C H A P T E R **3**

Installing the Cisco uBR924 Router

This chapter contains the following sections that provide instructions on installing the router, initial power-on, and verifying the installation:

- Cisco uBR924 Router Installation Checklist
- Physical Placement
- Verifying Power Requirements
- Connecting to the Cable System
- Connecting the Ethernet Cables
- Connecting to Telephones or Fax Devices
- Connecting the Backup POTS Connection
- Connecting Power
- Connecting to Telephones or Fax Devices
- Router Power-On and Initialization Sequence
- Verifying Installation

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Caution   Before proceeding with the installation, verify that you have fulfilled all of the requirements listed in Chapter 2, "Preparing for Installation." Also read and follow the safety guidelines in the "Safety" section on page 2-1, as well as those contained in this chapter.

Cisco uBR924 Router Installation Checklist

Table 3-1 presents a checklist, identifying the installation tasks to complete at each subscriber site. Use this table as a guide while installing the router.

Table 3-1   Installation Checklist

Checked Off	Task	For More Information, See...
	Ensure the selected location to install the router is free of dust and meets all requirements.	"Environmental" section on page 2-4
	Install the Cisco uBR924 router: • Close to the cable drop connection. • On a stable, flat surface or desktop close to the devices to be connected such that your cables reach all devices, but in a location where the bottom, sides, and rear of the router are clear of obstructions and away from the exhaust of other equipment. • Close to the power source—depending on the country in which the router operates, the power source must be a grounded 100 to 240 VAC outlet. • Near to a standard, analog telephone line if the router connects to a backup POTS connection.	"Physical Placement" section on page 3-4
	Check the power at the subscriber site before and after installation to ensure that you are receiving clean power. Ensure proper grounding.	"Verifying Power Requirements" section on page 3-4
	Verify that each PC to be connected to the router has an Ethernet NIC and that TCP/IP networking with DHCP support is enabled. Ensure that all other PC prerequisites are met.	
	Connect the router's F-connector to the cable TV coaxial drop cable. (If the subscriber also subscribes to cable TV services, install a cable splitter/directional coupler and high-pass filter as appropriate.)	"Connecting to the Cable System" section on page 3-5
	Connect the Cisco uBR924 router to CPE devices at the site: • To directly connect PCs to the Cisco uBR924 router, connect up to four of the unit's Ethernet hub ports directly to the 10BaseT Ethernet (RJ-45) ports of the PCs. Use 10BaseT Ethernet straight-through cables. • To connect additional PCs/devices at the site or to connect to an existing network at the site, connect one of the unit's Ethernet hub ports directly to the 10BaseT Ethernet port of an Ethernet hub. Use a 10BaseT Ethernet crossover cable. Then connect each computer/device to the hub, again using 10BaseT Ethernet crossover cables. Note If your hub has an uplink port, you might be able to use straight-through cables to connect the hub to the PC.	"Connecting the Ethernet Cables" section on page 3-6

Table 3-1   Installation Checklist (continued)

Checked Off	Task	For More Information, See...
	Connect the router's Phone V1+V2 and V2 connectors (RJ-11 to RJ-11) to telephones or fax devices directly, or to adapter(s) that allow multiple telephones or fax devices to be connected to the two VoIP telephone line(s). At subscriber sites supporting multiple voice devices on a single VoIP telephone line, ensure you have all certified connector assemblies/adapters and wiring items needed to support the configuration. ✎ **Note** Cisco does not provide these items. Since the V1+V2 connector is a 4-wire port, with the second telco pair wired in parallel with V2, a two-line telephone can be plugged into the V1+V2 connector using a single cable if the cable has four wires. If this is done, the V2 port is not used.	"Connecting to Telephones or Fax Devices" section on page 3-7
	Attach the 7-pin end of the power supply cord into the router's Power connector and connect the other end to the power supply. Plug the router's power supply into the wall outlet. Watch the router power on and initialize.	"Connecting Power" section on page 3-10
	If applicable, connect the router's Line (RJ-11 to RJ-11) connector to a standard, analog POTS telephone line. Verify the telephone circuit/connection is working.	"Connecting the Backup POTS Connection" section on page 3-9
	Power on all other devices at the subscriber site: PCs, Ethernet hub and all other equipment as applicable.	"Router Power-On and Initialization Sequence" section on page 3-12
	Ensure the data channel frequency has a sufficient RF signal level to meet your cable plant specifications and verify the RF input levels relative to a nearby analog video level: • Check the RF signal with an RF power meter at the Type F coax connector to verify the DOCSIS system signal. • Verify the nearby analog video signal is within the correct range—0 to +15 dBmV for most CATV systems.	
	Test the installation: • Establish an Internet connection and request data from a PC connected to the router. • Make a VoIP telephone call. • Send a VoIP fax. • To test the backup POTS connection, disconnect the three prong end of the power cord from the power outlet to power off the Cisco uBR924 (follow safety instructions in the "Connecting Power" section on page 3-10) and verify that a call can be established over the PSTN. Hang up that call, wait until the Cisco uBR924 reboots, and reverify that a VoIP telephone call can be made.	"Verifying Installation" section on page 3-13

