

Placer™ GPS 450/455

Installation and Operations Manual

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Quick Reference Guide

The Placer™ GPS 450 and the Placer™ GPS 455 provide vehicle location and status reporting using state-of-the-art, 8-channel, GPS receiver technology. The receiver supports standard positioning data formats and multiple I/O ports to optimize vehicle to office communications. Following is a quick overview of the primary steps required to install and operate the Placer GPS 450 and 455 equipment. It is strongly recommended that you also review the information provided in this manual before using the Placer GPS 450 and 455 sensors.

Step 1: The Antenna Connection

The Placer GPS 450 and 455 require a GPS antenna. This can be either a magnetic mount antenna and attached cable, or a permanent mount antenna (also known as hard mount) and separate cable. The antenna cable supplies power from the Placer unit to the preamplifier in the antenna unit and conducts the received satellite signals to the Placer. Connect the cable's small SMB push-on connector to the antenna connector on the Placer unit. For hard mount antennas, connect the cable's threaded connector to the antenna.

Remember, your antenna must be located outdoors to receive GPS satellite signals and compute your position.

Step 2: The Data Port Connection

If you connect the Placer directly to a personal computer, you may use any serial communications software package (e.g. Windows Terminal, Procomm etc.) to send and receive data.

The Placer GPS 450

The Placer GPS 450 has two RS-232 data I/O connectors: Radio connector and the MDT connector.

Radio Connector	By default, this port provides a Trimble ASCII Interface Protocol (TAIP) over a modem/radio. It is DB9F with DTE pinouts. Connect your CDPD modem or the MAP27 radio/modem to this port. If you have a Placer GPS 450 MAP27 you can disable the communication protocol and connect your DTE directly to the unit, without the radio. In this DIRECT mode the unit continues to talk TAIP message protocol (see TAIP message PC, >SPCMD< disables the MAP27 communication protocol).
MDT Connector	This port provides a TAIP interface, with no communications. It is DB9F with DCE pinouts. You can use this port to configure the unit by connecting a laptop PC running a terminal emulation program (9600, 8,1,None) such as Windows Terminal (please see Chapter 3, for launching Windows Terminal program) and issuing TAIP messages (please see Appendix A for a complete list of TAIP messages).

The Placer GPS 455 & 455DR

The Placer GPS 455 has three RS-232 data I/O ports: Radio connector and the MDT/RTCM connector, which is physically a single connector but provides interface to two separate I/O ports. Connect to the MDT/RTCM port using the Communications cable supplied (for the Placer GPS 455, this cable must be ordered separately) which is terminated with a single DB9M at one end and at the other end the cable is split, providing two DB9 connectors: one for connection to the MDT and the other for input of RTCM-104 data (please see Fig.1-5).

Radio Connector	By default, this port provides a Trimble ASCII Interface Protocol (TAIP) over a modem/radio. It is DB9F with DTE pinouts. Connect your CDPD modem or the MAP27 radio/modem to this port. If you have a Placer GPS 455 MAP27 you can disable the communication protocol and connect your DTE directly to the unit, without the radio. In this DIRECT mode the unit continues to talk TAIP message protocol (see TAIP message PC, >SPCMD< disables the MAP27 communication protocol).
MDT/RTCM Connector (MDT Side)	This port provides a TAIP interface. It is DB9F with DCE pinouts. You can use this port to configure the unit by connecting a laptop PC running a terminal emulation program (9600, 8,1,None) such as Windows Terminal and issuing TAIP messages (please see Appendix A for a complete list of TAIP messages). Connect to this using the Communications Cable supplied.
MDT/RTCM Connector (RTCM side)	This port is used to input RTCM-104 data on the Placer GPS 455 and 455DR differential ready units. Connect to this using the Communications Cable supplied.

The Interface Connections

Radio/Modem Connector Pinout (DTE)	
Pin #	Signal
2	Rx1
7	RTS1
3	Tx1
8	CTS1
5	Ground
1	unused
6	unused
4	unused

9	unused
MDT Connector Pinout (DCE)	
Pin #	Signal
2	Rx2
7	RTS2
3	Tx2
8	CTS2
5	Ground
1	unused
6	unused
4	unused
9	unused

Step 3: The Digital I/O Port Connection

If you want to monitor input lines or control the output lines provided by the Placer then you should connect these using the optional digital I/O cable. The Placer is triggered to send a time and position tagged message when it senses a contact closing to ground on any of the alarm signal wires. The digital I/O cable is terminated at the Placer end with a DB9 connector. The other end of the cable includes unterminated inputs, outputs, power and ground wires, these should be connected to the inputs you wish to monitor.

Step 4: The Power Connection

The Placer GPS 400 and 455 operate on input voltage from 9 to 32 volts. In all cases the red wire on the power cable is connected to battery (+) and the black wire is connected to vehicle ground. You can connect the Placer to either Switched Power or Continuous Power.

Switched Power	The “white” ignition sense wire on the power cable supplied is connected to ignition. When ignition is high the Placer will be powered and when ignition is turned off the Placer will also be switched off. The Placer draws 3.5W only when ignition is high.
Continuous Power	The “white” ignition sense wire on the power cable is connected to the vehicle’s battery (+). The Placer draws 3.5W at all times.

Step 5: Operation

When power is applied, the Placer will automatically search for GPS satellite signals and compute position. You should wait several minutes for the unit to acquire the satellite signals and calculate the first position fix. Once the unit has calculated a position, it should begin to respond to TAIP messages it receives on either the Radio port or the MDT port.

If you are using Trimble’s GPSSK or a serial communications software package you can issue simple TAIP message to query the Placer, as follows:

>QVR<	Issue this message to query the Placer’s name and software version
>QPV<	Issue this message to get position/velocity information.

Step 6: Configuring the Placer

You can configure the Placer by sending it appropriate TAIP messages (please see Appendix A for a complete list of messages and their description). You can do this by connecting a PC’s COM port to the Placer’s MDT/RTCM connector using either the Communications cable supplied or a straight-through cable. The PC’s COM port setting should be set up as follows: 9600, 8, 1, N. You can use any serial communications software package to send and receive TAIP messages.

Configuring Placer GPS 450/455 CDPD

You can customize the Placer GPS 450/455 CDPD by issuing the following TAIP messages:

Description	TAIP Message	Placer GPS 450/455
Set Dest Address	DA	Mandatory
Set Vehicle ID	ID	Optional
Set Protocol Control	PC	Optional
Set Report Mode	RM	Optional
Set Signal Status	SS	Optional
Set Time Distance Reporting	Scheduled Reporting Qualifiers 'D' or 'F'	Optional

The Destination Address message is mandatory only if time and distance reporting is required. If you do not set a destination address then the reports will be queued until a DA message is received from the base station. Responses to all query messages will, however, be sent to the address of the unit querying.

The Protocol Control (PC) message is available to specify how the autonomous reports and alarms are sent by the Placer GPS 450/455 CDPD to the base station. It defaults to sending all responses and messages generated by queries & alarms over the secured TCP channel and the time and distance autonomous reports over the UDP channel.

An extension of the Signal Status (SS) message is available to select the type of message to be reported on change in digital input status. The format is:

>SSS;MSG=xx<

where

xx = XS for XS message report
XT for XT message report,
XX for no report

Customizing Placer GPS 450/455 MAP27

You can customize the Placer GPS 450/455 MAP27 by issuing the following TAIP messages:

Description	TAIP Message	Placer GPS 450/ 455
Set Dest Address	DA	Mandatory
Set Vehicle ID	ID	Optional
Set Protocol Control	PC	Optional
Set Report Mode	RM	Optional
Set Signal Status	SS	Optional
Set Time Distance Reporting	Scheduled Reporting Qualifiers 'D' or 'F'	Optional

The Destination Address message is mandatory only if time and distance reporting is pre-configured and no MAP27 messages are sent to the Placer GPS 450/455 MAP27 from the base station. If you do not set a Destination address then the Placer GPS 450/455 uses the address of the last received TAIP message as the Destination until a DA message is received from the base station.

The Protocol Control (PC) message is available to restrict use of specific MAP27 message service if needed. For example, if messages are restricted to type SDM2 (short msgs), TAIP messages that do not fit the

SDM2 size restriction will be dropped.

An extension of the Signal Status (SS) message is available to select the type of message to be reported on change in digital input status. The format is:

>SSS;MSG=xx<

where

xx = XS for XS message report
XT for XT message report,
XX for no report

Customizing Placer GPS 455DR TAIP

Placer GPS 455DR TAIP has no communications protocol. It is, however, configured to speak TAIP message protocol on the 'Radio' connector. You can customize the Placer 455DR TAIP by issuing the following TAIP messages:

Description	TAIP Message	Placer GPS 455DR
Set Dest Address	not applicable	–
Set Vehicle ID	ID	Optional
Set Protocol Control	not applicable	–
Set Report Mode	RM	Optional
Set Signal Status	SS	Optional
Set Time Distance Reporting	Scheduled Reporting Qualifiers 'D' or 'F'	Optional

The Destination Address message is not needed; time and distance reports are sent to the Radio connector in TAIP format.

Step 7: The Heading Sensor Connection

The heading sensor can only be connected to a Placer GPS 455 unit. The DR Heading Sensor Cable connects the Placer and the heading sensor through DB9 connectors. Also, the Placer GPS 455DR needs signals from the vehicle's backup light to indicate direction of travel and the vehicle's odometer for distance traveled.

The heading sensor (gyroscope) must be rigidly mounted so the sensor's axes is vertical.

Connecting the Wires to the Vehicle

Connecting the Backup Signal	Connect the 'red' wire from the DR Sensor Cable to the positive side of your vehicle's backup light. Do NOT connect the 'black' backup ground wire.
Connecting the Vehicle Odometer	Connect the 'red' (signal) wire from the DR Sensor Cable labeled "ODO" to the vehicle's odometer signal. Do NOT connect the 'black' labeled Ground. The "OD1" cable is not used.

Calibrating the Heading Sensor

The odometer and the gyroscope sensors used in the Placer GPS 455DR system must be calibrated after installation for the system to function correctly. You should read the section on "Calibrating the Placer GPS 455DR" in Chapter 6 of this manual before running the calibration program, PLCRINIT.EXE. You can obtain this program from Trimble's Bulletin Board.

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Preface

Congratulations on your selection of the Placer GPS intelligent mobile sensor. You have purchased one of three models in this product family: the Placer GPS 450, the Placer GPS 455 or the Placer GPS 455DR. These models are described in Chapter 1 of this manual. Subsequent chapters provide the information you need to successfully install and operate the Placer GPS. The information is designed to get you up and running quickly and efficiently. Please review the remainder of this preface for an overview of this manual organization and conventions.

Manual Overview

This manual provides all the information required to install and operate the Placer GPS. It is designed to be a continuing source of instruction and reference as you use, install, and operate your Placer GPS equipment. Review the following chapter descriptions to determine the starting point for your reference.

Chapter 1, *Product Overview*, describes the three Placer GPS models, and includes a physical description and a functional overview of the product components.

Chapter 2, *Product Specifications*, lists the Placer GPS technical, environmental, and mechanical specifications.

Chapter 3, *Configuration*, covers the configuration process for customizing the Placer GPS operations for your application.

Chapter 4, *Installation*, provides detailed instructions for installing the Placer GPS 450 equipment.

Chapter 5, *Operation*, describes the operation of the Placer GPS 450.

Chapter 6, *Placer GPS 455 and 455DR: Installation and Operation*, provides additional information critical to successful installation and operation of the Placer GPS 455 and 455DR.

Appendix A, *Trimble ASCII Interface Protocol*, describes the TAIP communications protocol.

Conventions Used in This Manual

Annotations

Annotations are used extensively in this manual to highlight important information.



Special notes and tips are prefaced with the light bulb icon. Pay particular attention to this information.



Notes indicating potential hazards are prefaced with a lightning bolt icon. Caution notes describe operating procedures and practices required for correct operation. Failure to follow these recommendations could result in equipment malfunction, permanent equipment damage, and/or improper equipment operation.



Information regarding computer software is indicated by the diskette icon.



Operations that require computer interaction are prefaced with the keyboard icon.



Step-by-step computer instructions are indicated by the mouse icon.

Chapter 1

Product Overview

The Placer GPS 450 and the Placer GPS 455 provide vehicle location and status reporting using state-of-the-art, 8-channel, GPS receiver technology. The receivers support standard positioning data formats and multiple I/O ports to optimize vehicle to office communications.

The Placer GPS 450. The Placer GPS 450 features a receiver processing unit, a GPS antenna, and three RS-232 serial connectors for interfacing to a radio/modem, a mobile data terminal (MDT), and external alarms or relays. The Placer GPS 450 incorporates two alarm interface/event marker inputs which allow the Placer to output a time and position tagged message when it senses a contact closing to ground on any of the alarm signal wires.

The Placer GPS 455. The Placer GPS 455 offers all the features found in the Placer GPS 450 plus Differential GPS (DGPS) capability. The Placer GPS 455 is also field upgradeable to add dead reckoning capability. The Placer GPS 455 circuitry combines GPS and DR to provide uninterrupted, reliable position reporting during periods when the GPS satellites are obstructed from view

The Placer GPS 455DR. The Placer GPS 455DR offers all of the features found in the Placer GPS 455 plus a heading sensor for dead reckoning operation. The heading sensor is a piezoelectric, solid state gyro which provides the heading rate input required for the Placer to calculate dead reckoning (DR) based position data. The Placer is equipped with configurable conditioning circuitry to accept analog odometer and digital odometer signals. In addition, the Placer GPS 455DR is differential capable.

Functional Overview

The Placer GPS receiver processing unit is an 8-channel GPS Standard Positioning Service (SPS) receiver that provides worldwide, day-and-night, all-weather, position, speed, heading, and time data. GPS satellite signals are collected by the Placer GPS fixed pattern antenna, and then amplified by the antenna's preamp for transmission over coaxial cable to the Placer. The Placer GPS incorporates eight processing channels for managing satellite signal tracking and signal decoding. Once installed and configured, Placer operates without user intervention.

The Placer GPS incorporates a high performance microprocessor to calculate position, speed, heading and time, based on the satellite data. The Placer GPS is designed to interface with personal computers, mobile data terminals, modems, data radios and other communication equipment. Data communication occurs over three RS-232 interface channels. Com Port 1 provides a Trimble ASC II Interface Protocol (TAIP) over a modem/radio. Com Port 2 is a TAIP interface to a mobile data terminal (MDT). Any TAIP TX (text) messages sent to the Placer GPS over the modem/radio are passed through to the MDT; TX messages generated by the MDT are sent out through Com Port 1 over the modem/radio. Com Port 3, in the Placer 455 and 455DR products, it is used for differential GPS connections in RTCM format.

The Placer GPS 455 is capable of operating in differential GPS mode. Differential GPS is a more sophisticated form of GPS navigation which provides even greater positioning accuracy. Differential GPS relies on error corrections transmitted from a GPS receiver placed at a known location. This receiver, called a reference station, calculates the error in the satellite range data and broadcasts corrections to other receivers in the same locale. Differential GPS eliminates virtually all the measurement error in the satellite ranges and enables a highly accurate position calculation.

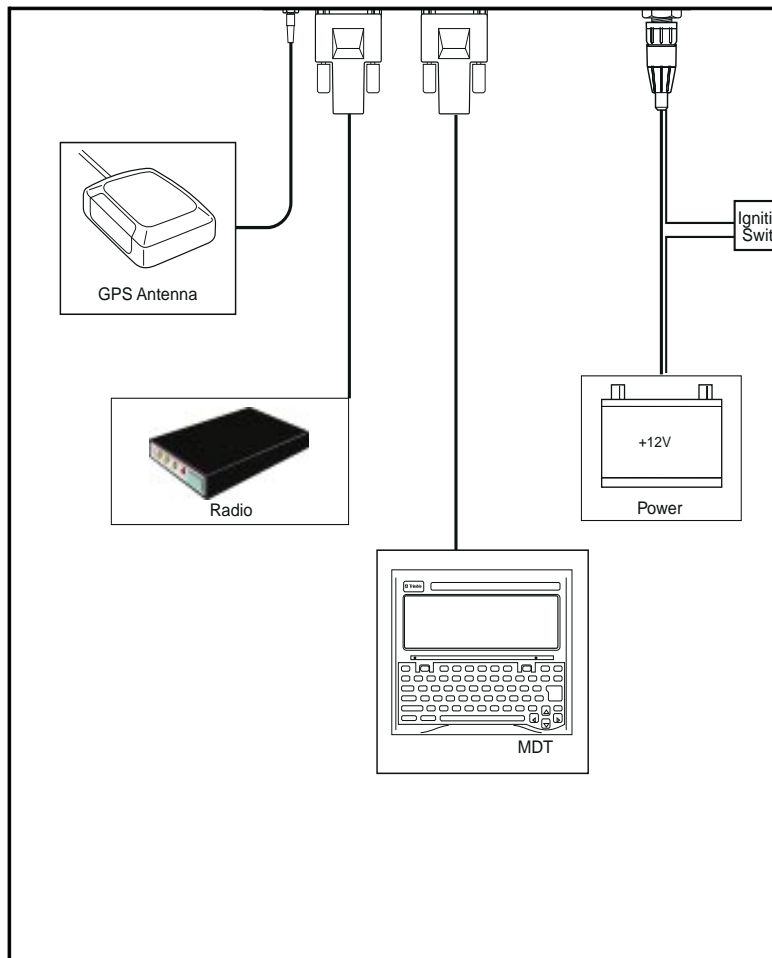
With the Placer GPS 455DR, GPS-based position information is augmented by dead reckoning (DR) to provide position information in areas where satellite signals are blocked by surrounding buildings, structures, or terrain. The Placer uses inputs from a heading sensor, pulses from an odometer, and a signal from the vehicle's backup light to dead reckon the vehicle's current position when GPS is unavailable. The unit automatically switches back to a combination of DR and GPS when satellite signals are available. The Placer GPS 455DR is described in Chapter 6 of this manual.

The Placer GPS 450

The Placer GPS 450 consists of a receiver processing unit, a GPS antenna, and the associated cables for connection to your communications equipment, the antenna and power.

The Placer GPS 450 system components are illustrated in Figure 1-1 and described in the following sections.

Figure 1-1
Placer 450
Interconnect Diagram

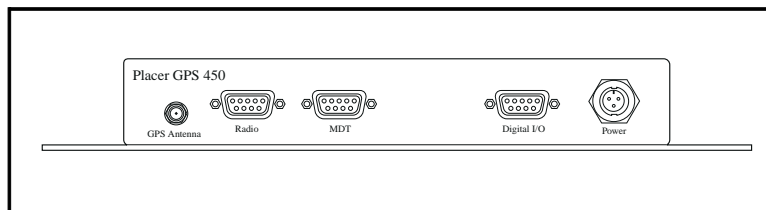


The Receiver/Processing Unit

The receiver/processing unit is the hub of the Placer GPS sensor. The Placer GPS 450 processes the satellite signals from the antenna; computes position, speed, heading and time; and manages communications with your peripheral equipment.

The Placer has a single printed circuit assembly (PCA) housed in a rugged metal enclosure. The metal enclosure serves as a Faraday cage for RFI shielding. The Placer provides three RS-232, DB-9 connectors for connection to your communications equipment. The 8-channel GPS receiver, the power supply, and the interface circuitry reside on the PCA. The Placer supports input voltages from 10 volts to 32 volts. The interface circuitry controls communications with the equipment connected to the RS-232 serial ports.

Figure 1-2
Placer 450



The Placer GPS 450 Digital I/O port features two alarm signal inputs. When the Placer receives a contact closing signal from an external alarm (not supplied), a time and position tagged message is output in the Trimble ASCII Interface Protocol (TAIP) format. The Digital I/O port also provides for two general purpose digital outputs.

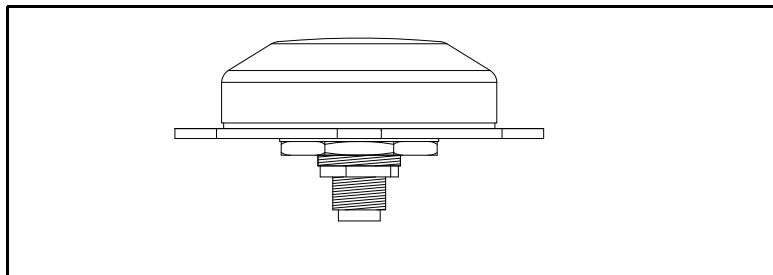
A long-life (lithium) battery maintains critical data in internal memory. In the absence of external power, the lithium battery maintains user configuration changes and reduces time to first fix at power-on.

The GPS Antenna

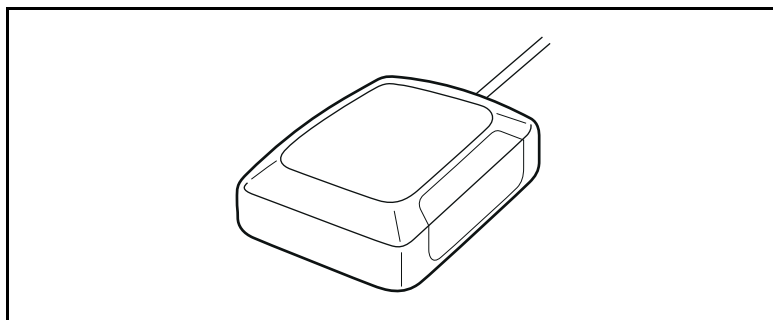
The antenna receives the GPS satellite signals, and amplifies them for transmission over the coaxial antenna cable to the Placer. The antenna combines an antenna element and a preamplifier in a compact low-profile enclosure. The GPS signals are spread spectrum signals in the 1575 MHz range and do not penetrate conductive surfaces. Therefore, the GPS antenna must be located outdoors with a clear view of the sky.

