NavStar GMS700 Installation and User Manual

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REVISION HISTORY

Rev.	Revision History	Date	Prepared By	Approved By
A	Initial release	23 November 2023	SM	JS
B	GMS700 product photography update	06 May 2024	SM	JS
C	Figure and content updates	17 January 2025	SM	SG,

1 OVERVIEW

NavStar's GMS700 is a compact, high-precision GNSS sensor that provides accurate three-dimensional displacement and tilt measurements for deformation monitoring. It has no moving parts and can provide 24/7 automated monitoring data in a wide variety of climates.

1.1 RTK TECHNOLOGY FOR MONITORING

The GMS700 uses Real Time Kinematic (RTK) GNSS processing to deliver highly accurate three-dimensional displacement measurements for deformation monitoring. The GMS700 also includes separate biaxial tilt sensors that provide tilt measurements independently of the RTK GNSS system, ensuring reliable data even when GNSS is not active.

Real-time kinematic GNSS is a type of satellite positioning technology that uses a combination of signals from multiple GNSS constellations (such as GPS, Galileo, GLONASS, BeiDou, and more) and a local Base Station to provide highly accurate positioning data. By using a local Base Station in addition to satellite signals, the RTK system can correct any errors that may be present in the GNSS data. This is achieved by comparing the GNSS data received by the Base Station and the GNSS data received by the rover. Any errors that are present in the data are then corrected, resulting in highly accurate positioning data.

A GNSS RTK-based monitoring system consists of one main Base Station and one or more GNSS rover units. The Base Station is always powered and active, receiving data from as many satellites as possible. Rover units make periodic calculations and, when active, receive satellite data as well as correction information from the Base Station (via terrestrial radio communication). During the window of monitoring, the rover(s) must be able to receive information from the same set of satellites as the Base Station, while receiving corrections from the Base Station. It is advised for rover units to be as near as possible to the Base Station since error is introduced proportional to the distance from the base (approximately ±1mm error in displacement per km from the base).

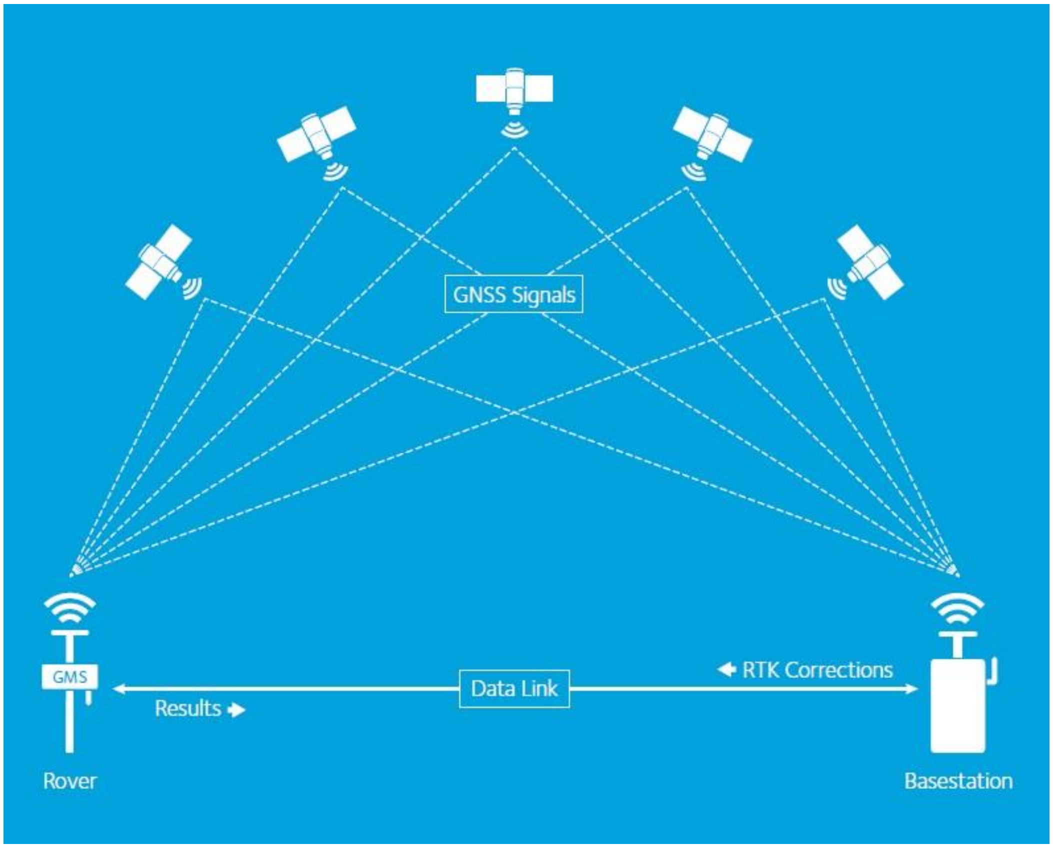


Figure 1: GMS700 System Overview

NavStar's monitoring system is also comprised of a pair of software applications called GeoExplorer and GeoServer (collectively referred to as GeoExplorer). These applications work with a client/server architecture so that many users of the client software can simultaneously access real-time monitoring data by connecting to the database via a corporate network or the internet.

1.2 NAVSTAR METHODOLOGY AND EQUIPMENT

Each piece of equipment has 2 antennas. One allows for terrestrial radio communication and the other for satellite reception. Both communication networks are necessary for the technology to function properly.

NavStar generally uses the 900MHz frequency band for terrestrial communication or something similar depending on local governing bodies for RF communication. Corrections from the base to the rovers are sent via this radio communication as well as the calculations from the rovers back to the base.

NOTE: For the remainder of the installation and user manual, the communication protocol will be simply referred to as radio communication.

1.2.1 NavStar FLP200 and GPM Module (GPM300)

The GPM300 is the GNSS Base Station module, and the FLP200 is the gateway/networking device. They are installed together in the main control box and are often referred to collectively by either name (Gateway or Base Station).

The FLP200 is a networking device that manages the connection between the software (GeoExplorer) and various hardware devices including GMS. NavStar refers to the FLP200 as a 'Gateway' because it often provides the pathway to the server where measurements are stored. The FLP200 also functions as a the RTK Base Station when a GPM300 high precision GNSS module is attached. Secondary FLP200s installed in the monitoring environment can act as additional Gateways, providing an important redundancy to the system.

The GPM300 is the GNSS module that clips onto the side of an FLP200 or FLL. The GPS connector (MCX) on the unit is attached to the base GNSS antenna.

Figure 2: FLP200 with attached GPM300 module

1.2.2 NavStar FLL400 Device

The FLL400 is a ‘lite’ version of the FLP having many of the same features but no ethernet connection. It is used for Base Stations without network access or in Repeater stations. The FLL is also used in other applications but for GNSS based monitoring solutions only the radio connector is important (radio 1, MCX). In the case of Repeaters, a small GPS antenna can be plugged into the GPS connector (MCX) but this is only to record the unit’s location (not for high-precision GNSS monitoring). The serial port (RJ45) is left disconnected when used for only GNSS monitoring.

Figure 3: FLL400 Unit

1.2.3 NavStar GMS700 Rover

The GMS700 rover is a low power device that is the essential component in the RTK monitoring environment. They are usually deployed with other rovers in an area of active surface monitoring. They require a Base Station to send RTK corrections in order for precise positioning calculations.

Figure 4: GMS700 GNSS Rover unit

1.3 INTENDED AUDIENCE

This guide is for the personnel responsible for installing or using NavStar's GMS700. This manual provides steps for installing and operating the GMS700.

1.4 ICONS AND CONVENTIONS USED IN THIS GUIDE

This guide uses the following icons to call attention to important information.

