Base Station Components

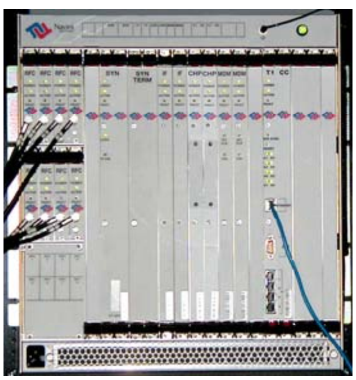
Base Transceiver Station (BTS)

The BTS consists of the RF Power Amplifiers (PAs), the digital circuit cards, the backplane, and the mechanical enclosure or housing. It performs the signal processing and RF transmission for the system. There are three types of chassis: Combo, Split, and Tower Top Amplifier (TTA). The Combo Chassis is used primarily with 2.4 GHz systems. The Split Chasses is used for all other (2.3, 2.5, 2.6 GHz) systems (Figure 5). The TTA is the latest chassis design, and is available at this time for 2.4 and 3.5 GHz systems.

The chassis is compartmentalized into two sections - the RF shelf and the Digital shelf. The BTS connects to the network using a 10/100 Base-T Ethernet connection or up to 8 T1 interfaces. Up to three BTS assemblies can be installed per system, depending on the configuration. The BTS specifications are provided in Appendix C.

Figure 5: BTS Chassis

TTA Chassis



Radio Frequency Subsystem (RFS)

The Radio Frequency Subsystem (RFS) is mounted on a transmission tower or building rooftop. It transmits and receives data to and from the Ripwave Modem using a digital beam forming transmission technique. The RFS may be either a panel antenna or an omni antenna (Figure 6). The RFS data sheets are provided in Appendix E.

An RFS panel transmits in a directional mode, covering a transmit angle of 120 degrees. The antenna can be used as a single mode antenna, or it can be used in a group of two or three sectored antennas, covering 240 and 360 degrees respectively. Each panel requires a BTS to operate. For example, in a tri-sectored cell with 3 panels, you would need 3 BTSs. The omni antenna provides omni-directional coverage of 360 degrees.

An RFS panel or omni contains eight (8) antenna elements, cavity filters, and, optionally, low noise amplifiers (LNA). In the TTA configurations, the PAs also are located in the RFS (antenna) by the LNAs and cavity filters.

Global Positioning System (GPS)

One Global Positioning System (GPS) antenna is used with each Base Station to provide a timing signal for synchronizaton. A second GPS antenna can be provided for redundancy. The Ripwave Base Station uses the VIC 100 GPS Antenna (Figure 7).

Figure7: VIC 100 GPS Antenna

CAUTION! GPS synchronization is essential for the BTSs in a network not to interfere with one another

Mounting Racks & Enclosures

The BTS can be installed indoors or outdoors in industry standard 19- or 23-inch racks. Rack adapters are needed to mount the equipment in a standard 23-inch rack. For outdoor BTSs, the customer can supply any standard enclosure from a multitude of vendors. Appendix E offers suggestions for outdoor BTS enclosures. Figure 8 shows 3 BTSs installed indoors.

Accessibility

Ripwave BTS equipment is required to be installed in a restricted access location, in accordance with NEC/CEC standards. Only authorized personnel should have access to this equipment.

