Navini NETWORKS™

Internet at the speed of thought™

Ripwave™ Base Station

Installation & Commissioning Guide

Part Number 40-00047-00
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About This Document

Purpose

This document provides a Navini-certified Installation & Commissioning Technician with instructions to properly install the Base Transceiver Station, Radio Frequency Subsystem, and cabling; and to test and commission the Base Station after installation.

Revision History

Date	Revision/Version	Authors	Editors	Comments
2001	A/1.0	J. Price C. Keltner A. Chua P. Blain J. Coulson D. Karina K. Sharp L. Hoffman	N/A	Draft
4.02	B/v1.0	Same	N/A	Preliminary
8.30.02	C/1.0	Same	N/A	Prepare for release 1.16
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2.7.03	D/1.0	Same	Same	Combined all Base Station I&C into one manual; Preliminary 1.19
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Contacts

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Safety

To optimize safety and expedite installation and service, read this document thoroughly. Follow all warnings, cautions, and instructions marked on the equipment and included in this document.

To aid in the prevention of injury and damage to property, cautionary symbols have been placed in this document to alert the reader to known potentially hazardous situations, or hazards to equipment or procedures. The symbols are placed before the information to which they apply. However, any situation that involves heavy equipment and electricity can become hazardous, and caution and safety should be practiced at all times when installing, servicing, or operating the equipment.

Caution Symbol - possible equipment or property damage

Warning Symbol - could cause personal injury or otherwise be hazardous to your health

Navini Networks, Inc., expressly requires that when using Navini electronic equipment always follow the basic safety precautions to reduce the risk of electrical shock, fire, and injury to people and/or property.

1. Follow all warnings and instructions that come with the equipment.
2. Do not use the equipment while you are in a bathtub, shower, pool, or spa. Exposure of the equipment to water could cause severe electrical shock or serious damage to the equipment.
3. Do not allow any type of liquid to come in contact with the equipment. Unplug the equipment from the power source before cleaning. Use a damp cloth for cleaning. Do not use any soaps or liquid cleaners.
4. Follow all airport and FAA regulations when using the equipment on or near aircraft.
5. Only operate the equipment from the type of power source(s) indicated in this manual (110 VAC or Navini supplied battery). Any other type of input power source may cause damage to the equipment.
6. Power the equipment using only the battery or the AC adapter cable provided, and in accordance with the instructions specified in the User Guide.
7. Do not use a frayed or damaged power cord. Do not place the power cord where it can be stepped on or tripped over.
8. Do not touch wires where the insulation is frayed or worn unless the equipment has been disconnected from its power source.
9. Do not overload wall outlets, power strips, or extension cords. This can cause serious electrical shock or fire.
10. Do not place the equipment on an unstable surface. It can fall and cause injury or damage to the equipment.

11. Do not disassemble the equipment. Removing covers exposes dangerous voltages or other risks and also voids the warranty. Incorrect reassembly can cause equipment damage or electrical shock. Only an authorized repair technician should service this product.
12. Do not expose the equipment to extreme hot or cold temperatures.
13. Do not use the equipment under the following conditions:
    - When the equipment has been exposed to water or moisture.
    - When the equipment has been damaged.
    - When the power cord is damaged or frayed.
    - When the equipment does not operate properly or shows a distinct change in performance.

Regulatory Information

FCC Notice

WARNING! This device is a Radio Frequency transmitter. It is required to comply with FCC RF exposure requirements for transmitting devices. A minimum separation distance of 8 inches (20 cm) or more must be maintained between the antenna and all persons during device operations to ensure compliance with the FCC's rules for Radio Frequency Exposure. If this minimum distance cannot be maintained, exposure to RF levels that exceed the FCC's limits may result.

FCC Compliance and Advisory Statement

Tested To Comply
With FCC Standards
FOR HOME OR OFFICE USE

This equipment has been tested and found to comply with the limits for a class B digital device, Pursuant to Part 15 of the FCC rules. The operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.
These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed or used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
(1) Reorient or relocate the receiving antenna;
(2) Increase the separation between the equipment and the receiver;
(3) Connect the equipment to an outlet on a circuit different from that to which the receiver is connected;
(4) Consult the dealer or an experienced radio/TV technician for additional suggestions.

INFORMATION TO USER
This device has been authorized as a radio frequency transmitter under the appropriate rules of the Federal Communications Commission. Any changes or modifications not expressly approved by Navini Networks could void the user's authority to operate the equipment.

Battery Caution & Procedures

WARNING! To reduce risk of injury or fire, follow these instructions when handling the battery.

1. Risk of explosion is possible if the battery is replaced with one not supplied by Navini Networks.
2. Do not dispose of the battery in a fire. It may explode. Check with the local codes for battery disposal guidelines.
3. Do not open or mutilate the battery. The battery contains substances that are toxic, corrosive, or harmful to humans. If battery substances come in contact with the skin, seek medical help immediately.
4. Do not attempt to recharge the battery by any means except per the instructions in this manual.
5. Remove the battery from the equipment if the equipment is not going to be used for a long period of time. The battery could leak and cause damage to the equipment.
6. Exercise care when handling the battery to prevent shorting the battery with conducting materials such as bracelets, rings, and keys.
7. Store the battery pack in a dry place, 0 to +40 degrees Celsius.
8. Dispose of used batteries according to environmental guidelines.

Glossary of Terms & Abbreviations

Term	Stands For....	Meaning
802.11	802.11 Standard	An IEEE LAN standard for wireless Ethernet replacement technology in the ISM band. Runs at up to 10 Mbps.
ACC	Access Channel or Access Code Channel	AKA, Paging Channel. The signal path that tells a mobile to prepare for an incoming call.
ACK	Acknowledge	Positive message sent by a protocol to acknowledge reception of a transmitted packet
AP	Access Point	Wireless LAN transceiver that acts as a center point of an all-wireless network or as a connection point between wireless and wired networks.
ARP	Address Resolution Protocol	The function of the ARP is to match higher-level network IP addresses with the physical hardware address of a piece of equipment.
ASYNCH	Asynchronous	Not occurring at regular intervals, as in data piped over a network
ATM	Asynchronous Transfer Mode	Transporting a broad range of user data at irregular intervals over network facilities
BB	Broadband	RF system with constant data rate of 1.5 Mbps or higher.
BCC	Broadcast Code (or Control) Channel	A channel of data transmitted by one entity and received by many devices.
BS	Base Station	Network Access equipment and software that transmits and receives, as well as processes, voice or data calls from mobile units to network connections. A Ripwave Base Station consists of the Base Transceiver Station (BTS) and the Radio Frequency Subsystem (RFS), or antenna, plus a Global Positioning System (GPS) antenna for timing.
BTS	Base Transceiver Station	The Ripwave BTS is a two-shelf rack that holds the RF modules and digital circuit cards that interpret radio signals into computer language and sends messages to and from the local or wide area network. It functions between the RFS and the EMS to handle the signaling.
BW	Bandwidth	Frequency spectrum usable for data transfers. It describes the maximum data rate that a signal can attain on the medium without encountering significant loss of power. Usually expressed in bits per second (digital) or Hertz (analog).
BYTE	Byte	8 bits
CAM	Configuration & Alarm Manager	An EMS functionality that is handled through a Graphical User Interface for purposes of configuring elements in the system and handling other OAM requirements.
CC	[1]Communications Controller or [2]Cross-check	[1]A type of circuit card that resides in the Digital shelf of the Ripwave BTS. It handles all interfaces between BTS and network. [2]An EMS functionality that allows the system to perform an automated sanity check of the datafill.

Term	Stands For....	Meaning
CD	[1]Compact Disk or [2]Change Directory	[1]An optical disk capable of storing large amounts of data (700x floppy disk). It can be inserted into most pc's and "read" to load files onto a computer [2]A software programming term in "C" language that tells the computer to go to a different location in the computer's memory.
CDMA	Code Division Multiple Access	Digital cellular technology that uses a spread-spectrum technique where individual conversations are encoded with a random digital sequence. Increases capacity and speed of communications messages between mobile units over other types of wireless networks.
CD-ROM	Compact Disk - Read Only Memory	See "CD." If a CD is not Read Only, computers can write data to it with that capability.
CHP	Channel Processor Card	A card in the digital shelf of the BTS that performs the first stage of signal processing for up to 4 antennae. One Navini 2.4 GHz BTS has 8 antennae. The card performs digital-to-analog conversion (DAC) and analog-to-digital conversion (ADC) for up to 10 carriers.
CLEC	Competitive Local Exchange Carrier	A telephone company that competes with an incumbent Local Exchange Carrier (LEC).
CLI	Command Line Interface	A text-based programming language through which a user communicates with an operating system or an application.
CORBA	Common Object Request Broker Agent	A standard for Network Management Systems that allows integration with NMS regardless of programming language or Operating System.
CPE	Customer Premise Equipment	Communications equipment that resides at the customer's location.
dB	Decibel	Unit of measurement for sound.
dBd	Decibel/Dipole	A ratio, measured in decibels, of the effective gain of an antenna compared to a dipole antenna (2 horizontal rods in line with each other). The greater the dBd value the higher the gain and therefore the more acute the angle of coverage.
dBi	Decibel/Isotropic	A ratio, measured in decibels, of the effective gain of an antenna compared to an isotropic antenna (measured along axes in all directions). The greater the dBi value the higher the gain and therefore the more acute the angle of coverage.
DHCP	Dynamic Host Configuration Protocol	A protocol for dynamically assigning IP addresses to devices on a network.
DiffServ	Differentiated Service	Different Quality of Service (QoS) descriptions for different types of traffic, i.e., voice, video, email. The DiffServ table is where each level of QoS is defined. Equivalent to Class of Service (COS) in POTS.
DIR	Directory	A special kind of file used to organize other files into a hierarchical structure.
DL	DownLink	In this case, data messages transmitted from the BTS to the CPE.
DNS	Domain Name Server	TCP/IP networking term that is a protocol for matching objects to network (IP) addresses.
DS-1	Digital Signal - 1	Also "T1" or "E1". Digital transmission equipment that can handle up to 1.544 Mbps.
DSL	Digital Subscriber Line	A type of service whereby users gain access to the Internet through high-speed data networks.

Term	Stands For....	Meaning
DSP	Digital Signal Processor	Compressing or manipulating analog signals to digital signals and vice-versa.
EID	Equipment Identifier	Field in EMS for assigning IP address or name to individual pieces of equipment for purposes of configuring the system.
EMS	Element Management System	An application that allows the user to define and manipulate managed objects as a system within an overall network.
ERP	Effective Radiated Power	The actual power in Watts radiated from a transmitter's antenna.
FCC	Federal Communications Commission	United States government regulatory agency that supervises, licenses and otherwise controls electronic and electromagnetic transmission standards.
FE	Far End	A relative term that refers to the receiving element in a network, as opposed to the near-end element that is transmitting data.
FTP	File Transfer Protocol	A TCP/IP method consisting of a client and server and used to transfer files between two or more sites or elements in a network.
Gain	Gain	Ratio of the output amplitude of a signal to the input amplitude of a signal, expressed in decibels (dB).
Gb	Gigabit	One billion (1,000,000,000) bits.
GB	Gigabyte	One billion (1,000,000,000) bytes.
GHz	Gigahertz	One billion (1,000,000,000) hertz - cycles per second. Ultra high frequency (UHF) signals, including microwave signals.
GPS	Global Positioning System	A constellation of 24 well-spaced satellites that orbit the earth and enable users with GPS antennas to pinpoint their exact geographical position.
GUI	Graphical User Interface	A graphic rather than purely text based user interface to a computer or computing system.
HW	Hardware	Physical, tangible equipment
Hz	Hertz	1 cycle per second.
I&C	Installation & Commissioning	Term used to describe the procedures of physically installing technical equipment then powering up the equipment to make sure it will operate (to put it "into commission").
IEC	Inter-exchange Carrier	Also IXC. Public switching network service provider (carrier) that connects across and between local exchange carriers (LEC).
IF	Interface Card	Card on the digital shelf of the Ripwave BTS that takes the analog signal from the Channel Processor card (CHP) and converts it to a baseband signal before sending it on to the RF modules for transmission (forward link), and vice-versa (reverse link).
IMA	Inverse Multiplexing over ATM	A method of building dynamic routes of 2 or more T1's to increase bandwidth so that PVC's can share the IMA resources, as needed, for data transmissions.
IP	Internet Protocol	A TCP/IP protocol used to route data from its source to its destination.
ISP	Internet Service Provider	A company that provides access to the Internet.
Kb	Kilobit	1,024 bits
KB	Kilobyte	1,024 bytes
KHz	Kilohertz	1,000 hertz.

