ARCell™
Planning and Installation Guide

The ARCell License-Free
Point-To-Multipoint
Wireless Broadband Solution

October 2003

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RETURN OF EQUIPMENT UNDER WARRANTY: If an item of Equipment malfunctions or fails in normal intended usage and maintenance within the applicable Warranty Period:

(a) The Customer shall promptly notify Arcwave of the problem and the serial number of the defective item;

(b) Arcwave shall, at its sole option, either resolve the problem over the telephone or provide the Customer with a Returned Materials Authorization number (RMA #) and the address of the location to which the Customer may ship the defective item;

(c) If the problem is not resolved over the telephone, the Customer shall attach a label to each returned item describing the fault and the Customer's return address. The Customer shall, at its cost, properly pack the item to be returned, prepay the insurance and shipping charges, and ship the item to the specified location;

(d) If the Arcwave product shall prove to be defective in material or workmanship upon examination by Arcwave, Arcwave shall either repair or replace the returned item at its sole option. The replacement item may be new or refurbished; if refurbished, it shall be equivalent in operation to new Equipment. If Arcwave replaces a returned item, the Customer agrees that the returned item shall become the property of Arcwave.

(e) Arcwave shall ship the repaired item or replacement to the Customer's return address by carrier and method of delivery chosen by Arcwave at its cost. If Customer has requested some other form of conveyance, such as express shipping, then the Customer shall pay the cost of return shipment.

NOTE: This publication may include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of this publication. Arcwave may make improvements and/or changes in the product(s) described in this publication at any time without notice.

FCC NOTICE: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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1 Introduction

The Arcwave™ License-Free, Point-to-Multipoint Wireless Broadband Solution provides a complete end-to-end solution for Cable MSOs, Wireless ISPs and other fixed wireless operators seeking to expand their markets by offering wireless delivery of the Internet to their customers at performance levels that normally exceed DSL.

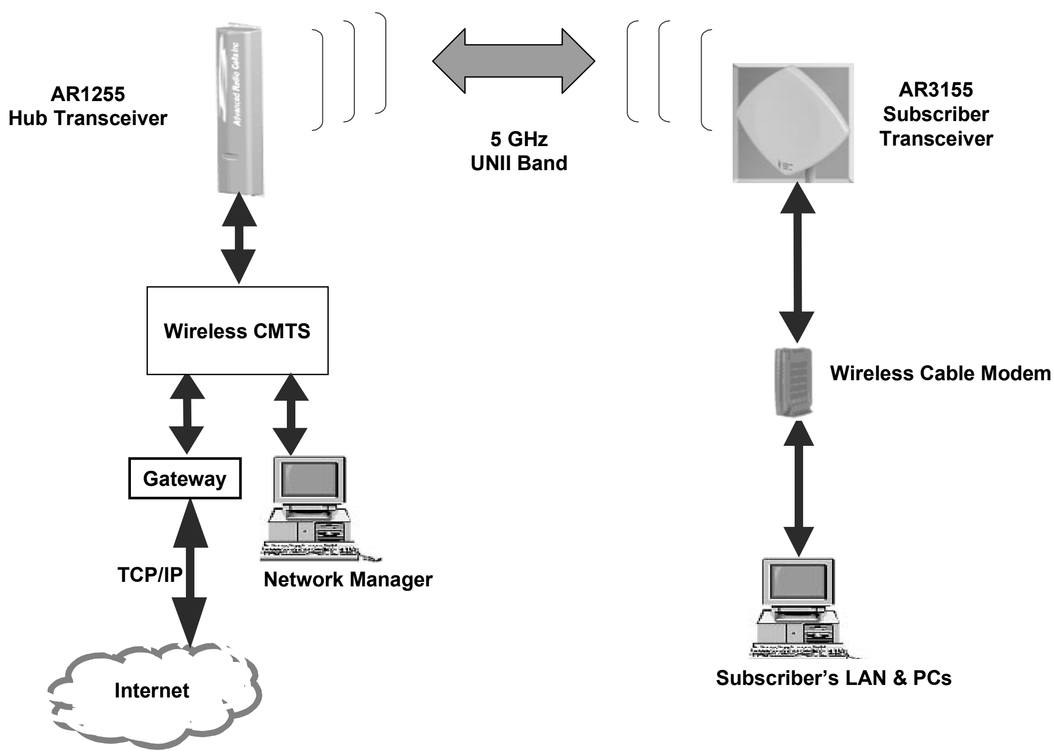

Figure 1-1: ARCell License-free Point-to-Multipoint Wireless Broadband Solution.

The ARCell™ Wireless System is typically mounted on a building roof. The ARCell Hub may be mounted on a tower structure, but tower or roof, the Hub usually has an unobstructed view of the geographic area to be served. The area has a radius of about 5 miles.

A typical Hub in a point-to-multipoint system illuminates a full circle, or 360 degrees. The ARCell Hub equipment can do this several ways:

1) 90-degree Hub Receivers plus an omni-directional (360 degree) Transmitter

2) 60-degree Hub Transceivers – with 6 of these the full circle is illuminated.

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An ARCell Wireless System looking up a narrow canyon from one end may have only one ARCell Hub Transceiver.

Cables are run from the Hub Transceiver(s) to the base station's Wireless Cable Modem Termination System (W-CMTS) in the equipment room. The equipment room also has a Gateway to access the Internet, the transceiver power supply, etc.

The ARCell AR3155 Subscriber Transceiver is mounted outdoors at the subscriber location with line of sight to the Hub Transceiver. A single TV-type coaxial cable is run indoors to the modem and computer(s).

The transceivers have a weatherproof housing containing transmit and receive antennas and electronics.

The Wireless CMTS (W-CMTS) Base Station controls the flow of data between the Internet and each subscriber's Wireless Cable Modem (WCM) using the DOCSIS™ suite of protocols. The W-CMTS transmits Downstream (Hub to subscriber) a continuous flow of user data interspersed with control commands to each WCM in the system. When a user has data to transmit Upstream (subscriber to Hub) to the Internet, the WCM turns on its transmitter, sends its data to the Hub Transceiver, and then turns off its transmitter. The DOCSIS protocol manages the time slot assignment.

The Arcwave Network Manager is an IBM-compatible PC with the Windows 2000 operating system plus management and provisioning software, including an SNMP package. It also provides the system with TCP/IP-related services such as DHCP, TFTP and TOD[1]. V3000W requires an external PC and ARCell's network management package. The BSR1000W comes with command-line management internal and ARCell's network management package can be added to provide TCP/IP services, if they are not already available in the network.

The Gateway to the Internet provides certain TCP/IP and ISP functions such as routing, address translation, caching, security, etc. The Gateway consists of a router or a PC running ISP-provided software (possibly a form of Unix) and may also include external hardware such as a router, CSU/DSU, etc.

The protocols that govern the operation of the ARCell License-Free, Point-to-Multipoint Wireless Broadband Solution generally conform to the cable TV industry DOCSIS standard, as enhanced for wireless operation.

1.1 Subscriber Site

The ARCell License-Free, Point-to-Multipoint Wireless Broadband Solution subscriber installation consists of the AR3155 Integrated Subscriber Transceiver mounted on the exterior of the subscriber facility and the Wireless Cable Modem (WCM) located inside the structure. A

™ DOCSIS is a trademark of Cable Television Laboratories, Inc.

[1] SNMP = Simple Network Management Protocol

TCP = Transmission Control Protocol

IP = Internet Protocol

DHCP = Dynamic Host Configuration Protocol

TFTP = Trivial File Transfer Protocol

TOD = Time of Day

single power and signal cable is run between the Subscriber Transceiver and the modem location. See Figure 1-2.

The Subscriber Transceiver is mounted on a chimney or a tripod similar to a TV antenna, or on a short pipe or bent-arm mounting arrangement similar to a small satellite TV dish, or a light duty non-penetrating flat roof mount. It must be in a position with line of sight to the Hub Transceiver location. At the time of installation the Subscriber Transceiver is carefully aimed to transmit and receive to/from the Hub Transceiver.

The *Subscriber Transceiver Installation Details* section of this manual provides mounting information and grounding recommendations for the integrated antenna.

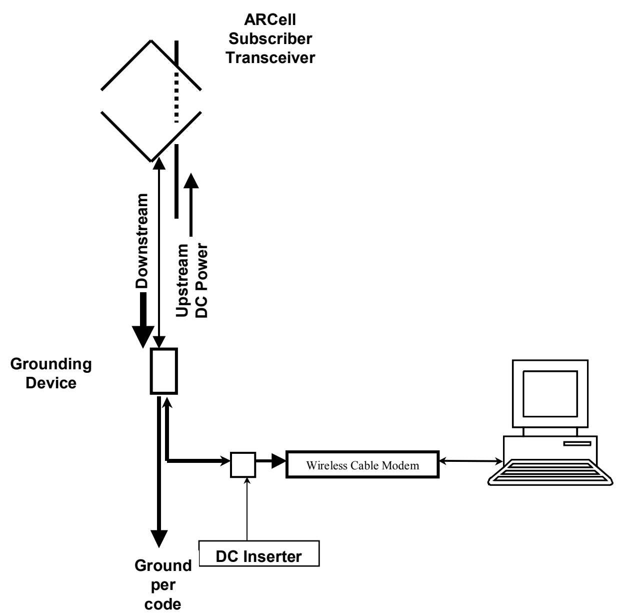

Figure 1-2: Subscriber Configuration.

Inside the Subscriber Location, the WCM is connected to the PC by means of a standard Ethernet LAN cable. Alternatively a LAN hub or switch may be employed between the WCM and the PC(s), as the WCM has a gateway function that will support up to 75 PCs sharing the modem. A small DC inserter device is connected between the WCM and the lead to the outdoor unit. The inserter and the modem each have a cord mounted power supply.

1.2 Hub Site

The License-Free, Point-to-Multipoint Wireless Broadband Solution Hub is the base station. It consists of one or more Hub Transceivers mounted outdoors on the building, tower or monopole structure. The associated equipment is located in the interior equipment room. Signal and power cables are run from the Hub Transceiver(s) to the equipment room. See Figure 1-3.

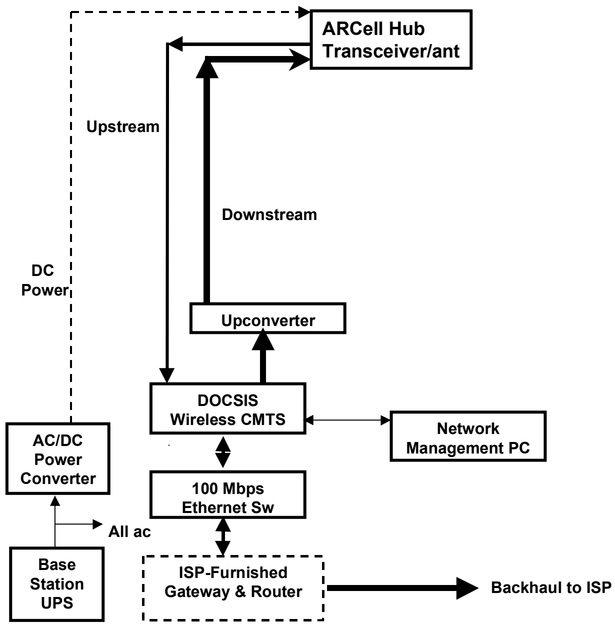

Figure 1-3: Single-Sector Hub Configuration.

The Hub Transceiver is aimed at the geographic area of the Subscriber Transceivers to be served. From one to four Hub Transceivers are required at the base station, depending on the desired subscriber coverage, as each Hub Transceiver “illuminates” a sector (arc).

The details of antenna coverage and frequency utilization are covered in the *Frequency/Coverage Planning* section of this manual.

Each Hub Transceiver requires a separate upstream and downstream IF cable, so a single-sector Hub system requires 2 IF coaxial cables, and a six-sector Hub requires 12 IF cables.

The DC power for the Transceivers can be run in parallel to the coax cables, one per Transceiver, or a larger shared cable can be run to an Outdoor Junction Box on the roof, and power distributed from there. Details are discussed in the *Base Station Installation Details* section of this manual.

The *Base Station Installation Details* section provides mounting, test access and system grounding recommendations for the Hub Transceiver.

The *Link Budget Parameters* section provides radio frequency details that are useful in those special cases when RF link planning is needed.

Located in the equipment room are:

1) Wireless CMTS (W-CMTS)
2) Network Manager System
3) Upconverter (in some configurations)
4) 100 Mbps Ethernet switch
5) ISP Access: Gateway, Router, Backhaul, as required

6) DC power supply for the Hub Transceiver electronics
7) Uninterruptible Power Supply system (UPS) to protect all the equipment

The ISP's Internet access equipment is selected and configured according to the requirements of the particular ISP and the backhaul transmission equipment between the base station and the ISP's facilities.

The installer must provide an AC/DC power supply with sufficient capacity to operate the outdoor Hub Transceiver. An Uninterruptible Power Supply (UPS) is strongly recommended to protect system operation during short outages, as well as to provide isolation between incoming power line anomalies and all of the base station equipment. See the *Base Station Installation Details* section of this manual.

1.2.1 Hub Transceiver

Industry standard interfaces are employed between the various elements of the Hub system. Note that specific manufacturer and part numbers are given in the *Installation Details* section of this manual.

