements (manual mode, 1 minute and 5 minutes), manual measurements from the transmitter can be initiated at any time using the transmitter button or Wave Viewer. SpO_2 must be turned on at the central station for alarms and for display and trending.

Note

If the transmitter is in manual mode, the SpO_2 parameter at the central station will turn on automatically when a measurement is initiated. If the transmitter is in the 1-minute or 5-minute sample mode, SpO_2 must be turned on at the central station by the user.

To initiate a Manual SpO_2 Measurement at the transmitter, do the following:

- Plug the transducer cable into the transmitter.
- Attach the transducer to the patient.
- Press and hold the transmitter button (approximately 6 seconds) until the LA light for standard ECG (S light for EASI ECG) begins flashing. When the transducer light turns off, the measurement is complete.
- Remove the transducer from the patient after the transducer light goes out. The measurements value and time stamp will be displayed at the Central Station for up to 1 hour or until the next measurement is made, whichever comes first.

Leads Off LEDs

A **Leads Off Light Emitting Diode (LED)** turns on whenever one of the leads falls off the patient, or if the circuitry for that lead is defective. There is one LED for each electrode, and they are shown in the electrode placement diagram on the transmitter in the standard lead placement.

ECG PCB

The **ECG Printed Circuit Board (PCB)** contains the ECG Front-end Circuitry, which acquires the ECG signal from the leadset. This circuitry provides basic preamplification of the signals, filters the signals, then performs the first stage of analog-to-digital conversion.

The output circuit of the reference drive sums the outputs of the four other electrode inputs to generate one output that is used for improving common mode rejection performance. The reference drive output can be switched to drive any of the four input electrodes.

The **Front-end Circuitry** for each input electrode does the following:

- acquisition and preamplification of ECG signal
- bandpass filtering and conditioning of the signal
- Initial analog-to-digital conversion of the ECG signal

Each **Analog-to-Digital Converter** consists of the following subcircuits:

- input buffer amplifier
- low frequency summing amplifier
- integrating analog-to-digital converter

The circuitry for each electrode is the same. Resistors of the input buffer amplifier provide input protection for the front end ICs. An operational amplifier sets the noise performance of the incoming ECG signal by filtering out unwanted noise on the input leads. A low frequency feedback summation amplifier provides preamplification and further conditioning of the incoming ECG signal. The final stage of the analog section is a pulse width modulated A/D converter. This is the first stage of the analog-to-digital conversion of the ECG signal. The second stage takes place on the Main PCB.

Main PCB

The **Main PCB** contains the main processing and signal transmitting circuits for the transmitter. The Main PCB can be broken into 3 functional areas:

- Digital Section
- RF Section
- Power Supply

Digital Section

The **Digital Section** of the transmitter consists of a digital ASIC, digital signal processor (DSP), and memory. The digital ASIC consists of a gate array, which provides interfaces to the DSP from the following circuits:

- ECG PCB
- 3/5 wire leadset switch
- nurse-call button
- Leads Off LEDs
- SpO_2 circuits
- Serial infrared (IR) port to Wave Viewer
- Control lines for the frequency synthesizer
- RF output circuit
- Power Supply control
- Memory Section

The gate array consists of latches and logic control gates that control the flow of information to the DSP. The DSP then processes the signal from each interface and includes it into the transmitted message. The following paragraphs describe each interface controlled by the gate array and processed by the DSP.

ECG PCB Interface

The **ECG PCB Interface** is a gate array that receives the output for each of the 4 input electrodes and routes the signal to the DSP for the following processing:

- Final analog-to-digital conversion of each lead signal.
- Checks for Leads-Off conditions
- Processing of the leads to be transmitted
- Pace pulse detection and processing

Lead Set Detect Circuit

A **Lead Set Detect Circuit** in the Transmitter senses whether a 3-wire or 5-wire leadset is being used. The transmitter has 2 pressure sensitive switches that change from high impedance to low when an RL or V lead wire (standard ECG leadset) or a Reference or E lead wire (EASI leadset) is inserted into the connector.

Note When replacing patient leadsets, it is very important to connect them properly. An incorrect connection can cause the transmitter to detect the wrong leadset

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Transmitter Button

The **Transmitter Button** on the Case Assembly has a direct connection to the Digital Section of the Main PCB. Refer to the previous section or the Instructions for Use for the Central Station for more information on the transmitter button.

Leads Off LEDs

Leads Off LEDs on the Case Assembly indicate when the leads are properly connected to the patient. When the leads are properly connected, the LEDs are off. When the Digital Section of the Main PCB senses a lead off condition, it turns on the appropriate LED on the Case Assembly via a direct line.

In general, when the transmitter is on a patient or a simulator, a Leads Off LED will light to indicate that a lead wire is not connected. However, there are some subtleties in operation that may raise some questions for the service provider. The LED that is on depends on several factors: if a leadset is attached, which type of leadset is attached, how Lead Selection for a 3-wire leadset in the transmitter is configured and which electrode wire is off.

There are 2 switches in the transmitter where the leadset plugs in. If the 2 switches are closed, the transmitter knows that a 5-electrode leadset is attached to the transmitter. If they are open, the transmitter will respond as if a 3-electrode leadset is attached. Note that the transmitter cannot distinguish between a 3-electrode leadset and no leadset. For this reason, if no leadset is attached, the LEDs will react as if the transmitter has a 3-electrode leadset attached.

Knowing which electrode is the reference electrode is important for understanding how the LEDs work, and the reference electrode depends on which leadset is attached to the transmitter. If a 5-electrode is attached, the RL (standard ECG) or the Reference (EASI) electrode is always the reference lead.

If a 3-electrode leadset is attached, the reference electrode depends on which lead is being measured by the transmitter.

When Lead Selection in the transmitter is configured to NO (factory default), the transmitter always measures lead II. Lead II is the voltage across the right arm and left leg (RA-LL) electrodes. This leaves the left arm (LA) as the reference electrode.

When Lead Selection in the transmitter is configured to YES, then the lead being measured can change and, as a result, the reference electrode can change.

Table 1-1. Reference Electrode for 3-Electrode Leadset with Lead Selection Configured for YES

Selected Lead	-	+	Reference
I	RA	LA	LL
II	RA	LL	LA
III	LA	LL	RA

Which LED lights also depends on which electrode wire is off. If the wire for the reference electrode is off, only the reference electrode LED will be on – even if multiple electrode wires are off. If the wires for any other electrode or combination of electrodes are off, those LEDs will be on. There is one exception to this. If all the electrode wires except for the reference electrode are off, the transmitter cannot distinguish between this situation and the reference electrode wire being off. In this situation, only the reference electrode LED will be on.

From a user perspective, using the LEDs is simple:

- Attach the electrode wire(s) indicated by the LEDs on the transmitter
- Check the transmitter LEDs again
- If additional LEDs are on, attach the electrode wires indicated
- If a LED is on, and that wire is attached, then all of the other electrode wires must be off.

Serial Infrared Port

The transmitter communicates to the TeleMon and Telemetry Configuration Tool via the **Serial Infrared Port (SIR)**. This port connects to the DSP via a 3 wire UART.

Power Supply Control

The transmitter monitors the operation of the power supply and controls its operation as appropriate. The digital section of the transmitter performs the following **Power Supply Control** functions:

Battery type sensing - The transmitter works with 8.4- and 9-volt batteries (alkaline, zinc-air, and lithium) except when SpO_2 is being used.

Caution

When using SpO_2, zinc-air batteries cannot be used. If a zinc-air battery is used with SpO_2, frequent BATTERY WEAK and/or REPLACE BATTERY INOP are sent to the Central Station.

If a BATTERY WEAK message occurs, no SpO_2 or TeleMon communication can occur, but the ECG functions normally.

If a REPLACE BATTERY message occurs, all functions cease.

Low Voltage and Replace Battery Circuit - If the battery voltage falls below 6.6 volts, a battery weak signal is generated and transmitted to the central station as an INOP. If the voltage falls below 5.9 volts, the replace battery signal is generated and sent to the central station as an INOP.

Memory Section

The **Memory Section** consists of a serial EEPROM, which stores the program for the DSP. The program is loaded at power-up using a small set of instructions contained within the ASIC. The DSP runs the program out of internal DSP RAM. The EEPROM stores several variables so that configuration information is kept when the battery is removed. The external RAM is used as a communication buffer area.

RF Section

The **RF Section** is a programmable frequency synthesized local oscillator operating at ultra-high frequency. A temperature compensated crystal oscillator provides the reference frequency. The digital bit stream from the DSP is used to modulate the carrier frequency. These data are applied to the synthesizer voltage controlled oscillator (VCO). The VCO output drives a common-emitter bipolar transistor output stage. The output stage filter provides spurious filtering and transforms the 50 Ohm nominal impedance of the antenna circuit to present the optimum impedance to the output stage collector for high efficiency. The shielded cable of the ECG lead set serves as the broadcast antenna for the transmitter.

The transmitter frequency can be changed or set using the Telemetry Service Tool or TeleMon.

Power Supply

The **Power Supply** provides all of the voltages for use by the transmitter. It consists of 2 linear low dropout regulators of 3 and 5 volts. This provides the 5V and 2.5V needed for the operation of the transmitter. Power to the regulators is derived from an 8.4- or 9-volt battery. To protect against battery reversal, power for the battery is delivered to a pair of back to back MOSFETs.

Comparators sense and warn of low and replace battery conditions via the power supply control circuitry of the digital section. The replace battery indication is sent to the DSP to control shutdown so that the necessary housekeeping and replace battery message can be transmitted prior to shutdown.

SpO_2 Module

The **SpO_2 Module** of the transmitter consists of an SpO_2 Transducer, which attaches to the patient's finger, and a SpO_2 Board.

SpO_2 Transducer

The **SpO2 Transducer** measurement is based on the phenomenon that oxygenated blood has different absorption in red and infrared light wavelengths, related to the oxygenation of the blood.The red and infrared LEDs in the SpO_2 sensor emit light, which is detected by a photo diode after passing through the patient's skin. The received signal is analog and digitally processed, which yields a pulsatile raw wave for the red and infrared absorption.

SpO_2 Board

The **SpO_2 Board** is shown in Figure 1-3. It contains a Main CPU with an algorithm that calculates SpO_2, pulse rate and perfusion value in numeric representation for the given raw wave. The red and infrared LED signals are 90^o out of phase. At the receiving **Photo Diode**, the sum of the signals is analog processed and digitally demodulated. This method, based on the theory of quadrature modulation, produces signals that are highly resistant to noise (ambient light) and consumes less power than other methods.

Photo Amplifier

The transducer routes the input current from the photodiode to the Photo Amplifier. The **Photo Amplifier** performs the following functions:

- Converts the input currents to output voltages
- First order, low bandpass filters the input signals to eliminate incoming disturbances of higher frequencies.

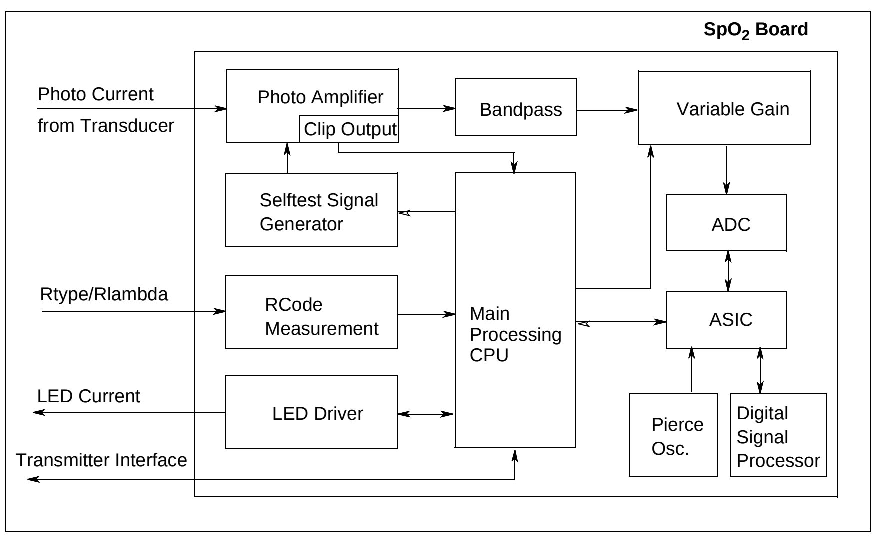


Figure 1-3 SpO_2 Board Block Diagram

The Photo Amplifier is implemented as a differential amplifier to provide balanced input characteristics and to suppress incoming disturbances.

A clipping detection circuit is connected to the output of the Photo Amplifier and serves as a controlling stage for the Photo Amplifier. By using a comparator connected as an inverting Schmitt Trigger, clipping of the Photo Amplifier signal caused by ambient light (for example) is detected. The output of this stage is connected to the front end controlling firmware of the Main CPU to generate an INOP alarm in case of excessive clipping. The comparator circuitry contains a hysteresis loop to avoid jittering of the output signal.

Bandpass Filter

The modulated signals coming from the photo amplifier pass through a third order Butterworth **Bandpass Filter**. This serves as an anti-aliasing filter and filters out all disturbance frequencies outside a passband centered on the modulation frequency.

Variable Gain Amplifier and Analog to Digital Converter (ADC)

The **Variable Gain amplifier** augments the signal from the bandpass filter and routes the signal to the **Analog to Digital Converter (ADC)**. The output of the ADC is sent to the digital ASIC.

ASIC

The digital **ASIC** works as an interface between the DSP and the main processing CPU. In addition, the digital ASIC acts as an interface to the ADC and contains all frequency generators for the ADC clock, the sampling frequency, and the modulation frequency and the necessary glue logic.

Digital Signal Processor (DSP)

The **Digital Signal Processor (DSP)** communicates via the digital ASIC with the ADC and main processing CPU. It demodulates and filters the incoming ADC signals and transmits the output signals to the main processing CPU.

Main Processing CPU

The **Main Processing CPU** performs the processing for the SpO_2 signals. It communicates via the digital ASIC with the DSP and contains the front end controlling firmware for the LED driver circuit, the RCode measurement circuit, the variable gain stage, the clipping detection, the power supply, and the self-test circuit. The main processing CPU also provides a communication interface to the transmitter controller.

LED Driver

The **LED Driver** circuit generates the LED current using two transistor current sources receiving a constant voltage input from the power supply. A bridge consisting of four transistors allows the LED current to be switched alternatively for individually driving the red and infrared LEDs of the sensor. To enable the different driving times of the LEDs, the main processing CPU controls the transistors in the bridge.

Self-Test Circuit

The **Self-Test Circuit** performs a self-test of the SpO_2 measurement device before patient signal processing begins. The Main Processing CPU produces a pulse-width modulated signal which is analog low pass filtered to a sine wave and converted to a photo current signal. During self-test, the connections of the photoamplifier to the photodiode of the sensor are interrupted by switches and the self-test signal is fed into the input of the Photo Amplifier.

RCode Measurement Circuit

The **RCode Measurement Circuit** identifies which sensor is being used by measuring coding resistors. The Main Processing CPU reads the measurement through a reference resistor and an amplifier stage.

Battery Extender

The **Battery Extender** consists of a cradle, which is fitted over the battery compartment of the transmitter, and a cable connecting to a wall-mounted dc power module.

When the battery Extender is in use, the transmitter is being powered by the wall mounted dc power module. If the cradle is disconnected, the power will immediately power the transmitter and the electrical unit ceases to power the transmitter.

Note

The purpose of the Battery Extender is to conserve battery life.

The Extender does not recharge the battery.

Receiver Mainframe

The **Receiver Mainframe** provides the physical interface between the receiver module and the central monitoring station via the Serial Distribution Network (SDN). The receiver mainframe houses up to 8 receiver modules, each one frequency-matched to a transmitter.

A BNC connector on the mainframe is used to connect to the antenna system output. The BNC connector is connected to the antenna distribution board, which distributes the combined RF signal to each receiver module. The receiver modules receive incoming RF signals via a semi-rigid RF cable connected to the antenna distribution assembly. The receiver modules plug into the receiver backplane, which provides an interface to the internal power supply and the digital backplane. The digital backplane provides interface to the digital cardcage, which houses the signal processing and distribution circuits.

For a standard ECG channel, the receiver mainframe calculates the heart rate from the user-selected primary ECG lead and sends the result, with the ECG wave information and any alarms, INOPS, and status information, over the SDN. The mainframe also provides lead reconstruction, gain adjustment, and filtering.

For an EASI channel, the receiver mainframe reconstructs Lead II information from the three directly acquired or “raw” EASI lead outputs sent by the transmitter (AI, AS, ES) and sends this information out on the SDN for overview purposes. The mainframe also sends the 3 “raw” EASI leads to the Philips Information Center (PIC) over the SDN.

The Philips Information Center (PIC) reconstructs the 12-lead EASI ECG lead information and performs all ECG analyses and alarms. The PIC detects arrhythmia and ST inoperative conditions and generates messages. The mainframe sources all other INOPs detected by the telemetry system (Leads Off, battery, SpO_2 equipment malfunctions, etc.) on the SDN.

The processing and distribution circuits of the receiver mainframe consist of the following components:

- Rack Interface
- Utility CPU
- 40 MHz configurable processor card (CPC)
- SDN Board

In addition to the 8 receiver module malfunction LEDs, the receiver mainframe has a separate mainframe malfunction LED. The mainframe malfunction LED is visible through a hole in the front dress cover and illuminates to indicate a malfunction has occurred within the mainframe.

Cooling for the internal assemblies of the receiver mainframe is provided by a dc fan. The fan operates on 12V dc from the power supply via the receiver backplane.

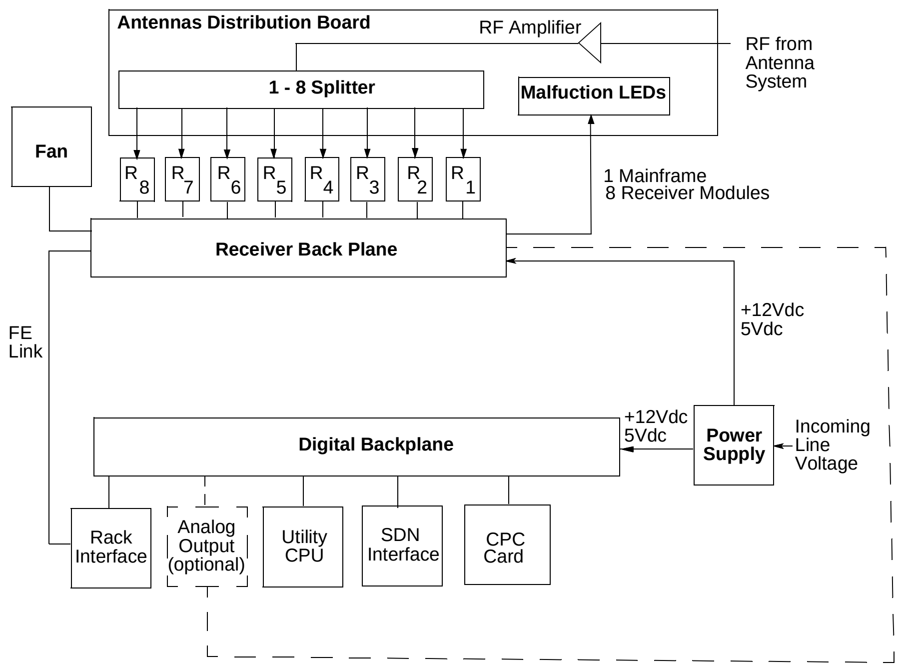


Figure 1-4 Block Diagram of Philips Receiver Mainframe

Power Supply

The **Power Supply** is an auto switching power supply with the following specifications:

Input Voltage: 100 - 240 Vac

Input Frequency: 47 to 63 Hz.

Power consumption (for M2604A with 8 M2603A receiver modules:

110 VA max, 95 VA average
81 W max, 72 W average

Radiated Immunity: 3 Volts/meter outside of operating receiver bands

The power supply generates two logic signals:

- SR (system reset) at start up
- PF (power fail) during power shut down

Antenna Distribution Assembly

The **Antenna Distribution Assembly** distributes the RF signal received from the external antenna system to each receiver. The external antenna connection to the receiver mainframe is made through a single BNC connector on the rear panel, through the internal antenna cable, and connected to the Antenna Distribution Assembly. An RF amplifier increases the incoming RF signal. A low loss 1-to-8 splitter follows the amplifier. It distributes the received RF signal to each receiver module.

The Antenna Distribution Assembly also contains a digital section consisting of 8 receiver malfunction LEDs, 1 power-on LED, and a watchdog circuit that drives the mainframe malfunction LED. A logic pulse train from the rack interface resets the watchdog timer. If greater than 600 msecs elapses between receipt of pulse trains, the watchdog timer output illuminates the mainframe malfunction LED.

The 8 LEDs indicate malfunctions that may occur in the receiver mainframe. Each receiver module slot (1 through 8) has a malfunction LED associated with it. The LEDs are located on the antenna distribution board. They are visible on removal of the front dress cover.

When an LED is **not illuminated**, the receiver module is not recognized by the mainframe.

When an LED is **flashing** at a rate of once per second, the receiver module for that LED is receiving and working properly.

When an LED is **flickering** at a rapid rate, the receiver module cannot find a good signal.

When an LED **remains illuminated** steadily, this indicates a malfunction has been detected in the receiver module corresponding to that LED.

Receiver Backplane

The **Receiver Backplane** provides the interfaces between the receiver modules, the power supply, receiver malfunction LEDs, and digital section of the mainframe. It provides connections from the 8 receiver modules to the rack interface using the front-end high-speed serial link (FE-LINK). The FE-LINK serves as an 8-to-1 multiplexer, which allows sequential communication between the rack interface and each receiver.

Digital Backplane

The **Digital Backplane** consists of one 9-pin connector and nine 96-pin connectors. The 9-pin connector interfaces the power supply with the digital backplane. The receiver mainframe PCBs plug into the 96-pin connectors creating a multiprocessor system consisting of the Utility CPU and the CPC Processor. The CPC processor card and the Utility CPU communicate with each other by exchanging messages, but do not have access to each other's memory.

The message passing architecture can be split into 3 logical parts or busses:

- Message Passing Bus (MPB)
- Local Bus
- Utility Bus

The **Message Passing Bus** is the global communications bus for the receiver mainframe, and is used for communications between the CPUs and intelligent interface PCBs.

The **Local Bus** is used for data transfer among the Utility CPU, SDN interface, and rack interface.

The **Utility Bus** routes power and clock functions to the PCBs connected to the backplane.

Rack Interface

The **Rack Interface** provides communication between the CPC processor card, via the Utility CPU, and the 8 receiver modules. It acquires serial data at 500 Kbaud and status from the receiver modules and sends control signals to them using the FE-Link. The Rack Interface polls the receivers in the receiver mainframe as to their status. It uses this information to control the logic pulse train to satisfy the watchdog timer on the antenna distribution assembly. If a malfunction occurs in a device in the receiver mainframe, the pulse train is inhibited, causing the watchdog timer to trigger the mainframe malfunction LED.

The Rack Interface transfers data internally using a switched RAM method. Two banks of switched RAM are used alternately by the on-board 8051 microprocessor and the 68000 microprocessor on the Utility CPU. Every 32 ms the RAMs are switched, so the RAMs can be accessed by the other microprocessor. This allows the faster 68000 microprocessor to exchange data with the RAM and then run on before the RAMs are switched. The 8051 microprocessor then converts the data into serial data for passing to the receiver modules over the FE-LINK. Received serial data from the receiver modules are converted to parallel data and placed into RAM by the 8051 microprocessor. The RAMs are then switched, allowing the Utility CPU to exchange data again.

Configurable Processor Card

The **Configurable Processor Card** (CPC) is a CPU card that is used to process the application data for the mainframe. The CPC receives data from the Message Passing Bus (MPB), processes the data, and places the results of the data processing back on the MPB.

The CPC contains the following functional areas: a 68030 Microprocessor, MPB Interface, a Flash ROM, DRAM, Fast SRAM, Buffered SRAM, Interface, and Service Port. The CPC CPU is based on the 68030 Microprocessor chip. This is the interface between the CPC and the MPB.

The **Flash EPROM** contains the operating software. The Flash EPROM is programmed using the CPC programming tool. The EPROM normally has VPP set low (between 4.0V and 4.5V) and functions as read-only memory. The tool operates by setting VPP high (12V) and writing an appropriate instruction to the EPROM.

The **DRAM** is used for 2 purposes -- to download programs from the flash EPROM for faster execution and to provide unbuffered storage for applications. The DRAM is configured as two 32 bit wide banks of 1 MB each.

The **Fast SRAM** is used primarily for program execution speed enhancement. The Fast SRAM is configured as one 32 bit wide bank.

The **Buffered SRAM** stores application data in the event of a power failure. The Buffered SRAM is configured as 1, 32-bit wide (512 Kbytes) bank and 4, 8-bit wide (256 Kbytes) banks. All banks are backed up by a super-capacitor to provide a minimum of three hours of storage.

Utility CPU

The **Utility CPU** is responsible for the rack and SDN interfaces, synchronization, and all of the clock signals for the receiver mainframe. The Utility CPU is based around a 68000 microprocessor and stores the configuration of the receiver mainframe on an 8-Kbyte EEPROM.

SDN Interface

The **SDN interface** provides the interface between the CPC processor card, via the Utility CPU, and the Serial Distribution Network (SDN). The SDN interface transmits and receives data to and from the SDN over a 2-wire bus.

The SDN polls the SDN interface every 32 ms. The poll cycle is divided into 4 ms dead time and 28 ms for passing data to and from the receiver mainframe. The onboard RAM consists of 2, 2 Kb buffers -- 1 transmit, 1 receive. During the dead time, the Utility CPU places all data into the transmit half of the SDN interface onboard RAM. An SDN interface circuit chip (SIC) chip on the SDN interface sends the data over the SDN during the 28 ms communication period. Received data are placed in the receive half of the onboard RAM where they are read by the Utility CPU during the dead time.

Patient Monitor/ Holter Recorder Interface (Analog Output)

The **Patient Monitor/Holter Recorder Interface** (Analog Output Option) creates analog signals that can be used to drive the ECG level inputs of bedside monitors or Holter recorders. The hardware limits the number of output leads to 2.

When a 3-electrode leadset is used on a standard ECG transmitter, only lead II is available.

When a 5-electrode leadset is used, only lead II and MCL is available.

Note

Because EASI ECG requires the 3 directly acquired or “raw” EASI leads (AI, AS, ES), the **Patient Monitor/Holter Recorder Interface is not compatible with channels using EASI transmitters**.

Digital data, in the form of a serial data stream, are acquired from the FE-Link at 500 Kbaud. The stream contains status information for all 8 receivers as well as digitized ECG signals. The data stream is decoded at the analog output board and converted to analog voltages at again 500 times the original signal level.

An external breakout box then splits the signal into 8 output pairs, which are placed on individual patient jacks to provide 1 bedside monitor and 1 Holter recorder output for each receiver module. The bedside and Holter output circuitry attenuates the signals back to ECG levels.

INOP flags from leads-off, replace battery, and data invalid conditions are encoded as voltage levels onto each analog output signal, causing the signal at the bedside Holter output circuitry to assume a very high impedance that is interpreted by the monitoring device as a LEADS OFF. A separate fail-safe circuit also forces all outputs to a LEADS OFF condition if mainframe power is lost or if there is a malfunction in the analog output system.

Pace pulse flags sent with the data stream cause the analog output system to create a synthesized pace pulse of fixed amplitude and duration. The system analyzes the ECG data surrounding the flags to determine and to match the original polarity of the pace pulse. The duration of the synthesized pace pulse is intentionally made very short so it will be detected by the bedside monitor, but will not disturb the arrhythmia monitoring system.

Receiver Module

The **Receiver Module** is housed in the receiver mainframe. Each receiver module is dedicated to a specific transmitter. It receives the UHF data transmission from the transmitter and converts the serial data stream into a format that can be transferred through the receiver backplane to the receiver mainframe. The receiver can handle information from either a standard ECG transmitter or an EASI ECG transmitter. The receiver module consists of two basic sections:

- RF section (including the tunable synthesizer)
- digital baseband section.

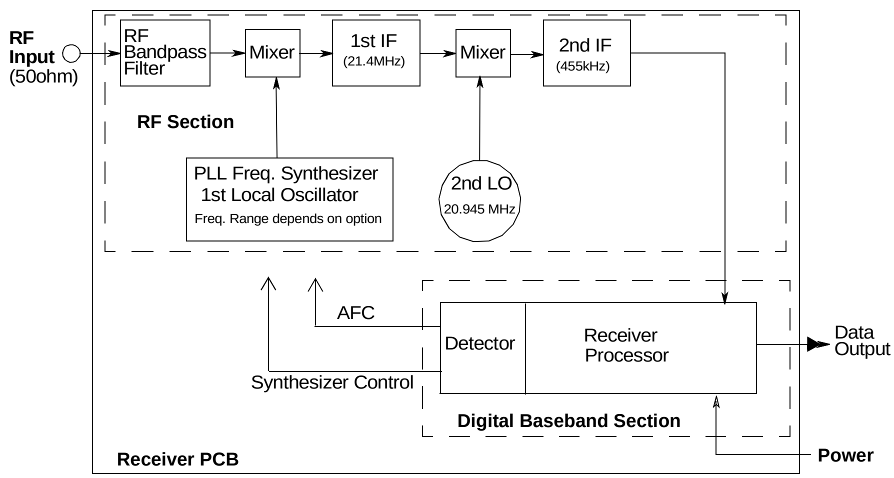


Figure 1-5 Block Diagram of Philips Receiver Module

RF Section

The **RF Section** of the receiver module receives the UHF digital data transmission, down-converts and demodulates it, and then routes it to the digital baseband section as a serial data stream.

The receiver module is a dual-conversion, narrow-band frequency modulation (FM) receiver. It takes the incoming RF signal (for example, 460 MHz), mixes it with a local oscillator frequency (481.40 MHz) to generate an intermediate frequency (IF) of 21.40 MHz.

The IF is filtered and amplified several times and then mixed with a second local oscillator frequency (20.945 MHz) to generate the second IF at 455 KHz.

The second IF is filtered and amplified several times and then demodulated.

Frequency Synthesizer Section

The **Receiver Frequency** is determined by the tunable RF module used to generate the first local oscillator frequency. The RF module circuitry is the same as that of the transmitter RF module.

In a system that operates between 406-480 MHz the receiver is tuned to the same frequency as the transmitter. Within a system that operates in the extended UHF band (590-632 MHz) the receiver is tuned to:

Receiver Frequency = Transmitter Frequency - Converter Frequency Shift Option

The **Frequency Synthesizer** is essentially a non-linear control system using a single narrow bandwidth loop to achieve low phase noise for good system adjacent channel rejection performance. The phase detector output drives the loop filter and the control port of a voltage controlled oscillator (VCO).

The **Loop Filter** controls all aspects of system performance. The phase detector drives both its inputs to zero phase error, so the VCO output frequency is locked to the reference frequency.

The **Phase Detector** derives its input from a temperature compensated crystal (TCXO) reference and a sample of the output VCO frequency. Programmable dividers separate the VCO output frequency before it is fed back to the phase detector.

The **Programmable Divider** allows incremental frequency control of the final VCO frequency. The design of the synthesizer allows frequency steps of 5kHz, 10kHz, or 12.5kHz.

Digital Baseband Section

The **Digital Baseband Section** converts the serial data stream detected by the RF Section into data suitable for transfer through the receiver backplane to the receiver mainframe. The conversion includes bit clock recovery, frame synchronization, unscrambling, error detection, unpacking and expansion of compressed data.

The Digital Baseband Section also supplies an Automatic Frequency Control (AFC) voltage to fine-tune the local oscillator of the RF section. The digital baseband section can be split into 3 functional parts:

- Detector
- Microcontroller
- Peripheral Devices

Detector

The **Detector** performs the basic conversion of the input serial data stream into digital data readable by the microprocessor. The bit pattern first passes through an RF filter, which ensures that digital noise generated in the digital baseband section is not coupled into the shielded RF section. The Detector then synchronizes where the bit cells (ones and zeros) are in the digital bit pattern and determines whether a one or zero was sent in each cell.

Microcontroller

The serial data stream output from the detector goes to the **Microcontroller** where it is manipulated and processed into separate data items contained in the serial data stream. This is where the unscrambling, unpacking, error detection, and expansion of the compressed data happens. The serial data are transferred to the Receiver Backplane of the Receiver Mainframe. The Microcontroller also provides control signals to the peripheral device and a signal to the board failure line.

Peripheral Devices

An Analog-to-Digital Converter and Digital-to Analog Converter are interfaced to the Microcontroller to provide Automatic Frequency Control (AFC) to the RF section and received signal strength measurement

M2613/14/15A Dual-Band UHF Antenna System

The **M2613/14/15A Dual-band UHF Antenna System** receives RF signals from transmitters in the coverage area broadcasting between 406-632 MHz. Antenna Systems consist of Antenna Strings and Combining Networks as shown in Figure 1-6.

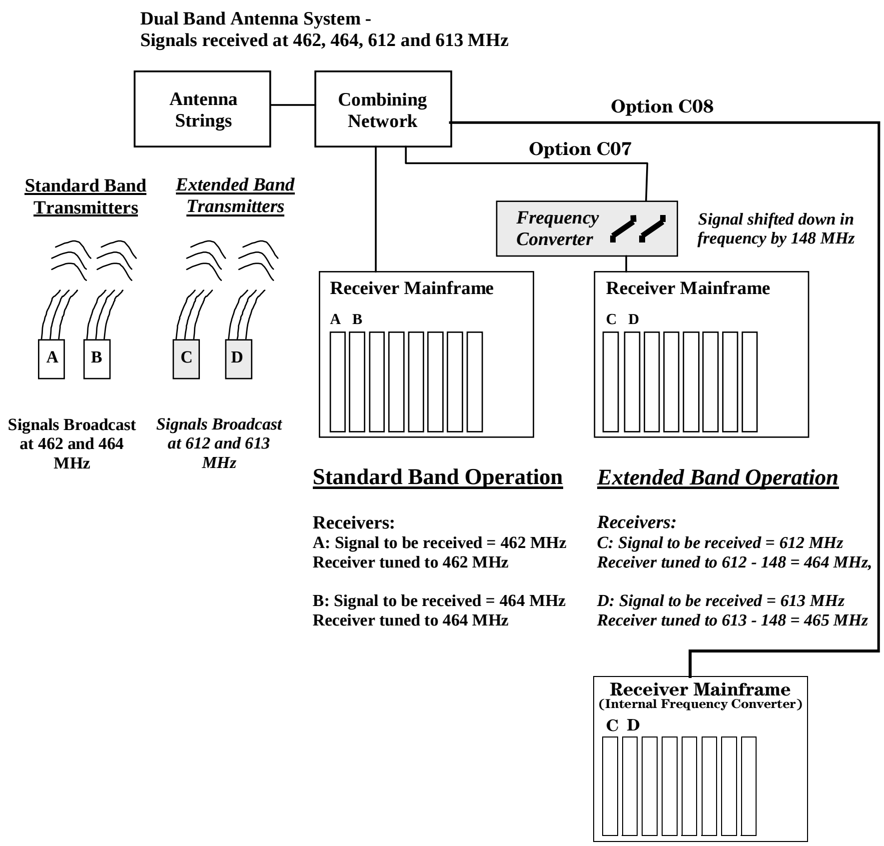


Figure 1-6 Dual Band Operation

406 - 480 MHz Operation

For operation between **406 - 480 MHz**, the signals are distributed directly to the receiver mainframe. Inside the mainframe, the signal is distributed further to the receiver modules, which are each tuned to receive one transmitters.

590 - 632 MHz Operation

For operation at the extended UHF frequencies, transmitters broadcast signals at **590-632 MHz**. These signals are received by the Antenna System and go into a device that is called a Frequency Converter, which shifts or "converts" the signal down in frequency. The converted signal is then fed into the receiver mainframe, which distributes it further to the installed receivers.

Dual-Band Operation

A **Dual-Band System** can have channels operating in both bands. A mainframe handling extended band frequencies will be attached to the antenna system through a frequency converter, and a mainframe handling the standard frequencies will tie directly to the Antenna System.

Antenna Strings

Antenna Strings are available of 1 to 6 antennas (M2613/14A options A01-A06). Each string consists of antenna/combiners and cables. Each Antenna String receives the RF signal from each transmitter in the coverage area.

Combining Networks

Combining Networks combine signals from the Antenna Strings and distribute them to the Receiver Mainframes or Frequency Converters. Combining Networks consist of splitter/combiners, amplifiers, power tees, and cabling. They supply the signal to each receiver module in the mainframe.

Frequency Converter

A **Frequency Converter** shifts or "converts" the signal from the Antenna System down in frequency. The "shifted" signal is then fed into the receiver mainframe, which distributes it to the installed receivers, which are tuned to receive one of the transmitters. The Frequency Converter can be either external (Option #C07) or internal (Option #C08) to the Receiver Mainframe.

Figure 1-7 shows a block diagram of a typical Antenna System.

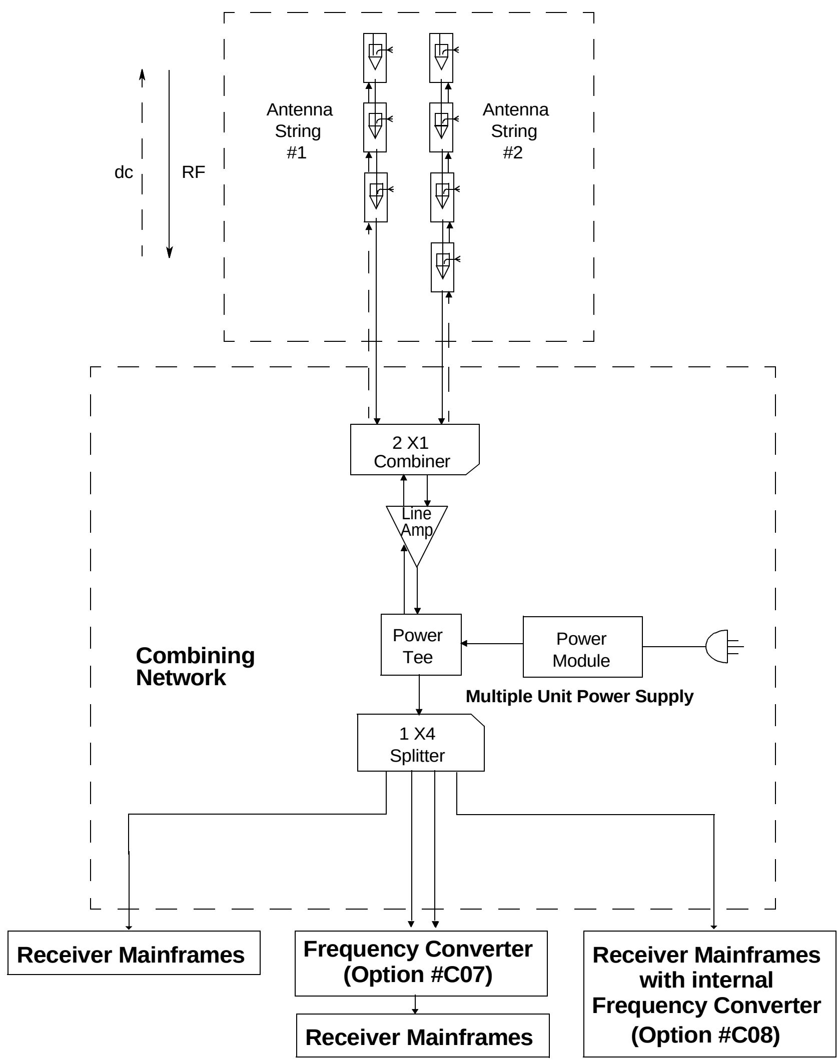


Figure 1-7 Block Diagram of a Typical Antenna System

M2608A Active Antenna/Combiner

The **M2608A Active Antenna/Combiner** incorporates a UHF quarter-wave monopole antenna, a signal combiner, and an RF amplifier in one unit. The amplifier has a bandpass range of approximately 406 - 650 MHz.

The **Antenna/Combiner** accepts 2 RF signals –1 from its flexible antenna and 1 from the line. The signals are coupled together in a Power Combiner, amplified, and then cascaded to the next Antenna/Combiner in the string. At the end of the string, the signal is routed to the combining network for final signal combining and distribution to the receiver mainframe. A block diagram of the antenna/combiner is shown in Figure 1-8.

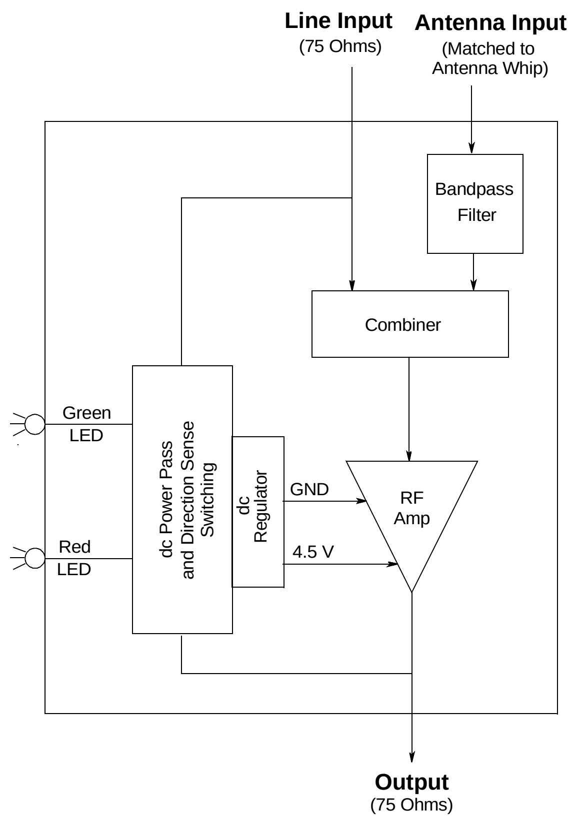


Figure 1-8 Block Diagram of the Active Antenna/Combiner

The incoming RF signal from the antenna is sent through a Bandpass Filter and coupled with the line signal in a Power Combiner. The Power Combiner is unequal for reduced system noise figure and high 1dB compression point. The 2 signals are impedance-matched in the Power Combiner and routed to the **RF Amplifier**, which increases their gain by approximately 10 dB. The RF Amplifier's operating voltage is 19 - 32 Vdc at typically 45 mA. It receives dc power from the coaxial cable at its RF output connection.

The Antenna/Combiner also has a switching regulator or circuit that regulates amplifier voltage to a 4.5 Vdc, and a sensing circuit that indicates, by LED, whether its power/signal cables are properly connected. If the antenna is installed properly, the green LED is on. If the antenna is installed backwards, the red LED is on.

Line Amplifier

The **M2606A Line Amplifier** increases the RF signal with a typical gain of 12.7 dB at 465 MHz and 13.3 dB at 611 MHz to compensate for losses in the antenna network. It is powered through the coaxial cable. The Line Amplifier draws required dc operating power through its RF signal connection, and passes unused power through to any other active elements further up the antenna system.

The Line Amplifier is used in the M2615A Combining Network. It has Green and Yellow LEDs that illuminate when it has power to its output or input ports respectively.

The Line Amplifier used in M2615A combining networks will have the Green LED illuminated.

In non-standard Antenna system designs, it is possible to provide power to the amplifier through the RF input port. In this case the Yellow LED will be illuminated. When installing or servicing a non-standard Antenna System, the service provider must check the amplifier labels and the schematic to determine if the installation is correct.

2-Way and 4-Way Splitter/Combiners

78103A 2- and 78104A 4-way Splitter/Combiners are used to route RF signals from multiple antennas to the receiver mainframe. Used in one direction, the splitter/combiners split an RF signal into 2 or 4 separate signals. Used in the opposite direction, they combine 2 or 4 separate RF signals into one signal. 2- and 4-way Splitter/Combiners are used in the M2615A Combining Networks.

Multiple Power Unit

The **M2607A Multiple Unit Power Supply** is composed of a Power Tee and a Power Module, which can supply up to14 active antenna/combiners and amplifiers in a pre-configured system. The 2 components are connected by a 7-foot, multi-conductor cable and a 6-pin Deutsch Industrie Normen (DIN) connector.

Power Tee

The **Power Tee** contains an RF biasing circuit, RF filtering with line loss equalization circuits, a circuit breaker, and a green power indicator that lights when the Tee is receiving power. The equalization circuit is designed to compensate for the increasing loss due to frequency of 139 feet of the RG-6 main cable used in the antenna strings. The Power Tee passes dc power out of its RF signal input and blocks dc voltage on its RF signal output. It, thereby, prevents unwanted dc voltage at the input of the receiver mainframe, and avoids placing 2 or more Power Tees in series and providing excessive power on the cable.

Power Module

The **Power Module** provides 24 Vdc, 1 ampere, regulated power. The output is a floating type, which is isolated from the ac mains supply ground. The power module connection to the ac mains is rated at 100 to 240 Vac, 50/60 Hz, and has the CE mark approval. This satisfies the input power requirements of the Antenna System.

Frequency Converter

A **Frequency Converter** is required for systems that operate in the extended UHF range, 590-632 MHz. The Frequency Converter shifts the signal received from an extended UHF transmitter down to a frequency that can be received by the Receiver Mainframe.

The Frequency Converter operates over an input range of 590 MHz to 632 MHz and shifts the input frequencies to an output range of 424 MHz to 502 MHz. The Frequency Converter provides the following hardware frequency shift options – 130, 136, 142, and 148 MHz. The Frequency Converter provides gain to help compensate for increased RF path loss at the higher UHF frequencies. The input frequency range is fixed by a 42 MHz bandpass filter that is integrated into the Frequency Converter.

The Frequency Converter provides 8 output ports, so 1 converter can support 8 mainframes or 64 receivers. The special shielded cable is required to avoid crosstalk with receiver operations with transmitters in the 424 MHz to 502 MHz range.

The Frequency Converter can be either external (Option #C07) or internal (Option #C08).

External Frequency Converter

The M2616A **External Frequency Converter** (**Option M2600A #C07**) consists of a shielded Frequency Converter Module, an external Power Supply Module, and special shielded coax cable assemblies. The External Frequency Converter with its Power Module are installed between the combining network and the Receiver Mainframe. The output of the combining network connects to the Frequency Converter, which then connects to the Mainframe using a specially shielded RF, 10 ft. (3 m) cable (M2616-60011). See Figure 1-9.

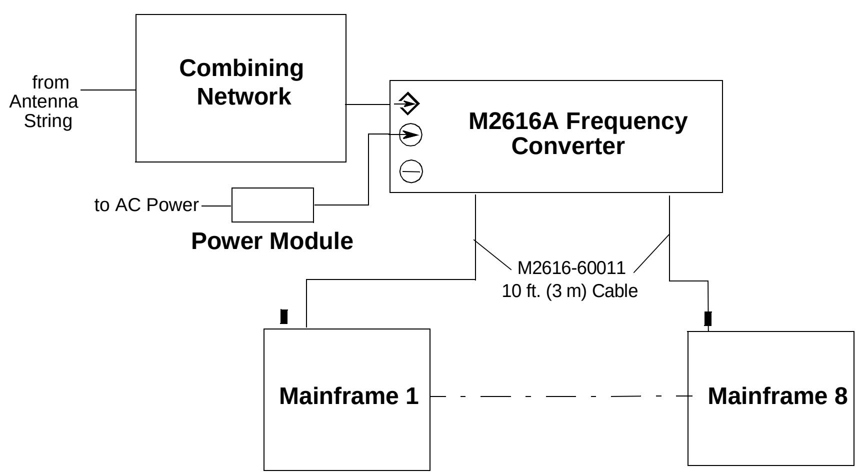


Figure 1-9 Connection with an External Frequency Converter

Internal Frequency Converter

Option M2600A #C08 provides a Receiver Mainframe with an **Internal Frequency Converter.** In this option, the Frequency Converter is built into the Antenna Distribution PC board inside the Receiver Mainframe. This installation is shown in Figure 1-10.

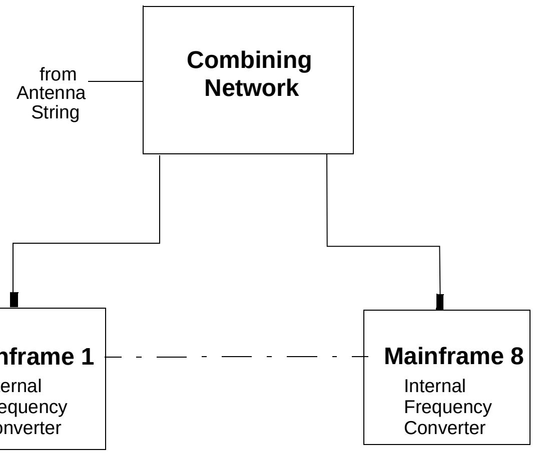


Figure 1-10 Connection with an Internal Frequency Converter

Attenuators

An **M2609A Attenuator** may be used in non-standard antenna system designs to provide precise attenuation of the signal in order to balance gain and loss in the system. Attenuation is available in 1 dB steps from 1- 9 dB. The Attenuator can pass dc power through to power active antenna components. It is physically housed in a cylindrical metal tube with 75 ohm BNC connectors at each end, one male and one female.

Bandpass Filters

M2612A Bandpass Filters aid in band limiting the frequency range of the signals received by the antenna system. These filters can be configured to provide filtering of 4 of the standard frequency bands (430-470MHz) and the 7 extended frequency bands (590-632 MHz) through hardware options. The Bandpass Filter can pass dc power to other connected antenna components. A green LED indicates that power is present at either port of the filter.

For the extended frequency band options, each of these filters has a 6 MHz bandwidth. The passband has an asymmetrical characteristic to provide more attenuation on the upper edge of the filter. If one of these filters is used, then usable frequency range is reduced. For details, see the Notes section on the Frequency and Check Code Listing shipped with the system.

Filtering of a system operating in dual bands requires a designed filtering network. This network uses power splitters, power combiners and line amplifiers.

These filters are typically used in telemetry systems with a large number of installed antennas or in systems that are located near an active TV station transmitter. The typical extended frequency customer will not need to use this filter since some band limiting filtering is provided in the Frequency Converters.

2
Service Tools

Overview

Chapter 2 describes how to use the telemetry service features. It includes descriptions of each of the following operations:

Controls and Indicators

This section describes the controls and indicators found on each subassembly of the telemetry system and gives the function of each.

Transmitter Controls and Indicators

The Transmitter controls and indicators are shown in Figure 2-1. A description of each control and indicator is given in Table 2-1.

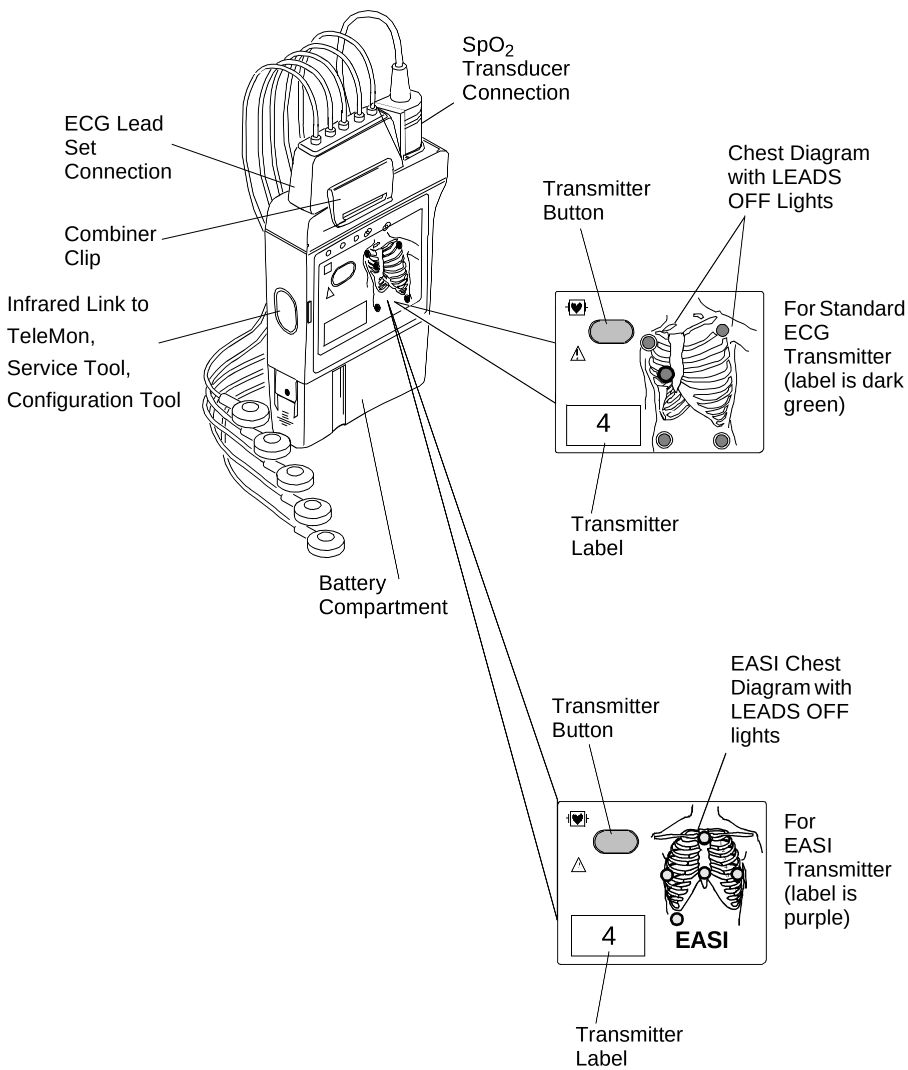


Figure 2-1 Transmitter Controls and Indicators

Table 2-1. Description of Transmitter Controls and Indicators

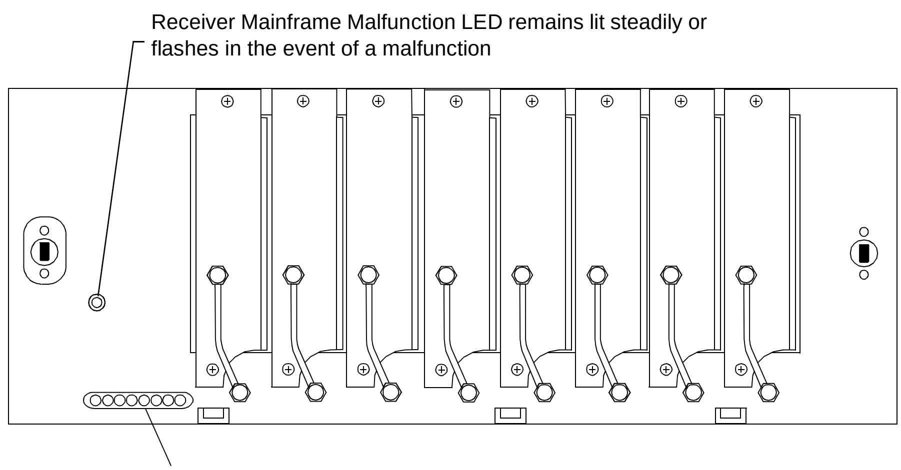
Control/Indicator	Function
Leadset Latch	Allows the leadset (3- or 5-wire) to be connected and held securely to the transmitter. Leadset detector switches within the transmitter let the transmitter know which leadset is being used.
Patient Button	Can be configured at installation to perform the following functions when pressed: 1. generate an alarm at the central station. 2. generate a recording at the central station. 3. generate both an alarm and a recording at the central station. 4. do nothing (Patient button is disabled). **Note:** In addition to the above configured functionality, the patient button can be used to initiate a manual SpO_2 measurement by pressing the button for 6 seconds or more.
Electrode Placement Diagram and Leads Off Lights	The Leads Off lights indicate that the connection for an electrode is bad. If there is a LEADS OFF INOP, check the lights to see which one is lit. The light that is lit identifies which lead is off.
Leadset	Connects to the electrodes that are applied to the patient to acquire patient ECG data. For standard ECG transmitters, leadsets can be 3- or 5-wire and can support standard and non-standard lead placements. For EASI transmitters, a 5-wire leadset must be used, and the EASI electrode placement must be followed. The leadset also serves as the broadcast antenna for the transmitter.
SpO_2 Connector	Allows the SpO_2 transducer to be connected to the transmitter. If SpO_2 is not in use, the connector cover should be placed into the connector.

Receiver Mainframe Controls and Indicators

Figure 2-2 and Figure 2-3 show the front and rear views of the Receiver Mainframe.

Front View

The front view is shown with the front dress cover removed.



Receiver Activity LEDs

The 8 Receiver Activity LEDs indicate malfunctions that may occur in the receiver mainframe. Each receiver module slot (1 - 8) has a malfunction LED associated with it.

When an LED is not illuminated, the receiver module is not recognized by the mainframe.

When an LED is flashing at a rate of once per second, the receiver module for that LED is receiving and working properly.

When an LED is flickering at a rapid rate, the receiver module cannot find a good signal.

When an LED remains illuminated steadily, this indicates a malfunction has been detected in the receiver module corresponding to that LED.

Figure 2-2 Receiver Mainframe — Front View

Rear View

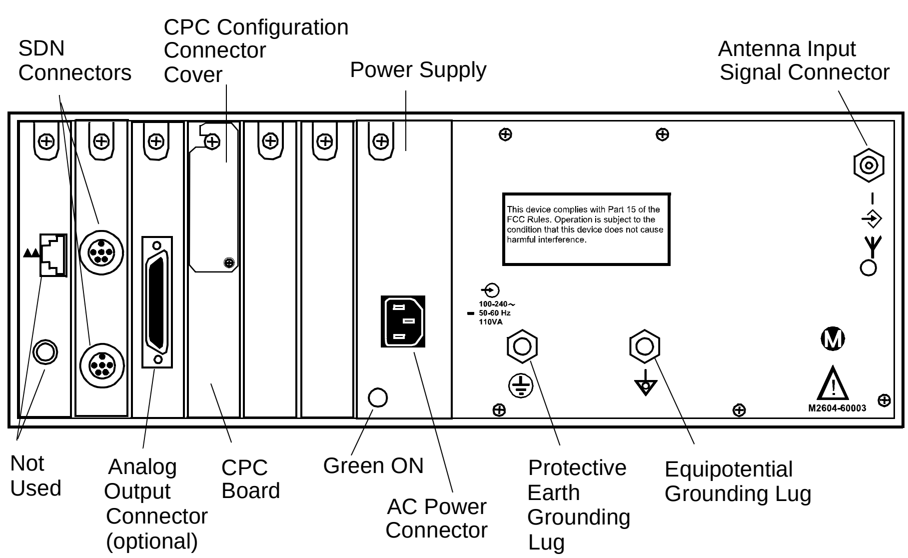


Figure 2-3 Receiver Mainframe — Rear View

Turning the Telemetry System On/Off

This section describes how to turn on the subassemblies of the telemetry system.

Turning on the Transmitter

The transmitter becomes operational as soon as a battery is placed in it. When a battery is placed in the transmitter, the transmitter goes through a self-test that checks the circuits of the transmitter and also checks to see which leadset is connected to it. During self-test, the following can be observed:

- The Leads Off lights illuminate steadily for about 3 seconds. Then all of the Leads Off lights flicker several times.
- Depending upon which leadset is connected, all 5 leads should flash, and 1 light should remain on. See Transmitter Controls and Indicators on page 2-2 for a detailed description of the transmitter and associated LEDs.
- The transmitter has an RF shutoff mode that turns the radio signal off if 10 minutes have passed and the leads are not attached to a patient and the battery is installed. This prevents heterodyning between transmitters, which can cause interference on other channels. The transmitter turns on when the leads are connected to a patient.

Turning on the Receiver Mainframe

The receiver mainframe is turned on by connecting the power cord to ac power to turn the unit on. Details on the proper boot sequence can be found in Chapter 4, Troubleshooting.

Turning on Antenna Components

Power is applied to the antenna components by connecting the components to the power tee, which is connected to ac power. Verify that power is applied to each component by observing the LEDs.

Setting Frequencies

This section describes how to:

- match a transmitter's frequency to a receiver frequency.
- change the frequency of a transmitter.
- change the frequency of the receiver.
- set a transmitter's frequency after repair.
- check for interference.
- troubleshoot errors that occur while setting frequencies.

Matching a Transmitter Frequency to a Receiver Frequency

The **Frequency** and **Check Code** of a transmitter can be determined using the Central Station. For systems operating in the 590-632 MHz frequency range (extended band) the Telemetry Service Tool must also be used.

At the Philips Information Center

Step 1. Assign each channel to a sector and take out of stand-by mode.

Step 2. Access the Telemetry Frequency window by clicking on the Telem Freq button on the Unit Settings window.

Step 3. Enter hp in the Password field.

Step 4. Highlight the desired channel from the displayed list.

For systems operating in the **406-480 MHz** frequency range (non-extended band), the receiver Frequency and Check Code is the same as the transmitter Frequency and Check Code.

For systems operating in the **590-632 MHz** frequency range (extended band), do the next step to determine the Frequency and Check Code.

Note

The following step assumes that the Telemetry Service Tool is available with the frequency calculator program loaded onto the PC. If the frequency calculator program is not available, contact the local response center.

Step 5. Run the frequency calculator program from the Telemetry Service Tool by doing the following:

a. Go to the DOS directory where the Telemetry Service Tool is loaded.

b. Type **freqcalc.exe** at the DOS prompt and press Enter to start the tool.

c. Verify that the Country Code, Locale Code, and Frequency Converter Option are set properly. Provide valid entries if necessary. If the Frequency Converter Option is not known, specify ALL, which provides the transmitter frequencies and Check Codes for each Frequency Converter Option.

d. Type Y when prompted whether to convert a receiver frequency to a transmitter frequency and press Enter.
e. Enter the Receiver Frequency when prompted and press Enter.
f. Enter the Check Code when prompted and press Enter.

The program provides the transmitter Frequency and Check Code for the frequency converter option specified.

If ALL was specified, the tool provides the transmitter Frequencies and Check Codes for each frequency converter option.

Changing a Transmitter's Frequency

The frequency of a transmitter can be changed using the Telemetry Service Tool, the Telemetry Configuration Tool, the TeleMon, or the Wave Viewer.

Using the Telemetry Service Tool

Step 1. Insert a battery into the transmitter.

Step 2. Align the serial-to-infrared converter with the infrared port of the transmitter.

Step 3. Go to the DOS directory where the Telemetry Service Tool is loaded.

Step 4. Type **trtool.exe** at the DOS prompt and press Enter to start the tool. When the tool is loaded properly and communicating with the transmitter, the screen displays the Transmitter Information One screen.

Step 5. Press the Config softkey in the Transmitter Information One screen. The Transmitter Configuration Screen 1 of 3 displays.

Step 6. Press the More Config softkey twice to access the Transmitter Configuration Screen 3 of 3.

Step 7. Go to the Frequency field using the down arrow and enter the new Frequency.

Step 8. Go to the Check Code field using the down arrow and enter the associated Check Code.

Step 9. Press the Store Settings softkey to download the settings. When the download is complete the tool displays the word Set to the left of the receiver number indicating that the download was successful. This sets the transmitter to the selected frequency.

Using the Telemetry Configuration Tool

For the procedure to change a Transmitter's frequency using the Telemetry Configuration Tool, see the Philips Telemetry System Service Configuration Guide (PN M2600-9523C).

Using the TeleMon

For the procedure to change a Transmitter's frequency using the TeleMon, see the M2636B TeleMon MonitorB Service Manual.

Using the Wave Viewer

For the procedure to change a Transmitter's frequency using the Wave Viewer, see the Appendix F: Wave Viewer.

Changing the Receiver Frequency

The receiver frequency can be changed using either the Central Station or the Telemetry Service Tool.

Using the Central Station

To change the receiver frequency at the Philips Information Center, perform the following procedure:

Step 1. Select the Frequency and Check code using the Frequency and Check Code listing shipped with the product.

Step 2. For systems operating between **406-480 MHz**, the receiver Frequency and Check Code are the same as the transmitter Frequency and Check Code. Proceed to Step 3.

For systems operating in extended UHF (**590-632 MHz**), determine the receiver Frequency and Check Code by running the frequency calculator program as follows:

a. Go to the DOS directory where the Telemetry Service Tool is loaded.

b. Type **freqcalc.exe** at the DOS prompt and press Enter to start the tool.

c. Verify that the Country Code, Locale Code, and Frequency Converter Option are set properly. Provide valid entries if necessary.
If the Frequency Converter Option is not known, specify ALL to display the receiver Frequency and Check Code for each frequency converter option.
If the Receiver Mainframe has an Internal Frequency Converter (IFC), then the Frequency Converter Option is #148.

d. Type N when prompted whether to convert a receiver frequency to a transmitter frequency and press Enter.

e. Enter the transmitter Frequency when prompted and press Enter.

f. Enter the Check Code when prompted and press Enter. The program provides the receiver Frequency and Check Code for the frequency converter option specified. If ALL was specified, the tool provides the receiver Frequencies and Check Codes for each frequency converter option.

g. Select the Frequency that falls in the receiver's frequency range.

Step 3. Access the Telemetry Frequency window in the Information Center by clicking on the Telem Freq button in the Unit Settings window.

Step 4. Enter Philips in the Password field.

Step 5. Highlight the desired channel.

Step 6. Enter the new receiver Frequency in the New Frequency field.

Step 7. Enter the associated Check Code in the New Check Code field.

Step 8. Set the frequency by clicking on the Set Frequency button.

Using the Telemetry Service Tool

To change the receiver frequency using the Telemetry Service Tool, do the following:

Step 1. Power off the receiver mainframe and disconnect it from the SDN.

Step 2. Install the RS-232 board into any unused slot in the rear of the Receiver Mainframe.

Step 3. Connect the RS-232 cable from the top port on the RS-232 board just put into the mainframe to the serial port connector of the computer being used to run the Telemetry Service Tool.

Step 4. Re-apply power to the Receiver Mainframe.

Step 5. Exit Windows in the computer and get into DOS.

Step 6. Go to the directory where the Telemetry Service Tool is loaded.

Step 7. Type **mftool.exe** at the DOS prompt and press Enter to start the tool. The Mainframe Main Screen displays.

Step 8. Press the CONFIG softkey. The Mainframe Configuration Screen One displays.

Step 9. Press the MORE CONFIG softkey until the last Mainframe Configuration Screen displays.

Step 10. Go to the Frequency Converter field using the down arrow key and specify the Frequency Converter option using the NEXT CHOICE/PREV CHOICE softkeys.

For systems operating at 406-480 MHz (non-extended band), there is no Frequency Converter and this field should be set to 0.

Step 11. Go to the Transmitter Frequency field for the desired receiver using the down arrow key and enter the new frequency.

Step 12. Go to the Check Code field and enter the Check Code corresponding to that frequency.

Note After the transmitter Frequency and associated Check Code are entered, the tool calculates the appropriate receiver frequency.

Step 13. Press the STORE SETTINGS softkey to copy the frequency change to the mainframe.

Step 14. Press the STORE SETTINGS softkey again when the screen prompts for confirmation. When the settings are successfully downloaded to the mainframe, the screen displays Ready!!! Thank-you!!! The configuration settings selected are now in affect in the receiver mainframe.

Setting a Transmitter's Frequency After Repair

To set a transmitter's frequency after repair, do the following:

Step 1. Determine its Frequency and Check Code. See Matching a Transmitter Frequency to a Receiver Frequency on page 2-6.

Step 2. Set the frequency. See Changing a Transmitter's Frequency on page 2-7.

Step 3. Perform a learn code if an INVALID SIGNAL E01 occurs. Performing Learn Codes on page 2-29.

Checking for Interference

Interference can be checked using either the RF History Strip or the RF INOP.

Note Before checking for interference, remove the battery from the transmitter.

Using the RF History Strip

To check for interference using the RF History Strip, let the receiver "listen" for the desired period of time, printing out an RF History Strip every 24 hours. Printing RF History Strips on page 2-22 and Chapter 4, Troubleshooting contain information on reading the strips.

Using the RF INOP

To check for interference using the RF INOP, turn the RF INOP on and check the Noise number. The lower the number, the better. It should be less than 90 counts. Turning on the RF INOP on page 2-22 and Chapter 4, Troubleshooting contain information on how to interpret the INOP.

Error Messages While Setting Frequencies

Table 2-2 provides a list of frequency setting error Messages and Actions that can be taken to resolve the problem.

Table 2-2. Extended Band Error Messages

Message	Action
A NO SIGNAL INOP plus the error message Frequency/Check Code Mismatch when trying to set frequencies.	Check that the Frequency, Check Code, Country Code and Locale Code have been entered properly (see the Frequency and Check Code Listing shipped with the system)
Transmitter Service Tool error message: Frequency Out of Option Range Wave Viewer error message: Enter new frequency	These messages indicate that the frequency entered is out of the hardware range of the transmitter. Enter a frequency that is within the hardware range or change the hardware range by changing the transmitter or the transmitter Main PCB to one that covers the desired frequency range.

Table 2-2. Extended Band Error Messages

Message	Action
A NO SIGNAL INOP plus one of the following error messages. • Mainframe service tool error message: Frequency out of range, valid range: ###.####-###.#### • Philips Information Center error message	These messages indicate that the frequency entered is out of the hardware range of the receiver. For extended band systems, this can also indicate that the receiver frequency that the Service Tool calculates (the entered transmitter frequency minus the entered frequency converter option) is out of the hardware range of the installed receiver. For example, if the receiver hardware option is 007 (460-470 MHz), the desired broadcast frequency is 611.0125 MHz, and the frequency converter option is entered as 136, then: 611.0125 MHz – 136 = 475.0125 MHz A Frequency out of range, valid range: 460.0125-470.0000 error message will appear because 475.0125 MHz is outside the hardware range of the receiver. To correct the problem, enter another frequency or another frequency converter option, or change the hardware range by changing the receiver PCB.

Managing Frequencies

This section describes how to:

- use the Frequency and Check Code listing for frequency management.
- select the extended UHF band frequency.

Using the Frequency & Check Code Listing

Patient data loss can occur if RF energy of sufficient strength is received by the antenna system at the same frequency as the telemetry transmitters. The effect of interference on the telemetry system ranges from a momentary loss of ECG to complete inoperability, depending on the situation. The strength, frequency, and proximity of the source of interference to transmitters or the antenna system are factors that determine the degree of severity.

Management of the RF environment in a facility is important to the overall performance of the telemetry system. Philips Medical Systems cannot control what wireless devices are used in a facility. Frequency management is, therefore, the hospital's responsibility. To assist in the management of frequencies in a hospital, a paper listing and a floppy disc with Frequencies and Check Codes approved for use in a country/hospital are shipped with each system.

This section provides information on frequency management in general and examples on how to use the Frequency and Check Code Listing.

Frequency Registration

Frequency registration is the registration of wireless devices used in a hospital with a government appointed agency. Registration requirements vary by country.

In the US, the Federal Communications Commission (FCC) requires registration of all Wireless Medical Telemetry Service (WMTS) devices. On October 16, 2000, the FCC published the wireless Medical Telemetry Service Final Rule. Under the provisions of this ruling, authorized health care providers that use wireless medical devices (608-614 MHz, 1395-1400 MH or 1427-1429 MHz) must register WTMS devices with a designated Frequency Coordinator (to avoid potential radio interference with other medical telemetry devices that could operate within these frequencies in the area). Registration for operation of medical telemetry devices at a particular radio frequency or range is on a first come first served basis.

The American Society for Healthcare Engineering (ASHE) of the American Hospital Association (AHA) has been named by the FCC to be the Frequency Coordinator for this registration.

Note **The Philips M2600A Telemetry System for extended band operation (608-614 MHz) is an FCC WMTS device that must be registered with ASHE.**

Following is the information required to register. This information is currently provided on an information sheet included with new product shipments.

- Equipment manufacturer and Model Number: Philips Medical Systems M2601A
- Modulation scheme used: The M2601A uses GMSK at 25 kHz spacing
- Effective Radiated Power (ERP): 95 dB (μV/m) or -31.4 dBW
- Deployment ERP: 6.5 dBm
- Maximum ERP: 8.1 dBm
- Receiver Threshold: -103 dBm
- Emission Designator:16K0F1D
- Receiver bandwidth: 9.9 MHz
- FCC ID: PQCM2601A Philips Medical Systems after 1 August, 2001
  OTLM2601A Agilent Technologies before 1 August 2001

Note

It is the customer's responsibility to register WMTS devices.

To contact ASHE/AHA regarding frequency coordination of WMTS equipment, contact

Dale Woodin
ASHE Advocacy Director
American Hospital Association
One North Franklin
Chicago, IL 60606

Tel: (312) 422-3812
Fax: (312) 422-4571
email: ***dwoodin@aha.org***

WMTS equipment can be registered on line at ***www.ashe.org***
There is a fee for registration

Frequency Management?

Frequency management is the selection of frequencies for wireless devices within a facility to prevent interference between devices.

Frequency Management Responsibility

Frequency management is the responsibility of the hospital.

Philips Medical Systems has no control over the RF environment in a hospital. If interference exists at the operating frequencies, telemetry system performance will be affected. Careful selection of frequencies for **all** wireless devices used within a facility (telemetry transmitters, walkie-talkies, ambulance radios, other wireless medical devices, etc.) is important to prevent interference between them.

Frequency Management Updating

If a telemetry system is in operation in the facility, frequency management should be updated whenever new wireless devices are to be purchased.

Interference from Wireless Devices

The following devices can cause interference within a facility:

- Other Philips, Agilent, or HP telemetry products operating at the same frequency (for example, M1403A Digital UHF Telemetry System, 78100/101A Analog Telemetry System, M1310A Series 50T Fetal Telemetry, 80240A Fetal Telemetry).
- Other medical manufacturer's wireless monitoring products.
- Paging systems
- Walkie-talkies
- Ambulance and police radios
- UHF-TV stations in the range of 590-632 MHz

Required Information for Frequency Management

To properly perform frequency management, the following should be available:

- A list of wireless devices that are currently in operation and new wireless devices as they are purchased.
- Broadcast frequency of devices in use.
- Power output of the devices.
- Broadcast antenna locations.

