Background

The Online Positioning User Service (http://www.ngs.noaa.gov/OPUS/) is provided without fees by the National Geodetic Survey. According to the National Geodetic Survey:

"This Online Positioning User Service (OPUS) provides you with simplified access to high-accuracy National Spatial Reference System (NSRS) coordinates: all you need is a clear view of the sky and a survey-grade (preferably dual frequency) Global Positioning System (GPS) receiver.

OPUS processes your GPS data files with the same models and tools which help manage the Nation's Continuously Operating Reference Station (CORS) network, resulting in coordinates which are both highly accurate and highly consistent with other users. Your computed NSRS position is sent privately via email, and, if you choose, can also be shared publicly via the NGS database.

OPUS is highly automated and requires minimal user input. To use properly, please familiarize yourself with the information provided under the About tab at the OPUS site."

This document will describe how to download data collected with a Trimble 5700 receiver collected with either a Trimble Zephyr or Zephyr Geodetic antenna. The only difference between the two antennas is the present of a ground plane (GP) on the Zephyr Geodetic. The GP helps mitigate multi-path errors and is generally used at base stations with long observation times.

Note that OPUS uses the best available ephemeris data available. If the service is used within about 24 hours of occupation, lower accuracy broadcast ephemeris will be used. This can result in somewhat less accurate positions – on the order of several decimeters. After about 24 hours, improved Rapid Ephemeris will automatically be used providing the potential for much better accuracy. The email response from NGS will indicate which ephemeris was used for that particular solution. The latest available Rapid Ephemeris can be found here. You may submit an observation data file as many times as you wish.

NGS makes the following statement concerning accuracy of OPUS positions:
"Under ideal conditions, OPUS can easily resolve most positions to within centimeter accuracy. Estimating the accuracy for a specific data file is difficult, however, as formal error propagation is notoriously optimistic for GPS reductions. Instead, the peak-to-peak error, or error range, is provided for each coordinate component (XYZ, Φλh and H). The peak-to-peak error is the difference between the maximum and the minimum value of a coordinate obtained from the 3 baseline solutions.

Please note that peak-to-peak accuracy estimates depend upon freedom from systematic error. Any misidentification of the antenna type or height, local multipath or adverse atmospheric conditions will NOT be averaged away by the 3 "independent" CORS solutions. The advantage of the peak-to-peak error measure is that the error range also reflects any error in the CORS reference coordinates. On the average, one should obtain larger peak-to-peak errors in the NAD 83 coordinates, when compared to the ITRF coordinates. This is due to the procedures used to derive the CORS coordinates. To serve our users, the NAD 83 coordinates of the National CORS are updated less frequently than ITRF coordinates. However, this also results in the NAD 83 coordinates being somewhat less accurate.

For rapid static: Absent any warning messages, the best estimates of coordinate accuracies are the standard deviations reported by single baseline analysis. Our experiments indicate that the actual error is less than these estimated accuracies more than 95 percent of the time, RSGPS statistics."

Required hardware:

1. Trimble 5700 receiver (the one on which you collected data),
2. Trimble Lithium-ion batteries (2) installed in the 5700,
3. USB cable, and
4. Either the Dell ATG or Panasonic Toughbook computer.

Required software:

