



Chapter 3

Installing the SubSpace 2001

This chapter describes how to install your SubSpace 2001 Wireless Router and contains the following sections:

- Safety Recommendations
- Installing the Wireless Subsystem
- Installing the Router Subsystem

Note Before you install your SubSpace 2001, review Chapter 2, “Preparing to Install the SubSpace 2001.”

3.1 Safety Recommendations

As with any piece of electronic equipment, follow proper installation and safety procedures when installing the SubSpace 2001 to minimize danger to both you and the equipment itself. Hazards range from chance of electrical shock to injuries resulting from falling objects or the improper use of tools. If climbing is involved, injury or death might result from a fall. Take extreme care when installing antennas and using power tools.

Follow these recommendations to ensure your own and the equipment’s safety:

- Ensure that you understand building construction and the use of light hand tools (both power and manual).
- Ensure that you have the knowledge and experience to install small antenna systems.
- Never install antennas, transmission lines, and support structures (including guy wires) during inclement weather.
- Never install antennas, transmission lines, and support structures (including guy wires) where they might fall on electrical lines.
- When installing outdoor antennas, always be accompanied by at least one other person.
- Ensure that you have adequate eye protection, particularly when drilling or installing a grounding rod.

3.2 Installing the Wireless Subsystem

This section describes how to install the wireless subsystem. The wireless subsystem consists of the following:

- Omnidirectional or high-gain directional antenna assembly
- Radio frequency (RF) transmission cable
- Spread-spectrum radio
- Power supply

To install the wireless subsystem, follow these basic steps:

- 1 Mount your antenna.
- 2 Connect the radio and antenna.
- 3 Test the radio and antenna installation.

The following subsections describe each of these tasks in greater detail.

3.2.1 Mounting Your Antenna

Set up your antenna based on information from the site survey and link analysis. Specific procedures differ depending on your antenna and on your network configuration. However, remember the following as you mount the antenna:

- Ensure that directional antennas, which can be installed with either vertical or horizontal polarization, are correctly oriented.
- Ensure that the antenna and mounting structure combination can withstand the forces incurred by typical winds. Ensure that the mount is rigid enough so that winds will not force the antenna out of alignment; an improperly mounted directional antenna might, for example, swing back and forth in the wind and disrupt the link.
- If you plan to mount the antenna to a shared tower, you might need to provide the tower owner with the antenna's weight and wind load. If you do not know the wind load, contact the antenna manufacturer.

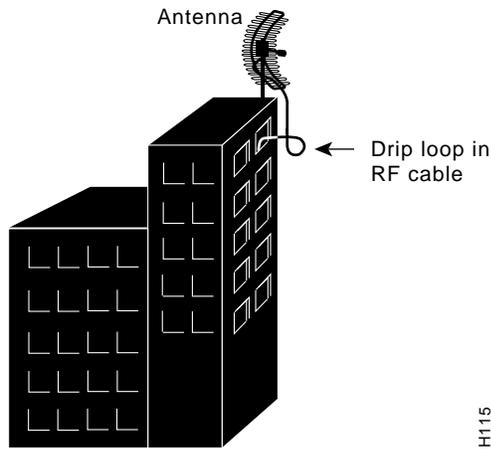
3.2.2 Connecting the Radio and Antenna

This section describes how to connect the radio to the antenna using the RF cable.

- 1 Lay out the RF cable between the radio and the antenna.

The cable is fragile. Therefore, as you lay out the cable, keep the following in mind:

- Do not bend the cable around tight corners.
- Do not crimp or deform the cable.
- Do not run the cable across long distances unsupported.
- Where it enters a building, ensure that the cable has a drip loop so that water does not enter the building by following the cable. See Figure 3-1.

Figure 3-1 Drip Loop on an RF Cable

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2 Install the connectors on the RF cable.

Install connectors at the radio, antenna, and at the point where the lightning arrester is to be inserted. If you are using conventional clamp-type Type-N male connectors, remember that the center pin might slip out of alignment or not align flush with the end of the connector. In these cases, attempting to mate such a connector with the female counterpart will cause damage. Special two-piece solder and crimp-type connectors that reduce or eliminate this problem are available from TAL.



Caution Always inspect connectors for cleanliness and pin alignment before joining.

3 Install lightning arrestors, if needed.

In general, you should install lightning arrestors where the cable enters the building; you can also install them at the antenna. To ensure that you adequately ground the lightning arrester, attach the lightning arrester to one of the following:

- Directly to the grounding point—The grounding point should be either an appropriate “building ground” or outdoor grounding rod that is driven at least 2.5 meters (8 feet) into the ground.
- Indirectly to the grounding point through a cable—Use a high-current, low-inductance cable such as welding wire or copper strapping tape. Because lightning energy prefers to follow a straight path to ground, keep the run as short and direct as possible and do not make abrupt turns.