Physical Placement

Place the cable access router on a stable, flat surface such as a desktop, close to the cable TV drop connection and all devices to be connected at the subscriber site. The bottom, sides, and rear of the router must remain unobstructed to ensure adequate airflow and to prevent the unit from overheating. The rubber feet on the bottom of the router provide enough clearance when the unit is placed on a flat, hard surface. Cisco recommends at least 3 inches of clearance at the rear of the router.

⚠

Caution Do not place the router on an uneven or soft surface.

Install the router in compliance with all national and local electrical codes such as:

- US NFPA 70
- Canadian Electrical Code, part I, CC22.1
- IEC 364, part 1 through part 7

Verifying Power Requirements

The cable access router uses one external AC-input power supply. The OK (power) LED on the front of the unit indicates that the power supply is supplying power to the unit when it is connected and operational.

The AC-input power supply uses a power factor corrector that allows the Cisco uBR924 cable access router to operate in any country where the input voltage is between 100 and 240 VAC, and 50 or 60 Hz. Different power cords are available to suit the country of operation.

Refer to Table A-1 on page A-1 for AC-input power supply specifications, including input voltage and operating frequency ranges. Cisco recommends that you follow these precautions:

- Check the power at the subscriber site before and after installation to ensure that you are receiving clean power. Install a power conditioner if necessary.

⚠

Warning The plug-socket combination must be accessible at all times because it serves as the main disconnecting device.

- If plugging the router into an Uninterruptible Power Supply (UPS), verify that the total power and current requirements used by all devices plugged into the UPS are within the maximum limits of the UPS.
- Install proper grounding to avoid damage from lightning and power surges. If using a North American (NEMA 5-15P) plug, you must plug the unit into a three-lead receptacle to ensure proper grounding.

⚠

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.

- Ensure that a fuse or circuit breaker no larger than 120 VAC, 15A U.S. (240 VAC, 10A International) is used on the phase conductors (all current-carrying conductors providing power to the device).

- Do not work on the system or connect or disconnect any cables (Ethernet, cable, or power) during periods of lightning activity—the possibility of serious physical injury exists if lightning should strike and travel through those cables. In addition, the equipment could be damaged by the higher levels of static electricity present in the atmosphere.

Note   Adhere to the safety guidelines presented in the "Safety" section on page 2-1 before following procedures in the remainder of this chapter. Be sure all equipment to be connected to the cable access router is powered off.

Caution   Do not connect the router to power at this point because the router will begin its initial power-on sequence and attempt to connect to the network. The unit should be powered on only after all other connections have been made, as described later in this chapter.

Connecting to the Cable System

To connect the Cisco uBR924 router to the cable system:

Step 1   Verify that the router is not connected to power.

Step 2   Locate the RF coaxial cable coming from the CATV wall outlet.

Step 3   Install a cable splitter/directional coupler if needed to separate signals for TV and computer usage. If necessary, also install a high-pass filter to prevent interference between the TV and computer signals.

Step 4   Connect the RF coaxial cable to the router's F-connector. Hand-tighten the connector, making sure it is finger tight; then give it a 1/6 turn with a wrench. (See Figure 3-1.)

