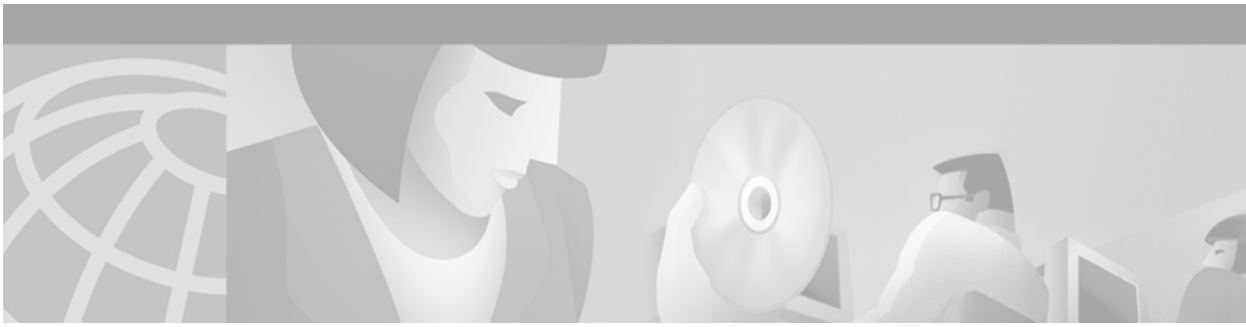


Cisco uBR7200 Series Universal Broadband Router Wireless Modem Card and Subsystem Installation and Configuration

Product Numbers: UBR-MCW-PDA, UBR-MCW-PDA=, UBR-WPFD=

This document explains how to install and configure the components for a high-speed point-to-point broadband fixed wireless system using Cisco uBR7200 series universal broadband routers. It includes instructions for installing a wireless modem card, and power feed panel, as well as instructions for configuring and verifying the system and troubleshooting the configuration.

The three routers that comprise the Cisco uBR7200 series are the:

- Three-slot Cisco uBR7223 (two modem card slots and one port adapter slot)
- Six-slot Cisco uBR7246 and Cisco uBR7246 VXR (four modem card slots and two port adapter slots)

Note Use this installation and configuration note in conjunction with the *Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide* and *Cisco uBR7200 Series Universal Broadband Router Software Configuration Guide* that shipped with your Cisco uBR7200 series router, and the *Cisco Broadband Fixed Wireless Site Planning Guide.*

The following sections are included in this document:

Corporate Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

If You Need More Information

The Cisco IOS software running on your router contains extensive features and functionality. The effective use of many of these features is easier if you have more information. For additional information on configuring and maintaining the Cisco uBR7200 series router, the following documentation resources are available:

- For hardware installation and maintenance information on the Cisco uBR7200 series router, refer to the *Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide* that shipped with your Cisco uBR7200 series router.
- For software configuration information on the Cisco uBR7200 series router, refer to the *Cisco uBR7200 Series Universal Broadband Router Software Configuration Guide* that shipped with your Cisco uBR7200 series router.
- For Cisco IOS software configuration information, refer to the modular configuration and modular command reference publications in the Cisco IOS software configuration documentation set that corresponds to the software release installed on your Cisco hardware.

Note You can access Cisco IOS software configuration documentation on the World Wide Web at http://www.cisco.com, http://www-china.cisco.com, or http://www-europe.cisco.com.

- For international agency compliance, safety, and statutory information for wide-area network (WAN) interfaces for the Cisco uBR7200 series, refer to the appendix containing the "Regulatory Compliance and Safety Information" in the *Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide*.
- To obtain general information about documentation, refer to the "Obtaining Documentation" section on page 124, or call customer service at 800 553-6387 or 408 526-7208. Customer service hours are 5:00 a.m. to 6:00 p.m. Pacific time, Monday through Friday (excluding Cisco-observed holidays). You can also send e-mail to cs-rep@cisco.com, or you can refer to the *Cisco Information Packet* that shipped with your router.

Wireless Modem Card and Subsystem Overview

The Cisco high-speed point-to-point broadband fixed wireless system provides a fixed, dedicated wireless link from one site to another. This link delivers full-duplex data in the Unlicensed National Information Infrastructure (U-NII) band (5.725 to 5.825 GHz).

The broadband fixed wireless system consists of a Cisco uBR7200 series universal broadband router (Cisco uBR7223, Cisco uBR7246, or Cisco uBR7246 VXR) and one or more wireless modem cards (see Figure 1), each with a power feed panel (see Figure 2) *at each site*. (The diversity option, which minimizes the effects of fading, uses two wireless transverters at each site, one for each of two antennas.)

Note Wireless transverters must be purchased from a third-party vendor. Refer to that vendor's documentation for installation instructions.

Figure 1 Wireless Modem Card

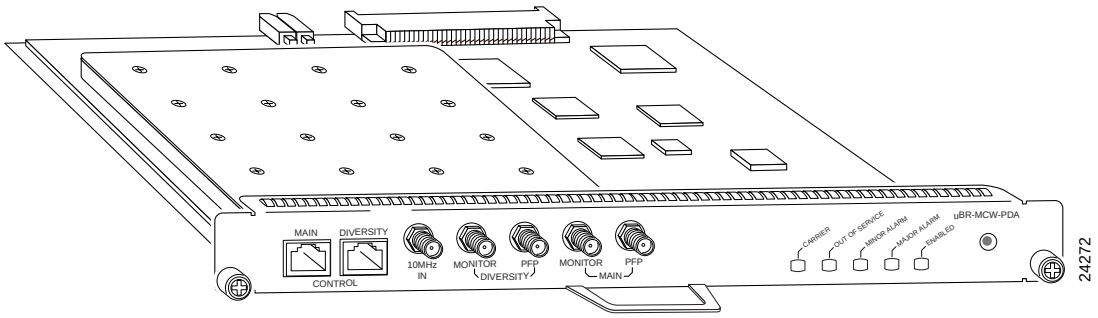
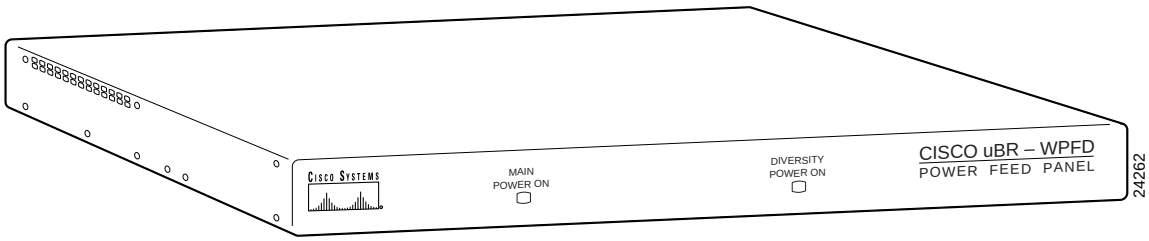
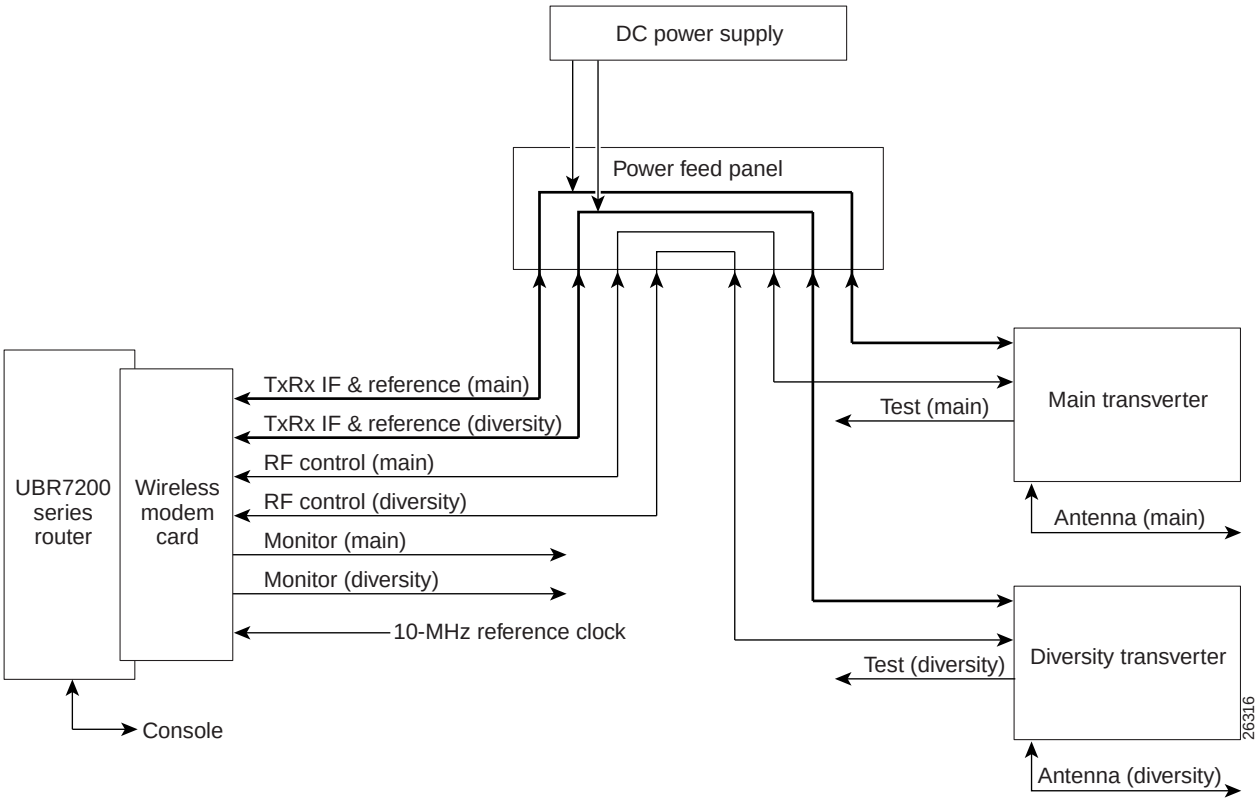


Figure 2 Power Feed Panel



The wireless modem cards are installed in a Cisco uBR7200 series router. Each modem card is cabled to a power feed panel installed either in the same equipment rack as the router or mounted on a wall. Cables from the power feed panel are attached to one or two wireless transverters, which are installed on antenna masts. The system is managed using a command-line interface (CLI) or CiscoView. Figure 3 shows the connections between the components.

Figure 3 Component Connections



Note The diversity transverter and 10-MHz clock connections are optional.

Wireless Modem Card

The wireless modem card provides the control and data interface between the system's digital motherboard and the radio frequency (RF) subsystem in the wireless transverter. It also provides the up/down conversion from baseband to intermediate frequency (IF).

Wireless modem cards consist of the following components:

- Main and diversity serial interface control connectors
- Connection for the optional 10-MHz external reference clock
- Monitor and power feed panel connectors (main and diversity)
- Light-emitting diodes (LEDs) that provide a visual indication of the state of the modem card

Figure 4 shows the connectors and LEDs on the wireless modem card. Table 1 describes the functions of the connectors, and Table 2 describes the functions of the LEDs.

Figure 4 Wireless Modem Card Connectors and LEDs

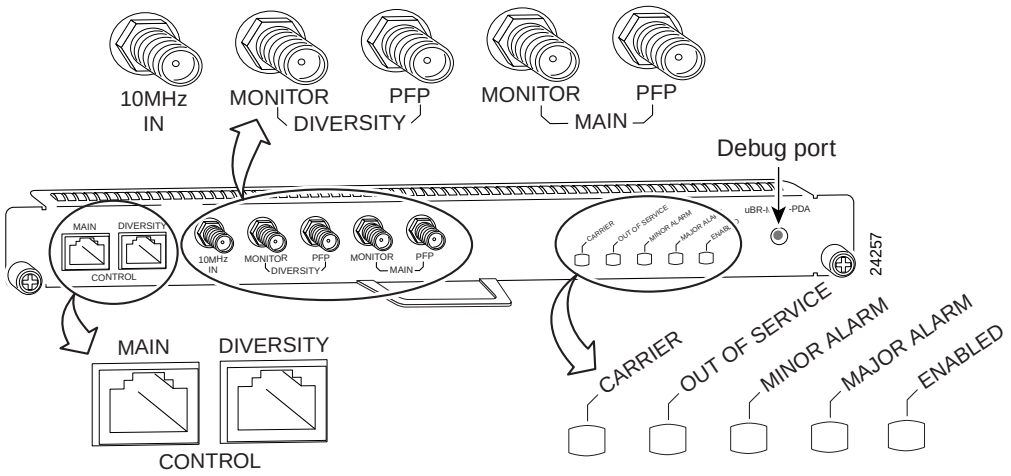


Table 1 Wireless Modem Card Connectors

Connector	Type	Input/Output	Function
Control—Main	8-pin RJ-45 (female)	Output	Physical connection to Power Feed Panel for RF subsystem interface control channel (main antenna).
Control—Diversity	8-pin RJ-45 (female)	Output	Physical connection to Power Feed Panel for RF subsystem interface control channel (diversity antenna when diversity option is used).
10-MHz Input	SMA (female)	Input	Connection for optional 10-MHz external reference clock. **Note** If you require greater frequency accuracy, an external clock can be attached to the wireless modem card designated as "master." (For a list of accessory suppliers, refer to the *Cisco Broadband Fixed Wireless Site Planning Guide*.)
Diversity — Monitor	SMA (female)	Output	For connection to spectrum analyzer for test/troubleshooting purposes (when diversity option is used). **Note** The monitor output level is the same as that of the power feed panel.
Diversity —PFP	SMA (female)	Output	24-MHz reference, receive and transmit IF signals (when diversity option is used).

Table 1 Wireless Modem Card Connectors (continued)

Connector	Type	Input/Output	Function
Main—Monitor	SMA (female)	Output	For connection to spectrum analyzer for test/troubleshooting purposes. **Note** The monitor output level is the same as that of the power feed panel.
Main—PFP	SMA (female)	Output	24-MHz reference, receive and transmit IF signals.
Debug Port	For factory use only.		

Table 2 Wireless Modem Card LEDs

LED	Function
Carrier LED	Indicates the state of the radio link. When green, the radio link is synchronized and the line protocol is up. When yellow, indicates loss of link synchronization.
Out of Service LED	Indicates the service availability of the radio link. When yellow, the radio link is still up, but not available for use (typically in a test or loopback mode).
Minor Alarm LED	When yellow, indicates the occurrence of a minor alarm in the radio subsystem. The link is degraded and may need maintenance action or, one or more user-defined event thresholds have been exceeded.
Major Alarm LED	When yellow, indicates the occurrence of a major alarm in the radio subsystem. The link is down.
Enabled LED	When green, indicates that the wireless modem card is on, receiving power from the router midplane, and enabled for operation. This LED remains on during normal operation of the Cisco uBR7200 series router.

Power Feed Panel

The power feed panel provides DC power, transmit and receive IF signals, frequency reference, and control signals to the wireless transverters. The unit contains circuit breakers for the DC power, and secondary lightning protection circuitry for the control cables. Local or national codes may require you to install primary lightning protection for the IF cable and the control cable.

The power feed panel consists of the following components:

- Power LEDs on front and rear panel
- Connector ports
  - Coaxial cable connection to the wireless modem card and the wireless transverter (main and diversity)
  - Control cable connection ports to the wireless modem card and wireless transverter (main and diversity)
- Power ON/OFF breaker switches (main and diversity)
- DC power supply terminal block
- Ground lug

Figure 5 shows the front panel of the power feed panel, and Table 3 describes the functions of the LEDs. Figure 6 shows the rear panel, and Table 4 describes the functions of the connectors.

Figure 5 Power Feed Panel (Front Panel)

Table 3 Power Feed Panel LEDs

LED	Function
Main Power On (visible on front and rear panel)	When lit, indicates that power is going to the main transverter.
Diversity Power On (visible on front and rear panel)	When lit, indicates that power is going to the diversity transverter.

Figure 6 Power Feed Panel (Rear Panel)

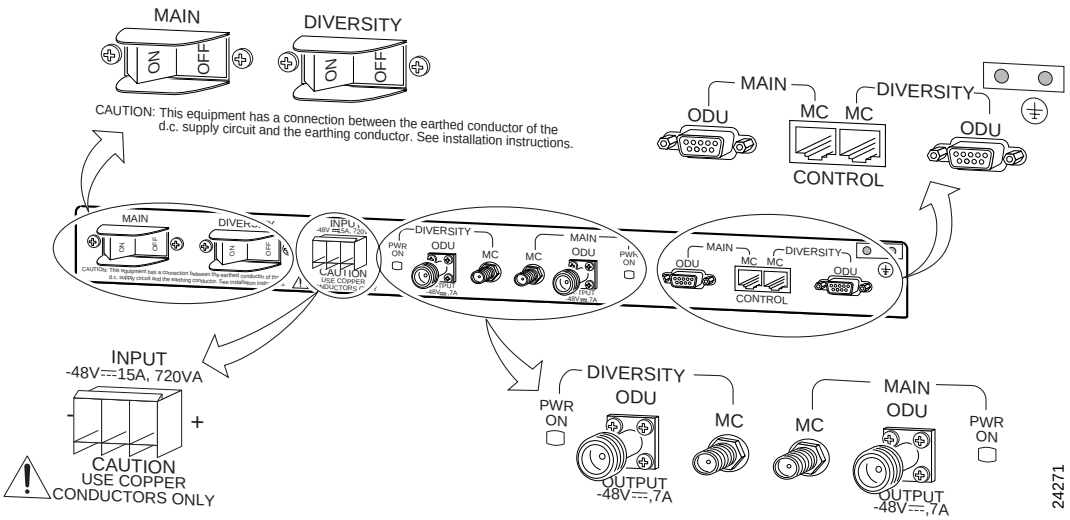


Table 4 Power Feed Panel Connectors

Connector	Type	Input/Output	Function
DC Power Input	Pluggable terminal block	Input	Power source connection for the main and diversity transverters.
Diversity ODU Output	N-Type (female)	Input and Output	Provides –48V power to the diversity transverter, 24-MHz reference, receive and transmit IF signal from/to the wireless modem card (if the diversity option is used).

Table 4 Power Feed Panel Connectors (continued)

Connector	Type	Input/Output	Function
Diversity MC (modem card)	SMA (female)	Input and Output	Provides 24-MHz reference, receive and transmit IF signals from/to the wireless modem card (if the diversity option is used).
Main ODU Output	N-Type (female)	Input and Output	Provides –48V power to the main transverter, 24-MHz reference receive and transmit IF signal from/to the wireless modem card.
Main MC (modem card)	SMA (female)	Input and Output	Provides 24-MHz reference, receive and transmit IF signals from/to the wireless modem card.
Main ODU Control	DB-9 (female)	Input and Output Bidirectional data communication between the wireless modem card and the main transverter.	Physical connection to the main transverter for RF subsystem control interface.
Main MC (modem card) Control	8-pin RJ-45 (female)	Input and Output Bidirectional data communication between the wireless modem card and the main transverter.	Physical connection for RF subsystem control interface from the wireless modem card.
Diversity ODU Control	DB-9 (female)	Input and Output Bidirectional data communication between the wireless modem card and the diversity transverter.	Physical connection to the diversity transverter for RF subsystem control interface (if the diversity option is used).
Diversity MC (modem card) Control	8-pin RJ-45 (female)	Input and Output Bidirectional data communications between the wireless modem card and the diversity transverter.	Physical connection for RF subsystem control interface from the wireless modem card (if the diversity option is used).

Field-Replaceable Units

All major components of the broadband fixed wireless system, as well as the major components of the Cisco uBR7200 series routers, are field-replaceable units (FRUs). Each FRU is shipped with instructions for removal and reinstallation.

The following components are available as FRUs:

- Wireless modem card
- Power feed panel
- Cisco uBR7200 series router components:
  - Network processing engine
  - Input/output controller
  - Port adapters
  - Power supplies
  - Fan tray
  - Chassis
  - Subchassis and midplane
  - Flash memory cards
  - Rack mount and cable-management kit

For ordering information, contact a Cisco customer service representative. See the "Cisco.com" section on page 125 for more information.

Installation Prerequisites

This section provides a list of parts and tools that you need to remove and replace a wireless modem card in the Cisco uBR7200 series router and the parts and tools to install the power feed panel in an equipment rack or on the wall. This section also includes safety and ESD-prevention guidelines to help you avoid injury to yourself and damage to the equipment.

Parts and Tools

The following sections describe the parts and tools required to install each of the components. If you need more detailed information regarding cables or connectors, refer to the *Cisco Broadband Fixed Wireless Site Planning Guide*.

Wireless Modem Card

You need the following tools and parts to remove and replace a wireless modem card. If you need additional equipment, contact a service representative for ordering information.

- New wireless modem card
- Number 2 Phillips screwdriver
- SMA production torque wrench
- Your own electrostatic discharge (ESD)-prevention equipment or the disposable grounding wrist strap included with all upgrade kits, FRUs, and spares
- Antistatic mat or surface
- Static shielding bag
- Shielded CAT-5 cable with RJ-45 connectors and plenum-rated coaxial cable with SMA connectors for connections between the modem card and the power feed panel. (Standard sets of these cables can be purchased from Cisco.)

Note If you are replacing a wireless modem card, these cables are already installed.

Power Feed Panel

You need the following tools and parts to install the power feed panel in an equipment rack or on a wall. If you need additional equipment, contact a service representative for ordering information.

- Power feed panel
- Number 2 Phillips screwdriver
- Bracket kit (provided)
- Rack- or wall-mount screws
- 1/8-inch flat-blade screwdriver
- 5/16-inch open-end wrench
- SMA production torque wrench
- 50-ohm coaxial cables with N-type (male) connectors for IF control
- Shielded CAT-5 outdoor-rated control cables with DB-9 (male) and LEMO-type (8 pin, P, 1K series) connectors

  Note If a lightning protection device is installed between the DB-9 and LEMO-type connectors, there may be one *logical* cable, but two *physical* cables. The portion of the cable that is located indoors does not need to be outdoor rated.

- –48 VDC power supply
- Ground lug (in grounding kit provided)

Software and Hardware Requirements

For this installation and configuration, you need a configured Cisco uBR7200 series router running Cisco IOS Release 12.0(7)XR, Cisco IOS Release 12.1(1)T, or any 12.1(x)T Cisco IOS release that is later than Software Release 12.1(1)T.

Safety Guidelines

Following are safety guidelines that you should follow when working with any equipment that connects to electrical power or telephone wiring.

Safety Warnings

Warning **This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Waarschuwing **Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van standaard maatregelen om ongelukken te voorkomen. Voor vertalingen van de waarschuwingen die in deze publicatie verschijnen, kunt u het gedeelte Regulatory Compliance and Safety Information (Informatie over naleving van veiligheids- en andere voorschriften) raadplegen in dit document.**

Varoitus **Tämä varoitusmerkki merkitsee vaaraa. Olet tilanteessa, joka voi johtaa ruumiinvammaan. Ennen kuin työskentelet minkään laitteiston parissa, ota selvää sähkökytkentöihin liittyvistä vaaroista ja tavanomaisista onnettomuuksien ehkäisykeinoista. Tässä julkaisussa esiintyvien varoitusten käännökset löydät tämän asiakirjan Regulatory Compliance and Safety Information -osasta (määräysten noudattaminen ja tietoa turvallisuudesta).**

Attention **Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents. Pour prendre connaissance des traductions d'avertissements figurant dans cette publication, consultez la section Regulatory Compliance and Safety Information (Conformité aux règlements et consignes de sécurité) de ce document.**

Warnung **Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an irgendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt. Übersetzungen der in dieser Veröffentlichung enthaltenen Warnhinweise finden Sie im Abschnitt "Regulatory Compliance and Safety Information" (Informationen zu behördlichen Vorschriften und Sicherheit) in diesem Dokument.**

Avvertenza **Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti. La traduzione delle avvertenze riportate in questa pubblicazione si trova nella documento Regulatory Compliance and Safety Information (Conformità alle norme e informazioni sulla sicurezza) nel presente documento.**

Advarsel **Dette varselsymbolet betyr fare. Du befinner deg i en situasjon som kan føre til personskade. Før du utfører arbeid på utstyr, må du vare oppmerksom på de faremomentene som elektriske kretser innebærer, samt gjøre deg kjent med vanlig praksis når det gjelder å unngå ulykker. Hvis du vil se oversettelser av de advarslene som finnes i denne publikasjonen, kan du se i avsnittet Regulatory Compliance and Safety Information (Overholdelse av forskrifter og sikkerhetsinformasjon) i dette dokumentet.**

Aviso **Este símbolo de aviso indica perigo. Encontra-se numa situação que lhe poderá causar danos físicos. Antes de começar a trabalhar com qualquer equipamento, familiarize-se com os perigos relacionados com circuitos eléctricos, e com quaisquer práticas comuns que possam prevenir possíveis acidentes. Para ver as traduções dos avisos que constam desta publicação, consulte a secção Regulatory Compliance and Safety Information (Informação de Segurança e Disposições Reguladoras) neste documento.**

¡Advertencia! **Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes. Para ver una traducción de las advertencias que aparecen en esta publicación, consultar la sección titulada Regulatory Compliance and Safety Information (Información sobre seguridad y conformidad con las disposiciones reglamentarias) que aparece en este documento.**

Varning! **Denna varningssymbol signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanligt förfarande för att förebygga skador. Om du vill se översättningar av de varningar som visas i denna publikation, se avsnittet "Efterrättelse av föreskrifter och säkerhetsinformation" i detta dokument.**

Note This installation must be made in accordance with all local and national regulations. Special attention must be made to Articles 800, 810, and 820 of the US National Electric Code, Sections 54 and 60 of the Canadian electric code, and equivalent sections of other local and national regulations that address telecommunications wiring for the control cable, and TV, Radio, and CATV wiring for the control cable and the coaxial cable.

Warning **This product requires short-circuit (overcurrent) protection to be provided as part of the building installation. Install only in accordance with national and local wiring regulations. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **A readily accessible two-poled disconnect device must be incorporated in the fixed wiring. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Electrical Equipment Guidelines

Follow these basic guidelines when working with any electrical equipment:

- Before beginning any procedures requiring access to the chassis interior, locate the emergency power-off switch for the room in which you are working.
- Disconnect all power and external cables before moving a chassis.
- Do not work alone if potentially hazardous conditions exist.
- Never assume that power has been disconnected from a circuit; always check.
- Do not perform any action that creates a potential hazard to people or makes the equipment unsafe.
- Never install equipment that appears damaged.
- Carefully examine your work area for possible hazards such as moist floors, ungrounded power extension cables, and missing safety grounds.

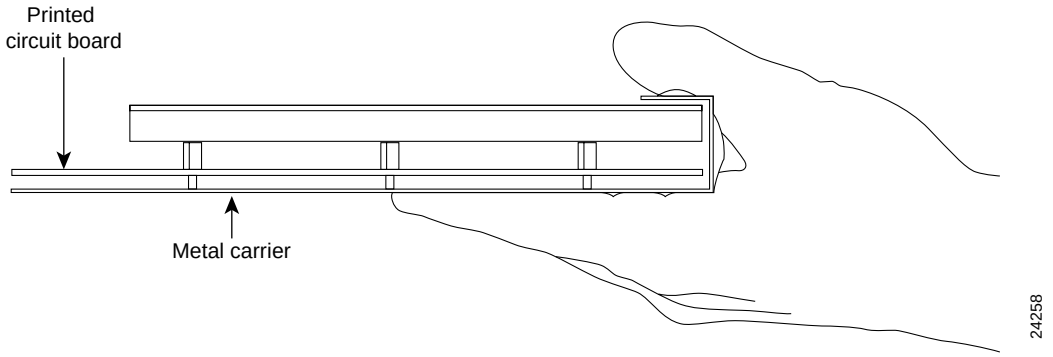
Preventing Electrostatic Discharge Damage

Electrostatic discharge (ESD) damages equipment and impairs electrical circuitry. ESD occurs when printed circuit boards are improperly handled and results in complete or intermittent failures

The network processing engine, input/output (I/O) controller, port adapters, and wireless modem cards consist of a printed circuit board that is fixed in a metal carrier. Electromagnetic interference (EMI) shielding, connectors, and a handle are integral components of the carrier. Handle the network processing engine, I/O controller, port adapters, and wireless modem cards by their carrier edges and handles; never touch the printed circuit board when handling either component.

Figure 7 shows the location of a printed circuit board when it is installed in a network processing engine, I/O controller, or Cisco uBR7200 series modem card metal carrier. Do not touch the printed circuit board when handling any of these components.

Figure 7 Handling the Cisco uBR7200 Series Wireless Modem Cards—Side View



Although the metal carrier helps to protect the printed circuit boards from ESD, wear a preventive antistatic strap whenever handling the network processing engine, I/O controller, port adapters, or wireless modem cards. Ensure that the strap makes good skin contact and connect the strap's clip to an unpainted chassis surface to safely channel unwanted ESD voltages.

If no wrist strap is available, ground yourself by touching the metal part of the chassis.

Caution Be sure to tighten the captive installation screws on the network processing engine, the I/O controller, and the wireless modem cards (use a number 2 Phillips screwdriver). These screws prevent accidental removal, provide proper grounding for the router, and help to ensure that the network processing engine, I/O controller, and modem cards are properly seated in the router midplane.

Following are guidelines for preventing ESD damage:

- Always use an ESD-preventive wrist strap or ankle strap when installing or replacing the network processing engine, I/O controller, port adapters, or modem cards. Ensure that the ESD-preventive strap makes contact with your skin.
- Handle the network processing engine, I/O controller, port adapters, or modem cards by their metal carrier edges and handles only; avoid touching the printed circuit board components or any connector pins.
- When removing the network processing engine, I/O controller, port adapters, or wireless modem cards, place them on an antistatic surface with the printed circuit board components facing upward, or in a static shielding bag. If you are returning an I/O controller, network processing engine, port adapter, or modem card to the factory, immediately place it in a static shielding bag.

Caution Periodically check the resistance value of the antistatic strap. The measurement should be within the range of 1 to 10 megohms.

Warning **Do not work on the system or connect or disconnect cables during periods of lightning activity. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Read the installation instructions before you connect the system to its power source. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Before working on equipment that is connected to power lines, remove jewelry (including rings, necklaces, and watches). Metal objects will heat up when connected to power and ground and can cause serious burns or weld the metal object to the terminals. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Care must be given to connecting units to the supply circuit so that wiring is not overloaded. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **This equipment is to be installed and maintained by service personnel only as defined by AS/NZS 3260.**

Warning **Only trained and qualified personnel should be allowed to install, replace, or service this equipment. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Product Disposal

Warning **Ultimate disposal of this product should be handled according to all national laws and regulations. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Compliance with U.S. Export Laws and Regulations Regarding Encryption

This product performs encryption (in the baseline privacy feature) and is regulated for export by the U.S. Government. Following is specific information regarding compliance with U.S. export laws and regulations for encryption products:

- This product is *not* authorized for use by persons located outside the United States and Canada that do not have export license authority from the U.S. Government.
- This product may *not* be exported outside the U.S. and Canada either by physical or electronic means without the *prior* written approval of the U.S. Government.
- Persons outside the U.S. and Canada may *not* re-export, resell, or transfer this product by either physical or electronic means without *prior* written approval of the U.S. Government.

