

Training on GNSS, 8 JAN 2020 11:00-12:00

Tokyo University of Marine Science and Technology

Contents

- 1. What is RTK
- 2. RTK applications
- 3. How to build RTK environment
- 4. RTK configuration on rover
- 5. Where can I buy GNSS devices?
- 6. Moving-base RTK
- 7. Useful web sites

1. What is RTK



1. What is RTK

If "Base station" is not fixed \rightarrow Moving-base RTK You can get precise relative position, angle between 2 antenna.





Mode: GNSS-based (auto) Fix Ambiguities

4

RTK can expand GNSS use field over traditional PNT (Positioning, Navigation, Timing).



Construction



Complex machine control

Traditional optical survey



<image>

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 10 REDUCED INEQUALITIES 1 SUSTAINABLE CITIES AND COMMUNITIES



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14 BELOW WATER ------Ò

♦ Maritime





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15 IFE ON LAND

SUSTAINABLE CITIES AND COMMUNITIES

10 REDUCED INEQUALITIES

♦Agriculture





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Base station overview

I explain the most common broadcast way using "Ntrip server".

However you can also use VHF/UHF radio, Bluetooth, LAN or cable communication to broadcast base station data.



◆Base station antenna

Install antenna in open sky & static environment.



Japanese government base station



Our University base station



Temporary base station

Base station antenna

There is many kind of antenna in the market. Choose which can receive GNSS signal you want to use.

• Antenna Type



Base station antenna

There is many kind of antenna in the market. Choose which can receive GNSS signal you want to use.

• Frequency





BENEFITS

- + Choke ring antenna functionality without the size and weight
- + Reduces equipment costs and need for future redesign
- + High quality measurements and stable phase center for precision applications

FEATURES

Check datasheet

+ L1, L2, L3, L5, B1, B2, E1 and E5a/b + GPS+GLONASS+BeiDou+Galileo signal reception

- + Excellent multipath rejection
- + Highly stable phase center

+ RoHS compliant

If you require more information about our antennas, visit www.novatel.com/antennas

Base station receiver selection

The receiver should support raw data output.

• RTCM3

Standard format for RTK. Select base station position and observation message is must.

 Receiver manufacturer format Binary message.

Input support is depend on the rover receiver.

🗲 septentrio

CHAPTER 4. CONFIGURING THE ASTERX SB AS A ROVER

Configure input of differential corrections

The format of the differential corrections output by the Base station should be compatible with what is accepted by the Rover. In the **Corrections Input** window of the **Corrections** menu, you can configure the AsteRx SB to only accept differential corrections of a particular format. The default 'auto' setting will accept correction data format RTCMv2, RTCMv3 or CMR+.

RTCM F	Rev3 Common Message Types
	Most common message used for >90% of all RTK applications
1004	Extended L1&L2 GPS RTK Observables for GPS RTK Use, the main msg X
1005	Stationary RTK Reference Station ARP 🗙
1006	Stationary RTK Reference Station ARP plus the Antenna Height $ {\sf X} $
1007	Antenna Descriptor (msg 1008 (X) is also commonly used) X
1012	Extended L1&L2 GLONASS RTK Observables, the other main msg X

https://www.use-snip.com/kb/knowledge-base/an-rtcm-message-cheat-sheet/

3.1.5.1 RTCM corrections

RTCM is a binary data protocol for communication of GNSS correction information. The ZED-F9P high precision receiver supports RTCM as specified by RTCM 10403.3, Differential GNSS (Global Navigation Satellite Systems) Services – Version 3 (October 7, 2016).

The RTCM specification is currently at version 3.3 and RTCM version 2 messages are not supported by this standard. Users can download the standard from the RTCM website here.

To modify the RTCM input/output settings, see the configuration section in the u-blox ZED-F9P Interface Description [2].

◆Base station receiver selection



◆Base station receiver setting

Change receiver configuration to output RTCM message from USB port.

Here I will show example using u-blox F9P and Septentrio AtseRx-m2a

◆Base station antenna position

You need to know your base station antenna position with cm level accuracy.

• RTK

If there is another RTK base station near your base, you can calculate by PPK (Post-Process Kinematic).



Nearest base

station

◆Base station antenna position

You need to know your base station antenna position with cm level accuracy.

Antenna IGS product • PPP If there is no another RTK base station, calculate by PPP. .sp3 & .clk data Free PPP service PPP by Receiver - RTKLIB with IGS product (<u>http://www.rtklib.com/</u>) RTKLIB/Net_Diff Rinex data - Net_Diff with IGS product (<u>https://github.com/YizeZhang/Net_Diff</u>) - Trimble RTX (<u>https://www.trimblertx.com/UploadForm.aspx</u>) or - CSRS-PPP (https://webapp.geod.nrcan.gc.ca/geod/tools-outils/ppp.php) Submit Rinex data - MADOCA-PPP PPP by IGS product : (<u>http://mgex.igs.org/IGS_MGEX_Products.php</u>) **RTKLIB**/NetDiff

Base station antenna position Sample of PPP solution



Net_Diff + MGEX product



Report Information

Trimble RTX Solution ID: Solution Type: Software Version: Creation Date: 22163547 Static 6.1.4.17185 11/05/2019 09:38:09 UTC

Trimble RTX service

Use this position as your base station position.

