Appendix A: Sample Statement of Work (SoW)

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, PVCs, 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 B: 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		
2	Network Architecture	2	1		
3	Provisioning Guidelines		1		

Item #	Task / Activity	Navini	Client	Other	Notes
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		
7	Tower Structural Analysis		1		
8	Contractor Qualifications and Selection		1		

Item #	Task / Activity	Navini	Client	Other	Notes
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.
9	DC Power System 24VDC @ 60 Amps for each BTS		S, I		
10	Batteries / UPS		S, I		

Item #	Task / Activity	Navini	Client	Other	Notes
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		
2	Pull Cables		1		
3	Install Connectors and Grounding		1		

Item #	Task / Activity	Navini	Client	Other	Notes
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		
12	DHCP Server: configure / test		1		
13	EMS Client: Configure / Test	1	2		

Item #	Task / Activity	Navini	Client	Other	Notes
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					
1	System Training for Service Provider	1			
2	Monitor Network	2	1		

Item #	Task / Activity	Navini	Client	Other	Notes
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		

Appendix C: Sample Work Breakdown Structure (WBS)

Site Deployment Work Breakdown						
Item No.		Activity	Responsibility			
			Navini Networks		Customer	3rd Party
			In-House	Contractor		
1		System Design Criteria Established				
	1.1	RF Design Requirements Established				
	1.2	Site Configuration / BTS & RES Requirements Established				
	1.3	Backhaul / T1 Requirements Established				
	1.4	Customer NOC / Operations Requirements Established				
	1.5	Network Design Requirements Established				
	1.6	Software Requirements Established				
	1.7	Hardware Requirements Established				
2		Site Selection Process				
	2.1	Candidate Identification / Site Selection				
	2.2	RF Propagation / Coverage Analysis				
	2.3	Interference Analysis / Intermod Study				
	2.4	Drive Test / Coverage Verification				
	2.5	Site Survey / Constructability Review				
	2.6	Zoning Analysis				
	2.7	FAA / FCC / ASAC Compliance Reviews / Submittals				
3		Site Acquisition and Leasing				
	3.1	Master License Agreements				
	3.2	Site License Agreements				
	3.3	Lease and Exhibit B Development Work				
	3.4	Rents and Payments				
	3.5	Entry and Testing Agreements				
	3.6	Phase 1 Environmental Screen				
	3.7	NEPA Checklist				
	3.8	State Historical Preservation Organization Review				
4		Site Design and Development				
	4.1	Design Coordination / Site Design Walks				
	4.2	A&E Drawing Package Development				
	4.3	Site Survey - 2C				
	4.4	Soils Report				
	4.5	Tower / Foundation Design				
	4.6	Structural Analysis				
	4.7	Permit and Const Drawing Package Review and Approval				
	4.8	Zoning Permits				
	4.9	Construction Permits - Building & Electrical				
5		Material Procurement				
	5.1	Bill Of Materials From Approved Construction Drawings				
	5.2	Vendor Selection				
	5.3	Bids / Quotes				
	5.4	Requisitions / Purchase Orders				
	5.5	Tower, Mounts, Lightning Protection, Lighting, Cable Ladder, Safety Climb,				
	5.6	BTS - with Rack (IBTS), with Enclosure (OBTS)				
	5.7	RES - Active, Passive				
	5.8	Cables, Connectors, Mounting Hardware, Surge Protection				
	5.9	AC Power Equipment				
	5.10	DC Power Equipment				
	5.11	Telco Equipment				
	5.12	Grounding Equipment and Materials				
	5.13	Delivery Coordination / Warehousing / Logistics				
6		Facilities Orders				
	6.1	Electric Power Service Order Site Walk / Engineering				
	6.2	Electric Power Service / Equipment Order				
	6.3	Telephone Service Order Site Walk / Engineering				
	6.4	Telco Service / Equipment Order				

Continued on next page.....

7		Site / System Construction				
	7.1	Vendor Selection				
	7.2	Bids / Quotes				
	7.3	Requisitions / Purchase Orders				
	7.4	Pre-Construction Walkthrough				
	7.5	Site Preperation Work - Clear, Grub, Foundation Work				
	7.6	Tower Delivery and Offload				
	7.7	Tower Installation				
	7.8	OBTS / Shelter Delivery and Installation				
	7.9	Site Materials Delivery and Offload				
	7.10	Power Equipment Installation				
	7.11	Telco Equipment Installation				
	7.12	Grounding System Installation				
	7.13	Grounding System Test and Verification				X
	7.14	Fencing and Security System Installation				
	7.15	Site Finish Work - Fencing, Landscaping,...				
	7.16	Punchlist Construction Work				
	7.17	Closeout / Customer Acceptance - Site Construction				
8		Equipment Installation Work				
	8.1	Material Delivery to Site				
	8.2	Install RFS(s)				
	8.3	Install Antenna System - Cable, Supports, Surge and Grounding Protection				
	8.4	Test and Verify Cable and Antenna System Installation Work				X
	8.5	IBTS Installation - Shelves, Cards, Power, Grounding...				
	8.6	AC Power Equipment Installation and Testing				
	8.7	DC Power Equipment Installation and Testing				
	8.8	Telco / T1 Equipment Installation and Testing				
	8.9	BTS Testing				
	8.10	EMS / Customer Operations Equipment Installation				
	8.11	Punchlist Installation Work				
	8.12	Closeout / Customer Acceptance - Equipment Installation Work				
9		System Testing / Optimization				
10		Customer Acceptance / Turnover				

Appendix D: Site Candidate Evaluation Form

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')	☐ YES	☐ OUTDOOR	_____ x _____
Room for Expansion BTS	☐ YES		
Type/Size of Cabinet required	☐ YES		_____ **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		☐ NO	_____ **FEET**
Cable Entry Available		☐ 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	_____

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

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

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

SITE MAP / SKETCH

Comments

GPS ANTENNA LOCATION

Comments

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

NORTH VIEW

Comments

NORTHEAST VIEW

Comments

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

EAST VIEW

Comments

SOUTHEAST VIEW

Comments

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

SOUTH VIEW

Comments

SOUTHWEST VIEW

Comments

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SITE EVALUATION FORM

Site Name **0**

WEST VIEW

Comments

NORTHWEST VIEW

Comments

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

EXISTING COMPOUND PICTURE

Comments

GROUNDING

Comments

NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

INGRESS

Comments

EGRESS

Comments

NAVINI NETWORKS
SITE EVALUATION FORM

Site Name **0**

POWER

Comments

TELCO

Comments

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NAVINI NETWORKS
SITE EVALUATION FORM

Site Name 0

SHELTER PICTURE

Comments

SHELTER LAYOUT AND DIMENSION DRAWING

Comments

Appendix E: Interference Sweep Procedure

Before You Start

The instructions in this document assume the Field Engineer is at the Base Station site and that the BTS and RFS have not yet been installed.

Required Equipment

You will need the following equipment to perform the Interference Sweep:

?? HP4404B Spectrum Analyzer or equivalent. An equivalent analyzer must have the following:
- Screen Save abilities
- Max-hold function
- Peak search
- Ability to operate in the required frequency range

?? Omni or Directional Antenna for the given frequency range
The directional antenna should have a gain of > 9 dBi.

?? Cavity Filter
Pass band should cover the frequency range. It must have good out-of-band rejection so the LNA is not jammed by high power AMP, PCS, or TV signals.

?? LNA Module
Gain > 21dB, NF < 7dB, for frequency range

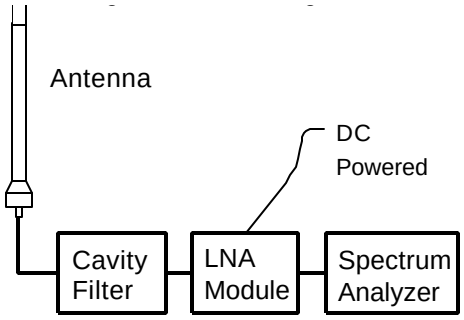
?? Various SMA and N-Type adapters

?? Various RF cables to connect to Antenna and to test equipment

Initial Configuration

The set-up shown in Figure E1 and the information below are for the initial configuration. It gives you a starting point for this procedure. During the later steps, this configuration will change.

Figure E1: Initial Configuration



Step 1. Configure test equipment as shown in Figure E1.

Step 2. Program the initial Spectrum Analyzer settings, per the following:

A. Resolution Bandwidth= 100KHz
B. Video Bandwidth = 100KHz
C. Attenuation = 0db
D. Ref level = -10db
E. Sweep time = auto
F. Detector mode = positive peak
G. Frequency = will be determined at each point during the procedure.

Step 3. Set the frequency sweep range per the following.

A. 2.4GHz = sweep for ranges 2.390GHz to 2.5GHz
B. 2.6GHz = sweep for ranges 2.596GHz to 2.644GHz

Interference Sweep Procedure

The following information applies to both Panel and Omni antennas. It guides you through the steps to capture data required for the interference study. The number of steps varies depending on the type of antenna you are using and the frequency band you are investigating. If you are using an omni antenna to perform this procedure, only one pass is required. If a directional antenna is used, the number of passes through the procedure is determined by the beamwidth of the antenna.

When using a directional antenna to pick up the interference, try to change the angle or downtilt to face a potential interference source such as a tower or a more populated area. A directional antenna is used to determine the location of the source that is generating the interference. The beamwidth of the directional antenna determines the number of directions that you need to sweep.

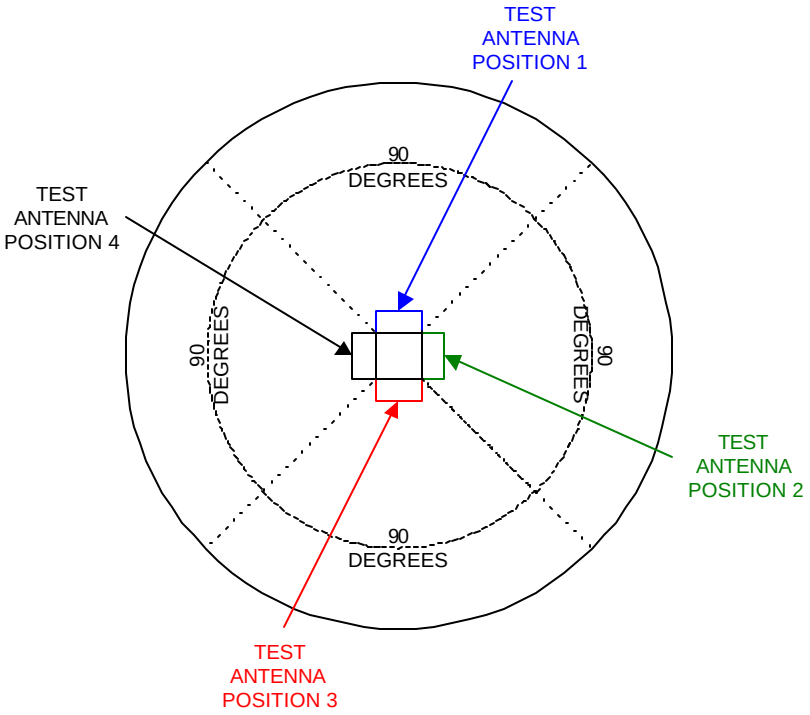
For example, if the beamwidth of the directional antenna is 90 degrees, then four passes of the procedure are necessary. Whereas, an antenna with a 30-degree beamwidth requires 12 sets of

sweeps to cover the same 360 degree area. The smaller beamwidth requires more sweeps but gives you greater accuracy in determining the source of the interfering signal. On each pass the directional antenna is moved per the beamwidth. Refer to Figure E2.

With both types of antennas, try to determine the polarization of the interfering signals during each sweep. To do this, flip the antenna 90 degrees. All measurements that are captured are with the antenna in the vertical polarization position.

The frequency band to be investigated is determined by the range of the BTS and RFS that is purchased by a customer. The 2.6GHz MMDS band is a licensed band, and the customer purchasing the equipment will have a license for a given 6MHz channel. The 2.4GHz band is an unlicensed frequency range that is open for many applications. The objective for the 2.4GHz sweeps is to find a 5MHz range that is the clearest of any interference.

