

WinFrog Device Group:	GPS
Device Name/Model:	TRIMBLE TSIP
Device Manufacturer:	Trimble Navigation Limited 645 North Mary Avenue Sunnyvale, CA 94086 Tel: 1 –(408) 481-8000 Technical Support Tel: 1-800-767-4822 Email: Trimble_Support@Trimble.com
Device Data String(s) Output to WinFrog:	Binary Message
WinFrog Data String(s) Output to Device:	Polls receiver for ephemeris data
WinFrog Data Item(s) and their RAW record:	PSEUDORANGE 303 TIMEDATE 999

DEVICE DESCRIPTION:

TSIP (Trimble Standard Interface Protocol) is available from several different models of Trimble receivers. WinFrog should interface to any Trimble receiver that uses this protocol. WinFrog obtains data by sending commands to the receiver consequently both the transmitter and receiver pins on the serial port must be connected. The pseudorange, ephemeris and time/date data is output on a single serial port and needs to be used in the WinFrog GPS Calculations Extension Module to generate a Multi-ref solution to provide DGPS positioning. WinFrog can also use the data to generate a single point solution if RTCM is not available but the GPS Calculations module is still required. WinFrog applies the ionospheric corrections.

DEVICE CONFIGURATION INSTRUCTIONS

WINFROG I/O DEVICES > EDIT I/O:

Serial
Configurable Parameters

WINFROG I/O DEVICES > CONFIGURE DEVICE:

No configuration is required at the I/O Device window level.

WINFROG VEHICLE > CONFIGURE VEHICLE DEVICES > DEVICE DATA ITEM > EDIT:

Adding the Trimble TSIP device creates three data items: PSEUDORANGE, EPHEMERIS and TIMEDATE. Once the data items have been added to the vehicle, they must be edited to suit the application.

**Data items: GPS, TRIMBLE TSIP, PSEUDORANGE
GPS, TRIMBLE TSIP, EPHEMERIS**

For use with WinFrog, this Device is set to output raw Pseudorange and Ephemeris data. WinFrog's optional GPS Calculations Extension Module can combine the raw Pseudorange and Ephemeris data with up to 5 differential GPS corrections to provide a Multi-Ref position.

With the extension module, WinFrog is able to combine the raw data with RTCM format differential corrections from up to 5 different base stations to calculate 5 independent antenna positions. These 5 positions are then combined in a weighted mean solution to result a single Multi-Ref antenna position. See chapter 14 of the WinFrog User's Guide for more details. A Calculations window can be configured, in WinFrog, allowing you to monitor the status of the Multi-Reference solution and make appropriate adjustments. See the section below entitled Configure Calculations Window for more details on setting up and using the Calculations window.

Although the EPHEMERIS data item is essential, no configuration is required for this device. All position calculation configurations are accomplished by highlighting the PSEUDORANGE data item in the Configure Vehicle-Devices window and selecting the Edit button. The Pseudorange Calculation window appears as seen below.

Calculation:

Select either the Primary or Secondary radio button. Devices set to Primary calculation are used to produce a vehicle position. If more than one positioning device added to the vehicle's device list is deemed as primary, WinFrog will weight them based on the accuracy value entered. Devices with a higher accuracy values (i.e. lower entered value) will be weighted higher.

If a positioning device's calculation is set to Secondary, WinFrog will not use the position data in the calculation of the vehicles' position solution; that device's position will simply be received and monitored. Note that in the case of Primary device failure, WinFrog will not automatically use the Secondary devices for the vehicle position computation. Instead, it will start dead reckoning (if dead reckoning is turned on). You must manually change a secondary device to primary status if you want to utilize the data coming from that device.

Use Elevation:

Setting the Elevation option to "On" will result in the elevation determined by GPS to be used as the elevation of the vessel's CRP referencing the GPS (WGS84) Ellipsoid. The height of the antenna above (below) the CRP must be entered. Do not enable this option unless you are utilizing high accuracy (centimeter level) RTK type GPS positioning.

Accuracy:

The Accuracy value entered provides WinFrog with the expected accuracy of the position from this device. This value is used in the weighting of this device compared to other positioning devices that may be added to the vehicle's device list. The smaller the value entered, the more accurate it is considered to be, and hence the more weight that will be applied to the device's data. The Accuracy parameter can be changed from the suggested values, although changes should be made with caution, as they will affect the final filtered position of the vehicle.