Interference Sources

The Philips Telemetry System receives RF energy between 406-650 MHz. Exact frequencies of operation available are dictated by each country, and are provided on a frequency listing shipped with each system. RF power at any of the approved frequencies exceeding –110 dBm, increases the amount of signal corruption for that bed, resulting in an increase of patient data loss at the central station.

RF energy received at any frequency within the 406-650 MHz band exceeding -5 dBm, drives the system into saturation, resulting in an increase in the amount of signal corruption for all telemetry beds.

Avoiding Interference

To avoid interference:

- Prevent interference with other Philips, Agilent, or HP telemetry products by avoiding any frequency already in use within one mile (1.7 km) of the facility.
- Be aware of frequency adjacent broadcasters. A frequency adjacent broadcaster can cause interference if its power is too high. Table 2-3 gives the minimum required frequency separation between the one selected and any adjacent broadcasters at the given maximum received power for the broadcaster, stated in decibel milliwatts (dBm).

Table 2-3. Minimum Required Frequency Separation

Frequency Separation from Adjacent Broadcaster	Maximum Received Power from Adjacent Broadcaster
12.5 kHz	-60 dBm
25 kHz	-40 dBm

Extended UHF Band Frequency Selection

At the time of publication, only the U.S.A., Canada, and Puerto Rico had authorized use of unused UHF TV stations for medical telemetry purposes. The Philips Telemetry System has 4 available frequency options in this area of the spectrum.

Table 2-4. Frequency Options in Range of Unused UHF TV

Option	Frequency Range	UHF TV Channel Assignment
034	590-596 MHz	36
035	596-602 MHz	35
036	602-608 MHz	36
037	608-614 MHz	37

Option 037 (TV channel 37, 608-614 MHz) is recommended for most customers in the US and Canada. If Option 037 is not acceptable, any of the other 3 should be considered. Check the recommendations in the sections that follow for picking a clear frequency range.

Channel 37 (608-614 MHz)

Bio-medical telemetry was been granted co-primary use of Channel 37 (608-614 MHz) by the FCC (Federal Communications Commission) and Industry Canada. This channel is shared with radio-astronomy observatories. Option 037 (608-614 MHz) is recommended for most customers. However, bio-medical telemetry must operate on a non-interference basis with these observatories.

In Canada

For operation in the frequency range 608 - 614 MHz:

This telemetry device is only permitted for installation in hospitals and health care facilities. This device shall not be operated in mobile vehicles (even ambulances and other vehicles associated with health care facilities). The installer/user of this device shall ensure that it is at least 80 km from the Penticton radio astronomy station (British Columbia latitude: 49° 19’ 12” N, longitude 118° 59’ 56” W). For medical telemetry systems not meeting this 80 km separation (e.g., the Okinagan Valley, British Columbia) the installer/user must coordinate with and obtain the written concurrence of the Director of the Penticton radio astronomy station before the equipment can be installed or operated.

The Penticton contact is: Tel: 250-493-2277
FAX: 250-493-7767.

For operation outside the frequency range 608 - 614 MHz:

Contact your local Industry Canada offices as licensure is required.

The term “IC” before the certification/registration number only signifies that Industry Canada technical specifications were **not** met.

To provide maximum RF shielding and minimum RF interference to the licensed service, this device should be operated indoors and away from 50-493-7767

In the U.S.A.

The Philips Telemetry System cannot be used in the locations listed in Table 2-5. If there is a question of possible interference, consultation with the affected observatory is required. The contact point is:

National Science Foundation
Spectrum Manager
Division of Astronomical Sciences
NSF Rm. 1045
4201 Wilson Blvd.
Arlington, VA 22230
Phone: 703-306-1823

Table 2-5. Channel 37 Observatories

Region	Location	Observatory	Telemetry Distance from Radio Astronomy Observatory	North Latitude	West Longitude
Arizona	Kitt Peak	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	31° 57′	110° 37′
California	Owens Valley	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	37° 14′	118° 17′
Hawaii	Mauna Kea	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	19° 49′	155° 28′
Iowa	North Liberty	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	41° 46′	91° 34′
New Hampshire	Hancock	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	42° 56′	71° 59′
New Mexico	Los Alamos	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	35° 47′	106° 15′
New Mexico	Pie Town	National Radio Astronomy Observatory, Very Long Baseline Array Station	50 miles (80 kilometers)	34° 18′	108° 07′

Table 2-5. Channel 37 Observatories

Region	Location	Observatory	Telemetry Distance from Radio Astronomy Observatory	North Latitude	West Longitude
New Mexico	Socorro	National Radio Astronomy Center	50 miles (80 kilometers)	34° 04′	107° 04′ 43″
Puerto Rico	Arecibo	National Astronomy and Ionosphere Center	50 miles (80 kilometers)	18° 20′	66° 45′ 09.42″
Texas	Fort Davis	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	30° 38′	103° 77′
Virgin Islands	Saint Croix	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	17° 46′	64° 35′
Washington	Brewster	National Radio Astronomy Observatory, Very Long Baseline Array Station	20 miles (32 kilometers)	48° 08′	119° 41′
West Virginia	Green Bank	National Radio Astronomy Observatory	50 miles (80 kilometers)	38° 2′	79° 49′ 42″

Channels 34, 35, 36

Clear TV Channels

If Channel 37 is not available, operation on any of the other 3 channels is allowed. However, a check must be done to ensure that there will not be interference from any TV stations.

The broadcast power of the TV station, the height of the broadcast antenna (HAAT), and the distance from the broadcast antenna to the hospital must be known. Be certain to check both existing UHF TV stations and existing or future Digital TV (DTV) stations.

Table 2-6. Criteria for Totally Clear TV Channels

TV Broadcast Power	Broadcast Antenna Height Above Average Terrain — "h" (HAAT)	Minimum Distance from TV Broadcast Antenna
Standard UHF TV Stations		
10 -100 kW	$h \leq 300$m (984 ft)	81 miles (130 km)
	300 m $< h \leq 600$ m (984 ft $< h \leq 1969$ ft)	100 miles (160 km)

Table 2-6. Criteria for Totally Clear TV Channels

TV Broadcast Power	Broadcast Antenna Height Above Average Terrain — "h" (HAAT)	Minimum Distance from TV Broadcast Antenna
100 kW - 1000 kW	h ≤ 300m (984 ft)	112 miles (180 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	130 miles (210 km)
1000 kW - 5000 kW	h ≤ 300m (984 ft)	137 miles (220 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	150 miles (241 km)
Digital TV (DTV) Stations		
10 -100 kW	h ≤ 300m (984 ft)	37 miles (60 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	46 miles (75 km)
100 kW - 500 kW	h ≤ 300m (984 ft)	43 miles (70 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	56 miles (90 km)
500 kW - 1000 kW	h ≤ 300m (984 ft)	48 miles (77 km)

Partially Clear TV Channels

If a usable frequency range is not found, it is possible to operate on standard UHF TV channels at frequencies between the picture carrier, the color sub-carrier and the sound carrier. Operating on a partially clear channel also decreases the number of usable frequencies within the 6 MHz TV channel. See Table 2-7 and Table 2-8.

Note **Telemetry systems cannot operate on Digital TV Channels.**

Table 2-7. Criteria for Partially Clear TV Channels

TV Broadcast Power	Broadcast Antenna Height Above Average Terrain "h" (HAAT)	Minimum Distance from TV Broadcast Antenna
Standard UHF TV Stations in Operation		
10 -100 kW	h ≤ 300m (984 ft)	5 miles (8 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	6 miles (10 km)
100 kW - 1000 kW	h ≤ 300m (984 ft)	9 miles (14.5 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	12 miles (20 km)
1000 kW - 5000 kW	h ≤ 300m (984 ft)	14 miles (22.5 km)
	300 m < h ≤ 600 m (984 ft < h ≤ 1969 ft)	19 miles (30 km)

Table 2-8. Usable Frequencies for Partially Clear TV Channels

TV Channel	Usable Frequency Ranges	# Usable Frequencies
34	590.0125 - 591.1375	46
	591.3625 - 594.7125	135
	594.9875 - 595.6875	29
	595.8125 - 595.9875	8
35	596.0125 - 597.1375	46
	597.3625 - 600.7125	135
	600.9875 - 601.6875	29
	601.8125 - 601.9875	8
36	602.0125 - 603.1375	46
	603.3625 - 606.7125	135
	606.9875 - 607.6875	29
	607.8125 - 607.9875	8

Available Frequency Management Tools

Media

Information on allowed frequencies is provided with each M2600A system. The information is provided in two formats –paper and floppy disc

The information includes Country Code, Locale Code, allowed Frequencies, Check Codes, and the Channel Number associated with the frequency for older Philips/Agilent/HP telemetry products -- 78100/101, M1400X series, 80240 (fetal telemetry), and M1310A (fetal telemetry). There are also some empty columns for customer notes. These notes can be the care unit where the telemetry channel is used, how the channel is labelled, what product is in use, and if interference exists at a specific frequency.

The data on the floppy disk are a comma-separated text file that can be used in spreadsheet programs, such as Lotus 1-2-3™ or Microsoft Excel™. An example of how the Frequency and Check Code Listing could be used is provided in Table 2-9.

Note See the RF Troubleshooting section in Chapter 4 of this manual for information on how to monitor for clear channels using the built-in RF tools.

Websites

The following website provides information on existing UHF TV stations (U.S.A.):

http://radiostations.com/kodis/

The following website provides information on existing or future DTV stations (U.S.A.):

http://www.fcc.gov/healthnet/dtv.html
(see List of All DTV Allotments)

The following website provides information on existing or future DTV stations (Canada.):

http://strategis.ic.gc.ca/SSG/sf01731e.html

The following web site does a detailed television station query by call sign (U.S.A. stations) and provides power and latitude and longitude of the broadcast tower, including DTV:

http://www.fcc.gov/mmb/vsd/tvq.html

The following web sites calculate distance, with latitude and longitude data:

http://www.nau.edu/~cvm/latlongdist.html

http://www.indo.com/distance

The following site provides the latitude and longitude for the center of a U.S. ZIP code:

http://www.census.gov/cgi-bin/gazetteer

Table 2-9. Frequency and Check Code Listing Example

M2600A Philips Telemetry System Frequency and Check Codes									
Country Code:			000		Country:	USA			
Locale Code:			0000		Location:		Order Number:	0	
System Frequency Range Option:			007						
Option Frequency Range:			460-470 MHz						
Customer Notes				Transmitter Frequency	Check Code	78100/ 101 Channel Number	M1400X Channel Number	80240 Channel Number	
	Unit	Label	Product						
MFREHAB1 SLOT 3	Rehab	23	M1400A M1402A	460.6625	XXXX	23	23	23	
				460.6875	YYYY	20	20	20	
MFREHAB1 SLOT 2	Rehab	26	M1400A M1402A	460.7125	ZZZZ	26	26	26	

Table 2-9. Frequency and Check Code Listing Example

M2600A Philips Telemetry System Frequency and Check Codes								
MFREHAB1 SLOT 1	Rehab	21	M1400A M1402A	460.7375	XXXX	21	21	21
				460.7625	YYYY	27	27	27
MFREHAB1 SLOT 4	Rehab	25	M1400A M1402A	460.7875	ZZZZ	25	25	25
				460.8125	XXXX	28	28	28
Do not use – interference with paging system				460.8375	YYYY	22	22	22
Do not use – interference with paging system				460.8625	ZZZZ	24	24	24
MF CCU 1 SLOT 1	CCU	TEL 1	M2601A M2603A	460.8875	XXXX	0	228	0
MF CCU 1 SLOT 2	CCU	TEL 2	M2601A M2603A	460.9125	YYYY	0	0	0
MF CCU 1 SLOT 3	CCU	TEL 3	M2601A M2603A	460.9375	ZZZZ	0	0	0
MF CCU 1 SLOT 4	CCU	TEL 4	M2601A M2603A	460.9625	XXXX	0	0	0
MF CCU 1 SLOT 5	CCU	TEL 5	M2601A M2603A	460.9875	YYYY	0	0	0
MF CCU 1 SLOT 6	CCU	TEL 6	M2601A M2603A	461.0125	ZZZZ	135	135	0
MF CCU 1 SLOT 7	CCU	TEL 7	M2601A M2603A	461.0375	XXXX	136	136	0
MF CCU 1 SLOT 8	CCU	TEL 8	M2601A M2603A	461.0625	YYYY	137	137	0

Using the Built-in RF Tools

This section describes how to use the built-in RF tools. It includes the following subsections:

- Turning on the RF INOP
- Printing History Strips

Turning on the RF INOP

At the Philips Information Center

To turn the RF INOP on at a Philips Information Center, do the following:

Step 1. Assign the desired channel to a sector and take out of stand-by mode.

Step 2. Click on the Telem Freq button in the Unit Settings Window to access the Telemetry Frequency window.

Step 3. Enter hp in the Password field.

Step 4. Highlight the desired channel from the displayed list.

Step 5. Enable the RF INOP by clicking in the RF INOP checkbox. A check in the RF INOP checkbox indicates that RF INOP is enabled.

Printing RF History Strips

This section describes how to print RF history strips at the Central Station. See Chapter 4, Troubleshooting for information on how to read the history strips.

To print history strips at the Philips Information Center, do the following:

Step 1. Click the All Controls button in the Patient Window.

Step 2. Click the Service button in the All Controls window.

Step 3. Click OK when prompted whether to continue.

Step 4. Enter m3150 in the Enter Service Password field and click OK.

Step 5. Select Telemetry Services from the Support Logs drop-down list.

Step 6. Select the desired mainframe from the Telemetry Mainframes list and click the Record RF History button.

Configuration

The telemetry system's operation can be customized for a site through configuration of the transmitter and the receiver mainframe. This section describes how to:

- Check the current receiver mainframe configuration.
- Check the current transmitter configuration.
- Change receiver mainframe configuration settings.
- Change transmitter configuration settings.

Note This section describes how to check and change configuration settings. It does not describe the various configuration parameters. See Appendix A, Telemetry System Parameters in the Philips Telemetry System Installation and Service Manual for a complete description of configuration parameters, their default settings, and valid settings.

Checking Receiver Mainframe Configuration

The current receiver mainframe configuration can be checked using the Telemetry Service Tool or from the Central Station.

Using the Telemetry Service Tool

To check the receiver mainframe configuration using the Telemetry Service Tool do the following:

Step 1. Power off the receiver mainframe and disconnect it from the SDN.

Step 2. Install the RS-232 board into any unused slot in the rear of the receiver mainframe.

Step 3. Connect the RS-232 cable from the top port on the RS-232 board just put into the mainframe to the serial port connector of the computer being used to run the Telemetry Service Tool.

Step 4. Re-apply power to the receiver mainframe.

Step 5. Exit Windows on the computer and get into DOS.

Step 6. Go to the directory where the Telemetry Service Tool is loaded.

Step 7. Type **mftool.exe** at the DOS prompt and press Enter to start the tool. The Mainframe Main Screen displays.

Step 8. Press the CONFIG softkey. The Mainframe Configuration Screen One displays.

Step 9. Check the configuration settings on each of the Mainframe Configuration Screens. Pressing the MORE CONFIG softkey advances to the next configuration screen.

Step 10. Press the EXIT softkey to exit from the program when the configuration settings have been checked.

Using the Central Station

To check the receiver mainframe configuration at the Philips Information Center, do the following:

Step 1. Click the All Controls button in the Patient Window.

Step 2. Click the Service button in the All Controls window.

Step 3. Click OK when prompted whether to continue.

Step 4. Enter m3150 in the Enter Service Password field and click OK.

Step 5. Select Telemetry Services from the Support Logs drop-down list.

Step 6. Select the desired mainframe from the Telemetry Mainframes list and click Configuration to view the Mainframe configuration information.

Checking Transmitter Configuration

A transmitter's configuration can be checked using the Service Tool, the TeleMon, the Telemetry Configuration Tool, or the Wave Viewer.

Using the Telemetry Service Tool

To check a transmitter's configuration using the Telemetry Service Tool, do the following:

Step 1. Place a fresh battery into the transmitter and allow it to go through self-test.

Step 2. Connect the cable from the serial-to-infrared converter to the 9-pin serial connector on the computer.

Step 3. Align the serial-to-infrared converter with the infrared port of the transmitter.

Step 4. Go to the DOS directory where the Telemetry Service Tool is loaded.

Step 5. Type **trtool.exe** at the DOS prompt and press Enter to start the tool. When the tool is loaded properly and communicating with the transmitter, the Transmitter Information One screen displays.

Notes

There are two transmitter information screens containing transmitter configuration information -- Transmitter Information One and Transmitter Information Two.

Press the More Info softkey to move between Transmitter Information screens.

Step 6. Check the Transmitter configuration information on each of the Transmitter Information screens.

Step 7. Press the Exit softkey to break the connection when the information has been checked. The No Communications screen displays.

Using the Telemetry Configuration Tool

To check a transmitter's configuration using the Telemetry Configuration Tool, see the Telemetry Configuration Tool Guide.

Using the TeleMon

To check a transmitter's configuration using the TeleMon, see the M2636B TeleMon MonitorB Service Manual.

Using the Wave Viewer

To check a transmitter's configuration using the Wave Viewer, see Appendix F: Wave Viewer.

Changing Transmitter Configuration

A transmitter's configuration settings can be changed using the Telemetry Service Tool, the Telemetry Configuration Tool, the TeleMon, or the Wave Viewer.

Using the Telemetry Service Tool

The Telemetry Service Tool can be used to change a transmitter's configuration by:

- copying an existing receiver mainframe configuration.
- loading the factory defaults.
- changing specific configuration parameters using the appropriate softkey.

The following procedure describes how to complete each of these functions.

Step 1. Place a fresh battery into the transmitter and allow it to go through self-test.

Step 2. Connect the cable from the serial-to-infrared converter to the 9-pin serial connector on the computer.

Step 3. Align the serial-to-infrared converter with the infrared port of the transmitter.

Step 4. Go to the DOS directory where the Telemetry Service Tool is loaded.

Step 5. Type **trtool.exe** at the DOS prompt and press Enter to start the tool. When the tool is loaded properly and communicating with the transmitter, the Transmitter Information One screen displays.

Step 6. Press the Config softkey to access the transmitter configuration screens.

Step 7. To change the configuration by downloading an existing receiver mainframe configuration do the following:

a. Press the Save/Load File softkey. The tool displays the Transmitter File Functions Screen.

b. Press the Load File softkey.

c. Type the directory path name for the location from which the file is to be loaded and press Enter. The tool retrieves the configurations from the saved file and displays the Transmitter Configuration Screen 1 of 3.

Step 8. To load the factory defaults into the transmitter, press the Factory Defaults softkey. This sets the values for all configuration parameters to the default setting. The default settings are:

- Lead Selection NO
- Ability to change frequency YES
- Automatic Shutoff YES

Step 9. Check the parameter settings On Transmitter Configuration Screen 1 of 3 and make any desired changes by pressing the appropriate softkey.

Step 10. Press the More Config softkey to display Transmitter Configuration Screen 2 of 3. Check the SpO_2 and the EASI settings and adjust them if necessary using the appropriate softkey(s).

Step 11. Press the More Config key to display Transmitter Configuration Screen 3 of 3.

Step 12. If the configuration was copied from an existing receiver mainframe file, Transmitter Configuration Screen 3 of 3 displays the frequencies retrieved from the saved file. Use the Up/Down arrows to scroll through the displayed receivers and select the receiver to which the transmitter is to be configured.

Step 13. Check the Country Code, Locale Code, and transmitter synthesizer Frequency and adjust them if necessary.

Note

Move between parameters using the Enter, Tab, and Up/Down arrow keys.

Rules governing specifying parameters are:

- If an invalid value is specified into any of the configurable parameters, the parameter is set back to its original value.
- The Frequency entered as the Transmitter Synthesizer Frequency parameter must be within the given Transmitter Frequency Option.
- Configuration settings to the transmitter can only be written after a valid Check Code has been accepted.

Step 14. When configuration settings have been changed, press the Store Settings softkey to download the configuration settings. When the download is complete the tool displays the word Set to the left of the receiver number indicating that the download was successful. This stores the configuration items into the transmitter.

Caution

Each transmitter must be set to its own unique frequency. Do not set more than one transmitter to the same frequency or interference between the transmitters will occur.

Using the Telemetry Configuration Tool

To change a transmitter's configuration using the Telemetry Configuration Tool, see the Telemetry Configuration Tool Guide.

Using the TeleMon

To change a transmitter's configuration using the TeleMon, see the M2636B TeleMon MonitorB Service Manual.

Using the Wave Viewer

To change a transmitter's configuration using the Wave Viewer, see Appendix F: Wave Viewer.

Changing Receiver Mainframe Configuration

The receiver frequency can be changed at the Central Station (see Changing the Receiver Frequency on page 2-8). All other configuration changes must be performed using the Telemetry Service Tool.

To change receiver mainframe configuration settings using the Telemetry Service Tool, do the following:

Step 1. Power off the receiver mainframe and disconnect it from the SDN.

Step 2. Install the RS-232 board into any unused slot in the rear of the Receiver Mainframe.

Step 3. Connect the RS-232 cable from the top port on the RS-232 board just put into the mainframe to the serial port connector of the computer being used to run the Telemetry Service Tool.

Step 4. Re-apply power to the Receiver Mainframe.

Step 5. Exit Windows on the computer and get into DOS.

Step 6. Go to the directory where the Telemetry Service Tool is loaded.

Step 7. Type **mftool.exe** at the DOS prompt to start the tool and press Enter. The Mainframe Main Screen displays.

Step 8. Press the CONFIG softkey. Mainframe Configuration Screen One displays.

Step 9. Change the Mainframe configuration settings to the desired values.

Notes

Press the FACTORY DEFAULTS softkey to change the parameter settings to the factory default settings.

Use the Up/Down arrow keys to move to the field to be changed.

Use the NEXT CHOICE/PREVIOUS CHOICE softkey to change a parameter.

Press the MORE CONFIG softkey to go to the next configuration screen.

See Appendix A, Telemetry System Parameters in the Philips Telemetry System Installation and Service Manual for parameter descriptions.

Step 10. Press the MORE CONFIG softkey to go to the last Mainframe Configuration Screen.

Step 11. Go to the Country Code field and enter the number appropriate for the country.

Step 12. Go to the Locale Code field and enter the number appropriate for the locale.

Note

The Country Code and Locale code can be found on the Frequency and Check Code Listing that is shipped with the product.

Step 13. For **dual-band systems**, go to the Frequency Converter field and specify the Frequency Converter option being used.

For systems operating in the **406-480 MHz** frequency range (non-extended band), there is no Frequency Converter and this field should be set to 0.

Step 14. Go to the Transmitter Frequency field for each receiver that needs to be configured and enter the Frequency and the Check Code corresponding to that frequency.

Note

When the transmitter Frequency and associated Check Code are entered, the tool calculates the appropriate receiver frequency.

Step 15. Press the STORE SETTINGS softkey when all of the settings have been made.

Step 16. Press the STORE SETTINGS softkey again when the screen prompts for confirmation. When the settings are successfully downloaded to the mainframe, the screen displays Ready!!! Thank-you!!! The configuration settings selected are now in affect in the receiver mainframe.

Note

To configure transmitters to match the receivers just configured without having to re-enter all of the Frequencies and Check Codes, do not exit the Service Tool or disconnect the PC from the mainframe until the following step is completed.

Step 17. Store the configuration to file as follows:

a. Press the SAVE/LOAD FILE softkey. The Mainframe File Functions Screen displays.

b. Press the SAVE FILE softkey to save the mainframe configuration settings.

c. Type the directory and filename where the configuration settings are to be saved and press Enter. The Telemetry Service Tool saves the configuration to the specified filename.

Step 18. Press the EXIT softkey to exit from the program.

Performing Learn Codes

This section describes how to perform a Learn Code if an INVALID SIGNAL E01 occurs. Learn Codes are performed at the Philips Information Center.

To perform a Learn Code complete the following steps at the Information Center:

Step 1. Assign a bed to a sector.

Step 2. Click on the Telem Freq button in the Unit Settings window to access the Telemetry Frequency window.

Step 3. Enter hp in the Password field.

Step 4. Click on the Telemetry Transmitter from the displayed list.

Step 5. Click on the Learn Xmit Code button.

Step 6. Press the transmitter button on the transmitter within 10 seconds. When the Learn Code is successful, the INVALID SIGNAL E01 INOP goes away. If it does not, repeat this step.

Checking Revision Information

This section describes how to access the revision screens to check revision information. Procedures are provided for checking Transmitter and Receiver Mainframe revision information.

Transmitter Revision Information

Transmitter revision information can be checked using the Telemetry Service Tool, the Telemetry Configuration Tool, or the Wave Viewer.

Using the Telemetry Service Tool

To check transmitter revision information using the Telemetry Service Tool do the following:

Step 1. Place a fresh battery into the transmitter and allow it to go through its self-test.

Step 2. Connect the cable from the serial-to-infrared converter to the 9-pin serial connector on the computer.

Step 3. Align the serial-to-infrared converter with the infrared port of the transmitter.

Step 4. Go to the DOS directory where the Telemetry Service Tool is loaded.

Step 5. Type **trtool.exe** at the DOS prompt and press Enter to start the tool. When the tool is loaded properly and communicating with the transmitter, the Transmitter Information One screen displays. The Transmitter Information One screen provides revision information for the transmitter's Main PCB and SpO_2 PCB.

Step 6. Check the revision information for the Main and SpO_2 PCBs.

Step 7. When finished checking the revision information, break the infrared connection and press the Exit softkey to return to the No Communications screen.

Using the Telemetry Configuration Tool

To check a transmitter's revision information using the Telemetry Configuration Tool, see the Telemetry Configuration Tool Guide.

Using the Wave Viewer

To check a transmitter's revision information using the Wave Viewer, see Appendix F: Wave Viewer.

Receiver Mainframe Revision Information

The current receiver mainframe configuration can be checked either using the Telemetry Service Tool or the Philips Information Center.

Using the Telemetry Service Tool

To check receiver mainframe revision information using the Telemetry Service Tool do the following:

Step 1. Power off the receiver mainframe and disconnect it from the SDN.

Step 2. Install the RS-232 board into any unused slot in the rear of the receiver mainframe.

Step 3. Connect the RS-232 cable from the top port on the RS-232 board just put into the mainframe to the serial port connector of the computer being used to run the Telemetry Service Tool.

Step 4. Re-apply power to the receiver mainframe.

Step 5. Exit Windows on the computer and get into DOS.

Step 6. Go to the directory where the Telemetry Service Tool is loaded.

Step 7. Type **mftool.exe** at the DOS prompt and press Enter to start the tool. The Mainframe Main Screen displays. The Mainframe Main Screen gives revision information for the mainframe software on the CPC board.

Step 8. Press the EXAMINE REVISION softkey. The Mainframe Examine Revision Screen displays. The Mainframe Examine Revision Screen gives revision information for each function and receiver module card.

Step 9. Check the revision information for the Receiver Mainframe.

Step 10. When finished checking revision information, press the EXIT softkey to return to the Mainframe Main Screen.

Using the Central Station

To check the receiver mainframe revision information at the Philips Information Center, do the following:

Step 1. Click the All Controls button in the Patient Window.

Step 2. Click the Service button in the All Controls window.

Step 3. Click OK to continue.

Step 4. Enter m3150 in the Enter Service Password field and click OK.

Step 5. Select Telemetry Services from the Support Logs drop-down list.

Step 6. Select the desired mainframe from the Telemetry Mainframes list and click on the Revision tab to view the mainframe revision information.

Locating Serial Numbers

If a failure occurs during the system's warranty period, the telemetry product's Serial Number must be reported. Serial Numbers are 10 characters long. The first 5 characters are alpha-numeric and represent the product's prefix date code. Table 2-10 provides the locations of Serial Numbers for various telemetry system products.

Note Some products are either not serialized or not tracked for warranty purposes.

Table 2-10. Serial Number Locations for Telemetry System Products

Failed Product	Product to Report	Serial Number Location
M2601A - Transmitter	M2601A - Transmitter	Transmitter battery compartment.
Telemetry ECG Leadsets M2590A M2591A M2592A M2593A M2594A M2595A M2596A M2597A		
Telemetry ECG Leadset Combiners M2598A or M2599A		
M2603A - Receiver	M2603A - Receiver	Front of the receiver (where the semi-rigid cable connects)
M2604A – Receiver Mainframe	M2604A – Receiver Mainframe	On the right side of the receiver mainframe on the outside of the instrument and under the front dress cover on the right hand side.
Antenna System Components		
M1191A – Reusable Adult Finger SpO2 Transducer	M1191A – Reusable Adult Finger SpO2 Transducer	On the connector that plugs into the transmitter.
M1192A – Reusable Pediatric/ Small Adult Finger SpO2 Transducer	M1192A – Reusable Pediatric/ Small Adult Finger SpO2 Transducer	On the connector that plugs into the transmitter.
M1191A – Reusable Adult/ Pediatric Ear Clip SpO2 Transducer	M1191A – Reusable Adult/ Pediatric Ear Clip SpO2 Transducer	On the connector that plugs into the transmitter.

Upgrading Software

Transmitters

Upgrades to transmitters are performed using the Telemetry Service Tool. See Chapter 5, Upgrading Transmitter Firmware in the Telemetry Service Tool Guide for information on upgrading transmitters.

Receiver Mainframes

Receiver mainframe software consists of software that resides on the CPC Card and configuration information that resides in the EEPROM on the Utility CPU Card. The receiver mainframe will fail its built-in self-test if the configuration information in the EEPROM is not compatible with the software in the CPC Card.

With release C (Revision E.00.19), the mainframe configuration changed to add NBP parameters, requiring a new EEPROM.

The CPC programming tool is used for loading new code into the receiver mainframe.

Upgrade the mainframe software by performing the following steps for the appropriate Revision of the Receiver Mainframe.

Rev D to Rev D
Rev E to Rev E

To burn new **Revision D** or **Revision E** software onto the CPC Card, do the following.

Step 1. Power off the receiver mainframe.

Step 2. Insert the Flash Card into the front of the CPC Programming Tool.

Step 3. Loosen the bottom screw on the CPC Card so that the cover moves and exposes the CPC programming port. See Receiver Mainframe Rear View on page 2-4.

Step 4. Connect the CPC Programming Tool to the port on the CPC Card of the receiver mainframe. Make certain that the grounding clip is grounded to the receiver mainframe.

Step 5. Set the dip switches of the CPC Programming Tool as follows:

To burn **new code** onto the CPC Card with **user defaults** into the EEPROM:

- Switches 1, 2, and 3 **UP**
- Switches 4-8 **DOWN**

To burn **new code** onto the CPC Card with **factory defaults** into the EEPROM:

- Switches 1 and 2 **UP**
- Switches 3-8 **DOWN**

To burn **just new code** onto the CPC Card

- Switch 1 **UP**
- Switches 2-8 **DOWN**

Step 6. Apply power to the receiver mainframe. The upgrade begins automatically.

During the upgrade, the green PASS LED on the tool **blinks**.

When the upgrade is successfully completed, the PASS LED stays on **steadily**.

If the red FAIL LED lights, the upgrade has failed and this procedure must be repeated. Make certain that the cables are connected properly and the connectors are not damaged.

Step 7. Remove power from the receiver mainframe, remove the programming tool, and close the cover.

Step 8. Secure the CPC Card mounting bracket to the receiver mainframe chassis using the screw and washer.

Step 9. Power on the receiver mainframe.

Rev D to Rev E

To upgrade software on the CPC Card from **Revision D to Revision E**, do the following:

Step 1. Power off the receiver mainframe.

Step 2. Insert the Flash Card into the front of the CPC Programming Tool.

Step 3. Loosen the bottom screw on the CPC Card so that the cover moves and exposes the CPC programming port. See Receiver Mainframe Rear View on page 2-4.

Step 4. Connect the CPC Programming Tool to the port on the CPC Card of the receiver mainframe. Make certain that the grounding clip is grounded to the receiver mainframe.

Step 5. Set the dip switches of the CPC Programming Tool as follows:

To burn **new code** onto the CPC card with **user defaults** into the EEPROM

- Switches 1, 2, and 3 **UP**
- Switches 4-8 **DOWN**

To burn **new code** onto the CPC card with **factory defaults** into the EEPROM

- Switches 1 and 2 **UP**
- Switches 3-8 **DOWN**

To burn **just new code** onto the CPC card

- Not applicable. The EEPROM must be updated.

Step 6. Apply power to the receiver mainframe. The upgrade begins automatically.

Step 7. During the upgrade, the green PASS LED on the tool **blinks**.

When the upgrade is successfully completed, the PASS LED stays on **steadily**.

If the red FAIL LED lights, the upgrade has failed and this procedure must be repeated. Make certain that the cables are connected properly and the connectors are not damaged.

Step 8. Remove power from the receiver mainframe, remove the programming tool, and close the cover.

Step 9. Secure the CPC Card mounting bracket to the receiver mainframe chassis using the screw and washer.

Step 10. Power on the receiver mainframe.

Rev E to Rev D

To change software on the CPC Card from **Revision E to Revision D**, do the following.

Step 1. Power off the receiver mainframe.

Step 2. Remove the Utility CPU Card from the Receiver Mainframe by removing 1 screw and 1 washer.

Step 3. Remove the existing EEPROM with a chip extraction tool.

Step 4. Replace the EEPROM with EEPROM M2604-84002 by aligning the corner notch of the new EEPROM chip with the arrow in the socket and gently but firmly push the chip into the socket until it snaps into place.

Step 5. Reinstall the Utility CPU card into its slot in the receiver mainframe.

Step 6. Insert the Flash Card into the front of the CPC Programming Tool.

Step 7. Loosen the bottom screw on the CPC Card so the cover moves and exposes the CPC programming port. See ‘Receiver Mainframe Rear View on page 2-4.

Step 8. Connect the CPC Programming Tool to the port on the CPC Card of the receiver mainframe. Make certain that the grounding clip is grounded to the receiver mainframe.

Step 9. Set the dip switches of the CPC Programming Tool as follows:

To burn **just new code** onto the CPC card

- Switch 1 **UP**
- Switches 2-8 **DOWN**

Step 10. Apply power to the receiver mainframe. The upgrade begins automatically.

During the upgrade, the green PASS LED on the tool blinks.

When the upgrade is successfully completed, the PASS LED stays on steadily.

If the red FAIL LED lights, the upgrade has failed, and this procedure must be repeated. Make certain that the cables are connected properly and the connectors are not damaged.

Step 11. Remove power from the Receiver Mainframe, remove the programming tool, and close the cover.

Step 12. Secure the CPC Card mounting bracket to the receiver mainframe chassis using the screw and washer.

Step 13. Power on the receiver mainframe.

Performing Self-Tests

Before using the Philips Telemetry System with patients, each Transmitter and the Receiver Mainframe should be tested as follows

Transmitter

The transmitter can be tested by performing a diagnostic test using the Telemetry Service Tool or the Wave Viewer.

Using the Telemetry Service Tool

The Transmitter Self Test Screen can be used to initiate a transmitter self-test. The transmitter takes approximately 8 seconds to run through its self-test. The flashing LEDs on the transmitter indicate that the transmitter is performing its internal tests.

Note The self-test does not indicate the status of the SpO_2 circuitry. SpO_2 test results can be viewed on the Central Station or the Wave Viewer.

To run the transmitter self-tests do the following:

Step 1. Connect the cable from the serial-to-infrared converter to the 9-pin serial connector on the computer.

Step 2. Align the serial-to-infrared converter with the infrared port of the transmitter.

Step 3. Go to the DOS directory where the Telemetry Service Tools loaded.

Step 4. Type **trtool.exe** at the DOS prompt and press Enter to start the tool. When the tool is loaded properly and communicating with the transmitter, the screen displays the Transmitter Information One screen.

Step 5. Press the Status & Test softkey. The Transmitter Self-Test Screen displays.

Step 6. Press the Start Selftest softkey to initiate the self-test. The transmitter takes approximately 8 seconds to run through its self-test. The flashing LEDs on the front of the transmitter indicate that the tests are taking place. When the self-test is complete the tool displays one of the following results:

- Test successful - The transmitter successfully passed internal tests.
- ECG Equipment Malfunction - There is a problem with the ECG portion of the transmitter. Refer to Chapter 4, Troubleshooting for procedures for the transmitter or replace the transmitter.
- Transmitter Malfunction - There is a problem with the firmware or memory portions of the transmitter. Refer to Chapter 4, Troubleshooting for troubleshooting procedures for the transmitter or replace the transmitter.

Step 7. Press the Exit softkey to return to the Transmitter Information One screen.

Using the Wave Viewer

To test the transmitter using the Wave Viewer, see Appendix F: Wave Viewer.

Receiver Mainframe

The receiver mainframe can be tested using the Telemetry Service Tool to cause a **Hot Start**, **Warm Start**, or a **Cold Start** to occur on the mainframe.

Using the Telemetry Service Tool

To run the mainframe self-tests using the Telemetry Service Tool, do the following:

Step 1. Power off the receiver mainframe and disconnect it from the SDN.

Step 2. Install the RS-232 board into any unused slot in the rear of the Receiver Mainframe.

Step 3. Connect the RS-232 cable from the top port on the RS-232 board just put into the mainframe to the serial port connector of the computer being used to run the Telemetry Service Tool.

Step 4. Re-apply power to the Receiver Mainframe.

Step 5. Exit Windows on the computer and get into DOS.

Step 6. Go to the directory where the Telemetry Service Tool is loaded.

Step 7. Type **mftool.exe** at the DOS prompt and press Enter to start the tool. The Mainframe Main Screen displays.

Step 8. Press the STATUS & TEST softkey. The Mainframe Fatal Status Log screen displays.

Step 9. To invoke a **Hot Start**, press the HOT START softkey.
When the screen prompts, press the HOT START softkey again.
A Hot Start leaves all user settings in the mainframe and the INOP Log intact.

To invoke a **Warm Start**, press the WARM START softkey.
When the screen prompts, press the WARM START softkey again.
A Warm Start leaves all user settings in the mainframe and the INOP Log intact and performs a more extensive set of testing than the Hot Start.

To invoke a **Cold Start**, press the COLD START softkey.
When the screen prompts, press the COLD START softkey again.
A Cold Start resets all user settings to the default values in the mainframe and erases the INOP Log.

Step 10. After the self-tests are completed, press the EXIT softkey to return to the Mainframe Main Screen.

3
Maintaining the Philips Telemetry System

Overview

Chapter 3 provides information on maintaining the Philips Telemetry System. Chapter 3 covers the following topics:

Caring for the Philips Telemetry System

Care and maintenance of the Philips Telemetry System is primarily making certain that the unit is clean and inspecting each component to see whether there are any damaged parts due to having been dropped or exposed to other such trauma.

Storage

There are no special storage requirements for the any parts of the telemetry system except for the transmitter. Batteries should always be removed from any unused transmitter if the transmitter auto-shut off function as been configured to OFF (the default setting for this function is ON, causing the transmitter to shut off if it is not being used after 10 minutes). Storing transmitters with their batteries installed can result in interference problems caused by intermodulation products, known as heterodyning. This can be corrected by removing the batteries and waiting for the interference due to heterodyning to go away.

Caution **Do Not Store Transmitters with Batteries Installed and the transmitter shut off function configured to OFF.**

Maintenance

No routine preventive maintenance tests are required for the Philips Telemetry System. However, Philips Medical Systems requires that the fan filter in the receiver mainframe be checked for dust every 3 months, or more frequently if required by the environment. Philips representatives will not perform these tasks during the warranty period.

Cleaning the Receiver Mainframe and Transmitters

Warning **To prevent fire when cleaning the transmitter or the receiver mainframe with a flammable liquid, such as alcohol, or sterilizing with ethylene oxide (EtO), provide adequate ventilation and do not permit smoking.**

To prevent electrical shock and accidental turn-on, disconnect line power from the receiver mainframe.

Caution **Do not use any abrasive cleaning materials on any part or component of the Philips Telemetry System.**

Do not clean any part or component of the Philips Telemetry System in any overly vigorous or abrasive fashion.

Do not use abrasive cleansers or abrasive cleaning actions because they can damage the components.

Cleaning the Receiver Mainframe

The receiver mainframe should be kept free of dust and dirt. Only the outside surfaces of the receiver mainframe should be cleaned. Wipe the outside of the receiver mainframe using a damp cloth or rag dampened with one of the following approved cleaning agents:

- Soap and Water
- Isopropyl Alcohol
- Ethyl Alcohol
- Hydrogen Peroxide
- Sodium Hypochlorite (chlorine bleach), 5% solution
- Sodium Hypochlorite (chlorine bleach), 10% solution prepared within 24 hours
- Cidex®
- Windex®
- Lysol®

Wipe all cleaned surfaces with distilled water to remove any residue. Allow to air-dry or dry with a non-lint producing cloth before use.

Cleaning the Transmitter & Battery Extender

The outside of the transmitter and battery extender should be kept free of dirt and dust. They can be cleaned by two methods -- wiping or soaking.

Caution

Remove the battery and any cables or accessories before cleaning and/or soaking the transmitter.

Wiping the Transmitter Exterior

Wipe the outside of the transmitter using the following procedure:

Step 1. Remove the battery and any cables or accessories.

Step 2. Wipe the outside of the transmitter clean using a cloth dampened lightly with one of the following approved cleaning agents:

- Isopropyl Alcohol
- Ethyl Alcohol
- Hydrogen Peroxide, 3% solution
- Sodium Hypochlorite (chlorine bleach), 5% solution
- Sodium Hypochlorite (chlorine bleach), 10% solution prepared within 24 hours
- Antibacterial soap and water.
- Cidex®
- Windex®
- Lysol®

Step 3. Wipe all cleaned surfaces with distilled water to remove any residue.

Step 4. Allow to air-dry or dry with a non-lint producing cloth.

Wiping the Battery Compartment

Under normal operation, the battery compartment should not require frequent cleaning. However, if it must be cleaned, use the following procedure.

Step 1. Remove the battery and any cables or accessories.

Step 2. Wipe the battery compartment clean by using a cloth dampened lightly with one of the following approved cleaning agents:

- Isopropyl Alcohol
- Ethyl Alcohol
- Hydrogen Peroxide, 3% solution
- Sodium Hypochlorite (chlorine bleach), 5% solution
- Sodium Hypochlorite (chlorine bleach), 10% solution prepared within 24 hours

Step 3. Wipe all cleaned surfaces with distilled water to remove any residue.

Step 4. Allow to air-dry, or dry with a non-lint producing cloth.

Caution

Do not use soap and water, Cidex®, Windex®, or Lysol® inside the battery compartment. These cleansers can damage the battery compartment.

Wiping the Battery Extender

The battery extender should be removed from the transmitter and power source before cleaning or disinfection. Wipe the battery extender using the following procedure:

Step 1. Disconnect the power module from the power source and remove the cradle from the transmitter.

Step 2. Wipe the battery extender with a cloth dampened lightly with one of the following approved cleaning agents:
- Isopropyl Alcohol
- Ethyl Alcohol
- Hydrogen Peroxide, 3% solution
- Sodium Hypochlorite (chlorine bleach), 5% solution
- Sodium Hypochlorite (chlorine bleach), 10% solution prepared within 24 hours

Step 3. Wipe all cleaned surfaces with distilled water to remove any residue.

Step 4. Allow to air-dry, or dry with a non-lint producing cloth.

Caution

Do not use soap and water, Cidex®, Windex®, or Lysol® on the cradle, wires, or aqua connector because they can cause damage.

Soaking the Transmitter & Cradle

The transmitter can also be soaked for up to 5 minutes. The battery extender cradle, cradle wire, connector, and wall cable can also be soaked. However, the power module should **never** be immersed in any cleaning solutions.

Caution

DO NOT soak the power module of the battery extender.
The wall cable and connector can be soaked.

Soak the transmitter and battery extender (except the power module) using the following procedure:

Step 1. Detach the transmitter from the battery extender and remove the battery and any cables or accessories.
Remove the power module from the power source.

Step 2. Soak the transmitter and extender (except the power module) in one of the following approved cleaning agents for up to 5 minutes:
- Isopropyl Alcohol
- Ethyl Alcohol

Step 3. Dip all cleaned surfaces in a bowl of distilled water to remove residue.

Step 4. Dry the equipment with a non-lint producing cloth.

Caution

Do not soak equipment in cleaners other than Isopropyl Alcohol or Ethyl Alcohol.
Do not soak equipment longer than 5 minutes.
Soaking longer than 5 minutes or in cleaners other than Isopropyl Alcohol or Ethyl Alcohol can cause severe damage.

Cross-infection Prevention for the Transmitter & Battery Extender

The procedure for cross-infection prevention for a Philips transmitter and battery extender requires the following 3 steps:

1. Cleaning the Transmitter and Battery Extender
2. Cross-infection Prevention and Aeration
3. Testing the Equipment

Note After the following procedure is completed, a cross-infection prevention assurance level of 10E-6 is achieved.

If there is concern about cross-contamination due to lead sets or the sensor, new lead sets or sensor should be used.

Cleaning the Transmitter and Battery Extender

The first step in cross-infection prevention is ensuring that the equipment to be processed is clean. See Cleaning the Transmitter & Battery Extender on page 3-4 for cleaning instructions.

Cross-infection Prevention and Aeration

When the equipment is clean, it is ready for cross-infection prevention and aeration.

Note To complete this stage of the process safely, harmful residue gas must be dissipated through aeration.

Equipment and Materials

The following equipment and material are required to process the transmitter:

1. Ethylene Oxide (Allied Signal Oxyfume-2002™) -- hereafter referred to as EO.
2. Gas sterilizer -- made by American Sterilizer Company or other manufacturers.
3. Mechanical aerator -- The intake air for the aeration chamber must be routed through bacterial filters and the exhaust air must be vented outside the building.

Note Available combination sterilizer/aerators bypass the problem of personnel exposure to EO during transfer of treated material to a separate aeration cabinet.

Warning

EO is highly explosive, toxic, and a potential occupational carcinogenic and reproductive hazard. Handle it with extreme care, following U.S. Occupational Safety and Health Administration (OSHA) standards for EO (29 CFR 1910.1047)[1]. Personnel exposure and/or room air must be monitored per OSHA standards.

Vent sterilizer gas outdoors or to a suitable, evacuated container for reprocessing, depending upon state, provincial, or country environmental regulations.

Vent aerator exhaust only to the outdoors. Do not vent sterilized gas indoors.

Cross-infection Procedure

The following general procedure can be used to supplement the sterilizer and aerator manufacturers' instructions, although the processing times, temperatures, and pressure must be the same as those given in this procedure.

Step 1. Remove any obvious contamination from the equipment to be processed using approved cleaners.

Step 2. Individually package each transmitter and/or battery extender in standard central supply room (CSR) wrapping material secured with EO color-change indicator tape.

Step 3. Apply -26 inHg ± 1 (-12.77 psig ±.49) vacuum to the empty sterilizer chamber 2 times to remove any residual EO or moisture. Vent the vacuum pump to the outdoors to avoid toxic hazards to personnel.

Step 4. Insert the equipment to be processed into the gas sterilizer.

Step 5. Heat the chamber and its contents to 54.4 ± 2.8^{o}C (130 ± 5^{o}F).

Step 6. Apply -26 inHg ± 1 (-12.77 psig ±.49) vacuum to the sterilizer chamber.

Step 7. Humidify the chamber at 50% ± 10% relative humidity for 20 to 30 minutes.

Step 8. Taking a minimum of 5 minutes, slowly introduce EO sterilant until the sterilizer unit pressure gauge reaches 11 ± 1 psig.

Note

At this pressure, the concentration of sterilant in the chamber will be 600 ± 50 mg/liter, regardless of the chamber size.

Step 9. Process the equipment to be processed as follows:

Pressure: 11 ± 1 psig (established in the preceding step).
Time: 2-3 hours
Temperature: 54.4 ± 2.8^{o}C (130 ± 5^{o}F)

Step 10. Extract the gas mixture from the sterilizer as follows:

Warning

Comply with OSHA standards[1].

Do not vent sterilizer gas to the room, but vent only outdoors or to a suitable, evacuated container, depending upon state, provincial, or country environmental regulations. (If the mixture is captured, it can be separated commercially and the component gases re-used.)

---

a. Pump the gas mixture out of the chamber until a vacuum of -26 inHg ± 1 (-12.77 psig ±.49) is reached, returning the mixture to a suitable evacuated container.

b. Return the sterilizer chamber to ambient pressure by introducing air that has been bacterially filtered.

Step 11. Air-wash the chamber and material as follows:

a. Apply -26 inHg ± 1 (-12.77 psig ±.49) vacuum to the chamber and processed material again to remove residual EO. The vacuum pump must be vented to the outdoors.

b. Return the sterilized chamber to ambient pressure by introducing air that has been bacterially filtered.

Aeration Procedure

Warning

To avoid chemical burns and toxic effects, the equipment must be aerated after sterilization, as described below.

The aerator must have bacterial filters and outdoor venting.[1]

Aerate the processed equipment by doing the following:

Step 1. To dissipate residual EO, aerate the processed equipment with air that has been bacterially filtered, using a mechanical aerator or combination sterilizer/aerator as follows:2

Time: 8-9 hours

Temperature: 54.4 ± 2.8°C (130 ± 5°F)

Ventilation Frequency: At least 30 air exchanges per hour.

References

[1] OSHA Standard for acceptable levels of personnel exposure to Ethylene Oxide Gas: 1 ppm on an 8-hour time-weighted average basis.

Reference: U.S.A. Federal Regulations 49 FR 25734/29 CFR Part 1910.1047, June 22, 1984; final approval 50 FR 9800/2- CFR Part 1910.1047, March 12, 1985.

[2] These values will produce EO and Ethylene Chlorohydrin residual levels in the transmitter and patient cable plastic that meet ISO 10993-7 in conjunction with AAMI Technical Information Report 19, that the FDA currently endorses.

Testing the Equipment

This test verifies that patient information for both ECG and SpO_2 (if pulse oximetry is being monitored) appears at the Information Center and at the bedside. A patient simulator can be used with this procedure.

Caution **This test must be performed each time a transmitter and battery extender is put through the cross-infection prevention procedure.**

Note This test assumes the Telemetry System and Information Center are installed and that the transmitter Identity Code Learn procedure has been performed.

Test the transmitter by performing the following steps. If the test indications do not appear, refer to the appropriate service person.

Step 1. \Perform a mechanical inspection of the transmitter (connectors, battery door opening and closing, patient button).

Step 2. Select the telemetry bedside being tested at the Information Center.

Step 3. Test the transmitter as follows:

a. Put a fresh battery in the transmitter and close the battery door

Result: All 5 lead lights should flash and 1 light should remain on.

b. Attach a lead set to the ECG connector and attach an SpO_2 transducer to the SpO_2 connector. If an ECG simulator is available, attach the ECG leads to the simulator and the SpO_2 sensor to yourself. Set the SpO_2 sample rate to Continuous, either at the Telemetry Configuration Tool or Wave Viewer or by inserting the transmitter into the Telemon.

Result: An ECG trace and SpO_2 information should be visible on the Information Center screen. All transmitter lights should be off.

c. Disconnect the Right Arm lead for standard ECG or the “I” lead for the EASI transmitter for that lead.

Result: The RA LED on the standard ECG transmitter or the “I” lead for the EASI transmitter for that lead should turn on and a Leads Off INOP should appear on the Information Center.

d. Reconnect the electrode.

Step 4. Connect the TeleMon to the transmitter and observe the ECG waveform and SpO_2 numerics on the palmtop screen.

Result: The ECG waveform and SpO_2 numerics should be displayed on the TeleMon screen.

Step 5. Test the battery extender as follows:

a. Remove the battery from the transmitter.

b. Attach the cradle to the transmitter and plug the power module into a power source.

Result: All 5 lead lights should flash and 1 light should remain on.

Cleaning ECG Patient Cables and Leads

Caution

Always follow the specific instructions delivered with the cables/leads.

The information given here is intended as a guideline when specific cleaning instructions delivered with the cables/leads are not available.

Cleaning

To keep patient cables free of dust and dirt do the following:

Step 1. Clean the cables with a lint -free cloth, moistened with warm water (40oC/104oF maximum) and soap, a diluted non-caustic detergent, or one of the approved cleaning agents in Table 3-1.

Step 2. Remove any residue by wiping the cables with a cloth moistened with clean, warm water.

Step 3. Allow the cables to air dry or dry them with a lint-free cloth.

Note

If signs of deterioration or damage are noted, replace the cable; do not use it for further patient monitoring.

Table 3-1. Recommended Cleaning Agents and Brands

Cleaning Agent	Description
Soaps	mild soaps
Tensides	dishwasher detergents
Ammonias	dilution of Ammonia <3%, windowcleaner
Alcohol	Ethanol 70%, Isopropanol 70%, windowcleaner
Other	U.S.P. Lysol® Brand Disinfectant deodorizing cleaner (household, not industrial strength). For adhesive tape residue: Ease-Away (Wood Life Ltd., Franklin Park, IL).

Caution

Do not immerse or soak the trunk cable or leads.

Disinfecting

Philips Medical Systems recommends that patient cables be disinfected only when necessary or as determined by hospital policy to avoid long term cable damage.

Note

Philips Medical Systems makes no claims regarding the efficacy of these chemicals or this method as a means for infection control. Consult the hospital's Infection Control Officer or Epidemiologist.

Disinfect the cable by doing the following:

Step 1. Clean the cable as described in the preceding section.

Step 2. Wipe the cable with a cloth dampened with one of the following approved disinfecting substances:

- Isopropyl Alcohol 91% (only on shielded leads, not on trunk cables)
- Chlorine bleach diluted with water (no stronger than 10%)
- Hydrogen Peroxide
- Cidex[R] (Surgikos Division of Johnson & Johnson Co.)

Caution

Be very careful to keep these chemicals (especially solutions containing chlorine bleach) from contacting any metal parts, such as pins, sockets, or springs. Permanent damage to the plating and underlying metal can occur.

Do not immerse the leads.

Step 3. Wipe all cleaned surfaces with a soft cloth dampened with water to remove any residue.

Step 4. Dry with a non-lint producing cloth, and allow to air dry before use.

Sterilizing

Patient cables can be sterilized when required using Ethylene Oxide (EtO) gas. Before sterilizing, clean the items as described under Cleaning the Receiver Mainframe and Transmitters. Be certain that all safety precautions regarding aeration after EO exposure are followed.

Philips Medical Systems recommends that these products only be sterilized when necessary, or as determined by the hospital's policy, to help prevent long term damage to the cables leads, etc.

Note

Never autoclave or steam sterilize these products.

Never sterilize these products by pasteurization (hot water soak).

Cleaning SpO_2 Adapter Cables & Transducers

Adapter Cables

Regularly clean the adapter cable (M1943A) as follows.

Note

If signs of deterioration or damage are noted, replace the cable; do not use it for further patient monitoring.

Step 1. Disconnect the adapter cable.

Step 2. Wipe the cable with a cloth dampened with isopropyl alcohol.

Caution

Do not use bleaches containing Sodium Hypochlorite (chlorine bleach).

Do not immerse the adapter cable in liquid, as this can lead to incorrect SpO_2 readings.

Step 3. Wipe all cleaned surfaces with clean water to remove any residue.

Step 4. Dry with a non-lint producing cloth, and allow to air dry before use.

Reusable Transducers

Regularly clean the transducers (M1191A, M1192A, M1194A) as follows.

Note

If signs of deterioration or damage are noted, replace the transducer; do not use it for further patient monitoring.

Step 1. Remove the transducer from the patient and disconnect it from the transmitter.

Step 2. Wipe the transducer with a cloth dampened in a mild detergent solution, a salt solution (1%) or one of the following approved cleaning solutions:

- Mucasol (3%)
- Buraton (pure) Incidin (10%)
- Alcohol (70%)
- Cidex® (pure)
- Alconox (1.2%)
- Sporicidin (6%)
- Cetylcide (1.6%)

Caution

Do not use bleaches containing Sodium Hypochlorite (chlorine bleach).
Do not autoclave the transducers.

Step 3. Wipe all cleaned surfaces with water to remove any residue.

Step 4. Dry with a non-lint producing cloth, and allow to air dry before use.

4
Troubleshooting

Overview

Chapter 4 provides troubleshooting procedures for the Philips Telemetry System, including a list of possible error messages with solutions.

Chapter 4 covers the following topics:

Caution

If the troubleshooting procedure calls for disassembly of the transmitter, follow the detailed disassembly and reassembly procedures given in Chapters 5 and 6.

Failure to follow these procedures carefully can result in damage to the transmitter.

Note

Whenever parts are replaced in the system, verify the hardware and software compatibility of the repaired system.

Troubleshooting the telemetry system presents some unique challenges. These challenges arise from several assemblies that acquire signals, process them, and transmit/receive them. Problems can occur that result from failed hardware, application errors, or the RF environmental conditions outside of the product.

This section divides the problems into 3 areas:

1. Equipment malfunctions
2. Application faults
3. RF problems

Troubleshooting Map

This section presents symptoms that show up when faults occur. Each symptom has its own list of checks and procedures to troubleshoot the problem. Figure 4-1 is a representation of the symptoms included in this section and the subassemblies that can cause the symptom.

To most effectively use the information in this chapter, begin troubleshooting using the following steps:

Step 1. Identify the symptoms of the problem.

Step 2. Find in Figure 4-1 where the symptom is located. This location gives a clear visual representation of the section of the system being affected by the fault.

Step 3. Find in Table 4-2 the Troubleshooting Tool that most applies to the symptom. Follow the steps of the troubleshooting table until the problem is resolved.

Note CANNOT ANALYZE ECG and CANNOT ANALYZE ST are not telemetry INOPs. They are INOPs generated by the central station in response to a loss of the ECG signal. Eliminating the telemetry INOP typically also eliminates the central station INOPs.

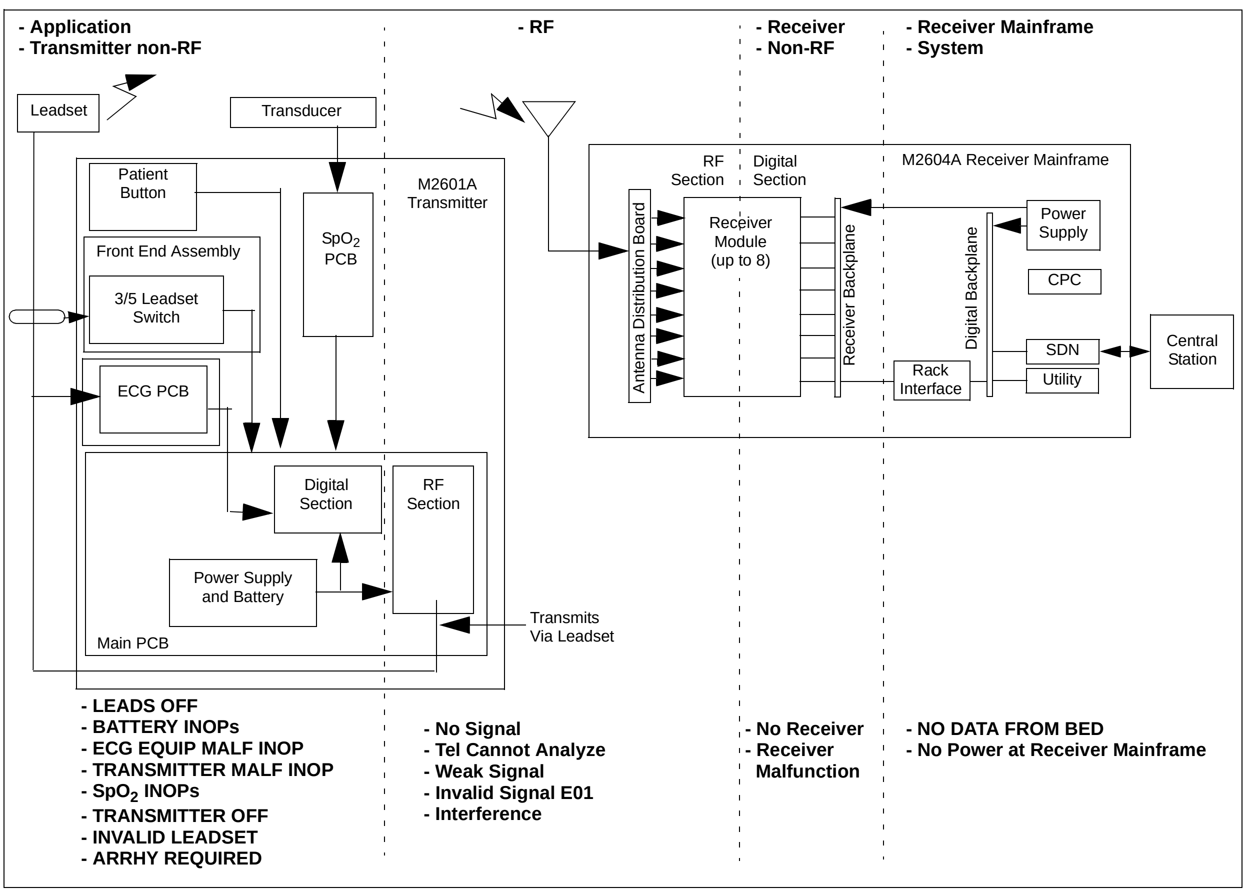


Figure 4-1 Philips Telemetry System Troubleshooting Map

Telemetry Troubleshooting Tools

There are several tools that can be used to troubleshoot the Telemetry System. Table 4-1 describes some of the tools and explains their uses. Table 4-2, Telemetry Subsystem Troubleshooting gives more details on how and when to use each tool.

Table 4-1. Troubleshooting Tools

Troubleshooting Tool	When Used	How Used
INOP messages and Block Diagrams	Useful for troubleshooting all types of problems. INOPs can be used with the system block diagram and lower level block diagrams to help determine the type of problem experienced.	The block diagram maps INOP messages seen at the central station to the portion of the system causing the INOP.
Transmitter Leads Off LEDs	Useful for troubleshooting problems related to the transmitter. This includes Application, Transmitter non-RF, and RF problems.	LEDs can tell about Leads Off situations and point to problems with power to the transmitter.
Transmitter Hardware Self-Test	Used for troubleshooting Transmitter non-RF problems. It runs automatically every time a battery is inserted.	Running self-test results in INOP messages that point to problems in the transmitter and exercises the transmitter LEDs.
Synthesizers in Transmitters and Receivers	Useful for troubleshooting RF and Transmitter non-RF problems. Can also be used to localize hardware problems.	Retune a suspect transmitter (receiver) to communicate to a known good receiver (transmitter) to determine if the product is bad.
Built-In RF Troubleshooting Tools (RF History Strip and RF INOP)	Used for troubleshooting RF problems. They can be used to determine RF problem type, to select clean frequencies, and, with the transmitter testbox, to troubleshoot antenna system hardware problems.	The RF History strip provides a 24 hour log for each channel of the RF signal strength vs. the amount of invalid data. The RF INOP is a real-time indication of the RF signal strength the receiver sees at the frequency it is tuned to. When used with the transmitter testbox, the gain through the antenna system or the power output of a transmitter can be determined.
Transmitter and Mainframe Service Tools and Service Screens at the Central Station	Used for general troubleshooting	Provides configuration, revision, product status information, etc.

Table 4-1. Troubleshooting Tools

Troubleshooting Tool	When Used	How Used
Transmitter Testbox	Used for troubleshooting RF problems. It can be used with the built-in troubleshooting tools to troubleshoot antenna system hardware problems. It can also be used with the built-in RF troubleshooting tools to determine transmitter hardware problems.	Provides a stable RF signal, which, when used with the built-in RF troubleshooting tools, can determine the gain through the antenna system or check the power output of a transmitter.
Antenna System LEDs	Used for troubleshooting RF problems. They are particularly useful to isolate faults to the antenna system. They can also be used at installation to verify the antenna system installation.	The green or yellow LED on all active components indicates that the device has power. The red LED on the antenna/ combiner indicates that the antenna/combiner has been installed backwards.

Subsystem Troubleshooting

This section describes how to isolate faults in failed subassemblies within the Telemetry System. Table 4-2 gives the Problem Area and the Symptoms that can be observed that indicate the problem along with the Page where descriptions of possible causes and actions that can be taken to resolve the problem are given.

Note For further information about using INOP Logs, Status Logs, and Error Codes, see Appendix E in the back of the manual.

Table 4-2. Telemetry Subsystem Troubleshooting

Problem Area	Symptom	Page
Application/Transmitter Non-RF	LEADS OFF INOP	4-6
Application/Transmitter Non-RF	TRANSMITTER OFF INOP	4-7
Application/Transmitter Non-RF	INVALID LEADSET INOP	4-7
Application/Transmitter Non-RF	NO SIGNAL INOP and an RF OUT OF LOCK INOP at Wave Viewer	4-8
Application/Transmitter Non-RF	Battery INOPs	4-8

Table 4-2. Telemetry Subsystem Troubleshooting

Problem Area	Symptom	Page
Application/Transmitter Non-RF	ECG EQUIP MALF INOP	4-12
Application/Transmitter Non-RF	TRANSMITTER MALF INOP	4-11
Application/Transmitter Non-RF	ARRHY REQUIRED INOP	4-11
Application/Transmitter Non-RF	EQUIP MALF INOP	4-12
Application/Transmitter Non-RF	ERRATIC INOP	4-12
Application/Transmitter Non-RF	INTERFERENCE INOP	4-12
Application/Transmitter Non-RF	NO TRANSDUCER INOP	4-13
Application/Transmitter Non-RF	NOISY SIGNAL INOP	4-13
Application/Transmitter Non-RF	NON-PULSATIL INOP	4-13
Application/Transmitter Non-RF	TRANS MALF INOP	4-13
Receiver Mainframe/ System	Power Does Not Come On when Receiver Mainframe is Plugged In	4-14
Receiver Mainframe/ System	NO DATA FROM BED INOP	4-14
Receiver Mainframe/ System	NO RECEIVER INOP	4-18
Receiver/Non-RF	RECEIVER MALF INOP	4-19
Other Problems	Pressing the Transmitter Button Does Not Give the Desired Result	4-20
RF Troubleshooting	INVALID SIGNAL E01 INOP	4-24
RF Troubleshooting	Frequent Dropouts and NO SIGNAL, WEAK SIGNAL and TEL CANNOT ANALYZE INOPs on a Single Channel	4-25
RF Troubleshooting	Frequent Dropouts and NO SIGNAL, WEAK SIGNAL, and TEL CANNOT ANALYZE INOPs with Multiple Channels	4-29
RF Troubleshooting	Frequent Dropouts and TEL CANNOT ANALYZE and INTERFERENCE INOPs	4-30
Analog Output	Analog Output Troubleshooting	4-64

Transmitter Non-RF/Application Problems

LEADS OFF INOP

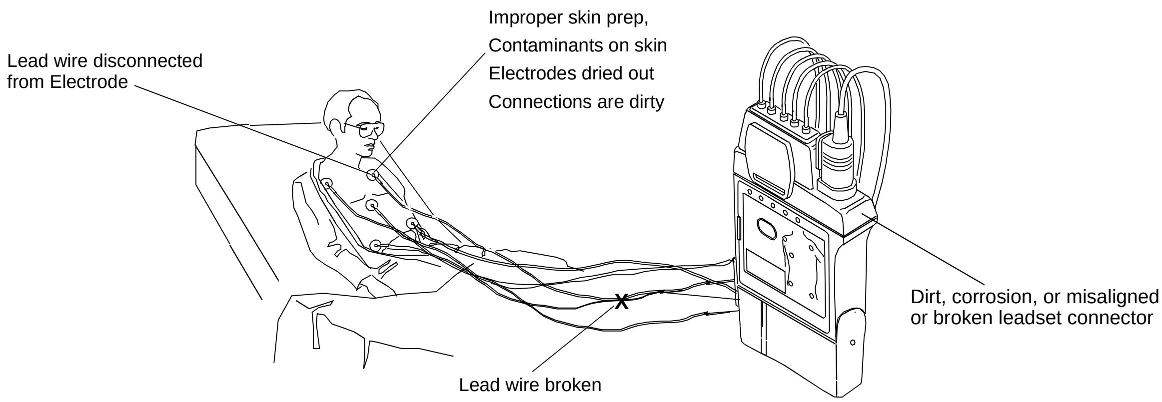


Figure 4-2 Troubleshooting Overview of LEADS OFF INOP

Each electrode has its own front end circuitry in the transmitter that routes the signal to the processing circuits of the transmitter. The transmitter sources an active signal for each connection. These signals are then combined to generate the transmitted leads: II, III, and MCL.

The LEADS OFF INOP generally means that one of the patient leads has fallen off the patient. It can also indicate a fault within the transmitter.

1. A lead may have become disconnected from the electrode. Go to the transmitter generating the INOP and make certain that all of the leads are connected to the electrodes on the patient's body. The LEDs on the front of the transmitter should be off if all of the lead wires are attached properly. If the leads are correctly connected, use the Wave Viewer at the bedside to make certain that there is a good waveform.

   The transmitter can also be connected to a patient simulator, if this is more convenient. Using the Wave Viewer, check the following:

   a. All of the available leads. If there is an ECG waveform and no LEADS OFF-Check Transmitter INOP on the Wave Viewer, the leads are connected.

   b. If there is not a good waveform, check the leads again and make certain they are applied properly before continuing with the procedures in this module. Proper application of electrodes includes:

      — Proper skin preparation.

      — Using "moist electrodes". If the gel on the electrodes is not moist, the electrodes are too dry to get a good signal.

      — Making certain the connections are not dirty.

2. If all of the leads are connected, and there is not a good signal, a lead wire may be broken or the connection between the leadset and the transmitter is compromised due to dirt or corrosion. Remove the leadset and make certain the leadset connector in the top of the transmitter is not dirty or corroded.

- If it is, clean or replace the connector.
- If there is no dirt or corrosion, make certain a leadset with a telemetry leadset combiner block with latch is used.
- Confirm that the leadset is securely attached (the leadset will click when it locks).
- Next, change the leadset. Check to see if this fixes the problem. If it does not, perform the following substeps:
  - Make certain the Front End Assembly to ECG PCB cable is connected (red tab connector) properly or not broken. If the cable is broken, replace the defective assembly (ECG PCB or the Front End Assembly).
  - Make certain the 3/5-Lead Switch connector is plugged-in properly. If it is, replace the ECG PCB.
  - If replacing the ECG PCB does not fix the problem, replace the Front End Assembly.

TRANSMITTER OFF INOP

A TRANSMITTER OFF message at the central station indicates that the transmitter has determined there has been a LEADS OFF condition on all leads for the last 10 minutes or longer and has gone into RF auto-shutoff.

1. Re-attach the leads to the patient. The transmitter will turn on automatically.

INVALID LEADSET INOP

This message indicates that the transmitter has either detected a 4-wire leadset or that an EASI ECG transmitter has a 3-wire leadset attached. Do the following:

1. If a 4-wire leadset has been installed, monitoring is not possible. Replace with a 3 or a 5 wire leadset.
   a. If the transmitter is a standard ECG transmitter, replace with a 3- or 5-wire leadset.
   b. If the transmitter is an EASI ECG transmitter, a 5-wire leadset must be used.
2. If the transmitter is an EASI ECG transmitter, this INOP will appear if monitoring is attempted while a 3-wire leadset is attached to the transmitter. Attach a 5-wire leadset.
3. If this is a standard ECG transmitter, it may be configured as an EASI transmitter. The configuration of the EASI parameter can be checked using the transmitter Service Tool or the Wave Viewer, as follows:

   Transmitter Service Tool: Connect the Service Tool to the transmitter and move to Transmitter Configuration Screen Two.

TeleMon: Connect a 5-wire leadset to the transmitter and to an ECG simulator. Establish communication between the TeleMon and the transmitter.

If the ECG waveform is labelled EASI and has the lead selections AI, AS and ES, the transmitter is configured for EASI operation.

If the ECG waveform is labelled Lead and has the lead selections: I, II, III, aVR, aVL, aVF, MCL and V, the transmitter is configured for standard ECG.

If the transmitter is configured incorrectly, reconfigure it using the transmitter service tool.

4. If the problem is not solved by Steps 1 - 3, then there may be a problem with the leadset switches not being detected properly.
   a. Check where the leadset attaches for dirt and clean as necessary. Leadset switches are located next to the reference and chest (standard ECG) or reference and E (EASI) lead wires.
   b. The 3/5 lead switch may not be connected to the ECG PCB properly.
   c. Replace the Front-End Assembly
   d. Replace the Main PCB.

NO SIGNAL INOP and an RF OUT OF LOCK INOP at Wave Viewer

This message means that the transmitter has determined that the phase-lock loop in the transmitter is no longer functioning (This condition also generates a NO SIGNAL INOP at the Central Station). Replace the Main PCB.

Battery INOPs

This section tells how to deal with INOPs related to battery operation. These INOPs are:

BATTERY WEAK

REPLACE BATTERY

Normally, either one of these INOP messages simply indicates that the battery in the transmitter generating the message should be replaced. However, if the battery is replaced and the message still occurs, do the following.

Note Battery life depends on the transmitter being used, the battery type, and the SpO_2 sample rate (if monitoring SpO_2). Refer to the specifications in Appendix A of this manual for expected battery life.