Removing and Installing the Wireless Modem Card

The following sections explain how to remove and replace or install the wireless modem card in a Cisco uBR7200 series router.

Removing the Wireless Modem Card

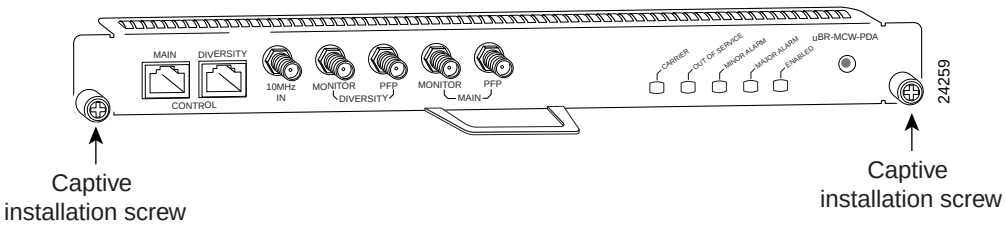
The following procedures explain how to remove the wireless modem card from a Cisco uBR7200 series router:

Step 1 Attach an ESD-preventive wrist strap between you and an unfinished chassis surface.

Caution Do *not* disconnect the cables until the modem card is pulled halfway out of its slot. Doing so can disrupt normal operation of the router.

Step 2 Unscrew the captive installation screws on the front of the wireless modem card. (See Figure 8.)

Figure 8 Captive Installation Screws



Step 3 Grasp the handle on the wireless modem card and carefully pull the modem card from the midplane, about halfway out of its slot. If you are removing a blank modem card, pull the blank modem card all the way out of the chassis slot.

Step 4 With the wireless modem card halfway out of the slot, disconnect all cables from the front of the modem card.

Caution Always handle the wireless modem card by the carrier edges and handle; never touch the modem card's components or connector pins. (See Figure 7.)

Step 5 After disconnecting the cables, pull the modem card from its chassis slot.

Step 6 Place the modem card on an antistatic surface with its components facing upward, or in a static shielding bag. If the modem card will be returned to the factory, immediately place it in a static shielding bag.

This completes the procedure for removing a wireless modem card from the Cisco uBR7200 series router.

Installing or Replacing the Wireless Modem Card

To install or replace the wireless modem card in the Cisco uBR7200 series router:

Step 1 Attach an ESD-preventive wrist strap between you and an unfinished chassis surface.

Step 2 Grasp the modem card by its metal carrier edges and position the modem card as shown in Figure 7.

Step 3 Align the left and right edges of the modem card metal carrier between the guides in the modem card slot. (For the Cisco uBR7223, see Figure 9. For the Cisco uBR7246 and Cisco uBR7246 VXR, see Figure 10.)

Figure 9 Aligning the Wireless Modem Card Metal Carrier Between the Slot Guides (Cisco uBR7223)

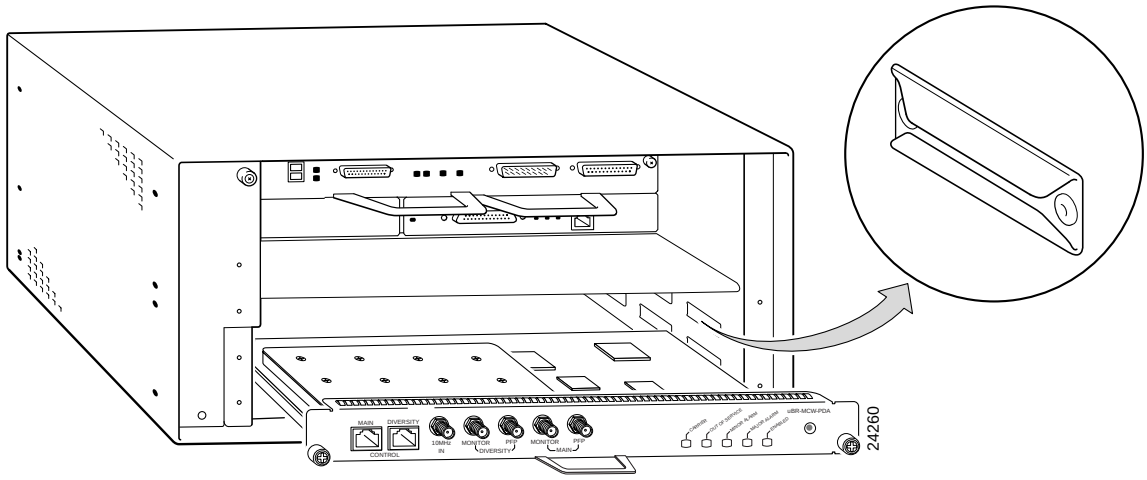
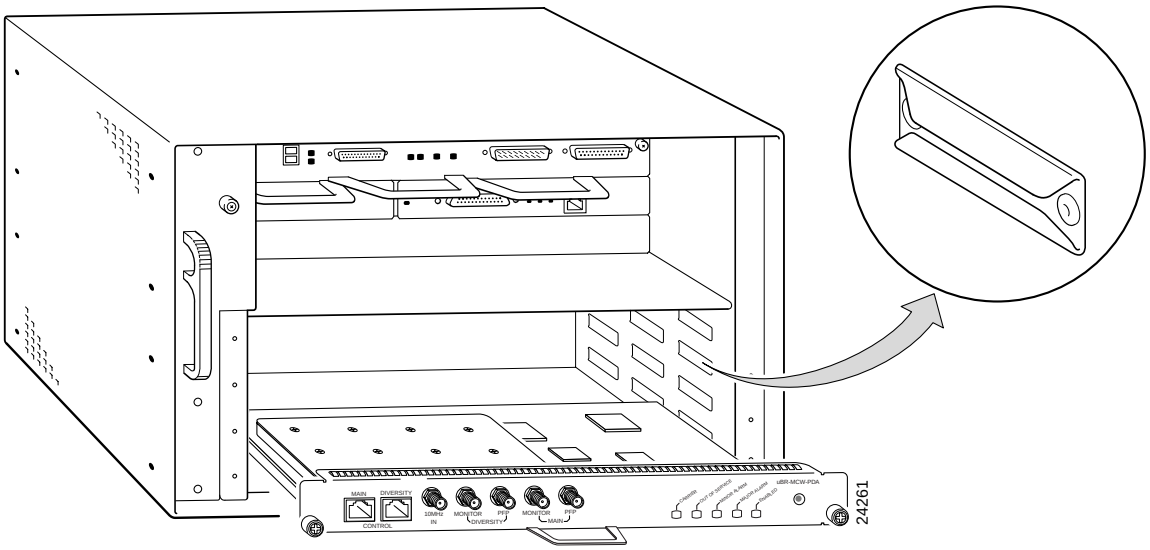


Figure 10 Aligning the Wireless Modem Card Metal Carrier Between the Slot Guides (Cisco uBR7246, Cisco uBR7246 VXR)



Step 4 With the metal carrier aligned in the slot guides, gently slide the modem card halfway into the modem card slot.

Caution Do not slide the modem card all the way into the slot until you have connected all required cables. Trying to do so will disrupt normal operation of the router.

Step 5 With the modem card halfway in the slot, connect all required cables to the front of the modem card. (See the "Cabling the Wireless Modem Card" section on page 19.)

Step 6 After connecting all required cables, carefully slide the modem card all the way into the slot until you feel the card's connectors mate with the midplane.

Step 7 Tighten the captive installation screws on the modem card. (See Figure 8.)

Note If the modem card captive installation screws do not tighten all the way, the card is not completely seated in the midplane. Carefully pull the modem card halfway out of the slot, reinsert it, and tighten the captive installation screws.

Caution Care must be taken when installing the wireless modem cards to not overtighten and strip the captive screws. Never use a screw gun or similar device when installing these cards.

Caution To ensure adequate airflow across the router's modem cards, a modem card or blank modem card (faceplate) must be installed in each modem card slot.

Warning **Blank faceplates and cover panels serve three important functions: they prevent exposure to hazardous voltages and currents inside the chassis; they contain electromagnetic interference (EMI) that might disrupt other equipment; and they direct the flow of cooling air through the chassis. Do not operate the system unless all cards, faceplates, front covers, and rear covers are in place. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

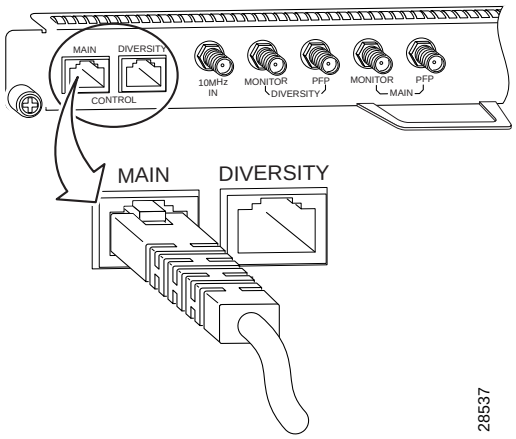
This completes the procedure for installing a wireless modem card in the Cisco uBR7200 series router.

Cabling the Wireless Modem Card

Attaching the RF Control Cable

Insert the RJ-45 connector on the control cable into the Main Control connector port. (See Figure 11.)

Figure 11 Attaching the RF Control Cable

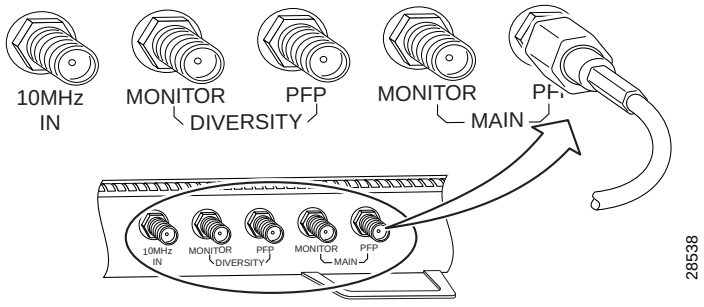


If you will be using the diversity option, use a second cable and attach it to the Diversity Control connector port.

Attaching the IF Cable

Connect one end of the IF signal cable to the Main PFP (power feed panel) port. (See Figure 12.)

Figure 12 Attaching the IF Cable



If you will be using the diversity option, use a second cable and attach it to the Diversity PFP port.

(Optional) Attaching the Monitor Cable

To use a spectrum analyzer to test or troubleshoot the signal on the modem card, attach it to the Main Monitor port or Diversity Monitor port.

(Optional) Cabling the 10-MHz Clock

To connect a 10-MHz clock to the master wireless modem card, connect an SMA to BNC adapter to the 10-MHz IN connector port. Attach the clock cable's BNC connector to the adapter.

Note Recommended torque for attaching connectors to SMA ports is 7 to 9 inch-pounds.

This completes the procedure for cabling a wireless modem card.

Installing the Power Feed Panel

The power feed panel can be mounted in a 19-inch rack or mounted on a wall. Depending on your site requirements, the unit can be co-located with the router or placed at an indoor location near the bulkhead opening leading to the outdoor wireless transverter.

Note When rack-mounting the power feed panel, allow at least one rack-unit space between the Cisco uBR7200 series router and the power feed panel or between multiple power feed panels.

Rack-Mounting the Power Feed Panel

The power feed panel can be rack-mounted with either the front panel or the rear panel facing forward depending on the cable handling requirements of your site, or in a center-mount telco rack. The power LEDs are visible on both the front and rear panels.

Warning **To prevent bodily injury when mounting or servicing this unit in a rack, you must take special precautions to ensure that the system remains stable. The following guidelines are provided to ensure your safety:**

- This unit should be mounted at the bottom of the rack if it is the only unit in the rack.
- When mounting this unit in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.
- If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the unit in the rack.

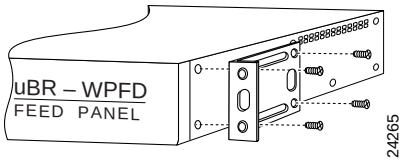
To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.

Warning **This unit is intended for installation in restricted access areas. A restricted access area is where access can only be gained by service personnel through the use of a special tool, lock and key, or other means of security, and is controlled by the authority responsible for the location. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Attaching the Brackets

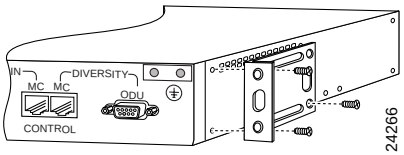
To install the power feed panel with the front panel facing forward, attach the brackets to both sides of the unit. (See Figure 13.)

Figure 13 Bracket Installation—Front Panel Forward



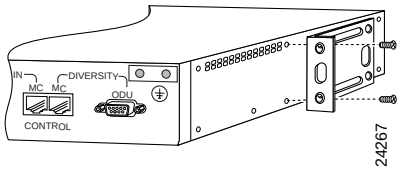
To install a power feed panel with the rear panel facing forward, attach the brackets to both sides of the unit. (See Figure 14.)

Figure 14 Bracket Installation—Rear Panel Forward



To install a power feed panel in a center-mount telco rack, attach the brackets to both sides of the unit. (See Figure 15.)

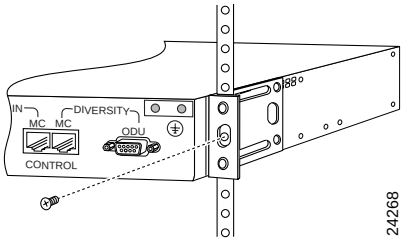
Figure 15 Telco Center-Mount Bracket Installation—Rear Panel Forward



Installing the Power Feed Panel in the Equipment Rack

After the brackets are secured, attach the brackets on both sides of the power feed panel to the equipment rack. (See Figure 16.)

Figure 16 Attaching the Power Feed Panel to an Equipment Rack



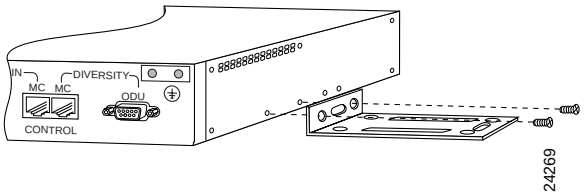
Wall-Mounting the Power Feed Panel

To wall-mount the unit, use the same brackets as those used to install the power feed panel in an equipment rack.

Use the following steps to wall-mount the power feed panel:

Step 1 Attach the brackets to both sides of the power feed panel. (See Figure 17.)

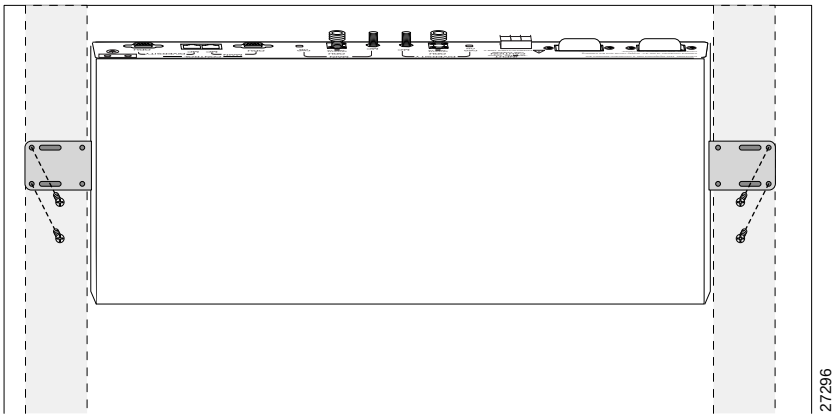
Figure 17 Attaching the Wall Mount Brackets



Step 2 Attach the power feed panel to the wall (see Figure 18), using screws and anchors you provide. To best support the power feed panel and cables, make sure the power feed panel is attached securely to a vertical wall stud or to a firmly attached plywood mounting backboard. This position will prevent the unit from pulling away from the wall when the cables are attached.

Note To meet safety requirements, the power feed panel must be installed with the rear panel connectors facing up.

Figure 18 Wall-Mounting the Power Feed Panel



Attaching the Ground Lug

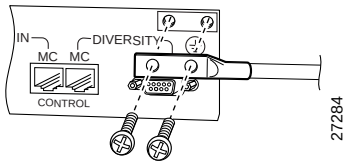
A ground lug kit is provided with the power feed panel. Use the following steps to attach the ground lug to the power feed panel chassis.

Step 1 Attach an approved ground wire to the ground lug.

Step 2 Locate the two ground lug threaded holes on the upper right of the rear panel.

Step 3 Align the ground lug with the threaded holes and fasten it to the chassis using the two screws included in the kit. (See Figure 19.)

Figure 19 Attaching the Ground Lug



Step 4 Using a number 2 Phillips screwdriver, tighten the screws.

Wiring the DC Power

Follow the procedures in this section to wire the DC power.

Note The color coding of DC-input power supply leads depends on the color coding of the DC power source at your site. Typically, green or green/yellow is used for ground, black is used for +48V (return), and red or white is used for –48V. Make certain the lead color coding you choose for the DC-input power supply matches lead color coding at the DC power source.

Note The length of the cable between the –48v power supply and the power feed panel must not exceed 9.4 feet (3m).

Warning **This product requires short-circuit (overcurrent) protection to be provided as part of the building installation. Install only in accordance with national and local wiring regulations. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **This equipment has a connection between the earthed conductor of the DC supply circuit and the earthing conductor.**

- 1) This equipment shall be connected directly to the DC supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the DC supply system earthing electrode is connected.

- 2) This equipment shall be located in the same immediate area (such as adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same DC supply circuit and the earthing conductor, and also the point of earthing of the DC system. The DC system shall not be earthed elsewhere.
- 3) The DC supply source is to be located within the same premises as this equipment.
- 4) There shall be no switching or disconnecting devices in the earthed circuit conductor between the DC source and the point of connection on the earthing electrode conductor.

To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.

Warning **Secure all power cabling when installing this unit to avoid disturbing field-wiring connections. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **When installing the unit, the ground connection must always be made first and disconnected last. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Figure 21 shows the DC power supply terminal block. Wire the DC power supply using the appropriate wire terminations at the wiring end, as illustrated. The proper wiring sequence is ground to ground, positive to positive (line to L), and negative to negative (neutral to N). Note that the ground wire should always be connected first and disconnected last. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **A readily accessible two-poled disconnect device must be incorporated in the fixed wiring. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Use copper conductors only. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **An exposed wire lead from a DC-input power source can conduct harmful levels of electricity. Be sure that no exposed portion of the DC-input power source wire extends from the terminal block plug. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **The customer 48 volt power system must provide reinforced insulation between the primary AC power and the 48 VDC output. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Connect the unit only to a DC power source that complies with the Safety Extra-Low Voltage (SELV) requirements in IEC 60950 based safety standards. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Warning **Before performing any of the following procedures, ensure that power is removed from the DC circuit. To ensure that all power is OFF, locate the circuit breaker on the panel board that services the DC circuit, switch the circuit breaker to the OFF position, and tape the switch handle of the circuit breaker in the OFF position. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

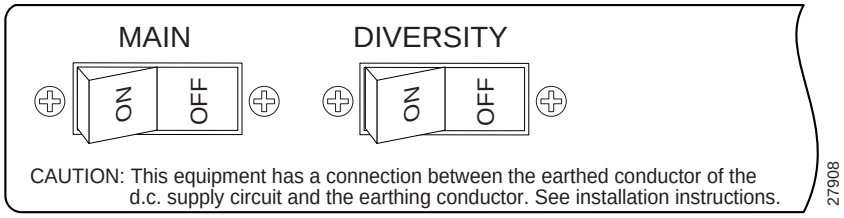
Wiring the DC power consists of attaching the wires of the DC power source to a removable wiring block, then plugging that block into the connection on the power feed panel. Refer to Figure 22 and Figure 23 and follow these steps.

Warning **Use 10 AWG wire with insulation rated for 75 C (167 F) or higher to wire the DC input power supply to the power feed panel. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Step 1 Ensure that the leads are disconnected from the power source.

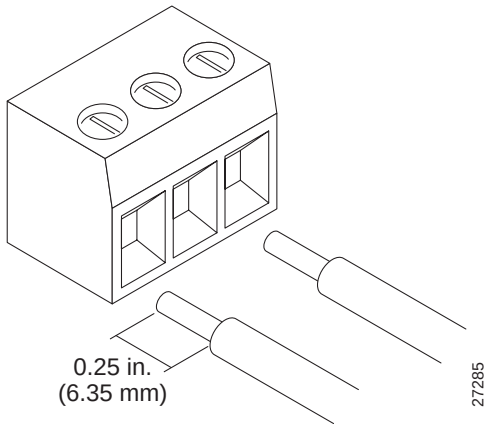
Step 2 Ensure that the power/breaker switch for both main and diversity are in the OFF position. (See Figure 20.)

Figure 20 Wireless Transverter Power/Breaker Switches



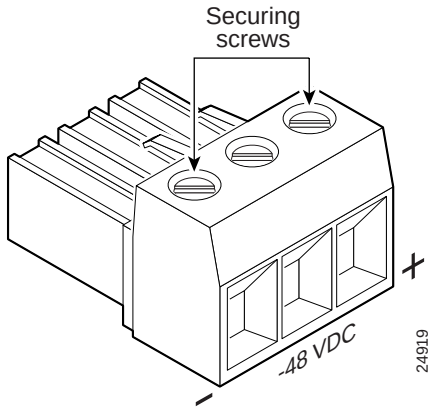
Step 3 Using a wire stripper, strip approximately 0.25 inch (6.35 mm) from the +48V and –48V leads. (See Figure 21.)

Figure 21 Stripping the Wire



Step 4 Insert the stripped ends of the wire in the removable wiring block according to the scheme in Figure 22. Figure 22 illustrates the polarity of each connection. The terminal on the left is for the –48 VDC wire. The terminal on the right is for the positive return wire.

Figure 22 Wiring Connections



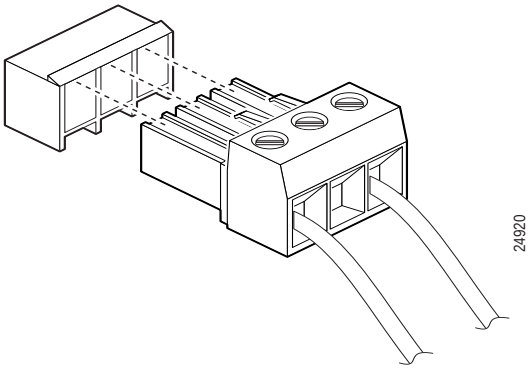
Step 5 Secure the wires using the 1/8-inch flat-blade screwdriver to tighten the screws in the top of the terminal block.

Step 6 Connect the DC input wiring to the DC source.

Warning **For personal safety, the ground wire must connect to safety (earth) ground at both the equipment and supply side of the DC wiring (unless the local electrical code requirements are different). To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Step 7 Plug the terminal block into the receptacle on the power feed panel. (See Figure 23.)

Figure 23 Plugging the Terminal Block into the Receptacle



Note Additional terminal blocks (part number 1804917) can be obtained from Phoenix Contact Inc., USA. Telephone: 800-888-7388. World Wide Web: http://www.phoenixcon.com.

Cabling the Power Feed Panel

This section describes the cabling of the power feed panel.

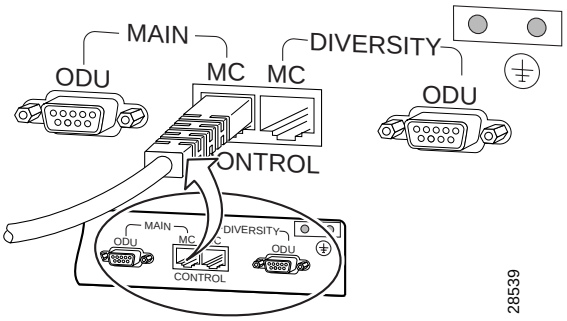
Warning **Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Note It is not necessary to terminate unused connectors.

Connecting the Control Cable (from the Wireless Modem Card)

Attach the end of the control cable coming from the Control-Main port on the modem card to the Control-Main/MC port on the power feed panel. (See Figure 24.)

Figure 24 Connecting the Control Cable (from the Wireless Modem Card)

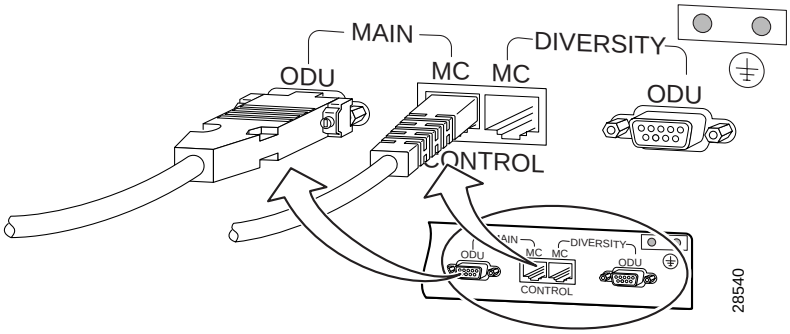


If you will be using the diversity option, also attach the second control cable coming from the Control-Diversity port on the modem card to the Control-Diversity/MC port on the power feed panel.

Connecting the Control Cable (to the Wireless Transverter)

Attach a cable with a DB-9 connector to the Control-Main/ODU port on the power feed panel. (See Figure 25.)

Figure 25 Connecting the Control Cable (to the Wireless Transverter)



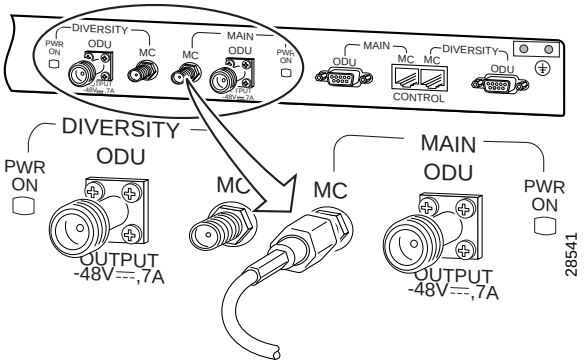
If you will be using the diversity feature, attach a second cable to the Control-Diversity/ODU port.

Warning **To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cord. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Connecting the IF Cable (from the Wireless Modem Card)

Connect the cable coming from the Main/PFP port of the modem card to the Main/MC port on the power feed panel. (See Figure 26.)

Figure 26 Connecting the IF Cable (from the Wireless Modem Card)



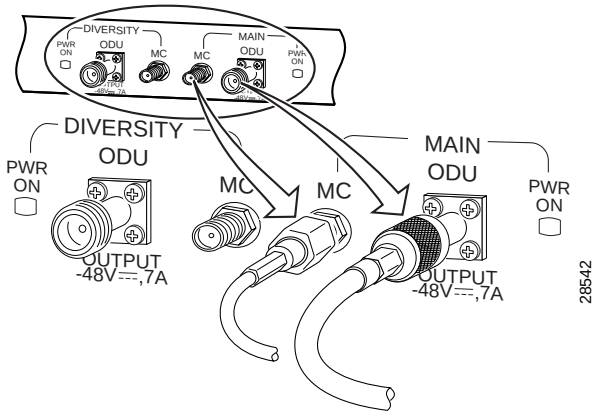
If you will be using the diversity feature, also connect the cable coming from the Diversity/PFP port of the modem card to the Diversity/MC port on the power feed panel.

Connecting the IF Cable (to the Wireless Transverter)

Attach one end of the IF cable to the Main-ODU/Output connector. (See Figure 27.) If stiff coaxial cable is being used for the connection, first attach a “pigtail” adapter using flexible coaxial cable.

Warning **Use 50-ohm coaxial cable with a center conductor size of 10 AWG or larger (for example, LMR-400, 3/8-inch FSJ Superflex Heliax, or larger). Failure to do so can result in overheating, fire, or long-term failure. Local and national electrical codes must be observed. To see translations of the warnings that appear in this publication, refer to the “Regulatory Compliance and Safety Information” section in this document.**

Figure 27 Connecting the IF Cable (to the Wireless Transverter)

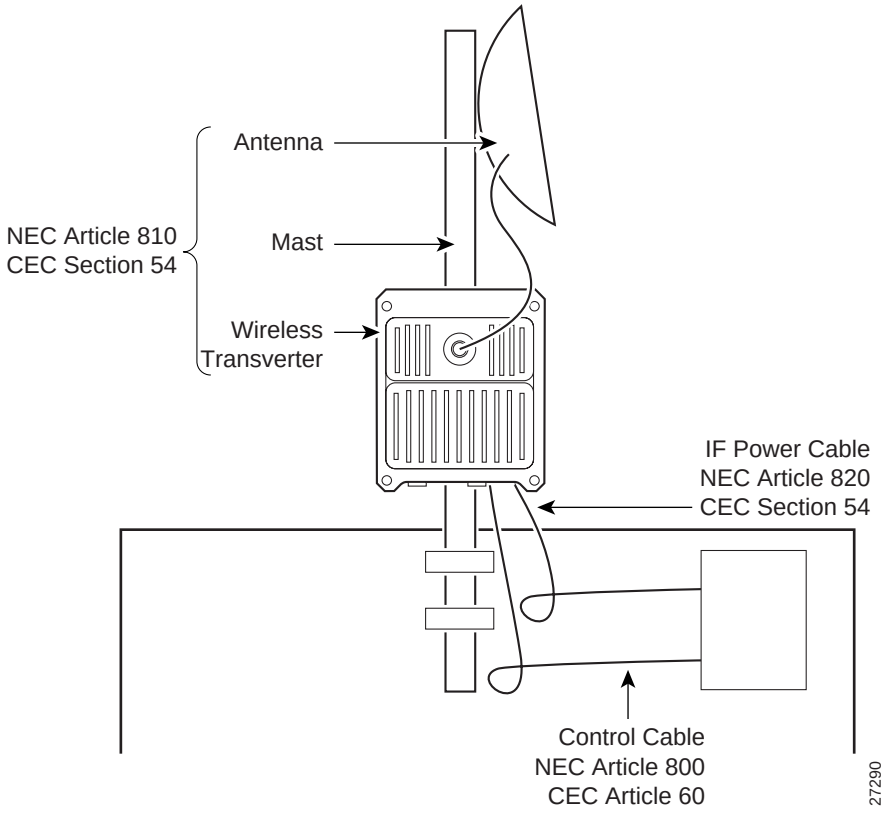


If you will be using the diversity feature, attach a second cable to the Diversity-ODU/Output connector.

This completes the procedure for installing and cabling a power feed panel. To install the wireless transverter, refer to the transverter vendor’s instructions.

