

becker

VARIS

**SMART UNDERGROUND
COMMUNICATIONS**

A division of Becker Mining Systems



Smart Com Ethernet Training Manual

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1.0 Overview

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1.1 Smart Com Ethernet Overview

Smart Com Ethernet operates over Smart Com systems to provide high speed network access using Leaky Feeder.

Standard, off the shelf cable network hardware is used to provide a network connection 4000x faster than any other Leaky Feeder data solution at ½ the cost.

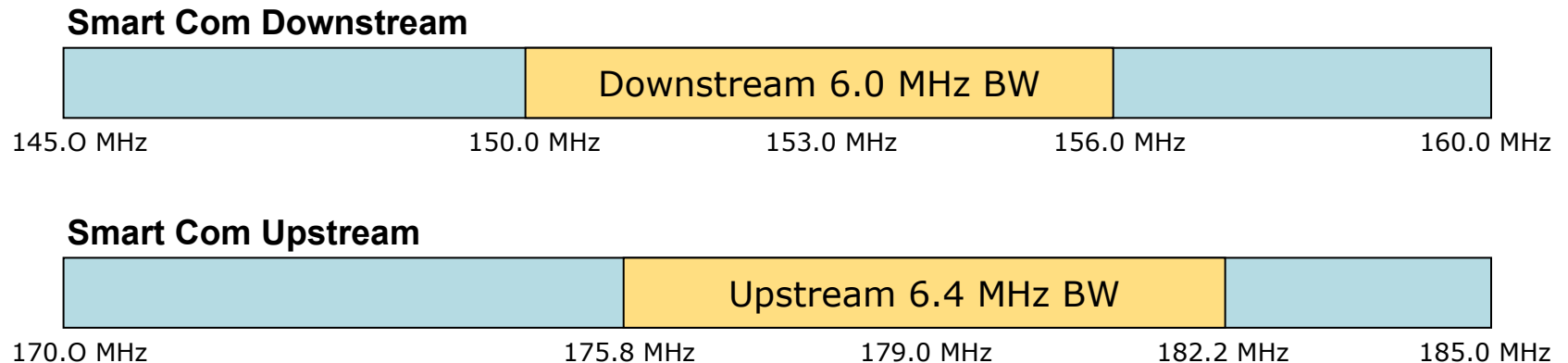
1.2 Hardware Overview

The industry standard cable network hardware used to provide wired and wireless access points includes:

- Cable Modems (wired and wireless)
- Cable Modem Termination System (CMTS)
- Gateways/Routers
- Cat 5/5e twisted pair cable

1.3 Smart Com Ethernet Bandpass

Smart Com Ethernet system uses Varis' proven Smart Com amplifier and its 30 MHz bandwidth to provide high speed TCP/IP data transfer.



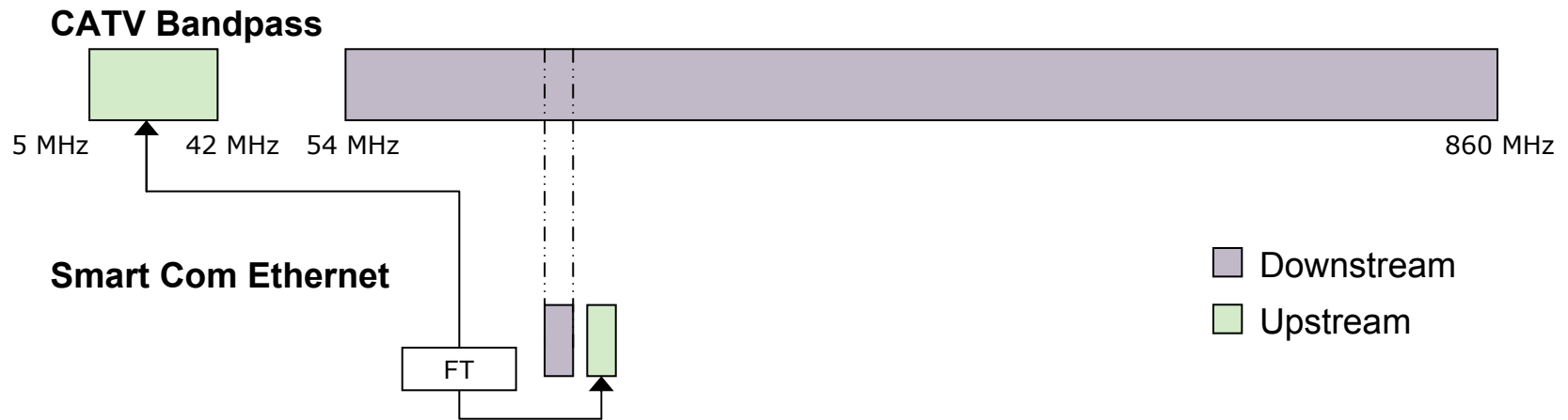
[See Smart Com Channel List 3.1](#)



1.4 Cable Network Bandpass

Although Smart Com Ethernet's downstream falls within the downstream bandpass of standard cable networks, the upstream does not.

As a result, upstream frequency conversion is required to send data over the Smart Com network.



2.0 Specifications



[2.1 Connection Specifications](#)

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2.1 Connection Specifications

Smart Com Ethernet facilitates a cable network connection with the following characteristics:

DOCSIS standard	2.0 (backwards compatible)
Modulation	Upstream: 64 QAM Downstream: 256 QAM
Data rates	Upstream: 41 Mbps Downstream: 54 Mbps
Bandwidth	Upstream: 6.4 MHz Downstream : 6.0 MHz
Upstream channel type	A-TDMA

2.2 What is DOCSIS?

Docsis (DOCSIS) defines interface requirements for cable modems involved in high speed data distribution over cable networks¹.

Four DOCSIS specifications are defined:

- DOCSIS 1.0
- DOCSIS 1.1
- DOCSIS 2.0
- DOCSIS 3.0 (released but not widely in use)

2.3 DOCSIS 2.0 Features

Cable Labs¹ outline the advantages of DOCSIS 2.0. These include:

- Backwards compatibility with DOCSIS 1.0 & 1.1.
- Increased immunity to upstream noise (ATDMA, SCDMA).
- More symmetrical upstream and downstream bandwidth and data rates.

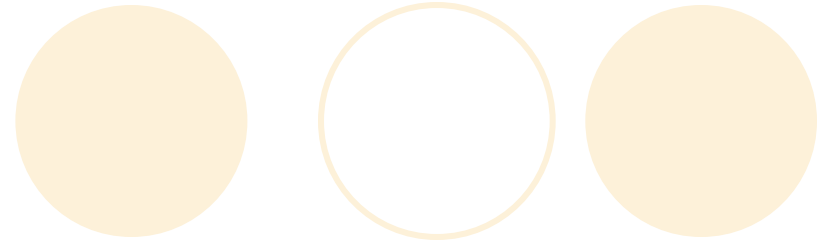
Up to 3x better upstream performance than DOCSIS 1.1
Up to 6x better upstream performance than DOCSIS 1.0

2.4 Data Rate Comparison

	<i>Data Rate (Mbps)</i>	<i>Modulation</i>	<i>Channel-Width (MHz)</i>
<i>DOCSIS 1.1</i>			
Downstream Channel	30.34	64 qam	6.0
	42.88	256 qam	6.0
Upstream Channel	2.56	QPSK	1.6
	5.12	16 qam	1.6
	5.12	QPSK	3.2
	10.24	16 qam	3.2
<i>DOCSIS 2.0</i>			
Downstream Channel	30.34	64 qam	6.0
	42.88	256 qam	6.0
Upstream Channel	12.80	32 qam	3.2
	15.36	64 qam	3.2
	20.48	16 qam	6.4
	25.60	32 qam	6.4
	30.72	64 qam	6.4



3.0 Applications



[3.1 Applications Overview](#)

[3.2 Network Applications](#)

[3.3 Smart Com Applications](#)



3.1 Applications Overview

Since standard network devices are used to facilitate Smart Com Ethernet, it provides the same flexibility as any network connection.

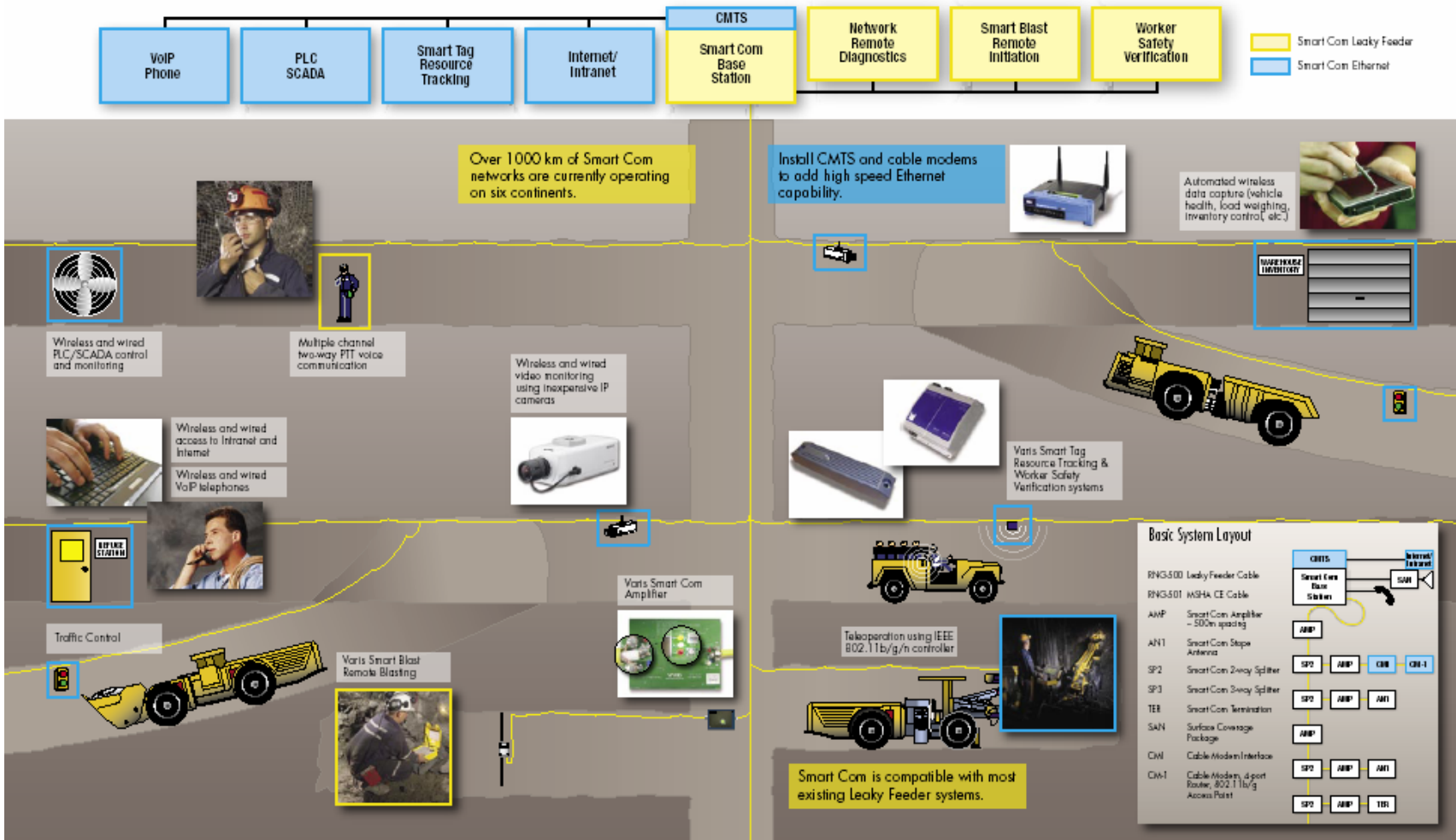
This enables the use of any standard network application device over the Varis Smart Com system.

3.2 Network Applications

Applications include:

- Computer access to Intranet and Internet
- IP cameras
- Tele operation
- VoIP communications
- PLC networking
- Gas Detection and Monitoring
- Smart Tag (RFID tagging)
- Automated wireless data capture

3.3 Smart COM Applications



4.0 System Layout

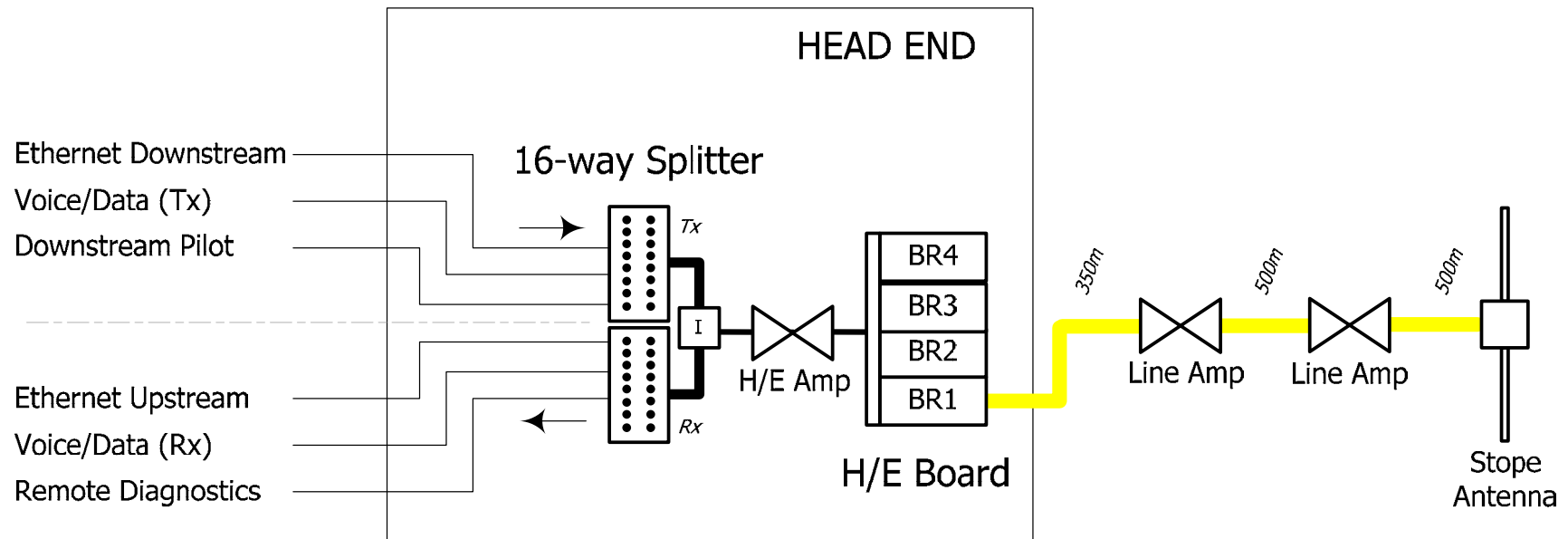
[4.1 Smart Com Layout](#)

[4.2 Smart Com Ethernet Layout](#)

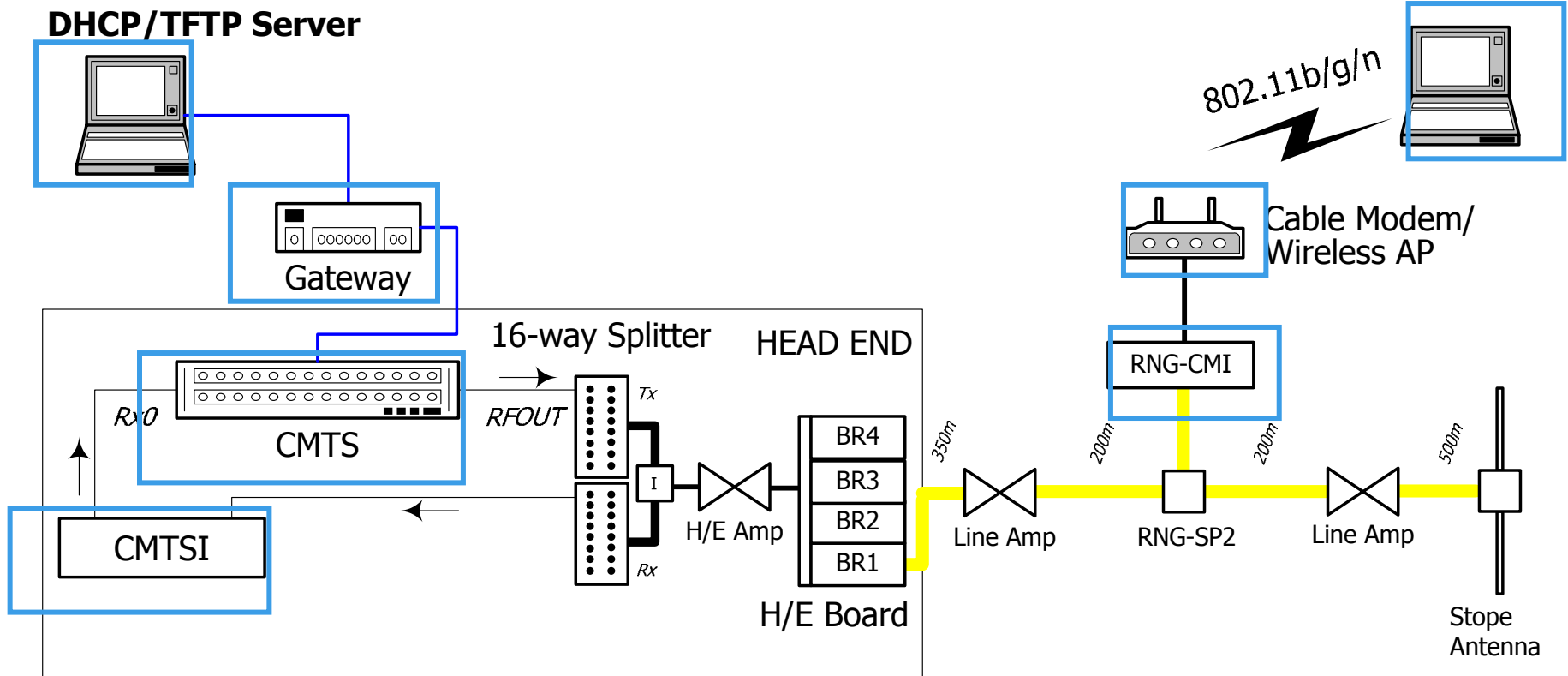


4.1 Smart Com Layout

A basic Smart Com network contains a head end (16/4-way Splitter, Head End Amp, Head End board), line amplifiers, LF cable and a stope antenna or termination unit.



