# SG7

## Geodetic GNSS RTK Receiver
## with Internal 2-Watt UHF Radio, 4G Cell Modem

# User Manual

Also see the *Getting Started Guide* for your selected Field Software.

This manual is for use with SG7- RTK GNSS receivers sold by iGage Mapping Corporation.

The factory User Manual may supplement the information contained in this document. See https://igage.com/out/SG7/UserManuals/index.htm:

Receivers purchased from other sources that appear similar will not match internal components provisioned by iGage: Cell Modems, UHF Radios, OEM GNSS receivers, firmware and registration are likely different.

The 'iGx Download Tool' supplied with only works with receivers purchased from iGage. The download tool is not sold separately.

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# Copyright, Control, FCC and Safety

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## GNSS Safety Warning

The SG7 GNSS receiver tracks and utilizes signals from many space-based satellite navigation systems:

The Global Positioning System (GPS) is operated by the US Government which is responsible for the accuracy and maintenance of the GPS network. Accuracy can also be affected by bad satellite geometry and obstructions including buildings and tree canopy.

The GLONASS (GLObal Navigation Satellite System), is a satellite navigation system operated by the Russian Aerospace Defense Forces.

The Galileo System is the global navigation satellite system (GNSS) that is operated by the European Union (EU) and European Space Agency (ESA)

BeiDou Navigation Satellite System (BDS) (also known as COMPASS or BeiDou-2) is operated by CNSA (China National Space Administration.)

SBAS (Satellite Based Augmentation Services) including WAAS (USA), MSAS (Japan), EGNOS (Europe), QZSS (Asia), and GAGAN (India) may also be utilized by the OEM engine for carrier-phase corrections, in addition to differential corrections.

iGage Mapping Corporation is not responsible for, nor warrants the viability of the space segment portion of the GNSS system. The user is cautioned that they alone are responsible for determining the application of the receiver to the task at hand.

**Any of the GNSS system components can fail at any time. Be prepared for downtime and failures. Do not use the SG7 receiver for any critical navigation purpose.**

## Export Controlled Device

The SG7 device should be considered an export-controlled device.

Because of the complex federal sanction regulations governing controlled countries, as well as the severe civil and criminal penalties for sanction violations, you should not attempt to interpret export licensing requirements or license exclusions for travel, or transactions with comprehensively embargoed countries. Before shipping, providing or hand carrying GNSS devices out of the United States, consult counsel who specializes in ITAR/DOD matters.

The following country list is not exhaustive:

> Afghanistan, Balkans, Belarus, Burundi, Central African Republic, Cote d'Ivoire, **Crimea Region of Ukraine**, **Cuba**, Cyprus, Democratic Republic of the Congo, Eritrea, Fiji, Haiti, **Iran**, Lebanon, Liberia, Libya, Myanmar (formerly Burma), **North Korea**, Republic of the Sudan (Northern Sudan), Rwanda, Somalia, South Sudan, Sri Lanka, **Sudan**, **Syria**, Ukraine, Venezuela, Vietnam, Yemen, Zimbabwe

**The countries in bold face type are comprehensively embargoed.** Do not transport an SG7 receiver to one of these countries.

## FCC Compliance

**FCC Notice**: SG7 receivers comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules when it is used in the Portable Mode.

FCC ID: 2A7ZC-SG7

Operation is subject to the following two conditions:

This device may not cause harmful interference.

This device must accept any interference received, including interference that may cause undesired operation.

An FCC License is required to use the SG7 as a UHF Base in transmit mode. See https://igage.com/fcc.htm :

Also consult the section Radio Notices on page 12 of this User Manual.

# Table of Contents

# Introduction

Thank you very much for choosing the SG7 GNSS receiver purchased from iGage!

With a ground-breaking price, outstanding performance, best-in-class tilt compensation, field ready case and easy-to-use features, we know that the SG7 receiver will be a valuable tool that will quickly pay for itself.

This guide is designed to help you become familiar with your new equipment and successfully use it in the field.

## Technical Support

If you need assistance, please contact iGage Mapping Corporation:


iGage Mapping Corporation
1545 South 1100 East Suite 1
Salt Lake City UT 84105 USA

+1-801-412-0011
email: info@igage.com


Your input is extremely valuable, and we will listen to your suggestions!

Software updates and news are available from:

www.igage.com

**Mail List**: Signup for the iGx mail list at: www.igage.com/ml to receive notices of new firmware. If you use LandStar8 field software signup for the LandStar8 mail list too.

**Firmware**: See 'Upgrading Firmware' on Page 64

Don't hesitate to call iGage for assistance deploying, using or updating your device. Remote assistance is available.

## iGage SG7 receivers

The iGage SG7 is available internationally in several variants from other vendors. The many versions of the receiver differ hardware options:

- GNSS Antenna and Antenna Model
- GNSS OEM engine
- Cell phone modem
- Wi-Fi and Bluetooth modules
- IMU devices
- UHF Radio Modules

You should be wary of devices purchased online as they could have cell modems that are not USA band compliant, UHF radios that are not FCC approved or acceptable for use in the USA, have geofenced registrations, have inferior GNSS engines or even be completely counterfeit.

iGage is unable to support, service or answer questions about receivers purchased elsewhere. We literally have no knowledge of the devices, applicable firmware or operation.

## iGage SG7

Specific naming conventions:

| | | |
|---|---|---|
| Model Name: | SG7 | |
| Part Number: | A19318-980901-070002 | |
| NGS Antenna Model: | GMTSG7 | **NONE** |

https://geodesy.noaa.gov/ANTCAL/LoadFile?file=GMTSG7_NONE.atx

FCC ID: 2A7ZC-SG7

# About the SG7 GNSS Receiver

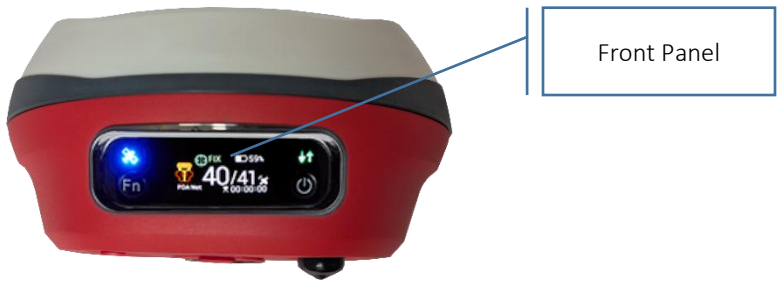
The SG7 GNSS receiver incorporates a GNSS engine, GNSS antenna, internal Rx/Tx UHF radio, Cellular modem, Bluetooth, Wi-Fi and large internal batteries in a ruggedized case that is easy to deploy and use.

The bright LCD panel enables you to check satellite-tracking, internal battery charge status, Wi-Fi, working mode, data logging status and basic receiver information. Bluetooth and Wi-Fi radios provide cable-free communication between the receiver and a data collector / controller.

You can change many of the basic settings of the receiver with the two front panel buttons and LCD panel. Additional configuration settings can be made via the web interface using Wi-Fi or with a Bluetooth connected data collector.

The UM980 GNSS engine is incredibly fast, accurate and operates under canopy.

## Front Panel




The Front Panel has a bright LCD screen, two indicator LED's and two pushbuttons.


**Satellite LED**

Indicates the number of satellites that the receiver is tracking:

When the receiver is searching and not tracking satellites it blinks Blue once every 5-seconds.

When the receiver is tracking and has a position the left LED blinks Blue once for each tracked satellite, then waits 5-seconds.

| | |
|---|---|
| **Correction LED** | Indicates that the receiver is transmitting or receiving data.<br>Base Operation: blinks amber as correction data is transmitted<br>note: if not blinking, base configuration was unsuccessful!<br>Rover Operation: blinks amber when Single, FLOAT or DGPS, green when fixed. |
| Fn / Next Button | Move to the next line of the current menu.<br>Move to the next character of a setting.<br>Changes a setting or character after being selected by Enter. |
| Power / **Enter** Button | Press and **hold** for 3-seconds to turn the receiver ON or OFF<br>Tap to accept a modified value: **Enter** |
| Mode description | Text description of Base or Rover mode. |
| Solution Type | Solution type: FIX, Float, RTD (Real-Time-Differential), Autonomous. |
| Battery Charge | 0 to 100%, animated battery charge icon when USB-C is charging. |
| SV Used / Tracking | Number of satellites Used / Number of satellites Tracked. |
| Current Observation | HH:MM:SS recording time of current observation. |

## Receiver Back and Bottom


**External Power**

7-pin LEMO connector supports RS-232 communication and external power (9 to 24 VDC) input. (See “Serial and USB IO Port Definitions“ on page 64 for pinout and cable information.)

**UHF Antenna Connector**

Connect a UHF Radio Antenna when using the Internal UHF Base or Internal UHF Rover mode.

An antenna is not required when using: NTRIP, APIS or Static Only operation. An antenna is required if the SG7 is a UHF Base or UHF Rover.


Do not overtighten the antenna. This forces the TNC connector to loosen within the receiver shell.

Can't find the UHF antenna? It may be in the recessed pocket at the top of the carry case.

**4G nano SIM Card**

Receivers use a NANO sized SIM card. (NANO is the smallest sized SIM card.) Insert cards with the gold contacts facing away from the 5/8" threaded insert at the center of the receiver. The notch end goes in first. The SIM card gold contacts should point towards the gold bar at the bottom of the slot. The icon shown on the rubber slot cover is misleading.

To eject a SIM card, push it in to trigger the spring-loaded ejection mechanism.

The data modem is an EG25 4G LTE modem and should work with all providers including Verizon.

Additional information is available in the 'Configuring the Internal Cellular Modem' on page 20.

**Type C-USB**

Standard USB Type-C connection to computer or wall charger.

When connected to a wall transformer the internal battery is charged. The battery will charge 20% per hour until the last 10% which is slower.

When connected to a computer using a standard USB cable, the receiver will mount as a Read-Only external disk drive: no device drivers are required.

Not all cables and USB wall transformers will charge the SG7.

# What's in the Box

Depending on your purchased configuration you may receive different accessories with your receiver. Typically, all kits include:

| | |
|---|---|
| **GNSS Receiver**<br>The SG7 receiver includes a state-of-the-art GNSS engine, high-speed IMU for tilt compensation, a 2-watt Tx/Rx UHF radio, a 4G cellular GSM modem, Bluetooth radio, and Display.<br>Note: the SG7 may be delivered with an orange or blue decorative band. There is |  |

| | |
|---|---|
| no difference between these receivers, other than the band color. | |
| **UHF Antenna**<br>5/8 λend-fed-dipole Antennas with TNC Connector.<br>IMPORTANT: the antenna is in the top of the carry case lid. |  |
| **Wall Adapter**<br>The Power Adapter is used with the Type-C cable to charge the receiver. |  |
| **USB Type-C Cable - A-Male to Type-C**<br>Used to:<br>Charge receiver internal battery.<br>Connect the receiver to a PC and download occupations from the internal memory. |  |
| **Measure-up Plate**<br>Tool for slant height measurements. |  |
| **Carbon Fiber Prism Pole**<br>2-meter carbon fiber prism pole with bubble |  |
| **Field Ready Case**<br>Sealed rugged hard cases with custom foam inserts, and plenty of open compartments to protect your receiver and accessories. |  |

# Optional Accessories

## iGA, High Gain UHF Antenna

Extends UHF Radio range, excellent spare antenna in case the factory antenna is broken.

Click to purchase:

## iGR, 35-Watt External Radio


Works as a remote repeater or cable connected high power radio.

Kit includes:

Radio, Power/Data Cable, 5-dBi Antenna, cable, 5/8” mount, USB-to-Serial adapter, User Manual

Click for additional information:

# Safety Information

Before you use your receiver, please make sure that you have read and understand the following warnings and safety requirements.

An absence of specific alerts does not mean that there is no safety risk involved. Warning and Caution information is intended to minimize the risk of personal injury and/or damage to the equipment.

## Use and Care

The receiver is a field ready instrument; however, it is also a delicate electronic instrument. Take suitable care to avoid damage to the instrument.

Please avoid dropping the receiver directly onto concrete, it can modify the phase center of the GNSS antenna, puncture the metal case, break the antenna mount or break the display.

Avoid storing the receiver at excessive temperatures (hot or cold) as it will damage the internal battery.

Avoid storing the batteries at temperatures less than -40° F (-40° C) and temperatures higher than 160°F (70°C) as it will permanently reduce the battery capacity and life.

DO NOT leave the SG7 or accessories inside a vehicle in the summer. Temperatures higher than 160°F will permanently reduce battery capacity and battery life.

GNSS receivers and especially Lithium-Ion batteries are like puppies: In the summer if you leave them in your vehicle with the windows rolled up, you will kill them.

# Battery Charging and External Power

The supplied wall transformer and cable will charge a fully discharged receiver in approximately 5 hours, 20% per hour. Only the Type-C connector charges the internal batteries.

The round external power connect does not charge the internal batteries; however, the receiver will run off external power indefinitely, switching to the internal battery when external power is removed.

It is possible to purchase reasonably priced external power cables either from Amazon or iGage. See https://igage.com/PowerCables.htm

# Radio Notices

**FCC Notice**: SG7 GNSS receivers comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules when it is used in the Portable Mode.

Operation is subject to the following two conditions:

The device may not cause harmful interference.

The device must accept any interference received, including interference that may cause undesired operation.

**FCC Compliance**:

| Function | FCC-ID | Module Type |
|---|---|---|
| SG7 Device | 2A7ZC-SG7 | Assembly |

# Bluetooth Radio

Radiated output power from the internal Bluetooth radio is far below FCC radio frequency exposure limits. The Bluetooth radio operates within guidelines for radio frequency safety standards and recommendations, which reflect the consensus of the scientific community.

The level of energy emitted is far less than the electromagnetic energy emitted by wireless devices such as mobile phones. However, the use of wireless radios may be restricted in some situations or environments, such as on aircraft or near blasting areas.

# UHF Radios

Every SG7 GNSS receiver includes a 2-watt Tx/Rx radio capable of broadcasting UHF radio transmissions.

## UHF Safety and General Information

When used in the transmitting mode, even though the broadcast power is relatively low, you should take these additional precautions:

### *Medical Devices - Hearing Aids*

Some digital wireless radios may interfere with some hearing aids. In the event of such interference, you may want to consult your hearing aid manufacturer to discuss alternatives.

### *Medical Devices - Pacemakers*

The Advanced Medical Technology Association recommends that a minimum separation of 6 inches (15 cm) be maintained between a handheld wireless radio and a pacemaker. These recommendations are consistent with the independent research by, and recommendations of the U.S. Food and Drug Administration.

Persons with pacemakers should:

- ALWAYS keep the radio more than 6 inches (15 cm) from their pacemaker when the radio is turned ON.

- Not carry the radio in the breast pocket.
- Turn the device OFF immediately if you have any reason to suspect that interference is taking place.

### *Other Medical Devices*

If you use any other personal medical device, consult the manufacturer of your device to determine if it is adequately shielded from RF energy. Your physician may be able to assist you in obtaining this information.

### *Blasting Caps and Blasting Areas*

To avoid possible interference with blasting operations, turn off your radio when you are near electrical blasting caps, in a blasting area, or in areas posted: "Turn off two-way radio." Obey all signs and instructions.

## FCC Licensing Information for UHF Radio Transmit Operation

The receiver includes transmit / receive UHF radios and requires FCC licensure for transmit operation in the United States. It is illegal to operate the device in Transmit mode (as a UHF Base) without a valid FCC license at any output power, in any area, under any non-emergency condition.

If you did not have an FCC license when your receivers were shipped, a default frequency table may have been installed on your receiver. Without an FCC license you may only receive transmissions on these frequencies.

You may not legally use this product in a transmit application without:

Obtaining a valid FCC License.

Verifying the frequency table matches your license.

Adding your FCC ID to the internal radios so that they can properly broadcast your license in Morse Code every 15 minutes.

Putting a label on the devices with your FCC ID.

Keeping a copy of your FCC License with the transmitting devices when they are in use as a transmitter.

In January 2020, the '**P**reventing **I**llegal **R**adio **A**buse **T**hrough **E**nforcement Act, or "PIRATE" Act (S.1228)' was signed raising the penalty for non-compliance to $100,000 per day with a $2,000,000 maximum!

If you choose to operate the receiver as a UHF Base without obtaining an FCC license, you do so at your own risk.

## Obtaining a New FCC License

If you don't have an existing FCC license to transmit UHF corrections and you will be using your receiver as a Base (no license is needed for Rover operation as it is receive-only) you will likely use a 'Radio Licensing Company' to obtain frequency coordination and apply for an FCC license.

We highly recommend using **Forest Industries Telecommunications** to acquire the necessary FCC licensure. For details see https://igage.com/fcc.htm:

The entire FCC application process typically costs around $470, which includes a Frequency Coordination and FCC filling fee.

You may be asked these questions when applying for a license:

| Question | Answer |
|---|---|
| **Frequency Requested** | "Standard RTK GPS Pool", Monitor: NO or "Nationwide Contractor package" |
| **Band** | 451-469, no splits |
| **System** | Conventional |
| **Type** | Base and Mobile Simplex FB.MO |
| **Wattage** | 35 Watts Mobile; 35 Watts Base |
| **Bandwidth** | 12.5 kHz |
| **Interconnection** | None |
| **Emission Type** | Digital Data |
| **Location** | The States where you might work or 'USA' |
| **Antenna Mounted On** | Survey Tripod, not to exceed 20 feet |

| Emission Designator | 9K75F1D |
|---|---|

# Best Practices for Extending UHF Radio Range

The UHF radio in the receiver has excellent range. However, range is greatly reduced by other users on the same frequency, damaged antennas, damaged cables and configuration issues.

The most common range issues are listed below. If you need to dependably operate at more than 3-miles from your Base, consider purchasing an iGR 35-watt base radio:

## Multiple Users on Same Radio Frequency

If someone or something else is utilizing the same frequency for voice or data, it will greatly reduce the distance you can move from your base. This is the most common cause of bad radio range.

Use a Handheld UHF radio to check if the frequency is unused before you start your base. Carry the Handheld radio with you all day so that you can check if someone sets up on your frequency after your session begins.

If you think someone else may have begun to use the same frequency, turn off your base while listening to the frequency.

The 'BaoFeng UV-5R' is available from Amazon for less than $20 and is a 'good-enough' choice for monitoring frequencies:

Become familiar with what it sounds like if you are the only user on a frequency and what it sounds like if there are more than one user on the same frequency.

Sources of interference include:

- other surveyors and engineers
- voice users (truckers, businesses, railroads, schools, service companies)
- wireless microphones
- SCADA equipment (like water or oil pipeline infrastructure)
- control backhauls on com links
- nearby AM or FM radio transmitters
- nearby radar systems

The radio frequencies that are usually assigned (by the FCC in conjunction with frequency coordination) are not exclusive and are assigned to many users in the same area.

Unlicensed voice transmissions have a higher priority than licensed data transmissions. Your radio (the radio built into your Base) will wait for other users before it transmits (this is called CSMA: collision sense multiple avoidance.)

If you find that the frequency that you were going to transmit is busy, you can change the channel/frequency of your Base and Rover to an alternate frequency.

## Base Output Power Setting

You probably will want the radio in your Base to output as high of power as possible.

If 2-watts with an elevated antenna is not sufficient, we recommend purchasing a high-power repeater.

## Bad Antennas

The UHF antennas on most GNSS equipment get beat around quite a bit.

If you suspect that your antenna has gone bad, we recommend that you purchase two spare antennas and change out both your Base and Rover. If the problem goes away, then you know that one (or perhaps both) of your original antennas have failed.

We recommend that you **not** use ¼ wavelength antennas:

They require a ground plane at the Base of the antenna and have significantly (about 1/3) the range of the ½ wavelength dipole antennas we supply. iGage has both factory replacement and heavy-duty super gain antennas available:

# Front Panel Operation

You can configure the SG7 as a UHF Rover or a UHF Base from the front panel interface. It is also possible to reset the receiver from the front panel.

From the primary Status Menu:


Click (Fn) to move to the Main Menu.

Then clicking the (Fn) button cycles through the Main Menu items:


. Click the (power) to select the displayed item.

| | | |
|---|---|---|
| | | |
| Device (power) displays | | |
| SN: 4021230<br>PN: A192189809010<br>7002<br>Register: FOREVER | **Serial Number**: of receiver<br>**Part Number**: of receiver<br>**Register**: Expiration date | click (Fn) to view the second status screen |
| RTK V: 8.1<br>OEM V: 14259<br>UHF V:04.04.06 | **RTK**: Primary Version Number<br>**OEM**: GNSS Board firmware version<br>**UHF**: Radio Firmware version | Click (power) to return to the Main Menu |

displays

| | | |
|---|---|---|
| SET: ON<br>Format: HCN<br>Sample: 1Hz<br>Duration: 1440min<br>OK<br>Cancel | **SET**: recording ON or OFF<br>**Format**: choose between<br>HCN<br>HCN and Rinex2.11<br>HCN and Rinex 3.02<br>Rinex2.11<br>Rinex3.02<br>**Sample**: choose between<br>5 Hz<br>1 Hz<br>2 seconds<br>5 seconds<br>10 seconds<br>15 seconds<br>30 seconds<br>60 seconds<br>**Duration**: enter file length in minutes.<br>**OK**: select and click to save changes.<br>**Cancel**: select and click to abandon changes. | Click Fn to move down through the items.<br>Click to change items.<br>Finally click on OK or Cancel, then to return to the previous menu. |

displays

| | | |
|---|---|---|
| Mode: Auto Rover<br>Protocol: SATEL 3A<br>Step: 12.5KHz<br>Band:9600<br>Channel:1<br>Freq: 461.0250<br>Power: 0.5W<br>Format: CHC516<br>Fec: Close<br>OK<br>Cancel | **Mode**: select between Auto Rover and Auto Base.<br>**Protocol**: SATEL 3AS, CHC, Transparent, TT450S. Satel 3AS is the preferred radio protocol in the USA.<br>**Step**: 12.5KHz or 25KHz channel bandwidth. Most FCC licenses require 12.5 KHz operation.<br>**Band**: the over-the-air Baud rate of the radio transmission. The Baud rate is forced by the channel bandwidth.<br>**Channel**: radio channel<br>**Freq**: the radio frequency of the selected channel<br>**Power**: 0.5W, 1W, 2W output power. (Only asked for Base operation.)<br>**Format**: CHC516, RTD, CMR, RTCM2.3, RTCM3.0, RTCM3.2. (Only asked for Base operation.) CHC516 is preferred and should be compatible with any modern receiver that accepts RTCM3.2 correction formats. (Only asked for Base operation.)<br>**OK**: select and click to save changes. | Click Fn to move down through the items.<br>Click to change items.<br>Finally click on OK or Cancel, then to return to the previous menu |

| | | |
|---|---|---|
| | **Cancel**: select and click to abandon changes. | |
| | | |
| Config displays | | |
| Reset | click to reset all setting to the Factory Defaults. This takes 15-seconds, then the receiver will reboot. | Click Fn to move to the Wi-Fi setting. |
| 2.4G WIFI | click to toggle between 2.4 G and 5.8 G Wi-Fi. 2.4 G is the default value. | Click Fn to move to the Language setting. |
| EN Language | click to toggle through the available languages:<br>EN English, RU Russian, FR French, SP Spanish, PT Portuguese, JP Japanese, CH Chinese | Click Fn to move to the Return icon. |
| Return | click to return to the Main Menu. | Click Fn to move to the Reset menu. |
| | | |
| Return returns to the Status Menu from the Main Menu. | | |

# Compatible Field Software

## LandStar8

The preferred field software for the SG7 receiver is LandStar8. LandStar8 runs on most Android devices, is reasonably priced and has native support for all SG7 functions. Full LandStar8 demos are available. Read this FAQ for step-by-step instructions:

## Other Field Software Tools

The following field software tools are compatible with the SG7 receiver:

| | |
|---|---|
| CHCNav LandStar7: | fully compatible |
| GeoMax X-PAD Ultimate: | fully compatible |
| MicroSurvey Field Genius: | fully compatible |
| Carlson SurvCE version 5.09 through 6.08: | compatible without IMU Tilt Enabled,<br>use iGage iG9 or CHC i90 driver, enter antenna params |
| Carlson SurvPC version 6.07 through 6.08: | compatible with IMU Tilt Enabled,<br>use iGage iG9 or CHC i90 driver, enter antenna params |

Note: Carlson has dropped support for all iGage receivers from all versions of SurvCE and SuvPC higher than 6.08. If you absolutely must use SurvCE or SurvPC, please read these detailed instructions, combined with the antenna definition from the back of this manual:

https://igage.com/out/CHC/faq/CHCiXXwithCarlsonSurvXX608_r002.pdf

# Using the IMU based Tilt Compensation

The SG7 receiver has a built-in, 4th generation accurate, 200 Hz fast, IMU based tilt compensator function. This allows the receiver to report the position of the pole tip, not the location below the receiver.