Warning **Do not locate the transverter near overhead power lines or other electric light or power circuits, or where it can come into contact with such circuits. (See Figure 28.) When installing the transverter, take extreme care not to come into contact with such circuits, as they may cause serious injury and death. To see translations of the warnings that appear in this publication, refer to the "Regulatory Compliance and Safety Information" section in this document.**

Figure 28 Roof Installation Considerations



Configuring a Wireless Modem Card

After you have installed or replaced a wireless modem card and subsystem, use the Cisco IOS software command-line interface (CLI) to configure the modem card for operation. Initial startup requirements and examples, as well as the commands to log in to the router and complete the initial configuration are described in this section.

Note You must perform a basic configuration of the Cisco uBR7200 series router before configuring the wireless modem cards. Refer to the *Cisco uBR7200 Series Universal Broadband Router Software Configuration Guide* that shipped with your Cisco uBR7200 series router for more information.

login

Use the steps in Table 5 to log in to the router and enter the required modes to start the configuration process.

Table 5 Login Steps

Step	Command	Purpose

1	`UBR1>` **`enable`**
	`Password: <password>`
	`UBR1#`
		Enter enable (privileged EXEC) mode.
		Enter the password.
		You have entered enable mode when the prompt changes to `UBR1#`.

2	`UBR1#` **`configure terminal`** `UBR1(config)#`	Enter global configuration mode. You have entered global configuration mode when the prompt changes to `UBR1(config)#`. This command can be abbreviated to **config term** or **config t**.
3	`UBR1(config)#` **`interface radio 3/0`** `UBR1(config-if)#`	Enter interface configuration mode for the specified modem card. In this example, the interface is the wireless modem card in slot 3, port 0.

Initial Configuration

Before configuring a wireless modem card, you need the following information:

- Number of antennas
- End of the communication link to be designated as “master”
- Transmit and receive frequencies
- IP address and subnet mask of the wireless modem card
- Transmit power
- IF cable loss between the wireless modem card and each wireless transverter (including loss in the power feed panel)

Configure the wireless interface in stages to ensure that each component is cabled correctly and that the hardware is functioning properly. These stages include:

- IF loopback
- RF loopback
- RF-to-RF link

Note IF loopback and RF loopback are optional, but recommended.

Following is an example of the running configuration for the “master” end of a 6-MHz high-throughput link with a single antenna. In these examples, UBR1 and UBR2 refer to the two Cisco uBR7200 series routers used at the ends of the radio link. The wireless modem cards are assumed to be in slot 6 of each of the routers. The reference to **radio 6/0** indicates that this interface occupies slot 6 and port 0.

The “slave” end of the link (UBR2) is configured in the same way except that the **radio master** command is omitted and the transmit and receive frequencies are reversed in the **radio operating-band** command.

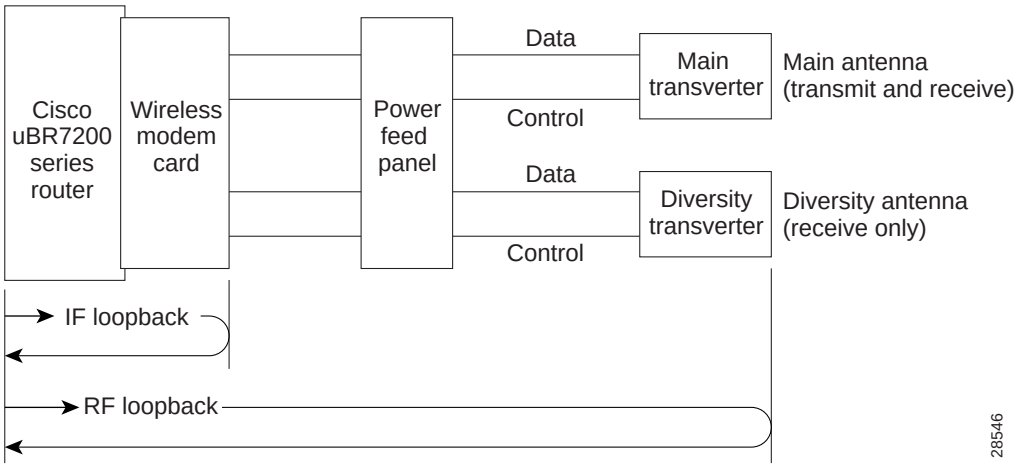
```
UBR1# show running-configuration interface radio 6/0

Current configuration:
!
interface Radio6/0
 ip address 10.0.0.1 255.255.255.0
 radio master
 radio receive-antennas 1
 radio operating-band tx 5733.00 rx 5781.00
 radio channel-setup bandwidth 6.0 throughput high
 radio transmit-power 15
end
```

IF Loopback

An IF loopback (see Figure 29) confirms that the hardware is seated properly in the chassis and that the wireless modem card is functioning as expected.

Figure 29 IF and RF Loopbacks



Use the following commands to execute an IF loopback. These commands will shut down the radio link and initiate the IF loopback.

```
UBR1(config-IF)# shut
UBR1(config-IF)# loopback local if
UBR1(config-IF)# no shut
```

The loopback should start and the Carrier and Out of Service LEDs on the wireless modem card should light. If so, proceed to the “RF Loopback” section.

If you reissue the **show running-configuration** command, you will see that dual antenna IF loopback has been selected. This is appropriate even if you are using a single antenna system.

If you are using two antennas and problems occur with the dual antenna command, reissue the command specifying **loopback local if main** or **loopback local if diversity** to help isolate the problem.

It may also be helpful to run a power-on self test (POST). The POST can be configured to run either once or every time the link is initiated. The following commands configure a self-test to run when the first **no shut** command is entered.

```
UBR1(config-if)# shut
UBR1(config-if)# radio self-test
UBR1(config-if)# no shut
```

If the POST fails, the wireless modem card may be faulty.

RF Loopback

An RF loopback (see Figure 29) confirms that the wiring to the transverter is correct, communication has been established, and the transverter appears to be operating correctly. (It does not test the duplexer, which is the final stage before the signal is sent to the antenna.) Because there is only one transmit path, the path to each transverter must be tested separately. Use the following commands:

```
UBR1(config-if)# shut
UBR1(config-if)# loopback local rf main
UBR1(config-if)# no shut
```

A loopback to the main transverter should start and the Carrier and Out of Service LEDs on the wireless modem card should light. If the loopback does not start (and the Carrier and Out of Service LEDs do not light), examine the data cable, the control cable, and the power supply for faults.

```
UBR1(config-if)# shut
UBR1(config-if)# loopback local rf diversity
UBR1(config-if)# no shut
```

A loopback to the diversity transverter should be initiated. If it does not start, examine the data cable, the control cable, and the power supply for faults.

If neither transverter operates properly, it is likely that there is a cabling, power-supply, or configuration problem. If one transverter fails, but the other transverter does not, try swapping the data and control cables to isolate the problem to either the transverter or the cables.

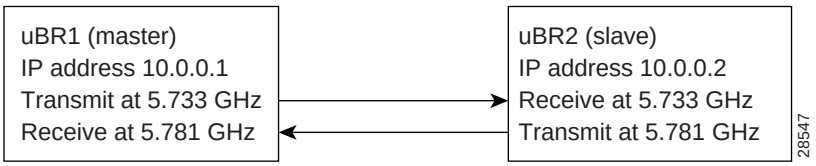
Be sure to remove any loopback commands used up to this point by entering the **no loopback** command.

RF-to-RF Link (Over the Air)

When both ends of the link have successfully performed RF loopbacks, the RF-to-RF link can be established. The following example represents the minimal configuration required to send a **ping** command over the radio link. Refer to other Cisco uBR7200 series documentation for information about specific traffic types.

This section gives an example of an RF-to-RF link operating at 6 MHz/high with the parameters specified in Figure 30. This example assumes that the IF cable-loss for uBR1 and uBR2 were determined to be 5 dB and 10 dB, respectively.

Figure 30 RF-to-RF Link Example



The configurations for both ends of the link are shown below.

uBR1 Configuration:

```
UBR1# show running-configuration interface radio 6/0

Current configuration:
!
interface radio6/0
 ip address 10.0.0.1 255.255.255.0
 radio master
 radio receive-antennas 1
 radio operating-band tx 5733.00 rx 5781.00
 radio channel-setup bandwidth 6.0 throughput high
 radio transmit-power 30
 radio cable-loss 1 5
end
```

uBR2 Configuration:

```
UBR2# show running-configuration interface radio 6/0

Current configuration:
!
interface radio6/0
 ip address 10.0.0.2 255.255.255.0
 radio receive-antennas 1
 radio operating-band tx 5781.00 rx 5733.00
 radio channel-setup bandwidth 6.0 throughput high
 radio transmit-power 30
 radio cable-loss 1 10
end
```

There are several important points to remember when configuring the RF-to-RF link:

- Only one end of the link must be the **master**. For this example, uBR1 represents the master.
- The **operating-band** transmit frequency on uBR1 must match the receive frequency on UBR2. If multiple wireless modem cards are used within the same Cisco uBR7200 series chassis or in the same location, refer to the *Cisco Broadband Fixed Wireless Site Planning Guide* for details on selecting the frequencies for multiple links.
- The **operating-band** transmit and receive frequencies must match those of the duplexer installed in the transverter.
- The **channel-setup** command must match on both ends of the link.
- The **transmit-power** level should be determined by referring to the *Cisco Broadband Fixed Wireless Site Planning Guide*. (In the previous example, the transmit power has been set to 30 dBm.)
- The **cable-loss** parameter should be determined by measuring the cable loss at the IF center frequency of 400 MHz. The system requires a combined 12 dB of loss from both the cabling and built-in attenuators. Setting the **cable-loss** parameter adjusts the built-in attenuators to keep the total loss at 12 dB. The default cable-loss value is set at 0 dB (short cables), meaning that all of the 12 dB of built-in attenuators are being used.

Caution If the maximum cable loss parameters are used with short cables, the transmit signal from the wireless modem card to the transverter can be too strong, resulting in damage to the transverter.

As the cable length increases, the cable loss increases. Your cable vendor's guide can help determine the expected loss per unit length (at 400 MHz), but Cisco recommends that you also measure accurately when installing the cabling to account for lightning suppression, connectors, and exact cable length.

The **antenna-alignment** command sends a voltage proportional to the received signal strength to the transverter. For example, to adjust the antenna on UBR1, first enter a **no shut** command on uBR2 to turn on the transmit signal. Then, enter the **antenna-alignment** command on uBR1 to make the adjustments.

```
UBR2(config-if)# no shut
```

This turns on the transmit signal from uBR2. The link does not need to come up.

```
UBR1(config-if)# shut
UBR1(config-if)# radio antenna-alignment
UBR1(config-if)# no shut
```

Attach a voltmeter to the test port on the transverter connected to uBR1. It will indicate a 0 to 5 volt signal. The larger the voltage, the better the alignment. By pointing the antenna in slightly different directions, the signal level will change. The largest signal expected is approximately 2.27 volts. Table 6 shows an example of some typical voltages for a range of receive signals.

Table 6 Example Receive Signals and Voltages

Rx Level (dBm)	DC Voltage (Volts
–26	2.27
–36	1.93
–46	1.51
–56	1.06
–66	0.69
–76	0.30

Use the same procedure to align the antenna(s) on uBR2.

The **antenna-alignment** command is only for installation and should not be used for normal operation. To cancel antenna alignment mode, use the following commands:

```
UBR1(config-if)# shut
UBR1(config-if)# no radio antenna-alignment
UBR1(config-if)# no shut

UBR2(config-if)# shut
UBR2(config-if)# no radio antenna-alignment
UBR2(config-if)# no shut
```

When the antennas are aligned and both ends of the link have initiated a **no shut** command, the link should be established.

To confirm that the link has been established, send a **ping** command to the other end of the link, using the following commands:

```
UBR1(config-if)# exit
UBR1(config)# exit
UBR1# ping 10.0.0.2

UBR2(config-if)# exit
UBR2(config)# exit
UBR2# ping 10.0.0.1
```

If the link is not established, double-inspect the duplexer and the cabling to the antenna itself. Check that the duplexers are installed with the correct orientation. It also might be necessary to adjust the **transmit-power**. If operating in a licensed band, use the power specified in your station license, or use the minimum transmitter power necessary for the desired communication. For non-line-of-site links over longer time periods, it may be necessary to adjust the transmit power over time (as permitted by your station license) if changes to the environment occur, such as a new skyscraper or a growing tree interfering with the link.

Command Reference

This section includes references to the commands mentioned in the previous examples and additional commands that can be used to configure, operate, and monitor the wireless link. The section is divided into subsections based on these tasks and includes the following:

- Syntax Conventions
- Startup Commands—Used to determine the status of the current configuration, and activate and de-activate the link:
  - **show interfaces radio**
  - **show running-configuration**
  - **show startup-configuration**
  - **shut, no shut**
  - **write**
- Installation and Configuration Commands—Used to set parameters and enter information regarding the broadband fixed wireless system:
  - **loopback**
  - **radio self-test**
  - **radio receive-antennas**
  - **radio master**
  - **radio channel-setup**
  - **radio operating-band**
  - **radio cable-loss**
  - **radio antenna-alignment**
  - **radio transmit-power**

- Operating Commands—Used during normal operation to configure baseline encryption, duplexer characteristics, LEDs, and Automatic Response Query (ARQ) settings:
  - **radio privacy**
  - **radio duplexor**
  - **radio led**
  - **radio arq**
  - **show interfaces radio (arq)**
- Monitoring the System—Used during operation to monitor the system's actions and set measurements of system statistics:
  - **radio metrics-threshold**
  - **radio threshold**
  - **show interfaces radio (thresholds)**
  - **show interfaces radio (link-metrics)**
  - **clear radio interface radio (link-metrics)**
- Troubleshooting—Used normally only by technical support personnel to manipulate microcode images and capture troubleshooting information:
  - **show controllers radio**
  - **radio histogram**
  - **radio byteErrorHist**
  - **show interfaces radio (histspec)**
  - **show interfaces radio (histdata)**
  - **debug radio**
  - **radio image-add**
  - **radio image-move**
  - **show interfaces radio (imagehdr)**
  - **show radio repository**
  - **radio snapshot**
  - **radio scope-output**
  - **radio timeline**
  - **show interfaces radio (tlspec)**
  - **show interfaces radio (tldata)**

Caution To save your configuration in case of power off or software reload, enter the **copy running-configuration startup-configuration** command at the `routername#` prompt both during and at the end of your configuration tasks.

Note To see a list of the configuration commands available to you, enter **?** at the prompt or type **help** while in configuration mode.

Syntax Conventions

The commands used in this section follow the conventions in Table 7.

Table 7 Syntax Conventions

Convention	Meaning	Comments
Boldface	Commands and keywords you enter literally as shown	**transmit-power**
Italics	Variables for which you supply values	**command** *type interface* You replace the variable with the type of interface.
Square brackets ([ ])	Optional elements	**command** [abc] abc is optional (not required), but you can choose it.
Vertical bars *(|)*	Separated alternative elements	**command** [abc | def] You can choose either abc or def, or neither, but not both.
Braces ({ })	Required choices	**command** {abc | def} You **must** use either abc **or** def, but not both.
Braces and vertical bars within square brackets ([{ | }])	A required choice within an optional element	**command** [abc {def | ghi}] You have three options: • Nothing • abc def • abc ghi
`System prompts`	Denotes interactive sessions, indicates that the user enters commands at the prompt	The system prompt indicates the current command mode. For example, the prompt `Router (config)#` indicates global configuration mode.
`Screen` **font**	Terminal sessions and information the system displays	
Angle brackets (<>)	Nonprinting characters such as passwords	
Exclamation points (!) at the beginning of a line	A comment line	Comments are sometimes displayed by the Cisco IOS software.

Startup Commands

Use these commands to determine the status of the current configuration, and to activate and deactivate the link:

- **show interfaces radio**—To display the protocol-specific details supported
- **show running-configuration**—To display the configuration currently in effect on the Cisco uBR7200 series router
- **show startup-configuration**—To display the system startup configuration
- **shut, no shut**—To shut down and reinstate the link
- **write**—To write the configuration currently being executed by the router to a specified device

show interfaces radio

Use this command in privileged EXEC mode to display the protocol-specific details supported by the specified interface. The **show interfaces** command is also the starting point to display interface-specific configurations such as thresholds and histograms.

show interfaces radio *slot number*/*port numbe*

Syntax Description

slot number	Positive integer representing the Cisco uBR7200 series slot number
port number	Positive integer representing the port number on that slot

Example

The following example shows the display received for a modem card located in slot 3, port 0:

```
UBR04# show interfaces radio 3/0

  Radio 3/0 is up, line protocol is up
  Hardware is CWRP2P
  Internet address is 192.168.168.233/24
  MTU 1500 bytes, BW 44419 Kbit, DLY 11000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive not set
  Last input 00:00:58, output 0:00:45, output hang never
  Last clearing of “show interface” counters never
  Queueing strategy: fifo
  Output queue 0/40, 7 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
    596 packets input, 197818 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    600 packets output, 198558 bytes, 0 underruns
    0 output errors, 0 collisions, 2 interface resets
    0 output buffer failures, 0 output buffers swapped out
    0 carrier transitions
```

show running-configuration
show startup-configuration

Use the **show running-configuration** command in privileged EXEC mode to display the configuration currently in effect on the Cisco uBR7200 series router. Use the **show startup-configuration** command in privileged EXEC mode to display the system startup configuration.

show {**running-configuration** | **startup-configuration**}

Example

The following example displays the configuration currently in effect on the Cisco uBR7200 series router:

```
UBR04# show running-configuration

Building configuration...

Current configuration:
!
version 12.0
service udp-small-servers
service tcp-small-servers
!
hostname UBR04
!
enable password 1234FCX
!
username tech07
!
interface FastEthernet0/0
 no ip address
 no ip route-cache
 shutdown
 media-type MII
!
ip name-server 192.168.168.1
ip name-server 192.168.168.181
ip name-server 192.168.168.178
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 password 1234FCX
 login local
!
interface BFWRadio3/0
 radio master
 radio channel-setup bandwidth 6.0 throughput medium
 radio transmit-power 22
 radio cable-loss 7
 radio event-threshold ......
 radio dsp-statistics .......
 radio codec-statistics ......
!
end
```

shut (shutdown and restart)

Use this command in interface configuration mode to shut down the radio link. Use the **no** version of the command to reinstate the radio link.

The state of the link is displayed on the console.

Caution When using telnet to control the far end of the link, use the **clear interface radio** *slot*/*port* command in privileged EXEC mode in place of the **shut**/**no shu**t command. The **clear interface** command will cause an automatic shutdown and restart.

shut
no shut

Example

The following command will shut down the radio link:

```
UBR04(config-if)# shut
```

write

Use this command in privileged EXEC mode to write the configuration currently being executed by the Cisco uBR7200 series router to a specified device.

write {**memory** | *network* | **terminal** | **erase**}

Syntax Description

memory	Configuration will be written to NV memory.
network	*remote-host configFileName*
remote-host	IP address of the host.
configFileName	The name of a file in which to save the configuration.
terminal	Configuration will be written to the terminal.
erase	Contents of NV memory will be erased.

Caution Do not enter the **write** command without designating a destination. If you enter the **write** command without designating a destination, the running configuration will be written by default to the startup configuration.

Example

The following example will write the current configuration information to the console:

```
UBR04# write terminal

Building configuration...

Current configuration:
!
version 11.1
service udp-small-servers
service tcp-small-servers
!
hostname WMCS01
!
enable password a23d56
!
username user220
!
interface FastEthernet0/0
 no ip address
 no ip route-cache
 shutdown
 media-type MII
!
ip name-server 192.168.168.1
ip name-server 192.168.168.181
ip name-server 192.168.168.178
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 password 123d56
 login local
!
interface BFWRadio3/0
 radio master
radio channel-setup bandwidth 6.0 throughput medium
 radio transmit-power 22
 radio cable-loss 7
 radio event-threshold ......
 radio dsp-statistics .......
 radio codec-statistics ......
!
end
```

Installation and Configuration Commands

These commands are used to set parameters and enter information regarding the broadband fixed wireless system. The commands include:

- **loopback**—To configure a specific module to loopback its data path at the specified subsystem
- **radio self-test**—To configure the wireless modem card to download and execute self-tests
- **radio receive-antennas**—To configure the number of receive antennas in use
- **radio master**—To configure the wireless modem card to operate as the master radio
- **radio channel-setup**—To adjust bandwidth and throughput to increase the reliability of the link

- **radio operating-band**—To specify the radio operating band and transmit/receive frequencies within that band
- **radio cable-loss**—To enter the effective IF cable loss
- **radio antenna-alignment**—To align the receive antenna with the transmitter
- **radio transmit-power**—To configure the antenna to transmit a specific amount of power

loopback

Use this command in interface configuration mode to configure the specified module to loopback its data path at the specified subsystem. If no optional parameters are specified, a local IF loopback is established.

Note While the loopback is in process, the Carrier and Out of Service LEDs will be lighted.

Use the **no** form of the command to remove the loopback specification.

Note If you perform a loopback of the RF module while the transverter is attached to an antenna, some transmit power will be radiated. If the transverter is not attached to an antenna, attach an RF termination device to the duplexer port. (For information regarding RF termination devices, refer to the *Cisco Broadband Fixed Wireless Site Planning Guide*.)

Use the **show interfaces radio** *slot*/*port* command to display the set of loopbacks currently in effect for the specified modem card.

loopback [**local** *module*]
no loopback [**local** *module*]

Syntax Description

module	{**codec** | **fir** | **if** [**diversity** | **dual** | **main**] | **rf** [**diversity** | **main**]}
slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.

Examples

The following example initiates a local RF loopback:

```
UBR04(config-if)# loopback local rf
```

The following example displays the set of loopbacks currently in effect for the modem card in slot 3, port 0 of the Cisco uBR7200 series router:

```
UBR04# show interfaces radio 3/0

Radio3/0 is up, line protocol is up (looped)
 Hardware is CWR P2P
 Internet address is 10.0.0.13/24
 MTU 1500 bytes, BW 44419 Kbit, DLY 11000 usec,
```

```
 reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback set
Keepalive set (10 sec)
Last input 00:00:01, output 00:00:01, output hang never
Last clearing of “show interface” counters never
Queueing strategy: fifo
Output queue 0/40, 8 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
  620 packets input, 203300 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
0 output errors, 0 collisions, 4 interface resets
0 output buffer failures, 0 output buffers swapped out
0 carrier transitions
```

radio self-test

Use this command in interface configuration mode to test the memory and hardware integrity of the wireless modem card. Use the **enable** option to execute self-tests each time the card is initiated (**no shut**). Use the command without the **enable** option to perform a self-test only on the first **no shut** after initiation. Each time the test is performed, results are displayed on the console.

Use the **no** version of the command to configure a restart of the link without executing self-tests.

Note Use the **show running-configuration interface radio** *slot*/*port* command to display the current setting.

radio self-test [**enable**]
no radio self-test

Syntax Description

enable	(Optional) causes execution of self-tests each time the card is initiated.

Example

The following example shows the configuration command to download and execute self-tests each time the modem card is enabled:

```
UBR04(config-if)# radio self-test enable
```

radio receive-antennas

Use this command in interface configuration mode to configure the wireless modem card to use a specified number of receive antennas. This command can be entered only when the radio link is down (**shut**), and will take effect when the link is again active (**no shut**). Use the **no** version of the command to set the number of receive antennas to 1 (the default value).

Note Before this command can take effect, the receive antennas and wireless transverters must be available.

Note Use the **show running-configuration interface radio** *slot*/*port* command to display the current setting.

radio receive-antennas {**1** | **2**}
no radio receive-antennas

Example

The following example configures the wireless modem card to use two receive antennas:

```
UBR04(config-if)# radio receive-antennas 2
```

radio master

Use this command in interface configuration mode to configure the wireless modem card to operate as the master radio. The master radio acts as the frequency source; the radio designated as the slave will track to the changes in the master's frequency. The default value is slave mode.

Note One end of the link (either end) must be designated as "master." Otherwise, unpredictable results can occur.

Use the **external clock-reference** option to specify that a 10-MHz external clock reference is being used. In slave mode, the default is automatically set to internal clock reference.

Note The attached external clock reference must be exactly 10 MHz for the link to function properly.

This command can be entered only when the radio link is down (**shut**), and will take effect only when the link is again active (**no shut**). Use the **no** version of the command to switch the modem card from master to slave mode.

Note The center frequency of both master and slave must be configured using the appropriate **operating band** and **channel parameters** commands.

Note Use the **show running-configuration interface radio** ***slot*/*port*** command to display the current setting.

radio master [external-clock-reference]
no radio master

Example

The following example configures the wireless modem card to operate as the master radio with internal clock reference:

```
UBR04(config-if)# radio master
```

radio channel-setup

Use this command in interface configuration mode to adjust bandwidth and throughput to increase the reliability of the link. For a selected bandwidth, data throughput can be reduced to increase reliability. This command can be entered at any time. If the link is up when it is entered, the command will take effect with the next **shut**/**no shut**. If the link is down when it is entered, the command will take effect with the next **no shut**.

Use the **no** version of the command to reset the parameters to the defaults (**bandwidth 6.0**, **throughput high, burstsize medium**).

Note Use the **show running-configuration interface radio** *slot number*/*port number* command to display the current setting.

radio channel-setup bandwidth *bw* **throughput** *dataThroughput* **burstsize** *BurstSize*

no radio channel-setup

Syntax Description

bw	{**6.0** | **12.0**}
dataThroughput	{**high** | **medium** | **low**}
high (default)	At 12 MHz, maximum 44.7 Mbps At 6 MHz, maximum 22.3 Mbps
medium	At 12 MHz, maximum 39.1 Mbps At 6 MHz, maximum 19.6 Mbps
low	At 12 MHz, maximum 22.4 Mbps At 6 MHz, maximum 11.2 Mbps
BurstSize	{**small** | **medium** | **large**}
small	Reduced burst size with increased burst frequency. Designed for specific uses.
medium (default**)**	Required by all U-NII transverters
large	Increased burst size with reduced burst frequency. Designed for specific uses.

SINR and Multipath Delay Spread

There are two fundamental limits to the performance of a digital radio link:

- Signal to Interference plus Noise Ratio (SINR)
- Multipath delay spread

SINR is the ratio of the received strength of the desired signal to the received strength of undesired signals (noise and interference). The SINR required for a link depends on the modulation being used, the amount of fading on the link, and the amount of error-correction coding used. Cisco point-to-point

broadband fixed wireless systems have two settings for the amount of error-correction coding. The SINR required for a link is reduced by 5 to 6 dB when the setting with the most error-correction coding is used (see Table 8 and Table 9).

Multipath delay spread occurs when the signal arrives at the receiver by multiple paths with differing path lengths. Signals that take longer paths will arrive later than signals that take shorter paths. The delay spread is the difference between the time it takes for the shortest path signal and the longest path signal to arrive. Typically, delay spread is the longest in urban areas with many buildings acting as reflectors. Delay spread is more important when the direct path between antennas is blocked, making the delayed signals stronger relative to the direct signal.

Both 6-MHz and 12-MHz bandwidths are available. For each of these bandwidths there are three possible throughput settings: **high**, **medium**, and **low**. The **low** setting uses the most error-correction coding and can handle the most multipath delay spread. The **medium** setting uses less error-correction coding, but can still handle the most multipath delay spread. The **high** setting uses less error-correction coding and can handle less multipath delay spread. Table 8 and Table 9 show that SINR tolerance is influenced by the error-correction coding, and multipath tolerance is influenced by the cyclic-prefix settings.

Table 8 12-MHz Bandwidth Values

Throughput Setting	High	Medium	Low
Payload throughput	44.6 Mbps	38.7 Mbps	22.1 Mbps
SINR (single antenna)			
AWGN channel	22 dB	22 dB	17 dB
Rayleigh fading channel	34 dB	34 dB	28 dB
SINR (dual antenna)			
AWGN channel	19 dB	19 dB	14 dB
Rayleigh fading channel	24 db	24 dB	18 dB
Multipath delay spread tolerance	2.4 µs	7.8 µs	7.8 µs
Error-correction coding	7/8-rate	7/8-rate	1/2-rate
Cyclic prefix setting	short	long	long

Table 9 6-MHz Bandwidth Values

Throughput Setting	High	Medium	Low
Payload throughput	22.0 Mbps	19.1 Mbps	10.9 Mbps
SINR (single antenna)			
AWGN channel	22 dB	22 dB	17 dB
Rayleigh fading channel	34 dB	34 dB	28 dB
SINR (dual antenna)			
AWGN channel	19 dB	19 dB	14 dB
Rayleigh fading channel	24 db	24 dB	18 dB
Multipath delay spread tolerance	1.5 µs	6.8 µs	6.8 µs

Table 9 6-MHz Bandwidth Values (continued)

Throughput Setting	High	Medium	Low
Error-correction coding	7/8-rate	7/8-rate	1/2-rate
Cyclic-prefix setting	short	long	long

Simplified Procedure to Choose Throughput Setting

These steps help determine the throughput setting by trying each setting and choosing the one that gives acceptable error performance:

Step 1 Initiate the link using the **low** throughput setting.

`UBR04(config-if) #` **radio channel-setup bandwidth 12.0 throughput low**

Step 2 Clear the link-metrics counters.

`UBR04 #` **clear radio interface radio** *slot/port* **link-metrics**

Step 3 Check the error performance of the link using the following link-metrics commands:

`UBR04 #` **show radio interface radio** *slot/port* **1second-metrics delta**

`UBR04 #` **show radio interface radio** *slot/port* **link-metrics**

Step 4 If the results of these commands show post-ARQ errors, or errored or severely errored seconds that exceed the requirements for the link, examine the antennas and cabling for faults, re-examine the link-planning calculations, and determine if more fading exists than had been expected. Use a spectrum analyzer or the histogram commands to examine the total automatic gain control gain (**totalGain**) and the constellation variance (**constVariance**).

Note To calculate an estimate for Received Signal Strength Indicator (RSSI), measure the **totalGain** of the antenna using the command:
`UBR04(config-if) #` **`radio histogram totalGain 1 0 4 5 collectionInterval 10 periodic 10 sum true`**.
This histogram reflects measurements for a single antenna system (main antenna). (Similar measurements can be performed on the diversity antenna by setting the *antenna_num* parameter to 2.) The start bin value is set to 0, the bin delta is set to 4, and the number of bins is set to 5.
To calculate the Average Received Signal Power, use the average **totalGain** value from the histogram in the following equation:
Average Received Signal Power = –96 + (average **TotalGain**)/2 dBm

For additional details on histogram commands, refer to the "radio histogram"section.

Step 5 If the link meets the required error thresholds, repeat steps 2 and 3 using the **medium** throughput setting. If the link does not meet the required thresholds using the **medium** setting, use the **low** setting for normal operation.

Step 6 If the link meets the required thresholds using the **medium** setting, repeat steps 2 and 3 using the **high** throughput setting. If the line does not meet the required thresholds using the **high** setting, use the **medium** setting for normal operations.