Term	Stands For....	Meaning
L1	Layer 1	Physical Layer. Part of the OSI rules and standards for network management. L1 describes the physical layer, or electrical and mechanical port-to-port connections, in the network.
L2	Layer 2	Data Link Layer. Part of the OSI rules and standards for network management. L2 describes the data link layer where data is set up and torn down in a specific format (frames), through the overall network. Also responsible for detecting and correcting errors by requesting retransmission.
L3	Layer 3	Network Layer. Part of the OSI rules and standards for network management. L3 describes the network addressing that gets data to its destination within the network, i.e., IP addressing.
LAN	Local Area Network	A data network of interconnected computers, servers, printers, and other peripherals that communicate at high speeds over short distances, usually within the same building. Also allows for sharing of resources.
LCP	Link Control Protocol	Basis of the Point-to-Point Protocol (PPP) scheme for negotiating and establishing connections.
LED	Light-emitting Diode	An electronic device that lights up when electricity passes through it. Often used to indicate equipment or system state.
LLC	Logical Link Controller	A protocol that governs the transition of frames between data stations regardless of how the medium is shared. It's the upper sub-layer that further defines the Media Access Control (MAC) protocol. It provides the basis for an unacknowledged connectionless service on a LAN - i.e., error correction, multiplexing, broadcasting.
LOS	Line-of-sight	Describes laser, microwave, RF, and infrared transmission systems that require no obstruction in a direct path between the transmitter and the receiver.
MAC	Media Access Control	Protocol that governs access to a network in order to transmit data between nodes. In a wireless LAN, the MAC is the radio controller protocol (L2).
Mb	Megabit	One million (1,000,000) bits.
MB	Megabyte	One million bytes. Literally - 1,048,576 bytes.
Mbps	Megabits Per Second	Transmission speed at rate of one million bytes per second.
MDM	Modem Card	A card in the Navini BTS that converts digital signals into analog so the signals can be transmitted over telephone lines, and vice-versa. Modem stands for modulator/demodulator.
MHz	Megahertz	One million (1,000,000) hertz - cycles per second. Normally used to refer to how fast a microprocessor can execute instructions.
MIB	Management Information Base	A collection of managed objects used in SNMP-based networks. MIB's carry information in a standard format so external tools can analyze network management and performance.
MMDS	Multipoint Multi-channel Distribution Service	Fixed wireless, high-speed local service that operates at 2.1 - 2.7 GHz. Speed 10 Mbps. Originally conceived for cable TV service.
NE	[1]Near-end or [2]Network Element	[1]The transmitting end, versus the receiving end, of a signal transmission. [2] A router, switch, or hub in an ISDN network.
NLOS	Non Line-of-site	Describes laser, microwave, RF, and infrared transmission systems that can penetrate obstructions in the path between the transmitter and the receiver.

Term	Stands For....	Meaning
NMS	Network Management System	A product that helps manage a network generally hosted on a well-equipped computer such as an engineering workstation. The system tracks network statistics and resources.
NOC	Network Operations Center	A centralized point, much like a traffic control tower, where technicians or engineers can monitor network activity, alarms, and statistics, as well as make network configuration and other changes dynamically. For Internet, the NOC is often a hub for ISP services.
OAM	Operation, Administration, Maintenance	A set of network management functions. Also describes the human-machine interface tasks - i.e., to operate the system, to administer the system, and to maintain the system.
OS	Operating System	A software program that manages the basic operation of a computer. Most Operating Systems are either based on
OSI	Open Systems Interconnection	An ISO model for worldwide communications that defines 7 layers of network protocol: L1 Physical Layer; L2 Data Link Layer; L3 Network Layer; L4 Transport Layer; L5 Session Layer; L6 Presentation Layer; L7 Application Layer.
PC	Personal Computer	Any IBM-compatible computer, so named because IBM's first commercial end user computer was called a PC.
PCB	Printed Circuit Board	A hardware module that holds electronic circuitry and usually fits into a larger frame where the various PCB's are interconnected electronically.
PDU	Packet Data Unit or Protocol Data Unit	A data packet. Refers to that which is exchanged between peer-layer entities. Contains header, data, and trailer information.
Ping	Ping	Generalized term from sonar science, where a short sound burst is sent out and an echo or "ping" is received. Used to determine if signals or packets have been dropped, duplicated, or reordered.
PPPoE	Point-to-point Protocol Over Ethernet	A protocol that allows dial-up Internet connections. Includes the Link Control Protocol as well as Network Control Protocols.
Propagation	Propagation	To spread out and affect a greater area; travel through space, as in radio waves.
PSK	Phase Shift Keying	Digital transmission term that means an angle modulation where the phase of the carrier varies in relation to a reference or former phase. An encoded shift. Each change of phase carries one bit of information, where the bit rate equals the modulation rate.
PSN	Packet Switched Network	A network in which data is transferred in units called packets. Packets can be routed individually and reassembled to form a complete message at the definition.
PSTN	Public Switched Telephone Network	Typically used in the same context as POTS. Analogous to a network of major highways originally built by a single organization but added to and expanded by multiple organizations. AKA, backbone networks.
QAM	Quadrature Amplitude Modulation	A bandwidth conservation process routinely used in modems. Creates higher throughput but decreased coverage area.
QoS	Quality of Service	A guaranteed throughput for critical network applications, such as Voice over IP. Term primarily used in an ATM environment. Five classes of service: Class 1 Video; Class 2 Audio; Class 3 Data Connection.

Term	Stands For....	Meaning
RAM	Random Access Memory	Computer memory that can be accessed randomly.
RF	Radio Frequency	A portion of the electromagnetic spectrum in the frequency range between audio and infrared: 100 KHz to 20 GHz. RF measurements are expressed in Hz (unit for measuring frequency); MHz = 1 Million Hz; GHz = 1 Billing Hz.
RFS	Radio Frequency Subsystem	A term for the antenna portion of the base station.
RSSI	Receiver Signal Strength Indicator	A term that describes the measure of the signal strength in kilohertz or gigahertz between the transmission and the receiving end.
Rx	Receive	An abbreviated way of expressing the term, receive, as in to receive a transmission.
S-CDMA	Synchronous Code Division Multiple Access	Wireless technology based on data being transferred at a fixed rate using Code Division Multiple Access algorithms.
SMDS	Switched Multi-megabit Data Service	Connectionless service for MAN/WAN based on 53-byte packets that target the interconnection of different LAN's into a public switched network at speeds higher than T1.
SMS	[1]Short Message Service or [2]Systems Management Server	[1]A protocol that allows mobile users to send text-based messages from one device to another. The text appears on a device's screen and may be a maximum 160 characters in length. [2]A Windows NT process that allows a network administrator to inventory all hardware and software on the network, then perform software distribution over the LAN.
SNMP	Simple Network Management Protocol	Standard management request-reply protocol for managing TCP/IP networks. A device is said to be SNMP compatible if it can be monitored or controlled using SNMP messages.
SNR	Signal-to-noise Ratio	Related to RSSI, a measurement of the intended signal being transmitted against the other entities that can interfere with the signal.
SO/HO	Small Office/Home Office	Small, remote office with a MAN or WAN connection back to a larger corporate network and/or the Internet.
SSI	Signal Strength Indicator	See "RSSI".
SW	Software	Computer instructions or data.
SYN	Synthesizer Card	A circuit card in the Navini BTS digital shelf that provides a local oscillator and system clock with a single calibration transceiver. The card is used to calibrate the Base Station so that no external spectrum analyzer or signal generator is required.
SYNCH	Synchronous	Digital packets or signals that are sent at the same, precisely clocked fixed rate of speed.
TCC	[1]Traffic Channel or [2]Transmission Control Code	[1]A portion of a radio channel used to enable transmission of one direction of a digitized voice conversation (as opposed to the Voice Channel). [2]A way of segregating traffic in order to define controlled communities of interest among subscribers.
TCP	Transport Control Protocol	A standardized transport protocol between IP-based network nodes that allows two hosts to establish a connection and exchange streams of data. TCP operates on top of Internet Protocols and handles the multiplexing of sessions, error recovery, reliability and flow; it guarantees packets are delivered in the same order in which they were sent.
TCP/IP	Transport Control Protocol/Internet Protocol	A set of protocols that allows cooperating computers to share resources across the network. TCP provides the reliability in the transmission, while IP provides connectionless packet service.

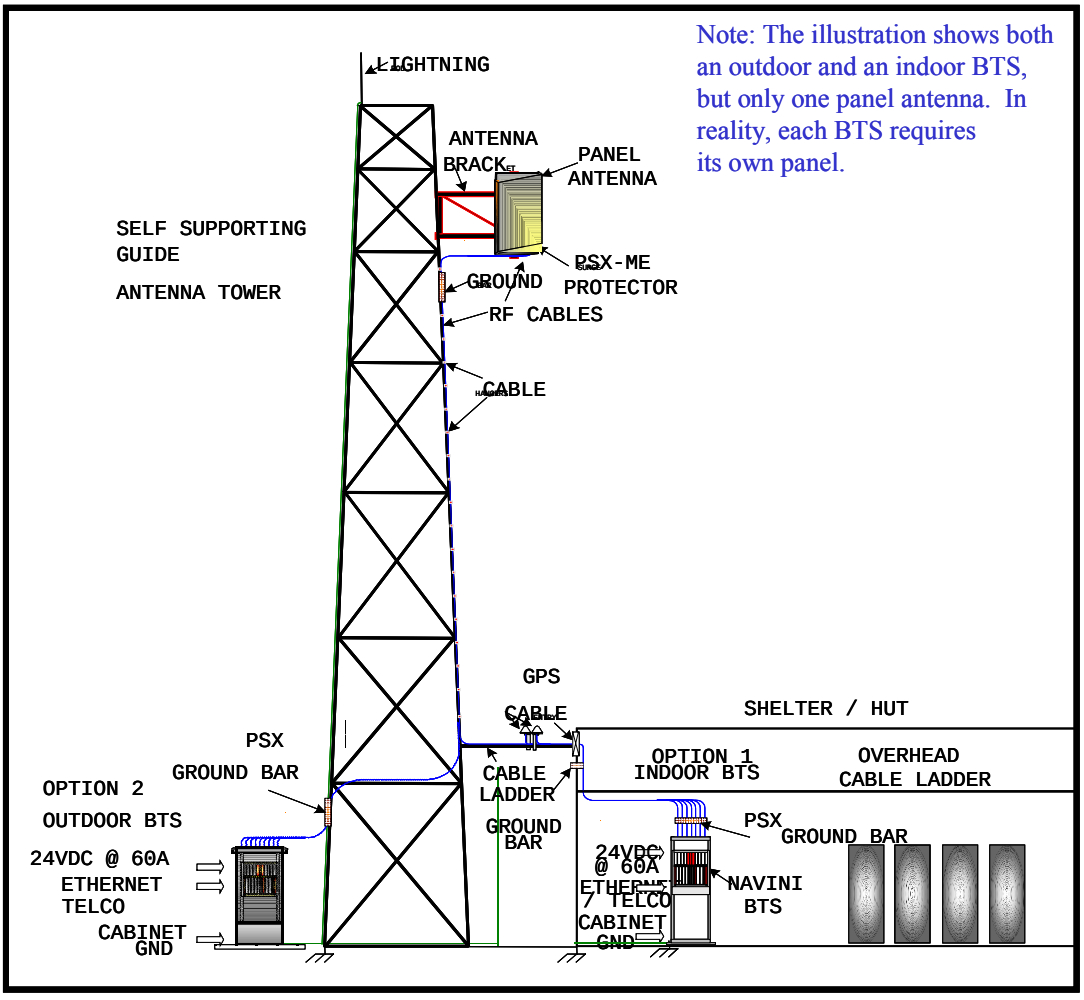
Term	Stands For....	Meaning
TDD	Time Division Duplex	A digital transmission method that combines signals from multiple sources and allows a single channel to alternately carry data in each direction of a link.
TFFS	True Flash File System	Memory in a computing device that does not lose its information when powered off. Available as a SIMM or PCMCIA card, it usually stores router Operating System (OS) software. Can be easily updated.
TTL	Time-to-live	A field in the Internet Protocol that specifies how many more hops a packet can travel before being discarded or returned.
Tx	Transmit	To send by wire or other medium electronically or through air via electromagnetic waves to a receiving communications device.
UL	UpLink	Describes the direction of signal flow being sent from a subscriber to a network system, as in from a mobile device (CPE) to a base station.
USB	Universal Serial Bus	An external bus standard for plug-and-play interfaces between a computer and add-on devices, such as a mouse, modem, keyboard, etc. One USB port can connect up to 127 devices.
VCC	Virtual Channel Circuit	AKA, Virtual Channel Connection or Virtual Circuit Connection. A logical circuit made up of Virtual Channel Links, which carry data between two end points in an ATM network.
VCI	Virtual Channel Identifier	A 16-bit value in the ATM cell header that provides a unique identifier for the Virtual Channel that carries that particular cell.
VCL	Virtual Channel Link	A connection between two ATM devices.
Vector	Vector	A quantity representative of both magnitude and direction (energy + orientation in space)
VPC	Virtual Private Channel	AKA, Virtual Path Connection. A grouping of Virtual Channel Connectors, which share one or more contiguous VPL's.
VP	Virtual Path	A set of Virtual Channels grouped together between cross-points (i.e., switches).
VPI	Virtual Path Identifier	An 8-bit value in the cell header that identifies the VP as well as the VC to which the cell belongs. The VPI + VCI identify the next destination of a cell as it passes through a series of ATM switches.
VPL	Virtual Path Link	A group of unidirectional VCL's with the same end points in a Virtual Path. Grouping VCL's into VPL's reduces the number of connections to be managed. One or more VPL's makes up a VPC.
WAN	[1]Wide Area Network or [2]Wireless Access Network	[1]A communications network that spans geographically separate areas and which provide long-haul services. Examples of inter-networked connections are frame relay, SMDS, and X.25 protocols. [2] General term for any product primarily used to gain access to the Internet, as opposed to being part of the actual Internet devices or software.