4.2 Smart Com Ethernet Layout



5.0 System Components

[5.1 Smart Com Ethernet Hardware](#)

[5.2 Cable Modem Termination System \(CMTS\)](#)

[5.3 Gateway](#)

[5.4 CMTS Interface \(CMTSI\)](#)

[5.5 CMTSI Features](#)

[5.6 Cable Modem Interface \(RNG-CMI\)](#)

[5.7 RNG-CMI Features](#)

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[5.9 Linksys Wireless-G, WCG200](#)

[5.10 Smart Com Ethernet Software](#)

[5.11 DHCP Server](#)

[5.12 TFTP Server](#)



5.1 Smart Com Ethernet Hardware

Base Station:

- Cable Modem Termination System (CMTS)
- CMTS Interface (CMTSI)

Underground Access Point(s):

- Cable Modem (wired/wireless)
- Cable Modem Interface (RNG-CMI)
- Two-way Splitter (RNG-SP2)

5.2 Cable Modem Termination System (CMTS)

Cable modems cannot communicate directly with each other, they must communicate through a CMTS.¹

The CMTS sends and receives digital cable modem signals and converts the signals into IP packets. These packets are then routed to provide connection to the Intranet/Internet.¹



[See Arris CMTS Specifications](#)

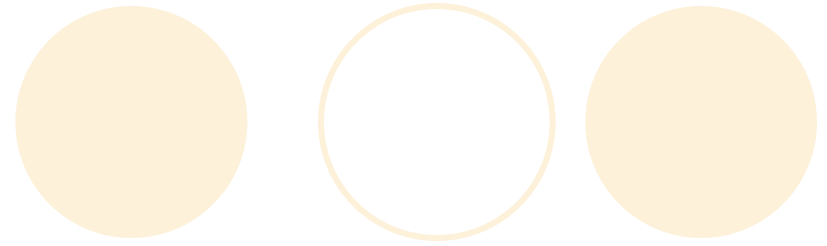
Cable Modem Termination System (CMTS) (Con't)

In addition to the Arris DOCSIS 2.0 CMTS, Varis also offers a low cost DOCSIS 1.0 CMTS suitable for installations with lower upstream bandwidth requirements.

C9 Networks C600 Series – DOCSIS 1.0 CMTS

- Built in DHCP/TFTP/ToD servers
- Downstream Data Rate: 38 Mbps
- Upstream Data Rate: 10 Mbps
- Web configuration interface

5.3 Gateway



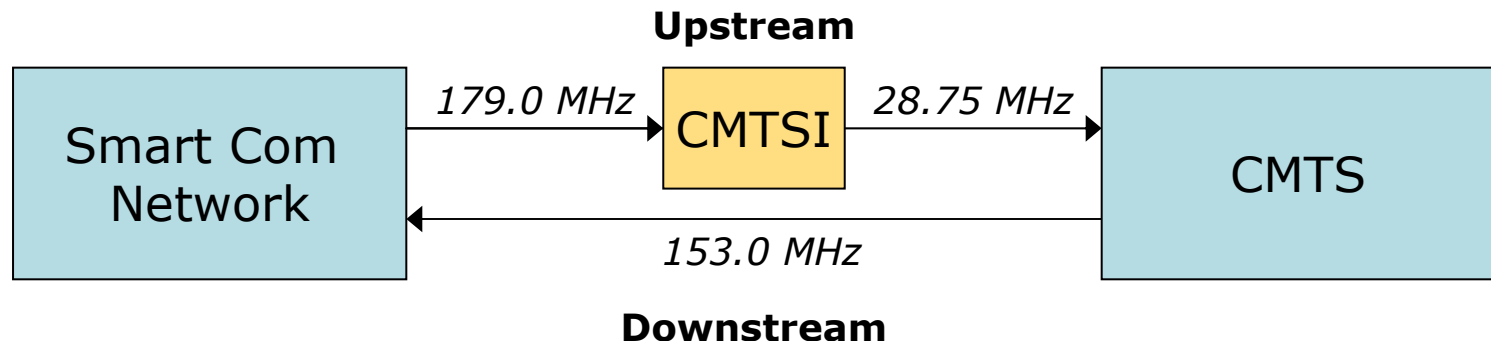
A gateway (also called a router) is a node on a network that serves as an entrance to another network.¹

Typically, the mine's gateway would replace the one shown in system layouts.

5.4 CMTS Interface (CMTSI)

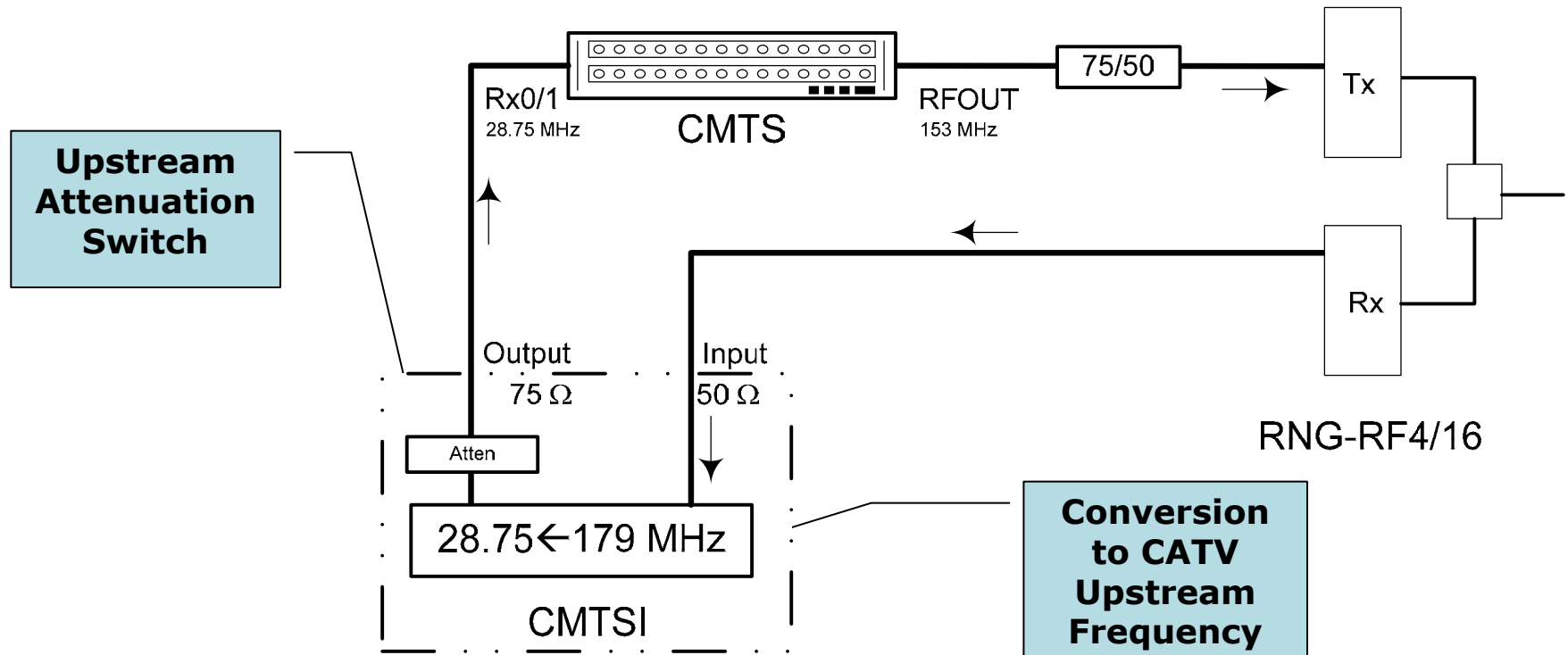
Varis CMTSI units perform a frequency down conversion for the system's upstream (i.e., 179.0 to 28.75 MHz) at the base station.

This device provides an interface between the Smart Com network and the CMTS. Only one CMTSI is required per Smart Com Ethernet installation.



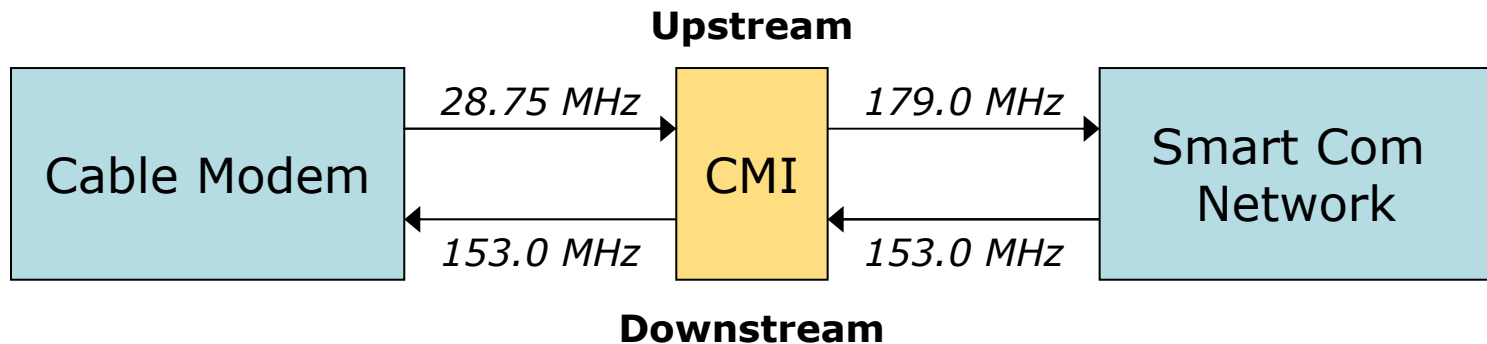
5.5 CMTSI Features

The CMTSI provides direct connection to the CMTS and Smart Com network.



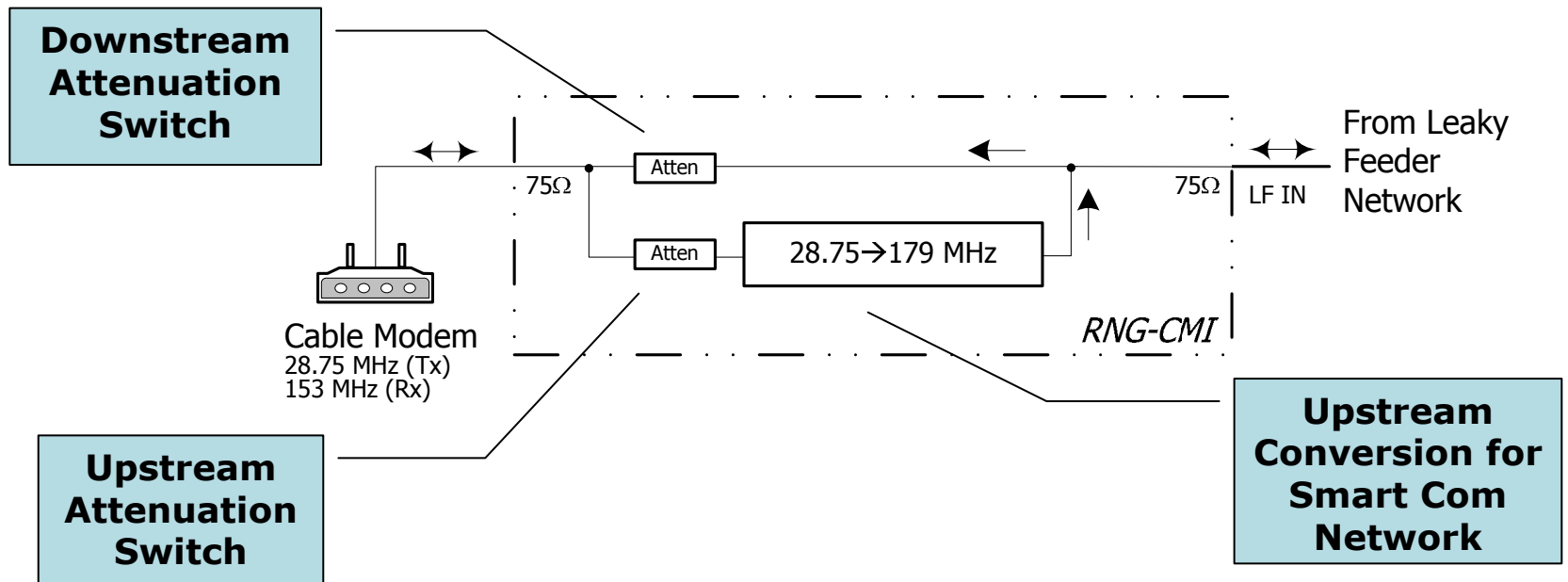
5.6 Cable Modem Interface (RNG-CMI)

The RNG-CMI provides the upstream frequency conversion required to interface a cable modem to the Leaky Feeder network.



5.7 RNG-CMI Features

The RNG-CMI connects to the Smart Com network through a standard two-way splitter (RNG-SP2) and provides an interface for cable modems. One RNG-CMI must be installed with each cable modem.



5.8 Arris Touchstone™ CM550

The Arris Touchstone™ CM550 cable modem offers DOCSIS 2.0 certification, compact design and signal diagnostics (web interface, LEDs). This cable modem offers one wired connection.¹



[See Arris Cable Modem Specifications](#)

5.9 Linksys Wireless-G, WCG200

The Linksys Wireless-G (WCG200) cable gateway provides a DOCSIS 2.0 certified wireless-G access point (IEEE 802.11g/IEEE 802.11b). Also provides four ports for wired network connection.¹



[See Linksys Cable Modem Specifications](#)

5.10 Smart Com Ethernet Software

Smart Com Ethernet requires a DHCP (Dynamic Host Configuration Protocol) and TFTP (Trivial File Transfer Protocol) Server.

Typically the installation would already have access to the software required to run these servers. The installation's servers can be used if they are able to provide the functionality described in the [installation procedure](#).

5.11 DHCP Server

A DHCP server is required to assign IP addresses dynamically on a network.¹

Each cable modem on the Smart Com Ethernet network must obtain an IP address from a DHCP server during initial registration.

The software Varis has used is called DHCP Turbo.²

5.12 TFTP Server

A TFTP Server is required by Smart Com Ethernet to send configuration files to the cable modems.

Cable modems require these files during registration and upgrade to DOCISIS 2.0.

The software Varis has used is 'WinAgents TFTP Server for Windows'¹.

6.0 CMTS Installation

[6.1 CMTS Settings](#)

[6.2 CMTS Configuration](#)

[6.3 CMTS Installation](#)



6.1 CMTS Settings

The CMTS comes preconfigured from Varis with the following parameters.

Upstream

Frequency:	28.75 MHz
Bandwidth:	3.2 MHz
Modulation:	16 QAM
Channel-Type:	TDMA

Downstream

Frequency:	153.0 MHz
Bandwidth:	6.0 MHz
Modulation:	64 QAM

6.2 CMTS Configuration

Prior to installing the CMTS, it's network settings must be changed to match the installation's configuration. The CMTS must also be configured to point to the DHCP server.

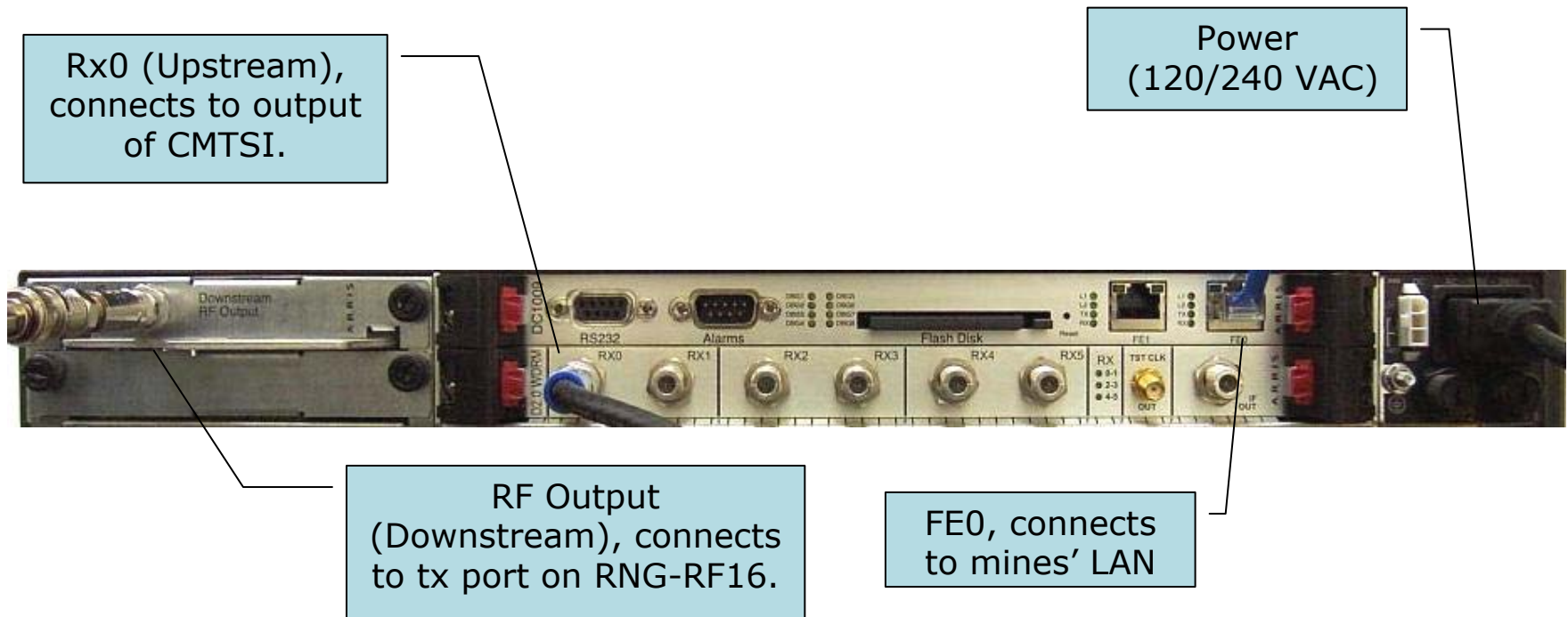
The CMTS parameters to be changed are:

- CMTS IP Address
- Gateway IP
- Netmask
- DHCP server IP address

See [Appendix B](#) for configuration instructions.

