Guide to GNSS Base stations

Outline

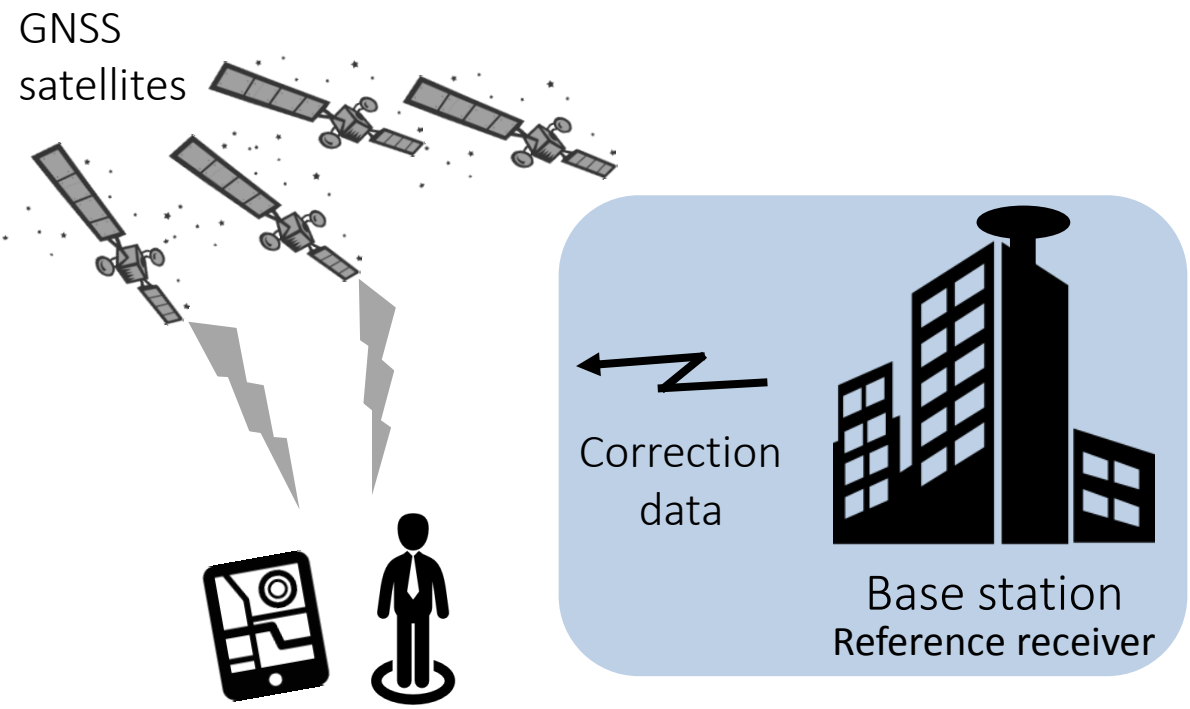
- Introduction
- Example of a base station (TUMSAT)
- Preparation for setting up a base station
- Procedure for setting up a base station
- Examples at two other universities

Based on documents:

- ✓ *Introduction to GPS (Global Positioning System)* by Leica
- ✓ *GPS Reference Stations and Networks An introductory guide* by Leica
- ✓ *Trimble NetR9 GNSS Reference Receiver User Guide*

Introduction

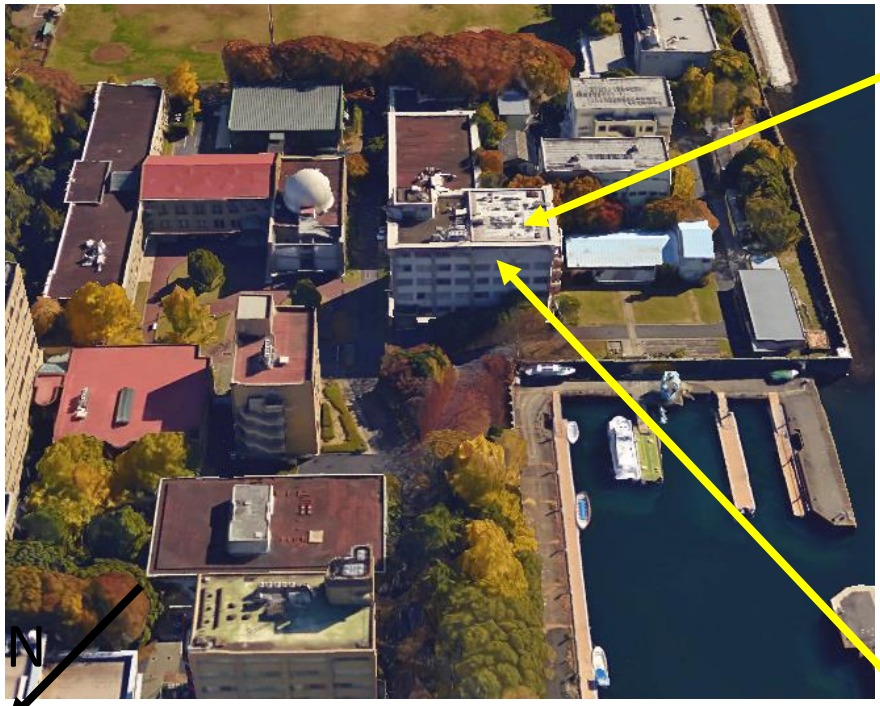
This guide describes and gives advice on how to set up a reference receiver for a base station.



