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OptiMesh™ Base Station Installation and User Guide

Revision M-B1

Publication History

Date	Revision	Description
November 2000	M-A1	Initial Release
January 2001	M-B0	Additions and Modifications to Procedures and Diagrams, Additions to Troubleshooting and Tips
February 2001	M-B1	Modification of Procedure 6-3 (additional steps and screen captures)

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About this Guide

GPS Base Station Overview

This document describes the installation and setup of the OptiMesh™ Global Positioning System (GPS) base station, used to obtain GPS reference data during the site commissioning process. It is written for site engineering and construction staff or individuals who will be performing the site installation and commissioning function.

The GPS base station plays a key role in site commissioning the OptiMesh nodes, the process by which the Element Management System (EMS) software establishes a connection (acquires a link between nodes) and brings the node online.

The base station is fixed equipment that remains installed throughout the life of the OptiMesh network, but is only required when commissioning a new node into an OptiMesh network. It is not required during normal operation of either an individual node or the OptiMesh network.

The GPS base station must be installed and reference data obtained before any other site commissioning procedures can take place. For additional information about the site commissioning process, refer to the *OptiMesh Site Commissioning Guide.*

The following diagram depicts the GPS base station in relation to the Link Acquisition System (LAS):

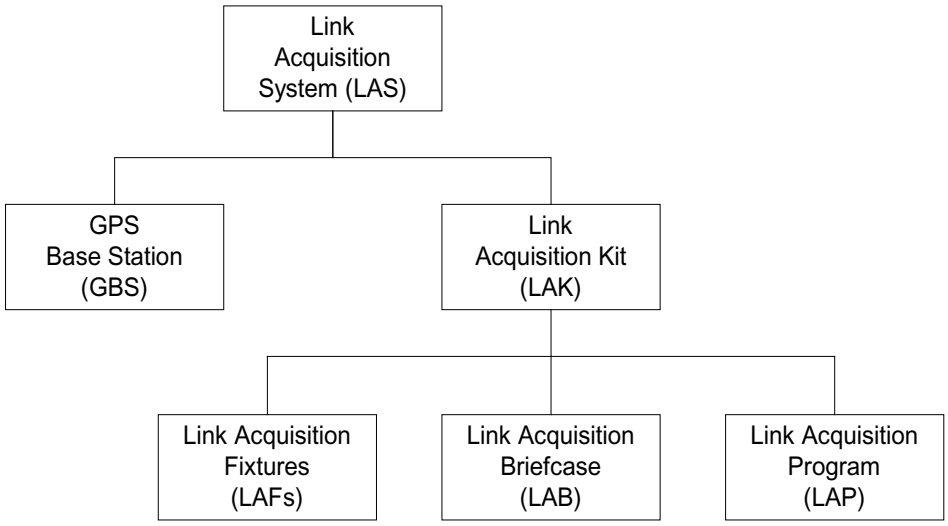

Figure i-1
The Link Acquisition System

Safety Considerations

The following safety precautions apply to the use of the GPS base station.

DANGER
If the configuration you are using to install the GPS base station consists of coaxial cable connecting to the GPS receiver located inside of the building, in-line lightning surge protection (provided in the base station installation kit) must be installed.

Ensure that the surge suppressor is connected to the building ground.

Document Conventions

The following conventions are used throughout this manual.

Notes

Notes are accompanied by an icon that indicates the type of note.

Informational Note

INFORMATION
The icon shown to the left denotes an informational note relating to the topic being discussed in that section of the document

Cautionary Note

CAUTION
The icon shown to the left denotes a cautionary note. A cautionary note provides information that is essential to preventing damage to the OptiMesh equipment or other equipment described in the note.

Warning Note

DANGER
The icon shown to the left denotes a warning note. A warning note provides information that is essential to preventing harm to individuals who are installing or operating the product.

Tip

TIP
The icon shown to the left identifies a tip or technique that is helpful to the topic being discussed.

Text Conventions

User Action

In instructions, when you are required to select an option, the option appears with the first letter of the word capitalized. For example:
From the computer's desktop, click on the Start button.
Information you are required to enter appears in a different font: courier new 10, bold. For example:
Type: **C:\Ashtech**
Information that the system displays appears in courier new 10. For example:
The system returns the message: `Disconnect the tiltmeter`.

