USER GUIDE
for the
MAGELLAN GPS PROMARK X
and the
MAGELLAN GPS PROMARK X-CM

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WARNINGS

A measure of knowledge by the user is required for proper and safe use of the **Magellan GPS ProMARK X™ and GPS ProMARK X-CM™**. READ THE USER GUIDE AND WARRANTY COMPLETELY.

Assess the Accuracy Required

The **ProMARK X** is generally capable of better than 12 meters (RMS) horizontal accuracy in autonomous operation and better than 3 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 the intstrumentation needed for first-order surveys.

Use Good Judgement

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

Use Care to Avoid Inaccuracies

The Global Position 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.

Accuracy can also be affected by poor satellite geometry. WHEN THE ACCURACY WARNING APPEARS ON THE SCREEN, USE THIS DATA WITH EXTREME CAUTION.

THE GLOBAL POSITION SYSTEM IS A DoD SYSTEM. The government can make changes to the system that could affect the performance of GPS receivers.

WARNING

The accuracy of position fixes can be affected by the periodic adjustments to GPS satellites by the U.S. Government and is subject to changes in accordance with the Department of Defense Civil GPS user policy and the Federal Radionavigation Plan.

Use Differential Judiciously

While differential and carrier phase 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 or carrier phase, the user must have a thorough understanding of datums and the theory behind the differential process.

CONTENTS

Chapter 3 — SETUP

Chapter 4 — Auxiliary Functions

Chapter 5 — Waypoints, Routes, and Navigation

Chapter 6 — Attributes

Chapter 7 — Differential

Chapter 8 — Troubleshooting and Operating Tips

Appendix

Welcome to the world of accurate positioning through the Global Positioning System (GPS). This manual was created to serve as a reference guide for the ProMARK X-CM and the ProMARK X GPS receivers, manufactured by Magellan Systems Corporation.

The ProMARK X-CM receiver is a 10-channel, SPS receiver that can collect carrier phase data. The ProMARK X receiver does not have carrier phase capability. Both models were designed for professional applications. Throughout the guide, references to the "ProMARK X" will be understood to mean both models; where information is specific to the ProMARK X-CM, the receiver is referred to as the "ProMARK X-CM."

This guide assumes that the user has a background specific to the application for which the receiver is being used. The guide therefore does not describe applications except where they directly affect the operation of the receiver. The guide was designed to follow the logical order of the receiver's functions wherever possible.

Feel free to skip the functions that do not pertain to your applications. Users, for example, who do not use differential need not read Chapters 6 and 7. All users, however, should read Chapters 1 through 4, which cover the basic operation of the receiver and the setup and auxiliary functions. The user who has no navigation experience may benefit from reading Chapter 5. Those with no previous experience with global positioning may also want to read the general information about GPS found in Appendices 6, 7, and 8.

The ProMARK X User Guide should be used in conjunction with the post-processing software guide and, where applicable, the submeter guide.

Chapter 1 INTRODUCTION

The ProMARK X

The ProMARK X-CM is a rugged, hand-held, 10-channel SPS code and carrier phase code receiver that is designed to collect pseudorange and carrier phase data. The ProMARK X collects pseudorange data only. Both models were developed primarily for land-based professionals who require a high level of accuracy in marking and relocating geographical sites. When used with position averaging and differential, it is an excellent tool for some third-order surveys, and is an ideal tool for GIS data collection, positioning, and navigation.

Both receivers are fast, powerful, and very easy to use. Only a few keystrokes are needed to access any features. You can also reset many of the unit's operating and display parameters, including operation mode (2-dimensional, 3-dimensional, or automatic mode switching) position coordinate system (geodetic, UTM, British grid, Irish grid, Malaysian, RSO, MGRS, Indonesian Southern Zone, UPS, or user-entered), and altitude reference.

The ProMARK X displays altitude as either height above the ellipsoid (of the selected datum) or as orthometric height (height above sea level). The geoidal height used can be from a unit-maintained model or a user-entered value.

The ProMARK X stores up to 500 user-stored waypoints, and as many as 10 routes of up to 20 legs each. In addition, the unit has sufficient memory to allow the unit to log and store up to 9 hour's worth of data in the field, without the need for a separate data logger. (The data is downloaded to a PC for post-processing.) The buffer is protected from inadvertent power loss by an internal rechargeable lithium battery.

The ProMARK X is generally capable of 12 meters (RMS) horizontal accuracy in autonomous operation and in the absence of selective availability (SA). This can be improved by using the Magellan Post-Processing Software to calculate differential; post-processed differential with the ProMARK X can achieve 3 meters horizontal accuracy.

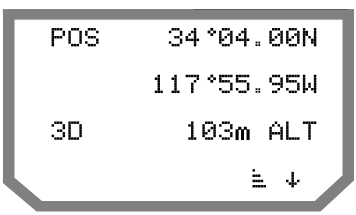
Centimeter (15mm ±3 ppm) and submeter accuracy (0.9 meters RMS) can be obtained by using the carrier phase module for the Post-Processing Software and a multipath-resistant antenna with the ProMARK X-CM.

About This Manual

This chapter presents a general overview of the manual and a brief description of the ProMARK X. Chapter 2 introduces the user to the unit's keys, walks the user through the initialization process, and describes how to get position fixes with the ProMARK X. Chapters 3 and 4 provide the user with a detailed description of the functions accessed through the SETUP and AUX (auxiliary) keys. These chapters should be read by all users before proceeding on to more complex topics such as navigation and the differential functions. Chapter 5 introduces waypoints, routes, and navigation, and explains the uses of each. Chapter 6 discusses attributes and their functional operations. Chapter 7 is devoted to the various differential functions obtained through the DIF key. If this is your first experience with GPS or differential processing, you may want to first read Appendices 1 and 2, which will provide some background information on GPS and differential theory. Specifications, accessories, and other specialized background information are covered in Appendices 1 through 5.

Sample Displays

Throughout this manual the ProMARK X's display screen will be represented by graphics similar to the following example:



Most screens consists of four display lines. The first three lines typically represent position fixes, navigation information, or data entry prompts, messages alerting the user to the current state or function of the receiver. The fourth line usually conveys system warnings; the down and/or right arrows alert the user to other options available from this screen. For example, the above screen displays a three-dimensional position fix with a down arrow in the lower right corner. The down arrow indicates that there is another screen accessible by pressing the down arrow key.

The position in the above example screen represents latitude and longitude in the format DEG/MIN, which will be used for all sample screens in this manual unless otherwise indicated.

Key Representation

The key names are always shown in caps and are abbreviated to appear as they appear on the unit's keypad: for example, the auxiliary key is "AUX." The exceptions are the arrow keys, whose names are always spelled out: LEFT ARROW or RIGHT ARROW.

How the keys are represented vary with the type of information being given. If the information is a step-by-step instruction, the text is indented and any key you should press is bolded. If the information is a general description, the text is not indented, and the keys are not bolded.

Chapter 2 GETTING STARTED

Introduction

Before your ProMARK X is ready for use, there are several tasks that must be completed. This chapter is intended to take the reader through these tasks and prepare the user for taking position fixes with the receiver. This chapter will cover operating the ProMARK X from either alkaline or NiCad batteries, as well as from external power sources. Also covered in this chapter are the keypad layout, entering data from the alphanumeric keys and initialization of the starting position. After a few steps this chapter will guide the user through obtaining a position fix and understanding the acquisition and position fix displays.

Batteries

The ProMARK X requires that six AA batteries be installed at all times, even when operating power is being provided from an external source. The batteries are needed to maintain the unit's memory between operating sessions. (ProMARK X has a rechargeable lithium backup battery to retain memory should the primary power source be lost.)

Battery power is provided by six AA alkaline batteries; we recommend Eveready Energizer™ batteries. You can also use the Magellan Rechargeable Battery Pack.

NOTE

NiCad and rechargeable alkaline batteries are never recharged while in the unit.

Alkaline batteries provide up to 3 hours of continuous use. The drop off at the end of their lives is gradual enough to allow the unit to display two power warnings: an initial warning that battery power is low, and a second warning that there is insufficient power remaining to continue operation.

The ProMARK X can also be powered from the Magellan Rechargeable Battery Pack. The battery pack contains six high-capacity nickel cadmium batteries, which are compatible with the power requirements of Magellan products. The battery clip is not required when using the battery pack and a connector for the charging adapter is available separately.

It is possible to use individual rechargeable batteries, but we cannot recommend their use. Commercially available NiCad batteries typically have poor power performance after repeated use, and rechargeable alkaline batteries maintain only 50% of the useful life of standard alkaline batteries.

Several things should be remembered when operating with the Rechargeable Battery Pack. The battery pack can be charged in 4 hours. The battery pack will power the unit for up to 3 hours of continuous use, after which the power drop can be quite sudden. In some instances, the drop may be so sudden that the battery pack may not retain enough charge to maintain the unit's memory for very long. We therefore suggest that replacement batteries, a fully-charged battery pack or external power be available when the unit is being operated from the Rechargeable Battery Pack for long periods.

The ProMARK X is shipped with alkaline batteries already installed. The Rechargeable Battery Pack and a variety of charging adapters are available as options from your Magellan dealer.

Loading the Alkaline Batteries. Use the procedure below to install alkaline batteries in the unit.

1. Make sure that the unit is off. If the unit was being operated on external power, also disconnect the ProMARK X from the external power source.
2. Holding the unit as shown in the illustration, pull the battery cover firmly towards the bottom of the unit until it stops, then lift the door off. To create a seal against moisture, the cover fits snugly and will not move easily.
3. Remove the old battery clip.

Removing the Battery Cover

4. Remove the batteries from the clip and replace them with fresh ones. Be sure the batteries are oriented as shown on the clip.

5. Insert the fresh clip into the battery compartment; it will fit only with the open side facing you and the clip's external contacts on the right.

6. Remove any dirt, sand, or other foreign matter from the battery compartment seal.

7. Replace the battery cover. Position the cover over the battery clip and push up firmly until the door settles into place. Be sure the door is secure.

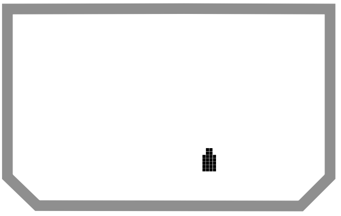
Loading the Rechargeable Battery Pack. The battery pack is installed in the unit in the same manner as alkaline batteries with the exception of step 4.

Battery Operation. When the unit is being operated from battery-supplied power, the ProMARK X remains on until the batteries become low or until the unit is turned off. The unit will acquire satellites and compute position fixes continuously after POS or NAV has been pressed.

You can generally expect about 3 hours of continuous use from alkaline batteries and up to 2 hours from the Rechargeable Battery Pack. Battery life can be extended by turning the Battery Saver on. When the Battery Saver is on, the unit operates for 2 minutes, then turns itself off if no keys have been pressed for the last 2 minutes.

Battery Warnings. There are two battery warnings. The first is a symbol that appears when the batteries are low. This symbol remains on all displays until the batteries are replaced.

If the Battery Saver is off when the battery warning appears, the unit is able to operate continuously for up to 20 minutes. If the Battery Saver is on, you can turn the unit on and obtain position fixes 15 more times.



If alkaline batteries are installed, they will have enough power to maintain the unit's memory for up to one month. If the Rechargeable Battery Pack is installed, the amount of charge remaining will vary according to the age of the battery pack.

External Power Operation

The ProMARK X can be operated from an external AC or DC power supply with a Magellan adapter. Only Magellan equipment should be used to connect the unit to any power source. All Magellan adapters and interfaces have been designed to supply the correct level of DC voltage; the use of any other equipment may harm the unit and will void the warranty.

As part of the power-on self-testing, the unit looks for an external power source. If external power is available, the unit will bypass the batteries to use external power. The batteries will not be recharged while external power is in use.

The unit will not continue to draw on external power after it is turned off. Batteries must therefore be installed in order to maintain the unit's memory.

NOTE

External power bypasses the batteries. At no time are alkaline or NiCad batteries recharged in the unit.

The unit can be operated from an AC power source when a Magellan adapter is used. AC adapters are currently available for 110 VAC, 220 VAC, and 240 VAC. A regulated +12 VDC adapter is also available. Discuss your needs with your Magellan dealer to be sure you purchase the correct adapter.

WARNING

Always be sure the unit is off when connecting or disconnecting external power. Failure to observe this precaution may result in memory loss or a frozen display.

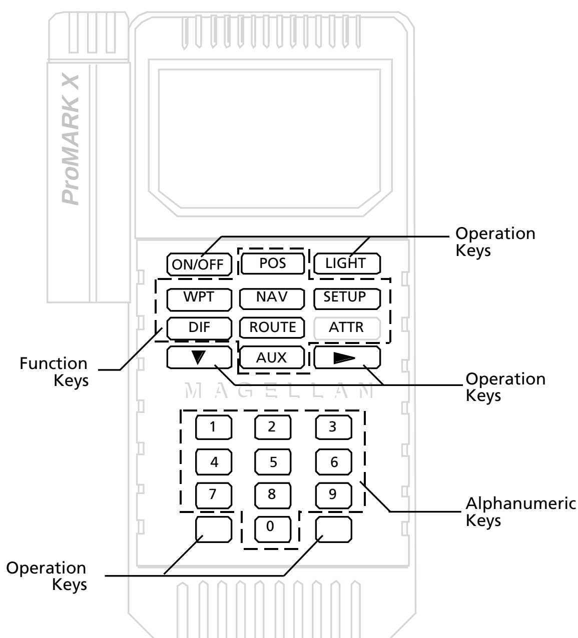
The external power jack is located on the right side of the unit, opposite the antenna. Insert the 8-pin connector of the adapter into the power jack.

The power lost message appears when the level of external power being supplied to the unit is below minimum requirements. The unit is operating on battery power. If no key is pressed within two minutes the unit will turn off.

The Keys

The ProMARK X has three types of keys: function keys, operation keys, and alphanumeric keys. The function keys are the eight center keys at the top of the unit. These keys are used to access the unit's functions and to select non-default operating parameters. The operation keys are the four keys in the corners of the top keypad, plus the ENTER and CLEAR keys at the bottom of the alphanumeric keypad. They are used to turn the unit and display light on and off, to scroll through information displays, to turn options on and off, and to save or delete information. The alphanumeric keys are used to input information and are generally used in conjunction with the function keys.

Detailed information relating to specific keys are found in following chapters.



Key Placement

Light

The LIGHT key backlights the message display and keypad. Press the key to turn the light on and off.

The light turns off automatically when the unit is turned off. It also turns off when the second battery warning appears and if external power is lost.

NOTE

The light is a significant drain on your batteries

The brightness of the display when the light is on can be adjusted in SETUP.

Entering Data

Information must be entered into the unit from the alphanumeric keypad to enter an initial position, to enter a user-entered datum or grid, to manually enter a waypoint, or to name or retrieve a waypoint.

Look at the keypad. It is arranged in the same way as your telephone keypad (reverse 10-key). Each key is assigned to a number and two or three letters.

Which character is displayed when a key is pressed is determined by the type of information being entered; the unit will not display letters in a space where a number should be entered. For example, the unit displays numbers only when entering position coordinates in the Lat/Lon and UTM coordinate systems. Either numbers or letters can be accessed when entering user grids and waypoint names.

To enter position coordinates, simply press the appropriate alphanumeric keys until the entire coordinate is entered; when entering geodetic coordinates, also press the RIGHT ARROW to toggle between hemispheres. Press ENTER to save the position. Trailing zeros can be entered by pressing the 0 key or by entering the coordinate up to the first zero. When ENTER is pressed, the empty spaces will be filled with zeros. (This does not work for zeros in the middle of the coordinate.)

An entry error can be deleted before **ENTER** is pressed by pressing **CLEAR**. During data entry, **CLEAR** operates like a backspace key; it deletes the character to the left of the cursor, then moves the cursor one space to the left.

Waypoint names are entered by pressing an alphanumeric key, then pressing the RIGHT ARROW until the desired character is displayed. Press another alphanumeric key to select the next character. When all of the desired characters have been entered, press ENTER to save the name entered.

ON/OFF

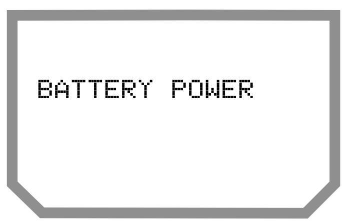
The ON/OFF key turns the ProMARK X on and off.

Power-On. The ProMARK X performs a self-test each time it is turned on.

When the unit is turned on, it performs a memory check.

Next, the unit displays a "title page."

The unit then displays a temporary power status message, indicating if the unit is operating from batteries or an external power source.



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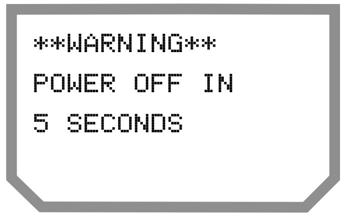
The unit then performs a brief self-test of its memory, almanac, and power. The "READY" display appears when the self-test is complete. The READY screen will also briefly (2 seconds) display the settings for mask angle (MA10 is a mask angle of 10°) and the dataport (DP=N indicates that the dataport is not on). (See SETUP 4 for Mask Angle and AUX 5 Data I/O for more details.)

Power-Off. To turn the unit off, press the ON/OFF key again. When the ON/OFF key is pressed while the unit is on, the unit begins a countdown from 5 to 0 seconds. This countdown is displayed on the screen.

When the counter reaches 0 the unit turns off. The countdown can be interrupted and the unit returned to normal operation before 0 seconds by pressing any key except **LIGHT** or **ON/OFF**. You can also turn the unit off immediately by pressing **ON/OFF** a second time.



Initialization

Initialization means telling the unit where it is, and if necessary, collecting an almanac.

To initialize, you must know your location within 300 miles (482.7 km). You should also know your altitude as accurately as possible and the correct date. If you do not know your position, consult an atlas or chart.

Although you can obtain a position fix without entering an initial position, the unit obtains the first position fix in 55 seconds or less (after locating the first satellite) if a correct initial position was entered. It is also possible to operate without having entered an altitude, but this will affect the accuracy of the position fixes, especially in 2D operation.

Regardless of which mode you plan to use, an altitude should be entered. When operating in 2D, this altitude will be used to calculate all position fixes; an inaccurate altitude will affect the accuracy of the computed fixes. When operating in 3D, the initial altitude will be used as the basis for further calculations; an inaccurate initial altitude will have a small effect on subsequent position fixes. An altitude must be entered when automatic operation is selected because the unit will switch between 2D operation and 3D operation. You should also enter the date, and if possible the time, although the date is the critical input.

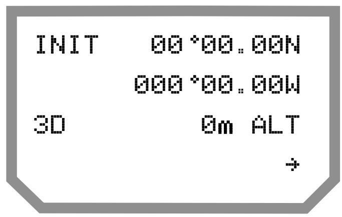
You must know your position within 300 miles (482.7 km) to initialize manually. If you do not know your position, you can press AUX 9 or POS to self-initialize. (This also requires that you are outside and have a clear view of the sky.) This procedure requires between 15 and 30 minutes to complete. Self-initialization is discussed later in this chapter.

NOTE

This section is intended to provide only enough information to set the initial position, altitude, mode, time, and date before the unit is used for the first time, and assumes that all user-set operating parameters will remain at default. You must read *SETUP* in Chapter 3 to fully customize the unit.

Initializing Manually.

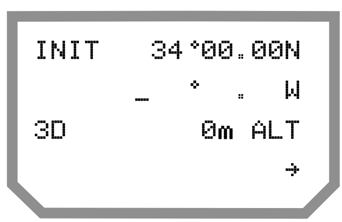
Press **SETUP**, **1**, and **ENTER**. If you are re-initializing, a position may be displayed; press **CLEAR** to erase it.



NOTE

The unit is initialized at the factory; this is usually cleared before the unit is shipped. Do **NOT** use the factory coordinates or the coordinates of the following sample as your initial position unless you are in the Southern California area of the United States.

To select position coordinates, press the appropriate keys on the 10-key keypad. You may have to select a hemisphere; the unit automatically displays "N" during initialization. If your position is south of the equator, press the **RIGHT ARROW** to select "S." Next, press **ENTER**.



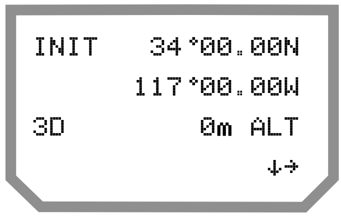
Coordinates with trailing zeros can be entered in two ways. You can key in the entire coordinate manually; for example, 34°00.00 would be 3, 4, 0,0,0,0, ENTER. You can also key in the digits up to the first trailing zero and let the unit fill in the blanks. For the same coordinate, you would key in 3,4, ENTER, and the unit would fill in the last four zeros.

The ProMARK X can display position coordinates in several formats. The default format is Lat/Lon displayed as degrees and minutes to two decimal places. You must enter your initial position in this format; the unit will not accept coordinates that are entered in an unselected format.

NOTE

If you initialize in Lat/Lon coordinates, the default hemispheres are North and West. The unit assumes that the hemispheres you choose here (or the hemispheres calculated in the last position fix, whichever is more recent) are current. These hemispheres are offered as your first choice when you enter a waypoint manually.

Enter the longitude; use the **RIGHT ARROW** to toggle between E and W (if necessary), then press **ENTER.**



Select a mode of operation and enter your altitude. Press the **DOWN ARROW** and **ENTER** to display the mode/altitude screen. Use the **RIGHT ARROW** to display the mode of operation you want to use. For land use, we recommend using the default 3D mode.

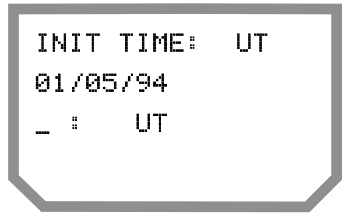
Now enter your current altitude. The default altitude is 0 meters (MSL). To enter a different altitude, press **CLEAR**, then key in the correct altitude. Use the **RIGHT ARROW** to toggle between positive and negative values. Press **ENTER**.

If you will be using an external antenna, be sure to enter the antenna altitude. Antenna altitude is the altitude of your position plus the height of the antenna installation above you.

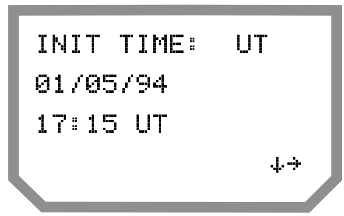
WARNING

Entering an incorrect altitude may introduce errors into the position fixes produced by the unit; accepting the default altitude of 0 meters when not at sea level will also introduce errors.

Press the **DOWN ARROW** and **ENTER** to enter in the initial date and time. The default format for the date is month/day/year. Enter in the date then press **ENTER**.



You are then prompted to enter the time in UT (Universal Coordinated Time) which is the time at Greenwich, England. If you know the current UT time enter it and press **ENTER**, otherwise press **ENTER** to select the default value.



NOTE

Entering the correct date is the important step here. The ProMARK X will obtain the correct UT from the satellites.

After the date and time have been entered the initialization process is complete and the SETUP menu can be exited by pressing any function key.

Self-Initializing. The unit will initialize itself when AUX 9 or POS is accessed and the unit has no initial position. At the same time, the unit will also collect a new almanac. Under certain circumstances, the unit will also self-initialize when NAV is pressed.

Although self initializing may be very helpful when you are unsure of your position, there are also several drawbacks to allowing the unit to initialize itself. During self-initialization, the unit calculates a position fix in 3D using 0 meters altitude. If you are not at sea level during initialization, this may result in position fixes that are not as accurate for a short period. Also, the unit will compute a position fix as soon as it has acquired four satellites, which will usually occur before the unit has acquired a complete almanac. The first available satellites may not be the satellites that provide the best position solution. Subsequent fixes will use the best satellite set, based on the initial position and the almanac, and should have better accuracy.

From start to finish, it takes about 15 to 30 minutes to self-initialize. The unit will obtain a first position fix much more quickly if the unit is initialized manually, even if an almanac must be collected.

Orienting the Antenna

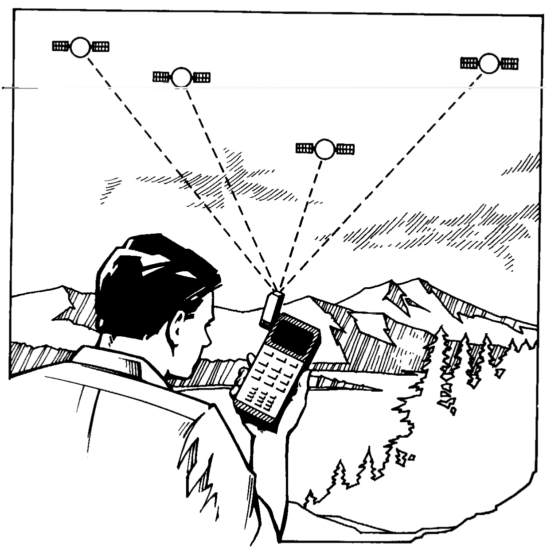
In order to locate and acquire satellites, the antenna must have a clear view of the sky. While signals will pass through canvas and glass (not fiberglass), satellite signals will not pass through metal or people.

The unit has a detachable, rotating quadrifilar antenna. Hold the unit in a comfortable position and rotate the antenna until it is vertical. (In order to operate more accurately, the antenna must be kept vertical.) If necessary, insert the unit in the optional unit holder to keep it steady and to free your hands.

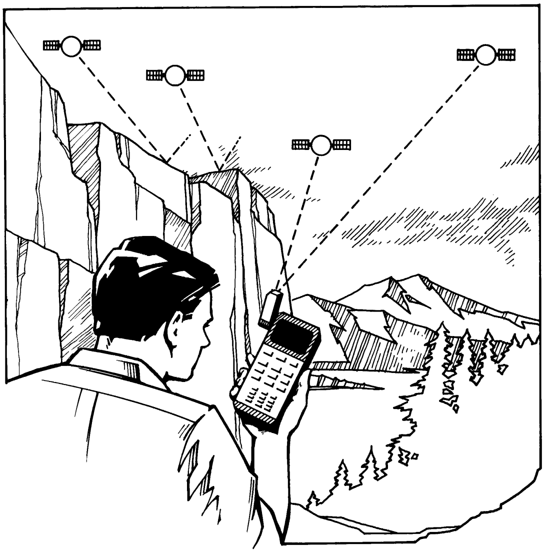
NOTE

If your signal appears to be blocked, sometimes moving a few feet in any direction will let you receive a signal. This is especially true in an area of dense or overhanging vegetation or structures.

If you are operating in an area with a sheltered view of the sky, you will probably not be able to provide the antenna with a clear view and read the unit's display at the same time. Disconnect the antenna from the unit and install the antenna cable between the quadrifilar antenna and the unit. Attach the antenna to any flat surface with the suction cup mount (provided with the unit). Be sure the antenna maintains a vertical position.



Give the Antenna a Direct View of Satellites



Obstructions Block the Signals

If you often operate in a sheltered or covered station, consider using the optional external antenna. The external antenna can be permanently mounted to any flat surface, temporarily attached to a flat surface with a magnetic mount, or screwed onto a range pole. The antenna's operating power is provided by the unit. The connection between the external antenna and the unit is made with a single cable; no couplers or additional connections are required.

NOTE

The external antenna increases the power drain on the unit's batteries, reducing their useful life. We recommend connecting to external power when using the external antenna.

Collecting An Almanac

The almanac is a schedule of satellite availability that is maintained by all satellites and is updated as required by the GPS system operators to reflect current conditions. (GPS is controlled and operated by the U.S. Air Force for the Department of Defense. The U.S. Coast Guard serves as a source of GPS information and as a point of contact. Refer to *Appendix 1* for a description of GPS.) The unit collects almanac information from any satellite and stores it in its memory. This means that before you obtain a position fix, the unit already knows which satellites are scheduled to be in view (given your last position or initial position) and where in the sky to look for them.

> **NOTE**
>
> The ProMARK X is shipped with an almanac. You should therefore have no difficulty getting your first position fix once the unit has been properly initialized.

The unit acquires almanac information in two ways: Almanac Collect and refresh. Almanac Collect is done by using the AUX 9 function, which causes the unit to search the sky for satellites and collect almanac data from them. In Almanac Collect, the unit acquires a full almanac and updates the "almanac age" date that is displayed on several of the screens.

Almanac information is refreshed while the unit is tracking satellites (getting position fixes). If the unit is tracking satellites for 12.5 minutes or more, it should be able to refresh the entire almanac. If the unit is tracking satellites for only a few minutes, however, it will refresh the almanac information for only a few satellites. Since how much of the almanac is refreshed depends on how long the unit is tracking satellites, you may occasionally have to collect a new almanc to be sure that the unit has up-to-date information for the entire satellite constellation. If the unit begins to consistently take a little longer than it should to locate satellites, it is probably time to collect a new almanac.

In general, an almanac that is about six months of age is so far out of date, especially if the unit has had little use since the almanac was collected. If the unit's almanac is more than six months of age, the unit may automatically collect a new almanac before providing positioning and navigation information.

The only way to be certain that your almanac is completely up-to-date is to collect an almanac with AUX 9. You should also collect a new almanac if you are planning a data collection session, or if the almanac contains dated information (this is likely if the almanac is one month old or more). You must collect an almanac when the unit's memory has been lost or cleared.

> **NOTE**
>
> If signal reception is good, it takes about 12-1/2 minutes to collect a complete almanac once a satellite signal has been located. When signal reception is poor and the unit is unable to maintain lock on a signal, almanac collection may require 20 to 30 minutes.

The Position (POS) Key

When the POS key is pressed, the ProMARK X checks its almanac. (ProMARK X is shipped with an almanac.) If satellites are visible to its last known position (last fix or initial position), the satellite search algorithm starts. In the satellite search algorithm, ProMARK X searches the sky for satellites. When enough satellites for a position fix are found and acquired, a position fix is computed and displayed.

You may key in waypoints, enter routes, change AUX and Setup settings, even collect data without pressing POS. If you access a function that requires positioning information, the search algorithm will be started automatically by that function.

The ProMARK X will update its almanac automatically as it tracks satellites. (This is called almanac refresh, and is described in *Collecting an Almanac*.) If the unit has not been used in 6 months or so, however, its almanac is out of date; the unit will automatically enter almanac collect to update its almanac before computing a position fix. This will require between 15 and 30 minutes to complete.

If the unit is not used for 6 months or more, or if you consistently use the unit only for short periods of time, use AUX 9 to collect a new almanac before using the unit.

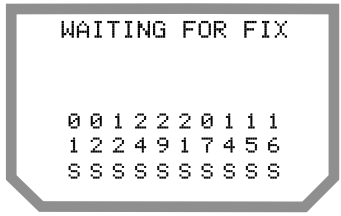
Obtaining a Position Fix.

Orient the antenna in an upward position with a clear view of the sky and press **POS**. The unit checks its almanac to determine which satellites are available, based on your last position fix, and the adjacent screen is displayed.

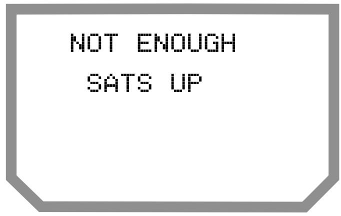
NOTE

If the unit's almanac is more than 6 months old, the unit enters Almanac Collect to locate a satellite and collect a current almanac before calculating a position fix.

If satellites are scheduled to be in view, the unit immediately starts searching for them. Satellite receiver activity is monitored on the 2- page receiver status screen.

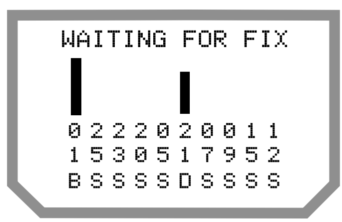


If there are not enough satellites scheduled to be in view, the satellite search and tracking algorithm will not begin and the adjacent screen is displayed. With the current satellite constellation it is unlikely you will ever see this message.