Once the receiver has a GNSS Fixed position, you need only move a few meters in any direction, then stop for a moment and the IMU should immediately initialize.

Once the IMU is initialized, if you move a few millimeters every 10 seconds, the IMU will continue to work. If you stop movement, for example attach a bipod, the IMU will lose initialization. Typically, you need only move a centimeter to instantly reinitialize.

If the receiver loses fix, then the IMU will lose initialization.

1. **The H.I. (pole height) of the instrument must be correctly entered into the field software**. This setting is communicated to the receiver, and it must be correct!

2. The receiver must have a clean RTK FIX to initialize tilt.

3. Usually, it is sufficient to move a few feet with the receiver fixed to fully initialize tilt.

3. If the pole is held still for 30 seconds, or the pole is violently moved (for example the point hitting the ground) tilt initialization will be lost.

4. The pole should be held relatively still while measurements are averaged.

5. Initialization will be required:

    When the receiver is turned on.
    When the IMU is turned on from the disabled state.
    When the pole is tilted more than 65 degrees from vertical.
    When the receiver is stationary (on a tripod) for more than 10-minutes.
    When the pole hits the ground sharply.

6. The IMU is always disabled for Verified survey and Control survey operation.

# Connecting to a PC or Smartphone via Wi-Fi

The receiver has an internal Wi-Fi Access Point which can be used in conjunction with a PC or smartphone to configure and control every feature of the receiver including firmware updates.

## Wi-Fi turns off after 15-minutes to Save Power

To save power, if the Wi-Fi modem is not connected to device for 15 minutes it may power down, even when Wi-Fi is enabled. Clicking either front panel button will enable it again.

## Connecting a computer or Mobile Device

Device Wi-Fi Overview:

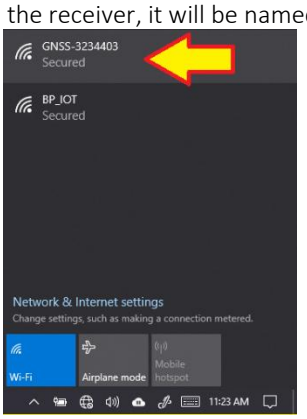
| | | |
|---|---|---|
| SSID: | GNSS-######## | device-serial-number |
| Wi-Fi Key: | (open) | if a Wi-Fi Password is requested, try 12345678 |
| Address: | 192.168.1.1 | |
| port: | 80 | |

User Name: admin lower case
password: password lower case

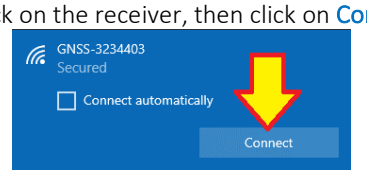
To connect the receiver to your PC with Wi-Fi:

Click on the Network icon in the System Tray

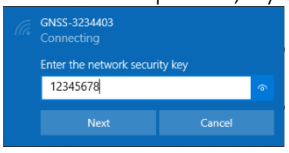
Find the receiver, it will be named 'GNSS-xxxxxxxx' followed by the full serial number of your device:




Click on the receiver, then click on Connect:

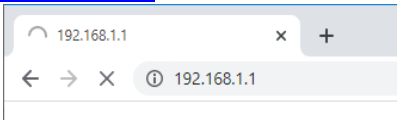



If a password is requested, try 12345678, then click on Next.




Open a browser window on your PC and type in the GPS IP address:

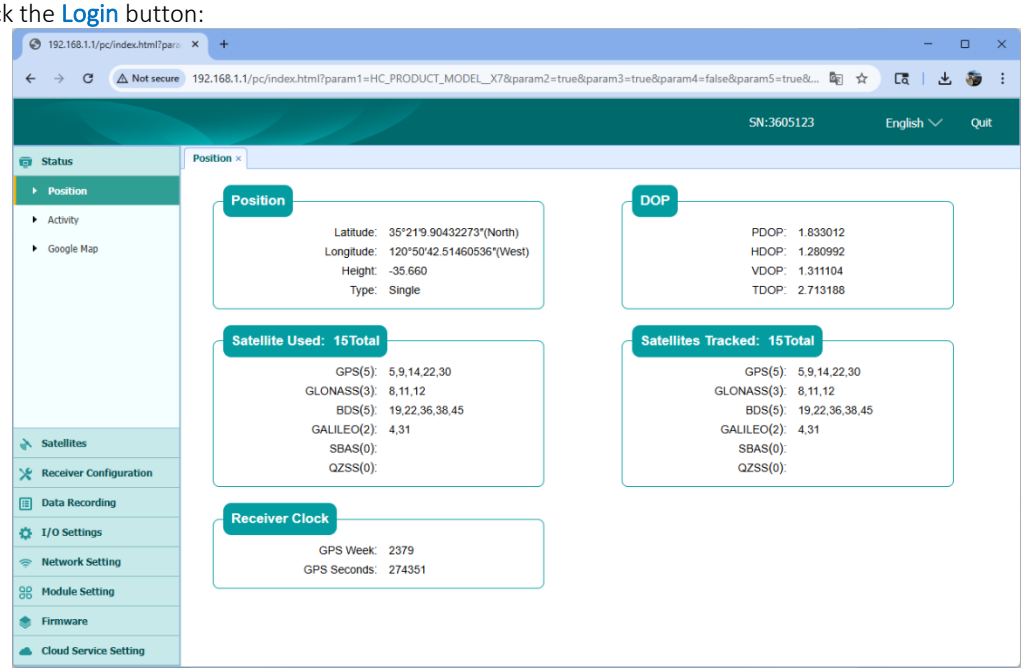
http://192.168.1.1




A Login screen will be shown:


The Login Account is admin and the Password is password.

Click the Login button:




From the Wi-Fi interface, you can configure nearly every aspect of the receiver's operation using the left-hand section tabs and sub-items.

# Configuring the Internal Cellular Modem

**Internal GSM Method:**

To use the internal Cellular modem, you will need an activated 4G NANO GSM SIM card. We recommend using simbase.com:

Triple carrier coverage is available for $0.02 per day, plus $10 per gig (Q3 2025.) A network rover operating 20 days per month for 8-hours per day will use about $4.50 per month in data. With Simbase you don't pay for data that you don't use, and you don't lose excess data that you are forced to purchase monthly. iGage has no affiliation with Simbase and we do not receive any compensation when you use Simbase services.

Insert the NANO SIM card into the card slot:

Receivers use a NANO sized SIM card. (NANO is the smallest sized SIM card.) Insert cards with the gold contacts facing away from the 5/8" threaded insert at the center of the receiver. The notch end goes in first. The SIM card gold contacts should point towards the gold bar at the bottom of the slot. The icon shown on the rubber slot cover is misleading.

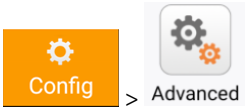
To eject a SIM card, push it in to trigger the spring-loaded ejection mechanism.

You must configure the APN (Access Point Name) via the web interface or with field software. In the United States of America, the modem power must be cycled to reset the cellular network. In other words, if the receiver is turned on and you insert or change the SIM card, you must cycle the receiver's power.

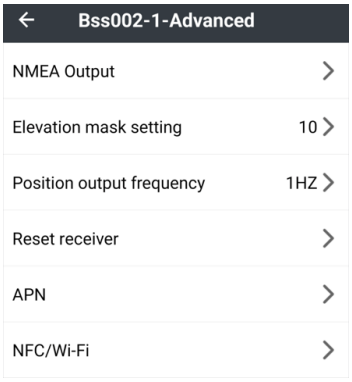
# Configuring the APN and Dialing parameters with LandStar8

Connect to the receiver.

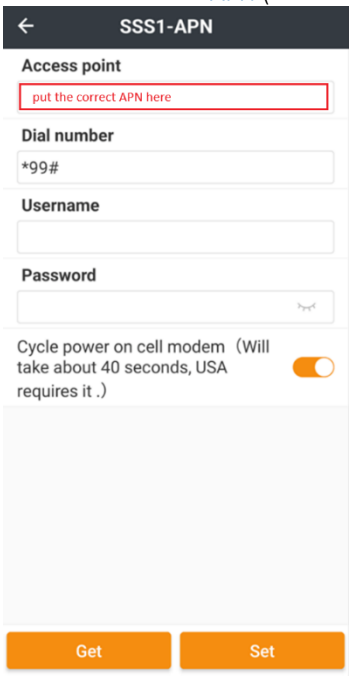
From the main menu Config (tab), click the Advanced button:




Click the APN selection:




Set the cellular modem APN (Access Point Name), Dialing number string, SIM Username and SIM Password:




If you are using a simbase card, the APN will be simbase with all lower-case characters.

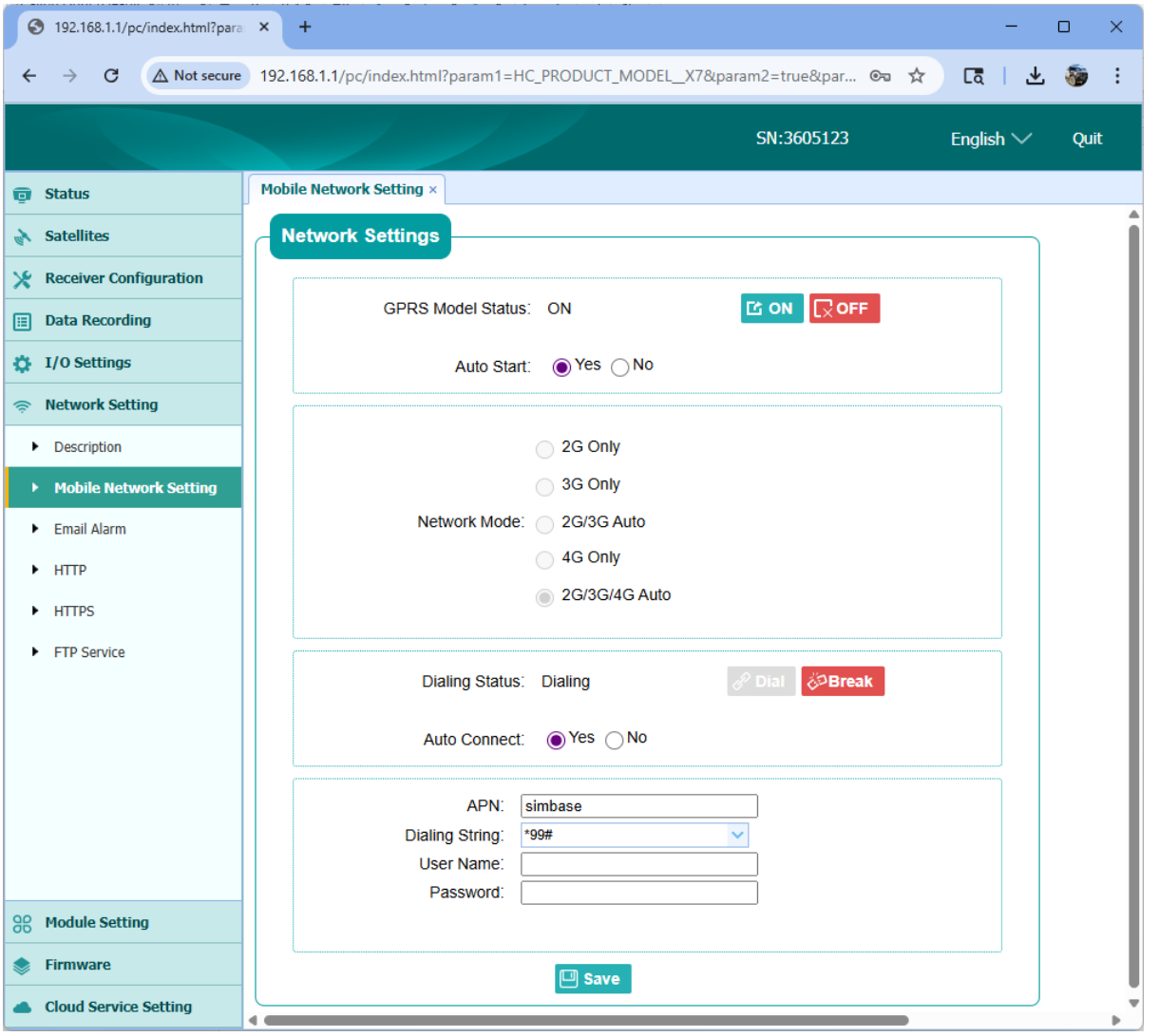
In the USA, the Dial number normally is *99# and both the Username and Password will be blank.

Important: It is necessary to power off the modem, wait 30 seconds then turn the modem back on after changing the Access Point Name (APN). Enable the Cycle power… option to automatically turn off the cellular modem, wait 40-seconds, then turn the modem back on again.

## Configuring the APN and Dialing parameters with the Web Interface

Follow the Wi-Fi connection instructions ‘Connecting to a PC or Smartphone via Wi-Fi’ on page 18.

Click on the left bar item Network Setting then Network: Mobile Network Setting:




Click the ON button to turn on the cellular modem.

Set **Auto Start** to Yes, set **Auto Connect** to Yes.

If you are using a:

simbase card: set the APN to simbase

'True ATT' SIM card: set the **APN** to Broadband (with capital 'B')

Verizon: set the APN to vzwinternet

T-Mobile: set the APN to fast.t-mobile.com

If you use another type of SIM card enter the appropriate APN for the card.

Set the Dial String to *99#, leave the User Name and Password empty. Click Save.

Turn off the GPRS Modem by clicking OFF, wait 15 seconds then turn the GPRS Modem on again by clicking ON. This resets the network connection with the correct APN and forces the network to reinitialize the data connection.

Click on **Dial** to connect. Within 30 seconds, the **Dialing Status** will change to '**Connected**' after the receiver is registered on the cellular network.

Alternatively, you can configure the Cellular modem with X-PAD, Field Genius or SurvCE/SurvPC when setting the receiver as a network Rover or Base.

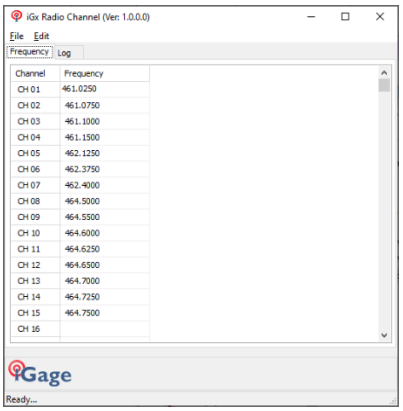
# Programming Radio Frequencies and FCC ID

In the United States an FCC license is required to operate the UHF radio at any power, on any frequency. Your FCC license will specify one or more frequencies and a 'Call Sign' which must be broadcast at least once every 15-minutes.

You can download the iGx_RadioChannel.exe tool along with prebuilt common radio frequency groups from the iGage.com website:

https://igage.com/out/RadioChannelFiles/cfg_WebInterface/index.htm

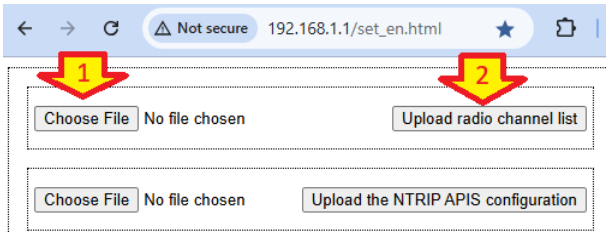
With the radio channel tool:




It is possible to create a standard list, modify frequencies, and reorder the frequency list. When the frequency list matches your FCC License, then you can save a .CFG file for uploading to the receiver.

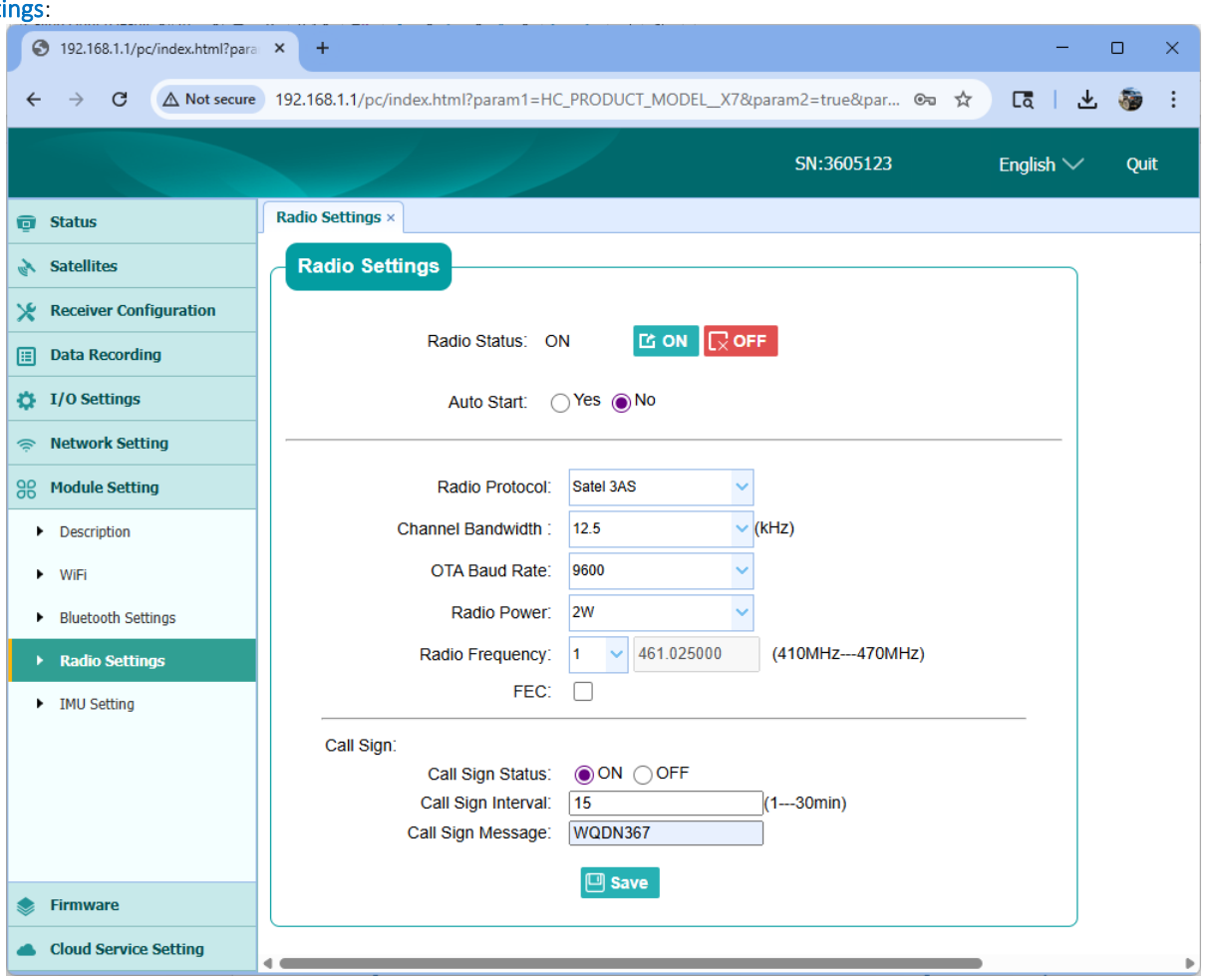
First login to the GPS receiver via Wi-Fi. See 'Connecting to a PC or Smartphone via Wi-Fi' on page 18.

Open a browser and go to this address http://192.168.1.1/set_en.html :




(1) Click on '**Choose File**' and browse to the settings file, then (2) click on '**Upload radio channel list**' the new radio table list will be installed in the head.

To set the broadcast FCC Call Sign, from the main menu (http://192.168.1.1), click on Module Setting then Radio Settings:




If the Radio Status is OFF, click ON to turn on the radio power.

The Call Sign Status should be set to ON, the Call Sign Interval should be 15 minutes or less, the Call Sign Message should be your FCC Assigned Call Sign.

Once entered, click on Save to commit the changes to the internal radio.