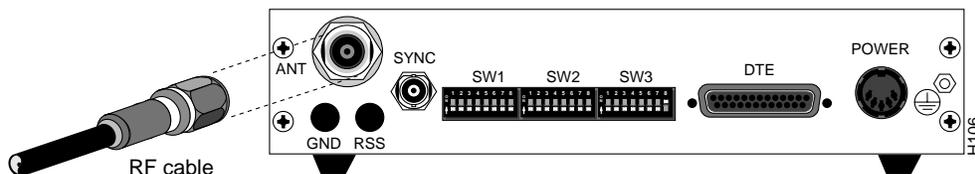
If you install the lightning arrester outdoors, ensure that it is waterproofed.

- 4 Connect the radio to the antenna using the RF cable.

Connect the Type-N connector on the RF cable to the antenna. Tighten the connector by hand. Do not use hand tools to tighten any Type-N connector.

Next, connect the RF cable to the radio. As shown in Figure 3-2, insert the Type-N connector on the RF cable into the port labeled ANT.

Figure 3-2 Connecting the RF Cable to the Radio



3.2.3 Testing the Radio and Antenna Installation

Testing the radio and antenna consists of checking the antenna's standing wave ratio (SWR) and testing the signal strength between radios. Before you can perform these tests, you must install the wireless subsystem at both ends of the link. As a result of these tests, you might need to adjust your frequency, power, and PN code settings.



Caution If a radio network is installed and operational, placing the radio in continuous transmit mode as described in the following test will reduce or eliminate throughput on the existing network. If you are installing the SubSpace 2001 in an active network and cannot tolerate disrupted throughput, skip to Section 3.3, "Installing the Router Subsystem."

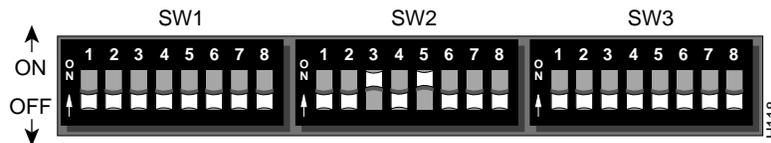
To test the signal strength between radios, you must change the switch settings and power on the radio.

Note Refer to the Appendix A or the label on the bottom of your radio for specific switch settings.

- 1 Set your initial frequency channel, power level, and pseudorandom noise (PN) code as determined during the link analysis:
 - Set the frequency channel with switches SW1-1 through SW1-4. Ensure that the frequency channels on the transmitting and receiving radios are the same.
 - Set the power level with switches SW1-5 through SW1-7.
 - Set the PN code with switches SW2-6 through SW2-8. Ensure that the PN codes on the transmitting and receiving radios are the same.

- 2 Set the transmitting radio into continuous transmit mode (labeled TRANSMIT TEST PATTERN on the bottom of your radio). See Figure 3-3.
 - Set SW2-3 to ON, SW2-4 to OFF and SW2-5 to ON.
 - Move SW3-8 to the OFF position. This turns the software configuration option off, so that the changes you make to the switch settings on the back of the radio are used instead of any software settings.

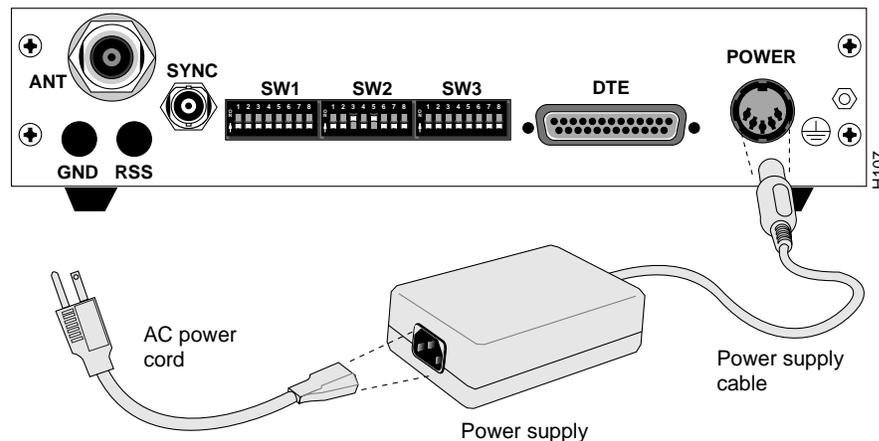
Figure 3-3 Continuous Transmit Mode Switch Settings



- 3 Connect the power supply.

The wireless subsystem includes an external power supply. To apply power to the radio, first plug the 5-pin DIN connector on the power supply cable into the port labeled POWER. Next, plug the AC power cord into the power supply, and then into the grounded electrical outlet. Refer to Figure 3-4.

