Satellite Positioning

GE-703

GNSS Survey Equipment
and
Processing Tools

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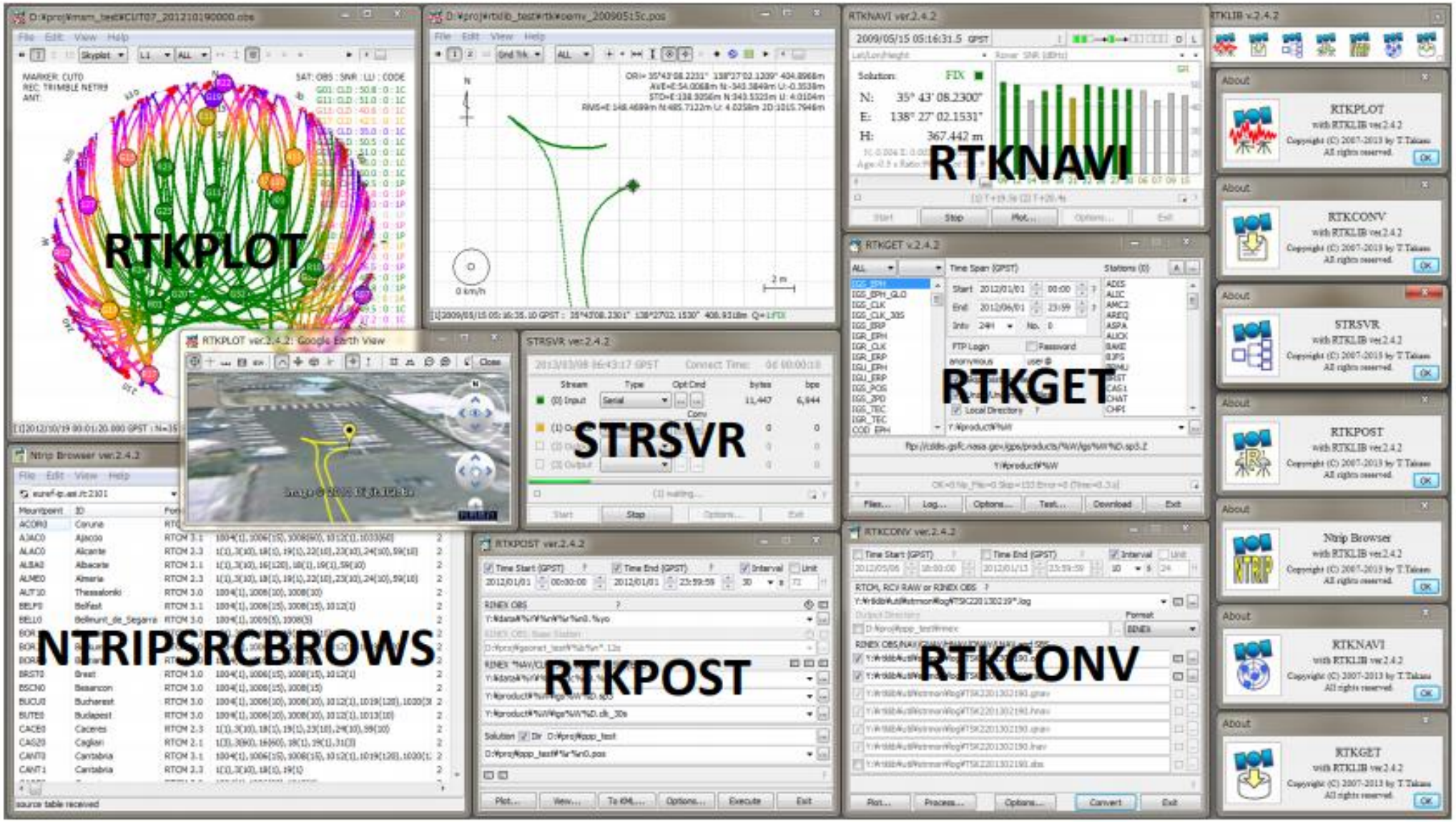
RTKLIB