The antenna options include a permanent hard mount antenna and a magnetic mount antenna. Both antenna options use the same “patch” antenna element, the same preamplifier, and have the same performance characteristics. The hard mount antenna is designed for permanent installations that require a low profile. The antenna's TNC-type connector exits the base of the antenna and requires that an access hole be drilled in the mounting surface. The magnetic mount antenna is designed for temporary installation. This antenna includes a magnetic surface for mounting to metal surfaces such as car roofs. The cable exits the side of the antenna allowing flexible routing.

**Figure 1-3
Hard Mount
Antenna**



**Figure 1-4
Magnetic Mount
Antenna**

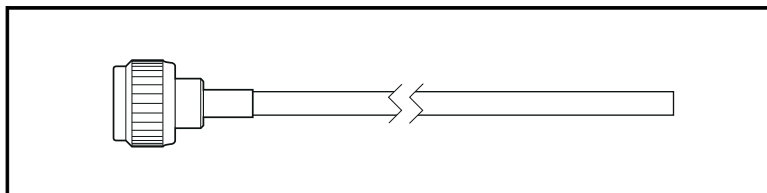


The Antenna Cable

The antenna cable is a single coaxial cable which links the antenna to the Placer. The antenna cable transmits DC power from the Placer to the antenna's preamplifier and carries the amplified satellite signals from the antenna to the Placer for processing. The antenna cable connects to the SMB connector on the back panel of the Placer.

The antenna cable is different for the two antenna mounting options. The magnetic mount antenna cable is 3 meters (10 feet) long and has an SMB connector on the Placer end and is permanently connected on the antenna end. The hard mount antenna cable is 3 meters (10 feet) long and has a TNC male connector at the antenna end and an SMB at the Placer end.

Figure 1-5
Antenna Cable

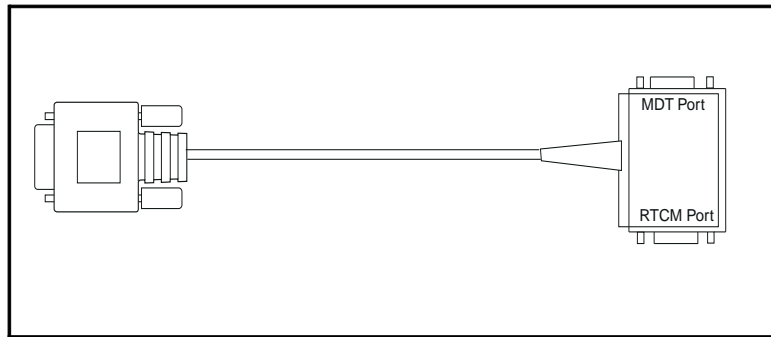


The Communications Cable (optional)

The communications interface cable supports RS-232 bi-directional communication between the Placer and the mobile data terminal (MDT). The MDT port may be used to configure the Placer for your application.

The communications cable is terminated at the Placer end with a single female DB9 connector which mates to the MDT connector on the Placer. The other end of the cable is split, providing two DB9 connectors. If you have the Placer 450, connect the port labeled MDT to the serial port of a PC or an MDT to send and receive messages in the selected protocol.

Figure 1-6
The Communica-
tions Cable



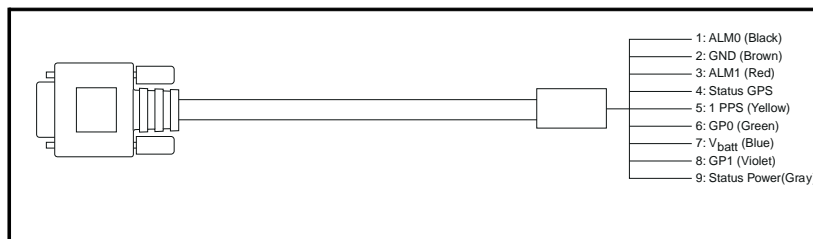
NOTE: The second serial port on the Communications cable, labeled RTCM, is used for the serial input of RTCM SC-104 data on the Placer 455 and Placer 455DR differential-ready units.

The Digital I/O Cable (optional)

The digital I/O cable provides the interface for the two alarm interface/ event markers which allow the Placer to output a time and position tagged message when it senses a contact closing to ground on any of the alarm signal wires.

The digital I/O cable is terminated at the Placer end with a standard DB9 connector. The other end of the cable includes several unterminated, 20 gauge digital outputs and two alarm inputs, as well as associated power and ground, for a total of 9 wires.

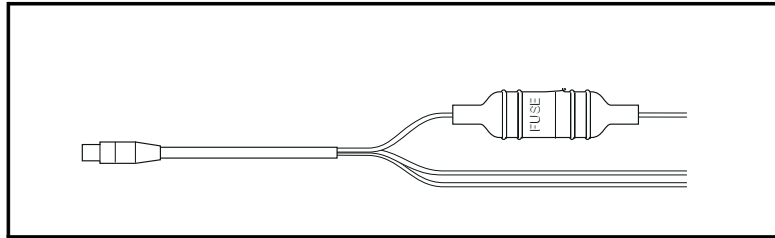
Figure 1-7
The Digital I/O
Cable



The Power Cable

The power cable supplies power to both the Placer and the GPS antenna. Power is applied through the red and black wires on the power cable. An in-line fuse protects the Placer against voltages above 70 volts, as well as reverse voltage.

Figure 1-8
The Power Cable



Chapter 2

Product Specifications

General Feature Description

Installation

Compact Unit is easily installed in any type of vehicle.

Position Reporting

Automatic reports based on user-defined parameters (e.g., time and/or distance) or available through polling.

Messaging

Accommodates a variety of TAIP or non-TAIP formatted terminals, PCs, or PDAs.

Fleet Management and AVL Software

FleetVision for Windows or AVL software available from VARs, or proprietary packages. (Software Development Kits available for registered channel partners.)

Wireless Communications Protocols

CDPD, MAP27, Transparent.

Optional Heading Sensor

Separate gyro supporting dead reckoning providing position information during GPS outages.

Output data

Latitude, longitude, altitude, speed, time, heading, alarms, and user-defined triggers.

Technical Specifications

Integrated Electronics

Power	3.2 watts; 250 mA @ 13V typical
Memory	256 Kbytes

Interfaces

Ports	1 – Radio: RS-232 DTE 2 – MDT (450/455)/RTCM (455): RS232 DCE(s) 3 – Heading Sensor (455): Gyro, Odometer, Backup 4 – Digital I/O
Message Formats	TAIP, TSIP, NMEA, RTCM
Comm. Protocols	CDPD, MAP27, (455) Transparent
Digital I/O	Input: 2 switch closure Outputs: 2 300mA low-side drivers; status GPS; status PWR; 1 pps
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400

GPS

Receiver	L1 frequency, C/A code (SPS), 8-channel, continuous tracking (8 satellites), 455 is differential and DR capable		
Update Rate	Once per second; programmable up to 9,999 seconds		
Accuracy*	Position (2D 95%RMS)		
		Without DR	With DR
	Non-Differential	15m	8m*
	Differential (1/s)	5m	3m
	Differential (1/10s)	20m	10m
	Velocity: 0.1 meters/sec. (1sigma), non SA conditions		
	Timing pulse: UTC to nearest microsecond		
	*All GPS receivers are subject to degradation of position and velocity accuracies under Department of Defense imposed Selective Availability (S/A). Position may be degraded up to 100 m 2 drms.		
First Acquisition	(typical)	Placer GPS 450	Heading Sensor
	Cold Start	ø90 seconds	ø90 seconds
	Warm Start	ø30 seconds	ø2 seconds
	Hot Back-up	ø10 seconds	ø2 seconds
	Reacquisition	ø1 second	Immediate
Datum	WGS-84		

Heading Sensor

Gyro	Piezoelectric vibrating beam gyro
Odometer Pulse	100 mV to 28V peak to peak square wave (user-supplied) analog or digital proportional to speed. Min. output:2,000 pulses per mile. Recommended output: >8,000 pulses per mile.

Physical Characteristics

	Placer GPS 450/455	Heading Sensor
Assembly	Anodized sheet metal enclosure	Injection molded plastic
Size	9" W x 3.75" D x 1.28" H 229mm W x 95mm D x 33mm H	4" W x 2.5" D x 3.625"W 102mm W x 64mm D x 92mm
Weight	450: 0.95 lb (0.43 kg) 455: 1 lb (0.45 kg)	0.35 lb (o.16 kg)
Connectors	Antenna: SMB (female) Ports 1–4: DB9 Power:	DB9

Environmental Specifications

	Placer GPS 450/455	Heading Sensor
Temperature:		
Operating	–40°C to +85°C	–40°C to +60°C
Non-Operating	–55°C to +85°C	–55°C to +85°C
Humidity	5% to 95% RH non-condensing at +40°C	
Altitude	–400 to +5,000 meters	
Shock	40g for 11 milliseconds	
Vibration	0.008g ² /Hz 0.05g ² /Hz –3dB/Octave	5Hz to 20Hz 20Hz to 100Hz 100Hz to 900Hz
Resistance	Splash proof and dust-proof	

Standard Components

In-vehicle unit (with integrated mounting bracket)

Power cable

Accessories (ordered separately)

GPS antenna (available in permanent or magnetic mount; with cable)

Heading sensor (455 only) and cables

Communications and Digital I/O cables (450 and 455)

FleetVision for Windows software

Installation and Operators manual is available for purchase in hardcopy or from BBS at no charge

Radio Frequency Interface

The Placer GPS processes the L1 GPS satellite navigation signals. The Placer GPS accepts signals from both the experimental Block I satellites as well as the operational Block II satellites and can compute position, speed and heading, and time data using a combination of Block I and Block II satellites. GPS satellite signals are collected by the antenna, and then amplified by the antenna's preamp for transmission over the coaxial antenna cable to the Placer. The antenna cable connects to the SMB connector on the front panel of the Placer.

Placer GPS has protection circuitry which prevents damage from RF signals near the L1 frequency GPS signals (1575.42 MHz). The Placer can withstand signals which are 100 MHz or farther away from the L1 frequency and which are one watt or less in received signal strength at the antenna.

Chapter 3

Configuring the Placer GPS

The Placer GPS is designed to communicate with a broad range of communications equipment. The receiver supports standard positioning data formats such as TAIP, TSIP, and RTCM SC-104, as well as wireless communications protocols such as MAP27 and CDPD.

The information provided in this chapter will assist you in integrating the Placer GPS in your application:

Communicating with the Placer GPS

The Placer GPS supports two I/O message protocols: TSIP and TAIP, as well as a range of wireless communications protocols.

Communication with the Placer GPS is established through two RS-232 serial I/O ports. The serial port default characteristics are 9600 baud, 8 data bits, 1 stop bit, and no parity. These port characteristics can be reprogrammed through the MDT port.

The serial port drivers in the configuration program are set to match the Placer GPS serial port characteristics. Any standard serial communications program such as Microsoft Windows Terminal can be used with TAIP or NMEA. Trimble provides a DOS compatible configuration program (PLCRINT.EXE) to configure the Placer GPS 455.

Wireless Communication Protocols

The Placer GPS features built-in wireless communications protocols to support use in a wireless network. The selected wireless protocol is used to transport messages formatted in a Trimble receiver protocol, normally TAIP. For example, if the CDPD protocol is selected, Placer GPS embeds each TAIP message in a TCP or UDP packet for transfer to the attached CDPD modem. The following sections describe the communications interface for the wireless protocols supported.

MAP27. MAP27 is the Mobile Access Protocol used in a trunked mobile radio system. This protocol specifies an interface between data terminal equipment (DTE) such as the Placer, and a MAP27 mobile radio. The MAP27 protocol specifies the messages and procedures required for call setup and data transfer between the Placer and the radio.

The Placer MAP27 communications firmware implements a protocol stack that supports the following MAP27 data services:

- Short data on a control channel or Single Segment Transactions (SST), for messages up to 23 bytes in length.
- Extended data on a control channel or Multiple Segment Transactions (MST), for messages up to 88 bytes.
- Non-prescribed data.

The services utilized by the Placer can be restricted via the TAIP Protocol Control (PC) message. The TAIP destination address (DA) message can be used to select the MAP27 network address where Placer autonomous messages will be sent. Responses to TAIP queries will be returned to the query sender's address.

CDPD. Cellular Digital Packet Data is, in effect a wireless mobile extension of the Internet. When connected to a CDPD modem, the Placer is capable of communicating with a base station via TCP and UDP network connections.

The Placer uses three virtual channels, each accessed by a specific port number for different types of message delivery: configuration and query channel, guaranteed reporting channel, and unacknowledged reporting channel.

The configuration and query channel is used for Placer configuration and polled status via TAIP Set/Query/Response messages. Access to this channel is gained by opening a TCP connection to the Placer IP address at port #59100.

The guaranteed reporting channel is used for reliable transmission of Placer automatic messages, such as those generated by change in Digital Input state. When such a message is generated, the Placer will attempt to open a TCP connection to the address specified by the TAIP Destination Address (DA) message at port #59600. After transmitting the available messages, the TCP connection is closed.

The unacknowledged channel is used for periodic reports from the Placer. The Placer 450 uses UDP to communicate these reports to the address specified by the TAIP DA message. Messages are sent to the address specified by the TAIP Destination Address (DA) message at port #59500.

The Placer GPS is factory configured for out-of-box operation. Alternatively, you may customize the receiver configuration for your application. For example, when the Placer GPS is programmed for the MAP27 protocol, it uses the address from the sender of the last TAIP message as its destination address for all responses. In this instance no autonomous reporting is possible until the Destination Address (DA message) is explicitly set.

Interface Protocols

The TAIP Interface Protocol. TAIP is a digital communication interface protocol developed for vehicle tracking, dispatching, and navigation applications. The TAIP protocol greatly enhances the integration of Placer GPS in networks, making Placer GPS compatible with mobile data terminals, seven bit modems, portable computers, and communication equipment.

The Placer GPS transmits and receives TAIP over a serial data link to the radio/modem. The TAIP interface provides the means to configure the Placer GPS to output various sentences in response to a query or on a scheduled basis. TAIP messages may be scheduled for output at a user specified rate starting on a given epoch from top of the hour. For communication robustness, the protocol optionally supports checksums on all messages. It also provides the user with the option of tagging all messages with the unit's user specified identification number (ID). This greatly enhances the functional capability of the unit in a network environment. The TAIP interface protocol is described in Appendix A.

The TSIP Interface Protocol. The Trimble Standard Interface Protocol (TSIP) is a powerful binary packet protocol which provides maximum configuration control over the Placer GPS for optimum performance in any number of applications. TSIP supports over 40 commands and their associated response packets for use in configuring the Placer to meet user requirements. This protocol is accessed through the provided configuration program (PCLRINT.EXE) and is transparent to the user. To configure a port for TSIP, see the PR TAIP message in Appendix A.

The NMEA Interface Protocol. The NMEA standard defines an electrical interface and data protocol for communications between marine instrumentation. NMEA is the National Marine electronics Association, a non-profit association composed of manufacturers, distributors, dealers, educational institutions, and other interested in peripheral marine electronics. The NMEA 0183 version 2.01 standard defines a number of standard sentences. These sentences start with \$; then a two letter device ID (GP for GPS instruments) followed by a 3 letter message ID (e.g., ALM for the Alarm message), data fields, carriage return and line feed. The Placer GPS 450 and 455 support the following NMEA 0183 sentences: GPGGA, GPGLL and GPVTG. You can use the PR TAIP message to control which I/O protocols are active on each of the data stream ports. for further details, please see the PR message in Appendix A.

Configuring the Placer GPS 450 and 455

When customizing the Placer GPS 450 and 455 receivers, the following settings should be configured using the Trimble ASCII Interface Protocol (TAIP) as described in Appendix A. A standard terminal emulator such as Microsoft Windows Terminal can be used to issue the appropriate TAIP commands.

- Vehicle ID
- Reporting Mode
- Destination Address
- Scheduled Reporting Intervals
- Protocol Configuration
- Signal Status Message

Following is a description of the Placer GPS operating parameters which must be configured for custom applications. Additional information is provided in Table 3-1 on page 3-8.

Vehicle ID. Assigning the Placer a Vehicle ID is optional. If you do not assign an ID, the Placer GPS will respond to all TAIP messages that are received. However, if a vehicle ID is assigned, then all incoming TAIP messages will be validated for an ID. If a match fails, the TAIP message will be ignored. This mechanism provides a level of security for erroneous messages.

Default value = Unspecified.

Reporting Mode. This is optional. See the TAIP messages described in Appendix A for the default settings.

Destination Address. This option is mandatory when configuring the Placer GPS for autonomous reporting. The destination address (DA) message specifies the recipient of the time and distance reports. If you do not configure the Placer GPS for the destination address, time and distance reports will not be sent.

Default value = For CDPD : 0.0.0.0. an invalid IP address

Default value = For MAP27 it is unspecified and invalid; first valid query message sets the DA to source address of query. This address will be used for time and distance reporting until, the destination address is explicitly set through the use of the DA message.

Scheduled Reporting Intervals. The Placer GPS can be configured to automatically issue reports when a specified distance has been traveled or a specified time period has elapsed using the 'D' qualifier. When configuring this setting, you must also specify the destination address (DA) to whom the reports should be sent (see above).

Default value = No TDR (Time and Distance Reporting), quiet.

Protocol Configuration. The 'out of the box' Placer is programmed for a specific communications protocol. While this is optional, you can use the protocol configuration (PC) message to further specify the communication protocol options. For example, if the Placer is configured for the MAP27 protocol, you can select protocol option 1 (SST) if you know that all your messages will be shorter than 23 characters.

Default value = For CDPD: 0 = normal mode.

Default value = For Map27: All MAP27 message services enabled.

Signal Status Message. Optionally, you may specify the type of message to be reported upon a change in digital input status. There are two message options: a short message that contains position and status data, or an extended message that contains the same data as an LN message.

Default value = SS;MSG = XT, i.e. XT TAIP message is transmitted.

Table 3-1. Placer GPS Configuration Options and Default Values

Item #	Parameter	MAP27	CDPD	Use TAIP Message
1	Vehicle ID	Optional[unspec'd]	Optional[unspec'd]	ID
2	Reporting Mode	n/a [ID,CS,EC,Cr=False]	n/a [ID,CS,EC,Cr=False]	RP
3	Destination Address	Optional (no TDR) Mandatory (with TDR) [invalid]	Optional (no TDR) Mandatory (with TDR) [invalid]	DA, DXX
4	Signal Status	Optional [SS;MSG=XT]	Optional [SS;MSG=XT]	SS
5	Protocol Configuration	Optional [all MAP27 msg services enabled]	Optional [0=normal]	PC
6	Time and Distance Reporting	Optional [quiet]	Optional [quiet]	DXX



NOTE: The default settings specified in Table 3-1 are enclosed in square brackets [...].

Configuring the Placer GPS 455DR

When configuring the Placer GPS455 for dead reckoning operation, the odometer and gyroscope must be configured using the provided DOS utility program PCLRINIT.EXE. Additional information regarding receiver setup is provided in Table 3-1 and Chapter 6.

Odometer. Use the PCLRINIT.EXE utility program to calibrate the odometer.

Gyroscope. Use the PCLRINIT.EXE utility program to calibrate the gyroscope.

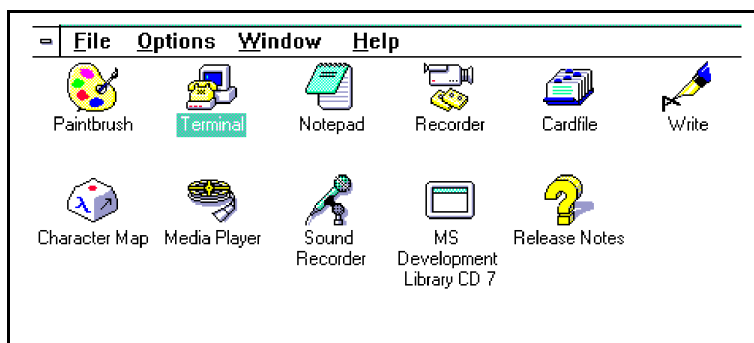
The Microsoft Terminal Program

You can use the Windows Terminal program to setup the Placer GPS 450, 455 and 455DR. The Windows Terminal program is located in the Accessories folder shown in Figure 3-1.



1. Double click on the Terminal icon to start the Terminal program.

Figure 3-1.
Microsoft Windows
Accessories Folder



Before you can begin using the Terminal program to send messages to the Placer GPS, configure the communications settings for the COM port that you are connecting to the Placer, and set up the terminal preferences so that what you type is echoed on the screen. Note that in its default mode, Terminal does not echo the characters typed at the keyboard.