Figure E2: 90 Degree Directional Sweep



The 2.6GHz sweeps are done to verify that there is not another carrier infringing on the given licensed channel. If you are performing the sweeps for a licensed 2.6GHz channel, it will greatly reduce the number of steps that you will need to perform. For a 2.6GHz system you only need to look at three channels for the spectrum. You will sweep the licensed channel as well as the channels above and below the licensed band.

For example: If you have an E3 license (2.620GHz – 2.626GHz), you will sweep E3 plus F2 (2.614GHz-2.620GHz) and F3 (2.626GHz – 2.632GHz).

You will only need the Max-hold portion of the procedure for 2.6GHz systems.

Max-hold

The Max-hold portion of the procedure is to be used for both unlicensed and licensed systems.

Step 1. If using a directional antenna, check the direction of the antenna with a compass. Record the results.

Step 2. Set the Start Frequency to 2.390GHz for a 2.4GHz system and to 2.595GHz for a 2.6GHz system.

Step 3. Set the Stop Frequency to 2.5GHz for a 2.4GHz system and to 2.645GHz for a 2.6GHz system.

Step 4. Replace the antenna with a terminator to get a noise floor level. Save a screen capture.

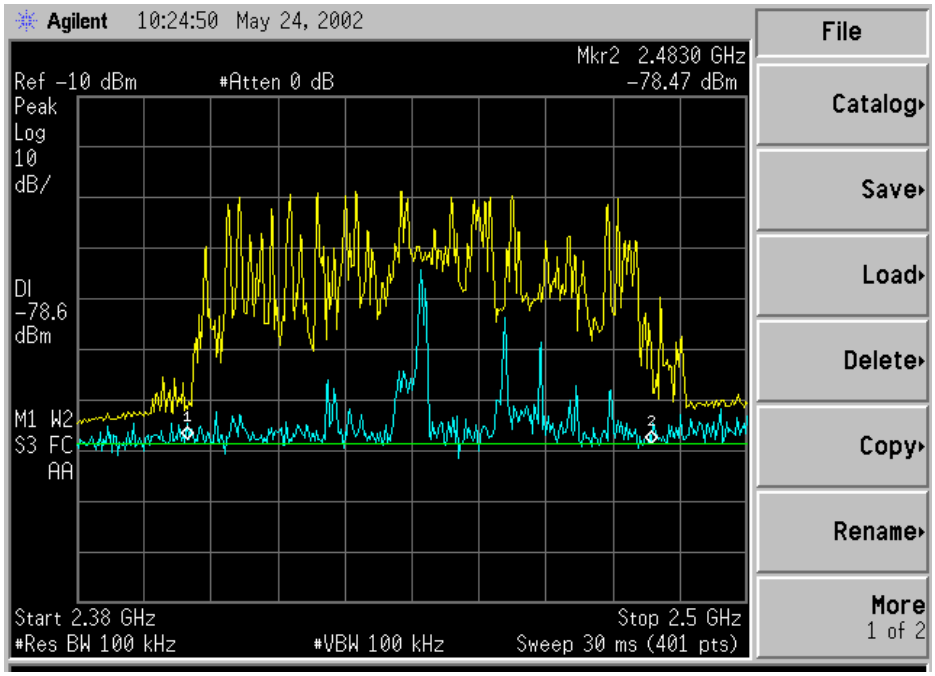
Step 5. Turn on the Max-hold feature and acquire the signal for two minutes. Save a screen capture.

Step 6. Run Single Sweep two times, saving the screen captures for both sweeps. This gives a reference for the worst case that is shown with the Max-hold in Step 5. Time can be saved on this step if the Spectrum Analyzer is equipped with a dual trace option. Turn Trace 2 on constant sweep and Trace 1 on Max-hold. After the Max-hold has acquired a signal for two minutes, press the single sweep. Save the screen capture. Refer to Figure E3, Max-hold Screen Capture.

Step 7. Repeat steps 5 and 6 with the following Start and Stop frequencies.

2.4GHz Band		2.6GHz Band		
Start	Stop	Channel	Start	Stop
2.4GHz	2.45GHz	E1	2.596GHz	2.602GHz
2.45GHz	2.5GHz	F1	2.602GHz	2.608GHz
2.4GHz	2.41GHz	E2	2.608GHz	2.614GHz
2.41GHz	2.42GHz	F2	2.614GHz	2.62GHz
2.42GHz	2.43GHz	E3	2.62GHz	2.626GHz
2.43GHz	2.44GHz	F3	2.626GHz	2.632GHz
2.44GHz	2.45GHz	E4	2.632GHz	2.638GHz
2.45GHz	2.46GHz	F4	2.638GHz	2.644GHz
2.46GHz	2.47GHz			
2.47GHz	2.48GHz			
2.48GHz	2.49GHz			

Figure E3: Max-hold Screen Capture



Time Domain

The Time Domain portion of the procedure is for unlicensed systems only.

Step 1. Set the Center Frequency to 2.4025GHz. Set the Resolution Bandwidth to 5 MHz.

Step 2. Set the Video Bandwidth to 1MHz.

Step 3. Set the Sweep Time to 40 ms.

Step 4. Set the Span to 0 Hz.

Step 5. Replace the antenna with a terminator to get a noise floor level. Save a screen capture.

Step 6. Set the display line to the noise floor level. The display line needs to stay on for all of the following sweeps. This display line is used for a reference point and should be set with the LNA powered on.

Step 7. Run the Single Sweep approximately 50 times and determine how often the interference occurs. Save a screen capture of one worst case and one typical. See Figure E4, Time Domain Screen Capture.

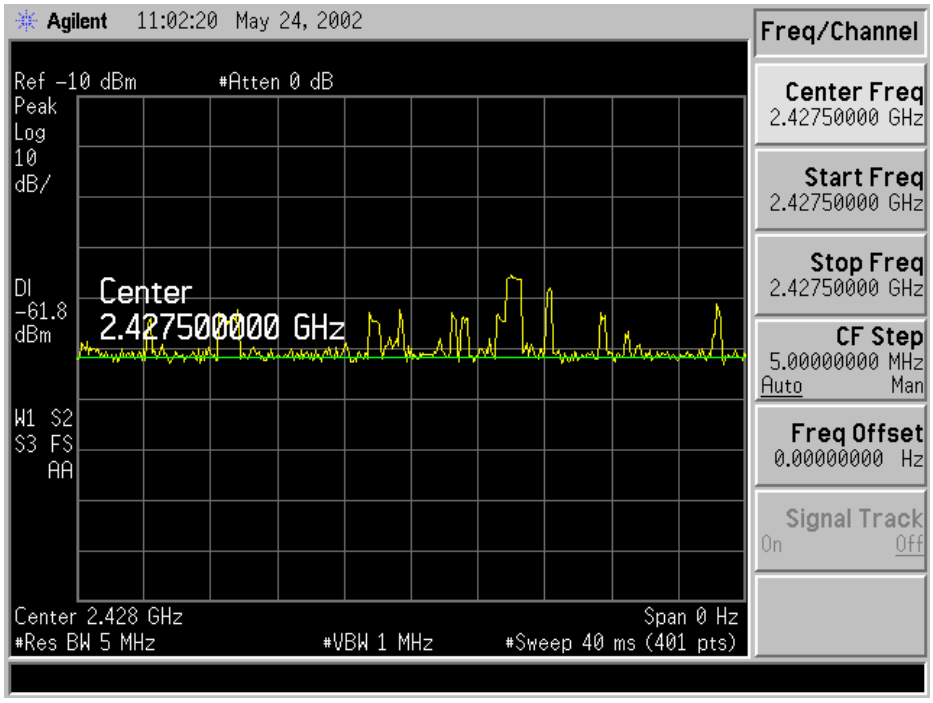
Step 8. Set the Sweep Time to 400 ms, and repeat Step 7.

Step 9. Repeat Steps 7 and 8 for an offset of 5MHz up to 24875MHz for 2.4 systems.

2.4GHz Band
Center Frequency
2.4075GHz
2.4125GHz
2.4175GHz
2.4225GHz
2.4275GHz
2.4325GHz
Up to 2.4875GHz

Step 10. If a directional antenna is used, repeat the Max-hold and Time Domain steps for each direction.

Figure E4: Time Domain Screen Capture



Appendix F: Interference Sweep Tool

Overview

The Navini 2.4 GHz frequency Interference Sweep Test tool is used by an Installation & Commissioning Technician or Field Engineer to sweep and collect data concerning RF conditions at a specific site. The location is typically a site that has been identified as a potentially good candidate for a Base Station installation.

The test tool manages the RF sweep and interference level conditions, with post-analysis performed by RF Engineering personnel using simulation models. The results of the analysis are not a guarantee of optimal operating conditions for the Ripwave system. The objective is to identify and eliminate sites that might pose high potential problems in order to prioritize a given list of sites for Base Station deployment.

Installation

Equipment

1. Navini Survey Test Box
2. 12 pin Control Cable
3. Laptop Computer
4. Power Box With Attached Ethernet Cable
5. Power Cable for the Power Box

Figure F1 is a block diagram showing the requirements to install the equipment. Figure F2 provides an example of the laptop and cable configuration.

Figure F1: Block Diagram

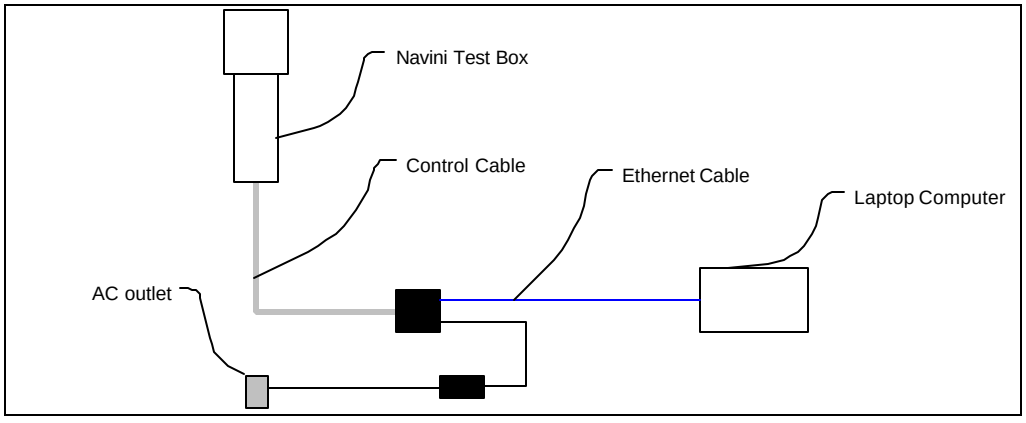


Figure F2: Laptop & Cable Configuration

Mounting

The Navini Test Box should be installed in the location where the RFS will be installed, or as close as possible. This will give the most accurate representation of the interference at the site. On the upper portion of the test box there are three labels indicating 0, 120, and 240 degrees (Figure F3). These are the antennas that are inside the test box. The label indicating 0 degrees should be pointed as close to north as possible. Connect the Control Cable from the Navini Test Box to the Control Box. The Control Box has a power connector, a circular control cable connector, and a blue Ethernet cable on it. The Ethernet cable will be connected to your laptop.

Figure F3: Test & Control Box Setup

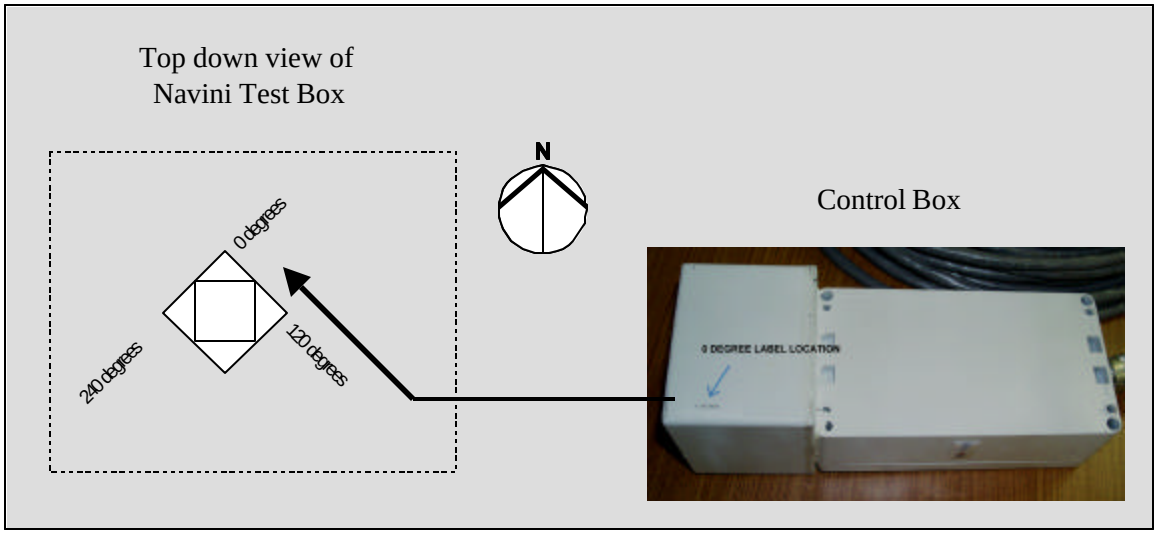


Figure F4 shows a sample of the mounting requirements for the installation.

