

GEM-2 and GEM-2H User Manual

(700 Series)



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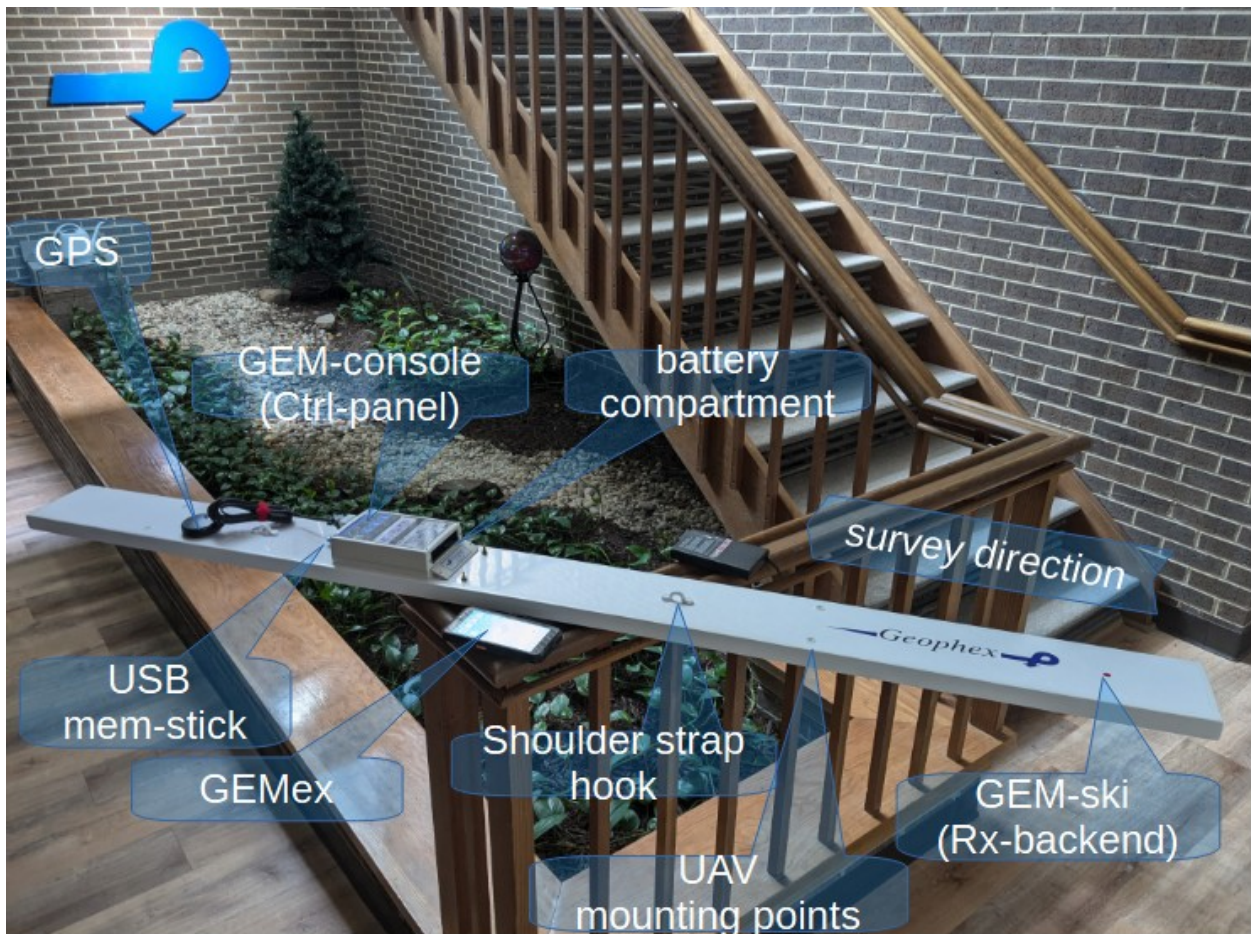
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1. Introduction

1.1 The GEM-2(H) hardware and GEMex software

The GEM-2(H) is the handheld electromagnetic induction (EMI) instrument which is used to collect EMI data during a survey. It consists of the sensor GEM-ski, its electronics command console with batteries (attached to or built in), android phone running the **GEMex** application, a carrying strap, and other accessories. The GEM-2(H) stores the data to an external USB memory drive as well as sending the data out as a serial stream to be processed in real time by a separate computer; the data link uses either Bluetooth or a hard-wired RS-232 serial connection.

Most users will use the GEM-2(H) console's control panel consisting of indicator lights and push buttons to manage the survey and record data for both drone and walking survey. The provided handheld Android phone running the GEMex application is optional to use, although handy if visualization of data in real-time is needed.