6.3 CMTS Installation

The CMTS should be mounted in the base station cabinet and requires the following connections.



7.0 Cable Modem Installation

[7.1 Site Requirements](#)

[7.2 RNG-CMI Connections](#)

[7.3 Cable Modem Connections](#)

[7.4 Cable Modem Diagnostics](#)

[7.5 Local Diagnostics](#)

[7.6 Remote Diagnostics](#)

[7.7 Registration Status](#)

[7.8 Transmit/Receive Levels](#)

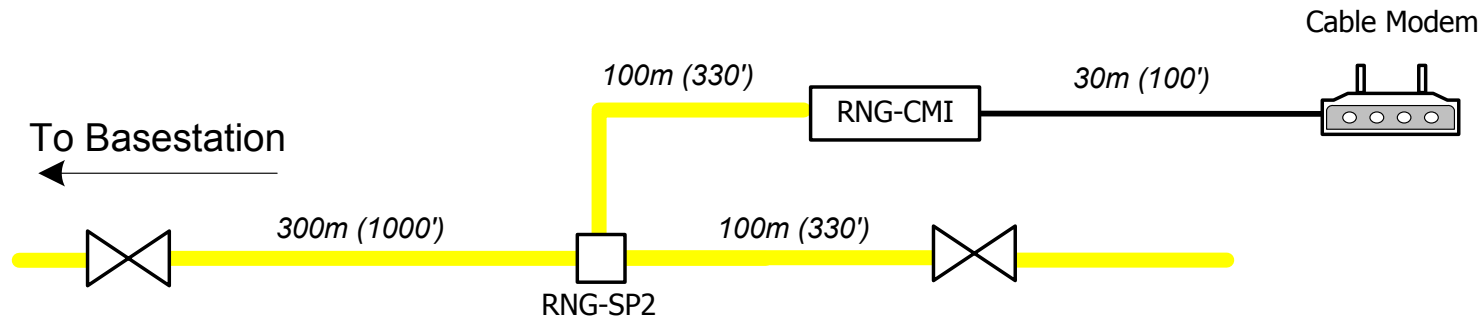
7.1 Site Requirements

Cable Modems can be installed anywhere along the Leaky Feeder network as long as the following criteria are met.

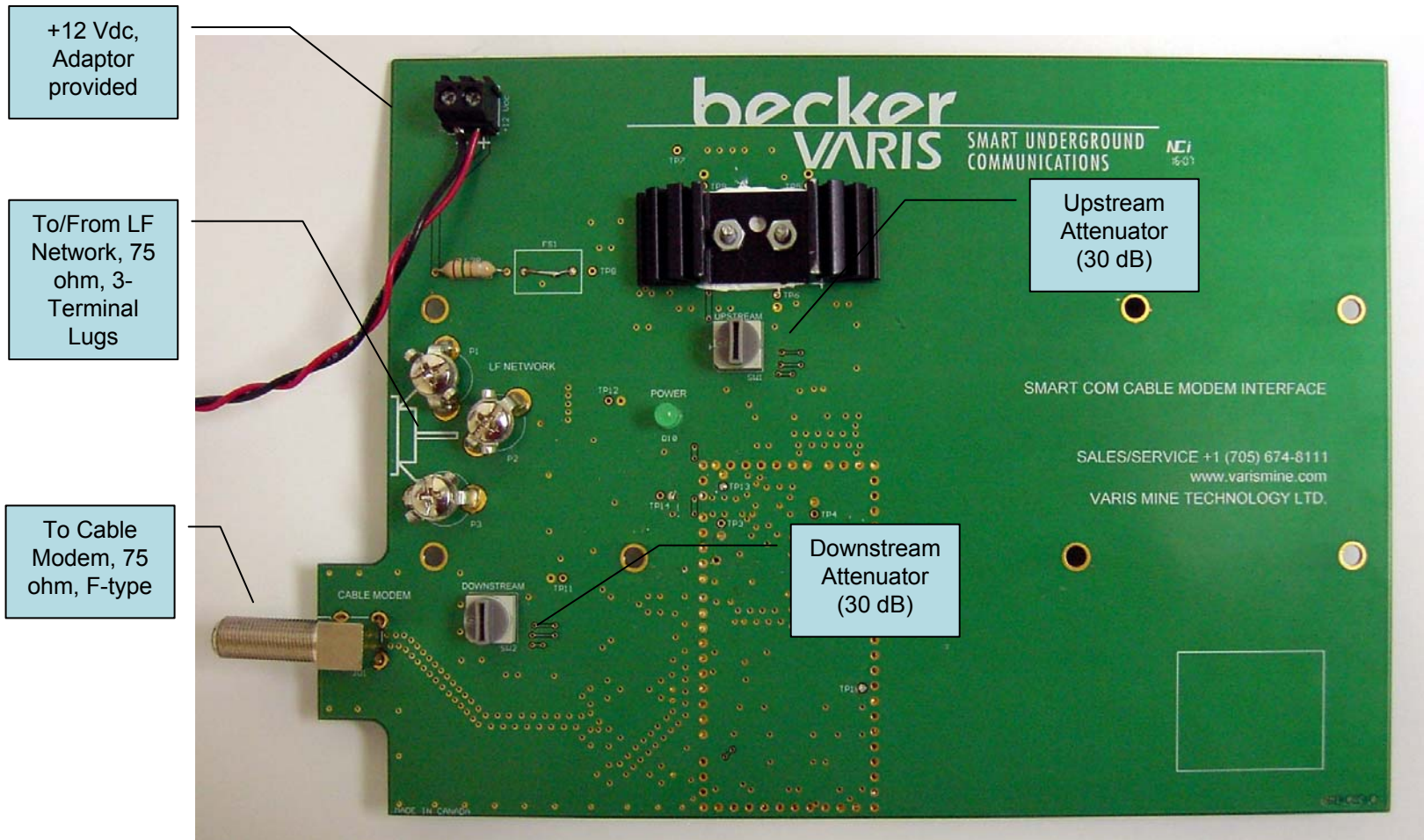
- Availability of 120/240 VAC. This is required for the RNG-CMI, cable modem and any other devices that may be connected to the cable modem (i.e., Tag Reader, PLC).
- Cable lengths between each device are not exceeded.

Site Requirements (Con't)

- A maximum of 400m (1300') of cable can be in place between the RNG-CMI and previous amplifier.
- A maximum of 30m (100') of RG6/U cable can be installed between the RNG-CMI and the cable modem.

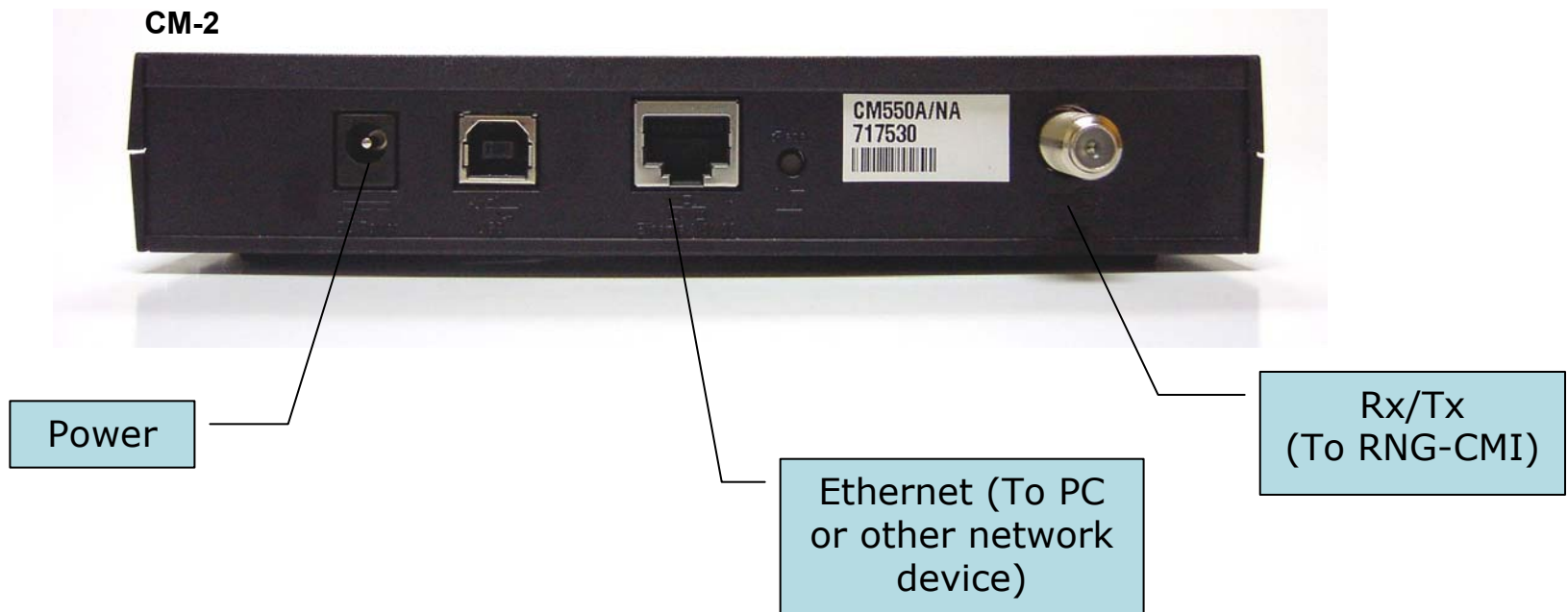


7.2 RNG-CMI Connections



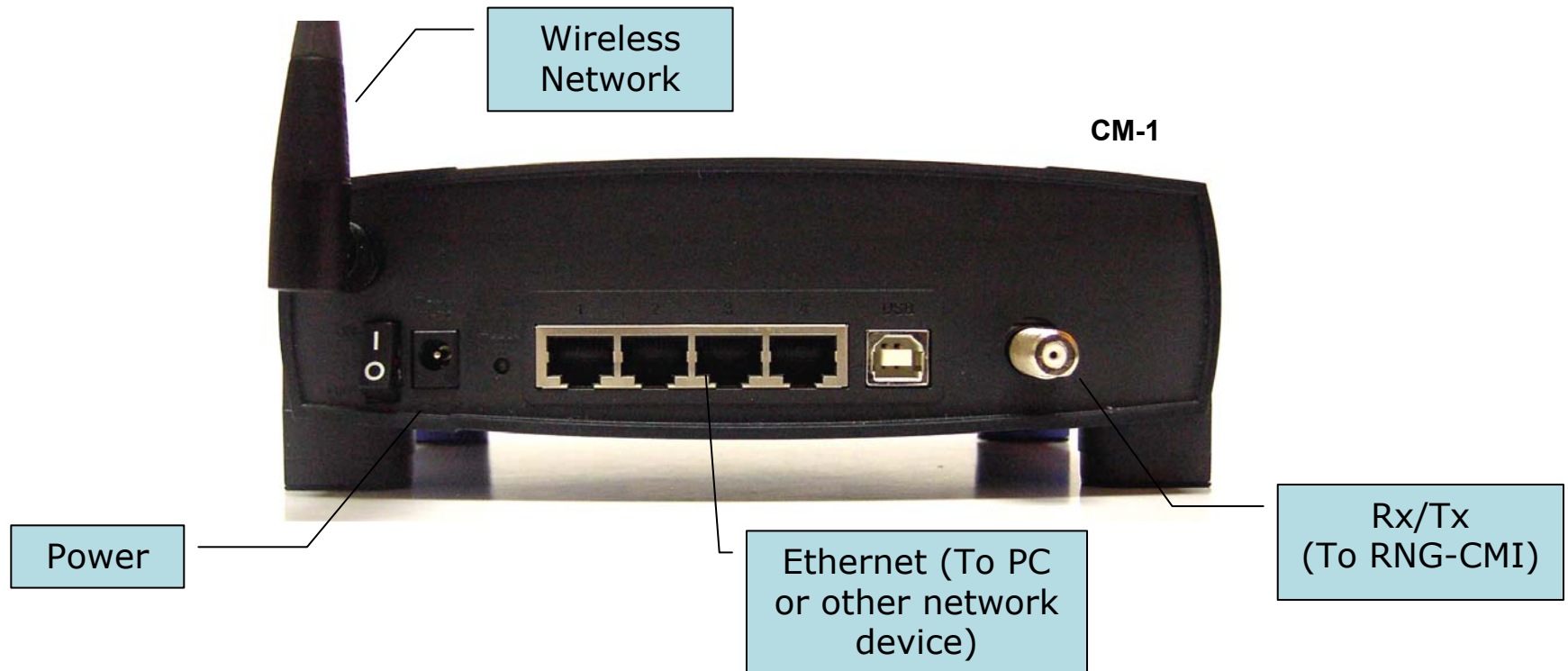
7.3 Cable Modem Connections

Arris Cable Modems have one wired Ethernet port.
Connections are shown below:



Cable Modem Connections (Con't)

Linksys cable modems provide 4 wired ports and wireless connection to network devices. Connections are shown below:



7.4 Cable Modem Diagnostics

Cable modems (CM-1, CM-2) offer local/remote diagnostics about initial registration and connection.

Registration Stages:

1. Establish Downstream connection
2. Establish Upstream connection
3. Obtain an IP Address from the DHCP Server
4. Obtain boot configuration files from the TFTP Server

Upstream (Tx) signal strength/center frequency/modulation

Downstream (Rx) signal strength/center frequency/
modulation

7.5 Local Diagnostics

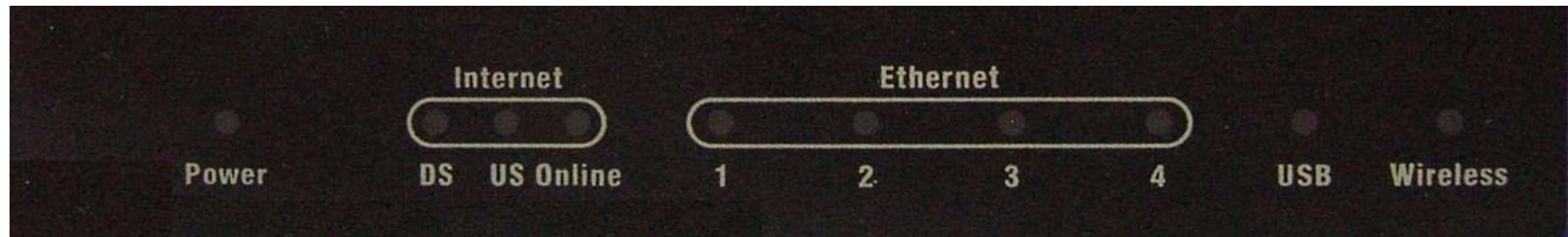
The Arris cable modem (CM-2) has diagnostic LEDs that show registration status.



CM-2

	Online	US	DS
1. Acquiring Downstream	Off	Off	Blinking
2. Acquiring Upstream	Off	Blinking	On
3. Obtaining IP address/ Configuration Files	Blinking	On	On
4. Cable Modem Registered	On	On	On

Local Diagnostics (Con't)



CM-1

	DS	US	Online
1. Acquiring Downstream	Blinking	Off	Off
2. Acquiring Upstream	On	Blinking	Off
3. Obtaining IP address/Configuration Files	On	On	Blinking
4. Cable Modem Registered	On	On	On

7.6 Remote Diagnostics

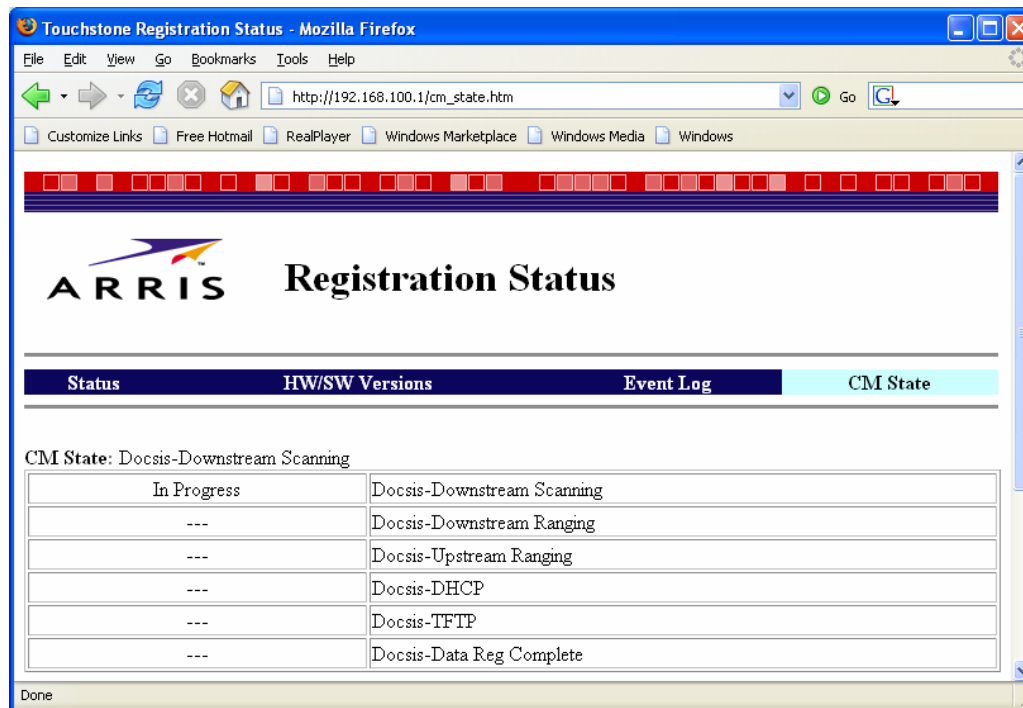
The Arris Touchstone™ CM550 cable modem and Linksys WCG200 also provide web interfaces that show:

- The cable modem's registration status
- The receive (downstream) and transmit (upstream) power levels/frequencies/modulation.

