

MAGELLAN
SYSTEMS CORPORATION

Magellan GPS NAV 1000 PRO™
User Guide

**READ USER GUIDE COMPLETELY TO
INSURE PROPER AND SAFE USE OF THE
MAGELLAN GPS NAV 1000 PRO™.**



**THIS SYMBOL IS USED FOR IMPORTANT
SAFETY INFORMATION. WHEN YOU SEE
THIS SAFETY SYMBOL, CAREFULLY
READ AND FOLLOW THE MESSAGE.**

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**MAGELLAN GPS NAV
1000 PRO™**

USER GUIDE

**Magellan Systems Corporation
260 East Huntington Drive
Monrovia, California 91016
(818) 358-2363
FAX (818) 359-4455**

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PREFACE

Two breakthroughs in technology make the **Magellan GPS NAV 1000 PRO™** the leading positioning and navigation product in the world.

First, the NAV 1000 PRO uses the standard positioning signal of the NavStar Global Positioning System (GPS) currently being put in place by the United States government. GPS will be the world's first truly global, 24-hour, continuous, precise, three-dimensional navigation system.

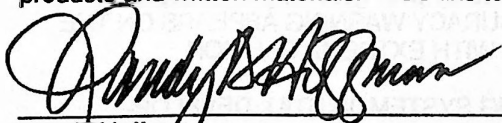
Second, the NAV 1000 PRO makes use of the latest developments in electronics. Using custom chips and technologies at the cutting edge, like gallium arsenide, have resulted in a revolutionary product in size, weight, flexibility and price.

Our goal is to bring the Global Positioning System (GPS) down to earth! The **Magellan GPS NAV 1000 PRO™** makes positioning with GPS easy to use, and affordable. The unit is designed in such a way to also make navigation functions completely accessible and easy to understand. To accomplish these goals...

WE'VE WRITTEN A TRAINING GUIDE: Spend one or two hours with the accompanying simple-to-follow booklet and you'll be a GPS expert.

WE'VE KEPT COMPLEX FEATURES SEPARATE FROM SIMPLE ONES: For the user with standard positioning and navigation needs, the NAV 1000 PRO remains as intuitive to use as our earlier products. A special chapter "Differential and the Dataport" is devoted to the technical user.

WE LISTEN: All comments are carefully considered for future products and written materials. We'd like to hear from you.



Randy Hoffman
President & Chief Executive Officer
Magellan Systems Corporation

WARNINGS ▲

A measure of knowledge by the user is required for proper and safe use of the **Magellan GPS NAV 1000 PRO™**. **READ THE USER GUIDE & WARRANTY COMPLETELY.** Heed this safety warning symbol.

Assess the Accuracy Required

The NAV 1000 PRO is generally capable of better than 15 meters (RMS) horizontal accuracy in autonomous operation and better than 5 meters (RMS) horizontal in differential operation -- with a little averaging. While this makes it a remarkable tool for some third order surveys and for marking and relocating geographical sites, the product is not intended as a replacement for instrumentation needed for first order surveys.

Use Good Judgment

This product is an excellent navigation aid, but it does not replace the need for careful orienteering and good judgment. Never rely solely on one device for navigating.

Use Care to Avoid Inaccuracies

The Global Positioning System (GPS) is operated by the U.S. government which is solely responsible for the accuracy and the maintenance of GPS. Certain conditions can make the system less accurate, such as changes in the orbit or health of a satellite.

Accuracy can also be affected by poor geometry with respect to the satellites. **WHEN THE ACCURACY WARNING APPEARS ON THE SCREEN, USE THIS DATA WITH EXTREME CAUTION.**

THE GLOBAL POSITIONING SYSTEM IS STILL DEVELOPMENTAL. The government can make changes to the system which could affect the performance of GPS receivers. Such a change could require a modification to your NAV 1000 PRO. Magellan

Systems can notify you of the opportunity to upgrade the unit to accommodate these changes and other software upgrade opportunities, *if you have filled out the registration card.*

Set the Correct Mode

AMONG THE MOST IMPORTANT THINGS YOU MUST KNOW IS WHETHER YOUR UNIT IS SET FOR TWO DIMENSIONAL (2D) OR THREE DIMENSIONAL (3D) MODE OF OPERATION. (REFER TO 2D VS. 3D IN SECTION 2.)

Using only three satellites for obtaining a position, 2D mode gives a grid or latitude and longitude position. HOWEVER, BEST ACCURACIES ARE OBTAINED WHEN THE CORRECT ALTITUDE IS ENTERED (within ± 5 meters). To obtain the accuracies achievable in differential operation, altitude must be entered to within ± 1 meter

The recommended mode for land use is 3D. That means the unit will require four satellites to obtain a position fix; thereby determining altitude as well as grid or latitude and longitude. (This insures the accuracy of the fix where exact altitude is not available.)

Use Differential Judiciously

While differential can completely remove the effects of government degradation of the GPS signal (selective availability), this process assumes identically matched data sets. Prior to using differential successfully, the user must have a thorough understanding of datum shifts and the theory behind the differential process.

INTRODUCTION TO THE GUIDE

This user guide is divided into six sections for easy reference. The sections contain the following information:

Section 1: General Information, overviews the NAV 1000 PRO unit and its available accessories.

Section 2: The Basics, covers basic information related to hand-held battery operation and external power operation of the unit, the keypad, and how to enter data.

Section 3: Function Keys, provides procedures for using the unit's function keys. Reference this section whenever you have questions on how to perform a function.

Section 4: Differential and the Dataport, lightly covers the theory of differential, its application with the NAV 1000 PRO and gives a complete description of the dataport possibilities.

Section 5: Auxiliary Functions, covers the auxiliary functions available under the AUX key.

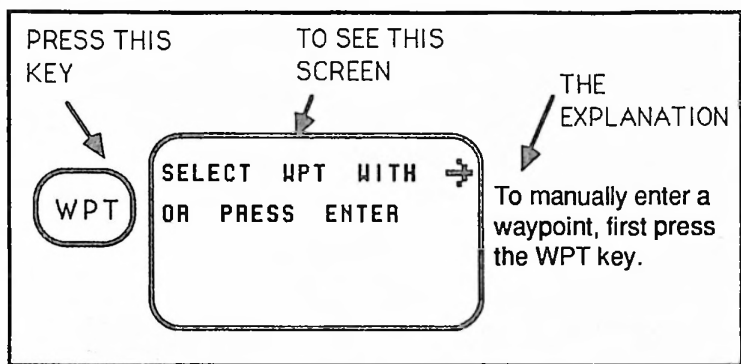
Section 6: Trouble Shooting and Tips, includes information for trouble shooting and instructions for maintaining your unit and tips.

We have written **All About GPS**, which appears in the Appendix, to give you an overview of the Global Positioning System.

The accompanying **Training Guide** is essential for quickly learning to operate the basic positioning and navigation features of the NAV 1000 PRO.

Editorial Approaches

The following editorial approaches have been used in this guide to make it easy to understand:



Reading the Guide



THIS SYMBOL IS USED FOR IMPORTANT SAFETY INFORMATION. WHEN YOU SEE THIS SAFETY SYMBOL, CAREFULLY READ AND FOLLOW THE MESSAGE.

Safety Symbols and Warning Messages

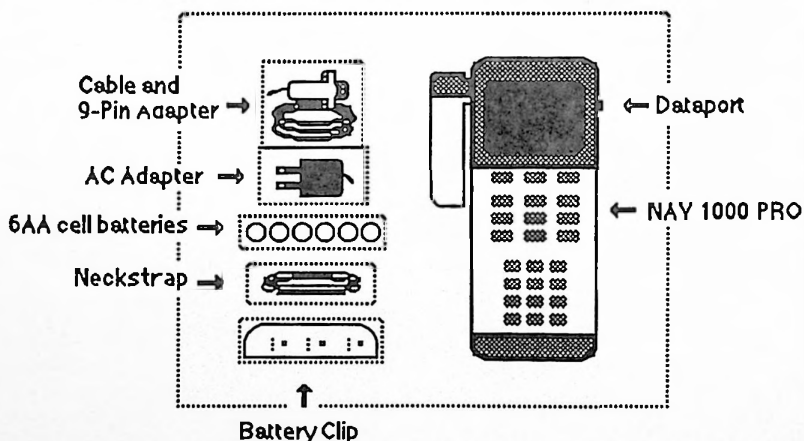
SECTION 1

GENERAL INFORMATION

PACKING LIST

The contents of your **Magellan GPS NAV 1000 PRO™** basic package includes

- Magellan GPS NAV 1000 PRO with dataport
- AC Adapter
- Neckstrap
- 6 AA Alkaline Batteries
- Battery Clips (2)
- Data Cable with 9-Pin Connector
- User Guide
- Training Guide
- Field Card
- Warranty
- GPSCOMM Software
To download data to laptop
- RE4MAT Software
To reformat raw data file and to post-process differential data files.
- C-SPREAD Software
Statistics on and scatterplot of a session



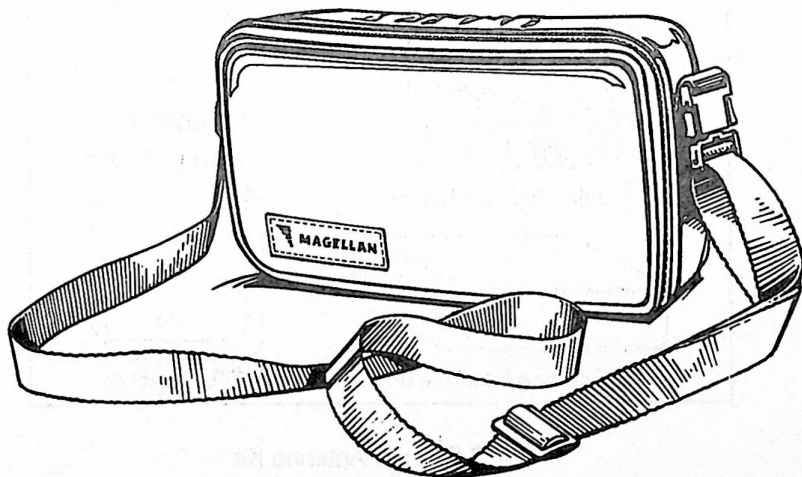
Magellan GPS NAV 1000 PRO™
Basic Package
PN 00-31000

ACCESSORIES

The NAV 1000 PRO has several optional accessories.

Carrying Case

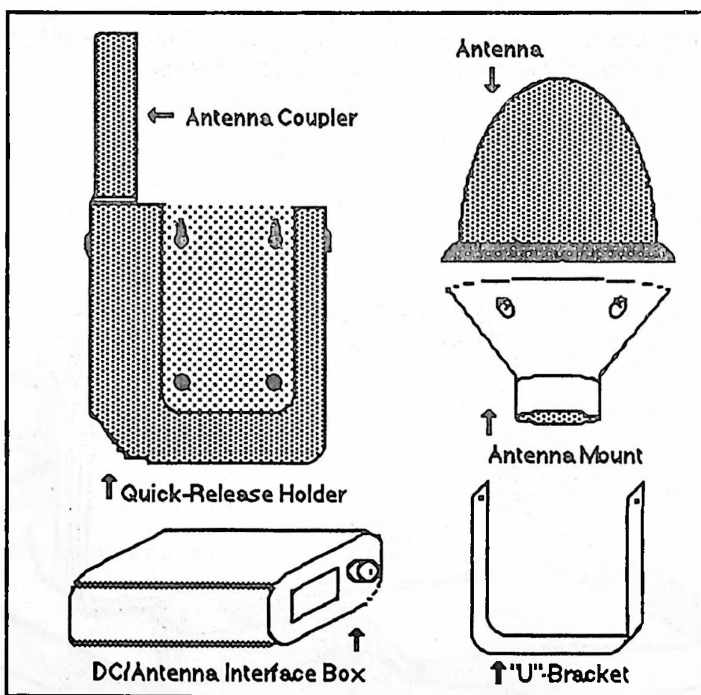
A durable woven Cordura™ carrying case is available for transporting your NAV 1000 PRO. The case can be worn over the shoulder or on a belt. It can be used for storing the unit safely. The field card and an extra battery clip fit into a specially designed pocket.



NAV 1000 PRO Carrying Case
PN 00-19005

GPS Exterior Antenna Kit

The GPS Exterior Antenna kit allows you to operate your NAV 1000 PRO in weak signal environments such as inside a vehicle, or in situations where elevating the antenna by means of a range pole or other device will improve the signal strength.

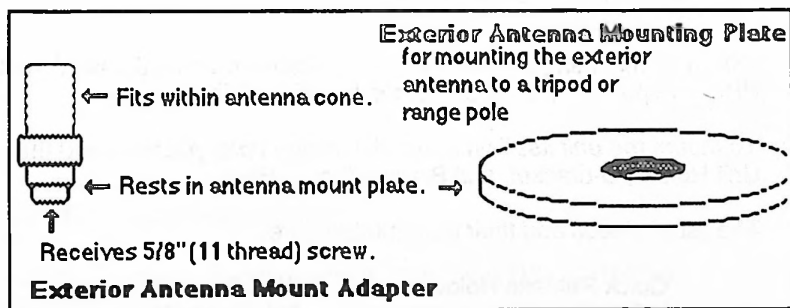


GPS Exterior Antenna Kit
Primary Components
PN 00-39001

The GPS Antenna Coupler fits within the unit holder. Connection of the coupler to the exterior antenna is made through the interface box. The unit slips freely in and out of the quick-release holder. Included in the kit are several attachments and adapters that lend the Magellan Exterior Antenna Kit the total flexibility to (1) mount the unit itself on a range pole or tripod, (2) to mount the exterior antenna on a range pole or tripod, (3) to mount the exterior antenna magnetically on a vehicle, (4) to connect the unit to a portable 12 volt battery, (5) to connect the unit to a vehicle battery directly or through the cigarette lighter.

The Kit consists of:

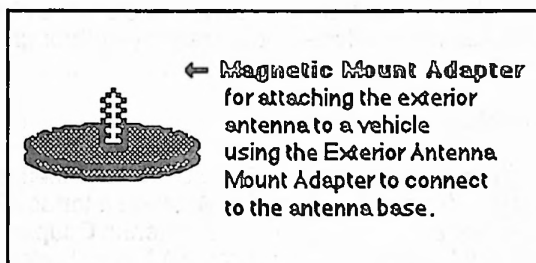
- Quick-Release Holder
- U-Bracket with Screws
- Exterior Antenna
- Antenna Mount
- Installation Instructions
- Magnetic Mount Adapter
- RG58U Cable (4 meters)
- DC/Antenna Interface Box
- GPS Antenna Coupler
- Antenna Mount Plate
- Exterior Antenna Mount Adapter
- Cigarette Lighter Adapter



**For Mounting the Exterior Antenna on a Range Pole
(Included in the GPS Exterior Antenna Kit)**

An external antenna mount plate and adapter are provided for mounting the exterior antenna on a tripod or range pole.

For use on a vehicle, the Magnetic Mount Adapter used in conjunction with the Exterior Antenna Mount Adapter will create an instant mounting of the exterior antenna on a vehicle. The Cigarette Lighter Adapter will permit you to power the external antenna from the vehicle's battery.



For Mounting the Unit on a Vehicle

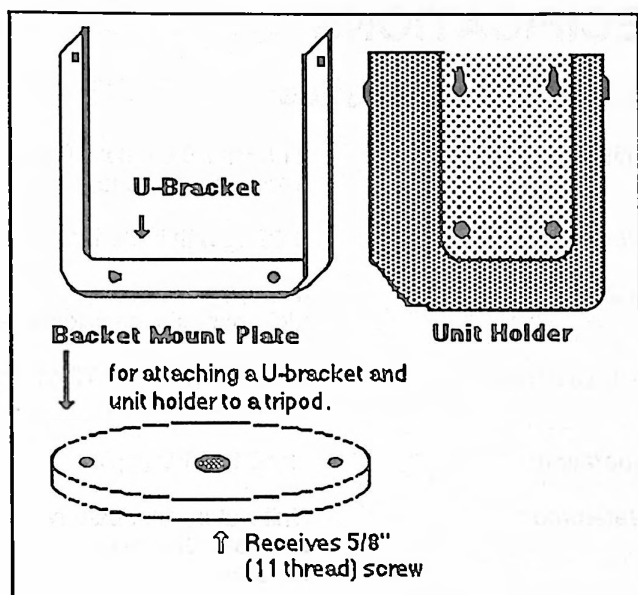
Mounting Accessories

Individual mounting accessories are available to adapt the NAV 1000 PRO for specific applications or for added flexibility.

To mount the unit itself on a tripod or range pole, you will need the Unit Holder, U-bracket, and Bracket Mount Plate.

The list of pieces and their part numbers are:

Quick Release Holder	PN 00-19002
U-Bracket	PN 00-19003
Bracket Mount Plate	PN 00-39002
Exterior Antenna Mount Plate	PN 27-00005
Exterior Ant. Mount Adapter	PN 27-00003
Magnetic Mount Adapter	PN 23-00001
Cigarette Lighter Adapter	PN 00-39003
DC Regulated Adapter	PN 00-09001



For Mounting the Unit on a Tripod

Other Accessories

Also available are Replacement Battery Clips (PN 00-19004).

SPECIFICATIONS

Physical Characteristics

Unit Size:	21.5 cm x 9.0 cm x 5.0 cm excluding antenna;
Weight:	0.85 kg with batteries
Display:	4 line, 16 character, alphanumeric, backlit LCD
LCD Dimension:	6.5 cm x 4.5 cm; 0.70 cm high digits (with cursor)
Operating:	-10°C to 60°C (typical)
Waterproof:	Unit waterproof; battery compartment water resistant
Buoyancy:	Specific gravity = 0.8 (it floats)
Safe Storage Temperature:	-40°C to 70°C
GPS Exterior Antenna:	9.0 cm x 9.0 cm, 4 meters of cable (See Instructions for the GPS Exterior Antenna Kit)



*Accuracy of position fixes can be affected by the periodic adjustments to GPS satellites by the U.S. Government and is subject to change in accordance with the Department of Defense civil GPS user policy.

Data Characteristics

Accuracy*:	HDOP < 1.75 (C/N ₀ ≥ 47 dB-Hz) POS (Single Fix) - 25 meters RMS in 2D; - 30 meters RMS (horizontal) in 3D; - 50 meters RMS altitude. POS (Autonomous -32 averaged) - 15 meters RMS in 2D; - 20 meters RMS (horizontal) in 3D; - 25 meters RMS altitude. POS (Differential -32 averaged) - 5 meters RMS in 2D; - 10 meters RMS (horizontal) in 3D; - 15 meters RMS altitude. VELOCITY - 0.4 Km/h RMS
Speed:	0 to 320 Km/h (200 MPH)
Update Rate:	11 seconds (2D) typical 13 seconds (3D) typical
Epoch In Differential:	15 seconds (2D) 20 seconds (3D)
Terrain Settings	Obscured for difficult signal environments. Interrupted for normal land environments. Clear for situations with a completely open view of the sky.
Almanac Collect:	12.5 minutes typical

Data Characteristics (cont.)

Memory: 60 user-stored waypoints or averaged positions plus data buffer of 200 fixes.

Electrical Characteristics

Receiver: Fast single channel

Power Requirements: 6 AA alkaline batteries (internal)

12 (10 to 15) volts DC with a Magellan regulated adapter (See *Connecting to an External Power Supply* in Section 2.)

115 volts AC $\pm 10\%$ with Magellan adapter PN 00-19006

220 volts AC $\pm 20\%$ with Magellan adapter PN 43-00002-001

240 volts AC $\pm 20\%$ with Magellan adapter PN 43-00002-002

Power Consumption: 260 MA typical without light (9 volts)
310 MA typical with light (9 volts)

Battery Life: Up to 7 hours continuous typical;
140 to 2200 single fixes
(depending on type of operation)

Modes of Operation: 2D (solves for LAT, LON and time with a user-entered altitude using best 3 satellites) or,

3D (solves for LAT, LON, altitude and time using best 4 satellites)

SECTION 2

THE BASICS



Illustration of a satellite in orbit

MESSAGE DISPLAY SYMBOLS

The following symbols appear in various message displays:



Warning - Appears in all position messages if the Position Dilution of Precision (PDOP) gets larger than 10 or when the Signal Quality (SQ) falls below four. If the PDOP, a measure of the geometric quality of the fix, rises above 10, do not use the position for navigating.



Satellite - Appears as each satellite is located during search and upon completion of data collection.



Battery Warning - Appears when the batteries are low and need to be replaced



Right Arrow - Appears when the RIGHT ARROW key can be pressed to toggle to another selection in that screen. It also appears when the RIGHT ARROW key will advance you to the next item, such as another waypoint.



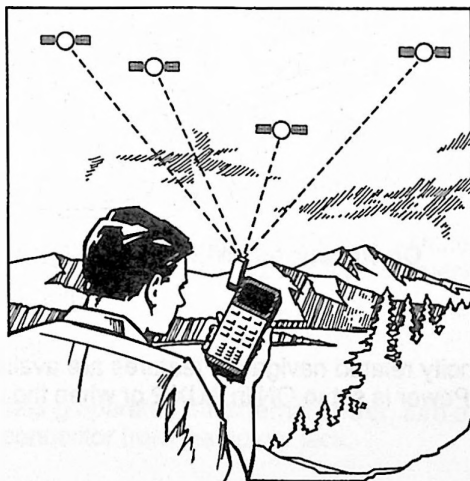
Down Arrow - Appears when the DOWN ARROW key can be pressed to scroll down, to view additional information about that item, like the time/date screen of a particular waypoint.

HAND-HELD BATTERY OPERATION

In hand-held battery operation, the Magellan GPS NAV 1000 PRO™ is powered by six AA alkaline batteries. The operation and electrical design of the unit are intended to extend the life of the batteries. Using AUX 2, you can turn continuous power on and off. When it is off, you enable the full PowerSaveR™ features. For example, when you press the SURVEY key, the receiver turns on; the unit takes one position fix, stores the position as the last fix, and shuts the receiver off. The NAV 1000 PRO automatically turns itself off within two minutes if no keys are pressed.

In continuous power, the unit stays on and give constant position updates. However, the unit will automatically revert to full PowerSaveR™ operation when the batteries reach the second low battery warning and continuous power will turn off.

To obtain signals in the hand-held operation, the unit must be held or placed in direct view of the satellites with the antenna pointing directly upward as shown in the figure below.

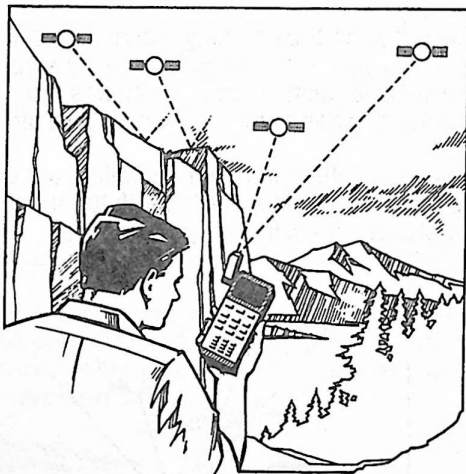


Give Antenna Direct View of Satellites

The unit will not receive signals if its view of the satellites is blocked by objects or people, or if you attempt to use it inside without an exterior antenna.