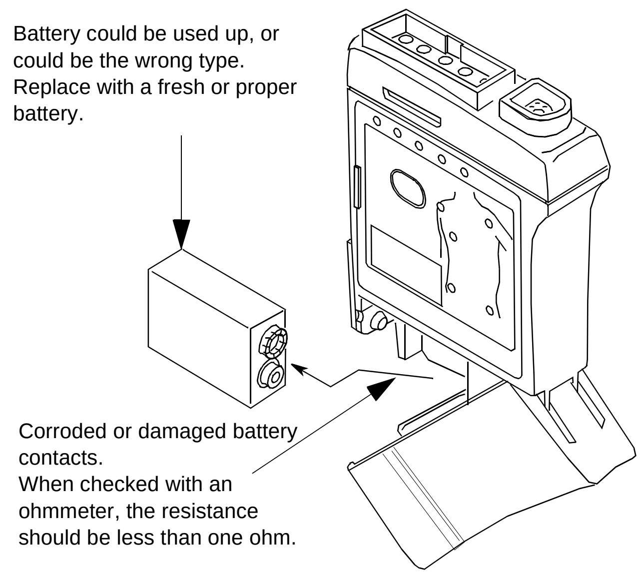


Figure 4-3 Troubleshooting Overview of Battery Problems

If the battery life is less than expected, some things to check are:

1. If the numbers are off, verify the SpO_2 sample rate using the TeleMon.
2. Remember that simply unplugging the SpO_2 transducer and turning the SpO_2 parameter off at the central station does not shut off SpO_2 sampling. The sampling rate must be set to Manual using the TeleMon.
3. Remove the batteries from the transmitter when they are not in use. The RF auto-shutoff feature does not save battery life because the circuitry is constantly checking to see if the unit has been connected to a patient.
4. The battery could be inserted improperly. Check the terminals of the battery to be sure they are oriented correctly with the battery contacts.
5. Open the battery door and check the battery contacts. Also, check the screws that connect the battery contacts to the Case Assembly.

   If they are corroded, clean them.

   If they appear damaged, replace the battery contacts.
6. Zinc-air batteries cannot be used in transmitters with SpO_2 hardware because zinc-air batteries cannot reliably supply enough current at start-up. Even if SpO_2 is not being monitored, if the transmitter has the SpO_2 hardware installed, a zinc-air battery cannot be used. A lithium or alkaline battery must be used.
7. Remove the battery and separate the case assembly from the transmitter's internal electronics (refer to Chapter 5, procedure To Remove the Case Assembly). Using an ohmmeter, check the resistance from the battery contact inside the case to its corresponding external battery contact. The resistance should be less than 1 ohm. If it is not, replace the battery contacts.
8. SpO_2 might be affecting the battery. Replace the SpO_2 PCB.

ECG EQUIP MALF INOP

The ECG EQUIP MALF INOP indicates one of two possibilities – a software incompatibility has been found or a fault has been detected in the ECG hardware in the transmitter.

1. If the transmitter is an EASI ECG transmitter, this INOP indicates that the software in either the receiver mainframe or the central station cannot process EASI ECG data. Perform one of the following actions:
   a. Update the software in the receiver mainframe and the central station to a compatible revision.
   b. Downgrade the transmitter firmware to a revision compatible with the mainframe and central station

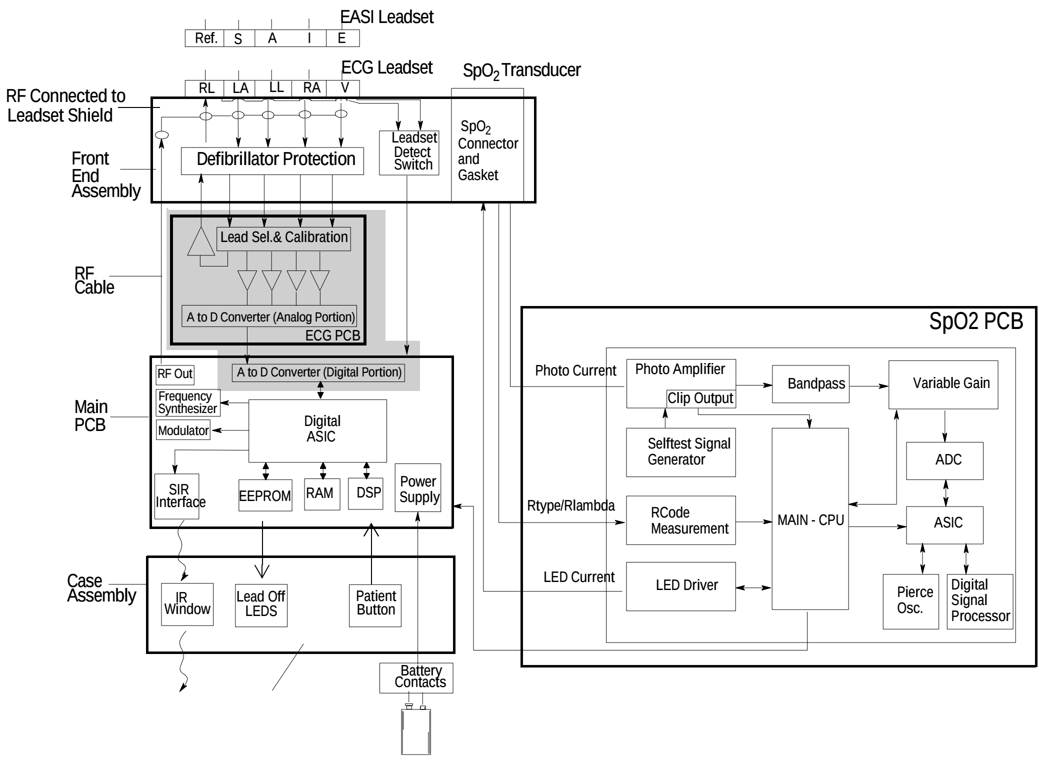


Figure 4-4 ECG EQUIP MALF INOP

The shaded area in Figure 4-4 shows the area in the transmitter where the problem is most likely to be occurring. To troubleshoot the transmitter, do the following:

1. If monitor SpO_2 can be monitored, replace the ECG PCB.
2. If changing the ECG PCB does not correct the problem, replace the Main PCB.

TRANSMITTER MALF INOP

This message indicates that self-test has discovered a problem with the internal, non-RF circuitry of the transmitter. The problem probably lies in the Digital ASIC or the RAM section of the Main PCB.

If this INOP occurs, replace the Main PCB. The shaded area of Figure 4-5 shows the area in the transmitter where the problem is probably occurring.

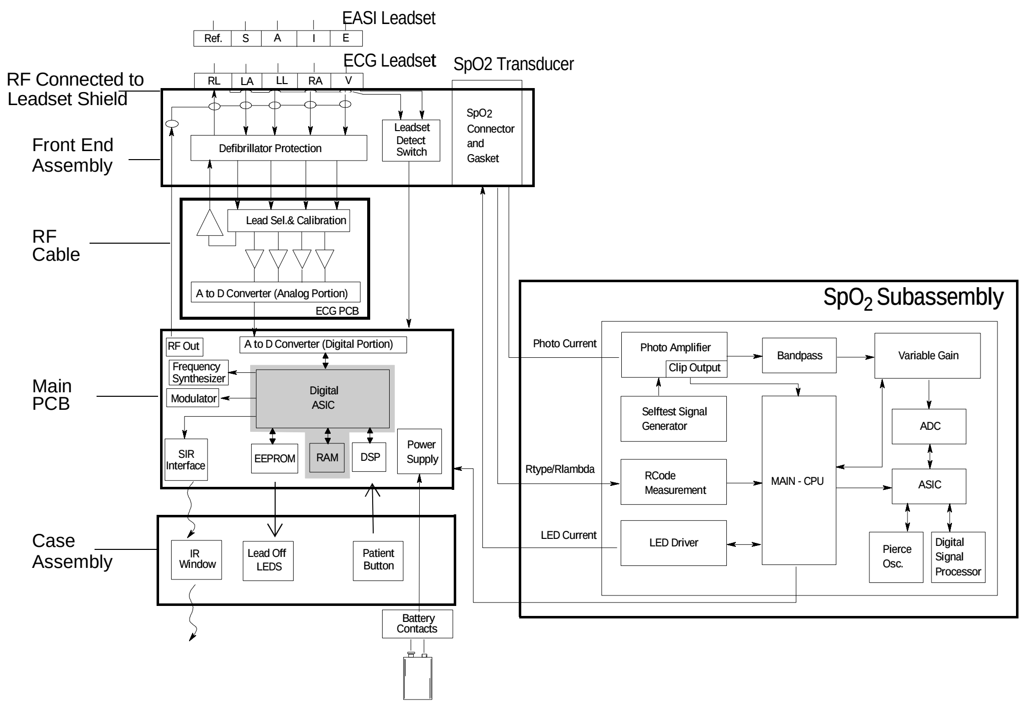


Figure 4-5 TRANSMITTER MALF INOP

ARRHY REQUIRED INOP

This message indicates that arrhythmia monitoring has been turned off for an EASI ECG transmitter.

1. Turn on arrhythmia monitoring at the Information Center.
2. If arrhythmia monitoring is not desired, then a standard ECG transmitter must be used.

Transmitter SpO_2 Problems

EQUIP MALF INOP

This message indicates there is a problem with the SpO_2 circuits associated with the transmitter. The following procedure describes how to troubleshoot this problem.

SpO_2 is a self-contained subsystem operating within the transmitter. It has its own sensor and sensor cable, which connects to the transmitter and provides a direct input to the SpO_2 board. Once the signal is processed, the SpO_2 digital signal is routed to the transmitter's Main PCB, where it is included in the transmitted message.

1. The transducer may be bad. Change the transducer to see if this solves the problem.
2. The SpO_2 adapter cable may be faulty. Replace the cable.
3. Open the transmitter and make certain that the SpO_2 connector cable is connected to the SpO_2 board. Make certain it is not damaged. If the cable is damaged, replace the Front End Assembly.
4. Make certain that the Main PCB to SpO_2 Board ribbon cable is connected properly and is not damaged. If the cable is damaged, replace the Main PCB.
5. Replace the SpO_2 Board.
6. If the problem still exists, replace the Main PCB.

ERRATIC INOP

This message indicates that SpO_2 measurements are erratic. This could be due to a faulty or incorrectly positioned the transducer. It could also be caused by optical shunting if the transducer is too big or too small. If this INOP occurs, do the following:

1. Verify that the transducer is appropriate for the patient's weight. If not, use a different transducer with the correct fit.
2. Make certain that the light source and the photodetector are opposite each other and that the light passes through the ateriolar bed.
3. Reposition the transducer to a site with higher perfusion.
4. Replace the transducer.
5. Replace the adapter cable.

INTERFERENCE INOP

This message can occur if the level of ambient light is so high that the SpO_2 transducer cannot measure SpO_2 or pulse rate. It can also be caused by an equipment malfunction. If this INOP occurs, do the following:.

1. Cover the transducer with a non-white, opaque material (e.g., pulse oximeter probe wraps - Posey wrap or equivalent). This may fix the problem and no further troubleshooting is necessary. If it does not, proceed.
2. Replace the transducer.
3. Replace the adapter cable.
4. This problem can also be caused by electrical interference. Reduce or remove any sources of electrical interference.

NO TRANSDUCER INOP

This message can occur if the SpO_2 transducer is disconnected, dirty, or broken. It can also be caused by a transmitter failure. If this INOP occurs, do the following:

1. If the transducer is disconnected, reconnect the transducer.
2. Replace the transducer.
3. Replace the SpO_2 Board.

NOISY SIGNAL INOP

This message can be caused by excessive patient movement or electrical interference, which is seen as irregular pulse patterns. If this INOP occurs, do the following:

1. Move the transducer to a site with less movement.
2. Reduce or remove any sources of electrical interference.

NON-PULSATIL INOP

This message can occur if the pulse is too weak or not detectable. Do the following to see if it corrects the problem:

1. Relocate the sensor to a site with improved circulation.
2. Warm the area to improve the circulation.
3. Try another sensor type.

TRANS MALF INOP

This indicates that the SpO_2 transducer is malfunctioning. Do the following:

1. Check to see whether the SpO_2 connector on the transducer or transmitter is dirty or corroded. Clean them if it is required.
2. Replace the transducer or adaptor cable.
3. Replace the Front End Assembly.

Receiver Mainframe/System Faults

Power Does Not Come On when Receiver Mainframe is Plugged In

1. The receiver mainframe power cord may be disconnected or connected to a bad source. Make certain that the power cord is plugged into the correct power source.
2. Check whether the green power-on LED on the rear of the Power Supply is lighted.
3. The power supply may be bad. Replace the power supply.

NO DATA FROM BED INOP

This message indicates that no information is going to the central station for a particular transmitter-receiver pair. To effectively troubleshoot this problem, make certain that the receiver mainframe is communicating with the SDN. This communication link determines the course of action. However, there is one other possibility to consider before re-booting the mainframe.

If the telemetry system is being used with a Philips Information Center, make certain that the telemetry bed(s) are not in Standby Mode. If the beds are in Standby Mode, this INOP is generated. Take the beds out of Standby Mode and the problem should disappear.

If NO DATA FROM BED INOPS occur intermittently, check the mainframe status logs for error codes. See Chapter 2 for information on how to access the logs and Appendix E for a list of the error codes.

Note Before performing the following procedure, make certain to check the receiver mainframe for power.

1. Check the overall operation of the receiver mainframe by re-booting it and observing the LEDs on the 40 MHz CPC card and Utility CPU board. To re-boot the mainframe, push the power button to halt power, then push it again to restore power. See Figure 4-6 for board location. The LEDs should behave shown in Table 4-3 and Table 4-4 .

Table 4-3. 40 MHz CPC Card

LED	Step 1	Step 2 (Normal Operation)
1 Red	ON	OFF
2 Green	ON	Slow Blink
3 Green	ON	Slow Blink

Note The 3 upper green LEDs on the Utility CPU are for the power supply and should remain GREEN whenever power is applied to the receiver mainframe.

Table 4-4. Utility CPU Board

LEDs	Step 1	Step 2	Step 3	Step 4 (Normal Operation)
1 Green	ON	ON	ON	ON
2 Green	ON	ON	ON	ON
3 Green	ON	ON	ON	ON
4 Green	ON	FAST BLINK	FAST BLINK	FAST BLINK
5 Green	ON	OFF	ON	OFF
6 Red	ON	OFF	OFF	OFF

The SDC cable has 3 data wires that enable communication between the devices using the SCC. The LDC cable has 3 data wires and 2 priority wires that allow communication between devices when there is no SCC.

If the Normal Bootstrap Sequence Occurs:

If the normal bootstrap sequence occurs, the receiver mainframe hardware is probably working correctly. This means the problem is elsewhere. Do the following to help isolate where the problem lies.

1. Check the SDN cable to see if it is missing or defective. If it is, replace or install a new cable as required.
2. Make certain there is not duplicate SDN beds. If there is, reconfigure the receiver mainframe for other branches or move the other bedside to another branch.
3. Make certain that 2 receiver mainframes do not have identical SDN Unit numbers. If they do, reconfigure a receiver mainframe with another SDN unit number.
4. If the system is non-SCC, an SDC cable may have been used instead of an LDC cable. Check the cable to make certain it is an LDC cable.
5. The breakaway board portion of the SDN board could be broken. Replace the SDN board.

If an Abnormal Bootstrap Sequence Occurs:

If an abnormal bootstrap sequence occurs, then the problem lies in the receiver mainframe. To troubleshoot the mainframe, do the following:

1. Remove power to the receiver mainframe and remove the 40 MHz CPC Card. Re-apply power to the receiver mainframe and observe the following LED pattern on the Utility CPU during the bootstrap routine:

Table 4-5. Utility CPU LED Pattern without the CPC Board Installed

LED	Step 1	Step 2	Step 3
Green 4	ON	FAST BLINK	FAST BLINK
Green 5	ON	OFF	SLOW BLINK
Red 6	ON	OFF	OFF

2. If the sequence in Table 4-5 occurs, the following list presents probable caused of the problem.
   a. Refer to the Philips Telemetry System Compatibility Matrix Service Note to verify compatibility between the Utility CPU and the CPC PCB.
   b. The 40 MHz CPC Card was in the wrong slot. Check the correct card placement and insert the 40 MHz CPC Card into the correct slot. The CPC belongs in the fourth slot from the left in the rear of the mainframe. (Refer to slot D5 of Figure 4-6.)
   c. The 40 MHz CPC Card is faulty. Replace it.
3. If the sequence does not occur, do the following:
   a. Remove the SDN board and re-initialize the receiver mainframe. If the sequence occurs, replace the SDN board.
   b. Remove the Rack Interface board and re-initialize the receiver mainframe. If the sequence occurs, replace the Rack Interface board. If the sequence does not occur, replace the Utility CPU board. If the Utility CPU is replaced, the EEPROM on the old PCB must be moved to the new PCB. The EEPROM must be the appropriate telemetry EEPROM for the product to work properly.
   c. If none of the above fixes the problem, replace the Digital Backplane.

Receiver Mainframe Board Location Diagram

R1-R8: Receiver Slots
D1: Rack Interface PCB
D2: Utility CPU PCB
D3: SDN Interface PCB
D4: Analog Output PCB
(optional)
D5: CPC PCB
D6: Unused
D7: Unused
D8: Power Supply PCB

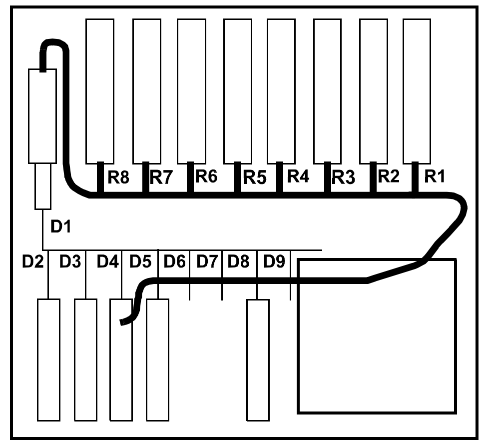


Figure 4-6 Receiver Mainframe Board Location Diagram

Receiver Non-RF Problems

NO RECEIVER INOP

This INOP is generated when the telemetry system does not detect a receiver present for a configured receiver slot. This problem can occur in 2 ways – in all or multiple channels or in a single channel. Depending on whether multiple or single channels are affected, corrective actions are different. If this INOP occurs, do the following:

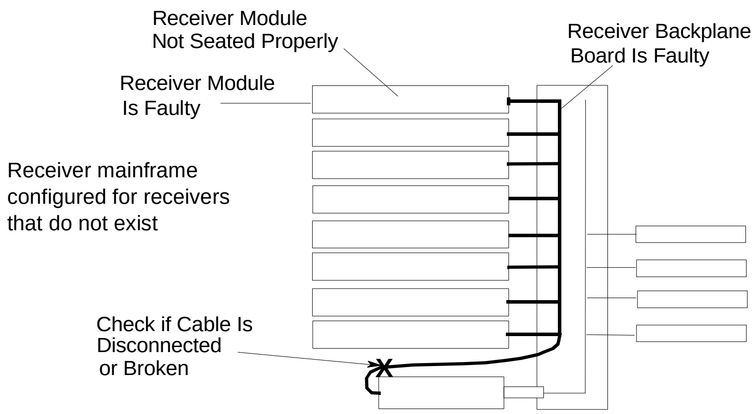


Figure 4-7 Troubleshooting Overview of NO RECEIVER INOP

If the problem is in a single-channel:

1. Check to see if the receiver module for the reporting slot is seated properly. If it is not, re-seat the module.
2. The receiver mainframe may be configured for receivers that do not exist. These are empty receiver slots with SDN branch assignments. Perform the following 2 steps to see if this fixes the problem.
   a. Check the configuration at the Central Station using the Telemetry Service Screen.
   b. Using the Telemetry Service Tool, reconfigure the receiver mainframe. For any empty receiver slots, assign a **0** to the SDN Branch Number.
3. The receiver module of the reporting channel is faulty. Replace the receiver module.
4. Check to see if the rack interface to the receiver backplane cable is disconnected or broken. Replace the cable if it is broken.
5. The receiver backplane is faulty. Replace the receiver backplane.

If the problem is in multiple channels:

1. Check to see if the rack interface to the receiver backplane cable is disconnected or broken. Replace the cable if it is broken.
2. Replace the Rack Interface PCB.
3. The receiver backplane is faulty. Replace the receiver backplane.

RECEIVER MALF INOP

This INOP is generated when a receiver is present for a configured slot (or slots) that is not working. This problem can occur in 2 ways -- in all or multiple channels or in a single channel.

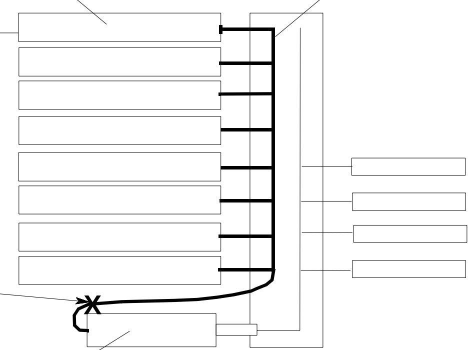


Figure 4-8 Troubleshooting Overview of RECEIVER MALFUNCTION INOP

1. If this INOP occurs, do the following:
2. Check to see if the receiver module for the reporting slot is seated properly. If it is not, re-seat the module.
3. The receiver module of the reporting channel or the receiver backplane is faulty. Exchange the positions of 2 receiver modules (make certain they are for the same frequency range).

   If the problem follows the receiver, it is faulty and must be replaced.

   If the problem stays with the slot proceed to Step 3. Replace the receiver module.
4. Check to see if the rack interface to the receiver backplane cable is disconnected or broken. Replace the cable if it is broken.
5. If the receiver backplane is faulty, replace the receiver backplane.
6. If the rack interface board is bad, replace the rack interface board.

Other Problems

Pressing the Transmitter Button Does Not Give the Desired Result

The receiver mainframe can be configured using the Telemetry Service Tool to respond to a Transmitter Button push in one of the following ways:

The function of the Transmitter Button is configured as part of the Receiver Mainframe configuration using the Telemetry Service Tool. The configuration affects all 8 patients. At the Central Station, the Transmitter Button can be disabled and enabled on a patient by patient basis.

- Start a recording for a patient at the Central Station by pressing the button.
- Generate a system alarm (short yellow) at the Central Station when the patient presses the button.
- Start a recording and generate an alarm at the Central Station when the patient presses the button.
- Do nothing. The Transmitter Button can be disabled.
- If a transmitter is set for intermittent SpO_2 measurements (manual mode, 1 min. and 5 min.), manual measurements from the transmitter can be initiated at any time using the Transmitter Button or Wave Viewer. SpO_2 must be turned on at the Central Station for alarms, display, and trending.

If the Transmitter Button is faulty, no INOPs occur at the Central Station.

1. Check that the Transmitter Button is not turned off (disabled) at the Central Station.
2. Using the telemetry Service screens available at the Central Station or the Telemetry Service Tool, make certain that the Transmitter Button is configured properly in the receiver mainframe. If it is not, configure it appropriately. See Chapter 2 for more information about checking the Mainframe configuration from the Central Station.

RF Troubleshooting

This section deals with troubleshooting problems in the RF portion of the Telemetry System. Troubleshooting RF problems presents unique problems because there are many confounding factors involved. With RF problems, a variety of causes can result in the same symptom, and a variety of symptoms can be the result of one cause.

The following paragraphs describe concepts that help when troubleshooting RF problems.

RF Problem Types

RF Problem INOPs

From the system block diagram of Figure 4-1, it can be seen that any problem that causes any of the following INOPs is an RF problem:

- NO SIGNAL
- WEAK SIGNAL
- TEL CANNOT ANALYZE
- INTERFERENCE
- INVALID SIGNAL E01

INVALID SIGNAL E01 is a special case of interference and is easily resolved. If this INOP occurs, go to INVALID SIGNAL E01 INOP on page 4-24.

An RF problem can be described as loss of monitoring capability due to signal corruption in the RF link (transmitter to antenna system to receiver).

CNR

Carrier-to-Noise Ratio (CNR) - At any time, the performance of the RF reception of the telemetry system depends on 2 factors -- the signal strength of the desired or “carrier” signal and the power level of any background RF activity or “noise” at the same frequency.

For the telemetry system to receive the RF signal without errors (corrupted or invalid data), the carrier power level must be at least 16 dB above the power level of any background noise. If data corruption occurs, it indicates that at that time, the CNR was less than 16 dB.

When RF data corruption occurs, the most obvious symptom is dropout of the ECG waveform.

The CNR can drop to less than 16dB for one or both of the following reasons:

- Low Signal — the signal strength of the carrier is lower than expected.
- Interference — the background noise level at the receiver frequency is higher than expected.

Ultimately, all RF problems within the system occur because of these reasons. Both problems can be identified using the INOP messages, the RF History Strip and the RF INOP. In addition to dropout of the ECG waveform, look for the following INOP messages and symptoms on the RF History Strip.

Low Signal Problems

See the following INOP Messages at Central Station:

- TEL CANNOT ANALYZE
- WEAK SIGNAL
- NO SIGNAL

RF History Strip Symptoms

- Low RF Signal Strength with frequent invalid data

Interference Problems

See the following INOP Messages at Central Station:

- TEL CANNOT ANALYZE
- INTERFERENCE

RF History Strip Symptoms

- Good RF Signal strength with frequent invalid data

A large part of this section is devoted to showing how to use these tools to identify whether there is a problem and how to isolate and remedy the situation.

Gathering Data

Gathering the information to troubleshoot a problem will probably account for at least 50 percent of the job in determining if in fact there is an RF problem. This section is divided into 3 main categories and are listed in the order they should logically be performed.

1. Observe system performance
2. Question the user
3. Check RF History Strips

Methodology

Observe System Performance

While telemetry monitoring offers many advantages, it can be a challenge. The reliability and quality of the signal transmission through the air and hospital walls is governed by a number of variables that can be difficult to control. A telemetry system cannot be as dependable as a hard-wired bedside monitor that transmits its signal through a wire. This is because signals travelling through a wire are not subject to factors in the RF environment. The effects of problems in the RF environment on the telemetry system range from a momentary loss of ECG to complete inoperability, depending on the situation. While momentary loss of ECG is to be expected, frequent, extended periods of signal loss need to be investigated.

Warning **Telemetry should not be used for primary monitoring in applications where the momentary loss of the ECG is unacceptable.**

Observe the system in operation and ask the following questions:

- Does the system operation appear normal?
- If not, what seems abnormal about it?
- What INOPs are occurring?

Question the User

Determining exactly what the operator is complaining about can be difficult. Some operators have had their expectations set incorrectly and do not understand the limitations of telemetry. But most operators are complaining about a real problem. The following checklist can be of assistance when questioning the user.

1. If the problem was observed during system operation, confirm that they are the problems of which the operator is complaining.
2. Has the system always had these problems or are they a recent development?
3. Is the symptom occurring on 1 channel, some channels, or all channels?
4. Is the symptom occurring in a specific area or place?
5. Is the symptom continuous or intermittent?

6. How long does the symptom last?
7. How often does the symptom occur?
8. Does the symptom occur only at specific times?
9. Does the symptom have “quiet” and “noisy” periods?
10. Does the operator have recording strips?

Check the RF History Strips

Refer to Analyzing RF History Strips on page 4-37 for information on how to check and use RF History Strips.

INVALID SIGNAL E01 INOP

An INVALID SIGNAL E01 INOP is a special case of interference. It indicates that the receiver has locked on to an M2601A transmitter, but the ID code the transmitter is broadcasting does not match the ID code stored in the receiver mainframe. If the message appears when a battery is installed in the corresponding transmitter, the Learn Code procedure must be performed. For more information on the Learn Code procedure, see Chapter 2.

If the message only appears when the corresponding transmitter does not have a battery installed, there is another M2601A transmitter broadcasting nearby at the same frequency. The frequency of one of the channels should be changed.

The transmitter-receiver pair recognize each other as follows. Each transmitter sends out an ID code or “spoof code” that uniquely identifies it to a receiver module. When the receiver module receives a signal at its set frequency, and the ID code matches, the receiver module accepts the signal. If the ID code does not match, an INVALID SIGNAL E01 INOP is generated.

The following analogy can be made. In the United States, the name John Smith is a very common name. Therefore, if looking in the phone listings for a John Smith, there would be quite a few of them. To find a particular John Smith, another piece of information would be needed. If the address of the John Smith being looked for was known, the desired John Smith could be matched with the correct address and the correct phone number found. Similarly, the receiver needs both the frequency of the transmitter and its ID Code also. When both match, the receiver receives the signal and the telemetry system works correctly.

Frequent Dropouts and NO SIGNAL, WEAK SIGNAL and TEL CANNOT ANALYZE INOPs on a Single Channel

These symptoms indicate that the signal being received has invalid or corrupted RF data and the signal strength is not at an acceptable level. The shaded area in Figure 4-9 shows the area in the transmitter where the fault is probably occurring, although the problem may lie in the receiver mainframe or elsewhere.

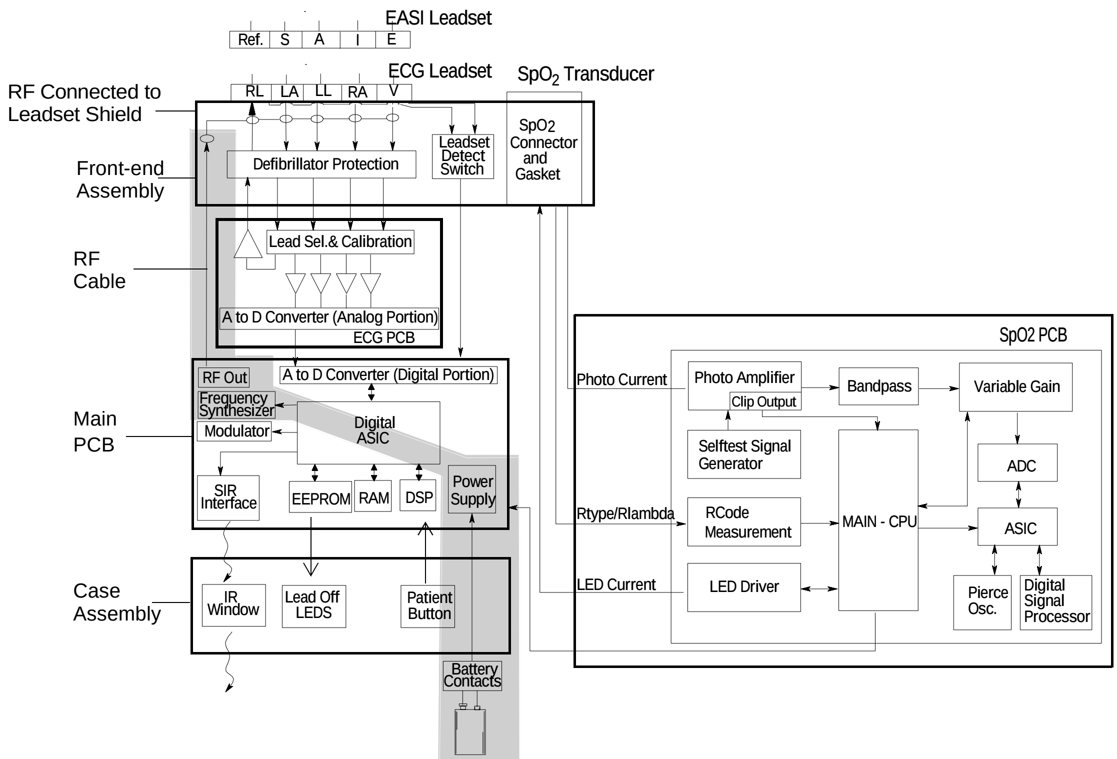


Figure 4-9 NO SIGNAL/WEAK SIGNAL INOP

To isolate this fault, do the following:

If the problem is occurring on a single channel:

1. If the INOP is intermittent or if there is intermittent operation of the leads off LEDs, complete the following substeps:
   a. Check to see if the battery contacts are corroded. If they are, clean or replace the battery contacts.
   b. Make certain the transmitter has both battery contact screws installed. If either of the screws is missing, replace it. (Screws are included in the battery contact kit).
   c. Check the transmitter case screw and make certain it is not loose. If this screw is loose, the battery contacts do not make a good connection with the internal electronics. See Chapter 6 for torque requirements.
2. The transmitter and receiver may not be set to the right frequencies.

- For systems operating between **406-480 MHz**, the transmitter and receiver must be set to the same frequency.
- For systems operating between 590-632 MHz (extended band) the combination of transmitter frequency, frequency converter option, and receiver frequency may be wrong. Check that the following equation is true for all installed channels:
- transmitter frequency – frequency converter option = receiver frequency
- If there are problems setting the frequencies, see Chapter 2.

3. If the frequencies are set properly, use the Wave Viewer to check the transmitter information. Refer to NO SIGNAL INOP and an RF OUT OF LOCK INOP at Wave Viewer on page 4-8.
4. Make certain the patient is in the antenna coverage area.
5. Check to see if the leadset is attached (the leadset is a broadcast antenna). The leadset wires must be shielded. The RF connection is made only to the shields.
6. The transmitter is not transmitting a signal. This can be the result of a dead battery or a power supply failure within the transmitter. To check if this is the problem, remove one of the leads from the patient and see if the corresponding leads off LED illuminates.

   If it does, proceed to Step 7.

   If it does not, complete the following substeps:

   a. Make certain that the battery is installed properly.
   b. Replace the battery with a fresh one.
   c. If using an ECG and SpO_2 capable transmitter (even if not monitoring SpO_2), make certain that a lithium or alkaline battery is being used. A zinc-air battery cannot be used with an ECG and SpO_2 capable transmitter. To check if the SpO_2 option is installed in the transmitter, look in the battery compartment. The option string 1SP indicates that the SpO_2 option is installed.
   d. Open the transmitter and make certain that the RF Cable is connected to both the Front End Assembly and the Main PCB. If it is not, connect it properly using the RF Cable seating tool and following the procedures for installing the RF Cable in Chapter 6.
   e. Replace the Main PCB in the transmitter.
7. The next step is to identify where the problem lies in the system. This can be done by following procedure.

Changing Frequencies to Troubleshoot Single-Channel Problems

One of the best troubleshooting features of the Philips Telemetry System is the ability to change the frequency in both the transmitter and receiver. This is invaluable in isolating a fault in a single channel, given that there is at least one other good channel. By changing frequencies, the fault can be isolated to one of the following:

- faulty transmitter
- faulty receiver
- bad frequency

The following procedure describes the method for using the changing of frequencies to isolate problems.

Given:

1. One **known bad channel** consisting of:

- Frequency 1
- Transmitter A
- Receiver A

2. One **known good channel**, consisting of:

- Frequency 2
- Transmitter B
- Receiver B

Isolate:

The fault to either Frequency 1, Transmitter A, or Receiver A

Figure 4-10 shows the “logic” for performing the procedure that follows. This procedure requires using Wave Viewer to change the transmitter frequencies and the Central Station to change the receiver frequencies. The Telemetry Service Tool can also be used to change the transmitter frequencies (**trtool**)) and the receiver frequencies (**mftool**). See Chapter 2 for information on changing frequencies.

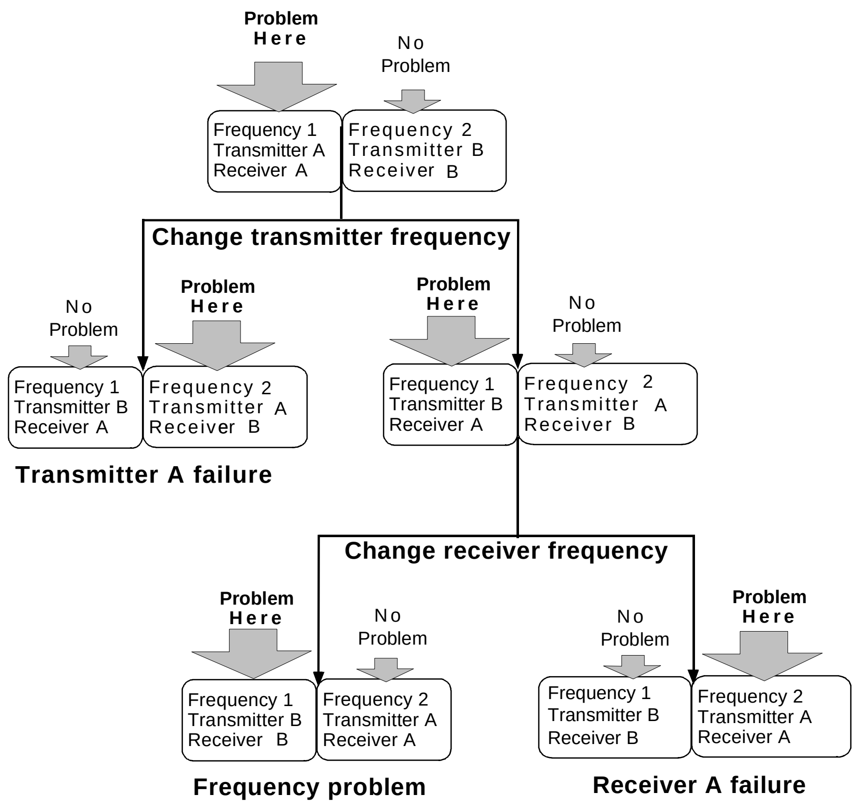


Figure 4-10 Changing Frequencies to Troubleshoot Single Channel Problems

Step 1. Change the transmitter frequency of Transmitter A to the frequency of the known good channel (Frequency 2). Change the transmitter frequency of Transmitter B to the frequency of the bad channel (Frequency 1). Observe what happens:

a. If the problem remains with Transmitter A, Transmitter A is faulty and should be repaired. Refer to Figure 4-9. The shaded area shows the area in the transmitter where the problems is probably occurring.

b. If the problem moves to Transmitter B, the problem is not in Transmitter A (transmitter of original bad channel). Proceed to Step 2.

Step 2. Since the problem is not in Transmitter A, either Receiver A or the frequency itself is faulty. To isolate between the two, first change the receiver frequency of Receiver A to the frequency of the known good channel (Frequency 2). Change the receiver frequency of Receiver B to the frequency of the bad channel (Frequency 1). Observe what happens:

a. If the problem remains with Frequency 1, the problem is in the frequency.The problem must be further isolated to the antenna system or the RF Signal environment. Either the Antenna System troubleshooting procedure must be performed or the RF History Strips evaluated.

b. If the problem moves to Frequency 2, the fault is in Receiver A. Before replacing the receiver, check the following:.
   - Make certain that the semi-rigid cable is connected correctly and not damaged. If the cable is suspected, swap it with one of the other cables in the mainframe and see if the problem switches to the other channel. If it does, replace the cable.
   - If the semi-rigid cable is okay, the receiver module may be bad. Exchange the receiver module with another one to confirm.
   - If the problem follows the receiver, replace the receiver PCB.
   - If the problem remains with the slot, replace the antenna distribution board in the receiver mainframe.

Frequent Dropouts and NO SIGNAL, WEAK SIGNAL, and TEL CANNOT ANALYZE INOPs with Multiple Channels

1. For extended band systems - See Step 2 of Frequent Dropouts and NO SIGNAL, WEAK SIGNAL and TEL CANNOT ANALYZE INOPs on a Single Channel
2. Check that the antenna system has power and that antenna/combiners, amplifiers, power tees, frequency converters, and filters all have their LEDs lit. If they do not:
   a. Check to see if a power tee circuit breaker has tripped due to a short in the system by resetting the circuit breaker
   b. If the system has failed while testing the hospital's emergency power, check that all power modules are plugged into emergency outlets.
3. Check that the patients are in the antenna system coverage area.
4. Check for hardware failures or installation problems with the antenna system and receiver mainframe by performing the Antenna System Troubleshooting Procedureon page 4-56. Tables describing faults and symptoms are provided in the procedures.

Note The antenna system used with a telemetry system operating in the extended band must be an M2613/14/15A or an M1413/14/15A/B antenna system that has been upgraded for operation in the extended band. Otherwise, the signal will be attenuated below an acceptable level. Upgrades typically consist of replacing the non-extended band antenna components (M14XXX series) with extended band compatible antenna components (M26XXX series).

The signal from the patient may be subject to shadowing, which is caused by RF blocking sources between the patient and the antenna. If the symptom is frequent NO SIGNAL or WEAK SIGNAL INOPs on a specific channel when the patient is in a particular room, the problem is probably shadowing. Check for RF blocking sources in the patient's area and, if possible, move them. If the blocking sources cannot be moved, the antenna must be repositioned. Contact a Philips Medical Systems service representative for assistance.

5. The antenna system may be inadequate. Contact a Philips Technologies service representative for assistance.

Frequent Dropouts and TEL CANNOT ANALYZE and INTERFERENCE INOPs

1. Print the RF History Strip for the problem channel and check for interference problems. Refer to Analyzing RF History Strips on page 4-37, for an example of interference problems.
2. Interference due to Heterodyning
   - Interfering signals can be generated if transmitters are stored with their batteries installed and close to other transmitters, for example in a drawer. The signal broadcasts into another transmitter where it mixes or heterodynes in the circuitry creating other frequencies that are then rebroadcast, interfering with other operating transmitters.
   - M2601A transmitters can be configured for RF auto-shutoff after 10 minutes of a leads-off situation.
   - Take the batteries out of all non-M2601A transmitters when they are not in use and configure all M2601A transmitters that have the RF auto-shutoff feature to NO.
3. Remove the battery from the problem transmitter and monitor the RF History Strip for that channel.

On-Channel or Narrowband Interference - is an interference source that occupies the same bandwidth as the transmitter and only interferes with 1 channel or 2 frequency adjacent channels.

It is likely that the channel is set to the same frequency as another telemetry unit. To correct this, change to a clear frequency or remove the interference source (refer to Monitoring a Channel for a Clear Frequency on page 4-55). Be certain to check for M2600A Telemetry Channels, M1403A Digital Telemetry channels, 78100/101A Analog Telemetry channels, and for M1310A and 80240A Fetal Telemetry channels. Also check for other radio devices such as walkie-talkies, paging systems, ambulance systems, etc.

Note

As the antenna system size increases, performance will degrade. This is because each active component (antennas, amplifiers, power tees, etc.) increases the noise floor of the system, reducing the system's CNR. In addition, with larger coverage areas and more antennas receiving signals, the chances of the antenna system picking up interfering signals also increase.

Broadband Noise - a broadband interference source occupies the bandwidth of many channels causing degradation of the CNR on all telemetry channels for as long as it is present. This results in an increase in dropouts and TEL CANNOT ANALYZE/INTERFERENCE INOPs on all of the channels. The system has quiet and noisy periods. When the noise source is on, the system is noisy. When the source is off, the system performs well.

To eliminate the problem, do the following:

1. Troubleshoot the problem as it occurs. Use RF History Strips and information from users to determine if there is a pattern to the episodes and how long they last. If there is a pattern, (e.g. every morning between 6 and 8 A.M., the first weekend of the month etc.) try to predict when the next occurrence will happen and prepare to troubleshoot.

2. Locate where the signal enters the system. Remove branches from the antenna system to see when the system quiets down. Remember that any patients that are being received by antennas that have been removed cannot be monitored. Refer to Figure 4-11, Isolating Broadband Interference, for a graphic representation of how to do this.
3. Remember! Sources can move, which makes troubleshooting more difficult. Work quickly.
4. Fix the system by eliminating or repairing the source. Relocate or permanently remove the antenna where the signal is entering. Some things to check for are:
   - failing fluorescent light ballast
   - vacuum cleaners
   - hand drills
   - electric pencil sharpeners
   - nurse call systems
   - vacuum tube delivery system motors
   - unused, unterminated, but still powered antenna systems
   - anything with a motor is suspect. Dirty motor brushes can arc and cause broadband noise.

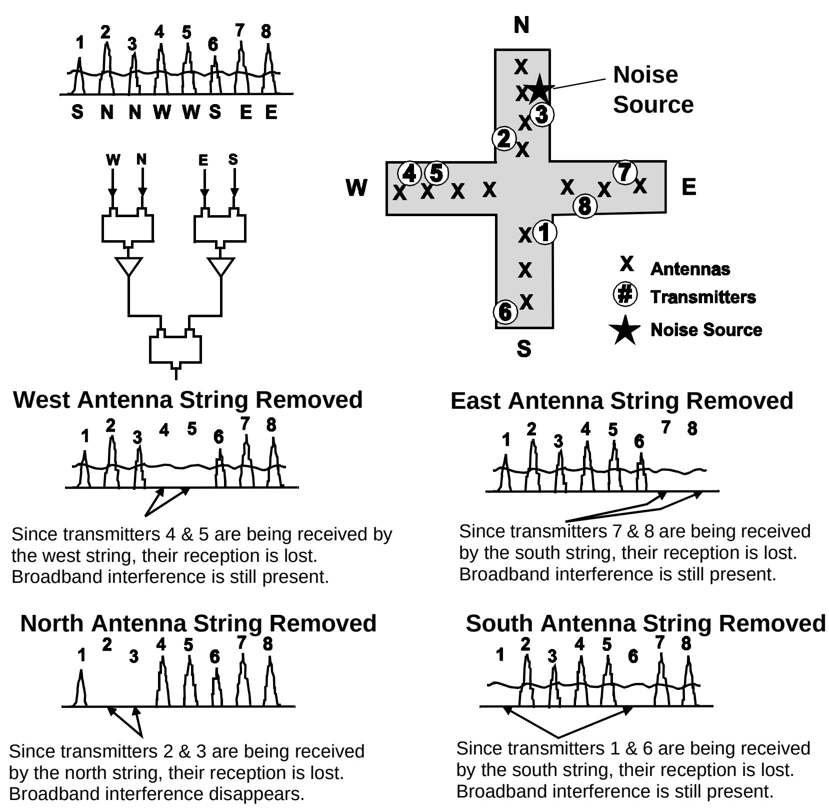


Figure 4-11 Isolating Broadband Interference

RF Troubleshooting Tools and Procedures

The Telemetry System provides 2 built-in tools to help with troubleshooting suspected RF link problems from the transmitter to the receiver -- RF INOP Real-time Data and RF History Strip Historical Data. The RF INOP or RF History Strip can be used along with the Transmitter Testbox for finding hardware failures and installation problems with the antenna system.

RF INOP Real-time Data

The **RF INOP** is a text message that appears in the sector for each bed on the Central Station display. It gives current RF link performance measurements at the Central Station and is part of the annotation for a requested strip recording.

The RF INOP uses the same reporting mechanisms as that of the Central Station to display INOPs. It has been assigned the lowest priority among messages using this reporting mechanism. If any other INOP or alarm condition exists, the RF Measurement Indicator is replaced by the INOP or alarm message.

The RF INOP, when enabled, is displayed in the alarm/INOP message field of the Central Station display. The format is ##HHH/LLL/(SSS) or, if there has been any corrupted RF data over the last minute, ##HHH/LLL/(SSS)NNN, where:

indicate that this is the RF Measurement INOP

HHH and LLL represent the RF Signal strength range over the last 5 minutes.

SSS represents the median value of the RF signal strength for valid data packets. Invalid data packets do not affect the value of the signal. The signal value represents the median value of the signal for the previous one minute of valid data.

NNN represents the median value of the RF signal strength for invalid data packets only. If no corrupted data occur, there is no NNN value. Valid data packets do not affect the value of noise. The value of noise represents noise for the preceding fifteen seconds of invalid data.

See Table 4-6 on page 4-34 for conversion of the received signal strength indicator (RSSI) value to power in decibel-milliwatts (dBm). For information on expected signal levels, see the discussion on the RF History Strip, Expected Performance on page 4-37.

The RF Measurement INOP can be turned on and off from the Central Station without leaving Monitoring mode. When an alarm or INOP condition occurs, the message for the alarm or INOP supersedes and replaces the text for the RF Measurement INOP. The exception to this is if one of the RF Performance INOPs occur (NO SIGNAL, WEAK SIGNAL, INTERFERENCE, TEL CANNOT ANALYZE). If an RF Performance INOP occurs while the RF Measurement INOP is enabled, then the RF Measurement INOP will be displayed. Refer to Chapter 2 for instructions on turning the RF Measurement INOP On or Off.

RF INOP Examples:

205/154(179) - indicates that over the last 5 minutes the received signal strength was typically between -55 dBm (205) and -79 dBm (154). Over the last minute, no RF data were corrupted (no noise value is reported) and the received signal strength was about -68 dBm (179 RSSI counts).

166/102 (154) 115 - indicates that over the last 5 minutes the received signal strength was typically between -74 dBm (166) and -98 dBm (102). Over the last minute when the RF signal was valid, the typical signal strength was -79 dBm (154). The RF signal was corrupted and the signal strength during those periods was down to -94 dBm (115).

RF History Strip Historical Data

The RF History Strip Recording provides long term RF link performance data. Data can be observed and trended from the RF History Strip Recording that can be printed from the Central Station without leaving Monitoring mode. The strip shows data reported on a minute-by-minute basis for the immediately preceding 24 hours. Therefore, the strip is a 24-hour log of corrupted data versus 24 hour signal strength. See Figure 4-12.

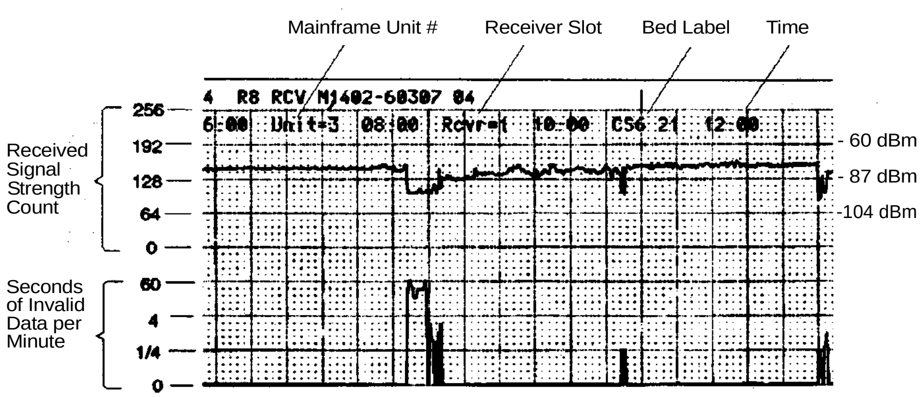


Figure 4-12 Example of an RF History Strip

The RF History Strip Recording contains the following aligned notation:

1. **Date** after the 24:00 time stamp.
2. **Time** stamp is given every 2 hours.The hour starts at the colon (:). Each small box is 5 minutes. 12 small boxes equal 1 hour.
3. **SDN Unit Number** of the recorded receiver mainframe
4. **Receiver Number** (Rcvr) which is the receiver slot being recorded for the respective receiver mainframe.
5. **Bed Label** for the receiver slot. This is the Bed Label assigned at the central station to the receiver slot.
6. **Marker between receivers**: The end of the RF History Strip for one receiver and the start of the strip for the next receiver is indicated by a short marker. (See Figure 4-13 for examples.)

This information is listed at the top of the received signal strength graph for the receiver module in the Receiver Mainframe being printed. Refer to Figure 4-12. The information above the grid lines can either be the mainframe Revision or the Status Log, depending on which screen was active when the RF History strip was requested.

The RF History Strip Recording gives signal strength and invalid data information on each receiver that is assigned in each Receiver Mainframe for the preceding 24 hour period.

The RF History Strip Recording can be requested from the central station without leaving Monitoring mode. Each request causes an RF History Strip for each receiver in a particular Receiver Mainframe. For information on how to print the RF History Strip, see Chapter 2.

Each RF History Strip Recording is a 2 channel stored recording. Each data point on the strip represents 1 minute of RF history. This means that at a recording speed of 25 mm, 1 inch of recorder paper contains about 2 hours of RF history. The following paragraphs describe how the information is presented on the strip and what it means.

Received Signal Strength

The RF History Strip Recording (see example in Figure 4-12) shows 2 graphs of the received signal. The upper graph, channel 1, shows the received signal strength for each receiver over time. The received signal strength, or RSSI count, is a value corresponding to the power of the signal in decibel milliwatts (dBm). Table 4-6 shows the relationship between RSSI count, and the actual power received for M2603A receivers with firmware Revision 2 installed. The RSSI count on the strip is the same value that appears in the RF INOP. The signal strength graph uses the top 4 large boxes on the recording strip.

Note

Received signal strength values from M1402A receivers and M2603A receivers with firmware Revision 1 are not calibrated.

Table 4-6. RSSI Count and Corresponding Power Level

RSSI Count	M2603A FW Rev 2 Power in dBm
255 (top major division on strip)	greater than -40
243	-40
230	-47
218	-51
205	-55
192 (next major division on strip)	-60
179	-68
166	-74
154	-79

Table 4-6. RSSI Count and Corresponding Power Level

RSSI Count	M2603A FW Rev 2 Power in dBm
141	-83
128 (next major division on strip)	-87
115	-94
102	-98
90	-101
77	less than -104
64 (next major division on strip)	less than -104
51	less than -104
38	less than -104
26	less than -104
13	less than -104
0 (lowest major division in upper graph)	less than -104

Note Approximate gain conversion from decibels (dB) to RSSI counts is:

$$1dB \approx 2.4 \text{ counts}$$

Invalid Data

The lower graph, Channel 2 of Figure 4-12, shows the number of invalid data packets received. Note that the invalid data are graphed logarithmically. Observing trends for particular receivers can indicate if a lot of invalid data packets are being received and what the signal strength is when invalid data packets are received.

Invalid data packets are graphed as a function of time. The graph shows the amount of invalid data packets (shown by the amplitude or height of the spike) and the duration of time the invalid packets are received (shown by the pulse width of the spike). Because some invalid data packets are expected and allowed during normal operation, all invalid data spikes do not mean that the system is operating poorly. Looking at the trace for Channel 2, the invalid packets are graphed using the bottom 3 boxes on the strip recording and are measured in seconds of invalid data per minute of monitoring.

Any spikes that remain in the bottom box indicate a low percentage of invalid data packets received and good receiver performance. As the amplitude of the spikes increase, the higher percentage of invalid data packets have been received. Spikes that reach the top of the third box, indicate an entire minute's worth of invalid data packets received.

For examples of what theses spikes represent from a user’s perspective, see the Performance Examples on page 4-50.

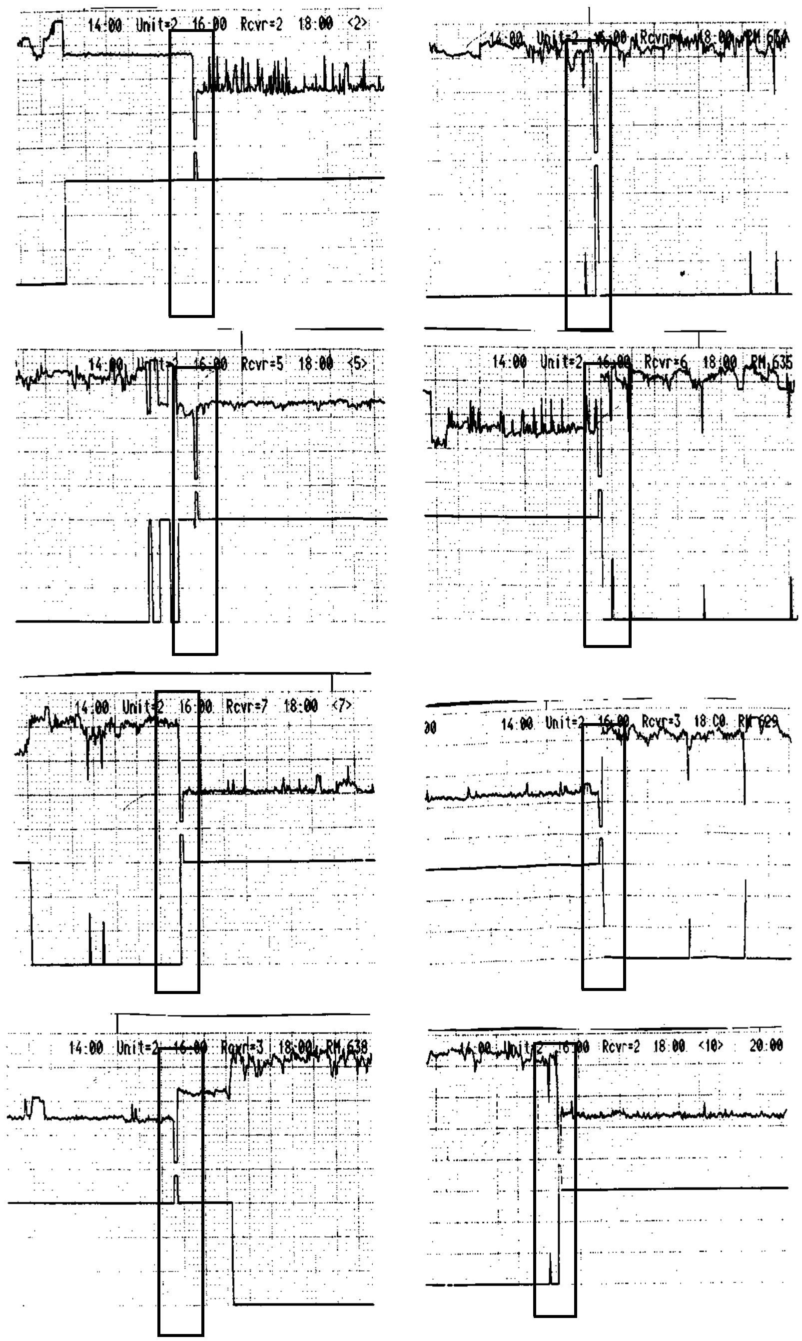


Figure 4-13 Example of a Marker to Separate Bed Data

Analyzing RF History Strips

RF History Strips can provide excellent insight into how the telemetry system is performing. This section gives some examples of the strips and the information they can provide.

Expected Performance

- A Mean Signal Strength of about -60 dBm (192 counts) is expected
- Dropouts are likely to occur if the signal strength drops below -87 dBm (128 counts)
- Signal strength “fades” of 30 dB are expected.
- A good noise floor measurement is about -100 dBm (90 counts)

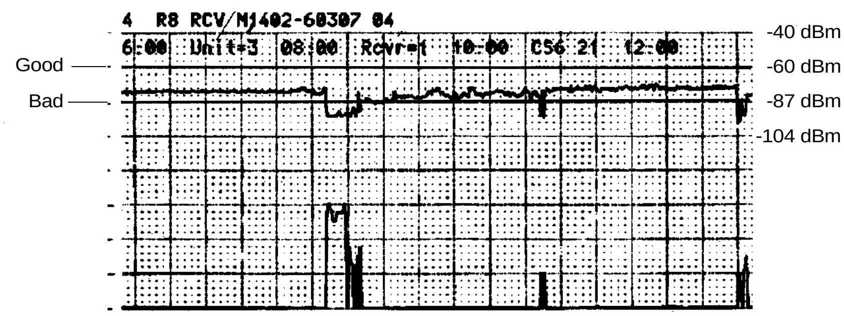


Figure 4-14 Boundaries of Good and Bad Data

RF History Strip - helpful hints:

- A 92% reduction on a copier will allow 24- hours of one channel to fit on an 8.5” x 11” sheet of paper.
- Draw lines at the -60dBm (Good) and the -87dBm (Bad) power levels on the RSSI plot.
- Examine the RF history strip and any other recording strips or wave review printouts and look for the following:
  - Is the signal strength where it is expected?
  - Does the time and number of “invalids” on the RF history strip correlate with any available ECG recording strips or wave review printouts?
  - What is the signal strength when “invalids” occur? Does this indicate corruption due to a low-signal strength or due to interference?
  - Are there specific channels exhibiting problems or are there patterns across channels?
- If the system includes M1403A Digital Telemetry channels, see Distinguishing M1400X Transmitters from M2601A Transmitters on page 4-49.

Example of No Receiver Installed in a Slot

Each of the strips shown in Figure 4-15 shows a “flatline” for both received signal strength at 0 counts and for invalid data at 0 seconds per minute. This indicates that there is no receiver installed in the slot. These strips provide no information for troubleshooting RF problems and can be discarded.

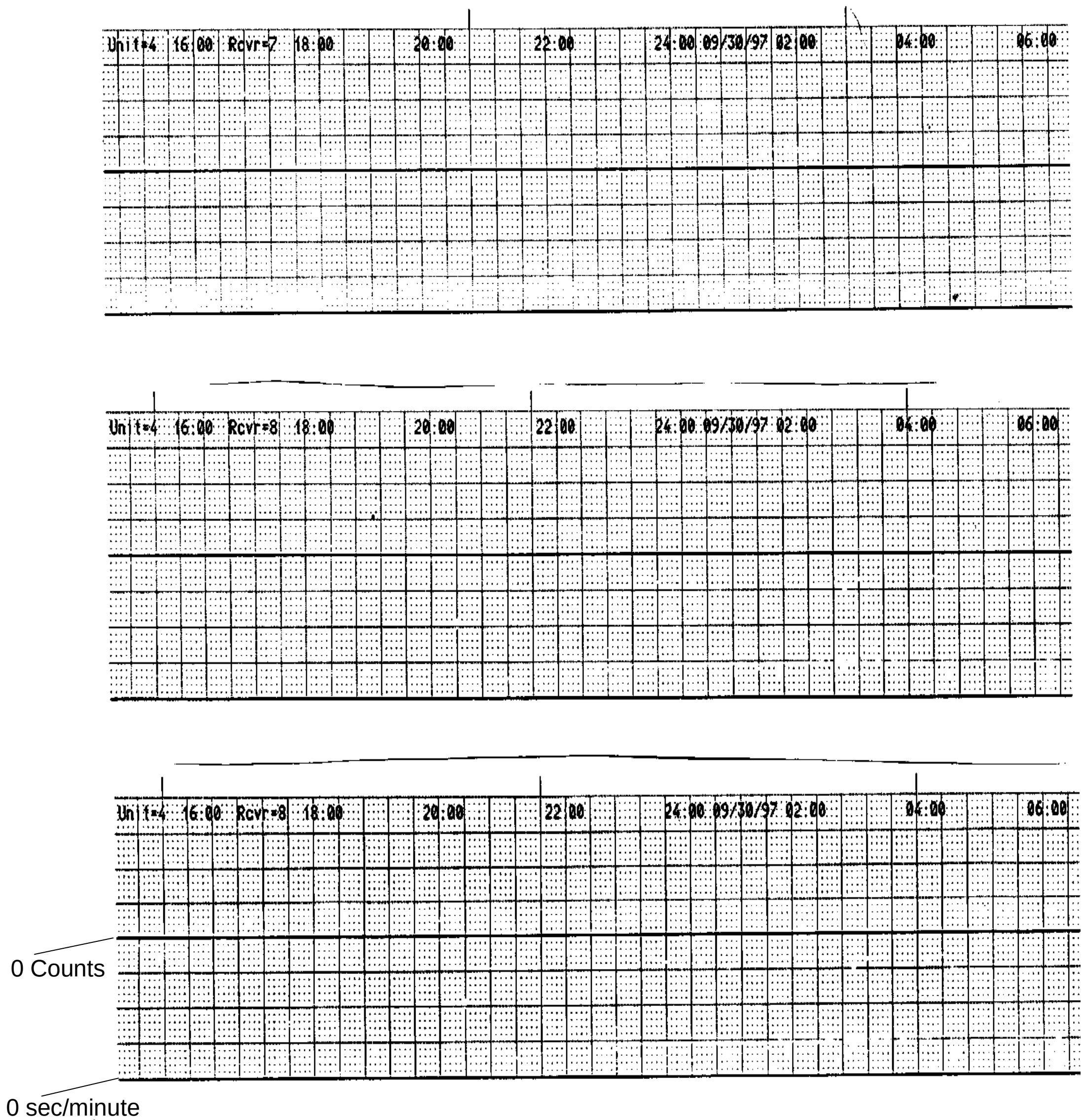


Figure 4-15 Example of No Receiver Installed in a Slot

Examples of Good Mean Signal Strength and Good Performance

The examples in Figure 4-16 show good performance of the telemetry system. In each strip, the received mean signal strength is at the expected level - approximately -60 dBm (192 Counts) (operating around the first box down from the top of the strip) and the seconds of invalid data are minimal (remaining on the bottom line or occasional spikes going into the first or second box). Although occasional spikes are seen in both areas of the recording, this is considered normal.

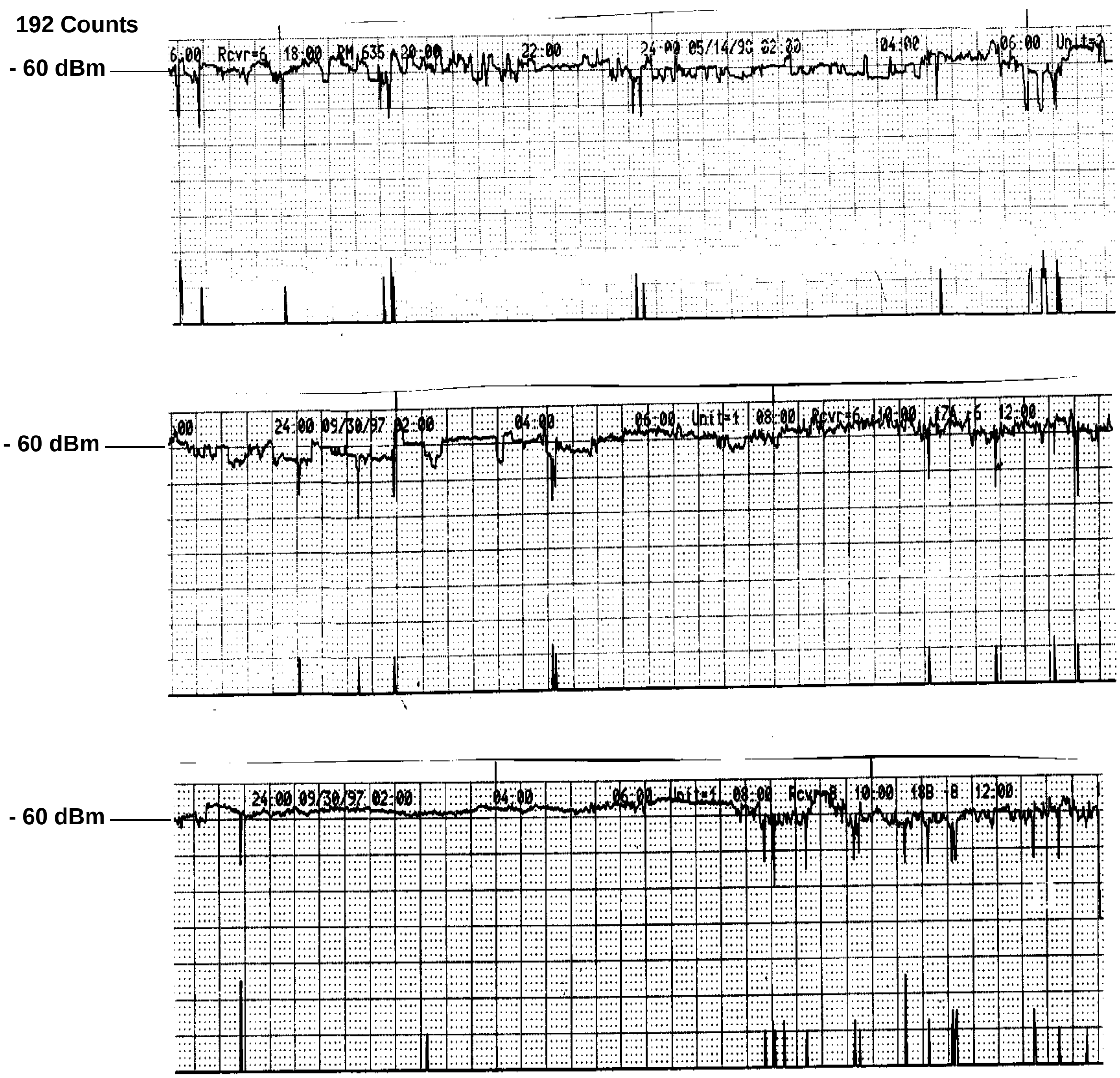


Figure 4-16 Examples of Good Mean Signal Strength/Good Performance

Examples of Low Signal Strength and Good Performance

The strips in Figure 4-17 show 2 different days (06 Feb 1998 and 23 Feb 1998) for the same room number (352A). The low signal (about 10-15 dBm below what is expected) seems to indicate coverage problems with this room. Because performance has not been impacted significantly, users may not notice.

If performance of the system is deemed unacceptable, the following corrective action can be taken:

1. Make certain that the area experiencing problems is within the coverage area of the antenna system. [Rule of thumb: within 32 feet (9.8 meters) of an antenna].
2. Check for large metal objects between the patient and the antenna. Reposition or add antennas if necessary (per Philips Medical Systems design rules).

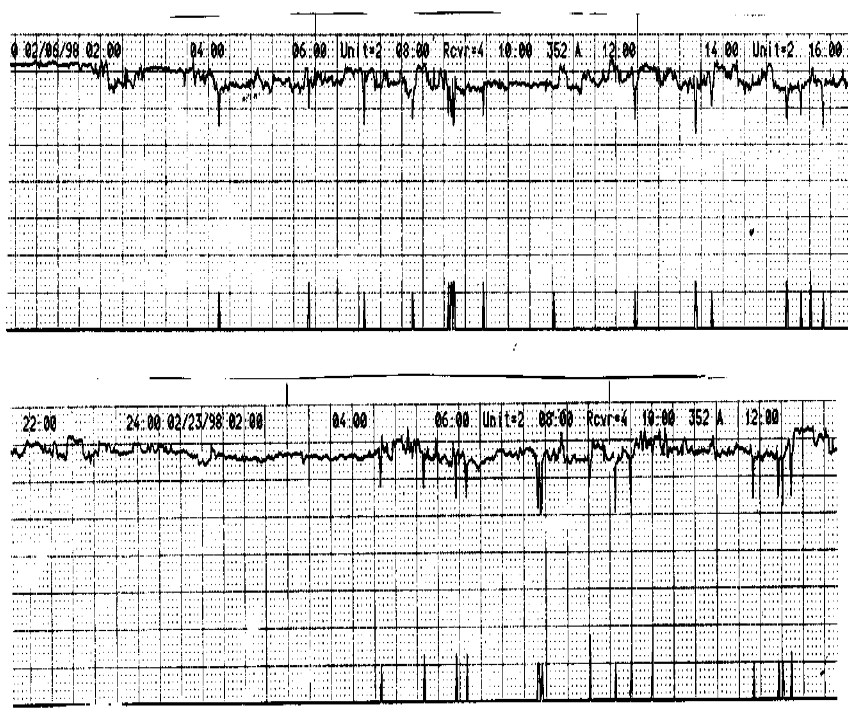


Figure 4-17 Low Signal Strength/Good Performance

Examples of Patient Leaving Coverage Area or Sleeping in an RF Null

RF Nulls are caused by the phenomenon of multipath propagation–multiple waves from the same transmitter arriving at an antenna at various amplitudes and phase angles. If there is not a lot of activity in the unit and the patient is not moving around, the RF signal can remain low causing lots of dropouts. This phenomenon is most easily explained using the following example: Occasionally, when stopping a car at a traffic light, the radio signal fades. After starting to move, however, the station comes in loud in clear. The car was simply in an RF null.

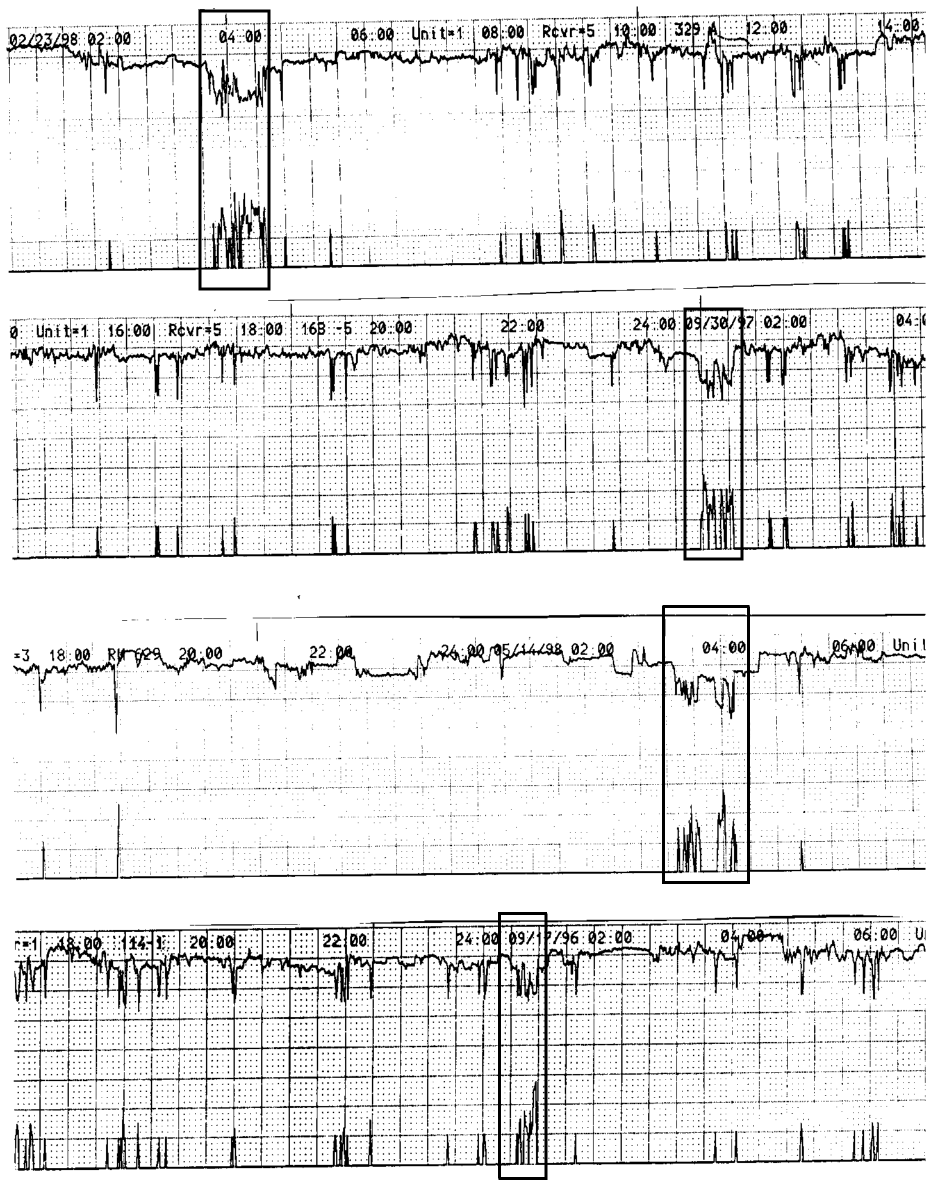


Figure 4-18 Examples of Patient Leaving the Coverage Area or Sleeping in an RF Null

If a patient is in an RF Null or has left the coverage area, the symptoms are essentially the same. Symptoms that can be observed on the strips to indicate that either of these situations exist are:

1. Mean signal strength is approximately -60 dBm for most of the day. This is a good signal strength.
2. Minimal invalid data during the periods when the signal strength is good.
3. Extended periods of weak signal strength (less than -87 dBm) with lots of invalid data.