1.2 The three stages of a survey

1.2.1 Before the survey

- Charge the batteries and check the connections.
- If necessary, re-configure the GEM-2 for the specific survey conditions. Often, the previous configuration, or the factory defaults, are sufficient, so there is little to do.

1.2.2 During the survey

- Perform the survey while monitoring the console indicator lights or the controller screen to ensure that the data is good quality and that it is being recorded.

1.2.3 After the survey

- Exporting the data to a desktop computer using the Geophex Gem2Exporter program to produce a CSV file. Gem2Exporter can perform additional post-processing features such as filtering, base leveling, electrical conductivity and magnetic susceptibility calculation, or inversion computation to a multi-layered model.
- 2-D mapping of exported/processed data.

1.3 Before the survey

1.3.1 Site survey

Before the survey, have someone visit the site to answer the questions:

- How flat is the ground?
- How irregular is the surface?
- What obstacles are there?
- Are there hazards such as holes or trip wires?
- How difficult would it be to walk the site while keeping the GEM-2 at uniform height and level?
- If there are plants or bushes that will make the survey more difficult, can they be mowed ahead of time? It is usually worth the cost of clearing the field to get better survey results, keeping in mind the cost of the survey itself, and the importance of the results.
- What kind of cart or sled would be useful for improving the quality of the data? It is usually worth the cost of building a cart to improve the survey results.

In most cases, the factory settings or the settings left over from a previous survey are sufficient and there is very little to configure. It is a good idea to charge batteries and verify that the GEM-2 connection (Bluetooth or cable) works.

The GEM-2 configurations are stored in non-volatile flash memory inside the GEM console, so they remain between surveys. The GEMex application does not hold any configuration.

1.3.2 Select operation frequencies (optional)

The GEM-2(H) comes configured with 3 standard frequency sets: Alternative, Factory, and Calibration. The last 2 are factory protected and cannot be customized. All frequencies must be compatible with the regional power-line frequency (50Hz or 60Hz) or be switched to regional settings to match. GEM2H configuration depends on the Frequency Mode Switch.

*The standard configuration sets for **GEM2***

Configuration set	Approximate frequencies used (Hz)	Notes
Default (as Factory for new unit)	Possibly customized by operator	This is last active settings, might come from a recalled set of predefined or fully modified custom frequency set
Alt	60Hz-based power-line: 450,1530,5310, 18330, 63030 50Hz-based power-line: 425,1525,5325,18325, 63025	A new GEM includes lower frequencies, for conductive areas and geology. This set may be overwritten bu user.
Factory	60Hz-based power-line: 1530,5310,18330, 63030 50Hz-based power-line: 1525,5325,18325, 63025	Excludes very low frequencies. This is the most suitable and versatile set.
Calibration	60Hz based power-line: 210,690,2430,8130, 27510, 63030, 93090 50Hz based power-line: 225,675,2425,8125, 27525, 63025, 93075	Wide range with 7 frequencies. This set is used for calibration and calibration adjustment. The set limits min/max frequency of device.

*The standard configuration sets for **GEM2H** – Low Frequency Mode*

Configuration set	Approximate frequencies used (Hz)	Notes
Default (as Factory for new unit)	Possibly customized by operator	This is last active settings, might come from a recalled set of predefined or fully modified custom frequency set
Alt	60Hz-based power-line: 690, 2250, 7350, 24030 50Hz-based power-line: 675, 2225, 7325, 24025	A new GEM includes lower frequencies, for conductive areas and geology. This set may be overwritten bu user.
Factory	60Hz-based power-line: 210, 690, 2250, 7350, 24030 50Hz-based power-line: 225, 675, 2225, 7325, 24025	This is the most suitable and versatile set.
Calibration	60Hz based power-line: 210, 450, 990, 2250, 5010, 10890, 24030 50Hz based power-line: 225, 425, 975, 2225, 4975, 7325, 24025	Wide range with 7 frequencies. This set is used for calibration and calibration adjustment. The set limits min/max frequency of device at the low freq. switch position.

*The standard configuration sets for **GEM2H** – High Frequency Mode*

Configuration set	Approximate frequencies used (Hz)	Notes
Default (as Factory for new unit)	Possibly customized by operator	This is last active settings, might come from a recalled set of predefined or fully modified custom frequency set
Alt	60Hz-based power-line: 5010, 10410, 21570, 44850, 93090 50Hz-based power-line: 5025, 10425, 21575, 44825, 93075	A new GEM includes lower frequencies, for conductive areas and geology. This set may be overwritten bu user.
Factory	60Hz-based power-line: 5010, 11670, 27090, 63030 50Hz-based power-line: 5025, 11675, 27075, 63025	Excludes very high frequencies.
Calibration	60Hz based power-line: 5010, 8130, 13290, 21570, 35130, 57210, 93090 50Hz based power-line: 5025, 8125, 13275, 21575, 35125, 57225, 93075	Wide range with 7 frequencies. This set is used for calibration and calibration adjustment. The set limits min/max frequency of device at the high freq. switch position.