Figure 3-4 Connecting the Radio Power Supply



Warning To avoid electrical shock or power loss, ensure that the power cord is securely seated in the port on the radio. This equipment is designed to work with electrically grounded systems. The AC power cord ends in a three-pole grounding plug. Do not use a three-pole to two-pole adapter with the plug. Verify that the outlet you intend to use is properly installed and grounded; the outlet must comply with the local electrical code for the country it is installed in. To ensure your safety, only connect the power cable to a properly grounded outlet.

4 Check the antenna's standing wave ratio (SWR).

SWR is a measurement of power delivered to the antenna versus any power reflected back to the radio to which it is attached. Ideally, the antenna should absorb all the transmitter power; none should be reflected back to the radio. Excessive reflected power (over 10 - 15%) indicates a problem with the antenna or antenna system (coaxial cable, Type-N connectors, lightning arrestor, and RF filter). If you are operating the radio on channels near the band edge, you might notice an increase in reflected power.

Ensure that the transmitting radio is in continuous transmit mode, as described in step 2. Measure the SWR using a directional RF wattmeter that can measure the high frequencies and low power levels required. We recommend the Bird Model 43 wattmeter and the appropriate elements for both the power being measured (1 watt or less) and the frequency range. See Section 2.3.2, "Required Tools and Equipment."

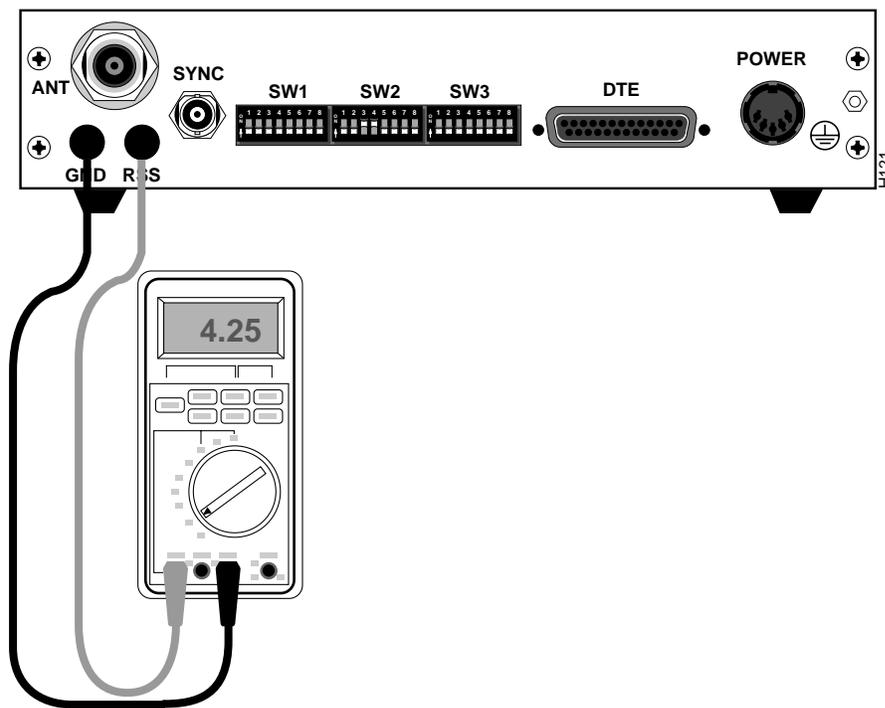
5 Check the signal strength between radios.

At this point, you are not transmitting any data across the link; you are just testing the signal strength between the links. This is called a static path analysis.

Ensure that the transmitting radio is in continuous transmit mode, as described in step 2. Also, ensure that the switches on the back of the radio are set so that both the transmitting and receiving radio are on the same channel and PN code.

On the receiving radio, check the received signal strength (RSS) by attaching a voltmeter to the RSS and ground test points on the rear of the radio. See Figure 3-5.

Figure 3-5 Testing the Received Signal Strength (RSS)



As Table 3-1 indicates, to achieve an average bit error rate (BER) of 10^{-6} , the voltage should be at least 4 Vdc, and preferably higher than 4.5 Vdc. Table 3-1 shows the relationship between the voltage you measure with the voltmeter, the digital RSS value (as reported in the TALnet software), the average BER, and the received signal strength. The correlation between these numbers is approximate; the exact values might vary.

