iG4

Static GNSS Receiver
User Manual

Revision **T** 2019.09.13 (B9630)

FCC Notice iG4 receivers comply with the limits for a Class B digital device, pursuant to the Part 15 of the FCC rules when it is used in the Portable Mode.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC ID:	SY4-A01024
Model Number:	1192110016
Model Name:	Geodetic GNSS Receiver (X900)
iGage Name:	iG4
NGS Antenna Designation:	"IGAIG4 NONE"

Table of Contents

Introduction

Thank you very much for choosing to purchase and use an iG4 GNSS receiver!

The iG4 features outstanding static performance and is easy-to-use with automated downloads and submissions, we know that your new receiver will be a valuable tool that quickly pays for itself.

This guide is designed to help you familiarize yourself with your new equipment and to offer basic information on the operation of NGS OPUS.

If you have questions or suggestions, don't hesitate to contact us:

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

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

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

Software updates and news are available from:
www.iGage.com

Click on the 'Support' link and then find the iG4 [resource] link.

Technical Specifications

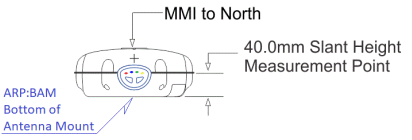
432 channel Unicorecomm UM4B0 GPS/GLONASS/Galileo/BDS Tracking

GPS	L1/L2/L5
GLONASS	L1/L2
Galileo	E1/E5a/E5b
BDS	B1/B2/B3
QZSS	L1/L2/L5
SBAS	L1

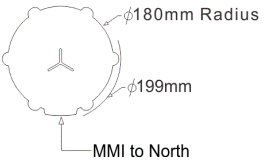
Time to First Fix (TTFF) Cold Start 25 seconds

Antenna Definition: NGS "IGAIG4 NONE"

IGAIG4 NONE
PN: 1192110016
Manufacturer: iGage Mapping Corporation



Antenna code: IGAIG4
Radome code: NONE
Antenna type: IGAIG4 NONE
Part#: 1192110016
ARP: BAM (bottom of antenna mount)
NRP: MMI (man-machine interface)



The Really-Quick-Start Guide

Before First Use

Please read the "Best OPUS Practices for New and Experienced Users" section of this User Manual on page 36. It will save you time and failed jobs.

In the Field

1. Put a charged battery in the receiver.
2. Mount the receiver over the point you want to survey. Level and measure the Instrument Height (HI), use a fixed height tripod or range pole with Hold-a-Pole if available. For best results: align the button panel to face north, double-check your bubble and the instrument height (HI.)
   Record the HI, start time and point description in your field notes:

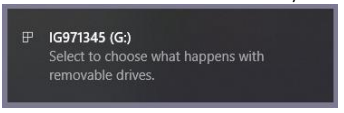
Point	Description	HI	Start Time	End
1001	*NW C Sec 14*	*2.0M V*	*9:45 am 1 March 2020*	*12:18 pm*

3. Push the ON/OFF button and hold it for 1-second until the lights flash. After 30 seconds the blue LED will flash once for every tracked Satellite.
4. Verify that the yellow 'Files' LED flashes once every 5-seconds (or 1-second if configured) as the receiver logs data.
5. Let the receiver record data for at least:
   OPUS-Rapid Static: 16-minutes
   OPUS-Static: 121-minutes
6. Turn the receiver off by pushing and holding the ON/OFF button for 1-second.

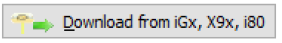
Office / Desktop

7. Install the download tool from the included DVD or (recommended) get the latest version from www.iGGPS.com.
8. Put a freshly charged battery in the receiver, turn on the receiver, wait 10-seconds for the power LED to flash and then plug your iG4 into a USB connector on your computer.
9. If you see the Windows AutoPlay screen:

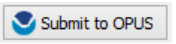
   click on the red 'X' button on the upper-right corner.
   If you see the Windows 10 AutoPlay screen:



   just ignore it.
10. Start the iGx Download tool from your desktop, push the 'Download from GPS' button:

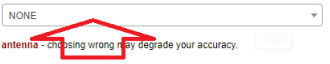


11. Highlight the occupation, set the Point ID, the Description and the HI; push the 'Submit to OPUS'



button.

12. When prompted press OK, then Control-V (to paste the file location and name,) then press the “Enter” key on your keyboard, or click on ‘Open’ to set the ZIP filename.
13. You will need to manually select the correct antenna type. Click anywhere in the ‘antenna’ selection box:



Then in the drop-down selection box:

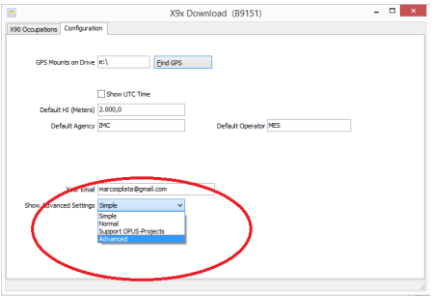
Enter ‘IG4”, wait a moment for the list to populate and then click on the ‘IGAIG4 NONE’ selection to choose the correct antenna model.

14. Finally press the ‘Upload to Rapid Static’ or ‘Upload to Static’ button as prompted at the bottom of the screen.

Exporting to other Programs (NOT OPUS)

The files that are submitted to OPUS are decimated and stripped of all satellite information except for GPS. Galileo, GLONASS and BeiDou are removed!

If you are using the iG4 occupation file in another application select the ‘Configuration’ tab, then choose 'Show Advanced Settings = Normal’ (or Advanced).



An ‘Export RINEX’ button will be shown on the main ‘Occupations’ tab:

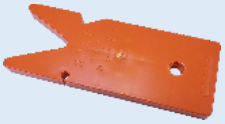
Use this export button to write full rate (not decimated), full constellation RINEX files for use in external applications.

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

What's in the iG4 Box?

Other than a suitable tripod or pole, iG4 receivers are sold as complete kits, ready to record OPUS compatible static raw data sets.

Each receiver kit includes these items:

A Hard Shell Carry Case 	This User Manual 
iG4 GNSS Head 	The iG Download DVD: 
GPS to PC Data Cable: Serial, USB and Ext. Power 	A high capacity 7.4 V Lithium-Ion Battery 
Quad Battery Charger 	Power Adapter with Cord: 
A Hold-A-Pole: 	External Battery Power Clips 

Technical Assistance

If you have questions or issues with your receiver, support is provided by iGage Mapping Corporation in Salt Lake City Utah:

iGage Mapping Corporation
www.iGage.com
1545 South 1100 East STE 1
Salt Lake City UTAH 84105
+1-801-412-0011 support@igage.com

Warranty

Please see the full warranty at the end of this manual for details.

The iG4 GNSS receiver has a 2-year warranty. Accessories (cables and chargers) are warranted for 1-year. Batteries are warranted for 90-days.

Advanced replacement programs are available for mission critical applications.

Service is provided by iGage Mapping Corporation in Salt Lake City Utah.

Safety Information

This manual describes the iG4 GNSS Receiver. Before you use your receiver, please make sure that you read and understand these warnings and safety requirements.

Warnings and Cautions

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

Use and Care

The iG4 receiver is a field ready instrument; however it is also a delicate electronic instrument. Take suitable care to avoid damage to the instrument.

Avoid dropping the receiver as it can change the phase center of the antenna.

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

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

Environment

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.

DO NOT leave the iG4 or accessories inside a vehicle in the summer. Temperatures higher than 160°F will permanently reduce battery capacity and battery life.

The receiver is suitable for use in a human appropriate atmosphere, it is not suitable for use in explosive environments.

Risk of Electrocution: Because of risk of electrocution it is very dangerous to use poles or extensions in the vicinity of overhead electrical lines. Maintain a safe distance from overhead electrical delivery systems.

If the receiver is used on a pole during an electrical storm there is a very high risk of being struck by lightning. Do not use the product during a thunderstorm.

Battery Safety and Disposal

The batteries are lithium-ion type cells.

Battery Warnings

WARNING - Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and property damage.

To prevent injury or damage:

Do not use or charge the battery if it appears to be discolored, warped, or leaking battery fluid.
Do not expose the battery to fire, high temperature, or direct sunlight.
Do not immerse the battery in water.
Do not store the battery inside a vehicle during hot weather.
Do not drop or puncture the battery.
Do not open the battery or short-circuit its contacts.
Do not charge the batteries in chargers other than the supplied charger or a direct replacement.
Do not charge similar batteries in the supplied charger, even if they fit well.
Do not short circuit the battery terminals or store batteries in a way that allows inadvertent shorting.

WARNING - Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. The battery fluid is extremely corrosive, and contact with it will result in personal injury and/or property damage.

If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!

If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.

Batteries

One Lithium-Ion battery is supplied with your receiver.