Step 7 If the link meets the required thresholds using the **high** setting, use the **high** setting for normal operations.

Expert Procedure to Choose Throughput Setting

These steps help determine the throughput setting by measuring the multipath delay spread and SINR, then choosing the appropriate throughput setting.

Step 1 Initiate the link using the **low** throughput setting.

```
UBR04(config-if) # radio channel-setup bandwidth 12.0 throughput low
```

Step 2 Measure the multipath delay spread of the channel by examining the channel impulse response using the **radio snapshot** command.

Step 3 Measure the SINR of the received signal by examining the constellation variance histogram using the **radio histogram** command.

Step 4 Using Table 8 and Table 9, choose the throughput setting that is appropriate for the measured multipath delay spread and SINR.

Step 5 Clear the link-metrics counters.

```
UBR04 # clear radio interface radio slot/port link-metrics
```

Step 6 Test the accuracy of the selected throughput setting by checking the error performance of the link.

```
UBR04 # show radio interface radio slot/port 1second-metrics delta
UBR04 # show radio interface radio slot/port link-metrics
```

radio operating-band

Use this command in interface configuration mode to specify the radio operating band and transmit/receive frequencies within the radio operating band. This command can be entered at any time. If the link is up when it is entered, the command will take effect with the next **shut**/**no shut**. If the link is down when it is entered, the command will take effect with the next **no shut**.

Use the **no** form of the command to reset the operating band to the default values.

Note Use the **show running-configuration interface radio *slot*/*port*** command to display the current setting.

radio operating-band Tx *transmit frequency* **Rx** *receive frequency*
no radio operating-band

Syntax Description

transmit frequency	Positive number in the range 5725.00 MHz to 5825.00 MHz
receive frequency	Positive number in the range 5725.00 MHz to 5825.00 MHz

Selecting the Transmit and Receive Frequencies

Use the **channel-setup** parameters to select the required bandwidth and data throughput prior to specifying the **operating-band**.

Transmit and receive frequencies must be consistent with the bandwidth the radio has been configured to operate in using the **channel-setup** command, and must fall within the passband of the duplexer used in the transverter. Table 10 provides center frequencies for the U-NII band. Transmit and receive frequencies must both be selected from one of the tables.

For a complete list of channel designations and start, center, and end frequencies, refer to the *Cisco Broadband Fixed Wireless Site Planning Guide*.

The transmit frequency on the radio designated as "master" must be identical to the receive frequency on the radio designated as "slave."

Note Although all the possible frequencies are listed in the tables, the actual list of frequencies available for use will be determined by the installed transverter and duplexer. Determine these capabilities and select appropriate transmit and receive frequencies.

Table 10 U-NII Band Center Frequencies (MHz)

6 MHz Bandwidth	12 MHz Bandwidth
5730.00	5733.00
5736.00	5745.00
5742.00	5757.00
5748.00	5769.00
5754.00	5781.00
5760.00	5793.00
5766.00	5805.00
5772.00	5817.00
5778.00	–
5784.00	–
5790.00	–
5796.00	–
5802.00	–
5808.00	–
5814.00	–
5820.00	–

Example

The following example sets center frequencies in the U-NII band:

```
UBR04(config-if)# radio operating-band Tx 5742.00 Rx 5790.00
```

radio cable-loss

Use this command in interface configuration mode to enter the effective cable loss (measured in dB at 400 MHz) of the cable between the wireless modem card and the specified wireless transverter, including the power feed panel, connectors, and lightning protection. Use the **no** version of the command to remove the setting.

Table 11 gives an example of estimated cable, connector, and equipment loss for a typical installation.

Table 11 Estimated Cable Loss Between Wireless Modem Card and Transverter

	Wireless Modem Card to Power Feed Panel	Power Feed Panel to Primary Lightning Suppression	Primary Lightning Suppression to Transverter
Cable length	4 feet	250 feet	50 feet
Cable type	RG-142	LMR-400	LMR-400
Loss per 100 feet	8 dB @ 400 MHz	2.7 dB @ 400 MHz	2.7 dB @ 400 MHz
Connectors	2	2	2
Loss per connector	.25 dB	.25 dB	.25 dB
Equipment loss	0.5 dB (power feed panel)	0.2 dB (Lightning suppression)	—
Loss per segment	1.32 dB	7.45 dB	1.85 dB
Total Loss = 10.62 dB			

Note The cable loss parameter cannot be set to a value greater than 12 dB. The exact cable loss value is determined by the transverter. The system checks against that value when a **no shut** command is entered.

Note Use the **show running-configuration interface radio** *slot number*/*port number* command to display the current setting.

radio cable-loss *antenna_num positive number*
no radio cable-loss

Syntax Description

antenna_num	Enter 1 (main antenna) or 2 (diversity antenna).
positive number	Positive number (less than or equal to 12 dB), reflecting effective cable loss.

Example

The following example adjusts the effective cable loss parameter for antenna 1 to 12 dB:

```
UBR04(config-if)# radio cable-loss 1 12
```

radio antenna-alignment

Use this command in interface configuration mode to align the receive antenna to the transmitter. After the next **no shut**, a separate voltage is sent to the alignment port located on each wireless transverter in the link, which can be read with a DC voltmeter. If the transmitter has been enabled, the meter should detect voltage changes when moving the antenna. A larger voltage represents a better receive signal.

Use the **no** version of the command to cancel antenna alignment mode.

Note Use the **show running-configuration interface** *slot*/*port* command to display the current setting.

radio antenna-alignment
no antenna-alignment

Note Do not use this command during normal operation; its use will degrade the performance of the radio link.

Example

The following example initiates antenna alignment mode during installation:

```
UBR04(config-if)# radio antenna-alignment
```

radio transmit-power

Use this command in interface configuration mode to configure the transverter to transmit the specified amount of power (in dBm) when in operation. Use the **no** version of the command to remove the setting.

Note Maximum transmission power is limited by the capabilities of the transverter. In addition, your country's telecommunications authority (the FCC in the United States) regulates the maximum power or the EIRP or both. It is the responsibility of the installer and operator to comply with the relevant regulations.

Note In order to have the maximum number of users in an area, keep the power as low as possible while maintaining sufficient margin and performance. Refer to the *Cisco Broadband Fixed Wireless Site Planning Guide* for additional information.

Note Use the **show running-configuration interface radio** *slot*/*port* command to display the current setting.

radio transmit-power *power*
no radio transmit-power

Syntax Description

power	Positive number representing power stated in dBm. Transmit power range for U-NII is between 4 and 24 dBm.

Example

The following example sets the U-NII transmit power to +20 dBm:

```
UBR04(config-if)# radio transmit-power 20
```

Operating Commands

These commands are used during the normal operation of the broadband fixed wireless system to configure baseline encryption, duplexer characteristics, LEDs and Automatic Repeat Query (ARQ). The commands include:

- **radio privacy**—To configure the baseline encryption options provided by the wireless modem card
- **radio duplexor**—To enter duplexer characteristics
- **radio led**—To manually highlight specific conditions displayed on the LEDs on the front panel of the wireless modem card
- **radio arq**—To configure the ARQ mechanism on the wireless modem card
- **show interfaces radio (arq)**—To display the current ARQ configuration

radio privacy

Use the options of this command in interface configuration mode to configure the baseline encryption options provided by the wireless modem card. The radio designated as “master” controls privacy authorization and encryption key distribution. The radio designated as “slave” tracks the master radio’s signals. The default setting is off (privacy not enabled).

Use the **enable** option to enable baseline privacy options at each end of the link. Use the other options to configure timeout values. When privacy is enabled, the timeout values determine how long the master or the slave radio will wait for either authentication or encryption keys to be revalidated. If this revalidation fails, meaningful communication between master and slave radios will not be possible.

Note Using baseline privacy has no effect on throughput and only a negligible effect on latency.

Use the **no** form of the command to turn privacy options off.

Use the **show running-configuration** command to view the current settings.

Note These parameters can only be changed when the radio link is down (**shut**), and will not take effect until the next **no shut** command is entered.

radio privacy {**enable** | **auth-wait-time** *secs* | **reauth-wait-time** *secs* | **auth-grace-time** *secs* | **op-wait-time** *secs* | **rekey-wait-time** *secs* | **tek-grace-time** *secs* | **auth-lifetime** *secs* | **tek-lifetime** *secs*}

no radio privacy

Syntax Description

auth-wait-time	The number of seconds the slave radio will wait before issuing a new authorization request to the master radio.
reauth-wait-time	The number of seconds the slave radio will wait before issuing a new reauthorization request to the master.
auth-grace-time	Grace time for an authorization key. The slave radio is expected to start trying to get a new authorization key beginning auth-grace-time seconds before the authorization key actually expires.
op-wait-time	Operational wait timeout.
rekey-wait-time	The amount of time (in seconds) that the slave radio waits before issuing a new request to the master radio for an encryption key.
tek-grace-time	Grace time for a traffic encryption key (TEK). The slave radio is expected to start trying to get a new TEK beginning tek-grace-time seconds before the traffic encryption key actually expires.
auth-lifetime	The lifetime (in seconds) the master radio assigns to an authorization key for the slave radio.
tek-lifetime	The lifetime (in seconds) assigned to traffic encryption keys by the master radio.

Example

The following command will configure baseline privacy:

```
UBR04(config-if)# radio privacy enable
```

radio duplexor

The duplexer is a mechanical device that acts as a band pass filter when installed in the wireless transverter. This filter restricts the transverter to operate in a specified part of the frequency spectrum. One duplexer provides a high- and low-frequency specification for one wireless transverter.

Use this command in interface configuration mode to enter duplexer specifications.

Note This command should be entered each time the frequency specifications are changed.

radio duplexor *antenna_num PartNum LoPassbandRange HiPassbandRange RxPassband* [low-passband | hi-passband] *CLEIcode VendorName SerialNumber*

Syntax Description

antenna_num	Enter 1 (main antenna) or 2 (diversity antenna). Identifies the antenna to which the duplexer is connected.
PartNum	A string representing the duplexer's part number
LoPassbandRange	Identifies the duplexer's low frequency range. This range is lower than the range specified in the HiPassbandRange parameter.
HiPassbandRange	Identifies the duplexer's high frequency range. This range is higher than the range specified in the LoPassbandRange parameter.
RxPassband	Identifies the frequency range used to receive transmissions.
CLEIcode	Common Language Equipment Identifier code.
VendorName	The name of the vendor of the duplexer.
SerialNumber	Serial number of the duplexer.

radio led

There are three categories of LEDs: alarm, user-controlled, and other LEDs. The two alarm LEDs will normally remain illuminated only for the duration of the alarm. However, this condition can be overridden using the **latch** form of the command. This command causes the LEDs to remain illuminated until the LED is cleared by using the **latch** form of the command again.

The led-service LED can only be controlled by entering an LED command. All the LEDs can be forced to illuminate or blink under operator control. This can be used as a "lamp test" to verify that the hardware is functional or to remotely indicate a specific wireless modem card to be examined.

Use this command in interface configuration mode to manually highlight specific conditions on a specified wireless modem card using the five LEDs on the card. Use the **no** form of the command to reset the settings of the LED to the default values—where the system controls the behavior of the LEDs at all times.

Use the **show interfaces radio** *slot*/*port* form of the command to display the current configuration and the state of the LEDs.

radio led {*latchLeds latchLedOptions* | *otherLeds otherLedOptions*}
no radio led *latchLeds*

show interfaces radio *slot*/*port* **led**

Syntax Description

latchLeds	{**led-major-alarm** | **led-minor-alarm**}
led-major-alarm	Indicates the occurrence of a major alarm in the radio subsystem. Unless the default mode is overridden, the LED will remain illuminated for the duration of the alarm.

led-minor-alarm	Indicates the occurrence of a minor alarm in the radio subsystem. Unless the default mode is overridden, the LED will remain illuminated for the duration of the alarm.
latchLedOptions	{**latch** | **off** | **green** | **yellow** | **blinkGreen** | **blinkYellow** | **blinkBoth**}
latch	The system will turn the LED on indicating an alarm condition; the operator must turn it off by entering the **radio led** *latchLeds* **latch** command. **Note** The **latch** option is available only for **led-major-alarm** and **led-minor-alarm**.
off	This forces the LED to turn off, and remain off under all conditions.
green	Lamp test for the LED. The LED turns green and remains green under all conditions.
yellow	Lamp test for the LED. The LED turns yellow and remains yellow under all conditions.
blinkGreen	Blinks the LED green.
blinkYellow	Blinks the LED yellow.
blinkBoth	Blinks the LED alternately yellow and green.
otherLeds	{**led-carrier** | **led-service** | **led-ok**}
led-carrier	Represents the state of the radio link. This LED cannot be latched, but the operator can turn these LEDs on or off manually.
led-service	Indicates the service availability on this radio link. This LED cannot be latched, but the operator can turn these LEDs on or off manually. This LED is operator-controlled only.
led-ok	Indicates that the wireless modem card is on, receiving from the router midplane, and enabled for operation. This LED remains on during normal operation of the router.
otherLedOptions	{**off** | **green** | **yellow** | **blinkGreen** | **blinkYellow** | **blinkBoth**}

Example

The following command sets the behavior of the major alarm LED to be controlled by the system at all times:

```
UBR04(config-if)# no radio led led-major-alarm
```

radio arq (automatic repeat query)

Use these commands in interface configuration mode to configure the Automatic Repeat Query mechanism on the wireless modem card. With ARQ, the transmitter resends data that is received in error at the receiver. This allows the radio link to run at a substantially lower error rate in RF channels with rapid fading or bursty interference.

Enabling requires a small amount of additional overhead and increases the latency of the link. However, even with small maximum latency and maximum overhead settings, enabling ARQ can dramatically improve link performance.

Latency values should be related to the bandwidth and throughput settings for **channel-setup**. Refer to Table 12.

Table 12 Minimum Latency Values for Bandwidth and Throughput (ARQ on) (Bandwidth Percentage Set to 12.5%)

Bandwidth	Throughput	Minimum Latency
6 MHz	Low	11 ms
6 MHz	Medium	7 ms
6 MHz	High	7 ms
12 MHz	Low	7 ms
12 MHz	Medium	6 ms
12 MHz	High	5 ms

Note The by default latency value for **arq on** is 11 ms, which can be used for all combinations of bandwidth and throughput.

Note When ARQ is **off**, the latency value will be 2 ms for each direction of the link.

Use the **no** form of the command to reset the current ARQ settings to the default values (ARQ **on**, 11-ms latency).

Use the **on/off option** to turn on or off the ARQ feature on the link.

Use the **reset option** to reset the current ARQ values to consistent settings based on the channel-parameter configuration.

Note If ARQ is turned off, it may be difficult to establish the radio link in adverse environments.

Note These parameters can only be changed when the radio link is down (**shut**), and will not take effect until the next **no shut** command is entered.

radio arq {*pctBw dataLatency* [*BurstSize*]} | {**on** | **off** | **reset**}
no radio arq

Syntax Description

pctBw — Positive number representing the highest percentage of the link bandwidth to be used for the ARQ mechanism. The value may be 1 to 5000, representing 0.01 to 50 percent of the available bandwidth. The default value is 1250.

Note Regardless of the *pctBw* setting, link bandwidth is only consumed by ARQ when tdata errors need to be corrected.

dataLatency — Positive number specifying the expected latency value for normal data. Latency values are measured in milliseconds. The default value is 11 ms.

BurstSize — Positive number specifying the maximum number of consecutive ARQ codewords that will be transmitted. Smaller values result in lower jitter. The default value is 8.

Example

The following command sets the ARQ mechanism for 0.01% of the bandwidth, a 10-millisecond data latency value, and 24 consecutive ARQ codewords:

```
UBR04(config-if)# radio arq 1 10 24
```

show interfaces radio (arq)

Use this command in privileged EXEC mode to display the current ARQ configuration on the wireless modem card.

show interfaces radio *slot*/*port* **arq**

Syntax Description

slot — Positive integer representing the Cisco uBR7200 series slot number.

port — Positive integer representing the port number on that slot.

Display Elements

pctBW	The maximum percent link bandwidth being used for ARQ.
voiceLatency	Hardware will restrict the maximum latency for voice data to this value.
dataLatency	Hardware will restrict the maximum latency for packet data to this value.
BurstSize	Currently configured burst size, in number of codewords.
OnOff	Whether ARQ is turned on or off.

ARQPeakBitRate	The maximum possible peak bit rate that the link can handle based on the current channel-parameter and ARQ settings.
ARQMinBitRate	The minimum bit rate that may be seen on the link based on the current channel-parameter and ARQ settings.
ARQMaxLatencyJitter	The maximum jitter expected on this link based on the current configuration.

Example

The following command will display the ARQ configuration for the modem card in slot 3, port 0:

```
UBR04# show interfaces radio 3/0 arq

ARQ State = on
Data Latency = 20 ms
Voice Latency = 20 ms
Maximum ARQ Bandwidth Overhead = 12.50%
Typical Bit Rate = 10845152 bits/sec
Minimum Bit Rate = 9488600 bits/sec
Burst Size = 16 codewords
Maximum Latency Jitter = 2679 usec
```

Monitoring the System

These commands are used during operation to monitor the system's actions and set up measurements of system statistics. They are not required for operation. The commands include:

- **radio metrics-threshold**—To measure how well the radio link is performing over time
- **radio threshold**—To configure a threshold event specification
- **show interfaces radio (thresholds)**—To display the set of currently configured thresholds
- **show interfaces radio (link-metrics)**—To display performance metrics of the radio link
- **clear radio interface radio (link-metrics)**—To clear configured metrics

radio metrics-threshold

Use this command in interface configuration mode to set threshold values for the radio link to measure how well the radio link is performing over time. When the radio link is synchronized, the measurement parameters used are error-free seconds (EFS), errored seconds (ES), severely errored seconds (SES), consecutively errored seconds (CSES), degraded seconds (DS), and degraded minutes (DM).

All link metrics are measured in terms of codewords. A codeword is a unit (228 bytes) of data transmission over the radio link. It contains user data, error counts and collation information so that successive codewords may be reconstructed at the receiving end into the transmitted data.

Note This command must be used with care; arbitrary changes will distort the performance metrics reported for the radio link.

Use the **radio metrics-threshold code-word** command to configure thresholds that determine when a second is classified as ES, DS, SES, or CSES.

Use the **radio metrics-threshold 1hour** command to configure limits on the ES, SES, CSES, and Degraded Minutes DM. When these limits are exceeded in a 1-hour period, alarms will be generated to notify the user. Minor alarms are generated and displayed on the console when the specified 1-hour threshold is exceeded.

Use the **radio metrics-threshold 24hour** command to configure limits on the ES, SES, CSES, and DM. When these limits are exceeded in a 24-hour period, alarms will be generated to notify the user. Minor alarms are generated and displayed on the console when the specified 24-hour threshold is exceeded.

Use the **no** version of the commands to force the thresholds back to the default values.

Use the **show interfaces** version of the command to display the currently configured threshold settings.

radio metrics-threshold code-word *ESThresh DSThresh SESThresh CSESThresh*
radio metrics-threshold 24hour *ESLimit SESLimit CSESLimit DMLimit*
radio metrics-threshold 1hour *ESLimit SESLimit CSESLimit DMLimit*

no radio metrics-threshold {**code-word** | **24hour** | **1hour**}

show interfaces radio *slot/port* **metrics-threshold**

Syntax Description

ESThresh	Specifies the number of codeword errors that must be detected within a 1-second interval for that second to be treated as an errored second. Typically, ESThresh = 1.
DSThresh	If the number of codeword errors detected within 1 second is greater than or equal to this threshold and less than SESThresh, that second is treated as a degraded second.
SESThresh	If the number of codeword errors detected within a 1-second interval is greater than or equal to this threshold, that second is treated as a severely errored second.
CSESThresh	Specifies the number of consecutive severely errored seconds that must be detected for the sequence to be treated as one consecutively severely errored second.
ESLimit	Specifies the number of errored seconds that should be detected within the specified time period (1 operational hour or 24 operational hours), after which the ESLimit minor alarm will be generated.
SESLimit	Specifies the number of codeword severely errored seconds that should be detected within the specified time period (1 operational hour or 24 operational hours), after which the SESLimit minor alarm will be generated.
CSESLimit	Specifies the number of codeword consecutively severely errored seconds that should be detected within the specified time period (1 operational hour or 24 operational hours), after which the CSESLimit minor alarm will be generated.
DMLimit	Specifies the number of codeword degraded minutes that should be detected within the specified period (1 operational hour or 24 operational hours), after which the DMLimit minor error alarm will be generated.

Example

The following example will configure the link so that:

- If more than 3 codeword errors are detected in a given second, that second will be treated as an errored second.
- If the number of errors detected in one second is between 30 and 150, that second will be flagged as a degraded second.
- If more than 150 errors are detected in one second, that second will be flagged as a severely errored second.
- If more than 4 severely errored seconds are detected in sequence, that sequence is flagged as 1 consecutively severely errored second.

```
UBR04(config-if)# radio metrics-threshold code-word 3 30 150 4
```

The following example will configure the link alarms so that:

- If the link has 24 errored seconds in one hour, an alarm will be generated.
- If the link was severely errored more than 1 percent of the time in one hour, an alarm will be generated.
- If the link had more than 12 consecutive severely errored second events in one hour, an alarm will be generated.
- If the link had more than 5 degraded minutes, an alarm will be generated.

```
UBR04(config-if)# radio metrics-threshold 1hour 24 36 12 5
```

radio threshold

Use this command in interface configuration mode to configure a threshold event specification. When the specified threshold is crossed, an event of type *threshParam eventType* will be generated and the event logged to the console.

Only one threshold can be defined for each of the identified *threshParam threshType* [**dsp** *dspId*] combination. When a threshold is crossed, the *threshParam threshType* [**dsp** *dspId*] combination identifies the threshold specification that caused the event.

For every threshold defined, antennaNum is conditional. Antenna number is applicable for the *threshParam* attributes **in**, *receivedPower*, *gainSettingsIf*, *gainSettingsRF*, and *totalGain*.

Note If an antenna number is used when a threshold is created, it must also be specified when it is deleted.

Use the **no** version of the command to terminate the event-threshold setup. The **no radio threshold** command requires the *threshParam*, *threshType*, and [**dsp** *dspId*] attributes.

For each event, the *threshParam* [**dsp** *dspId*] *threshType eventType* will be output identifying the threshold crossed.

radio threshold *threshParam antennaNum* [**dsp** *dspId*] *threshType threshValue* **repeatTime clearTime**

no radio threshold *threshParam antennaNum* [**dsp** *dspId*] *threshType*

Selecting the Correct Data

In most cases, the default DSP should provide acceptable results. Table 13 outlines for which DSPs the statistical parameters are most meaningful.

Table 13 Statistical Parameters and Meaningful DSPs

Statistical Parameter	Antenna-Specific Parameter	Data Meaningful on DSP (12 MHz)	Data Meaningful on DSP (6 MHz)
Received Power	Yes	rx3b	rx2b
Gain Settings IF	Yes	rx3b	rx2b
Gain Settings RF	Yes	rx3b	rx2b
Total Gain	Yes	rx3b	rx2b
Interference + Noise	Dual Antenna Required	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Interference + Noise Ratio	Dual Antenna Required	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Constellation Variance	No	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Sync Status	No	rx3b	rx2b
Timing Offset	No	rx3b	rx2b
Frequency Offset	No	rx3b	rx2b

Note When changing from 12 MHz to 6 MHz mode, the DSP on which the parameter is defined may no longer be valid. If so, redefine the threshold on a DSP where the parameter is meaningful.

Syntax Description

threshParam {**in** | **inr** | *constVariance* | *timingOffset* | *freqOffset* | *syncStatus* | *receivedPower* | *gainSettingsIF* | *gainSettingsRF* | *totalGain*}

in (Interference + Noise) The interference plus noise power levels are computed by the hardware on a burst-by-burst basis.

Note This parameter is available for a dual antenna system only.

inr (Interference + Noise Ratio) The ratio of the interference plus noise power levels captured by the first antenna to the second antenna on a burst-by-burst basis. This value is specified as a log to base 2 number.

constVariance (Constellation Variance) The average energy of the constellation error signal – the error between the received (noisy) constellation symbol and the nearest ideal constellation symbol. Constellation Variance is a measure of the Signal to Interference plus Noise ratio (SINR) for that tone. On a single antenna system, it represents $(SINR)^{-1}$. On a dual antenna system, it represents a composite value providing $(SINR)^{-1}$ after antenna combining.

timingOffset Represents the timing delay variations detected in the radio link.

freqOffset	Represents the carrier frequency offset between the slave radio and the master radio.
syncStatus	Represents the synchronization status.
receivedPower	A measure of the analog signal power received by the radio system on a burst-by-burst basis.
gainSettingsIF	Represents the IF attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the intermediate frequency (IF) module.
gainSettingsRF	Represents the RF attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the radio frequency (RF) modules.
totalGain	Represents the total attenuation commanded by the automatic gain control loop. This can be captured for each antenna.
antennaNum	Enter either 1 (main antenna) or 2 (diversity antenna).
dspId	{**dsprx1a** (Receive DSP 1a) | **dsprx1b** (Receive DSP 1b) | **dsprx2a** (Receive DSP 2a) | **dsprx2b** (Receive DSP2b) | **dsprx3a** (Receive DSP 3a) | **dsprx3b** (Receive DSP 3b)}
threshType	{**highThreshold** | **lowThreshold** | **upChange** | **downChange** | **posCrossing** | **negCrossing**}
highThreshold	The upper limit for the *threshParam* being monitored.
lowThreshold	The lower limit for the *threshParam* being monitored.
upChange	The positive change limit allowed for the *threshParam* being monitored.
downChange	The negative change limit allowed for the *threshParam* being monitored.
posCrossing	The limit that applies only when the *threshParam* is increasing in value.
negCrossing	The limit that applies only when the *threshParam* is decreasing in value.
threshValue	A 32-bit integral value
repeatTime	When radio signals are monitored, they can oscillate across a specified threshold (such as highThreshold) very rapidly. In such a case, an event is generated for each crossing of the threshold, which could flood the system. The repeatTime parameter specifies the amount of time (in seconds) the system should wait, in this case, before another event of the same type is generated.
clearTime	When radio signals oscillate across a threshold, it is often desirable to identify when the signal has stabilized. The clearTime parameter specifies how many seconds the radio signal must stay below a threshold (after crossing it once) before the system generates the clear event.

Example

The following command sequence will set up a threshold for totalGain. When the totalGain for the system on antenna2 falls below 70, the eventSet event type will be generated.

```
UBR04(config-if)# radio threshold totalGain 2 lowThreshold 70
```

show interfaces radio (thresholds)

Use this command in privileged EXEC mode to display the set of currently configured thresholds on the modem card on the specified digital signal processor (DSP). If *dspNum* is not specified, the thresholds for DSP 3 will be displayed.

show interfaces radio *slot*/*port* **thresholds** [*dspNum*]

Syntax Description

slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.
dspNum	The DSP number.

Example

The following command will display the set of currently configured thresholds for the modem card in slot 6, port 0 for the Receive DSP 1b:

```
UBR04# show interfaces radio 6/0 thresholds dsp dsprx1b

Threshold Attributein
Threshold TypedownChange
Antenna Id2
Threshold Value200
Threshold Repeat Time5
Threshold Clear Time8
Threshold DSP Numberdsprx1b
Index2
Default Thresholdfalse
```

show interfaces radio (link-metrics)

Use this command in privileged EXEC mode to display the parameters measured during the operation (and in some cases, nonoperation) of the radio link. These metrics provide a quantitative measure of how well the radio link is performing over time.

There are two classes of link metrics:

- Metrics that quantify how the link performed since the system was powered on:

show interface radio *slot*/*port* **link-metrics**

- Metrics that quantify how the link performed while the two ends of the link were synchronized:

show interface radio *slot*/*port* **24hour-metrics**
(details for the last 32 days)
show interface radio *slot*/*port* **radio 1hour-metrics** *1Hr_options*

(details for the last 24 hours)
show interface radio *slot*/*port* **radio 1minute-metrics** *1min_options*
(details for the last 60 minutes)
show interface radio *slot*/*port* **radio 1second-metrics** *1sec_options*
(details for the last 60 seconds)
show interface radio *slot*/*port* **radio 1tick-metrics** *1tick_options*
(details for the last *n* hardware ticks)

Four categories of metrics are maintained by the radio link's software and hardware:

Category 1—Cumulative metrics where only one set is maintained for the entire collection period. **LinkMetrics** fall under this category.

Category 2—Cumulative metrics where a table of values is maintained, providing metrics relating to the time period when the two ends of the link are synchronized. **24hour-metrics**, **1hour-metrics**, and **1minute-metrics** fall into this category.

Category 3—Cumulative metrics where a table of values is maintained, providing metrics maintained by the hardware to derive the information in categories 2 and 3. **1second-metrics** fall into this category.

Category 4—Noncumulative. A table of instantaneous values are maintained. They provide metrics that the hardware maintains to derive the information in category 3. **1tick-metrics** fall into this category.

Syntax Description

slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.
1Hr_options	[{all | G.821}] [latest_entries] [delta]
All	Show all details.
G.821	Show G.821 (ES) metrics
latest-entries	Number of latest entries to show (1 to 60, depending on the command).
delta	Values displayed are differences between successive measurements.
1sec_options	[{all | Error-metrics | RR-metrics}] [latest-entries] [delta]
Error-metrics	Show listing of pre-ARQ and post-ARQ codeword errors.
RR-metrics	Show statistics of repeat requests.
1tick_options	[{all | Error-metrics | RR-metrics}] [latest-entries]

Display Elements

When *linkMetrics* are requested, the following values are displayed:

Availability of the Physical Link

Link available for:	Represents AvailableSeconds—Number of seconds (while the link was up) during which the link was available for data transmission (Error Free Seconds + Errored Seconds – Severely Errored Seconds).
Link unavailable for:	Represents UnAvailableSeconds—Number of seconds (while the link was up) during which the link was not available for data transmission (Severely Errored Seconds + SyncLossSeconds).
Link availability percent:	Represents the ratio of the AvailableSeconds to the seconds the link was up, stated as a percentage.
Link was not synchronized for:	Represents SyncLossSeconds—Number of seconds (while the link was up) that were spent with the link out of synchronization.
Time since last successful synchronization:	Represents the elapsed time since the radio link successfully synchronized with the remote end.
Time since last synchronization failure:	Represents the elapsed time since the radio lost synchronization with the remote end.

Error Characteristics of the Physical Link

Percent error free seconds:	Represents the ratio of cumulative Codeword Error Free Seconds (EFS) to the seconds the link was up, stated as a percentage.
Percent errored seconds:	Represents the ratio of cumulative Codeword Errored Seconds (CES) to the seconds the link was up, stated as a percentage.
Percent severely errored seconds:	Represents the ratio of cumulative Codeword Severely Errored Seconds (SES) to the seconds the link was up, stated as a percentage.
Percent degraded minutes:	Represents the ratio of Codeword Degraded Minutes (DM) to the seconds the link was up, stated as a percentage.