# Configuring a Base Receiver as a Wi-Fi NTRIP Caster for use with a UAV / USV

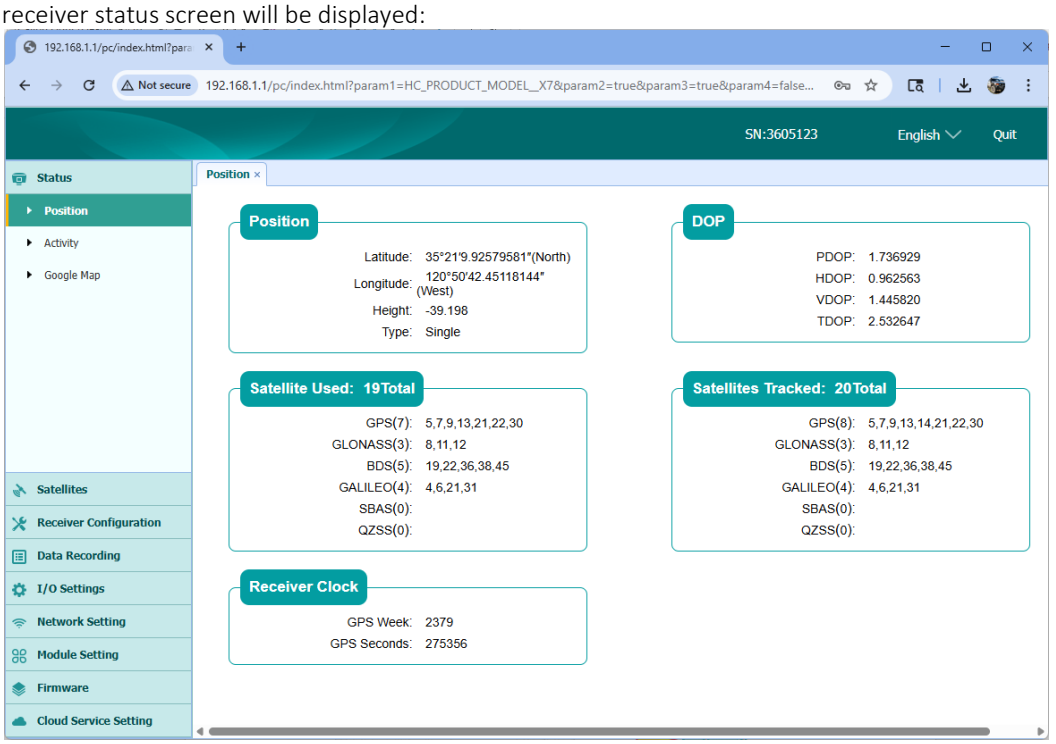
The receiver has an internal NTRIP caster that can be used to send Base corrections to drone controllers or other devices via Wi-Fi.

APIS or a Static IP enabled SIM card can also be used to transport corrections to external devices via the NTRIP protocol.

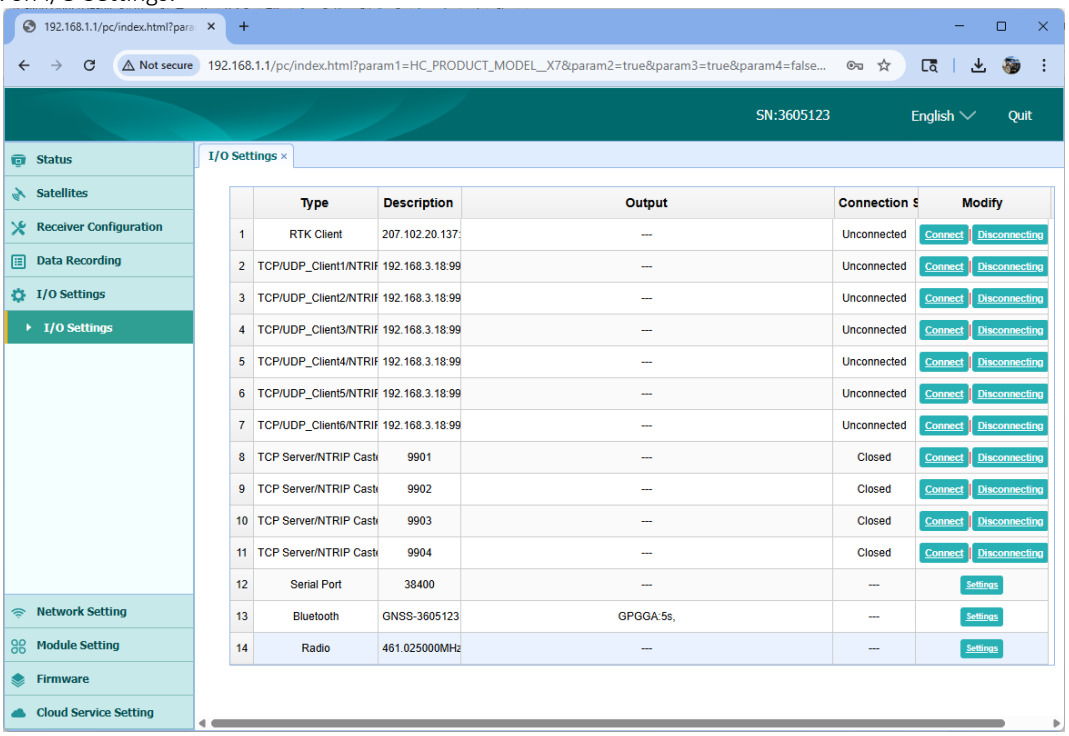
Once you configure the caster, it will stay setup until a complete factory reset is performed. This is a once and done configuration.

1. Connect to the receiver via Wi-Fi as shown in 'Connecting to a PC or Smartphone via Wi-Fi' on page 18.

2. The receiver status screen will be displayed:

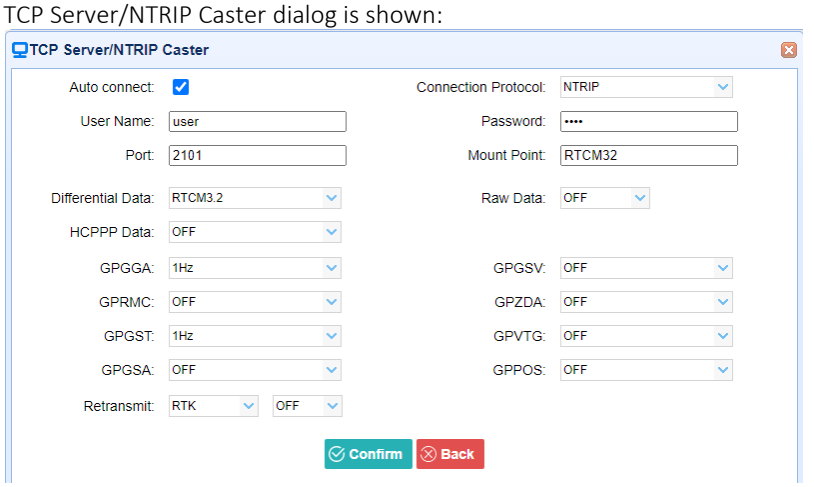



3. Click on I/O Settings:




4. Click on the Connect button for the first TCP Server... line, usually line 8:

5. The TCP Server/NTRIP Caster dialog is shown:

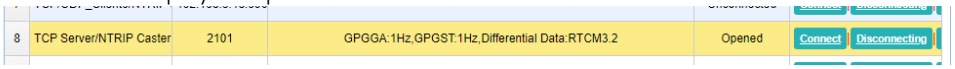



Configure:

| | |
|---|---|
| Auto connection | Checked (TRUE) |
| Connection Protocol | NTRIP |
| User Name | user |
| Password | user |
| Port | 2101 |
| Mount Point | RTCM32 |
| Differential Data: | RTCM3.2 |

Click on Confirm.

6. The port will now display as 'opened':




The NTRIP configuration is complete and will remain available/active until you change it or do a factory reset on the receiver.

You must setup the receiver as a Base with a location that matches the location.

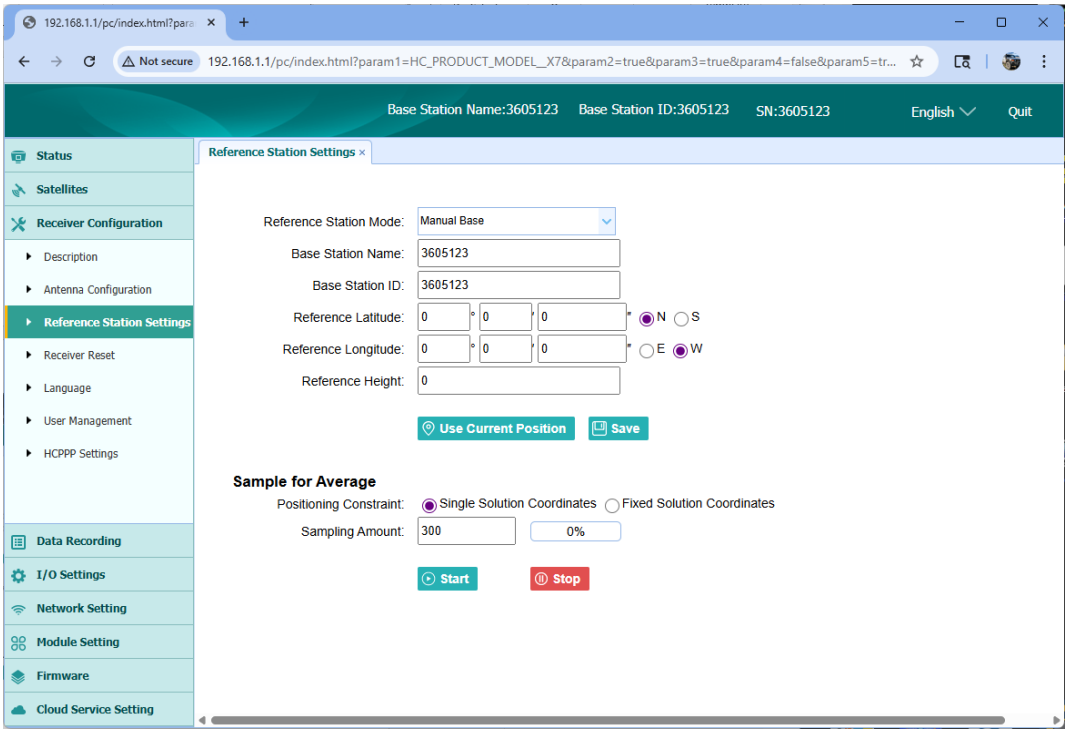
## Configure the Caster Receiver as a Base

Setup the head as a Base using Carlson SurvCE/SurvPC, X-PAD, Field Genius, LandStar or via the Web interface directly (shown below).

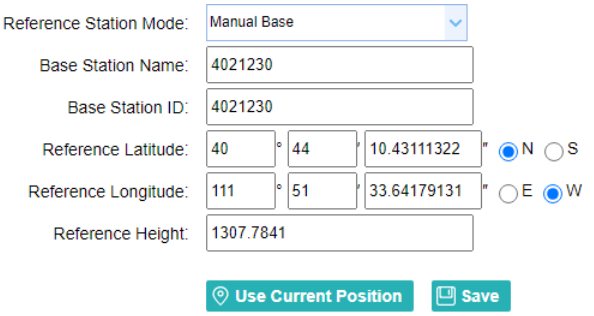
### To configure from the web interface

Login to the receiver as shown above.

Click on Receiver Configuration, then Reference Station Settings:



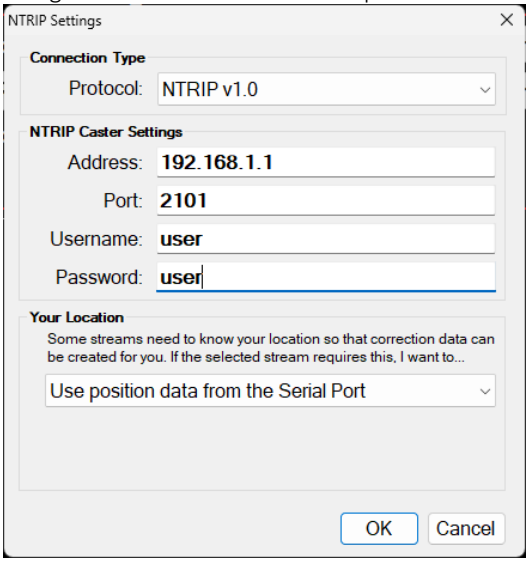

Set Reference Station Mode = Manual Base. Click on Use Current Position:




The receiver's autonomous position will be loaded, click Save to start Base operation at the entered coordinate.

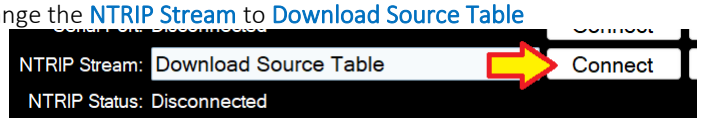
## Verifying the NTRIP Caster

While a PC is connected to the receiver, it is possible to use an NTRIP client to verify that the caster is functional. This is the configuration for the receiver setup above:



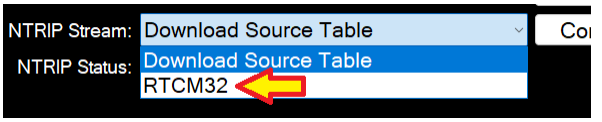
Click OK.

Change the NTRIP Stream to Download Source Table



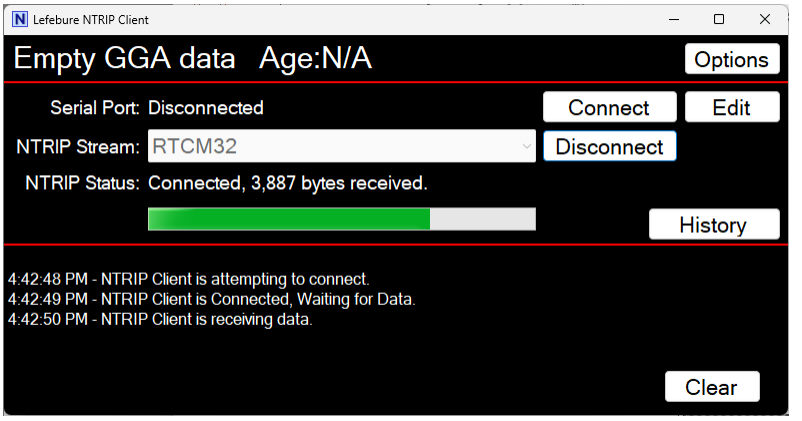

Then click Connect.

Drop the NTRIP Stream:




and select RTCM32.

Click Connect:




Correction data will begin streaming.

## HCN vs. RINEX2 vs. RINEX3 Observation files

The SG7 receiver can directly record 3 types of observation files:

| | |
|---|---|
| RINEX2 Legacy: | no longer suitable for GNSS receivers. |
| RINEX3: | correct choice if you don't want to use the iGx_Download helper tool. |
| HCN: | correct choice if you want to use iGx_Download. |

The selection can be made within LandStar8 when configuring a Base profile, from the Config > GNSS static recording button and from the Wi-Fi interface.

**RINEX2** is no longer viable because the legacy tool TEQC which the NGS and most other tools use to process RINEX2 crashes when BeiDou satellite PRN's higher than 47 are encountered. This means that if one of the new BeiDou satellites is in view at any time during your observation, processing will crash. In addition, it is not possible to fully encapsulate all modern signals within RINEX2 files, so there will also be a loss of signal recording.

**RINEX3** is the correct choice for submitting GNSS files to OPUS as it begins to process full GNSS data. However, OPUS will not accept large observation files so if you collect at higher than 15-second observation rates, you may need to manually decimate files prior to submission.

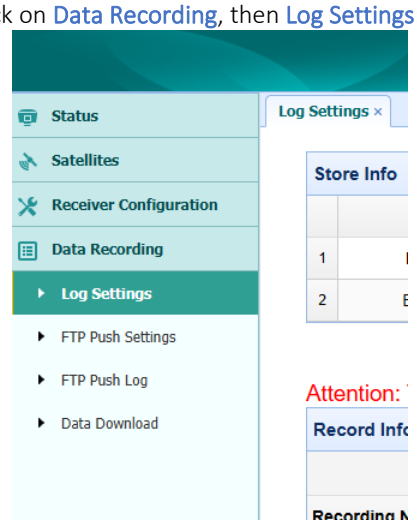
**HCN** format is compressed, and it is possible to create both RINEX2 and RINEX3 files from HCN files. If you want to use the iGx Download tool you must set the filetype to '.HCN'. iGx_Download always allows you to export full rate data, however it automatically decimates data to 30-second interval when sending to OPUS. With .HCN files and iGx_Download, you can have high-rate data and send smaller files to OPUS.

## Recording Repeating Observation (RINEX) Files

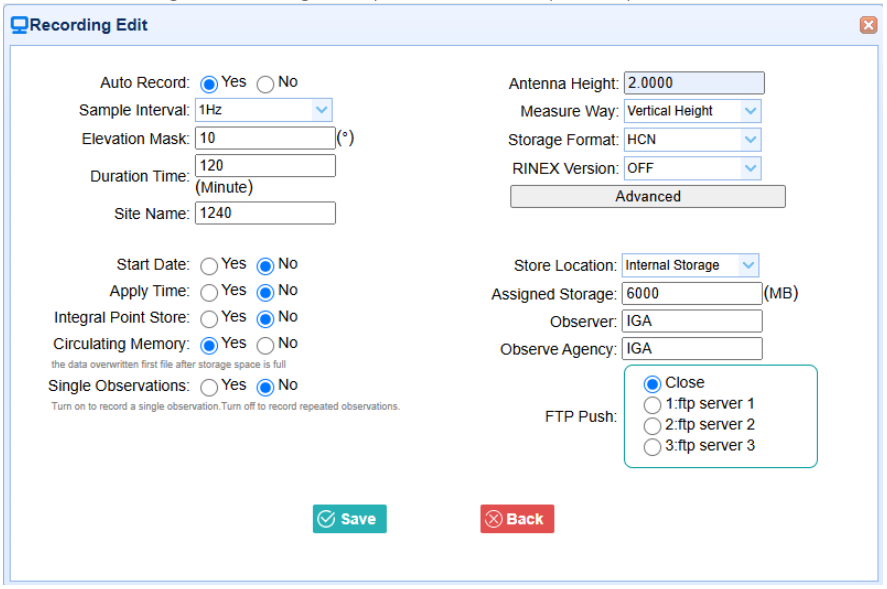
Observation files are limited to 24 hours (1,440 minutes). If you want longer files, continuous recording allows multiple end-to-end files to be collected. These files can be concatenated after collection.

By default, the SG7 will record one file and then stop recording. To record continuous files, log into the device web interface as shown in the section Connecting to a PC or Smartphone via Wi-Fi on page 18.

Click on Data Recording, then Log Settings:




These are the settings for making multiple 120-minute-(2-hour) files:




The title Repeat Observations is misleading, the title should be Single Observations. Set this to No to enable multiple observation files.

# Downloading, Processing and Archiving Static Data

Your SG7 GNSS receiver is compatible with a download, preprocessing and archive tool called:

### iGx Download

This tool simplifies RINEX file generation and submission to NGS OPUS, RTX and exporting general files for external use. iGx_Download runs on Windows PC's and is available by web download.

# Installing the Download Tool

Download the latest version of the iGx_Download tool from the iGage.com website and install it on your computer. From the main iGage page, look for this link:


Or use this link: https://www.igage.com/iGx_Download.htm

Follow the on-screen instructions to install the iGx Download tool on your computer.

# Starting the iGx Download Tool

You can start the iGx download tool by clicking on the iGx shortcut on your desktop:


# Downloading Data

Data can be downloaded using the included USB Type-C to Type-A cable, or via the Wi-Fi connection.

## USB Cable Download

Summary: Turn on the GPS, plug the USB Cable into your computer.

The receiver mounts just like a USB thumb drive (flash drive) on your computer. No special drivers are required.

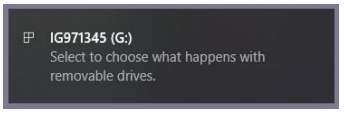
To download data from your receiver:

1. Turn on the GPS receiver.
2. Plug the USB-C connector into the USB hole on your receiver:

and the other end into a USB port on your computer.

3. If you see the Windows AutoPlay screen:


click on the red 'X' button on the upper-right corner to close it.
If you see the Windows AutoPlay screen:




ignore it.

The first time you attach a receiver; you may need to wait for a few minutes for standard device drivers to be downloaded / installed.

Since the drive connects as a standard USB thumb drive the drivers are built into Windows XP, Windows Vista, Windows 7, Windows 8, Windows 10 and Windows 11.

If your receiver does not mount or an error message is displayed, you can usually unplug the receiver, wait a moment, then plug it back in.

Assuming the receiver is plugged in and has mounted (as a lettered drive) just press:

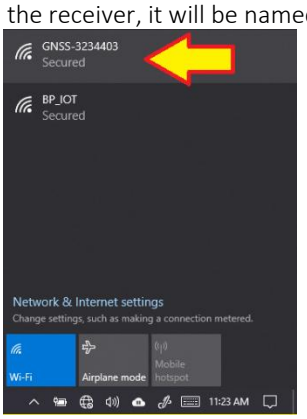

The program will automatically switch to the '_New' project and download every new file from your receiver. As files are downloaded, they are marked on the receiver as 'Downloaded', however they are not deleted from the receiver and can be manually downloaded again later if needed.

## Wi-Fi Download

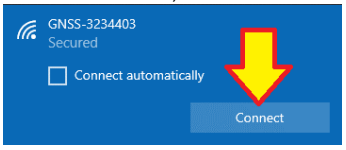
Connect the receiver from your computer using Wi-Fi.

Click on the Network icon in the System Tray

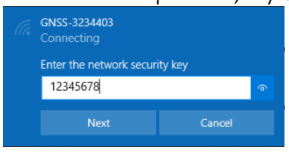
Find the receiver, it will be named 'GNSS-xxxxxxxx' followed by the full serial number of your device:




Click on the receiver, then click on Connect:

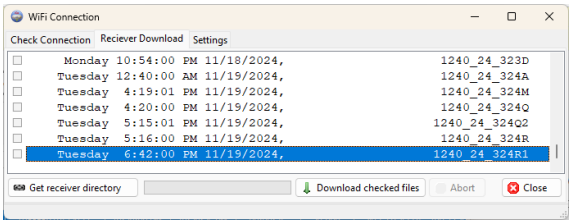



If a password is requested, try 12345678, then click on Next.




