

Install the BTS

Install Mounting Rack or Enclosure

The BTS mounting rack (Figure 17) or enclosure is to be installed in compliance with applicable portions of the National Electrical Code (NEC), articles 800 and 810. You will need to adhere to local installation standards, as well as Navini Networks standards and procedures. Refer to [Appendix J](#) for guidelines on outdoor BTS enclosures.

Figure 17: BTS Mounting Rack



Install Chassis

The BTS chassis may be one of two types: Combo Chassis or Split Chassis. Prior to Ripwave Release 1.19, only the Combo Chassis was used (Figure 18). The advantage of the Split Chassis has to do with improved RF power output (Figure 19). The Split Chassis is available for the 2.3, 2.5, and 2.6 GHz systems; it is not available for the 2.4 GHz system.

Install the BTS chassis in the mounting rack using ten (10) screws.

Figure 18: BTS Chassis

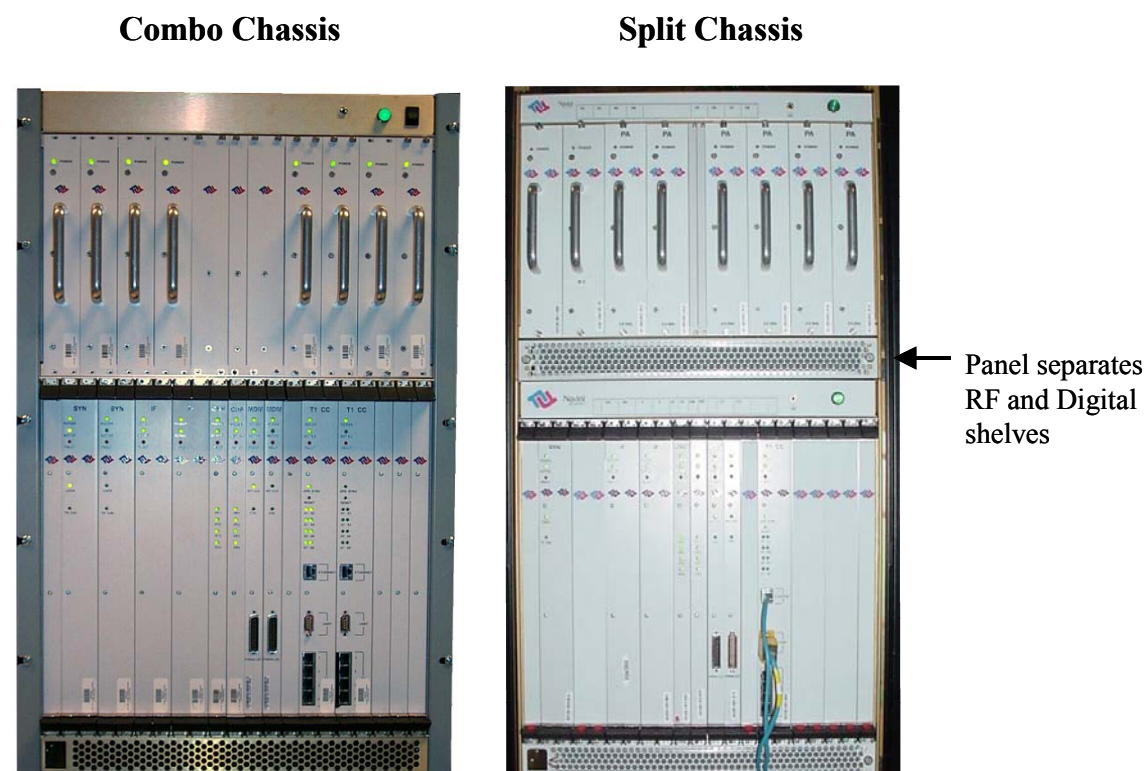
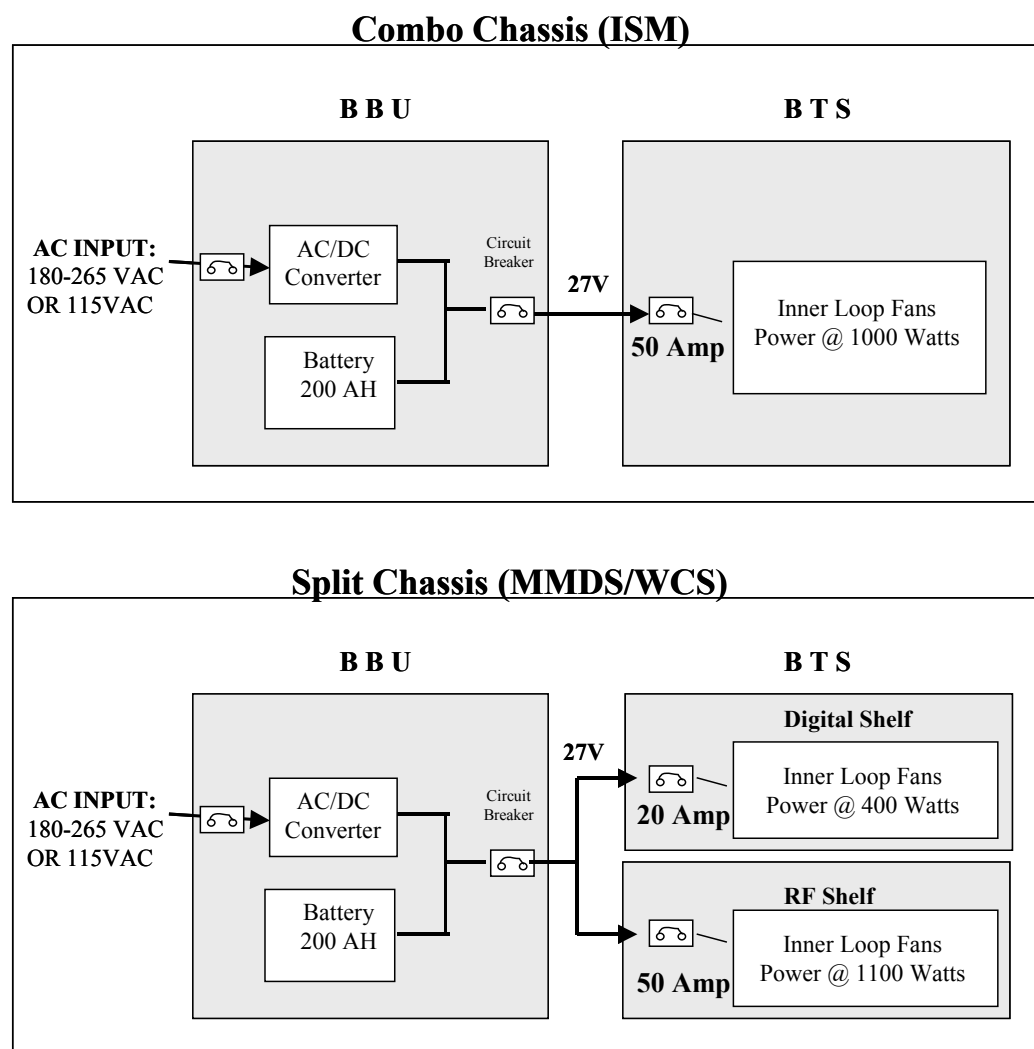


Figure 19: Split Vs. Combo Chassis Power

Connect Input Power

Next, connect the power supply to the BTS card cage (Figure 20). The gauge of the wire is determined by the length of the run and by NEC standards. Use a 60-amp circuit breaker when running the line. Terminate both of the input power wires and the ground wire with a 1/4-inch terminal lug. Assuming a +24 VDC power supply, connect the +24 VDC input power connections and the +24 VDC return wires to the BTS card cage.

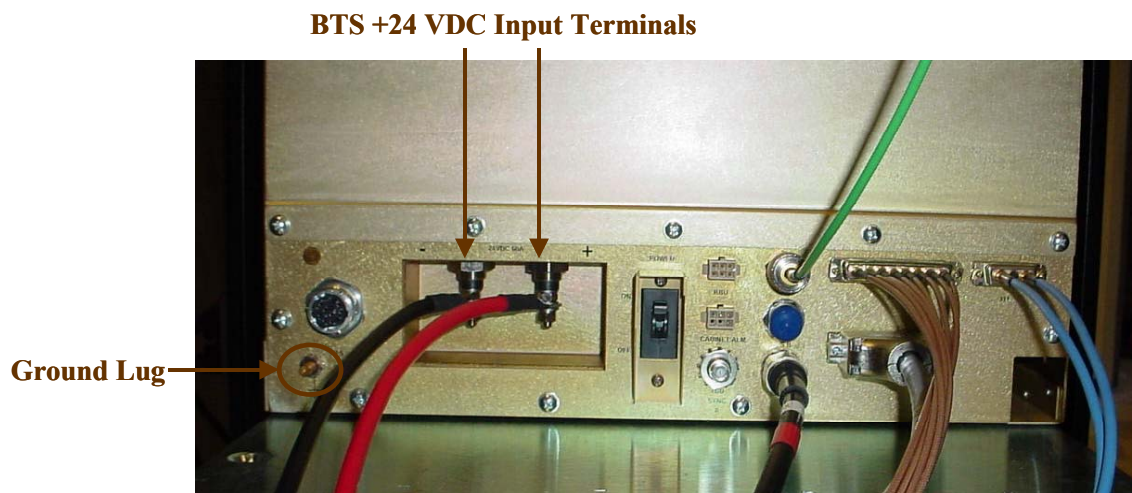


WARNING! Ensure that the power is off before connecting the input power wires to the BTS input terminals.

If the input power is 120 VAC, plug the two power supply input cables into 120 VAC outlets, and turn on the circuit breaker on the power supply. If the input power is 24 VDC, check for +24 VDC across the input terminals of the BTS card cage. If +24 VDC is not present across the input terminals, check all input power wiring for proper connections. Also, check the power supply for proper operation and the fuses for continuity.

When finished, turn off the power supply.

Figure 20: Split Chassis Power Connections



Connect BTS to Ground Connections

All connections need to be checked before power is applied to the system. At a minimum, perform the following:

- Ensure continuity across all ground connections.
- Ensure an open connection from the power supply output (positive input to the BTS card cage) to frame ground.

Connect Chassis Alarms

The chassis contains two connectors that are used to send alarm indications to the BTS when the BTS is housed in an outdoor enclosure. One of the connectors, labeled “CABINET ALARM”, is used to trigger alarm conditions that occur within the external chassis. The second connector, labeled “BBU”, is used to process alarms from a battery backup unit. Refer to [Appendix L](#) for instructions on connecting the alarms.

Install GPS Antennas

As mentioned earlier, there are two models of GPS antennas that can be used with the Ripwave Base Station, as shown in Figures 21 and 22: Motorola Timing 2000 and VIC 100. The system will use either one or two GPS antenna modules.

Figure 21: Motorola Timing 2000 GPS



Figure 22: VIC 100 GPS



The mounting location for the GPS antenna is determined during the site survey. When installing, ensure that the following requirements are met:

- The GPS antenna is installed within 100 feet of the BTS.
- The GPS antenna is located to provide the widest view of the sky (objects such as buildings or trees can interfere with signals from the satellite).

Motorola Timing 2000

For the Motorola Timing 2000, mount each GPS antenna module using the mounting bracket hardware (Figures 23 and 24). Connect the GPS cable(s) to the GPS antenna module(s). Torque the connector(s) to 20-24 inch-pounds.

Figure 23: Motorola GPS Antenna Mounting Brackets

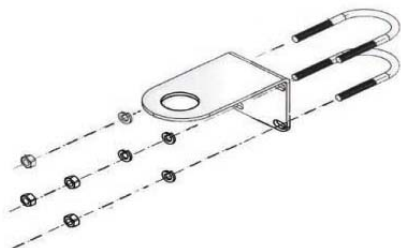
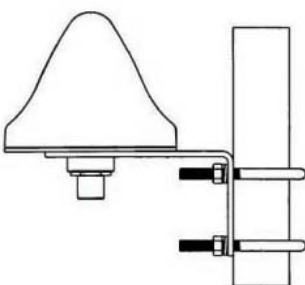


Figure 24: Motorola GPS Antenna Mounted to a Pole



VIC 100

For the VIC 100, mount each GPS antenna module, run the cable through the pipe clamp mount (Figure 25). Connect the cable to the GPS antenna, then weatherize the connection (Figure 26). Secure the antenna module to the pipe clamp mount using the captive mounting hardware. Install the GPS antenna module and the pipe clamp mount to the mounting pipe and tighten the two mounting screws (Figure 27).

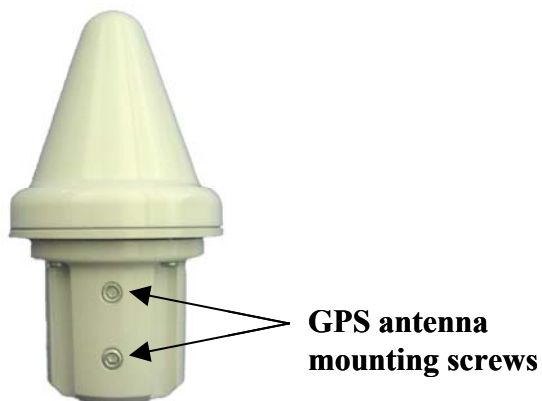
Figure 25: VIC 100 Pipe Clamp Mount



Figure 26: VIC 100 GPS Antenna



Figure 27: Assembled VIC 100 Antenna & Mount



Install the RFS

Now that the BTS is in place, the RFS is readied for installation. Follow either the Panel Antenna or Omni Antenna information and procedures below. Reference the drawings in [Appendix M](#).

Panel Antenna

The RFS Panel antenna is installed on a structure, such as a tower or a pole, which is defined in the site survey and design. Following are the steps to complete the installation of the panel antenna.

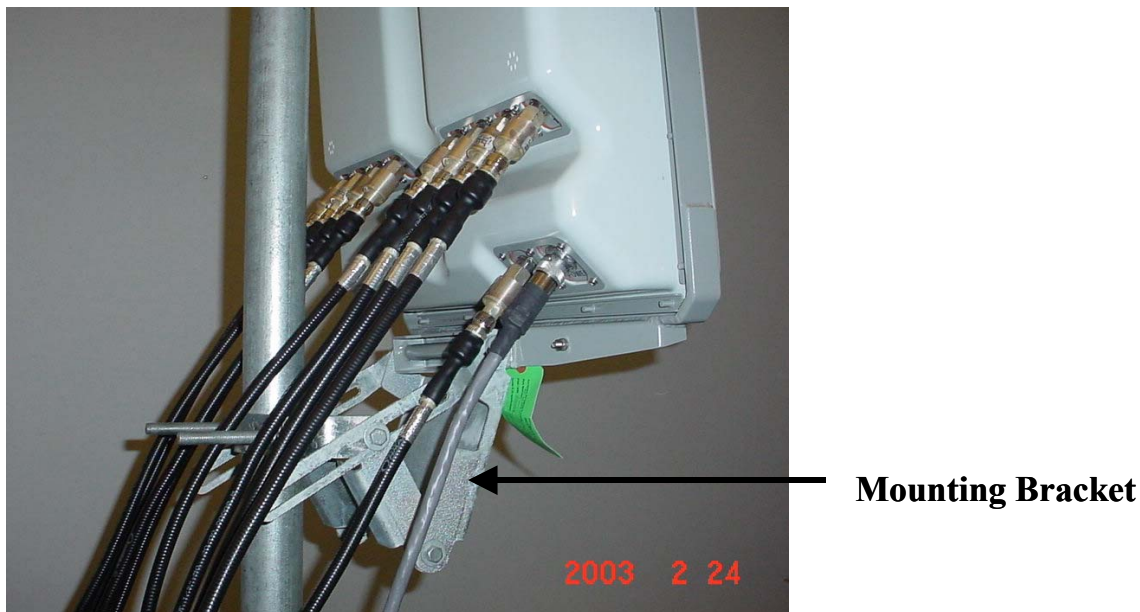
Verify RFS Operation

Verify proper operation of the RFS *before* installation. Test the transmit and receive path of each antenna in the RFS per [Appendix C](#), the RFS System Test.

Set the Downtilt

Check the engineering study for the required downtilt of the antenna. Normally, it will be 2 degrees for omni and 6 degrees for panel downtilt. Each notch in the mounting bracket is equal to 1 degree of downtilt (Figure 28). Set the upper mounting bracket to achieve the required downtilt. Be sure to include in the setting any electrical uptilt or downtilt built into the antenna.

Figure 28: RFS Mounting Bracket



The following steps are critical !

Set the Azimuth

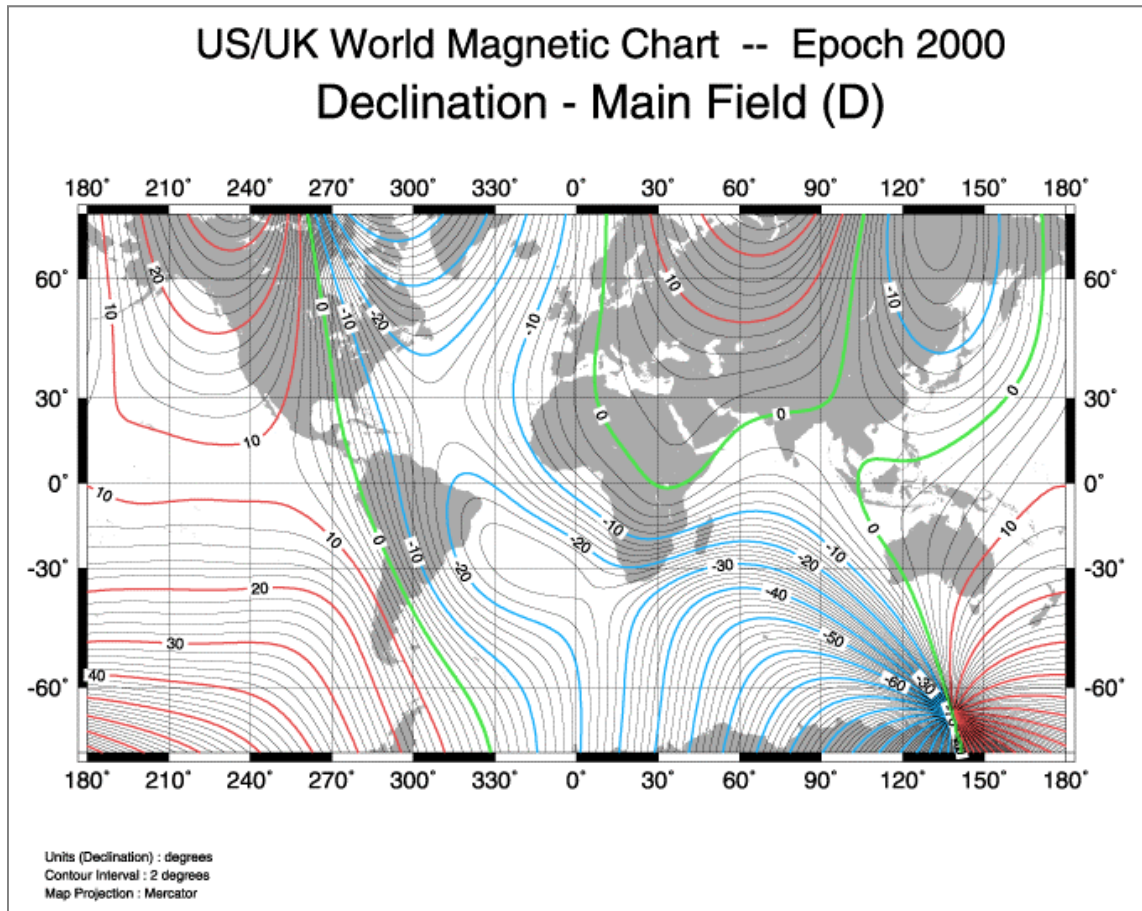
Position the RFS on the mounting pole or structure, ensuring that the antenna is pointing in the proper azimuth direction determined by the engineering study. For an omni, the first antenna element must face East (Figure 29).

Figure 29: Omni Antenna Elements



The azimuth direction is stated in degrees from true north. Use the diagram shown in Figure 30 to determine the declination angle for your location. Add or subtract the declination angle from magnetic north to obtain true north.

Tighten the four nuts on each of the two antenna mounting brackets to secure the RFS to the mounting pole. Use a compass to check the direction from the center of the panel (this is magnetic north).

Figure 30: Declination Angle

Verify the Downtilt

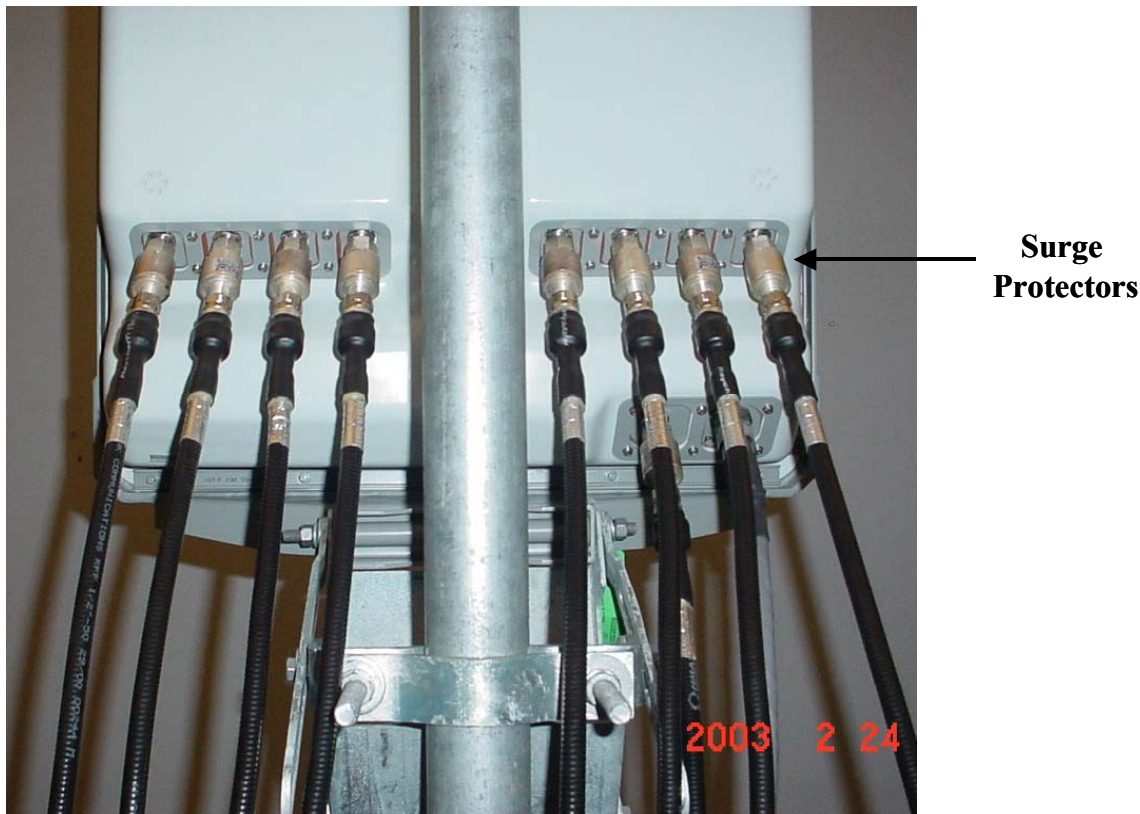
Using an inclinometer, check the downtilt of the RFS antenna. If required, adjust the angle using the downtilt adjustment brackets. Be sure to include any electrical uptilt or downtilt built into the antenna in the setting.

Tighten the mounting hardware to secure the RFS in the proper position. Recheck the downtilt angle again to verify proper position. Repeat the procedure for all other antennas that are installed in the system. Ensure that they are mounted in the proper direction and with the correct downtilt angle.

Install Surge Protectors

The RFS has ten cable connectors on the bottom of the unit. Eight are antenna connections, with the connectors alternately numbered from right to left as shown in Figure 31. The two connectors in the middle are for antenna calibration and data/DC power connections. Install surge protectors on nine (9) of the RFS connectors – the eight antenna connectors and the calibration connector. The surge protectors must be installed directly to the RFS to provide protection for the antenna elements. Torque the surge protectors to 20-24 inch-pounds.

Figure 31: Surge Protectors



Install Cables Between the RFS & BTS

Connect all of the cables – the eight antenna cables, the calibration cable and the data/power cable – to the surge protectors on the RFS (Figure 32). For ease of installation, install the cables from the inside out. Ensure that the proper cable is connected to the proper antenna (Figure 33). Torque the RF cable connectors to 20-24 inch-pounds.

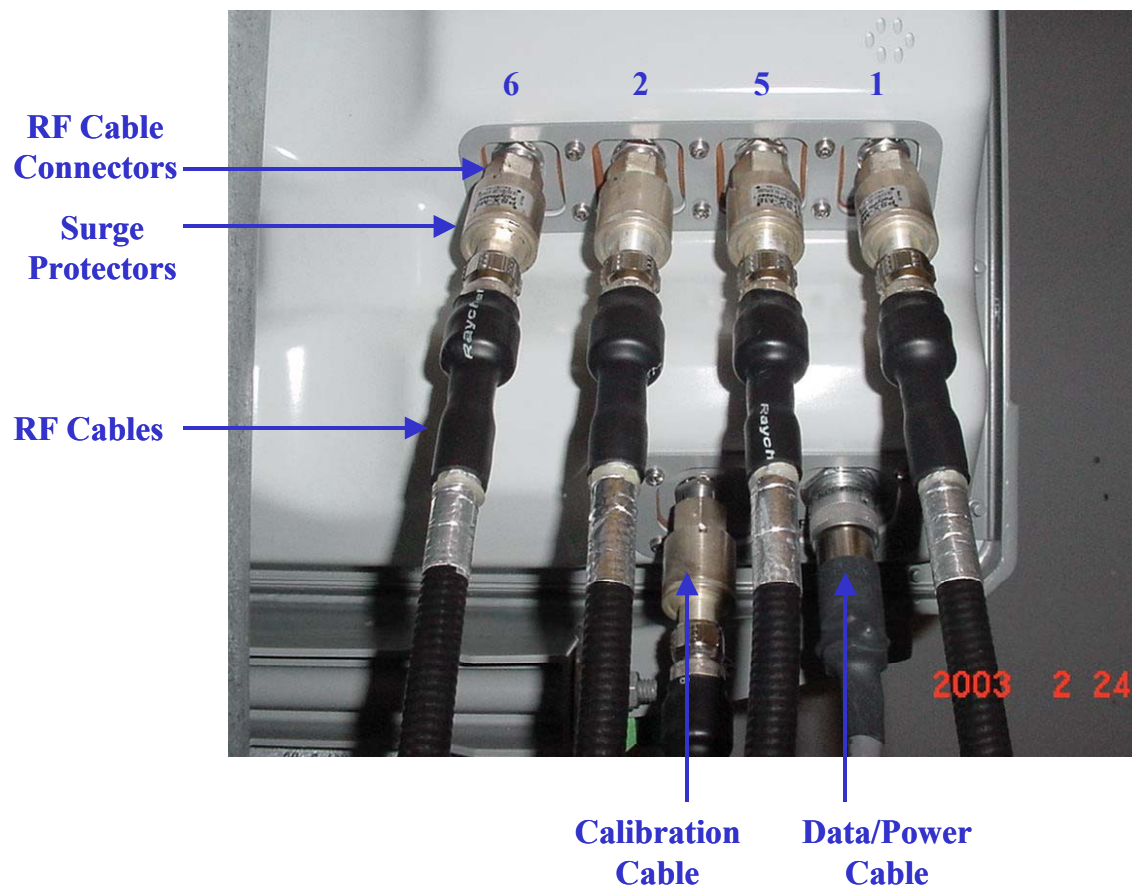
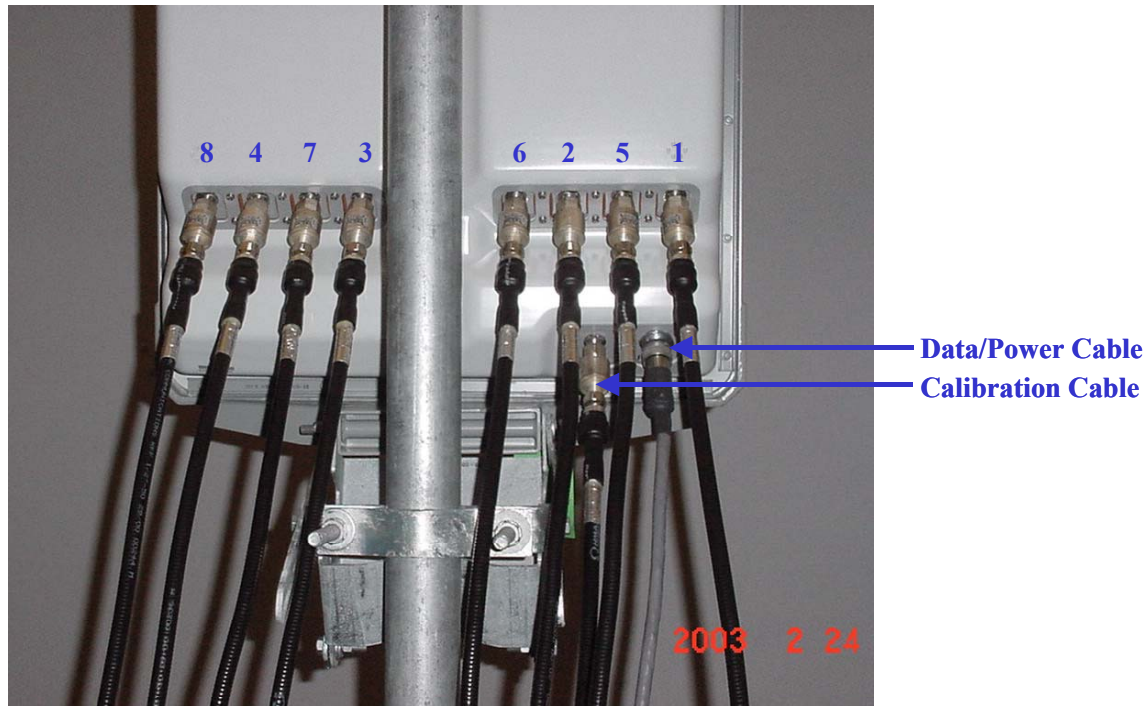
Figure 32: RFS Connectors

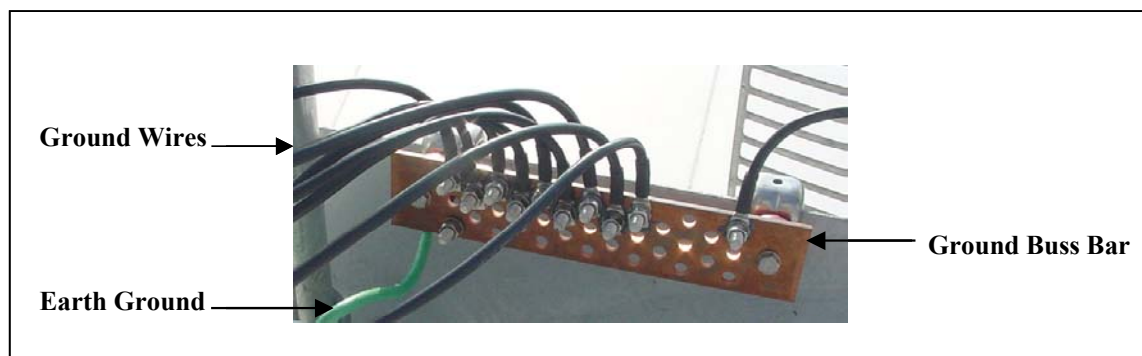
Figure 33: Completed Cable Installation

Install Grounding Kit on Cables

Install grounding kit wire connections on the eight (8) RFS cables and the one (1) CAL cable per the instruction sheet that comes with the grounding kit. Install the grounding wire in a position on the cable so that it can be attached to the ground buss bar that is mounted close to the RFS. More than one ground buss bar may be installed in the system, depending on the length of the cable run.

Connect Ground Wires to the Ground Buss Bar

Connect the ground wires on the cables to the ground buss bar using the hardware supplied with the grounding kit. Connect the ground stud on the RFS to the ground buss bar. Use a 1/4-inch terminal lug to connect the ground wire to the ground stud on the RFS. Connect the ground buss bar to earth ground. An example is shown in Figure 34.

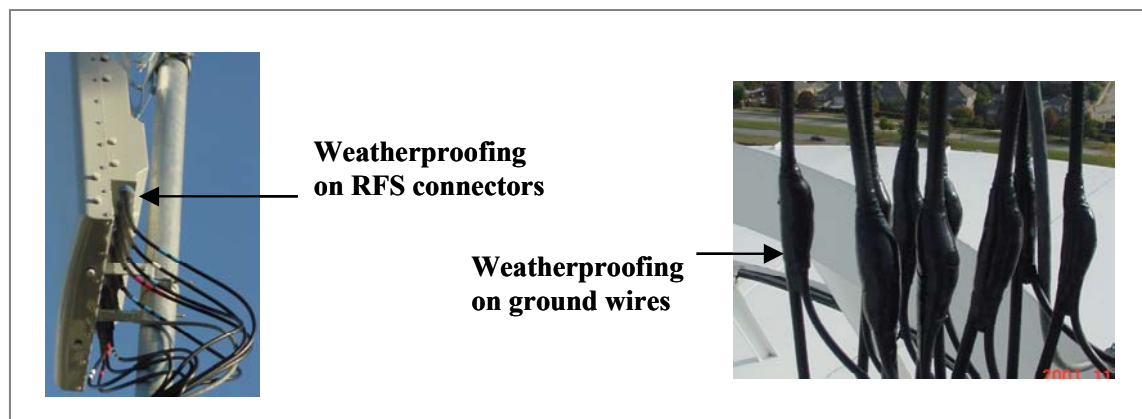
Figure 34: RFS Grounding

Test the RFS & Cables

Test the RFS and the eight (8) cables per [Appendix C](#), the RFS System Test. Record the results in the form. For this test, use the cable connectors that will be attached to the BTS. Include the jumpers and all surge protectors.

Weatherize the RFS Cable Connectors

Weatherize all ground wire connections exposed to weather using electrical tape and butyl mastic tape. Follow the instructions supplied with the weatherproofing kit. Examples are shown in Figure 35.

Figure 35: Weatherized Cables

Connect RF Cables & Alarms to BTS

Connect all of the cables to the BTS. The connection points are shown in Figures 36, 37, and 38. Torque the cable connectors to 20-24 inch-pounds. If applicable, connect the cabinet alarm connector and Battery Backup connector (Cabinet Alarm and BBU) to the back of the chassis. More information on connecting alarms, rectifiers, and battery backup equipment are provided in [Appendix L](#) and [Appendix N](#), respectively.

Figure 36: Combo Chassis Rear View

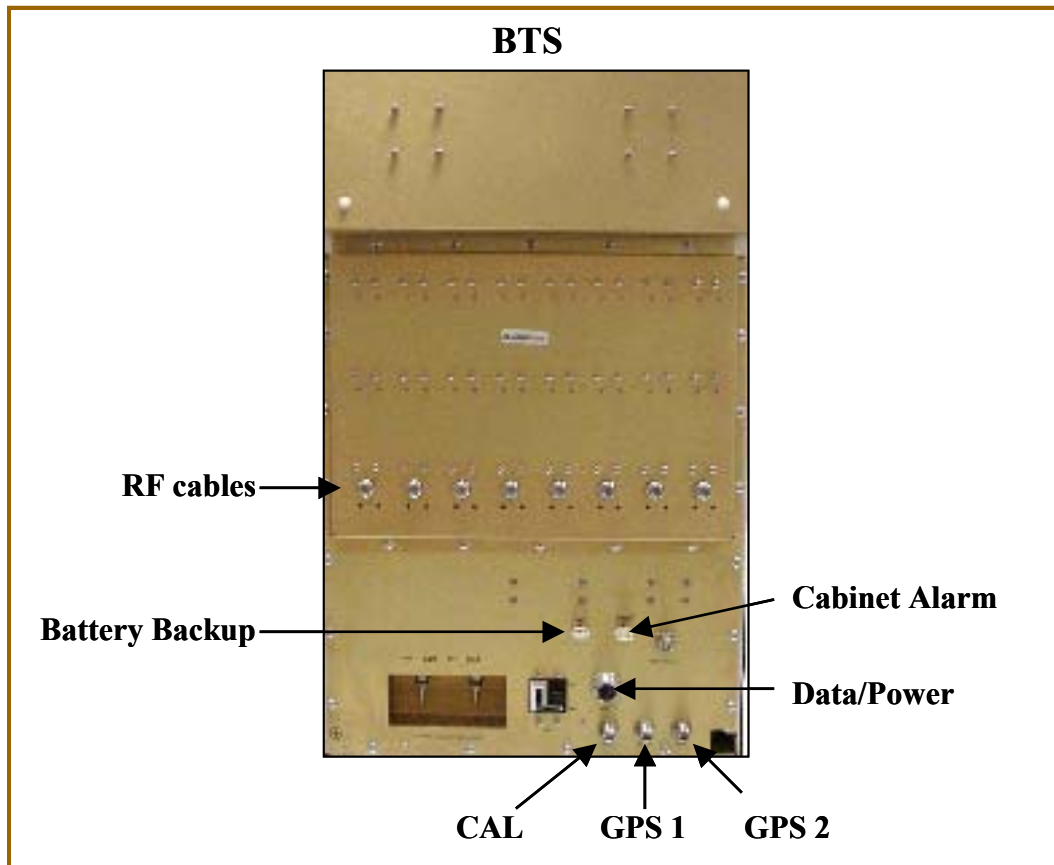
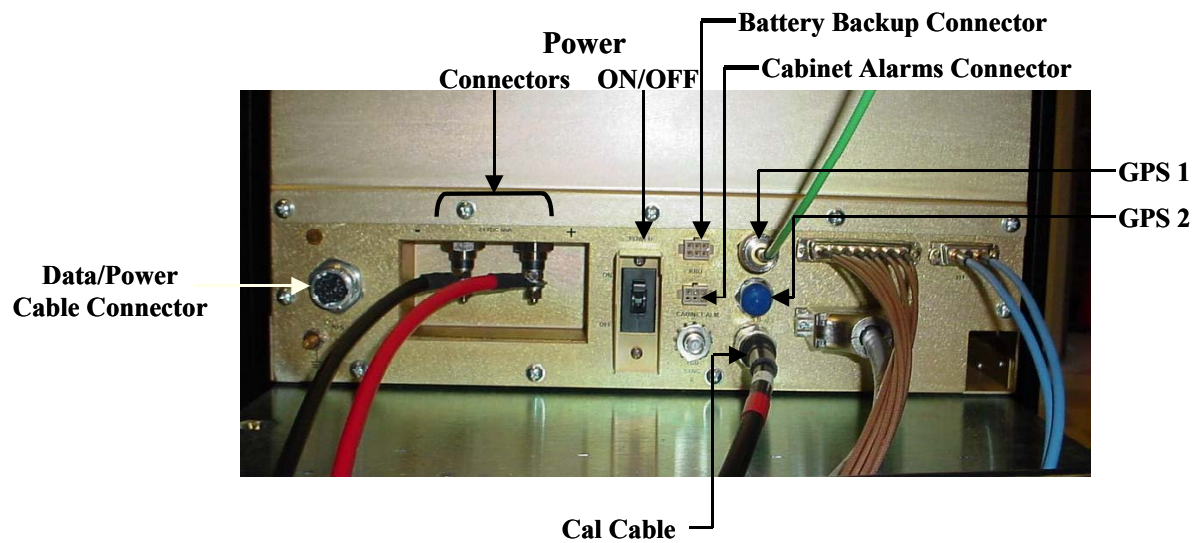


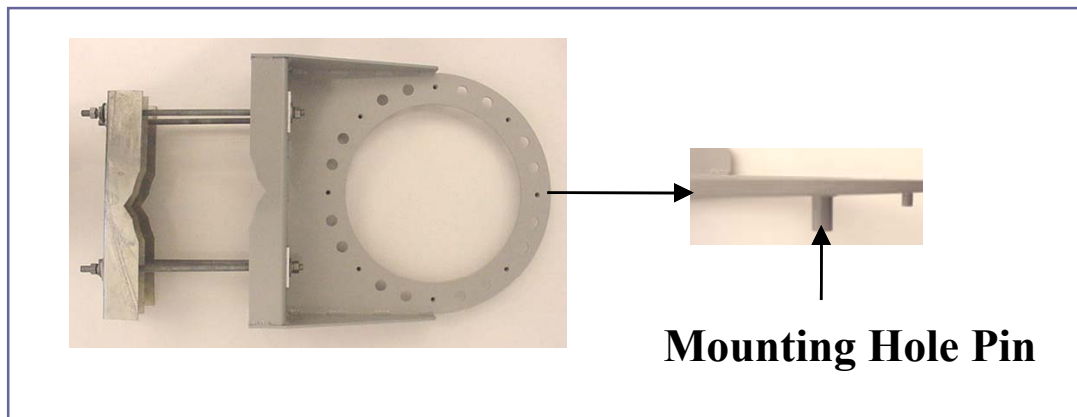
Figure 37: Split Chassis RF/PA Shelf Rear View**Figure 38: Split Chassis Digital Shelf Rear View**

Omni Antenna

The RFS Omni antenna is installed on a structure, such as a tower or a pole, which is defined in the site survey and design. Following are the steps to complete the installation of the panel antenna.

Assemble the Antenna Mount per the instructions that come with it (Figure 39). Use a compass to determine which direction is true East (incorporating declination angle - see Figure 30).

Figure 39: Omni Antenna Mount



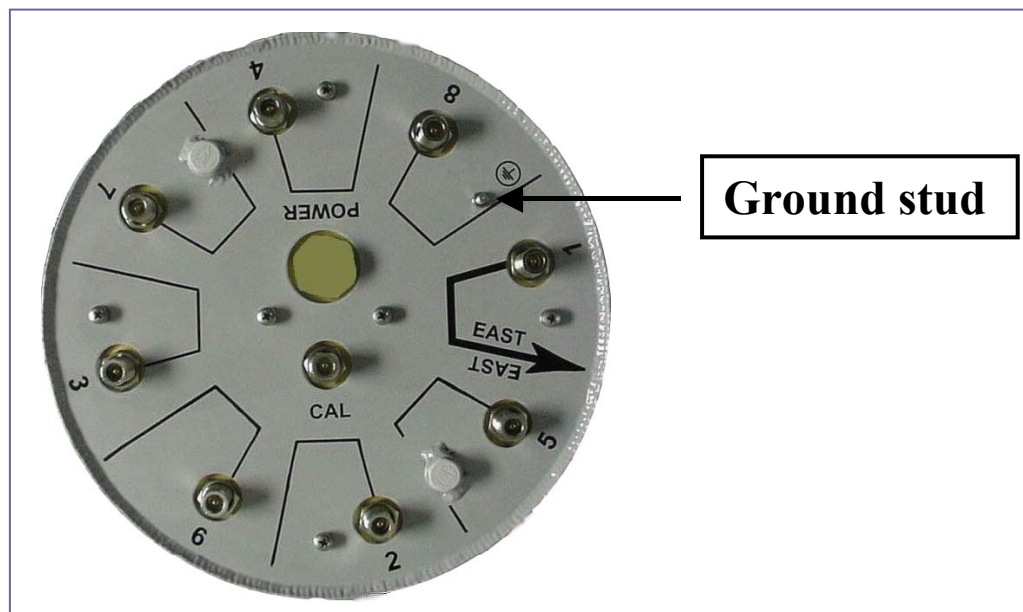
Position the Antenna Mount in a direction to provide accessibility to the RFS after it is installed. Position and install the Antenna Mount on the mounting structure so that any one of the eight mounting hole pins is facing East. Tighten the Antenna Mount hardware to secure it to the structure (Figure 40).

Figure 40: Secured Omni Antenna Mount



Sweep the RFS antenna inputs for db loss. Record all results for later calculations. Position the RFS on the Antenna Mount, ensuring that the arrow on the bottom of the Antenna Mount faces true East. Secure the RFS antenna to the Antenna Mount (Figure 41). Install surge protectors on the 8 antenna and 1 cal connector.

Figure 41: Omni Ground Stud



Connect the eight antenna cables, cal cable, and Data/Power cable to the RFS antenna. Attach the ground wire to the ground stud. Install grounding kits from RF cables to buss bars. Sweep the antenna and cables from the RF cable connectors that attach to the BTS. Record all measurements. Weatherize all connections (Figure 42).

Figure 42: Weatherized Connectors



Verify Installed Circuit Cards



WARNING! Ensure that power to the BTS chassis is off before installing the circuit cards or any of the RF Power Amplifiers in the chassis.

The circuit cards, including the RF/PA cards, normally come seated in the BTS chassis. If they are already installed, verify that the correct cards are placed and seated properly. The RF/PA modules may be installed in any position on the top (RF) shelf. For the Digital shelf, refer to Figure 36 for correct card placement. Table 9 describes the name of each type of card in the Digital shelf.

