

T-Series NTP Network Time Server

GPS/GNSS Antenna Installation Guide

Models Covered: T100, T300, T550

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The latest version of this user guide can be obtained from TimeToolsLtd.com.



WARNING:

Comply with all health and safety standards when installing a GNSS antenna.

Do not work at heights without a fall protection device.

Do not install or maintain the antenna or cabling when there is a risk of lightning or electrical storms.



CAUTION:

Before installing and configuring any T-Series NTP server appliance, please read the manuals and retain for future reference. Please follow all instructions and heed all warnings.

Full product documentation can be found at TimeToolsLtd.com.

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Revision History

Date	Doc. Rev.	Changes
27-Jan-17	T1202-01	Initial release.
18-Nov-20	T1202-02	Updated surge-suppressor and coaxial cable grounding installation instructions.

1. Introduction

A good antenna, together with a good installation, is vital for getting the best performance from a GPS/GNSS receiver. This guide explains the requirements for the antenna and provides recommendations for a good installation.

The T-Series NTP Server has an integrated GPS/GNSS receiver. An external antenna provides synchronisation with global navigation satellite systems. GPS/GNSS solutions can be utilised anywhere in the world.

Ideally, the GPS antenna should be roof mounted with a 360-degree unobscured view of the sky. As a rule of thumb, the better the view of the sky, the more chance of a good consistent signal lock. However, satisfactory operation can often be achieved by citing the antenna on the side of a building, on a window sill or in some circumstances indoors.

2. Antenna Types

The antenna receives the GNSS satellite signals and amplifies them for transmission along a coax cable to the receiver. The GNSS signals are spread spectrum signals in the 1551MHz to 1614MHz range and do not penetrate conductive or opaque surfaces. Therefore, ideally, the antenna should be located outdoors with a clear view of the sky.

TimeTools supplies two different types of antenna with T-Series NTP servers:

T-3040	Permanent-Mount GPS L1 Antenna	- T100 and T300 models.
T-3740	Permanent-Mount Multi-Constellation Antenna	- T550 model.

2.1. T-3040 Permanent-Mount GPS L1 Antenna (T100, T300 models)

The T-3040 Permanent Mount GPS L1 Antenna is supplied with T100 and T300 models.

The antenna is a professional grade, permanent mount GPS L1 antenna, specially designed for professional precision timing applications. The T-3040 features a custom high performance, wide band patch element, a 40dB gain LNA stage and a high rejection out-of-band SAW filter. It provides ± 10 MHz bandwidth centred on 1575.42 MHz and covers the GPS L1 and SBAS (WAAS/EGNOS/MSAS) signals, and it provides great axial ratio, excellent circular polarized signal reception, great multipath rejection and great out-of-band signal rejection.

The T-3040 is housed in a permanent mount industrial-grade weather-proof enclosure.

2.2. T-3740 Permanent-Mount Multi-Constellation Antenna (T550 models)

The T-3740 Permanent Mount Multi-Constellation Antenna is supplied with T550 models.

The T-3740 is a precision high gain multi-GNSS antenna covering the BeiDou B1, Galileo E1, GPS L1, GLONASS L1 and SBAS (WAAS, EGNOS, QZSS & MSAS) frequency band (1557 to 1606 MHz). It provides truly circular polarized signal reception through the entire bandwidth of the antenna, thereby providing superior multipath signal rejection. It is especially designed for precision timing applications.

The T-3740 features a three stage Low Noise Amplifier, comprised of one input LNA per feed, a mid section SAW to filter the combined output, and a final output gain stage.

The T-3740 is housed in a permanent mount metal base with two nickel coated nuts and a weatherproof enclosure.