Figure F4: Mounting Requirements

Using the Site Survey Tool

Recommended Settings

1. Interval Setting
   Provided by Navini Networks RF planning group

2. Frequency Selection
   2.400 to 2.476 GHz approved ISM operating frequency

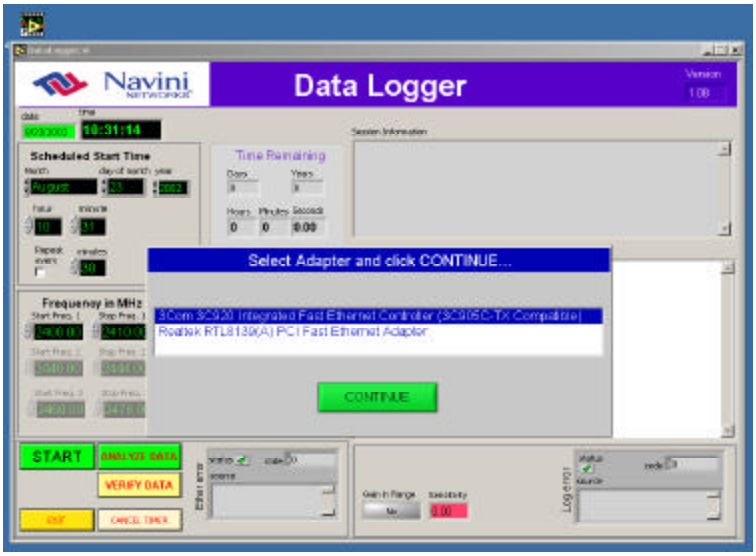
3. Number of Frames for Gain Adjustment
   Provided by Navini Networks RF planning group; site specific

4. Number of Stored Frames
   Provided by Navini Networks RF planning group; site specific

Procedure

Step 1. Open the application by selecting the Data Logger icon. Figure F5 shows the icon in the background.

Figure F5: Data Logger

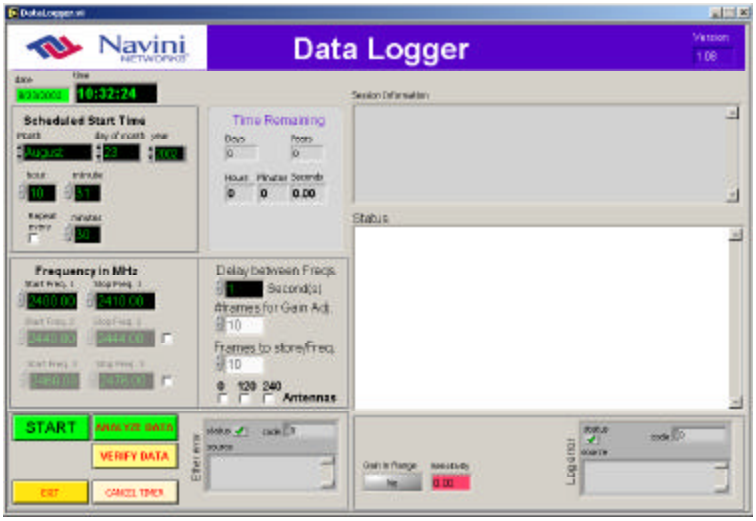


Step 2. Select the desired Ethernet adapter in the pop-up window.

Step 3. Starting in the upper left corner of the program screen, set the date and time for the application to start its measurement interval. If the date and time set are earlier than the current time, logging will begin immediately.

Step 4. If the measurement needs to be repetitive, determine the interval between measurements by selecting the repeat box and entering the time interval (Figure F6).

Figure F6: Measurement Interval



Step 5. Select the frequencies to be measured.

a. There are 3 frequency band selections. By default two are not available until selected by clicking on the white checkboxes to the right of each.
b. If you select more than one band, it is best if you put in some delay between each band's measurements, as mentioned in Step 6 below.

Step 6. If more than one frequency band has been selected, choose the delay to be used between each band's measurements. You can use the scroll bar or just type in the interval.

Step 7. Select the number of frames for Gain Adjust. This allows the system to calculate the Modem's receiver sensitivity.

Step 8. Select the number of frames to be stored for analysis. The same number will be captured for each frequency band if more than one is selected.

Step 9. Ensure antenna orientation is selected properly. It takes about 1 second to log one frame of data. Therefore:

Elapsed time = #antSelected ? [(number_of_gain_adj Frames) ? n + (Freq_Range/2) ? #of_framesToLog + (Freq_Range/2) ? delayBetweenFreqs]

Where n is the number of gain adjustment loops. Up to 10 are possible if the received signal varies to a great extent in amplitude from frame to frame.

Step 10. Select the Start button.

Step 11. Enter in the desired Site Name in the pop-up window, and press Enter to start the measurements.

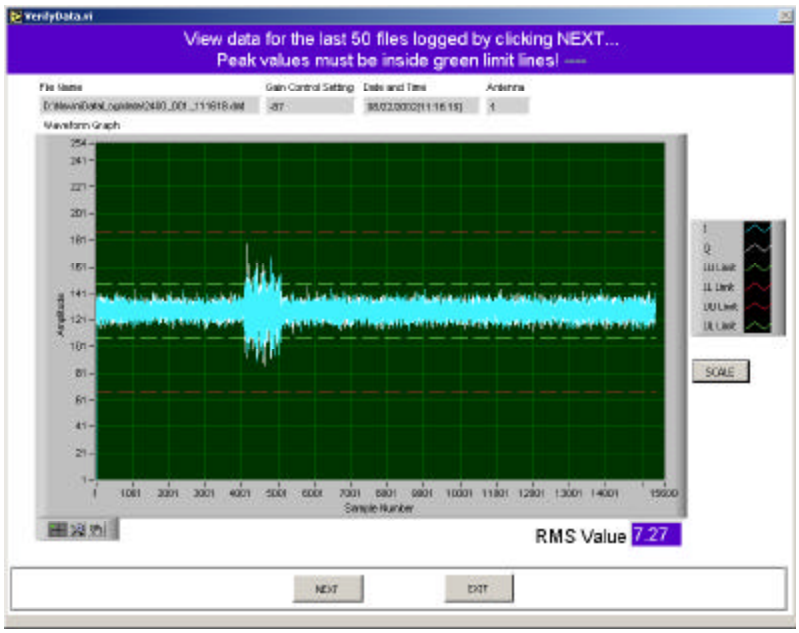
Step 12. To stop the measurement, select the Abort button.

Step 13. PC and Test operation should be validated every 3-4 hours for working order.

To Verify the Data

Step 1. Click the Verify Data button. The screen shown in Figure F7 appears. The last 50 data files logged can be viewed with this screen. Click on NEXT to view the next file.

Figure F7: Verify Data



Analysis of Data

Not available on this release.

FTP Instructions

Step 1. Launch FTP Pro.

Step 2. Select the file, “Rfsweep”.

Step 3. The FTP Password is provided by Navini in a separate document.

Step 4. To transfer the file, locate the Navinidatalog folder on the “C” drive of the laptop.

Step 5. Select all files in the data folder via FTP browser, then, send the files.

Step 6. Once the file transfer is complete, delete the data folder and rename the “gain.adj” file for the next test sequence. Create a new “gain_adj” folder under the NaviniDataLog folder.

Appendix G: BTS Specifications

Figure G1: Combo Chassis (Front)

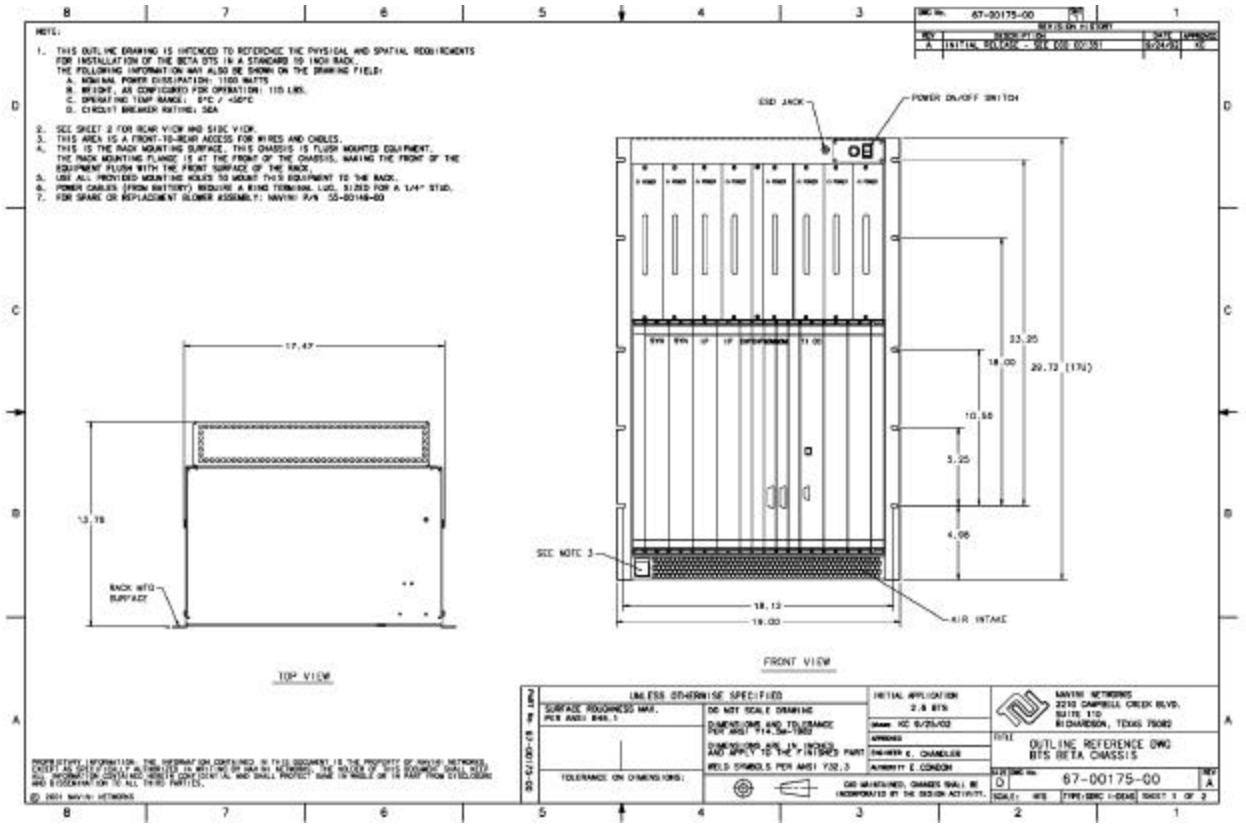


Figure G2: Combo Chassis (Back)