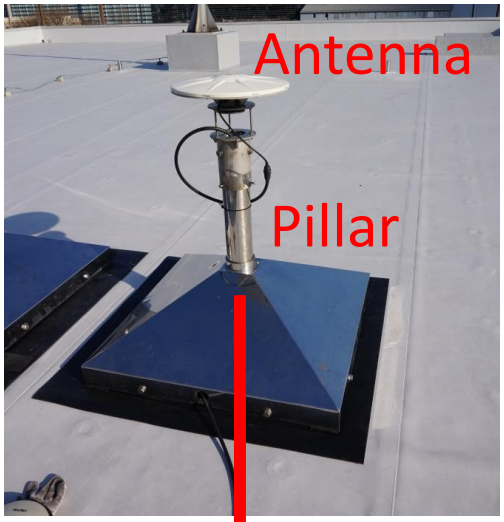
Real time correction data
Accuracy 10 m → 2 cm (RTK)

Many of the errors affecting satellite range measurements can be removed using differential techniques. A reference receiver antenna is mounted at a location whose coordinates are already known. Because it is at a known point, the reference receiver can estimate very precisely what the ranges to each visible satellite should be. A reference receiver can therefore calculate the differences between the computed (theoretical) ranges and those that are measured by the reference receiver. These differences are known as *corrections*.

Example of Base Station at TUMSAT
(Tokyo University of Marine Science and Technology)



Rooftop of the building at TUMSAT



Sky view
(No obstacles)

Cable

Top floor of the building (our lab is there)

Receiver

Receiver (Trimble NetR9)
- ✓ Built-in battery and memory
- ✓ Suited for Continuously Operating Reference Station (CORS)
- ✓ Supports NTRIP Server

This base station has been operated for 5 - 10 years.

Preparation for setting up a base station

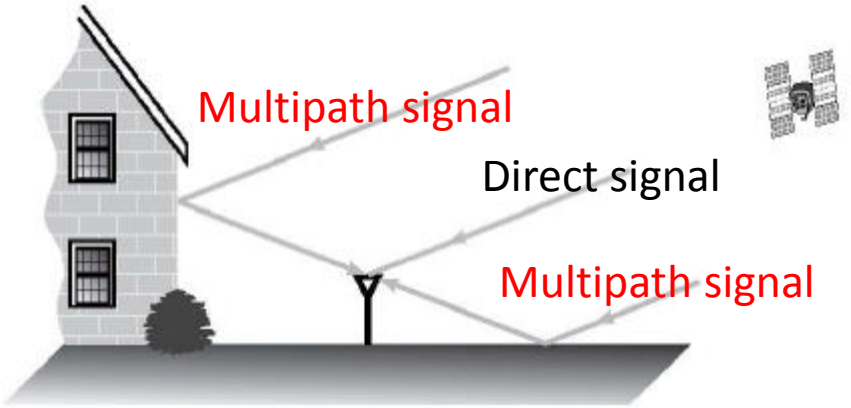
1. Selecting a suitable site
2. Selecting equipment
   - GNSS receivers
   - GNSS antennas
   - Antenna cables
3. Power supply and network
4. Conclusion

Preparation for setting up a base station

1. Selecting a suitable site

Requirements for a base station

- Able to continuously log reliable data
  - Equipment and cables need to be stable
- No obstacles limit the data quality
  - Obstacles that cause loss of satellite signals
  - Obstacles that generate multipath signals
- Known antenna position
  (e.g., close to another base station)
  - To provide highly accurate correction data