	WARNING: This icon appears when an operating procedure or practice, if not correctly followed, could result in personal injury or loss of life.
	CAUTION: This icon appears when an operating procedure or practice, if not strictly observed, could result in damage to or destruction of equipment.
	NOTE: This icon appears to highlight specific non-safety related information.

2 SAFETY

WARNING: Always follow safety precautions and use proper personal protective equipment (PPE) including safety glasses and high-visibility clothing when working in the field with this equipment.

3 INSTALLATION

NOTE: The installation images provided in the following sections are for illustrative purposes and show a prototype GMS700 unit. The appearance of the actual GMS700 units will be such as the one shown in Figure 4.

3.1 PREREQUISITES

3.1.1 Sky View

To compute a three-dimensional position both the Base Station and rover need to have a clear view of at least 5 GPS/GNSS satellites in common. In practice, this means that both the Base Station and rover need to have clear views of the sky free of obstructions of any kind above 15 degrees from the horizon. This includes power poles, trees, buildings, rock faces, and other similar obstructions.

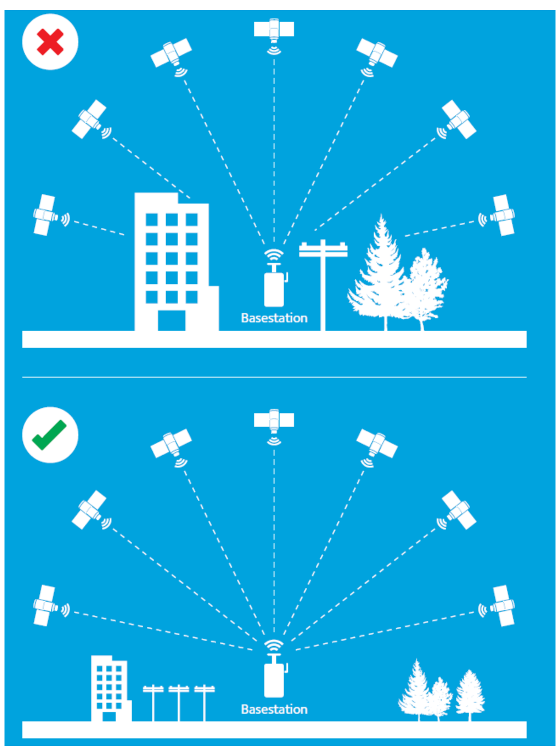


Figure 5: Non-Ideal and Ideal Base Station Sky View

EXAMPLE INSTALLATIONS

Ideal Installation

- radio and GNSS antennas free from obstruction and clear view of sky.

→ **NOTE**:
Raising the radio antenna up on a mast would allow the system to function even more effectively.

Non-Ideal Installation

- Power lines / obstructions

Figure 6: Example Installations

3.1.2 Base Station Installation Requirements

The RTK Base Station is the fixed point to which the computed coordinates for rovers are referenced. If the Base Station is moving this will cause apparent movement of all rovers in the monitoring environment. It is critical to ensure there is reliable power and communications for the Base Station. If the Base Station goes offline, all rovers will be unable to compute positions.

