Pro XR/XRS

Receiver Manual

Part Number 31172-20-ENG

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About This Manual

Welcome to the *GPS Pathfinder™ Pro XR/XRS Receiver Manual*. This manual describes how to install, set up, and use the Trimble Pro XR/XRS receiver.

Scope and Audience

Even if you have used other Global Positioning System (GPS) products before, we recommend that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GPS, we suggest that you read the booklet *GPS, A Guide to the Next Utility* that is available from Trimble Navigation Limited.

The following sections provide a guide to this manual, as well as to other documentation that you may have received with this product.

Organization

This manual contains the following:

- Chapter 1, GPS and the Pro XR and Pro XRS Receivers, provides an overview of the Pro XR and Pro XRS receivers. This chapter describes the three integrated components of the Pro XR and Pro XRS receivers: GPS, MSK beacon, and satellite differential (Pro XRS only).
- Chapter 2, Accuracy, provides a brief overview of Differential GPS, details the Pro XR and Pro XRS systems' accuracy, the conditions necessary to obtain it, and any factors that can adversely affect it.
- Chapter 3, Pro XR/XRS Beacon Components, provides a more in-depth look at the components of a DGPS system.
- Chapter 4, Pro XR/XRS System Equipment, provides details of the equipment associated with the Pro XR and Pro XRS receivers and shows how to assemble the equipment.
- Appendix A, Upgrading Receiver Firmware, provides detailed instructions for updating the firmware in the Pro XR and Pro XRS receivers.
- Appendix B, Specifications, lists the specifications for the Pro XR and XRS receivers, integrated Beacon/GPS antenna, combined GPS/Beacon/Satellite Differential antenna, and GPS-only compact dome antenna, as well as pinout diagrams for Pro XR and Pro XRS system cables.
- Appendix C, Trimble Mapping & GIS Training Programs, provides information on Mapping & GIS training courses available.

Related Information

The following sections discuss other sources of information that introduce, extend, or update this manual.

Release Notes

The release notes describe new features of the product, information not included in the manuals, and any changes to the manuals.

Update Notes

There is a warranty activation sheet with this product. Send it in to automatically receive update notes as they become available. These contain important information about software and hardware changes. Contact your local Trimble Dealer for more information about the support agreement contracts for software and firmware, and an extended warranty program for hardware.

Other Information

This section lists sources that provide other useful information.

World Wide Web (WWW) Site

For an interactive look at Trimble, visit our site on the World Wide Web:

- http://www.trimble.com

File Transfer Protocol (FTP) Site

Use the Trimble FTP site to send files or to receive files such as software patches, utilities, and answers to frequently asked questions (FAQs):

- ftp://ftp.trimble.com

You can also access the FTP site from the Trimble World Wide Web site (http://www.trimble.com/support/support.htm).

Technical Assistance

If you have a problem and cannot find the information you need in the product documentation, ***contact your local dealer***.

If you need further assistance, contact the Trimble Technical Assistance Center (TAC) by phone, fax, or email. A support technician can help determine the cause of the problem and provide technical assistance.

To contact TAC:

Phone:	+1-800-SOS-4TAC (North America) +1-408-481-6940 (International) Phones are answered from 6:00 am to 5:30 pm Pacific Standard Time.
Fax:	+1-408-481-6020
Email:	trimble_support@trimble.com

When you contact TAC, have the following information available:

- The Trimble product name, any software or firmware version number(s), and if appropriate, the serial number.
- Your specific question or problem.

  Please detail background information, such as the configuration of your data logger or receiver, and the exact type, make, and configuration of your computer. If you have received error messages, please specify the exact wording.

If you need to send a data file with your inquiry, please compress the file using PKZIP software by PKWARE, Inc., and name the file with the extension .ZIP.

Use one of the following methods to send the file:

- Attach the file to your email inquiry.
- Put the file on the Trimble FTP site and include the file name in your email inquiry.

Reader Comment Form

Thank you for purchasing this product. We would appreciate feedback about the documentation. Use the reader comment form at the back of this manual or, if this is not available, send comments and suggestions to the address in the front. All comments and suggestions become the property of Trimble Navigation Limited.

Document Conventions

Italics identify software menus, menu commands, dialog boxes, and the dialog box fields.

SMALL CAPITALS identify DOS commands, directories, filenames, and filename extensions.

`Courier` represents messages printed on the screen.

`Courier Bold` represents information that you must type in a software screen or window.

Helvetica Bold identifies a software command button.

[Ctrl] is an example of a hardware function key that you must press on a personal computer (PC). If you must press more than one of these at the same time, this is represented by a plus sign, for example, [Ctrl] + [C].

[Enter] is an example of a hardware key (hard key) that you must press on the keypad.

[Delete] is an example of a softkey.

'Select *Italics* / *Italics*' identifies the sequence of menus, commands, or dialog boxes that you must choose in order to reach a given screen.

Warnings, Cautions, Notes, and Tips

Warnings, cautions, notes, and tips draw attention to important information and indicate its nature and purpose.

Warning – Warnings alert you to situations that could cause personal injury or unrecoverable data loss.

Caution – Cautions alert you to situations that could cause hardware damage or software error.

Note – Notes give additional significant information about the subject to increase your knowledge, or guide your actions.

Tip – Tips indicate a shortcut or other time- or labor-saving hint that can help you make better use of the product.

1 GPS and the Pro XR and Pro XRS Receivers

The Pro XR and Pro XRS receivers are Trimble's high-performance Global Positioning Systems (GPS) receivers. They can be operated with one of the following controlling software systems designed for effective geographic data acquisition:

- Trimble's Asset Surveyor™ software running on the rugged TSC1, TDC1 and TDC2 data collectors
- Trimble's ASPEN™ software running on a user-supplied notebook or pen computer

The Pro XR and XRS receivers use differential GPS to provide submeter position accuracy on a second-by-second basis. NMEA-0183 messages and raw measurements in TSIP (Trimble Standard Interface Protocol) are also available, offering optimal flexibility when interfacing with other instruments.

1.1 What is GPS?

The Global Positioning System (GPS) is a satellite-based positioning system operated by the U.S. Department of Defense (DoD). The 24 operational NAVSTAR satellites orbiting the earth every twelve hours provide worldwide, all-weather, 24-hour time and position information. For more information regarding GPS concepts, refer to the *Mapping Systems General Reference*.

1.2 What is the Pro XR Receiver?

The Pro XR receiver is available in two configurations: GPS/MSK (Minimum Shift Keying) Beacon and GPS only. The Pro XR GPS/ MSK Beacon receiver includes a differential GPS receiver module and a fully automatic, dual-channel MSK beacon receiver module packaged within a lightweight, rugged, weatherproof housing for receiving DGPS (Differential GPS) broadcasts conforming to the IALA (International Association of Lighthouse Authorities) standard.

1.3 What is the Pro XRS Receiver?

The Pro XRS receiver is Trimble's most versatile real-time GPS mapping receiver ever. By combining a GPS receiver, an MSK beacon differential receiver and a satellite differential receiver in a single housing, the Pro XRS system offers you unsurpassed flexibility in choosing a source for real-time differential corrections. One receiver and antenna is all that is required for the flexibility of receiving GPS, MSK Beacon differential corrections, and satellite differential corrections.

A subscription to a differential correction service is required and multiple vendors are supported. An integrated virtual reference/base station (VRS/VBS) technology permits the satellite corrections to be uniformly accurate over the entire satellite coverage area, without degradation in the accuracy associated with increasing distance from fixed reference stations.

Note – The use of satellite differential corrections may not be appropriate for operations in areas with substantial canopy.

At the time of printing, the Pro XRS receiver supports two differential correction services. For more information on these services, refer to the following web sites :

- http://www.omnistar.com/
- http://www.racal-landstar.com/index.html

1.4 What Can the Pro XR and Pro XRS Receivers Do?

The Pro XR and Pro XRS receivers, in combination with the controlling software (Asset Surveyor or ASPEN) are advanced systems for geographic data collection. These GPS systems are designed for accurate mapping, and creation and updating of Geographic Information Systems (GIS) databases. By combining the high performance controlling software with the accuracy of the Pro XR or Pro XRS receiver, you can quickly inventory resources by recording precise position and attribute information in digital form, which can later be imported into the spatial database of your choice.

The foundation of the Pro XR and Pro XRS receivers is precise GPS positioning technology. The GPS receiver features 12 channels of continuous satellite tracking. Using differential GPS, the Pro XR and Pro XRS receivers deliver differentially corrected C/A code positions to submeter accuracy on a second-by-second basis under the most challenging operating conditions.

The MSK beacon receiver allows users of the Pro XR and Pro XRS receivers free access to real-time solutions transmitted from DGPS radiobeacons operating in the MF (medium frequency) band from 283.5 kHz to 325 kHz. The integrated MSK beacon receiver (optional on a Pro XR receiver) is an advanced dual channel radiobeacon receiver that tracks broadcasts from DGPS radiobeacons conforming to the IALA Standard. The beacon receiver uses its *all-digital signal processing* techniques to track and demodulate signals from DGPS radiobeacons.

For an up-to-date list of beacon stations, see the following web page:

http://www.trimble.com/gis/beacon/

1.5 Standard Pro XR/XRS Receiver Features

The Pro XR GPS-only receiver provides the following:

- 12-channel DGPS receiver with Everest™ multipath rejection technology, L1 C/A code with carrier-phase filtering and instantaneous full wavelength carrier-phase measurements
- Submeter MCORR400 accuracy—typically less than 50 cm RMS (assumes at least 5 satellites, PDOP less than 6, and corrections from a Trimble Reference Station, 4000RS, or Trimble Community Base Station with Everest multipath rejection technology)
- 1 Hz position and velocity update rate
- Velocity computations incorporate carrier-phase data
- Time to First Fix (TTFF): typically less than 30 seconds
- NMEA-0183 Message Outputs: ALM, GGA, GLL, GSA, GSV, VTG, ZDA
- Two RS-232 serial ports
- NMEA-0183 output or TSIP output/External RTCM input
- TSIP Interface Protocol I/O
- GPS-only compact dome antenna
- User upgradeable receiver firmware
- Receiver Manual
- CE Mark compliance

The Pro XR GPS/Beacon receiver provides the items listed above, plus:

- Integrated GPS/MSK Beacon antenna
  (replaces the compact antenna listed above)
- Fully automatic and manual beacon operating modes
- Fast acquisition of differential beacon signals
- Immunity to MSK jamming signals
- Advanced techniques for combatting atmospheric noise in the beacon receiver

The Pro XRS GPS/MSK/Beacon/Satellite Differential receiver provides the items listed above, plus:

- Integrated L-band Satellite Differential correction receiver
- Combined L1 GPS/Beacon/Satellite Differential antenna

1.5.1 Antenna Options

There are three antenna options:

- Compact Dome GPS-only antenna
- Integrated GPS/MSK Beacon antenna
- Combined L1 GPS/Beacon/Satellite differential antenna

Compact Dome GPS-only Antenna

The GPS-only antenna is a lightweight L1 compact dome GPS antenna (P/N 16741-00), as shown in Figure 1-1. The antenna is weatherproof and is designed to withstand harsh environmental conditions.

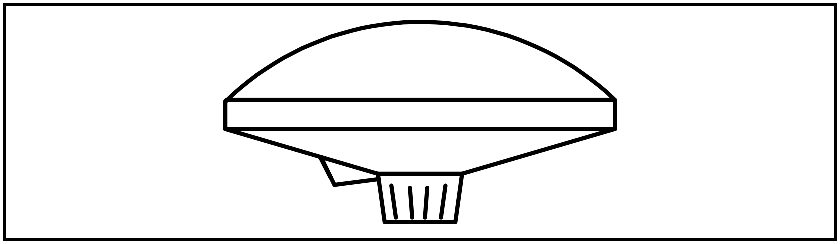


Figure 1-1 Pro XR GPS-only Compact Dome Antenna

Integrated GPS/MSK Beacon Antenna

The Pro XR receiver's integrated GPS/MSK Beacon antenna (P/N 29653-00) features two antenna components: an L1 GPS antenna and an MSK H-field Loop beacon antenna.

- The L1 GPS antenna is an active antenna designed to filter out unwanted signals and amplify the L1 GPS signal for transmission over the antenna cable to the Pro XR receiver.
- The MSK H-field Loop beacon antenna features a pre-amplifier for filtering out signal interference such as AM radio broadcasts and noise from switching power supplies. After filtering, the pre-amp amplifies the MF signal for transmission over the same antenna cable to the beacon receiver.

The coaxial antenna cable also carries DC power to the pre-amp of both the L1 GPS and beacon antennas over the center conductor of the cable.

The antenna assembly integrates the L1 GPS antenna and a beacon antenna into a single antenna assembly, as shown in Figure 1-2. The antenna assembly is completely weather-proof and is designed to withstand harsh environmental conditions.