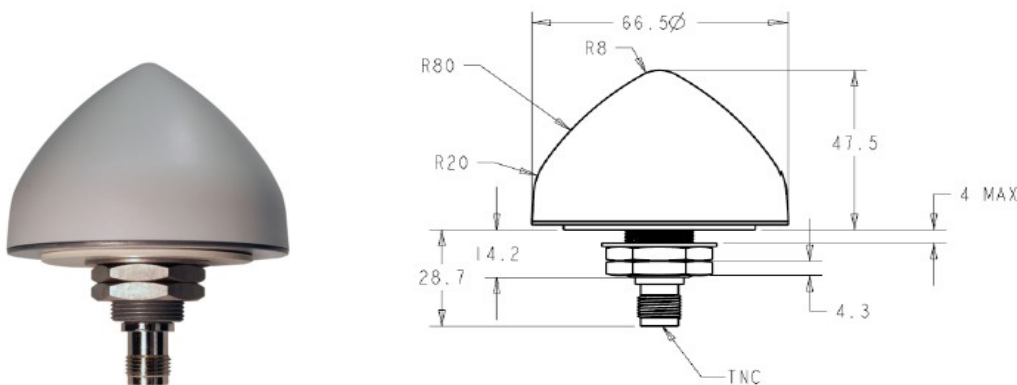


Fig. T-3040 and T-3740 Antenna and Dimensions.

2.3. Mounting bracket (T-3070/T-3740 Antennas)

TimeTools provides a mounting bracket for use with T-3070 and T-3740 antennas. The bracket can be used to mount the antenna to a vertical surface such as a wall or fascia. The mount is also supplied with a 1.5" V-bolt, which can be used to mount the antenna to a pole or mast, if required.

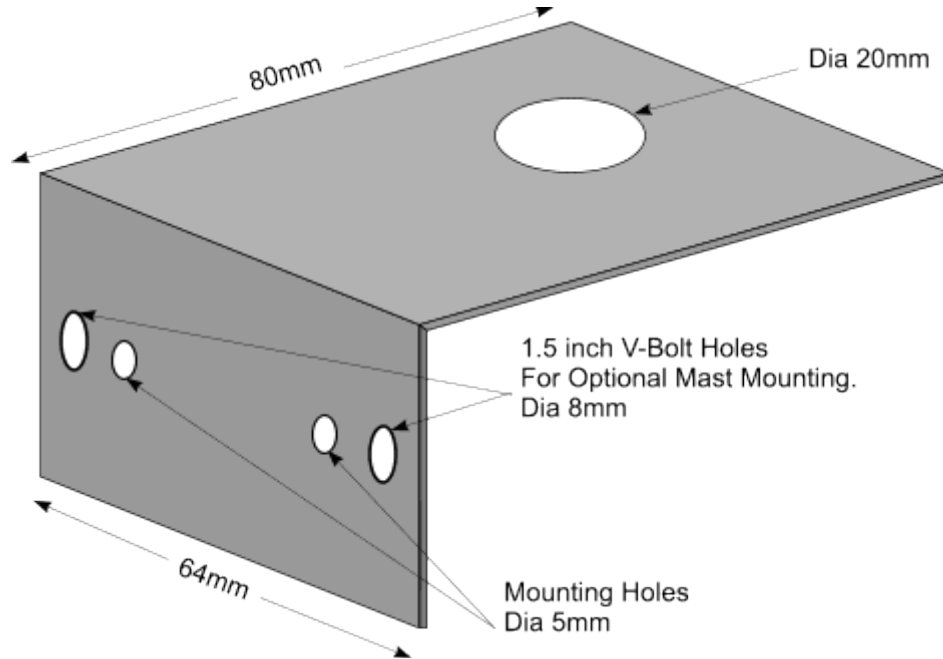


Fig. MT4-GPS Mounting Bracket – Supplied 1.5 inch V-Bolt Not Shown.

3. Antenna Placement

GNSS signals can only be received with a direct line of sight between antenna and satellite. The antenna should see as much as possible of 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 installation site, the antenna should be placed south of the obstacles, preferably, in order not to block sky-view to the south.

If the installation site is in the southern hemisphere of the earth, then the statements above are reversed – more satellites will be visible in the northern direction.

For installations near to the equator, satellites are visible directly overhead.

Partial sky visibility often causes poor Dilution of Precision (DOP) values due to the geometry of the visible satellites in the sky. If the receiver can only see a small area of the sky, the DOP has a high degree of uncertainty and will be worse compared to a condition with better geometric distribution. It may happen that a receiver is seeing 6 satellites, all close together, and still get a much worse DOP than a receiver which sees 4 satellites, but all in different corners of the sky. The receiver's DOP filter rejects fixes with high DOP (high uncertainty), therefore it can take longer to get the first acceptable fix if sky visibility is partly obstructed.



WARNING:

Any local installation regulations for rooftop antennas in the country where the antenna is installed must be observed.

4. Antenna Cabling

TimeTools can provide pre-terminated cables for use with GPS and multi-GNSS antennas.