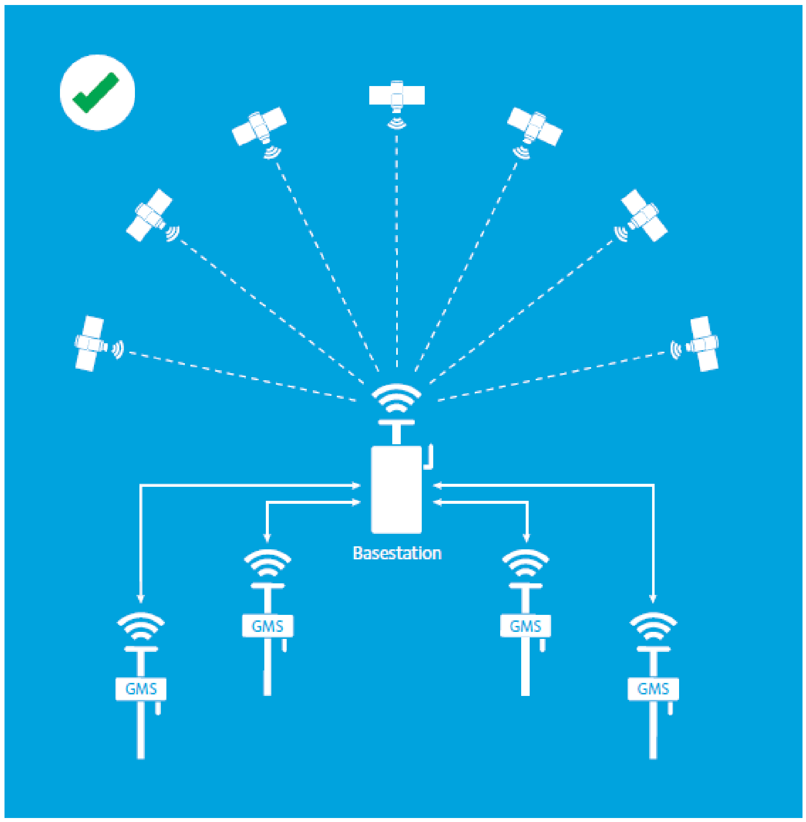


Figure 7: Base Station Installation

EXAMPLE INSTALLATION

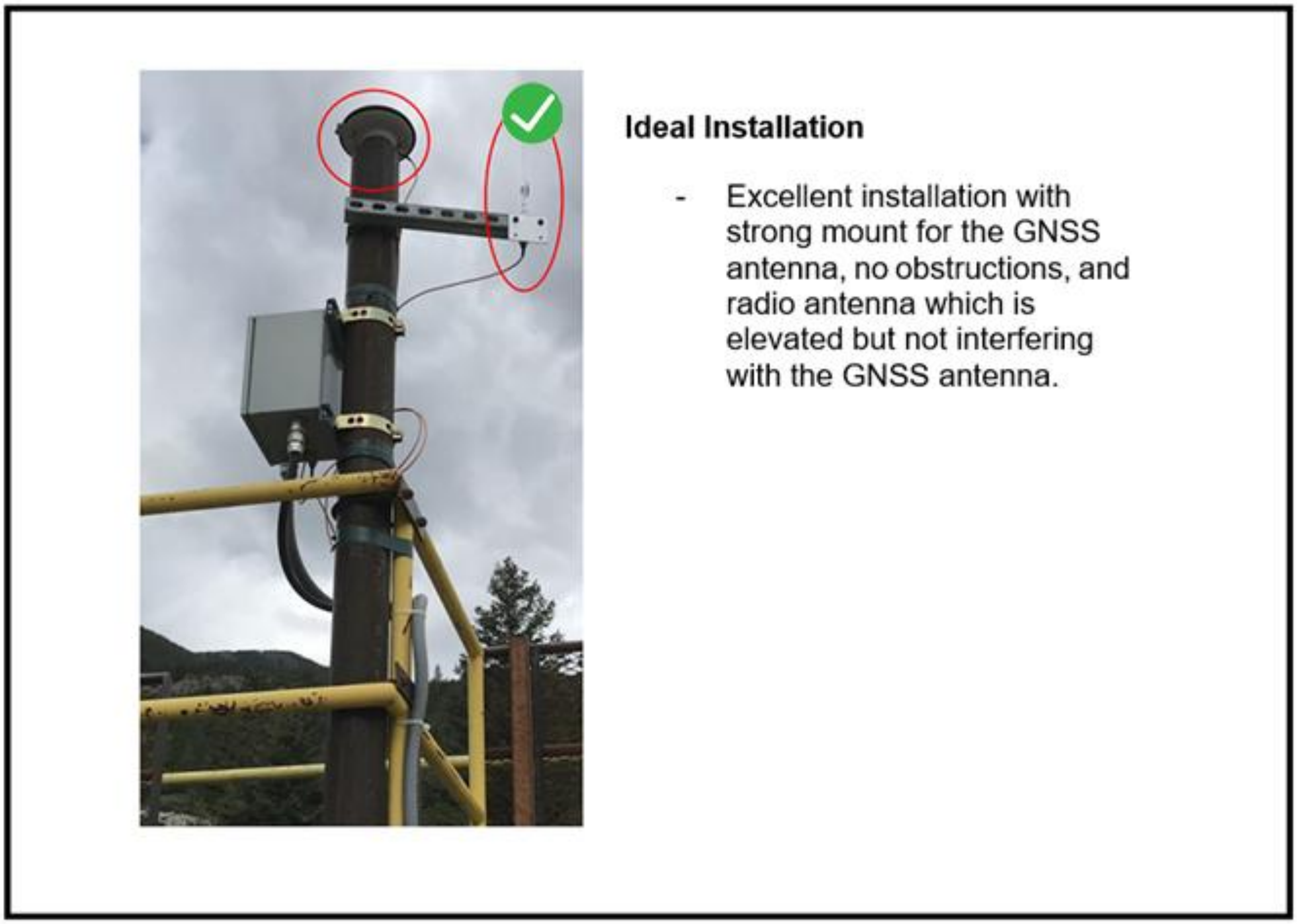


Figure 8: Example Installation

3.1.3 Reliable RTK Corrections

The GMS700 can only compute its RTK position with additional data sent from the Base Station during the calculation phase. To receive this correction data, the GMS700 would ideally have a clear line-of-sight to the Base Station (rover antenna to Base antenna).

The ideal location for the Gateway/Base Station would be near a consistent power source (AC or solar) and close to a network switch. It is possible to have network access via point-to-point wireless link, but it is more reliable to have a wired connection if possible.

→| **NOTE**: If the base loses power OR network access, then the entire system is offline and not collecting data.

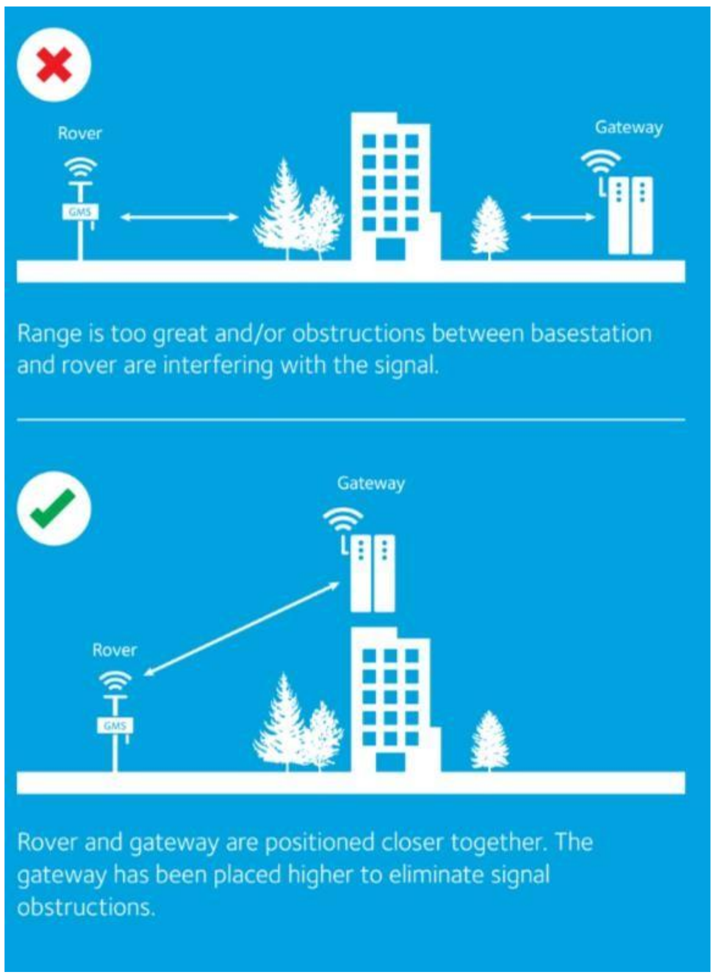


Figure 9: Non-Ideal and Ideal Rover and Base Station Installation

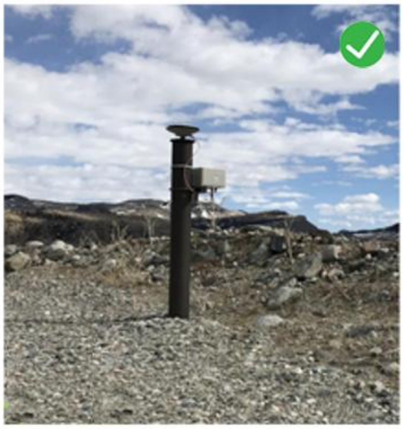
3.1.4 GNSS Rover Installation

The GNSS antenna should be the highest point of the installation and secured permanently (concrete pillar is the best). The GNSS antenna should have a clear view of the sky, 15 degrees and higher from the horizon.

Please ensure that the GNSS antenna is installed at a height of at least 1m from the ground to avoid multipath (ground reflection).

See next page for example installations.

EXAMPLE INSTALLATIONS

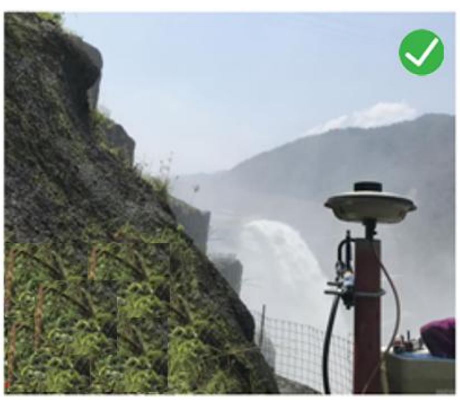


Excellent Installation

- Strong metal pole with concrete foundation
- Antenna has clear 360˚ view of the sky

Acceptable Installations

- Susceptible to minor vibrations
- This type of installation is much easier to work with if no concrete work is necessary



Unacceptable Installation

- Rover installation next to a steep embankment
- Due to antenna obstructed from sky view in one direction, there is a chance the system may not work at all or may provide intermittent data

Figure 10: Example Installations

3.1.5 Other Installation Notes

The radio antenna with the Base Station should be as high as possible and free from obstructions. If possible, there would be a 'line of sight' view to each of the rover units. The GNSS antenna should be secure without possibility of vibration or movement. A concrete pillar is the best solution. NavStar uses an FLP based system for Base Stations with network access and an FLL when there is no network access. When using an FLL-based Base Station it is necessary to have an FLP Gateway as part of the system. Every Base Station (FLP or FLL) has an attached GPM module which functions as the GNSS base.

3.1.6 Power

GMS700 rover units are powered with lithium metal battery packs.

NOTE: The battery packs are custom manufactured for the GMS700, and replacements are available for purchase. The lifespan of the battery pack ranges from approximately 1 to 2 years depending on environmental conditions, installation location and measurement frequency.

3.1.7 Tiltmeters

The GMS700 rovers have built in bi-axial Tiltmeters. It is important to choose a reference orientation for the A and B axis so that changes in tilt can be quantified in the future. For example, the A axis could be positioned north/south or in a hillside situation, one of the axes could be positioned up/down slope.

Figure 11: Example of GMS700 showing direction for Tiltmeter orientation

3.1.8 Additional Gateways

It is possible and encouraged to have additional Gateways, especially for larger installations. This adds an important level of redundancy to the system. Additional Gateways provide multiple pathways to the GeoExplorer server/software. The 'Gateway' aspect of these stations is that they have another path to the network. These stations can also rebroadcast corrections from the base. NavStar uses the FLP line of products for Gateways.