Transmit and receive signal interfaces:

- Upstream signal frequency 6.4 through 32 MHz.
- Downstream signal frequency 477 through 577 MHz.

1.2.2 Wireless CMTS

- Network connection 100baseT Ethernet with RJ-45 jack (female) connector.
- Upstream input signal frequency 6.4 through 32 MHz.
- Downstream output depends upon whether the Upconverter function is internal or external to the W-CMTS.
    a. If external, 44 MHz.
    b. If internal, 477 through 577 MHz.

1.2.3 Upconverter

If Upconverter is external to the W-CMTS:

- Input signal frequency 44 MHz.
- Output signal frequency 477 through 577 MHz.

1.2.4 Amplifier

If the Upconverter is external, there may need to be an amplifier between it and the W-CMTS.

1.2.5 100 Mbps Ethernet Switch

- The Ethernet switch is the connection point for all TCP/IP data flow on the ARCell Wireless System side of the Gateway (subnet).
- Subscriber traffic flows through the Gateway to the Internet via the switch, as does network management traffic to and from the W-CMTS and the Internet.
- Other devices such as a laptop computer can be plugged into the switch.

1.2.6 Network Manager PC

The network manager PC provides three categories of services to the ARCell Wireless System.

- Firmware residence and configuration utilities for the W-CMTS Base Station and Wireless cable modems.
- TCP/IP services such as DHCP, TFTP and time server
- SNMP network manager and W-CMTS- and WCM-specific interfaces.

1.2.7 Gateway

This equipment provides functions required to interface the wireless network to the backhaul transmission facility to the ISP. The ISP will normally specify and configure this equipment. It interconnects with the ARCell Wireless System via a standard port on the 100 Mbps Ethernet switch.

The ARCell Wireless System is simply a standalone IP network that requires the presence of a gateway through which packets are routed between the wireless network and the Internet. The network interface on the ARCell side of the gateway must be Ethernet 100baseT. The gateway itself is typically one of two types depending on the network IP address:

- If the network IP address is registered with its country's Network Information Center then the gateway may be a conventional router.
- If the network IP address is one of the RFC1597 private addresses the gateway must be a proxy server of some sort. For example, the gateway may provide RFC1631 Network Address Translation (NAT) services.

The ISP may use additional security measures, such as firewalls.

1.2.8 DC Power Supply

The DC power supply is located in the equipment room and supplies DC power to operate all of the Hub Transceivers in the installation. In a single sector Hub Transceiver configuration a single power cable is run along with the signal cables from the Hub Transceiver to the base station equipment room.

In a multi-sector Hub Transceiver configuration separate power cables can be run to the equipment room from each Hub Transceiver, or an Outdoor Junction Box (OJB) can be installed in the vicinity of the Hub Transceivers (on the rooftop or tower structure) and a single appropriately sized cable run to the equipment room. See the *Hub Transceiver Installation Details* section of this manual for more information.

The electronics in the Hub Transceiver are designed to function with a DC voltage at the hub nominally 8 – 8.5 VDC. See the *Hub Transceiver Installation Details* section of this manual for more information on recommended power supplies.

1.3 Frequency Band of Operation

This system operates in the frequency band designated by the FCC as UNII and is governed by Part 15, Subpart E, of the FCC Rules and Regulations (http://ftp.fcc.gov/oet/info/rules/). The components that Arcwave sells comply with these Rules.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Briefly, the UNII rules are:

- Lower band is 5.15-5.35 GHz
    - Transmitted power in the band 5.25 – 5.35 GHz cannot exceed 250 mW.

- The band 5.15 – 5.25 GHz is for indoor use, and is not used by ARCell.
- Upper band is 5.725-5.825 GHz
  - Transmitted power in the band 5.725-5.825 GHz cannot exceed 1 Watt[2].

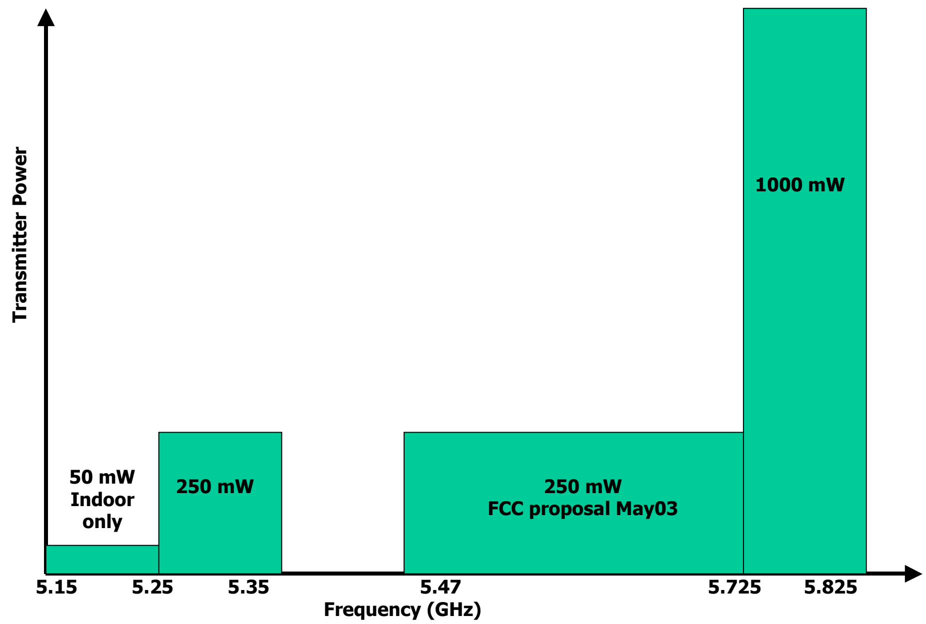

Figure 1-4: Transmitter power limitations set by FCC.

1.4 Data Rates

The downstream data path can be configured for one of two data rates within the 6 MHz CATV channelization:

1. 10 Mbps: QPSK modulation, 10.608 Mbps modulated data, 8 Mbps throughput
2. 20 Mbps: 16-QAM modulation, 20.216 Mbps modulated data, 17 Mbps throughput.

The Downstream data is received by all the subscribers' modems, and each modem selects the packets addressed to it.

The Upstream path is "5 Mbps" in a 3.2 MHz channel: QPSK modulation, 5.12 Mbps modulated data, 5 Mbps throughput.

Each modem's transmission upstream is controlled by the W-CMTS, which assigns it a time slot in which to transmit the RF signal containing the packet data.

[2] In May 2003 the FCC issued a Notice of Proposed Rule Making (NPRM) to enhance the 5 GHz band. Arcwave is following that NPRM activity and will enhance products as the Rules are finalized.

2 Subscriber Installation Detail

Installation at the subscriber's site is very simple – one small outdoor unit (the transceiver) and one cable modem indoors. Power for the outdoor unit is carried over the TV-type coaxial cable between the two units.

Frequency of operation, RF power, etc. are all determined automatically. There are no settings to be made on site, with very few exceptions, which are discussed in this Section.

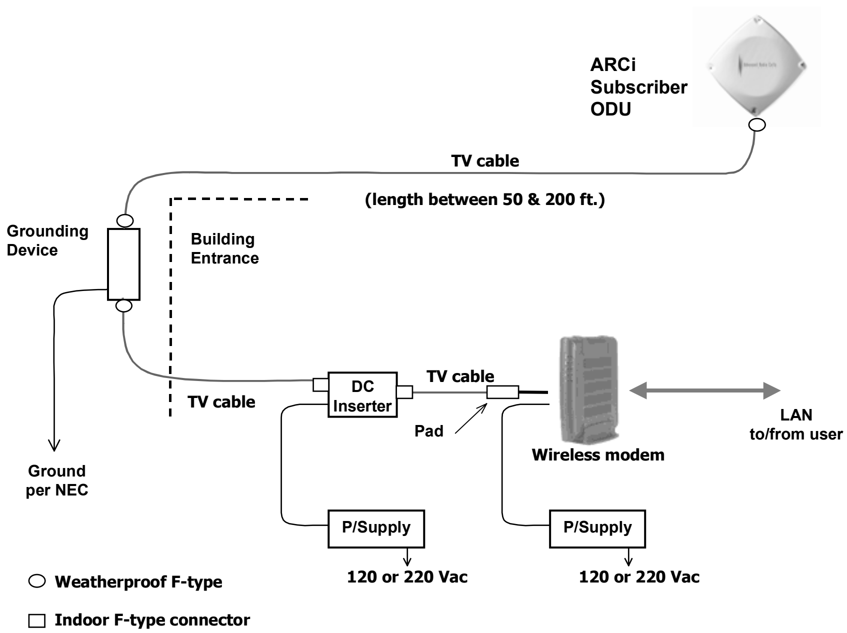

Figure 2-1: Schematic diagram subscriber installation.

2.1 Transceiver

The Subscriber Transceiver contains a transmitter, a receiver and the antenna, all in one integrated weatherized unit that is about 1x1 foot square.

2.1.1 Mounting

Mount the Subscriber Transceiver on a vertical pipe with at least 12 inches clear of any hardware or other impediments. The mounting brackets will accommodate pipe outside diameter from 1.25 to 2 inches. The front face of the antenna must point in the direction of the system base station and have a clear view of the Hub Transceiver antenna[3].

Up-tilt or down-tilt is accomplished by loosening the cap screws on the sides of the mounting assembly, as in Figures 2-2 & 2-3. Do not over tighten the mounting bolts or the up/down tilt cap screws. The F-type connector must be waterproofed after installation, to keep out moisture. This is typically done with electrical tape.

[3] Subscriber installations located close to the base station installation may work successfully through tree foliage, so called "near line of sight", but this must be verified in the field. A rule of thumb for the loss through deciduous foliage is 0.15 dB / ft in the UNII band.

Figure 2-2: Subscriber Transceiver pointing towards Hub.

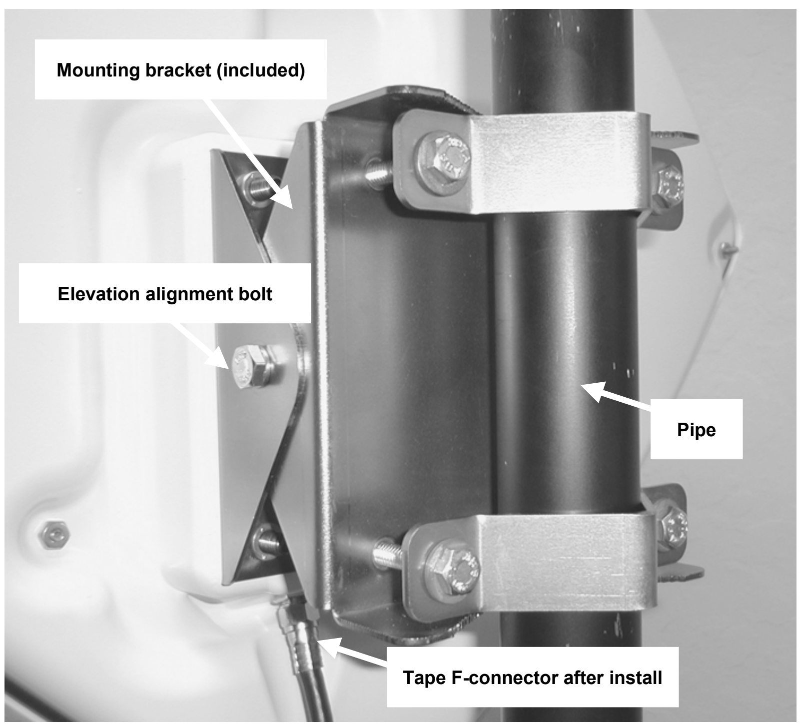

Figure 2-3: Subscriber Transceiver mounted on pipe.

2.1.2 Subscriber Transceiver Alignment Methods

There are three recommended methods for aligning the Subscriber Transceiver for maximum performance:

- Arcwave Signal Strength Meter (AR100)

- Dedicated modem signal meter (Sencore MSM980)
- Spectrum analyzer (Anritsu MS2711B)
- Channel-selectable cable-TV meter.

They are described below.

All devices measure the downstream signal level received from the base station. This provides an optimum alignment as the downstream receive antenna has a narrower beam width than does the upstream transmit antenna also housed in the Transceiver. By optimizing the downstream, the upstream is optimized automatically.

Once the particular alignment method is chosen, and connected to measure the downstream signal level (receive), the Subscriber Transceiver is peaked as follows:

1. Using a 7/16" open end, box or socket wrench, loosen the two elevation alignment bolts until the Transceiver can be oriented up or down by hand, but will hold its position.
2. Observe the display of the alignment device being employed and orient the Transceiver up and down to achieve a maximum peak signal. There may be other smaller peaks, but the main one should be evident.
3. Tighten the elevation alignment bolts slightly.
4. Using the same wrench loosen the four mounting bolts so the transceiver can be oriented side to side by hand.
5. Observe the display of the alignment device being employed and orient the transceiver side to side to achieve a maximum peak signal. There may be other smaller peaks, but the main one should be evident.
6. Tighten the elevation alignment bolts slightly.
7. Repeat the elevation (up or down) adjustment, and then the azimuth (side by side) adjustment once again.
8. Tighten the elevation alignment bolts taking care not to over tighten.
9. Tighten the mounting bolts firmly, but do not over tighten as that simply bends the mounting brackets.