These symptoms indicate:

1. The patient may have left the coverage area. Bring the patient back into the coverage area.
2. Patient may be in an RF Null. The user can correct this situation by moving the transmitter or patient about 6 inches (15 cm).

Problems due to Low Signal Strength

If the received signal strength is lower than expected for most of the day and there is a rise in the number of seconds of valid data received, there may be a true low signal problem.

Low signal problems would be due to:

- hardware
  - failures in the transmitter, antenna system, receiver or mainframe.
  - installation errors (amplifiers or antennas in backwards, disconnected or cut cables, etc.)
- Environmental problems
  - going beyond the defined coverage area
  - LMOs (Large Metal Objects)
- Antenna system design problems

Follow the procedures for frequent dropouts, NO SIGNAL,WEAK SIGNAL, and TEL CANNOT ANALYZE INOPS, Modules 25 and 26.

Examples of RF Auto Shutoff

The M2601A transmitter is designed to "shutoff" the RF signal if it detects a LEADS OFF condition on **all** of the ECG leads for longer than 10 minutes. This is to prevent problems with heterodying that can be created when unused transmitters are stored close together with batteries installed (for example, in a drawer).

When the RF is "shut off", invalid data go to 100% bad data, because the modulation is turned off, and it attenuates the RF signal by 30-50 dB. Figure 4-19 illustrates four examples of RF Auto Shutoff.

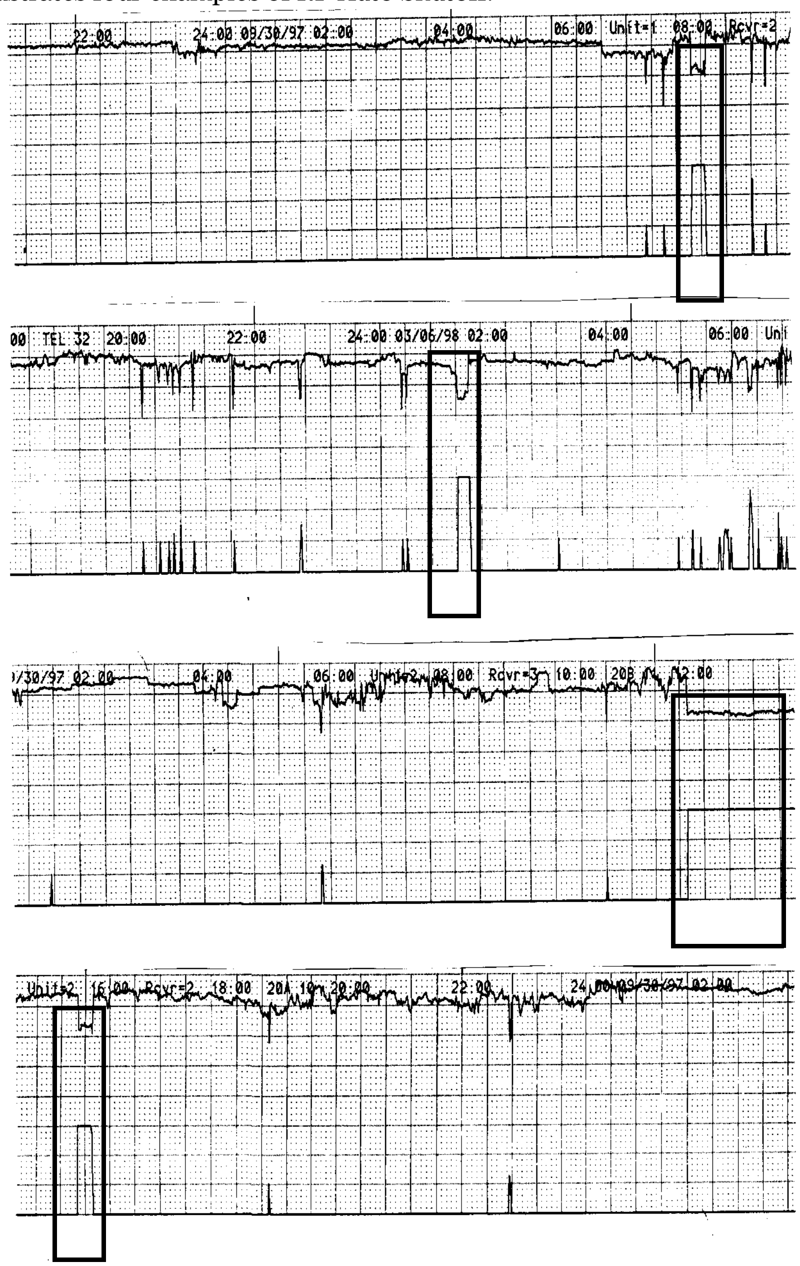


Figure 4-19 Transmitter RF Autoshutoff

High Power Narrowband Interference

With high power narrowband interference, there is good signal strength (-60 dBm), but invalid data and frequent dropouts occur. A narrowband interference source occupies the same bandwidth as the transmitter and only interferes with 1 channel or 2 frequency adjacent channels.

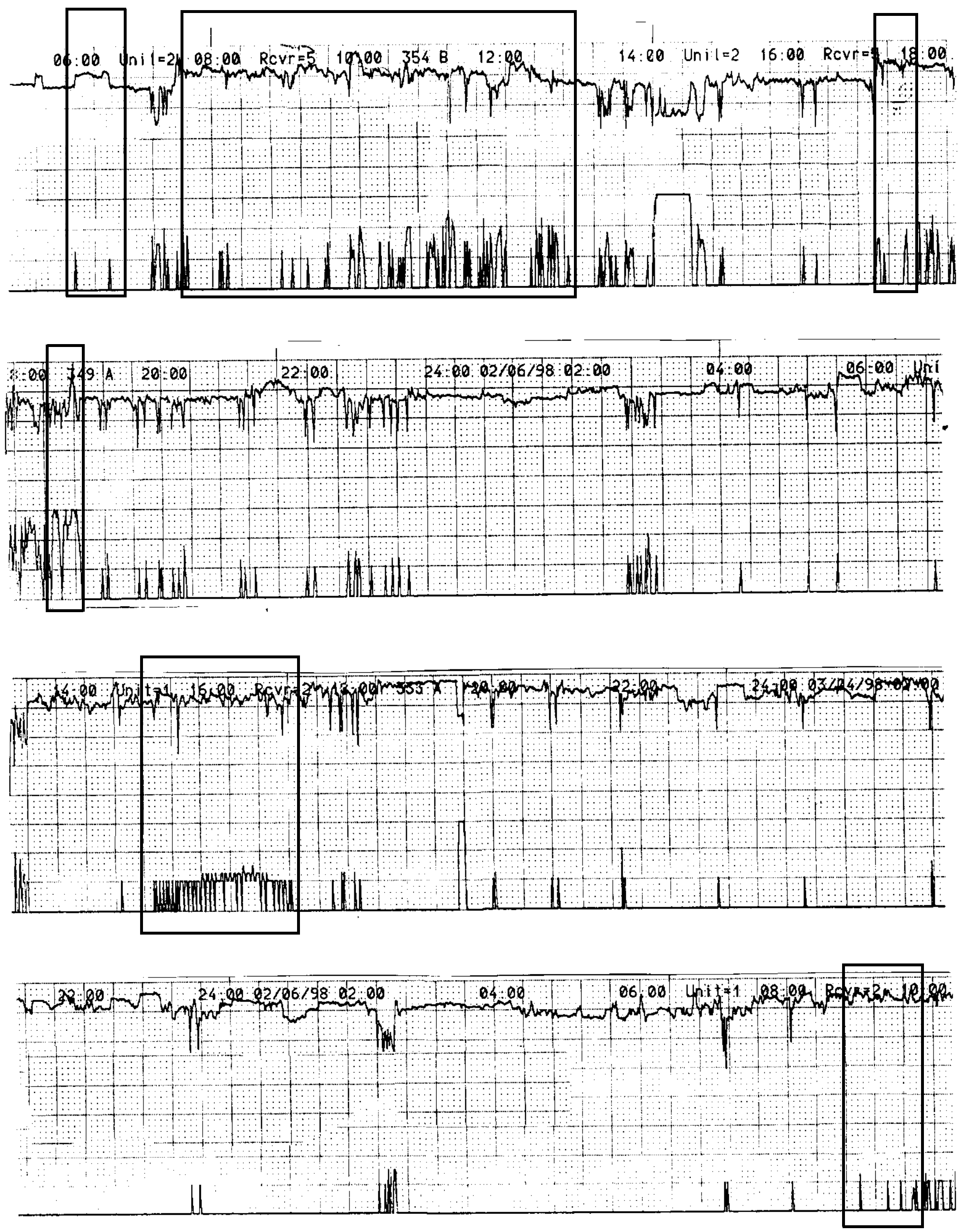


Figure 4-20 Examples of Narrowband Interference

Interference problems can be differentiated from weak signal problems by observing the RF History Strip. In the examples shown in Figure 4-20, dropouts (invalid data packets) are occurring even though there is a strong signal (between -51dBm and -74dBm). This indicates that the “noise” present at those times is just 16 dB lower (16 dB minimum carrier to noise ratio) or between -67 dBm and -90 dBm. “Noise” levels are expected to be -100 dBm or lower.

When this occurs intermittently, it is not a problem and should be considered normal operation. If the interference occurs often, the reasons why should be investigated. Although finding the source of interference can be difficult, the strips can be analysed to see if there is a pattern to when the interference occurs. If a pattern becomes evident, check to see if anything peculiar is going on at those times and take action as necessary.

Another approach is to re-tune the transmitter and receiver to a new frequency to see if that frequency is less susceptible to the interference. Before doing this, make certain that the new frequency being used is free of interference. Test the frequency by taking the battery out of a transmitter, tuning the receiver to the new frequency, and letting the receiver go into a “listen” mode. While in the listen mode, check the RF INOP to see if there is a low noise number (less than 90 is acceptable. Refer to RF INOP Real-time Data on page 4-32. Running the RF History Strip for the time the receiver is listening should indicate if the channel is clear. Following are 2 examples:

Example: No Battery in Transmitter, No Interference Present

The following RF History Strips (Figure 4-21) show a receiver in listen mode. The number of seconds of invalid data received per minute is 60, or 100% of invalid data per minute, indicating that the transmitter is turned off. The received signal strength is very low (-100dBm). The important thing to notice is that there are minimal spikes in the received signal strength; it remains fixed about a low signal strength baseline. These RF History Strips indicate a frequency that is free of transmission and interference. This would be a good channel to tune the transmitter-receiver pair to.

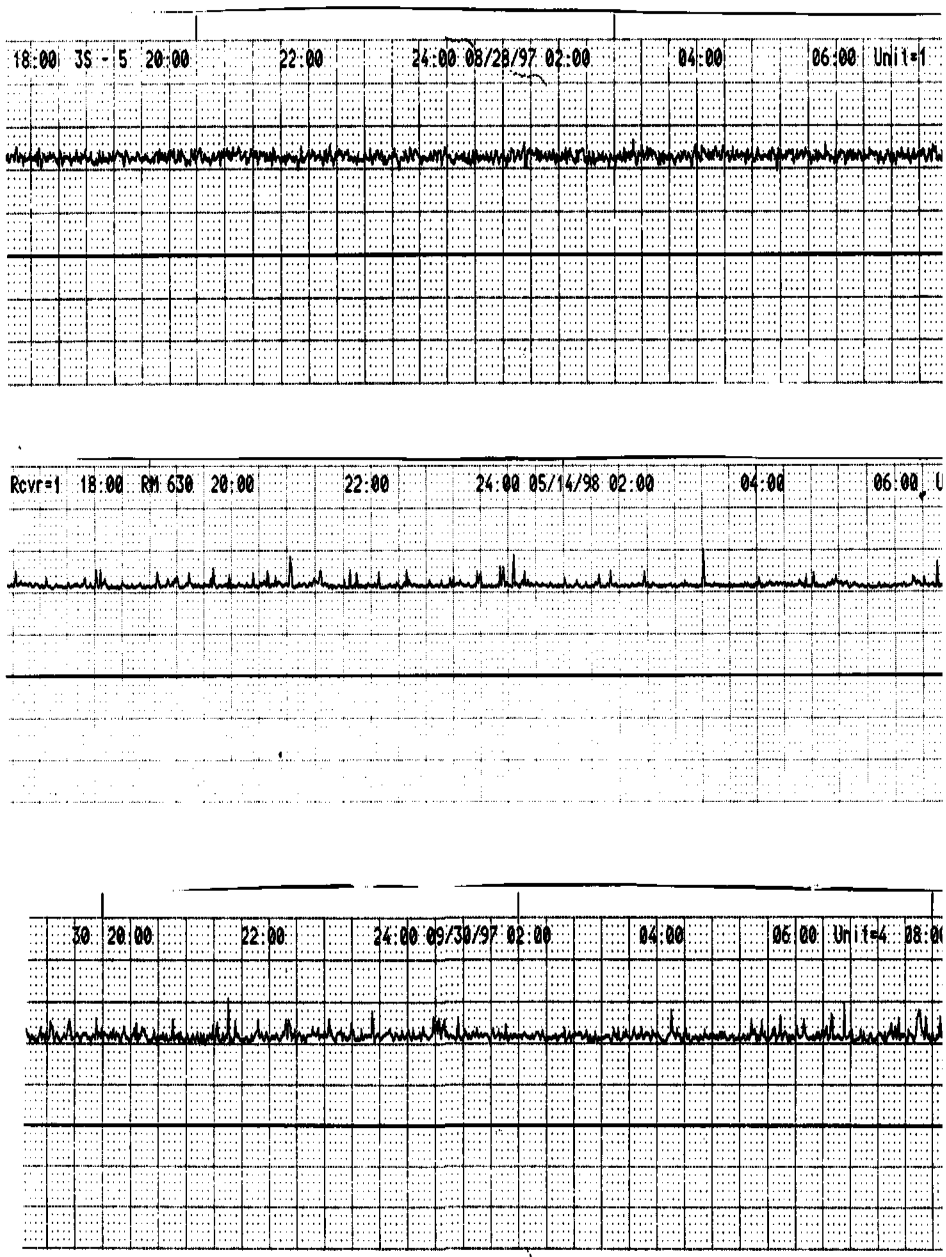


Figure 4-21 Examples of Noise Floor Measurements with No Interference Present

Example: No Battery in a Transmitter, Interference Present

The RF History Strips of Figure 4-22 show a frequency channel that would not be a good choice to tune the transmitter-receiver pair to. The number of seconds of invalid data received per minute is 60, or 100% (the transmitter is turned off), and the received signal strength is low. In this example there are spurious spikes and extended periods when the receiver is detecting interference on the channel. These RF History Strips indicate a frequency plagued with interference. This frequency would not be a candidate for use.

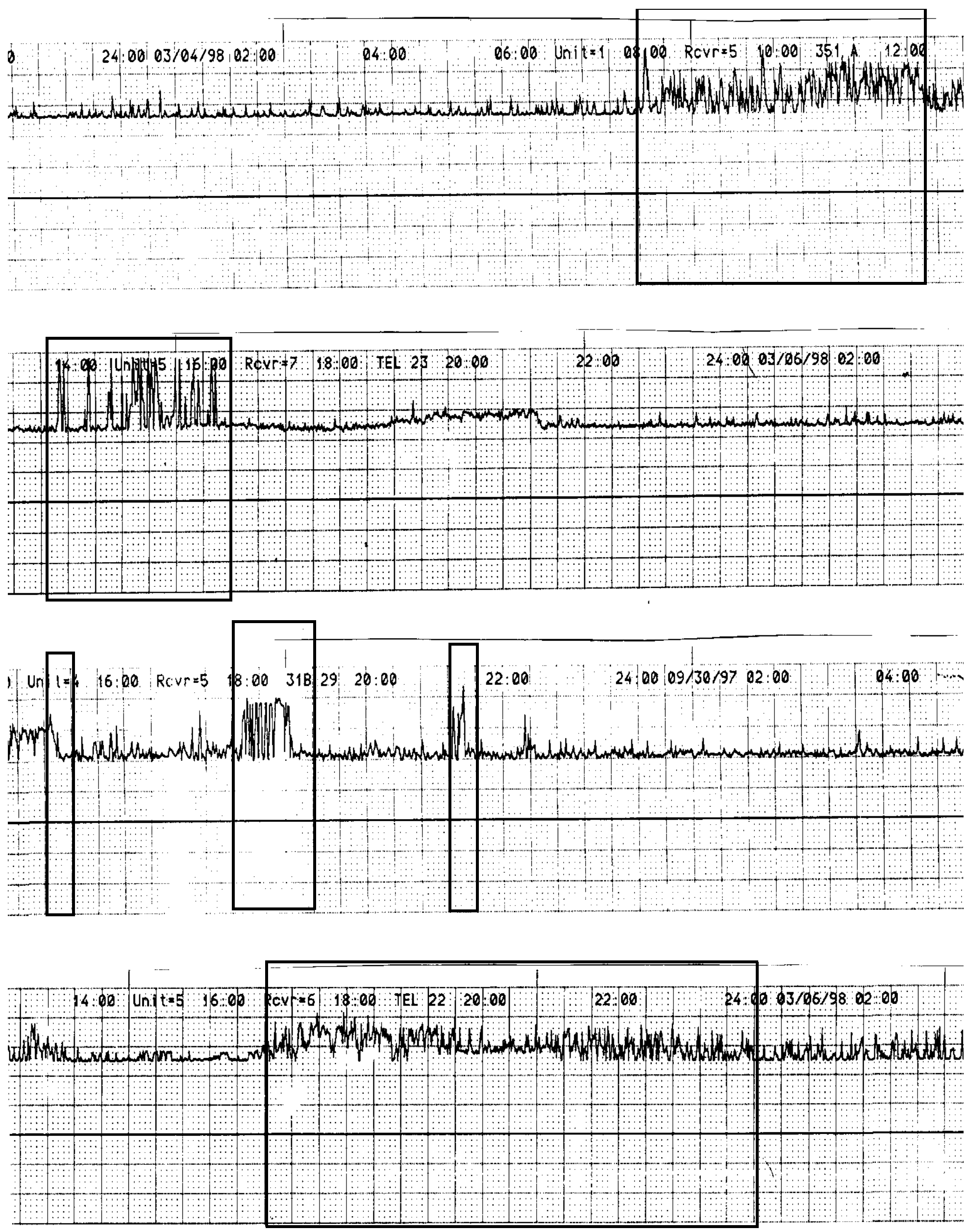


Figure 4-22 Examples of Noise Floor Measurements with Interference Present

Broadband Interference

A broadband interference source occupies the bandwidth of many channels at the same time. Figure 4-23 shows interference occurring for more than one of the installed beds during the same time period (17:50 - 18:45). When interference occurs on multiple channels during the same time period, this is broadband interference because it is affecting more than one frequency. To troubleshoot this problem, refer to Frequent Dropouts and TEL CANNOT ANALYZE and INTERFERENCE INOPs on page 4-30.

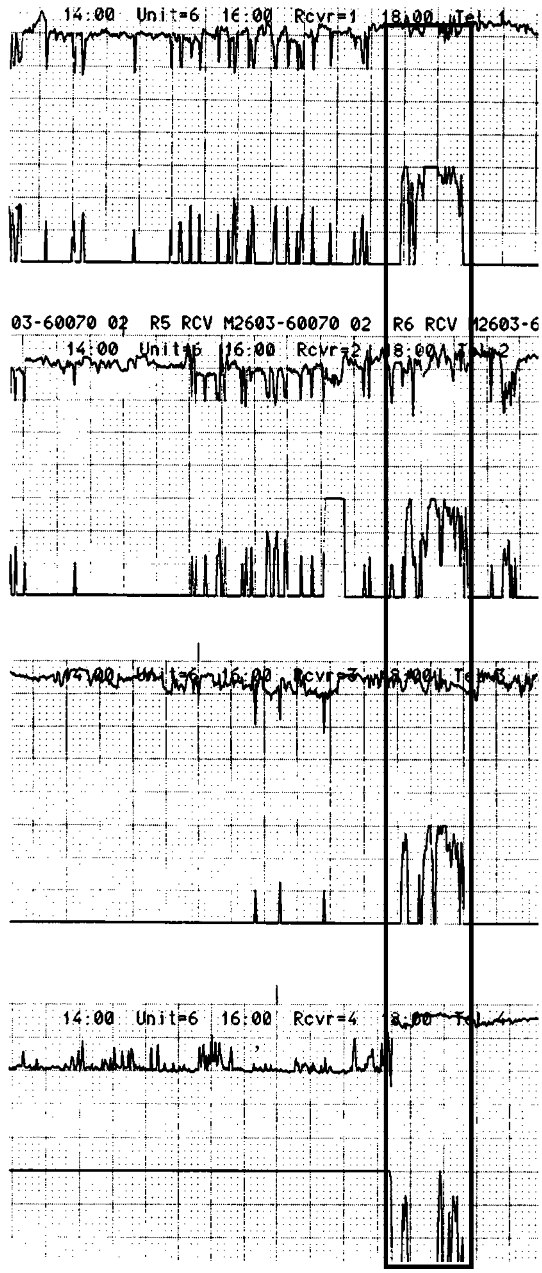


Figure 4-23 An Example of Broadband Interference

Multiple Problems

If an RF History Strip does not look like any of the previous examples, multiple problems may be occurring on the system. Try troubleshooting one problem at a time, starting with low signal problems, which tend to be more stable. Then progress to troubleshooting interference problems.

Distinguishing M1400X Transmitters from M2601A Transmitters

The RF History strips of Figure 4-24 illustrate how to distinguish M1400X transmitters from M2601A transmitters on a strip:

- M2601A transmitters - smallest invalid data spike will be 1 large box high (5 small boxes)
- M1400X transmitter -invalid data spikes will be less than 1 large box high (the smallest spikes will be 1.5 small boxes high).

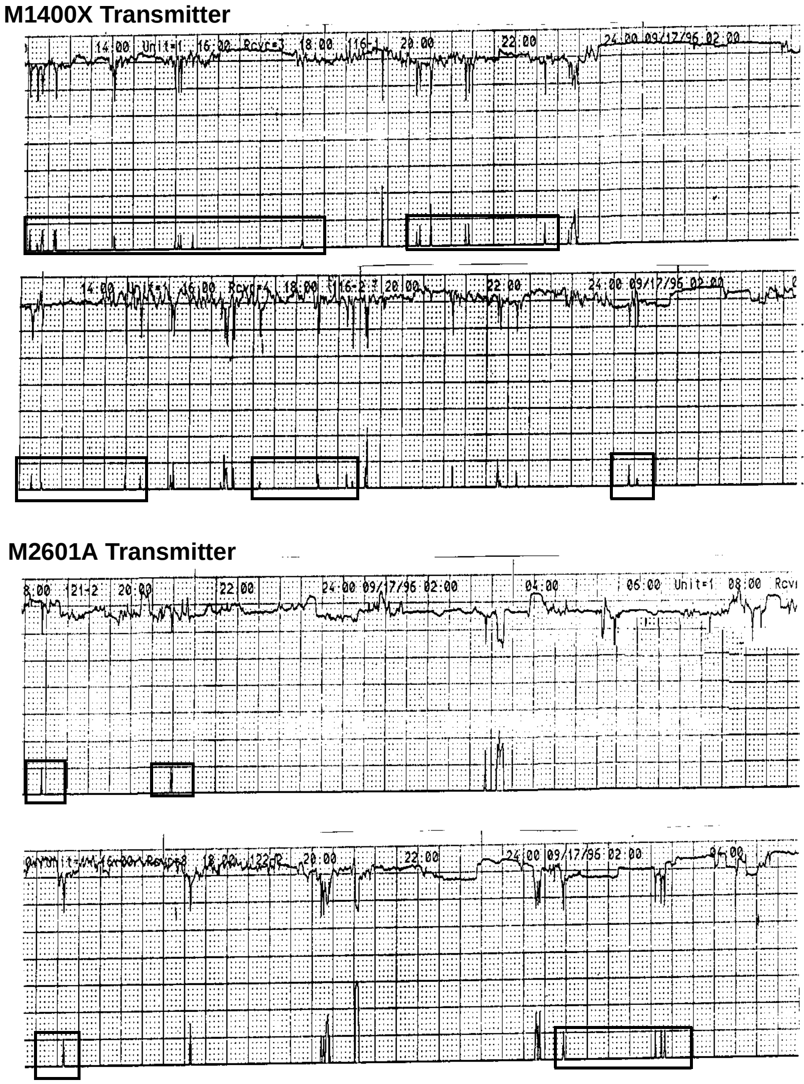


Figure 4-24 M1400X vs M2601A Transmitters

Performance Examples

The darkened lines on Figure 4-25 indicate 1 hour between 1:00 -2:00 am on September 17, 1996. At 1:30, a spike appears from the bottom of the strip. The height of the spike indicates that, for this 1-minute period, 1/4 second or 250 ms of the data received were invalid due to RF corruption. Because this is the only spike in the 1:00-2:00 time period, only 25 ms out of the hour was invalid.

Figure 4-26 is a full disclosure printout for the same 1-hour time period. Note that the invalid data are only a small portion of the overall data received.

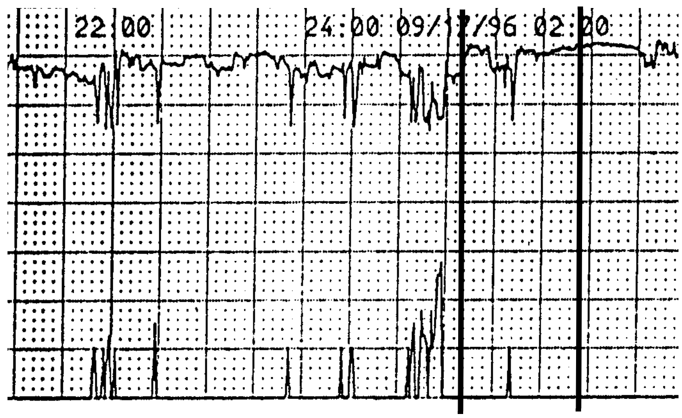


Figure 4-25 History Strip indicating One-Hour of Data

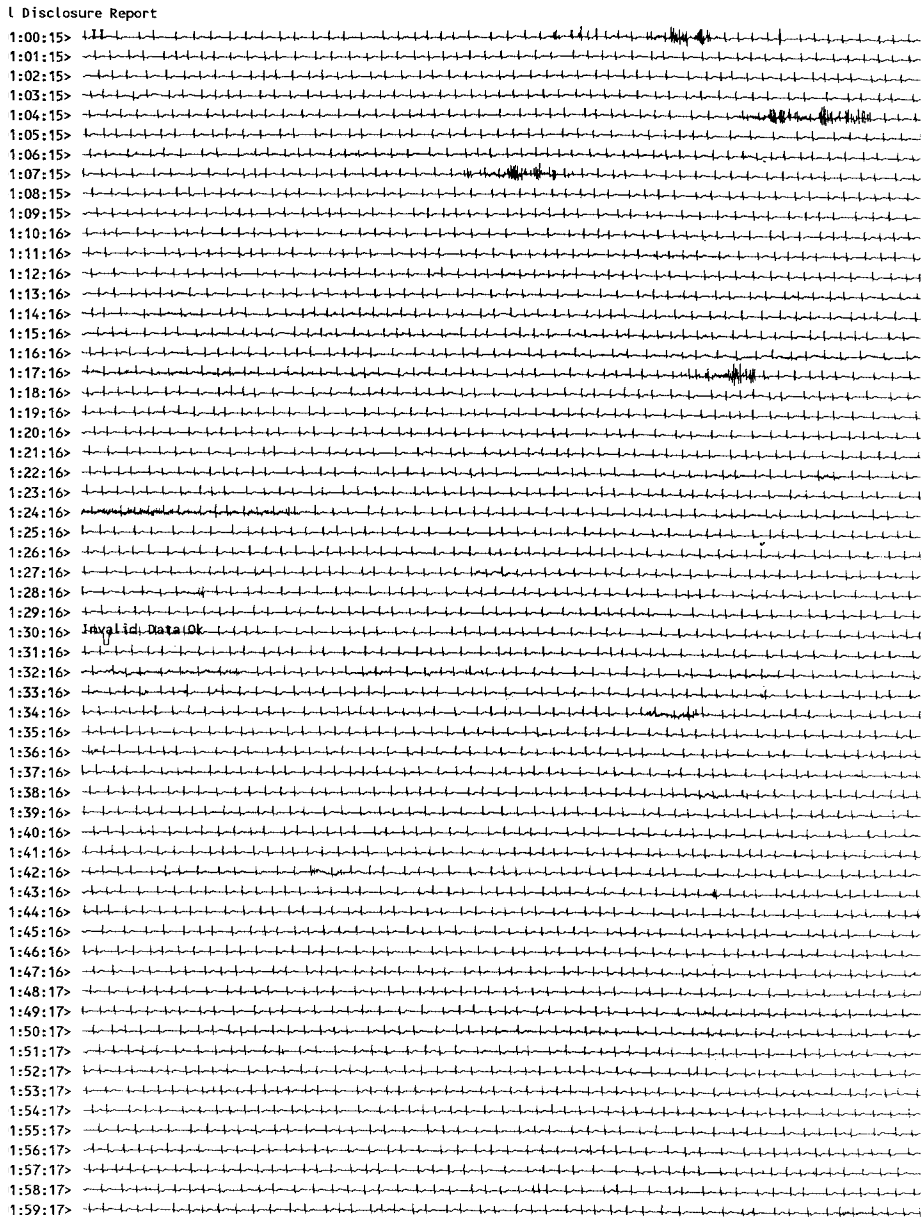


Figure 4-26 History Strip Indicating Invalid Data

One Hour Time Period

The History Strip of Figure 4-27 indicates a 1 hour period of time between midnight and 1:00 on September 17, 1996. Note the spikes between the darken lines that appear to increase in height.

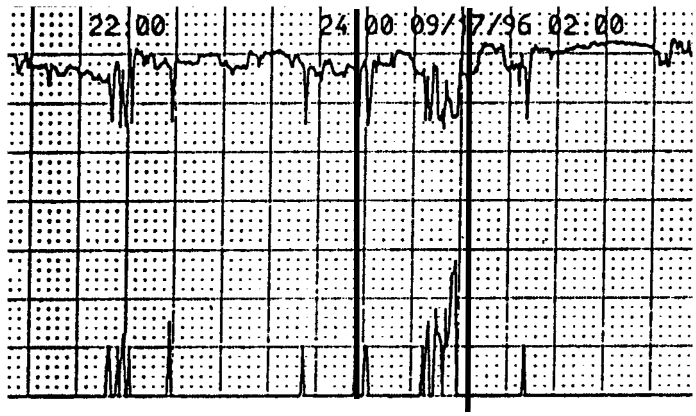


Figure 4-27 History Strip for One-Hour Time Period

The full disclosure printout of Figure 4-28 indicates invalid data that occurred during the same time period. Note that the invalid data occur over a very short period of time compared to the overall data collected.

On the RF History Strip, note that the spike at about 00:05 is the same height, but appears a bit wider than the spike in the previous example. This indicates that short 250 ms dropouts occurred during more than a 1 minute period. This can be seen in the associated full disclosure printout as one 250 ms dropout at 00:07 and another at 00:08.

No dropouts occurred during the next 25 minutes. During the last 25 minutes, however, the signal strength decreased and the number of dropouts increased.

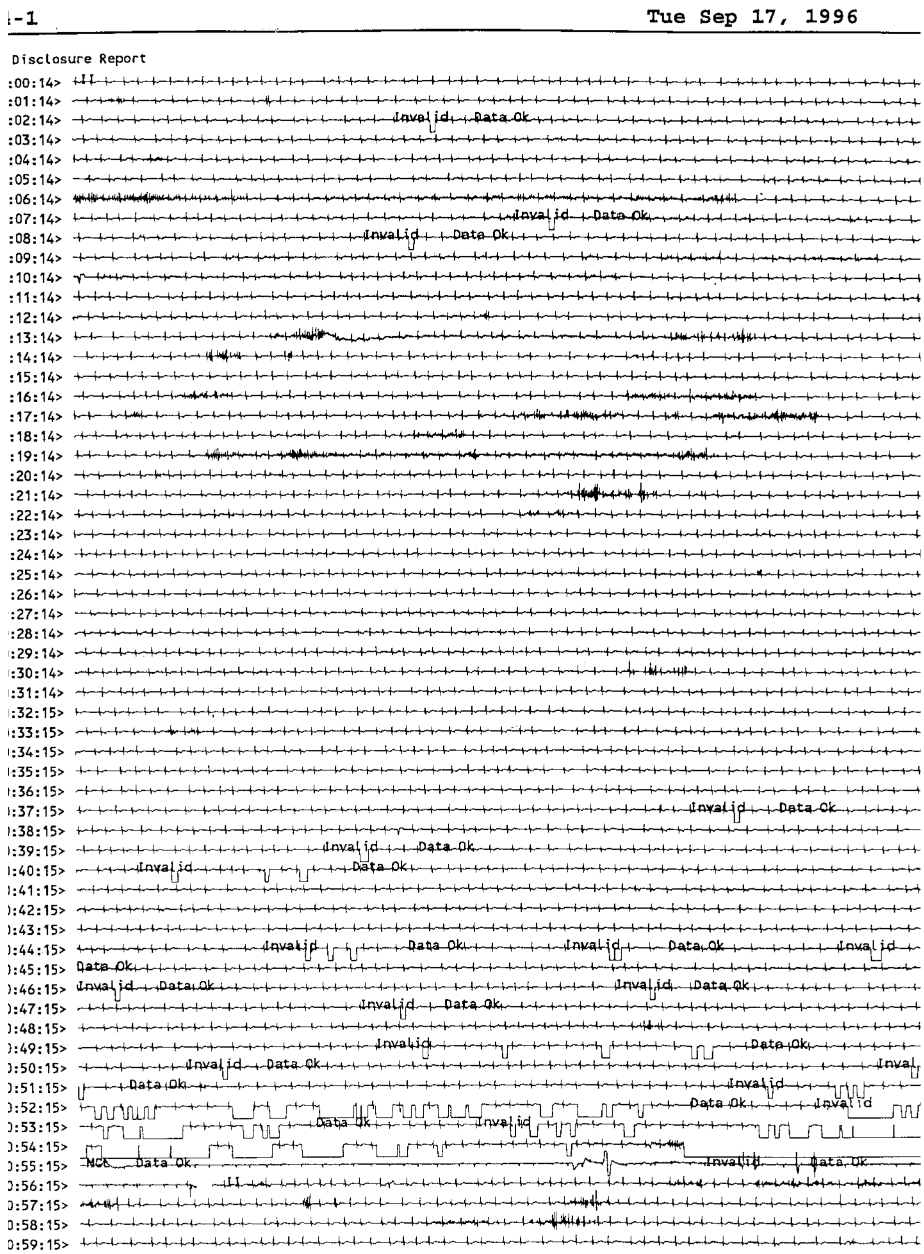


Figure 4-28 Several Invalid Data Periods

Distinguishing RF Performance from LEADS OFF

Not all ECG waveform dropouts are due to RF problems. Some are due to LEADS OFF conditions or an application problem, not an RF Performance problem.

If a clinician reviewed the printout of Figure 4-29 and wanted to know more about the event that occurred at 18:16, print out the RF History Strip for that bed. This printout is shown in Figure 4-30.

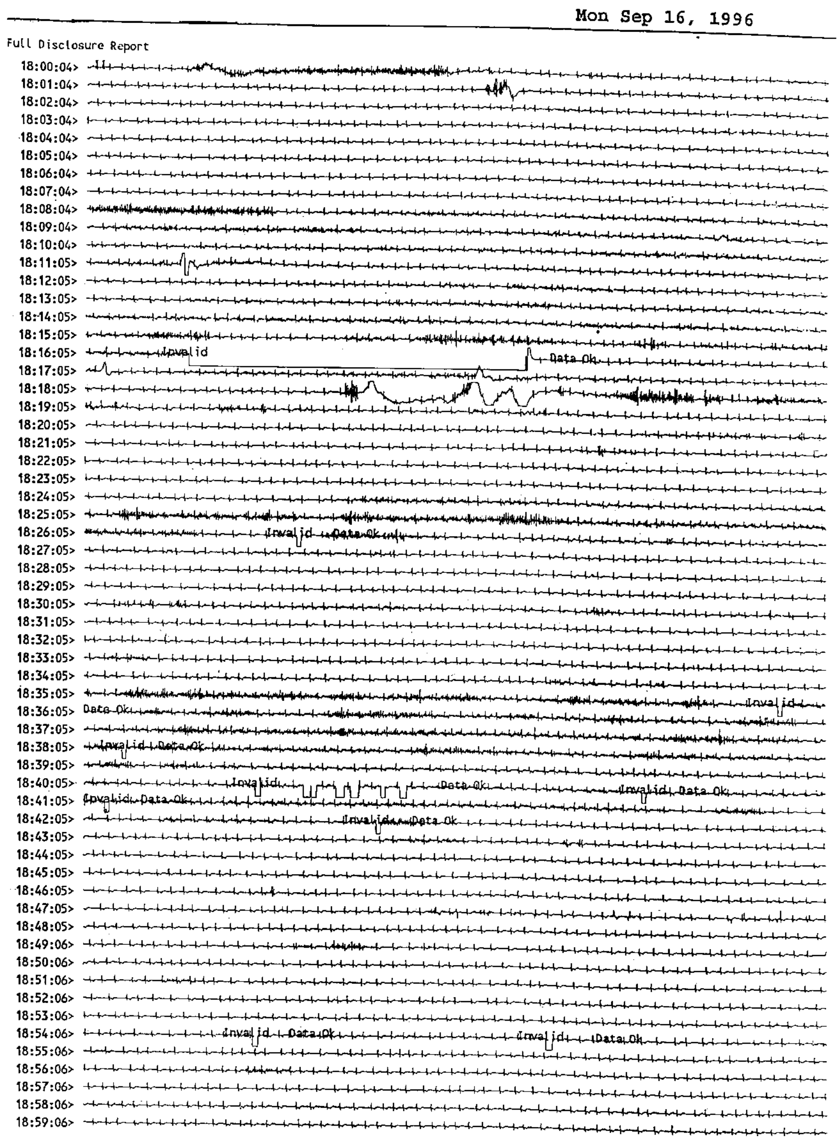


Figure 4-29   Full Disclosure Printout.

If the dropout is due to RF signal corruption, a spike should appear at 18:16, that represents about 30 seconds of invalid data for that minute. The spike would be about 2.5 boxes high. Locate 18:00 on the RF History strip. A line has been drawn on the figure at 18:00 and at 19:00. Count 3 small boxes, which represents 15 minutes.

As can be seen, there is no spike on the Invalid Data plot. This indicates that the data being received over the RF link have not been corrupted. The data on the full disclosure printout are the actual patient data. There is no ECG wave because this is a LEADS OFF condition.

The shorter duration dropouts at 18:26, 18:35, 18:38, 18:40-18:42, and 18:54 are RF dropouts due to short signal fades because there are spikes at those times on the Invalid Data Plot.

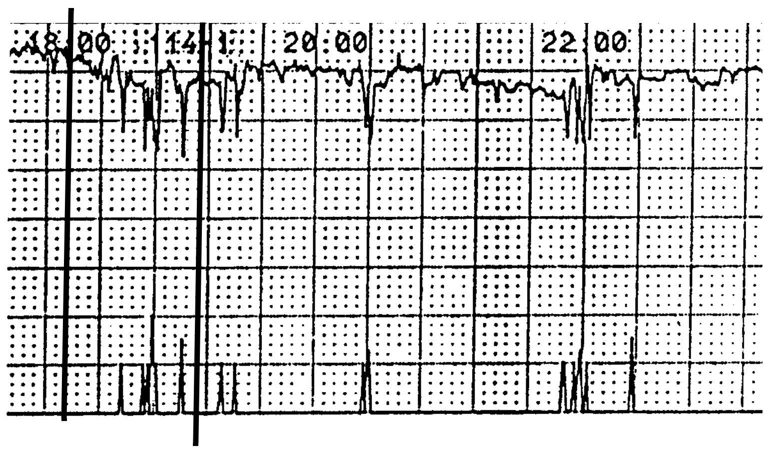


Figure 4-30 RF History Strip indicating Data Collection Between 18:00 and19:00.

Monitoring a Channel for a Clear Frequency

To monitor for a clear channel, do the following:

1. Remove the battery from a transmitter and keep the battery out for the desired monitoring period.
2. Set receiver to the desired frequency.
3. Print out the RF History Strip for the associated receiver mainframe after the desired monitoring period. Remember that the RF History Strip just stores the last 24 hours of data. If longer monitoring periods are desired, they must be printed out every 24 hours.
4. Check the strips for RF activity:
   a. A clear channel shows a very low signal strength (approx. -100 dBm) all day with 100% bad data (remember, if the transmitter is not on, no valid should data should be logged). For examples, Example: No Battery in Transmitter, No Interference Present on page 4-46.
   b. A problem channel shows extended periods of high signal strength with 100% bad data. For examples, Example: No Battery in a Transmitter, Interference Present on page 4-47.

Antenna System Troubleshooting Procedure

This procedure determines whether low RF signal performance problems are due to hardware faults in an M1413/M1414/M1415B or M2613/14/15A antenna system that is connected to a Philips Telemetry System.

Notes

This procedure does not test the RF environment of the installed system.

The specifications provided in this test procedure are only valid for M2601A - Philips Transmitters used with M2603A Philips Receivers with receiver firmware revision 2 or greater.

This test procedure cannot be used with systems with option J01 (Patient Monitor/Holter Recorder Interface) that have no connection from the receiver mainframe to the SDN because the RF signal strength measurement is not available from these systems.

A test of the antenna system is to make certain that it is connected properly and to see if there is any excessive signal loss in the system.

The test uses a testbox with a transmitter placed inside it to inject a test signal directly into the receiver mainframe. Using the RF troubleshooting tools built into the receiver mainframe:

- Measure the signal strength received.
- Inject the test signal into the antenna system and measure the signal level received by the receiver mainframe.
- Compare the signal level to the expected signal level (test signal plus the antenna system gain). Discrepancies point to faults in the system.

This test procedure requires the Transmitter Test Box (part number M2600-67000), a short BNC cable (part number M1413-60100) and a transmitter with a battery. Perform this test on each antenna string in the system.

Equipment Required

The following equipment is required to perform this test:

- Fully installed M2600A - Philips Telemetry System
  - M2601A - Philips Transmitter with battery
  - M2603A - Philips Receiver with Revision 2 or higher firmware (upgraded M1402A - Receivers cannot be used because the RSSI value is not calibrated)
  - M2604A - Philips Receiver Mainframe (or an upgraded M1401A Receiver Mainframe with Revision D.00.13 or greater)
- M2600-67000 - transmitter testbox, quantity 1
- M2609A-#A09 - 9 dB Attenuator (PN 0955-1093), quantity 1
- M1413-60100 - 1 ft RG-6 cable, quantity 1

Notes

Either the RF INOP or the RF History Recording Strip can be used to gather the RSSI (Received Signal Strength Indicator) values.

- **RF INOP** - When using the RF INOP, wait a minimum of 1.5 minutes for the value to stabilize. Use the “signal” value reported at the central station in the INOP field (it is the number in parentheses). The RF INOP is turned on in the Telemetry Frequency Screen at the central station. You must return to the central station for each measurement. Refer to RF INOP Real-time Data on page 4-32 for more inf6ormation about the signal.
- **RF History Strip** - When using the RF History Strip, allow each measurement to stabilize for about 5 minutes to get a discernable mark on the recording strip. You do not have to return to the central for each measurement. The bed can be put in standby (Philips Information Center) to avoid annoying false alarms and INOPs at the central.

Procedure

The transmitter test box shorts all of the ECG leads together. This results in an asystole alarm at the Central Station. If the system configuration does not allow red level alarms to be suspended, the RF History Strip method may be less annoying.

Step 1. Tune the transmitter and receiver to the same frequency and perform a Learn Code (see Chapter 2).

Step 2. Turn the RF INOP on. (See Chapter 2)

Step 3. Insert the transmitter into the testbox and close the testbox cover.

Step 4. Connect the attenuator to the Antenna/Mainframe Attenuated Port on the testbox and the 1 ft. RG-6 cable to the attenuator.

Step 5. Before performing the next step, inform the clinical staff that they will be losing monitoring for about 2 - 5 minutes.

Step 6. If the system is operating between 406-480 MHz, connect the testbox to the antenna port of the receiver mainframe using the 1 ft. RG-6 cable with 9 dB attenuator (0955-1093, M2609A-#A09).

If the system is operating between 590-632 MHz, connect the textbox to the RF input on the frequency converter.

Step 7. Wait 1.5 to 5 minutes for the measurement to stabilize (refer to the **Notes**).

Step 8. Verify that the Received Signal Strength Indicator (RSSI) measurement falls between 160 and 198 for a system operating in 406-480 MHz range or between 180-230 for a system operating in the 590-632 MHz range. This is the test signal count, S. If the RSSI does not fall into this range, there is a problem with the basic test system (transmitter, testbox, receiver mainframe, or receiver) that needs to be resolved before proceeding.

Frequency Range	S (RSSI Counts)	Signal Strength (dBm)
406 to 480 MHz	160-198	-68 dBm ± 8 dB
590 to 632 MHz	180-230	-59 dBm ± 8 dB

Step 9. Disconnect the transmitter testbox from the mainframe or frequency converter and connect the antenna system to the receiver mainframe or frequency converter.

Step 10. Perform the following steps for each antenna string in the antenna system.

a. Go to the antenna electrically farthest from the receiver mainframe.

b. Remove the antenna whip.

c. Connect the transmitter testbox to the antenna using the 1 Ft. RG-6 cable with 9dB attenuator (0955-1093),.

d. Wait for the measurement to stabilize (refer to the **Notes**) and record the value.

e. Remove the testbox and re-attach the antenna whip.

f. Repeat for each antenna string.

Step 11. Turn the RF INOP off.

Step 12. If using the RF History Strip to get the RSSI values, do the following:

a. After all of the measurements have been completed, print the RF History Strip.

b. Review the information for the receiver slot used.

Step 13. Determine the signal strength expected after injection into the antenna system (test signal plus gain and tolerance) by performing the following steps. Consult the appropriate appendix and frequency option tables for the values required below.

- Appendix C M1413/14/15B - UHF Antenna System.
- Appendix D M2613/14/15A - Dual-band UHF Antenna System

a. Determine the **expected gain**:

– Consult the Combining Network Gain Table and locate the combining network used by option number and note the gain, **Gc**, in RSSI counts.

– Consult the Antenna String Gain Table and locate the antenna string option used and note the gain, **Gs** in RSSI counts.

– The expected gain of the whole system, **G**, is the sum of the combining network gain and the antenna string gain, **G = Gc + Gs**.

b. Determine the **measurement tolerance**:

– Consult the Combining Network Tolerance Table and locate the Combining Network used by option number and note the tolerance in RSSI counts. This is the combining network tolerance **Tc**.

– Consult the Antenna String Tolerance Table and locate the antenna string option measured and note the tolerance in RSSI counts. This is the antenna string tolerance, **Ts**.

– The tolerance of the entire system is **T**, which is the sum of the combining network tolerance and the antenna string tolerance, **T = Tc + Ts**.

c. The expected signal strength at the mainframe for when the test signal is injected into the antenna, **X**, is: **X = (S+G)** with a tolerance of **±T**.

If the measured signal is not in the expected range of values, there is an installation problem that must be corrected. Table 4-7 lists some common installation problems and their symptoms.

General Faults and Symptoms

Table 4-8, Table 4-9, Table 4-10 and Table 4-11 list common faults when antenna systems are upgraded for extended-band operation.

Table 4-7. Installation Faults and Symptoms

Fault	Symptom
Amplifier in Backwards	-30 dB approximate gain change/difference (approx. -72 RSSI counts)
Two-Way Improperly Connected	-15 dB approximate gain change/difference (approx. -36 RSSI counts)
Cables in Wrong Place 18.9 meters or 62 ft. Intermediate (42.4 meters or 139 ft.Main)	± 4 dB approximate gain change/difference (approx. ±10 RSSI counts)
Active Antenna/Combiner in Backwards	-30 dB approximate gain change/difference (approx. -72 RSSI counts)

Extended-Band Upgrades Faults, and Symptoms

Fault: a single component has not been upgraded. Table 4-8 lists symptom by component.

Symptom: gain through antenna system is lower than expected by the amount given in Table 4-8.

Table 4-8. Faults and Symptoms for Upgraded Systems

Fault	Frequency Range	Symptom
Antenna		
Antenna input: Wrong antenna installed (M1408A instead of M2608A) Applies to M1413/14B antenna strings	590 MHz 611 MHZ 632 MHz	Gain lower than expected by ~ 4dB (10 RSSI Counts) Gain lower than expected by ~ 8dB (19 RSSI Counts) Gain lower than expected by ~ 7dB (17 RSSI Counts)

Table 4-8. Faults and Symptoms for Upgraded Systems

Fault	Frequency Range	Symptom
Line input: Wrong antenna installed (M1408A instead of M2608A) Applies to M1413/14B antenna strings	590 MHz 611 MHz 632 MHz	Gain lower than expected by ~ 2dB (5 RSSI Counts) Gain lower than expected by ~ 4dB (10 RSSI Counts) Gain lower than expected by ~ 7dB (17 RSSI Counts)
Wrong antenna whip on an M2608A antenna/combiner base Applies to M1413/14B antenna strings **Note:** The proper antenna whip can be identified by the green dot on its tip.	611 MHz	Gain lower than expected by ~1dB (2 RSSI Counts)
Wrong antenna whip on an M1405A passive antenna base. Applies to M1413/14A antenna strings. **Note:** The proper antenna whip can be identified by the green dot on its tip.	611MHz	Gain lower than expected by ~3dB (7 RSSI Counts)
Line Amplifier		
Wrong line amplifier installed (M1406A instead of M2606A)	590 MHz 611 MHz 632 MHz	Gain lower than expected by ~3dB (7 RSSI Counts) Gain lower than expected by ~4dB (10 RSSI Counts) Gain lower than expected by ~4dB (10 RSSI Counts)

Table 4-8. Faults and Symptoms for Upgraded Systems

Fault	Frequency Range	Symptom
Power Tee		
Wrong power tee installed (M1407A instead of M2607A)	590 MHz	Gain lower than expected by ~1dB (2 RSSI Counts)
	611 MH	Gain lower than expected by ~0dB (0 RSSI Counts)
	632 MHz	Gain lower than expected by ~0dB (0 RSSI Counts)

Table 4-9 provides Antenna String Options and the Frequency Range.

Fault: M1413/14B antenna strings are not upgraded for extended band operation.

Symptom: Gain from antenna farthest from the mainframe is lower than expected by approximately the amount given in Table 4-9. RSSI counts are given in parentheses.

Table 4-9. M1413/14B Antenna String Option

Frequency Range	A06	A05	A04	A03	A02	A01
590MHz	14dB (34)	12dB (29)	10dB (24)	8dB (19)	6dB (14)	4dB (10)
611MHz	30dB (72)	25dB (60)	21dB (50)	17dB (41)	12dB (29)	8dB (19)
632MHz	43dB (103)	36dB (86)	29dB (70)	22dB (53)	15dB (36)	7dB (17)

Table 4-10 combines Antenna String Options and the Frequency Range.

Fault: M1413/14A antenna strings are not upgraded for extended band operation.

Symptoms: Gain from antenna farthest from the mainframe is lower than expected by approximately the amount given in the table. RSSI counts are given in parentheses.

Table 4-10. M1413/14A Antenna String Option

Frequency Range	A06	A05	A04	A03	A02	A01
590MHz	19dB (46)	16dB (28)	13dB (31)	10dB (24)	6dB (14)	3dB (7)
611MHz	22dB (53)	19dB (46)	15dB (36)	11dB (26)	7dB (17)	4dB (10)
632MHz	26dB (62)	22dB (53)	18dB (43)	13dB (31)	9dB (22)	4dB(10)

Table 4-11 is listed by Combining Network option and frequencies.

Fault: M1415A/B combining network is not upgraded for extended band operation

Symptom: Gain through combining is lower than expected by approximately the amount given in the table. RSSI counts are given in parentheses.

Table 4-11. M1415A/B Combining Network

Antenna Strings In	Frequency	1	2	3-4	5-8
1		A11	A12	A14	
	590 MHz	1dB (2)	1dB (2)	3dB (7)	
	611MHz	0dB (0)	0dB (0)	3dB (7)	
	632MHz	0dB (0)	0dB (0)	3dB (7)	
2		A21	A22	A24	A28
	590MHz	1dB (2)	3dB (7)	3dB (7)	3dB (7)
	611MHz	0dB (0)	3dB (7)	3dB (7)	3dB (7)
	632MHz	0dB (0)	4dB (10)	4dB (10)	4dB (10)
3-4		A41	A42	A44	A48
	590MHz	3dB (7)	3dB (7)	3dB (7)	5dB (12)
	611MHz	3dB (7)	3dB (7)	3dB (7)	7dB (17)
	632MHz	4dB (10)	4dB (10)	4dB (10)	9dB (22)
5-8			A82	A84	A88
	590MHz		3dB (7)	5dB (12)	5dB (12)
	611MHz		3dB (7)	7dB (17)	7dB (17)
	632MHz		4dB (10)	9dB (22)	9dB (22)

Analog Output Troubleshooting

If the system has analog output, use Table 4-12 to troubleshoot the system based on the symptoms.

Table 4-12. Analog Output Troubleshooting

Symptom	Possible Cause	Corrective Action
LEADS OFF indication at all analog output bedside monitors, plus red LED on receiver mainframe analog output board illuminated.	Failed analog output board.	Replace board.
LEADS OFF indication at all bedsides, plus red LED on receiver mainframe analog output board flashing rapidly.	Analog output link cable not properly connected.	Reconnect cable.
LEADS OFF indication at all analog output bedside monitors, plus following receiver mainframe analog output board LED display: Red LED off, one or both green LEDs on or off steadily.	Failed analog output board.	Replace board.
LEADS OFF indication at all analog output bedsides, plus Status and Power LEDs on analog output connector box not lit.	No power to connector box.	Plug in or replace power supply.
LEADS OFF indication at all analog output bedsides, plus the following analog output connector box LED display:	Analog trunk cable not properly connected to receiver mainframe or output connector box.	Connect analog trunk cable.
POWER LED on	Receiver mainframe power is off.	Energize receiver mainframe.
STATUS LED off	Analog output board is faulty.	Replace analog output board.

Table 4-12. Analog Output Troubleshooting

Symptom	Possible Cause	Corrective Action
All analog output board and output connector box LEDs indicate normal operation, but one or more analog output channels indicate LEADS OFF, even when valid signal is present.	One or more receiver modules need firmware upgrade.	Check receiver module firmware of affected channels, and upgrade receiver module firmware as necessary.
	EASI ECG transmitter is being used.	Analog output will not work with an EASI ECG transmitter. A standard ECG transmitter must be used.
LEADS OFF indicated on a single analog output bedside monitor.	Bedside not assigned to correct lead selection.	Assign correct lead selection as follows: Transmitter Cableset Valid Lead Selections 3-lead: II 5-lead: II, MCL
	Bedside monitor cable type does not match transmitter cableset type.	Check for valid monitor cable/ transmitter cable combination
	Analog output cable not properly connected.	Check cable connection at output connector box and at attenuator.

5
Disassembling the Transmitter

Overview

Chapter 5 describes the procedures for completely disassembling the Transmitter, including the disassembly and reassembly of the Leadset Combiner. It includes the following sections.

Caution

Transmitters contains components that can be damaged if ESD precautions are not observed.

The transmitter can be damaged if it is not disassembled according to the procedures given in this chapter. Failure to follow the procedure as presented can result in the transmitter not working.

Never disassemble the transmitter beyond the point required to replace or check a suspect replaceable assembly.

Table 5-1 shows the damage that can occur to a transmitter if the above cautions are not followed.

Table 5-1. Repair Mistakes and their Subsequent Failures

If...	Then...
Proper ESD precautions are not followed	ESD can damage circuit boards and the circuit boards must be replaced.
Transmitter is opened too quickly	Damage can occur to the ribbon cable, which is part of the Case Assembly, requiring replacement of the Case Assembly.
Red Tab connector is not removed correctly	Damage can occur to the mating connector on the Front End Assembly requiring replacement of the Front End Assembly.

Table 5-1 is not all inclusive. Observe all CAUTIONS as they are presented in the disassembly procedures. Failure to do so can result in the transmitter failing.

Disassembly/Assembly of the Leadset Combiner

There are 2 Leadset Combiner/gasket connector kits – M2598A for the 3-wire leadset and M2599A for the 5-wire leadset. These combiner/gasket kits can be used either for repair of a broken combiner or for converting a Philips CMS leadset to be compatible with the M2601A transmitter. In this way, the leadset can remain on the patient when there is an equipment change from hardwired bedside monitoring to telemetry monitoring. This combiner/gasket contains the locking clip to secure the leadset to the transmitter to reduce accidental disconnects.

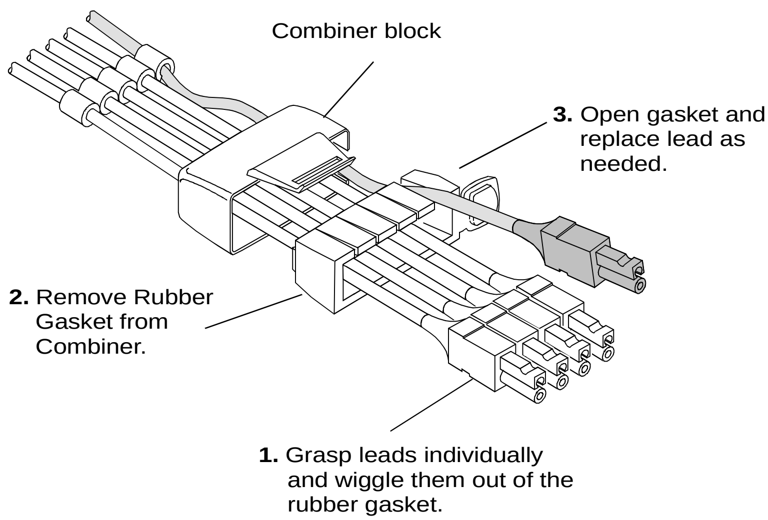


Figure 5-1 Example of a 5-wire Lead Set

To **disassemble** the lead set:

Step 1. Remove the individual lead wires by grasping each wire and wiggling it out of the Rubber Gasket.

Step 2. After removing all wires from the gasket, remove the Rubber Gasket from the Combiner.

Step 3. Separate the Combiner from the lead wires.

To **assemble** the lead set:

Step 1. lace the lead wires into the Combiner.

Step 2. OPpen the Rubber Gasket and place the lead wires into the Gasket.

Step 3. Seat the Gasket into the Combiner until the lower lip protrudes at the top of the Combiner. It may be helpful to press it in with a blunt object.

Step 4. Seat each lead wire into the Rubber Gasket, making certain that the square connector is on the clip side.

Step 5. Press each lead wire until the lead color is visible above the lip.

Disassembly of the Transmitter

Tools Required

Table 5-2 lists the tools that are required to disassemble a transmitter. Additional tools are required for reassembly. Refer to Chapter 6: Reassembling the Transmitter, for additional tool descriptions.

Table 5-2. Tools Required

Tool
Needle-nose Pliers
Torque Driver capable of 2, 3, and 6 inch-pounds (.23, .34, and.68 joules) (Such as Philips Part number 1535-2653)
Size 1 Pozidriv bit for Torque Driver - 3-inches long (approx 76 mm)
Japan only: Special bit for the main case screw to fit the torque driver (Philips part number 5966-5066)
RF Cable Tool (M2601-67002)
Size 0 Pozidrive Screwdriver (for battery contact removal)
Small flat blade screwdriver (for battery contact removal)

Single-Use Screw Kit

To assure that the transmitter's electronics compartment works and remains water-resistant, all of the screws and the O-ring must be replaced with ones from the single-use screw kit (PN. M2601-68302, for all countries except Japan; M2601-68304 for Japan only).

Each screw is treated with an adhesive material that assures that the internal parts of the transmitter stay connected with satisfactory mechanical robustness. Each single-use screw kit comes with 2 of each screw and a replacement O-ring for the transmitter.

Caution

Whenever disassembling the Case Assembly from the Front End Assembly, the O-ring must be replaced before reassembly.

All of the screws removed during disassembly must be discarded and replaced with new screws from the single-use screw kit during reassembly.

If the RF Cable is disconnected, it must be replaced. The RF Cable must be removed whenever the Main PCB or Front End Assembly is removed. The RF Cable is not part of the Single Use Screw Kit, but comes with a replacement Front End Assembly and Main PCB.

Failure to replace the O-ring, screws and RF Cable can result in the transmitter not working or leaking and lead to early failure of the transmitter's internal assemblies.

Procedure

Figure 5-1 gives an overview of the procedure for disassembling the transmitter to remove and replace any of its subassemblies. For an exploded view of the transmitter, see Figure 5-2.

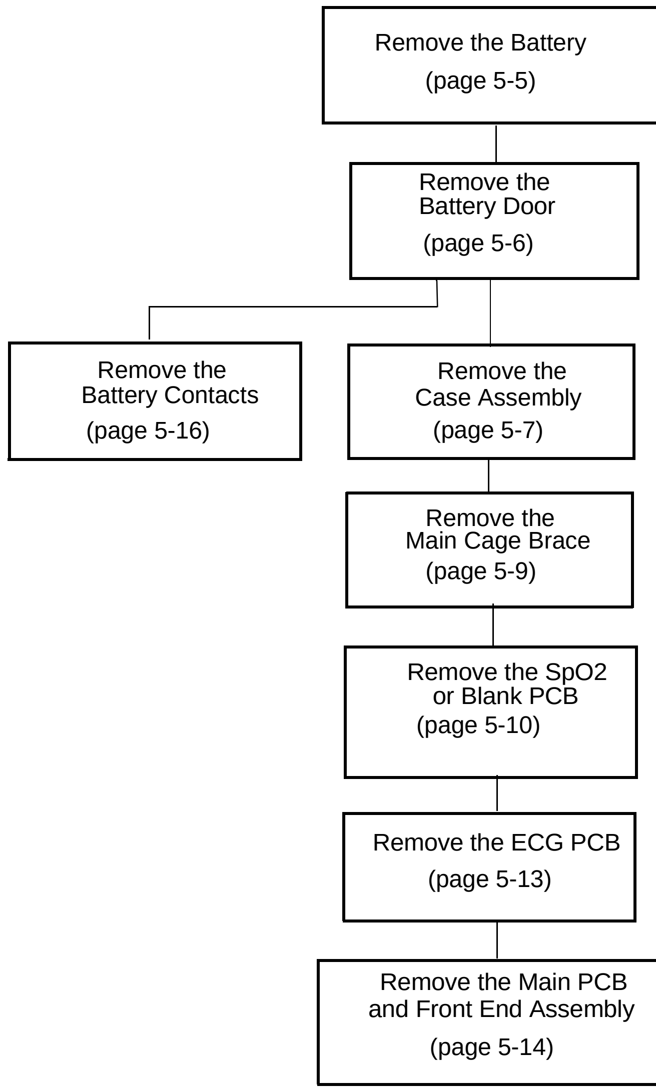


Figure 5-1 Transmitter Disassembly Overview

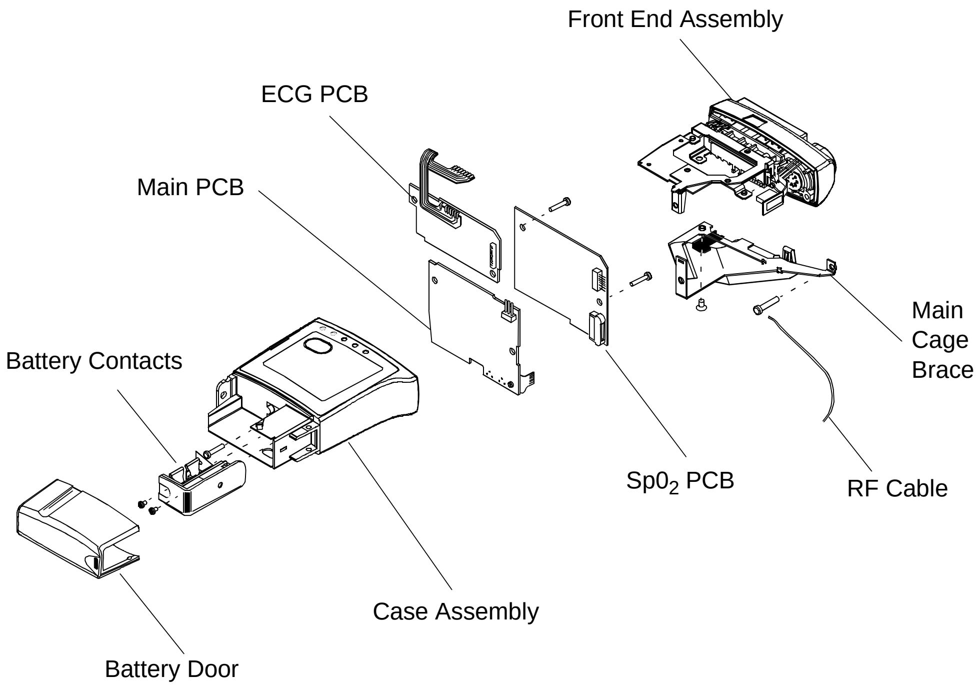


Figure 5-2 Exploded View of the Philips Transmitter

Removing the Battery

The first step in Transmitter disassembly is to remove the battery. This can be done simply for battery replacement or for a more complete disassembly. To remove the battery, do the following. See Figure 5-3.

Step 1. Swing the battery door down to expose the battery.

Step 2. Pull the battery out from its chamber, releasing the battery terminal clips.

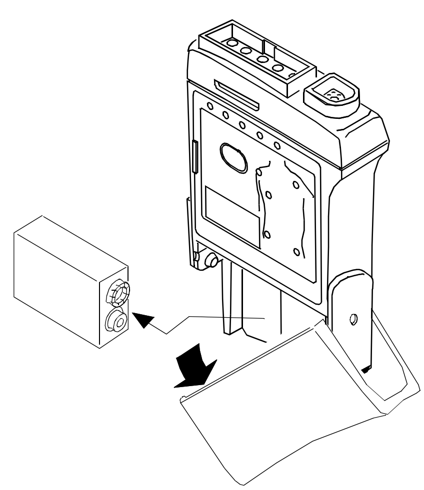


Figure 5-3 Removing the Battery

Removing the Battery Door

To remove the Battery Door, do the following. See Figure 5-4.

Step 1. Remove the battery.

Step 2. Pry one side of the Battery Door until the retaining pin is clear of its hole.

Step 3. Unclip the Battery Door from the Case Assembly.

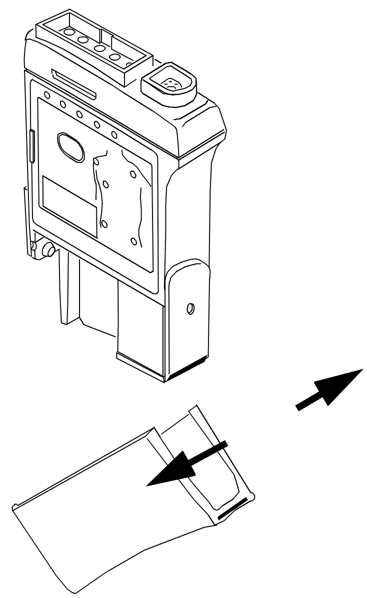


Figure 5-4 Removing the Battery Door

Removing the Case Assembly

To remove the Case Assembly, do the following. See Figure 5-5.

Step 1. Loosen the screw that secures the Case Assembly to the transmitter's internal electronics using the #1 Pozidriv bit (for Japan, use the special bit).

Caution

When separating the Front End Assembly from the Case Assembly, pull the Front End Assembly slowly and gently.

DO NOT pull the two pieces apart quickly or forcefully. There is a ribbon cable that connects the front panel of the Case Assembly to the Main PCB that can break if the two pieces are not treated carefully.

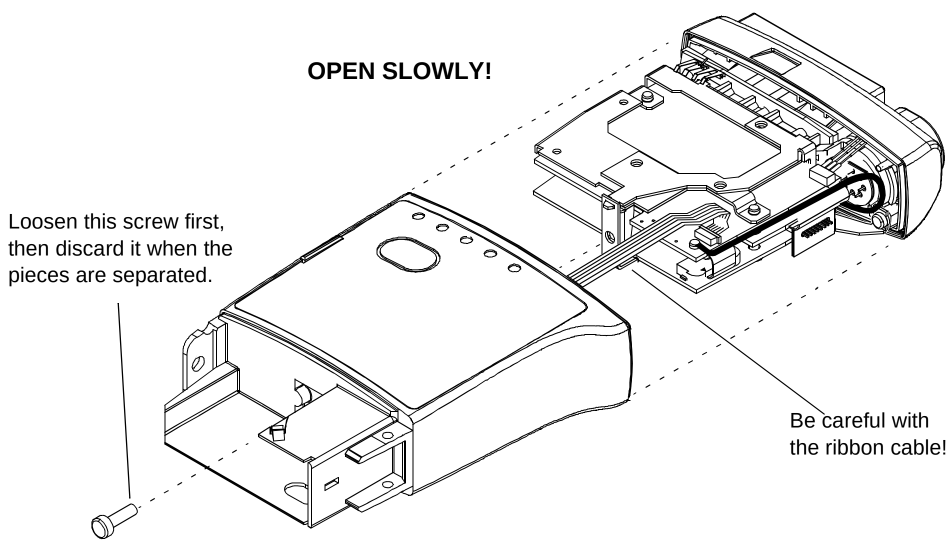


Figure 5-5 Removing the Case Assembly

Step 2. Pull the transmitter's Front End Assembly from the top of the transmitter until the ribbon cable from the Main PCB to the Case Assembly is accessible. The ribbon cable from the Case Assembly to the Main PCB connects via a collared connector. See Figure 5-6.

Step 3. Slide the collar out and then hinge the collar up to remove the ribbon cable from the connector.

Step 4. Separate the Case Assembly from the transmitter's internal electronics.

Step 5. Remove the screw from the Case Assembly and discard it.

Step 6. Remove any debris or residue from the screw hole.

Step 7. Remove and discard the O-ring from the Front End Assembly.

Step 8. Clean the O-ring groove if it is dirty.

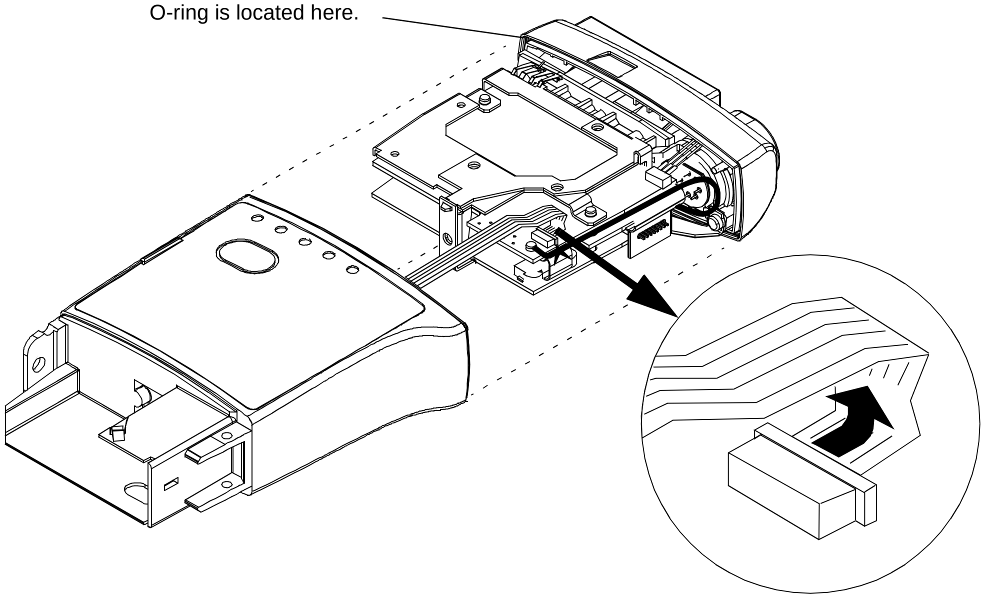


Figure 5-6 Removing the Case Assembly from the Transmitter

Removing the Main Cage Brace

To remove the Main Cage Brace, do the following. See Figure 5-7.

Step 1. Turn the transmitter over to access the 2 screws that secure the Main Cage Brace to the Front End Assembly.

Step 2. Remove and discard the 2 screws to free the Main Cage Brace from the Front End Assembly.

Step 3. Remove the Main Cage Brace from the transmitter.