Table 3-1 Received Signal Strength (RSS)

DC Voltage at the RSS Test Point	Digital RSS Value in Decimal	Signal Quality (Average BER)	RSS in dBm (Interference Free)
7.5	192	$<10^{-10}$	>-70
7.0	179	$<10^{-10}$	>-70
6.5	166	$<10^{-10}$	>-70
6.0	154	$<10^{-10}$	-70
5.5	141	$<10^{-10}$	-88
5.0	128	10^{-7}	-94
4.5	115	10^{-6}	-95
4.0	102	10^{-5}	-98
3.5	90	10^{-4}	-100
3.0	77	10^{-3}	-101
2.5 ¹	64	10^{-3}	-102
2.0 ¹	51	10^{-2}	-103
1.5 ¹	38	10^{-2}	-105

1. Occasional sync loss

Fluctuation of the voltage is normal, and is caused by propagation or interference. If the voltage drops below 4 Vdc for prolonged periods (several seconds), use a spectrum analyzer attached to the antenna system to identify possible interference. You might be able to achieve acceptable signal strength by adjusting the power settings on the transmitting radio.

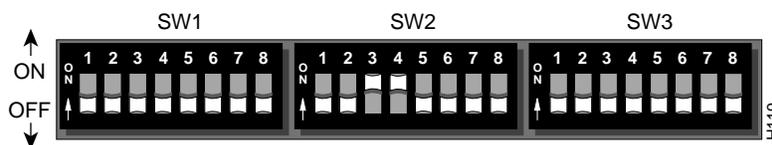
If you do not have a clear line of site and are depending on the proximity of antennas to overcome physical obstructions, move the antenna laterally a few centimeters or inches to identify dramatic peaks and nulls in the received signal strength.

Because you are not transmitting data, this analysis will *not* reveal multipath interference. Multipath interference results from multiple reflections of the transmitted signal arriving at the receiver at different times after being reflected by buildings or natural obstructions—similar to an echo in a canyon. You must test for this phenomenon after you install the router.

- 6 Disconnect the power supply to the radio and return the switches to half-duplex mode (also called semi-duplex mode) before moving on to Section 3.3, “Installing the Router Subsystem.”

To place the radio in half-duplex mode, set the switches SW2-3 to ON, SW2-4 to ON, and SW2-5 to OFF. See Figure 3-6.

Figure 3-6 Half-Duplex Mode Switch Settings



3.3 Installing the Router Subsystem

This section describes how to install the router subsystem and perform a dynamic link analysis.

To install the router subsystem, follow these basic steps:

- 1 Connect the router to the radio.
- 2 Make optional connections to the service console, Ethernet local area network (LAN), and to devices such as personal computers (PC) and other routers using the Point-to-Point Protocol (PPP).
- 3 Perform a dynamic link analysis.

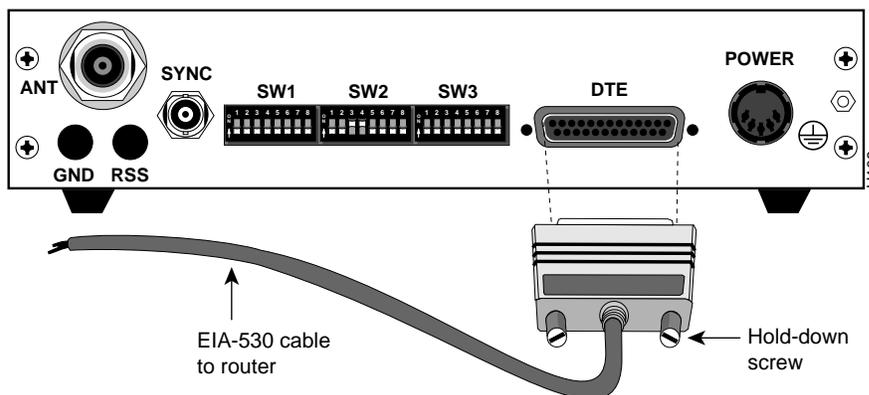
The following subsections describe each of these tasks in greater detail.

3.3.1 Connecting the Router to the Wireless Subsystem

Follow these steps to connect the router to the radio using the EIA-530 cable.