Chapter 1: Overview

Ripwave Description

A Ripwave system has three main components: the Customer Premise Equipment (CPE); the Base Station; and the Element Management System (EMS). The Base Station performs the CPE registration and call processing, and provides the interface between the backhaul network and the EMS. It is made up of the Base Transceiver Station (BTS) and the Radio Frequency Subsystem (RFS) (Figure 1). This manual provides the guidelines and instructions for installing and commissioning (I&C) the Base Station.

Figure 1: Base Station Installation With Panel Antenna



Procedural Documents & Forms

You will refer to other Ripwave documents, procedures, and forms in the process of installing and commissioning the Base Station. They are listed in Appendix A of this manual. The product documentation is provided on the Ripwave Standard Documentation CD (Table 1). As well, the EMS manuals can be viewed on-line through the EMS Server and Client applications.

Table 1: Ripwave Standard Documentation CD

Order Number 95-00116-00	Component or Part Number	Format
EMS Overview Manual	40-00016-03	MSWord/.pdf
EMS Software Installation	40-00017-00	MS Word/.pdf
EMS Administration Guide	40-00031-00	MS Word/.pdf
Ripwave Configuration Guide	40-00016-01	MS Word/.pdf
EMS CLI Reference Manual	40-00016-02	MS Word/.pdf
Ripwave Alarm Resolution Reference Manual	40-00033-00	MS Word/.pdf
Ripwave Base Station Operations & Maintenance Guide	00-00046-00	MS Word/.pdf
Ripwave RFS Configuration Quick Guide	40-00067-00	MS Word/.pdf
EMS Diagnostic Tools Guide	40-00032-00	MS Word/.pdf
Ripwave Modem Quick Installation Guide	40-00112-00	MS Word/.pdf
English	40-00098-00	MS Word/.pdf
Spanish	40-00096-00	MS Word/.pdf
Ripwave Modem User Guide	40-00111-00	MS Word/.pdf
English	40-00097-00	MS Word/.pdf
Spanish	40-00099-00	MS Word/.pdf
Ripwave Modem Software Update Tool Guide	40-00066-00	MS Word/.pdf

A separate CD specifically created for personnel involved with installation and commissioning of the Ripwave system, called “VAR I&C Documentation”, may be ordered by authorized business partners and customers. The CD includes detailed procedures and electronic forms that are used during the I&C process. Table 2 contains a partial listing of the files on this CD, while Appendix A provides the complete list. The I&C forms found on the CD are referenced throughout this manual, and copies are included in the appendices.

Table 2: VAR I&C Documentation CD

Order Number 95-00017-00	Part Number	Format
RFS Omni & Panel Data Sheets	44-00037/38-00	Excel (includes drawings)
Site Candidate Evaluation Form	40-00091-00	Excel Spreadsheet
RFS System Test Form	40-00093-00	Excel Spreadsheet
Base Station Calibration Verification Form	40-00059-00	Excel Spreadsheet
Drive Study Survey Form	40-00076-00	Excel Spreadsheet
Location (FTP) Test Form	40-00077-00	Excel Spreadsheet
Customer Acceptance Form	40-00117-00	MS Word Document
BTS Outdoor Selection Guide	44-00035-00	MS Word Document
Rectifier/Battery Backup Specification	44-00036-00	MS Word Document

I&C Process Flowchart

To put the I&C activities in the context of overall system deployment, Figure 2 provides a 'flow' of the key activities that are performed prior to and during the installation and commissioning of the Ripwave Base Station. Post-I&C, the system that has been installed and commissioned goes through Acceptance Testing against the customer's objectives for that site. Once customer sign-off on the site is achieved, the customer becomes fully responsible for operating the system.

Different job holders may perform various portions of these activities and not necessarily all of the activities. In fact, Marketing and Engineering personnel typically handle the earlier tasks, while installation may be a stand-alone function. Commissioning may or may not be handled by the same people who designed or installed the site. Regardless of who does them, these key activities have to be accomplished for successful deployment:

- Site Engineering
- Installation
- Commissioning
- Acceptance Testing and sign-off

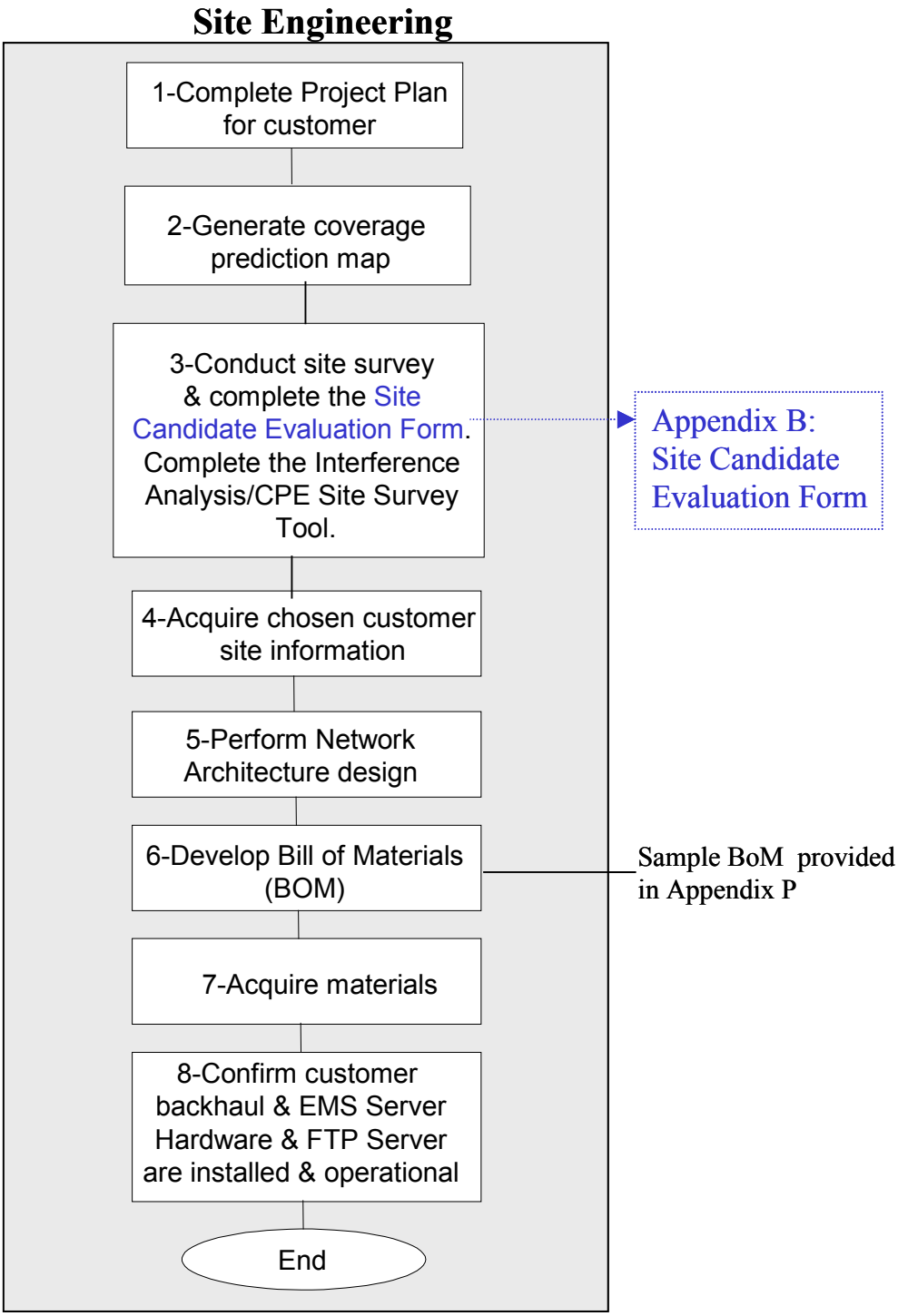
Prior to installation, Navini and the customer formulate a Project Plan and Responsibility Assignment Matrix (RAM) to clarify who will do what to complete the I&C activities. If requested by the customer, Navini may provide personnel, procedures, forms, and/or tools required to install and commission the Base Station equipment. They may also provide special commissioning software programs, computers, and any other special test equipment required.

As part of the I&C duties, all testing results are recorded and kept for the customer to review and approve. These test results include the cable sweeps, the BTS Calibration Verification, RF System Tests, Drive Study, Line-of-Sight (LOS) FTP tests, and Non-Line-of-Sight (NLOS) FTP test results. The I&C Supervisor provides site tracking and weekly status reports. All of these tasks can be negotiated with the customer.

If Navini Networks is hired by a customer to provide Installation & Commissioning Services, involvement and some actual deliverables are still required by the customer. For example, the customer will need to review or perhaps even explain their Site Design Specifications, approve Logistics Plans, provide shipping information, approve the Network Architecture Plan, etc.

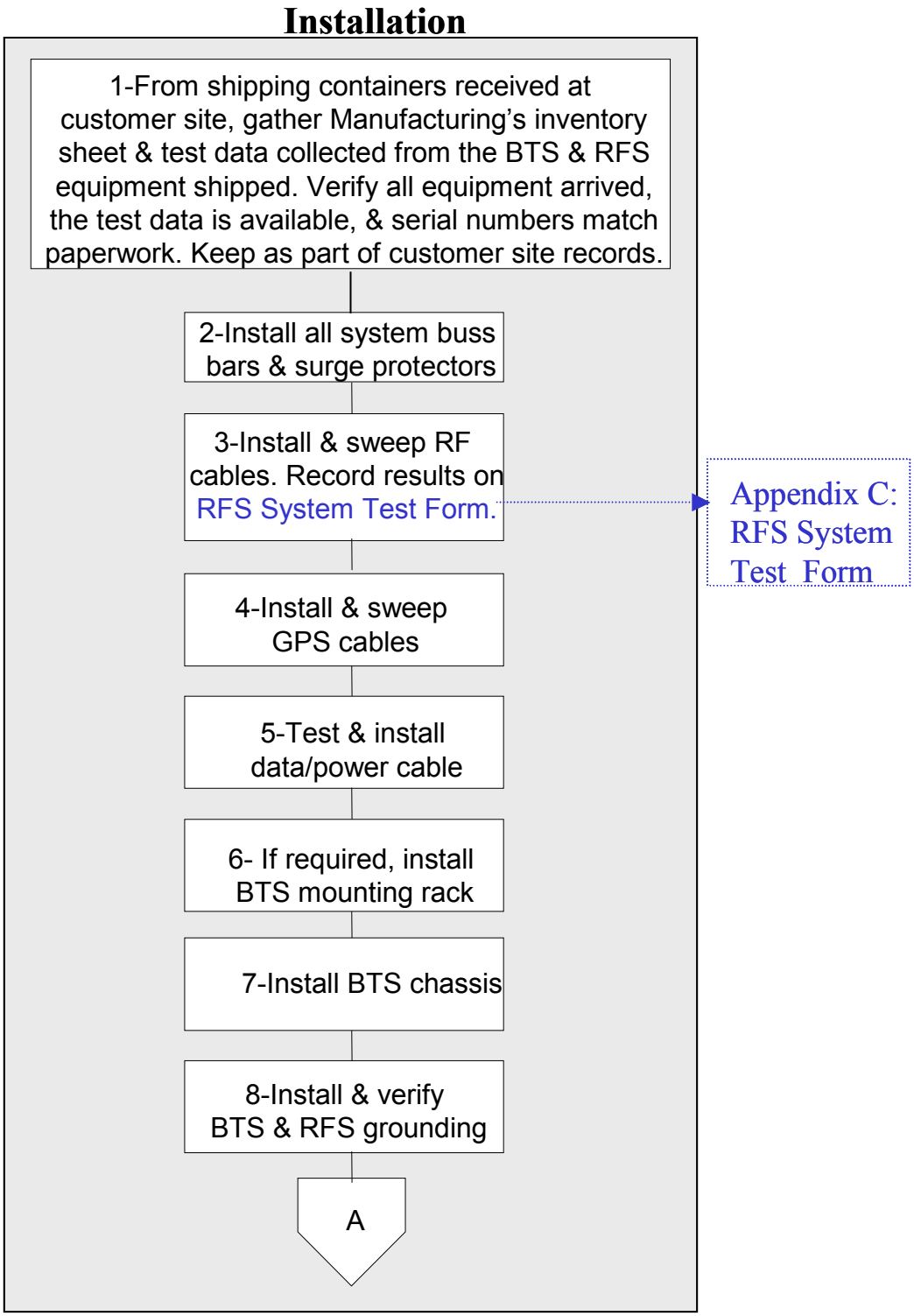
As part of a successful hand-off from Navini to the customer, it is usually necessary for Navini to provide some product training to customer personnel who will support the Base Station operation on-going. Customers may opt to take on a Train-the-Trainer program, in which case Navini certifies the customer's instructors who then provide staff training thereafter.