- An Open-source Software Package for GNSS Positioning
- RTKLIB consists of a portable program library and several APs (application programs) utilizing the library.
- The features of RTKLIB are:
  - Supports standard and precise positioning algorithms with
    GPS, GLONASS, Galileo, QZSS, BeiDou and SBAS
  - Supports various positioning modes with GNSS for both real-time and post-processing:
    - Single, DGPS/DGNSS, Kinematic, Static, Moving-Baseline, Fixed, PPP-Kinematic, PPP-Static and PPP-Fixed
  - Supports standard formats and protocols for GNSS:
    - RINEX, NTRIP, NMEA, etc.
  - Supports external communication vai:
    - Serial, TCP/IP, NTRIP, local log file & FTP/HTTP.

http://www.rtklib.com/

RTKLIB: GUI APs



RTKLIB: CLI APs

- **RNX2RTKP (rnx2rtkp)**
  Post-processing Positioning
- **RTKRCV (rtkrcv)**
  Real-time Positioning
- **CONVBIN (convbin)**
  RINEX Translator
- **STR2STR (str2str)**
  Stream Server
- **POS2KML (pos2kml)**
  Google Earth Converter

	Function	GUI AP	CUI AP
(a)	AP Launcher	RTKLAUNCH	-
(b)	Real-Time Positioning	RTKNAVI	RTKRCV
(c)	Communication Server	STRSVR	STR2STR
(d)	Post-Processing Analysis	RTKPOST	RNX2RTKP
(e)	RINEX Converter	RTKCONV	CONVBIN
(f)	Plot Solutions and Observation Data	RTKPLOT	-
(g)	Downloader of GNSS Data	RTKGET	-
(h)	NTRIP Browser	SRCTBLBROWS	-

RTKLIB: Supported Recivers

Format	Data Message Types							
	GPS Raw Meas Data	GLONASS Raw Meas	GPS Ephemeris	GLONASS Ephemeris	ION/UTC Parameters	Antenna Info	SBAS Messages	Others
RTCM v.2.3	Type 18, 19	Type 18, 19	Type 17	-	-	Type 3, 22	-	Type 1, 9, 14, 16
RTCM v.3.1	Type 1002, 1004	Type 1010, 1012	Type 1019	Type 1020	-	Type 1005, 1006, 1007, 1008, 1033	-	SSR corrections
NovAtel OEM4/V, OEMStar	RANGEB, RANGECMPB	RANGEB, RANGECMPB	RAWEPHEMB	GLO-EPHEMERISB	IONUTCB	-	RAWWAAS-FRAMEB	-
NovAtel OEM3	RGEB, RGED	-	REPB	-	IONB, UTCB	-	FRMB	-
NovAtel Superstar II	ID#23	-	ID#22	-	-	-	ID#67	ID#20, #21
u-blox LEA-4T, LEA-5T	UBX RXM-RAW	-	UBX RXM-SFRB	-	UBX RXM-SFRB	-	UBX RXM-SFRB	-
Hemisphere Crescent, Eclipse	bin 96	-	bin 95	-	bin 94	-	bin 80	-
SkyTraq S1315F	msg 0xDD (221)	-	msg 0xE0 (224)	-	msg 0xE0 (224)	-	-	msg 0xDC (220)
JAVAD (GRIL/GREIS)	[R*],[r*],[*R], [*r],[P*],[p*], [*p],[D*],[*d], [E*],[*E],[F*]	[R*],[r*],[*R], [*r],[P*],[p*], [*p],[D*],[*d], [E*],[*E],[F*]	[GE],[GD], [gd]	[NE],[LD]	[IO],[UO], [GD]	-	[WD]	[~~],[::],[RD], [SI],[NN],[TC], QZSS Data, Galileo Data
Furuno GW10 II	msg 0x08	-	msg 0x24	-	msg 0x26	-	msg 0x03	msg 0x20

