

Performance Testing of the Trimble GPS Pathfinder Pocket Global Positioning System Receiver

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Introduction:

The GPS Pathfinder Pocket is an 8-channel L1/CA Code Global Positioning System (GPS) receiver. It is manufactured by Trimble Navigation. This receiver was tested by the U S Forest Service to determine performance and accuracy under Western Oregon forest canopy conditions. The tests were made between September 20 and Oct 7, 2002.

The GPS receiver performance tests were made at two sites. The first site is under Western Oregon forest canopy at the Clackamas Test Network. The second site was the open-sky National Geodetic Survey control station "Nelson" in Portland, Oregon. The tests were designed to examine the effect of tree canopy on the following:

- 1) The positional accuracy point features consisting of 1 position, 5 positions, and 60 positions per point feature to determine what, if any, increases in accuracy occur through the averaging of more positions per feature.
- 2) Receiver efficiency which in this report is defined by the number of positions logged divided by the number of potential positions. This factor was qualitatively observed not quantitatively calculated. The efficiency figures in this report are my estimates.

Equipment:

This test was performed with the GPS Pathfinder Pocket using the manufacturer standard equipment external antenna. A Compact 3.3 V active micropatch antenna was used in all tests. The manufactures list price for this system is \$495. PN 44310-00

It should be noted that this configuration includes only the GPS receiver, receiver power supply, and external antenna. To log GIS data in the field a user must add to this configuration, at a minimum, a Windows CE device and Data collection software. The estimated cost for an entry level CE device is \$350, Data collection software that logs data for differential correction such as ESR ArcPad w/ GPS correct, Tripod Data systems SoloField, or Trimble TerraSync all cost approximately \$1000. A total system with all of the above components is estimated to cost about \$1850. Additionally, Pathfinder Office is required make post-processed differential corrections.

This test was made using an iPaq 3900 model Windows CE device with Tripod Data Systems SoloField data logging software version 3.1.1. The GPS Pathfinder Pocket was configured using Trimble GPS Controller Software version 1.1 to send Trimble Standard Interface Protocol (TSIP) data to the data collector.

Test Network and Survey Station Data:

Forested Site: The Clackamas Test Network is located in Western Oregon on the Mt. Hood National Forest. Clackamas GPS Test Network is a site for testing P and C/A Code (resource grade) GPS receiver performance under moderate to heavy western Oregon timber canopy. The vegetation at the site consists of Douglas Fir and Western Hemlock over story, these trees are approximately 24-40" d.b.h., with a Vine Maple and Red Alder under story. The terrain at the site is nearly flat with no terrain obstructions above 20 degrees. The test network is composed of

twelve points with known geographic positions. These twelve points were established by a conventional Total Station closed traverse survey, which was based on two GPS points adjacent to the site which had satellite horizon. These two points were established by static carrier phase GPS survey connected to the Oregon High Accuracy Reference Network (HARN).

Open Site: The station "Nelson" was used as a control site due to its clear-sky nature with no obstructions. Station "Nelson" is an Oregon High Accuracy Reference Network (HARN) Order B survey mark established by the National Geodetic Survey in 1998 the PID-is A12002.

Reference Station: Differential Correction Base (reference) data was downloaded from the Community Base Station (CBS) at the Portland State University Geology Department in Portland, Oregon. The Portland State University CBS uses 12 channel Trimble Maxwell chip receiver recording SYNC measurements at 5 second intervals at a 10 degree elevation mask with Trimble CBS software version 2.67. This CBS is located approximately 84 Km from the Clackamas Test Network and 10km from station Nelson.

Field Data Logging Procedures:

All GPS observations were made at approximate antenna height of 1.5 meters. The receiver or external antenna with ground plane was mounted on a tripod for all tests.

All GPS data was logged at 1 position / second, the elevation mask used was 15 degrees.

Data Logging:

- Data was logged for 60 positions / point feature at both sites. Data at Clackamas was also logged at 5 positions / point feature.
- Logging rate was 1 position / second.
- Receiver configuration of maximum PDOP of 8 and minimum and SNR of 6.
- SoloField data collection software configured to log TSIP , data for differential correction, and max PDOP 8.0

Office Data Processing Procedures:

Data was post processed to make differential corrections using the Trimble Pathfinder Office version 2.90 software package. Post-processing consisted of Differential corrections of the raw (.ssf) receiver files using the Forest Service Portland Oregon CBS. The corrected (.cor) files were then exported in database .dbf format.

The data analysis was made using Microsoft Office 2000 Excel spreadsheet application.

The National Standard for Spatial Data Accuracy (NSSDA) was used to evaluate and report the positional accuracy of (see appendix 1 for formulas). The Federal Geographic Data Committee specifies that the NSSDA be used to evaluate and report the positional accuracy of geospatial data produced, revised, or disseminated by or for the Federal Government

The NSSDA reports accuracy values at 95% confidence. In other words, 1 out of 20 measurements made with the same receiver and data logging settings under similar forest canopy conditions should have errors larger than those published in this report.

