Antenna Installation Guide

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Select Antenna Location

- Select an outdoor location for the antenna, like the roof of your building, which has a relatively unobstructed view of the horizon.
- Install the GNSS antenna vertically to the earth.
- Dense wood, concrete or metal structures will shield the antenna from satellite signals.
- GNSS signals can be reflected by objects, where metal, walls and shielded glass parts are reflectors. The antenna should not be placed near a wall, window or other large vertical objects.
- The GNSS antenna is an active antenna. For optimal performance, locate the antenna as far as possible from transmitting antennas, including radars, satellite communication equipment, and cellular and pager transmitters.

Avoid RF Sources

- When locating the antenna near an RF Transmitter installation, ensure that the antenna is positioned outside of the transmitter's cone of transmission. Follow the same guideline when installing the antenna near satellite communication equipment.
- For the best results, mount the antenna below and at least 3m away from communication equipment.
- The length of cable run from your GNSS receiver to the antenna location should not degrade the supply voltage below the minimum requirement of the antenna.

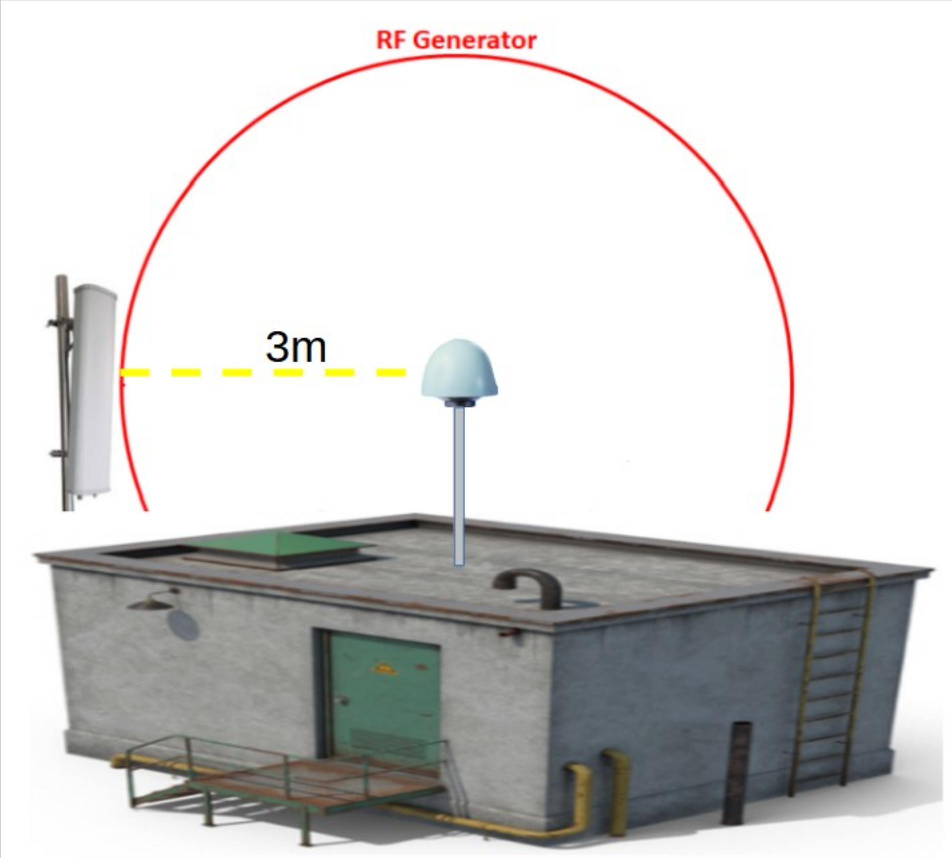


Figure 1

The antenna should be at least 3 meters away from any RF generators to avoid signal interference.

Antenna Placement

Pole or bracket mount

Depending on the antenna, a bracket or pole can be used to fasten the antenna to a support structure.