Additional batteries are available from iGage and 3rd party sources. Non-iGage supplied batteries may not have the same capacity, especially after several charge cycles.

For shipping regulation compliance, batteries are shipped inside the receiver and are fully discharged. You will need to remove the battery from the receiver and fully charge it before first use.

If you plan on running the receiver for longer than 5-hours, it is suggested that you use the supplied Battery Clip cable to connect the auxiliary power connector to an external 12-volt battery.

Battery Charger

The battery charger will charge 4 batteries at once.

Plug the charger into the supplied wall transformer.

You may also use the supplied alligator clip cable to connect to a 12 Volt battery. We supply alligator clips instead of cigarette adapters so you don't have to leave your keys in the ignition if you need to field charge batteries.

The supplied charger has a RED LED on each side to indicate that power is attached.

Next to each battery is a GREEN LED.

GREEN LED	STATUS
Off	No Battery Inserted
Blinking	Battery Charging
ON Steady	Battery is fully charged

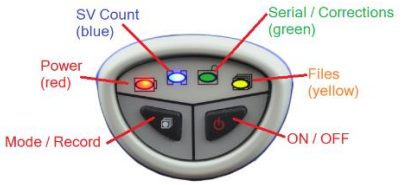
After a battery is fully charged, it is recommended to remove the battery for extended storage.

Optional Accessories

Optional Heavy-Duty External Power Cables are available for the iG4 from iGage. They are reasonably priced and are perfect for attaching your receiver to external power for extended operation.

The matching part number for the iG4 is 'M9'.

Front Panel Operation



Pushbuttons

The receiver's front panel has two pushbuttons **On/Off** and **Mode / Record**:

On/Off Pushbutton

Press the **On/Off** button for 1-second and release to turn ON the receiver.

If the receiver is ON, press the On/Off button for 1-second to turn the receiver OFF. The receiver will not begin shutting down until you remove your finger from the button.

Mode / Record Pushbutton

iG4 receivers are factory configured to automatically begin recording after the receiver is turned on and tracking satellites. (You probably won't ever need to use the **Record** button.)

If the receiver is recording data, pressing and holding the **Record** button for two seconds toggles the receiver from collecting data, to not collecting data and closes the current occupation file. The yellow **Files** LED will stop flashing when recording stops.

When the receiver is not recording, pressing and holding the record button again for two seconds will open a new observation file and begin collecting observation data.

You can also use the **Mode / Record** button to check the collection state:

Tapping the **Mode** button will cause either the Serial or the Files button to flash:

Serial green	receiver is recording
Files yellow	receiver is NOT recording

LED Indicators

There are four LED indicators on the receiver:

Power (Red)

Power is ON. If flashing, the battery charge is very low.

SV's (Satellite Count) (Blue)

Blinks once for each tracked satellite, waits 5-seconds, repeats.

Serial (Green)

Blinks when data is received by the serial port. Blinks when the 'Record' button is pressed if the receiver is storing to a static file.

Files (Yellow)

Blinks each time data is stored to the static file.

When the receiver turns on:

All LEDs will flash.

The Blue SV's LED will flash three times, then after 1-second, once more.

The Red Power LED will flash three times.

After the Blue SV's LED flashes three times, the receiver will automatically begin searching for satellites. When enough satellites are found to determine the receiver position and current date/time, a new occupation file is opened and the Yellow Files LED will begin to flash, once each epoch (the default epoch is 5-seconds.)

NOTE: If the receiver is deployed after not being used for more than a month, or was last turned on more than a couple hundred miles from the current location, it may take an extra few minutes for the receiver to obtain a position.

NOTE: if the Yellow LED is not blinking, then the receiver is NOT collecting data. If you have waited a few minutes and the receiver is not collecting data, something is wrong.

After the Blue SV's LED flashes three-times, you may plug the receiver into your PC and it will mount as a fixed USB drive.

To turn the iG4 off, press and hold the On/Off button for one second. All four LED's will quickly flash three times and the receiver will power down.

NOTE: If the two right LEDS (Green and Yellow) flash at the same time, then the flash memory has been corrupted (typically by removing the cable while downloading data.) Check the troubleshooting section at the end of this manual for instructions on fixing this issue.

Collecting Static Data

OPUS-Static, OPUS-RS and OPUS-Projects

Additional information on OPUS-Static and OPUS-Rapid Static can be found in the 'OPUS' section of this manual.

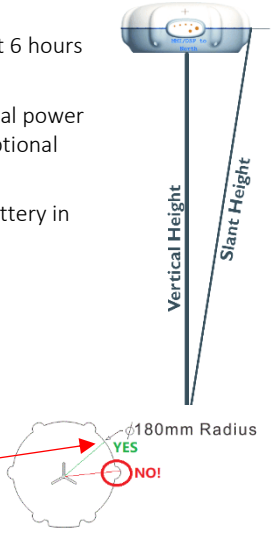
Please read the "Best OPUS Practices for New and Experienced Users" section of this User Manual on page 36. It will save you time and failed jobs.

Prior to using the receiver, fully charge the battery to ensure that the static occupation is not interrupted by power failure.

A fresh battery when new and fully charged will run the receiver for about 6 hours and 55 minutes at 60 degrees F.

When making occupations longer than 5-hours you should provide external power to the receiver with the included battery clips, the power supply or the optional heavy duty power cable.

If you use an external battery/power you MUST also provide a charged battery in the receiver.



1. Place a freshly charged battery into the receiver.
2. Place the receiver above the point you want to survey.
3. Rotate the receiver so the pushbutton panel faces the North.
4. Level the receiver.
5. Record the 'Vertical Height' from the top of the survey mark to the bottom of the receiver; alternatively, you may measure a 'Slant Height' to the bottom of the blue rubber gasket at the minimum radius.
6. At a minimum, make a careful note of the following items in your field book:

   Start Time and Date

Instrument Height (HI)
PID (Point ID, Mark Name)
Description

Point	Description	HI	Start Time	End
1001	*NW C Sec 14*	*2.0M V*	*9:45 am 1 March 2020*	

7. Turn on the receiver. After 30 to 90-seconds, you will see the Yellow "Files" LED flash once every epoch (default 5-seconds) as the receiver records observables. Check that 5 or more satellites are tracked (the blue LED will blink 5 or more times.)
8. Wait an appropriate time period for data collection:

   OPUS-RS (Rapid Static)

   Minimum of 15-minutes
   Maximum of 2-hours

   OPUS-STATIC

   Minimum of 2-hours
   Maximum 48-hours
   4-hours suggested minimum

   Remember that for OPUS the data is going to be decimated to 15-second intervals. It is best to wait at least 1-minute longer than required to insure that the decimation process does not leave your file too short.

9. At the end of the occupation Press and hold the ON/OFF key for one-second until the receiver closes the current file and turns off.
10. Make a note of the end time in your field book:

Point	Description	HI	Start Time	End
1001	*NW C Sec 14*	*2.0M V*	*9:45 am 1 March 2013*	***12:18 pm***

Downloading, Processing and Archiving Data

Your iG4 GNSS receiver includes a download, preprocessing and archive tool called

iGx Download

for use with the NGS OPUS, RTX, AUSPOS and IBGE online products. This tool runs on Windows PC's and distributed on a DVD-ROM in the box and is also available by web download.

Installing the Download Tool

Insert the provided disk in the DVD ROM drive of your computer and the installation tool should automatically run.

If you don't have a DVD ROM drive, you can download the latest version of the tool from www.iGgps.com click on the 'iGx-Download' tool link to get the latest program version.

Follow the on-screen instructions to install the download tool and support tools on your computer.

Connecting the iG4 Receiver to your Computer

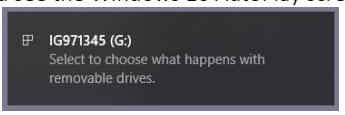
Summary: Turn on the GPS, wait fo 10-seconds; plug in the USB Cable to your computer.

The iG4 receiver mounts just like a USB thumb drive (flash drive) on your Windows computer. No special drivers are required.

To download data from your receiver:

1. Turn on the GPS receiver
2. Wait 10 seconds for the power LED (Red) to blink 3 times.
3. Plug the USB connector into a port on your computer
4. If you see the Windows AutoPlay screen:

click on the red 'X' button on the upper-right corner.
If you see the Windows 10 AutoPlay screen:



just 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 thumbdrive the drivers are built into Windows XP, Windows Vista, Windows 7, Windows 8 and Windows 10.

If your iG4 receiver does not mount or an error message is displayed, you can usually unplug the receiver, wait a moment, then plug it back in.

If you continue to have problems check the 'Troubleshooting…' section at the end of this manual.