The three pieces of equipment are discussed below.

2.1.3 AR100 Signal Strength Meter

The AR100 Signal Strength Meter (SSM) is a small hand held device that is temporarily inserted between the Transceiver end of the coaxial cable down lead and the Transceiver itself.

Figure 2-x: Photo of the AR100 Signal Strength Meter (SSM).

Figure 2-4: AR100 Signal Strength Meter (SSM) at transceiver.

Complete the subscriber physical installation (at least the Subscriber Transceiver and power inserter). Connect the coax lead from the indoor power inserter to the SSM "RX" port and a short coax jumper from the SSM "LNB" port to the Transceiver. The SSM and the Transceiver will then be powered from the power inserter[4]. Align the Transceiver by peaking the signal on the SSM's meter, adjusting the sensitivity control on the SSM as needed.

Note that the AR100 SSM is a very broadband device which responds to energy below 500 MHz. It will “see” all energy from few hundred MHz to at least 1900 MHz, and thus can be spoofed by a stray signal near the Transceiver and SSM.

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[4] The external power jack on the SSM is unused.

2.1.4 Sencore MSM980

The Sencore MSM980 is a dedicated test device, which provides a number of tests and storage of results related to the installation and troubleshooting of subscriber units. One of its basic modes is to display in large numbers on its LCD screen the received signal level (from the Subscriber Transceiver) when connected to the Transceiver in lieu of (or in parallel with) the wireless cable modem.

Connect the Sencore meter to the coaxial cable from the Subscriber Transceiver. Select the Install main menu, and then DS Level. Align the Transceiver by peaking the signal on the display.

The MSM980 is battery operated and has the additional feature that its battery can feed DC power to the Subscriber Transceiver, so the installation can be completed outdoors without additional AC power. Contact Sencore at 1-800-SENCORE (736-2673).

2.1.5 Spectrum Analyzer

Connect the spectrum analyzer in place of or in parallel (via a 2-way splitter) with the wireless cable modem. Adjust the spectrum analyzer to display the downstream IF signal from the Subscriber Transceiver (which will be between 425 and 525 MHz). Reduce the frequency span and adjust the amplitude to achieve a trace similar to the one below.

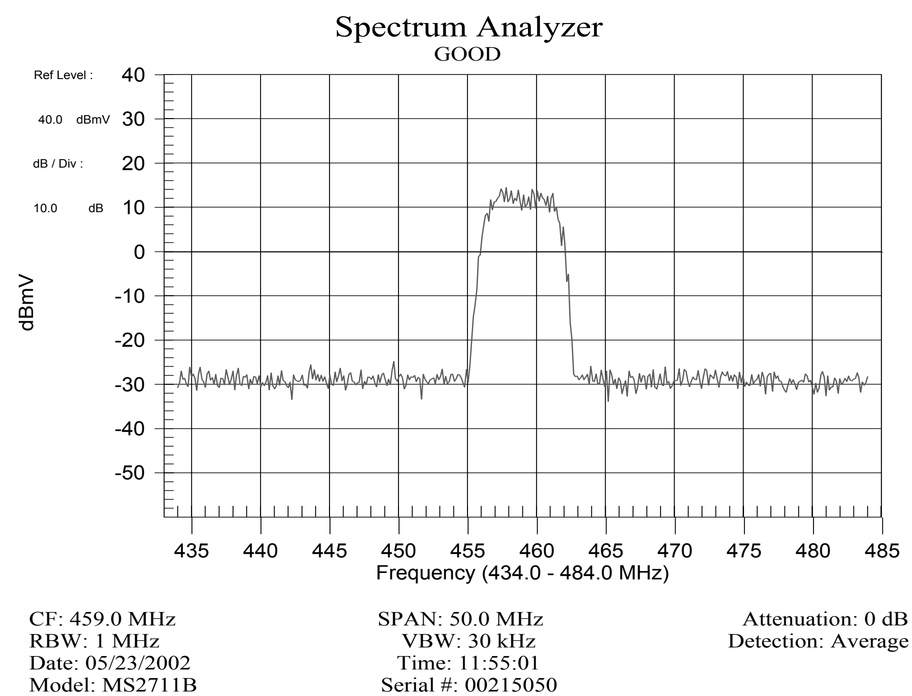

Figure 2-5: Proper Downstream IF input to subscriber's modem.

The spectrum analyzer settings were as in Table 2-1:

Table 2-1: Typical spectrum analyzer settings.

Parameter	Setting
Center Frequency	IF frequency in use (481 – 571 MHz)
Span	50 MHz
RBW	1 MHz
VBW	30 kHz
Vertical Scale	linear, 10 dB / division
Reference Level	+40 dBmV
Attenuation	20 dB
Detection Mode	Averaging

Align the subscriber Transceiver antenna as described above, adjusting for maximum signal amplitude.

2.2 Cable Connection and Grounding

Attach the single RG-6 coaxial cable to the F connector on the rear of the Subscriber Transceiver. See Figure F2. Waterproof the connection using a suitable method such as taping with Scotch #88. Be sure to leave sufficient slack to allow the antenna to be oriented and that the cable runs directly downward from the connector to avoid water running down the cable and into the F connection.

Route the coaxial cable to the building entry point utilizing UV-resistant tie-wraps and staples or cable clamps as required.

UV-rated cable should be used outdoors, and UV- or Riser-rated cable can be used indoors. In some buildings, a Plenum-rated or riser-rated cable is required. Consult the local codes.

Mount the grounding device (e.g. Radio Shack 15-909C in Figure 3-4) as near as practicable to the point of cable entry to the structure. Connect the grounding device to a suitable "grounding electrode".[5] Connect the RG-6 coaxial cable from the Subscriber Transceiver to the grounding device and waterproof all outdoor F connectors as described above.

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[5] The National Electric Code, sections 820-33 and 820-40, describes this requirement in detail.

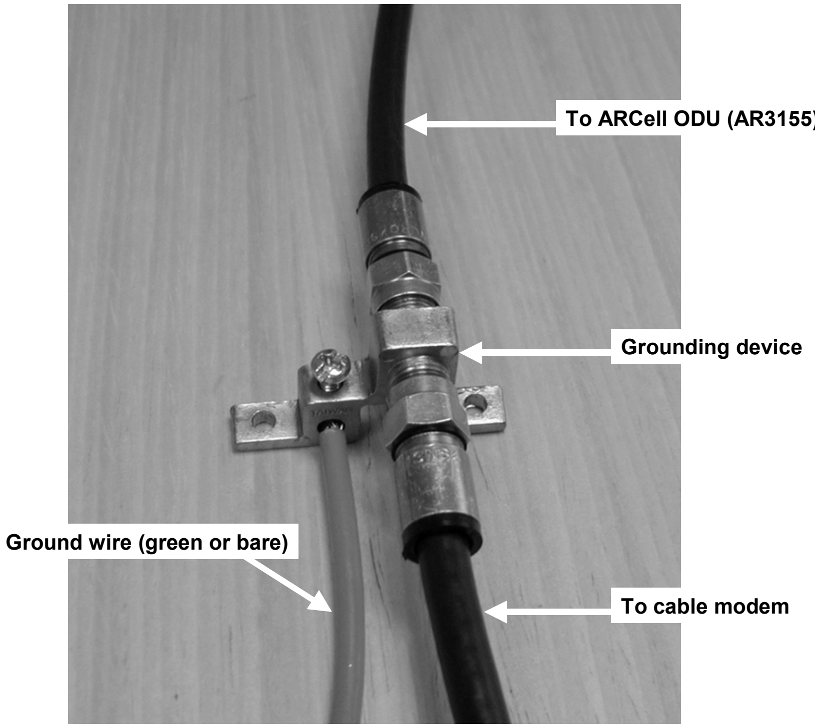


Figure 2-4: Typical grounding device at subscriber premises.

2.3 DC Power Supply

The Transceiver is powered over the coaxial cable via a Power Inserter (Figure 2-5) provided with the Transceiver.

Inside the building, route the RG-6 from the building entrance point to the wireless cable modem location. Install an F connector on the cable. Connect the transceiver cable to the "To Antenna" F-type female connector of the Power Inserter.

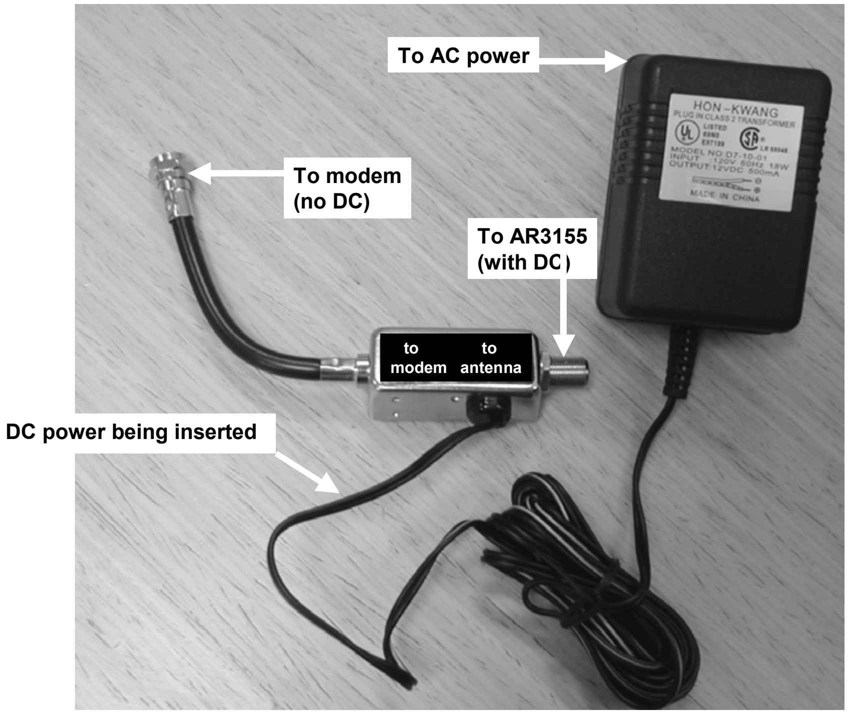


Figure 2-5: Power Inserter and AC/DC converter.

2.4 Wireless Cable Modem

Place the wireless cable modem where it will be used and attach the short cable on the power inserter (labeled "To Modem" in Figure 2-5) to the F connector on the rear of the modem. Connect the (separate) modem wall-mounted power supply (included with the wireless cable modem) to the power connector on the rear of the modem. Plug both wall mounted power supplies into suitable AC power sources – preferably a UPS or surge protected power strip. Connect a straight-through 10/100BaseT LAN cable between the RJ-45 jack on the modem and the user hub, router or personal computer.

Figure 2-6 illustrates the modem connections at the back of a typical modem. The DB-9 connector is a maintenance port for the modem shown.

The WCM, when it is first powered up or when it has lost the downstream signal, will "step" through the standard EIA channel list looking for the downstream signal. Alternatively, the WCM may be optioned through its administrator interface to lock onto a specific downstream frequency.

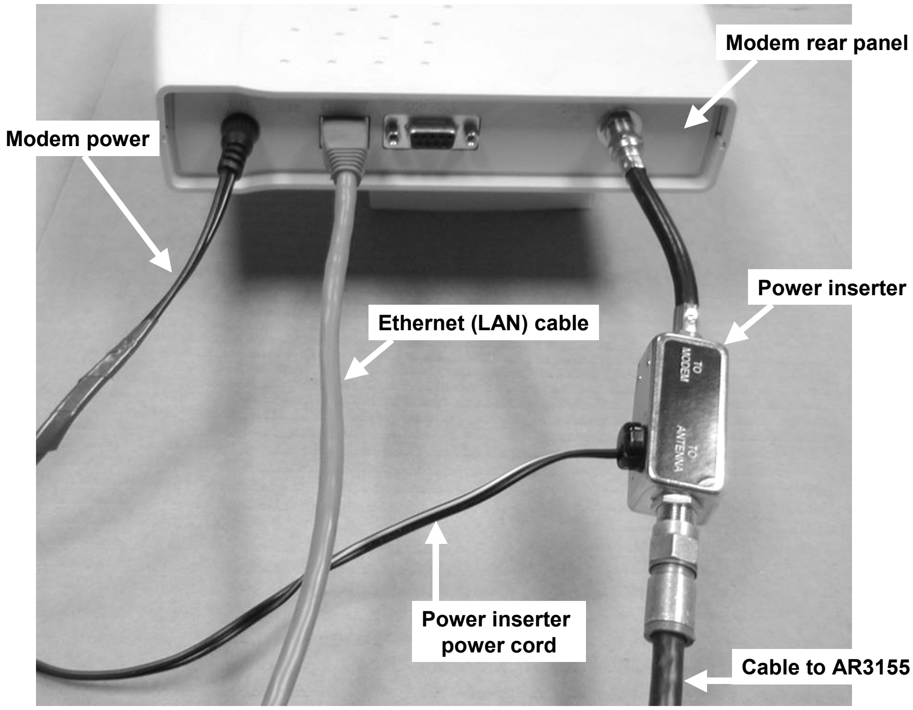


Figure 2-6: Rear view of typical wireless cable modem.