Optional pre-terminated cable lengths of 10m, 30m, 50m and 100m are available for the T-3040 and T-3740 antennas, supplied with the T100, T300 and T550 models .

Customers are free to source and utilise their own cables, if required, provided TimeTools recommendations are observed.

4.1. Typical Minimum and Maximum Cable Length (T-3040, T-3740 Antennas)

GPS and multi-GNSS antenna systems utilise coax cable and are sensitive to both cable type and length. Coax cable and connectors with an impedance of 50 ohms should be utilised. The table below provides the minimum and maximum cable lengths for the T-3040 and T-3740 antennas, supplied with T100, T300 and T550 models.

Cable Type	Minimum Cable Distance	Maximum Cable Distance
RG58 C/U	7m	36m
LMR195	10m	50m
LMR400	30m	130m
LMR600	45m	210m

Table: Minimum and maximum cable lengths for T-3040 and T-3740 antennas (supplied with T100, T300, T550).

4.2. Routing Cable



CAUTION:

Be careful not to damage cable. Take care to avoid sharp bends or kinks in the cable, hot surfaces (for example, exhaust manifolds or stacks), rotating or reciprocating equipment, sharp or abrasive surfaces, door and window jambs, and corrosive fluids or gases.

4.3. Coax Cable Minimum Bend Radius

Modern coax cables can be quite easily damaged. Bending, stretching and kinks in the cable can affect the characteristics of the cable.

Observing the minimum bend radius for a cable can be critical to the correct installation of coax cables. This is especially so if the cable passes through walls or other structures.

In order to maintain the specified characteristics of the coax cable, each cable type has a recommended minimum bend radius. As a general rule, the minimum bend radius is five times the diameter of the cable. For a list of cable types and there associated minimum bend radius, please see the table below.

Cable Type	Minimum Bend Radius
RG58	26mm
LMR195	13mm
LMR400	26mm
LMR600	39mm

Table: Typical minimum bend radius of common cable types.

An installer must take care to only use moderate force on the cable, especially when feeding cables through walls and



other structures.

A particular weak spot is where the coax connector mates with the cable. Exerting force on the connector can not only damage the cable, but also damage the termination of the connector itself.

Where cable routing involves tight bends, it may be prudent to utilise a right-angle connector.

4.4. Connector Types

TimeTools GPS and Multi-GNSS systems utilise coax cable and connectors of 50 ohm impedance. Both cable and connector specification should have an operating frequency of at least 1575 MHz.

The T-Series NTP server and T-3040/ T-3740 antenna require a TNC type male connector on the attached cable.

Optional T-AD200-8 GPS amplifier and SPP-GPS surge suppressor require N-type male connectors on the attached cable.

Pre-terminated 100m cable (TCX-100) is terminated with N-type male connectors and is provided with N-type female to TNC male pigtails (short cable lengths of RG58 for converting N-type connectors to TNC).

4.5. Longer Cable Runs

Longer coax cable runs can be accommodated by the use of GPS amplifiers. Alternatively, GPS over fibre solutions can be provided to transmit GPS signals very long distances over optical fibre.

4.5.1. GPS Amplifiers

A GPS amplifier (T-AD200-8) is a small weather-proof device that is inserted in-line on the coax cable. The amplifier casing is 55 mm long and 41 mm in diameter. It requires no external power supply. The amplifier boosts the signals from the antenna to utilise longer cable runs.

Ideally, amplifiers should be located at equidistant intervals along the cable run. A single amplifier should be located at the mid-point of the cable length. If two amplifiers are utilised, one should be located at one-third of the length of the cable, the second at two-thirds.

Cable Type	Maximum Cable Distance with Single GPS Amplifier	Maximum Cable Distance with Two GPS Amplifiers
LMR400	250m	370m
LMR600	390m	570m

Table: Maximum cable lengths with amplifier for T-3040 and T-3740 antennas (supplied with T100, T300, T550).

TimeTools T-AD200-8 GPS amplifier requires N-type male connectors to be installed on connecting cables.





T-AD200-8 GPS in-line amplifier 20dB

4.5.2. GPS Over Fibre Solutions

For extremely long cable runs or in very secure environments, TimeTools GPS Over Fibre kit can be used to transmit GPS signals over optical fibre.

Please refer to TimeTools GPS over fibre kit data sheet for more information.