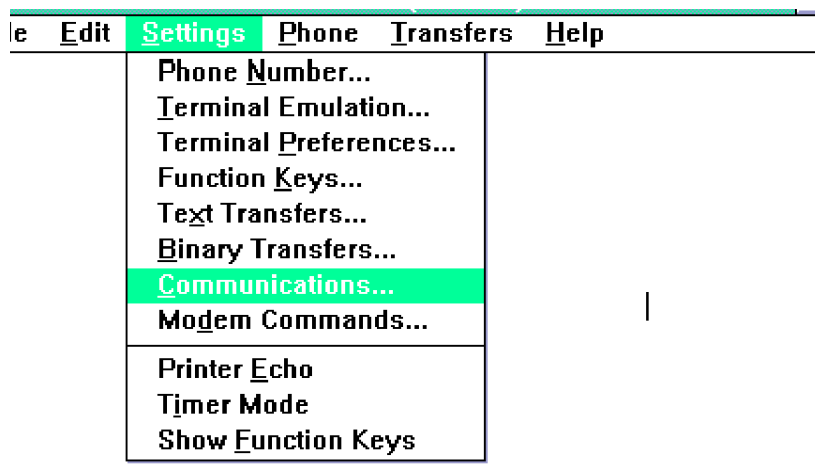
Terminal Settings for Communications

To configure the Terminal program to communicate with the Placer GPS 455 via the computers serial communications port, configure the Communications options.



2. Double click on the Communications option listed under the Settings Communications menu to modify the settings as indicated in Figure 3-2.

Figure 3-2.
Terminal Programs
Settings Menu



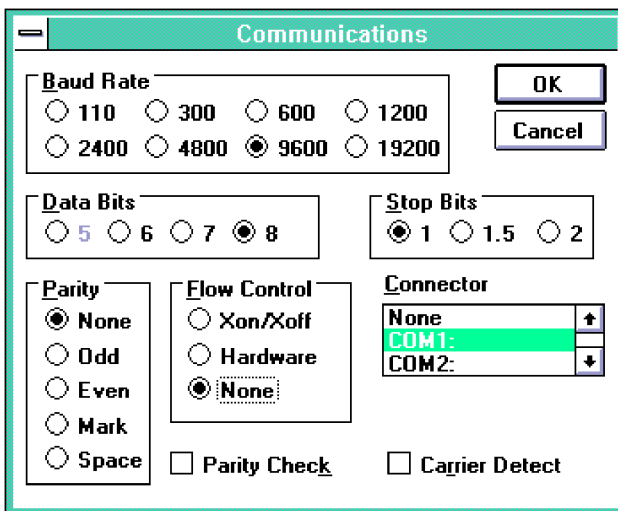
Terminal program Settings Menu

Configure the COM port to the following settings: baud rate = 9600, data bits = 8, stop bits = 1, parity = none, and flow control = none.



3. Click on the desired COM port settings.

Figure 3-3.
Terminal Program
Communications
Settings



Terminal Settings for Terminal Preferences

Use the options under the Settings/Terminal Preference menu to modify the terminal preferences so that what you type is echoed on the screen. This will also automatically advance the cursor to the next line when you press the Enter key. The terminal preferences are listed in Figure 3-5.

Figure 3-4
Terminal Preferences Menu Items

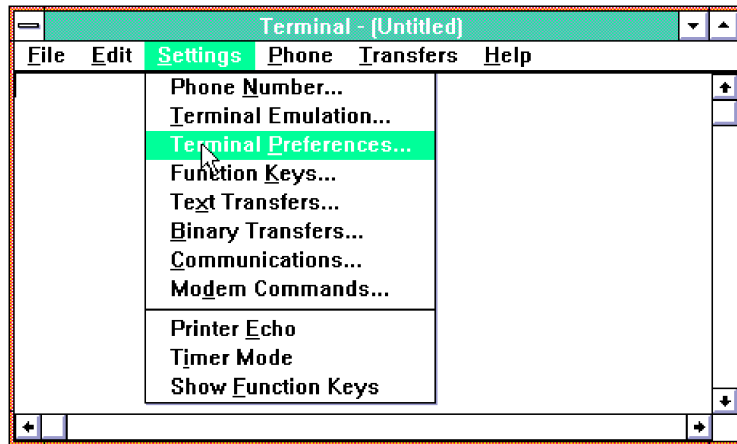
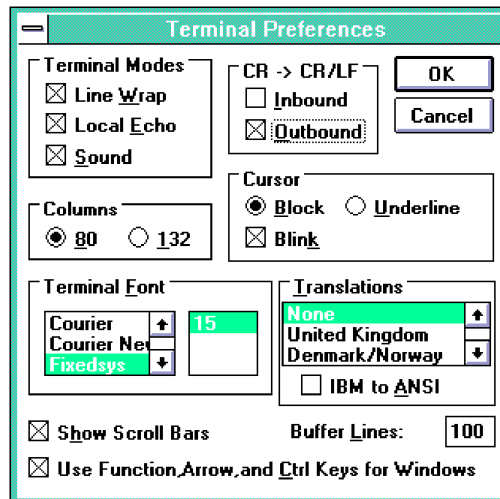


Figure 3-5
Terminal Preferences





NOTES: Microsoft Terminal will not function properly unless it is zoomed to a full screen. Click on the up arrow in the upper right hand corner of the Terminal window to zoom to a full screen.

For a complete list of the TAIP messages, see Appendix A.

Chapter 4

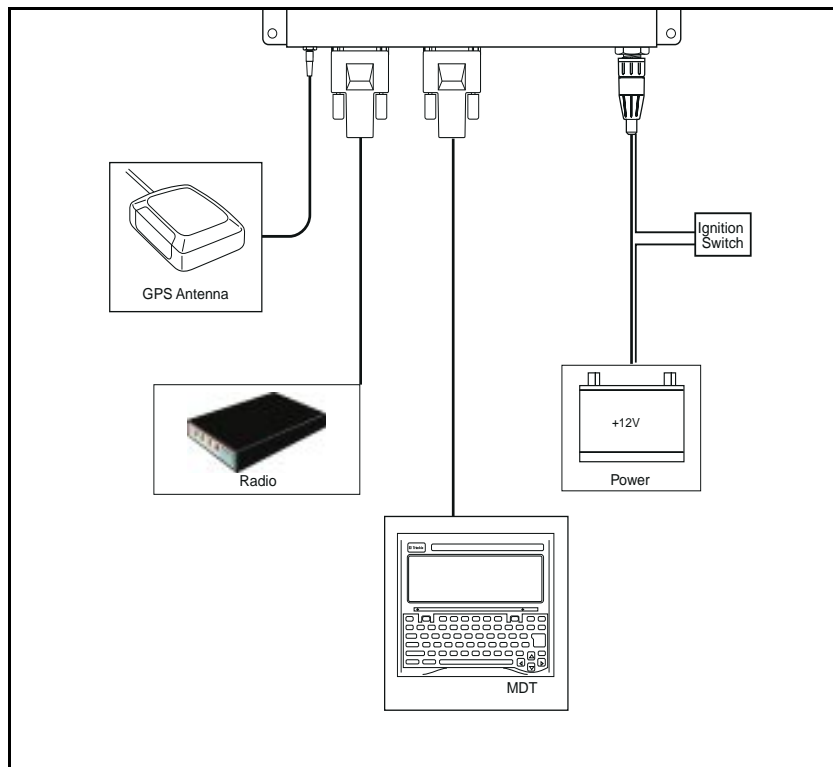
Installing the Placer GPS 450

The Placer GPS 450 can be installed in a variety of mobile environments. Follow the installation instructions and guidelines provided in this chapter for optimal performance.

NOTE: For instructions on installing the Placer GPS 455 and 455DR, see Chapter 6.



Figure 4-1
Interconnect Diagram



Inventory

Upon receipt of the Placer GPS 450, verify that you have the following components. Figure 4-1 illustrates the interconnection of the Placer GPS 450 components.

Table 4-1. Placer GPS 450 Inventory

Component	Part Number
Placer GPS 450 receiver processing unit	30837-10 or 30837-20
Antennas:	
Magnetic Mount Antenna and cable	28367-00 or
Hard Mount Antenna and Cable	31192-00 or
Hard Mount Antenna Cable (used with HMA option)	
right angle TNC	31193 or
straight TNC	30893
Optional Accessories:	
Communications cable (optional)	19309-00
Digital I/O cable (optional)	30512
Power Cable	30514

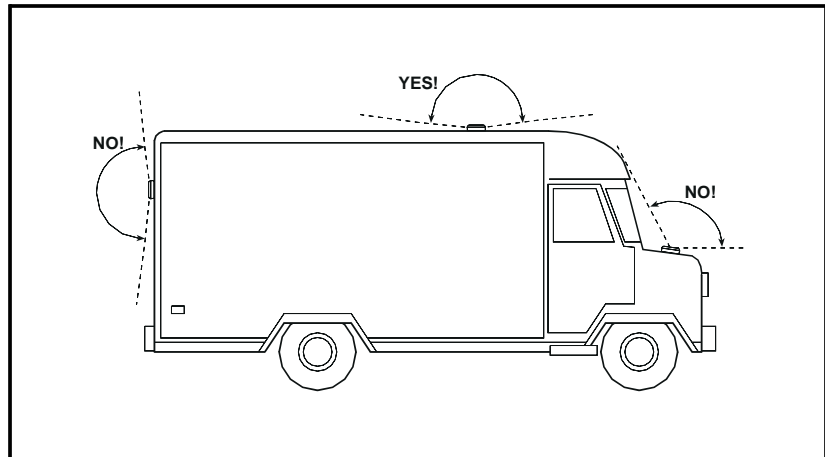
Survey the Vehicle

Prior to installing the Placer GPS 450 equipment, survey the vehicle to determine the best location for the GPS antenna and the receiver processing unit. Follow the provided guidelines.

Antenna Location

Antenna location is critical for optimum Placer performance. Choose a location for the GPS antenna which has a relatively unobstructed view of the horizon during all types of vehicle movement, and which will be safe from damage during normal vehicle operation and maintenance.

Figure 4-2
Antenna Mounting
Locations



Mount the antenna in a horizontal position, facing the sky. If the antenna must be located in the vicinity of other antennas (radar, satellite communication, cellular phone, etc.) locate the GPS antenna at least 1.5 feet away. Avoid areas of high vibration (e.g., engine hoods). For permanent installation, choose a location with access both above and below the antenna mounting surface. This access is required for installing fasteners and for routing the antenna cable in hard mount applications.

Placer Location

The Placer may be installed in any type of vehicle. Since the unit does not require operator intervention during operation, it may be installed in an enclosed compartment with limited accessibility.

Choose a location for the Placer which allows for convenient routing and connection of the antenna and interface cables, and which has access to a power source. When selecting a mounting location avoid the following hazards:

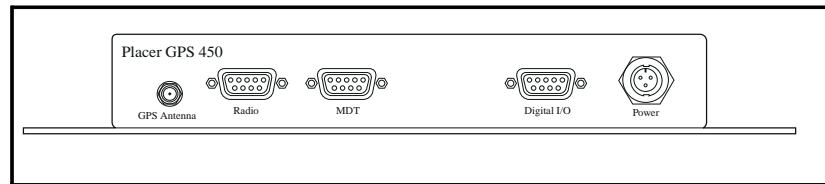
- Exposure to weather
- Excessive heat (exhaust manifolds)
- Excessive cold (refrigeration units)
- High vibration areas (engine compartment, transmission)
- Corrosive fluids and gases (acids, petroleum products)
- Exposure to water

Avoiding these conditions will improve Placer performance and will ensure long term product reliability.

Install the Placer

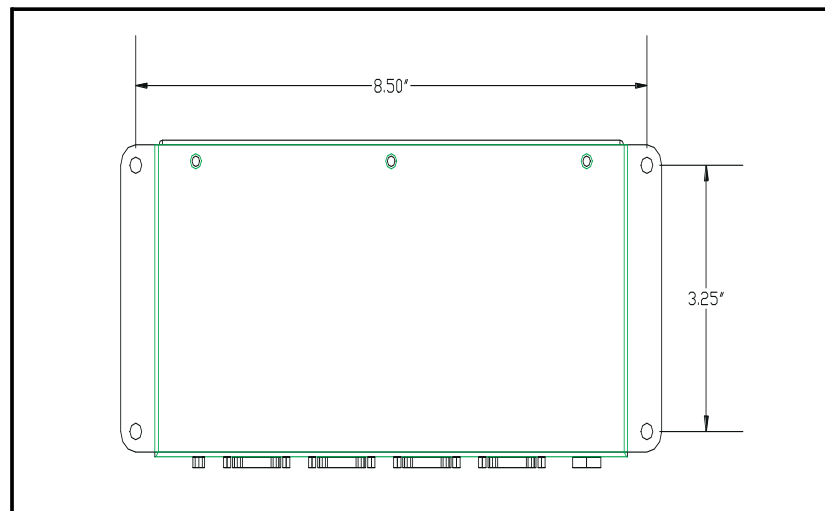
The Placer can be mounted in any orientation (horizontal, vertical, etc.). A vertical mount is recommended for installations where splash resistance is a factor. Use a mounting scheme appropriate for the mounting surface and allow proper clearance for the antenna and interface cable connections. The Placer must be mounted solidly.

Figure 4-3
Placer GPS 450



CAUTION: Use machine screws for all installations. Select a screw length which extends a safe distance beyond the mounting surface. Secure the screw with a nut. In general, Trimble Navigation recommends the use of a number 8 pan head machine screw.

Figure 4-4
Placer GPS 450



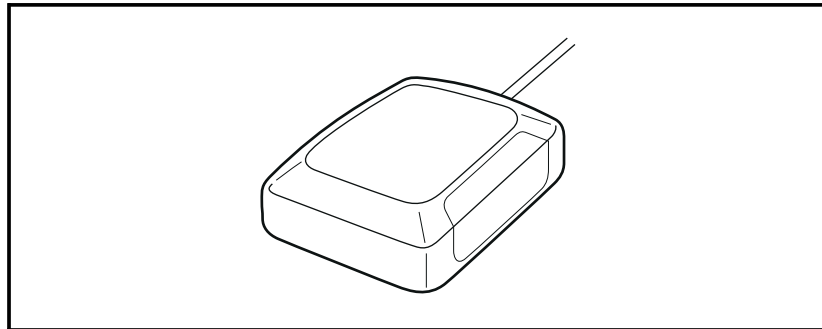
Install the Antenna

The GPS antenna receives the GPS satellite signals and passes them to the receiver. The received GPS signals are very low power (approximately -140 dB). Trimble's active antennas include a preamplifier that filters and amplifies the GPS signals before delivery to the receiver. Because the GPS signals are spread spectrum signals in the 1575 MHz range and do not penetrate conductive or opaque surfaces, the GPS antenna must be located outdoors with a clear view of the sky. The Placer GPS 450 requires an active antenna.

Magnetic Mount Antenna

The magnetic mount antenna is designed for temporary installation. This antenna can be placed on any ferrous-based metal surface in a location that meets the requirements defined earlier in this chapter.

Figure 4-5
Magnetic Mount
Antenna

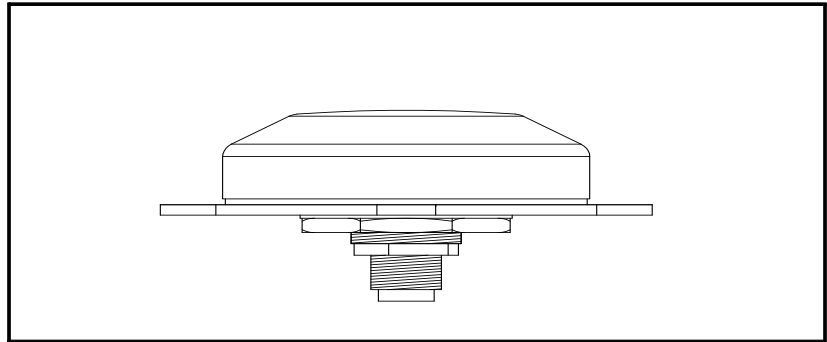


CAUTION: The magnetic mount uses a very strong magnet. Be sure to keep this magnet away from equipment sensitive to strong magnetic fields (e.g., computer disks, analog wrist watch, credit cards, etc.).

Hard Mount Antenna

The hard mount antenna is designed for permanent installations that require a low profile. The antenna's TNC-type connector exits the base of the antenna and requires that a single access hole be drilled in the mounting surface. Four additional holes are required to fasten the antenna to the mounting surface. Refer to the installation instructions provided with the antenna.

Figure 4-6
Hard Mount
Antenna



Select a screw length which extends a safe distance beyond the mounting surface. Secure the screw with a nut. In general, Trimble Navigation recommends the use of a number 8 pan head sheet metal screws with washers. Secure each mounting screw with a flat washer, a rubber washer and a lock washer. This fastener scheme will prevent accidental loosening of the antenna during normal vehicle operation. Mounting screw length is dictated by the thickness of the mounting surface. Screws, washers, and nuts are not provided with Placer GPS, since hardware must be selected that is appropriate to your mounting surface.



NOTE: It is not necessary to mount the antenna on a metal surface. The antenna does not require an external ground plane for proper operation. The mounting surface must be structurally sound and relatively flat (to 0.02 inch) to prevent warping of the antenna during installation, and water leakage after installation.

Figure 4-7
Antenna Mounting
Template

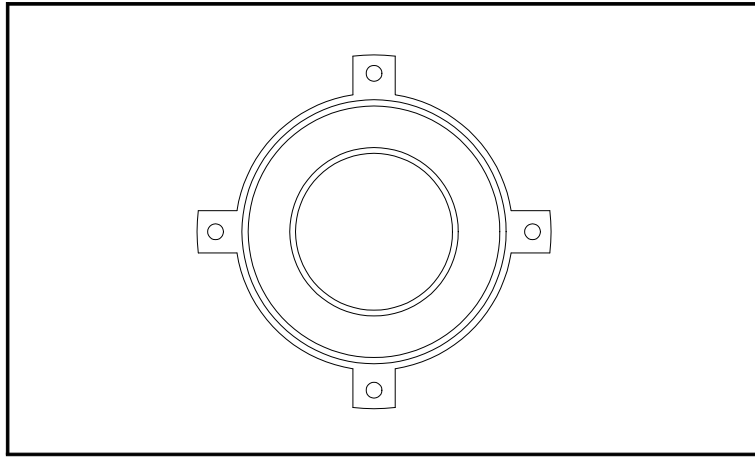
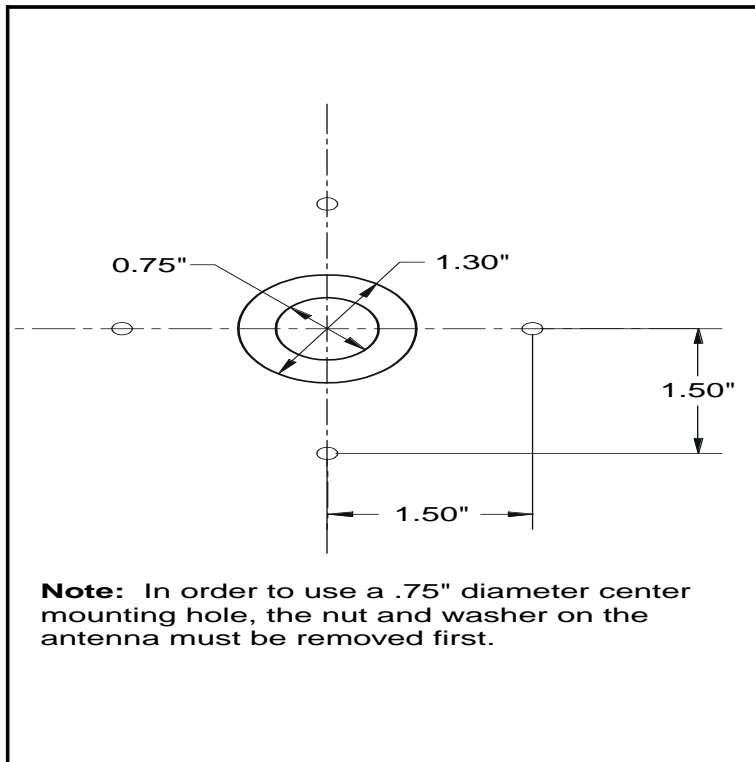


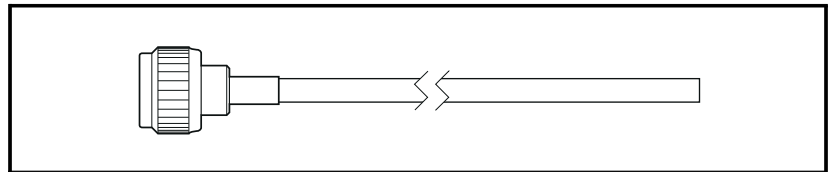
Figure 4-8
Antenna Mounting
Instructions



Route the Antenna Cable

A 3 or 5 meter (10 or 16 feet) coaxial antenna cable is provided with the Placer GPS 450, depending on your antenna selection (see *Placer 450 Interconnect Diagram* on page 1-4). Coaxial cable is sturdy, reliable, and weather resistant. The hard mount antenna cable differs from the magnetic mount cable. The hard mount cable has an TNC connector which mates with the connector on the antenna, while the magnetic mount cable is permanently connected to the antenna.

Figure 4-9
Hard Mount
Antenna Cable



After mounting the GPS antenna, the next step in the installation process is routing the antenna cable. When routing the cable, choose the most direct path to the Placer while avoiding the following hazards:

Avoid:

- Sharp bends or kinks in the cable
- Excessive heat
- Exposure to erosive fluids
- Rotating or reciprocating equipment
- Sharp or abrasive surfaces
- Overtightening the cable ties
- Running the cable in door jams



NOTES: For proper operation, the signal attenuation of the cable cannot exceed 10 dB at 1575 MHz, the Voltage Standing Wave Ratio (VSWR) cannot exceed 2.0:1, and the round trip DC resistance cannot exceed 1 Ohm.