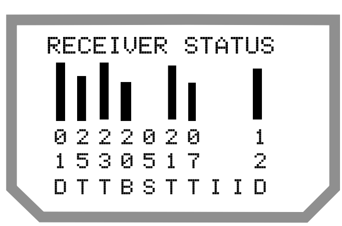


The unit devotes all ten channels to the search for the satellite the almanac indicates is directly overhead, given your last fix or initial position. This generally takes a few seconds. If the satellite cannot be located, the unit looks for the satellite with the next highest elevation. Searching for the highest satellite greatly shortens the length of time required to obtain a position fix.

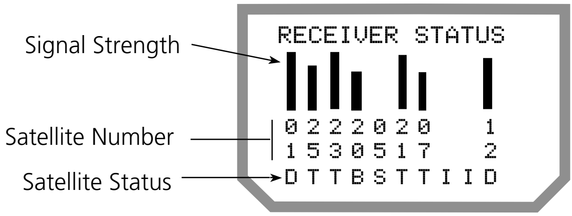
Once the satellite has been located, the receiver searches for other satellites that are scheduled to be in view.



Throughout the search and acquisition of satellites the receiver status screen monitors the activity of all ten channels. (You may also access the receiver status screen at any time with AUX 1.). Refer to the following illustration to interpret this screen.



When the unit is first turned on, the unit's internal clock is updated in the first 10 seconds of ephemeris data collection. Thereafter, the clock is updated every few position fixes.



Satellite Status Codes:

S - Searching – Receiver is searching for a particular satellite. This is based on information from the almanac.

T - Time – Receiver is collecting time from the almanac.

B - Bit Sync – Receiver is looking for the start bit to synchronize with the satellite.

D - Data Collect/Tracking – Receiver is using the satellite to calculate a position fix.

I - Idle

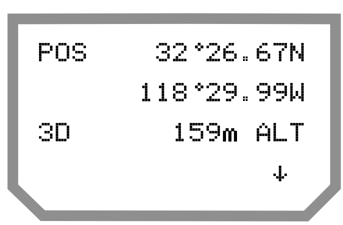
Reading the Receiver Status Screen

A position fix is calculated when enough satellites for the mode you have chosen have been acquired. If the unit was initialized correctly, the first position fix can be made in 55 seconds or less. Subsequent fixes can be made in about 30 seconds, if the previous fix was made in the last hour and you are using the same set of satellites.

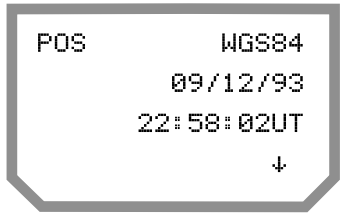
If the unit has no memory when POS is pressed, it enters Almanac Collect to locate a satellite, collect an almanac, and self-initialize before a position fix is displayed.

The Position Display. The position is automatically displayed on three screens once it has been calculated. Scroll through the screens with the DOWN ARROW.

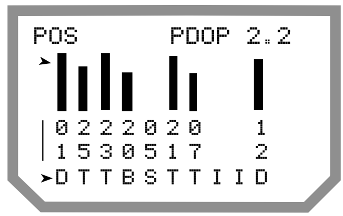
The first position screen shows the coordinates, mode, and altitude. Remember that altitude is a user-entered value in 2D; the unit computes it in 3D.



Press the **DOWN ARROW** to see the current datum, date, and time.



Press the **DOWN ARROW** again to see which satellites were used to compute the position, the SQ, and the PDOP of the fix. (See Appendix 8 and 9 for a description of PDOP and SQ.)



Press the **DOWN ARROW** again to return to the first screen.

NOTE

You may perform other functions, such as entering a route or checking satellite status and schedule while the satellite search and tracking algorithm is on.

Position Fix Updates. The position fix is normally updated approximately once every second, unless a satellite sets or its signal becomes blocked.

When the unit loses a satellite signal it tries to locate the satellite again and, if necessary, replaces the satellite with a new one. This rarely takes more than 10 seconds, but if it does, the most recent position fix is displayed with an Old Data symbol which is explained in the next section.

Message Displays

The ProMARK X displays a variety of messages during the operation of the unit. Some messages appear as an icon on the fourth line of the screen during normal operation; they are intended to alert the operator to an existing condition. A few messages appear on the first two lines of the screen, and indicate a condition that prevents the unit from performing the function selected; these are described in Chapter 8.

The following icons and messages may appear on the fourth line of the screen during normal operation.

PDOP — Appears on all position screens when the Position Dilution of Precision (PDOP) of the position fix is 10.1 or greater. The accuracy of the fix is uncertain; do not use this fix for navigating. May override the SQ icon.

Signal Quality — Appears on all position screens when the Signal Quality (SQ) of a position fix falls to 3 or below. The strength of one or more satellite signals is weak, and the receiver may lose its lock on it. This has a minimal effect on accuracy, and is intended only to alert the user that a signal may be lost. May be overridden by the PDOP icon.

Battery Warning — Appears on all screens when the batteries are low and should be replaced.

A **Almanac Update** — Appears when the unit is collecting or verifying almanac data. Requires about 10 minutes to complete. Do not turn the unit off while this icon is displayed.

D **RTCM Corrections** — Appears on the position displays when the unit is receiving RTCM corrections. May be overridden by the Old Data icon.

T **Timer** — Appears when the dif timer is on. See Setup 6.

Old Data — Appears when the unit has been unable to compute and display a position fix update for the past 10 seconds. This occurs when the signal from one or more satellites is lost and the unit has been unable to recover or replace the signal. The position fix displayed is at least 10 seconds old, and should not be used for navigation. May override the RTCM icon.

NOW IN 2D — This line appears for a few seconds on power-on when the unit has been set to 2D operation. It also appears briefly during Automatic operation when the unit switches from 2D operation to 3D.

NOW IN 3D — This line appears for a few seconds on power-on when the unit has been set to 3D operation. It also appears briefly during Automatic operation when the unit switches from 3D operation to 2D.

→ **Right Arrow** — Appears in the SETUP function and some AUX functions, and during data entry to indicate that additional options are available. Also appears in the ROUTE and WPT functions to allow the user to scroll through additional routes or stored waypoints and in the POS and WPT functions when more than four satellites were used to compute the displayed position fix.

⇣ **Down Arrow** — Appears on most function displays to indicate the presence of additional information screens. In SETUP and AUX, indicates additional SETUP and AUX features.

Chapter 3 SETUP

In this chapter the user will be introduced to the eighteen setup functions which are accessed by pressing the SETUP key. These set up functions will be covered in the numerical order in which they appear in the ProMARK X, and are listed in the table below.

SETUP	NO.	PAGE	DESCRIPTION/FUNCTION
Initial Position	1	3-3	Used to set the initial position during the initialization process.
Solve for Altitude	2	3-4	Allows the user to select the operation mode of the receiver (2D, 3D, or AUTO).
Time and Date	3	3-4	Allows the user to set the time and date during the initialization process.
Mask Angle	4	3-5	Allows the user to set the angle above the horizon, below which the receiver will not look for satellites.
Sampling Rate	5	3-6	Allows the user to set the rate at which position and raw data is stored in a file.
Timer	6	3-6	Allows the user to set a time and duration for a selected function to start and operate.
Dataports	7	3-7	Allows the user to turn dataport 1 or 2 on or off and to select the function for each.
Coordinate System	8	3-8	Allows the user to select a coordinate system or set up a user-defined grid.
Map Datum	9	3-11	Allows the user to choose a particular map datum.
Altitude Reference	10	3-12	Allows the user to select how the unit calculates the altitude (MSL, HAE, or HAG).

SETUP	NO.	PAGE	DESCRIPTION/FUNCTION
Altitude Units	11	3-14	Select either meters or feet to represent altitude.
Magnetic Variance	12	3-14	Allows the user to define whether a magnetic variation is applied automatically by the ProMARK X, not applied at all, or has a user-defined value applied.
Distance Units	13	3-15	Allows the user to select the distance and speed units used by the ProMARK X.
Route Mode	14	3-15	Allows the selection of automatic or manual route modes.
Velocity Average	15	3-16	Allows the use of averaging to be applied to velocity measurements.
Battery Saver	16	3-16	Allows the battery save to be turned on and off.
Beeper Control	17	3-17	Allows the beeper to be turned on and off.
Display Control	18	3-17	Allows the adjustment of contrast and light brightness.
Date Order	19	3-17	Allows the user to select the order in which the unit displays the month, day, and year.

A sample SETUP Worksheet is provided so you can record your SETUP parameters.

SETUP

SETUP is used to initialize the unit before it is used for the first time or when it has been moved more then 300 miles (482.7 km) from where the last fix was taken. (Although it is possible to get a position fix without an initialized position, the unit performs better when it has been initialized manually.)

SETUP is also used to change the unit's operating parameters and to re-initialize after a memory loss.

The SETUP functions can be accessed in one of two ways. One method is to press SETUP and the number of the SETUP function you want to access, followed by ENTER, ENTER. The other method is to press SETUP and use the DOWN ARROW to scroll forward or use CLEAR to scroll backward through the SETUP functions until the one you want is displayed. Press ENTER.

NOTE

In this chapter the user is prompted to "access" a SETUP function. Either of the above methods is acceptable to select the proper SETUP function.

To exit SETUP when all entries are complete, press any function key other then SETUP.

SETUP 1 — Entering an Initial Position. The initial position entered here must be correct within 300 miles (482.7 km). If you are not sure of your position, consult an atlas or chart, or allow the unit to self-initialize by pressing POS or accessing AUX 9 to initiate Sky Search. Self-initialization requires about 15 minutes. (Refer to *Initialization* in Chapter 2 for a full discussion on initialization methods.)

If the unit has been moved 300 miles (482.7 km) or more since its last position fix, you must re-initialize. You must also re-initialize if the unit has suffered a memory loss or the memory has been cleared.

Initialization can be done only in the currently selected coordinate format. The default coordinate system is Lat/Lon to two decimal places. If you know your coordinates only in another coordinate system, you must first select that system with SETUP 8.

Access SETUP 1. If an initial position is displayed, erase it by pressing **CLEAR** or by entering the first value of the new position; the old position will be deleted. Key in the latitude of the initial position; if necessary, use the **RIGHT ARROW** to toggle between N and S hemispheres. Press **ENTER**.

NOTE

When entering Lat/Lon coordinates, the default hemispheres (before initialization or after memory loss) are north and west. The unit assumes that the hemispheres you choose here (or the hemispheres calculated in the last fix, whichever is more recent) are current. These hemispheres are offered as your first choice when you enter a waypoint manually.

Key in the longitude, then use the **RIGHT ARROW** to toggle between E and W hemispheres. Press **ENTER**.

SETUP 2 — Selecting Mode and Entering Altitude. The ProMARK X has three modes of operation. The default mode is 3D, which uses a minimum of four satellites to determine position. It is used primarily on land. The 2D mode uses three satellites to calculate position; 2D requires a user-entered value for altitude and is used primarily at sea and when altitude is known. Automatic switches from 3D to 2D when there are insufficient satellites visible for a 3D fix, and returns to 3D when more satellites become available. AUTO is not recommended for the differential functions discussed later in this manual.

Access SETUP 2. Press the **RIGHT ARROW** to select a mode of operation.

Key in an altitude (MSL) in meters. It should be accurate to ±5 meters, ±1 meter if you will be using differential. (An existing value can be deleted by pressing **CLEAR** or by entering a new value.) Use the **RIGHT ARROW** to toggle to a negative altitude. Press **ENTER**.

The default is MSL (mean sea level) in meters. To enter altitude in HAE or HAG and feet, you must first select the appropriate settings with SETUP 9 and SETUP 10. If you know your altitude in MSL and meters, go ahead and enter it now. The unit will convert all stored altitude measurements to the selected altitude reference and unit of measure when they are changed.

Regardless of the operation mode you select, this step **must** be completed. Failure to enter an altitude will cause the unit to assume that the initial altitude is 0 (sea level), which may prevent the unit from obtaining the best accuracies possible. Altitude can be entered at any mode screen.

NOTE

The unit can accept altitudes up to 57,415 feet (17,500 meters).

If you are using an external antenna, be sure you enter antenna altitude (altitude plus antenna height).

SETUP 3 — Setting the Time. The GPS satellites operate on GPS time, which is within a few seconds of Universal Coordinated Time (UT). UT is the time and date that is current at the Prime Meridian, which runs near Greenwich, England.

The unit collects the current time (UT) from the GPS satellites when it collects or refreshes its almanac. It is therefore unnecessary to set the date or time if you want to operate on UT.

If you prefer, the unit can display local time on a 12-hour (AM/PM) clock or a 24-hour local clock.

Access SETUP 3. The screen displays the current date and time on the UT clock. Do nothing to use UT.

Press the **RIGHT ARROW** to display local time on a 12-hour clock (AM/PM). Press **CLEAR**, then key in the current date for your time zone in month/day/year order. (Date order is changed with SETUP 20.) Press **ENTER**.

Key in the local time (hours, minutes, seconds). Use the **RIGHT ARROW** to select AM or PM. Press **ENTER**.

OR

From the UT display, press the **RIGHT ARROW** twice to display time on a 24-hour local clock. Enter the local date and time as described above.

SETUP 4 — Choosing a Mask Angle. The mask angle is the angle above the horizon below which the unit will not search for satellites. The ProMARK X has a user-adjustable mask angle.

The default mask angle is 10°. The unit will not search for satellites whose elevation is less than 10° and will stop tracking any satellite that sets below that elevation.

If there are not enough visible satellites above 10°, you can extend the search as low as the horizon. This feature gives the unit more flexibility, but using the lower elevation satellites may affect the accuracy of the position fixes computed by the unit. Errors may be induced by humidity, and tropospheric and ionospheric conditions may also increase the possibility of errors. Always carefully evaluate the integrity of your fixes when using low elevation satellites before using the data.

Alternatively, you can also limit the search to 15° or 20°. Under certain circumstances, this may prevent the unit from using the best satellite set among the visible satellites by forcing the unit to consider only satellites with higher elevations. Remember that the PDOP is generally better when there is sufficient “spread” between the satellites being used for the position solution.

The currently selected mask angle is displayed on the Unit Ready display for 2 seconds when the unit is turned on. This will appear in the form MAxx on the fourth line of the display, where xx is a number representing the mask angle.

> Access SETUP 4. Press the **RIGHT ARROW** to increase the mask angle by increments of 1° until it gets to a mask angle of 20°. The next press of the RIGHT ARROW sets the mask angle to 0°.

SETUP 5 — Data Sample Rate. The data sample rate allows you to select how quickly the unit saves information to an internal file or outputs it to a PC or data logger. You may select separate data sample rates for the raw data collected by the unit and for the position fixes it calculates.

When the receiver is on, the unit constantly collects raw data and calculates position fixes. Both types of data are stored in a file or downloaded if the dataport is on. In most instances, both types of data are not required. Since you can set different sample rates for position fixes and raw data, you can keep only the amount of each data type that you require for your application.

The data sample rate for either type of data can be set to any frequency from 0 seconds (no sampling) to every 999 seconds. Select 1 to save or output data every second. The default data sample rate for both data types is 1.

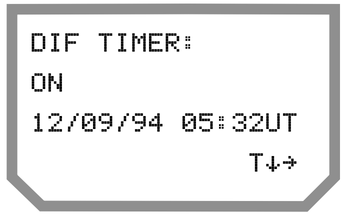
> Access SETUP 5. To select a sample rate for position fixes, press CLEAR, then enter any number between 0 and 999 seconds. (Leading zeros are not required.) Press **ENTER**.
>
> If you want to change the raw data sample rate without altering position sample rate, retype the same position rate and press **ENTER**. Now enter the raw data sample rate.
>
> To select a sample rate for raw data, enter any number between 0 and 999 seconds. Press **ENTER**.

NOTE

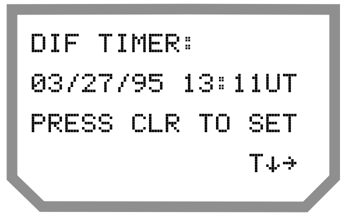
If you are logging data for carrier phase differential, you must select 1 to sample raw data every second. This will allow you to match data sets more easily.

SETUP 6 — Timer. The Dif Timer allows you to set a starting time and duration for a stationary differential session. (A session must be defined with DIF 2 for the timer to work properly.) When the time is set to ON, any stationary session you initiate will start at the designated time and for the designated duration. This function remains on until turned off with SETUP 6.

Access SETUP 6 (Timer). Select "ON" by pressing the **RIGHT ARROW**.



Press **ENTER**. To key in a new date and time, press **CLEAR**. Enter the date followed by **ENTER**, then enter the time. Press **ENTER** again.



If you accepted the original date/time, key in the start time as an offset from the current time. Press **ENTER**.

Enter the duration of the data collection session and press **ENTER**.

The display returns to the Timer ON/OFF screen. The timer is on and set.

SETUP 7 — Dataports. Dataports turns the two dataports on and off and selects the baud rate.

Access SETUP 7. Dataport 1 is displayed. To set dataport 2, press the **RIGHT ARROW**. Press **ENTER** to continue.

Use the **RIGHT ARROW** to SELECT LOG, COMM, OFF, NMEA, or RTCM. Press **ENTER**.

Next, use the **RIGHT ARROW** to select the baud rate for port 1. Select 9600, 19.2, 38.4, 115, 1200, 2400, or 4800. After you have set the ports, press the **RIGHT ARROW** to select DONE.

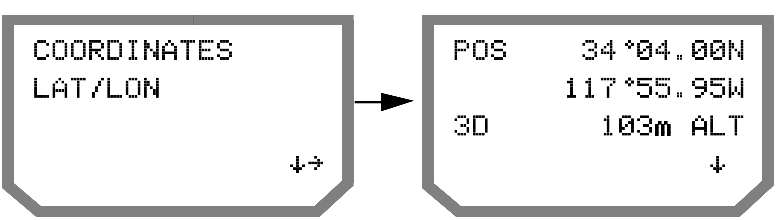
NOTE

You can override these port settings in each individual function.

SETUP 8 — Choosing a Coordinate System. The ProMARK X can display positions in ten coordinate systems (Lat/Lon, MGRS UTM, UTM, British Grid, Irish Grid, UPS, MGRS UPS, West Malaysian, Indonesia South, and Indonesia Equatorial), plus any user-entered grid reference system. You may enter and store up to five user-entered grids or use the COMM module of the PPSW to upload grids.

Once selected in SETUP, the coordinate system you choose will be used to display all position fixes, including current position, initial position, waypoints, and fixes in the buffer. (This may not occur when British grid, Irish grid, or UPS coordinates are selected. Please refer to *Appendix 5*.)

When you select latitude/longitude (LAT/LON), position displays look like this:

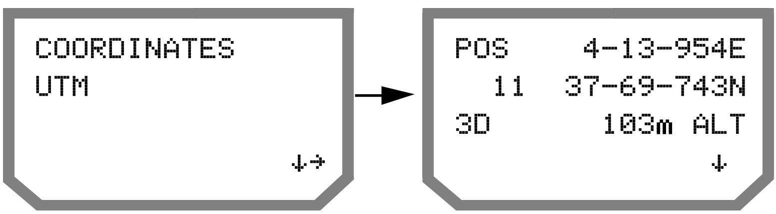


You may also select how Lat/Lon coordinates are displayed. You may select degrees/minutes and display minutes to two or four places, or select degrees/ minutes/seconds and display the two-digit seconds with or without two decimal places. The following table shows the same position in each format.

DEG/MIN (.01)	DEG/MIN (.0001)	DEG/MIN/SEC (1.0)	DEG/MIN/SEC(.01)
34°06.56N	34°06.5639N	34°06’34N	34°06’3383N
117°49.52W	117°49.5216W	117°49’31W	117°49’3129W

To select a Lat/Lon format, press **ENTER**, then press **RIGHT ARROW** until the desired format is displayed.

When you select UTM, British grid, Irish grid, or UPS, position displays look like this:



All position displays for UTM, British grid, Irish grid, and UPS will be in meters. This cannot be changed.

The British and Irish grid coordinates can be used only in Great Britain and Ireland, respectively. UPS can be used only in polar regions (areas south of 80°S and north of 84°N). For more information on operating with these coordinate systems refer to *Appendix 5*.

NOTE

The standard notation for Lat/Lon coordinates places latitude (north/south) first and longitude (east/west) second. The standard notation for UTM, British grid, and Irish grid places the zone first, easting (east/west) second, and northing (north/ south) third. The ProMARK X displays easting first, then zone and northing.

If you prefer, you can enter and save up to five user-entered grids. User-entered grids are non-standard grids that are used in relatively small operational areas, in areas where grid systems are locally prescribed, and in areas that are not directly supported by any of the built-in coordinate systems. A user-defined grid can also be used to increase the accuracy of position data that is collected in an area that is more accurately described by a local grid. The user-defined grid utility can also be used to input State Plane Coordinate Systems. Parameter tables for these inputs are provided in Appendix 12.

A number of options are available when entering a user-defined grid. Refer as necessary to Table 4-1 while entering a grid.

Mapping Function	Options	Origin	Scale	Local Units of Measure	False Coordinates
Transverse Mercator	Any	Not at Poles	Always Near 1.0	Yards to Meters – All input and display of these coordinates will be in these units of measure.	In local units of measure as previously defined
Lambert Conical	2 Standard Parallel				
	1 Standard Parallel				
Stereographic	N. Polar	North Pole			
	S. Polar	South Pole			
	Polar - Scale at Input Parallel	Either Pole			
	Oblique	Not at Equator			
	Equatorial	Not at Poles			
Oblique Mercator	Point – Azimuth	Any			
	Two – Point	– Lat 1 not at equator – Lat 1 ≠ Lat 2 – Lat 1 & Lat 2 in same Hemisphere			
Polyconic	Any	Any			

To enter a user-defined grid, access SETUP 8 and use the **RIGHT ARROW** to scroll through the coordinate systems. Stop when an empty user grid is displayed and press **ENTER.**

Key in any grid name up to 16 characters long and press **ENTER**. Press the **RIGHT ARROW** to select the mapping function or projection (transverse mercator, lambert conical, stereographic, oblique mercator, or polyconic). Press **ENTER** when the desired function/projection is displayed.

Key in the grid's latitude of origin (refer to Table 4-1 for origin guidelines), using the **RIGHT ARROW** to select N or S. Press **ENTER**.

NOTE

The unit will not accept an entry that is inappropriate for the entries already made. An attempt to enter an inappropriate option or origin will cause the unit to display "INVALID INPUT."

Key in the grid's longitude of origin using the **RIGHT ARROW** to select E or W. Press **ENTER**.

Key in a scale factor. The scale factor is normally a number that is close to 1. Press **ENTER**, then key in a units-to-meters conversion factor for all subsequent displays in this coordinate system. Press **ENTER**.

Key in a false easting, followed by **ENTER**, then a false northing followed by **ENTER**. (These entries are required to avoid displaying negative coordinates.)

To save the grid just entered, press any function key. To reset the grid parameters, press **CLEAR**. To select a different coordinate system and return the parameters to default, press the **RIGHT ARROW**.

NOTE

You must exit SETUP to save the user-entered grid.

SETUP 9 — Selecting a Map Datum The ProMARK X provides 66 geodetic map datums for use with charts and maps worldwide. (These datums are identifed in *Appendix 4*.) The unit also allows you to key in or upload up to five map datums that are not currently in the unit's memory.

The Map Datum feature allows you to operate the ProMARK X on a datum that corresponds to the maps you are using. Which horizontal datum your map uses can usually be found in the legend.

A datum refers to a mathematical model of the earth. The coordinates of a position differs from one model (datum) to another. It is therefore important to know which horizontal map datum you will be using if you want to relate your positioning information to a map, since using a different datum may result in positioning errors of more than 300 meters when the unit's position is compared with the map.

Access SETUP 9. Use the **RIGHT ARROW** to scroll through the available datums until you find one that corresponds to your chart. Press **ENTER**.

> **NOTE**
>
> If you select British grid or Irish grid coordinates, the unit automatically uses the OSGB or Eire datums, respectively; UPS coordinates require WGS84. Other datums are not available when any of these coordinate systems is chosen. (Refer to *Appendix 5*.)

If your map uses a datum that is not included in the choices listed on the SETUP worksheet, you can use a user-entered datum. Refer to *Appendix 2* for the constants to convert WGS84 coordinates to the most common local datums.

To enter a user-entered datum, press the **RIGHT ARROW** until an undefined datum is displayed.

Press **ENTER**. If a value other than 0 is displayed, this user-entered datum has been defined. Press **CLEAR** to delete the existing value or select another user datum.

> **NOTE**
>
> Be sure to key in all leading zeros.

The unit will prompt you through the entry of values for Δa, Δf x 104, ΔX, ΔY, and ΔZ. (The unit displays "Δ" as "DELTA." Press the **RIGHT ARROW** to show a negative value. Press **ENTER** after each entry is complete to continue. Press **ENTER** after keying in ΔZ to save the datum.

SETUP 10 — Choosing an Altitude Reference. The ProMARK X calculates and stores altitude as height above the WGS84 ellipsoid, but converts and expresses altitude in three ways; Mean Sea Level (MSL), Height Above Geoid (HAG), and Height Above Ellipsoid (HAE) of the currently selected datum. Which altitude reference you choose is determined by your application.

Measurements of and on the earth are based on one or two models of the earth. One model is the ellipsoid, which is a mathematically defined, regular surface. Each datum uses the ellipsoid or arc of an ellipsoid that corresponds most closely to the earth's true shape in that area. Measurements of the earth can be related to the ellipsoid vertically, as well as horizontally. These measurements are based on the height of the position above (or below) the ellipsoid being used by the currently selected datum, or the HAE. When you select HAE, the unit always displays the height of the position above the ellipsoid of the currently selected datum.

The other model is the geoid. The geoid is the surface over which water would flow if free to adjust to the effects of gravity and the earth's rotation. This is often referred to as the Mean Sea Level (MSL).

Since the geoid is not a mathematically smooth surface and does not always correspond to the ellipsoid, the unit adds the Geoidal Height (GH, or the difference between the geoid and the ellipsoid) to the HAE to calculate the height of a position relative to the geoid. This is the Height Above the Geoid (HAG).

We said above that the geoid and mean sea level are the same; this means that HAG and height above MSL are the same. In the ProMARK X they differ only in the value used for GH.

The ProMARK X contains a global geoidal model; when you select MSL, the unit calculates the altitude of a location using a standard value for GH that is accurate to within a few meters. This is usually accurate enough for most applications even though the difference between the unit's GH and true GH changes rapidly over several miles.

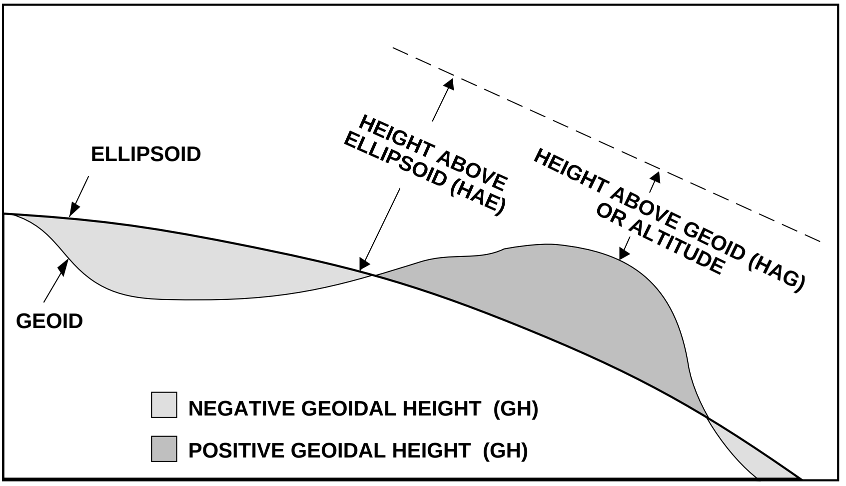
If known, you may use the actual GH of your area. This will increase the accuracy of the position fixes calculated by the unit, especially when collecting data for differential positioning over long baselines. Select HAG to enter your own value for GH.

NOTE

If you are not sure which reference to use, select ALT to display elevation above mean sea level.

Access SETUP 10. Press the **RIGHT ARROW** to select ALT, HAG, or HAE.

If you select HAG, you must enter a value for Geoidal Height. Press **ENTER**. If a value is displayed, press **CLEAR** to erase it. Key in a new value and press the **RIGHT ARROW** to select positive or negative. Press **ENTER** to save the new value.



Height Reference

SETUP 11 — Altitude Units. Changing the altitude units affects all displays where altitude is shown. The unit recalculates all stored altitude measurements to the new unit of measure.

Access SETUP 11. The default unit of measurement is meters. Use the **RIGHT ARROW** to toggle between meters and feet.

SETUP 12 — Magnetic Variation Display. Select one magnetic variation for all heading and bearing displays.

Auto Mag (M)	An automatic adjustment made by the ProMARK X. (Default)
True (T)	No magnetic adjustment in readout.
User Set (U)	A constant user-entered adjustment.

Access SETUP 12. Use the **RIGHT ARROW** to select a Magnetic Variation display.

If you select User Set (U), the screen displays the last value entered. To change the value displayed, either press **CLEAR** or begin entering numbers to clear the display. Enter the constant compass error in degrees and minutes, and use the **RIGHT ARROW** to toggle between east and west.

NOTE

Use leading zeros as required.

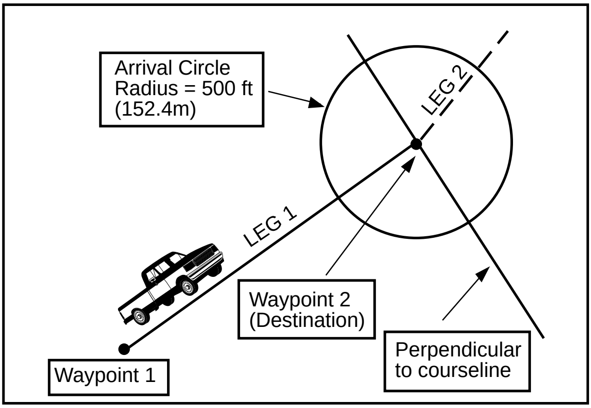
Press **ENTER** to save the value entered and to return to the original display.

SETUP 13 — Choosing Distance/Speed Units. Changing distance/speed units affects all displays where distance or speed measurements are shown. All stored distance values will be converted to the new unit of measure for display.

Access SETUP 13. The currently selected unit of measure for distance and speed is displayed. Use the **RIGHT ARROW** to scroll through kilometers and kilometers per hour, statute miles and miles per hour, nautical miles and knots, meters and meters per second, or feet and feet per second.

SETUP 14 — Choosing Automatic or Manual Leg Switching Modes. Which route mode is selected here determines how the unit switches legs when navigating on a route.

With both modes, the unit constantly updates the navigation screens to reference your present position to the current leg's destination waypoint. It also displays "CLOSE" (at the bottom of the screen) when you are within 500 feet (152.4 meters) of the destination waypoint.



In the automatic route mode, the unit switches from the current leg to the next when you cross an imaginary line that runs through the destination waypoint and is perpendicular to the courseline. All navigation information is now referenced to the destination waypoint of the new leg.

In the manual mode, the unit does not switch legs. Instead "ARRIVED" is displayed at the bottom of the screen, and the unit continues to compute navigation information referenced to the destination waypoint you just passed. You must switch to the next leg manually by displaying the current route with ROUTE and using the RIGHT ARROW to select the next leg and then press NAV to continue navigating.

Access SETUP 14. Press the **RIGHT ARROW** to toggle between automatic and manual leg switching modes.

SETUP 15 — Velocity Average. Velocity-related values (such as SOA and SOG) are based on an instantaneous measurement of speed (velocity). In practice, the instantaneous nature of the velocity measurement makes the values based on it vulnerable to momentary fluctuations in velocity. The measurements appear to vary from one moment to the next, sometimes considerably.

Velocity Average allows you to replace the instantaneous measurements with a weighted average, taken over a selected number of seconds. This has the effect of "smoothing" and stabilizing the values displayed on the screen.