Figure 2: I&C Process Flowchart



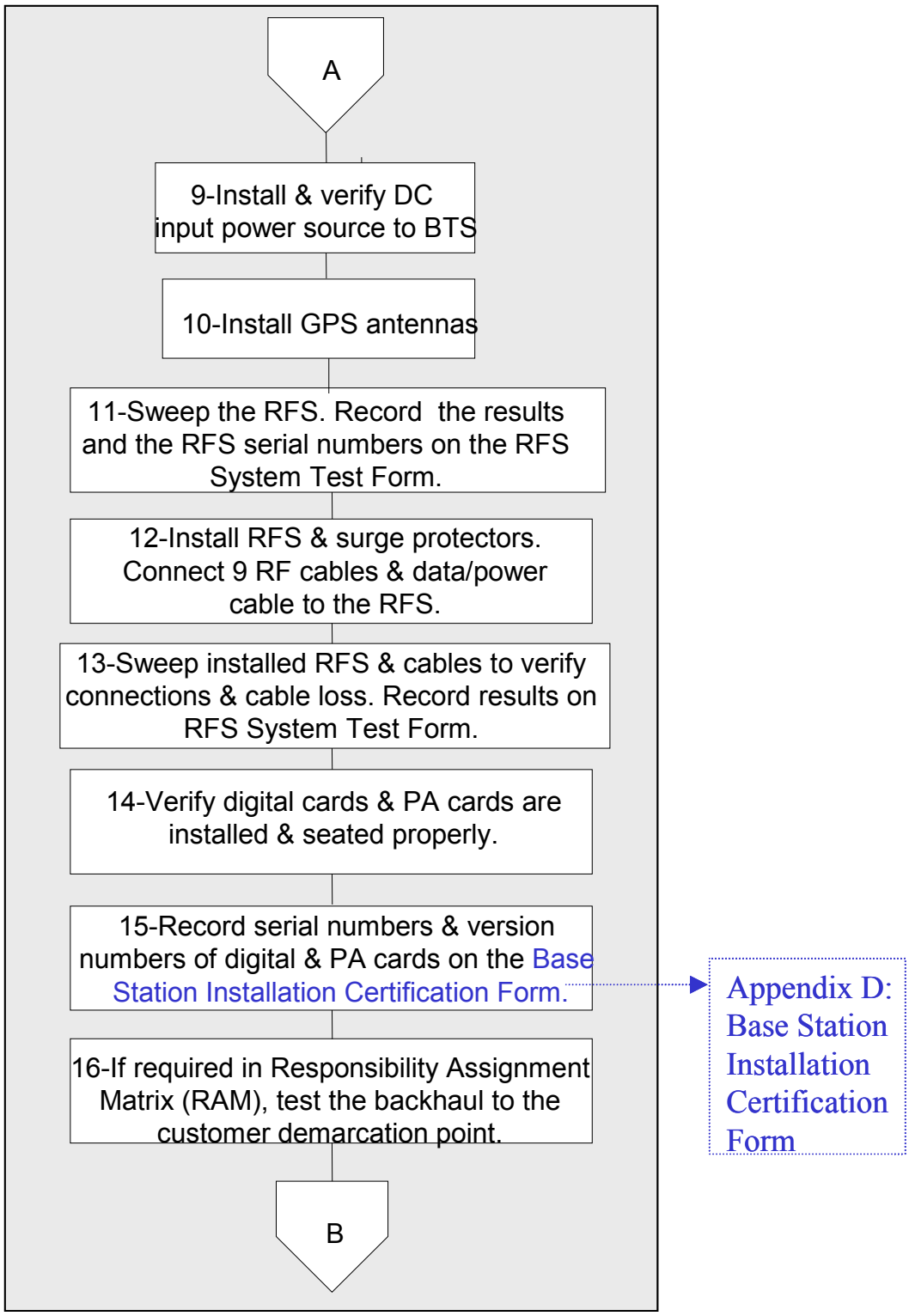
Click here to link to Appendix B or to Appendix P.

Figure 2: I&C Process Flowchart, cont'd.



Click here to link to Appendix C.

Figure 2: I&C Process Flowchart, cont'd.



Click here to link to Appendix D.

Figure 2: I&C Process Flowchart, cont'd.

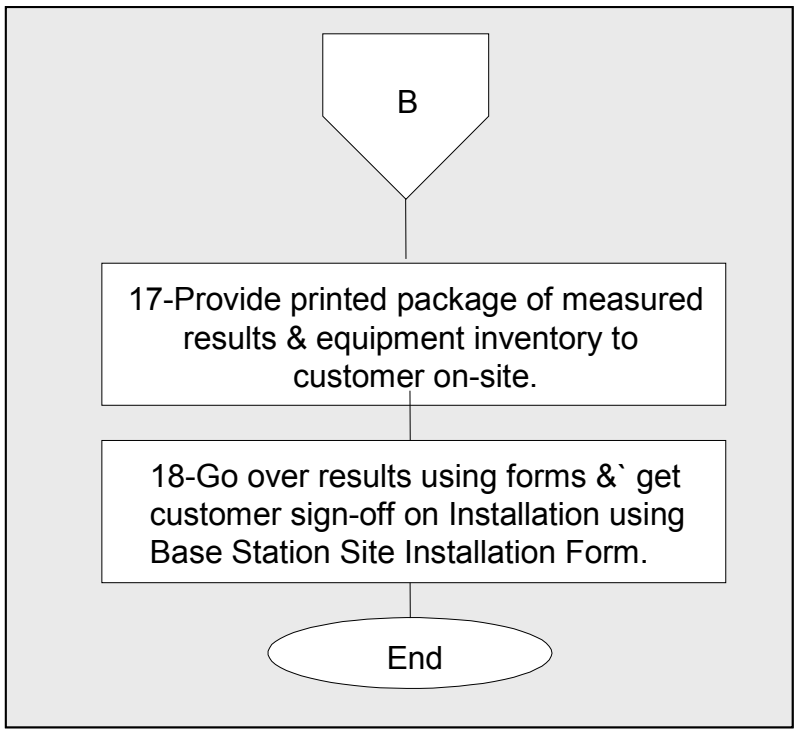
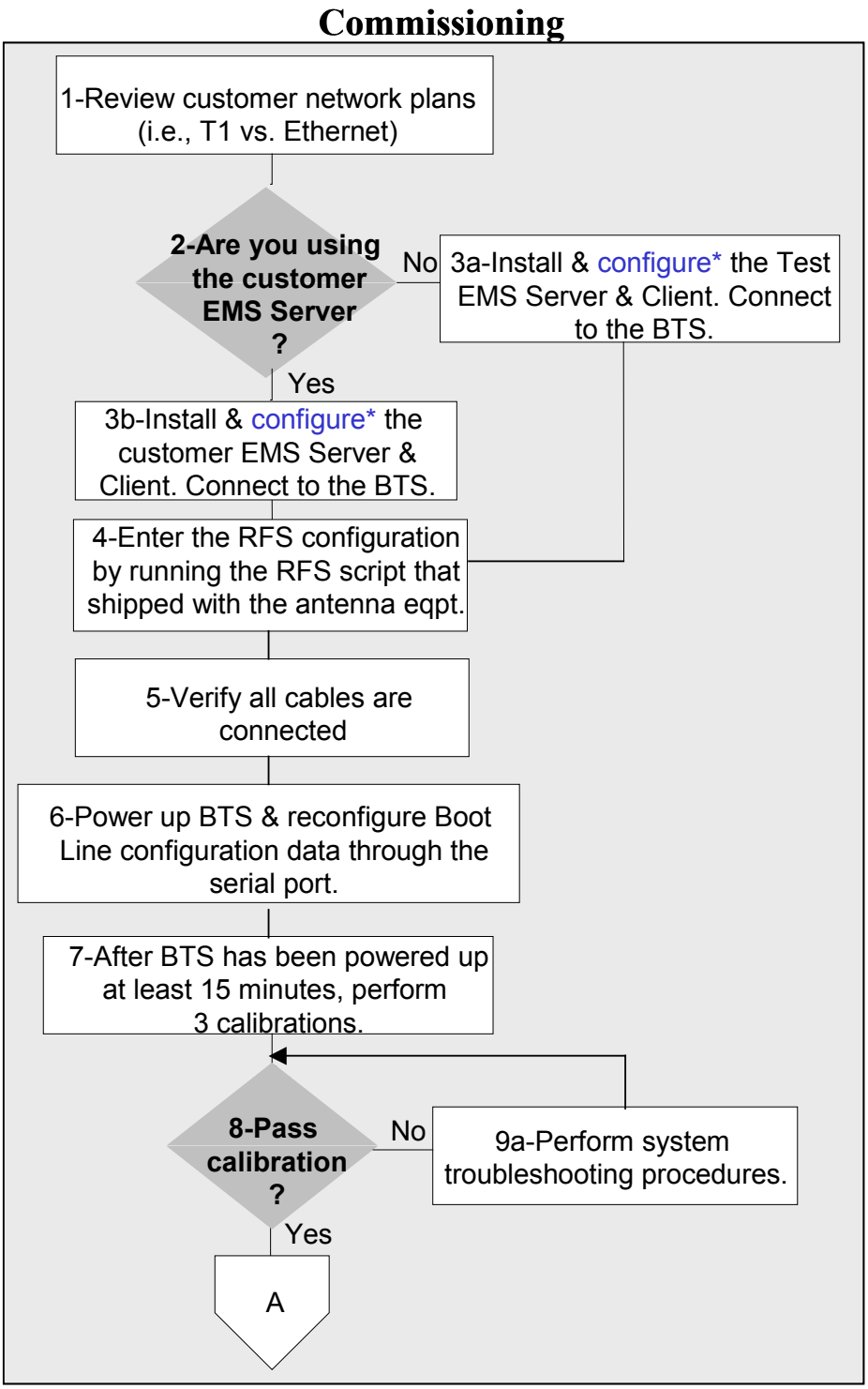
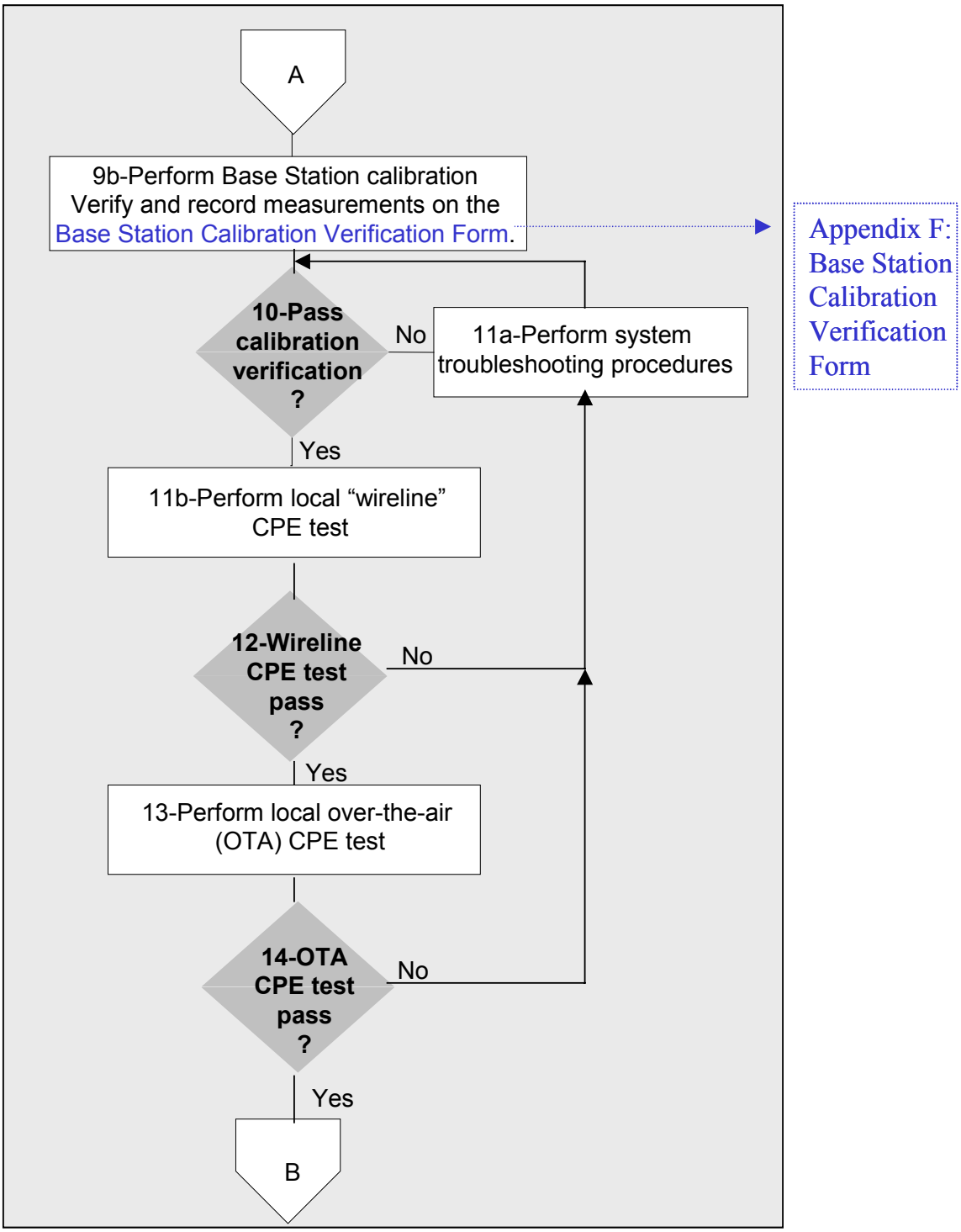