Customer Support

Contact AirFiber's Customer Support department at 858.676.7001 or toll-free at 877.576.7001, or send email to support@airfiber.com. You can also contact Customer Support through the AirFiber website: www.airfiber.com.

1 GPS Base Station Overview

General Description

The GPS base station plays a key role in the site commissioning of the OptiMesh nodes. Site commissioning is the process by which the Element Management System (EMS) software establishes a connection (acquires a link between nodes) and brings the node online. The GPS base station provides reference GPS data during the site commissioning process, ensuring centimeter alignment of the wireless optical links (WOLs) between nodes. Figure 1-1 provides an overview of the site commissioning process.

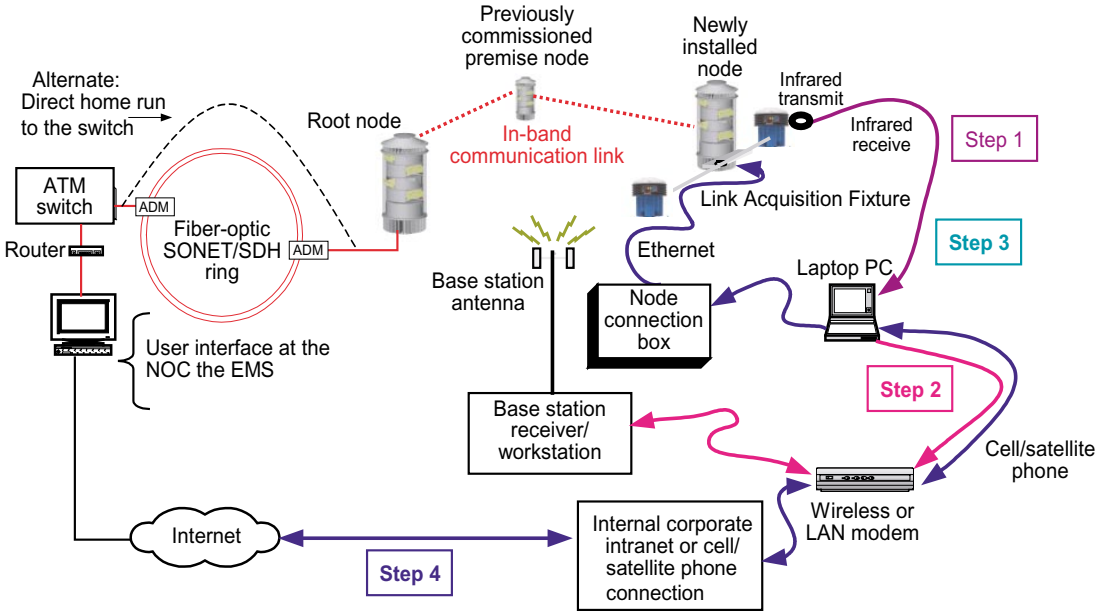

Figure 1-1
The Site Commissioning Process

Table 1-1
Site Commissioning Process Detail Steps

Sequence	Description
Step 1	Under LAP control and using the LAF, measure the node position (x.y.z, tip, tilt, orientation). Store this information on the laptop PC.
Step 2	Collect reference position data from the base station and download to the laptop PC.
Step 3	Laptop PC computes the precise node position (centimeter accuracy) from data obtained in steps 1 and 2 above.
Step 4	Laptop PC transfers the precise node location to the EMS. The EMS then: computes the turret pointing vectors, downloads the pointing vectors to the laptop PC, and requests that the newly installed node align its turrets to those of its partner nodes.

The GPS base station is used only for site commissioning; it is not required for ongoing operation of the OptiMesh network. However, because the GPS base station provides reference position data for the nodes in the OptiMesh network, it is installed permanently for future commissioning of OptiMesh nodes, or to recommission a node if necessary.

If the OptiMesh network is configured so that no one base station can be located within 12.4 mi (20 km) of each node in the network, additional GPS base stations are required to provide reference data for the site commissioning process. These additional base stations will use positioning data from the original base station to determine a reference position. This methodology ensures that all position measurements in the entire OptiMesh network are in reference to one position—the first base station installed. Specific instructions on how to collect this data are provided in Chapter 6, Obtaining GPS Base Station Reference Data.