5. GNSS Antenna Surge Protection

Externally mounted antennas can be prone to lightning strikes and other electrical surges. The RF input of the T-Series is ESD protected, but not surge protected against external, larger, over voltage peaks. In order to arrest higher energy from lightning and other surges, a coax surge suppressor is required.



GPS Surge Suppressor (TimeTools Product Code: SPP-GPS)

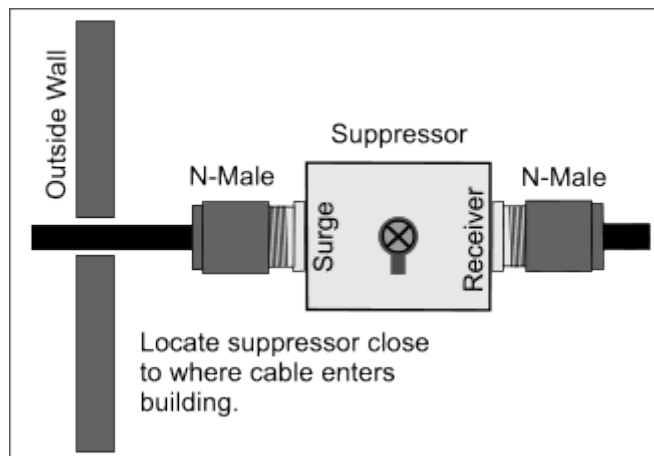
A surge-suppressor (Part: SPP-GPS) should be installed with all outdoor located antennas.

The surge suppressor provides surge protection and grounding of coax cables.

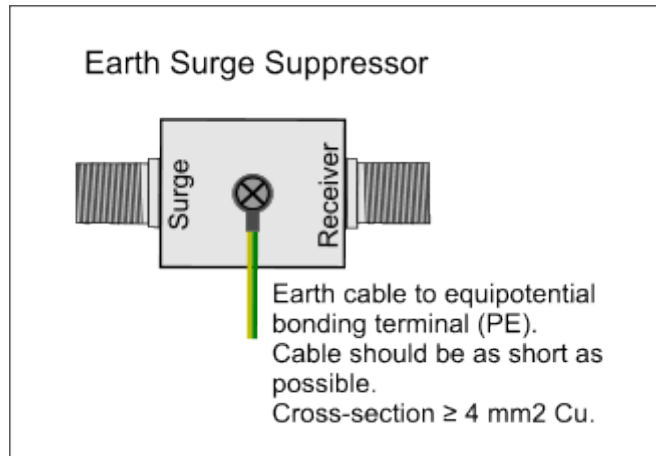
The SPP-GPS surge suppressor has a weather-proof enclosure. It is suitable for indoor or outdoor installation.

TimeTools recommends that the suppressor is fitted indoor, as close to where the coax cable enters the building as possible.

TimeTools SPP-GPS surge suppressor requires N-type male connectors to be installed on connecting cables.



Ground the surge-suppressor by connecting it to an equipotential bonding rail. The bonding conductor should be as short as possible and have a cross-section $\geq 4 \text{ mm}^2 \text{ Cu}$.



For more information about installing surge suppressors, see the manufacturers installation guide for detailed installation instructions on the PolyPhaser web site at: www.polyphaser.com.



WARNING:

Please refer to the surge suppressor manufacturers engineering specification and installation guide for further information on installation best practice.

5.1. Grounding Coax Cables

A surge-suppressor should be fitted to all outdoor located antennas.

If for any reason a suppressor is **NOT** fitted, then the coaxial cable shield must be grounded using a coax cable grounding kit. Most grounding kits clamp to an exposed section of the coax braid:

1. Select a straight cable section. Cut the cable sheath to expose a section of the coax outer braiding. Be careful to avoid damaging the coax braiding.
2. Remove the section of sheath. Clean the exposed coax outer conductor braiding to ensure a good electrical contact.
3. Open the contact clip of the Grounding-Kit carefully and place it over the the exposed braided outer conductor of the cable. Close the clamp and tighten the fixing screw. Ensure that the clamp tightly grips the coax outer braiding.
4. Fix the Grounding-Kit cable lug to an equipotential bonding terminal (PE). The DC resistance to the nearest point of equipotential bonding (PE) shall be lower than 5Ω .