Starting the iGx Download Tool

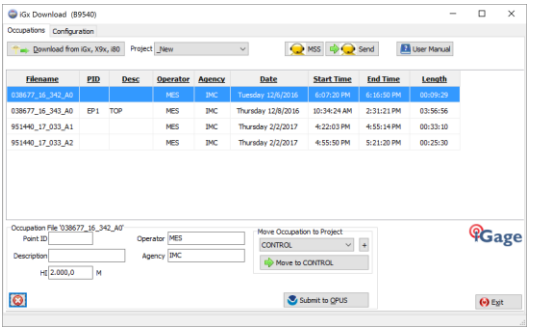
You can start the iGx download tool by clicking on the iGx shortcut on your desktop:

Downloading Data

Assuming the iG4 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 may be manually downloaded again at a later time if needed.

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 order the grid.

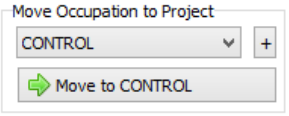
If you have any really short or unneeded occupations, you can select and delete them with:

 <- 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 submitted to OPUS and can be used to correlate occupations to OPUS solutions.
2. **Description** A longer description of the point. Note that quotes " and ' 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

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

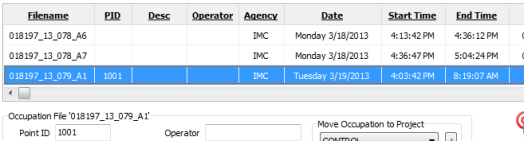


Submitting an Occupation to OPUS

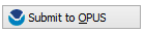
NOTE: The iGx Dowload tool will run under **Windows XP** however it is **not** possible to submit observation files to NGS OPUS from a Windows XP machine. This limitation is imposed by the NGS, not by iGage and there is no work-around.

Once all of 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:



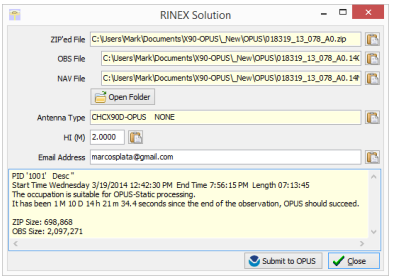
Click on the 'Submit to OPUS' button:



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

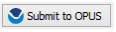
1. the file is decimated to 15-second epochs, header information is stuffed
2. the file is run through TEQC to insure it will be acceptable to OPUS
3. an Observation file and a Navigation file are generated
4. the Observation file is compressed into a ZIP file

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:



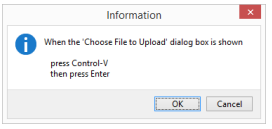
The program will suggest which service (OPUS-Static or OPUS-RS) and list the time since the end of the occupation with notes about the observation.

You can click the 'Submit to OPUS' button:

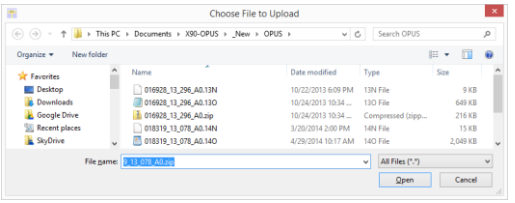


to automatically open an internet browser, which will load the NGS OPUS Submission form. After the web page has loaded, the program will automatically fill in the 'Antenna Type', the 'Antenna Height' and the 'Email address.'

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

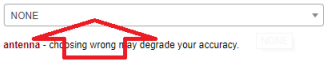


Click OK and then 'Choose File to Upload' will be displayed:



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

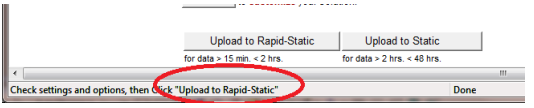
You will need to manually select the correct antenna type. Click anywhere in the 'antenna' selection box:



In the drop-down selection box:

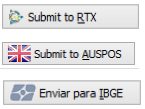
Enter 'IG4" and then click on the 'IGAIG4 NONE' selection to choose the correct antenna model.

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.

Note, you may select an alternative PPP Service provider (on the configuration tab.) Some of the alternative providers are:



Trimble's RTX Service

AUSPOS

Brazilian Institute of Geography and Statistics

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 modify the device type while the receiver is connected on the 'Configuration' tab.

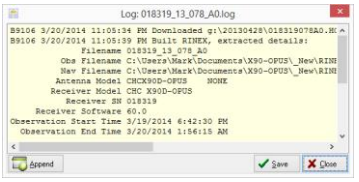
Viewing the Observation Log

(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

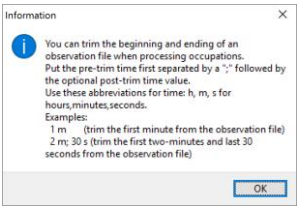
(Hidden when Simple)

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

Common reasons for wanting to do this include:

- 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 usage instructions:



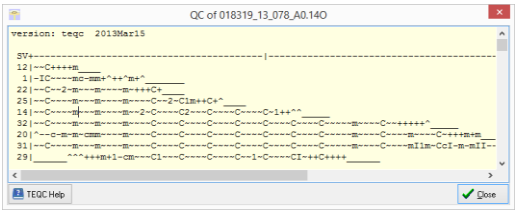
Note: the trimmed length is not reflected in subsequent screens or on the occupation grid. Only the submitted file is trimmed, all of the original data remains in the occupation. The trim settings must be reloaded after each submission.

Performing Quality Control Checks

(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.

We use it to verify receiver operation in our hardware validation process.

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.

The Send to Factory Support Button

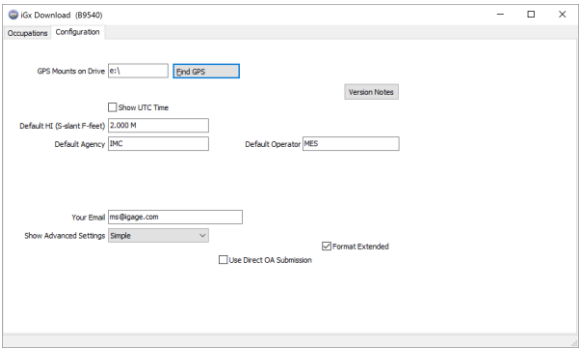
An iGage support technician may ask you to send a troublesome occupation to the factory for assistance. Simply highlight the occupation in the grid, click the 'Send' button and the occupation with all of the support files and settings will be bundled into a single ZIP file and pushed to the factory.

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 and help you.

Advanced Download Settings

Configuring the Download Tool

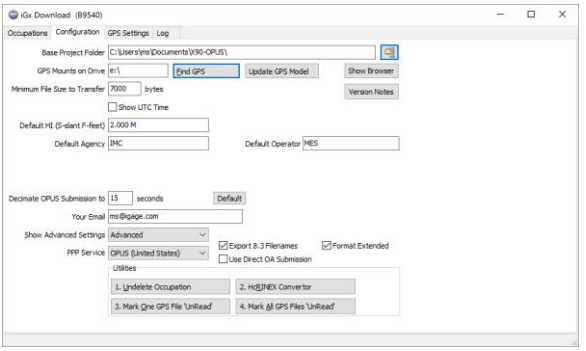
Click on the 'Configuration':



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' or 'Advanced' 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 of the data is stored. The default location is in your 'Documents' folder in a folder named 'iGx_Projects'. (If you have previously used 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	if you delete an occupation, it is not really deleted, just 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 backup every occupation in every project to a single ZIP file.

This is handy if you want to move all of 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'

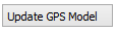
This is the drive letter that the GPS receiver was last found on. Don't worry if the drive letter changes, the program will automatically find the receiver when you download data.

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

> Note: If you manually delete 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.

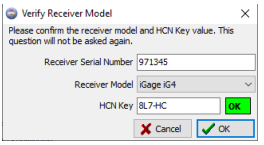
'Update GPS Model'

(Shown only when Advanced selected.)



The GPS Model is written into the receiver at the factory. If you delete 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.

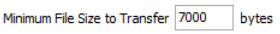
If the HCN Key has been lost, you will find it on a white sticker inside the battery compartment.

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 both the receiver and your computer.

'Minimum File Size to Transfer'

(Hidden when Simple)



Every time you turn on the GPS receiver, it will attempt 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 and you won't have to worry about HI blunders.

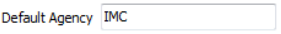
FEET: If you measure up in feet, you can enter the height in decimal feet and put an 'F' after the measurement. The program will automatically convert to Meters for you.

SLANT HEIGHT in Meters: If you measure a slant height, 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 10 characters in length however the RINEX definition allows values up to 40 characters in length.

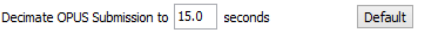
'Default Operator'

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)



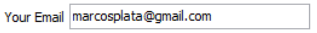
When you submit a file to OPUS, it is always decimated at the NGS server to 30-second epochs (recording interval = 1 point every 15 seconds.)