RTKLIB

http://www.rtklib.com/rtklib_tutorial.htm

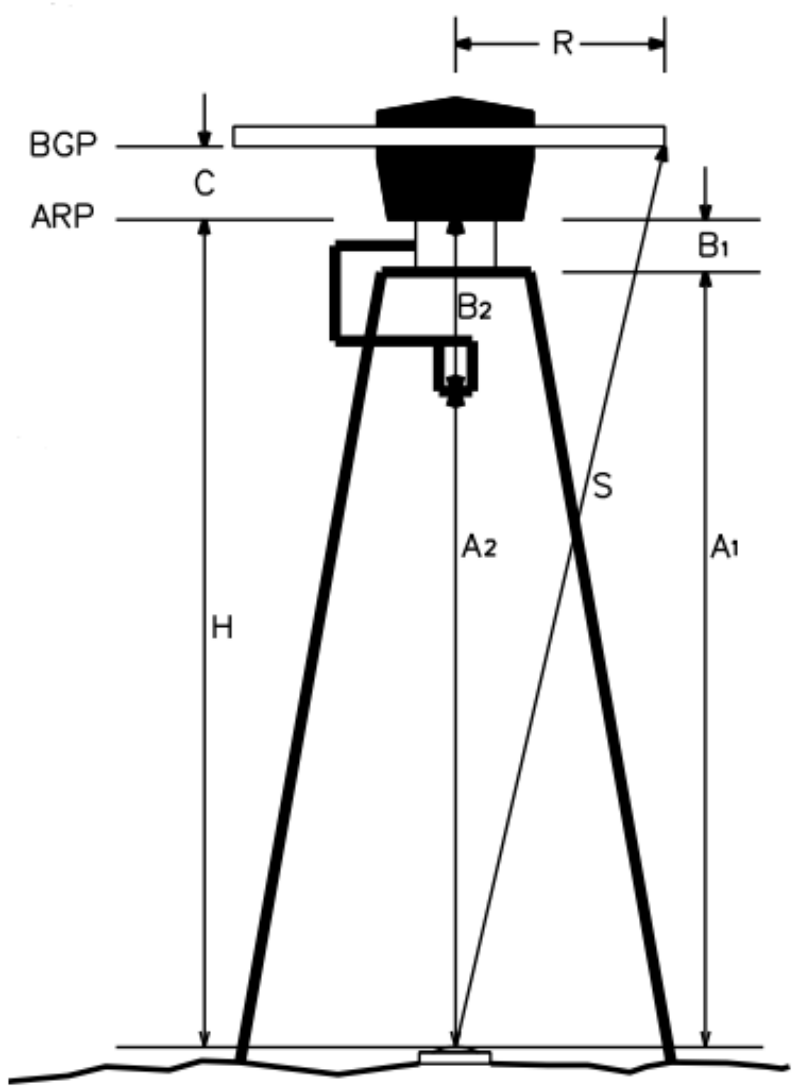
Demo

GNSS Receiver for Geodetic Survey

- The GNSS static survey operations shall receive both carrier frequencies transmitted by the current constellation of GNSS satellites
  - The receiver shall have the capability of tracking a minimum of eight GNSS simultaneously.
- The receivers shall have the capability to receive and decode the C/A code and the P-code data on the L1 frequency and the P-code in the L2 frequency.
  - Dual frequency receivers are required for precision surveys to correct for the effects of ionospheric refraction.
- The receivers must record the phase of the satellite signals, the receiver clock times and the signal strength or quality of the signal.
  - The phase center of the antenna, which is constant and unique to the antenna model, should be known from the manufacturer.

GNSS Receiver for Geodetic Survey

- If the receiver does not have a known phase center database relating to antenna type
  - the user should have the ability to enter the measurement components for the phase center height of the antenna.
- The measurement components are a measured height above a survey point to a mark on an adapter (or to a corner of the antenna) and the fixed constant distance from an adapter mark to the phase center of the antenna (provided by the manufacturer).