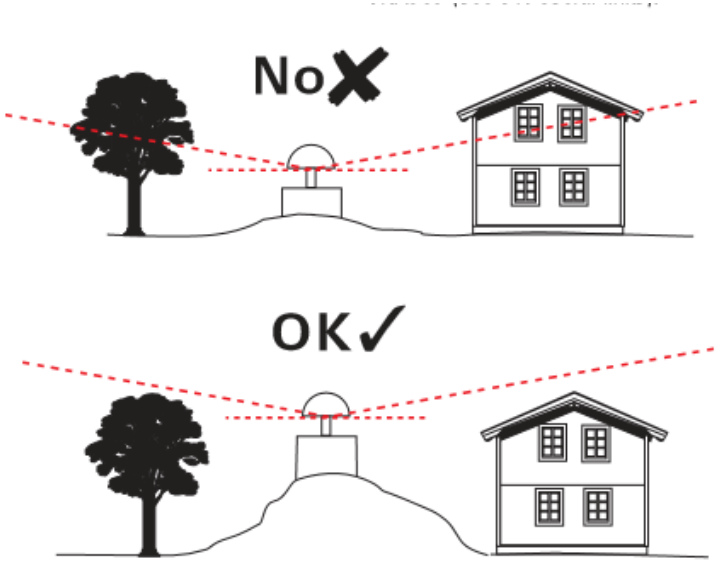


Preparation for setting up a base station

1. Selecting a suitable site

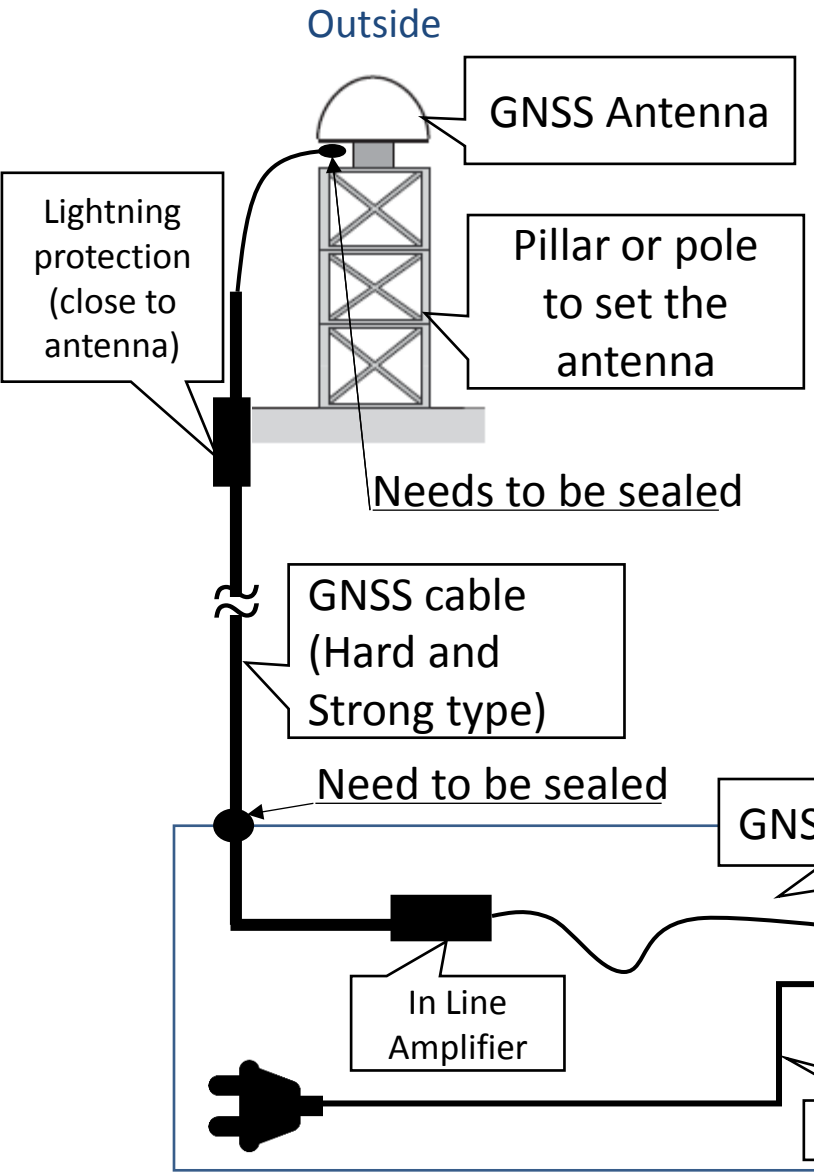
Requirements for base station site:

- Open view of the sky
- No objects in the vicinity
- No other transmitters near GNSS frequencies
- Power and communication
- Structures to house and protect the equipment
- A stable mount for the antenna (e.g., on the roof of a building)
- Accessibility for inspection and maintenance



Preparation for setting up a base station

2. Selecting equipment



- ✓ **GNSS antenna**
- ✓ **GNSS receiver**
- ✓ **Several Antenna cables (TNC-type connector)**
  - Standard length is 10 m
  - Longer cables are heavier and more unwieldy
  - Can use TNC extension cables instead
- GNSS In Line Amplifier used with extension cables
- Lightning protection
- Sealing tape, rubber tape for water proofing

Preparation for setting up a base station

2. Selecting equipment

- Selecting suitable **receivers** and **antennas** for your objective
  - Dual or single frequency
  - Multi-GNSS or GPS-only satellite constellations
  - Multiple types of observation
  - Cost

Trimble Zephyr Geodetic Antenna

Trimble Zephyr Geodetic Antenna

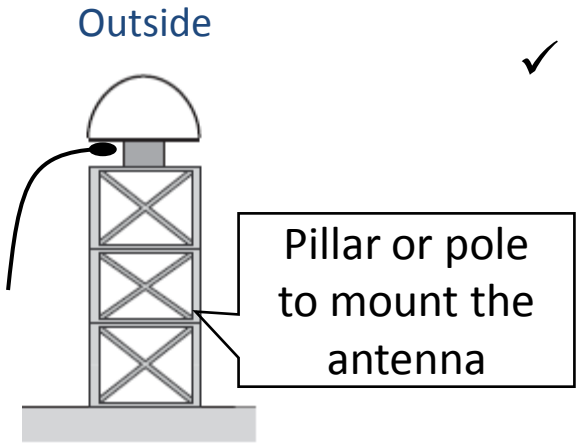
- ✓ Technology for multipath reduction
- ✓ Supports multiple satellite signals
- ✓ Sub-millimeter phase center repeatability
- ✓ **5/8" x 11 female threaded stainless steel mounting point**
- ✓ **TNC-type female connecter for connecting to the antenna**

Trimble NetR9 GNSS Reference Receiver

- ✓ Built-in battery and memory
- ✓ Suited for Continuously Operating Reference Station (CORS)
- ✓ Supports NTRIP Server

Preparation for setting up a base station

2. Equipment for antenna

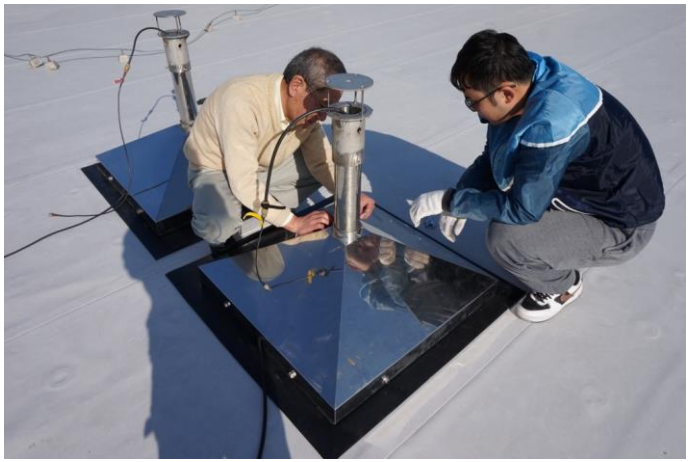


✓ Pillar

- Solid foundation (e.g., bedrock), suitably designed
- Provides reliable power and communication
- Supports the receiver, power supply and communication devices
- Provides security
- Holds antenna horizontally

Chulalongkorn Univ.