6. Typical GPS/GNSS Installation

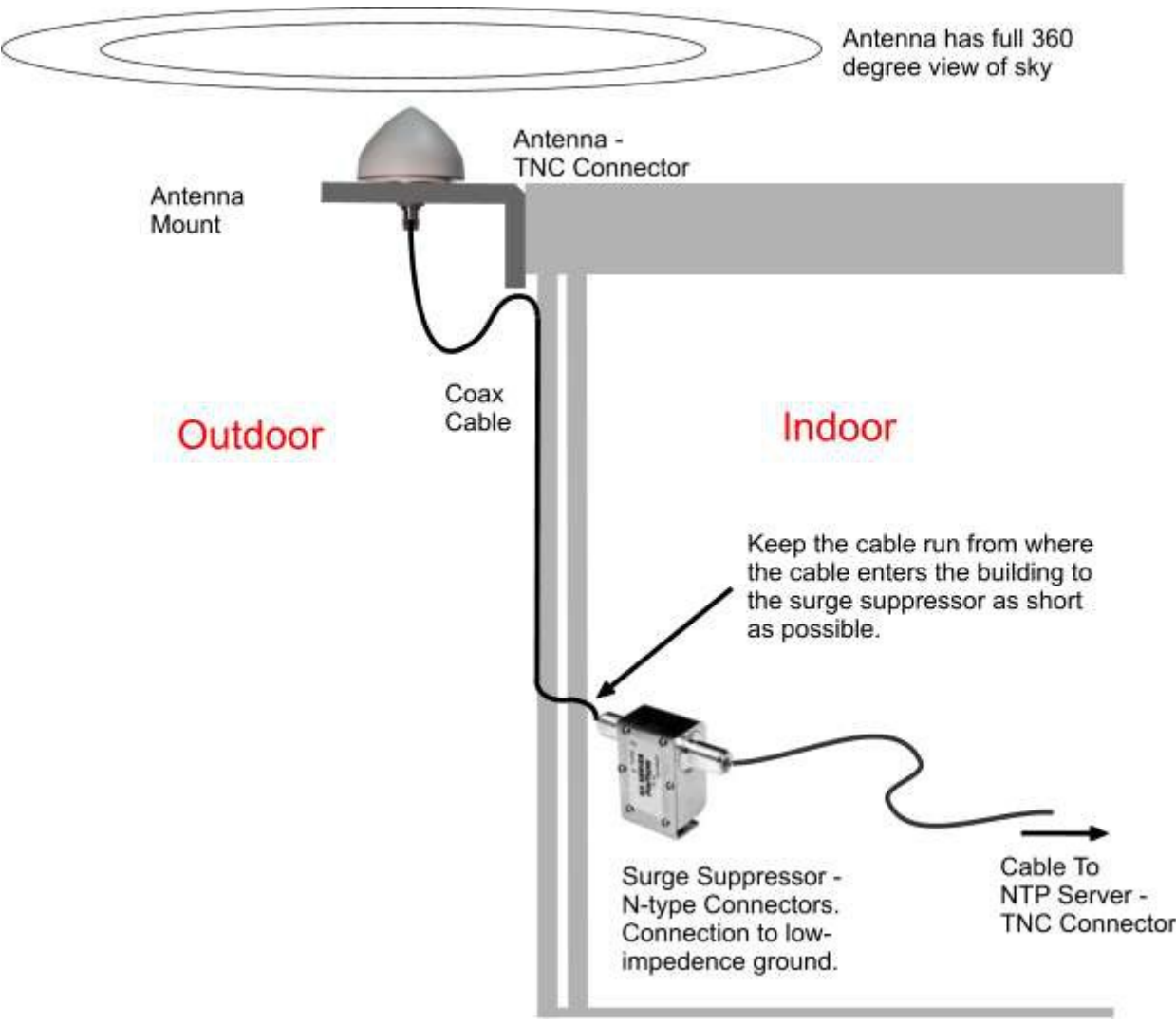


Fig: Typical Antenna installation



7. Indoor Operation

TimeTools T-Series NTP servers have cutting-edge high sensitivity GPS/GNSS timing receivers designed for static operation.

The receivers high sensitivity mode often allows GPS/GNSS signals to be received with an antenna located indoors or in a window. This can considerably reduce installation costs and potentially eliminate the need for surge suppression.

Additionally, the static operation mode allows the receiver to operate from a single-satellite-in-view allowing a signal lock to be obtained in highly challenging conditions.