Tighten the screws to secure the RF/PA's into the RF shelf. For the circuit cards, follow the markings on the backplane for the position of each card in the Digital shelf. Make sure the ejectors on all cards are engaged in the chassis. Figure 43 represents a fully populated Digital shelf. If the BTS is not fully populated, blank panels are installed to fill in the empty card space. They are also used to fill in the empty space between the circuit cards and the end of the cabinet.

Figure 43: Digital Shelf



Table 9: Digital Card Names

Abbreviation	Card Name	Number of Cards
SYN	Synthesizer	1 or 2
IF	Intermediate Frequency	Always 2
CHP	Channel Processor	Always 2
MDM	Modem	Always 2
CC	Communications Controller	1 or 2

Base Station Installation Certification

When the installation of the equipment is complete, the Base Station Installation Certification form needs to be completed and signed off by both the installer and the customer. A copy of this form may be found in [Appendix D](#).

Chapter 3: Commissioning

This chapter provides post-installation instructions on provisioning, configuring, calibrating, testing, and commissioning the Ripwave Base Station.

Review Customer Network Plans

As part of preparing to put the BTS into commission, it is important to review the actual installed site against the customer Network Architecture Plan - i.e., checking that all equipment and software are installed and available for use. Verify that all routers are installed and IP addresses are correct. Finally, make sure the installation is approved and signed off by all responsible parties.

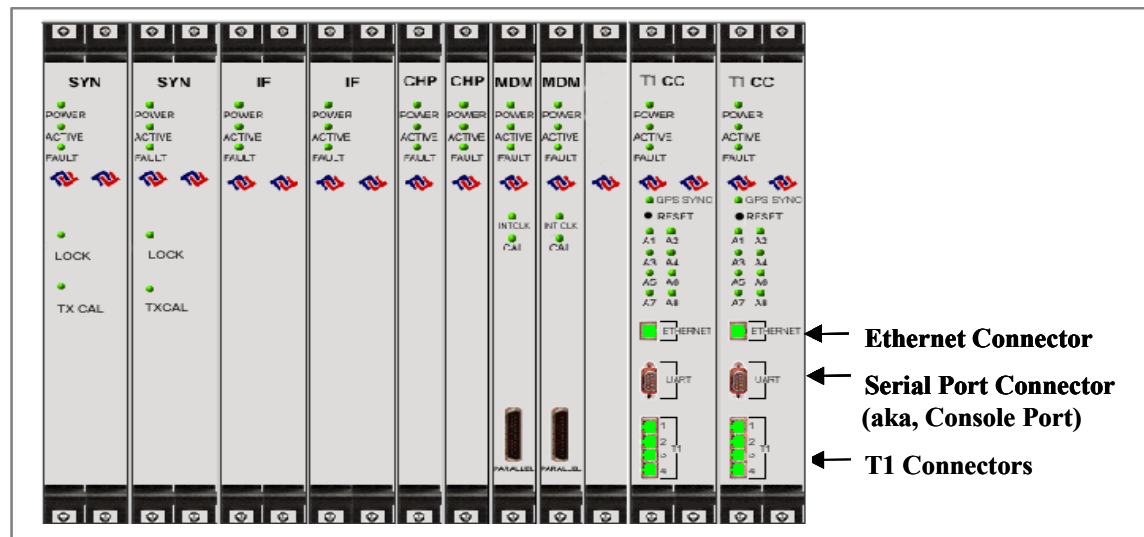
Install EMS Server

The EMS is the management interface for all elements in the Ripwave system. The EMS Server has to be installed on a computer that is connected directly to the Base Station (called the Test EMS) or through the system backhaul (customer EMS).

For testing purposes, the Test EMS Server is connected through an Ethernet hub or switch to the Ethernet port found on the front of the BTS (Figure 44). Note that the EMS Server does not support more than one Network Interface Card (NIC).

The other port on the front of the CC card is a Serial (Universal Data) Port, also known as the Console Port. Using a laptop/portable computer connected through the data port, an on-site technician can communicate directly with the BTS using a terminal emulation software package. However, this is not recommended. It is always best to rely on the EMS interface for BTS information.

Figure 44: Ports on CC Card



If the customer's EMS is installed and can be accessed through the backhaul, it can be connected via T1 or Ethernet to the BTS and used for testing purposes. The EMS software installation procedures can be found in the *EMS Software Installation Guide*, P/N 40-00017-00.

After the EMS Server and Client applications are installed, the EMS database needs to be configured with the settings that are designated for the Base Station. The settings are found in the Network Architecture Plan provided by the customer.

Verify Cable Connections

Before proceeding, verify that all power is connected and present. Ensure that all T1 or Ethernet connections are installed correctly and are active. Verify that the BTS and the RFS are properly installed and that all cables are connected.

Configure & Power Up the BTS

Overview

During initial power up a minimal set of configuration parameters have to be input to the BTS through the serial port on the CC card. These early configuration parameters are referred to as the “boot parameters”. They are required to get the BTS to communicate with the EMS Server so that all the configuration data can be downloaded from EMS to the BTS.

The PC used at this point is a Test EMS Server (i.e., laptop). If the customer’s actual EMS Server is available, a separate Test EMS (i.e., laptop) may not be necessary. For simplification, whether it is a Test EMS laptop or the customer’s EMS Server, we refer to the device at this stage as the Test EMS.

Set Up the Test EMS

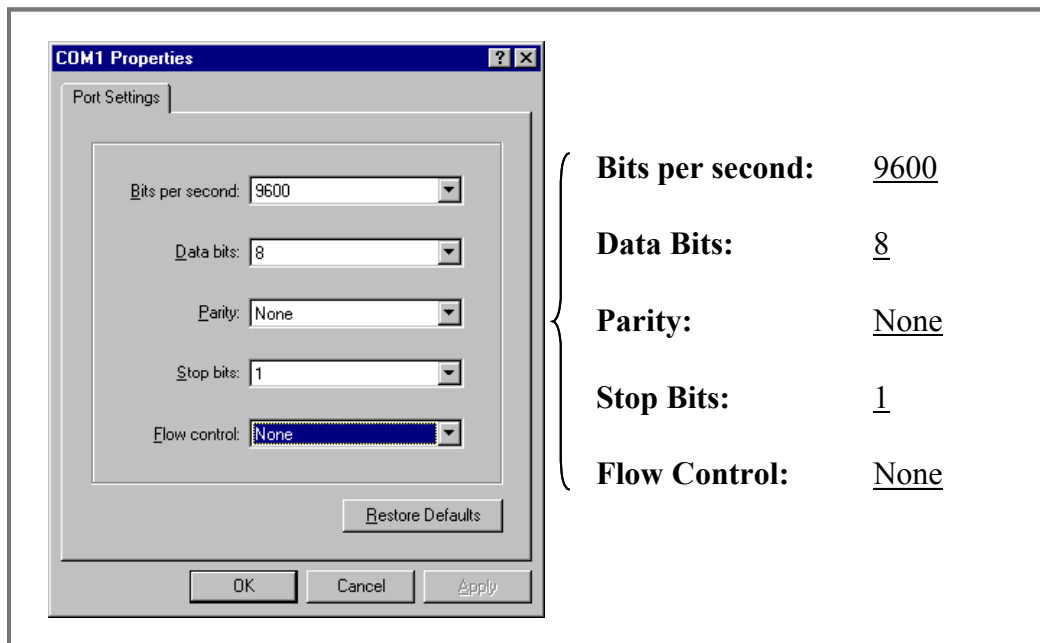
Typically, in order to keep a constant link an Ethernet hub (10/100 Base-T) connects the Test EMS to the BTS via a male to female RS-232 cable connected to the CC serial port. A connection between the serial port on the CC and the serial port on the Test EMS is also used. Standard communication software, i.e., a standard terminal emulation program, such as Windows HyperTerm or TeraTerm, is used during these early configuration stages.

- Step 1.** Verify all RF cables going to the BTS are securely connected to the proper connector.
- Step 2.** Connect an Ethernet cable to the Ethernet connector located on the CC card and to an Ethernet hub. Connect another Ethernet cable from the Ethernet hub to the Ethernet connector on the PC containing the Test EMS Server and Client applications.
- Step 3.** Connect an RS-232 cable (DB-9 male to female) to the serial port (UART) located on the CC card to the serial port connector on the Test EMS computer.



Note: A VT 100 terminal or any standard Windows based ASCII terminal emulation program can be used for connecting to the serial port. The connection for HyperTerminal is explained here. The steps to get to the HyperTerminal program may be different due to variances in the Operating Systems and in the setup of the PC.

- Step 4.** Power on the Test EMS Server.
- Step 5.** On the desktop, go to **Start > Programs > Accessories > HyperTerminal > HyperTerminal** (using whichever terminal emulation program you are running).
- Step 6.** In the COM1 Properties window (Figure 45), under the Port Settings tab, enter the following configuration options. Click **OK**.

Figure 45: COM1 Properties

- Step 7.** On the Test EMS Server, click on the Server icon to start the EMS Server. NOTE: This step assumes you have loaded and configured the EMS Server & Client applications.
- Step 8.** Click on the EMS Configuration & Alarm Manager (CAM) icon to start the EMS Client GUI.
- Step 9.** At the EMS Configuration & Alarm Manager login screen, enter the user name and password. The defaults are both **emsAdmin**.

Add BTS in EMS

Once you have the CAM application running on the Test EMS server, you will need to click on the BTS element tab to add the new BTS. Only the minimal configuration parameters have to be completed at this time - i.e., BTS name, ID, IP address, subnet mask, and gateway. Follow the Network Architecture Plan designed for this system.

Also configure the GPS offset time. The default is 0 minutes, indicating the BTS would be located in the same time zone as Greenwich Mean Time (GMT). Change this value to whatever time is appropriate to the location of the BTS in relation to GMT time zone. For example, if the BTS is located in Dallas, Texas, which is 6 hours behind GMT time zone, you would enter -360. As you will see in the section that follows, you will also configure the RFS splitter loss at this time. For more details about configuring a BTS, refer to the *Ripwave Configuration Guide*.

Configure RFS (Splitter Loss Value)

Each RFS shipped is pre-programmed for the customer's specific operating environment. An RFS Configuration CD accompanies the RFS equipment when it is shipped. The CD includes an RFS script and a Quick Guide with procedures on selecting the appropriate splitter loss values to be entered into the EMS database for the given Base Station. Each Configuration disk is unique to the individual RFS that is shipped. You cannot use the same disk on other RFS equipment.

RFS Configuration Procedure

Step 1. Remove the RFS Configuration disk from the RFS packaging, and insert it in the floppy drive of the Test EMS.

Step 2. Copy the folder named "RFS" that is on the disk to the Test EMS Server:
<ems install dir>/scripts.
It will take approximately 20 seconds to complete.

Step 3. Open the new folder on the EMS server. You will see a list of file names. The format of the file names is as follows:

RFS_serial number_frequency.cli

Example: "RFS_024300001_2402500.cli" - This example of the configuration file is for an RFS with serial number 024300001 and a center frequency of 2.4025.

Verify the correct serial number in the file name against the serial number of the RFS equipment. The equipment serial number may be found on the back of the RFS panel or on the side of the bottom cylinder of the omni antenna.

Step 4. Determine which file you need to run, depending on the provisioned frequency of your BTS.

NOTE: For 2.6 GHz systems, select the frequency that is closest to your provisioned center frequency. To find the provisioned center frequency for your BTS, open the EMS Configuration & Alarm Manager (CAM) application. Select the BTS tab and specific BTS, then Air Interface / Layer 2 / Carrier Data / Show Configuration. This will display the center frequency information.

Step 5. Open the selected CLI file for editing using any text processing application program. Note the power splitter values listed there (i.e., write them down or print them out).

Step 6. Modify the line that starts with "bts" by changing the BTS ID for your BTS. The default is "BTS 1". For example, if the ID for your BTS is 252, change the "1" to "252".

Step 7. Save this file as text, and then close it.

Step 8. Start the EMS Config CLI application to run “script <CLI script>”. Do this by entering the following:

```
>enable <user name> <password>
>configure
>script scripts/rfs/rfs_<serial number>_<7-digit frequency>.cli
```

NOTE: For Unix operating systems, the CLI text is case sensitive and the slash marks should be backward slashes instead of forward slashes.

Step 9. View the Power Splitter values in EMS to verify that the CLI script ran as expected. The Power Splitter values may be found under Layer 1 / Show Configuration > Antenna Table. You will need to “Refresh” the active screen to view the updated information.

Step 10. Type “Exit” twice to exit the Config CLI edit mode.

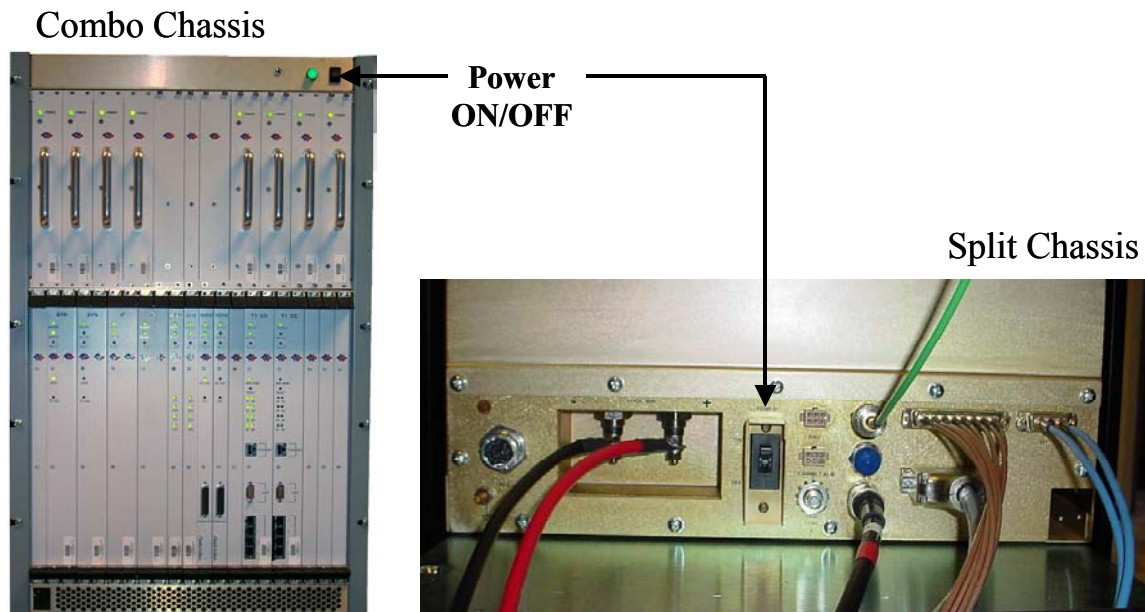
Power Up BTS

Now you are ready to power up the BTS.

Step 1. Ensure that input power has been connected to the BTS.

Step 2. Switch the Power to ON. If the BTS is a Combo Chassis, the switch is located on the top right front of the BTS. The green Power On light next to the switch will illuminate (Figure 46).

If the BTS is a Split Chassis, the Power ON switch is located on the back lower middle of the Digital shelf. The green LED's on the RF/PA modules and the circuit cards in the BTS chassis should illuminate.

Figure 46: BTS Power On Switches

Step 3. Watch for the auto-boot countdown command. Type in **config** on the computer keyboard to interrupt the standard boot sequence. The window of time to type in “config” after auto-boot starts is 20 seconds.

BTS Bootup

The BTS is shipped with a default value of a 20-second countdown to interrupt the standard bootup sequence. You can escape the standard bootup when the display shows the following:

autoboot countdown : quick [quick|delayed]

To escape the initialization sequence, type in **config** before the 20-second counter reaches zero.



Note: Under the next section, “Boot Prompt”, you will see how to disable the 20-second countdown in lieu of a shorter, 1-second countdown. This will minimize downtime during unattended restart conditions, for example, if there is a power outage and the BTS is recovering.

Boot Prompt

After you have escaped from the automated boot sequence, the console will display a rudimentary Boot prompt:

[Navini Boot]:

This prompt offers the ability to perform a small set of operations. Enter ‘?’ or ‘h’ followed by the Enter key to display a list of commands (Exhibit 1). To invoke any of the commands, simply enter the single letter command with optional parameters, followed by the Enter key.

Exhibit 1: Boot Commands

[Navini Boot]: ?

?	- print this list
@	- resume boot sequence
p	- print boot params
c	- change boot params
d adrs[,n]	- display memory
m adrs	- modify memory
f adrs, nbytes, value	- fill memory
t adrs, adrs, nbytes	- copy memory

@ – Use this command once all parameters have been set as desired. This will resume the boot initialization sequence that you escaped from previously.

p – This command displays a concise representation of the current parameters used for boot configuration.

c – Use this command to alter the current boot parameters. Once selected, a detailed sequence of options is prompted, and is covered in detail later. After all of the items in this list are completed, you return to the *[Navini Boot]:* prompt. This option sequence allows you either to accept the current value by pressing the Enter key or to enter a new value from the range or values listed, followed by the Enter key. Additionally, you can enter ‘.’ followed by the Enter key to erase the current value of an item and return it to a default state. If you make an error, you can choose ‘-’ (hyphen) followed by the Enter key to return to the previous item in the list. Alternatively, you can fix an error by proceeding with the selections and select ‘change’ when you return to the *[Navini Boot]:* prompt.

d – Display memory allows you to display portions of the BTS’s memory with user-defined values. It should only be performed with the assistance of a certified Navini service technician.

m – Modify memory allows you to alter portions of the BTS’s memory with user defined values. It should only be performed with the assistance of a certified Navini service technician.

f – Fill memory allows you to alter portions of the BTS’s memory with a fixed pattern. It should only be performed with the assistance of a certified Navini service technician.

t – Fill memory allows you to alter portions of the BTS’s memory with a pattern from another area of memory. It should only be performed with the assistance of a certified Navini service technician.

Ethernet Configuration

The Ethernet configuration is grouped into three sections: general, EMS, and traffic path. An example of the Ethernet configuration parameters is shown in Exhibit 2.

Exhibit 2: Ethernet Configuration

```
[Navini Boot]: p
date and time      : 01/09/2003[10:19] MM/dd/yyyy[hh:mm]
autoboot countdown : delayed [quick|delayed]
ems inet           : 172.16.0.10
snmp community     : public
traffic path       : enet [enet|atm]
mac address        : 00:04:6a:00:01:20
ip on enet (active) : 172.16.23.181
ip on enet (standby) : 172.16.23.182
netmask on enet    : 255.255.0.0
ip on backplane    : 10.0.0.1
gateway on enet    : 172.16.0.100
```

General

The general section offers you the ability to change the date and time manually. If a GPS has been installed, the BTS will automatically set the date and time:

date and time : 08/21/2002[13:21] MM/dd/yyyy[hh:mm]

When this line is displayed, the current date (08/21/2002) and time [13:21] are displayed. Accept the defaults by pressing the Enter key, or enter “date” at the console and a new value using the format indicated in military time (Hours 1-24). All 5 fields must be entered as specified. Leading zeroes can be omitted.

Previously, it was mentioned that the 20-second auto-boot countdown timer can be disabled and a 1 second countdown can be used instead. To enable this feature, change the autoboot countdown item from “delayed” (which is 20 seconds) to “quick”, which is 1 second:

autoboot countdown : delayed [quick|delayed]

EMS

This section concerns the configuration of the EMS Server itself. First, the Internet (inet) IP address of the Server is specified. Make sure to fill this field with the address of the Server used to configure this BTS. Your BTS is shipped with this field un-initialized. You must provide a valid 4-digit IP address before you can proceed. For example:

ems inet : 172.16.0.10

The second parameter that you must specify to allow the EMS Server to recognize this BTS is a community string for the EMS's Simple Network Management Protocol (SNMP) interface. The default community string shipped with the BTS is "public". Press the Enter key to accept this default, or type in a new value and press the Enter key to alter it:

snmp community : public

Traffic Path

The last major block of configurations required for an Ethernet backhaul to the BTS is the traffic path parameters. The first prompt instructs the BTS to use the Ethernet as the WAN (backhaul) configuration. It must be set to "enet" for an Ethernet backhaul.

If "atm" is selected, proceed with the description in the ATM or IMA sections. The BTS is pre-configured to use Ethernet for the WAN connection. Press the Enter key to accept this default:

traffic path : enet [enet|atm]

The BTS address is specified next. Every BTS must be uniquely addressed and have values that equate in the EMS configurations. This address information defines the Layer 2 parameters first, and then it defines the Layer 3 parameters. For Layer 2, you are only given an opportunity to see the Ethernet Media Access Control (MAC) address used by this BTS. This is a unique number programmed in the BTS. You cannot alter it. However, situations may develop in which you need to know the MAC address and, therefore, need to display the information. For example:

mac address : 00:04:6a:00:01:20

Next are the IP addresses that represent this BTS: one for the active CC card and one for the standby CC card. The active Controller card is always addressed using an odd-numbered IP address, i.e., 172.16.23.181. The standby Controller card uses the corresponding even-numbered IP address one digit higher, i.e., 172.16.23.182.

ip on enet (active) : 172.16.23.181
ip on enet (standby) : 172.16.23.182

For this reason, the BTS only allows you to enter odd addresses in the range XXX.XXX.XXX.1 to XXX.XXX.XXX.253 in this field. The standby field is only displayed for your convenience and cannot be altered. Note that the BTS automatically handles switching the address when a failure occurs on an active Controller card, requiring the standby Controller to go into service. However, the MAC addresses remain fixed.

Coupled with any IP configuration is a need to specify the corresponding subnet mask. Refer to common network administration literature for guides on addresses, networks, masks, and gateways. In short, the subnet mask identifies the portion of the IP address that is common to those devices connected to the same Ethernet. The most important “other” device is the BTS’s default gateway (specified later).

The portion is identified using a logical “and” of the mask with the address. For example, a subnet mask of 255.255.0.0. and with an IP address of 172.16.23.182 yields a network of 172.16.x.x. In this case, the default gateway must also be on the 172.16.x.x network. The BTS requires that this association be met. If not, you will be asked to try again.

netmask on enet : 255.255.0.0

The BTS uses a high-speed Serial Line Internet Protocol (SLIP) connection to communicate with the redundant T1/Controller Card. This interface is only used internally and has a fixed subnet mask of 255.255.255.252.

The host portion of the address - that is the least significant 2 bits - is automatically provided by the software based upon slot ID. However, you may want to alter the default network address to avoid conflict with your network.

The BTS is shipped with the 10.0.0.0 network as the internal network. This is a reserved network not used on the Internet. However, if your private network utilizes this private address space, you may need to change it to avoid the conflict.

ip on backplane : 10.0.0.1

As for the default gateway for the BTS, all traffic routed outside the directly connected Ethernet port goes through the gateway. Furthermore, the gateway must be reachable on the directly connected Ethernet port. Therefore, the BTS will prevent you from entering a default gateway address that fails the logical “and” test discussed previously. This address is specified on the line item shown below:

gateway on enet : 172.16.0.100

ATM/T1 Configuration

For an ATM/T1 configuration, the items shown in Exhibit 3 are identical to Ethernet with the exception of the traffic path, which must show “atm” for this type of configuration.

Exhibit 3: ATM/T1 Configuration

```
date and time          : 01/09/2003[10:22]
autoboot countdown     : delayed
ems inet               : 172.16.0.10
snmp community         : public
traffic path           : atm
mac address            : 00:04:6a:00:01:20
ip on atm (active)     : 172.16.23.181
ip on atm (standby)    : 172.16.23.182
netmask on atm         : 255.255.0.0
```

When ATM is selected for the WAN interface using the traffic mode parameter, an additional set of parameters is required (Exhibit 6). First of all, another IP address must be identified for the ATM interface. The ATM IP address cannot be the same as the Ethernet IP address. In this case, the Ethernet IP address is only used for debug purposes and is a non-routed interface. This means that the BTS can only reach other computers directly connected to the Ethernet port of the BTS.

The only routed interface available is through the ATM port. This routed interface address is specified with the “ip on atm” line item and the corresponding netmask parameter (Exhibit 4). The information on network address specifications from the Ethernet Configuration section of this chapter applies to ATM as well. For ATM, the only gateway allowed for the BTS is on the ATM interface, as specified here.

Exhibit 4: Additional ATM Parameters

```
ip on atm (active)     : 172.17.0.101
ip on atm (standby)    : 172.17.0.102
netmask on atm         : 255.255.0.0
ip on backplane        : 10.0.0.1
gateway on atm         : 172.17.0.100
```

For an ATM system, the BTS must have some additional configuration for the Management Private Virtual Channel (Management PVC). Recall the boot parameter philosophy discussed before. The boot parameters only identify those settings required to allow the BTS to reach the EMS. Note that the boot parameters only allow specification for one PVC (the Management PVC), which is used to reach the EMS.

All user traffic PVC parameters are specified in the EMS configuration. Ensure that the EMS parameters for the Management PVC match those being set here through the boot prompt. If not, as soon as connection is made with the EMS, the Management PVC will be reconfigured and can potentially disconnect the BTS from the network.

The PVC configuration is broken into 3 sections: ATM layer parameters; optional Inverse Multiplexing over ATM (IMA) parameters, and T1 physical layer parameters. The first item selects which ATM interface will be used for the Management PVC. If IMA is not selected, you may select from one of the 8 T1 ports numbered 1-8 using the option t1-N, where N is the port number. This is the same interface port number specified in the EMS. If IMA is desired, reference the following section:

pvc type-atm i/f : t1-0 [t1-(1-8)|ima-(1-2)]

The circuit identifier for this segment of the Management PVC is the next item specified. The first parameter identifies the maximum number of bits for any PVC's identifier Virtual Path Identifier/ Virtual Channel Identifier (VPI/VCI) pair. The BTS restricts the available set to 13 total bits. However, you are free to divide those 13 bits between the VPI and VCI as needed, with the VPI having a maximum allocation of 8 bits. You can choose the number of bits for each by selecting two values separated by a ":". Or you may select the BTS default of 3 VPI bits and 10 VCI bits by pressing the Enter key:

pvc id size vpi:vci : 3:10 [1-8:1-13]

Having specified the number of significant VPI and VCI bits, now select the actual identifier. The BTS will restrict the values entered for the VPI and VCI to the ranges you selected in the previous size specification. For instance, if 3:10 is selected as a size allocation, the VPI must be between 0 and 7.

Again, you can select the values for the VPI and VCI separated by a ":" or accept the default value of VPI = 1 and VCI = 100 by pressing the Enter key. Be careful not to use the reserved VCI values from 0-15 that are often used in ATM networks for Operation, Administration, and Maintenance (OAM) purposes.

pvc vpi:vci : 1:100 [0-255:16-8192]

The service category for the Management PVC is specified next. The choices are Unspecified Bit Rate (UBR) or Constant Bit Rate (CBR). Other ATM service categories are available for traffic PVC's, but those are specified in the EMS configuration. UBR and CBR both require a set data rate and delay variation parameter. The data rate is specified in cells per second in the ATM Traffic Contract's Peak Cell Rate (PCR) field. The delay variation is in the ATM Cell Delay Variation Tolerance (CDVT) in the ATC's CDVT field. Specify the PCR and the CDVT values separated by a ":" or chose the default by pressing the Enter key.

**pvc service category : ubr [cbr|ubr]
pvc atc pcr:cdvt : 3641:100 [1-3641:0-100]**

The final set of values is used to configure the T1 parameters. The line type allows you to select Extended Super-Frame (ESF) or D4. ESF format is the standard format for ATM/T1 applications. D4 format is supported as an alternate; however, T1 signaling capabilities may be limited. Check your network plans for a definition for your specific application.

line type : esf [esf|d4]

Additionally, you must choose a line coding type:

line coding : b8zs [b8zs|ami]

The approximate length of the T1 line is specified next. It is used to control the signal conditioning used on the T1:

line length (ft) : 500

Finally, the T1's timing source must be specified. A T1 uses only one timing source either at the near-end or far-end of the line. You may select the BTS as the originator of the timing source by selecting "local", or you may select the far-end as the timing reference by selecting "loop".

line clock source : loop [loop|local]

IMA Configuration

If you decide to utilize IMA groups to pool the T1 resources, then the same parameters described for the ATM/T1 Configuration above also apply to configuring IMA's. Refer to Exhibit 5.

Exhibit 5: IMA Configuration

```
date and time      : 08/21/2001[10:22]
ems inet           : 172.16.0.10
snmp community     : public
traffic path       : atm
mac address        : 00:04:6a:00:01:20
ip on enet (active) : 172.16.23.181
ip on enet (standby) : 172.16.23.182
netmask on enet    : 255.255.0.0
ip on atm (active)  : 172.17.0.101
ip on atm (standby) : 172.17.0.102
netmask on atm     : 255.255.0.0
ip on backplane    : 10.0.0.1
gateway on atm     : 172.17.0.100
```

In addition, the ATM interface must be specified as IMA and reference one of two IMA groups used for the Management PVC. This IMA group must match what is identified in the EMS. Use "0" for the first group and "1" for the second group.

Each group identifies a set of T1 ports that are being combined to form one larger virtual port. For the sake of boot parameter specification, ALL T1 interfaces for the Management PVC's IMA group are assumed to be identical. So the parameters for T1 specifications apply to all T1's of the IMA group:

pvc type-atm i/f : ima-0

Once the IMA interface is selected, a set of IMA parameters must be specified for the IMA group used by the Management PVC. An IMA group inherently supports dynamic addition and drops of individual T1 facilities from the group to facilitate fault tolerance to failed T1 facilities.

The minimum number of T1 ports, or links, that must exist for the IMA group to function is specified here. A value from 1-7 is required for each of the receive and transmit directions. Separate the values with ":". You can increase the values from the default of 1 link in each direction or accept the default by pressing the Enter key.

ima min rx:tx links : 1:1 [1-7:1-7]

Next, specify which T1 ports are used to form the IMA group. This is a list of T1 port identifiers (1-8), each separated by commas. The BTS makes sure you enter at least as many links as you specified for the minimum requirements above:

selected ima links : 1,2,3,4,5,6,7,8

The near- and far-end IMA protocols use an ID number to identify each other. This value must agree with that provisioned at the far-end of the IMA link. The BTS defaults to a value of 0, but you can specify any value from 0 to 255:

ima group id : 0 [0-255]

Group symmetry modes allow symmetric or asymmetric operation of IMA links:

ima symmetry : sym [sym|asym|asym-cfg]

IMA frame length specifies the size of the IMA frames that are being transmitted:

ima frame length : 128 [32|64|128]

The IMA alpha/beta/gamma parameters are used by the IMA frame synchronization mechanism.:

ima alpha:beta:gamma : 2:2:1 [1-2:1-5:1-5]

The IMA clock mode selects either a common or independent IMA clock mode (Exhibit 6). It is the same as for ATM/T1.

Exhibit 6: IMA Clock Mode

```

ima clock mode      : ctc [ctc|itc]
pvc id size vpi:vci : 3:10
pvc vpi:vci        : 1:100
pvc service category : ubr
pvc atc pcr:cdvt    : 3641:100
line type          : esf
line coding         : b8zs
line length (ft)    : 500
line clock source   : loop

```

Standard Boot Sequence

The first items in Exhibit 7 (Ethernet) and Exhibit 8 (ATM) illustrate the BOOTROM loading and launching of the core application. This is a fixed process that cannot be altered in the field.

Auto-booting is the process that can be escaped by user intervention, (i.e., enter “config”), in order to enter the boot prompt. Without user intervention, the remaining sequence occurs automatically; hence, “auto-boot”.

Exhibit 7: Standard Ethernet Boot Sequence - Example

System Boot

```

Copyright 2000-2001 Navini Networks, Inc.
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```

```

CPU: CC (PPC860P)
Kernel Version: 5.4
BSP version: 1.0/110501
Creation date: Nov  5 2001, 13:09:12

```

```

Attaching to TFFS... done.
Loading /tffs0/LOADS/BTSA/core...5249740
Starting at 0x10000...

```

```

Auto-booting.....Done
Starting File System.....Done
Mounting Drive /tffs0.....Done
Mounting Drive /dev0.....Done
Mounting Drive /dev1.....Done
Starting TCP/IP Stack.....Done
Starting ARP.....Done
Starting motfec I/f.....Done
Attaching sl(0) I/f.....Done
Attaching motfec(0) I/f.....Done
Attaching lo(0) I/f.....Done
Mounting Remote Filesystem.....Done
Starting Telnet Daemon.....Done
Starting Load Monitoring Tools.....Done
Loading Target Shell Symbols.....Done
Starting WDB Tools.....Done
Starting Target Shell.....Done
Initializing System Logger.....Done
Starting Application.....Done
Starting LLC I/f.....Done
Starting LLC Proxy.....Done
Starting Lpbk Proxy.....Done

```

```

Starting CDI.....Done
Starting CAM I/f.....Done
Starting MME.....Done
Starting EtherBridge.....Done
Starting DHCP Relay Agent.....Done
Starting Peer ARP Proxy Agent.....Done
Starting Host ARP Proxy Agent.....Done
Starting Mobile IP Proxy Agent.....Done
Starting LLC Proxy.....Done
Selecting Config Data Source as EMS .....Done
Loading LLC.....Done
Initializing NvRam Mib .....Done
Initializing SNMP Agent .....Done
Pinging EMS (172.28.79.30).....Done
Loading MTMG.....Done
Loading MDSW.....Done
Loading MBSW.....Done
Loading CAP.....Done
Loading AUX_.....Done
Loading LLC.....Done
Loading MTMG.....Done
Loading MDSW.....Done
Loading MBSW.....Done
Loading CAP.....Done
Loading BAUX.....Done
Loading BMCB.....Done
Loading MACA.....Done
Loading MACB.....Done
Loading CHAD.....Done
Loading CHTT.....Done
Loading CDSW.....Done
Loading BDSC.....Done
Loading CHSL.....Done
Loading CHMA.....Done
Loading AUX_.....Done
Loading LLC.....Done
Stopping LLC Proxy.....Done
Evaluating bootload status.....Done
Initializing DSP(s).....Done
Starting LLC Proxy.....Done
Starting LLC Proxy.....Done
Updating Slot Table.....Done
Requesting EMS for Configuration Data ...Done
Configuring BTS from EMS .....Done
Starting LLC Proxy.....Done
Configuring Diag Feature(s).....Done

```

!!!!!!! BTS Initialization Complete !!!!!!!!

```

              Z   (TM)
            NNNN   ZZZ
          NNNNNN  ZZZZZ
        NNNNNNNN  ZZZZZZ
      NNNNNNNNNN  ZZZZZZ
    NNNNNNNNNNNN  ZZZZZZ
  NNNNNN  NNNNNN  ZZZZZZ
NNNNNN  Z  NNNNNN  ZZZZZZZZZ
NNNNNN  ZZZ  NNNNNN  ZZZZZZZZZ
NNNNNN  ZZZZZ  NNNNNN  ZZZZZZZ
NNNNNNN  ZZZZZZ  NNNNN  ZZZZZZ
NNNNNNNNN  ZZZZZZ  NNN  ZZZZZZ
NNNNNNNNNN  ZZZZZZ  N  ZZZZZZ
NN  NNNNNN  ZZZZZZ  ZZZZZZ
NNNNNN  ZZZZZZ  ZZZZZZ
NNNNNN  ZZZZZZZZZZZ
NNNNNN  ZZZZZZZZZZZ
NNNNNN  ZZZZZZZZZ
NNNNN  ZZZZZZ
NNN  ZZZZ
N

```

N N i i
 NN N
 N N N aaa v v i n n n i
 N N N a v v i n n n i
 N N N aaaa v v i n n i
 N NN a a v v i n n i
 N N aaaa v i n n i

N E T W O R K S (TM)

Internet at the Speed of Thought (TM)

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```
        KERNEL : 5.4(WIND version 2.5)
        BSP    : 1.0/01.19.00.00
        CPU: CC (PPC860P).  Processor #0.
        Memory Size: 0x3f80000.
        WDB: Ready.
```

Last reset caused by a power on condition.
Current time is FRI JUL 12 14:48:29 2002

bts-4 [Active]%

Exhibit 8: Standard ATM Boot Sequence - Example

System Boot

Copyright 2000-2001 Navini Networks, Inc.
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CPU: CC (PPC860P)
Kernel Version: 5.4
BSP version: 1.0/110501
Creation date: Nov 5 2001, 13:09:12

Attaching to TFFS... done.
Loading /tffs0/LOADS/BTSB/core...5249740
Starting at 0x10000...

```
Auto-booting.....Done
Starting File System.....Done
Mounting Drive /tffs0.....Done
Mounting Drive /dev0.....Done
Mounting Drive /dev1.....Done
Starting TCP/IP Stack.....Done
Starting ARP.....Done
Starting motfec I/f.....Done
Starting wec I/f.....Done
Attaching wec(0) I/f.....Done
Attaching sl(0) I/f.....Done
Attaching motfec(0) I/f.....Done
Attaching lo(0) I/f.....Done
Mounting Remote Filesystem.....Done
Starting Telnet Daemon.....Done
Starting Load Monitoring Tools.....Done
Loading Target Shell Symbols.....Done
Starting WDB Tools.....Done
Starting Target Shell.....Done
Initializing System Logger.....Done
Starting Application.....Done
Starting LLC I/f.....Done
Starting LLC Proxy.....Done
Starting Lpbk Proxy.....Done
Starting CDI.....Done
Include CME Starting T1 I/f.....Done
Starting CAM I/f.....Done
Starting MME.....Done
Starting EtherBridge.....Done
Starting DHCP Relay Agent.....Done
Starting Peer ARP Proxy Agent.....Done
Starting Host ARP Proxy Agent.....Done
Starting Mobile IP Proxy Agent.....Done
Starting PCI Bridge.....Done
Starting Network Processor.....Done
Starting LLC Proxy.....Done
Loading LLC.....Done
Selecting Config Data Source as EMS .....Done
Initializing NvRam Mib .....Done
Booting Network Processor .....Done
Configuring T1(s).....Done
Configuring ATM Interface.....Done
```

```

Configuring IMA Group.....Done
Configuring IMA Link.....Done
Configuring PVC(s).....Done
Configuring Management PVC.....Done
Initializing SNMP Agent .....Done
Pinging EMS (172.28.79.30).....Done
Loading MTMG.....Done
Loading MDSW.....Done
Loading MBSW.....Done
Loading CAP.....Done
Loading AUX.....Done
Loading LLC.....Done
Loading MTMG.....Done
Loading MDSW.....Done
Loading MBSW.....Done
Loading CAP.....Done
Loading BAUX.....Done
Loading BMCB.....Done
Loading MACA.....Done
Loading MACB.....Done
Loading CHAD.....Done
Loading CHTT.....Done
Loading CDSW.....Done
Loading BDSC.....Done
Loading CHSL.....Done
Loading CHMA.....Done
Loading AUX.....Done
Loading LLC.....Done
Stopping LLC Proxy.....Done
Evaluating bootload status.....Done
Initializing DSP(s).....Done
Starting LLC Proxy.....Done
Starting LLC Proxy.....Done
Updating Slot Table.....Done
Requesting EMS for Configuration Data ...Done
Configuring BTS from EMS .....Done
Starting LLC Proxy.....Done
Starting AtmMgmt.....Done
Configuring Diag Feature(s).....Done

```

!!!!!!! BTS Initialization Complete !!!!!!!!

```

          Z   (TM)
      NNNN   ZZZ
    NNNNNN  ZZZZZ
  NNNNNNNN ZZZZZZ
NNNNNNNNNN ZZZZZZ
NNNNNNNNNN ZZZZZZ
NNNNNNN NNNNNN ZZZZZZ
NNNNNNN NNNNNN ZZZZZZ ZZ
NNNNNNN Z NNNNNN ZZZZZZZZZ
NNNNNNN ZZZ NNNNNN ZZZZZZZZZ
NNNNNNN ZZZZZ NNNNNN ZZZZZZ
NNNNNNNNN ZZZZZZ NNN ZZZZZZ
NNNNNNNNNN ZZZZZZ N ZZZZZZ
NN NNNNNN ZZZZZZ ZZZZZZ
NNNNNNN ZZZZZZ ZZZZZZ
NNNNNNN ZZZZZZZZZ
NNNNNNN ZZZZZZZZZ
NNNNN ZZZZZZZ
NNN ZZZZZ
N

```

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 Copyright (c) RSA Data Security, Inc. 1991-1992
 Copyright (c) SNMP Research, Inc. 1989-1999
 Copyright (c) Texas Instruments, Inc. 2000-2001
 Copyright (c) Wind River Systems, Inc. 1984-2000
 KERNEL : 5.4(WIND version 2.5)
 BSP : 1.0/01.19.00.00
 CPU: CC (PPC860P). Processor #0.
 Memory Size: 0x3f80000.
 WDB: Ready.

```

N   N           i   i
NN  N
N N  N   aaa v   v i n nn i
N N N   a v   v i nn n i
N   N N   aaaa v   v i n n i
N   NN a   a v v i n n i
N   N   aaaa v   i n n i

```

NETWORKS (TM)

Internet at the Speed of Thought (TM)

```
Last reset caused by a power on condition.  
Current time is FRI JUL 12 14:26:59 2002
```

```
bts-4 [Active]%
```

```
Attaching to TFFS... done.  
Loading /tffs0/LOADS/BTSB/core... 4337576  
Starting at 0x10000...
```

```
Auto-booting.....Done
```

The line items in Exhibit 9 are the ones that create and initialize the core components to the BTS's on-board file system. This file system is used to store operating code images, configuration data, and log files. The BTS Operating System software handles the images, data, and files and does not require operator assistance.

There are three on-board file systems' FLASH and RAM drives. The FLASH drive is at /tffs0 and the two RAM drives use /dev0 and /dev1. All on-board file system drives have dedicated functions and should not be altered or used through manual operations.

Exhibit 9: On-board File Systems

```
Starting File System.....Done  
Mounting Drive /tffs0.....Done  
Mounting Drive /dev0.....Done  
Mounting Drive /dev1.....Done
```

The sequence shown in Exhibit 10 initializes the TCP/IP stack on the BTS. The TCP, UDP, IP, and ARP protocol stacks are created. Interfaces for the stack are then created and attached to the stack. Three or four interfaces are created depending on the selection for "traffic path" in the boot parameters.

The Fast Ethernet Controller, fec (0), is created and attached for the 10/100 Ethernet ports on the BTS. If "atm" is selected, then a WAN Ethernet Controller, WEC (0), is also created and attached to the stack to perform RFC1483 Ethernet bridging onto the ATM interface. Internally, the BTS utilizes a high-speed SLIP interface, sl (0), to provide communication between redundant devices. Finally, a debug local loopback interface, lo (0), is created and attached.

Exhibit 10: TCP/IP Stack

```
Starting TCP/IP Stack.....Done  
Starting ARP.....Done  
Starting fec I/f.....Done  
Starting wec I/f.....Done  
Attaching wec(0) I/f.....Done  
Attaching sl(0) I/f.....Done  
Attaching fec(0) I/f.....Done  
Attaching lo(0) I/f.....Done
```

Next, the user interface through the console port on the BTS is activated. It should be noted however, that once the Telnet Daemon has been started, this same interface is available remotely through a password protected telnet session. You can access the remote shell service by telnetting directly to the well-known Telnet port (23) of the BTS:

Starting Telnet Daemon.....Done

This invokes a suite of tools accessible by the Navini developers to assess runtime loads of various components in the system:

Starting Load Monitoring Tools.....Done

This creates a database of commands that can be issued from the shell:

Loading Target Shell Symbols.....Done

This in turn invokes a suite of tools accessible by the Navini software developers to access runtime debugging of the system:

Starting WDB Tools.....Done

This starts the actual interface for the console command interface:

Starting Target Shell.....Done

The BTS is equipped with a rich suite of logs that are automatically collected for analysis by Navini developers in the unlikely event a crash occurs. This line item invokes the automatic log collection:

Initializing System Logger.....Done

The core software is separated into operating system initialization and Ripwave application software that provides OAM and bridging functionality. This line item identifies the transition point from OS initialization to the point where the OS begins spawning application level tasks:

Starting Application.....Done

The next task provides an interface to the Logical Link Control (LLC) on the MDM card and forms a conduit for all message and user traffic from the CC to MDM card.