Click the Wi-Fi download button:

iGx will build a list of all observation files available on the receiver:

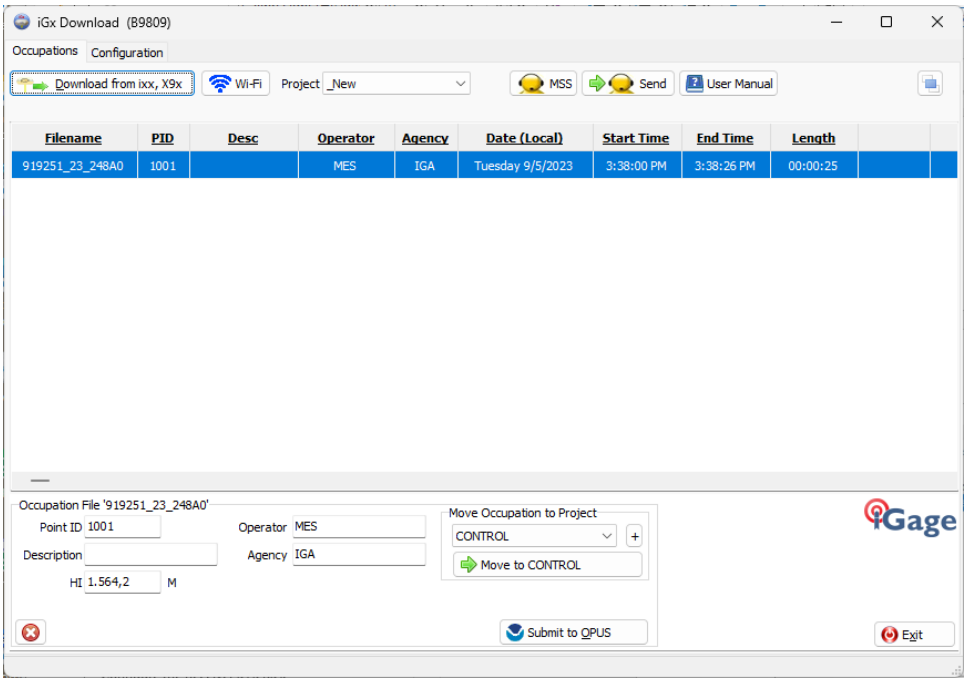



Check the files you want to download, then click the Download checked files:


The program will automatically switch to the '_New' project and download the selected files from your receiver. As files are downloaded, they are marked on the receiver as 'Downloaded' however they are not deleted from the receiver and may be manually downloaded again later if needed.

## After downloading by cable or Wi-Fi

As the '.HCN' binary files are downloaded from the receiver they are automatically converted to RINEX and added to the '_New' project and displayed in the occupation grid.




You can sort the grid by Filename, PID, Description, Operation, Agency, Start Date/Time, End Date/Time and Length by clicking on the column header. Clicking twice on the header will reverse the grid sort order.

If you have any short or unneeded occupations, you can select and delete them with:

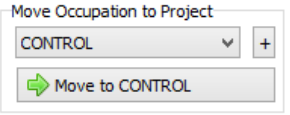
 <- the 'Delete Occupation' button.

For each required observations, enter the values you recorded in your field book:

1. **PID:** (Point ID) A unique short identifier for each marker (usually a 4-digit integer.) Only letters, numbers and the underscore are allowed in the PID. This number ends up as the first four characters of the filename sent to OPUS and can be used to correlate occupations to OPUS solutions.
2. **Description:** A longer description of the point. Note that quotes (", ') are not allowed in the description.
3. **HI:** The Instrument Height which is the distance from the ground mark to the bottom of the receiver
   add '**F**' to enter feet.
   add '**S**' to enter slant height.
   add '**SF**' or '**FS**' to enter slant feet height.
4. **Operator:** This value gets placed in exported RINEX files

5. **Agency:** This value gets placed in exported RINEX files. By convention this is usually less than 6 characters. A current list of official contributors can be found with this online link: https://geodesy.noaa.gov/cgi-bin/get_contrib2.prl. If you plan to contribute to NGS or international projects follow this link: https://geodesy.noaa.gov/FGCS/BlueBook/annexc/annexc.index.shtml for information on obtaining an agency code.

If the '_New' folder gets too full, you can make a new project folder (with the "+" button) and move occupations to the new project:

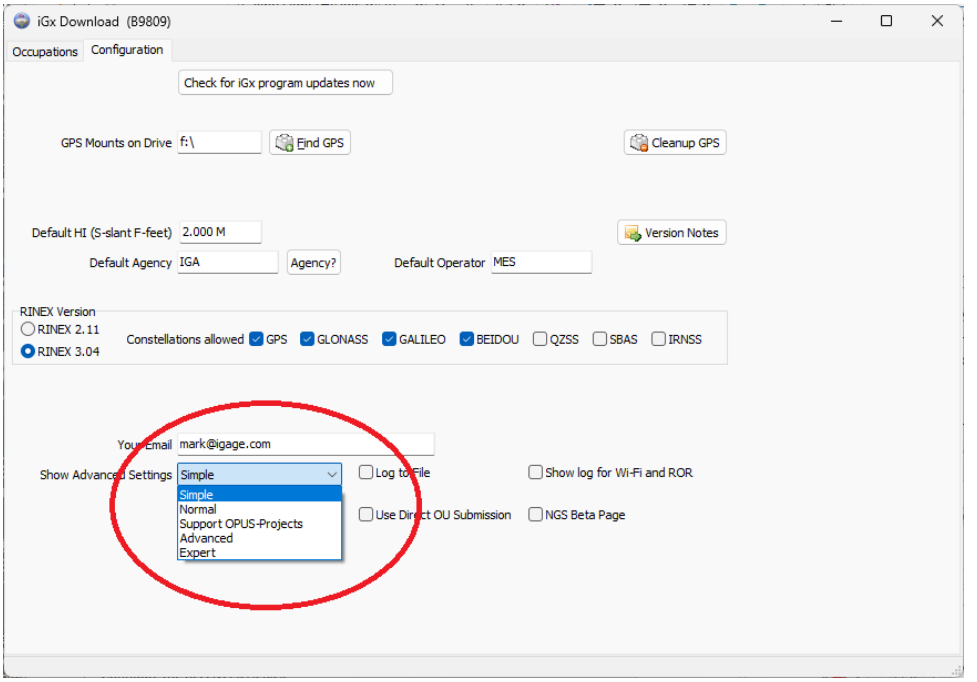



## IMPORTANT! Exporting to other Programs (NOT OPUS)

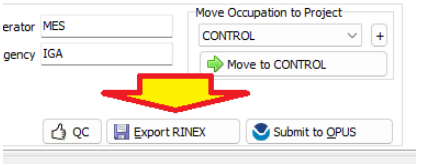
The files that are sent to OPUS by the iGx_Download tool are decimated and may be stripped of all satellite information except for GPS.

Again, Galileo, GLONASS and BeiDou may be removed, and the files are decimated to even 15-second intervals!

If you are using the occupation file in another application select the 'Configuration' tab, then choose 'Show Advanced Settings = Normal' (or Advanced).




An 'Export RINEX' button will now be shown on the main 'Occupations' tab:



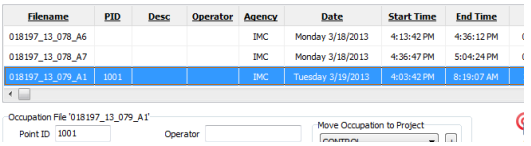

Use this export button to write **full rate** (not decimated), **full constellation** RINEX files for use in external applications.

RINEX files generated with this export function have the correct User, Agency, HI, Antenna Type loaded into the headers.

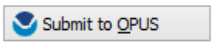
## Submitting an Occupation to OPUS

Once the new occupations have downloaded you can submit an occupation to NGS OPUS, NGS OPUS-RS, RTX, AUSPOS. IBGE or post-process them using other software / services.

Click on an occupation to select it:



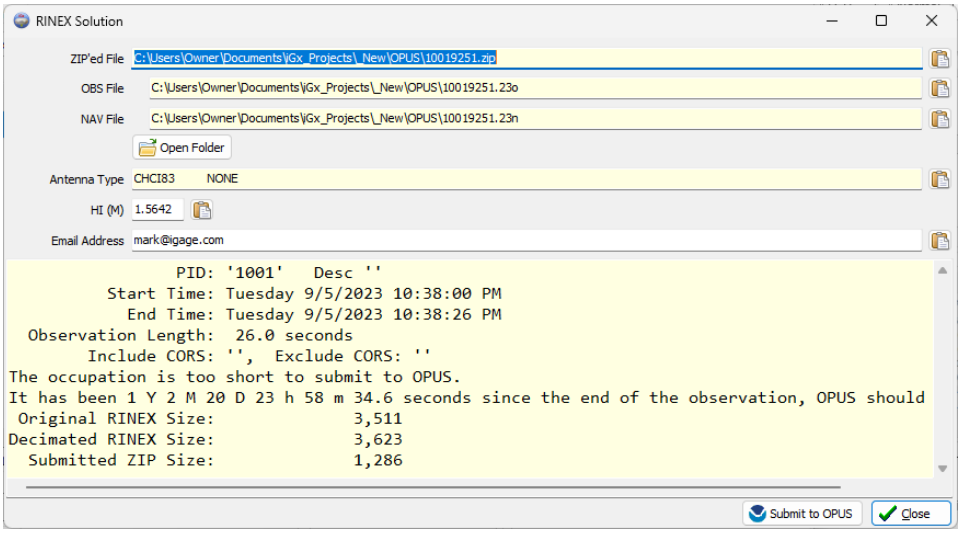

Click on the 'Submit to OPUS' button:




The currently selected occupation will be processed and prepared for upload to OPUS:

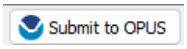
1. The file is decimated to 15-second epochs, header information is stuffed.
2. The file is run through TEQC to insure it will be acceptable to OPUS.
3. An Observation file and a Navigation file are generated.
4. The Observation file is compressed into a ZIP file.

If the 'Show Advanced Settings' is set to "Simple" then the program will skip directly to the '**Verify Filename to Upload**' screen (shown below.) If 'Show Advanced Settings' is set to "Normal", "Support OPUS-Projects" or "Advanced" then this 'RINEX Solution' helper screen is shown:



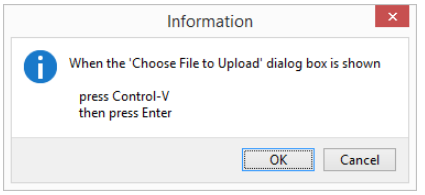

The program will suggest which service (OPUS-Static or OPUS-RS) and list the time since the end of the occupation with notes about the observation.

You can click the 'Submit to OPUS' button:

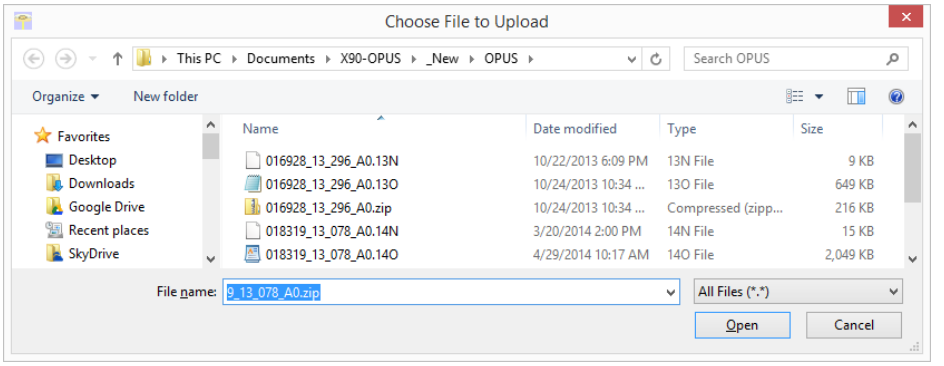



to automatically open an internet browser, which will load the NGS OPUS Submission form. After the web page has loaded, the program will automatically fill in the 'Antenna Type', the 'Antenna Height' and the 'Email address.'

Next the program will prompt you with instructions for automatically entering the Zipped observation file name into the browse dialog:

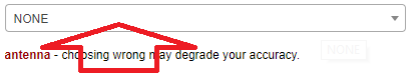



Click OK and then 'Choose File to Upload' will be displayed:




Press Control-V, then the 'Enter' key on your keyboard. You may also press Control-V, then click the 'Close' button with your mouse.

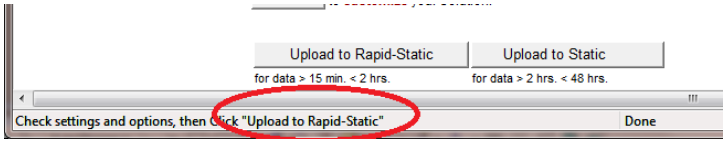
You will need to manually select the correct antenna type. Click anywhere in the 'antenna' selection box:




In the drop-down selection box:

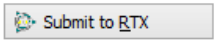

Enter the first few characters of the antenna name and then click on the correct selection to choose the antenna model.

The NGS OPUS Submission form will be ready to submit, check the entries and any extended options that you might want to use. The status bar will prompt you with the correct submission button:




Press either the 'Upload to Rapid-Static' or 'Upload to Static' button as directed, and your occupation will be uploaded to OPUS for processing.

On the configuration tab, you may select the alternative RTX PPP Service provider:



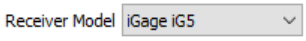

Trimble's RTX Service

# Occupation settings

## Setting the Receiver Type

(Hidden when Simple)

When files are downloaded from the receiver, the receiver type is associated with the .HCN file. The 'Receiver Model' shows an occupation's associated hardware type:




If this is consistently incorrect, you can change the device type while the receiver is connected on the 'Configuration' tab.

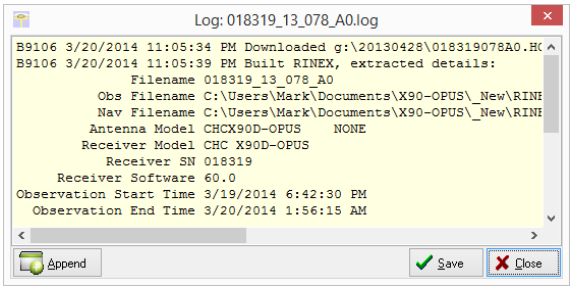
## Viewing the Observation Log

*(Hidden when Simple)*

A detailed log is automatically kept for the files that you download and submit for processing.

Pressing the 'Log'

button shows the log file for the currently selected observation:




Pressing the 'Append'


button adds a date/time stamp and opens the log for user editing.

Press 'Save' to store your changes or 'Close' to close without saving.

## Trimming Occupation Files

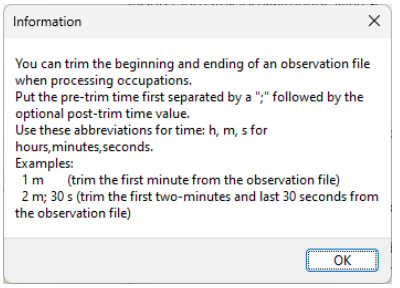
*(Hidden when Simple)*


Sometimes you may want to trim the start or end of an occupation file before you send it to OPUS.

Common reasons for wanting to do this include:

- The receiver is turned on while sitting on your tailgate and then moved 20 feet and spun onto the tripod. The first 5-minutes of the observation are bogus.
- The operator forgets to turn off the receiver and observation data is collected while the receiver is transported back to the truck. The last 2 minutes of the observation file are bogus.
- The observation extends 5-minutes past midnight UTC, you don't want to wait an extra day to process. Trim 6 minutes from the end of the file.

Clicking the '?' button to the right of the trim dialog displays helpful instructions:



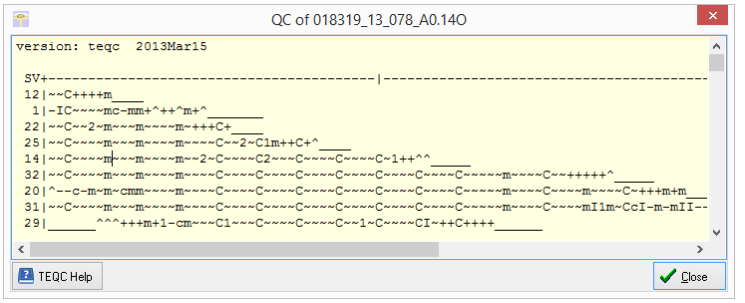

Note: the trimmed length is not reflected in later screens or on the occupation grid. Only the submitted file is trimmed, all the original data remains in the occupation.

## Performing Quality Control

*(Hidden when Simple)*

Pressing the


button will launch the UNAVCO TEQC tool and run a standard RINEX QC run on the currently selected observation file. When the run is complete, the results will be shown in a window:




You can press the TEQC Help button to download the User Guide for TEQC from the UNAVCO web site.

TEQC is a great tool for evaluating both the receiver's performance and the site suitability for collected data.

## The MSS Factory Support Button


If you contact iGage for support, the technician may ask to view your computer screen remotely. Clicking the MSS button will download a support tool and provide a passcode that you can read to the technician who will then be able to view your screen and assist with issues.

## The Send Occupation to Factory Button

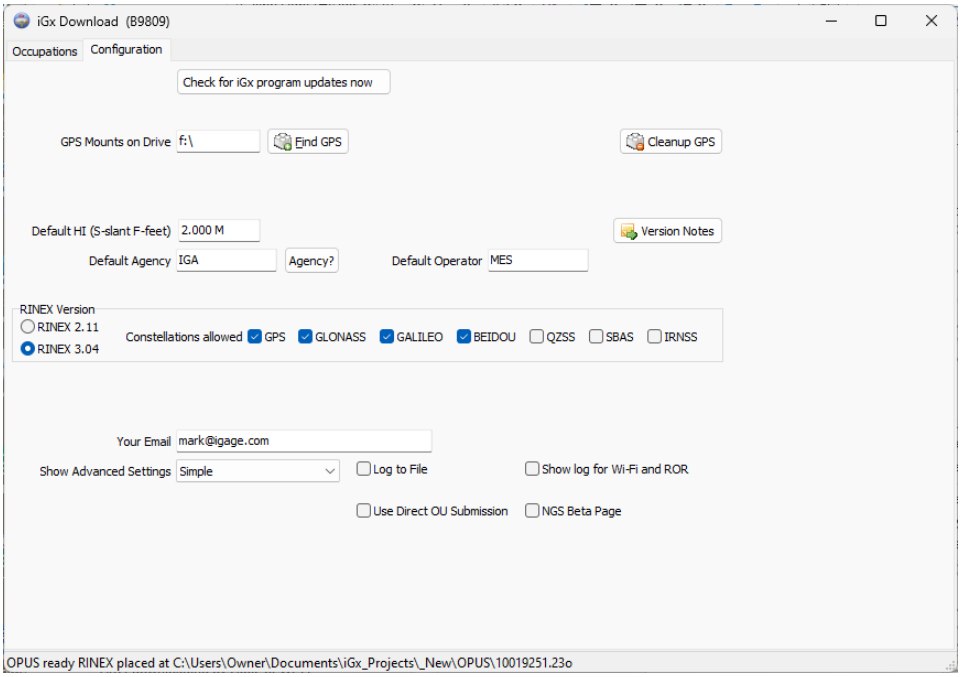

An iGage support technician may ask you to send a troublesome occupation to the factory for assistance. Simply highlight the occupation in the grid, click the 'Send' button and the occupation with all of the support files and settings will be bundled into a single ZIP file and pushed to the factory.

After you send a file, the resulting filename will be shown. You need to let the factory support person know what the filename is so they can find it on our servers.

# Advanced Configuration Settings

## Configuring the Download Tool

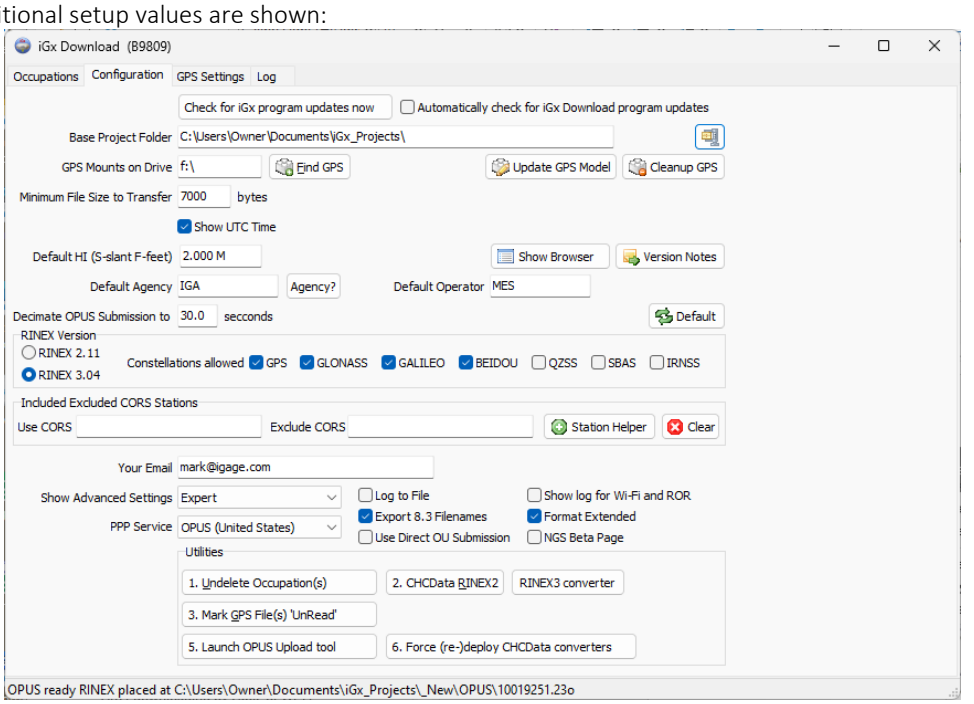
Click on the 'Configuration' tab:




At a minimum enter these values:

**Agency** Your company name.
**Operator** The name of the default operator.
**Email** Your email address.

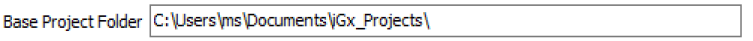
If you change 'Show Advanced Settings' from 'Simple' to 'Normal', 'Support OPUS Projects', 'Advanced' or 'Expert' additional setup values are shown:




You can change the rest of the configuration values as needed. Here are detailed descriptions for each of them:

## 'Base Project Folder'

*(Hidden when Simple)*




This is the full Window's path to the base folder where all the data is stored. The default location is in your 'Documents' folder in a folder named 'iGx_Projects'. (If you have used earlier versions of the X9x download tool, the default location may be 'X90-OPUS'.)

Double-click over the current path to change the folder location.

In the Base Folder, the download tool will create a sub-folder for each Project that you add. In addition, there are always three special folders:

**_New** new occupation files downloaded from the receiver are placed here first.
**_Deleted** When you delete an occupation, it is not really deleted, it is moved to the _Deleted folder. An undelete function is included in Utilities.
**_Error** sometimes short occupations won't include navigation records; these short files end up here.

## 'Archive All Projects'

*(Hidden when Simple)*

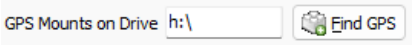
Pressing the 'Archive' button to the right of the Base Project Folder entry will back up every occupation in every project to a single ZIP file.

