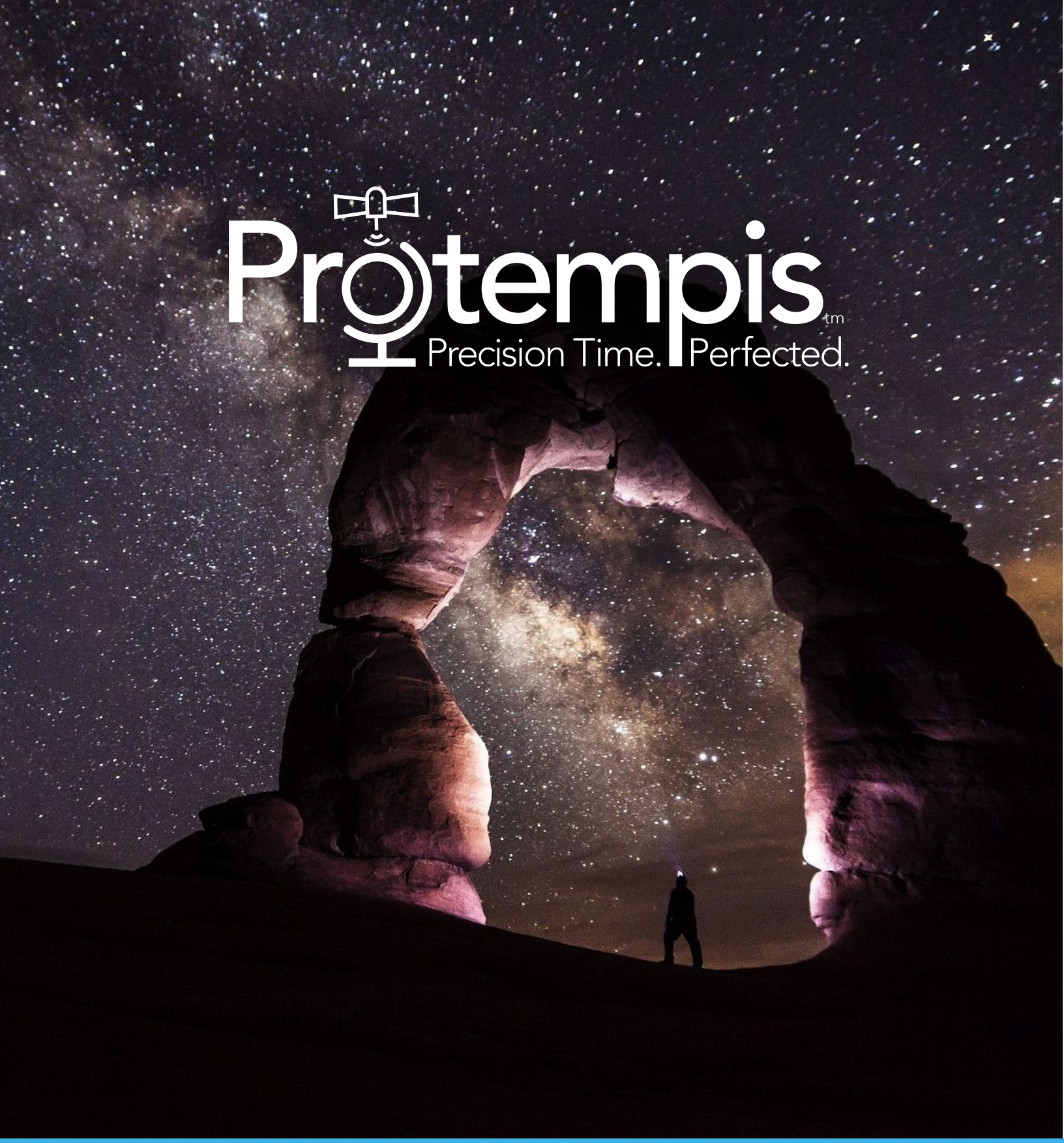


# Antenna Installation Guide for Timing Receiver

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## Select Antenna Location

The GNSS antenna is designed for a pole or bracket mount

- 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  he antenna as far as possible from transmitting antennas, including radars, satellite communication equipment, and cellular and pager transmitters.

## Near a Radar Installation

- When locating the antenna near a radar installation, ensure that the antenna is positioned outside of the radar'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 satellite 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.