The Velocity value is used in positional filtering. The lower the value entered, the more smoothing that is applied.

Remote Unit ID:

The Remote Station ID parameter is set to zero (0) unless the GPS device is interfaced to WinFrog via a telemetry device.

Antenna Height:

Set the Antenna Height using the radio buttons and the (input) Ellipsoid Height field. Settings are as follows:

Calculated – Select this option to force WinFrog to calculate the GPS antenna Height as well as its Latitude and Longitude. In this mode, WinFrog requires a minimum of four satellites to be visible.

Fixed – Select this option to fix the GPS antenna ellipsoid height to the value entered in the **Ellipsoid Height** field. In this mode, WinFrog is able to calculate valid positions using a minimum of three satellites.

AutoLast Height – If this mode is selected, WinFrog will calculate a 3D position if four or more satellites are available. If only three satellites are visible, or if the VDOP of the solution exceeds the value set in the Alarms dialog box, the height is fixed to that of the last valid position. In this mode WinFrog is able to calculate valid positions using a minimum of three satellites.

AutoInput Height – If this mode is selected, WinFrog will calculate a valid 3D position if four or more satellites are available. If only three satellites are available, or if the VDOP of the solution exceeds the value set in the Alarms dialog box, the height is fixed to the value entered in the **Ellipsoid Height** field. In this mode, WinFrog is able to calculate valid positions using a minimum of three satellites.

Note: The Antenna height entered in the **Pseudorange Calculation** dialog box refers to the WGS 84 Ellipsoid.

Offsets:

Offsets are entered to relate the GPS antenna position to the vessel's Common Reference Point (CRP). Offsets are entered as measured from the CRP (of the vehicle) to the device (antenna) location. Offsets Fore and Starboard are entered as positive values, offsets measured Port and Aft are entered as negative values. Rule of thumb suggests the CRP "Z" reference should be at the water line.

DGPS Mode:

Select the desired mode of DGPS operation

There are four different DGPS modes: Auto, On, Off and Generate.

Auto: WinFrog will automatically use differential corrections in its position calculations, when available. If no corrections are available, WinFrog will compute a single point (aka autonomous) position solution.

On: WinFrog will always attempt to use differential corrections. If no corrections are available, no position will be computed.

Off: WinFrog will not use differential corrections in its position computations, even if they are available. Instead it will always compute a single point GPS solution.

Generate: WinFrog will generate differential corrections based on a fixed reference position. This option is used for Base Stations only.

Phase Smoothing:

Phase smoothing utilizes the GPS receiver's observations of the GPS satellite's carrier signals. Because the GPS L1 frequency has a wavelength of only 19 cm., measurements made using this signal will provide higher accuracy than measurements made on the C/A code message modulated onto the L1 signal. Note, however, that since the carrier phase position is derived from the C/A code position, it does not offer an improvement in precision.

If the Phase Smoothing feature is enabled, WinFrog will use the C/A Code derived (DGPS corrected) position to derive the number of L1 wavelengths to each of the observed satellites. Over the length of time entered into the **Filter Length** field (value in seconds), WinFrog will switch the GPS calculated position from the C/A code position to the derived Carrier Phase position.

WinFrog will continue to use the carrier phase data to provide positioning until the **Cycle Slip Tolerance** is exceeded. A Cycle Slip is the loss of lock on a satellite's signal. This loss of lock forces WinFrog to re-establish the number of wavelengths from the antenna to the satellite. If the number of cycle slips exceeds the Cycle Slip Tolerance, WinFrog will resort back to the C/A code position and re-calculate the number of wavelengths to all received satellites.

Graphics:

Select the On radio button to display a labeled square in the Graphics and Bird's Eye displays, depicting the raw (unfiltered) location of the GPS antenna. This provides a means of comparing raw and filtered positions between different sources.

Display:

The selection made here determines which type of information will be displayed in WinFrog's Calculations window (when the GPS Pseudorange device is turned on for display in that window). Select from the three provided options:

Results – The Calculations window will show the results of the GPS Calculations, including the Multi-Ref position and all individual solutions.

Data - The Calculations window will show the results of the GPS Calculations, including the Multi-Ref position and data related to each individual carrier phase solution (when Phase Smoothing is enabled).