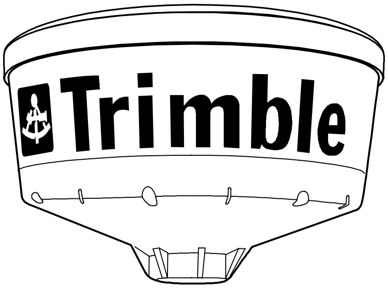


Figure 1-2 Pro XR Integrated GPS/MSK Beacon Antenna

Combined L1 GPS/Beacon/Satellite Differential Antenna

The Pro XRS receiver’s integrated L1 GPS/Beacon/Satellite Differential antenna (P/N 33580-50) features two antenna components:

- L1 GPS/Satellite Differential antenna

  This is an active antenna designed to filter out unwanted signals and amplify the L1 GPS and Satellite Differential signals for transmission over the antenna cable to the Pro XRS receiver.

- MSK H-field Loop beacon antenna

  This features a pre-amplifier for filtering out signal interference such as AM radio broadcasts and noise from switching power supplies. After filtering, the pre-amp amplifies the MF signal for transmission over the same antenna cable to the beacon receiver.

The coaxial antenna cable also carries DC power to the pre-amp of both the L1 GPS/Satellite Differential and beacon antennas over the center conductor of the cable.

The antenna assembly integrates the L1 GPS/Satellite Differential antenna and a beacon antenna into a single antenna assembly, as shown in Figure 1-3. The antenna assembly is completely weatherproof and is designed to withstand harsh environmental conditions.

Figure 1-3 Pro XRS Combined L1 GPS/Beacon/Satellite Differential Antenna

2 Accuracy

The accuracy of the Pro XR and Pro XRS receivers without real-time or postprocessed differential correction is 100 meters (2dRMS). After differential correction, the horizontal accuracy of each position is better than 50 cm (RMS) + 1 part-per-million (ppm) times the distance between the base and the rover. The vertical accuracy of each position is submeter +2 ppm times the distance between the base and the rover. Using real-time corrections, the accuracy of each position can be as good as submeter, but is subject to a number of operational conditions.

Note – 2dRMS means that approximately 95% of the positions are within the specified value. RMS means that approximately 68% of the positions are within the specified value.

2.1 Differential GPS Positioning

The Pro XR and Pro XRS receivers use differential GPS (DGPS) to achieve positions accurate to the submeter level. DGPS employs two or more receivers. One receiver, called the base station, is placed at a known point to determine the errors in the pseudoranges to the satellites. An unlimited number of other mobile receivers, called rovers, collect data at unknown locations within the vicinity.

The base station receiver computes corrections. These corrections are based on the differences between the actual and observed ranges to the tracked satellites. The pseudorange corrections (PRC) are based on these differences. The coordinates of the rover receivers are then computed by applying the PRCs to the observed ranges in real time.

The concept of DGPS is based on the fact that because GPS satellites are in high orbits (the orbital radius is greater than four times the radius of the Earth), the pseudorange errors observed by the base station receiver are virtually identical to the pseudorange errors seen by all rover receivers in the vicinity.

2.2 Sources of DGPS Error

Pseudorange errors can come from several sources. Some errors are common to both the base station and the rover receivers, such as satellite clock errors. These can be reduced using differential corrections. Errors that are not common to both the base station and rover receiver include multipath and receiver noise. These errors cannot be removed using differential corrections.

Each satellite broadcasts orbital and satellite clock data based on predicted behavior. If the orbit of a satellite does not behave as predicted, an error in the pseudorange results. The commonality of the orbital error between two receivers depends on the distance between the receivers and the direction of the orbital error. Because GPS satellites orbit at high altitude, pseudorange errors caused by orbital prediction errors are nearly identical between two receivers within 100 kilometers of each other. At greater distances between receivers, orbital errors become noticeably different for each receiver, therefore becoming a source of error that is more difficult to resolve with differential correction.

The greatest source of pseudorange error is Selective Availability (S/A). S/A refers to the errors in the data and satellite-clock dithering that are deliberately induced by the U.S. Department of Defense (DoD), operators of GPS. This restricts full GPS accuracy to all users except authorized users, typically the U.S. military and its allies. The magnitude of S/A errors combined with other error sources results in autonomous (single receiver) horizontal accuracy so that 95% of the positions are within 100 meters of truth.

S/A errors can be removed using DGPS. The clock-dither error, like unplanned clock errors, is common to all receivers using the satellite. S/A data errors are similar to orbital errors and can be removed by DGPS.

Other sources of pseudorange error include ionospheric delay, tropospheric delay, multipath, and receiver noise. DGPS removes most of the errors due to ionospheric and tropospheric delay as long as the distance between the base station receiver and rover receiver is not too large.

Multipath and receiver noise are unique to a receiver and cannot be removed by differential techniques. The Pro XR and Pro XRS receivers use the latest advancements in GPS receiver design, has appreciably better signal-to-noise ratio than earlier receivers, and uses advanced filtering and signal-processing techniques. The receiver design, when combined with a low-multipath environment, minimizes errors from ionospheric and tropospheric delay, so that the resulting DGPS positions are more accurate.

2.3 Real-Time Differential Correction

In real-time DGPS, the base station calculates and broadcasts through radio signals, the correction for each satellite as it receives the data. This correction is received by the rover and applied to the position it is calculating. As a result, the position displayed by the controlling software and logged to the data file is a differentially corrected position.

The Pro XRS and Pro XR GPS/Beacon receivers have a built-in beacon receiver component. If you are using the integrated GPS/MSK beacon antenna then you can collect real-time data if you are in range of a DGPS radiobeacon transmitter. You do not need to purchase, connect and configure an external radio. In addition, the receiver allows the controlling software, Asset Surveyor or ASPEN, to record postprocessable real-time (PPRT) data. This allows you to collect data in real-time; you can postprocess this data later for even greater accuracy. (See Section 2.7, Postprocessed Real-Time (PPRT)).

You must maintain radio contact with the base station. If contact is lost, the rover receiver either stops computing positions or computes positions with non-differential GPS accuracy (up to 100 meters horizontal 2dRMS), depending on the positioning mode (configured in the controlling software).

You can always collect base data for postprocessing, even if you are using external radios, radiobeacons or satellites for real-time differential operation. Back in the office, you can differentially correct positions not corrected in the field using real-time differential operation, and reprocess positions that were differentially corrected in real-time to improve their accuracy. Also, your colleagues may want to use the base data for their own differential corrections.

2.4 Postprocessed Differential Correction

In postprocessed DGPS the base station records the pseudoranges for each satellite directly into a computer file. The rover also records its own positions in a computer file. After returning from the field, the two files are processed together and the output is a differentially corrected rover file.

2.5 Factors Affecting Postprocessed DGPS Accuracy

The accuracy you can obtain after data collection depends on several factors, including:

- Number of visible satellites
- Multipath
- Distance between base station and rover receivers
- Position Dilution of Precision (PDOP)
- Signal-to-Noise Ratio (SNR)
- Satellite elevations
- Occupation time at a point
- Differential correction
- Receiver type at base station

The horizontal accuracy of the Pro XR and Pro XRS receivers with postprocessed differential correction is better than 50 cm (RMS) +1 ppm times the distance between the base station and the rover receiver given the following conditions:

- Number of satellites used: ≥ 5
- PDOP: < 6
- GPS Signal-to Noise Ratio (SNR): > 6
- Satellite Elevation Mask: ≥ 15°
- Base station receiver is a Pro XR, Pro XRS, 4600LS, or Series 4000 GPS receiver equipped with the Everest multipath rejection technology

Note – Using receivers without the appropriate Everest firmware installed results in a degradation in accuracy.

In addition, the following conditions must be met to obtain submeter accuracy:

- Synchronized measurements are logged at the base station.
- The logging interval for the roving receiver is the same as, or a multiple of, the logging interval at the base station.
- The base station uses the correct antenna.

For detailed information on GPS data accuracy, see Chapter 4 of the *Mapping Systems General Reference*. For more information on the accuracy of the Pro XR and Pro XRS receivers when using the integrated MSK beacon and satellite differential receivers, see Section 2.6, Real-time DGPS Accuracy.

2.5.1 Number of Visible Satellites

A minimum number of satellites (usually four) is needed to calculate a position. If you have five or more satellites, this increases the accuracy by a small amount. When using 2D position mode, you can obtain positions from three satellites by using 2D position mode, but this can significantly reduce accuracy. You must manually supply an accurate height, or let the controlling software use the last determined height. Any inaccuracy in height causes inaccuracies in the horizontal coordinates.

You can make sure that at least five satellites are always tracked, by using Overdetermined 3D position mode.

When the number of visible satellites drops below the required number, the controlling software stops logging positions for the current feature and displays the message `Too few satellites`.

2.5.2 Multipath

Satellite signals can sometimes be reflected off large nearby objects, such as buildings or cars, causing an erroneous signal to be received by the GPS antenna. This phenomenon is known as multipath and is illustrated in Figure 2-1.

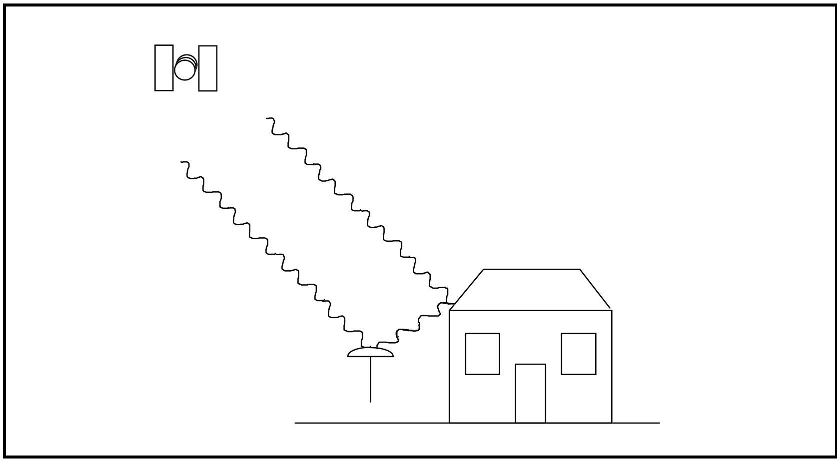


Figure 2-1 Multipath

Severe multipath can induce errors of dozens of meters, while mild multipath can cause small errors of only a meter or less. Optimal accuracy is obtained by collecting data in an environment that has no large reflective surfaces and has a clear view of the sky.

The Pro XR and Pro XRS receivers are fitted with Everest™ multipath rejection technology. This technology removes multipath signals before code measurements are stored or used to calculate positions. For a detailed description of this technology, refer to the Trimble web page at http://www.trimble.com/gis/pdf/everest.pdf.

2.5.3 Distance Between Base Station and Roving Receiver

When you postprocess using the Pathfinder Office Differential Correction Utility, the horizontal accuracy of the positions received is 50 cm (RMS) at a 1 km base line (distance from base). Accuracy degrades by 1 part per million (ppm) as the distance between base station and rover increases. For example, 1 millimeter of degradation occurs for every kilometer between the base and rover. You must capture data within 500 kilometers (310 miles) of your base station to obtain submeter accuracy.

2.5.4 PDOP

PDOP (Position Dilution of Precision) is a unitless measure of the current satellite geometry that indicates when the most accurate results are provided. When satellites are spread around the sky, the PDOP value is low (the computed position is more accurate). When the satellites are grouped closely together, the PDOP value is high (the computed position is less accurate). The lower the PDOP value, the more accurate the GPS positions.

You can configure the PDOP Mask so that if the PDOP exceeds the PDOP Mask, the controlling software stops logging positions. A PDOP Mask of 6 is required for submeter accuracy.

2.5.5 SNR

SNR (Signal-to-Noise Ratio) is a measure of the strength of the satellite signal relative to the background noise. Accuracy degrades as the signal strength decreases. You can configure the controlling software to log GPS positions from weak space signals by setting the SNR Mask. The recommended SNR Mask is 6. In areas of dense canopy, the SNR Mask can be lowered to 3. Although you may not achieve submeter accuracy, this provides the ability to collect GPS positions in marginal areas.

Note – PDOP and SNR act in opposite directions: greater accuracy is achieved with low PDOP and high SNR.

2.5.6 Satellite Elevations

When a satellite is low on the horizon, the satellite signals travel a greater distance through the atmosphere, resulting in a lower signal strength and delayed reception by the GPS receiver. Low-elevation satellites tend to yield noisy data.

Make sure that the roving receiver does not use satellites that are low in the sky and may not be seen by the GPS base station. Collect position data using only satellites that are at least 15° above the horizon. You can configure the controlling software to ignore satellites that are low in the sky by setting the Elevation Mask. The recommended Elevation Mask is 15°.

2.5.7 Occupation Period

The Pro XR and Pro XRS receivers achieve submeter (50 cm) horizontal accuracy with a one-second occupation time.