1. Trimble Data Transfer (All Programs -> Trimble Data Transfer -> Data Transfer)
2. Convert to RINEX (All Programs -> Trimble Office -> Utilities -> Convert to RINEX).
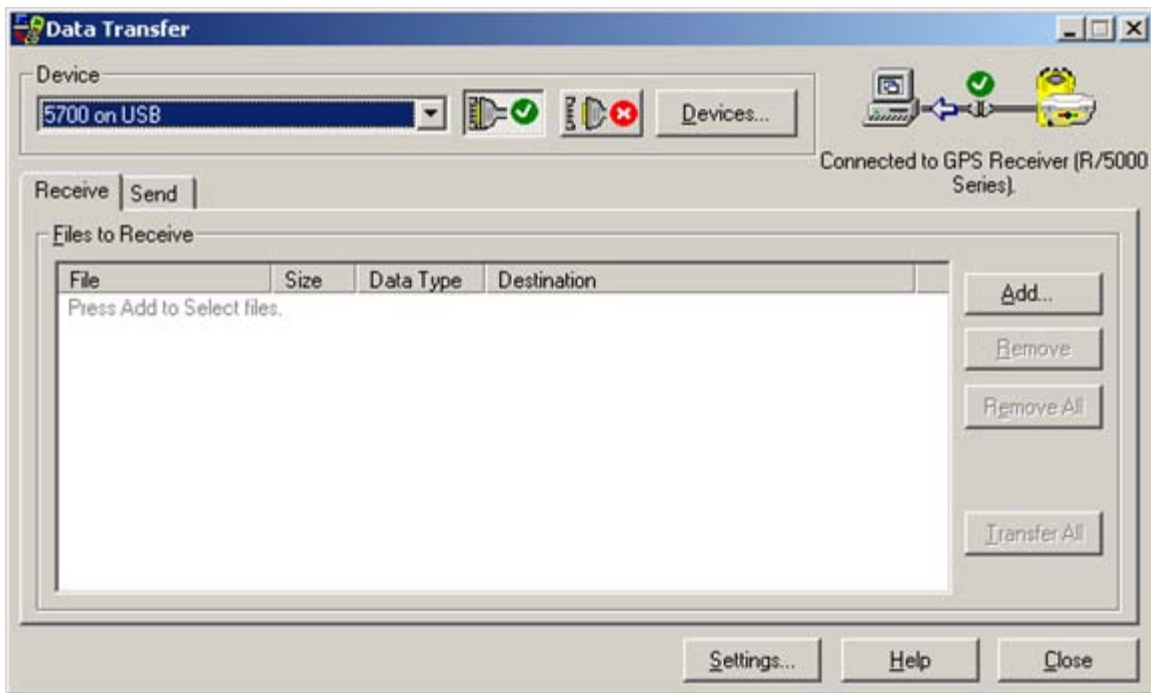
NOTE: Only the versions of the software installed on the Dell ATG and the Panasonic Toughbook have the necessary receiver definitions required for this process.
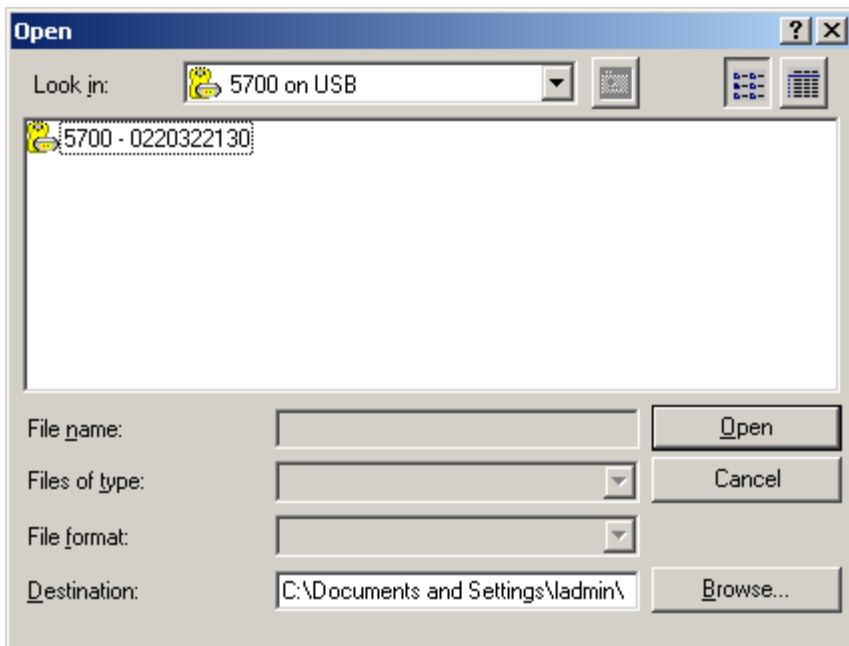
Transfer raw data to field computer
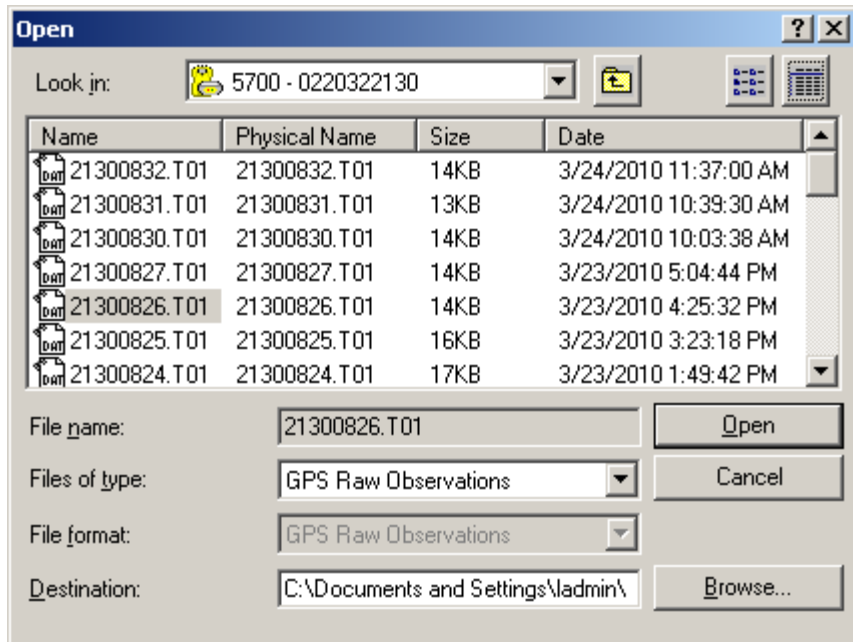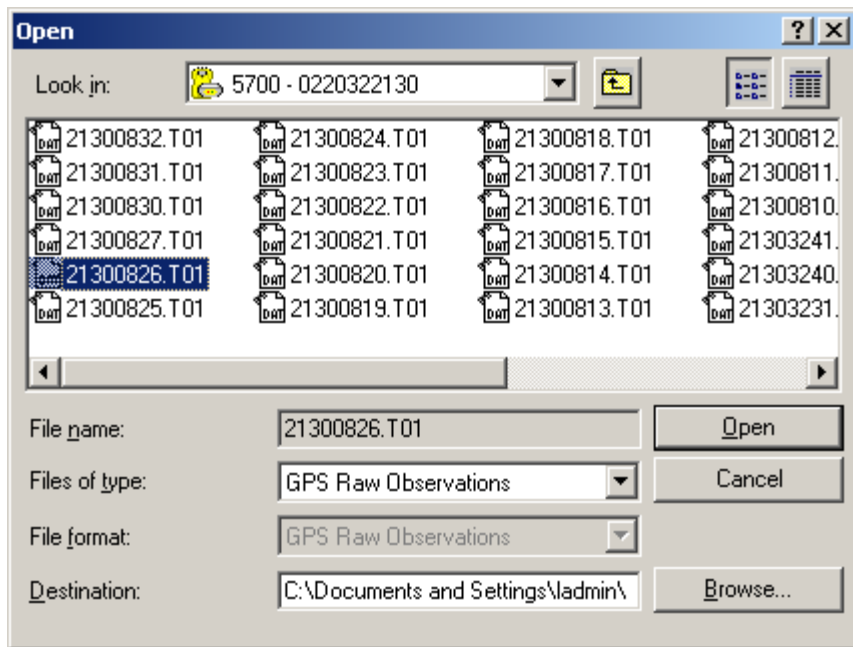
1. Attach 5700 to computer using USB cable.

