GPS6000-PRO

GNSS Time Receiver

User Manual

Version 1.0

worldtime
SOLUTIONS

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In the event of product failure due to faulty parts or workmanship within the warranty period, World Time Solutions Limited, at its own discretion, will either (a) repair the product, (b) supply a replacement product, (c) supply a functionally equivalent replacement product, or (d) refund the purchase price of the product.

The limited warranty will not apply if (a) the product has not been installed or operated as per our instructions, (b) the product has been modified in anyway.

In the event of failure, the GPS6000-PRO should be returned to the manufacturer for inspection and repair. Please visit our support pages for further details:

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TECHNICAL SUPPORT

To obtain help with the installation or operation of the GPS6000-PRO, please visit our web site at:

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1 - Introduction

1.1 - Overview

The GPS6000-PRO accurately synchronises your time server with international atomic standards. Incorporating the latest in GNSS technology and multi-constellation support *(GPS/GLONASS/Galileo ready)*, the GPS6000-PRO ensures accurate and reliable time on your systems, even in hostile RF environments.

With 32 satellite parallel tracking and class-leading high performance design, the GNSS decoder supplies time data accurate to within 30 nsec of UTC. The user programmable cable delay compensation ensures timing accuracy is maintained, even over long cable runs.

The system has been engineered to ensure reliable performance. The high sensitivity GPS6000 decoder allows for operation in the most demanding weak signal and hostile RF environments. The GPS6000 fully integrates with your time server, providing real time diagnostics and active antenna monitoring. Advanced anti-jam technology and multi-constellation support further increase system reliability.

Installing the GPS6000 is simple. All cables are supplied pre-terminated. The GPS6000 has also been purpose designed to allow cost saving installation into your data centre, optionally connecting to your time server via existing cat 5 structured cabling.

1.2 - Scope of supply

Scope of supply:

- 1 x multi-constellation GNSS anti-jam antenna

- 1 x multi-constellation GNSS decoder

- 1 x antenna mount

- 1 x lightning arrester

- 1 x 8m antenna coax cable

- 1 x 1m arrester coax cable

- 1 x 5m output cable

- 1 x user manual

1.3 - Options

- GPS6000-ANT-15: 15m *(49ft)* antenna cable

- GPS6000-ANT-25: 25m *(82ft)* antenna cable

- GPS6000-OUT-15: 15m *(49ft)* output cable

- GPS6000-OUT-50: 50m *(164ft)* output cable

- GPS6000-OUT-150: 150m *(492ft)* output cable

- GPS6000-PRO-GPS: GPS6000-PRO with GPS only support

- GPS6000-PRO-GLONASS: GPS6000-PRO with GLONASS only support

2 - The GPS6000-PRO in detail

2.1 - The GNSS anti-jam antenna

The GNSS antenna receives data from the GPS and GLONASS global navigation satellite systems. The antenna incorporates anti-jamming technology and is designed to withstand extreme temperature environments, excessive vibration, rain, snow and sunlight.
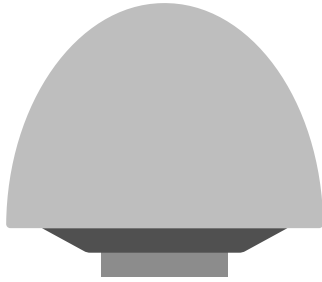

Figure 2.1 - The anti-jam antenna

2.2 - The GNSS decoder

The GNSS decoder converts satellite data into highly accurate time information. The cable delay offset function ensures timing accuracy is maintained over long cable runs.
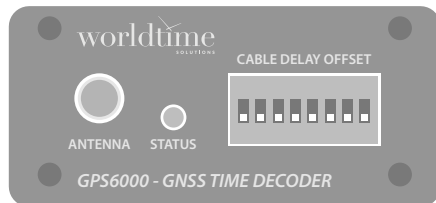

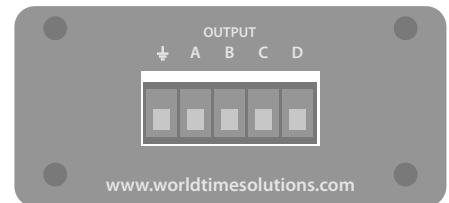
Figure 2.2 - The GNSS Decoder (front)