Note – You can achieve higher levels of accuracy using the Pro XR and Pro XRS receivers if you collect carrier phase data, and postprocess using the Pathfinder Office software.

2.5.8 Differential Correction

The accuracy of a GPS receiver before differential correction is 100 meters (2dRMS). To achieve higher accuracy you must perform differential correction in either real-time or postprocessed mode.

2.5.9 Receiver Type

The following Trimble receiver models have Maxwell-based technology and, when used as the base station, yield submeter accuracy with the Pro XR and Pro XRS receivers:

DSM Reference Station
4000RS/DS
4000MSK DGPS Reference Station
Site Surveyor 4400
Land Surveyor II
Land Surveyor IID
System Surveyor II
Geodetic Surveyor
Geodetic System Surveyor
Pathfinder Community Base Station(CBS)
4600LS Surveyor
GPS Pathfinder Pro XL (12-channel)
GPS Pathfinder Pro XR (12-channel)
GPS Pathfinder Pro XRS (12-channel)

Note – To determine if you are using one of the 4000SE/SSE/SSi receivers, press the STATUS soft key, then press the OPTIONS soft key to view *Receiver Configuration*. Press the MORE soft key until *MODEL* is visible. If the model displayed is one of the models listed above, you will get submeter accuracy when it is used as a reference station for the Pro XR rover receivers. If your receiver is not listed above, contact your Trimble dealer to learn about upgrade options.

It is possible to obtain submeter accuracy using a pair of Pro XR or Pro XRS receivers as a base and rover. However, unless you are using 12-channel Pro XR or Pro XRS receiver at the base station, you risk being unable to differentially correct some of your data. This is because an 8-channel receiver can only log from 8 satellites at a time and there are now occasionally more than 8 satellites visible above the standard 15° rover Elevation Mask. If the base does not log from satellites the rover is using, the data collected by the rover cannot be differentially corrected.

2.5.10 Synchronized Measurements

To obtain optimal accuracy from differential correction, the base station must record base data or output differential corrections from synchronized measurements. Synchronized measurements occur when the base and the rover receivers simultaneously make measurements to all the satellites they are tracking.

When a Pro XR/XRS, Pro XL or any Maxwell-based 4000 series receiver is used as a base, the data is always synchronized. When measurements are not synchronized, there is no equivalent base position measured at exactly the same time as the rover position. A simultaneous base position must be interpolated, which reduces accuracy.

Synchronized measurements can be recorded by the base station receivers listed in Section 2.5.9, Receiver Type.

2.5.11 Logging Intervals

Ideally, the logging interval at the base should be the same as the logging interval at the rover. For example, if the base station is using a 5-second logging interval then the rover logging interval should be 5 seconds. The rover logging interval can also be a direct integer multiple of the interval at the base. For example, if the base station is logging every 5 seconds then the rover could log every 10 seconds.

If the rover logging interval is not synchronized with the base station, the accuracy of the GPS positions logged by the rover may not be submeter. This is because the base station measurements must be interpolated in order to correct the roving receiver’s measurements.

If the synchronized measurement logging interval at the base is 1 second, you can use any logging interval at the rover. However, this generates a large file at the base. If the base station data collector runs out of space you can not differentially correct any rover data collected after the base file ends.

When disk space is at a premium, the best option is a 5-second logging interval for synchronized measurement data at the base and a 5-second logging interval for positions at the rover. This is frequent enough to be practical at the rover and uses the default base logging interval, which results in base files that are not too large.

Table 2-1 gives examples of various base and rover intervals and their effect on accuracy. They are valid for both postprocessed and real-time corrections.

Table 2-1 Logging Interval Accuracy

Base Interval	Rover Interval	Effect on Accuracy
1 second	1 second	Recommended for best accuracy. Base data is not interpolated.
1 second	3 seconds, or 5 seconds, or 6 seconds, etc.	Base data is not interpolated.
3 seconds	1 second	Interpolates base data at seconds 1 and 2; a slight degradation of accuracy occurs with interpolation. One in three of the rover positions is not interpolated.
3 seconds	6 seconds	No interpolation of base data, because the rover interval is a direct integer multiple of the base interval.
5 seconds	1 second	Interpolates base data at seconds 1, 2, 3 and 4; a slight degradation of accuracy occurs with interpolation. One in five of the rover positions is not interpolated.
5 seconds	5 seconds	Base data is not interpolated. Recommended if base station disk space is at a premium.
5 seconds	10 seconds	No interpolation of base data, because the rover interval is a direct integer multiple of the base interval.

2.6 Real-time DGPS Accuracy

Real-time DGPS offers similar accuracies to that of postprocessed GPS for dynamic applications. However, there are a number of factors (in addition to those discussed in Section 2.5, Factors Affecting Postprocessed DGPS Accuracy) that affect the accuracy of real-time DGPS positions:

- Ephemeris at the reference station is different from that used by the rover.
- Frequency of message output.
- RTCM SC-104 format message types.
- Accuracy of the Reference Station position.
- Corrections based on different datum.

2.6.1 Ephemeris

The ephemeris contains orbital information for all of the GPS satellites. It is transmitted by the satellites and automatically recorded and decoded by each GPS receiver. If the ephemeris data at the reference station differs from that at the roving receiver, this can cause momentary periods of lesser accuracy as one receiver has less information regarding the whereabouts of the satellites than does the other. The error caused by a difference in ephemeris can be anywhere between 1 centimeter and 5 meters.

2.6.2 Frequency of Message Output

The frequency, or rate, at which the RTCM differential correction messages are output from the reference station affects the accuracy of the GPS positions recorded by the roving receiver. The longer it takes for up-to-date information to get from the reference station to the rover, the less accurate the information is. This period of delay, known as latency, can be attributed to a number of factors:

- Transmission rate

  The rate at which the RTCM message is output from the transmitting station affects the accuracy of real-time DGPS positions. Roving receivers receive corrections from transmitters outputting at 9600 baud faster than from transmitters outputting at 50 baud.

- Number of RTCM messages

  The number of RTCM messages generated by the reference station in each transmission, and received by the roving GPS receiver has an effect on the latency of the correction. Roving receivers collecting transmissions from stations outputting only one or two messages experience lower latencies than outputs from reference stations that include five or six messages.

- Reference station correction output rate

  The rate at which the reference stations generate corrections to be output is the most important factor determining the accuracy of positions collected at the rover. Most reference stations generate corrections every 5 seconds, however some generate corrections only every 20 or 30 seconds.

The effect that the latency and the length of time between generated corrections has upon the accuracy of positions recorded is that the receiver has to extrapolate positions longer than what may be required for greater accuracies.

2.6.3 RTCM Message Types

Real-time DGPS requires that a Type 1 or several Type 9 RTCM messages are received by the rover to provide a DGPS solution. These messages are similar in content, but depending on the rate of output and the strength of the signals output from the reference station, can affect the accuracy of positions recorded by the rover.

RTCM Type 1 Message

RTCM Type 1 message is the primary message type that provides the pseudorange and range rate corrections for any DGPS-capable receiver. Type 1 messages contain every correction for each of the satellites in view by the reference station. If the reference station is tracking nine satellites, each Type 1 message sent contains nine pseudorange corrections and nine range rate corrections. The length of the message sent varies depending on the number of satellites tracked by the reference station, and may be very long if many satellites are being tracked.

RTCM Type 9 Message

The RTCM Type 9 message serves the same purpose as the Type 1 message; it contains the primary differential corrections. However, unlike Type 1 messages, Type 9 messages do not require a complete satellite set to be transmitted at once. Type 9 messages allow corrections to be grouped together in smaller groups until all the corrections are sent by a number of different Type 9 messages. Also, corrections from partial Type 9 messages can be applied as soon as they are received, further reducing the effects of message latency.

For example, if a beacon reference station is tracking 8 satellites, the corrections are sent out in three separate messages, the first two messages containing the pseudorange information for 3 satellites, and the third message containing information for 2 satellites. With Type 1 messages the receiver has to wait until the information for all satellites is received to correct a particular position (greater latency), Type 9 messages can be used as soon as the first packet arrives at the receiver (less latency).

2.6.4 Accuracy of the Beacon Reference Station Position

If the position of the beacon reference station has been determined with approximate coordinates the corrections transmitted by the reference station reflects this, and the positions recorded by the roving receivers are offset by that amount. To determine the accuracy of your local DGPS reference station coordinates, please request this information from the provider of that particular service.

2.6.5 Datum of Corrections

Errors can occur if the beacon reference stations use a datum other than the RTCM SC-104 standard (WGS-84) as the basis for the DGPS corrections. The error introduced by using a beacon that transmits coordinates using a different datum are generally quite small. However, in some places the margin of error can be 5-10 meters. There is little you can do in these situations, except to set the controlling software to collect postprocessable real-time data.

2.7 Postprocessed Real-Time (PPRT)

With the Pro XR and Pro XRS receivers and Asset Surveyor (version 3.10 or later) or ASPEN (version 1.20 or later) controlling software, you can log additional data so that GPS positions corrected in real-time can be postprocessed in the office, provided you have access to a base station that logs data for postprocessing.

Postprocessing of RTCM-corrected GPS positions is worthwhile if the real-time base station you are using is a considerable distance from where you collected the data (and your postprocessing base station is nearer), or if the real-time base station is inaccurate for reasons such as those listed in Section 2.6, Real-time DGPS Accuracy.

A typical application for PPRT would be to use free real-time services such as the U.S. Coast Guard DGPS service to get typical accuracies of 1-10 meters in real-time. You could then reprocess your data in the office to get accuracies as good as submeter.

2.8 Summary

Table 2-2 lists the recommended operational techniques and rover settings for obtaining submeter (50 cm) accuracy on a second-by-second basis.

Table 2-2 Recommended Settings

Parameter	Specification
Base Receiver Type	Synchronized measurements can be recorded by Trimble 12-channel Maxwell-based CBS or Maxwell-based 4000 Series receiver, or 12-channel Pro XR/XRS or Pro XL Receiver in Base Station mode
Logging Intervals	Same as base or a direct integer multiple. See Table 2-1.
PDOP Mask	6 or less
SNR Mask	6 or more
Elevation Mask	15° or more
Position Mode	Manual 3D, or Overdet. 3D if desired.

Note – If you are using real-time corrections to collect data, configure the controlling software to log PPRT data to reprocess the real-time data.

3 Pro XR/XRS Beacon Components

The International Association of Lighthouse Authorities (IALA) has established a standard for modulating DGPS corrections in the RTCM SC-104 format on marine radio beacon broadcasts using minimum shift keying (MSK) modulation.

The differential beacons are a subset of the large number of existing marine radio beacons, which operate in the 283.5 to 325 kHz band. The MSK beacon component of the Pro XR and Pro XRS receivers is a radio beacon receiver that tracks and demodulates differential beacon broadcasts conforming to the IALA standard.

This chapter provides an introduction to the advanced operating characteristics of the MSK beacon component of the Pro XR and Pro XRS receivers.

3.1 Real-Time DGPS Beacon Components

Real-time DGPS beacons require the following three components for a complete system architecture (see Figure 3-1):

- DGPS reference station
- Broadcast site
- GPS/MSK Beacon equipment

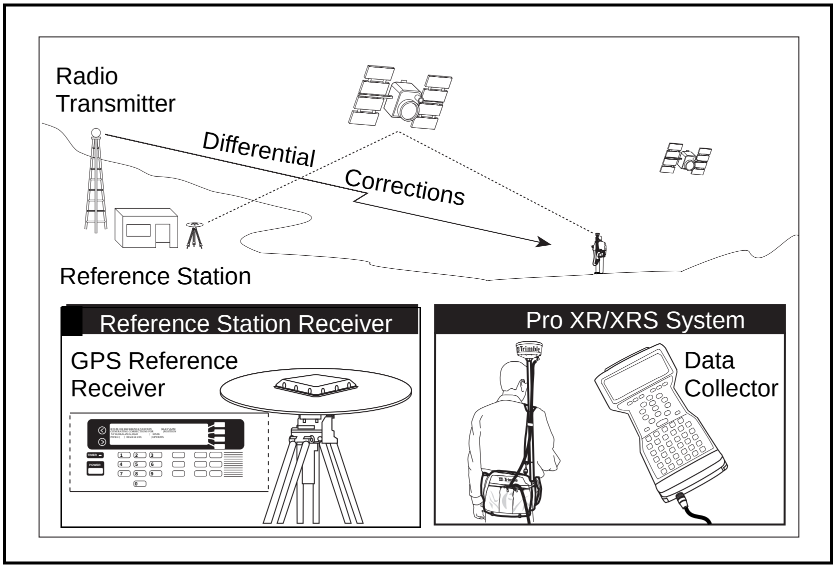


Figure 3-1 Components of a DGPS System

3.1.1 DGPS Reference Station

DGPS relies on GPS error corrections calculated by a reference station placed at a precisely known location. The reference station measures the ranges to each satellite and calculates the magnitude and rate of change of error in each measurement based on its known location.