Figure 3-1   Connecting the CATV Coaxial Cable to the Cisco uBR924 Router

⚠
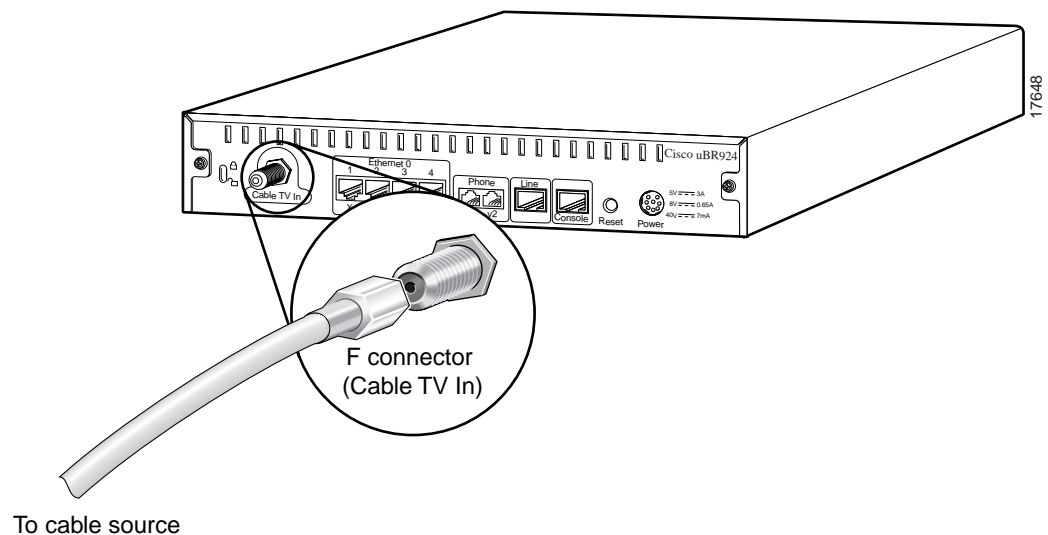
Caution   Do not overtighten the connector because this can break off the connector. Using a torque wrench is not recommended because of the danger of tightening the connector more than the recommended 1/6 turn after it is finger tight.

Step 5   Make sure all other coaxial cable connectors—all intermediate splitters, couplers, or ground blocks—are securely tightened from the distribution tap to the Cisco uBR924 router, following instructions in step 4.

✎

Note   Loose connectors inside the building or residence can cause intermittent router operation.

⚠

Caution   To ensure compliance with FCC limits, connection to the cable system must be made with a high-quality, shielded cable. If the quality or general condition of the coaxial cable at the subscriber site is in question, Cisco recommends that you replace the coaxial cable. For more information on the effects of substandard cabling on the cable access router installation, see the "Cabling" section on page 2-6.

Connecting the Ethernet Cables

To connect the Cisco uBR924 router to computers and other CPE devices at the site:

Step 1   Locate all needed 10BaseT RJ-45 Ethernet cables:

- Use straight-through Ethernet cables to directly connect up to four PCs to the Cisco uBR924 cable access router's four Ethernet hub ports.

- Use a crossover Ethernet cable to connect the Cisco uBR924 cable access router to an Ethernet hub if more than four PCs or other LAN devices are to be connected at the site (supported only when running Cisco IOS Release 12.0(5)T or higher images). Connect all devices to the hub using straight-through Ethernet cables. (If your hub has an uplink port, you might be able to use a straight-through cable to connect the hub directly to the computer.)

Step 2   Connect one end of the Ethernet cable to one of the router's Ethernet ports (labeled 1X, 2X, 3X, or 4X) at the rear of the unit. (See Figure 3-2.)