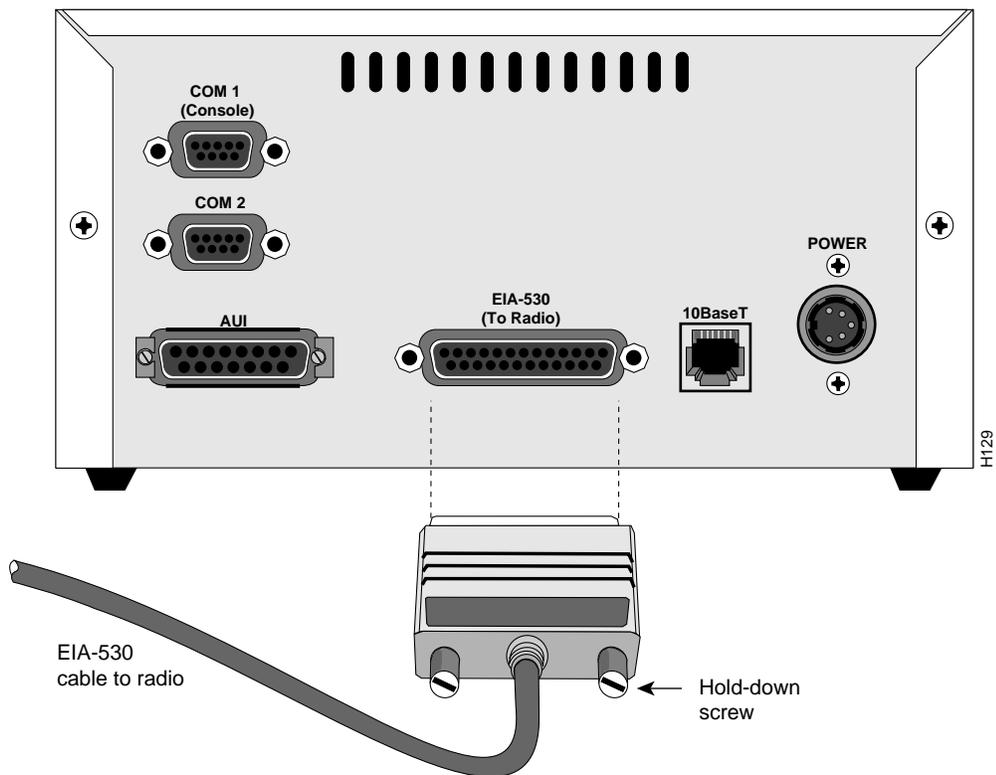
- 1 Insert the male end of the EIA-530 cable into the port on the radio labeled DTE. See Figure 3-7.

Figure 3-7 Connecting the EIA-530 Cable to the Radio



- 2 Insert the female end of the EIA-530 cable into the port on the router labeled EIA-530 (To Radio). See Figure 3-8.

Figure 3-8 Connecting the EIA-530 Cable to the Router



3.3.2 Make Optional Router Connections

Depending on the needs of your internetwork, you can connect the router to any of the following:

- Service console
- Ethernet LAN
- Another PC or router

Follow the steps in this subsection to make these connections. Omit any step that is not necessary in your application.

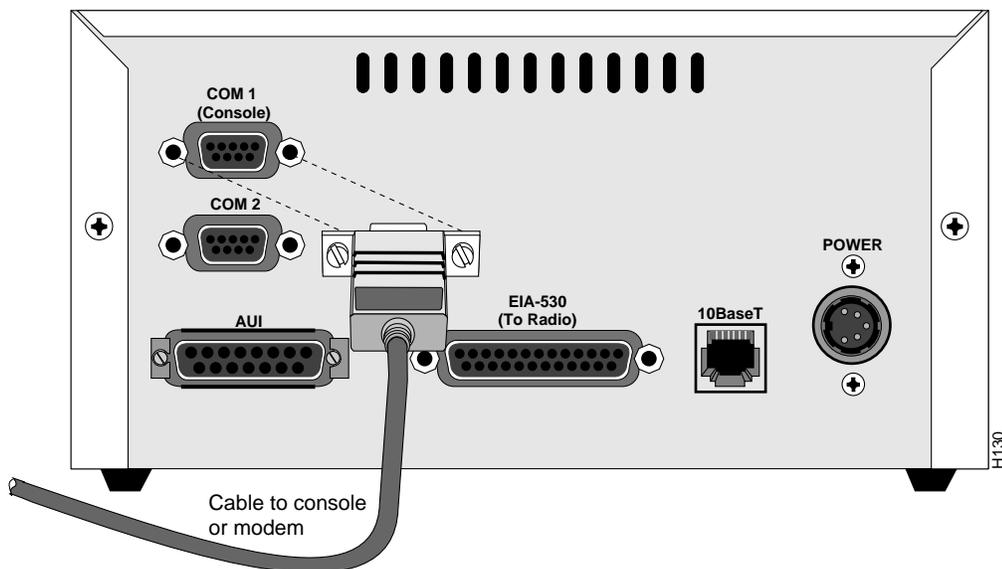
1 Connect a console to the router.

Use an RS-232 terminal or a computer running terminal emulation software as a service console.

Insert an RS-232 null-modem cable into the router port marked COM 1 (Console). See Figure 3-9. Ensure that the terminal or terminal-emulation software uses VT100 emulation and is set at 9600 baud, no parity, 8 data bits, 1 stop bit.

Note You can also connect the console to the router through a modem.

Figure 3-9 Connecting the Service Console to the Router



2 Connect the router to the Ethernet LAN.

Depending on the type of Ethernet LAN you are connecting to, you can connect the router to the Ethernet LAN in one of two ways:

- To connect to a 10BaseT LAN or hub, use a standard RJ-45 connector with a modular patch cable, twisted pair category 3 or higher. Insert the connector into the port labeled 10BaseT. See Figure 3-10.
- To connect to other types of Ethernet, insert an AUI connector into the port labeled AUI. See Figure 3-11.