This is handy if you want to move all your data to another computer or make regular disaster recovery backups.

There are similar Archive buttons on the main page: one archives the current occupation and the other archives the entire current project.

The download tool does not provide a method to restore these backups, however they are standard ZIP files, and the Windows operating system does include a tool to decompress them.

## 'GPS Mounts on Drive'




This is the drive letter that the GPS receiver was last found on. Don't worry if the drive letter changes when you plug in your receiver, the program will automatically find the receiver when you try to download data.

If you want to verify that the GPS receiver is connected and the receiver has successfully mounted as a drive, press 'Find GPS'.

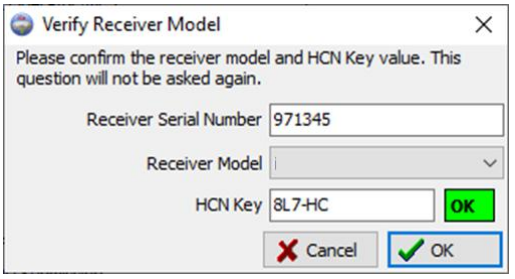
> Note: If you manually remove every single file and folder on the GPS receiver, the program won't be able to automatically find the receiver until after the GPS has recorded at least one file.

## 'Update GPS Model'

*(Shown only when Advanced selected.)*


The GPS Model is written into the receiver at the factory. If you remove ALL of the files on the receiver or format the receiver (it is a standard flash drive) it is possible that it will lose its receiver type.

With the receiver attached to your computer with the USB cable, click on the 'Update GPS Model' button to display this dialog:




Use the drop down 'Receiver Model' to change the receiver type.

If the HCN Key is empty, look for a white sticker inside the carry case, or call iGage +1-801-412-0011 x0 and ask for one.

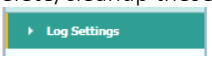
If the HCN Key has been correctly entered, the 'OK' will be shown in a green box, otherwise it will display '????' in a red box.

Click the 'OK' button to store the receiver type and HCN key on your computer.

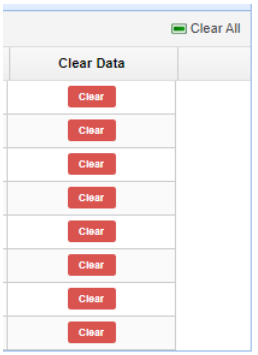
## 'Cleanup GPS'

Note: Cleanup GPS is not possible on the SG7. You must login to these receivers by Wi-Fi and use the Clear button under Data Recording > Log Settings > Clear data > Clear

To delete/cleanup these read-only receivers you log into the Web interface, click on Log Settings:




Then use the Clear buttons:



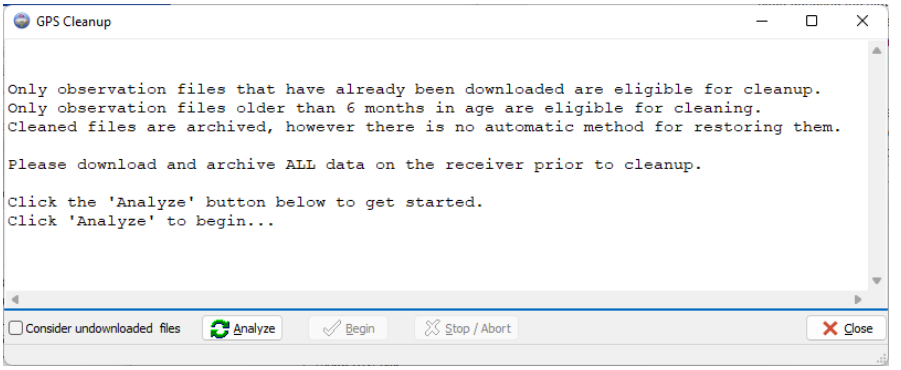

to clear the recording bins or 'Clear All' files on the receiver.

Receivers have different amounts of internal memory available to store observations. Some receivers will automatically delete older files to make room for new observations. Other receivers like: X91+, X900+, X90, X900S, iG3, iG4 will eventually fill up.

Clicking the:


Will analyze the attached receiver and aid in cleaning up older files. Only files that have previously been downloaded (this can be overridden) and are older than 6-months are eligible for deletion. All files are backed up to a special folder on your computer prior to deletion.

After clicking 'Cleanup GPS' this dialog will be shown:

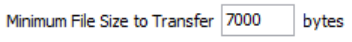



Click the 'Analyze' button. The cleanup tool will display a summary of the space used, space available and the space that will be recovered if cleaned.

Click the 'Begin' button to start the cleanup process. Each cleaned file will be copied to the '__GPSBackup' folder under the 'Base Project Folder'. After all files eligible for cleaning are copied and removed from the receiver, all empty folders on the receiver will be removed.

## 'Minimum File Size to Transfer'

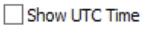
*(Hidden when Simple)*




Every time you turn on the GPS receiver, it may try to track satellites and open a new occupation file. Often several small junk files will be created that don't have any meaningful data and are of no value.

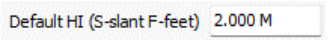
The download tool will automatically ignore files smaller than this minimum value. This keeps useless files from cluttering your computer.

## 'Show UTC Time'




When unchecked (the default,) the download tool will show the observation start and end times in your local time zone. If you check 'Show UTC Time', then the times are displayed in UTC time.

## 'Default HI'




When you download an occupation from the receiver, this HI will be the default associated with every occupation. You can change the HI for each individual occupation later, this is just the default.

If you ALWAYS use a 2-meter range pole, then this value will always be 2.000 M and you won't have to worry about HI blunders.

FEET: If you measure up in feet, you can enter the height in decimal feet and put an 'F' after the measurement. The program will automatically convert to Meters for you.

SLANT HEIGHT in Meters: If you measure a slant height in meters, enter an 'S' after the measurement and the program will compute the vertical height for you.

**SLANT HEIGHT in FEET**: If you measure a slant height in feet, enter 'SF' or 'FS' after the measurement and the program will compute the vertical height in Meters for you.

Note: if you use the 'PPP Service' = 'RTX (CenterPoint)' the submitted RINEX file spoofs a 'UNKNOWN EXT NONE' and adjusts your actual HI to reflect the generic antenna L1 offset.

## 'Default Agency'

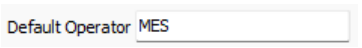

Enter your company code here. This value is placed into every RINEX file that is exported. You can override this value on a file-by-file basis.

Typically, the Agency is 2 to 6 characters in length however the RINEX definition allows values up to 40 characters in length.

Clicking the 'Agency?' button will launch your web browser to the NGS site:
https://geodesy.noaa.gov/FGCS/BlueBook/annexc/annexc.index.shtml

Where you can read about how to apply for a unique code recognized by the NGS.

## 'Default Operator'




Enter the default name of the operator / observer here. This value is placed into every RINEX file that is exported. You can override this value on a file-by-file basis.

Typically, the observer is 2 to 10 characters or the operator's initials, however the RINEX definition allows values up to 20 characters in length.

## 'Decimate OPUS Submission to ...'

*(Hidden when Simple)*


When you submit a file to OPUS, it is always decimated at the NGS server to 30-second epochs (recording interval = 1-observation every 30-seconds.)

Clicking the 'Default' button sets the decimate value to 30-seconds and selects RINEX 3 format.

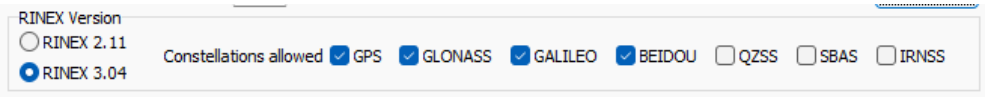
The default recording interval your receiver is probably 5 or 1-second.

By pre-decimating the RINEX file before uploading, the file size is greatly reduced speeding transfer to the NGS. This makes the upload process much faster while having no impact on the resulting solution.

Observations exported with the **Export** button, and those sent to RTX are not decimated.

## RINEX Version

(Hidden when in Simple mode)

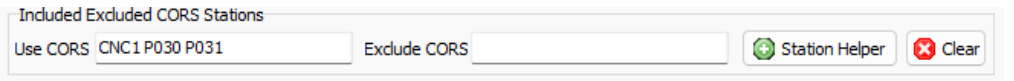



You can select RINEX2 or RINEX3 files for use with OPUS and RTX. As of 2022, RINEX3 is suitable for all online services and is preferred.

If you select RINEX2 then you can individually remove observations from GNSS constellations.

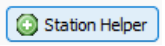
## 'Included Excluded CORS Stations'

(Hidden when Simple)



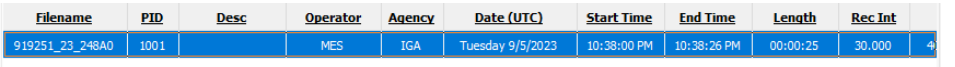

iGx Download will automatically fill in the Included and Excluded CORS boxes for OPUS submissions (both using the online form and OPUS_Upload).

If you click the 'Station Helper' button:




An automated dialog will appear that will help you control the use of nearby stations.

Before clicking the 'Station Helper' button, select / highlight an occupation on the Occupations tab:



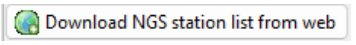
| Filename | PID | Desc | Operator | Agency | Date (UTC) | Start Time | End Time | Length | Rec Int | |
|---|---|---|---|---|---|---|---|---|---|---|
| 919251_23_248A0 | 1001 | | MES | IGA | Tuesday 9/5/2023 | 10:38:00 PM | 10:38:26 PM | 00:00:25 | 30.000 | 4 |

The receiver's approximate position from the observation RINEX file will be used as the center point for ranking distance to nearby CORS.

The first time you enter the Station Helper, you will be prompted to download the latest NGS Station Position lists. Both the COMP and HTDP lists:

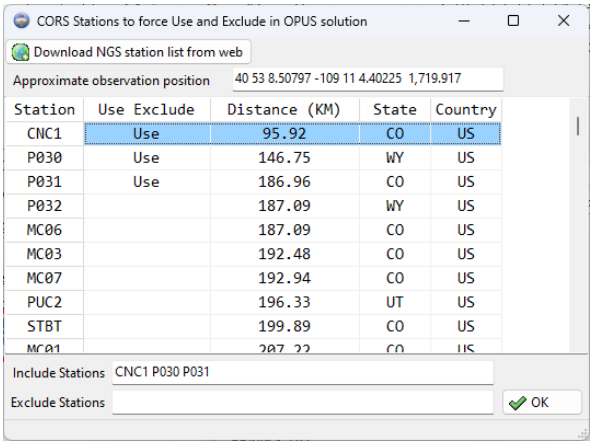
```
/corsdata/coord/coord_14/itrf2014_geo.comp.txt
/corsdata/coord/coord_14/itrf2014_geo.htdp.txt
```

are downloaded and combined. You are encouraged to click the:

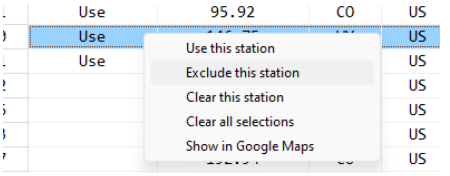



download button monthly to retrieve the latest list of stations. If you are working with very old observations, the current station list may not represent stations that were available at the time of collection. For these stations, you will need to just enter the station names on the Configuration tab manually.

When you click the 'Station Helper' button, a sorted list of stations nearby your observation will be shown:

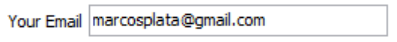



Select, then right-click on stations to control their use:



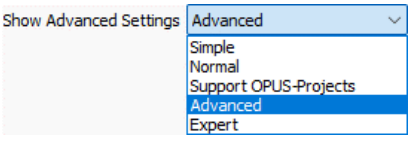

Click the OK button to transfer your selection to the Include and Exclude boxes on the Configuration tab.

## 'Your Email'




When you submit a file to OPUS, you need to provide your Email address so the OPUS processor can return a solution to you. The email address that you enter here will be automatically entered for all submissions performed by the program.

## 'Show Advanced Settings'



This setting sets the complexity of the iGx-Download program.

**Simple**: *(the Default setting)*
Hides archive functions, Minimum File size, Receiver Model, Antenna Name Decimate setting, QC function, Export to RINEX button, OPUS-Projects, the GPS Settings tab and the Log tab.

**Normal**:
Shows everything except for OPUS-Projects, the GPS Settings and Log tab.

**OPUS-Projects**:
Displays the OPUS-Projects checkbox which allows automatic submission to a NGS registered project.

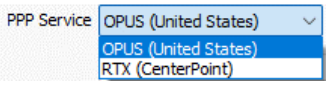
**Advanced**:
Displays the GPS Settings and Log tabs.

**Expert**:
Displays the 'View HCN Header', 'View RINEX Header', 'Force Agency-Operator' buttons and the trimming tool debug screen.

Typically, you will never need to use the 'Advanced' or 'Expert' functions.

## 'PPP Service'

*(Hidden when Simple)*

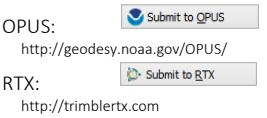



The iGx download tool supports the OPUS and RTX services directly.

Support for AUSPOS and IBGE has been removed, use the 'Export' button to build compatible files for these services.

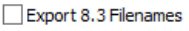
The Submit button on the main page tracks this setting and the upload strategy is adjusted to each available service.

Additional Information is available on each service on the web:




## Export 8.3 Filenames

*(Hidden when Simple)*




If this box is unchecked, then the iGx download program submits files using full filenames like this:

917226_14_072_A0.OBS

The device serial number, the year, the Julian day of year and the observation number are included in the filename.

Checking the 8.3 Filename box results in exported filenames like:

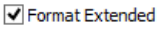
10050720.14O

Where 1005 is the Point ID, 072 is the Julian date, 0 is the observation number, 14 is the year and O indicates an observation file.

Because OPUS includes the filename in the generated report, we recommend that you check the 'Export 8.3 Filenames' option. This will encode the Point ID into the returned report.

## Format Extended

(Only shown when PPP Service = OPUS)




The NGS returns three styles of reports:

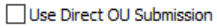
Standard: Single Page Report
Extended: Standard + baseline details + State Plane in (s)Ft
Standard + XML: Single Page + XML

For new OPUS users, the 'Format Extended' includes one important addition: State Plane coordinates are shown in both Meters and US Survey Feet (or International Feet) at the bottom of the report. We recommend keeping 'Extended' checked by default for this reason.

Prior to submitting an observation, you can modify any of the Option settings, checking this box results in the extended output initially being checked.

We recommend that you check the 'Format Extended' box.

## Use Direct OU Submission



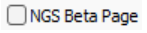

Checking this box allows the program to skip displaying the NGS submission web page. All information is uploaded automatically without operation intervention.

If you use direct submission, then you will not be able to specify CORS stations to include and exclude. OPUS Projects and extended outputs are supported.

We recommend that you enable the 'Use Direct OU Submission' checkbox if you are not an expert user. It greatly simplifies the submission process.

## 'NGS Beta Page'

(Hidden when Simple)




When checked the NGS OPUS Beta submission is used:

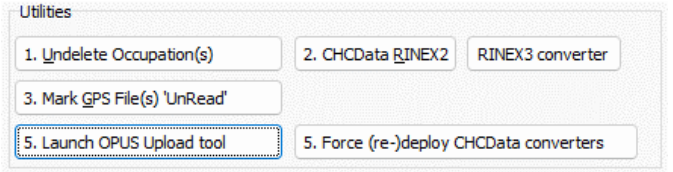
`https://beta.ngs.noaa.gov/OPUS/`

when unchecked:

`https://www.ngs.noaa.gov/OPUS/`

# Utilities

*(Hidden when Simple)*



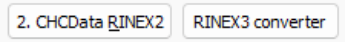

Additional utilities for working with observations are included.

## "1. Undelete Occupations"


When you delete an observation, it is moved to a special "_Deleted" folder.

Clicking the **Undelete Occupation** button allows you to specify a deleted observation to restore. When an occupation is undeleted, it is always returned to the _New project folder.

## "2. CHCData RINEX2/3 Convertor"




Files are stored on the receiver in an '.HCN' extension binary file. When the iGx download tool downloads a file, it is automatically converted to standard RINEX2 or RINEX3 using the CHCData tool.

'CHCData RINEX2' launches the CHCData tool in RINEX2 manual mode. The 'RINEX3 Converter' button launches the converter in RINEX3 mode.

Clicking this button runs the CHCData tool in manual mode. You can browse for HCN files and manually convert them to standard RINEX files. Results are always placed in a subfolder named 'RINEX' under the file to be converted.

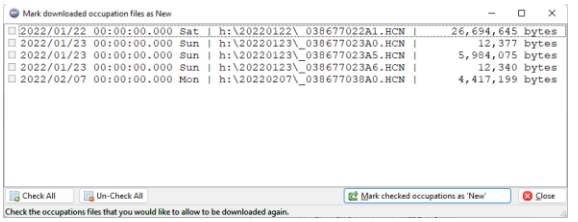
## “3. Mark GPS File(s) UnRead”

Note: this function will not work with the SG7, i73, i83, i89 and i93 receivers.


When files are downloaded from the receiver, they are not removed from the receiver, but the filename on the receiver is modified to begin with an underscore ‘_’.

This function allows you to specify a single or multiple files to mark as ‘unread’ or ‘New’. Once a file is unread the next download action will re-download and convert the file.

When you click the Mark GPS File(s) UnRead button, the tool will search the currently attached receiver for occupations which have already been downloaded. The occupations will be listed by observation date (the latest occupations will be at the bottom of the list):




Check the occupations that you would like to redownload.

Click the ‘Mark checked occupations as ‘New’’ button.

Return to the ‘Occupations’ tab in the download tool and click the ‘Download’ button.

## “5. Force (re-)deploy of CHCData converters”

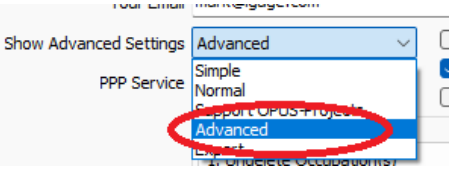
(Visible when in Expert mode)


If you use CHCData in manual mode (either RINEX2 or RINEX3) it is possible to damage the CHCData conversion defaults. This button will delete the existing deployment and redeploy both the RINEX2 and RINEX3 tools with the recommended settings.

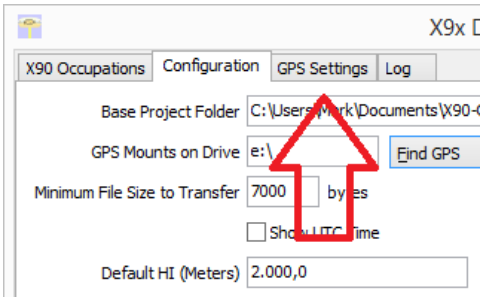
# GPS Settings

*(Hidden when Simple)*

To modify the ‘GPS Settings’ or view the log, select the 'Configuration' tab, then choose 'Show Advanced Settings = Advanced.’




When ‘Advanced’ is selected, two more tabs will be displayed:



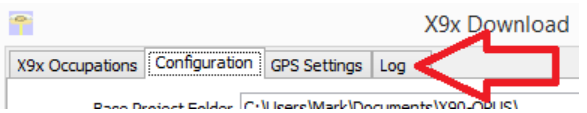
## GPS 'Settings' Tab

The GPS Settings options on the download tool are only compatible with these receivers:

X90, X91+, X900+, X900S, iG3, iG4

For other receivers use the Wi-Fi connection to make recording interval changes. Check the hardware manual that came with your receiver.

## The 'Log' Tab




The 'Log' tab shows detailed results of the current program operation. It may be useful to debug some aspects of file processing.

## OPUS: What is it?

OPUS (Online Positioning User Service) is a free service provided by the NGS (National Geodetic Survey.)

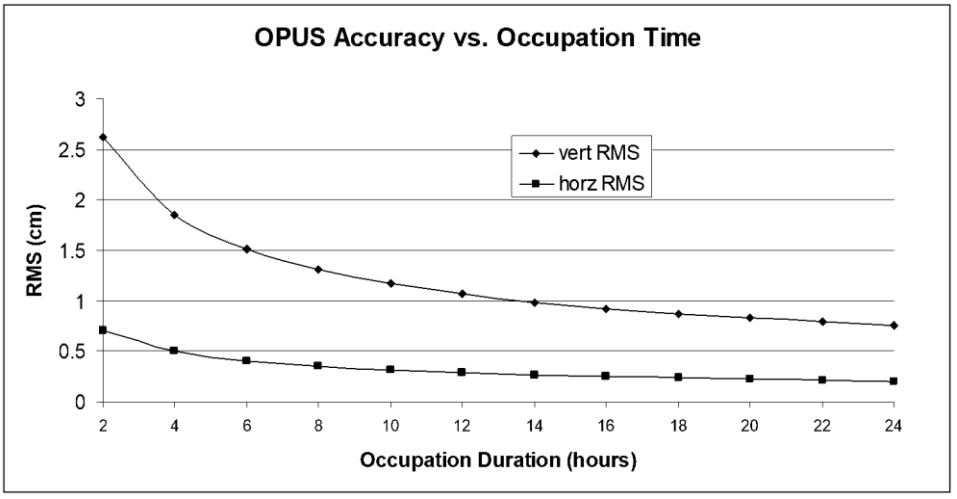
From the NGS Website:

> "This Online Positioning User Service (OPUS) provides simplified access to high-accuracy National Spatial Reference System (NSRS) coordinates. Upload a GPS data file collected with a survey-grade receiver and obtain an NSRS position via email.
>
> OPUS requires minimal user input and uses software which computes coordinates for NGS' Continuously Operating Reference Station (CORS) network. The resulting positions are accurate and consistent with other National Spatial Reference System users."

Here are links to more detailed information:

http://geodesy.noaa.gov/INFO/OnePagers/OPUSOnePager.pdf
http://geodesy.noaa.gov/OPUS/about.jsp

One of the most important contributions to vertical accuracy computed by OPUS is the length of occupation. Longer times are better. If you are concerned about elevation, please remember that a 2-hour OPUS static observation has an expected height accuracy of 2.5 cm. A 6-hour occupation has an expected accuracy of 1.5 cm.




## OPUS-RS (Rapid Static)

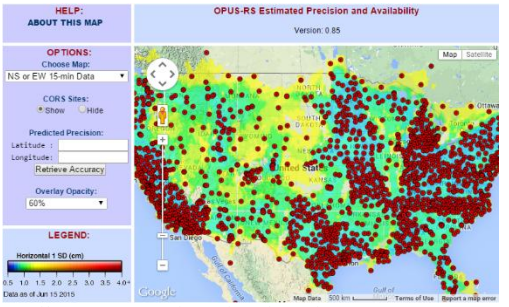
Standard OPUS-Static sessions require 2 hour observations. OPUS-RS sessions can be as short as 15 minutes.