Figure 2: I&C Process Flowchart, cont'd.



Click here to link to Appendix E.

Figure 2: I&C Process Flowchart, cont'd.



Click here to link to Appendix F.

Figure 2: I&C Process Flowchart, cont'd.

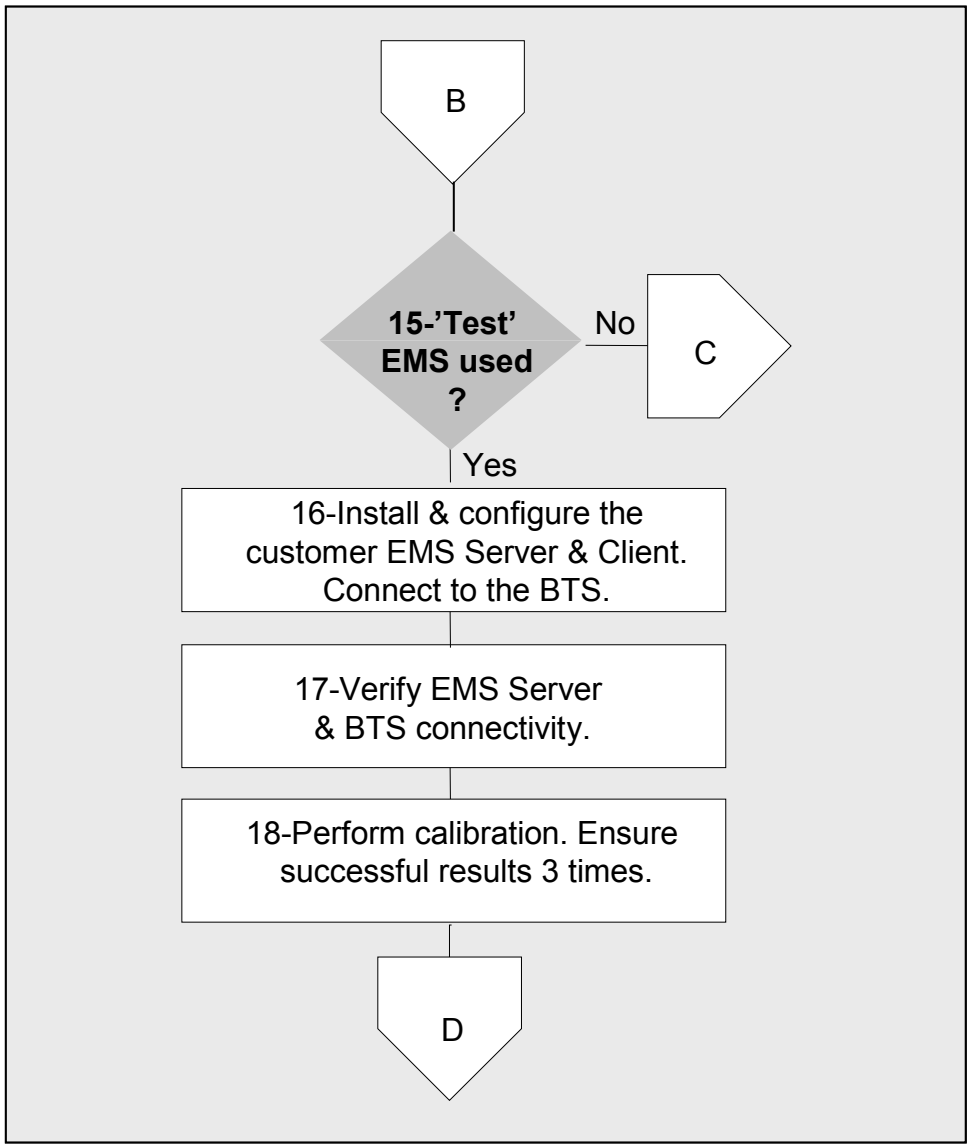
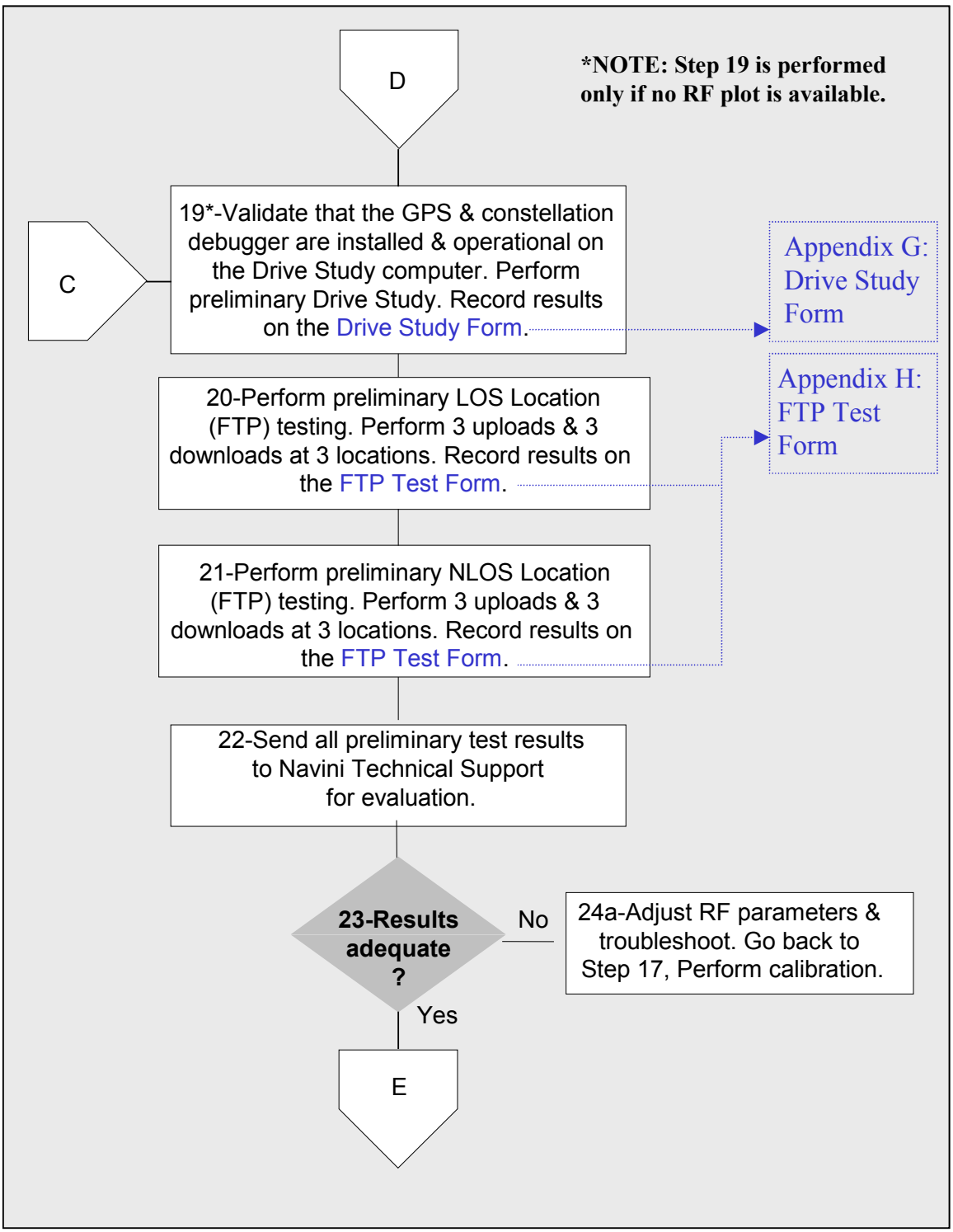
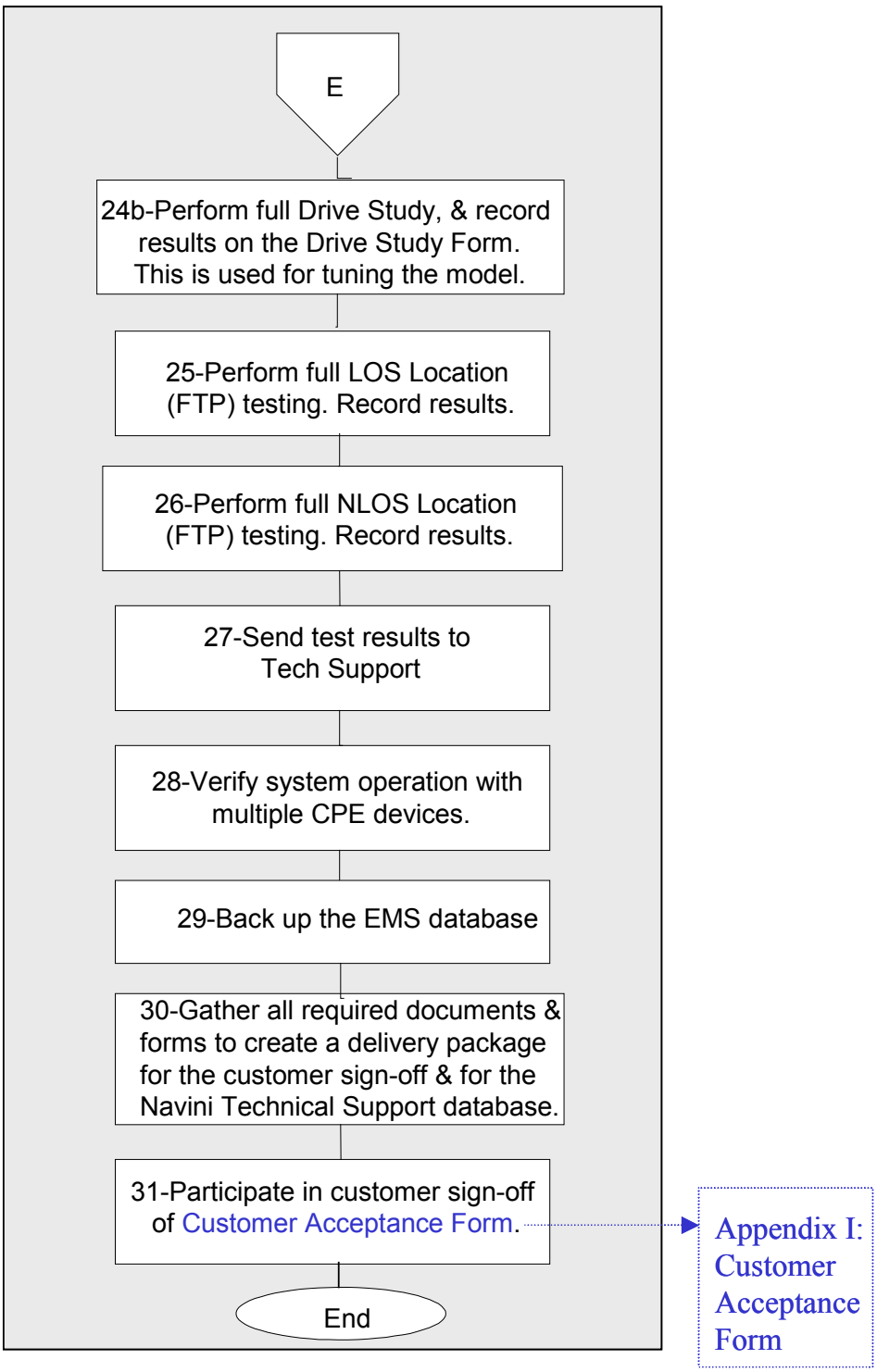


Figure 2: I&C Process Flowchart, cont'd.