The antenna cable provided by Trimble Navigation operates within these parameters. Consult Trimble Navigation before using a custom cable, or installing the cable in a way that could result in operation outside of these parameters.



CAUTION: The magnetic mount antenna cable and connectors will be exposed to the environment. Since the cable could whip around for the effects of wind, use tie wraps or other means to secure the cable along its routing. For permanent flange mount installations, seal the antenna connector to prevent water intrusion and corrosion.

The Interface Connections

The Placer GPS 450 has two serial interface ports that conform to the RS-232 standard. The three hardware connectors are specified for use as described in Table 4-2. The interface protocols are described below. Installation guidelines are provided on subsequent pages.

Table 4-2. Interface Connection—DTE Labeling Convention

Connector	Type	Interface
Radio/Modem	DB9 DTE connector	MAP27, CDPD radio protocols (TAIP message format)
MDT	DB9 DCE connector	TAIP message format
Digital I/O	DB9 DCE connector	Alarms/event markers/pps output

Wireless Communications Protocols. The Placer GPS 450 supports a variety of wireless communications protocols such as MAP27 and CDPD. These protocols incorporate the TAIP message format to manage communications between the base station and the mobile units.

The MAP27 protocol allows communication between the Placer GPS and the base station via the MAP27 mobile radio network. The Placer Radio/Modem port provides the serial interface to a MAP27 radio modem. The MAP27 protocol specifies the messages and procedures required for call set-up and data transfer between the Placer GPS and the radio.

The CDPD protocol allows communications between the Placer GPS and the base station via the CDPD network and the Internet. The Placer Radio/Modem port provides the serial interface to a CDPD modem. The Placer utilizes the TCP/IP and the UDP network capabilities of the CDPD modem to make network connections and to send/receive data via TCP/IP and UDP sockets.

TAIP. The Trimble ASCII Interface Protocol (TAIP) is a Trimble-specified digital communication interface based on printable ASCII characters over a serial data link. TAIP was designed specifically for vehicle tracking applications but has become common in a number of other applications because of its ease of use. TAIP supports both scheduled and polled responses from the Placer GPS. See Appendix A for protocol and message descriptions.

Connect the Radio/Modem

Use a standard straight-through DB9-DB9 cable between the Radio/Modem connector on the Placer GPS 450 and the input connector of the radio or modem being used. Note that the Radio/Modem port is type DTE.

Table 4-3. Radio/Modem Port Pinout

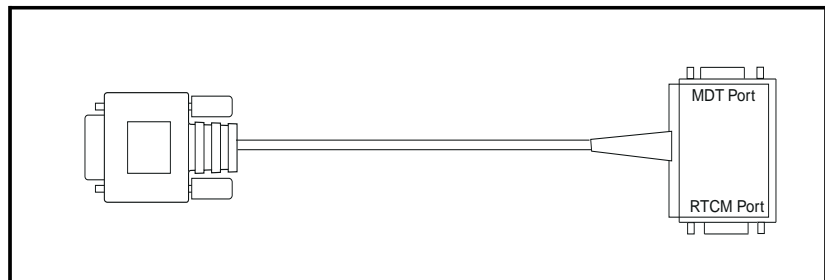
Pin Number	Signal
2	Rx1
7	RTS1
3	Tx1
8	CTS1
5	Ground
1	unused
6	unused
4	unused
9	unused

Connect the MDT

The communications interface cable supports RS-232 bi-directional communication between the Placer and the mobile data terminal (MDT). This connection enables you to easily send and receive messages in the TAIP interface protocol and to configure the Placer operation for your application.

The communications cable is terminated with a single DB9 connector at the Placer end and a 2xDB9 at the other end. Connect one end of the cable to the MDT connector on the Placer, and the other end of the cable to your MDT or laptop computer.

Figure 4-10
The Communications Cable



NOTE: Your communications equipment will typically have either a 25-pin or a 9-pin connector. If your equipment has a 25-pin D connector, attach a commercial 9-pin to 25-pin adapter to match the Placer GPS 450 connectors. The MDT port is type DCE.

Table 4-4. Communications Cable - MDT Port Pinout

Pin Number	Signal
2	Rx2
7	RTS2
3	Tx2
8	CTS2
5	Ground
1	unused
6	unused
4	unused
9	unused

General Purpose I/O

The digital I/O cable provides the interface for the two alarm interface/event markers which allow the Placer to output a time and position tagged message when it senses a contact closing to ground on any of the alarm signal wires.

The digital I/O cable is terminated at the Placer end with a standard DB9 connector. The other end of the cable includes three unterminated, 20 gauge digital outputs and two alarm inputs, as well as associated power and ground, for a total of 9 wires (see Table 4-6).

The digital outputs can be connected to electronic door-lock relays or other devices so that the devices can be controlled remotely via the TAIP SS message format (see Appendix A). A pulse per second (pps) output is also provided.

The three digital inputs: Alarm 1, Alarm 2 and Backup Light (455 only) are considered active(true) when grounded. If left open circuit or pulled high (5V), they will be considered inactive (false). Digital input status is reported via the TAIP SS, XT, and XS messages (see Appendix A.)

The five outputs: Output 0, Output 1, Status GPS, Status PWR and 1 PPS are capable of driving external devices such as relays (e.g., electronic door locks) which require less than 300 mA of current. An active output will sink up to 300 mA to ground. Sinking more than 300 mA may cause damage to the Placer. Digital outputs 0 and 1 can be controlled via the TAIP SS msg (See Appendix A.) Status power is active whenever the Placer is on. PPS is an active pulse occurring precisely once per second. Status GPS can be connected to an LED with a proper current limiting resistor. The LED indicates GPS and DR status (see Table 4-5).

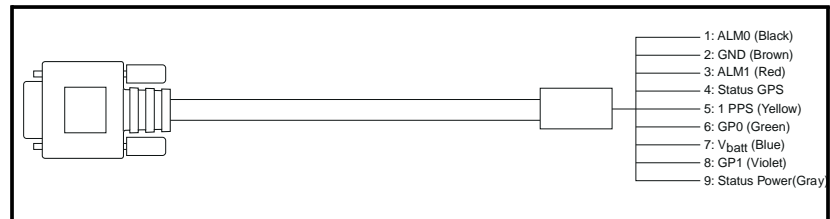
Table 4-5. Operation of Status Indicator

State	Flashing Rate
μP dead	off
no GPS & no DR fixes	10s/10s
GPS and DR fixes	2s/2s
GPS only fixes	1s/1s
DR only fixes	.5s/.5s



NOTE: The data communication signals conform to the electrical specifications of EIA RS-232.

Figure 4-11
The Digital I/O
Cable

**Table 4-6. Digital I/O Cable**

Pin Number	Wire Color	Signal	Type
1	Black	Alarm 0	Input
2	Brown	Ground	Output
3	Red	Alarm 1	Input
4	Orange	Status GPS	Output
5	Yellow	1 Pulse Per Second	Output
6	Green	General Purpose out 0	Output
7	Blue	V _{batt}	Output
8	Violet	General Purpose out 1	Output
9	Gray	Status Power	Output

Power

The Placer GPS operates on input voltages from 10 to 32 volts DC. The maximum allowable voltage is 32 volts DC. The Placer consumes 3.5 watts at a supply voltage of 12 volts. The antenna's preamplifier draws power from the Placer through the antenna cable. The Placer GPS does not require any special power up or down sequencing.

The Placer GPS features input power circuitry designed to protect the Placer from off-nominal power conditions. A crowbar circuit provides protection from most over-voltage situations, and external fusing protects the Placer against voltages above 36 volts, as well as reverse voltage.

Trimble Navigation recommends that the Placer GPS be connected to a source of continuous DC power to keep the receiver's RAM memory alive and power the real-time clock when the receiver's main power is turned off. RAM memory is used to store the GPS almanac, ephemeris, and user configuration data. Though not required, providing back-up power can reduce the time required at power-on for the Placer GPS to acquire GPS satellite signals and compute position to less than 50 seconds (typical).

Figure 4-12. Switched Power

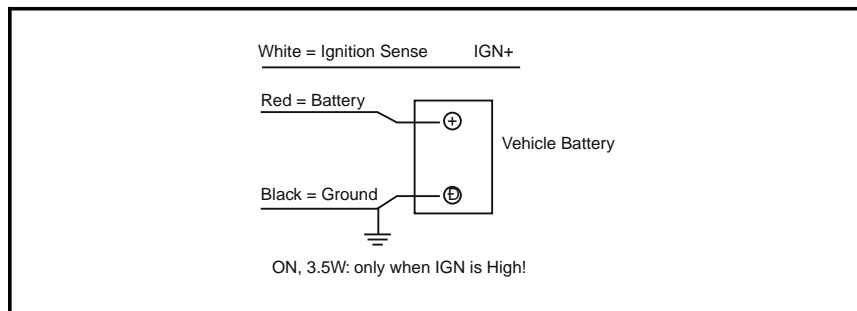
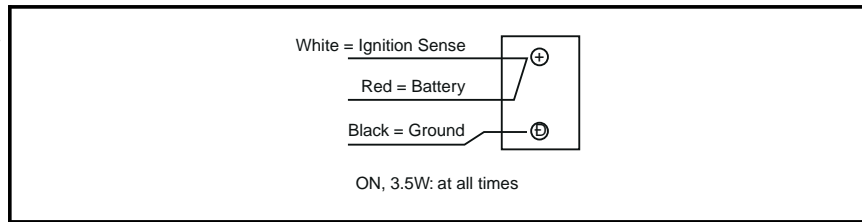


Figure 4-13.
Continuous Power



NOTE: If the Placer GPS is connected to the vehicle battery in the continuous power mode, the vehicle is left off for extended periods, this power drain will significantly reduce the vehicle's battery life.

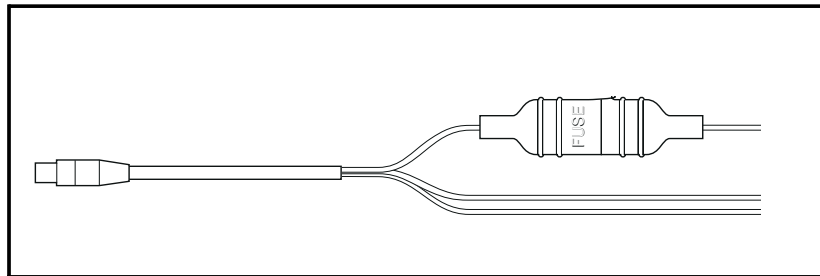
Connecting Power

Power is applied to the Placer through the red and black wires on the power cable. Attach the power cables' leads to the appropriate locations: the battery lead- to a source of vehicle battery power; the ignition lead- to positive sense signal from the ignition switch; ground - to system ground. These connections will supply power to both the Placer and the GPS antenna. The power cable is fused with a 1 amp fuse.

When routing the power cable, avoid the following hazards:

- Sharp bends or kinks in the cable
- Excessive heat
- Exposure to corrosive fluids
- Rotating or reciprocating equipment
- Sharp or abrasive surfaces
- Running the cable in door jams

Figure 4-14
Power Cable



Chapter 5

Operation

The Placer GPS is designed for automatic operation. After initial setup, no operator intervention is required for initialization or typical operation. When connected to an external GPS antenna, the Placer GPS automatically acquires GPS satellite signals, tracks up to 8 GPS satellites, and computes location, speed, heading, and time. The Placer automatically begins to search for and track GPS satellite signals at power-up.

This chapter discusses Placer GPS operation from initial power-up and configuration, through information output.

Initial Power-On

Continuous Power Operation

The Placer GPS operates most efficiently when it is connected directly to the vehicle's battery (or other continuous 12 volt DC source), so it remains on even when the vehicle has been turned off. The time to first fix from a complete cold start (See "Cold Start" on page 5-4) is normally 1 to 2 minutes, varying with time required to acquire satellite almanac data and ephemeris. When back-up power is used to power the real-time clock and maintain RAM, the Placer GPS will respond to commands almost immediately after power-up.

Switched Power Operation

Alternatively, the Placer GPS may be connected to a switched DC power source such as accessory or ignition power in a vehicle. Under these circumstances, power will automatically re-initialize the GPS receiver. This initialization will take approximately 30 seconds.

The Placer GPS will respond to commands almost immediately after power is switched. The vehicle's position will be reported as the last position prior to powering-off for about 30 seconds, at which time a new GPS vehicle position will be reported.



NOTE: The Placer GPS draws 3.5 watts and may deplete a vehicle battery if not started for an extended period. A receiver normally connected to continuous power should be disconnected while the vehicle is not in use. After reconnecting, follow the provided directions for switched power operation.

GPS Satellite Message

Every GPS satellite transmits the Coarse/Acquisition (C/A) code and satellite data modulated onto the L1 carrier frequency (1575.42 MHz). The C/A code is a unique pseudo-random number for each satellite. The satellite data transmitted by each satellite includes a satellite almanac for the entire GPS system, its own satellite ephemeris and its own clock correction.

The satellite data is transmitted in 30-second frames. Each frame contains the clock correction and ephemeris for that specific satellite, and two pages of the 50-page GPS system almanac. The time required to transmit the complete system almanac is 12.5 minutes and the time to transmit the satellite ephemeris is 30 seconds.

The system almanac contains information about each of the satellites in the constellation, ionospheric data, and special system messages. The ephemeris contains detailed orbital information for a specific satellite. The GPS system almanac is updated weekly and is typically valid for months. Ephemeris data changes hourly, but is valid for up to four hours. The GPS control segment updates the system almanac weekly and the ephemeris hourly through three ground-based control stations. During normal operation, the Placer GPS updates its ephemeris and almanac as needed.

The performance of a GPS receiver at power-on is determined largely by the availability and accuracy of the satellite ephemeris data and the availability of a GPS system almanac.



NOTE: The L1 GPS satellite navigation signals are described in the following GPS specifications: SS-GPS-300B and ICD-GPS-200.

Satellite Acquisition and Time to First Fix

Cold Start. The term “cold start” describes the performance of a GPS receiver at power-on when no navigation data is available. “Cold” signifies that the receiver does not have a current almanac, satellite ephemeris, initial position, or time. The cold start search algorithm applies to a Placer GPS which is powered on without the memory backup circuit connected to a source of DC power. This is the “out of the box” condition of the GPS module as received from the factory.

In a cold start condition, the receiver automatically selects up to eight satellites and dedicates an individual tracking channel to search the Doppler range frequency for each satellite in the set. If none of the eight selected satellites are acquired after a pre-determined period of time (time-out), the receiver will select a new search set of eight satellites and will repeat the process, until the first satellite is acquired. As satellites are acquired, the receiver automatically collects ephemeris and almanac data. The Placer GPS uses the knowledge gained from acquiring a specific satellite to eliminate other satellites, those below the horizon, from the search set. This strategy speeds the acquisition of additional satellites required to achieve the first position fix.

The cold start search sets are established to ensure that at least three satellites are acquired within the first two time-out periods. As soon as three satellites are found, the receiver will compute an initial position fix. The typical time to first fix is less than 2 minutes.

A complete system almanac is not required to achieve a first position fix. The almanac is used in subsequent warm starts, and to aid in acquiring GPS satellites that come into view.

Warm Start. In a warm start condition, the receiver has been powered down for a period of time but has a current almanac, and an initial position (within 3,000 km) stored in memory. When connected to an external backup battery and power is turned-off, the Placer GPS retains the almanac and initial position and time to aid in satellite acquisition and reduce the time to first fix.

During a warm start, the Placer GPS identifies the satellites which are expected to be in view, given the system almanac, the initial position and the approximate time. The receiver calculates the elevation and expected Doppler shift for each satellite in this expected set and directs the eight tracking channels in a parallel search for these satellites. If the internal oscillator error is known, the Placer GPS compensates for the offset to optimize the search. If the offset is not known, the search algorithms will be set wide enough to allow for oscillator tolerance, aging, and temperature errors.

The warm start time to first fix, when the receiver has been powered down for more than four hours (i.e. the ephemeris data is old) is usually less than 50 seconds (35 seconds typical).

Garage Search Strategy. During a warm start search, the Placer GPS knows which satellites to search for, based on the system almanac, the initial position (last known position) and the current time. In some cases, the receiver may not be able to acquire the expected satellite signals (e.g. a vehicle parked in a garage or a vessel in a covered berth). Trimble's patented "garage search" strategy, also known as a split search, is designed for such situations.

If the receiver does not acquire the expected set of satellites within 5 minutes of power-on, three of the eight tracking channels will continue to search for the expected satellites (garage search) while the remaining five channels are directed in a cold start search. This strategy minimizes the time to first fix in cases where the stored almanac, position and time are invalid. The stored information is flushed from memory, if the cold start search proves effective and the garage search fails.

Hot Start. A hot start strategy applies when the Placer GPS has been powered down for less than four hours, and the almanac, position and ephemeris are valid. The hot start search strategy is similar to a warm start, but since the ephemeris data in memory is considered current and valid, the acquisition time is typically less than 20 seconds.

Operating Characteristics

The Placer GPS incorporates a sophisticated 8-channel GPS receiver capable of tracking up to eight satellites. The GPS receiver calculates a new position once every second. Position accuracy is specified at 25 meters spherical error probability (SEP) and speed and heading accuracy is specified at 0.1 meters per second without selective availability. The Department of Defense (DoD) reserves the right to implement selective availability (SA). Under SA, position accuracy will be degraded to 100 meters (2D RMS) and speed and heading accuracy will also be reduced.

Placer GPS operates in automatic 2-D/3-D mode. In this mode, Placer GPS will calculate position solutions using up to eight satellites that pass the mask criteria specified in Table 5-1 (these are the default masks and may be modified by the user). If only three satellites are available that meet the mask criteria or the PDOP of the available satellites is too high, the Placer GPS automatically calculates 2-D position solutions.

Satellite Mask Settings

Once the Placer GPS has acquired and locked onto a set of satellites, which pass the mask criteria listed below, and has obtained a valid ephemeris for each satellite, it will output regular position, velocity and time reports according to the protocol selected.

The default satellite masks used by the Placer GPS are listed in Table 5-1. These masks serve as the screening criteria for satellites used in fix computations and ensure that position solutions meet a minimum level of accuracy. The Placer GPS will only output position, course, speed and time when a satellite set can be acquired which meets all of the mask criteria.

Table 5-1. Default Satellite Mask Settings

Mask	Setting
Elevation	10°
SNR	2.2
PDOP	8
PDOP Switch	6

Alarm Interface/Event Marker

The Placer GPS features an alarm interface. The alarm condition is initiated by closing to ground of a normally open contact, external user supplied alarm switch. The Placer GPS provides two digital alarm inputs. A TAIP XT or XS message is sent out the radio port upon detection of closure on either of these inputs. (See SS message description in Appendix A for selection of message type to be reported.) A second message will be sent when the alarm input is opened.

MDT Interface

The MDT port can be used for configuration and status of the Placer GPS via TAIP messages. The TAIP TX message can be used to transfer text to an MDT from a base station (and vice versa) in a “pass through” or “transport” mode as described in Appendix A.

Differential GPS (Placer GPS 455 only)

Differential GPS is the most accurate form of GPS navigation. Differential GPS relies on error corrections that are transmitted from a reference station placed at a known location. This reference station calculates the error in the satellite range data and broadcasts corrections to receivers in the same locale. RTCM-104 is the industry standard format for differential GPS corrections. A significant portion of the error in GPS measurements can be eliminated by GPS receivers incorporating these corrections.

The Placer GPS accepts differential corrections conforming to the RTCM-104 standard. The differential corrections can be received in the RTCM format and fed to the Placer, or the differential corrections may be enveloped in the TAIP protocol. In most applications, the second method is preferred since it eliminates the need for an additional communication link. Contact Trimble Navigation for the following information:

- Using Placer GPS in a differential GPS application
- GPS Reference Stations
- Differential GPS Operation

Chapter 6

The Placer GPS 455 and 455DR

The Placer GPS 455 product family enhances the functionality of the Placer GPS 450 with the addition of Differential GPS (DGPS) in the Placer 455, and DGPS and integrated dead reckoning (DR) in the Placer 455DR.

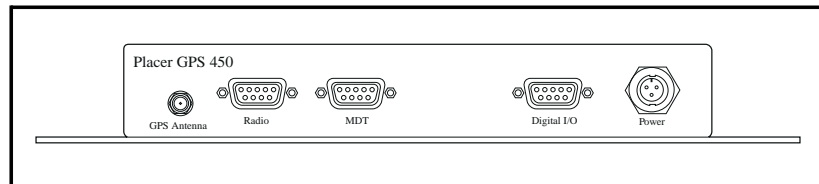
Chapters 1 through 4 of this manual cover the common elements of the Placer systems. This chapter provides instructions for installing the Placer GPS 455 and 455DR. A complete description of the Placer GPS 455DR calibration procedure is also included.

Functional Overview

The Placer GPS 455

The Placer GPS 455 features all the functionality of the Placer GPS 450, plus differential GPS. By using a differential corrections service such as the US Coast Guard Beacons, a Satellite Direct broadcast, or an FM-Sub-carrier system, the Placer GPS 455 automatically removes most position inaccuracies created by the US Government's use of Selective Availability (SA) in the Standard Positioning Service (SPS) for GPS.