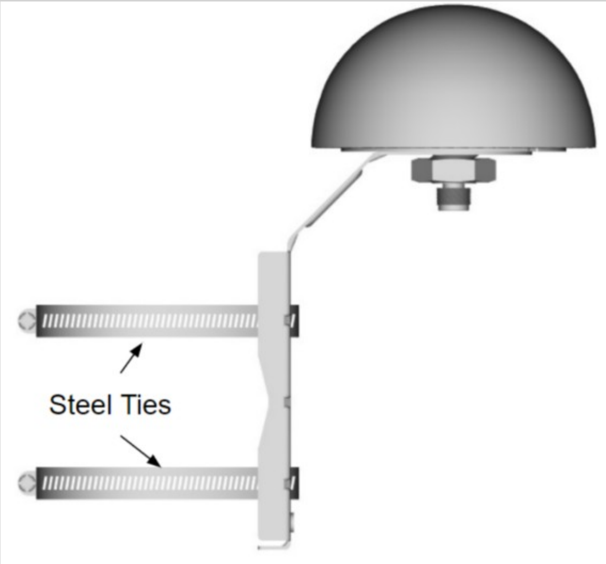


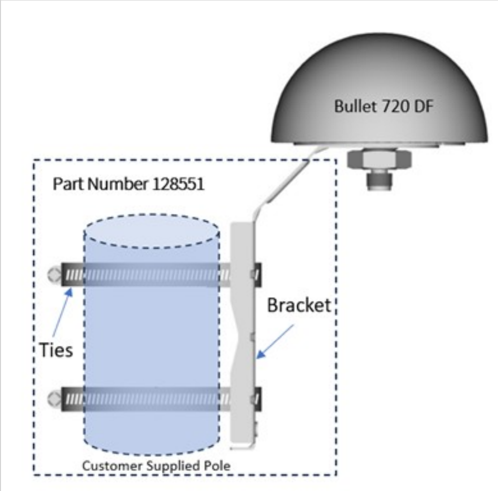
Figure 2: Bracket

Figure 3: Pole

Mounting The Bullet 720 DF Antenna

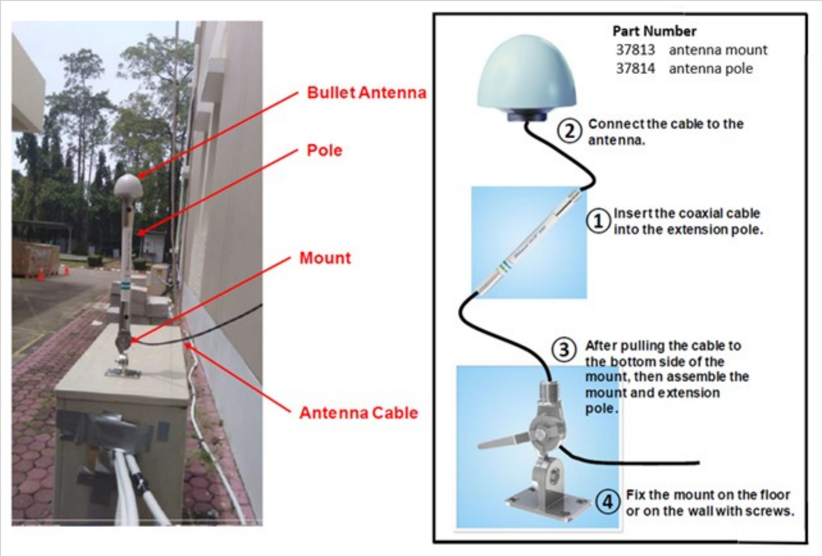
The Bullet 720 is a bulkhead mount antenna. It mounts through a hole in a bracket. A nut is placed on the other side to hold it in place. Please see the picture below of the bracket with the antenna mounted with a nut securing it in place.

Part Number 128551 consists of the bracket that you see and securing straps (Ties).



Mounting the Bullet SF Antenna

Bullet (360/40db/GG/etc.) form factor antenna



Roof Considerations

Here is an example of what needs to be considered for placing the antenna on a roof.

Nearby building obstructions, lighting rod and grounding.