3.1.9 Repeaters

Repeater stations are essentially Gateways without network access. They can 'repeat' the radio data but have no direct access to the network. NavStar uses FLL series equipment as Repeaters.

3.2 Optional Configurations

3.2.1 Base with No Network Accessibility

The gateway and base aspects of the Base Station can be separated. If there is a good location for sky visibility without network connection it is possible to set up an FLL-based station. Corrections are broadcast across the radio network but require an FLP based Gateway to receive the rover responses and pass the data onto the network (GeoExplorer).

3.2.2 Base with No Access to Radio Network

It is also possible to have the base in a location with network access but no good line of sight to the rover units for radio communication. In this case, it is possible for the base to pass correction information across the network to a separate Gateway station. This other Gateway can broadcast the base's corrections to the rover units. In this situation the base would not need a radio antenna (only GNSS antenna).

3.2.3 Distant Rover Units

By default, NavStar provides a small BNC omnidirectional antenna. For units that do not have line of sight or are further than a kilometer away, it is possible to install a directional or different type of antenna that can improve the quality of communication. It is also possible to install cable extensions so the small BNC antenna can be raised up on a mast.

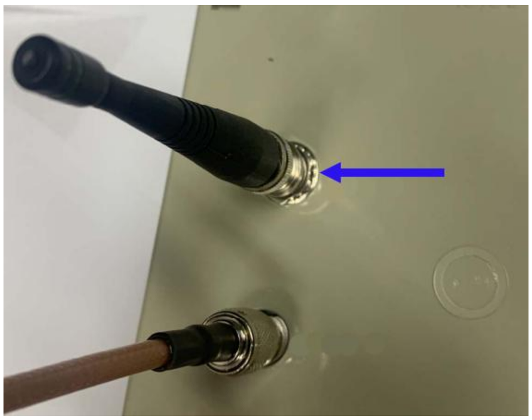
3.3 GMS700 INSTALLATION

3.3.1 Step 1: Mount GNSS Antenna

Mount the GNSS antenna with a clear view of the sky and connect to the GMS700 using the supplied TNC – TNC antenna cable.

NOTE: The GNSS antenna screws on to a 5/8" x 11 threaded rod. This rod size/threading is standard for survey equipment and is not supplied as part of the installation package.

3.3.2 Step 2: Attach Radio Antenna



Attach the radio antenna to the BNC port on the GMS700.

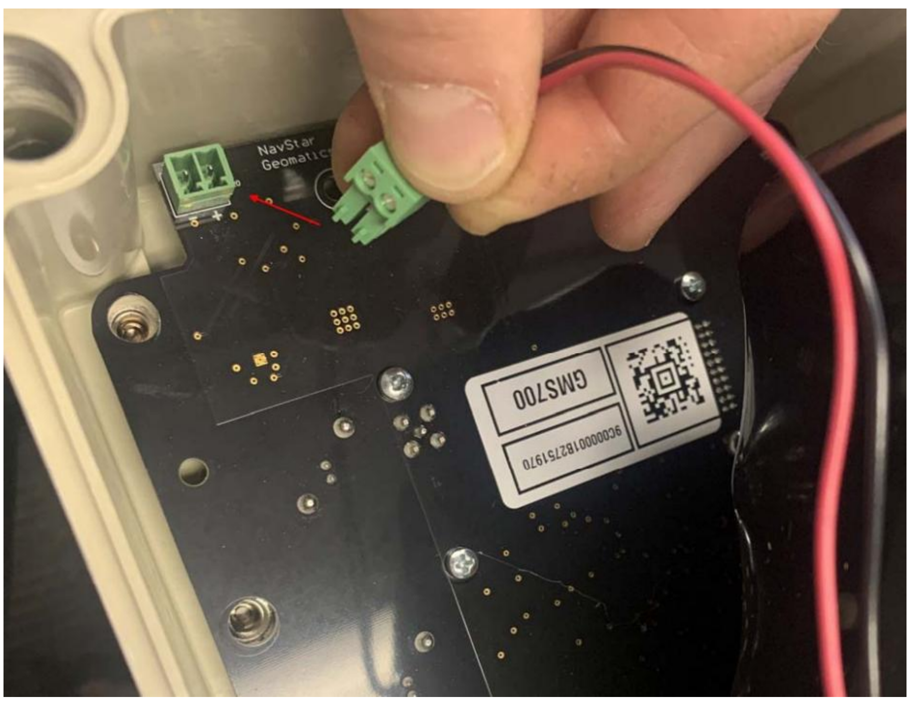
NOTE: If necessary, an external antenna with extension cable maybe used.

3.3.3 Step 3: Applying Power

The GMS700 has a custom battery pack made of lithium metal D cells in a configuration that outputs 14.4 V.

Connecting the battery pack to the GMS700 will apply power instantly and allow the GMS700 to begin default operation.

To apply power, plug the battery pack into the 2-pin connector as shown below.



The red PWR LED will illuminate immediately when power is applied.

3.4 GMS700 OPERATION

The GMS700 functions simply by applying power. All units have been programmed (firmware/application) prior to shipping and are plug-and-play ready for installation/operation immediately with no additional configuration required for default operation.

3.4.1 Default Operation

The GMS700 is by default on a measurement cycle of one hour. In between measurements it is in a ‘deep sleep’ (low battery usage) state. Removing and applying power can force a measurement (and the cycle to restart).

When the GMS700 is first powered, the PWR (red) LED will turn on and remain solid for the duration of the cycle. The TX (yellow) LED blinks during a transmission and the RX (green) LED blinks during reception. The CORR (green) LED blinks every time a correction is received from the Base Station.

When power is first applied or the GMS700 ‘wakes up’ for a new cycle, it sends a message via the Base Station to the server (GeoExplorer software) to request any new configuration that may have been sent since the last measurement. An example of this is the measurement cycle interval. If a new configuration is received, then that will be applied before measurement.

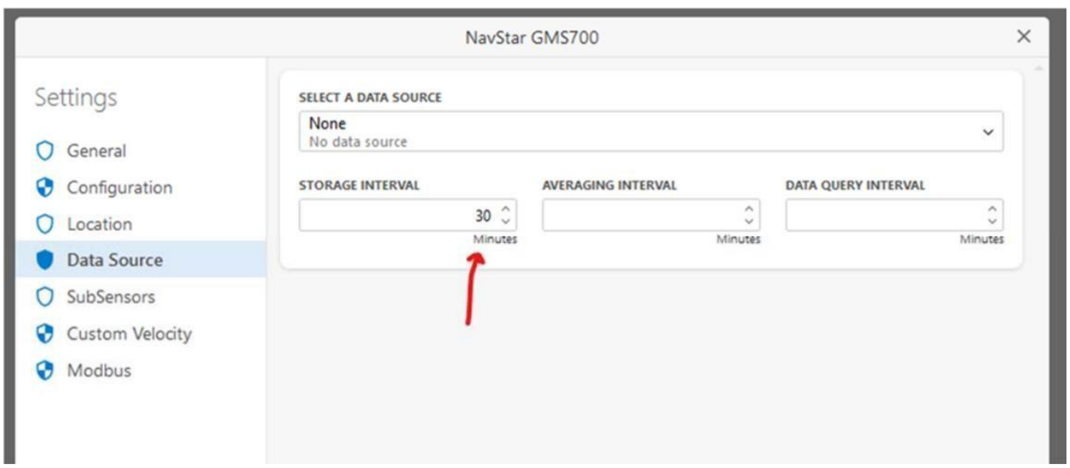


Figure 12: Measurement interval of GMS700 set to 30 mins in GeoExplorer

The GMS700 begins its measurement cycle by tracking and receiving data from satellites. At the same time, it receives correction information from the Base Station (CORR LED blinks). When sufficient data is received from both these sources, a calculation is made, and the result is sent to the server.