Synchronization Event Counters

Synchronization success count:	Represents the SyncSuccessCount—Number of successful synchronization attempts.

Synchronization failure count:	Represents the SyncFailureCount—Number of failed synchronization attempts.
Synchronization loss count:	Represents the number of times the radio link was synchronized, but lost synchronization with the remote end without intervention.
Managed synchronization loss count:	Represents ManagedSyncLoss—Number of synchronization losses initiated by the operator or the network (IP layer) during the seconds the link was up.

Synchronization Recovery Counters

High effort resynchronization count:	Represents the SyncLossCount (high effort)—Number of times that the high-effort resynchronization procedure was performed.
Medium effort resynchronization count:	Represents the SyncLossCount (medium effort)—Number of times that the medium-effort resynchronization procedure was performed.
Low effort resynchronization count:	Represents the SyncLossCount (low effort)—Number of times that the low-effort resynchronization procedure was performed.

Physical Link Data Rates

Effective rate:	Represents the effective data throughput while the link was synchronized. For a given bandwidth and throughput selection, it represents the data throughput being achieved. **Note** If ARQ is turned on, or there are errors due to propagation conditions, this number may be less than the expected total throughput.
Percent efficiency:	Represents the ratio of total good codewords received to the total number of codewords received, stated as a percentage.

Example

The following command will display the link metrics for the wireless modem card in slot 6, port 0 of the Cisco uBR7200 series router:

```
UBR04# show interfaces radio 6/0 link-metrics

Link Metrics since the router was reloaded:

Availability of the physical link:
Link available for: 00:25:11
Link unavailable for: 00:00:15
Link availability percent: 99.2
Link was not synchronized for: 00:00:14
Time since last successful synchronization: 00:25:12
```

```
Time since last synchronization failure: 00:25:14

Error characteristics of the physical link:
Percent error free seconds: 99.2
Percent error free seconds: 0.7
Percent severely errored seconds: 0.7
Percent degraded minutes: 0.0

Synchronization event counters:
Synchronization success count: 1
Synchronization failure count: 0
Synchronization loss count: 0
Managed Synchronization loss count : 0

Physical link data rates:
Effective rate: 44230307
Percent efficiency: 100.0
```

When *24hour-metrics* are requested, a table of values for the preceding 32 days is displayed. Values are cumulative—every successive row is the sum of the corresponding values in the previous row plus the values determined for the 24-hour period represented by that row. The following values are displayed:

Days Ago	Represents how long ago (in days) the data was captured.
Time	Represents the time at which the entry was updated.
EFS	Represents Codeword Error Free Seconds detected in the last 24 operational hours. A Codeword EFS is 1 second when the radio was synchronized and no ARQ codeword errors were detected on the link.
ES	Represents the Codeword Errored Seconds detected in the last 24 operational hours. A Codeword ES is 1 second when the radio link was synchronized and 1 or more ARQ codeword errors were detected on the link.
SES	Represents the Codeword Severely Errored Seconds detected in the last 24 operational hours. A Codeword SES is 1 second when the radio link was synchronized and the number of ARQ codeword errors detected was greater than a configured threshold.
CSES	Represents the Codeword Consecutively Severely Errored Seconds detected in the last 24 operational hours. This measures the number of times a sequence of Codeword SES crosses a configured threshold value. The counter is incremented by 1 for each occurrence.
DM	Represents the Codeword Degraded Minutes detected in the last 24 operational hours. It is equal to 60 Codeword Degraded Seconds.

Example

The following command will display the 24-hour link metrics for the wireless modem card in slot 6, port 0 of the Cisco uBR7200 series router:

```
UBR04(config-if)# show interfaces radio 6/0 24hour-metrics

Day statistics (cumulative). Captured at 12:33:01 UTC Tue May 25 1999
=====|=========|==========|==========|==========|==========|==========|
 Days|   Time  |    EFS   |    ES    |    SES   |   CSES   |    DM    |
 Ago |         |          |          |          |          |          |
=====|=========|==========|==========|==========|==========|==========|
   0   16:00:23      57599          1          1          0          0
```

When *1hour-metrics* are requested, a table of values for the last 24 hours are displayed. Values are cumulative—every successive row is the sum of the corresponding values in the previous row plus the values determined for the 1-hour period represented by that row.

Note If the **delta** option is specified, the values displayed represent the differences between the previous row and the current row.

The following values are displayed:

Hour Ago	Represents how long ago (in hours) this entry was captured.
Time	Represents the time this entry was updated.
EFS	Represents Codeword Error Free Seconds detected in the last 1 operational hour. A Codeword EFS is 1 second when the radio was synchronized and no ARQ codeword errors were detected on the link.
ES	Represents the Codeword Errored Seconds detected in the last 1 operational hour. A Codeword ES is 1 second when the radio link was synchronized and 1 or more ARQ codeword errors were detected on the link.
SES	Represents the Codeword Severely Errored Seconds detected in the last 1 operational hour. A Codeword SES is 1 second when the radio link was synchronized and the number of ARQ codeword errors detected was greater than a configured threshold.
CSES	Represents the Codeword Consecutively Severely Errored Seconds detected in the last 1 operational hour. This measures the number of times a sequence of Codeword SES crosses a configured threshold value. The counter is incremented by 1 for each occurrence.
DM	Represents the Codeword Degraded Minutes detected in the last 1 operational hour. It is equal to 60 Codeword Degraded Seconds.
Pre ARQ Errored Codewords	Represents the pre-ARQ errored codewords detected in the last 1 hour. This is the number of Reed-Solomon codeword errors indicated by the codec to the ARQ.

Post ARQ Errored Codewords	Represents the post-ARQ errored codewords detected in the last 1 hour. This is the number of codewords not passed to the protocol control information (PCI) physical layer by the ARQ because they remained uncorrected even after ARQ.
Total Codewords	Represents the total number of codewords received on this link in the last 1 hour.

Example

The following command will display the 1-hour link metrics for the wireless modem card in slot 6, port 0 of the Cisco uBR7200 series router:

```
UBR04(config-if)# show interfaces radio 6/0 1hour-metrics

One hour statistics (cumulative). Captured at 12:33:01 UTC Tue May 25 1999
=====|=========|==========|==========|==========|==========|==========|
 Hour|   Time  |    EFS   |    ES    |    SES   |   CSES   |    DM    |
 Ago |         |          |          |          |          |          |
=====|=========|==========|==========|==========|==========|==========|
   1   16:00:23      57599          1          1          0          0


=========|==========|==================|
 Pre ARQ | Post ARQ |        Total     |
 Cwd Err | Cwe Err  |      Codewords   |
=========|==========|==================|
        1          0          1506296619
```

When *1minute-metrics* are requested, a table of values for the last 60 minutes are displayed. Values are cumulative—every successive row is the sum of the corresponding values in the previous row plus the values determined for the 1-minute period represented by that row. The values displayed are identical to those displayed for *1hour-metrics*, except that the period is 1 minute.

When *1second-metrics* is requested, a table of values for the last 60 seconds is displayed. Values are cumulative—every successive row is the sum of the corresponding values in the previous row plus the values determined for the 1-second period represented by that row.

Note If the **delta** option is specified, the values displayed represent the differences between the previous row and the current row.

The following values are displayed:

Sec Ago	Represents how long ago (in seconds) this entry was captured.
Total Codewords	Represents the total number of codewords received on this link in the last 1 second.
Pre ARQ Codeword Errors	Represents the pre-ARQ errored codewords detected in the last 1 second. This is the number of Reed-Solomon codeword errors indicated by the codec to the ARQ.

Post ARQ Codeword Errors	Represents the post-ARQ errored codewords detected in the last 1 second. This is the number of codewords not passed to the PCI physical layer by the ARQ because they remained uncorrected even after ARQ.
Post ARQ Good Codewords	Represents the sum of the total number of codewords received by this radio link in the last 1 second.
Consecutive Codeword Errors	Represents the site of the largest grouping of pre-ARQ codeword errors received over the last 1 second.
Repeat Request Count	Represents the number of unique repeat requests that enter a “pending repeat request” list.
Repeat Request Event Count	Represents the number of Retransmit Requests (RR) that were serviced during the last second. A serviced RR is one that is drawn from the “pending RR list” and requested by the remote end.
Transmit ARQ Count	Represents the number of unique ARQs that were received by the transmit side of the local end during the last second. This provides an indication of how error-free the transmissions of the local end are being received by the remote end.
Transmit ARQ Event Count	Represents the number of ARQs that were drawn from the pending ARQs list and serviced during the last second. A serviced ARQ results in a retransmitted codeword.
Corrected Sync Byte Errors	Represents the number of sync byte errors that were seen by the Viterbi decoder in the codec but were corrected by the Reed-Solomon decoder over the last 1 second.

Example

The following command will display the 1-second link metrics for the wireless modem card in slot 6, port 0 of the Cisco uBR7200 series router. It will display the error metrics for the last three entries.

```
UBR04(config-if)# show interfaces radio 6/0 1second-metrics error-metrics 3

One second statistics (cumulative). Captured at 13:08:14 UTC Tue May 25 1999
=====|==================|==========|==========|====================|==========|
 Sec |      Total       | Pre ARQ  | Post ARQ |       Post ARQ     |  Consec  |
 Ago |    Codewords     | Cwd Err  | Cwd Err  |    Good Codewords  |  Cw Errs |
=====|==================|==========|==========|====================|==========|
   2          1506296820          49         49           1506296663          0
   1          1506321176          49         49           1506321019          0
   0          1506321176          49         49           1506321019          0
```

When *1tick-metrics* are requested, a table of values for the last *n* hardware ticks are displayed. Values are cumulative—every successive row is the sum of the corresponding values in the previous row plus the values determined for the *n*-tick period represented by that row. The values displayed are identical to those of *1second-metrics* except that the period is 1 hardware tick.

clear radio interface radio link-metrics

Use this command in privileged EXEC mode to clear all physical layer metrics associated with the radio interface.

clear radio interface radio *slot*/*port* **link-metrics**

Note To keep physical layer and protocol layer statistics consistent, Cisco recommends that a **clear interface radio** *slot*/*port* command be entered to also clear the protocol layer statistics.

Syntax Description

slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.

Example

The following command clears all radio link-metrics details:

```
UBR04 # clear radio interface radio 6/0 link-metrics
```

Troubleshooting

These commands normally are used only by technical support personnel to gain the information needed to troubleshoot a system:

- **show controllers radio**—To display attributes of a wireless modem card
- **radio histogram**—To configure a histogram collection specification
- **radio byteErrorHist**—To set the histogram collection interval for uncorrected codewords
- **show interfaces radio (histspec)**—To display the details of the histogram specifications
- **show interfaces radio (histdata)**—To display the collected histogram data
- **debug radio**—To set debug commands and display current debug settings
- **radio image-add**—To add a specified image to the image repository
- **radio image-move**—To move a specified image to the beginning of the repository list
- **show interfaces radio (imagehdr)**—To display details of the images to be downloaded
- **show radio repository**—To display the protocol-specific list of images in the repository
- **radio snapshot**—To capture a specified amount of data from the wireless modem card
- **radio scope-output**—To configure a DSP to send an identified type of output to the serial port for analysis
- **radio timeline**—To collect a sequence of data values for a specified attribute
- **show interfaces radio (tlspec)**—To display timeline specifications
- **show interfaces radio (tldata)**—To display timeline data

show controllers radio

Use this command in privileged EXEC mode to display all or a subset of attributes of a particular modem card. If none of the options are specified, all the hardware subsystem(s) information will be displayed. Actual output parameters depend on the hardware and implementation.

show controllers radio *slot number*/*port number* [{**if** | **rf** | **fir** | **codec** | **dsp** | **arq** | **pci** | **phy** | **driver**}]

Syntax Description

slot number	Positive integer representing the Cisco uBR7200 series slot number.
port number	Positive integer representing the port number on that slot.

Note Entering the command **show controllers** *slot*/*port* **rf** will display electrically erasable programmable read-only memory (EEPROM) values and report if the wireless transverter is not detected.

Example

The following example shows the output received when the **pci** option is specified for the modem card in slot number 3, port number 0.

```
UBR04# show controllers radio 3/0 pci

Interface Radio 3/0
Hardware is CWRP2P
 throttled 0 enabled 0 disabled 0
 Rx: spurious 0 framing_err 0 no_buffer 0, pause_no_err_ints 0
     no_enqueue 0 no_stp 0 no_enp 0
 Tx: full 0 drop 0
 rx ring entries 32 tx ring entries 128
 Rx ring 0x4B05A0C0 shadow 0x61399C60 head 2
 Normal Latency Tx ring 0x4B05A680 shadow 0x6139A1C0 head 0 tail 0 count 0
 Low Latency Tx ring 0x4B05A220 shadow 0x61399D50 head 3 tail 3 count 0

PCI Configuration Registers
    Device/Vendor IDs - 0x00141137
    Command/Status    - 0x02000086
    Latency Timer     - 0x0000FF00
    Base Address 0    - 0x4E000000
Max Lat - 0x000001FF

PCI Interface FPGA
    dmac_control               - 0x00440002
    dmac_status                - 0x00004000
    dmac_int_status            - 0x99800001
    dmac_int_enable            - 0x66710FF8
    dmac_tx0_ring_base         - 0x4B05A220
    dmac_tx1_ring_base         - 0x4B05A680
    dmac_rx_ring_base          - 0x4B05A0C0
    dmac_configuration         - 0x66040303
    local_bus_error_status     - 0x00000000
    local_bus_error_address    - 0x010C0000
    local_bus_reset            - 0x00000000
    fpga_configuration_control - 0x00000000
    fpga_configuration_status  - 0x000000FF
```

radio histogram

A histogram is a collection of statistics sampled over time on a burst-by-burst basis and presented as a function of bins. The number of bins and the size of bins are user defined.

Use this command in interface configuration mode to configure a histogram collection specification. The data for the histogram is collected as soon as the command succeeds and continues until either the specification is deleted using the **no** option, or the specified *collectionInterval* expires. The collected data is printed out to the console at user-specified intervals.

A histogram statistic is created when data is sampled for every burst. For each sampled burst, the count in a specific bin is incremented. The number of bins in the histogram is specified by the NumBins parameter.

For every histogram defined, *antenna_num* and *tone* are conditional. The *antenna_num* is required for the attributes **in**, **receivedPower**, **GainSettingsIF**, **gainSettingsRF**, and **totalGain**. **Tone** may optionally be specified for the attributes **in**, **inr**, and **constVariance**.

Use the **no** version of this command to delete any histogram configuration specification.

Use the **histdisplay** format of this command to control the printing of the information to the screen.

Use the **histclear** format of this command to clear the collected histogram data.

radio histogram *statParam antenna_num* [**dsp** *dspId*] *StartBinValue BinDelta NumBins BitShift* [**collectionInterval** *interval*] [**periodic** *interval* **sum** {**true** | **false**}] [**tone circulate** | **average** | **number** *tone-number*]

no radio histogram *statParam antenna_num* [**dsp** *dspId*]

radio histdisplay *statParam antenna_num* [**dsp** *dspId*] {**on** | **off**}

radio interface *slot*/*port* **histclear** *statParam antenna_num* [**dsp** *dspId*]

Note There should be no measurable impact or degradation of router performance from running histograms. Cisco recommends, however, that the number of histograms run simultaneously be kept to a minimum, and that any histograms no longer needed be terminated.

Note Up to 1024 32-bit words are available for all histogram parameters on a single DSP. Each histogram requires (NumBins + 4) * 2 words. The attributes in **in**, **inr**, and **constVariance** can be captured on any DSP, while the others can be captured only on certain DSPs. Distributing histogram requests across DSPs provides better memory utilization. In general, it is best not to specify the DSPs without special knowledge of the system.

Selecting the Correct DSP

In most cases, the default DSP should provide acceptable results. Table 14 outlines for which DSPs the statistical parameters are most meaningful.

Table 14 Statistical Parameters and Meaningful DSPs

Statistical Parameter	Antenna-Specific Parameter	Data Meaningful on DSP (12 MHz)	Data Meaningful on DSP (6 MHz)
Received Power	Yes	rx3b	rx2b
Gain Settings IF	Yes	rx3b	rx2b
Gain Settings RF	Yes	rx3b	rx2b
Total Gain	Yes	rx3b	rx2b
Interference + Noise	Dual Antenna Required	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Interference + Noise Ratio	Dual Antenna Required	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Constellation Variance	No	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Sync Status	No	rx3b	rx2b
Timing Offset	No	rx3b	rx2b
Frequency Offset	No	rx3b	rx2b

Note When changing from 12 MHz to 6 MHz mode, the DSP on which the parameter is defined may no longer be valid. If so, redefine the histogram on a DSP where the parameter is meaningful.

Syntax Description

statParam {**in** | **inr** | **constVariance** | **timingOffset** | **freqOffset** | **syncStatus** | **receivedPower** | **gainSettingsIF** | **gainSettingsRF** | **totalGain**}

The radio attribute whose data is to be collected as a histogram.

in (Interference + Noise) The interference plus noise power levels are computed by the hardware on a burst-by-burst basis.

inr (Interference + Noise Ratio) The ratio of the interference plus noise power levels captured by the first antenna to the second antenna on a burst-by-burst basis. This value is specified as a log to base 2 number.

Note This parameter is available for a dual antenna system only.

constVariance (Constellation Variance) The average energy of the constellation error signal—the error between the received (noisy) constellation symbol and the nearest ideal constellation symbol. Constellation Variance is a measure of the Signal to Interference plus Noise ratio (SINR) for that tone. On a single antenna system, it is proportional to $(SINR)^{-1}$. On a dual antenna system, it represents a composite value that is proportional to $(SINR)^{-1}$.

timingOffset	Represents the timing delay variations detected in the radio link.
freqOffset	Represents the carrier frequency offset between the slave radio and the master radio.
syncStatus	Represents the synchronization status.
receivedPower	A measure of the analog signal power received by the radio system on a burst-by-burst basis.
gainSettingsIF	Represents the IF attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the intermediate frequency (IF) module.
gainSettingsRF	Represents the RF attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the radio frequency (RF) module.
totalGain	Represents the total attenuation commanded by the automatic gain control loop. This can be captured for each antenna.
antenna_num	Enter 1 (main antenna) or 2 (diversity antenna).
dspId	{**dsprx1a** (Receive DSP 1a) | **dsprx1b** (Receive DSP 1b) | **dsprx2a** (Receive DSP 2a) | **dsprx2b** (Receive DSP2b) | **dsprx3a** (Receive DSP 3a) | **dsprx3b** (Receive DSP 3b)}
StartBinValue	Any value below this value will not be stored in the histogram. Range is -2^{31} to 2^{32-1}.
BinDelta	The "width" of each histogram bin. For example, if the StartBinValue is 10 and BinDelta is 64, then all values in the range 10 to 74 will be in the first bin. All values from 75 to 138 will be in the second bin, and so on. Range is 2 to 2^32, and must be a power of 2.
NumBins	The number of histogram bins to be configured for the collection. Range is 0 to 508.
BitShift	Specifies the number of bits by which the collected data should be shifted to the right, providing a mechanism to control overflow of the values in the histogram. Range is 0 to 31.
collectionInterval	Specifies, in seconds, the interval in which histogram data will be collected.
periodic	Specifies, in seconds, how often the collected histogram data should be printed to the screen. The **sum** option specifies whether successive histogram sets retrieved from the hardware should be added to replace the existing histogram data. Specifying a statistic collection to be periodic effectively reduces the size of the NumBins to half the possible amounts. The default is periodic. If the interval is 0, output is generated only at the termination of the collection.

tone	Identifies how the histogram sample should be computed when sampling a burst. A burst contains data samples from N frequency tones.
circulate	Implies successive histogram data samples should use successive frequency tones.
average	Implies successive histogram samples should average the burst data over all the frequencies and use that value.
number	Specifies that a particular tone in the burst should be used to report the histogram data. The frequency tone is passed in as a number specified in the *tone-number* parameter.

Example

The following example will configure a histogram specification. The histogram collection will start as soon as the command succeeds. It will collect a histogram for interference noise ratio. The histogram will be collected with starting bin of 2^{-4} (a starting ratio of 0.0625), bindelta of 1, 32 bins in total, and no bitshift. It will average the results on all frequency tones for each sample. The collection will continue for 1 hour, reporting data every 30 seconds and keeping the cumulative histogram.

```
UBR04(config-if)# radio histogram inr -4 1 32 0 collectionInterval 3600 periodic 30 tone
average sum true
```

radio byteErrorHist

Use this command in interface configuration mode to specify the collection interval for the histogram for uncorrected codewords, as well as how often the collected histogram data should be printed to the display screen.

Use the **no** version of this command to delete the specification.

radio byteErrorHist [**collectionInterval** *interval*] [**periodic** *interval sum* {*true* | *false*}]

no radio byteErrorHist [**collectionInterval** *interval*] [**periodic** *interval sum* {*true* | *false*}]

Syntax Description

collectionInterval	Specifies, in seconds, the duration of histogram data collection.
periodic	Specifies, in seconds, how often the collected histogram data will be printed to the screen. The **sum** option specifies whether successive histogram sets retrieved from the hardware should be added to replace the existing histogram data. Use an interval of 0 to print the data to the screen only at termination of the collection.

Example

The following example will configure a collection interval of 1 hour and print to the screen every 30 seconds:

```
UBR04(config-if)# radio byteErrorHist collectionInterval 3600 periodic 30 sum false
```

show interfaces radio (histspec)

Use this command in privileged EXEC mode to display the details of the histogram specifications currently configured. If none of the optional parameters are specified, all histogram specifications on the modem card are displayed.

show interfaces radio *slot*/*port* **histspec** [*statParam antenna_num* [**dsp** *dspnum*]]

Syntax Description

slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.
statParam	{**in** | **inr** | **constVariance** | **timingOffset** | **freqOffset** | **syncStatus** | **receivedPower** | **gainSettingsIF** | **gainSettingsRF** | **totalGain**} The radio attribute whose data is to be collected as a histogram. **Note** If the *statParam* is specified, *antenna_num* is conditionally required.
in	(Interference + Noise) The interference plus noise power levels are computed by the hardware on a burst-by-burst basis.
inr	(Interference + Noise Ratio) The ratio of the interference plus noise power levels captured by the first antenna to the second antenna on a burst-by-burst basis. This value is specified as a log to base 2 number. **Note** This parameter is available for a dual antenna system only.
constVariance	(Constellation Variance) The average energy of the constellation error signal—the error between the received (noisy) constellation symbol and the nearest ideal constellation symbol. Constellation Variance is a measure of the Signal to Interference plus Noise ratio (SINR) for that tone. On a single antenna system, it represents $(SINR)^{-1}$. On a dual antenna system, it represents a composite value providing $(SINR)^{-1}$.
timingOffset	Represents the time delay variations detected in the radio link.
freqOffset	Represents the carrier frequency offset between the slave radio and the master radio.
syncStatus	Represents the synchronization status.

receivedPower A measure of the analog signal power received by the radio system on a burst-by-burst basis.

gainSettingsIF Represents the IF attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the intermediate frequency (IF) module.

gainSettingsRF Represents the RF attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the radio frequency (RF) module.

totalGain Represents the total attenuation commanded by the automatic gain control loop. This can be captured for each antenna.

antenna_num Enter 1 (main antenna) or 2 (diversity antenna).

Note For every histogram defined, antenna_num is conditional. The *antenna_num* is required for attributes **in**, **receivedPower**, **GainSettingsIF**, **gainSettingsRF**, and **totalGain**.

dspnum The DSP number.

Note If the DSP number is not specified, the specification on the default DSP will be displayed.

Example

The following example shows details of the histogram Constellation Variance specification configured for the modem card in slot 3, port 0 of the uBR:

```
UBR04# show interfaces radio 3/0 histspec constVariance

ClassconstVariance
Start Bin Value0
Bin Delta4
Number of Bins100
Update Rate10
Collection duration20
Bit Shift0
Tone Selectionaverage
Dsp Numberdsrx1a
Index9
Periodic Sumfalse
Default Histfalse
Display statuson
Histogram Statuscaptured
```

show interfaces radio (histdata)

Use this command in privileged EXEC mode to display the collected histogram data for the identified histogram specification. The values are displayed as a *BinID:Value* pair. BinId represents the sample value contained in that bin. Value represents the count in the histogram bin.

show interfaces radio *slot*/*port* **histdata** *statparam antenna_num* **dsp** *dspnum*

Syntax Description

slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.
statParam	{**in** | **inr** | **constVariance** | **timingOffset** | **freqOffset** | **syncStatus** | **receivedPower** | **gainSettingsIF** | **gainSettingsRF** | **totalGain** | **codewordError**} The radio attribute whose data is to be collected as a histogram. **Note** If <statParam> is specified, antenna_num is conditionally required.
in	(Interference + Noise) The interference plus noise power levels are computed by the hardware on a burst-by-burst basis.
inr	(Interference + Noise Ratio) The ratio of the interference plus noise power levels captured by the first antenna to the second antenna on a burst-by-burst basis. This value is specified as a log to base 2 number. **Note** This parameter is available for a dual antenna system only.
constVariance	(Constellation Variance) The average energy of the constellation error signal —the error between the received (noisy) constellation symbol and the nearest ideal constellation symbol. Constellation Variance is a measure of the Signal to Interference + Noise ratio (SINR) for that tone. On a single antenna system, it represents $(SINR)^{-1}$. On a dual antenna system, it represents a composite value providing $(SINR)^{-1}$.
timingOffset	Represents the timing delay variations detected in the radio link.
freqOffset	Represents the carrier frequency offset between the slave radio and the master radio.
syncStatus	Represents the synchronization status.
receivedPower	A measure of the analog signal power received by the radio system on a burst-by-burst basis.
gainSettingsIF	Represents the intermediate frequency (IF) attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the IF module.

gainSettingsRF Represents the radio frequency (RF) attenuation value commanded by the automatic gain control loop. This can be captured for each antenna and for the RF module.

totalGain Represents the total attenuation commanded by the automatic gain control loop. This can be captured for each antenna.

antenna_num Enter 1 (main antenna) or 2 (diversity antenna).

Note For every threshold defined, *antenna_num* is conditional. The attributes **in**, **receivedPower**, **GainSettingsIF**, **gainSettingsRF**, and **totalGain** are applicable for *antenna_num*.

dspnum The DSP number.

Note If the DSP number is not specified, the specification on the default DSP will be displayed.

Example

The following example shows the command to display the histogram data for the histogram configured on the modem card in slot 6, port 0 of the uBR for receive DSP 1a.

```
UBR04# show interfaces radio 6/0 histdata inr dsp dsprx1a

Histogram 4/1/8 [*=100] min=-2 avg=0
157         0=<0     **
137         0=<1     **
115         1=<2     **
44          2=<MAX   *
```

Reading the Data

Some data returned by the DSPs can be more useful if you convert it to more meaningful values. Table 15 provides conversion formulas.

Table 15 Value Conversions

Parameter	Units Reported (X)	Units	Conversion Formula
receivedPower 1	DSP Receive Signal Strength	Same	Same
totalGain 1	0.5 dB	dB	X/2
gainSettingIF 1	0.5 dB	dB	X/2
gainSettingRF 1	$2^{(-16)}$ dB	dB	$X/2^{16}$
constVariance	$86016/(10^{(0.1*SNRdb)})$	SNR in dB	10 * log10(86016/X)
freqOffset	$11.71875/2^{16}$ kHz	kHz	X/5592.4
syncStatus	No units	Same	Same
timingOffset	In samples	Same	Same
receivedPower 2	DSP Receive Signal Strength	Same	Same

Table 15 Value Conversions (continued)

Parameter	Units Reported (X)	Units	Conversion Formula
totalGain 2	0.5 dB	dB	X/2
gainSettingIF 2	0.5 dB	dB	X/2
gainSettingRF 2	$2^{(-16)}$ dB	dB	$X/2^{16}$
in 1	SINR = $10*\log10(x/2^{16}) + 9$	SINR in dB	$10 * \log10(2^{16}/X) + 9$
in 2	SINR = $10*\log10(x/2^{16}) + 9$	SINR in dB	$10 * \log10(2^{16}/X) + 9$
inr	log2 (Ratio)	In ratio in dB	$10 * \log10(2^{x})$
byteErrors	Number of errors	Same	Same

debug radio

Use the command **debug radio ?** to display a list of all available debug commands.

Use the **no** version of the command to stop the process.

Use the **show debug** command to display the current debug settings.

debug radio {**lm_log** | **messages** | **phy**}
no debug radio

show debug

Syntax Description

lm_log	**log [verbose]**
phy	{**radioLog** | **cwrLog**}
radioLog	**radio** *slot*/*port subModule*
slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.
subModule	{**cli** | **gal** | **snmp**} *logLevel*
cli	Tracing for radio interface CLI commands.
gal	Tracing for the gate-array logic (GAL) module.
snmp	Tracing for the radio Simple Network Management Protocol (SNMP) module.
logLevel	Acceptable values are: {all | controlFlow | dataFlow | validation | verbose}
cwrLog	**cwrLog** *modName*
modName	Name of the module

Debug commands are divided into four general categories: Link Manager Logging, Link Management Messages, Physical Layer Messages, and Radio Interface Specific Logging. Each of these is described below.