1. Turn on 5700 by pressing and holding the green power button on the receiver control panel until the indicator lights come on.
2. Open the Trimble Data Transfer utility (All Programs -> Trimble Data Transfer -> Data Transfer),
3. Choose "5700 on USB" as Device type using the dropdown field circled in red.

1. Press the green check button to establish connection. Note that the connection should occur automatically but may not.
2. Press the **Add...** button. A file selection dialog will open showing the top level folder on the device. The folder name is the serial number of the receiver.
3. Using the fields circle in red on the figure below, choose a location to save the GPS observation file.

1. Choose file(s) to transfer. Here we've chosen file 210300826.T01. Note that the first four digits of the data file name are the last four digits of the devices serial number. The last four digits are a unique identifier. To choose the correct data file, switch to detail view using the button circled in blue. This detailed view shows the date and time each data file was created.

Open dialog

Look in: 5700 - 0220322130

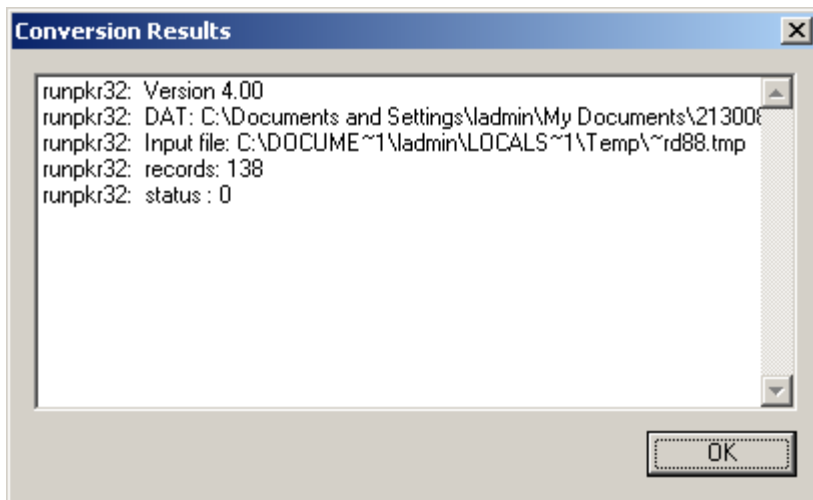|			
21300832.T01	21300824.T01	21300818.T01	21300812.
21300831.T01	21300823.T01	21300817.T01	21300811.
21300830.T01	21300822.T01	21300816.T01	21300810.
21300827.T01	21300821.T01	21300815.T01	21303241.
21300826.T01	21300820.T01	21300814.T01	21303240.
21300825.T01	21300819.T01	21300813.T01	21303231.