Velocity Averaging can be set to NONE, every 20 SECONDS, or every 120 SECONDS.

Access SETUP 15. The default setting is NONE. To choose a different setting, press the **RIGHT ARROW** to scroll through the available values.

SETUP 16 — Battery Saver. The Battery Saver allows you to choose how long the unit operates (continuously or 2-minute periods) when using battery power.

When the Battery Saver is off, the unit operates until it is turned off with the ON/OFF key or until 2 minutes after the second battery warning appears. Battery Saver off is the default setting.

When the Battery Saver is on, the unit obtains position fixes for 2 minutes and turns itself off. This drains relatively little power from the batteries. (The unit will **not** turn itself off during Almanac Collect or Almanac Verify.)

Several of the unit's functions require that the unit operate for more than 2 minutes. At the same time, operating with the Battery Saver off is a heavy drain on the batteries. We therefore recommend that you operate from external power when averaging, collecting data, downloading or logging data, and navigating on a route.

Battery Saver on is useful primarily as a means to conserve power when the batteries are low and when performing single-fix positioning.

Once set, Battery Saver remains unchanged until reset in SETUP.

Access SETUP 16. Use the **RIGHT ARROW** to toggle between on and off.

SETUP 17 — Beeper Control. The unit beeps when any key on the keypad is pressed, when a fix is updated, and when an SQ, PDOP, or Old Data symbol appears. The beeper can be turned on and off; default is on.

Access SETUP 17. Press the **RIGHT ARROW** to toggle between on and off.

SETUP 18— Display Control . The Display Control function allows you to change the display brightness (when the light is on) and contrast.

Access SETUP 18. Press the **RIGHT ARROW** to change the display brightness.

The possible levels of brightness are 0 through 7. Each time the RIGHT ARROW is pressed, the brightness increases to the next value; at 7, the value rotates back to 0. (The default setting is 7.)

To change the display contrast, press **DOWN ARROW** from the brightness display. Press the **RIGHT ARROW** to change the display contrast. (It is not necessary for the light to be on to change contrast.)

The possible levels of contrast are odd numbers 0 through 5. Each time the RIGHT ARROW is pressed, the contrast increases to the next value; at 5, the value rotates back to 0. (The default setting is 5.)

SETUP 19 — Date Order. All dates are displayed in month/day/year order. SETUP 19 allows you to use day/month/year instead.

Access SETUP 19. Press the **RIGHT ARROW** to change the data order.

SETUP WORKSHEET

SELECT ONE OPTION FOR EACH SETUP FEATURE (Factory defaults shown in bold)

1. INITIAL POSITION

Lat/Northing: ____________________

Lon/Easting: ____________________

2. SOLVE FOR ALTITUDE

☐ 3D
☐ AUTO (Automatic)
☐ 2D

ALT: ________________

3. TIME AND DATE

☐ **UT**
☐ LOCAL (AM/PM)
☐ LOCAL (24-Hour)

4. MASK ANGLE

☐ **10°** ☐ 0° ☐ 15°
☐ 2° ☐ 20° ☐ 5°

5. DATA SAMPLE RATE

POSITION DATA

☐ **1 (Every Fix)**
☐ 0 (off)
☐ Other _____ (2 – 999)

RAW DATA

☐ **1 (Every Fix)**
☐ 0 (none)
☐ Other _____ (2 – 999)

6. TIMER

☐ **OFF** ☐ ON

7. DATAPORTS

Dataport 1

☐ **OFF** ☐ ON

☐ **LOG** ☐ COMM
☐ OFF ☐ NMEA
☐ RTCM

Baud ____________

Dataport 2

☐ **OFF** ☐ ON

☐ **LOG** ☐ COMM
☐ OFF ☐ NMEA
☐ RTCM

Baud ____________

8. COORDINATE SYSTEM

- ☐ **LAT/LON**
  - ☐ **DEG/MIN (.01)**
  - ☐ DEG/MIN (.0001)
  - ☐ DEG/MIN/SEC (1.0)
  - ☐ DEG/MIN/SEC (.01)
- ☐ UTM
- ☐ British grid
- ☐ Irish grid
- ☐ UPS
- ☐ MGRS UTM
- ☐ MGRS UPS
- ☐ W. Malaysian
- ☐ Indonesia SO
- ☐ Indonesia EQ
- ☐ User Grid 1
- ☐ User Grid 2
- ☐ User Grid 3
- ☐ User Grid 4
- ☐ User Grid 5

9. MAP DATUM

- ☐ **WGS84**
- ☐ USER 1
- ☐ USER 2
- ☐ USER 3
- ☐ USER 4
- ☐ USER 5
- ☐ OTHER ____________________

10. ALTITUDE REFERENCE

- ☐ **ALT (ELEV ABOVE MSL)**
- ☐ HAE (HT. ABOVE ELLIPSOID)
- ☐ HAG (HT. ABOVE GEOID)

11. ALTITUDE UNITS

- ☐ **Meters**
- ☐ Feet

12. MAGNETIC VARIATION

- ☐ **AUTO MAG (M)**
- ☐ SET (USER SET – U)
  _ _ ° _ _ E OR W (Specify)
- ☐ TRUE (T)

13. DISTANCE, SPEED UNITS

- ☐ **Km (kilometers) and Km/HR**
- ☐ MI (statute miles) and MPH
- ☐ NM (nautical miles) and KNOTS (knots)
- ☐ Meters, m/sec
- ☐ Feet, ft/sec

14. ROUTE MODE

- ☐ **Automatic**
- ☐ Manual

15. VELOCITY AVERAGE

- ☐ **NONE**
- ☐ 20 SECONDS
- ☐ 120 SECONDS

16. BATTERY SAVER	☐ **OFF**	☐ ON
17. BEEPER CONTROL	☐ **ON**	☐ OFF
18. DISPLAY CONTROL		
BRIGHTNESS	☐ **7**	
	☐ Other _____	
CONTRAST	☐ **3**	
	☐ Other _____	
19. DATE ORDER	☐ **MONTH/DAY/YEAR**	
	☐ DAY/MONTH/YEAR	

In addition to the nineteen SETUP functions in Chapter 3, the ProMARK X has fourteen auxiliary functions. These functions provide the user with additional information as well as control over how the unit handles information. These functions will be covered in the numerical order in which they appear in the ProMARK X and are listed in the following table.

AUXILIARY	AUX	PAGE	DESCRIPTION/FUNCTION
Receiver Status	1	4-2	Displays up to ten satellites that are in view and monitors the search, acquisition, and ranging of those satellites.
Sat Schedule	2	4-3	Calculates the window of availability for the location and date entered.
Sat Status	3	4-5	Displays the current status of the satellites that are listed as healthy. The angle and elevation of satellites above the horizon are also displayed. Determines PDOP and CPDOP of optimum satellite set for that place and time.
View Data	4	4-6	Displays the names of files in the receiver, the file size, and allows the user to view the position fixes in the file if any fixes exist.
Data I/O	5	4-6	Transfers user-selected files between a PC or datalogger and the unit, and downloads data.
Waypoint Projection	6	4-9	Estimates the latitude and longitude (or northing/easting) of a distant position, based on the estimated distance and bearing from POS or a waypoint.
Erase Waypoints	7	4-10	Deletes all waypoints and routes from the unit's memory.

AUXILIARY	AUX	PAGE	DESCRIPTION/FUNCTION
Reverse Route	8	4-11	Reverses the order of all waypoints in the selected route.
Almanac Collect	9	4-11	Searches for satellites in a pre-scribed hierarchy to collect an almanac. After a memory loss, can also be used to determine position. Also initiated with POS or NAV after a memory loss.
Memory Stats	10	4-13	Displays the percentages of memory used and remaining.
File Maintenance	11	4-14	Erases or renames selected files; erases all or selected parts of the unit's memory.
NMEA Output	12	4-15	Turns a dataport on and output NMEA data to a PC or external navigation equipment.
Product Support	0	4-16	Displays phone numbers for Magellan Systems.

The Auxiliary functions can be accessed in one of two ways. One method is to press AUX and the number of the AUX function you want to access, followed by ENTER, ENTER. The other method is to press AUX and use the DOWN ARROW or CLEAR to scroll through the AUX functions until the one you want is displayed and press ENTER.

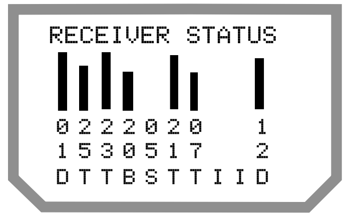
NOTE

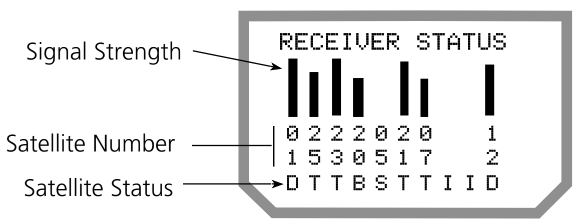
In this chapter the user is prompted to "access" an AUX function. Either of the above methods is acceptable to select the proper AUX function.

AUX 1 — Receiver Status. The receiver status screen allows you to monitor the search, acquisition, and ranging of satellites that are visible and may be used for a position fix.

The receiver status display appears when POS is pressed and during the Sky Search portion of Almanac Collect. You can also go to this display manually when you want to know which satellites are being tracked and the signal quality from each satellite. This can be helpful if you are having difficulty getting a position fix, especially if you think the signals may be blocked.

Access AUX 1. Each column on the display represents a channel; the unit searches for up to 10 satellites simultaneously. The last line monitors the search and acquisition of the satellites. The satellite numbers are displayed vertically just above that. The strength of signal being received from each satellite is indicated by how high the bar above the satellite's number is. The higher the bar, the stronger the signal.





Satellite Status Codes:

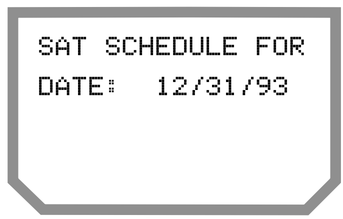
- B - Bit Sync
- D - Data Collect/Tracking
- I - Idle
- S - Searching
- T - Tracking

READING THE RECEIVER STATUS SCREEN

AUX 2 — Satellite Schedule. Full 3D, 24-hour satellite coverage may not be available in polar regions or in areas with a limited view of the sky. Some availability planning will be required if data collection is to be done in these areas. Also, there may be a time you need to compute an availability schedule in the field.

AUX 2 computes a 24-hour schedule of satellite availability for the position and date you select, and the mode of operation (2D or 3D) the unit is currently using. Although not as detailed as the schedule that is computed by the Post-Processing Software, the computed schedule covers the 24 hours (midnight to midnight of the date selected.

Access AUX 2. The first display shown is POS. You may use the current position or a waypoint. To select a waypoint press the **RIGHT ARROW** or key in all or part of the waypoint name followed by **ENTER**.



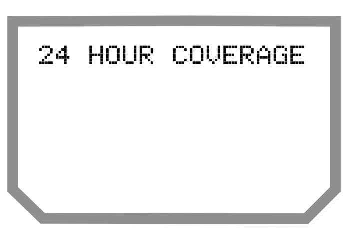
Press **ENTER** to accept the displayed position. The current date is displayed. Do nothing to accept the date, or key in a new one.

NOTE

You may enter any date that is within six months of the age of the unit's almanac, but the schedule will be more accurate if the date is within two weeks of the almanac age.

Press **ENTER** to begin computing. As the unit calculates the satellite schedule for a 2D or 3D solution, the time advances in 15-minute increments.

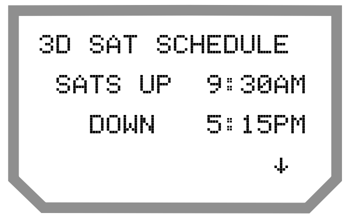
When the computations are complete, the unit displays the "window of availability." This is when there will be enough satellites to obtains a position fix.



NOTE

The schedule computed will be based on the currently selected mask angle and mode of operation.

You may see a shorter window of availability, especially if you are operating near the poles. A **DOWN ARROW** appears when there is more than one window; press the **DOWN ARROW** to view the next window.



AUX 3 — Satellite Status. Satellite Status ("Sat Status" throughout this guide) displays the elevation and azimuth of available satellites in relation to the selected position.

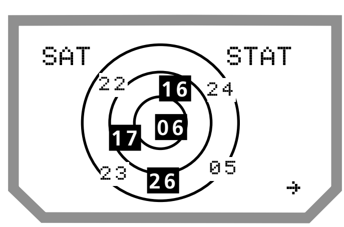
Satellites are identified by a pseudorandom number (PRN), which is used by the government to identify a specific satellite.

Access AUX 3. Use the **RIGHT ARROW** to select POS or any waypoint, or key in the name of the desired waypoint. Press **ENTER**.

Next key in the desired date and press **ENTER**, followed by the time of day and **ENTER.**

Use the **RIGHT ARROW** to view the status of each satellite. Elevation and azimuth is displayed for satellites that are above the horizon. SQ is displayed as a numerick value when the satellite has been tracked recently. (Signal quality is described in *Appendix 11*.)

Press **ENTER.** The unit displays a north-up, overhead view of the available satellites. Each satellite's location is indicated by its pseudorandom number (PRN). Satellites that are being used in the position solution are highlighted.



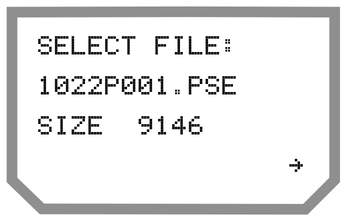
The concentric circles indicate elevation, or height above the horizon. The outer circle is the horizon, or 0° elevation. The next two circles are 30° and 60°, respectively. The center is 90°, or straight up.

Azimuth, or satellite bearing, is also indicated by the PRN's location within the circles. North is immediately above the center circle. A PRN there indicates an azimuth of 0°. A PRN to the right indicates an azimuth of 90°.

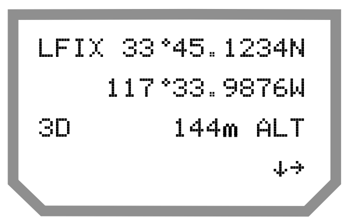
AUX 4 — View Data Files. The View Data function allows you to select a data file that has been collected in order to view the position fixes in that file.

Data files can be downloaded to a PC for post-processing or analysis.

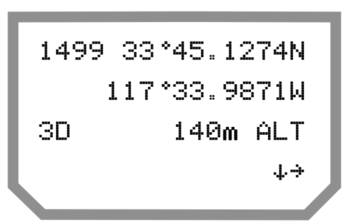
Access AUX 4. Press the **RIGHT ARROW** to scroll through the filenames in the unit's memory. The file's size is also displayed.



To view the contents of a file, press **ENTER**. The unit displays the most recent position fix in the file (labeled LFIX).



Earlier position fixes are numbered in reverse order (the more recent the fix is, the higher the number is). Continue pressing the **RIGHT ARROW** to scroll through the earlier fixes and back to LFIX. At any time, press the **DOWN ARROW** to view the second and third position screens showing PDOP and SQ's.

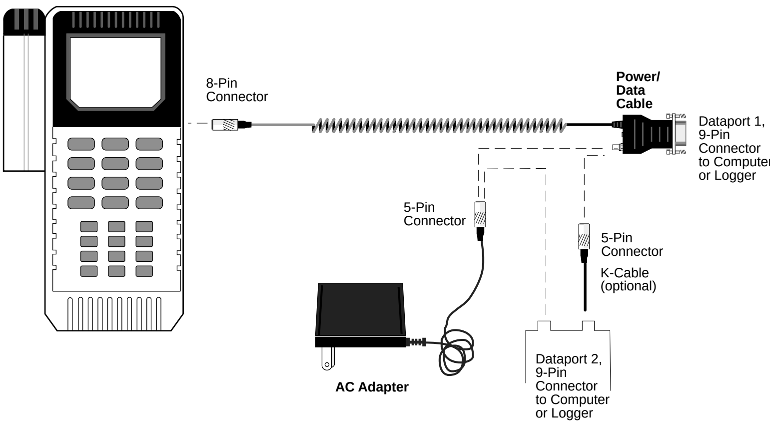


If there are no fixes in the selected file, the unit displays "NO FIXES IN FILE."

AUX 5 — DATA I/O. Data I/O allows you to transfer data files between the unit and a PC. Use of this feature requires the PPSW and the data cable that is provided with the unit.

Data I/O interacts with either the COMM submodule or the LOG module to the PPSW. Which module is used is determined by which type of data file you transfer. You can also use AUX 5 to log data in real-time directly to a PC or data logger.

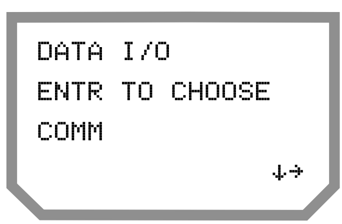
First, connect the unit to a PC or data logger. Use SETUP 7 to set one of the dataports to "COMM" and select a baud rate. You may also connect the unit to an external power source at the same time.



External Connections for the ProMARK X

The port on the side of the ProMARK X provides a connection for both external power and for transferring data. The Power/Data Cable has two receptacles on one end. One receptacle is for the 8-pin AC adapter. The other receptacle is a 9-pin RS-232 connector, and is used to connect the unit to the serial or comm port of a personal computer or data logger.

Access AUX 5. Press the **RIGHT ARROW** to toggle between the SLAVE and DOWNLOAD DATA options.



NOTE

If you see the message "PORT NOT SET" when accessing this function, press ENTER to override the Port Setup (Setup 7) and reassign a port to this function. Keep in mind that the changes you make here will be reflected in Setup 7.

Select "COMM" to use the COMM module of the PPSW to download data files, almanac, routes and waypoints, grids, datums, setup parameters, or attributes from the receiver to a PC as well as uploading almanacs, routes and waypoints, setup, grids, datums, and attributes from a PC to the receiver. Select DOWNLOAD DATA to download real-time data, almanac, ephemeris, waypoints, averaged position, or the POS data buffer to a PC from the receiver using the LOG software.

NOTE

Uploading WAYPOINTS, ALMANAC, or EPHEMERIS from a PC to the unit will replace any information currently in the target file.

If "COMM" was selected and the dataport and baud rate have been chosen, the unit will wait for a transfer data command from the PPSW. Initiate the transfer as described in the *PPSW User Guide*. If you like, you can press the **RIGHT ARROW** twice to return to the initial AUX 5 display before starting the data transfer.

This message is displayed briefly during data upload. It indicates that the unit is receiving the selected file. Once upload is complete, the "WAITING FOR CTRL COMMAND" message is displayed. Press the **RIGHT ARROW** twice to return to the initial AUX 5 display.

If data is being downloaded from the unit to a PC, the message "TRANSMIT DATA ALMANAC" is displayed briefly, along with the type of data being transferred. Once download is complete, the "WAITING FOR CTRL COMMAND" is displayed. Press the **RIGHT ARROW** twice to return to the initial AUX 5 display.

NOTE

After downloading data from your ProMARK X, always turn the unit off before collecting another data session. This will clear any settings that the Comm mode may have introduced into the unit and restart the receiver. To remind you, the ProMARK X displays the message "PLEASE RESTART UNIT AFTER COMM MODE" to alert you.

If DOWNLOAD DATA was selected, you may choose which type of data will be downloaded. First, start the logging equipment or initiate the LOG submodule of the PPSW. Next, press the **DOWN ARROW** to scroll through waypoints, averaged positions, POS data buffer, almanac, or ephemeris data. When the desired data type is displayed, press **ENTER** to begin downloading data.

NOTE

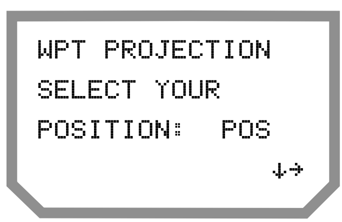
Only position and raw data are output when POS is pressed — an ephemeris needs to be downloaded at a later date.

Transferring data is described more fully in the *PPSW User Guide.*

The display returns to the Dif Timer ON/OFF screen. The timer is on and set.

AUX 6 — Waypoint Projection. The ProMARK X can calculate the coordinates of a remote destination based on a relative distance, bearing, and altitude that you enter.

Access AUX 6. The first position displayed is the current position. Use POS or select a waypoint by pressing the **RIGHT ARROW** or keying in all or part of the waypoint name followed by **ENTER.**

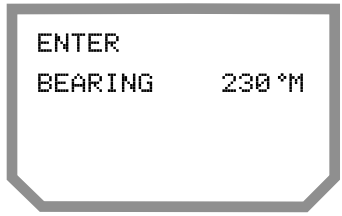


WARNING

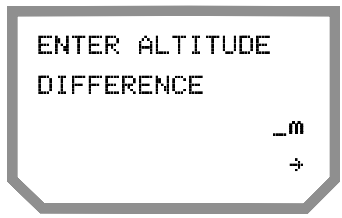
POS is not your current position if you have moved since taking this position fix.

Press **ENTER** to accept the displayed position. The unit asks for the distance between the selected position and the projected position. Key in the estimated distance in meters.

Press **ENTER**. Key in the estimated bearing from the selected position to the projected position.

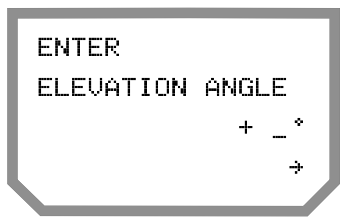


Press **ENTER**. Key in the difference in altitude between the selected position and the projected position.

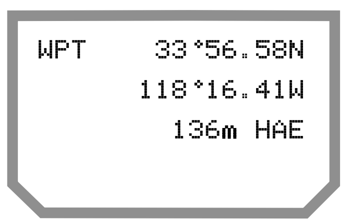


OR

Press the **RIGHT ARROW** key to enter elevation angle to the projected position.



Press **ENTER**. The unit calculates and displays the projected waypoint. It also displays the bearing and distance you entered above.



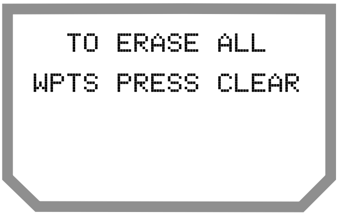
If you like, you can save the projected waypoint. This will allow you to use a projected waypoint as part of a route. To save the projected waypoint, press ENTER and key in a waypoint name as described in *Saving a Position as a Waypoint*.

AUX 7 — Erase Waypoints. This is a fast way to clear all waypoints and routes stored in the ProMARK X's memory.

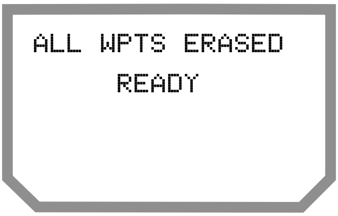
WARNING

Do not use this Auxiliary Function unless you really want to clear everything stored in Waypoint and Route.

Access AUX 7.

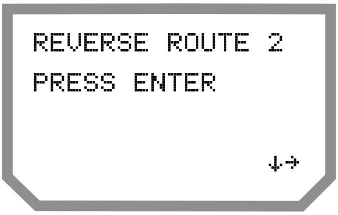


Press **CLEAR**. All waypoints and routes are immediately erased.

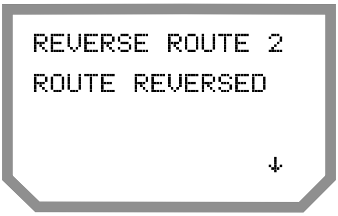


AUX 8 — Reverse Route. Reverse Route allows you to reverse the order of all waypoints in a selected route. When a route has been reversed, the starting waypoint for leg 1 becomes the destination waypoint for the final leg of the reversed route; the destination waypoint for the final leg becomes the starting waypoint for the first leg of the reversed route. This means that you can navigate an outbound route, reverse it, and navigate back without having to manually enter a separate inbound route. Routes are covered in the next chapter.

Access AUX 8, then use the **RIGHT ARROW** to scroll to the route you want to reverse.



Press **ENTER**. The displayed route is reversed. Press any function key to exit AUX 8.



If you realize that you reversed the wrong route, press ENTER again to return the route to its original order.

AUX 9 — Almanac Collect. In Almanac Collect, the unit collects a new almanac from any satellite, replacing the almanac that is currently in memory. This feature is initiated manually with AUX 9 when the unit's almanac is at least 6 months old, or whenever you need to be sure that the almanac is completely up to date. Almanac Collect is initiated automatically when POS or NAV is pressed and the unit has no almanac and/or no initial position.

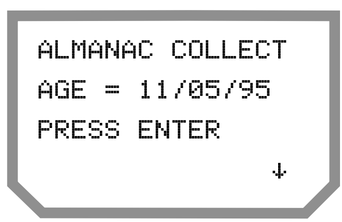
Although the receiver collects updated almanac information from the satellites it tracks, (when it is getting position fixes), the receiver must be on and tracking satellites for at least 12.5 minutes to update the entire almanac. Otherwise, you may not have a current almanac. If the unit's almanac is very out of date, the receiver may not be able to locate satellites as quickly as possible.

Generally, the Almanac Collect procedure takes about 15 minutes from start to finish. The unit will not turn itself off during Sky Search, Almanac Collect, or Almanac Verify, even if the Battery Saver is on.

NOTE

An almanac can be uploaded from a PC using AUX 5 and the Post-Processing Software.

Access AUX 9. If the unit already has an almanac, the "age" is displayed.

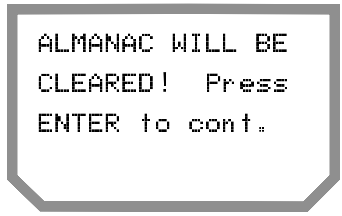


Age is the date that is assigned to almanac information that is broadcast from a specific satellite on a specific day by GPS operators. Generally, age is within six days of the actual date of collection. If the unit has no almanac, the second line is blank.

NOTE

Since all satellites may not be operating on exactly the same almanac cycle, almanacs collected on the same day from different satellites may have different dates. This does not affect almanac accuracy. When collecting data for differential processing, it is sufficient if the almanacs in the units being used are within several weeks of each other.

Press **ENTER.** If the unit already has an almanac, a warning is displayed. Press **ENTER** again to delete the current almanac and collect a new one.



If none of the satellites in the system can be found, or if the unit cannot find enough satellites for a 2D position fix (three satellites), the unit will restart the search. This should occur only if the antenna does not have a clear view of the sky.

Once a satellite is located, the unit acquires clock and ephemeris information from it, then almanac information. (Ephemeris data is precise positioning data for the broadcasting satellite.) At the same time, the unit continues to search on the remaining channels.

A position fix is calculated and displayed when the unit has acquired ephemeris data from three satellites. This generally occurs while ALM COLLECT or ALM VERIFY is displayed on the fourth line.

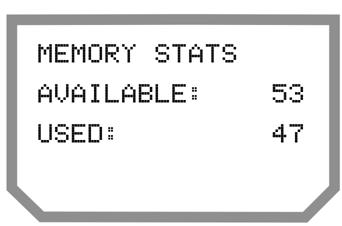
Since the unit does not have a complete almanac when this fix is calculated, it is unable to select the satellite set with the best PDOP. The fix may therefore not be as accurate as subsequent position fixes, which will be obtained with the optimum satellite set.

NOTE

The unit must remain on for about 15 minutes once Almanac Collect is started to be sure the unit will have a complete almanac. An incomplete almanac may have an adverse effect on unit operation.

AUX 10 — Memory Stats. Memory Stats displays the percentage of memory used and of memory remaining for file storage.

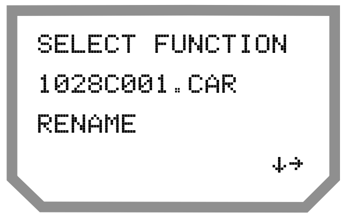
Access AUX 10. The unit displays how much buffer memory is in use and how much is available.



AUX 11 — File Maintenance. File Maintenance allows you to perform routine management tasks, such as renaming or deleting files. You can also use AUX 11 to erase selected parts of the unit's memory

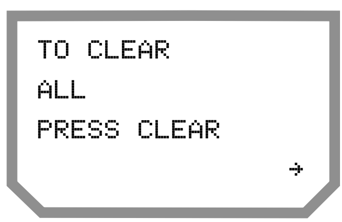
Access AUX 11. The first filename and its file size in the unit's memory are displayed. Press the **RIGHT ARROW** to scroll through the file names in alphanumeric order.

To rename a file, press the **ENTER**. Key in a new filename, followed by **ENTER**. The file is renamed, and the unit returns to the initial AUX 11 display.



To delete the displayed file, press the **RIGHT ARROW**, followed by **ENTER**. The file will be cleared from the unit's memory.

To erase all or selected portions of the unit's memory, press the **DOWN ARROW**. If you press CLEAR now, all of the unit’s memory is erased. Press the **RIGHT ARROW** to scroll through the selections listed below.



ALL	erases everything in the unit’s memory.
USER DATUM	erases all user-entered datums.
SETUP	erases all non-default SETUP parameters.
WAYPOINT/ROUTE	erases all waypoints and the route.
ALMANAC/EPHEM	erases the almanac and any ephemeris data the unit may have collected from satellites.
LAST FIX/INIT	erases the last fix and initial position.

As you press the RIGHT ARROW you will notice that the second line of the screen shown above changes, indicating what part of the memory will be cleared.

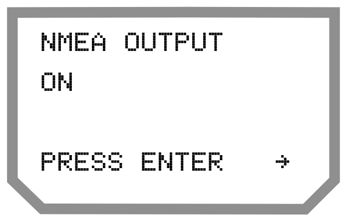
Press CLEAR when the area you want to erase is displayed on the second line. The third line then displays "CLEARED."

NOTE

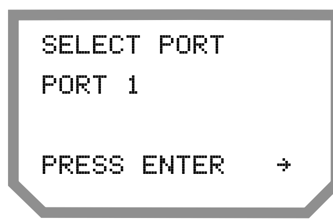
The unit must be powered off after clearing any part of the unit's memory.

AUX 12 — NMEA Output. This function outputs data in the NMEA (National Marine Electronics Association) format. To output data in this format, the unit must be connected to a compatible external device.

Access AUX 12. Use the **RIGHT ARROW** to select "ON." Press **ENTER**.

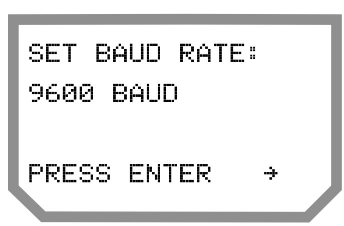


Use the **RIGHT ARROW** to select Port 1 or Port 2. If you select a port that is already in use, the NMEA selection overrides any previous selection. Press **ENTER**.



If you don't have the port set to output NMEA (Setup 7), you can override the port setting by just pressing ENTER when you access this function.

Use the **RIGHT ARROW** to select the baud rate for the port you have selected. Press **ENTER**. The unit will now output position fix data in the NMEA format through the port you have selected.



AUX 0 — Product Support. The ProMARK X has an additional auxiliary function that you may find useful. AUX 0 displays the telephone numbers for the Magellan offices in San Dimas, California. This means that if you have problems and require help, the necessary telephone numbers are always at hand.

Access AUX 0. The unit displays our telephone number and fax number. Be sure to direct your inquiries to Customer Support, from 8 to 5 PST.

Attribute Lock. The ProMARK X features a hidden AUX function that may be used to lock the active attribute file. When this mode is set, users may not add, delete, or edit attributes, until this function is turned off. To activate the attribute lock, press AUX, 60, ENTER, and set the "OFF" to "ON" by pressing the RIGHT ARROW. The same technique can be used to turn the attribute lock off.

Using this function, a supervisor can establish a data collection procedure, and reduce the chance that the attributes may be inadvertantly changed while they are being used in the field.

Chapter 5 WAYPOINTS, ROUTES, AND NAVIGATION

GPS technology originated from the need for a precise navigational system, and for that reason the ProMARK X is able to offer navigational functions. If your applications does not require a need for the navigational functions of the ProMARK X, you may want to read the section in this chapter on waypoints and bypass the remaining sections until needed.