Click here to link to Appendix G.
Click here to link to Appendix H.

Figure 2: I&C Process Flowchart, cont'd.



Click here to link to Appendix I.

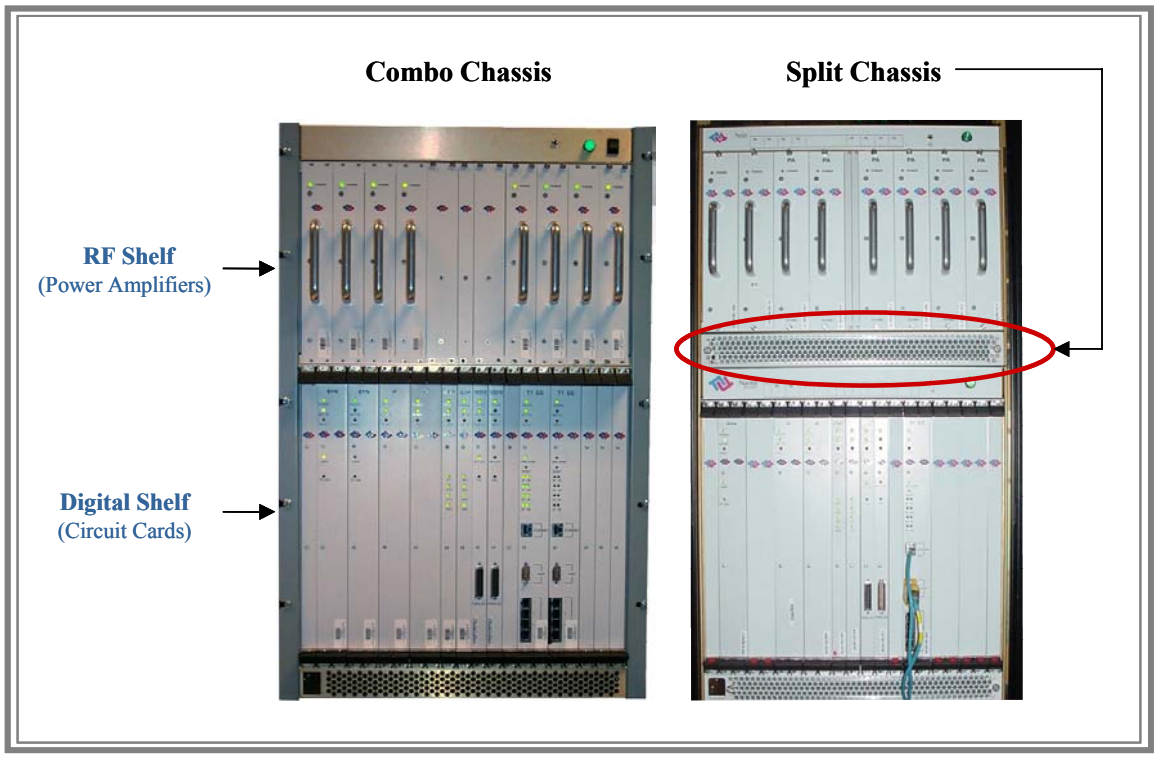
Base Station Components

Base Transceiver Station (BTS)

The BTS consists of the RF Power Amplifiers (PA's), 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 two types of chassis: Combo and Split. 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 3).

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.

Figure 3: BTS Chassis



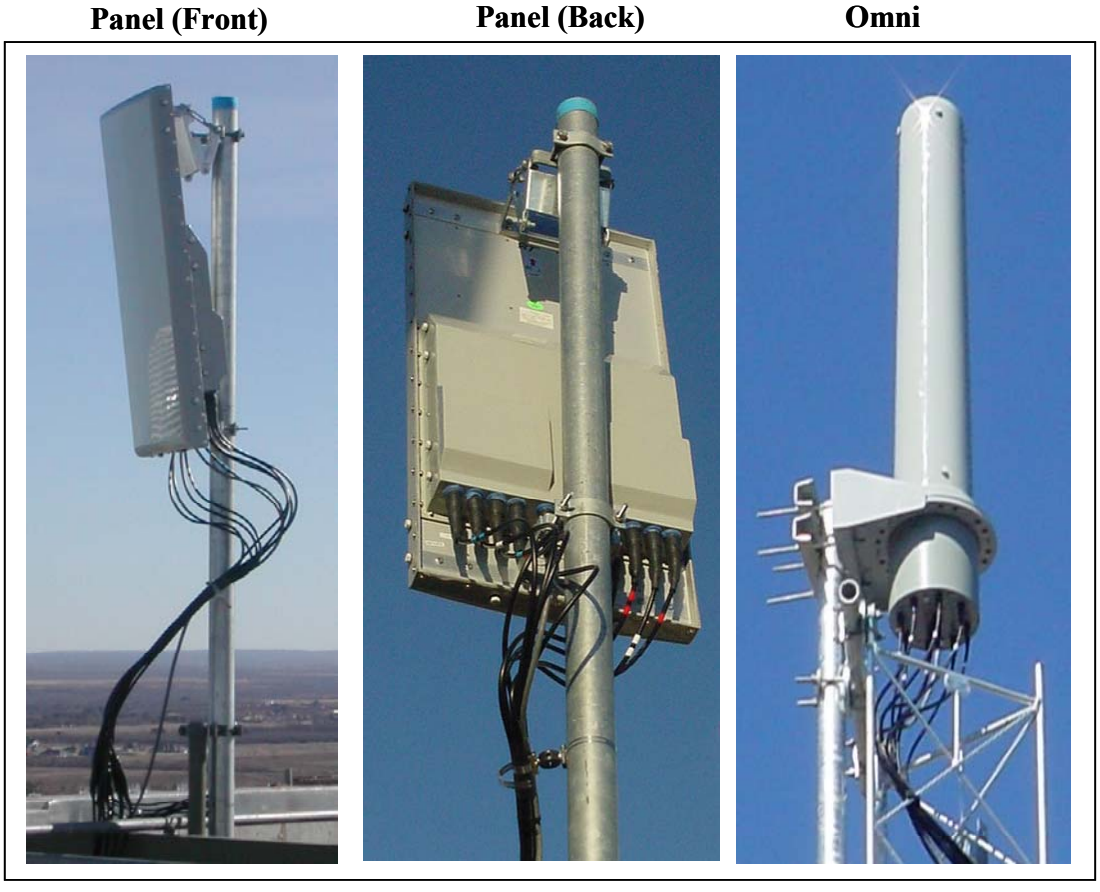
Radio Frequency Subsystem (RFS)

The Radio Frequency Subsystem (RFS) is mounted on a transmission tower or building rooftop. It transmits and receives data to and from the Ripwave Customer Premise Equipment (CPE) using a digital beamforming transmission technique. The RFS may be either a panel antenna or an omni antenna (Figure 4).

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 BTS's. 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). For downtilt, the omni must be situated as it comes from the factory. A panel's downtilt can be adjusted at the site. The higher up the antenna is placed, the more downtilt it typically required.

Figure 4: RFS



Global Positioning System (GPS)

One or two Global Positioning System (GPS) antennas are used with each Base Station. A GPS antenna works with a constellation of satellites that orbit the earth, and it provides the ability to pinpoint geographical locations. The two types of GPS antennas that may be ordered with a Ripwave Base Station are the VIC 100 and the Motorola Timing 2000 (Figure 5).

Figure 5: GPS Antennas

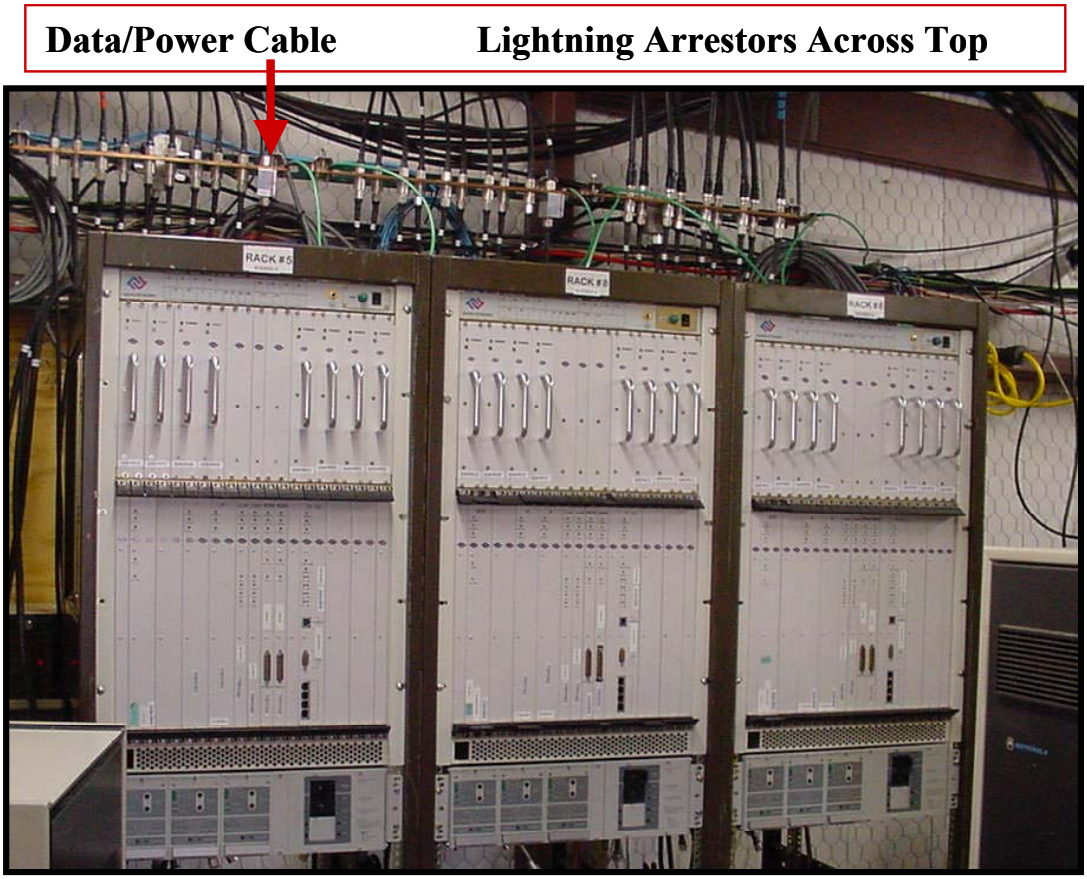
VIC 100 GPS

Motorola Timing 2000 GPS

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 BTS's, the customer can supply any standard enclosure from a multitude of vendors. Appendix J offers suggestions for outdoor BTS enclosures. Figure 6 shows 3 BTS's installed indoors.

Figure 6: Indoor BTS



General Specifications

Input Power

The BTS requires +21 to 28 VDC power supply rated at 60 amps. Installers are referred to industry standards for power supply installations.

Humidity

The operating environment of the BTS must control relative humidity to 5% to 95% RH, non-condensing.

Heat Dissipation

The combo BTS chassis, under normal operating conditions, will dissipate a maximum of 1000 Watts or 3415 BTU's. The split chassis will dissipate a maximum of 1500 watts.

Airflow

Fresh air intake for the BTS chassis is along the lower front vertical panel. Exhaust is out of the upper rear of the chassis. The I&C crew must ensure there are no obstacles to airflow present in these areas. Exhaust air from other equipment should not mix with the BTS fresh air intake.

Accessibility

The BTS is intended for installation and use only in a restricted access location.

Base Station Specifications

Current Ripwave operating frequencies include those shown in Table 3. Testing on other frequencies is underway and soon will be commercially available.

Table 3: Operating Frequencies

Model	Frequency Range	Operating Band	Chassis
2.3 GHz	2.305 GHz to 2.359 GHz	WCS	Split
2.4 GHz	2.40 GHz - 2.473 GHz	ISM	Combo
2.5 GHz	2.50 GHz - 2.595 GHz	MMDS/ITFS	Split
2.6 GHz	2.602 GHz – 2.637 GHz	MMDS/ITFS	Split

The Ripwave Base Station can be in a combo chassis or split chassis system. The split chassis is for MMDS bands only; it is not available for 2.4 GHz systems. The specifications for the combo and split chassis are shown in Tables 4 and 5.