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◆Base station antenna position

Unless there is a special reason, I don't recommend to use optical survey position or SPP average position for the base station position.





- ◆Get Ntrip server
- RTK2GO

Free Ntrip server. You can create your mount point and broadcast data.

The Front Page for RTK2go.com

RTK2go® is a community NTRIP Caster created to allow you to publish your GNSS correction streams for others to use with their NTRIP Clients. It is built using the same *Pro* edition of the SNIP Caster you can find on the use-SNIP.com site. Why do we do this?, because many of the RTK2go users here end up operating a SNIP network of their own. You can download and evaluate your own copy of SNIP® from here. It is one part of the overall *simple NTRIP*[™] project created by SubCarrier Systems Corp. (SCSC).

> RTK2go: 200+ Public Base Stations, 10,000+ Users, 50,000,000+ Sessions, Professional Grade, and Free to use

Send your Base Station data to **RTK2go**® if you do not wish to run your own NTRIP Caster.

Please download and use **SNIP**® if you want to run your own NTRIP Caster.

Other server

• BKG

https://igs.bkg.bund.de/ntrip/download

http://www.rtk2go.com/

- ◆Push out data to Ntrip server
- RTKLIB STRSVR (Free)

RTKLIE	B v.2.4.3 b3	31				×							
***				8	8								
STRSV	/R ver.2.4.3	3 b31											
2019	/12/29 11:	11:06 GPST			Connec	t Time:	0d 00	0:00:00					
	Stream	Туре		Opt Cm	d Conv		Bytes	Bps					
0 🗆	0) Input	Serial	\sim				0	0	NTRIP Server O	otions			>
. (1	1) Output	NTRIP Serve	$1 \sim$				0	0	NTRIP Caster Ho	ost		Port	
	2) Output		~				0	0	rtk2go.com		TD	2101 Password	
	3) Output		\sim				0	0	ECJ70	 User 	10	•••••	
								. ?	String GPS+GLO+BDS				
	► <u>S</u> tart		¢	<u>Options</u>			E <u>x</u> it		Ntrip		ОК	Cance	el

- ◆Push out data to Ntrip server
- SNIP (Lite is Free) https://www.use-snip.com/pricing/





◆Push out data to Ntrip server

You can check your Mount Point from "NTRIP Browser" in RTKLIB.

RTKLIB v.2.4.3 b31	_	×						
🧩 🖻 🗄								
Ntrip Browser ver.2.4.3 b31 X								
File Edit View								
Meuntraint		NET SRC	Map E-mat Dataile					
Mountpoint DevPLO	ID 5220K44662	Format	Format-Details	$^{\circ}$				
Dever	Dover	AUTO DTCM 3.2	1004(1) 1006(15) 1008(15) 1012(1) 1013(10) 103					
Drumade Farms	5748P31517	CMP+	100-(1),1000(13),1000(13),1012(1),1013(10),103.					
EC171	Is near: Chivoda, Tokvo	Griter		- 1				
EmlidCarkvo	Cairo	AUTO	1002(1),1006(10),1008(1),1010(1),1019(1),1097(1					
EPCWID1-Fabens	Fabens, Tx	RTCM 3.1	1004(1),1006(10),1008(10),1012(1),1033(10),409					
ESCADERA_NTRIP	San Diego, Calif.	RTCM 3.2	1006(10), 1008(10), 1013(45), 1033(10), 1075(1), 108					
F9P-FB	Waldshut-Tiengen	RTCM 3.2	1005(1),1074(1),1084(1),1094(1),1230(1)					
F9P-tomi	Neunforn	RTCM 3.2	1005(1),1074(1),1084(1),1094(1),1230(1)					
FRA56141PIKSI	MOUSTOIR-AC	RTCM 3.2	1006(1),1008(1),1033(1),1075(1),1085(1),1095(1)					
FUSOU	FUSO	RTCM 3.2	1005(1),1074(1),1084(1),1094(1),1124(1),1230(1)					
geosense_f9p	Is near: Tokyo, Tokyo	uBlox						
gitt	Chihuahua	RTCM 3.3	1006(10), 1033(13), 1074(1), 1084(1), 1094(1), 1104	5				
<	a		>					
source table received								

Rover antenna

Same manufacturer antenna with base station is recommended.

However, there is not much degradation between antennas from other manufacturers.