For ease and comfort of operation; place the unit in a holder; prop it up on a rock; or support your arm if you will be using the unit for several minutes.

In continuous operation, you can expect about 7 hours of position data (over 2,200 fixes) on a fresh set of alkaline batteries. In push-to-fix (non-continuous) operation, you can expect to obtain at least 140 individual position fixes.



Obstructions Will Block Signal

NOTE: Velocity related navigation features are available when Continuous Power is set to ON in AUX 2 or when the unit is externally powered.



Battery Warning Symbol



The battery warning symbol appears on each display when the batteries are low. You can continue operating with the battery warning symbol, but be prepared to change batteries by having a loaded battery clip handy.

NOTE: You can obtain approximately 15 more fixes after the first warning appears or operate continuously for another 30 minutes.

When the second low warning level is reached, you will see the message: "Replace batteries or lose data." Replace the batteries now.

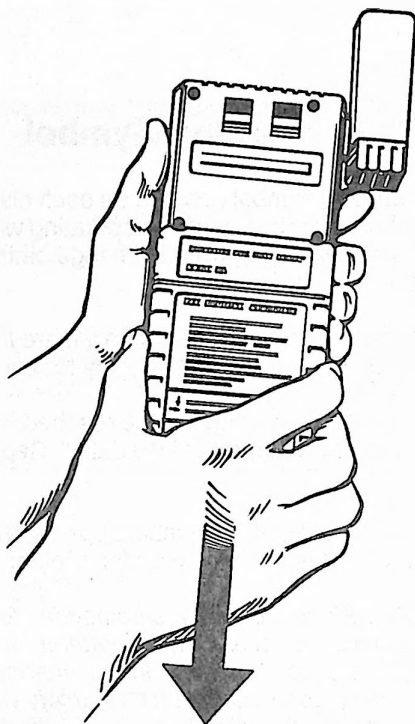
When the second low battery symbol appears, there is generally enough power to save your memory for another four weeks.

Rechargeable batteries are not recommended for two reasons. First, their life expectancy is considerably shorter than that of fresh alkaline batteries. Second, the sharp drop in power near the end of their charge cycle can jeopardize the unit's memory without warning. In hand-held operation, the alkaline batteries serve to both power the unit and protect critical memory, like stored waypoints.

Loading the Alkaline Batteries

Follow these steps to load the six AA alkaline batteries into your unit:

1. Load the extra battery clip with six AA alkaline batteries following the placement instructions in the clip. We recommend Eveready Energizer® batteries.
2. Turn the unit off.
3. If the unit is being operated on external power, turn off the unit, remove the connector from the power jack.
4. Grip the battery compartment door on each side as shown. Remove door by pulling the door very firmly toward the bottom of the unit.



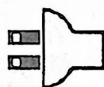
Opening the Battery Door



WARNING: The open side of the clip must face outward. You have two minutes to exchange battery clips before the unit will lose its memory.

5. Replace old battery clip with a fresh one.
6. Remove any dirt, sand, or other foreign matter from the battery compartment seal.
7. Replace the battery compartment door by pushing up until it is firmly in place.

EXTERNAL POWER AND CONTINUOUS OPERATION



The Magellan GPS NAV 1000 PRO™ can be operated using an external power supply. When the unit uses external power, the receiver remains on continuously after you press the Survey (SURV), Navigation (NAV) or Velocity (VEL) keys. It senses when the power jack is supplying current and switches to continuous operation automatically. Continuous operation is also available when the unit is powered by its internal 6 AA alkaline batteries. Use AUX 2 to turn continuous operation on and off when not powered externally.

You must attain a speed of 0.3 Km/HR and be in continuous operation before the unit displays speed over ground (speed). Ground course and steering are also available once a speed of 0.3 Km/HR is reached. Until threshold speed is attained, dashes will appear. Dashes also appear in navigation data when you are within 20 meters of the destination.

Velocity related information is available after the second position fix. Refer to *VEL* in Section 3. After the second fix, navigation data is calculated using Magellan's doppler sensitive navigation filter. Information catches up to sudden changes of speed within two fixes.

This update rate may lag by a few seconds when the unit switches to a new satellite. Every 10 minutes the NAV 1000 PRO evaluates the signal quality and geometric quality of the satellites overhead. You will know if the unit switches to one or more new satellites because a message will appear beneath the main display that says "SATS", followed by "DATA". During this time, your position does not update.

POS	32°26.67N
	118°29.99W
2D	00140m ALT
SATS	* ↓→

POS	4-08-10E
	11 37-78-17N
2D	00140m ALT
SATS	* ↓→

A Symbol Appears on the Screen for Each New Satellite Being Acquired.

Your NAV 1000 PRO will operate using AC or DC power. Use only Magellan equipment for connecting to external power because all adapters and interfaces have been designed to supply the unit with the correct level of DC voltage. Any other equipment may cause harm to the NAV 1000 PRO.

For AC
(115 volts AC \pm 10%,
50/60 Hz)

Use the Magellan AC Adapter
(PN 00-19006).

(220 volts AC \pm 20%,
50/60Hz, VDE)

Or the Magellan International
AC Adapter for Europe (PN-
43-00002-001).

(240 volts AC \pm 20%,
50/60Hz, UK (BSI))

Or the Magellan International
AC Adapter for the United
Kingdom (PN-43-00002-
002).

For DC
(12 volts DC,
negative ground)

Use the Magellan DC/
Antenna Interface Box
available in the Magellan GPS
Exterior Antenna kit with the
Quick Release holder (PN 00-
39001).

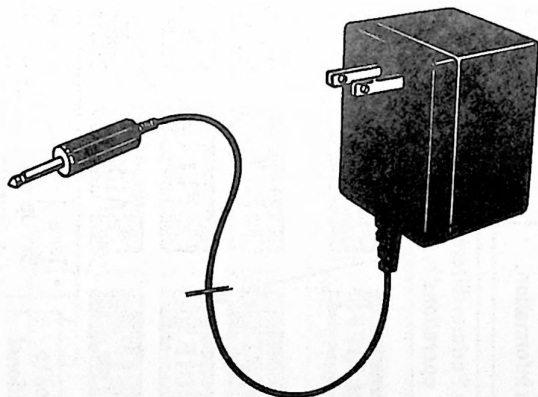
Or use the Magellan
Regulated 12 volt DC adapter
(PN 00-19001) for con-
necting the unit directly to a
12-volt DC power source.

Connecting to an External Power Supply

▲ WARNING: Use only the Magellan power adapters to connect your unit to an external power supply. Use of other adapters will void the warranty and may severely damage the unit. To avoid the possibility of losing your memory or freezing up the NAV 1000 PRO make sure the unit is always turned off before connecting or disconnecting the external power supply.

Do not direct wire your NAV 1000 PRO to a 12 volt battery without a Magellan DC power adapter.

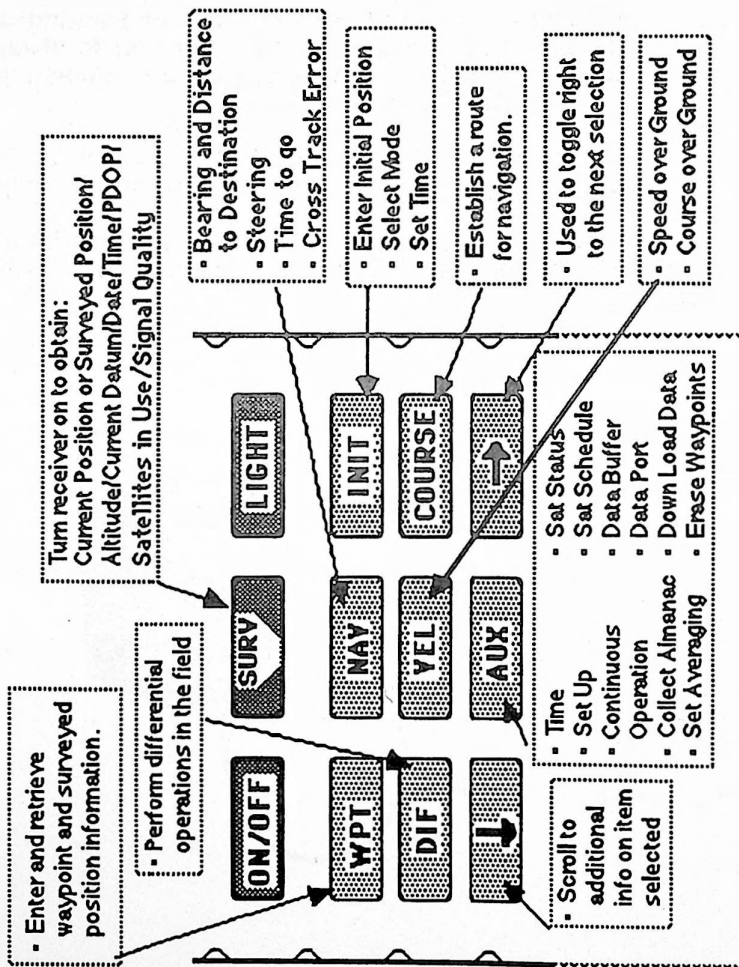
The NAV 1000 PRO external power jack is located on the side of the unit opposite the antenna. Pull back the rubber tab and insert the connector.



AC Power Jack and Adapter

THE KEYPAD

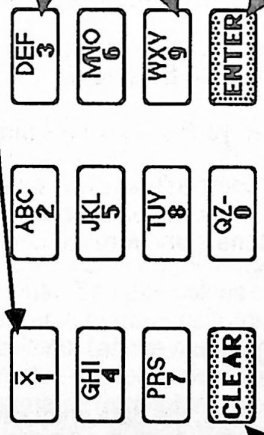
The unit's keyboard has 12 function keys and an alphanumeric keypad.



MAGELLAN

▪ For quick access to surveyed positions

▪ Alphanumeric keys



▪ Hold or freeze position as a waypoint
▪ Store surveyed position or waypoint
▪ Enter information for waypoint

▪ Clear display
▪ Backspace
▪ Erase info

ENTERING DATA

To enter or change data, like a waypoint, use the alphanumeric keypad. This is on the lower half of the keyboard; it looks like a telephone keypad.

Data entries are *always completed* by pressing the ENTER key which saves the information. Until then corrections can be made by pressing the CLEAR key.

Entering Waypoint Labels

Some entries, such as waypoint labels, let you enter alphabetic or numeric characters. To make alphanumeric entries:

1. Press the key that displays the letter or number you want to enter.
2. Press the RIGHT ARROW key to toggle to the desired letter.
3. To move the cursor one space to the right, press the key that has the next letter or number to be entered.
4. When you have completed your entry, press the ENTER key.

NOTE: If you make a mistake, you can erase one letter or number at a time by pressing the CLEAR key. If you cannot correct your error with the CLEAR key, start the entry from the beginning by pressing the function key again.

Entering Numbers Only

When a field requires a numeric entry, the data entry keys automatically input numbers only. The RIGHT ARROW does not toggle to alphas.

A number *must be entered* in each available space. For example, if you want to enter an altitude of 200 meters, you would press 00200. Use the Right Arrow key to toggle from "+" to "-".

INTERPRETING YOUR POSITION FIX

To use the NAV 1000 PRO in a prudent manner, interpret the data wisely by evaluating your position fixes.

- Determine if you are in 2D (two dimensional or no altitude), or a 3D (three dimensional including altitude) mode.
- In 2D mode, enter your altitude correctly.
- Be aware of the factors affecting fix accuracy.



Read this entire section, *Interpreting Your Position Fix*, for safe operation of the NAV 1000 PRO.

2D vs. 3D Mode

Two Dimension — Three Satellite — Mode

Two dimension (2D) mode is normally used for positioning near a vertical control marker or where altitude is known from a previous study. It can also be used to navigate where altitude is known, for example, on a body of water.

In 2D mode, a minimum of three satellites must be in direct view of the unit's antenna. The unit solves only for latitude and longitude or universal transverse mercator coordinates, and *bases its solution on the antenna altitude (above mean sea level (MSL)) that you have entered.* Altitudes are referenced to mean sea level which the NAV 1000 PRO estimates from information on the height of the geoid stored within the unit. Enter the correct altitude above MSL for best accuracies. This is especially important if 2D differential is used.

Note that the unit solves for position at the point of the antenna which is the same as the unit in hand held operation, but may be many meters away when you are using an exterior antenna. Antenna altitude is the sum of your height above mean sea level plus the

height of the exterior antenna above the unit. If you are on a lake with an elevation of 300 meters and have an exterior antenna placed 6 meters above the water, your antenna altitude would be 306 meters ($300 + 6$). If you are on the ocean, the antenna altitude of this same boat would be 6 meters ($0+6$), since the elevation at sea level is zero.

For best results in 2D (three satellite) mode, the antenna altitude should be known as accurately as possible because an incorrect antenna altitude entry can cause a corresponding error in the position solution. The amount of additional position error is roughly the same as the error in the entered antenna altitude when the PDOP is less than 6, but can become considerably larger than this for poor geometries.

Position Dilution of Precision or PDOP is a measurement of the geometry of the satellites used for triangulating a position. Roughly speaking, the more "spread out" the satellites are, the better the accuracy of the fix. When the satellites are bunched together in the sky, the position solution may not be as accurate. For example, an error of 200 meters in the entered antenna altitude could be expected to cause a position error on the order of 200 meters when the PDOP is less than 6. (The exact amount of error depends on the specific satellite geometry). However, if the PDOP were greater than 10, it might be possible for the position error to be much larger.

NOTE: Normal tidal fluctuations will cause no altitude errors.

The greatest amount of error in a position fix lies in the altitude element of the position fix. By entering in a known altitude, you can increase accuracy. This is why 2D is the recommended mode if you do know exact altitude.



WARNING: Best accuracies are obtained in 2D when the correct altitude is entered (within ± 5 meters). Accuracies achievable in 2D differential require the altitude to be entered within ± 1 meter.

Three Dimension — Four Satellite — Mode

On land where altitude may not be known precisely, the unit needs four satellites in direct view. This is a 3D solution: the unit solves for latitude, longitude *and* altitude.


We suggest 3D mode be used when the unit is used on land, unless you are certain of your altitude.



WARNING: Use 3D If you are uncertain of your altitude.

Geometric Quality


Position accuracy is affected by geometric quality or Position Dilution of Precision (PDOP). The PDOP value appears on the third screen of current position, buffered positions and waypoints (saved fixes). Use this guide for evaluating position fixes based on geometric quality.

PDOP	
<5	Good Accuracy
5-10	Fair Accuracy
>10	Poor Accuracy
	DON'T USE THIS DATA!!

The unit will not report a position which has a PDOP > 75. It will try three times to obtain a fix and then display "ERROR -- SEE USER GUIDE".

Signal Quality

Signal Quality (SQ) gives an indication of the carrier-to-noise ratio (C/N₀) of each satellite signal being used. Each satellite being used and its signal are reported on the third message of position displays. The SQ level ranges from 0 (lowest quality) to 9 (highest quality). An SQ of 4 or better on a position fix indicates the C/N₀ is strong enough that you will not lose lock on that signal. SQ has almost no bearing on accuracy.

<u>SIGNAL QUALITY</u>	
7-9	Strong
4-6	Not as strong
1-3	Weak
	MAY LOSE LOCK.

NOTE: You can often improve the SQ by moving the antenna into a more favorable area. Even moving a few inches can often make a great difference in SQs. (See *Hand-Held Battery Operation* in Section 2.)

<u>SQ Level</u>	<u>C/N₀ of Weakest Signal (dB-Hz)*</u>	<u>How to Evaluate</u>
9	≥ 45	Strong
8	44	
7	43	
6	42	Not as strong
5	41	
4	40	
3	39	Weak
2	38	
1	37	
0	< 37	*C/No at antenna

Terrain Setting

The NAV 1000 PRO allows you to set the unit for three different satellite visibility conditions: Clear, Interrupted and Obscured.

CLEAR assumes a clear view of the sky in all directions. Every 10 minutes the unit re-evaluates the PDOP of the satellite it is using. In this terrain setting, the satellite which will give the best geometry (consequently, accuracy) will be used. Choose this setting when you are using the unit for positioning.

INTERRUPTED assumes a good view of the sky but that objects like trees or vehicles may temporarily interrupt the signal. It also assumes that you or objects around you are moving. Once the unit finds the best satellites possible in terms of accuracy, it is programmed to hold onto these satellites. At its 10 minute re-evaluation window, it will not switch satellites unless the PDOP is higher than 6 in 3D or 4 in 2D, which will still give you typical accuracies no worse than 30 meters RMS. Choose this setting when you are navigating.

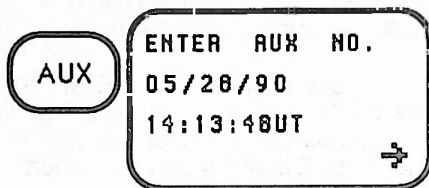
OBSCURED means that you are in a valley, canyon, drainage, or are surrounded by objects, such as trees. When you select obscured, the unit will first look for satellites 20° above the horizon. If there are not enough satellites in that region of the sky, it lowers its search angle to below 20° but not lower than 10°. Once it "locks on" to those satellites, it will not switch satellites until the PDOP is greater than 15. Choose this setting when you are navigating or positioning in very difficult terrain.

TIME

The **Magellan GPS NAV 1000 PRO™** provides time in both universal time (UT) and local time (both 24 hour and AM/PM time). Universal time, formerly called Greenwich Mean Time, is the same where ever you are in the world.

Each of the GPS satellites has the exact time in UT. When you take a position fix, your NAV 1000 PRO corrects any error in its oscillator or "clock". If you made an incorrect entry when you initialized the unit

(INIT), UT time will be corrected. Local time in minutes and seconds is also corrected.



Press the AUX key to display time.

When the unit saves position information, waypoints, and other time related data, it always saves the information in universal time, even if you have the unit set to display in local time in AUX 1.

Upon memory loss, the NAV 1000 PRO must first be initialized in UT. Once this is done, you can then initialize local time in either AM/PM or 24 hour. When you set the local time, the NAV 1000 PRO simply remembers the offset (difference) between UT and local time in days and half hours. It adds or subtracts this offset before displaying the time data. Minutes themselves are based on time from the satellites. Once you have initialized time, select the time display in AUX 1.

If you travel into another time zone, it's up to you to reset the local time. Even if you forget to do so, it's not a problem because your NAV 1000 PRO always works using UT. If you are confused about time zone or the local offset, simply change the time back to UT.

The inherent time accuracy used in calculating a position fix is usually better than one micro second. However, the time of the fix in the display is shown to the nearest second.

Note that the time of the fix is not the same as current time which can be viewed on the AUX screen. When the receiver is on and providing continuous positioning, time on the AUX screen is accurate to one second. When the receiver is not on, it will take up to one minute for the seconds to display on the AUX screen and may lack accuracy if the receiver has not been used in a while. The time on the AUX display will be corrected as soon as you take a fix or collect time using a single satellite. Refer to AUX 3 in Section 5 for collecting time from the satellites when fewer than three sats are available.

SECTION 3

FUNCTION KEYS

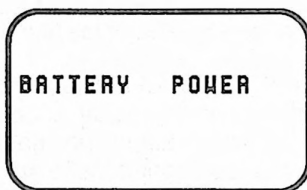


ON/OFF KEY

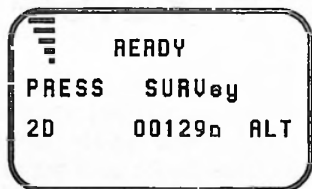
Press the ON/OFF key to turn the **Magellan GPS NAV 1000 PRO™** on. Press it again to turn the unit off.

Power-Test

When you turn on the NAV 1000 PRO, it performs a self-test of memory, Almanac and power.



The battery status temporarily displays on the screen.

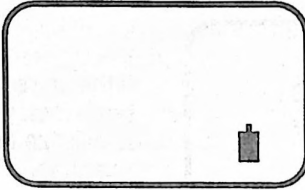


When the NAV 1000 PRO is ready to use, this message displays. The mode and previously set antenna altitude display.

NOTE: The unit will remain on unless continuous power is set to OFF in AUX 2. In this case, the unit will turn itself off in two minutes if no key is pressed.

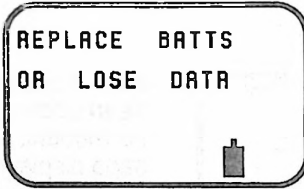
ON/
OFF

Power Warning



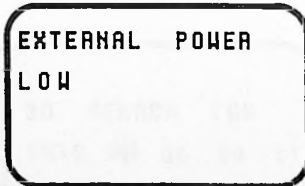
If the batteries are low, the battery warning symbol will continue to be present on all displays until the batteries are replaced.

WARNING: Replace the batteries when you see this display.



If the batteries become dangerously low, information stored in memory may be lost. To prevent this, a second power warning will appear. Continuous operation will automatically switch off.

NOTE: When the second battery warning appears, there is enough residual power in the 6 AA batteries to hold up memory for another month if you discontinue use of the unit.



If external power is being used, this message will appear when the level of external power is below minimum.

ON/
OFF

Memory Warning

MEMORY LOST
PRESS INIT

If the unit's memory has been lost, you must reinitialize and collect an Almanac.



WARNING: Read *Initializing Your Unit* in the Training Guide and **SECTION 3, INIT** in the User Guide before initializing your NAV 1000 PRO.

Almanac Warning

NEED ALMANAC
PRESS AUX 3

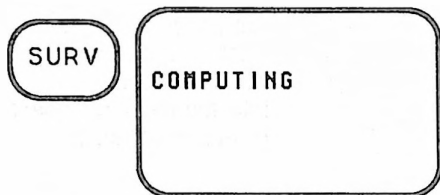
If the Almanac has not been updated in over six months, this message displays. **You must collect an Almanac.** (See **AUX 3** in Section 5 of the User Guide.)



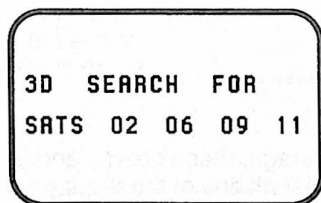
SURVEY (SURV) KEY

The SURVEY (SURV) key activates the unit's receiver. After obtaining the initial position, the unit will continuously update your current position, the current time, and the navigation solutions. Under normal conditions, it will take less than three minutes to obtain a position. If you have taken a reading within the hour, it will take approximately two minutes.

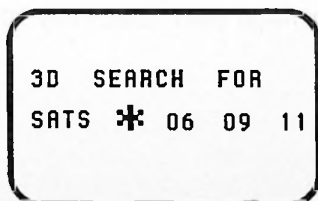
Search and Acquisition



The NAV 1000 PRO will begin by computing which satellites are available and among those which would give the best geometries and, therefore, the most accurate position.



The first search message displays giving the mode (2D or 3D) and the ID number of the satellites selected by the unit. (See *Interpreting your Position Fix* in Section 2.)



As the satellites are located, the "*" symbol appears over the satellite number.



```
COLLECTING DATA
02 06 09 11
```

When the appropriate number of satellites have been located (three for 2D, four for 3D), this message displays.

```
COLLECTING DATA
* * * *
```

As the ephemeris data is being collected, symbols appear until all data is obtained. There will be a brief pause while the pseudo-range information is collected from each satellite.

```
COMPUTING POS
```

After all data has been collected from the satellites, this message displays. The position solution will display next unless the unit has been set to average.