Table 4: Combo Chassis System (ISM Systems)

Antenna Downtilt:	2 & 4 degree options for Omni-directional; Mechanical for 120 degree Sectored
Antenna Gain:	12dBi Omni-directional, 17 dBi for 120-degree Sectored
Antenna Options:	Omni-directional or 120-degree Sectored
Backhaul Interfaces:	10/100 BaseT Ethernet or ATM over T1; up to (8) T1's with or without IMA, long haul support
Bandwidth Allocation:	Dynamic
Baseband Modulation:	Uplink QAM4
Beamforming Gain:	18dB
Configurations:	Omni-directional or Sectored; Indoor or Outdoor
DC Power Consumption:	21VDC to 28VDC @ 40 amps; 1000 watts
Duplex Format:	Time Division Duplexing (TDD)
Mechanical Dimensions:	30''x19''x14'' for indoor BTS (single cell/sector), 60"x15"diameter for omni RFS antenna, 46"x23" sectored RFS antenna
Multiple Access Schemes:	Multi-carrier Beamforming Synchronized (MCBS) CDMA
Operational Frequency Band:	See Table 3
Operational Temperature:	0 to +50 degrees C (indoor); -40 to +50 degrees C (outdoor)
Polarization:	Vertical
Power Control:	Forward & reverse, open & closed loop
Regulatory:	UL 1950, FCC part 15
Reliability/Availability:	Load-sharing
RF Channel Bandwidth:	6MHz
RF Output Power (per channel):	5 watts max
Sensitivity:	-114 dBm/single channel (NF of 5dB)
Serviceability:	Field replaceable cards, EMS remote reset
Spreading Spectrum Scheme:	Direct Sequence Spreading (DSS)
Storage Temperature:	-40 to +70 degrees C
System Features:	Reed Soloman forward error correction (FEC), congestion control, automatic

	repeat request (ARQ), extensive GoS/QoS mechanisms
System Throughput:	12 Mbps (fully loaded max raw data rate downstream + upstream)
Up/down Link Duplex:	Symmetrical TDD
Upgradeability:	Software downloads
Weight:	100 lbs (indoor BTS), 64 lbs (RFS antenna)

Table 5: Split Chassis System (MMDS & WCS Systems)

Antenna Downtilt:	2 & 4 degree options for Omni-directional; Mechanical for 120 degree Sectored
Antenna Gain:	12dBi Omni-directional, 17 dBi for 120-degree Sectored
Antenna Options:	Omni-directional or 120-degree Sectored
Backhaul Interfaces:	10/100 BaseT Ethernet or ATM over T1; up to (8) T1's with or without IMA, long haul support
Bandwidth Allocation:	Dynamic
Baseband Modulation:	Uplink QAM4
Beamforming Gain:	18dB
Configurations:	RFS Omni-directional or Sectored. 1 BTS per antenna.
DC Power Consumption:	21VDC to 28VDC; 1353 Watts typical, 1500 Watts maximum
DC Power Interface:	2 - ¼" lugs for +24V DC and 24V return.
Duplex Format:	Time Division Duplexing (TDD)
Humidity:	0 to 95% non-condensing
Mechanical Dimensions:	**Digital**: H19.2" X W19.0" X D12.9" (add ~1.3" to D with modules installed). **RF**: H14.0" X W19.0" XD15.2" (add ~1.5" to D with modules installed).
Multiple Access Schemes:	Multi-carrier Beamforming Synchronized (MCBS) CDMA
Operational Frequency Band:	See Table 3
Operational Temperature:	0 to +50 degrees C (indoor); -40 to +50 degrees C (outdoor)
Polarization:	Vertical
Power Control:	Forward & reverse, open & closed loop
Regulatory:	UL 1950, FCC part 15
Reliability/Availability:	Load-sharing
RF Channel Bandwidth:	6MHz
RF Output Power (per channel):	5 watts max
Sensitivity:	-114 dBm/single channel (NF of 5dB)
Serviceability:	Field replaceable cards, EMS remote reset; Front and rear access required
Spreading Spectrum Scheme:	Direct Sequence Spreading (DSS)
Storage Temperature:	-40 to +70 degrees C
System Features:	Reed Soloman forward error correction (FEC), congestion control, automatic repeat request (ARQ), extensive GoS/QoS mechanisms
System Throughput:	12 Mbps (fully loaded max raw data rate downstream + upstream)
Up/down Link Duplex:	Symmetrical or Asymmetrical TDD with a maximum of 3:1 ratio for down/up allocations
Upgradeability:	Software downloads
Weight:	Digital Shelf 35 lbs + RF Shelf 82 lbs.

Materials Specifications

The Base Station installation requires general materials and parts for installation. In Table 6 is a partial list of the items that may be used for a typical installation of the Ripwave Base Station. A more complete list is provided in Appendix O. The quantity and use of materials will vary depending on the specific installation. The lists in Table 6 and in Appendix O are based on a 150-foot site.

Table 6: Materials Specifications

Base Station General Materials Requirements List			
BTS Install Kit 96-05000-00	Description	Supplier	Rqd Qty
GROUNDING			
Lightning Rod	Lightning Rod - 8'	MTS	
Ground Rod	Tinned copper ground rod, 5/8" x 8'	MTS	
Ground Wire	# 2 Stranded green ground wire	MTS	50 Ft
Ground Wire	# 6 AWG Stranded Green Wire	LOCKE	50 Ft
Ground Buss Bar (Tower)	Ground buss bar kit, 1/4" x 2-1/2" x 12-1/2"	MTS	1 Kit
Ground Buss Bar (Shelter)	Copper Gnd buss bar, 1/4" x 4", drilled to 5/8"	ALT	1 Kit
Ground Lug	#6, One Hole	T&B	3 Pcs
Ground Lug	#6, Two Hole	T&B	6 Pcs
Ground Lug	#2, Two Hole	T&B	2 Pcs
Grounding Kit (1/2"), LMR600	STD Ground kit, LMR-600, 5' x 3/8" 2 hole lug	MTS	27 Kits
Grounding Kit (3/8"), LMR400	STD Ground kit, LMR-400, 5' x 3/8" 2 hole lug	MTS	2 Kits
Grounding Kit (1/2"), RF-1/2"	Ground Kit, RF-1/2", 2 hole lug	NK Cables	
Universal Grounding kits	Universal grounding kit, 3' with 3/8" 2 hole lug	MTS	
ANTENNA SYSTEM			
RFS Antenna	Omni Antenna	Navini	
RFS Surge Protector	RFS surge protector	POLYPHASER	9 Pcs
RFS Antenna Mount	Omni Antenna Mount	MTS	1 Kit
Weatherproofing kits	Universal weatherproofing kit, Large	MTS	2 Kits
RFS Antenna Power Cable	RFFE Power/Data Main Cable assembly	Probity	1 Kit
RFS Antenna Jumper Cable	RFFE Power/Data Jumper cable, 10 Feet.	Probity	1 Kit
Mounting Clamps	Crossover Clamp, 1.5" x 3.5" OD	MTS	1 Kit
Mounting Clamps	Pipe to pipe clamps, kit of 2	MTS	1 Kit
MAIN FEEDER			
RFS Cable	LMR 600, 1/2" coaxial cable	HUTTON/TIMES	1350 Ft
RFS Type N Male Connectors	EZ600 N type, Male connectors	HUTTON/TIMES	36 Pcs
Hoisting Grips	Pre-laced Hoisting Grip, 1/2"	MTS	10 Pcs
Cushion Hangers 1/2"	Cushion hanger assembly, 5H, 1/2", kit of 5	MTS	12 kits
Cushion Hangers 3/8"	Cushion hanger assembly, 6H, 3/8" for LMR400	MTS	
Angle Adapter	Adapter, Galvanized, Angle kit of 10	MTS	
Cross Cushion Hanger Mounts	Cross cushion hanger mount, kit of 5	MTS	6 Kits
Universal Hanger 1/2"	Hanger, Universal, Snap-In, 1/2", kit of 10	NK Cables	
Support Blocks	Mini Coax Support Blocks, kit of 10	MTS	2 Kits
RFS Connector	MALE, N TYPE, 3/8 INCH	NK Cables	
RFS Connector	MALE, N TYPE, 5/8 INCH	NK Cables	
RFS Connector	MALE, N TYPE, 1/2 INCH	NK Cables	
RFS Connector	MALE, N TYPE, 7/8 INCH	NK Cables	

RFS Connector	FEMALE, N TYPE, 5/8 INCH	NK Cables	
RFS Connector	FEMALE, N TYPE, 7/8 INCH	NK Cables	
RFS Connector	N STRAIGHT PLUG, EZ PIN, FEMALE (LMR400)	HUTTON/TIMES	
RFS Connector	N RIGHT ANGLE, EZ PIN, MALE (LMR400)	HUTTON/TIMES	
RFS Connector	N RIGHT ANGLE, SOLDER PIN, MALE (LMR400)	HUTTON/TIMES	
RFS Connector	N STRAIGHT, SOLDER PIN,MALE (LMR400)	HUTTON/TIMES	
Weatherproofing	Sealing Compound, Coax Cable Connector	NK Cables	
RFS Cable	CABLE, COAX, RF, CORRUGATED, 3/8 INCH	NK Cables	
RFS Cable	CABLE, COAX, RF, CORRUGATED, 5/8 INCH	NK Cables	
RFS Cable	CABLE, COAX, RF, CORRUGATED, 1/2 INCH	NK Cables	
RFS Cable	CABLE, COAX, RF, CORRUGATED, 7/8 INCH	NK Cables	
GPS SYSTEM			
GPS Antenna	GPS Antenna, N-type Female	Motorola	2 Pcs
GPS Surge Protector	GPS surge protector, Redundant	POLYPHASER	2 Pcs
GPS Surge Protector	GPS surge protector, Non-redundant	POLYPHASER	1 Pc
GPS Cable	LMR400, 3/8" coaxial cable	HUTTON/TIMES	200 Ft
GPS Type N Male Connectors	EZ400 N type, Male connectors	HUTTON/TIMES	8 Pcs
ENTRY PORT SYSTEM			
Goose Neck - J type Hood entry		TBD	
Feed Thru Entry Panel		TBD	
Boot Assembly Kits	Boot Assembly Kit, 4" w/ 4 holes (LMR 600)	MTS	4 Kits
BTS SYSTEM			
Ripwave 2400 BTS		Navini	
BTS Surge Protector	BTS surge protector	POLYPHASER	9 Pcs
24 VDC Power Supply		Argus	1 Unit
DC Power Wire	# 6 AWG, Stranded, RED Wire		
DC Power Wire	# 6 AWG, Stranded, BLACK Wire		
BREAKER	24 VDC, 60A Distribution Breaker	Argus	
ROUTER	CISCO 2600 Dual 10/100 ENET, WIC/NM Slots	CISCO	
SERIAL WAN	Serial Interface WAN Card, One Port	CISCO	
T1-IMA MODULE	Multiport T1/E1 Network Module with IMA	CISCO	
Air conditioning		TBD	
110 VAC Power Outlets		TBD	
Telco / Ethernet Connectors RJ45		TBD	
MISCELLANEOUS			
Expanding Foam Sealer		TBD	
Bolts (Ground)	Bolt, Hex, 1/4-20 x 1.000 LG, SSPA	QUESTRON	
Nuts (Ground)	Nut, Reg, Hex, Cres, 1/4-20UNC	QUESTRON	
Flat Washer (Ground)	Wash, Flat, Cres, #6 T-B-Reg .156x.438x.040	QUESTRON	
Lock Washer (Ground)	Wash, Lock. Split, Cres 1/4, Reg .252x.487x.062	QUESTRON	
Star Washer (Ground)	Wash, Star, 1/4	QUESTRON	
Star Washer (BTS Chassis Ground)	Wash, Star, #10	QUESTRON	
Nut (BTS, Power/Data Surge P)	Nut, Hex, #10-24	QUESTRON	
Equipment Open Rack	Rack, 19" x 72" with 1/4" x 1" holes	CHATSWORTH	
Tie wraps		TBD	
Split Bolt #2/0		TBD	
Uni-Struts		TBD	
Anchor/Expansion Bolts		TBD	
Cable Ladder		TBD	

Chapter 2: Installation

Pre-installation

As was shown in Figure 2, prior to installation a number of planning activities take place. The installation itself takes only about 2 days. The I&C crew usually is not involved with all the pre-installation activities. Of these, they are likely to be most involved in the Site Candidate Evaluation.

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 as well as Marketing objectives with the service itself. 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 is used to ensure all aspects of the site have been considered. Information 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 B. 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

The RF Engineer(s) also analyzes existing interference from other sources, and takes that into account when creating the coverage prediction map. 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 will help Navini and the customer decide which type of system (frequency) and antenna (panel or omni) will provide the best results.