3.1.2 Broadcast Site

A broadcast site is a radiobeacon transmitting correction data in the 283.5 to 325 kHz band. The GPS error corrections from the reference station are modulated on the radio beacon broadcast using minimum shift keying (MSK) modulation.

3.1.3 GPS/MSK Beacon Equipment

The MSK beacon component of the Pro XR or Pro XRS tracks and demodulates the DGPS broadcasts from differential beacons, and outputs the DGPS corrections to the GPS component in the industry standard RTCM SC-104 format. The GPS component of the Pro XR or Pro XRS receiver applies the DGPS corrections output from the MSK beacon component to achieve accurate position and velocity measurements.

3.2 Advanced DGPS System Components

In addition to the three DGPS components listed in Section 3.1, Real-Time DGPS Beacon Components, a DGPS service may have advanced components as an integral part of the DGPS system they operate:

- Integrity monitor
- Control Station

3.2.1 Integrity Monitor

An integrity monitor is a precisely located GPS receiver and MSK beacon receiver that applies differential corrections. The differentially corrected position is compared to its known location to determine if the corrections broadcast from the Reference Station are within the preset tolerance.

3.2.2 Control Station

Some DGPS services maintain centralized control sites to administer the DGPS service elements.

3.3 MSK Beacon Receiver Signal Processing

MSK signal processing is broken down into five stages:

- MSK pre-filtering
- MSK automatic gain control
- MSK analog-to-digital conversion
- MSK digital signal processing
- MSK I/O processing

3.3.1 MSK Pre-filtering

The MSK pre-filter rejects additional interference in the MF signal that was not attenuated by the pre-amp filter or was picked up by the antenna cable.

3.3.2 MSK Automatic Gain Control

This stage automatically amplifies the filtered MF signal to an optimal level for the analog-to-digital conversion stage.

3.3.3 MSK Analog-to-Digital Conversion

The analog MF signals are converted into digital signals for the digital signal processing stage. The MSK receiver uses a wide-band conversion unlike most other receivers. This technique improves acquisition performance by allowing a broader range of beacon signals to pass to the signal processing stage for evaluation. The wide-band technique also improves signal processing by eliminating the need for dedicated mixing stages that can generate non-linearities in the frequencies of interest.

In addition, the wide-band analog-to-digital conversion enables the use of special digital noise reduction techniques for handling impulse noise. This permits a highly adaptable and optimized response to impulse noise such as lightning.

3.3.4 MSK Digital Signal Processing

Controlled by proprietary processing algorithms, the MSK digital signal processor (DSP) digitally filters the wide-band sample, selects the best beacon signal, and passes the selected signal through a matched filter to the I/O processor. In addition, the DSP measures signal level, noise level, and frequency offset.

During the signal acquisition process, the DSP employs a 128-point FFT (Fast Fourier Transform) algorithm for evaluating the spectral content of the digitized signal. The FFT algorithm orders the beacon signals by relative strength. By filtering and squaring the signals before the FFT stage, the MSK modulation rate and the transmitter versus receiver frequency offset for a particular beacon may be determined. This signal processing technique permits rapid acquisition of the most powerful MSK signal and automatic identification of the modulation rate.

In tracking mode, the DSP rejects out-of-channel interference by selectively filtering the desired MSK signal. This technique allows the MSK receiver to track a weak differential beacon in the presence of much stronger signals from other radiobeacons. The DSP applies dual, low-noise, second-order, phase-locked loops for tracking the MSK carrier phase and symbol phase. The DSP coherently demodulates the MSK signal using a MSK matched filter. The matched filter offers optimal performance in a Gaussian noise environment. In addition, the DSP employs a proprietary noise cancellation technique for combating impulse noise.

3.3.5 MSK I/O Processing

The MSK I/O processor monitors the integrity of the data signal from the DSP, formats the RTCM SC-104 data messages, and outputs the data.

3.4 Worldwide DGPS Beacon Coverage

For an up-to-date list of beacon stations around the world, refer to the following web page: http://www.trimble.com/gis/beacon/

3.5 Activating the OmniSTAR Satellite Differential Service

Do the following to activate the OmniSTAR satellite differential service.

Step 1 – Prepare the Pro XRS GPS receiver

- Connect Asset Surveyor to the Pro XRS receiver and begin tracking GPS satellites with a clear view of the sky.
- Open the *Receiver status* form through the *Main menu*. Write down the *OmniSTAR ID* as displayed.

Step 2 – Call OmniSTAR

Give OmniSTAR:

- your location (for example, Sunnyvale, California, USA)
- the OmniSTAR ID you copied from the *OmniSTAR ID* field in *Receiver status*

OmniSTAR gives you:

- the OmniSTAR satellite and frequency for your local area
- a 24-digit activation code

Note – Phone numbers and further details on how to access the Fugro-OmniSTAR service are contained in the OmniSTAR booklet that accompanies this product.

Step 3 – Configure the Pro XRS GPS receiver

- Open the *Integrated DGPS* form (using the DGPS softkey in *Configuration/Communication options/Real-time input options*).
- Set the *Source* to 'Satellite'.
- Set the *Service Provider* field to 'OmniSTAR'.
- Enter the satellite you want to receive corrections from in the *Satellite* field.

  The *Frequency* and *Data rate* fields are automatically set once the *Satellite* field has been configured.
- Press Enter.

  At this point the *Activation code entry* form displays.
- Enter the 24-digit code you received from OmniSTAR.
- Press Enter to start the activation process.

Caution – Make sure that the 24-digit code is typed correctly. Typographic errors prevent successful activation.

Step 4 – Wait 45 minutes

Wait up to 45 minutes for the activation process to complete.

Note – If the activation process does not complete within 45 minutes, call Fugro-OmniSTAR and report your problem.

Note – The 45 minute wait period is for activation only. Once activated, OmniSTAR corrections begin less than 10 seconds after configuring the Pro XRS receiver to receive them.

3.6 Activating the Racal-LandStar Satellite Differential Service

Do the following to activate the Racal-Land Star Satellite Differential Service.

Step 1 – Prepare the Pro XRS GPS receiver

- Connect Asset Surveyor to the Pro XRS receiver and begin tracking GPS satellites with a clear view of the sky.
- Open the *Receiver status* form through the *Main menu*. Write down the *LandStar ID* as displayed.

Step 2 – Call Racal-LandStar

Give Racal-LandStar:

- your location (for example, Sunnyvale, California, USA)
- the LandStar ID you copied from the *LandStar ID* field in *Receiver status*

Racal-LandStar gives you:

- the LandStar satellite and frequency for your local area

Note – Phone numbers and further details on how to access the Racal-LandStar service are contained in the LandStar booklet that accompanies this product.

Step 3 – Configure the Pro XRS GPS receiver

- Open the *Integrated DGPS* form (using the DGPS softkey in *Configuration/Communication options/Real-time input options*).
- Set the *Source* to 'Satellite'.
- Set the *Service Provider* field to 'LandStar'.
- Enter the satellite you want to receive corrections from in the *Satellite* field.

  The *Frequency* field is automatically set once the *Satellite* field is configured
- Set the *Station preference* field to 'Virtual' or 'Closest', depending on your requirements.
- Press Enter to start the activation process.

Step 4 – Wait 45 minutes

Wait up to 45 minutes for the activation process to complete.

Note – If the activation process is not completed within 45 minutes, call Racal-LandStar and report your problem.

Note – The 45 minute wait period is for activation only. Once activated, Racal-LandStar corrections begin less than 10 seconds after configuring the Pro XRS receiver to receive them.

4 Pro XR/XRS System Equipment

This chapter provides details of the equipment associated with the Pro XR and Pro XRS receivers and shows how to assemble the equipment.

4.1 Pro XR Receiver Front Panel

The Pro XR receiver, shown in Figure 4-1, is mounted in a weatherproof housing.

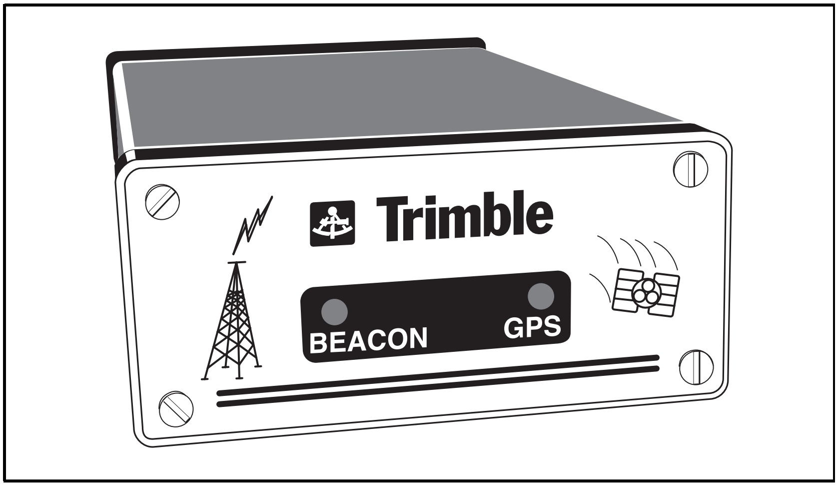


Figure 4-1 Pro XR Receiver Front Panel

4.2 Pro XRS Receiver Front Panel

The Pro XRS receiver, shown in Figure 4-2, is mounted in a weatherproof housing.

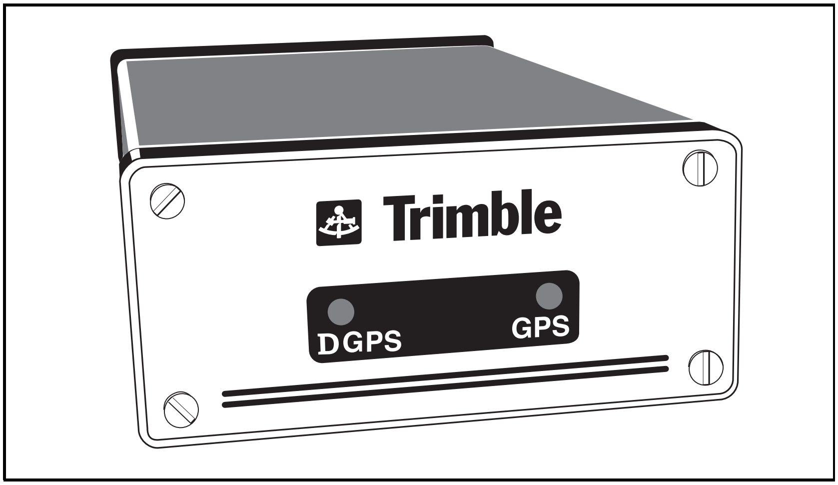


Figure 4-2 Pro XRS Receiver Front Panel

4.2.1 Pro XR Status Lights

The two status lights on the front panel of the Pro XR receiver provide the status information listed in Table 4-1.

Table 4-1 Pro XR Status Lights

	GPS	Beacon
OFF	Unit not powered up	Unit not powered up or beacon function is disabled
FAST FLASH	Searching for satellites	Searching for MSK signals
SLOW FLASH	Found one or more satellites. Not enough for a position fix.	Found MSK signal. RTCM data has not been sent to GPS receiver.
ON	Performing position fixes	Good RTCM data is being provided to the GPS receiver

4.2.2 Pro XRS Status Lights

The two status lights on the front panel of the Pro XRS receiver provide the status information listed in Table 4-2.

Table 4-2 Pro XRS Status Lights

	GPS	DGPS
OFF	Unit not powered up	Unit not powered up or DGPS function is disabled
FLASHING YELLOW	Searching for satellites	Searching for DGPS signals from MSK radiobeacon
FLASHING GREEN		Searching for DGPS signals from satellite differential provider
SOLID YELLOW	Performing position fixes using autonomous GPS	Differential corrections are being received from MSK radiobeacon
SOLID GREEN	Performing position fixes using differential GPS	Differential corrections are being received from satellite differential provider

4.3 Back Panel

The Pro XR and Pro XRS receivers have two serial communications ports (RS232) and an antenna cable port. The serial communications ports, shown in Figure 4-3, are 12-pin(m) bulkhead connectors located on the back panel of the Pro XR and Pro XRS receivers.