Figure 3-2   Connecting the Ethernet Cable to the Cisco uBR924 Cable Access Router
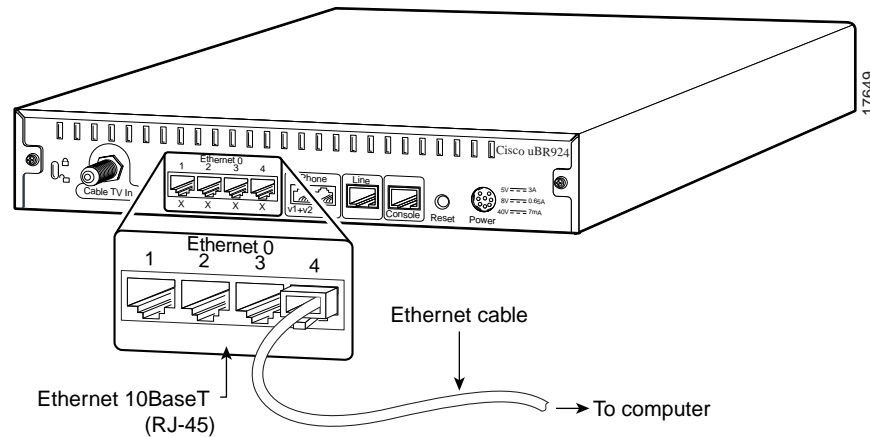
Note   Do not connect the Ethernet cables into the RJ-45 console connector.

Step 3   Press the cable end firmly into the router's Ethernet receptacle and connect the other end to the computer or hub as applicable.

Step 4   Repeat steps 2 and 3 for each Ethernet connection from the Cisco uBR924 cable access router.

Warning   **To avoid electric shock, do not connect safety extra-low voltage (SELV) circuits to the telephone-network voltage (TNV) circuits. LAN ports contain SELV circuits and WAN ports contain TNV circuits. RJ-45 connectors are used for both LAN and WAN ports—use caution when connecting cables to ensure that the proper ports are being connected.**

Hazardous network voltages are presented in WAN ports regardless of whether power to the unit is OFF or ON. To avoid electric shock, use caution when working near WAN ports. When detaching cables, detach the end away from the unit first.

Connecting to Telephones or Fax Devices

If you have purchased voice services from your service provider and are using a Cisco IOS image with voice support, use the following procedure to connect the Cisco uBR924 router to telephone or fax devices at the site:

Step 1   Use one RJ-11 to RJ-11 cable for each analog telephone or fax device that is directly connected to the Cisco uBR924 router. If multiple analog telephones or fax devices are to be connected to a VoIP telephone line, ensure the wiring is in place to support the configuration and assemble all needed items to support the site's configuration.

✎
Note   Refer to the "Required Tools and Equipment" section on page 2-11. Cisco does
not provide these items.

Step 2   Connect one end of the cable to one of the Phone ports (labeled V1+V2 and V2) at the rear of the router.
Press the cable firmly into the receptacle. (See Figure 3-3.)

Figure 3-3   Telephone Cable and RJ-11 Connector
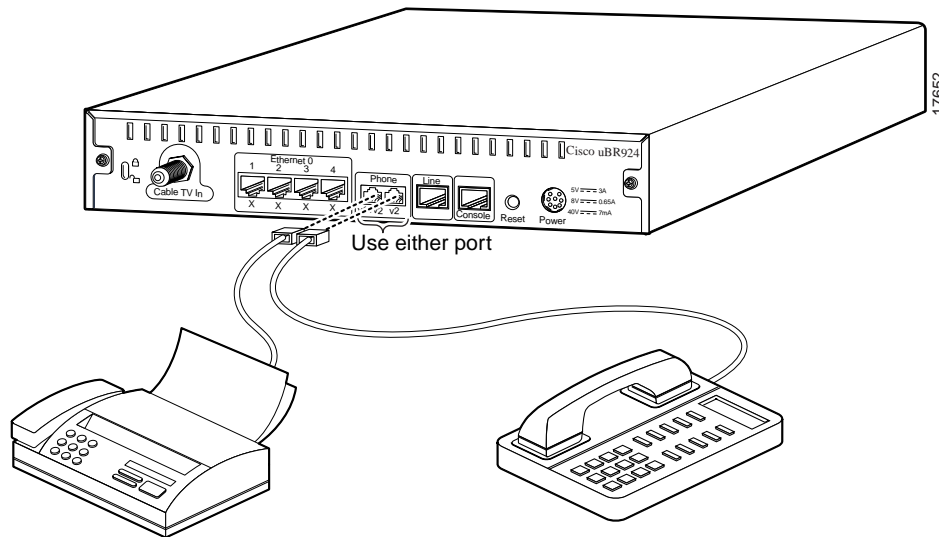
The V1+V2 connector supports either a single-line analog telephone or a two-line analog telephone that
uses four wires. If using a two-line telephone, line 2 of the telephone behaves as if a single-line
telephone is plugged into the second voice port. In this configuration, devices plugged into the V2 port
act as extensions to the line 2 telephone.