Best performance is obtained from an externally mounted antenna with a good view of the sky. An indoor located antenna will adversely affect signal reception performance. However, adequate performance can often be achieved with the advantage of reduced installation costs.



INFORMATION:

GPS/GNSS signals do not penetrate conductive surfaces. Metal clad or metal framed buildings will require a window-mounted or externally-mounted antenna.

8. GPS/GNSS Receiver Site Survey and Signal Lock

At power-on, the T-Series GPS/GNSS receiver will “search the sky” in order to collect satellite orbital information. This process is fully automatic and, under normal circumstances, will take 3-4 minutes to achieve a signal lock. Additionally, the receiver needs to download almanac information from the orbiting satellites, which can take a further 10-15 minutes. However, it can take much longer in challenging reception conditions.

If powered on in a new location, the device will perform a self-survey by averaging 2000 position fixes, in order to calculate a very precise position. The self-survey will take approximately 30 minutes. Once a position has been calculated, it will be stored in memory for future use.



INFORMATION:

A GPS signal lock may take as long as 20-25 minutes, longer in challenging conditions. If powered up in a new location, a site survey will take, approximately, an additional 30 minutes.

8.1. Signal Lock Problems

Antenna OPEN/SHORT Detection

The T-Series contains advanced circuitry for monitoring the antenna supply status, providing current limiting in case of short circuit conditions of the antenna cable and protecting the receiver against surges on the RF input.

The T-Series status and configuration web pages provides antenna supply information along with detailed satellite status information, useful for installation debugging.

Multipath-reflections

Multipath occurs when the GNSS signals are reflected by objects, such as metallic surfaces, walls and shielded glass for example. The antenna should not be placed near a wall, window or other large vertical objects if it can be avoided.

Jamming

Jamming occurs when the receiver function is disturbed by external RF sources that interfere with GNSS signals or saturate the antenna LNA or receiver front-end. A good indicator to detect jamming is switching off all other equipment except the GNSS. Watch the satellite signal levels in this condition. Then switch on other equipment and see if the signal levels go down. A drop of signal levels indicates interference to GNSS from the other equipment.

This method cannot, however, detect all possible kinds of jamming. Spurious events are hard to catch. Low frequency fields, like 50 Hz, are unlikely to jam the receiver. Broadband sparks are a potential source of spurious jamming. There's no general installation rule or specification though, because the effect of jamming highly depends on the nature of the jamming signal and there are uncountable many variations possible, so that it's not possible to standardize a test scenario.

9. Tips and Trouble Shooting

Provided a GPS/GNSS antenna has a good view of the sky, generally, a signal lock should be achieved within a few minutes. However, in challenging conditions, such as indoor antenna location, or if the antenna has a much reduced view of the sky, it can take much longer to acquire a signal lock. In such circumstances, TimeTools recommends that the device be left for around 1 hour after power-up in order to try to achieve a signal lock.

**INFORMATION:**

Check the T-Series GPS status web page – if satellites are listed and they have a high SNR, then leave the device for at least one hour until it obtains a signal lock.

If after 1 hour the unit has still not achieved a signal lock, here's a few things to check:

1. GPS/GNSS systems utilise the global positioning system, which is a constellation of satellites orbiting the Earth. Therefore, ideally, an antenna should have the best possible view of the sky – ideally, 360 degrees.
2. If the antenna is located indoors, metal structures can block the weak GPS/GNSS signals and prevent a signal lock. Ensure the antenna is mounted away from metal frames, structures or enclosures. Also, sun-dimmed glass contains metal flecks that reflect sunlight and which also reflect GPS/GNSS signals which can cause problems.
3. Check the T-Series GNSS status web page to check for antenna open or short-circuit. The page also provides detailed receiver status information, satellites currently in view along with their associated 'signal to noise' ratio and position in the sky.
4. If available, a volt-meter can be used to check that approximately 5 volts is present at the GPS antenna connector between the inner pin and the outer shell of the TNC connector. If a voltage is not present, it indicates an open-circuit fault along the cable.
5. If a GPS surge suppressor is fitted, ensure it is fitted the correct way around, with the 'Surge' input going to the antenna and the 'Equipment' output to the time server.
6. Check the cable and connectors for any visible damage that may have occurred during installation, particularly where the cable has been fed through conduit or holes in walls.
7. If you have sourced your own cable and connectors, ensure that they are of the correct type and that cable is not too long or too short.