Starting LLC I/f.....Done

A Command and Debug Interface is initialized to extend rudimentary target shell capabilities for Navini developers to diagnose problems with the Digital Signal Processors on the MDM and CHP cards:

Starting CDI.....Done

The Content Addressable Memory (CAM) is used to provide mappings of users to channels. This mapping interface is started at this point:

Starting CAM I/f.....Done

The management entity for CPE mobility, nomadicity, and access control security is handled by the MME application that is started at this point:

Starting MME.....Done

The protocol bridging performed by the BTS for user traffic is handled by the EtherBridge component. Depending on the traffic mode selected, the EtherBridge will perform varying protocol encapsulation methods, such as RFC1483 bridging over ATM. The bridge is started at this point:

Starting EtherBridge.....Done

Network layer protocol security and mobility applications are handled by specialized protocol handler components. Various modes of operation are configurable through the EMS and provide such services as DHCP address learning and authentication assistance via the DHCP Relay Agent, Proxy ARP broadcast security, and network layer mobility support. These components are started at this point:

Starting DHCP Relay Agent.....Done

Starting Peer ARP Proxy Agent.....Done

Starting Host ARP Proxy Agent.....Done

Starting Mobile IP Proxy Agent.....Done

An LLC Proxy is an object that provides relay service via the LLC IF conduit to the MDM card. Objects on the CC card can communicate with an object on the MDM card directly using such a proxy. Several such proxied objects exist and are created with this message:

Starting LLC Proxy.....Done

As the CC card downloads and initializes the DSP's on the MDM and CHP cards, each component is identified with a "Loading" message:

Loading LLC.....Done

The next item that appears notifies the user of the location where the BTS is retrieving its Management Information Base (MIB). After initial installation and provisioning through the boot line, “EMS” is selected as the Config Data Source. In this case, all remaining parameters are downloaded from the EMS.

Once the BTS and EMS have synchronized and ownership of individual elements in the MIB negotiated, subsequent reboots of the BTS will indicate the local “BTS” copy of the MIB is being used. This reduces the burden and start-up time of a system-wide restart:

Selecting Config Data Source as BTSDone

Once the MIB information is identified, the SNMP agent is initialized. At this point, the EMS can begin communicating with the BTS via this agent:

Initializing SNMP AgentDone

The BTS tests that a path through the WAN exists to its EMS Server. That test is identified next in the sequence. If the EMS is selected as the Config Data Source, the initialization cannot continue. If the “BTS” is selected as the data source, the BTS can continue to initialize. However, it will be unmanaged, as the EMS cannot communicate with the BTS.

Pinging EMS (172.16.0.10).....Done

A status message appears indicating that all DSP’s have been downloaded and are now beginning the initialization process:

Bootload is a success.....Done

Initialization can take a significant period of time, with progress through the DSP initialization shown by a growing string of “.” on this line. Initialization is complete with “Done” on this line, and the configuration data is passed to the application entities on each device:

Initializing DSP(s).....Done

Configuring LLC Bandwidth Management.....Done

Configuring MAC Carrier Data.....Done

Configuring MAC Bandwidth Management.....Done

Configuring Layer 1.....Done

Configuring CPE Descriptor TableDone

The final step in the BTS initialization is to start up the GPS subsystem. With the GPS, the BTS will remain time synchronized with the other BTS’s in the network:

Configuring GPS.....Done

The BTS is now provisioned with minimal data. This is enough data to be able to calibrate and test the BTS. Power cycle the BTS for the changes to take place. An example of a reboot is shown in Exhibit 11.

Exhibit 11: BTS Reboot - Example

```
!!!! Shutdown Started. Terminating all interfaces!!!!
Stopping Ime.....Done
Stopping Cme.....Done
Stopping EtherBridge.....Done
Stopping CAM I/f.....Done
Stopping Lpbk Proxy.....Done
Stopping LLC Proxy.....Done
Stopping LLC I/f.....Done
!!!!!!!!!!!! Shutdown Completed. Rebooting !!!!!!!!!!!!!
```

```
.
Attaching to TFFS... done.
Loading /tffs0/LOADS/btsb/core...5569208
Starting at 0x10000...
```

```
Auto-booting.....Done
Starting File System.....Done
Mounting Drive /tffs0.....Done
Mounting Drive /dev0.....Done
Mounting Drive /dev1.....Done
Starting TCP/IP Stack.....Done
Starting ARP.....Done
Starting motfec I/f.....Done
Attaching sl(0) I/f.....Done
Attaching motfec(0) I/f.....Done
Attaching lo(0) I/f.....Done
Mounting Remote Filesystem.....Done
Starting Telnet Daemon.....Done
Starting Load Monitoring Tools.....Done
Loading Target Shell Symbols.....Done
Starting WDB Tools.....Done
Starting Target Shell.....Done
Initializing System Logger.....Done
Starting Application.....Done
Starting LLC I/f.....Done
Starting LLC Proxy.....Done
Starting Lpbk Proxy.....Done
Starting CDI.....Done
Starting CAM I/f.....Done
Starting MME.....Done
Starting EtherBridge.....Done
Starting ARP Conflict Detection.....Done
Starting DHCP Relay Agent.....Done
Starting Peer ARP Proxy Agent.....Done
Starting Host ARP Proxy Agent.....Done
Starting Mobile IP Proxy Agent.....Done
Starting LLC Proxy.....Done
Selecting Config Data Source as BTS .....Done
Initializing SNMP Agent .....Done
Loading BLLC.....Done
Pinging EMS (172.16.100.9).....Done
Loading MTMG.....Done
Loading MDSW.....Done
Loading MBSW.....Done
Loading CAP.....Done
Loading AUX_.....Done
Loading BLLC.....Done
Loading MTMG.....Done
Loading MDSW.....Done
Loading MBSW.....Done
```

```

Loading CAP.....Done
Loading BAUX.....Done
Loading BMCB.....Done
Loading MACA.....Done
Loading MACB.....Done
Loading CHAD.....Done
Loading CHTT.....Done
Loading CDSW.....Done
Loading BDSC.....Done
Loading CHSL.....Done
Loading CHMA.....Done
Loading AUX_.....Done
Loading LLC.....Done
Stopping LLC Proxy.....Done
Evaluating bootload status.....Done
Initializing DSP(s).....Done
Starting LLC Proxy.....Done
Starting LLC Proxy.....Done
Updating Slot Table.....Done
Configuring LLC Bandwidth Management.....Done
Configuring MAC Carrier Data.....Done
Configuring MAC Bandwidth Management.....Done
Configuring Layer 1.....Done
Configuring CPE Descriptor Table .....Done
Starting LLC Proxy.....Done
Configuring Diag Feature(s).....Done
Configuring GPS.....Done

```

!!!!!!! BTS Initialization Complete !!!!!!!!

```

              Z   (TM)
      NNNN      ZZZ
      NNNNNN   ZZZZZ
      NNNNNNNN ZZZZZZ
      NNNNNNNNN ZZZZZZ
      NNNNNNNNNNN ZZZZZZ
      NNNNNN  NNNNNN  ZZZZZZ
      NNNNNN  NNNNNN  ZZZZZZ  ZZ
      NNNNNN  Z  NNNNNN  ZZZZZZZZZZ
      NNNNNN  ZZZ  NNNNNN  ZZZZZZZZZZ
      NNNNNN  ZZZZZ  NNNNNN  ZZZZZZZ
      NNNNNNNN  ZZZZZZ  NNNNN  ZZZZZZ
      NNNNNNNNN  ZZZZZZ  NNN  ZZZZZZ
      NNNNNNNNNN  ZZZZZZ  N  ZZZZZZ
      NN  NNNNNN  ZZZZZZ  ZZZZZZ
      NNNNNN  ZZZZZZ  ZZZZZZ  Copyright(c)Navini Networks,Inc.2000-2002
      NNNNNN  ZZZZZZZZZZZZ  Copyright(c)Conexant,Inc. 2000-2001
      NNNNNN  ZZZZZZZZZZZZ  Copyright(c)Free Sw Foundation,Inc.1988-1999
      NNNNNN  ZZZZZZZZZZ  Copyright(c)NComm, Inc.1997-2001
      NNNN  ZZZZZZ  Copyright(c)RSA Data Security,Inc.1991-1992
      NNN  ZZZZ  Copyright(c)SNMP Research,Inc.1989-1999
      N  ZZ  Copyright(c)Texas Instruments,Inc.2000-2001
              Copyright(c)Wind River Systems,Inc.1984-2000
              KERNEL : 5.4(WIND version 2.5)
              BSP : 1.0/RW1.19.1.3
              CPU: CC (PPC860P). Processor #0.
              Memory Size: 0x3f80000.
              WDB: Ready.

```

Last reset caused by a user request from the console.
Current time is FRI JAN 10 14:38:36 2003

```

bts-120 [Active]% TimerHandler called for port /tty/2
--> 1/10/2003 14:38:38
Position fix: latitude: 32:58:42, longitude: -96:42:4, height: 188.78

```

Calibrate the Base Station

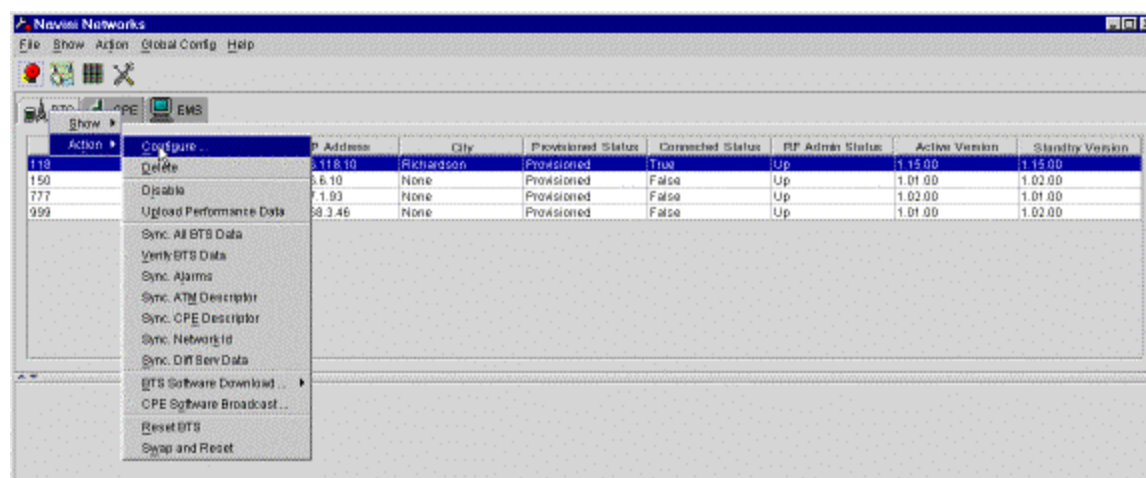
Calibrating the Base Station detects the phase differential between the antennas and matches the output power across all antennas in the RFS. The calibration procedure must be performed at least **three times** to ensure validity. Ensure that the BTS has been powered on **with the power amplifiers on for at least fifteen minutes** to allow them time to warm up and stabilize.

Calibration Procedure

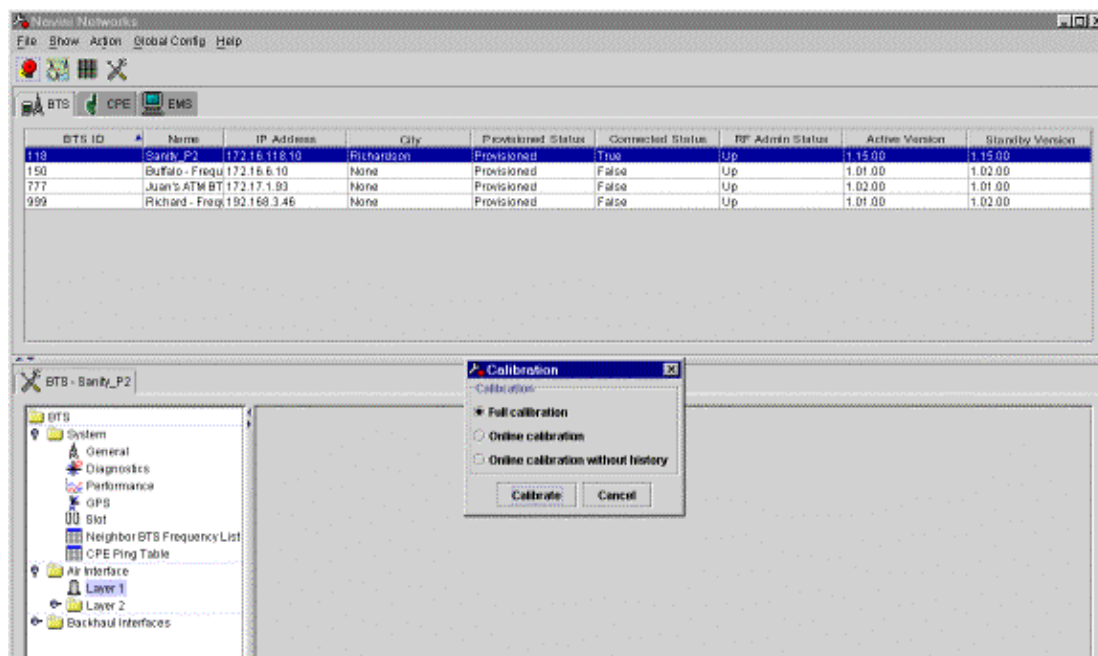
To calibrate the BTS, follow the steps in the procedure below. Refer to the *Ripwave Configuration Guide*, as needed.

- Step 1.** On the Test EMS, click on the Server icon to start the EMS Server.
- Step 2.** Click on the EMS Configuration icon to start the EMS Client GUI.
- Step 3.** At the EMS Configuration & Alarm Manager login screen, enter the user name and password. The defaults are **emsAdmin / emsAdmin**.
- Step 4.** Verify that Antenna Power, RX Sensitivity, and Cal Cable Loss values are entered in the fields in the EMS. NOTE: The Power Splitter Loss was entered when you performed the RFS configuration earlier.
- Step 5.** Click on the BTS that is being installed to select it. Right-click on the highlighted BTS and select **Action > Configure**. Refer to Figure 47.

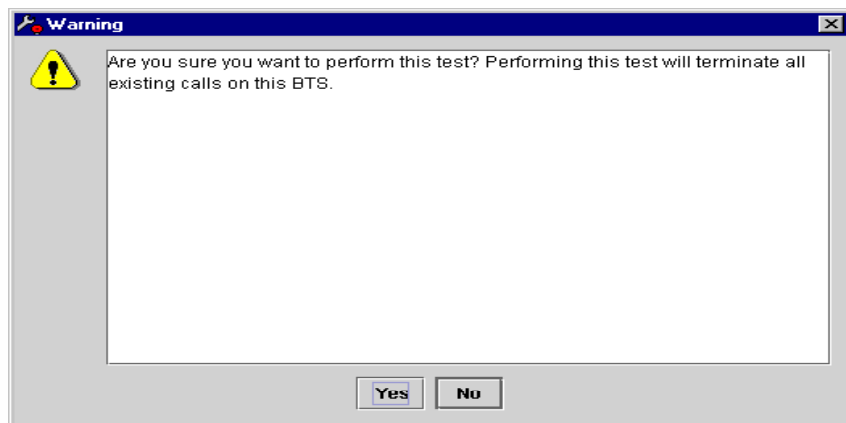
Figure 47: Select BTS



- Step 6.** Click on **Air Interface > Layer 1**, and then click **Calibrate**. In the resulting dialog box (Figure 48), select **FULL CALIBRATION** and **Calibrate**.

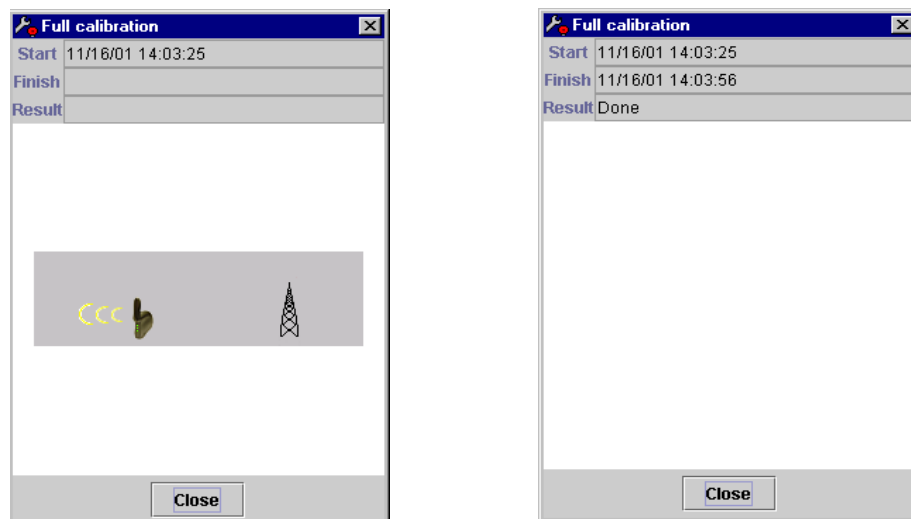
Figure 48: Calibrate BTS

Step 7. When the Warning window appears (Figure 49), click **Yes**.

Figure 49: Warning Window

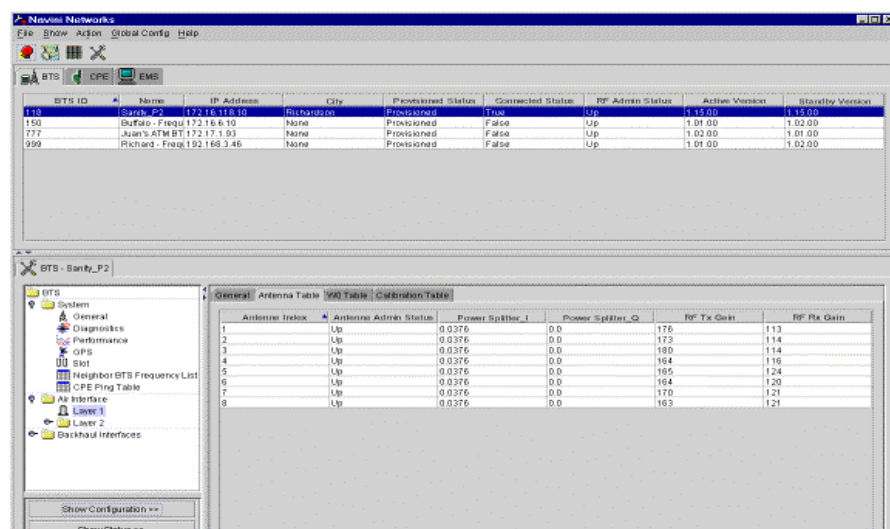
Step 8. The Full Calibration window appears during system calibration (Figure 50). When calibration is complete, the Full Calibration window changes and displays the finish time and the result. Click the **Close** button to close the Full Calibration window. Note that the result of “Done” does not mean that the system passed calibration.

Figure 50: Full Calibration Window



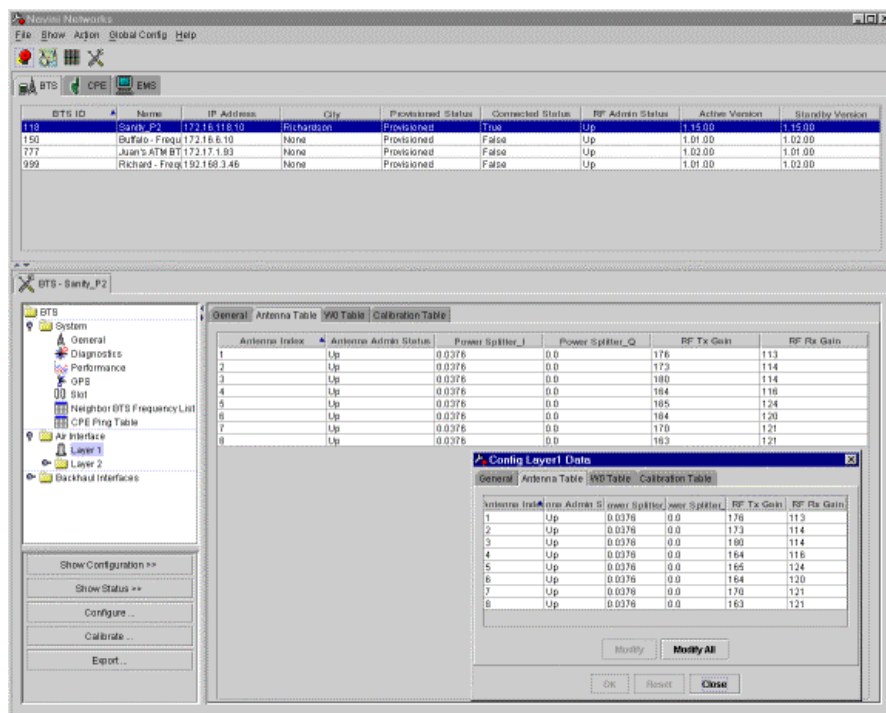
Step 9. Click **Show Configuration** and select the Antenna Table tab (Figure 51). Check the Tx Gain and Rx Gain columns (the last two columns in the table) for transmit and receive results. The transmit and receive results for all eight antennas must be between 1 and 254. The eight values in each column should be relatively close to each other. A value of zero indicates a problem with the associated antenna path.

Figure 51: Show Configuration/Antenna Table



Step 10. Perform the calibration function two more times. Ensure each time that the values remain relatively stable (± 3), and that none of the results is zero. After you perform the second calibration, click on **Configure**. The Config Layer 1 Data window (Figure 52) shows the data from the second calibration. The values in the main screen from the Show Config selection are from the first calibration. Compare the values from the two calibrations to ensure that they are stable, and not equal to zero.

Figure 52: Config Layer 1 Data Window



Step 11. Close the Config Layer 1 Data window. Update the main screen by clicking the Show Configuration button.

Verify the Calibration

Base Station Calibration Verification is a set of procedures to verify that the equipment has passed calibration and that the RF portion of the equipment is operating within acceptable parameters. The results of the tests should be documented in the Base Station Calibration Verification Form, P/N 40-00059-00. This form, along with instructions, may be found in [Appendix F](#).

Test Cable & Coupler Insertion Loss Measurement

This test measures the insertion loss of the test cable and coupler.

Equipment Required

- Signal generator - Agilent 8648C, or equivalent, tunable to the RFS center frequency
- Spectrum analyzer - Agilent E4402B, or equivalent
- Two cables – one will be a reference cable; the other will be a test cable
- RF coupler

Equipment Settings

Turn on the Signal Generator and the Spectrum Analyzer. Allow the equipment to warm up for 15 minutes.

Signal Generator:

- Output = Base Station center frequency
- Amplitude = Between -10 and +10 dBm

Spectrum Analyzer:

- Span = 20 MHz
- Resolution Bandwidth (RBW) = 100 KHz
- Video Bandwidth (VBW) = Auto
- Sweep Time = Auto
- Frequency = BTS center frequency

Test Cable Sweep Setup

Refer to Figures 53, 54, and 55 when performing the Test Cable procedure below.

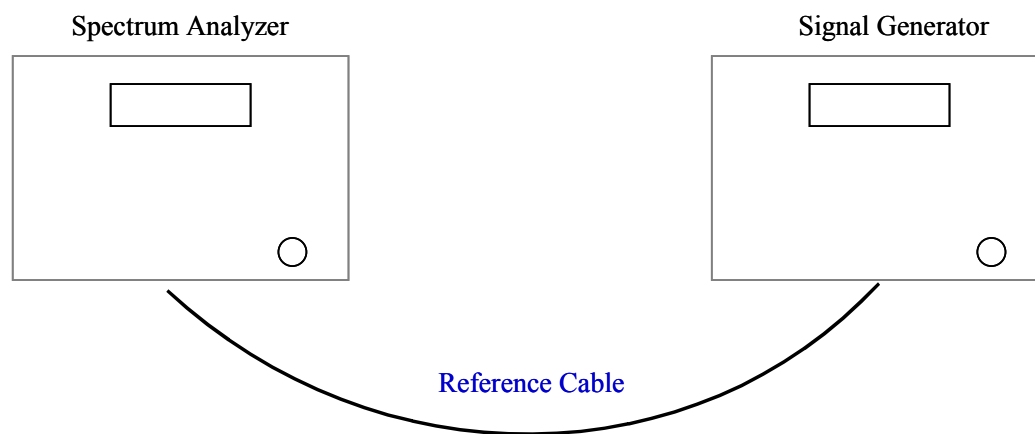
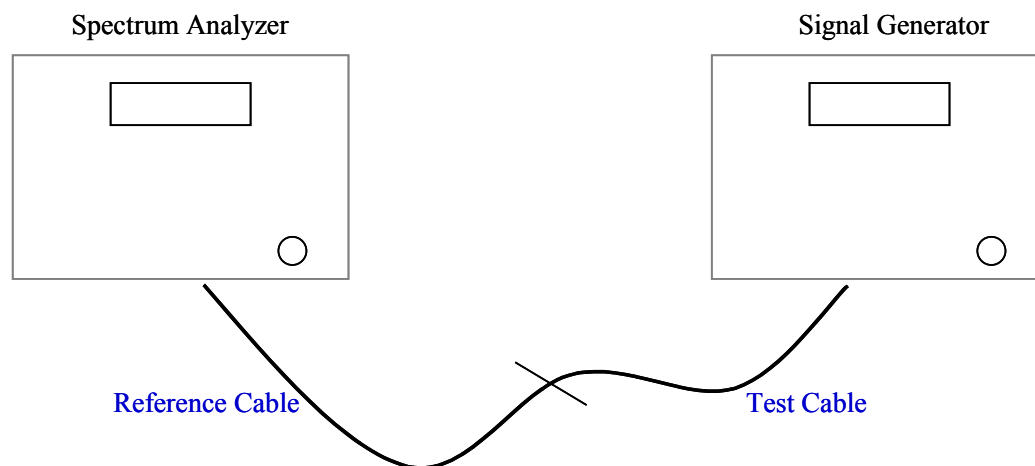
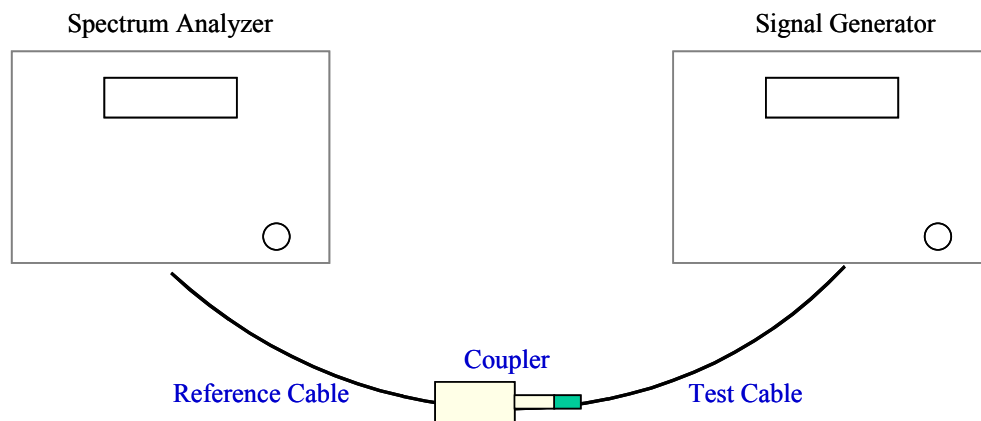
Figure 53: Reference Cable Measurement**Figure 54: Reference & Test Cable Measurements**

Figure 55: Coupler Measurement

Test Procedure

- Step 1.** Connect a test cable to the Signal Generator and to the Spectrum Analyzer. This will be the reference cable (Figure 53).
- Step 2.** Turn on RF Power on the Signal Generator.
- Step 3.** On the Spectrum Analyzer, set the reference level so that the signal peak is no more than 1 division down from the top of the screen, but does not go past the top of the screen.
- Step 4.** Press the Peak Search button on the Analyzer. If the marker is bouncing excessively, turn on the averaging function. Adjust averaging to stabilize the marker but not slow down the sweep too much. Once the marker is stabilized, press Peak Search again to make sure you are on the peak, then press marker delta. This establishes the reference point for measurements.
- Step 5.** Turn off RF Power on the Signal Generator. Disconnect the reference cable from the Spectrum Analyzer.
- Step 6.** Connect the other test cable to be measured between the reference cable and the Spectrum Analyzer (Figure 54). This will be the test cable.
- Step 7.** Turn on RF power on the Signal Generator. The delta between the markers is the loss/gain of the test cable or the coupler. Record that value in the appropriate field on the Base Station Calibration Verification Form.
- Step 8.** Turn off RF Power on the Signal Generator.
- Step 9.** Repeat steps 6 through 8 for the RF coupler (Figure 55). Leave the equipment on until the Base Station calibration verification test is complete. When finished, be sure to disable the RF Power on the Signal Generator.

Receive Verification

This test verifies the Receive function of the Base Station.

Equipment Required

- Signal Generator - Agilent 8648C, or equivalent, tunable to the RFS center frequency
- Oscilloscope – Agilent 54622 D, or equivalent
- Test cable (optional)
- Test Channel Processor board

Note: Some test equipment may have a DC block for input protection. If so, do not remove the DC block from the equipment.

Equipment Settings

Ensure that the Signal Generator and the Spectrum Analyzer have been allowed to warm up for 15 minutes before beginning testing.

Signal Generator:

- Output frequency = Base Station center frequency + 300 KHz (i.e. if the center frequency of the BTS is 2640.5 MHz, set the Signal Generator frequency to 2640.8 MHz).
- Output power = The RF Power injected at the cal cable to get sensitivity at the antenna (line 25) of the Base Station Calibration Verification Form. This value cannot be obtained until steps 1 – 5 of this test are performed.

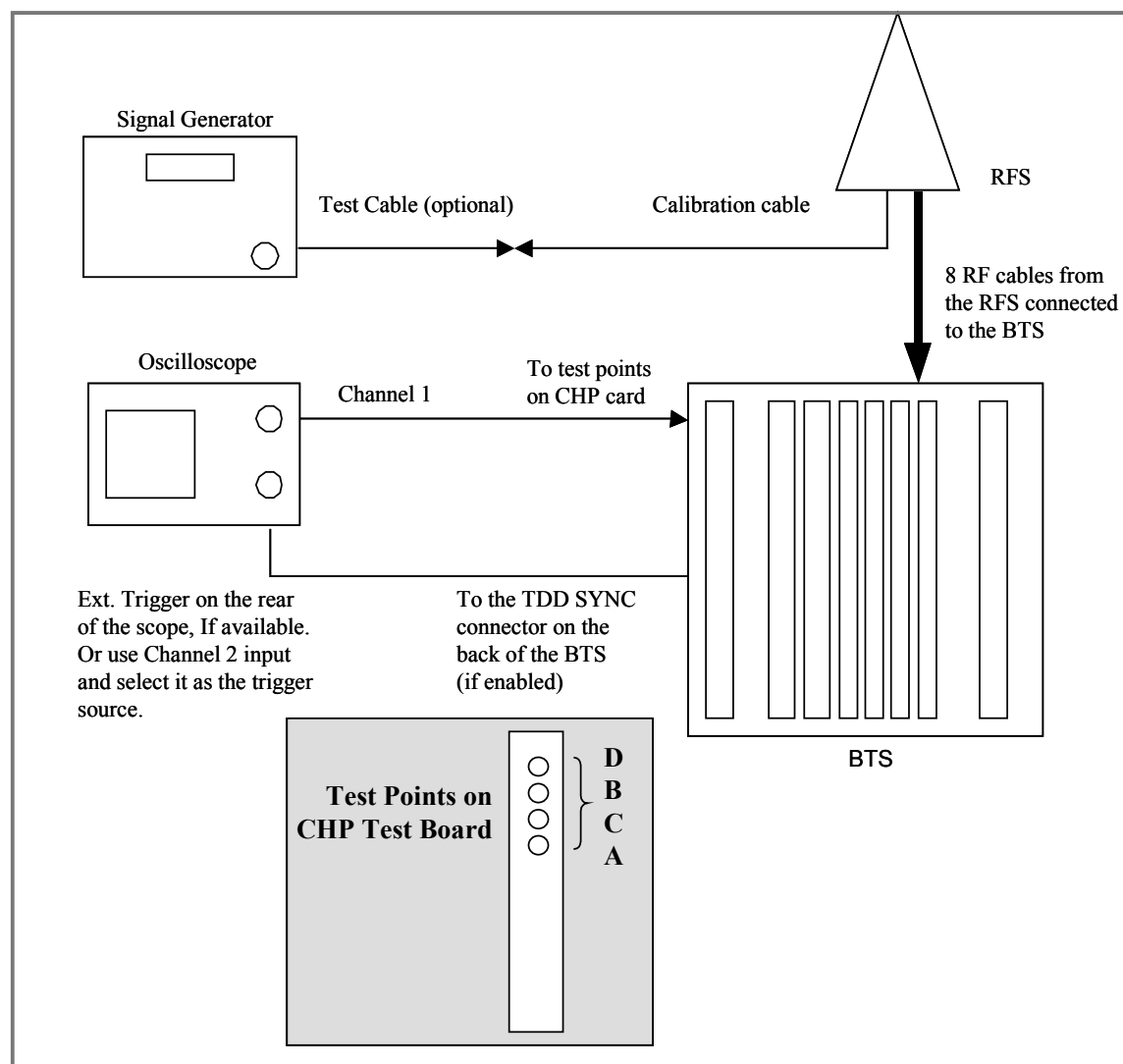
Oscilloscope:

- Horizontal sweep = 100 us/division
- Amplitude = 200 mV/division. Setting is arbitrary depending on the environment. It should be as low as possible, while still being able to differentiate between signals.
- Channel = AC coupled
- Bandwidth (BW) = 20 MHz
- Limiting = on
- Trigger = EXT (or channel 2 if used)

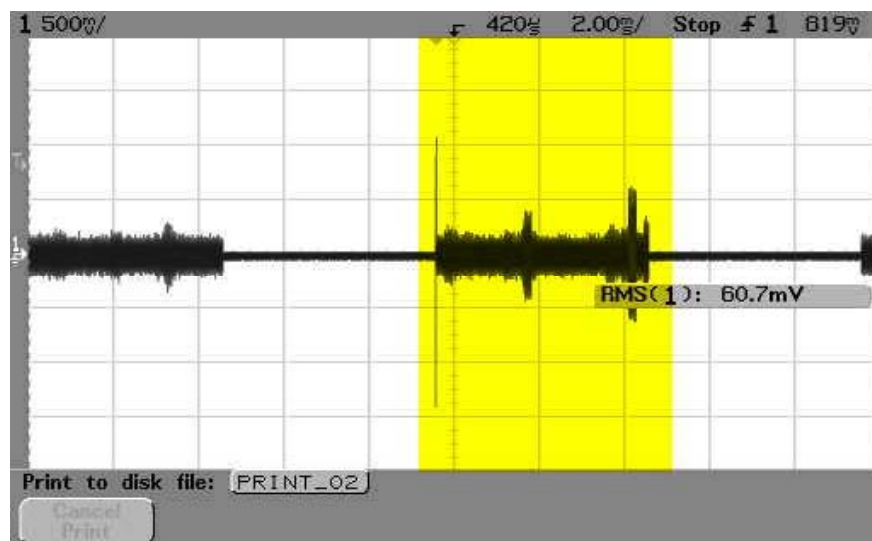
Test Procedure

Follow the steps in the procedure below.

- Step 1.** Ensure that system calibration has been successfully performed.
- Step 2.** Enter the value for receive sensitivity (line 23) into the Base Station Calibration Verification Form. It is located in the EMS Configuration & Alarm Manager (CAM) GUI by selecting the BTS, then selecting **air interface > layer 1 > show configuration**. Select the General tab.
- Step 3.** Enter the value for the test cable loss (line 24) into the Base Station Calibration Verification Form. Test cable loss has to be measured before testing begins. If a test cable is not used, enter zero for test cable loss in the Base Station Calibration Verification Form.
- Step 4.** Enter the values for the antenna cable loss and RFS sweeps (measured) into the Base Station Calibration Verification Form under cable loss (lines 40 to 48) and insertion loss through cal cable and RFS (lines 54 to 69). The values are obtained from the RFS System Test Form.
- Step 5.** Record the DAC words for RX gain from EMS Layer 1 data into the Base Station Calibration Verification Form (lines 90 to 97). It is located in the EMS Configuration & Alarm Manager by selecting the BTS, then select **air interface > layer 1 > show configuration**. Select the Antenna tab.
- Step 6.** Set the Output power of the Signal Generator equal to the RF Power injected at the cal cable to get sensitivity at the antenna (line 25) of the Base Station Calibration Verification Form. Ensure that the spreadsheet has calculated the value by pressing F9 to calculate.
- Step 7.** Confirm that all CPE's are turned off. Enter the command "ebCamShow" at the BTS console to check for packets being transferred. Run the command two or three times to validate that packet numbers are not changing.
- Step 8.** Set the power switch on the BTS to "OFF".
- Step 9.** Remove the CHP-A board from the BTS chassis.
- Step 10.** Install the CHP test board into the CHP-A slot in the BTS chassis.
- Step 11.** Set the power switch on the BTS to "ON".
- Step 12.** Set up the test equipment as shown in Figure 56.

Figure 56: Test Equipment for Receive Verification

Step 13. Adjust the Oscilloscope to view only the receive timeframe, as shown in Figure 57. Center the quietest area of one RX frame in the middle of the screen. Adjust the horizontal sweep for 100 to 200 us/division to obtain the best reading. This ensures that you measure only the noise of the receive frame. The amplitude for each channel should be approximately 200 mV/division. This setting is arbitrary depending on the environment. The setting should be as low as possible, and you should still be able to differentiate between the signals. Set the Oscilloscope to display the RMS (average) voltage of the waveform. If the equipment permits, also display the peak-to-peak value. Setting the channel on the Oscilloscope to AC, coupled with BW limit “on”, limits the noise being measured to less than 20 MHz in bandwidth. The objective is to measure only the noise within the receiver bandwidth (5 - 6 MHz).

Figure 57: Oscilloscope Receive Time

Step 14. Measure the RMS voltage (in mV) in the quietest area of each of the four baseband signals from the front of the Channel Processor test board – test points A, B, C, D. Enter the values into the Base Station Calibration Verification Form under receiver performance - noise level (lines 76 to 79). To ensure that there are no surges or random interference signals included in the measurement, use the single sweep function on the Oscilloscope. Figure 57 shows an example of unwanted noise bursts in the waveform.

Step 15. Turn on the Signal Generator's RF output.

Step 16. Measure the RMS voltage (in mV) on the Oscilloscope (signal + noise, S+N) in the quietest area of each of the four baseband signals from the front of the Channel Processor test board – test points A, B, C, D. Enter the values into the Base Station Calibration Verification Form under receiver performance - noise + signal (lines 76 to 79). If the calibration was successful, then all of the levels should be between 180 and 240 mV rms. The spreadsheet will then calculate the signal, SNR, noise power, and relative noise figure. For example, values typically are -102, 10, and 3.5 dB for a 2.6 GHz system.

Step 17. Turn off the Signal Generator's RF output.

Step 18. Set the power switch on the BTS to OFF.

Step 19. Remove the CHP test board from the BTS chassis.

Step 20. Install the CHP-A board into the BTS chassis.

Step 21. Remove the CHP-B board from the BTS chassis.

Step 22. Install the CHP test board into the CHP-B slot in the BTS chassis.

Step 23. Set the power switch on the BTS to "ON".

Step 24. After the BTS boots up, repeat steps 12 thru 17 for the CHP test board in the CHP-B slot. Enter the data into the Base Station Calibration Verification Form (lines 80 to 83).

Step 25. Turn off the Oscilloscope.

Step 26. Set the power switch on the BTS to OFF.

Step 27. Remove the CHP test board from the BTS chassis.

Step 28. Install the CHP-B board into the BTS chassis.

Step 29. Set the power switch on the BTS to “ON”.

Step 30. Ensure the BTS boots up without any faults.

Transmitter Verification

This test verifies the Transmit function of the Base Station.

Equipment Required

- Spectrum analyzer - Agilent E4402B, or equivalent
- Coupler
- Attenuator - 30 dB, 25 watt
- Terminator - 50 ohm, 5 watt

Equipment Settings

Ensure that the Signal Generator and the Spectrum Analyzer have been allowed to warm up for at least 15 minutes before beginning testing.

Spectrum Analyzer:

- Center Frequency = BTS center frequency
- Span = 0 Hz
- RBW = 5 MHz *
- VBW = Auto
- Sweep Time = 15 ms
- TRIG = Video ** (adjust level to stabilize signal)
- Display line = On
- Reference level = Adjust to display entire signal
- Detector = RMS ***

* If the Spectrum Analyzer will not support 5 MHz RBW, use the following formula to determine the correction factor: $10 * \log_{10} (5 \text{ MHz} / \text{RBW})$. Add this value to the measurements.

**If possible, connect a cable from the TDD SYNC connector on the back of the BTS to the EXT TRIGGER input on the rear of the Spectrum Analyzer. Set the TRIG to EXT.

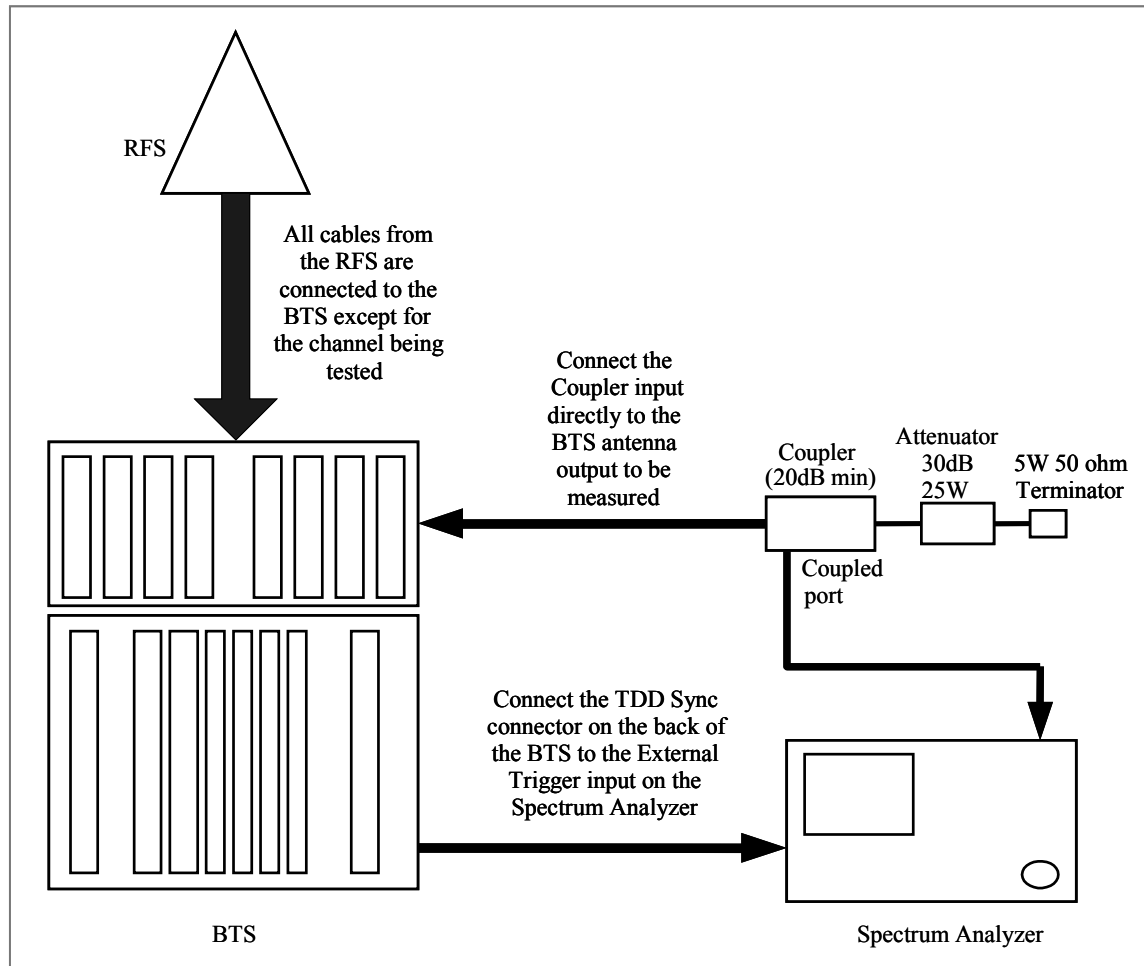
***If the RMS detector is not available, measure with the peak detector and subtract 9.5 dB for peak to average ratio (calculated by the spreadsheet). This value is determined by measuring both the peak detected and RMS detected power values, then taking the average of the two readings. Due to equipment variations, this value will not always be the same; however, it should be within +/- 1 dB.