The GPS base station consists of the following components:

- A rooftop-mounted antenna that can be located up to 12.4 miles (20 km) from the farthest node in the AirFiber OptiMesh network
- A GPS receiver that processes signals from the GPS satellite constellation to provide real-time position, velocity, and time measurements used to generate reference position of the GPS base station
- A Windows NT Workstation running the following software packages:

  Geodetic Base Station Software (GBSS)

  Locus GPS and GPS Base Station Software (LGPS–GBSS)

Various Utility Programs: (Cygnus BASH, PKZIP, Tornado FTP daemon, TweakUI)

Ashtech Locus Survey Project Manager Software

- A coaxial cable connecting the antenna to the GPS receiver, and associated surge protection equipment.
- An optional customer supplied fiber-optic cable to connect the GPS receiver to the NT workstation, used when the distance between the antenna and the GPS receiver is greater than 500 ft (152.4 m), or when the receiver is located outside on the rooftop.
- Optional serial fiber converter modem(s) used when a fiber-optic cable is used to connect the GPS receiver to the NT workstation.
- An optional environmentally hardened receiver enclosure containing the GPS receiver and a serial fiber converter modem in the case of an outdoor configuration.
- A DB25 to DB9 cable for connecting the GPS receiver to the serial port of the Windows NT workstation.

The antenna, standing atop one or two four-foot pipes (maximum height of the pipes is 8 ft [2.4 m]), is mounted on the roof of the building so that the antenna has an unobstructed view of the sky for satellite tracking. A wall mount or non-penetrating tripod can be used to anchor the antenna to the building rooftop.

Next, the antenna is connected to the GPS receiver, which in turn is connected to a Windows NT workstation running the GPS base station software programs designed to collect and process reference data. Attachment to the NT workstation is accomplished with a standard RS-232 serial port, and to a standard power outlet for power with a power transformer.

There are three main configuration choices for connecting the components of the GPS base station assembly.

INFORMATION

The key factors that determine which choice is appropriate for your installation are the distance from the antenna to the GPS receiver, the distance from the antenna to the NT workstation and the physical characteristics of the site.

If the building layout prohibits the location of the GPS receiver within 500 ft (152.4 m) of the antenna, then an outdoor configuration should be used. Please see Table 1-2, and Configuration Options in Chapter 2 for additional information about the configurations.

Table 1-2
Configuration Options

Distance Characteristics	Configuration
Distance from antenna to NT workstation less than 500 ft (152.4 m)	Indoor, coaxial cable option
Distance from the antenna to GPS receiver less than 500 ft (152.4 m), and distance from GPS receiver to NT workstation greater than supported by the RS-232 serial cable	Indoor, coaxial cable and fiber option
Distance from the antenna to the GPS receiver greater than 500 ft (152.4 m) if GPS receiver were to be housed inside the building	Outdoor, coaxial cable and fiber option, use of environmentally hardened box to house GPS receiver outside.

Hardware Components

Rooftop Antenna

The antenna is mounted on the rooftop and can be located up to 12.43 miles (20 km) from the farthest node in the OptiMesh network. The antenna must have a clear view of the sky without any obstructions, and should be located away from potential EMI interference.
There are two different types of mounts available for the antenna:

- Parapet: Antenna is mounted on one or two 4 ft poles, and attached to the wall with mounting brackets. Figure 1-2 provides an example of the GPS base station using a parapet mount.

