

FieldGenius Technical Notes

GPS – Terminology

Almanac

A set of Keplerian orbital parameters which allow the satellite positions to be predicted into the future.

Ambiguity

An integer value of the number of the signal carrier cycles between the GPS satellite and the GPS receiver. This is not a direct observable and must be determined from double or triple differencing computations.

Astronomic Coordinates

A three dimensional coordinate of latitude (Φ), longitude (Λ) and orthometric height (H) referenced to the earth's geoid and determined by astronomical observations to celestial bodies.

Autonomous (GPS)

A mode of positioning using independent GPS observations, in other words no differential corrections being applied. Also called single point positioning or absolute positioning. Achievable accuracies are between 20 and 75 meters.

Baseline Vector

The computed three dimensional vector (ΔX , ΔY , ΔZ) between a pair of GPS receivers which have collected data simultaneously.

Broadcast Ephemeris

A set of Keplerian orbital parameters to allow satellite orbital positions to be predicted at any point in time. The data is a component of the transmitted satellite signal used by GPS receivers to determine position. Compared to the almanac, the broadcast ephemeris is more precise due to additional parameters and more frequent updates.

C/A Code

Coarse Acquisition code is modulated on the GPS L1 carrier signal. Used to relay the broadcast ephemeris, almanac and ranging information to the GPS receiver.

Carrier Phase

A GPS observable of the carrier signal and when correctly processed can obtain centimeter level accuracies for relative positioning.

CMR (Compact Measurement Record)

A message format for transmitting corrections and observations from the reference GPS station to the rover GPS station for use in RTK positioning. CMR was developed by Trimble and is generally available for use in other manufacturer's GPS receivers.

Covariance Matrix

A three by three matrix describing the accuracies of a computed GPS baseline vector

Cycle Slip

An effect characteristic to carrier phase observations when there is discontinuity of signal lock to one or more satellites. A cycle slip will result in the ambiguities needing to be recomputed for the affected satellites.

Datum

A reference frame upon which coordinates and measurements are based.

DGPS (Differential GPS)

A method of positioning using differential pseudorange code observables to achieve meter level accuracies. At minimum, two single frequency GPS receivers are required, a reference station and a rover station. DGPS can also refer to any type of relative positioning whether it uses pseudorange observations or carrier phase observations.

DOP (PDOP, HDOP, VDOP)

A measure of the geometrical strength of a position determined by GPS. DOP can be represented by three dimensional position (PDOP), two dimensional horizontal (HDOP) and one dimensional vertical (VDOP). Lower DOP values denote better satellite geometry and thus better position reliability. A DOP of between 4 and 6 can be considered the threshold for good and poor geometry.

Dual Frequency GPS Receiver

Each GPS satellite transmits signals on two distinct frequencies (L1 and L2) and the measured deviations between the two frequencies will denote ionospheric propagation errors. Detection and correction of ionospheric errors will improve accuracies over longer baselines. Dual frequency receivers are often referred to as survey or geodetic grade receivers and are significantly more expensive than single frequency GPS receivers.

ECEF Coordinates

A cartesian (X, Y, Z) coordinate system with the origin at the geometrical center of the ellipsoid or the centroid of earth's mass. The Z axis is the rotational axis of the ellipsoid, the X axis intersects the meridian of Greenwich and equator, and the Y axis completes an orthogonal right handed system.

EGNOS

A system of geostationary satellites to provide differential corrections to GPS receivers. The system is to be implemented in the year 2004 and operated by the European Union and European Space Agency as a European regional augmentation to GPS. Similar in concept to WAAS.

Elevation Mask

Satellites which are low on the horizon from the observing position will have more errors induced into their observations. These errors are due to the signal having to travel

through more of the ionosphere and troposphere as opposed to a satellite situated near the zenith. GPS receivers can be configured with an elevation mask to eliminate satellites that are within a specific angle above the horizon. Suggested elevation masks are between 10 and 20 degrees.