The default recording interval for **static** receivers sold by iGage is 5-seconds. If we know you will be processing UAV data with the iG4 files we will preset the interval to 1-second at the factory prior to shipping. The default recording interval for **RTK** receivers sold by iGage is 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.

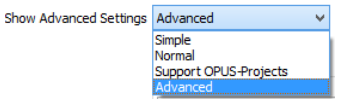
Observations submitted to RTX are not decimated, AUSPOS submissions are decimated to 15 seconds. Observations exported directly to RINEX are not decimated.

'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 determines 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.

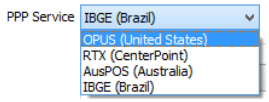
OPUS-Projects:
Displays the OPUS-Projects checkbox which allows automatic submission to a NGS registered project.

Advanced:
Displays the GPS Settings and Log tabs.

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

'PPP Service'

(Hidden when Simple)



The iGx download tool supports several PPP (Precise Point Positioning) services.

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

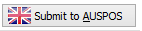
Additional Information is available on each service on the web:

OPUS: 

http://geodesy.noaa.gov/OPUS/

RTX: 

http://trimblertx.com

AUSPOS: 

http://www.ga.gov.au/bin/gps.pl

IBGE: 

http://www.ibge.gov.br/home/geociencias/geodesia/ppp/default.shtm

Export 8.3 Filenames

(Hidden when Simple)

If this box is unchecked then the iGx download program submits files using 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 this box results in exported filenames like:

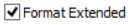
10050720.14O

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.

Format Extended

(Only shown when PPP Service = OPUS)



The NGS returns three styles of reports:

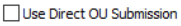
Standard: Single Page Report
Extended: Standard + baseline details + State Plane in (s)Ft
Standard + XML: Single Page + XML

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 OPUS report, 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



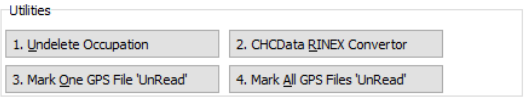
Checking this box allows the program to skip displaying the NGS submission web page. All information is uploaded automatically without operation assistance.

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 disable the 'Use Direct OU Submission' checkbox.

Utilities

(Hidden when Simple)



Additional utilities for working with observations are included.

"1. Undelete Occupations"

When you delete an observation, it is actually 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. HcRINEX Convertor"

Files are stored on the receiver in a .HCN binary file. When the iGx download tool downloads a file, it is automatically converted to standard RINEX using the CHCData tool.

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 One File Unread"

When files are downloaded from the receiver, they are not deleted from the receiver. The filename on the receiver is modified to begin with an underscore '_'.

This function allows you to specify a single file to mark as 'unread.' Once a file is unread the next download action will re-download and convert the file.

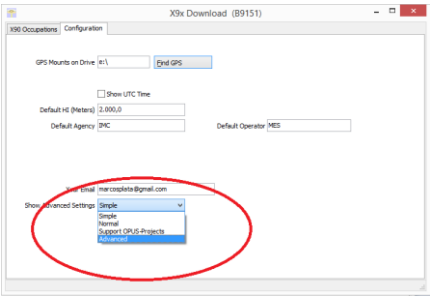
"4. Mark All GPS Files Unread"

This function marks EVERY observation file on the receiver as unread. The next download will read every single file on the receiver. (This will take quite a bit of time if your receiver had hundreds of files.)

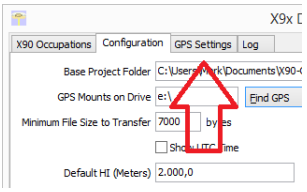
GPS Settings

(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 additional tabs will be displayed:



The 'Log' Tab

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

GPS 'Settings' Tab

The 'GPS Settings' tab allows you to change these receiver behaviors:

Automatic End of Sessioning
Recording Interval for Static Data

Elevation Mask
Check and Update Receiver Firmware

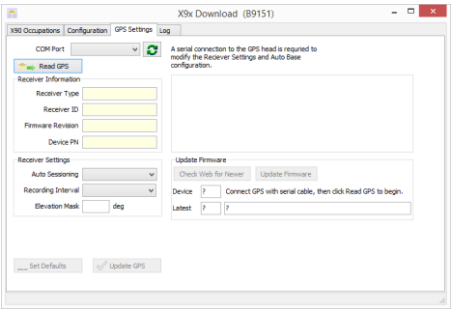
To configure the GPS settings, first connect the GPS receiver to your computer using the 'Serial Port' connector. If your computer does not have a built-in serial port, you will need to use a 'USB to Serial' converter.

We highly recommend the

PN: USB2-VE487-TG ; Tera Grand - Premium USB 2.0 to RS232 Serial DB9 Adapter - Supports Windows 10, 8, 7, Vista, XP, 2000, 98, Linux and Mac - Built with FTDI Chipset

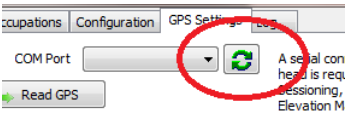
Which is available from Amazon for less than $12.

To configure the receiver, turn on the GPS receiver, select the 'Show Advanced Settings' checkbox and then select the 'GPS Settings' tab:



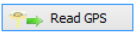
The configuration tool should automatically detect the correct COM (Serial) port number. If you have more than one serial port, you may need to manually adjust the 'COM Port' setting to match the port that the GPS is connected to.

If you plug a USB-to-serial port adapter into your computer after starting the download tool, press the refresh button:



the program should find the newly installed port. (Only ports in the range 1 through 32 are detected.)

Click on the 'Read GPS' button:



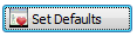
The configuration tool will interrogate the GPS receiver and display the 'Receiver Type', the 'Receiver ID' (the Serial Number), the GPS 'Firmware Revision' and the 'Device PN'.

The current values for 'Auto Sessioning', 'Recording Interval' and 'Elevation Mask' will also be shown and can be edited.

To return to the factory defaults:

'Auto Sessioning'	None
'Recording Interval'	5-seconds
'Elevation Mask'	0 degrees

Press the 'Set Defaults' button:



Or you can change the settings as required for your application. When you have made your selections, click on the 'Update GPS' button to send the changes to the GPS receiver.

Additional details for each of these settings follow.

Recording Interval

The recording interval defaults to 5-seconds on the iG3. Additional recording rates are also available:

1 second, 2 seconds, 3 seconds…59 seconds
1 minute, 2 minutes, 3 minutes…190 minutes
2 Hz , 5 Hz

The default interval (5-seconds) allows for files to safely contain over 7-days of continuous observations.

If you intend to use the observation files with OPUS you must use one of these recording intervals:

1, 2, 3, 5, 10, 15 or 30 seconds

Auto Sessioning

The default 'Auto Sessioning' setting is 'NONE.' Some applications may benefit from having the receiver automatically close files after a preset period.

'Auto Sessioning' only closes the current file. A new file is not automatically opened.

Elevation Mask

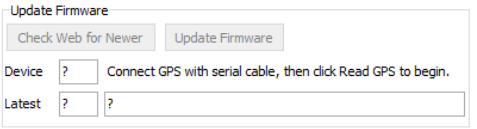
The default setting for 'Elevation Mask' is 0 degrees. All visible satellites are tracked.

OPUS automatically ignores satellites lower than 10-degrees.

There is a benefit to having the receiver track satellites for as long as possible as they rise to 10-degrees. (We don't want to start tracking at the exact moment that OPUS begins to use the satellite.)

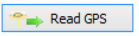
The internal memory of the receiver is huge. There probably is no advantage to raising the tracking elevation for any application and it is recommended that you keep the tracking angle set to the default 0-value unless you have a really good reason to change it.

Update Firmware

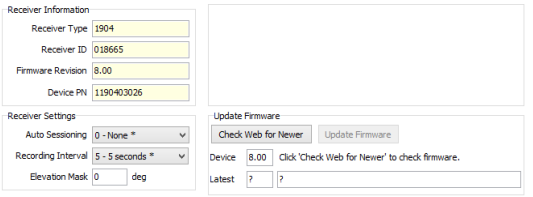


Updating the firmware in your receiver requires that the GPS be connected to a COM port on your computer (COM1 is best) and that your computer has an active internet connection.