The GEMex application offers an uncomplicated way to activate any predefined set. From the home screen, select “More Settings” to show all available sets and select the desired frequency set..

1.4 Performing the survey

1.4.1 Preliminary checks

Check that the GEM-2 battery is charged. There is a button on the battery itself that turns on a charge indicator. Also ensure that the Android phone is charged if intended to be used for the survey.

Turn on the GEM-2 before starting the GEMex application.

1.4.2 Starting GEM sensor

Press and hold the power button on the control panel until the power light illuminates. It may take 2-3 seconds.

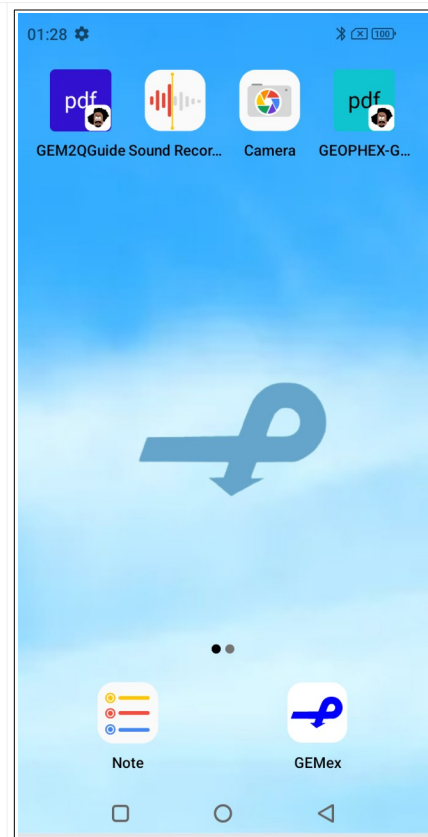
1.4.3 Before Starting GEMex application

Press the power button and wait for Android Phone to start. It should look like in the picture on the right:

Swipe screen up to **Unlock** device if necessary.

GEM2QuickGuide, Geophex Certificate of Conformity of Quality/Calibration, GEMex application and a few utilities will become available on the main screen of the device. By default, Bluetooth is on and device is already paired with the GEM console. If not, you may turn the Bluetooth on from phone settings. Device must be paired before starting the GEMex application. Check battery charge status.

GEM2QuickGuide is available if needed to familiarize with the instrument.



1.4.4 Check the Bluetooth and battery status

If BT icon is visible.
The battery icon provides a battery charge status.

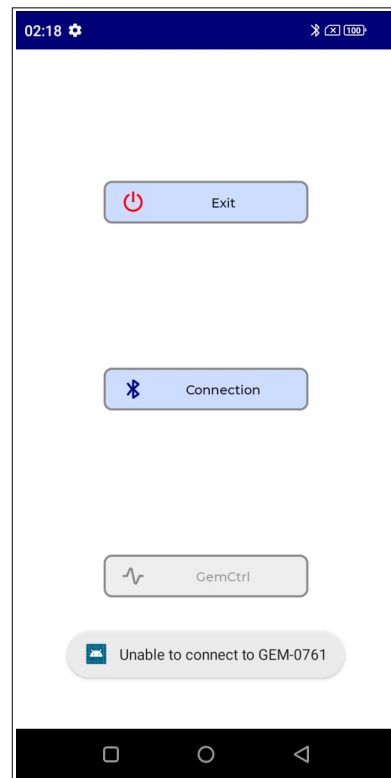


1.4.5 Starting GEMex application

Make sure the GEM-2 is powered on and the red power light is illuminated.

Note: If you start the GEMex application before the GEM-2 is ready, you will see “Unable to connect to GEM-xxx” message. In this case, quit GEMex application, re-power GEM2 and then restart the app again.

If the GEMex takes you directly to Connection Screen, select your GEM from the list. If your GEM is not in the list, you need to pair the GEM with your phone. In that case, exit the GEMex application and using Bluetooth settings of the phone to start the pairing process (see Section 1.4.6). The GEM2 console must be on.