OPUS-RS solutions are not available universally. In general, OPUS-RS needs:

3 (or more) CORS within 250 km of your site
your site must be within 50 km of the polygon formed by the CORS sites

If you are working in Southwest Nevada, along the high line of Montana or in North or South Dakota, OPUS-RS probably will not succeed, and you will need to collect at least 2-hours of data for submission to OPUS-STATIC.

Prior to collecting data for OPUS-RS you can check the latest status map to ensure that OPUS-RS will work. The online OPUS-RS resource:




http://geodesy.noaa.gov/OPUSI/Plots/Gmap/OPUSRS_sigmap.shtml

is updated routinely and reflects the probability that an occupation at a given location will be successful and predicts a best-case accuracy for a 15-minute or 1-hour occupation.

In remote areas there is a risk that if a single CORS site is unavailable, your OPUS-RS job will not be processed.

25% of all submitted OPUS-RS occupations fail. Please read the "Best OPUS Practices for New and Experienced Users" section of this User Manual on page 50. It will save you time and failed jobs.

## OPUS-Projects

OPUS Projects is a relatively new online tool. Its use requires taking a NGS training class. OPUS-Projects will allow you to combine the observation files from multiple receivers and multiple sessions.

There is an excellent article and video describing OPUS Projects in the October 2013 'American Surveyor' magazine. Search for "OPUS-Projects: The Next Revolution in GPS" to find a full resolution PDF.

## OPUS Error Messages and Failures

There are lots of possible error messages when processing OPUS solutions. It is our experience that almost all errors fall into a single category:

"There is not enough nearby CORS data to effectively process your occupation…**yet**."

In general, the resolution is nearly always the same:

"Wait until more data becomes available and resubmit your job."

If you are processing OPUS-RS jobs in an area with very few CORS stations, and one CORS station was offline, waiting may not help as more data may never become available. OPUS-Static is the solution for locations where OPUS-RS is not dependable.

# Interpreting OPUS Results

When you receive an OPUS solution by email from the NGS if formatted using a fixed space font it will look like this:

```
        USER: testbench@igage.com     DATE: May 06, 2014
RINEX FILE: p4490900.14o              TIME: 16:08:35 UTC

  SOFTWARE: page5  1209.04 master93.pl 022814
                                    START: 2014/03/31 00:00:00
 EPHEMERIS: igs17861.eph [precise]  STOP: 2014/03/31 23:59:00
  NAV FILE: brdc0900.14n         OBS USED: 45735 / 47174  :97%
  ANT NAME: TRM29659.00     SCIT
                              # FIXED AMB:   162 /   171  :95%
ARP HEIGHT: 0.0083            OVERALL RMS: 0.011(m)

 REF FRAME: NAD_83(2011)(EPOCH:2010.0000)
                                IGS08(EPOCH:2014.2452)

         X:  -2184137.494(m) 0.003(m) -2184138.362(m) 0.003(m)
         Y:  -3839941.381(m) 0.001(m) -3839940.177(m) 0.001(m)
         Z:   4585410.516(m) 0.005(m)  4585410.529(m) 0.005(m)

       LAT: 46 15 35.23578   0.005(m)  46 15 35.25052 0.005(m)
```

```
      E LON: 240 22  8.47069   0.002(m) 240 22  8.40767 0.002(m)
      W LON: 119 37 51.52931   0.002(m) 119 37 51.59233 0.002(m)
     EL HGT:       208.861(m)   0.003(m)       208.444(m) 0.003(m)
  ORTHO HGT:       230.163(m)   0.018(m)
                                [NAVD88 (Computed using GEOID12A)]

                     UTM COORDINATES     STATE PLANE COORDINATES
                      UTM (Zone 11)          SPC (4602 WA S)
Northing (Y) [meters] 5126276.950           103343.987
Easting (X) [meters]   297235.684           566995.383
Convergence [degrees] -1.90148112           0.63125220
Point Scale            1.00010542           0.99993063
Combined Factor        1.00007268           0.99989789
```

The most important indicators of the quality of an OPUS solution are highlighted in yellow.

Here are some general rules to help judge the quality of a solution:

> 90% observations used or > 80% # Fixed Ambiguities
> 50% Fixed Ambiguities or > 95% observations used
Overall RMS < 0.030(m)
Both Lat and Lon Peak-to-Peak < 0.030(m)
Ellipsoid Height Peak-to-Peak < 0.040(m)

If you collect data under canopy or in an area where there are buildings or trees that obstruct the view above 10° elevation, the number of observations used will be lower.

Make sure you use the left-hand column (NAD_83) results, not the right-hand column (IGS08) unless you know you want IGS framed results.

Be careful with heights. Both ellipsoid and orthometric heights are listed. The orthometric height is NAVD88 GPS derived and typically is the elevation you need.

The Peak-to-Peak error estimate for the orthometric height includes the error estimate for the GEOID in addition to the Peak-to-Peak error estimate value for the ellipsoid height.

### US Survey Feet vs. International Feet, Scale Factors

IMPORTANT: The state plane coordinates are listed at the bottom in the right-hand column. They are in Meters. If you need Feet, you can convert them; however, be careful to convert to International Feet or U.S. Survey Feet as required by your State and application:

US Survey Feet = Meters * (3937/1200)
International Feet = Meters / 0.3048

The misapplication of Ft/M scale factor can result in a 30-foot coordinate blunder! If you request an 'Extended Format' OPUS result, the state plane coordinates are computed and returned at the bottom of the report in the nominal foot units for the area.

If your survey is at a significant elevation (> 100 feet) you may need to apply the Combined Factor (listed on the OPUS report for both UTM and State Plane Coordinates) to inversed distances to match optical shots made at ground level.

## Getting ready to use OPUS

OPUS is a great tool for grounding your survey. But OPUS is part of a larger toolset. Before you begin a project take a moment to think about the 'Big Picture':

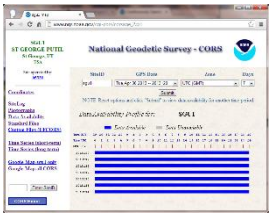
A. What are your GOALS?
   a. Required accuracy.
   b. Horizontal and Vertical Datum; Geoid model choice.
   c. Survey style: OPUS-Static, OPUS-Rapid Static, OPUS-Projects.
   d. Consider FGDC Standards:

      http://www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy

B. Are there passive marks available for control?
   a. Will CORS, passive or a combination control the survey?
   b. Are local passive marks recoverable, undisturbed, sufficient quality, stable and GPS friendly?

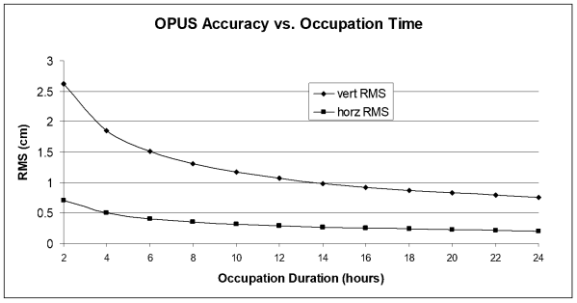
c. Where are the nearby NGS CORS stations? This will determine 'Rapid Static' or 'Static' availability.

C. OPUS-Rapid Static Requirements
   a. Find the closest 9 CORS sites with available observations.
   b. A minimum of 3 CORS stations within 250 KM are needed.
   c. Your site must be within 50 km of a polygon created by the remaining available CORS.
   d. If the eligible CORS count is low, check the past reliability of recent observations to ensure that there is a high probability of sufficient sites for OPUS-RS to compute a solution. Use the CORS 'Data Availability' to check for recent observations:




D. Mission Planning: Satellite Availability and Network Planning
   a. How many receivers will you use for simultaneous observations? If you are using OPUS-Projects, then more receivers is better.
   b. Checkout online 'Mission Planning' tools for U.S. satellite availability using reasonable masks (>15 degrees) during collection periods. If there are any periods with fewer than 6 SV's or PDOPS higher than 3, plan on occupying points longer.

E. How long will you observe a site? Again:

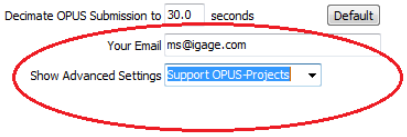



F. Are your sites GPS compatible? Are there obstructions higher than 10 degrees?

## Using OPUS-Projects

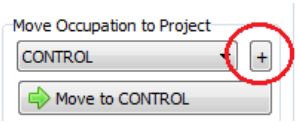
If you are contributing occupations to a registered OPUS-Project, the iGx tool can assist you when uploading files into your project by automatically entering the NGS project ID:

1. Turn ON OPUS-Projects support. On the 'Configuration' tab, set 'Show Advanced Settings' to "Support OPUS-Projects" or "Advanced":

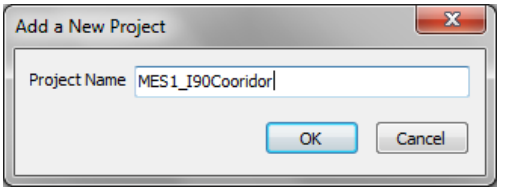



2. Add the NGS registered OPUS-Projects 'Project Identifier' supplied by your project administrator:

   Click the "+" button

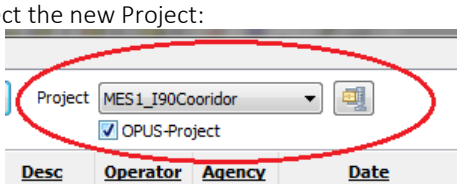


Enter the exact identifier:



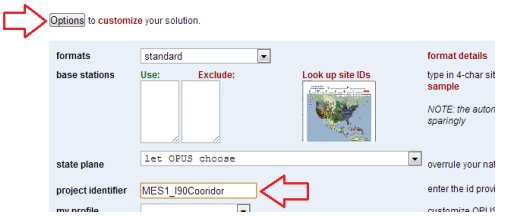

as the new project name.

Select the new Project:




and check the 'OPUS-Project' checkbox under the Project selector.

3. When you submit an occupation that has been moved to the project, the upload tool will automatically press the 'OPTIONS' button on the OPUS submission form and fill in the project identifier:




# Best OPUS Practices for New and Experienced Users

After supplying OPUS targeted receivers for many years, we know that most users experience the same reoccurring problems.

The suggestions in this chapter will save you time and failures.

## The 'OPUS Error Message' Joke

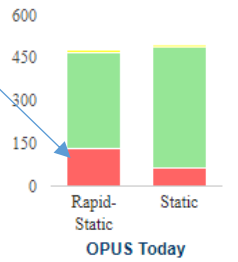
> "The NGS processing engine has a big fishbowl with 500 possible error messages printed on little slips of paper. If a job fails, the OPUS processor removes the five best error messages from the fishbowl. Next the fishbowl is shaken, and three to five slips are randomly pulled from the fishbowl and returned to the user."

OPUS error reporting is getting better. Someday this joke won't be funny anymore.

But you should remember this: 'you are not alone.' Every-Single-Day a substantial number of all OPUS submissions fail and most fail with a confusing error message.

## #1 OPUS-RS is Dicey

When you send OPUS occupations, there is a graphic that shows the daily number of jobs and the daily success rate. **On most days over 25% of all submitted OPUS-RS (Rapid Static) jobs fail!**




Relatively few OPUS-Static jobs fail, and most of the Static jobs that fail initially will successfully process when resubmitted the following day.

When using OPUS RS or Static longer occupations are **always** better. OPUS-Static is always more reliable than OPUS-Rapid Static.

Please remember if you are submitting 15 to 30-minute OPUS-RS occupations **they WILL fail regularly**. Don't be surprised and don't blame your receiver.

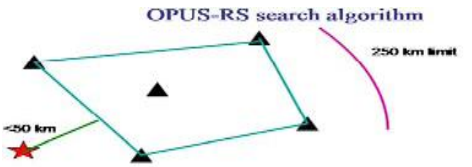
## #2 Only Some Submissions are being returned by OPUS

OPUS always returns an email. **Always**. But missing solutions is a common issue.

If you are not getting solutions or an error message back, the missing solutions have been trapped in your email SPAM filter or you have entered your email address incorrectly on the submission form.

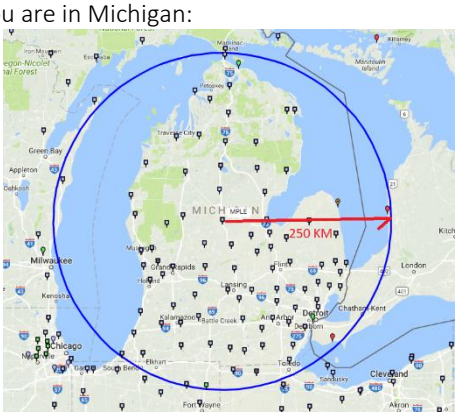
## #3 OPUS-RS is Very dependent on the Number, Availability, Proximity, Distribution and Quality of nearby CORS Stations

The initial stage of OPUS-RS processing determines if a network of three to nine CORS stations within 250 KM of the user location can be built.



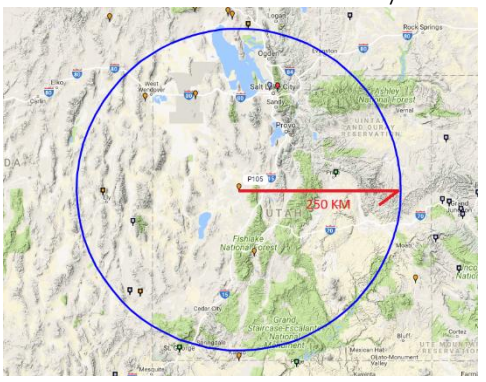

The user location is allowed to be up to 50 KM from the polygon surrounding the selected sites which allows OPUS-RS to succeed in coastal areas where there are no CORS sites offshore. However, every CORS site that is used must be within 250 KM of the user site.

If you are in Michigan:




There are a lot of CORS stations within 250 KM of everywhere. OPUS-RS is likely to always succeed, even if a few of the stations are offline, are missing data or are very noisy and must be discarded.

If you are in the middle of Utah there are very few CORS sites available on a good day:

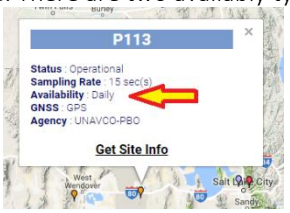



On a bad day, if a few stations are offline or have not yet archived data then your OPUS-RS solution will fail because there are not enough stations close to your occupation.

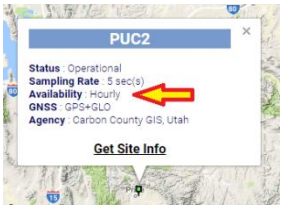
In many areas a single offline CORS station without data will make OPUS-RS impossible.

## #4 Daily vs. Hourly CORS Availability

If you click a CORS station pin on the NGS CORS map, you will get a station summary which includes an 'Availability' note. There are two availably types:




Daily




Hourly

Daily means that a full day's CORS station data is collected and then sometime after midnight UTC the data is archived and becomes available for use as CORS data. Observation collection is ONCE PER DAY.

Hourly means that the previous hour's data is collected and available immediately after the top of each hour. Collection is EVERY HOUR.

Hourly data is much more desirable.

For the two sites above:

P113 data is typically available at 09:03 am (UTC) on the following day.

PUC2 data is typically available 35 minutes after the top of each hour.

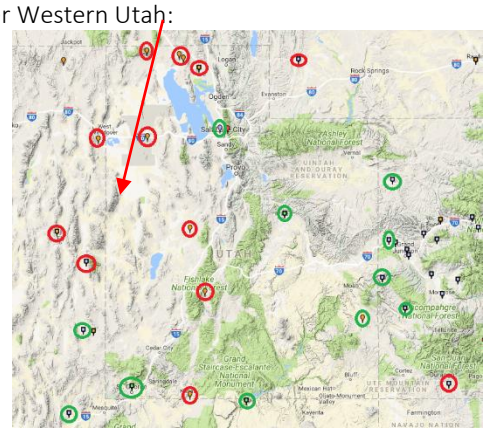
If your OPUS submission has sufficient nearby hourly stations, then you can probably wait 45 minutes after the top of the hour following your file collection and an OPUS submission will be successful.

However, if you are collecting data in an area where most of the stations have only **daily** availability you will have to wait a longer time before the nearby stations will be available for use.

This is especially troublesome if you acquire observation data in two separate UTC days. (In other words, your observation spans midnight UTC.)

## #5 Some areas of the United States effectively ONLY have Daily Data

Consider Western Utah:



Daily Stations Red; Hourly Stations Green

If your observation is in the western part of the state there are only daily stations available.

Let's look at an example with two observations collected on the Northwest side of Utah near Wendover Nevada:

The two observations were performed Monday afternoon (the red bars). One is a section corner, the other is vertical bench mark which is only 400 feet northeast of the section corner. Both locations enjoy completely open sky – no canopy. Both observations are **exactly** three hours in length.

The first observation starts at 1:59 pm Mountain Time (20:59 UTC) and ends at 4:59 pm Mountain Time (23:59 UTC).

The second observation starts two minutes after the first at 2:01 pm Mountain Time (21:01 UTC) and ends two minutes after the first observation ends at 5:01 pm Mountain Time.

We submit both occupations to OPUS Tuesday morning, the day after we collect the observations.

OPUS returns the first solution, and it looks fantastic with 98% observations used and an ellipsoid height RMS error estimate of 0.011 meters.

OPUS returns the second solution with an ominous warning 'the observation data is noisy', only 62% of the observations were used and the ellipsoid height RMS error estimate is 0.219 meters!

*Q: Is the second receiver defective?*

The first OPUS solution was able to use all the nearby UNAVCO PBO CORS sites which surround Wendover Utah. Data from these sites were available in the archive at 2:35 am Mountain (09:35 UTM) on Tuesday; in this case 9 hours and 34 minutes after the end of the first occupation.

The second occupation extended one minute into Tuesday. Data from the UNAVCO PBO sites will not be available until after 2:35 am on **Wednesday**; 33 hours and 32 minutes after the end of the second occupation.

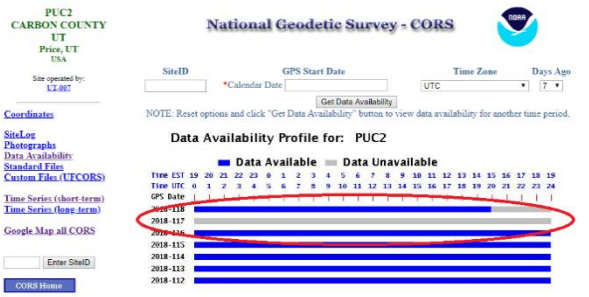
Because no other nearby CORS data is available, OPUS has used hourly files from CORS sites over 250 KM away to process the second file. These long baselines have much higher uncertainty and result in higher peak-to-peak error estimates. If we resubmit the 2nd occupation on Wednesday, it will have excellent results, similar to the first observation.

*A: The receivers are identical, and neither is defective.*

**A smart rule-of-thumb is to try to never collect observation data that spans midnight UTC**. It causes additional problems a few days after collection when OPUS is forced to splice ultra-rapid and rapid orbits. It causes additional problems in a few weeks if precise orbits become available for only the 1st portion of an occupation and OPUS has to splice precise orbits for the first portion and rapid orbits for the second portion.

## #6 Offline CORS Stations

Often when you look at the 'Data Availability' plot from a CORS station's information page:




You will sometimes find that several hours or an entire day's observation data is unavailable, shown as gray instead of blue.

For a station to be used in a solution, overlapping data for the ENTIRE user occupation must exist. So if you performed an observation on Julian day 117 near the station PUC2 (shown above) and were planning on having PUC2 data available, then you are out of luck.

## #7 NGS CORS Station Quality

When you submit an occupation from your receiver, your receiver's recorded data is compared with the recorded data from nearby surrounding CORS stations.

OPUS assumes that all CORS data is perfect, so if a baseline solution appears to be noisy, then (obviously) your rover data must be at fault.

In other words, any high residuals in the baseline processing are the fault of the user data and are never a result of bad CORS station data. Even when the CORS station data is bad.

OPUS error messages are structured based on this assumption of highest quality CORS data and low expectations of your user data quality.

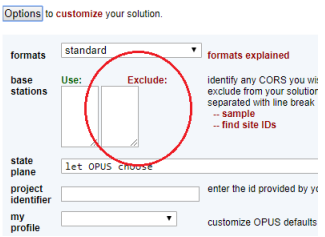
While most CORS stations are:

- Sited at excellent stable locations.
- Have 100% open sky view above 10-degree elevation in all directions.
- Have top quality leveling mounts.
- Are bolted to stable masonry structures or well-engineered ground monuments.
- Have booked coordinates that are within 2 cm of their apparent actual location.
- Have state of the art choke ring antenna.

- Have short, high-quality low-loss coaxial antenna cables with dielectric filled connectors.
- Enjoy top of the line GNSS receivers with the latest firmware.

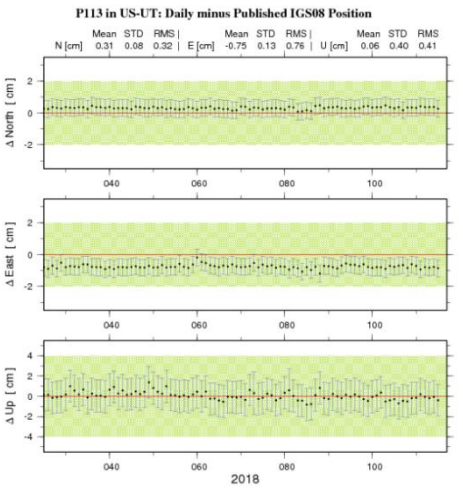
Stuff happens and some of the CORS stations are unreliable, and a few are horrible. No matter how bad a station might be, NGS CORS will collect the bad data, and the OPUS engine will use the bad data and then blame your occupation for all issues.