To update your receiver firmware click on:

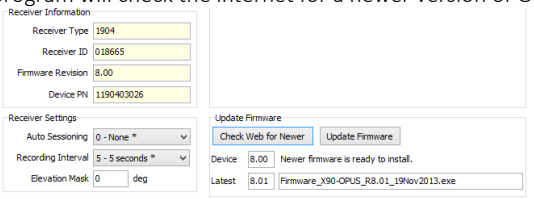


Once the current receiver's firmware version is shown:

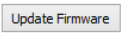


the 'Check Web for Newer' will be enabled. Click on:

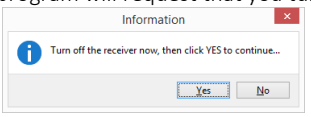
The program will check the internet for a newer version of GPS control software:



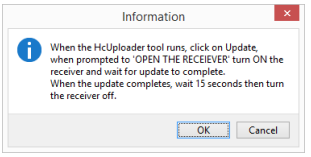
If updated firmware is available, the new firmware will be downloaded and the 'Update Firmware' button will be enabled, click on:



The program will request that you turn off the receiver:

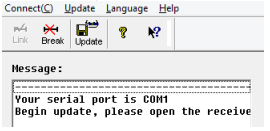


The firmware will be downloaded and a short instruction screen is shown:



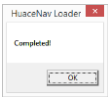
Click on OK. The firmware uploader tool will be displayed:

Click on the 'Update' button:



Turn on the GPS receiver:

After 5-seconds, the blue-bar will slowly move across the uploader screen. When it reaches the end:



Click on OK, then wait 30-seconds, turn off the GPS receiver, finally turn it back on. Your receiver has the latest firmware.

OPUS: What is it?

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

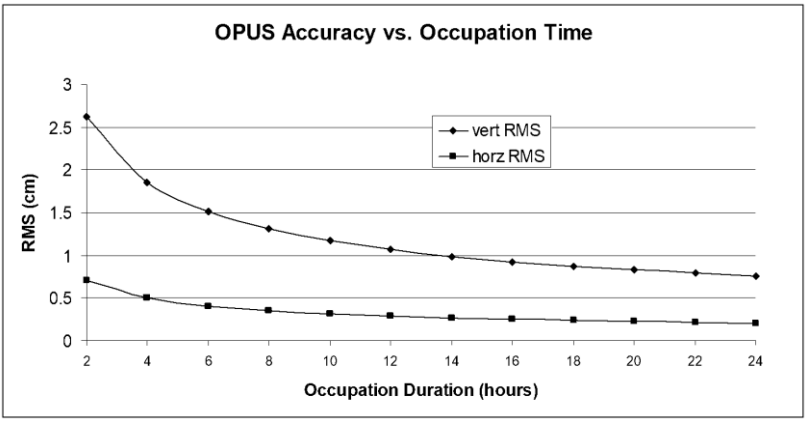
From the NGS Website:

> "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)

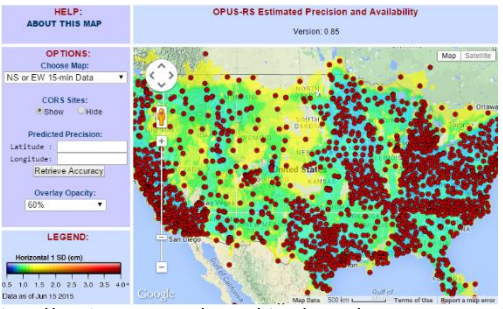
Standard OPUS-Static sessions require 2-hour observations. OPUS-RS sessions can be as short as 15-minutes.

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

> 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 work and you will have 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 insure 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 some 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 36. 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 IG8 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.

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 results, the state plane coordinates are computed and returned at the bottom of the report in the nominal foot type 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

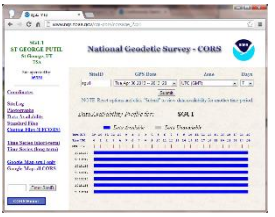
OPUS is a great tool for grounding your survey. But OPUS is part of a larger toolset. Before you begin a project take a moment to think about the 'Big Picture':

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

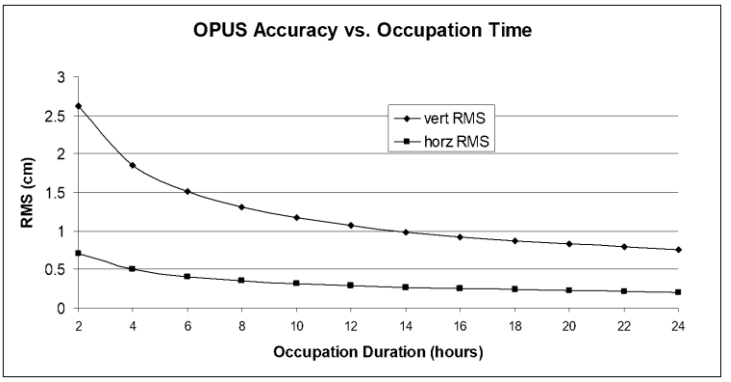
B. Are there passive marks available for control?
   a. Will CORS, passive or a combination control the survey?
   b. Are local passive marks recoverable, undisturbed, sufficient quality, stable and GPS friendly?
   c. Where are the nearby NGS CORS stations? This will determine 'Rapid Static' or 'Static' 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 required.
   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 insure 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 = 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?

G. Field Checklist:

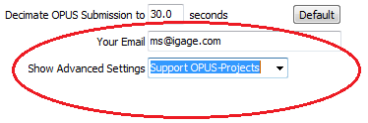
o Maps, aerial photography, ingress/egress plans
o Receiver with memory available
o Batteries fully charged plus battery-to-receiver cables with 12V external battery
o Compass for orienting receiver to North, current declination
o Fixed Height Tripods: Bubbles calibrated? Height verified?
o Tripods / Bipods /Tribrachs / Tribrach adaptors: Tribrachs calibrated?
o Tools for adjusting bubbles (the correct Allen wrenches)

o Measure tape for slant measurements
o Digital Camera, batteries, memory: take close ups of cap and 4 horizon shots w/ receiver
o Station information observation log sheets
o Inclinometer for checking and documenting horizon obstructions
o Field Book, Observation Schedule, pencils
o Cell phone
o Flagging, paint, PK nails, hubs, rebar, caps, hammer
o Fluorescent vest, hat, bug dope, sunscreen, lunch, water, traffic control equipment
o Names, addresses, telephone numbers of property owners
o Gate keys / combinations

Using OPUS-Projects

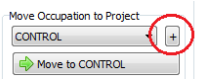
If you are contributing occupations to a registered OPUS-Project, the iGx tool can assist you when uploading files into your project by automatically entering the NGS project ID:

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

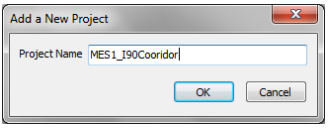


2. Add the NGS registered OPUS-Projects 'Project Identifier' supplied by your project administrator:

Click the "+" button

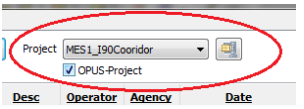


Enter the exact identifier



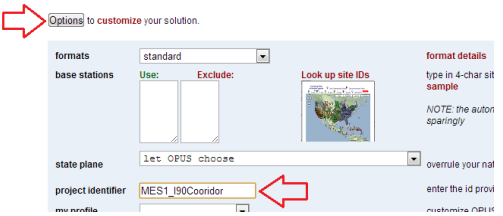
as the new project name.

Select the new Project



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

3. Now, 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

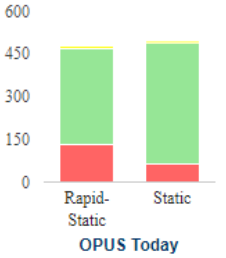
> "The NGS processing engine has a big fishbowl with 500 possible error messages printed on little slips of paper. If a job fails, the OPUS processor removes the five best error messages from the fishbowl. Next the fishbowl is shaken and three to five slips are randomly pulled from the fishbowl and returned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

#1 OPUS-RS is Dicey

When you submit 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.

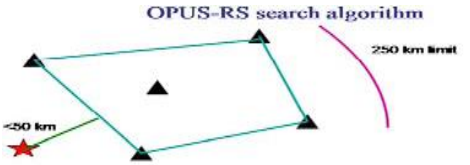
#2 Only Some Submissions are being returned by OPUS

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

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

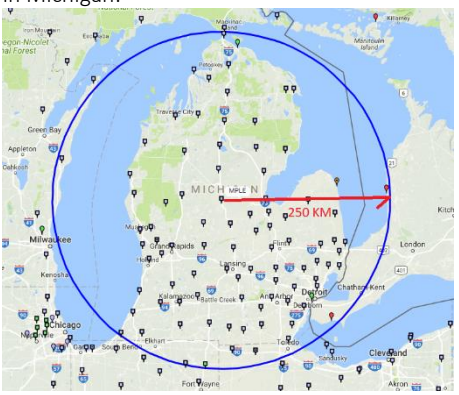
#3 OPUS-RS is Very dependent on the Number, Availability, Proximity, Distribution and Quality of nearby CORS Stations

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.

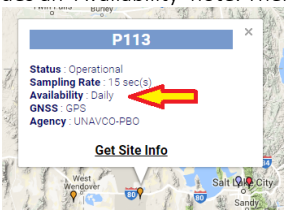
If you are in the middle of Utah there are very few CORS sites available on a good day:

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. 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.