NOTE: If the unit is set to average, these search and acquisition screens do not appear. The fourth line of the display will instead give the Receiver Activity Messages.



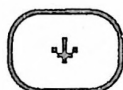
Position Solution

The NAV 1000 PRO will emit a beep to indicate that the first position solution has been calculated.

POS	32° 26 . 6744N
	118° 29 . 9912W
3D	+00103m ALT

↓

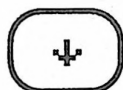
The coordinates of your position will display. The mode -- 2D or 3D -- appears on the lower left of the display. Altitude is also given.



POS	WGS84
	12/30/89
	21:59:13UT

↓

Press the DOWN ARROW key to display the date and time, and the datum currently selected.



POS	PDOP	4.5
SAT	03 06 11 14	
SQ	7 4 9 8	

↓

Press the DOWN ARROW key to display information about each of the satellites being used and the signal quality being received from each. The PDOP of the resulting fix appears on the top right of the display.

Press the DOWN ARROW key again to return to the first position display.



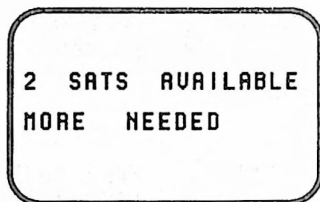
Difficulties in Obtaining a Position Fix

Certain conditions can interfere with successfully obtaining your position:

- Insufficient number of satellites.
- Inability to acquire satellites.
- Incorrect initialization.

Insufficient Number of Satellites

The NAV 1000 PRO consults its Almanac before beginning its search for satellites overhead. The receiver will not turn on when the unit knows that according to its schedule, determined from the Almanac information, not enough satellites are available.



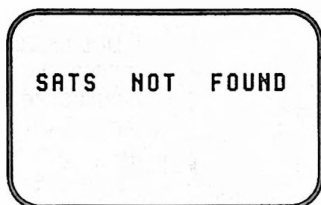
When an insufficient number of satellites are available, a message display indicates the number of satellites currently available.

Press AUX 6, Satellite Schedule, to compute a satellite schedule for the next 24 hours. Also remember to check Sat Status in AUX 5 to make certain that no satellites have been set to "OFF". (Refer to AUX 5 in Section 5.)

Inability to Acquire Satellites

In continuous operation, the unit will continue to look for satellites temporarily blocked from view by continually searching the sky until it knows that the satellites have set below 10° on the horizon. The time between fixes may lengthen in difficult signal environments.

In push-to-fix (non-continuous) operation, the unit will look three times for satellites it has determined should be available.



In push-to-fix operation, the NAV 1000 PRO displays this message after three unsuccessful attempts to find satellites.

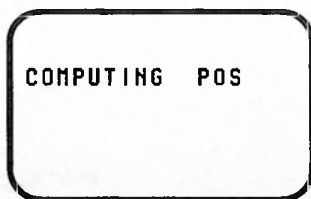
Difficulty in locating satellites may be due to the following conditions:

- The NAV 1000 PRO has been moved more than 300 miles from the last fix or the wrong date or time was entered when the unit was initialized.
- The antenna is not properly positioned.
- The satellites are blocked from view by buildings, mountains, vessels, or the foliage is too dense.
- There are satellite outages.
- There are signal reflections that can be corrected by moving the antenna.

For more information, consult the checklist of possible problems provided in *Trouble Shooting* in Section 6.

Incorrect Initialization

When the unit computes a position that it detects is more than 600 miles from the initialization information, it will not display the position. In conditions when the satellite geometry is not good, that is when the PDOP is greater than 8, the unit will require you to initialize the position within 300 miles.





Whether continuous power is on or off, you will see the unit make three attempts at collecting data and computing.



ERROR - SEE
USER GUIDE

If unsuccessful, this message will appear. Reinitialize and check the time. If that doesn't solve the problem, read *Trouble Shooting* in Section 5.

Warning

POS 32°26.67N
 118°29.99W
3D +00103_m ALT
  

The warning symbol will display on all fix messages if the PDOP reaches 5 or greater in 2D or 10 or greater in 3D. It will also appear when the signal quality (SQ) falls below 4.



WARNING: Check the position fix if the accuracy warning appears. Do not use data when the GQ falls below four. Read *Quality of the Fix* in Section 2.



Receiver Activity Message

After obtaining your first position in continuous operation, the unit will provide you with new position fixes every 11-13 seconds. Unless you have locked on to specific satellites, the unit will occasionally change satellites, as one goes down and others rise. The units will also change satellites when the geometries can be improved. The signal from a satellite can also become obscured by people or objects.

The unit will always inform you of its activity in the bottom line of the display.

POS	32°26.6744N	
	118°29.9912W	
3D	+00103D	ALT
SATS	* * *	↓

In this example, the unit is indicating that it is selecting one or more new satellites to use.

If, however, you have turned your unit to push-to-fix operation (continuous power off) by using AUX 2, you will not see all these receiver activity messages. The unit will take one fix, save it as Last Fix (LFIK available in AUX 7, Data Buffer), and turn off if no key is pressed for 2 minutes.

Receiver Activity Messages

SATS **

The unit has located the sat(s) selected. The number of satellites found will be displayed.

DATA **

The unit has collected data from the new sat(s).

SATS DOWN

The satellites have set. Not enough are now in view to get a position fix.



TRY 2D

Three satellites are in view, but the unit is set for 3D operation which requires four satellites.

Averaged Positions

NOTE: The NAV and VEL functions do not work when the unit is set to average. Use the COURSE function to determine the distance and bearing of averaged positions from a landmark.

Position fixes can be averaged. This is useful for improving the accuracy in autonomous operation (one unit by itself) and is essential for the accuracies sought in differential operation.

Averaging is set in AUX 4, Set Averaging, where you must first select the number to be averaged, then select the type of Averaging, Running Average or Auto Stop. Running Average is always synchronized with GPS time. With Auto Stop you can choose no time synchronization. With Running Average or synced Auto Stop, you will then enter the satellites to be used in the session.

Time synchronization means the time between fixes is set to precise epochs: 15 seconds in 2D and 20 seconds in 3D. If the same satellites are used by two different units, this will produce identically matched data sets needed for differential positioning.

NOTE: Averaging resets to 1 (no averaging) when power is turned off.

Auto Stop with no time synchronization is best used in autonomous operation because (1) it is forgiving of interruptions, and (2) it has the shortest overall session length.

Running Average is necessary for differential where time synchronizing of fixes is required. This means pseudo-range collection begins at precise 15-second epochs in 2D or 20-second



epochs in 3D. When the dataport is not being used, interruption in the session will cause the count to restart, causing potential loss of data. Data from an interrupted session is available in the data buffer or in Waypoint, stored temporarily as an averaged waypoint \bar{x} TMP. A computer or data logger should be used in long sessions with Running Average to guard against lost information.

With experience, the user can use time synchronization in Auto Stop successfully for differential applications.

Auto Stop for Autonomous Operation



```
AVERAGING      2D
                WAIT
(001)           s=000.0m
SATS
```

When the SURV key is first pressed, the wait message will appear while the unit is accumulating the data indicated in AUX 4, Set Averaging.



```
AVERAGING      2D
                WAIT
(004)           s= 55.1m
```

The mode is displayed in the upper right. The number of fixes is displayed in the lower left. The figure of merit (s) is given.

The figure of merit ("s" for sigma) is the standard deviation of the horizontal position variation in meters.



```
AVG      33°41.5941N
          117°46.4342W
2D      +00743m ALT
          ↓
```

When the number of fixes needed for the average are accumulated in the buffer, the average position (AVG) will appear and the unit will beep once.

```
↓
AVG      WGS84
( 17.6)  12/12/89
(032)   13:13:13UT
          ↓
```

The second message shows the datum currently being used, the figure of merit for the averaged position, the date of the last fix in the set, the number of fixes averaged, and the time of the last fix.

```
↓
AVG       $\bar{x}$ PDOP   12.6
SAT      03 06 11 14
 $\bar{x}$ SQ    7  4  9  8
          ↓
```

The average PDOP and average SQ for each satellite used appears on the third message of the display.

```
↓
DELTA      +0.0m
            +0.0m
            +0m ALT
            ↓
```

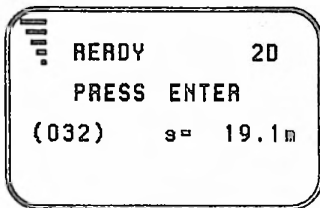
The fourth message is for displaying a Delta or correction in meters. A Delta of zero appears until a Delta is entered using the DIF function.



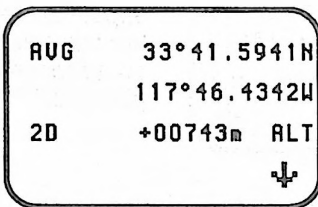
Running Average

When the running average option is chosen, the average position (AVG) does not display when the requisite number of positions have been collected in the buffer. Rather, the unit indicates it is "READY" and updates the running average dropping out the oldest fix and replacing it with the newest. Hence the term running average.

Refer to *Differential and the Dataport* in Section 4.



When the required number of fixes are collected in Running Average, the unit indicates "READY". Wait until you hear a beep and ...



Press the ENTER key. When the current fix is completed (15 seconds in 2D or 20 seconds in 3D), the average will display.

Saving Averaged Positions

Saved Average Positions are accessed in the Waypoint function and are distinguished by the mean notation (\bar{x}) in the first letter of the label.

The last averaged position is automatically stored as \bar{x} TMP, a transient averaged waypoint accessible in Waypoint. It can be renamed before the next session, if you want to save it permanently before the next press of the SURVEY key.



AUG 33°41.5941N
117°46.4342W
2D +00743M ALT
↓

To give the averaged position information a label, you can do so while it is still displayed.



- 33°41.5941N
117°46.4342W
2D +00743M ALT
↓

Press the ENTER key.

B

\bar{x} B_ 33°41.5941N
117°46.4342W
2D +00743M ALT
↓

The mean (\bar{x}) sign will appear in the first space of the name field as soon as an alphanumeric key is pressed.

BM1



\bar{x} BM1 33°41.5941N
117°46.4342W
2D +00743M ALT
↓

The averaged position can be identified with up to three letters in addition to the mean (\bar{x}) sign. This chosen label should correspond to field notes or markings on a map.

The unit remains in the Waypoint Function after saving the Averaged Position.

Averaged positions can be automatically named by pressing the ENTER key twice. Automatically named averages begin with the convention \bar{x} ..., for example \bar{x} 001, \bar{x} 002, and so forth, depending on availability.



To Clear the Buffer While Receiver is On

CLEAR

AVERAGING 2D
WAIT
(001) s=

↓

If the unit is moved to a new location while the receiver is on, the buffer is cleared and averaging can be restarted by pressing the CLEAR key.

When the Signal is Interrupted

REDF 2D
PRESS ENTER
(032) s= 17.3m

When the unit is averaging and ...

SIGNAL
INTERRUPTED

the signal is interrupted for any reason...

AVERAGING 2D
WAIT
(001) s=

The buffer will clear, and the averaging will restart. The former partial data will be saved as XTMP.



NOTE: A dataport should be used for data collection sessions of more than 10 minutes to avoid loss of information possible with long sessions. Averaged data from partial sessions are saved as \bar{x} TMP which will be written over as soon as the session is restarted. This temporary data is accessed in the Waypoint function.

When the Satellites Set During a Session

2 SATS AVAILABLE
MORE NEEDED

When the satellites set during a session, this message will appear. A partial session will be temporarily saved as \bar{x} TMP.

LIGHT

LIGHT KEY

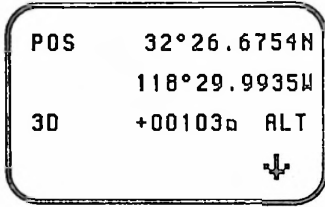
The LIGHT key illuminates the message display. Press the key to turn the light on and off. If continuous power is turned to OFF in AUX 2, the unit (including the display light) will automatically turn itself off if a key is not pressed within 2 minutes.



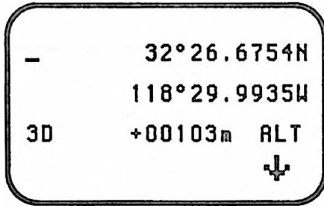
WAYPOINT (WPT) KEY

The WAYPOINT key lets you view, save, enter, rename or clear waypoints (positions that have been saved in the unit's memory). Their process is quite similar to saving averaged positions. The NAV 1000 PRO lets you store up to 60 waypoints or averaged positions.

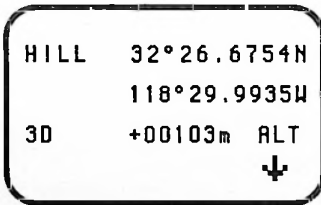
Saving Positions as Waypoints



To save a waypoint, you must first have a current position.



Press the ENTER key. The cursor is in the upper-left corner of the message display.



Enter a waypoint name or acronym with up to 4 letters or numbers. Then, press the ENTER key to save the position. This name will momentarily display before returning to the previous function, e.g. position.

ENTER

```

-          32° 26.6754N
          118° 29.9935W
3D        +00103M  ALT
          ↓

```

If you decide not to identify the waypoint yourself, the NAV 1000 PRO will automatically generate a name using the format WPXX, like WP01, WP02, WP03, in available sequence.

ENTER

```

WP01     32° 26.6754N
          118° 29.9935W
3D        +00103M  ALT
          ↓

```

Simply press ENTER again. The unit will automatically create the name before it returns to its previous activity.

The date/time and satellite information messages are also saved with the waypoint.

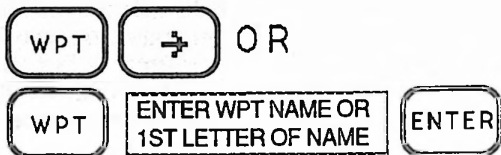
If you are operating in push-to-fix, you will stay in the waypoint function rather than returning to the previous activity. Pressing the DOWN ARROW key will reveal the date/time and satellite information of the saved position. The current datum will always display on the second display. Also, the RIGHT ARROW key will display the next sequential waypoint.

###

WPT

Waypoint Key Sequences:

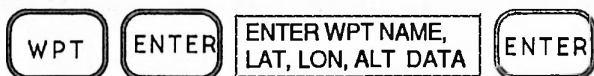
To View Waypoints:



To Save a Position as a Waypoint:



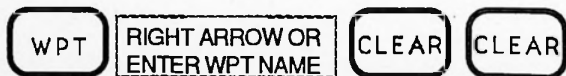
To Enter Waypoints:



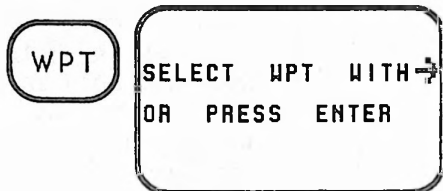
To Rename Waypoints:



To Erase Waypoints:



Viewing Waypoints



To select the waypoint you want to view, you may:

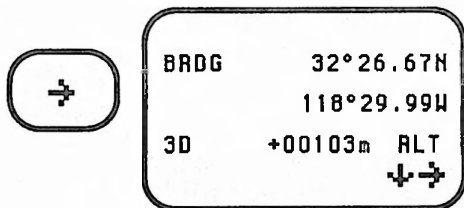
Press the RIGHT ARROW key to display waypoints in alphanumeric order.

OR

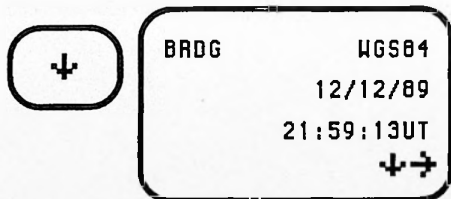
Enter the waypoint name, then press the ENTER key.

OR

Enter a portion of the waypoint name, then press the ENTER key (the unit will scan to the first waypoint that matches your entry).



Here the RIGHT ARROW key was used to select the waypoint named "BRDG" for Bridge. You would press the RIGHT ARROW key again to scroll to the next waypoint, or ...



Press the DOWN ARROW key to display the current datum, and the date and time of the position fix.

WPT



BRDG		PDOP	12.6	
SAT	03	06	11	14
SQ	7	4	9	8



Press the DOWN ARROW key to display information about each of the satellites used, the signal qualities, and the PDOP of the fix.



BRDG	PDOP
SAT	
SQ	



If you enter this waypoint manually, the PDOP and signal quality fields will be blank.

Entering Waypoints

WPT

SELECT WPT WITH →
OR PRESS ENTER

To manually enter a waypoint, press the WPT key.

ENTER

-
ENTER WPT NAME

Press the ENTER key. Enter a one-to-four character waypoint name or press the ENTER key again to automatically name this waypoint.

For information on data entry, see *Tutorial* in Section 3 and *Entering Data* in Section 2.

ENTER

DUPLICATE NAME
READY

If a waypoint with the same name already exists, this message will display.

WPT

XING
ENTER

XING - ° . N

Press the ENTER key to put in the latitude. Press the RIGHT ARROW key to toggle to N (northern hemisphere) or S (southern hemisphere).

330611
ENTER

XING 33°06.11N
- ° . W

Press the ENTER key to put in the longitude. Press the RIGHT ARROW key to toggle to W (west) or E (east).

1185943
ENTER
00174

XING 33°06.11N
118°59.43W
+00174 ALT

Working with a longitude of 118°59.43W, press the ENTER key again to put in the altitude. Use the RIGHT ARROW key to toggle a negative altitude, if appropriate.

NOTE: Remember to enter numbers in each of the six numeric spaces, using leading and following zeros if required. For example, to enter a latitude of 9°18.00, you must enter 0 9 1 8 0 0, then press the ENTER key.

ENTER

XING 33°06.11N
 118°59.43W
 +00174_B ALT
 ↕→

Press the ENTER key again to save this information.

CLEAR

CLEAR WAYPOINT
 TO CONTINUE

If all 60 waypoints have been used, this message will display. You must clear a waypoint (see *Clearing Waypoints* below) from the memory prior to making any more waypoint entries.

###

Renaming Waypoints

To rename a waypoint, locate the appropriate waypoint and press the ENTER key at any of the three message displays. Enter the new waypoint name. Then, press the ENTER key.

###

WPT

Clearing Waypoints

CLEAR

TO ERASE XING
PRESS CLEAR

To clear a particular waypoint, locate it first, and then, press the CLEAR key. This message will display.

If you want to escape this function, press any function key.

If you want to continue erasing the waypoint, press the CLEAR key again.

NOTE: Use AUX 10 to erase all waypoints.

Viewing Averaged Waypoints

WPT

\bar{x}

1

ENTER

\bar{x} BM1 33°41.5941N
117°46.4342W
2D +00743m ALT
↕→

To quickly reach the first averaged position in Waypoint, press the WPT key followed by the mean (\bar{x}) key (the "1" key) and ENTER.



```

x̄BM1      HGS84
( 17.6)  12/12/89
(032)   13:13:13UT
  
```



The DOWN ARROW key reveals the second message showing the current datums, the figure of merit for the averaged position, the date of the last fix in the set, the number of fixes averaged, and the time of the last fix.



```

x̄BM1  x̄PDOP   12.6
SAT   03 06 11 14
x̄SQ   7  4  9  8
  
```



The second Down Arrow reveals the third screen of the averaged position showing mean PDOP for the session and average SQ for each satellite used, if the same sats were used for all fixes in the session.



```

DELTA      +12.7m
           -14.8m
           +0m ALT
  
```



The fourth message is for displaying a DELTA or correction entered in the DIF function. A DELTA of zero appears when the data represents only an averaged position with no differential correction.

CLEAR

```

TO REMOVE DELTA
FROM x̄BM1
PRESS CLEAR
  
```

To remove a DELTA previously applied to an averaged waypoint, simply press the CLEAR key when the DELTA is displayed.

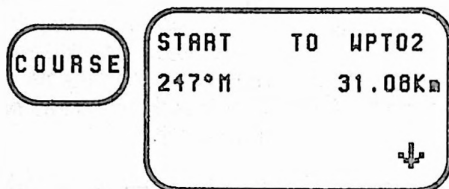
Press the CLEAR key again to restore the averaged waypoint to its original (before the DELTA correction) value.

COURSE

COURSE KEY

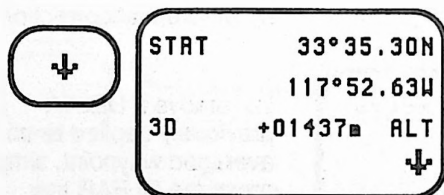
The COURSE key displays the great circle bearing and distance of the course starting from point to destination. The COURSE key will accept positions, averaged positions or waypoints as the start and end of the destination.

NOTE: When Averaging is being used, the COURSE function can be used to calculate the bearing and distance between surveyed (averaged) positions unless the positions are within 20 meters. Use the DIF function to compute relative distances in close range.



When you press the COURSE key, the course previously set displays unless the last course set has been cleared. When a current position or averaged position is used as the Start, a down arrow appears on the display.

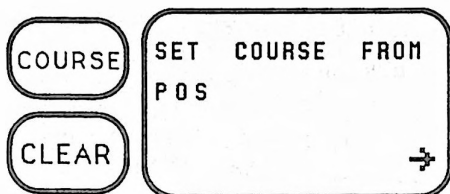
Reviewing Your Course Settings



To review the position you selected as the course start, press the DOWN ARROW key.

NOTE: If a waypoint or the averaged position information had been used as the course start, the waypoint name rather than "START" (for start), would appear on the display. There would be no Down Arrow.

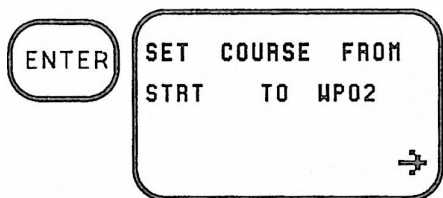
Setting Your Course



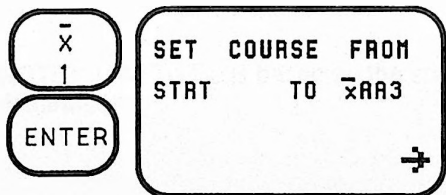
To reset the course, press the COURSE key and then the CLEAR key.

To accept the current position "POS" as the course start, press the ENTER key. Your selection is renamed START or use the RIGHT ARROW key to select a saved position or averaged position as the course starting point.

Remember, if a waypoint or saved averaged position (e.g., \bar{x} BM3) is used to set the course start, it will not be renamed START. In that case, to view the LAT/LON or UTM coordinate for the beginning of the course you must view it in the Waypoint function.

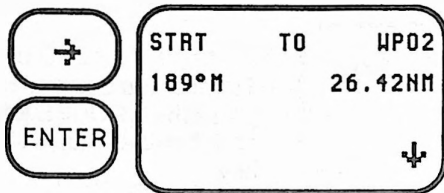


The destination waypoint is selected from set waypoints. Press the RIGHT ARROW key to select your destination or select the first letter of the waypoint and press ENTER. The previously set waypoint is the default.