Test Procedure

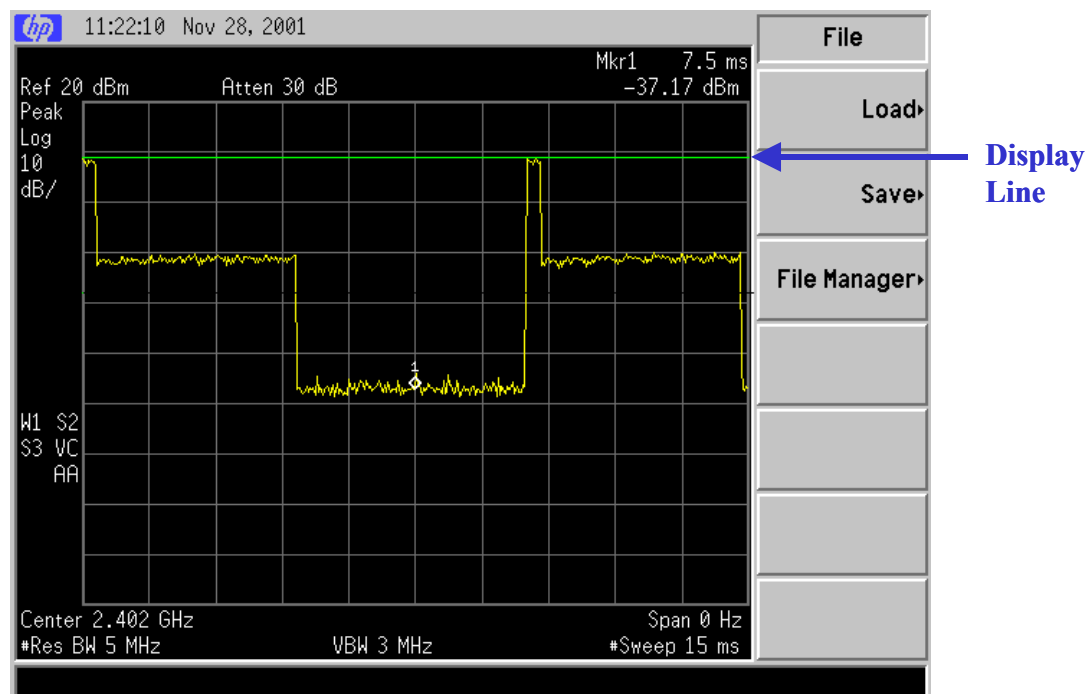


WARNING! Before performing the procedure below, disable power to the transceiver modules before disconnecting any RF cables. All antenna cables must be connected to the BTS during testing except for the one that is being tested.

- Step 1.** Disable the RF shelf by turning off the power to the Transceiver modules. From the EMS GUI, select the BTS. Then from the menu bar select action > disable. Ensure that the Power LED on each Transceiver module is off. Also ensure that the A1 – A8 LED's on the CC card are off.
- Step 2.** Disconnect the RF cable for the channel being tested from the back of the BTS. All other RF cables must be connected to the BTS.
- Step 3.** Connect the Spectrum Analyzer, Coupler, Attenuator, and 50 ohm Terminator to the RF input on the BTS, as shown in Figure 58. The RF cable for the channel being tested is not connected during the test.

Figure 58: Test Equipment for Transmitter Verification

- Step 4.** Enable the RF shelf by turning on the power to the Transceiver modules. From the EMS GUI, select the BTS. Then from the menu bar select action > enable. Ensure that the Power LED on each Transceiver module is on. Also ensure that the A1 – A8 LED's on the CC card are on.
- Step 5.** On the Spectrum Analyzer, adjust the display line to the top of the sync signal, as shown in Figure 59. Measure the signal level.

Figure 59: Sync Signal

- Step 6.** Repeat steps 1 through 5 for the remaining seven antenna outputs. Record the peak value into the spreadsheet under analyzer readings – Peak (lines 90 to 97).
- Step 7.** Enter the value for antenna power that is set in the EMS into the spreadsheet (line 30). It is located in the EMS Configuration & Alarm Manager GUI by selecting the BTS, then selecting **air interface > layer 1 > show configuration**. Select the General tab.
- Step 8.** Enter the Coupler/test cable loss (line 31) and antenna gain (line 32) (8 dBi for 2.4 GHz and 17 dBi for 2.6 GHz systems) into the spreadsheet.
- Step 9.** Record the DAC words for the TX gain from EMS Layer 1 data into the spreadsheet (lines 93 to 100). From the EMS GUI, select the BTS. Then select **air interface > layer 1 > show configuration**. Select the Antenna tab.
- Step 10.** Verify that RMS power at the antenna (lines 90 to 97, column G) is within +/- 1 dB of antenna power (line 30) and that the deviation across all eight antennas is less than or equal to 3 dB.

Export BTS Data

Once you complete the calibration verification, export the BTS configuration data to a text file. This is done by highlighting the specific BTS in the CAM window, and on the Main Menu select **File > Export BTS Data**. This saves the configuration information if needed for later retrieval.

Perform Local CPE Tests

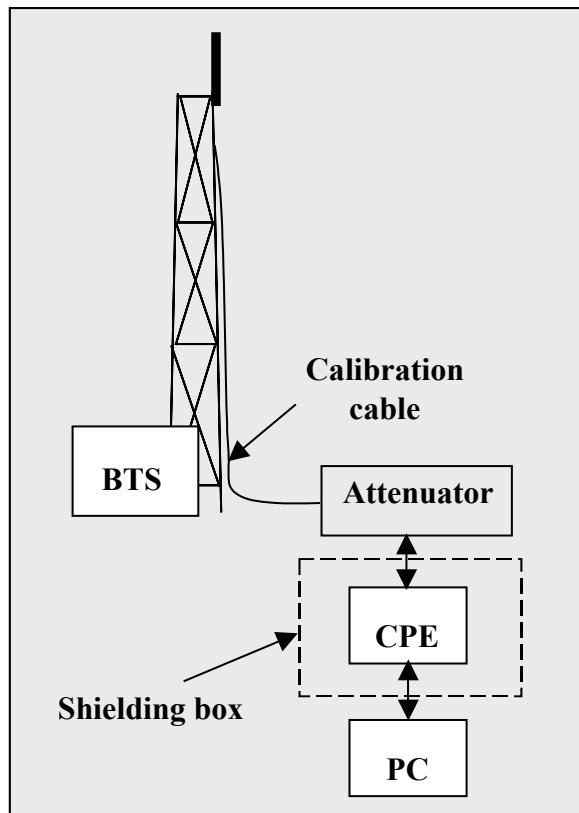
Local wireline, then over-the-air, CPE testing will verify that the Base Station is working and is able transmit and receive data. Data rates are not being checked at this time. Refer to Figure 60 when setting up and performing the Wired CPE procedures.

Wired CPE Test

Equipment Required

- CPE - Ordinate the Ripwave Modem (CPE)
- PC - Laptop with CPE debug tool. Connect to CPE with an Ethernet cable
- Attenuator - 70dB fixed attenuation, plus 40 adjustable range with 1dB resolution (cascade multiple attenuators)
- Shielding box - Need to provide 80dB isolation. Shielding box may not be needed if the CPE cannot sync to BTS over-the-air at the test location.

Figure 60: Wired CPE Setup



Equipment Settings

Part of the Test Procedures below.

Test Procedure Setup

Set up the test procedures, per the following.

- Step 1.** Calibrate and sanity check the BTS.
- Step 2.** Connect the CPE and the attenuators. The combined attenuation should be set roughly as follows:
Total attenuation = $PTX - 30 + 18 - \text{Cal cable loss} + 80$
Where PTX is the Tx output power at antenna input port that is set in EMS during calibration. Cal cable loss is the loss of the calibration cable.
The total attenuation should be partitioned between fixed and adjustable attenuators in such a way that the adjustable attenuator is set to about 10dB.
- Step 3.** Disconnect the calibration cable from the back of the BTS shelf and connect it to the attenuator as shown in the drawing
- Step 4.** Ping the BTS continuously from the CPE.
- Step 5.** Check the sync level at the CPE debug tool. The level should be about -80dBm.

Test Procedure - Check CPE Sensitivity & Output Power

Follow the steps in the procedure below.

- Step 1.** Record the downlink TCC power level and SNR reading on the CPE debug tool.
- Step 2.** Calculate the effective noise floor: $NF = SNR_{TCC} - Level_{TCC}$.
Where SNR_{TCC} is the TCC SNR and $Level_{TCC}$ is the received downlink TCC level.
NF should be close to -127 ± 5 .
- Step 3.** Check CPE output power cap difference. It should be greater than 0.
- Step 4.** Increase the attenuation by 10dB (increase the attenuation of the adjustable attenuator).
- Step 5.** Measure the effective noise floor and the output power cap difference gain.
- Step 6.** Increase the attenuation by another 10dB and take the measurements again (if the link is broken when the attenuation increases 10dB, back off the attenuation by 10dB and then increase the attenuation with 1dB steps until the link is broken. Then reduce the attenuation by 4dB).

Step 7. Calculate the maximum path allowed as follows:

$$\text{Max loss} = \text{Attenuation total} + \text{Cal cable loss} + 30$$

Where Attenuation total is the total attenuation of all attenuators (fixed + adjustable).

Test Procedure - Check BTS Sensitivity (Individual Antenna)

Step 1. Set the attenuation of the attenuator so the total attenuation is about

$$P_{TX} - 30 - \text{Cal cable loss} + 80.$$

Step 2. Activate antenna #1 only.

Step 3. Record the uplink TCC power level and SNR reading on the BTS debug tool.

Step 4. Calculate the effective noise floor: $NF = SNR_{TCC} - Level_{TCC}$.

Where SNR_{TCC} is the TCC SNR and $Level_{TCC}$ is the received downlink TCC level.

NF should be close to: $SNR - \text{BTS Sensitivity} + 25 \pm 5$.

Where BTS sensitivity is the BTS sensitivity setting during calibration.

Step 5. Record the CPE output power.

Step 6. Increase the attenuation by 10dB (increase the attenuation of the adjustable attenuator).

Step 7. Measure BTS effective noise floor and CPE output power again.

Step 8. Increase the attenuation by another 10dB and take the measurements again (if the link is broken when the attenuation increases 10dB, back off the attenuation by 10dB and then increase the attenuation with 1dB steps until the link is broken. Then reduce the attenuation by 4dB. The same attenuation will be used for all antenna tests).

Step 9. Calculate the maximum path allowed as follows:

$$\text{Max loss} = \text{Attenuation total} + \text{Cal cable loss} + 30$$

Where Attenuation total is the total attenuation of all attenuators (fixed + adjustable).

Step 10. Repeat the steps for antennas 2 through 8.

Step 11. Average the CPE output power over antennas 1~8 for each attenuation setting.

Test Procedure - Check BTS Sensitivity (Antenna Array)

Step 1. Set the initial attenuation the same as in the individual antenna testing procedure.

Step 2. Activate all antennas.

Step 3. Record the uplink TCC power level and SNR reading on BTS debug tool.

- Step 4.** Calculate the effective noise floor: $NF = SNR_{TCC} - Level_{TCC}$.
Where SNR_{TCC} is the TCC SNR and $Level_{TCC}$ is the received uplink TCC level.
NF should be close to $SNR - BTS \text{ Sensitivity} + 25 \pm 5$.
Where BTS sensitivity is the BTS sensitivity setting during calibration.
- Step 5.** Record the CPE output power.
- Step 6.** Increase the attenuation by 10dB (increase the attenuation of the adjustable attenuator).
- Step 7.** Measure BTS effective noise floor and CPE output power again.
- Step 8.** Increase the attenuation by the same amount as in individual antenna tests and measure the BTS effective noise floor and CPE output power.
- Step 9.** For each attenuation setting, the CPE output power should be 9dB less compared to those (average) in individual antenna tests.
- Step 10.** Increase the attenuation by another 18dB. The link should be on.
- Step 11.** Calculate the maximum path allowed as follows:
 $Max \text{ loss} = \text{Attenuation total} + \text{Cal cable loss} + 30$
Where Attenuation total is the total attenuation of all attenuators (fixed + adjustable).

Test Procedure - Data Rate

- Step 1.** Set the attenuation of the attenuator so the total attenuation is about
 $PTX - 30 + 18 - \text{Cal cable loss} + 80$.
- Step 2.** Activate all antennas.
- Step 3.** FTP a file with size >10Mbps from CPE to BTS (uplink).
- Step 4.** Check the uplink data rate. It should be ~1Mbps.
- Step 5.** FTP a file with size >20Mbps from BTS to CPE (downlink).
- Step 6.** Check the downlink data rate. It should be ~2Mbps.

After the test is completed, reconnect the calibration cable back to the BTS and run the calibration. The new calibration table should be the same as before (the changes in Tx and Rx AGC should be within 2 bits).

Over-the-air CPE Test

Equipment Required

Same as for Wired CPE Test.

Equipment Settings

Included in the Test Procedure.

Test Procedure

To set up a CPE for local over-the-air testing, follow the steps below.

- Step 1.** Connect a CPE to a test computer. Reference the *Ripwave CPE User Guide*, P/N 40-00026-00 for CPE setup procedures. The location of the test computer setup needs to be close to the Base Station, within its coverage range.
- Step 2.** Ensure that the CPE is registered in the EMS. Refer to *EMS Configuration & Alarm Manager (CAM) User Guide*, P/N 40-00016-00, for CPE registration procedures.
- Step 3.** Using FTP software, transfer a 2 Mb file over-the-air from the test computer to the BTS. This is a system uplink transfer.
- Step 4.** Using FTP software, transfer a 10 Mb file over-the-air from the BTS to the test computer. This is a system downlink transfer.
- Step 5.** Ensure that both files transferred during testing.

Install & Test Customer EMS Operations

If you have been using a Test EMS up to this point, you will now need to install and test the customer's EMS server. This involves installing the EMS Server and Client on a computer that is connected through the system backhaul. If the customer's EMS is already installed and has been used for testing purposes, skip to the "[Verify System Performance](#)" section of this chapter.

Install EMS Software

The EMS software installation procedures can be found in the *EMS Software Installation* manual, P/N 40-00017-00. After installing the EMS Server and Client applications, the EMS needs to be configured with the settings that are designated for the Base Station. The settings are found in the Network Architecture Plan provided by the customer.

Ensure connection between the Base Station and the backhaul. The connection to the Base Station will be either an Ethernet connection or T1 connections.

Verify EMS to Base Station Connectivity

Follow the steps below to ensure the EMS and Base Station can communicate.

- Step 1.** Open a Command Prompt window on the computer where the EMS is installed.
- Step 2.** Ping the Base Station using the CLI command **ping <base station ip address>**. Verify a reply from the Base Station.

Perform Calibration Using Customer's EMS

This step is necessary only if you have been using a Test EMS up to this point. You will need to install the customer's EMS server and software. Calibrate the Base Station using the customer's EMS. Follow the same calibration procedures described earlier in this chapter, Calibrate the Base Station. Perform the procedure three times and make sure that the results are stable (+/- 3).

Verify System Performance

Drive Study

The *preliminary* Drive Study is performed if no RF coverage model is available. The Drive Study helps you to map out the coverage area. Later, the full Drive Study is performed to see if the system's coverage area is as predicted and, if necessary, to fine-tune the RF model.

Following the detailed Drive Study procedures in [Appendix G](#), you will perform a preliminary Drive Study by driving back and forth through a sector, staying on major roads about a kilometer apart. Special attention has to be paid to the null and fringe areas. You will follow this scheme for each sector in the site, recording the results of all tests. The test results will be sent for evaluation, along with the Location (FTP) test results, to Navini Networks Technical Support. If the results are not adequate, Technical Support will have you adjust some of the RF parameters and perform the Drive Study again.

Location (FTP) Test

Location Tests are performed to see if the system file transfer functions are working as predicted between CPE and Base Station. These are conducted in stages as well. The first stage is the *preliminary* Location Test, where you perform three uploads and three downloads at three locations with the Base Station in line-of-sight (LOS). Then you perform three uploads and three downloads at three locations with the Base Station in non-line-of-sight (NLOS). For the NLOS testing, you will need to find an obstacle, such as a building, between the CPE and Base Station.

Results are sent, along with the preliminary Drive Study results, to Navini Networks Technical Support for evaluation. If the results are not adequate - i.e., file transfers do not meet customer's objectives - Technical Support will have you adjust some of the RF parameters and perform the Location tests again. The detailed Location Test procedures and form are located in [Appendix H](#).

To summarize, these are the high-level steps for verifying system performance:

1. Conduct *preliminary* Drive Study (if no RF coverage map is available).
2. Conduct *preliminary* LOS Location Tests.
3. Conduct *preliminary* NLOS Location Tests.
4. Send all test results to Navini's Technical Support for evaluation.
5. If directed by Technical Support, adjust RF parameters.
6. Conduct full Drive Study.
7. Conduct full LOS Location Tests.

8. Conduct full NLOS Location Tests.
9. Send all test results to Navini's Technical Support for evaluation.

The cycle continues until the performance objectives are reached.

Verify System Operation With Multiple CPE's

Set up three computers with CPE's connected to them. Perform file transfers from all three computers to verify Base Station operation.

Back Up EMS Database

After all system installation and commissioning activities are complete, perform a backup of the EMS database. The procedure can be found in the *EMS Configuration & Alarm Manager (CAM) User Guide*, P/N 40-000-16-00. Place the backup files on a system server where they will be periodically backed up on a tape drive.

Customer Acceptance

To conclude the installation and commissioning activities, gather all of the required documents and forms from the installation and commissioning procedures to create a comprehensive system I&C package. The customer and Navini Networks will sign the Customer Acceptance Form. A copy of this form is provided in [Appendix I](#). The signed form and the system I&C package are provided to the customer. The original, signed Customer Acceptance Form and system I&C package are stored in the Navini Networks Technical Support database.

Appendix A: Ordering Documentation & Forms

Navini Networks product documentation and forms may be ordered by calling 1-972-852-4200, or by using the web site: www.navini.com. Select Support / Technical Support.

Document Name	Component/Part Number
STANDARD DOCUMENTATION CD	95-00116-00
EMS Overview Manual	40-00016-03
EMS Software Installation Guide	40-00017-00
EMS Administration Guide	40-00031-00
Ripwave Configuration Guide	40-00016-01
EMS Configuration CLI Reference Manual	40-00016-02
EMS Alarm Resolution Reference Manual	40-00033-00
EMS Diagnostic Tools Guide	40-00032-00
Ripwave Modem Quick Installation Guide	40-00112-00/40-00098-00 English /40-00096-00 Spanish
Ripwave Modem User Guide	40-00111-00/40-00097-00 English /40-00099-00 Spanish
Ripwave Modem Software Update Tool - Quick Guide	40-00066-00
VAR I&C DOCUMENTATION CD	95-00017-00
<i>Site Design Documents:</i>	
RFS Omni Data Sheet	44-00037-00
RFS Panel Data Sheet	44-00038-00
BTS Outdoor Selection Guide	44-00035-00
Rectifier/Battery Back-up (BBU) Specification	44-00036-00
Responsibility Assignment Matrix (RAM) Template	00-30003-00
<i>Installation & Commissioning Documents:</i>	
Base Station Installation & Commissioning Guide	40-00047-00
EMS Software Installation	40-00017-00
RFS Configuration Quick Guide	40-00067-00
BTS Configuration Data Form	44-00032-00
EMS Configuration Data Form	44-00034-00
CPE Configuration Data Form	44-00033-00
Site Candidate Evaluation Form	40-00091-00
RFS System Test Form	40-00085-00
Base Station Installation Certification Form	40-00092-00
Base Station Calibration Verification Form	40-00059-00
Location (FTP) Tests Form	40-00077-00
Drive Study Survey Procedures	40-00087-00
Drive Study Survey Form	40-00076-00
Customer Acceptance Form	40-00117-00
<i>Operations Documents:</i>	
Ripwave Modem Quick Installation Guide	40-00112-00/40-00098-00 English /40-00096-00 Spanish

Ripwave Modem User Guide	40-00111-00/40-00097-00 English /40-00099-00 Spanish
EMS Administration Guide	40-00031-00
Ripwave Configuration Guide	40-00016-01
EMS CLI Reference Manual	40-00016-02
EMS Alarm Resolution Reference Manual	40-00033-00
EMS Diagnostic Tools User Guide	40-00032-00

Appendix B: Site Candidate Evaluation Form



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NAVINI NETWORKS SITE EVALUATION FORM PN - 40-00091-00

Site Name _____
Date _____
FSE _____

SITE INFORMATION

COMPANY NAME _____
ADDRESS _____
SITE OWNER _____
SITE CONTACT NO. _____

GPS COORDINATES _____ LAT _____ LONG _____
ANT TYPE (OMNI, PANEL) ☐ OMNI ☐ PANEL ☐ 2.3GHZ ☐ 2.4GHZ ☐ 2.5GHZ ☐ 2.6GHZ
ENCLOSURE TYPE (HUT, ETC) _____ ELEV (AMSL) _____ FEET
TOWER TYPE (SS, MP, ETC) _____ HEIGHT (AGL) _____ FEET
SITE ACCESS RESTRICTIONS ☐ 24HRS ☐ 8-5PM _____ OTHER _____
DRIVE TO DIRECTIONS _____

SITE CONSTRUCTION INFORMATION

BTS Space Availability (3' x 3') _____ x _____
Room for Expansion BTS ☐ YES ☐ NO _____ x _____
Type/Size of Cabinet required ☐ INDOOR ☐ OUTDOOR _____ FEET
110VAC, 20A Available/Distance ☐ YES ☐ NO _____ FEET
AC Outlet Available/Distance ☐ YES ☐ NO _____ FEET
24VDC, 60A Available/Distance ☐ YES ☐ NO _____ FEET
Breaker(s) Required ☐ YES ☐ NO ☐ AC ☐ DC
Sub-metering Required ☐ YES ☐ NO
Ground Available/Distance ☐ YES ☐ NO _____ FEET
Gnd Buss Bar Available/Distance ☐ YES ☐ NO _____ FEET
Cable Entry Available ☐ YES ☐ NO
Cable Routing Distance _____ FEET
Kind of Entry Material _____
Kind of Sealing Required _____
Site Plans Available ☐ YES ☐ NO
Cable Tray Available ☐ YES ☐ NO
Cable Hangers Required ☐ YES ☐ NO
Floor/Wall Drilling Permitted ☐ YES ☐ NO
Airconditioning Available ☐ YES ☐ NO
Telco/LAN/WAN Available ☐ YES ☐ NO
Demarc Location/Distance _____ FEET
Room has Adequate Lighting ☐ YES ☐ NO
Room has Adequate Ventilation ☐ YES ☐ NO
Any Door Entry Restrictions ☐ YES ☐ NO _____ DOOR DIMENSION
Enclosure Access ☐ Ground ☐ Elevator _____ OTHER
Crane/Heavy Eqpmt Required ☐ YES ☐ NO _____


**NAVINI NETWORKS
SITE EVALUATION FORM**

 Site Name 0
Internet at the speed of thought™
TOWER/ANTENNA CONSTRUCTION INFORMATION

Proposed Antenna Height	_____	FEET	_____	COMMENTS
Cable Run Length to entry port	_____	FEET	_____	COMMENTS
Ant Space Available (10' spacing)	☐ YES	☐ NO	_____	OTHER
Special Bracket Required	☐ YES	☐ NO	_____	OTHER
Cable Hangers Required	☐ YES	☐ NO	_____	OTHER
Crane/Heavy Eqpmt Required	☐ YES	☐ NO	_____	OTHER
Structural Test Required	☐ YES	☐ NO	_____	OTHER
Interference Test Required	☐ YES	☐ NO	_____	OTHER
GPS Location Available	☐ YES	☐ NO	_____	CABLE RUN LENGTH IN FEET
GPS Comments / Details	_____			
Detailed Tower Description	_____			

TOWER PICTURE



Site Name	0
-----------	---

SITE MAP / SKETCH

GPS ANTENNA LOCATION

Comments



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Comments

[illegible]

Comments

[illegible]



Site Name	0
-----------	---

EAST VIEW

Comments

SOUTHEAST VIEW

Comments



Site Name	0
-----------	---

SOUTH VIEW

Comments

SOUTHWEST VIEW

Comments



Site Name	0
-----------	---

WEST VIEW

Comments

NORTHWEST VIEW

Comments



Site Name	0
-----------	---

EXISTING COMPOUND PICTURE

Comments

GROUNDING

Comments



Site Name	0
-----------	---

INGRESS

Comments

EGRESS

Comments



Site Name	0
-----------	---

POWER

Comments

TELCO

Comments



Site Name 0

SHELTER PICTURE

Comments

SHELTER LAYOUT AND DIMENSION DRAWING

Comments

Appendix C: RFS System Test (Cable Sweeps)

Introduction

Before installing a Base Station at a site, the RFS and the associated cables must be tested, and the results of the tests documented. The tests verify the performance of three major components: the data/power cable, the RF cables, and the RFS unit. This procedure includes, as well, the full RFS sub-assembly with the associated cables. All results for the RFS and cable testing are recorded in the RFS System Test Form, P/N 40-00093-00.

Procedures

RFS Data/Power Cable

This test will check the integrity of the data/power cable. The cable being tested consists of six twisted pairs of conductors. The conductors will be tested for continuity, opens, and shorts. Male connectors are on both ends of the cable. Each connector is wired the same. You will need to check all cables – the main cable from the RFS to the data/power cable surge protector, and the jumper cable from the data/power cable surge protector to the BTS. The pin layout is shown in Figure C1, looking at the connector face. Table C1 provides the pinout details.

Figure C1: Pin Layout

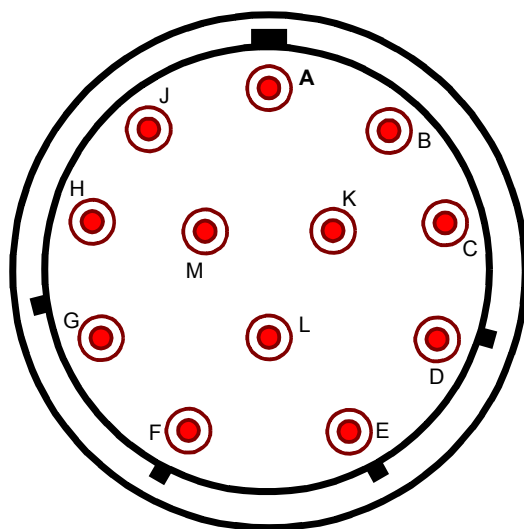


Table C1: Pinout Details

POWER CABLE PIN OUT			
Circular Connector(s)	Wire Color	Wire Color	Signal Name
A	RED	PAIR	+12V A
B	BLACK		+12V A RTN
C	BROWN		Heater
D	DRAIN		GND (Shield Wire)
E	BLACK	PAIR	RX_EN_B-
F	WHITE		RX_EN_B+
G	BLUE	PAIR	RX_EN_A+
H	BLACK		RX_EN_A-
J	BLACK	PAIR	Diagbus-
K	GREEN		Diagbus+
L	BLACK	PAIR	+12V B Return
M	YELLOW		+12V B

Perform the continuity test with both the Volt Ohm Meter (VOM) and the power/data cable tester. If the power/data cable tester is not available, perform the continuity test with the VOM.

Required Equipment

- VOM – Continuity tester
- Jumper for shorting pins
- RFS power/data cable tester

Continuity Test With VOM

- Step 1.** On one end of the cable, short a pair of conductors using a shorting device.
- Step 2.** Using a VOM/Digital Volt Meter (DVM) set to ohms, verify a short is present on the pair at the other end.
- Step 3.** Leaving one probe on one of the paired pins, contact all of the other pins with the other probe, ensuring an open connection.
- Step 4.** Check all 6 pairs of wires in the same manner.
- Step 5.** Verify continuity from the connector case to the drain wire (pin D) on each end of the cable and between each connector case.
- Step 6.** Verify an open circuit from the connector case to each individual wire, except to the drain wire.

Continuity Test With Power/Data Cable Tester

- Step 1.** Connect one end of the power/data cable to the connector on the power/data cable tester.
- Step 2.** Using a VOM/DVM set to ohms, check resistance to ground on the other end of the cable. Resistance is checked from the case of the connector to the individual pin. Resistance readings (+/- 10 percent) are shown in Table C2.

Table C2: Resistance to Ground

Pin	Resistance	Pin	Resistance
A	1K ohms	G	6.2K ohms
B	2K ohms	H	8.2K ohms
E	3.3K ohms	L	10K ohms
F	5.1K ohms	M	12K ohms

- Step 3.** Using a VOM/DVM set to ohms, check resistance between the pairs on the other end of the cable. Resistance should be the sum of the resistance of the two pairs, +/- 10 percent. Refer to Table C3.

Table C3: Resistance of Two Pairs

Pins	Resistance	Pins	Resistance
A & B	3K ohms	G & H	14.4K ohms
E & F	8.4K ohms	L & M	22K ohms

- Step 4.** Remove the power/data cable tester from the power/data cable.

Sweep Test of RF Cables & RFS

Sweep testing of the RF cables and the RFS is performed in three separate steps.

- Sweep of the cables
- Sweep of the RFS
- Sweep of the cables and the RFS together

All results will be entered in the RFS System Test Form, P/N 40-00093-00. The total of the insertion loss for the cables and the RFS will be equal to the insertion loss of both parts swept together. The minimum and maximum cable loss are listed in Table C4.

Table C4: Active & Passive RFS Loss / Operating Parameters

	PA Max Output Power [dBm]	BTS Max Output power with *Filter [dBm]	CAL Cable Min Loss	CAL Cable Max Loss	RF Cable Min Loss [dB]	Active RFS Loss Typ [dB]	Passive RFS Loss Typ [dB]	TX Pwr to Ant Min [dBm]	TX Pwr to Ant Max [dBm]	RX Power to Ant Min [dBm]	RX Power to Ant Max [dBm]	Notes
2.3	+38	+37	3.0	6.0	0	3.2	1.7	20	35	-95	-75	
2.4	+37	N/A	4.0	9.5	0	3.2	1.7	10	25	-85	-65	-05 SYN
2.4	+37	N/A	3.0	4.5	0	3.2	1.7	18	30	-95	-70	-01 SYN
2.5	+39	+38	3.0	6.0	0	3.2	1.7	20	35	-95	-75	
2.6 EF GH	+39	+38	3.0	6.0	0	3.2	1.7	20	35	-95	-75	
2.6 EF	+37	+35	3.0	4.5	0	3.2	1.7	20	35	-95	-75	-05 SYN

* Channel filter for 2.5/2.6 or Block Filter for 2.3 has 1.0 +/- 0.2 dB Insertion Loss

* Channel filter for 2.6 EF Combo is 1.8 +/- 0.2 dB including cable to backplane.

Equipment Required

- Signal Generator - Agilent 8648C, or suitable alternative, tunable to the RFS center frequency
- Spectrum Analyzer - Agilent E4402B, or equivalent
- Signal Generator cable and Spectrum Analyzer cable – Gender can be changed using a barrel connector
- Male and Female barrel connectors for Signal Generator cable and Spectrum Analyzer cable connections
- Power/data test cable
- Navini RFS Test Box

Equipment Settings

Spectrum Analyzer:

- Spectrum Analyzer - 5M
- RBW - 100 KHz
- VBW - 100 KHz
- Sweep Time - Auto
- Frequency (Provided in Table C5)

Signal Generator:

- Amplitude - 0 dB
- Frequency (Provided in Table C5)

Test Setup

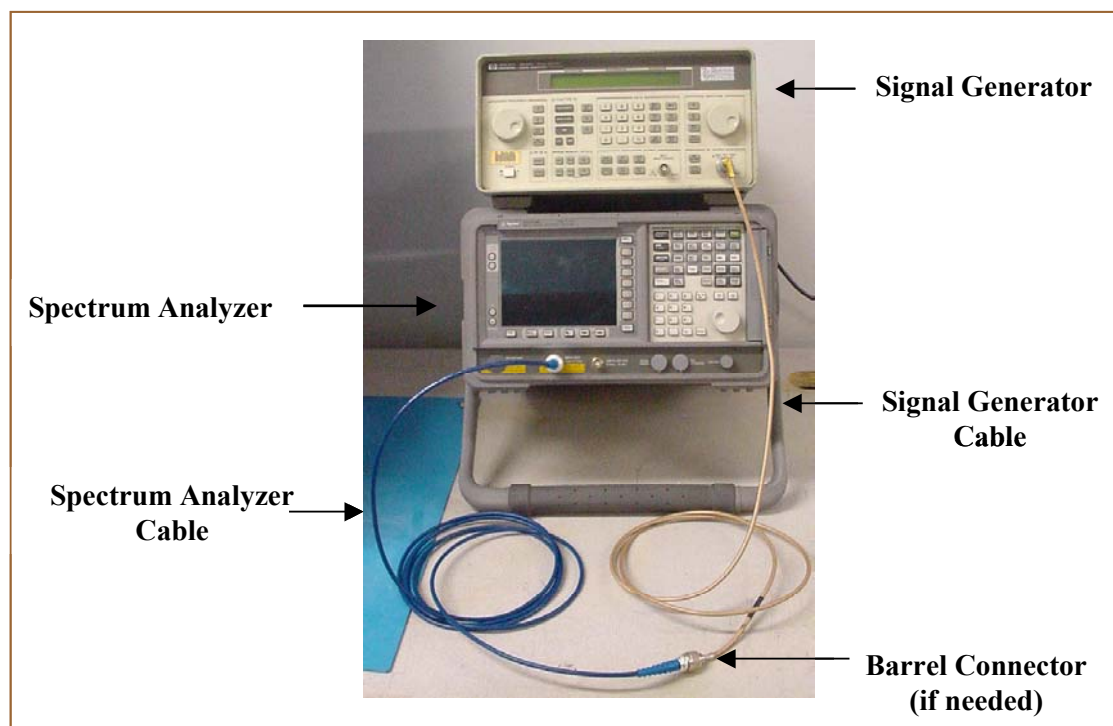
When performing each type of sweep, the sweep has to be performed at certain frequency intervals (Table C5). Perform the complete test at the first frequency. Go to the next frequency and recalibrate the test setup. Perform the complete test again. Do the same for the third frequency. Refer to Figure C2.

Table C5: Sweep Frequencies

System	Sweep 1	Sweep 2	Sweep 3
2.3 GHz High band	2348.25	2352.50	2357.50
2.3 GHz Low band	2307.50	2312.50	2316.75
2.4 GHz	2400.00	2440.00	2473.50
2.5 GHz	2500.00	2548.00	2596.00
2.6 GHz	2602.00	2620.00	2641.00
2.6 GHz EFGH	2602.00	2641.00	2683.00

1. Connect the Signal Generator cable to the Signal Generator.
2. Connect the Spectrum Analyzer cable to the Spectrum Analyzer.
3. Connect the other end of the cables together. Use a barrel connector if needed.

Figure C2: Test Setup

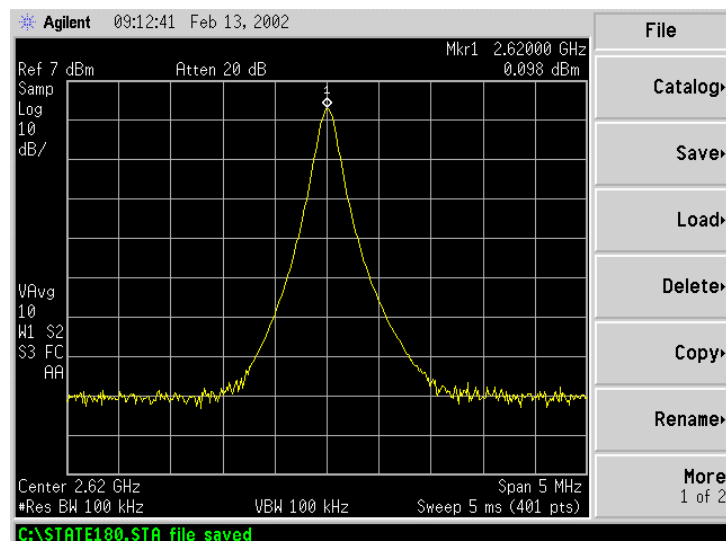


Test Procedure

The following procedures are for the Agilent E4402B Spectrum Analyzer. If alternative equipment is used, refer to the manufacturer's calibration procedures. The key point is to make accurate microwave frequency power measurements.

- Step 1.** Turn the Signal Generator and Spectrum Analyzer on. Allow the equipment to warm up for 15 minutes for the output to stabilize.
- Step 2.** Set the Signal Generator frequency to the desired test frequency (Table C5) of the RFS under test.
- Step 3.** Set the Signal Generator output amplitude to 0 dBm.
- Step 4.** Set the center frequency of the Spectrum Analyzer to the center frequency of the RFS under test.
- Step 5.** Set the Spectrum Analyzer to Span = 5 MHz and Resolution Bandwidth = 100kHz.
- Step 6.** Take a marker measurement on the Spectrum Analyzer by using the 'marker to peak' or the 'peak search' function. The screen on the Spectrum Analyzer should look similar to that shown in Figure C3.

Figure C3: Sweep Test Marker Measurement Example



- Step 7.** If the marker measurement doesn't read 0.0 dBm, adjust the amplitude on the Signal Generator until the Spectrum Analyzer marker reads 0.0 dBm, or as close to 0.0 dBm as possible. This will remove all losses associated with the test cables. All measurement data should be recorded one digit to the right of the decimal point. For example, 31.5dB.

Once the test setup is calibrated, these cables will remain in place and will be used throughout the whole test. If the test cables are removed or changed, incorrect readings will result.

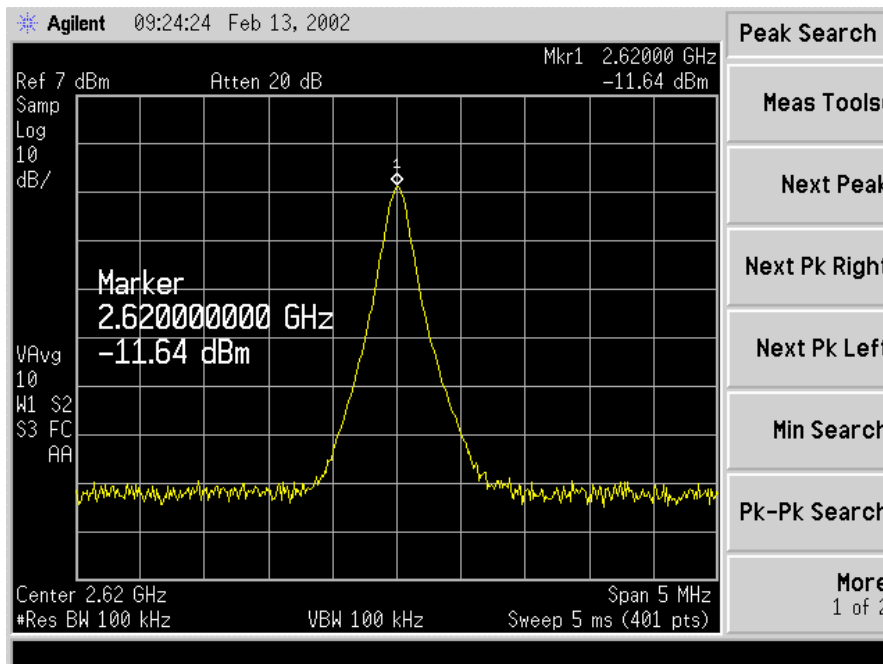
RF Cable Insertion Loss

This test is performed on all RF cables that are installed in the system. This includes the eight antenna cables, the system calibration cable, and all jumper cables. Follow the procedures for either the cables on the ground or cables run up the tower.

Test Procedure For RF Cables on the Ground

- Step 1.** Ensure calibration of the test setup has been performed each time the test frequency is changed.
- Step 2.** If present, remove the barrel connector from between the Signal Generator and Spectrum Analyzer cables.
- Step 3.** Connect the cable from the Signal Generator to one end of the cable. Use a barrel connector to change the gender, if required.
- Step 4.** Connect the cable from the Spectrum Analyzer to the other end of the cable. Use a barrel connector to change the gender, if required.
- Step 5.** Take a marker measurement on the Spectrum Analyzer by using the ‘marker to peak’ or the ‘peak search’ function. The screen on the Spectrum Analyzer should look similar to the one shown in Figure C4.

Figure C4: Insertion Loss (Cables on Ground) Marker Measurement Example



Step 6. The result should be within +/- 0.5 dB of the calculated value. If the insertion loss results do not agree with the manufacturer's data, check the connectors for proper connection to the cable, and check for kinks in the cable. If the Spectrum Analyzer has a distance to fault (DTF) function, it can be used to help troubleshoot kinks in the cable.



CAUTION! Cables with results greater than the specified limits (i.e., 2 or 3 dB high) should not be installed, as a potential hardware fault exists.

Step 7. Record the data in the RFS System Test Form under "MAIN FEEDER LOSS" or "JUMPER LOSS". Ensure that the information is recorded under the channel number that is on the cable label.

Step 8. Repeat steps 3 through 7 for all remaining cables and jumpers.

Step 9. Change the frequency to the next test frequency (refer back to the Test Setup section of these procedures). Perform steps 1 – 8 until all cables have been successfully tested at the frequencies shown in Table C5.

Test Procedure For RF Cables Already Run Up the Tower

Step 1. Ensure calibration of the test setup has been performed each time the test frequency is changed.

Step 2. If present, remove the barrel connector from between the Signal Generator and Spectrum Analyzer cables.

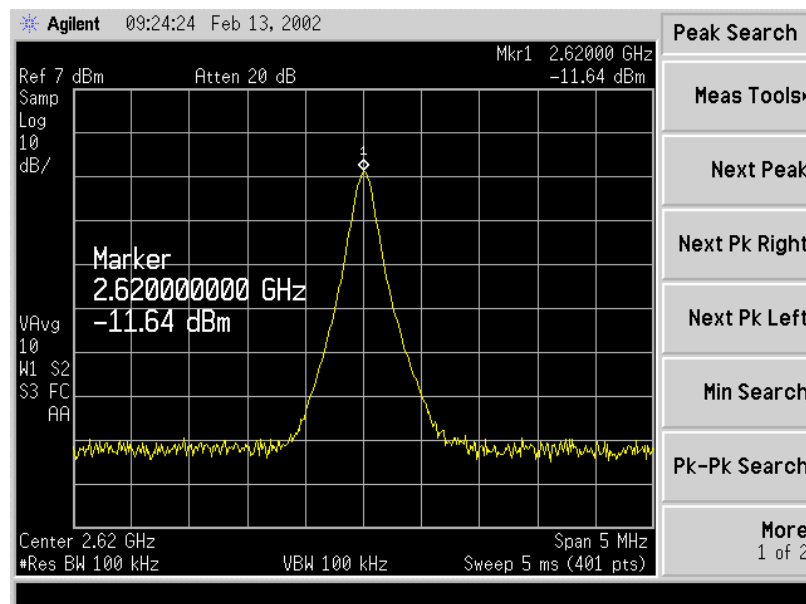
Step 3. Have a member of the tower crew, positioned at the upper end of the cables on the tower, connect the calibration cable to antenna cable 1 with a barrel connector.

Step 4. At the lower end of the RF cables, connect the cable from the Signal Generator to the calibration cable. Use a barrel connector to change the gender, if required.

Step 5. Connect the cable from the Spectrum Analyzer to antenna cable 1. Use a barrel connector to change the gender, if required.

Step 6. Calculate the marker using the following formula: (the length of **BOTH** the calibration cable and the antenna cable) x (loss per foot at the RFS center frequency for the type of cable used).

Step 7. Take a marker measurement on the Spectrum Analyzer by using the 'marker to peak' or the 'peak search' function. The screen on the Spectrum Analyzer should look similar to the one shown in Figure C5.

Figure C5: Insertion Loss (Cables on Tower) Marker Measurement Example

Step 8. The result should be within +/- 0.5 dB of the calculated value. If the insertion loss results do not agree with the manufacturer's data, check the cable connectors for proper connection to the cable, and check for kinks in the cable. If the Spectrum Analyzer has a distance to fault (DTF) function, this can be used to help troubleshoot kinks in the cable.

Step 9. Divide this value in half and assign the result to the calibration cable and to the antenna cable.



Caution: Cables with results greater than the specified limits (i.e., 2 or 3 dB high) should not be installed, as a potential hardware fault exists.

Step 10. Record the data in the RFS System Test Form under "MAIN FEEDER LOSS". Ensure that the information is recorded under the channel number that is on the cable label.

Step 11. Repeat steps 3 through 10 for antenna cables 2 through 8.

Step 12. When finished, take the average of the eight values obtained for the calibration cable. Use this value for the insertion loss of the calibration cable.

Step 13. Change the frequency to the next test frequency (refer back to Test Setup). Perform steps 1 – 12 until all cables have been successfully tested at the frequencies given in Table C5.

Step 14. Check the value of the nine jumpers at all three frequencies, per the procedure for cables on the ground. Record the data in the RFS System Test Form under "JUMPER LOSS". Ensure that the information is recorded under the channel number that is on the cable label.

RFS Test Box Setup

Step 1. For **RFS only** testing, connect the power/data test cable to the data connector on the RFS and to the RFS Test Box.