2.5 Installations Close to Hub

The subscriber installation Schematic Diagram (Figure 2-1) shows a 6 or 10 dB attenuator (pad) installed between the power inserter and the wireless cable modem ("dry" side of the power inserter). Small pads of many values are available with F-type connectors to screw in line with the coaxial cable connection, such as Channel Visions #3000-10, and they may be cascaded to sum their attenuation. At the time of system set-up it may be determined that such pads are required in subscriber installations extremely close (less than a mile) from the base station site to reduce excess downstream signal.

2.6 Frequency Channel

The cable modem will automatically search for the active channels, go through a handshake with the Hub, and be told all the parameters it will need to join the wireless network.

2.7 Modem http Interface

The modem status can be determined by the LEDs and by a browser interface.

The LEDs and their use are:

- Power: ON = power OK
- Cable: ON = ranged & registered with CMTS, blinking= in process
- LAN: ON = connected

- USB: ON = connected [some modems have both USB & LAN connectors]
- Activity: blinking = data (transmit or receive)

The browser interface is available on some modems and contains more information. To reach it, follow these steps:

- Connect a PC to either the modem's USB or the Ethernet interface
- Launch the PC's browser, such as Microsoft's Internet Explorer
- Address: http://192.168.100.1
- User: (leave this blank)
- Password: cable

The screen looks like Figure 2-7.

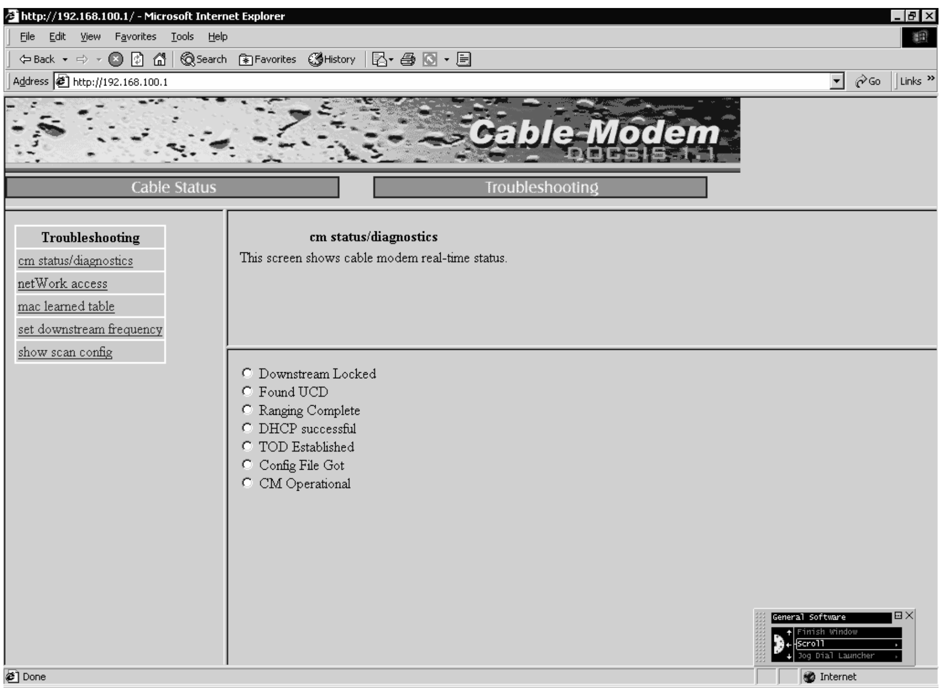


Figure 2-7: Screen for cable modem status.

3 Hub Installation Detail – Omni + 4x90

One popular design for the Hub is to transmit from an omnidirectional antenna, as in Figure 3-1, and receive in 90-degree sectors.

The transmit traffic capacity is 20 Mbps, and each of the receive traffic capacities is 5 Mbps, so the total receive capacity is equal to the transmit capacity, i.e., 20 Mbps.

Figure 3-1: Omnidirectional transmitter and antenna.

The system diagram is shown in Figure 3-2. The four receive/antenna units connect directly to the Wireless Cable Modem Termination System (W-CMTS), which is using DOCSIS protocols to control the subscriber's wireless cable modems.

The BSR1000W W-CMTS can handle a large number of subscriber's modems, more than will normally be in the wireless cell. The specified capacity is 16,000 service flows, so it easily supports over 1000 cable modems.

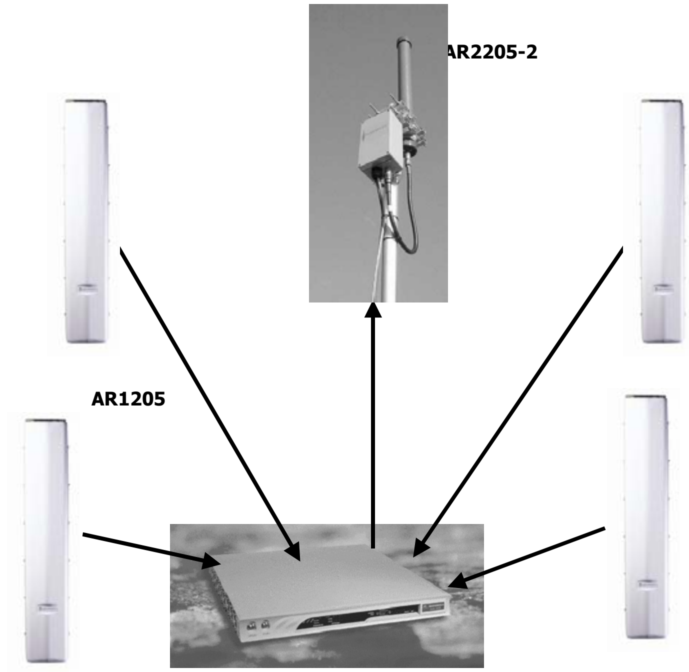


Figure 3-2: System diagram.

3.1 Installation Detail – AR2250 Transmitter/Antenna

The Transmitter and Antenna are two units joined with a short coaxial cable. They are normally mounted on the same pipe.

3.1.1 Pole Mount

The omnidirectional antenna is mounted at the top of a 1.25 to 2.0-inch Outside Diameter (OD) pipe, so that it radiates unobstructed in a full 360 degree circle.

The antenna is inside a cylindrical "plastic" PVC radome. It is connected to the Transmitter via a short coaxial cable.

The Transmitter is a transmit module inside a weatherproof housing with pipe mounting hardware.

3.1.2 Cabling

There are three cables between the equipment room and the Transmitter:

- IF coaxial cable
- DC power twisted pair cable
- Grounding wire

Arcwave recommends the use of premium quad-shielded RG-6 coaxial cable (such as Belden 1189A) for base station installations. This is used by the cable TV industry and it reduces leakage through the shielding, as well as minimizing interference from outside sources.

UV-rated coax and power cable should be used outdoors, and UV-, plenum- or Riser-rated cable can be used indoors. In some buildings, a Plenum-rated cable is required. Consult the local codes.

The ground wire should be #6AWG copper connecting the pipe and Transmitter housing to building ground. Follow the local code requirements.

A surge suppressor[6] is needed at the building entrance or in the equipment room; the location depends upon local code. Arcwave recommends the PolyPhaser IS-75F-C1 protector, as in Figure 3-3, for the IF coaxial cable.

Figure 3-3: PolyPhaser coaxial cable lightning protector.

Arcwave recommends the PolyPhaser IS-17VDC-30A-NG protector shown in Figure 3-4 for DC power.

Figure 3-4: PolyPhaser DC lightning protector #IS-17VDC-30A-NG.

If the installation requires a separation between the Transmit module and the omni antenna, then the installer will have to use a suitable coaxial cable type, with N-type connectors at each end. Suitable cable at the 5.8 GHz transmit frequency is Cablewave Low-Loss ½ inch foam FLC 12-50J, which has about 6.1 dB loss/100 ft, so a 10 ft cable is suitable. So are FSJ2-50 and Times LMR-400.

3.1.3 DC Power

The AR2250 Transmitter must be powered from 8.0 to 8.5 Vdc at the Transmitter connector.

The Transmitter typically consumes 550-650 mA (see Data Sheet).

The wire gauge can be selected, preferably for less than ¼ Volt drop from the power supply to the Transmitter.

---

[6] The manual uses the terms “surge suppressor” and “lightning protector” interchangeably. It is understood that a lightning bolt has enough energy to light a town for a year, so a direct lightning strike will melt/damage all the metal it touches, including the antenna.

The DC power takes a wire pair to the Outdoor Junction Box (OJB), and thence to each of the Transceivers. The negative lead is grounded in the equipment room, inside the OJB and inside the Transceiver.

Examples of voltage-drop calculations:

1. The standard cable shipped with the Transmitter is 25 feet of #18 AWG shielded twisted pair annealed copper wire (Belden 3124A), which will have a 0.1 Volt drop at 600 mA. Remember that the ground return is #18 in parallel with the #6 and some building ground, so the return resistance is negligible.
2. If the installer splices on an additional 50 feet of #14 AWG twisted pair power cable to the factory cable (to avoid changing the connector), the additional cable will have a voltage drop of 0.1 Volts, so the total drop is 0.2 Volts.

Table 3-1: Wire resistance (annealed copper)

AWG	Ohms/100ft
24	2.567
22	1.614
20	1.015
18	0.6385
16	0.4016
14	0.2525

3.1.4 Transmitter

The radiated power from the antenna is 1 Watt (30 dBm). This maximum power is set by FCC regulations. The user must not add any amplifiers or make any other changes that will exceed this wattage.

The omnidirectional antenna gain is 13 dBi. Assuming the transmitter is located a short distance from the antenna, so that the loss in the coaxial cable is negligible, the output of the transmitter must be no more than 17 dBm.

The omnidirectional antenna radiates 360 degrees (hence the name) horizontally, and about 5 degrees vertically.

The antenna is designed so that when the mechanical mounting is true vertical, there is an electrical downtilt of one degree. That makes the radiated pattern 1.5 degrees above and 3.5 degrees below horizontal. An inexpensive tool to help establish true vertical is a level made for fence posts, which has two spirit/liquid levels at right angles.

The spectrum at the input to the transmitter will look like Figure 3-5.

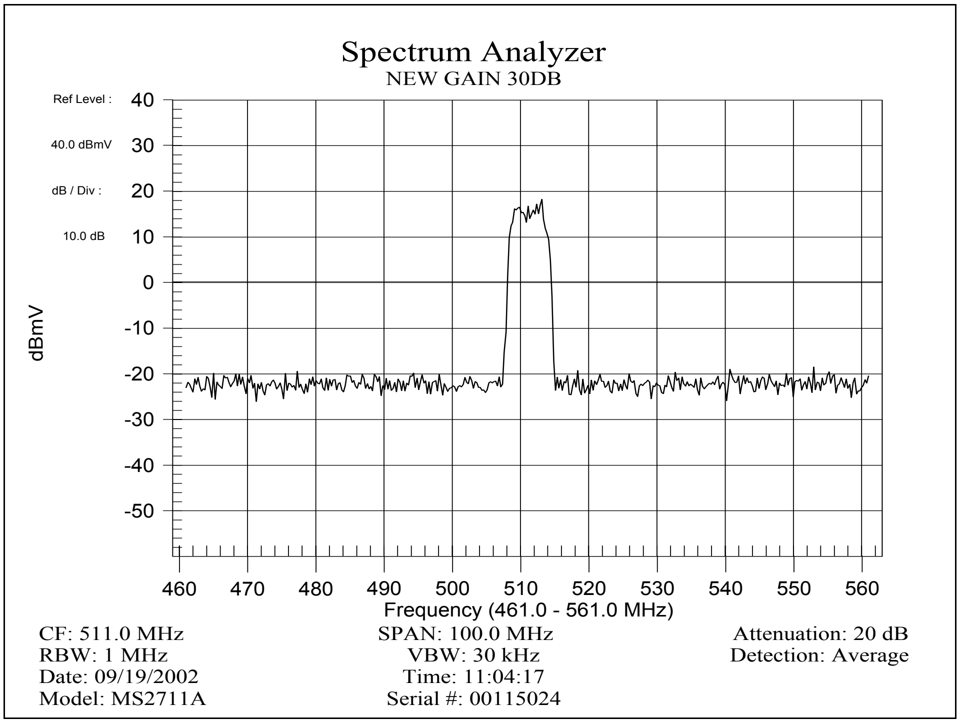


Figure 3-5: Spectrum at the input to the Hub Transmitter for properly driven IF.

The transmit frequency is a configuration setting for the Downstream upconverter (internal or external to the W-CMTS).

3.2 Installation Detail – AR1205 Receiver/Antenna

Mount the AR1205 Receiver/Antenna on a vertical pipe with at least 44 vertical inches clear of unrelated hardware or other impediments. The Receiver mounting brackets will accommodate pipe from 1.5 to 2.25 inches in outside diameter. Up-tilt or down-tilt is accomplished by means of adjusting the nuts on the 5/16 inch threaded bolts captive to the mounting assembly. See Figure 4-4 for mounting details.

The standard carrier frequencies for the Receivers are 5287.2 and 5290.4 MHz. One frequency must be chosen and specified when ordering.

Ground the Receiver/Antenna to the metallic mounting structure (tower or monopole) or suitable rooftop ground point according to local codes and installation practices. Normally #6 AWG or larger wire is utilized for this purpose. A ¼-20 ground bolt is provided on the bottom flange of the Hub Receiver to attach the ground wire. This is illustrated in Figure 3-6 & 3-7.