Figure 6-1.
Placer 455

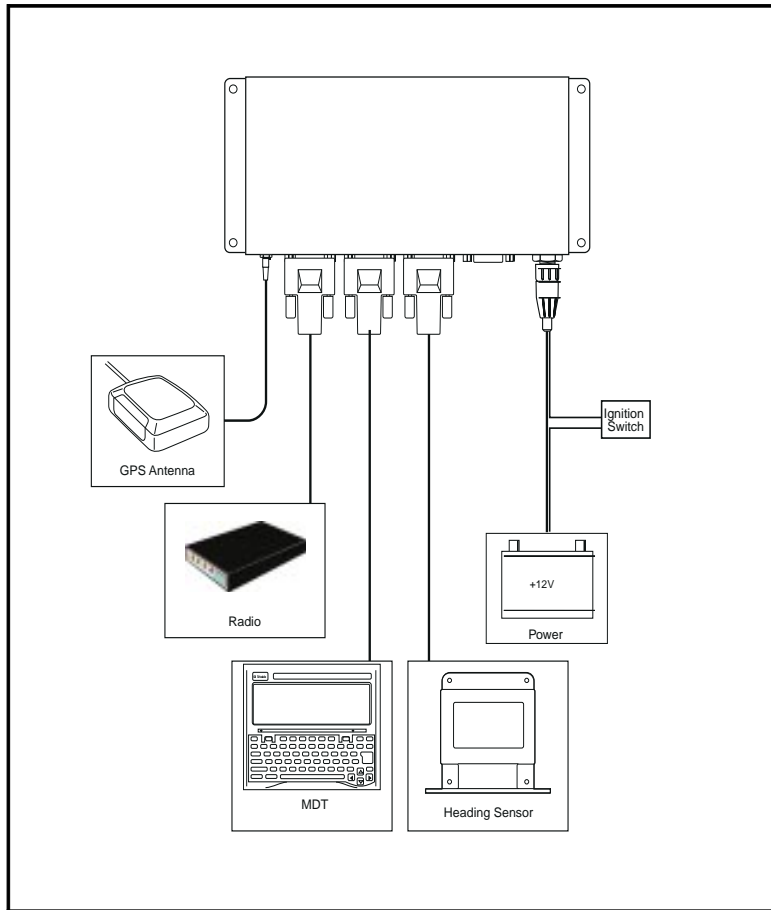


The Placer GPS 455 is configured to accept the Radio Technical Committee for Maritime Services (RTCM) differential correction data format on Port 3 using the provided communications cable (see Figure 6-3). In some situations, corrections can be sent using the TAIP DC and DD messages from a software package such as Trimble's PC Community Base Station. DGPS corrections can be transmitted over the same Radio/Modem link the Placer uses to send vehicle position and other TAIP messages. With good satellite visibility and RTCM corrections less than 30 seconds old, typical position accuracy for the Placer GPS 455 is about 10 meters 95% 2D RMS compared to the 100 meters without DGPS corrections and SA.

The Placer GPS 455DR

The Placer GPS 455 DR enhances the Placer GPS 455 with heading and distance sensors for dead reckoning operation. The heading sensor is a piezoelectric, solid state gyro which provides the heading rate input to the Placer. The vehicles odometer is also used as a distance measurement sensor for the Placer which is equipped with configurable conditioning circuitry to accept both analog and digital odometer signals. A signal from the vehicle's backup light indicates the direction of travel. The odometer and gyroscope are integrated in the Placer with the GPS (or DGPS) measurements to provide more accurate position estimates than either system alone.

Figure 6-2.
Placer 455
Interconnect Dia-
gram



The Placer GPS 455DR guarantees continuous position reporting even during periods when all GPS signals are obscured. In many city driving situations, tall buildings and narrow streets obscure most or all of the GPS signals. These urban canyons can also degrade visible GPS signals by reflections or multipath. These conditions fall substantially outside the U.S. Government specifications for the SPS GPS performance and often create position errors several times the 100 meters SPS specification. Under urban canyon conditions, the Placer 455DR is able to reject the degraded GPS signals and produce position accuracy of 35 meters 95% 2D RMS compared to the 100 meters for standard GPS with SA.

When the Placer GPS 455DR is enhanced with the DGPS option using RTCM corrections less than 30 seconds old, position accuracy is improved to about 15 meters in urban canyon driving and about 5 meters in open areas with good GPS visibility.

Placer GPS 455DR Calibration

For optimal performance, the Placer GPS 455DR must be calibrated at installation. Trimble provides the DOS compatible program PLCRINIT.EXE for this purpose. Calibration is usually performed by connecting a laptop or portable PC to the Placer's mobile data terminal (MDT) port, running the PLCRINIT program and following a series of menu prompts.

The odometer installation is checked by driving at several speeds and observing consistent pulses from the program, then calibrated by driving a known distance and inputting the number of pulses per mile via the calibration menus.

The gyroscope is calibrated by first driving clockwise for several complete circles, and then counter-clockwise for the same number of circles. Full details of the calibration are included later in this chapter.



NOTE: The functional specifications for the Placer 455DR and the gyroscope (heading sensor) are provided in Chapter 2 of this manual.

Installation

Instructions for installing and configuring the Placer GPS 455 and 455DR are provided in this chapter. Following the provided instructions will eliminate many of the common causes of system failures. Chapter 4 describes the installation of the Placer and the antenna that are common to all Placer GPS systems.

Inventory

Upon receipt of the Placer GPS 455, verify that you have the following components. The interconnection of the Placer GPS 455 components is illustrated in Figure 6-2.

Table 6-1. Placer GPS Inventory

Component	Part Number
Placer GPS 450 receiver processing unit	30837-10 or 30837-20
Placer GPS 455	
MAP27	30376-10
CPDP	30376-20
TAIP	30376-90
DR/MAP27	31601-00
DR/CPDP	31602-00
DR/TAIP	32343-00
DR Sensor Cable	30315
Gyroscope and Upgrade Kit (heading sensor)	31321-00
Antennas:	
Magnetic Mount Antenna and cable	28367-00 or
Hard Mount Antenna and Cable	31192-00 or

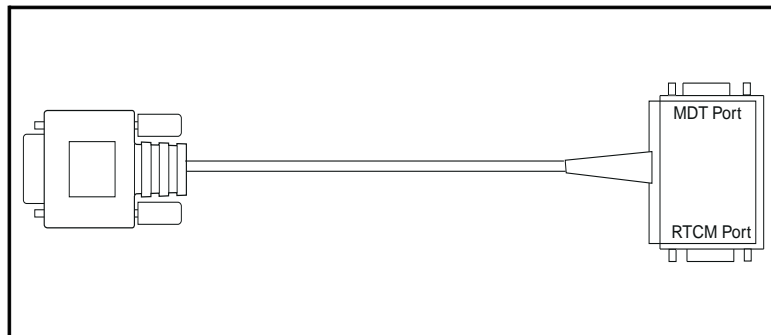
Component	Part Number
Hard Mount Antenna Cable (used with HMA option)	31193 or
right angle TNC	30893
straight TNC	
Optional Accessories:	
Communications cable	19309-00
Digital I/O cable	30512
Power Cable	30514

The Communications Cable

The communications interface cable supports RS-232 bi-directional communication between the Placer and the mobile data terminal (MDT) and between the Placer and the RTCM port.

The communications cable is terminated at the Placer end with a single female DB9 connector which mates to the MDT/RTCM connector on the Placer. The other end of the cable is split, providing two DB9 connectors. The first connector, labeled MDT, connects to the serial port of a PC or an MDT to send and receive messages in the selected protocol. The second serial port on the Communications cable labeled RTCM is used for the serial input of RTCM SC-104 data to the Placer 455 and Placer 455DR to receive differential corrections

Figure 6-3.
The Communica-
tions Cable



The Interface Connections

The Placer GPS 455 has four interface ports: Radio/Modem, MDT/RTCM, Digital I/O, and Heading Sensor. The Radio/Modem port, the Digital I/O port and the MDT/RTCM port are described in Chapter 4 of this manual. The four receiver hardware connectors are specified for use as described in Table 6-2. The interface protocols for each port are also listed in this table.

Table 6-2. Interface Connection

Placer Port	Connection Type	Communication Interface
Radio/Modem	DB9 F DTE connector	MAP27, CPDP radio protocols (TAIP message format)
MDT/RTCM	DB9 F DCE connector (Pins 2, 3, 5, 7, 8 (see Table 4-4))	(MDT) TAIP message format. Also unit configuration.
	DB9 F DCE connector (Pins 1, 4, 5, 6, 9)	(RTCM) RTCM CS-104 standard differential corrections format.
Digital I/O	DB9 F DCE connector	Alarms/event markers/pps output
Heading Sensor	DB9 F DCE connector	Gyroscope and vehicle connections for odometer and backup light

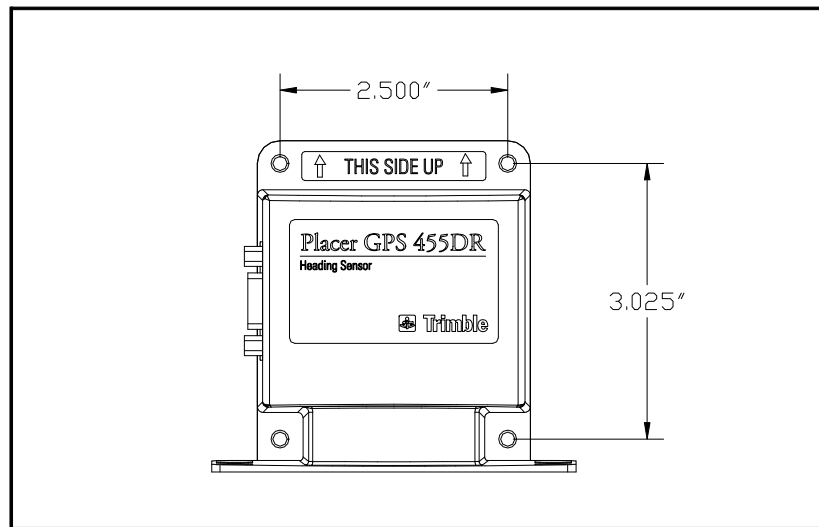
Installing the Heading Sensor

The heading sensor (gyroscope) must be rigidly mounted so the sensor's axes is vertical. The heading sensor mounting bracket provides for both side and bottom mounting options.



NOTE: It is critical to Placer 455 performance that the heading sensor be mounted within 5° of vertical.

Figure 6-4.
Heading Sensor



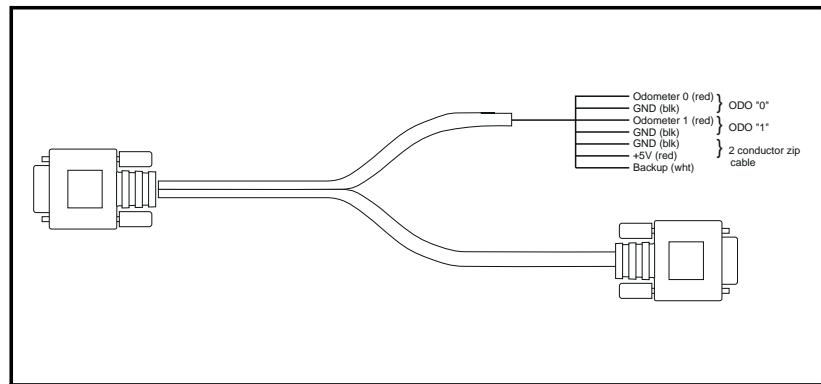
When mounting the heading sensor in the vehicle, avoid the following hazards:

- Exposure to bumping (the cargo area)
- Exposure to strong magnetic fields (audio equipment or the magnetical-mounted antenna)
- Excessive heat (exhaust manifolds) or excessive cold (refrigeration units or air conditioning ducts)
- High vibration areas (Engine compartment, transmission)
- Corrosive fluids and gasses
- Exposure to water

Connecting the Heading Sensor

The heading sensor connects to the Placer through the Heading Sensor cable (see Figure 6-5). Choose a location for the heading sensor that allows for convenient connection to the Placer using the supplied DR sensor cable.

Figure 6-5.
Heading Sensor
Cable



1. Connect the heading sensor to the Placer through the female 9-pin connector on the DR Sensor Cable. The connector labeled Heading Sensor connects to the heading sensor; the connector labeled Sensors connects to the Placer.



WARNING: The heading sensor contains mechanical shock sensitive components. Do not drop this equipment.

Connecting the Backup Signal

The Placer 455DR uses the signal from the vehicle's backup light to indicate direction of travel. This is required because odometer signals are the same when driving forward or backward at the same speed.

- 1.** Connect the white wire from the DR Sensor Cable to the positive side of your vehicle's backup light.
- 2.** Do not connect the black backup ground; leave the wire unterminated.

Connecting the Vehicle Odometer

Prior to connecting the heading sensor to your vehicle, study the vehicle wiring diagram to locate the odometer/speed signal. If possible, examine the odometer signal using an oscilloscope to determine if the signal type is analog or digital. If examining the signal directly is not feasible, it is usually possible to determine if the signal is digital or analog by attempting the odometer calibration procedure described later in this chapter. First try the default digital setting.

Connecting a Digital Odometer

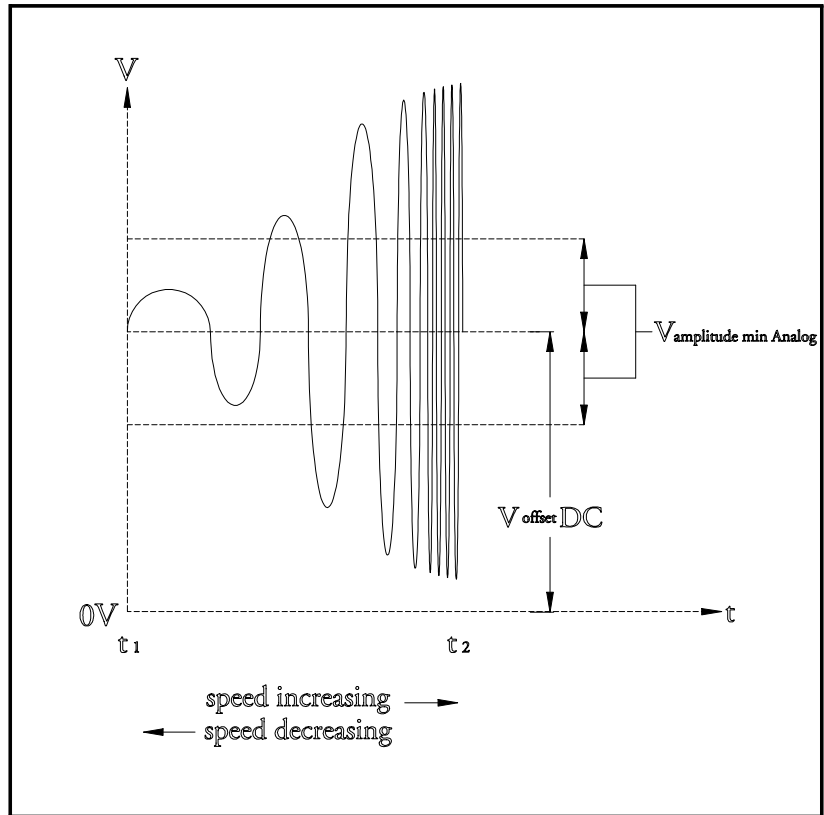
The default odometer type for the Placer 455 DR is digital. If when running the odometer calibration program no pulses are detected at low speeds but are seen at high speeds, then the setting may need to be changed to analog using the PCLRINIT.EXE configuration program described later in this chapter.

1. Connect the red (signal) wire from the cable labeled “ODO 0” on the DR Sensor Cable to the vehicle odometer signal.
2. Do not connect the black wire labeled Ground. The “ODO 1” cable is not used and can be trimmed as is convenient.

Table 6-3. Analog and Digital Signals

Period Between Pulses or Peaks	Threshold Below Which Pulses Cannot be Detected	
	Digital Peak Amplitude	Analog Peak Amplitude
2 secs	1.6 V	.21 V
1 secs	1.5 V	.21 V
0.1 sec	1.2 V	.11 V
0.01 sec	1.2 V	.11 V
1 milisec	1.3 V	.14 V
.2 milisec	2.7 V	.38 V

Figure 6-6.
Analog Signal



Vehicle Odometer Information

Vehicle odometers generally fall into one of three categories: digital, analog or mechanical. Following is a description of each type.

Digital Signals. Square wave signals usually from 0 to the vehicles positive battery voltage (12 Volts). The pulse frequency is proportional to the vehicle speed.

Possible problem: The Placer 455 DR requires a minimum of 2000 pulses per mile (ppm).

Solution: This requires the installation of a Hall Effect Transducer in the odometer cable line by a speedometer service technician. The vehicle's standard odometer signal will not be used.

Analog Signals. Approximately sinusoidal or triangular signals where both the frequency and amplitude increase proportionally to the vehicle speed.

Possible problem: At (very) low speeds the analog signal amplitude is too small and the Placer 455 counts zero pulses and treats the vehicle as if it is stopped.

Solution: Use a signal conditioner to convert the analog signal into a square wave provided the underlying analog signal is capable of outputting at least 2000 ppm. Then the digital signal description above applies. If the pulse rate is below the required 2000 ppm value, this requires the installation of a Hall Effect Transducer or contact Trimble for adjustment instructions.

Mechanical Odometer. This requires the installation of a Hall Effect Transducer in the odometer cable line by a speedometer service technician. This creates a digital signal as described above.

Signal conditioners and Hall Effect transducers can be obtained from taxi supply distributors or odometer repair shops.

Calibrating the Placer GPS 455DR

The odometer and gyroscope sensors used in the Placer 455DR system must be calibrated after installation for the system to function correctly. The calibration values are stored in the Placer's battery backed memory for use in the normal daily operation of the system. Please read this section thoroughly prior to running the calibration program.

During the calibration procedure, you will be monitoring your vehicle for the odometer pulse rate and driving specific measured distances. In general, you will do the following:

- Check the odometer for pulses and pulse rate consistency at slow, medium, and fast speeds.
- Drive a known distance (usually 1/2 or 1 mile) and measuring the number of pulses per mile from the vehicles odometer.
- Drive 3 to 5 circles, first turning right, then turning left.



Trimble provides a DOS compatible calibration program, `PLCRINIT.EXE`, to assist you in the calibration procedure. This program will guide you through each step of the process.



After the mechanical installation of the Placer 455 DR is complete, connect a (portable) IBM compatible PC to the Placer using the MDT side of the communications cable. Configure the PC as described in Table 6-4.

Table 6-4. Portable PC Requirements for Calibration

Item	Requirement
Operating System	MS DOS V6.1 or later, Windows V3.1 or later, or Windows 95.
RS-232 Port	9600 baud, 8, none, 1 (default)



NOTE: For MS DOS/PC DOS operating systems, both **PLCRINIT.EXE** and **CHAT.INI** must be copied onto the hard disk into the same sub-directory. Select the sub-directory before executing **PLCRINIT.EXE**. For Windows 3.1 and Windows 95, select a DOS box to run **PLCRINIT.EXE**. For proper operation, zoom the window to the full size of the screen.

Conventions Used in the following Sections

The calibration instructions provided in this chapter will appear in **helvetica bold** type. Brackets (<>) are used to indicate characters typed by the user. Conventions are used as follows:

- **<cr>** is the indicator for the enter key or carriage return key
- **<sp>** indicates the space bar
- **<esc>** is the escape key

Responses by the calibration software that will vary in different installations are shown in *italics*. For both these entries **d** is used to indicate any digit and **a** indicates any letter. When the actual letters “d” or “a” are used, they will appear in double quotes.

Installing the Configuration Program

PLCRINIT.EXE can be run directly from the provided diskette or a local copy created on your PC.



1. At the DOS prompt, select the directory or drive. Then, type **PLCRINIT** then **<cr>**.
2. Type **“d” <cr>** to begin the calibration process. You should see the main calibration menu illustrated below.

```
PLCRINIT Vx.xx, Use <esc> to Quit; Use ? for Help Screen
Sensor Calibration Menu
1.) Start Gyro Scale Factor Cal.
2.) Display Raw Odometer Pulses
3.) Set Sensor Data
Enter choice: d <cr>
```


Calibrating the Odometer

The PLCRINIT program divides the screen into two windows. The upper window provides a series of menus and choices for the calibration procedure. The data scrolling in the lower window is not relevant to the configuration process.

It is recommended that you first calibrate the odometer, and then start the gyroscope scale factor calculation.



1. Type **2 <cr>** in the main calibration menu to display the following screen.

```

***** Odometer Raw Pulse Measurement *****
Odometer raw pulse measurement started
      Press any key to stop calibration.
ODOM PULSES = dddd
  
```

Conduct the following vehicle tests to begin the calibration procedure.



2. Verify that there are no pulses while the vehicle is stopped. This test should run for about 60 seconds.
3. Drive at a slow speed (below 5 m.p.h.). There should be a consistent non-zero pulse rate.
4. Drive at about 25 m.p.h. Again, there should be a consistent pulse rate greater than that observed in Step 3.
5. Drive at 55 m.p.h. The pulse rate should be greater than that in Step 4.