Averaged positions are quickly reached by using the "1" (\bar{x}) key and ENTER then pressing the RIGHT ARROW key until the desired averaged position is located.

COURSE



Press the ENTER key to display your course, which is the great circle bearing and distance from the start to the destination waypoint.

NOTE: To simply reset your course from the current position to the same destination, remember these four quick key strokes: COURSE◊CLEAR◊ENTER◊ENTER.

▲ WARNING: Consult local maps before setting a course. Check for obstacles or natural conditions which can make your chosen route impossible. Make certain that the datum of your map matches the one selected in AUX 1, Set Up.



NAVIGATION (NAV) KEY

The NAVIGATION (NAV) key provides bearing, distance, steering, time to go, as well as cross track error (XTE) data: bearing and distance to courseline. Navigation calculations are based on the current position (or the last fix, if continuous power is off) and require that you first set a course. You must be traveling at least 0.3 Km/H to obtain velocity-related data like steering and time to go.

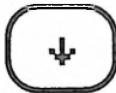
The navigation function is not available when the unit is averaging positions. In push-to-fix operation, only bearing and distance to destination and XTE are available.

NOTE: Before you can use this function, you must enter a course (using the COURSE key). No data is entered using the NAVIGATION key.



TO B103
345°T 1.44Km
STEER RIGHT 90°
 ↓

When you press the NAV key, your bearing and distance to the destination waypoint (set in COURSE) and direction to steer to that point displays.



TTG 15:14:59
345°T 1.44Km
STEER RIGHT 90°
 ↓

Pressing the DOWN ARROW key once for Time To Go (TTG) information which will appear on the top line of the display.

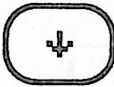
NOTE: Time To Go is based on the speed of advance toward a destination.

NAV



TO COURSE XTE
355°M 0.27Km
↓

Press the DOWN ARROW key again to display the cross track error messages.



TO COURSE XTE
PAST DESTINATION
↓

If you have moved past a line perpendicular to the destination, no cross track information is available. Time To Go will not be available.



NAV

TO BM03
---°T .01Km
STEER RIGHT ---°
↓

When you are within 20 meters of your destination, bearing and steering will not be available.

VEL

VELOCITY (VEL) KEY

The VELOCITY key contains information about your rate and direction of travel when your speed exceeds 0.3 Km/H. This information is available only in continuous operation.

VEL

SPEED	107	Km/H
GND CRS	127°	T

To obtain speed and ground course, simply press the VEL key.

INIT

INITIALIZATION (INIT) KEY

Initialization gives the NAV 1000 PRO a position that it uses to locate satellites within direct view of the unit's antenna. Knowing where it is, the unit consults information in the Almanac (which it keeps in memory) to begin its search for satellites overhead.

INIT is where you set universal time and date, the mode (2D or 3D), the initial search position and your altitude. Unless it is changed in INIT, the last fix is the initial position. The last fix (LFX) can be seen in the Data Buffer, AUX 7. Basically, the INIT function is where you reinitialize the unit.

Refer to *Intializing the Unit* in the Training Guide or *Entering Data* in Section 2, if you need help with entering position, date and time information.

Viewing the Initialization Information

INIT

INIT 34°46.36N
 118°15.75W
2D +00159m ALT
 ↕↔

When you select INIT, the initial position and mode displays, unless there has been memory loss.

↕

INIT TIME: UT
08/11/89
00:28:00UT
 ↕↔

The second message in Initialization is time display (with date) in Universal Time or local (AM/PM or 24 hour) time.

INIT

Resetting the Initial Position

The NAV 1000 PRO must be initialized within 300 miles of the true position. In good satellite geometry conditions, that is when the PDOP ≤ 8 , the unit relaxes the initialization requirement to a 600 mile radius.

INIT

```
INIT      34°46.36N
          118°15.75W
2D      +00159 ▣ ALT
          ↵ →
```

Begin with the first INIT display, if you want to reset position.

CLEAR

```
INIT      - ° N
          ° W
2D      +00159 ▣ ALT
          ↵
```

By pressing the CLEAR key or by just entering in a number, the old initialization position clears. Altitude is changed when mode is set to 2D or when a new fix is taken in 3D.

Enter the new coordinates, first the latitude (or easting). Toggle the hemisphere from N (north) to S (south), if needed, by using the RIGHT ARROW key, then press the ENTER key. Now enter the longitude (or northing) and press ENTER again.

INIT

Resetting the Mode

INIT

```
INIT      34°46.36N  
          118°15.75W  
3D      +00181m ALT  
          ↕ →
```

Begin with the first INIT display for resetting mode.

→

```
MODE:    3D  
(SOLVE  FOR  ALT)  
          ↕ →
```

The RIGHT ARROW key is used to change mode.

→

```
MODE:    2D   (4.6)  
ALT +00181m  
          ↕ →
```

The antenna altitude default for 2D operation is the last one set in 2D operation or the altitude of the last 3D fix. The PDOP of that fix appears in the upper right of the display. To change the antenna altitude in 2D simply . . .

00056

```
MODE:    2D  
ALT +00056m  
          ↕ →
```

. . . press the CLEAR key or begin entering the new altitude. Toggle to a negative altitude with the RIGHT ARROW key.

Press the ENTER key to complete the altitude entry.

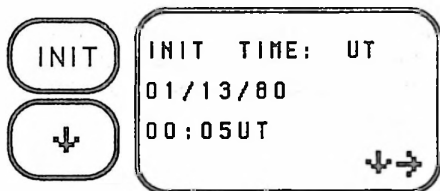
INIT

Resetting Time

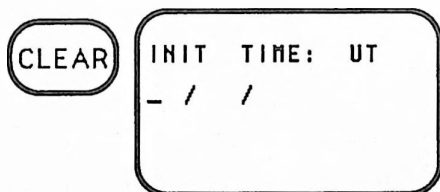
The unit can be operated in both Universal Time (UT) or local time, but must be initialized in Universal Time coordinates (UT) before initializing local time. The actual time display is selected in AUX 1, Set Up. Before setting or resetting time read the chapter *Time* in Section 2.

Since the GPS satellite system provides more accurate time than is usually available to you, it is wise to collect time directly from the satellites using AUX 3, Almanac Collect.

The NAV 1000's internal clock may drift if it has not received satellite information in quite a while. You can refresh the AUX time display by simply taking a position fix. If fewer than three satellites are available, use AUX 3 to refresh time. Refer to *AUX 3* in Section 5 for details.



Press the INIT and DOWN ARROW keys. The UT time and date display. When there has been a recent memory loss, this data will appear.



In those circumstances when you want to reset the time, simply press CLEAR to reenter UT time. Enter the date first. Then the time field will appear.

NOTE: Date Order MMDDYY or DDMMYY is selected in AUX 1.

INIT

INIT
↓
INIT TIME: UT
01/13/80
00:05UT
↓ →

To initialize local time, start from the INIT Time display.

→
INIT TIME: LOCAL
08/11/89
00:28:00AM
↓ →

The RIGHT ARROW key is used to select local time (AM/PM or 24 hour). Time is changed in the same manner as shown above.

NOTE: 24 hour local time has no label. The unit will remember the half hour offset between your entry and UT. Whatever your local time, the unit will correct minutes and seconds based on universal time obtained from the satellites.

SECTION 4

DIFFERENTIAL AND THE DATAPORT

THE THEORY BEHIND DIFFERENTIAL

The horizontal accuracy of a single position fix from a GPS receiver is typically 25 meters RMS (root-mean-square) or better. If the distribution of fixes about the true position is circular normal with zero mean, an accuracy of 25 meters RMS implies that approximately 63% of the fixes will be within 25 meters and approximately 98% will be within 50 meters.

The sources of positioning error generally fall into two categories: those which are correctable with a process called differential positioning; and those which are not. In the first category are those errors which are essentially the same for two GPS receivers located sufficiently close together and which can be mostly cancelled by using differential positioning. Note the errors do not add directly because totals are based on root sum squared calculations.

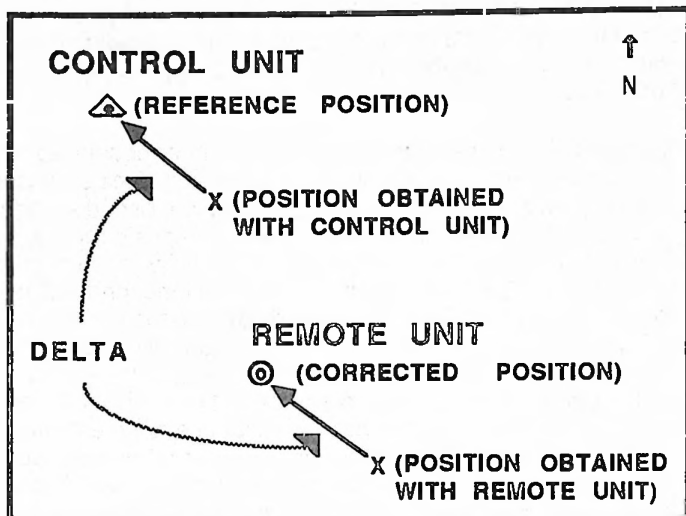
ERROR SOURCE	APPROXIMATE AMOUNT OF EQUIVALENT RANGE ERROR (RMS)
<u>Correctable with Differential</u>	
Clock (Space Segment)	3.0 meters
Ephemeris (Control Segment)	2.7 meters
Ionospheric Delay (Atmosphere)	8.2 meters
Tropospheric Delay (Atmosphere)	1.8 meters
Selective Availability (if implemented)	27.4 meters
TOTAL	28.9 meters
<u>Not Correctable with Differential</u>	
Receiver Noise (Unit)	9.1 meters
Multipath (Environment)	3.0 meters
TOTAL	9.6 meters
Total User Equivalent Range Error (all sources)	30.5 meters
Navigation Accuracy (HDOP=1.5)	45.7 meters

The second category consists of errors which are not correlated between two GPS receivers located in the same general area. Operation in the differential mode is ineffective in eliminating these errors, although they are substantially reduced by fix averaging in the NAV 1000 PRO.

As shown in the above table, there are five primary error sources which are correctable by differential operation. The satellite clock error is a slowly changing error which appears as a bias on the pseudo-range measurement made by a GPS receiver. The ephemeris error is a residual error in the transmitted data used by the GPS receiver to locate the position of each satellite in space. The ionosphere delay error results from the inability to precisely determine the variation in the velocity of the GPS radio signal caused by the density of electrons along the signal path through the ionosphere (located in the upper portion of the earth's atmosphere). A similar, but usually smaller error, called tropospheric error, results from the residual error in estimating the refraction, or curving, of the GPS signal path as it travels through the troposphere (lower portion of the atmosphere). Tropospheric refraction is related to humidity, temperature and altitude at points along the signal path. The last error source is due to selective availability (S/A), in which errors are deliberately introduced into the GPS signals and data to degrade fix accuracy. The amount of S/A error varies randomly in time and is not transmitted to the GPS receiver.

Each of these five error sources shares an important characteristic---the amount (and direction) of the error at any given time does not change rapidly as the location of the GPS receiver changes. In other words, two GPS receiver units sufficiently close together (say, within 100 Km of each other), will observe about the same fix error due to these five error sources.

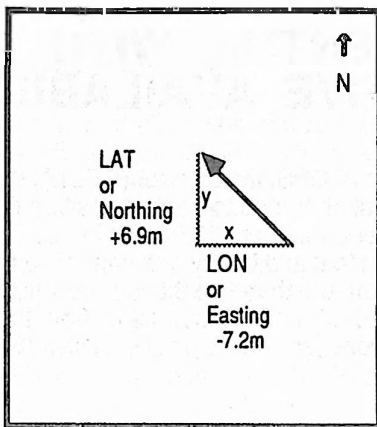
The idea behind differential operation is to put one unit (called the "Control Unit") at the control point whose position is known with sub-meter accuracy and to compare the fix given by the Control unit with the accurately known control point to obtain a fix error. This fix error (called DELTA in the NAV 1000 PRO) is assumed to be about the same as the error in a second unit (called the "Remote Unit") located in the field, so a fix taken at the same time by the Remote unit can be corrected by DELTA to improve its accuracy. The resulting accuracy of the Remote unit is typically within 5 meters RMS in 2D mode as contrasted with 25 meters in single-fix, non-differential 2D operation.



CORRECTABLE POSITION ERROR IN DIFFERENTIAL OPERATION

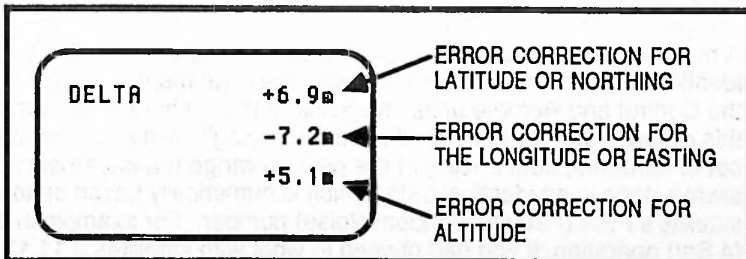
In order for differential operation to work, both the Control and Remote units must use the same satellites, must operate in the same mode (2D or 3D), must take their fixes at the same time and must be located close enough together so that the ionospheric and tropospheric errors are nearly the same. While others have reported success in separating the Control and Remote units by over a thousand kilometers, we recommend the two units be no further than 50 kilometers apart because of the limitations of the tropospheric corrections. The requirement for time synchronization of the fixes arises from the rapidity with which the S/A errors vary, which is discussed in the next section.

The DELTA always directs you to the *desired* position, whether it be the corrected position or a place you are trying to locate from the position obtained with a unit.



COMPONENTS OF THE DELTA

Always given in meters, the DELTA correction is parallel to the surface of the earth. Expressed using a local coordinate system, the DELTA in 2D uses a North-South axis (y) and an East-West axis (x). In 3D, a third axis perpendicular to the surface of the earth is used for altitude. Thus, DELTA has two components in 2D and three components in 3D. The DELTA always directs you to the *desired* position, whether it be the corrected position or a place you are trying to locate from the position given by the unit. When DELTA is calculated using the DIF key, its y, x, and z (north, east, altitude) components are listed in that order.



THE DELTA DISPLAY IN DIF

DIFFERENTIAL WITH SELECTIVE AVAILABILITY

In the early days of GPS, the fix error (DELTA) determined at the control point could be used to correct position fixes obtained by the Remote unit over a period of 10 to 15 minutes. This permitted a user with a single unit to stand briefly at a control point, establish the DELTA correction and then use that correction reliably at a new location within 10-15 minutes travel time from the control point. This technique still works with the Block I satellites (Sat numbers 3, 6, 9, 11, 12 and 13).

However, the Department of Defense policy at the printing of this user guide is to employ a technique referred to as Selective Availability (S/A) to degrade the GPS signal at their discretion. The exact method used to do this remains classified but it will involve dithering the satellite clocks and corrupting the ephemeris in such a way that a DELTA correction is useful for a maximum of about 40 seconds. The non-differential accuracy during periods when S/A is in effect is 100 meters 2D RMS or 50 meters RMS. (2D RMS is always twice the RMS value.)

When S/A is being applied users have reported that fixes in differential operation mis-matched in time by as little as 5 seconds suffer in accuracy formerly achievable with differential operation in the absence of S/A.

A method to circumvent this and to defeat selective availability is to identically match the timing of the pseudo-range measurements of the Control and Remote units. Magellan has a technique for doing this called "Time synchronized pseudo-ranging". Among a chosen set of satellites, sequencing of the pseudo-range measurements is always done in an identical order which is numerically based on the satellite's PRN (Pseudo-Random Noise) number. For example in 3D (4 Sat) operation, if you had chosen to work with satellites 3,11,13 and 14, the NAV 1000 PRO would collect pseudo-range data in that order. Furthermore, data collection would always begin at specific 20 second epochs (in 3D), or 15 second epochs (in 2D). This results in

data collection which is identically matched in time; hence, the error due to selective availability is effectively cancelled when the DELTA correction is applied to the Remote unit.

Successful implementation of time synchronized pseudo-ranging requires that each fix taken by the Control unit has a corresponding synchronized fix taken by the Remote unit. The full benefit of differential operation is obtained by averaging a number of synchronized fixes at both the Control and Remote points to reduce the random errors (primarily caused by receiver noise and multipath effects) which cannot be reduced by differential correction. In the NAV 1000 PRO, this is accomplished by storing a running average of time-synchronized fixes in both the Control and Remote units. The average of a specified set of these fixes is used to compute the DELTA correction, which can then be relayed to the Remote site by voice link. The correction can then be applied to the average of the corresponding fixes in the Remote unit to obtain a high accuracy fix. This method of differential correction is especially useful when the NAV 1000 PRO is being used to locate bench marks in near-real-time in the field. Alternately, post-processing can be used to select the corresponding Control/Remote fix sets. Post-processing is especially useful in marginal situations where signal dropouts might occur, because one has the capability to cull out fixes which do not have a matching fix from the other unit.

Pre-site planning is essential for a smooth session. If both the Remote and Control operators agree on the best satellites to use during each half hour interval (See *Aux 5, Sat Status* in Section 5) and the number of fixes to keep in the running average, a half minute cellular or VHF communication is all that is needed to stop the running average and communicate the DELTA correction from the control to the Remote user. Accuracies achievable using this method of post in-the-field processing are remarkable, even with S/A in effect.

DIF (DIFFERENTIAL) KEY

The DIFFERENTIAL function (DIF) is a simple feature that allows you to remove a known GPS system error from an averaged position in the field. If the data is to be post-processed using the raw data files, the DIF (differential) key is not used.

The DELTA is obtained from a control point using a precisely surveyed reference point. ** The averaged position is obtained from the SURVEY function, when averaging is set in AUX 4.

The Control Point is a known position, which the unit uses to calculate a correction in the form of a DELTA to a Remote unit to improve its accuracy.

The user first enters a reference waypoint using the Waypoint Function then collects fix data at this point, which is called the Control point. DELTA is the difference in meters of the averaged fix data from the reference point. The DELTA is then applied to a matched set of fixes at the Remote location, using the "differential" to improve the accuracy of the Remote unit. The corrections can be made using post-processing or in the field using the DIF key.

With the DIF key, the user corrects for a known offset to make use of the capabilities of differential GPS. Horizontal accuracies of 5 meters or better (when HDOP \leq 1.75) can be achieved using this capability when the necessary considerations are followed.

** Contact the Geodetic Survey officials in your area to obtain horizontal and vertical geodetic control points to work with. In the United States, contact the National Geodetic Information Branch of the National Geodetic Survey (NGS) at (301) 443-8631. Specify a 30 minute area, and they will give you a quotation for the data over the phone.

**Considerations Necessary for
Field Use of Differential:**

- One unit must be at a known position, a previously surveyed position or a geodetic control point.
- The Remote and Control units must be within 50 km of each other.
- The units must be locked on to identical satellites and be set in the same mode. (See AUX 4 and INIT.)
- Both units must average the same number of fixes. (See AUX 4.)
- The Remote and Control data sets must be synchronized and matched time-wise. (See the next section and AUX 4.)

NOTE: Refer to *Easy Steps for Running a Differential Session in Setting Up for Differential*.

Synchronized Data Collection

To match data sets time-wise, Magellan employs time-matched pseudo-ranging. Using the first satellite in the data and pseudo-range collection sequence, it sets a 15-second epoch in 2D and a 20-second epoch in 3D. During post-processing, the RE4MAT software first sorts the Control and Remote files making certain the same mode and satellites have been used, and then time matches individual Remote and Control unit fixes.

For using differential in the field, Magellan has two methods of matching averaged data sets: Running Average and Auto Stop. Of the two, Running Average is recommended for general use. Running Average is always time synchronized. It averages the number of fixes set in AUX 4; instead of giving an average at that point, it will then keep a running average of that number available in memory. To obtain the average, the user merely presses the ENTER key when the display says "READY" (and within 5 seconds of the beep). If both Control and Remote operation stop data collection at the same time, their data sets are matched identically in time.

DIF

In the event that averaging is interrupted in Running Average, the units will automatically restart. After some time and when the "READY" display appears, both data sets will be time-matched again.

Where signal interruptions are highly unlikely, Auto Stop can be used to time match. After selecting Auto Stop in AUX 4, you must select "SYNCED" for "synchronized" and select identical satellites to be used in the session, just as in Running Average. Then press the SURVEY key on both the Control and Remote units. When the units begin averaging, you will see the number averaged in the lower left of the displays. If those numbers do not match, simply wait for the next beep and press the CLEAR key on both units. The number will reset to "0". When the number selected for averaging is reached, the average position will be automatically displayed. If, however, the signal is interrupted, the unit will not restart; rather it will display "SIGNAL INTERRUPTED".

The DELTA can be added in the field immediately after data collection, or later back in the office, if the accuracies achievable with differential are not needed in the field.

The field differential process is easier to understand by doing than by reading about it. The best way is to run two units side by side using Running Average and the same number of fixes to average. If the users of the Remote and Control unit press the ENTER key simultaneously (± 5 seconds), the units will be able to provide roughly 5 meters RMS of accuracy when fixes are averaged for about 10 minutes (32 fixes).

Averaged and/or corrected positions can be stored. If a DELTA correction is made, the corrected position is stored along with the DELTA. Simply press the CLEAR key when the DELTA screen is being viewed either in the Waypoint (WPT) or Differential (DIF) function to restore the original information.

Stored averaged positions are retrieved in the Waypoint Function. All averaged fixes have labels that begin with \bar{x} ... If the DIF Function

has been employed to add a DELTA to averaged data, the waypoints will keep that value in the fourth display.

We will explain this field differential process from the perspective of the Control unit and the Remote unit.

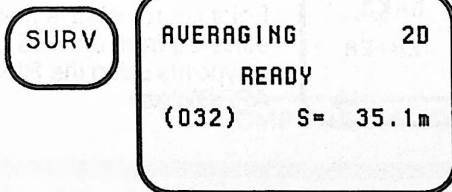
Unit at the Control Point

For both the Control and Remote units:

- (1) Select the same mode (2D or 3D) with INIT.
- (2) Enter the identical number of fixes to average with AUX 4
- (3) Select running average with AUX 4.
- (4) Select the same satellites with AUX 4.
- (5) Press the SURVey key.

To illustrate this process, we will use an example where the Reference is a geodetic control point with the coordinates 34°00.0000N, 118°00.0000W, 159 meters ALT (MSL). This reference point was entered as the waypoint MRK3.

Data was collected simultaneously at both the Control point and a Remote station about 10 kilometers away where a surveying crew was attempting to locate a monument covered by brush and sand. Using pre-site planning and brief telephone communication, data collection was coordinated so both units averaged 32 fixes, collected using Running Average (synchronized), using 2D mode with a known altitude. The units selected the same satellites: 11, 13, and 19.



Set to Running Average, the unit has collected a Running Average of 32 fixes.

DIF

ENTER

```
AUG      34°00.0005N  
          118°00.0017W  
2D      +00159m ALT  
                               ↓
```

Both the Control and Remote unit operators press the ENTER key at the same time, just after a beep.

↓

```
AUG      NR083  
(35.1)   05/04/90  
(032)   15:16:49UT  
                               ↓
```

Press the DOWN ARROW key to reaffirm that the average at both the Control and Remote units have the same date, time, satellites, and therefore, the data sets are matched.