# Antenna Mount

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

*Figure 1: Bracket*

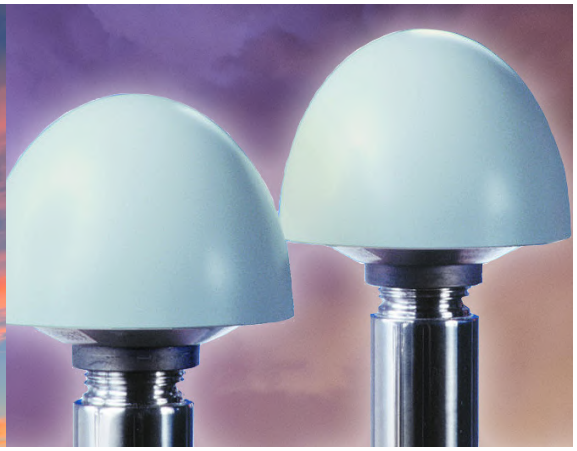


*Figure 2: Pole*

# Antenna Placement

It's very important that you survey the area for your antenna placement for any metal objects or RF transmitters.

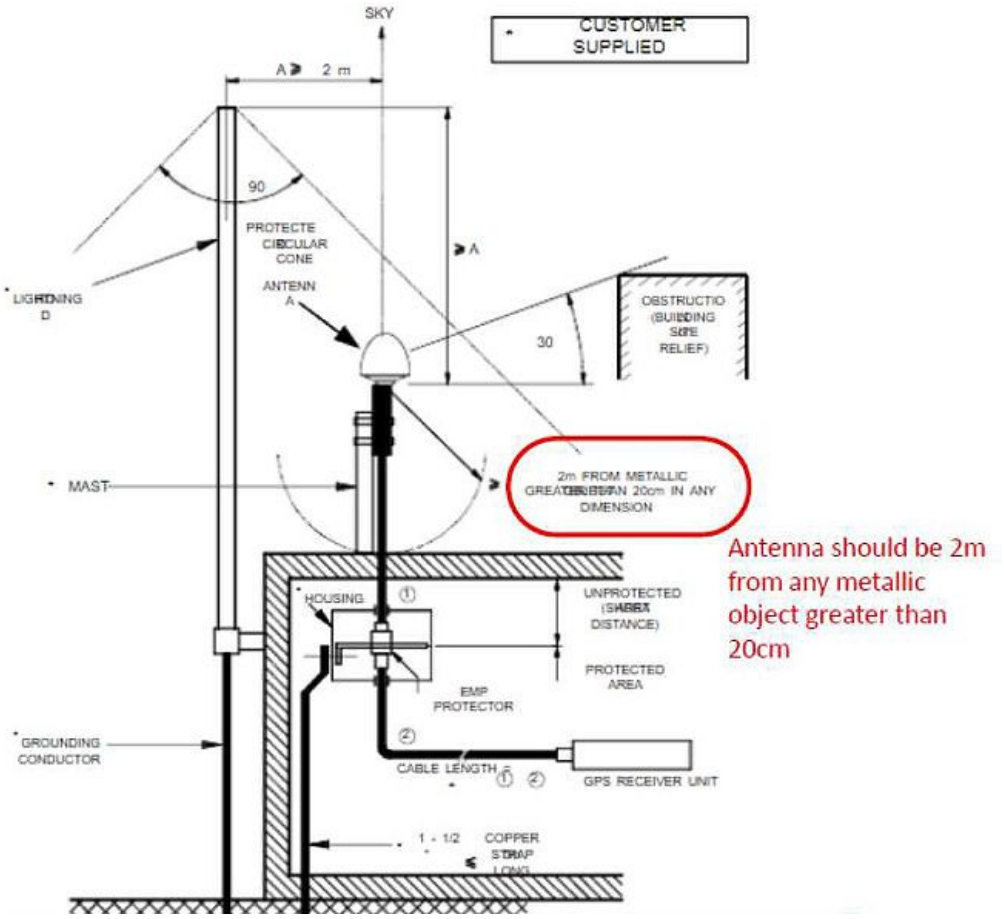

*Figure 3: Placement*

GNSS Antenna should be at least 1 meter away from any metallic objects to avoid multi-path reflections.

GNSS Antenna should be at least 2 meters away from any RF generators to avoid signal interference.