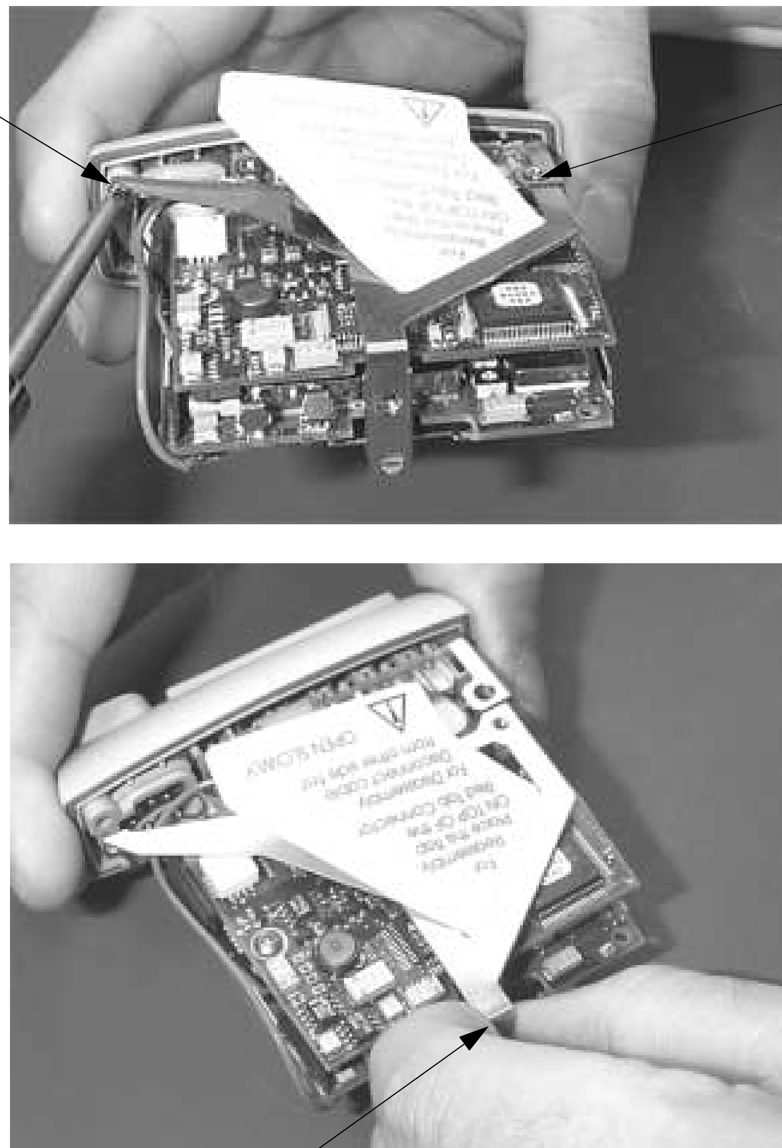


Figure 5-7 Removing the Main Cage Brace

Removing the SpO_2 or Blank PC Board

To remove the SpO_2 (or blank) PC Board, do the following. See Figure 5-8 - Figure 5-12.

Note

If the transmitter does not have an SpO_2 Board installed, a blank board is in its place. The procedure for removing the blank board is the same as for removing the SpO_2 board except that there are no cables connected to the blank board.

Caution

The ECG PCB red tab connector protects a fragile plug-in connector. This plug-in connector can break if the red tab connector is not disconnected according to the following step.

Do not lift the red tab connector by hand. Failure to observe this caution can result in the plug-in connector on the Front End Assembly breaking and causing costly repairs to the transmitter.

Step 1. Disconnect the ECG PCB red tab connector from the Front End Assembly by sliding needlenose pliers under the red tab where the it clips onto the plug-in connector and gently lifting the retaining hook until it is clear of the PCB on the Front End Assembly. See Figure 5-8.

Step 2. Slide the red tab connector apart after the retaining hook is free of the Front End Assembly.

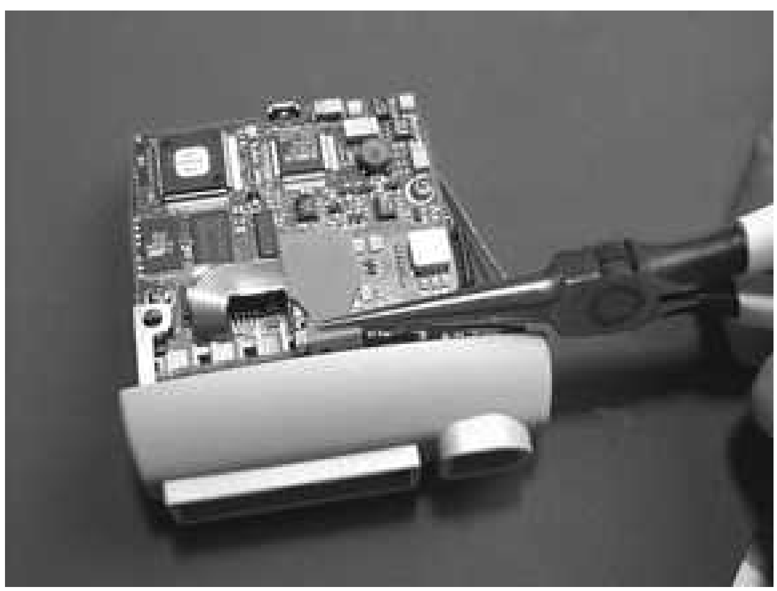


Figure 5-8 Disconnect the ECG PCB red tab connector

Step 3. Disconnect the SpO_2 connector cable from the side of the SpO_2 Board. See Figure 5-9. (For ECG only transmitters, skip this step.)

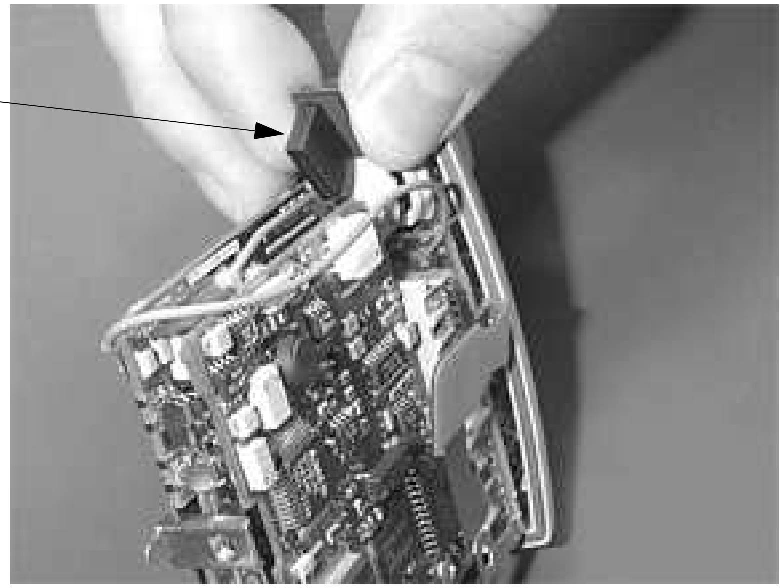


Figure 5-9 Disconnect the SpO_2 connector cable from the SpO_2

Step 4. Remove and discard the two screws securing the SpO_2 Board to the Main PCB. See Figure 5-10.

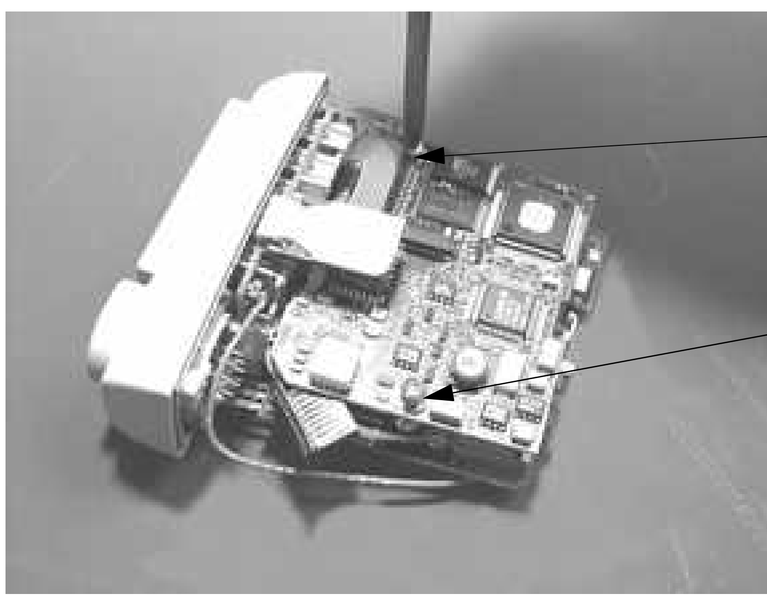


Figure 5-10 Remove the screws from the SpO_2 Board

Step 5. Lift up on the red tab connector and unfold the SpO_2 board from the Main PCB until the flex circuit tab and the collared connector it mates with are accessible. See Figure 5-11.

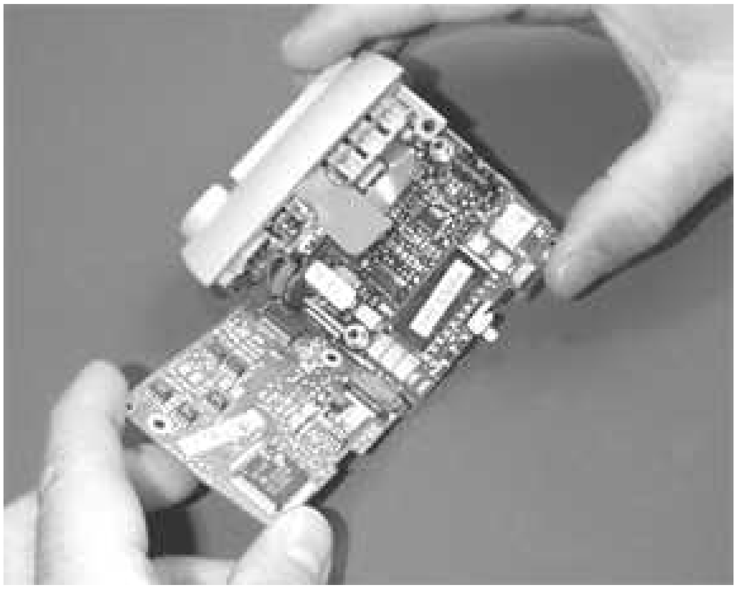


Figure 5-11 Unfold the SpO_2 Board from the Main PCB

Step 6. Slide the collar out and then hinge it up to release the flex circuit tab from the SpO_2 Board. See Figure 5-12. The SpO_2 Board is then free from the transmitter.

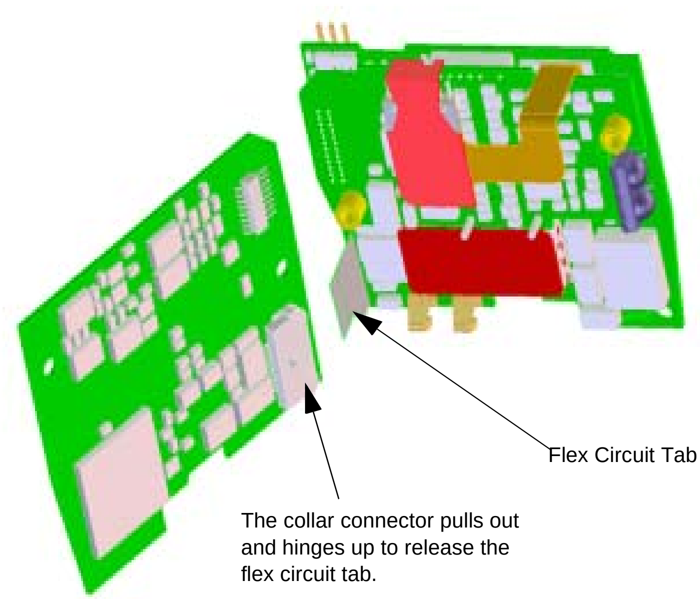


Figure 5-12 Releasing the Flex Circuit Tab

Removing the ECG PCB

To remove the ECG PCB, do the following. See Figure 5-13.

Note

The ECG PCB and the Main PCB will still be inside the lower cage brace and the Main PCB will still be connected to the Front End Assembly via the 3/5-lead switch connector and the RF Cable. Figure 5-13 shows the boards out of the Front End Assembly for clarity.

Step 1. Grab the Main PCB and the ECG PCB and carefully pull them apart to unplug them from each other. The ECG PCB is now free of the transmitter.

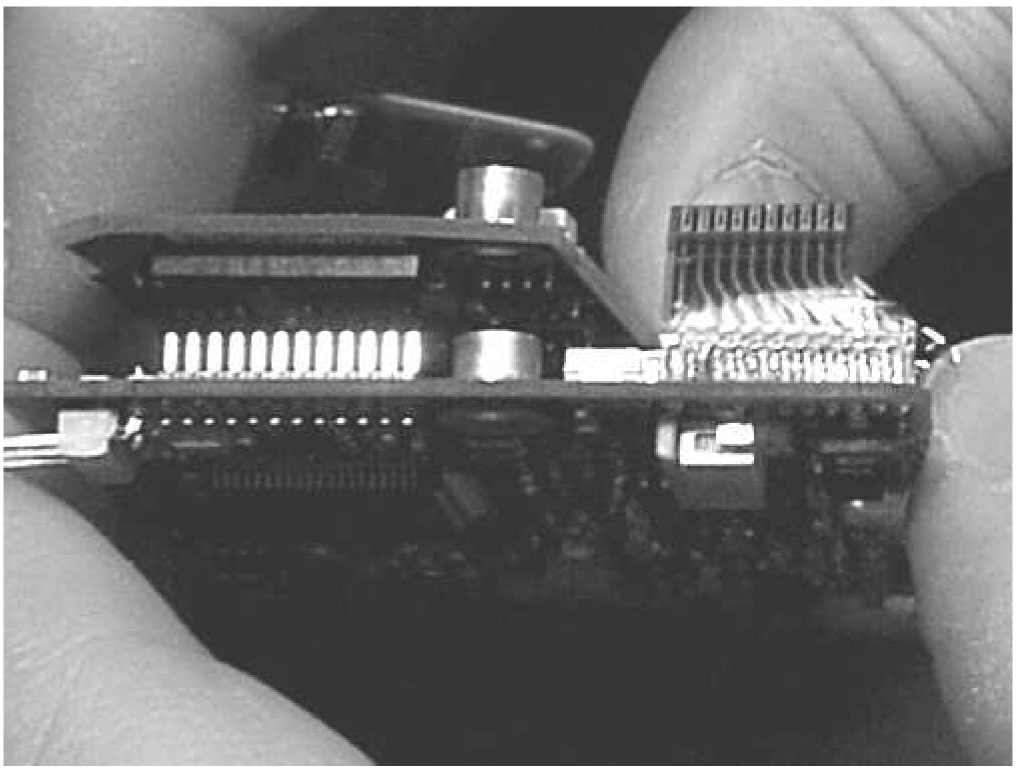


Figure 5-13 Pull the Main PCB and ECG PCB Apart

Removing the Main PCB and Front End Assembly

To remove the Main PCB and Front End Assembly, do the following. See Figure 5-14.

Step 1. Turn the transmitter over.

Step 2. Grab the flex circuit portion of the 3/5-lead switch connector gently with needlenose pliers for support and gently pull the Main PCB to disconnect the connector from the Main PCB.

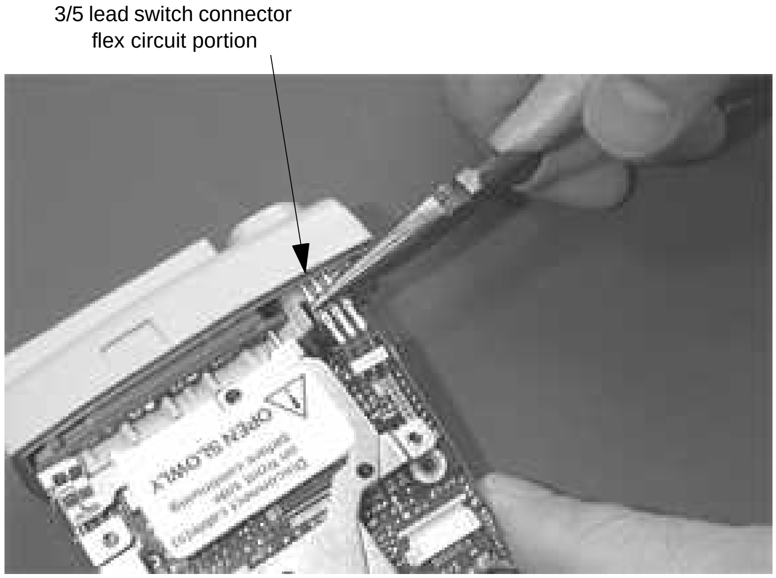
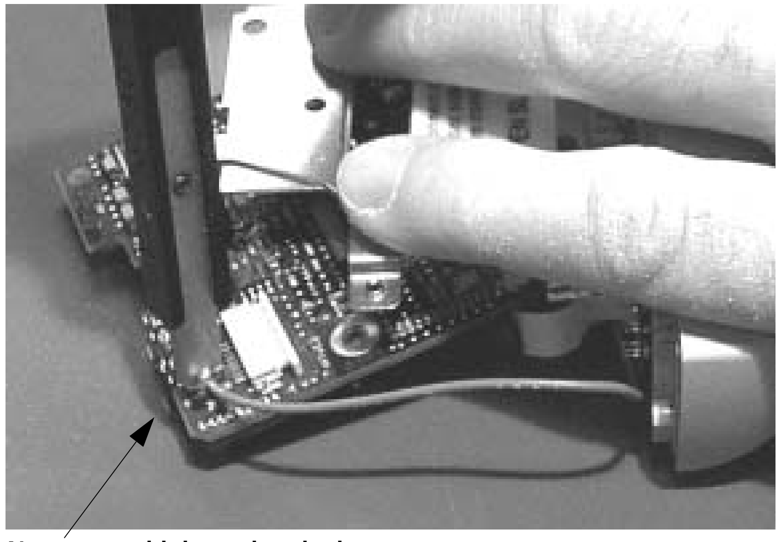


Figure 5-14 Grab the Flex Circuit with the Needlenose Pliers

Step 3. Disconnect the RF Cable from the Main PCB by sliding the RF Cable Tool over the connector and pulling it up from its connection on the Main PCB. See Figure 5-15. The Main PCB is now free of the Front End Assembly.

Caution **The Main PCB must be supported while performing this procedure.**

The power contacts can be deformed or broken by applying pressure on the Main PCB without support. See Figure 5-15.



Note: to avoid damaging the battery contacts, support
the Main PCB so it does not press on a hard surface.

Figure 5-15 Pull the RF Cable to Disconnect It from the Main PCB.

Step 4. Position the RF cable as shown in the Figure 5-16.

Step 5. Disconnect the RF Cable from the Front End Assembly using the RF Tool. Discard the RF Cable.

Note Because the RF Cable has been disconnected, it must be replaced.

The Front End Assembly and the Main PCB are now free and can be replaced as required.

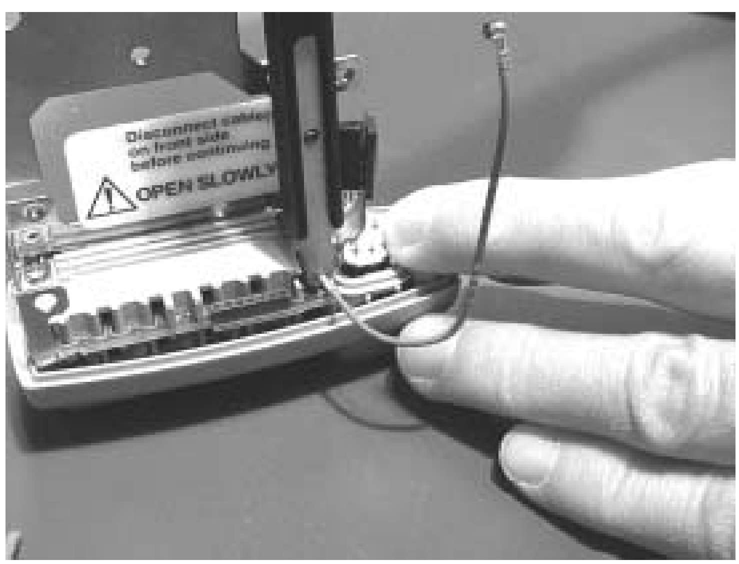


Figure 5-16 Disconnect the RF Cable from the Front End Assembly

Removing the Battery Contacts

To remove the Battery Contacts, do the following. See Figure 5-17 and Figure 5-18.

Note

The Battery Contacts can be removed without removing any other Transmitter subassemblies. Only the Battery Door must be removed.

The Battery Contacts do not need to be removed to access the internal transmitter electronics.

Step 1. Remove the Battery.

Step 2. Remove the Battery Door.

Step 3. Remove the 2 screws that secure the Battery Contacts to the Transmitter Case assembly using the #0 Pozidriv Screwdriver. Discard these screws.

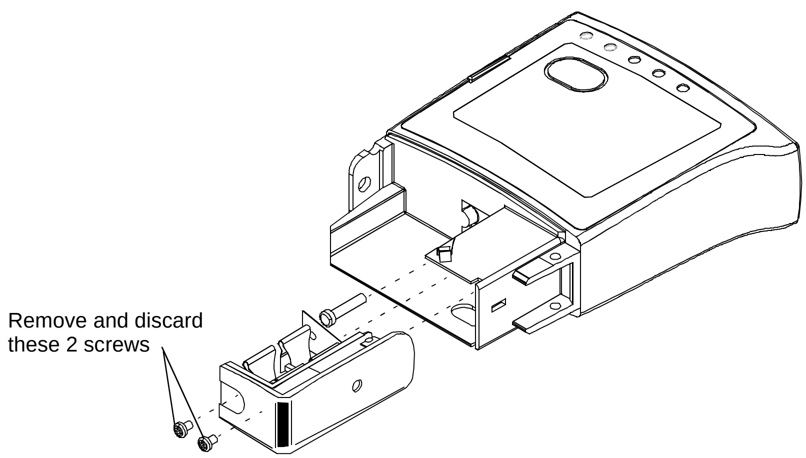


Figure 5-17 Removing the Battery Contacts

Step 4. Insert a small flat blade screwdriver into the opening between the contact cover and the case. See Figure 5-18.

Step 5. Twist the screwdriver counter clockwise. The battery contact assembly should release with applied pressure.

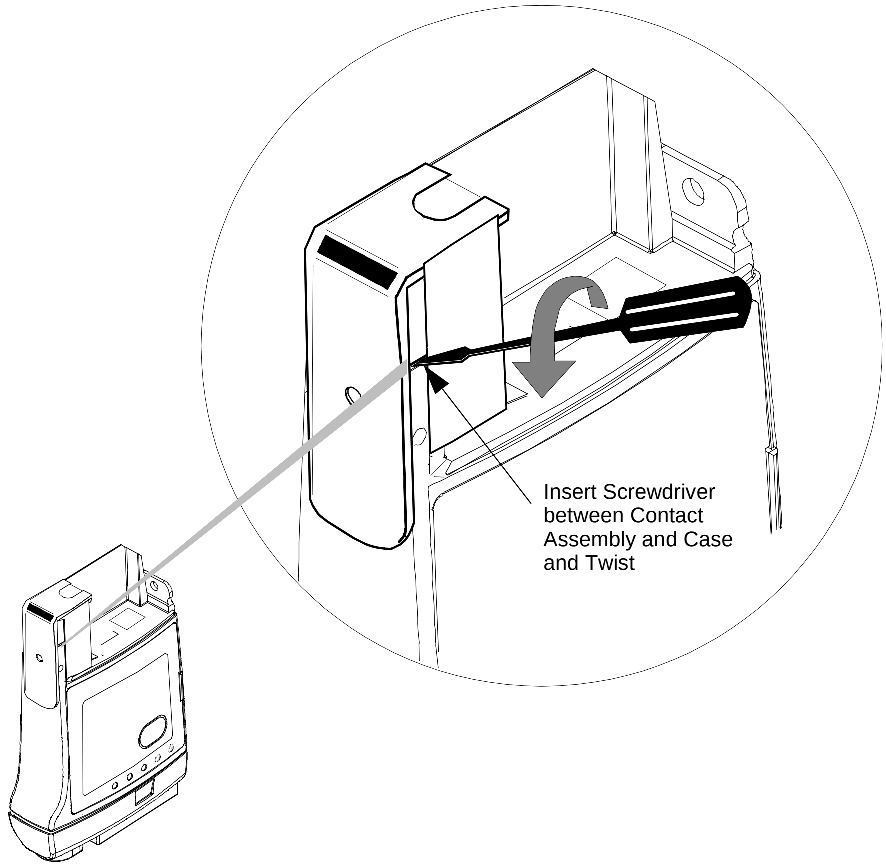


Figure 5-18 Removing the Battery Contact Assembly

6
Reassembling the Transmitter

Overview

Chapter 6 describes the procedure for reassembling a completely disassembled transmitter. It includes the following sections.

Note

If only a part of the transmitter that did not require a complete disassembly is being reassembled, go to the section that describes how to install that part and begin reassembly there.

Caution

The transmitter contains components that can be damaged if ESD precautions are not observed.

The transmitter can be damaged if it is not reassembled following the procedure given in this chapter. There are several details in transmitter assembly that are crucial to proper transmitter operation.

Failure to follow the procedures as presented can result in the transmitter not working.

Table 6-1 shows the damage that can occur to a transmitter if the listed cautions are not followed.

Table 6-1 is not all inclusive. Read the notes carefully as they are presented in the disassembly instructions. Failure to do so may result in the transmitter failing.

Table 6-1. Repair Mistakes and their Subsequent Failures

If...	Then...
Screws and O-ring are not replaced with replacements from the single-use screw kit	The transmitter can leak, causing failures on the circuit boards and requiring replacement of some or all of the boards.
The screws are not set to the appropriate torque	The transmitter can leak, causing failures on the circuit boards and requiring replacement of some or all of the boards.
The RF cable are not replaced every time they are disconnected. (this includes seating it properly and using the RF Cable Tool)	RF cable can pop off if the transmitter is dropped, resulting in the loss of the RF signal, requiring re-opening the transmitter and replacing the cable.
The SpO_2 flex circuit tab is not aligned properly	SpO_2 cannot be monitored, requiring re-opening the transmitter and properly connecting the flex circuit tab.

Table 6-1. Repair Mistakes and their Subsequent Failures

If...	Then...
The SpO_2 collared connector is not closed properly	The SpO_2 flex circuit tab can disconnect if the transmitter is dropped, requiring re-opening the transmitter and correcting the problem.
The 3/5 lead switch is not aligned properly	There can be leadset detection problems, requiring re-opening the transmitter and correcting the problem.
The red tab connector is not aligned properly	There can be ECG signal problems requiring re-opening the transmitter and correcting the problem.
The threaded hole on the Main Cage Brace is not positioned below the bracket on the Front End Assembly	The transmitter can leak, causing failures on the circuit boards, requiring replacement of some or all of the boards.
The plastic flap is not positioned on top of the Red Tab connector	The Red Tab connector can get caught between the Case Assembly and the Front End Assembly, resulting in damage to the mating connector on the Front End Assembly and requiring replacement of the Front End Assembly.
The O-ring is not seated properly	The transmitter can leak, causing failures on the circuit boards and requiring replacement of some or all of the boards.
The O-ring groove are not cleaned before the O-ring is replaced	The transmitter can leak, causing failures on the circuit boards and requiring replacement of some or all of the boards.
The collared connector for the ribbon cable is not closed from the Case Assembly to the Main PCB properly	Ribbon cable can disconnect if the transmitter is dropped, requiring re-opening the transmitter and correcting the problem.
The ribbon cable from the Case Assembly to the Main PCB is not aligned properly	Leads Off LEDs and patient button problems can occur, requiring re-opening the transmitter and correcting the problem.
Debris is not removed from the screw hole in the Case Assembly	The transmitter can leak, causing failures on the circuit boards, requiring replacement of some or all of the boards.
The foam on the SpO_2 cable connector in the Blank Board is not captured. (ECG Only transmitters)	The foam can fall off. This can cause shorts resulting in PCB failures, requiring replacement of some or all of the boards.
The flex circuit tab is not folded under the Blank Board properly (ECG Only transmitters)	This can cause shorts resulting in PCB failures, requiring replacement of some or all of the boards.

Note Whenever servicing the telemetry system, be certain to verify the compatibility of the software and hardware. See Chapter 3 for additional information about software and hardware compatibility.

Tools Required

Table 6-2 lists the tools that are required to reassemble the transmitter.

Table 6-2. Required Tools (for all countries except Japan)

Tool
Needle-nose Pliers
Torque driver capable of 2, 3, and 6 inch-pounds (.23, .34, and.68 joules) (such as Philips PN 1535-2653)
Size 1 Pozidriv bit for torque driver - 3-inches long (approx 76 mm)
Japan Only: Special bit for the main case screw to fit the torque driver (Philips PN 5966-5066)
RF Cable Tool (M2601-67002)
Single-use Screws and O-ring Kit (Philips PN M2601-68302)
Size 0 Pozidriv screwdriver (for battery contacts)
Battery Contact Screw Holding Tool (useful but not required)
HP OmniBook 800C or HP OmniBook 4150 PC with capability of running DOS
Telemetry Service Tool Software (M2600-67013)
Serial-to-Infrared Converter (M2601-63010, M2601-63020)
Appropriate revision of Transmitter Main PCB Firmware floppy disc
Appropriate revision of Transmitter SpO_2 PCB Firmware floppy disc
M2605A Wave Viewer (useful)

Single-Use Screw Kit

To assure that the transmitter works and remains water-resistant, all of the screws and the O-ring must be replaced with ones from the single-use screw kit (PN M2601-68302, all countries except Japan; M2601-68304 for Japan only)

Each screw is treated with an adhesive material that assures that the internal parts of the transmitter stay connected with mechanical robustness. Each single-use screw kit comes with 2 of each screw and a replacement O-ring for the transmitter.

Caution

Whenever disassembling the Case Assembly from the Front End Assembly, the O-ring must be replaced before reassembly.

All of the screws removed during disassembly must be discarded and replaced with new screws from the single-use screw kit during reassembly.

If the RF Cable is disconnected, it must be replaced. The RF Cable must be removed whenever the Main PCB or Front End Assembly are removed. The RF Cable is not part of the Single Use Screw Kit, but comes with a replacement Front End Assembly and Main PCB.

Failure to replace the O-ring, screws, and RF Cable can result in the transmitter not working or leaking and can lead to early failure of the transmitter's internal assemblies.

Torque Requirements

When reassembling the transmitter, the screws must be reinstalled as shown in Figure 6-1 to the torque specified. This is required to assure that the electronic assemblies connect properly and that the transmitter remains water-resistant.

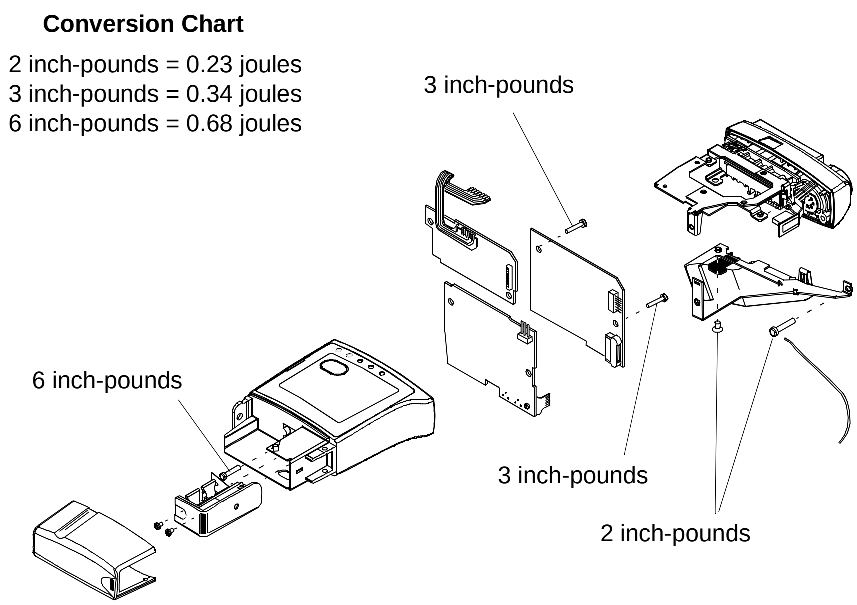


Figure 6-1 Torque Requirements

Procedure

Figure 6-1 gives an overview of the procedure to follow when reassembling the transmitter after removing or replacing any of its subassemblies. For an exploded view of the transmitter, see Figure 6-1.

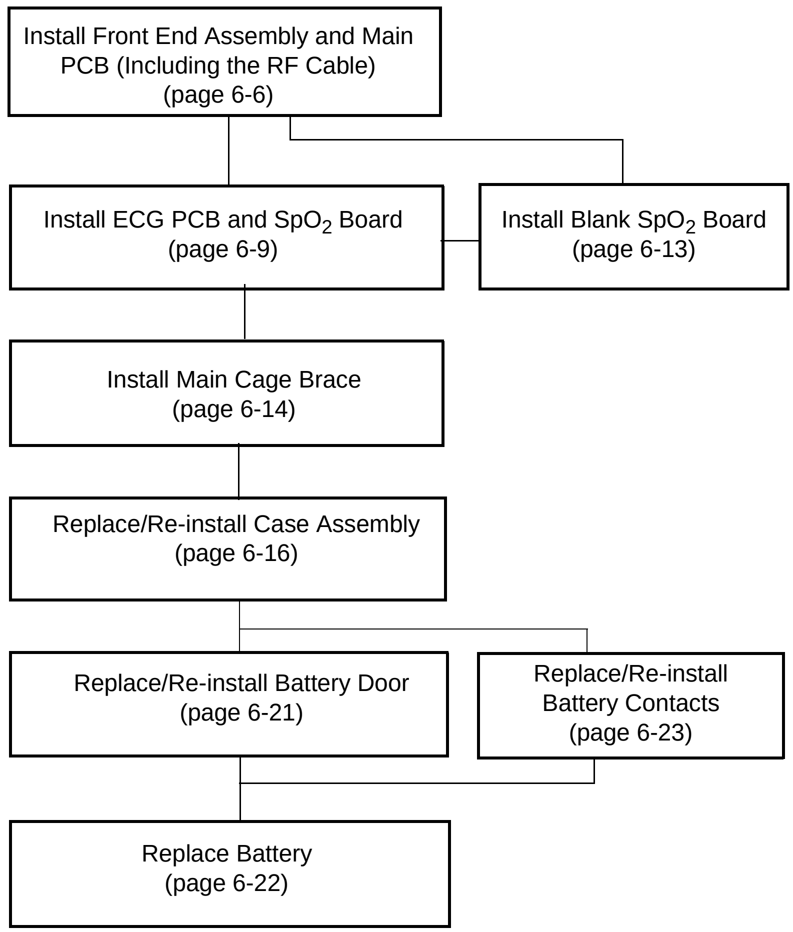


Figure 6-1 Transmitter Re-Assembly Overview

Installing the Front End Assembly and Main PCB

The first step in Transmitter re-assembly is to install the Front End Assembly and Main PCB, including the RF Cable. To install these components, do the following.

Note When replacing the Main PCB, the transmitter must be reconfigured and the compatibility of software and firmware verified.

Step 1. Move the SpO2 connector cable out of the way and place the Main PCB into the lower cage brace on the Front End Assembly. The Main PCB should be oriented so the 24-pin connector to the ECG PCB is facing up. See Figure 6-2.

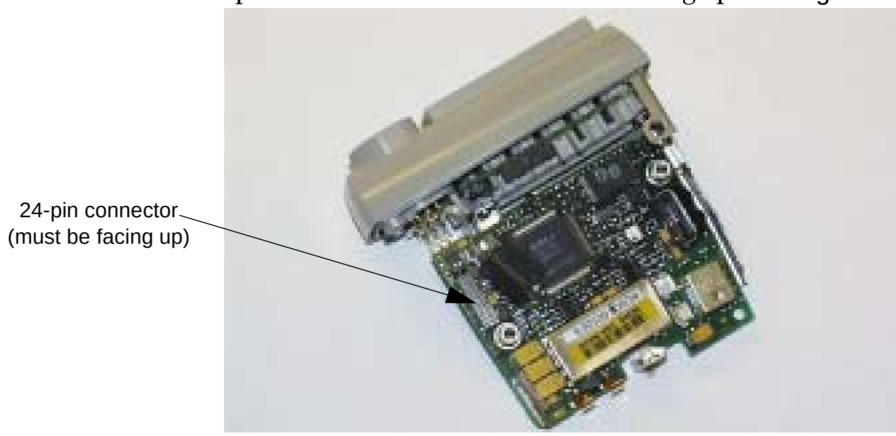


Figure 6-2 The 24-pin Connector

Step 2. Turn the Front End Assembly over so the 3/5 lead switch connector is on top.

Step 3. Grab the flex circuit side of the 3/5 lead switch connector gently with needle-nose pliers and gently insert the plug on the Main PCB into its connector. Make certain that all pins are plugged-in. See Figure 6-3.

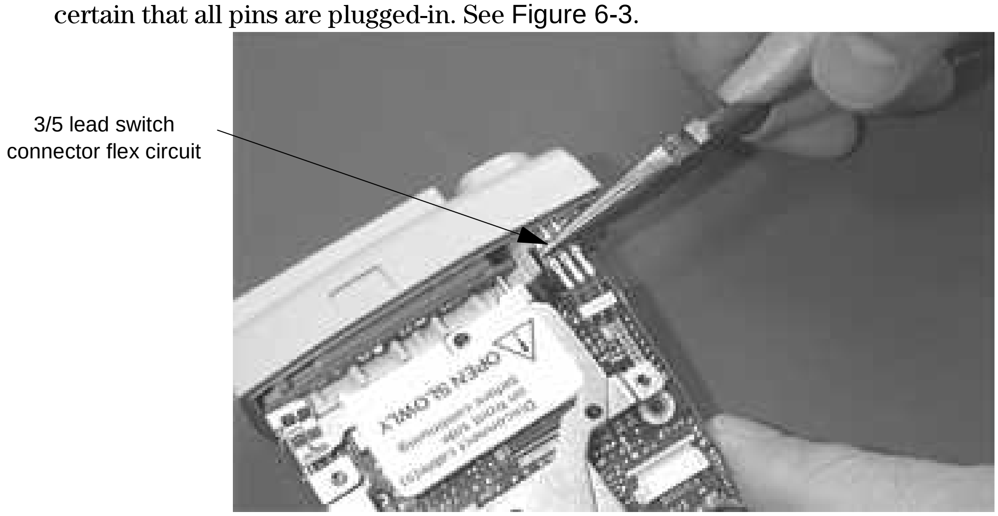


Figure 6-3 Hold the Lead Switch Gently

Step 4. A replacement RF Cable must now be connected to both the Front End Assembly and Main PCB.

Caution **The RF Cable must be replaced whenever the Main PCB or Front End Assembly has been removed. The RF Cable is included with a replacement Front End Assembly and Main PCB.**

Step 5. Place one end of the new RF Cable into the RF Cable Tool.

Step 6. Place the cable end over the connector in the Front End Assembly and push the cable end into place. See Figure 6-4.

Step 7. Pull on the cable to make certain it is seated and securely connected.

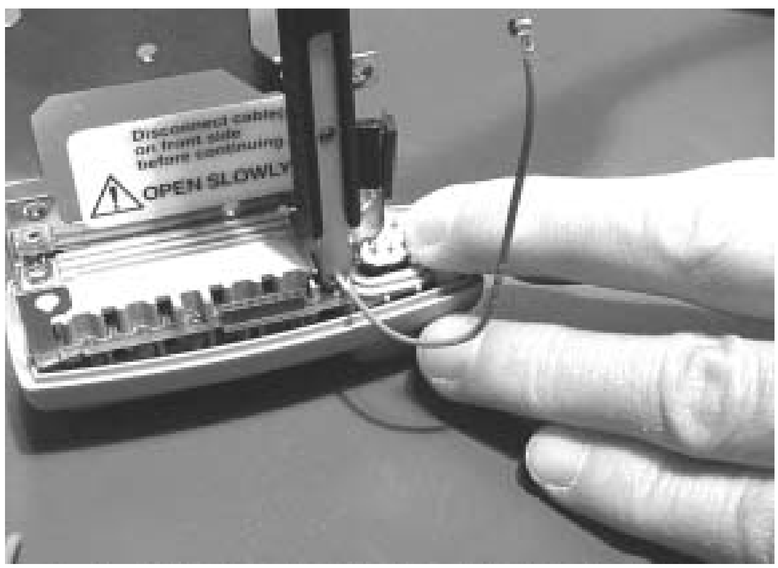


Figure 6-4 Install new RF Cable using the RF Cable Tool

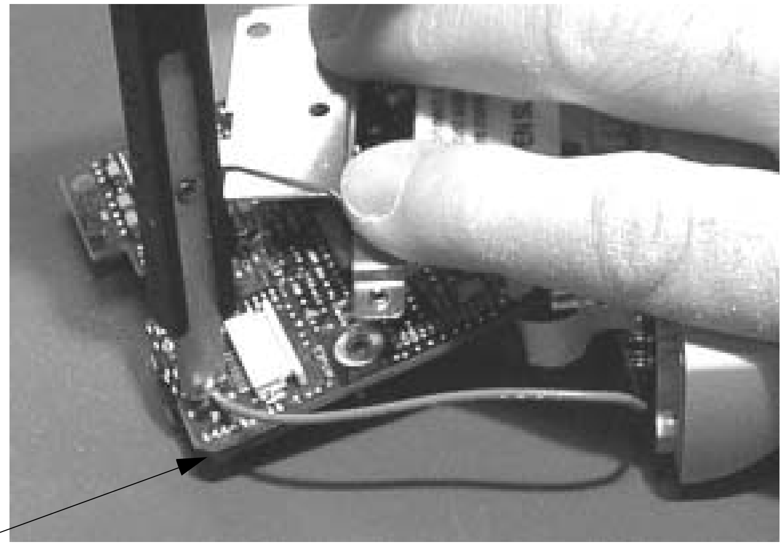
Step 8. Hold the Main PCB in place and turn the assemblies over to access the RF Cable connector on the Main PCB.

Step 9. Place the free end of the RF Cable into the RF Cable tool.

Step 10. Plug the RF Cable into the RF connector on the Main PCB. See Figure 6-5.

Step 11. Pull on the RF Cable to make certain it is firmly attached in both places.

Caution **The Main PCB must be supported while performing this procedure. The power contacts can be deformed or broken by applying pressure on the Main PCB without support. See Figure 6-5.**



Note: to avoid damaging the battery contacts, support the Main PCB Board so that it does not press on the hard surface.

Figure 6-5 Plug the RF Cable into the RF Connector on the Main PCB

Installing ECG PCB and SpO_2 Board

To install the ECG and SpO_2 boards, do the following.

Note

If the transmitter is not intended for SpO_2 capability, there is a blank board instead of the SpO_2 Board. See the next section, Re-installing a Blank SpO2 Board on page 6-13, for how to install a blank board. Then return to Step 7 of this procedure.

Step 1. Hold the SpO2 connector cable out of the way and line up the 24-pin male plug-in connector on the Main PCB and the female plug-in connector on the ECG PCB. See Figure 6-6.

Step 2. Plug the boards together. Make certain the connectors on the boards are not mismated.

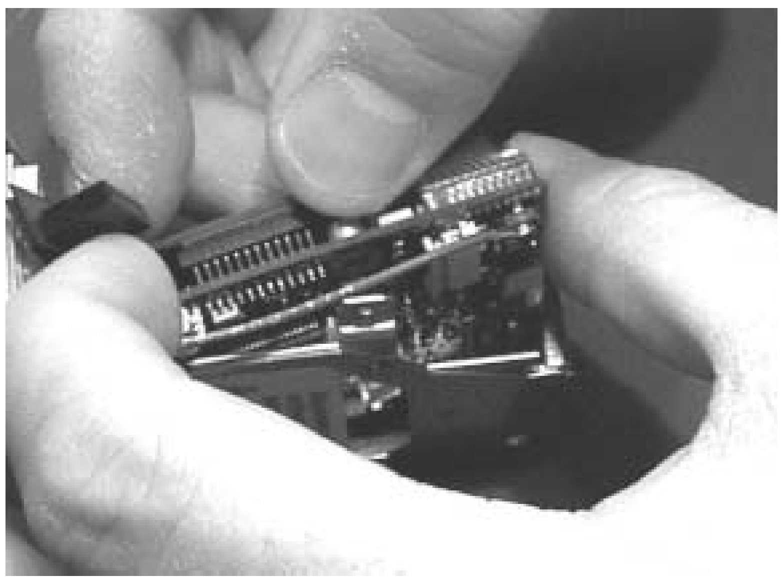


Figure 6-6 Line up the 24-pin plug

Step 3. Locate the collared connector on the SpO_2 Board.

Step 4. Prepare the connector by pulling the collar out and hinging it up.

Step 5. Connect the Main PCB to the SpO_2 Board by placing the flex circuit tab into the collared connector, hinging the collar down, and pushing it in. Make certain the alignment marks on the flex circuit tab are almost under the collared connector (See Figure 6-7). If they are not, repeat this step.

Step 6. Pull gently on the flex circuit tab to make certain the collared connector is latched securely.

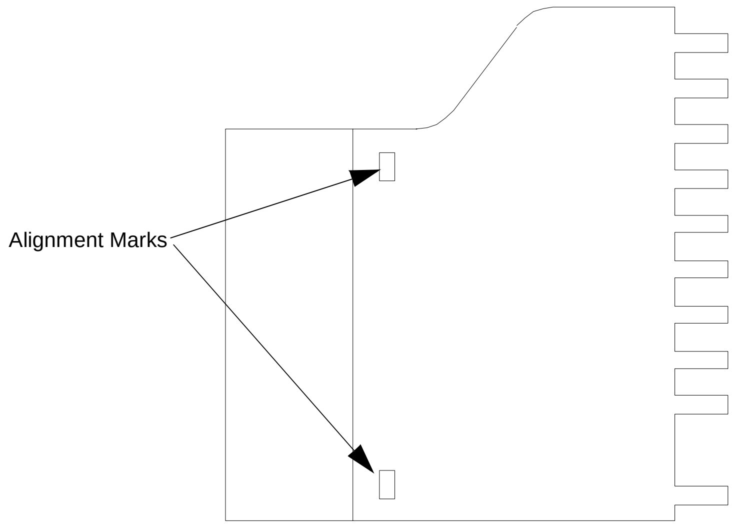


Figure 6-7 Alignment Marks on the Flex Circuit

Step 7. Hold the red tab connector on the ECG PCB out of the way and fold the SpO_2 board onto the other boards. See Figure 6-8.

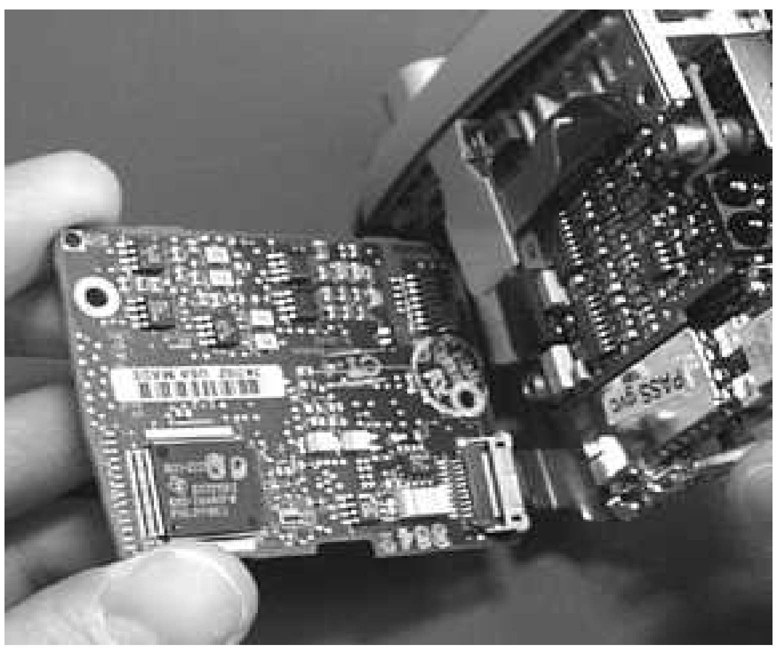


Figure 6-8 Connect the Main PCB to the SpO_2

Step 8. Secure the SpO_2 Board to the Main PCB using 2 of the longest screws from the single-use screw kit. Use a torque driver and set the torque for these screws to 3 inch-pounds (.34 joules). See Figure 6-9.

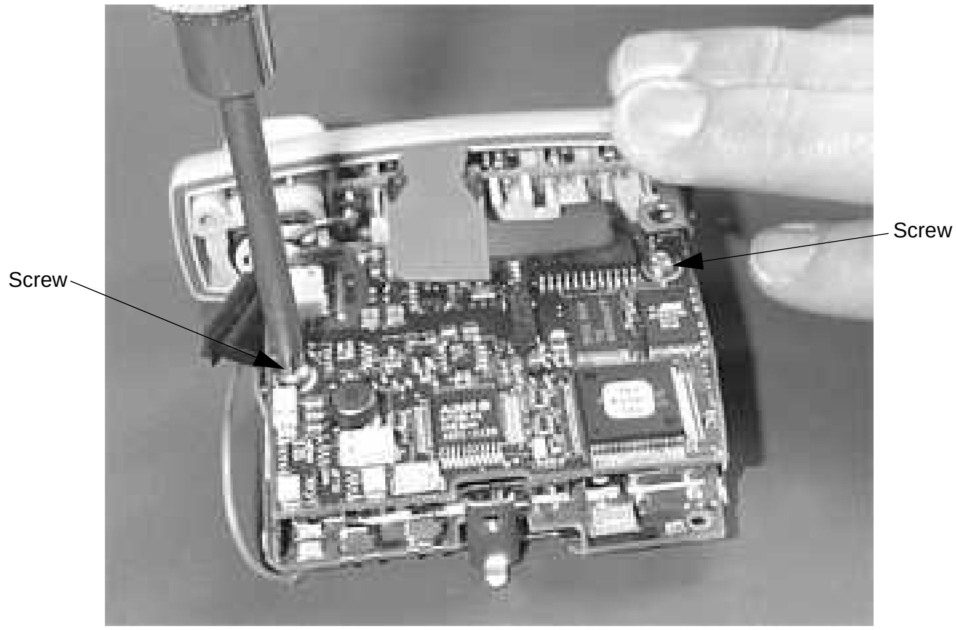


Figure 6-9 Secure the SpO_2 Board

Step 9. Connect the SpO_2 connector cable to the side of the SpO_2 Board. The connector is keyed so t cannot be inserted incorrectly. See Figure 6-10.

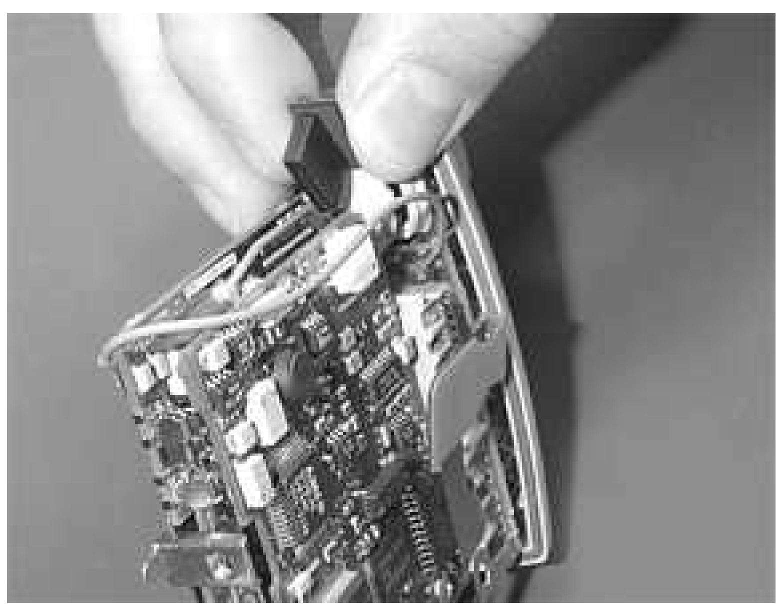


Figure 6-10 Connect the SpO_2 Connector Cable

Step 10. Plug the ECG PCB into the connector on the Front End Assembly by placing the red tab connector over the plug-in connector and inserting the plug into the connector. When doing this, the red tab connector snaps into place. Make certain the plug-in connector is not mismated.

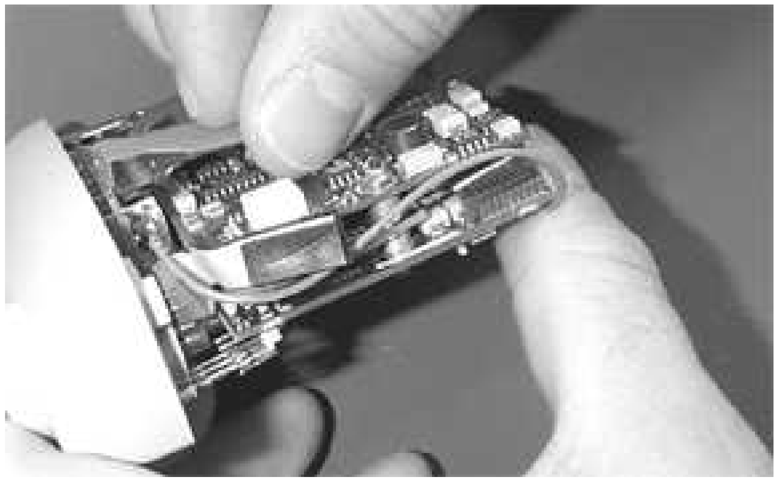


Figure 6-11 Plug the ECG PCB into the Connector

Re-installing a Blank SpO_2 Board

If the transmitter is not capable of monitoring SpO_2 (ECG-only), the transmitter has a blank board in place of the SpO_2 Board. To re-install the blank board, do the following. Then return to Step 7 of the previous procedure.

Step 1. Slide the top of the SpO2 cable connector into its retaining slot on the Blank Board. When sliding the connector into the slot, make certain to capture the foam portion of the connector.

Note A common problem is that the foam on the SpO_2 cable connector has not been captured in the slot provided in the Blank Board. Make certain the foam is captured before proceeding with the re-assembly procedure.

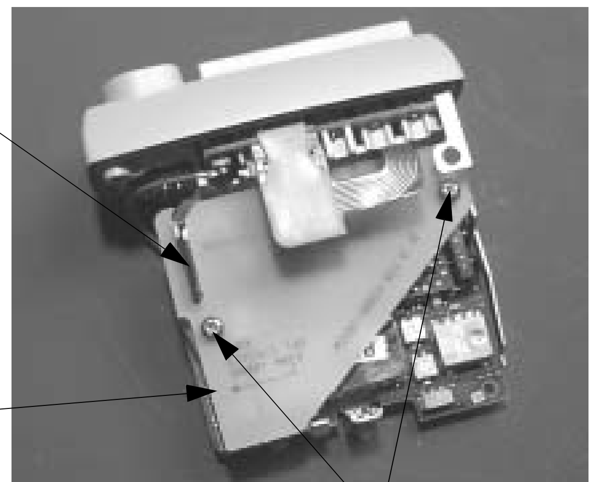


Figure 6-12 Installing a Blank SpO_2 Board

Step 2. Place the Blank Board under the Red Tab Connector.

Step 3. Fold and tuck the flex circuit tab under the blank board.

Step 4. Secure the Blank Board, ECG PCB, and Main PCB in place using the 2 longest screws in the single-use screw kit. Set the torque of these screws to 3 inch-pounds (.34 joules).

Step 5. Return to **Step 7** of the previous procedure for Installing ECG PCB and SpO2 Board on page 6-9.

Installing the Main Cage Brace

To install the Main Cage Brace, do the following.

Caution **The yellow plastic flap on the Main Cage Brace MUST go over the red tab connector. Failure to do this can cause the Front End Assembly to ECG PCB connector to be broken when the Case Assembly is installed. This will result in the transmitter not working and require replacement of the Front End Assembly and/or ECG PCB.**

Step 1. Lift the yellow plastic flap and place the Main Cage Brace under the red tab connector. See Figure 6-13.

Step 2. Align the Main Cage Brace with its mounting holes and place the yellow plastic flap over the top of the red tab connector. When aligning the holes, the threaded hole on the Main Cage Brace must be positioned **below** the bracket on the Front End Assembly.

Note When positioning the Main Cage Brace, be certain the Ground Clip comes into contact with the gold top of the RF Cable.

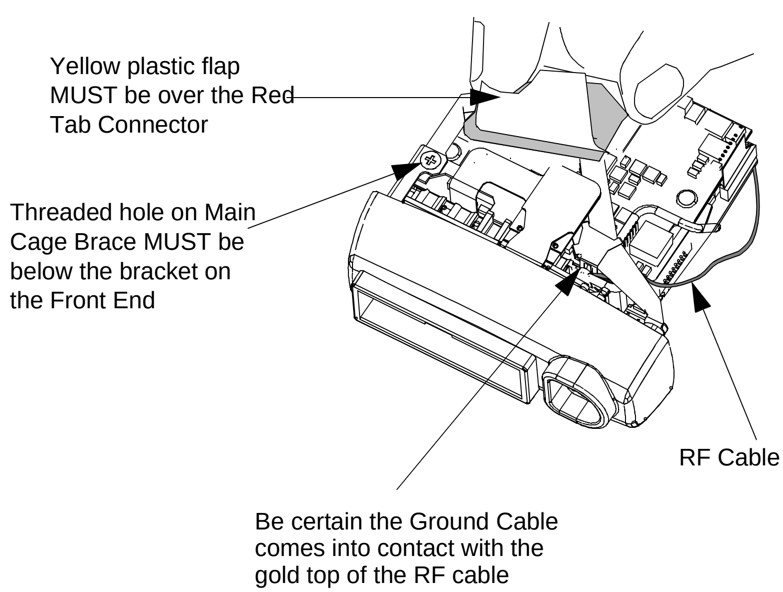


Figure 6-13 Lift Yellow Flap Over Red Tab Connector

Step 3. Fit the tab from the lower cage brace into the slot on the Main Cage Brace. See Figure 6-14.

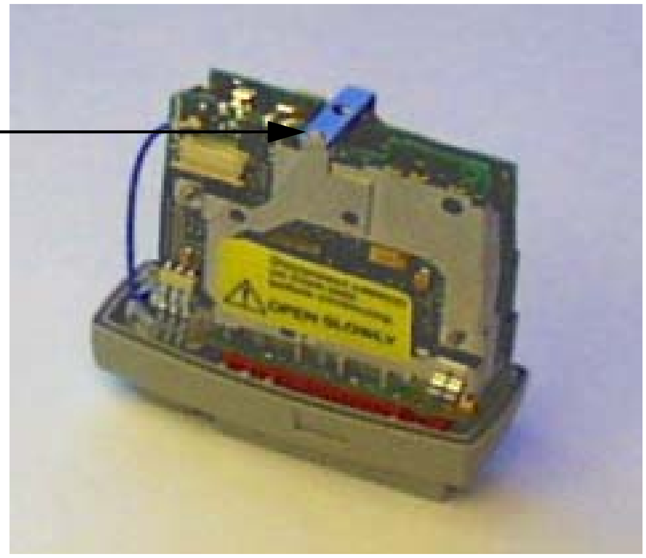


Figure 6-14 Fit the tab into the slot

Step 4. Route the RF Cable as shown in Figure 6-15.

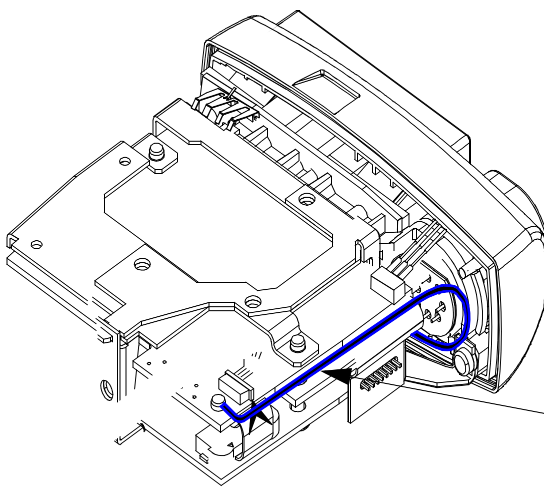


Figure 6-15 Route the RF Cable

Step 5. Secure the Main Cage Brace in place using the 2 screws (1 long and 1 short flathead) from the single-use screw kit. Use a torque driver and set the torque of these screws to 2 inch-pounds (.23 joules). Make certain the RF cable does not get caught under the screw or the lower cage brace. See Figure 6-16.

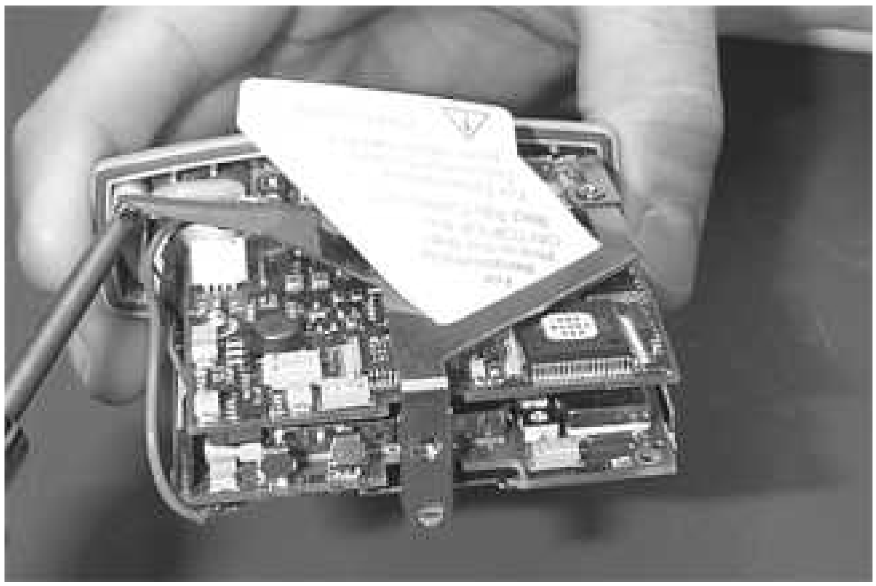


Figure 6-16 Secure the Main Cage Brace

Replacing/ Re-installing the Case Assembly

To replace or re-install the Case Assembly, do the following.

Note

Before assembling the Case Assembly, check the RF Cable again. It must be routed as shown in Figure 6-15 before securing the Case Assembly to the Front End.

Step 1. Install the O-ring from the single-use screw kit into the groove in the Front End Assembly. See Figure 6-18. The O-ring must be installed without twists or kinks.

Note

The O-ring has a narrow end and a wide end. See Figure 6-17. This corresponds to the narrow and wide ends on the Transmitter Front End Assembly. For the O-ring to seat properly, the wide and narrow ends must be matched up properly.

Clean the groove for the O-ring before installing the O-ring.

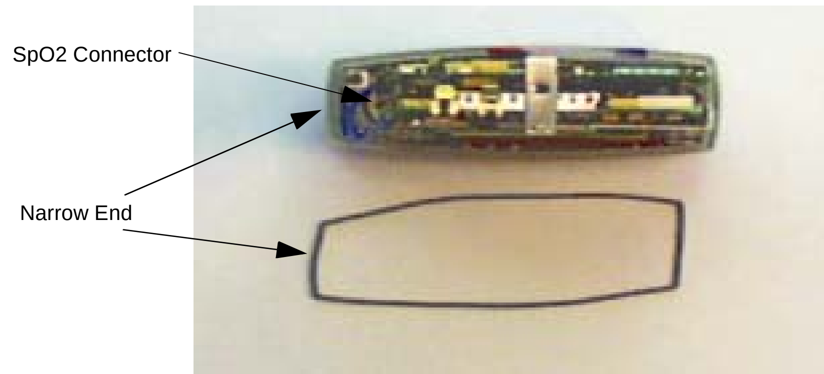


Figure 6-17 O-ring and SpO_2 Connector

Figure 6-18 Grove in Front End for O-ring

Step 2. Pull the collared connector on the Main PCB out and hinge it up.

Step 3. Place the ribbon cable from the Case Assembly into the collared connector on the Main PCB.

Step 4. Hinge the collar down and push it in to secure the ribbon cable in place. See Figure 6-19.

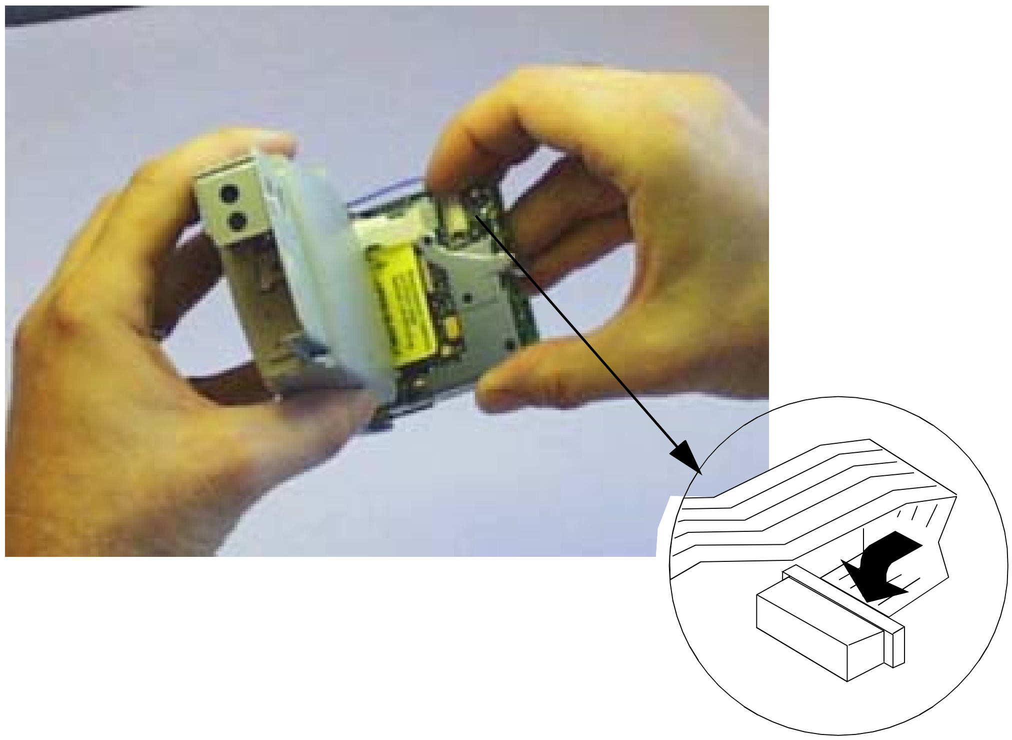


Figure 6-19 Hinge Collar Down and Push In

Step 5. Gently press and hold the red flex connector and its cable (including the yellow plastic flap) toward the circuit boards and slide the Case Assembly over the internal electronics until it butts up against the Front End Assembly. Make certain the O-ring has not moved or twisted and that the RF Cable is routed correctly. See Figure 6-20.

Figure 6-20 Press and Hold the red flex Connector

Caution

Damage to the mating connector on the Front End Assembly can occur if the red tab connector cable gets caught between the Case Assembly and the Front End Assembly.

Make certain that the yellow plastic flap on the Main Cage Brace is over the top of the red tab connector on the Front End Assembly to ECG PCB connector before sliding the Case Assembly and the Front End Assembly together. Failure to do this can break the connector and require costly repairs to the transmitter.

Step 6. Secure the Case Assembly in place using one of the sealing screws from the single-use screw kit. This screw must be replaced each time the transmitter is opened.
Use a torque driver and set the torque for this screw to 6 inch-pounds (.68 joules). See Figure 6-21.

Step 7. When the screw is in place, check the space between the Front End Assembly and the Case Assembly to make certain that no part of the O-ring between the two is showing. If any part of the O-ring is showing, remove the screw, check and adjust the O-ring, and use a new screw to secure the pieces together.

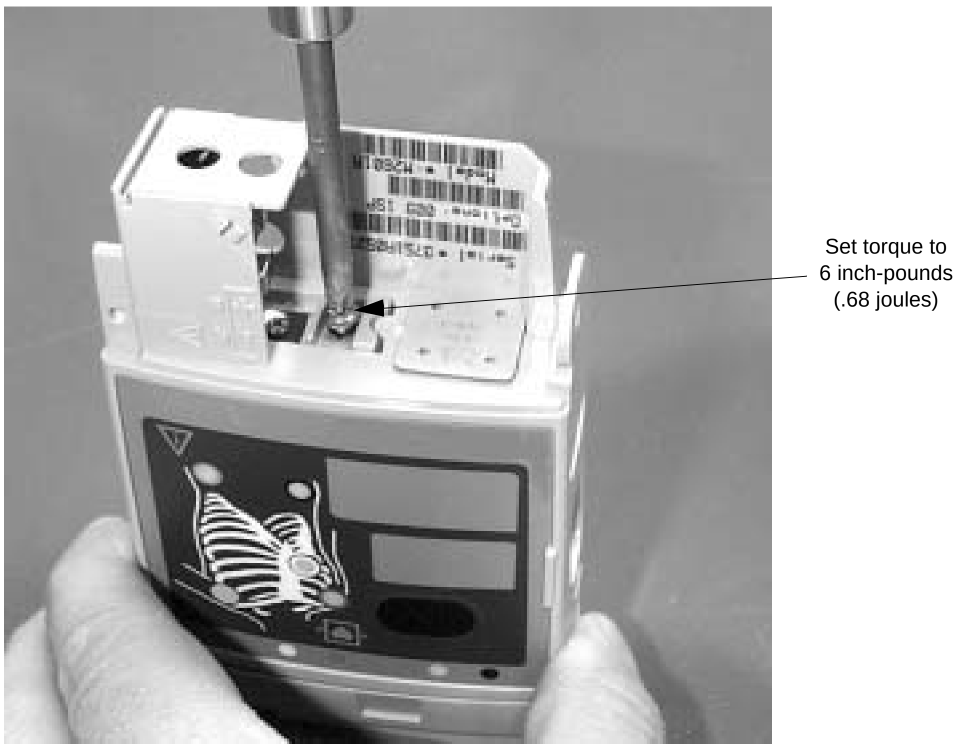


Figure 6-21 Secure the Case Assembly

Replacing/ Re-installing the Battery Door

To replace or re-install the Battery Door, do the following.

Step 1. Align the Battery Door with the bottom of the transmitter. See Figure 6-22.

Step 2. Push the door until it snaps into place.

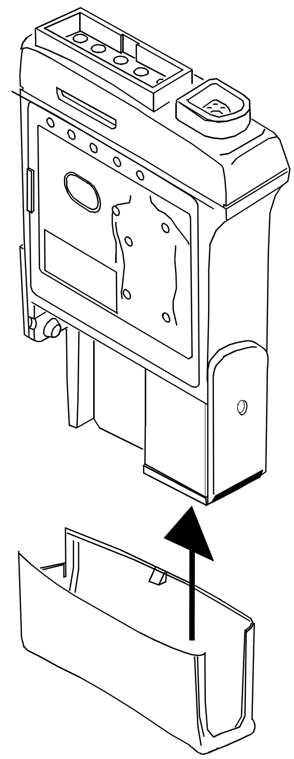


Figure 6-22 Align the Battery Door

Replacing the Battery

To replace the Battery, do the following.

Step 1. Align the terminals of the battery correctly with the battery contacts. See Figure 6-23.

Step 2. Snap the battery into place.

Step 3. Close the battery door.

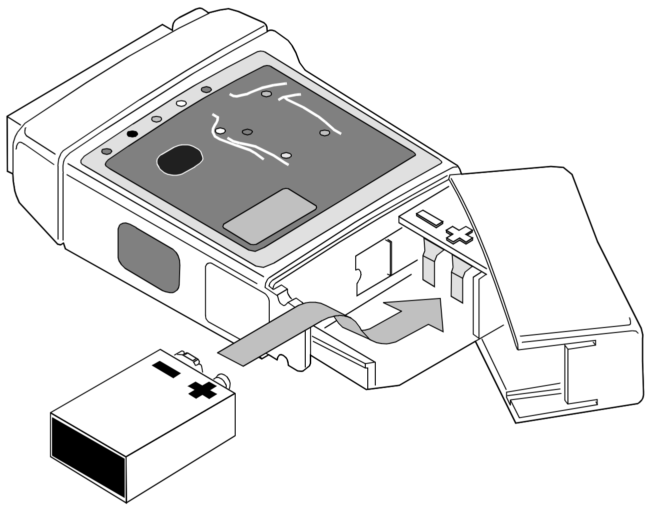


Figure 6-23 Align the Terminals Correctly Before Installing Battery

Replacing/ Re-installing the Battery Contacts

To replace or re-install the Battery Contact, do the following.

Caution **The screws that come with the new Battery Contacts must be used.**

Step 1. Slide the Battery Contacts into the bottom of the Case Assembly until the retaining pins snap into place. See Figure 6-24.

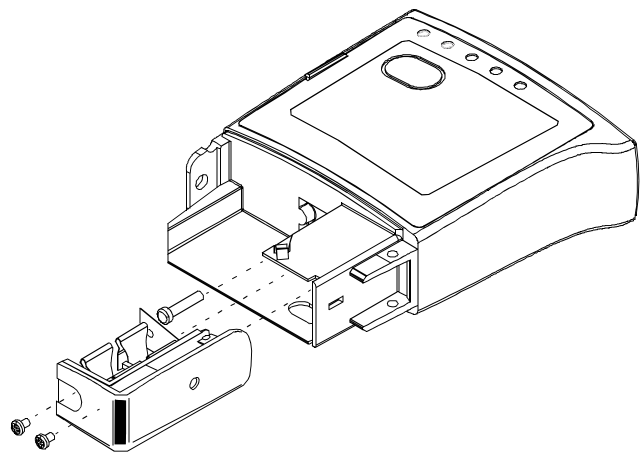


Figure 6-24 Slide the Battery Contacts into the Case Assembly

Step 2. With the pointed-tip of the battery contact screw-holding tool in the extended position, position one of the battery contact screws on top of the tip so that the tip fits in the cross on the screwhead.

Step 3. Push the screw down firmly so that the tip of the tool expands to hold the screw in place.

Step 4. Position the battery contact screw in place using the battery contact screw tool.

Step 5. Tighten the screw one complete turn to start the screw in the thread. **DO NOT USE THE TOOL TO SCREW THE SCREW IN COMPLETELY.**

Step 6. Secure the Battery Contacts to the Case Assembly using a #0 Pozidriv screwdriver. See Figure 6-25.

Caution **If excessive force (>1 inch-pound) is used to tighten the screws for the Battery Contacts, they can become damaged and need to be replaced.**

Figure 6-25 Use the #0 Pozidriv Screwdriver to Tighten the Screw

Step 7. Perform Steps 2 through 6 for the other screw.