Caution Note that you should not connect to both ports at the same time. If you do so, the router will use the 10BaseT connection.

Figure 3-10 Connecting the Router to a 10BaseT LAN

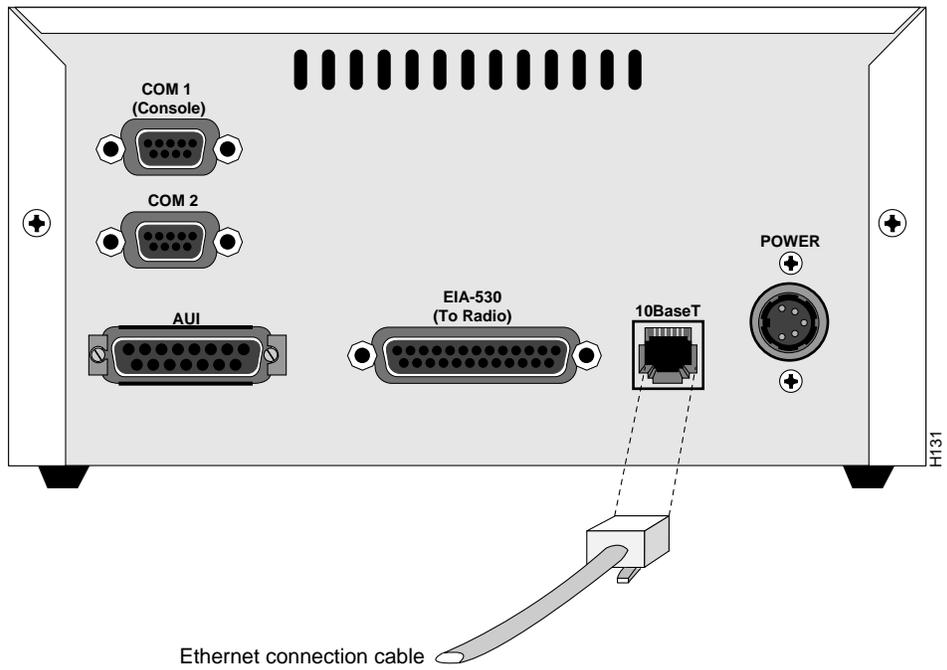
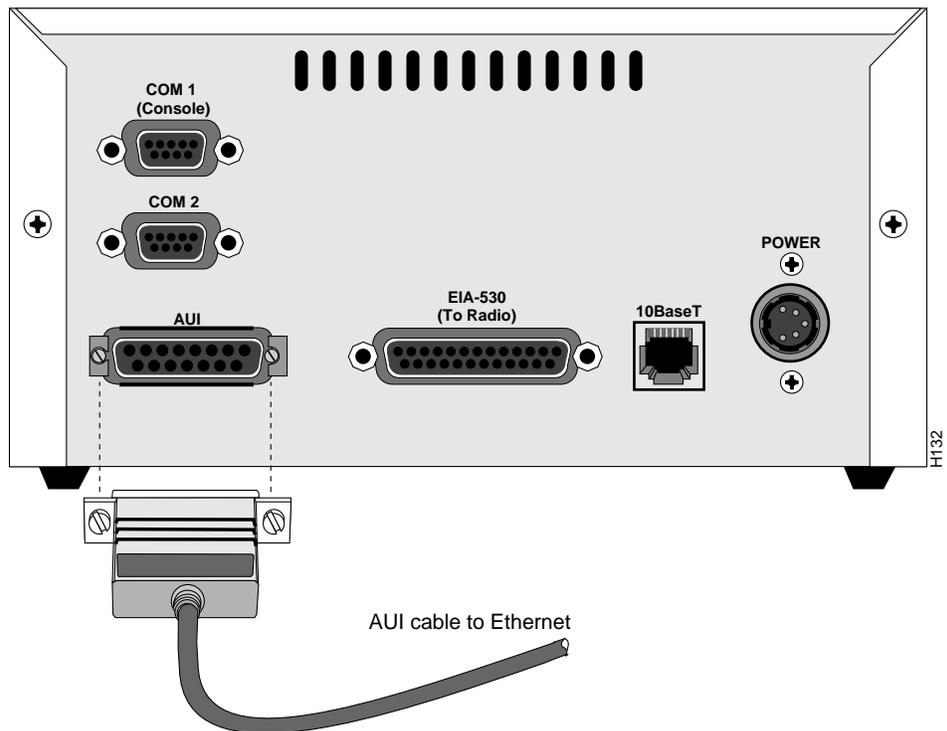