NOTE:

Operation with insufficient data

When the GMS700 is unable to properly track satellites (example: full view of sky is restricted because of nearby obstacles) or it is unable to receive enough quality corrections from the base, it will fail to make a calculation. A timeout of 120 seconds indicates that there was an inability to make a calculation (resolve a position). The GMS700 will enter its sleep cycle and wake after an hour (default) to try again.

Operation without a Base Station

At the beginning of a cycle, the GMS700 requests a configuration change from the server. If there is no response, this is interpreted as no Base Station found. In this case, the GMS700 times out after 14 seconds and enters deep sleep (and will try again next measurement cycle). Without a Base Station, the red PWR LED will turn on and there will be activity on the TX transmission LED but no activity on the RX (reception) or CORR LED (corrections from base).

3.4.2 Radio Configuration

In many cases, radio configuration is performed at the factory but in certain cases it is necessary to switch radios or reconfigure settings before installation. To configure the radio settings, plug a USB-C from computer to NBUS connector on GMS700.

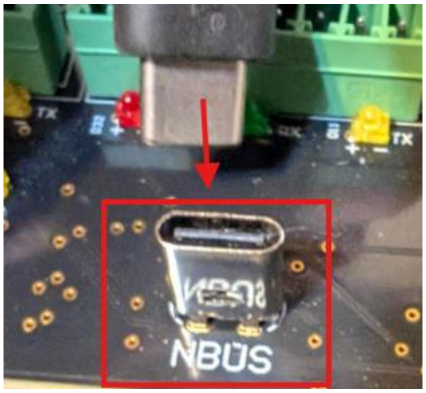


Figure 1: Using the NBUS Port to Initiate Radio Settings Configuration Process

The FLP Discovery Application is used for the configuration.

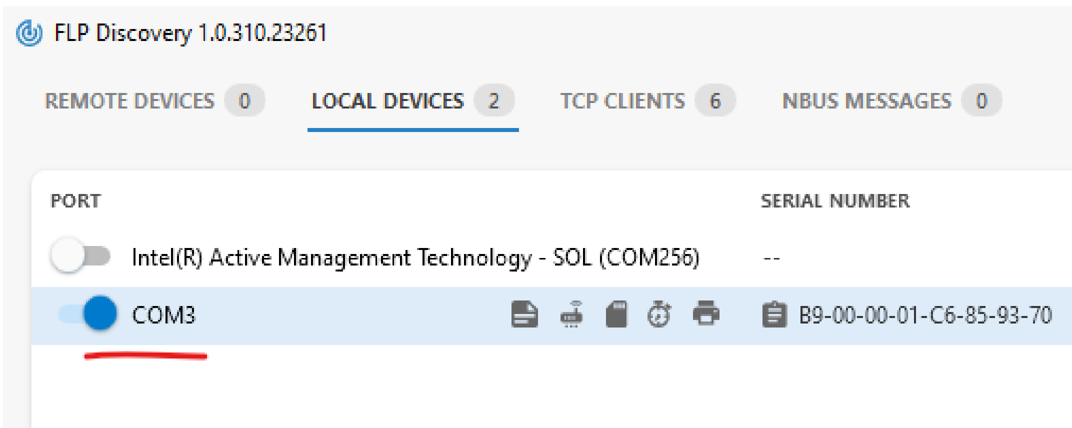
1. Open FLP Discovery and select the LOCAL DEVICES tab.

   There should be a new COM port generated when the USB-C cable is inserted.

2. Click on the COM port and this should open the current radio settings.

   If no COM port appears when the cable is inserted into the NBUS port, the computer may lack the required drivers.

   Here is a link to the current drivers for Windows 10: click here



NOTE: Please contact NavStar for a link to the latest version of the FLP Discovery Application.

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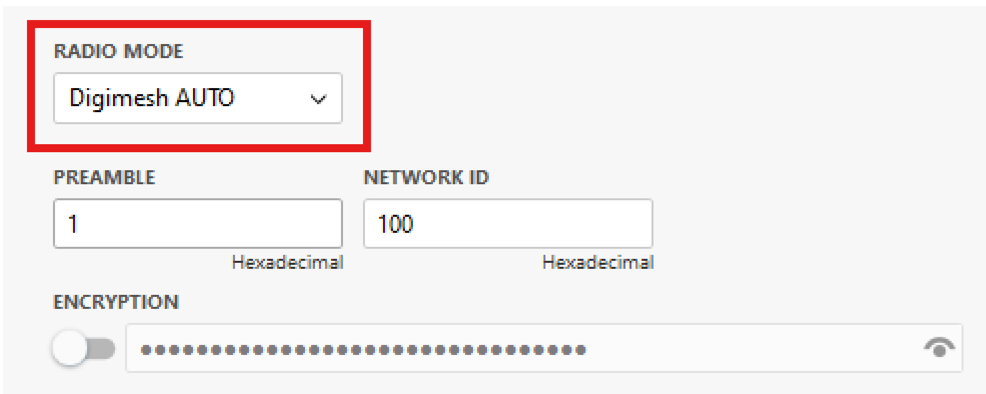
3.4.3 DigiMesh® Configuration

The GMS700 only operates in DigiMesh® radio mode (Wi-Fi or LTE configuration unavailable).

For the DigiMesh® radio configuration, a GMS700 will require the presence of an FLP200-based Gateway to be present. Both the Gateway and GMS700 will need to be outfitted with matching radios and identical radio settings.

Select DigiMesh® AUTO for 900Mhz, 868Mhz or other similar radio (depends on country specification/regulations).

For 2.4GHz, choose DigiMesh® 24 and follow the same procedure.



NOTE: Please contact NavStar support to determine the specific settings for the other paramerters (PREAMBLE, NETWORK ID, ENCRYPTION).

3.5 GMS700 Firmware Update

The GMS700 is shipped with the latest available firmware but there are instances when it is necessary to update or restore firmware manually.

NOTE: Please contact NavStar support to confirm that the application version is the latest, as confirmed by the application version number (see image above).

3.5.1 Manual Firmware Update

NOTE: In certain circumstances it is necessary to manually update the GMS700 firmware. The app 'TinyCLR Config' is required.

Please see a recent download link: click here

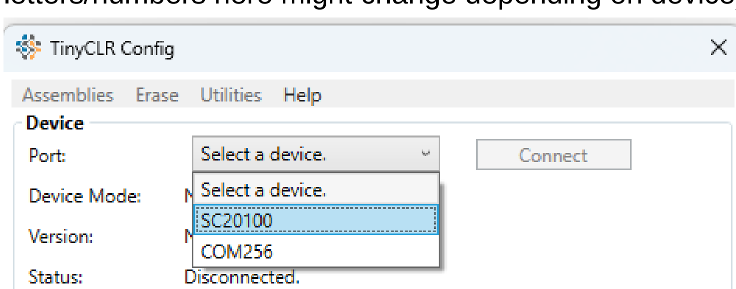
Note that new versions are periodically posted. Ensure that the latest version is being used.

1. Plug a USB-C cable from the laptop to the port on the GMS700 unit labelled "GHI".

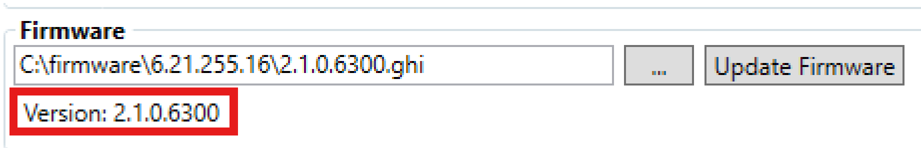
2. Three files are needed to perform the firmware update. These can be received directly from NavStar support on a case-by-case basis. There is a 'firmware' file (.ghi extension) and an "application" file (.tca extension). There is also a hex application key that needs to be entered (in the .txt file).