Step 8. Re-install the Battery Door.

Step 9. Re-install the Battery.

Post Assembly Tasks

After any transmitter subassemblies have been replaced, its software upgraded, or its frequency options changed during a repair or upgrade, there are specific tasks that must be performed to make certain that the transmitter is labelled properly and working correctly.

Following are the post assembly tasks.

- Replace the following labels as indicated in Table 6-3.

Table 6-3. Transmitter Labels Requiring Replacement

Part Number	Description	Replace when ...
M2601-83021	Blank Serial Number label	Case Assembly has been replaced or changed **Note:** Use indelible ink to transfer original Serial Number
M2601-83061	Series B or Series C label	original shipped software as been changed
5969-3925	FCC 007 USA label	Case Assembly has been replaced on a 460 - 470 MHz transmitter, Option 007 (USA only)
5969-3926	FCC 020 USA label	Case Assembly has been replaced or transmitter is being upgraded from 460 - 470 MHz to WMTS 608 - 614 MHz (USA only)
M2601-83202	PTT label (France only)	Case Assembly has been replaced on a transmitter used in France
M2601-83300	PTT international label, except France, Canada, Italy, Brazil	Case Assembly has been replaced on a transmitter used in international countries except France, Canada, Italy, and Brazil
M2601-83321	PTT label Canada, Italy, and Brazil	Case Assembly has been replaced on a transmitter used in Canada, Italy, and Brazil

- Check the compatibility of the hardware/software/firmware. See Chapter 1 for additional information.
- Ensure that the configuration matches the other transmitters on the unit.

Note If this is an SpO_2 or EASI transmitter, the SpO_2 and EASI features can only be enabled using the Service Tool.

- Set the transmitter frequency and do a Learn Code if required.
- Test the transmitter following the procedures described in the Philips Telemetry System Test and Inspection Guide.

7
Disassembly/Assembly of Receiver Mainframe Components

Overview

Chapter 7 describes the disassembly/assembly of Receiver Mainframe components, including the Receiver Mainframe and Receiver Modules. It includes the following sections.

Caution

Parts can be damaged if not disassembled according to the procedures given in this chapter. Failure to follow the instructions as presented can result in a malfunction or unspecified behavior.

Disassembly/Assembly of the Receiver Mainframe

This section contains procedures for disassembling the Receiver Mainframe in order to replace failed assemblies.

Tools Required

The following tools are required to disassemble the Receiver Mainframe

Table 7-1. Tools Required to Disassemble the Receiver Mainframe

Tool
Pozidriv Screwdriver
Adjustable Wrench
1/4” (6mm) Wrench
EEPROM Chip Extraction Tool (M1186-45001)
CPC Programming Tool (M2300-67100)
Telemetry Receiver Mainframe Software FLASH card, appropriate revision
HP OmniBook 800 or HP OmniBook 4150 PC with the capability of running DOS
Telemetry Service Tool Software (M2604-67013)
RS-232 PCB (M1085-66501)
RS-232 Cable, Hewlett-Packard 24542G or 9-pin female to 9-pin female modem cable (F1047-80002) plus 9-pin male to 25-pin male printer adapter (5181-6640). Both pieces can be found in the Hewlett-Packard F1023A Connector Kit.

Procedures

Removing Function Cards

To remove Function Cards, do the following. See Figure 7-1.

Step 1. Disconnect any cables from the Function Card to be removed.

Step 2. Remove the 1 screw and lock washer that secures the Function Card to the Receiver Mainframe.

Note

When removing the Analog Output Function Card, the cable from the top of the card must also be disconnected.

Step 3. Pull the function card from the rear of the Receiver Mainframe.

Step 4. Repeat this procedure for each function card being removed.

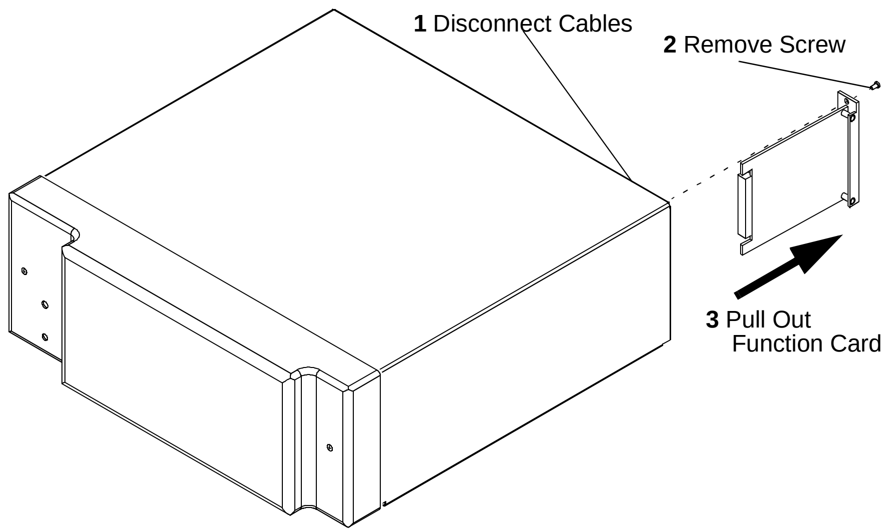


Figure 7-1 Removing the Function Cards

Replacing Function Cards

To replace a Function Card, do the following.

Step 1. Push the Function Card into its slot at the rear of the Receiver Mainframe.

Note

When replacing the Analog Output Function Card, the cable on the top of the card must first be connected.

Step 2. Secure the Function Card to the Receiver Mainframe using 1 screw and 1 lock washer.

Step 3. Connect cables as required to the Function Card.

Step 4. Repeat this procedure for each Function Card being replaced.

Removing the Front Dress Cover

The first step in disassembling the Receiver Mainframe is to remove the Front Dress Cover. See Figure 7-2.

Step 1. Loosen the 2 quarter-turn screws on the front of the Receiver Mainframe.

Step 2. Remove the front dress cover from the front of the Receiver Mainframe.

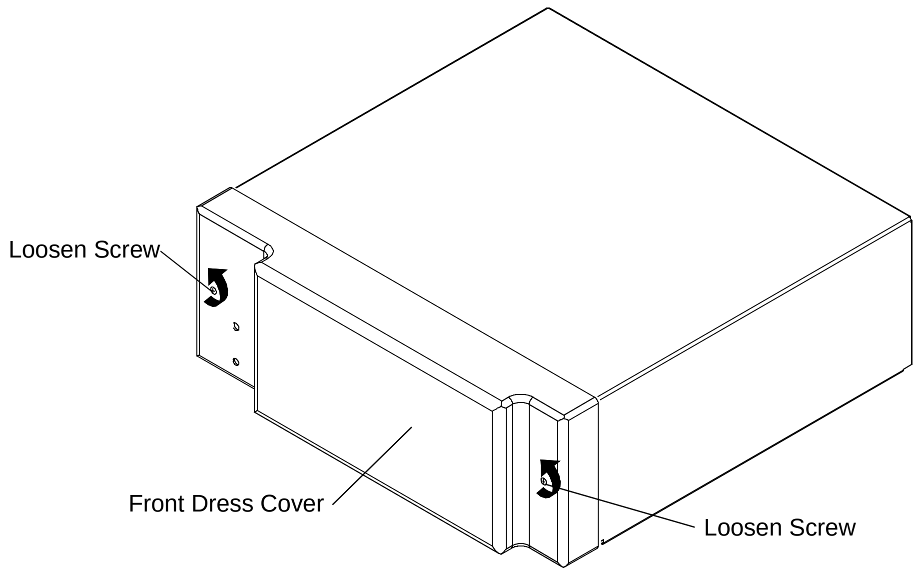


Figure 7-2 Front of the Receiver Mainframe

Replacing the Front Dress Cover

To replace the Front Dress Cover, do the following.

Step 1. Place the front dress cover over the front of the Receiver Mainframe.

Step 2. Turn the 2 quarter-turn screws to secure the front dress cover in place.

Removing Receiver Modules

To remove Receiver Modules, do the following. See Figure 7-3.

Caution

Do not remove the Receiver Modules from the Receiver Mainframe with power applied. This can damage the equipment and result in costly repairs.

Step 1. Remove the front dress cover.

Step 2. Disconnect the RF cable connector from the front of the Receiver Modules and Receiver Mainframe. Use 2 wrenches to keep the cable from twisting.

Step 3. Remove the 2 screws that secure the Receiver Module to the chassis.

Step 4. Detach the Receiver Module from the Receiver Mainframe.

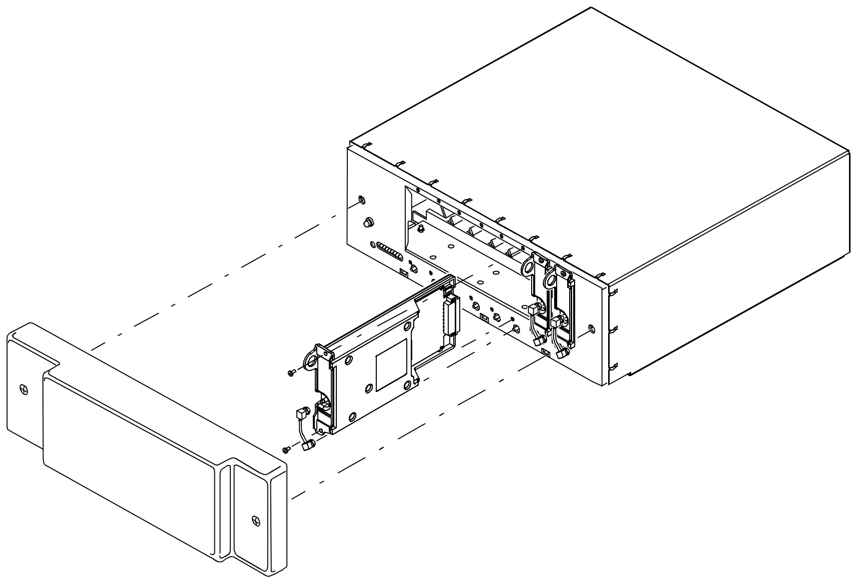


Figure 7-3 Remove the Receiver Module

Replacing Receiver Modules

To replace Receiver Modules, do the following.

Caution

Do not replace or re-insert Receiver Modules into the Receiver Mainframe with power applied. This can damage the equipment and result in costly repairs.

Step 1. Slide the Receiver Module into its place in the Receiver Mainframe.

Step 2. Connect the RF cable connectors to the Receiver Module and to the Receiver Mainframe.

Step 3. Secure the Receiver Module in place using 2 screws.

Step 4. Re-install the front dress cover.

Removing the Top Cover

To remove the Top Cover, do the following. See Figure 7-4.

Step 1. Remove the 2 screws on the rear of the Receiver Mainframe that secure the top cover to the Receiver Main**frame chassis.**

Step 2. Slide the top cover to the rear of the Receiver Mainframe until it stops.

Step 3. Pull one side of the top cover until it clears the Receiver Mainframe chassis and remove the top cover.

Note On European versions of the Receiver Mainframe, tiger strips are secured to the top of the Mainframe chassis to assure good electrical contact with the top cover. See Figure 7-5.

Caution **These tiger strips are sharp and can cause cuts if rubbed against the grain.**
If tiger strips must be touched, only move with the grain of the strip.

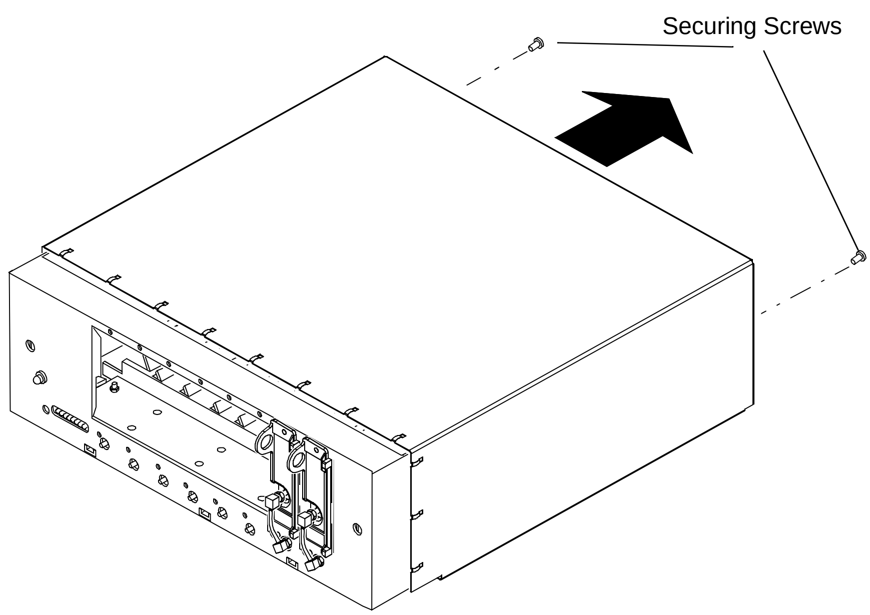


Figure 7-4 Removing the 2 screws of the Receiver Mainframe

Replacing the Top Cover

To replace the Top Cover of the Receiver Mainframe, do the following.

Step 1. Slide the top cover over the receiver Mainframe until it is in place. It may be necessary to pull one side out as the cover slides on so it does not get caught.

Step 2. Secure the top cover in place using the 2 screws on the rear of the Receiver Mainframe.

Removing the Rear Brace (European Version Only)

On European versions of the Receiver Mainframe, there is a Rear Brace that must be removed before further disassembly. To remove the Rear Brace do the following:

Step 1. Remove the 4 screws that secure the Rear Brace to the Receiver Mainframe chassis. Save the screws. S**ee Figure 7-5.**

Step 2. Remove the Rear Brace from the Chassis.

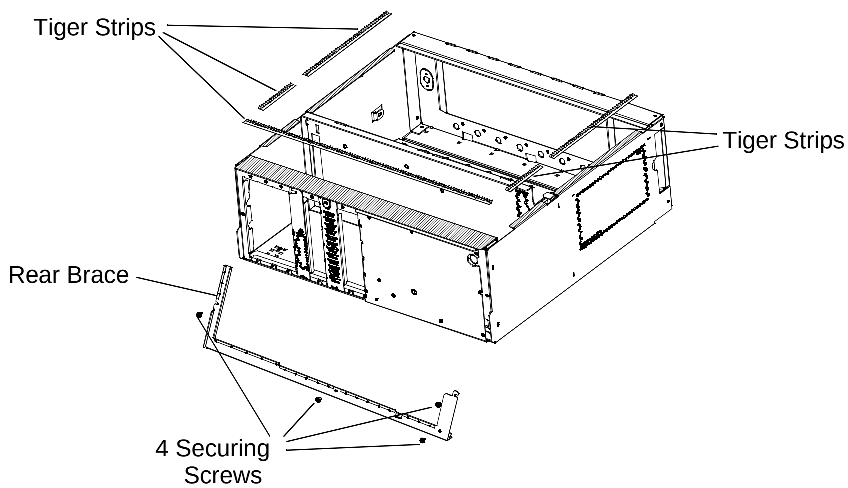


Figure 7-5 Removing Rear Brace (European Version Only)

Replacing the Rear Brace

To replace the Rear Brace, do the following:

Step 1. Place the Rear Brace on the rear of the Receiver Mainframe so that its 4 holes align with their mating threaded hol**es.**

Step 2. Secure the Rear Brace using the 4 screws that were saved when the Brace was removed

Removing the Antenna Distribution Board

To remove the Antenna Distribution Board, do the following. See Figure 7-6.

Step 1. Disconnect the Receiver backplane cable from the connector on the Antenna Distribution Board.

Step 2. Disconnect the antenna cable from the connector on the Antenna Distribution Board using a 1/4-inch wrench.

Step 3. Disconnect the malfunction LED cable from the Distribution Board.

Step 4. Remove the 2 screws that secure the Antenna Distribution Board to the Receiver Mainframe chassis.

Step 5. Detach the RF cables from the front of the Distribution Board.

Step 6. Disengage the Antenna Distribution Board from the Mainframe.

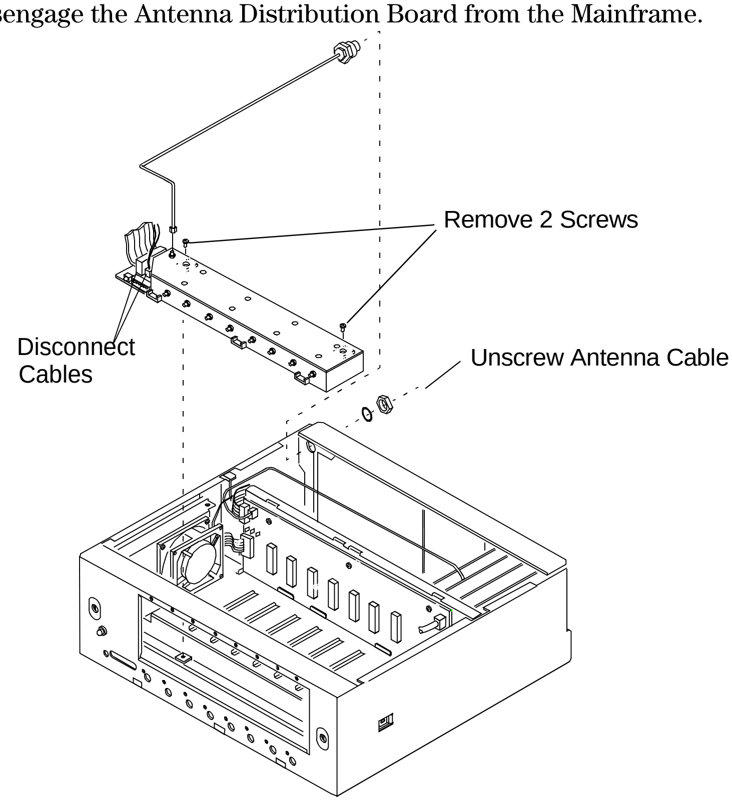


Figure 7-6 Removing the Antenna Distribution Board

Replacing the Antenna Distribution Board

To replace the Antenna Distribution Board, do the following.

Step 1. Place the Antenna Distribution Board into the Receiver Mainframe.

Step 2. Secure the Antenna Distribution Board to the Receiver Mainframe chassis using 2 screws.

Step 3. Connect the malfunction LED cable to the Antenna Distribution Board.

Step 4. Connect the antenna cable to the connector on the Antenna Distribution Board using a 1/4-inch wrench.

Step 5. Connect the Receiver backplane cable to the connector on the Antenna Distribution Board.

Removing the Chassis Cooling Fan

To remove the Chassis Cooling Fan, do the following.

Step 1. Disconnect the fan cable at the connector on the cable to the receiver backplane. See Figure 7-7.

Step 2. Remove the Cable Tie that secures the Fan Cable to the Antenna Cable Assembly (if present).

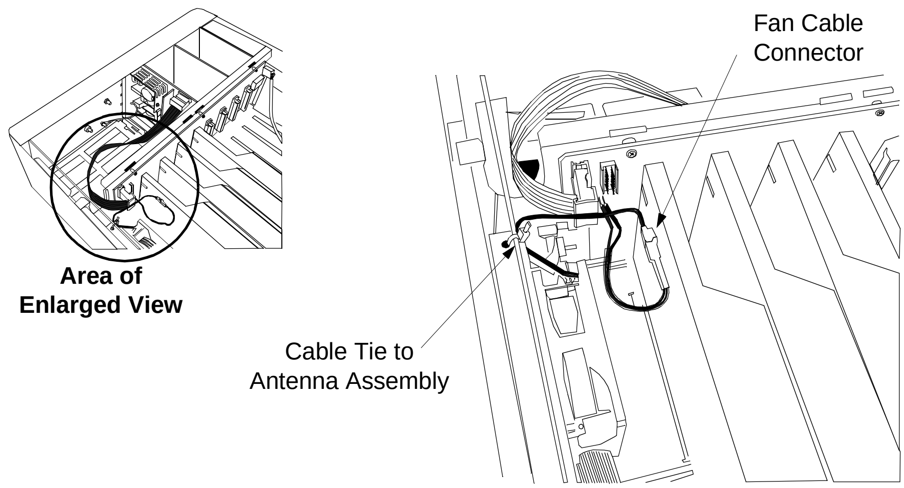


Figure 7-7 Disconnecting the Fan Cable

Step 3. Remove the 2 screws that secure the Chassis Cooling Fan to the chassis using a thin cross-tip screwdriver. See Figure 7-8.

Step 4. Remove the Chassis Cooling Fan from the Receiver Mainframe.

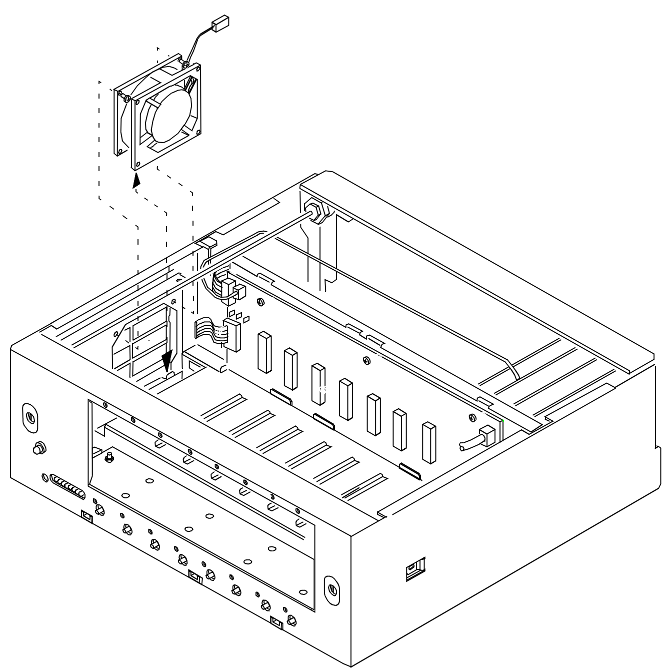


Figure 7-8 Removing the Chassis Cooling Fan

Replacing the Chassis Cooling Fan

To replace the Chassis Cooling Fan, do the following.

Step 1. Place the Chassis Cooling Fan into the Receiver Mainframe.

Step 2. Connect the fan cable connector to the cable to the receiver backplane.

Step 3. Secure the Chassis Cooling Fan to the chassis using 2 screws.

Removing the Power Supply

To remove the Power Supply, do the following.

Step 1. Disconnect and remove the 6-conductor cable from the Power Supply to the Receiver backplane at both ends. See Figure 7-9.

Step 2. Disconnect the Power Supply ground wire from the threaded post on the rear panel. Save the threaded nut.

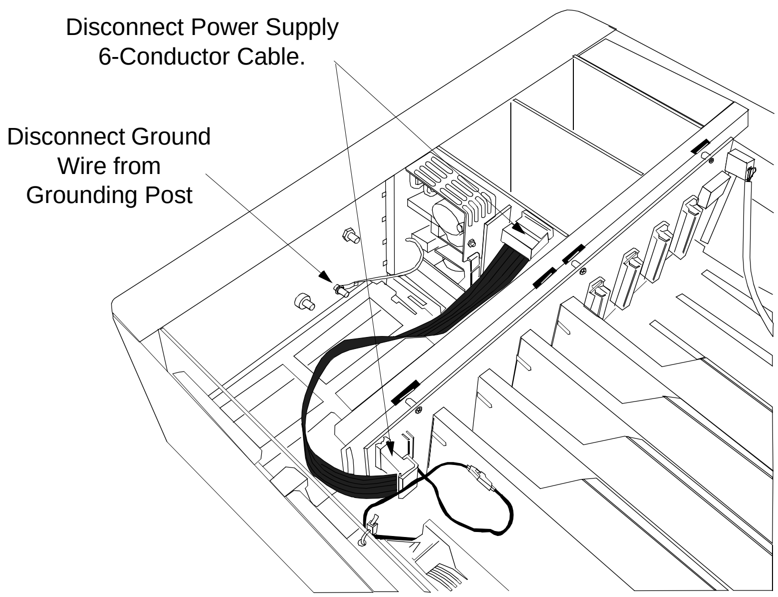


Figure 7-9 Removing the Power Supply Cable

Step 3. Remove the screw that secures the Power Supply to the Receiver backplane. See Figure 7-10.

Step 4. Slide the Power Supply out of its slot.

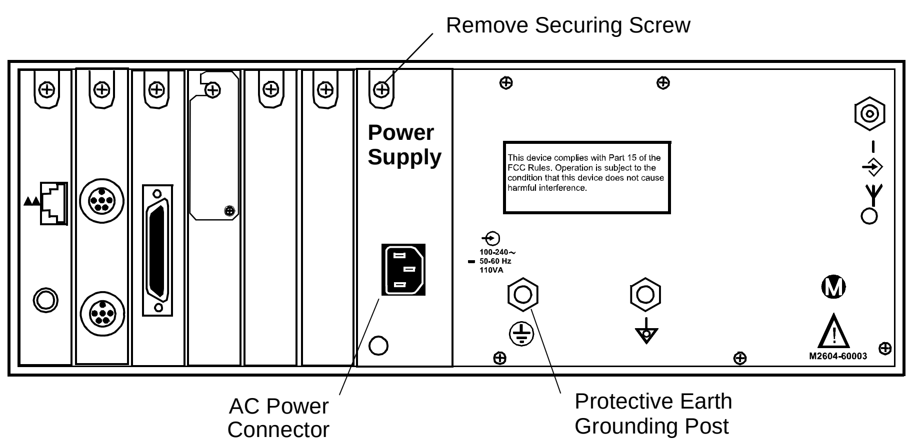


Figure 7-10 Removing Power Supply from Rear Panel Slot

Replacing the Power Supply

To replace the Power Supply, do the following.

Step 1. Slide the Power Supply into the open slot in the rear of the Receiver Mainframe.

Step 2. Secure the Power Supply to the rear of the Receiver chassis with 1 screw.

Step 3. Connect the Power Supply ground wire to the threaded Grounding Post on the inside of the blank panel. See Figure 7-9.

Step 4. Connect the 6-conductor cable to the Receiver backplane and to the Power supply. See Figure 7-9. The cable can be inserted only one way.

Removing the Rack Interface Board

To remove the Rack Interface Board, do the following. See Figure 7-11.

Step 1. Remove the 1 screw that secures the rack interface mounting bracket to the right side of the chassis.

Step 2. Disconnect the Receiver backplane cable from the connector on the Receiver backplane.

Step 3. Remove the Rack Interface Board and mounting bracket from the Receiver Mainframe.

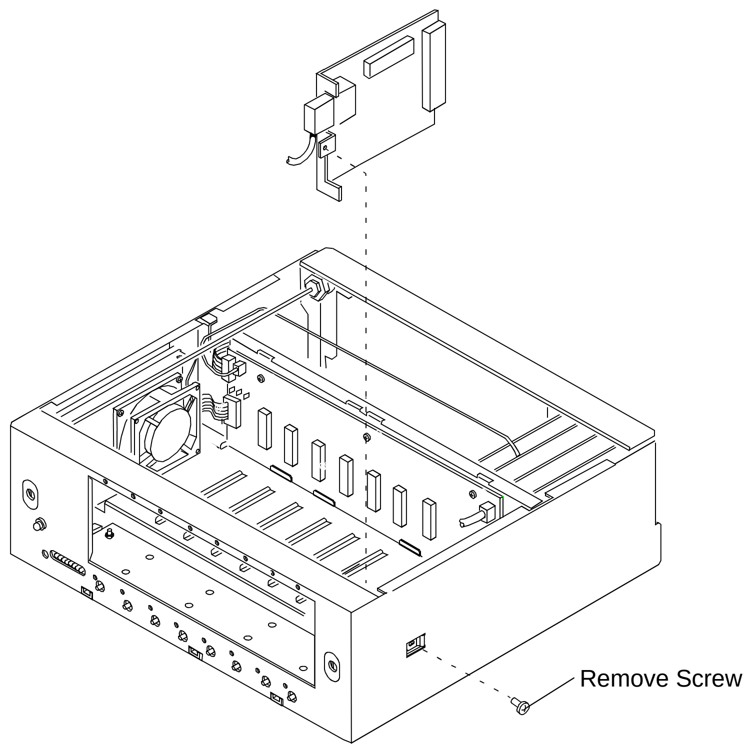


Figure 7-11 Removing the Rack Interface Board

Replacing the Rack Interface Board

To replace the Rack Interface Board, do the following.

Step 1. Place the Rack Interface Board and mounting bracket into the Receiver Mainframe.

Step 2. Connect the Receiver backplane cable to the Rack Interface Board.

Step 3. Secure the rack interface mounting bracket to the right side of the chassis using 1 screw.

Removing the Receiver Backplane

To remove the Receiver Backplane, do the following. See Figure 7-12.

Step 1. Detach the following cables from the Receiver backplane.

- Power Supply Cable
- Antenna Distribution board ribbon cable
- Rack interface cable
- Chassis Cooling Fan Cable

Step 2. Remove the 3 screws that secure the Receiver backplane to the chassis.

Step 3. Remove the Receiver backplane.

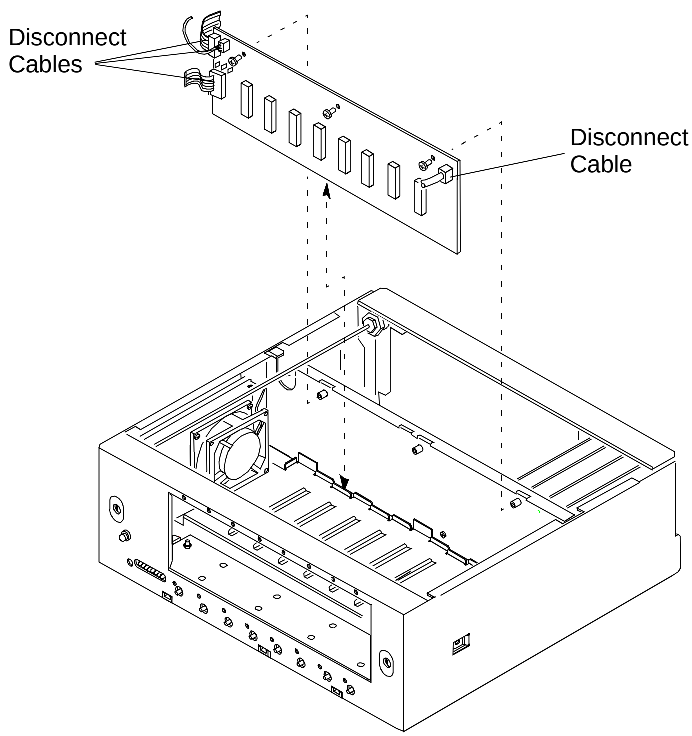


Figure 7-12 Removing the Receiver Backplane

Replacing the Receiver Backplane

To replace the Receiver Backplane, do the following.

Step 1. Place the Receiver backplane into the Receiver Mainframe.

Step 2. Secure the Receiver backplane to the chassis using 3 screws.

Step 3. Reattach the following cables to the Receiver backplane.

- Power Supply Cable
- Antenna Distribution board ribbon cable
- Rack interface cable
- Chassis Cooling Fan Cable

Removing the Digital Backplane

To remove the Digital Backplane, do the following. See Figure 7-13.

Step 1. Remove all of the Function Cards, the Power Supply, and the Rack Interface Board from the Digital Backplane. See Removing Function Cards on page 7-3, Removing the Power Supply on page 7-11, and Removing the Rack Interface Board on page 7-13.

Step 2. Disconnect the Chassis Cooling Fan cable from the connector to the Digital Backplane.

Step 3. Remove the 3 screws that secure the Digital Backplane to the Receiver Mainframe chassis.

Step 4. Remove the Digital Backplane from the Receiver Mainframe.

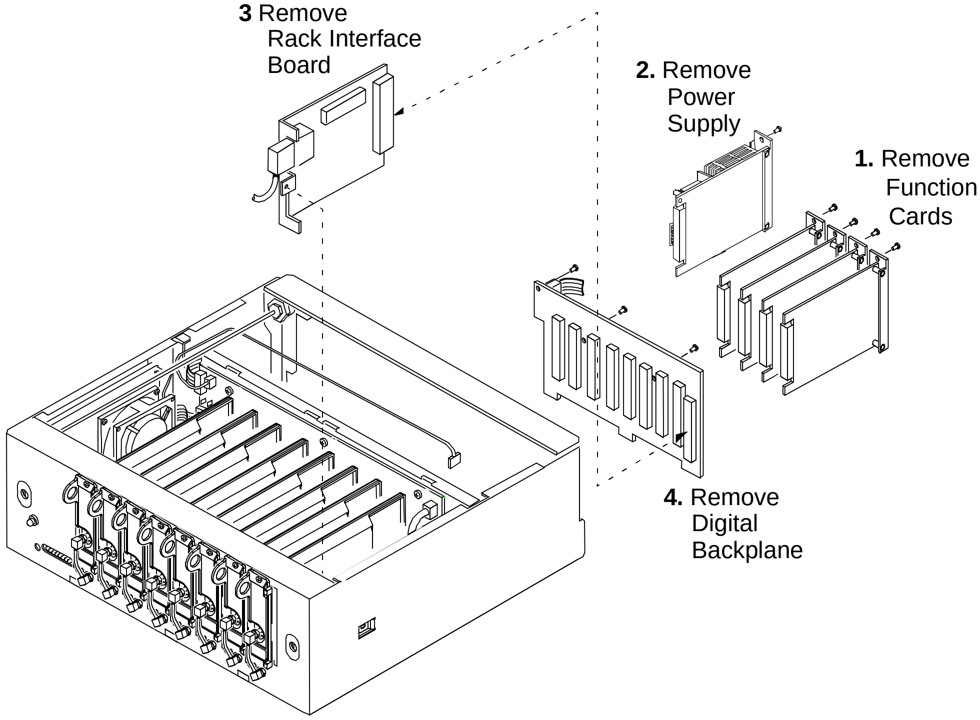


Figure 7-13 Removing the Digital Backplane

Replace the Digital Backplane

To replace the Digital Backplane, do the following.

Step 1. Place the Digital Backplane into the Receiver Mainframe.

Step 2. Secure the Digital Backplane to the Receiver Mainframe chassis using 3 screws.

Step 3. Reconnect the Chassis Cooling Fan cable to its connector to the Digital Backplane

Step 4. Replace all of the Function Cards, the Power Supply, and the Rack Interface Board. See Replacing Function Cards on page 7-3 Replacing the Power Supply on page 7-12, and Replacing the Rack Interface Board on page 7-13.

Removing the Antenna Cable

To remove the Antenna Cable, do the following. See Figure 7-14.

Note

To get at the connector for the Antenna Cable on the antenna distribution board, some Receiver Modules must be removed.

Step 1. Remove as many Receiver Modules as required to access the Antenna Cable. See Removing Receiver Modules on page 7-5.

Step 2. Remove the Antenna Cable from the antenna distribution board using a 1/4-inch wrench.

Step 3. Remove the hex-nut that secures the Antenna Cable to the Receiver Mainframe at the rear of the Receiver Mainframe.

Step 4. Pull the Antenna Cable forward to clear the opening in the Receiver Mainframe chassis and then pull the Antenna Cable from the Receiver Mainframe.

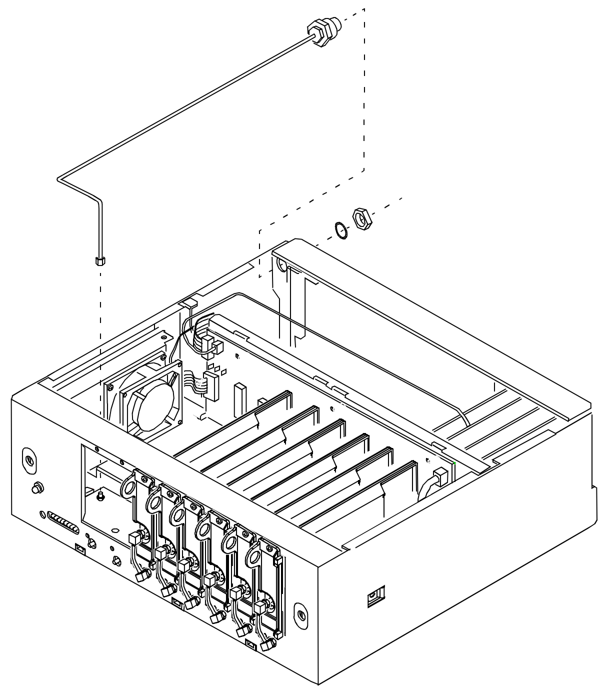


Figure 7-14 Removing the Antenna Cable

Replacing the Antenna Cable

To replace the Antenna Cable, do the following.

Step 1. Place the Antenna Cable into the Receiver Mainframe c**hassis.**

Step 2. Secure the Antenna Cable to the rear of the Receiver Mainframe chassis using 1 hex-nut.

Step 3. Secure the Antenna Cable to the antenna distribution board using a 1/4-inch wrench.

Step 4. Replace any Receiver Modules that were removed. See Replacing Receiver Modules on page 7-5.

Receiver Mainframe Post Assembly Tasks

Once subassemblies have been replaced and the Receiver Mainframe reassembled, there are specific tasks that must be performed to make certain that the Receiver Mainframe is working correctly.

Following are Receiver Mainframe post assembly tasks:

- Check the compatibility of the hardware/software/firmware.
  See Chapter 1 for additional information.
- Check the configuration of the Mainframe (this includes frequencies for the synthesized Receivers).
- Relearn transmitter ID codes if required
- Perform the required tests using the procedures in the Philips Telemetry Test and Inspection Guide.

Disassembly/Assembly of a Receiver Module

This section describes how to disassemble a Receiver Module in order to replace failed assemblies. An exploded view of a Receiver Module is shown in Figure 7-15. The following disassembly/assembly procedures are described:

- RF Cable Assembly
- Receiver Shield Assembly
- Large Receiver Shield Gasket
- Small Receiver Gasket
- Receiver Board Assembly
- Receiver Board Gasket

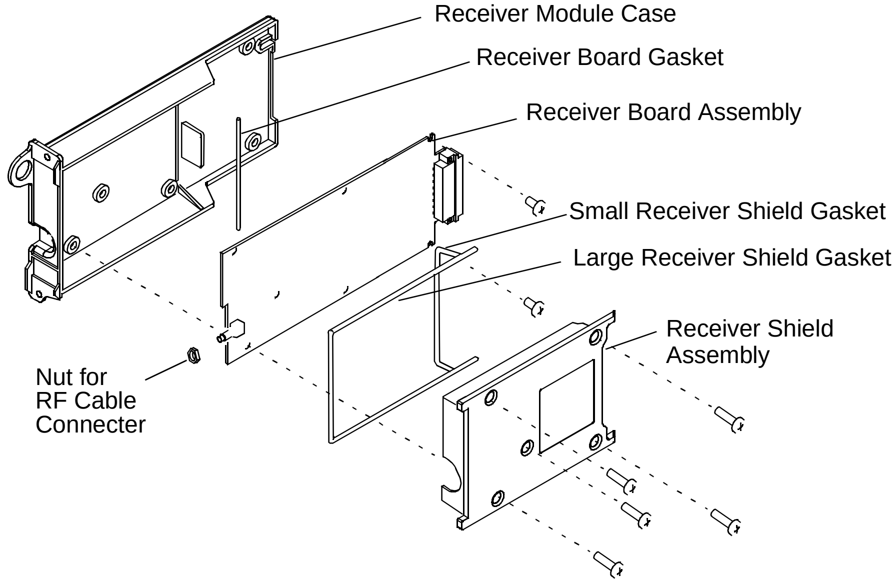


Figure 7-15 Exploded View of a Receiver Module

Tools Required

The following tools are required to disassemble a Receiver Module

Table 7-2. Tools Required to Disassemble a Receiver Module

Tool
Pozidriv Screwdriver
1/4 inch wrench (6 mm)
Chip Extraction Tool (44PPLCC) PN (8710-1995)

Disassembly Procedures

The following procedures describe how to disassemble components of a Receiver Module.

RF Cable Assembly

Step 1. Remove the RF Cable Assembly from the front of the Receiver Module using the 1/4 inch (6 mm) wrench.

Receiver Shield Assembly

Step 2. Remove the 5 screws that secure the Receiver Shield to the Receiver Module using the Pozidriv screwdriver.

Step 3. Remove the RF Shield.

Large Receiver Shield Gasket (U-shaped)

Step 4. Pull the Large U-shaped Receiver Shield Gasket from the Receiver Shield Assembly.

Small Receiver Shield Gasket

Step 5. Pull the Small Receiver Shield Gasket from the Receiver Shield Assembly.

Receiver Board Assembly

Step 6. Remove the nut that secures the RF connector to the front of the Receiver Module using the 1/4 inch (6 mm) wrench.

Step 7. Remove the 2 screws that secure the Receiver Board Assembly to the Receiver Module using the Pozidriv screwdriver.

Step 8. Remove the Receiver Board Assembly.

Receiver Board Gasket

Step 9. Pull the Receiver Board Gasket from the Receiver Module Case.

Reassembly Procedures

The following procedures describe how to reassemble components of a Receiver Module.

Receiver Board Gasket

Step 1. Push the Receiver Board Gasket into the track provided in the Receiver Module Case.

Receiver Board Assembly

Step 2. Guide the RF connector on the Receiver Board into the hole in the front of the Receiver Module.

Step 3. Secure the RF connector in place with 1 nut using the 1/4 inch wrench.

Step 4. Secure the Receiver Board Assembly to the Receiver Module with 2 screws using the Pozidriv screwdriver.

Small Receiver Shield Gasket

Step 5. Push the small Receiver Shield Gasket into the track provided on the Receiver Shield Assembly.

Large Receiver Shield Gasket (U-shaped)

Step 6. Push the Large U-shaped Receiver Shield Gasket into the track provided on the Receiver Shield Assembly.

Receiver Shield Assembly

Step 7. Place the RF Shield on the Receiver Module.

Step 8. Secure the RF Shield in place with 5 screws using the Pozidriv screwdriver.

RF Cable Assembly

Step 9. Connect the RF Cable Assembly to the front of the Receiver Module using the 1/4 inch (6 mm) wrench.

8
Replaceable Parts

Overview

Chapter 8 contains information for ordering replaceable parts and assemblies for the Philips Telemetry System. It provides information on parts and ordering in the following sections.

Table 8-1 gives the Product Number for each Major Assembly of the Philips Telemetry System. Following sections give tables with part number information for the sub-assemblies that make up each of these assemblies.

The following information is provided for each sub-assembly part in the tables:

- Description of part
- Exchange Part Number (if available)
- New Part Number

Table 8-1. Major Assembly Product Numbers

Major Assembly	Product Number
Transmitter	M2601A
Receiver Module	M2603A
Receiver Mainframe	M2604A
Dual-band Line Amplifier	M2606A
Dual-band Multiple Unit Power Supply	M2607A
Dual-band Antenna/Combiner	M2608A
Dual-band Attenuator	M2609A
Bandpass Filter	M2612A
Frequency Converter	M2616A
Line Amplifier	M1406A
Multiple Unit Power Supply	M1407A
Active Antenna/Combiner	M1408A

Ordering New Parts

Ordering Procedure

To order a replacement part follow the steps below:

Step 1. Identify the faulty component or assembly from the information provided in the exploded views.

Step 2. Look up the component or assembly in the appropriate table for the end item to which it belongs

Step 3. Record the entire part number.

Step 4. Order the desired part, using the part number, from the nearest Philips Medical Systems Sales Office or the Philips Support Materials Organization (telephone 1-877-447-7278 in U.S.A.)

Philips Offices Worldwide

If located outside the United States, call the nearest office listed below for information about obtaining Philips Telemetry System support:

CORPORATE HEADQUARTERS:

Philips Medical Systems
Nederland B.V.
Postbus 10.000
5680 DA Best
Netherlands

UNITED STATES:

Philips Medical Systems
Cardiac and Monitoring Systems
3000 Minuteman Road
Andover, MA 01810
(800) 934-7372

CANADA:

Philips Medical Systems
2660 Matheson Blvd. E.
Mississauga, Ontario L4W 5M2
(800) 291-6743

EUROPE, MIDDLE EAST AND AFRICA:

Philips Medizinsysteme Böblingen GmbH
Cardiac and Monitoring Systems
Hewlett-Packard Str. 2
71034 Böblingen
Germany
Fax: (+49) 7031 463 1552

LATIN AMERICA HEADQUARTERS:
Philips Medical Systems
1550 Sawgrass Corporate Parkway #300
Sunrise, FL 33323
Tel: (954) 835-260
Fax: (954) 835-2626

ASIA PACIFIC HEADQUARTERS:
Philips Medical Systems
24F Cityplaza One
1111 King's Road
Taikoo Shing, Hong Kong
(+852) 3197 7777

Note The Philips Medical Systems website address is:

www.medical.philips.com

Unlisted Parts

To order a part not listed in any of the tables, provide the following information:

- **Model Number** of the instrument.
- Complete **Serial Number** of the instrument. Refer to Locating Serial Numbers on page 8-32.
- **Description** of the part, including function, location, color, and any numbers appearing on the part.

Wires and wiring harnesses are not considered to be replaceable parts, even if they are attached to a PC assembly.

Designated internal cables may be ordered separately.

Refer to the chapters on disassembly, assembly, and troubleshooting for recommended and required tools.

Transmitter

This section gives the part numbers for the sub-assemblies of the Transmitter. See Figure 8-1 for part identification. The column Ref Des in Table 8-2 corresponds to the reference designator in Figure 8-1.

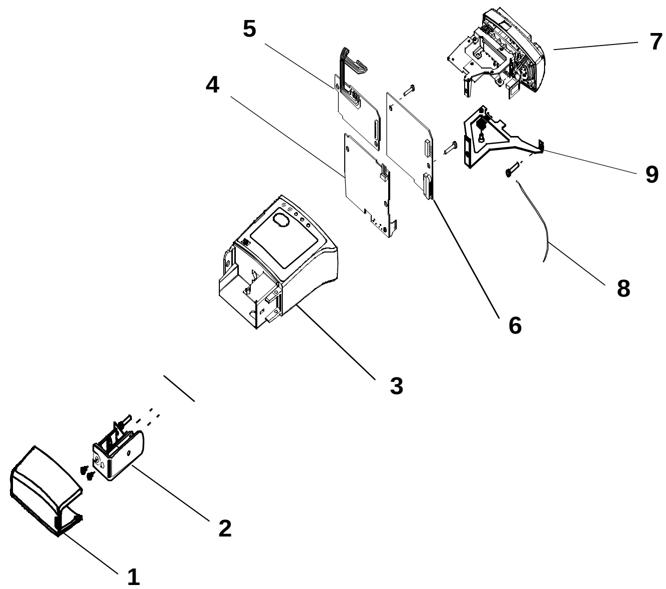


Figure 8-1 Digital Transmitter Exploded View

Table 8-2. Digital Transmitter Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Series C Exchange Transmitter, ECG Only, Opt. 007, 460-470 MHz, AAMI Case	M2601- 89007 (USA only)	
	Series C Exchange Transmitter, ECG & SpO2 Transmitter, Opt. 007, 460-470 MHz, AAMI Case	M2601- 89107 (USA only)	
	Series C Exchange Transmitter, EASI Only, Opt. 007, 460-470 MHz, AAMI Case	M2601- 89207 (USA only)	
	Series C Exchange Transmitter, EASI & SpO_2 Transmitter, Opt. 007, 460-470 MHz, AAMI Case	M2601- 89307 (USA only)	
	Series C Exchange Transmitter, ECG Only, Opt. 020, 590-632 MHz, AAMI Case	M2601-89020 (USA only)	

Table 8-2. Digital Transmitter Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Series C Exchange Transmitter, ECG & SpO_2 Transmitter, Opt. 020, 590-632 MHz, AAMI Case	M2601-89120 (USA only)	
	Series C Exchange Transmitter, EASI Only, Opt. 020, 590-632 MHz, AAMI Case	M2601-89220 (USA only)	
	Series C Exchange Transmitter, EASI & SpO_2 Transmitter, Opt. 020, 590-632 MHz, AAMI Case	M2601-89320 (USA only)	
	Series B Exchange Transmitter, ECG Only, Opt. 007, 460-470 MHz, AAMI Case	M2601-88007 (USA only)	
	Series B Exchange Transmitter (ECG/ SpO_2), Opt. 007, 460-470 MHz, AAMI Case	M2601-88107 (USA only)	
	Series B Exchange Transmitter, ECG Only, Opt. 020, 590-632 MHz, AAMI Case	M2601-88020 (USA only)	
	Series B Exchange Transmitter, ECG & SpO_2 Transmitter, Opt. 020, 590-632 MHz, AAMI Case	M2601-88120 (USA only)	
1	Battery Door		M2601-40029
1& 2	Battery Contact Kit — for use with the Battery Extender — includes screws and Battery Door		M2601-60174
	Battery Extender Cradle		M2601-60014
	Battery Extender Power Module — USA 120V, 60Hz		M2601-60018
	Battery Extender Power Module — Euro 220-240 V, 50 Hz		M2601-60183
	Battery Extender Power Module — Japan 100 V, 50/60 Hz		M2601-60184
	Battery Extender Power Module — UK 220-240 V, 50 Hz		M2601-60185
	Battery Extender Power Module — Australia 220-240 V, 50 Hz		M2601-60186

Table 8-2. Digital Transmitter Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Single Use Screw Kit (all countries except Japan)		M2601-68302
	Single Use Screw Kit (Japan only)		M2601-68304
3	Series C EASI Case Assembly, AAMI Colors (green, black, red, white and brown) without FCC ID number embossed		M2601-60171
3	Series C EASI Case Assembly, IEC Colors (black, yellow, green, red and white) without FCC ID number embossed		M2601-60172
3	Series C Standard ECG Case Assembly, AAMI Colors (green, black, red, white and brown) without FCC ID number embossed		M2601-60025
3	Series C Standard ECG Case Assembly, IEC Colors (black, yellow, green, red and white) without FCC ID number embossed		M2601-60026
3	Series B Standard ECG Case Assembly, AAMI Colors (green, black, red, white and brown, without FCC ID number embossed)		M2601-60407
3	Series B Standard ECG Case Assembly, IEC Colors (black, yellow, green, red and white, without FCC ID number embossed)		M2601-60408
	RF Grounding Strip (applied to Case Assembly)		M2601-83033
4	4 mW Main PCB, Opt. 001, 406-412.5 MHz	M2601-68101	M2601-60101
4	4 mW Main PCB, Opt. 002, 412.5-421.5 MHz	M2601-68102	M2601-60102
4	4 mW Main PCB, Opt. 003, 421.5-430 MHz	M2601-68103	M2601-60103
4	4 mW Main PCB, Opt. 004, 430-440 MHz	M2601-68104	M2601-60104
4	4 mW Main PCB, Opt. 005, 440-450 MHz	M2601-68105	M2601-60105
4	4 mW Main PCB, Opt. 006, 450-460 MHz	M2601-68106	M2601-60106

Table 8-2. Digital Transmitter Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
4	4 mW Main PCB, Opt. 007, 460-470 MHz	M2601-68107	M2601-60107
4	4 mW Main PCB, Opt. 008, 470-480 MHz	M2601-68108	M2601-60108
4	4 mW Main PCB, Opt. 020, 590-614 MHz	M2601-68120	M2601-60120
4	1 mW Main PCB, Opt. 002, 412.5-421.5 MHz (Japan)	M2601-68502	M2601-60502
4	1 mW Main PCB, Opt. 003, 421.5-430 MHz (Japan)	M2601-68503	M2601-60503
4	1 mW Main PCB, Opt. 005, 440-450 MHz (Japan)	M2601-68505	M2601-60505
5	ECG PCB		M2601-60300
6	SpO_2 Board	M2601-68010	M2601-66010
	Blank PCB		M2601-40024
7	Front End Assembly		M2601-60200
	SpO_2 Connector Plug (ECG-only transmitters)		M2601-40013
	Combiner Hood		M2601-40014
	Combiner Latch		M2601-40019
8	RF Cable		8120-6790
9	Main Cage Brace (w labels attached)		M2601-00607
	Grounding Clip (Main Cage Brace)		M2601-20021
	Transmitter Channel ID Labels (1-100)		M2601-83026
	Blank Serial Number Label		M2601-83021
	“Philips Series B” & “Series C” Identification Label		M2601-83061
	PTT Labels (international, except France, Canada, Italy, Brazil)		M2601-83300
	PTT Label — France		M2601-83202
	PTT Label ---- Canada, Italy, Brazil		M2601-83321
	FCC Label — Option 007		5969-3925
	FCC Label — Option 020 (extended UHF band)		5969-3926
	Extended UHF Band Upgrade (007 to 020) FCC Label		M2601-83056

Table 8-2. Digital Transmitter Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Supplies And Accessories for Transmitter		
	Telemetry leadset — 3-wire snap, 30 in (76 cm), AAMI colors		M2590A
	Telemetry leadset — 3-wire grabber, 30 in (76 cm), AAMI colors		M2591A
	Telemetry leadset — 5-wire snap, 30 in (76 cm), AAMI colors		M2592A
	Telemetry leadset — 5-wire grabber, 30 in (76 cm), AAMI colors		M2593A
	Telemetry leadset — 3-wire snap, 30 in (76 cm), IEC colors		M2594A
	Telemetry leadset — 3-wire grabber, 30 in (76 cm), IEC colors		M2595A
	Telemetry leadset — 5-wire snap, 30 in (76 cm), IEC colors		M2596A
	Telemetry leadset — 5-wire grabber, 30 in (76 cm), IEC colors		M2597A
	Telemetry 3-wire leadset combiner		M2598A
	Telemetry 5-wire leadset combiner		M2599A
	Philips Reusable Adult Finger SpO_2 Transducer		M1191A
	Philips Reusable Pediatric/Small Adult Finger SpO_2 Transducer		M1192A
	Philips Reusable Adult/Pediatric Ear Clip SpO_2 Transducer		M1194A
	Wristband for SpO_2 finger transducers		M1627A
	Adapter Cable for Nellcor Oxisensor™ Disposable SpO_2 Transducers		M1943A
	Nellcor Oxisensor™ D-25, SpO_2 Transducer		M1904B
	Nellcor Oxisensor™ D-20, SpO_2 Transducer		M1903B
	Disposable Telemetry Transmitter Pouch, box of 50		9300-0768-050
	Disposable Telemetry Transmitter Pouch, box of 200		9300-0768-200
	9V Lithium Batteries, Box of 10		ULBU9VLJ
	8.4V Zinc Air Batteries, Box of 12		40455A

Table 8-2. Digital Transmitter Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Tools Required for Transmitter Assembly		
	Battery Contact Screw Holding Tool		M2601-67001
	Torque Screwdriver		1535-2653
	RF Cable Tool		M2601-67002
	Special bit for Main Case Screw (Japan Only)		5966-5066
	Transmitter Testbox		M2600-67000
	RG-6U Antenna Cable, Non-Plenum, 0.3 m or 1 foot (for use with testbox)		M1413-60100
	Telemetry Service Tool Software (transmitter tool revision B.00.01, mainframe tool revision B.00.01, frequency calculator revision A.00.00)		M2600-67013
	Serial-to-Infrared Converter II		M2601-63020
	Serial-to-Infrared Converter		M2601-63010
	Revision B.00.05 Transmitter Main PCB Firmware Floppy Disk (Release C)		M2601-50006
	Revision A.03.02 Transmitter Main PCB Firmware floppy disk (Release B)		M2601-50005
	Revision A.02.42 SpO_2 PCB Firmware floppy disc		M2601-10030

Receiver Module

This section gives the part numbers for the sub-assemblies of the Receiver Module. Refer to Figure 8-2, for part identification. The column Ref Des in Table 8-3 corresponds to the reference designator in Figure 8-2.

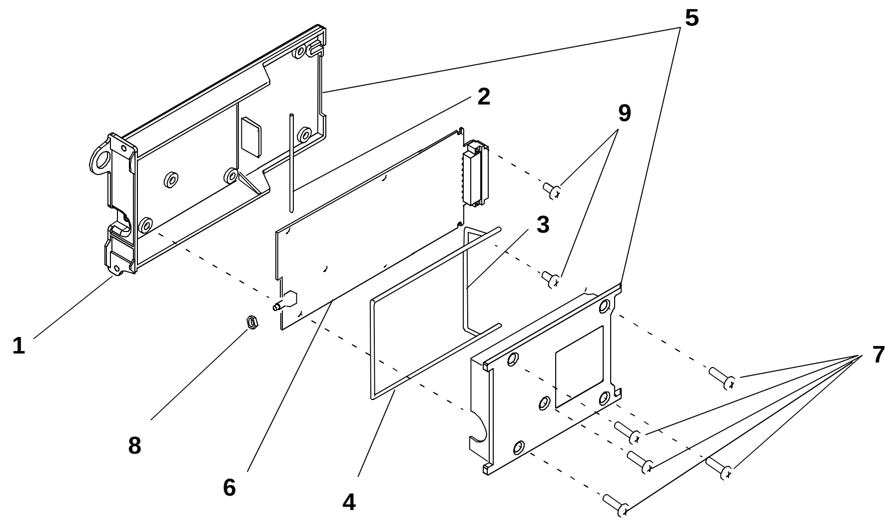


Figure 8-2 Receiver Module Exploded View

Table 8-3. Receiver Module Exchange and New Assemblies

Ref. Des.	Description	Exchange Part No.	New Part No.
1	Semi-Rigid Cable Assembly		M1402-60690
2	Small RF Gasket		M2603-01000
3	Medium RF Gasket		M2603-01001
4	Large RF Gasket		M2603-01002
5	Receiver Shield Assembly		M2603-60540
6	Receiver Board Opt. 001 406-412.5 MHz	M2603-68010	M2603-60010
6	Receiver Board Opt. 002 412.5-421.5 MHz	M2603-68020	M2603-60020
6	Receiver Board Opt. 003 421.5-430 MHz	M2603-68030	M2603-60030
6	Receiver Board Opt. 004, 430-440 MHz	M2603-68040	M2603-60040
6	Receiver Board Opt. 005, 440-450 MHz	M2603-68050	M2603-60050
6	Receiver Board Opt. 006, 450-460 MHz	M2603-68060	M2603-60060
6	Receiver Board Opt. 007, 460-470 MHz	M2603-68070	M2603-60070
6	Receiver Board Opt. 008, 470-480 MHz	M2603-68080	M2603-60080
9	Screw, short, receiver shield		0515-2735
7	Screw, receiver shield to PCB shield (5)		0515-1280

Table 8-3. Receiver Module Exchange and New Assemblies

Ref. Des.	Description	Exchange Part No.	New Part No.
	Screw, receiver to mainframe		0515-0842
	Washer (for RF connector)		2190-0124
8	Nut (for RF connector)		2950-0078
	M2603A Rcvr FW Rev. A.00.02		M2603-84100
	Receiver Channel ID Labels (1-100)		M2603-83018
	M1402A Receiver FW 5 (for use with M2601A - Transmitters) **Note:** The following chip is used in upgrades of M1403A systems to Philips Telemetry functionality.		M2603-84010
Tools Required for Receiver Module Assembly			
	Chip Extraction Tool (44PPLCC)		8710-1995

Receiver Mainframe

This section gives the part numbers for the sub-assemblies of the Receiver Mainframe. See Figure 8-3, for part identification. Figure 8-4 shows additional parts for European version Mainframes. The column Ref Des in Table 8-4 corresponds to the reference designator in Figure 8-3.

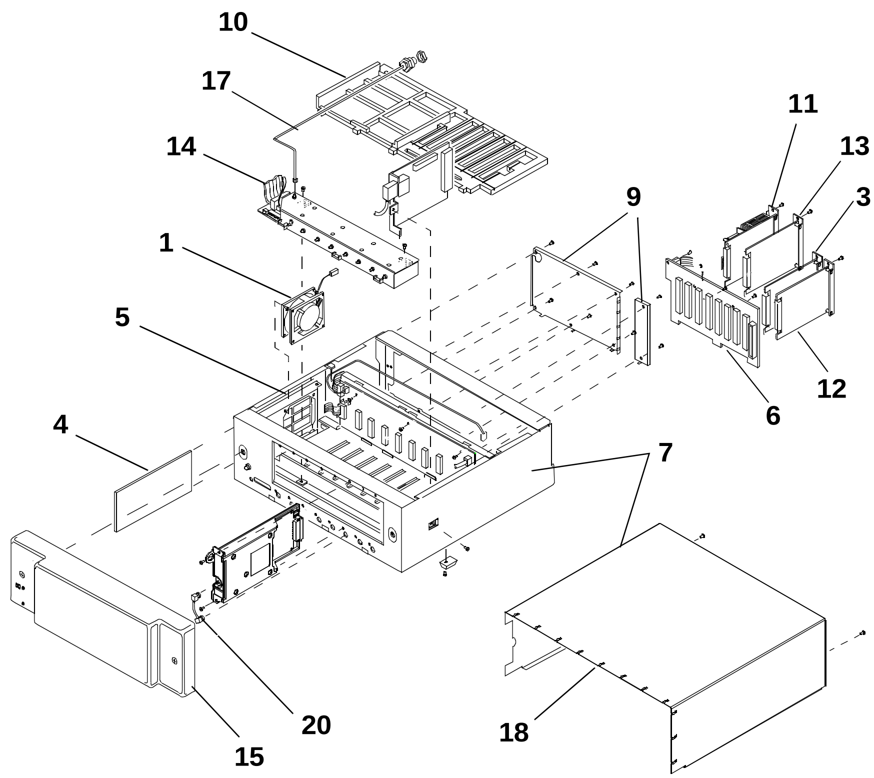


Figure 8-3 Receiver Mainframe Exploded View

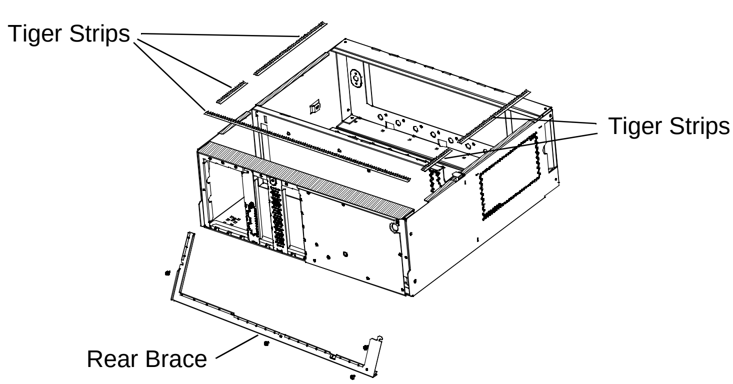


Figure 8-4 Receiver Mainframe (European Version)

Table 8-4. Receiver Mainframe Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
1	Fan		3160-0816
3	SDN Interface Board	M1082-68502	M1082-66502
4	Air Filter		M1401-02100
5	Receiver Backplane		M1401-60300
6	Digital Backplane		M1401-60400
7	Chassis Assembly (includes Top Cover)		M2604-00102
9	Blank Board Cover (Large)		M2604-00300
	Blank Board Cover (Small)		M2604-00290
	Rack Interface PCB Bracket		M2604-00400
10	Card Guide		M2604-40000
11	Power Supply (auto switching) U.S.A., Canada, Puerto Rico only	M2604-68005	M2604-60005
	Power Supply (linear) All other countries	M2604-68001	M2604-60001
12	Utility CPU PCB (NOTE: Return without EEPROM)	M1059-68501	M1059-66501
	Telemetry EEPROM Rev. E		M2604-84003
	Telemetry EEPROM Rev. D		M2604-84002
13	CPC Board Assembly	M2604-68010	M2604-60010
14	Antenna Distribution Assembly	M2604-68640	M2604-60640
	Antenna Distribution PC Board	M2604-68648	M2604-60648
	Malfunction LED Cable Assembly		M2604-60740
15	Front Dress Cover		M2604-81002
17	Antenna Cable Assembly		M1401-60750
18	Top Cover Assembly		M2604-00242
20	RF Cable (part of receiver module)		M1402-60690
	Perm IEC Ground Cable		M1401-60675
	Lamp Clip Set		1400-0560
	Grommet		0400-0133
	RFI Spring		5001-1320
	Cable, Receiver Backplane to Antenna Distribution PCB		M1401-60780
	Cable, Rack Interface to Receiver Backplane		M1401-60650

Table 8-4. Receiver Mainframe Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Power Supply Cable to Digital Backplane		M1401-60670
	Power Supply Cable to Receiver Backplane		M1401-60660
	78000AI-#R86 Mount Retrofit Kit		78000-91907
	Mount Assembly (R86 Mount)		M1401-02970
	Unit Mount (R86 Mount)		M1401-02990
	Power Cord, U.S.A.		8120-5429
	Power Cord, U.K.		8120-1351
	Power Cord, Australia/New Zealand		8120-4475
	Power Cord, Europe		8120-1689
	Power Cord, Switzerland		8120-2104
	Power Cord, Denmark		8120-2956
	Power Cord, S. Africa/India		8120-4211
	Power Cord, China		8120-8376
	Fuse 1.6A 250V (earlier Power Supply)		2110-1001
	Fuse 0.8A 250V (earlier Power Supply)		2110-1002
	Machine Screw (for Receivers, Digital Cards, and Power Supply in Mainframe)		0515-0842
	Screw M3 x 0.5 (for backplane assemblies)		0515-0897
	Screw M3 x 6mm (Analog Output PCB, CPC PCB, and Antenna Distribution PCB)		0515-1146
	Screw M5 x 10mm pan (R86 mount)		0515-1546
	Rack Interface Board	M1088-68501	M1088-66501
Additional Parts for European Version (See Figure 8-4.)			
	Tiger Strips Qty 1, 16” (40.6 cm)		5969-3994
	Qty 2, 2.75” (7.0 cm)		5969-3995
	Qty 2, 7.03” (17.9 cm)		5969-3996
	Rear RF Brace (B)		M2604-60801
Tools Required for Receiver Mainframe Assembly			
	EEPROM Chip Extraction Tool		M1186-45001
	CPC Programming Tool		M2300-67100

Table 8-4. Receiver Mainframe Exchange and New Assemblies

Ref Des	Description	Exchange Part No.	New Part No.
	Telemetry Receiver Mainframe Software FLASH Card, Revision E.00.19 (Release C)		M2604-70008
	Telemetry Receiver Mainframe Software FLASH card, Revision D.03.02 (Release B)		M2604-70006
	Telemetry Service Tool Software (transmitter tool revision B.00.01, mainframe tool revision B.00.01, frequency calculator revision A.00.00)		M2600-67013
	Telemetry Configuration Tool		M2601-67020
	RS-232 PCB		M1085-66501
	RS-232 Cable		HP 24542GCP
	Safety Analyser		

Analog Output Option

This section lists replaceable parts for components of Analog Output Option J01 (Patient Monitor/Holter Interface).

Table 8-5. Analog Output Option Replaceable Parts

Description	Exchange Part No.	New Part No.
Analog output board assembly	M2604-68021	M2604-60021
Analog link cable		M1401-60751
Analog trunk cable		M1401-60752
Output connector box assembly		M2604-60961
Output Connector Box Power Module		M2600-60008
Power Module Mount		M1407-00070
Power Module Mount “L” Bracket		M1407-00040
Analog output cable, non-plenum, 15.2 m (50 ft)		M1401-60761
Analog output cable, non-plenum, 30.5 m (100 ft)		M1401-60762
Analog output cable, non-plenum, 76.2 m (250 ft)		M1401-60763
Analog output cable, non-plenum, 152.4 m (500 ft)		M1401-60764
Analog output cable, plenum, 15.2 m (50 ft)		M1401-60765
Analog output cable, plenum, 30.5 m (100 ft)		M1401-60766
Analog output cable, plenum, 76.2 m (250 ft)		M1401-60767
Analog output cable, plenum, 152.4 m (500 ft)		M1401-60768
Bedside monitor cable, 3-wire, 8-pin		M1401-60753
Bedside monitor cable, 3-wire, 12-pin		M1401-60754
Bedside monitor cable, 5-wire, 8-pin		M1401-60755
Bedside monitor cable, 5-wire, 12-pin		M1401-60756
Analog Output Firmware — Revision A.01.00		M2604-84050
Bedside Attenuator Faceplate		M1401-67020
Holter Attenuator Faceplate		M1401-67030
Bedside Attenuator/SDN Faceplate		M1401-67040
Tools Required for Analog Output Assembly		
Chip Extraction Tool (44PPLCC) (Microcontroller)		8710-1995

M2613/14/15A Antenna System

This section lists part numbers for the sub-assemblies of the M2613/14/15B Antenna System.

Table 8-6. M2613/14/15A Antenna System Parts

Description	Exchange Part No.	New Part No.
Base, Antenna/Combiner		M2608-60000
Antenna Wall Mount		M1404-60001
Black Flexible Antenna, 406-650MHz		5969-3927
White Flexible Antenna, 406-650MHz		5969-3924
Line Amplifier		M2606-60000
Power Tee		M2607-60000
Power Module, CE Marked		M2600-60008
Power Module Mount “L” Bracket		M1407-00040
Mounting Bracket for Power Module, 0950-3221		M1407-00070
Power Cord, U.S.A.		8120-5429
Power Cord, U.K.		8120-1351
Power Cord, Australia/New Zealand		8120-4475
Power Cord, Europe		8120-1689
Power Cord, Switzerland		8120-2104
Power Cord, Denmark		8120-2956
Power Cord, S. Africa/India		8120-4211
Power Cord, China		8120-8376
2-Way Splitter/Combiner		0960-0323
Spacer, 2-Way		M1415-00003
4-Way Splitter/Combiner		0960-0324
Spacer, 4-Way		M1415-00004
Attenuator, 1dB		0955-1085
Attenuator, 2dB		0955-1086
Attenuator, 3dB		0955-1087
Attenuator, 4dB		0955-1088
Attenuator, 5dB		0955-1089
Attenuator, 6dB		0955-1090
Attenuator, 7dB		0955-1091
Attenuator, 8dB		0955-1092
Attenuator, 9dB		0955-1093
Filter, 430-440 MHz		M2612-60004
Filter, 440-450 MHz		M2612-60005
Filter, 450-460 MHz		M2612-60006
Filter, 460-470 MHz		M2612-60007

Table 8-6. M2613/14/15A Antenna System Parts

Description	Exchange Part No.	New Part No.
Filter, 590-596 MHz		M2612-60034
Filter, 596-602 MHz		M2612-60035
Filter, 602-608 MHz		M2612-60036
Filter, 608-614 MHz		M2612-60037
Filter, 614-620 MHz		M2612-60038
Filter, 620-626 MHz		M2612-60039
Filter, 626-632 MHz		M2612-60040
dcBlocking Capacitor		HP 10240B
75 ohm Terminator with DC Block		1250-2403
BNC(m) to BNC (m) adapter		1250-0216
RG-6U Antenna Cable, Non-Plenum, 0.3 (1 ft)		M1413-60100
RG-6U Antenna Cable, Non-Plenum, 1.5 m (5 ft)		M1413-60105
RG-6U Antenna Cable, Non-Plenum, 3.0 m (10 ft)		M1413-60101
RG-6U Antenna Cable, Non-Plenum, 18.9 m (62 ft) intermediate cable		M1413-60103
RG-6U Antenna Cable, Non-Plenum, 42.4 m (139 ft) main cable		M1413-60102
RG-11 Antenna Cable, Non-Plenum, 34.1 m (112 ft) intermediate cable		M1413-60203
RG-11 Antenna Cable, Non-Plenum, 76.2 m (250 ft) main cable		M1413-60202
RG-6U Antenna Cable, Non-Plenum, Special Order, Specify Loss in dB		M2617A-#J30 (M1413-60109)
RG-11U Antenna Cable, Non-Plenum, Special Order, Specify Loss in dB		M2617A-#J31 (M1413-60119)
RG-6U Antenna Cable, Plenum, 18.9 m (62 ft)		M1414-60103
RG-6U Antenna Cable, Plenum, 42.4 m (139 ft)		M1414-60102
RG-11 Antenna Cable, Plenum, 22.9 m (75 ft) intermediate cable		M1414-60203
RG-11 Antenna Cable, Plenum, 50.3 m (165 ft) main cable		M1414-60202
RG-6U Antenna Cable, Plenum, Special Order, Specify Loss in dB		M2617A-#J40 (M1414-60109)
RG-11U Antenna Cable, Plenum, Special Order, Specify Loss in dB		M2617A-#J41 (M1414-60119)
Tools Required for M2613/14/15 Antenna System		
Transmitter Testbox		M2600-67000
RG-6U Antenna Cable, Non-Plenum, 0.3 meter or 1 foot (for use with testbox)		M1413-60100
Attenuator 9dB		0955-1093

Frequency Converter

This section lists part numbers for the sub-assemblies of the External Frequency Converter.

Table 8-7. M2616A Frequency Converter Parts

Description	Exchange Part No.	New Part No.
External Frequency Converter Assembly, Option 130	M2616-68130	M2616-60130
External Frequency Converter Assembly, Option 136	M2616-68136	M2616-60136
External Frequency Converter Assembly, Option 142	M2616-68142	M2616-60142
External Frequency Converter Assembly, Option 148	M2616-68148	M2616-60148
External Frequency Converter Assembly, Option 154	M2616-68154	M2616-60154
External Frequency Converter Assembly, Option 160	M2616-68160	M2616-60160
External Frequency Converter Assembly, Option 166	M2616-68166	M2616-60166
0.3 m (10 ft) Cable, External Frequency Converter to Receiver Mainframe		M2617A-#J20 (M2616-60011)
Power Module, CE Marked		M2600-60008
Power Module (0950-3221) Mount "L" Bracket		M1407-00040
Mounting Bracket for Power Module		M1407-00070
Power Cord, U.S.A.		8120-5429
Power Cord, U.K.		8120-1351
Power Cord, Australia/New Zealand		8120-4475
Power Cord, Europe		8120-1689
Power Cord, Switzerland		8120-2104
Power Cord, Denmark		8120-2956
Power Cord, South Africa/India		8120-4211
Power Cord, China		8120-8376

Release C Documentation

This section lists part numbers for Documentation for the Philips Telemetry System, Release C.