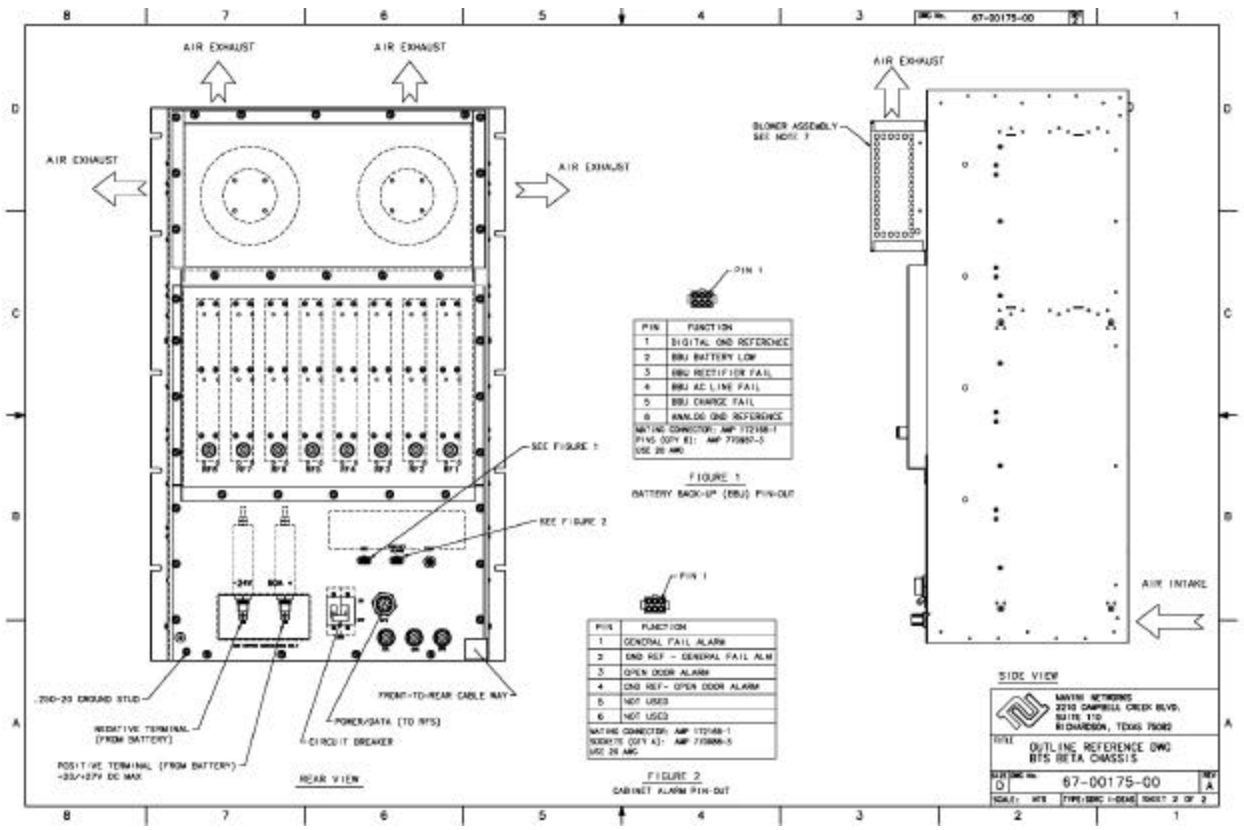


Figure G3: Split Digital Chassis (Front)

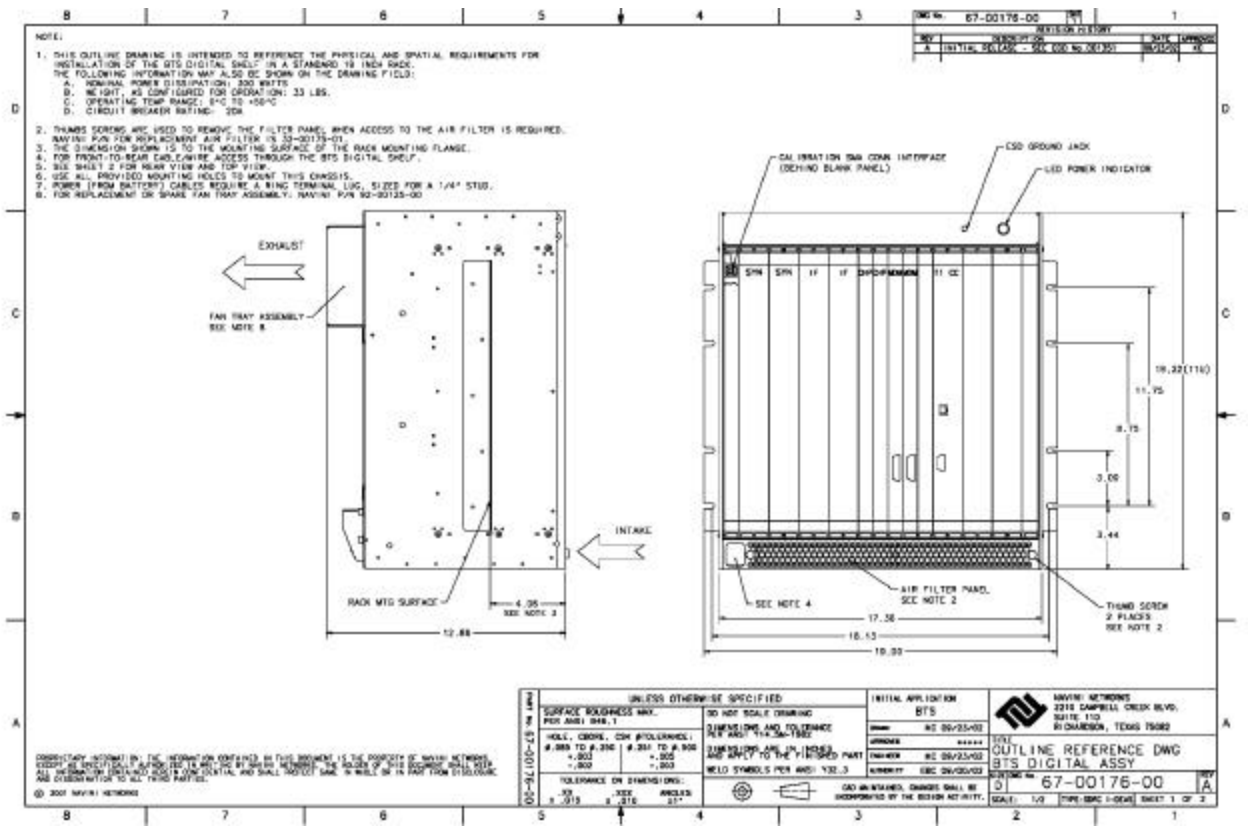


Figure G4: Split Digital Chassis (Back)

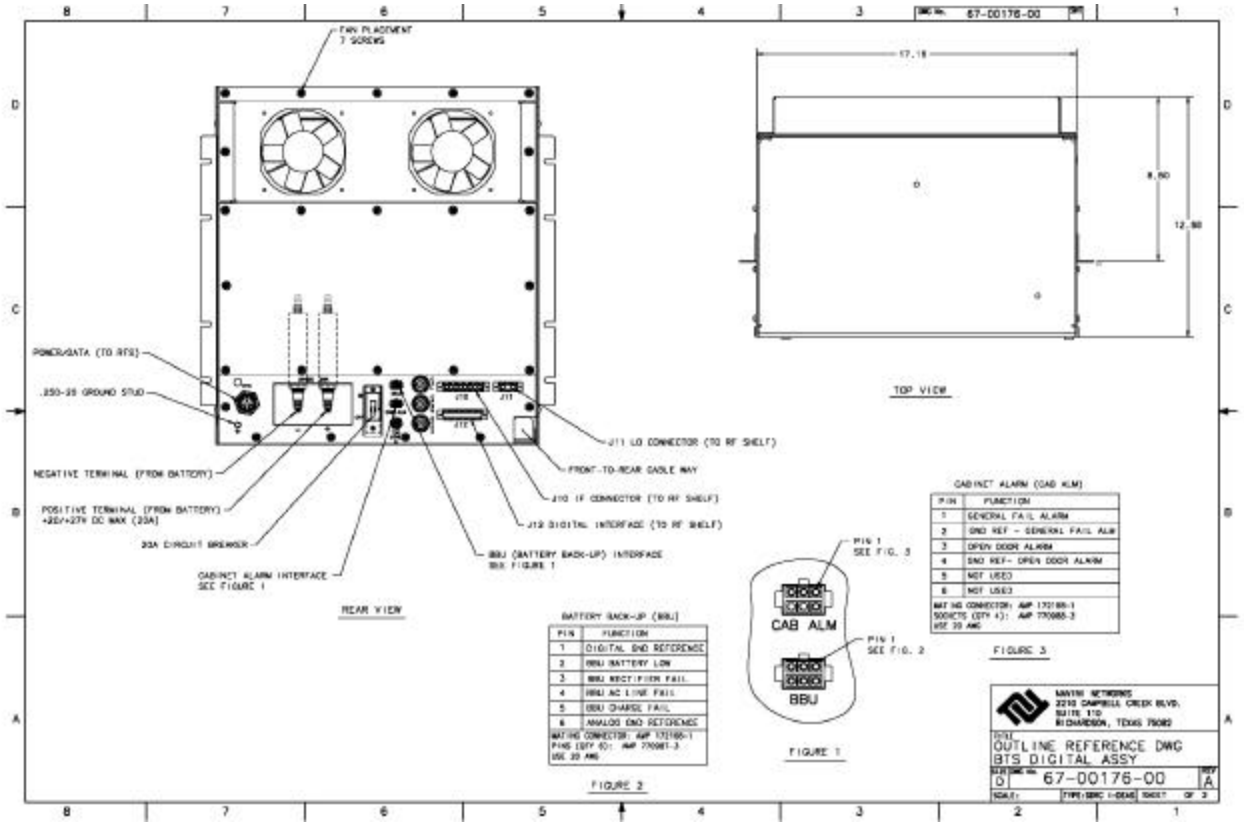


Figure G5: Split RF Chassis (Front)

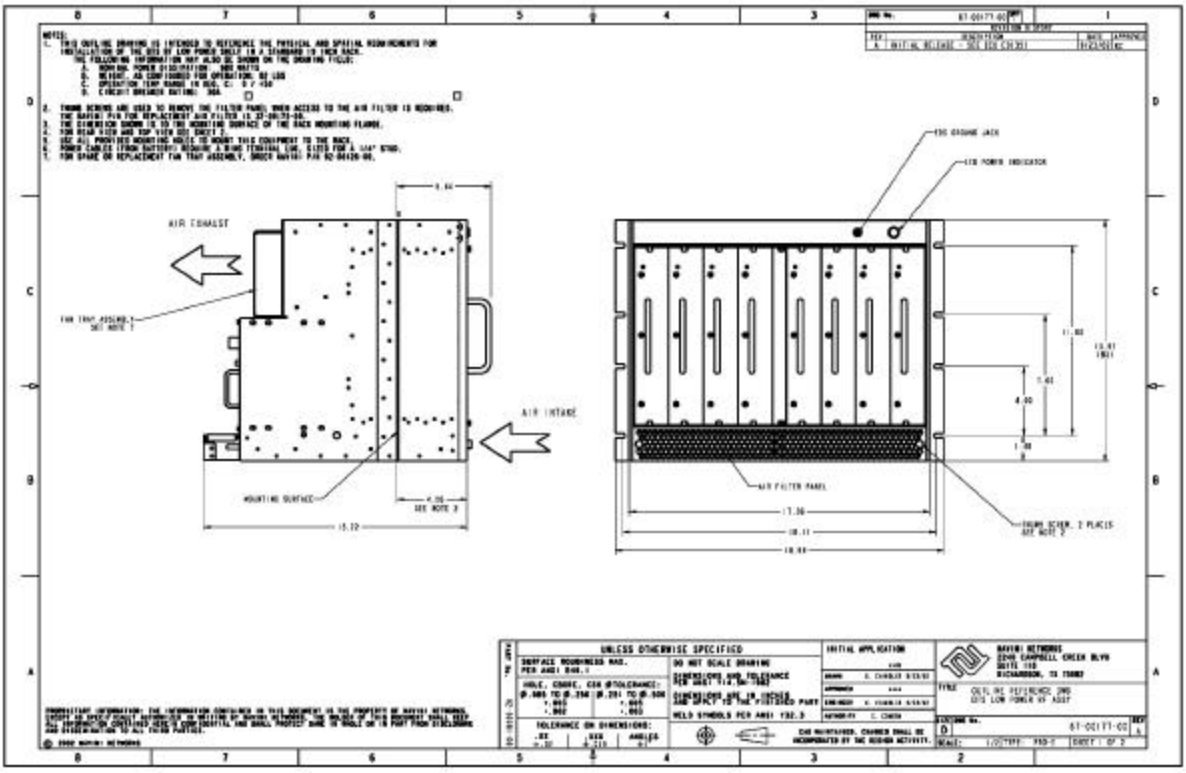


Figure G6: Split RF Chassis (Back)