◆RTK (Septentrio with PC)

Use Ntrip client function of "Data Link" in "RxTools"

https://www.septentrio.com/en/products/software/rxtools

Downloand link https://www.septentrio.com/en/support/software/rxtools



	File Tools Help Select base statio
Position Information Position Velocity Geodetic φ: N 35" 39"59.43250" No No Base station λ: : 139" 47'32.59835" n: +59.444m σ'u +0.015m Satellite Status GPS GLONASS Galileo BeiDou SBAS QZSS GPS GLONASS Galileo BeiDou SBAS QZSS GPS GLONASS Galileo BeiDou SBAS QZS G20 G23 G21 G23 G25 G26 G26 G27 G28 G29 G29 G30 G31 G32 G25 G26 G26 G27	$\begin{array}{c c c c c c c c c c c c c c c c c c c $
Receiver Status Time RxClock GNSS time frame PDOP: 2.03 J 30-12-2019 TDOP: 1.37 07:20:42.000 HDOP: 0.85 +18s offset to UTC VDOP: 1.85 SBF Status DiffCorr ExEvent ExSensor	GGA +> 1 2 3 4 3 0 Send every 10'th received GGA •
SSRC12 - AsteRx-m2a UAS - SEPT	

Input to COM17 port Connection 2 Serial COM17-115200-8-None-1-Off Disconnect Show Data → 🗹 1 2 3 4 5 6 Link $\mathsf{GGA} \rightarrow \boxed{1} \boxed{2} \boxed{3} \boxed{4} \boxed{5} \boxed{6}$ Send every 10'th received GGA 🛛 😫 Connect Script: Send every 1.00 s. ÷ Close Script: 🗌 Log File: Connected to COM17 I/O 1.1/1.4 kBps Connection 5 TCP/IP Client Connect localhost:28784 Show Data Link \rightarrow 1 2 3 4 5 6 $\mathsf{GGA} \to \square 1 \square 2 \square 3 \square 4 \square 5 \square 6$ Send every 10'th received GGA 🛛 😫 Connect Script: Send every 1.00 s. -Close Script: 🗌 Log File: I/O 0.0/0.0 kBps Press Connect.

◆RTK (Septentrio with smartphone)

Android app that supports septentrio receiver.



0 III 🕅

STATUS

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* 💎 📉 75% 💼 13:49

COLLECTOR

Pin'Point'@GIS"

CORRECTIONS

 \clubsuit RTK (ublox with PC)

Use Ntrip client setting in u-center.

https://www.u-blox.com/en/product/u-center

NTRIP client setting Receiver>NTRIP Client

Select mount point and click "OK".



◆RTK (ublox with smartphone)

Android app of Ntrip client.



https://play.google.com/store/apps/details?id=com.lefebure.ntripclient&hl=en

You need to setup ublox's UART port that connect with Bluetooth module

- ·Input : RTCM
- ·Output : NMEA
- · Baud rate : Same with Bluetooth module.



◆RTK (RTKNAVI)

Real time RTK engine that supports many receivers. To use RTKNAVI, first you should set receiver to output "raw data". "raw data" means binary observation message include RTCM. RTKNAVI decodes this "raw data" and calculate RTK solution.

Here, I show the example using u-blox receiver.



RTCM 2 RTCM 3 NovAtel OEM6 ComNav u-blox Swift Navigation SB Hemisphere SkyTrag GW 10 Javad NVS BINR BINEX Trimble RT17 Septentrio CMR/CMR+ FRSUS

Supported "raw data" formats

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◆RTK (RTKNAVI)

Receiver configuration on u-center.

First, select COM port of the receiver and connect. Then open "message view".



◆RTK (RTKNAVI)

Receiver configuration on u-center. Open message view from View>Message View. You need to click "send" after change configuration.