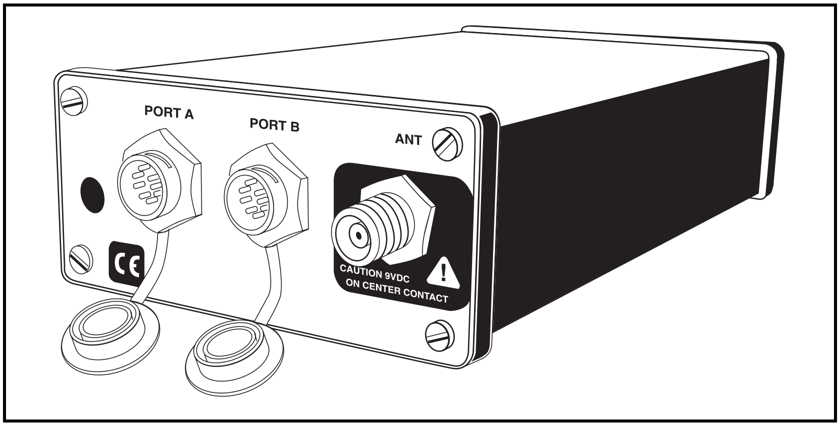


Figure 4-3 Pro XR/XRS Receiver Back Panel

4.3.1 Port A

Port A offers RS232 communication standards. It is designed for NMEA-0183 output and RTCM input.

4.3.2 Port B

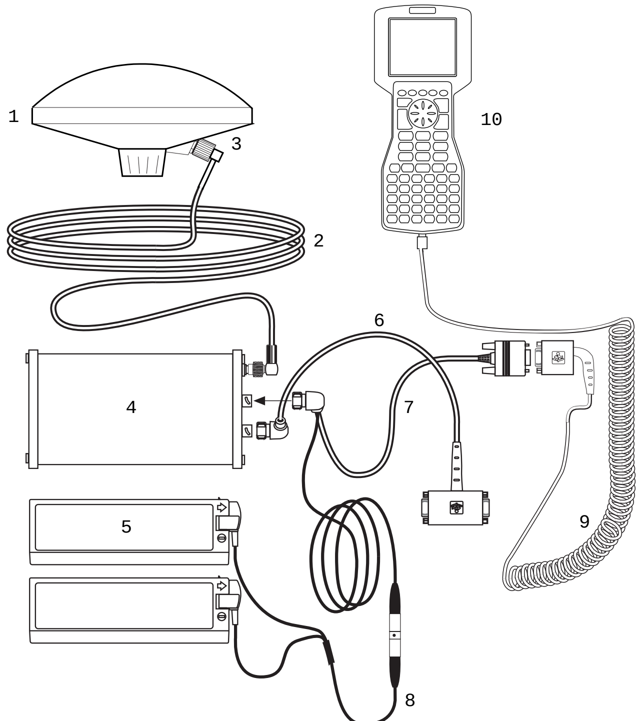
Port B also offers RS232 communication standards. It is designed for two-way data flow, external sensor input and power.

4.3.3 Antenna Port

The antenna connector is a TNC(f) connector located on the far right on the back panel of the Pro XR or Pro XRS receiver.

4.4 GPS Pro XR Cabling

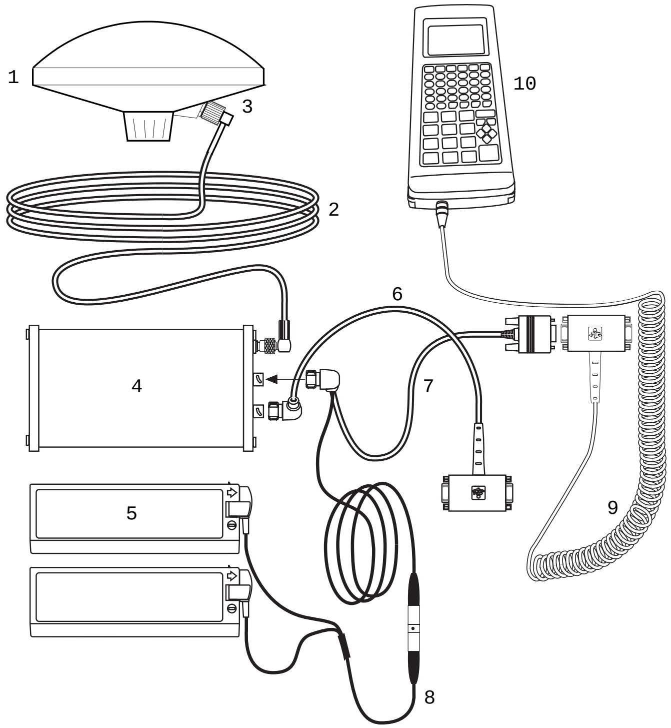
To use the TSC1 handheld with a GPS Pro XR receiver, connect the system as shown in Figure 4-4.



1	P/N 16741-00	Compact Dome Antenna
2	P/N 22628	Antenna Cable
3	P/N 31180	Antenna Cable Adapter
4	P/N 29654-11	12-channel Pro XR receiver
5	P/N 17466	Camcorder Batteries
6	P/N 30232-00	NMEA/RTCM Cable
7	P/N 30231-00	Data/Power Cable
8	P/N 24333	Dual Battery Cable
9	P/N 32287-00	TSC1 Data/ESP Cable
10	P/N 29673-50	TSC1 Handheld

Figure 4-4 GPS Pro XR / TSC1 Connection Diagram

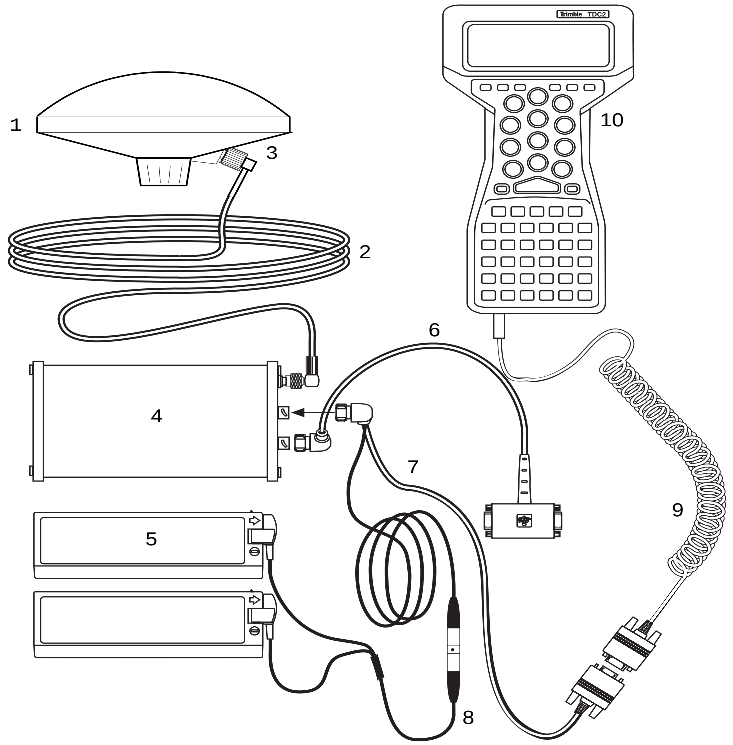
To use the TDC1 datalogger with a GPS Pro XR receiver, connect the system as shown in Figure 4-5.



1	P/N 16741-00	Compact Dome Antenna
2	P/N 22628	Antenna Cable
3	P/N 31180	Antenna Cable Adapter
4	P/N 29654-11	12-channel Pro XR receiver
5	P/N 17466	Camcorder Batteries
6	P/N 30232-00	NMEA/RTCM Cable
7	P/N 30231-00	Data/Power Cable
8	P/N 24333	Dual Battery Cable
9	P/N 30233-00	TDC1 Data/ESP Cable
10	P/N 21675-00	TDC1 Datalogger

Figure 4-5 GPS Pro XR / TDC1 Connection Diagram

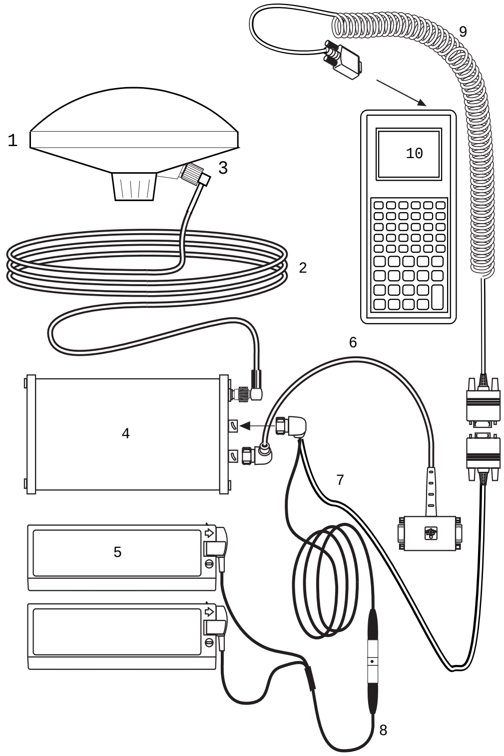
To use the TDC2 datalogger with a GPS Pro XR receiver, connect the system as shown in Figure 4-6.



1	P/N 16741-00	Compact Dome Antenna
2	P/N 22628	Antenna Cable
3	P/N 31180	Antenna Cable Adapter
4	P/N 29654-11	12-channel Pro XR receiver
5	P/N 17466	Camcorder Batteries
6	P/N 30232-00	NMEA/RTCM Cable
7	P/N 30231-00	Data/Power Cable
8	P/N 24333	Dual Battery Cable
9	P/N 30234	TDC2 Data Cable
10	P/N 28002-02	TDC2 Datalogger

Figure 4-6 GPS Pro XR / TDC2 Connection Diagram

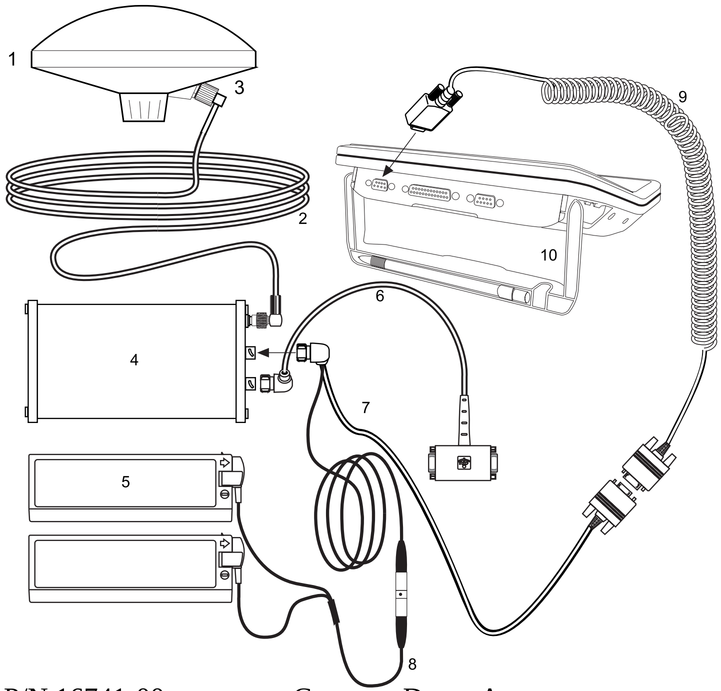
To use the MC-V datalogger with a GPS Pro XR receiver, connect the system as shown in Figure 4-7.



1	P/N 16741-00	Compact Dome Antenna
2	P/N 22628	Antenna Cable
3	P/N 31180	Antenna Cable Adapter
4	P/N 29654-11	12-channel Pro XR receiver
5	P/N 17466	Camcorder Batteries
6	P/N 30232-00	NMEA/RTCM Cable
7	P/N 30231-00	Data/Power Cable
8	P/N 24333	Dual Battery Cable
9	P/N 30236	Field Computer/MC-V Data Cable
10	P/N 17663-30	MC-V Datalogger

Figure 4-7 GPS Pro XR / MC-V Connection Diagram

To use a notebook or pen computer with a GPS Pro XR receiver, connect the system as shown in Figure 4-8.