Figure 2.3 - The GNSS Decoder (rear)

2.3 - The lightning arrester

The multi-strike fast response lightning arrester connects between the antenna and the GNSS decoder. The lightning arrester protects the GNSS decoder and attached systems from damage due to a lightning strike.
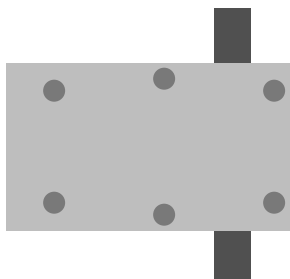

Figure 2.4 - The lightning arrester

3 - Installing the GPS6000

Installing the GPS6000-PRO is a straightforward procedure. All cables are supplied pre-terminated and no specialist tools are required. However, to ensure reliable and safe operation, care should be taken selecting appropriate locations for the GNSS antenna and lightning arrester.

Please follow the installation guidelines below to ensure a trouble-free installation.
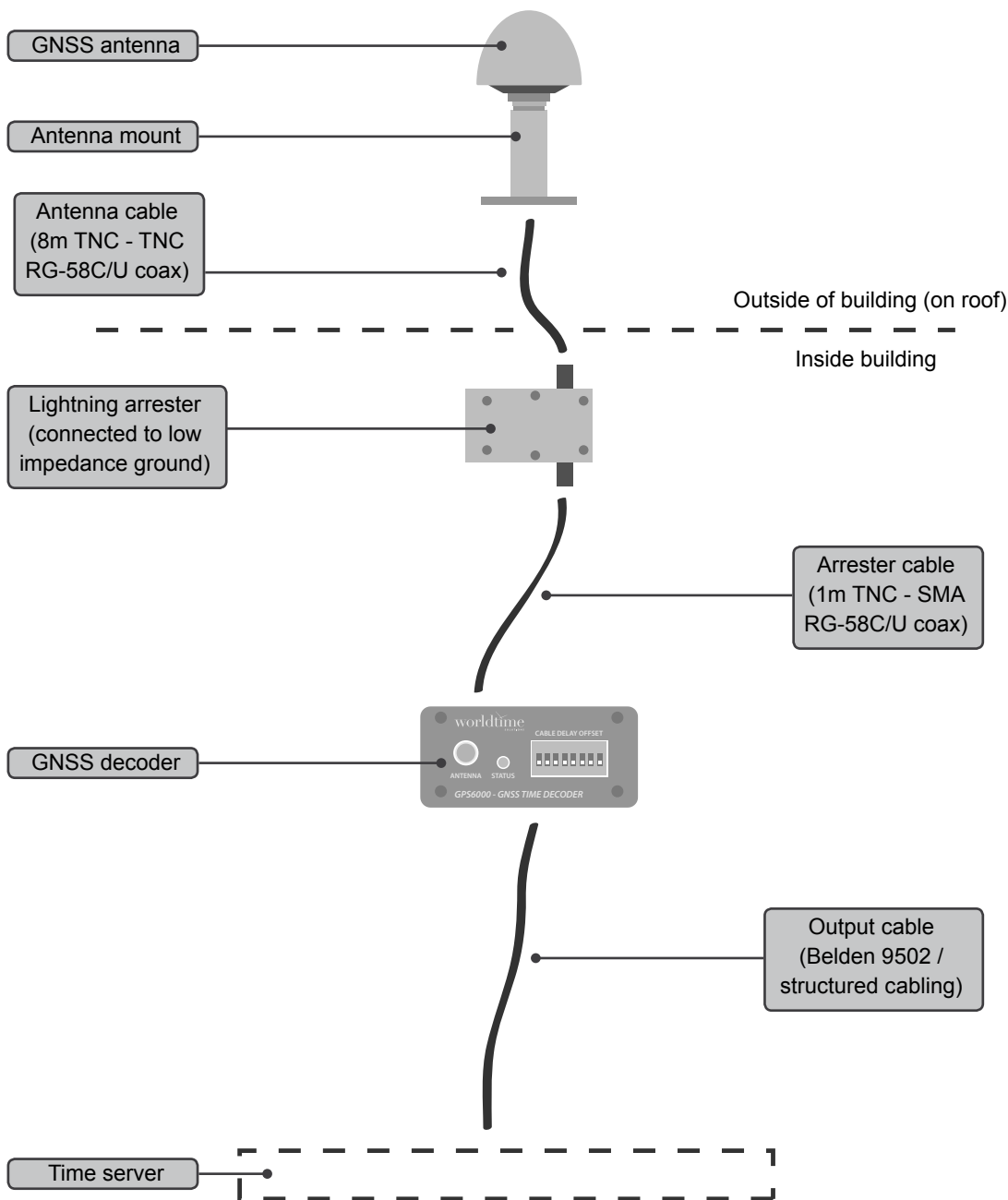
3.1 - System installation overview