File name: 21300826.T01   Open

Files of type: GPS Raw Observations   Cancel

File format: GPS Raw Observations

Destination: C:\Documents and Settings\ladmin\   Browse...

Open dialog

Look in: 5700 - 0220322130

Name	Physical Name	Size	Date
21300832.T01	21300832.T01	14KB	3/24/2010 11:37:00 AM
21300831.T01	21300831.T01	13KB	3/24/2010 10:39:30 AM
21300830.T01	21300830.T01	14KB	3/24/2010 10:03:38 AM
21300827.T01	21300827.T01	14KB	3/23/2010 5:04:44 PM
21300826.T01	21300826.T01	14KB	3/23/2010 4:25:32 PM
21300825.T01	21300825.T01	16KB	3/23/2010 3:23:18 PM
21300824.T01	21300824.T01	17KB	3/23/2010 1:49:42 PM

File name: 21300826.T01   Open

Files of type: GPS Raw Observations   Cancel

File format: GPS Raw Observations

Destination: C:\Documents and Settings\ladmin\   Browse...

1. Press the **Transfer All** button.

1. If the transfer is successful you will see the report below which reminds you where the file is located on your hard drive. The transfer moves *.T01 file to the download folder and creates a *.DAT file in the download folder. The *.DAT file will be converted to the open standard RINEX format (in the form of *.OBS and *.NAV files) during the next step.
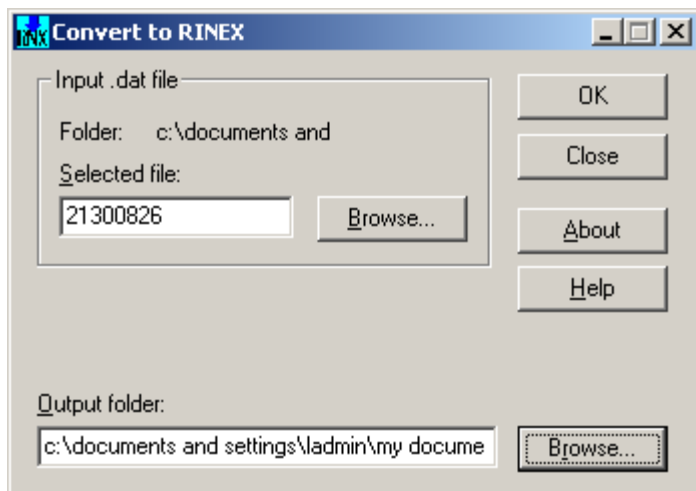

2. Close the Trimble Data Transfer program and turn off the 5700 by pressing and holding the green power button until the indicator lights go out.
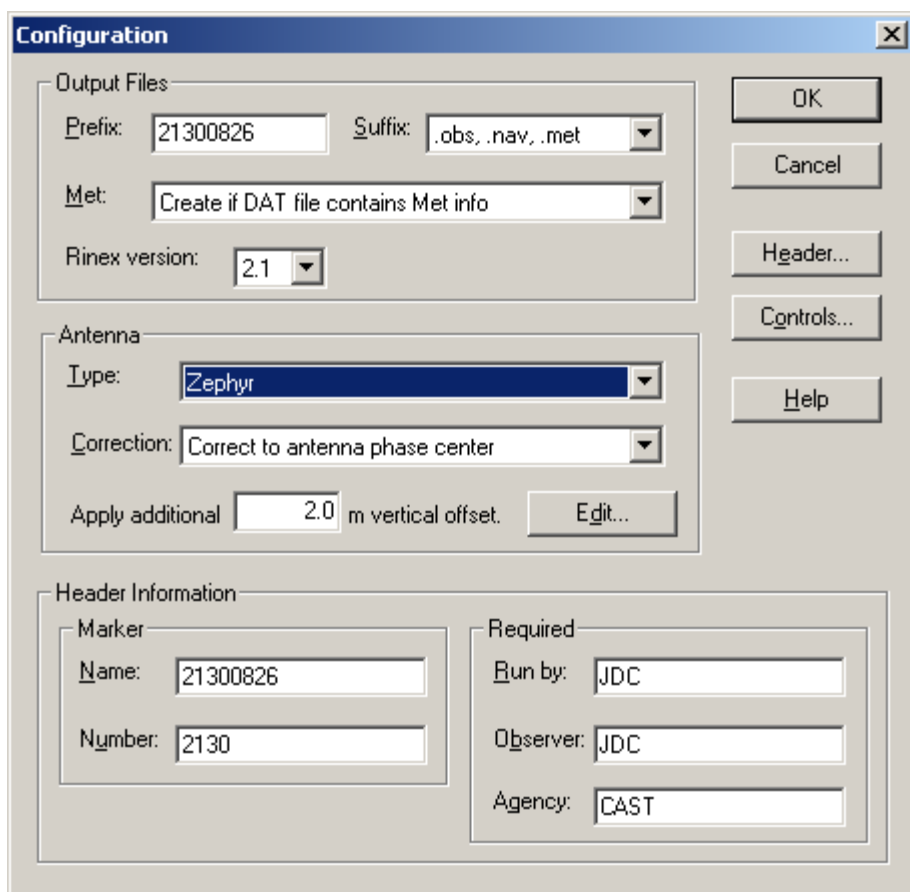
Convert DAT file to RINEX