B- LOG (Data Logger) MGA (Multiple GNSS Assistance) B- MON (Monitor) B- NAV (Navigation) D- RXM (Receiver Manager) ALM (Almanac) EPH (Ephemeris) IMES (IMES Status)		Local Time Leap seconds SV Sig Q01 L1C G02 L1C G04 L1C	2076:348 G Pser	3065.398000000 [s] 18 (VALID) [s] sudo Range [m] Ca 37223900.80 22341332.90	Clock reset arrier Phase [c 195612923.91 117404505.26	Dopple L 28.4 3011.0
		Q01 L1C G02 L1C G04 L1C	- - -	37223900.80 22341332.90	195612923.91 117404505.26	28.4 3011.0
MEASX (Measurement Data) PMREQ (Power Mode Request) RAW (Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RTCM (REturn Link Message) RTCM (RTCM input status) SFRB (Subframe Data) G- SFRBX (Subframe Data) G- ch 5 ch 6 ch 8 -ch 9 -ch 10]] "EI	G09 L1C G05 L1C E20 E1C B20 B1D1 B30 B1D1 B32 B1D1 B27 B1D1 B27 B1D1 R02 L10F	- - - - - - - -	20278115.92 20286923.31 23527761.48 18369556.63 21114834.17 21290715.17 22459560.90 39857882.93 21662199.02 25144750.43 18475732.07	106562222.86 106608505.60 123639230.02 96532675.43 109950483.79 110866337.03 116952823.37 207550458.79 112800758.73 130935296.26 98590048.80	2281.8 537.0 3616.5 285.2 1384.3 -809.0 -1394.8 -955.9 2330.6 -2458.8 -152.9
	Prinked (Power Mode Request) RAW (Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (RTCM input status)	Prikley (Power Mode Request) RAW (Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (Multi-GNSS Raw Measurement Data) RAWX (Return Link Message) RETCH (RTCM input status) SFRBX (Subframe Data NG) G- SFRBX (Subframe Data NG) G- SFRBX (Subframe Data NG) G- ch 5 G- ch 6 Right click -> "E Ch 9 G- ch 10 Enable output of RAWX & SF		PMW(2) (Power Mode Request) PAW(2) (Power Mode Request) PAW(2) (Power Mode Request) PAW(2) (Power Pote) Pawer Pote)		

Setting to output UBX format (UBX-CFG-PRT)

◆RTK (RTKNAVI)

After receiver configuration was completed, save it and disconnect receiver.



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RTK (RTKNAVI) Open RTKNAVI.



RTKNAVI ver.demo5 b33a				
2000/01/01 00:00:00.0 GPST				I
🚟 Pitch/Yaw/Length-Baseline 🝷	Rover:Base SYS SNR (dBHz)		• •	Baseline • •
Solution: P: 0.000 ° Y: 0.000 ° L: 0.000 M: 0.000 U: 0.000 m Age: 0.0 s Ratio: 0.0 #Sat: 0			50 40 20 50 40 30 22	
<				Y: 0.0° P: 0.0°
				2. ?
► <u>S</u> tart		🕀 Plot	Cotions	E <u>x</u> it

◆RTK (RTKNAVI)

Set input stream.

com0com - serial port emulator CNCB1 (COM41) Intel(R) Active Management Technology - SOL (COM3) USB シリアル デバイス (COM11) Ŵ. RTKNAVI ver.demo5 b33a (COM1) 通信ボート (COM1) ____•_•___ o | L I 2000/01/01 00:00:00.0 GPST Pitch/Yaw/Length-Baseline • Rover:Base SYS SNR (dBHz) Baseline Serial Options \times COM11 Port \sim Parity None \sim Bitrate (bps) 115200 1 bit Solution \sim Stop Bits \sim P: 0.000 ° 8 bits Flow Control None Input Streams Byte Size \sim × Y: 0.000 ° Output Received Stream to TCP Port Input Stream Opt Cmd Format L: 0.000 m Type Opt E: 0.000 N: 0.000 U: 0.000 m (1) Rover Serial u-blox \sim \sim Age: 0.0 s Ratio: 0.0 #Sat: 0 OK Cancel (2) Base Station NTRIP Client RTCM 3 \sim \sim (3) Correction Serial RTCM NTRIP Client Options × Transmit NMEA GPGGA to Base Station NTRIP Caster Host OFF √ 0.000000000 0.000000000 0.000 Port 153.121.59.53 ~ 2101 Max Baseline 10 Reset Cmd km < > ... Mountpoint User-ID Password Input File Paths ✓ gspase ECJ27 C:¥Users¥d650e¥Documents¥GNSSLab¥2019¥RTKcore¥rktrcv_vs_ASMB_2 🕀 Pl Start Mark...
 Mark... String C:¥Users¥d650e¥Documents¥GNSSLab¥2019¥RTKcore¥rktrcv_vs_ASMB_2 Select Ntrip mount point OK Ntrip.... Cancel ✓ Time x10 ∨ + s 32bit <u>O</u>K \sim Cancel

マ 開 ポート (COM と LPT)

÷.

com0com - serial port emulator CNCA1 (COM40)

◆RTK (RTKNAVI)

Set output stream & log stream.

Here the RTK position will be written to the file. Also you can choose other option (TCP, Serial) according to your use case