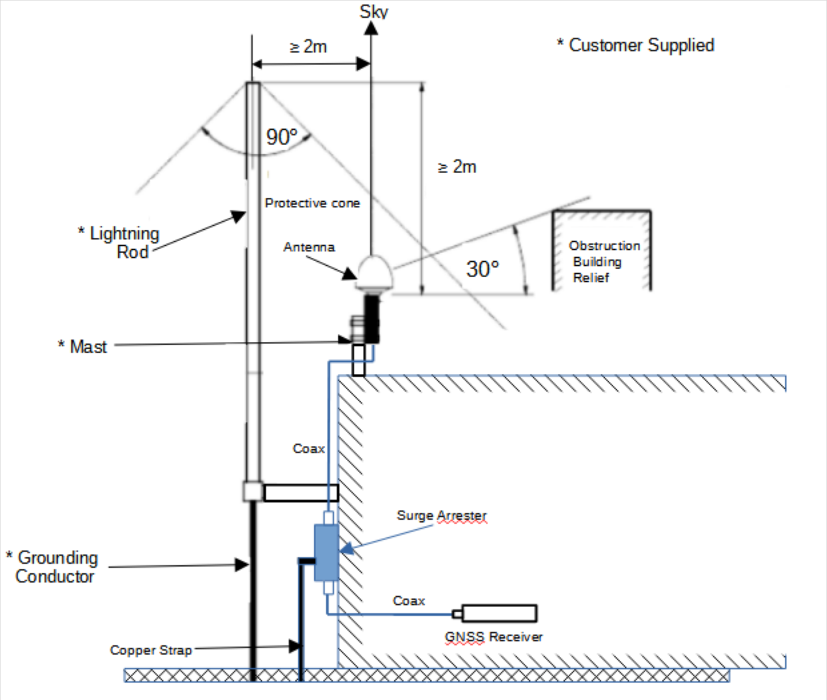


Figure 4

Good Sky Visibility

For the antenna to perform optimally, it needs to have good sky visibility. The satellites could be located anywhere in the sky.

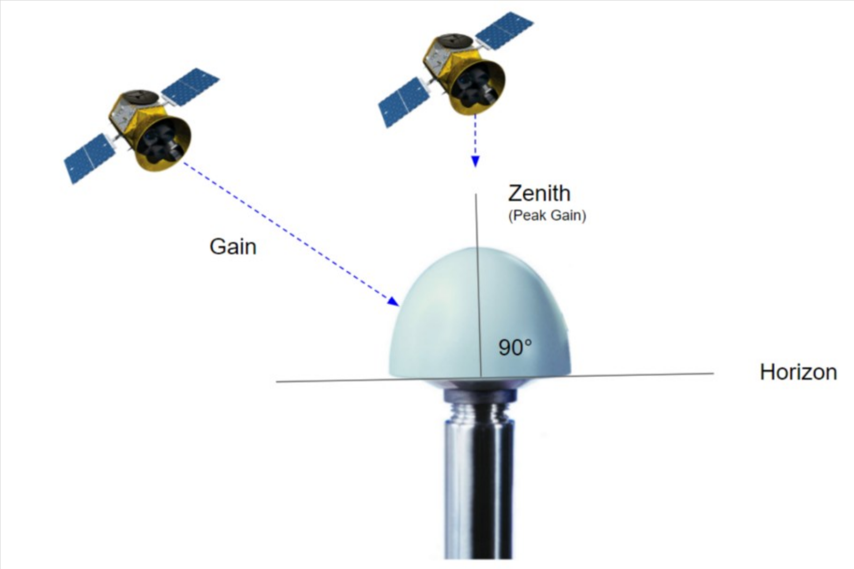


Figure 5

If the GNSS antenna does not have a clear view of the sky, multipath errors are possible. The signals should be received on a direct line of sight between antenna and satellite. The antenna should see as much as possible from the total sky. Seen from the northern hemisphere of the earth, more satellites will be visible in the southern direction rather than in northern direction. The antenna should therefore have open view to the southern sky. If there are obstacles at the place of installation, the antenna should be placed south of the obstacles, preferably, in order not to block sky-view to the south.

If the place of installation is in the southern hemisphere of the earth, then things are reversed – more satellites will be visible in the northern direction. Near the equator, it doesn't matter.
Partial sky visibility causes often poor performance due to the geometry of the visible satellites in the sky.

Multipath Reflections

GNSS signals can be reflected by objects, where metal, walls and shielded glass parts are pretty good reflectors. The antenna should not be placed near a wall, window or other large vertical objects.

Jamming

External RF sources can interfere with the GNSS receiver's ability to receive proper satellite signals, by causing the antenna's LNA and/or receiver front-end to saturate. Switching off all other equipment except the GNSS is a good way to detect jamming. By monitoring the satellite signal levels in this condition. Then switch on other equipment and see if the signal levels go down. A drop in signal levels indicates interference of GNSS with other equipment. This method can, however, not detect all possible kinds of jamming.

Spurious events are hard to catch. Low frequency fields, like 50Hz, are unlikely to jam the receiver. Broadband sparks are a potential source of spurious jamming. It is not possible to standardize a test scenario because the effect of jamming is highly depends on the nature of the jamming signal.