The web interface for each cable modem can be accessed at <http://192.168.100.1>.

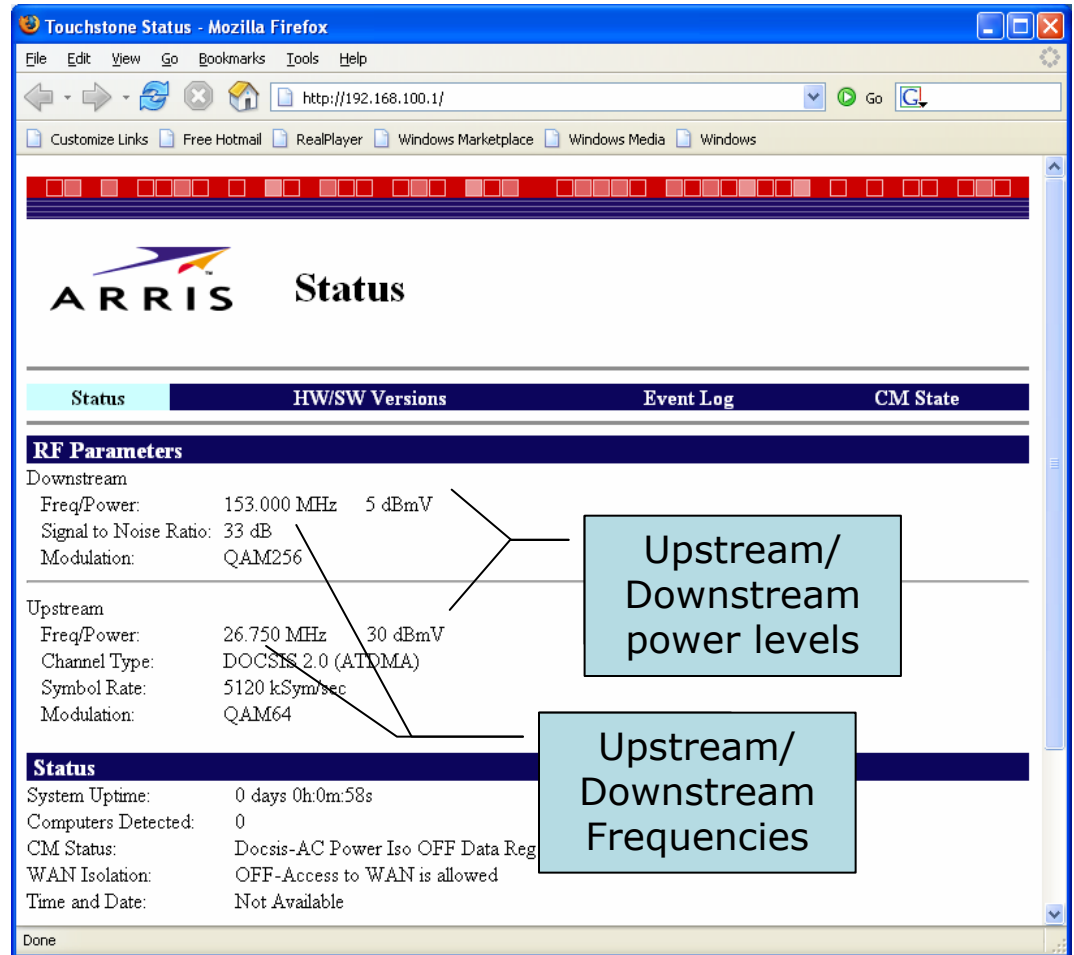
7.7 Registration Status

On the CM550 web interface, the *CM State* Tab shows the stage of cable modem registration.



7.8 Transmit/Receive Levels

The Rx (downstream) and Tx (upstream) frequencies and signal levels are shown on the *Status* Tab of the web interface as they are acquired.



8.0 System Performance

[8.1 Data Throughput](#)

[8.2 Network Analyzer Tools](#)

[8.3 QAM/CATV/Video Spectrum Analyzer](#)

[8.4 Cable Modem Network Analyzer](#)

[8.5 Network Measurements](#)

[8.6 Modulation Error Rate \(MER\)](#)

[8.7 Bit Error Rate \(BER\)](#)

[8.8 Typical MER/BER Results](#)

[8.9 Downstream Analysis](#)

[8.10 Upstream Analysis](#)

[8.11 MER/BER Statistics](#)



8.1 Data Throughput

Although DOCSIS 2.0 data rates are listed as:

Upstream: 41 MBps

Downstream: 54 MBps

It should be noted that network and IP overhead (~35% of total data rate) will contribute to a lower actual data throughput.

Smart Com Ethernet can provide throughput values of (after network/IP overhead):

Upstream: 27 MBps

Downstream: 35 MBps

8.2 Network Analyzer Tools

Varis uses Sunrise Telecom Broadband¹ cable network analyzer equipment to verify the quality of the Smart Com Ethernet network.



**QAM/CATV/Video Spectrum Analyzer
(AT2500RQv)**



**Cable Modem Network Analyzer
(CM-1000 with USG)**

8.3 QAM/CATV/Video Spectrum Analyzer

Sunrise Telecom's AT2500RQv QAM/CATV/Video Spectrum Analyzer can measure the quality of 16, 64 and 256 QAM digital signals.



[See AT2500RQv Specifications](#)

Features:

- Spectrum Analyzer
- CATV Package
- Time Domain Measurement
- Digital Measurements ¹

8.4 Cable Modem Network Analyzer

Sunrise Telecom's CM1000 Cable Modem Network Analyzer can be used with an Upstream Signal Generator (USG) module to generate a constant 16 QAM upstream signal.

This upstream signal can then be injected onto the cable network and measured using the QAM Analyzer.¹



[See CM1000 Specifications](#)

8.5 Network Measurements

Using these tools several important measurements can be made to verify the quality of Smart Com Ethernet's upstream/downstream signals.

Measured values include:

- Modulation Error Rate (MER)
- Bit Error Rate (BER)
- Signal Power-Level
- Ingress
- Phase Noise
- Compression

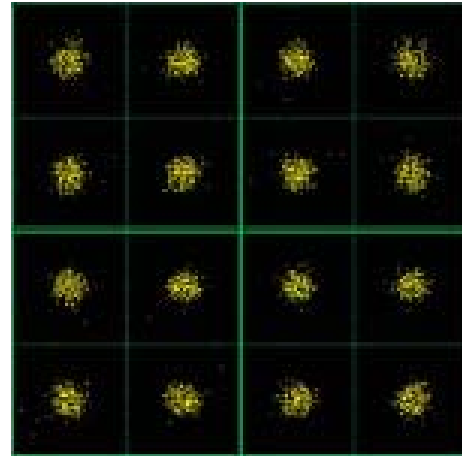
Network Measurements (Con't)

The most important measurements for the upstream/downstream are the MER (Modulation Error Rate) and BER (Bit Error Rate).

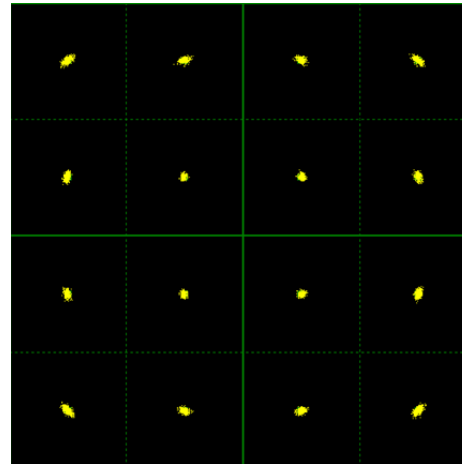
Both the Pre-FEC (Forward Error Correction) and Post-FEC BER can be measured using the QAM analyzer¹.

8.6 Modulation Error Rate (MER)

Modulation Error Rate (MER): MER corresponds to the size of the cluster around the constellation target points. A higher value MER will indicate smaller clusters and better signal quality¹.



Low MER,
25.6 dB



High MER,
>40 dB

8.7 Bit Error Rate (BER)

Bit Error Rate (BER): BER is the percentage of bits that have errors relative to the total number of bits received in a transmission¹.

- BER (Pre-Fec) is the bit error rate before forward error correction while BER (Post-Fec) is the bit error rate after forward error correction.
- The goal is to have no Pre or Post errors, but in practice that is difficult to achieve. An average of $< 1.0E-8$ Pre-FEC errors and $< 1.0E-9$ Post-FEC errors should result in reliable network performance¹.

8.8 Typical MER/BER Results

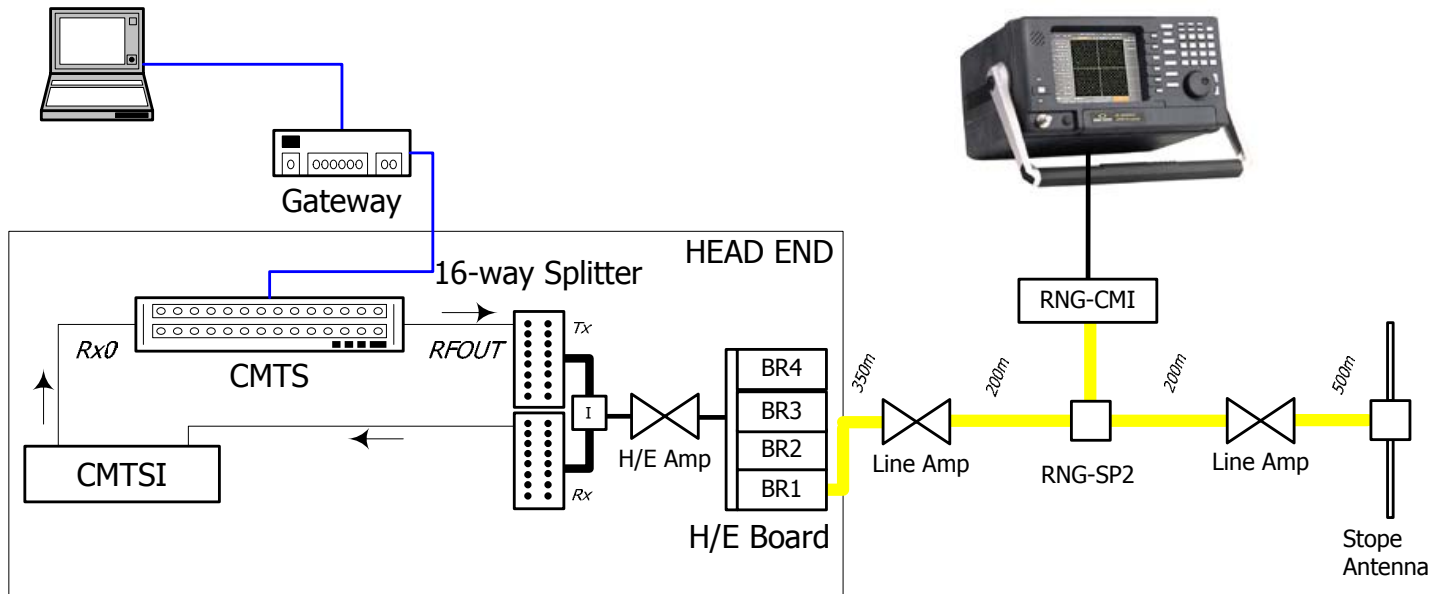
BER	64 QAM MER	256 QAM MER	
1.E-10	>35	>35	Excellent
1.E-08	27-34	31-34	Good
1.E-06	23-26	28-30	Marginal
1.E-05	<23	<28	Fail

In-house testing shows the upstream/downstream MER for Smart Com Ethernet is typically 40 dB with no channels active. Worst case testing with 16 simultaneous channels shows a downstream MER of approximately 34 dB. These values will vary depending on an installations LF network quality.

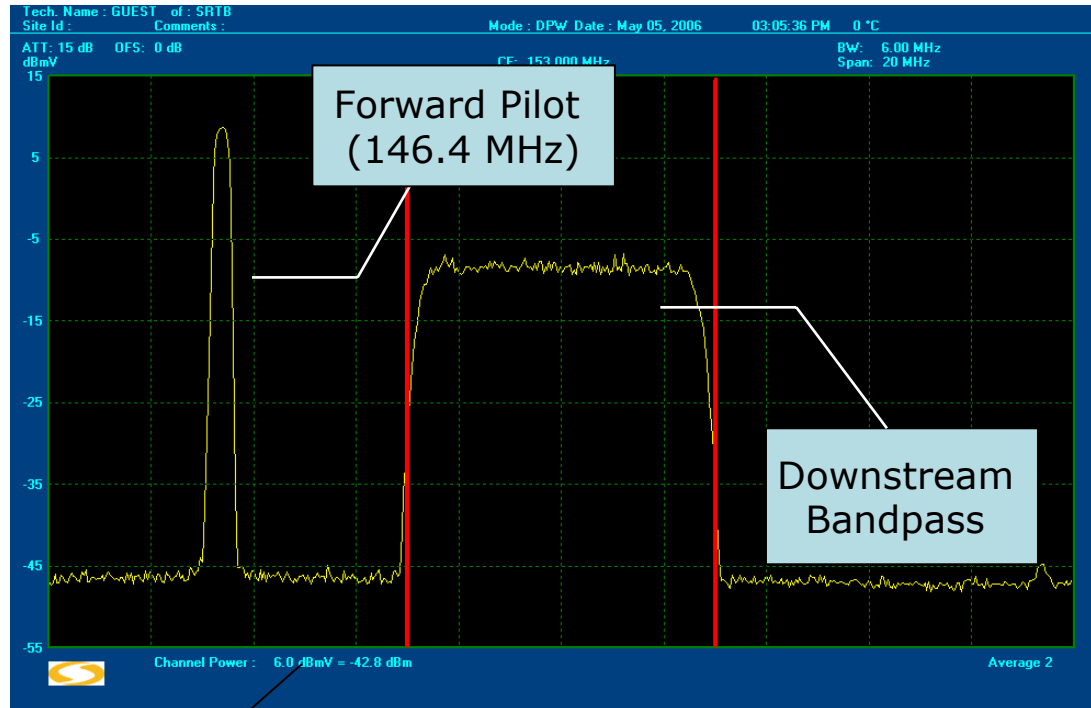
8.9 Downstream Analysis

The CMTS downstream signal quality can be measured directly at the point where the cable modem connects to the network.