This chapter will introduce the concepts of waypoints, routes, and navigation. The topic of waypoints will be presented first followed by a discussion of routes and then navigation. These topics are all closely related in that waypoints are needed to set routes and routes are needed to navigate.

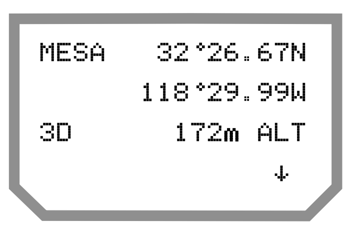
WAYPOINT

A waypoint is position coordinates that have been saved, usually so you can return to the same position. The ProMARK X allows you to name and store waypoints in its memory, either by saving a position fix or a fix from the buffer, or by manually keying in coordinates that have been picked up from a map or received from a colleague.

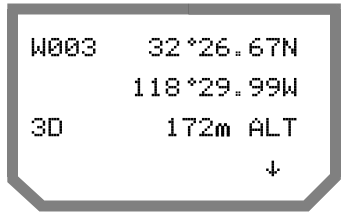
Waypoints can also be viewed, deleted, and renamed. They are stored in alphanumeric order.

Saving Positions as Waypoints. Use the following key sequence to save a position as a waypoint.

Obtain a position fix with **POS**. Press **ENTER**. A cursor appears in the upper left corner on the message display. Key in a 1- to 4-character name (as described in *Entering Data)* followed by **ENTER**. If the name you chose is already being used, the unit displays "DUPLICATE NAME." Press **ENTER** and key in another name.



A waypoint can also be named automatically. Unit-generated names are in the format Wxxx, where xxx represents numbers 001 through 999. Waypoints are numbered in sequence. To name a waypoint automatically, press **ENTER** without keying in any characters.



NOTE

Use waypoint names that are easy to remember, and keep a log of waypoints that you have stored as a reference. This is especially important if you use unit-generated waypoint names. Sample logbook pages are included at the back of this manual.

A position that is stored as a waypoint retains the date/time display and the SQ/PDOP display. Press the DOWN ARROW at any time to view these displays.

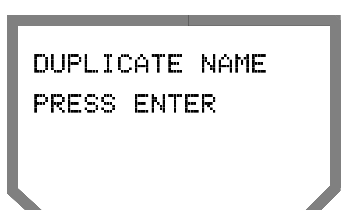
Entering Waypoints Manually. Use the following key sequence to enter a waypoint manually.

Press **WPT**, then **ENTER**. Key in a one- to four- character waypoint name from the alphanumeric keypad followed by **ENTER**, or press **ENTER** without making an entry to name the waypoint automatically.

NOTE

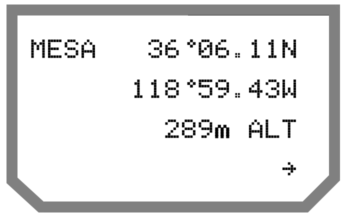
Refer to *Entering Data* for instructions on entering text from the alphanumeric keypad.

This message appears if the name you chose is already being used. Press **ENTER** and try again.

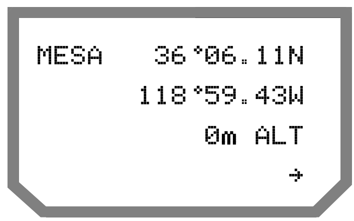


Key in the latitude. If necessary, use the **RIGHT ARROW** to toggle between N (north) and S (south). Press **ENTER**.

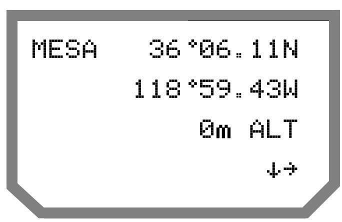
Key in the longitude. If necessary, use the **RIGHT ARROW** to toggle between W (west) and E (east). Press **ENTER**. The unit automatically enters the default altitude.



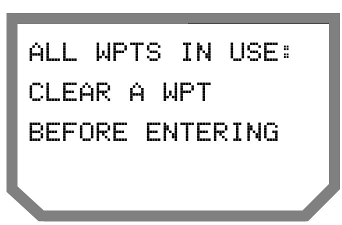
To enter a different altitude, press **CLEAR** and key in the new altitude. Use the **RIGHT ARROW** to toggle between positive and negative values. Press **ENTER**.



Press **ENTER** again to store this information. The **DOWN ARROW** appears on the display when the waypoint has been stored.



This message appears when there is no room to store another waypoint. You must delete a waypoint before another can be stored. See *Clearing a Waypoint* .



Saving an Averaged Position as a Waypoint. The ProMARK X produces two types of averaged position fixes. It produces AVG, which is the average of a preset number of fixes or the average of the fixes collected before the preset number is reached. The unit also produces x̄TMP, which is the average of the last two position fixes until the preset number of fixes has been reached; x̄TMP is then the average of AVG and the most recent position fix.

AVG and x̄TMP are automatically saved as temporary waypoints, and can be viewed with the WPT key. They are replaced as soon as the unit computes another AVG or x̄TMP, and cannot be used in a route. To save these temporary waypoints or to use them in a route, they must first be copied to new waypoint names as described in *Renaming a Waypoint*.

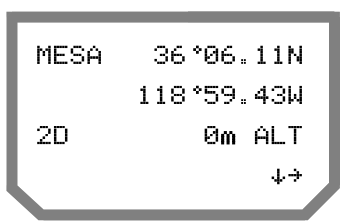
Waypoint AVG can either be copied to another name from the position display after averaging (with DIF1) is complete, or retrieved from the buffer with AUX 5. Waypoint x̄TMP can be saved only by retrieving it from the buffer.

As soon as the desired averaged position is displayed, press **ENTER**. The unit displays x̄ and a cursor. Key in any three characters and press **ENTER** again. You can also name the averaged waypoint automatically by pressing **ENTER** without keying in any characters. The waypoint will be named in the format "x̄yyy", where "yyy" is any number from 001 to 999, in sequence.

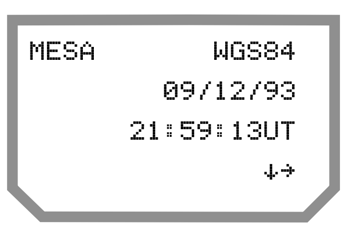
The x̄ is required to identify the position as an averaged position. If you do not use the mean symbol, the unit will not store the figure of merit or the number of fixes, and x̄SQ and x̄PDOP will be displayed as SQ and PDOP. You will have no way to identify this as an averaged position.

Viewing Stored Waypoints. Use the following key sequence to access and view a waypoint or a saved average position.

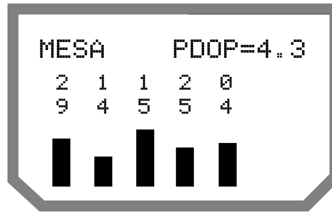
Press **WPT**. Waypoints are accessed by using **RIGHT ARROW** to scroll through all of the stored waypoints or by keying in all or part of a waypoint name followed by **ENTER**.



Press the **DOWN ARROW** to see the datum, date, and time of the position fix for the displayed waypoint.



Press the **DOWN ARROW** again to see the SQ and PDOP of the fix.



If a waypoint was entered manually, no values will be displayed for satellite signal quality and geometric quality.

Renaming Waypoints. To rename a waypoint, retrieve it as described in *Viewing a Waypoint*. From any of the waypoint message displays, press ENTER. Enter the new name, and press ENTER again.

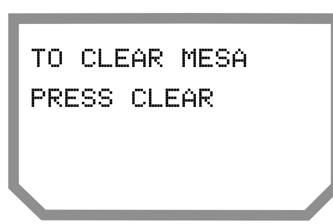
An averaged waypoint is also renamed in this way. When you start to enter the new name, however, the x̄ will automatically appear as the first character.

Waypoint stxx, waypoint AVG, and waypoint x̄TMP cannot be renamed. They can, however, be copied. Retrieve the waypoint and rename it as described above. (When renaming an averaged waypoint, x̄ is kept as the first character.) The unit copies the position data to the new waypoint name.

Waypoints that are assigned to a route cannot be renamed.

Clearing a Waypoint. Use the following key sequence to delete a waypoint from the unit's memory.

Display the waypoint as described in *Viewing a Waypoint*. Press **CLEAR**.



The unit displays a message asking if you really want to clear the displayed waypoint. If you do, press CLEAR again.

To abort and keep the waypoint, press any function key.

To clear **all** waypoints, use AUX 7.

NOTE

Waypoints assigned to a route cannot be erased.

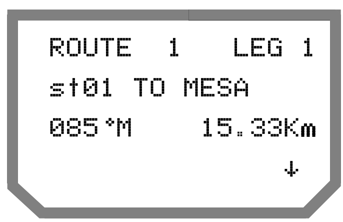
ROUTE

A route is a planned course of travel from one place to another. The ROUTE key allows you to enter and store up to 10 routes, and to divide each route into 1 to 20 legs. You can also view, add to, edit, reverse, and navigate on a route.

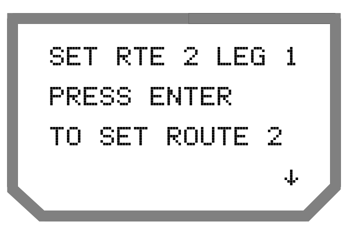
Choosing a Leg Switching Mode. The ProMARK X can automatically switch from one leg to the next when navigating on a route, or it can wait for the user to activate the next leg. Automatic or manual leg switching is selected with SETUP, and is described in Chapter 3.

Creating a Route. A route is created by using waypoints as the start and destination of each leg. The route is therefore defined by a series of waypoints, with the destination of one leg being the start of the next leg. A route cannot be created unless you already have waypoints stored.

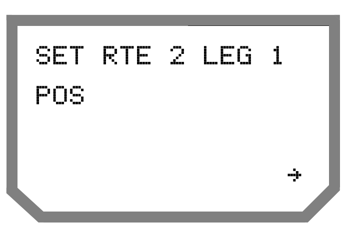
Press the **ROUTE** key. The current leg of an existing route will appear. A **RIGHT ARROW** will appear if there is more than one leg in the route.



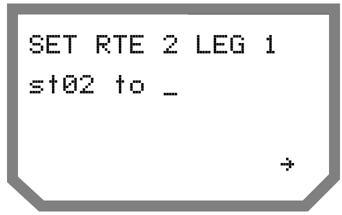
Use the **DOWN ARROW** to scroll to an unused route. If no routes are available, display a route you do not need anymore, and press **CLEAR** twice to erase it.



Press **ENTER**. The current position (POS) is displayed. To select a different position, press the **RIGHT ARROW** to scroll through the stored waypoints, or key in all or part of a waypoint name followed by **ENTER**.



When the desired position is displayed, press **ENTER**.

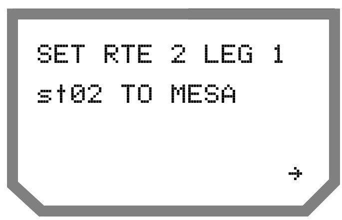


You may choose POS as the starting point or destination of any leg. When POS is chosen, it is stored as waypoint "stxx," where "xx" is a number from 1 to 10 that corresponds to the route number. POS is no longer available, and will not be displayed when defining another leg. Waypoint "stxx" is available, however, to define another leg of the same route.

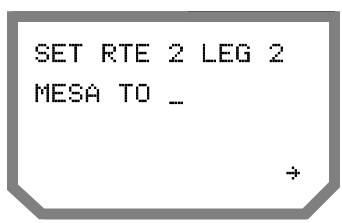
NOTE

The "stxx" waypoint from one route can not be used in another route, and is not displayed when you scroll through waypoints from ROUTE. If you want to reuse any "stxx," copy it as described in *Renaming Waypoints*.

Select a destination waypoint by using the **RIGHT ARROW** to scroll through the stored waypoints, or key in all or part of a waypoint name followed by **ENTER**.

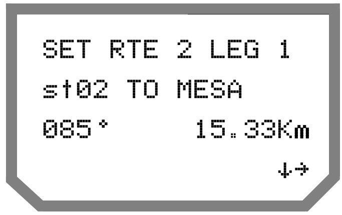


Press **ENTER**. The unit automatically moves to the next leg.



Repeat the steps above to enter route legs until you have completed your route, or until all 20 legs have been set.

When all of the route legs have been set, press **ENTER** twice. The first leg of the route you just entered is displayed, along with the bearing and great circle distance from the starting waypoint to the destination waypoint.

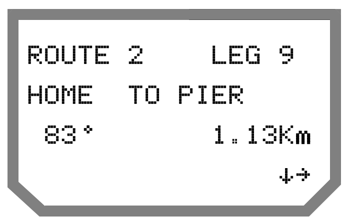


To activate this route now, first be sure the desired leg is displayed, then press NAV.

Activating a Route. In order to navigate on a route, one must be activated.

To activate a route, press **ROUTE** and the **DOWN ARROW** until the desired route is displayed.

Press the **RIGHT ARROW** until the desired leg is displayed. Press **NAV** to begin navigating on the displayed route and leg.

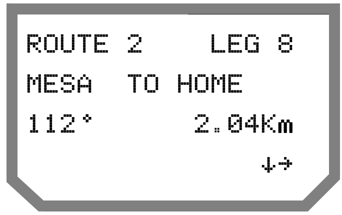


NOTE

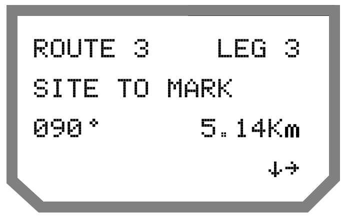
Creating a route does not automatically activate it. A route must be activated by accessing NAV from the desired route/leg display.

Viewing and Editing a Route. A route can be viewed and edited at any time by pressing the ROUTE key and scrolling through the routes and legs.

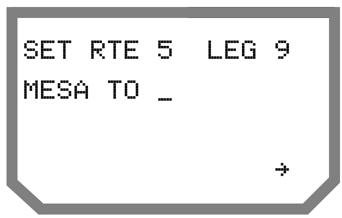
Press **ROUTE** and use the **DOWN ARROW** to scroll through the routes you have stored. At any time, use the **RIGHT ARROW** to view the legs of any route.



You can also scroll from any route leg to the same leg in another route. Press the **DOWN ARROW** to move from one route and leg to the same leg in another route. If the next route has fewer legs, the **DOWN ARROW** takes you to the last leg of the route.

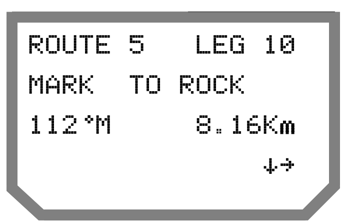


When you reach the leg you want to edit, press **ENTER**. The starting waypoint remains the same, and the destination waypoint is erased.



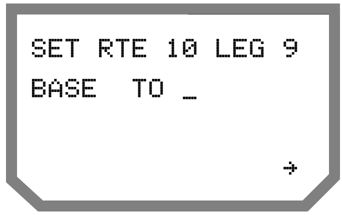
Use the **RIGHT ARROW** to scroll through POS and the stored waypoints.

When you reach the waypoint you want to use, press **ENTER**. The waypoint is saved as the leg's destination and as the starting waypoint for the next leg, which is displayed on the screen. The destination waypoint of the next leg is not erased.

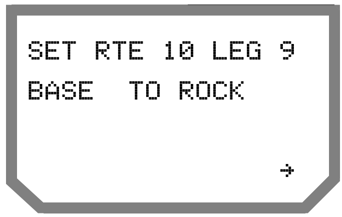


Appending a Leg. You can also add legs to an existing route.

Scroll to the last leg of a route and press **ENTER**. The destination waypoint of the leg is erased.



Use the **RIGHT ARROW** to scroll through POS and the stored waypoints.



When the waypoint you want to use is displayed, press **ENTER** to save the destination. The waypoint is also saved as the start of the next leg, which is displayed on the screen.

Continue, adding waypoints as described in *Creating a Route*, until you have added all the legs you want, then press ENTER twice to save the changes you have made.

Reversing a Route. Reverse Route is an auxiliary function (AUX 8) that allows you to reverse the waypoint order of any route. This means you can navigate from one place to another, reverse the route, and navigate back to your original starting point without manually entering a new route for the return trip.

Reverse Route is described in more detail in the AUX 8 section of Chapter 4.

NAVIGATION (NAV)

The NAV key provides information that relates your progress along a courseline to the destination of the current leg. It also displays information relating to your current rate and direction of travel.

Navigation information (bearing, distance, direction of travel) is available only if a route has been activated.

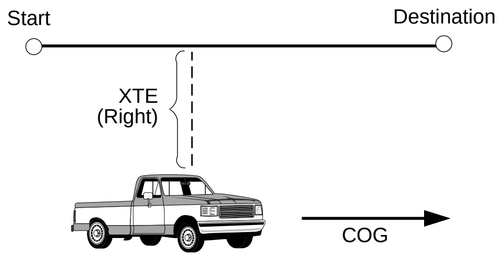
Velocity information (speed, time of arrival) is available whenever you have reached a minimum speed of 2 kilometers per hour, whether you have an active route or not. Since velocity-related information is based on instantaneous speed, you may notice some fluctuation in the values displayed. This effect can be "smoothed" by using velocity average to substitute a weighted average for the instantaneous measurement. Refer to SETUP to use velocity average.

If you are navigating on a route, three messages are displayed at the bottom of the screen that indicate how close you are to the TO-waypoint: CLOSE, ARRIVED, and COMPLETE. (Refer to *SETUP, Choosing a Leg Switching Mode* during this discussion.) CLOSE is displayed when you enter the arrival circle around the leg's destination. If the leg switching mode is set to manual, the unit displays ARRIVED when the perpendicular that intersects the TO-waypoint is crossed. (If the leg switching mode is set to automatic, crossing this line causes the unit to switch legs.) COMPLETE is displayed when you enter the arrival circle for the route's destination.

Navigation information is displayed on four screens; all four display the destination waypoint of the current leg on the fourth line, and the bearing/distance to the waypoint on the first line. (All distances are great circle.) The fifth screen displays your rate and direction of travel.

Press **NAV**. The first screen displays the "to" waypoint on the first line. Bearing to and great circle distance from the destination waypoint are on the second line. The third line displays the cross track error, which is abbreviated as "XTE." The information on the second and third lines will be updated as you travel. The fourth line indicates the current route and leg.

XTE (cross track error), on the third line of the sample screen above, is the length of the perpendicular between your present position and the courseline. It is described as being to the right or left of the courseline, facing the destination.



Cross Track Error (XTE)

If you are 18.5 km or more from the selected route leg the ProMARK X will display the "INVALID LEG" message.

```
TO CLIF
052°M      11.47Km
XTE 9.99Km LEFT
INVALID LEG    ↓→
```

Press the **DOWN ARROW** once to see steering. Steering is the course correction you should make in order to travel toward the leg's **destination**, given your current ground course (SOG) and bearing.

```
TO BASE
120°M       0.14Km
STEER LEFT    43°
R 1 LEG 19     ↓→
```

NOTE

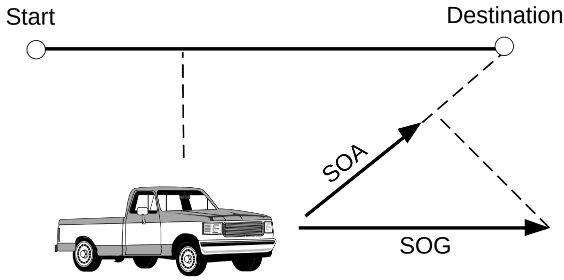
You must be traveling at least 0.3 km/hr to get velocity-related data such as steering or time to go.

Press the **DOWN ARROW** again to see time to go (TTG) and speed of advance (SOA).

```
TO BASE
TTG       02:50:00
SOA     9.8 Km/HR
R 1 LEG 19     ↓→
```

Time to go (TTG), on the second line of the screen above, is the length of time required to complete the current leg, given the current speed of advance.

Speed of advance (SOA), on the third line, is the vector component of the ground speed in the direction of the destination waypoint. It is calculated using speed and ground course. When XTE = 0, SOA = VMG.



Speed of Advance (SOA)

Information about your rate and direction of travel is viewed by pressing the **RIGHT ARROW** at any time. This information is available only when your speed exceeds 0.3 km/hr. (Speeds greater than 951 mph/826.40 knots/1530.5 km/hr cannot be measured.) If you are on a route you will also see bearing and distance to destination, as well as the current route and leg.

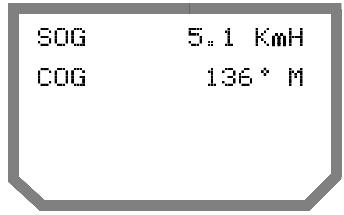
Speed over ground (SOG), on the first line of the above screen, is actual groundspeed measured as instantaneous groundspeed and direction.

Course over ground (COG), on the second line, is the true direction of travel achieved. It is sometimes referred to as ground course.

Press the **DOWN ARROW** to return to the first NAV display.

If no routes are active and the NAV key is pressed the adjacent screen will appear.

In this case, speed over ground and course over ground can still be obtained by pressing the **RIGHT ARROW**.



To go to any other display, press the appropriate function key for that display.

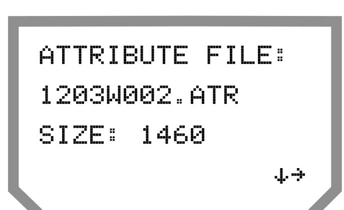
Chapter 6 ATTRIBUTES

ATTRIBUTION

This chapter will address the ProMARK X's attribution capability. The ProMARK X is capable of assigning attributes to data by either utilizing sets of previously defined attributes, editing existing attributes, or creating new attributes. The attributes can be extremely valuable as direct input into a GIS to accurately describe feature in combination with position. Specifically, this chapter will provide instruction on the use of the ATTR key in order to activate and create attributes to be used during data collection. Data collection is covered in detail in *Chapter 7 — Differential*, which will also provide instruction on inputting the attributes created with ATTR key while data is collected. By reading this Chapter you will be able to create attribute files on the receiver, assign numeric keys to attributes, select attributes from existing attribute files, activate and deactivate attribute files, edit individual attributes, and add individual attributes to an attribute file. This chapter will also provide suggestions on maximizing the attribution capability of the ProMARK X.

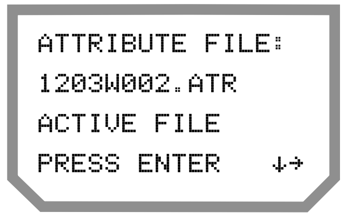
ATTR KEY OPERATION

The ProMARK X provides the utility to input unlimited user-defined attributes and to utilize up to 99 preassigned attributes, which can be assigned to data during collection simply by keying in a preassigned number. A file of attributes may be created either on the PC and then uploaded to the receiver (refer to the utilities section of the *MSTAR User Guide*) or created in the receiver. From an efficiency standpoint, it is preferable to create the attribute file on the PC (and then upload it to the receiver) although you can create an attribute file on the receiver is provided as well. In this first example, attribute files have been created and are stored in the receiver. In the receiver the user can choose one file to make it active, assign key numbers to the attributes, edit the attributes in the file, or add new attributes to the file.



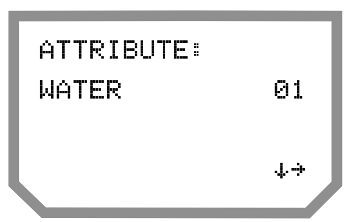
Press the **ATTR** key on the keypad. If no attribute files exist in the receiver, it will display the message "NO FILES AVAIL" and the user is given the chance to enter a file by pressing **CLEAR** (covered later in this chapter). Otherwise, the receiver displays the attribute files currently stored in the unit along with the size of the file. (Note that attribute files have a .ATR extension.) Use the right arrow to toggle through the list of attribute files stored in the receiver.

If you come across a file which you wish to utilize, press the down arrow to make the file ACTIVE. By making a file ACTIVE, you are activating the key numbers to which attributes have been assigned. These keys can then be used during data collection to quickly “tag” data with attributes.

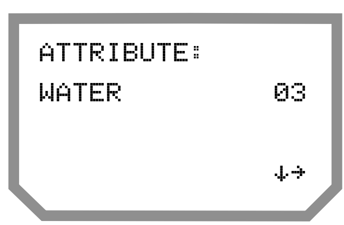


If the down arrow is pressed to activate a file while a DIF function is currently running (see DIF chapter), the receiver will display a message to that effect. Hit the DIF key and select the DIF function in progress to return to that function in order to complete it.

If the user wishes to edit an attribute file to add attributes or assign number keys to the attributes, press **ENTER** when the desired filename is displayed. The first attribute in that file is displayed on the Attribute screen along with its numeric key assignment (if one has previously been assigned.)



Use the **RIGHT ARROW** to toggle through the list of attributes in the selected file. (The attributes are listed in numerical order.) You may also key in a new number to assign the attribute to a new number. If you key in a number which already has an attribute assigned to it, the new entry becomes the assignment and the old attribute’s key assignment is deleted. For example, if the attribute file has POLE assigned to 03 and WATER assigned to 01 and 03 is



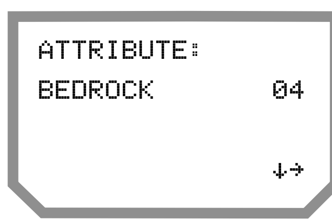
keyed in when WATER is displayed, WATER is now assigned to 03 and POLE no longer has an assignment.

If you wish to edit an attribute, press the down arrow to move to the EDIT attribute screen. The **CLEAR** key will delete one character at a time (like a backspace key). Delete as many characters as desired and then re-enter characters with the alphanumeric keys. Press **ENTER** when finished to return to the Attribute screen.

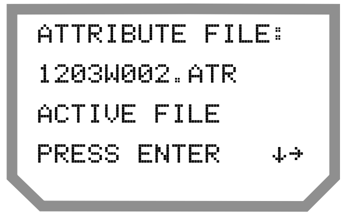
If you wish to add a new attribute to the attribute file, press the **CLEAR** key from the Attribute screen to move to the INPUT NEW ATTRIBUTE screen.

Type in the new attribute (up to 72 characters) with the alphanumeric keys. Press **ENTER** when entry is completed to return to the Attribute screen with the newly entered attribute displayed.

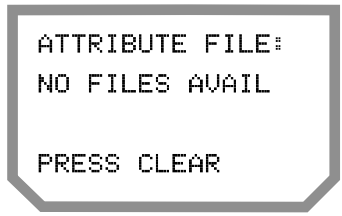
Now key in a number assignment from 1 - 99 and press **ENTER** (if you wish to actively use this attribute). Remember that if the number you key in is already assigned, the new attribute will get the number assignment and the old attribute number assignment will be deleted. Press **ENTER** from the Attribute screen to return to the Attribute file screen. You may also continue to add new attributes by the preceding steps, use the **RIGHT ARROW** to toggle through other attributes, key in new key number assignments, or edit other attributes.



In order to make the key assignments in a particular attribute file active, you must use the **DOWN ARROW** from the attribute file screen to make the file the ACTIVE FILE. Note that only one attribute file may be made active at any time, (i.e., activating a file will deactivate any other active files).

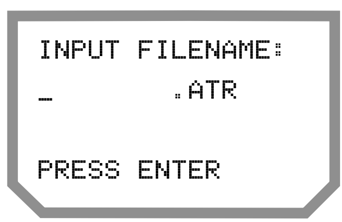


If no attribute files exist in the receiver the receiver will display this message when the ATTR key is pressed. To create a new file, press **CLEAR**. (You can also press **CLEAR** to create a new file from the Attribute file screen.)

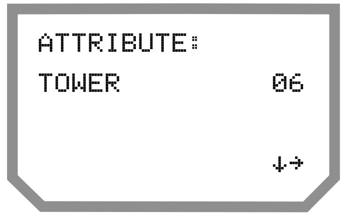


The receiver displays a NEW FILE screen with a unit generated filename. Press **ENTER** to accept the file name and to begin inputting attributes.

You can also press **CLEAR** to rename the file to a name of your choice.



Type in a file name up to 8 characters and press **ENTER**. (Pressing ENTER without entering a filename returns the user to the NEW FILE screen). Now begin entering attributes on the INPUT NEW ATTR screen (up to 72 characters).



Press **ENTER** when the entry is complete to move to the Attribute screen. Now key in the desired key number to assign the attribute to that key, and press **ENTER**. In this example, TOWER is the new attribute and is assigned to 06. You may continue to add new attributes to the file by pressing **CLEAR** to move to the INPUT NEW ATTR screen, press the **DOWN ARROW** to edit the displayed attribute, press the **RIGHT ARROW** to toggle through other attributes in the file, or press **ENTER** to move the ATTRIBUTE FILE screen. From the ATTRIBUTE FILE screen you may press any function key.

Suggestions on Using the ATTR Key. Since the ProMARK X attribution function provides maximum flexibility, there are several things you can do to more efficiently utilize this capability. As mentioned earlier, it is advantageous and more time efficient to create your attribute files in the PPSW with the editor feature (part of the utilities function), and then upload these attribute files to the receiver. All attribute files, whether created on the PC with the PPSW or in the receiver, will have a (.ATR) extension in the filename. Attribute files may have any number of attributes in them, although only 99 may be active at any one time. In addition, only one attribute file may be active at any one time.

In order to most efficiently utilize the ProMARK X's attribution capability, some planning must take place. For example, if you are going to be collecting data in a vegetation zone, you may want to have tree types assigned to keys 1 – 10, grasses from 11 – 20, and individual species from 21 – 40. You might also have a separate file for urban attributes and a separate file for utility related attributes. Try to create these files beforehand on the PC, upload the attribute files to the receiver, and then merely activate the desired file in the receiver. Try also to anticipate the type of data you will be collecting and create and upload only the necessary attribute files to the receiver. But in the event you get into a situation where you must assign attributes not previously anticipated, the ProMARK X has the flexibility to allow you to input any attribute as needed. It is a good idea to review the previous sections in this chapter addressing the operation of the ATTR key, and then try a few practice scenarios prior to using attributes in the field. You should also refer to the PPSW user guide to create and upload an attribute file. Refer to the *Chapter 7 — Differential* for information about data collection operations.

To set the attributes so they can't inadvertly be changed, you can use AUX 60, Attribute Lock. Refer to the section on Auxiliary Functions for more information.

Numerical Attributes

You can enter numerical attributes and associate these with a point. For example, if you are logging the position of a siting, you can manually enter a number that describes it (i.e., the number of a certain type of animal seen or the density of a certain occurrence). An attribute #tree, for example, can accept numerical values for height (say, 25 feet). This attribute would be stored as "#tree,25" in the unit, but after being processed with MSTAR, will read "tree,25."

To make use of this feature, use MSTAR to create an attribute file with attributes that start with # (#tree, #pole, etc.). Send this attribute file to the ProMARK X by making use of MSTAR's communication capabilities.

When you are ready to add numerical attributes, begin your differential session, and make the new attribute file active. When you call up the numerical attribute, the ProMARK X will ask you to enter in a numerical value. This numerical value will be tied to the closest position as an attribute when you process the data file in MSTAR.

Attributes from External Sources

The ProMARK X can now accept incoming streams of ASCII data (that terminate in CR/linefeed) and tag these to a point. In essence, you can connect a device that outputs a string of data, for example, a yield monitor, and have this data tied to a point as an attribute. To set this, perform the following:

Press AUX, 5, ENTER

Press RIGHT ARROW to select 'ENTER FOR ATTRIB".

Your screen should display "DATA I/O, ENTER FOR ATTRIB, 4800 BPS PORT 1".

(If the port is already assigned to another function (Comm, etc.), you may have to press clear to deselect the current function, and then scroll and select "ENTER FOR ATTRIB". Also, don't forget to set the correct baud rate.

After setting this function, you can setup and collect a data file, and the ProMARK X will automatically associate the incoming data as an attribute to the nearest position (the position with the closest time).