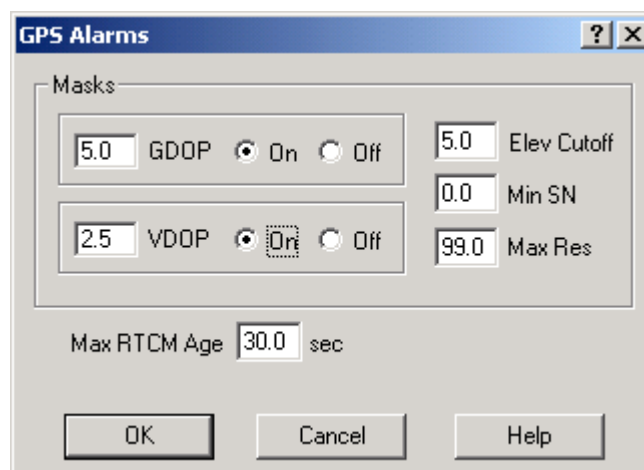
Statistics - The Calculations window will show the results of the GPS Calculations, including the Multi-Ref position and statistical data related to each individual solution.

Use For Heading Calculations:

Select this checkbox if the device is to be used in conjunction with another GPS device for determination of heading of the vessel. In most cases, only high accuracy receivers should be used for heading calculations as WinFrog simply inverts the individual sensors' raw positions to derive the bearing between them.

Alarms:

Click this button to view and enable various GPS alarms, as described below.



GDOP – Geometric Dilution of Precision. GDOP is a numerical value that serves as a measure of the effect of the satellite constellation's geometry on the derived positional accuracy. In other words, the GPS receiver's measurement accuracy is multiplied by the GDOP value to derive the overall positional accuracy of the GPS receiver (including the three positional dimensions and clock offset). If the GDOP mask is set to On and the calculated GDOP exceeds the entered value, WinFrog will not compute a position solution using pseudoranges. If the Calculations window is enabled, an alarm will sound to indicate that the GDOP has been exceeded.

VDOP – Vertical Dilution of Precision. This parameter is also calculated from satellite geometry and gives an indication of the expected accuracy of the vertical component of the GPS position solution. If the VDOP mask is set to On and the calculated VDOP exceeds the entered value, WinFrog will automatically initiate 2D or fixed height mode using either the last valid calculated height or the height entered in the Antenna Height **Ellipsoid Height** field. If the Calculations window is enabled, an alarm will sound to indicate that the VDOP has been exceeded.

Elev. Cutoff – (Elevation Angle Cutoff). WinFrog will not use measurements from any satellites with elevation angles below the angular value input in the Elevation Angle Cutoff field. Any satellites not used in the pseudorange position calculations are indicated in the Calculations window by a change of color.

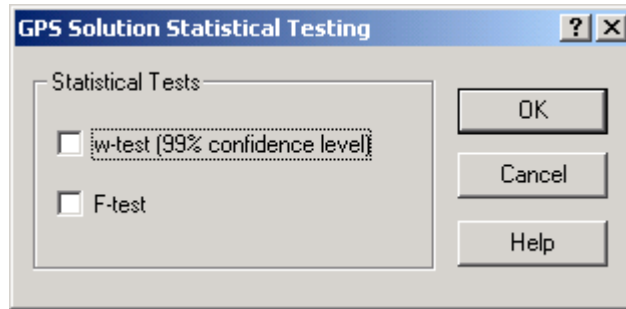
Min SN – Minimum Signal to Noise. This field is used to set the minimum signal to noise ratio for the pseudorange calculations. If a satellite's signal to noise ratio falls below the entered value, the satellite will not be used in position computation by WinFrog. Satellites not used in the position computation due to low signal to noise values are indicated in the Calculations window by a change of color.

Max Res – Maximum Measurement Residual. WinFrog will not use any satellite measurement with a residual greater than the Maximum Measurement Residual in its pseudorange position computations. Satellites not used in the position computation due to measurement residuals are indicated in the Calculations window by a change of color.

Max RTCM Age – Maximum RTCM Differential Correction Age. This parameter sets the maximum latency of real time differential corrections for pseudoranges. If the maximum latency is exceeded, WinFrog will not apply the corrections from that RTCM source. To indicate this condition, the **STAT** light in the Position portion of the Calculations window will turn yellow. Click on the **ACK** button to acknowledge this alarm.