1. Open the "Convert to RINEX" utility provided by Trimble (All Programs -> Trimble Office -> Utilities -

\> Convert to RINEX).

1. Browse to the data file (*.dat) you downloaded in the preceding section.
2. Choose the location of where you wish to save the RINEX files (*.obs and *.nav). Use the controls circled in blue. The default location is the location of the *.dat file.
3. Choose the antenna type using the field circled in red. For the smaller antenna choose Zephyr. For the larger antenna with the ground plane chose Zephyr Geodetic.
4. Assign the height of the antenna above the ground. If a fully extended fixed-height tripod was used, this value is 2.0 meter.
5. Fill in your initials and the organization you represent (CAST).

1. Press OK to convert the *.dat file to RINEX format.
2. Two new files should be in the download folder. Two files names the same as the original T01 file.

The *.nav file contains the satellite ephemeris. You don't need this one for OPUS. The *.obs file contains raw observations (pseudo-range and carrier-phases) and will be sent to OPUS for processing in the next step.

3. Press Cancel to close the Convert to RINEX utility.

Differentially correct carrier phase data using OPUS

1. Open a browser and go to http://www.ngs.noaa.gov/OPUS/
2. Follow the directions on the website:
    1. Enter an email address where you would like the results will to be sent.
    2. Load you the *.obs file you created in the previous step.
    3. Choose your antenna type. If you used the Zephyr antenna (without ground plane) select *TRM39105.00 Trimble Zephyr without Ground Plane*. If you used the Zephyr Geodetic antenna (with the ground plane) select *TRM41249.00 Trimble Zephyr Geodetic with GP*.
    4. Set the antenna height to 2.0 meters (you added the antenna height in the conversion process but OPUS does not recognize this in the observation file).
3. Choose **Upload to Rapid Static** if you collected data for more than 15 minutes but less than 2 hours. Choose **Upload to Static** if you collected data for more than 2 hours.

1. After uploading the data you should see a summary screen. Verify the information you gave was correct and wait for the email response. The email could take up to several hours but most responses come within a few minutes.

While the GPS unit can be used without the data logger it is normally the case that you will use the data logger to configure the system. This is **required** if you are creating a new job.

You can "connect" the data logger to the GPS via cable or Bluetooth. When using Bluetooth check to make sure you are connecting to the proper GS15 – especially when they are close to each other. The steps to configure the base are quite different than those for the rover and you can accidentally convert the base into the rover (or vice versa) if you are not careful. Be sure to check the arrows to the right of the FUNCTION key (one with antenna symbol on it) on the side of the GS15 to insure that the base has an outgoing arrow.