DIF

```
SELECT  
SITE:    CONTROL  
AND PRESS ENTER  
                               →
```

DIF is now used to calculate the DELTA. When the DIF key is pressed, Control is the first option.

ENTER

```
SELECT REFERENCE  
WAYPOINT:  MARK3  
AND PRESS ENTER  
                               →
```

Press ENTER. The Reference Waypoint containing the true Control Point coordinates is now selected from entered waypoints using the RIGHT ARROW key.

ENTER

SELECT AVERAGED
POSITION: AVG
AND PRESS ENTER



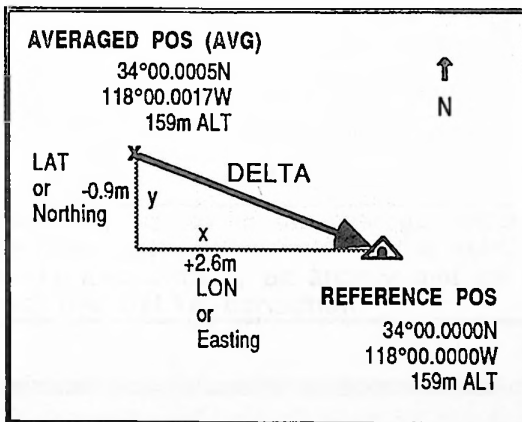
After pressing the ENTER key, the first option is the averaged position (AVG) just calculated. (The RIGHT ARROW key selects other averaged positions stored in Waypoints.)

ENTER

DELTA -0.9m
 +2.6m
 +0m ALT

Press ENTER and the DELTA is computed. This correction can now be applied to the data set collected at the Remote site.

Note that the altitude component is zero, since in 2D mode, known altitudes are used.



COMPONENTS OF DELTA

DIF

ENTER

DELTA

18.1

+2 ALT

No DELTA will be displayed for any component that exceeds the equivalent of 1° latitude or longitude.

The Remote Unit

At the work site, the Remote unit obtained an average position of 34°05.1425N, 117°59.6588W, and 163 meters ALT (MSL) in 2D.

ENTER	AUG	34°05.1425N
		117°59.6588W
	2D	+00163m ALT
		↓

Working with the averaged position obtained with the Remote unit, you will now add the DELTA correction obtained with the Control unit.

ENTER	ARC5_	34°05.1425N
		117°59.6588W
	2D	+00163m ALT
		↓

C
5

First, save the averaged position, giving it a name that is appropriate for the job.

We recommend saving the averaged data twice when using differential in the field. Save the data once as an archive and for adding the DELTA correction.

DIF

DIF

SELECT
SITE: CONTROL
AND PRESS ENTER

Press the DIF key, and then...

→

SELECT
SITE: REMOTE
AND PRESS ENTER

the RIGHT ARROW key to select Differential for the Remote Site.

ENTER

SELECT AVERAGED
POSITION: AVG
AND PRESS ENTER

After pressing ENTER, the user is asked to select the averaged position. The current average (AVG) appears. Another averaged position can be selected using the RIGHT ARROW key or by entering in its name, e.g. $\bar{x}C5$.

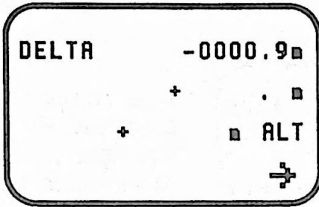
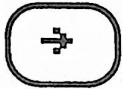
ENTER

DELTA +0.0m
 +0.0m
 +0m ALT

To enter the DELTA, press the CLEAR key to begin data entry, ...

DIF

00009



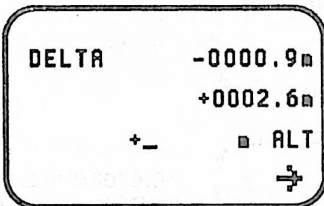
Or begin entering the new numbers to put in the DELTA exactly as it appears in the Control unit. Remember to use leading 0s and toggle to negative sign with the RIGHT ARROW key, if needed.

NOTE: Simply enter the DELTA value exactly as calculated by the Control unit; the NAV 1000 PRO calculates and applies DELTAs with the proper direction (+ or - sign); simply enter the DELTA value calculated by the Control unit.

ENTER

00026

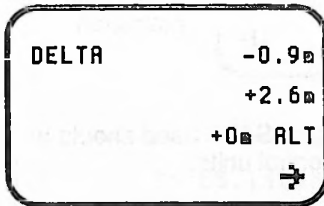
ENTER



Continue to enter in the entire DELTA.

00000

ENTER



The altitude correction will be 0 since this was 2D differential. After pressing ENTER, the leading 0s disappear. Press the ENTER key one last time to complete the process.

DIF

ENTER

```
AUG      34°05.1420N
          117°59.6571W
2D       +00163m ALT
          ↓
```

After completing the entry, press ENTER and the averaged position recalculates, taking into consideration the DELTA.

↓

```
AUG      NAD83
(15.3)   05/14/90
(032)    15:16:49UT
          ↓
```

The DOWN ARROW key simply reveals the figure of merit, fix current datum and date (time of the last fix in the set).

↓

```
AUG       $\bar{x}$ PDOP    1.6
SAT      11  13  19
 $\bar{x}$ SQ      9    7    8
          ↓
```

Another press of DOWN ARROW reveals the average PDOP and average signal quality for the data collection session.

NOTE: The date, time, mode and SATS used should be identical on the Remote and Control units.

↓

```
DELTA      -0.9m
            +2.6m
            +0m ALT
```

The last DOWN ARROW reveals the DELTA just entered.

NOTE: The position has been permanently recalculated using the DELTA just applied. To remove the DELTA and go back to the original uncorrected position, locate the averaged position in the WPT function. Use the DOWN ARROW key to reach the DELTA screen. Press the CLEAR key twice. The DELTA will automatically be removed and the position or averaged data will be restored to the original values.

Using DIF to Find an Object

Once the correct Remote position has been calculated there are two ways to determine where you are in relation to your objective: the DIF key and COURSE key. Only when you are at least 20 meters from your objective can the COURSE feature be used.

Let us say that your goal is a Benchmark located in heavy brush at 34°05.1674N, 117°59.6570W, 163m ALT. Enter this position as a waypoint.

WPT	GOAL	34°05.1674N
G		117°59.6570W
ENTER		+00163m ALT
		↓ →

Enter your objective position as a waypoint...

	AUG	34°05.1420N
		117°59.6571W
	2D	+00163m ALT
		↓

To compare it with the corrected average position.

DIF

DIF

SELECT
SITE: CONTROL
AND PRESS ENTER



Use the DIF feature to orient yourself to the objective.

ENTER

SELECT REFERENCE
WAYPOINT: MARK
AND PRESS ENTER



The reference waypoint will be the one containing the coordinates of your objective.



SELECT REFERENCE
WAYPOINT: GOAL
AND PRESS ENTER



Press the RIGHT ARROW key until the objective waypoint (GOAL in the example) is selected.

ENTER

SELECT AVERAGED
POSITION: AVG
AND PRESS ENTER



Now select the corrected average.

ENTER

DELTA	+47.1m
	-0.2m
+0m ALT	

To find your objective walk 47 meters directly north. You will likely be within 5 meters RMS of your objective.

AVG	TO	GOAL
000°T		47m

When the object is more than 20 meters from your position, use the **COURSE** function to calculate the bearing and distance from your current position to the objective.

SETTING UP FOR DIFFERENTIAL

Based on our work and that of others, we recommend that the Control unit and the Remote unit be no further than 50 kilometers apart for best accuracies.

First assemble equipment needed to complete the assignment. These may include a laptop computer or data logger, disks, communications software, mounts to adapt to range pole or tripod, batteries or power interfacing. (The unit will operate continuously on one set of internal AA batteries for up to 7 hours.)

Weigh the accuracy needed for the project with the maximum achievable with the Magellan GPS NAV 1000 PRO. The accuracy of the Control point, plus the innate accuracy of the NAV 1000 PRO at the given PDOP (HDOP in 2D) is the maximum accuracy achievable.

The accuracies achievable with differential reported by Magellan are based on 10 minute data collection sessions. Combining the results from several good data collection sessions with good PDOPs will often produce horizontal accuracies better than a meter. Conditions for this are that the sessions represent samples of different times in the GPS constellation day and that the satellites with the best geometries are used.

Best results occur using 2D mode with a known altitude. Where the altitude of both points is known to be within 3 meters or better, use 2D which will always achieve better horizontal accuracies (<5 meters RMS) than 3D (<10 meters RMS).

Pre-site planning or experimentation is usually necessary.

- (1) Using a map or pre-site visit, evaluate the constraints of the site in terms of the view of the sky.
- (2) Compare that to satellite elevations in AUX 5, Sat Status, looking in half hour intervals at the elevation and azimuth of the satellites and the PDOP of the optimum constellation (the one with the best accuracy. (See EXAMPLE PRE-SITE PLANNING WORKSHEET and see AUX 5 in

Section 5.)

- (3) Select the candidate satellites, four for 3D and three for 2D, to be used in the session.
- (4) Check the PDOPs of the candidate satellites if they are different from the optimum constellation computed in Step 2. To do this, repeat step 2 and either turn off satellites (using AUX 5) that will not be used in the session or use AUX 4 to specify the session satellites.

With pre-site planning, the Control unit and the Remote unit always follow the set up planned in this worksheet. If post-processing is to be done, rather than using the differentially corrected information in the field, there is no need to communicate during the data collection period, unless one or the other units is having problems.

PRE-SITE PLANNING WORKSHEET

DATE: 12/8/89 JOB: Example
 TIME: 6:00am-8:00am
 MODE: 2D

SATS, WITH ELEVATION/AZIMUTH

TIME	FILE NAME	2	3	6	9	11	12	13	14	16	19	PDOP (2D)
5:45-6:15	A-12-8.2D	-	49°/300°	-	<u>14°/167°</u>	6°/49°	47°/200°	44°/15°	<u>20°/44°</u>	-	<u>34°/274°</u>	1.3
6:15-6:45	B-12-8.2D	-	51°/323°	-	1°/165°	-	32°/194°	32°/31°	<u>15°/32°</u>	<u>8°/164°</u>	<u>33°/258°</u>	1.8
6:45-7:15	C-12-8.2D	-	52°/347°	-	-	-	18°/188°	<u>30°/46°</u>	8°/23°	<u>20°/161°</u>	<u>28°/242°</u>	1.5
7:15-7:45	D-12-8.2D	-	<u>51°/10°</u>	-	-	-	-	24°/61°	-	<u>33°/156°</u>	<u>22°/229°</u>	1.6
7:45-8:15	E-12-8.2D	-	<u>48°/33°</u>	-	-	-	-	<u>16°/17°</u>	-	<u>48°/152°</u>	<u>13°/218°</u>	2.1

RUNNING AVERAGE = 32

NB: SATS with best PDOP are underlined.

Easy Steps For Running A Differential Session

Instructions for use with a laptop or data logger

With both the Control and Remote units:

- (1) Connect units to a laptop or data logger.
- (2) Start up the communications software (GPSCOMM) on the computers, coordinating file names for easy post-processing, e.g. A-MALL.CTL, A-MALL. RMT for Control and Remote units.
- (3) Select the same mode (2D or 3D) with INIT.
- (4) Enter any number of fixes to average (other than 1) with AUX 4. (NOTE: The figure of merit will reflect the number of fixes selected to average.)
- (5) Select running average in AUX 4.
- (6) Select the same satellites with AUX 4.
- (7) Turn the dataport on with AUX 8.
- (8) Press the SURVey key. The unit will search, collect ephemeris data and begin sending individual unformatted fixes both to the laptop and the data buffer.
- (9) When the data collection session is complete, press ENTER after you hear the beep and close the file on the laptop.

NOTE: For mistake-proof post-processing, store each data collection session separately. If you change satellites or mode, open a new file. Read the next section on the Dataport and GPSCOMM for more information.

Instructions for field use of real-time differential

With both the Control and Remote units:

- (1) Select the same mode (2D or 3D) with INIT.
- (3) Enter the identical number of fixes to average with AUX 4
- (4) Select running average with AUX 4.
- (2) Select the same satellites with AUX 4.
- (5) Press the SURVey key. The unit will search, collect ephemeris data and begin the averaging process. The raw data is available in the Data Buffer, AUX 7*.
- (6) When the READY display appears, get in contact with the Control unit. Wait for the next beep, press ENTER together.
- (7) Save the AVG (averaged data)

* AUX 8, data cables, and GPSCOMM can be used to log data simultaneously on a lap top computer.

For a better understanding, read the remainder of this chapter.

Post-processing using buffer files

It is possible to use the post-processing software (RE4MAT) with the buffer files downloaded after the session. Clear the buffer by pressing the CLEAR key at the AUX 7 display before collecting data so only a single session will be in the data buffer. A text editor can also be used on the Control buffer to create separate files with only those fixes which apply to the session.

THE DATAPORT

Magellan supports MS-DOS based computer systems. To log data with an external computer, use the 9-pin adapter. The three-pin adapter end of the cable plugs into the PRO's dataport at the right side of the unit. The DB-9 connector fits onto the laptop or other computer serial port.

If your computer uses another type of connector for its serial port, e.g. DB-25, an inexpensive adapter is available at any computer store.

Magellan has provided three different communications and post-processing software packages to assist you in working with data. These are all MS-DOS compatible and are supplied on both a 3-1/2" and 5-1/4" double-sided, double-density format.

- GPSCOMM** to log data on a laptop or computer and to transfer files from one computer to the next.
- CSPREAD** to see a scatterplot of your data collection session and to obtain useful statistics about the variability of the data.
- RE4MAT** to take Magellans' unformatted files and put them in fixed length, single record per line, ASCII files. This software is also used to post-process for differential operation.

The list of files on the disks are:

- LOG.EXE** to execute GPSCOMM.
- CS.EXE** C-SPREAD session statistics .
- CS87.EXE** same as above but for use with a math co-processor.
- RE4MAT.EXE** reformatting and differential post-processing.
- RE4MAT87.EXE** same as above but for use with a math co-processor.

- ANSI.SYS** to set the terminal interface to ANSI standards.
- CONFIG.SYS** to configure the memory properly for both GPSCOMM and RE4MAT.
- RE4MAT.DOC** extra documentation for RE4MAT which explains file formats for the various options available in the program.
- GPSCOMM.DOC** extra documentation for GPSCOMM.

Keep the original disk as an archive. Copy the programs to a work disk. Now erase from the work disk the duplicate CSPREAD and RE4MAT files. This will make more room on the disk for logging data. If you have a math co-processor on the computer you will be using, erase the versions without the capability to use it. If you do not have a co-processor, erase the files with "87" in the name.

For ease of use, start with a fresh disk and create a bootable disk using the following DOS commands. Put your DOS disk in the drive and the new disk in the B: drive and do the following:

```
A> FORMAT/s B: <ENTER ↵>
A> COPY COMMAND.COM B: <ENTER ↵>
```

Now put the work disk in the A:drive:

```
A> COPY *.* B: <ENTER ↵>
```

To log data, you will need GPSCOMM, a simple program provided by Magellan for naming and writing data to a file. Data can also be logged using a communications package of your own choice, though we do not guarantee that our other programs will work with files generated with such software.

GPSCOMM

To capture data from the PROs RS-232 data port to an external computer, use GPSCOMM, which consists of three files:

LOG.EXE
ANSI.SYS
CONFIG.SYS

This program can also be used to transfer data from one computer to another .

To Log Data

At the A> prompt from DOS, type LOG <ENTER ↵>

You will see the following displays:

MAGELLAN GPSCOMM

Copyright Magellan Systems Corp., 1989, 1990.

F7 - Log data
F1 - Help
F3 - Transmit existing file to a computer
F4 - Receive file from a computer
ALT X - Exit

Press <F7> to log data and enter the file name.

Enter LOG filename: ACULLIN.3D <ENTER ↵>

The laptop will display:

LOG ON

The LOG ON message indicates the laptop is ready to receive data.

NOTE: Each data collection session should be stored into separate files.

When the session is finished, complete it in an orderly way, by pressing ENTER, if Running Average is used. Then close the laptop file by pressing <F7>. You will see the lap top display "LOG OFF". Use <ALT> <X> to return to DOS.

To Transmit Files From Computer To Computer

To start, you will need to have a copy of GPSCOMM on both the sending and receiving computers in order to transmit the file from one file to the next. This process requires the serial ports be connected.

First type "LOG" on the receiving computer. Select <F4> receive file from a computer. GPSCOMM will ask you to :

"ENTER RECEIVE FILE NAME"

Name the file and press <ENTER ↵>

The display will tell you:

"READY TO RECEIVE"

Now at the send computer, type "LOG" at the DOS A> prompt. At the selection, press <F3> to transmit the existing file to a computer. GPSCOMM requests you to:

"ENTER TRANSMIT FILE NAME"

Enter the name of a file, e.g., 12-12.3D and press <ENTER ↵>

The display will inform you :

"ENTER TRANSMIT FILE NAME: 12-12.3D"

"FILE OPEN"

"PLEASE WAIT"

When the transmission is complete, the display will inform you:

"COMPLETED"

Press <F3> again to close the file.

Returning to the receiving computer, press <F4> to close the newly transferred file. The display will read:

"FILE CLOSED"

Unformatted Data

Data coming from the unit is downloaded in real-time or after the data collection session from data stored in the unit.

This data is unformatted and may not be particularly useful to you without running Magellan's RE4MAT program. However, we will describe it here so you can understand the file structure and many messages embedded in the flow of information.

REAL TIME DATA

A sample of the data you will see being logged real-time is provided in the table below:

UNFORMATED DATA SAMPLE FILE REAL-TIME DATA

Ⓐ	SATS 5 03 09 11 12 FAIL SRCH FAIL SRCH
Ⓑ	SATS 4 03 11 12 13 DATA 1 DATA 1 DATA 1 DATA 1 TIME,LAT,LON,ALT +2. 14793847306053 E + 05 +5. 88719450389604 E - 01 -2. 05606265275151 E + 00 +6. 20885696411133 E + 01 MODE 3D SATS,SNR,GPSWK 03 11 12 13 0091 0044 0063 0122 0518 PDOP +5. 0838652 E+00
Ⓒ	TIME,LAT,LON,ALT +2. 14812875331802 E + 05 +5. 88721730805605 E - 01 -2. 05606418961781 E + 00 -6. 88419036865234 E + 01 MODE 3D SATS,SNR,GPSWK 03 11 12 13 0099 0041 0070 0135 0518 PDOP +5. 0838652 E+00

At the first fix, the data will list the number of satellites (SATS) available (5) to the user, according to almanac information, that are above the 10° mask angle. On the same line, it lists the ones it will search for.

If it fails in the search for one of those satellites it will declare it temporarily unavailable in the almanac, assuming it is hidden from the antenna's view. See (A) in the sample unformatted data file.

Before the next search, the next line shows the number now available (4) and list the SATS it will look for. See (B) in the sample. "DATA 1" means successful search for all satellites and that it has collected the ephemeris data from a SAT.

The other terms are described below:

The last variable in the record is PDOP.

The numbers are given in scientific notation, where $2.1 \text{ E}+05 = 2.1 \times 10^5 = 210,000$.

The next and subsequent records until the unit switches SATS again is limited to TIME, LAT, LON, ALT, through PDOP. (See (C))

TERMS FOR UNFORMATTED DATA

SATS	Satellites, identified by their pseudo-random noise (PRN) number.
DATA 1	Collection of the ephemeris data from a satellite has been successful.
TIME	GPS time in seconds from the beginning of the GPS week. (Mid-night, Sunday in UT).
LAT	Latitude in radians based on the WGS84 datum.
LON	Longitude in radians based on the WGS 84 datum.
ALT	The altitude, as height above the WGS 84 ellipsoid in meters.
MODE	Mode in 2D or 3D.
SNR	Signal-to-noise ratio.
GPSWK	The GPS week counting from week one, January 6, 1980.
PDOP	Position Dilution of Precision.
FAIL SRCH	Failed search; couldn't find the satellite.
PSDR FAIL	The unit failed during pseudo-range collection on a satellite.
DATA /	The unit failed during collection of the ephemeris data.
BIRDIE	The unit encountered a spurious signal where it expected a satellite signal.
TEN MINUTES	The unit is doing its 10 minute housekeeping chores, including checking power levels, calculating PDOP, checking the status of other available SATS.

DOWNLOADED STORED DATA

When the fix buffer, waypoints or averaged data is downloaded, the data is slightly different. None of the search information is stored in the unit, so it is unavailable.

The records are from the fix buffer, which can store up to 200 of the last fixes. From this file, you will recognize these variables: time, latitude, longitude, altitude, mode, the SATS used, their signal-to-noise ratio, the week, the PDOP and the NAME.

The fix buffer data is named in the convention L001, L002, L003,.... Averaged position data all begin with an \bar{x} followed with the three letters you named them with. Just preceding the name associated with the data, averaged positions will include the number of fixes, the figure of merit in meters, and the DELTA LAT, DELTA LON, and DELTA ALT in meters and in that order. Waypoints are labelled just as you named them.

UNFORMATTED DATA SAMPLE FILE BUFFER

TIME,LAT,LON,ALT	
+5.73842000000000	E+05
+5.88691293495612	E-01
- 2.05606976902126	E+00
+4.20702503356934	E+01
MODE 2D	
SATS, SNR, GPSWK	
03 12 13	
0095 0045 0061	
0516	
PDOP	
+1.99477005004883	E+00
NAME L001	

Time on position fixes from the buffer is stored to the second and is truncated rather than rounded.

C-Spread

Magellan has provided a statistical program to run with your unformatted data file. It can be used to analyze a data set alone or in comparison with a known point.

At the DOS prompt type:

A> CS <ENTER ↵>

A> CS87<ENTER ↵>, if the co-processor version is used.

The display will show:

MAGELLAN C-SPREAD

Copyright Magellan Systems Corp., 1989, 1990.

PRESS ANY KEY TO CONTINUE

KNOWN LOCATION: NOT USED

GRAPHICS ADAPTER: NONE

SELECTION ITEMS:

RD--TO RETRIEVE KNOWN POSITION AND GRAPHICS ADAPTER FROM DEFAULT FILE
SD--TO STORE KNOWN POSITION AND GRAPHICS ADAPTER (ABOVE) IN DEFAULT FILE
NL--TO ENTER A NEW KNOWN LOCATION
N--IF A KNOWN LOCATION IS NOT TO BE USED
C,E,V OR H--TO USE PROGRAM WITH CGA/EGA/VGA/HERCULES GRAPHICS
NG--IF COMPUTER HAS NO GRAPHICS CAPABILITY (SCATTERPLOT NOT SHOWN)
R --TO RUN PROGRAM
Q--TO QUIT

ENTER SELECTION:

CSPREAD MAIN MENU

To enter in a known point select NL. The data must be entered in WGS 84 datum. Use the height above ellipsoid. Note that you can enter the position in degrees, minutes, seconds:

LATITUDE OF KNOWN POSITION, NORTH (N) OR SOUTH (S)? N

ENTER DEGREES: 33

ENTER MINUTES: 47

ENTER DECIMAL SECONDS: 48.48

LONGITUDE OF KNOWN POSITION, EAST (E) OR WEST (W)? W

ENTER DEGREES: 118

ENTER MINUTES: 21

ENTER DECIMAL SECONDS: 09.03

IF ALTITUDE OF KNOWN POSITION IS NOT AVAILABLE, JUST HIT ENTER .