Technical Specifications

Table 2: Technical Specifications

		COMBO (no longer in production)		SPLIT	TTA		
Frequency Band (GHz)		2.4	2.6	2.3 2.5 2.6	2.4	2.6	3.5
Frequency Band (Name)		ISM	MMDS	WCS/ ITFS/ MMDS	ISM	MMDS	BWA/FWA–
Frequency Range (GHz)		2.400–2.473	2.602–2.638	2.305–2.385 2.500–2.596 2.596–2.686	2.400–2.483	2.596–2.686	3.410–3.600
Maximum Power Dissipation (Thermal Load)	**Watt**	725	1150	1150	435	390	380
	BTU per hour	2475	3925	3925	1485	1331	1297
Rectifier Rating (Watt)*		975	1500	1500	504	724	614
Circuit Breaker Rating (Amp)		60		RF Shelf: 50 Dig. Shelf: 20	40		
Duty Cycle		75%					
Input Voltage		+21 to 27 VDC					
Relative Humidity of BTS Operating Environment		0% to 95% relative humidity, non-condensing					
Operating Temperature (°Celsius)		0 to 50					
Storage Temperature (°Celsius)		–40 to +70					
Air Flow (on each shelf)		Fresh air intake along the lower front vertical panel, air exhaust out of the upper rear of the chassis					
Modulation	**Downlink**	DQPSK, 8PSK & QAM16					
	Uplink	DQPSK					
Multiple Access Scheme		Multi-Carrier Synchronous Beam-forming (MCBS) CDMA					
Power Control		Forward & reverse, open & closed loop					

*The BTS must be connected to a power supply/rectifier that is UL listed

(continued on the next page)

<table>
<tr><th colspan="2"></th><th colspan="2">COMBO
(no longer
in production)</th><th>SPLIT</th><th colspan="3">TTA</th></tr>
<tr><td colspan="2">Frequency Band (GHz)</td><td>2.4</td><td>2.6</td><td>2.3
2.5
2.6</td><td>2.4</td><td>2.6</td><td>3.5</td></tr>
<tr><td rowspan="2">Antenna Downtilt</td><td>Omni</td><td colspan="5">2° electrical downtilt</td><td>–</td></tr>
<tr><td>120° panel</td><td colspan="3">6° electrical downtilt (fixed) plus
0°to 10° mechanical uptilt (adjustable)</td><td colspan="3">6° electrical downtilt (fixed) plus
–4° to +8° mechanical uptilt (adjustable)</td></tr>
<tr><td rowspan="2">Antenna Gain per antenna element (Approximate)</td><td>Omni</td><td colspan="6">8 dBi</td></tr>
<tr><td>120° panel</td><td colspan="6">15 dBi</td></tr>
<tr><td colspan="2">Backhaul Interfaces</td><td colspan="6">10/100 BaseT Ethernet or ATM over T1/E1;
up to 8 T1s/E1s with or without IMA, long haul support</td></tr>
<tr><td colspan="2">Bandwidth Allocation</td><td colspan="6">Dynamic</td></tr>
<tr><td colspan="2">Duplex Format</td><td colspan="6">Time Division Duplex</td></tr>
<tr><td colspan="2" rowspan="2">Chassis Mechanical Dimensions (inches H x W x D)</td><td colspan="2" rowspan="2">30 x 19 x 14</td><td>RF:
14x19x15.2</td><td colspan="3" rowspan="2">19.2 x 19 x 12.9</td></tr>
<tr><td>Digital:
19.2x19x12.9</td></tr>
<tr><td colspan="2" rowspan="2">Chassis Weight (lb)</td><td colspan="2" rowspan="2">60</td><td>RF: 82</td><td colspan="3" rowspan="2">36</td></tr>
<tr><td>Digital: 33</td></tr>
<tr><td colspan="2">Omni Antenna Mechanical Dimensions (inches H x Diameter)</td><td colspan="3">60 x 15</td><td colspan="2">56.6 x 13.2</td><td>■</td></tr>
<tr><td colspan="2">Omni Antenna Weight (lb)</td><td colspan="5">65</td><td>52</td></tr>
<tr><td colspan="2">Panel Antenna Mechanical Dimensions (inches H x W x D)</td><td colspan="4">48 x 23 x 10</td><td>54 x 23
x 7.5</td><td>38 x 19
x 20</td></tr>
<tr><td colspan="2">Panel Antenna Weight (lb)</td><td colspan="4">64</td><td>81*</td><td>50</td></tr>
<tr><td colspan="2">Polarization</td><td colspan="6">Vertical</td></tr>
<tr><td rowspan="2">Beam Forming Gain (dB)</td><td>Downlink</td><td colspan="6">18</td></tr>
<tr><td>Uplink</td><td colspan="6">9</td></tr>
</table>