Figure 3.1 - System installation overview

3.2 - Installing the antenna

3.2.1 - Selecting an installation location

The antenna should be installed externally, with the maximum possible sky visibility. For most installations, the ideal location will be the roof of your building *(the antenna is able to withstand extreme temperatures, excessive vibration, rain, snow and sunlight)*.

Ideally, the antenna should have a clear uninterrupted 360º view of the horizon. For installations where an unobstructed view of the sky is not practical, the antenna should be installed with as large a view as possible of the sky towards the equator. Installing the antenna with a substantially reduced view of the sky will degrade system performance and may increase synchronisation time.

3.2.2 - Mounting the antenna

The antenna should be mounted with the top of the dome facing directly upwards and secured using the stainless steel surface mount antenna bracket. Care should be taken to ensure the fixings used *(not supplied)* are suitable for the application. Figure 3.2 below details the antenna mount fixing dimensions.

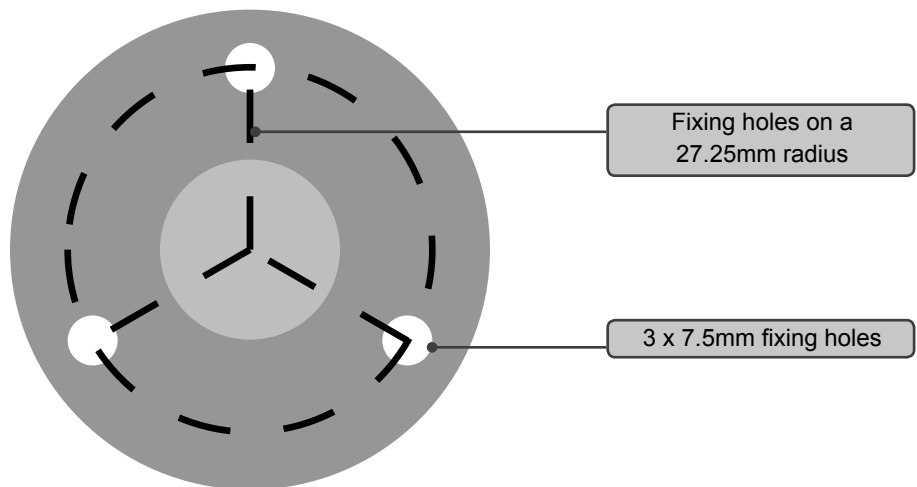Fixing holes on a 27.25mm radius

3 x 7.5mm fixing holes

Figure 3.2 - Antenna mount fixing dimensions

3.2.3 - The antenna cable

The GPS6000-PRO is supplied as standard with an 8m *(26ft)* pre-terminated RG-58C/U TNC to TNC coaxial cable for connection to the lightning arrester. Longer antenna cables are optionally available if required.

3.3 - Installing the lightning arrester

The multi-strike fast response lightning arrester connects between the antenna and GNSS decoder. The lightning arrester provides surge protection for the GNSS decoder *(and attached systems)* in the event of a lightning strike.

PLEASE NOTE: THE LIGHTNING ARRESTER MUST NOT BE INSTALLED EXTERNALLY.

The lightning arrester should be installed internally at the point where the antenna cable enters the building. It is important that the lightning arrester is grounded to a low impedance ground system for proper operation.