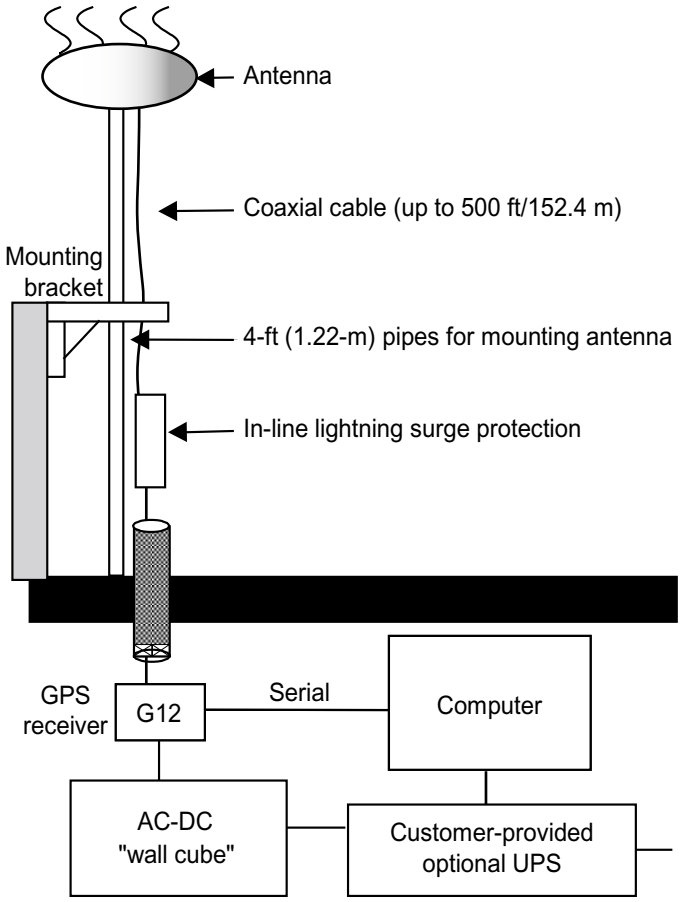

Figure 1-2
GPS Base Station using a Parapet Mount

- Non-penetrating Tripod: A 4 ft (1.2 m), 6 ft (1.8 m), or 8 ft (2.4 m) pole is inserted in the tripod base. The antenna is mounted on a pole, and attached to the tripod pole by means of two clamps. The tripod is anchored to the roof by means of concrete cinderblocks. As an alternative, you may choose to anchor the tripod in a permanent manner (for example, using bolts) according to your building conditions and requirements. Figure 1-3 provides an example of the GPS base station with a non-penetrating tripod mount.

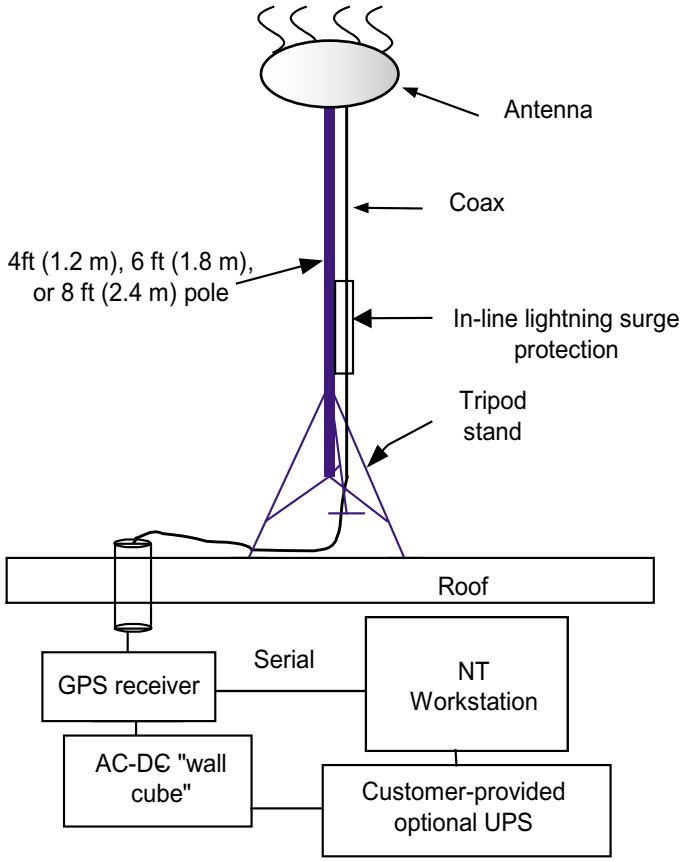

Figure 1-3
GPS Base Station with Tripod Mount

GPS Receiver

The GPS receiver processes signals from the GPS satellite constellation to provide real-time position, velocity, and time measurements. It uses 12 dedicated separate and parallel channels for Coarse/Acquisition (C/A) code-phase (pseudo-range) and carrier-phase measurement on the L1 (1575.4 MHz) band. The GPS receiver receives satellite signals via an L-band antenna and low-noise amplifier (LNA).