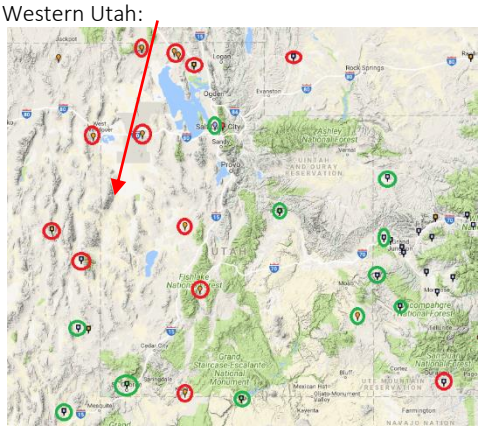
If your OPUS submission has sufficient nearby hourly stations, then you can probably wait 45 minutes after the top of the hour following your file collection and an OPUS submission will be successful.

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

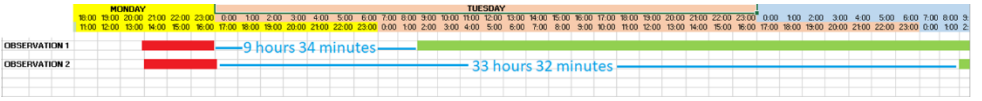
Consider Western Utah:



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 of 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.

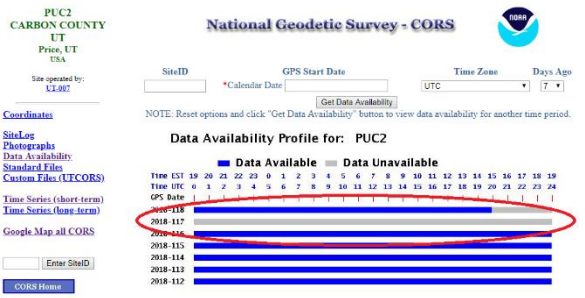
Because no other nearby CORS data is available, OPUS has used hourly files from CORS sites over 250 KM away to process the second file. These long baselines have much higher uncertainty and result in higher peak-to-peak error estimates. If we resubmit the 2nd occupation on Wednesday, it will have excellent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

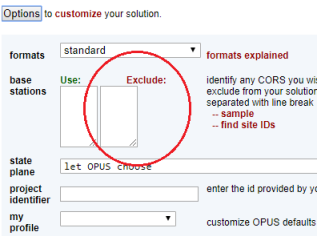
OPUS error messages are structured based on this assumption of highest quality CORS data and low expectations of your user data quality.

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

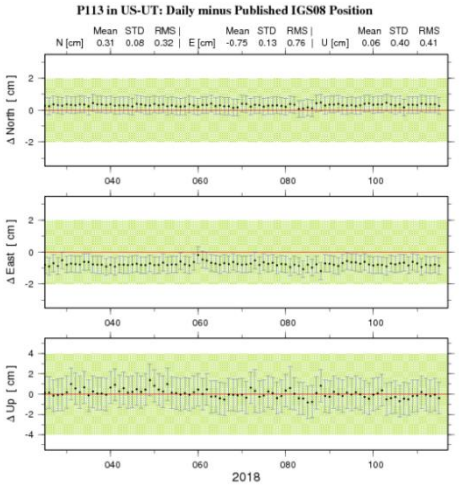
Stuff happens and some of the CORS stations are unreliable and a few are horrible. No matter how bad a station might be, NGS CORS will collect the bad data and the OPUS engine will use the bad data and then blame your occupation for all issues.

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



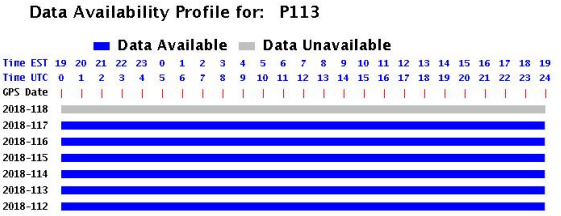
But how can you determine if a CORS station should be excluded?

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

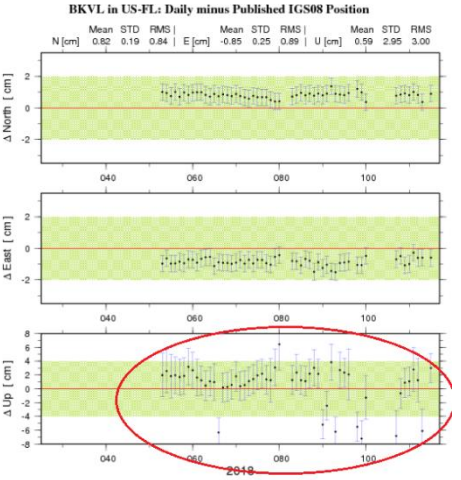
You also want to look at the recent 'Data Availability':



Availability for P113

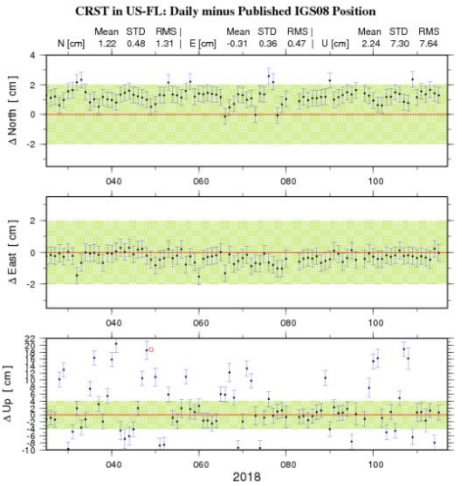
The position trends are very stable and are within 1 cm horizontal and vertical of the published IGS08 positions. The average locations and all of the error bars are fully contained in the green error bands. Coupled with continuous recent Data Availability this station appears be a great CORS resource.

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



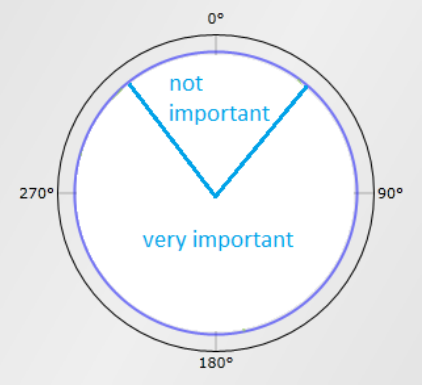
These stations and all the others like them are unsuitable for any processing use. It is your responsibility to exclude them from your solutions.

#8 GPS Suitable Locations

The NGS recommends that you submit GPS occupations collected in **GPS suitable locations**. However, very 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 totally clear view of the sky above 10° at all azimuths where there is a possibility of a GPS satellite being in the sky:

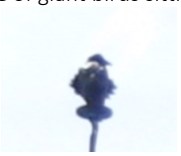


Obstructions to the North not important in North America

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.
- 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 great 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 of 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.

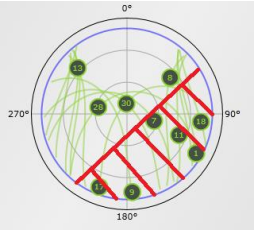
Semi-Trucks and Trains

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 a 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

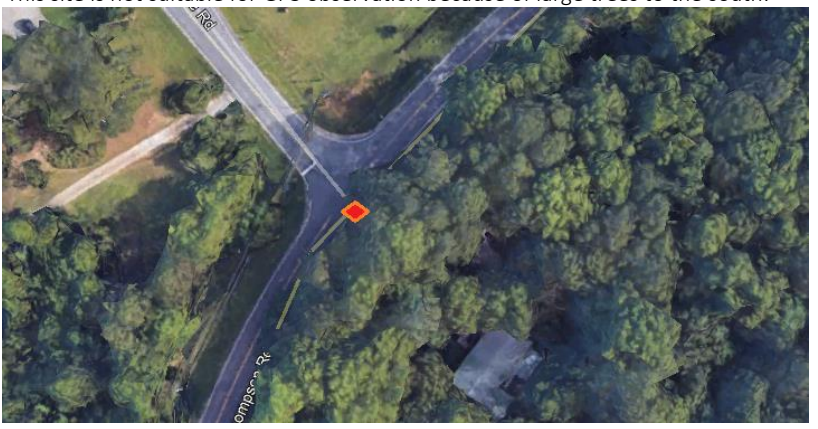
This 8-story parking garage is 40 feet to the southeast of the brass rivet in the street. The red arrow points South.