TUMSAT

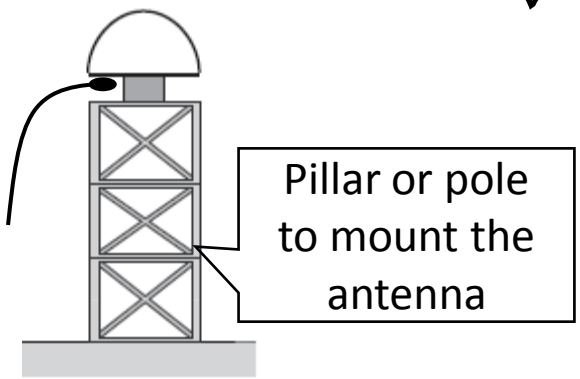


Univ. of Philippines

Preparation for setting up a base station

2. Equipment for antenna

Outside



✓ Pole

- Using a 5/8" x 11 male threaded stainless steel mounting point fixed firmly in position
- Attaching a pole or console to a wall, etc.

Universitas Indonesia

5/8" x 11 female threaded stainless steel mounting point

Pole to mount the antenna fixed to the wall of the rooftop

3. Power supply and network

- GNSS base station needs a reliable, continuous power supply.
  - NetR9 receiver includes an internal battery that lasts for several hours
  - No need for UPS
- To provide real-time correction data via the internet
  - Fixed Global IP address
  - Continuous internet network
- To set up and configure the receiver, a PC with an Ethernet port is required.

Conclusion – check list for preparation

- Selecting a suitable site
  - Is a rooftop available?
  - Are there any significant obstacles?
  - Are there any other transmitters near the GNSS bands?
  - Is a pillar or a pole used? Is it stable?
  - How long is the distance between the antenna and the receiver housing?
- Selecting suitable equipment
  - Receiver and antenna combination
  - Are the cables of sufficient length?
  - In Line Amplifiers for extension cables (as needed)
  - How safely positioned is each piece of equipment?
  - Are continuous power and network resources available?
  - Will you be able to obtain a very accurate pre-surveyed position of the base station?

Procedure for setting up a base station

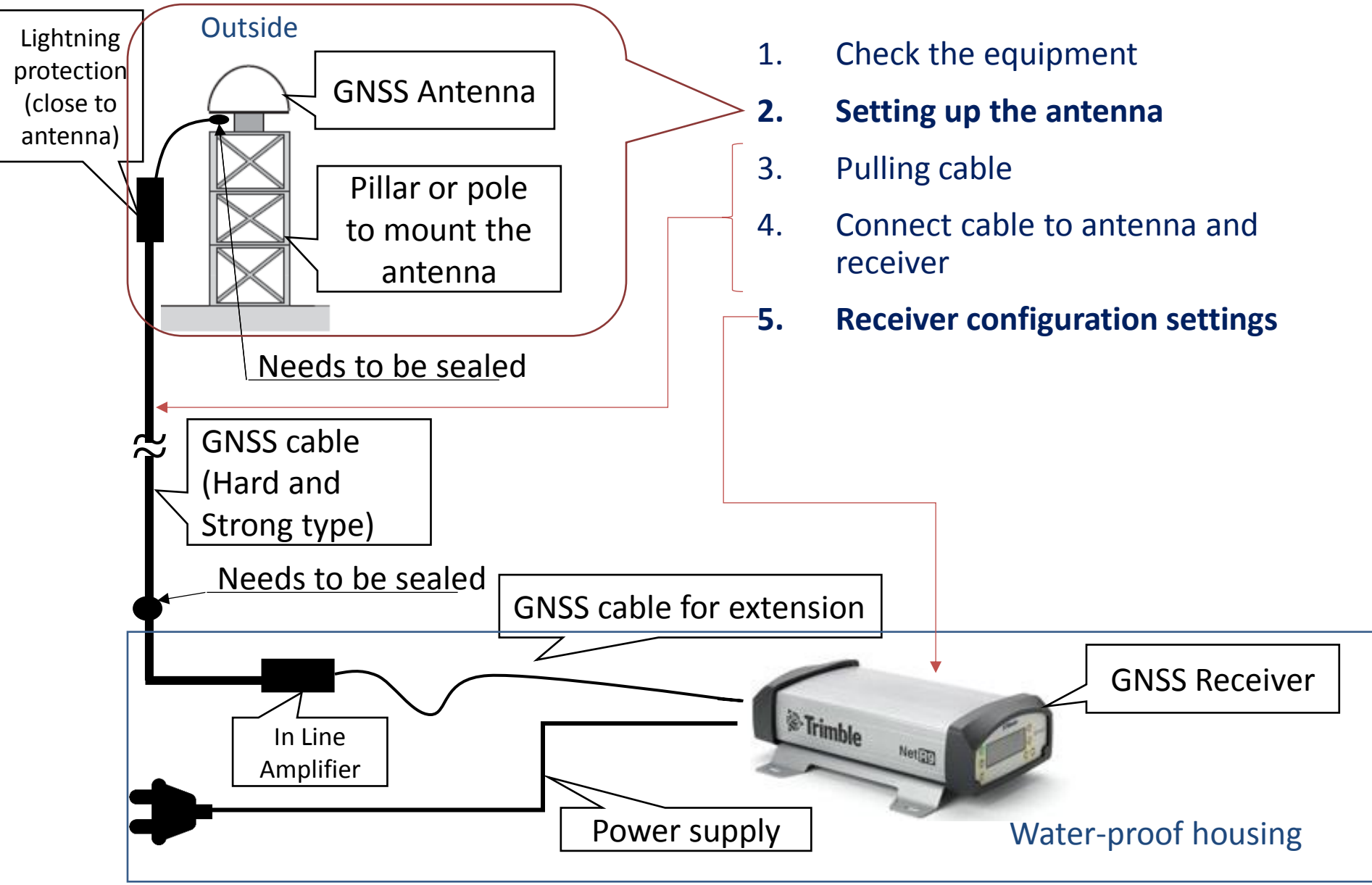
1. Check the equipment
2. **Setting up the antenna**
3. Installing cable
4. Connect cable to antenna and receiver
5. **Receiver configuration settings**