IN THIS CASE, ALTITUDE WILL BE ASSUMED TO BE 0 METERS.

IF ALTITUDE OF KNOWN POSITION IS AVAILABLE, ENTER THE ALTITUDE AS +/-
DECIMAL METERS ABOVE THE WGS-84 ELLIPSOID.

ENTER ALTITUDE: 126

ENTERING KNOWN POSITION

You can also select the graphics adapter so the scatterplot will display on your screen. From the main menu, press C,E,V or H for a CGA/EGA/VGA/HERCULES Graphics adapter. If you get a graphics error message, try a different adapter selection.

To store both the known location and the type of graphics adapter for future use, select **SD**. The information will be stored in a file named "CDEFAULT.DAT" on the default disk drive.

Press **N** if you are not comparing your data to a known point. And press **R** to run the program.

The program will prompt you for the file name:

```
ENTER FILESPEC OF INPUT FILE: B:12-20.30R

ENTER ERROR LIMIT FOR OUTLIERS, METERS: 1000

DATA FILE FORMAT ERROR AT FIX NUMBER 23 IN DATA FILE.
SOME FIXES FROM FILE WILL PROBABLY BE LOST.
PRESS C TO CONTINUE READING FILE, R TO RETURN TO MENU: R

THE CALCULATION OF CEP AND SEP VALUES REQUIRES
CONSIDERABLE TIME FOR LARGE DATA FILES.
DO YOU WANT TO CALCULATE AND DISPLAY CEP AND SEP VALUES (Y OR N)?
```

The CSPREAD program will ask if you want to specify a limit for outliers. If it encounters incomplete records (caused by disconnecting unit during a session), the program will inform you as shown. You must specify if you want to calculate Spherical Error Probable (SEP) and Circular Error Probable (CEP). Large data sets on computers without a math co-processor will take a very long time to calculate SEP and CEP if this option is selected.

The following statistical report is supplied when the program is run compared to a known point:

```
MEAN ERROR VECTOR X-COMPONENT, METERS: 1.084572953926541
MEAN ERROR VECTOR Y-COMPONENT, METERS: 2.530793522353966
MEAN ERROR VECTOR ALT-COMPONENT, METERS: 11.5659988627713
STANDARD DEV OF ERROR VECTOR X-COMPONENT, METERS: 9.77670759098368
STANDARD DEV OF ERROR VECTOR Y-COMPONENT, METERS: 7.377059915540356
STANDARD DEV OF ERROR VECTOR ALT-COMPONENT, METERS: 33.8501887603201
RMS X-ERROR, METERS: 9.836681849688279
RMS Y-ERROR, METERS: 7.799097951062103
RMS ALT-ERROR, METERS: 35.77160338596708
2-DIMENSIONAL RMS ERROR, METERS: 12.5533357583651
3-DIMENSIONAL RMS ERROR, METERS: 37.91033958519996
2-DIMENSIONAL MEAN RADIAL ERROR, METERS: 11.33665870669519
3-DIMENSIONAL MEAN RADIAL ERROR, METERS: 30.99960400219654
CEP, METERS: 9.872983840810431
SEP, METERS: 24.22011359008849
X-Y SCATTERPLOT (Y OR N)?
```

**STATISTICS
COMPARING DATA TO A KNOWN POSITION**

If the proper graphics adapter has been specified, the x-y scatterplot can be displayed. The scale for the display can be adjusted.

When a known point is not used, the statistics include the average of the data set, as shown below.

FILE NAME: 1-30-90.3D
OUTLIER LIMIT: 1000
NO OF GOOD SAMPLES USED: 366

AVE LATITUDE (DEG, MIN, SEC)
33 47 48.56184421807541 NORTH

AVERAGE LONGITUDE (DEG, MIN, SEC)
118 21 8.987793346900617 WEST

AVERAGE ALTITUDE ABOVE/BELOW WGS 84 ELLIPSOID, METERS 3.8766

STANDARD DEV OF SCATTER X-COMPONENT, METERS: 9.992539405719839
STANDARD DEV OF SCATTER Y-COMPONENT, METERS: 7.400605022532591
STANDARD DEV OF SCATTER ALT-COMPONENT, METERS: 121.4028115830612
2-DIMENSIONAL RMS DEVIATION, METERS: 12.43462096223276
3-DIMENSIONAL RMS DEVIATION, METERS: 122.0379549932762
2-DIMENSIONAL MEAN RADIAL DEVIATION, METERS: 10.87703091171739
3-DIMENSIONAL MEAN RADIAL DEVIATION, METERS: 29.42714285847287
CEP RELATIVE TO AVERAGE POSITION, METERS: 11.14751888522858
SEP RELATIVE TO AVERAGE POSITION, METERS: 22.09860671370709

X-Y SCATTER PLOT (Y OR N) ?

STATISTICS WITHOUT KNOWN POSITION

RE4MAT

RE4MAT is used to either reformat the data file or post-process two differential files. The Magellan unformatted data files are always in radians using WGS 84 datum and height above the WGS 84 ellipsoid.

MAGELLAN RE4MAT

Copyright Magellan Systems Corp., 1989, 1990.

THIS PROGRAM REFORMATS POSITION DATA FILES.

SELECT ONE OF THE FOLLOWING OPTIONS:

- 1 = REFORMAT A SINGLE MAGELLAN DATA FILE.
- 2 = COMPARE TWO MAGELLAN DIFFERENTIAL FILES AND CREATE OUTPUT FILE OF ADJUSTED POSITIONS.

MAIN MENU

The RE4MAT program works best using a computer with a hard disk drive and a math co-processor. In fact, large data sets may not run on disk drives using 3-1/2" or 5-1/4" when there is insufficient disk space for the scratch files.

Reformatting a Data File

To reformat a file, first specify the data file and then the new file which will be created through reformatting. Print the RE4MAT.DOC to interpret each of the output formats.

1	ENTER NAME OF MAGELLAN DATA FILE.	CTEST1.DATE
	ENTER NAME FOR OUTPUT DATA FILE.	OUT.DAT
	THIS FILE ALREADY EXISTS. OVERWRITE IT? (Y/N) Y	
SELECT OUTPUT FORMAT:		
1 = DEGREES MINUTES SECONDS		+DDMMSSsssss
2 = DEGREES MINUTES		+DDMMmmmmmmm
3 = DEGREES		+DDddddddddd
4 = NGS BLUEBOOK *80*		DDNNSSsssssN
5 = UTM		MMMMMMMMM
6 = UTM AS NGS BLUEBOOK *81*		MMMMMMMMM000

One of eight datums are available. Output as height above Geoid (MSL) or height above ellipsoid can be selected.

The most accurate results are obtainable in WGS 84, geographic coordinates (LAT/LON), and height above ellipsoid. Transformation using local information is usually more accurate than using tables contained within the unit itself, because of the precision of information which may be available to you.

SELECT GEODETIC DATUM OF OUTPUT COORDINATES.		
1 = NAD 27, CONUS		(CLARKE 1866)
2 = NAD 27, ALASKA AND CANADA		(CLARKE 1866)
3 = TOKYO		(BESSEL)
4 = WGS 72		(WGS 72)
5 = WGS 84		(WGS 84)
6 = NAD 83		(GRS 80)
7 = AUSTRALIAN GEODETIC		(GRS 67)
8 = EUROPEAN 1950		(INTERNATIONAL)

ELEVATION ABOVE WGS 84 ELLIPSOID (E) OR ABOVE GEOID (G)?

Reformatted Data File

Reformatted data does not include any delimiters or punctuation. This enables it to be used with any other programs, e.g. data bases, statistical packages, map systems, text editors or spreadsheets. Print the RE4MAT.DOC program for more information on the output formats. Use a text editor or spread sheet to add any special characters required by your software.

```
00180 1329030+3408236/6/5-11/694390916+013381 3 06 09 11 13 8 8 9 8 0532 112289
      NAD 27
000190 1401420+34082376422-117594361651+016459 3 03 06 09 11 9 5 9 9 0307 112289
      NAD 27
000200 1411170+34082358690-117594363385+013677 2 03 09 11 0 0 0 0156 112289
      NAD 27
```

Post Processing

RE4MAT also provides you the capability to improve the accuracy of a data file through post-processing. At the RE4MAT first selection menu, choose 2- Compare Two Magellan Differential Files and Create Output File of Adjusted Positions.

The program asks you to specify the file collected at the Control position; then the file collected at the Remote position. You will then give the program a name for the new file which will store the corrected output of the Remote file.

```
2
ENTER NAME OF CONTROL POSITION DATA FILE.  CTEST1.DAT
ENTER NAME OF REMOTE POSITION DATA FILE.   RTEST1.DAT
ENTER NAME FOR OUTPUT DATA FILE.         OUT.DAT
THIS FILE ALREADY EXISTS.  OVERWRITE IT? (Y/N)
```

To do this, you supply the Reference position in the format and datum chosen for the output file.

The software first goes through the Control and Remote files, culling any fixes where the SATS, mode, time and date are not coordinated.

It then looks at the difference of each position in the Control file to the reference point. That difference is then applied to the corresponding fix in the Remote file to first create the new, corrected, output file and then to display the new corrected position. Accuracies better than 5 meters with good HDOPs and some minutes of averaging are easily achievable on the session average. The accuracy of individual positions is only marginally improved.

ENTER CONTROL POSITION IN REFERENCE TO NAD83

LATITUDE OF CONTROL POINT, NORTH (N) OR SOUTH (S)? N

ENTER DEGREES: 34

ENTER MINUTES: 8

ENTER DECIMAL SECONDS: 0.

LONGITUDE OF CONTROL POINT, EAST (E) OR WEST (W)? W

ENTER DEGREES: 117

ENTER MINUTES: 59

ENTER DECIMAL SECONDS: 0.0

ENTER HEIGHT OF CONTROL POINT AS +/- DECIMAL METERS ABOVE
WGS84 ELLIPSOID.

0.0

AVERAGE LATITUDE. 33 59 4.04 N

AVERAGE LONGITUDE. 117 54 57.58 W

AVERAGE HEIGHT ABOVE WGS84 ELLIPSOID (METERS) 16.04

SECTION 5

AUXILIARY FEATURES

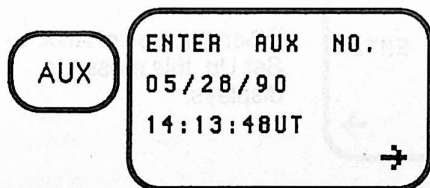
AUXILIARY (AUX) KEY

The AUXILIARY (AUX) key is a feature that contains a series of supplementary functions. To access each function, press the RIGHT ARROW key to scroll through the options or enter the related number code; then, press the ENTER key. AUX 13, CLEAR MEMORY, and AUX 20, TUTORIAL POSITION, can be accessed only by entering their code number.

The AUXILIARY functions are:

<u>Code</u>	<u>Display Name</u>	<u>Auxiliary Function</u>
1	SET UP	Set up (customization).
2	CONTINUOUS OPERATION	Turns continuous operation on and off.
3	COLLECT ALMANAC	Collects information from satellites for database.
4	SET AVERAGING	Set the number of fixes averaged. When power is cycled, the number is set to 1.
5	SAT STATUS	Multi-featured function containing the list of satellites in the Almanac, the satellites in view, (<i>their SQs</i>) their angle and elevation, which satellites are in use, and their SQs.
6	SAT SCHEDULE	Computes a 24 hour schedule for the windows of time in which you can use the unit (based on 2D or 3D set up) on the date you specify.

- | | | |
|----|-------------------|---|
| 7 | DATA BUFFER | Up to 200 of the last fixes obtained since turning the unit on. Can be erased (or reset) by pressing the CLEAR key. Last Fix is the first position seen in the Data Buffer. |
| 8 | DATAPORT | This simple feature turns the dataport on and off. |
| 9 | DOWNLOAD | Permits the download of waypoints, averaged positions and the buffer. |
| 10 | ERASE WAYPOINTS | Automatically erases all waypoints, the data stream and the course. |
| 13 | CLEAR MEMORY | Erases the Almanac, waypoints and more from memory. |
| 20 | TUTORIAL POSITION | Creates a temporary position (POS) that works with the Tutorial in the Training Guide. |



When you press the AUX key, this message displays. Press the RIGHT ARROW key to scroll to the desired functions.

OR

Enter the auxiliary code number. Then press the ENTER key.



NOTE: Time in hours, minutes and seconds appear on the Main Auxiliary display. The time display is in Universal Time (UT) unless it has been set up for local time or 24-hour time in *AUX 1, Set Up*.

Time in seconds does not appear for up to one minute after the unit is first turned on, then it updates each second. (Refer to *Time* in Section 2.)

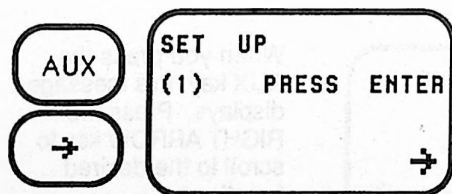
Auxiliary 1 - Set Up

The Auxiliary 1 - Set Up function guides you through a number of customized features.

The following features are available in the Set Up:

- Terrain Setting
- Position Coordinates Displays
- Map Datum
- Magnetic Variation
- Distance and Speed Units
- Altitude Units
- Time Display
- Beeper
- Date Order

Displaying the Set Up Features

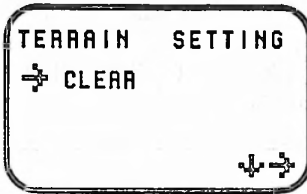


When you select AUX 1 - Set Up, this message displays.

- Press the ENTER key to use the function.
- Press the DOWN ARROW key to sequentially display the features.
- Then use the RIGHT ARROW key to toggle to the selections within each feature.

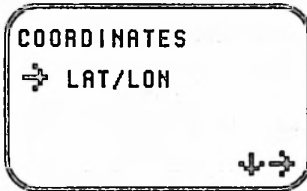
AUX

ENTER



For example, in the first selection, the RIGHT ARROW key will toggle the three options; INTERRUPTED, OBSCURED and back to CLEAR.

↓



The DOWN ARROW key then brings you to the next Set Up selection which in this case is Coordinates.

Customizing Your NAV 1000 PRO

Before using the Set Up option, take a moment to fill out the following worksheet and keep it as a record. In the event that your unit loses memory, you can simply refer to it when you set up your unit again.



SET UP WORKSHEET

SELECT ONE OPTION FOR EACH SET UP FEATURE
(Factory defaults are shown in bold)

**TERRAIN
SETTINGS**

- CLEAR**
- INTERRUPTED**
- OBSCURED**

COORDINATES

- LAT/LON**
- UTM**

LAT/LON DISPLAY

- DEGREES/MINUTES (.01)**
- DEGREES/MINUTES (.0001)**
- DEGREES/MIN/SECONDS (1)**
- DEGREES/MIN/SECONDS (.01)**

MAP DATUM

- NAD27**
 - ALSKA**
 - TOKYO**
 - WGS72**
 - WGS84**
 - NAD83**
 - AUSTR**
 - EUROP**
 - USER-1** _____
 - USER-2** _____
 - USER-3** _____
 - USER-4** _____
 - USER-5** _____
-
-

SET UP WORKSHEET

SELECT ONE OPTION FOR EACH SET UP FEATURE
(Factory defaults are shown in bold)

-
-
- MAGNETIC VARIATION
- M (AUTO MAGNETIC)
 - T (TRUE)
 - U (SET ___°___'E or W (SPECIFY))
-
-

- DISTANCE/SPEED DISPLAY
- KM (kilometers) and KM/HR (kilometers per hour)
 - STAT. MI (statute miles) and MPH (miles per hour)
 - NM (nautical miles) and NM/HR (knots)
 - m (meters) and m/s (meters per second)
 - f (feet) and f/s (feet per second)
-
-

- ALTITUDE UNITS
- METERS
 - FEET
-
-

- TIME DISPLAY
- UTC
 - LOCAL AM/PM
 - LOCAL 24 HR
-
-

- BEEPER
- ON
 - OFF
-
-

- DATE ORDER
- DAY/MONTH/YEAR
 - MONTH/DATE/YEAR
-
-

Notes on the Set Up Features

When you change a setting, all related displays will be affected.

If you press any function key while you are in the Set Up feature, the selection currently displayed on the Set Up display will implement.

Position Coordinates Display

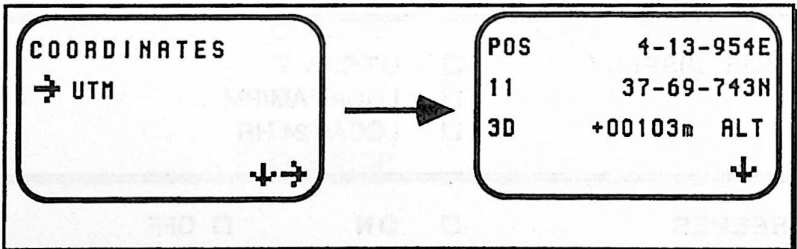
Two position coordinate options are available:

- UTM (Universal Transverse Mercator projections)
- LAT/LON (Latitude/Longitude readings)

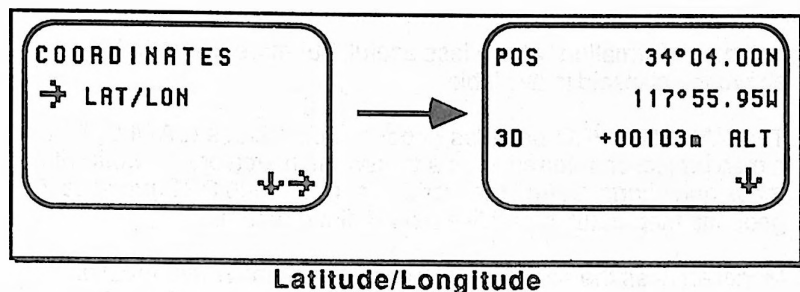
Once selected in AUX 1, the coordinates chosen will appear on all position displays:

- Current Position
- Average Positions
- Data Buffer
- Differential and Delta
- Waypoints
- Initialization Position

The options below are shown next to an example of position display in that system.



Universal Transverse Mercators



Lat/Lon Display

If latitude/longitude coordinates are chosen, the position can be displayed in four different ways.

DEG/MIN (.01)	34°05.85N
DEG/MIN (.0001)	34°05.8534N
DEG/MIN/SEC (1)	34°05'51N
DEG/MIN/SEC (.01)	34°05'5120N

Map Datum

Maps and charts consist of lines, like meridians and parallels, which represent the earth on a flat surface. Each chart and map is based on a particular model of the earth's surface which consists of an ellipsoid and the distance of that ellipsoid from the center of the earth. In addition, the chart is made using a particular projection of the surface of the earth onto paper.

The GPS system is based on the World Geodetic Survey of 1984 (WGS84); therefore, best accuracies from the NAV 1000 PRO are obtained using the WGS84 datum. Altitude presented on the display is height above mean sea level based on the height above the geoid, an equipotential model of the earth's surface based on gravity. This model, like a model of the magnetic variation around the globe, is contained within the unit. Geoidal height (MSL) is accurate to ± 5 meters, so best accuracies on height are obtained from the

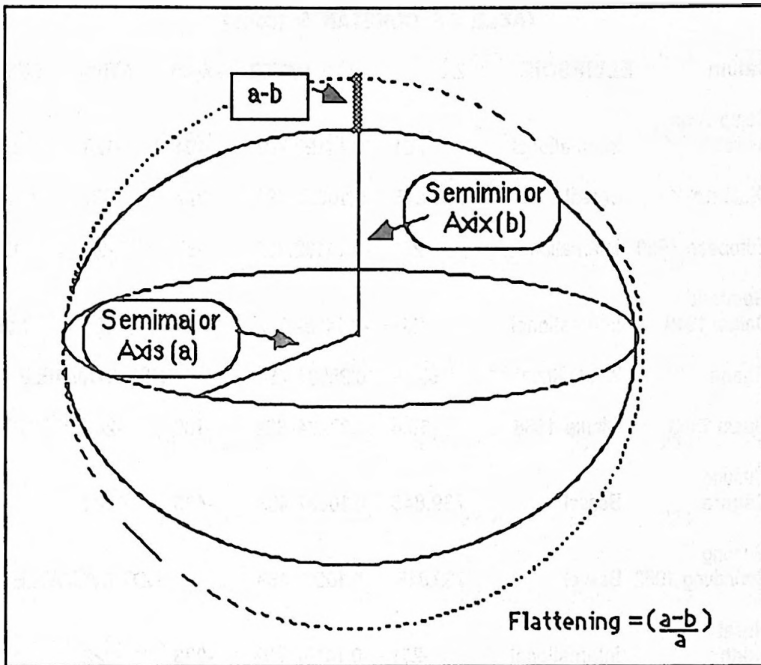


dataport information, where less useful, but more accurate height above the ellipsoid is available.

The NAV 1000 PRO provides geodetic coordinates (LAT/LON) and a map projection referred to as a transverse mercator. To work with maps and charts around the world, the NAV 1000 PRO provides 7 geodetic map datums and five user defined datums.

Magellan uses the abridged Molodenskiy Datum Transformation algorithms for these calculations. The constants used in the equations are based on averaged information obtained by geodocists and is generally closer than five meters to most local control points. None of this variability is found using WGS84. So you may wish to output data in WGS84 and transform it using your own datum conversion technique, which may have greater accuracy.

The Map Datum option lets you select the datum that corresponds to the chart you are using. In the legend of your chart, you will find reference to the datum upon which the chart is based. We provide only seven pre-programmed transformations. But we provide a list of constants you may program yourself. Just remember that a given position can be accurately placed on a chart only when you have the unit's datum setting matched to that of the chart.



Ellipsoid Model of the Earth

See *Tips, Choosing the Right Datum* in Section 6 for more information on this subject.

TABLE OF CONSTANTS

**MOLODENSKIY TRANSFORMATION CONSTANTS
LOCAL DATUM TO WGS '84**

Datum	ELLIPSOID	Δa	$\Delta f \times 100000$	$\Delta X(m)$	$\Delta Y(m)$	$\Delta Z(m)$
Adindan	Clarke 1880	-112.145	0.54750 714	-162	-12	206
Arc 1950	Clarke 1880	-112.145	0.54750 714	-143	-90	-294
Australian Geodetic	GRS 67	-23	-0.00081 204	-133	-48	148
Bukit Rimpah	Bessel	739.845	0.10037 483	-384	664	-48

TABLE OF CONSTANTS (cont.)