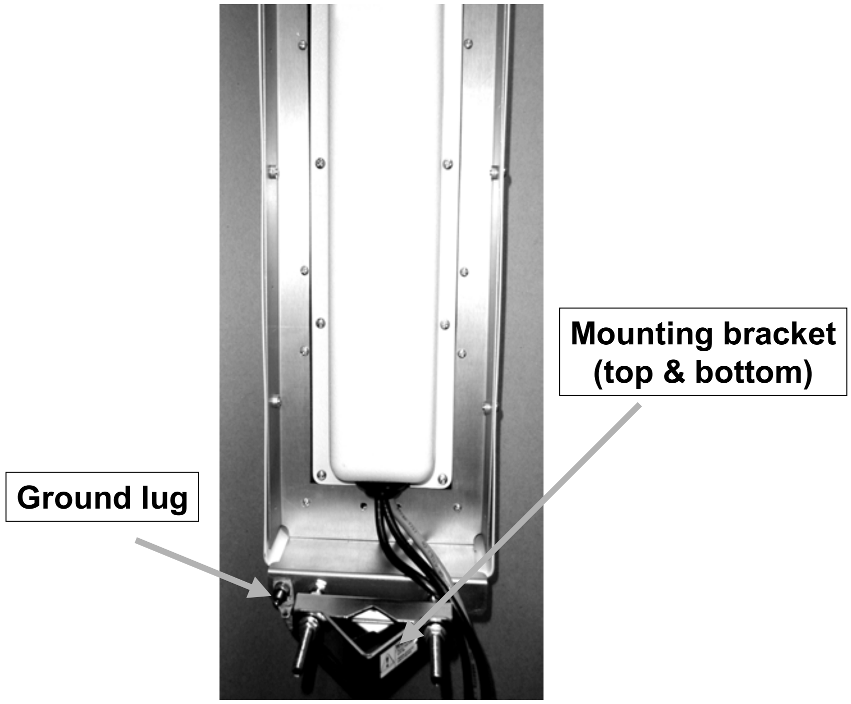


Figure 3-6: Cable installation and dressing with weather cap installed.

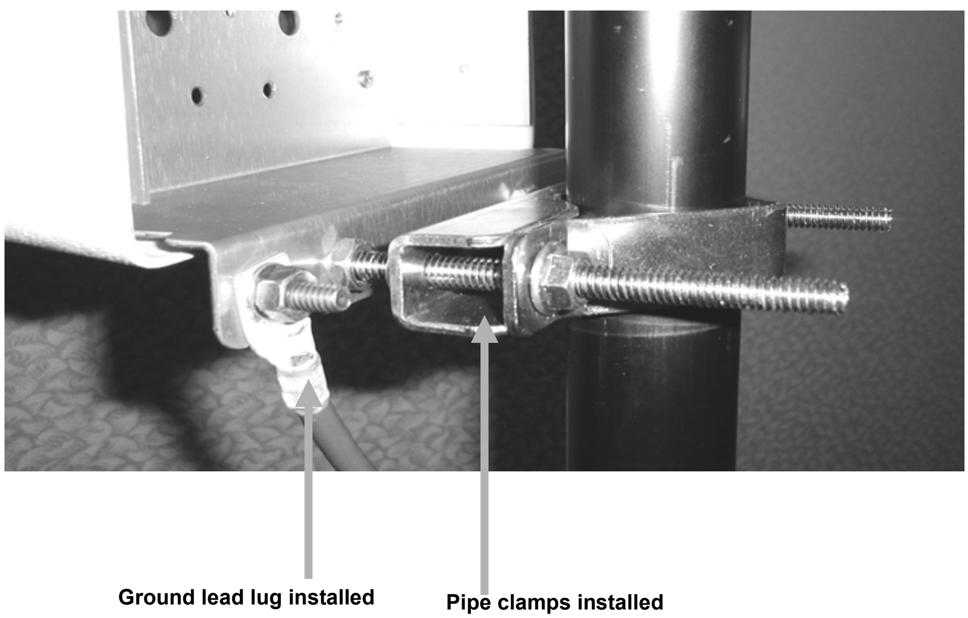


Figure 3-7: Hub Receiver Bracket Close-up Details

3.2.1 Cabling

The AR1205 Receiver requires three cables:

- IF coaxial cable
- DC power twisted pair

- Ground wire

As with the Transmitter, Arcwave recommends quad-shielded RG-6 coaxial cable (Belden 1189) and twisted pair of a suitable gauge wire.

When the equipment room is a short distance from the transmitter and receiver installation, the simplest cabling is to install separate cables for each unit, i.e., 5 coaxial cables, 5 power cables and 1 ground wire.

The AR1205 Receiver must be powered from 8.0 to 8.5 Vdc at the Receiver connector.

The Receiver typically consumes 275-350 mA.

The wire gauge can be selected, preferably for less than ¼ Volt drop from the power supply to the Transmitter. For example, the standard power cable (25 ft. of #18 AWG) will have a voltage drop (round trip) at 300 mA of under 0.05 Volts, which is negligible.

Arcwave recommends a common Uninterruptible Power Supply (UPS), such as the APC1400, to protect all the base station equipment.

The coaxial cables terminate directly on the W-CMTS.

In a later Section, we will discuss the fault-isolation advantage of inserting a “tap” just before the coaxial cable is attached to the W-CMTS.

In a later Section we will discuss an installation option of having a common DC power supply in the equipment room and sharing the power cable in the building riser. This goes to an Outdoor Junction Box, where the individual DC cables terminate.

The Receiver and its pipe must be grounded to the building or tower ground system with #6 AWG or larger wire. Follow the local building code.

The Hub Receiver is factory-tuned to its Receive Carrier Frequency and Receive Output Frequency to be delivered to the W-CMTS Upstream input. Hence the frequency planning must be done prior to ordering equipment and the frequency must be specified in the purchase order. These details are discussed in the Section on Frequency Planning.

3.3 Installation W-CMTS BSR1000W

The BSR 1000W is a compact, DOCSIS-compatible high-performance Wireless-Cable Modem Termination System (W-CMTS) and full-featured router, which enables wireless broadband service providers to cost-effectively deliver voice, data and multimedia content and services to over 1000 subscribers.

The Wireless CMTS BSR1000W is a single “pizza box” W-CMTS that can be placed on a table or rack mounted.

The BSR1000W has 1 downstream output supporting 10 and 20 Mbps. The lower speed occurs when the robust modulation is used, called QPSK. The higher speed occurs when the higher 16-QAM modulation is used.

The BSR1000W has 4 upstream input ports supporting 5 Mbps each.

The BSR1000W can connect directly to the Omnidirectional Transmitter (AR2250-2) and up to 4 of the 90-degree Receivers (AR1205). It does not need external amplifiers or upconverters.

Networking features include:

1. **INTEROPERABILITY**
    a. DOCSIS 1.0-qualified,

b. EuroDOCSIS 1.0-qualified,

c. DOCSIS 1.1-compatible,

d. EuroDOCSIS 1.1-compatible,

e. PacketCable 1.0-compatible

2. **NETWORK MANAGEMENT AND PROVISIONING**
    a. Cisco-compatible CLI
    b. SNMP v1 and v3
    c. Standard DOCSIS and IETF MIBs
    d. Motorola MIBs
    e. LDAP v3
    f. Open Interfaces to Provisioning, Accounting and Billing Applications
    g. HTTP/Java/XML Integration
    h. DHCP Relay
    i. Multiple Levels of Account/Password
    j. Authentication
    k. Telnet with Security Extensions
    l. Multiple Community Strings
3. **INTRADOMAIN/ INTERDOMAIN ROUTING**
    a. RIP v1 OSPF v2
    b. RIP v2 BGP4
    c. IS-IS VRRP
4. **MULTICAST ROUTING SUPPORT**
    a. DVMRP IGMP v2
    b. PIM-SM/DM MBGP
5. **BRIDGING AND ROUTING**
    a. Layer 2 Bridging Layer 3 Routing
    b. SmartFlow Wire-speed QoS
    C. Forwarding and Flow Classification

Figure 3-8: BSR1000W on table.

3.3.1 Default Configuration

3.3.2 Server Software

This is discussed in other Sections of this manual. The server software is pre-loaded at the factory.

3.4 Network Management

For a multi-sector Hub with dozens of subscribers, the alarming and other features in the Arcwave Network Management is really key to operating a successful system.

However, Arcwave's network management software is optional and for a single Hub sector and a few subscribers, a technician may prefer to start with just a Command Line Interface and manually check the performance of the links hourly or daily.

3.4.1 PC Installation

Arcwave recommends a PC be installed locally at the Hub so maintenance logs and other information are not dependent upon a backhaul link.

The Arcwave software assumes a Microsoft Windows 2000 system.

3.4.2 SNMP

For large BSR1000W networks, Motorola's Advanced Provisioning Manager may be suitable since it includes extensive SNMP functionality. See http://www.gi.com/ipns%5Fapm.html

3.5 Wireless Network Addresses

This purpose of this Section is to assist you in feeding in your Internet connection through the W-CMTS to subscriber wireless modems. In order to accomplish this, you configure a gateway (router) with Internet access on the local network (10.10.10.x), and configure the Windows 2000 DHCP server running in the NMS Server machine.

IP addresses used as an example in Figure 3-6:

ISP Addresses

ISP Gateway	169.245.0.1
ISP Subnet mask	255.255.255.248
Assigned IP address from ISP	169.245.0.2

Router Addresses

WAN (internet) Address	169.245.0.2
WAN Sub mask	255.255.255.248
LAN Address	10.10.10.200
LAN DHCP server	OFF

ARCell Default Addresses for Vyyo

NMS (Windows) Server	10.10.10.201
WMTS	10.10.10.202
LAN Subnet mask	255.255.255.0
Available DHCP Addresses	10.10.10.x

ARCell Default Addresses for BSR1000W

NMS (Windows) Server	10.10.10.201
BSR1000W #1	10.10.10.203
BSR1000W #n	10.10.10.20(n+2)
LAN Subnet mask	255.255.255.0
BSR cable IP address	192.168.2.1
Available DHCP Addresses	(Internal to BSR)