			Οι	utput Streams				\times
				Output Stream	Туре	Option	Format	
				(4) Solution 1	File	· · · · ·	Lat/Lon/Height	\sim
				(5) Solution 2	Serial	~ …	Lat/Lon/Height	\sim
			0	Output File Paths				
			С	C:¥Users¥d650e¥Deskto	p¥F9P_RTKNAVI.	.pos		
Base SYS SNR (dBHz)	•••	Baseline						
	50			Time-Tag Swap Intv	/H ?	ОК	Cancel	
	20			va Streams				\sim
			100	y streams				\sim
		0.000 mE		Log Stream	Туре	Opt	_	Ŷ
		0.000 mE		Log Stream	Type File	Opt	Output Event	Â
		0.000 mE		Log Stream (6) Rover (7) Base Station	Type File File	Opt	Output Event	^
		0.000 m		Log Stream (6) Rover (7) Base Station (8) Correction	Type File File Serial	Opt ···· ···· ···· ····	Output Event	^
		0.000 mE		Log Stream (6) Rover (7) Base Station (8) Correction Log File Paths	Type File Serial	Opt	Output Event	^
		0.000 m E		Log Stream (6) Rover (7) Base Station (8) Correction Log File Paths C:¥Users¥d650e¥Deskto	Type File Serial	Opt ··· ··· ··· ··· ···	Output Event	-
	50 40 30 20	0.000 mE		Log Stream (6) Rover (7) Base Station (8) Correction Log File Paths C:¥Users¥d650e¥Deskto C:¥Users¥d650e¥Deskto	Type File File Serial op¥rover.ubx	Opt	Output Event	
		V: 0.0° P: 0.0°		Log Stream (6) Rover (7) Base Station (8) Correction Log File Paths C:¥Users¥d650e¥Deskto C:¥Users¥d650e¥Deskto	Type File File Serial op¥rover.ubx op¥base.ubx	Opt ··· ··· ··· ···	Output Event	····
		Y: 0.0° P: 0.0°		Log Stream (6) Rover (7) Base Station (8) Correction Log File Paths C:¥Users¥d650e¥Deskto C:¥Users¥d650e¥Deskto	Type File File Serial	Opt 	Output Event Cancel	····

◆RTK (RTKNAVI)

Options

Positioning Mode

Frequencies / Filter Type

Ionosphere Correction

Troposphere Correction

Satellite Ephemeris/Clock

Load

Elevation Mask (°) / SNR Mask (dbHz)

Rec Dynamics / Earth Tides Correction

Excluded Satellites (+PRN: Included)

Save

Setting1 Setting2 Output Statistics Positions Files

Sat PCV Rec PCV PhWU Rej Ed RAIM FDE DBCorr

GPS
 GLO
 Galileo
 QZSS
 SBAS
 BeiDou
 IRNSS

Set option to calculate RTK. After option setting, click "Start" and then RTK starts.

Misc

 \sim

✓ OFF

Cancel

✓ Forward

Kinematic

L1+L2

15

OFF

Broadcast

Broadcast

<u>O</u>K

Saastamoinen

× Options

Load

Save

<u>O</u>K

Cancel



<u>O</u>K

Cancel

Load

O

Cancel

Load

Save

Save

Load

Save

<u>O</u>K

Cancel

I show some shop that you can buy GNSS devices.

♦Antenna



AliExpress

Eltehs GNSS OEM Store

♦Antenna



Ardusimple

ebay



◆ Receiver



Eltehs GNSS OEM Store (ublox)

◆ Receiver



Ardusimple (ublox)



ublox direct shop

♦ Receiver



Septentrio direct shop

swift direct shop

◆Cable & connector





US \$2.79 / lot (2 pieces) Color: Quantity: - 1 + 39828 lots available **Free Shipping** to Japan via China Post Ordinary Small Packet Plus ~ Estimated Delivery: 15-29 days 3 **Buy Now** ♡ 38 60-Day Buyer Protection Money back guarantee

JX connector 2pcs RF coaxial coax adapter TNC Male Female Jack to SMA Male Plug S

SMA or TNC type connector are major in GNSS.

Moving-base RTK (AsteRx-m2a)
 Just connect 2 antenna to the receiver.





\$GPGGA,071402.00,3539.9910977,N,13947.5434857,E,2,28,0.6,17.3133,M,39.3 \$GPVTG,,T,,M,0.00,N,0.01,K,D*27 \$GPHDT,225.230,T*31

ASCII output by nmea "HDT" message.

Moving-base RTK (F9P)Hardware configuration.



Moving-base RTK (F9P) Base configuration.

ODO (Odometer/Low-Speed COG filter) PM (Power Management)	^	UBX - CFG (Co	onfig) - PRT (Ports)	
PM2 (Extended Power Management)		Tarnet	1. UART1	-
PMS (Power Management Setup)		raiget	JI 'OAITT	
PRT (Ports)		Protocol in	5-RTCM3	-
PWR (Power)		Protocol out	5-BTCM3	-
RATE (Rates)				
RINV (Remote Inventory)		Baudrate	115200	•
RST (Reset)				
RXM (Receiver Manager)				
SBAS (SBAS Settings)		Databits	8	
SLAS (SLAS settings)		Stopbits	1	•
SMGR (Sync Manager Config)		Poritu	Mana	
TMODE (Time Mode)		Failty	INone	
TMODE2 (Time Mode 2)		Bit Order	LSB First	•
TMODE3 (Time Mode 3)				