NOTE: At any time during this process the odometer counter can be reset to zero by the following sequence of keystrokes: **<sp>**, **N**, **“d”**, then **2**. This will briefly enter the value in the Odometer screen in Step 7 and exit back to the start of the calibration.

The final odometer measurement is the number of pulses per mile (PPM).

6. Reset the odometer counter to 0 as above (<sp>, **N**, “**d**”, then **2**).



7. Stop, press <sp> and you will see the first four lines in the following screen. Note the number of pulses on the installation checklist.

```
***** Odometer Raw Pulse Measurement *****
Odometer raw pulse measurement stopped.
ODOM PULSES = dddd
Enter new odometer pulses per mile value? (Y/N) YES
```

8. Enter **Y** to “enter new odometer pulse per mile value”?

```
***** Odometer Raw Pulse Measurement *****
Set Odometer Data
Change odometer type?: (Y/N) YES
Odometer type: (<space> cycle, <CR> select, ^Z abort)
```

9. From here you have the option to change the odometer type. The default is digital and if no change is required (based on the section Connecting the Vehicle Odometer) the response to “Change odometer type?” should be **N**. For analog odometers respond **Y**.



10. The next option allows you to cycle between “Odometer type: Digital (1)” and “Odometer type: Analog (2)” by typing **<sp>**. Select by typing **<cr>** or use control z (**^Z**) if you entered this menu line accidentally.

```
***** Odometer Raw Pulse Measurement *****
Change odometer scale factor? : (Y/N) YES
Enter odometer sf: dddd
```

11. The next section allows you to enter the odometer scale factor in ppm based on the measured mile results from screen 2. Respond **Y** to “Change odometer scale factor?”, enter the number of pulses per mile per mile as determined in Step 6, then type **<cr>**.

```
***** Odometer Raw Pulse Measurement *****
Set new odometer values to
  Odometer type: <Digital odometer, Analog Odometer,
  unchanged>
  Odometer scale factor: < w/ dddd.000000 scale factor,
  unchanged>
  (Y/N)
```

12. The confirmation message at the bottom of the screen appears. If the values are correct type **Y**.

The odometer calibration procedure is complete.



NOTE: The entry process can be repeated without redoing the ppm measurement by selecting 3) “Set Sensor Data” from the screen 1 menu.

Calibrating the Gyroscope

Having completed the odometer calibration, the next step is to calibrate the gyroscope. Completing the odometer calibration prior to the gyroscope calibration is important because the Placer 455 system relies on the odometer to detect when the vehicle is in motion during the gyroscope calibration.

After completing the odometer calibration procedure, return to the main Calibration menu.



1. Type **"d"** to return to the main Calibration menu.

```
PLCRINIT Vx.xx, Use <esc> to Quit; Use ? for Help Screen
Sensor Calibration Menu
1.) Start Gyro Scale Factor Cal.
2.) Display Raw Odometer Pulses
3.) Set Sensor Data
Enter choice: d <cr>
```

2. Type **1 <cr>** to select gyroscope calibration.

```
***** Gyro Scale Factor Calibration *****
The odometer installation/calibration should be complete before
starting the gyro calibration
Are you ready to calibrate the gyro? (Y/N) YES
```

3. Type **Y** to confirm that you want to calibrate the gyroscope.

The next screen you will see prompts you to press any key when you are ready to begin the calibration procedure. It is usually easiest to line up the vehicle with a line in a parking lot or an equivalent indicator of the vehicles direction.

```
***** Gyro Scale Factor Calibration *****
Gyro scale factor calibration begins with clockwise (RIGHT)
turns. Prepare to make right turns.
Press ANY KEY to begin calibration.
```



4. Press any key or type **<sp>** to access the following screen.

```
***** Gyro Scale Factor Calibration *****
Right Scale Factor Cal Started.
Press ANY KEY to stop calibration.
DR Sensor Calibration Data:
Calibration heading: ddd.ddd
```

5. Drive 3 to 5 circles clockwise returning to the original vehicle direction at completion. Each circle should be completed under about 20 seconds at reasonable constant speed. The heading displayed should be about 360 degrees for each turn +/- 10%.



6. Once stopped type **<sp>** to end the calibration. The following screen is displayed.

```
***** Gyro Scale Factor Calibration *****
Prepare to make left turns.
Press ANY KEY to begin calibration.
```

7. Move the vehicle if necessary to the position for completing counterclockwise turns. You should perform the calibration in a similar fashion to the clockwise one, including the same number of turns.



8. Type **<sp>** to begin calibration.

```
***** Gyro Scale Factor Calibration *****
Left Scale Factor Cal Started.
      Press ANY KEY to stop calibration.
DR Sensor Calibration Data:
      Calibration heading: -ddd.ddd
```

9. As you drive, notice that the counterclockwise turns are indicated by a negative calibration heading.



10. Type **<sp>** to end calibration.

```
***** Gyro Scale Factor Calibration *****
      GYRO BIAS RATE (FYI) : sd.ddddd
      GYRO LEFT SCALE FACTOR : d.ddddd
      GYRO RIGHT SCALE FACTOR : d.ddddd
1) Save these values.
2) Use results in BBRAM.
3) Use default values. Enter choice:
```

The bias rate is not used in the calibration but should be within the range of -10 to +10 degrees per second for correctly functioning gyroscopes. The left and right scale factors should lie in the range from 0.9 to 1.1 and be close to each other in value. If you feel that the calibration was performed accurately the scale factors should be saved in battery backed-up memory on the Placer (BBRAM). These values will then be used in all future operation of the Placer 455DR.

The gyroscope calibration procedure is complete.

Modifying the DR Sensor Values

If during the calibration procedure you determine that your odometer is digital rather than analog, the Sensor Calibration Data screen provides the most efficient method for changing the odometer type during installation. The gyroscope will require that you enter both the left and right scale factors. Any combination of the three items: odometer type, odometer scale factor, and gyroscope scale factors can be changed independently.



1. Type **3 <cr>** at the main calibration menu. Then, follow the prompts on the screen to modify the DR sensor values.

```

***** Sensor Calibration Data *****
Set Sensor Data
Change odometer type?: (Y/N) YES
    Odometer type: (<space> cycle, <CR> select, ^Z abort)
Change odometer scale factor? : (Y/N) YES
    Enter odometer sf: dddd
Change gyro scale factors? : (Y/N) YES
    Enter left gyro sf: d.ddddd
    Enter right gyro sf: d.ddddd
Set new sensor values to
    Odometer type: <Digital odometer, Analog Odometer,
unchanged>
    Odometer scale factor: < w/ dddd.000000 scale factor,
unchanged>
    Gyro scale factors: LEFT d.ddddd RIGHT d.ddddd
(Y/N) YES

```


Chapter 7

Maintenance

The Placer GPS 450, 455 and 455DR sensors are designed to provide years of trouble-free operation. The units are simple to maintain.

Should any major Trimble component fail (Placer, antenna, antenna cable, interface cables), a replacement can be ordered (or repaired/replaced, if under warranty) from Trimble Technical Assistance Center. The new component can be substituted for the failed component without concern for compatibility, since the Placer GPS 450, 455 and 455DR sensors do not rely on "matched" components. The major replaceable components for the Placer GPS 450 are listed in Table 4-1 and for Placer 455 and 455DR in Table 6-1.



NOTE: The telephone number for the Trimble Technical Assistance Center and Repair center is 1-800-SOS-4-TAC. Contact them to order spare or replacement components. Special order processing may be required.

Troubleshooting

Should you experience problems with the Placer, be sure to check the simple items listed below prior to contacting Trimble Technical Assistance Center. Many "failures" are due to improper connections, or a misunderstanding of how the equipment should be installed or operated.

- For operational problems, confirm the following:
- All connections are made securely.
- The Placer is connected to DC power source of 9 to 32 volts.

The ignition sense wire is connected either to the battery (+) for continuous power or to the ignition switch, so when ignition is turned on power is supplied to the Placer.

If the Placer is receiving power and is properly connected, but communication cannot be established, check the following:

- With the Terminal or PC configured to match the setup of the MDT port (default set to 9600, 8, 1, N), connect to the MDT port. To confirm communication, query the Placer for version number (>QVR<). The Placer should respond with the firmware version number and the release date.

>RVR PLACER 450; VERSION X.XX (MM/DD/YY) or
>RVR PLACER 455; VERSION X.XX (MM/DD/YY) or

If the problem persists, refer to the following sections titled Communications Troubleshooting and GPS Troubleshooting. If you have a Placer GPS 455DR unit and you are having problems with the heading sensor then consult the section on Dead Reckoning Troubleshooting.



NOTE: Trimble offers the GPS Starter Kit (GPSSK) software package to assist users of the TAIP protocol. GPSSK runs on any IBM compatible PC and displays TAIP message data in an easy to read format. Please ask Trimble or your sales representative for more information on GPSSK.

Communications Troubleshooting

The standard Placer GPS 450 has two serial ports:

- Radio Connector (port 0) and
- MDT Connector (port 1).

Units with the DGPS option, Placer GPS 455s, have an additional port:

- MDT/RTCM Connector which provides connection to the MDT (port 1) and also to an RTCM -104 port (port 2) for input of differential corrections.

If you are experiencing communications problems, refer to the table below.

Symptom	Action
No output from Radio port (port 0)	<p>If the Placer is not configured for a communication protocol (that is DIRECT connection) then there will be no output on the Radio port.</p> <p>If the Placer is configured for a communications protocol (CDPD or MAP 27) then, on power up, it will attempt to handshake with the external radio/modem and there will be some output (binary characters). If there is no output from the Radio port then: Check all connections are secure</p> <p>Check: Is the unit powered.</p> <p>Check ignition sense wire on the power cable is connected either to the battery (+) for continuous power or to the ignition (+) for switched power.</p> <p>Connect a null modem if output is to DTE equipment.</p> <p>Confirm baud rate, parity, data and stop bit settings are the same for port and radio/modem (9600, 8, 1, N).</p> <p>Use the MDT port to confirm settings for the Radio port (port 0): issue >QAP0< to get port 0 settings.</p>

Symptom	Action
No output from the MDT port (port 1)	<p>Check: Is the unit powered.</p> <p>Connect the MDT side of the communications cable supplied (the other side is for the RTCM port, for Placer 455 only).</p> <p>Confirm baud rate, parity, data and stop bit settings are the same on the PC (9600, 8, 1, N).</p>
Garbage output from the MDT port (port 1)	<p>Check baud rate, parity, data and stop bit settings (9600, N,8,1) are the same on the PC.</p>
MDT port does not respond to input messages.	<p>Check: Is the unit powered.</p> <p>Connect the MDT side of the communications cable supplied (the other side is for the RTCM port).</p> <p>Check Appendix A , TAIP Protocol, for complete instructions.</p> <p>Confirm baud rate, parity, data and stop bit settings are the same for the MDT port and the PC (9600, 8, 1, N).</p> <p>Ensure that all queries, commands are delimited with > <.</p> <p>Ensure that all queries, commands are in CAPITAL letters.</p> <p>If sending a query command with a checksum, try without using the checksum.</p> <p>Confirm that message format is correct.</p> <p>Try a simple query, like >QVR<. This should cause a response regardless of GPS status.</p>
No output from the RTCM port (port 2)	<p>The RTCM port is for input only of RTCM formatted differential corrections. The MDT port (port 1) is the primary TAIP port.</p>

Symptom	Action
The differential corrections input on the RTCM port (port 2) are not being processed by the Placer.	<p>Check: Is the unit powered.</p> <p>Connect the RTCM side of the communications cable supplied (the other side is for the MDT port, for Placer 455 only).</p> <p>Confirm baud rate, parity, data and stop bit settings are the same on the PC (9600, 8, 1, N). Use the MDT port to confirm settings for the RTCM port (port 2): issue >QAP2< to get port 2 settings.</p>

GPS Troubleshooting

To troubleshoot the GPS receiver portion of the Placer GPS 450/455 sensor, query the sensor with the TAIP command, >QST< on the MDT port, for the current status. See Appendix A for information on decoding the status message, and then refer to the table below.

GPS Tracking Status Messages from TAIP >QST<	
Doing position fixes	Doing position fixes, GPS is providing the position solution.
Does not have GPS time yet.	No satellites visible, none have been visible since power on.
PDOP is too high	Three or more satellites are visible but the constellation geometry exceeds the PDOP mask level. Contact Trimble Technical Assistance Center.
No usable satellites	<p>No usable satellites. Satellites may be visible but are too low in elevation or signal strength is too low.</p> <p>Be sure the antenna has a clear view of the sky.</p>
Only 1, 2 or 3 usable satellites	Satellites are visible, and meet mask criteria, but not enough satellites are usable for a position fix. If only 3 usable satellites, but no position fix, then the receiver is set to the 3-D only mode and will require 4 satellites for a GPS position fix.

GPS Error Codes from TAIP >QST<

Battery backup failed and/or Battery Powered timer/clock fault. This message normally occurs when units are first installed but will disappear the first time power is switched off and then back on. If the message persists after cycling power contact Trimble Technical Assistance Center.

The internal lithium battery has failed. This causes the satellite almanac, as well as the configuration settings to be lost when power is removed from the receiver. If the receiver is operating fine now, it should continue to do so as long as power is applied but all configuration information may be lost when power is removed. Contact Trimble Technical Assistance Center to arrange to have the battery replaced.

Antenna feedline fault The antenna is not properly connected. Check connections and re-seat the antenna cable connections at both the antenna and receiver ends.

Check that the antenna cable is not crimped.

If no difference, try another antenna or antenna cable.

If still no difference contact Trimble Technical Assistance Center.

The stored almanac is not complete and current If the receiver has not tracked satellites for several days, the stored almanac may no longer be current. A current almanac will be read the next time a satellite is tracked. This will increase the time to first fix. During this time DR positions (for Placer 455DR units) will still be available.

This could also be an indication of a failed internal battery. If so, there should also be a battery backup failure reported. Contact Trimble Technical Assistance Center to arrange for battery replacement.

Dead Reckoning Troubleshooting

Dead Reckoning Diagnostic Messages from Calibration using PLCRINIT.EXE

<p>No raw odometer pulses at any speed</p>	<p>There should be no odometer pulses when the vehicle is stationary.</p> <p>Confirm that the odometer signal meets the requirements specified in Chapter 6.</p> <p>If a signal conditioner or Hall Effect transducer was installed, verify that the installation was performed correctly. Test odometer sensor per manufacturers instructions, if provided.</p> <p>Verify that the connection is made to the correct signal source, if monitoring an existing speed/odometer signal.</p>
<p>No raw odometer pulses at low speeds, pulses are output at higher speeds.</p> <p>or</p> <p>Raw odometer pulses output while stationary.</p>	<p>Check that the Odometer Sensor has been installed correctly, as outlined in Chapter 6: Connecting the Vehicle Odometer.</p> <p>The odometer output may require a signal conditioner.</p>

Dead Reckoning Diagnostic Messages from TAIP >QX1<

<p>No pulses received from the odometer since startup.</p>	<p>If the vehicle has not been moved since the Placer GPS 455DR was powered on, this is not an error.</p> <p>If the vehicle has moved since power on, this is an error. Follow the instructions provided in Chapter 6 to verify the odometer installation. If the odometer pulses are not adequate, a signal conditioner or Hall Effect transducer will be required for installation.</p>
--	---

Dead Reckoning Diagnostic Messages from TAIP >QX1<	
Odometer scale factor out of tolerance.	The scale factor entered in Nominal Odometer Scale Factor is not within 50% of the actual scale factor. Follow calibration instructions in Chapter 6 to correctly calibrate the odometer.
Backup light is active.	Use this indicator to test your backup light connection.
Odometer Scale Factor.	This is the current calibrated odometer scale factor. This may differ for the Nominal Odometer Scale Factor entered during installation.
Gyro Hardware failed internal diagnostics.	Indicates gyro failure or board level failure inside the receiver. Check connections to the heading sensor and the Placer unit. If these are correct then contact Trimble Technical Assistance Center.
Gyro bias out of tolerance	The most likely cause for this message is connecting the heading sensor after powering up the unit. With all the sensors properly connected, cycle power off and then on, and re-check. If the error persists contact Trimble Technical Assistance Center.
Gyro scale factor out of tolerance.	This could be the result of a failed calibration. If no other errors are reported, retry the calibration procedure provided in Chapter 6.

Dead Reckoning Diagnostic Messages from TAIP >QX1<

Gyro rate Bias	<p>This is the current estimate of the heading sensor drift value. The Placer GPS 455DR automatically calculates this value without operator initialization.</p> <p>The normal range for this value is -10 to +10 deg/sec. The value of the bias will never be 0.0 unless an error has occurred. With the vehicle stopped, cycle power to force the receiver to recalculate the initial bias estimate.</p> <p>Errors in this rate bias may be caused by the gyro not being rigidly mounted. The gyro must be properly mounted before beginning calibration. refer to Chapter 6 for installation instructions.</p>
Gyro Left Scale Factor	<p>This is the heading sensor scale factor for left hand turns, currently being used for DR calculations. If the last gyro calibration was saved in battery backed RAM, this will be that value. If the last calibration was not saved in battery backed RAM, that value will be used and displayed here until power is cycled. After power-up, the value in battery backed RAM will be used in the DR function and displayed here.</p> <p>The allowable range of values is 0.9 to 1.1.</p>
Gyro Right Scale Factor	<p>The allowable range of values is 0.9 to 1.1.</p>

Appendix A

TAIP Protocol

The Trimble ASCII Interface Protocol (TAIP) is a Trimble-specified digital communication interface based on printable ASCII characters over a serial data link. TAIP was designed specifically for vehicle tracking applications but has become common in a number of other applications because of its ease of use. TAIP supports both scheduled and polled responses from the Placer GPS. If you are developing console software or using the Placer in data messaging applications, the information in this appendix will be of assistance to you.

For communication robustness, the TAIP protocol optionally supports checksums on all messages. It also provides the user with the option of tagging all messages with the unit's user specified identification number (ID). This greatly enhances the functional capability of the unit in a network environment. Additionally, given the printable ASCII format of all communication, TAIP is ideal for use with mobile data terminals, seven bit modems and portable computers.



NOTE: The special XT and XS messages are transmitted in binary format and therefore do not conform to printable ASCII characters.

The following table lists the TAIP messages available for the Placer GPS and the message qualifiers supported for each:

MSG	Description	Qualifier		
		Q	S	F/D
AL	Altitude/Up Velocity	✓	✓	✓
AP	Auxiliary Port Characteristic	✓	✓	✓
CP	Compact Position	✓	✓	✓
DA	Destination Address	✓	✓	
DC	Differential Corrections (455 only)		✓	
DD	Delta Differential Corrections (455 only)		✓	
ID	Vehicle Id	✓	✓	✓
IP	Initial Position	✓		
LN	Long Navigation Message	✓		✓
PC	Protocol Configuration	✓	✓	
PR	Protocol	✓	✓	✓
PT	Port Characteristics	✓	✓	✓
PV	Position/Velocity Solution	✓	✓	✓
RM	Reporting Mode	✓	✓	✓
SS	Signal Status	✓	✓	
ST	Status	✓		✓
TM	Time/Date	✓		✓
TX	Text Message	✓	✓	✓
VR	Version Number	✓	✓	✓
XS	Short Binary Position	✓		✓
XT	Extended Binary Position	✓		✓
X1	Extended Diagnostics (455 only)	✓	✓	✓

Qualifier	Action
Q	Query for a single sentence (sent to Placer).
S	Set or configure parameters (sent to Placer)
F	Schedule a reporting frequency interval in seconds
D	Specify a minimum distance traveled and a minimum and maximum time interval for the next report

Placer deviates somewhat from the implementation of **TAIP** used by other Trimble sensors:

- The “epoch” parameter in the F and D specification is ignored. The reporting epoch will be set to the time at which the F or D request is issued to the Placer
- The TX message may contain lower-case characters. This is the only place lower-case letters are allowed in TAIP.
- The XS and XT messages are transmitted in (non-ASCII) binary format.

Message Format

All TAIP communication (with the exceptions of XT and XS messages) uses printable, ASCII characters. The interface provides the means to configure the unit to output various sentences in response to query or on a scheduled basis. Each sentence, with the exception of the XS message, has the following format:

>ABB{C} [;ID=DDDD][;PORT=E][;*FF]<

where:

>	start of new message
A	message qualifier
BB	a two character message identifier,
C	data string
DDDD	optional 4 character vehicle ID,
E	Port Id: 0 for radio/modem port, 1 for MDT port.
FF	optional 2 character checksum,
<	the delimiting character.

Notation:

{x} signifies that x can occur any number of times

[x] signifies that x may optionally occur once

Start of New Message

The “>” character (ASCII code 62 decimal) is used to specify the start of a new sentence.

Message Qualifier

A one-character message qualifier is used to describe the action to be taken on the message. The following table lists the valid qualifiers:

Qualifier	Action
Q	Query for a single sentence
S	Set or configure parameters
R	Response to a query or a scheduled report
F	Schedule a reporting frequency interval in seconds
D	Specify a minimum distance traveled and a minimum and maximum time interval for the next report

Details on the use of message qualifiers will follow in the section *Communication Using TAIP*.

Message Identifier

A unique two-character message identifier consisting of letters of alphabet is used to identify different type messages.

Data String

The format and length of the data string are dictated by the message qualifier and the message identifier. It can consist of any printable ASCII character with the exception of the “>”, “<”, and “;” characters. A detailed descriptions of each message format is provided later in this appendix. Most messages are length sensitive and unless otherwise specified, field separators including space are not used. Some TAIP messages use sub-fields to distinguish between several possible queries. These are described

under the individual messages.