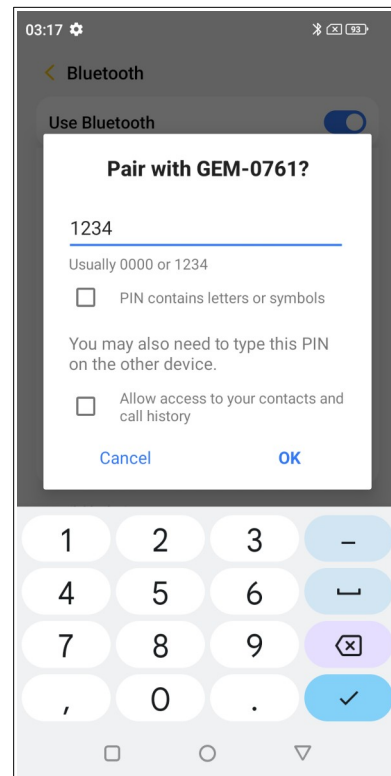
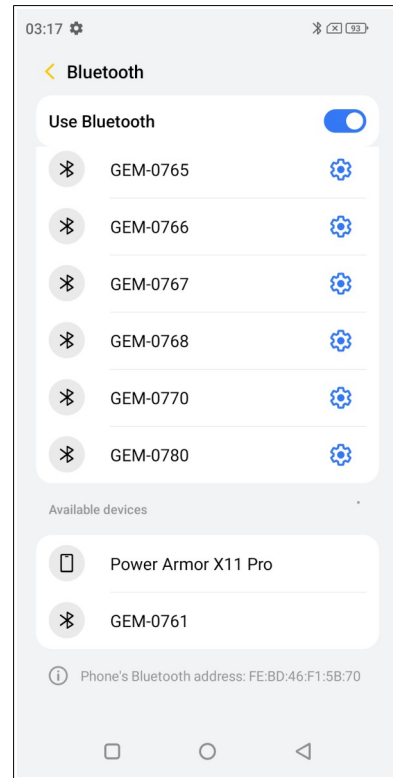


1.4.6 Pairing Bluetooth with GEM

From Phone Settings, select Bluetooth and make sure it is on. Scroll down to “**Available devices**” and wait for your GEM to appear. This may take a minute. You may re-power GEM if it takes longer. Once the GEM moves to “**Paired device**”, it is paired and ready to connect to the GEMex application. Start the application and select the GEM when prompted.

Note: After powering on the GEM console, connection is waiting for either Bluetooth or wired RS232 port. Whichever sends the connection request first will win and disables the other port. So only one external device can control the GEM console at a time. Similarly, if EM is started from GEM console before GEMex (BT) is started, Bluetooth module will be powered off and disabled.

If your GEM appears in “Available devices”, click on it and enter “1234” for the pairing code.



1.5 GEMex survey screens

1.5.1 GEMex home screen

GEMex Home Screen:

The title bar shows Bluetooth name of GEM.

Tri-dot in the top right will open the command menu.

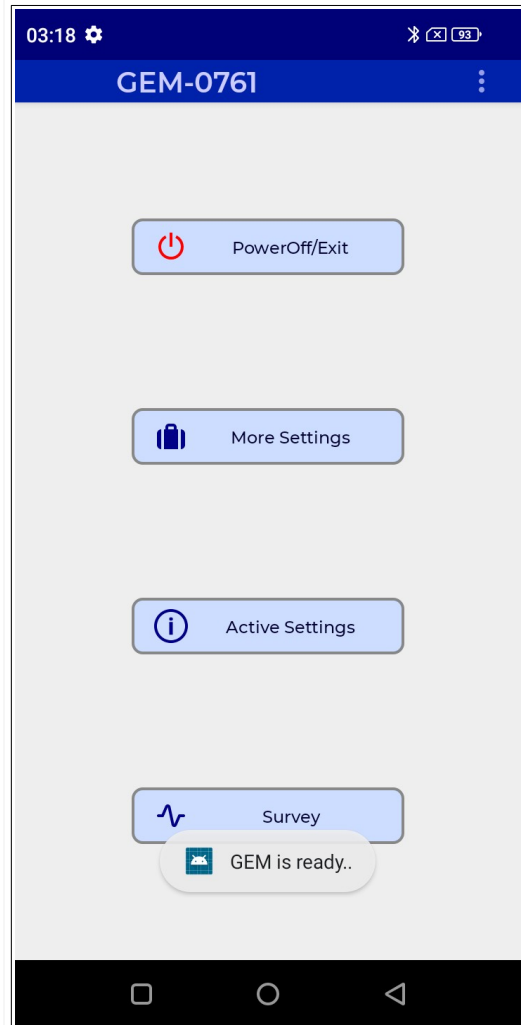
Power Off/Exit sends command to GEM to shut down (if connected) and exits application.