Ground-Plane

A big metal plate under the receiver can block signals (reflections) from below. This is a good method to improve the robustness against reflections, if the receiver is mounted on high masts or other elevated places.

Surge Protection

Lightning protection shall be mounted at the place where the antenna cable enters the building. In case of a rooftop antenna, you'll need a coax surge arrester, similar to the devices used for Satellite antenna installations.

Rooftop antenna installation should only be made by experienced electricians, who are familiar with the local regulations and standards. Not following these regulations may lead to legal actions and rejection of insurance coverage in case of damage from lightning. The lightning protection requirements depend on the type of building, for example, between residential buildings versus office buildings versus safety critical buildings such as hospitals.

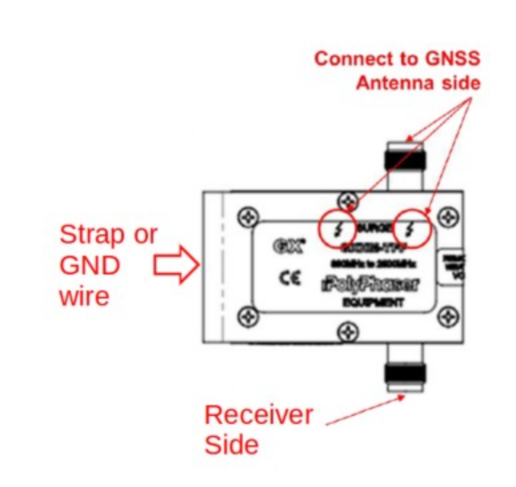


Figure 6

Grounding

The antenna's ground conductor provides a path of least resistance for transients or high currents in an event of a Lightning strike.

A surge arrester should be used and will protect equipment inside the structure. It should also be connected to earth ground as shown in Figure 4.

Powering the Antenna

GNSS antennas are active, they need power for the internal LNA. Depending on the antenna, you need to supply 3.3 or 5V. Usually, circuitry on the GNSS receiver supplies the LNA power through the coax cable.

If you are using an RF Splitter, make sure only one of the GNSS receivers is powering the GNSS antenna. You can use a DC Block for this.

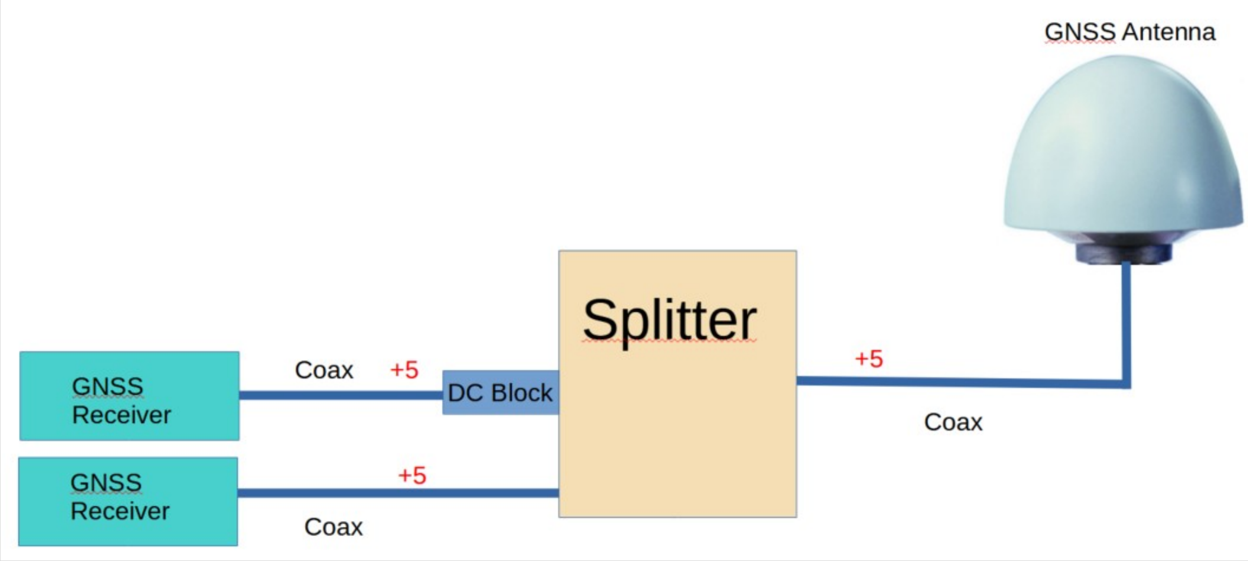


Figure 7

Coax Cable Considerations

Calculating Signal loss

To ensure proper GNSS signal strength you need to calculate the cable loss.
Figure 8 shows cable types appropriate for different cable lengths.