THE LIGHTNING ARRESTER IS SUPPLIED WITH A SEPARATE INSTRUCTION SHEET WITH FULL INSTALLATION DETAILS. PLEASE CONSULT THIS SEPARATE INSTRUCTION SHEET CAREFULLY WHEN INSTALLING YOUR LIGHTNING ARRESTER.

3.4 - Installing the GNSS decoder

3.4.1 - Mounting the GNSS decoder

The GNSS decoder converts the raw satellite data into highly accurate time information. The decoder should be installed internally, close to the output of the lightning arrester *(the system is supplied with a 1m (3ft) pre-terminated coaxial cable for connection between the lightning arrester and the GNSS decoder)*.

PLEASE NOTE: THE GNSS DECODER IS NOT SUITABLE FOR EXTERNAL INSTALLATION.

The decoder should be secured in position using the integral surface mounting brackets. Care should be taken to ensure the fixings used *(not supplied)* are suitable for the application. Figure 3.3 below details the enclosure bracket fixing dimensions.
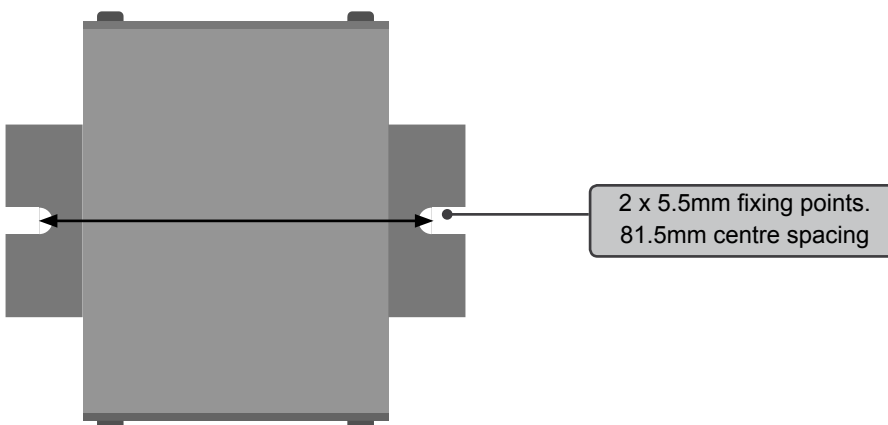
2 x 5.5mm fixing points.
81.5mm centre spacing

Figure 3.3 - GNSS decoder enclosure mounting dimensions

3.4.2 - Cable connections

The connection between the lightning arrester and the GNSS decoder should be made using the supplied 1m *(3ft)* pre-terminated RG-58C/U TNC to SMA coaxial cable.

The system is supplied as standard with a pre-terminated 5m *(16ft)* output cable for the connection between the GNSS decoder and your time server. Longer cables are optionally available if required. Alternatively, the output cable may be extended using Belden 9502 cable up to a maximum total length of 150m *(492ft)*. Table 3.1 details the cable colour scheme.

Terminal ID	Cable colour code
GND	Cable screen drain wire
A	Black / Red
B	Red
C	Black / White
D	White

Table 3.1 - Output cable connection detail

For low smoke/plenum applications, the supplied cable should be substituted for a Belden 82502 *(or equivalent)* type cable.

3.4.3 - Optional connection using structured cabling

To enable simple installation into a data centre or office complex, the GNSS decoder may be connected to your time server using category 5, category 5e or category 6 structured cabling.

Table 3.2 below details the suggested RJ45 / 8P8C pin connections. Using this configuration, cable lengths of up to 300m *(984ft)* may be used reliably.

RJ45 / 8P8C pin	T568A Colour	T568B Colour	GNSS decoder output pin
1	White / Green	White / Orange	A
2	Green	Orange	B
3	White / Orange	White / Green	A
4	Blue	Blue	D
5	White / Blue	White / Blue	C
6	Orange	Green	B
7	White / Brown	White / Brown	GND
8	Brown	Brown	GND

Table 3.2 - RJ45 / 8P8C structured cabling wiring detail

3.5 - The cable delay offset

The GPS6000-PRO is capable of providing time data accurate to within 30 nsec of UTC. At this level of accuracy, taking account of cable lengths becomes critical. Every metre of cable between the GNSS antenna and your time server causes an additional error of approximately 5 nsec *(see note over page)*. For long cable lengths, this accumulated error can become very significant.