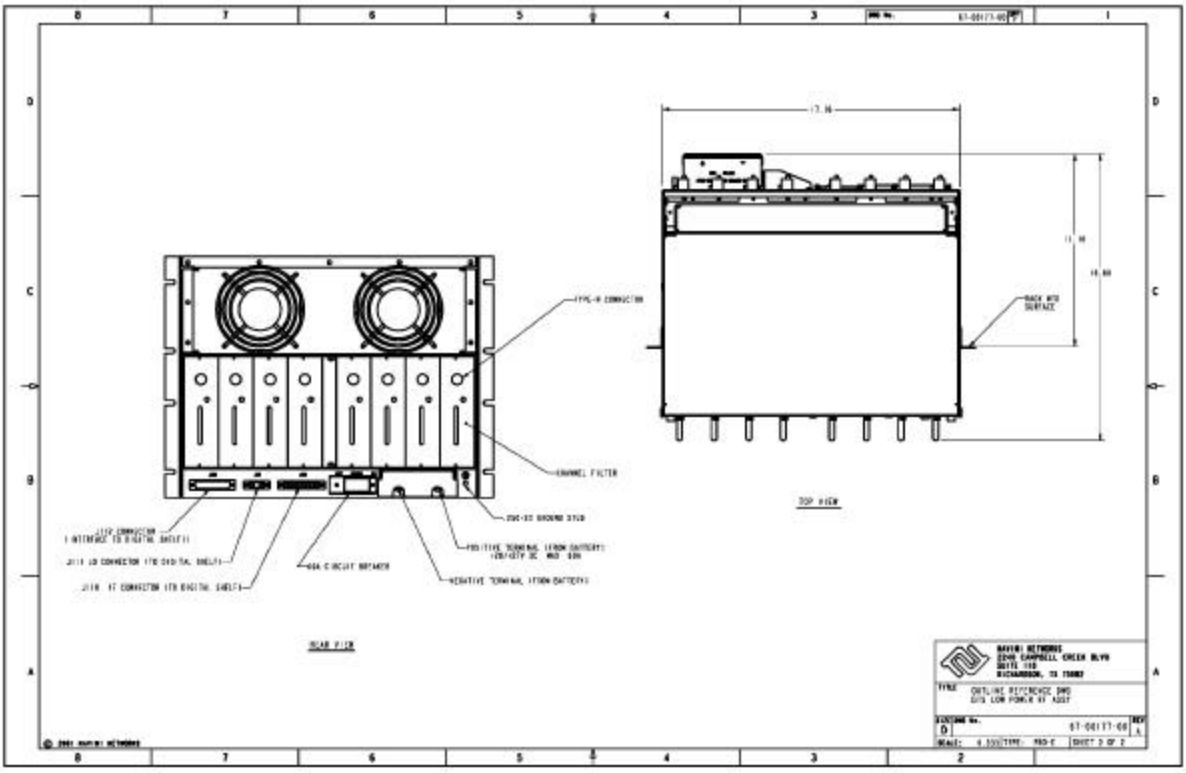
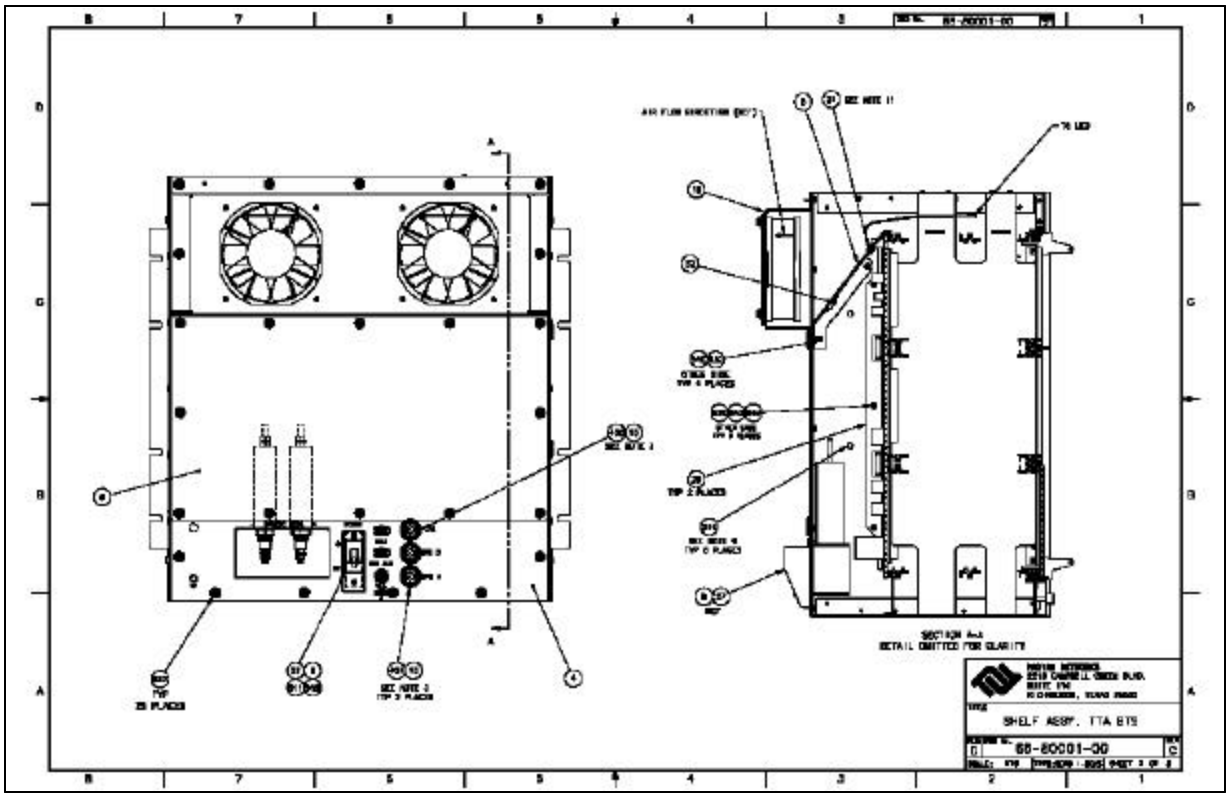


Figure G7: TTA Digital Chassis (Front)

Figure G8: TTA Digital Chassis (Back)



Appendix H: RFS Data Sheets

Figure H1: Panel

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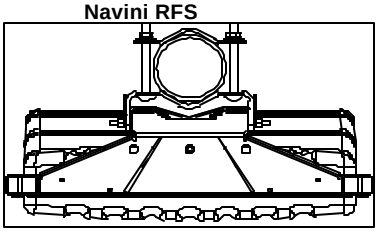
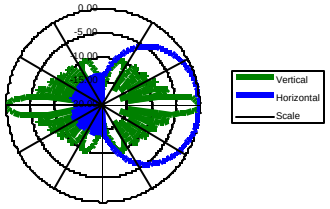
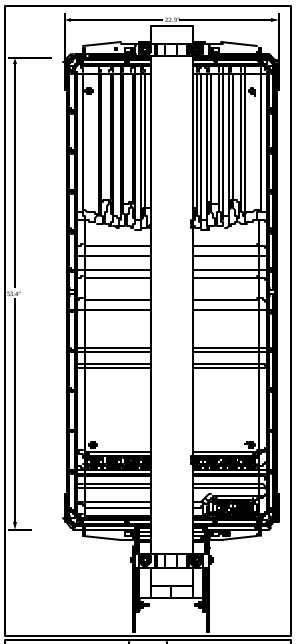
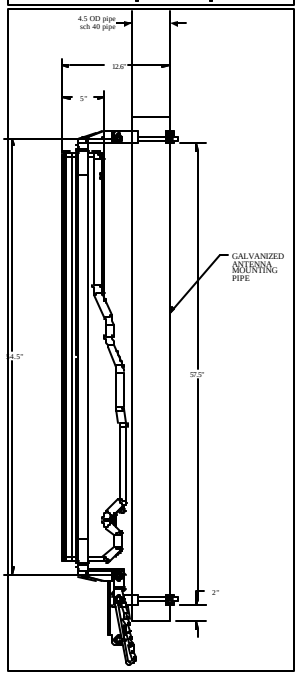
Broadband Sectored Panel Antenna
Navini RFS



Panel RFS Antenna Pattern







NAVINI PART NUMBER:	2.3GHz Low Band	95-23000-00
	2.3GHz Low Band w/o LNAs	95-23100-00
	2.3GHz High Band	95-23000-05
	2.3GHz High Band w/o LNAs	95-23100-05
	2.4GHz with LNAs	95-00043-05
	2.4GHz w/o LNAs	95-10043-05
	2.5GHz ABCD with LNAs	95-25000-00
	2.5GHz ABCD w/o LNAs	95-25100-00
	2.6GHz EFGH with LNAs	95-00005-05
	2.6GHz EFGH w/o LNAs	95-10005-05

DESCRIPTION	
Frequency Range	2.3GHz low band range = 2.305GHz Through 2.320GHz 2.3GHz high band = 2.345GHz through 2.360GHz 2.4GHz range = 2.4GHz through 2.473GHz 2.5GHz range = 2.500GHz through 2.596GHz 2.6GHz EFGH range = 2.596GHz through 2.686GHz
Polarization	Vertical
Antenna Gain	17-17.5 dBi for 120 Degree Sectored
Horizontal HPBW	130 Degrees
Vertical HPBW	6 Degrees
Connector Type's	9 Female "N" Type 1 - 12 Pin Female Circular
Lateral Thrust at 100 MPH (161 KM/HR) w/o ice	220 LB. Lateral Load
Mounting Configurations	To Pipe Mount - 2 3/4" TO 3" OD
Electrical Downtilt	6 Degrees
Mechanical Downtilt/Uptilt	0 - 10 Degrees Mechanical
Weight	81 LB. Including Bracket Mount no pipe

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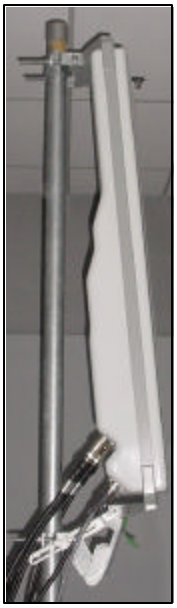
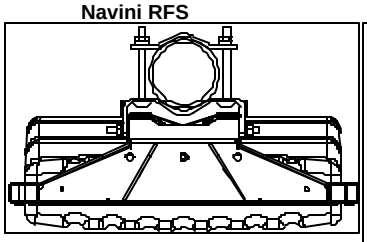
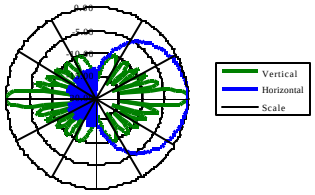
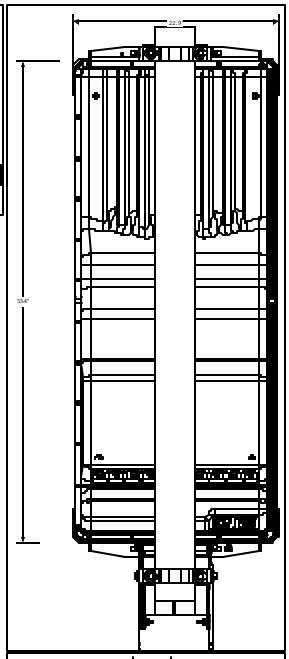
Broadband Sectored Panel Antenna
Navini RFS