More Settings displays single-click buttons for loading available configuration sets (see 1.5.2).

Active Settings displays active frequencies and other parameters (see 1.5.3).

Survey takes us to main survey control panel (see 1.5.4).

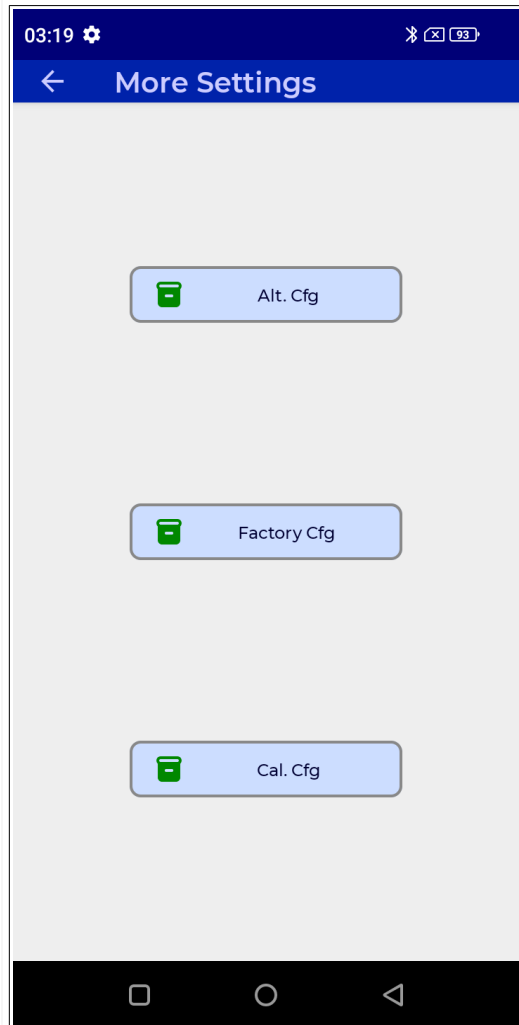
Swiping left or pressing a triangle in the bottom control bar or pushing on left arrow in the title bar takes us to previous screen (if applicable/available).



1.5.2 GEMex “More Settings” screen

“More Settings” screen.

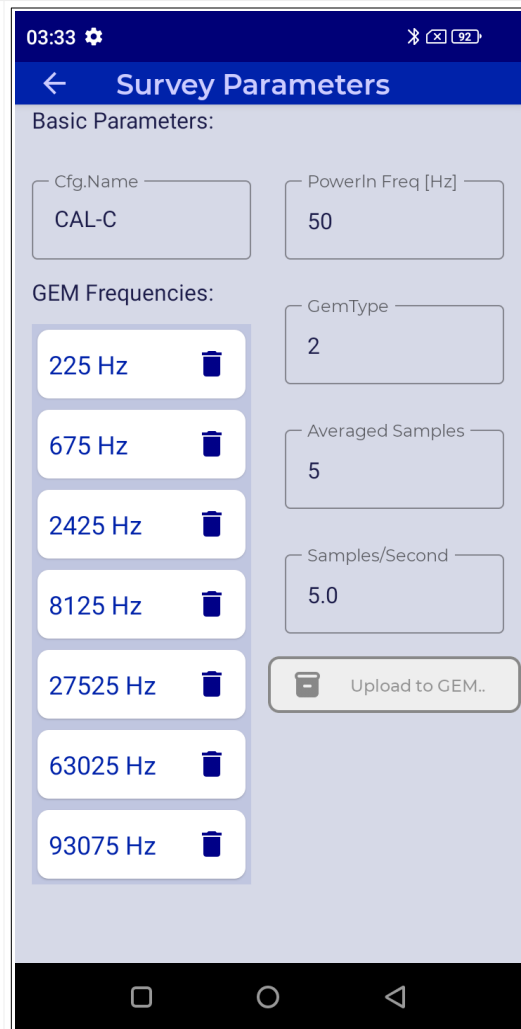
Single click to recall/activate a predefined settings. Once recalled, the “Survey parameters” will be displayed in read-only mode not allowing to change frequencies.



1.5.3 GEMex “Active Settings” screen

“Active settings / Survey Parameters” screen.

The Active setting/Survey parameters are showing the frequencies (read only) and sampling rate (modifiable by changing “Averaged Samples” entry)



1.5.4 GEMex “Survey” screen

“Survey” screen.

This is the main view for performing a survey. The screen is divided into “Title Bar”, “Survey Status Bar” “Charting with Zooming”, “Interactive Control Bar”.