There are a number of "paths" through the menus and you can use both/either the keys on the data logger and/or the touch screen. After a bit the keys may be easiest since you don't have to have one hand on the stylus – and you don't risk losing the stylus – which is docked in the top of the data logger. The instructions below focus on the use of the keys but do switch back and forth when the stylus option is easier. You can use a fingernail instead of the stylus.
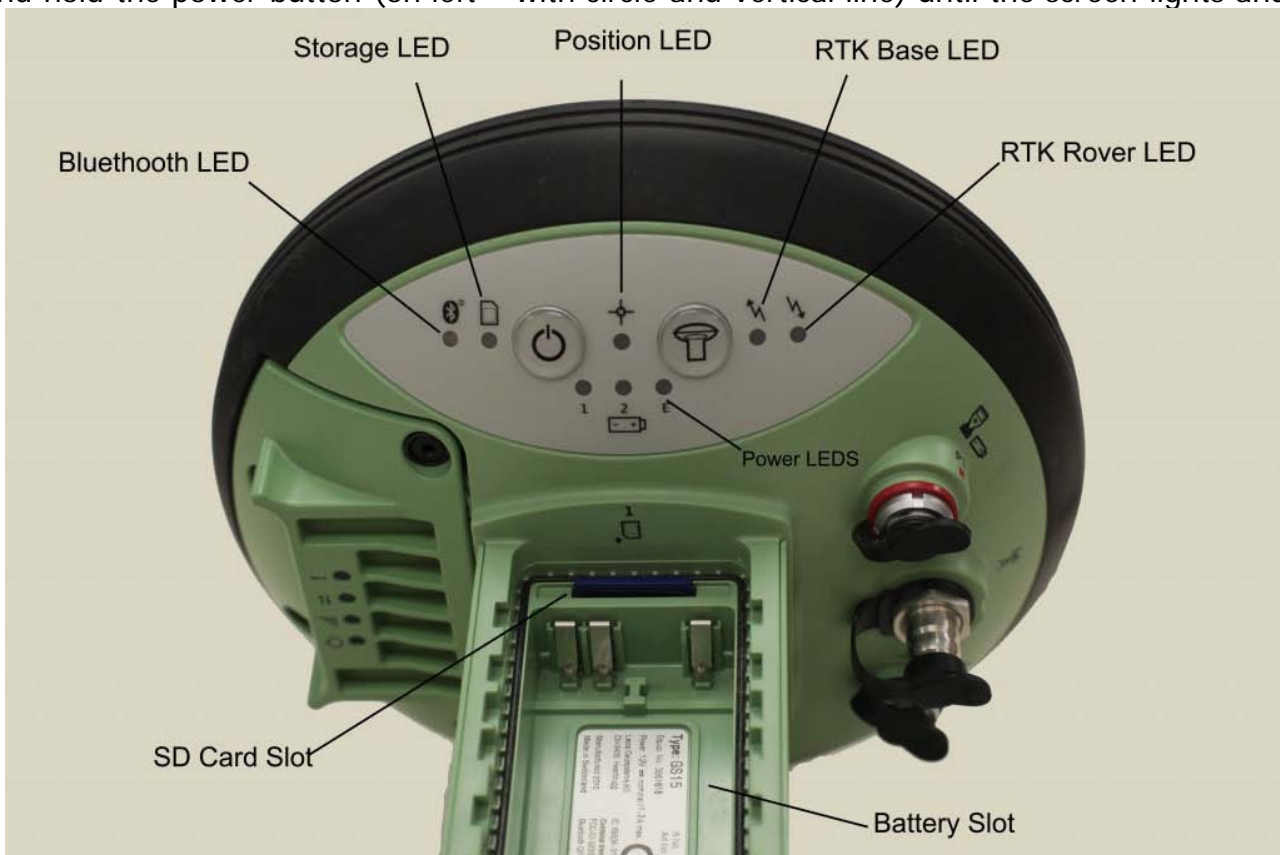
Step1. Start GPS units (GS15)

1. Set up tripod (see **Setting up tripod workflow**)
2. On the GPS unit press and hold the power button (circle with vertical line) briefly till battery LEDs light up release.
3. It will take a while for the base to fully power up, acquire the almanac (if needed) and perform other actions. You can monitor the status with the GPS LEDs.

1. When fully operational the outgoing LED ("e" in figure) will flash and the position LED ("c" in figure) will be solid yellow.
2. Depending on how the unit was previously used it may be configured as either a base or a rover. You can reconfigure using the FUNCTION key (press briefly to switch from base to rover mode or vice versa) and/or by using the data logger as described below. If the unit has not previously been configured to log raw data to the SD card you MUST use the data logger to set up this configuration. The Storage LED will flash slowly if the unit is logging data to the SD card.

3. If the outgoing light is solid green the unit is NOT sending data. When sending data the outgoing LED will flash (sometimes slowly).

Step 2. Set up Job or select existing one on data logger

You will need to either set up a new job or use an existing one. You will need to turn on the data logger. Press and hold the power button (on left – with circle and vertical line) until the screen lights and then

release.

1. The SmartWorx set up wizard will appear.
    1. Select "Use GPS Only"
    2. Press (F1) Next
    3. Check that GC10/15 is selected
    4. Press Next
    5. Then either
        1. Continue with last used job
        2. Or New job
2. To set up a new job:
    1. Press "Home" key (one with house symbol)
    2. Setting up a JOB
        1. Use red arrow key (in center) to move left to "Jobs and Data"
            1. Press 1 "New job"

2. Enter
    1. Name
    2. Description
    3. Creator
        1. Note: to move from data entry filed to the next press the "Return" key (right angle arrow pointing to left)
    4. When the last field is completed and you press the return arrow you will see the word "Store" (above the F1 key and "Page" above the F6 key. If you want to create a code list (e.g. a data dictionary) press F6 (or use stylus to click "Page" (or use stylus to click the tab at top of page "Code-list")
    5. If you are setting up a base station you won't have a code-list or need other options.
    6. You should page over to Coordinate System to confirm is it WGS84. It is possible to configure other coordinate systems. Those instructions are in Section 8 (pages 146ff of Viva Tech Manual)
    7. After checking everything press F1 for store.
3. Press home again
3. Alternatively you may use an existing job.
    1. Press "home" key (one with house symbol)
        1. Use red keys to move right to Jobs and Data
            1. Press "4" or use down key to move to 4 – Chose working Job
            2. Use up/down arrow keys to move to desired job
            3. Press "OK"
                1. Note you may wish/need to edit the job properties
                2. To do so move to job and press the F3 "edit" key

(If needed – connect to GPS)

You may need to connect to the GPS. This can either be done via cable or Bluetooth.