* including the bracket mount

BTS Input/Output Specifications

Table 3: BTS Input/Output Specifications

Item	Description	Termination	Protection specified in Manual
+24 VDC Power	+21 to +27 VDC input, –/+ terminals	Power Supply/Rectifier customer equipment	Rectifier must be UL-listed, comply with UL60950 or UL60950-1 and have earthed SELV output
GND	Chassis Ground Connection	Earth Ground	GND required
T1/E1	T1/E1 communication lines off CC card	T1s/E1s interface switch customer equipment. Typical installation requires DSU or CSU providing loopback capability and primary Type 1 protection.	In-Line Devices such as DSU/CSU/TSU/PPC must be UL497 listed
Ethernet	10/100 BaseT communication off CC card	PC/Router/Hub/Gateway	Not Required
UART	D sub serial connection off CC card, used for on-site communication to PC	PC	Not Required
BBU	BBU connector can accept up to 4 alarm inputs plus GND. BTS monitors alarms and reports back condition to EMS. Inputs come from dry contacts at the BBU side, normally open circuit, can be closed circuit for alarmed condition	BBU customer equipment	Not Required
Cabinet Alarms	Door open and HMC alarms plus 2 GND inputs. BTS monitors alarms and reports back condition to EMS. Inputs come from dry contacts at the BBU side, normally open circuit, can be closed circuit for alarmed condition	Cabinet customer equipment	Not Required

(continued on the next page)

Item	Description	Termination	Protection specified in Manual
TDD SYNC	TDD Sync is a TTL Sync pulse at 10 ms cycle rate, 0 t0 +5V swing, which is 5 µs long in width. This output of BTS is used for equipment debugging and to synchronize test equipment	Test equipment such as oscilloscope or spectrum analyzer	Not Required
GPS Antenna A/B (2)	The GPS coax cable connected to GPS antenna LNA carries +5 VDC and a 1.57 GHz RF signal. RF is an input to BTS; DC is an output from BTS	GPS antenna/LNA, which is normally located at BTS or on hut of BTS; not on tower	Not Required
RFS Calibration Cable (1)	This coax cable is an RF signal path to the RFS. The signal is a low power, at the operating frequency of the BTS	RFS connection to BTS	Lightning protection devices must be UL497 listed
RFS Antenna Cables (8)	This coax cables are an RF signal path to the RFS. The signal frequency is the operating frequency of the BTS. In the TTA version of the BTS, these cables also contain a +24 VDC component and the 10.7 MHz TDD signal on the center conductor.	RFS connection to BTS	Lightning protection devices must be UL497 listed
Power/Data Cable	This cable is a 6-twisted pair bundle cable used for sending low-current DC voltage to the RFS at +8 to +12 V as well as RS485 digital bus for TDD control	RFS connection to BTS	Lightning protection devices must be UL497 listed

Chapter 2: Installation

Pre-installation

As was shown in Figure 4, prior to installing the equipment a number of planning and acquisition activities take place. The installation itself takes only about 2 days. The I&C crew may or may not be involved with all the pre-installation activities. Of these, they are most likely to be involved in the Site Candidate Evaluation, the gathering of data for the Interference Analysis, and the Antenna Power & Cable Selection step of the process.

Project Plan

A Project Plan is a document that lays out the work to be done, the objectives of the project, the schedule, resources required, and so forth. If Navini is performing the I&C activities, a Project Manager is assigned. The Project Manager prepares the Project Plan and shares it with the Navini and customer teams.

Coverage Prediction Map

Early in the planning of deployment of Ripwave Base Station equipment, an RF Engineer will go through the process of studying the RF environment of the candidate sites that the customer has identified. Readings are taken and analyzed at each site in order to predict what range of coverage can be expected from installing a Base Station at the site.

Coverage predictions account for both Base Station performance and Marketing objectives with the service. The customer accomplishes the latter as part of the decisions concerning site selection.