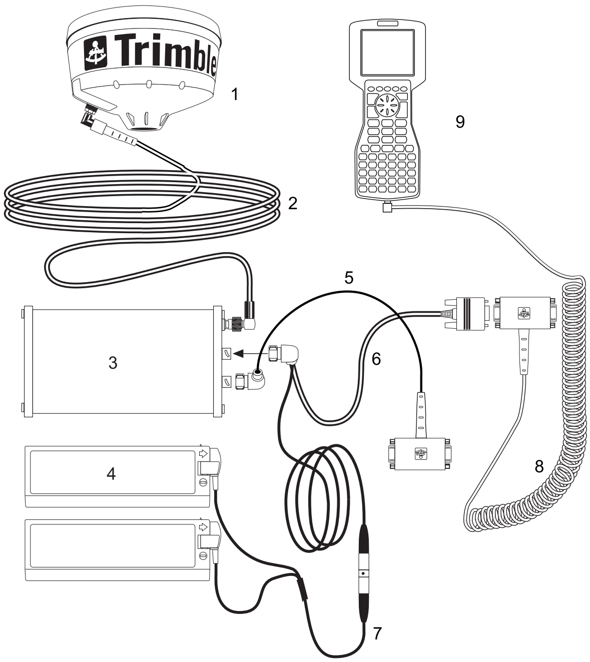


1	P/N 16741-00	Compact Dome Antenna
2	P/N 22628	Antenna Cable
3	P/N 31180	Antenna Cable Adapter
4	P/N 29654-11	12-channel Pro XR receiver
5	P/N 17466	Camcorder Batteries
6	P/N 30232-00	NMEA/RTCM Cable
7	P/N 30231-00	Data/Power Cable
8	P/N 24333	Dual Battery Cable
9	P/N 30236	Field Computer/MC-V Data Cable
10	Field Computer	

Figure 4-8 GPS Pro XR / Field Computer Connection Diagram

4.5 Pro XR GPS / Beacon Cabling

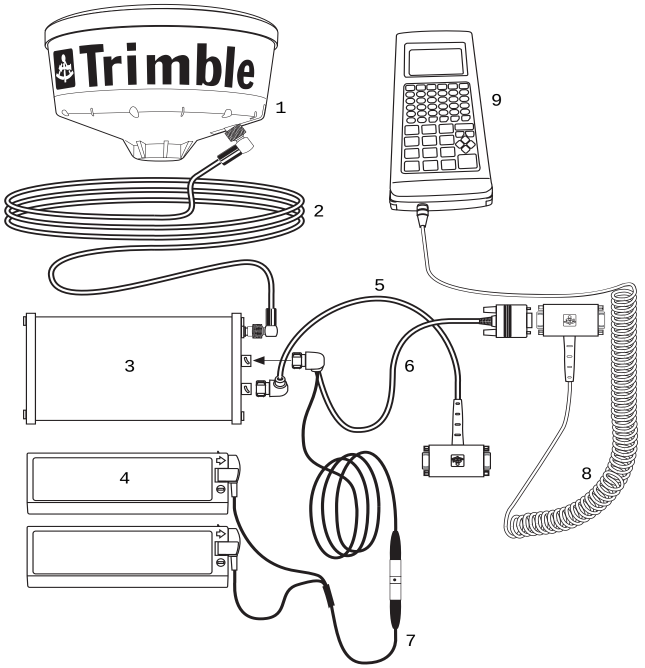
To use the TSC1 handheld with a Pro XR GPS/Beacon receiver, connect the system as shown in Figure 4-9.



1	P/N 29653-00	Integrated GPS/Beacon Antenna
2	P/N 22628	Antenna Cable
3	P/N 29654-11	12-channel Pro XR receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 32287-00	TSC1 Data/ESP Cable
9	P/N 29673-50	TSC1 Handheld

Figure 4-9 Pro XR GPS /Beacon / TSC1 Connection Diagram

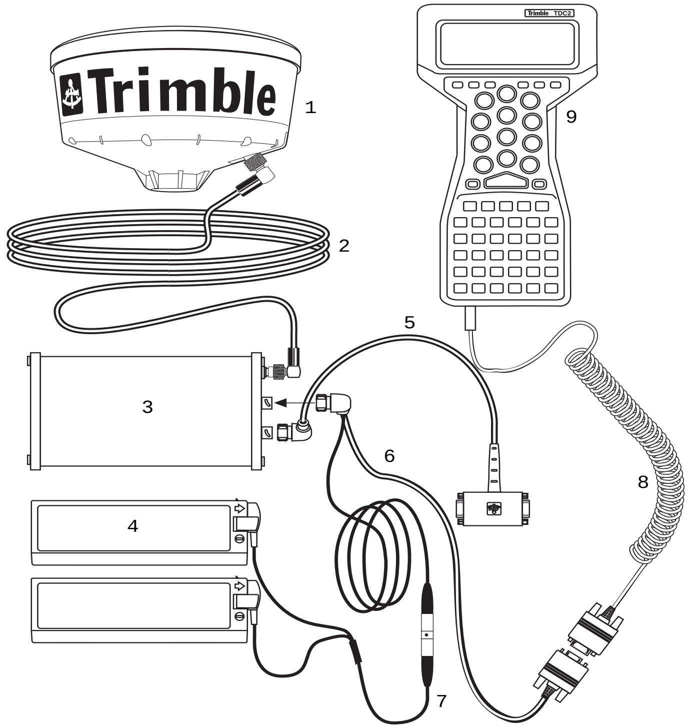
To use the TDC1 datalogger with a Pro XR GPS/Beacon receiver, connect the system as shown in Figure 4-10.



1	P/N 29653-00	Integrated GPS/Beacon Antenna
2	P/N 22628	Antenna Cable
3	P/N 29654-11	12-channel Pro XR receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30233-00	TDC1 Data/ESP Cable
9	P/N 21675-00	TDC1 Datalogger

Figure 4-10 Pro XR GPS / Beacon / TDC1 Connection Diagram

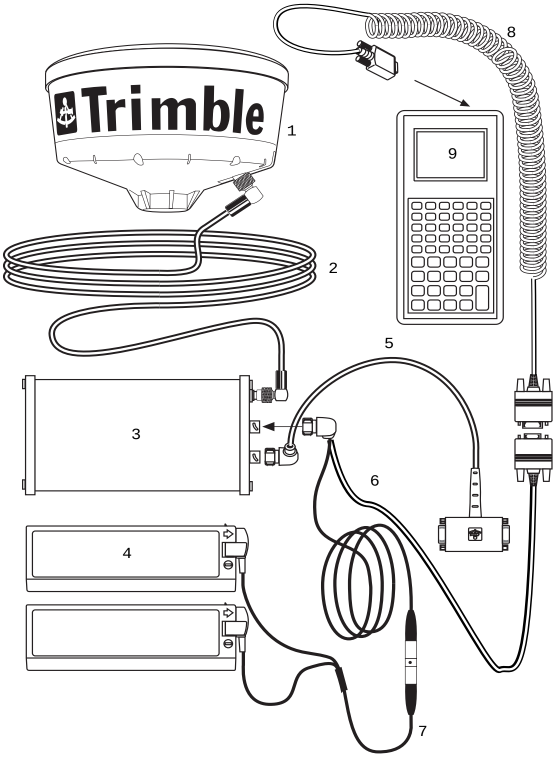
To use the TDC2 datalogger with a Pro XR GPS/Beacon receiver, connect the system as shown in Figure 4-11.



1	P/N 29653-00	Integrated GPS/Beacon Antenna
2	P/N 22628	Antenna Cable
3	P/N 29654-11	12-channel Pro XR receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30234	TDC2 Data Cable
9	P/N 28002-02	TDC2 Datalogger

Figure 4-11 Pro XR GPS / Beacon / TDC2 Connection Diagram

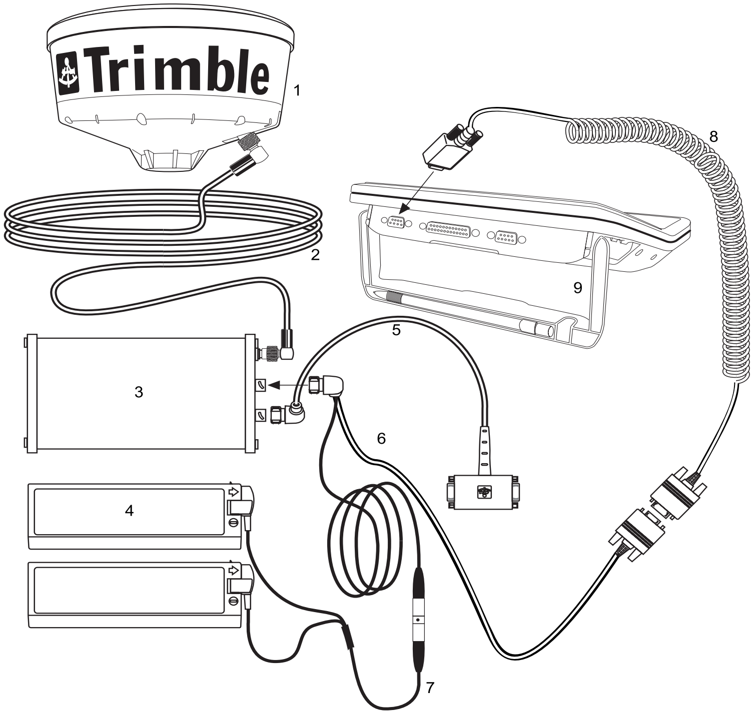
To use the MC-V datalogger with a Pro XR GPS/Beacon receiver, connect the system as shown in Figure 4-12.



1	P/N 29653-00	Integrated GPS/Beacon Antenna
2	P/N 22628	Antenna Cable
3	P/N 29654-11	12-channel Pro XR receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30236	Field Computer/MC-V Data Cable
9	P/N 17663-30	MC-V Datalogger

Figure 4-12 Pro XR GPS / Beacon / MC-V Connection Diagram

To use a notebook or pen computer with a Pro XR GPS/Beacon receiver, connect the system as shown in Figure 4-13.

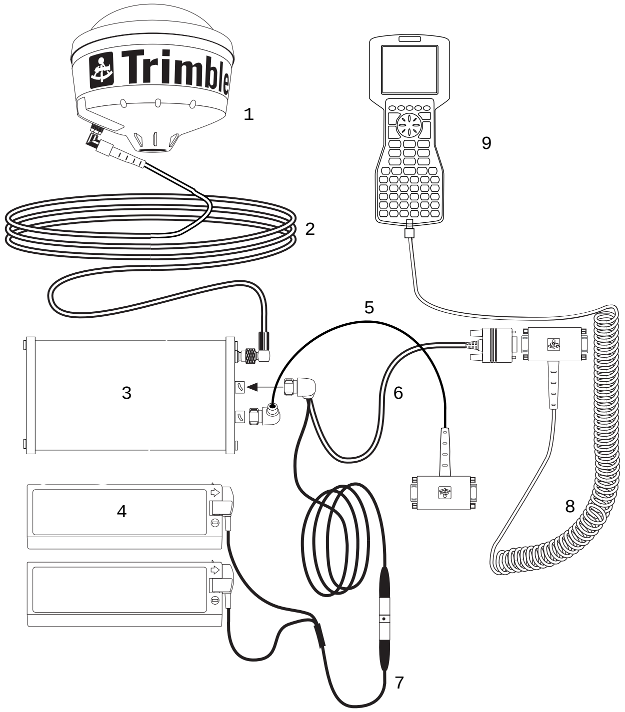


1	P/N 29653-00	Integrated GPS/Beacon Antenna
2	P/N 22628	Antenna Cable
3	P/N 29654-11	12-channel Pro XR receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30236	Field Computer/MC-V Data Cable
9	Field Computer	

Figure 4-13 Pro XR GPS / Beacon / Field Computer Connection Diagram

4.6 Pro XRS Cabling

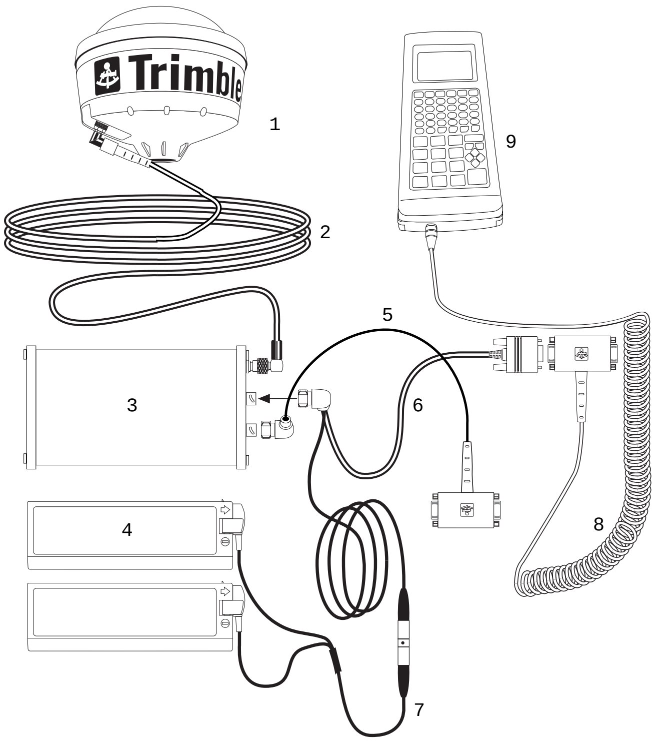
To use the TSC1 handheld with the Pro XRS receiver, connect the system as shown in Figure 4-14.