DHCP/TFTP Server



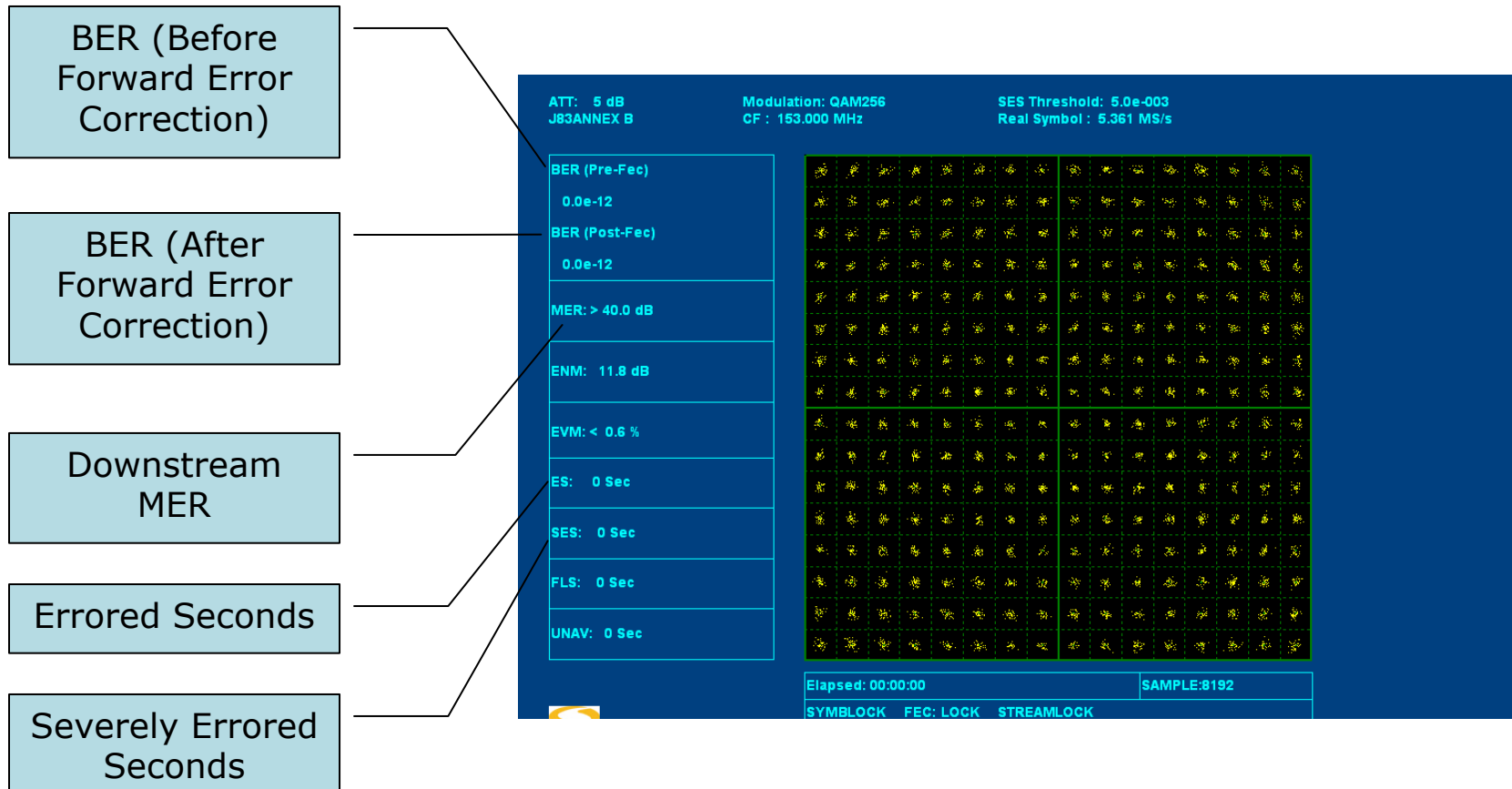
Downstream Analysis (Con't)



Downstream Power-Level (dBmV)

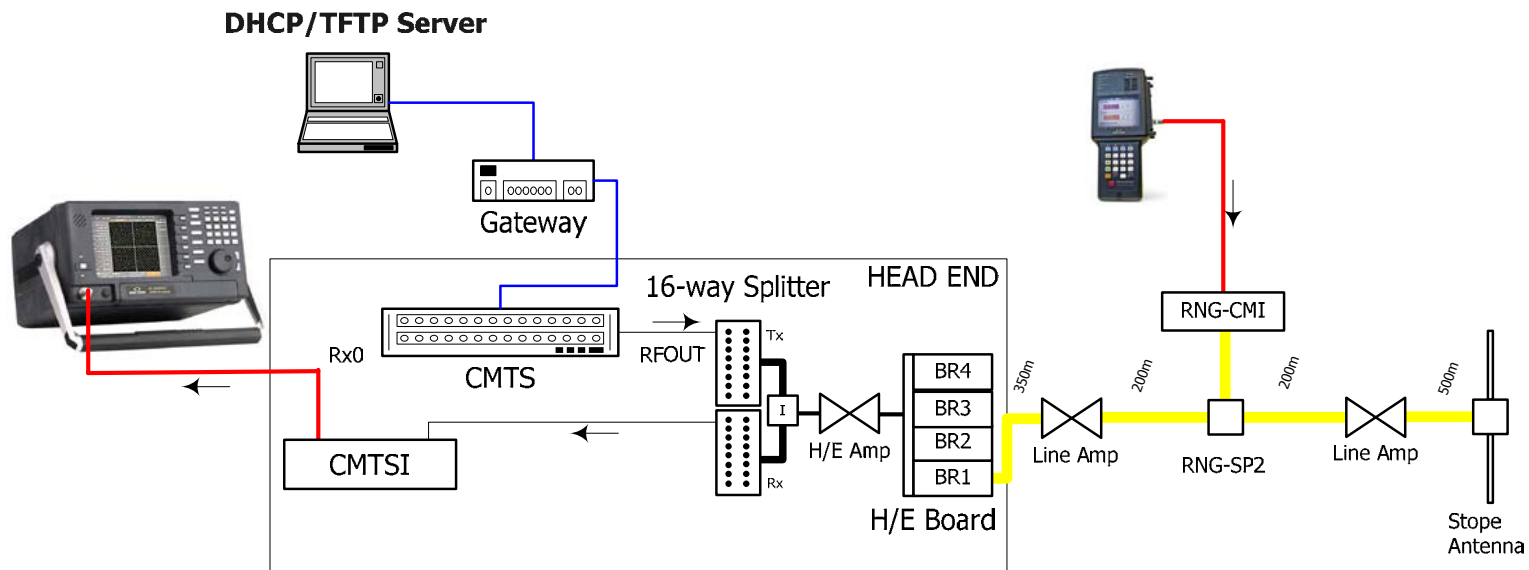


Downstream Analysis (Con't)

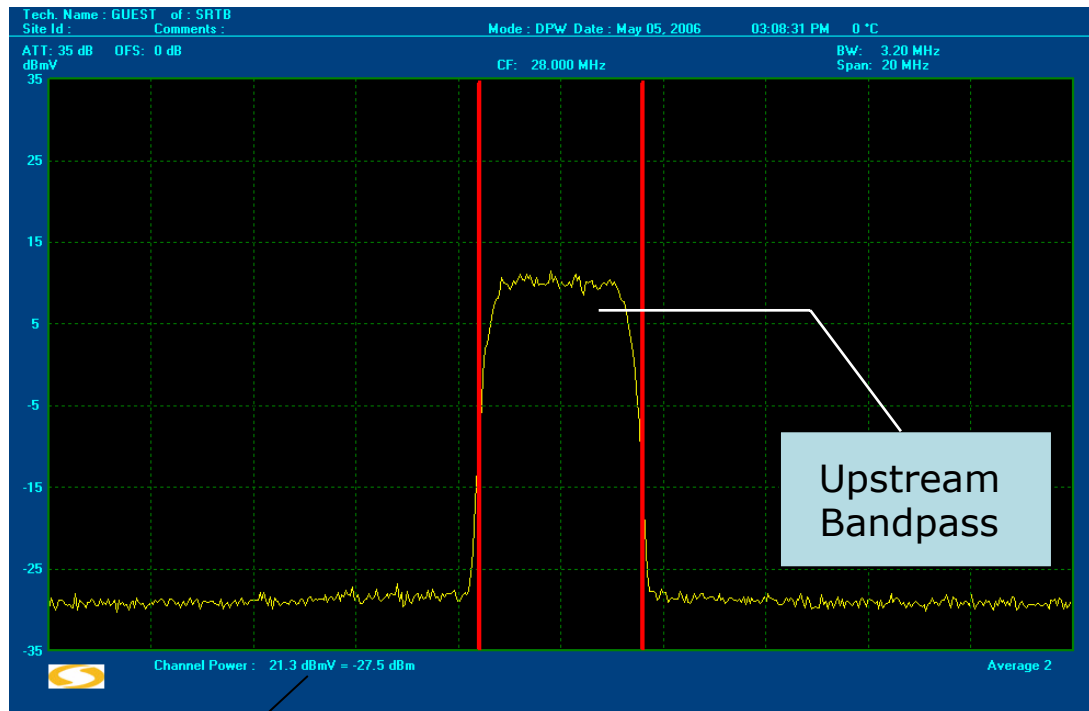


8.10 Upstream Analysis

In order to analyze the upstream, the USG must be used to inject a 16 QAM upstream signal onto the Smart Com network. The signal is then measured at the CMTS.



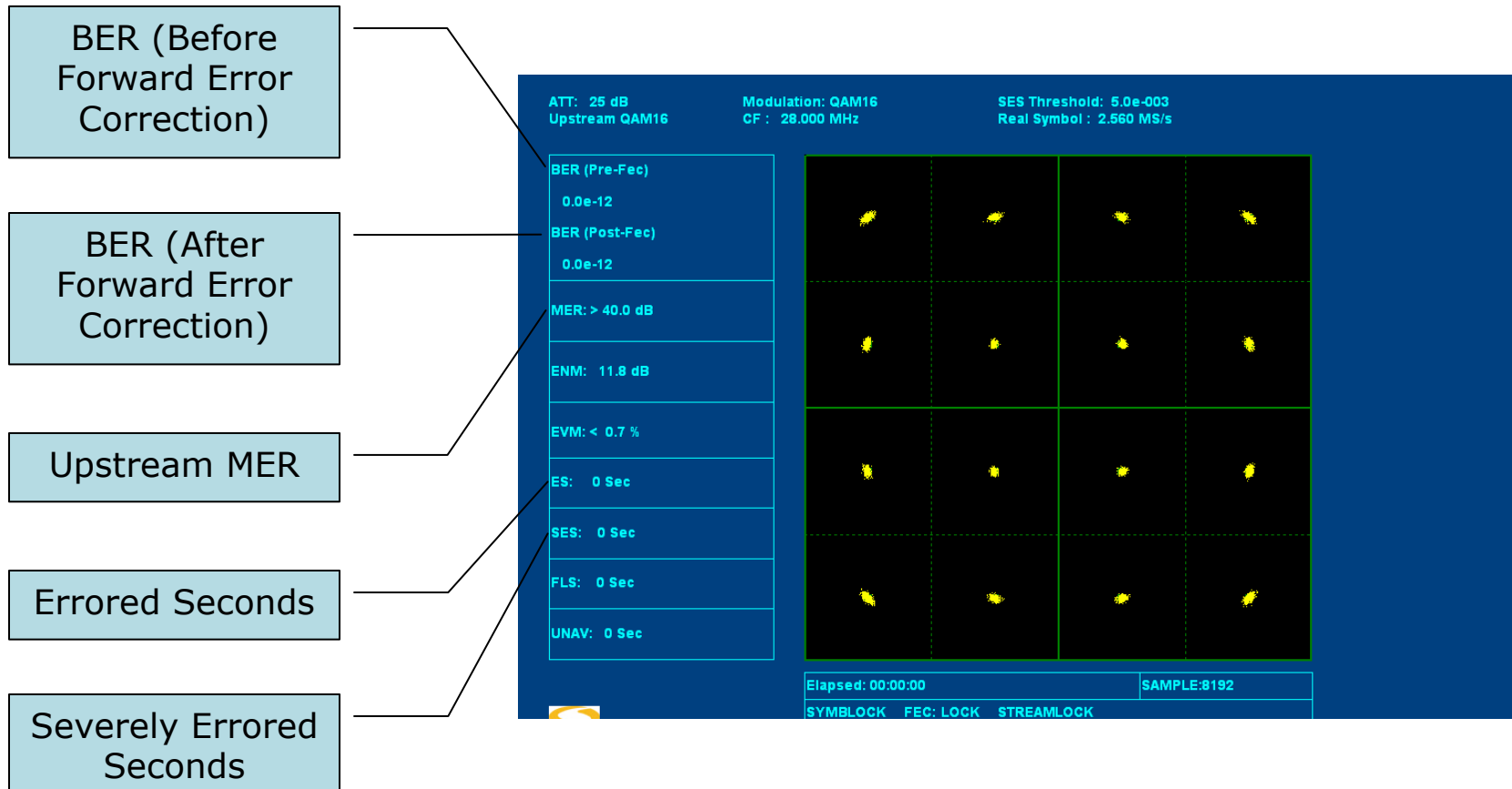
Upstream Analysis (Con't)



Upstream
Power-Level
(dBmV)

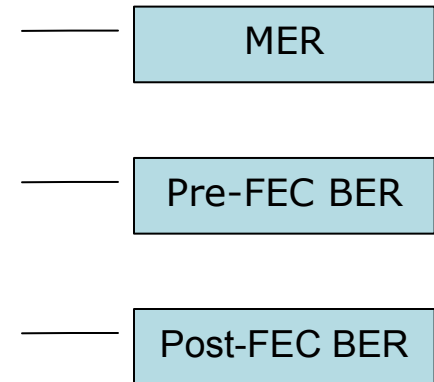
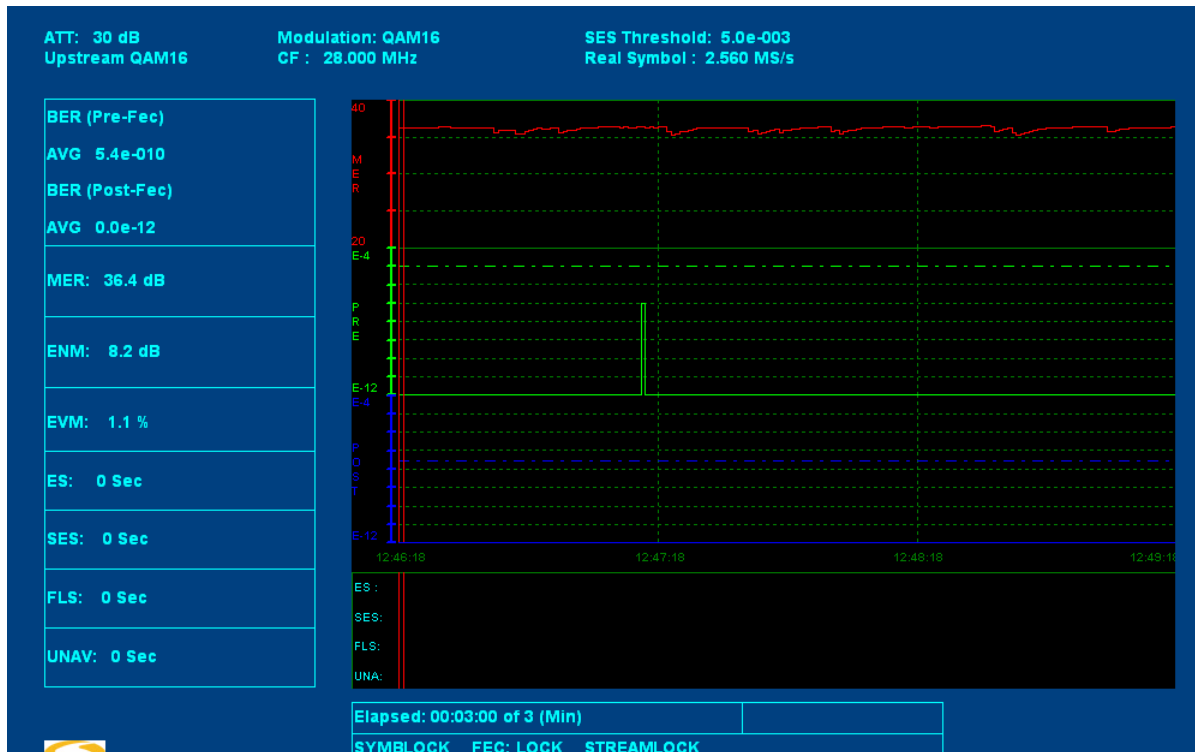
The USG can generate a 16QAM
signal with 6.4 MHz channel
width.

Upstream Analysis (Con't)



8.11 MER/BER Statistics

The AT2500RQ QAM analyzer can also be used to monitor the MER and Pre-FEC/Post-FEC BER for up to 7 days.



Contact Information

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Appendices

[Appendix A: System Installation Guide](#)

[Appendix B: CMTS Configuration](#)

[Appendix C: DHCP Server Configuration](#)

[Appendix D: TFTP Server Configuration](#)

[Appendix E: Linksys Cable Modem Configuration](#)



Appendix A: System Installation Guide

[A.1 DHCP Server Installation](#)

[A.2 TFTP Server Installation](#)

[A.3 Basestation Installation](#)

[A.4 Cable Modem Installation](#)

[A.5 Network Quality](#)



A.1 DHCP Server Installation

Step 1: Install/Configure DHCP Server

1. Install and configure the DHCP server as outlined in [Appendix C](#).
2. Ensure that the DHCP server is on the same network as the CMTS.

A.2 TFTP Server Installation

Step 2: Install/Configure TFTP Server

1. Install and configure the TFTP server as outlined in [Appendix D](#).
2. Ensure that the TFTP server is on the same network as the CMTS.

***Typically the TFTP server would run on the same computer as the DHCP server.

A.3 Basestation Installation

Step 3: Install/Configure Basestation Equipment

Ensure that you have access to 120/240 VAC and an Ethernet connection to the mine's LAN. Connection to the LAN may be required for the DHCP and TFTP Servers.