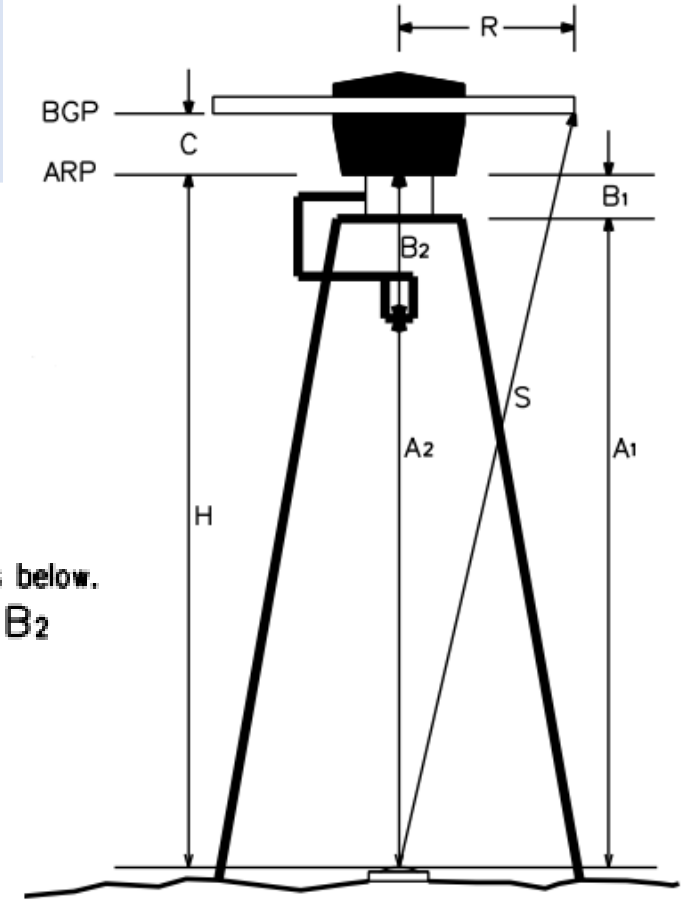


Antenna Height Measurement

I. Instructions for Fixed-Height Tripods:

Measure & record the length (A) and other offsets, if any, between the tripod and Antenna Reference Point (ARP) (B) and/or between the tripod and datum point (Q).

Antenna Height = $H = A_1 + B_1 - Q$



II. Instructions for Slip-Leg Tripod:

NOTE: For Leica measuring hooks, use the instructions below.

Leica Measuring Hook = $H = A_2 + B_2$

1. Measure the Slant Height

Before and after the observation session, measure the slope distance from the mark at least three notches on the Bottom of Ground Plane (BGP) using two independent rulers (e.g. metric and imperial). Record measurments in the table below, and compute the average.

Measure S	Notch *_	Notch *_	Notch *_	Average
Before, cm				
Before, inch				
After, cm				
After, inch				
Note: cm = Inch x (2.54)		Overall average, cm		

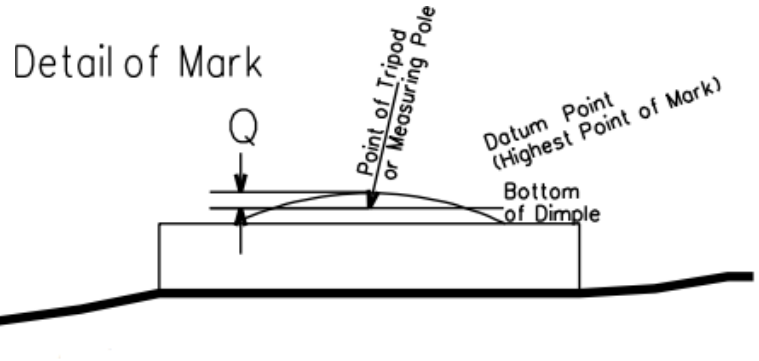
S = _____ cm

2. Record the Antenna Radius (R) and the Antenna Constant (C)

The antenna radius is the horizontal distance from the Antenna Reference Point (ARP) to the measurment notch. The antenna constant is the vertical distance from the ARP to the BGP. See your Antenna specification manual for exact measurments.

R = _____ cm

C = _____ cm



3. Compute Antenna Height (H)

Use the following Pythagorean formula:

Antenna Height $H = ((\sqrt{S^2 - R^2}) - C) - Q$

GNSS Survey Equipment

Surveying Tribrach

GNSS ADJUSTABLE TRIPOD

Figure 1.1

Figure 1.2

Figure 1.3

HEAVY-DUTY GNSS ADJUSTABLE TRIPOD

GeoMax

The fully integrated GNSS

Zenith10 & Zenith20 are complete and fully integrated satellite positioning systems. They comprise of only two main components, a GNSS antenna and a handheld computer that can be setup on a pole or tripod.

The integrated wireless technology, provides a completely cable free and light-weight solution that is ready for an entire day's work.

FieldGenius software makes positioning easy and includes many features to satisfy even the most demanding user. Finish tasks faster than ever before with the fully integrated Zenith Series.

Quality GNSS

Equipped with state-of-the-art NovAtel satellite receiver technology, the Zenith10 & Zenith20 provide maximum performance. The AdVance® RTK technology developed by NovAtel ensures maximum positioning availability under challenging conditions.