Link Manager Logging

This command controls the debugging of the Link Manager and Baseline Privacy Interface:

`UBR04(config-if)#` **debug radio log** [**verbose**]

When this command is enabled, the following events can be reported:

```
CWRP2P_LOG_BPKM_INVALID_CODE_IN_BPKM_MSG
CWRP2P_LOG_BPKM_REPLY_MSG_RCVD
CWRP2P_LOG_BPKM_REQUEST_MSG_RCVD
CWRP2P_LOG_BPKM_REPLY_MSG_SENT
CWRP2P_LOG_BPKM_REQUEST_MSG_SENT
CWRP2P_LOG_DRIER_RESET
CWRP2P_LOG_STATE_CHANGE
CWRP2P_LOG_UNKNOWN_TIMER
CWRP2P_LOG_WATCHDOG_TIMER
CWRP2P_LOG_PRVACY_TIMER
CWRP2P_LOG_PRIVACY_ERROR_CODE
CWRP2P_LOG_ENCRYPION_NOT_ENABLED
CWRP2P_LOG_ENCRYPTION_IS_NOT_AVAILABLE
CWRP2P_LOG_PRIVACY_ESTABLISHED
CWRP2P_LOG_PRIVACY_SYNC_LOST
CWRP2P_LOG_PRIVACY_CANT_GEN_RSA_KEYS
CWRP2P_LOG_PRIVACY_CANT_DECRYPT_AUTH_KEY
CWRP2P_LOG_PRIVACY_CANT_ENCRYPT_AUTH_KEY
CWRP2P_LOG_RADIO_PHY_UP
CWRP2P_LOG_RADIO_PHY_DOWN
CWRP2P_LOG_RADIO_PHY_SYNC_LOST
CWRP2P_LOG_UNKNOWN_RADIO_PHY_LM_MSG_ID
CWRP2P_LOG_UNKNOWN_QUEUE_EVENT
CWRP2P_LOG_UNKNOWN_BOOLEAN_EVENT
CWRP2P_LOG_UNKNOWN_SCHEDULER_EVENT
CWRP2P_LOG_BAD_LM_MSG_LENGTH
CWRP2P_LOG_UNKNOWN_MSG_RCVD
CWRP2P_LOG_UNEXPECTED_MSG_RCVD
CWRP2P_LOG_PRIVACY_PROCESS_ALREADY_RUNNING
CWRP2P_LOG_CANT_START_PRIVACY_PROCESS
```

```
CWRP2P_LOG_BPKM_COPY_FAILED
CWRP2P_LOG_NO_MEMORY
CWRP2P_LOG_PRIVACY_UNKNOWN_RX_QUEUE_EVENT
CWRP2P_LOG_PRIVACY_UNKNOWN_BOOLEAN_EVENT
CWRP2P_LOG_PRIVACY_UNKNOWN_MAJOR_EVENT
CWRP2P_LOG_PRIVACY_PROCESS_EXITING
CWRP2P_LOG_PRIVACY_BAD_PACKET_LENGTH
CWRP2P_LOG_PRIVACY_BAD_MSG_ID
CWRP2P_LOG_PRIVACY_BAD_MESSAGE_CODE
CWRP2P_LOG_PRIVACY_KEY_SEQUENCE ERROR
CWRP2P_LOG_PRIVACY_REAUTH_REQUEST
CWRP2P_LOG_PRIVACY_FSM_BAD_STATE_EVENT
CWRP2P_LOG_PRIVACY_FSM_NO_TRANSITION
CWRP2P_LOG_PRIVACY_KEK_FSM_EVENT
CWRP2P_LOG_PRIVACY_KEK_FSM_STATE
CWRP2P_LOG_PRIVACY_TEK_FSM_EVENT
CWRP2P_LOG_PRIVACY_TEK_FSM_STATE
CWRP2P_LOG_PRIVACY_MESSAGE_FAILED_VERIFICATION
CWRP2P_LOG_PRIVACY_BAD_ATTRIBUTE_LENGTH
CWRP2P_LOG_PRIVACY_UNABLE_TO_GET_PAK_BUFFER
CWRP2P_LOG_PRIVACY_UNEXPECTED_ATTRIBUTE
CWRP2P_LOG_PRIVACY_INSTALLED_KEY
CWRP2P_LOG_PRIVACY_REMOVED_KEY
CWRP2P_LOG_PRIVACY_INVALIDATED_KEYS
CWRP2P_LOG_DRIVER_IDB_RESET
CWRP2P_LOG_UNKNOWN_TIMER_EVENT
CWRP2P_LOG_RESET_PRIVACY_WATCHDOG_DRIVER
CWRP2P_LOG_RESET_NO_MEMORY
CWRP2P_LOG_RESET_CANT_START_PROCESS
CWRP2P_LOG_RESET_FROM_DRIVER
CWRP2P_LOG_RESET_OPERATIONAL_WATCHDOG_DRIVER
CWRP2P_LOG_SEND_RADIO_UP_COMMAND_FAILED
CWRP2P_LOG_SEND_RADIO_DOWN_COMMAND_FAILED
CWRP2P_LOG_SEND_RADIO_UP_NOTIFY_FAILED
CWRP2P_LOG_SEND_RADIO_DOWN_NOTIFY_FAILED
CWRP2P_LOG_CANT_FIND_RADIO_PHY_QUEUE
CWRP2P_LOG_CANT_FIND_CARD_STRUCT
```

Link Management Messages

This command causes the contents of the Link Management and BPI messages to be dumped in a formatted fashion as they are transmitted or received.

Note The meanings of these fields are documented in the Data Over Cable System Interface Specification (DOCSIS) standards.

`UBR04(config-if)#` **debug radio messages**

Following is an example of the results:

```
00:01:35:    Message type (0x0C): BPKM-REQ msgLEN: 133
00:01:35         BPKM Code (0x04): Auth Request Identifier: 0x00 Length: 129
00:01:35           Attribute Type (0x04): RSA-Public-Key Length: 126
00:01:35:                307C 300D 0609 2A86  4886 F70D 0101 0105
00:01:35:                0003 6B00 3068 0261  00B1 5407 9843 23EA
00:01:35:                74A9 3E26 07C7 686D  BCA0 94ED E388 14C3
00:01:35:                B4D7 BE5E F0DA 39C1  BBC6 9A5B 6259 2F82
00:01:35:                D0A7 0704 3B61 BB61  5F10 0600 D198 3DD2
00:01:35:                9DAB 0C50 2DDA 6DDC  A0F0 128E 4C00 2C6F
00:01:35:                C3FC D596 2207 20F9  C58B B777 5BDC D786
00:01:35:                E60D B8EF 7484 9B1F  7B02 0301 0001
```

Physical Layer Messages

This command causes various physical layer entities to log debug output:

`UBR04(config-if)#` **debug radio phy cwrLog** `modName`

modName values are described below:

image	Modules related to image management (open, close, rewind).
download	Modules related to the download task.
chip	Modules related to chip management.
message	Modules related to cwrMessage.
task	Modules related to the internal cwrTask management layer.
state	Modules related to generic state machine.
file	Modules related to the internal cwrFile layer.
card	Modules related to the card object as a whole.
subsystem	Modules related to subsystems, such as dsp, fir, and arq.
repository	Modules related to the image repository.

symbol	Logging related to symbols generated from an image.
decompressor	Logging related to the cwrDecompressor layer used by the cwrImage layer.
download_fsm	Logging for the download state machine.
matlab	Logging for the matlab task.
queue	Logging for the cwrQueue layer.
dspmsgdown	Tracing for messages sent down to the DSPs from the host.
dspmsgup	Tracing for messages sent up to the host from the DSPs.
subsystem	Subsystem messages or problems.
subsystem_detail	Verbose debugging information from the subsystems.
memspace	Memory space driver messages or problems.

Radio Interface Specific Logging

This command provides facilities to control interface-specific logging for other entities related to the radio interface:

```
UBR04(config-if)# debug radio phy radio 3/0 snmp verbose
```

Various logLevels determine what and how much debug log output is generated.

Images and Image Repositories

A microcode image is software that gets downloaded to the chips and processors to provide the required functionality. The image repository contains images that are downloaded to the wireless modem card when a **no shut** command is issued. When images need to be downloaded, the software will search the repository for an image whose capabilities match the specified link configuration parameters and download that image to the appropriate hardware component. The list of available images can be manipulated using the **radio image** commands.

Caution It is not necessary to manipulate the image repository for normal operation of the wireless modem card or the router. The repository should be manipulated only by an authorized technical support person. Arbitrary modifications can cause the wireless system to malfunction.

radio image-add

Use this command in privileged EXEC mode to add the specified image to the image repository. When an image has to be downloaded according to the specified configuration, the repository is searched for an appropriate file. If found, the file is retrieved and downloaded to the hardware. Use the **no** version of the command to delete the specified image from the repository.

radio image-add *protocol://host/directory/filename*
no radio image-add *protocol://host/directory/filename*

Syntax Description

protocol	{**mem** | **tftp** | **flash**}
host	IP address.
directory	Directory name. (No embedded spaces accepted.)
filename	Name of image file.

Example

The following command selects the image disp1a.img at the address 192.168.33.44 to be added to the repository:

```
UBR04# radio image-add tftp://192.168.33.44/myDspImages/dsp1a.img
```

radio image-move

Use this command in privileged EXEC mode to move the specified image to the beginning of the repository list of images. When the radio card is initiated (**no shut**), the repository is searched for a firmware image with characteristics matching the current configuration. Once found, that image is downloaded. Moving an image to the beginning of the list ensures that the image is searched first when a configuration match is attempted.

radio image-move *protocol://host/directory/filename*

Syntax Description

protocol	{**mem** | **tftp** | **flash**}
host	IP address.
directory	Directory name. (No embedded spaces accepted.)
filename	Name of image file.

Example

The following example selects the image dsp1a.img at the address 192.168.33.44 to be moved to the start of the repository list:

```
UBR04# radio image-move tftp://192.168.33.44/myDspImages/dsp1a.img
```

show interfaces radio (imagehdr)

Use this command in privileged EXEC mode to display details of the images to be downloaded on a single chip or on all chips.

If a particular chip is identified, the details of the image to be loaded on that chip are displayed. If no chip name is specified, the current radio configuration is retrieved for every chip on the modem card. All the images in the repository are compared. The image that provides the closest match in capability is selected, and the details of that image are displayed.

show interfaces radio *slot*/*port* **imagehdr** [**chip** *chipname* [**current** | **operational**]]

Syntax Description

slot	Positive integer representing the Cisco uBR7200 series slot number.
port	Positive integer representing the port number on that slot.
chipName	A character string identifying a chip.
current	Display the image header (details) for the image currently loaded on the chip.
operational	Display the image header for the image that will be loaded on the chip for the current configuration.

Example

The following example will display the image details of the chip named dsp1a currently loaded on the chip on the modem card in slot 3, port 0:

```
UBR04# show interfaces radio 3/0 imagehdr dsp1a current
```

show radio repository

Use this command in privileged EXEC mode to display the protocol-specific list of images in the repository. The repository is a list of current configuration images. When the modem card is initiated (**no shut**), this list is searched and the correct image downloaded. Privileged configuration access is required.

show radio repository [header] [*protocol*]

Syntax Description

header	Image header details associated with the list of images will also be displayed.
protocol	{**mem** | **tftp** | **flash**}

Example

The following example lists images related to memory:

```
UBR04# show radio repository mem

mem:/MyMemImages/dsp1Dual.img
mem:/MyMemImages/dsp2Dual.img
mem:/MyMemImages/dsp1Single.img
```

radio snapshot

A snapshot is a specified amount of data captured from the wireless modem card. Use these commands in privileged configuration mode to manipulate snapshots on the modem card.

Use the **radio snapshot** command to create a snapshot specification. When this command is entered, the specification is created and the data is captured. Use the **no** form of the command to delete a specification and its associated data.

Use the **show interfaces radio snapshot** command to display the configured snapshot information.

Use the **show interfaces radio snapdata** command to display the data captured for the snapshot specification.

Reading the Data

Some data returned by the DSPs can be more useful if you convert it to more meaningful values. Table 16 provides conversion formulas.

Table 16 Value Conversions

Parameter	Units Reported (X)	Units	Conversion Formula
receivedPower 1	DSP Receive Signal Strength	Same	Same
totalGain 1	0.5 dB	dB	X/2
gainSettingIF 1	0.5 dB	dB	X/2
gainSettingRF 1	$2^{(-16)}$ dB	dB	$X/2^{16}$
constVariance	$86016/(10^{(0.1*SNRdb)})$	SNR in dB	10 * log10(86016/X)
freqOffset	$11.71875/2^{16}$ kHz	kHz	X/5592.4
syncStatus	No units	Same	Same
timingOffset	In samples	Same	Same
receivedPower 2	DSP Receive Signal Strength	Same	Same
totalGain 2	0.5 dB	dB	X/2
gainSettingIF 2	0.5 dB	dB	X/2
gainSettingRF 2	$2^{(-16)}$ dB	dB	$X/2^{16}$
in 1	$SINR = 10*\log10(x/2^{16}) + 9$	SINR in dB	$10 * \log10(2^{16}/X) + 9$
in 2	$SINR = 10*\log10(x/2^{16}) + 9$	SINR in dB	$10 * \log10(2^{16}/X) + 9$
inr	log2 (Ratio)	In ratio in dB	$10 * \log10(2^{x})$
byteErrors	Number of errors	Same	Same

Use the **radio interface radio snapcapture** command to capture another snapshot on the identified DSP. The snapshot specification already configured on the DSP will be used.

Use the **radio interface radio snapclear** command to clear the data collected for the specified snapshot on the identified DSP.

When a snapshot request is issued, up to four simultaneous radio signal attributes can be captured. The four attributes are specified by adding the attribute numbers for up to four of the snapshot types identified below.

Note The Tx and Rx types cannot be mixed. Rx and Sync types can be mixed. When a **radio snapshot** command is issued, up to four signal attributes may be requested at once, one from each set.

Type	Set1	Set2	Set3	Set4
Rx	y1n(x1)	y2n(x2)	y2k(x8)	y1k(x4)
	h2k(x80)	h1k(x40)	h1n(x10)	h2n(x20)
	–	–	zhat(x100)	–
Sync	–	FreqCorr(x8000)	FreqOffCF(x2000) (*)	BrstTimeCF(x1000) (**)
	–	FLL_FFT_Sp(x20000)	–	TT_FCorr(x10000)
Tx	CodecIn(x200)	IFFTIn(x400)	–	RoundOut(x800)

* FreqOffCF cannot be mixed with Set1.

** BrstTimeCF cannot be mixed with Set2.

radio snapshot *dspId snapshotType*
no radio snapshot *dspId snapshotType*

show interfaces radio *slot*/*port* {**snapshot** | **snapdata**} *dspId*

radio interface radio *slot*/*port* **snapcapture** *dspId*
radio interface radio *slot*/*port* **snapclear** *dspId*

Syntax Description

dspId	{**dsprx1a** (Receive DSP 1a) | **dsprx1b** (Receive DSP 1b) | **dsprx2a** (Receive DSP 2a) | **dsprx2b** (Receive DSP 2b) | **dsprx3a** (Receive DSP 3a) | **dsprx3b** (Receive DSP 3b) | **dsptx1** (Transmit DSP 1) | **dsptx2** (Transmit DSP 2)}
snapshotType	Unsigned number. Up to four different snapshot types may be requested at once. When more than one snapshot is requested in a command, all snapshots will be captured from the same DSP. See snapshot type definitions below.
rx-rawburst-ant1-y1n (0x01)	Represents a snapshot of the received signal for RF resource 1. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
rx-rawburst-ant2-y2n (0x02)	Represents a snapshot of the received signal for RF resource 2. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities

rx-spectrum-ant1-y1k (0x04)	Represents a snapshot of the spectrum of the received signal for RF resource 1. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
rx-spectrum-ant2-y2k (0x08)	Represents a snapshot of the spectrum of the received signal for RF resource 2. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
rx-timedomainchannel-ant1-hln (0x10)	Represents a snapshot of the time domain channel for RF resource 1. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
rx-timedomainchannel-ant2-h2n (0x20)	Represents a snapshot of the time domain channel for RF resource 2. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
rx-freqdomainchannel-ant1-hlk (0x40)	Represents a snapshot of the frequency domain channel for RF resource 1. For every sample, the real and imaginary components are captured. Units (I, q) Value: 32-bit quantities
rx-freqdomainchannel-ant2-h2k (0x80)	Represents a snapshot of the frequency domain channel for RF resource 2. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
rx-constellation-zhatk (0x100)	Represents a snapshot of the soft decisions. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
tx-codec-input (0x200)	Represents a snapshot of input values to the Tx Code. Units: Real values Value: 32-bit quantities
tx-ifft-input (0x400)	Represents a snapshot of the IFFT signal for the transmitted data. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities

tx-round-output (0x800)	Represents a snapshot of the Rounded Constellation signal for the transmitted data. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
sync-burst-timecost-func (0x1000)	Represents the timing cost function for Sync bursts. Units: Real Values Value: 32-bit quantities
sync-freq-offset-costfunc (0x2000)	Represents a snapshot of the frequency offsets. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities
sync-fll-freq-correlation (0x8000)	Represents a snapshot of Frequency correlation. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32 bit quantities
sync-fll-train-tone-correlation (0x10000)	Represents a snapshot of Frequency locked loops, Training tone correlation. For every sample, the real and imaginary components are captured. Units (I, q) Value: 32-bit quantities
sync-fll-fft-spectrum (0x20000)	Represents a snapshot of Frequency locked loop, FFT Spectrum. For every sample, the real and imaginary components are captured. Units: (I, q) Value: 32-bit quantities

radio scope-output

Use this command in privileged EXEC mode to configure a single DSP to send the identified type of output to the serial port. An oscilloscope can be connected to the serial port to analyze the output of the DSP. Use the **no** form of the command to turn off the serial output.

Use the **show interfaces radio** *slot*/*port* **scope-output** command to display the attribute being directed to the scope port.

radio scope-output *dspId outputType*
no radio scope-output *dspId*

show interfaces radio *slot*/*port* **scope-output**

Syntax Description

dspId {**dsprx1a** (Receive DSP 1a) | **dsprx1b** (Receive DSP 1b) | **dsprx2a** (Receive DSP 2a) | **dsprx2b** (Receive DSP 2b) | **dsprx3a** (Receive DSP 3a) | **dsprx3b** (Receive DSP 3b) | **dsptx1** (Transmit DSP 1) | **dsptx2** (Transmit DSP 2)}

outputType {**rx-rawburst-ant1-y1n** | **rx-rawburst-ant1-y2n** | **rx-spectrum-ant1-y1k** | **rx-spectrum-ant1-y2k** | **rx-timedomainchannel-ant1-h1n** | **rx-timedomainchannel-ant2-h2n** | **rx-freqdomainchannel-ant1-h1k** | **rx-freqdomainchannel-ant2-h2k** | **rx-constellation-zhatk** | **tx-codec-input** | **tx-ifft-input** | **tx-round-output** | **sync-burst-timecost-func** | **sync-freq-offset-costfunc** | **sync-fll-freq-correlation** | **sync-fll-train-tone-correlation** | **sync-fll-fft-spectrum**}

slot Positive integer representing the Cisco uBR7200 series slot number.

port Positive integer representing the port number on that slot.

Example

The following command sends an output of type rx-timedomainchannel-ant2-h2n to the serial port:

```
UBR04# radio scope-output dsprx1a RxTimeDomainChannelAnt2H2n
```

radio timeline

A timeline is a sequence of data values collected for a specified attribute. The amount of data collected is controlled by the *tlSize* parameter. The maximum size is determined by the hardware memory size.

Use this command in privileged EXEC mode to configure a timeline collection specification with the software. The collection starts as soon as the command succeeds, and continues until the **trigger** occurs or the **timelineStop** command is executed.

For every timeline defined, antenna_num and tone are conditional. The *antenna_num* is required for the attributes **in**, **receivedPower**, **GainSettingsIF**, **gainSettingsRF**, and **totalGain**. The **tone** may be optionally specified for the attributes **in**, **inr**, and **constVariance**.

Use the **no** version of this command to delete a timeline specification.

Use the **timelineStop** form of the command to stop a currently executing timeline specification.

Use the **timelineStart** form of the command to start a stopped timeline specification.

Unless an error occurs, no notifications are displayed on the console.

radio timeline *statParam antenna_num* [**dsp** *dspId*] *tlSize* [**decimationFactor** *df*] [**presummationShift** *pss*] [**print** {**on** | **off**}] [**tone** {**circular** | **average** | **number** *tone-number*] [**trigger** *threshParams threshType* (*antenna_num*) *postTrigBufMgt*]

no radio timeline *statParam antenna_num* [**dsp** *dspnum*]

radio interface radio *slot*/*port* **timelineStart** *statParam* (*antenna_num*) [**dsp** *dspnum*]

radio interface radio *slot*/*port* **timelineStop** *statParam* (*antenna_num*) [**dsp** *dspnum*]

Note Up to 1024 32-bit words are available for all timeline parameters on a single DSP. Each timeline requires (tlsize+1) * 2 words. The attributes in **in**, **inr**, and **constVariance** can be captured on any DSP, while the others can be captured only on certain DSPs. Distributing timeline requests across DSPs provides better memory utilization.

Selecting the Correct DSP

In most cases, the default DSP should provide acceptable results. Table 17 outlines for which DSPs the statistical parameters are most meaningful.

Table 17 Statistical Parameters and Meaningful DSPs

Statistical Parameter	Antenna-Specific Parameter	Data Meaningful on DSP (12 MHz)	Data Meaningful on DSP (6 MHz)
Received Power	Yes	rx3b	rx2b
Gain Settings IF	Yes	rx3b	rx2b
Gain Settings RF	Yes	rx3b	rx2b
Total Gain	Yes	rx3b	rx2b
Interference + Noise	Dual Antenna Required	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Interference + Noise Ratio	Dual Antenna Required	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Constellation Variance	No	Any rx DSP	rx1a, rx1b, rx2a, rx2b
Sync Status	No	rx3b	rx2b
Timing Offset	No	rx3b	rx2b
Frequency Offset	No	rx3b	rx2b

Note When changing from 12 MHz to 6 MHz mode, the DSP on which the parameter is defined may no longer be valid. If so, redefine the timeline on a DSP where the parameter is meaningful.

Syntax Description

statParam — {**in** | **inr** | **constVariance** | **timingOffset** | **freqOffset** | **syncStatus** | **receivedPower** | **gainSettingsIF** | **gainSettingsRF**}

in — (Interference + Noise) The interference plus noise power levels are computed by the hardware on a burst-by-burst basis.

inr — (Interference + Noise Ratio) The ratio of the interference plus noise power levels captured by the first antenna to the second antenna on a burst-by-burst basis. This value is specified as a log to base 2 number.

Note This parameter is available for a dual antenna system only.

constVariance	(Constellation Variance) The average energy of the constellation error signal—the error between the received (noisy) constellation symbol and the nearest ideal constellation symbol. Constellation Variance is a measure of the Signal to Interference plus Noise ratio (SINR) for that tone. On a single antenna system, it represents $(SINR)^{-1}$. On a dual antenna system, it represents $(SINR)^{-1}$ after antenna combining.
timingOffset	Represents the timing delay variations detected in the radio link.
freqOffset	Represents the carrier frequency offset between the slave radio and the master radio.
syncStatus	Represents the synchronization status.
receivedPower	Measure of the analog signal power received by the radio system on a burst-by-burst basis.
gainSettingsIF	Represents the intermediate frequency (IF) attenuation value commanded by the automatic gain control loop. This may be captured for each antenna and for the IF module.
gainSettingsRF	Represents the radio frequency (RF) attenuation value commanded by the automatic gain control loop. This may be captured for each antenna and for the RF modules.
totalGain	Represents the total attenuation commanded by the automatic gain control loop. This can be captured for each antenna.
dspId	{**dsprx1a** (Receive DSP 1a) | **dsprx1b** (Receive DSP 1b) | **dsprx2a** (Receive DSP 2a) | **dsprx2b** (Receive DSP2b) | **dsprx3a** (Receive DSP 3a) | **dsprx3b** (Receive DSP 3b)} The DSP on which to collect the timeline data.
antenna_num	Enter 1 (main antenna) or 2 (diversity antenna). The antenna for which the timeline data should be collected.
tlSize	Positive number representing the number of values to collect.
decimationFactor	The rate at which data is received is high, so retrieving every successive data sample will likely provide little information (due to memory limitations). The decimation factor specifies how many successive data samples should be added together and reported as one data sample. If the decimation factor is not specified, every successive data sample is reported.
df	$\{0 . . 2^{31}\}$

presummationShift	If decimationFactor is specified, then successive data samples get added. This can potentially cause an overflow. The presummationShift value specifies the number of bits by which the data sample should be right-shifted before being added. Specifying a presummationShift value will result in less precise individual data samples but provides a mechanism to analyze the behavior over longer duration of time.
pss	(0 . . 32)
print	{on | off} Specifies whether or not the collected values should be printed out when the collection completes. The default is **on**.
tone	{circular | average | number *tone-number*} Every burst of signal data contains samples from N frequency tones. This parameter identifies which of those frequency tones should be used.
circular	Implies successive data samples should use successive frequency tones.
average	Implies successive data samples should average the burst data over all the N frequencies and then use that value.
number	Specifies that data from a particular frequency in the burst should be reported.
tone-number	for **in** and **inr** { {0 . . 27} for 12 MHz high, 6 MHz high } { {0 . . 33 } otherwise } for **constVariance** { {0 . . 216} for 12 MHz high } { {0 . . 198} for 12 MHz med, low } { {0 . . 108 } for 6 MHz high } { {0 . . 99 } for 6 MHz med, low }
trigger	Specifies when the collection has to be stopped. The *threshParam threshType antenna_num* parameters uniquely identify a threshold specification. When this threshold is reached, the timeline will be stopped and the data collected.
threshParam	{**in** | **inr** | **constVariance** | **timingOffset** | **freqOffset** | **syncStatus** | **receivedPower** | **gainSettingsIF** | **gainSettingsRF**}
threshType	{**highThreshold** | **lowThreshold** | **upChange** | **downChange** | **posCrossing** | **negCrossing**}
highThreshold	An upper limit for the *threshParam* being monitored.
lowThreshold	A lower limit for the *threshParam* being monitored.
upChange	The positive change limit allowed for the *threshParam* being monitored.
downChange	The negative change limit allowed for the *threshParam* being monitored.
posCrossing	The limit that applies only when the *threshParam* is increasing in value.

negCrossing	The limit that applies only when the *threshParam* is decreasing in value.
postTrigBufMgt	Specifies the position of the trigger in the data collected. If it is 1, then most of the data collected prior to the trigger is returned. If it is 2, most of the data returned is captured after the occurrence of the trigger.

Example

The following example configures a timeline specification. The collection process starts as soon as the command succeeds. The ***inr*** parameter will be monitored. A total of 640 values will be collected.

Of the N tones in a burst, the average value of all the tones (for the burst) is retrieved as one data sample. Each data sample will be right shifted by 2 bits. Twenty successive (right-shifted) data samples will be added together and reported as one value (of the 640 values in total).

When the threshold **inr lowThreshold 2** is reached, the collection will stop and the results will be printed.

```
UBR04# radio timeline inr 640 dec 20 pre 2 tone average trigger inr
lowThreshold 2
```

show interfaces radio (tlspec)

Use this command in privileged EXEC mode to display the details of the currently configured timeline specifications. If none of the optional parameters are specified then all the timeline specifications on the modem card are displayed. If the *statParam antenna_num* combination only is specified, then the configuration setup on the default will be displayed. if the [**dsp** *dspId*] parameter is specified, then the configurations on that DSP will be displayed.

show interfaces radio *slot*/*port* **tlspec** [*statParam antenna_num* [**dsp** *dspId*]]

Syntax Description

Refer to **radio timeline** for syntax descriptions.

Example

The following example displays the ***inr*** timeline specification configured for the modem card in port 3, slot 0 of the Cisco uBR7200 series router:

```
UBR04# show interfaces radio 3/0 tlspec inr

Classinr
Resource Id1
Buffer size50
Number of buffers20
Collection method30
Tone Selectionaverage
Stop threshold attributein
Stop threshold typedownChange
Stop antenna number1
Print optionsoff
Dsp Number3
Default T1false
```

show interfaces radio (tldata)

Use this command in privileged EXEC mode to display the timeline data collected for the identified specifications.

show interfaces radio *slot/port* **tldata** [*statParam antenna_num* [**dsp** *dspId*]]

Syntax Description

Refer to **radio timeline** for syntax descriptions.

Example

The following example will display the timeline **inr** data for the modem card installed in slot 3, port 0 of the Cisco uBR7200 series router:

```
UBR04# show interfaces radio 3/0 tldata inr

Number of Points Captured=100 Trigger Location=54
0    :0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
10   :0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
20   :0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
30   :0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
40   :0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
50   :FFFFFFFF FFFFFFFF 0000 0000 0000 0000 0000 0001 FFFFFFFF FFFFFFFF
60   :0000 0002 FFFFFFFF FFFFFFFF 0000 0001 0000 0000 0000 0000
70   :0000 0000 0000 0001 FFFFFFFF FFFFFFFF 0000 0000 0000 0001
80   :FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF 0000 0002 FFFFFFFF FFFFFFFF 0000 0002
90   :FFFFFFFF FFFFFFFF 0000 0000 0000 0001 FFFFFFFF FFFFFFFF 0000 0000
```

Reading the Data

Some data returned by the DSPs can be more useful if you convert it to more meaningful values. Table 18 provides conversion formulas.

Table 18 Value Conversions

Parameter	Units Reported (X)	Units	Conversion Formula
receivedPower 1	DSP Receive Signal Strength	Same	Same
totalGain 1	0.5 dB	dB	X/2
gainSettingIF 1	0.5 dB	dB	X/2
gainSettingRF 1	$2^{(-16)}$ dB	dB	$X/2^{16}$
constVariance	$86016/(10^{(0.1*SNRdb)})$	SNR in dB	10 * log10(86016/X)
freqOffset	$11.71875/2^{16}$ kHz	kHz	X/5592.4
syncStatus	No units	Same	Same
timingOffset	In samples	Same	Same
receivedPower 2	DSP Receive Signal Strength	Same	Same
totalGain 2	0.5 dB	dB	X/2
gainSettingIF 2	0.5 dB	dB	X/2
gainSettingRF 2	$2^{(-16)}$ dB	dB	$X/2^{16}$
in 1	$SINR = 10*\log10(x/2^{16}) + 9$	SINR in dB	$10 * \log10(2^{16}/X) + 9$

Table 18 Value Conversions (continued)

Parameter	Units Reported (X)	Units	Conversion Formula
in 2	SINR = 10*log10(x/2^{16}) + 9	SINR in dB	10 * log10(2^{16}/X) + 9
inr	log2 (Ratio)	In ratio in dB	10 * log10(2^{x})
byteErrors	Number of errors	Same	Same

Regulatory Compliance and Safety Information

This section provides international agency compliance, safety, and statutory information regarding the installation of the Cisco broadband fixed wireless modem card and subsystem.

FCC Registration and Requirements

The following paragraph describes requirements and information based on FCC rules.

This Cisco product has been tested and complies with the limits for a Class A digital device, pursuant to Part 15 and Part 21 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with the instruction manual, can cause harmful interference to radio transmissions.

This product complies with FCC Class B limits with the use of shielded control cable.

Translated Safety Warnings

This section provides translations of the warnings found in this document.