✎
Note   Use only telephones with a pushbutton dial set. Fax/modem cards and software on
a PC can be used but only in fax mode; the data mode of the fax/modem card
cannot be used with the VoIP network. Contact your network management,
provisioning, or operations team to determine if modems are supported across
your VoIP network. When combining telephones and fax devices on a VoIP line,
only one voice call—telephone or fax—can be active on that line at a time.

Step 3   Connect the other end of each RJ-11 cable directly to the telephone or fax device as shown in
Figure 3-3. For multiple telephones or fax devices, connect the other end to an adapter and ensure all
telephones and fax devices are connected correctly on that VoIP telephone line.

⚠
Caution   If you are connecting multiple telephones or fax devices to a telephone line, be sure the
sum of the RENs of all devices on any one line does not exceed five. If too many devices
are attached, they may not ring properly.

⚠
Warning   **Equipment must be installed using an acceptable method of connection. Install adapters and/or connector assembly parts to support multiple voice devices per VoIP telephone line in compliance with regulations in your country. Incorrect connection of this or connected equipment to a general purpose outlet could result in a hazardous situation.**

Step 4   Repeat steps 2 and 3 to connect the device(s) to the second telephone line according to the configuration to support at the site.

⚠
Warning   **This equipment contains a ring signal generator (ringer), which is a source of hazardous voltage. Do not touch the RJ-11 (phone) port wires (conductors), the conductors of a cable connected to the RJ-11 port, or the associated circuit board when the ringer is active. The ringer is activated by an incoming call.**

Connecting the Backup POTS Connection

To connect the Cisco uBR924 router to the backup, standard analog telephone line, follow the instructions below.

⚠
Warning   **To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cord. For Australia and New Zealand operation, this equipment is to be installed and maintained by service personnel only as defined by AS/NZS 3260 Clause 1.2.14.3 Service Personnel.**

Step 1   Obtain an RJ-11 to RJ-11 cable (minimum 26 AWG).

Step 2   Connect one end of the cable to the backup POTS line port (labeled Line) at the rear of the router. Press the cable firmly into the receptacle. When properly connected, the RJ-11 connector locks into the receptacle and can only be removed by pressing the plastic tab on the connector while pulling the cable back from the receptacle. (See Figure 3-4.)

Figure 3-4   Backup Telephone Line Connector

To RJ-11 phone wall jack
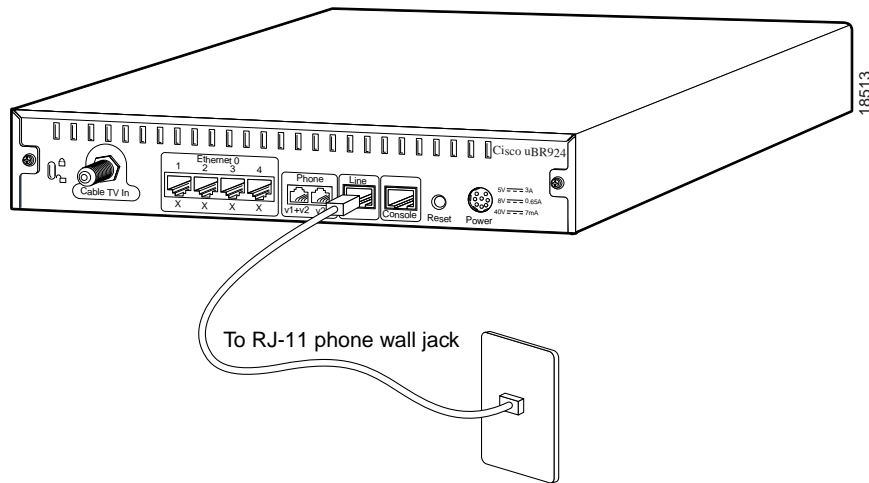
Step 3   Connect the other end of the cable to the telephone wall jack.