P Me	essages - UBX - CFG (Config) - MSG (Messages)			
	DOSC (Disciplined Oscillator)	^	UBX - CFG	i (Config) - MSG (Messages)
	EKF (EKF Settings)			
	ESFGWT (Gyro+Wheeltick)			
	ESRC (External Source Config)		Message	F5-FE RTCM3.3 4072.0 •
	FXN (Fix Now Mode)		12C	🗖 On 🛛
	GEOFENCE (Geofence Config)	- d	LIART1	F 0 ₂ 1
	GNSS (GNSS Config)	L	UANTI	l≪ Oh I
	HNR (High Nav Rate)		UART2	🗖 On 🛛
	INF (Inf Messages)		USB	🗆 On 🛛
	ITFM (Jamming/Interference Monitor)			
	LOGFILTER (Log Settings)		SPI	On 0
	MSG (Messages)			
	NAV5 (Navigation 5)			
	NAVX5 (Navigation Expert 5)			
	MMEA (NMEA Protocol)			

At UBX-CFG-MSG enable following message to output from used UART. RTCM3.3 1077 (GPS)

RTCM3.3 1087 (GLONASS) RTCM3.3 1097 (Galileo) RTCM3.3 1127 (BeiDou) RTCM3.3 4072.0 (For Moving-Base special message) RTCM3.3 4072.1 (For Moving-Base special message)

Set protocol out of used UART to RTCM. Baudrate should be over 115200. (UBX-CFG-PRT)

◆Moving-base RTK (F9P) Rover configuration.

		INF (Information)	
ssages - UBX - CFG (Config) - PRT (Ports)			Reference Station ID: 0
ESRC (External Source Config)	UBX - CFG (Config) - PRT (Ports)	ian MON (Monitor) ⊡ NAV (Navigation)	GPS ToW: 351613.600 [s]
GEOFENCE (Geofence Config) GNSS (GNSS Config) HNR (High Nav Rate) INF (Inf Messages)	Target T · UART1	AOPSTATUS (AssistNow Autonomous Status) ATT (Attitude Solution) CLOCK (Clock Status)	GNSS Fix OK 🔽 Differential Solution 🗖 Carrier Range Status: Not used
ITFM (Jamming/Interference Monitor) LOGFILTER (Log Settings) MSG (Messages) NAV5 (Navigation 5) NAVX5 (Navigation Expert 5) NMEA (NMEA Protocol) ODO (Odometer/Low-Speed COG filter) PM (Power Management) PM2 (Extended Power Management)	Protocol dut 0+1-0BX+NMEA Baudrate 115200 Databits 8 Stopbits 1 Parity None Bit Order LSB First		Relative Position Valid Relative Position Heading Valid Relative Position Normalized Moving Baseline Extrapolated Ref. Position Extrapolated Ref. Observ.
PMS (Power Management Setup) PRT (Ports) PWR (Power) RATE (Rates) RINV (Remote Inventory)			N 0.0000 [m] 0.0000 [m] E 0.0000 [m] 0.0000 [m]
		RESETODO (Reset Odometer) SAT (Satellite Information) SBAS (SBAS Status)	D 0.0000 [m] 0.0000 [m]
		SIG (Signal Information) SLAS (QZSS SLAS Status) SOL (Navigation Solution) STATUS (Navigation Status)	Lengtr 0.0000 [m] 0.0000 [m] Heading 0.00000 [*] 0.00000 [*]

Messages - UBX - NAV (Navigation) - RELPOSNED (Relative Position NED)

HNR (High Navigation Rate)

◆Moving-base RTK (F9P)

HNR (High Navigation Rate)	LIBX - NAV (Navigation) - BELPOSNED	(Belative Position N	JEDI
INF (Information)		(ricidave riosalorri	,
LOG (Data Logger)		0	
MGA (Multiple GNSS Assistance)	Reference Station ID:	ľ	
MON (Monitor)	GPS Tow/	252102.000	
NAV (Navigation)		1333103.000	[8]
AOPSTATUS (AssistNow Autonomous Status)	GNSS Fix OK	$\overline{\mathbf{v}}$	
ATT (Attitude Solution)	Differential Solution	V	
CLOCK (Clock Status)	Carrier Bange Status:	Fined	
DGPS (DGPS Data)	Califer hange status.	ILIXEO	
DOP (Dilution of Precision)	Relative Position Valid	\checkmark	
EKFSTATUS (Status)	Relative Position Heading Valid	v	
EOE (End Of Epoch)	Belative Position Normalized		
GEOFENCE (Geofencing status)	Maxima Davalina		
HPPOSECEF (High Precision Position ECEF)	Moving Baseline	·	
HPPOSLLH (High Precision Geodetic Position)	Extrapolated Ref. Position		
ODO (Odometer)	Extrapolated Ref. Observ.		
ORB (Orbit Info)			
POSECEF (Position ECEF)	Relative Position and Accuracies		_
POSLLH (Geodetic Position)	N 0.6718 [m]	0.0100	[m]
- PVT (Navigation PVT Solution)	- 0.0752	0.0100	—
RELPOSNED (Relative Position NED)	E 0.6752 [m]	0.0100	[m]
RESETODO (Reset Odometer)	D 0.0018 [m]	0.0100	[m]
SAT (Satellite Information)	[]	1	
SBAS (SBAS Status)	Length 0.9525 [m]	0.0100	[m]
SIG (Signal Information)		0.0100	[11]
SLAS (QZSS SLAS Status)	Heading 45.14771 [*]	0.60155	[*]
SOL (Navigation Solution)	,	1	
STATUS (Navigation Status)			