Ellipsoidal Height (h)

Heights from the ellipsoid surface to the terrain surface. GPS computed heights are always referenced to the ellipsoid.

Fixed Solution

Refers to the solution status of a RTK position with regard to the integer ambiguities. The ambiguities are reliably fixed to whole numbers. Fixed solutions have position accuracies of 0.01 to 0.05 meters.

Float Solution

Refers to the solution status of a RTK position with regard to the integer ambiguities. The ambiguities could not be reliably fixed to whole numbers due to high residuals in the observations. Float solutions have position accuracies of 0.2 to 1.0 meters.

GALILEO

A system of navigation satellites to be operated by the European Union and European Space Agency. This non-military system is planned for completion by 2010 with a constellation of about 30 satellites. Similar in concept to GPS.

Geocentric

Refers to a datum, ellipsoid or coordinate system whose origin is located at the center of the earth's mass.

Geodetic Coordinates

A three dimensional coordinate of latitude (ϕ), longitude (λ) and ellipsoidal height (h) referenced to an ellipsoid representing the earth's geoid and commonly determined by satellite observations.

Geoid

An equipotential surface of the gravity field and is the reference surface for measuring orthometric heights. The geoid is an approximation for the mean sea level.

Geoidal Undulation (N)

A value which describes the difference between the geoid surface and ellipsoid surface at a particular position. Orthometric heights can be determined from GPS positions by algebraically subtracting the geoidal undulations from the ellipsoidal heights ($H = h - N$). Geoidal undulations for the United States and Canada are supplied in the formats GEOID99 and HTv2.0 respectively.

GIS (Geographical Information System)

A software application which integrates mapping and database storage into a graphical system for querying and manipulating data with related geographical positions.

GLONASS

A satellite navigation system operated by the Ministry of Defense of the Russian Federation Coordination Scientific Information Center. The system consists of nine satellites and is modeled on the GPS system.

GNSS (Global Navigation Satellite System)

A term used to describe a combination of different satellite navigation systems which can complement each other. These systems include GPS, GLONASS, GALILEO, WAAS and EGNOS.

GPS (Global Positioning System)

A satellite navigation system operated by the United States Military. The constellation consists of at least 24 satellites orbiting at an altitude of about 20000 km. Often referred to as NAVSTAR.

GSD (Geodetic Survey Division)

Canada's national authority for managing all aspects of surveying and mapping.

Ionosphere

Part of the earth's atmosphere which is from approximately 60 km to 500 km above the earth's surface. Ionospheric induced errors on the GPS signal include time delay, carrier phase advance, angular refraction and amplitude and phase scintillation.

ITRF (International Terrestrial Reference Frame)

A realization of ITRS with estimates of coordinates and velocities for a collection of worldwide stations. Updated coordinates and velocities are routinely published by the International Earth Rotation Service (IERS).

ITRS (International Terrestrial Reference System)

A definition of the origin and orientation of a global coordinate system maintained by the International Earth Rotation Service (IERS).

Kinematic (GPS)

A mode of collecting GPS observations while the receiver is in a combination of static and kinematic states. Positions can be determined either in real time or post-processed.

Least Squares Adjustment

A mathematical technique of combining multiple types of observations which will result in a solution where the residuals have been rigorously minimized.

Multipath

Refers to an error caused by a GPS signal not following a direct path from the satellite to the receiver antenna. Multipath is attributed to the signal being reflected off of external objects such as buildings and cars which will result in greater range measurements.

Map Projection

A technique of relating the three dimensional surface of the earth to a two dimensional plane while minimizing distortions.

Mission Planning

The process of predicting satellite constellation DOP values and number of visible satellites. A useful tool in maximizing productivity and avoiding periods of poor satellite conditions.

NAD27 (North American Datum of 1927)

A datum with its origin at Meades Ranch in Kansas and coinciding with the surface of the Clarke 1866 ellipsoid. This datum is not geocentric and has inherent distortions throughout North America. NAD27 is not compatible for direct use with GPS observations.