OR

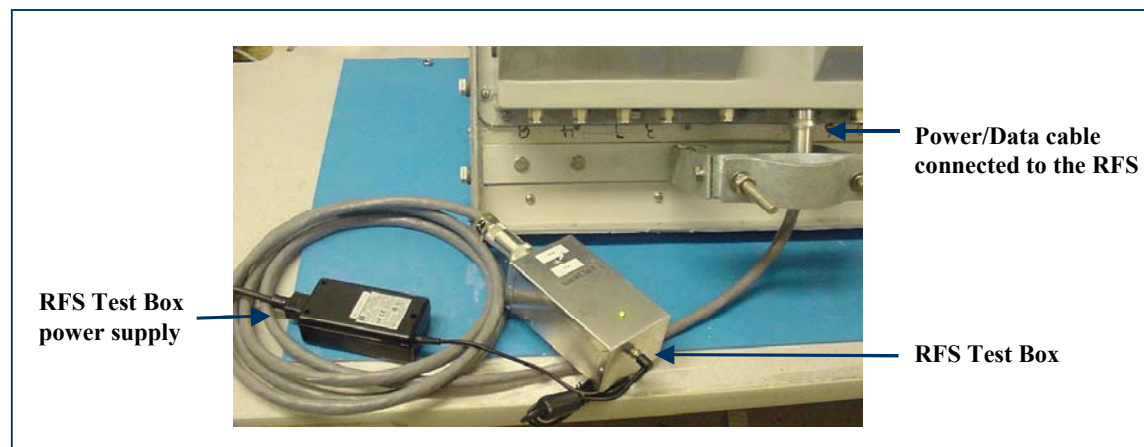
For RFS and cable testing, connect the installation power/data cable to the data connector on the RFS and to the RFS Test Box.

Refer to Figure C6.

Step 2. Connect the RFS Test Box power supply to the RFS Test Box.

Step 3. Plug the RFS Test Box power supply into a 110 VAC outlet.

Figure C6: RFS Only Testing Setup



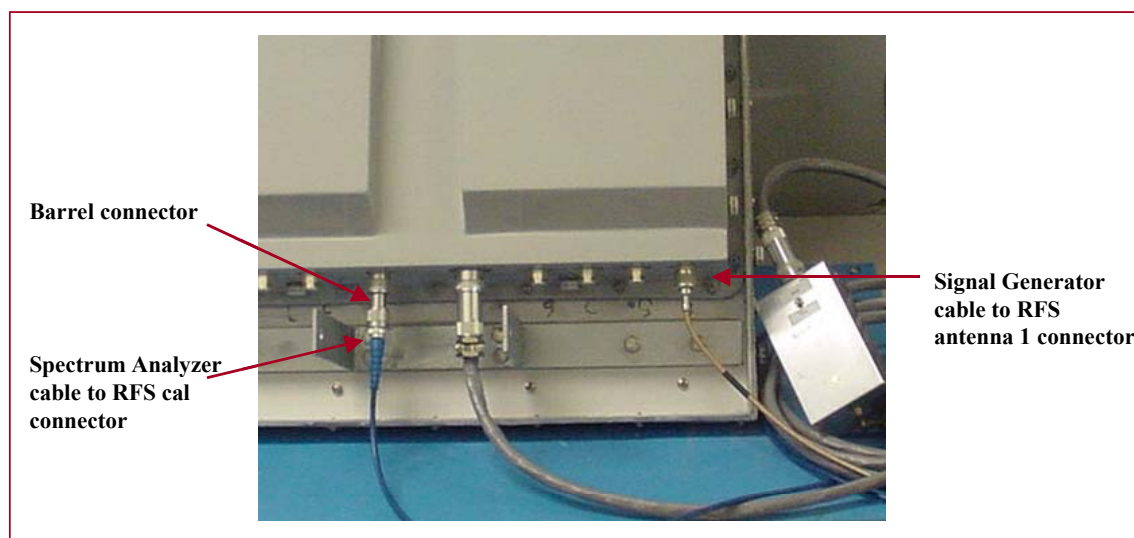
RFS Only Transmit Verification

Ensure that the calibration of the test setup and RFS Test Box setup for RFS Only has been performed each time the test frequency is changed. Refer to Figure C7.

Step 1. Switch the RFS Test Box to the transmit (Tx) mode.

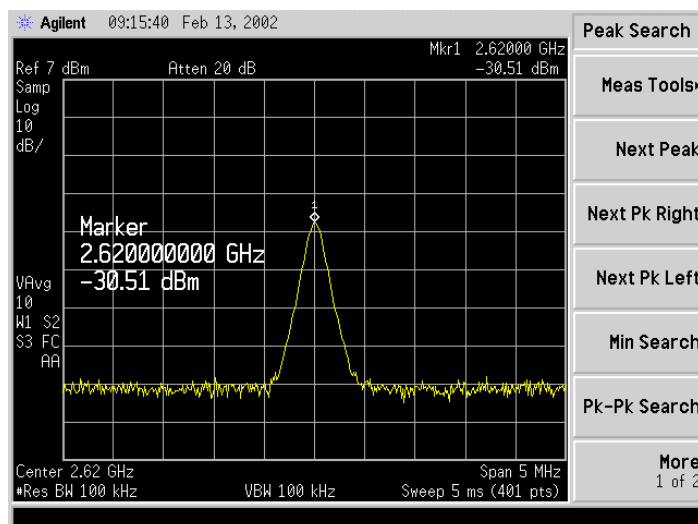
Step 2. Connect the cable from the Spectrum Analyzer to the RFS cal connector. Use a barrel connector to change the gender, if required.

Step 3. Connect the cable from the Signal Generator to the RFS antenna input number 1. Use a barrel connector to change the gender, if required.

Figure C7: RFS Only Tx Verification

Note: The position of the RFS will vary the sweep results due to reflections from the test surface.

Step 4. Take a marker measurement on the Spectrum Analyzer by using the ‘marker to peak’ or the ‘peak search’ function. The screen on the Spectrum Analyzer should look similar to the one shown in Figure C8.

Figure C8: RFS Only Tx Marker Measurement Example

Step 5. The marker value should be equal to the RFS Only Tx insertion loss within ± 2.0 dB, per the manufacturer's data. If the insertion loss results do not agree with the manufacturer's data, check the test setup.



Caution: An RFS with results greater than the ± 2.0 dB limits should not be installed, as a potential hardware fault exists. Contact Navini Networks Technical Support.

Step 6. Record the data in the RFS System Test Form under "RFS TX PATH LOSS (RFS ONLY)". Ensure that the information is recorded under the channel number of the RFS antenna that is being tested.

Step 7. Repeat steps 5 and 6 for the remaining seven antenna inputs on the RFS.

Step 8. Change the frequency to the next test frequency (refer back to Test Setup). Perform steps 1 – 8 until the RFS has been successfully tested at the frequencies shown in Table C5.

RFS Only Receive Verification

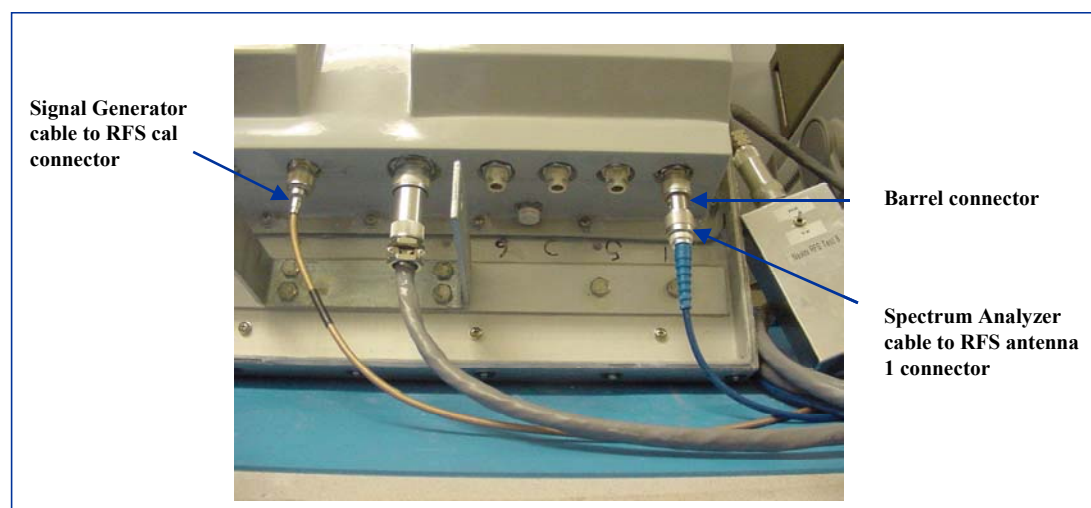
Step 1. Ensure calibration of the test setup and RFS Test Box setup for RFS Only has been performed each time the test frequency is changed.

Step 2. Switch the RFS Test Box to the Receive (Rx) mode.

Step 3. Connect the cable from the Signal Generator to the RFS cal connector. Use a barrel connector to change the gender, if required.

Step 4. Connect the cable from the Spectrum Analyzer to the RFS antenna input number 1. Use a barrel connector to change the gender, if required. See Figure C9.

Figure C9: RFS Only Rx Verification

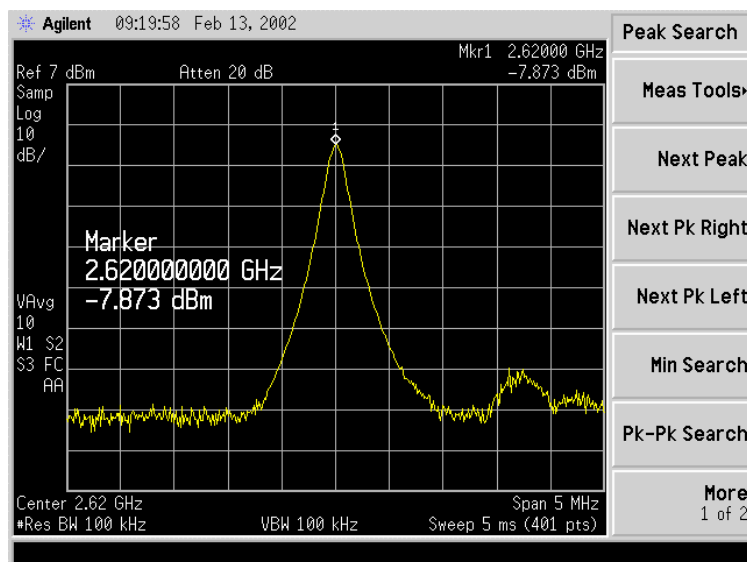




Note: The position of the RFS will vary the sweep results due to reflections from the test surface.

- Step 5.** Take a marker measurement on the Spectrum Analyzer by using the ‘marker to peak’ or the ‘peak search’ function. The screen on the Spectrum Analyzer should look similar to the one shown in Figure C10.

Figure C10: RFS Only Rx Marker Measurement Example



- Step 6.** The marker value should be equal to the RFS Only Rx insertion loss within +/- 2.0 dB, per the manufacturer’s data. If the insertion loss results do not agree with the manufacturer’s data, check the test setup.



Caution: An RFS with results greater than the +/- 2.0 dB limits should not be installed, as a potential hardware fault exists. Contact Navini Networks Technical Support.

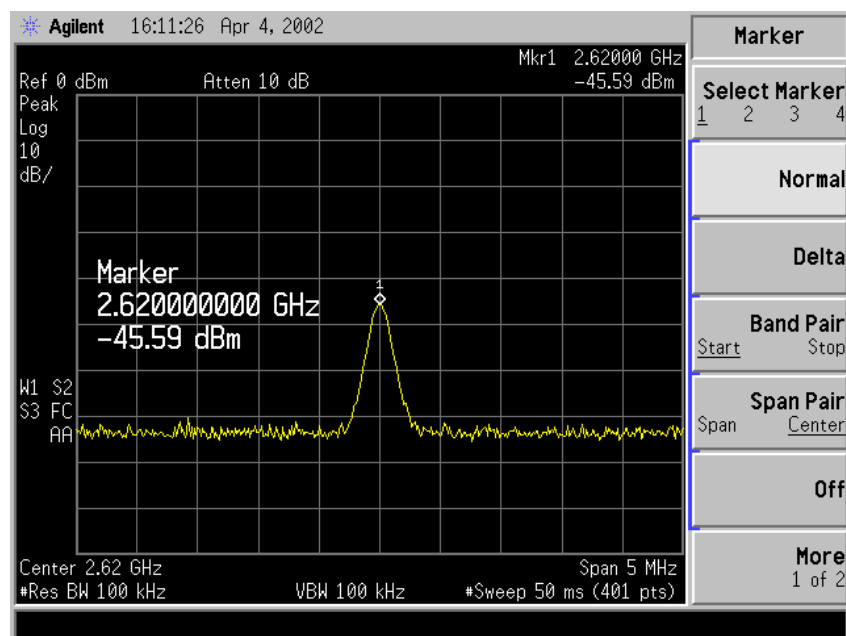
- Step 7.** Record the data in the RFS System Test Form under “RFS RX PATH LOSS (RFS ONLY)”. Ensure that the information is recorded under the channel number that is on the RFS antenna that is being tested.
- Step 8.** Repeat steps 5 through 7 for the remaining seven antenna inputs on the RFS.
- Step 9.** Change the frequency to the next test frequency (refer back to Test Setup). Perform steps 1 – 8 until the RFS has been successfully tested at the frequencies shown in Table C5.

RFS & Cables Transmit Verification

This test is performed after the RFS is installed and the antenna cables, calibration cable, and power/data cable are connected to the inputs on the RFS.

- Step 1.** Ensure calibration of the test setup and RFS Test Box setup for RFS and cables has been performed each time the test frequency is changed.
- Step 2.** Switch the RFS Test Box to the Transmit (Tx) mode.
- Step 3.** Connect the cable from the Spectrum Analyzer to the RFS calibration cable connector. Use a barrel connector to change the gender, if required.
- Step 4.** Connect the cable from the Signal Generator to the RFS antenna cable number 1 connector. Use a barrel connector to change the gender, if required.
- Step 5.** Take a marker measurement on the Spectrum Analyzer by using the ‘marker to peak’ or the ‘peak search’ function. The screen on the Spectrum Analyzer should look similar to the one shown in Figure C11.

Figure C11: RFS & Cables Tx Marker Measurement Example



- Step 6.** The marker value should be equal to the RFS Only Tx insertion loss + calibration cable loss + antenna cable loss + antenna cable jumper loss. Transmit insertion loss should be within +/- 2.0 dB of the sum of the parts. If the insertion loss results do not agree with the manufacturer's data, check the test setup and the cable connections.



Caution: If RFS & cables test results are greater than the +/- 2.0 dB limits, they should not be installed on a tower, as a potential hardware fault exists. Verify the connections and contact Navini Networks Technical Support.

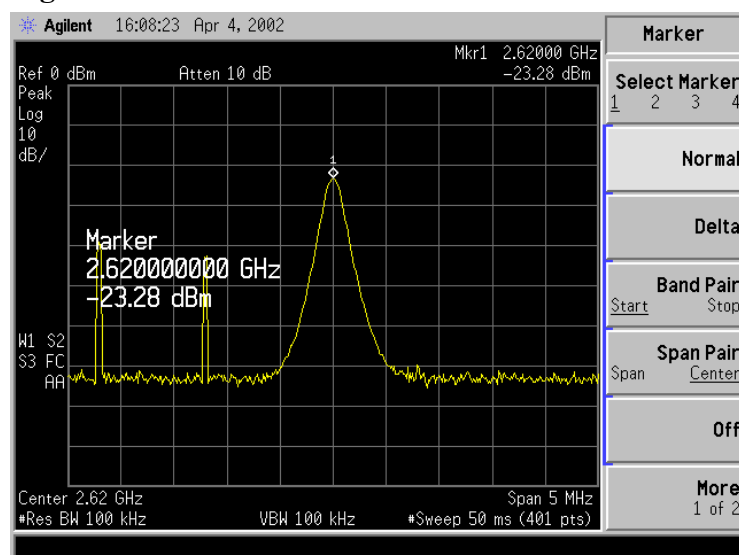
- Step 7.** Record the data in the RFS System Test Form under “TOTAL TX PATH LOSS (CABLE-RFS)”. Ensure that the information is recorded under the channel number that is on the cable label.
- Step 8.** Repeat steps 5 through 7 for the remaining seven antenna cable inputs on the RFS.
- Step 9.** Change the frequency to the next test frequency (refer to Test Setup). Perform steps 1-8 until the RFS has been successfully tested at the frequencies shown in Table C5.

RFS & Cables Receive Verification

This test is performed after the RFS is installed and the antenna cables, calibration cable, and power/data cable are connected to the inputs on the RFS.

- Step 1.** Ensure that the calibration of the test setup and RFS Test Box setup for RFS and cables has been performed each time the test frequency is changed.
- Step 2.** Switch the RFS Test Box to the Receive (Rx) mode.
- Step 3.** If present, remove the barrel connector from between the Signal Generator and Spectrum Analyzer cables.
- Step 4.** Connect the cable from the Signal Generator to the RFS calibration cable connector. Use a barrel connector to change the gender, if required.
- Step 5.** Connect the cable from the Spectrum Analyzer to the RFS antenna cable number 1 connector. Use a barrel connector to change the gender, if required.
- Step 6.** Take a marker measurement on the Spectrum Analyzer by using the ‘marker to peak’ or the ‘peak search’ function. The screen on the Spectrum Analyzer should look similar to the one shown in Figure C12.

Figure C12: RFS & Cables Rx Marker Measurement Example



Step 7. The marker value should be equal to the RFS Only RX Insertion Loss + Calibration Cable Loss + Antenna Cable Loss + Antenna Cable Jumper Loss. RX Insertion Loss should be within +/- 2.0 dB of the sum of the parts. If the Insertion Loss results do not agree with the manufacturers data, check the test setup and the cable connections.



Caution: If RFS & cables test results are greater than the +/- 2.0 dB limits, they should not be installed on a tower, as a potential hardware fault exists. Verify connections and contact Navini Networks Technical Support.

Step 8. Record the data in the RFS System Test Form under “TOTAL RX PATH LOSS (CABLE-RFS)”. Ensure that the information is recorded under the channel number that is on the cable label.

Step 9. Repeat steps 5 through 8 for the remaining seven antenna cable inputs on the RFS.

Step 10. Change the frequency to the next test frequency (refer to Test Setup). Perform steps 1-9 until the RFS has been successfully tested at the frequencies given in Table C5.

2.4 RFS System Test Form



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**2.4 GHz RFS INSTALL
TEST RESULT FORM**

RFS SN
NAME
DATE

MEASUREMENT DESCRIPTION	CHANNEL	2400MHz	2440MHz	2473MHz	AVERAGE
RFS TX PATH LOSS (RFS ONLY)	1	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	2	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	3	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	4	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	5	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	6	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	7	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	8	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	1	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	2	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	3	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	4	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	5	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	6	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	7	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	8	-	-	-	- 0.00
JUMPER LOSS	1	-	-	-	- 0.00
JUMPER LOSS	2	-	-	-	- 0.00
JUMPER LOSS	3	-	-	-	- 0.00
JUMPER LOSS	4	-	-	-	- 0.00
JUMPER LOSS	5	-	-	-	- 0.00
JUMPER LOSS	6	-	-	-	- 0.00
JUMPER LOSS	7	-	-	-	- 0.00
JUMPER LOSS	8	-	-	-	- 0.00
JUMPER LOSS	CAL	-	-	-	- 0.00
MAIN FEEDER LOSS	1	-	-	-	- 0.00
MAIN FEEDER LOSS	2	-	-	-	- 0.00
MAIN FEEDER LOSS	3	-	-	-	- 0.00
MAIN FEEDER LOSS	4	-	-	-	- 0.00
MAIN FEEDER LOSS	5	-	-	-	- 0.00
MAIN FEEDER LOSS	6	-	-	-	- 0.00
MAIN FEEDER LOSS	7	-	-	-	- 0.00
MAIN FEEDER LOSS	8	-	-	-	- 0.00
MAIN FEEDER LOSS	CAL	-	-	-	- 0.00
TOTAL CABLE RUN LOSS	1	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	2	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	3	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	4	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	5	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	6	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	7	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	8	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS	CAL	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	1	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	2	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	3	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	4	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	5	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	6	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	7	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	8	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	1	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	2	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	3	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	4	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	5	-	-	-	- 0.00

2.6 RFS System Test Form



Internet at the speed of thought™

**2.6 GHz RFS INSTALL
TEST RESULT FORM**

RFS SN
NAME
DATE

MEASUREMENT DESCRIPTION	CHANNEL				AVERAGE
RFS TX PATH LOSS (RFS ONLY)	1	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	2	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	3	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	4	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	5	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	6	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	7	-	-	-	- 0.00
RFS TX PATH LOSS (RFS ONLY)	8	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	1	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	2	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	3	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	4	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	5	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	6	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	7	-	-	-	- 0.00
RFS RX PATH LOSS (RFS ONLY)	8	-	-	-	- 0.00
JUMPER LOSS (Measured)	1	-	-	-	- 0.00
JUMPER LOSS (Measured)	2	-	-	-	- 0.00
JUMPER LOSS (Measured)	3	-	-	-	- 0.00
JUMPER LOSS (Measured)	4	-	-	-	- 0.00
JUMPER LOSS (Measured)	5	-	-	-	- 0.00
JUMPER LOSS (Measured)	6	-	-	-	- 0.00
JUMPER LOSS (Measured)	7	-	-	-	- 0.00
JUMPER LOSS (Measured)	8	-	-	-	- 0.00
JUMPER LOSS (Measured)	CAL	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	1	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	2	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	3	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	4	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	5	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	6	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	7	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	8	-	-	-	- 0.00
MAIN FEEDER LOSS (Measured)	CAL	-	-	-	- 0.00
TOTAL CABLE RUN LOSS (Measured)	1	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	2	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	3	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	4	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	5	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	6	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	7	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	8	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL CABLE RUN LOSS (Measured)	CAL	- 0.00	- 0.00	- 0.00	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	1	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	2	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	3	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	4	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	5	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	6	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	7	-	-	-	- 0.00
TOTAL TX PATH LOSS (CABLE-RFS)	8	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	1	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	2	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	3	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	4	-	-	-	- 0.00
TOTAL RX PATH LOSS (CABLE-RFS)	5	-	-	-	- 0.00

Appendix D: Base Station Installation Certification



COMPANY _____
 SITE NAME _____
 SITE NO _____
 LOCATION _____

BASE STATION INSTALLATION CHECKLIST 40-00092-00

SITE TYPE
 ANTENNA TYPE
 FREQUENCY BAND
 BTS ENCLOSURE

☐ MONOPOLE ☐ CO-LOCATE ☐ OTHER _____
☐ OMNI ☐ SECTORIZED
☐ 2.4GHz ☐ 2.6GHz
☐ INDOOR ☐ OUTDOOR ☐ OTHER _____

A	Equipment Installed in Building	☐ YES	☐ NO	
1	Equipment Installed and Secured Per Plan	☐ YES	☐ NO	☐ N/A
2	Roof/Ceiling/Wall Penetrations Patched, Sealed and Painted	☐ YES	☐ NO	☐ N/A
3	Penetration(s) Inspected by Landowner Representative	☐ YES	☐ NO	☐ N/A
B	Equipment Installed on Roof	☐ YES	☐ NO	
1	Equipment Installed and Secured Per Plan	☐ YES	☐ NO	☐ N/A
2	Structural Upgrades to Roof Installed Per Plan	☐ YES	☐ NO	☐ N/A
3	Equipment Support Frame Installed	☐ YES	☐ NO	☐ N/A
C	Equipment Installed on Grade	☐ YES	☐ NO	
1	Equipment Installed and Secured Per Plan	☐ YES	☐ NO	☐ N/A
2	Special Inspection for Foundation Steel Complete	☐ YES	☐ NO	☐ N/A
3	Concrete Placed and Vibrated	☐ YES	☐ NO	☐ N/A
4	Concrete Break Test Report Complete	☐ YES	☐ NO	☐ N/A
D	Civil/Site Work			
1	Fencing Complete (Tie-In to Ground System) Per Plan	☐ YES	☐ NO	☐ N/A
2	Gravel/Crushed Rock Placed over Weed Barrier	☐ YES	☐ NO	☐ N/A
3	Above Ground Conduits Installed Plumb	☐ YES	☐ NO	☐ N/A
4	Landscaping/ Erosion Control Complete Per Plan	☐ YES	☐ NO	☐ N/A
5	Access Road Complete Per Plan	☐ YES	☐ NO	☐ N/A
6	All Trash and Debris Hauled Off Site	☐ YES	☐ NO	☐ N/A
7	Site Area restored to Original Condition	☐ YES	☐ NO	☐ N/A
8	Unistruts, iron angles and Rods properly cold galvanized	☐ YES	☐ NO	☐ N/A
9	RF Safety Signage Installed where Required	☐ YES	☐ NO	☐ N/A
E	Monopole/Tower			
1	Monopole/Tower Plumb, Torqued and Free of Visible Defects	☐ YES	☐ NO	☐ N/A
2	Orientation of Monopole/Tower Per Plan	☐ YES	☐ NO	☐ N/A
3	Safety Climb Installed and Tensioned per Manufacturer Spec.	☐ YES	☐ NO	☐ N/A
4	Weep Hole Free of Obstructions	☐ YES	☐ NO	☐ N/A
5	Step Bolts Installed/ Removed Below 30 feet	☐ YES	☐ NO	☐ N/A
6	Monopole/Tower Tie-In to Ground Ring Complete	☐ YES	☐ NO	☐ N/A

F	Grounding			
1	Monopole/Tower Grounding Installed	☐ YES	☐ NO	☐ N/A
2	Ground Wire Types and Size meet construction Specs	☐ YES	☐ NO	☐ N/A
3	Lightning Rod Provided and Installed Per Plan	☐ YES	☐ NO	☐ N/A
4	5 Ohm Megger Ground Resistance Test Complete	☐ YES	☐ NO	☐ N/A
5	Buss Bars Installed Per Plan	☐ YES	☐ NO	☐ N/A
6	Surge Protector Installed Between RFS Antenna and Cable	☐ YES	☐ NO	☐ N/A
7	Coax Ground Kits Installed at RFS Antenna Per Plan	☐ YES	☐ NO	☐ N/A
8	Coax Ground Kits Installed at Tower Base Per Plan	☐ YES	☐ NO	☐ N/A
9	Coax Ground Kits Installed at Buss Bar Prior to BTS Per Plan	☐ YES	☐ NO	☐ N/A
10	Double Lug Connectors Used at All Buss Bar Attachments	☐ YES	☐ NO	☐ N/A
11	Cable Tray/Ice Bridge Bonded and Grounded to Buss Bar	☐ YES	☐ NO	☐ N/A
12	Surge Protectors Mounted and Secured on ground Buss Bar	☐ YES	☐ NO	☐ N/A
13	Master Ground Buss Bar Tied-In to Ground Ring	☐ YES	☐ NO	☐ N/A
14	Equipment Rack Ground Per Plan	☐ YES	☐ NO	☐ N/A
15	Power Supply/UPS, Rectifier Ground Per Plan	☐ YES	☐ NO	☐ N/A
16	Meter and Telco box Ground Per Plan	☐ YES	☐ NO	☐ N/A
17	Fence Work Grounded Per Plan	☐ YES	☐ NO	☐ N/A
18	Additional Equipment Tied-In to BTS properly Grounded	☐ YES	☐ NO	☐ N/A

G	Electrical, Telco and Network			
1	Power and Telco Conduits Installed Per Plan	☐ YES	☐ NO	☐ N/A
2	Conduits Are Labeled and Pull Strings are Provided	☐ YES	☐ NO	☐ N/A
3	Meter and Telco Box are Installed Per Plan	☐ YES	☐ NO	☐ N/A
4	Circuit Breakers Installed and Properly Labeled	☐ YES	☐ NO	☐ N/A
5	UPS Installed and All Internal Connections Made	☐ YES	☐ NO	☐ N/A
6	Rectifier Installed, Output and Wiring to BTS Checked	☐ YES	☐ NO	☐ N/A
7	Telco Tie-In to Source, Tested and Complete	☐ YES	☐ NO	☐ N/A
8	Network/Telco Tie-In to BTS, Tested and Complete	☐ YES	☐ NO	☐ N/A
9	EMS Installed and Connected to Network	☐ YES	☐ NO	☐ N/A

H	BTS System			
1	Cabinet is Positioned, Secured and Leveled Per Plan	☐ YES	☐ NO	☐ N/A
2	Cabinet Outer Surfaces Free from scratches, dents, corrosion	☐ YES	☐ NO	☐ N/A
3	All Hardware Connections within BTS are tightened/secured	☐ YES	☐ NO	☐ N/A
4	RF/GPS Coax Connectors Securely Connected to BTS	☐ YES	☐ NO	☐ N/A
5	Signal/Power Cable Securely Connected to BTS	☐ YES	☐ NO	☐ N/A
6	Ethernet/T1 cables Dressed and Secured to BTS	☐ YES	☐ NO	☐ N/A
7	Documents, License are Stored or Posted on BTS	☐ YES	☐ NO	☐ N/A

J	Antenna and Feeder System
----------	----------------------------------

- | | | | | |
|----|---|------------------------------|-----------------------------|------------------------------|
| 1 | RFS Antenna Height and Orientation Per Plan | ☐ YES | ☐ NO | ☐ N/A |
| 2 | RFS Antenna Mount Plumb Per Axis | ☐ YES | ☐ NO | ☐ N/A |
| 3 | GPS Antenna Mounted Per Plan | ☐ YES | ☐ NO | ☐ N/A |
| 4 | Zinc Cold Galvanizing compound used everywhere | ☐ YES | ☐ NO | ☐ N/A |
| 5 | Coaxial Cables Run Straight (Not Exceeding Bend Radius) | ☐ YES | ☐ NO | ☐ N/A |
| 6 | Coaxial Cables Tagged and Color Coded Per Plan | ☐ YES | ☐ NO | ☐ N/A |
| 7 | Connectors and Jumpers Installed and Weatherproofed | ☐ YES | ☐ NO | ☐ N/A |
| 8 | Cable Hangers, Bands or Ties Spaced up every 3 Feet | ☐ YES | ☐ NO | ☐ N/A |
| 9 | Antenna Power and Data Cable Continuity Tested | ☐ YES | ☐ NO | ☐ N/A |
| 10 | Antenna System Sweep Test Performed and Passed | ☐ YES | ☐ NO | ☐ N/A |
| 11 | SW and Hard Copy of Antenna Sweep Test Results Provided | ☐ YES | ☐ NO | ☐ N/A |

NOTES

Printed Name
Signature / Date
Company
Phone No.

Printed Name
Signature / Date
Company
Phone No.

Printed Name
Signature / Date
Company
Phone No.

Appendix E: Configuration Forms

The configuration forms are used to plan and design the operating parameters for the system. The parameters for every system element are defined in the EMS Server.

BTS Configuration Form

Company: _____
 Your Name: _____ Date: _____
 BTS ID/NAME: _____

NOTE 1: Field Values in gray rows indicate data that ordinarily should not be changed or that is populated automatically by the system.

NOTE 2: Default Field Values are underlined.

General Parameters

Status

Field Name	Values	Description
RF Admin Status	<u>Up</u> or Down	Determines if the BTS is transmitting Radio Frequency (RF). Up means transmitting. Down means not transmitting. To bring the RF Admin Status Up, execute the Enable action. To bring it Down, execute the Disable action.
Connected Status	True or False	Display only. The user cannot set this field. Indicates if the EMS can communicate with the BTS. The EMS Server sends a message to the BTS periodically. If the BTS responds, the EMS sets this field to True. If the BTS does not respond in a reasonable amount of time, the EMS changes the Connected Status to false. If the Connected Status is False, the EMS will not send any configuration messages to the BTS because it cannot communicate.
Provisioned Status	Provisioned or <u>Unprovisioned</u>	If Provisioned, the BTS has been configured and is ready for use.

IP

Field Name	Values	Description
BTS IP Address		Unique IP address for each BTS. Space bar used to remove or skip existing digits.
EMS Server IP Address		Unique IP address for an EMS. Defaults to the IP on which the EMS Server is running. Space bar used to remove or skip existing digits.
BTS Default Gateway		Default Gateway used to route IP packets for a BTS.
BTS Subnet Mask		Subnet Mask used to route IP packets for a BTS.
Street Address		Physical location of this BTS.
City		City in which BTS is located.
State		State in which BTS is located.
Zip		Zip code for location in which BTS is located
BTS ID		Unique numeric identification number for this BTS. Cannot be changed once the BTS is created in the system.
BTS Name		Unique name given to this BTS. No two BTS's can have the same name.
Suppress Alarms	TRUE or <u>FALSE</u>	To suppress alarms from BTS to EMS, set to TRUE until problem is resolved. Useful if BTS is flooding EMS and affecting its performance. To allow alarms to be sent, set to FALSE.
Suppress CPE Registration	TRUE or <u>FALSE</u>	Determines if BTS can send CPE Registration messages to EMS. Useful if BTS is flooding EMS and affecting its performance. To allow messages to be sent, set to FALSE.
Calibration Interval (hours)	<u>1</u> - 24	The interval of hours by which on-line calibration occurs.
Bridge Aging Timer (minutes)	1 - <u>60</u>	BTS Bridge Table timer that controls how long a PVC is assigned to an EID (CPE). The PVC to EID association is removed when no user traffic is received for the timer interval. Applicable only when dynamic PVC assignment is used.
Enable PVC Loopback	TRUE or <u>FALSE</u>	Determines if any PVC on this BTS can perform loopback test.
BTS Contact Personnel		Textual identification of a contact person for this BTS and how to contact them.
BTS Configuration Source	<u>EMS</u> or BTS	Determines where the BTS obtains its configuration data when reset. If provisioning BTS for first time, set to EMS. After successful reset, defaults to BTS.
Interface Type	Ethernet or ATM	Indicates the backhaul to which the BTS is connected.
BTS Profile Type	Unlicensed 2.4 GHz MMDS 2.6 GHz	Select the correct system. 2.4 GHz is the only unlicensed frequency. Any other system, 2.3, 2.5, and 2.6, select MMDS.
Frequency	2.305 GHz - 2.359 GHz 2.40 GHz - 2.473 GHz 2.50 GHz - 2.595 GHz	Scroll bar that allows you to set the center frequency for the BTS operation. The range depends on the type of system, i.e., 2.3 GHz, 2.4 GHz, 2.5 GHz, 2.6 GHz. The field is operated by clicking on the center frequency scroll bar and moving it left or right. The center frequency of an MMDS band BTS must match what is hard-wired on the RFS. During installation, the installers should check that the configured center frequency is identical to the center frequency labeled on the Channel

	2.602 - 2.686 GHz	Filter component of the RFS.
		 CAUTION: Changing an MMDS BTS center frequency may result in destruction of the PA's.

Diagnostics

Field Name	Values	Description
Enable Const Display	<u>True</u> or False	Determines if the BTS Constellation Display application can be logged into and used on this BTS. If set to True, this BTS can be logged into and its Constellation Display viewed.
Max Beamform Displays	0-9	The maximum number of CPE's that can be viewed simultaneously using the BTS Beamforming diagnostic display.
User Name	<u>ems</u>	Authorized user of all diagnostic tools.
Password		The password used to authenticate the login to all diagnostic tools.
Enable Spec Analyzer Display	True or <u>False</u>	Determines if the BTS Spectrum Analyzer (frequency) application can be logged into and used on this BTS.
Confirm Password		Confirms that the correct password is entered.

Performance

Field Name	Values	Description
Perf Log Server IP Address		IP address of the performance log collection server.
Perf Log Storage Directory		The name of the directory at the Performance Log server where the performance logs are to be sent. Note: The location of the log directory is "<ftp root directory>/<pm data directory>". Example: If the FTP root directory is set to "d:/naviniems/ftp" and the pm data directory is set to "performance", the location of the log directory will be "d:/naviniems/ftp/performance". Therefore, when configuring the FTP Daemon, set the FTP root directory to "<ems install directory>/ftp".
Upload Interval (minutes or hours)	Disable, 15 minutes, 30 minutes, 1 hour, 2 hours, etc.	The interval that the BTS uploads performance data to the EMS.
Collection Interval (minutes or hours)	Disable, 15 minutes, 30 minutes, 1 hour	The interval that the BTS collects the performance logs.
Perf Log FTP User Name		The FTP user name set in the FTP Daemon running on the server where performance logs are captured.
Perf Log FTP Password		The FTP password set in the FTP Daemon running on the server capturing performance logs.
Confirm Password		Re-enter password to confirm authorized access.

GPS

Field Name	Values	Description
GPS Latitude	<u>North</u> or South 0 (deg) 0 (min) 0 (sec)	The latitude of the BTS in degrees, minutes, and seconds.
GPS Longitude	<u>East</u> or West 0 (deg) 0 (min) 0 (sec)	The longitude of the BTS in degrees, minutes, and seconds.
GPS Height (cm)	0	The height of the BTS in centimeters.
GPS Gmt Offset (min)	-360	The difference in time (minutes) between Greenwich Mean Time (GMT), which is zero, and the time zone where the BTS is located. For example, if the BTS is located in Dallas, Texas, the local time is 6 hours earlier than GMT. In this example, you would enter -360, which is 6 hrs x 60 mins. If the local time is ahead of GMT, you would enter a + in front of the number.

Neighbor BTS Frequency List

Field Name	Values	Description
Center Frequency (Scroll Bar)	2.305 GHz - 2.359 GHz 2.40 GHz - 2.473 GHz 2.50 GHz - 2.595 GHz 2.602 - 2.686 GHz	The frequency at which the neighboring BTS is transmitting.
Colocated	Checkmark or blank	Click to place a checkmark indicating that the neighboring BTS is located on the same tower as the current BTS.

CPE Ping Table

Field Name	Values	Description
Ping Sequence	0, 1, 2, 3, etc.	Order in which the element with this IP address is pinged.
Ip Address		IP address of the element being added to the Ping Table.
Display String	Alphanumeric (up to 30 characters)	User-assigned designation (name/string) for this element.

Air Interface Parameters

Layer 1 - General

Field Name	Values	Description
RFS	<u>Active</u> or Passive	Specifies whether the RFS has active or passive circuitry.
Gps Offset	<u>0</u>	This is the GPS timing offset to apply to the BTS in order of chips (2.5us). The GPS offset must be different for each BTS sharing the same frequency so they do not interfere with each other.
Sync Scale	<u>0.1125</u>	The scale setting applied to the transmitted synchronization signal.
Acc Scale	<u>0.0557</u>	The scale setting applied to the Access Channel.
Tcc Scale	<u>0.0197</u>	The scale setting applied to the Traffic Channel.
Max Scale	<u>0.2516</u>	The maximum allowable scale setting for each of the above scales: Sync, ACC, TCC.
Rx Sensitivity (-dBm)	<u>100.0</u>	The target Receiver sensitivity for each antenna. This target is used during full calibration. If it is changed, full calibration must be performed for it to take effect.
Antenna Power (dBm)	<u>30.0</u>	The target antenna power for each antenna. This target is used during full calibration.
Cal Cable Loss (dB)	<u>0.0</u>	Entered in the EMS during commissioning as one of several inputs for performing full calibration. This value is the measured calibration cable loss. If it is changed, full calibration must be performed for it to take effect.
Cal Backplane Loss (dB)	<u>5.0</u>	Calibration Backplane Loss (dB)
Cal Total Loss (dB)	<u>0.0</u>	Displays the total calibration loss, calculated from the values in Cal Cable Loss and Cal Backplane Loss fields.
Synthesizer Tx Gain		Displays the Transmitter gain setting for the Synthesizer used during calibration. This field is a result that is automatically returned from full calibration.
Synthesizer Rx Gain		Displays the Receiver gain setting for the Synthesizer used during calibration. This field is a result that is automatically returned from full calibration.
Synthesizer Sc Gain		Displays the Loopback gain setting for the Synthesizer used during calibration. This field is a result that is automatically returned from full calibration.
Synthesizer Level		Displays the power level of the Synthesizer.

Layer 1 - Antenna Table

Field Name	Values	Description
Antenna Index	1-8	The number of the antenna (1-8) that maps to a specific antenna element in the RFS.
Admin Status	<u>Up</u> or Down	Determines if the antenna is transmitting RF. Up means transmitting; Down means not transmitting.
Power Splitter_I		The real element of the calibrator board characteristics that is found in the RFS. This information captures the loss and phase information of the board. The Power Splitter data is unique to each RFS. An RFS Configuration CD ships with the equipment. It provides an RFS script and instructions for selecting the correct value to match the specific RFS that is physically installed with the BTS.
Power Splitter_Q		The imaginary element of the calibrator board that is found in the RFS. This information captures the loss & amplitude information of the board. The Power Splitter data is unique to each RFS. An RFS Configuration CD ships with the equipment. It provides an RFS script and instructions for selecting the correct value to match the specific RFS that is physically installed with the BTS.
RF Tx Gain	0-255	The Transmit gains for each antenna element, ranging from 0-255, with 0 being the lowest gain. This data is returned as a result of full calibration.
RF Rx Gain	0-255	The Receive gains for each antenna element, ranging from 0-255, with 0 being the lowest gain. This data is returned as a result of full calibration.

Layer 1 - w0 Table

Field Name	Values	Description
Sub Carrier Id	1-5	The subcarrier number. Subcarriers are assigned in pairs.
Antenna Index	1-8	The number of the antenna element.
W0 Weight_I		Real elements of the vector used to control ACC spatial pattern.
W0 Weight_Q		Imaginary elements of the vector used to control ACC spatial pattern.

Layer 1 - Calibration Table

Field Name	Values	Description
Sub Carrier Id	1-10	The subcarrier number.
Antenna Index	1-8	The number of the antenna element.
Tx Weight_I		Real elements of the vector used while transmitting to control ACC spatial pattern. This data is returned as a result of any of the calibration modes.
Tx Weight_Q		Imaginary elements of the vector used while transmitting to control ACC spatial pattern. This data is returned as a result of any of the calibration modes.
Rx Weight_I		Real elements of the vector used during Receive to control ACC spatial pattern. This data is returned as a result of any of the calibration modes.
Rx Weight_Q		Imaginary elements of the vector used during Receive to control ACC spatial pattern. This data is returned as a result of any of the calibration modes.

Layer 2 - Carrier Data

Field Name	Values	Description
Sub Carrier Number / Sub Carrier	1-2, 3-4, 5-6, 7-8, 9-10	These two fields identify the 10 subcarriers. You can click on the pair of subcarriers to be enabled for this BTS. Subcarriers are assigned in pairs, one for uplink and one for downlink.
Access Channel	<u>Checkmark</u> or blank	Access Code Channels: The ACC Channel occupies the Code Channel with Walsh Index 0 configured on a specified subcarrier frequency. Each checkbox indicates which pair of subcarriers is used for the Access Channel(s).
Broadcast Channel	<u>Checkmark</u> or blank	Broadcast Code Channel: If the box is checked, then this channel is used to broadcast BTS related information. If left blank, then information is broadcast on the ACC channel.
TDD Symmetry Ratio	<u>Symmetric</u> or Asymmetric	Symmetric Ratio is 1:1. Asymmetric Ratio is 1:3. This parameter determines the variable uplink and downlink ratio in a TDD frame. If set to Asymmetric, the downlink will have 3 times more bandwidth than the uplink. This is sometimes desired due to the types of users on the system, i.e., downloading files off the Internet.
Repeat Uplink Pkts	<u>Checkmark</u> or blank	If the box is checked, this carrier will repeat uplink packets.
Frequency (Scroll Bar)	2.305 GHz - 2.359 GHz 2.40 GHz - 2.473 GHz 2.50 GHz - 2.595 GHz 2.602 - 2.686 GHz	Indicates the center frequency of the BTS transmit signal.

Layer 2 - Bandwidth

Field Name	Values	Description
Underload Threshold (%)	<u>80%</u>	The threshold crossing in which a BTS changes its load congestion state from Overload (either Positive Access Overload or Negative Access Overload) to Underload.
Overload Threshold (%)	<u>85%</u>	The threshold crossing in which a BTS changes its load congestion state from Underload to Positive Access Overload.
Positive Access Overload Threshold (%)	<u>90%</u>	The threshold crossing in which a BTS changes its load congestion state from Negative Access Overload to Positive Access Overload.
Negative Access Overload Threshold (%)	<u>95%</u>	The threshold crossing in which a BTS changes its load congestion state from either Underload or Positive Access Overload.
Reserved Channels for Accesses	<u>12</u>	Number of channels reserved for access when in the Underload state.
CPE Inactive Time (min)	<u>15</u>	When a CPE has not communicated with a BTS for the set Inactive Time, the status of the CPE changes from active to inactive, as expressed in minutes.
Bandwidth Adjust Interval (10ms)	<u>20</u>	A user's bandwidth (uplink or downlink) is adjusted every Adjust Time if needed when on TCC. Expressed in units of 10 milliseconds.
Realtime Session Hold Time (10ms)	<u>250</u>	The length of time a user with realtime data holds RF resources after the incoming packet queue is empty. Expressed in units of 10 milliseconds.
Non-realtime Session Hold Time (10ms)	<u>250</u>	The length of time a user with non-realtime data holds RF resources after the incoming packet queue is empty. Expressed in units of 10 milliseconds.
Non RT PreRelease BW (Kbps)	0 - 2,048 Default is <u>32</u>	The bandwidth a user is assigned while in Non-realtime Session Hold Time. The Non RT PreRelease BW is in units of MAC packets.
Denied Req Number	<u>5</u>	The number of consecutive times a user's access request fails due to lack of RF resources before access is denied.
Average LCC Q LEN Factor	<u>2</u>	Factor used to determine the average LLC queue length.
Exponential For Average	<u>1</u>	Average exponent for all statistical variables but power.
Average Burst Time (ms)	<u>50</u>	Average time for a data burst, expressed in units of 10 milliseconds.
Max Bts Power (TCC Power)	<u>320</u>	Maximum RF power a BTS has. It is in units of maximum TCC power per channel. This field is not configurable.
DL ACC Power Per Channel (TCC Power)	<u>8</u>	Downlink ACC RF power per channel. It is expressed in units of maximum TCC power per channel.
TCC Initial Setup Power (%)	<u>25%</u>	Initial setup power of a TCC channel. Expressed in units of the percentage of the max. TCC power per channel.
Average Exponential Factor	<u>1</u>	Average exponent for average power.
TCC Power per Channel Range (dB)	<u>19</u>	Number of decibels the downlink TCC power per channel can vary.
Min Realtime Data Bandwidth (Kbps)	0 - 2,048 Default is <u>32</u>	The minimum bandwidth a user with realtime data holds that is not used for acknowledgement. Expressed in units of MAC packets (data rate).