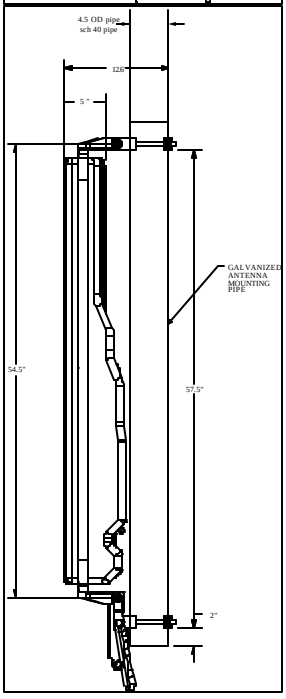




Panel RFS Antenna Pattern







NAVINI PART NUMBER:	2.4GHz TTA RFS	95-00043-10

DESCRIPTION

Frequency Range	2.4GHz range = 2.4GHz through 2.483GHz
Polarization	Vertical
Antenna Gain	17-17.5 dBi for 120 Degree Sectored
Horizontal HPBW	130 Degrees
Vertical HPBW	6 Degrees
Connector Type's	9 Female "N" Type
DC Power Dissipation	80 Watts
Lateral Thrust at 100 MPH (161 KM/HR) w/o ice	220 LB. Lateral Load
Mounting Configurations	To Pipe Mount - 2 3/4" TO 3" OD
Electrical Downtilt	6 Degrees
Mechanical Downtilt/Uptilt	0 - 10 Degrees Mechanical
Weight	81 LB. Including Bracket Mount no pipe

Figure H2: Panel TTA

Figure H3: Omni

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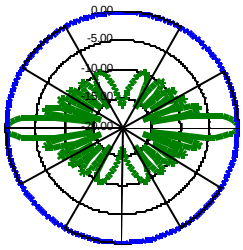
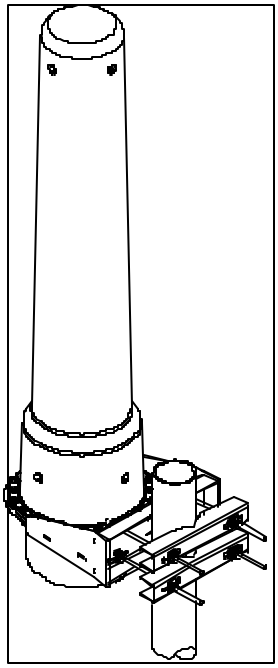
P/N 44-00038-01 Rev A v1.0 Feb.14, 2003

Broadband Omnidirectional Antenna
Navini RFS

Omni RFS Antenna Pattern





NAVINI PART NUMBERS:		
note: * 02 or 12 are for degree of downtilt also available are 04 and 14	2.3GHz- low band with LNAs	95-23008-02*
	2.3GHz- high band with LNAs	95-23008-12*
	2.3GHz- low band without LNAs	95-23108-02*
	2.3GHz- high band without LNAs	95-23108-12*
** xx is the degree of downtilt 02 or 04.	2.4GHz- with LNAs	95-24008-xx**
	2.4GHz- without LNAs	95-24108-xx**
	2.5GHz- with LNAs	95-25008-xx**
	2.5GHz- without LNAs	95-25108-xx**
	2.6GHz- EFGH with LNAs	95-26008-xx**
	2.6GHz- EFGH without LNAs	95-26108-xx**

DESCRIPTION	
Frequency Range	2.3GHz low band range = 2.305GHz Through 2.320GHz 2.3GHz high band = 2.345GHz through 2.360GHz 2.4GHz range = 2.4GHz through 2.473GHz 2.5GHz range = 2.500GHz through 2.596GHz 2.6GHz EFGH range = 2.596GHz through 2.686GHz
Polarization	Vertical
Antenna Gain	11.5dBi
Horizontal HPBW	Omni
Vertical HPBW	6 Degrees
Connector Type's	9 Female "N" Type 1 - 12 Pin Female Circular
Lateral Thrust at 100 MPH (161 KM/HR) w/o ice	132 LB. Lateral Load
Mounting Configurations	To Pipe Mount
Electrical Downtilt	2 and 4 Degree
Mechanical Downtilt	N/A
Weight	73 lbs. Including mount

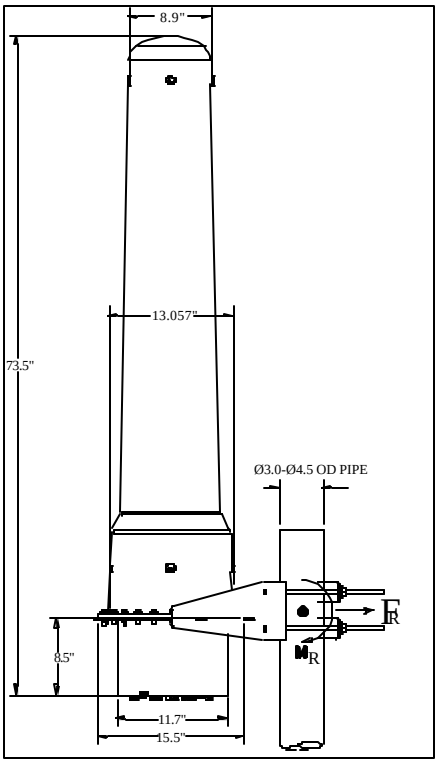


Figure H4: Omni TTA

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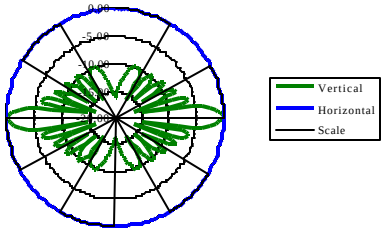
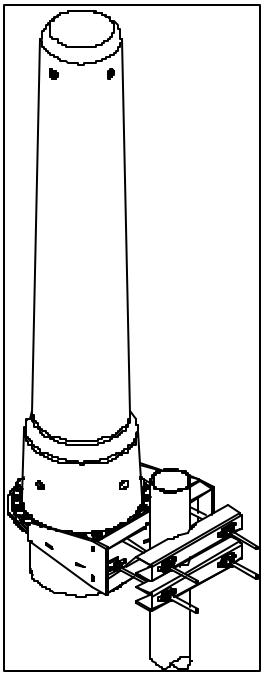
Broadband Omnidirectional Antenna
Navini RFS

Omni RFS Antenna Pattern

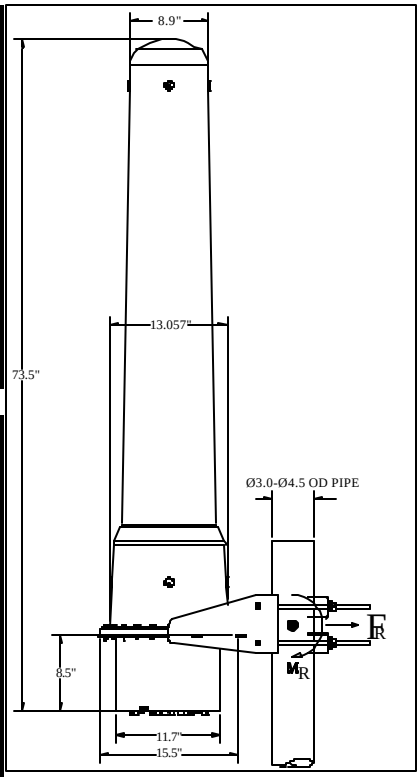




NAVINI PART NUMBERS:	2.4GHz TTA RFS, 2 degree downtilt	95-24018-02

DESCRIPTION

Frequency Range	2.4GHz range = 2.4GHz through 2.483GHz
Polarization	Vertical
Antenna Gain	11.5dBi
Horizontal HPBW	Omni
Vertical HPBW	6 Degrees
Connector Type's	9 Female "N" Type
DC Power Dissipation	80 Watts
Lateral Thrust at 100 MPH (161 KM/HR) w/o ice	132 LB. Lateral Load
Mounting Configurations	To Pipe Mount
Electrical Downtilt	2 and 4 Degree
Mechanical Downtilt	N/A
Weight	73 lbs. Including mount



Appendix I: BTS Outdoor Enclosure Manufacturers

General

Navini Networks does not manufacture external cabinets for the Ripwave BTS. The following lists two manufacturers who are positioned to provide external cabinets for the Navini system. Inclusion of the manufacturers on this list does not represent an endorsement of the manufacturer or its products by Navini Networks.

Manufacturers List

Purcell Systems
22924 E. Appleway Avenue
Liberty Lake, WA 99019
509 755-0341
Steve Busby
Http://www.purcellsystems.com/

Hendry Telephone Products
55 Castillan Drive
Santa Barbara, CA 93117
805 571-8287
Phil Skeen

Appendix J: Rectifier/BBU Suppliers

General

This section includes contact information for two rectifier/BBU suppliers. Inclusion of a supplier on this list does not represent an endorsement of the supplier or its products.

Suppliers List

Valere Power Systems
651 N. Plano Road, Suite 421
Richardson, TX 75081
469 330-9100
Matt McManus

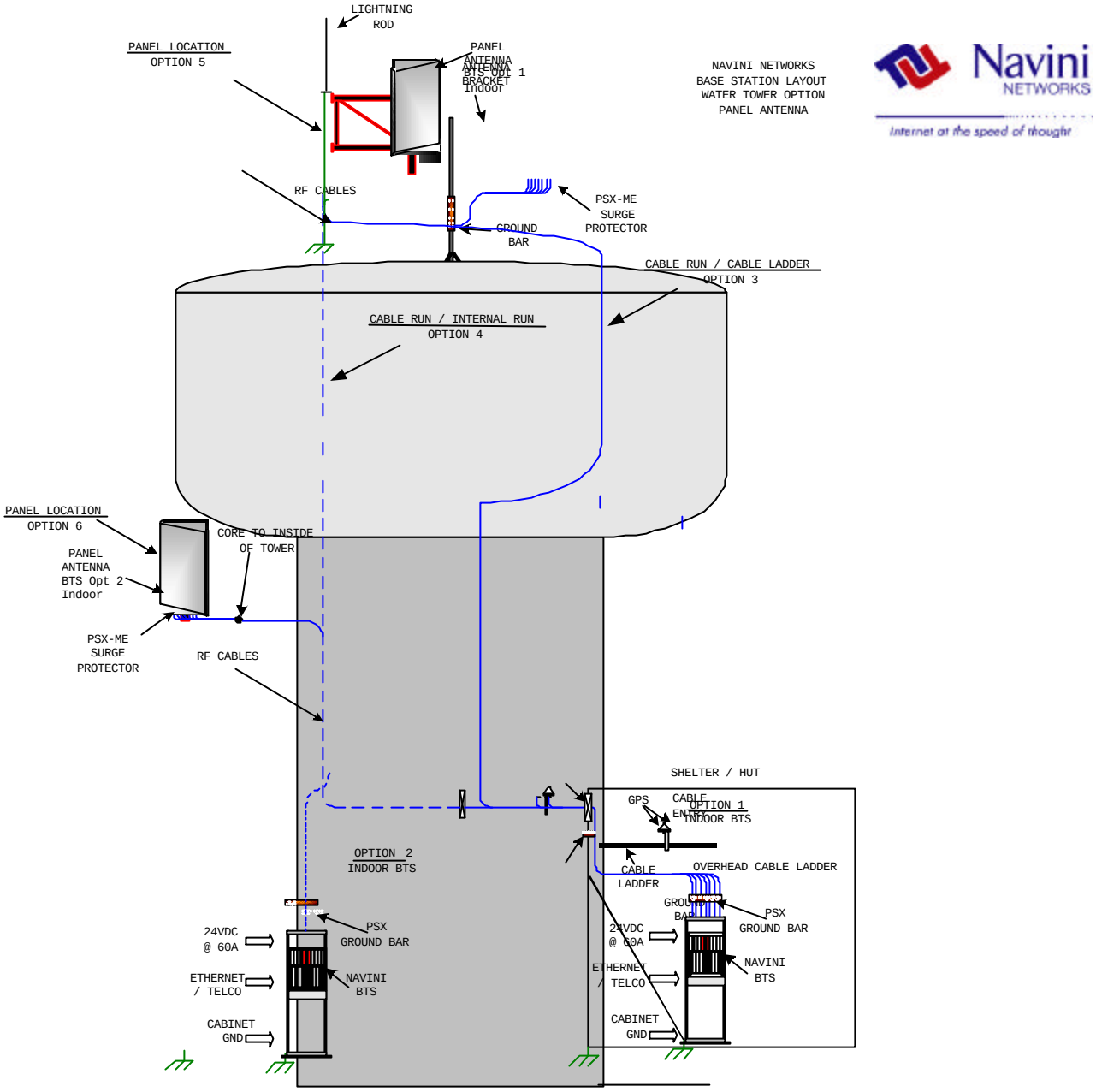
Argus DC Power
Argus Regional Sales Manager
Addison, IL
630 530-5006
Richard Meyer
http://www.argusdcpower.com/

Regulatory

Reference Chapter 1, Page 8 “Regulatory Information” requirements.