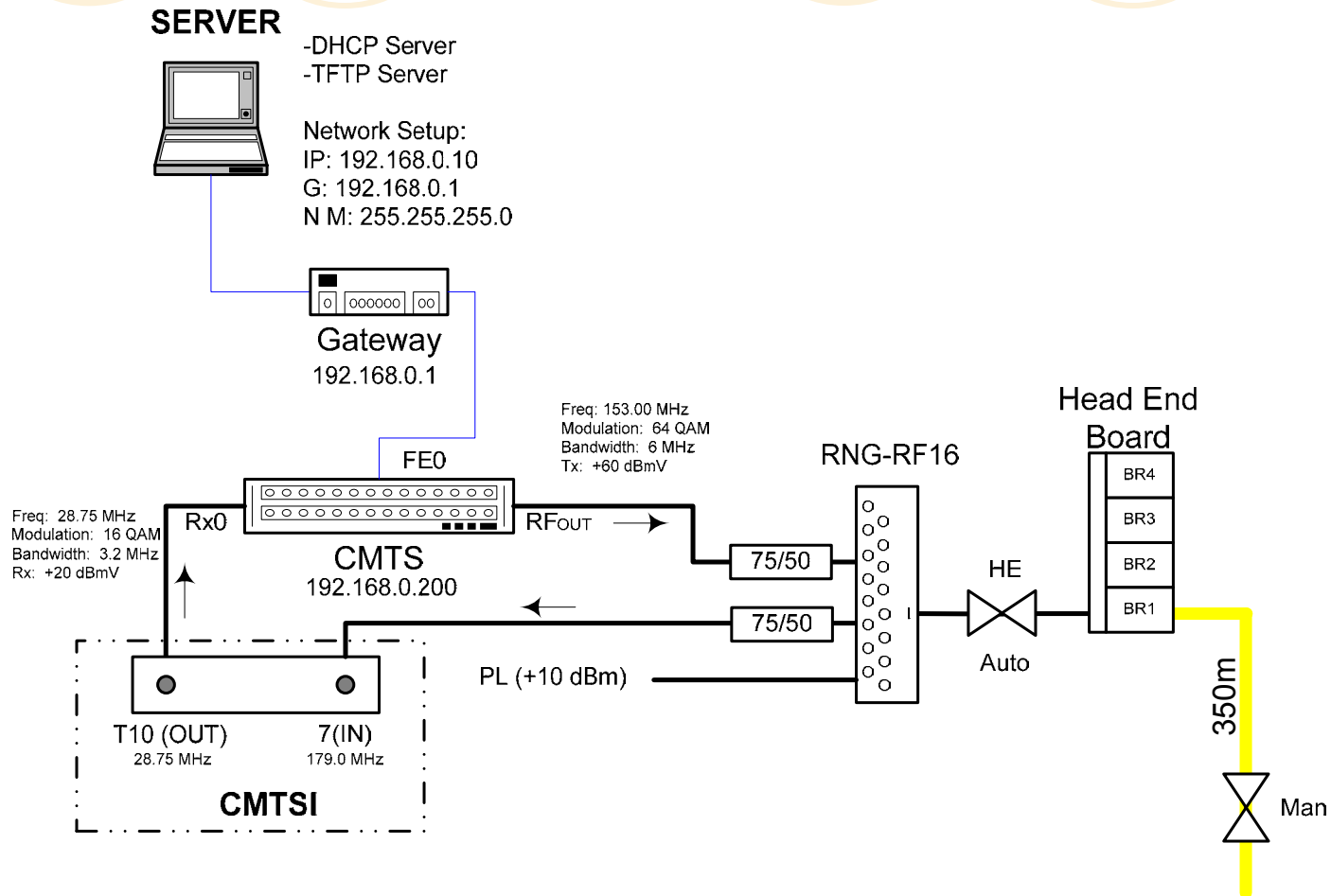
Basestation Installation (Con't)

1. Ensure that the installation's communication hardware is programmed according to Smart Com Channel List Version 3.1.
2. Ensure that the output level of each voice channel is ~0 dBm (-10 dBm at the output of the Head End LF distribution board).
3. Ensure that the output level of the downstream pilot is +10 dBm (0 dBm at the output of the Head End LF distribution board).
4. Install the CMTS in the basestation cabinet.
5. Install the CMTSI in the basestation cabinet.

Basestation Installation (Con't)

6. Configure CMTS as required (See [Appendix B](#)).
7. Connect CMTS to the mine's LAN using a CAT5 cable (port FE0 on the CMTS).
8. Ensure that basestation wiring is as shown on the next slide.
9. Verify Downstream MER is ≥ 40 dBmV at the output of the Head End LF distribution board.

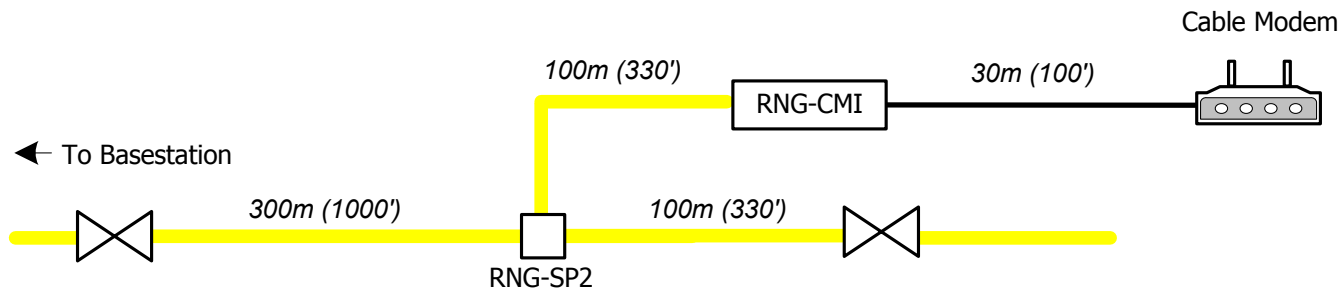
Basestation Installation (Con't)



A.4 Cable Modem Installation

Step 4: Install/Configure Cable Modem

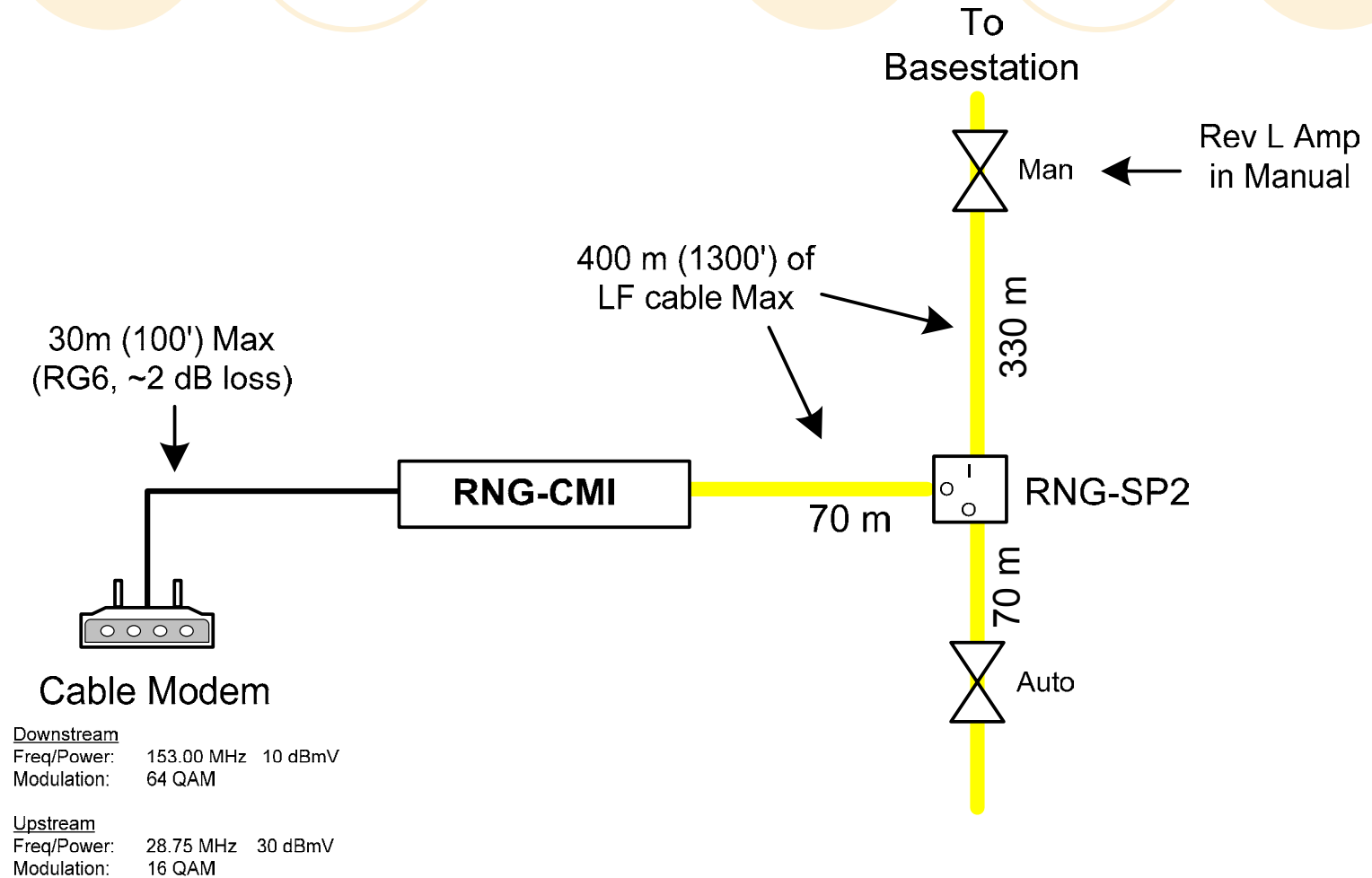
1. Select a location that has 120/240 VAC.
2. Ensure that there will be no more than 400m (1300') of LF cable between the RNG-CMI and previous line amplifier. Also, ensure that no more than 30m (100') of RG6/U cable is required between the RNG-CMI and cable modem.



Cable Modem Installation (Con't)

3. Install RNG-SP2 and run leaky feeder cable between the RNG-SP2 and RNG-CMI location.
4. Install the cable modem and RNG-CMI.
5. Install RG6/U cable between the cable modem and RNG-CMI.
6. Ensure that all Rev L amplifiers (and older) are in manual mode if they are between the cable modem and basestation.

Cable Modem Installation (Con't)



Cable Modem Installation (Con't)

7. Ensure that the upstream power level is ~30 dBmV through the cable modems web interface (<http://192.168.100.1/>). You must be connected directly to the cable modem to view this interface. Use the RNG-CMI onboard attenuator as required. Increasing the upstream attenuation by 2 dB (1 clockwise “click”) will increase the cable modem’s upstream power level by 2 dB.
8. Ensure that the downstream power level is no lower than 10 dBmV and no higher than 15 dBmV. Use the RNG-CMI’s onboard downstream attenuator as required. Increasing the downstream attenuation will decrease the cable modem’s downstream power-level.
9. Verify that the cable modem registers.

A.5 Network Quality

Step 5: Verify upstream/downstream quality

1. Verify proper upstream and downstream MER/BER using Network Analyzer equipment. See [Section 8](#) for more information on determining network quality.

Appendix B: CMTS Configuration

[B.1 Connecting to the CMTS](#)

[B.2 Changing CMTS Network Settings](#)

[B.3 Changing DHCP Server IP](#)

[B.4 Configuring Downstream Channel](#)

[B.5 Configuring Upstream Channel](#)

B.1 Connecting to the CMTS

1. Connect power cord to the CMTS, do not power yet.
2. Connect the RS232 cable to the CMTS serial port and connect the other end to a PC with a terminal emulation program (i.e., Tera Term²).



Connecting to the CMTS (Con't)

3. Start a terminal emulation program and set the serial configuration to:

Port: Com1/Com2

Baud rate: 38400

Data: 8 bits

Parity: None

Stop bit: 1

Flow control: None

B.2 Changing CMTS Network Settings

4. Apply power to the CMTS. You will see the boot process on the terminal program as the CMTS starts.
5. Wait for the message “*Press any key to stop auto-boot...*” to appear. Press any key to stop auto booting before the count reaches 0.
6. Enter privileged mode using the enable command.

```
CMTS>enable
```

Changing CMTS Network Settings (Con't)

7. Enter the following command to change the boot parameters.

```
CMTS>bootCfg
```

8. Press enter until the *CMTS IP Address* option is shown. Specify the new IP address of the CMTS.

```
CMTS Ip Address : [192.168.1.88]  
192.168.0.200
```

Changing CMTS Network Settings (Con't)

9. Press enter to show the *Subnet Mask* option. Enter the new subnet mask.

```
CMTS Subnet Mask : [255.255.0.0]  
255.255.255.0
```

10. Press enter to show the *Gateway IP address* option. Enter the new Gateway IP.

```
Gateway Ip Address : [192.168.1.1]  
192.168.0.1
```

Changing CMTS Network Settings (Con't)

11. Press Enter to save the new settings.
12. Restart the CMTS and allow the auto boot process to complete.
13. Log into the CMTS.

Login:a

Password:a

Changing CMTS Network Settings (Con't)

14. Enter the following to configure the CMTS gateway settings.

```
C3_Demo>enable
Password:a
C3_Demo#configure terminal
C3_Demo(config)#ip routing
C3_Demo(config)#ip default-gateway 192.168.0.1
C3_Demo(config)#ip route 0.0.0.0 0.0.0.0 192.168.0.1
```

15. Enter the CMTS's new IP address and netmask as shown below.

```
C3_Demo(config)#interface FastEthernet 0/0
C3_Demo(config-if)#ip address 192.168.0.200
255.255.255.0
```

Changing CMTS Network Settings (Con't)

16. Enter the following to configure the CMTS cable interface.

```
C3_Demo(config-if)#exit  
C3_Demo(config)#interface cable 1/0
```

17. Enter the CMTS' new IP address and netmask as shown below.

```
C3_Demo(config-if)#ip address  
192.168.0.200 255.255.255.0
```

B.3 Changing DHCP Server IP

18. Specify the new IP address of the DHCP server as shown below (see Note 1).

```
C3_Demo(config-if)#cable helper-  
address 192.168.0.10
```

19. Save changes to the CMTS by typing the following.

```
C3_Demo(config-if)#exit
```

```
C3_Demo(config)#exit
```

```
C3_Demo#copy running-configuration  
startup-configuration
```

B.4 Configuring Downstream Channel

1. Connect to the CMTS.
2. Logon to the configuration interface.

Login:a

Password:a

C3_Demo>enable

Password:a

C3_Demo#configure terminal

C3_Demo(config)#interface cable 1/0

Configuring DS Channel (Con't)

3. To change the downstream modulation to 64 qam, enter the following command.

```
C3_Demo(config-if)#cable downstream modulation  
64qam
```

4. Otherwise, change the downstream modulation to 256 qam by entering the following command.

```
C3_Demo(config-if)#cable downstream modulation  
256qam
```

Configuring DS Channel (Con't)

5. To change the downstream power level enter the following. Please note that 60 dBmV is the recommended power level.

```
C3_Demo(config-if)#cable downstream power-level 60
```

6. To change the downstream center frequency, enter the following. 153 MHz is recommended.

```
C3_Demo(config-if)#cable downstream frequency  
153000000
```

Configuring DS Channel (Con't)

7. Ensure that changes are saved by typing the following:

```
C3_Demo(config-if)#exit
```

```
C3_Demo(config)#exit
```

```
C3_Demo#copy running-configuration startup-  
configuration
```

B.5 Configuring Upstream Channel

1. Connect to the CMTS.
2. Logon to the configuration interface.

Login:a

Password:a

C3_Demo>enable

Password:a

C3_Demo#configure terminal

C3_Demo(config)#interface cable 1/0

Configuring US Channel (Con't)

3. To change the upstream frequency for Rx channel 0, enter the following. Substitute required center frequency.

```
C3_Demo(config-if)#cable upstream 0 frequency  
28750000
```

4. To change the upstream power level for Rx channel 0, enter the following command. Substitute the required power level (20 is recommended).

```
C3_Demo(config-if)#cable upstream 0 power-level  
20 fixed
```

Configuring US Channel (Con't)

5. To change the upstream modulation to DOCSIS 1.1 (3.2 MHz bandwidth, 16QAM), enter the following:

```
C3_Demo(config-if)#cable upstream 0 shutdown
C3_Demo(config-if)#cable upstream 0 channel-width 320000
C3_Demo(config-if)#cable upstream 0.0 channel-type TDMA
C3_Demo(config-if)#cable upstream 0.0 modulation-profile 2
C3_Demo(config-if)#no cable upstream 0 shutdown
```

Configuring US Channel (Con't)

6. To change the upstream modulation to DOCSIS 2.0 (3.2 MHz bandwidth, 64QAM), enter the following:

```
C3_Demo(config-if)#cable upstream 0 shutdown
C3_Demo(config-if)#cable upstream 0 channel-width 3200000
C3_Demo(config-if)#cable upstream 0.0 channel-type ATDMA
C3_Demo(config-if)#cable upstream 0.0 modulation-profile 30
C3_Demo(config-if)#no cable upstream 0 shutdown
```

7. Ensure that changes are saved by typing the following:

```
C3_Demo(config-if)#exit
C3_Demo(config)#exit
C3_Demo#copy running-configuration startup-configuration
```

Appendix C: DHCP Server Configuration

[C.1 Installation](#)

[C.2 DHCP Start up](#)

[C.3 Adding A New Scope](#)

[C.4 Configure Local Scope](#)

[C.5 Configure Relay Scope](#)

[C.6 Adding New Options](#)

[C.6.1 Time Offset Option](#)

[C.6.2 Gateway Option](#)

[C.6.3 Time Server Option](#)

[C.6.4 DNS Option](#)

[C.6.5 MS Option 66](#)

[C.6.6 MS Option 67](#)

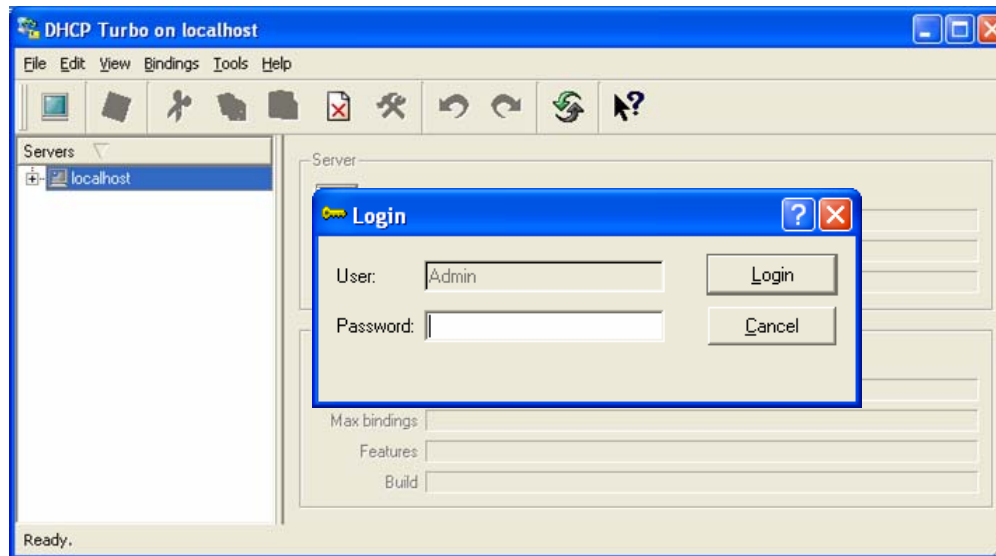
C.1 Installation

Install the DHCP server software (DHCP Turbo) on a PC with a static IP. The CMTS will be configured to forward all DHCP requests to this PC.