Pausing and Resuming Mobile Sessions

Using the attribute feature, you can effectively pause and resume the collection of a mobile file. While the unit will continue to compile data as it is paused, MSTAR will ignore all the data between the two attributes "pause," and "resume." To use this feature, you simply enter an attribute called "pause." You can create "pause" when you need it by manually entering it each time, or create the attribute ahead of time in the unit or PC, and then call it up. When paused, the unit displays a "Pause On" message on the data collection screen that tells you the unit is paused. You can resume mobile data collection by entering any attribute, or the attribute "Resume."

Chapter 7 DIFFERENTIAL

This chapter will introduce the user to the differential capabilities of the ProMARK X as well as some basic differential techniques. Please refer to Appendix 2 (Differential Theory) for a more detailed explanation of the basic theory behind differential. After reading this chapter, you will be able to initiate data collection with the receiver using any of the four differential functions contained within the DIF key. You will also be able to "tag" the collected data with attributes and learn how to check on the status of the receiver while data is being collected.

DIF Functions

The ProMARK X contains four different differential functions, all of which can be initiated with the DIF key: DIF1 (Averaging), DIF2 (Stationary Differential), DIF3 (Mobile Differential), and DIF4 (RTCM Differential). Data collection for any application can be accomplished by using one of these DIF functions. This section gives a brief description of each function and examples of how they might be used. Note that DIF3 Mobile requires the 3D mode. You must also use 3D if using a ProMARK X CP to collect carrier phase data; all other DIF functions may operate in either 2D or 3D.

DIF1 — Averaging. The ProMARK X can average the number of position fixes where the number of fixes you select. An average can be computed to simply improve the accuracy of a stationary position fix. An averaged position can also be used as a waypoint to define a route or as a waypoint reference for waypoint projection. (The computed average is automatically saved as a temporary waypoint.)

The DIF1 Averaging function can serve many applications. If you want to improve the accuracy of that position fix, you could perform an average of many fixes (the exact number specified by you) to do so. In general, the more fixes that are averaged the more the position fix will be improved. The averaged position can also serve as a reference waypoint for defining routes.

DIF2 — Stationary Differential. The ProMARK X collects (raw) data for the purpose of post-processing this data on a PC with the PPSW to compute a differential solution. Files collected by initiating DIF2 can be used for a number of purposes. For example, by setting the data sample rate to 1 sec for position data and 1 sec for raw data on each receiver, pseudorange differential and statistical analysis can be performed in the PPSW. It should be noted that in Stationary Differential, one receiver must be at a known "control" position and both receivers should use the same data sampling rate and collect data simultaneously.

Data collection for submeter post-processing uses the DIF2 feature and a ProMARK X CP. The ProMARK X does not output all of the data required to obtain submeter results.

DIF3 — Mobile Differential. The ProMARK X is capable of collecting data in a mobile mode for the purpose of computing a differential correction that is applied to each position in the mobile data stream. This is performed by the PPSW on a PC and requires one receiver to be at a known "control" point while the other receiver is moving. The ProMARK X allows the user to select a specific satellite set or have the unit automatically select the best satellites available. (When utilizing a base station with all-in-view capability at the control point, use the unit-selected set.) The ProMARK X mobile differential utility can be used as locational input into a GIS for network type applications. The resulting differentially processed output files (refer to PPSW user guide) can be converted to a variety of formats with the PPSW to be directly input into a GIS or plotting system. With this DIF function, you could create a map of a street network, for example, based on the positions computed. This is done by placing an all-in-view or parallel-tracking receiver at a known control point.

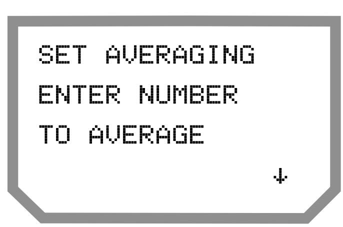
DIF4 — RTCM. The ProMARK X can receive broadcast corrections in the RTCM-104 format through its dataport. This allows the receiver to apply a differential correction to the computed position fixes before it is displayed on the receiver's screen. This technique requires an external device to receive and demodulate the corrections, then relay them through a physical connection to the ProMARK X. The receiving device may be a differential beacon receiver (DBR) or a radio modem that receives corrections from a PC or base station. The DBR requires that you be within range of a broadcasting differential radio beacon (in the United States, beacons are operated by the U.S. Coast Guard). A number of services are now broadcasting corrections for use by radio modems; they currently cover most major U.S. cities.

DIF Functions Operations

Now that some preliminaries have been addressed it is appropriate to discuss the actual receiver interactions required to perform the DIF functions.

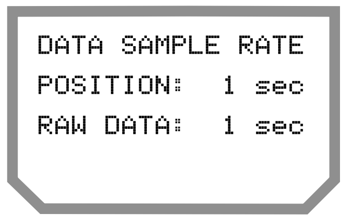
DIF1, Averaging

Press **DIF, 1,** and **ENTER** (or press **DIF** and the **DOWN ARROW** once, then **ENTER**). The receiver displays the number to average screen. Key in the number of fixes you wish to average, up to 1499. (The **DOWN ARROW** moves you to the next DIF function, DIF2.) Press **ENTER**.



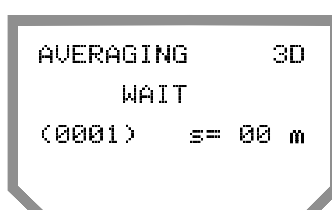
Upon pressing **ENTER**, the receiver displays the descriptor screen. You can enter any type of descriptive information you wish regarding the file (for example time, date, place, weather, etc.). This can be helpful in keeping files separate if many are collected in a short period of time. Key in the descriptor up to 72 characters and press **ENTER**. You may also press **ENTER** without entering anything to have no descriptor.

The receiver now displays the Data Sampling Rate screen. You can either accept the data sampling rates displayed or key in a new data sampling rate for both POSition data and RAW data. To enter a new data sampling rate, key in the number desired followed by **ENTER**. Do this first for the POSITION data and then for the RAW data. To change POSITION only, key in the new number and press **ENTER**. Now re-enter the raw data rate followed by **ENTER**. To accept the displayed setting, simply press **ENTER**.

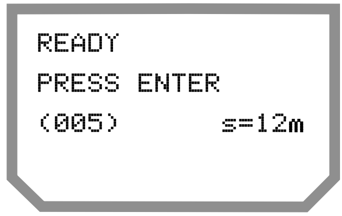


Upon pressing **ENTER**, the receiver displays the START AVERAGING screen. To start averaging, press **ENTER**.

Upon pressing **ENTER**, the receiver displays the AVERAGING screen. The number of fixes to be averaged will count off in the lower left corner. The standard deviation of horizontal position variation is also displayed in the lower right (S=) and is updated as each fix is computed.



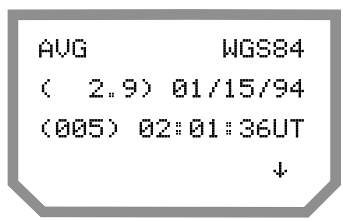
When the number of fixes to average has been reached, this screen will appear.



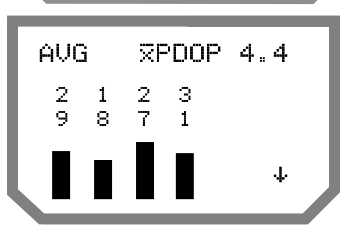
Press **ENTER** to display the averaged position.

Note that the display uses the same format as a waypoint. If the number of fixes selected has not yet been reached and ENTER is pressed from the "WAIT" display, a confirmation message appears stating to press ENTER to stop the session or CLEAR to continue.

From the resultant average screen, press the **DOWN ARROW** to view the figure of merit (standard deviation of horizontal position variation) the number of fixes in the set, and the time of the last fix in the set.



Press the **DOWN ARROW** again to view the satellites used and their average SQs and the average PDOP of the fixes.



Note that averaging creates two temporary waypoints, AVG and ⧖TMP. Waypoint AVG is calculated when the preset number of position fixes have been collected. Until the preset number of fixes have been collected, waypoint ⧖TMP is the average of the last two position fixes. Once the preset number of fixes have been collected, ⧖TMP is the average of waypoint AVG and the most recent position fix. This makes it an easily recognizable "end of file" marker, especially when averaging is stopped because of signal interruption.

Both AVG and ⌛TMP can be viewed with WPT, but they cannot be used in a route. (To use either waypoint in a route, they must first be copied to another name; refer to *Renaming Waypoints*.) AVG and ⌛TMP will be overwritten the next time averaging is done.

Once an average is computed, you can clear the AVG waypoint by pressing CLEAR.

DIF2, Stationary Differential

Data Collection Guidelines

Your results and differential accuracy will vary depending on the baseline, satellite geometry, number of satellites, and angles of these satellites. We recommend the following guidelines to help ensure a successful data collection session.

For Centimeter Accuracy:

5 sats with elevation > 15° : 25 minutes + 3.0 minutes/km of baseline
6 sats with elevation > 15° : 22 minutes + 2.5 minutes/km of baseline
7 sats with elevation > 15° : 20 minutes + 2.0 minutes/km of baseline

While collecting data:

1500 CM credits + 180 credits/km of baseline

(May require more time to collect if there are gaps or relatively low elevation angles, and if the raw data sample rate is set to 2 or 3 seconds.)

NOTE

When collecting for centimeter accuracy, the quality indicators don't increment for the first 2 minutes of a session.

For Submeter Accuracy:

4 sats with elevation > 15° : 15 minutes + 1.7 minutes/km of baseline
5 sats with elevation > 15° : 12 minutes + 1.5 minutes/km of baseline
6 sats with elevation > 15° : 11 minutes + 1.2 minutes/km of baseline
7 sats with elevation > 15° : 10 minutes + 1.0 minutes/km of baseline

While collecting data:

800 CM credits + 100 credits/km of baseline

To give you an indication of the quality of your data collection session in the field, the ProMARK X and ProMARK X-CM feature quality indicators. These quality indicators represent the effective number of standard observations that will affect how the data will process (centimeter, submeter, and pseudorange). These quality indicators display in the differential collection screen and increment with each valid data observation. You can scroll through the different quality indicators by pressing the RIGHT ARROW in the differential data collection screen. Also, the bottom line of the differential collection screen displays the effective number of satellites that apply for the particular session (centimeter, submeter, and pseudorange).

Here is the criteria that the ProMARK X uses:

Centimeter— each credit represents a valid standard observation that contains at least 5 satellites with elevation angles at more than 15°.

Submeter — each credit represents a valid standard observation that contains 4 satellites with elevation angles at more than 25°.

Pseudorange — exch credit represents a pseudorange solution with a PDOP of at least 2.0.

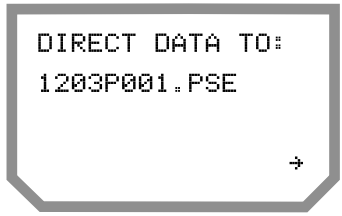
In general, with each quality indicator, any observations that are less than the ideal as set forth above, only receive partial credit.

If you have the option, you will generally get better results by locating the control point in an area that is similar to that of the remote. In other words, if the remote antenna is collecting data on a flat, asphalt surface you can obtain better results by choosing a nearby control point that is on a similar flat, asphalt surface. This way, both points will be affected by similar multi-path conditions.

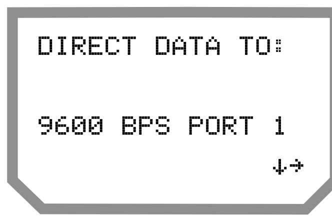
Before collecting your centimeter or submeter differential session, be sure to position (turn) the multi-path resistant antenna so its embedded marker points North. This ensures that the phase centers of both antennas at the remote and control positions are consistant. This is important when you are collecting data for centimeter accuracy.

Stationary Differential

Press **DIF, 2,** and **ENTER** (or press **DIF** and the **DOWN ARROW** two times, then **ENTER**). The receiver will compute the optimal satellite set (based on PDOP), then display the Direct Data To screen with a receiver-generated filename. Press **CLEAR** to key in your own 8-character filename, or , if you are logging to a PC or external logging device with the LOG module, use the **RIGHT ARROW** to toggle to the Data To Port option.



If you select Data To Port, the output dataport and baud rate selected in SETUP 7 are shown.



NOTE

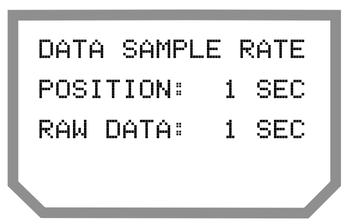
The dataport and baud rate must be selected in SETUP 7 first.

Note that files created in DIF2 will have a .PSE or .CAR extension and that the unit generated filename consists of the date (1203), the letter "S", and a file sequence number (001) which will automatically increment by 1 each time a new session is started. Press ENTER to make a selection.

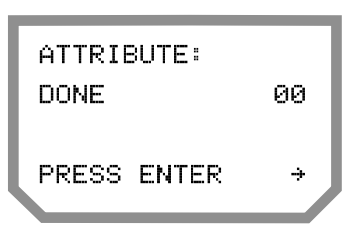
The receiver will display a descriptor screen. You may enter any type of descriptive information you wish regarding the file (for example, time, date, place, weather, etc.). This can be helpful in keeping files separate if many are collected in a short period of time. Key in the descriptor up to 72 characters and press **ENTER**. You may also press **ENTER** without entering anything to have no descriptor.

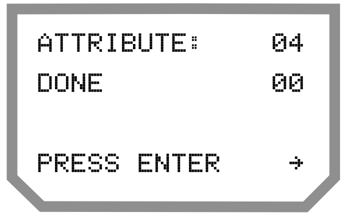
If you prefer, you may use a waypoint instead of a descriptor. Press the **DOWN ARROW** to scroll through the stored waypoints, or key in the desired filename followed by **ENTER**. Press **ENTER** when the desired waypoint is displayed to return to the previous display, and **ENTER** again to continue.

Upon pressing **ENTER**, the receiver displays the Data Sampling Rate screen. You can either accept the data sampling rates displayed or key in a new sampling rate for both Position data and Raw data. To enter a new data sampling rate, key in the number you want followed by **ENTER**. Do this first for POSition and then for RAW data. To change POSITION only, key in the new number and press **ENTER**. Now re-enter the RAW data rate followed by **ENTER**. To change RAW data rate only, re-enter Position rate and press ENTER, then key in new Raw data rate followed by **ENTER**. To accept the displayed sampling rates, simply press **ENTER**. Note that you can also enter new sampling rates by pressing **CLEAR** to clear the individual sampling rates, then keying in new rates.

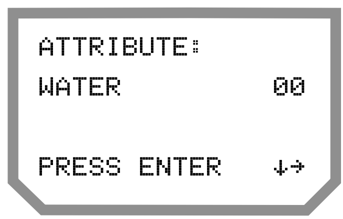


The receiver will now display the Attribute screen. If an attribute file has been made active (refer to Attribute chapter), you can use the **RIGHT ARROW** to toggle through the active attributes (up to 99).

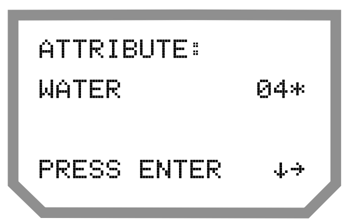




If you know the attribute number, you may also key in the attribute number to go directly to that attribute. Note that keying in an attribute number results in that number being echoed in the upper right of the display. Key in the number and press **ENTER** to go to that attribute, or use the **RIGHT ARROW** to toggle through the active attributes. You may also press **ENTER** when DONE is displayed or key in 00 and **ENTER** to assign no attributes. If no attribute files have been made active with the ATTR key, a message to that effect is displayed.



To use the active attributes, press the **RIGHT ARROW** to toggle to the attribute you want (or key in the attribute number). Use the **DOWN ARROW** to scroll through characters in the attribute if the attribute name exceeds the display length.

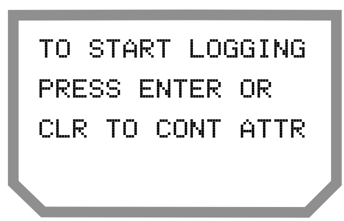


To tag the data with this attribute, press **ENTER**. An asterisk appears next to the attribute number. This indicates that the attribute has been entered into the data file. You may continue to toggle with the **RIGHT ARROW** to other attributes (or key in another attribute number). To stop entering attributes, press **ENTER** from the screen with an asterisk or key in 00 to go to DONE (or use the **RIGHT ARROW** to toggle to DONE) and press **ENTER**.

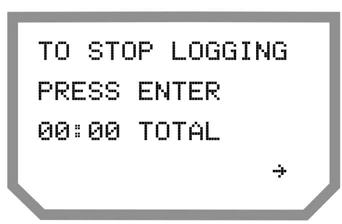
If you wish to enter a new attribute not in the active attribute file, you may do so at any time. The attributes you create are input into the data file. They are not, however, stored in the active attribute file. To do this, press **CLEAR** from any Attribute display (displays with ATTRIBUTE: across the top of the screen). You can also do this from the NO ATTR FILES AVAIL display if no attribute files have been made active. The receiver displays the INPUT NEW ATTRibute screen. Key in an attribute up to 72 (10 displayable at a time) characters. Press **ENTER**. This attribute is now written to the data file and the receiver returns you to the ATTRIBUTE display.

NOTE

You may enter as many attributes as you like, both before and during data collection. All entered attributes will be written to the head of the file.

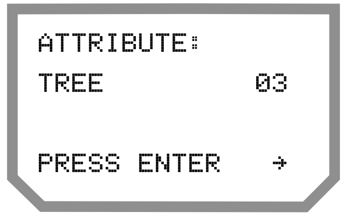


Upon pressing **ENTER** to conclude attribution, the receiver displays the START LOGGING screen. Press **ENTER** again to begin logging data.

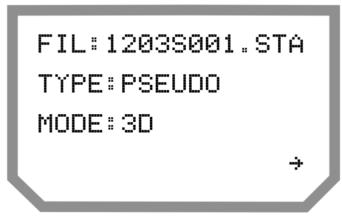


The receiver immediately displays the STOP LOGGING screen with a counter. The receiver will locate and acquire the selected satellites, then collect data to the file specified or send it to the dataport (depending on the option you selected). The counter will begin after lock has been acquired on the satellites and data is being collected; this usually occurs in about 10 seconds.

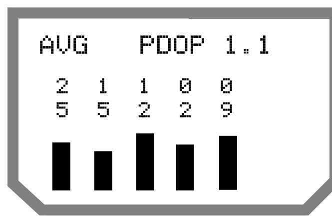
Press the **DOWN ARROW** or **ATR** key to assign attributes at any time during a defferential session. The attributes will be put at the head of the file (Attribute entry is described in Chapter 6.)



To view the status screen, press the **RIGHT ARROW**. File status includes the filename, the type of file, and the mode of operation.



You can also view the receiver status by pressing the right arrow again. This will show you which satellites are being used by the receiver to compute files, their signal strengths at the receiver, and whether or not you are locked onto a satellite. It is recommended that you check this screen shortly after you initiate logging to make sure you are getting complete signal information from the satellites.

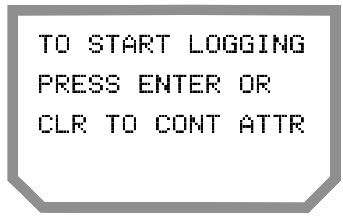


After you've pressed ENTER to START LOGGING, you will experience a delay between 10 seconds and 2 minutes before the counter begins. The receiver will acquire lock on all the specified satellites and then download ephemeris data. After this, the receiver's counter will begin. To STOP LOGGING press ENTER from the STOP LOGGING screen. The screen will prompt you to either press ENTER to stop or press CLEAR if you wish to continue the session. Upon pressing ENTER, the receiver will display a message that the session was stopped as well as how long the session was.

At this point you may want to know how long your pseudorange session should be collected. As a rule, plan on logging for 3– 5 minutes at a 1 second data sampling rate to achieve 2 – 5 meter accuracy. If sampling rates are set to something other than 1 second, you will need to occupy the point for a longer period of time. It is recommended that occupation time be multiplied by t for every t second increase in the sampling rate. Again, be sure that both the control and remote receivers are using the same data sampling rate and the same satellite sets.

Once a session is stopped, you may start another function or immediately begin another session.

To start another session using the same parameters (descriptor, data sample rate, and attribute file), press **CLEAR**. The unit displays the Start Logging screen. Press **ENTER** to start a new session, or press **CLEAR** again to enter new attributes.



When using the ProMARK X as a base station, make sure you set the mask angle in your field unit to a number greater than that of the ProMARK X. Most users prefer to set the base unit to 10°, while setting a 15° mask in the field unit. The higher cutoff value in the field unit will ensure any satellites used will still be in the view of the base.

All-in-view base stations such as the ProMARK X are simple to operate, support an unlimited number of field units, require minimal attendance, and are very economical in the long run when you consider staffing costs, communications issues, and overall ease of operation.

Please note that Magellan complies fully with the GPS standard RINEX format—short for Receiver INdependent EXchange. With RINEX you may export data to other systems' post processing packages, or import base station files to the Magellan system for simplified processing.

DIF3, Mobile Differential.

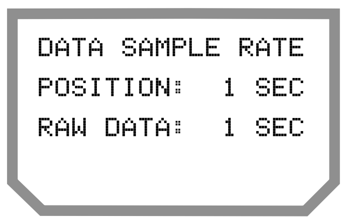
Press **DIF, 3,** and **ENTER** (or press **DIF** and the **DOWN ARROW** three times, then **ENTER**). The receiver displays the Direct Data To screen. You may use the **RIGHT ARROW** to toggle between a receiver generated filename (consisting of a date (1203), the letter "M", a file sequence number (001) and an .MOB extension) and a Data to Port option. You can also press **CLEAR** to give the receiver generated filename a name of

your own. Select the Data to Port option if you wish to log the data to an external device using the LOG software module supplied on the PPSW disk.

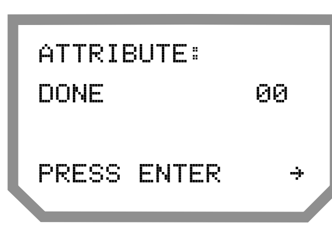
Press **ENTER** to select one of the choices. In the following steps, we have pressed **ENTER** to select the receiver generated filename.

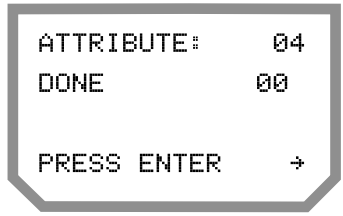
The receiver now prompts you for a descriptor. You may enter any type of descriptive information you wish (for example time, date, place weather, etc.). This can be helpful in keeping files separate if several are collected in a short period of time. Key in a descriptor up to 72 characters and press **ENTER**. You may also press **ENTER** without entering anything to have no descriptor.

Upon pressing **ENTER**, the receiver displays the Data Sampling Rate screen. You can either accept the data sampling rates displayed or key in a new sampling rate for both position data and raw data. To enter a new data sampling rate, key in the number you want followed by **ENTER**. Do this first for POSITION and then for RAW Data. To change POSITION only, key in the new number and press **ENTER**. Now re-enter the raw data rate followed by **ENTER**. To change RAW data rate only, re-enter position rate and press **ENTER**, then key in new raw data rate followed by **ENTER**. To accept the displayed sampling rates, simply press **ENTER**. Note than you can also enter new sampling rates by pressing **CLEAR** to clear the individual sampling rates, then keying in new rates.

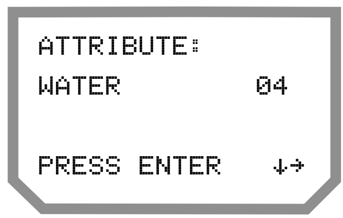


The receiver will now display the Attribute screen. If an attribute file has been made active (refer to Attribute chapter), you can use the **RIGHT ARROW** to toggle through the active attributes (up to 99).

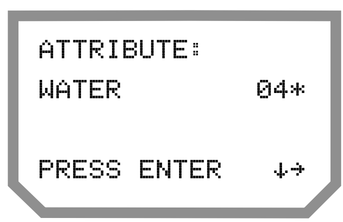




If you know the attribute number, you may also key in the attribute number to go directly to that attribute. Note that keying in an attribute number results in that number being echoed in the upper right of the display. Key in the number and press **ENTER** to go to that attribute, or use the **RIGHT ARROW** to toggle through the active attributes. You may also press **ENTER** when DONE is displayed or key in 00 and **ENTER** to assign no attributes. If no attribute files have been made active with the **ATTR** key, a message to that effect is displayed.



To use the active attributes, press the **RIGHT ARROW** to toggle to the attribute you want (or key in the attribute number). If you wish for the data to be tagged with this attribute, press **ENTER**. You can also use the **RIGHT ARROW** to scroll through the characters in the attribute should the attribute exceed the display length.



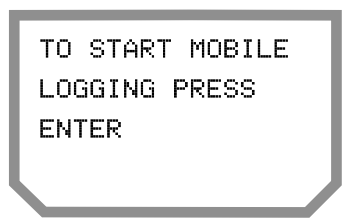
An asterisk appears next to the attribute number. This indicates that the attribute has been entered into the data file. You may continue to toggle with the **RIGHT ARROW** to other attributes (or key in another attribute number). If you are finished entering attributes, press **ENTER** from the screen with an asterisk or key in 00 to go to DONE (or use the **RIGHT ARROW** to toggle to DONE) and press **ENTER**.

If you wish to enter a new attribute not in the active attribute file, you may do so at any time. The attributes you create are input into the data file. They are not, however, stored in the active attribute file. To do this, press **CLEAR** from any Attribute display (displays with ATTRIBUTE: across the top of the screen). You can also do this from the NO ATTR

FILES AVAIL display if no attribute files have been made active. The receiver displays the INPUT NEW ATTRibute screen. Key in an attribute up to 72 characters (16 displayable at a time). Press **ENTER**. This attribute is now written to the top of the data file and the receiver returns you to the ATTRIBUTE display.

NOTE

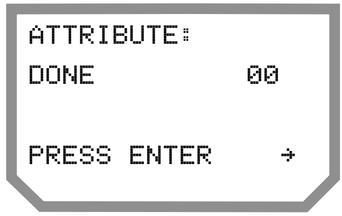
You may input as many attributes as you like before and during logging. Attributes entered before logging are put at the head of the file. Attributes entered during logging are inserted into the data file, paired with the fix computed at the time the attribute was entered.



Upon pressing **ENTER** to conclude attribution, the receiver displays the START LOGGING screen. Note that attributes are assigned at the start of a session for static applications. Mobile applications, allow for attribution both at the start of a session and throughout the session. Press **ENTER** to begin logging data.

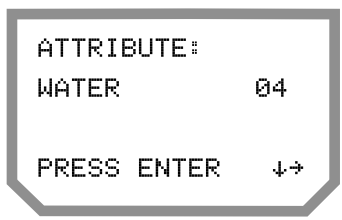
The receiver will display the STOP LOGGING screen. Again, as in DIF3 and 4, you can use the **RIGHT ARROW** to view the file status screen and the receiver status screen. If you wish to end the session, press **ENTER**. Mobile DIF gives you the utility to tag data as it is being collected with attributes during a differential session. To assign attributes, press the **DOWN ARROW** or **ATR** key.

The Attribute screen is displayed showing the DONE 00 option. If you don't want to assign attributes, press **ENTER** to return to the STOP LOGGING screen. You can also use the right arrow to toggle throughout the attributes which are active (made active by the **ATTR** key function). In addition, you can enter your own attribute by pressing **CLEAR**.

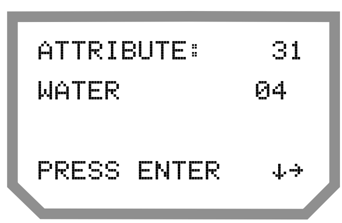


Pressing **CLEAR** will display the INPUT NEW ATTRibute screen. You can access this screen by pressing **CLEAR** any time you are on a display which says ATTRIBUTE: across the top. Type in the new attribute and press **ENTER**. This newly entered attribute is now written into the data file, but is not entered into the active attribute file. Pressing **ENTER** after keying in an attribute returns you to the Attribute screen you were on when your pressed **CLEAR**.

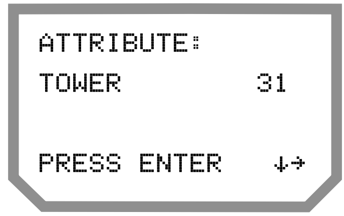
To utilize an active attribute, you can use the **RIGHT ARROW** to toggle through the active attributes to get to the one that you want to use. You can also use the **DOWN ARROW** to scroll through the characters in an attribute name.



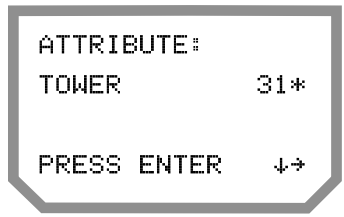
You can also key in the attribute number to go directly to the attribute you want. This entry is also echoed on the upper right of the display.



Press **ENTER** when both digits have been entered. The receiver now displays the attribute assigned to the number just keyed in.

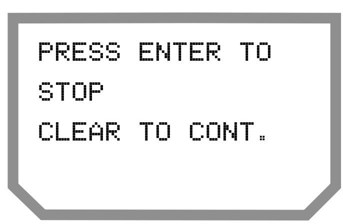


To tag data with an active attribute, go to the attribute you want to use (via keying in an active attribute number or using the **RIGHT ARROW** to toggle through the active attributes) and simply press **ENTER**. An asterisk appears for 1 second, indicating that this attribute has been written to the data file at that point in time. You can now go to another active attribute (via keying in an active attribute number or using the **RIGHT ARROW** to toggle through the active attributes); you can enter a new attribute (via the **CLEAR** key) or you can press **ENTER** at the DONE option to return to the STOP LOGGING screen.

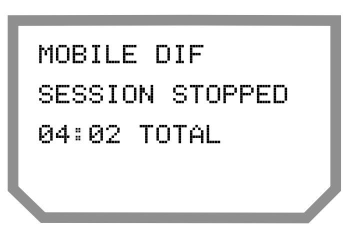


Remember, that at any time you can return to the STOP LOGGING screen by keying in “00” or selecting DONE by pressing **ENTER** on the DONE display.

To stop logging, press **ENTER** from the STOP LOGGING screen. The receiver will prompt you to confirm the selection by pressing **ENTER**. You can continue the session without interruption by pressing **CLEAR** to return to the STOP LOGGING screen.



Pressing **ENTER** will actually stop the session. A message is displayed showing that the session has been stopped and the duration of the session.



Once a session is stopped, you may start another function or immediately begin another session.

To start another session using the same parameters (descriptor, data sample rate, and attribute file), press **CLEAR**. The unit displays the Start Logging screen. Press **ENTER** to start a new session, or press **CLEAR** again to enter new attributes.

```
TO START LOGGING
PRESS ENTER OR
CLR TO CONT ATTR
```

DIF4, RTCM:

Press **DIF, 4,** and **ENTER** (or press **DIF** and the **DOWN ARROW** four times then, **ENTER**). Use the **RIGHT ARROW** to toggle ON or OFF. In order to receive RTCM corrections you must have the receiver connected to a Differential Beacon Receiver (DBR) or a radio modem device. Once you have connected your receiver to a correction source, you can toggle this option to ON.

```
RECEIVE RTCM104
OFF

                  →
```

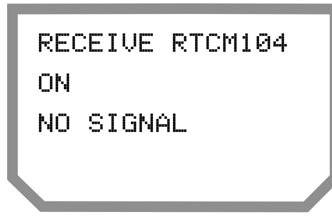
NOTE

If you see the message "PORT NOT SET" when accessing this function, press ENTER to override the Port Setup (Setup 7) and reasign a port to this function. Keep in mind that changes that you make here will be relected in Setup 7.