The cable delay offset provides a simple solution to correct for errors due to cable propagation delays. The total cable length between the GNSS antenna and your time server is entered using the switch bank. The GNSS decoder then automatically advances the time data by the required offset to correct for the cable propagation delay.

GPS6000-PRO systems are supplied with the correct cable delay offset value pre-programmed. For a typical installation, this preset value should not need any adjustment. However, if required, the cable delay offset can be programmed using the following guidelines.

3.5.1 - Programming the cable delay offset

PLEASE NOTE: THE PRESET CABLE DELAY OFFSET SHOULD NOT NORMALLY REQUIRE ANY ADJUSTMENT.

The cable delay offset is programmed in metres using the cable delay offset switch bank. The total cable length *(in metres)* should be encoded in an 8 bit binary format and entered into the switch bank. Switches set to on *(the upper position)* are summed. As shown in figure 3.4 below, the left-hand switch is the most significant bit *(128m)* and the right-hand switch the least significant digit *(1m)*.
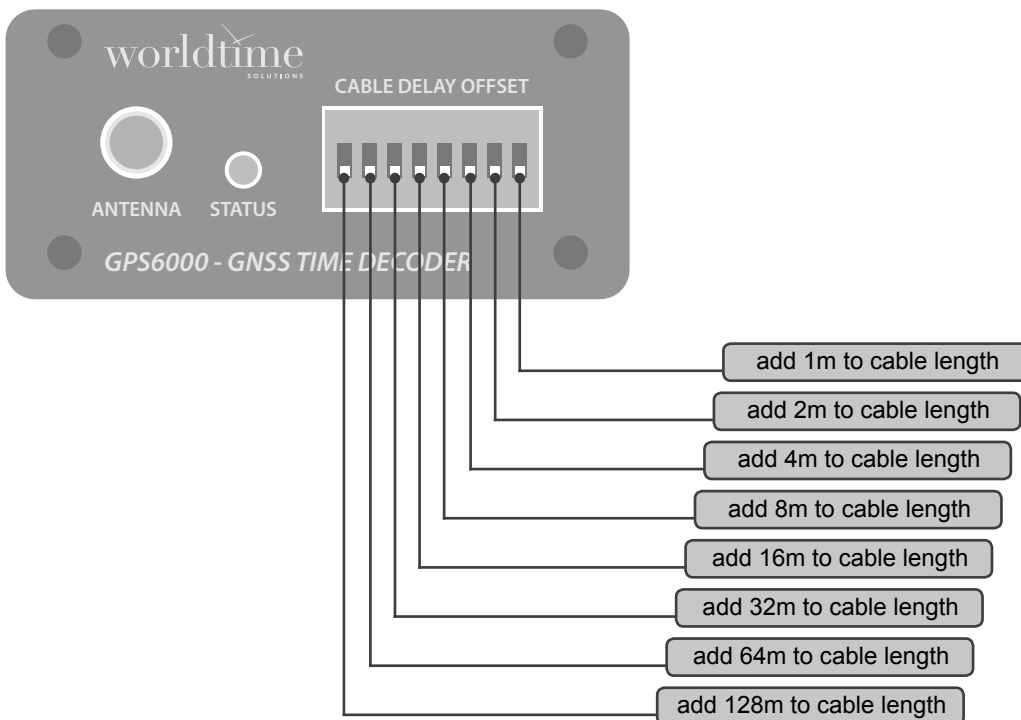

Figure 3.4 - The cable delay offset switch bank

For example, to set a total cable length of 14m *(or 00001110 in binary)*, set the 8m, 4m and 2m switches on *(as shown in figure 3.5 below)*.
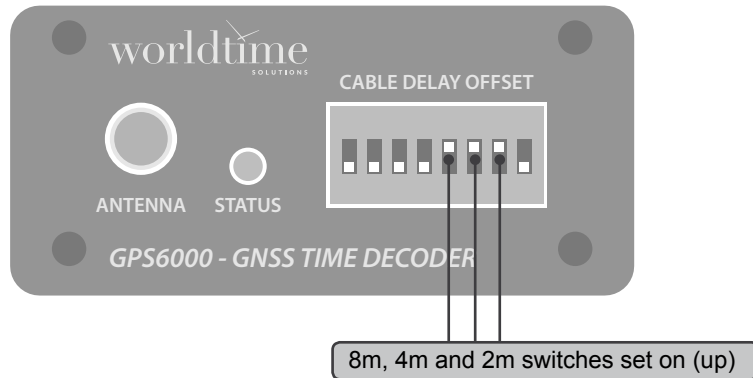