NAD83 (North American Datum of 1983)

This datum is a successor to NAD27 and originally defined to be compatible with the BIH Terrestrial System and WGS84 but has since gone through several refinements with the densification of GPS baselines. NAD83 is defined with the reference ellipsoid of GRS80.

NGS (National Geodetic Survey)

The United States national authority for managing all aspects of surveying and mapping.

Orthometric Height (H)

Heights from the geoid surface to the terrain surface. Also commonly referred to as height above sea level.

P Code

This code is modulated on the GPS L1 and L2 carrier signal. Used to relay the broadcast ephemeris, almanac and ranging information to the GPS receiver. The resolution of P code is higher than the C/A code and therefore has a ten times improvement in accuracy. Access to P code is restricted for military use by the application of Anti-Spoofing (AS).

Post Processing

A term used to describe the method of independently collecting GPS observations at concurrently operating GPS receivers and then at a later time computing the common data to produce positions and baseline vectors.

Pseudorange

The computed distance from a GPS satellite to a GPS receiver using the transmitted code signal. A set of pseudoranges from multiple satellites permits the use of trilateration to determine the position of the GPS receiver.

Radio Modem

A device for transmitting and receiving digital data on a radio frequency (RF) carrier. Commonly used for DGPS and RTK applications for transferring GPS corrections and observations.

Reference Station

A GPS receiver which has an antenna occupying a point with known coordinates and is transmitting its corrections and observables to rover stations. Also can be called a base station.

RINEX (Receiver Independent Exchange)

A digital file format for storing raw GPS observations and raw GPS ephemerides for post processing. Intended to be a medium upon which data can easily be interchanged between various manufacturers of GPS receivers and GPS post processing software.

RMS (Root Mean Square)

A statistical measure of the variation of a sample data set from its mean. RMS is similar to standard deviation and has an associated probability of 68.27% based on the normal distribution function.

RTCM (Radio Technical Commission for Maritime Services)

A message format for transmitting corrections and observations from the reference GPS station to the rover GPS station for use in DGPS and RTK positioning. RTCM is an organization of manufacturers and government entities who have designed a standard for transmitting GPS differential messages.

RTK (Real Time Kinematic)

A method of real time positioning using differential carrier phase observables to achieve centimeter level accuracies. The reference station GPS receiver will occupy a point with known coordinates and transmit corrections and observables to one or more rover stations GPS receivers.

Rover Station

A GPS receiver which is in a kinematic or static state and possibly using differential corrections from a reference station for determining positions. Also can be called a remote station.

Selective Availability (SA)

A method of degrading the C/A code position solutions by dithering the satellite clocks. The United States military initially had this feature enabled when GPS was implemented but has disabled it since May 1, 2000.

Single Frequency Receiver

A GPS receiver which is capable of only receiving one (L1) of the two frequencies transmitted from each satellite (see Dual Frequency Receiver). Single frequency receivers are often referred to as mapping grade receivers and are characteristic of handheld GPS receivers used for recreational purposes.

SNR (Signal to Noise Ratio)

Denotes the strength of a signal being received from a particular satellite in Decibel-Hertz (dB·Hz). Satellites with stronger signals will be denoted by higher SNR values.

Static (GPS)

A mode of collecting GPS observations while the receiver is in a static state. Observations are typically stored for post processing and provide the most favorable accuracy of all GPS positioning methods.

Troposphere

Part of the earth's atmosphere which is from the surface to approximately 60 km above the earth's surface. Tropospheric induced errors on the GPS signal include refraction and signal delay.

WAAS (Wide Area Augmentation System)

A system of geostationary satellites to provide pseudorange differential corrections to GPS receivers. WAAS is maintained by the Federal Aviation Authority (FAA) and is characterized by its high reliability and integrity with accuracies in the one to three meter range.

WGS84 (World Geodetic System of 1984)

A reference frame and datum upon which the GPS system is based for positioning.