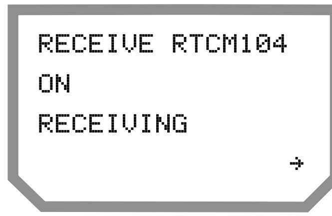
"WAITING" is displayed until the unit establishes a connection with the correction source.

```
RECEIVE RTCM104
ON
WAITING
                  →
```

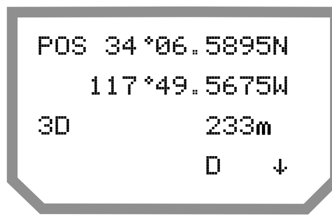
If no connection is established after two minutes, the receiver will read NO SIGNAL to indicate that it was unable to establish a connection. Check your cabling and restart the process.



Once a connection is established, the receiver will display the message RECEIVING. At this point, the ProMARK X is accepting the corrections being input. These corrections are then applied automatically to fixes being computed by the receiver.



When the ProMARK X-CM is receiving broadcast corrections, it will indicate that the corrections are being applied to position fixes by displaying a “D” on the position display when POS is pressed. If you then go to DIF6 and toggle to OFF and then return to the POS display, the “D” is no longer displayed indicating the broadcast corrections are no longer being received and applied to the position fixes.



FILE STRUCTURE

Since you have now learned how to initiate data collection with the differential functions, it is now appropriate to summarize the file structures for files created with these differential functions.

The ProMARK X is capable of creating attribute files both on the PC and on the receiver. These files will contain a .ATR extension regardless of what name is given to the file. Normally, the file name will be structured as 1203W002.ATR, with 1203 being the date, W being an arbitrary file type indicator, 002 being a file sequence number which will increment by 1 each time a file is created. The file itself will contain a list of attributes and up to 99 key assignments for the attributes.

Files created with DIF2 Stationary will have a similar naming convention (1203S001.XXX, with S being the arbitrary file type indicator and .XXX the extension, either .PSE or .CAR). The file will contain the ephemeris data for the satellites utilized, attributes (if any have been entered), a descriptor (if one has been used) followed by the actual data, both position fixes and pseudoranges depending on the data sampling rate setting. Files created with DIF2 and a ProMARK X-CM will have the same structure other than the naming convention, which will be 1203C001.CAR (C being the arbitrary indicator and .CAR being the extension).

Files created with DIF3 Mobile will have a similar naming convention (1203M001.MOB with M being the arbitrary indicator and a .MOB extension). The mobile file will contain the same information as other DIF initiated files (ephemeris data, attributes, descriptor) but attributes may appear anywhere in the data portion of the file, corresponding to the point in time that it was entered.

Once files have been created in the ProMARK X, it is possible to rename or delete these files using the AUX 11 (File Maintenance) function.

We suggest when using two Magellan receivers (control and remote) that you either give the file a unique name of your choosing when the files are created or use the RENAME utility in AUX 11 to differentiate the file names prior to downloading. This will prevent files in two separate receivers from having the same filename, as would occur in the case where receiver-generated filenames are used. In any event, files from the control and remote receivers should have unique names to avoid confusion.processing the collected data.

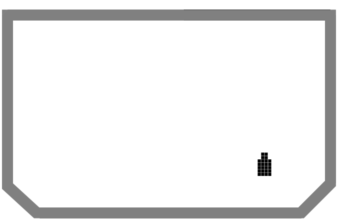
Chapter 8 TROUBLESHOOTING AND OPERATING TIPS

This chapter contains the miscellaneous information you will require to interpret the error/warning messages, troubleshooting for operating problems, and prepare the unit for long-term storage.

ERROR AND WARNING MESSAGES

Error and warning messages are displayed to alert you to a condition you need to be aware of. Most messages require a response or action on your part. A few are informative only.

MESSAGE **DESCRIPTION/SOLUTION**



First battery warning: The six AA-batteries or the Rechargeable Battery Pack is getting low. Typically, the unit can be operated for 20 minutes (Battery Saver off) or 15 sets of fixes (Battery Saver on) without jeopardizing the unit's memory.

Do this: ***Replace the batteries. We recommend that you always keep the spare battery clip at hand, loaded with fresh batteries.***

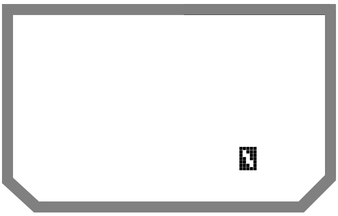
Old data: The unit has lost contact with one or more of the satellites used for the previous fix and cannot find another available satellite. The position fix displayed with this symbol is 10 seconds old or older, and should not be used for navigation.

Try this:

1. ***Reposition the antenna to see if you can get a clearer view of the sky.***

2. Check the terrain setting (SETUP 5). Is it correct for the conditions at your location?

3 If using 3D, try 2D.



Accuracy warning: The Position Dilution of Precision (PDOP) of the position fix is 10.1 or more; the fix is not accurate, and should not be used to navigate by. This symbol appears on all screens of the affected position fix.

Try this:

1. Scroll to the third screen of the position fix. Note which satellites were used for the fix.

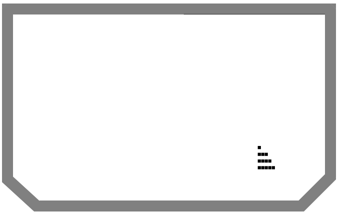
2. Check Sat Status (AUX 3) to be sure all satellites are ON.

3. Check the angle of elevation and azimuth of the visible satellites: are signals being blocked by your surroundings? Try changing your position or the location of the antenna and taking another fix.

4. Did you turn on any satellites that are currently visible? If so, take another position fix.

5. Check the mask angle in SETUP. Is it too high?

6. If using 3D, try 2D.



SQ warning: The Signal Quality of one or more satellites is very low. This indicates that the signal is not strong and the unit may lose it. SQ has little effect on PDOP or accuracy; it is displayed for information only. This symbol appears on all screens of the affected position fix.

Try this:

Change your position or the position of the antenna. Even a slight change may be enough to allow the receiver to get a stronger signal.

Not enough satellites are visible to take a position fix: If operating in 2D, there are fewer than three satellites; if operating in 3D, there are fewer than four satellites.

Try this:

1. ***Make sure the antenna has a clear view of the sky.***
2. ***If using an exterior antenna, check the connections.***
3. ***Verify the initial position and time (see SETUP).***
4. ***be sure enough satellites are available at this time.***
5. ***If in 3D, try using 2D or switch to AUTO. In AUTO the unit takes 3D fixes when four satellites are available and 2D fixes when only three satellites are available.***

6. ***If none of the above works, or if the unit has not been used for more than a few minutes in the past six months, press AUX 9 to initiate Almanac Collect and collect a new almanac.***

```
EXTERNAL POWER
LOST
HIT KEY TO
CONTINUE
```

External power lost or the level of external power supplied to the unit is below minimum requirements: The unit is therefore operating on battery power.

Do this:

1. ***Check the cable and/or adapter to be sure they are secure. Be sure to turn the unit off before securing loose cables.***

2. ***Check the external power source for malfunctions.***

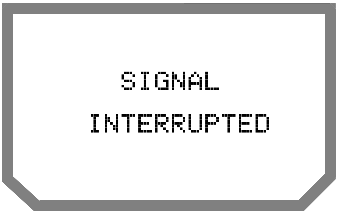
3. ***Press any function key except ON/OFF or LIGHT to continue.***

```
REPLACE BATTS
OR LOSE DATA
```

Second battery warning: You ignored the first battery warning and battery power is now dangerously low. The unit turns itself off two minutes after this message appears, even if the Battery Saver is off. The batteries have enough residual power to protect memory for up to four weeks, but cannot provide operating power. Until fresh batteries are installed, the unit can be operated only from external power.

Do this:

Turn the unit OFF immediately and insert new batteries.



Satellite signal lost during averaging: This message is displayed during averaging when a satellite signal is lost or is lost and recovered, and when several satellites move below the mask angle. The unit will not restart automatically.

Do this: ***Restart with DIF 1.***

OPERATING PROBLEMS

Use the table below to identify problems that arise when operating the unit.

CONDITION	DESCRIPTION/SOLUTION
FROZEN DISPLAY:	The display is frozen and the keypad does not respond.
Do this:	***Remove the batteries and wait for the unit to turn off.*** ***OR*** ***With the batteries in place and the unit on, create a short by using a coin to complete the circuit between the two center connectors in the battery compartment.*** ***NOTE: This will clear the unit's memory.***
NO POWER:	
battery operation	The batteries are inserted into the clip incorrectly.
Do this:	***Insert the batteries into the clip correctly.***

	The battery compartment is not clean or dry.
Do this:	***Make sure the battery compartment is clean and dry.***
	The batteries have run down completely; memory is lost.
Do this:	***Replace the batteries, then initialize the unit as described in Initialization or SETUP.***
external power	The power jack is not fully inserted.
Do this:	***Make sure the jack is fully inserted.***
UNIT TURNS OFF DURING USE	The unit is operating from battery power with the Battery Saver on.
Do this:	***Turn unit back on. Use SETUP 15 to turn the Battery Saver off.***
	External power was interrupted, and the unit switched to battery power.
Do this:	***Turn the unit on. Watch the self-test display to verify the power source. Check the external power source for malfunctions. Also check all connections.***
POSITION FIX DOESN'T CHANGE	The signal from one or more satellites has been lost; the position fix displayed is the most recent one available, and the hourglass is visible on the fourth line of the display.
Do this:	***Refer to ⧗, in "Error and Warning Messages."***
	Display may be frozen; keypad does not respond.

Do this:	***Remove the batteries and wait for the unit to turn off.*** ***OR*** ***With the batteries in place and the unit on, create a short by using a coin to complete the circuit between the two center connectors in the battery compartment.*** ***NOTE: This will also clear the unit's memory.***
FIXES VARY A LOT	The position accuracy of the ProMARK X is affected by several variables, the most important of which is the geometric quality of the fix. Therefore, the specified accuracy of 12 meters RMS in 2D is statistical, not absolute and assumes the absence of SA. A good rule of thumb is that approximately two-thirds of the fixes will be within 12 meters of the true position and about 95% of the fixes will be within 20 meters under good conditions and without SA. Since 20 meters is approximately 0.01 minute of latitude (and 0.01 minute of longitude at the equator), it is possible to see variations as large as ±0.03 minutes of latitude/longitude from fix to fix when conditions are good. Under less favorable conditions, larger variations are normal. You can increase position fix accuracy by using position fix averaging, differential, or carrier phase differential (with the Submeter Kit). If the unit is being operated near the poles, small changes in position may cause great variations in position and velocity-related data. Refer to *Using the Unit Near the Poles* later in this chapter.

DATA IS NOT BEING TRANSFERRED	Baud rate on the receiver and PC do not match.
Do this:	***Use SETUP 7 to set the baud rate.***
	The PC or data logger is not turned on; the PC was not ready to receive or transmit data.
Do this:	***Turn the PC or data logger on. If using a PC, you must also enter the Post-Processing Software to select the LOG submenu (or use the LOG software module to log data in real time).***
	Cables and adapters are not secure or are not connected correctly.
Do this:	***Check all cables and adapters; refer to the illustration on page 4-9 for proper connections.***
	The unit is not in continuous operation.
Do this:	***Turn the unit off, connect it to an external power source, then turn the unit back on; or use SETUP to turn the Battery Saver off.***
NAV DOES NOT WORK	NAV displays bearing and distance information only when a route has been activated. Without an active route, only velocity-related information is available.
Do this:	***Activate a route to navigate on.***
	You must be travelling faster than 0.3 km/hr to get velocity-related data, such as speed over ground (SOG), course over ground (COG), steering, speed of advance (SOA) or time to go (TTG).
Try this:	***Increase speed to 0.3 km/hr or greater.***

	Navigation- and velocity-related data is not available until three fixes have been made.
Do this:	***Wait until three position fixes have been taken, then try again.***
DASHES APPEAR IN NAV DISPLAYS	You are 65.6 feet (20 meters) or less from your destination. Distance to destination is no longer available, and bearing varies considerably. This is normal.
SOME VALUES IN NAV DISPLAYS ARE NOT STABLE	Certain values are calculated from an instantaneous measurement of speed. Since speed may fluctuate from one instant to another, these calculations may seem unsteady. The navigation calculations that may be affected are VMG, SOA, COG, TTG, and ETA; the velocity calculation that may be affected is SOG.
Do this:	***Use Velocity Average to replace the instantaneous measurement.***
SATELLITE AVAILABILITY NOT TO YOUR EXPECTATIONS	The unit may not have a current almanac, or the position or health of one or more satellites may have changed since the last almanac update.
Do *this:*	***Check your initial position, time, and the satellites displayed with Sat Status (AUX 3). Collect a new almanac with Almanac Collect, then check Sat Status again. Note if more satellites are listed now.***
	You are using 3D, which requires four satellites. Satellite coverage in some areas to the far north or south and at some times of day may not be sufficient to support 3D operation to your complete satisfaction.

Try this:	***Check Sat Schedule with AUX 2. If the window of availability for 3D operation is insufficient, try operating in 2D or Automatic.***
	The mask angle is set to 15° or 20°. Available satellites have lower elevations.
Do this:	***Change the mask angle with SETUP. Usually, a mask angle of 10° is sufficient.***

OPERATING TIPS

General. Most equipment malfunctions can be prevented by observing the following rules:

- Turn the unit off before inserting or removing a power jack.
- Do not leave the unit face up in the sun.
- Do not operate the unit in temperatures above 60°C or below -10°C.
- Do not store the unit at temperatures above 70°C or below -40°C.
- If the unit is dropped in the water, use fresh water to carefully rinse both the outside of the unit and the battery compartment. Dry the unit and battery compartment thoroughly.

Unsure of Your Position When Initializing. When you want to initialize the unit, but do not know your current position and have no map to refer to, self-initialize with AUX 9 or POS. AUX 9 initiates Almanac Collect, and accepts the first position fix computed as the initial position. (This is described more fully in *AUX 9*.) (Be sure you have a clear view of the sky.) An initial position entered in this way is sufficient to operate the unit, but the unit will obtain its first position fix much faster if it is initialized by manually entering the position.

If you know where you were, you can use Waypoint Projection (AUX 6) to project your current position and date.

Search and Acquisition Errors. Under the following conditions, the unit may be unable to obtain a position fix:

- Initialization was not done correctly.
- Poor signal environment.
- Insufficient number of satellites.
- Unit searches constantly.

Initialization Errors. An initialization error occurs when:

- The initial position entered in SETUP or during initialization was incorrect by 300 miles (482.7 km) or more.
- The unit has been moved 300 miles (482.7 km) or more from its last position fix or initial position.

Either condition can cause the unit to be unable to find the satellites it looks for. Since the unit searches for satellites based on where it thinks it is, an initial position or last position fix that is 300 miles (482.7 km) or more away from the unit's current position may cause the unit to search for satellites that are not available at the unit's true location.

Either condition can also cause the unit to calculate a position fix that is 300 miles (482.7 km) or more from its initial position or the last position fix calculated. The unit regards this position fix as an error, and tries three more times to obtain a position fix that it can accept.

After the fourth attempt to obtain an acceptable position fix, the unit discards the initial position or last fix and assumes that an initialization error has occurred. The unit then re-initializes itself, using the satellites that it has already acquired. This takes between 10 and 60 seconds.

Sometimes, the initial position is so far off from the present position that the unit is unable to locate enough satellites to obtain a fix. When this happens, the unit searches until it has enough satellites to obtain a fix. You will notice the PRNs on the receiver status screen change periodically.

If the unit does not have a new position fix after about 20 minutes, either re-initialize the unit or initiate Almanac Collect with AUX 9 to collect a new almanac.

The Signal Environment. The signal environment refers to the physical conditions in which the unit is being operated. A poor signal environment limits the receiver's ability to locate and track satellite signals.

Poor environments include areas of dense foliage or dense construction (even a one-story building can block signals when the visible satellites have low elevations). It also includes locations with a limited view of the sky, such as a site at the bottom of a deep canyon.

Often, the effects of a poor signal environment can be alleviated by adequate planning. For example, be sure the antenna has as clear a view of the sky as possible. Use SETUP to be sure the mask angle adequately reflects the physical conditions at the location. Setting the unit to use 2D instead of 3D or AUTO will often help since the unit will use a different satellite set for a 2D solution than for a 3D solution. Also, check Sat Schedule to be sure that you are using the unit when as many satellites as possible are visible to your location.

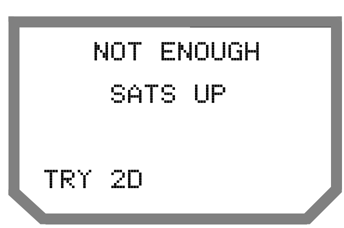
A weak signal environment may also cause multipath problems. Multipath errors occur when the unit receives a mix of direct and indirect signals. Indirect signals are usually caused when atmospheric conditions affect the signals emitted by satellites with low elevations. They may also be caused by highly reflective structures in the vicinity of the receiver. Multipath errors are characterized by sudden shifts and variations in the SQ of collected data. Some multipath problems can be eliminated by using satellites with high elevations. A multipath-resistant antenna is available as part of the Submeter Kit.

Insufficient Number of Satellites. The ProMARK X checks its almanac before beginning to search for satellites. The receiver will not turn on if the almanac indicates that not enough satellites are within view to establish a position fix.

This message appears when the almanac indicates that not enough satellites are in view to take a fix. The receiver remains off.

If you are operating with the Battery Saver on, the unit shuts itself off if it cannot locate enough satellites for a fix.

This message appears when the unit is set to 3D operation, and not enough satellites are available for a 3D fix. Try 2D, which requires fewer satellites.



Unit Searches Constantly. If the unit has an almanac and is unable to locate satellites, it searches continually until a satellite is found.

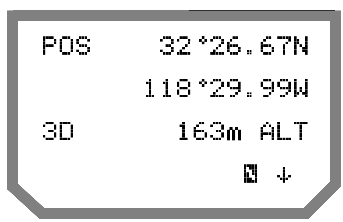
The unit may be unable to locate satellites under the following conditions:

- The antenna is not positioned correctly.
- The satellite signals are blocked from view by buildings, mountains, etc.
- There are signal reflections that can be corrected by moving the antenna.
- There are satellite outages.

Refer to *AUX 3 — Sat Status*, to verify that satellites should be available. Refer to *Orienting the Antenna* to position your antenna.

Accuracy Warning Symbol. The accuracy of a position fix is determined by the position of the satellites used relative to each other. The closer the satellites are to each other, the less accurate the fix. This is referred to as the Position Dilution of Precision (PDOP), and is displayed on the third screen of the fix. (PDOP is described in greater detail in Appendix 6.)

This symbol appears on the fourth line of all screens when the PDOP is 10.1 or more.



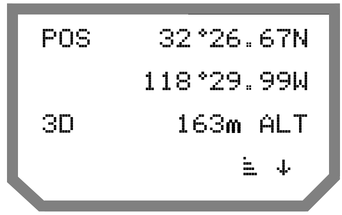
WARNING

When the accuracy warning symbol appears, do **not** use this data to navigate.

Signal Quality. The unit also measures the strength of the signal it receives from the satellites and displays this information on the third screen of the position fix. A very low signal quality indicates that a signal is so weak that it may be lost.

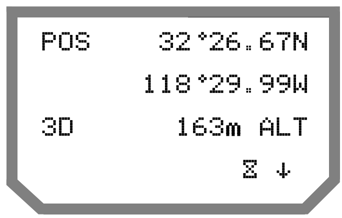
SQ has little effect on the accuracy of the fix; it is intended only to alert you that a signal from one or more satellites is not as strong as it could be.

This symbol appears on all three screens when the SQ from one or more satellites is 3 or less.



Old Data. The unit automatically updates its position every second. If a satellite signal is lost, or a satellite sets or becomes obstructed, the unit switches to other satellites to update the fix. If other satellites are not available, the unit cannot update the position fix.

The hourglass symbol appears on all displays when the unit has been unable to update the position fix for at least 10 seconds. The position displayed is not current, and should not be used for navigating.



CHOOSING A DATUM

All charts are created using a system that includes the scale, type of projection, and a map datum. There are hundreds of map datums in use throughout the world, but only a few are in widespread use today.

The ProMARK X has 66 map datums plus five user-entered datums. You should set the unit to use the same datum as your charts and equipment; a position in one datum may differ by 300 meters or more from one calculated using another datum.

Before setting the datum in SETUP 9, check the datum used by your charts (look at the legend) and the manuals for your electronic navigation equipment. If the datum you need is not available with the ProMARK X, set a user-entered datum. This is described in Chapter 4.

The National Oceanic and Atmospheric Administration (NOAA) is currently changing its charts to NAD83; for most purposes, this is the same as WGS84. Most NOAA charts in use now are NAD27 or NAD83. USGS maps are usually in NAD27.

USING THE UNIT NEAR THE POLES

Since all meridians of longitude converge at the North and South poles, any distance measurement can span many degrees of longitude near the poles. This means that small changes in position can cause large variations in position.

The inherent accuracy of the ProMARK X does not change near the poles, but this mathematical sensitivity problem can cause position and velocity-related data to appear unstable when the unit is operated at latitudes greater than 85° north or south of the equator. Use caution in interpreting displayed data in these areas.

STORING THE UNIT

Use the instructions below to store the unit.

- Use AUX 5 to transfer all data files, attribute files, almanac, user grids, and datums to a PC.
- Record any non-default parameters from SETUP, or transfer the SETUP file to a PC.
- Set Battery Saver to ON. Should the ON/OFF key be pressed inadvertently, this will prevent the batteries from being run down.
- Place the unit in the carrying/storage case or in its original box.
- If the unit is stored in the carrying/storage case, place the field card in the front pocket, to be sure no keys are accidentally pressed.

When the unit is taken out of storage, re-initialize the unit and re-enter non-default SETUP parameters, or upload parameters from a PC. Also upload any necessary data files.

WHEN NOTHING ELSE WORKS

When nothing described in *Operating Problems* solves your problem, you can try clearing the unit's memory by pressing AUX 11 and select ALL to clear memory. This is a last-ditch solution, since all of the unit's memory will be cleared. Be sure to record your waypoints and any non-default SETUP features before clearing the memory.

In extreme cases, such as when the display is frozen and the keypad will not work, remove the battery clip for at least 1/2 hour. This will also erase the memory.

MAGELLAN'S CUSTOMER SUPPORT

Representatives are available Monday through Friday, between 8 AM and 5 PM, Pacific Standard Time at 800-229-2400 or email at support@ashtech.com. Faxes can be sent to 408-615-5200. These numbers are stored in the unit, and can be accessed by pressing AUX 0.

If necessary, you can also return your unit to Magellan for repair. (Please call Customer Support for assistance first.) If possible, please notify us before shipping the unit by Parcel Post or UPS, and include with the unit a description of the problem and your name, address, and phone number. If your return shipping address is different, please include it.

Packages should be sent to:

Magellan Corporation
469 El Camino Real
Santa Clara, California 95050
Attention: Repair

Appendix 1 GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a constellation of satellites that orbit the earth twice a day, transmitting precise time and positioning information to anywhere on the globe, 24 hours a day.

The GPS constellation consists of 24 satellites orbiting the earth in six fixed planes that are inclined at 60° from the equator. Each satellite is 11,000 nautical miles above the earth, and orbits the earth twice a day.

The system was developed and deployed by the U.S. Department of Defense primarily to provide continuous, worldwide positioning and navigation data to U.S. and allied military forces around the globe. GPS also has broad civilian and commercial applications, ranging from navigation and surveying to exploration and tracking.

MONITORING AND CONTROLLING GPS

GPS is operated by the U.S. Air Force from a master contol station in Colorado, USA. The facility is equipped for satellite monitoring, telemetry, tracking, command and control, data uploading, and navigation message generation.

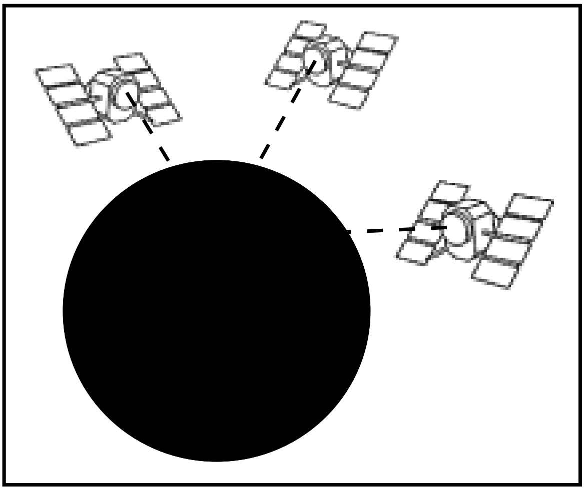
Monitor stations and ground antennas throughout the world passively track the GPS satellites and relay data to the master control station. Exact satellite position and signal data accuracy can therefore be constantly updated and maintained. Minor discrepancies between where the satellite "thinks" it is and where the monitor station "knows" it is can also be adjusted when needed.

If any satellite emits erroneous data or is otherwise not operating properly, a ground station marks it "unhealthy." The affected satellite broadcasts its status to the GPS receiver, which is programmed to ignore an unhealthy satellite and use the next best satellite to obtain a position fix. Also, satellites are occasionally taken off-line in order to do maintenance. A satellite may also be taken off-line in order to move it to a new orbit position.

How GPS Works

Each GPS satellite continuously broadcasts two signals: a Standard Positioning Service (SPS) signal for worldwide civilian use, and a Precise Positioning Service (PPS) signal for U.S. and allied military use. The SPS is a spread-spectrum signal broadcast at 1575.42 MHz. The signal is virtually resistant to multipath and night-time interference, and is unaffected by weather and electrical noise.

The SPS signal contains two types of orbit data: almanac and ephemeris. Almanac data contains the health and approximate location of every satellite in the system. A GPS receiver collects almanac data from any available satellite, then uses it to locate the satellites that should be visible at the receiver's location. Ephemeris data represents the precise orbital parameters of a specific satellite.



The Global Positioning System

Receivers listen to signals from either three or four satellites at a time. Three satellites are required for two-dimension positioning (which determines position only), and four satellites are required for three-dimension positioning (to determine position and elevation). The interval between the transmission and reception of the satellite signal (range data) is used to calculate the unit's distance from each of the satellites being used. Those distances are processed by the ProMARK X to compute a position.

ACCURACY

In general, an SPS receiver can provide position information with an error of less than 25 meters and velocity information with an error of less than 5 meters per second. (The ProMARK X is accurate to 15 meters.) Because the system is so accurate, the U.S. Government has activated Selective Availability (SA) to maintain optimum military effectiveness. Selective Availability inserts random errors into the ephemeris information broadcast by the satellites, which reduces the SPS accuracy to around 100 meters.

For many applications, 100-meter accuracy is more than acceptable. For applications that require much greater accuracy, the effects of SA and environmentally produced errors can be overcome by using a technique called Differential GPS (DGPS), which increases overall accuracy. (DGPS is described in *Appendix 2*.)

GPS INFORMATION SOURCES

The Civil GPS Information Center (GPSIC) in Virginia is operated and maintained by the United States Coast Guard for the Department of Transportation. It was established to accommodate the needs of the worldwide civil GPS user community, and its primary function is to provide information and to serve as a point of contact.

The GPSIC has general GPS literature available free upon request. The Center also maintains up-to-date almanac data and Operational Advisory Broadcasts containing current constellation status and planned satellite outages.

There are three ways to quickly obtain current information from the GPSIC:

1. 24-hour recorded phone message at (703) 313-5905
2. Computer bulletin board at (703) 313-5910
3. 24-hour live information at phone (703) 313-5900

(Users who are calling from outside of the United States must prefix these telephone numbers with “1”, the international dialing code for the USA.)

There are other sources for GPS information, ranging from free, governmentally produced literature to purchased professional literature and seminars. The geography department of your local college or the local office of the National Geodetic Survey may be able to help.

Appendix 2 DIFFERENTIAL THEORY

Differential positioning is a technique that allows you to overcome the effects of environmental errors and Selective Availability (SA) on the GPS signals to produce a highly accurate position fix. This is done by determining the amount of the positioning error and applying it to position fixes that were computed from collected data.

Typically, the horizontal accuracy of a single position fix from a GPS receiver is 15 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 15 meters RMS implies that about 63% of the fixes obtained during a session are within 15 meters of the true position.

There are two types of positioning errors; correctable and non-correctable. Correctable errors are the errors that are essentially the same for two GPS receivers in the same area. Non-correctable errors cannot be correlated between two GPS receivers in the same area.

Correctable Errors

Sources of correctable errors include satellite clock, ephemeris data, and ionospheric and tropospheric delay. If implemented, Selective Availability may also cause a correctable positioning error.

Clock errors and ephemeris errors originate with the GPS satellite. A clock error is a slowly changing error that appears as a bias on the pseudorange measurement made by a receiver. An ephemeris error is a residual error in the data used by a receiver to locate a satellite in space.

Ionospheric delay errors and tropospheric delay errors are caused by atmospheric conditions. Ionospheric delay is caused by the density of electrons in the ionosphere along the signal path. (The ionosphere is the upper portion of the earth's atmosphere.) A tropospheric delay is related to humidity, temperature, and altitude along the signal path. Usually, a tropospheric error is smaller than an ionospheric error.

Another correctable error is caused by Selective Availability (SA). SA is used by the United States Department of Defense to introduce errors into the Standard Positioning Service (SPS) GPS signals to degrade fix accuracy. This is done to maintain optimum military effectiveness by U.S. and allied forces.

All of these error sources have an important characteristic in common; the amount and direction of the error at any given time does not change rapidly. Therefore, two GPS receivers that are sufficiently close together will observe the same fix error, and the size of the fix error can be determined.

Non-Correctable Errors

Non-correctable errors cannot be correlated between two GPS receivers that are located in the same general area. Sources of non-correctable errors include receiver noise, which is unavoidably inherent in any receiver, and multipath errors, which are environmental. Multipath errors are caused by the receiver "seeing" reflections of signals that have bounced off of surrounding objects. (The ProMARK X antenna and the Magellan exterior antenna have been designed to minimize the effects of this problem. The submeter antenna is multipath-resistant; its use is required when logging carrier phase data.) Neither error can be eliminated with differential, but they can be reduced substantially with position fix averaging.

ERROR SOURCES

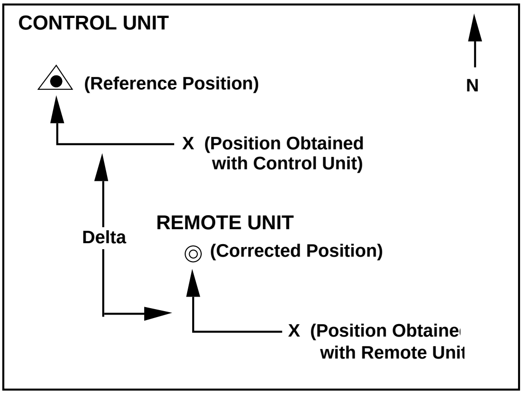
Error Source	Approx. Equivalent Range Error (RMS)
Correctable with Differential	
Clock (Space Segment)	3.0 meters
Ephemeris (Control Segment)	2.7 meters
Ionospheric Delay (Atmosphere)	8.2 meters
Tropospheric Delay (Atmosphere)	1.8 meters
Selective Availability (if implemented)	27.4 meters
TOTAL	28.9 meters
Non-Correctable with Differential	
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
Navigational Accuracy (HDOP=1.5)	45.8 meters

Differential GPS

Most DGPS techniques use a GPS receiver at a geodetic control site whose position is known. The receiver collects positioning information and calculates a position fix, which is then compared to the known coordinates. The difference between the known position and the acquired position of the control location is the positioning error.

Because the other GPS receivers in the area are assumed to be operating under similar conditions, it is assumed that the position fixes acquired by other receivers in the area (remote units) are subject to the same error, and that the correction computed for the control position should therefore be accurate for those receivers. The correction is communicated to the remote units by an operator at the control site with radio or cellular equipment. (In post-processed differential, all units collect data for off-site processing; no corrections are determined in the field.)

Some have had success in separating the control and remote units by over 1,000 kilometers; because all of the GPS receivers must be using the same satellite set and because tropospheric corrections are limited, we do not recommend any separation greater than 50 kilometers.