1. To connect
2. Press Home key
3. Red arrow to "Instrument"
    1. Instrument Connections
        1. GPS Connection Wizard
        2. On next screens confirm
            1. GS Sensor is GS10/15
            2. Bluetooth (or) cable
    2. The unit will then display the current connected unit. If using Bluetooth, confirm that it is connected to the correct GS15 –
    3. if so press Next
        1. OTHERWISE – press Search
        2. After a bit review list and select the correct unit to connect to
        3. Press Next (F1)
        4. After a moment you should see "successfully connected"
    4. Press Finish
        1. The Bluetooth LED on the data logger will be blue and the Bluetooth on the GS15 will be blue as well.
    5. If you are unable to connect to the proper unit it may be necessary to step through the wizard again making sure that you have selected the correct unit. If this fails again it may be necessary to power down both the GS15 and the data logger and start again. This usually fixes any connection issues.

Step 2. Set up base station parameters

For OPUS work you will be post-processing the base data and it is ESSENTIAL that the data be logged to the SD card. Be sure that the SD card has adequate memory for the work you plan. The SD card is any standard one (1) GB SD card. It is installed in the SD slot at the top inside of the battery cover.

1. Set/Check GPS Settings
2. Press "home" key
    1. If the unit is already in base mode you can proceed with settings. HOWEVER it may have been left in rover mode. As noted you can change this via the FUNCTION button on the GS15 or you can press 7 "Switch to Base Mode" on data logger
    2. This may cause a lost connection message to display/sound but usually it will then reconnect as a base. If it does not the cycle through the GPS connection wizard again.
        1. To cycle through connection wizard
            1. Press Home key again
            2. Right red arrow to "Instruments"
                1. Select "Instrument Connections"
                    1. Select GPS Connection Wizard
                        1. Choose GS10/GS15
                        2. Press Next (F1)
                        3. Select Bluetooth (or cable if using a cable)
                        4. Press next
                        5. Confirm the correct unit is involved (SSN is on base of unit)
                        6. If correct
                            1. press NEXT
                                1. Dialogue should report "Connected to GS Sensor"
                        7. If Not
                            1. Press Search
                            2. Will identify different sensor
                            3. Press Next to connect
                        8. Press Finish
3. After re-running GPS Connection wizard – if needed.
4. Press Home key again
    1. Press red right arrow to move right to "Instrument"
        1. Select "1" GPS Settings (use down arrow or press "1")
            1. Check Satellite Tracking – indicate if you want GLONASS and L5 here
            2. Check Antenna Height
                1. This is usually 2 meters but should be set to the tripod height

Insure that you are logging raw data

1. Press "GO BACK" key (e.g. "U shaped arrow") as needed to get to "Base Menu" (at upper left of screen)
    1. You should see "Go to Work" and "Instruments" as options on Base Menu
    2. Select Instruments
        1. Select Base Settings
            1. Select Raw Data Settings
            2. Confirm or set "Log base data for post-processing" (normal method for most of Center's applications) check box is checked. If not checked use stylus (or finger nail) to check.
                1. Check that rate is 1.0s
                    1. It is possible to set rates from 0.05s to 300s. The one second (1.0s) seems to be the best option for our work.
                2. Data type "Leica Format (MDB)"
        2. Press "OK" (F1)

Confirm settings

1. Press "GO BACK" key "U shaped arrow" as needed to get to "Base Menu"
    1. You should see "Go to Work" and "Instruments"
    2. Select Instrument
        1. Select Base Status
        2. Under base status entries are:
            1. Battery and memory
            2. Satellite status
            3. Data Link Status
            4. Current Position
            5. Raw data logging
            6. Connections Status
        3. Go into each and check status – in particular
            1. Under battery and memory
                1. The first tab is data logger memory and battery
                    1. Use Page (F6) to move to GPS base tab
                    2. Confirm adequate battery and memory
            2. Under Raw Data Logging
                1. Confirm data logging
                    1. Note at least 20 minutes of RAW data needed for OPUS Rapid-Static solution
                        1. At one obs per second this is some 1,200 observations.
                        2. The data logger reports the number of observations logged. Under Base Status, Raw data Logging

Setting up over any point

You will probably usually use the "set up over any point" option when locating the base. "Any point" means that you do not, initially, know the point's locations, though you can determine this very precisely after the OPUS system after data are acquired.