Datum	ELLIPSOID	Δa	$\Delta f \times 100000$	$\Delta X(m)$	$\Delta Y(m)$	$\Delta Z(m)$
Camp Area Astro	International	-251	-0.14192 702	-104	-129	239
Djakarta	Bessel	739.845	-0.10037 483	-377	681	-50
European 1950	International	-251	-0.14192 702	-87	-98	-121
Geodetic Datum 1949	International	-251	-0.14192 702	84	-22	209
Ghana	War Office	163.58	0.25567 714	NOT AVAILABLE		
Guam 1963	Clarke 1866	-69.4	-0.37264 639	-100	-248	259
Gunung Segara	Bessel	739.845	0.10037 483	-403	684	41
Gunung Serindung 1962	Bessel	739.845	0.10037 483	NOT AVAILABLE		
Herat North	International	-251	-0.14192 702	-333	-222	114
Hjorsej 1955	International	-251	-0.14192 702	-73	46	-86
Hu-Tzu- Shan	International	-251	-0.14192 702	NOT AVAILABLE		
Indian	Everest	860.655	0.28361 368	173	750	264
Ireland 1965 (Eire 1965)	Mod. Airy	796.811	0.11960 023	506	-122	611
Kertau 1948 (Malayan Revised Triangulation)	Mod. Everest	832.937	0.28361 368	-11	851	5
Liberia 1964	Clarke 1880	-112.145	-0.54750 714	-90	40	88
Luzon	Clarke 1866	-69.4	-0.37264 639	-133	-77	-54
Merchich	Clarke 1880	-112.145	-0.54750 714	31	146	47

TABLE OF CONSTANTS (cont.)

Datum	ELLIPSOID	Δa	$\Delta f \times 100000$	$\Delta X(m)$	$\Delta Y(m)$	$\Delta Z(m)$
Montjong Lowe	Bessel	739.845	0.10037 483		NOT AVAILALBE	
Nigeria	Clarke 1880	-112.145	-0.54750 714	-92	-93	122
North American 1927 CONUS	Clarke 1866	-69.4	-0.37264 639	-8	160	176
North American 1927 Alaska and Canada	Clarke 1866	-69.4	-0.37264 639	-9	151	185
Ola Hawaiian, Maui	International	-251	-0.14192 702	210	-230	-357
Old Hawaiian, Oahu	International	-251	-0.14192 702	201	-224	-349
Old Hawaiian, Kauai	International	-251	-0.14192 702	190	-230	-341
Ordnance Survey of Great Britain 1936	Airy	573.604	0.11960 023	375	-111	431
Qornoq	International	-251	-0.14192 702	164	138	-189
Sierra Leone 1960	Clarke 1880	-112.145	-0.54750 714		NOT AVAILABLE	
South America (Campo Inchauspe)	International	-251	-0.14192 702	-148	136	90
South America (Chua Astro)	International	-251	-0.14192 702	-134	229	-29
South America (Corrego Alegre)	International	-251	-0.14192 702	-206	172	-6

TABLE OF CONSTANTS (cont.)

Datum	ELLIPSOID	Δa	$\Delta f \times 100000$	$\Delta X(m)$	$\Delta Y(m)$	$\Delta Z(m)$
South America (Provisional South American 1956)	International	-251	-0.14192 702	-288	175	-375
South America (Yacare)	International	-251	-0.14192 702	-155	171	37
Tananarive Obsv. 1925	International	-251	-0.14192 702	-189	-242	-91
Timbalai 1948	Everest	860.655	0.28361 368	-689	691	-46
Tokyo	Bessel	739.845	0.10037 483	-128	481	664
Voirol	Clarke 1880	-112.145	-0.54750 714	NOT AVAILABLE		
Special Datums (SD) MGRS related, Indian Special	Everest	860.655	0.28361 368	173	750	264
SD, Luzon Special	Clarke 1866	-69.4	-0.37264 639	-133	-77	-54
SD, Tokyo Special	Bessel	739.845	0.10037 483	-128	481	664
Default Datum, WGS 84	WGS 84	0.0	0.0	0	0	0
WGS 72	WGS 72	2.0	0.00031 211	0	0	4.5

ΔX , ΔY , ΔZ are the differences in height from the center of the earth from the WGS model of the earth's surface to the local datum's model of the earth's surface.

Δa = the difference from the WGS semi-major axis to that of the local datum.

$\Delta f (\times 10,000)$ = the difference in flattening from the WGS84 model to the local datum.
Flattening = $(a-b)/a$, where a = semi-major axis and b = semi-minor axis.

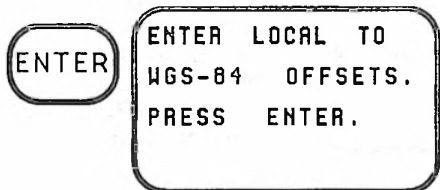
*Approximations are of questionable precision.



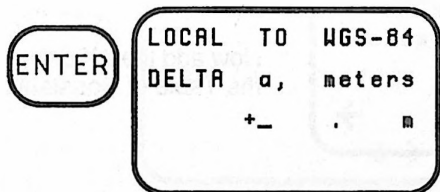
At this display, you can use the RIGHT ARROW key to scroll to the datum that corresponds to the one used in your chart, or ...



set up your own datum conversion using one of the five User Set datums.



Press the ENTER key to set the constants.



First you will enter the Δa , or the difference in the semi-major axis from the local datum to WGS84.

AUX

0251
000

➔

LOCAL TO WGS-84
DELTA a, meters
-0251.000m

In this example, we are entering the constants for Old Hawaiian, Maui. Change + to - with the RIGHT ARROW key.

ENTER

LOCAL TO WGS84
DELTA f * 10,000
+-. m

Press ENTER to see the Δf display where you will put in ...

01419
2702

➔

LOCAL TO WGS-84
DELTA f * 10,000
-0.14192702m

the constant which represents the difference in the ellipsoid flattening between WGS 84 and the local datum.

ENTER

LOCAL TO WGS-84
DELTA X, meters
+-. m
➔

Now add the ΔX using the Table of Constants.

Press the ENTER key. Now add the ΔY and ΔZ.

Using the TUTORIAL DEMO point, AUX 20, the transformation to Old Hawaii data should be.... 33°46'07.08"N
117°45'19.66"W
+918m ALT

Magnetic Variation Display

You can select one of the three available heading and bearing types for all displays and entries.

Magnetic Variation Settings

Auto Mag (M)	Includes an automatic adjustment for variation by the NAV 1000 PRO. (The default)
True (T)	No magnetic adjustment in readouts.
Set (U)	A constant user-entered adjustment.



MAGNETIC VAR
 → AUTO MAG (M)

To select your heading display, press the RIGHT ARROW key to toggle to the magnetic variation choice.



MAGNETIC VAR
 SET (U) E14°38'

If you select Set (U), this message will display with the last entered value.



AUX

1

SET DEVIATION
E1_°__'

Begin entering numbers as shown here or press the CLEAR key to see this display. Enter the constant compass error in degrees and minutes. To change the East/West setting, press the RIGHT ARROW key to toggle to East (E) or West (W). Press ENTER when the entry is complete.

Local Time Display

Although local time, either AM/PM or 24 hour is entered in the Initialization function, the option to select it for display is in Set Up. Once chosen, the time option will appear on all position data, the satellite information and on the main AUX screen.

Beeper

The default for the NAV 1000 PRO is ON. Use this feature to turn the beeper OFF. The unit will give you three types of beeper noises.

A Short Beep: Indicates key touch feedback, a completed fix, or that averaging is completed.

A Long Beep: Indicates that you are locked out of the keyboard or that your fix has an accuracy warning.

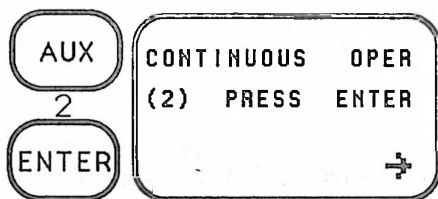
Three Short Beeps : Indicates when the batteries get low.

We recommend you turn the beeper on whenever possible to "hear" the unit's messages.

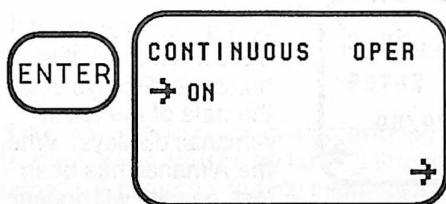
Auxiliary 2 - Continuous Operation

The AUX 2 - Continuous Operation function lets you set the unit for discrete operation . Generally, when the the SURVey key is pressed in continuous operation, the unit continuously updates the position and you can obtain velocity-related information. By turning continuous power to OFF, the unit will take a single position fix; then, if no key is pressed the unit will turn itself off after two minutes.

When the batteries get critically low (reaches the second warning level), the unit will automatically go to push-to-fix (continuous power off) operation.



When you select AUX 2 - Continuous Operation, this message displays.



Press the RIGHT ARROW key to switch the continuous power off. When this operation is selected the unit will take one fix and automatically turn off if no key is pressed.

AUX

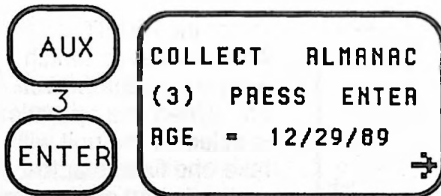
Auxiliary 3 - Collect Almanac

An almanac is like a bus schedule which the NAV 1000 PRO stores in its memory. It must be collected from one of the GPS satellites if your unit has lost its memory. The unit will automatically attempt to collect an Almanac when the SURVey key is pressed after memory loss.

Since each of the satellites in the constellation transmits the entire Almanac, only one satellite must be available to perform this function. It takes approximately 12 1/2 minutes to collect the Almanac. We recommend that you connect the unit to external power for this function since it may be a while before a satellite comes into view of the unit.

The AUX 3 - Collect Almanac function can also be used to update the Almanac, collecting the most recent information from the satellites. If you have not been using your NAV 1000 PRO regularly, it's a good idea to update your Almanac. In fact, you will be required to collect one if the Almanac is more than six months old.

For complete information on the purpose and use of the Almanac, see *Collecting an Almanac* in the Training Guide, and *All About GPS* in the Appendix.



When you select AUX 3 - Collect Almanac, this message displays and the date of the latest Almanac displays. When the Almanac has been lost, no date will appear here.

WARNING: Use external power when collecting an Almanac.

AUX

ENTER

PRESS ENTER TO
COLLECT ALMANAC

To start the Almanac
Collect process ...

ENTER

SEARCHING THE
SKY FOR SAT 14

The ENTER key must be
pressed one more time.
At this point it begins to
search the sky indicating
the Sat number it seeks
on the display.

COLLECTING RLM
12/30/89 14:47UT

When the unit locates
and locks onto a satellite,
this message displays.

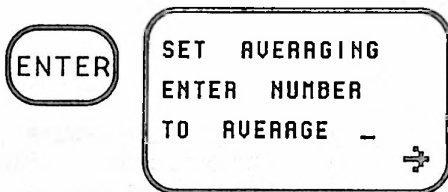
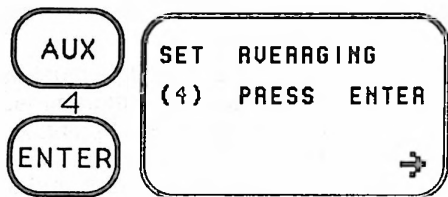
The date on the new Almanac will be a couple of days into the future. This is the way the GPS system date stamps the Almanac information.

If the unit is merely updating previously stored Almanac information, an interruption caused by turning the unit off or driving through a tunnel, will not erase the old information. It will simply update what it can.

AUX

Auxiliary 4 - Set Averaging

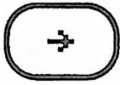
Averaging can be used to improve the accuracy of the position fixes and it is very definitely needed to apply differential positioning.




The user can enter up to 200 fixes to average before obtaining a fix. One is the default reset each time the unit is turned off.

When averaging type is set to Running Average, the unit keeps taking fixes once it achieves the number specified. Running Average always synchronizes using an epoch of 15 seconds in 2D and 20 seconds in 3D. It will keep a constantly updated buffer with the number of fixes set in averaging.

Refer to *Differential with S/A* in Section 4.




AVERAGING TYPE
 AUTO STOP



When averaging is set to auto stop, the unit will beep once and display the average position information when the unit has collected the the number of fixes set in averaging.



SYNCED MODE?
 NO



With AUTO STOP the data can be time synchronized, as in RUNNING AVERAGE. If it is not, the unit will average as quickly as possible, which is best for autonomous operation.

Note: To use AUTO STOP for differential, first set both units to AUTO STOP then say yes to synced operation. Pressing the CLEAR key after the beep will reset the count to zero, thus the units will stop their sessions simultaneously.

If Running Average or Auto Stop synced were selected, you would next specify the satellites to be used in the session based on the pseudo-random code number of the satellites.

Auxiliary 5 - Sat Status

AUX 5 is important for planning the survey site ahead of time and for trouble shooting. It is used to determine:

- satellites listed in the Almanac as healthy by the GPS system operators,
- the elevation and azimuth of each satellite now above the horizon,
- satellites and their signal qualities used to calculate the last fix,
- the satellites the unit is having difficulty using,
- the health status of every satellite in the system.



The satellite status will have one of four messages:

ON which indicates the satellite is operating and that it is healthy.

TEMP OFF which means the satellite is temporarily being ignored by the unit because it is having difficulty with the signal, for example there is an obstacle (a mountain) between the satellite and the unit.

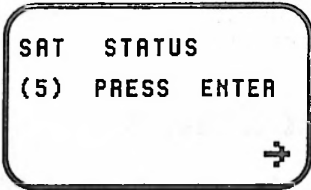
OFF is an option that can be selected by the user when he does not wish to use a particular satellite, for example when foliage makes the signal intermittent or when differential is not being employed.

Rules for changing satellite status messages:

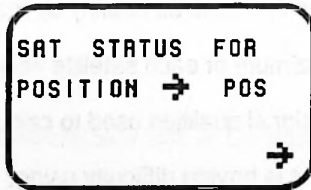
ON	Can be turned OFF
OFF	Can be turned ON
TEMP OFF	Can be turned OFF or ON



5



AUX 5 or AUX and five Right Arrows bring you to the function.



The default position is the last position fix. Use the right arrow to select other stored waypoints or averaged positions.

ENTER

SAT STATUS
 DATE: 07/06/90
 TIME: 14:33UT

Press ENTER. The default is the current date and time. Enter a new date and time and/or

ENTER

SAT SQ EL RZM
 02 7 90° 318°T
 ON
 ↓ →

Press ENTER. The first screen displays information about the satellite with the lowest number.

The sat number and the signal quality being received

The angle of elevation of the sat in the sky and the azimuth (direction) of its position.

SAT SQ EL RZM
 03 7 90° 318°T
 ON
 ↓ →

The GPS system operators say the sat is healthy. The unit has encountered no problems with it.

Right Arrow to toggle to OFF
 Down Arrow to next sat info.

Interpreting the Sat Status Information

AUX



SAT	SQ	EL	AZM
06		2°	83° T
ON			

Down Arrow brings you to information on the next satellite. Sat 6 is just above the horizon at an azimuth of 83° True. It is not being used though it is healthy.

NOTE: The unit will not attempt to use a satellite until it reaches an elevation of 10°. If a waypoint is used for Sat Status, or more than 5 minutes has passed since the last fix time, the SQ will not appear on the display.



MODE	3D			
SATS	03	09	14	15
PDOP	□ 12.4			

Press the ENTER key on any of the Sat Status screens to see the best constellation at that time for the mode (2D or 3D) selected. The PDOP of that choice is also calculated.

The DOWN ARROW key returns the user to the status displays.

Auxiliary 6 - Sat Schedule

Until the full constellation of satellites is complete, the GPS receiver will not work 24 hours a day in all areas of the world. The AUX 6 key for the Satellite Schedule computes the windows of time in which you will be able to use the unit (based on 2D or 3D set up). The **Magellan GPS NAV 1000 PRO™** provides you with a schedule for the entire 24 hours of the date entered. The unit computes and displays the satellite schedule beginning at midnight of the date indicated.



Press AUX 6 and ENTER to begin calculation of the 24 hour satellite schedule...



Press the Right Arrow key to select a saved position.

The selection of positions from which to run the satellite schedule appear in this sequence:

- Current Position (POS)
- Averaged Positions (\bar{x} ...)
- Waypoints (in alpha/numerical order).

AUX

ENTER

SAT SCHEDULE FOR
DATE: 01/01/90

Enter the date that you require the schedule, then press the ENTER key.

OR

Press the ENTER key to accept the current date.

NOTE: You can enter any date that is within 9 months of the date of your current Almanac.

ENTER

2D SAT SCHEDULE
COMPUTING 11:15

As the unit calculates the satellite schedule for a 2D or 3D solution, time ticks off in 15 minute intervals at the top right of the display as the unit computes a 24-hour schedule. (See *2D vs. 3D Mode* in Section 2.)

2D SAT SCHEDULE
SATS UP 9:30AM
↓ DOWN 5:15PM

After completing its computation, the "window of availability appears". If there is more than one "window" when the satellites will be available, a Down Arrow will appear on the screen.



```

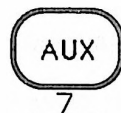
2D SAT SCHEDULE
SATS UP      7:30PM
↓ DOWN      11:45PM
  
```

To display remaining satellite schedule messages, press the DOWN ARROW key.

NOTE: The more recent your Almanac, the more accurate your satellite schedules. Please read *AUX 3* in Section 5.

Auxiliary 7 - Data Buffer

A history of up to 200 individual position fixes are saved in the Data Buffer.



```

DATA BUFFER
(?) PRESS ENTER
  
```

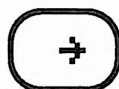
The user can review the data in memory by pressing AUX 7.



```

LFIX  33°45.1234N
      117°33.9876W
3D    +00144m ALT
      ↓→
  
```

The first of such positions is the Last Fix. With each fix, also saved is the date, time, PDOP, sats used and their SQ's.



```

109   33°45.1274N
      117°33.9871W
3D    +00140m ALT
      ↓→
  
```

The other fixes in the buffer are numbered in declining order.

AUX

To Clear the Buffer

Clearing out old data before a session will make file handling easier during post-processing.

AUX
7

DATA BUFFER
(7) PRESS ENTER

Begin at the Data Buffer selection screen.

ENTER



CLEAR

TO CLEAR
DATA BUFFER
PRESS CLEAR

Press the CLEAR key.

CLEAR

DATA BUFFER
CLEARED - READY

To erase data buffer, press the CLEAR key again.

NOTE: The Last Fix can still be viewed in AUX 7, Data Buffer, but it will not be downloaded using AUX 9.

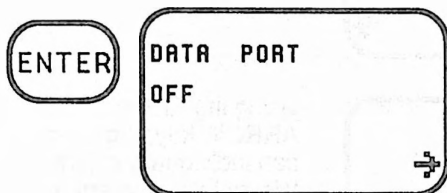
Auxiliary 8 - Data Port

The dataport is automatically turned off when the unit is turned off; this is to conserve power.

AUX



AUX 8 is where the dataport is turned on.



Use the RIGHT ARROW key to turn the Dataport ON and OFF.

Refer to the *Dataport* in Section 4.

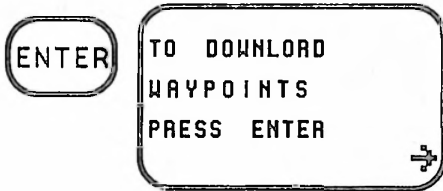
AUX

Auxiliary 9 - Download

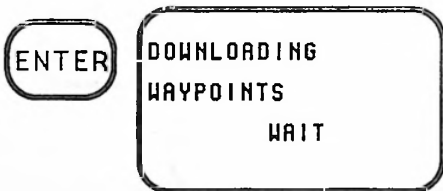
See *Dataport* in Section 4 for instruction on connecting the unit to a computer.



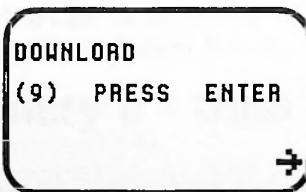
AUX 9 facilitates downloading specific information being stored in the memory of the unit.



Using the RIGHT ARROW key, the user can individually select Waypoints, Averaged Positions and Buffer to download.

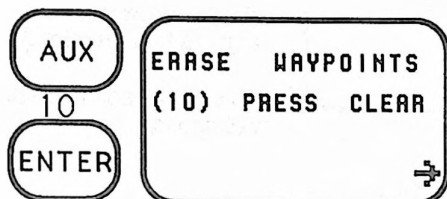


The dataport is automatically turned on. As the downloading occurs, this message appears.

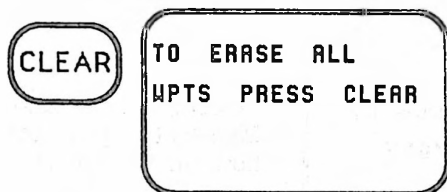


When downloading is complete, the AUX 9 select screen displays again. The dataport is automatically turned off.

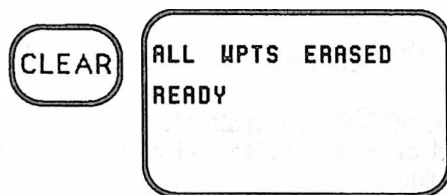
Auxiliary 10 - Erase Waypoints



AUX 10, the Erase Waypoints function, automatically erases all waypoints and your course.



The CLEAR key must be pressed twice to erase the waypoints.



Auxiliary 13 - Clear Memory

There may be occasions when you think your NAV 1000 PRO is behaving in a peculiar way, as indicated by an unusual symbol appearing in the display. (See *Trouble Shooting* in Section 6.)

Clearing memory is the best way to correct malfunctions related to the data. The AUX 13 function will delete the Almanac, erase the time and initialization position, remove all waypoints, clear the last fixes and course, and reset the factory settings.

AUX

AUX

13

ENTER

TO CLEAR MEMORY
PRESS CLEAR

To locate the clear memory function, press AUX 13 and ENTER. (Right Arrow will not access this function.)

This intermediate display will appear.



WARNING: Record all waypoints before continuing.

CLEAR

MEMORY CLEARED
PRESS ON/OFF

To complete the Clear Memory task you must now turn the unit off.

Auxiliary 20 - Tutorial

The Magellan GPS NAV 1000 PRO™ can create a last fix (POS) from its software that can be used for training and to work with the Tutorial classroom in the Training Guide.

AUX

20

TO LOAD LAST FIX
PRESS ENTER

Press AUX 20 and ENTER. Press ENTER once again to create this temporary position.

TUTORIAL POSITION: 33°45.88N
117°45.14W
3D 918ft ALT
WGS84

ERROR MESSAGES

The information on this page is for your reference only. It is not intended to be used as a troubleshooting guide.

SECTION 6

TROUBLE SHOOTING AND TIPS

ERROR MESSAGES

The **Magellan GPS NAV 1000 PRO™** has many helpful prompts to assist you in trouble shooting. These are a few:

"SATS NOT FOUND" The Almanac has determined that enough satellites are available for taking a position fix, but the unit cannot locate the signals.

Try this:

1. Make sure the antenna is straight up. Remove obstruction or move the unit. (The antenna needs a clear view of the sky.)
2. Check the initialization position and time.
3. If using an exterior antenna, check connections.
4. Set the terrain setting to INTERRUPTED. Press SURVey again.
5. If these fail, collect a new Almanac.

"NOT ENOUGH SATS AVAIL"

There are insufficient satellites visible for taking a position fix, that is there are less than 3 satellites in 2D mode and less than 4 satellites in 3D mode.