Port Numbering

The TAIP protocol numbers the communications ports on the Placer as 0, 1 (and 2 on the Placer 455). These numbers correspond to the radio modem port, the MDT port and the RTCM port, respectively.

Vehicle ID

A vehicle identification (ID) may optionally be used in all the communications with the Placer. Each Placer in a fleet may be assigned a four character alpha-numeric ID and be configured to output that ID in all messages. The default is: ID set to “0000” and the ID Flag set to “F” (false).

The Placer will check all incoming messages for ID. If no ID is specified, the Placer will accept the message. If the ID is included in messages but does not compare with the ID previously set, the message will be ignored. This applies even when the ID Flag is turned off.



NOTE: If a communications protocol (such as CDPD or MAP27) is being used, the radio/modem unit will normally filter messages using the network address, making the ID unnecessary, although still available.

Checksum

The checksum field provides for an optional two-digit hex checksum value, which is computed as XOR of all characters from the beginning of the sentence up to and including the “*” character. If included, the checksum is always the last element of the sentence before the message delimiter. The default mode of operation is to exclude checksum in sentences. The use of checksums can help in instances where the communication channel is noisy.

Example

The following message sets the vehicle ID flag on, and includes checksum.

```
>SRM;ID_FLAG=T;*6F<
```

The checksum (6F) was generated by XOR'ing the ASCII codes for ">" and "S" then XOR'ing that result with the ASCII code for "R" and so forth, up to and including the "*" character.

Message Delimiter

The “<” character signifies end of a sentence and is used as the message delimiter. All characters following the “<” up to the start of the next sentence will be ignored.

Sample PV Message

The Position/Velocity Solution (PV) message is one of the more commonly used TAIP messages. The following analysis of a typical PV message is provided to further explain the TAIP message protocol.

>RPV15714+3739438-1220384601512612;ID=1234;*7F<

>	Starting Delimiter
R	Response Qualifier
PV	PV Message Identifier
15714	GPS Time of Day
+3739438	Latitude
-12203846	Longitude
015	Speed
126	Heading
1	Source of Data
2	Age of Data
;ID=1234	Vehicle ID
*7F	Checksum
<	Ending Delimiter

Data String Information

GPS Time of Day:	15714 seconds, 04:21:54 GPS (time of last fix)
Latitude:	+37.39438 degrees
Longitude:	-122.03846 degrees
Speed:	15 MPH
Heading:	126 degrees
Source of Data:	3D GPS
Age of Data:	Fresh (<10 seconds)



NOTE: Refer to the discussion of the PV message data string for more detail on how this message is interpreted.

Latitude and Longitude Conversion

The TAIP protocol reports latitude as positive north decimal degrees and longitude as positive east decimal degrees, using the WGS-84 datum. For your application, you may wish to convert to degrees, minutes and seconds. The following example illustrates the conversion of decimal degrees to degrees, minutes and seconds.

Example:

Given latitude and longitude in decimal degrees,

Latitude: +37.39438 degrees
Longitude: -122.03846 degrees

Convert latitude by multiplying the decimal fraction of degrees by 60 to convert to minutes,

$$0.39438 \times 60 = 23.6628 \text{ minutes}$$

Retain the integer (23) portion as the minutes then multiply the decimal fraction by 60 to convert to seconds,

$$0.6628 \times 60 = 39.768 \text{ seconds}$$

Since the sign of the latitude in this example is positive the result is:

Latitude: N 37° 23' 39.77"

The longitude is converted in the same fashion:

Longitude: W 122° 02' 18.46"



NOTE: At the earth's equator, one degree of latitude and longitude represents 68.7 miles; therefore, 0.00001 degrees represents approximately 3.6 feet or 1.1 meters. Each second represents approximately 100.76 ft (30.7 m).

Communication Using TAIP

Communication with the unit takes place in four different ways. Message qualifiers are used to differentiate between these. The protocol is identical for sessions at the local (Service) port and sessions conducted over the air.

Query for single sentence

The query (Q) message qualifier is used to query the Placer to respond immediately with a specific message. The format is

>QAA[;ID=BBBB];*CC<

where AA is the requested message identifier. Messages supported by this qualifier are indicated on page A-2.

Response to Queries and Reported Messages

Responses to queries and reports autonomously generated by the Placer are indicated by the response (R) qualifier. The XT and XS messages are exceptions that do not use the 'R' qualifier. The format is:

>RAA[{B}][;ID=CCCC];*DD<

where AA is the two character message identifier and {B} specifies the data string within the message. For the format of {B}, please refer to the message definitions in the following section.

Scheduled Reporting Interval

The scheduled reporting frequency interval (F or D) message qualifier is used to tell the unit how often and when to report a specific message. The format of the data string is as follows:

>AXXppppooooddddmmmm[;ID=dddd][;PORT=n][;*hh]<

ID	Meaning
A	F or D
XX	message diagram
pppp	the maximum message reporting rate (sec)
oooo	the offset from the top of the hour (sec.)
dddd	the minimum distance between reports (meters)
mmmm	the maximum time that can pass between successive reports

The following values have special meaning:

Value	Meaning
p=0	no message reported
d=0	distance based reports deactivated
m=0	maximum time is infinite

Reporting intervals can be set independently for suitable TAIP messages and can be set independently for each available TAIP port. The specified reporting interval applies to the port that receives this message unless the “;PORT=n” string is supplied. For example, to set the Placer for reporting PV messages every 10 seconds on the radio/modem port, the following can be entered from the MDT port: >FPV10;PORT=0.

Some abbreviated formats are also accepted. When the digit section length is less than 16, the message is interpreted as if the missing values are 0 and the digits for the last field entered are right justified. For example:

>FXX<	p=0	o=0	d=0	m=0
>FXX10<	p=10	o=0	d=0	m=0
>FXX006010<	p=60	o=10	d=0	m=0
>FXX00100000010 0<	p=10	o=0	d=100	m=0

For example, when the message: >DPV0030000005000900;ID=0105< is sent to the Placer, it specifies that vehicle number 105 (GGGG = 0105) is to report the Position Velocity message (AA = PV) whenever its current position differs from the previously reported position by at least 500 meters (EEEE = 0500), but no more often than every 30 seconds (BBBB = 0030) or less often than every 15 minutes (FFFF = 0900 seconds). The optional checksum was not used in this example. The square brackets, [. . .], shown in the format description above are used to indicate optional data. The brackets themselves are never included in the actual TAIP message string.

Messages normally supported by the F and D qualifier are indicated on page A-2. Placer does not support all messages with scheduled reporting qualifiers. An unsupported schedule will be ignored.

The Set qualifier

The set (S) qualifier enables the user equipment to initialize/set-up various types of data in the Placer. The format is:

>SAA{B} [[:ID=CCCC][:*DD]<

where AA is the two character message identifier and {B} specifies the data string within the message. For the format of {B}, please refer to the message definitions in the previous section. Note that all the messages have very specific formats and are length dependent. Messages supported by the set qualifier are indicated on page A-2.

Sample Communication Session

The following is a sample communication session to illustrate how message qualifiers are used.

Query the Placer for its ID number:

```
>QID<
```

The Placer will respond (assuming factory default settings):

```
>RID0000<
```

Set the ID to match the number for a vehicle in your fleet and then tell the Placer to include the Vehicle ID in its responses:

```
>SID1234<  
>SRM;ID_FLAG=T<
```

To schedule unit 1234 to report its position every 15 minutes or 1000 meters (but not more often than every 2 minutes) use the following command:

```
>DPV0120000010000900;ID=1234<
```

The Placer will check the ID included in the message for a match with its own and then reschedule the PV message. At the next scheduled time, the Placer will respond with:

```
>RPV15714+3739438-1220384601512612;ID=1234<
```

Notice that the time given in the message is the time of the last GPS fix (04:21:54 GPS), not necessarily the time of the message response. If the time of last fix is 10 or more seconds old, the age flag will be set to "1".

AL Altitude/Up Velocity

The format of the data string is as follows:

AAAAABBBBBBCCCCDE

Item	# of Char	Units	Format (Value)	
GPS Time of day	5	Sec	AAAAA	
Altitude	6	Meters	BBBBBB	
Vertical Velocity	4	MPH	CCCC	
Source	1	n/a	D	(0 = 2D GPS) (1 = 3D GPS) (2 = 2D DGPS) (3 = 3D DGPS) (6 = DR) (8 = Degraded DR) (9 = Unknown)
Age of Data Indicator	1	n/a	E	(2 = Fresh, <10 sec) (1 = Old, 10 sec) (0 = Not available)
Total		17		

Altitude is above mean sea level in WGS-84. The GPS time of day is the time of fix rounded to the nearest second. This message contains data obtained from the last 3 dimensional fix and may not be current.



NOTE: The data in this message is to be considered invalid and should not be used, if the "Age of Data Indicator" is equal to 0 (signifying data not available).

AP Auxiliary Port Characteristic

The format of the data string is as follows:

AAAA,B,C,D,E,F

Item	# of Char	Units	Format (Value)
Baud Rate	4	n/a	AAAA (9600, 4800, 2400, 1200, or 0300)
# of data bits	1	n/a	B (7 or 8)
# of stop bits	1	n/a	C (1 or 2)
Parity	1	n/a	D (N = None) (O = Odd) (E = Even)
Auxiliary Port Number	1	n/a	E(1)
Reserved	1	n/a	F (0)
Total		14 (including commas)	

This messages defines the characteristics for a specified port. The port characteristics can be queried using >QAPn< for:

n=0: radio port)

n=1: MDT port

n=2: RTCM port (Placer 455 only)

>QAPn< returns the parameters of port, n. If n is not specified parameters for the lowest port number not equal to the current port are returned.

Example . The following command will set the auxiliary port characteristics to 2400 baud, 8 data bits, 1 stop bit and no parity.

>SAP2400,8,1,N,1,0<



NOTES: The inclusion of "0" in the reserved field.

The AP command applies only to receivers with dual serial ports.

CP Compact Position Solution

The format of the data string is as follows:

AAAAABBBCCCCDDDEEEF

Item	# of Char	Units	Format (Value)	
GPS Time of day	5	Sec	AAAAA	
Latitude	7	Deg	BBB.CCCC	
Longitude	8	Deg	DDDD.EEEE	
Source	1	n/a	F	(0 = 2D GPS) (1 = 3D GPS) (2 = 2D DGPS) (3 = 3D DGPS) (6 = DR) (8 = Degraded DR) (9 = Unknown)
Age of Data Indicator	1	n/a	G	(2 = Fresh, <10 sec) (1 = Old, 10 sec) (0 = Not available)
Total		22		

Position is in latitude (positive north) and longitude (positive east) WGS-84. The GPS time of day is the time of fix rounded to the nearest second.



NOTE: The data in this message is to be considered invalid and should not be used, if the “Age of Data” is equal to 0 (signifying data not available).

DA Destination Address

The DA message must be set to enable automatic reporting in all Placer units with built-in communications protocols (i.e., MAP27 and CDPD). The DA message does not apply to the TAIP version of the Placers (i.e., those that do not have built-in communications protocols).

The DA message varies according to the radio protocol. The format of the data string is as follows:

ABC{D}

Item	# of Char	Units	Format (Value)
Index	1	n/a	A
Address Type	1	n/a	B
Address Subtype	1	n/a	C
Address	Varies	n/a	DDD...

Total 3+length of address

The Destination Address messages indicate where autonomously generated messages, such as PV, LN, XT, and XS messages, are to be sent. The Address Type and Subtype specify the format of the address field. Address Type indicates the applicable radio protocol: "C" for CDPD, "M" for MAP27, and "R" for RDI. The Address field specifies the destination address in appropriate format according to the radio protocol. Address formats for supported protocols are described below.

The DA messages is supported by the Q qualifier. The data string need not include the Address Index. The address specification is returned in the format described above.

NOTE: The index field can be used to specify up to 10 destination addresses (0-9). This feature is currently not implemented.



CDPD Destination Addresses

The Address Type and Subtype specify the format of the address field. For CDPD, the Type is specified as “C”; the Subtype is not used and will always be set to 0. The Address field specifies an IP address as four 3-digit segments separated by “.”. Each 3-digit segment must be in the range 0–255; if any segment is invalid, the DA message is ignored.

The IP Address field, once set, is used as the destination address for all messages sent from the Placer 450/CDPD that were not responses to queries on the configuration/query communications channel. Each IP address must be formatted according to Interned addressing standards. The Placer 450/CDPD stores the DA in battery backed RAM so it will be preserved while the unit is powered off.

Example: CDPD. The following command will set the destination address as IP address 192.133.032.014.

```
>SDAOCO192.133.032.014<
```

Where:

- Index=0 (not used)
- Type=C for CDPD
- Subtype=0 (not used)
- Address=192.133.032.014

Note that leading zeros must be used in each three digit segment.

MAP27 Destination Addresses

The Address Type and Subtype specify the format of the address field. For MAP27, the Type is specified as 'M'; the Subtype field is not used and will always be set to 0. The Address field specifies the destination address. For MAP27, the address field contains the 3-digit PFX and 4-digit IDENT separated by ':'. Valid MAP27 addresses have PFX in the range 0-127, and IDENT in the range 1-8191.

The Destination Address message indicates where messages are to be sent. For MAP27, this address is used for all 'automatic' messages, such as messages scheduled by time / distance or messages resulting from changes in digital input states. Messages sent as response to Queries will be addressed to the sender of the Query. The Index can be used to specify up to 10 destination addresses (0-9). (This field is not used with the MAP27 protocol and will always be set to 0.)

Example: MAP27 The following command will set the destination address as MAP27 address 3:237.

```
>SDAOM003:0237<
```

Where:

- Index=0 (not used)
- Type=M for MAP27
- Subtype=0 (not used)
- Address=003:0237

DC Differential Corrections

This message provides the sensor with differential corrections from RTCM-104 record types 1 and 9. The values are numerical values written out in hex format, thus for each byte of data there is a two digit hex number.

The format of the data string is as follows:

AAAABBCC{DDEEEFFGG}

Item	# of Char	Type	Units	Format
Modified Z-count	4	WORD	.6 sec	AAAA
Station health	2	BYTE	n/a	BB
Number of SVs	2	BYTE	n/a	CC
The next 5 bytes (10 characters) are repeated for each SV				
SV PRN & health				
(UDRE)	2	BYTE	n/a	DD
Range Correction	4	WORD	RTCM-104	EEEE
Range-rate correction	2	BYTE	RTCM-104	FF
IODE	2	BYTE	n/a	GG

The units and scale factors are as defined by RTCM-104 version 1. The SV PRN and health contains the SV PRN in the lower 5 bits and the health/UDRE/scale factor in the upper 3 bits. Range corrections are scaled by 0.02 meters times 2 raised to the “health” power. Range-rate corrections are scaled by 0.002 meters per second times 2 raised to the “health” power.



NOTE: This message is supported by the Placer GPS 455 only. Use of DC and DD messages to input corrections requires only one communications channel. Use of the auxiliary port to input RTCM-104 corrections assumes a separate communications channel is available for broadcast and receipt of differential corrections.

DD Delta Differential Corrections

This message provides the sensor with delta differential corrections from RTCM-104 record type 2. The values are numerical values written out in hex format, thus for each byte of data there is a two digit hex number.

The format of the data string is as follows:

AAAABB{CCDDDD}

Item	# of Char	Type	Units	Format
Modified Z-count	4	WORD	.6 sec	AAAA
Number of SVs	2	BYTE	n/a	BB
The next 3 bytes (6 characters) are repeated for each SV				
SV PRN	2	BYTE	n/a	CC
Delta Range Correction	4	WORD	RTCM-104	DDDD

The units and scale factors are as defined by RTCM-104 version 1. The health/UDRE/scale factor given for the specific SV in the most recent message "DC" is used. Delta range corrections are scaled by 0.02 meters times 2 raised to the "health" power.



NOTE: Use of DC and DD messages to input corrections requires only one communications channel. Use of the auxiliary port to input RTCM-104 corrections assumes a separate communications channel is available for broadcast and receipt of differential corrections. This message is supported by the Placer GPS 455 only.

ID Identification Number

The format of the data string is as follows:

AAAA

Item	# of Char	Units	Format
Vehicle ID	4	n/a	AAAA
Total	4	4	

This message is used to report or set the Placer's unique four character, alpha-numeric, user assigned ID. The default at cold start is "0000".

Example:

The following message will set the vehicle ID to 101.

>SID0101<

The following is simply a response to a query for vehicle ID.

>RID0101<



NOTE: The sensor will always check incoming messages for ID and compare with the vehicle ID set in the sensor's memory. If no ID is included in the message, the sensor will assume a match and accept the message. If the message sent to the sensor does contain a vehicle ID but that ID does not match the ID previously set in the sensor, the message will be ignored. This process is followed even when the ID_Flag is turned off (refer to the message RM).

IP Initial Position

The format of the data string is as follows:

AAABBBBCCCC

Item	# of Char	Units	Format
Initial Latitude	3	Deg	AAA
Initial Longitude	4	Deg	BBBB
Initial Altitude	5	10 Meters	CCCCC
Total		12	

This is a very coarse initial position that the user can provide to aid the sensor in obtaining its first fix. This is specially useful with sensors that do not have non-volatile (Battery Backed-up) memory. In such cases, every time the unit is powered up, it goes through a complete cold-start and it has absolutely no knowledge of where it is. Providing this message improves performance by decreasing the time to first fix and enhances the accuracy of the initial two dimensional navigation solutions by providing a reference altitude.



NOTE: For all the above values, the first character specifies the sign (\pm). The Placer 450 and 455 have battery backed memory.

Example:

The following message will set the initial position to 37° North, 122° West, altitude 10 meters.

>SIP+37-122+0001<

LN Long Navigation Message

The format of the data string is as follows:

**AAAAAABBCCDDDDDDDEEEEF-
 FFFFFFFGGGGGGHHIIJJKKKLMMMNOO{PPQQ} RRRRRRRRRRST**

Item	# of Char	Units	Format (Value)
GPS Time of day	8	Sec	AAAAA.BBB
Latitude	10	Deg	CCC.DDDDDDD
Longitude	11	Deg	EEEE.FFFFFFF
Altitude above MSL	9	Ft	GGGGGGG.HH
Horizontal Speed	4	MPH	III.J
Vertical Speed	5	MPH	KKKK.L
Heading	4	Deg	MMM.N
Number of SVs used	2	n/a	OO
The following two entries (4 characters) are repeated for each SV used:			
SV Id	2	n/a	PP
IODE (2 digit hex)	2	n/a	QQ
Reserved	10	n/a	RRRRRRRRRR
Source	1	n/a	S (0 = 2D GPS) (1 = 3D GPS) (2 = 2D DGPS) (3 = 3D DGPS) (6 = DR) (8 = Degraded DR) (9 = Unknown)

Age of Data Indicator	1	n/a	T sec)	(2 = Fresh, <10 (1 = Old, 10 sec) (0 = Not available)
-----------------------	---	-----	-----------	---

Total 65 + (Number of SVs used times 4)

Position is in latitude (positive north) and longitude (positive east) WGS-84. Heading is in degrees from True North increasing eastwardly. The GPS time of day is the time of fix rounded to the nearest second.



NOTE: The data in this message is to be considered invalid and should not be used, if the “Age of Data Indicator” is equal to 0 (signifying data not available).

PC Protocol Configuration

This message allows configuration of options specific to the Placer 450 communications protocol. Note that this message is not supported or required for Placers that do not have built-in radio protocols (e.g., MAP27, CPDP). The format of the data string is as follows:

Item	# of Char	Units	Format (Value)
Protocol Type	1	n/a	A protocol ID ('M' for MAP27, 'C' for CPDP)
Enable Flag	1	n/a	B protocol enable ('E') or disable ('D')
Protocol configuration string			C string varies by comm. protocol

The protocol enable/disable option(not available for CPDP) allows the Placer radio/comm port to be switched between network communications port and straight TAIP port.

NOTE: Protocol enable/disable is currently not supported for CPDP.



MAP27

For the MAP27 protocol, the format of the Protocol Configuration string is:

- C = MAP27 support mode
- = 1 for MAP27 SST support only
- = 2 for MAP27 MST support only
- = 3 for SST and MST support
- = 4 for MAP27 non-prescribed data support
- = 5 for non prescribed data and SST support
- = 6 for non-prescribed data and MST support
- = 7 for non-prescribed data, MST and SST support

For the MAP27 protocol, the protocol configuration option allows restriction of the message support that will be employed by the Placer. For each message to be transmitted, the Placer selects the 'lowest level' of support according to the message length. If the Placer message is short enough to be transmitted as a MAP27 SST message (1-23 characters) and SST support is enabled, then SST will be used. If too long for SST but short enough for MST (1-88 characters), and MST support is enabled, then MST will be used. Otherwise, if non-prescribed data support is enabled, this message type will be used. Configuration of the MAP27 support mode allows the user to match Placer MAP27 message use with any restrictions that may be imposed on the MAP27 network.

CDPD

For the CDPD protocol, the format of the Protocol Configuration string is as follows:

Item	# of Char	Units	Format (Value)
Protocol Option	1	n/a	C 0 = normal (default setting) 1 = all TCP 2 = all UDC

The Protocol Option is currently the only configurable part of this messages. It can be set to any of the three values shown; any other value will be ignored. The Placer 450/CDPD stores this configuration in battery backed RAM so it will be preserved while the unit is powered off.