Appendix K: Sample Base Station Drawing

Figure K1: 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 L: Antenna Power & Cable Selection

Overview

This section provides formulas and data that are necessary inputs for determining the right cable to be measured, cut, and installed. There are 3 types of cables that are part of the Base Station installation: antenna cables, calibration (cal) cable, and data/power cable.

The antenna cables are the eight cables that carry amplified RF signals. They run between the RF/PA cards and the 8 antenna elements. The calibration (cal) cable is a single RF coaxial cable that provides an RF feedback path for calibrating the system. It runs between the backplane of the digital shelf and the RFS. The data/power cable may or may not be a separate cable from the cal cable. It is possible to use different types of cable with different loss factors for the antenna cables and cal cable. The formulas presented in this section call for either an antenna cable loss or a cal cable loss. Most applications deploy the same cable type for both the antenna and cal cables.

To determine the type of cable and acceptable loss of that cable for a site, the operating transmit and receive range must be known. This is commonly referred to as the maximum transmit output power and the receiver sensitivity range. The operating transmit power and receive range should have been identified during the site survey, or they may be based on regulatory compliance.

Determining the cable type and acceptable loss for a site are typically driven by two goals: (1) Which is the least expensive cable; and (2) Which has the higher (normally) loss. Whether or not the goals are achieved is determined by the output power. For example, the maximum transmit output power for a 2.6 Base Station might be given as +30dBm, or 1 Watt, to the antenna. An example of receiver sensitivity for a 2.6 system would be given as – 80 to –90 dBm.

In addition to cable power loss, other types of loss have to be factored - for example, the calibration board. The calibration board is part of the RFS that samples the energy being transmitted from or received by the 8 antenna elements and combines that energy which is used when performing a calibration on the Base Station. This loss, plus cable loss and other types of loss in the equipment are called out in the following procedure.

Procedure

Read and follow the 7 steps/formulas below, in the order shown, to determine the resulting PA/RFS output power and desired transmit and receive calibration range for the type of Base Station you will be installing. Refer to Tables L1 and L2 to complete the steps. Table L1 provides Base Station operating parameters based on system type (2.3, 2.4, etc.), as well as other variables. Table L2 provides cable attenuation data. Before you begin, read through the steps/formulas, notes, and Table L1 in detail. Refer to the column letters at the top of Table L1 to locate the appropriate values requested in some of the formulas. Note that step/formula 1 contains a sub-procedure for determining antenna cable loss using Table L2.

Step/Formula 1 **Determine the maximum capable BTS output power to the antenna.**

= [(PA Output to Meet FCC) or (to Meet SNR)] – BTS Loss – RFS Loss – BTS Antenna Cable Loss* [Column A or B][1] – [Column E][2] – [Column F or G] – [Calculated* or Measured]

?? BTS Antenna Cable loss < 18 dB for ACTIVE RFS configurations
?? BTS Antenna Cable loss < 8 dB for PASSIVE RFS configurations

Change the EMS settings accordingly.

***Sub-procedure**: **Calculate BTS antenna cable loss, referring to Table 8.**

= [[Distance (length in ft) ÷ 100 ft] x Attenuation value/cable type] + 0.6 for 6 connectors/3 cables

Antenna Cable Selection

Step/Formula 2 **Determine the maximum BTS output power that can be calibrated.**

= Max Synth Input + Cal Cable Loss + Min Cal Board Loss[3] + Backplane Loss[4]
[Column K] + [Calculated or Measured] + [Note [3]] + [Default of 5.0 in EMS or Measured]

Step/Formula 3 **Determine the actual** max BTS output power available to the antenna.**

= The lesser of the two values of Step/Formula 1 and Step/Formula 2 (*aka*, the "floor")

** Actual is what you can calibrate the BTS at.

Step/Formula 4 **Determine the minimum BTS output power that can be calibrated .**

= Min Synth Input + Cal Cable Loss + Max Cal Board Loss[3] + Backplane Loss[4]
[Column J] + [Calculated or Measured] + [Note [3]] + [Default of 5.0 in EMS or Measured]

Step/Formula 5 **Determine the actual** maximum EIRP.**

= Step/Formula 3 + Antenna Gain. The antenna gain is affected by the type of antenna (omni, panel, 2.3, 2.4, etc.) and refers to the values in the RFS Configuration Script that accompanied the antenna from Manufacturing.

**Actual is what you can calibrate the BTS at.

Cal Cable Selectio

Step/Formula 6 **Determine the minimum BTS RX input power that can be calibrated.**

= Min Synth Output - Cal Cable Loss - Min Cal Board Loss[3] - Backplane Loss[4]
[Column H] - [Calculated or Measured] - [Note [3]] - [Default of 5.0 in EMS or Measured]

Step/Formula 7 **Determine the maximum BTS RX input power that can be calibrated.**

= Max Synth Output - Cal Cable Loss -Max Cal Board Loss[3] - Backplane Loss[4]
[Column I] - [Calculated or Measured] - [Note [3]] - [Default of 5.0 in EMS or Measured]

NOTES

[1]This note pertains to Step/Formula 1: For **PA_Output_Power**, if in the U.S. use Column A. If outside the U.S., as a precaution contact Navini Technical Support (Engineering) for sign-off. The value input cannot be more than the value shown in Column B.

[2]This note pertains to Step/Formula 1: **BTS_Loss** is either (a) loss with a filter - i.e., if operating in the U.S. or other market that requires a filter, or (b) loss with a bypass cable. The first number (+1) is the correct value if a standard filter is used. The second number (0.4) is the correct value if a bypass cable is used. In Column D, for a 2.3 GHz system the values are the same for both the 8-carrier and the 10-carrier systems.

[3]Min loss in Cal Board is 27 dB. Max loss in Cal Board is 31 dB.

[4]In the EMS the backplane loss will show 5.0 as default. Actual measured loss will be indicated on the back of the chassis.

Table 7: Transmitter Operating Parameters

	A	B	C	D	E	F	G	H	I	J	K
	PA Max Output Power to Meet FCC Limits (dBm)	PA Max Output Power (dBm)	PA Min Output Power Before Damage Level or Auto Shutdown* (dBm)	Max Antenna Terminal Power to Meet FCC Limits (dBm)	BTS Loss With Standard Filter / Bypass Cable** (dB)	Active RFS Loss Type (dB)	Passive RFS Loss Type*** (dB)	Synth Min Output (dBm)	Synth Max Output (dBm)	Synth Min Input (dBm)	Synth Max Input (dBm)
2.3 (6 carrier)	+38	+40	+42	+30	1 / 0.4 Block Filter has 1.0 dB max insertion loss	3.2	1.7	-60	-32	-23	+0
2.3 (8 carrier)	+38	+40	+42	+30	1 / 0.4 Block Filter has 1.0 dB max insertion loss	3.2	1.7	-60	-32	-23	+0
2.3 (10 carrier)	+37	+40	+42	+30	1 / 0.4 Block Filter has 1.0 dB max insertion loss	3.2	1.7	-60	-32	-23	+0
2.4 (combo)	+37	+37	+42	+17.5	0.4 Bypass	3.2	1.7	-50	-20	-35	-10
2.5	+39	+41	+42	Limited by Cable Loss	1.0 / 0.4 Channel Filter has 1.0 +/- 0.2 dB insertion loss	3.2	1.7	-60	-32	-23	+0
2.6 (EFGH Split)	+39	+41	+42	Limited by Cable Loss	1.0 / 0.4 Channel Filter has 1.0 +/- 0.2 dB insertion loss	3.2	1.7	-60	-32	-23	+0
2.6 (EF Combo)	+37	+41	+42	Limited by Cable Loss	1.8 / 0.4 Channel Filter has 1.8 +/- 0.2 dB including cable to backplane	3.2	1.7	-60	-30	-20	+0

* The lowest value at which 2.3, 2.5, and 2.6 EFGH PAs will shut down automatically. There is no auto shutdown for 2.4 and 2.6 EF combo systems.
** The value at which the bypass does not meet FCC limits.
***Passive configurations of BTS affect system Noise figure. For passive systems other than 2.4, consult SYSTEMS ENGINEERING.

Table L2: Cable Attenuation in dB per 100 Feet

Cable Type	2 ¼? LDF 12-50	1 5/8? LDF 7-50A	LMR 1700	1 ¼? LDF 6-50A	LMR 1200	7/8? LDF 5-50A	LMR 900	5/8? LDF 4.5-50A	½ ? LDF 4-50A	LMR 600	½ ? Superflex FSJ 4-50B	LMR 500	3/8? LDF 2-50A	LMR 400
Frequency/Size	2.350	1.980	**1.670**	1.550	**1.200**	1.090	**0.870**	0.865	0.630	**0.590**	0.520	**0.500**	0.440	**0.405**
2000 MHz	0.994	1.11	**1.5**	1.42	**1.99**	1.82	**2.64**	2.27	3.25	**3.9**	5.09	**4.84**	5.17	**6**
2400 MHz	N/A	1.24	**1.7**	1.5	**2.2**	2.02	**2.9**	2.52	3.63	**4.3**	5.67	**5.4**	5.67	**6.6**
2500 MHz	N/A	1.27	**1.71**	1.53	**2.26**	2.07	**3**	2.58	3.70	**4.42**	5.8	**5.48**	**5.79**	**6.8**
2600 MHz	N/A	1.3	**1.8**	1.57	**2.3**	2.12	**3.1**	2.64	3.78	**4.5**	5.94	**5.6**	5.91	**6.9**
Weight lbs/ft	1.22	0.82	**0.74**	0.63	**0.45**	0.33	**0.27**	0.15	0.15	**0.13**	0.14	**0.1**	0.08	**0.07**
Bend Radius (inches)	24	20	**13.5**	15	**6.5**	10	**3**	8	5	**1.5**	3	**1.25**	3.75	**1**

Table L3: 2.4 GHz TTA BTA Max Power and Frequency Range Supported

		Max Power	Frequency Range Supported
US	**Omni**	17.5 dBm	2.400 to 2.483 GHz
	Sector	16 dBm	
ETSI	**Omni**	24 dBm	
	Sector	18 dBm	

Table L4: 2.4 GHz TTA BTA Cable Loss and Corresponding Cable Length

			Cable Loss	Calculated Length of RG6 Bundled Cable	Engineering Notes
US (Omni & Sector)		**Min**	5 dB	40 ft (12 m)	For a cable loss of more than 15 dB, Adjacent Channel Power degradation will occur. At 20 dB of cable loss a minimum ACP degradation of 3dB will occur
		Max(1)	20 dB	180 ft (55 m)	
ETSI	**Omni**	**Min**	5 dB	40 ft (12 m)	For a cable loss of more than 15 dB, Adjacent Channel Power degradation will be dominated by RFC. At 20 dB of cable loss RFC SNR will be approaching 30 dB
		Max(2)	20 dB	180 ft (55 m)	
	Sector	**Min**	5 dB	40 ft (12 m)	
		Max(1)	20 dB	180 ft (55 m)	

Table L5: 3.5 GHz TTA BTA Max Power and Frequency Range Supported

	Max Power	Frequency Range Supported
ETSI (Omni & Sector)	30 dBm	3.410 to 3.700 GHz

Table L6: 3.5 GHz TTA BTA Cable Loss and Corresponding Cable Length

		Cable Loss	Calculated Length of RG6 Bundled Cable	Calculated Length of RG11 Bundled Cable
ETSI (Omni & Sector)	**Min**	5 dB	35 ft (11 m)	53 ft (16 m)
	Max(1)	30 dB	225 ft (68 m)	340 ft (104 m)

Appendix M: Sample Bill of Materials (BoM)

1/13/2003 1:58:54 PM

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 N: Install Connectors on Cables

Reference Chapter 1, Page 8 "Regulatory Information" requirements.