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 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)

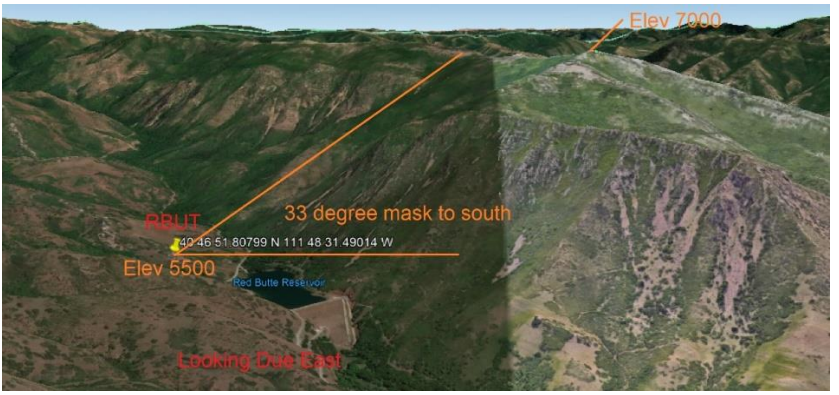
Flat metal surfaces are bad. Corrugated metal surfaces (like corrugated roofing) are even worse. Some mirrored glass windowing used on building exteriors is reflective at microwave frequencies. Box truck bodies, metal buildings, metal roofs and open water are all potential sources of multipath.

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.



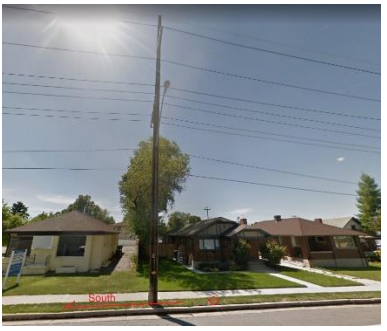
Power Poles

< 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 powerline. 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.

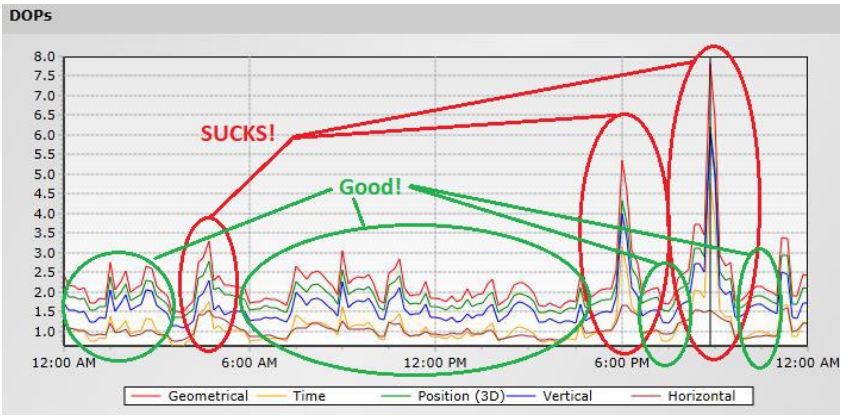
A six-hour occupation may return great results at a site where 2-hour occupations fail. More-time in adverse locations is always better.

#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.

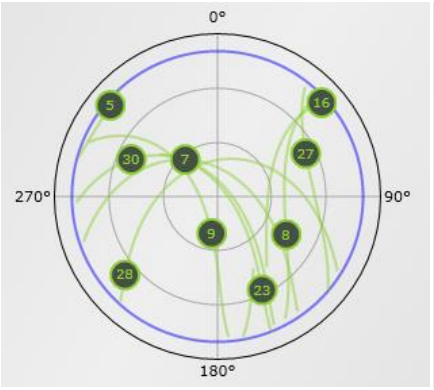
Here is a typical GPS Only Mission Planning example:



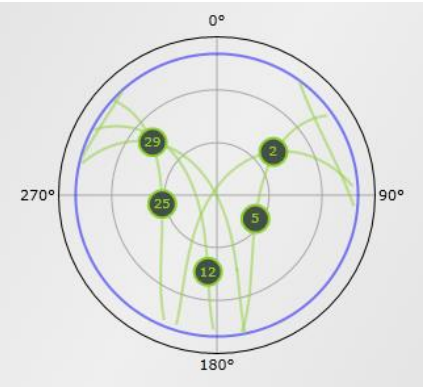
Lower DOP is better than higher DOP. You can see that most of the day, DOP is excellent. Most OPUS submissions will be successful. However starting at 5:30 pm there are large DOP spikes.

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.

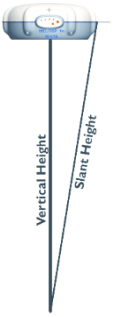
The change in satellite constellation, which determines PDOP is why a receiver will work one day and then not work in a nearby location at a different time.

#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 are going to 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. The process is described on page 58 in the 'Slant Height' to 'Vertical Height' section of this User Manual.

Slant reduction error is also very 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.

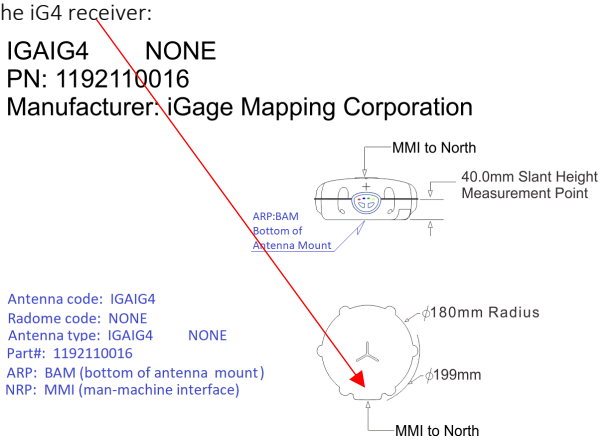
Transposition of digits in random heights that occur with tribrachs on tripods is a common source of error. Measurement to the wrong place on the antenna is a common source of error. Mixing slant measurements in feet with metric SHMT and radius constants is a common source of error. Confusing slant heights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

All of 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 very 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. Here is the information from the NGS site for the iG4 receiver:



The iG4 should have the MMI (the button/LED panel) turned to face the North.

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 be responsible for making an occupation appear noisy. OPUS compensates for the antenna vertical offset changes depending where satellites are in the sky. If you mis-rotate the antenna then the compensation will be applied incorrectly.

Use the Correct Antenna Model

Make sure that you have the correct antenna model selected. Some antenna 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 model or you will introduce substantial height uncertainty to your solution.

Batteries In or Batteries Out?

Every single thing inside an integrated receiver's body changes the effective antenna calibration. **Everything**.

Slight changes in the PCB's, UHF radios being installed / omitted, the cellular modem model: they all result in a change in antenna calibration. Sometimes the change is very small and other times a seemingly innocuous change will result in a substantial phase center change.

iG4 receivers are calibrated with a battery inserted into the battery compartment. If you power an iG4 with external power, you should still include a battery in the head to match the original antenna calibration conditions

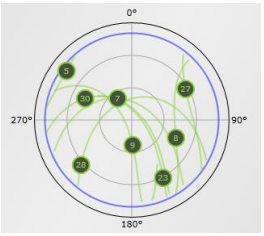
#12 Why does Modern RTK work where OPUS fails?

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.

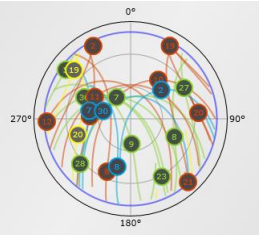
Number of Satellites and Signals

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 iG4 tracks GPS, GLONASS, Galileo and BeiDou satellites, OPUS currently only uses the GPS observations. So a great constellation like the one on the right is reduced to the minimal constellation on the left.

A modern GNSS RTK receiver has and **uses** more signals at all times than the OPUS processing tools.

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

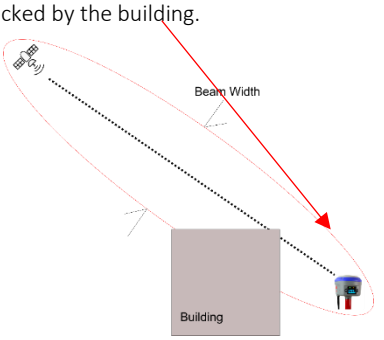
Most GPS users think of the radio path from their receiver to each of the satellites is like a small laser beam. This is incorrect.

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 checkout the section on 'Fresnel Zone Clearance' mid-article.

The Fresnel effect explains for 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.

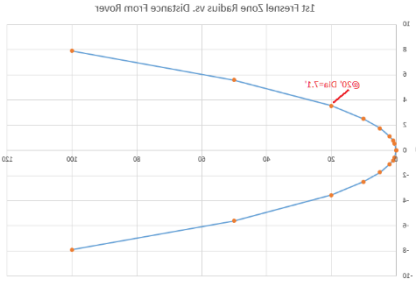
To compute an accurate position, your receiver needs a very clean signal with few reflections, obstructions or delays. Any object blocking a part of the beam can be a source of reflection, attenuation or delay.