Moving-base RTK (RTKNAVI)Hardware Configuration





Moving-base RTK (RTKNAVI) Receiver configuration (both receiver).

Messages - UBX - CFG (Config) - PRT (Ports)		Messages - UBX - RXM (Receiver Manager) - RAWX (Multi-GN)	ISS Raw Measurement Data)
ACK (Acknowledge)	UBX - CFG (Config) - PRT (Ports) Target 3 - USB	HNR (High Navigation Rate) INF (Information) LOG (Data Logger)	UBX - RXM (Receiver Manager) - RAWX (Multi-GNSS Raw Measurement Data)
ANT (Antenna Settings) BATCH (Batch mode output) CFG (Configuration) DAT (Datum) DGNSS (Differential GNSS configuration) DOSC (Disciplined Oscillator) EKF (EKF Settings) EKF (EKF Settings) ESFGWT (Gyro+Wheeltick) ESRC (External Source Config) FXN (Fix Now Mode) GEOFENCE (Geofence Config)	Protocol in 0+1+5 - UBX+NMEA+RTCM3 Protocol out 0+1 - UBX+NMEA	MGA (Multiple GNSS Assistance) MON (Monitor) NAV (Navigation) ASM (Receiver Manager) ALM (Almanac) EPH (Ephemeris) IMES (IMES Status) MEASX (Measurement Data) PMREQ (Power Mode Request) RAW (Raw Measurement Data)	SV Sig G Pseudo Range [m] Carrier Phase [c Dopple Loci Q01 L1C 37223900.80 195612923.91 28.4 6 G02 L1C 22341332.90 117404505.26 3011.0 6 G04 L1C 20278115.92 106562222.86 2281.8 6 G05 L1C 20286923.31 106608505.60 537.0 6 G05 L1C 23527761.48 123639230.02 3616.5 6 E20 E1C 18369556.63 96532675.43 285.2 6 B20 B1D1 21114834.17 109950483.79 1384.3 6 B30 B1D1 21290715.17 110866337.03 -809.0 6 B32 B1D1 22459560.90 116952823.37 -1394.8 6
GNSS (GNSS Config) HNR (High Nav Rate) INF (Inf Messages) INF (Inf Messages) OGFILTER (Log Settings) MSG (Messages) NAV5 (Navigation 5) NAV5 (Navigation Expert 5) NMEA (NMEA Protocol) ODO (Odometer/Low-Speed COG filter) PM (Power Management) PM2 (Extended Power Management)	Extended T× timeout (>=FW7.00) T×-Ready Feature (>=FW7.00) Enable Inverse Polarity (low-active) Threshold 0 PI0	KLM (Keturn Link Message) RTCM (RTCM input status) SERB (Subframe Data) SFRBX (Subframe Data NG) ch 6 ch 6 ch 8 ch 9 ch 10	B07 B1D1 - 39857882.93 207550458.79 -955.9 6 B29 B1D1 - 21662199.02 112800758.73 2330.6 6 B27 B1D1 - 25144750.43 130935296.26 -2458.8 6 R02 L10F -4 18475732.07 98590048.80 -152.9 6
PMS (Power Management Setup) PRT (Ports) PWR (Power) RATE (Rates)			

Setting to output UBX format (UBX-CFG-PRT)

Enable output of RAWX & SFRBX (UBX-RXM)

TUMSAT GNSS Lab

Moving-base RTK (RTKNAVI) RTKNAVI set up.