# Antenna Installation

Here are other issues to consider. Nearby building obstructions, lighting rods and grounding.




*Drawing 1: installation*

# Good Sky Visibility

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

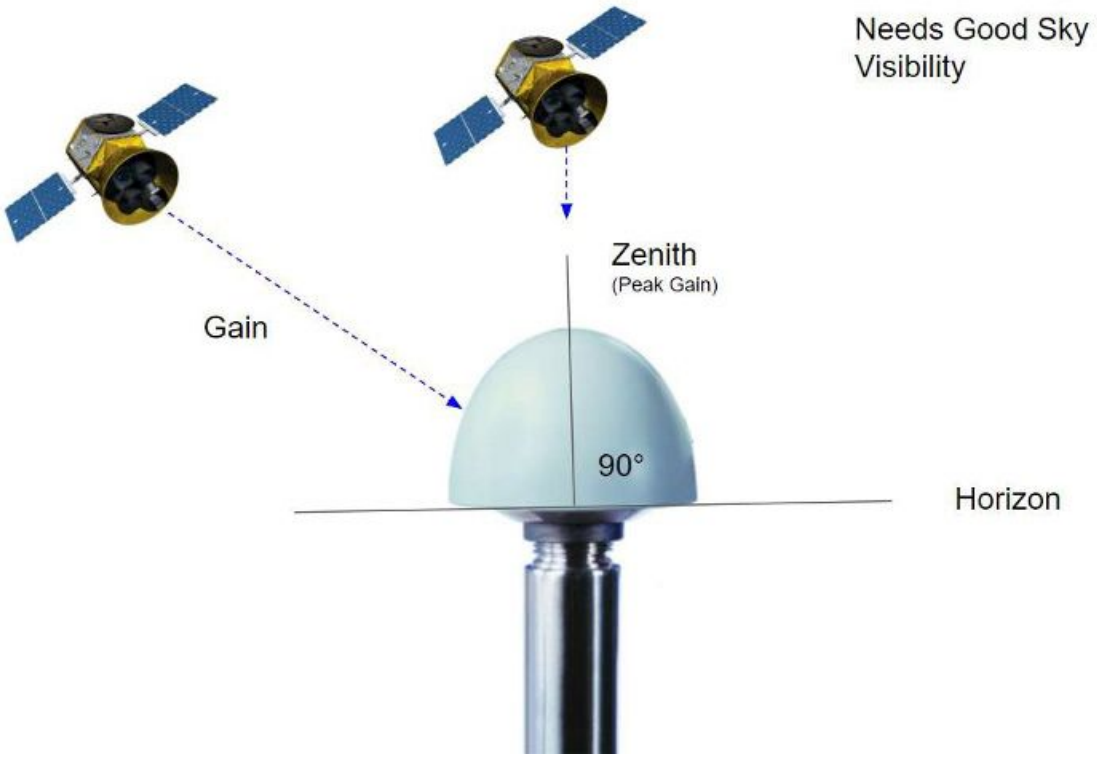



*Figure 4: Good Sky Visibility*

## Good Example

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

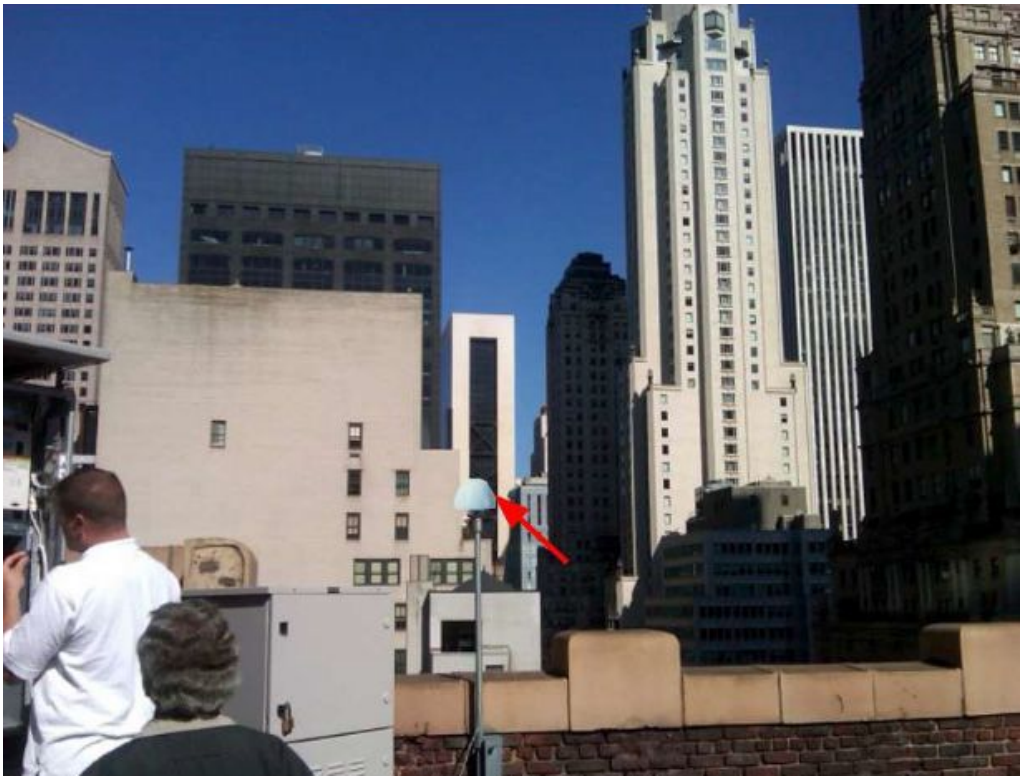


*Figure 4: Good Sky Visibility*

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.

## Bad Example

Here is an example of a bad location, there are 4G and 5G cellular transmitters nearby.


*Figure 6: Bad Example*

This location would be too close to transmitting antennas.

# Use Starter Kit to Test Antenna

To test a location, cabling or antenna placement. It is recommended you use the RES/ICM 720 starter kit. 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 7: RES/ICM Starter Kit*

# The Timing GPS 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.

# Starter Kit Using VTS Software

Here's an example of the featurfes that the software provides:

## Use Monitor & Alarms

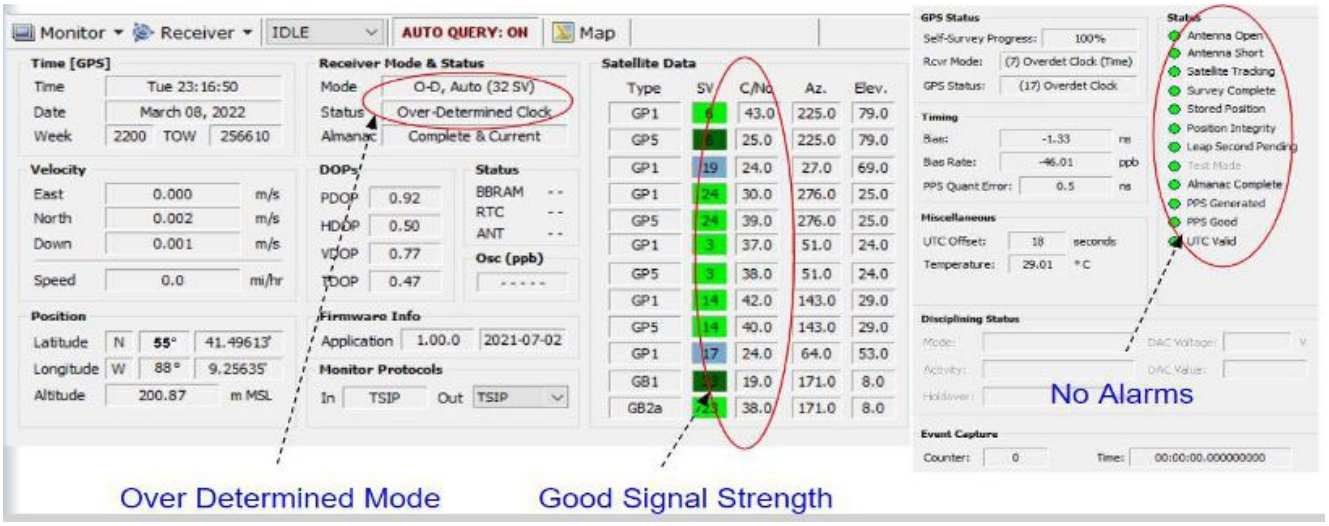



*Figure 8: Receiver Status & Alarms*

# 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.

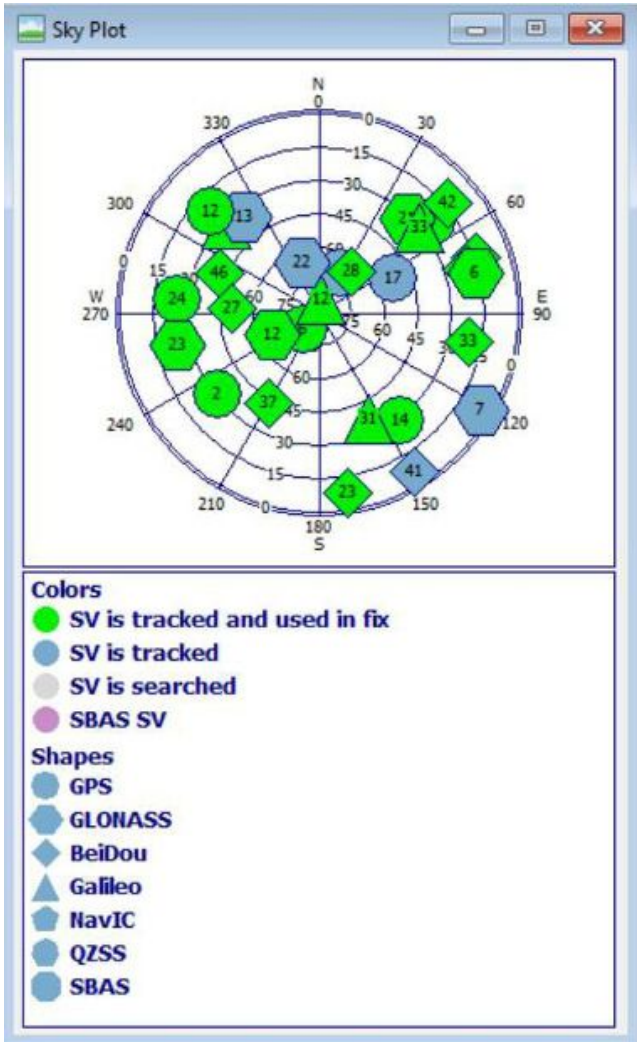



*Figure 9: Satellite Status*

## Satellite Masks

- The receiver continuously tracks and uses any enabled L1 or LS satellite that has been configured by 0x91-01 command, in an OD clock solution. The satellites must pass the mask criteria to be included in the solution.

- The following table lists the default satellite masks used by the receiver. These masks serve as the screening criteria for satellites used in fix computations and ensure that solutions meet a minimum level of accuracy.

| Mask Elevation | Setting | Notes |
|---|---|---|
| Elevation | | SV Elevation Above Horizon |
| C/No | 30 | Signal Strength |
| PDOP | 06 | Self-Survey Only |

## Elevation Mask

- Satellites below 5° elevation are not used in the solution. Generally, signals from low elevation satellites are of poorer quality than signals from higher elevation satellites.

- These signals travel farther through the ionospheric and tropospheric layers and undergo distortion due to these atmospheric conditions.

## CNO Mask

- If the receiver antenna has a clear view of the sky (outdoor Antenna Installation Guide), a CNO mask of 35dB-Hz is recommended for optimal results.

- However, for indoor use or operation with an obscured view of the sky, the mask must be low enough to allow valid weak signals to be used. For indoor operation, an CNO mask of 0dB Hz (zero) is recommended.