1	P/N 33580-50	Combined L1 GPS/MSK Beacon/ Satellite Differential Antenna
2	P/N 22628	Antenna Cable
3	P/N 33302-50	12-channel Pro XRS receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 32287-00	TSC1 Data/ESP Cable
9	P/N 29673-50	TSC1 Handheld

Figure 4-14 Pro XRS / TSC1 Connection Diagram

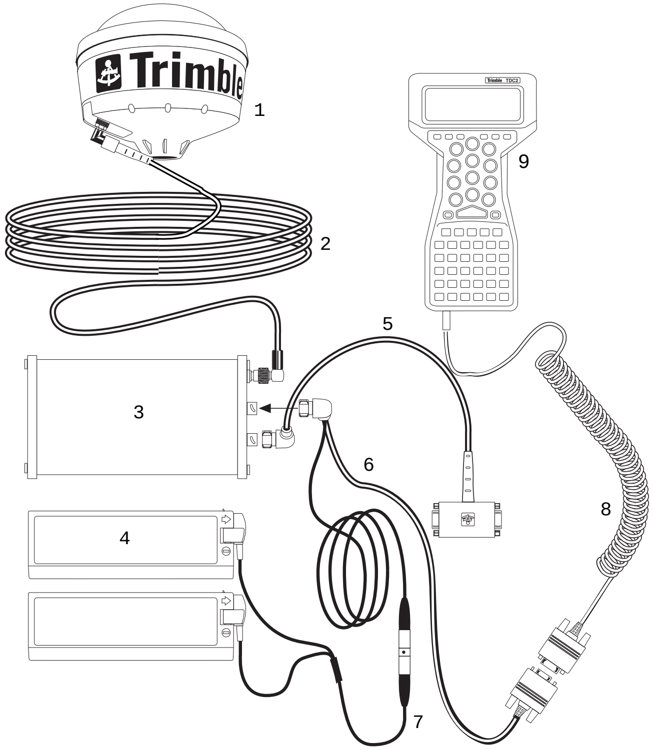
To use the TDC1 datalogger with the Pro XRS receiver, connect the system as shown in Figure 4-15.



1	P/N 33580-50	Combined L1 GPS/MSK Beacon/ Satellite Differential Antenna
2	P/N 22628	Antenna Cable
3	P/N 33302-50	12-channel Pro XRS receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30233-00	TDC1 Data/ESP Cable
9	P/N 21675-00	TDC1 Data Logger

Figure 4-15 Pro XRS / TDC1 Connection Diagram

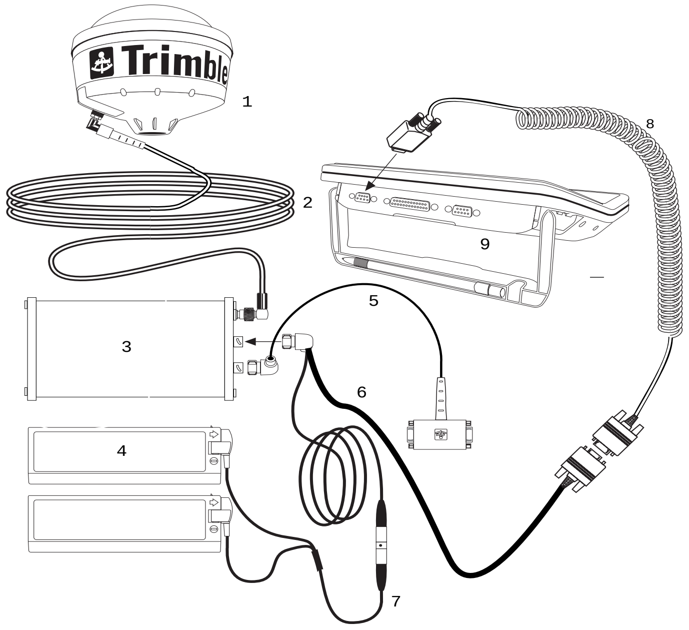
To use the TDC2 datalogger with the Pro XRS receiver, connect the system as shown in Figure 4-16



1	P/N 33580-50	Combined L1 GPS/MSK Beacon/ Satellite Differential Antenna
2	P/N 22628	Antenna Cable
3	P/N 33302-50	12-channel Pro XRS receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30234	TDC2 Data Cable
9	P/N 28002-02	TDC2 Data Logger

Figure 4-16 Pro XRS / TDC2 Connection Diagram

To use a notebook or pen computer with the Pro XRS receiver, connect the system as shown in Figure 4-17.



1	P/N 33580-50	Combined L1 GPS/MSK Beacon/ Satellite Differential Antenna
2	P/N 22628	Antenna Cable
3	P/N 33302-50	12-channel Pro XRS receiver
4	P/N 17466	Camcorder Batteries
5	P/N 30232-00	NMEA/RTCM Cable
6	P/N 30231-00	Data/Power Cable
7	P/N 24333	Dual Battery Cable
8	P/N 30236	Field Computer/MC-V Data Cable
9	Field Computer	

Figure 4-17 Pro XRS / Field Computer Connection Diagram

4.7 Pro XR/XRS System Hip Pack

The Pro XR and Pro XRS systems come equipped with an ergonomic hip pack carrying system, see Figure 4-18. The receiver, batteries and antenna are carried in the field using this hip pack/strapping system.

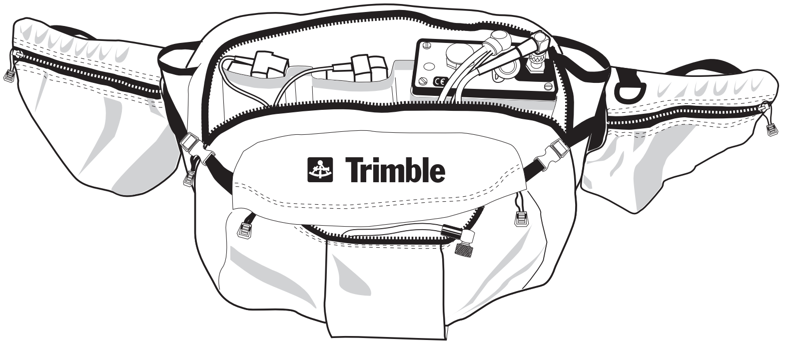


Figure 4-18 Pro XR/XRS System Hip Pack

4.7.1 Pro XR/XRS Hip Pack Contents

The Pro XR and Pro XRS systems are packed so that they are almost ready for use. The items not included in the hip pack are three 1-foot antenna poles, one 6-inch antenna pole and the data collector cable (P/N 30233-00 for TDC1, P/N 30234 for TDC2, or P/N 30236 for Field Computer/MC-V). These are located inside the shipping case.

The large interior of the hip pack contains: the Pro XR or Pro XRS receiver, two camcorder batteries, the power/data cable, and the camcorder power cable. All of these are set up inside the pack and ready for use. The exterior pocket of the hip pack contains a 3-meter antenna cable attached to the receiver and routed through a passage between the large interior pocket and exterior pocket. Both the data collector cable and antenna are routed out of the exterior pocket through the double zipper.

To route the data collector cable:

1. Locate the data collector cable and connect it to the data power cable, DE-9 connector labeled TO RECEIVER.
2. Once connected, feed the coiled cable through the passage and into the exterior pocket.

4.7.2 Wearing and Adjusting the Hip Pack

The Pro XR/XRS hip pack, once adjusted to suit, is comfortable and easy to use. See Figure 4-19.

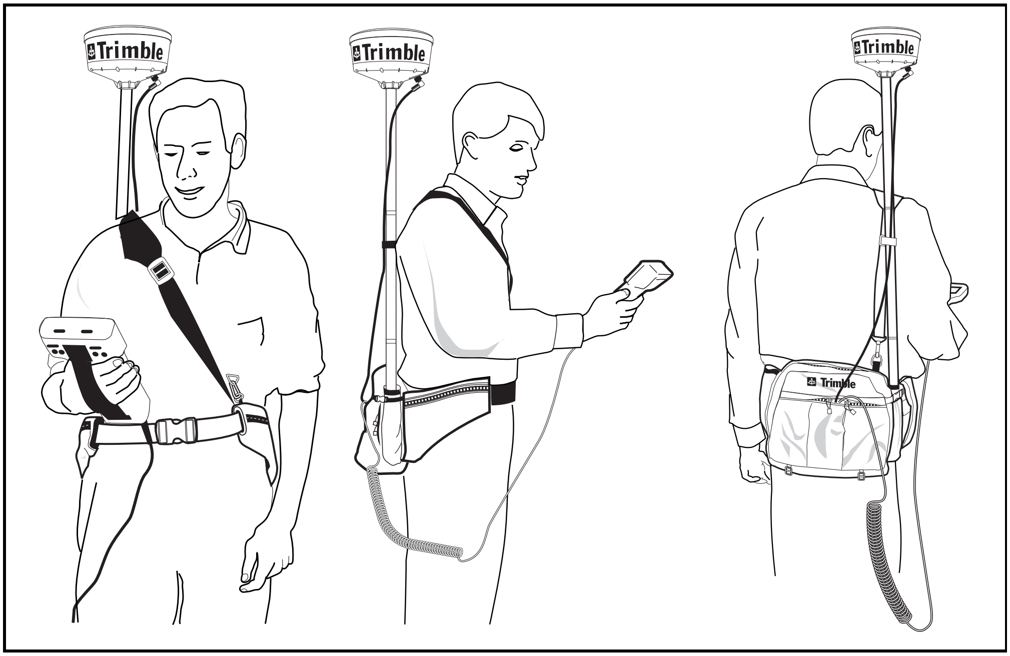


Figure 4-19 View of Hip Pack Setup

Antenna

When wearing the hip pack, the antenna height should be 3-4 inches above your head. The number of antenna pole sections required varies depending on your height. For example, if you are 5'5" tall, you may need two 1-foot and one 6-inch pole sections. If you are 6’2" tall, you may need three 1-foot poles. Try out different pole heights.

To set up the antenna with the hip pack:

1. Attach the pole sections together and connect the antenna onto the top of the pole sections.
2. Attach the pole/antenna to the hip pack.
3. Choose the side of your body that you prefer the antenna to be on and slide the pole sections into the small sleeve on that side of the hip pack.

Hip Pack and Strap

To adjust the hip pack and strap:

1. Connect the strap to the rear D-ring on the side of the pack on which the antenna is located.
2. Connect the other end of the strap to the D-ring on the belt on the opposite of the bag.
3. Slide the antenna pole through the velcro connection on the strap.
4. Put the strap over your head and across your opposite shoulder.

   At this point, the shoulder strap should lead naturally from the antenna pole across your chest to the belt.
5. Buckle the hip pack around your waist/hip area so that the belt buckle is centered in the middle of your body.

   The pack should adjust to fit close to the small of your back.

6. Adjust the front and back straps so the shoulder strap is situated squarely on your shoulder.
7. Put the pack on by slipping the strap over your head and across your body and then buckling the belt of the hip pack.

   The hip pack includes side compression straps that can be pulled towards you to hold the pack firmly and comfortably against your back.

Remove the hip pack/strap by unbuckling the belt and slipping the strap over your head.

The hip pack and strap can also double as a shoulder bag. Tuck the belt portion of the pack into the webbing material on the back of the pack and hook the strap on the large D-rings of the pack. The unit can now be carried on your shoulder instead of around your waist.

The pack has extra room in the interior and exterior pockets for additional items you may need in the field. The hip pack also includes straps on the bottom of the pack to secure an extra sweater or coat while in the field.

4.8 Optional Range Poles and Tripods

Range poles and tripods are very useful when collecting carrier phase data. The height of the antenna can be accurately measured, and the antenna can be held still easily, compared to an antenna mounted from the hip pack.

4.9 Optional Vehicle Kit

The optional vehicle kit contains a number of useful accessories for working in a car, boat, or plane. The vehicle kit contains the magnetic mount, vehicle power (cigarette lighter) to TA3-F (battery) adapter, and quick-release and two adapters.

Use the magnetic mount in a car, boat, or plane to provide maximum stability for the antenna. The hip pack can be kept inside the vehicle and the antenna cable fed through a window. Do not crush the antenna cable.

Use the quick-release to provide a little more height for the antenna so it is easier to connect the antenna cable. The quick-release adapters allow the antenna to be quickly removed and placed on a range pole.

Use the vehicle power adapter to power the Pro XR or Pro XRS instead of the camcorder batteries.

A Upgrading Receiver Firmware

This appendix provides instructions for upgrading the firmware in the Pro XR or Pro XRS receiver. First you connect the receiver to an office computer, then you upgrade the firmware from the office computer, using the upgrade files.

A.1 Downloading the Firmware Files

Upgrade firmware files can be downloaded from Trimble's FTP site at ftp://ftp.trimble.com/pub/mapping/bin.

If you have a Pro XR receiver, download `xr_`*nnn*`.exe`, where *nnn* is the version number of the firmware. For example, the filename for firmware version 1.10 is called `xr_110.exe`. This is a self-extracting zip file. Run the executable file from DOS or Windows to extract the firmware file. This will have the same name with an extension of `.tnr`.

If you have a Pro XRS receiver, download `xrs_`*nnn*`.exe`, where *nnn* is the version number of the firmware. For example, the filename for firmware version 1.10 is called `xrs_110.exe`. This is a self-extracting zip file. Run the executable file from DOS or Windows to extract the firmware file. This will have the same name with an extension of `.tnr`.