A Position Error Corrected with Differential

The difference between the known position and the acquired position at the control point is the DELTA correction. DELTA, which is always expressed in meters, is parallel to the surface of the earth. When expressed in a local coordinate system, DELTA uses a North-South axis (y) and an East-West axis (x) in 2D operation; an additional vertical axis (z) that is perpendicular to the y and x axes is used in 3D operation for altitude.

RTCM Corrections.

RTCM corrections are determined by a GPS receiver at a control site, which are broadcast by a radio beacon at the same site. The difference is that the GPS receiver at the control site tracks and computes a range error for all visible satellites. This means that the broadcast corrections are not limited by distance from the control site or tropospheric conditions.

The ProMARK X can receive RTCM corrections in two ways. It can be connected to a differential radio beacon receiver (also referred to as a DGPS receiver or an MSK, or minimum shift key, receiver) such as the Magellan DBR™ to receive the corrections directly from the beacon. This requires that the receiver be within range of a beacon (usually 300 miles) and that the receiver be compatible with the ProMARK X. To be compatible, the differential radio beacon receiver must receive and demodulate the corrections, then relay them to the ProMARK X through an RS-232 line. The ProMARK X will then apply the corrections to the positioning information it collects to calculate and display differentially corrected position fixes.

Alternatively, the ProMARK X can accept RTCM corrections via PC or telephone modem through its RS-232 data port. This method has no distance limitations, but does require the appropriate equipment.

Appendix 3 USER-DEFINED DATUM WORKSHEET

Use this log to enter the values for user-defined datums. The values for many local datums can be found in Appendix 2, Table of Constants.

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

User-	Datum:	
Ellipsoid:		
Δa:	Δf x 10:	
Δx:	Δy:	Δz:

The following table contains the constants needed to convert a local datum to WGS84. This is the equivalent of entering a user-entered datum in SETUP. Datums marked with "*" are defined in the unit.

When entering these constants, remember that Δa is displayed on the screens as “DELTA A”, $\Delta f \times 10^4$ is “DELTA f * 10000”, and so on.

MOLODENSKY TRANSFORMATION CONSTANTS
LOCAL DATUM TO WGS84

DATUM	ELLIPSOID	Δa	$\Delta f \times 10^4$	ΔX(m)	ΔY(m)	ΔZ(m)
ADINDAN	Clarke 1880					
Mean Value*		-112.145	-0.54750714	-162	-12	206
Ethiopia		-112.145	-0.54750714	-166	-11	206
Mali		-112.145	-0.54750714	-123	-20	220
Senegal		-112.145	-0.54750714	-128	-18	224
Sudan		-112.145	-0.54750714	-161	-14	205
AFG	Krassovsky	-108	0.00480795			
Somalia				-43	-163	45
AIN EL ABD 1970	International	-251	-0.14192702			
Bahrain Island				-150	-251	-2
ANNA 1 ASTRO 1965	Australian	-23	-0.00081204			
Cocos Islands	National			-491	-22	435
ARC 1950	Clarke 1880					
Mean Value*		-112.145	-0.54750714	-143	-90	-294
Botswana		-112.145	-0.54750714	-138	-105	-289
Lesotho		-112.145	-0.54750714	-125	-108	-295
Malawi		-112.145	-0.54750714	-161	-73	-317
Swaziland		-112.145	-0.54750714	-134	-105	-295
Zaire		-112.145	-0.54750714	-169	-19	-278
Zambia		-112.145	-0.54750714	-147	-74	-283
Zimbabwe		-112.145	-0.54750714	-142	-96	-293
ARC 1960	Clarke 1880					
Mean Value*		-112.145	-0.54750714	-160	-8	-300
Kenya		-112.145	-0.54750714	-161	-7	-300
Tanzania		-112.145	-0.54750714	-158	-12	-299
ASCENSION ISLAND 1958						
Ascension Island	International	-251	-0.14192702			
				-207	107	52
ASTRO BEACON “E”	International	-251	-0.14192702			
Iwo Jima Island				145	75	-272

DATUM	ELLIPSOID	Δa	Δf x 10⁴	ΔX(m)	ΔY(m)	ΔZ(m)
ASTRO B4 SOR. ATOLL Tern Island	International	-251	-0.14192702	114	-116	-333
ASTRO POS 71/4 St. Helena Island	International	-251	-0.14192702	-320	550	-494
ASTRONOMIC STATION 1952 Marcus Island	International	-251	-0.14192702	124	-234	-25
AUSTRALIAN GEODETIC 1966* Australia and Tasmania Island	Australian National	-23	-0.00081204	-133	-48	148
AUSTRALIAN GEODETIC 1984* Australia and Tasmania Island	Australian National	-23	-0.00081204	-134	-48	149
BELLEVUE (IGN) Efate and Erromango Islands	International	-251	-0.14192702	-127	-769	472
BERMUDA 1957 Bermuda Islands	Clarke 1866	-69.4	-0.37264639	-73	213	296
BOGOTA OBSERVATORY* Colombia	International	-251	-0.14192702	307	304	-318
BUKIT RIMPAH* Bangka and Belitung Islands (Indonesia)	Bessel 1841	739.845	-0.10037483	-384	664	-48
CAMP AREA ASTRO* Camp McMurdo Area, Antarctica	International	-251	-0.14192702	-104	-129	239
CAMPO INCHAUSPE* Argentina	International	-251	-0.14192702	-148	136	90
CANTON ISLAND 1966 Phoenix Islands	International	-251	-0.14192702	298	-304	-375
CAPE* South Africa	Clarke 1880	-112.145	-0.54750714	-136	-108	-292
CAPE CANAVERAL Mean Value (Florida and Bahama Islands)	Clarke 1866	-69.4	-0.37264639	-2	150	181
CARTHAGE* Tunisia	Clarke 1880	-112.145	-0.54750714	-263	6	431
CHATHAM 1971* Chatham Island (New Zealand)	International	-251	-0.14192702	175	-38	113

DATUM	ELLIPSOID	Δa	Δf x 10[4]	ΔX(m)	ΔY(m)	ΔZ(m)
CHUA ASTRO*						
Paraguay	International	-251	-0.14192702	-134	229	-29
CORREGO ALEGRE*						
Brazil	International	-251	-0.14192702	-206	172	-6
DJAKARTA (BATAVIA)*						
Sumatra Island (Indonesia)	Bessel 1841	739.845	-0.10037483	-377	681	-50
DOS 1968	International	-251	-0.14192702			
Gizo Island (New Georgia Islands)				230	-199	-752
EASTER ISLAND 1967						
Easter Island	International	-251	-0.14192702	211	147	111
EUROPEAN 1950	International					
Mean Value* (Austria, Denmark, Finland, France, Federal Republic of Germany, Gibraltar, Greece, Italy, Netherlands, Norway, Portugal, Spain, and Switzerland)		-251	-0.14192702	-87	-96	-120
Cyprus*		-251	-0.14192702	-104	-101	-140
Egypt*		-251	-0.14192702	-130	-117	-151
England, Channel Islands, Scotland, and Shetland Islands		-251	-0.14192702	-86	-96	-120
England, Ireland, Scotland, and Shetland Islands		-251	-0.14192702	-86	-96	-120
Greece		-251	-0.14192702	-84	-95	-130
Iran*		-251	-0.14192702	-117	-132	-164
Sardinia (Italy)		-251	-0.14192702	-97	-103	-120
Sicily (Italy)*		-251	-0.14192702	-97	-88	-135
Norway and Finland		-251	-0.14192702	-87	-95	-120
Portugal and Spain		-251	-0.14192702	-88	-109	-122
EUROPEAN 1979*	International					
Mean Value (Austria, Finland, Netherlands, Norway, Spain, Sweden, and Switzerland)		-251	-0.14192702	-86	-98	-119
G. SEGARA*						
Kalimantan Island (Indonesia)	Bessel 1841	739.845	-0.10037483	-403	684	41
GANDAJIKA BASE*	International	-251	-0.14192702			
Republic of Maldives				-133	-321	50

DATUM	ELLIPSOID	Δa	Δf x 10^4	ΔX(m)	ΔY(m)	ΔZ(m)
GEODETIC DATUM 1949*						
New Zealand	International	-251	-0.14192702	84	-22	209
GUAM 1963*	Clarke 1866					
Guam Island		-69.4	-0.37264639	-100	-248	259
GUX 1 ASTRO	International	-251	-0.14192702			
Guadalcanal Island				252	-209	-751
HERAT NORTH*						
Afghanistan	International	-251	-0.14192702	-333	-222	114
HJORSEY 1955*	International					
Iceland		-251	-0.14192702	-73	46	-86
HONG KONG 1963	International	-251	-0.14192702			
Hong Kong				-156	-271	-189
HU-TZU-SHAN*						
Taiwan	International	-251	-0.14192702	-634	-549	-201
INDIAN [1]	Everest					
Thailand and Vietnam*		860.655	0.28361368	214	836	303
Bangladesh, India,* and Nepal		860.655	0.28361368	289	734	257
IRELAND 1965*	Modified Airy					
Ireland		769.811	0.11960023	506	-122	611
ISTS 073 ASTRO 1969						
Diego Garcia	International	-251	-0.14192702	208	-435	-229
JOHNSTON ISLAND 1961						
Johnston Island	International	-251	-0.14192702	191	-77	-204
KANDAWALA	Everest	860.655	0.28361368			
Sri Lanka				-97	787	86
KERGUELEN ISLAND						
Kerguelen Island	International	-251	-0.14192702	145	-187	103
KERTAU 1948	Modified Everest					
West Malaysia and Singapore		832.937	0.28361368	-11	851	5
KKJ*						
Sweden	International	-251	0.14192702	-78	-231	-97
LA REUNION	International	-251	-0.14192702			
Mascarene Island				94	-948	-1262

DATUM	ELLIPSOID	Δa	Δf x 10⁴	ΔX(m)	ΔY(m)	ΔZ(m)
L.C. 5 ASTRO	Clarke 1866	-69.4	-0.37264639			
Cayman Brac Island				42	124	147
LIBERIA 1964*	Clarke 1880					
Liberia		-112.145	-0.54750714	-90	40	88
LUZON [2]	Clarke 1866	-69.4	-0.37264639			
Philippines (Excluding* Mindanao Island)				-133	-77	-51
Mindanao Island		-69.4	-0.37264639	-133	-79	-72
MAHE 1971	Clarke	-112.145	-0.54750714			
Mahe Island	1880			41	-220	-134
MARCO ASTRO	International	-251	-0.14192702			
Salvage Islands				-289	-124	60
MASSAWA*	Bessel	739.845	0.10037483			
Eritrea (Ethiopia)	1841			639	405	60
MERCHICH*	Clarke 1880					
Morocco		-112.145	-0.54750714	31	146	47
MIDWAY ASTRO 1961						
Midway Island	International	-251	-0.14192702	912	-58	1227
MINNA*	Clark 1880					
Nigeria		-112.145	-0.54750714	-91	-93	122
NAHRWAN	Clarke 1880					
Masirah Island (Oman)		-112.145	-0.54750714	-247	-148	369
United Arab Emirates		-112.145	-0.54750714	-249	-156	381
Saudi Arabia*	-112.145-0.54750714		-231	-196	482	
NAPARIMA, BWI	International	-251	-0.14192702			
Trinidad and Tobago				-2	374	172
NORTH AMERICAN 1927						
Mean Value*	Clarke 1866					
(CONUS)		-69.4	-0.37264639	-8	160	176
Alaska*		-69.4	-0.37264639	-5	135	172
Bahamas (Excluding San Salvador Island)		-69.4	-0.37264639	-4	154	178
San Salvador Island		-69.4	-0.37264639	1	140	165
Canada (Including Newfoundland Island)*		-69.4	-0.37264639	-10	158	187
Alberta and British Columbia		-69.4	-0.37264639	-7	162	188
East Canada (Newfoundland, New Brunswick, Nova Scotia, Quebec)		-69.4	-0.37264639	-22	160	190

DATUM	ELLIPSOID	Δa	$\Delta f \times 10^4$	ΔX(m)	ΔY(m)	ΔZ(m)
Manitoba and Ontario		-69.4	-0.37264639	-9	157	184
Northwest Teritories and Saskatchewan		-69.4	-0.37264639	4	159	188
Yukon		-69.4	-0.37264639	-7	139	181
Canal Zone		-69.4	-0.37264639	0	125	201
Caribbean (Barbados, Caicos Islands, Cuba, Dominican Republic, Grand Cayman, Jamaica, Leeward Islands, and Turks Islands)		-69.4	-0.37264639	-7	152	178
Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua)*		-69.4	-0.37264639	-6	127	192
Cuba		-69.4	-0.37264639	-9	152	178
Greenland (Hayes Peninsula)		-69.4	-0.37264639	11	114	195
Mexico		-69.4	-0.37264639	-12	130	190
NORTH AMERICAN 1983*	GRS80					
Alaska, Canada, Central America, CONUS, Mexico)	0	-0.00000016	0	0	0	
OBSERVATORIO 1966						
Corro, Santa Cruz, and Flores Islands (Azores)	International	-251	-0.14192702	-425	-169	81
OLD EGYPTIAN 1930*	Helmert 1906					
Egypt		-63	0.00480795	-130	110	-13
OLD HAWAIIAN	Clarke 1866					
Mean Value*	-69.4	-0.37264639	61	-285	-181	
Hawaii*		-69.4	-0.37264639	89	-279	-183
Kauai*		-69.4	-0.37264639	45	-290	-172
Maui*		-69.4	-0.37264639	65	-290	-190
Oahu*		-69.4	-0.37264639	56	-284	-181
OMAN*	Clarke					
Oman	1880	-112.145	-0.54750714	-346	-1	224
ORDNANCE SURVEY OF GREAT BRITAIN 1936						
Mean Value* (England, Isle of Man, Scotland, Shetland Islands, Wales)	Airy	573.604	0.11960023	371	-111	431
England		573.604	0.11960023	371	-112	434
England, Isle of Man, and Wales		573.604	0.11960023	371	-111	434
Scotland and Shetland Islands		573.604	0.11960023	384	-111	425
Wales		573.604	0.11960023	370	-108	434
PICO DE LAS NIEVES						
Canary Islands	International	-251	-0.14192702	-307	-92	127
PITCAIRN ASTRO 1967*						
Pitcairn Island	International	-251	-0.14192702	185	165	42

DATUM	ELLIPSOID	Δa	Δf x 10[4]	ΔX(m)	ΔY(m)	ΔZ(m)
PROVISIONAL SOUTH CHILEAN 1963	International	-251	-0.14192702	16	196	93
South Chile (near 53°S)						
PROVISIONAL SOUTH AMERICAN 1956						
Mean Value*	International	-251	-0.14192702	-288	175	-376
(Bolivia, Chile, Columbia, Ecuador, Guyana, Peru, Venezuela)						
Bolivia		-251	-0.14192702	-270	188	-388
Chile (Northern Chile near 19°S)		-251	-0.14192702	-270	183	-390
Chile (Southern Chile near 43°N)		-251	-0.14192702	-305	243	-442
Columbia		-251	-0.14192702	-282	169	-371
Ecuador		-251	-0.14192702	-278	171	-367
Guyana		-251	-0.14192702	-298	159	-369
Peru		-251	-0.14192702	-279	175	-379
Venezuela		-251	-0.14192702	-295	173	-371
PUERTO RICO	Clarke 1866	-69.4	-0.37264639			
Puerto Rico and Virgin Islands				11	72	-101
QATAR NATIONAL*	International	-251	-0.14192702			
Qatar				-128	-283	22
QORNOQ*	International					
So. Greenland		-251	-0.14192702	164	138	-189
ROME 1940	International	-251	-0.14192702			
Sardinia Island				-225	-65	9
RT90*	Bessel 1841					
Finland		739.845	-0.10037483	498	-36	568
SANTA BRAZ	International	-251	-0.14192702			
Saint Miguel, Santa Maria Islands (Azores)				-203	141	53
SANTO (DOS)	International	-251	-0.14192702			
Espirito Santo Island				170	42	84
SAPPER HILL 1943	International	-251	-0.14192702			
East Falkland Island				-355	16	74
SCHWARZECK*	Bessel	653.135 [3]	0.10037483			
Namibia	1841			616	97	-251
SO. AMERICAN 1969	South American 1969					
Mean Value*		-23	-0.00081204	-57	1	-41
Argentina		-23	-0.00081204	-62	-1	-37
Bolivia		-23	-0.00081204	-61	2	-48
Brazil		-23	-0.00081204	-60	-2	-41
Chile		-23	-0.00081204	-75	-1	-44
Colombia		-23	-0.00081204	-44	6	-36

DATUM	ELLIPSOID	Δa	Δf x 10^4	ΔX(m)	ΔY(m)	ΔZ(m)
Ecuador		-23	-0.00081204	-48	3	-44
Guyana		-23	-0.00081204	-53	3	-47
Paraguay		-23	-0.00081204	-61	2	-33
Peru		-23	-0.00081204	-58	0	-44
Trinidad and Tobago		-23	-0.00081204	-45	12	-33
Venezuela		-23	-0.00081204	-45	8	-33
SOUTH ASIA	Modified	-18	0.00480795			
Singapore	Fischer 1960			7	-10	-26
SOUTHEAST BASE	International	-251	-0.14192702			
Porto Santo and Madeira Islands				-499	-249	314
SOUTHWEST BASE	International	-251	-0.14192702			
Azores (Pico and Terceira Islands)				-104	167	-38
TMBALI 1948*	Everest					
Brunei and East Malaysia (Sarawak and Sabah)		860.655	0.28361368	-689	691	-46
TANANARIVE OBSERVATORY 1925*						
Madagascar	International	-251	-0.14192702	-189	-242	-91
TOKYO	Bessel 1841					
Mean Value*		739.845	0.10037483	-128	483	662
Japan		739.845	0.10037483	-123	481	664
Korea		739.845	0.10037483	-128	481	665
Okinawa		739.845	0.10037483	135	478	661
TRISTAN ASTRO 1968						
Tristan da Cunha	International	-251	-0.14192702	-632	438	-609
VITI LEVU 1916	Clarke	-112.145	-0.54750714			
Viti Levu Island (Fiji Islands)	1880			51	391	-36
WAKE-ENIWETOK 1960	Hough	-133	-0.14192702			
Marshall Islands				101	52	-39
WORLD GEODETIC SYSTEM 1972*						
	International	-251	-0.14192702	0	0	4
YACARE*						
Uruguay	International	-251	-0.14192702	-155	171	37
ZANDERIJ*	International	-251	-0.14192702			
Suriname				-265	120	-358

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.

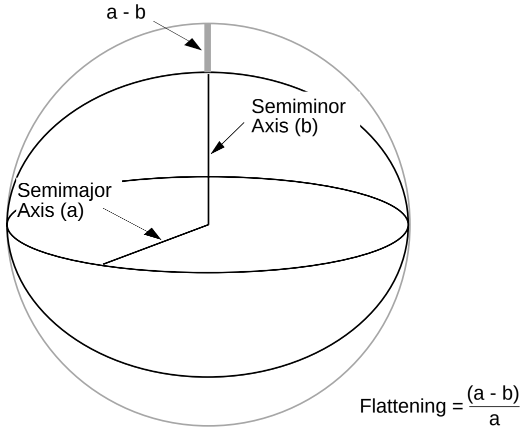
Δf (x 10,000) = the difference in flattening from the WGS84 model to the local datum.

Flattening = (a-b)/a, where a = semi-major axis and b = semi-minor axis.

[1] The Indian datum defined in the unit is an average for the Indian subcontinent and southeast Asia. These constants are provided in the event that the more accurate offsets are required.

[2] The Luzon datum defined in the unit is an average for all of the Philippines. These constants are provided in the event that the more accurate offsets are required.

[3] This value reflects a difference in the definition of legal and international meters in Namibia. (The semimajor axis for the Bessel 1841 Ellipsoid in Namibia is: a = 6377483.865 legal meters.)



ELLIPSOIDAL MODEL OF THE EARTH

Datum Abbreviations. Datums defined in the ProMARK X are accessed with the following abbreviations.

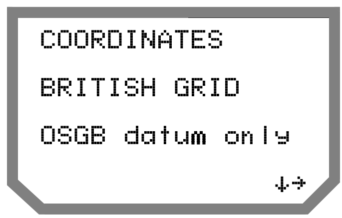
WGS84 .... WGS84
North American 1927 .... NAD27
North American 1983 .... NAD83
Adindan ....ADIND
Alaska, NAD27 .... ALASK
Arc 1950 .... ARC50
Arc 1960 .... ARC60
Campo Area Astro .... ASTRO
Australian Geodetic 1966 ... AUS66
Australian Geodetic 1984 ... AUS84
Bogota Observatory .... BOGOT
Bukit Rimpah .... BUKIT
Camp Inchauspe .... CAMPO
Canada, NAS27 .... CANAD
Cape .... CAPE
Carthage .... CARTH
Central America, NAD27 .... CENAM
Chatham 1971 .... CHATH
Chau Astro .... CHUAA
Corrego Alegre .... CORRE
Cyprus, European, 1950 ..... CYPRU
Djakarta (Batavia)................ DJAKA
Egypt, European 1950 .... EGYPT
European 1950 .... EUR50
European 1979 .... EUR79
Gandajika Base .... GANDA
Geodetic Datum 1949 .... GEO49
Ornance Survey of Great
Britain 1939 .... GRB36
Guam .... GUAM
G. Segara .... GUNSG
Old Hawaiian, mean value .. HAWAI
Herat North .... HERAT
Hjorsey 1955 .... HJORS
Hu-Tzu-Shan .... HUTZU
Indian (India, Nepal) .... INDIA
Iran, European 1950 .... IRAN
Ireland 1965 .... IRELA
Kaui, Old Hawaiian .... KAUAI
Kertau 1948 .... KERTA
KKJ (Finland) .... KKJ
Liberia 1964 .... LIBER
Luzon (Philippines) .... LUZON
Massawa .... MASSA
Maui, Old Hawaiian .... MAUI
Merchich .... MERCH
Minna (Nigeria) .... MINNA
Nahrwan .... NAHRW
Oahu, Old Hawaiian .... OAHU
Old Egyptian 1930 .... OEGYP
Hawaii, Old Hawaiian .... OHAWA
Oman .... OMAN
Pitcairn Astro 1967 .... PITCA
Qatar National .... QATAR
Qornoq .... QORNO
RT90 (Sweden) RT90
Provisional So. Am. 1956 .... SAM56
South American 1969 .... SAM69
Sicily, European 1950 .... SICIL
Schwarzeck (Namibia) .... SCHWA
Tananarive Observatory
1925 ....TANAN
Indian (Thailand, Vietnam) .. THAI
Timbalai 1948 .... TIMBA
Tokyo, mean value .... TOKYO
World Geodetic Sys. 1972 .. WGS72
Yacare (Uruguay) .... YACAR
Zanderij .... ZANDE

Appendix 5 BRITISH, IRISH, AND UPS GRIDS

The British, Irish, and UPS grids differ from geodetic and UTM coordinates in that they apply only to a specific part of the world and to a specific map datum. This has a small effect on how the ProMARK V operates.

When the British, Irish, or UPS grid system is selected in SETUP, the unit automatically uses the applicable map datum. If the British grid is selected, the unit uses the OSGB datum; if the Irish grid is selected, the unit uses the Eire datum; if UPS is selected the unit uses the WGS84 datum.

The unit displays the required datum when British, Irish, or UPS grid is displayed with SETUP 7. The required datum is automatically selected when any of these grids is selected.



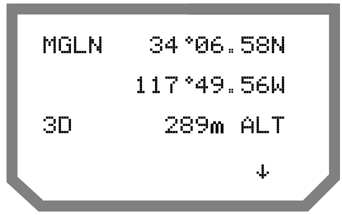
When Map Datums (SETUP 8) is accessed after selecting any of these grids, the unit automatically displays the selected datum. A different datum cannot be accessed until another coordinate system is selected.

The unit stores the positions it calculates (and the waypoints you enter) in the WGS84 datum and as height above ellipsoid (HAE). A position is converted from WGS84 and HAE to the systems you have selected when it is displayed. Since Lat/Lon and UTM are global systems, they can be used to describe locations anywhere on earth. A position in the area described by British grid can therefore be described in Lat/Lon, UTM, or British grid. It cannot be described in UPS or Irish grid.

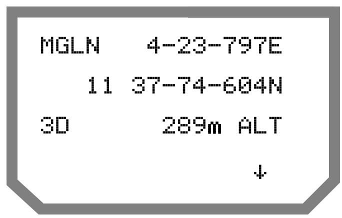
At the same time, a position that was originally described in Lat/Lon or UTM may not be convertable to any special grid. **In order to be described by a special grid (British grid, Irish grid, UPS, or any user-entered grid), the position must lie in the area that is described by that special grid.** Since the special grids describe small portions of the earth, any position that lies outside of the grid's area does not have a designation in that system and cannot be converted into it. For the same reason, a position that can be described in one special grid cannot usually be described in another special grid.

For example:

These are the coordinates for the Magellan offices in San Dimas, California, displayed in Lat/Lon (Deg/Min .01).



This is the same location, described in UTM coordinates. The conversion from Lat/Lon to UTM is made automatically by the unit when the position is displayed. This is possible because Lat/Lon and UTM describe the same areas.



British, Irish, and UPS grids do not describe southern California; this position can not be described using those coordinate systems.

Appendix 6 USER-DEFINED GRID WORKSHEET

Use this log to record the user-entered grids you use most often.

User Grid #:	Grid Name:
Mapping Function:	
Lat of Origin:	Lon of Origin:
Scale Factor:	Units-to-Meters Conv:
False Easting:	False Northing:

User Grid #:	Grid Name:
Mapping Function:	
Lat of Origin:	Lon of Origin:
Scale Factor:	Units-to-Meters Conv:
False Easting:	False Northing:

User Grid #:	Grid Name:
Mapping Function:	
Lat of Origin:	Lon of Origin:
Scale Factor:	Units-to-Meters Conv:
False Easting:	False Northing:

User Grid #:	Grid Name:
Mapping Function:	
Lat of Origin:	Lon of Origin:
Scale Factor:	Units-to-Meters Conv:
False Easting:	False Northing:

User Grid #:	Grid Name:
Mapping Function:	
Lat of Origin:	Lon of Origin:
Scale Factor:	Units-to-Meters Conv:
False Easting:	False Northing:

Appendix 7 STATE PLANE COORDINATE SYSTEM CONSTANTS

The Field PRO V can display position coordinates in the State Plane Coordinate System (SPCS) for 1983 or 1927 when a user-entered coordinate system (grid) is entered with SETUP 7.

This appendix consists of two tables that contain the constants necessary to enter an SPCS83 or SPCS27 grid. Please note that all units of measure in this table are in meters; conversion to feet is dependent on whether you are using SPCS83 or SPCS27, and on the zone being displayed. If you will be using feet, check with the Survey Office of your state to verify whether a U.S. Survey Foot or an International Foot is used in your area. For your convenience:

U.S. Survey Foot = (1200/3937)m
International Foot = 0.3048m

When using the following tables, please note the following exceptions:

1. Zones based on a Transverse Mercator Projection contain a scale factor, while those based on a Lambert projection contain two standard parallels.
2. In a Transverse Mercator Projection, the Longitude of Origin and the Central Meridian are the same; the terms are sometimes used interchangeably.
3. Zones based on the Transverse Mercator Projection in SPCS27 have no False Northing.
4. In SPCS83, zone 1 code 5001 is based on the Oblique Mercator Projection, and is defined with point azimuth equal to arc tan -3/4. This zone is not defined in SPCS27.