Warning   **This equipment contains a ring signal generator (ringer), which is a source of hazardous voltage. Do not touch the RJ-11 (phone) port wires (conductors), the conductors of a cable connected to the RJ-11 port, or the associated circuit board when the ringer is active. The ringer is activated by an incoming call.**

When the Cisco uBR924 router has a backup connection to the PSTN and the router loses power while VoIP calls are in progress, the subscriber can establish a voice connection by dialing out over the public switched telephone network (PSTN).

The backup POTS connection enables only one of the two VoIP lines connected to the Cisco uBR924 router to function during a power outage. Calls in progress prior to the power outage are disconnected. If power is re-established while a cutover call is in progress, that connection remains in place until the call is terminated. When the call is terminated, the router automatically reboots.

Note   Calls using the backup POTS connection are made over the PSTN, not the VoIP network. Any special features of the VoIP network are not available until power is restored and network connections are re-established.

Connecting Power

To connect AC-input power to the Cisco uBR924 router:

Step 1   Locate the power receptacle at the rear of the cable access router. (Refer to "Verifying Power Requirements" section on page 3-4 to verify that this power source is adequate for the router.)

Step 2   Plug the 7-pin end of the AC power supply cord into the power connector at the rear of the router. (See Figure 3-5.)

Figure 3-5   Connecting the Power Cord
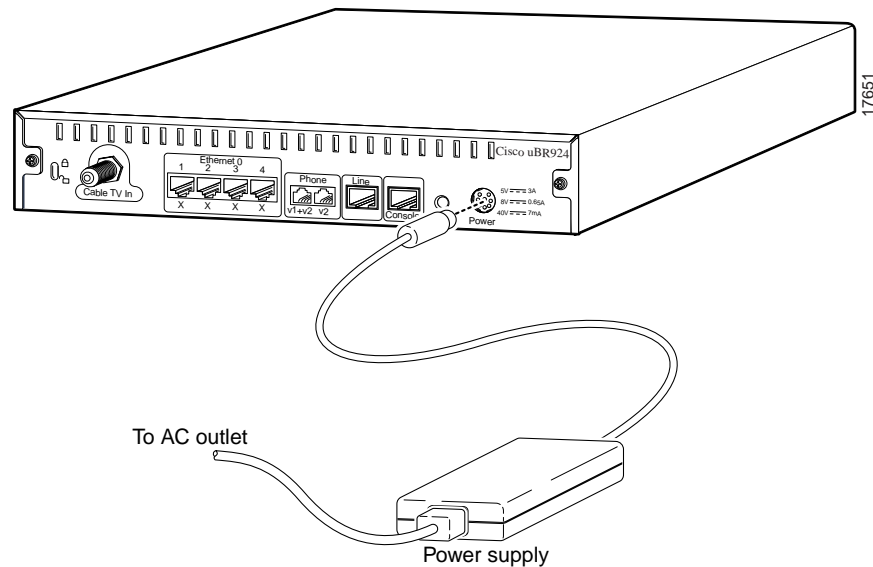
Step 3   Connect the AC power supply cord to the power supply.

Step 4   Plug the 3-prong end of the power cord into a standard electrical power outlet at the site. Power is immediately supplied to the router. The router is meant to be left on at all times, and therefore, has no power switch.

Warning   **This product relies on the building's installation for short-circuit (overcurrent) protection. Ensure that a fuse or circuit breaker no larger than 120 VAC, 15A U.S. (240 VAC, 10A International) is used on the phase conductors (all current-carrying conductors). The plug-socket combination must be accessible at all times because it serves as the main disconnecting device.**

Step 5   Turn ON power for all other equipment, and wait for the devices to complete their startup processes.