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 lots of 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 iG4 Receiver

1. Receiver won't turn on:

Battery is installed backwards or upside down: remove and install properly.
Battery contacts are not aligned with the metal pads on the battery: bend them slightly to align and reinsert the battery.
Battery is fully discharged: Charge battery or use external power.
Contacts on battery are dirty: Clean battery and receiver contacts with a soft cloth.
Battery is bad: Try another battery.

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.

3. Is the receiver storing observation data?

The right-hand YELLOW LED will flash once every time data is stored to the current occupation file.
The default recording rate is 5-seconds, thus the YELLOW LED will flash once every 5-seconds when data is being stored.
It is possible to stop the recording of data and close the observation file by pressing and holding the BLUE Record button. You can verify the mode by quickly pressing the record button:
If the GREEN radio LED flashes, then the receiver is RECORDING.
If the YELLOW files LED flashes, then the receiver is NOT RECORDING.

4. The RED Power LED is flashing!

If the RED Power LED is flashing, then the internal battery is very low. Connect external power or turn receiver off and replace the battery.

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

A. Before plugging GPS cable into your PC try turning on the GPS and waiting for 20 seconds?
B. Unplug, wait 15-seconds, try again
C. Try another USB port.
D. Use an external USB Hub (this fixes intermittent disk mounts, but we don't know why.)
E. Try other computers.
F. Try turning off your PC, wait a minute and then turn on again. Reinsert the USB cable.
G. Get the DevView tool from http://www.nirsoft.net/utils/usb_devices_view.html and use it to uninstall the errant device driver for the GPS receiver.
Download the **USBDeview** tool, there is a 32-bit and a 64-bit version, choose the correct version for your computer.
Unzip the distribution ZIP file, run the "USBDeview" tool as an administrator.
Unplug the GPS receiver.
Look for the entry "OLIMEX LPC1766 Storage USB Device", right-click it and "Uninstall Selected Devices", answer yes to 'Do you want to uninstall?" wait 10-seconds and then plug the GPS receiver back in.

6. Yellow and Green LED's Flash Once Each Second

If your receiver has both the YELLOW and GREEN LED's flash simultaneously, then the internal flash memory directory block has become corrupted. This is a status message indicating that the receiver is unable to open or write to a new file in the 4 GB Flash memory.
Follow these instructions to fix this issue:

- Attach the receiver to a computer, it will mount as a disk drive letter. Note the drive letter. If your operating system requests that you check the disk for errors, do so.
- Download all of the current files from the receiver using the iGx tool.
- Reformat the receiver using the Windows Explorer on your computer.

More Information

The receiver is a flash memory drive. Just like a real thumb drive, the directory block on the flash memory can become corrupted if the battery dies at the exact moment the receiver is writing to the occupation file (once every 5 seconds typically) or if the USB cable is removed from a computer while the receiver is downloading a file, or if the battery dies while the receiver is

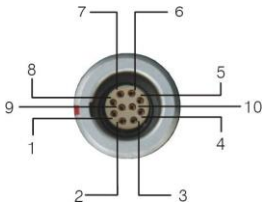
attached to a computer.

Just as a USB thumb drive can become corrupted, the receiver's memory will suffer the same issue. Sometimes a 'Checkdisk' operation will fix this issue, however a drive format will always fix this issue.
The chance of the battery expiring at the exact same moment that the receiver is writing occupation to the flash memory is extremely low: the write occurs once every 5-seconds (by default) and the write operation is very-very quick. In addition, the receiver monitors the battery voltage and automatically closes output files and shuts down a few seconds before the battery expires.

However, if the battery has been allowed to deplete and then is used when downloading to the computer the battery will likely run down while the files are transferring. Downloading files keeps files open most of the time and the probability of a nearly depleted battery failing during transfer is quite high.

For this reason, it is best to use a freshly charged battery when downloading a receiver to a PC.

iG4 10-Pin Connector

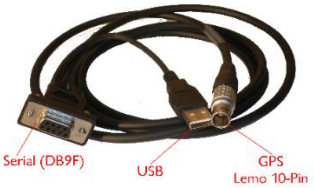


WARNING! If you attach external power with reversed polarity you will destroy the GPS receiver.

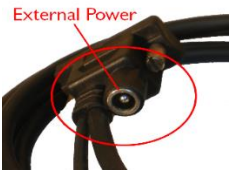
PIN	Signal Name	Description
1	TXD	Transmit Data(PC receive data through this pin)
2	RXD	Receive Data(PC transmit data through this pin)
3	PWR	External Power Input (9-15 V DC)
4	PWR	External Power Input (9-15 V DC)
5	GND	External Power Ground
6	GND	External Power Ground
7	USB PWR	USB Power +
8	D-	USB Data -
9	D+	USB Data +
10	Not Used	(nc)

iG4 PC Data Cable

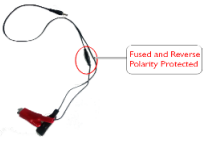
The supplied interface cable includes connections for GPS, USB, Serial and External Power:



Interface Cable



External Power



Battery Clips

External power should be in the range: 9 VDC to 18 VDC.

The supplied battery clip cable includes a fuse and is reverse polarity protected.

iG4 Antenna Model

The iG4 antenna has been modeled by the NGS as:

'IGAIG4 NONE'

The calibration is available in the master antenna calibration list available from:

https://www.ngs.noaa.gov/ANTCAL/

The absolute calibration is reproduced below:

```
IGAIG4          NONE Igage IG4                    MMI->North NGS 17/03/23
       2.2       -0.3       80.8
   0.0   1.0   1.6   1.9   1.9   1.7   1.4   1.1   0.9   0.9
   0.9   1.1   1.2   1.4   1.6   1.8   2.1   0.0   0.0
       1.5       5.7     103.3
   0.0  -0.3  -0.6  -0.9  -1.1  -1.2  -1.3  -1.4  -1.3  -1.2
  -1.2  -0.9  -0.7  -0.7  -1.2  -2.2  -3.7   0.0   0.
```

Calibration Values:

L1	0.0808 Meters	0.0808 meters
L2	0.1033 Meters	0.1033 meters
Radius (not to bumps)		0.1800 meters
SHMP		0.0400 meters

If you encounter an application that does not have the correct antenna model available, the antenna model:

'IGAIG3S NONE

is nearly identical and may be substituted with minimal change in computed location.

‘Slant Height’ to ‘Vertical Height’

The iGx Download tool automatically converts from ‘feet to meters’ and from ‘slant to vertical’ using the currently selected receiver model.

If you have a vertical measurement in feet you can enter an ‘F’ after the measured vertical height:

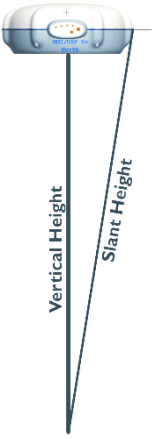
“4.512 F” becomes “1.375” meters vertical

If you have a slant height in feet you can enter a ‘FS’ (or ‘SF’) after the measured slant height:

“4.512 FS” becomes “1.323” meters vertical

If you have a slant height in meters, enter an ‘S’ after the measured slant height:

“1.523 S” becomes “1.480” meters vertical



Manually Converting Heights

$v = Vertical\ Height$
$s = Slant\ Height$
$r = Receiver\ Radius$
$h = SHMP = Slant\ Height\ Measurement\ Point$

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

Receiver	Radius r (meters)	SHMP h (meters)
iG4	0.1800 (not nub)	0.040

Examples

Measured Slant s (feet)	Slant s (m)	iG4 Vertical v (m)
6.965	2.123	2.081
5.148	1.569	1.526

Warranty

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

IMC warrants the iG4 receiver to be free of defects in material and workmanship and will conform to our published specifications for these periods:

GPS receivers:	2-years
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 the software will meet purchaser's requirements or that its operation will be uninterrupted, error-free or virus-free. Purchaser assumes the entire risk of using the software.

Exclusions

The following are excluded from the warranty coverage:

1. Periodic maintenance and repair or replacement of parts due to normal wear and tear.
2. Product Finishes.
3. Batteries exposed to heat, cold; or batteries opened or physically damaged.
4. Installations or defects resulting from installation.
5. 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.
6. Service performed or attempted by anyone other than an authorized IMC service center.
7. That the receiver will be free from any claim for infringement of any patent, trademark, copyright or other proprietary right, including trade secrets.
8. 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, GLONASS, BDS and GALILEO 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 is 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 fault of IMC or negligent usage of the product.

In no event will IMC be responsible for such damages, 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 the purchaser must obtain a return materials authorization (RMA) number prior to shipping by calling 1-801-412-0011.

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.

NEVER INCLUDE BATTERIES in return shipments. If you ship batteries to iGage they **WILL NOT BE RETURNED TO YOU.**

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 contiguous 48-states. The purchaser shall always pay any associated duty associated with warranty repairs.