For at least one day

6. Obtaining the base station position

Procedure for setting up a base station

Overview of equipment connections

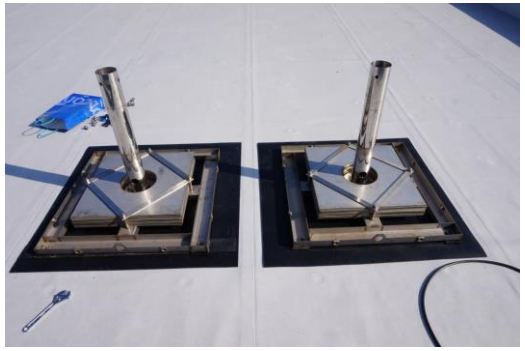


1. Check the equipment
2. **Setting up the antenna**
3. Pulling cable
4. Connect cable to antenna and receiver
5. **Receiver configuration settings**

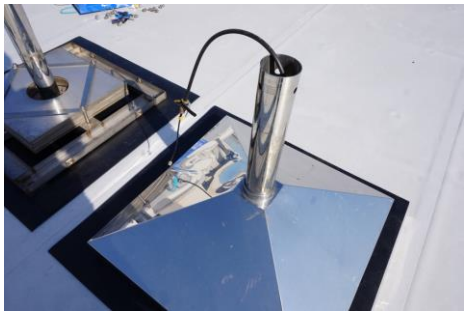
Procedure for setting up a base station

2. Setting up the antenna

Case1. Pillar (Example at TUMSAT)

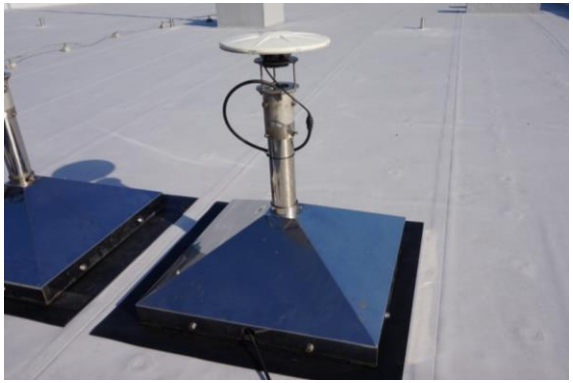


1. Set the foundation structure on the rooftop of the building.
The foundation structure is made of stainless steel and is heavy.



2. Antenna cable
Cable is installed inside the pillar for security and to protect against wind.

3. Fix the antenna
With stainless steel mount for the foundation structure.

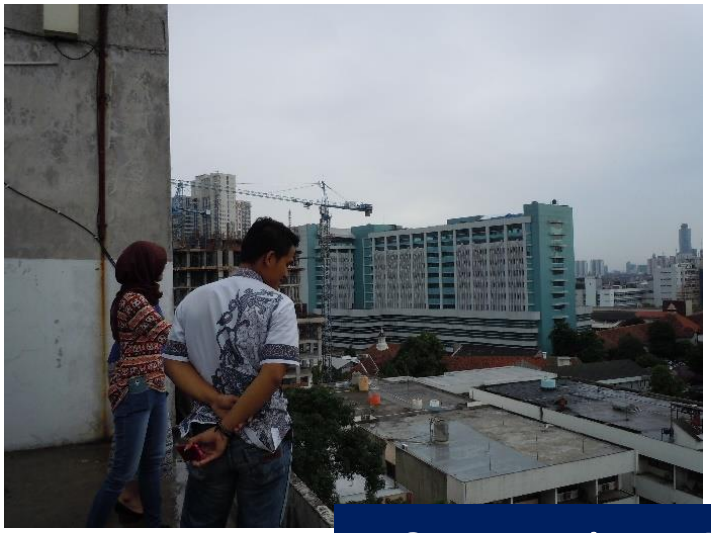


4. Finish antenna setup.
Then connect to the cable.

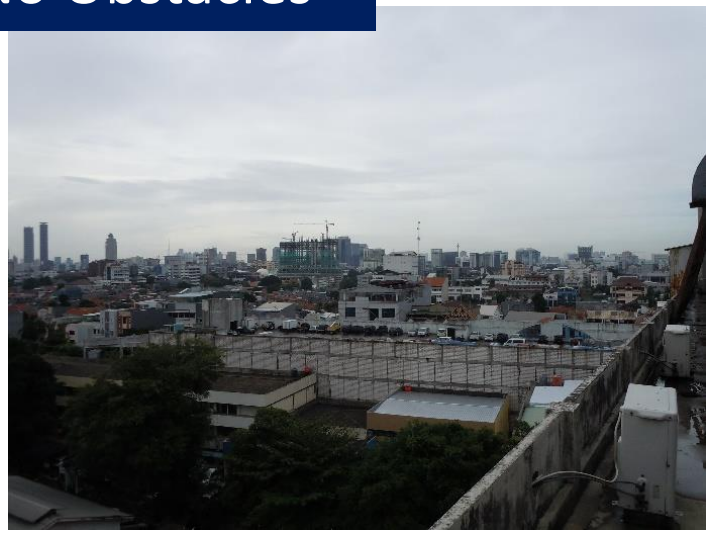
Procedure for setting up a base station

2. Setting up the antenna

Case2. Pole (Example at Universitas Indonesia)