Table 8-8. Release C Documentation

Description	New Part No.
Service Documentation	
Philips Telemetry System Service Kit, which includes: • Service Quick Reference Guide • Service and User Documentation CD-ROM, containing .pdf files of: – Philips Telemetry System Service and Reference Guide – Installation and Configuration Guide – Service Tool Guide – Test and Inspection Guide – Service Configuration Guide – Dual-band UHF Antenna System Installation Note – System Upgrade Installation Note – M2610AU #J01 Patient Monitor/Holter Recorder Interface Upgrade Installation Note – Philips Telemetry System Instructions for Use	M2600-90182
User Documentation	
Philips Telemetry System Instructions for Use (Telemetry Release C, for use with Philips Information Center) - Edition 2, May 2002	
English	M2600-9001C
French	M2600-9002C
German	M2600-9003C
Dutch	M2600-9004C
Spanish	M2600-9005C
Italian	M2600-9006C
Norwegian	M2600-9007C
Swedish	M2600-9008C
Finnish	M2600-9009C
Japanese	M2600-9010C
Danish	M2600-9011C
Traditional Chinese	M2600-9012C

Table 8-8. Release C Documentation

Description	New Part No.
Simplified Chinese	M2600-9013C
Portuguese	M2600-9014C
Greek	M2600-9015C
Russian	M2600-9017C
Hungarian	M2600-9018C
Czech	M2600-9019C
Polish	M2600-9020C
What's New in Release C (Telemetry Release C, for use with Philips Information Center) - Edition 2, May 2002	
English	M2600-9101C
French	M2600-9102C
German	M2600-9103C
Dutch	M2600-9104C
Spanish	M2600-9105C
Italian	M2600-9106C
Norwegian	M2600-9107C
Swedish	M2600-9108C
Finnish	M2600-9109C
Japanese	M2600-9110C
Danish	M2600-9111C
Simplified Chinese	M2600-9113C
Portuguese	M2600-9114C
Greek	M2600-9115C
Czech	M2600-9119C
Polish	M2600-9120C
Application Notes	
EASI Monitoring Application Note	5980-1198E
SpO2 Telemetry Monitoring Application Note	5980-1197E
Arrhythmia Monitoring Application Note	5980-1267E
ST Segment Monitoring Application Note	5968-8852E

9 Standard Antenna System Design

Overview

Telemetry monitoring offers the wireless transmission of patient monitoring data through the air and hospital walls. However, its reliability and quality is determined by several variables that are difficult to control. Although the performance of a telemetry system will never be as good as that of a hardwired bedside monitor, it can be optimized by good antenna system design.

Chapter 9 presents a step by step process for designing a standard antenna system. It includes the following sections:

Note Chapter 9 only covers the design of standard antenna systems. If a non-standard design is required, contact a Philips Medical Systems service provider.

Setting Expectations

No matter how good the antenna system design is, a telemetry system will always experience occasional loss of radio communications, resulting in ECG waveform dropouts. A telemetry system will never be as reliable as a hardwired bedside monitor that transmits its signal through a wire. If occasional loss of ECG monitoring is not acceptable for certain patients, they should be connected to a hardwired bedside monitor.

Warning **Telemetry should not be used for primary monitoring in applications where the momentary loss of the ECG is unacceptable.**

Following are guidelines to set proper expectations of hospital staff and to improve system performance:

- Clinicians will tend to see more motion related artifact on the ECG of ambulatory patients than on patients that are restricted to a bed. Proper skin preparation and electrode application are very important in reducing this problem.
- Patients should be restricted to the designated coverage area. Monitoring performance will degrade if patients go outside the radius of coverage of the receiving antennas.
- Keep the antenna system size as small as possible. Telemetry system performance will degrade as the system size increases. The larger a system is, the greater the potential for receiving interfering signals. In addition, as more devices are added to the antenna system, the noise generated by the antenna system itself increases.
- A patient location protocol is critical to a telemetry system. If a life-threatening event occurs, the clinician must be able to locate the patient quickly. The importance of this increases as the antenna system size increases.
- Philips Medical Systems has no control over the RF environment in the hospital. If interference exists at the operating frequencies, telemetry system performance will be affected. Careful selection of frequencies for **all** wireless devices used within a facility (telemetry transmitters, walkie-talkies, ambulance radios, other wireless medical devices, etc.) is important to prevent interference between them.

Note **Frequency management is the responsibility of the hospital.**

Determining Needs and Gathering Site Data

To design the system properly, several needs must be taken into consideration. These include the following:

- How many channels are to be monitored?
- What area of the hospital is to be covered?
- Where will the equipment be located?
- Is future system expansion anticipated?

Use the blueprints or dimensioned floorplan and the checklist provided at the end of this chapter to record site data. Make a copy of the checklist page before beginning. Consider each item and check the box for each item as it is completed. When finished, save the checklist and all blueprints, calculations, and drawings for future use in troubleshooting and system expansion.

Standard and Non-Standard Antenna System Design

After determining needs and gathering required site data, whether to use a standard or non-standard antenna system should be considered.

Standard Systems

Standard systems are the simplest approach to antenna design. These systems consist of pre-configured strings of 1 to 6 antennas and one of the pre-configured combining networks. Standard systems are used in a building-block approach to minimize design time and simplify the analysis that otherwise would be required to ensure good performance.

A standard system can be used if the system meets the following criteria:

- The coverage area does not exceed **85,000 square feet** (7,897 square meters).
- The coverage area is essentially **rectangular** in shape (see explanation under special coverage areas).
- The system requires **no more than 48 antennas**.
- The system needs **no more than 8 output ports**.
- There is **no multi-floor or multi-building coverage** required, necessitating the use of non-standard cable lengths.
- There is **no conduit or cable tray installation** that requires using non-standard cable lengths.
- There are **no special coverage areas**, for example:
  - shielded areas such as x-ray or fluoroscopy rooms
  - large open areas such as atriums and gymnasiums
  - hallway-only coverage areas

Non-Standard Systems

Non-standard systems are used when site geometries prohibit using standard cable lengths or when the system size or coverage area dictates that a standard approach is impractical.

Non-standard systems can be a combination of various standard antenna strings and combining networks or they can be designed component by component. Designing non-standard systems is a complex, time-consuming task that requires a specially trained Philips Medical Systems telemetry expert.

Standard Coverage Areas

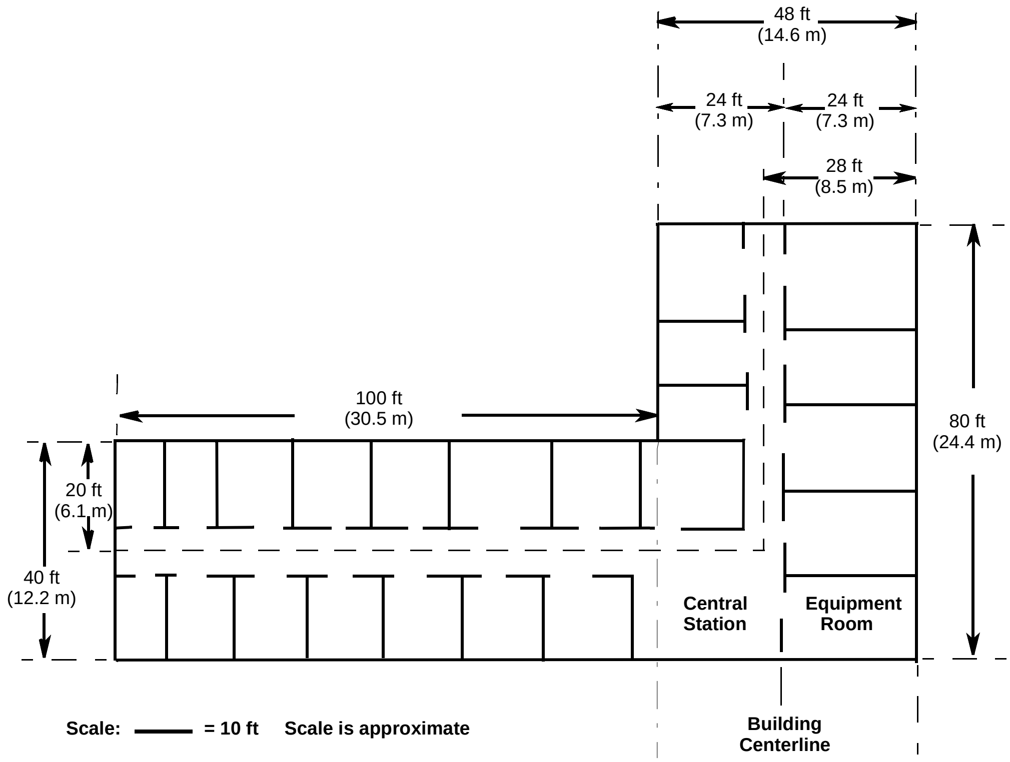


Figure 9-1 Rectangular Shape Coverage Area

Rectangular Coverage Area

The standard design assumes a coverage area that is essentially rectangular in shape, or one that can be easily divided into rectangles or squares. Figure 9-1 is an example of a coverage area that meets this criterion.

Number of antennas required

The standard design estimates the number of antennas required based on the amount of area to be covered. These estimates assume a typical coverage area (essentially rectangular in shape) where antennas are located in a hallway and non-shielded patient rooms are located off these hallways.

Coverage areas that do not meet this criterion will impact the antenna number estimate and may require modifications to cable lengths.

Special Coverage Areas

The standard design presented in this chapter does not account for the requirements of certain types of special coverage areas. If the system requires coverage of any of these, consult with a trained Philips Medical System telemetry expert.

Non-rectangular coverage areas

Figure 9-2 is an example of a coverage area that cannot be easily divided into rectangles and squares and where the standard antenna number estimates would not apply.

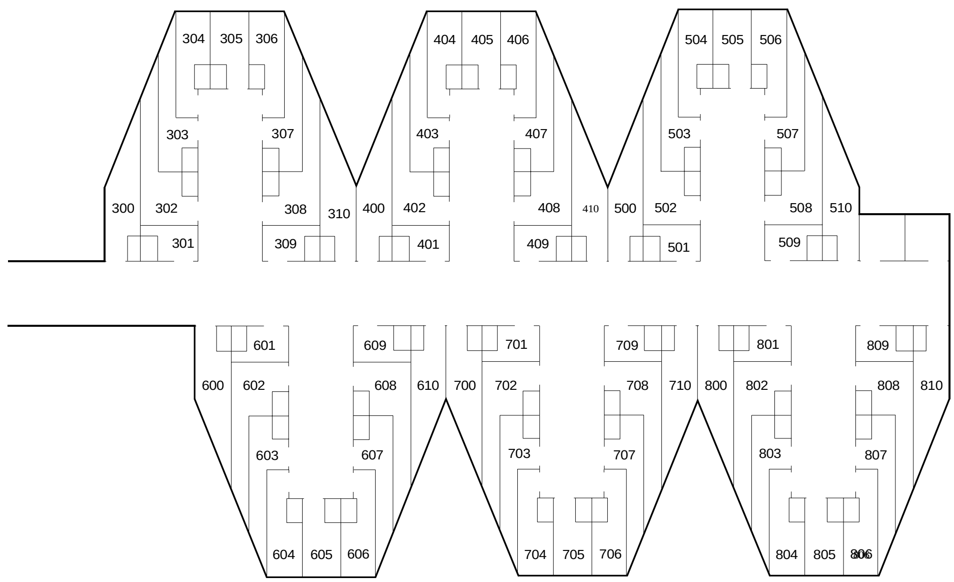


Figure 9-2 Non-Rectangular Coverage Area

Shielded Areas

Shielded areas, such as x-ray and fluoroscopy rooms, will block RF signals. Therefore, antennas located in hallways outside these rooms will not cover them. Shielded areas are treated as separate entities and are best handled in a non-standard system design.

Large Open Areas and Hallways

Large open areas, such as atriums, gymnasiums, and hallways, impact both antenna number estimates and cabling requirements. Consult with a Philips Medical Systems telemetry expert.

Antenna Design Considerations

There are two objectives to good antenna system design – good signal reception and preservation of the received signal. Good signal reception results from knowledge of the RF characteristics of the desired coverage area and proper antenna placement. Preservation of the received signal results from active antenna components with low noise characteristics and proper amplification techniques.

Signal Reception

There are two factors that determine whether a telemetry signal will be received by an antenna – the radiating power of the transmitter/antenna and the path or propagation loss of the signal. The propagation loss of an RF signal in an enclosed environment depends on the distance between the transmitter and the antenna and on RF blocking sources and other clutter in the signal's path.

Blocking sources include large metal objects, such as elevators, fire doors, filing cabinets, and air shafts. Clutter is furniture, drapery, plants, and even people. Clutter can absorb and deflect the signal, making it difficult to predict what the signal will do or where it will go. The design rules have been established to ensure acceptable performance of the system in a typical hospital environment.

Signal Preservation

The function of an antenna system is both to receive and to preserve a signal as faithfully as possible. Between the point where the signal is received by the antenna and the point where it is delivered to the receiver, the signal must pass through a variety of antenna system components – antennas, coaxial cables, signal splitters and combiners, line amplifiers, and power tees. These components subject the signal to a certain amount of loss, noise, and distortion.

A standard antenna system utilizes pre-configured strings of antennas (M2613/14A - Dual band UHF Antenna Systems) and pre-configured combining networks (M2615A - Dual-Band Combining Networks). These systems have been designed by the factory to optimize signal preservation.

In situations where a standard system cannot be used, consult with a Philips Medical System telemetry expert, who has been trained to design non-standard antenna systems that optimize signal preservation.

Designing Standard Antenna Systems

Designing a standard antenna system is a step-by-step procedure in which 4 tools are used -- compass, ruler, set of blueprints or dimensioned floorplan of the coverage area, and a set of colored markers. The procedure is composed of the following tasks and are described in the following sections:

- Outlining and Marking the Coverage Area
- Calculating Coverage Area
- Determining Antennas for Contiguous Areas
- Determining Antennas for Non-Contiguous Areas
- Placing and Connecting Antennas
- Ordering Antenna System Components

Outlining and Marking the Coverage Area

Step 1. Outline the Coverage Area

- Outline the boundary of the entire coverage area with a marker.
- Enclose any room or irregular space that projects from the overall scheme

Step 2. Mark the location of the equipment room and the Central Station

- Mark both the location of the Central Station and the Equipment Room on the floorplan.

Note

The Equipment Room, where the receiver mainframe and combining network resides, should not be adjacent to any electrical equipment with dc motors, such as elevators, that generate RF interference. The receiver mainframe and antenna system must be connected to a circuit that is on the hospital's emergency power system.

Step 3. Determine and mark the building centerlines.

- Divide the width of the area by two and draw the centerlines as shown in Figure 9-3.

Note

Centerlines divide the width of a coverage area and lie midway between the area's outside walls. Marking centerlines on the floorplan discloses any irregularities in the architecture. There may be rooms that are deeper on one side of the area and may require more antennas for adequate coverage.

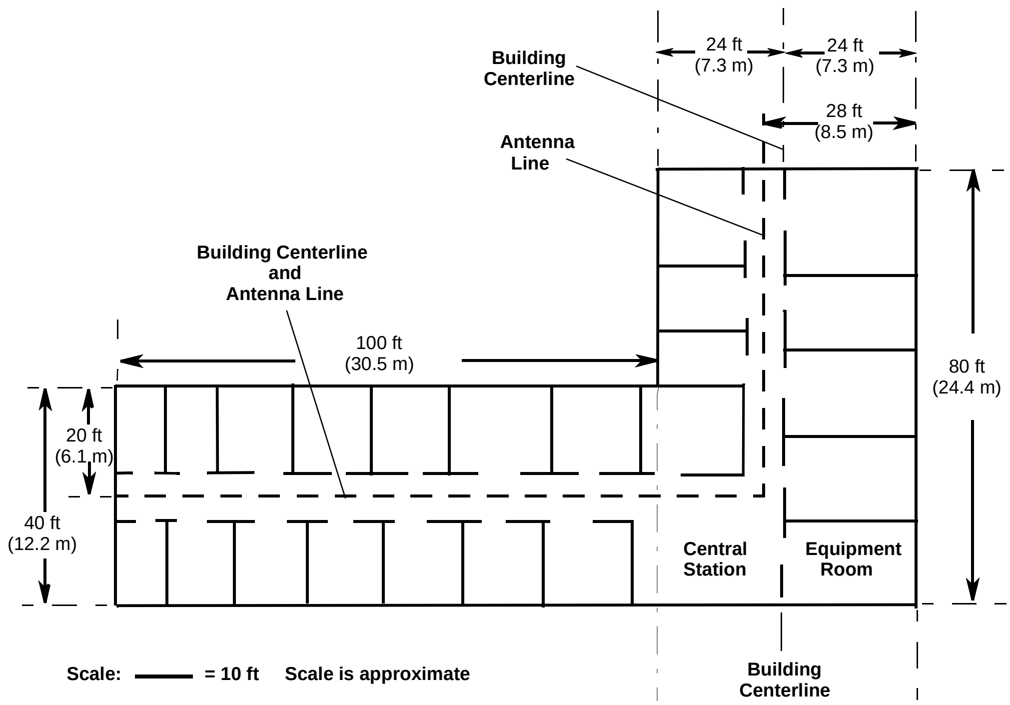


Figure 9-3 Outlining and Marking the Coverage Area

Step 4. Determine and mark the antenna line

- The antenna line and the building centerline may be the same or the two lines may run parallel to each other, as shown in Figure 9-3.

Note Consider ceiling obstructions that would inhibit antenna installation, for example air-duct location and RF blocking sources. Antennas cannot be placed within 2 feet of large metal objects and, because antennas are typically placed in hallways, a difference in the width of the coverage area on either side of the hallway must be considered.

- Use the building centerline as a guide.
- Check for ceiling obstructions, RF blocking sources, and irregular coverage area widths on either side of hallway-mounted antennas and offset the antenna line if needed.
- Mark the antenna line on the floorplan.

Step 5. Measure the longest distance from the antenna line to the outside walls

- If the distance from any antenna line to the outside wall is greater than 30 feet (9.1m), there will be problems with antenna placement. Consult a Philips Medical Systems telemetry expert.

In the example, note that the antenna line on the right side is not on the building center line. This difference indicates that the rooms on one side of the hallway are deeper than on the other side. The distance from the antenna to the outside walls on one side is 20 feet (6.1 m) and on the other side is 28 feet (8.5 m). This distance is less than 30 feet (9.1 m), so the standard design approach does not apply.

Calculating Coverage Area

The number of antennas needed to adequately cover an area is based on the area's square footage. The easiest way to calculate an area's square footage is to divide the area into squares or rectangles. These divisions will be contiguous or non-contiguous. Contiguous objects, or areas, contact each other along the whole, or most, of one side.

Step 1. Determine and calculate subsections

- Divide contiguous areas into subsections of squares and rectangles.
- Calculate square footage by multiplying length times width.

Step 2. Add each sub-section's dimensions as shown in the example that follows. See Figure 9-4 as an example of a hospital floor.

Area of Subsection 1 = 100 ft. X. 40 ft. = 4,000 ft.^{2}
(30.5m x 12.2m = 372m^2)

Area of Subsection 2 = 80ft x 48ft = 3,840ft^2
(24.4m x 14.6m = 356 m^2)

Total Contiguous Coverage Area =

Subsection 1	4,000ft^2	372m^2
Subsection 2	<u>3,840ft^2</u>	<u>356m^2</u>
	7,840 ft.^{2}	728m^2.

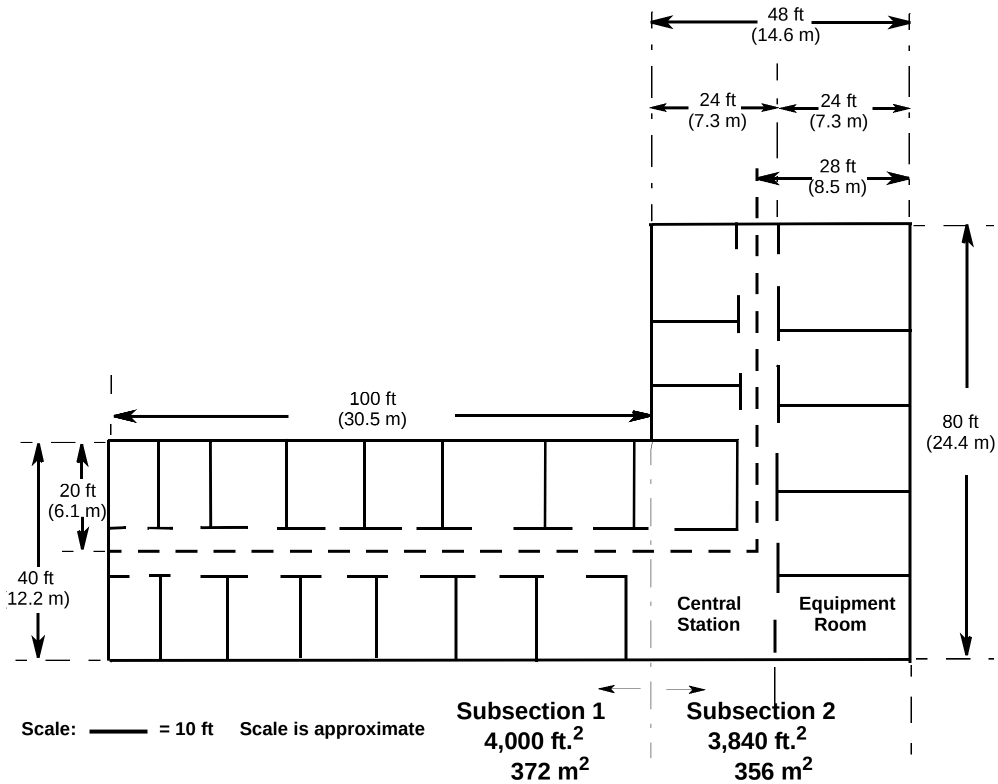


Figure 9-4 Determining and Calculating Sub-Sections

Determining Antennas for Contiguous Areas

Step 1. Determine the number of antennas required from Table 9-1.

- Use the **total** contiguous coverage area to find the number of antennas needed from Table 9-1. Select an even number of antennas, rounding up if necessary.

Note

If the total of each sub-area is used, the calculations will be incorrect, as shown in the following incorrect example.

An **Incorrect** Example:

Sub-section 1 with 4,000 $ft.^2$ yields 4 antennas from Table 9-1.

Sub-section 2 with 3,840 $ft.^2$ also yields 4 antennas.

Total number of antennas = 8, which is an incorrect number

A **Correct** Example:

The total contiguous coverage area is 7,840 $ft.^2$. From Table 9-1, this yields **Total number of antennas = 6**, which is the correct number.

Table 9-1. Antennas Required for Contiguous Coverage Areas

Total Number of Antennas	Maximum $ft.^2$ (m^2)	Total Number of Antennas	Maximum $ft.^2$ (m^2)
2	1,800 (167)	14	23,400 (2,174)
3	3,600 (334)	15	25,200 (2,341)
4	5,400 (502)	16	27,000(2,508)
5	7,200 (669)	17	28,800 (2,676)
6	9,000 (836)	18	30,600 (2,843)
7	10,800 (1,003)	19	32,400 (3,001)
8	12,600 (1,171)	20	35,200 (3,270)
9	14,400 (1,338)	21	37,000 (3,437)
10	16,200 (1,505)	22	38,800 (3,605)
11	18,000 (1,672)	23	40,600 (3,772)
12	19,800 (1,839)	24	42,400 (3,939)

Step 2. Calculate the number of antennas needed for each subsection.

- Divide the area of each sub-section by the total contiguous area and multiply that number by the total number of antennas from Table 9-1.
- Round to the nearest whole number.

Number of Antennas

antennas for subsection = (subsection area/total area) x Total # antennas (Table 9-1)

1. Subsection 1
2. Subsection 2
3. Subsection 3
4. Subsection 4

Step 3. Check the calculations for accuracy.

- Compare the total number of antennas obtained from this step with the total number of antennas obtained from Table 9-1. If the numbers are not the same, rework the calculations. See the following example:

Example:

Refer to the preceding floor plan diagram with its two subsections.

where:	Sub-section 1 = 4,000 ft.^{2}	372 m^2
	Sub-section 2 = 3,840 ft.^{2}	356 m^2
	Total section = 7,840 ft.^{2}	728 m^2

then:

Number antennas for subsection 1 = (4,000/7,840) x 6 = 3 antennas
(372/728) x 6 = 3 antennas

Number antennas for subsection 2 = (3,840/7,840) x 6 = 3 antennas
(356/728) x 6 = 3 antennas

Determining Antennas for Non-Contiguous Areas

Not all coverage areas are contiguous. For antenna calculation purposes, non-contiguous areas are treated separately. For separate, non contiguous areas:

- Calculate the square-footage of each area without computing the sum.
- Determine the number of antennas required for each area from Table 9-1.

Placing and Connecting Antennas

The next step is to place the antennas in their coverage areas and connect them.

Step 1. Place an antenna at each Area End Point. See Figure 9-5.

- On the Antenna Line, mark the location of the first antenna 2 to 6 feet (0.6 to 1.8 meters) from the coverage area's end point.

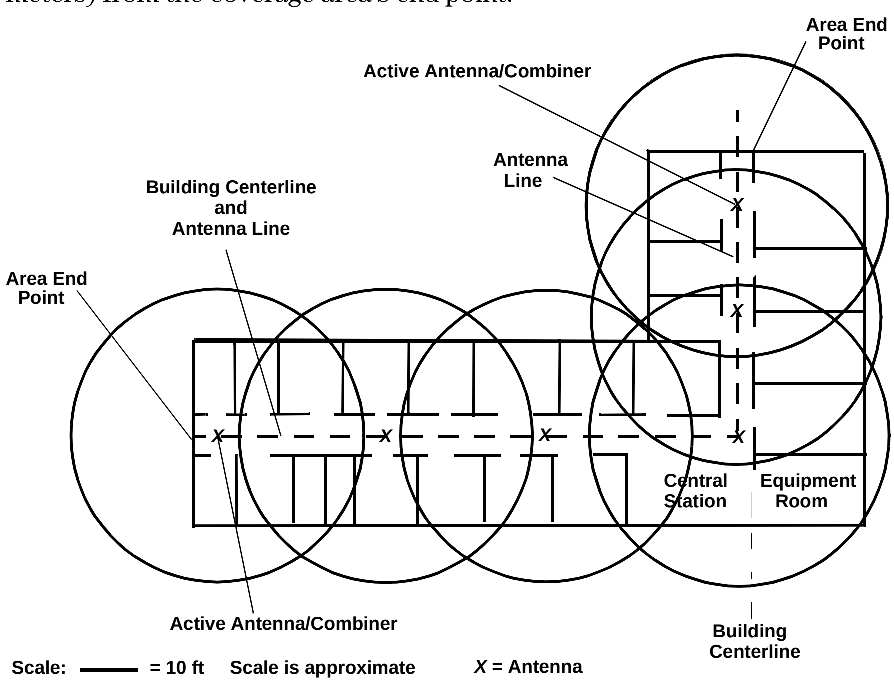


Figure 9-5 Placing Antennas

Step 2. Place the remaining antennas equally along the antenna line. See Figure 9-5.

- Locate and mark the remaining antennas equally along each Antenna Line.
- Locate the antennas close enough to ensure conservative overlaps when tracing the antenna's coverage pattern.
- Adjust the locations to keep the antennas at least 2 feet (0.6 m) from large metal objects, such as ductwork and firedoors.
- Draw a 32 foot (9.8 meter) radius around each antenna's location to show the antenna's coverage pattern. The antenna circles should cover the entire coverage area without gaps.

Step. 3. Connect the antennas into strings of 1 to 6 antennas. Refer to the following section, Pre-configured Antenna Strings on page 9-15, for details.

- Draw connecting lines between the antennas, ending with a final cable running into the equipment room as shown in Figure 9-6.

Note The antenna nearest the equipment room in each sub-area must be no further from it than 139 feet (42.4 meters).

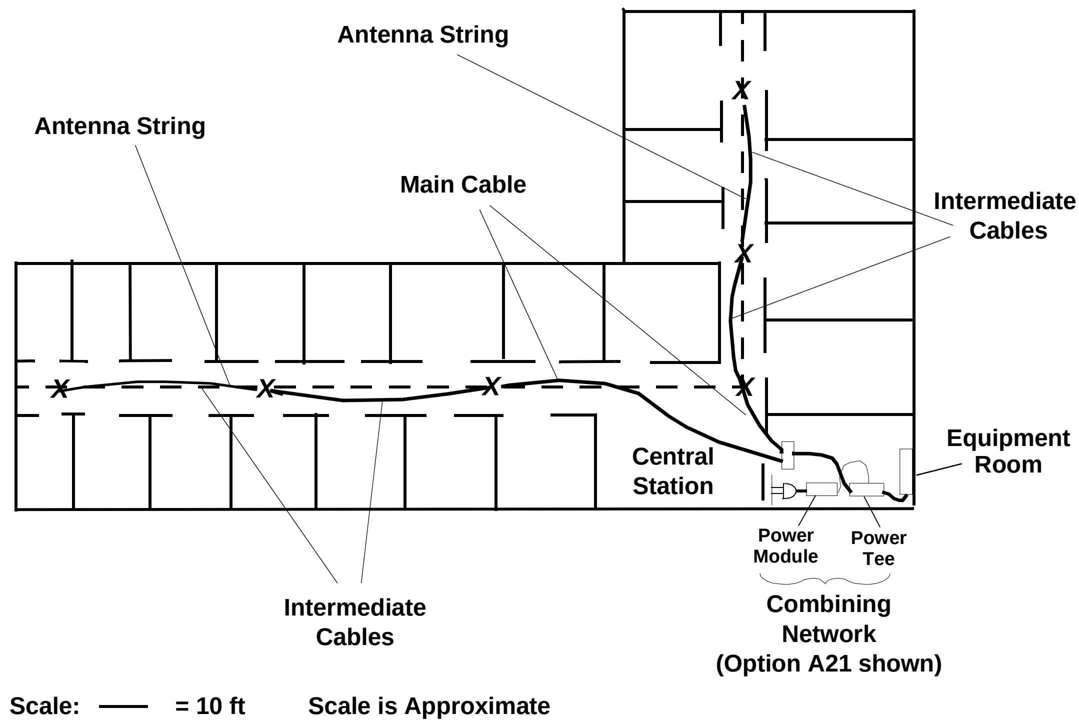


Figure 9-6 Connecting Antennas into Strings

Ordering Antenna System Components

Pre-configured Antenna Strings

When ordering standard systems, the antenna strings are ordered and installed in options of 1 to 6 antennas. In addition to the antennas, each string contains pre-cut lengths of main and intermediate coaxial cables.

Main cables connect the antenna strings to the combining network in the equipment room.

Intermediate cables connect antennas together.

There are 2 antenna string systems available that cover the **406 - 632 MHz** frequency range. -- M2613A and M2614A.

Note also that:

- M2614A uses **fire retardant plenum cable**s.
- M2613A uses **non-fire retardant cables**.

Main and Intermediate cables are cut for specific loss characteristics and are shipped in the following, standard lengths:

Main Cable (connects strings to combining network)	139 feet	(42.4 m)
Intermediate Cable (connect antennas together)	62 feet	(18.9 m)

Figure 9-7 and Figure 9-8 show the available Antenna String Options.

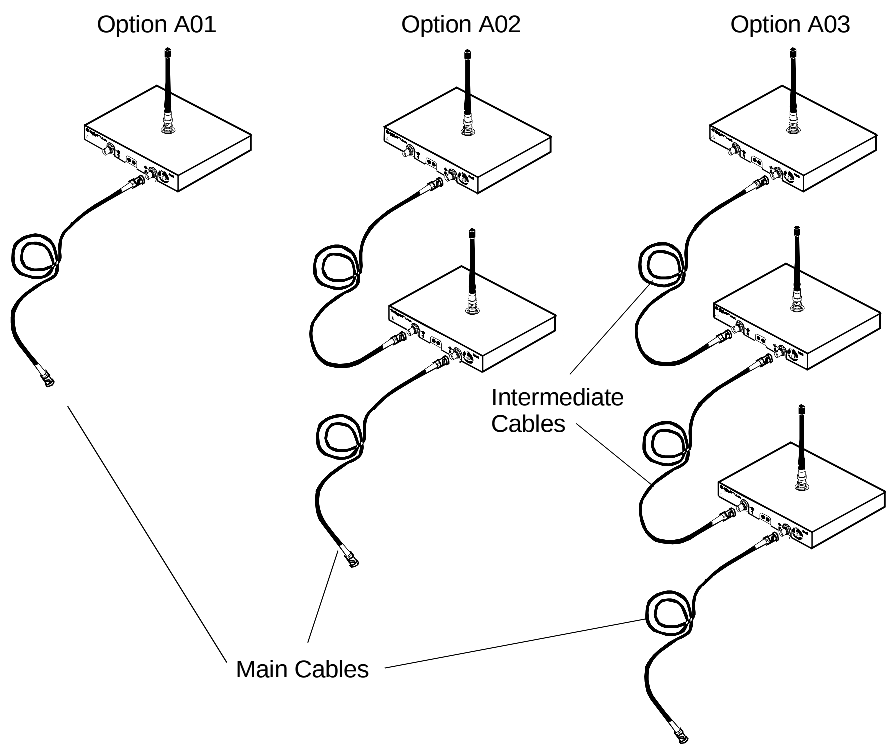


Figure 9-7 M2613/14A Antenna String Options

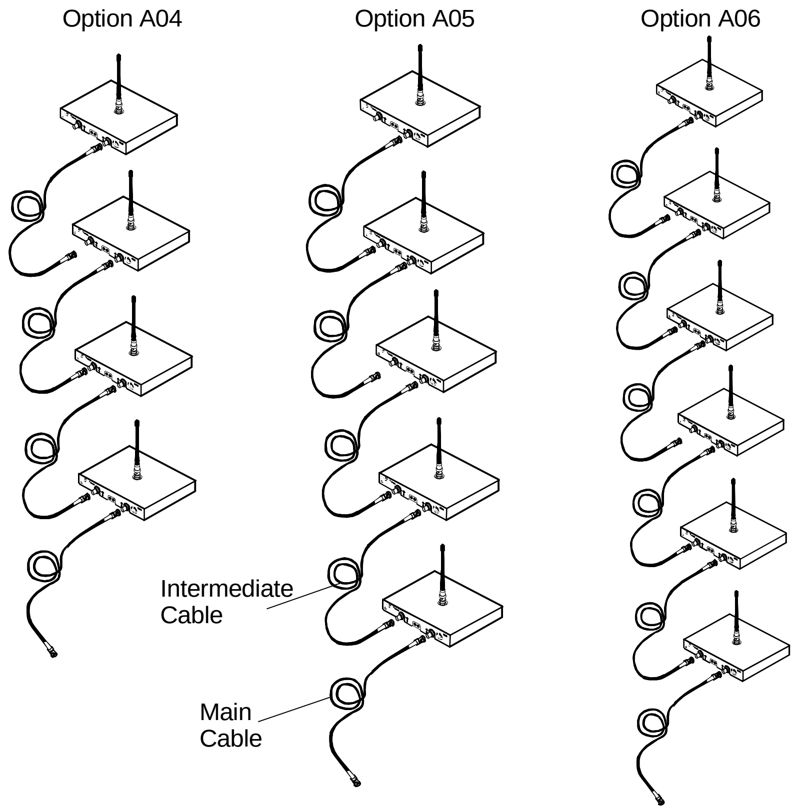


Figure 9-8 M2613/14A Antenna String Options

Pre-configured Combining Networks

Combining networks provide power to the antenna system. The networks also combine incoming signals from all the antenna strings into one cable. They then fan the signals out to the various receiver mainframes and /or frequency converters. Combining networks consist of a specified number of power modules, power tees, splitter/combiners, amplifiers, and coaxial cables. For more information about combining networks, see Chapter 1.

The M2615A combining network, covering the **406 - 632 MHz** range, is available.

Step 1. Order the total number of antenna strings as follows.

- Count the number of antennas in each of the strings drawn.
- Find the appropriate option (A01-A06).
- Determine the antenna string system to order, M2613A or M2614A, based on availability, frequency range, and cable type. See Table 9-2.

Table 9-2. Antenna String System Availability

Frequency Range	Non-fire Retardant Cables (Non-Plenum)	Fire Retardant Cables (Plenum)
406-480 MHz	M2613A (Check availability)	M2614A (Check availability)
590-632 MHz	M2613A	M2614A

Example: For the example presented in this chapter, two, 3 antenna strings (option A03) would be required. For a system operating between 406-480MHz requiring standard cable, order 2, M2613A Option A03.

Step 2. Determine the required number of combining network output ports.

- For operation between **406-480 MHz**, an output port is required for each Receiver Mainframe.
- For operation between **590-632 MHz**, an output port is required for each Frequency Converter.
- For **dual-band operation** (operation in both the 406-480 MHz and the 590-632 MHz bands), one output port is required for each Receiver Mainframe operating between 406-480 MHz and one output port for each Frequency Converter.

Step 3. Determine and order the combining network option. See Table 9-3.

Note When selecting the combining network, it is generally advisable to plan for future expansion by ordering a larger network and terminating any unused ports.

Example: For the example presented in this chapter, which has 2 antenna strings and 1 receiver mainframe, order M2615B option A21. To plan for future expansion for another 2 receiver mainframes, order an M1415B Option A24 and terminate the 3 unused output ports.

Step 4. Determine and order the number of 75-ohm terminators with dc block.

- Terminate all unused input/output ports with a 75-ohm terminator with dc block (M2617A Option J50).

Example: For example, if an option A21 is ordered, there will be no unused input or output ports. If an option A24 is ordered, there will be 3 unused output ports so order a 75-Ohm Terminator and dc Block for each, or 3 M2617A Option J50

Table 9-3. M2615A Systems Operating between 406-632 MHz

# Inputs (Strings)	# Outputs (Mainframes or Frequency Converters)	M2615A Option	# Multiple Unit Power Supplies
2	1 4	A21 A24	1 1
4	4 8	A44 A48	2 2
8	2 8	A82 A88	4 4

Note See the Dual-band UHF Antenna System Installation Note (PN M2600-90185) for combining network installation diagrams.

Site Information Checklist

Following is a Site Information Checklist that should be used to gather site data necessary for designing a high performance telemetry antenna system.

Note **Consider each item carefully, checking each item as it is completed**.

FREQUENCY MANAGEMENT

__ 1. Record the number of channels (beds) required.

__ 2. Record the number of future channels required, if any.

__ 3. Record desired frequency range(s) of operation.

__ 4. Record any HP/Agilent/Philips telemetry frequencies already in use in the hospital (M2601A or M1400A/B/J, 78100A Telemetry, M1310A or 80240A Fetal Telemetry).

__ 5. List any HP/Agilent/Philips telemetry frequencies used within a mile of the hospital.

__ 6. List other local UHF radio frequencies in use at the hospital (e.g., paging systems, ambulance radios, walkie-talkies, other medical manufacturers' UHF telemetry products).

SYSTEM CONSIDERATIONS

__ 1. Provide a copy of any existing antenna network documentation.

__ 2. Record number of receiver mainframes and frequency converters.

__ 3. Indicate whether an HP/Agilent/Philips 78581A System Communication Controller (SCC) is currently in use.

__ 4. Record the number of emergency power outlets required for receiver mainframes and frequency converter power supplies.

__ 5. Record the number of emergency power outlets required for multiple unit power supplies (Use Table 9-3 for this calculation).

BLUEPRINTS AND DIMENSIONED FLOOR PLANS

__ 1. Outline the coverage areas on the blueprint.

__ 2. Outline future coverage areas, if any are planned.

__ 3. Locate the Equipment Room and Central Station on the blueprint.

__ 4. Indicate fire doors, stairwells, and elevator locations in the coverage area.

__ 5. Indicate RF blocking sources in the coverage area (e.g., ducts, sprinkler systems, large metal cabinets, walls containing foil-backed insulation).

__ 6. Indicate potential sources of RF interference (e.g., motors, computer equipment) on blueprint.

__ 7. Provide electrical blueprints, if available.

__ 8. Provide heating, ventilation, and air conditioning blueprints, if available.

A
Specifications

Overview

Appendix A provides specifications for the Philips Telemetry System. It includes tables of specifications of Telemetry System sub assemblies as well as information on Safety Requirements, Electromagnetic Compatibility, and explanations of the Symbols used on Telemetry System hardware.

Transmitter

Table A-1. Transmitter (M2601A) Specifications

Specification	Value
Dimensions at widest point (HxWxD)	129 x 85 x 35 mm (5.08 x 3.35 x 1.38 in)
Dimensions at mid-point (HxWxD)	127 x 74 x 33 mm (5.0 x 2.92 x 1.30 in)
Volume	267 cm^3
Weight (ECG Only)	202 g (7.2 oz) nominal without battery 238 g (8.4 oz) nominal with battery
Weight (ECG + SpO_2)	213 g (7.5 oz.) nominal without battery 249 g (8.8 oz) nominal with battery
Operating Temperature	0^o C to $+45^o$ C (32 to 113^o F) **Note:** SpO_2 transducers have a maximum operating temperature of 37^o C. See transducer product specifications for more detail.
Storage Temperature (without battery)	-40^o C to $+70^o$ C (-40 to $+158^o$ F)
Altitude	Operating and storage up to 4572 meters (15,000 feet)
Defibrillator Patient Protection	Transmitter ECG input is protected against 400 joules discharge into a 50 ohm load.
RF Auto Shut Off Mode	Transmitter shuts off RF section after 10 minutes with all leads off. This prevents interference on other UHF channels.
Shock Resistance	Withstands 1.2 meter (4 foot) drop to vinyl covered concrete surface with only cosmetic damage.
Water Resistant Electronics	5 minutes submersion in 30.48 cm (1 foot) of water, 10 minutes water exposure in a shower.
Cross-infection Prevention	Transmitter can be processed with Ethylene Oxide (EtO) to cross infection assurance level of 10E-6.
Nurse Call Delay	5 seconds maximum from button push to alarm or generation of a recording.

Table A-1. Transmitter (M2601A) Specifications

Specification	Value
Carrier Frequency Range	Option #001: 406 to 412.5 MHz Option #002: 412.5 to 421.5 MHz Option #003: 421.5 to 430 MHz Option #004: 430 to 440 MHz Option #005: 440 to 450 MHz Option #006: 450 to 460 MHz Option #007: 460 to 470 MHz Option #008: 470 to 480 MHz Option #020: 590 to 632 MHz Carrier Frequency Ranges for M2601-#ABJ,#AR0: Japan Only Option #02J: 412.5 to 421.5 MHz Option #03J: 421.5 to 430 MHz Option #05J: 440 to 450 MHz
RF Output Power at 25^{o} C:	Transmitters Option 001-008: 6.5 dBm, +1.6 / -2.0 dB (2.8 mW to 6.5 mW) into 50 ohm load at nominal battery voltage Transmitter Option 020: 6.5 dBm, +1.6 / -2.5 dB (2.5 mW to 6.5 mW) into 50 ohm load at nominal battery voltage Transmitters Japan-only: 0 dBm +0.8 / -3.0 dBm (0.5 to 1.2 mW)
Frequency Accuracy:	± 2.5 ppm at (0 - 45^{o} C)
Occupied Bandwidth:	< 10 kHz
Data Rate:	9600 bits per second
Modulation Type:	GMSK
Current Draw	12.0 mA (ECG only) 43.4 mA (ECG and $Sp0_2$) typical

Battery Life Expectancy

Table A-2. Transmitter Battery Life Expectancy

Recommended Battery Types	Nominal Life Expectancy			
	ECG Only	ECG & Continuous SpO_2	ECG & Intermittent SpO_2	ECG with SpO_2 Transducer Detached
Lithium[1] (supplied)	3 days, 23 hours	23 hours	*1 min. intervals:* 1 day, 22 hours *5 min. intervals:* 3 days, 3 hours	3 days
Alkaline[2]	1 day, 18 hours	10 hours	*1 min. intervals:* 1 day *5 min. intervals:* 1 day, 11 hours	1 day, 11 hours
Zinc-Air[3]	4 days, 18 hours	Not Applicable	Not Applicable	Not Applicable

1. Tested with ULTRALIFE U9VL-J batteries.
2. Tested with DURACELL MN1604 batteries.
3. Tested with DURACELL DA146X batteries.

Battery Extender

Table A-3. Battery Extender (M2611A) Specifications

Specification	Value
Dimensions at widest point (HxWxD) (Transmitter with Cradle)	135 x 96 x 36 mm (5.31 x 3.65 x 1.34in)
Weight (Cradle)	60 g (2.1 oz.) nominal
Patient Connector material	PVC Medical grade
Cradle wire line length	254 mm (10 inches) nominal
Battery Extender	Patient Isolated
Power cable length	3 meters (10 feet) nominal
Power Module weight	320 to 335 g (11.28 to 11.82 oz.) nominal
Output Voltage	9.5V to 10V
Output Current limit	< 300mA
Input Voltage	USA 120 Vac +/-10% (57-63Hz) Europe 220-240 Vac +/-10% (47-53Hz) Japan 100 Vac +/-10% (47-63Hz) UK 220-240 Vac+/-10% (47-53Hz) Australia 220-240 Vac+/-10% (47-53Hz) S. Africa 220-240 Vac+/-10% (47-53Hz)
Shock Resistance	Withstands 1.2 meter (4 foot) drop to vinyl covered concrete surface with only cosmetic damage.
Water Resistant Electronics	5 minutes submersion in 30.48 cm (1foot) of water 10 minutes water exposure in a shower.
Cross-infection Prevention	Can be processed with Ethylene Oxide (EtO) to cross infection assurance level of 10E-6.

ECG Measurement

Table A-4. ECG Measurements

Specification	Value
ECG Input	Differential, defibrillator protected
Input Impedance	>5 M Ohms below 10 Hz
Input Dynamic Range	± 9 mV
DC Offset Range	± 320 mV
Common Mode Rejection Ratio	>90 dB (differential input)
Bandwidths ± 3dB	Monitoring: 0.5 to 40 Hz
Gain Accuracy	± 5% at 77° F (25° C)
ECG Amplification	Central Station selectable gain of 250, 500, 1000, 2000, and 4000
Noise at ECG Output	40 µV peak-to-peak referred to input, with each ECG lead connected to the same point through a 51 kohm resistor in parallel with a .047 µF capacitor.
Calibration	1 mV pulse on central station recordings.
ECG Output	Compatible with Philips Care Network and optional Patient Monitor/Holter Recorder Interface.
Note: The following Cardiotach specifications only apply to conventional ECG transmitters that are not arrhythmia monitored	
Cardiotach Accuracy	± 3 beats *plus* ± 2% of heart rate for constant rate input. At fewer than 15 bpm, the heart rate indication is 0.
Cardiotach Alarm Range	Central station selectable, in 5 bpm increments. High: 20 - 250 bpm Low: 15 - 245 bpm
Cardiotach Alarm Accuracy	± 1 bpm of displayed value
Cardiotach Time to Alarm for Cardiac Standstill	<10 s
Displayed Cardiotach Update	1 second, nominal
Cardiotach Display Range	15 - 300 bpm

SpO_2 Measurement

Table A-5. Philips Telemetry System SpO_2 Measurement Specifications

Measurement	Specification
Measurement Range (Calibration and Display)	0-100%
Accuracy (1 standard deviation)	With Philips reusable transducer M1191A, M1192A: 70-100 ±2.5%
	With Philips re-usable transducer M1194A: 70-100 ±4%
	With NELLCOR sensors D-25, D-20: 80-100% ±3%
Resolution	1%
$Sp0_2$ Numerics Averaging	10 seconds
Calibration	Automatic self-calibration when device is turned on. The pulse oximeter is calibrated to display functional saturation.
Alarm Range	Central Station selectable, in 1% increments: High: - 51 to 100% Low: - 50 to 99%
Measurement Rate	Continuous: (Always on) Intermittent: 1 minute, 5 minute Manual
Pulse Rate	Range: 30-300 bpm Accuracy: ±2% Resolution: 1 bpm

Receiver Module

Table A-6. Receiver Module (M2603A) Specifications

Specification	Value
Frequency Tuning	Programmable, synthesizer controlled
Channel Spacing	25 kHz minimum
Image Rejection	less than -75 dB
Radiation Immunity	3V per meter outside operating receiver bands and reduced levels inside bands.
Carrier Frequency Range	Same as transmitter

Receiver Mainframe

Table A-7. Receiver Mainframe - (M2604A)Specifications

Specification	Value
Dimensions (H x W x D)	60 x 425.5 x 430.8 mm (6.30 x 16.75 x 16.96 in)
Weight	13.8 kg (30.5 pounds) with 8 receiver modules
Color	Gray
Operating Temperature	0 to +45°C (32 to 113°F)
Storage Temperature	-40 to +70°C (-40 to 158°F)
Humidity Range	15% to 95% RH
Altitude	Operating and Storage up to 4572 m (15,000 ft)
Number of Channels	Maximum of 8 per receiver mainframe. Accommodates both M1402A and M2603A receivers.
Outputs	SDN system output standard. Patient Monitor/Holter Recorder Interface optional.
Altitude	Operating and storage up to 4570 meters (15,000 feet)
Power Input Voltage	Rating: 100 - 250 Vac Operating Range: 88 - 280 Vac
Power Frequency	47 to 63 Hz
Power Consumption	110 VA max (60 W) 95 VA average (45 W)
Frequency Tuning	Programmable, synthesizer controlled
Channel Spacing	25 kHz minimum
Image Rejection	less than -75 dB

Table A-7. Receiver Mainframe - (M2604A)Specifications

Specification	Value
Radiation Immunity	3 V per meter outside operating receiver bands and reduced levels inside bands
Carrier frequency range	Same as transmitter
Patient Monitor/Holter Recorder Interface (Analog Output-Option J01) Only available when standard ECG transmitters are used. Cannot be used with EASI transmitters.	Analog Output Gain (from output of receiver module) High-level outputs: 500 ± 5% Low-level outputs: 1 +7%/-6% ECG Bandwidth: Determined by ECG system bandwidth Inoperative Mode (INOP Condition) Output Level High-level output: 10.8 volts ± 1.2 volts Low-level output: >100 megohms with respect to reference electrode Delay from Transmitter Input to Analog Output: 400 milliseconds max – Philips Transmitter **Note:** Not intended for use with synchronized cardioversion due to processing delay.
Output Connector Box	Indicators: status and power LEDs Connections: Input (50-pin jack); Output (8 pairs of 9-pin D connectors) Analog Output Card: Output (50-pin jack) Bedside Attenuator: Output (3-conductor phone jack) Holter Attenuator: Output (set of 5-button connectors) Dimensions (H x W x D): 463 x 133 x 28 mm (18.3 x 5.3 x 1.1 in) Weight: 0.68 kg (1 lb., 8 oz) Input Voltage: 100 - 240 Vac, ± 10% Frequency Range: 47 - 63 Hz. Power Consumption: 10 VA max with all outputs terminated

Antenna System

Table A-8. Antenna System Specifications

<table>
<tr><th>Product</th><th>Measurement</th><th>Specification</th></tr>
<tr><td rowspan="3">All Antenna System Components</td><td>Temperature Range</td><td>Operating: 0 to 55ºC (32 to 131ºF)
Storage: -40 to +70ºC (-40 to +158ºF)</td></tr>
<tr><td>Altitude Range</td><td>Operating and storage:
up to 4,570 m (15,000 ft.)</td></tr>
<tr><td>Humidity</td><td>Operating: 15 to 95% relative humidity
Storage: 90% relative humidity maximum</td></tr>
<tr><td rowspan="7">M2608A Active Antenna/Combiner</td><td>RF Frequency Range</td><td>406 to 650 MHz</td></tr>
<tr><td>Operating Voltage</td><td>19 to 32 Vdc @ 24 V</td></tr>
<tr><td>Current Requirements</td><td>45mA typical at 24 V (62 mA max)</td></tr>
<tr><td>Average Power Consumption</td><td>approximately 1.1 W</td></tr>
<tr><td>RF Gain</td><td>Antenna port:
9.7 dB ± 1.0 db at 406 MHz
10.2 dB ± 1.0 db at 465 MHz
9.7 dB ± 1.0 db at 611 MHz
9.7 dB ± 1.5 db at 650 MHz
Line port:
3.2 dB ± 0.7 dB at 406MHz
3.5 dB ± 0.3 dB at 465 MHz
3.9 dB ± 0.7 dB at 611 MHz
4.0 dB ± 0.7 dB at 650 MHz</td></tr>
<tr><td>Dimensions (HxWxD):</td><td>31.7 x 188.4 x 228.6mm (1.25 x 7.42 x 9 in) nominal</td></tr>
<tr><td>Weight typical</td><td>< 450 g (15.9 oz.)</td></tr>
<tr><td rowspan="7">M2606A Line Amplifier</td><td>RF Frequency Range</td><td>406 to 650 MHz</td></tr>
<tr><td>RF Gain</td><td>12.0 dB ±1.0 dB at 406 MHz
12.7 dB ± 1.0 dB at 465 MHz
13.3 dB ± 1.0 dB at 611 MHz
13.2 dB ±0.8 dB at 650 MHz</td></tr>
<tr><td>Operating Voltage</td><td>19 V to 32 V</td></tr>
<tr><td>Current Requirements</td><td>30 mA typical @ 24 V (38 mA max)</td></tr>
<tr><td>Average Power Consumption</td><td>approximately .75 W</td></tr>
<tr><td>Dimensions</td><td>38.3 x 63.5 x 114.3mm [139.7mm (5.5 in.) including mounting feet & BNC connectors]
(1.5 x 2.5 x 4.5 in) nominal</td></tr>
<tr><td>Weight</td><td>< 145 g (5.1 oz.), typical 138 g (4.8oz)</td></tr>
</table>

Table A-8. Antenna System Specifications

Product	Measurement	Specification
M2607A Multiple Unit Power Supply	RF Frequency Range	406 to 650 MHz
	Input Voltage	Line Voltage: 90 - 264 Vac Line Frequency: 47 – 63Hz
	Output Voltage	23 Vdc nominal (32 Vdc max)
	Average Power Consumption	33 VA max
	Output Current	1 A max
	Overload Protection	Externally resetable circuit breaker with trip rating of 1A
	Dimensions: Nominal	38.3 x 63.5 x 114.3mm [139.7mm (5.5 in.) including mounting feet & BNC connectors}] (1.5 x 2.5 x 4.5in) nominal
	Weight	< 155 g (5.5 oz.), typical 150 g (5.3 oz.)
M2609A Attenuator	Current Carrying Capacity	Maximum dc Voltage: +30 Vdc maximum Maximum dc Current: 1 A maximum
	RF Frequency Range	406 - 650 MHz
	RF Attenuation	1-9 dB in increments of 1 dB, based on option
	Dimensions	Length: 66 mm (2.6 in.) Diameter: 18.5 mm (0.73 in.)
	Weight	48 g (1.7 oz) typical
M2612A Bandpass Filter	Current Carrying Capacity	Maximum dc Voltage: 32 Vdc Maximum dc Current: 1 A
	Power Requirements	Negligible
	RF Frequency Range	#004 430 - 440 MHz #005 440 - 450 MHz #006 450 - 460 MHz #007 460 - 470 MHz #034 590 - 596 MHz #035 596 - 602 MHz #036 602 - 608 MHz #037 608 - 614 MHz
	Dimensions	38.3 x 63.5 x 114.3mm [139.7mm (5.5 in.) including mounting feet and BNC connectors] (1.5 x 2.5 x 4.5 in) nominal
	Weight	225g (7.8 oz.) typical range 196 to 215g (6.9 oz to 7.6 oz)

Table A-8. Antenna System Specifications

Product	Measurement	Specification
M2616A Frequency Converter	Number of RF Outputs	8 RF Outputs (Supports 8 receiver mainframes with 8 channels each)
	RF Input Frequency Range	590 - 632 MHz
	RF Output Frequency Ranges	#130 460 - 502 MHz #136 454 - 496 MHz #142 448 - 490 MHz #148 442 - 484 MHz
	RF Gain:	+2.2 db ± 1.5 dB at 590 MHz input +1.4 db ± 2.0 dB at 632 MHz input
	Frequency translation options, #130 to #166	130, 136, 142, 148 MHz
	Dual band operation	Simultaneous operation of transmitters in 406 - 480 MHz & 590 - 632 MHz UHF bands, rejects standard telemetry transmitter with 6 dBm RF power in 460 - 470 MHz at 6 feet from system Mainframe.
	Input Current for M2616A	Current after 4 minutes < 155 mA at 24 V
	Input Voltage for M2616A	24 V nominal, 1 9V to 32 V
	Average Power Consumption	3.8 W at 24 V
	Dimensions:	66 x 120 x 462 mm (2.6 x 4.7 x 18.2 in) nominal
	Weight	< 2 kg (4.4 labs)
	External ac/dc Power Adapter: Input	Line Voltage: 90 - 264 VAC Line Frequency: 47 – 63 Hz Power In: 14 VA max with M2616A
	External ac/dc Power Adapter: Output	Voltage: 24 V, nominal Current: 1.4 A, max

Safety Requirements

Declaration

CE 0891 (!)
0123

The M2600A-Philips Telemetry System complies with the requirements of the Council Directive 93/42/EEC of 14 June 1993 concerning medical devices and carries CE-marking accordingly.

The M2600A Philips Telemetry System Revision B and later (options 004 - 008 and 020) also comply with the Council Directive 1999/5/EC of 9 March 1999 concerning radio equipment and telecommunications terminal equipment.

The following symbol CE (!) means that this device is considered Class 2 radio equipment per Directive 1999/5/EC for which Member States may apply restrictions on putting the device into service or placing it on the market. This system is intended to be connected to the Publicly Available Interfaces (PAI) for use throughout the EEA – AT, BE, CH, DE, ES, FI, FR, IE, IS, IT, LI, LU, NL, NO, PL, PT, SE, UK, and others.

The Philips Telemetry System (except the Wave Viewer) also complies with the following international safety requirements for medical electrical equipment:

- UL 2601-1
- CAN/CSA C22.2 NO. 601.1-M90
- EN 60601-1/IEC 60601- 1
- EN 60601-1-1/IEC 60601-1-1
- EN 60601-1-2/IEC 60601-1-2
- EN 865:1997
- AAMI voluntary performance standards for cardiac monitors sections: 3.1.2.1.c, 3.2.6.1.a-c, 3.2.6.2, 3.2.6.3, 3.2.7, 3.2.8.3, 3.2.8.4, 3.2.8.7, 3.2.9.2, 3.2.9.3 and 3.1.4.1

The system is protected against the effects of defibrillation.

This system provides continuous operation when in use.

The Wave Viewer complies with EN 60601-1/IEC 60601-1.

The following accessories and system components are independently CE marked to the Medical Device Directives. They are not covered by the CE marking of the Philips Telemetry System:

- All SpO_2 accessories and equipment
- Electrodes
- ECG Lead Sets

Authorized EU Representative:

Philips Medizinsysteme Boeblingen GmbH
Hewlett-Packard Str. 2
71034 Boeblingen
Germany
(+49) 7031 463 3232

Electromagnetic Compatibility

The electromagnetic compatibility (EMC) validation of the M2600A Philips Telemetry System included testing performed according to the international standard for EMC with medical devices. See the Manufacturer's Declaration of Conformity for details.

Philips Telemetry System Testing

During the test program, the M2600A was subjected to many EMC tests, both international standard and Philips Technologies proprietary tests. During most of the testing no anomalies were observed. For three of the tests, EN 61000-4-3 Radiated Immunity, IEC 801-4 Fast Transients, and IEC 801-2 Electrostatic Discharge, some reduced performance was observed.

EN61000-4-3

EN61000-4-3 specifies that the product be subjected to a field of 3 V/m over a frequency range of 26 to 1000 MHz with no degradation of performance. At most of the test frequencies over the specified range, no anomalies were observed. However at the transmit/receive frequencies, and a few others, the radiated field caused interference with a resulting drop-out of signal. For these test points the radiated field was reduced to the level at which communication was restored. These reduced levels are shown in the following table.

Table A-9. Minimum Immunity Level (V/m)

	In Band Radiation (Transmit freq. +/- 1 MHz)	Out of Band Radiation
Transmitter	0.03	1.81 (380 MHz - 400 MHz) 2.83 (at 571 MHz)
Receiver	0.01	Pass at 3 V/m

IEC 801-4

IEC 801-4 specifies that the product be subjected to high speed pulses up to 1000 V applied to the power cord and 500 V applied to all I/O cables greater than 3 m. During all of this testing no anomalies were observed on the Central Station display. However, at pulse levels of 300 V and above applied to the power cord, occasional spikes appeared on the monitor connected to the analog output of the receiver mainframe. These spikes sometimes caused the heart rate reading (on the analog output monitor only) to change momentarily.

Philips Telemetry System Characteristics

The phenomena discussed above are not unique to the M2600A, but are characteristic of wireless patient monitors in use today. This performance is due to the very sensitive high gain front end amplifiers used to display the physiological signals and the nature of wireless communication. Among the many similarly performing monitors already in use by customers, interference from electromagnetic sources is rarely a problem.

Warning **Although this device is shielded against electromagnetic interference (EMI), it is recommended that the use of other electrically radiating devices in close proximity to this equipment be avoided.**

Avoiding EMI

When electromagnetic interference (EMI) is encountered, there are a number of things that can be done to mitigate the situation.

- **Eliminate the source.** Possible sources of EMI can be turned off or moved away to reduce their strength.
- **Attenuate the coupling.** If the coupling path is through the patient leads, the interference may be reduced by moving and/or rearranging the leads. If the coupling is through the power cord, connecting the M2600A to a different circuit may help.
- **Add external attenuators.** If EMI becomes an unusually difficult problem, external devices such as an isolation transformer or a transient suppressor may be of help. A Philips Medical Systems Service Provider can be of help in determining the need for external devices.

FCC Compliance (USA only)

The Philips Transmitter and Philips Receiver Mainframe are subject to radio frequency interference from radio and television stations licensed as primary users. In the event of suspected radio frequency interference with the device, contact a Service Provider. The FCC requires the following statement for this device:

The M2600A Philips Telemetry System complies with Part 15 of the Federal Communications Commission (FCC) Rules. Operation is subject to the following two conditions:

1. *This device may not cause harmful radio frequency interference to a primary licensed user (radio and television stations), and*
2. *This device must accept any interference received from a primary licensed user, including interference that may cause undesired operation.*

Pursuant to Part 15.21 of the FCC Rules, any changes or modifications to this equipment not expressly approved by Philips Technologies may cause harmful radio frequency interference and void your authority to operate this equipment.

Canadian Radio Equipment Compliance (Canada Only)

For operation in the frequency range 608 - 614 MHz:

This telemetry device is only permitted for installation in hospitals and health care facilities. This device shall not be operated in mobile vehicles (even ambulances and other vehicles associated with health care facilities). The installer/user of this device shall ensure that it is at least 80 km from the Penticton radio astronomy station (British Columbia latitude: 49° 19’ 12” N, longitude 118° 59’ 56” W). For medical telemetry systems not meeting this 80 km separation (e.g., the Okinagan Valley, British Columbia) the installer/user must coordinate with and obtain the written concurrence of the Director of the Penticton radio astronomy station before the equipment can be installed or operated.

The Penticton contact is: Tel: 250-493-2277
FAX: 250-493-7767.

For operation outside the frequency range 608 - 614 MHz:

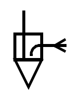
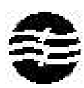
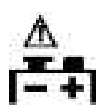
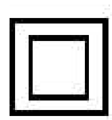
Contact your local Industry Canada offices as licensure is required.

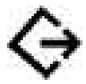
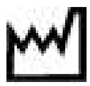
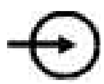
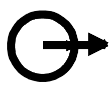
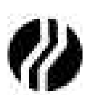
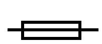
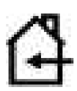
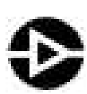
The term “IC” before the certification/registration number only signifies that Industry Canada technical specifications were **not** met.

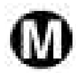
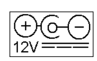
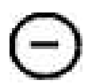
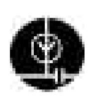
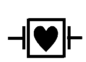
To provide maximum RF shielding and minimum RF interference to the licensed service, this device should be operated indoors and away from windows.

System Symbols

Following are explanations of the symbols found on hardware components of the Philips Telemetry System:

Symbol	Explanation
~	ac Line Current.
	Active Antenna Combiner.
	Antenna Input.
	Attention. See Instructions For Use.
	Bandpass Filter
	Battery Polarity
REF	Catalog Number
	Class 2 Equipment
	Data In
	Data In, Data Out

Symbol	Explanation
	Data Out
	dc Voltage
	Date of Manufacture
	Do Not Reuse. Use Only Once. Dispose of properly after use in accordance with local regulations.
	Electrical Input
	Electrical Output.
	Equipotential Grounding System.
	Frequency Converter
	Fuse Input.
	Grounding system.
	Indoor Use Only
	Line Amplifier

Symbol	Explanation
	Mainframe. For future use.
	Receiver Mainframe Malfunction
	Non-ionizing Radiation
	Palmtop. Power Polarity
	Power On/Off
OPT	Product Option
	Protective Earth (Ground)
	Power Tee
SN	Serial Number
	Type CF Defibrillation Proof
	Class 2 Radio equipment identifier (1999/5/EC). Member states may apply restrictions on putting this device into service or placing on the market. This device is intended to be connected to the Publicly Available Interfaces (PAI) for use throughout the EEA.

Symbol	Explanation
CSA NRTL/C	This device complies with Canadian Standards Association and nationally recognized testing lab requirements.
IPXO	The M2600A is rated IPXO in degrees of protection by enclosures; not protected against ingress of water.
CE 0123	Compliance to Council Directive 93/42/EEC (Medical Device Directive)
CE 0891 (!)	Compliance to Council Directive 1999/5/EC (R&TTE) when transmitter is used with the M2611A Battery Extender device, radio restrictions may apply.
CE 0168 (!)	Compliance to Council Directive 1999/5/EC (R&TTE) when transmitter is used with M2636B TeleMon B Monitor, radio restrictions may apply.

Type CF Defibrillation Proof

The following symbol indicates that the various instruments connected to the Philips Telemetry System are Type CF Defibrillation Proof.

TYPE CF
DEFIBRILLATION PROOF

Type CF Defibrillation Proof equipment is designed to have special protection against electric shocks for intracardiac application (particularly regarding allowable leakage currents by having an F-type isolated or floating applied part), and is defibrillator proof.

B

Ordering Information

Overview

Appendix D gives ordering information for the Philips Telemetry System. It includes following tables for Telemetry System sub assemblies.

Basic System

The Philips Telemetry System comprises the following components

System Components

Table B-1. Philips Telemetry System - Basic System

Product Number	Component
M2600A	Philips Telemetry System
M2601A	Transmitter
M2603A	Receiver Module
M2604A	Receiver Mainframe

Product Options

Table B-2. Philips Telemetry System Product Options

M2600A Option #	Description	Quantity		
		M2601A Transmitter	M2603A Receiver	M2604A Mainframe
A01	1 channel telemetry system	1	1	1
A02	2 channel telemetry system	2	2	1
A04	4 channel telemetry system	4	4	1
A06	6 channel telemetry system	6	6	1
A08	8 channel telemetry system	8	8	1
A10	Replacement transmitter	1	0	0
A11	Transmitter/ Receiver pair	1	1	0
A12	Receiver	0	1	0
A13	Receiver Mainframe	0	0	1

Feature Options

Table B-3. Feature Options

M2600A Option #	Description	Hardware Requirements
J01[a]	Patient Monitor/Holter Recorder Interface (Analog Output)	Add 1 Analog Output PCB and 1 Output Connector Box
C05	Add SpO_2 to one ECG only transmitter	Add SpO_2 to one ECG only transmitter on the order
C07	Add an External Frequency Converter	Add an External Frequency Converter with outputs for up to 8 receiver mainframes
C08	Internal Frequency Converter	Receiver Mainframe with Internal Frequency Converter
C12	Add EASI to one transmitter.	Add the EASI feature to one transmitter on the order.
C13	Add Series B Transmitter.	Convert one transmitter to Series B.
C14[b]	Install Series B software into transmitter.	

a This option can only be used with standard ECG transmitters and does not apply to EASI transmitters.

b This option can only be attached to an option A10 or A11

Frequency Options

Table B-4. Frequency Options

M2600A Option #	Description - Transmitters and/or Receivers that can be tuned to frequencies between:
#001	406 - 412.5 MHz
#002	>412.5 - 421.5 MHz
#003	>421.5 - 430 MHz
#004	>430 - 440 MHz
#005	>440 - 450 MHz
#006	>450 - 460 MHz
#007	>460 - 470 MHz
#008	>470 - 480 MHz
#034	>590 - 596 MHz
#035	>596 - 602 MHz
#036	>602 - 608 MHz
#037	>608 - 614 MHz

ECG Accessory Options

Table B-5. ECG Accessory Options

M2600A Option #	Description	Colors	Hardware Requirements
K01	Telemetry leadset 3-wire grabber, 30” (76 cm)	AAMI	1 - M2591A
K02	Telemetry leadset 3-wire snap, 30” (76 cm)	AAMI	1 - M2590A
K03	Telemetry leadset 5-wire grabber, 30” (76 cm)	AAMI	1 - M2593A
K04	Telemetry leadset 5-wire snap, 30” (76 cm)	AAMI	1 - M2592A
K11	Telemetry leadset 3-wire grabber, 30” (76 cm)	IEC	1 - M2595A
K12	Telemetry leadset 3-wire snap, 30” (76cm)	IEC	1 - M2594A
K13	Telemetry leadset 5-wire grabber, 30” (76 cm)	IEC	1 - M2597A
K14	Telemetry leadset 5-wire snap, 30” (76 cm)	IEC	1 - M2596A

SPO_2 Accessory Options

Table B-6. SpO_2 Accessory Options

M2600A Option #	Description	Hardware Requirements
K06	Philips Adult/pediatric ear clip reusable SpO_2 transducer	1 - M1194A
K07	Philips adult finger reusable SpO_2 transducer	1 - M1191A
K08	Philips pediatric/small adult finger reusable SpO_2 transducer	1 - M1192A
K09	Nellcor SpO_2 adapter cable and start-up kit (U.S. only)	1 - M1943A adapter cable and assortment of Nellcor adult transducers
K15	Nellcor SpO_2 transducer M1904A and M1943A adapter cable and start-up kit (Europe and Asia Pacific)	1 - M1943A adapter cable and assortment of Nellcor adult transducers
K20	Battery Extender	1-M2611A battery extender

Installation Materials

Receiver Mainframe Mounts

Table B-7. Receiver Mainframe Mounts

Product Number	Description
78000AI-#R86	Mainframe flush wall mount
78000AI-#R90	Mainframe GCX wall mount

Patient Monitor/Holter Recorder Interface Cables and Faceplates

Table B-8. Patient Monitor/Holter Recorder Interface Cables and Faceplates

Options	Description
78599AI-#K67	Analog Output Cable, non-plenum 50 ft
78599AI-#K68	Analog Output Cable, non-plenum 100 ft
78599AI-#K69	Analog Output Cable, non-plenum 250 ft
78599AI-#K70	Analog Output Cable, non-plenum 500 ft
78599AI-#K71	Bedside Cable, 3/4 lead, 8 pin
78599AI-#K72	Bedside Cable, 3/4 lead, 12 pin
78599AI-#K73	Bedside Cable, 5 lead, 8 pin
78599AI-#K74	Bedside Cable, 5 lead, 12 pin
78599AI-#K75	Bedside Attenuator
78599AI-#K76	Holter Attenuator
78599AI-#K81	Bedside/SDN Attenuator
78599AI-#K78	Analog Output Cable, plenum 100 ft
78599AI-#K80	Analog Output Cable, plenum 500 ft

Dual-band UHF Antenna System

The following Antenna System products can be used with the M2600A Philips Telemetry System:

Pre-Configured Antenna Strings

M2613A Dual-band UHF Non-Plenum Antenna Systems

Table B-9. M2613A Dual-band UHF Non-Plenum Antenna Systems

Product Number Option	Component
Antenna String Options	
A01	1 Antenna String
A02	2 Antenna String
A03	3 Antenna String
A04	4 Antenna String
A05	5 Antenna String
A06	6 Antenna String
Substitute Cable Options	
J03	Substitute Intermediate Cable: Deletes 1, 62 ft (19 m) intermediate cable (RG-6) Adds 1, 112ft (34 m) intermediate cable (RG-11)
J04	Substitute Main Cable: Deletes 1, 139 ft (42 m) main cable (RG-6) Adds 1, 250ft (76 m) main cable (RG-11)

M2614A Dual-band UHF Plenum Antenna Systems

Table B-10. M2614A Dual-band UHF Plenum Antenna Systems

Product Number Option	Component
Antenna String Options	
A01	1 Antenna String Plenum,
A02	2 Antenna String Plenum
A03	3 Antenna String Plenum
A04	4 Antenna String Plenum
A05	5 Antenna String Plenum
A06	6 Antenna String Plenum
Substitute Cable Options	
J03	Substitute Plenum Intermediate Cable: Deletes 1, 62 ft (19 m) intermediate cable (RG-6) Adds 1, 75ft (23 m) intermediate cable (RG-11)
J04	Substitute Plenum Main Cable: Deletes 1, 139 ft (42 m) main cable (RG-6) Adds 1, 165ft (50 m) main cable (RG-11)

Pre-configured Combining Networks

M2615A Dual-band Antenna System Combining Network

Table B-11. M2615A Dual-band Antenna System Combining Networks

Product Number Option	Component
Basic System Options	
A21	Combining network with 2 input ports (antenna strings) and 1 output port (receiver mainframes or frequency converters).
A24	Combining network with 2 input ports (antenna strings) and 4 output ports (receiver mainframes or frequency converters).
A44	Combining network with 4 input ports (antenna strings) and 4 output ports (receiver mainframes or frequency converters).
A48	Combining network with 4 input ports (antenna strings) and 8 output ports (receiver mainframes or frequency converters).
A82	Combining network with 8 input ports (antenna strings) and 2 output ports (receiver mainframes or frequency converters).
A88	Combining network with 8 input ports (antenna strings) and 8 output ports (receiver mainframes or frequency converters).