- Low SNR values can result from low-elevation satellites, partially obscured signals (for example, dense foliage), or multi-reflected signals (multi-path).

## PDOP Mask

- Position Dilution of Position (PDOP) is a measure of the error caused by the geometric relationship of the satellites used in the position solution. Satellite sets that are tightly clustered or aligned in the sky have a high PDOP and contribute to lower position accuracy.

- For timing applications, a PDOP mask of 6 offers a satisfactory trade-off between accuracy and GNSS coverage.

- Note - PDOP is only applicable during self-survey or whenever the receiver is performing position fixes.

# Antenna Commissioning

The steps described on the next slides will allow you to determine if the GNSS receiver is able to produce a reliable PPS by:

- Making sure the received signal strength is adequate.
- Determines that the GNSS receiver completes the self survey.
- Ensures the position has been stored.
- Determines that the GNSS receiver stays In OD (over determined mode).
- Tests that the system Is stable and available for a 24 hour period.
- Connect the GNSS antenna to the receiver.
- Apply power to the GNSS receiver.
- Monitor the 0x10-A3-11 packet, byte 6.
- While the GNSS receiver is in Self Survey Mode the value will be 0x03.
- While the GNSS receiver is in OD Mode the value will be 0x06.
- Monitor the 0x10-A3-00 packet, bytes 6-9 for 24 hours
- During the first 40 minutes of operation some bits will be set high.