RF Gain at the GNSS Receiver:
GNSS Antenna Gain - (Surge Protector + adapters + Cable loss) ≥ 20dB

Example:

Bullet 40dB(40dB) – [Surge Protector(1dB) + adapter(0.5dB) + RG58_30m(19.2dB)] = 19.3dB

Typical dB loss values by Cable type:

Cable type	dB / 100 ft	dB / 100 meter	Max length for 18 dB loss at 1575 MHz (feet/meter)
RG8 (and 8/U)	9.6	31	185/58
RG-8X	16.8	55	107/33
RG-58	19.6	64	92/28
RG-59	14.7	48.2	122/37
LMR-400	5.3	17.2	340/105
LMR-600	3.4	11.2	530/161

Figure 8

Calculating Cable delay

Absolute PPS accuracy is the delay introduced by the antenna cable. For long cable runs, this delay can be significant. For the best absolute PPS accuracy, adjust the cable delay to match the installed cable length (check with your cable manufacturer for the delay for a specific cable type).

Typical delay with RG-59 is around 4.07 ns/m. If the cable run to the antenna Is 9.85m you need to compensate the receiver with an antenna delay of:

*Coax delay = 9.85m * 4.07 ns/m = 40 ns*
** This value should be entered at the receiver to compensate for this delay*

Figure 9 is showing an example of adjusting the antenna cable delay in a Protempis GM200.

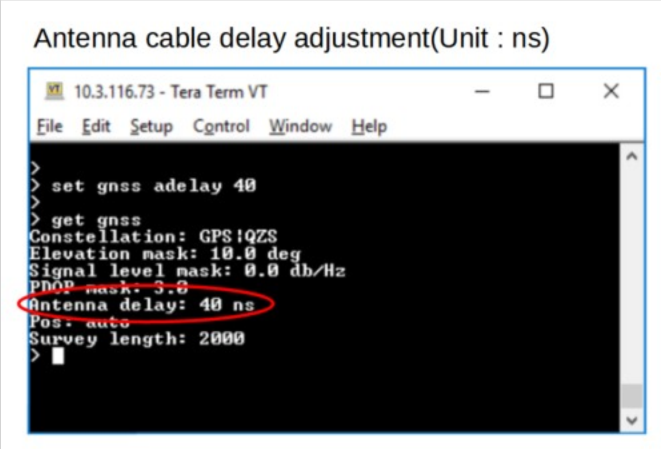


Figure 9

Location Examples

Good Location

Here is an example of a good place for the antenna in an urban environment surrounded by tall buildings.

Figure 10

The antenna is on the mast with the best practical sky view, and not in the beam of any transmit antenna, It could have been a bit higher on the mast for more distance away from other RF equipment, but this is generally a good place.

Cautious Location

Here is example of a location where you need to be cautious, there are 4G and 5G cellular transmitters nearby. As shown in Figure 1, the antenna needs to be at least 3m away from a transmitter.

Figure 11: Cautious Example

Use Starter Kit to Test Antenna

You can use the RES/ICM 720 starter kit to test a location, cabling or antenna placement. The kit can be used with the free VTS software. The software will identify satellites in the area and the quality of the signals. There are also antenna alarms to help detect problems with the antenna and cabling.

Figure 12

Using Kit's VTS software

Here is an example of the features that the software provides. With the features displayed in Figure 13, you can determine the following:

- Receiver Mode – In this case the receiver is in Over Determined mode
- Satellite Signal Strength
- Alarm Status