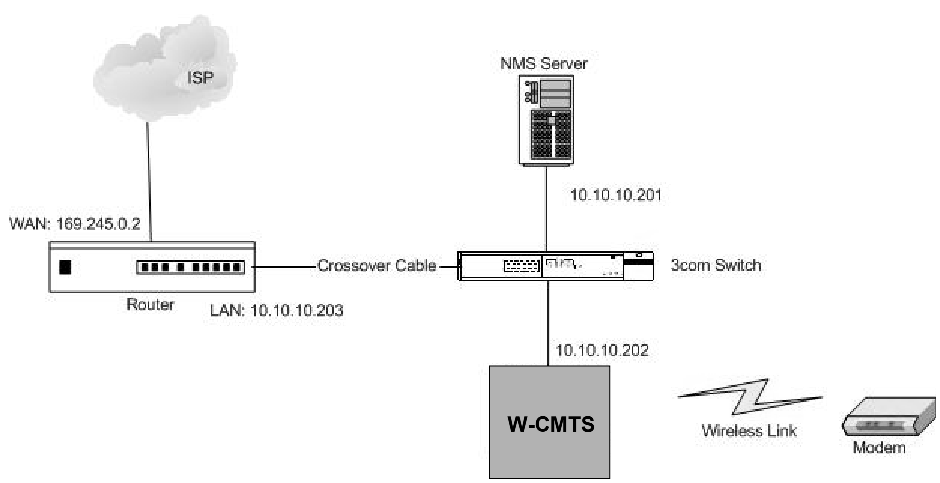


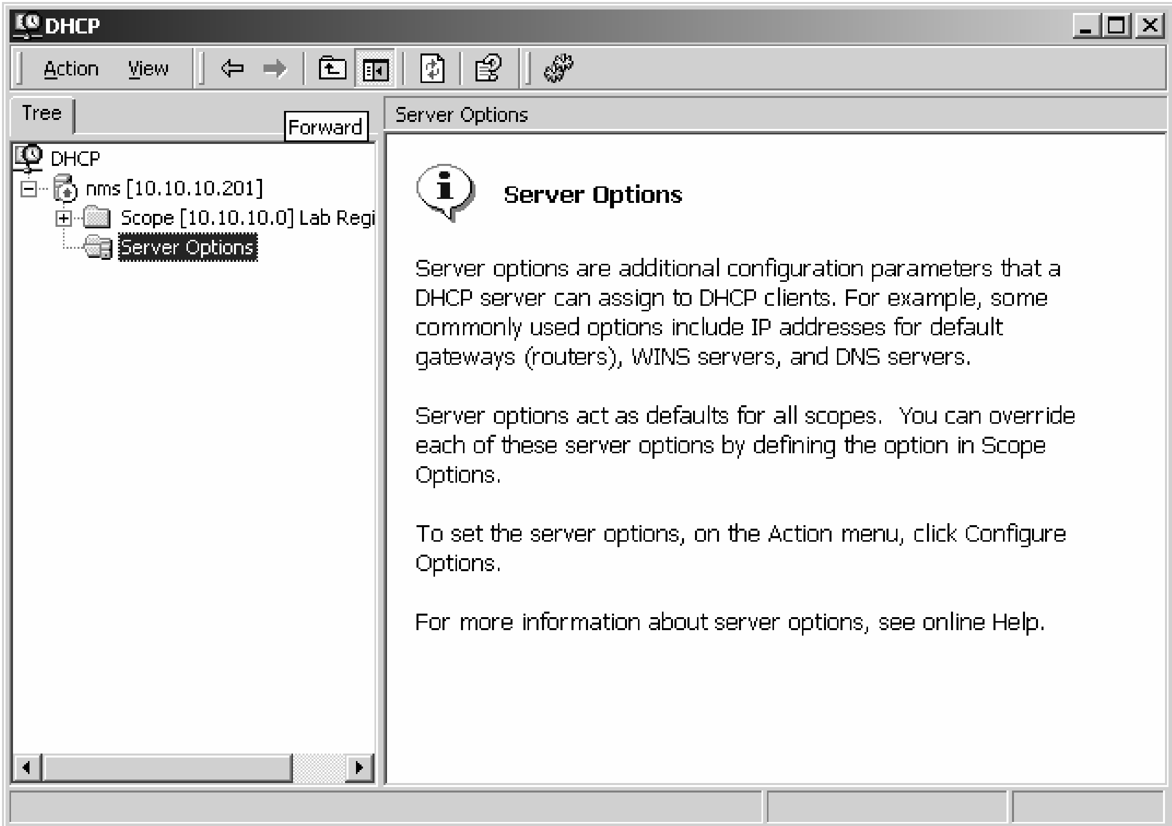
Figure 3-9: Network Diagram

3.5.1 NMS Server Configuration

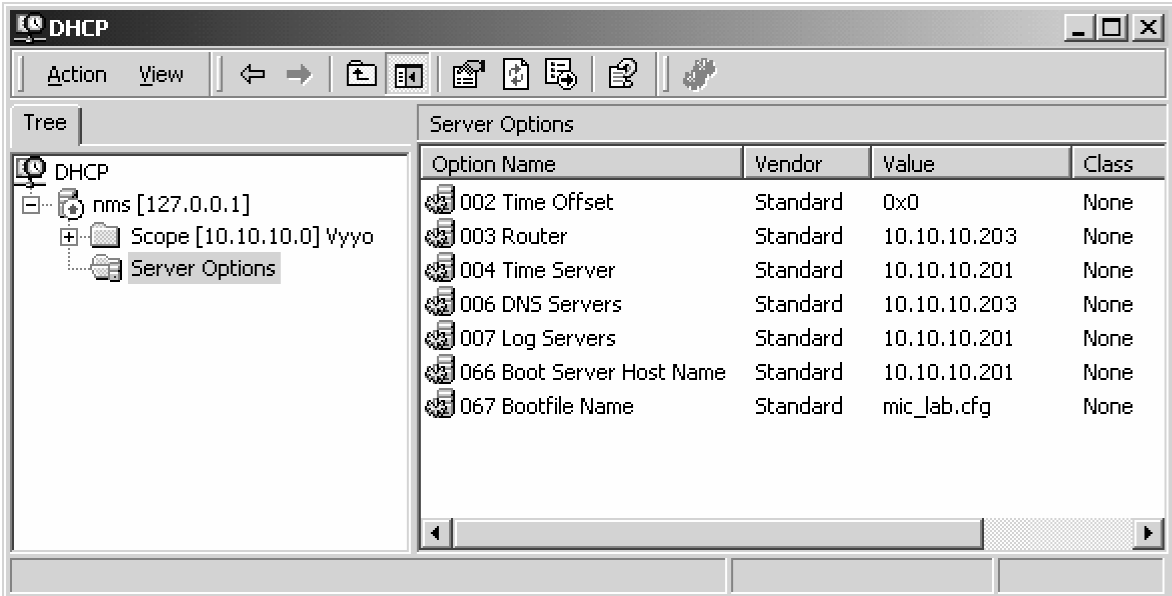
In order to allow the wireless modem to have access to the Internet, it must know the address of the router. The wireless modem gets this address from the DHCP server, which is a component of the Windows 2000 Server operating system running the NMS Server.

Open the DHCP server in Windows 2000 Server (Start Menu -> Settings -> Control Panel -> Administrative Tools)

1. Highlight “Server Options” and Click “Action” > “Configure Options”.



2. In the “General Tab”, check the following and enter the specified value
    a. 002 Time Offset – Input: 0
    b. 003 Router – Input: Enter router’s IP address or NMS’ IP address (Require by Vyyo Modem)
    c. 004 Time Server – Input: NMS’ IP address (e.g. 10.10.10.201)
    d. 006 DNS Server –Enter the IP address of the DNS server (e.g. router or NMS)
    e. 007 Log Server – Input: NMS’ IP address (e.g. 10.10.10.201)
    f. 066 Boot Server Host Name - Input: NMS’ IP Address (e.g. 10.10.10.201)
    g. 067 Bootfile Name - Input: configuration file the modem loads (e.g. mic1.cfg)
3. When finished Click “Apply” then “OK”. Your window should now look similar to this:

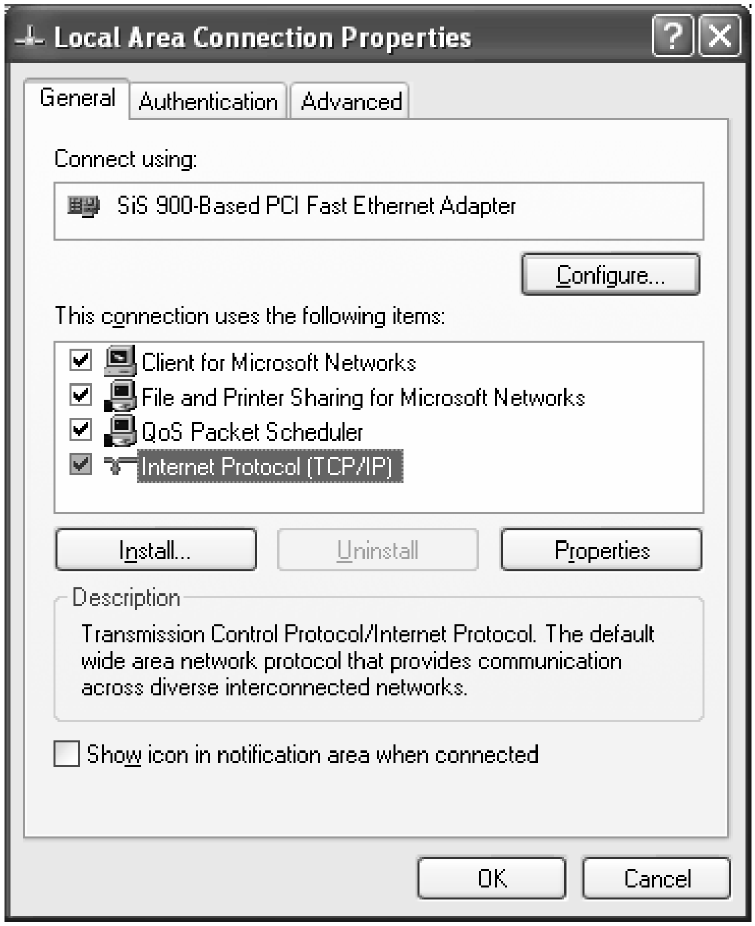


Be sure the "003 Router" and "006 DNS Server" options are set correctly with the Internet router's IP address. In this example both Router and DNS server options are set to 10.10.10.203.

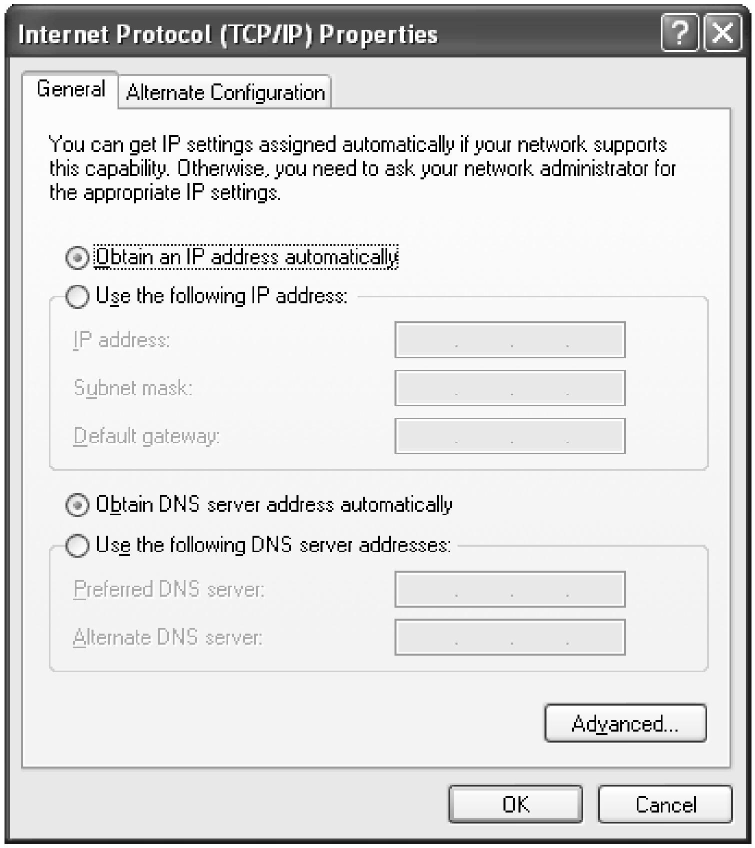
3.5.2 Network Testing for Vyyo system

The easiest way to test whether your NMS Server's DHCP server options are configured correctly is to connect a computer (MAC, PC, or Laptop) to the Ethernet switch.

Be sure that the user's PC is set to obtain its networking settings using DHCP. This is done by going to Start Menu -> Settings -> Control Panel ->, Network Connection -> Local Area Connection. Click on "Internet Protocol (TCP/IP)" and then "Properties" in order to verify that DHCP is enabled.



"Obtain an IP address automatically" and "Obtain DNS server address automatically" must be checked as shown below.



If you are using Windows 95/98 you may need to reset the computer after making any network changes. If you are using Windows 2000/XP, you can check to see if the system obtained an IP address by opening a DOS prompt and typing "ipconfig /all" [NOTE: the space after "ipconfig" is necessary]. The system should have IP address in the range specified by the DHCP server, something in the range of 10.10.10.x for this example. If the operating system is not able to pull a proper IP address, unplug the network cable from the computer system for 30 seconds, and the plug it back in. Wait about 30 seconds to a minute and check again to see if the system pulls an IP Address.

Once the computer is set for automatic DHCP, automatic DNS, and gets an IP address from the NMS Server, open a web browser and attempt to connect to a web page. If the web page loads, then your active DHCP server in the NMS Server machine is configured properly. Any computer behind a wireless modem and on the local network should be able to go out to the Internet if it is set to obtain IP addressing information through a DHCP server.

***Note**: This portion of document that outlines how to check for DHCP setting was written for the Windows XP operating systems. Getting to the "Local Area Connection Properties" will vary slightly depending on which version of Windows you are using

3.6 Wireless Network System Testing

After installing the Hub equipment, take a subscriber unit into each of the Hub sectors and verify that Internet service is available and that it has the planned range.

4 Antenna and Frequency Planning

This Section describes some of the issues involved in planning a wireless network deployment.

The ARCell wireless system uses different frequencies for Downstream (Hub to subscriber) and Upstream (subscriber to Hub) communications, which is referred to as a Frequency Division Duplex system.

The Downstream uses a channel within the UNII “high” band, 5.725-5.825 GHz. Upstream uses a channel within the UNII “low” band, 5.250-5.350 GHz.

4.1 Antenna Patterns

Each Hub Transceiver has a specific antenna built in. They are labeled according to their horizontal pattern:

- Omnidirectional (360 degrees)
- 90-degrees directional
- 60-degree directional

Each antenna is directional in the vertical plane as well, with the strongest power straight out from the antenna’s axis. This means that elevations above straight out from the front of the antenna (up in the sky) receive less power, as do elevations below straight out. Therefore, the antenna is normally pointed at the furthest subscriber to be served, with the lower elevations providing appropriately less power to closer subscribers. This pointing is usually referred to as “downtilt” because the typical directional transceiver is pointed downward by less than 1 degree.

Omnidirectional antennas need to be mounted vertically, i.e., no mechanical downtilt. The ARCell omni antenna has an electrical downtilt of about 1 degree.

4.2 Frequency Planning – Downstream

4.2.1 Available Channels

There are 16 available downstream channels in the ARCell standard 5.725-5.825 GHz UNII band. The frequencies (Table 4-1) were chosen such that the resulting signal as received by the wireless cable modem (WCM) corresponds to a standard EIA CATV channel.