The only effective control that a user has is the 'Exclude' box under 'Options':



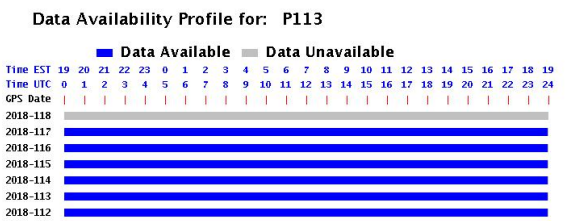

*But how can you figure out if a CORS station should be excluded?*

This is a great question. The best way is to click on the 'Time Series (short term)' button. Here is an example of a great station:




Time Series for P113

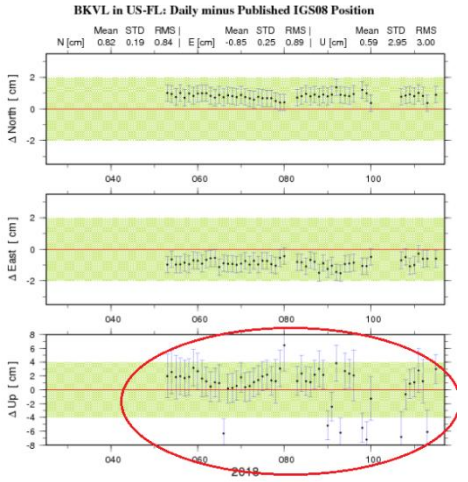
You also want to look at the recent 'Data Availability':




Availability for P113

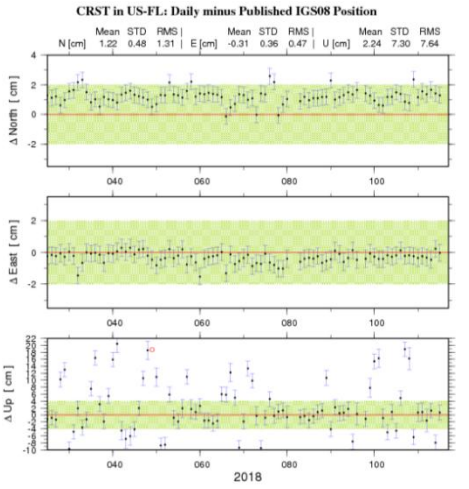
The position trends are very stable and are within 1 cm horizontal and vertical of the published IGS08 positions. The average locations and all the error bars are fully contained in the green error bands. Coupled with continuous recent Data Availability this station appears to be a great CORS resource.

However, if you look at a station's Time Series and it looks like this:




You will want to ALWAYS exclude the station from your solutions. If you catch this site on a bad day (and it has a lot of them) you can expect significant elevation and horizontal errors.

Even worse sites abound in the NGS array:



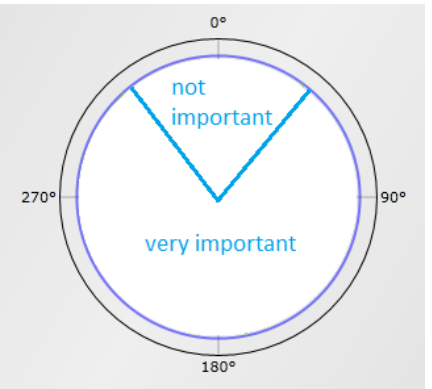

These stations and all the others like them are unsuitable for any processing use. It is your responsibility to exclude them from your solutions.

## #8 GPS Suitable Locations

The NGS recommends that you send GPS occupations collected in **GPS suitable locations**. However, little NGS guidance is provided for what is 'GPS suitable' in the context of OPUS submissions. Let's compare good and bad locations.

## Best Case Scenario

**The best possible site would have a clear view of the sky above 10° at all azimuths where there is a possibility of a GPS satellite being in the sky:**

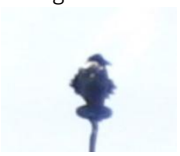



Obstructions to the North not important in North America

*Note: OPUS will process observations down to 10° elevation so you should set your receiver to start tracking a few degrees below 10°, or just allow it to track all the way to the horizon (0 degrees Elevation Mask.)*

Attributes of a great GPS location for collection OPUS ready occupations:

- No overhead power lines.
- No trees: leaves on or leaves off.
- No power poles (wood or metal).
- No radar or radio paths that cross over the top of the receiver.
- No chain link fences nearby.
- Locations under busy landing paths are undesirable.
- No large 'GPS reflective' surfaces (metal roofs) nearby: avoid multipath.
- Receiver facing correct direction: usually MMI (Man-Machine-Interface AKA the push buttons), antenna connector or North fiduciary pointing to the North.
- The receiver mounted very securely on well braced, fixed-height tripod.
- No chance of giant birds sitting on your antenna during occupations:



This picture is an actual GIANT crow sitting on an actual CORS antenna!

- No chance of trucks higher than your antenna passing nearby during occupation

Yes, users get remarkable results in challenging locations all the time. And you may be lucky, but these are real rules, and you should consider respecting them.

## Worst Case Scenarios

All the sites presented below are actual customer sites (or in some cases slightly obfuscated locations to save embarrassment.)

Remember that during times of low DOP (see the mission planning section of this document) you may get reasonable OPUS-Static and OPUS-RS solutions at these challenging locations. Longer (3-hour) and very long occupations (over 8-hours) may be dependable because the high-DOP conditions are bridged with times of good coverage. However, in general, you should avoid the following scenarios.

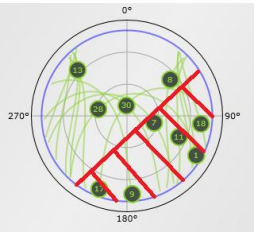
### *Semi-Trucks and Trains*

This bench mark is 3 feet north of the eastbound edge-of-pavement of I80 near Green River Wyoming:

It has fantastic views in all directions, unfortunately a semi-truck drives by every 20-seconds and completely obscures the receiver's view of the southern sky. This forces the receiver (and OPUS) to lose lock. This is a BAD location and will greatly increase the RMS error estimates and drop the percentage of observations used.

## *Large Structures to the South*

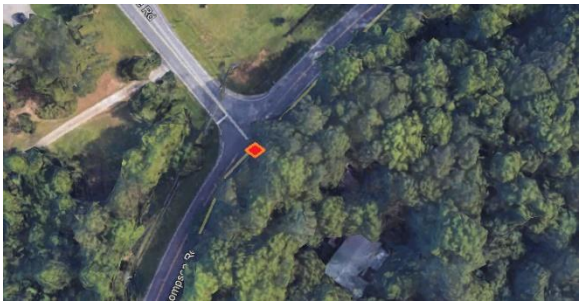
This 8-story parking garage is 40 feet to the southeast of the brass rivet in the street. The red arrow points South.




This is a bad location because the structure completely blocks the antenna's view to the South and East.

## *Huge Trees to the South*

BAD: This site is not suitable for GPS observation because of large trees to the south:



Southern sky is fully blocked and trees obscure the view directly overhead.

We can debate:

- leaves on, leaves off
- pine needles vs. broad leaves
- length of pine needles
- size of tree-trunks
- size of branches

But trees above 10° to the East, South or West are bad and 100% canopy is really bad.

## *Huge Trees Overhead*

Trees (with or without leaves) directly above the antenna prevent the receiver from having a clear view of the sky. Even though this location has open water to the South, it is directly underneath large trees. Water can also be a source of significant multipath (see the next section). This is a BAD location:

## *Large Reflective Surfaces Nearby*

Your receiver trusts that the signals that it receives have traveled directly from the satellite to your antenna. Large nearby surfaces present opportunities for the receiver to have signals arrive having taken multiple paths (multipath) or entirely the wrong path.

Not only do these tanks block the view to the South, but they also have metal-reflective surfaces that provide a multiple length signal path for every signal from every satellite to the observation area:

(this image is looking South)

Flat metal surfaces are bad. Corrugated metal surfaces (like corrugated roofing) are even worse. Some mirrored glass windowing used on building exteriors is reflective at microwave frequencies. Box truck bodies, metal buildings, metal roofs and open water are all potential sources of multipath.

## *Deep Canyons*

Locations at the bottom of deep canyons, especially East-West trending canyons will present full, 100% obstruction below the ridge line to the South. Most of the GPS satellites are to the South. This is BAD.

RBUT (below) is a NGS CORS site and is the closest CORS site to the iGage office in Salt Lake City Utah. This site is hindered by a solid mountain 30° mask to the South. This could be a challenging location for GPS observations and is not a great location for a CORS site.

Moving further North would gain elevation, effectively lowering the southern mask.

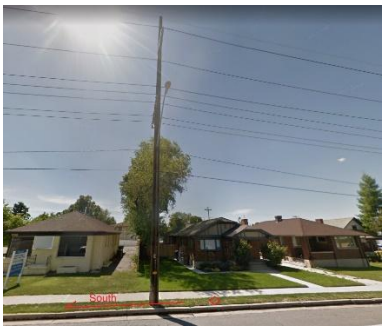

## *Power Poles*


< 500 KV DC Transmission Lines and Tower

This class-1 elevation bench mark with measured gravity is unfortunately in a location that is no longer suitable for GPS observations. It was set prior to the construction of the power line. This is a BAD location.

You should avoid locations that are under high voltage transmission lines and have large steel towers directly to the south.

Smaller power poles and lines are also unacceptable, especially if they are south of the occupation site:




## #9 Optimizing Occupations in the Real-World

### *Receiver Placement*

In North America, the most important sky is to the East, South and West (because there are never any GPS satellites directly north.) So, if you are setting up in a field that is surrounded by large trees, locations in the middle of the North side of the open area are preferable because the southern sky effectively opens up:


### *Longer Observations*

OPUS-RS is especially vulnerable to bad sites. If you think a site may have problems, try to collect over two hours of data so that you will have the option of using OPUS-Static. You can always trim the 2-hour observation file and also submit it as a Rapid Static job in addition to the Static job.

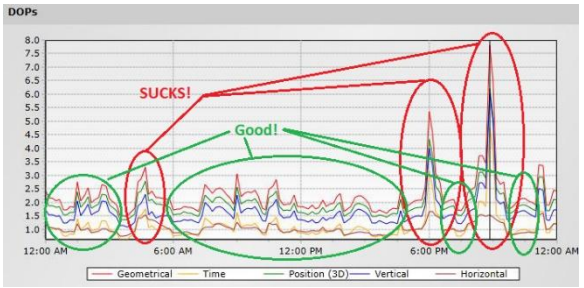
A six-hour occupation may return remarkable results at a site where 2-hour occupations fail. More-time in adverse locations is always better.

## #10 Mission Planning

With modern GNSS RTK receivers that track lots of satellite constellations and lots of signals, mission planning is no longer required. A full GNSS receiver tracks so many satellites that there are no bad times.

However, OPUS is **GPS only** and mission planning should be used to select better times to occupy sketchy locations. Especially if you are using OPUS-RS.

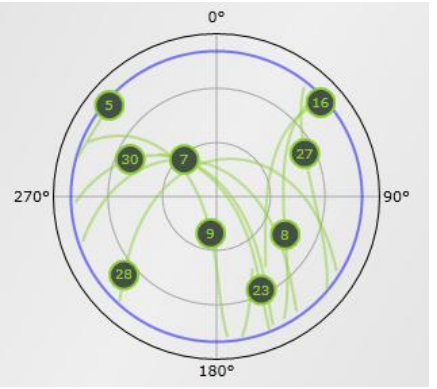
Here is a typical GPS Only Mission Planning example:



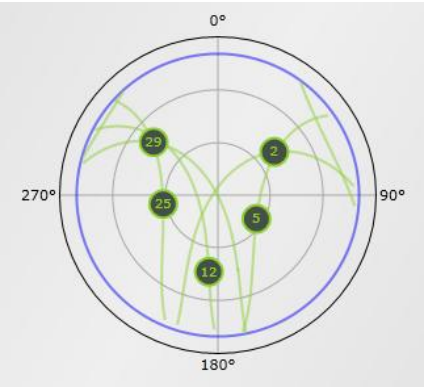

Lower DOP is better than higher DOP. You can see that most of the day, DOP is excellent. Most OPUS submissions will be successful. However, starting at 5:30 pm there are large DOP spikes.

At this location, on this day, any one-hour OPUS-RS occupation from 5:30 pm to 9:30 pm will certainly fail. However, a one-hour OPUS-RS occupation from 11:30 am to 12:30 pm (or most of the rest of the day) will probably be successful.

DOP is a function of how many and where the satellites are in the sky. We prefer more satellites, spread over a larger portion of the sky, with one or more satellites in every quadrant:




11:30 am Great




8:50 pm Bad

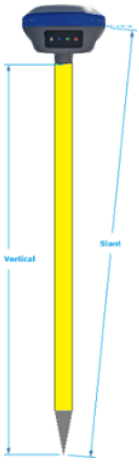
One pitfall of OPUS-RS is very short occupations may entirely fall into a very high-DOP period. As you can see from the DOP plot above, high DOPs rarely last for more than an hour and longer OPUS-Static occupations will usually have some periods of low DOP and excellent coverage.

The change in satellite constellation, which determines PDOP is why a receiver will work one day and then not work in a nearby location at a different time.

## #11 Be Procedure Smart: avoid Blunders

Assuming that your receiver is in a location that is suitable for GPS observations, at a suitable time, there are several procedural blunders that you can do to force a bad result:

- Mounting system is not level and receiver is not centered over the ground mark.
- Antenna height (HI) is wrong.
- Antenna is mis-rotated, doubling antenna compensation errors.
- Wrong antenna type is selected.
- No battery in head with external power




### *Use a Fixed Height Tripod, Get the HI Correct!*

The #1 OPUS procedure failure is a blundered instrument height. The ONLY HI that OPUS will accept is the vertical height above ground to the ARP (Antenna Reference Point) in meters.

If you use a tribrach, you will have to make a slant measurement and then reduce the slant distance and SHMP (Slant Height Measurement Point) vertical offset to a metric vertical height.

Slant reduction error is also a common source of blundered instrument height. The iGx_Download tool makes this computation automatically for you; however, you must keep track of Slant vs. Vertical and Feet vs. Meters.

Transposition of the digits of random heights that occur with tribrachs on tripods is a common source of error. Measurement to the wrong place on the antenna is a common source of error. Mixing slant measurements in feet with metric SHMT and radius constants is a common source of error. Confusing slant heights between multiple occupations is a common source of errors. Using 'inch' tapes instead of 'tenths' tapes is a common source of errors.

All these errors are eliminated if you use a fixed height 2.0-meter tripod or a 2-meter pole with a Hold-a-Pole for every static occupation. The answer is always just "2.0" meters. Which is easy to remember.

### *Rotate your Receiver Correctly*

Every antenna has a 'correct' rotation. It is VERY important to spin the antenna so that it faces the correct direction.

You can determine the correct rotation for any modeled antenna by looking up the antenna definition on the NGS Antenna Calibration website. The SG7 receiver should be rotated so that the display points to the north.

*North Reference Point (NRP) = Man-Machine Interface (MMI)*

*What happens if you don't rotate the antenna correctly?* OPUS has a calibration file for every antenna that relates a change in L1 height offset by the position of the satellite in the sky and the XY offset of the center of the antenna from the center of the mounting nut.

OPUS compensates for the northing, easting offset assuming the antenna is facing North. If you rotate the antenna 180° so that the MMI is pointing to the South, then the offset error is doubled, and your final solution will be in error by double the centering offset!

Bad rotation alignment can also make an occupation appear noisy. OPUS compensates for the antenna vertical offset changes depending on where satellites are in the sky. If the antenna is mis-rotated, the compensation will be applied incorrectly.

### *Use the Correct Antenna Model*

Make sure that you have the correct antenna model selected. Some antennas have multiple radomes and revisions listed.

For example: the Ashtech version of the Dorne Margolin chokering (which is a replacement of ASH700936 which has even more models and revisions) has 10 revision / dome combinations:

```
ASH701945B_M     NONE
ASH701945B_M     SCIT
ASH701945B_M     SCIS
ASH701945B_M     SNOW
ASH701945C_M     OLGA
ASH701945C_M     SCIS
ASH701945C_M     SNOW
ASH701945C_M     SCIT
ASH701945C_M     PFAN
ASH701945C_M     NONE
```

Each revision has a different calibration, you must select the correct radomes model, or you will introduce height uncertainty to your solution.

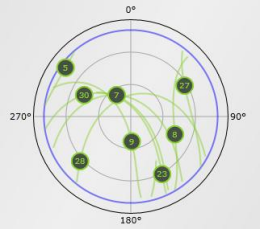
## #12 Why does Modern RTK work where OPUS fails?

Yes, OPUS is substantially more finicky than modern GNSS RTK. OPUS jobs routinely fail in places and at times that RTK works flawlessly. There are two primary reasons: number of satellites and baseline length.

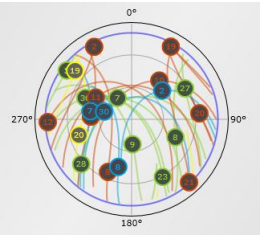
### *Number of Satellites and Signals*

OPUS is GPS only. Modern GNSS RTK uses additional satellites (GLONASS, Galileo, BeiDou) and additional signals like GPS L2C, GPS L5 and GLONASS L3.

Compare these two sky plots (same time, same location):




GPS Only




GPS + GLONASS + Galileo + BeiDou

More satellites are better. More signals are better. Even though the receiver tracks GPS, GLONASS, Galileo and BeiDou satellites, OPUS currently only uses GPS observations. So, a great constellation like the one on the right is reduced to the minimal constellation on the left.

### *Baseline Distance*

OPUS processes GPS baselines from your receiver all the way back to each individual CORS station. Typically, these will be 45 KM (28 miles) to 150 KM (93 miles) baselines. In some areas the nearest CORS station might be 250 KM distant!

RTK processes the baseline from your RTK Base to your RTK Rover which typically will be less than 10 KM (6 miles.)

Short baselines 'Fix' more easily and have substantially less noise.

## #13 Fresnel Zone Considerations

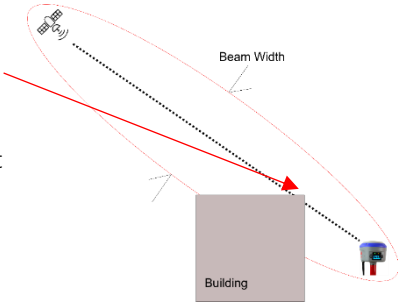
Most GPS users think of the radio path from their receiver to each of the satellites is like a small laser beam. This is incorrect.

The GPS beam width is spread out in a cigar shaped area known as the 'Fresnel Zone'.

*Fresnel is pronounced with a silent-s: "Frenel", named after French physicist Monsieur Fresnel.*

Wikipedia has an excellent article on the Fresnel effect: https://en.wikipedia.org/wiki/Fresnel_zone; be sure to check out the section on 'Fresnel Zone Clearance' mid-article.

The Fresnel effect explains why your GPS receiver will track a satellite which is fully behind a building or ridgetop. The beam width is wide enough that a portion of the signal reaches the GPS receiver, even though the beam's center is fully blocked by the building.




Tracking a satellite means that the satellite is 'visible' to your receiver, however just tracking is not sufficient to accurately evaluate a carrier-phase position.

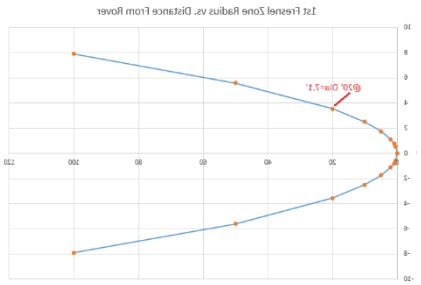
To compute an accurate position, your receiver needs a very clean signal with few reflections, obstructions or delays. Any object blocking a part of the beam can be a source of reflection, attenuation or delay.

Clear path means that you don't just need a small opening in the trees for a laser beam to shoot through. You need an opening in the trees large enough that most of the energy which is spread out over the Fresnel beam width reaches the receiver with no obstructions.

***How wide is the Fresnel beam along the path?*** Much wider than you think!

Here is a beam-width chart for GPS L1 (1.575 GHz):

| Distance | 1st Fresnel Dia |
|---|---|
| 0.0 | 0.0 |
| 0.5 | 1.1 |
| 1.0 | 1.6 |
| 2.0 | 2.2 |
| 5.0 | 3.5 |
| 10.0 | 5.0 |
| 20.0 | 7.1 |
| 50.0 | 11.2 |
| 100.0 | 15.8 |
| 33000000.0 | 6414.3 |



1 foot above your GNSS antenna, the beam width is 1.6' in diameter. 20 feet above the rover antenna (perhaps the midpoint of tree canopy), the 1st Fresnel beam diameter is 7 feet! A clearing in the treetops 100' above your antenna needs to be 16' in diameter.

At the midpoint between your receiver and the satellite, the Fresnel beam is over 6,000 feet in diameter! And that is for the signal for a single satellite, multiply this by the number of tracked satellites and there is signal energy everywhere.

## Conclusion

There are many things that can go wrong with OPUS occupations. Some you can control, some you can't.

If you stack multiple problems:

Bad Constellation + Short Occupation + Moderate Canopy + Bad HI => FAILURE

Your OPUS solutions will fail or have high RMS estimates and the time you spent collecting the observation will be wasted.

The OPUS family of online tools: OPUS-Static, OPUS-RS, OPUS-Projects are amazing. They allow users to generate reliable X, Y and Height coordinates for GPS suitable locations, anywhere in the world. Hopefully by utilizing the simple rules presented in this chapter, all your jobs will be

OPUS-Successful!

# Troubleshooting the SG7 Receiver

## 1. Receiver won't turn on:

Batteries are fully discharged: Charge batteries or use external power.

Battery is bad: return to factor for replacement.

## 2. Is the receiver tracking satellites?

The BLUE LED flashes once for each SV (satellite vehicle) that is currently tracked.

If you are indoors, the LED will flash **once** every 5 seconds. However, no SV's will be tracked.

The receiver should begin tracking within 30-seconds after a warm start. After a cold start (off for more than 1 week) it may take 90-seconds for the receiver to begin tracking.

If the receiver will not track satellites outside after waiting 5-minutes do an OEM engine reset using one of the methods outlined in GNSS OEM Reset on page 69.

## 5. The receiver won't mount as a Disk Drive.

Unplug, wait 15 seconds, try again.

Try another USB port, try another USB cable. The factory cable has purple plastic inside the cable housing.

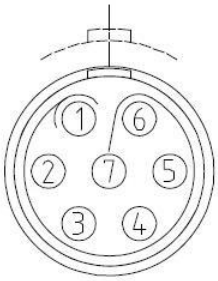
Use an external USB Hub (this fixes intermittent disk mounts.)

Try another computer.

Try turning off your PC, wait a minute and then turn it on again. Reinsert the USB cable.

# Serial and USB IO Port Definitions

## Serial IO Port Definition




| PIN | FUNCTION |
|---|---|
| 1 | Ground ( -) |
| 2 | Ground ( -) |
| 3 | RS232-TX (Output) |
| 4 | PPS (Pulse Output) |
| 5 | Not Used |
| 6 | VIN (9 to 24 VDC) |
| 7 | RS232-RX (Input) |

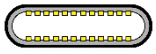
*Figure 1 7-Pin Serial IO Connection Information*

External Power Cable:

External Radio Cable:

## USB Port Definition

The receiver has a standard USB Type-C connector.