8m, 4m and 2m switches set on (up)

Figure 3.5 - Example 14m cable delay offset

Alternatively, to set a total cable length of 59m *(or 00111011 in binary)*, set the 32m, 16m, 8m, 2m and 1m switches on *(as shown in figure 3.6 below)*.
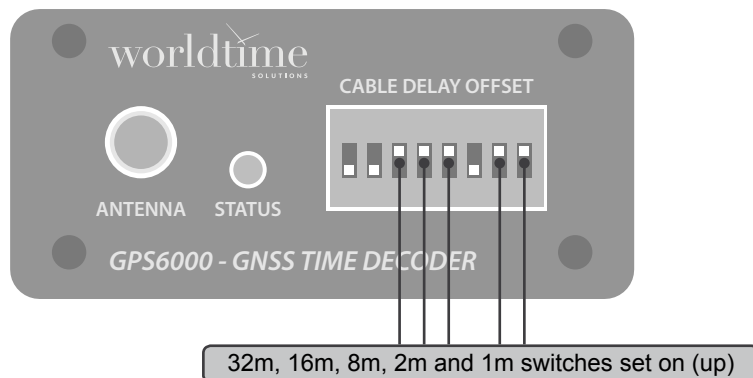

32m, 16m, 8m, 2m and 1m switches set on (up)

Figure 3.6 - Example 59m cable delay offset

A NOTE REGARDING THE CABLE DELAY OFFSET ACCURACY:

The GPS6000-PRO advances the time data by 5 nsec for every additional metre added to the cable delay offset value. This 5 nsec per metre value has been chosen as a good approximation to the velocity of propagation for RG-58C/U (at 66%, or 5.05 nsec/m). However, users wishing to achieve the highest level of accuracy should take account of the nominal velocity of propagation for Belden 9502 (at 60% or 5.56 nsec/m) and correspondingly increase the programmed cable delay offset at longer output cable lengths.

4 - System operation

Operation of the GPS6000-PRO is fully automatic. The following theory of operation is supplied as a reference, to allow the user to gain a basic understanding of the technology used in the GPS6000-PRO.

4.1 - Theory of operation

When first powered-up, the GPS6000-PRO initiates a cold start search acquisition process. Satellites are tracked from all available GNSS constellations *(GPS/GLONASS/Galileo ready)* and an initial location/timing solution is computed. Typically, the search acquisition process will complete within one minute.

After the search process has been successfully completed, the GPS6000-PRO begins downloading GNSS almanac data *(containing orbit and status reference information for each satellite vehicle, along with UTC offset data)*. The GPS6000-PRO must continuously track the GNSS satellites for around 15 minutes to download a complete almanac.

Once the almanac download is complete, the GPS6000-PRO begins transmitting time data and enters self-survey mode. In self-survey mode, the GPS6000-PRO computes a highly accurate reference location by averaging multiple position fixes.

After a successful self-survey has completed *(approximately 35 minutes of uninterrupted GNSS tracking)*, the computed reference location is stored and the GPS6000-PRO moves to high-accuracy timing mode. In this mode, the GPS6000-PRO is able to provide time data accurate to within 30 nsec of UTC.

Note that if your GPS6000-PRO has previously performed a full self-survey and the location has not changed, a new self-survey will not be performed. The GPS6000-PRO will move directly from almanac download to high-accuracy timing mode. If the GPS6000-PRO has previously performed a full self-survey and the location has changed, a new self-survey will be performed.

4.2 - Operation in non-static applications

The GPS6000-PRO is optimised for use in static installations. In normal operation, the GPS6000-PRO performs a self-survey then switches to high-accuracy timing mode *(where the system corrects only for clock errors)*. In this mode, the GPS6000-PRO assumes the location does not change.