Caution   To turn off the router when it is operational, disconnect the 3-prong end of the power cord from the power outlet. To prevent electrical shock, do not disconnect the AC power supply cord from the power supply while the router is operating.

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.**

Router Power-On and Initialization Sequence

When the Cisco uBR924 router is connected and powered on, it executes automatic self-diagnostic and installation procedures. The following procedure describes what you should see during this process.

> ✎
> **Note**   For the router to complete its power-on sequence, a number of tasks must be completed at the CMTS. Refer to the "Initial Power-On and Provisioning" section on page 1-4 for an overview of the router's initialization and provisioning processes.

While the Cisco uBR924 cable access router initializes:

Step 1   Watch the LEDs on the front of the router. When the cable access router first powers on, all LEDs (except for the four Ethernet LEDs and the ACT LED) briefly light and then turn off. As self-test is executed, various LEDs light to reveal diagnostic progress and turn off when self-test is complete.

Step 2   The OK LED then blinks as the router completes self-test and boots a Cisco IOS image. When this is finished, the OK LED lights again.

> ✎
> **Note**   The six LEDs in the lower right of the front panel display—V OK, V1, V2, DS, US, DSNR—display the power-on self-test progress and status. Should the self-test fail, these six LEDs display error codes. Because self-test failed, the OK LED remains off. Refer to the "Initialization and Self-Test Problems" section on page 4-2 for a description of self-test LED error patterns.

Step 3   During the router's initialization and download, the green OK and ACT LEDs both blink. After completing the download procedure (which could take up to 10 minutes if downloading a new Cisco IOS image as well as a configuration file), the green OK LED remains on.

Step 4   Check that the DS, US, LINK, and DSNR LEDs remain on to indicate the router is operational and receiving a healthy signal:

- The DS LED reveals the router is locked to a downstream channel.
- The US LED reveals the router has established connectivity with the CMTS and is operating within 6 dB of desired power level (generally within 3 dB).
- The LINK LED reveals the cable interface is operational.
- The DSNR LED reveals the router is receiving a quality downstream signal with a low signal-to-noise ration and that is 5 dB above the downstream lock threshold.

Step 5   Check the remaining LEDs for proper operation:

- The ACT LED blinks to indicate activity on the cable interface.
- The Ethernet 1, 2, 3, 4 LEDs blink to indicate activity from the PCs and other customer premises devices connected to the corresponding Ethernet ports.
- The V OK LED indicates the VoIP system is operational. The V1 and V2 LEDs light when the voice ports are active. (These LEDs light only if the router has loaded a Cisco IOS image with voice support.

Step 6   If all LEDs appear normal, proceed to the "Verifying Installation" section on page 3-13 to test the router and its connection to each part of the network. If any problems occur, proceed to Chapter 4, "Troubleshooting," to troubleshoot and solve the problem.

Step 7   After verifying operations, acquaint the subscriber with the router recommended ambient temperature requirement of 23° to 113°F (-5° to 45°C). Remind the subscriber to keep the area around the router as free from dust as is practical and review general safety standards.

Step 8   Give the subscriber the Cisco-provided subscriber publications, along with any literature your company provides, including instructions on how to contact your customer service department.

Verifying Installation

Use the following procedures to verify the router's installation and operation; see Chapter 4, "Troubleshooting," if any problems occur.

- Internet Connection
- VoIP Telephone Connection
- VoIP Fax Connection
- Backup POTS Connection

Internet Connection

Use the following procedure to verify Internet connectivity between the PCs connected to the router's Ethernet ports and the internet access provided by the CMTS:

Step 1   From a PC connected to the Cisco uBR924 router, start the Internet browser program installed on the PC.

Step 2   Enter a URL of your choice in your web browser. If a URL is not known, use http://www.cisco.com to connect to Cisco's CCO web site.

Step 3   Watch the appropriate Ethernet LED on the front of the router blink as data is transmitted on the link. If the selected web page comes up in the Internet browser screen, the network connection is successfully established and this particular Ethernet port is operational.

Step 4   Repeat steps 1 through 3 for each PC connected to the Cisco uBR924 router.

Step 5   Disconnect the cable system input by unscrewing the cable F-connector at the back of the router.