Site Candidate Evaluation

Often Technicians will be very comfortable with either the networking side or the wireless side of the system, but not usually both. To evaluate a potential install site, a form helps ensure all aspects of the site have been considered. Information about the site is recorded on the form. Since each site is unique, the form helps to ensure nothing is taken for granted or assumed about the installation site for the Ripwave equipment.

A copy of this form may be found in Appendix A. It includes places to capture the logistics of the site, tower or rooftop mount possibilities, GPS coordinates, type of antenna to be installed, whether or not an outdoor enclosure is provided, power availability, distance between connection points, ventilation, a place for drawings from every angle, etc. It is from this information that the site will be designed, then installed to plan.

Interference Analysis

As part of deploying a Ripwave Base Station, the Field Service Engineer must collect critical information from the site. The data is provided to the RF Engineering personnel, who can then evaluate the Radio Frequency (RF) conditions. The RF Engineer analyzes the data for existing interference from other sources, and takes that into account when creating the coverage prediction map.

The RF Engineer, in turn, supplies to the Field Service Engineer at the site valuable data parameters and configuration information unique to each system and each site. In addition to coverage, though, the interference analysis also helps to predict the quality of service, the power requirements to get above the noise floor, and other expectations regarding the site.

This study helps Navini and the customer decide which type of system (frequency) and antenna (panel or omni) will provide the best results. To collect the data the on-site Technician or Field Engineer performs an Interference Sweep Procedure (Appendix B) and supplies that data to the RF Engineer(s).

Site Selected & Designed

After evaluating the potential sites and the coverage prediction, the customer must select the specific site where the Base Station is to be deployed. The site must be carefully blueprinted to prepare for equipment ordering and installation. Navini can supply specifications and drawings to help the customer design the site. Refer to Appendices C D, E, F, and G for BTS Specifications, RFS Data Sheets, BTS Outdoor Enclosures Manufacturers, Rectifier/Battery Backup Manufacturers, and a sample Base Station drawing. Check all regulatory standards (refer to Chapter 1, Page 8 “Regulatory Information”) prior to installation.

Network Architecture Plan

The IP Networking community involved in the project, both from Navini and the customer, often work together to analyze and plan how the Ripwave system will be integrated into the customer’s network. Of course, they are looking for efficient operation of the system and seamless integration. They have to plan the traffic routing, IP addressing, protocol compatibility, and so forth.

Antenna Power & Cable Selection

The size and type of cable used to install the Base Station affect power loss and calibration range for the transmitter and receiver. It is at this point in the process that the specific cable manufacturer, type of cable, and cable size must be determined. A complete procedure and tool are explained in Appendix H. Refer, also, to Chapter 1, Page 8 "Regulatory Information" for FCC warning regarding RF, and UL and NEC/CEC information regarding cable length and connectors. All BTS and RF shelf Coax and Digital cables between the Digital and RF Shelves are 60 inches in length. Physical distance between Digital and RF Shelves will always be less than the cable length.

Bill of Materials

The customer has to generate the Bill of Materials (BoM) - the actual equipment order to be manufactured and shipped to the installation site. Navini can provide part numbers and ordering information, as well as recommendations and other details that will assist customers in the correct placement of orders. There is a sample Bill of Materials in Appendix I.

Acquire Materials

Once ordered, the customer ensures that everything required for installing the Base Station is secured and at the deployment site.

Confirm Backhaul Connection, EMS Server & FTP Server, Input Power & Grounding at Site

The Backhaul connection for the Ripwave Base Station consists of up to two (2) Ethernet cable connections with RJ-45 connectors for each BTS installed, OR, up to eight (8) T1/E1 connections with RJ-48 connectors for each BTS. The quantity of each connection will depend on the site requirements. These connections need to be made available before installation begins. Refer to the Regulatory Information in Chapter 1, Page 8 regarding backhaul connections, power and grounding.

The customer's EMS Server and FTP Server should be put into place prior to the installation crew's arrival at site. If the customer's EMS Server is not available until after installation begins, the crew can typically use a laptop to perform initial configuration. The FTP Server, however, must be in place in order to commission the Base Station and test its operation.