Ensure that the DHCP server is installed as a service. This ensures that the DHCP server will automatically start each time the PC reboots.

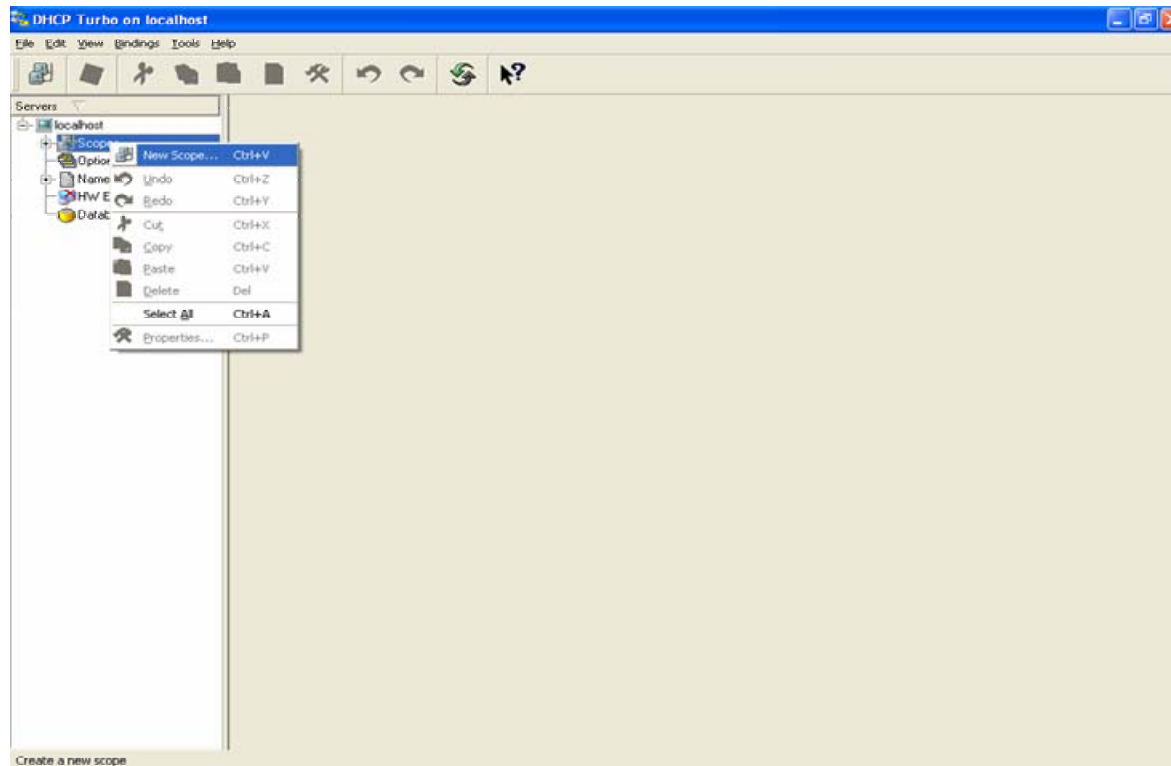
C.2 DHCP Start up

1. Open *DHCP Turbo*. Double-click local host on the interface to bring up the *login* screen.
2. The default Username is “Admin” and the password is “ ” (blank).



C.3 Adding A New Scope

3. Once the DHCP server's main interface is shown, right click on *Scopes* and select *New Scope*.



C.4 Configure Local Scope

4. Configure a new scope as shown below. This scope will assign IP address locally (not through the CMTS). Save changes.

The screenshot shows the 'New Scope' dialog box with the following configuration:

- Scope:**
 - Active
 - Name: Local Scope
 - Description: Assigns IP addresses locally.
- Address Range:**
 - Start address: 192.168.1.1
 - End address: 192.168.1.2
 - Subnet mask: 255.255.255.0
- Lease:**
 - Unlimited
 - Days: 0, Hours: 6, Minutes: 0
- Segment:**
 - Local
 - Relay agent: (empty)

The start/end addresses shown will allow only two IP addresses to be assigned locally (192.168.1.1 and 192.168.1.2).

The *Segment* must be specified as *Local*.

C.5 Configure Relay Scope

5. Configure another new scope as shown below. This scope will allow IP addresses to be assigned through the CMTS (relay agent). Save changes.

The screenshot shows the 'New Scope' dialog box with the following configuration:

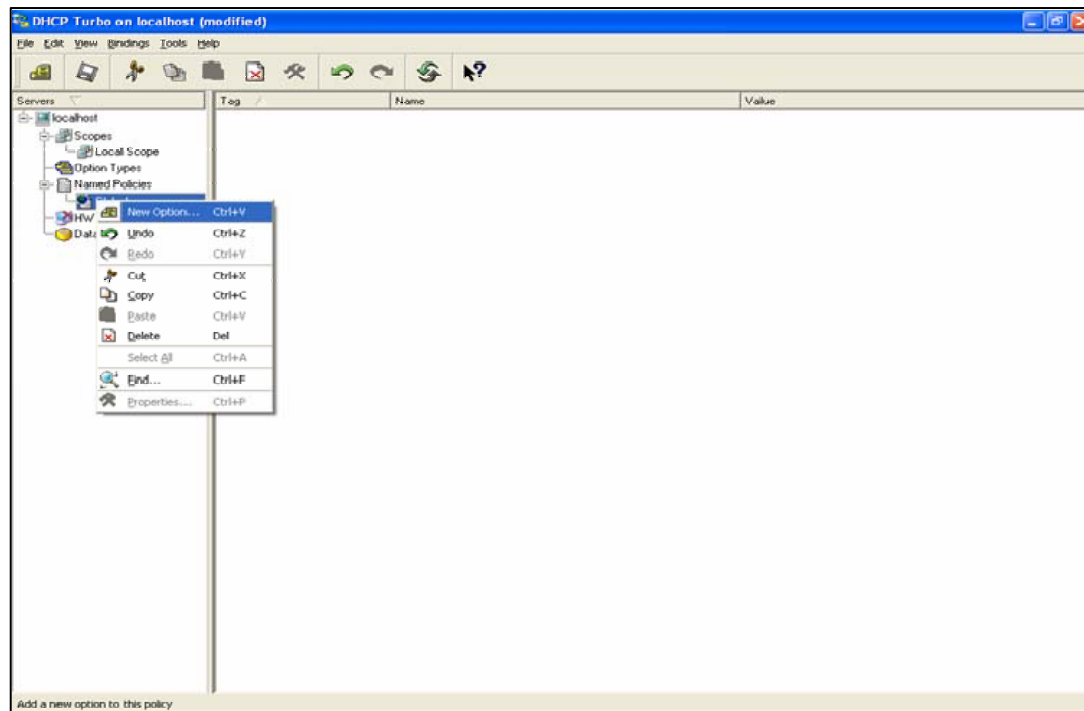
- Scope:**
 - Active
 - Name: Relay Scope
 - Description: Assigns IP's through a Relay Agent
- Address Range:**
 - Start address: 192.168.1.3
 - End address: 192.168.1.5
 - Subnet mask: 255.255.255.0
- Lease:**
 - Unlimited
 - Days: 0, Hours: 6, Minutes: 0
- Segment:**
 - Local
 - Relay agent: 192.168.1.105

The start/end addresses shown will allow three IP addresses to be assigned through the CMTS

Specify the IP address of the CMTS as the relay agent.

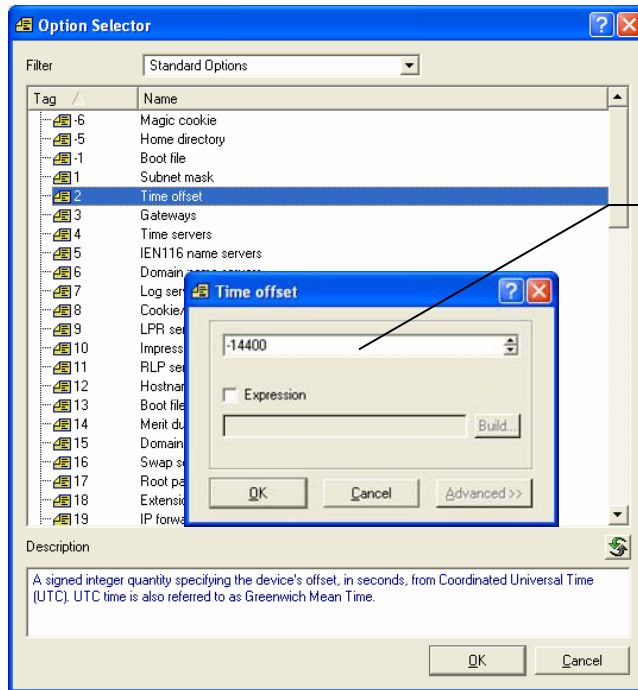
C.6 Adding New Options

- Next, options will be added to the Global policy. Right click on the *Global* policy and select *New Option*.



C.6.1 Time Offset Option

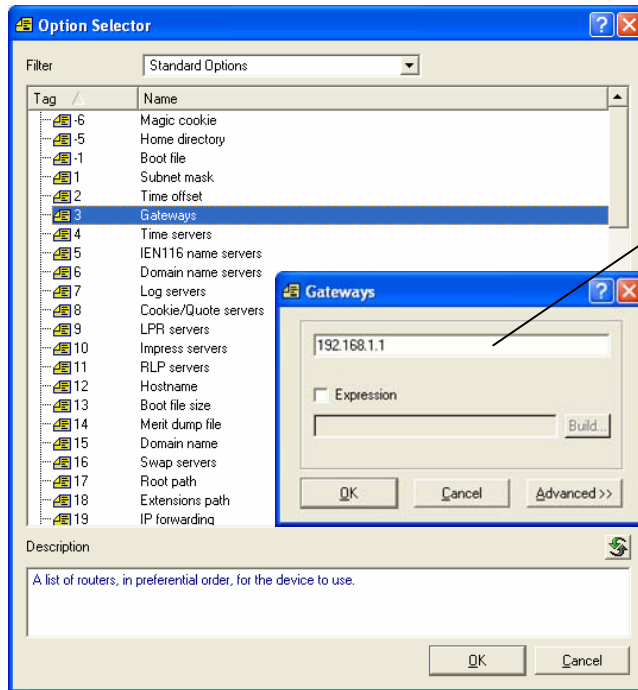
7. Add the *Time offset* option and specify its value as required.



-14400 is a signed integer that specifies the DHCP servers offset, in seconds, from Coordinated Universal Time (UTC).

C.6.2 Gateway Option

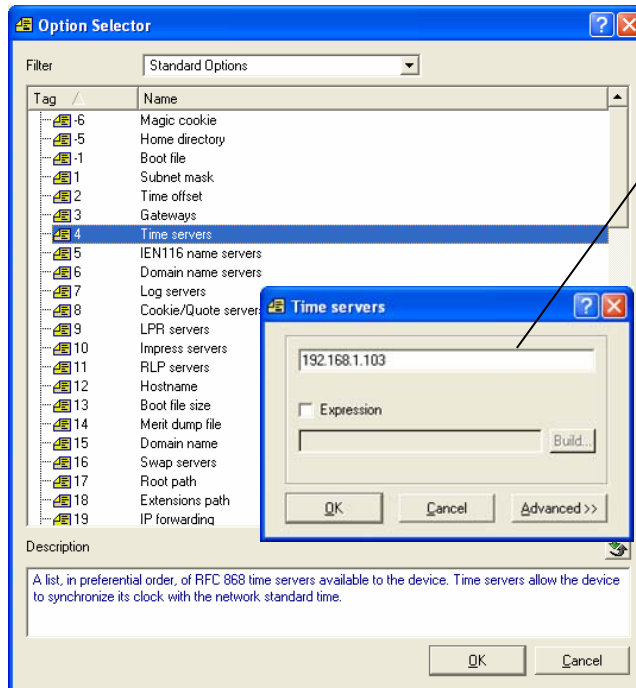
8. Add the *Gateway* option and specify it's value as required.



Enter the IP address of the network gateway.

C.6.3 Time Server Option

9. Add the *Time Server* option and specify it's value as required.

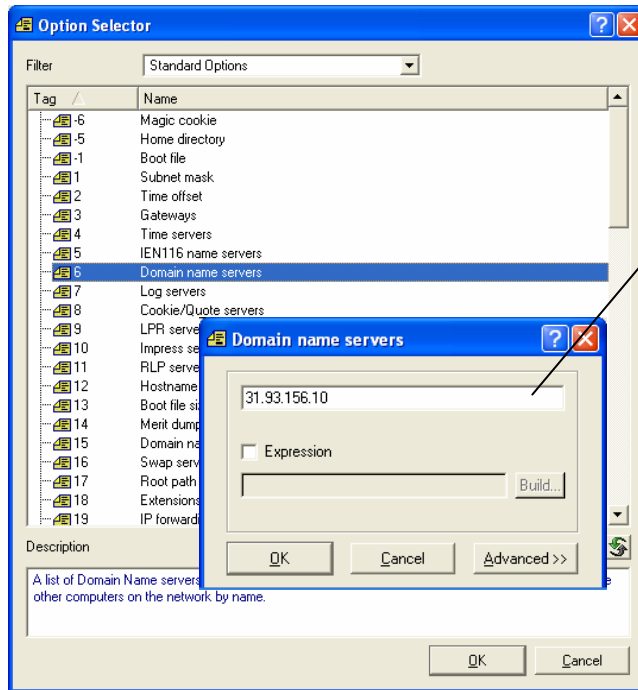


Enter the IP address of the Time server.

A time server such as Net Time or Windows XP's built in time server should be installed/activated on the network.

C.6.4 DNS Option

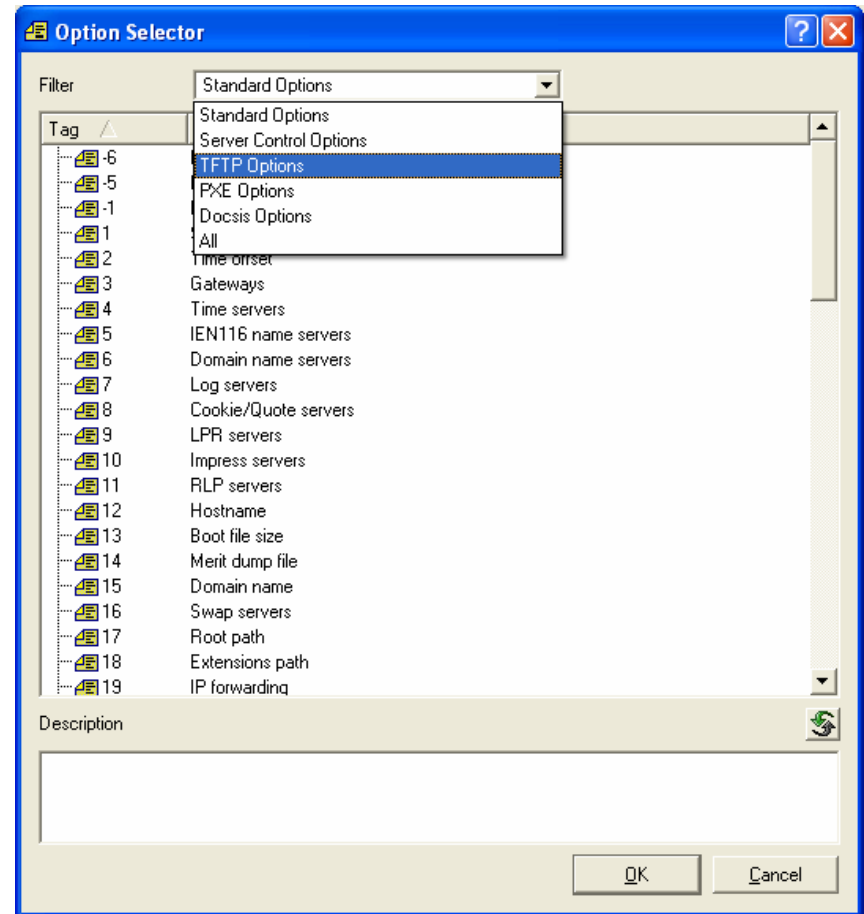
10. Add a new Domain Name Server (DNS) option and specify the value as required.



The IP address shown must be substituted with the DNS of the current network.