When connected to a computer with a USB cable, the receiver mounts as a lettered disk drive.

# Upgrading Firmware

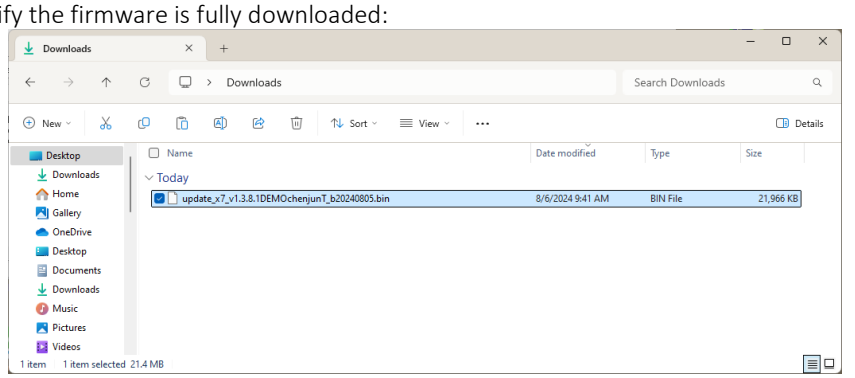
The SG7 has three sets of upgradable firmware:

Main Board
OEM Board (the GNSS Engine)
UHF Radio Board

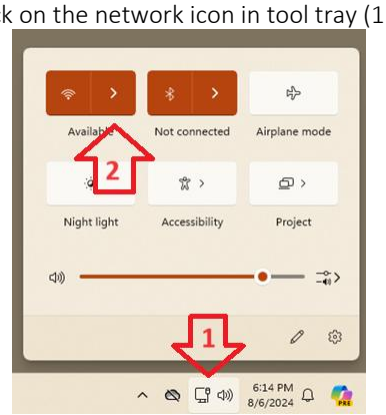
All three are updated using a similar process via the Wi-Fi interface.

1. Charge the receiver to at least 50%.
2. First download the desired firmware files from: https://igage.com/out/SG7/firmware/index.htm There will be a main firmware file and a OEM firmware file.

3. Verify the firmware is fully downloaded:

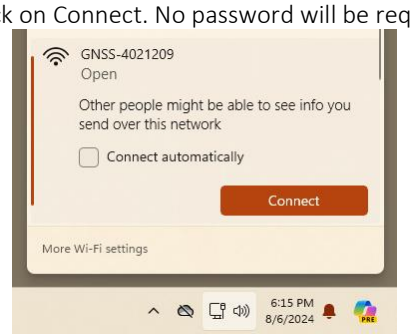



4. Connect to the receiver by Wi-Fi:
Click on the network icon in tool tray (1), then expand the list of available connections (2):

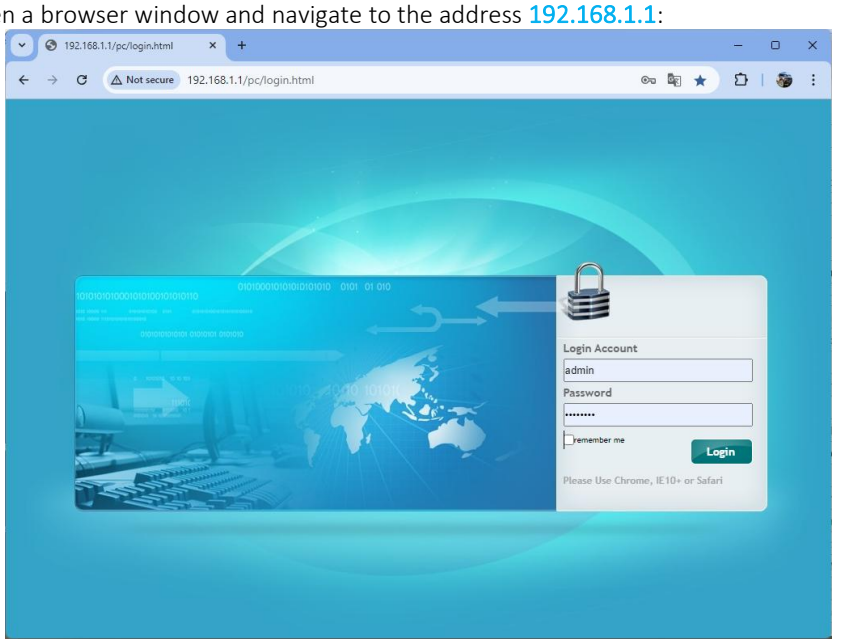



Click on the device with GNSS-serial_number of your receiver:


Click on Connect. No password will be required for the SG7:

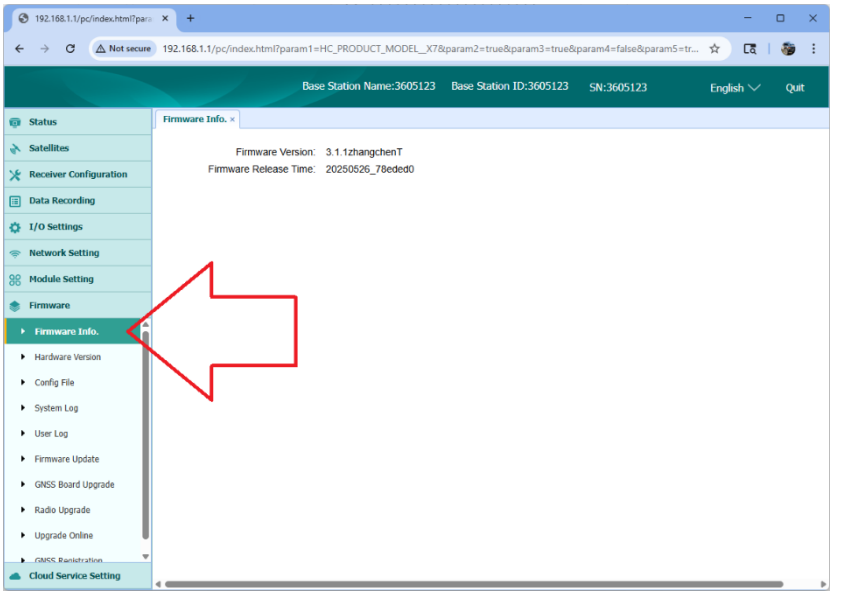


5. Open a browser window and navigate to the address 192.168.1.1:

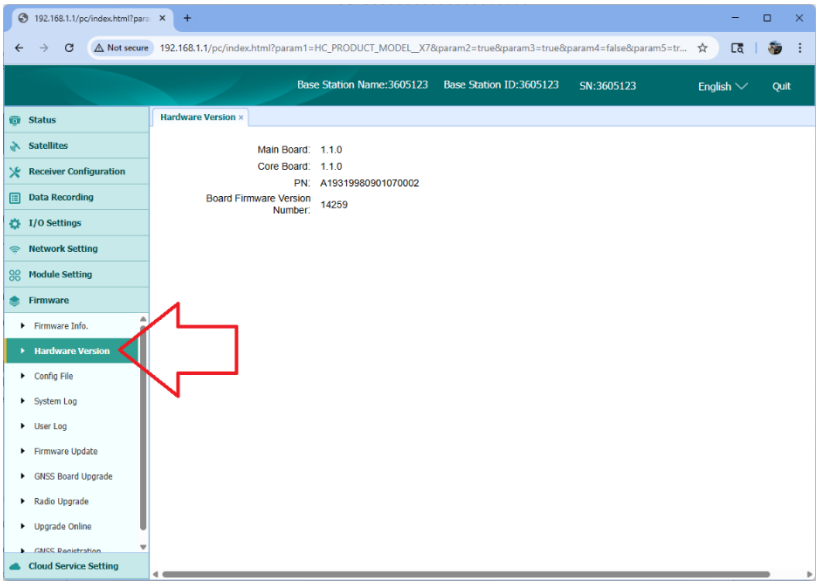



The Login Account is admin and the Password is password (lower case).
Click Login.

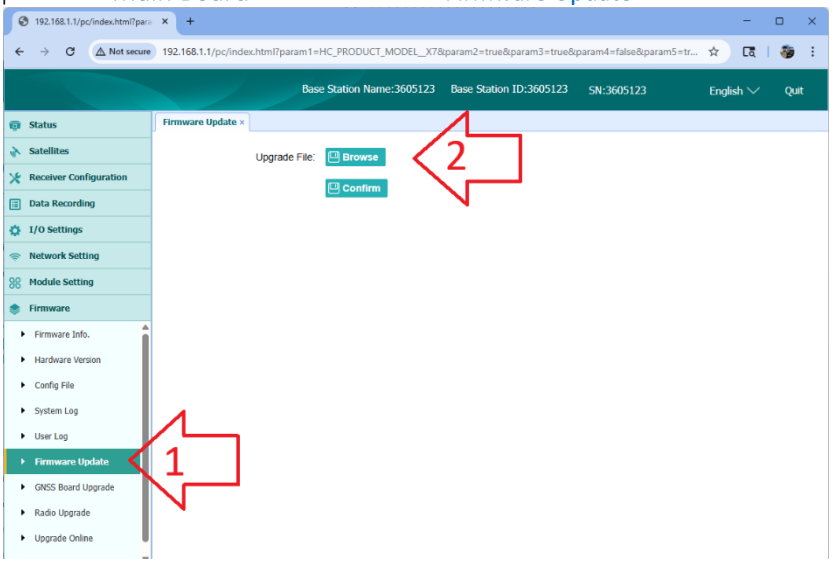
6. Click on Firmware, then Firmware info to see the current firmware version:
Main Board Firmware version:



Click on Hardware Version to see the OEM Board Firmware:

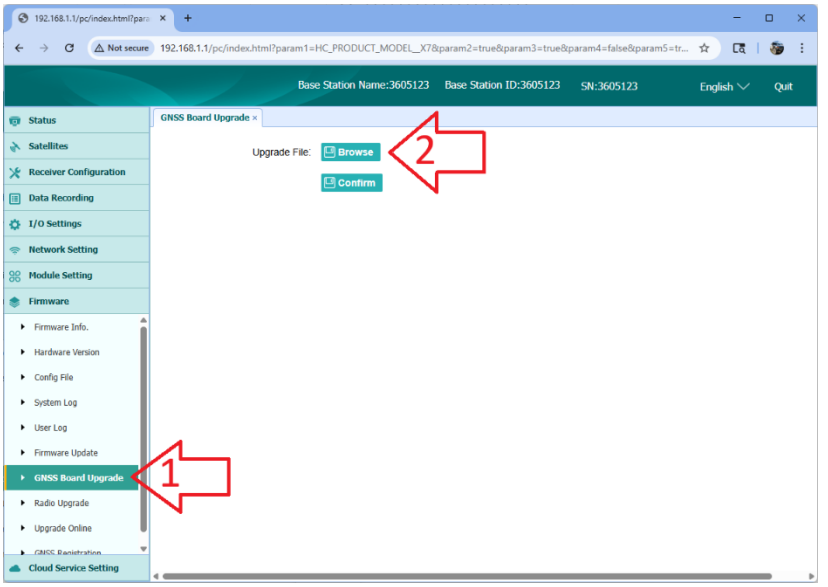



7. To update the Main Board firmware click on Firmware Update



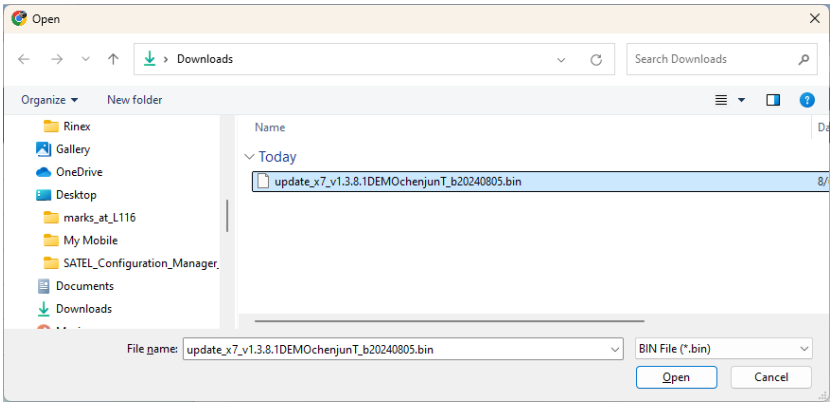

Then click on Browse, find the downloaded firmware file, finally click on Confirm.

To update the **OEM Board**: click on GNSS Board Upgrade:

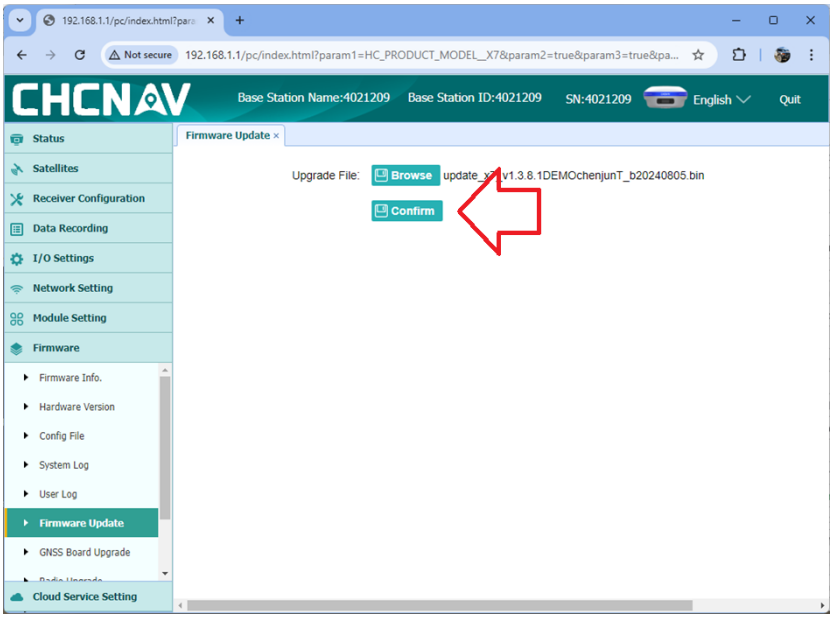



Then click on Browse

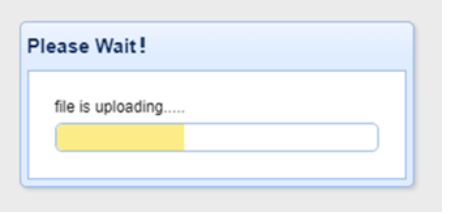
8. Select the correct downloaded firmware file:




9. Click the Confirm button:



The update will take approximately 2-minutes to complete




When the update is in progress the receiver window will show: Updating…

At the end of the update, the receiver window will show: Update Success for 10 seconds.

The receiver will then reboot.

If you have multiple firmware updates (Main, OEM, Radio), return to step 3 and repeat as needed.

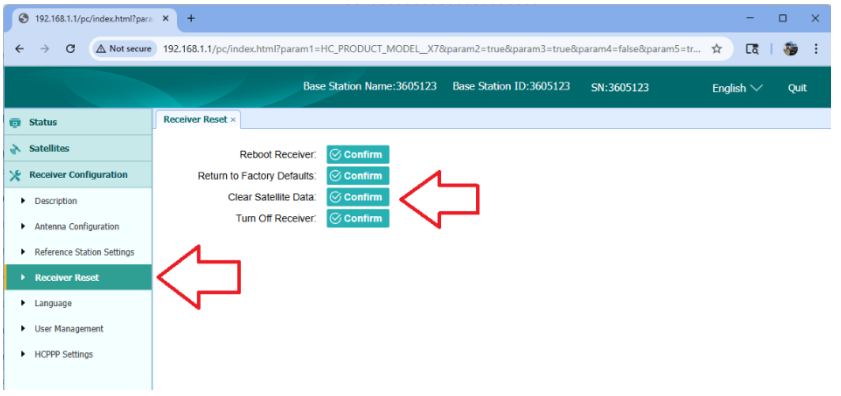
# GNSS OEM Reset

It is possible to reset the receiver from the Front Panel and from the web interface. This procedure should not be required for normal operation.

## Web Interface Reset

Connect a PC, tablet or smartphone to the Wi-Fi web interface as shown in 'Connecting to a PC or Smartphone via Wi-Fi' section on page 18.

Once connected, from the Main Menu:




Click on Receiver Configuration: Receiver Reset then Clear Satellite Data Confirm.

## Front Panel Reset

Click Fn to move to the Main Menu:


to reset all settings to the Factory Defaults.

This takes 15-seconds, then the receiver will reboot

# SG7 Antenna Model

The SG7 receiver has NGS calibration "GMTSG7 NONE"

The .atx and .003 antenna files can be found on the NGS website:

.atx .003

and:

https://igage.com/out/SG7/antenna_model/index.htm

Summary

| | |
|---|---|
| L1 | 76.74 mm |
| L2 | 68.45 mm |
| Radius to Bar Tip | 124.00 mm   |
| SHMP | 0.00 mm |
| ARP | Bottom of Antenna Mount (BAM) |
| North Reference | Turn Display to North |

The antenna designator is "GMTSG7 NONE"
1234567890123456789 0

A summary of the .atx file:

```
G01                                                     START OF FREQUENCY
   0.76      -0.33      76.74                           NORTH / EAST / UP
G02                                                     START OF FREQUENCY
   0.21      -3.16      68.45                           NORTH / EAST / UP
```

# ‘Slant Height’ to ‘Vertical Height’

Vertical Heights are measured from the Ground Mark (GM) to the bottom of the SG7’s 5/8” 11 TPI nut, the ARP (Antenna Reference Point) = BAM (Bottom of Antenna Mount).

Slant Height is measured from the Ground Mark (GM) to the top of the Measure Up Plate, which is the same as the ARP and BAM.

Place the Measure-Up Plate directly under the receiver with the embossed arrow facing up:


## Manually Converting Heights

| Receiver | Radius r (meters) | SHMP h (meters) |
|---|---|---|
| SG7 | 0.1240 | 0.0 |

$$v = \sqrt{s^2 - r^2}$$

*v*: vertical height

*s*: slant height

*r*: Length of Measure-Up-Bar

The SHMP is 0.000 m.


## Examples

| Measured Slant s (feet) | Slant s (m) | Vertical v (m) |
|---|---|---|
| 6.965 | 2.123 | 2.119 |
| 5.148 | 1.569 | 1.564 |

# Warranty

Before you get hung-up with hardware and software problems, please give us (iGage Mapping Corporation) a call:

+1-801-412-0011

Our goal is to take great care of our customers and be reasonable with everyone. Our response to issues may exceed your expectations and our written warranty.

IMC is “iGage Mapping Corporation” of Salt Lake City Utah USA.

IMC warrants the SG7 receivers, which we sell, to be free of defects in material and workmanship and will conform to our published specifications for these periods:

| | |
|---|---|
| GPS receivers: | 1-year |
| Cables and accessories: | 1-year |
| Batteries: | 90-days |

This warranty applies only to the original purchaser of the product.

Hardware: Purchaser's exclusive remedy under this warranty shall be limited to the repair or replacement, at IMC's option, of any defective part of the receiver or accessories which are covered by this warranty. Repairs under this warranty shall only be made by IMC at an IMC service center. Any repairs by a service center not authorized by IMC will void this warranty.

In the event of a defect, IMC will at its option, repair or replace the hardware product with no charge to the purchaser for parts or labor. The repaired or replaced product will be warranted for 30 days from the date of return shipment, or for the balance of the original warranty, whichever is longer.

Software: IMC warrants that software products included with hardware products will be free from media defects for a period of 30-days from the date of shipment and will substantially conform to the then-current user documentation provided with the software. IMC's sole obligation shall be the correction or replacement of the media so that it will substantially conform to the then-current user documentation. IMC does not warrant that the software will meet purchaser's requirements or that its operation will be uninterrupted, error-free, or virus-free. The purchaser assumes the entire risk of using the software.

# Exclusions

The following are excluded from the warranty coverage:

Periodic maintenance and repair or replacement of parts due to normal wear and tear.

Display windows.

Product Finishes.

Batteries exposed to heat, cold; or batteries opened or physically damaged.

Installations or defects resulting from installation.

Any damage caused by (i) shipping, misuse, abuse, negligence, tampering, or improper use; (ii) disasters such as fire, flood, wind, and lightning; (iii) unauthorized attachments or modification.

Service performed or attempted by anyone other than an authorized iGage Mapping Corporation service center.

That the receiver will be free from any claim for infringement of any patent, trademark, copyright, or other proprietary rights, including trade secrets.

Any damage due to accident, resulting from inaccurate satellite transmissions. Inaccurate transmissions can occur due to changes in the position, health or geometry of a satellite or modifications to the receiver that may be required due to any change in the GPS. IMC GPS receivers use GPS satellites to obtain position, velocity, and time information. GPS is operated by the US government, which is solely responsible for the accuracy and maintenance of the GPS system. OPUS and OPUS-RS are a service of the NGS and IMC shall not be responsible for issues with NGS provided services.

Except as set forth in this limited warranty, all other expressed or implied fitness for any particular purpose, merchantability, or non-infringement, are hereby disclaimed.

IMC shall not be liable to the purchaser or any other person for any incidental or consequential damages whatsoever, including but not limited to lost profits, damages resulting from delay or loss of use, loss of or damages arising out of

breach of this warranty or any implied warranty even though caused by negligence or other faults of IMC or negligent usage of the product.

In no event will IMC be responsible for such damage, even if IMC has been advised of the possibility of such damages.

This written warranty is the complete, final, and exclusive agreement between IMC and the Purchaser.

## RMA

To obtain warranty service from iGage Mapping Corporation the purchaser must obtain a return materials authorization (RMA) number prior to shipping by calling

+1-801-412-0011

Or by email:

info@igage.com

Purchaser's return address and the RMA number must be clearly printed on the outside of the package. IMC reserves the right to refuse to provide free-of-charge service if the date of sale cannot be determined or if the serial number is altered or removed. IMC will not be responsible for any losses or damage to the product incurred while the product is in transit or is being shipped for repair. Insurance is recommended. IMC suggests using a traceable shipping method such as UPS, FedEx or USPS with signature tracking when returning a product for service.

Do NOT send batteries with equipment for repair. If you do, they will not be returned as we are unable to ship used batteries.

The Purchaser shall always pay shipping to IMC, IMC will return warranty repairs by UPS ground, unless the Purchaser agrees to prepay expedited service costs. IMC will not pay for warranty returns to destination outside of the United States. The purchaser shall always pay any associated duty associated with warranty repairs.