1. From the base screen select "Go to work"
    1. Select "over any point"
    2. Confirm (or set)
        1. "Antenna height" to proper value (usually 2.0 m when using standard tripod)
        2. RTK Base Antenna : GS15 Pole
        3. Point ID: enter a value that you note for future reference.
    3. Base set up is complete
2. You will be directed to the Rover Connection
    1. You will NOT need to configure the rover for a single system OPUS process.

Setting up over a known point

1. It may be the case that you can set up the base station over a known point.
2. One way to accomplish this is to set up the base alone and acquire adequate data for an OPUS solution. Submit the data to OPUS and then use the results. Reset the base over the same point and enter the OPUS coordinates.
    1. In this case you would
        1. Press "go back" arrow until you get to Base Menu screen
        2. Select "Go to work"
            1. Select "Over known point"
                1. Confirm antenna height and press" Next"
            2. You will be given the select known point

1. Clicking in the "Point ID" field will take you to the Data screen when all currently known points are displayed and you can use these.
2. However – you will Not have the OPUS solution in the list and will need to enter it to be able to choose it as a Known Point
3. To enter a new point press F2 "New" at the bottom of the "Data: Points" tab screen
   1. Press F2 "coordinates" to shift from lat/lon, Cartesian etc. coordinate types.
   2. ENTER the OPUS solution here.
4. IMPORTANT: If you are using the WGS84 coordinates be SURE to enter the ITRF 2002 OPUS solution not the NAD83(CORS) ones.
5. When complete press STORE (F1)
3. Use return arrow (sideways "U") to move back to the Select Know Point screen.
   1. Confirm that the OPUS solution is correct
4. Press NEXT and you will then be at the "Base set up complete"
2. If the base mode LED (outgoing arrow) is
   1. OFF – the unit is not in base mode but in RTK rover – press FUNCTION to switch to base mode – check LEDs again
   2. The base mode LED should be either
      1. **Green** – the unit IS in base mode but NO DATA is being sent to radio
      2. Transmission is not needed for single point work but you do need to insure that the unit is NOT in rover mode.
      3. **Or Flashing green**
         – unit in base mode AND data is being sent.
         1. WARNING – the unit may flash very slowly!
         2. Again – this is not necessary – as there is no rover.
3. If the Position LED is
   1. OFF – no satellites are being tracked and/or unit is off
   2. **Flashing yellow**
      – less than four (4) satellites are tracked, no position available
      1. It may take a bit after you power up the unit for tracking to begin. This is especially true if the unit has been off for a while or if it is being restarted in an entirely new location. The delay is because the almanac has to be downloaded/updated.
   3. **Yellow** – a navigated position is available
      1. If you are setting up over "any point," that is you don't know the coordinates of the base from some outside source(s) (e.g. NGS benchmark, then only a navigated position.
      2. Typical readings for a base in navigation mode are in the order of 0.5 to 2 meters for 2nd order while the rover using the base will have values of 10-30 millimeters!
      3. It is possible to set up a base over "any point" acquire at least 20 minutes of good data, process it via OPUS (see that work flow) and then locate the base over the same point bus as a KNOWN point, using the OPUS provided coordinates.
      4. BUT – the position LED will still be YELLOW!
   4. **Flashing green**
      - a code-only position is available
      1. You will NOT get either a flashing or a solid green one if you are stand-alone and over an unknown point.
   5. **Green** – a fixed RTK position is available
      1. You will NOT get either a flashing or solid green if you are stand-alone and over an unknown point

1. To calculate an OPUS rapid-static position you need to have between 20 minutes and 2 hours of data.
   1. Data longer than two hours needs to be submitted to the OPUS static system. Not rapid-static
      1. Generally rapid-static positions are more than adequate for most purposes. They commonly are +/- 10-30 millimeters.
2. When you have adequate data you need to power down the system
   1. Hold power button down until LEDs turn red and quickly remove finger.
      1. Continuing to hold will cause a reset or reformat operation!

3. Remove SD card from unit and place in SD card reader attached to a PC running LGO
4. Detailed directions are provided in **LGO data transfer to OPUS workflow**
5. Basic steps are as follows.
    1. Note that you do NOT need a licensed version of LGO for this task
    2. Create or select a project
    3. Import data from SD card to LGO
    4. Export data from LGO to a RINEX file
    5. Upload the RINEX file to OPUS
        1. OPUS is found at http://www.ngs.noaa.gov/OPUS/
        2. The antenna type of the GS15 is **LEIGS15**
        3. Enter **2.0 m** for antenna height if using normal tripod setup
        4. Wait for e-mail

]]> http://gmv.cast.uark.edu/gps/hardware-gps/leica-cs-15-controller/setup-operations-leica-cs-15-controller/using-cs15-data-logger-to-set-up-gs15-as-base-for-opus-2-3/feed/ 0