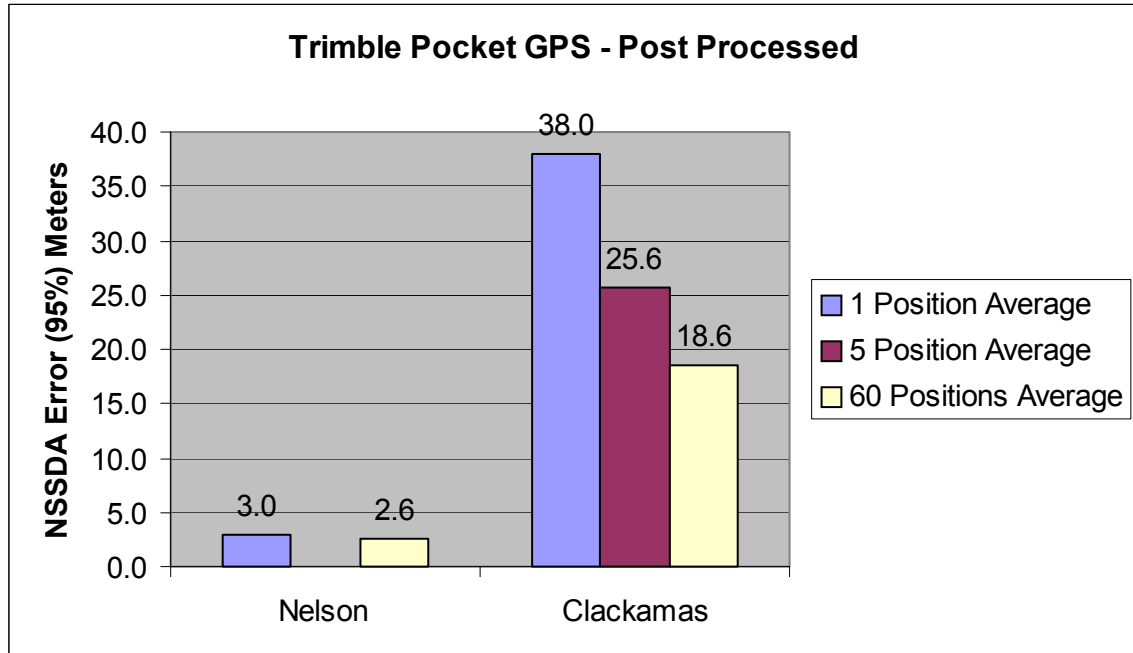
All data was analyzed in the North American Datum of 1983 (NAD 83).

These tests were made under dry canopy conditions.

Test Results:

The test results for all observed data are illustrated in Chart 1.

Chart 1:



The Pocket GPS open site accuracy at station Nelson was very good. Very little difference in positional accuracy was noted between both the 1 position averages and the 60 position averages using both the internal and external antenna. The observed efficiency was 100%.

The Pocket GPS forested site accuracy at the Clackamas test network varied from just adequate for the 60 positions / feature data to relatively poor for the 1 and 5 positions / feature.

At station Nelson the maximum was PDOP = 2.7 and the average was PDOP 2.4

At the Clackamas Network the maximum was PDOP = 12.0 and the average was PDOP= 7.3. GPS Pathfinder Controller software version 1.10 was used to set the Pocket GPS to PDOP 8 and SNR 6. SoloField data collection software was used to set the maximum PDOP to 8.

This data in this test indicates that the use of 120 and 180 position / point feature should be examined for this receiver.

Recommendations for the GPS Pathfinder Pocket:

The following are general recommendations for using this GPS Pathfinder Pocket receiver.

For open sites:

- Point features can consist of only 1 position per feature. .
- 3 meter accuracy at 95% confidence (NSSDA) can be achieved.

For Forested Sites:

- Point features should consist of at least 60 positions per feature.
- The receiver settings of PDOP 8 and SNR 6 should be used.
- 18.6 meters at 95% confidence (NSSDA) can be achieved with these settings.
- Line and area features which use a series of connected single GPS positions to identify the feature will have a line accuracy of 38 meters.

The National Map Accuracy Standard for point positions on 1:24,000 Scale Quadrangle maps is 12.2 meters at 90% or NSSDA 95% confidence of 14.8 meters at 95%. Therefore this receiver when used as outlined above **does not** meet national map accuracy standards when operating under tree canopy.

Appendix 1: Horizontal Accuracy using NSSDA formulas:

Determine the radial Root Mean Square Error (RMSE) for the GPS data set:

$$RMSE_r = \sqrt{[\sum ((X_{data} - X_{check})^2 + (Y_{data} - Y_{check})^2) / n]}$$

where:

X_{data} , Y_{data} are the coordinates of the check point in the GPS data, i data, i
X_{check} , Y_{check} are the coordinates of the check point in GPS test network.

Modify RMSE error to NSSDA 95% probability:

$$NSSDA\ Accuracy_r = 1.7308 * RMSE_r$$

Appendix 2: Photo of GPS Pathfinder Pocket (Photo from Trimble Navigation)