Test:

Click this button to open the **GPS Solution Statistical Testing** dialog box, as seen below.



This dialog box provides you with the ability to enable or disable statistical w test and F tests. By default, both of the w-test and the F-test are turned off.

w-Test:

The w-test entails normalizing the residuals of a GPS pseudorange solution and testing these against a 99% confidence limit for outliers. This limit is 2.576. If outliers are found, they are removed and the solution is re-executed excluding that satellite data pertaining to the outlier. If more than one satellite is found to produce a residual outlier, only that satellite with the largest normalized residual is eliminated. This continues until no outliers are present *or* until the exclusion of any more data would result in insufficient data for a solution (four satellites for 3D and three for 2D). Since the normalized residuals tend towards being equal with reduced redundancy (as the number of satellites used in the solution approaches the minimum required), it is unlikely that WinFrog will ever have to stop the exclusion of data due to insufficient satellites. Nonetheless, WinFrog still checks for this condition.

Caution should be exercised when using this option. If the vessel is too far away from the selected reference stations and/or there are few satellites in common with the vessel and the reference station(s) the w-test option may eliminate data to the point where the solution approaches the minimum required.

F-Test:

The F-test is a check of the unit variance of the GPS pseudorange solution. This confirms the validity of the model used for the solution and the weighting of the observations used. Note that it is only a confirmation check, no data or solution results are thrown out based on the results of the test.

The unit variance is the sum of the weighted, squared residuals, divided by the degrees of freedom (number of redundant measurements) in the solution. The F-Test should result in unity. If the unit variance is consistently different from unity, it indicates that there may be a problem with the stochastic model used, or an unmodeled bias in the data.

Ref-Stns:

Click the RefStns button in the Pseudorange Calculation dialog box to open the Select DGPS Reference Stations dialog box, as seen below.

ID	Off	Use	Monitor	Relative Std. Dev.
535	☐	☒	☐	1
545	☐	☒	☐	2
570	☐	☒	☐	3
334	☐	☐	☒	1
336	☐	☒	☐	8

The Select DGPS Reference Stations dialog box allows you to define which reference stations will be used by WinFrog in its Multi-Ref solution. You can either configure WinFrog to simply use all received stations (to a maximum of 5), or you can control the use of corrections, as deemed proper.

To use all received DGPS corrections, select the **Use all Available Stations** checkbox. When this checkbox is selected, all available RTCM corrections are utilized in the solution, each with the same Relative Standard Deviation.

The individual station method is preferable as it allows you to remove or de-weight solutions that may not agree with the weighted mean solution. If this method is used, you should add the RTCM data item to the vehicle's device list once for each solution, then edit that solution entering the proper code and coordinates. For example, if there are 5 Reference stations to be used in the Multi-Ref solution, add the **RTCM,RTCM1, DGPS-COR's** data item to the vehicle's device list 5 times.

From the Configure Vehicle-devices dialog box, highlight and edit each RTCM data item to indicate a unique Code.

Now, back in the **Select DGPS Reference Station** dialog box, ensure that the Use all Available Stations checkbox is not selected. Now the individual reference station ID's

must be entered, along with station usage and relative standard deviation values, as detailed below:

Select DGPS Reference Stations:

Selection of individual stations is as follows:

ID – The Reference Station identification code. See SkyFix documentation for a listing of all SkyFix reference station ID Codes. Coast Guard Beacon corrections also contain unique codes for each station.

In the above example, SkyFix stations 535, 545 and 570 are used with assigned relative standard deviations along with Coast Guard station 336. Coast Guard Station 334 is monitored and is therefore not utilized in the position solution.

Off – Corrections from the selected Reference Station will not be used in the Multi-Ref position solution. This individual solution will appear in red text in WinFrog's Calculations window and not update.

Use – Reference Station is used in the Multi-Ref position solution, and will appear in the Calculations window in black text. This individual solution will appear in red text if no solution (refer to DGPS Mode) can be calculated from the data.

Monitor – Reference Station is simply monitored by WinFrog, and is not used in the Multi-Ref position. This solution will appear in yellow text in WinFrog's Calculations window.