It is possible to use the GPS6000-PRO in non-static applications. However, the system will not operate in high-accuracy timing mode and timing accuracy will be degraded.

4.3 - Anti-jam protection

The GPS6000-PRO combines two discrete layers of anti-jam protection. When used together, these systems provide a high level of resistance against the affects of both GNSS spoofing and GNSS jamming.

The GNSS antenna incorporates class leading anti-jam technology, providing reliable operation, even in hostile RF environments.

The GNSS decoder provides a second layer of protection, with advanced anti-spoofing functionality.

Please contact us if you require further details regarding the operation of these functions.

4.4 - Synchronisation status

The status LED provides a visual indication of the synchronisation status of your GPS6000-PRO. In normal operation, the status LED will be flashing green. A red LED indicates the system is not synchronised or there is an error. See table 4.1 for more details.

LED	Status
Solid red	System booting
Single red flash	Searching / downloading almanac data
Single green flash	Locked
Double red flash	Antenna disconnected
Triple red flash	Antenna shorted

Table 4.1 - Status LED functions

More detailed status information can be accessed via your time server. The GPS6000-PRO fully integrates with your time server, providing real time diagnostics and active antenna monitoring. Please refer to the user manual for your time server for further details.

A - Specifications

Timing performance:	
Synchronised accuracy:	30 nsec (1 sigma)

GNSS decoder:	
GNSS engine:	Anti-jam capable, multi-constellation, 32 satellite parallel tracking
Minimum acquisition sensitivity:	-148dBm (cold start)
Minimum tracking sensitivity:	-160dBm
Operating temperature:	0 to 50ºC
Relative humidity:	0% - 95%, noncondensing
Enclosure:	85 x 65 x 30mm (3.35" x 2.56" x 1.18") aluminium enclosure with wall mount brackets
Weight:	0.2 kg
Cable delay compensation:	User programmable
Status monitoring:	Fully integrated diagnostic system with active antenna monitoring. Multi-colour status LED

Antenna:	
Antenna:	Waterproof (to 1m), corrosion resistant multi-constellation anti-jam antenna. Designed to withstand extreme temperature environments, excessive vibration, rain, snow and sunlight
Gain:	30dB (@ 25ºC)
Noise:	3.3dB max (25ºC +/-5ºC)
Azimuth coverage:	360º (omni-directional)
Elevation coverage:	0º to 90º (hemispherical)
Operating temperature:	-40ºC to +80ºC
Dimensions:	78 x 66mm (3.05" x 2.61")

Antenna mount:	
Antenna mount:	105mm (4.13") stainless steel antenna mount

Lightning arrester:	
Lightning arrester:	Multistage, multi-strike fast response

Cabling:	
Antenna cable:	8m (26ft) pre-terminated RG-58C/U TNC to TNC coaxial
Arrester cable:	1m (3ft) pre-terminated RG-58C/U TNC to SMA coaxial
Output cable:	5m (16ft) pre-terminated Belden 9502 (two pair plus drain 24 AWG stranded cable with 100% foil shield and semirigid, sunlight resistant, Polyvinyl Chloride (PVC) jacket)

Standards compliance:	
Electrical Safety:	BS EN 60950-1:2006
Radio Disturbance:	BS EN 55022:2006
Immunity Characteristics:	BS EN 55024:2003
RoHS:	RoHS-Compliant

Scope of supply:	
GPS6000-PRO scope of supply:	1 x multi-constellation GNSS decoder 1 x multi-constellation anti-jam antenna 1 x antenna mount 1 x lightning arrester 1 x 8m antenna coax cable 1 x 1m arrester coax cable 1 x 5m output cable

Options:	
GPS6000-ANT-15:	15m (49ft) antenna cable
GPS6000-ANT-25:	25m (82ft) antenna cable
GPS6000-OUT-15:	15m (49ft) output cable
GPS6000-OUT-50:	50m (164ft) output cable
GPS6000-OUT-150:	150m (492ft) output cable
GPS6000-PRO-GPS:	GPS6000-PRO with GPS only support
GPS6000-PRO-GLONASS:	GPS6000-PRO with GLONASS only support