The Placer 450/CDPD normally operates in mode 0. In this mode, all TAIP messages are sent out via their regular predefined protocol. In mode 1, all TAIP messages that are generated autonomously, periodic location reports and alarm triggered messages, will be sent out over the reliable TCP channel. In mode 2, all TAIP messages that are generated autonomously will be sent out over the unreliable UDP channel.

PR Protocol

The protocol (PR) message is used to control which I/O protocols are active on each of the data streams. Each protocol can be configured as follows: off, input only, output only, or both input and output.

The data string format is as follows:

```
>aPR  
[;TAIP = wxy]  
[;TSIP = wxy]  
[;NMEA = wxy]  
[;RTCM = wxy]  
[;ID=dddd] [;*hh]<
```

Where:

- a = S, Q, or R
- w, x, y, z = T for input and output, I for input only, O for output only, and F for off

w, x, y, and z set or display the protocol status on ports 0 and 1, respectively. If a protocol is not implemented within the application, it will not appear in the output messages, and any “set message” for that protocol is ignored. If the application has two streams (Placer 450) instead of four (Placer 455), only two fields, wx, will appear.

It is possible to turn off all input processing on a stream. In this situation, neither TAIP nor TSIP can be used to change the active protocols. The break sequence detected on the asynchronous interface will provide an escape in this situation by reestablishing a default protocol as input and output.

PT Port Characteristic

The format of the data string is as follows:

AAAA,B,C,D

Item	# of Char	Units	Format (Value)
Baud Rate	4	n/a	AAAA (3840, 1920, 9600, 4800)
# of data bits	1	n/a	B (7 or 8)
# of stop bits	1	n/a	C (1 or 2)
Parity	1	n/a	D (N = None) (O = Odd) (E = Even)
Total		10 (including commas)	

This message defines the characteristics for the currently connected TAIP communications port.

Most TAIP using sensors use the following default port characteristics (consult the Installation and Operator's Manual): 9600 baud, 8 data bits, 1 stop bit and no parity.

NOTE: The PT command uses commas between data fields.



PV Position/Velocity Solution

The format of the data string is as follows:

AAAAABBBCCCCDDDEEEEEFFGGGHI

Item	# of Char	Units	Format (Value)
GPS Time of day	5	Sec	AAAAA
Latitude	8	Deg	BBB.CCCCC
Longitude	9	Deg	DDDD.EEEEE
Speed	3	MPH	FFF
Heading	3	Deg	GGG
Source	1	n/a	H (0 = 2D GPS) (1 = 3D GPS) (2 = 2D DGPS) (3 = 3D DGPS) (6 = DR) (8 = Degraded DR) (9 = Unknown)
Age of Data Indicator	1	n/a	I (2 = Fresh, <10 sec) (1 = Old, 10 sec) (0 = Not available)
Total		30	

Position is in latitude (positive north) and longitude (positive east) WGS-84. Heading is in degrees from True North increasing eastwardly. The GPS time of day is the time of fix rounded to the nearest second.



NOTE: The data in this message is to be considered invalid and should not be used, if the “Age of Data Indicator” is equal to 0 (signifying data not available).

RM Reporting Mode

The format of the data string is as follows:

[;ID_FLAG=A];;CS_FLAG=B];;EC_FLAG=C] [;FR_FLAG=D] [;CR_FLAG=E]

Item	# of Char	Units	Format (Value)
ID Flag	1	n/a	A (T = True, F = False)
CS Flag	1	n/a	B (T = True, F = False)
EC Flag	1	n/a	C (T = True, F = False)
FR Flag	1	n/a	D (T = True, F = False)
CR Flag	1	n/a	E (T = True, F = False)

ID Flag dictates whether the unit is to include the vehicles ID with each report.

CS Flag dictates whether the unit is to include a checksum as part of each message.

EC Flag, when set, will cause the unit to echo back all complete and properly formatted set commands, except for DC and DD, with a “Response” qualifier. This provides an easy way to verify that the unit did in fact receive the intended data.

FR Flag indicates whether the unit is to report messages automatically per their individually scheduled frequency. When set to false, the unit will only respond when queried for a specific message.

CR Flag, when set to True, will cause the sensor to append a carriage return and line feed [CR] [LF] to the end of each message output. This is useful when viewing the unencoded sensor responses on a terminal or a PC.

The default value at start-up for the CR, CS, EC, and ID flags are false. The default for FR is true.

Example:

The following command will turn checksums off and carriage return on:

```
>SRM;CS_FLAG=F;CR_FLAG=T<
```



NOTE: Note the use of semicolon before the flag name.

SS Signal Status

Data String Format:

AAABCDDDD

Item	# of Char	Units	Format (Value)
Signal ID	3	n/a	AAA (see notes)
Instantaneous Status	1	n/a	B (0-1)
Register Status	1	n/a	C (0-1)
Toggle Time	4	1/10 sec	DDDD (1-599.9 sec)
Total	5		

The SS message allows for the inspection of all signal states and the setting of certain signals.

The Placer 450 supports two discrete input signals with Signal Ids IP0 & IP1. Two discrete outputs are supported with Signal Ids XP0 & XP1. Any additional signals supported will be listed in the release notes for the Placer.

When Signal ID refers to a discrete input line, Instantaneous Status represents the current state of the input. If the input is low, as 0 will be returned. If the input is driven by a pulsing or periodic signal, the Register status should be examined instead. For all other Signal IDs this character is identical to the register status (see Note 2).

The Register Status field represents the internally stored value of the signal. A 1 indicates the signal is active, 0 indicates the signal is inactive. In the case of discrete outputs, the status is 1 when the driver is enabled (i.e. driving low), 0 when the driver is disabled. For discrete inputs the status represents the debounced register state of the input (see Note 2).

The S prefix is supported for only the discrete outputs. When the S prefix is used, the instantaneous status and register status values must be identical and the Toggle Time field (if present) represents the amount of time the output is to remain in the state specified. At the end of the Toggle time period the output will be reset to its previous state. The toggle field is optional, so omitting the toggle time field or passing a zero value will cause the output to be set to the value specified by the Register Status and not toggled. The maximum toggle time possible is 600 seconds.

Examples:

Query for the state of discrete input 2:

```
>QSSIP2<
```

Set output driver 1 to inactive:

```
>SSSXP10<
```

Set output driver 0 to active for 2.3 secs, then return to current state:

```
>SSSXP0110023<
```



NOTE:

1. The Q qualifier may be used to inspect the state of any signal output. The signal or input name must be supplied (e.g., >QSSIP0<). If the signal or input is undefined or unsupported, the following string will be returned:>RSS???.<
2. The Placer 450 makes no distinction between Instantaneous status and Register status for either Discrete Inputs or Discrete Outputs. The Placer provides only 1-sec sampled (not de-bounced) signal input values.
3. For Placer 450, any change in status for a Discrete Input signal can trigger the output of a position report message (either XT or XS) containing the status values for the Discrete Inputs. This report message can be selected using a ‘;MSG=xx’ qualifier string to the SS message, where xx= XT, XS, or XX (XX for no report). For example, to select XS message on input state change, enter >SSS;MSG=XS< ; to disable reporting on input state change, enter >SSS;MSG=XX<; to query for currently selected message, enter >QSS;MSG<. By default, XT message is selected.

ST Status

The format of the data string is as follows:

AABCDDEFGG

This message provides information about the satellite tracking status and the operational health of the sensor. This information is contained in five status bytes which are output as five 2 digit hexadecimal values. The data format and the meanings of the hex characters are given in the following tables.

Item	# of Char	Units	Format (Value)
Tracking Status Code	2	n/a	AA (see table below)
Error Codes—Nibble 1	1	n/a	B (not currently used)
Error Codes—Nibble 2	1	n/a	C (see table below)
Machine ID	2	n/a	DD
Error Codes—Nibble 3	1	n/a	E (not currently used)
Error Codes—Nibble 4	1	n/a	F (see table below)
(reserved)	2	n/a	GG (not currently used)

Tracking Status Code

Machine Id

The machine Id (DD) specifies the Placer GPS product:

- 84 (54 Hex) for Placer 450,
- 85 (55 Hex) for Placer 455.

In the tables below, an X in a column means that fault is being reported.

Error Codes – Nibble 2

Value of C	Alignment error, channel or chip 2 (note 1)	Alignment error, channel or chip 1 (note 1)	Signal Processor error (note 1)	Battery back-up failed
0				
1				X
2			X	
3			X	X
4		X		
5		X		X
6		X	X	
7		X	X	X
8	X			
9	X			X
A	X		X	
B	X		X	X
C	X	X		
D	X	X		X
E	X	X	X	
F	X	X	X	X



NOTE 1: Only the “Battery back-up failed” column is applicable to Placer GPS

Error Codes – Nibble 4

Value of F	The stored almanac is not complete or current	A-D converter fault (note 1)	Battery Powered Timer/Clock fault	Synthesizer Fault (note 1)
0				
1				X
2			X	
3			X	X
4		X		
5		X		X
6		X	X	
7		X	X	X
8	X			
9	X			X
A	X		X	
B	X		X	X
C	X	X		
D	X	X		X
E	X	X	X	
F	X	X	X	X



NOTE 1: Only the “stored almanac” and “Battery-Powered Timer/Clock” fault columns are applicable to Placer GPS.

TM Time/Date

The format of the data string is as follows:

AABBCCDDDEEFFGGGGHHIIJKLLLL

Item	# of Char	Units	Format (Value)
UTC Time of Day			
Hours	2	Hour	AA
Minutes	2	Min	BB
Seconds	5	Sec	CC.DDD
Date; Day	2	Day	EE
Date; Month	2	Month	FF
Date; Year	4	Year	GGGG
GPS/UTC Time Offset	2	Sec	HH
Current Fix Source	1	n/a	I (0 = 2D GPS) (1 = 3D GPS) (2 = 2D DGPS) (3 = 3D DGPS)(6 = DR) (8 = Degraded DR) (9 = Unknown)
Number of Usable SVs	2	n/a	JJ
GPS/UTC Offset Flag	1	n/a	K (1 = Valid) (0 = Invalid)
Reserved	5	n/a	LLLLL
Total		28	

This message outputs the time and date as computed by the GPS sensor. The time is most accurate when the unit is doing fixes. It is less accurate but still usable when the unit is not doing fixes but the “Number of Usable SVs” is one or more.



NOTE: GPS/UTC Time Offset is the difference between GPS and UTC time standards in seconds. The “UTC time of Day” is only valid if the “GPS/UTC Offset Valid Flag” is indicating valid.

TX Text Message

This message is designed to provide a method for the Placer GPS/DR to send text messages for user warnings, instructions, or clarification within the TAIP message format. The message is not cleared after sending so user requests >QTX< or >FTX...< will output the last message in the requested format. The next new application TX message will override the last set of frequency/distance parameters as well as the message content.

The format of the data string is as follows:

```
>RTXaaa...aaa[;ID=dddd][;*hh]<
```

Where the string “a” cannot contain the characters ‘<’ or ‘>’.

Any TX messages received as input on one of the Placer GPS ports is rebroadcast as an output TX message on all other ports that have TAIP as an active output protocol.

VR Version Number

Data String Format:

XXXXXXX ;VERSION A.AA(BB/BB/BB); CORE VERSION C.CC (DD/DD/DD); E

Item	# of Char	Units	Format (Value)
Product Name	n	n/a	n/a
Major Version number	4	n/a	A.AA
Major Release Date	8	n/a	BB/BB/BB (month/day/year)
Core Version number	4	n/a	C.CC
Core Release Date	8	n/a	DD/DD/DD (month/day/year)
Copyright Text Variable		n/a	

The user cannot set the version information that is returned using the >SVR.< message. The default is the Placer GPS/DR version. The user can query directly using the appropriate digram subfield. The data string format is: **aVR;bb=[:ID=dddd] [:*hh]**

Where:

- a is S or Q, and
- bb is one of the following digrams:
 - AP - Placer GPS/DR
 - ST - stinger
 - TP - Trimble protocol handler
 - HW - hardware

For compatibility with previous versions of TAIP, the message format >aVR< will be equivalent to using the digram AP.

XS Short Binary Position

Data String Format:

ABBBCCCDDEE

Item	# of Char	Units	Format (Value)
Message Id	1	n/a	A = BE (hex)
Latitude	3	n/a	BBB: packed binary data: Data Valid Indicator - Most Sig Bit of byte 1 0=valid GPS data 1=invalid GPS data Latitude - lower 23 bits unsigned Scale: $1/2^{*}23$ semi-circle Ref: 90 deg. South Range: 180 degs. Precision: 2.4 meters
Longitude	3	n/a	CCC: binary data: Longitude - 24 bits unsigned Scale: $1/2^{*}24$ circle Ref: 0 deg. East Range: 360 degs. Precision: 2.4 meters
Time	2	n/a	DD: binary data Time - 16 bit unsigned Scale: $1/2^{*}16$ day Ref: start of GPS day Range: 1 day Precision: 1.3 sec.

Speed, Heading, Digital Inputs	2	n/a	EE: packed binary data Speed- Most Sig 7 bits of byte 1 Units: MPH Range: 0=127 Direction of travel - Next 5 bits Scale: 1/2**5 circle Ref: North Range: 360 degs. Precision: 11.25 deg. Digital Input states - Last 4 bits Least sig. bit of 4 = Input Line 0, (AL0) bit set if line is high
--------------------------------	---	-----	---

The XS message provides position & status data in 11-byte binary format. It is intended for use where communications bandwidth is very limited. (Note: for MAP27 networks, the XS message can be transmitted in 2 codewords or 11 bytes.) The message consists of a message Id byte and 10 data bytes; the TAIP wrapper (beginning '>', trailing '<') is not used. Compared to LN / PV / XT msgs, the XS msg reduces lat/lon, speed, heading, and time precision, does not provide altitude, and does not provide satellite Ids (no "inverted differential" capability). The XS message can be selected for reporting on change in digital input state (see SS message, ";MSG=" qualifier.)

Example

The following example shows a binary XS message, 2 Hex characters per byte, and conversion of each message item.

BE 5A 97 34 A9 37 8C E4 F8 03 62(hex)

Message Id: BE (hex)

Data Valid: top bit of 5A = 0 = data valid

Latitude:

5A 97 34 (hex) = 5936948 / 2**23 = .707739353
 .707739353 *
 180 = 127.3930836 deg(ref 90 deg South)
 - 90 = 37.3930836 deg (ref 0 deg)

Longitude:

A9 37 8C (hex) = 11089804 / 2**24 = .661003828
 .661003828 * 360 = 237.9613781 deg(ref 0 deg East)
 - 360 = -122.0386219 deg(ref 0 deg West)

Time:

E4 F8 (hex) = 58616 / 65536 = .894409 day
 .894409 * 86400 = 77277 secs in day

Speed:

03 (hex) = 00000011 (binary),
 MS 7 bits = 0000001 = 1 MPH

Heading:

03 62 (hex) = 0000001101100010,
 next 5 bits = 10110 = 22 / 2**5 = .6875
 .6875 * 360 = 247.5 deg

Digital Inputs:

62 (hex), lower 4 bits = 0010 (binary)
 Digital Input Line 0 = AL0
 Digital Input Line 1 = AL1

XT Extended Binary Position

Data String Format:

AAAAAAAAABCCCCDEEEE

Item	# of Char	Units	Format (Value)
Latitude, Longitude, Altitude	8	n/a	AAAAAAAA: packed binary data, starting with Most Significant Bit (MSB) bit of byte 1, in the following order: Latitude - 25 bits signed, radians x 10^{*7} , + for North, - for South (negative numbers in 2's complement form) Longitude - 26 bits signed, radians x 10^{*7} , + for East, - for West (negative numbers in 2's complement form) Altitude - 13 bits unsigned (0-8191), meters above MSL - 2000m (0= MSL-2000, 2000=MSL, 8191=MSL+6191m)
Speed	1	MPH	B: binary data Speed - integer MPH (0-255)
Heading, Time	4	n/a	CCCC: packed binary data, Time starting with Most Significant Bit (MSB) of byte 1, Heading - 12 bits unsigned, degrees x 10, Time - Least Significant 20 bits, secs in GPS day x 10

Digital Inputs, GPS Source	1	n/a	D: packed binary Digital Inputs - Most Significant 4 bits, least significant bit of 4 = Input Line #0 (AL0), bit set if line high GPS Source - Least Significant 4 bits, (0=2D GPS, 1=3D GPS, 2=2D DGPS, 3=3D DGPS, 6=DR, 8=Degraded DR, 9=Unknown, 15=No fix available)
SVNs used	4	n/a	EEEE: binary data SVNs - bit pattern: LSbit for SV 1, MSbit for SV32, bit set if SVN used
Total	18		

The XT message provides, in compressed form, essentially the same data as the TAIP LN message. XT Report msgs will be sent according to time & distance parameters as configured by standard TAIP T&D command (F or D qualifier for the XT msg) and in response to queries (>QXT<). The XT message report also contains the current state of General Purpose Input Alarm lines connected to the Placer, and an XT msg will be sent on change in state of any of these inputs (subject to “;MSG=” qualifier for SS message.)

Example

The following example shows a binary XT message, 2 Hex characters per byte, and conversion of each message item.

3E 58 54 31 CA D3 57 5F C1 27 A7 00 50 31 08 CE 21 50 10 60 01 3C (hex)

Latitude:

31 CA D3 57 (hex) (bits 1-25) =
 0011 0001 1100 1010 1101 0011 0 = 0 63 95 A6 (hex)
 = 6460374 / 10**7 = 0.6460374 radians
 = 0.6460374 * 180 / Pi = 37.0152 degrees

Longitude:

57 5F C1 27 (hex) (bits 2-27) =
 101 0111 0101 1111 1100 0001 001 (sign bit set)
 2's complement = - 1010001010000000111110111
 = - 21079703 / 10**7 = -2.1079703 radians
 = - 2.1079703 * 180 / Pi = -120.77774. degrees

Altitude:

27 A7 (hex) (lower 13 bits) =
 0 0111 1010 0111 = 7A7 (hex) = 1959 (dec)
 1959 - 2000 = - 41 m (rel. to MSL)

Speed:

00 (hex) = 0 MPH

Heading:

50 31 (hex) (1st 12 bits) = 503 (hex) = 1283 (dec)
 1283 / 10 = 128.3 degrees

Time:

31 08 CE (hex) (lower 20 bits) = 1 08 CE (hex)
 67790 / 10 = 6779 secs in day

Digital Inputs:

21 (hex), (1st 4 bits) = 0010 (binary)
 Digital Input Line 0 = AL0
 Digital Input Line 1 = AL1

GPS Source:

21 (hex), (lower 4 bits) = 0001 (binary)
 1 = 3D GPS

SVNs used:

50 10 60 01 (hex) =
 = 0101 0000 0001 0000 0110 0000 0000 0001 (binary)
 SVNs 1, 14, 15, 21, 29, 31 used

X1 Extended Diagnostics Message 1; Dead Reckoning (Placer 455 only)

The format of the data string is as follows:

,A,BC,DDDDDD,EF,GG.GGGG,HH.HHHH,II.III

Item	# of Char	Units	Format (Value)
Diagnostics sub-message ID	1	n/a	A
Odometer Status 1	1	n/a	B (reserved)
Odometer Status 2	1	n/a	C (see table below)
Odometer Scale Factor	7	Pulses/Mile	DDDDDDD
Gyro Status 1	1	n/a	E (reserved)
Gyro Status 2	1	n/a	F (see table below)
Gyro Rate Bias	7	Deg/Sec	GG.GGGG
Gyro Left Scale Factor	7	n/a	HH.HHHH
Gyro Right Scale Factor	7	n/a	II.III
Total		40 (Including commas and decimal points)	

Odometer Status

Value of C	No valid time for odometer measurements	Backup light drive)	Odometer scale factor is out of tolerance	No pulses received from odometer since start-up
0				
1				X
2			X	
3			X	X
4		X		
5		X		X
6		X	X	
7		X	X	X
8	X			
9	X			X
A	X			
B	X			X
C	X	X		
D	X	X		X
E	X	X	X	
F	X	X	X	X

Gyro Status 1

Value of C	Gyroscope scale factor calibration has not been performed	No valid for gyroscope measurements	Heading has not been initialized	Zero bias not performed
0	no problem reported			
1				X
2			X	
3			X	X
4		X		
5		X		X
6		X	X	
7		X	X	X
8	X			
9	X			X
A	X			
B	X			X
C	X	X		
D	X	X		X
E	X	X	X	
F	X	X	X	X

Gyro Status 2

Value of C	Gyro scale factors out of tolerance	Gyro bias is out of tolerance	Gyro Hardware failed internal diagnostics
0	no problem reported		
1			X
2		X	
3		X	X
4	X		
5	X		X
6	X	X	
7	X	X	X

Example: An Odometer Status 2 value of “0” indicates no faults. An Odometer Status 2 value of “4” simply indicates the backup light is active. An Odometer Status 2 value of “2” indicates the odometer scale factor is out of tolerance.

Example: A Gyro Status 2 value of “0” indicates no faults. A Gyro Status 2 value of “5” indicates the gyro hardware failed the internal diagnostics and that the scale factors are out of tolerance.GPSSK

Appendix B

Mechanical Drawings

This appendix contains mechanical drawings and specifications for the Placer GPS 450/455 equipment.