Please also not that LAT/LON (and standard parallel**Table 1. Constants for the 1983 State Plane Coordinate System**

State/Zone/Code	Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	Grid Origin False Easting/ False Northing (meters)

Table 1. Constants for the 1983 State Plane Coordinate System Transverse Mercator (TM), Oblique Mercator (OM), and Lambert (L) Projections

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Alabama	AL					
East	E	0101	TM		85.83333333	200,000.
				0.99996000	30.50000000	0
West	W	0102	TM		87.50000000	600,000.
				0.99993333	30.00000000	0
Alaska	AK					
Zone 1		5001	OM	Axis Azimuth =	133.66666666	5,000,000.
				arc tan -3/4	57.00000000	-5,000,000.
				0.99990000		
Zone 2		5002	TM		142.00000000	500,000.
				0.99990000	54.00000000	0
Zone 3		5003	TM		146.00000000	500,000.
				0.99990000	54.00000000	0
Zone 4		5004	TM		150.00000000	500,000.
				0.99990000	54.00000000	0
Zone 5		5005	TM		154.00000000	500,000.
				0.99990000	54.00000000	0
Zone 6		5006	TM		158.00000000	500,000.
				0.99990000	54.00000000	0
Zone 7		5007	TM		162.00000000	500,000.
				0.99990000	54.00000000	0
Zone 8		5008	TM		166.00000000	500,000.
				0.99990000	54.00000000	0
Zone 9		5009	TM		170.00000000	500,000.
				0.99990000	54.00000000	0
Zone 10		5010	L	51.83333333	176.00000000	1,000,000.
				53.83333333	51.00000000	0
Arizona	AZ					
East	E	0201	TM		110.16666666	213,360.
				0.99990000	31.00000000	0
Central	C	0202	TM		111.91666666	213,360.
				0.99990000	31.00000000	0
West	W	0203	TM		113.75000000	213,360.
				0.99993333	31.00000000	0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Arkansas	AR					
North	N	0301	L	34.93333333 36.23333333	92.00000000 34.33333333	400,000. 0
South	S	0302	L	33.30000000 34.76666666	92.00000000 32.66666666	400,000. 400,000.
California	CA					
Zone 1		0401	L	40.00000000 41.66666666	122.00000000 39.33333333	2,000,000. 500,000.
Zone 2		0402	L	38.33333333 39.83333333	122.00000000 37.66666666	2,000,000. 500,000.
Zone 3		0403	L	37.06666666 38.43333333	120.50000000 36.50000000	2,000,000. 500,000.
Zone 4		0404	L	36.00000000 37.25000000	119.00000000 35.33333333	2,000,000. 500,000.
Zone 5		0405	L	34.03333333 35.46666666	118.00000000 33.50000000	2,000,000. 500,000.
Zone 6		0406	L	32.78333333 33.88333333	116.25000000 32.16666666	2,000,000. 500,000.
Colorado	CO					
North	N	0501	L	39.71666666 40.78333333	105.50000000 39.33333333	914,401.8289 304,800.6096
Central	C	0502	L	38.45000000 39.75000000	105.50000000 37.83333333	914,401.8289 304,800.6096
South	S	0503	L	37.23333333 38.43333333	105.50000000 36.66666666	914,401.8289 304,800.6096
Connecticut	CT					
		0600	L	41.20000000 41.86666666	72.75000000 40.83333333	304,800.6096 152,400.3048
Delaware	DE					
		0700	TM	 0.99999500	75.41666666 38.00000000	200,000. 0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Florida	FL					
East	E	0901	TM		81.00000000	200,000.
				0.99994118	24.33333333	0
West	W	0902	TM		82.00000000	200,000.
				0.99994118	24.33333333	0
North	N	0903	L	29.58333333	84.50000000	600,000.
				30.75000000	29.00000000	0
Georgia	GA					
East	E	1001	TM		82.16666666	200,000.
				0.99990000	30.00000000	0
West	W	1002	TM		84.16666666	700,000.
				0.99990000	30.00000000	0
Hawaii	HI					
Zone 1		5101	TM		155.50000000	500,000.
				0.99996666	18.83333333	0
Zone 2		5102	TM		156.66666666	500,000.
				0.99996666	20.33333333	0
Zone 3		5103	TM		158.00000000	500,000.
				0.99999000	21.16666666	0
Zone 4		5104	TM		159.50000000	500,000.
				0.99999000	21.83333333	0
Zone 5		5105	TM		160.16666666	500,000.
				1.00000000	21.66666666	0
Idaho	ID					
East	E	1101	TM		112.16666666	200,000.
				0.99994737	41 .66666666	0
Central	C	1102	TM		114.00000000	500,000.
				0.99994737	41.66666666	0
West	W	1103	TM		115.75000000	800,000.
				0.99993333	41.66666666	0
Illinois	IL					
East	E	1201	TM		88.33333333	300,000.
				0.99997500	36.66666666	0
West	W	1202	TM		90.16666666	700,000.
				0.99994118	36.66666666	0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Indiana	IN					
East	E	1301	TM		85.66666666	100,000.
				0.99996666	37.50000000	250,000.
West	W	1302	TM		87.08333333	900,000.
				0.99996666	37.50000000	250,000.
Iowa	IA					
North	N	1401	L	42.06666666	93.50000000	1,500,000.
				43.26666666	41.50000000	1,000,000.
South	S	1402	L	40.61666666	93.50000000	500,000.
				41.78333333	40.00000000	0
Kansas	KS					
North	N	1501	L	38.71666666	98.00000000	400,000.
				39.78333333	38.33333333	0
South	S	1502	L	37.26666666	98.50000000	400,000.
				38.56666666	36.66666666	400,000.
Kentucky	KY					
North	N	1601	L	37.96666666	84.25000000	500,000.
				38.96666666	37.50000000	0
South	S	1602	L	36.73333333	85.75000000	500,000.
				37.93333333	36.33333333	500,000.
Louisiana	LA					
North	N	1701	L	31.16666666	92.50000000	1,000,000.
				32.66666666	30.50000000	0
South	S	1702	L	29.30000000	91.33333333	1,000,000.
				30.70000000	28.50000000	0
Offshore		1703	L	26.16666666	91.33333333	1,000,000.
				27.83333333	25.50000000	0
Maine	ME					
East	E	1801	TM		68.50000000	300,000.
				0.99990000	43.66666666	0
West	W	1802	TM		70.16666666	900,000.
				0.99996666	42.83333333	0
Maryland	MD					
		1900	L	38.30000000	77.00000000	400,000.
				39.45000000	37.66666666	0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Massachusetts	MA					
Mainland	M	2001	L	41.71666666	71.50000000	200,000.
				42.68333333	41.00000000	750,000.
Island	I	2002	L	41.28333333	70.50000000	500,000.
				41.48333333	41.00000000	0
Michigan	MI					
North	N	2111	L	45.48333333	87.00000000	8,000,000.
				47.08333333	44.78333333	0
Central	C	2112	L	44.18333333	84.36666666	6,000,000.
				45.70000000	43.31666666	0
South	S	2113	L	42.10000000	84.36666666	4,000,000.
				43.66666666	41.50000000	0
Minnesota	MN					
North	N	2201	L	47.03333333	93.10000000	800,000.
				48.63333333	46.50000000	100,000.
Central	C	2202	L	45.61666666	94.25000000	800,000.
				47.05000000	45.00000000	100,000.
South	S	2203	L	43.78333333	94.00000000	800,000.
				45.21666666	43.00000000	100,000.
Mississippi	MS					
East	E	2301	TM		88.83333333	300,000.
				0.99996000	29.50000000	0
West	W	2302	TM		90.33333333	700,000.
				0.99994118	29.50000000	0
Missouri	MO					
East	E	2401	TM		90.50000000	250,000.
				0.99993333	35.83333333	0
Central	C	2402	TM		92.50000000	500,000.
				0.99993333	35.83333333	0
West	W	2403	TM		94.50000000	850,000.
				0.99994118	36.16666666	0
Montana	MT					
		2500	L	45.00000000	109.50000000	600,000.
				49.00000000	44.25000000	0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Nebraska	ME					
		2600	L	40.00000000	100.00000000	500,000.
				43.00000000	39.83333333	0
Nevada	NV					
East	E	2701	TM		115.58333333	200,000.
				0.99990000	34.75000000	8,000,000.
Central	C	2702	TM		116.66666666	500,000.
				0.99990000	34.75000000	6,000,000.
West	W	2703	TM		118.58333333	800,000.
				0.99990000	34.75000000	4,000,000.
New Hampshire	NH					
		2800	TM		71.66666666	300,000.
				0.99996666	42.50000000	0
New Jersey	NJ					
(NY East)	2900	TM			74.50000000	150,000.
				0.99990000	38.83333333	0
New Mexico	NM					
East	E	3001	TM		104.33333333	165,000.
				0.99990909	31.00000000	0
Central	C	3002	TM		106.25000000	500,000.
				0.99990000	31.00000000	0
West	W	3003	TM		107.83333333	830,000.
				0.99991666	31.00000000	0
New York	NY					
East	E	3101	TM		74.50000000	150,000.
(New Jersey)				0.99996666	38.83333333	0
Central	C	3102	TM		76.58333333	250,000.
				0.99993750	.66.00000000	0
West	W	3103	TM		78.58333333	350,000.
				0.99993750	40.00000000	0
Long	L	3104	L	40.66666666	74.00000000	300,000.
Island				41.03333333	40.16666666	0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
North Carolina NC						
		3200	L	34.33333333	79.00000000	609,601.22
				36.16666666	33.75000000	0
North Dakota ND						
North	N	3301	L	47.43333333	100.50000000	600,000.
				48.73333333	47.00000000	0
South	S	3302	L	46.18333333	100.50000000	600,000.
				47.48333333	45.66666666	0
Ohio	OH					
North	N	3401	L	40.43333333	82.50000000	600,000.
				41.70000000	39.66666666	0
South	S	3402	L	38.73333333	82.50000000	600,000.
				40.03333333	38.00000000	0
Oklahoma	OK					
North	N	3501	L	35.56666666	98.00000000	600,000.
				36.76666666	35.00000000	0
South	S	3502	L	33.93333333	98.00000000	600,000.
				35.23333333	33.33333333	0
Oregon	OR					
North	N	3601	L	44.33333333	120.50000000	2,500,000.
				46.00000000	43.66666666	0
South	S	3602	L	42.33333333	120.50000000	1,500,000.
				44.00000000	41.66666666	0
Pennsylvania		PA				
North	N	3701	L	40.88333333	77.75000000	600,000.
				41.95000000	40.16666666	0
South	S	3702	L	39.93333333	77.75000000	600,000.
				40.96666666	39.33333333	0
Rhode Island		RI				
		3800	TM		71.50000000	100,000.
				0.99999375	41.08333333	0
South Carolina SC						
		3900	L	32.50000000	81.00000000	609,600.
				34.83333333	31.83333333	0

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
South Dakota		SD				
North	N	4001	L	44.41666666	100.00000000	600,000.
				45.68333333	43.83333333	0
South	S	4002	L	42.83333333	100.33333333	600,000.
				44.40000000	42.33333333	0
Tennessee	TN					
		4100	L	35.25000000	86.00000000	600,000.
				36.41666666	34.33333333	0
Texas	TX					
North	N	4201	L	34.65000000	101.50000000	200,000.
				36.18333333	34.00000000	1,000,000.
North Central	NC	4202	L	32.13333333	98.50000000	600,000.
				33.96666666	31.66666666	2,000,000.
Central	C	4203	L	30.11666666	100.33333333	700,000.
				31.88333333	29.66666666	3,000,000.
South Central	SC	4204	L	28.38333333	99.00000000	600,000.
				30.28333333	27.83333333	4,000,000.
South	S	4205	L	26.16666666	98.50000000	300,000.
				27.83333333	25.66666666	5,000,000.
Utah	UT					
North	N	4301	L	40.71666666	111.50000000	500,000.
				41.78333333	40.33333333	1,000,000.
Central	C	4302	L	39.01666666	111.50000000	500,000.
				40.65000000	38.33333333	2,000,000.
South	S	4303	L	37.21666666	111.50000000	500,000.
				38.35000000	36.66666666	3,000,000.
Vermont	VT					
		4400	TM		72.50000000	500,000.
				0.99996429	42.50000000	0
Virginia	VA					
North	N	4501	L	38.03333333	78.50000000	3,500,000.
				39.20000000	37.66666666	2,000,000.
South	S	4502	L	36.76666666	78.50000000	3,500,000.
				37.96666666	36.33333333	1,000,000.

Table 1. Constants for the 1983 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Washington		WA				
North	N	4601	L	47.50000000	120.83333333	500,000.
				48.73333333	47.00000000	0
South	S	4602	L	45.83333333	120.50000000	500,000.
				47.33333333	45.33333333	0
West Virginia		WV				
North	N	4701	L	39.00000000	79.50000000	600,000.
				40.40000000	38.50000000	0
South	S	4702	L	37.48333333	81.00000000	600,000.
				38.88333333	37.00000000	0
Wisconsin	WI					
North	N	4801	L	45.56666666	90.00000000	600,000.
				46.76666666	45.16666666	0
Central	C	4802	L	44.40000000	90.00000000	600,000.
				45.50000000	43.83333333	0
South	S	4803	L	42.73333333	90.00000000	600,000.
				44.06666666	42.00000000	0
Wyoming	WY					
East	E	4901	TM		105.16666666	200,000.
				0.99994118	40.50000000	0
East	EC	4902	TM		107.33333333	400,000.
Central				0.99994118	40.50000000	100,000.
West	WC	4903	TM		108.75000000	600,000.
Central				0.99994118	40.50000000	0
West	W	4904	TM		110.05000000	800,000.
				0.99994118	40.50000000	100,000.
Puerto Rico and Virgin Islands			PR			
		5200	L	18.03333333	66.43333333	200,000.
				18.43333333	17.83333333	200,000.

Table 2. Constants for the 1927 State Plane Coordinate System Transverse Mercator (TM), Oblique Mercator (OM), and Lambert (L) Projections

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Alabama	AL					
East	E	0101	TM		85.83333333	152400.3048
				0.99996000	30.50000000	0
West	W	0102	TM		87.50000000	152400.3048
				0.99993333	30.00000000	0
Alaska	AK					
Zone 2		5002	TM		142.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 3		5003	TM		146.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 4		5004	TM		150.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 5		5005	TM		154.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 6		5006	TM		158.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 7		5007	TM		162.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 8		5008	TM		166.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 9		5009	TM		170.00000000	152400.3048
				0.99990000	54.00000000	0
Zone 10		5010	L	51.83333333	176.00000000	914401.8288
				53.83333333	51.00000000	0
Arizona	AZ					
East	E	0201	TM		110.16666666	152400.3048
				0.99990000	31.00000000	0
Central	C	0202	TM		111.91666666	152400.3048
				0.99990000	31.00000000	0
West	W	0203	TM		113.75000000	152400.3048
				0.99993333	31.00000000	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Arkansas	AR					
North	N	0301	L	34.93333333	92.00000000	609601.2192
				36.23333333	34.33333333	0
South	S	0302	L	33.30000000	92.00000000	609601.2192
				34.76666666	32.66666666	0
California	CA					
Zone 1		0401	L	40.00000000	122.00000000	609601.2192
				41.66666666	39.33333333	0
Zone 2		0402	L	38.33333333	122.00000000	609601.2192
				39.83333333	37.66666666	0
Zone 3		0403	L	37.06666666	120.50000000	609601.2192
				38.43333333	36.50000000	0
Zone 4		0404	L	36.00000000	119.00000000	609601.2192
				37.25000000	35.33333333	0
Zone 5		0405	L	34.03333333	118.00000000	609601.2192
				35.46666666	33.50000000	0
Zone 6		0406	L	32.78333333	116.25000000	609601.2192
				33.88333333	32.16666666	0
Zone 7		0407	L	33.86666666	118.33333333	1276106.451
				34.41666666	34.13333333	1268253.007
Colorado	CO					
North	N	0501	L	39.71666666	105.50000000	609601.2192
				40.78333333	39.33333333	0
Central	C	0502	L	38.45000000	105.50000000	609601.2192
				39.75000000	37.83333333	0
South	S	0503	L	37.23333333	105.50000000	609601.2192
				38.43333333	36.66666666	0
Connecticut	CT					
		0600	L	41.20000000	72.75000000	182880.3658
				41.86666666	40.83333333	0
Delaware	DE					
		0700	TM		75.41666666	152400.3048
				0.99999500	38.00000000	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Florida	FL					
East	E	0901	TM		81.00000000	152400.3048
				0.99994118	24.33333333	0
West	W	0902	TM		82.00000000	152400.3048
				0.99994118	24.33333333	0
North	N	0903	L	29.58333333	84.50000000	609601.2192
				30.75000000	29.00000000	0
Georgia	GA					
East	E	1001	TM		82.16666666	152400.3048
				0.99990000	30.00000000	0
West	W	1002	TM		84.16666666	152400.3048
				0.99990000	30.00000000	0
Hawaii	HI					
Zone 1		5101	TM		155.50000000	152400.3048
				0.99996666	18.83333333	0
Zone 2		5102	TM		156.66666666	152400.3048
				0.99996666	20.33333333	0
Zone 3		5103	TM		158.00000000	152400.3048
				0.99999000	21.16666666	0
Zone 4		5104	TM		159.50000000	152400.3048
				0.99999000	21.83333333	0
Zone 5		5105	TM		160.16666666	152400.3048
				1.00000000	21.66666666	0
Idaho	ID					
East	E	1101	TM		112.16666666	152400.3048
				0.99994737	41.66666666	0
Central	C	1102	TM		114.00000000	152400.3048
				0.99994737	41.66666666	0
West	W	1103	TM		115.75000000	152400.3048
				0.99993333	41.66666666	0
Illinois	IL					
East	E	1201	TM		88.33333333	152400.3048
				0.99997500	36.66666666	0
West	W	1202	TM		90.16666666	152400.3048
				0.99994118	36.66666666	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Indiana	IN					
East	E	1301	TM		85.66666666	152400.3048
				0.99996666	37.50000000	0
West	W	1302	TM		87.08333333	152400.3048
				0.99996666	37.50000000	0
Iowa	IA					
North	N	1401	L	42.06666666	93.50000000	609601.2192
				43.26666666	41.50000000	0
South	S	1402	L	40.61666666	93.50000000	609601.2192
				41.78333333	40.00000000	0
Kansas	KS					
North	N	1501	L	38.71666666	98.00000000	609601.2192
				39.78333333	38.33333333	0
South	S	1502	L	37.26666666	98.50000000	609601.2192
				38.56666666	36.66666666	0
Kentucky	KY					
North	N	1601	L	37.96666666	84.25000000	609601.2192
				38.96666666	37.50000000	0
South	S	1602	L	36.73333333	85.75000000	609601.2192
				37.93333333	36.33333333	0
Louisiana	LA					
North	N	1701	L	31.16666666	92.50000000	609601.2192
				32.66666666	30.66666666	0
South	S	1702	L	29.30000000	91.33333333	609601.2192
				30.70000000	28.66666666	0
Offshore		1703	L	26.16666666	91.33333333	609601.2192
				27.83333333	25.66666666	0
Maine	ME					
East	E	1801	TM		68.50000000	152400.3048
				0.99990000	43.83333333	0
West	W	1802	TM		70.16666666	152400.3048
				0.99996666	42.83333333	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/Lat	False Easting/ False Northing (meters)
Maryland	MD					
		1900	L	38.30000000	77.00000000	243840.4877
				39.45000000	37.83333333	0
Massachusetts	MA					
Mainland		2001	L	41.71666666	71.50000000	182880.3658
	M			42.68333333	41.00000000	0
Island	I	2002	L	41.28333333	70.50000000	609601.2192
				41.48333333	41.00000000	0
Michigan	MI					
North	N	2111	L	45.48333333	87.00000000	609601.2192
				47.08333333	44.78333333	0
Central	C	2112	L	44.18333333	84.33333333	609601.2192
				45.70000000	43.31666666	0
South	S	2113	L	42.10000000	84.33333333	609601.2192
				43.66666666	41.50000000	0
Minnesota	MN					
North	N	2201	L	47.03333333	93.10000000	609601.2192
				48.63333333	46.50000000	0
Central	C	2202	L	45.61666666	94.25000000	609601.2192
				47.05000000	45.00000000	0
South	S	2203	L	43.78333333	94.00000000	609601.2192
				45.21666666	43.00000000	0
Mississippi	MS					
East	E	2301	TM		88.83333333	152400.3048
				0.99996000	29.66666666	0
West	W	2302	TM		90.33333333	152400.3048
				0.99994118	30.50000000	0
Missouri	MO					
East	E	2401	TM		90.50000000	152400.3048
				0.99993333	35.83333333	0
Central	C	2402	TM		92.50000000	152400.3048
				0.99993333	35.83333333	0
West	W	2403	TM		94.50000000	152400.3048
				0.99994118	36.16666666	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Montana	MT					
North	N	2501	L	47.85000000	109.50000000	609601.2192
				48.71666666	47.00000000	0
Central	C	2502	L	46.45000000	109.50000000	609601.2192
				47.88333333	45.83333333	0
South	S	2503	L	44.86666666	109.50000000	609601.2192
				46.40000000	44.00000000	0
Nebraska	ME					
North	N	2601	L	41.85000000	100.00000000	609601.2192
				42.81666666	41.33333333	0
South	S	2602	L	40.28333333	99.50000000	609601.2192
				41.71666666	39.66666666	0
Nevada	NV					
East	E	2701	TM		115.58333333	152400.3048
				0.99990000	34.75000000	0
Central	C	2702	TM		116.66666666	152400.3048
				0.99990000	34.75000000	0
West	W	2703	TM		118.58333333	152400.3048
				0.99990000	34.75000000	0
New Hampshire NH						
		2800	TM		71.66666666	152400.3048
				0.99996666	42.50000000	0
New Jersey NJ						
		2900	TM		74.66666666	609601.2192
				0.99997500	38.83333333	0
New Mexico NM						
East	E	3001	TM		104.33333333	152400.3048
				0.99990909	31.00000000	0
Central	C	3002	TM		106.25000000	152400.3048
				0.99990000	31.00000000	0
West	W	3003	TM		107.83333333	152400.3048
				0.99991666	31.00000000	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
New York	NY					
East	E	3101	TM		74.33333333	152400.3048
				0.99996666	40.00000000	0
Central	C	3102	TM		76.58333333	152400.3048
				0.99993750	40.00000000	0
West	W	3103	TM		78.58333333	152400.3048
				0.99993750	40.00000000	0
Long	L	3104	L	40.66666666	74.00000000	609601.2192
Island				41.03333333	40.50000000	30480.06096
North Carolina	NC					
		3200	L	34.33333333	79.00000000	609,601.2192
				36.16666666	33.75000000	0
North Dakota	ND					
North	N	3301	L	47.43333333	100.50000000	609601.2192
				48.73333333	47.00000000	0
South	S	3302	L	46.18333333	100.50000000	609601.2192
				47.48333333	45.66666666	0
Ohio	OH					
North	N	3401	L	40.43333333	82.50000000	609601.2192
				41.70000000	39.66666666	0
South	S	3402	L	38.73333333	82.50000000	609601.2192
				40.03333333	38.00000000	0
Oklahoma	OK					
North	N	3501	L	35.56666666	98.00000000	609601.2192
				36.76666666	35.00000000	0
South	S	3502	L	33.93333333	98.00000000	609601.2192
				35.23333333	33.33333333	0
Oregon	OR					
North	N	3601	L	44.33333333	120.50000000	609601.2192
				46.00000000	43.66666666	0
South	S	3602	L	42.33333333	120.50000000	609601.2192
				44.00000000	41.66666666	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Pennsylvania		PA				
North	N	3701	L	40.88333333	77.75000000	609601.2192
				41.95000000	40.16666666	0
South	S	3702	L	39.93333333	77.75000000	609601.2192
				40.96666666	39.33333333	0
Rhode Island		RI				
		3800	TM		71.50000000	152400.3048
				0.99999375	41.08333333	0
South Carolina	SC					
North	N	3901	L	33.76666666	81.00000000	609601.2192
				34.96666666	33.00000000	0
South	S	3902	L	32.33333333	81.00000000	609601.2192
				33.66666666	31.83333333	0
South Dakota		SD				
North	N	4001	L	44.41666666	100.00000000	609601.2192
				45.68333333	43.83333333	0
South	S	4002	L	42.83333333	100.33333333	609601.2192
				44.40000000	42.33333333	0
Tennessee	TN					
		4100	L	35.25000000	86.00000000	609601.2192
				36.41666666	34.66666666	0
Texas	TX					
North	N	4201	L	34.65000000	101.50000000	609601.2192
				36.18333333	34.00000000	0
North	NC	4202	L	32.13333333	97.50000000	609601.2192
Central				33.96666666	31.66666666	0
Central	C	4203	L	30.11666666	100.33333333	609601.2192
				31.88333333	29.66666666	0
South	SC	4204	L	28.38333333	99.00000000	609601.2192
Central				30.28333333	27.83333333	0
South	S	4205	L	26.16666666	98.50000000	609601.2192
				27.83333333	25.66666666	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Utah	UT					
North	N	4301	L	40.71666666	111.50000000	609601.2192
				41.78333333	40.33333333	0
Central	C	4302	L	39.01666666	111.50000000	609601.2192
				40.65000000	38.33333333	0
South	S	4303	L	37.21666666	111.50000000	609601.2192
				38.35000000	36.66666666	0
Vermont	VT					
		4400	TM		72.50000000	152400.3048
				0.99996429	42.50000000	0
Virginia	VA					
North	N	4501	L	38.03333333	78.50000000	3,500,000.
				39.20000000	37.66666666	2,000,000.
South	S	4502	L	36.76666666	78.50000000	3,500,000.
				37.96666666	36.33333333	1,000,000.
Washington		WA				
North	N	4601	L	47.50000000	120.83333333	500,000.
				48.73333333	47.00000000	0
South	S	4602	L	45.83333333	120.50000000	500,000.
				47.33333333	45.33333333	0
West Virginia		WV				
North	N	4701	L	39.00000000	79.50000000	600,000.
				40.25000000	38.50000000	0
South	S	4702	L	37.48333333	81.00000000	600,000.
				38.88333333	37.00000000	0
Wisconsin	WI					
North	N	4801	L	45.56666666	90.00000000	600,000.
				46.76666666	45.16666666	0
Central	C	4802	L	44.25000000	90.00000000	600,000.
				45.50000000	43.83333333	0
South	S	4803	L	42.73333333	90.00000000	600,000.
				44.06666666	42.00000000	0

Table 2. Constants for the 1927 State Plane Coordinate System

State/Zone/Code			Projection	Scale Factor (TM) or Standard Parallels (L)	Grid Origin Lon/ Lat	False Easting/ False Northing (meters)
Wyoming	WY					
East	E	4901	TM		105.16666666	152400.3048
				0.99994118	40.66666666	0
East Central	EC	4902	TM		107.33333333	152400.3048
				0.99994118	40.66666666	0
West Central	WC	4903	TM		108.75000000	152400.3048
				0.99994118	40.66666666	0
West	W	4904	TM		110.08333333	152400.3048
				0.99994118	40.66666666	0
Puerto Rico and Virgin Islands	PR					
Zone 1		5201	L	18.03333333	66.43333333	152400.3048
				18.43333333	17.83333333	0
Zone 2		5202	L	18.03333333	66.43333333	152400.3048
				18.43333333	17.83333333	30480.06096

Appendix 8 WAYPOINT LOG, GRID

Always keep a written record of all waypoints, especially of waypoints that are named by the unit. Uses these pages to log waypoints entered in any grid coordinate system.

Wpt Name:			Date:
Easting:		Northing:	
Alt:		Datum:	
Zone:	Note:		

Wpt Name:			Date:
Easting:		Northing:	
Alt:		Datum:	
Zone:	Note:		

Wpt Name:			Date:
Easting:		Northing:	
Alt:		Datum:	
Zone:	Note:		

Wpt Name:			Date:
Easting:		Northing:	
Alt:		Datum:	
Zone:	Note:		

Wpt Name:			Date:
Easting:		Northing:	
Alt:		Datum:	
Zone:	Note:		

Wpt Name:	Date:
Easting:	Northing:
Alt:	Datum:
Zone:	Note:

Wpt Name:	Date:
Easting:	Northing:
Alt:	Datum:
Zone:	Note:

Wpt Name:	Date:
Easting:	Northing:
Alt:	Datum:
Zone:	Note:

Wpt Name:	Date:
Easting:	Northing:
Alt:	Datum:
Zone:	Note:

Wpt Name:	Date:
Easting:	Northing:
Alt:	Datum:
Zone:	Note:

Wpt Name:	Date:
Easting:	Northing:
Alt:	Datum:
Zone:	Note:

Appendix 9 WAYPOINT LOG, LAT/LON

Always keep a written record of all waypoints, especially of waypoints that are named by the unit. Copy these pages for your waypoint notebook.

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Wpt Name:	Date:
Lat:	Lon:
Alt:	Datum:
Note:	

Appendix 10 POSITION DILUTION OF PRECISION

Position Dilution of Precision (PDOP) is a measurement of the possible position error that is related to geometric quality. It is displayed on the third screen of any position fix, any fix in the buffer, and any fix that is saved as a waypoint.

A position fix is calculated by triangulating from three satellites (a fourth is added to get altitude). In general, the farther apart the satellites being used are, the lower the PDOP and the greater the accuracy of the fix. A fix obtained from satellites that are close together may not be as accurate.

Acceptable PDOPs are a little higher in 3D operation than in 2D operation.

PDOP		
Good Accuracy		
	<4	2D
	<6	3D
Poor Accuracy		
	4-9.9	2D
	6–9.9	3D

When the PDOP of a position fix is poor, a warning symbol **( )** appears in the lower right corner of all displays.

The unit does not display any position whose PDOP is >75. Instead, the unit tries continually to obtain a position fix with an acceptable PDOP.

Appendix 11 SIGNAL QUALITY

Signal quality (SQ) is an indication of the carrier-to-noise ratio (C/N_O) of the signal of each satellite being used for a position fix. SQ has very little affect on the accuracy of the position fix; it is only an indication of signal strength.

SQ is displayed as a bar on several screens, such as the Receiver Status screen, and as a numeric value in Sat Status. When SQ is shown as a bar the taller the bar is, the stronger the signal. When SQ is shown numerically, it ranges from 0 (lowest quality) to 9 (highest quality). An SQ of 4 or higher indicates a strong signal that the unit will not lose its lock on.

SIGNAL QUALITY

7 - 9	Strong
4 - 6	Good
0 - 3	Weak: may lose lock

When SQ is weak,  is shown on all displays.

ACQUISITION	Occurs when the unit locates a signal and collects data from a satellite.
ALMANAC	Data on the general location and health of all satellites in the GPS constellation. Can be collected from any available satellite.
ANTENNA ALTITUDE	The sum of the altitude at your location (zero at sea level) and the antenna height.
ARRIVED	The message displayed when navigating on a route in manual mode, indicating that you have reached the destination of the current leg.
AUTOMATIC MODE	The mode of operation that uses either 2D or 3D, depending on the number of available satellites. (Preference is given to 3D.)
AUTOMATIC LEG SWITCHING MODE	A mode of operation used when navigating on a route. In the automatic leg switching mode, when you pass the leg's destination the unit automatically switches to the next leg of the route.
BEARING	The direction of a destination or target in relation to the vessel.
C/N_O	Signal-to-noise ratio. An absolute means of specifying the signal-to-noise ratio (SNR) that is independent of band width. Indicated on the unit display by SQ.

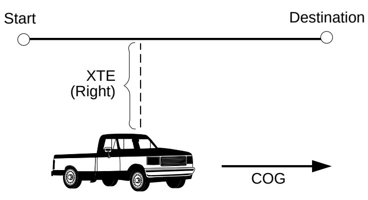
CLOSE — The message displayed when navigating on a route, indicating that you are within 500 feet of the destination of the current leg.

COG — Course over ground.

COURSELINE — The planned line of travel; the line between your start point and destination.

COURSE OVER GROUND — The true direction of travel achieved, which may differ from courseline. Sometimes referred to as ground course.

CROSS TRACK ERROR — The perpendicular distance between the present position and the courseline. Given as right or left of course when facing the destination. Displayed in NAV as XTE.



DEFAULT — The value or setting automatically chosen by the unit unless directed otherwise. Can be changed in SETUP and certain auxiliary functions.

DIFFERENTIAL — A method of removing a known GPS system error from an averaged position. Can be done in the field, but has greater accuracy when done in post-processing.

EPHEMERIS DATA — Data on the precise location of a satellite. Collected by the unit in the first few second of data acquistion, and retained for two hours.

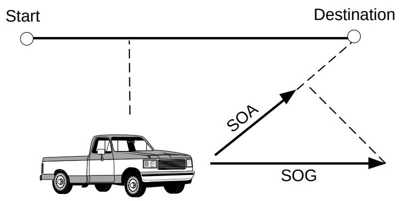
FIX	A single position, defined by latitude, longitude, and altitude.
GROUND COURSE	See Course over ground.
GROUND SPEED	See Speed over ground.
HEADING	The direction your vessel is facing, defined as an angle from North.
LAST FIX	The position fix taken before the current position fix, stored in the unit's memory and accessed by pressing AUX 6.
LATITUDE	The distance north or south of the equator, measured in an arc with the equator being 0° and the poles being 90°. (The default latitude is north.)
LONGITUDE	The distance east or west of the prime meridian (0°), which intersects Greenwich, England. The range is 0°–180°E, moving east of 0°, and 0°–180°W, moving west of 0°. (The default longitude is west.)
MANUAL LEG SWITCHING MODE	A mode of operation used when navigating on a route. In the manual leg switching mode, when you pass the leg's destination, the screen displays "ARRIVED" on the fourth line. The unit must be switched to the next leg manually by pressing the RIGHT ARROW.
MAP DATUM	A method of assigning position coordinates to real-world locations. Based on an underlying ellipsoidal model of the earth, and subject to other scientific assumptions. Identified by a unique name, such as WGS84 or NAD27.

MASK ANGLE	The elevation (height above the horizon, measured in degrees), below which the unit will not search for satellites. The mask angle is selected by the user in SETUP.
PDOP	Position Dilution of Precision.
POSITION	A location that is obtained in real time and expressed in a coordinate system. Sometimes called a fix. Also a waypoint location obtained from a chart or other source.
POSITION DILUTION OF PRECISION	A measurement of possible geometric error, and abbreviated PDOP. See *Appendix 10* and *Error/Warning Messages*.
PSEUDORANGE DATA	Data on the precise location of a satellite in relation to the receiver. Used to calculate a position fix, then discarded by the unit.
RECEIVER	The electronic components of the ProMARK X that receive satellite signals.
ROUTE	A planned course of travel, divided into one to ten legs, each with its own start and destination.
ROUTE LEG	A portion of a route.
SIGNAL QUALITY	An indication of the signal-to-noise ratio of each satellite signal being used, and abbreviated as SQ. Ranges from 0 (lowest) to 9 (highest). A scale for indicating the strength of the signal, and the likelihood of the lock on the signal being lost. See *Appendix 11* and *Error/Warning Messages*.

SOA — Speed of advance.

SOG — Speed over ground.

SPEED OF ADVANCE — A vector component of ground speed (SOG) towards the destination. Abbreviated as SOA. Displayed when NAV is pressed and after three position fixes have been taken.



SPEED OVER GROUND — Actual ground speed measured as instantaneous speed and direction. Abbreviated as SOG. The calculation is made by the unit instantly and displayed with VEL.

SQ — See Signal Quality.

3D — Three dimensional. The mode of operation that calculates latitude, longitude, and altitude, requiring the use of four satellites.

TIME TO GO — Time to go. The time necessary to reach the destination of the current leg, based on Speed of advance (SOA).

TOGGLE — To switch back and forth between two settings, or to move through settings in a continuous loop. For example, when setting latitude, use the RIGHT ARROW to toggle between North and South.

TTG — Time to go.

2D	Two dimensional. The mode of operation that calculates latitude and longitude only, requiring the use of three satellites. Altitude in 2D is user-entered.
UNIVERSAL TIME	Universal Time, formerly referred to as GMT or Greenwich Mean Time. Abbreviated as UT.
UT	Universal Time.
WAYPOINT	A position stored in the unit's memory under a unique name.
XTE	Cross Track Error.

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