If you do not already have Trimble's Flash Loader 100 software installed on your computer, you will need to download and install this program. Download the file `fl100v11.exe`, which is an installation program for the Flash Loader 100 software. To install the software, run the executable file from within Windows.

Note – Later versions of the Flash Loader 100 software may become available. To ensure you have the latest version of the software, download the file `fl100v`*nn*`.exe`, where *nn* is the highest version number present.

A.2 Connecting the Cables

To connect a Pro XR or Pro XRS receiver to the PC:

1. Connect the AC power adapter (P/N 31197) to the TA3 (male) connector on the GPS receiver data/power cable (P/N 30231-00). Then connect the AC power adapter to a suitable AC power outlet.
2. Connect the DE-9 connector on the GPS receiver data/power cable (P/N 30231-00) to COM port 1 or COM port 2 on the PC.

The GPS receiver data/power cable must be connected to the receiver. A standard serial cable can extend the reach of the data/power cable to the PC.

Caution – Cable 30231-00 contains 3 connectors, a DE with 9 pins that connects to the PC or data collector (depending on the operation), a 12-pin that connects to the receiver, and a 3-pin that connects to the power supply. In this operation, the DE-9 connects to the PC, the 12-pin connects to port B of the receiver, and the 3-pin connects to the power supply. Pin 9 of the DE-9 connector is powered by the receiver at 12 volts DC with 1 amp capability. This is used to charge the battery in the data collector (TDC1 or TDC2) when connected to this device, but is not necessary in this operation. Consult with your PC documentation before connecting this pin to your PC.

A.3 Upgrading the Receiver Firmware

To perform the receiver firmware upgrade, use a computer with the Flash Loader 100 software installed and the appropriate `.tnr` file. For details on which files you need, refer to Section A.1, Downloading the Firmware Files.

To upgrade the receiver firmware:

1. On your PC, start the Flash Loader 100 program by double-clicking on its desktop icon or by selecting Flash Loader 100 from the Programs menu.
2. By default, the software assumes that the receiver is connected to COM1 on your computer. You can change this manually by selecting Options / Settings from the menu. Alternatively, press **Find Receiver** to let Flash Loader 100 determine which port the receiver is connected to.
3. Check the box labeled *Upload new firmware*.

   A standard File Open dialog appears.
4. Navigate to the folder where you downloaded the `tnr` file from Trimble's FTP site. Select it and press **OK**.

   The software will take a few seconds to process this file.
5. Press **Proceed** to upload the new firmware to the receiver.

   This may take several minutes.
6. When the process is complete, close the Flash Loader 100 program by clicking the cross in the top-right corner of the window.

Warning – Do not turn off your computer or disconnect power to your receiver. Do not disconnect the cables between the PC and the receiver. Doing this will interrupt the update process.

B Specifications

Table B-1 lists specifications for the Pro XR and Pro XRS receivers.

Table B-1 Pro XR/XRS Receiver Specifications

Parameter	Specification
General	Fully sealed, dustproof, waterproof, shock resistant
Update Rate	1 Hz
Time to First Fix	<30 seconds, typical
Size	11.1cm x 5.1cm x 19.5cm (4.4" x 2" x 7.7")
Weight	0.76 kg (1.68 lbs)
Power	5 watts (maximum)
Temperature	-30°C to 65°C (-22°F to 149°F) Operating -40°C to 85°C (-40°F to 185°F) Storage
Humidity	100% non-condensing

Table B-2 and Table B-3 list specifications for the Pro XR antennas.

Table B-2 Integrated GPS/Beacon Antenna Specifications

Parameter	Specification
General	Right-hand, circular polarized; omnidirectional; hemispherical coverage
Size	15.5cm diameter x 10.8 cm high (6.1" x 4.2")
Weight	0.49 kg (1.08 lbs)
Temperature	-30°C to 65°C (-22°F to 149°F) Operating -40°C to 85°C (-40°F to 185°F) Storage
Humidity	100% fully sealed
Case	Dustproof, waterproof, shock resistant

Table B-3 Compact Dome GPS-Only Antenna Specifications

Parameter	Specification
General	Right-hand, circular polarized; omnidirectional; hemispherical coverage
Size	15.4 cm diameter x 8.9 cm high (6" diameter x 3.5" high)
Weight	0.25 kg (0.55 lbs)
Temperature	-40°C to +70°C operating -40°C to +70°C storage
Humidity	Will operate at 100% humidity
Case	Dustproof, splashproof, shock resistant

Table B-4 lists specifications for the Pro XRS antenna.

Table B-4 Combined L1 GPS/Beacon/Satellite Differential Antenna Specifications

Parameter	Specification
General	Right-hand, circular polarized; omnidirectional; hemispherical coverage
Size	15.5 cm diameter x 14 cm high (6.1” x 5.5”)
Weight	.55 kg (1.2 lb)
Humidity	100% fully sealed
Case	Dustproof, waterproof, shock resistant

Table B-5 lists the pinout diagram for the Data/Power Cable.

Table B-5 Data/Power Cable Pinout (P/N 30231-00)

To Pro XR Receiver			Data Collector	Input Power	
Conn P1		7 Cond Cbl #1	Conn P2 DE9-F	2 Conn Cbl #2	Conn P3 TA3-M
Event In	1 in	—	—	—	—
TXD	2 out	Orange	2 RXD	—	—
RXD	3 in	Red	3 TXD	—	—
Chg Ctrl	4 in	Black	4 DTR	—	—
Sig Gnd	5 in/out	Shield	5 Sig Gnd	—	—
DSR	6 out	Yellow	6 DSR	—	—
Pwr On	7 in	Brown	7 RTS	—	—
CTS	8 out	Green	8 CTS	—	—
Charge	9 out	Blue	9 RI	—	—
V+ In	10 in	—	—	White	1 V+ In
V- In	11 in	—	—	Black	2 V- Out
PPS	12 —	—	—	—	—

Table B-6 lists the pinout diagram for the NMEA/RTCM Cable.

Table B-6 NMEA/RTCM Cable Pinout (P/N 30232-00)

To Pro XR Receiver			NMEA/RTCM Output Connectors		
Conn P1		**9 Cond Cbl #1**	**Conn P2 DE9-M**	**7 Conn Cbl #1**	**Conn P3 DE9-F**
Event In	1 in	—	—	—	—
TX- (232)	2 out	—	—	Orange	2 TXD
RX- (232)	3 in	Red	2 RXD	—	—
Chg Ctrl	4 in	—	—	Shield	
Sig Gnd	5 in/out	Shield	5 Sig Gnd	—	5 Sig Gnd
TX+ (422)	6 out	—	—	—	
Pwr On	7 in	—	—	—	—
RX+ (422)	8 out	—	—	—	—
Charge	9 out	Yellow	9 Pwr	—	—
V+ In	10 in	—	—	—	—
V- In	11 in	—	—	—	—
PPS	12 —	—	—	Brown	4 DTR

Table B-7 lists the pinout diagram for the TSC1 Data Cable.

Table B-7 TSC1 Data Cable Pinout (P/N 32287-00,-10)

To Pro XR Receiver Cable	TSC1 Data Logger	
Conn P1 LEMO OB-M	**7 Cond Cbl #1**	**Conn P2 DE9-M**
Charge 6 in	Black	9 Charge
RXD1 7 in	Red	2 RXD1
Pwr On 4 out	Blue	4 Chg Ctrl
Pwr On 4 out	White	7 Pwr On
TXD1 3 out	Brown	3 TXD1
Gnd 1.2 in/out	Shield	5 Sig Gnd
Charge 5 in	Green	8 RTS

Table B-8 lists the pinout diagram for the TDC1 Data/ESP Cable.

Table B-8 TDC1 Data/ESP Cable Pinout (P/N 30233-00)

To Pro XR Receiver Cable		TDC1 Data Logger		
Conn P1 Hirose-M	**9 Cond Cbl #1**	**Conn P2 DE9-M**	**9 Conn Cbl #1**	**Conn P3 DE9-M**
Sig Gnd 1 in/out	Shield	5 Sig Gnd	Shield	5 Sig Gnd
TXD1 2 out	Yellow	2 RXD1	—	—
RXD1 3 in	Red	3 TXD1	—	—
RXD2 4 in	—	—	Brown	2 RXD2
Pwr In 5 in	Black	9 Charge	—	—
TXD2 6 out	—	—	Orange	3 TXD1
Pwr On 10 out	Blue	4 Chg Ctrl	—	—
Pwr On 10 out	Green	7 Pwr On	—	—

Table B-9 lists the pinout diagram for the TDC2 Data Cable.

Table B-9 TDC2 Data Cable Pinout (P/N 30234)

To Pro XR Receiver	TDC2 Datalogger	
Conn P1 Fischer 5-M	**7 Cond Cbl #1**	**Conn P2 DE9-M**
Charge 1 in	Black	9 Charge
RXD1 2 in	Red	2 RXD1
Pwr On 3 out	Blue	4 Chg Ctrl
Pwr On 3 out	Green	7 Pwr On
TXD1 4 out	Brown	3 TXD1
Gnd 5 in/out	Shield	5 Sig Gnd

Table B-10 lists the pinout diagram for the Field Computer/MC-V Data Cable.

Table B-10 Field Computer/MC-V Data Cable Pinout (P/N 30236)

To Pro XR Receiver	MC-V Datalogger Field Computer	
Conn P1 DE9-F	**7 Cond Cbl #1**	**Conn P2 DE9-M**
Event In 1 out	White	1 CD
TXD 2 in	Orange	2 RXD
RXD 3 out	Red	3 TXD
Chg Ctrl 4 out	Black	4 DTR
Sig Gnd 5 in/out	Shield	5 Sig Gnd
DSR 6 in	—	6 DSR
Pwr On 7 out	Brown	7 RTS
CTS 8 in	Green	8 CTS
Charge 9 in	Blue	9 RI

C Trimble Mapping & GIS Training Programs

This appendix describes Trimble Mapping & GIS training courses for the Pro XR/XRS receiver and the types of training options available.

C.1 Training Courses

The following courses are offered for the Pro XR/XRS receiver.

C.1.1 Introduction to Pro XR™ with Asset Surveyor™

This three-day course is designed for instruction on Asset Surveyor software with Pro XR/XRS or Pro XL receivers. Students also learn the processing software, Pathfinder Office.

The course includes the following:

- Completion of a GPS/GIS data collection project
- Mission planning and data dictionary creation
- Hands-on field exercises
- Data processing and analysis
- GIS data export and import

C.1.2 Introduction to Pro XR with ASPEN™

This three-day course is designed for instruction on ASPEN software with Pro XR/XRS receivers. Students also learn the processing software, Pathfinder Office.

The course includes the following:

- Completion of a GPS/GIS data collection project
- Mission planning and data dictionary creation
- Hands-on field exercises
- Data processing and analysis
- GIS data export and import

C.2 Training Options

There are two options for taking Trimble's Mapping & GIS training courses:

1. Onsite Training

   Hire a Trimble trainer to come to your site. Onsite training allows you to train a group of people in a comfortable, familiar environment. You supply the facility, computers, and equipment. Using your equipment, you can customize the curriculum to include field exercises that mimic the jobs you do most.

2. Trimble Certified Training

   Hire a Trimble Certified Trainer, authorized by Trimble to instruct introductory classes. Training can be at your site or the trainer's location. You negotiate pricing and scheduling directly with the Trimble Certified Trainer.

More detailed information about training is available on the Internet at **`www.trimble.com/support`**. The following information is included:

- Up-to-date course descriptions
- List of Trimble Certified Trainers near you
- Training schedules
- Travel information
- Registration forms

C.2.1 Onsite Training

For more information about onsite training, contact one of the following offices:

- Sunnyvale, California (+1-408-481-2038)
- Christchurch, New Zealand (+64-3-339-1400)
- Hook, England (+44-1-256-746-221)

C.2.2 Trimble Certified Training

For a list of Trimble Certified Trainers, visit the Trimble World Wide Web site at **`http://trimble.com/support`** and click *Mapping & GIS Systems* under the heading *List of Certified Trainers*, or call the Training Center at +1 408-481-2038.

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Reader Comment Form

Pro XR/XRS Receiver Manual — **May 1998**
P/N: 31172-20 — **Revision: A**

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I use the following Trimble product__________ ____ ,

for ____

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1 = Strongly Agree 2 = Agree 3 = Neutral 4 = Disagree 5 = Strongly Disagree

The manual is well organized	1	2	3	4	5
I can find the information I want.	1	2	3	4	5
The information in the manual is accurate.	1	2	3	4	5
I can easily understand the instructions.	1	2	3	4	5
The manual contains enough examples.	1	2	3	4	5
The examples are appropriate and helpful.	1	2	3	4	5
The layout and format are attractive and useful.	1	2	3	4	5
The illustrations are clear and helpful.	1	2	3	4	5

The manual is: too long just right too short

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