Supported Modulations	QAM4 QAM4 QAM8 <u>QAM4 QAM16</u> QAM4 QAM8 QAM16	The highest QAM Rank the BTS can process.
Total Priority Level Num.	<u>8</u>	The total number of QoS classes the BTS can maintain. Each class is associated with a priority.
Max Bandwidth for Priority 1-8 (%)	<u>1 default 85%</u> <u>2 default 10%</u> <u>3 default 5%</u> <u>4-8 default 0%</u>	The percentage of the total bandwidth a QoS class associated with a certain priority is entitled to.

Layer 2 - WAN Congestion Control

Field Name	Values	Description
Average Queue Size Weight (%)	<u>100.0</u>	For downlink, this value - expressed as a percentage - indicates how much the current queue size contributes to the calculation of the average queue size. The average queue size is used by the BTS Resource Management software to determine how many resources (Code Channels) to give a CPE. The greater the weight, the greater influence the current queue size has on the average queue size. The lower the weight, the more the queue size is an actual average of the current queue size over time.
Max Queue Size (KB)	<u>512</u>	For downlink, the maximum queue size - in kilobytes - for each priority queue (high, low, voice). Once the queue is full (at Min Drop Threshold) all packets are dropped.
Min to Max Drop Probability (%)	<u>10</u>	For downlink, the probability of a packet being dropped when the Min Threshold has been reached. The higher this number, the more likely a packet will be dropped between the Min Threshold and the Max Threshold. NOTE: All packets are dropped at the Max Threshold.
Realtime Min Drop Threshold (%)	<u>100</u>	For downlink, the minimum queue size in which voice priority packets are considered for being dropped. For example, if set to 10%, once the queue size reaches 11% or more, voice priority packets may be dropped. The Max Drop Probability field determines if a packet is dropped once the Min Threshold is exceeded.
High Priority Min Drop Threshold (%)	<u>100</u>	For downlink, the minimum queue size in which high priority packets are considered for being dropped. For example, if set to 10%, once the queue size reaches 11% or more, high priority packets may be dropped. The Max Drop Probability field determines if a packet is dropped once the Min Threshold is exceeded.
Low Priority Min Drop Threshold (%)	<u>100</u>	For downlink, the minimum queue size in which low priority packets are considered for being dropped. For example, if set to 10%, once the queue size reaches 11% or more, high priority packets may be dropped. The Max Drop Probability field determines if a packet is dropped once the Min Threshold is exceeded.

Layer 2 - CPE Uplink Congestion Control

Field Name	Values	Description
Avg Queue Size Weight (%)	<u>100.0</u>	For the uplink, this value - expressed as a percentage - indicates how much the current queue size contributes to the calculation of average queue size. The average queue size is used by the BTS Resource Management software to determine how many resources (Code Channels) to give a CPE. The greater the weight, the greater influence the current queue size has on the average queue size. The lower the weight, the more the average queue size is an actual average of the current queue size over time.
Max Queue Size (KB)	<u>512</u>	For the uplink, the maximum queue size for each priority queue (high, low, voice). Once the queue is full (at Min Drop Threshold) all packets are dropped.
Min to Max Drop Probability (%)	<u>10</u>	For the uplink, the probability of a packet being dropped when the Min threshold has been reached. The higher this number, the more likely a packet will be dropped between the Min Threshold and Max Threshold. Note: All packets are dropped at the Max Threshold.
Realtime Min Drop Threshold (%)	<u>100</u>	For the uplink, the minimum queue size in which voice priority packets are considered for being dropped. For example, if set to 10% once the queue size reaches 11% or more, voice priority packets may be dropped. The Max Drop Probability field determines if a packet is dropped once the Min Threshold is exceeded.
High Priority Min Drop Threshold (%)	<u>100</u>	For the uplink, the minimum queue size in which high priority packets are considered for being dropped. For example, if set to 10% once the queue size reaches 11% or more, high priority packets may be dropped. The Max Drop Probability field determines if a packet is dropped once the Min Threshold is exceeded.
Low Priority Min Drop Threshold (%)	<u>100</u>	For the uplink, the minimum queue size in which low priority packets are considered for being dropped. For example, if set to 10% once the queue size reaches 11% or more, low priority packets may be dropped. The Max Drop Probability field determines if a packet is dropped once the Min Threshold is exceeded.

Backhaul Interface Parameters

T1

Field Name	Values	Description
Admin Status	<u>Up</u>	Up or Down. Display only. The administrative (operational) status of this T1. If Down, no traffic is able to go through this interface. This field is not configurable.
Line Type	<u>ESF</u> or D4	Framing format
Send Code	<u>Send line code</u> , Send No Code, Send Payload Code, Send Reset Code	Selection of codes used for far-end loopback tests
Signal Mode	<i>None</i>	Always None
Line Length (foot)	<u>5000</u>	Length of T1 cables from BTS to terminating equipment
Fdl	None, Att54016, <u>AnsiT1403</u>	Facility Data Link (FDL) signaling type
Line Status Change Trap	<u>Enabled</u> or Disabled	Enables generation of traps based on changes to the line status
Line Index	<u>1</u>	The ATM IF index that this T1 is associated with
Line Coding	<u>B8ZS</u> or AMI	Type of coding used to encode bits on the line
Circuit Identifier		Transmission vendor's circuit identifier
Transmit Clock Source	<u>Loop timing</u> or Local Timing	Source of the framer Transmit clock
Channelization	<i>Disabled</i>	Always Disabled (clear channel)

IMA Groups

Field Name	Values	Description
Admin Status	<u>Up</u>	Up or Down. This is the administration (operational) status of the IMA group. If Down, no traffic is able to go through this interface.
Symmetry	<u>Symmetric operation</u> , Symmetric & Asymmetric, or Asymmetric	Three options for the relationship of the Transmit and Receive link throughput: - Symmetric operation - all links should be configured in both directions. Tx and Rx must both be active to use the disk. - Symmetric and Asymmetric operation - all links should be configured in both directions. Transmitting is allowed when Tx is active and Rx is not active. - Asymmetric operation - not required to configure the IMA links in both Tx and Rx directions.
Min Num Rx Links	<u>3</u>	Minimum number of active Receive links that is necessary for the IMA group to be active.
Tx Ima Id	<u>0</u>	Near-end (Transmit) IMA ID.
Alpha Value	<u>2</u>	Used to specify the number of consecutive valid ICP cells to be detected before moving to the IMA hunt state from the IMA sync state.

Gamma Value	<u>1</u>	Used to specify the number of consecutive valid ICP cells to be detected before moving to the IMA sync state from the IMA pre-sync state.
Index	<u>IMA group 2</u>	IMA Group 1 or 2. Unique sequence number of the IMA group.
Min Num Tx Links	<u>1</u>	Minimum number of Transmission links that have to be active for the IMA group to be active.
Ne Tx Clk Mode	<u>ITC</u>	Near-end Transmit clock mode.
Tx Frame Length	<u>M128</u>	Length of IMA frame being transmitted. It is defined as M consecutive cells.
Beta Value	<u>2</u>	Used to specify the number of consecutive ICP cells with errors to be detected before moving to the IMA hunt state from the IMA sync state.

Add T1's to IMA Groups

IMA Group	T1's Associated With this IMA Group	Notes
IMA 1		
IMA 2		

ATM

Field Name	Values	Description
If Index	<u>T1-1</u> (first T1 ID)	Interface (IF) Index associated with this ATM interface.
Max Vccs	<u>1001</u>	Maximum Virtual Channel Circuits for this interface.
Max Active Vci Bits	<u>9</u>	The number of bits for Virtual Channel Identifier (VCI). Determines the maximum VCI value allowed for this interface. The Max Value is calculated by $2^{\text{max active vci bits}}$.
Max Vpcs	<u>0</u>	Maximum Virtual Private Circuits for this interface.
Max Active Vpi Bits	<u>3</u>	The number of bits for Virtual Private Identifier. Determines the maximum VPI value allowed for this interface. The max value is calculated by $2^{\text{max active vpi bits}}$.

PVC

Field Name	Values	Description
if Index	<u>T1-1</u>	The ATM IF index that this PVC is associated with.
Vpi (start and end)	<u>0</u>	Virtual Path Identifier. The VPI + VCI are in the cell header and identify the next destination of a cell as it passes through a series of ATM switches.
Vci (start and end)	<u>0</u>	Virtual Channel Identifier. The VPI + VCI are in the cell header and identify the next destination of a cell as it passes through a series of ATM switches.
Tr/Re Traffic Descr Indexes	<u>2</u>	Index of the ATM Descriptor that applies to this PVC. The Transmit and Receive Descriptors are the same.
AAL5 CPCS Tx SDU Size (Byte)	<u>1528</u>	The maximum AAL5 CPCS SDU size, in bytes, that is supported in the Transmit direction.

AAL5 CPCS Rx SDU Size (Byte)	<u>1528</u>	The maximum AAL5 CPCS SDU size, in bytes, that is supported in the Receive direction.
Admin Status	<u>Up</u>	Up or Down. The administrative (operational) state of the PVC. If it is Down, this PVC may not be used for traffic.
AAL Type	<u>AAL5</u> (1-5)	The type of ATM Adaptation Layer (AAL) used on this PVC: AAL1, AAL2, AAL3, AAL4, or AAL5.
AAL5 Encap Type	<u>LLC encapsulation</u>	The type of data encapsulation used over the AAL5 SSCS layer.
Cast Type	<u>P2P</u>	The connection topology type.
Conn Kind	<u>PVC</u>	The type of VCL. This is always PVC.

Assign CPE to PVC

Field Name	Values	Description
PVC	T1-1-1-100 (example)	Identifies the PVC to be assigned to the specified CPE.
CPE	<u>0</u>	CPE assigned to specified PVC.
Data		Denotes what type of PVC to assign.

CPE Configuration Data Form

Company: _____
 Your Name: _____ Date: _____

NOTE 1: Field Values in gray rows indicate data that ordinarily should not be changed or that is populated automatically by the system.

NOTE 2: Default Field Values are underlined.

Add CPE

Field Name	Values	Description
EID (hex)	<u>0</u>	Equipment Identifier unique to each CPE. This value is determined during the manufacturing process and is displayed on the case of the CPE hardware, as well as entered and displayed as a hexadecimal number in this field.
Descriptor Name	<u>CPE Descriptor-1</u>	The name of the CPE Descriptor to be used with this CPE. The CPE Descriptor level affects Quality-of-Service (QoS) for this CPE's data packets.
Collect Perf Data	<u>True</u>	True or False. Collect Performance Data. If True, this CPE sends performance metrics to the BTS at the set interval. The BTS then uploads the performance data to the EMS at set intervals. The interval setting for collection and upload from the BTS to the EMS is set in the Performance fields for the BTS.
Nomadic	<u>Disabled</u>	Enabled or Disabled. If Enabled, this CPE can access any BTS in the network that is defined in its Available Home

		BTS list at the bottom of the screen. When enabled, the Current Home BTS list is ignored. If disabled, this CPE can only access a BTS in its Available Home BTS list.
Admin Status	<u>Active</u>	Active or Suspended. If suspended, the CPE cannot access any BTS. A Service Provider may decide to make the CPE suspended due to late service payments, security concerns, etc., rather than deleting the CPE from the system database.

Home BTS

Field Name	Values	Description
Available Home BTS		Add or Remove BTS Names. A list of available BTS's to include in the Current Home BTS list for this CPE.
Current Home BTS		Add or Remove BTS Names. If Nomadic is disabled, these are the only BTS's this CPE can access. If Nomadic is enabled, this list is ignored.

Layer 3

Field Name	Values	Description
Ingress Acl	(Checkbox)	If checkbox is clicked "on" any incoming packet whose MAC address cannot be found in the current CPE Authenticated IP List will be discarded.
Ingress Broadcast	(Checkbox)	If checkbox is clicked "on" any incoming MAC broadcast message will be discarded.

DHCP Relay

Field Name	Values	Description
Free Address High Drop Policy	<u>Drop most recently leased</u> or Drop least recently leased	Drop the most recently leased or least recently leased IP addresses
Max Address Number	<u>Drop most recently leased</u> or Drop least recently leased	Drop the most recently leased or least recently leased IP addresses

IP Address

Field Name	Values	Description
Static Client IP Address	<u>0.0.0.0</u>	Use static, rather than dynamic, IP addressing for this device. If static IP assignment is being made, add this IP address to the Ingress Filter Authenticated IP List. Otherwise, leave zeroes.
Hardware Address	<u>0:0:0:0:0:0</u>	Enter the Ethernet address of the host computer to which the CPE is connected and that corresponds to the above Client IP Address.

EMS Configuration Data Form

(To configure EMS Servers & Clients in the Ripwave System)

Company: _____
 Your Name: _____ Date: _____

NOTE 1: Field Values in gray rows indicate data that ordinarily should not be changed or that is populated automatically by the system.

NOTE 2: Default Field Values are underlined.

Field Name	Values	Description
EMS Id		Unique identifier for this EMS.
Alarm AutoAck	<u>True</u>	True or False. If True, the EMS will automatically acknowledge all alarms except alarms with a severity level of Warning (blue). An Alarm Engineer will only see current alarms on the system. However, all alarm activity is logged to an alarm file.
Server Ip Address		IP address of the EMS Server.
Database Schema Version	01 (example)	Version of the EMS server database schema.
Mib Version	1.19.01 (example)	Version of the BTS Management Information Base (MIB).
BTS/CPE SW Directory	loads (example)	Directory where BTS and CPE software loads are stored. Used by the EMS to obtain the location of the software loads during downloads. Copy BTS and CPE software loads to this directory during initial installations or upgrades. Otherwise, the EMS cannot download the software to the BTS. This field is used in conjunction with the FTP Server Root Path field by the EMS to obtain the software loads. The full path the EMS searches for software loads is <FTP Server Root Path>\<BTS/CPE SW Directory>. Example - C:\naviniems\ftp\loads.
FTP Server Root Path		The Root directory where BTS and CPE software loads are stored. This field must match what is configured in the FTP Daemon. Otherwise, the EMS will not be able to download BTS and CPE software loads to the BTS. This path is used by the EMS to obtain the location of the software loads during downloads. Copy BTS and CPE software loads to this root directory during initial installations or upgrades. This field is used in conjunction with the BTS/CPE SW Directory field by the EMS to obtain the software loads. The full path the EMS searches for software loads is <FTP Server Root Path>\<BTS/CPE SW Directory>. Example - C:\naviniems\ftp\loads.
Network ID		Unique identifier for this Service Provider's wireless network. Intended to ensure other Service Providers' CPE's cannot operate in the identified network. A CPE with a different BTS network ID cannot be provided

		service by that BTS.
Server Name		Host name of the EMS Server machine.
EMS Version	1.19.01 (example)	Version of the EMS Server software.
Idl Build Number	1.18.09 (example)	CORBA networking software IDL version used by the EMS Server.
BTS/CPE SW Ftp User Name		User name for downloading BTS and CPE software from the EMS. This field must match what is configured in the FTP Daemon. Otherwise, the EMS cannot download BTS and CPE software loads to the BTS.
BTS/CPE SW Ftp Password		Password used when downloading BTS and CPE software. This field must match what is configured in the FTP Daemon. Otherwise, the EMS cannot download BTS and CPE software loads to the BTS.
Confirm Password		Password must be re-entered for security purposes.
CPE AutoProvisioning	<u>Disabled</u>	Enable or Disable. Determines if the EMS is in AutoProvision mode during CPE registration. If enabled, the EMS will allow unprovisioned CPE's to access the system with minimum bandwidth for a short period of time. The minimum bandwidth is defined by the first entry in the CPE Descriptor table. Once the CPE is allowed limited access to the system, it can connect to a default web site to enter billing information and the CPE can be provisioned automatically with the EMS. If disabled, the EMS will NOT allow an unprovisioned CPE to access the system.

Global Parameters Configuration Form

Company: _____

Your Name: _____ Date: _____

NOTE 1: Field Values in gray rows indicate data that ordinarily should not be changed or that is populated automatically by the system.

NOTE 2: Default Field Values are underlined.

ATM Descriptor

Field Name	Values	Description
Index	<u>0</u>	Identifier for this ATM Descriptor
Type	<u>NOCLPNOSCR</u> , NOCLPSCR, CLPNOTAGGINGSCR, CLPTAGGINGSCR, CLPNOTAGGINGMCR, CLPTRSPARENTNOSCR, CLPTRSPARENTSCR, NOCLPTAGGINGNOSCR	Type of ATM

Category	<u>CBR</u> , RTVBR, NRTVBR, ABR, UBR	Category of this ATM (see parameters, below)
Frame Discard	<u>True</u>	True or False. If set to True, enables the ability to discard ATM frames.
Param1 - Param5	<u>0</u>	Described below
CBR Parameters: PCR		Peak Cell Rate
RTVBR Parameters: PCR SCR MBS		Peak Cell Rate Sustainable Cell Rate Maximum Burst Size
NRTVBR Parameters: PCR SCR MBS		Peak Cell Rate Sustainable Cell Rate Maximum Burst Size
ABR Parameters: PCR MCR ICR RDF RIF CDF		Peak Cell Rate Minimum Cell Rate Initial Cell Rate Rate Decrease Factor Rate Increase Factor Cutoff Decrease Factor
UBR Parameters: PCR		Peak Cell Rate

CPE Descriptor

Field Name	Values	Description
Name		Name given to this CPE Descriptor.
Index	<u>1</u> (1-8)	Unique index identifier for this CPE Descriptor.
Priority	<u>0</u>	The priority that a CPE with this assigned Descriptor will receive from the BTS Resource Manager software when requesting RF resources. This field maps to the Layer 2 > Bandwidth Data component in the BTS.
UL Max Bandwidth (Kbps)	<u>0</u> , 32, 64, 96, 128, 160, 192, 224, etc.	Maximum uplink bandwidth allowable for a CPE with this Descriptor. The maximum number of code channels allocated for a CPE is directly related to this field.
UL Min Bandwidth (Kbps)	<u>0</u> , 32, 64, 96, 128, 160, 192, 224, etc.	Minimum uplink bandwidth allowable for a CPE. This field determines the number of code channels allocated when a CPE begins a data session. The larger this value, the more code channels allocated at session startup.
DL Max Bandwidth (Kbps)	<u>0</u> , 32, 64, 96, 128, 160, 192, 224, etc.	Maximum downlink bandwidth allowable for a CPE. The maximum number of code channels allocated for a CPE is directly related to this field.
DL Min Bandwidth (Kbps)	<u>0</u> , 32, 64, 96, 128, 160, 192, 224, etc.	Minimum downlink bandwidth allowable for a CPE. This field determines the number of code channels allocated when a CPE begins a data session. The larger this value, the more code channels allocated at session startup.
Avg Queue Size Weight (%)	<u>100.0</u>	How much the current queue size contributes to the calculation of average queue size. The average queue size is used by the BTS Resource Manager to determine

		how many resources (code channels) to give a CPE. The greater the weight, the greater influence the current queue size has on the average queue size. The lower the weight, the more the average queue size is an actual average of the current queue size over time.
Max Queue Size (KB)	<u>512</u>	Maximum queue size for each priority queue (high, low, voice). Once full (Max Threshold) all packets are dropped.
Min to Max Drop Probability (%)	<u>10</u>	The probability of a packet being dropped when the Min Threshold has been reached. The higher this number, the more likely a packet will be dropped between the Min and Max Threshold. All packets are dropped at Max Threshold.
Realtime Min Drop Threshold (%)	<u>100</u>	The minimum queue size at which voice priority packets are considered for being dropped. For example, if set to 10% once the queue size reaches 11% or more, voice priority packets may be dropped. The Max Threshold Probability field determines if a packet is dropped once the Min Threshold is exceeded.
High Priority Min Drop Threshold (%)	<u>100</u>	The minimum queue size which high priority packets are considered for being dropped. For example, if set to 10%, once the queue size reaches 11% or more, high priority packets may be dropped. The Max Threshold Probability field determines if a packet is dropped once the Min Threshold is exceeded.
Low Priority Min Drop Threshold (%)	<u>100</u>	The minimum queue size which low priority packets are considered for being dropped. For example, if set to 10%, once the queue size reaches 11% or more, low priority packets may be dropped. The Max Threshold Probability field determines if a packet is dropped once the Min Threshold is exceeded.

DiffServ

Field Name	Values	Description
Code Point	<u>0</u>	Unique index (bit) to be mapped to a defined Differentiated Service. The code point is structured as follows: <pre> 0 1 2 3 4 5 6 7 +---+---+---+---+---+---+---+ DSCP CU +---+---+---+---+---+---+---+ </pre> DSCP: Differentiated Services Code Point CU: Currently Unused The Type of Service (ToS) bits are included in the DSCP.
Priority	<u>Low</u> , High, Voice	Low, High, or Voice. This is the priority given to data packets associated with this Code Point/Service. The BTS processes data packets with Voice, then High priority before Low priority packets.

DHCP Relay

Field Name	Values	Description
Relay Config Enabled	(Checkbox)	Enable or Disable. Clicking on the checkbox enables the DHCP Relay feature.
Free Address Low Agent Threshold	<u>80</u>	
Free Address High Agent Threshold	<u>100</u>	
Relay Config MaxDhcp Size	<u>1488</u>	
Option 82 Tagging	(Checkbox)	Enable or Disable. Clicking on the checkbox enables the inclusion of one or more of the following Relay Information sub-options.
Remote Id	(Checkbox)	If checked (enabled), include the CPE's EID as the Remote ID Relay Information sub-option. It will be formatted as a 6 octet string "0000<EID>". This format is often used in cable modem scenarios.
Circuit Id	(Checkbox)	If checked (enabled), include the BTS's ID as the Circuit ID Relay Information sub-option. It will be formatted as a 4-octet string "<BTS ID>". This format is often used in cable modem scenarios.
VPN Id	(Checkbox)	If checked (enabled), include the CPE's EID as the VPN ID Relay Information sub-option. It will be formatted as a text string "navini<EID>". This format is often used in DSL scenarios.
Subnet Selection/Addr	(Checkbox)	If checked (enabled), include the specified Subnet Address as the Subnet Selection Relay Information sub-option.
DOCSIS Device/Class	(Checkbox)	If checked (enabled), include the specified DOCSIS Device Class as the DOCSIS Device Relay Information sub-option.

ARP Proxy

Field Name	Values	Description
ARP Ingress Proxy	(Checkbox)	If clicked, this enables the BTS to respond to ARP messages coming from the CPE's/Modems to the BTS.
ARP Egress Proxy	(Checkbox)	If clicked, this enables the BTS to respond to ARP messages coming from the network (backhaul) to the BTS on behalf of the CPE's/Modems.

Layer 3 Filter

Field Name	Values	Description
Dynamic Acl	(Checkbox)	If clicked, this enables the Dynamic Access Control List. It provides the filtering rules for DHCP Relay - where a BTS configured with these capabilities may add learned addresses to the CPE's Authenticated IP List (the CPE's Ingress Filter). When BTS's and CPE's are configured for this feature, any packet whose MAC address cannot be found in the current CPE Authenticated IP List will be discarded.
Egress Broadcast Filter	(Checkbox)	If clicked, this enables configured BTS's to drop all Ethernet Broadcast packets.

Appendix F: Base Station Calibration Verification*

Instructions

This procedure and form are created to explain how and what to enter into the Base Station Calibration Verification spreadsheet, as well as define each cell's function. The cells that need an entry are shown in green. This procedure and form are to be used in conjunction with the Installation & Commissioning manual.

General Information

- A. Site Name (D4) - Enter the site name or customer designation.
- B. BTS ID (D5) - Enter the BTS identification number or customer description.
- C. Date (D6) - Excel will enter the current date.
- D. Software Release (D7) - Enter the release number of the software load being used.
- E. Personnel (D8) - Enter your name.
- F. 2.4 GHz (B12) - Enter an X or some other mark in the appropriate box for the frequency slot that the system will be operating at.**
- G. 2.6 GHz (B17-F17) - Enter an X or some other mark in the appropriate box for the frequency slot that the system will be operating at.**
- H. Cal Path Loss (average) (H21) - This is a calculated value determined from the data entered in Section II.
- I. Receiver Sensitivity (set in the EMS) (H23) - Enter the same number entered in the EMS under Air Interface > Layer 1 > General tab > Receiver sensitivity.
- J. Test Cable Loss (H24) - Enter the loss of the test cable that will be used to connect the signal generator to the calibration cable. Do not try to approximate this value. Measure all test cables before starting any testing. If no additional cable is necessary, enter zero (0). Include the minus sign, as it is a loss.
- K. RF Power Injected at Cal Cable to Get Sensitivity at Antenna (H25) - This is a calculated value determined from the values in H21-H24.
- L. Antenna Power (in the EMS) (H30) - Enter the same number entered in the EMS under Air Interface > Layer 1 > General tab > Antenna power.
- M. Coupler/Test Cable Loss (H31) - Enter the loss of the coupler's coupled port plus the test cable that will be used to connect the spectrum analyzer to the BTS's output ports. Do not try to approximate this value. Measure all test items and cables before starting any testing.

*Sometimes called the RF Sanity Test.

****The Ripwave Radio Frequency Sub-system (RFS) is pre-programmed for your specific operating environment. Before configuring the RFS parameters, follow the procedures below. (Note: These are also found in the *Ripwave RFS Configuration Quick Guide*). You will need access to the EMS Server console to perform the configuration. Please note that each Configuration disk is unique to the individual RFS that is shipped. You cannot use the same disk on other RFS equipment.**

Configuration Procedure

- Step 1.** Remove the RFS Configuration disk from the RFS packaging, and insert it in the floppy drive.
- Step 2.** Copy the folder named “RFS” that is on the disk to the EMS Server: <ems install dir>/scripts. It will take approximately 20 seconds to complete.
- Step 3.** Open the new folder on the EMS server . You will see a list of file names. The format of the file names is as follows:

RFS_serial number_frequency.cli

Example: “RFS_024300001_2402500.cli” - This sample configuration file is for an RFS with serial number 024300001 and a center frequency of 2.4025.

Verify the correct serial number in the file name against the serial number of the RFS equipment. The equipment serial number may be found on the back of the RFS panel or on the side of the bottom cylinder of the omni antenna.

- Step 4.** Determine which file you need to run, depending on the provisioned frequency of your BTS.

NOTE: For 2.6 GHz systems, select the frequency that is closest to your provisioned center frequency. To find the provisioned center frequency for your BTS, open the EMS Configuration & Alarm Manager (CAM) application. Select the BTS tab and specific BTS, then Air Interface / Layer 2 / Carrier Data / Show Configuration. This will display the center frequency information.

- Step 5.** Open the selected “CLI” file for editing using any text processing application program. Note the power splitter values listed there (i.e., write them down or print them out).
- Step 6.** Modify the line that starts with “bts” by changing the BTS ID for your BTS. The default is “BTS 1”. For example, if the ID for your BTS is 252, change the “1” to “252”.

Step 7. Save this file as text, and then close it.

Step 8. Start the EMS CONFIG CLI application to run “script <CLI script>”. Do this by entering the following:

```
>enable <user name> <password>
>configure
>script scripts/rfs/rfs_<serial number>_<7-digit frequency>.cli
```

NOTE: For Unix operating systems, the CLI text is case sensitive and the slash marks should be backward slashes instead of forward slashes.

Step 9. View the Power Splitter values in EMS to verify that the CLI script ran as expected. The Power Splitter values may be found under Layer 1 / Show Configuration > Antenna Table. You will need to “Refresh” the active screen to view the update/changes.

Step 10. Type “Exit” twice to exit CLI edit mode.

Cable & RFS Performance

- A. Cable Loss (B40-D48) - Enter the values measured during the cable sweeps. Include the minus sign on all entries. Include jumpers and surge protectors.
- B. Insertion Loss Through Cal Cable and RFS (C54 - E69) - Enter values measured during the RF sweeps of the cables and the RFS. Include the minus sign for all entries.
- C. Cal Path Loss (calculated) (H54-H69) - A calculated value based on absolute loss measured during RF sweeps. The measured cable loss for antenna 1 plus 3dB for inherent loss in the RFS (internal cables and LNA loss) is subtracted from the measured TX path loss to give absolute calibration path loss. It is important to check this value to ensure that it does not exceed -45dB.
- D. LNA Gain (calculated) (J55 - L69) - A calculated value based on absolute loss measured during RF sweeps. The absolute value of the difference between TX path loss and RX path loss equals LNA gain for each antenna path.

Receiver Performance

- A. Backplane Slot & Pin # (A76-A83) - These are the pin numbers for the baseband output of the two channel processor slots. Only accessible in the Ripwave 2.4 GHz system if the back plate is removed. Only used in extreme situations where access from the front using the CHP test card is not available. Do not use this method in a Ripwave 2.6 GHz system. Damage will occur to the interconnecting RF cables on the channel filters.

- B. Test CHP Card (D76-D83) - These are the jack identifiers for the CHP test card, which is modified to provide baseband signals to the front panel. Be aware that the order on the card is not sequential from top to bottom. The first (top) jack is channel #4, the second jack is channel #2, the third jack is channel #3, and the last (bottom) jack is channel #1.
- C. Noise Level (mVrms) (F76-F83) - Measured baseband noise level of each channel. This measurement includes noise generated by the BTS (Noise figure) plus ambient noise of the surrounding environment.
- D. Noise + Signal (mVrms) (G76-G83) - The signal level measured when a Continuous Wave tone is injected at the calibration cable. Tone amplitude is calculated in cell H25. This is a composite signal including noise.
- E. Signal (H76-H83) - The calculated signal level. Noise is subtracted from signal + noise using the following formula: square root of the signal plus noise level, squared, minus the square of the noise level:

$$\text{Signal} = \text{SQRT} ((\text{signal} + \text{noise})^2 - (\text{noise})^2).$$
- F. Signal-to-Noise Ratio (SNR) (I76-I83) - Calculated value of the signal-to-noise ratio. Determined by the following formula: Log10 of the signal + noise level, divided by the noise level, multiplied by 20. Dividing gives you the ratio. Taking the Log10 of the ratio converts to power. Multiple by 20 to convert to dB:

$$\text{SNR} = \text{Log10} (\text{signal} + \text{noise} / \text{noise}) * 20$$
- G. Noise Power (J76-J83) - Calculated value of the noise power at the baseband input to the Channel Processor. Calculated by adding the signal level injected at the antenna (RX sensitivity) plus the SNR value. Unit of measure is dBm.
- H. Relative Noise Figure (K76-K83) - Calculated noise figure of the system. Since the noise level includes thermal and ambient noise in addition to the BTS noise figure, and we have no control over the signal source noise, it is labeled as “relative” and is then referenced to the thermal noise floor. It is calculated by subtracting the theoretical thermal noise floor (Ktb) (-106 dBm, in a 6 MHz bandwidth) from the noise power calculation. This establishes a noise figure that includes any noise from the signal source as well as the BTS noise figure.
- I. RX Gain (DAC Word) (L76-L83) - The hex data generated during calibration for the receiver gain DAC that controls the IF attenuator. It is found in the EMS under Air Interface > Layer 1 > Show Configuration > Antenna tab.

Transmitter Performance

- A. Analyzer Readings (A90-B97)
 - 1. Peak - The peak amplitude of the sync signal measured on the spectrum analyzer. The measurement is taken with the spectrum analyzer in time domain (0 Hz span) and RBW set for 5 MHz. Sweep time is typically between 10 and 20 ms. When taking the measurement, the sync signal will have peaks and valleys associated with it. Make sure to measure the absolute peak.

2. RMS - This is a calculated value based on measurements taken on several occasions, comparing peak power to RMS power on a Rhode & Schwartz spectrum analyzer. It has been determined that the correction factor for peak to average on a standard spectrum analyzer is 9.5dB. This correction factor is the default entry in this section. If it is possible to make the RMS measurement with the proper equipment, then that is the preferred method. The calculation is very straight-forward:

$$\text{Peak Power minus 9.5dB} = \text{Power RMS.}$$

- B. P out Transceiver (D90-E97) - Power peak and Power RMS are calculated values using the value from the spectrum analyzer readings and the value entered for coupler/test cable loss. (Cell H31)
- C. Power at Antenna (RMS) (G90-G97) - Calculated value using the P out of the transceivers and the Cable Loss plus the inherent loss of the RFS.
- D. Radiated Power (RMS) (I90 - I97) - Calculated value using Power at the antenna and the value entered for antenna gain. (Cell H32)
- E. TX Gain (DAC Word) - The hex data generated during calibration for the transmit gain DAC that controls the IF attenuator. It is found in the EMS under Air Interface > Layer 1 > Show Configuration > Antenna tab.
- F. Max Power Deviation Across All Antennae (E99, G99, I99) - Calculated value showing the deviation between the lowest power antenna and highest power antenna for each column.

General information							Data input by user
Site Name							
BTS ID							
Date							
Software release							
Personnel							
2.4 GHz		MHz					
2.6 GHz	E1	E2	E3	F1	F2		
Cal path loss (averaged)							-33.0
RX sensitivity (set in EMS)							-90.0
Test cable loss							-2.0
RF power injected at cal cable to get sensitivity at antenna							-55.0
Antenna power (in EMS)=							18.0
Coupler/test cable loss =							-22.0
Antenna gain=							8.0
Cable and RFS performance							
		Cable Loss					
Cable	Low	Mid	High	Avg. loss			
1	-6.0	-6.0	-6.0	-6.0			
2	-6.0	-6.0	-6.0	-6.0			
3	-6.0	-6.0	-6.0	-6.0			
4	-6.0	-6.0	-6.0	-6.0			
5	-6.0	-6.0	-6.0	-6.0			
6	-6.0	-6.0	-6.0	-6.0			
7	-6.0	-6.0	-6.0	-6.0			
8	-6.0	-6.0	-6.0	-6.0			
cal	-6.0	-6.0	-6.0	-6.0			

Insertion loss thru cal cable and RFS						Cal path loss				LNA gain	
		Low	Mid	High	Average	(calculated)				(calculated)	
1	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
2	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
3	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
4	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
5	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
6	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
7	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
8	TX path	-42.0	-42.0	-42.0	-42.0	-33.0			20.0	20.0	20.0
	RX path	-22.0	-22.0	-22.0	-22.0						
Reciever performance											
	Backplane Slot and pin #		Test CHP card		Noise level (mVrms)	Noise + Signal (mVrms)	Signal	SNR	Noise Power	Relative Noise figure	RX Gain (DAC) word
Ant 1	CH-A-2d		Jack A		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 2	CH-A-6d		Jack B		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 3	CH-A-10d		Jack C		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 4	CH-A-14d		Jack D		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 5	CH-B-2d		Jack A		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 6	CH-B-6d		Jack B		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 7	CH-B-10d		Jack C		40.0	125.0	118.4	9.9	-99.9	6.1	150
Ant 8	CH-B-14d		Jack D		40.0	125.0	118.4	9.9	-99.9	6.1	150
Transmitter Performance											
Analyzer readings			P out Transceiver								
Peak	RMS		Power (peak)	Power (RMS)		Power at antenna (RMS)		Radiated power (RMS)	TX Gain (DAC word)		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
15.0	5.5		37.0	27.5		18.5		26.5	200		
Max power deviation across all antennea				0.0		0.0		0.0			
P out = Power Out											

Appendix G: Drive Study

Overview

The Drive Study is performed to confirm Base Station coverage. It is used to validate that the Base Station can be “seen” by a CPE throughout its predicted coverage area.

The RF coverage analysis displays areas of coverage from “good” to “bad” by the use of color-coding. An RF coverage analysis and its legend may be seen in Figure G1. The legend on the left displays the decibel strength for a given area, with red designating ‘good coverage’ and white designating ‘bad coverage’. The RF coverage analysis is used to map out the Drive Study route (Figure G2), along with geographic areas of concern. You should pay particular attention to null (white) areas and the cell edges.

Figure G1: RF Coverage Analysis Example

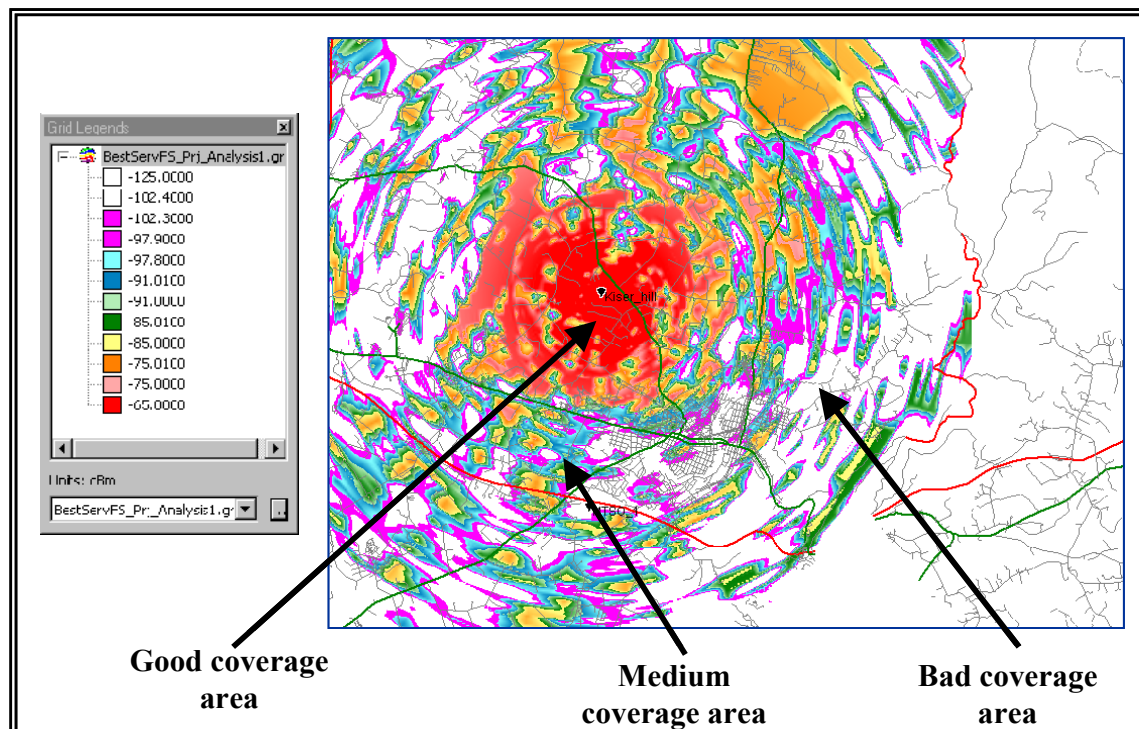
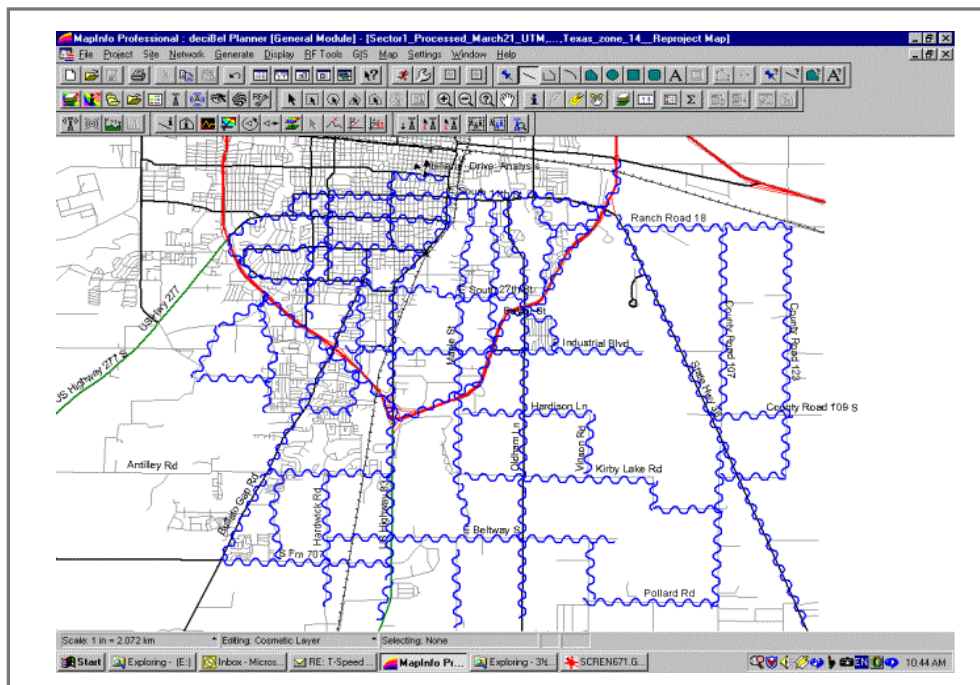


Figure G2: Drive Study Route Example

Equipment Required

- Omni-directional antenna mounted outside vehicle
- GPS with serial cable
- CPE
- Ethernet Cable
- CPE power supply
- DC to AC power converter
- Laptop computer
- Drive Study Form <shown later in this section>

Drive Test Procedure

While driving you will collect statistics to validate the coverage plot. The application takes a reading every second and records the data in comma delimited file format. It is important to ensure that the GPS is on and that you can see the GPS coordinates in the application.

Since the Ripwave system is not a mobile system, do not exceed 10 mph during the Drive Study. Going any faster will negate the adaptive beamforming, as the vehicle will not be in the exact position calculated by the Base Station.

- Step 1.** Ensure that the Base Station has successfully completed calibration and RF sanity measurements at the frequency and TX/RX signal levels that were determined during the site survey. Ensure that the Base Station is powered on and able to TX/RX data.
- Step 2.** Create a CPE Descriptor, and assign it to the CPE's to be used for the Drive Study:
CPE Descriptor Parameters
Name: Drive Study
Index: Next available number
Priority: 1
UpLink Max Bandwidth: 64
UpLink Min Bandwidth: 32
DownLink Max Bandwidth: 96
DownLink Min Bandwidth: 64
Other parameters: Use defaults.
- Step 3.** Mount an omni-directional antenna on the roof of the vehicle. This will serve as the antenna for the CPE.
- Step 4.** Bring the RF cable from the omni-directional antenna into the vehicle through the window. Attach the antenna to the antenna input of the CPE. The rotating upright antenna on the CPE needs to be removed to perform this step. You will also need to disconnect the patch antennas inside (Figure G3).

Figure G3: Patch Antennas

- Step 5.** Connect the DC to AC power converter to the power port in the vehicle.
- Step 6.** If applicable, place the external antenna on the top of the vehicle.
- Step 7.** Connect the CPE power supply to the CPE and to the DC to AC power converter.
- Step 8.** Connect the Ethernet cable to the Ethernet port on the laptop computer and to the Ethernet port on the CPE.
- Step 9.** Connect the GPS to the serial port on the laptop computer.
- Step 10.** Optional: Connect the laptop power supply to the DC to AC power converter. (The laptop can be run off of its battery.)
- Step 11.** Power on the GPS and the laptop computer.
- Step 12.** On the laptop computer, start the Navini Networks Drive Study application.
- Step 13.** Verify that the GPS location – latitude, longitude, and time – is seen in the application.
- Step 14.** Power on the CPE.
- Step 15.** Enter a memo into the log file comment field of the Constellation Debugger about the route of the Drive Study being performed. When finished, click the log comment button.
- Step 16.** Start driving along the Drive Study route determined during the RF coverage analysis. Do not exceed 10 - 15 mph.
- Step 17.** When testing is completed, prepare the file(s) to be sent back to Navini for post-processing and analysis.