The following steps show a firmware update in TinyCLR Config using the example of firmware file "2.1.0.6300.hex" and application file '6.21.255.16.tca'. The actual firmware will be named differently.

3. Select 'SC13048Q' or 'SC20100' in the port menu and 'connect' (the letters/numbers here might change depending on device).

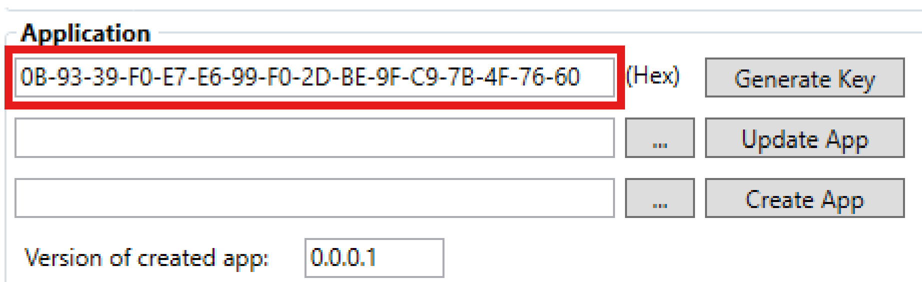


4. Browse to the firmware file (3 dots menu) and then click update firmware. There will be an erase and the load process will complete.

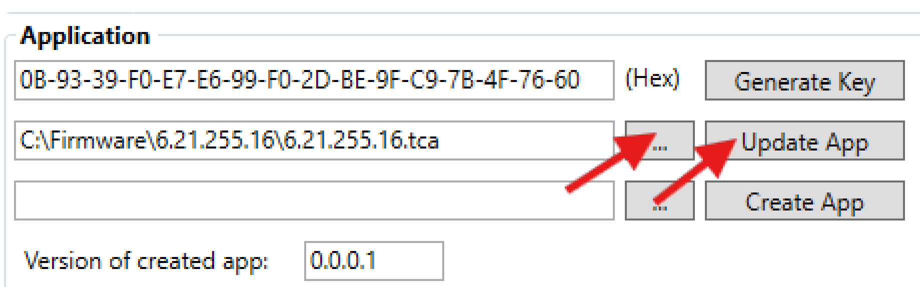


5. Reconnect to the SC20260 using the port menu above

6. Copy the Key into the key field. Please ensure there is no extra text in the field.



7. Browse to the .TCA file from the download using the browse button below. Then click Update App.



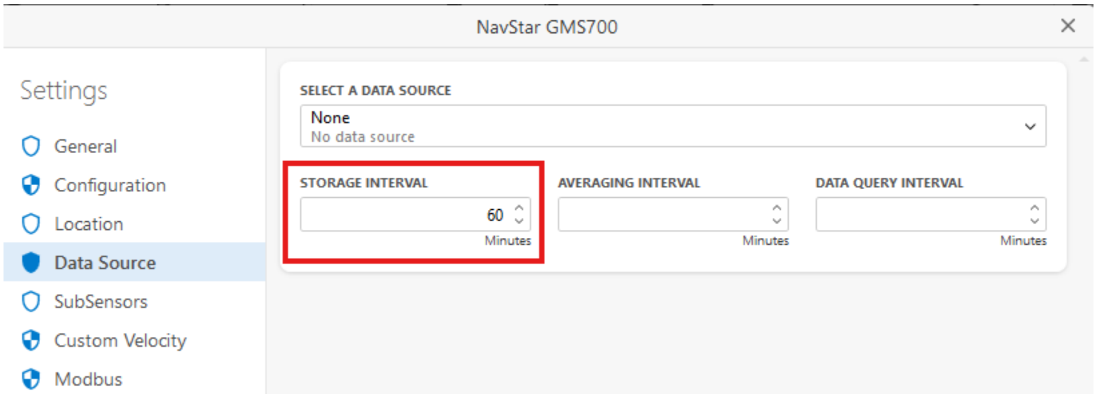
8. A successful update message appears, confirming the firmware update.

3.6 GMS700 GEOEXPLORER CONFIGURATION

Aside from radio configuration via FLP Discovery, there is no required configuration of GMS700. The device will automatically generate in GeoExplorer during the first measurement cycle.

3.6.1 Measurement Interval

By default, the GMS700 is set to calculate a measurement every 60 minutes.



The STORAGE INTERVAL setting in GMS700 settings>Data Source is an important value which sets several intervals:

1. GMS700 diagnostic message frequency
2. Database measurement frequency
3. RTK positioning calculation frequency

It is not possible to have different measurement intervals for each of the items mentioned.

3.7 GMS700 TESTING

A GMS700 is essentially tested and functions correctly if it can make a calculation and send it to the server (GeoExplorer software).

It is not possible to test a GMS700 for complete functionality without several other components of the system including:

1. Server with GeoServer (server portion of GeoExplorer) and SQL database installed.

2. Base Station (FLP200 + GPM300) with functioning radio and GNSS antenna and clear view of the sky.

3. GMS700 with GNSS and radio antennas attached and clear view of sky.

To perform a test, this setup must be complete (refer to Installation prerequisites) and the only required step is to apply power to the GMS700.

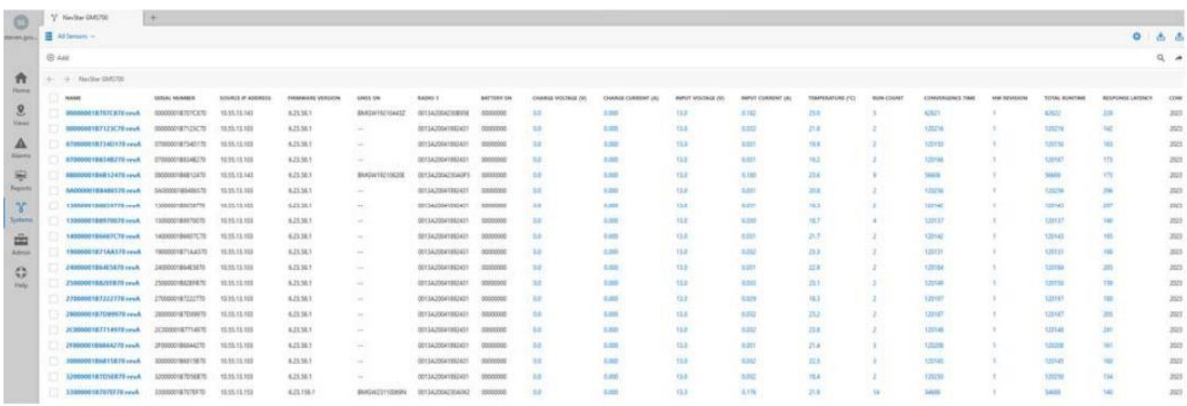


Figure 13: Screenshot of GMS700 tests in GeoExplorer

NOTE:

A successful test in GeoExplorer provides an incredible amount of detail regarding the GMS700 operation and functionality.