Power Requirements for the Base Station

Refer to Table 3 Technical Specifications and to the Regulatory Information found in Chapter 1, Page 8. The BTS must be connected to a power supply/rectifier that is UL listed to UL60950 or UL60950-1 and has a grounded SELV output; and it must be installed in accordance with NEC/CEC Articles 800/810/830. A UL listed disconnect device, such as a circuit breaker or fuse, must be installed between the power supply and the BTS chassis connections.

Ground Requirements for the Base Station

The Base Station requires an earth ground connection. Grounding from copper point to copper point shall be less than 1 ohm. Grounding from copper point to earth ground shall be less than 5 ohms. All power and ground conductors must be mechanically supported to avoid strain of the wires and connection points. Refer to the Regulatory Information in Chapter 1, Page 8.

NOTE: The installation procedures, which begin next, follow the same order as shown in the High-level I&C Process Flowchart in Figure 4.

Install Power & Grounding

Check all regulatory standards (refer to Chapter 1, Page 8 “Regulatory Information”) prior to installation.

System Ground Buss Bar & Surge Protectors

The Base Station system ground buss bar and data/power cable surge protectors are mounted on the wall adjacent to the BTS rack or enclosure. They should be mounted per accepted telecom standards and procedures.

Step 1. Mount the data/power cable surge protectors (Figure 10) with the label ‘lines’ toward the RFS and the label ‘BTS’ toward the BTS.

Step 2. Apply a thin coat of anti-oxidant joint compound to both sides of the system ground buss bar to ensure proper connection between it and the surge protectors.

To install the eight (8) antenna and one (1) cal cable surge protectors (Figure 11), and the one (1) or two (2) Global Positioning System (GPS) surge protectors (Figure 11) in the system ground buss bar, follow the steps below.

1. Install the rubber gasket into the groove in the surge protector.
2. Install the surge protector in the system ground buss bar with the surge side toward the antenna and the protected side toward the BTS.
3. Install the star washer and nut on the top of the surge protector. Torque the nut to 140-150 inch-pounds.
4. When finished, the mounted surge protectors in the buss bar will appear as in Figure 12.

CAUTION! Navini Networks provides both Secondary (built-in) and Primary (optional) Lightning Protection. Lightning Protection helps to protect the RFS, the BTS, and the RF lines against “tower lightning” events occurring at the Base Station. The customer must exercise judgment when balancing risk against cost to decide whether to install the primary protection kit at an extra cost or to rely on the secondary protection only. NOTE: Navini does not warranty equipment against lightning

Figure 11: Surge Protectors

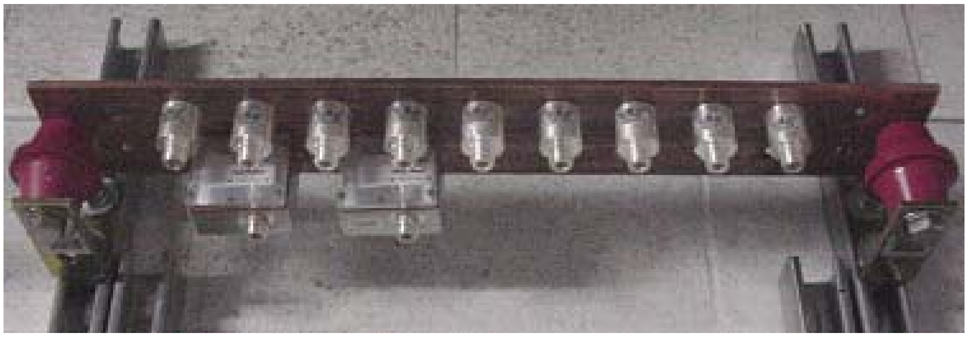
From left to right: PolyPhaser surge protectors are used with the Combo Chassis and Split Chassis configurations (PSX-ME for the Cal and RF cables, at the antenna, PSX for the Cal and RF cables at the ground Buss Bar, and DGXZ+06NFNF-A for the GPS antenna cable at the ground Buss Bar.