Short-Circuit Protection Warning

Warning **This product requires short-circuit (overcurrent) protection, to be provided as part of the building installation. Install only in accordance with national and local wiring regulations.**

Waarschuwing **Voor dit product moet kortsluitbeveiliging (overstroombeveiliging) deel uitmaken van de installatie in het gebouw. De installatie moet voldoen aan de nationale en lokale bedradingvoorschriften.**

Varoitus **Tämä tuote vaatii suojauksen oikosulkuja (ylivirtaa) vastaan osana asennusta rakennukseen. Asenna ainoastaan kansallisten ja paikallisten johdotussäännösten mukaisesti.**

Attention **La protection de ce produit contre les courts-circuits (surtensions) doit être assurée par la configuration électrique du bâtiment. Vérifiez que l'installation a lieu uniquement en conformité avec les normes de câblage en vigueur au niveau national et local.**

Warnung **Für dieses Produkt ist eine Kurzschlußsicherung (Überstromsicherung) erforderlich, die als Teil der Gebäudeinstallation zur Verfügung gestellt wird. Die Installation sollte nur in Übereinstimmung mit den nationalen und regionalen Vorschriften zur Verkabelung erfolgen.**

Avvertenza **Questo prodotto richiede una protezione contro i cortocircuiti, da fornirsi come parte integrante delle dotazioni presenti nell'edificio. Effettuare l'installazione rispettando le Norme CEI pertinenti.**

Advarsel **Dette produktet krever beskyttelse mot kortslutninger (overspenninger) som en del av installasjonen. Bare installer utstyret i henhold til nasjonale og lokale krav til ledningsnett.**

Aviso **Este produto requer proteção contra curto-circuitos (sobreintensidade de corrente), que deve estar instalada nos edifícios. Instale apenas de acordo com as normas de instalação elétrica nacionais e locais.**

Advertencia **Este producto necesita estar conectado a la protección frente a cortacircuitos (sobretensiones) que exista en el edificio. Instálelo únicamente en conformidad con las regulaciones sobre cableado, tanto locales como nacionales, a las que se tenga que atener.**

Varning! **Denna produkt kräver att kortslutningsskydd (överström) tillhandahålles som en del av byggnadsinstallationen. Installera bara i enlighet med nationella och lokala kabeldragningsbestämmelser.**

Disconnect Device Warning

Warning **A readily accessible two-poled disconnect device must be incorporated in the fixed wiring.**

Waarschuwing **Er moet een gemakkelijk toegankelijke, tweepolige stroomverbreker opgenomen zijn in de vaste bedrading.**

Varoitus **Kiinteään johdotukseen on liitettävä kaksinapainen kytkinlaite, johon on helppo päästä käsiksi.**

Attention **Un disjoncteur bipolaire facile d'accès doit être intégré dans le câblage fixe.**

Warnung **Die feste Verdrahtung muß eine leicht zugängliche, zweipolige Trennvorrichtung enthalten.**

Avvertenza **Nei cablaggi fissi va incorporato un sezionatore a due poli facilmente accessibile.**

Advarsel **En lett tilgjengelig, topolet frakoblingsenhet må være innebygd i det faste ledningsnettet.**

Aviso **Deverá incorporar-se um dispositivo de desconexão de dois pólos de acesso fácil, na instalação eléctrica fixa.**

¡Advertencia! **El cableado fijo debe incorporar un dispositivo de desconexión de dos polos y de acceso fácil.**

Varning! **En lättillgänglig tvåpolig frånkopplingsenhet måste ingå i den fasta kopplingen.**

Lightning Activity Warning

Warning	Do not work on the system or connect or disconnect cables during periods of lightning activity.
Waarschuwing	Tijdens onweer dat gepaard gaat met bliksem, dient u niet aan het systeem te werken of kabels aan te sluiten of te ontkoppelen.
Varoitus	Älä työskentele järjestelmän parissa äläkä yhdistä tai irrota kaapeleita ukkosilmalla.
Attention	Ne pas travailler sur le système ni brancher ou débrancher les câbles pendant un orage.
Warnung	Arbeiten Sie nicht am System und schließen Sie keine Kabel an bzw. trennen Sie keine ab, wenn es gewittert.
Avvertenza	Non lavorare sul sistema o collegare oppure scollegare i cavi durante un temporale con fulmini.
Advarsel	Utfør aldri arbeid på systemet, eller koble kabler til eller fra systemet når det tordner eller lyner.
Aviso	Não trabalhe no sistema ou ligue e desligue cabos durante períodos de mau tempo (trovoada).
¡Advertencia!	No operar el sistema ni conectar o desconectar cables durante el transcurso de descargas eléctricas en la atmósfera.
Varning!	Vid åska skall du aldrig utföra arbete på systemet eller ansluta eller koppla loss kablar.

Installation Warning

Warning	Read the installation instructions before you connect the system to its power source.
Waarschuwing	Raadpleeg de installatie-aanwijzingen voordat u het systeem met de voeding verbindt.
Varoitus	Lue asennusohjeet ennen järjestelmän yhdistämistä virtalähteeseen.
Attention	Avant de brancher le système sur la source d'alimentation, consulter les directives d'installation.
Warnung	Lesen Sie die Installationsanweisungen, bevor Sie das System an die Stromquelle anschließen.
Avvertenza	Consultare le istruzioni di installazione prima di collegare il sistema all'alimentatore.
Advarsel	Les installasjonsinstruksjonene før systemet kobles til strømkilden.
Aviso	Leia as instruções de instalação antes de ligar o sistema à sua fonte de energia.

¡Advertencia! **Ver las instrucciones de instalación antes de conectar el sistema a la red de alimentación.**

Varning! **Läs installationsanvisningarna innan du kopplar systemet till dess strömförsörjningsenhet.**

Jewelry Removal Warning

Warning **Before working on equipment that is connected to power lines, remove jewelry (including rings, necklaces, and watches). Metal objects will heat up when connected to power and ground and can cause serious burns or weld the metal object to the terminals.**

Waarschuwing **Alvorens aan apparatuur te werken die met elektrische leidingen is verbonden, sieraden (inclusief ringen, kettingen en horloges) verwijderen. Metalen voorwerpen worden warm wanneer ze met stroom en aarde zijn verbonden, en kunnen ernstige brandwonden veroorzaken of het metalen voorwerp aan de aansluitklemmen lassen.**

Varoitus **Ennen kuin työskentelet voimavirtajohtoihin kytkettyjen laitteiden parissa, ota pois kaikki korut (sormukset, kaulakorut ja kellot mukaan lukien). Metalliesineet kuumenevat, kun ne ovat yhteydessä sähkövirran ja maan kanssa, ja ne voivat aiheuttaa vakavia palovammoja tai hitsata metalliesineet kiinni liitäntänapoihin.**

Attention **Avant d'accéder à cet équipement connecté aux lignes électriques, ôter tout bijou (anneaux, colliers et montres compris). Lorsqu'ils sont branchés à l'alimentation et reliés à la terre, les objets métalliques chauffent, ce qui peut provoquer des blessures graves ou souder l'objet métallique aux bornes.**

Warnung **Vor der Arbeit an Geräten, die an das Netz angeschlossen sind, jeglichen Schmuck (einschließlich Ringe, Ketten und Uhren) abnehmen. Metallgegenstände erhitzen sich, wenn sie an das Netz und die Erde angeschlossen werden, und können schwere Verbrennungen verursachen oder an die Anschlußklemmen angeschweißt werden.**

Avvertenza **Prima di intervenire su apparecchiature collegate alle linee di alimentazione, togliersi qualsiasi monile (inclusi anelli, collane, braccialetti ed orologi). Gli oggetti metallici si riscaldano quando sono collegati tra punti di alimentazione e massa: possono causare ustioni gravi oppure il metallo può saldarsi ai terminali.**

Advarsel **Fjern alle smykker (inkludert ringer, halskjeder og klokker) før du skal arbeide på utstyr som er koblet til kraftledninger. Metallgjenstander som er koblet til kraftledninger og jord blir svært varme og kan forårsake alvorlige brannskader eller smelte fast til polene.**

Aviso **Antes de trabalhar em equipamento que esteja ligado a linhas de corrente, retire todas as jóias que estiver a usar (incluindo anéis, fios e relógios). Os objectos metálicos aquecerão em contacto com a corrente e em contacto com a ligação à terra, podendo causar queimaduras graves ou ficarem soldados aos terminais.**

¡Advertencia! **Antes de operar sobre equipos conectados a líneas de alimentación, quitarse las joyas (incluidos anillos, collares y relojes). Los objetos de metal se calientan cuando se conectan a la alimentación y a tierra, lo que puede ocasionar quemaduras graves o que los objetos metálicos queden soldados a los bornes.**

Varning! **Tag av alla smycken (inklusive ringar, halsband och armbandsur) innan du arbetar på utrustning som är kopplad till kraftledningar. Metallobjekt hettas upp när de kopplas ihop med ström och jord och kan förorsaka allvarliga brännskador; metallobjekt kan också sammansvetsas med kontakterna.**

Supply Circuit Warning

Warning **Care must be given to connecting units to the supply circuit so that wiring is not overloaded.**

Waarschuwing **Let erop dat de toestellen op voedingscircuits worden aangesloten zonder het vermogen van de bedrading te overschrijden.**

Varoitus **Laiteyksiköt on yhdistettävä huolellisesti syöttöpiiriin niin, että johdot eivät ole ylikuormitettuja.**

Avertissement **Veillez à bien connecter les unités au circuit d'alimentation afin de ne pas surcharger les connections.**

Achtung **Beim Anschließen der Geräte an das Stromnetz ist darauf zu achten, daß die Schaltverbindungen nicht überlastet werden.**

Avvertenza **Fare attenzione quando si collegano le unità al circuito di alimentazione, per non sovraccaricare i cablaggi.**

Advarsel **Vær nøye med å koble enheter til strømforsyningskretsen slik at ledningene ikke overbelastes.**

Aviso **Deverá ter precaução ao ligar unidades ao circuito de fornecimento de energia, para não sobrecarregar a instalação.**

¡Atención! **Poner mucho cuidado al conectar los equipos al circuito de alimentación a fin de no sobrecargar el cableado.**

Varning **Var noga vid anslutning av enheter till matarströmkretsen så att ledningarna inte överbelastas.**

Service Personnel Warning

Warning	Only trained and qualified personnel should be allowed to install, replace, or service this equipment.
Waarschuwing	Deze apparatuur mag alleen worden geïnstalleerd, vervangen of hersteld door bevoegd geschoold personeel.
Varoitus	Tämän laitteen saa asentaa, vaihtaa tai huoltaa ainoastaan koulutettu ja laitteen tunteva henkilökunta.
Attention	Il est vivement recommandé de confier l'installation, le remplacement et la maintenance de ces équipements à des personnels qualifiés et expérimentés.
Warnung	Das Installieren, Ersetzen oder Bedienen dieser Ausrüstung sollte nur geschultem, qualifiziertem Personal gestattet werden.
Avvertenza	Questo apparato può essere installato, sostituito o mantenuto unicamente da un personale competente.
Advarsel	Bare opplært og kvalifisert personell skal foreta installasjoner, utskiftninger eller service på dette utstyret.
Aviso	Apenas pessoal treinado e qualificado deve ser autorizado a instalar, substituir ou fazer a revisão deste equipamento.
¡Advertencia!	Solamente el personal calificado debe instalar, reemplazar o utilizar este equipo.
Varning!	Endast utbildad och kvalificerad personal bör få tillåtelse att installera, byta ut eller reparera denna utrustning.

Product Disposal Warning

Warning	Ultimate disposal of this product should be handled according to all national laws and regulations.
Waarschuwing	Het uiteindelijke wegruimen van dit product dient te geschieden in overeenstemming met alle nationale wetten en reglementen.
Varoitus	Tämä tuote on hävitettävä kansallisten lakien ja määräysten mukaisesti.
Attention	La mise au rebut ou le recyclage de ce produit sont généralement soumis à des lois et/ou directives de respect de l'environnement. Renseignez-vous auprès de l'organisme compétent.

Warnung **Die Entsorgung dieses Produkts sollte gemäß allen Bestimmungen und Gesetzen des Landes erfolgen.**

Avvertenza **Lo smaltimento di questo prodotto deve essere eseguito secondo le leggi e regolazioni locali.**

Advarsel **Endelig kassering av dette produktet skal være i henhold til alle relevante nasjonale lover og bestemmelser.**

Aviso **Deitar fora este produto em conformidade com todas as leis e regulamentos nacionais.**

¡Advertencia! **Al deshacerse por completo de este producto debe seguir todas las leyes y reglamentos nacionales.**

Varning! **Vid deponering hanteras produkten enligt gällande lagar och bestämmelser.**

Faceplates and Cover Panel Requirement

Warning **Blank faceplates and cover panels serve three important functions: they prevent exposure to hazardous voltages and currents inside the chassis; they contain electromagnetic interference (EMI) that might disrupt other equipment; and they direct the flow of cooling air through the chassis. Do not operate the system unless all cards, faceplates, front covers, and rear covers are in place.**

Waarschuwing **Lege vlakplaten en afdekpanelen vervullen drie belangrijke functies: ze voorkomen blootstelling aan gevaarlijke voltages en stroom binnenin het frame, ze bevatten elektromagnetische storing (EMI) hetgeen andere apparaten kan verstoren en ze leiden de stroom van koellucht door het frame. Het systeem niet bedienen tenzij alle kaarten, vlakplaten en afdekkingen aan de voor- en achterkant zich op hun plaats bevinden.**

Varoitus **Tyhjillä tasolaikoilla ja suojapaneeleilla on kolme tärkeää käyttötarkoitusta: Ne suojaavat asennuspohjan sisäisille vaarallisille jännitteille ja sähkövirralle altistumiselta; ne pitävät sisällään elektromagneettisen häiriön (EMI), joka voi häiritä muita laitteita; ja ne suuntaavat tuuletusilman asennuspohjan läpi. Järjestelmää ei saa käyttää, elleivät kaikki tasolaikat, etukannet ja takakannet ole kunnolla paikoillaan.**

Attention **Ne jamais faire fonctionner le système sans que l'intégralité des cartes, des plaques métalliques et des panneaux avant et arrière ne soient fixés à leur emplacement. Ceux-ci remplissent trois fonctions essentielles : ils évitent tout risque de contact avec des tensions et des courants dangereux à l'intérieur du châssis, ils évitent toute diffusion d'interférences électromagnétiques qui pourraient perturber le fonctionnement des autres équipements, et ils canalisent le flux d'air de refroidissement dans le châssis.**

Warnung **Blanke Faceplates und Abdeckungen haben drei wichtigen Funktionen: (1) Sie schützen vor gefährlichen Spannungen und Strom innerhalb des Chassis; (2) sie halten elektromagnetische Interferenzen (EMI) zurück, die andere Geräte stören könnten; (3) sie lenken den kühlenden Luftstrom durch das Chassis. Das System darf nur betrieben werden, wenn alle Karten, Faceplates, Voder- und Rückabdeckungen an Ort und Stelle sind.**

Avvertenza **Le piattaforme bianche e i panelli di protezione hanno tre funzioni importanti: Evitano l'esposizione a voltaggi e correnti elettriche pericolose nello chassis, trattengono le interferenze elettromagnetiche (EMI) che potrebbero scombussolare altri apparati e dirigono il flusso di aria per il raffreddamento attraverso lo chassis. Non mettete in funzione il sistema se le schede, le piattaforme, i panelli frontali e posteriori non sono in posizione.**

Advarsel **Blanke ytterplater og deksler sørger for tre viktige funksjoner: de forhindrer utsettelse for farlig spenning og strøm inni kabinettet; de inneholder elektromagnetisk forstyrrelse (EMI) som kan avbryte annet utstyr, og de dirigerer luftavkjølingsstrømmen gjennom kabinettet. Betjen ikke systemet med mindre alle kort, ytterplater, frontdeksler og bakdeksler sitter på plass.**

Aviso **As faces furadas e os painéis de protecção desempenham três importantes funções: previnem contra uma exposição perigosa a voltagens e correntes existentes no interior do chassis; previnem contra interferência electromagnética (EMI) que poderá danificar outro equipamento; e canalizam o fluxo do ar de refrigeração através do chassis. Não deverá operar o sistema sem que todas as placas, faces, protecções anteriores e posteriores estejam nos seus lugares.**

¡Advertencia! **Las placas frontales y los paneles de relleno cumplen tres funciones importantes: evitan la exposición a niveles peligrosos de voltaje y corriente dentro del chasis; reducen la interferencia electromagnética (EMI) que podría perturbar la operación de otros equipos y dirigen el flujo de aire de enfriamiento a través del chasis. No haga funcionar el sistema a menos que todas las tarjetas, placas frontales, cubiertas frontales y cubiertas traseras estén en su lugar.**

Varning! **Tomma framplattor och skyddspaneler har tre viktiga funktioner: de förhindrar att personer utsätts för farlig spänning och ström som finns inuti chassit; de innehåller elektromagnetisk interferens (EMI) som kan störa annan utrustning; och de styr riktningen på kylluftsflödet genom chassit. Använd inte systemet om inte alla kort, framplattor, fram- och bakskydd är på plats.**

Chassis—Rack-Mounting and Servicing Warning

Warning **To prevent bodily injury when mounting or servicing this unit in a rack, you must take special precautions to ensure that the system remains stable. The following guidelines are provided to ensure your safety:**

- This unit should be mounted at the bottom of the rack if it is the only unit in the rack.
- When mounting this unit in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.
- If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the unit in the rack.

Waarschuwing **Om lichamelijk letsel te voorkomen wanneer u dit toestel in een rek monteert of het daar een servicebeurt geeft, moet u speciale voorzorgsmaatregelen nemen om ervoor te zorgen dat het toestel stabiel blijft. De onderstaande richtlijnen worden verstrekt om uw veiligheid te verzekeren:**

- Dit toestel dient onderaan in het rek gemonteerd te worden als het toestel het enige in het rek is.
- Wanneer u dit toestel in een gedeeltelijk gevuld rek monteert, dient u het rek van onderen naar boven te laden met het zwaarste onderdeel onderaan in het rek.
- Als het rek voorzien is van stabiliseringshulpmiddelen, dient u de stabilisatoren te monteren voordat u het toestel in het rek monteert of het daar een servicebeurt geeft.

Varoitus **Kun laite asetetaan telineeseen tai huolletaan sen ollessa telineessä, on noudatettava erityisiä varotoimia järjestelmän vakavuuden säilyttämiseksi, jotta vältytään loukkaantumiselta. Noudata seuraavia turvallisuusohjeita:**

- Jos telineessä ei ole muita laitteita, aseta laite telineen alaosaan.
- Jos laite asetetaan osaksi täytettyyn telineeseen, aloita kuormittaminen sen alaosasta kaikkein raskaimmalla esineellä ja siirry sitten sen yläosaan.
- Jos telinettä varten on vakaimet, asenna ne ennen laitteen asettamista telineeseen tai sen huoltamista siinä.

Attention **Pour éviter toute blessure corporelle pendant les opérations de montage ou de réparation de cette unité en casier, il convient de prendre des précautions spéciales afin de maintenir la stabilité du système. Les directives ci-dessous sont destinées à assurer la protection du personnel :**

- Si cette unité constitue la seule unité montée en casier, elle doit être placée dans le bas.
- Si cette unité est montée dans un casier partiellement rempli, charger le casier de bas en haut en plaçant l'élément le plus lourd dans le bas.
- Si le casier est équipé de dispositifs stabilisateurs, installer les stabilisateurs avant de monter ou de réparer l'unité en casier.

Warnung **Zur Vermeidung von Körperverletzung beim Anbringen oder Warten dieser Einheit in einem Gestell müssen Sie besondere Vorkehrungen treffen, um sicherzustellen, daß das System stabil bleibt. Die folgenden Richtlinien sollen zur Gewährleistung Ihrer Sicherheit dienen:**

- Wenn diese Einheit die einzige im Gestell ist, sollte sie unten im Gestell angebracht werden.
- Bei Anbringung dieser Einheit in einem zum Teil gefüllten Gestell ist das Gestell von unten nach oben zu laden, wobei das schwerste Bauteil unten im Gestell anzubringen ist.
- Wird das Gestell mit Stabilisierungszubehör geliefert, sind zuerst die Stabilisatoren zu installieren, bevor Sie die Einheit im Gestell anbringen oder sie warten.

Avvertenza **Per evitare infortuni fisici durante il montaggio o la manutenzione di questa unità in un supporto, occorre osservare speciali precauzioni per garantire che il sistema rimanga stabile. Le seguenti direttive vengono fornite per garantire la sicurezza personale:**

- Questa unità deve venire montata sul fondo del supporto, se si tratta dell'unica unità da montare nel supporto.
- Quando questa unità viene montata in un supporto parzialmente pieno, caricare il supporto dal basso all'alto, con il componente più pesante sistemato sul fondo del supporto.
- Se il supporto è dotato di dispositivi stabilizzanti, installare tali dispositivi prima di montare o di procedere alla manutenzione dell'unità nel supporto.

Advarsel **Unngå fysiske skader under montering eller reparasjonsarbeid på denne enheten når den befinner seg i et kabinett. Vær nøye med at systemet er stabilt. Følgende retningslinjer er gitt for å verne om sikkerheten:**

- Denne enheten bør monteres nederst i kabinettet hvis dette er den eneste enheten i kabinettet.
- Ved montering av denne enheten i et kabinett som er delvis fylt, skal kabinettet lastes fra bunnen og opp med den tyngste komponenten nederst i kabinettet.
- Hvis kabinettet er utstyrt med stabiliseringsutstyr, skal stabilisatorene installeres før montering eller utføring av reparasjonsarbeid på enheten i kabinettet.

Aviso **Para se prevenir contra danos corporais ao montar ou reparar esta unidade numa estante, deverá tomar precauções especiais para se certificar de que o sistema possui um suporte estável. As seguintes directrizes ajudá-lo-ão a efectuar o seu trabalho com segurança:**

- Esta unidade deverá ser montada na parte inferior da estante, caso seja esta a única unidade a ser montada.
- Ao montar esta unidade numa estante parcialmente ocupada, coloque os itens mais pesados na parte inferior da estante, arrumando-os de baixo para cima.
- Se a estante possuir um dispositivo de estabilização, instale-o antes de montar ou reparar a unidade.

¡Advertencia! **Para evitar lesiones durante el montaje de este equipo sobre un bastidor, o posteriormente durante su mantenimiento, se debe poner mucho cuidado en que el sistema quede bien estable. Para garantizar su seguridad, proceda según las siguientes instrucciones:**

- Colocar el equipo en la parte inferior del bastidor, cuando sea la única unidad en el mismo.
- Cuando este equipo se vaya a instalar en un bastidor parcialmente ocupado, comenzar la instalación desde la parte inferior hacia la superior colocando el equipo más pesado en la parte inferior.
- Si el bastidor dispone de dispositivos estabilizadores, instalar éstos antes de montar o proceder al mantenimiento del equipo instalado en el bastidor.

Varning! **För att undvika kroppsskada när du installerar eller utför underhållsarbete på denna enhet på en ställning måste du vidta särskilda försiktighetsåtgärder för att försäkra dig om att systemet står stadigt. Följande riktlinjer ges för att trygga din säkerhet:**

- Om denna enhet är den enda enheten på ställningen skall den installeras längst ned på ställningen.
- Om denna enhet installeras på en delvis fylld ställning skall ställningen fyllas nedifrån och upp, med de tyngsta enheterna längst ned på ställningen.
- Om ställningen är försedd med stabiliseringsdon skall dessa monteras fast innan enheten installeras eller underhålls på ställningen.

Restricted Area Warning

Warning **This unit is intended for installation in restricted access areas. A restricted access area is where access can only be gained by service personnel through the use of a special tool, lock and key, or other means of security, and is controlled by the authority responsible for the location.**

Waarschuwing **Dit toestel is bedoeld voor installatie op plaatsen met beperkte toegang. Een plaats met beperkte toegang is een plaats waar toegang slechts door servicepersoneel verkregen kan worden door middel van een speciaal instrument, een slot en sleutel, of een ander veiligheidsmiddel, en welke beheerd wordt door de overheidsinstantie die verantwoordelijk is voor de locatie.**

Varoitus **Tämä laite on tarkoitettu asennettavaksi paikkaan, johon pääsy on rajoitettua. Paikka, johon pääsy on rajoitettua, tarkoittaa paikkaa, johon vain huoltohenkilöstö pääsee jonkin erikoistyökalun, lukkoon sopivan avaimen tai jonkin muun turvalaitteen avulla ja joka on paikasta vastuussa olevien toimivaltaisten henkilöiden valvoma.**

Attention **Cet appareil est à installer dans des zones d'accès réservé. Ces dernières sont des zones auxquelles seul le personnel de service peut accéder en utilisant un outil spécial, un mécanisme de verrouillage et une clé, ou tout autre moyen de sécurité. L'accès aux zones de sécurité est sous le contrôle de l'autorité responsable de l'emplacement.**

Warnung **Diese Einheit ist zur Installation in Bereichen mit beschränktem Zutritt vorgesehen. Ein Bereich mit beschränktem Zutritt ist ein Bereich, zu dem nur Wartungspersonal mit einem Spezialwerkzeugs, Schloß und Schlüssel oder anderer Sicherheitsvorkehrungen Zugang hat, und der von dem für die Anlage zuständigen Gremium kontrolliert wird.**

Avvertenza **Questa unità deve essere installata in un'area ad accesso limitato. Un'area ad accesso limitato è un'area accessibile solo a personale di assistenza tramite un'attrezzo speciale, lucchetto, o altri dispositivi di sicurezza, ed è controllata dall'autorità responsabile della zona.**

Advarsel **Denne enheten er laget for installasjon i områder med begrenset adgang. Et område med begrenset adgang gir kun adgang til servicepersonale som bruker et spesielt verktøy, lås og nøkkel, eller en annen sikkerhetsanordning, og det kontrolleres av den autoriteten som er ansvarlig for området.**

Aviso **Esta unidade foi concebida para instalação em áreas de acesso restrito. Uma área de acesso restrito é uma área à qual apenas tem acesso o pessoal de serviço autorizado, que possua uma ferramenta, chave e fechadura especial, ou qualquer outra forma de segurança. Esta área é controlada pela autoridade responsável pelo local.**

¡Advertencia! **Esta unidad ha sido diseñada para instalarse en áreas de acceso restringido. Área de acceso restringido significa un área a la que solamente tiene acceso el personal de servicio mediante la utilización de una herramienta especial, cerradura con llave, o algún otro medio de seguridad, y que está bajo el control de la autoridad responsable del local.**

Varning! **Denna enhet är avsedd för installation i områden med begränsat tillträde. Ett område med begränsat tillträde får endast tillträdas av servicepersonal med ett speciellt verktyg, lås och nyckel, eller annan säkerhetsanordning, och kontrolleras av den auktoritet som ansvarar för området.**

Earthed Conductor Warning

Warning **This equipment has a connection between the earthed conductor of the DC supply circuit and the earthing conductor.**

- This equipment shall be connected directly to the DC supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the DC supply system earthing electrode is connected.
- This equipment shall be located in the same immediate area (such as adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same DC supply circuit and the earthing conductor, and also the point of earthing of the DC system. The DC system shall not be earthed elsewhere.
- The DC supply source is to be located within the same premises as this equipment.
- There shall be no switching or disconnecting devices in the earthed circuit conductor between the DC source and the point of connection on the earthing electrode conductor.

Attention **Cet appareil comporte une connexion entre le conducteur relie à la terra du circuit d'alimentation c.c. et son conducteur de terre.**

- Ce matériel doit être reccordé directement au conducteur de la prise de terre du circuit d'alimentation c.c. ou à une tresse de mise à la masse reliée à une barre omnibus de terre laquelle est raccordée à l'électrode de terre du circuit d'alimentation c.c.
- Les appareils don't les conducteurs de terre respectifs sont raccordés au conducteur de terre du même circuit d'alimentation c.c. doivent être installés à proximité les uns des autres (p.ex., dans des armoires adjacentes) et à proximite de la prise de terre du circuit d'alimentation c.c. Le circuit d'alimentation c.c. ne doit comporter aucune autre prise de terre.
- La source d'alimentation du circuit c.c. doit être située dans la même pièce que le matérial.
- Il ne doit y avoir aucun dispositif de commutation ou de sectionnement entre le point de raccordement au conducteur de la source d'alimentation c.c. st le point de raccordement à la prise de terre.