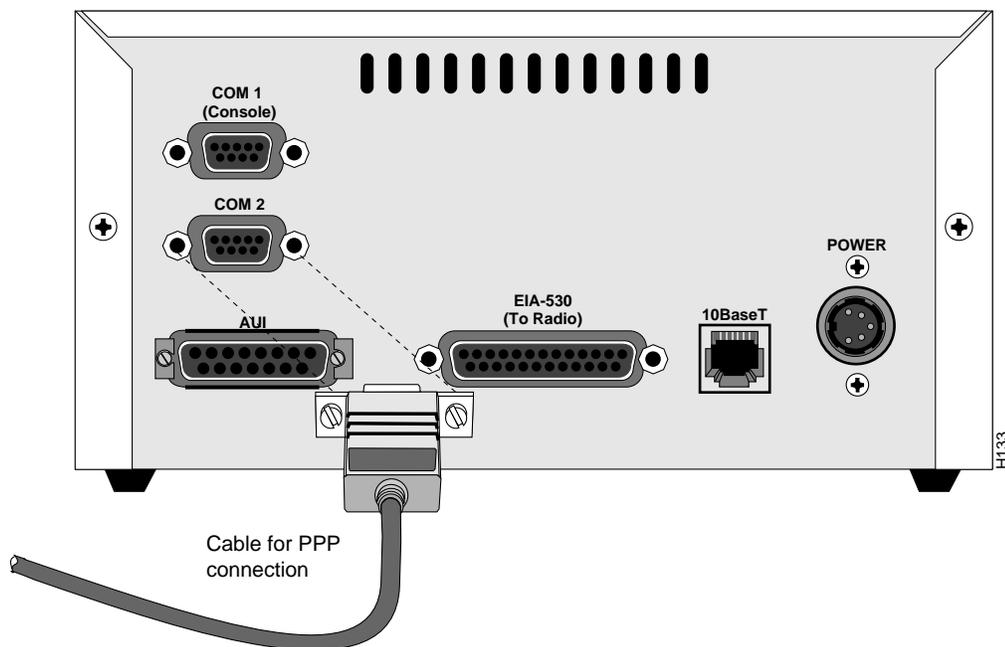
Figure 3-11 Connecting the Router to a LAN Using an AUI Cable



3 Connect to other devices using a PPP connection.

Use an RS-232 cable to make a PPP connection to a PC or another router. You can connect to the PC or another router either directly or through a modem. Insert the cable into the port labeled COM 2, as shown in Figure 3-12.

Figure 3-12 Making a PPP Connection



3.3.3 Testing the Paths

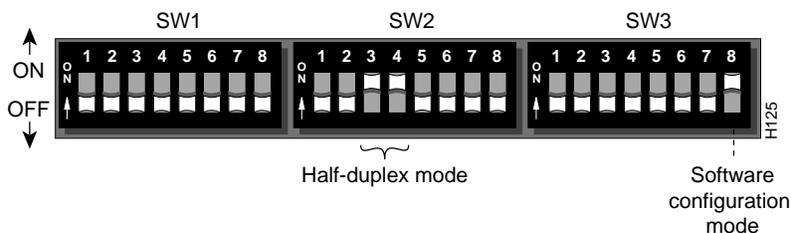
Perform the following steps to perform a dynamic path analysis between two SubSpace 2001 Wireless Router links. Before you test the links, you must install an operational Wireless Router on both ends of the link.

1 Set the switches on the radio.

In the Section 3.2, “Installing the Wireless Subsystem,” you turned off the software configuration mode. The tests you are going to perform in this section require that the switches be in software configuration mode. Reset the switches as follows (see Figure 3-13):

- Move the switch SW3-8 to software configuration mode (ON).
- Confirm that the radio is in half-duplex mode (SW2-3 is ON, SW2-4 is ON, and SW2-5 is OFF).