Drive Study Form

Navini Networks Drive Test Check list		
Specify the following items before the drive test		
Drive test area name		
Date of Drive Test		
Drive Tester Name		
Standard Vehicle Name and Type		
CPE EID		
Frequency Band (ISM, MMDS)		
CPE test device RF cable loss (dB)		
CPE Test device Antenna gain (calibrated)		
Drive Route (Map attached)		
Drive test file name		
BTS Transmit Power		
Fill the site configuration		
BTS ID		
BTS antenna height		
BTS antenna Omni/Patch		
Mounted on the top or side		
Antenna Azimuth		
Antenna downtilt		
Drive Test Route Plan	Yes / No	Typical Clutter Height
High Density Urban Covered		
Commercial/Industrial		
Residential with Trees		
Residential with Few Trees		
Paved Areas		
Grass/Agriculture		
Open Area		
Forested Areas		
Water		
Airports		
Others		

Things to pay attention to:

1. Make sure that the GPS data on the constellation debugger is updating all the time during the drive test.
2. Make sure that the antenna only selects the omni port all the time.
3. Make sure that the CPE is locked to the correct BTS by checking the BTS ID and frequency.
4. Make sure that the RF connections are good all the time. Check this by observing the stability of the R
5. Please make proper log information in certain important locations.

Appendix H: Location (FTP) Tests

Introduction

The Location, or FTP, Test is performed to check the Ripwave system operation through file transfers between the Base Station and the CPE. The test measures the data rate performance at various locations within the coverage area. Data throughput is measured by executing file transfers using the FTP protocol for both upstream and downstream links. A file server must be in place on the same subnet with the BTS to accurately perform the file transfer, and the CPE User computer must be loaded with an FTP Client. As the file transfer is running, a data file is captured by the CPE tool. Data rates are captured by the FTP program.

Data is recorded in a spreadsheet format. The spreadsheet lists the location, GPS, and other information. As data rates are captured, the results are entered manually. An average SNR and sync RSSI can be read from the debug tool, and recorded, for quick comparison to the acceptable criteria (see “Acceptable Criteria” section of this appendix). For NLOS indoor locations, tests are performed both outside the building and inside, so that the obstruction loss for the building can be determined. Unless the customer can provide indoor access, all results will be LOS or Near NLOS.

Planning the Locations

Before the actual testing is conducted, you will need to select the locations for the testing to occur. The sites should meet specific criteria and include a mixture of the following environments:

- High Power (A), low clutter; close in, residential
- High Power (A), high clutter; close in, commercial
- Medium Power (B), low clutter; mid-range, residential
- Medium Power (B), high clutter; mid-range, commercial
- Low Power (C), low clutter; distant, residential
- Lower Power (C), high clutter; distant, commercial

Where:

(A) High Power is equal to > -70 dBm sync value

(B) Medium Power is equal to < -70 dBm and > -85 dBm sync value

(C) Low Power is equal to < -85 dBm, but > -95 dBm sync value

At least 5 test points for each type are attempted. This may be difficult, depending upon the actual deployment scenario. Results may yield a very large percentage in one of the categories. For selecting an even spread across a 120 degree sector for a panel antenna installation, divide the 120 degrees into 6 even slices of 20 degrees each. Then divide each slice into 2 Km segments. This spaces each location at an approximate even distance throughout the complete sector and yields 36 test sites.

To select an even spread across a 360 degree cell for an omni antenna installation, divide the 360 degree cell into 12 even slices of 30 degrees each. Next, divide each slice into segments based on distance (1 Km or 2 Km, depending upon propagation). This will approximately space each location an even distance from each other throughout the complete cell, yielding approximately 48 test sites (based on a 4 Km cell radius). To do this, split the cell into 4 quadrants. Using the RF coverage analysis, select up to 16 locations per quadrant (Figure H1). Pay particular attention to null areas and the cell edges. At these locations you will perform a file transfer to measure the data rates available. The FTP/Location Test Tool program and the BTS Beamforming Display tool will be used to record RF parameters during each test. Figures H1 and H2 provide examples of simple guidelines for selecting an even spread across a cell area.

Figure H1: Example of a 3-sector Site

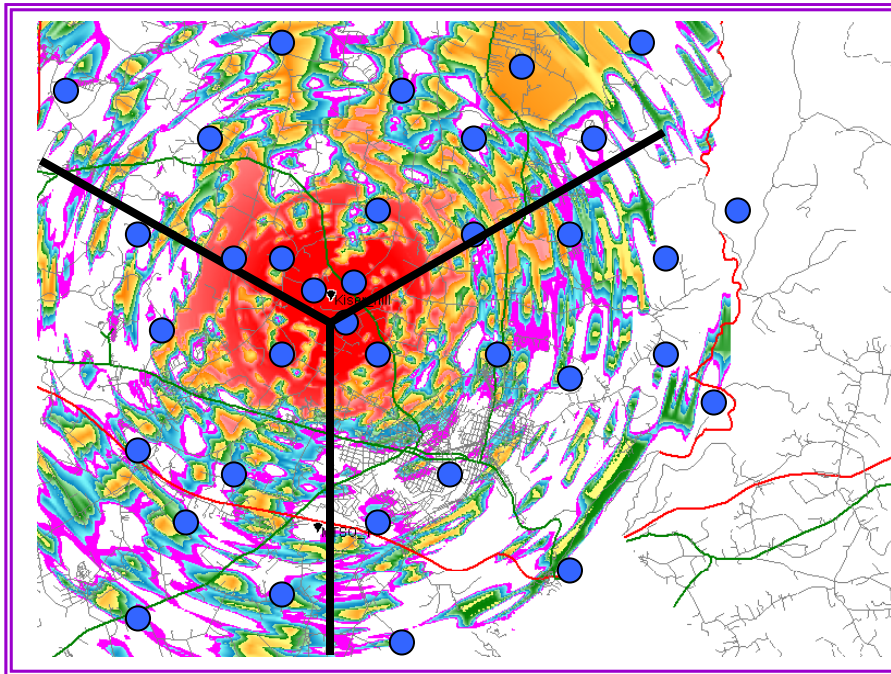
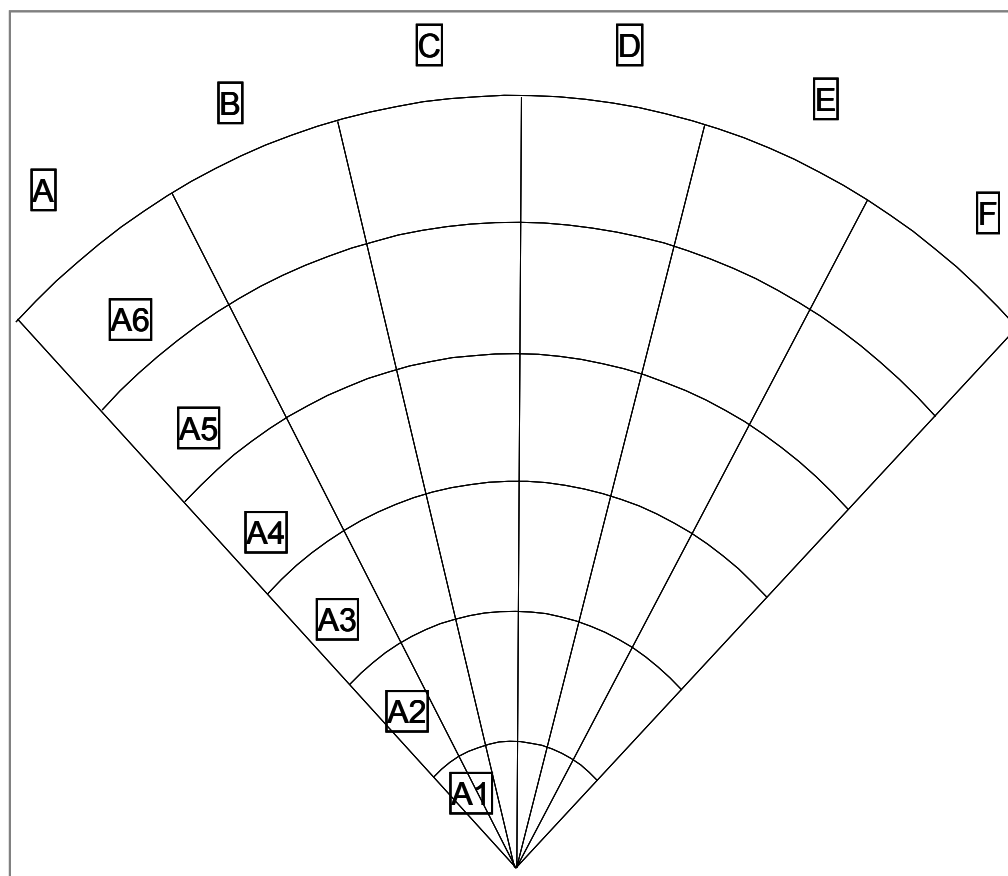


Figure H2: Example of 120° of an Omni Site

Acceptable Criteria

In order to evaluate the test results, several criteria are reviewed. These criteria are valid for both LOS and NLOS measurements.

- ❑ Processed Sync Signal Strength: For a given test location, +/- 2 dB variation during FTP
- ❑ Absolute Sync Signal Strength - Processed Sync Signal Strength: <= to 2 dB variation during FTP
- ❑ SNR values consistent during the FTP for all carriers used:
 - a. QPSK: >= 11 dB
 - b. 8 PSK: >= 16 dB
 - c. QAM 16: >= 19 dB
- ❑ UL and DL Packet Error Rates (PER) <= 1%. This will vary according to interference levels, but may not render the system inoperable.
- ❑ Uplink Beamforming Gain: <= 21 dB and >= 16 dB. Perform a comparison of UL and DL, Beamforming Gain differences should be <= 3 dB.

- ❑ CPE Transmit Power < 25 dBm; BTS Transmit Power < 0 dBm per code channel with power control

- ❑ Sync vs. Data Rate:

<u>Absolute Sync (dBm)</u>	<u>UL Data Rate (Mbps)</u>	<u>DL Data Rate (Mbps)</u>
(A) -55 to -70	0.6 to 1.0	1.5 to 2.0
(B) -70 to -85	0.5 to 1.0	1.2 to 2.0
(C) -85 to -95	0.10 to 0.5	0.3 to 1.0

Process

The recommended process for performing the Location (FTP) tests is described below.

First: Verify that a single CPE transmits and receives data at expected rates, as indicated previously.

Second: Verify that multiple CPE's simultaneously transmit and receive data at acceptable rates, and the parameters listed above are being met. NOTE: The exact number of CPE's is determined by field conditions. The minimum is two.

Third: Verify operation at the full range of the system*. Include LOS Location Tests at cell edges. The height of CPE and uplink and downlink data rates are recorded for each site. Data rates are to be compared with expected results, as seen in the last item (Sync vs. Data Rate) of Acceptance Criteria. For example:

*2.6 GHz : ~12 Km

*2.4 GHz: ~ 3 Km

Equipment Required

- Laptop computer
- GPS with serial cable
- FTP/Location Test Tool application
- BTS Beamforming diagnostic tool
- CPE
- CPE power supply
- DC to AC power converter
- Ethernet Cable

Location (FTP) Test Procedure

Two people are needed to perform this procedure. One will be in the car performing the location test, and the other will be at the Base Station checking the operation using the BTS Beamforming diagnostic tool.

1. Ensure that the Base Station has successfully completed calibration, RF sanity measurements, and the Drive Study at the frequency and TX/RX signal levels that were determined by the cell site survey. Also ensure that the Base Station is powered on and is able to transmit and receive data.
2. Connect the DC to AC power converter to the power port in the vehicle.
3. Connect the CPE power supply to the CPE and to the DC to AC power converter.
4. Connect the Ethernet cable to the Ethernet port on the laptop computer and to the Ethernet port on the CPE.
5. Connect the GPS to the serial port on the laptop computer.
6. Drive to one of the locations selected on the RF coverage analysis. Stop and turn off the vehicle.
7. Power on the GPS, the CPE, and the laptop computer. Place the CPE on the roof of the vehicle.
8. Start the Navini Networks FTP/Location Test Tool program.
9. Verify that the Base Station is transmitting and that the CPE establishes sync and can communicate with the Base Station. Ping a device address on the network side of the Base Station, and verify that a reply is received. While monitoring the Constellation Debugger, position the CPE to reduce the difference between absolute sync and processed sync levels to 2 or less.
10. Enter a memo into the comment field about which link of the test is being performed.
11. Verify that the GPS input is seen in the application.
12. Put the location number/site identifier into the comment field of the Navini Networks Constellation Debugger, and press the Enter key. This will identify the site location.
13. On the EMS connected to the Base Station, start the BTS Beamforming diagnostic tool.
14. From the laptop computer with the CPE connected to it, start a downlink FTP file transfer. Record the results on the site page or in the log.
15. On the EMS connected to the Base Station, using the BTS Beamforming diagnostic tool verify the strength and direction of the beam during the file transfer. Record the results on the site page or in the log.
16. Repeat the file transfer three times, stopping and starting the Debugger and Beamforming tool for each transfer
17. Repeat steps 14-15, this time performing an uplink FTP transfer.

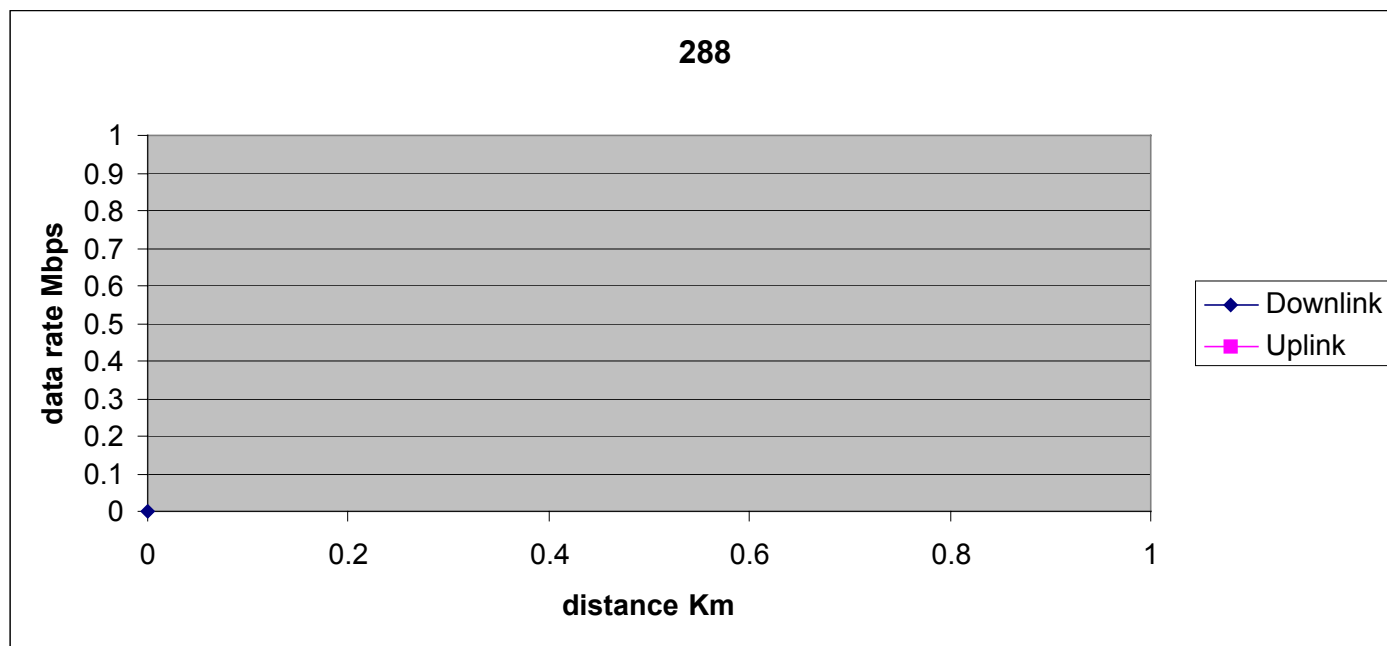
18. When finished, remove the CPE from the roof and secure equipment for travel.
19. Drive to the next location selected on the RF coverage analysis. Stop, and turn off the vehicle.
20. Repeat steps 7 to 19 until all locations are tested. At this point send this data to the RF Engineers to analyze, or continue until each quadrant in the cell is complete. When you send the results depends upon the schedule or results from the file transfers.

Location (FTP) Test Form

The form for recording the Location (FTP) test results is an Excel spreadsheet. Shown in Table H1, the actual column headers go across the top of the form, but are broken into two sections here for readability.

Table H1: Location (FTP) Test Form

BTS ID		Sector				Software Release					
Site name	File name; CPE	File name; BTS	Distance (Km)	LOS	NLOS	CPE	CPE w/ ext	FTP Data Rate Downlink (Kbps)	FTP Data Rate Uplink (Kbps)	Absolute Sync (dB)	Remarks
			0					0			
								0			



Appendix I: Customer Acceptance

Base Station Installation & Commissioning Services Customer Acceptance Form

Customer Name: _____

Customer's Authorized Representative: _____

Job Title: _____

Office Address: _____

Email Address: _____

Office Phone: _____

Cell Phone or Pager: _____

Site Name: _____

Site Description: _____

Site Physical Address: _____

INSTALLATION SECTION:

Date Installation Started: _____ Completed: _____

Customer Acceptance By: _____ Title: _____ Date: _____

COMMISSIONING SECTION:

Date Commissioning Started: _____ Completed: _____

Customer Acceptance By: _____ Title: _____ Date: _____

TEST ACCEPTANCE SECTION:

Date Testing Started: _____ Completed: _____

Customer Acceptance By: _____ Title: _____ Date: _____

This Customer Acceptance Form is subject to and governed by all of the terms and conditions set forth in the Master Supply Agreement between the parties. The Customer acknowledges, understands and agrees that when it's Authorized Representative signs-off the Test Acceptance Section of this Form, Customer has thoroughly inspected the installation and commissioning services, and Customer's sign-off means that completion of on-site verification that the Equipment installed by Seller performs in accordance with the Acceptance Criteria set forth in the Master Supply Agreement between the parties. The completed Navini Networks' Site Installation and Commissioning Documents referenced below and attached hereto are incorporated by reference into this Customer Acceptance Form for all purposes.

Navini Networks Site Installation and Commissioning Documents (double-click on the box to check or de-select a checkmark when completing the form):

- ☐ Site Candidate Evaluation Report
- ☐ Site Materials BoM
- ☐ Site Drawings
- ☐ Site Construction Specific Tests, as required – Grounding System Test Results, Concrete Break Test Results, Tower Guy Tensioning Test Results, etc.
- ☐ Site Specific Digital Photographs, as Required
- ☐ RFS System Tests
- ☐ Base Station Installation Certification
- ☐ Base Station Calibration Verification
- ☐ Location (FTP) Tests
- ☐ Drive Studies
- ☐ Coverage Predictions Maps
- ☐ Soft Copies of Test Results, if Requested

Appendix J: Outdoor Enclosures

Overview

The information in this Appendix is intended to assist Navini Networks' customers in identifying typical features and requirements for an outdoor telecommunications equipment enclosure (outdoor cabinet or cabinet) that is compatible with Navini Networks Base Transceiver Station (BTS) equipment. This document is not intended to be an all-inclusive explanation of outdoor cabinet design and selection requirements.

Instead, it is focused on providing customers with design suggestions for an outdoor cabinet that will attempt to replicate an environmentally controlled indoor environment for Navini Networks BTS equipment. Additionally, other design and performance suggestions are provided in an effort to assist customers, who may be unfamiliar with developing requirements for outdoor cabinets, to communicate more effectively a set of design and performance requirements to a cabinet manufacturer.

The information in this document pertains only to Navini Networks BTS equipment. Customers are advised to consult with a manufacturer specializing in the construction of customized outdoor cabinets and to take the manufacturer's recommendations for designing an outdoor cabinet that will meet Navini Networks BTS equipment installation and operating requirements.

Due to (a) customer-specific site installation requirements and/or installation standards and the use of customer supplied ancillary equipment, including but not limited to rectifiers, batteries, microwave radios, networking equipment, network interface equipment, or other electronic, electrical, and mechanical components, and (b) customer supplied third-party installation services, Navini Networks cannot guarantee the operational performance of BTS equipment installed within an outdoor cabinet that does not maintain an operating environment within the defined operating parameters of the Navini Networks BTS equipment.

Navini Networks does not manufacture or sell outdoor cabinets, and does not recommend the use of any particular manufacturer's outdoor cabinet.

BTS Mechanical & Electrical Specifications

Table J1: 2.6 GHz BTS

Physical:	2.3, 2.6GHz Split Digital & RF Chassis
Mechanical Dimensions Digital:	19" X 19" X 13" (HWD)
Mechanical Dimensions RF	14" X 19" X 13" (HWD)
DC Power:	1,353 Watts, 21VDC to 28VDC @ 56A (4,618 BTU)
DC Power Interface:	2 - 1/4" lugs for +24Vdc and 24VReturn
Operational Temperature Range:	0 to +50 degrees C
Storage Temperature Range:	-40 to +70 degrees C
Weight:	100 lbs.
Service Accessibility:	Front and rear access required
Humidity:	0 to 95% non-condensing

Table J2: BTS to RFS Interface

RFS Antenna (per BTS):	8 Type N Female Connectors
RFS Antenna Calibration (per BTS):	1 Type N Female Connector
RFS Antenna Power/Data (per BTS):	Burndy G6B14-92PNE-32 Power Connector (1.0625" OD). The power connector is part of a pre-terminated cable assembly ordered in 25' increments. The power data cable assembly utilizes an Alpha Wire (P/N 5136C) composite cable.
GPS Antenna:	2 Type N Female Connectors
Network (WAN) Interfaces	
T1/E1 Interface	
Number of T1/E1's:	8
Standards Compliance:	ANSI, Bellcore ANSI T1.403
Line Coding:	AMI/B8ZS
Inverse Multiplexing ATM (IMA):	Spec 1.1
ATM	
Standards Compliance:	UNI 4.0
Number of PVC's:	2000
ATM Adaptation:	AAL5 ATM Adaptation (VBR real, VBR Non-Real, UBR)
Bridging Protocol:	RFC 1483 (LLC, SNAP)
Ethernet	
Standards Compliance:	10/100BaseT (Ipv4) Ethernet
QoS:	Diffserv, Class based queuing (3 priority queues), WFQ
Packet Format:	IEEE 802.3 / Ethernet II

Outdoor Cabinet Features & Considerations

General

Outdoor cabinets are designed to house electronic equipment, electrical equipment, and other ancillary components (equipment) in outdoor environments where temperature, dirt, dust, oil, water, and other contaminants may be a factor in the operation of the equipment.

Cabinet Construction

Frames, Doors & Mounting Rails

Outdoor cabinets may have any number of metallic and non-metallic (non-conductive) corrosion resistant materials in their construction. Predominantly due to a combination of acceptable overall cost, strength, weight, and corrosion resistance, .125 (1/8") thick 5052 H32 aluminum or other similar alloys are typically utilized in cabinet construction. Aluminum alloys provide approximately the same stiffness as steel at about half the weight of steel, even though about 40% more aluminum is required to attain the same stiffness as steel.

Fabrication

Outdoor cabinets are typically constructed of a combination of welded, bolted, hinged, or screwed panels attached or bonded to structural components. Construction methods used are determined by a combination of price and function.

NEMA Rating

Outdoor cabinets normally utilize fabrication and assembly methods that will meet NEMA Type 3R or Type 4 rating requirements. The use of either NEMA Type 3R or Type 4 cabinets is subject to the customer's specific design requirements. Other types of NEMA rated enclosures may be provided by a cabinet manufacturer to meet customer design requirements.

NEMA Type 4

NEMA Type 4 enclosures are rated for indoor or outdoor use to provide a degree of protection against splashing water, windblown dust and rain, and hose directed water, and to remain undamaged by the formation of ice on the enclosure. NEMA Type 4 enclosures do not provide protection against submersion. Gaskets are typically utilized to provide weather tight seals for hinged, bolted, and screwed panels on NEMA 4 rated enclosures.

NEMA Type 3R

NEMA Type 3R enclosures are rated for indoor or outdoor use to provide a degree of protection against falling rain and sleet and to remain undamaged by the formation of ice on the enclosure. NEMA Type 3R enclosures do not provide protection against submersion. Typical examples of NEMA 3R cabinets are external enclosures containing above-ground electrical panels, and other equipment, that may or may not require ventilation

Finishes

Outdoor cabinets are normally finished with UV resistant powder-coated polyurethane coatings. The finishes are baked on after coating, provide excellent resistance to damage, are very durable, and provide superior corrosion resistance. Normal colors are tan, white, and green, in shades typically used by traditional telecom service providers. Other types of coatings and colors may be available from a cabinet manufacturer to meet specific zoning requirements. In the event that a cabinet manufacturer is unable to provide a specific custom color, the cabinet manufacturer will usually be able to provide a refinishing process and third-party coating sources that can supply coatings that are compatible with the original factory finish.

Bullet Resistance

Due to the emphasis on being light-weight, low maintenance, and corrosion resistance, outdoor cabinets are not normally constructed to provide bullet resistance, although a cabinet manufacturer may be able to provide this functionality.

Expandability

Outdoor cabinets come in both single- and multi-cabinet styles in order to meet the design criteria of the customer. Manufacturer designs of multi-bay cabinets may utilize either single cabinet modular sections that bolt together to form larger multi-bay cabinets with seals between cabinets, or welded multi-bay cabinets that do not utilize seals between cabinet equipment mounting bays. Care should be taken to ensure that multi-bay cabinet designs or expansions of single-bay cabinets provide adequate airflow between cabinet equipment bays.

Lifting Eyes

Cabinets are usually equipped by the manufacturer with lifting eyes to permit placement on site using a crane. Depending on the manufacturer, the lifting eyes may or may not be removable.

Equipment Access

BTS equipment will require an outdoor cabinet that provides front and rear access for installation and maintenance of the BTS equipment.

Sizing

Outdoor cabinets should be sized or designed to provide:

- Unrestricted maintenance access to all installed equipment, wiring, cabling, and conduits by field maintenance personnel.
- Placement of equipment at internal mounting elevations, relative to ground level, that will provide field maintenance personnel with access to installed equipment at reasonable working heights, for all or the majority of installed equipment. These requirements may be met through the use of base extenders, bottom mounted battery cabinets, taller equipment bays, or a combination of all of these design techniques.
- Sufficient space for the routing and termination of all internal wiring, cables, and conduits, consistent with minimum bend radius requirements, and direction and/or manner of entry into or out of the equipment cabinet.
- Sufficient space in front of, behind, above, and below installed equipment to allow for unrestricted airflow within the cabinet.
- Sufficient reserve space in front of, behind, above, and below installed equipment to support minor changes to installed equipment mechanical dimensions, as a result of changes in vendor equipment utilized, or to support future vendor equipment design modifications.

Optional Cabinet Components

Integral AC Load Center

Integral AC load centers provide the ability to connect the outdoor cabinet's commercial AC power input directly to a power utility transformer. A typical load center will employ a meter base, service disconnect, and breaker equipped load center, installed on the cabinet by the manufacturer.

Advantages

Factory installation of an integral AC load center offers lower field installation costs; quicker cabinet field deployment; improved site installation quality; and reduced instances of cabinet damage caused by installation personnel unfamiliar with the cabinet design, construction, penetration, and weather sealing requirements.

Disadvantages

Higher initial costs.

Air Conditioner(s)

Air conditioners provide active cooling to equipment in the outdoor cabinet and are normally used on cabinets where thermoelectric coolers, multiple air insulated walls, Air to Air Heat Exchangers, and Forced Air cooling do not provide adequate capability to maintain internal cabinet air temperatures within acceptable ranges for installed equipment. Air conditioners may be equipped with economizers to reduce operating costs, as well as heat strips, to prevent ice formation on the evaporator coils, and heat to the interior of the cabinet. The use of air conditioners requires careful consideration of airflow within the interior of the cabinet, to ensure that adequate cooling is provided to all equipment in the cabinet and that hot spots are not created.

Sizing

Air conditioners should be sized to provide for an optimal duty cycle and reserve cooling capacity. A high duty cycle will typically lead to early failure of the air conditioner, since air conditioners are not normally intended to have an extremely high duty cycle. Significant oversizing of an air conditioner will lead to inefficient operation and greater initial air conditioner and cabinet costs required to support the larger air conditioner.

Consideration should be given to providing a percentage of reserve capacity to allow for additions to the installed equipment, increases in power requirements of installed equipment, and loss of efficiency of the air conditioner due to age or leakage of refrigerant over time. Reserve capacity is likely to be reflected in a reduced duty cycle for the installed air conditioner.

Advantages

Air conditioners can be sized to support thermal loads in excess of those that can be managed with other active and passive cooling techniques. Additionally, internal cabinet temperatures and humidity levels can be maintained at consistent levels, which may contribute to greater equipment stability and longevity.

Disadvantages

The loss of commercial power to an outdoor cabinet equipped with an air conditioner and a backup power system may not prevent the site from failing, even if adequate backup power exists to power the equipment installed in the cabinet for the duration of the power outage, due to the inability of the backup power system to operate the air conditioner. Without the air conditioner removing waste heat generated by the equipment installed in the cabinet and by heat contributed by solar gain, during summer months, the internal air temperature inside the cabinet may reach a sufficiently high level to cause failure to one or more pieces of installed equipment within the cabinet, as a result of overheating. Additionally, utility costs and maintenance costs will be higher for sites with air conditioners installed in an outdoor cabinet.

Backup Power System

General

Backup power systems provide a means of extending operations of the installed equipment during periods of extended commercial power failure. Backup power systems may be as simple as providing a combination of suitably sized rectifiers and DC storage batteries, or may include more complicated site installed generators in combination automatic transfer switches, and storage batteries.

Rectifiers

The AC/DC rectifier(s) should be chosen based on power delivered to the load(s). For example, the DC Power requirements listed for the Base Station RF & Digital chassis may be just part of the overall power requirement. It is recommended that the AC/DC rectifier's rating exceed the expected load by some 20%, or per the rectifier manufacturer's guidelines based on consideration not limited to expected load, temperature range, and reliability.

Storage Batteries

Storage batteries provide variable capacity backup power to extend installed equipment operations. Storage batteries utilized for outdoor, uncontrolled environment operations normally consist of valve regulated lead acid batteries. The selection of storage batteries depends on a combination of factors that may include, but are not limited to

- The surrounding environmental conditions in which the outdoor cabinet will be placed;
- The amount of backup time desired by the customer;
- The stability of the local power grid;
- The historical duration of commercial power outages; and
- Local environmental regulations.

Low Voltage Disconnect

Low voltage disconnect should be provided to protect the batteries & the Base Station equipment once the batteries reach the manufacturer's rating for minimum cell voltage. The Base Station is rated to 20VDC minimum. It should be noted that as battery voltage declines, the current demanded increases as power required remains constant.

Generator

Power generators provide an alternative for back-up power. Generator ratings are again based on the power required by the loads, which, as mentioned above, include the Base Station RF & Digital chassis as well as other supporting equipment. Consult with the manufacturer's recommendations when selecting a particular generator based on required installation.

Generator Receptacle

Typically, enclosures and generators are custom entities. The receptacle that is chosen is influenced by the generator chosen, the outdoor enclosure, and the customer's needs. Several types are used, and we recommend consulting with the generator & enclosure manufacturers.

External Battery Compartment

General:

External battery compartments provide ventilated enclosure space suitable for the installation of batteries that will allow extended operation of installed electrical and electronic equipment in the event of the loss of primary electrical power at the site where the cabinet is installed. The use of an external battery compartment is generally recommended to prevent battery gases from reaching electronic and electrical equipment located inside a NEMA 4 Type outdoor cabinet.

Construction:

Battery compartments normally utilize NEMA 3R ventilated enclosures to allow venting of battery gases, and are normally installed beneath a NEMA Type 4 cabinet containing electrical and electronic equipment and components. The use of a battery compartment usually improves access for field maintenance personnel by elevating the electrical and electronic equipment inside the main cabinet to a better working height.

Battery Warmer

The use of a battery warming pad is generally recommended for backup power systems utilizing storage batteries, in climates where air temperatures may drop sufficiently low to reduce the available capacity of storage batteries or cause the battery to freeze.

Base Extender

The use of a base extender should be considered to elevate the base of the cabinet above a foundation to prevent the accumulation of water in contact with the cabinet base, or to permit the accumulation of minor amounts of snow or other debris at a level cabinet base. Depending on the environment in which the outdoor cabinet is installed, the lack of a base extender may contribute to accelerated corrosion of the cabinet or allow moisture and debris entry into either the cabinet or a battery compartment.

Thermal Management

General

Outdoor cabinets utilize various methods to maintain a cabinet's internal temperature with acceptable operating ranges of equipment installed within the cabinet. Thermal management includes management of heat gain from internal and external sources, as well as heat loss, to a lesser extent, due to low winter air and ground temperatures. A BTS installed in an outdoor cabinet will likely be impacted to a greater extent by environmental conditions during summer months, due to a combination of radiant solar heat gain and outside air/ground temperatures, which limit the cabinet's ability to dissipate internally generated heat out of the cabinet. During winter conditions, except in extreme conditions, thermal dissipation by electric and electronic equipment and components inside the cabinet are generally sufficient to maintain the interior temperature of the cabinet at a level within the operational range of all installed equipment.

Heat Transfer

Heat may enter (or exit) an outdoor cabinet in one of three transfer modes: conduction, convection, and radiation (radiant heat). Heat gain and loss from conduction is a result of direct contact between the cabinet and the foundation or other structure with which the cabinet is in contact. Convection heat gain and loss results from the transfer of heat between the cabinet and the outside air in contact with the cabinet. Radiant heat gain and loss results from absorption of radiant energy from a warmer source by a cooler source. Radiant energy is transferred through air without heating the air. Every material or object with a temperature above absolute zero emits radiant energy in all directions until it is deflected or absorbed.

For an outdoor cabinet, the primary method of heat gain into the interior of the cabinet is usually from radiant heat from the sun, although convection and conduction will play varying but usually lesser roles. Control of each type of heat gain or loss usually requires different techniques by cabinet manufacturers. The selection of one or more methods used to control heat gain or loss is dependent upon the customer's specific equipment requirements.

External Heat Sources

External cabinet heat sources primarily consist of the following:

- Radiant - sun, rooftops, nearby structures.
- Convection - structures or material in direct contact with the cabinet.
- Convection - air surrounding the cabinet.

Internal Heat Sources

Internal cabinet heat sources primarily consist of installed electrical and electronic equipment that dissipate waste heat during operation of the BTS equipment. Waste heat may be controlled to a limited extent by careful selection of electrical and electronic components that operate more efficiently and thus dissipate less waste heat into the interior of the cabinet.

Equipment Thermal Dissipation

The limiting factor in the operation of the BTS will be the single component or piece of electrical or electronic equipment installed within the cabinet that is most susceptible to failure as a result of the internal temperature of the cabinet, whether it is the BTS or another piece of ancillary equipment. Based on the climate, operating environment, amount and type of equipment installed within the cabinet, and susceptibility of installed equipment to the internal environmental conditions within the cabinet, different thermal management solutions may be required to maintain an acceptable operating temperature range within the cabinet. Cabinet manufacturers utilize various types of active and passive cooling systems:

- Air Conditioners
- Air to Air Heat Exchangers
- Multiple Wall and Heat Shields
- Forced Air
- Insulation

Airflow

Sufficient airflow must be provided around installed equipment to eliminate hot spots that may contribute to shortened installed equipment life or failure.

Security

Locks

In order to restrict access to internal areas of the outdoor cabinet to only authorized maintenance personnel, the cabinet should be equipped with (a) corrosion resistant integral keyed locks for all hinged access doors; and (b) corrosion resistant fasteners, which require the use of special tools for access points, where routine entry is not allowed.

External Lighting

Consideration should be given to the site location where the outdoor cabinet will be installed. While lighting is not a cabinet specific function, in the event that external lighting is necessary or anticipated, allowances should be made during the cabinet design to support the necessary requirements placed on the cabinet in this event. This includes but is not limited to requirements for power, cabinet penetrations, and light control equipment placement.

Site Placement

Ground installation

The outdoor cabinet should be placed on a solid foundation or equipment platform designed by a licensed engineer. Foundation design should be based on the bearing capacity of the soil on which the foundation or platform is located.

Building Rooftop or Equipment Room Installation

A structural analysis should be performed by a licensed Structural Engineer. The Structural Engineer will determine if (a) a rooftop or interior equipment room floor must be reinforced; (b) the cabinet should be relocated to another point on the rooftop; or (c) another site should be selected to prevent damage to the rooftop or to the building structure. The combination of the weight of the cabinet material and the installed electrical, electronic, or mechanical components may readily exceed the design load capacity of the rooftop or floor on which the cabinet is installed.

Maintenance Access

Ensure either through on-site measurement or through review of site A&E, survey, or building drawings that the outdoor cabinet, as placed at the final site location, will permit:

- Unrestricted access to all points of access to the cabinet interior.
- All cabinet doors to fully open and latch (if equipped). In inclement weather conditions, unrestrained access doors are a potential hazard to maintenance personnel and equipment located between the cabinet frame and the door.
- Required separation from certain electrical equipment and panels in compliance with the latest edition of the National Electrical Code (NFPA 70).

Conduit & Cable Access

Placement of the cabinet should take into consideration the routing, size, bend radius, and maintenance access of all required power, signal, RF, or other cables and conduits that must enter and exit the cabinet. Care should be taken in the routing of all conduits placed at ground level that may restrict access to maintenance battery compartments or that may create a potential personnel hazard when placed in access routes used by maintenance personnel.

Penetrations

General

Numerous penetrations into an outdoor cabinet may be required, and the total quantity and location are dependent upon the cabinet design, installed equipment, unique site requirements, and customer preference. For an environmentally controlled cabinet that is designed to maintain a weather tight seal, all penetrations - whether utilized or not - should be sealed with an appropriate and durable seal, gasket, plate, or other material that will maintain the weather-tight integrity of the outdoor cabinet.

Failure to maintain an adequate seal may allow the entry of moisture, insects, small animals, or battery gases into the outdoor cabinet. An inadequate seal may also negatively impact the ability of the environmental equipment to maintain the installed equipment within the designed operating range, or to incur greater energy utilization.

Design

Cabinet penetrations should be designed, sized, and located to permit the easy entry of required wiring and cabling into and out of the cabinet, and should be of sufficient size to permit the insertion/removal of pre-terminated cables and wires, if utilized. Cabinet penetrations should support site-specific installation requirements. For example, the RFS antenna coaxial cable type and size will vary due to the combination of the height of the installed antenna and the horizontal and vertical runs from the cabinet to the antenna support structure, as well the customer's choice of vendor for the coaxial cables.

Cabinets should be designed to prevent weakening of the cabinet structure due to close proximity or excessive penetrations within a confined space. Reinforcement of the cabinet, or special access ports, may be utilized by a cabinet manufacturer to mitigate or eliminate this as a concern. Cabinets should maintain the bend radius of all wire and cables penetrating the cabinet within acceptable tolerances. Obstructions within the cabinet, either singularly or in combination, may be created as a result of internal placement of cabinet structural components, or installed electrical, electronic, mechanical equipment. Cabinet design should minimize or eliminate potential personnel hazards caused by cables and conduit exiting the cabinet.

Penetrations Required

Subject to other considerations defined in this document, the following penetrations may or may not be utilized:

- AC Power (service entrance, convenience outlet(s), external lighting, etc.)
- DC Power (connection to battery compartment)
- Generator receptacle
- Grounding (electrical, antenna lightning arrestors, AC surge protection, Telco surge protection)
- Network Transport (microwave, fiber, T1, Ethernet, etc..)
- Telco (POTS)
- Alarm
- Antenna (multiple - refer to Navini BTS requirements)

Outdoor Cabinet Manufacturers

General

This section includes a list of several outdoor cabinet manufacturers, with available contact information. Inclusion of a manufacturer on this list does not represent an endorsement of the manufacturer or its products by Navini Networks.

Manufacturers List

EMAR

EMAR Inc.
2200 E. Memorial Drive
Muncie, Indiana 47302
Phone: (765)-289-3777
Fax: (765)-289-3785
<http://www.emarinc.com>
[email: info@emarinc.com](mailto:info@emarinc.com)

Hendry

Hendry
55 Castilian Drive
Santa Barbara, CA 93117-3080
Phone: (805) 968-5511
Fax: (805) 968-9561
<http://www.hendry.com>

Contacts:

Jim Heath, Eastern Region Sales Manager, Phone: (321) 733-7850, [email: jheath@hendry.com](mailto:jheath@hendry.com)

Emerson Energy Systems

Emerson Energy Systems Limited Inc.

Phone: (972) 367-4300

Fax: (972) 367-0066

<http://www.-emersonenergy-na.com/>

[email: US@EmersonEnergy-NA.com](mailto:US@EmersonEnergy-NA.com)

Contacts:

Hans Heimersson, Product Manager, Phone: (972)-367-4376

Henrik Schubert, Business Development Manager, (972) 367-4380

Marconi

Marconi Communications

4350 Weaver Parkway

Warrenville, IL 60555

Phone: (630) 579-5000

Fax: (630) 579-5050

<http://www.marconi.com/osp>

Appendix K: Install Connectors on Cables

The following procedures are for installing Times connectors on LMR cable. The procedure may vary for different types of connectors and cables.

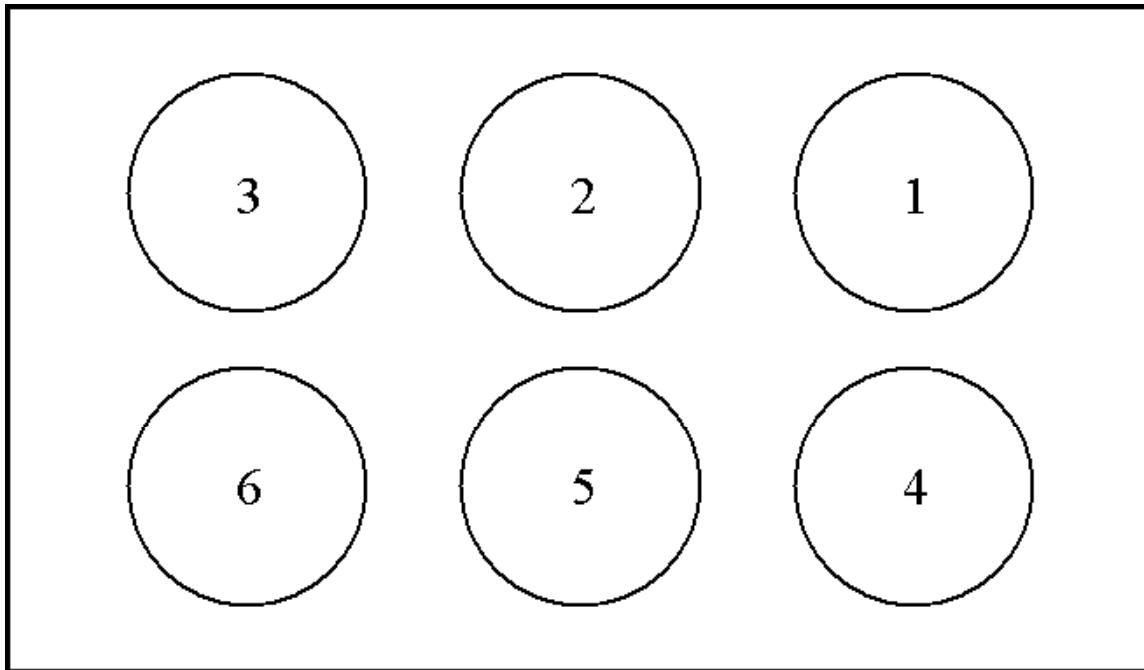
You will need to install connectors on both ends of each cable. Install EZ-600 N-type male connectors on all LMR 600 cables. Install EZ-400 N-type male connectors on all LMR 400 cables. The steps below can be used for both connectors.

- Step 1.** Ensure that the cable is cut straight.
- Step 2.** Slide the heat shrink boot and crimp ring onto the cable. Strip the cable end using the ST-600-EZ prep/strip tool by inserting the cable into End 1 and rotating the tool. Remove any residual plastic from the center conductor.
- Step 3.** Insert the cable into End 2 of the ST-600-EZ prep/strip tool and rotate the tool to remove the plastic jacket.
- Step 4.** Debur the center conductor using the DBT-01 deburring tool.
- Step 5.** Flare the braid slightly and push the connector body onto the cable until the connector meets resistance and then snaps into place. Then slide the crimp ring forward, creasing the braid.
- Step 6.** Slide the crimp ring back, and trim the excess braid at the crease line. Slide the crimp ring forward until it butts up against the connector body.
- Step 7.** Position the heavy duty HX-4 crimp tool with the appropriate dies (.510"hex) directly behind and adjacent to the connector body, and crimp the connector. The crimp tool automatically releases when the crimp is complete.
- Step 8.** Position the heat shrink boot as far forward on the connector body as possible without interfering with the coupling nut. Use a heat gun to shrink the heat shrink and form a weather tight seal.
- Step 9.** Label all cables on both ends. Label the nine LMR-600 cables RFS 1 through RFS 8 and CAL. Label the two LMR-400 cables GPS 1 and GPS 2. Label the data/power cable (from the supplier) as POWER.