Power Cabling Warning

Warning **Secure all power cabling when installing this unit to avoid disturbing field-wiring connections.**

Waarschuwing **Zet alle stroomkabels vast wanneer dit toestel wordt geïnstalleerd om te voorkomen dat de verbindingen van de veldbedrading worden verstoord.**

Varoitus **Kiinnitä kaikki voimakaapelit tiukkaan tätä laitetta asentaessasi, jotta vältät kentän johdinkytkentöjen vioittumista.**

Attention **Lors de l’installation de cet appareil, fixer tous les câbles d’alimentation pour éviter de provoquer des perturbations aux raccordements des câblages propres au site.**

Warnung **Bei der Installation dieser Einheit die Netzverkabelung befestigen, um die Störung von Feldkabelanschlüssen zu vermeiden.**

Avvertenza **In fase di installazione dell'unità, assicurare tutti i cablaggi di alimentazione per evitare di alterare i collegamenti degli avvolgimenti di campo.**

Advarsel **Når denne enheten installeres, må alle kraftledninger sikres for å unngå at feltkabelkoblingene forstyrres.**

Aviso **Para evitar problemas com as ligações de rede de campanha, prenda todos os cabos de corrente quando instalar esta unidade.**

¡Advertencia! **Sujetar todo el cableado de alimentación cuando se instale este equipo para evitar que se mezcle con las conexiones del cableado "in situ".**

Varning! **Fäst allt starkströmskablage vid installation av denna enhet så att fältkopplingen inte rubbas.**

Ground Connection Warning

Warning **When installing or replacing the unit, the ground connection must always be made first and disconnected last.**

Waarschuwing **Bij installatie of vervanging van het toestel moet de aardverbinding altijd het eerste worden gemaakt en het laatste worden losgemaakt.**

Varoitus **Laitetta asennettaessa tai korvattaessa on maahan yhdistäminen aina tehtävä ensiksi ja maadoituksen irti kytkeminen viimeiseksi.**

Attention **Lors de l’installation ou du remplacement de l’appareil, la mise à la terre doit toujours être connectée en premier et déconnectée en dernier.**

Warnung **Der Erdanschluß muß bei der Installation oder beim Austauschen der Einheit immer zuerst hergestellt und zuletzt abgetrennt werden.**

Avvertenza **In fase di installazione o sostituzione dell'unità, eseguire sempre per primo il collegamento a massa e disconnetterlo per ultimo.**

Advarsel **Når enheten installeres eller byttes, må jordledningen alltid tilkobles først og frakobles sist.**

Aviso **Ao instalar ou substituir a unidade, a ligação à terra deverá ser sempre a primeira a ser ligada, e a última a ser desligada.**

¡Advertencia! **Al instalar o sustituir el equipo, conecte siempre la toma de tierra al principio y desconéctela al final.**

Varning! **Vid installation eller utbyte av enheten måste jordledningen alltid anslutas först och kopplas bort sist.**

Power Supply Wiring Warning

Warning **The illustration shows the DC power supply terminal block. Wire the DC power supply using the appropriate wire terminations at the wiring end, as illustrated. The proper wiring sequence is ground to ground, positive to positive (line to L), and negative to negative (neutral to N). Note that the ground wire should always be connected first and disconnected last**

Waarschuwing **De figuur toont de aansluitstrip van de gelijkstroomvoeding. Breng de bedrading aan voor de gelijkstroomvoeding met behulp van de juiste draadaansluitingen aan het draadeinde zoals aangegeven. De juiste bedradingsvolgorde is aarde naar aarde, positief naar positief (lijn naar L) en negatief naar negatief (neutraal naar N). Let op dat de aarddraad altijd het eerst verbonden en het laatst losgemaakt wordt.**

Varoitus **Kuva esittää tasavirran pääterasiaa. Liitä tasavirtalähde johdon avulla käyttäen sopivia johdinliitäntöjä johdon päässä kuvan esittämällä tavalla. Oikea kytkentäjärjestys on maajohto maajohtoon, positiivinen positiiviseen (johto L:ään) ja negatiivinen negatiiviseen (nollajohto N:ään). Ota huomioon, että maajohto on aina yhdistettävä ensin ja irrotettava viimeisenä.**

Attention **La figure illustre le bloc de connexion de l'alimentation en courant continu. Câbler l'alimentation en courant continu en fixant les extrémités de fil qui conviennent aux extrémités câblées conformément au schéma. La séquence de câblage à suivre est terre-terre, positif-positif (ligne sur L), et négatif-négatif (neutre sur N). Noter que le fil de masse doit toujours être connecté en premier et déconnecté en dernier.**

Warnung **Die Abbildung zeigt den Terminalblock des Gleichstrom-Netzgeräts. Verdrahten Sie das Gleichstrom-Netzgerät unter Verwendung von geeigneten Kabelschuhen am Verdrahtungsende (siehe Abbildung). Die richtige Verdrahtungsfolge ist Erde an Erde, positiv an positiv (Leitung an L) und negativ an negativ (neutral an N). Beachten Sie bitte, daß der Erdungsdraht immer als erster verbunden und als letzter abgetrennt werden sollte.**

Avvertenza **L'illustrazione mostra la morsettiera dell alimentatore CC. Cablare l'alimentatore CC usando i connettori adatti all'estremità del cablaggio, come illustrato. La corretta sequenza di cablaggio è da massa a massa, da positivo a positivo (da linea ad L) e da negativo a negativo (da neutro a N). Tenere presente che il filo di massa deve sempre venire collegato per primo e scollegato per ultimo.**

Advarsel **Figuren viser likestrømforsyningsenhetens tilkoplingsterminal. Likestrømforsyningsenheten tilkoples ved hjelp av ledningsavslutningene, slik som vist i figuren. Riktig tilkoplingssekvens er jord til jord, positiv til positv (linje til L), og negativ til negativ (nøytral til N). Husk at jordingsledningen alltid bør tilkoples først og frakoples sist.**

Aviso **A figura mostra o bloco do terminal de fornecimento de corrente contínua. Ligue o fornecimento de corrente contínua recorrendo aos terminadores localizados na extremidade do cabo, conforme ilustrado. A sequência correcta de instalação é terra-a-terra, positivo-positivo (linha para L), e negativo-negativo (neutro para N). Note que o fio de terra deverá ser sempre o primeiro a ser ligado, e o último a ser desligado.**

¡Atención! **La figura muestra la caja de bornes de la fuente de alimentación de corriente continua. Cablear la fuente de alimentación de corriente continua, usando los terminales apropiados, en el extremo del cable tal como se muestra. Las conexiones deben realizarse en el siguiente orden: tierra con tierra, positivo con positivo (la línea con la L) y negativo con negativo (el neutro con la N). Tenga en cuenta que el conductor de tierra siempre tiene que conectarse el primero y desconectarse el último.**

Varning! **Illustrationen visar anslutningsplinten för likströmförsörjningsenheten. Koppla ledningarna till strömförsörjningsenheten med lämpliga ledningsavslutningar som bilden visar. Korrekt kopplingssekvens är jord till jord, positiv till positiv (linje till L) och negativ till negativ (neutral till N). Observera att jordledningen alltid skall anslutas först och kopplas bort sist.**

Copper Conductors Warning

Warning **Use copper conductors only.**

Waarschuwing **Gebruik alleen koperen geleiders.**

Varoitus **Käytä vain kuparijohtimia.**

Attention **Utilisez uniquement des conducteurs en cuivre.**

Warnung **Verwenden Sie ausschließlich Kupferleiter.**

Avvertenza **Usate unicamente dei conduttori di rame.**

Advarsel **Bruk bare kobberledninger.**

Aviso **Utilize apenas fios condutores de cobre.**

¡Advertencia! **Emplee sólo conductores de cobre.**

Varning! **Använd endast ledare av koppar.**

Exposed DC Power Wire Warning

Warning **An exposed wire lead from a DC-input power source can conduct harmful levels of electricity. Be sure that no exposed portion of the DC-input power source wire extends from the terminal block plug.**

Waarschuwing **Een blootgestelde verbindingsdraad van een ingangsgelijkstroombron kan gevaarlijke elektriciteitsniveaus geleiden. Zorg ervoor dat geen blootgesteld deel van het draad van de ingangsgelijkstroombron zich uitstrekt vanuit het aansluitblok van de terminal.**

Varoitus **Tasavirtalähteestä tuleva avoin johto voi johtaa vaarallisen määrän sähköä. Varmista, ettei kaapelikengän pistokkeesta tule esille lainkaan tasavirtajohdon avointa osaa.**

Attention **Pour éviter tout risque de choc électrique, vérifiez que les câbles d'alimentation secteur sont protégés par une gaine. Aucun fil dénudé ne doit apparaître hors du bloc d'alimentation du terminal.**

Warnung **Eine ungeschützte Kabelleitung von einer Gleichstrom-Eingangsspannungsquelle kann schädliche Elektrizitätslevel führen. Achten Sie darauf, daß von dem Klemmleistenstecker aus kein ungeschütztes Eingangsgleichstromkabel freiliegt.**

Avvertenza **Un cavo elettrico scoperto proveniente da un alimentatore DC-INPUT può trasmettere scariche elettriche ad elevata tensione. Assicuratevi che i cavi in uscita dall'alimentatore DC-input non presentino punti scoperti.**

Advarsel **En avdekket ledning fra en likestrømskilde kan lede farlig elektrisitet. Kontroller at ingen avdekkede deler av ledningen til likestrømskilden stikker ut av terminalens koblingsblokk.**

Aviso **Um fio condutor exposto de uma unidade de entrada de DC (corrente contínua) pode transportar níveis perigosos de electricidade. Certifique-se de que nenhuma secção exposta de um fio condutor da fonte de energia de entrada de DC se extende a partir da ficha da placa de terminais.**

¡Advertencia! **Un cable desnudo de una fuente de entrada de alimentación de corriente directa (DC) puede conducir niveles de electricidad peligrosos. Asegúrese de que ninguna parte del cable de la fuente de alimentación de DC de entrada sale del enchufe del bloque de terminal.**

Varning! **En blottad trådledning från en likströmsförsörjningsenhet kan utgöra en ledare för skadliga elektricitetsnivåer. Se till att inte någon blottad ledningsdel från likströmsförsörjningsenheten sticker ut från stiftplinten.**

48 VDC Power System Warning

Warning The customer 48 volt power system must provide reinforced insulation between the primary AC power and the 48 VDC output.

Waarschuwing Het 48 volt stroomsysteem van de klant dient versterkte isolatie tussen de primaire wisselstroom en de 48 VDC-uitgang te verschaffen.

Varoitus Asiakkaan 48 voltin virtajärjestelmän on tarjottava vahvistettu eriste ensisijaisen vaihtovirtalähteen ja 48 voltin tasavirtaliitännän välille.

Attention Le bloc d'alimentation 48 volts du client doit assurer une isolation renforcée entre l'alimentation CA principale et la sortie 48 V CC.

Warnung Das 48-Volt-Stromsystem des Kunden muß eine verstärkte Isolierung zwischen dem primären Wechselstrom und dem 48 VDC-Output aufweisen.

Avvertenza Il sistema elettrico di 48 volt del cliente deve avere un isolamento fra l'alimentatore elettrico AC e il VDC 48 di output.

Advarsel Kundens eget 48 volts strømopplegg må ha forsterket isolasjon mellom den primære vekselstrømskilden og den 48 volts likestrømsutgangen.

Aviso O sistema habitual de corrente de 48 volts deverá fornecer isolamento reforçado entre a corrente alternada (AC) principal e a saída de 48 VDC (tensão em corrente contínua).

¡Advertencia! Aviso: El sistema del cliente de 48 voltios debe proporcionar aislamiento reforzado entre la energía principal AC y la potencia de salida de 48 VDC.

Varning! Kundens 48-volt strömsystem måste vara försett med förstärkt isolering mellan den primära växelströmmen och utmatningen av 48 V likström.

SELV-IEC 60950 DC Power Supply Warning

Warning Connect the unit only to DC power source that complies with the Safety Extra-Low Voltage (SELV) requirements in IEC 60950 based safety standards.

Waarschuwing Sluit de eenheid alleen maar aan op een gelijkstroombron die voldoet aan de veiligheidsvereisten voor extra-laag voltage (SELV) in de op IEC 60950 gebaseerde veiligheidsnormen.

Varoitus Liitä laite ainoastaan tasavirtalähteesen, joka on yhdenmukainen IEC 60950:n suojattujen erittäisen alhaisen jännitteen (SELV) turvavaatimusten kanssa.

Attention **Connectez l'unité uniquement à une alimentation CC compatible avec les recommandations SELV (Safety Extra-Low Voltage) des normes de sécurité IEC 60950.**

Warnung **Schließen Sie die Einheit nur an eine Gleichstrom-Stromquelle an, die mit den Safety Extra-Low Voltage (SELV)-Anforderungen in den auf IEC 60950 basierenden Sicherheitsstandards übereinstimmen.**

Avvertenza **Collegare l'unità esclusivamente a una presa di corrente continua rispondente ai requisiti SELV (Safety Extra-Low Voltage) in base alle norme di sicurezza IEC 60950.**

Advarsel **Koble bare enheten til en likestrømsforsyning som er i henhold til kravene for lavspenning (SELV) i IEC 60950-baserte sikkerhetsstandarder.**

Aviso **Conecte a unidade apenas à fonte da energia de CC que se encontra em conformidade com os requisitos dos circuitos de segurança de baixa tensão (SELV) constantes dos padrões de segurança baseados no IEC 60950.**

¡Advertencia! **Conecte la unidad sólo en una fuente de energía DC que cumpla con los requisitos de voltaje extra bajo (SELV - Extra-Low Voltage) en los estándares de seguridad IEC 60950.**

Varning! **Anslut enheten endast till en likströmsförsörjningsenhet som uppfyller kraven för SELV (skyddskretsar för mycket låg spänning) i IEC 60950-baserade säkerhetsstandarder.**

DC Power Disconnection Warning

Warning **Before performing any of the following procedures, ensure that power is removed from the DC circuit. To ensure that all power is OFF, locate the circuit breaker on the panel board that services the DC circuit, switch the circuit breaker to the OFF position, and tape the switch handle of the circuit breaker in the OFF position.**

Waarschuwing **Voordat u een van de onderstaande procedures uitvoert, dient u te controleren of de stroom naar het gelijkstroom circuit uitgeschakeld is. Om u ervan te verzekeren dat alle stroom UIT is geschakeld, kiest u op het schakelbord de stroomverbreker die het gelijkstroom circuit bedient, draait de stroomverbreker naar de UIT positie en plakt de schakelaarhendel van de stroomverbreker met plakband in de UIT positie vast.**

Varoitus **Varmista, että tasavirtapiirissä ei ole virtaa ennen seuraavien toimenpiteiden suorittamista. Varmistaaksesi, että virta on KATKAISTU täysin, paikanna tasavirrasta huolehtivassa kojetaulussa sijaitseva suojakytkin, käännä suojakytkin KATKAISTU-asentoon ja teippaa suojakytkimen varsi niin, että se pysyy KATKAISTU-asennossa.**

Attention **Avant de pratiquer l'une quelconque des procédures ci-dessous, vérifier que le circuit en courant continu n'est plus sous tension. Pour en être sûr, localiser le disjoncteur situé sur le panneau de service du circuit en courant continu, placer le disjoncteur en position fermée (OFF) et, à l'aide d'un ruban adhésif, bloquer la poignée du disjoncteur en position OFF.**

Warnung **Vor Ausführung der folgenden Vorgänge ist sicherzustellen, daß die Gleichstromschaltung keinen Strom erhält. Um sicherzustellen, daß sämtlicher Strom abgestellt ist, machen Sie auf der Schalttafel den Unterbrecher für die Gleichstromschaltung ausfindig, stellen Sie den Unterbrecher auf AUS, und kleben Sie den Schaltergriff des Unterbrechers mit Klebeband in der AUS-Stellung fest.**

Avvertenza **Prima di svolgere una qualsiasi delle procedure seguenti, verificare che il circuito CC non sia alimentato. Per verificare che tutta l'alimentazione sia scollegata (OFF), individuare l'interruttore automatico sul quadro strumenti che alimenta il circuito CC, mettere l'interruttore in posizione OFF e fissarlo con nastro adesivo in tale posizione.**

Advarsel **Før noen av disse prosedyrene utføres, kontroller at strømmen er frakoblet likestrømkretsen. Sørg for at all strøm er slått AV. Dette gjøres ved å lokalisere strømbryteren på brytertavlen som betjener likestrømkretsen, slå strømbryteren AV og teipe bryterhåndtaket på strømbryteren i AV-stilling.**

Aviso **Antes de executar um dos seguintes procedimentos, certifique-se que desligou a fonte de alimentação de energia do circuito de corrente contínua. Para se assegurar que toda a corrente foi DESLIGADA, localize o disjuntor no painel que serve o circuito de corrente contínua e coloque-o na posição OFF (Desligado), segurando nessa posição a manivela do interruptor do disjuntor com fita isoladora.**

¡Advertencia! **Antes de proceder con los siguientes pasos, comprobar que la alimentación del circuito de corriente continua (CC) esté cortada (OFF). Para asegurarse de que toda la alimentación esté cortada (OFF), localizar el interruptor automático en el panel que alimenta al circuito de corriente continua, cambiar el interruptor automático a la posición de Apagado (OFF), y sujetar con cinta la palanca del interruptor automático en posición de Apagado (OFF).**

Varning! **Innan du utför någon av följande procedurer måste du kontrollera att strömförsörjningen till likströmskretsen är bruten. Kontrollera att all strömförsörjning är BRUTEN genom att slå AV det överspänningsskydd som skyddar likströmskretsen och tejpa fast överspänningsskyddets omkopplare i FRÅN-läget.**

DC Input Wiring Warning

Warning **Use 10 AWG wire with insulation rated for 75˚C (167˚F) or higher to wire the DC input power supply to the power feed panel.**

Waarschuwing **Gebruik kabels van 10 AWG (American Wire Gauge) met een isolering voor tenminste 75˚ celsius om de gelijkstroomvoedingseenheid op de netvoeding aan te sluiten.**

Varoitus **Käytä 10 AWG:n johdinta, jonka eristys kestää vähintään 75˚C, kun vedät johdot virtalähteestä virransyöttöpaneeliin.**

Attention **Utilisez un câble isolé de 10 AWG (American Wire Gauge) conçu pour une température d'au moins 75˚C (167˚F) pour relier la source d'alimentation en courant continu au panneau d'alimentation.**

Warnung **Verwenden Sie ein 10 AWG (American Wire Gauge) Kabel mit Isolierung für mindestens 75˚C, um das Eingangsgleichstrom-Netzgerät mit dem Power Feed Panel zu verdrahten.**

Avvertenza **Per collegare l'alimentazione di corrente continua in entrata al pannello di alimentazione, usare un cavo 10 AWG con capacità di coibentazione per 75˚C (167˚F) o superiore.**

Advarsel **Bruk en 10 isolert AWG-ledning beregnet på 75˚C eller mer for å koble strømforsyningen til strømpanelet.**

Aviso **Utilize fio 10 AWG com isolamento indicado para 75˚C (167˚F) ou superior para ligar o fornecimento de alimentação de entrada de corrente contínua ao painel de alimentação de energia.**

¡Advertencia! **Utilice un cable 10 AWG (American Wire Gauge) con un aislamiento cualificado para 75˚C (167˚F) o superior al conectar la entrada de corriente continua al panel de alimentación.**

Varning! **Använd 10 AWG-kabel med isolering som klarar minst 75˚C för likströmsförsörjningen till strömpanelen.**

Ground Wire Connection Warning

Warning **For personal safety, the ground wire must connect to safety (earth) ground at both the equipment and supply side of the DC wiring (unless the local electrical code requirements are different).**

Waarschuwing **Om veiligheidsredenen moet de gebruikte gelijkstroomkabel aan beide zijden, zowel waar deze is aangesloten op de apparatuur als waar deze is aangesloten op de netvoeding, voorzien zijn van aarding (tenzij de ter plaatse geldende elektricteitsvoorschriften anders bepalen).**

Varoitus **Turvallisuussyistä on maadoitusjohdon oltava kytketty maadoitukseen sekä laitteessa että virtalähteessä (ellei sähkösäännöksissä vaadita muuta).**

Attention **Pour votre sécurité, le fil de masse doit être relié à la terre au niveau de l'équipement et de la source d'alimentation du câblage d'alimentation en courant continu (sauf si les normes électriques locales sont différentes).**

Warnung **Zu Ihrer eigenen Sicherheit muss der Erdungsdraht sowohl am Gerät als auch an der Stromquelle der Gleichstromverkabelung sicher geerdet sein (es sei denn, die örtlichen Sicherheitsstandards lauten anders).**

Avvertenza **Per garantire l'incolumità personale, il cavo di messa a terra deve essere collegato alla terra dalla parte sia dell'apparecchiatura che dell'alimentazione dei cavi di corrente continua (a meno che i requisiti dei codici elettrici locali indichino diversamente).**

Advarsel **For å beskytte person må jordingsledningen være koblet til jord både på utstyrssiden og strømforsyningssiden av strømledningen (med mindre lokale forskriftskrav er annerledes).**

Aviso **Por razões de segurança, o fio terra deve ter ligação terra no equipamento e no fornecimento de energia dos fios de corrente contínua (a não ser que os requisitos eléctricos locais seja diferentes).**

¡Advertencia! **Para mayor seguridad, el cable de toma de tierra debe conectarse a una toma de tierra segura tanto en el equipo como en la parte del cableado de CC (a no ser que las normas eléctricas locales establezcan algo distinto).**

Varning! **Jordkabeln måste, för personsäkerhetens skull, vara jordad både vid utrustningen och uttaget för likströmskablaget (om inte de lokala elföreskrifterna säger annorlunda).**

Ground Conductor Warning

Warning **Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.**

Waarschuwing **De aardingsleiding mag nooit buiten werking gesteld worden en de apparatuur mag nooit bediend worden zonder dat er een op de juiste wijze geïnstalleerde aardingsleiding aanwezig is. Neem contact op met de bevoegde instantie voor elektrische inspecties of met een elektricien als u niet zeker weet of voor passende aarding gezorgd is.**

Varoitus **Älä koskaan ohita maajohdinta tai käytä laitteita ilman oikein asennettua maajohdinta. Ota yhteyttä asianmukaiseen sähkötarkastusviranomaiseen tai sähköasentajaan, jos olet epävarma maadoituksen sopivuudesta.**

Attention **Ne jamais rendre inopérant le conducteur de masse ni utiliser l'équipement sans un conducteur de masse adéquatement installé. En cas de doute sur la mise à la masse appropriée disponible, s'adresser à l'organisme responsable de la sécurité électrique ou à un électricien.**

Warnung **Umgehen Sie auf keinen Fall den Erdungsleiter und nehmen Sie die Geräte nicht in Betrieb, wenn der Erdungsleiter nicht sachgemäß installiert ist. Wenden Sie sich an die entsprechende Behörde, die für die Inspektion elektrischer Anlagen zuständig ist, oder an einen Elektriker, wenn Sie nicht sicher sind, ob der Anschluß ordnungsgemäß geerdet ist.**

Avvertenza **Non escludere mai il conduttore di protezione né usare l'apparecchiatura in assenza di un conduttore di protezione installato in modo corretto. Se non si sa con certezza che è disponibile un collegamento di messa a terra adeguato, esaminare le Norme CEI pertinenti o rivolgersi a un elettricista qualificato.**

Advarsel **Jordingslederen må aldri hindres, og utstyret må aldri brukes uten at en forsvarlig jordingsleder er installert. Kontakt elektrisitetstilsynet eller en elektriker dersom du er usikker på om riktig jording er tilgjengelig.**

Aviso **Nunca anule o condutor à terra nem opere o equipamento sem ter um condutor à terra adequadamente instalado. Em caso de dúvida em relação ao sistema de ligação à terra, contacte os serviços locais de inspecção eléctrica ou um electricista qualificado.**

¡Advertencia! **No desactive nunca el conductor de tierra ni opere el equipo sin un conductor de tierra instalado correctamente. Póngase en contacto con las autoridades de inspección eléctrica pertinentes o con un electricista, si no está seguro de contar con una toma de tierra adecuada.**

Varning! **Koppla aldrig från jordledningen och använd aldrig utrustningen utan en på lämpligt sätt installerad jordledning. Om det föreligger osäkerhet huruvida lämplig jordning finns skall elektrisk besiktningsauktoritet eller elektriker kontaktas.**

No. 26 AWG Wire Warning

Warning **To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cord.**

Waarschuwing **Om brandgevaar te reduceren, dient slechts telecommunicatielijnsnoer nr. 26 AWG of groter gebruikt te worden.**

Varoitus **Tulipalovaaran vähentämiseksi käytä ainoastaan nro 26 AWG- tai paksumpaa tietoliikennejohdinta.**

Attention **Pour réduire le risque d'incendie, n'utiliser que des cordons de lignes de télécommunications de type AWG nº 26 ou plus larges.**

Warnung **Zur Reduzierung der Feuergefahr eine Fernmeldeleitungsschnur der Größe 26 AWG oder größer verwenden.**

Avvertenza **Per ridurre il rischio di incendio, usare solo un cavo per linea di telecomunicazioni di sezione 0,12 mm^2 (26 AWG) o maggiore.**

Advarsel **Bruk kun AWG nr. 26 eller telekommunikasjonsledninger med større dimensjon for å redusere faren for brann.**

Aviso **Para reduzir o risco de incêndio, utilize apenas terminais de fio de telecomunicações Nº. 26 AWG ou superiores.**

¡Advertencia! **Para reducir el riesgo de incendios, usar sólo líneas de telecomunicaciones de calibre No. 26 AWG o más gruesas.**

Varning! **För att minska brandrisken skall endast Nr. 26 AWG eller större telekommunikationsledning användas.**

Coaxial Cable Specification Warning

Warning Use 50-ohm coaxial cable with a center conductor size of 10 AWG or larger (for example, LMR-400, 3/8-inch FSJ Superflex Heliax, or larger). Failure to do so can result in overheating, fire, or long-term failure. Local and national electrical codes must be observed.

Waarschuwing Gebruik coaxiale kabels van 50 ohm met een centrale ader van tenminste 10 AWG (American Wire Gauge), bijvoorbeeld LMR-400, 3/8-inch FSJ Superflex Heliax, of groter. Bij gebruik van andere kabels kan oververhitting optreden of kunnen zich op lange termijn systeemproblemen voordoen. Plaatselijke en nationale voorschriften op het gebied van elektriciteitsvoorzieningen moeten in acht worden genomen.

Varoitus Käytä 50 ohmin koaksiaalikaapelia, jonka keskijohdin on kooltaan vähintään 10 AWG (esim. LMR-400, 3/8 tuuman FSJ Superflex Heliax tai suurempi). Ellet tee niin, voi seurauksena olla ylikuumeneminen, tulipalo tai pitkäaikainen häiriö. On noudatettava paikallisia ja kansallisia sähkösäännöksiä.

Attention Utilisez un câble coaxial de 50 ohm doté d'un conducteur central d'au moins 10 AWG (American Wire Gauge), par exemple, LMR-400 ou FSJ Superflex Heliax d'au moins 3/8 de pouce. Autrement, il y a risque de surchauffe, d'incendie ou de défaillance grave. Vous devez respecter les normes électriques locales et nationales.

Warnung Verwenden Sie ein 50-Ohm-Koaxialkabel mit einem Zentralleiter von mindestens 10 AWG (beispielsweise LMR-400, 3/8-Zoll FSJ Superflex Heliax oder größer). Andernfalls besteht die Gefahr von Überhitzung, Brand oder langfristigen Schäden. Örtliche und nationale Sicherheitsstandards müssen eingehalten werden.

Avvertenza Usare un cavo coassiale da 50 ohm con dimensione di conduttore centrale di 10 AWG o superiore (ad esempio, LMR-400, FSJ Superflex Heliax 3/8 di pollice o superiore). La mancata osservanza di queste indicazioni può risultare in surriscaldamento, incendio o eventuale malfunzionamento. È necessario osservare le normative in materia elettrica locali e nazionali.

Advarsel Bruk en 50 ohms koakskabel med en senterleder med en størrelse på 10 AWG eller større (f.eks. LMR-400, 3/8 tommers FSJ Superflex Heliax, eller større). Hvis ikke dette gjøres, kan det føre til overoppheting, brann eller langvarige driftsfeil. Lokale og nasjonale elektrisitetsforskrifter må følges.

Aviso Utilize um cabo coaxial de 50-ohm com um condutor central de 10 AWG ou superior (por exemplo, LMR-400, FSJ Superflex Heliax 3/8 pol., ou superior). O incumprimento pode ter como resultado sobreaquecimento, incêndio ou falhas a longo prazo. Devem ser respeitados os preceitos eléctricos locais e nacionais.

¡Advertencia! **Utilice cable axial de 50 ohmios con un conductor central de 10 AWG (American Wire Gauge) de tamaño o superior (por ejemplo, LMR-400, Superflex Heliax FSJ de 3/8 pulgadas o superior). De lo contrario se puede producir sobrecalentamiento, incendios o fallos de funcionamiento a largo plazo. Se deben seguir las normas eléctricas locales y nacionales.**

Varning! **Använd en koaxialkabel på 50 ohm med en central ledningsyta på minst 10 AWG (t.ex. LMR-400, 3/8-tums FSJ Superflex Heliax eller större). Underlåtenhet att göra det kan orsaka överhettning, brand eller långvarigt funktionsavbrott. De lokala och nationella elföreskrifterna måste följas.**

Transverter Location Warning

Warning **Do not locate the transverter near overhead power lines or other electric light or power circuits, or where it can come into contact with such circuits. (See Figure 28.) When installing the transverter, take extreme care not to come into contact with such circuits, as they may cause serious injury and death.**

Waarschuwing **Zorg dat de transverter niet in de buurt wordt geplaatst van langs het plafond lopende stroomkabels of andere voorzieningen voor licht of elektriciteit of op een plaats waar contact met dergelijke stroomvoorzieningen mogelijk is. (Zie Figuur 28.) Wees bij het installeren van de transverter uiterst voorzichtig dat u niet in contact komt met hierboven bedoelde stroomvoorzieningen, aangezien dit kan leiden tot ernstig letsel, de dood tot gevolg hebbende.**

Varoitus **Älä sijoita muunninta lähelle voimajohtoja, muita sähkövalo- tai virtapiirejä tai paikkaa, jossa se voi joutua kosketuksiin sellaisten piirien kanssa. (Katso kuva 28.) Kun asennat muunninta, pidä huolta, ettet joudu kosketuksiin mainittujen piirien kanssa, sillä seurauksena voi olla vakava vamma tai kuolema.**

Attention **Ne placez pas la commutatrice à proximité d'une ligne aérienne ou d'autres circuits d'éclairage ou d'alimentation, ou dans un endroit où elle risque d'être en contact avec des circuits de ce type. (Voir Figure 28.) Lors de son installation, assurez-vous bien qu'elle ne touche pas de tels circuits car cela risquerait d'entraîner des blessures graves voire mortelles.**

Warnung **Plazieren Sie den Transverter nicht in der Nähe von Starkstrom-Freileitungen oder Schwach- bzw. Starkstromkreisen oder an Stellen, wo er damit in Kontakt kommen könnte. (Siehe Abbildung 28) Gehen Sie bei der Installation des Transverters besonders vorsichtig vor, damit Sie nicht in Kontakt mit derartigen Stromkreisen kommen, da dies zu schweren Verletzungen sogar mit Todesfolge führen kann.**

Avvertenza **Non posizionare il transverter nelle vicinanze di cavi di corrente o di circuiti di illuminazione o di alimentazione, o dove potrebbe venire in contatto con tali circuiti (vedere la figura 28). Durante l'installazione del transverter prestare estrema attenzione a non entrare in contatto con tali circuiti, dal momento che potrebbero causare seri danni e morte.**

Advarsel **Plasser ikke tverrlederen nær de overliggende strømledningene eller andre lys- eller strømkretser, eller der den kan komme i kontakt med slike kretser. (Se Figure 28) Ved installering av tverrlederen, må du være ytterst forsiktig slik at du ikke kommer i kontakt med slike kretser. Dette kan føre til alvorlig skade eller dødsulykke.**

Aviso **Não coloque o transformador perto de linhas de corrente suspensas ou outros circuitos de luz eléctrica ou de corrente, ou onde possa ter contacto com esses circuitos. (Consultar Figure 28) Ao instalar o transformador tenha muito cuidado para não tocar nesses circuitos, visto que podem provocar ferimentos graves ou até morte.**

¡Advertencia! **No coloque el transverter cerca de cables de tendido eléctrico u otros circuitos, ni donde pueda entrar en contacto con dichos circuitos. (Ver Figura 28) Al instalar el transverter, extreme las precauciones para no entrar en contacto con circuitos de esas características, ya que puede sufrir heridas graves e incluso la muerte.**

Varning! **Placera inte transvertern nära överhängande kraftledningar, andra elljus- eller strömkretsar eller där den kan komma i kontakt med sådana kretsar. (Se Bild 30) Vid installation av transvertern måste du vara mycket försiktig så att du inte kommer i kontakt med sådana kretsar, eftersom de kan orsaka allvarlig kroppsskada och dödsfall.**

Obtaining Documentation

The following sections provide sources for obtaining documentation from Cisco Systems.

World Wide Web

You can access the most current Cisco documentation on the World Wide Web at the following sites:

- http://www.cisco.com
- http://www-china.cisco.com
- http://www-europe.cisco.com

Documentation CD-ROM

Cisco documentation and additional literature are available in a CD-ROM package, which ships with your product. The Documentation CD-ROM is updated monthly and may be more current than printed documentation. The CD-ROM package is available as a single unit or as an annual subscription.

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Technical Assistance Center

The Cisco TAC website is available to all customers who need technical assistance with a Cisco product or technology that is under warranty or covered by a maintenance contract.

Contacting TAC by Using the Cisco TAC Website

If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

http://www.cisco.com/register/

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

http://www.cisco.com/tac/caseopen

Contacting TAC by Telephone

If you have a priority level 1 (P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.

This document is to be used in conjunction with the *Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide* and *Cisco uBR7200 Series Universal Broadband Router Software Configuration Guide* publications.