Setup site: No Obstacles



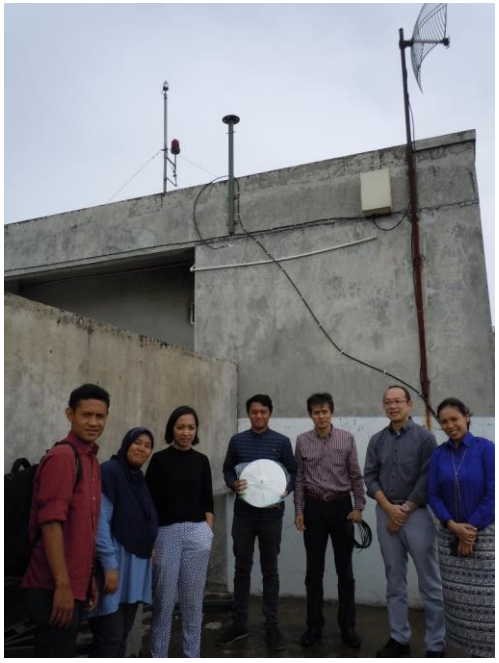
Procedure for setting up a base station

2. Setting up the antenna

Case2. Pole (Example at Universitas Indonesia)

1. Install the pole on the rooftop of the building.
Fixed to the wall.
Antenna cable is already well fixed to the wall.

2. Install a metal structure to secure the top of the pole.



3. After installing the pole, the antenna is connected to the cable .

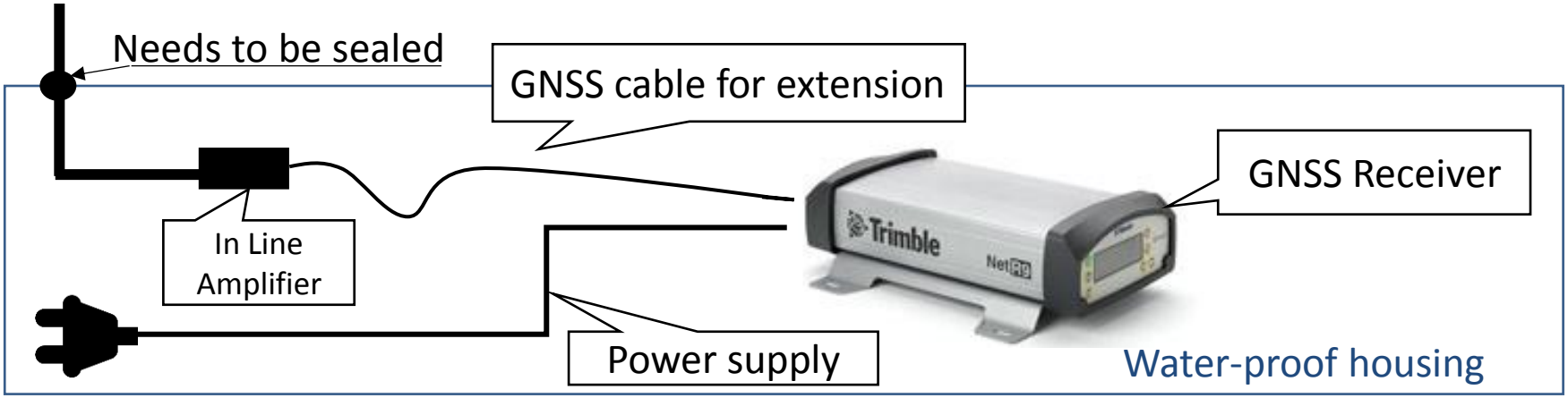
Procedure for setting up a base station

Check points for equipment setup

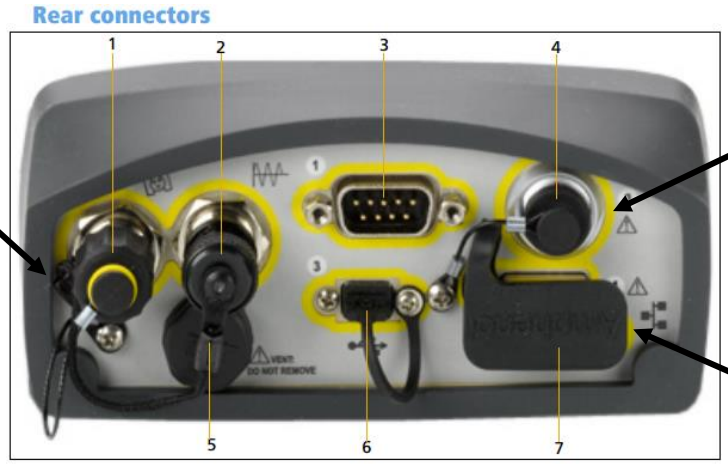
- For the antenna
  - Is the antenna foundation installed in a stable manner?
  - Is the antenna installed horizontally?
- For the antenna cable
  - Does the cable have plenty of length and flexibility? Is there any stress in the cable?
  - Is the cable well secured against the wind?
  - Are the joints well sealed against water?
    - Antenna-to-cable, cable-to-cable, the point where the cable enters the receiver housing.
- Other items
  - In Line amplifiers for the extension cables, if needed
  - Lightning protection