Operation

Within 6 seconds after the first satellite (Space Vehicle or SV) lock, the GPS receiver time is set. If no ephemeris data are in memory, or if the data are older than 10 hours, 30 to 60 seconds are needed to collect data. After three or four SVs are locked and the almanac/ephemeris data is collected, the GPS receiver computes its first position. At the next power up,

if the data has been backed up and is less than 10 hours old, the GPS receiver uses it to search only visible SVs. Under these conditions, the GPS receiver recomputes position in 10 to 12 seconds.
The GPS can track all Block I and Block II GPS satellites. All thirty-two PseudoRandom Noise (PRN) numbers (as specified in Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS-200, Revision B) are coded inside the receiver/processor card. The GPS constellation comprises twenty-four SVs. As it acquires each SV, the GPS receiver notes the time and collects the ephemeris data about the orbit of that SV, and almanac data about the orbits of all the SVs in the constellation. To compute three-dimensional position and velocity, the GPS receiver needs to lock on to at least four SVs. Up to 20 independent measurements are determined per cycle, with no interpolation or extrapolation from previous solutions.

Light-Emitting Diodes

The GPS receiver has a two-color light-emitting diode (LED); red indicates the power status, and green indicates the number of SVs locked. As an example, four green flashes indicate four satellites are locked.
On power-up, the status LED lights red and then continues to flash red indicating that the unit is on and there is no position computed. When the GPS automatic search results in an SV acquisition, the status LED flashes green between the red power status flashes. Every SV lock-on produces a green flash, where a short green flash indicates the satellite is locked but not being used; a medium-duration green flash means the SV is locked but ephemeris for that satellite has not yet been collected; and a long green flash indicates that ephemeris for that satellite is available. Once the unit is locked to enough satellites to compute a position, the red flash is longer, indicating it is computing a position. Table 1-2 provides a quick reference to LED status operations.

Table 1-3
GPS Receiver LED Quick Reference

LED Function Color (green/red alternate in the LED)	Satellite Tracking and Power Status
Red/Short Flash	Unit on, no position computed yet.
Green/Short Flash	Satellite locked but not being used.
Green/Medium Flash	Satellite locked, and data is being collected.
Green/Long Flash	Satellite locked, enough positioning data has been collected
Red/Long Flash	Receiver has tracked and collected enough data from the satellites, and is computing a position.

Power Requirements

The GPS receiver requires a direct current input voltage of 5 V dc (regulated ± 5%) and consumes approximately 1.4 W of power.
The GPS receiver is capable of 110 V/60 Hz or 220 V/50 Hz operation. A power adapter is supplied in the GPS base station kit.

Serial Fiber-optic Converter Modem

The serial fiber-optic converter modem is designed to draw power from the power jack only and consumes very low power. The input direct current voltage is from 9 V to 14 V and current is @300 mA. The connector is a terminal block type with polarity indicated on the top cover of the unit. If the external power adapter need to be replaced, use one with the following specifications: 12 V dc @800 mA.
The modem is capable of 110 V/60 Hz or 220V /50 Hz operation.

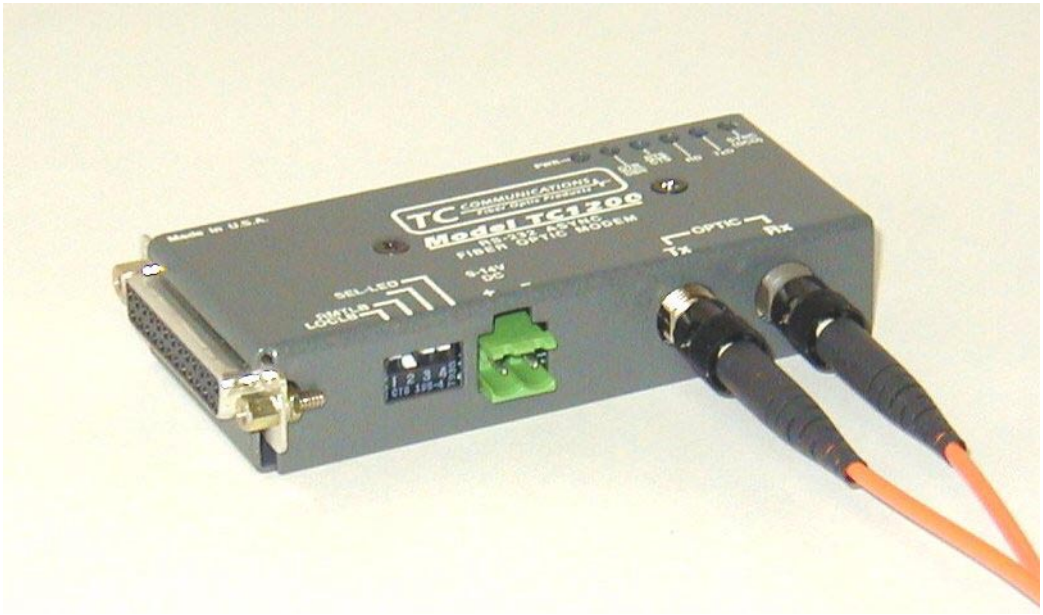

Figure 1-4
Serial Fiber-optic Converter Modem

Environmentally-Hardened Receiver Enclosure

The environmentally-hardened receiver enclosure is used to house the GPS receiver in the event the receiver needs to be located outside on the rooftop (outdoor configuration).
The enclosure contains the:

- GPS receiver
- Serial fiber-optic converter modem
- Alternating current/direct current power supply
- AirFiber direct current/direct current board
- Heater
- Heater controller

Figure 1-5
Environmentally-hardened Receiver Enclosure

The enclosure is capable of accepting 93 to 132 V ac and 187 to 264 V ac. The power supply automatically adjusts according to the input voltage range. The power supply operates over a 47 to 63 Hz power input frequency range, and a –40°C to +70°C temperature range.
The enclosure will draw approximately 50 W with the heater operating (during low temperature situations) and 5 W without the heater.

Table 1-4
Environmentally-hardened Receiver Enclosure Physical Characteristics

Characteristic	Comment	Measurement
Weight		27.6 lb (12.519 kg)
Size	Height x width x depth	20 x 15.6 x 8.4 in. (50.80 x 39.62 x 21.34 cm)
Power	Without heater With node heater and connector box heater	15 W 105 W
Primary Input Voltage	120 V ac nominal 240 V ac nominal	104 V ac to 127 V ac, 60 +/-3 Hz 208 V ac to 254 V ac, 50 +/- 3 Hz

Optional Battery Box

The battery box can be used as an alternative or backup power source for the environmentally-hardened outdoor receiver enclosure used in the outdoor configuration.

Table 1-5
Battery Box Physical Characteristics

Characteristic	Comment	Measurement
Weight	Without batteries With batteries	33.2 lb (15.060 kg) 85.6 lb (38.83 kg)
Size	Height x width x depth	24 x 15.6 x 13 in. (60.96 x 39.62 x 33.02 cm)
Power	Without heater With heater	1 W 45 W

Table 1-6
Battery Physical Characteristics

Characteristic	Comment	Measurement
Length		7.13 in. (18.11 cm) maximum
Width		3 in. (7.62 cm) maximum
Height		6.59 in. (16.74 cm) maximum
Approximate Weight		13.10 lbs (5.94 kg)
Terminals	Faston Quick Disconnect Tabs	0.250 x 0.032 in. (0.635 x 0.0813 cm)
Case	ABS Plastic	

Table 1-7
Battery Electrical Characteristics

Characteristic	Comment	Measurement
Battery type	Sealed Lead Acid Rechargeable	
Nominal voltage (per battery)	12 V (six cells in series)	
*Nominal capacity (per battery)	20 hour rate	18 ampere-hours
Operating temperature range		-40°C to +60°C

Table 1-7
Battery Electrical Characteristics

Charging temperature range		-20°C to +40°C
Charge voltage provided	Four batteries in float mode	54.0 V dc to 55.0 V dc (54.4 V dc nominal)
Charge current provided		750 mA maximum

*Capacity can vary based on customer requirements
Additional Notes:

Note 1: To minimize the effects of individual battery differences, which detrimentally affect recharging, all four batteries should be of the same age, storage history, and usage. All batteries must be replaced at the same time.

Note 2: Battery discharging is limited to 42 V across 4 batteries (10.5 V dc per battery).

Note 3: Recharging is disconnected above +37°C.

Windows NT Workstation

The Windows NT workstation is shipped as part of the GPS base station package. The specific configuration is designed for optimal performance and maintenance of the GPS base station. The workstation is shipped with the software installed on the system.
The NT workstation is a customized Dell workstation that includes the following components:

- Intel Celeron processor with Intel 810 chipset
  - 64 Mbyte SDRAM memory
  - Enhanced IDE 7 Gbyte hard drive
  - CD-ROM Drive and 3.5-in. floppy drive
- Dell E550 15 in. monitor
- Quietkey keyboard
- Two-button PS/2 Mouse
- Internal modem and cable for connectivity to the LAK laptop

Software Components

The Windows NT workstation that is shipped with the GPS base station is installed with all the software that is needed to establish the GPS base station reference data. Certain software parameters do need to be configured to enable the GPS base station to effectively communicate during

the link acquisition process, and to properly collect GPS base station positioning data.
In the event the software needs to be reinstalled, please refer to the installation notes in Chapter 8, Troubleshooting.