Huber+Suhner surge protectors are used with TTA configurations. The Female-Female model is used for Primary Surge protection* at the ground Buss Bar (RF and Cal cables near the BTS); and the Male-Female model is used for Primary Surge protection (RF and Cal cables) at the RFS and with the GPS cable.

PolyPhaser surge protectors block DC, are unidirectional (there is an “equipment side” and a “line side”), have multi-strike capability, and have no gas tubes. Huber+Suhner surge protectors allow the DC component that powers the PAs through but stop lightning surges and electrical transients, are bi-directional, and have a gas discharge tube.

The Navini Part Numbers for the Huber+Suhner surge protectors are 32-00228-00 and 32-00229-00, respectively. Similar surge protectors may be obtained from NexTek (Navini Part Numbers 32-00228-20 and 32-00229-20).

Figure 12: Surge Protectors in Buss Bar (Non-TTA system)



Antenna Ground Buss Bar

You should install the Antenna Ground Buss Bar on the mounting structure per accepted telecom standards and procedures (Figure 13). The location is decided on during the site survey and should be close to the RFS. Two or more buss bars may be installed per system.

Figure 13: Buss Bars

BTS Buss Bar

Antenna Buss Bar

System Ground Wiring

A minimum #6 stranded, green-coated copper wire and grounding hardware are used for ground connections. Install the system ground as a single-point connection between the system ground buss bars, the data/power surge protector, the BTS chassis, the BTS mounting rack, and the RFS antenna. Connect the system ground to earth ground. Apply anti-oxidant joint compound to all connections (Figure 14). Tighten all connections until secure.

CAUTION! Without proper grounding a BTS is much more susceptible to damage

Install Cables

All cable connections in the Combo and Split-Chassis configurations are made using standard RF coaxial cable. The Navini Networks minimum for cable connections from the GPS to the BTS is LMR 400, 3/8-inch coaxial cable. Other types of cable that are comparable may be used. These were determined under “Antenna Power & Cable Selection” (Appendix H) activities cited earlier. The TTA configuration uses a composite cable containing nine RG-6 or RG-11 individual strands to replace the 8 RF cables, the Cal cable and the Power/Data cable (the signal previously sent through the Power/Data cable is now sent through the center connector of the individual RG-6 or RG-11 strands).

All Coaxial and Digital cables between the Digital and RF shelves are 60 inches in length. Physical distance between Digital and RF shelves will always be less than the cable length.

Figure 15: Coaxial Cables

Cut Cables for the Combo and Split Chassis Configurations

The cable run is determined during the site survey. Note that the length of the cables may need to be slightly different, depending on the position of the buss bar relative to the BTS.

- Cut nine (9) pieces of cable for the main feeder cables to connect the nine RFS connectors to the surge protectors on the system ground buss bar. Leave enough extra length for the service loop below the RFS and for connection to the surge protectors.

- Cut eight (8) pieces of cable for the jumper cables to connect the surge protectors on the system ground buss bar to the eight (8) RF input connectors on the back of the BTS. Leave enough extra cable length for service.

- Cut one (1) piece of cable for the jumper cable to connect the surge protector on the system ground buss bar to the CAL connector on the back of the BTS. Leave enough extra cable length for service.

- Cut a piece of LMR 400 cable to connect each of the GPS antennas to the surge protectors on the system ground buss bar. Leave enough extra cable length for service. The maximum loss for the cable to the GPS antenna is 11 dB.

- Cut a piece of LMR 400 cable to connect the surge protectors on the system ground buss bar to each GPS connector on the back of the BTS. Leave enough extra cable length for service. If there is more than one BTS co-located in the installation, two GPS antennas can serve all BTSs in the installation.

- The cable from the GPS antenna (after it goes through the surge protector) is connected to the antenna input of the GPS distribution amplifier (Figure 16). The output ports of the GPS distribution amplifier are connected to the GPS inputs of the BTS. The GPS distribution amplifier is powered by the GPS antenna input. The drawing in Figure 17 depicts the placement of the shared GPS resources among three BTSs.

CAUTION! GPS is required to prevent the BTSs in a network from interfering with one another.