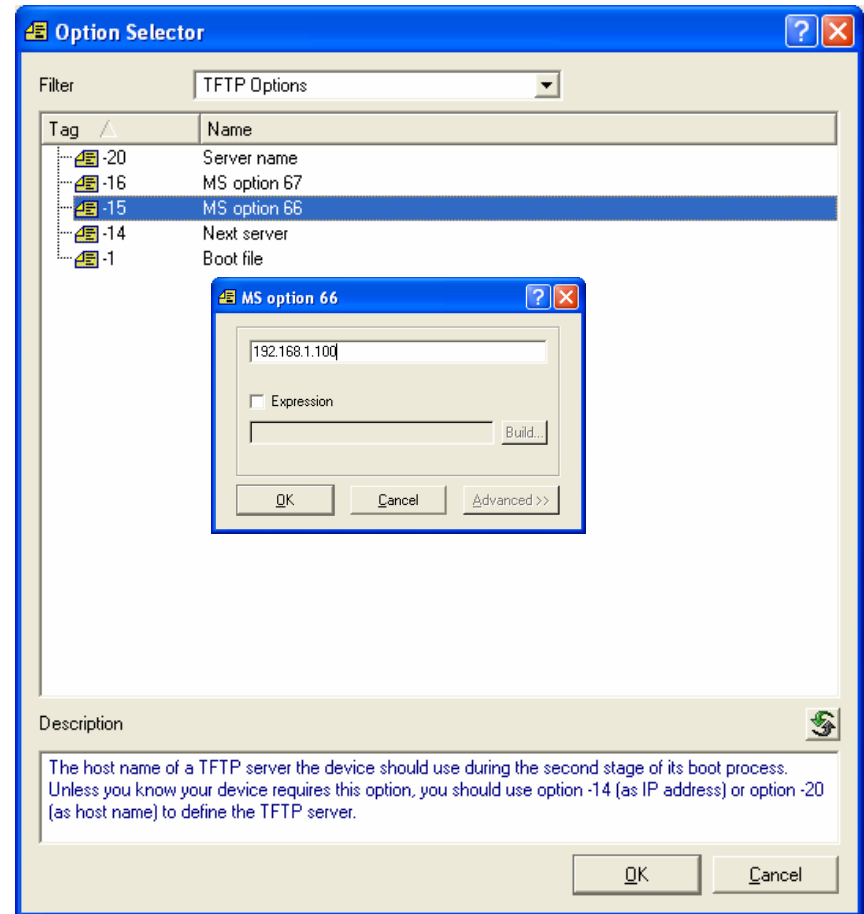
C.6.5 MS Option 66

11. Open the *Option Selector* Dialog Box and change the Option Type to *TFTP Options*.



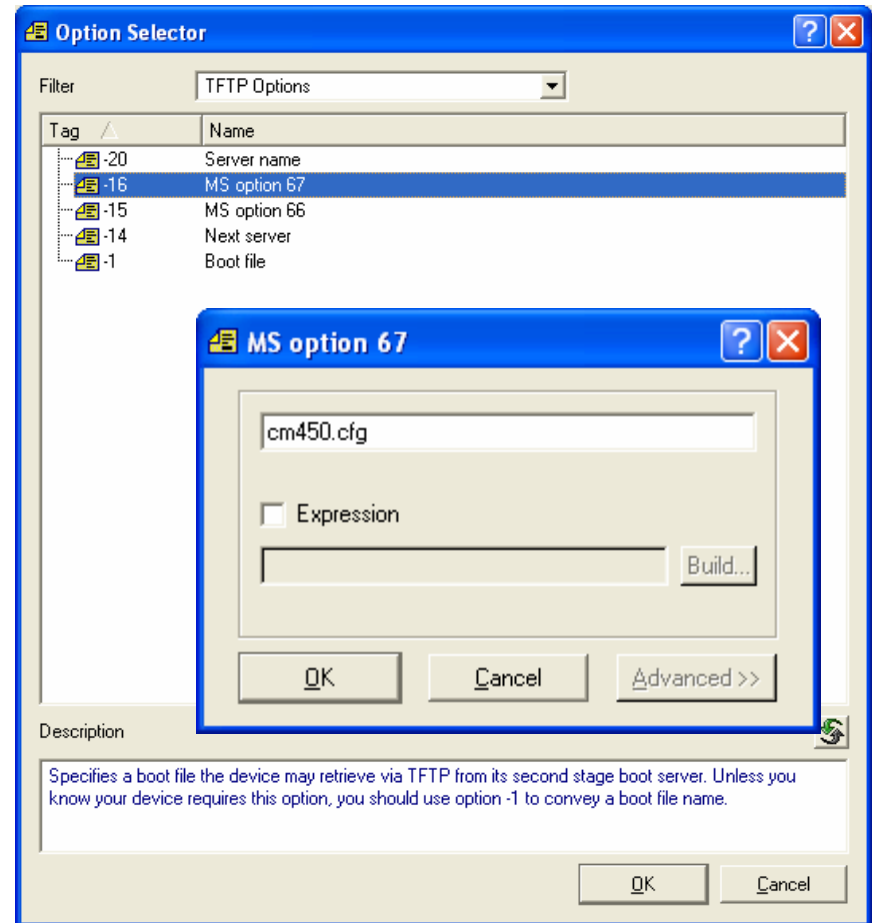
MS Option 66 (Con't)

12. Add *MS option 66* and specify its value as the IP address of the PC on which the TFTP server is installed.



C.6.6 MS Option 67

13. Add *MS option 67* (TFTP Options) and specify its value as “cm450.cfg”.
14. Save changes to DHCP server configuration.



Appendix D: TFTP Server Configuration

[D.1 Installation](#)

[D.2 TFTP Server Configuration](#)

[D.3 Cable Modem Boot Files](#)



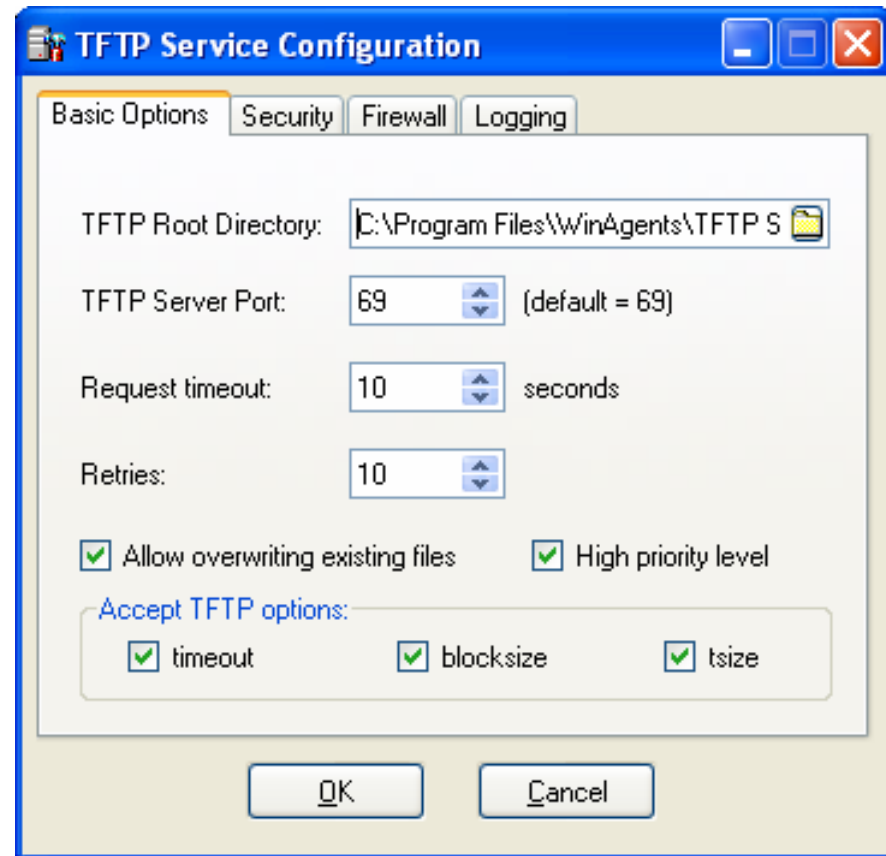
D.1 Installation

The TFTP Server software can be installed on the same PC as the DHCP server or another PC that has a static IP address.

We have used WinAgents TFTP server. This software is installed as a service by default.

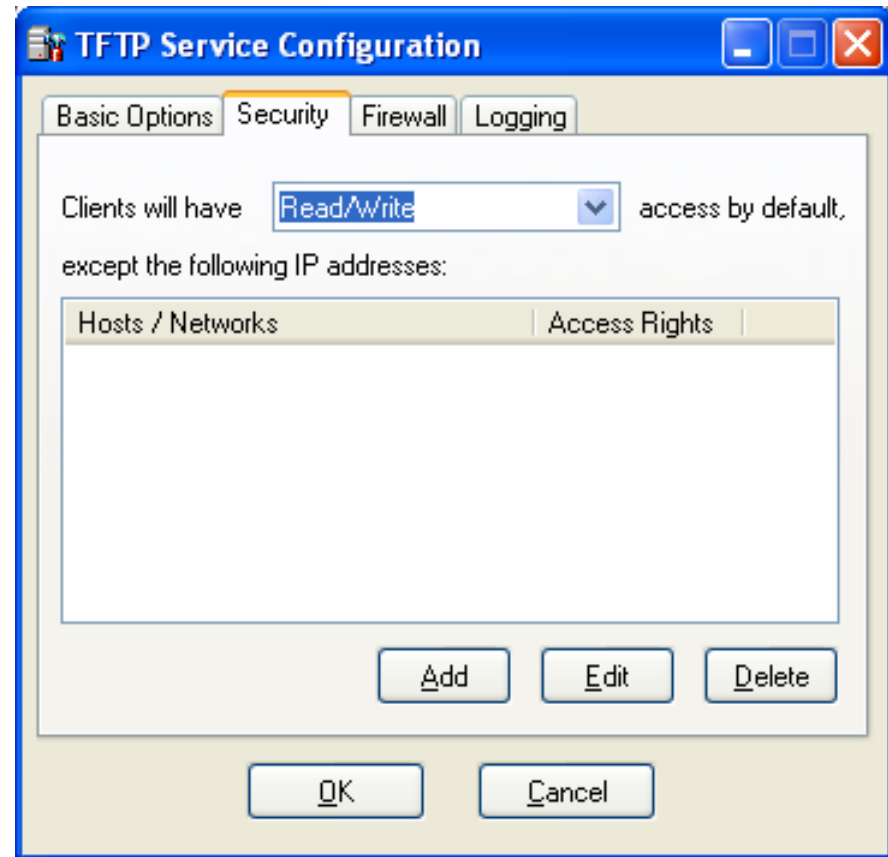
D.2 TFTP Server Configuration

1. Open the *TFTP Service Configuration* interface from the program menu. Leave all *Basic Options* at their default values.



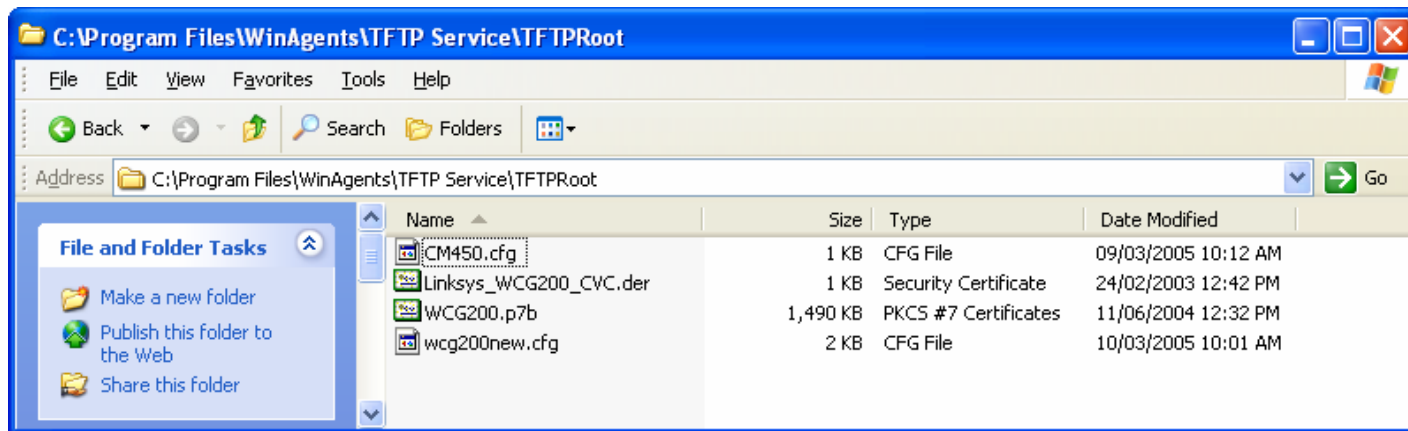
TFTP Server Configuration (Con't)

2. From the *Security* tab, ensure that the TFTP Server is set to provide read/write access. In our application, the TFTP server will have to send files to each cable modem.



D.3 Cable Modem Boot Files

3. Open an Explorer window and navigate to the TFTP Root Directory (see [Basic Options](#) tab).
4. Copy the files provided on the training CD to the folder.



Appendix E: Linksys Cable Modem Configuration

[E.1 Linksys Configuration](#)

[E.2 DOCSIS 2.0 Upgrade Procedure](#)



E.1 Linksys Configuration

1. Configure your PC to “*Obtain an IP Address Automatically*”.
2. Connect a straight through network cable between the cable modem and your PC.
3. Open a browser and navigate to <http://192.168.0.1>.

Linksys Configuration (Con't)

4. Logon to the web page.

User Name: **(blank)**

Password: **Admin**

5. Ensure the settings under the *Setup*, *Wireless*, *Security* and *Administration* tabs are as shown in the following screens.

Linksys Configuration (Con't)

LINKSYS
A Division of Cisco Systems, Inc. Firmware Version: 2.0.2.9.4-1104

Setup Wireless-G Cable Gateway **WCG200**

Setup **Wireless** Security Access Restrictions Applications & Gaming Administration Status

Internet Setup

Internet Connection Type

Obtain IP Address Automatically (DHCP)

IP Address ---.---.---.---

Set Static IP Manually

Optional Settings (required by some ISPs)

Host Name

Domain Name

Network Setup

Gateway IP

Local IP Address . . .

Network Address Server Settings (DHCP)

Local DHCP Server Enabled Disabled

Start IP Address 192.168.1.

Number of Address

IP Address Range 192.168.1.10 ~ 254

CISCO SYSTEMS



Linksys Configuration (Con't)

The screenshot displays the Linksys configuration interface for a Wireless-G Cable Gateway (WCG200). The top navigation bar includes the Linksys logo, the text "A Division of Cisco Systems, Inc.", and the firmware version "2.0.2.9.4-1104". The main navigation menu is divided into "Wireless" and "Setup" sections. The "Wireless" section is active, showing sub-menus for "Basic Wireless Settings", "Wireless Security", "Wireless Network Access", and "Advanced Wireless Settings". The "Basic Wireless Settings" sub-menu is selected, displaying the following configuration options:

- Wireless Network: Enable Disable
- Wireless Network Name (SSID):
- Wireless Channel: (dropdown)
- Wireless Network Type: (dropdown)
- Current Encryption: No Encryption

At the bottom of the configuration area, there are two buttons: "Save Settings" and "Cancel Changes". The Cisco Systems logo is visible in the bottom right corner of the interface.

Linksys Configuration (Con't)

The screenshot displays the Linksys configuration web interface for a Wireless-G Cable Gateway (WCG200). The interface is primarily blue and black. At the top left, the Linksys logo is visible, along with the text "A Division of Cisco Systems, Inc." and the firmware version "2.0.2.9.4-1104". The main navigation bar includes "Security" (highlighted), "Setup", "Wireless", "Access Restrictions", "Applications & Gaming", "Administration", and "Status". Under "Security", "Firewall" and "VPN Passthrough" are listed. The "Firewall" section is active, showing a list of settings:

- Firewall Protection: Enable Disable
- Filter Proxy: Enable Disable
- Filter Cookies: Enable Disable
- Filter Java Applets: Enable Disable
- Filter ActiveX: Enable Disable
- Filter Popup Windows: Enable Disable
- Filter Multicast: Enable Disable

Below this list, under the "Block WAN Requests" section, there is one setting:

- Block Anonymous Internet Requests (for example, block a "ping" from the WAN): Enable Disable

At the bottom of the configuration area, there are "Save Settings" and "Cancel Changes" buttons. The Cisco Systems logo is in the bottom right corner of the interface.



Linksys Configuration (Con't)

The screenshot displays the Linksys configuration interface for a Wireless-G Cable Gateway (WCG200). The top navigation bar includes the Linksys logo, the text 'A Division of Cisco Systems, Inc.', and the firmware version '2.0.2.9.4-1104'. The main navigation menu shows 'Administration' as the active section, with sub-menus for 'Wireless', 'Administration', and 'Status'. Under 'Administration', 'Security' and 'Advanced' are visible. The 'Advanced Administration' section is currently selected, showing two configuration options: 'Restore Factory Defaults' with radio buttons for 'Yes' and 'No' (where 'No' is selected), and 'Routing and NAT' with radio buttons for 'Enable' and 'Disable' (where 'Disable' is selected). At the bottom of the page, there are buttons for 'Save Settings' and 'Cancel Changes', and the Cisco Systems logo is located in the bottom right corner.

E.2 DOCSIS 2.0 Upgrade Procedure

1. The Linksys cable modem must be connected to the system. Do not power yet.
2. Open DHCP Turbo.
3. Double click on MS Option 67 (Global Policy).
4. Change it's value to wcg200new.cfg.
5. Save changes to the DHCP server.
6. Power Linksys cable modem.
7. The cable modem will automatically upgrade to DOCSIS 2.0 during registration.

Upgrade Procedure (Con't)

8. Disconnect the cable connection from the Linksys cable modem.
9. Connect a PC to the Cable modem using a Cat 5 straight through cable.
10. Verify that the cable modem has been upgraded through the administration web interface.

Upgrade Procedure (Con't)

The screenshot shows the Linksys WCG200 status page. The top navigation bar includes 'Setup', 'Wireless', 'Security', 'Access Restrictions', 'Applications & Gaming', 'Administration', and 'Status'. The 'Status' page is divided into 'Information' and 'Status' sections. The 'Information' section contains the following data:

Standard Specification Compliant	DOCSIS 1.0/1.1/2.0
Hardware Version	1.2b
Software Version	2.0.2.9.4-1104
Cable Modem MAC Address	00:0c:41:df:ba:c7
Cable Modem Serial Number	KBG4129633
CM Certificate	Installed

The 'Status' section contains the following data:

System Up Time	0 days 00h:05m:42s
Network Access	Denied
WAN IP Address	---
WAN DHCP IP Address Lease	D: -- H: -- M: -- S: --
WAN DHCP IP Expires	---

A callout box points to the 'Standard Specification Compliant' field, stating: 'Shows DOCSIS 2.0 compliance'.



Upgrade Procedure (Con't)

11. Once you are sure that the cable modem has been upgraded, change the value of MS Option 67 (DHCP Server) back to cm450.cfg.
12. Reconnect the Linksys Wireless-G cable modem to the cable network.