The following article, written by Lou Caruso of **Times Microwave Systems**, appears in Volume 8 Issue 5, 2000 of *Telecom Exchange*.

"Among the keys to success in any wireless system are the quality and reliability of the connector installations on the coaxial cable transmission lines. And it naturally follows that the more difficult the connectors are to install, the lower the likelihood that they will be installed correctly thus adversely affecting the quality and reliability of the entire system.

Traditional connectors require the pin contact to be soldered to the center conductor of the coax cable. Unfortunately, when RF transmission lines are installed outdoors as is often the case, weather conditions may not be conducive to using soldering equipment. Wind, rain and snow all can make soldering difficult if not impossible. If electrical power isn't available, gas or butane fired soldering equipment may be the only recourse and these devices typically do not generate as much heat as electrically powered devices. Consequently, they may not do as good of a job. The physical handling of the cable, connector pin, butane torch and solder can also be tricky (not enough hands!), especially if there's only one person doing the installation.

For indoor installations, such as distributed antenna systems in buildings, the installer may be working in cramped spaces, on a ladder and in low-light conditions. How can these issues be overcome to ensure a reliable connector installation and proper system performance?

Simplicity is the key. The connector installation process can be simplified with the use of non-solder connectors and the correct installation tools. We have designed non-solder connectors to work with our LMR? low-loss flexible 50-Ohm coaxial cables. These connectors may be installed under all field installation conditions, because they use either silver or gold plated copper-beryllium spring finger contacts that make positive contact with the center conductor and do not require soldering.

Small cable sizes, LMR-400 (3/8") and LMR-600 (1/2"), require a crimp-style contact attachment ring. When the cable is larger, the LMR-900-DB (5/8") for example, a larger clamp method of attachment is needed. Interfaces available include 7-16DIN, N, TNC and reverse polarity TNC connectors.

Even though using non-solder connectors is simpler, there are still certain techniques that must be used if a proper connection is to be achieved. Additionally, you must use the proper tools to get the job done, including stripping, prepping and deburring instruments. Poorly installed connectors are the most common cause of voltage standing wave ratio problems. Likewise, a good connection will achieve the best RF transmission performance with a minimum of signal loss. The following techniques will ensure a good connection and long-term reliability.

The typical procedure for installing the connector on cable sizes LMR-400 and LMR-600 (also is the same procedure on DB and FR) is:

?? Flush cut the cable squarely.
?? Slide the heat shrink boot and crimp ring onto the cable. Strip the cable-end using the ST-400-EZ or ST-600-EZ prep/strip tool by inserting the cable into End 1 and rotating the tool. Remove any residual dielectric material from the center conductor.
?? Insert the cable into End 2 of the tool and rotate the tool to remove the plastic jacket.
?? Deburr the center conductor using the DBT-01 deburring tool.
?? Flare the braid slightly and push the connector body onto the cable until the connector snaps into place, then slide the crimp ring forward, creasing the braid.
?? Temporarily slide the crimp ring back, and remove the connector body from the cable to trim the excess braid at the crease line, then remount the connector and slide the crimp ring forward until it butts up against the connector body.
?? Position the heavy duty HX-4 crimp tool with the appropriate dies (CT-400/300 tool may be used on LMR-400) directly behind and adjacent to the connector body, and crimp the connector. The HX-4 crimp tool automatically releases when the crimp is complete.
?? Position the heat shrink boot as far forward on the connector body as possible, without interfering with the coupling nut and use a heat gun to form a weather tight seal.

The procedure for installing the connector on cable sizes LMR-400-LLPL and LMR-600-LLPL is very similar with a couple of differences:

?? Flush cut the cable squarely.
?? Slide the heat shrink boot and crimp ring onto the cable. Strip the cable-end using the ST-400-EZ or ST-600-EZ prep/strip tool by inserting the cable into End 1 and rotating the tool. Remove any residual dielectric material from the center conductor.
?? Insert the cable into End 2 of the tool and rotate the tool to remove the plastic jacket.
?? Deburr the center conductor using the DBT-01 deburring tool.
?? Flare the braid slightly, then put a slight taper on the front edge of the aluminum-covered dielectric by ‘rolling’ your fingers around the stripped end. (The heat shrink boot can also be used rather than your fingers.)
?? Rotate (turn) and push the connector body with a screwing motion (to prevent the foil from pushing back) onto the cable until the connector snaps into place. Then slide the crimp ring forward creasing the braid.
?? Temporarily slide the crimp ring back, and remove the connector body from the cable to trim the excess braid at the crease line, then remount the connector and slide the crimp ring forward until it butts up against the connector body.
?? Position the heavy duty HX-4 crimp tool with the appropriate dies (CT-400/300 tool may be used on LMR-400-LLPL) directly behind and adjacent to the connector body, and crimp the connector. The HX-4 crimp tool automatically releases when the crimp is complete.
?? Position the heat shrink boot as far forward on the connector body as possible, without interfering with the coupling nut and use a heat gun to form a weather tight seal.

For installing the 'EZ' connectors on LMR-900-DB, FR and LLPL cables and larger, the process is as follows:

?? Flush cut the cable squarely.
?? Slide the backnut and gasket onto the cable.
?? Strip the cable-end using the EZ prep/strip tool by inserting the cable into the proper end of the tool (note that only one strip is needed).
?? Slide the gland washer on the end of the cable and over the braid (being careful not to disturb the braid) until it rests on the end of the cable jacket.
?? Spread the braid over the gland washer.
?? Slide the collar over the foil.
?? Push the 'spring finger' end of the connector pin assembly into the hollow center conductor.
?? Bring up the backnut and gasket.
?? Screw the connector head onto the backnut and tighten with proper size wrenches until the gasket is almost fully compressed."

Table N1: Reference Chart Showing 'EZ' Connectors For Use with LMR, DB & FR Cables

LMR[?] FR DB	Interface	Description	Part Number	Coupling Nut	Inner Contact	Outer Contact
400	N Male	Straight Plug	EZ-400-NMH	Hex	Spring Finger	Crimp
400	N Female	Straight Jack	EZ-400-NF	NA	Spring Finger	Crimp
400	N Female	Bulkhead Jack	EZ-400-NF-Bh	NA	Spring Finger	Crimp
400	TNC Male	Straight Plug	EZ-400-TM	Knurl	Spring Finger	Crimp
400	TNC Male	Reverse Polarity	EZ-400-TM-RP	Knurl	Spring Finger	Crimp
400	TNC Female	Reverse Polarity	EZ-400-TM-RP	Knurl	Spring Finger	Crimp
400	UHF Male	Straight Plug	EZ-400-UM	Knurl	Spring Finger	Crimp
600	N Male	Straight Plug	EZ-600-NMH	Hex	Spring Finger	Crimp
600	N Male	Right Angle	EZ-600-NMH-RA	Hex	Spring Finger	Crimp
600	N Female	Straight Jack	EZ-600-NF	NA	Spring Finger	Crimp
600	N Female	Bulkhead Jack	EZ-600-NF-BH	NA	Spring Finger	Crimp
600	TNC Male	Straight Plug	EZ-600-TM	Knurl	Spring Finger	Crimp
600	TNC Male	Reverse Polarity	EZ-600-TM-RP	Knurl	Spring Finger	Crimp
600	TNC	Reverse	EZ-600-	NA	Spring	Crimp

LMR[2] FR DB	Interface	Description	Part Number	Coupling Nut	Inner Contact	Outer Contact
	Female	Polarity	TM-RP		Finger	
600	UHF Male	Straight Plug	EZ-600-UM	Knurl	Spring Finger	Crimp
600	716 DIN Male	Straight Plug	EZ-600-716-MH	Hex	Spring Finger	Crimp
900	N Male	Straight Plug	EZ-900-NMC	Hex	Press Fit	Clamp
900	N Female	Straight Jack	EZ-900-NFC	NA	Press Fit	Clamp
900	716 DIN Male	Straight Plug	EZ-900-716MC	Hex	Press Fit	Clamp
900	716 DIN Male	Right Angle	EZ-900-716-MCRA	Hex	Press Fit	Clamp
900	716 DIN Female	Straight Jack	EZ-900-716-FC	NA	Press Fit	Clamp
900	7/8 EIA	Straight Plug	EZ-900-78EIA	NA	Press Fit	Clamp
1200	N Male	Straight Plug	EZ-1200-NMC	Hex	Press Fit	Clamp
1200	N Female	Straight Jack	EZ-1200-NFC	NA	Press Fit	Clamp
1200	716 DIN Male	Straight Plug	EZ-1200-716MC	Hex	Press Fit	Clamp
1200	716 DIN Female	Straight Jack	EZ-1200-716-FC	NA	Press Fit	Clamp
1200	7/8 EIA	Straight Plug	EZ-1200-78EIA	NA	Press Fit	Clamp
1700	N Male	Straight Plug	EZ-1700-NMC	Hex	Press Fit	Clamp
1700	N Female	Straight Jack	EZ-1700-NFC	NA	Press Fit	Clamp
1700	716 DIN Male	Straight Plug	EZ-1700-716MC	Hex	Press Fit	Clamp
1700	716 DIN Female	Straight Jack	EZ-1700-716-FC	NA	Press Fit	Clamp

Table N2: Reference Chart Showing 'EZ' Connectors For Use with LMR LLPL Cables

LLPL	Interface	Description	Part Number	Coupling Nut	Inner Contact	Outer Contact
400	N Male	Straight Plug	EZ-400-NMH-PL	Hex	Spring Finger	Crimp
600	N Male	Straight Plug	EZ-600-NMH-PL	Hex	Spring Finger	Crimp
900	N Male	Straight	EZ-900-	Hex	Press Fit	Clamp

LLPL	Interface	Description	Part Number	Coupling Nut	Inner Contact	Outer Contact
		Plug	NMC-PL			
900	N Female	Straight Jack	EZ-900-NFC-PL	NA	Press Fit	Clamp
1200	N Male	Straight Plug	EZ-1200-NMC-PL	Hex	Press Fit	Clamp
1200	N Female	Straight Jack	EZ-1200-NFC-PL	NA	Press Fit	Clamp

Table N3: Reference Chart Showing the Proper Tools for Use with 'EZ' Connectors

LMR? LMR? -FR LMR? -DB LMR? -LLPL	'EZ' Connector Type	Strip/Prep Tool	Deburr Tool	Crimp Handle	Crimp Dies	Wrenches
400 (3/8")	Crimp	ST-400EZ	DBT-01	HX-4 CT-400/300	Y1719 Included w/Handle	N/A
600 (1/2")	Crimp	ST-600EZ	DBT-01	Hex-4	Y1720	N/A
900-DB (5/8")	Clamp	ST-900/1200C	N/A	N/A	N/A	WR-900 WR-900
1200-DB (7/8")	Clamp	ST-900/1200C	N/A	N/A	N/A	WR-1200A WR-1200B
1700-DB (1-1/4")	Clamp	ST-1700C	N/A	N/A	N/A	WR-1700 WR-1700

All outdoor installations should be weatherproofed with either a standard weatherproofing kit such as the Times WK-2 kit or a cold shrink kit, also available from Times. Times LMR? coax cables are low loss, flexible and non-kinking, unlike corrugated coax cables, which are much less flexible and prone to kinking. Times Microwave Systems offers a complete range of LMR? cables to suit every possible type of installation and need:

?? LMR? – Low loss coax, flexible and non-kinking; suitable for general outdoor use such as jumpers, rooftops and short tower runs.
?? LMR? DB – Watertight outdoor cable; designed for tower feeder runs, jumpers and rooftops applications; uses the same connectors as LMR? cable.
?? LMR? FR – Riser rated (UL/CSA listed); fire retardant; employs a low smoke non-halogen polyolefin jacket; for use in vertical riser/access shafts – unoccupied building spaces or anywhere that fire retardance is needed; uses the same connectors as LMR? cable.
?? LMR? – LLPL – Plenum rated (UL/CSA listed); for in-building runs; can be used in open air handling spaces such as above drop ceilings and air plenums; flame retardant and low smoke generating design; uses special 'EZ' connectors.