Try this:

Check 1, 2 and 3 above. Contact other users or the U.S. Naval Observatory to determine when satellites will be available at your location.

Make certain that all the sats in AUX 5 are set to "ON". Use AUX 6 to determine when enough satellites will be available.

"SEE USER GUIDE"

Usually this occurs when the unit has been moved more than 300 miles from your last position. The unit will collect data and attempt to compute SURVEY three times before giving this error message.

This message will also appear when the PDOP is greater than 75.

Try This:

Re-initialize unit using the INIT key.
Collect Time using AUX 3.

**"MEMORY LOST
PRESS INIT"**

The unit has lost all of its memory. Several conditions can cause the NAV 1000 PRO to display the memory warning message: (1) before first use, (2) if you fail to replace batteries at the second low battery warning, (3) if you have cleared all memory by pressing AUX 13, or (4) if you have purposely caused the unit to lose its memory by removing batteries.

Do this:

Replace the 6 AA cell batteries.
Reinitialize the unit (INIT). Collect a new Almanac (AUX 3).

**"INITIALIZE -
PRESS INIT"**

The unit has detected something unexpected in the initialization position and time.

Try this:

Use INIT to reenter the correct information.

**"NEED ALMANAC
PRESS AUX 3"**

The Almanac is either erased or too old. If the Almanac is more than 6 months old, this message will appear.

Try this:

Check the initialization time and date.
Collect a new almanac (AUX 3).



When the 6 AA cell alkaline batteries are getting low, this symbol displays. The unit will run up to another 40 minutes continuously or take about 10 more single fixes with no danger of losing memory. We recommend that you be prepared at this point by loading the spare battery clip with fresh batteries.

"REPLACE BATTS OR LOSE DATA"

Turn the unit OFF. As long as you do not operate the unit, the memory will be protected up to four weeks with the power remaining in the batteries. Change the batteries by inserting a fresh battery clip.

PROBLEMS

No Power

Always turn the unit off before inserting or removing power jacks.

If the unit fails to power on, make certain the battery clip is in place and that it has fresh batteries. The battery compartment should be clean and dry. Check that the clip is touching the contacts on the unit.

If you are using external power, make certain that the power jack is fully inserted and power is being supplied to the unit. Test this by removing the power jack to determine if the unit will work without external power.

The Position Fix Is Not Changing

The satellites may temporarily be low on the horizon or the antenna may have become obscured. The search status will appear on the lowest line of the display during these outages. Check the time message on the SURVey key. If the unit beeps informing you that you are locked out of the keypad, this is because the unit is busy searching or collecting data from the satellite.

Follow the same instructions for the "SATS NOT FOUND" error message.

The Unit Collects Data But Goes Back To Search

An incorrect initialization will give this symptom. Refer to *INIT* in Section 3 and *Tips* in Section 6.

Unit Will Not Stay On When You Have It Connected To An External Power Source

The unit will automatically switch to push-to-fix operation when the external power is interrupted. You are probably operating on the unit's internal batteries. Cycle power watching the self-test displays to confirm this. Check the external power source.

No Data Is Leaving The Data Port

Use AUX 8 to turn the Dataport ON.

The Unit Will Not Average

Make certain that Continuous Operation is set to ON in AUX 2.

The Fixes Seem To Vary A Great Deal

The position accuracy of the NAV 1000 PRO is affected by many variables, the most important of which is the PDOP (Position Dilution of Precision or geometric quality) and to some extent, the SQ (signal quality). Because of this variability, the specified accuracy of 25 meters RMS in 2D is a statistical rather than an absolute accuracy, and further assumes that PDOP is less than 5, SQ is at least 7. This means that even under good conditions, not all fixes will be within 25 meters of the true position. However, a good rule of thumb is that approximately two-thirds of the fixes will be within 25 meters of the true position and about 95% of the fixes will be within 50 meters under good conditions, and assuming that the government is not "adjusting" the satellites.

Since 20 meters is approximately 0.01 minute of latitude (and 0.01 minute of longitude at the equator), it is normal to see variations as large as ± 0.03 minutes of latitude/longitude from fix to fix under good conditions and more under less favorable conditions.

When the Terrain setting (visibility) is turned to obscured, the unit only looks for satellites above 20°. It will choose the three (2D) or four (3D) that will give the best PDOP. Further, the NAV 1000 PRO will hang on to the signals until the PDOP goes to 25, at which time you may experience a substantial variation, e.g. ± 150 meters.

From time to time, the government may degrade the accuracy of the system. Check with military officials or the U.S. Naval Observatory for more information

Receiver Is Turning Off

about this (719-550-2115).

Entering certain functions, like SATS and AUXILIARY, will turn the receiver off after a few minutes. To reactivate it, you must press SURVEY, NAV or VEL. About 2 minutes will elapse before your position updates again. Unless you are in continuous operation or on external power, the receiver will turn itself off after obtaining a single fix.

The NAV And VEL Keys Will Not Work

There are several things you must know about the NAV function in addition to what is covered within *Navigation (NAV Key)* in Section 3.

1. Navigation requires that you enter a course with a start and destination. (You can select your present position as the course start.)
2. If you are not in continuous operation, only distance and bearing are available to you.
3. Bearings are not displayed when you are within ± 20 meters of your destination. Use the DIF function at close range to get the Delta in meters between your average position and a control point.
4. You must be travelling at least 0.3 Km/HR to get speed (SOG), ground course (COG) and steering.
5. Despite the speed of your vehicle, velocity related data is not available until the unit has taken two fixes.

The Unit Beeps When You Press A Key

You are locked out of the keypad. Be patient a moment and try again. The unit was receiving important information from the satellite and did not want to be interrupted. To turn the receiver off, thereby freeing the keypad, simply turn the unit off.

Dashes Appear In The Position And Navigation Or Velocity Displays

Dashes will display when your speed is too slow for providing velocity related information. The unit must be moving 0.3 kilometer per hour (Km/HR) to obtain speed, ground course and steering. When you are 20 meters or less from your destination, distance is not displayed and bearing will vary considerably.

The Satellites' Availability Does Not Seem Consistent With Your Expectations

There is a very good chance that the U.S. Government may have changed the position or health of a satellite, or even launched a new satellite. There is also a possibility that you collected an Almanac on a day when one or more satellites were set "unhealthy". Check the numbers of satellites listed in *AUX 5, Sat Status*. Collect a new Almanac using *AUX 3, Almanac Collect*. Note whether there are more or less satellites now listed. For more information on satellite availability, call the Naval Observatory at 719-550-2115.

EQUIPMENT MALFUNCTION

Most malfunctions can be avoided by remembering these rules:

- Turn the unit off before inserting or removing the power jack.
- Do not leave the unit face up in the direct sun.
- Do not try to operate the unit above 60° C. or below -10° C.
- Do not store the unit at temperatures above 70° C. or below -40° C.
- If the unit gets dropped in water, rinse the unit, including the battery compartment, with fresh water and dry it carefully.

Maintain a waypoint log—always "backing up" your favorite waypoints—just in case.

If the equipment malfunctions, try this procedure:

First, turn the unit OFF and ON. This will "cure" a great number of errors. If the unit will not turn on, refer to *No Power* under Problems.

Second, if the problem persists, write down all your waypoints and clear the unit's memory using AUX 13. Refer to *AUX 13* in Section 4.

Or, if the display is "frozen" and the keypad will not work, remove the battery clip for at least 1/2 hour. This too will erase the memory, just like AUX 13.

TIPS

Using The Unit Near The Poles

Only latitude, longitude readouts (not UTM or MGRS) are available north of 84°N and south of 80°S. Use AUX 1-Set Up-- to change to LAT/LON.

Note that all meridians of longitude converge at the North and South poles. Near the poles, a kilometer can span many degrees of longitude, so small changes in position can cause large variations. While the inherent measurement accuracy of the NAV 1000 PRO does not change near the poles, this basic mathematical sensitivity problem can cause position and velocity related data to appear unstable when the unit is operated at latitudes exceeding approximately 85 degrees north or south. In these regions, caution must be exercised in interpreting displayed data.

When The Almanac Is More Than 6 Months Old

If your Almanac is a few days too old, you can trick the unit into giving you a fix by reinitializing the unit to a few days back in time.

When You Can't Figure Out Your Initialization Position

When you have no map to refer to and you simply don't know your initialization, try this: Look at your last fix. Think how far you have moved since then. Each 60 nautical miles is approximately equivalent to 1° of latitude. Guess an approximate new position and enter it as the initialization. If your initial position was 40°N and 100°W and you had moved about 600 miles north, your new position would be 50°N and 100°W.

Choosing The Right Datum

All charts are created using a system that includes the scale, type of projection, and a map datum. There are hundreds of map data throughout the world, but fortunately most charts in common use today employ one of a select few of these datums.

The Magellan GPS NAV 1000 PRO provides positions in 48 different map datums plus it gives the user the facility to define 5 datums. If your chart or other electronic navigation equipment is created using a different datum, you must take this into account before comparing positions. A position in WGS 84 could differ by 300 meters or more from one calculation using another datum. Check the datum in the legend of your chart and the manuals of your other navigation equipment. Use AUX 1 in your NAV 1000 PRO to enter the correct datum. If the datum you need is not available, create the one you need as explained in AUX 1, *Set Up* in Section 5.

Maps created by the U.S. Defense Mapping Agency can use one of 47 datums. The National Oceanic and Atmospheric Administration (NOAA) is presently changing its charts to NAD-83 (which is the same as WGS84 for most purposes). The bulk of NOAA charts in present use are NAD-27. USGS maps are generally in NAD-27.

If You Can't Figure Out The Correct Datum To Use

First, if you are not using a chart or other electronic navigation equipment, it is unnecessary to be concerned with datums. It is important simply to use the same datum at all times.

However, if you must work with a map or chart with an unknown datum, simply go to a reference point on the map and take a few fixes. (Make certain the PDOP is 3 or less for best results). Compare the position you obtained to the chart. If it doesn't match, try another datum in the NAV 1000 PRO that you suspect is correct. Now compare the positions. If they match, you've probably located the right datum.

STORING YOUR UNIT

On occasion, you may need to store your unit for a long period of time. These precautions should be taken to ensure that you will continue to get the very best performance from your unit.

If you are storing the unit for more than three months:

1. Manually record all waypoints.
2. Remove the battery clip from the unit.
3. Place the unit in a NAV 1000 PRO carrying case or the original box.

When you take the unit out of storage, reload the battery clip and collect a new Almanac and key in desired waypoints. Reinitialize.

If you are storing the unit for less than three months:

1. Load new batteries (see *Loading Batteries* in this section) in the unit. This will preserve the stored waypoints, Almanac, and custom settings.
2. Place the unit in a NAV 1000 PRO carrying case or the original box.
3. If you store it in the carrying case, place the field card in the front pocket to prevent accidental pressing of the keys.

ALL ABOUT THE GLOBAL POSITIONING SYSTEM

GPS is a satellite-based navigation system that provides location and time information in all weather conditions. It is used by a wide variety of users, from hikers and fishermen to pilots and truck drivers. GPS is a global system, meaning it can be used anywhere on the planet.

APPENDICES

The Global Positioning System (GPS) is a satellite-based navigation system that provides location and time information in all weather conditions. It is used by a wide variety of users, from hikers and fishermen to pilots and truck drivers. GPS is a global system, meaning it can be used anywhere on the planet.

The GPS system consists of three main components: a constellation of satellites in orbit around the Earth, a ground control segment, and a user segment. The satellites transmit signals that are received by the user's GPS receiver, which then calculates the user's position.

The ground control segment consists of a network of ground stations that monitor the satellites and provide them with precise timing and orbital data. The user segment consists of GPS receivers used by a wide variety of users, from hikers and fishermen to pilots and truck drivers.

The GPS system is used for a wide variety of applications, including navigation, surveying, and timing. It is also used for scientific research and for military operations. The GPS system is a global system, meaning it can be used anywhere on the planet.

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ALL ABOUT THE GLOBAL POSITIONING SYSTEM

GPS —

Worldwide Navigation from a New Perspective

The concept of a highly accurate, worldwide navigation and positioning system that could be used continuously at any time of the day began with the Department of Defense. It envisioned radio signals transmitted from a satellite constellation, a system that would not be fraught with the limitations of existing navigation technologies.

Their vision was realized with the Global Positioning System made possible by rapid advancements in aerospace technology, a firm financial commitment from the U.S. government, and the intense participation of individuals and corporations with communications expertise.

The heart of the Global Positioning System is a constellation which will eventually consist of 21 satellites and 3 spares in six planes. Circling the Earth twice daily, each satellite is in a fixed orbit, approximately 10,900 nautical miles above the surface of the earth, inclined at 55 degrees from the equator.

This new navigation infrastructure, though primarily designed for the U.S. military, is available to a variety of worldwide users including recreational boaters, fishing and shipping fleets, general and commercial aviation aircraft, and surveyors and engineers. Recent technological innovations have made GPS worldwide navigation an affordable reality.

Information provided is precise and transmitted in real time. The most accurate, on-demand worldwide navigation system, GPS is extremely resistant to interference from weather and earth-based radio signals.

All of these advantages make GPS greatly superior to any other navigation system.

Satellite Navigation Made Simple

Navigation by Satellite on Demand.

Each GPS satellite continuously transmits two types of orbit data used to calculate a position: Almanac and Ephemeris. Listening to only one satellite, a GPS receiver can gather the Almanac information, which contains the approximate location of every satellite in the system. From the Almanac, the receiver determines which satellites will give the best geometries. The better the geometry, the more accurate the position fix. The Ephemeris data is more precise and is used in obtaining the exact position of each satellite.

In addition to this information, two codes are transmitted: a protected code (P-Code) and an unprotected code (C/A Code). The P-Code is more accurate and is reserved for military use; the C/A Code while intended for public access is also used by the military. The NAV 1000 PRO uses the C/A code.

The C/A code has two purposes. It provides immunity of the signal to interference from undesired signals. Secondly, the C/A code is used in determining the precise range of the user from each satellite—the first stage in calculating a position fix.

"Reading" Satellite Information.

While the Global Positioning System may appear complex, navigation with GPS can be amazingly simple. A well-designed GPS receiver uses the signal information in a fundamental geometric equation. It solves the equation and presents it in easy-to-use navigation displays.

To obtain a position fix, a minimum of three satellites are "read" (2D). First the receiver determines the time of transmission and reception of the signal from each satellite. It then multiplies the difference in these times by the speed of light (186,000 miles per second) to arrive at an estimate of the satellite's distance from the receiver.

Using the calculated distance and the calculated orbital position of each satellite, the receiver determines and displays a position fix in degrees of latitude and longitude. Exact time of that fix, accurate to one ten-millionth of a second can also be determined. Although accuracy varies somewhat with satellite constellation geometry, a position fix accuracy of 30 meters or better is typical with C/A code receivers.

Monitoring and Controlling GPS.

A master control station operated by the Air Force in Colorado, USA gathers pertinent navigation data from the satellite constellation. This dedicated facility is especially equipped for satellite monitoring, telemetry, tracking, command and control, data uploading, and navigation message generation.

Monitor stations and ground antennas strategically located around the world passively track the GPS satellites, relaying data to the master control station. Through the monitor stations, exact satellite position and signal-data accuracy are constantly updated and maintained.

The master control station routinely adjusts minor discrepancies between where the satellite "thinks" it is and where the monitor stations "know" it is. The compensations are relayed to a ground antenna which then transmits the correction to the appropriate satellite.

If for any reason a satellite emits erroneous data or is otherwise not operating properly, a ground station will mark it "unhealthy" and the satellite will broadcast this fact to the user. Receivers are programmed to ignore the unhealthy ones, "reading" instead the next best satellite for determining the user's position.

GPS Brings New Navigation Horizons.

GPS is the technology of the future. Based on ingenuity and vanguard capabilities, GPS will replace systems based on technologies developed decades ago. GPS is superior, to other systems in its accuracy, coverage, and resistance to interference.

Accuracy.

The most remarkable feature of the Global Positioning System is its accuracy. Position accuracies of 30 meters or better are commonly obtained from C/A code GPS receivers. Repeatable accuracy, that is being able to return to the same spot, will also be experienced by GPS users.

Coverage.

The completed GPS constellation of 21 satellites plus spares will provide 24-hour continuous coverage world-wide. Unlike all other electronic navigation systems, the signal never weakens because of distance from the broadcast source.

Interference.

Another remarkable feature of GPS is its resistance to interference from conditions which disturb other electronic navigation systems: thunder, lightning, heavy weather, radio signals, on-board electronics, passing ships, on-shore electronic installations, ignition of the boat engines, portable radio receivers, and so forth.

The high frequencies (1227MHz and 1575MHz) used by GPS means that it operates in a wave environment where there is less interfering radiation. More important, GPS uses spread spectrum technology which greatly reduces any possible interference in the frequencies where it operates.

Other Navigation Systems

Most of the current means of electronic navigation are land based, like Omega, Decca, radio beacons, and Loran C. These systems have inherent limitations in coverage area, accuracy, and/or susceptibility to interference.

Transit (Sat/Nav), the other U.S. satellite-based system, does not provide continuous navigation information, only periodic position fixes once every one to three hours. In addition, the user must already have a close approximation of his position and velocity to make use of the system. SatNav requires about 15 minutes even under good conditions to take a fix.

Omega, Loran C and Transit are all destined to be replaced by GPS.

TRANSIT

- Sometimes hours between fixes.
- Requires user to know rough position, and accurate velocity.
- 15 minutes for a fix.
- Coverage = 100% of earth.

LORAN C & DECCA

- Accuracy highly dependent on geometry, where vessel is in relation to the transmitters.
- Highly susceptible to interference.
- May require user input.
- Coverage = 10% of earth.

OMEGA

- Disrupted by storms.
- Requires time, date input.
- Requires pre-voyage initialization.
- Intolerant of power failures.
- Coverage = 90% of earth.

CELESTIAL

- Accuracy 1 to 5 miles.
- Requires complex and recurrent training.
- Clear weather only.
- Error prone.
- At most, 3 fixes per day.

WAYPOINT LOG - LAT/LON

KEEP A WRITTEN RECORD OF ALL WAYPOINTS. COPY THESE PAGES FOR THE NOTEBOOK YOU KEEP.

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT _____ ° _____ N or S	ALTITUDE:
LON _____ ° _____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT _____ ° _____ N or S	ALTITUDE:
LON _____ ° _____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT _____ ° _____ N or S	ALTITUDE:
LON _____ ° _____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT _____ ° _____ N or S	ALTITUDE:
LON _____ ° _____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT ___ ° ____ . ____ N or S	ALTITUDE:
LON ___ ° ____ . ____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT ___ ° ____ . ____ N or S	ALTITUDE:
LON ___ ° ____ . ____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT ___ ° ____ . ____ N or S	ALTITUDE:
LON ___ ° ____ . ____ E or W	_____ f or m
NOTE: _____	DATUM: _____

WAYPOINT NAME: _____	DATE: ___ / ___ / ___
LAT ___ ° ____ . ____ N or S	ALTITUDE:
LON ___ ° ____ . ____ E or W	_____ f or m
NOTE: _____	DATUM: _____

GLOSSARY

ACQUISITION

Referring to signal acquisition, when the NAV 1000 PRO locates and receives data from the GPS satellites.

ALMANAC

Information the NAV 1000 PRO obtains from a single satellite, containing data on the general location and health of all satellites in the GPS constellation.

ANTENNA ALTITUDE

The sum of the elevation (above mean sea level) and the antenna height.

BEARING

The direction the vessel is moving in relation to a destination or target.

C/N₀

Carrier-to-noise ratio is an absolute means of specifying signal-to-noise ratio (SNR) that is independent of band width.

COURSE

The great circle line connecting the two points between which the vessel intends to travel.

CROSS TRACK ERROR

The perpendicular distance between the present position and the course line, given as right or left of course.

DEFAULT

The displayed or system selected choice. If you do not want to use the default

(automatic) value, you can erase it and enter your own choice.

DELTA

The calculated error between the average data collected in a session (AVG) at the control point and the actual value of the reference point.

ELLIPSOID

The idealized mathematical model of the earth's surface used in developing charts.

FIX

A single position with latitude, longitude, altitude, time, and date. When recorded on a chart, it may include speed and ground course.

GEOID

A model of the distortions of the earth's surface due to global gravity variation. Primarily used to establish sea level at specific locations.

GREAT CIRCLE

The shortest distance between any two points. Can be viewed as a circle on the earth's surface that is described by a plane cutting through the earth's center. Also see Rhumb Line.

GROUND COURSE

The direction your vehicle is actually moving. Also called course over ground (COG).

HDOP

Horizontal Dilution of Precision is a measurement of possible error related to the geometry of the satellites; it

	includes only the horizontal (Lat/Lon) aspect of the error. In 2D mode, our PDOP is actually HDOP.
HEADING	The direction your vehicle is oriented.
LAST FIX	A fix stored in temporary memory, a record of an earlier position fix.
LATITUDE	The distance north or south of the equator, measured in an arc with the equator being 0° and the poles being 90°.
LONGITUDE	The distance east and west, measured in an arc from the prime meridian (0°) which intersects with Greenwich England. The range is 0°-180°E moving east and 0°-180°W moving west of the Prime Meridian.
MAP DATUM	A coordinate system with an associated ellipsoid upon which a given chart is based (as noted on each individual chart).
PDOP	Position Dilution of Precision is a measurement of possible error related to the geometry of the satellites. It includes both the horizontal (Lat/Lon) and the vertical (altitude) aspect of the error.
POSITION	The current position (POS) obtained in real time expressed in a coordinate

expressed in a coordinate system (also called a fix) or a waypoint position obtained from a chart or other source. Press SURvey for position information.

RECEIVER

The electronic components of the NAV 1000 PRO that receive the satellite signals.

RHUMB LINE

The straight line between two points on a chart. Over long distances, the rhumb line is actually longer than a great circle course since the chart projection does not entirely account for the curvature of the earth.

SEARCH

The task of the NAV 1000 PRO that locates the GPS satellite signals in the sky overhead.

SPEED

The speed over ground (SOG) is the distance you have moved over the ground floor divided by the time required to move that distance. This is an instantaneous measurement.

TERRAIN SETTING

A set up feature that lets the user program the NAV 1000 PRO to pick the best satellite search strategy for the environment. Refer to *Terrain Setting* in Section 2.

3D

Three dimensional, referring to a latitude, longitude, and altitude position, requiring four GPS satellites in view.

SURVEY

In Magellan's design, the survey key is used for positioning. By setting a number to average in AUX 4, the user can improve the stationary accuracy of the unit. Each data collection period is called a session.

TOGGLE

To switch back and forth between two settings (for example, north and south). Information is toggled with the RIGHT ARROW key.

2D

Two dimensional, referring to a latitude, longitude position, requiring a user entered antenna altitude and three GPS satellites in view.

UT

Universal Time, formerly GMT or Greenwich Mean Time. Refer to *Time* in Section 2.

UTM

Universal Transverse Mercator coordinate given in meters contains an easting (meters east) and a northing (meters north) within one of 60 zones. (Refer to *Position Display* in the Training Guide.)

WAYPOINT

A position stored in the unit's memory.

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260 EAST HUNTINGTON DRIVE
MONROVIA, CA 91016
(818) 358-2363