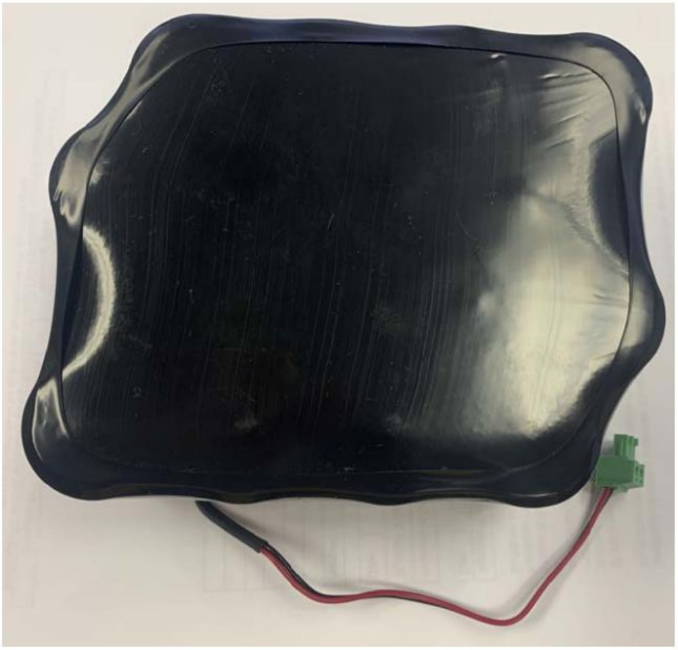
A list of some details that can be seen in GeoExplorer:

1. Serial number of GMS700 (also a sticker on the PCB + enclosure)
2. IP address of gateway/Base Station
3. Firmware version
4. GNSS daughter board serial number
5. Radio module serial number
6. Battery board serial number
7. Solar power details (charge voltage, current)
8. Input voltage to GMS700 (can use to determine voltage/life of battery pack)
9. Input current to GMS700
10. Internal temperature of GMS700
11. Total number of measurement cycles ever performed.
12. Convergence time of calculation
13. Response latency (measurement of comms quality to gateway)
14. Tilt measurement (X, Y, Z axis)
15. Correction packets (received from the base for previous calculation)
16. Positioning info (lat/long/elevation etc.)
17. Number of satellites used in calculation.
18. 3D displacement referenced to chosen baseline.
19. Seconds since last measurement

4 MAINTENANCE

NavStar's GMS700 is maintenance-free by design. The only consideration is its internal power source, which is a custom lithium battery pack.

The lithium battery pack will need to be replaced after some months / years. The specific time frame is based on several factors including installation climate and measurement interval. In a mild climate with the default 60-minute intervals, the battery pack can be expected to power the device for 1 to 2 years.

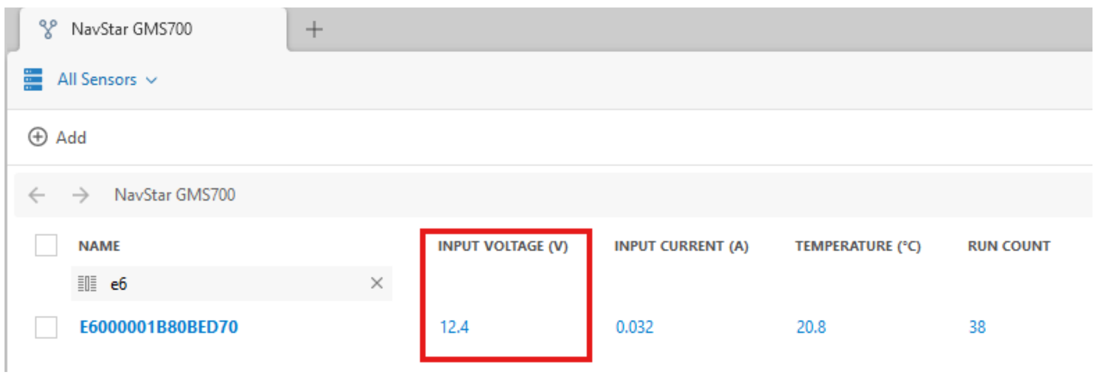


5 Troubleshooting

NOTE: The troubleshooting procedures mentioned here are for most encountered issues, which relate to communications and power. For additional support, contact RST Instruments.

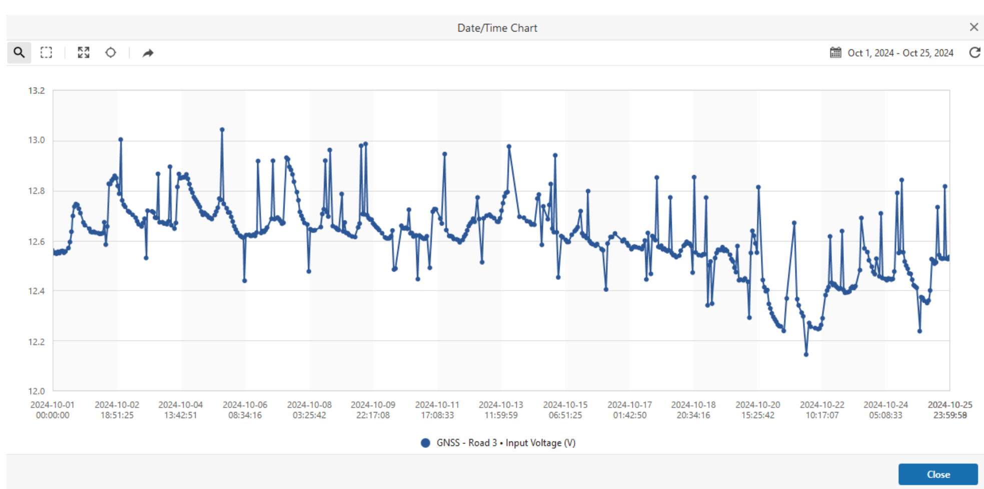
5.1 Power Troubleshooting

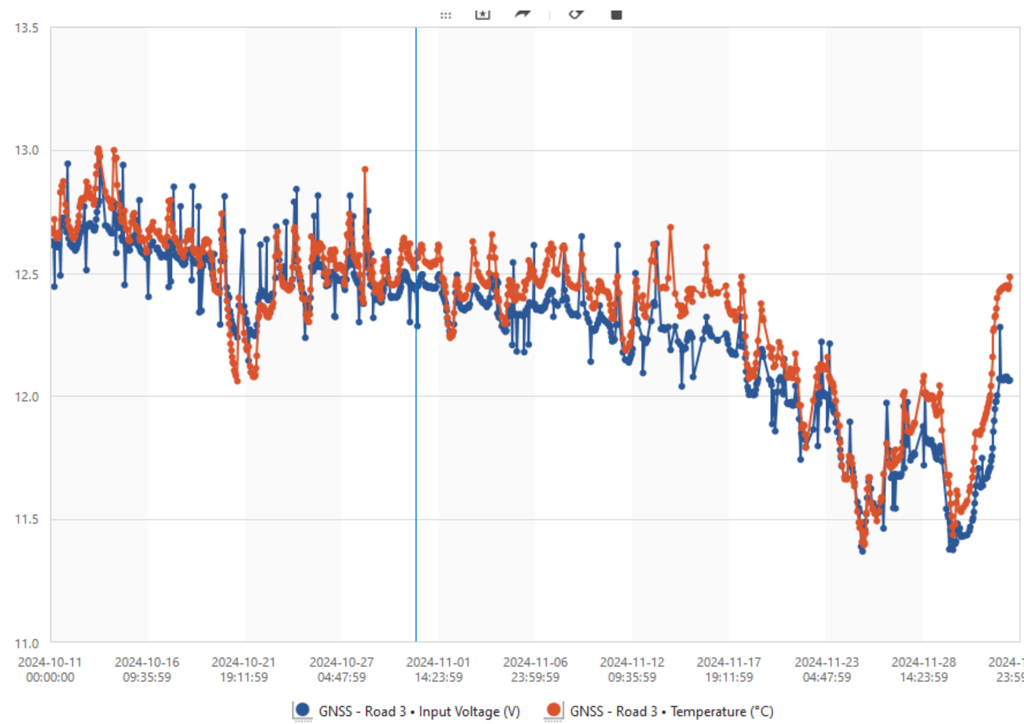
A power issue can be monitored and detected by watching the ‘input voltage’ trend from the GMS700 diagnostic messages in GeoExplorer.