Geodetic Base Station Software (GBSS)

The GBSS software is a Windows NT and 2000 program specifically designed for continuous logging of high-quality GPS data. After a period of writing to a file, the file is closed and a new one is opened. This length of time is 1 hour by default, but can be made longer. In practice, there is approximately a 5 second delay between one file closing and the next one opening, which will invalidate measurements made across that delay.

As part of the software licensing requirements, the GBSS software requires a hardware key—a "dongle"—be attached to the NT workstation's parallel port in order to run. The dongle is provided with the NT workstation.

CAUTION
Safeguard the GBSS software dongle.
Replacing a lost hardware dongle/key requires the purchase of an additional software license; please ensure the hardware dongle/key is kept securely on the NT workstation at all times.

Locus Processor Software

The Locus Processor software is AirFiber software that performs the timing association between data collected at the remote node and the data collected at the base station.

Additional Utility Programs

Cygnus BASH, PKZIP, Tornado FTP daemon, TweakUI, perform various utilities in the site commissioning process.

Locus Survey Project Manager

The Locus Survey Project Manager software computes the base station's position data. This is used for determining the "seed" value or reference value of the base station position for the entire OptiMesh network. Instructions for obtaining reference data are provided in Chapter 6, Obtaining GPS Base Station Reference Data.

System Requirements

The GPS base station software is designed for use on a Windows NT 4.0 system. The NT workstation is shipped as part of the GPS base station package. In the event the workstation needs to be replaced, please contact AirFiber customer support for information about system requirements for the NT workstation.

GPS Base Station Parts Listing

All the components needed for the GPS base station assembly will be provided in the packaging sent to your site, with the exception of some standard tools listed in Chapter Two, Tools and Materials.

INFORMATION
The component list will vary, depending upon the configuration selected for your site.

For those sites using the Indoor Configuration, the necessary crimp tools and connectors will be provided.
The parts used for all GPS base station configurations are listed below. Verify shipped components against the items in this list identified for your configuration, and if replacement parts are required, use this list to identify needed components.

Note: Excess hardware may be included as spares.

Table 1-8
GPS Base Station Parts

AirFiber Part Number	Qty Used	Description
395-0031-001	1	GBS indoor receiver
072-0051-000	1	GBS antenna
072-0050-000	1	Coaxial cable—33 ft (10 m) with connectors (outdoor configuration)
072-0036-000	1	Coaxial cable—500 ft (152.4 m) with connectors (indoor configuration)
072-0016-000	1*	Modem, fiber-optic, RS232, async, high temp (serial fiber-optic converter modem) (indoor coaxial and fiber option, and outdoor configurations)

AirFiber Part Number	Qty Used	Description
300-0017-002	1	AirFiber outdoor receiver enclosure (environmentally hardened receiver enclosure) (outdoor configuration)
072-0035-000	1	Surge protector, coax in-line, GPS (indoor configurations)
072-0038-000	0-5**	Connector, N-type, Male
072-0039-000	1	Tool, crimp (0.429 hex)
072-0040-000	1	Tool, cable prep, LMR-400
700-0043-001	1	GBS User Manual (CD-ROM) or AirFiber Web site
300-0016-002	1	GBS battery assembly enclosure*** (outdoor configuration, optional)
022-0017-000	1	Batteries*** (outdoor configuration, optional)
072-0044-000	1	Computer, GPS base station
101-0089-001	1	RS-232 cable
395-0032-001	1	Parapet mount (wall, corner and penthouse)
395-0033-001	1	Tripod mount

Note: *Two serial fiber-optic converter modems will be provided for the indoor configuration, fiber-optic option. For the outdoor configuration, the 2nd fiber-optic converter modem is included in the outdoor receiver enclosure.

Note: **Five connectors will be shipped for both indoor configurations; four are used at each end of the cable attachment and one is a spare.

Note: ***Please note that the battery backup unit is optional, and is applicable only to the outdoor configuration.

Please see Configuration Options in Chapter Two for additional information about the indoor and outdoor configurations.

INFORMATION

For documentation and software updates, please visit www.airfiber.com.