Rel. Std. Dev – This value defines the relative standard deviation of this solution as compared to the other solutions used in the Multi-Ref position. Equal Rel. Std. Dev. values indicate that all individual solutions will be equally weighted in the Multi-Ref solution. Entering a higher Rel. Std. Dev value will de-weight an individual solution compared to the others in the Multi-Ref solution.

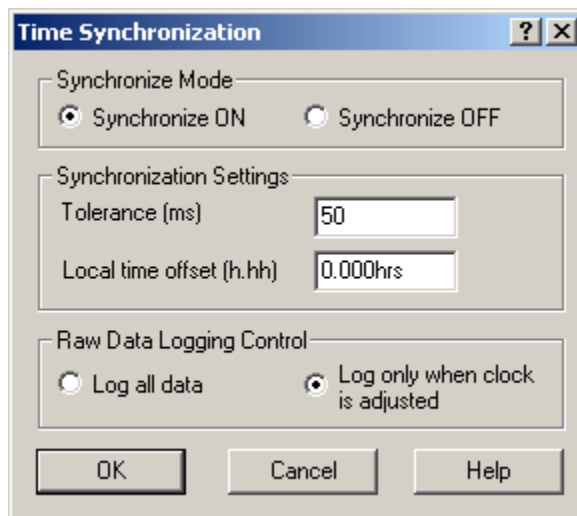
CONFIGURE CALCULATIONS WINDOW

A Calculations window can be configured in WinFrog, allowing you to monitor the status of the Multi-Ref solution and make appropriate adjustments. To open the Calculations window select **View > Calculations** from the main menu. In the Calculations window, select the appropriate vehicle from the dropdown list and click the Setup button.

In the Setup Calculation View dialog box, select the **Position** and **Data Item Text** checkboxes. Next, highlight the **Pseudorange data item**, click the **On** button and exit with OK. Refer to Chapter 14, GPS Calculations Displays section of the WinFrog User's Guide for more detailed descriptions of the various options and displays available with the Calculations window.

Data item: GPS, TRIMBLE TSIP, TIMEDATE

The TIMEDATE data item must be edited once it is added to a vehicle's device list. Highlight the data item in the vehicle's device list, then select the Edit button. The Time Synchronization dialog box appears as seen below.

**Synchronize Mode**

The synchronization can be turned On or Off. Note that multiple TIMEDATE data items can be added to the same or other vehicles, but WinFrog will only allow one to be set to On and actually be used to synchronize the WinFrog clock. The others can only be compared to the WinFrog clock.

Synchronization Settings

The tolerance setting controls the maximum limit of the deviation of the WinFrog clock from the timing device before WinFrog resets its clock. This should not be set too small, or the clock will constantly be re-setting. A tolerance of 50 ms for a 1PPS pulse results in the resetting of the clock approximately every 5-6 minutes.

WinFrog monitors the variation between the UTC time and the WinFrog clock using a fading history of the last 20 samples of the variation between the WinFrog clock synchronization time stamp and the associated UTC time. This is filtered using a Central Tendency algorithm. When the filter result exceeds the tolerance, the clock is reset.

Local time offsets can be entered to allow synchronization to UTC while working in a local time zone. The offset is entered in +/-hours.

Raw Data Logging Control

You can control the logging of the TIMEDATE raw data records. Every time synchronization data reception update can be logged, i.e. a raw record every second. Alternatively, the data is only logged to the raw file when the clock is reset.

The data logged includes the time of the clock adjustment and the amount it was adjusted.

Note that this is only in affect if Raw Data recording is turned on.

Monitoring the synchronization

The synchronization of the WinFrog clock can be monitored from the Calculation Window using the Data Item Text and Time Series options.

In the Data Item Text panel, the following information is displayed:

- **Status**
Displays the data type status (On/Off) and the associated device status.
- **Sync'd at**
Displays the time the WinFrog clock was last adjusted.
- **Computer time**
WinFrog clock time stamp of last synchronization data input
- **UTC time**
UTC time (from device) of last synchronization data input
- **Raw Delta**
The difference between the UTC and associated WinFrog time stamp (UTC – WinFrog) for the last epoch
- **Filter Delta**
The difference between the UTC and filtered WinFrog time for the last epoch

In the Time Series panel, the difference between the UTC time and the raw and filtered WinFrog times are plotted.