Procedure for setting up a base station

5. Receiver configuration settings

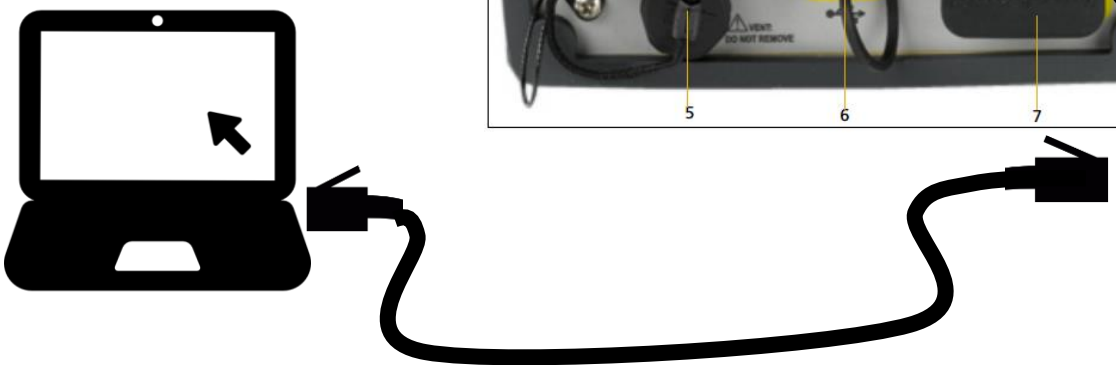


1. Connect to the **antenna cable**



2. Connect to the **Power supply**

3. Connect to the **PC** to configure the receiver over an Ethernet comm. link



Procedure for setting up a base station

5. Receiver configuration settings

User Guide
http://trl.trimble.com/docushare/dsweb/Get/Document-495804/NetR9_UserGuide_13506.pdf

Button	Name	Function
	Power	Turn on or turn off the receiver. To turn off the receiver, hold down for two seconds.
	Escape	Return to the previous screen or cancel changes you make on a screen.
	Enter	Advance to the next screen or accept changes you make on a screen.
	Up	Move the cursor between multiple fields on a screen, or make changes.
	Down	Move the cursor between multiple fields on a screen, or make changes.
	Left	Move the cursor between characters in an editable field.
	Right	Move the cursor between characters in an editable field. Initiate edit mode for the current field.

- Power on and check the display
  - SV # is the number of received satellites. If the antenna is connected well, more than 10 satellites will be able to be received.
- Connect to the PC
  - The receiver Ethernet port connects to an Ethernet network, over you can configure and monitor the receiver.
  - The default setting of the receiver is to use DHCP. This enables the receiver to automatically obtain an IP address.
  - When the receiver is connected to a network using DHCP, the network assigns the receiver an IP address. To verify this address, open the Home screen and then press

Procedure for setting up a base station

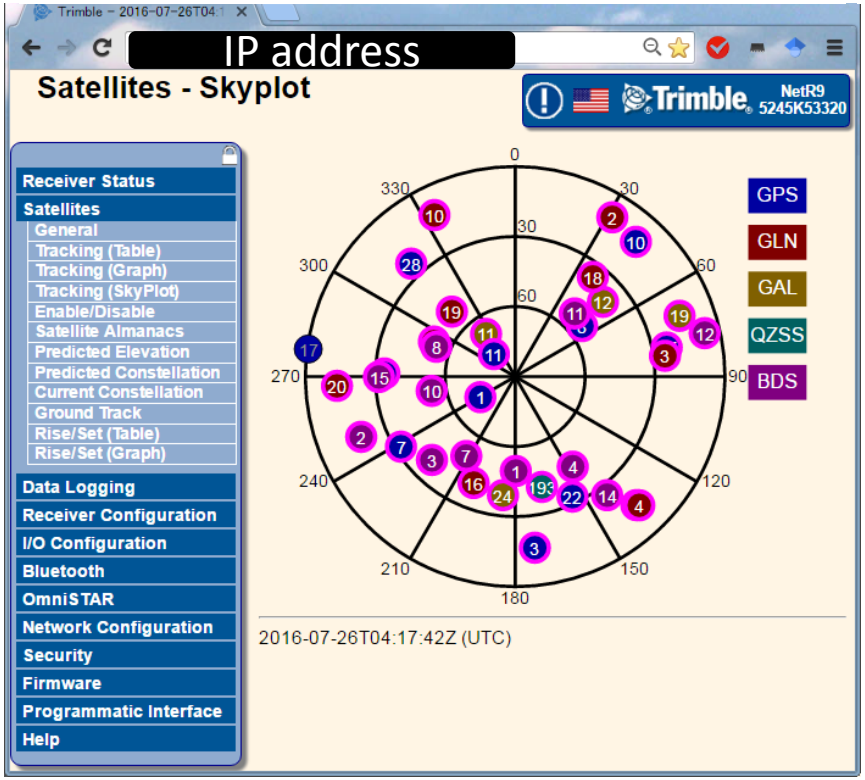
5. Receiver configuration settings

User Guide
http://trl.trimble.com/docushare/dsweb/Get/Document-495804/NetR9_UserGuide_13506.pdf

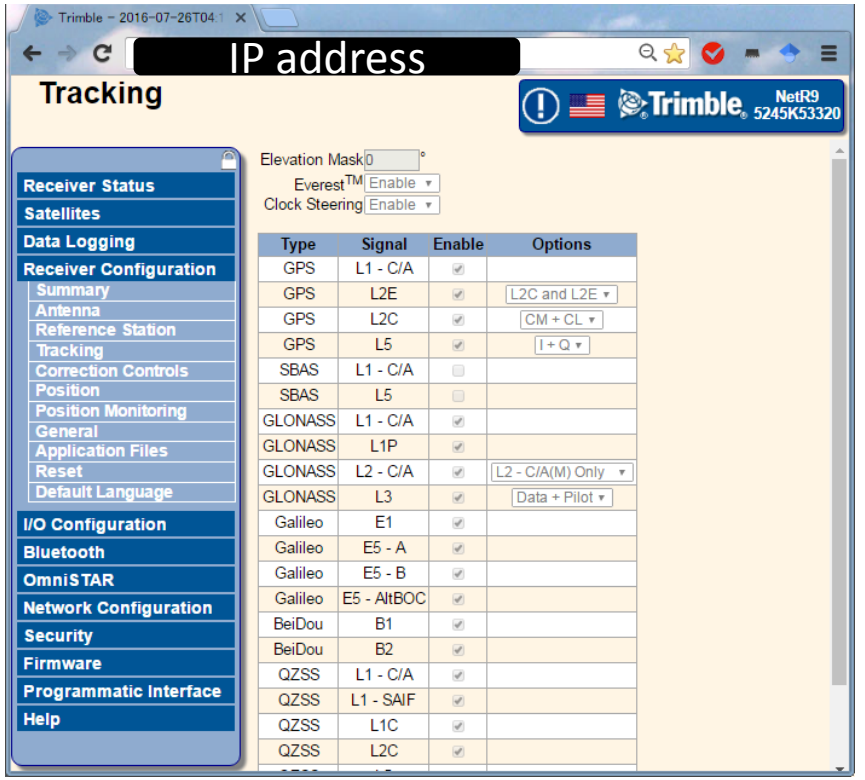
1. On the PC, enter the IP address of the receiver into the address bar of a web browser, then press <Enter>