Since the GMS700 is powered from an internal lithium battery pack, the input voltage to the GMS700 is essentially the voltage of the battery pack. Therefore, this value can be used to discern some aspects of battery health and life.

Lithium battery primary cells tend to hold their charge steady until end-of-life, so it is generally not possible to watch a slow voltage decline to determine near end-of-life status. The input voltage in a healthy system will range from 12 to 14 volts. There will be some fluctuation between measurements and a slight drop in colder temperatures.



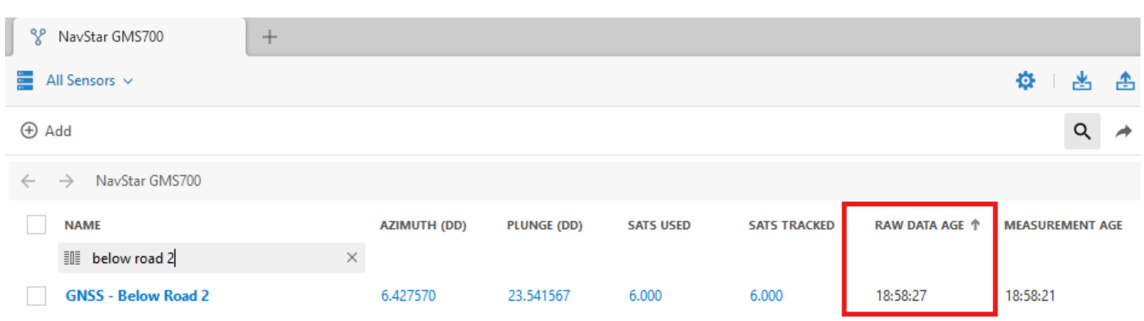


Lithium battery voltage tends to follow temperature trends.

If this is drastically reduced for a certain measurement, it could indicate some damage or final discharge of the battery pack. If the system goes offline at the same time, this is typically an indication that the battery pack needs replacement.

5.2 Communications Troubleshooting

Monitoring the 'raw data age' in GeoExplorer is the best way to detect any communications failure. The raw data age shows the time since last diagnostic measurement from the GMS700. If this time is larger than the measurement interval, there may be a communication problem (or weak connection). If communication stops (especially if there is nothing unusual from a power perspective), it is likely necessary to visit the device to investigate the reason for the outage (perhaps physical damage to antenna / antenna cable or a new comms obstruction).



5.3 GNSS MEASUREMENT TROUBLESHOOTING

From time to time, the GMS700 may not make a successful RTK calculation.

A lack of positioning data in the regular GMS700 diagnostic message indicates that a successful RTK calculation did not occur.

NAME	CORRECTION PACKETS	ANTENNA HEIGHT (SFT)	LATITUDE (DD)	LONGITUDE (DD)	ELLIPSOIDAL HEIGHT (SFT)	GEOID S
apm						
SE Corner of APM	170	0.0000	--	--	--	--

Please see below for the most common reasons for the GMS700 not making a successful calculation:

1. Lack of correction data from the Base Station.

If the user is physically present at the GMS700, inspect the CORR LED.

It will blink every time the GMS700 receives a correction message from the Base Station. If the CORR LED does not blink at all, the GMS700 is not receiving corrections from the Base Station.

NAME	DELTA TILT X (MM/M)	DELTA TILT Y (MM/M)	CORRECTION PACKETS
apm			
SE Corner of APM	-0.694	-1.066	170

2. Sky blocked or partially blocked by vegetation or other obstruction

It is necessary for the GMS700 units to have a line of sight to the same set of satellites as the Base Station. If some or all of the skyline is blocked for either the base or the rover, a successful calculation will not be achieved every measurement cycle.
A convergence time of 120000 (or 120 seconds / 2 minutes) indicates the GMS700 has timed out and was not able to calculate an RTK position.

NAME	TAGE (V)	INPUT CURRENT (A)	TEMPERATURE (°F)	RUN COUNT	CONVERGENCE TIME	HW REVISION
apm						
SE Corner of APM		0.262	38.9	5850	120047	4

3. Sky blocked or partially blocked by vegetation or other obstruction

It is necessary for the GMS700 units to have a line of sight to the same set of satellites as the Base Station. If some or all the skyline is blocked for either the base or the rover, a successful calculation will not be achieved every measurement cycle.
A convergence time of 120000 (or 120 seconds / 2 minutes) indicates the GMS700 has timed out and was not able to calculate an RTK position.

4. Noisy data results

Noisy data is often related to a portion of the sky being obstructed from the GNSS antenna for either the Base Station or rover. Noise can also be introduced depending on installation quality. For example, vibration or movement at the GNSS antenna could affect data quality. Note that any noise introduced at the base (reference) will present in all rover data.

5. Hardware problem

If there is a problem with the GMS700's GNSS antenna or antenna cable, it will fail to calculate a successful RTK position. In this situation, the GMS700 may be regularly contacting GeoExplorer and receiving ample correction data but the convergence time will consistently show approximately 120000ms.

6 PRODUCT SPECIFICATIONS

Item	Specification
Physical and Electrical	
Enclosure Dimensions	160 mm x 160 mm x 100 mm
Enclosure Material	Fiberglass Reinforced Polyester
Weight* **Without battery*	1.35 kg
Connectors	TNC(F) for GNSS Antenna BNC(F) for Radio Antenna
Mounting	2" Pole Clamps included. Flexible hole pattern also works for alternate mounting
Temperature	Operating: -40°C to +85°C Storage: -55°C to +85°C
Power Consumption	42 mWH per measurement ~8000 measurements with 6 X Lithium D Batteries at room temperature with 'In RTK mode'
Sensors	
GNSS Channels	555
GNSS Signals Received	GPS L1 C/A, L1C, L2C, L2P, L5 GLONASS* L1 C/A, L2 C/A, L2P, L3, L5 Galileo* E1, E5 AltBOC, E5a, E5b, E6 BeiDou* B1I, B1C, B2I, B2a, B3I QZSS* L1 C/A, L1C, L2C, L5, L6 **Optional, requires extra license*
Biaxial Tilt Accuracy	< 0.01°
Environmental Sensors	Temperature, Input Voltage, Input Current, Charge Voltage, Charge Current, Runtime Metrics

Typical GNSS Measurement Performance		
	Post-processing mode	RTK mode
Horizontal Repeatability (24 hr. average)	3 mm	8 mm
Vertical Repeatability (24 hr. average)	5 mm	15 mm
Included GNSS Antenna* **Additional antenna options available*		
Signals Received	GPS L1/L2 GLONASS L1/L2 Galileo E1 BeiDou B1	
Dimensions	176 mm D x 55 mm H	
Connector	TNC (F)	
Mounting	5/8" Coarse Thread Mount	
Phase Center Ability	< 2.0 mm	
Noise Figure	< 2.0 dB (typical)	
Power Supply Options		
Lithium Battery	1 x 68AH 14.4V Battery Pack 1 – 3 year lifespan Non-rechargeable	
Telemetry		
Mesh Radio	868 MHz, 900 MHz, 2.4 GHz	
Wi-Fi	802.11 B/G/N	

The repeatability and precision of GNSS measurements at a particular location and time are affected by the number and geometric distribution of satellites in the visible sky, the effect of multipathing, unit distance from Base Station, and other factors. The measurement performance stated above assumes a typical installation with favorable topography.

7 SERVICE, REPAIR AND CONTACT INFORMATION

This product does not contain any user-serviceable parts.

- For technical support: support@navstar.com
- Website: www.navstar.com
- Toll free: 1-800-665-5599

NavStar Canada Office

Address: 11545 Kingston Street, Maple Ridge, BC, Canada V2X 0Z5

Telephone: 604-540-1100

Fax: 604-540-1005

Business hours: 7:30 a.m. to 5:00 p.m. (PST) Monday to Friday, except holidays