GeoMax offers two types of GNSS receivers, the Zenith10 with 72 channels and the Zenith20 with 120 channels. Both receivers can track satellite signals of the GPS and GLONASS type. The Zenith20 additionally supports Galileo. By having access to a maximum number of satellites, positions can be determined at any time, ensuring that Geomax GNSS works when you do!

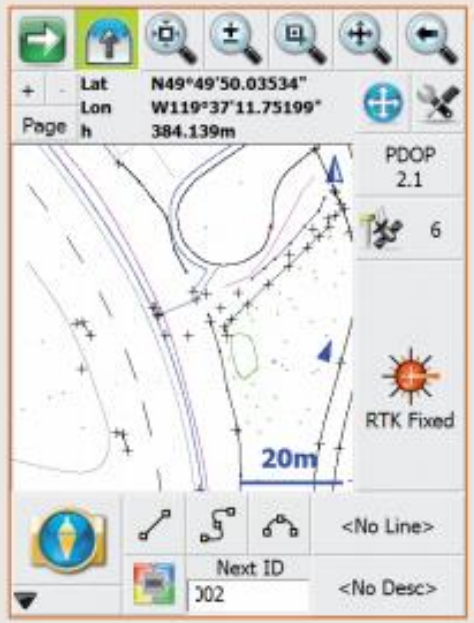
GeoMax

A rugged handheld, packed with features

The PS236 is a compact handheld that is rugged enough for any task. Running Windows® Mobile, the PS236 is packed with features.

Rapid data entry is possible thanks to an extensive keyboard and touchscreen display. With a powerful processor and large internal memory, there are no limits to the possibilites offered by the PS236 handheld.

Being extremely rugged and with a sunlight readable display, you can continue to use the Zenith10 & Zenith20 in all outdoor environments. And with a long battery life of 10 hours, keep working until your job is complete.



GeoMax offers FieldGenius software with high-def graphics and intuitive interface providing you with the most efficient way to survey since the complete job is always visible in the convenient mapview.

Handheld Software

MicroSurvey FIELDGenius

GeoMax Specifications

Receiver specifications

NovAtel AdVance® technology

Zenith10	72 channels (GPS/GLONASS) Maximum 36 Satellites simultaneously
Zenith20	120 channels (GPS/GLONASS/Galileo) Maximum 60 Satellites simultaneously

Satellite signals tracked:

GPS	L1, L2, L2C
GLONASS	L1, L2
Galileo*	

5 Hz raw measurement & position outputs, 20Hz optional

RTK signal initialization typically less than 10 sec**

Initial capture time	< 15 sec**
Internal memory	256 MB (more than 60 days of raw static data storage with recording sample every 15 sec)

Raw Data Logging to internal memory or MicroSD card

Receiver accuracy

Static horizontal accuracy	5 mm ± 0.5 ppm (RMS)**
Static vertical accuracy	10 mm ± 0.5 ppm (RMS)**
Kinematic horiz. accuracy	10 mm ± 1 ppm (RMS)**
Kinematic vert. accuracy	20 mm ± 1 ppm (RMS)**

DGPS/RTCM differential positioning: 0.25 m (RMS)**

Connection devices

Connectors I/O:
5-pin LEMO connector for external power supply and serial connection
4-pin LEMO connector for connecting with PC USB port
Two TNC connectors for UHF and GSM antennas

Bluetooth® device class II

Internal radio with 1 W transmission power. Programmable frequency range of 403 – 473 MHz, optional.

GSM/GPRS data modem at 800 MHz, 900 MHz, 1800 MHz & 1900 MHz

Sim card slot in battery compartment

MicroSD card slot in battery compartment

Power Supply

Interchangable 2500mAh / 7.4V Li-Ion battery providing 4.5 hours RTK operation

9V to a 18V DC external power input with over-voltage protection

GeoMax


Q-Lock satellite tracking technology
120-channel GNSS receiver
Integrated GSM & UHF modules
Internal GSM/GPRS antenna
Connection for UHF antenna
Quick swappable SIM and microSD cards
LED indicators for complete operation overview
Port for external power and radio
Function key for switching of operating modes

GNSS Survey Equipment

Best Practices for Minimizing Errors during Data Collection

GNSS Logger for Android

https://developer.android.com/guide/topics/sensors/gnss

References

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