The Title Bar: shows “Nulling” and “Hide geology” icons status. Clicking on “nulling” icon turns on “nulling” to offset all ip-qd channels to 0. It is only the graphical data manipulation – not stored or used for computation of other channels.

“Hide geology” filters out a slow moving background. It is useful if looking for small, near surface targets only. The filter size is about 15 sec. The command may be called from the menu only.

When a “Survey” is open, the filename is displayed here as well.

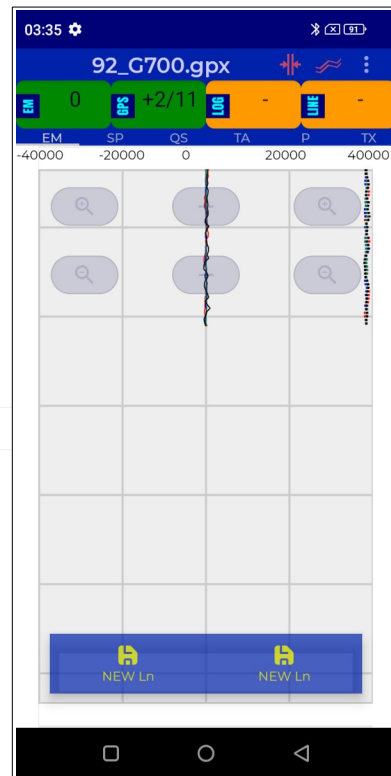
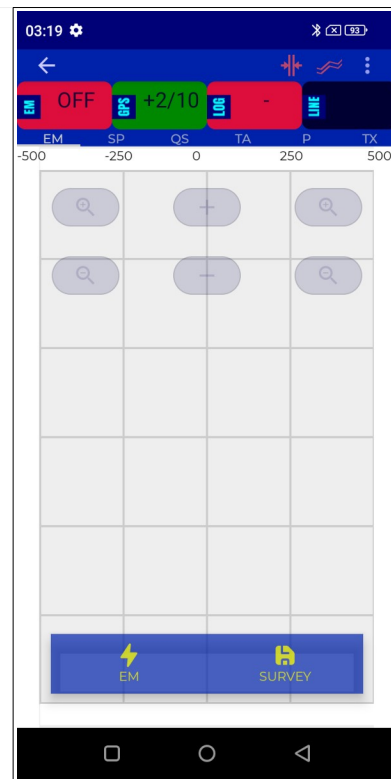
The Survey Status Bar:

indicates survey and device status of the instrument.

EM status displays green if EM is running and no errors indicated, otherwise it will appear red and indicate the numerical error code: 0-OK, 1-overloading (target too big/close), 2-Tx error, 4-memory error, 8-processing error (too many frequencies).

GPS status is green if differential correction is successful (2-for WAAS and 4-for real-time base station). For other diff-correction states, light is amber. If no GPS signal is received, status becomes red. Plus sign indicates PPS (pulse-per-second) being present from GPS port.

The numbers correspond to quality/satellites.



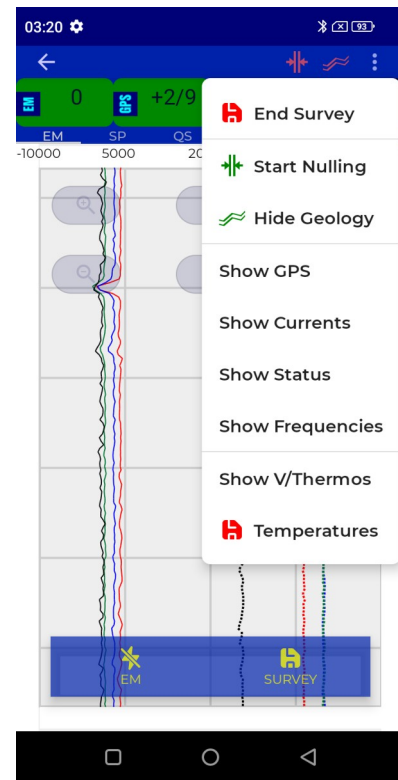
LOG status is red if no file is open (survey has not been started), amber if paused (off-the-line) and green if un-paused (on-the-line). To start survey, press “Survey” button at the bottom of the screen or on console’s control panel.

LINE status indicates which line number has been recorded. Color shows if on-line or off-line. To change, press interactive “Pause”, “Resume Ln” or “New Ln”. On console, you may press “Pause”, “Res”, or “NewLine”. When OnLine Pressing “Mark” will record and display mark number pressed. Ln number and Mark is recorded, for each em sample. Console can be used instead of GEMex.