Table 4-1: Downstream Frequency Plan

WCMTS Down or Upconverter Output Center freq. (MHz)	**Transceiver Radiated** Center freq. (MHz)	**Modem IF Input** Center freq. (MHz)	**Modem** **EIA TV Channel**
Fd	Ftx=Fd+5248	Fif=Fd-52	
481	5729	429	58
487	5735	435	59
493	5741	441	60
499	5747	447	61
505	5753	453	62
511	5759	459	63
517	5765	465	64
523	5771	471	65
529	5777	477	66
535	5783	483	67
541	5789	489	68
547	5795	495	69
553	5801	501	70
559	5807	507	71
565	5813	513	72
571	5819	519	73

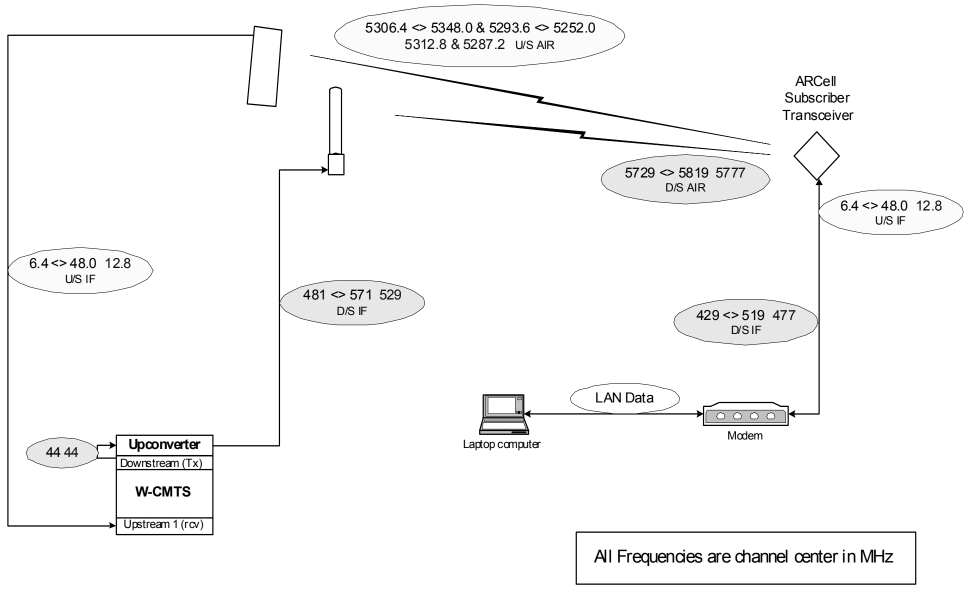


Figure 4-1: Frequency Plan.

Figure 4-1 illustrates the range of frequencies and an example of one configuration of up and down conversions. The example is:

a) The 44 MHz Downstream IF signal at the W-CMTS is upconverted to 529 MHz. In the BSR1000W this is done internally, in the V3000W this is done externally by the Cadco Upconverter unit.

b) The Figure shows that this upconversion could be any frequency in the range 481 to 571 MHz.

c) The Hub Transmitter modulates this new IF to the 5 GHz band. In this example, the 529 MHz is upconverted to 5777 MHz.

d) The Subscriber Receiver downconverts example's 5777 MHz to 477 MHz IF, which is a standard CATV channel the modem can detect.

e) Going in the Upstream, the modem output (transmit) upstream is 12.8 MHz in this example.

f) The Subscriber Transmitter (inside the Transceiver) up-converts this to 5312.8 MHz and to 5287.2 MHz, which goes over the air to the Hub Receiver. The transmission is scheduled by the DOCSIS protocol, so that it does not interfere with other modem transmission on this channel.

g) The Hub Receiver tuned to 5312.8 MHz, down-converts this to 12.8 MHz.

h) The W-CMTS Upstream port detects the 12.8 MHz upstream signal.

The Figure also shows what a spectrum analyzer would see, namely that the subscriber unit is also transmitting at 5287.2 MHz, but to receive this, the Hub would need the Receiver tuned to 5287.2 MHz.

4.2.2 Downstream Adjacent 90-degree Sectors

The 90-degree-Sector Transceiver has a half-power horizontal beam width of 90 degrees, i.e., 45 degrees each side of center. But, the energy of the antenna does not simply cut off at 45 degrees in horizontal pattern from the centerline of the antenna. Rather, the energy falls off as the angle from the centerline increases. This means that a subscriber in the vicinity of 45 degrees clockwise from antenna A will also be in the vicinity of 45 degrees counterclockwise from adjacent antenna B. Subscribers in the overlap zone – especially if they are relatively close to the base station – will receive downstream signals from both adjacent Hub Transceivers. This will cause unacceptable interference if both Hub Transceivers are transmitting on the same frequency, even though the subscriber is receiving nominally the same signal from both Hub Transceivers.

The solution for this is to ensure that adjacent Hub Transceivers are never transmitting on the same frequency. Two downstream frequencies (A & B) are required for an omnidirectional system employing 4x90-degree Hub Transceivers. Figure 4-2 shows the recommended ABAB pattern.

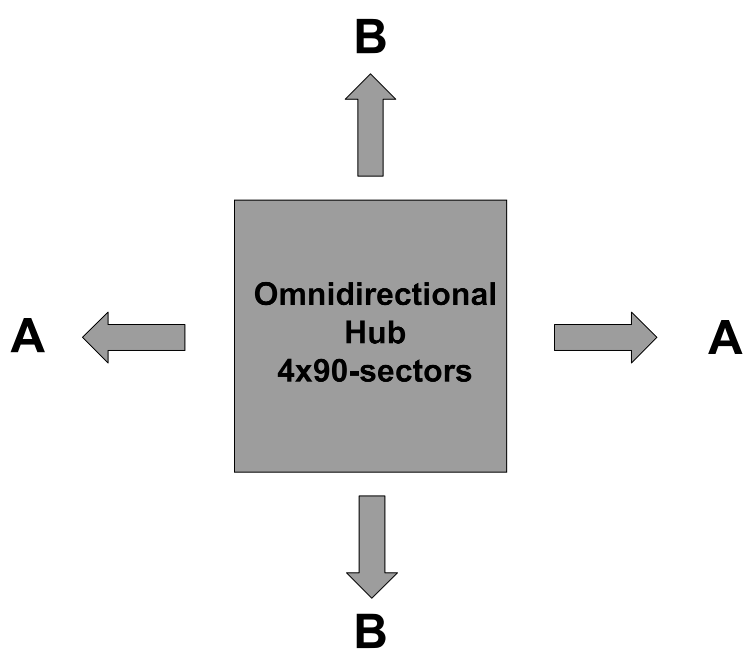


Figure 4-2: Downstream Channel Example of ABAB.

4.2.3 Downstream Logical Channels

It is important to note the distinction between "downstream frequencies" and "downstream logical channels". The "downstream frequencies" (A & B) discussed above refer to the actual RF carrier frequencies transmitted over the air. "Downstream logical channel" refers to the downstream data stream at the output of a base station W-CMTS downstream module. In the examples here, the frequencies employed may be driven from one to two downstream logical channels. The difference lies in the traffic capacity of the Hub. For example, Figure 4-3, below, illustrates a four-sector system that utilizes the ABAB frequency pattern and one downstream logical channel, which is split ultimately to all four sectors. This system has an aggregate raw downstream capacity of 10 Mbps, when utilizing QPSK modulation, and 20 Mbps when using 16-QAM modulation.

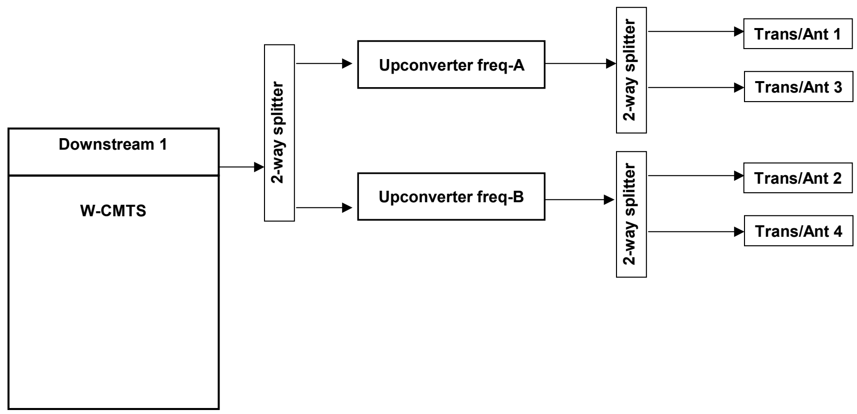


Figure 4-3: Four-Sector ABAB System with 1 downstream data stream, total 10 Mbps.

Figure 4-4, below, illustrates a four-sector system that utilizes the ABAB frequency pattern and two downstream logical channels that are split ultimately to all four sectors. This system has an aggregate raw downstream capacity of 20 Mbps, when utilizing QPSK modulation, and 40 Mbps when using 16-QAM modulation.

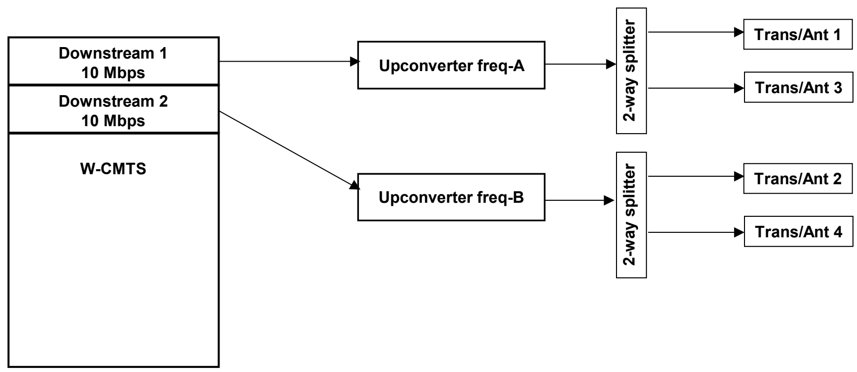


Figure 4-4: Four-sector ABAB system with dual downstream data stream, total 20 Mbps.

4.3 Frequency Planning – Upstream

This Section discusses several issues related to planning the use of the frequency band for Upstream communications.

4.3.1 Upstream Logical Channels

It is important to recall that any given downstream logical channel may have a large number of upstream logical channels associated with it, and that any given upstream is always associated with one and only one downstream. Thus, for example, the system in Figure 4-3 has only one logical downstream (split to all sectors) and four logical upstreams (one from each sector) connected to 4 upstream input ports on the W-CMTS. The association of one or more upstream logical channel with a downstream logical channel is made in the W-CMTS configuration. Upstream logical channels from one or more Hub Transceivers may not be combined into a single upstream input to the W-CMTS.

4.3.2 Upstream Frequencies

Figure 4-5, below, illustrates the 4 upstream signals from 4 Hub Transceivers arranged in a standard omnidirectional receive configuration. Note that this upstream configuration applies to all of the downstream configurations illustrated in the Figures above.

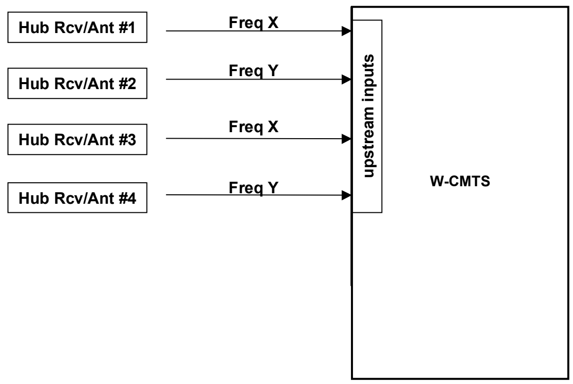


Figure 4-5: Four Hub Transceivers as input to W-CMTS.

4.3.3 Available Frequencies

All wireless modems in the same Hub sector must transmit upstream on the same frequency, and each wireless modem can operate on only one upstream channel.

There are 3 upstream frequencies. The Upstream data rate is 5.12 Mbps with Channel Bandwidth of 3.2 MHz. See Table 4-2.

The receiver within each Hub Transceiver is factory-tuned to its Receive Carrier Frequency and Receive Output Frequency to the W-CMTS. Hence the frequency planning must be done prior to ordering equipment and the frequency must be specified in the purchase order.

The W-CMTS commands the wireless modem to its Upstream Transmit Carrier frequency during the wireless modem registration process. These are configuration parameters that are set in the W-CMTS network management system. See the software installation guide for that product.

Table 4-2: ARCell Upstream Frequency Plan[7]

Modem Tx & W-CMTS Rx Input center (MHz)	RF Upstream center (MHz)	Model # (90 deg Rcv)	Product Status
6.4	5306.4	AR1205-064H	
9.6	5309.6	AR1205-096H	
12.8	5312.8	AR1205-128H	
6.4	5293.6	AR1205-064L	
9.6	5290.4	AR1205-096L	Standard
12.8	5287.2	AR1205-128L	Standard

NOTE: the 9.6 & 12.8MHz frequencies are supported by both the V3000W and the BSR1000W Wireless CMTS Hub controllers. The other frequency (6.4MHz) is not supported by the BSR1000W.

[7] A spectrum analyzer looking at the subscriber's transmitted RF will see two frequencies. The two carriers are 5300 MHz +- the upstream IF frequency.

5 Hub Installation Detail – 6x60

This Section will describe a six-sector Hub using 60-degree AR1255 Hub Transceivers. These Transceivers contain the transmitter, receiver and both Tx & Rx antennas in a single integrated outdoor unit.

This Section also describes a system using the V3000 W-CMTS, which is a chassis-based CMTS. This chassis has six card slots for upstream & downstream cards. The Downstream card is a single port. The upstream card provides 6 upstream ports. Thus the system scales from a single Downstream and single Upstream (2 cards) to a larger system. For example, the six-sector system described earlier can have 3 Downstream cards and one Hex-Upstream card.

The maximum traffic capability possible with the V3000W is 100 Mbps in each direction.