Step 6   Using an in-line attenuator, add 3 to 6 dB of attenuation between the router and the CATV cable input.

> **Note**   The addition of 3 to 6 dB of attenuation simulates the variation found in a cable network over time and in relation to temperature. If you install a router at a time of year when the temperature is cooler, this step might not be necessary.
>
> If you install a cable access router at a time of year when the temperature is warmer, this step might assist you in determining how the cable access router will function over time. If the router does not function properly with the addition of attenuation, you should replace and reconfigure the coaxial cables at the subscriber site.

Step 7   Reconnect the cable system to the router and recheck the network connection at one of the PCs. Reload the previous web page or another URL to verify that you can still access the Internet.

Step 8   Disconnect the cable system again by unscrewing the cable connector at the back of the router.

Step 9   Remove the in-line attenuator from the back of the router.

Step 10   Reconnect the cable system to the router and recheck the network connection at the PC as in step 7.

VoIP Telephone Connection

If the router has loaded a Cisco IOS image with voice support, use the following procedure to test the VoIP network by making a telephone call over the HFC and IP backbone network:

Step 1   Pick up a telephone connected to one of the router's VoIP (V1+V2 or V2) rear ports. This signals an off-hook condition. In response, the router's voice software issues a dial tone and waits for a telephone number to be dialed.

If you do not hear a dial tone, the router's voice ports may be not enabled. Refer to the "VoIP Subsystem" section on page 4-11.

Step 2   Dial a number. The QoS reservations specified by the configuration file are sent to achieve the desired QoS over the cable system and IP network. The router turns on the codecs and protocols required to transmit packetized voice and the call proceeds.

The V1 or V2 front-panel LED (depending on the port the telephone is using) lights to denote a call is in progress and remains on until the call is disconnected.

Any call-progress indications and other signals that can be carried in-band (for example, remote phone ringing) are cut through the voice path as soon as an end-to-end audio channel is up. You either hear the far end telephone ringing until the caller picks up or you hear a busy signal if the far end telephone is already in use.

Step 3   When either end hangs up, the call is torn down. The session ends, with each end going idle, waiting for another off-hook condition.

VoIP Fax Connection

If the router has loaded a Cisco IOS image with voice support, use the following procedure to test the VoIP network by sending a fax over the HFC and IP backbone network:

Step 1   Place a document in the fax machine's document feeder, according to instructions for the fax device.

Step 2   Enter a destination number to receive the fax and press Dial or Start on most fax machines. The QoS reservations specified by the configuration file are sent to achieve the desired QoS over the cable system and IP network. The router turns on the CODECs and protocols required to transmit fax data and the fax proceeds.

The V1 or V2 LED (depending on the port the fax machine is using) lights to denote a fax is in progress and remains on until the fax call is disconnected.

Any call-progress indications and other signals that can be carried in-band (for example, remote phone ringing) are cut through the voice path as soon as an end-to-end audio channel is up. You either hear the far end ringing (depending on the fax machine setup) until the remote fax answers or you hear a busy signal if the remote fax is already in use.

Step 3   Listen for the fax tone on the other end and verify that the fax is transmitted. When either end hangs up, the call is torn down. The session ends, with each end going idle, waiting for another off-hook condition.

Step 4   Verify that the fax was correctly received at the destination.

Backup POTS Connection

To verify the backup POTS line to the PSTN is operational:

Step 1   Simulate a power failure in the Cisco uBR924 router by disconnecting the 3-prong end of the power cord from the power outlet—be certain to follow all safety instructions in the "Connecting Power" section on page 3-10.

Step 2   Pick up one of the telephones connected to the VoIP ports and dial out over the backup POTS line. Wait for a connection to be established.

Step 3   When a cutover call is in place, connect the 3-prong end of the power cord to the power outlet. Power is immediately supplied to the router.

Step 4   Verify that the cutover call remains connected.

Step 5   Disconnect the call. The router automatically reboots.

Step 6   After the router has come back online, test one of the VoIP ports (see "VoIP Telephone Connection" section on page 3-14) to verify that VoIP connectivity has been re-established.