The Charting displays EM data “In-phase and Quadrature” in time or as spectral data, “QSum”, “power-line monitoring”, or “total apparent el. conductivity”. The GEMex application displays all Ip-Qd pairs in PPM (part per million) values. PPM is a relative unit - the ratio of the received field strength, relative to the transmitted field strength. If there are variations in the strength of the transmit field, due to heat or low battery, the ppm value will remain constant.

Zooming buttons appearing overlay-ed over the chart enable quick zoom to max/min of last 5 seconds - upper middle “+” button. The lower middle “-” button re-scales to min/max of the last 30sec (full screen time of data). The repeated push on “+” or “-” will auto-scale to min/max or symmetric around 0 min/max. Mag. glass zooms in/out single axis only (left or right) side.

The Interactive Control Bar provides access to necessary survey commands: EM, SURVEY, RESUME Ln, NEW Ln, MARK, PAUSE used for dead-reckoning and GPS survey.



The menu can be opened by pressing the three dots in the top right and contains multiple commands, mostly useful for managing surveys. “End Survey” is used for closing the file after completing a survey.

1.1 Data collection

1.1.1 Performing a dead reckoning survey

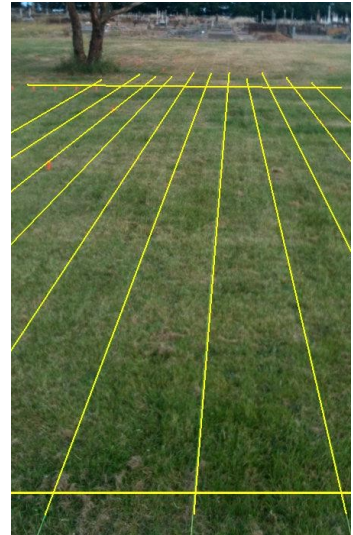
What is a dead reckoning survey?

GPS is not very accurate, with errors of as much as a several meters. Also, GPS signals can be lost due to local interference from trees, buildings, etc. A potentially more reliable alternative is a dead reckoning survey.

In a dead reckoning survey, the survey area is marked with parallel lines, using paint or string. In this photo, the lines run vertically. (The definition of horizontal and vertical is arbitrary, but it may be easier if “vertical” is approx. North-South) The line spacing is always the same, for example 1 meter. So the X position = line spacing * line number.

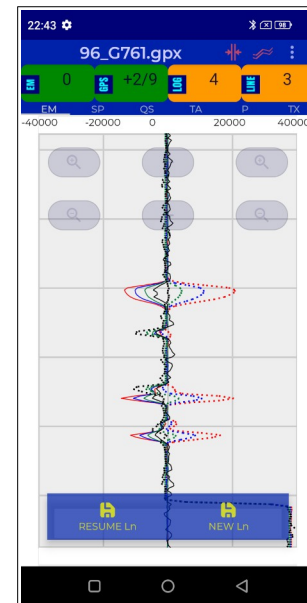
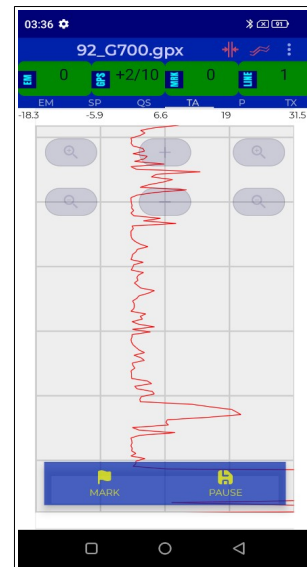
The length of the lines is also the same, say 15 meters. Perpendicular markings define the start and end of each line. When doing the survey, the operator marks the start and end of each line as they move by the end. The mark defines the start and end of the lines. If the start is at 0 meters, then the end will be at 15 meters; if walking in the other direction, the start is at 15 meters, then the end will be at 0 meters.

Note: It is still helpful to connect a GPS to the GEM during a dead reckoning survey. The GPS will provide very reliable time stamps for logging the data. Also, the GPS position information will be recorded and may be useful to supplement the dead reckoning position estimates.



The steps to perform a dead reckoning survey are:

- Start the transmitter by pressing the **EM** button in GEMex or on console. The EM status will turn green, EM will light up on console.
- Start the survey by pressing the **Survey** button in GEMex or Console. Note: while survey is open, the EM button disappears to prevent accidentally stopping the transmitter.
- Press the **NewLn** button or **Log** on console as you start walking down the first line; the Log status will go green (lights up on console) and the LN box will show the first line number, which is **1**.
- When you get to the end of the line, press the **Pause** button in GEMex or **Log** on the console. The console's **Log** led will dim and GEMex's Log status will turn amber. Recording of data will be temporarily paused.
- Get positioned to start the next line and press the **NewLn** button in GEMex or **Log** on the console to start the next line.
- Walk all the remaining lines in the same way.
- After all the lines have been logged, end the survey. From the menu select **End Survey** or press **Survey** on the console – to end survey. Power off and remove the mem-stick from the USB port.