Figure 3-13 Dynamic Path Analysis Switch Settings



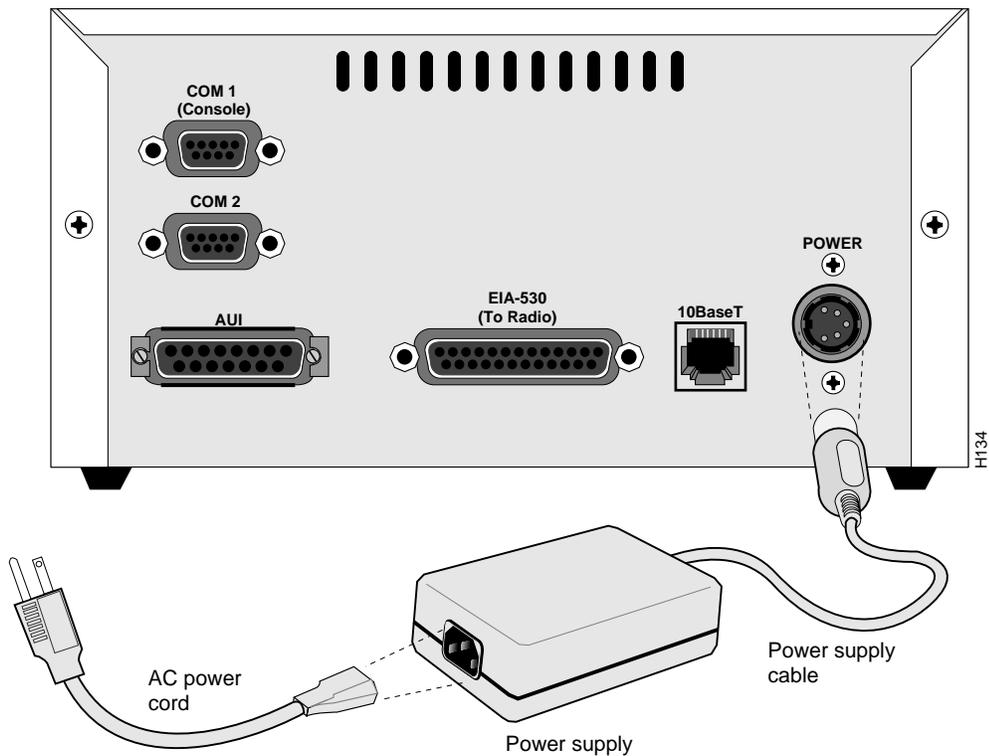
You are now ready to test the paths.

2 Connect the power supply to the radio and the router.

To connect the power supply to the radio, follow the instructions in step 3 in Section 3.2.3, “Testing the Radio and Antenna Installation.” Ensure that the power light on the front panel illuminates.

To connect the power supply to the router, first plug the 5-pin DIN connector on the power supply cable into the port labeled POWER. Next, plug the AC power cord into the power supply, and then into the grounded electrical outlet. See Figure 3-14.

Figure 3-14 Connecting the Router Power Supply



Ensure that the power light on the front panel of the router illuminates.

3 Minimize interference among systems operating in the same band.

A flickering or illuminated SYNC light on the front panel of the radio indicates the presence of another signal that uses the same PN code and the same or an adjacent frequency. This interference might be caused by another SubSpace 2001; however, if you suspect that the interference is from a radio that is not part of your network (especially if the signal is relatively constant), move the antenna around to identify the direction, polarity, and strength of the interfering signal.

Note The SubSpace 2001 is more sensitive in locating spread-spectrum signals than a spectrum analyzer, so do not be surprised if you locate a signal that did not appear in the initial analysis.

After reducing the amplitude of interfering signals by changing the antenna location, polarity, or direction, select a different PN code from the interfering radio. Changing the PN code might extinguish the SYNC light because the radio will not receive data with a different PN code; however, the unwanted signal still exists.

4 Establish communications on the console.

To establish communications, enter a carriage return. The `TAL>` prompt should appear.

5 Assign a global Internet Protocol (IP) address to your Wireless Router, as described in the *TALnet Configuration Guide*. If you are testing a link in a new network, you can use the default frequency, power, and PN codes. However, if you are testing a link in an existing network, you must configure these parameters as described in the *TALnet Configuration Guide*.

6 Perform a dynamic path analysis through the radio.

During a dynamic path analysis, you are transmitting data. This analysis tests signal paths and antenna alignment under difficult conditions. You can also identify any incidences of multipath interference. In some locations, you might have an apparently adequate line-of-sight path, but still have poor data throughput. You can reduce or eliminate multipath interference by raising one or both antennas, relocating the antenna, or using narrow-beam directional antennas in the path.

Perform a dynamic path analysis using a combination of ping and File Transfer Protocol (FTP) tests.

- Start a rapid ping (300 ms or less) of small packets (50 bytes). Use the following command:

ping *hostid* **50 300**

Move the antenna and note the speed at which successive pings are reported on the console. As the optimum antenna location is obtained, increase the packet size to 250-, 750-, and 1000-byte packets. You can stop the series of pings using the **reset** command.

- Make an FTP connection from a client at one end of the wireless link to a server at the other end of the link. Transfer a file that is around 100 kilobytes (KB). Note the throughput of the data transfer; a throughput during the transfer that is greater than 8 KB per second is acceptable.

7 Verify your results for all frequency channels on which you are authorized to operate.

Note problematic channels for future reference and possible system expansion. Decrease RF power on these frequencies, then run another ping to verify acceptable signal strengths.

As a result of these tests, you might need to adjust your frequency, power, and PN code settings.

Once you have tested signals, you are ready to configure your TALnet software. If you experience problems with your Wireless Router, refer to Chapter 4, “Troubleshooting the SubSpace 2001.”