_												
		Input Streams										
		Input Str	eam	Type				Cmd	Format			Opt
		🗹 (1) Rover		Serial		\sim			u-blo	x	\sim	
		🗹 (2) Base Sta	tion	Serial		\sim			u-blo	x	~	
		(3) Correctio	n	Serial					RTCM	12		
		Transmit NMEA	GPGGA	PGGA to Base Station								
		OFF	~	0.0000	00000	0	.0000	0000	00	0.000		
/		Reset Cmd							Max B	aseline	10	km
		Input File Paths										
					Cabit	. [01/			CI	
Time X1 V + U S 64bit OK									Cancel			
		Serial Options										×
			Port	t	COM5		\sim	Pari	ty	Nor	ne	~
			Bitra	ate (bps)	115200		\sim	Stop	o Bits	1 bi	it	~
			Byte	e Size	8 bits		\sim	Flov	v Conti	rol Nor	ne	~
				Outout Pe	ceived 9	tre	am to	тср	Port			
				σαφατικέ	cerveu a			TCF	FUIL			
\setminus						L		ОК		(Cancel	
	Output Str	reams									×	
	Ou		Type Optio			۱ _		t	_			
	🗹 (4) Solı	ution 1	File		\sim		E	/N/U	J-Base	line	\sim	
	✓ (5) Solution 2 TCP Client ∨ … E/N/U-Baseline								line	\sim		
	Output File Paths C:¥Users¥d650e¥Documents¥GNSSLab¥2019¥Ublox¥190415_F9P_RTK¥I									_		
	Time-Ta	ag Swap Intv	~	н ?		ок			Ca	ancel		
		L	_								-1	
				TCP Client	Options						×	
				127.0.0.1	ress			~	1111			
				Mountpoint		Jser-I	D		Passwo	ord		
				String								

Cancel

OK

Select "Serial" in both rover and base and format is "u-blox".

Select COM port number.

Select output format to "E/N/U-Baseline". If you want to show in RTKPLOT, set one output stream to TCP.

TUMSAT GNSS Lab

Moving-base RTK (RTKNAVI) Option configuration



- "Fix and Hold" is recommended in "Integer Ambiguity Res" setting.
- If 2 antenna relative length is not changed, set "Baseline Length Constraint" is better.

(Input value is

length between 2 antenna [m]/length error level[m])

• Without highlighted in red are default values.

Options X			Options	\times	Options					
Setting1 Setting2 Output Statistics Position	ns Files Misc		Setting1 Setting2 Output Statistics	Misc	Setting1 Setting2 Output Statistics Positions Files Misc					
Positioning Mode	Moving-Base ~		Integer Ambiguity Res (GPS/GLO/BDS	5) Fix and I 🗸	OFF \checkmark ON \checkmark	Measurement Erro Code/Carrie	ors (1-sigma) r-Phase Error Ratio L1/L	.2 300	300	
Frequencies / Filter Type	L1+L2 V Forward	\sim	Min Ratio to Fix Ambiguity 3.0			Carrier-Phas	e Error a +b/sinEl (m)	0.003	0.003	
Elevation Mask (°) / SNR Mask (dbHz)	15 ~		Min Confidence / Max FCB to Fix Amb	0.9999	0.20	Carrier-Phas	e Error/Baseline (m/10k	m) 0.000	0.000	
Rec Dynamics / Earth Tides Correction	OFF V OFF	\sim	Min Lock / Elevation (°) to Fix Amb	0	0	Doppler Frequency (Hz)		1.000	1.000	
Ionosphere Correction	Broadcast \checkmark		Min Fix / Elevation (°) to Hold Amb	10	40	Process Noises (1	-sigma/sqrt(s))			
Troposphere Correction	Saastamoinen 🗸 🗸		Outage to Reset Amb / Slip Thres (m)	5	0.050	Receiver Acc	Receiver Accel Horiz/Vertical (m/s2)		1.00E+01	
Satellite Ephemeris/Clock Broadcast		\sim	Max Age of Diff (s) / Sync Solution	30.0	OFF ~	Carrier-Phase Bias (cycle)		1.00E-04	1.00E-04	
Sat PCV Rec PCV PhWU Rej Ed RAIM FDE DBCorr			Reject Threshold of GDOP/Innov (m)	30.0	30.0	Vertical Ionospheric Delay (m/10km)		1.00E-03	1.00E-03	
Excluded Satellites (+PRN: Included)			Max # of AR Iter/# of Filter Iter	Max # of AR Iter/# of Filter Iter 1 1 Zenith Tropospheric Delay (m)		1.00E-04	1.00E-04			
GPS GLO Galileo QZSS SE	BAS 🗹 BeiDou 🗌 IRNSS		Baseline Length Constraint (m) 0.95 0.		0.05	Satellite Cloc	k Stability (s/s)	5.00E-12	5.00E-12	
Load Save	OK Cancel		Load Save	ОК	Cancel	Load	Save	ОК	Cancel	

◆Moving-base RTK (RTKNAVI)

Change shown format type by this button. ENU or PYL



◆RTKNAVI PLOT configuration



7. Useful web sites

- ◆Useful web sites for your RTK experiment
- <u>https://www.ardusimple.com/blog/</u>
- <u>http://rtkexplorer.com/how-to/posts-getting-started/</u>
- <u>http://www.denshi.e.kaiyodai.ac.jp/gnss_tutor/base_station.html</u>
- https://home.csis.u-tokyo.ac.jp/~dinesh/