This system is ideal for large metropolitan area networks with multiple Hub sites.

NOTE: The ARCell Hub must be professionally installed. The installer must be familiar with local electrical, building, and other codes, as well as national codes and microwave regulations. This is for regulatory as well as safety reasons.

5.1 Installation Detail – AR1255 60-degree Hub Transceiver

The Hub Transceiver is almost 4 feet long but weighs less than 12 lbs. It is normally mounted on a vertical pipe.

Note: The *Base Station Installation Checklist* is included in the manual as a summary.

5.1.1 Cable connections

It will be more convenient to connect the transceiver cables and close the transceiver rear weather cap prior to attaching the transceiver to its mounting pipe. Refer to the Connection Diagram – Hub Transceiver on the following page.

Remove the sixteen screws securing the rear weather cap to the anodized aluminum back plate of the transceiver, taking care not to damage the gasket around the weather cap. This will reveal two aluminum modules containing the ARCell outdoor electronics[8]. The upper module contains the receiver and the lower the transmitter. Note the F-female and power[9] connectors on the bottom of each.

Attach the receive (upstream) RG-6 to the F connector on the upper electronics module and the transmit (downstream) RG-6 to the F connector on the lower electronics module. Arcwave recommends the use of premium quad-shielded RG-6 coaxial cable (such as Belden 1189A) for base station installations.

Attach the ARCell-provided power "Y" cable to the connectors on both electronics modules (connectors are interchangeable). Note that the power connector is keyed and must be rotated into the correct position prior to seating. The locking ring is quite stiff and must be turned approximately ¼ turn clockwise for proper connection. Be sure that the upstream and downstream RG-6 and the power cables clear the mounting screw holes for the rear weather cap. Refer to the photograph in Figure 5-1. Dress the cables as shown in the photograph and

[8] Complete replacement of one or both of the aluminum modules containing the electronic assemblies is the only user service possible for the ARCell Hub Transceiver.

[9] The pin connection information is detailed on the last page of this chapter – it is not normally needed as ARCell supplies the power cable.

secure with a tie-wrap below the lower electronics module. Although the power connectors are interchangeable, the method illustrated in the photograph will produce best results.

It is not necessary to disturb the SMA coaxial connector on the top of each electronics module. This is the connection to the actual antenna panel.

Replace the transceiver rear weather cap taking care that the gasket is seated smoothly around the edge of the weather cap and that the three cables pass through the cable access on the bottom end of the weather cap. Replace the sixteen screws securing the weather cap snugly but not tightly enough to distort the gasket. See Figure 5-2.

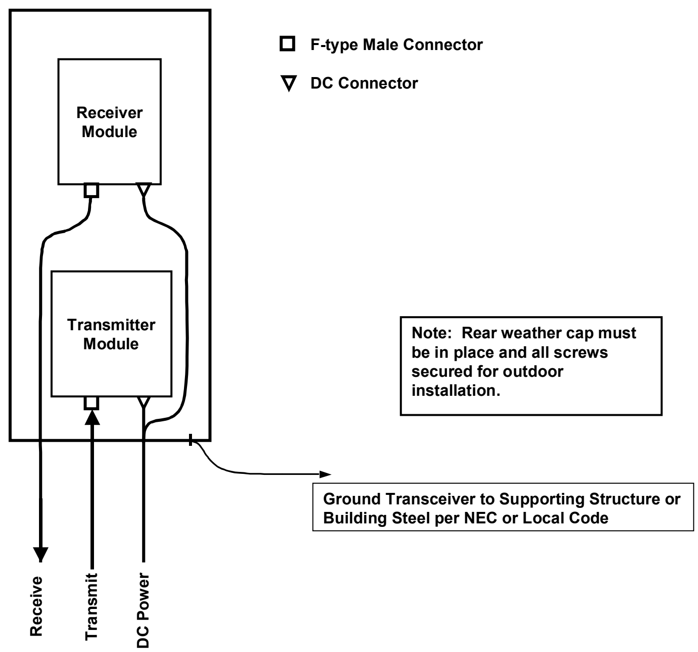


Figure 5-1: Hub Transceiver Connection diagram.

The photos in Figures 5-2 and 5-3 show how this is implemented.

5.1.2 Mounting

Mount the Hub Transceiver on a vertical pipe with at least 44 vertical inches clear of unrelated hardware or other impediments. The transceiver mounting brackets will accommodate pipe from 1.5 to 2.25 inches in outside diameter. Up-tilt or down-tilt is accomplished by means of adjusting the nuts on the 5/16 inch threaded bolts captive to the mounting assembly. See Figure 5-4 for mounting details.

Ground the transceiver to the metallic mounting structure (tower or monopole) or suitable rooftop ground point per local codes and installation practices. Normally #6 AWG or larger wire is utilized for this purpose. A ¼-20 ground bolt is provided on the bottom flange of the Hub Transceiver to attach the ground wire. This is illustrated in Figure 5-4 as well.

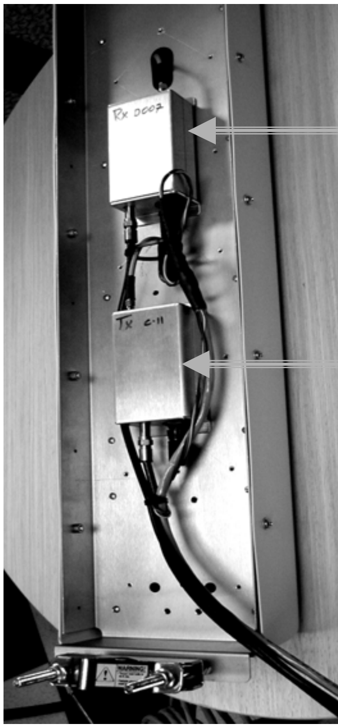


Figure 5-2: Cable Installation and Dressing.

Figure 5-3: Weather cap installed.

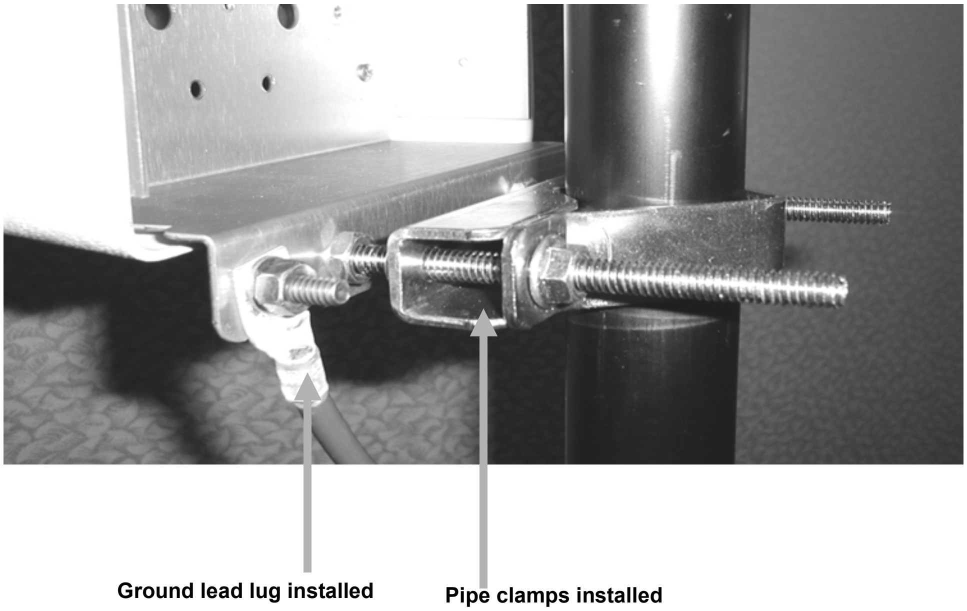


Figure 5-4: Hub Transceiver Bracket Detail

Bundle the three cables (2 x RG-6, power) with suitable (UV rated) tie wraps and secure to the mounting structure in a manner to prevent rainwater from flowing down the cable and into the cable access opening in the rear weather cap. Figure 5-5 illustrates a typical installation. Be certain to provide a drip loop if the cable bundle is routed upward.

In the case of a single sector, single Hub Transceiver installation, route the bundle of three cables to the base station indoor equipment room. Take care to leave suitable drip loops and bond the shields of the RG-6 and power cables to ground per local codes and installation practices.

If the base station site is multi-sector (two or more collocated Hub Transceivers), route the bundles of three cables to the equipment room as above. If an Outdoor Junction Box (OJB) is to be employed in the installation, route the cables to the OJB.

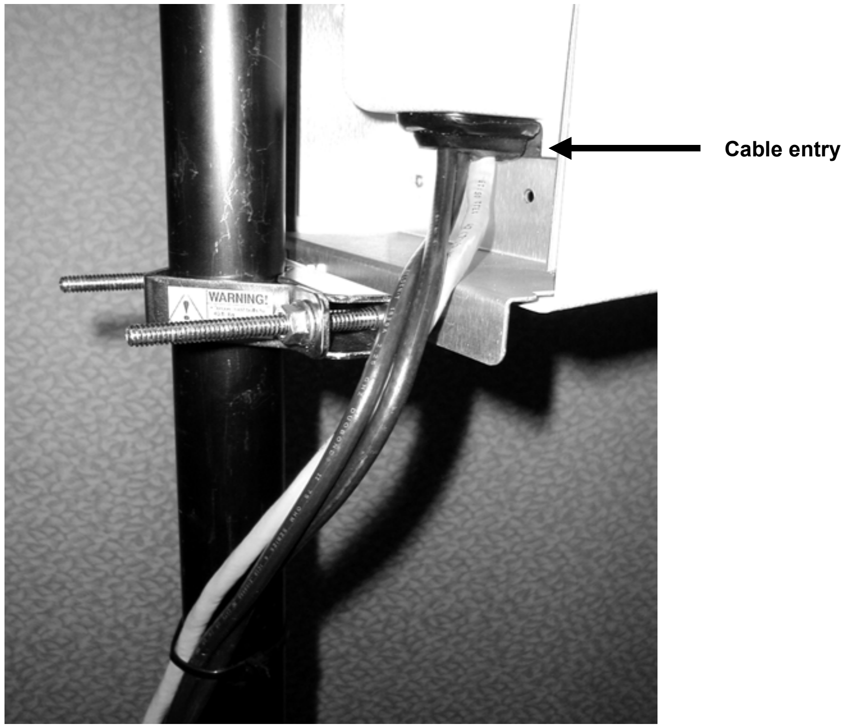


Figure 5-5: Hub Transceiver Cable Installation

5.2 Installation Detail – Outdoor Junction Box (OJB)

A multi-sector configuration consists of two or more Hub Transceivers mounted on a common building roof or tower/monopole structure served by a single Wireless CMTS (W-CMTS) located in an adjacent equipment room.

Each Hub Transceiver requires a separate upstream and downstream IF cable, so a six sector (six Hub Transceiver) installation would require 12 IF coaxial cables. The DC power cables are simply paralleled. This can be accomplished by running separate power cables from each Hub Transceiver to the equipment room, or by installing an Outdoor Junction Box (OJB) on the mounting structure adjacent to the Hub Transceivers and paralleling the DC power in the OJB.

An OJB may be used as a junction point for DC power as described here. It may also house lightning protection, IF signal splitters and power supplies.

It is the installer's responsibility to furnish, assemble and install the OJB.

5.2.1 Implementation

Arcwave's implementation of an OJB as its test site is described and pictured below (Figures 5-6 – 5-8).

Figure 5-6: Photo of open OJB.

The upper barrier strip terminates the shielded/outdoor CAT 5 cable (black jacket). This is reserved for the future applications.

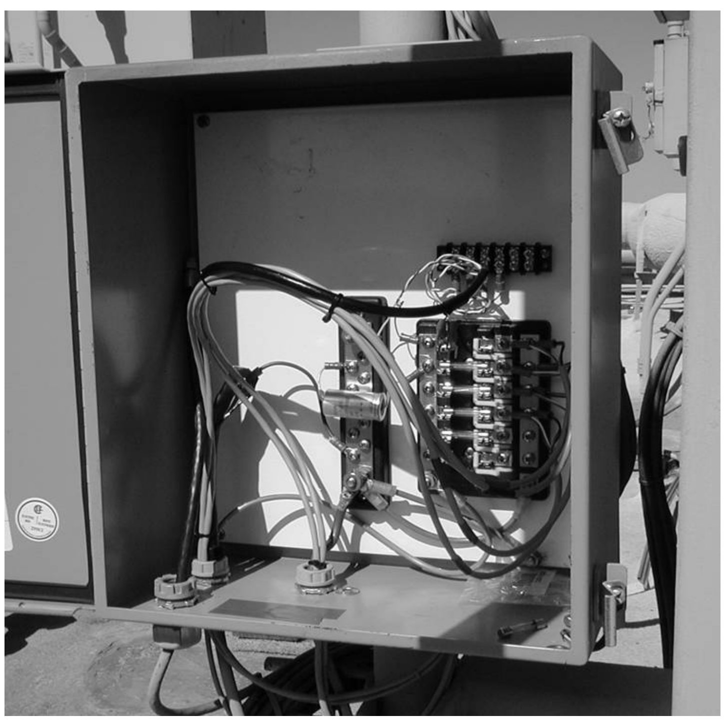


Figure 5-7: OJB