2. Proceed to configure the receiver status and monitor

Example 1. Satellites-> Tracking(Skyplot)



Example 2. Recover configuration -> Tracking



Procedure for setting up a base station

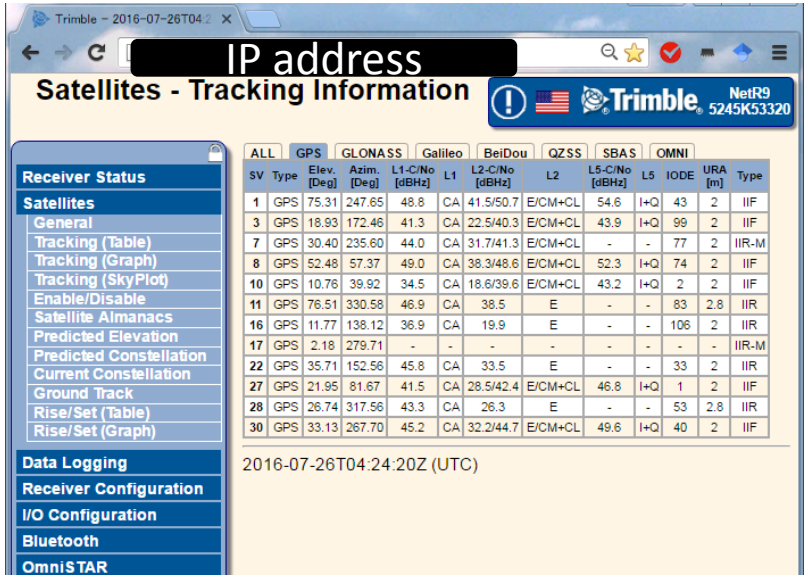
5. Receiver configuration settings

User Guide
http://trl.trimble.com/docushare/dsweb/Get/Document-495804/NetR9_UserGuide_13506.pdf

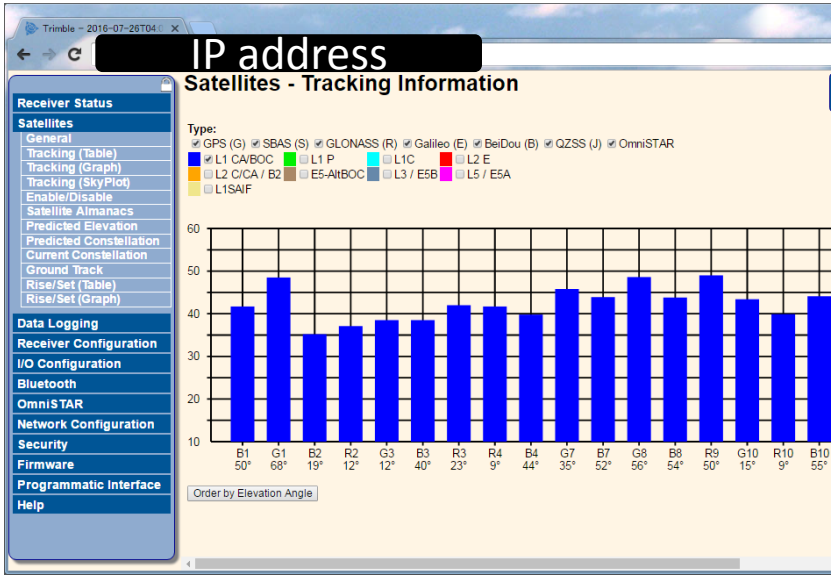
Do not forget to check the signal strength of received satellites

If the antenna is connected well, the maximum C/N_0 (Carrier to Noise ratio) for the GPS L1 C/A-code signal will be approximately 50 dB-Hz

Example of TUMSAT base station
Satellites ->Tracking (Table)



Example of TUMSAT base station
Satellites ->Tracking (Graph)



Procedure for setting up a base station

5. Receiver configuration settings

User Guide
http://trl.trimble.com/docushare/dsweb/Get/Document-495804/NetR9_UserGuide_13506.pdf

- Data Logging
  - For data logging to obtain raw data for post-processed RTK positioning.
- I/O Configuration
  - For streaming correction messages from the base station (to rovers)
  - To set up all receiver outputs and inputs. The receiver can output several correction message formats.

I/O Configuration

Type	Port	Input	Output
TCP/IP	5017	-	RT27(1Hz)
TCP/IP	5018	-	-
UDP	9750	-	-
TCP/IP	14999	-	NMEA-GGA(5 Sec.)
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client	155.63.159.80:28004/VRS_CMRx	CMR	NMEA-GGA(5 Sec.)
NTRIP Server	-	-	-
NTRIP Caster 1	2101	-	-
NTRIP Caster 2	2102	-	-
NTRIP Caster 3	2103	-	-
Serial	Serial 1 (38.4K-8N1)	-	-
Serial	Serial 2 (38.4K-8N1)	-	-
Bluetooth	1	-	-
Bluetooth	2	-	-
Bluetooth	3	-	-
USB	-	-	-