Use Monitor & Alarms

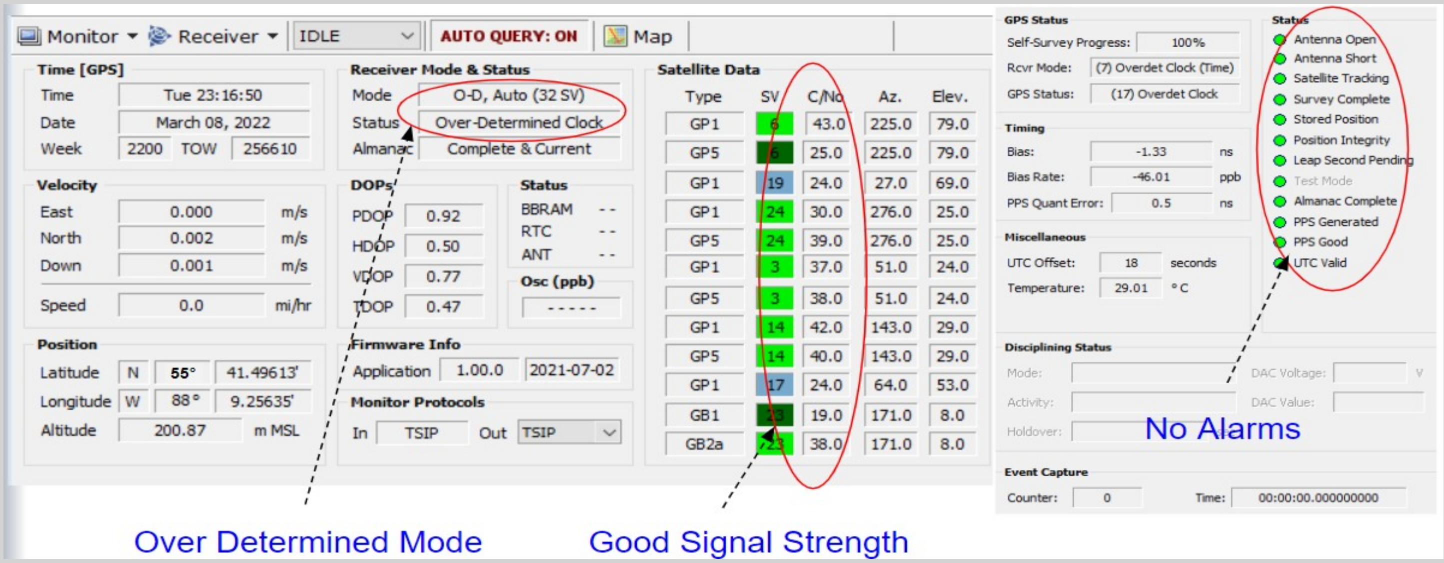
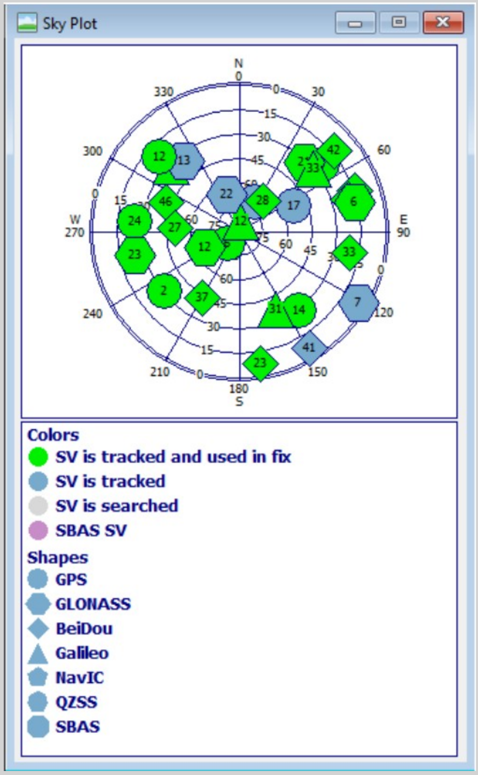


Figure 13: Receiver Status and Alarms

Use Sky Plot to view Satellites

This feature displays the satellites that are being tracked, the constellation and if the satellite is being used in the calculation.



The Timing GNSS Operation

Start-up

- When the receiver is turned on, it automatically begins to acquire and track GNSS Satellite signals.
- It usually obtains its first fix in under one minute.
- During the satellite acquisition process, the receiver module outputs periodic TSIP status messages.
- These status messages confirm that the receiver is working.

Automatic operation

- When the receiver has acquired and locked onto a set of satellites that pass the mask criteria and has obtained a valid ephemeris for each satellite, it performs a self-survey.
- After 2000 position fixes the self-survey is complete.
- The position is saved to memory.
- At that time, the receiver automatically switches to "Over Determined" (OD) mode.