Antenna Mounting Hardware

Table B-12. 78000AI Antenna Mounting Hardware Options

Product Number Option	Component
R86	Mainframe Flush Wall Mount
R89	Antenna Wall Mount
R90	Mainframe GCX Wall Mount

Antenna System Products

Table B-13. Antenna System Products

Option	Description
M2606A	Line Amplifier
M2607A	Multiple Unit Power Supply
M2608A	Active Antenna /Combiner

Attenuator (M2609A)

Table B-14. Attenuator (M2609A)

Option	Description
A01	1dB Attenuator
A02	2 dB Attenuator
A03	3 dB Attenuator
A04	4 dB Attenuator
A05	5 dB Attenuator
A06	6 dB Attenuator
A07	7 dB Attenuator
A08	8 dB Attenuator
A09	9 dB Attenuator

Bandpass Filter (M2612A)

Table B-15. Bandpass Filter (M2612A)

Option	Description
004	Filter Range 430 - 440 MHz
005	Filter Range 440 - 450 MHz
006	Filter Range 450 - 460 MHz
007	Filter Range 460 - 470 MHz
034	Filter Range 590 - 596 MHz
035	Filter Range 596 - 602 MHz
036	Filter Range 602 - 608 MHz
037	Filter Range 608 - 614 MHz

External Frequency Converter (M2616A)

Table B-16. External Frequency Converter (M2616A)

Option	Description
130	Frequency Shift of 130 MHz
136	Frequency Shift of 136 MHz
142	Frequency Shift of 142 MHz
148	Frequency Shift of 148 MHz
154	Frequency Shift of 154 MHz
160	Frequency Shift of 160 MHz
166	Frequency Shift of 166 MHz

Antenna System Accessories (M2617A)

Table B-17. Antenna System Accessories (M2617A)

Option	Description
J20	Frequency Converter to Mainframe Cable 1, 10 ft (3m) specially shielded external frequency converter
J30	RG-6 Special Loss Cable (1, RG 6 cable cut to specified loss)
J31	RG-11 Special Loss Cable (1, RG-11 cable cut to specified loss)
J40	Plenum RG-6 Special Loss Cable (1, RG 6 cable cut to specified loss)
J41	Plenum RG-11 Special Loss Cable (1, RG 11 cable cut to specified loss)
J50	75-ohm Terminator with integrated DC Block, used to terminate any unused input or output ports.
J51	dc Block.

Supplies and Accessories

The following tables list the supplies and accessories that can be ordered for use with a Philips Telemetry System

ECG Leadset with Telemetry Combiner

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Table B-18. ECG Leadset with Telemetry Combiner (CMS compatible)

Product Number	Description	Colors
M2590A	3 wire snap (76cm or 30”)	AAMI
M2591A	3 wire grabber (76cm or 30”)	AAMI
M2592A	5 wire snap (76cm or 30”)	AAMI
M2593A	5 wire grabber (76cm or 30”)	AAMI
M2594A	3 wire snap (76cm or 30”)	IEC
M2595A	3 wire grabber (76cm or 30”)	IEC
M2596A	5 wire snap (76cm or 30”)	IEC
M2597A	5 wire grabber (76cm or 30”)	IEC

Table B-19. Telemetry Combiner (CMS compatible, used to convert CMS leadsets for use with Philips Telemetry System)

Product Number	Description
M2598A	Telemetry 3-wire Leadset Combiner
M2599A	Telemetry 5-wire Leadset Combiner

ECG Electrodes

Table B-20. ECG Electrodes

Product Number	Description
14445A	High Performance Foam, 1/pack, 200/case
14445C	High Performance Foam, 3/pack, 300/case
40493A	Foam, 1/pack, 300/case
40493E	Foam, 30/pack, 300/case
40489E	Porous, High Tack Adhesive Carrier Paper tape, 30/pack, 300/case
M2202A	Radiotranslucent foam, 5/pack, 300/case

SpO_2 Transducers

Table B-21. SpO_2 Transducers

Product Number	Description
M1191A	Philips Reusable Adult finger transducer SpO_2
M1192A	Philips Reusable Pediatric/Small adult finger SpO_2 transducer
M1194A	Philips Reusable Adult/Pediatric ear clip SpO_2 transducer
M1627A	Wristband
M1943A	Adapter cable for Nellcor Oxisensor ™
M1904A/B	Nellcor Oxisensor™ D-25, SpO_2 transducer
M1903A/B	Nellcor Oxisensor™ D-20, SpO_2 Transducer

Transmitter Pouches

Table B-22. Transmitter Pouches

Product Number	Description
9300-0768-050	Transmitter Pouch, disposable, 50 per case
9300-0768-200	Transmitter Pouch, disposable, 200 per case

Battery Products

Table B-23. Telemetry Battery Products

Product Number	Description
ULBU9VLJ	9V Lithium battery, box of 10
40455A	Zinc Air battery

Feature Upgrades

Table B-24. Feature Upgrades

M2610AU Option	Description
Add SpO_2 to ECG Only M2601A Transmitter	
A15	Add SpO_2 to an existing M2601A ECG Only Transmitter
Add EASI 12-lead to an M2601A Transmitter	
A12	Add EASI 12-lead to an existing M2601A Transmitter
Convert an M2601A Transmitter to Extended UHF Band Operation	
A16	Hardware to change the frequency band of operation to 590 - 632 MHz.

Table B-24. Feature Upgrades

M2610AU Option	Description
Add Battery Extender to M2601A Transmitter	
K20	Battery Extender for an M2601A Transmitter with a Prefix date code of ≥ 4015A
K21	Battery Extender, Battery Contacts and Door For an M2601A Transmitter with a Prefix date code of < 4015A
TeleMon Compatibility	
A13	Add TeleMon interface to an M2601A Transmitter
Add Button Initiated SpO_2 Measurement	
C11	Update an M2601 Transmitter to add the button initiated SpO_2 measurement feature.
Add the Patient Monitor/Holter Recorder Interface	
J01	Add Patient Monitor/Holter Recorder Interface (Analog Output) to an existing M2604A - Receiver Mainframe

C

M2613/14/15A Antenna System Troubleshooting - Pass/Fail Criteria

Overview

Appendix C gives the pass/fail criteria to determine if an M2613/14/15A Dual-band UHF antenna system has passed the Antenna System Troubleshooting Procedure given in Chapter 4. The appendix is divided into sections according to the different frequency options. There are different criteria for each frequency option range. Following are the frequency options:

Each section is made up of 4 tables.

The first table lists the **Expected Gain of the Combining Network** using the measurement **Gc**.

The second table lists the **Expected Gain of the Antenna String** using the measurement **Gs**.

The third table lists the **Measurement Tolerance for the Combining Network** using the measurement **Tc.**

The fourth table lists the **Measurement Tolerance for the Antenna Strings** using the measurement **Ts**.

For example, a system made up of an option A24 combining network -- 1 A06 string and 1 A02 string -- is operating in the 406 - 412.5 MHz range.

To calculate the Expected Gain, **G**, of the **A06** string:

G = Gc + Gs = -8 + 5 = -3

To calculate the Tolerance, **T**, for **A06** string measurement:

T = Tc + Ts = 4 + 5 = ±9

To determine the Expected Gain, **G**, for the **A02** string:

G = Gc + Gs = -8 + 5 = -3

When calculating the Tolerance, **T**, for **A02** string measurement:

T = Tc + Ts = 4 + 3 = ±7

M2613/14/15A Dual-Band UHF Antenna System

Frequency Option 001 406-412.5 MHz

Table C-1. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-18		A24 **Gc**=-8	
3-4			A44 **Gc**=-17	A48 **Gc**=-4
5-8		A82 **Gc**=-17		A88 **Gc**=-16

Table C-2. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=5	**Gs**=5	**Gs**=5	**Gs**=5	**Gs**=5	**Gs**=5

Table C-3. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-4. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 002
412.5-421.5 MHz

Table C-5. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-18		A24 **Gc**=-7	
3-4			A44 **Gc**=-16	A48 **Gc**=-3
5-8		A82 **Gc**=-16		A88 **Gc**=-14

Table C-6. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	**Gs**=5	**Gs**=5	**Gs**=5	**Gs**=5	**Gs**=5

Table C-7. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-8. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 003 421.5-430 MHz

Table C-9. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-17		A24 **Gc**=-7	
3-4			A44 **Gc**=-16	A48 **Gc**=-3
5-8		A82 **Gc**=-15		A88 **Gc**=-13

Table C-10. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	**Gs**=6	**Gs**=5	**Gs**=5	**Gs**=6	**Gs**=6

Table C-11. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-12. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 004 430-440 MHz

Table C-13. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-17		A24 **Gc**=-7	
3-4			A44 **Gc**=-17	A48 **Gc**=-2
5-8		A82 **Gc**=-15		A88 **Gc**=-13

Table C-14. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	**Gs**=6	**Gs**=6	**Gs**=6	**Gs**=6	**Gs**=6

Table C-15. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±3		A88 **Tc**=+11,-5

Table C-16. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 005 440-450 MHz

Table C-17. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-17		A24 **Gc**=-6	
3-4			A44 **Gc**=-17	A48 **Gc**=-2
5-8		A82 **Gc**=-16		A88 **Gc**=-13

Table C-18. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	**Gs**=6	**Gs**=6	**Gs**=6	**Gs**=6	**Gs**=6

Table C-19. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-20. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 006 450-460 MHz

Table C-21. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-16		A24 **Gc**=-6	
3-4			A44 **Gc**=-16	A48 **Gc**=-1
5-8		A82 **Gc**=-17		A88 **Gc**=-13

Table C-22. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	**Gs**=6	**Gs**=5	**Gs**=6	**Gs**=6	**Gs**=7

Table C-23. Combining Network Tolerance (Tc) in RSSI Counts (based on M26415A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-24. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 007 460-470 MHz

Table C-25. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-16		A24 **Gc**=-5	
3-4			A44 **Gc**=-16	A48 **Gc**=0
5-8		A82 **Gc**=-16		A88 **Gc**=-12

Table C-26. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	**Gs**=6	**Gs**=5	**Gs**=6	**Gs**=6	**Gs**=7

Table C-27. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-28. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 008 470-480 MHz

Table C-29. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-16		A24 **Gc**=-5	
3-4			A44 **Gc**=-16	A48 **Gc**=0
5-8		A82 **Gc**=-15		A88 **Gc**=-10

Table C-30. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=5	**Gs**=5	**Gs**=5	**Gs**=6	**Gs**=7	**Gs**=7

Table C-31. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A88 **Tc**=±4	A48 **Tc**=+10,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+11,-5

Table C-32. Antenna String Tolerance (Ts) in RSSI Counts (based on M26413/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 034 590-596 MHz

Table C-33. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-14		A24 **Gc**=-3	
3-4			A44 **Gc**=-13	A48 **Gc**=4
5-8		A82 Gc=-13		A88 **Gc**=-7

Table C-34. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=3	**Gs**=3	**Gs**=3	**Gs**=4	**Gs**=4	**Gs**=5

Table C-35. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=+8,-5
5-8		A82 **Tc**=±4		A88 **Tc**=+10,-5

Table C-36. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 035 596-602 MHz

Table C-37. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-14		A24 **Gc**=-2	
3-4			A44 **Gc**=-12	A48 **Gc**=5
5-8		A82 **Gc**=-13		A88 **Gc**=-7

Table C-38. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=3	**Gs**=3	**Gs**=4	**Gs**=4	**Gs**=4	**Gs**=5

Table C-39. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=8,-5
5-8		A82 **Tc**=±4		A88 **Tc**=10,-5

Table C-40. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 036 602-608 MHz

Table C-41. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-13		A24 **Gc**=-2	
3-4			A44 **Gc**=-12	A48 **Gc**=4
5-8		A82 **Gc**=-13		A88 **Gc**=-7

Table C-42. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=3	**Gs**=3	**Gs**=4	**Gs**=4	**Gs**=4	**Gs**=5

Table C-43. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=8,-5
5-8		A82 **Tc**=±4		A88 **Tc**=10,-5

Table C-44. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

Frequency Option 037 608-614 MHz

Table C-45. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Gc**=-13		A24 **Gc**=-3	
3-4			A44 **Gc**=-13	A48 **Gc**=4
5-8		A82 *Gc*=-14		A88 **Gc**=-8

Table C-46. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=3	**Gs**=3	**Gs**=3	**Gs**=4	**Gs**=4	**Gs**=5

Table C-47. Combining Network Tolerance (Tc) in RSSI Counts (based on M2615A - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1				
2	A21 **Tc**=±3		A24 **Tc**=±4	
3-4			A44 **Tc**=±4	A48 **Tc**=8,-5
5-8		A82 **Tc**=±4		A88 **Tc**=10,-5

Table C-48. Antenna String Tolerance (Ts) in RSSI Counts (based on M2613/14A - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=±2	**Ts**=±3	**Ts**=±3	**Ts**=±4	**Ts**=±4	**Ts**=±5

D

M1413/14/15B Antenna System Troubleshooting - Pass/Fail Criteria

Overview

Appendix D gives a description of the M1413/14/15B Antenna System, including the pass/fail criteria to determine if anM1413/14/15B Digital UHF antenna system has passed the Antenna System Troubleshooting Procedure given in Chapter 4. The pass/fail criteria section is divided according to the various frequency options. There are different criteria for each frequency option range. Following are the frequency options:

The information provided in Appendix D applies to the M1413/14/15B Digital UHF Antenna System. For M2613/14/15A Dual-band UHF Antenna Systems, see Appendix C.

Each section is made up of 4 tables.

The first table lists the **Expected Gain of the Combining Network** using the measurement **Gc**.

The second table lists the **Expected Gain of the Antenna String** using the measurement **Gs**.

The third table lists the **Measurement Tolerance for the Combining Network** using the measurement **Tc.**

The fourth table lists the **Measurement Tolerance for the Antenna Strings** using the measurement **Ts**.

For example, a system made up of an option A24 combining network -- 1 A06 string and 1 A02 string -- is operating in the 406 - 412.5 MHz range.

To calculate the Expected Gain, **G**, of the **A06** string:

G = Gc + Gs = 2 + 4 = 6

To calculate the Tolerance, **T**, for **A06** string measurement:

T = Tc + Ts = 7 + 9 = ±16

To determine the Expected Gain, **G**, for the **A02** string:

G = Gc + Gs = 2 + 7 = 9

When calculating the Tolerance, **T**, for **A02** string measurement:

T = Tc + Ts = 7 + 7 = ±14

M1413/14/15B Digital UHF Antenna System

Description

The **M1413/14/15B UHF Antenna System** receives RF signals from transmitters in the coverage area broadcasting between 406-480 MHz. It then provides the signal to each receiver module in the receiver mainframes. Antenna systems consist of antenna strings and combining networks.

Antenna Strings

Antenna Strings are available in strings of 1 to 6 antennas (M1413/14B options A01-A06). Each string consists of antenna/combiners and cables. Each antenna string receives RF signals from each transmitter in the coverage area.

Combining Networks

Combining Networks connect the signals from the antenna strings together and then distribute them to the receiver mainframes. Combining networks consist of splitter/combiners, amplifiers, power tees, and cabling. They provide the signal to each receiver module in the receiver mainframe.

Block Diagram

Figure D-1, shows a block diagram of a typical antenna system.

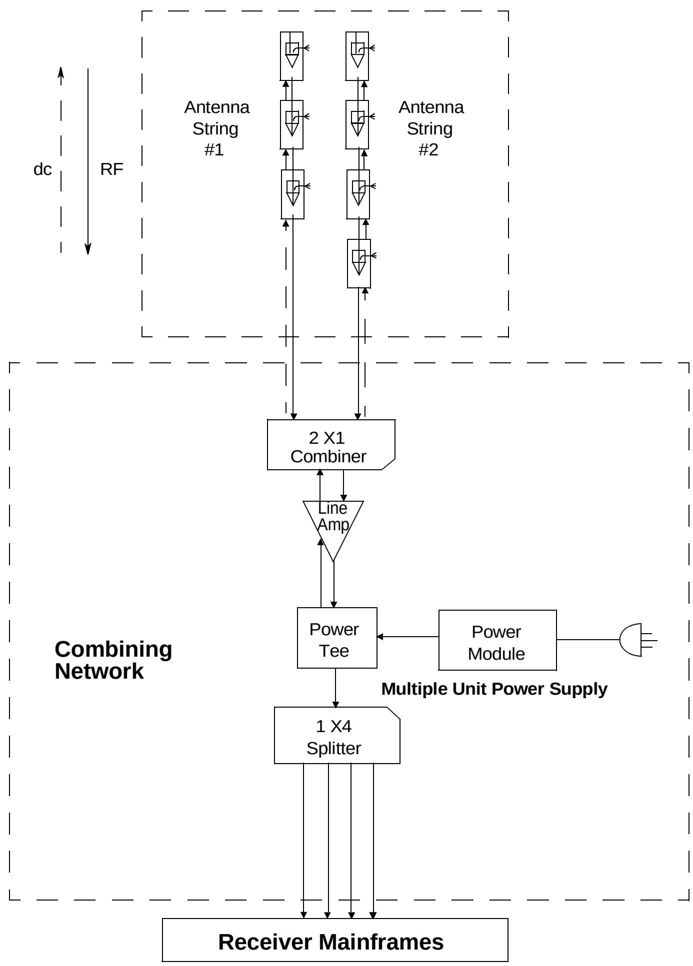


Figure D-1 Block Diagram of a Typical Antenna System

M1408A Active Antenna/ Combiner

The **M1408A Active Antenna/Combiner** incorporates a UHF quarter-wave monopole antenna, a signal combiner, and an RF amplifier in one unit. The amplifier has a bandpass range of approximately 406-512 MHz. See Figure D-2.

The Antenna/Combiner accepts 2 RF signals–1 from its flexible antenna, and 1 from the line. The signals are coupled together in a power combiner, amplified, and then cascaded to the next Antenna/Combiner in the string. At the end of the string, the signal is routed to the combining network for final signal combining and distribution to the receiver mainframe.

A block diagram of the antenna/combiner is illustrated in Figure D-2. As shown, the incoming RF signal from the antenna is sent through a Bandpass Filter and coupled with the line signal in a Power Combiner. The Power Combiner is unequal for reduced system noise figure and high 1dB compression point. The 2 signals are impedance-matched in the combiner and routed to the RF Amplifier, which increases their gain by approximately 9.7 dB. The Amplifier's operating voltage is 19 - 32 Vdc at 50 mA. It receives dc power from the coaxial cable at its RF output connection.

The Antenna/Combiner also has a circuit that regulates amplifier voltage to a maximum of +12 Vdc, and a sensing circuit that indicates by LED whether its power/ signal cables are properly connected. If the antenna is installed properly, the green LED is on. If the antenna is installed backwards, the red LED is on.

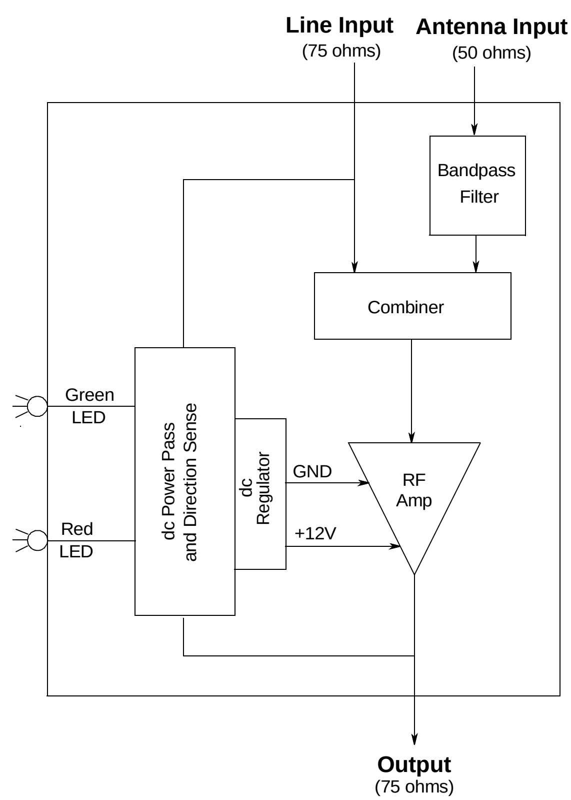


Figure D-2 Block Diagram of the Active Antenna/Combiner

Line Amplifier

The **M1406A Line Amplifier** increases the RF signal with a typical gain of 12.5 dB to compensate for losses in the antenna network. It is powered through the coaxial cable on its output. The Line Amplifier draws required dc operating power through its RF signal output connection and passes unused power through its input to any other active elements further up the antenna system. The Line Amplifier is used in the M1415B Combining Network. The Line Amplifier has a Green LED that illuminates when it has power.

2-Way and 4-Way Splitters/ Combiners

78103A 2- and 78104A 4-way Splitter/Combiners are used to route RF signals from multiple antennas to the receiver mainframe. Used in one direction, the splitter/ combiners split 1 RF signal into 2 or 4 separate signals. Used in the opposite direction, they combine 2 or 4 separate RF signals into one signal. 2- and 4-way Splitter/ Combiners are used in the M1415B Combining Networks.

Multiple Unit Power Supply

The **M1407A Multiple Unit Power Supply** is composed of a Power Tee and a Power Module that can supply up to 14 line amplifiers or active Antenna/Combiners in a pre-configured system. The 2 components are connected by a 7-foot, multi-conductor cable and a 6-pin Deutsch Industrie Normen (DIN) connector.

Power Tee

The **Power Tee** contains an RF biasing circuit, RF filtering circuits, a circuit breaker, and a green power indicator that lights when the Tee is receiving power. The Power Tee passes dc power out of its RF signal input and blocks dc voltage on its RF signal output. It, thereby, prevents unwanted dc voltage at the input of the receiver mainframe and avoids placing 2 or more Power Tees in series and providing excessive power on the cable.

Power Module

The **Power Module** provides 24 Vdc, 1 ampere, regulated power. The output is a floating type, which is isolated from the ac mains supply ground. The power module connection to the ac mains is rated at 100 to 240 Vac, 50/60 Hz, and has the CE mark approval. This satisfies the input power requirements of the antenna system.

Frequency Options

Frequency Option 001 406-412.5 MHz

Table D-1. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=3	A12 Gc=11	A14 Gc=11	
2	A21 Gc=-11	A22 Gc=14	A24 Gc=2	A28 Gc=0
3-4	A41 Gc=14	A42 Gc=5	A44 Gc=-3	A48 Gc=18
5-8		A82 Gc=-8	A84 Gc=13	A88 Gc=4

Table D-2. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=8	Gs=7	Gs=6	Gs=5	Gs=4	Gs=4

Table D-3. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-4. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=7	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 002 412.5-421.5 MHz

Table D-5. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-3	A12 Gc=-11	A14 Gc=9	
2	A21 Gc=-11	A22 Gc=14	A24 Gc=1	A28 Gc=-8
3-4	A41 Gc=13	A42 Gc=4	A44 Gc=-5	A48 Gc=15
5-8		A82 Gc=-7	A84 Gc=13	A88 Gc=4

Table D-6. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=8	Gs=7	Gs=6	Gs=5	Gs=4	Gs=3

Table D-7. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-8. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=3	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 003 421.5-430 MHz

Table D-9. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-3	A12 Gc=-12	A14 Gc=8	
2	A21 Gc=-11	A22 Gc=12	A24 Gc=0	A28 Gc=-8
3-4	A41 Gc=12	A42 Gc=3	A44 Gc=-8	A48 Gc=13
5-8		A82 Gc=-7	A84 Gc=11	A88 Gc=3

Table D-10. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=7	Gs=6	Gs=5	Gs=3	Gs=2	Gs=1

Table D-11. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-12. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=3	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 004 430-440 MHz

Table D-13. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-3	A12 Gc=-12	A14 Gc=8	
2	A21 Gc=-11	A22 Gc=11	A24 Gc=-1	A28 Gc=-9
3-4	A41 Gc=10	A42 Gc= 2	A44 Gc=-9	A48 Gc=11
5-8		A82 Gc=-10	A84 Gc=7	A88 Gc=-1

Table D-14. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	Gs=5	Gs=4	Gs=3	Gs=2	Gs=1

Table D-15. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-16. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=3	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 005 440-450 MHz

Table D-17. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-3	A12 Gc=-12	A14 Gc=7	
2	A21 Gc=-11	A22 Gc=10	A24 Gc=-1	A28 Gc=-11
3-4	A41 Gc=9	A42 Gc= 1	A44 Gc=-11	A48 Gc=8
5-8		A82 Gc=-11	A84 Gc=5	A88 Gc=-3

Table D-18. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=6	Gs=5	Gs=4	Gs=3	Gs=2	Gs=2

Table D-19. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-20. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=3	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 006 450-460 MHz

Table D-21. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-3	A12 Gc=-12	A14 Gc=6	
2	A21 Gc=-11	A22 Gc=9	A24 Gc=-2	A28 Gc=-12
3-4	A41 Gc=8	A42 Gc=0	A44 Gc=-12	A48 Gc=6
5-8		A82 Gc=-10	A84 Gc=5	A88 Gc=-5

Table D-22. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=5	Gs=5	Gs=4	Gs=4	Gs=4	Gs=3

Table D-23. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-24. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=7	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 007 460-470 MHz

Table D-25. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-4	A12 Gc=-12	A14 Gc=4	
2	A21 Gc=-11	A22 Gc=9	A24 Gc=-4	A28 Gc=-12
3-4	A41 Gc=8	A42 Gc=-1	A44 Gc=-11	A48 Gc=6
5-8		A82 Gc=-13	A84 Gc=1	A88 Gc=-8

Table D-26. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=5	Gs=5	Gs=5	Gs=5	Gs=5	Gs=5

Table D-27. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-28. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=3	Ts=5	Ts=6	Ts=8	Ts=9

Frequency Option 008 470-480 MHz

Table D-29. Gain of Standard Combining Networks (Gc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Gc=-4	A12 Gc=-12	A14 Gc=3	
2	A21 Gc=-12	A22 Gc=10	A24 Gc=-5	A28 Gc=-11
3-4	A41 Gc=9	A42 Gc=0	A44 Gc=-10	A48 Gc=6
5-8		A82 Gc=-14	A84 Gc=-1	A88 Gc=-8

Table D-30. Gain of Standard Antenna Strings (Gs) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Gs=5	Gs=5	Gs=5	Gs=6	Gs=6	Gs=6

Table D-31. Combining Network Tolerance (Tc) in RSSI Counts (based on M1415B - Combining Network Option)

Strings In	1 Mainframe Out	2 Mainframes Out	3-4 Mainframes Out	5-8 Mainframes Out
1	A11 Tc=4	A12 Tc=5	A14 Tc=5	
2	A21 Tc=5	A22 Tc=7	A24 Tc=7	A28 Tc=8
3-4	A41 Tc=7	A42 Tc=8	A44 Tc=8	A48 Tc=10
5-8		A82 Tc=8	A84 Tc=10	A88 Tc=11

Table D-32. Antenna String Tolerance (Ts) in RSSI Counts (based on M1413/14B - Antenna String Option)

Option A01	Option A02	Option A03	Option A04	Option A05	Option A06
Ts=2	Ts=3	Ts=5	Ts=6	Ts=8	Ts=9

Replaceable Parts

This section lists part numbers for the sub-assemblies of the M1413/14/15B Antenna System.

Table 2-1. Active Antenna/Combiner Parts (M1408A)

Description	New Part No.
Base, Active Antenna/Combiner (M1408A)	M1408-60004
Wall Mount	M1404-60001
Flexible antenna 406 to 450 MHz	0950-2029
Flexible antenna 450 to 512 MHz	0950-2028

Table 2-2. Line Amplifier Parts (M1406A)

Description	New Part No.
Line amplifier	M1406-67000

Table 2-3. M1413/14/15B Antenna System Parts

Description	New Part No.
Four-way splitter/combiner	0960-0324
Two-way splitter/Combiner	0960-0323
DC blocking capacitor	Hewlett-Packard 10240B
75-ohm terminator with DC block	1250-2403
RG-6U Antenna cable (non-plen, 0.3 meters or 1 foot)	M1413-60100
RG-6U Antenna cable (non-plen, 1.5 meters or 5 feet)	M1413-60105

E
INOP Logs, Status Logs, and Error Codes

Overview

Appendix E describes INOP Logs and Status Logs that can be used in troubleshooting the Telemetry System.

INOP Logs can be viewed using the Telemetry Service Tool and provide a rough count of the number of times selected INOPs occur.

Status Logs can be viewed at the Central Station or with the Telemetry Service Tool and give Error Codes that provide information about failed conditions within a particular mainframe.

INOP Logs

There are two types of INOP Logs – Bed INOP Log and Time/Date INOP Log:

Bed INOP Log - displays the INOPs that occurred for a particular mainframe and are sorted by the receiver (or bed) in that mainframe. The log has a screen for each receiver and each receiver can be viewed using the NEXT and PREVIOUS keys provided at the Central Station or in the Telemetry Service Tool.

Time/Date INOP Log - displays the INOPs logged by a particular mainframe and are sorted by the Time and Date they occur. There is a column that specifies which receiver (or bed) reported the INOP.

Both INOP logs provide trends and history of the performance of the Telemetry System that can aid in troubleshooting.

For more information about INOP Logs, see the Philips Telemetry System Service Tool Guide (PN M2600-90179).

Status Logs

The Status Log screen provides viewing of logged error information for each receiver mainframe.   The log lists Errors of 2 types – Non-Fatal and Fatal.

Non-Fatal Errors are soft errors that allow the system to keep running and, in general, do not affect system performance. They are used primarily by Research and Development engineers for troubleshooting. Non-Fatal errors can be used to check for trends or patterns.

Fatal Errors are errors that cause a hard system failure and generally cause the receiver mainframe to re-boot.

This section is primarily concerned with Fatal Errors. Fatal errors provide a definitive error code that indicates which device in the system has failed. Tables listing Fatal Error Codes are presented at the end of this section.

Each log entry provides information in the following format:

CARD NAME or CARD ID - is an abbreviation of the Card in the mainframe reporting the error.

PART # - is the Part Number of the card reporting the error.

DEV ID - is the ID Code of the software module reporting the error.

SLOT - is the Slot Number of the card reporting the error.

ERROR CODE - is a Code that describes the failure that occurred.

DATE/TIME - is the Date and Time the error was reported.

Error Codes

Error Codes given in the Status Log are generated when a certain operation is not completed or when a certain input is missing or not of an expected value. The most important information provided in a start-up error message or in the Status Log is:

- Device ID
- Error Code
- Slot Number

The following tables lists **Error Codes** that affect system performance and generally are fatal to the system. **Possible Causes** and **Corrective Actions** that can be taken to resolve the problem are also given. Error Code numbers are provided in decimal notation and are broken down into error ranges. This information can help to identify which board is defective and should be replaced. The following Error Code tables are provided:

Device Error Codes

Table E-1. Device (16400) Error Codes

Error Code	Possible Cause	Corrective Action
1 - 99	Hardware problem in given slot. Failed board may have a red LED illuminated.	Replace the board in the given slot.
100 - 199	Unexpected microprocessor interrupts on a board in the receiver mainframe. Failed board may have a red LED illuminated.	Replace the board in the given slot.
201	Software problem	Make certain the current software release is installed.
202	Invalid contents of the Util CPU EEPROM	Reprogram EEPROM.
203 - 239	MPB chip errors: Can be caused by hardware defects on the CPC or Utility CPU.	Refer to Chapter 4, NO DATA FROM BED INOP.

Table E-1. Device (16400) Error Codes

Error Code	Possible Cause	Corrective Action
240	Software problem	Make certain the current software release is installed.
241	Same as errors 203 - 239	Refer to Chapter 4, NO DATA FROM BED INOP
242	Software problem	Make certain the current software release is installed.
243 - 299	Same as errors 203 - 239	Refer to Chapter 4, NO DATA FROM BED INOP
300 - 301	EPROM defect	Refer to Chapter 4, NO DATA FROM BED INOP
330	CPC card has detected an error in the receiver mainframe.	Refer to Chapter 4, NO DATA FROM BED INOP
335	CPC card has detected an error in the receiver mainframe.	Refer to Chapter 4, NO DATA FROM BED INOP
340, 356, 370	A communication problem exists between the CPC and other cards in the receiver mainframe.	Refer to Chapter 4, NO DATA FROM BED INOP
400 - 409	Out of memory	- Replace card in slot indicated in error message. - Replace CPC
410 - 419	Missing file errors	- Replace CPC - Reprogram EEPROM on Utility CPU board.
420 - 449	Utility CPU / EEPROM error	- Reprogram EEPROM on Utility CPU. - Replace Utility CPU. - Replace CPC
500 - 699	Software problem	Make certain the correct version of software is installed.
700 - 799	Communication problem	Replace card in given slot.
800 - 899	Software problem	Make certain the correct version of software is installed.
900 - 914	Background check of memory detected an error	Replace card in given slot.
915	CPC card has detected an error.	Replace card in given slot.
916 - 919	Same as error range 900 - 914	Replace card in given slot.
920	Indicates a missing frame interrupt on the CPC. This could be caused by a missing electrical connection or failure on the Util CPU.	- Replace card in given slot - Replace Utility CPU or CPC card if not replaced in first step.
921 - 999	Same as error range 900 - 914	Replace card in given slot.
1000 - 1999	Error detected by CPC	Refer to Chapter 4, NO DATA FROM BED INOP

Heart Module Error Codes

Table E-2. Heart Module (25001) Error Codes

Error Code	Description	Probable Cause/ Action
11000 through 11001	Active setting data lost at start-up.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
11100 through 11104	Active settings checksum error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
11200	Buffered data found corrupt at start-up.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13000	Missing MAK header.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13001	Missing header.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13002	No pulse header found.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13003	No pulse CW header found.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13004	No CW headers found.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13200	Table size error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13410	Error in route enable.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13411	Error in enabling conference mode route.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13450	Error in disabling a routine.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13440	Error in disabling a realization.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-2. Heart Module (25001) Error Codes

Error Code	Description	Probable Cause/ Action
13540	Buffered data checksum error.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13580	No global information pointer received.	Software/config
13640 through 13644	Get message ID error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13650	Get header error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
15500	No valid EEPROM data.	Replace board as indicated by LED.
20000	Numerics message too large.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Rack Manager Error Codes

Table E-3. Rack Manager (25010) Error Codes

Error Code	Description	Probable Cause \ Action
11200	Checksum verification of device status list failed during initialization.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
11201	Checksum verification of interface information buffer failed during initialization.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
11300	Checksum verification of device status list failed during runtime.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
11301	Checksum verification of interface information buffer failed during run time.	Refer to Philips Telemetry System Troubleshooting Map.
13100	Size of device status list differs from size specified in module table.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
12000	EEPROM block missing - EEPROM read request failed X times.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
12100	EEPROM block corrupt - Invalid configuration data found.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-3. Rack Manager (25010) Error Codes

Error Code	Description	Probable Cause \ Action
13000	Header missing - headers for static link missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13001	Header missing - headers for static link missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13010	Header missing - other message headers missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20000	Routine activation error - system call disable or enable/disable failed.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20100	Invalid pointer to the system-device information list passed from the OS.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20101	Device status entries stored in the device status list don't correspond with the extended device tables after a Hot-start.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20102	Front-end interface 0 device information request failed X times.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20103	Optional front end interface 1 device failed after a Hot or Warm start.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20110	List that holds extended device tables ext_dev_tbls is too small.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20120	No more room in the scan table to insert scan entries.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20121	No longer possible to allocate receive/transmit buffer blocks in the shared memory of a front end interface.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20122	Not possible to allocate receive/transmit buffer blocks for the automatic ID request output data.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20200	Invalid number of polls.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20201	No header found for ASW information message.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-3. Rack Manager (25010) Error Codes

Error Code	Description	Probable Cause \ Action
20202	No header found for front-end control/status message.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20203	Too many front end messages found for a front-end device.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20204	Too many transmit blocks defined for a front-end device.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20205	Number of receive/transmit bytes to sort exceed the length of a message sort table retry.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20206	Description of poll structure of front-end device contains invalid message variable.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20300	Receiver mainframe status message no longer received from front-end interface 0.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20301	Receiver mainframe status message no longer received from front-end interface "1".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20400	One or more checksums of static front-end manager tables are corrupt.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20401	Invalid configuration data found.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20402	Contents of plugged devices do not correspond to the number of front-end devices marked as PLUGGED in the device status list.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20403	No valid pointer to global information block get command from OS.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
20500	Invalid slot number found in device status list.	Replace board as indicated by LED.
20501	Invalid interface number found in device status list.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21000	No ECG-sync output source device found in device ID list.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21010	Synchronization between two front-end interface devices failed.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-3. Rack Manager (25010) Error Codes

Error Code	Description	Probable Cause \ Action
21100	Receiver mainframe status message of invalid length received from front-end interface "0".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21101	Receiver mainframe status message of invalid length received from front-end interface "1".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21103	ID request output message of invalid length or invalid receiver mainframe slot received from front-end interface "0".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21104	ID request output message of invalid length or invalid receiver mainframe received from front-end interface "1".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21105	General status message of invalid length received from front-end interface "0".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21106	General status message of invalid length received from front-end interface "1".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21107	Error message of invalid length or invalid device ID received from front end interface "0".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21108	Error message of invalid length or invalid device ID received from front end interface "1".	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21500	Invalid receiver mainframe number found in an ID request output buffer entry.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21501	Device ID changed without a device unplugged status in-between.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21502	No pointer to a device list entry defined for a plugged device.	Rack interface error. Refer to Philips Telemetry System Troubleshooting Map.
21503	Operating mode has been changed during runtime.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
21504	Pointer to ECG sync output source entry has been changed during runtime.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
21510	Length of new created global information message exceeds allowed maximum message length.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Alarm Manager Error Codes

Table E-4. Alarm Manager (25011) Error Codes

Error Code	Description	Probable Cause/Action
11100 through 11104	Active settings corrupt during run-time.	EEPROM error. Refer to Philips Telemetry System Troubleshooting Map.
11200	Buffered data corrupt after hot-start.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
11300 through 11304	Buffered data corrupt during run-time.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13000	Missing transmit header after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13001	Missing receive header after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13002	No NU header after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13003	No PS header after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13004	Inconsistent header list after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13005	Unused alert header after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13006	ECG message received without header.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13007	INOP header not found.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13008	Alarm header not found.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13009	MAK header missing after power-on.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13200	Alarm table overfill.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-4. Alarm Manager (25011) Error Codes

Error Code	Description	Probable Cause/Action
13201	INOP table overfill.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13202	Numeric enhancement table overfill	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13203	Source table overfill.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13204	Stack table overfill.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13205	Limit table overfill.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13206	Parameter table overfill.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13410	Enable route error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13411	Enable service route error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13412	Enable conf. route error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13420	Disable realization error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13421	Disable route error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13520	Data written to table of contents is wrong.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13521	Data written to table of contents is wrong.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13522	Buffered data in INOP table is corrupt.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-4. Alarm Manager (25011) Error Codes

Error Code	Description	Probable Cause/Action
13523	Buffered data in alarm table is corrupt.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13524	Buffered data in number table is corrupt.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13525 through 13527	Security data structure corrupt.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13530	Buffered data verification errors.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13580	Global info pointer error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13640 through 13648	Message acquisition errors.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13650 through 13651	Header acquisition errors.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20000	Incorrect values for operation mode.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20001	Incorrect values for Power On mode.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20002	Incorrect sense values.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20003	Incorrect item number value.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20020	Alert table initialization failed.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20021	Source value table exceeds limits.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20800	Received alarm timeout.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-4. Alarm Manager (25011) Error Codes

Error Code	Description	Probable Cause/Action
20900	Received INOP timeout.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
25500	No valid EEPROM data.	Replace card as indicated by LED.

SDN Error Codes

Table E-5. SDN (25020) Error Codes

Error Code	Description	Probable Cause\Action
09000	Unspecified DLC error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
09001	DLC error - duplicated unit i.d. stamp.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
09002	DLC error - duplicated bed.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5
09003	DLC error - duplicated unit i.d. stamp.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
09105	Send APPL error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
09107	Group channel error.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
09108	Group SOUR error.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
11200	SDN data in buffered memory lost after hot start.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
12000	SDN EEPROM contents found missing.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
12150 through 12153	SDN EEPROM contents found corrupt.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
13000	Header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-5. SDN (25020) Error Codes

Error Code	Description	Probable Cause\Action
13100	SDN data in buffered memory lost.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13410	Enable routine error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13420	Disable routine error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13470	Change to operational mode failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13490	Send contents of EEPROM message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13520	Error writing SDN data to buffered memory.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
13540	SDN buffered data checksum error.	SDN error. Refer to Philips Telemetry System Troubleshooting Map5.
13590	Shared memory access error.	Replace board as indicated by LED.
13640	ID message acquisition failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

INOP Module Error Codes

Table E-6. INOP Module (25100) Error Codes

Error Code	Description	Probable Cause\Action
13001	Clear INOP log message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13002	Set INOP filters message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13003	INOP total message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13004	INOP data message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-6. INOP Module (25100) Error Codes

Error Code	Description	Probable Cause\Action
13005	ECG INOP message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13411 through 13417	INOP enable routine errors.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13421 and 13422	INOP disable routine errors.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13491	Data acknowledge message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13492	INOP Total message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13493	INOP Filter message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13494	Clear INOP Log message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13521 and 13522	Error writing contents of buffered memory to INOP filters.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13523 through 13529	Error writing contents of buffered memory to INOP log.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13531	Bad INOP log data in buffered memory at start up.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13532	Bad INOP filter data in buffered memory at start up.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13533 through 13535	INOP log data requested from buffered memory is bad.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13641	Message ID acquisition error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-6. INOP Module (25100) Error Codes

Error Code	Description	Probable Cause\Action
13691	INOP log checksum error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13692	INOP filter checksum error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Service Module Error Codes

Table E-7. Service Module (25101) Error Codes

Error Code	Description	Probable Cause\Action
13411	RS-232 interface enable error.	Check/replace RS-232 card reboot instrument.
13412	Message send enable error.	Check/replace RS-232 card reboot instrument.
13413	TEST STAT ENA	Check/replace RS-232 card reboot instrument.
13414	RTN MAIN ENA	Check/replace RS-232 card reboot instrument.
13415	BLD ILOG ENA	Check/replace RS-232 card reboot instrument.
13416	CONFG ACK ENA	Check/replace RS-232 card reboot instrument.
13417	ILOG DAT ACK ENA	Check/replace RS-232 card reboot instrument.
13418	ILOG CLR ACK ENA	Check/replace RS-232 card reboot instrument.
13419	ILOG TOT ACK ENA	Check/replace RS-232 card reboot instrument.
13420	ILOG FLT ACK ENA	Check/replace RS-232 card reboot instrument.
13421	CS RESET REQ ENA	Check/replace RS-232 card reboot instrument.
13422	CS RESET ACK ENA	Check/replace RS-232 card reboot instrument.
13423	RD SERNO ENA	Check/replace RS-232 card reboot instrument.
13491	RD INOP BED MSG	Check/replace RS-232 card reboot instrument.
13492	CLR INOP MSG	Check/replace RS-232 card reboot instrument.
13493	RD INOP TOT MSG	Check/replace RS-232 card reboot instrument.
13494	INOP FILT MSG	Check/replace RS-232 card reboot instrument.
20000	SVC TASK ERR	Check/replace RS-232 card reboot instrument.
20100	SVC COMM ERR	Check/replace RS-232 card reboot instrument.

Table E-7. Service Module (25101) Error Codes

Error Code	Description	Probable Cause\Action
20200	SVC CNFG ERR	Check/replace RS-232 card reboot instrument.
20201	No alarm mode match.	Check/replace RS-232 card reboot instrument.
20202	NO ALRM RMDR MATCH	EEPROM/Configuration. See Philips Telemetry System Troubleshooting Map.
20203	NO LD LBL MATCH	EEPROM/Configuration. See Philips Telemetry System Troubleshooting Map.
20204	NO BW MATCH	EEPROM/Configuration. See Philips Telemetry System Troubleshooting Map.
20205	NO FALLBACK MATCH	EEPROM/Configuration. See Philips Telemetry System Troubleshooting Map.
20206	NO LD RECON MATCH	EEPROM/Configuration. See Philips Telemetry System Troubleshooting Map.
20207	NO EXT MON MATCH	EEPROM/Configuration. See Philips Telemetry System Troubleshooting Map.
20500	SVC MISC ERR	Reboot instrument.
20501	OPMODE CHANGE ERR	Valid error - indicates time the Operational mode was changed.
20502	Receiver Mainframe Reset	Reset due to Central Station reset.
20600	SVC REC ERR	Check Central Station recorder and/or reboot mainframe.
20601	SVC REC CHK	Check Central Station recorder and/or reboot mainframe.

User Interface Error Codes

Table E-8. User Interface (25102) Error Codes

Error Code	Description	Probable Cause\Action
11001	Active settings found corrupt after hot start.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
11201	ECG data in buffered memory found corrupt after hot start.4	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
11202	SDN data in buffered memory found corrupt after hot start.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
11203	Alarm data in buffered memory found corrupt after hot start.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
11204	Heart data in buffered memory found corrupt after hot start.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
11205	Service data in buffered memory found corrupt after hot start.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
12001	ECG EEPROM contents missing.	Replace board as indicated by LED.
12002	SDN EEPROM contents missing.	Replace board as indicated by LED.
12003	Alarm EEPROM contents missing.	Replace board as indicated by LED.
12004	Heart EEPROM contents missing.	Replace board as indicated by LED.
12005	Service EEPROM contents missing.	Replace board as indicated by LED.
12101	ECG EEPROM contents corrupt.	Replace board as indicated by LED.
12102	SDN EEPROM contents corrupt.	Replace board as indicated by LED.
12103	Alarm EEPROM contents corrupt	Replace board as indicated by LED.
12104	Heart EEPROM contents corrupt.	Replace board as indicated by LED.
12105	Service EEPROM contents corrupt.	Replace board as indicated by LED.

Table E-8. User Interface (25102) Error Codes

Error Code	Description	Probable Cause\Action
13001	VC Open message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13002	VC close message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13003	MA APP message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13004	Reset message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13005	WV ANN message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13006	Bed control message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13007	PTN Check message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13008	VTP APPL message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13009	VCP APPL message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13050	Recorder start message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13051	Store Required message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13052	Store Check message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13053	Store STOPN message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13054	Store ANNREQ message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-8. User Interface (25102) Error Codes

Error Code	Description	Probable Cause\Action
13055	Store STOPCK message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13056	Data request message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13057	Read data CHK message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13059	RD TOTS CHK message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13060	INOP clear request message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13061	INOP clear check message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13062	Receiver revisions message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13063	Operational mode change request message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13064	Operational mode change acknowledge message header missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13410 through 13414	MUA message enable route error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13420 through 13424	MUA message disable route error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13440	Disable realization error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13490	Send contents of EEPROM message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13491	Send ECG data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-8. User Interface (25102) Error Codes

Error Code	Description	Probable Cause\Action
13492	Send alarm data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13493	Send heart data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13494	Send SDN data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13495	Send service data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13496	Send VCP data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13497	Send VTP data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13498	Send GEN data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13499	Send INOP data message error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13520	Error writing ECG data to buffered memory.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13521	Error writing SDN data to buffered memory.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13522	Error writing alarm data to buffered memory.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13523	Error writing heart data to buffered memory.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13524	Error writing service data to buffered memory.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.
13525	Error writing active data to buffered memory.	40 MHz CPC error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-8. User Interface (25102) Error Codes

Error Code	Description	Probable Cause\Action
13541	ECG checksum failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13542	SDN checksum failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13543	Alarm checksum failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13544	Heart checksum failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13545	Service checksum failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13546	ACT VAL checksum failure.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
13580	Shared memory access error.	Replace board as indicated by LED.
20002	ECG control check missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20003	SDN control check missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20004	Alarm control check missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20005	Heart control check missing.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20006	Invalid message received.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20007	RVT display NCHK.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20100	MAS change to operational mode failed.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

Table E-8. User Interface (25102) Error Codes

Error Code	Description	Probable Cause\Action
20101	MAS clear log failed.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20102	MAS data request failed.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20103	MAS RD TOTS timeout error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20111	MAS RD DATA timeout error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20119	MAS INOP clear error.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20120	MAS recorder stopped notification.	Refer to recorder configuration.
20136	MAS recorder stopped because XXX.	Refer to recorder configuration.
20152	MAS recorder stopped.	Refer to recorder configuration.
20168	MAS recorder stopped message header missing.	Software/configuration. Refer to Philips Telemetry System Troubleshooting Map.
20169	MAS received message from invalid receiver number.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.
20170	MAS invalid CCB.	Software/config error. Refer to Philips Telemetry System Troubleshooting Map.

3-Channel ST Module Error Codes

Table E-9. 3-Channel ST (32734) Module Error Codes

Error Code	Description	Probable Cause\Action
11000	Actual settings lost on hot start.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
12100	Corrupted EEPROM block.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13000	Missing message header.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13200	No unbuffered memory configured.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13300	No buffered memory configured.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13410	Error occurred when enabling a routine.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13420	Error occurred when disabling a routine.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13440	Error occurred when disabling a realization.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
20000	No global information present.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
20001	Unsupported ECG wave received.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
20003	Corrupted data structure.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
20006	Checksum of response error.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
20010	MUA control message error.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
20011	MUA control message contains incorrect bed number.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map

Table E-9. 3-Channel ST (32734) Module Error Codes

Error Code	Description	Probable Cause\Action
11000	Actual settings lost on hot start.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
12100	Corrupted EEPROM block.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13000	Missing message header.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map
13200	No unbuffered memory configured.	Philips Software/config error. Refer to Telemetry System Troubleshooting Map

F

Wave Viewer

Overview

Appendix F describes the **M2605 Wave Viewer**. The M2605 Wave Viewer enables selected system support functions and viewing of patient information at the bedside. Appendix F includes the following sections:

Note

The M2605 Wave Viewer has been discontinued. Its description here is for customers who presently have a Wave Viewer. The following system support functions formerly available on Wave Viewer can now be performed using the **Telemetry Configuration Tool**.

- Set RF frequency
- Change SpO_2 sample rate
- Change transmitter setting

Other Wave Viewer functions, such as viewing wave forms and heart rate, can be performed using the **M2636B TeleMon Monitor**. The TeleMon can also be used to measure SpO_2 and NBP. For more information see the Philips M2636B TeleMon Monitor Instructions for Use.

Description

The Wave Viewer is used to verify the quality of the ECG and SpO_2 measurement at the patient's bedside and to make limited patient assessments. This functionality means that clinicians can view information without having to go back to the Central Station. It also provides technicians and engineers with an additional troubleshooting tool.

Features

The Wave Viewer has the following features:

- Displays the ECG waveform, Pleth wave, and the SpO_2 and pulse rate value obtained from the connected transmitter.
- Displays an SpO_2 Pleth waveform along with the ECG wave for indication of measurement quality.
- Allows choosing the SpO_2 measurement interval and to obtain STAT readings.
- Displays electrode placement diagrams for non-standard lead placement with 3-lead cable set.
- With standard ECG transmitters, provides for lead selection with 3-lead cable set, when enabled.
- With standard ECG transmitters, allows examination of multiple leads, one at a time, with a 5-lead cable set.
- With EASI transmitters (5-wire only), allows viewing of each of the 3 directly acquired or “raw” EASI waves (AI, AS and ES), one at a time.
- Enables calculation of the estimated Heart Rate using electronic callipers.
- Allows configuration of key transmitter parameters such as the transmitter frequency.

The Wave Viewer can be used to do the following:

- Make a determination of a patient's tolerance to exercise during ambulation.
- Perform a patient assessment while waiting for information for monitoring, diagnostic, or therapeutic equipment to arrive.
- Include additional input to a routine physical assessment of a patient, such as reading and recording SpO_2 values while on rounds.

Wave Viewer Hardware

The Wave Viewer is an HP® Palmtop Personal Computer running Wave Viewer software to display waveforms (for use with Philips Transmitters only). The software is available on the Flash Card, which is inserted into the slot on the side of the PC. As long as it remains in place, the PC can only be used as the Wave Viewer.
See Figure F-1.

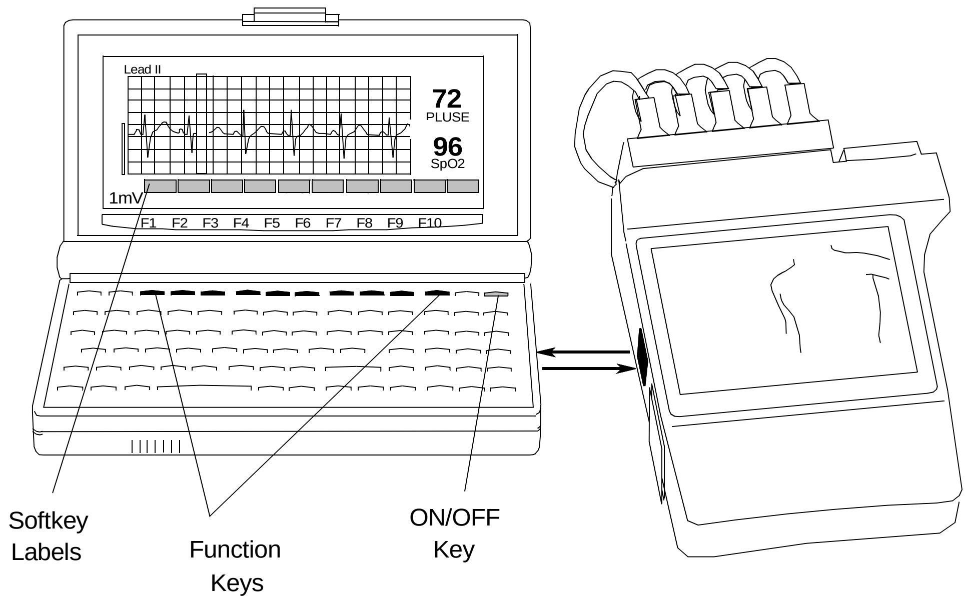


Figure F-1 M2605 Wave Viewer

The Wave Viewer connects to the transmitter via an infrared connection. It obtains ECG wave data and displays approximately 5 seconds of ECG data on the Palmtop PC in real-time. If the transmitter is configured for SpO_2, it also displays the Pleth wave, the pulse rate, and SpO_2 values.

Use of a fiber-optic light pipe is also possible when direct line-of-sight connections are not convenient.

Wave Viewer Information

Wave Viewer can provide 3 basic types of information:

- ECG Information
- SpO_2 Information
- System Information

ECG Information

ECG Information for the Philips Telemetry System is displayed on the ECG Screen in the Wave Viewer. This screen permits changing of the size of the ECG on the Wave Viewer display, freezing the display to estimate heart rate, or selecting a different lead. Five wave sizes are provided, with a 1 mv calibration bar for comparison provided in the lower left of the screen area.

The size setting is stored in the transmitter so that connecting to a different Wave Viewer shows the same size as last displayed for the current patient. The default size, when the transmitter is initially turned on, is 5mm/mv.

The wave content settings for Wave Viewer communication are stored in the transmitter and remain in effect until changed by the current or another Wave Viewer. When a different Wave Viewer is connected to this transmitter, the previously viewed ECG lead and size appears except for the special case where the transmitter must reset these settings to the default values.

Note

Changes made to lead selection and waveform size at the Wave Viewer have no affect on the central monitor display unless a 3-lead cable is being used on the transmitter **and** lead select is enabled. The system must be configured for this capability.

SpO_2 Information

Wave Viewer gives **SpO_2 Information** using 2 screens – the SpO_2 screen and the ECG/Pleth screen.

The **SpO_2** screen provides a large character display for viewing SpO_2 and pulse rate from a distance. It also provides user controls for setting the SpO_2 update rate in the transmitter. Continuous and intermittent (1- and 5-minute intervals, plus “on demand”) updates are supported.

The SpO_2 screen also provides access to the **SpO_2 Quality** screen, where the pleth wave can be viewed as an indicator of measurement quality.

The **ECG/Pleth** screen provides access to the pleth wave and can be used to verify SpO_2 measurement quality. This screen stays on view for 1 minute only and then reverts to the previous screen, either the Main Screen or SpO_2 Numbers screen.

Alarms and INOPs for SpO_2 measurements are announced at the Central Station. STAT SpO_2 provides both the SpO_2 value and the INOP status (if present) at Wave Viewer. From this display, it can be determined if an INOP condition has cleared. When STAT information is reflected at the Central Station, alarm conditions can be silenced by pressing SILENCE/RESET at the central. If the INOP or alarm is cleared before the next periodic update, it continues to be announced at the Central Station until the next measurement is made and the transmitter sends the new status to the mainframe.

System Information

System Information is displayed on the System Information screens. The System Information screens enable viewing of the status of the transmitter and Wave Viewer. This is particularly useful during fault isolation and testing. Changes to the software or hardware configuration cannot by made in the System Information screens. Transmitter status information remains available even if the transmitter has been disconnected. When Wave Viewer is connected to another transmitter, information for the previous transmitter can be erased by pressing the same key.

System Information is displayed on 3 types of screens:

- Transmitter Information One -- Identification of the transmitter revision, SpO_2 firmware revision, and transmitting frequency
- Transmitter Information Two -- Elected configuration data; dynamic status information
- Wave Viewer -- Software information

Dynamic status information is updated approximately once per second. This permits limited testing of features such as the transmitter button.

Starting the Wave Viewer

Warning **The Wave Viewer is not intended for use as a diagnostic patient monitoring tool. No patient alarms are articulated at the Wave Viewer. Telemetry alarms are presented at the central monitor only, and all alarm adjustments must be made at central.**

The Wave Viewer program resides on a flash disk card, thus providing immunity to battery failure and memory corruption. The Palmtop PC connects to the transmitter using an infrared port, either directly or through a fiber optic light pipe. Navigation and control functions within the Wave Viewer are provided by function keys on the Palmtop.

Wave Viewer is started from the flash disk card when the Palmtop computer is turned on or rebooted with the flash disk card in place. Wave Viewer cannot be started from Windows.

To start Wave Viewer, do the following:

Step 1. Insert the Wave Viewer flash disk card - red arrow side up - into the left end of the palmtop. See Figure F-2.

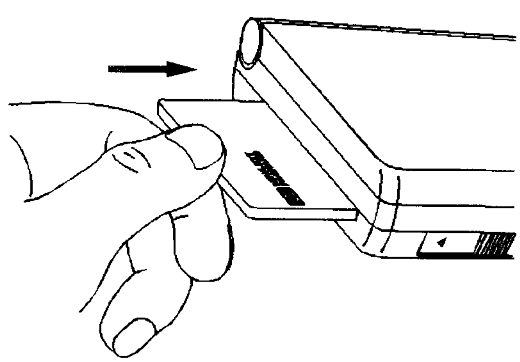


Figure F-2 Inserting the Flash Disk Card

Step 2. Turn the Palmtop on.

Step 3. Press the Ctrl + Alt + Del keys simultaneously to reset (reboot) the system. The Welcome to the Wave Viewer screen displays, followed by the Communication Disrupted screen.

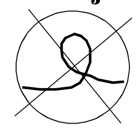
Note If the Wave Viewer does not start when the disk card is inserted, the Palmtop may be out of batteries or it may have insufficient memory. Two megabytes of memory are required to run the Wave Viewer.

Step 4. Make the infrared connection as follows:

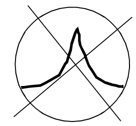
Caution

The light pipe is made of optical-grade plastic and is therefore subject to breakage. *Always handle the light pipe with care.*

Do not coil the light pipe smaller than 4 in. in diameter.



Do not kink or bend the pipe sharply or handle it roughly.



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a. **Without Light Pipe** - Line up the infrared port of the Palmtop with the infrared port of the transmitter. The distance should be between 1 and 10 inches.

b. **With Light Pipe** - Remove the infrared cover on the Palmtop and replace it with the modified cover supplied with the light pipe.

– Connect the small end of the light pipe to the modified cover.

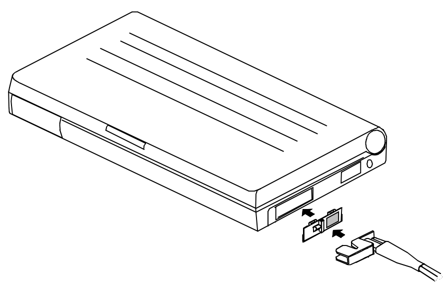

Figure F-3 Connecting the Light Pipe to the Cover

– Attach the clip end of the light pipe to the transmitter, covering the infrared port completely.

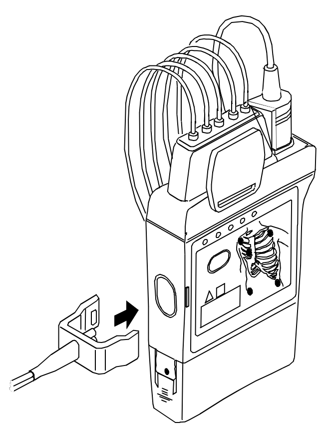

Figure F-4 Connecting the Light Pipe to the Transmitter

When the infrared connection is made, the Main Screen displays in the Wave Viewer application.

Exiting the Wave Viewer

To exit the Wave Viewer program, do the following.

Step 1. Move the transmitter away from the Palmtop or remove the light pipe to break the infrared link. The Interrupted screen displays.

Step 2. Press the Exit to DOS softkey to exit to DOS.

Step 3. Type **200** and press Enter to start the Palmtop Application Manager. The palmtop can now be used to launch other software applicat**ions.**

Using the Wave Viewer

To Check Wave Viewer Revision Information

To check Wave Viewer revision information do the following:

Step 1. Press the Config key from the Wave Viewer Main Screen. The Transmitter Information One screen displays.

Step 2. Press the Info key to display Wave Viewer software revision information.

Step 3. Check the Wave Viewer software revision information.

Step 4. When finished checking the revision information, press the Exit Config key to return to the Wave Viewer Main Screen.

To Check Transmitter Revision Information

To check transmitter revision information using the Wave Viewer do the following:

Step 1. Insert a battery into the transmitter and allow it to go through its self-test.

Step 2. Make the infrared connection between the Wave Viewer and the transmitter. See Starting the Wave Viewer on page F-6. When the infrared connection is made, the Main Screen displays in the Wave Viewer application.

Step 3. Press the Config key. The Transmitter Information One screen displays. The Transmitter Information One screen provides revision information for the transmitter's Main PCB and SpO2 PCB.

Step 4. Check the revision information for the Transmitter.

Step 5. When the revision information has been checked, press the Exit Config key to return to the Wave Viewer Main scr**een.**

To Check Transmitter Configuration

Note If the transmitter has been configured to not allow a frequency change, the transmitter configuration must first be changed to allow a frequency change.

To check a transmitter's configuration using the Wave Viewer, do the following:

Step 1. Insert a battery into the transmitter.

Step 2. Make the infrared connection between the Wave Viewer and the transmitter. See Starting the Wave Viewer on page F-6. When the infrared connection is made, the Main Screen in the Wave Viewer displays.P

Step 3. Press the Config key. The Transmitter Information One screen displays.

Step 4. Press the Exit Setup key to return to the Transmitter Information One screen.

Notes

There are two transmitter information screens containing transmitter configuration information -- Transmitter Information One and Transmitter Information Two.

Press the Xmtr Info 1 or the Xmtr Info 2 keys to move between the Transmitter Information screens.

In addition to configuration information, the Transmitter Information Two screen contains a status column containing dynamic information that changes while the transmitter is running. The screen does not update real-time. To update the screen, press the Xmtr Info 2 key.

Step 5. Check the Transmitter configuration information on each of the Transmitter Information screens.

Step 6. Press the EXIT softkey to exit when the Transmitter configuration information has been checked.

To Change Transmitter Configuration

The Wave Viewer can be used to configure a transmitter by using the Wave Viewer to copy the configuration settings from one transmitter to another or by using the Wave Viewer to configure specific parameters.

Only the following transmitter configuration parameters can be changed using the Wave Viewer:

- whether the user may change frequencies.
- whether 3-wire lead selection is enabled.
- whether the transmitter auto-shutoff feature is enabled.

To change any other configuration items (for example, Country Code, Locale code, SpO_2 On/Off, etc.) the Telemetry Service Tool must be used.

Notes

Before copying configurations from one transmitter to another, the frequency in the new transmitter must first be set. (see To Change a Transmitter's Frequency on page F-12).

When copying transmitter configuration settings, the transmitter frequency does not get copied.

To Copy Configuration Settings

To copy the configuration settings to a new transmitter using the Wave Viewer, do the following:

Step 1. Make the infrared connection between the Wave Viewer and the transmitter from which the configuration settings are to be copied. See Starting the Wave Viewer on page F-6. When the infrared connection is made, the Main Screen displays in the Wave Viewer application.

Step 2. Press the Config key.

Step 3. Press the Setup key. The System Setup Password screen displays.

Step 4. Type 14432 and press Enter. The System Setup Menu screen displays.

Step 5. Press the Copy Config key. The Copy Configuration screen displays.

Step 6. Press the Save Config key to copy the configuration settings. When the configuration is copied into Wave Viewer memory, the Configuration saved successfully message displays and the following settings are copied.

- whether the user can change frequencies.
- whether 3-wire lead selection is enabled.
- whether the transmitter auto-shutoff feature is enabled.

Step 7. Disconnect the Wave Viewer from the transmitter from which configuration settings are being copied. The Interrupted Screen displays.

Step 8. Make the infrared connection between the Wave Viewer and the transmitter to which configuration settings are being copied.

Step 9. Press the Setup key. The System Setup Password screen displays.

Step 10. Type 14432 and press Enter. The System Setup Menu screen displays.

Step 11. Press the Copy Config key. The Copy Configuration Screen displays.

Step 12. Press the Copy Config key to copy the configuration to the new transmitter. When the configuration is copied to the transmitter, the Configuration copied into transmitter successfully message displays. The transmitter now has the desired configuration.

To Configure Specific Items

Step 1. Make the infrared connection between the Wave Viewer and the transmitter. See Starting the Wave Viewer on page F-6. When the infrared connection is made, the Main Screen displays in the Wave Viewer application.

Step 2. Press the Config key.

Step 3. Press the Setup key. The System Setup Password screen displays.

Step 4. Type 14432 and press Enter. The System Setup Menu screen displays.

Step 5. Press the Config Xmtr key. The Transmitter Configuration screen displays. Make any desired configuration changes by pressing the corresponding Wave Viewer key to enable (YES) or disable (NO) a particular parameter as appropriate. The keys listed below provide the following functionality:

- Lead Select - when Lead Selection is enabled (set to YES), the user can select different leads (I, II, III). This only applies to the 3-wire leadset on a standard ECG transmitter.
- Freq Change - when Frequency Change is enabled (set to YES), the user can change the frequency of the transmitter using Wave Viewer.
- Auto Shutoff - when the Automatic Shutoff feature is enabled (set to YES), the transmitter shuts off if 10 minutes elapse and the leadset is not connected to a patient or simulator.

Step 6. When the desired changes have been made, press the Store Setting key to store the configuration parameters to the transmitter.

To Change a Transmitter's Frequency

The frequency of a transmitter can be changed using the Wave Viewer as follows.

Note If the transmitter has been configured to not allow the transmitter frequency to be changed using Wave Viewer, the configuration of the transmitter must first be changed to allow a frequency change. See To Change Transmitter Configuration on page F-10.

Step 1. Insert a battery into the transmitter.

Step 2. Make the infrared connection between the Wave Viewer and the transmitter. See Starting the Wave Viewer on page F-6. When the infrared connection is made, the Main Screen displays in the Wave Viewer application.

Step 3. Change the frequency of the transmitter at the Wave Viewer as follows:

a. Select Config from the Wave Viewer Main Screen.
b. Select Setup.
c. Enter the password 14432 and press Enter.
d. Select Chang Freq.
e. Enter the new Frequency followed by Enter.
f. Enter the associated Check Code followed by Enter.
g. Select Confirm to set the new frequency.

To Test the Transmitter

To test the transmitter using the Wave Viewer, do the following:

Step 1. Insert a battery into the transmitter and allow it to go through its self-test.

Step 2. Make the infrared connection between the Wave Viewer and the transmitter. See Starting the Wave Viewer on page F-6. When the infrared connection is made, the Main Screen displays in the Wave Viewer application.

Step 3. Press the Config key. The Transmitter Information One screen displays.

Step 4. Press the Test key. The Test screen displays.

Step 5. Press the Test Xmtr key. The screen displays a message that Wave Viewer is initiating the self-test on the transmitter. The takes about 6 seconds to complete.

Step 6. When the test is complete, Wave Viewer displays one of the following results:

- **Test successful** - The transmitter successfully passed the internal tests.
- **Cannot connect to transmitter. Please press F3 to retry** - If Wave Viewer was not connected to the transmitter, this message displays. Check the connection and retry the test by pressing F3.
- **ECG Malfunction** - There is a problem with the ECG portion of the transmitter. Refer to Chapter 4, Troubleshooting for troubleshooting procedures for the transmitter or replace the transmitter.
- **Transmitter Malfunction** - There is a problem with the firmware or memory portions of the transmitter. See Chapter 4, Troubleshooting for troubleshooting procedures for the transmitter or replace the transmitter.

Troubleshooting the Wave Viewer

The Wave Viewer is a software application running on a Hewlett-Packard 200LX Palmtop computer. Most of the problems encountered are from the program locking up or attempting to perform another application (such as Help) when checking waves.

Wave Viewer Hangs-up

1. Make certain that the application is not in Help. If it is, exit Help before attempting any Wave Viewer procedures.
2. If the screen does not respond to keypad presses, depress and hold the Ctrl, Alt, Del keys. This restarts the Wave Viewer program. (The Wave Viewer FLASH card must be installed to run).
3. If the Wave Viewer program is restarted and it does respond, then perform a drastic hard reboot by pressing and holding CONTROL, ON and the gold left Up arrow key. This re-initializes the Palmtop. During the start-up, there will be a prompt to initialize the RAM. Press N for no.
4. If the preceding steps do not solve the problem, replace the batteries in the Palmtop following procedures in the Palmtop documentation.

Wave Viewer will not Communicate with the Transmitter

This generally means there is a problem in the infrared communication between the transmitter and the Palmtop where the Wave Viewer program resides. Check the following:

1. The battery in the transmitter may be too low to support communications with the Wave Viewer. Install a fresh battery.
2. Make certain that the infrared ports on both the Wave Viewer and the transmitter are clean. If the light pipe is being used, make certain that the light pipe is not broken or improperly connected.
3. Check to see if the Palmtop communicates with another transmitter. If it does, the problem is in the transmitter. Replace the Main PCB in the transmitter.
4. If the Palmtop does not communicate with any transmitters, replace the Palmtop.

Wave Viewer Beeps and Shuts Off

This symptom indicates that the batteries in the Palmtop are too low to support basic operation. Replace the batteries following the procedures in the Palmtop documentation.

Cleaning the Palmtop Computer

The Hewlett-Packard 200X Palmtop computer and light pipe should be kept clean and free of dust, dirt, and fluids. If cleaning is necessary, wipe the surface carefully with sterile premoistened isopropyl alcohol preps. Do not allow liquids to run into the Palmtop.

Specifications

Following are specifications of the Wave Viewer.

Table F-1. Wave Viewer (M2605A) Specifications

Specification	Value
Temperature	*Operating:* 0 to +50°C (32 to 122° F) *Storage:* 0 to +60°C max (32 to 140° F) for data retention
Humidity Range	*Operating and Storage:* 90% RH at +40°C max. (104°F)
Safety	IEC 950: 1991 +A1, A2 EN 60950: 1992 +A1, A2
Display Area	*Resolution Waveform Display:* 4 s or 5 s of ECG wave on a 40-division vertical grid. *Time Base Accuracy:* 25 mm/sec +/- 10%
Signal Input	Via infrared port
ECG Bandwidth	0.5 to 28 Hz (-3dB from a midband response)
ECG Calibration	1 mV calibration bar at left edge of display
ECG Amplification	Any of 5 fixed gain settings: 0.25, 0.5, 1.0, 2.0, 4.0 mm/mV
Heart Rate Indication	By manual placement of electronic calipers on display. Accuracy: +/- 10% if caliper is placed within 1 pixel of R-wave peak at each end for up to 200 bpm.
Alarms	No capability
Battery	Two 1.5 V AA cells, alkaline or nickel-cadmium Caution: AC power adapter is not approved for use with Wave Viewer in the vicinity of medically-instrumented patients.
Battery Life	2 to 8 weeks
Power-Down Mode	Shuts itself off 10 minutes after last key press.

Replaceable Parts

This section lists replaceable parts for the Wave Viewer.

Table 4-1. Wave Viewer Replaceable Parts

Description	Exchange Part No.	New Part No.
Hewlett-Packard Palmtop PC, English — U.S.A./Japan	F1061-69011CP	F1061-60901CP
Hewlett-Packard Palmtop PC, International English — Europe	F1061-69001C	F1061-60902C
Wave Viewer, FLASH Card — English, French, German, Dutch Revision B.00.01		M2605-73102
Wave Viewer FLASH Card — Spanish, Italian, Portuguese, Japanese Revision B.00.01		M2605-73202
Wave Viewer FLASH card — Norwegian, Swedish, Finnish, Danish Revision B.00.01		M2605-73302
Wave Viewer Label — English		M2600-90301
Wave Viewer Label — French		M2600-90302
Wave Viewer Label — German		M2600-90303
Wave Viewer Label — Dutch		M2600-90304
Wave Viewer Label — Spanish		M2600-90305
Wave Viewer Label — Italian		M2600-90306
Wave Viewer Label — Norwegian		M2600-90307
Wave Viewer Label — Swedish		M2600-90308
Wave Viewer Label — Finnish		M2600-90309
Wave Viewer Label — Japanese		M2600-90310
Wave Viewer Label — Danish		M2600-90311
Wave Viewer Label — Portuguese		M2600-90314
Light Pipe		M2601-60170