Appendix L: Chassis Alarms

The chassis contains two connectors that are used to send alarm indications to the BTS. One of the connectors, labeled CABINET ALARM, is used to trigger alarm conditions that occur within the external chassis. The second connector, labeled BBU, is used to process alarms from the battery backup unit. Both connectors contain six pins. The pin orientation, as seen from the back of the chassis, is shown in Figure L1.

Figure L1: Pin Orientation



The alarm connector uses only four of the six pins. The pin names can be found in Table L1.

Table L1: Pin Names

Pin	Name
1	General Fail Alarm
2	Ground reference for General Fail Alarm
3	Door Open Alarm
4	Ground reference for Door Open Alarm
5	Not Connected
6	Not Connected

The first pin of the alarm connector is the General Fail Alarm. This signal should be left open to indicate an alarm condition from the HMC module located in the outdoor chassis. If no alarm condition exists, this pin should be driven low. Pin 2 is used as the ground reference for this alarm. The second alarm sent to the chassis is located on pin 3, Door Open Alarm. This signal should be driven low when the door is closed. To indicate that the door of the outdoor chassis is open, this signal should be left open. The associated ground reference for this signal is taken from pin 4.

The BBU connector contains four alarm signals. These signal names are listed in Table L2.

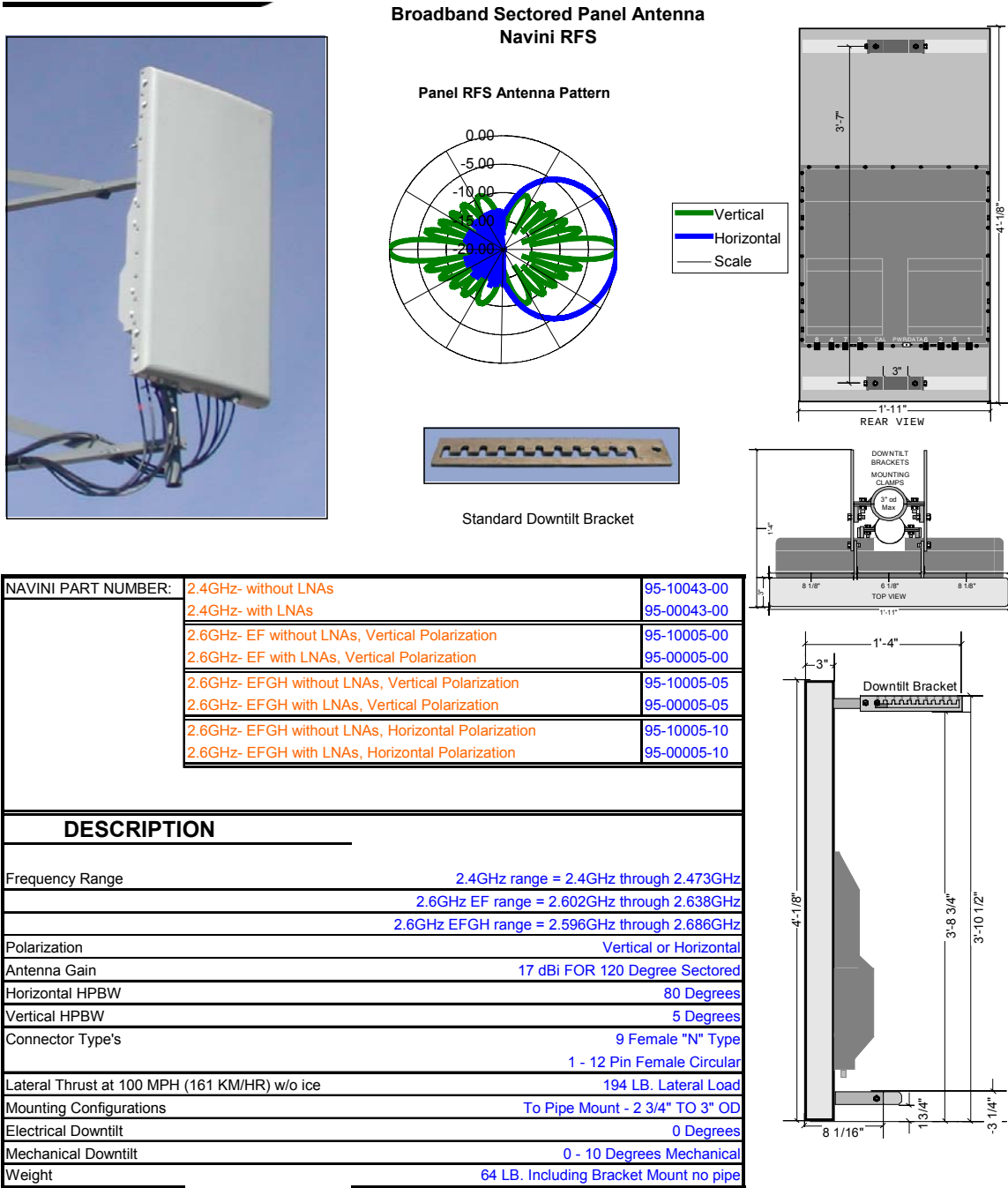
Table L2: BBU Signal Names

Pin	Name
1	Digital Ground Reference
2	BBU Battery Low
3	BBU Rectifier Fail
4	BBU AC Line Fail
5	BBU Charge Fail
6	Analog Ground Reference

The first alarm signal is located on pin 2, BBU Battery Low. If the BBU's battery is running low, the signal on pin 2 should be left open. BBU Rectifier Fail alarm is the next alarm and is located on pin 3. This signal should be left open to indicate a failure on the Battery Backup Unit's rectifier. The next alarm condition occurs if the AC Line to the BBU fails. In this condition, signal BBU AC Line Fail on pin 4 should be left open. If the BBU is unable to hold a charge, then the BBU Charge Fail signal on pin 5 should be left open. For non-alarm conditions (normal operation), these signals should be driven low. The digital ground reference for these signals is located on pin 3. The analog ground reference should be located on pin 4.

Appendix M: Antenna Drawings

Panel Antenna

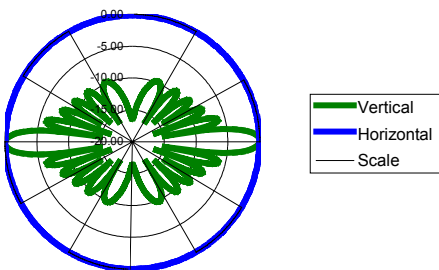


Omni Antenna

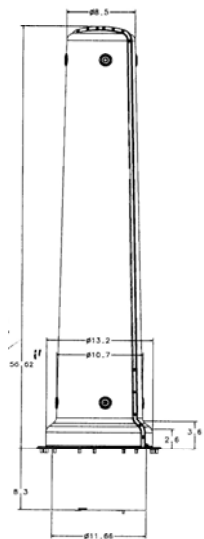


Broadband Omnidirectional Antenna
Navini RFS

Omni RFS Antenna Pattern



NAVINI PART NUMBERS:	2.4GHz- without LNAs	95-24108-xx*
	2.4GHz- with LNAs	95-24008-xx*
	2.6GHz- EF without LNAs	95-26308-xx*
	2.6GHz- EF with LNAs	95-26108-xx*
	2.6GHz- EFGH without LNAs	95-26108-xx**
	2.6GHz- EFGH with LNAs	95-26008-xx**
* for 2.4GHz and 2.6GHz EF products, the present downtilt options are 0, 3, 5, and 7 degrees, to be specified by a -00, -03, -05, and -07 in place of -xx		
** for 2.6GHz EFGH, the downtilt options are 2 and 4 degrees, to be specified by a -02 or a -04 in place of -xx		
DESCRIPTION		
Frequency Range	2.4GHz range = 2.4GHz through 2.473GHz	
	2.6GHz EF range = 2.602GHz through 2.638GHz	
	2.6GHz EFGH range = 2.596GHz through 2.686GHz	
Polarization	Vertical	
Antenna Gain	8dBi	
Horizontal HPBW	Omni	
Vertical HPBW	15 Degrees	
Connector Type's	9 Female "N" Type	
	1 - 12 Pin Female Circular	
Lateral Thrust at 100 MPH (161 KM/HR) w/o ice	110 LB. Lateral Load	
Mounting Configurations	To Pipe Mount	
Electrical Downtilt	0, 2, 3, 4, 5, and 7 Degree	
Mechanical Downtilt	N/A	
Weight	43 LB. Including Mount	

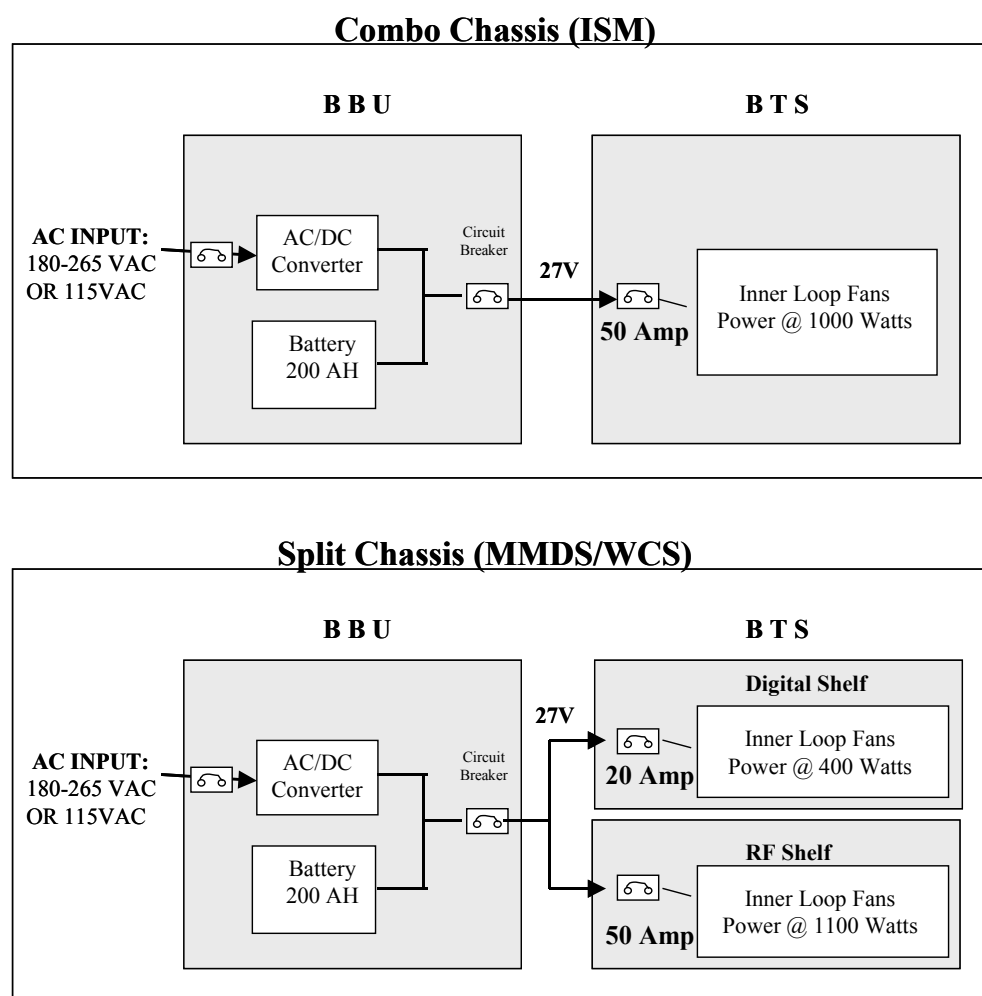


Appendix N: Rectifier/BBU Specifications

System Block Diagram

Navini Networks uses a 1000 Watt Rectifier/Battery Backup Unit (BBU) for the Ripwave Base Transceiver Station (BTS) combo chassis, and a 1500 watt Rectifier/BBU for the Ripwave BTS split chassis. The system diagrams in Figure N1 depict the current flow from incoming AC voltage to BBU and the converted power into the BTS. The BBU is designed to provide a four-hour battery backup for the BTS. The rectifier is designed with hot-swappable modules. Module redundancy of N+1 is required.

Figure N1: System Diagrams



Input Specifications

The information in Table N1 shows the input required for the Ripwave BTS backup unit.

Table N1: Input Specifications

Input Voltage:	180 to 265 VAC
(Optional) Input Voltage:	92-125 VAC
Frequency:	47 to 63 Hz
Input Circuit Protection:	Circuit Breaker
Surge Voltage/Current:	6 kV / 3 kA
Connection:	4 wire – 220V, 3 wire – 110V

Output Specifications

In Table N2 are the output specifications for the Ripwave BTS backup unit.

Table N2: Output Specifications

Nominal Rectifier DC Voltage:	+27.2V +/- 2% (grounded negative pole)
Permitted Output Voltage Range:	+22V ~ +28V (battery backup range: +21.0V ~ +27V)
Shutoff Voltage:	At 21V
Load:	10% to maximum load
Recharge Maximum Battery Voltage:	+27.6V
Dynamic Load Response Time:	<5% - overshoot/undershoot for 10% to 90% load step in 50 uS.
Ripple & Noise:	Psophometric voltage: less than 2mV rms
	10Hz ~ 14MHz: less than 250mVp-p
	10Hz ~ 10MHz: less than 50mV rms
	Wideband ripple and noise 1% of output voltage
Stability of Output Voltage:	Line regulation: +/- 0.2%
	Load regulation: +/- 0.5%
Output Circuit Breakers:	Each rectifier module requires input and output overload protection

General Specifications

The information in Table N3 provides other specifications for the Ripwave BTS backup unit. Note that some specifications vary by BTS frequency model: 2.3, 2.4, 2.5, or 2.6 GHz.

Table N3: General Specifications

BTS Power Consumption:	1000 Watts – Combo Chassis 1500 Watts – Split Chassis
Efficiency:	Minimum of 88 % (at maximum load)
Power Factor:	Minimum of 95% (at 50 ~ 100% load)
Redundancy:	Any single failure in the rectifier or controller shall not turn off output or cause voltage dip.
Battery Charge:	Charge time shall be less than 10 hours. Charge method to be temperature compensated.
Turn on Delay:	1 sec maximum. The rectifier shall start with any load.
Leakage Current:	Maximum of 3.5 mA
Withstanding Voltage:	1 minute/ 3.5 kVac (10mA)
Recharging:	If the electricity fails, the battery must immediately turn on. When electricity is restored, it must begin recharging.
Floating:	When the battery has been fully charged.
Hot Swappable:	Rectifier consists of modules, which are hot-swappable. +/- 5% maximum voltage change when inserting or extracting one module.

Protection

Table N4 shows the protection specifications for the Ripwave BTS backup unit.

Table N4: Protection Specifications

Over-voltage Protection:	Shutdown at 30V. Power cycle to recover.
Under-voltage Protection:	Shutdown at 21V with disconnect relay
Over-current Limit:	At 110% ~ 130%. Auto recovery after the condition is removed.
Over Temperature:	Auto-recovery
Short Circuit:	Infinite short protection. Auto recovery after the condition is removed.
Input Protection:	AC main circuit breaker required
Battery Protection:	Battery protection fuse required Reverse battery connection fuse protected

Environmental Requirements

Table N5 provides the environmental requirements for the Ripwave BTS backup unit.

Table N5: Environmental Requirements

Operating Temperature:	0 C to +50 C
Storage Temperature:	-40 C to +70 C
Relative Humidity:	5 to 95% non-condensing
Altitude:	-100 to 3,000 meters operating -100 to 12,000 meters non-operating
Vibration:	Telcordia GR-63-CORE, section 4.4, Zone 4, GR-487-CORE
Input Surge:	GR-1089-CORE

Regulatory Requirements

The BBU shall comply with all applicable requirements and conditional requirements of Telcordia. These are called out in Table N6.

Table N6: Regulatory Requirements

Input Surge Protection:	GR-1089-CORE, section 4, up to 6 kV, 3 kA
Safety:	UL 1950, 3 rd ed, CSA 22.2 #950
EMI/EMC:	FCC Part 14 Subpart B, Class A
Telcordia Requirements:	GR-1089-CORE “Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment” Section 3. Class A Section 4, up to 6 kV, 3 kA Appendix C, Type 1 GR-63-CORE “Network Equipment – Building System (NEBS) Requirements: Physical Protection: Section 4, Zone 4” GR-487-CORE “Electronic Equipment Cabinets”

Reliability

The reliability requirements for the Ripwave BTS backup unit are provided in Table N7.

Table N7: Reliability Requirements

Derating:	Use NAVMAT P4855 as a derating guideline. Exceptions must be approved by Navini Networks.
MTBF:	>500,000 hours for rectifier using Telcordia methodology. >100,000 hours for total system including over current protection.
Expected Life:	15 years
Maintainability:	There shall be no components that require periodic maintenance.

Alarm & Control

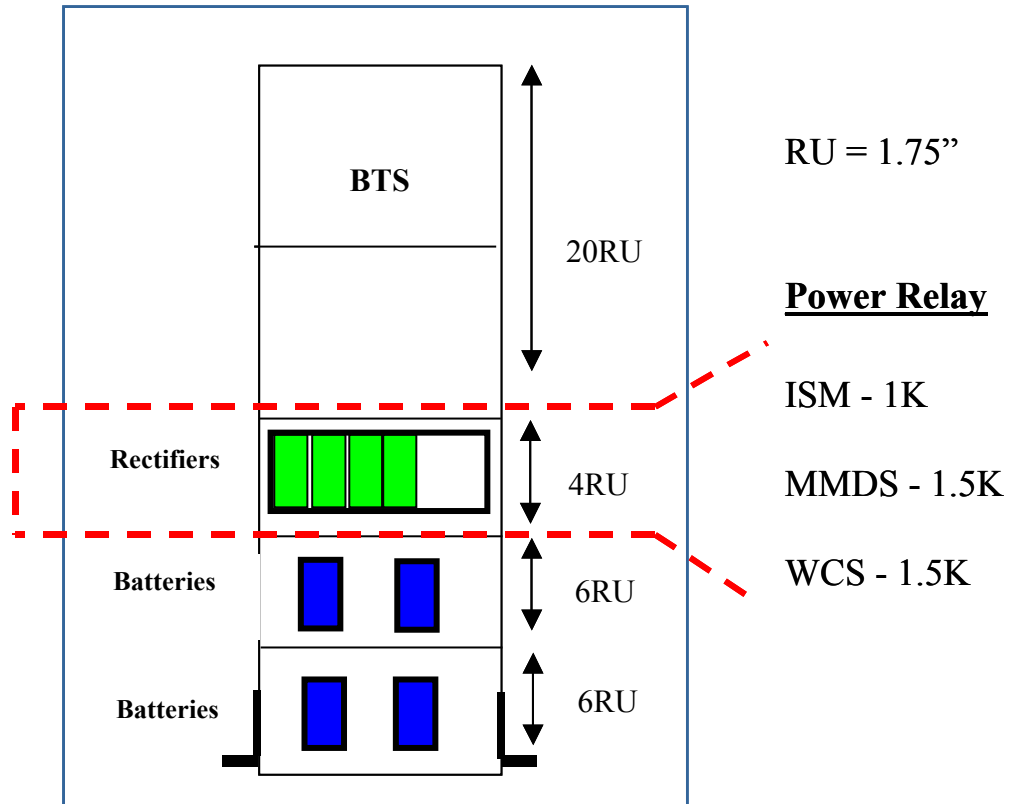
The Alarm and Control Relay has dry contact: open for alarm, normally grounded (safe), for the following:

- AC line failure
- Low battery voltage
- Rectifier failure
- (Optional) - self test go/no-go, if applicable
- (Optional) - charger failure, if provided
- (Optional) - output voltage sense line
- Common chassis ground

Mechanical Configuration

The following list covers the mechanical configuration requirements for the Ripwave BTS backup unit. The internal rectifier should be 19 inch rack-mountable. The rectifier shall consist of N+1 hot swappable modules. If one module fails, there must be enough power handling capability to provide full output power for a load of 1KW.

- Rectifiers to provide internal cooling. No external forced air provided.
- Acoustic Noise less than 60dBA, 1 meter from front.
- Rectifier to provide front panel indicators: AC ON, Module Failure.
- The maximum dimensions of the rack are: 84" (H) x 19" (W).
- The BBU shall be placed in a single 19-inch rack. See diagram in Figure N2.
- Power exits: rear preferred; front is not acceptable.

Figure N2: BBU Rack

Appendix O: Sample Bill of Materials (BoM)

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BOM EXPLOSION REPORT

KIT, INSTALLATION, BTS, 2.6 Revision B

Part Number: 95-05001-00

Part

13-00034-00 : CONN, COAX, CRIMP, N STRAIGHT PLUG, EZ PIN (LMR600) . Quantity: 36

Part

13-00194-00 A CONN, COAX, CRIMP, N STRAIGHT PLUG, EZ PIN, MALE (LMR400). Quantity: 8

Part

Connectors, NType

13-00218-00 A CONN, LUG, ONE-HOLE #6. Quantity: 10

Connectors

13-00219-00 : CONN, LUG, TWO-HOLE #6. Quantity: 10

Connectors

13-00220-00 : CONN, LUG, TWO-HOLE #2. Quantity: 10

Part

18-00001-00 : CABLE, COAX, OUTDOOR RF, LMR600. Quantity: 1350

Part

18-00035-00 A WIRE, GROUND, GREEN, STRANDED, #2. Quantity: 50

Part

18-00036-00 : CABLE, COAX, OUTDOOR RF, LMR400. Quantity: 200

Cables, Coax

18-00049-00 : WIRE, STRANDED, GREEN, #6 AWG 50. Quantity: 13

Part

24-00045-00 : NUT, REG. HEX, CRES, 1/4-20UNC. Quantity: 8

Part

24-00117-00 : BUSS BAR, GROUND, TOWER, 1/4IN X 2-1/2IN X 12-1/2IN. Quantity: 1

Part

24-00118-00 : BUSS BAR, GROUND, SHELTER, 1/4IN X 4IN, DRILLED TO 5/8IN. Quantity: 1

Part

24-00119-00 : GRIP, HOISTING, PRE-LACED, FOR 1/2IN COAX CABLE. Quantity: 10

Part

24-00120-00 : HANGERS, ASSY, CUSHION, 5H, 1/2IN CORREGATED COAX. Quantity: 4

Mechanical Hardware

24-00121-00 : MOUNT, HANGER, CROSS CUSHION, KIT OF 5. Quantity: 2

Part

24-00122-00 : BLOCK, SUPPORT, MINI COAX. Quantity: 2

Part

24-00134-00 A BREAKER, OUTPUT DISTRIBUTION, 60 AMP, BTS INSTALLATION. Quantity: 1

Mechanical Hardware

24-00156-00 : CLAMP, PIPE TO PIPE, KIT OF 2. Quantity: 1

Mechanical Hardware

24-00170-00 : NUT, REG. HEX, CRES, #10-24. Quantity: 3

Part

24-00171-00 : WASH, STAR, #10. Quantity: 3

Part

24-00172-00 : WASH, STAR, ¼. Quantity: 16

Part

24-00250-10 : BOLT, HEX, 1/4-20 X 1.000 LG, SSPA. Quantity: 8

Mechanical Hardware

24-06156-43 : WASH, FLAT, CRES, #6 T-B-REGULAR, .156 X .438 X .040. Quantity: 16

Part

24-06250-14 : WASH, LOCK, SPLIT, CRES 1/4, Reg, .252X.487X.062. Quantity: 16

Part

32-00031-00 : ARRESTOR, LIGHTNING, RF 1.2 - 2.8GHz, N TYPE FEMALE, DC BLOCK, PSX. Quantity: 9

Part

32-00033-00 : ARRESTOR, LIGHTNING, GPS, PICKOR, DC PASS, MM50MNZ+6. Quantity: 2

Part

32-00052-00 : KIT, GROUNDING, LMR-600, 5FT X 1/2 IN, 2 HOLE LUG. Quantity: 9

Part

32-00053-00 : KIT, GROUNDING, LMR-400, 5FT X 3/8 IN, 2 HOLE LUG. Quantity: 2

Part

32-00077-00 : KIT, WEATHERPROOFING, GEL WRAP. Quantity: 1

Part

32-11004-00 : ARRESTOR, SURGE, EMP, DC BLOCK, RF COAX, In-line 2.4 GHz., PSX-ME. Quantity: 9

Part

92-00006-00 : SUBASSY, MOUNT UNIVERSAL FOR OMNI ANTENNA. Quantity: 1

Antennas

68-00006-00 : DWG, ASSY MOUNT UNIVERSAL FOR OMNI ANTENNA. Quantity: REF

Assembly Drawing, Mechanical

55-00063-00 : BASE, WELDMENT, ANTENNA MOUNT, OMNI. Quantity: 1

Part

55-00079-00 : FLANGE C, ANTENNA MOUNT, OMNI. Quantity: 1

Part

55-00080-00 : GUSSET, ANTENNA MOUNT, OMNI . Quantity: 2

Part

55-00081-00 : PLATE, BASE, ANTENNA MOUNT, OMNI. Quantity: 1

Part

24-10000-00 : NUT, PEM, BLIND .250 1/4-20 BS-0420-2. Quantity: 8

Part Type

55-00088-00 : FLANGE, CLAMP, STANDARD MOUNT, GALVANIZED. Quantity: 2

Part

24-09000-00 : STUD, 7/16 X 14 LG ALL THREAD, GALVANIZED, ANTENNA MOUNT, OMNI. Quantity: 4

Mechanical Hardware

24-09001-00 : WASHER, SQ, ALUMINUM, ANTENNA MOUNT. Quantity: 4

Mechanical Hardware

24-09002-00 : WASHER, SQ, GALVANIZED, ANTENNA MOUNT. Quantity: 4

Mechanical Hardware

24-09003-00 : FLAT WASHER 7/16 REG GALVANIZED. Quantity: 12

Mechanical Hardware

24-09005-00 : LOCK WASHER, 7/16, GALVANIZED. Quantity: 12

Mechanical Hardware

24-09004-00 : HEX NUT 7/16 GALVANIZED. Quantity: 12

Mechanical Hardware

24-00124-00 : BOLT, HEX 1/4-20 X 1.250 LG SSPA. Quantity: 8

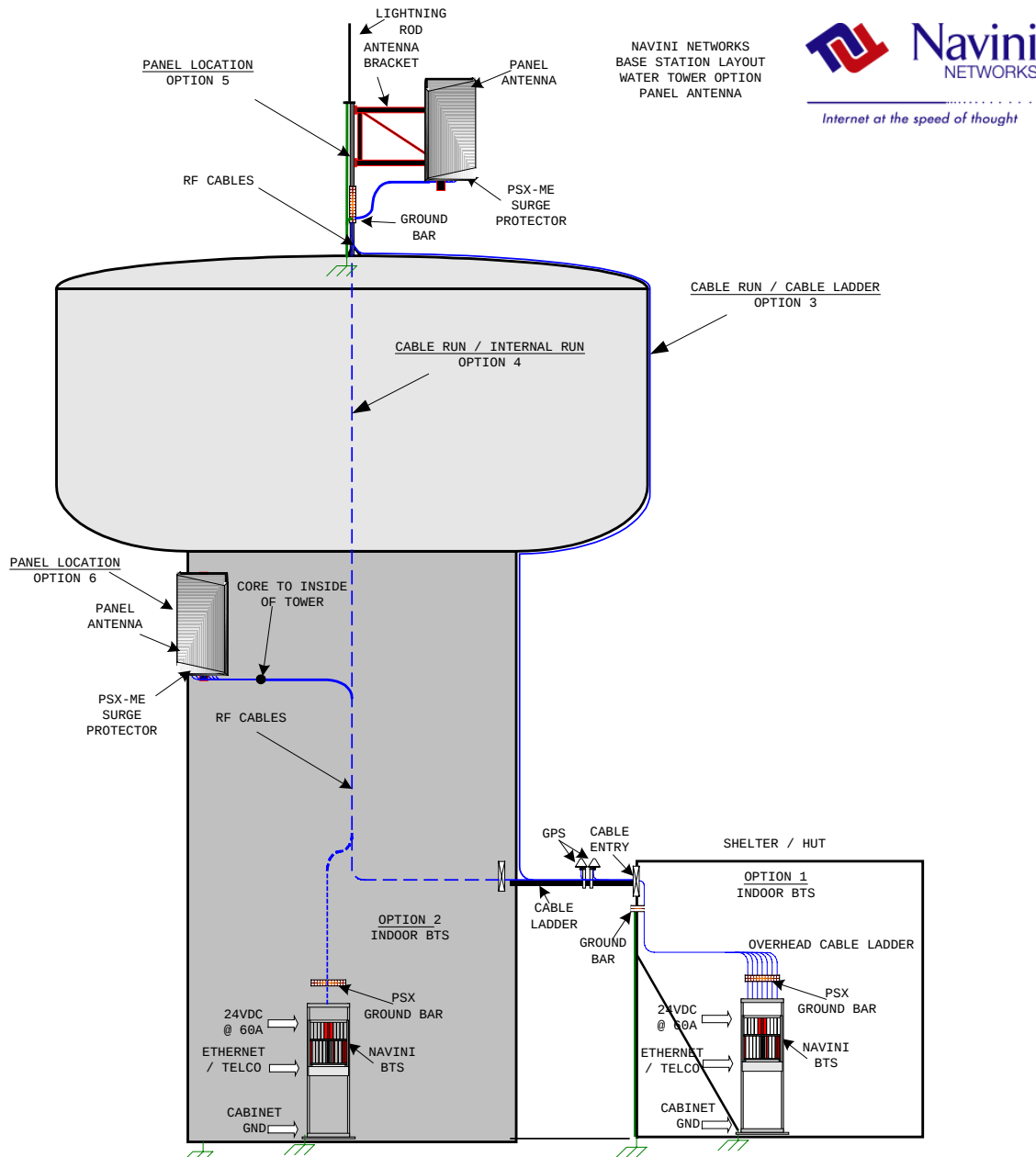
Part Type

24-06250-14 : WASH, LOCK, SPLIT, CRES 1/4, Reg, .252X.487X.062. Quantity: 8

Part

24-06250-28 : WASH, FLAT, CRES, 1/4 T-B-REGULAR, .281 X .734 X .063. Quantity: 8

Appendix P: Sample Base Station Drawing



NOTE

- 1.CABLE BUNDLE CONSIST OF 9 RF CABLES AND 1 POWER/DATA CABLE
- 2.RF CABLE TYPE TO BE DETERMINED BASED ON RUN LENGTH AND DB LOSS/FT
- 3.CABLE HANGERS TO BE SPECIFIED/RECOMMENDED BY TOWER CREW
- 4.ANTENNA BRACKET TO BE SUPPLIED BY CUSTOMER AS RECOMMENDED BY TOWER CREW
- 5.BTS REQUIRES 24VDC @ 60A.
- 6.PSX-ME SURGE PROTECTORS TO BE INSTALLED IN-LINE BETWEEN RF CABLE AND ANTENNA
- 7.PSX SURGE PROTECTOR TO BE MOUNTED ON GROUND BAR CLOSE TO BTS CABINET/CHASSIS
- 8.ETHERNET/TELCO BACKHAUL TO BE PROVIDED BY CUSTOMER
- 9.ALL INSTALLED EQUIPMENT/MATERIALS MUST BE PROPERLY GROUNDED
- 10.OPTION 1 IS FOR AN INDOOR BTS INSTALL, OPTION 2 IS FOR OUTDOOR BTS

CUSTOMER	
SITE NAME	
LOCATION	

1	PANEL LOCATION OPTION 5=DOME TOP 6=SIDE		
2	ANTENNA BRACKET TYPE		
3	PSX-ME SURGE PROTECTOR		PCS
4	ANTENNA AZIMUTH		
5	ANTENNA HEIGHT		
6	ANTENNA DOWNTILT		DEGREES
7	TOWER JUMPER LENGTH		FEET
8	TOWER JUMPER CABLE TYPE		

9	MAIN FEEDER TYPE		
10	MAIN FEEDER LENGTH		FEET
11	GROUND BUSS BAR		PCS
12	CABLE HANGER TYPE		
13	WEATHERPROOFING KIT		PCS
14	GROUNDING CABLE LENGTH		FEET
15	GROUNDING KIT		PCS
16	HOISTING GRIP		PCS

17	GPS MOUNT		
18	GPS CABLE LENGTH		FEET
19	GPS CABLE TYPE		

20	LOCATION OPTION 1=SHELTER 2=INSIDE TOWER		
21	CABLE RUN OPTION 3=EXTERNAL 4=INTERNAL		
22	JUMPER CABLE LENGTH		FEET
23	JUMPER CABLE TYPE		
24	PSX SURGE PROTECTOR		PCS
25	GPS SURGE PROTECTOR		PCS
26	ALT GROUND BUSS BAR		PCS
27	24VDC/60A POWER SUPPLY		
28	INDOOR RACK/CABINET		

Appendix Q: Sample Statement of Work

The following is an example of a Statement of Work. The Statement of Work outlines the general activities that must be conducted in order to complete the installation and commissioning tasks for a Ripwave Base Station.

Example: Statement of Work for Standard Installation Services

The following statement of work will be used to outline the areas of responsibilities for the Navini Networks antenna (known as the RFS) and Base Station (known as the BTS) installations to be completed with Navini Networks Client (referred to as Client in this document). Client may choose to hire a contractor or tower crew to assist with its activities. Navini Networks has no formal contract relationship with the contractor, who will be managed by Client. The following work items are suggested content only - - final scope and terms to be negotiated directly with Client. Navini Networks support personnel will be on site for the entire installation and commissioning process, and will provide technical expertise, information, and recommendations with respect to site design and installation.

It is recommended that contractor have a Non-Disclosure Agreement (NDA) in place with Client and Navini Networks prior to execution of work. Contractor shall not publicly disclose any information concerning this deployment or trial with any other parties, unless approved in writing in advance by Client and Navini Networks.

Navini Networks

1. Provide Field Engineer to consult with Client and Contractor for planning efforts.
Review Site design sketches and BOM prepared by others.
2. Review network architecture information (connection diagram and logical addresses) prior to start of installation.
3. Review Sweep results with Client and contractor. Sweep to be provided of RFS after shipment, of coax cables and RF path on tower, and of cables and RFS after installation, before power up.
4. Review AC and DC power system installation. Review DC power system test with Client and contractor.
5. Review backhaul circuit installation test results with Client.
6. Review GPS antenna and cable installations.
7. Review and Verify Cable and Antenna System Installation Work
8. Site walk with contractor and Client for Punchlist.
9. Load EMS software on Client supplied workstation, and verify connectivity to BTS.

10. Provide BTS installation – Chassis and Cards.
11. Apply power to BTS and perform all power up, BTS calibration verification checks, commissioning and initial testing of Navini Networks system. May use EMS on local laptop.
12. With assistance of Client, Perform Drive Test / Coverage Verification.
13. With assistance of Client, perform data rate testing at mutually specified locations – 15 for Omni, 5 for each panel RFS.
14. With client, integrate BTS into backhaul network and verify operation.
15. Closeout / Customer Acceptance package, including inventory of hardware.
16. Navini Networks to provide own tools and test equipment.
17. Clean job site daily.

Client / Contractor Work Items

1. Perform Site survey at each site.
2. Prepare Installation sketch and Bill of Materials (BOM) for each site. Note that these are not sealed construction drawings.
3. Client / Contractor Site Design and Bid Walk.
4. Material Procurement.
5. Acquire building permits.
6. Inside Network cabling from demark to BTS rack
7. AC power installation (provide dedicated 115 VAC 20 A circuit for each BTS, dual outlet receptacle).
8. Air conditioning work or other hut electrical work.
9. 24 VDC rectifier installation, cabling to BTS chassis, cabling to AC circuit breaker. Test 24 VDC system (note: do not apply power to BTS).
10. Mount 19" TELCO rack inside hut (base anchors, or overhead brackets or both)
11. Provide core drilling and furnish and install feed through panel for coax cables, unless already existing. Seal holes using similar materials to other existing feed-through at each site.
12. Install grounding inside hut for rack and 24 VDC system. Install ground bus bar inside hut entry per drawings. Install ground bus bars on antenna structure and ground coax cables per sketch.
13. Install and apply coax cables and connectors. This includes main coax runs on tower, plus coax jumpers at antenna and at hut, as specified by drawings. Recommend and Install all cable hangers and supports, and grounding, per standard practice in use at tower location. Install surge protectors per design sketches and BOM.
14. Sweep test coax cables at designated sweep frequencies.
15. Install power and data cable from antenna to BTS.
16. Weather seal all outside connections.
17. Recommend, furnish and install mounting structure (arm assembly) to stand-off Navini RFS from tower. Standoff assembly to include pipe mount for antenna mount. Install Navini RFS on arm on tower. Connect to coax cables and provide sweep of cable / RFS assembly. Provide photographic documentation of tower top installation work.
18. Provide equipment and cable labeling as required.
19. Install (2) GPS antennas on ice bridge (or other agreed upon location). Furnish and

- install any required brackets or pipe mounts. Install GPS coax cables and connectors from GPS antenna to BTS.
20. Site walk at completion with Client and Navini, create Punchlist; clear applicable punchlist items.
 21. Arrange disposal of trash
 22. Provide RF coverage analysis plots before start of installation. Provide model tuning, if required.
 23. Provide architecture document before start of installation, including connection diagram and logical network element assignments (IP addresses, PVC's, etc.).
 24. Set Up and Verify all network equipment and backhaul circuits.
 25. Set Up and Verify Operation and connectivity of EMS computer.
 26. Provide one resource to assist with drive testing and location data rate testing.
 27. Provide all end user / CPE provisioning in EMS after initial testing.
 28. Provide all end user interface and troubleshooting.
 29. Monitor EMS / alarms. Forward trouble issues to Navini call center.
 30. Contractor and Client to provide own tools, computers, and test equipment.

Appendix R: Sample Responsibility Assignment Matrix (RAM)

The following is an example of a Responsibility Assignment Matrix (RAM). The RAM is a tool for capturing who will do what to get systems deployed and turned up. It provides an easy-to-read and follow tabular format. Each of the activities in the list must be addressed in order to complete the installation and commissioning tasks for a Ripwave Base Station.

1 = Primary Responsibility
2 = Secondary Responsibility

S = Supply
I = Install

Item #	Task / Activity	Navini	Client	Other	Notes
MARKET PLANNING and RF ENGINEERING					
1	Develop coverage objectives		1		
2	Provide Hardware Specifications	1			
3	Provide Link Budget	1			
4	Prepare Preliminary Coverage Plots	2	1		
5	Interference Analysis / Noise Floor	2	1		
6	Link Specific Channel Assignments	2	1		
7	Review / Approve RF Design	2	1		
8	SCT Filing fees		1		
9	SCT licensing / clearing		1		
10	Contract RF consulting engineering		1		
11	Obtain SCT Test Permit		1		
NETWORK ENGINEERING & BACKHAUL					
1	Network Requirements	2	1		

Item #	Task / Activity	Navini	Client	Other	Notes
2	Network Architecture	2	1		
3	Provisioning Guidelines		1		
4	IP / data Address Assignment / management		1		
5	Review / Approve Network Design	2	1		
6	Network Architecture – backhaul		1		
7	ATM layer Provisioning / management		1		
8	Order Circuits		1		
9	Order equipment for backhaul / interface		1		
10	Backhaul Network Test		1		
SITE ACQUISITION					
1	Identify BTS candidates in search ring		1		
2	Identify CPE Candidates per ring		1		
3	Identification of Zoning requirements		1		
4	Select BTS sites		1		
5	Negotiate and close lease		1		
6	Pay lease costs		1		
7	Obtain any building permits if required		1		
8	Arrange Site Access		1		
SITE DESIGN					
1	Site Survey – BTS sites	2	1		
2	Prepare Site Design Sketches / Layout	2	1		
3	Prepare BOM	2	1		
4	Review Design / Approve	2	1		
5	A&E Selection and management		1		
6	Prepare / approve A&E drawings		1		

Item #	Task / Activity	Navini	Client	Other	Notes
7	Tower Structural Analysis		1		
8	Contractor Qualifications and Selection		1		
9	Contractor walk through		1		
10	Obtain / Review bids / Award contract		1		
11	Obtain Building permits or other approvals		1		
LOGISTICS / SHIPPING / DELIVERY					
1	Create Logistics Plan	2	1		
2	Ship Navini supplied Equipment to designated warehouse	1			
3	Deliver Equipment to Specific Sites		1		
4	Disposal of Shipping materials	2	1		
CONSTRUCTION / INSTALLATION					
1	Antenna Mounts / brackets		S, I		
2	Antennas (Navini RFS)	S	I		Navini will assist and supervise installation from the ground.
3	Coax Cable / Connectors		S, I		
4	Power / Signal Cable / Connectors (BTS to RFS)	S	I		1 per BTS.
5	Ground Kits		S, I		
6	Surge protectors/Ground Buss Bars		S, I		Navini to supply surge protector for the power and data cable. Client to supply surge protectors for coaxial feedlines.
7	GPS 4-Way Splitters for multiple BTS' installed at one site.		S, I		2 4-Way Splitters needed for 3-sector installation.
8	BTS Equipment Racks / Enclosures		S, I		Need to confirm indoor installation. Enclosure not required indoors.

Item #	Task / Activity	Navini	Client	Other	Notes
9	DC Power System 24VDC @ 60 Amps for each BTS		S, I		
10	Batteries / UPS		S, I		
11	Intra – rack cabling		S, I		
12	Electrical Circuits		S, I		
13	Electrical – wiring from panel to rack		S, I		
14	Electrical (conduit, distribution panels, etc.)		S, I		
15	Environmental Equipment		S, I		
16	Miscellaneous Hardware		S		
17	BTS cages / cards	S, I			
18	Network Router		S, I		
19	Network Ethernet Switch with ATM interface		S, I		
20	EMS Server / workstation		S, I		
21	EMS client workstation (for techs)		S, I		
22	EMS client workstation (for Navini)	S, I			
23	Server for DHCP and network applications		S, I		
24	CPE	S			
25	User PC with Ethernet and/or USB Card		S		
26	Provide Construction Supervisor	2	1		Navini will supervise installation of Navini equipment.
27	Provide Installation Resources	2	1		Client contractors. Navini will install the BTS in the client installed rack/cabinet. Navini will provide technical guidance for installation of the RFS.
CONSTRUCTION					
1	Site Preparation/Infrastructure	2	1		

Item #	Task / Activity	Navini	Client	Other	Notes
2	Pull Cables		1		
3	Install Connectors and Grounding		1		
4	Install Surge Protectors	2	1		
5	Test / Sweep Coax	2	1		
6	Install mounts / brackets	2	1		
7	Install Racks	2	1		
8	Electrical power to Rack		1		
9	Backhaul to rack		1		
10	Environmental (if required)		1		
11	Quality Assurance	2	1		
12	Inspections / Punch List	2	1		
13	Close all Punch List Items	2	1		
14	Provide POTS line for technician use		1		
EQUIPMENT COMMISSIONING & INTEGRATION					
1	Inspect / Test Cabling / Connections	2	1		
2	Install Rack Mount Power System / Card Cages	1	2		
3	Test DC System	2	1		
4	Plug cards in BTS	1			
5	Load EMS / Configure	1			
6	Boot BTS	1			
7	Provision EMS / BTS / CPE	1			
8	Test Operation	1			
9	Integrate Backhaul	2	1		
10	Verify Operation	2	1		
11	Router: Configure / test		1		

Item #	Task / Activity	Navini	Client	Other	Notes
12	DHCP Server: configure / test		1		
13	EMS Client: Configure / Test	1	2		
14	Configure monitoring for routers		1		
TESTING					
1	Determine Network Test Criteria	2	1		Based on trial agreement.
2	Determine RF Test Criteria	1	1		Based on trial agreement.
3	Generate Acceptance Test Plan (ATP)	1	1		
4	Review Test Plan	1	1		
5	Supply Test Equipment HP/Agilent E4402B Spectrum Analyzer with Floppy Storage Option, HP/Agilent 8648C RF Signal Generator, Tektronix TDS 3012B Scope	1	2		Some tests will utilize built in test capability.
6	Execute Trial Test Plan and capture data	2	1		
7	Provide Vehicle and Driver for System Drive Testing		1		
8	Analyze test data and write report	2	1		
9	Review Report, Trial test results	1	1		
END USER ENGAGEMENT					
1	Prepare End User profile		1		
2	Develop User Procedures		1		
3	Recruit and Sign Up Users		1		
4	Distribute CPE kits		1		
5	Develop User Surveys		1		
6	Survey Users, collect data		1		
7	Issue reports		1		
SUPPORT & SERVICES					

Item #	Task / Activity	Navini	Client	Other	Notes
1	System Training for Service Provider	1			
2	Monitor Network	2	1		
3	End User Contact (answer phones)		1		
4	Fault Determination and Isolation	2	1		Client to provide Level 1 support.
5	Performance Reporting	2	1		
6	Field Repairs / Replacements (if needed)	1	2		
7	Shipping for Repairs / Replacements	2	1		
8	Spares		1		Spares count TBD.
9	Install Hardware Upgrades (if needed)	2	1		
10	Install Software Upgrades (if needed)	2	1		

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