**This is because the following needs to be achieved:**

- Find and track satellites to get a fix
- Collect an Almanac
- Complete the Self Survey
- Save surveyed position

- After 40 minutes (depending on GNSS coverage) all bits of byte 6-9 should be 0.
- Possible exception is bit 1 for Short Alarm if using external antenna power. Also bit 2 maybe set if a leap second is due for an update.

**0x10-A3-00 packet, bytes 6-9 bit description**

Bit 0 - Antenna Open

Bit 1 - Antenna shorted

Bit 2 - Leap second pending

Bit 3 - Total almanac status:

1 - almanac incomplete.

0 - almanac complete.

Bit 4 - Survey in progress

Bit 5 - GPS almanac status

Bit 6 - GLONASS almanac status Bit 7 - Beidou almanac status

Bit 8 - Galileo almanac status

- Monitor the 0x10-A3-11 packet bytes 6 and 7 for 24 hours.After the receiver has had time to transition to OD mode these bytes should always be 6 and 0xFF respectively.

# Check List

Here is list with recommended areas to check to make sure your antenna will operate correctly.

| Action | Yes | No | Comment |
|---|---|---|---|
| Antenna in clear view of sky | | | |
| 0x10 A3 bytes 6 9 (Minor Alarms) | | | Describe and account for any bits left at 1 |
| Bit 0: Antenna open = 0 | | | Check antenna connection if = 1 |
| Bit 1: Antenna shorted = 0 | | | Check for short (maybe "1" if using external power) |
| Bit 2: Leap second pending | | | is set to "1" to provide notice that a leap second is to be added in the near future<br>Check with the constellation authority for latest leap second status information.<br>For instance GPS is at https://www.iers.org/IERS/EN/Publications/Bulletins/bulletins.html |
| Bit 3: Almanac not complete = 0 | | | Almanac complete for all tracked constellations. Wait for 15 minutes after the first fix for this bit to clear from "1" to "0" |
| Bit 4: Survey-in progress = 0 | | | Should be "1" for 40 minutes after first power up, then "0", may take longer in poor coverage |
| Bit 5 - GPS almanac status | | | GPS almanac available if constellation is tracked. |
| Bit 6 - GLONASS almanac status | | | GLONASS almanac available if constellation is tracked. |
| Bit 7 - Beidou almanac status | | | Beidou almanac available if constellation is tracked. |
| Bit 8 - Galileo almanac status | | | Galileo almanac available if constellation is tracked. |
| 0x10-A3 bytes 14-17 (Major Alarms) | | | |
| Bit 0 - Not tracking satellites | | | Check for adequate view of sky |
| Bit 1 - PPS bad | | | If not zero then investigate presence of other alarms and RF signal quality |
| Bit 2 - PPS not generated | | | If not zero then investigate presence of other alarms and RF signal quality |
| Bit 3 - Bit 6 - Reserved | | | Reserved |
| Bit 7 - Spoofing/multipath | | | Check for sources of signal reflection in particular areas with high buildings |
| Bit 8 - Jamming | | | Check for nearby source of jamming signal (radar, microwave etc). |
| 0x10-A3-11 byte 6 | | | |
| Automatic = 3 | | | Should be 3 while doing self survey if not check antenna position |
| Have GPS time fix (OD mode) = 6 | | | Should be 6 while in OD mode if not check antenna position |
| 0x10 A3 11 byte 7 | | | |
| Doing position fixes = 0 | | | Should be 0 while doing self survey if not check antenna position |
| Have GPS time fix (OD mode) =FF | | | Have GPS time fix (OD mode) |

*Table1: Checklist*

- Except for bits 2 and 3 of 0x10-A3, bytes 6-9 all other parameters should be able to maintain a zero value for a period of over 24 hours.

- Bits 0, 1, 2, 7,and 8 of 0x10-A3 bytes 14-17 should also remain zero value.

- If there is a problem and there is a non zero value then the antenna position needs to be changed for a better GPS signal.