Network Architecture Plan

The IP Networking community involved in the project, both from Navini and the customer, 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.

Bill of Materials

Someone 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 O.

Backhaul Connections

The Backhaul connections for the Ripwave Base Station consist of up to two (2) Ethernet cable connections with RJ-45 connectors for each BTS installed, OR, up to eight (8) T1 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.

Power Requirements for the Base Station

The input power source will be determined during the site survey. The DC power source needs to be an independent hard-wired circuit of 21VDC to 28VDC with a 50-amp breaker for the Combo Chassis and a 70-amp breaker for the Split Chassis. The power plant return bus must be connected to an earth ground connection similar to the Base Station chassis. Insulated #6 AWG cable is recommended. The combo chassis system generates up to 1000 Watts, and the split chassis system generates up to 1500 Watts maximum; however, 1353 Watts is typical.

Ground Requirements for the Base Station

The Base Station requires an earth ground connection. This ground should exhibit a maximum of five ohms across true ground.

NOTE: The installation procedures, which begin next, follow the same order as shown in the I&C Flowchart in Figure 2.

An example of a Base Station drawing for a particular site is provided in Appendix P.
An example of a written Statement of Work (SOW) and Responsibility Assignment Matrix (RAM) for installation and commissioning are provided in Appendices Q and R. This type of document may be used in negotiating work between companies and contractor services.

Install Power & Grounding

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 7) 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.

Figure 7: Data/Power Cable Surge Protector

To install the eight (8) antenna and one (1) cal cable surge protectors (Figure 8), and the one (1) or two (2) Global Positioning System (GPS) surge protectors (Figure 9) 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 10.

Figure 8: Antenna & Cal Cable Surge Protector

Figure 9: GPS Cable Surge Protector

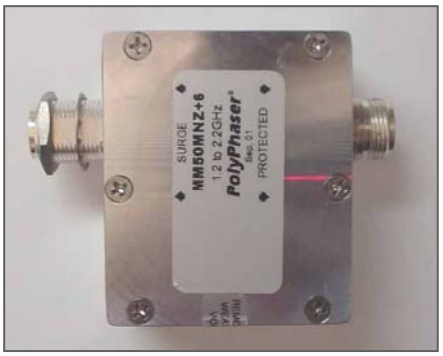


Figure 10: Surge Protectors in Buss Bar

Antenna Ground Buss Bar

You should install the Antenna Ground Buss Bar on the mounting structure per accepted telecom standards and procedures (Figure 11). 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 11: Buss Bars

BTS Buss Bar

Antenna Buss Bar

System Ground Wiring

A minimum #6 stranded copper, green-coated 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. Tighten all connections until secure.

Install Cables

All cable connections are made using standard RF coaxial cable. The Navini Networks standard 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. Using Tables 7 and 8, determine the size and type of cable to be used in the installation of the Base Station.

Table 7: Active & Passive RFS Loss / Operating Parameters

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

* Channel filter for 2.5/2.6 or Block Filter for 2.3 has 1.0 +/- 0.2 dB Insertion Loss
* Channel filter for 2.6 EF Combo is 1.8 +/- 0.2 dB including cable to backplane.

Table 8: 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 ″ Super flex 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**	5.91	**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**

Cable Preparation

The cable run is determined during the site survey. Note that **t**he 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 length of the LMR 400 cable for the GPS antenna is 100 feet.

- 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 BTS's 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 12). 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 13 depicts the placement of the shared GPS resources among three BTS's.

Figure 12: GPS Distribution Amplifier

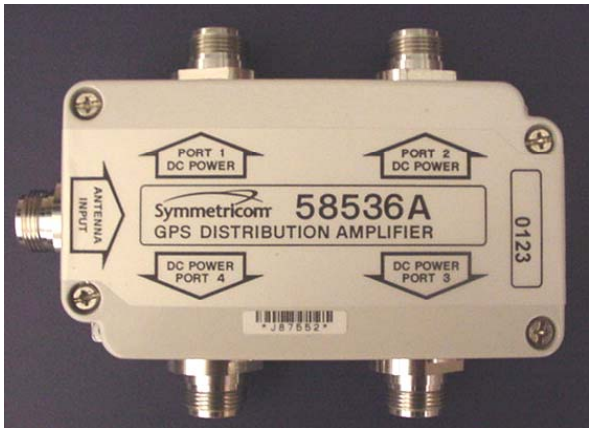
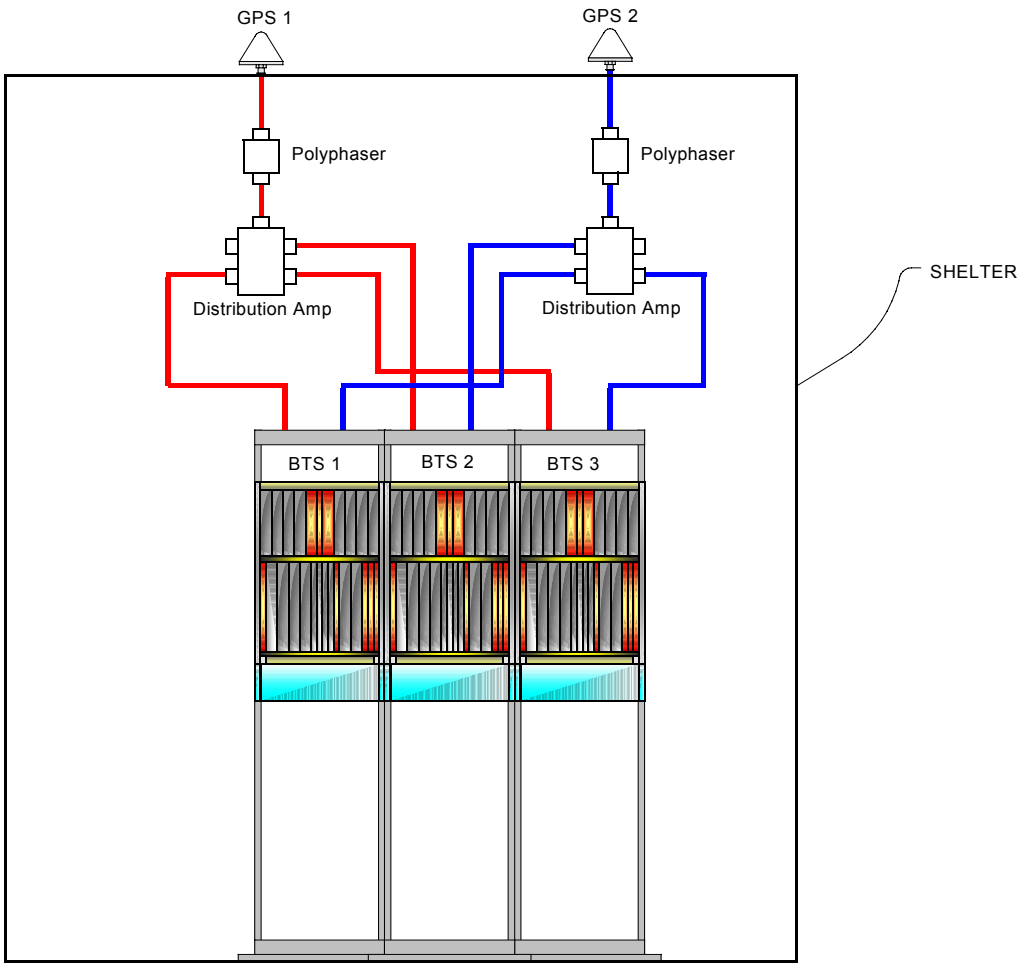


Figure 13: Depiction of GPS Distribution Amplifier



Install Connectors on Cables

Install connectors on both ends of each cable. For LMR 600 cables, install EZ-600 N-type male connectors. For LMR 400 cables, install EZ-400 N-type male connectors. Steps for installing both types of connectors can be found in Appendix K. For reference, Appendix L also provides a list of vendors who can make cables.

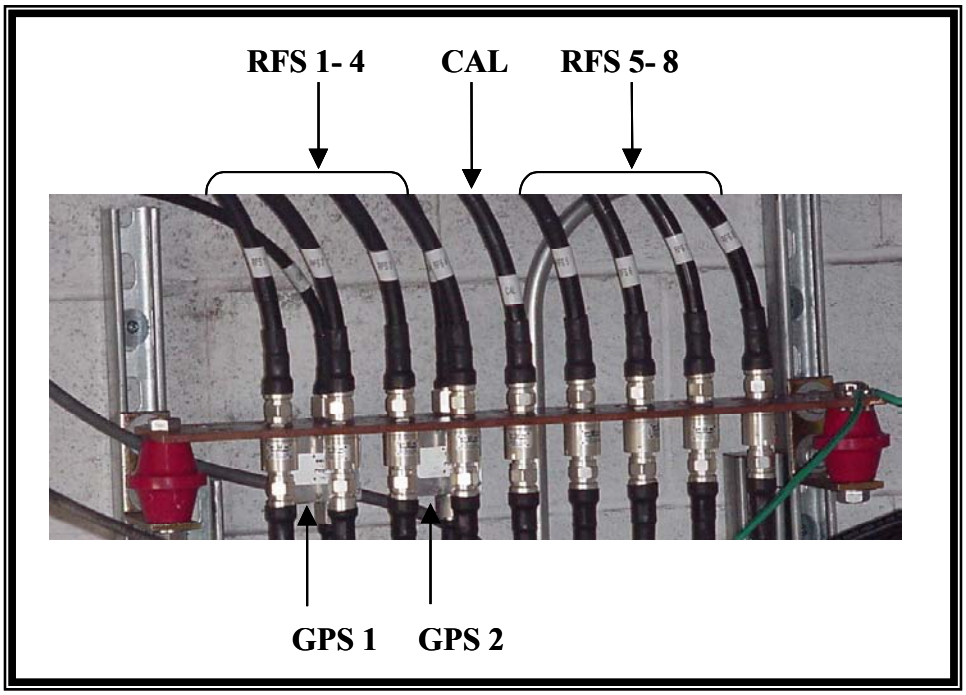
Sweep Individual Cables

Sweep each individual cable, the RFS (8) and CAL main feeder and jumper cables, to check for line loss. Follow the instructions for sweeping the cables provided in Appendix C, entering the results in the RFS System Test Form. Check continuity of the data/power cable. When finished, cover the cable connectors for protection until they are connected to the RFS or GPS.

Connectorize & Run Cables

Connect all of the RF cables to the surge protectors in the system ground buss bar. An example of a buss bar connection is shown in Figure 14. Ensure that the proper cable is connected to the proper surge protector. Connect the power/data cable to its surge protector. Also connect all the jumper cables to the surge protectors that will attach to the BTS. Do not connect these cables to the BTS at this time. Torque all the cable connectors to the surge protectors on the system ground buss bar to 20-24 inch-pounds.

Figure 14: Buss Bar Connections



Route all of the cables – RFS (8), CAL, DATA/POWER and GPS (1 or 2) - between the system ground buss bar and the RFS, and GPS mounting sites. If running the cables up a tower, use a hoisting grip to lift the cables (Figures 15 and 16).

Figure 15 : Omni Cable Routing

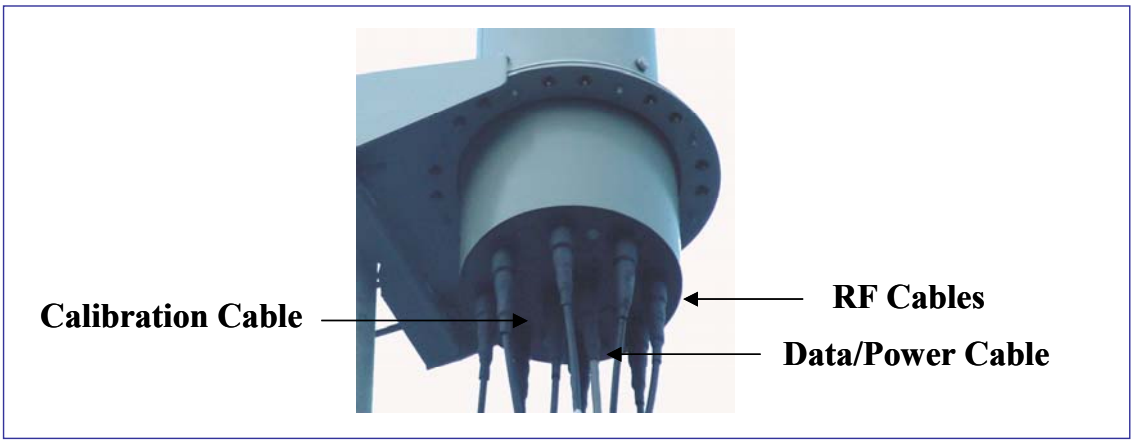


Figure 16: Panel Cable Routing

Install the BTS

Install Mounting Rack or Enclosure

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

Figure 17: BTS Mounting Rack