1.1.2 Performing a GPS-based survey

If a reliable and accurate GPS is available, a GPS survey is possible. The process is the same as before, without the need to pause logging at the end of the lines. The GPS also means that the survey does not need to be laid out as straight lines, though it might be preferred for simpler data processing.

As always, it is recommended to manually check the collected data before leaving the survey site. See the section “**CSV file inspection**”, below.

2 Customization of GEM settings

If a need for a different set of frequencies comes, you may define a new combination of frequencies and store it in ALT configuration for quick recall in future.

2.1 Changing regional settings

The GEM2(H) provides two base frequencies for operation: 25Hz and 30Hz. These are used in environments where AC power generation at 50Hz or 60Hz is expected. Odd harmonics of the base frequency (75, 125, 175, ... Hz for a 25Hz base frequency example) provide quiet bands to transmit and listen on. Even harmonics can be monitored for presence of activity in the local environment (power lines, generators.)

To minimize noise, it is not recommended to mismatch the instrument's region selection with local power line frequency. Even though GEM is shipped set to region corresponding to the destination power lines frequency, if a survey is to be performed in an area with different power lines frequencies, system should be switched to match. Move the GEM sensor ski to a safe place away from active power lines. Then execute the command: Home Menu >> [Customize] >> :Menu>>[Change Region to 50(60)Hz]. All system frequencies will be automatically converted to the closest suitable.

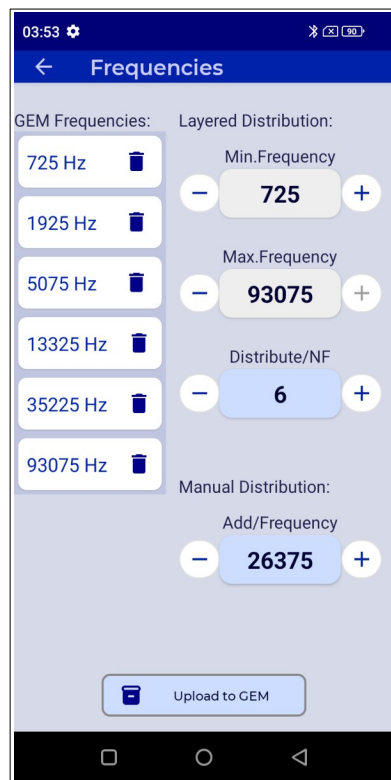
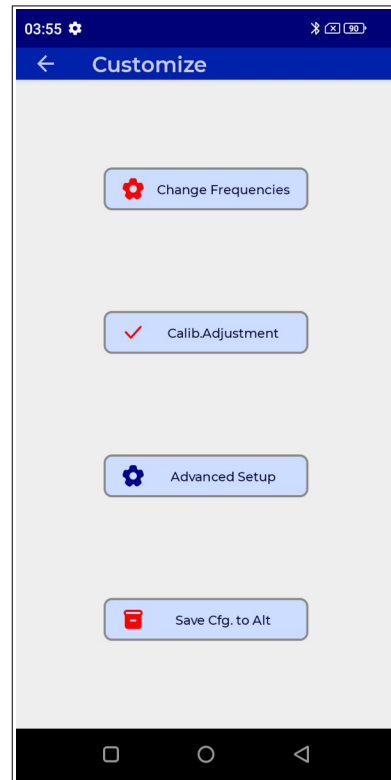
2.2 Changing frequencies

“Frequencies” screen.

From the home screen menu, select “Customize...”. The seed value for settings will be the current active set. Selecting “**Change Frequencies**” will display a dialog with frequencies and buttons for adjustment (see below).

To achieve equal depth penetration/layer increment, we recommend using the “**Layered Distribution**” option, selecting minimum and maximum required frequency and number of required frequencies (NF). Clicking on [Distribute/NF] button will redraw a new suggesting list of frequencies. Each frequency can additionally be modified/deleted. Once you are satisfied with the constructed frequencies, hit “**upload to GEM**” to update the active set.

After uploading/updating active set with new changes, run the “**Calib. Adjustment**” to finalize the change. This procedure will require leaving the ski in a stable horizontal or vertical position away from any conductors. It is best if the receiver end is at least one meter above the ground and preferably in a location away from industrial noise. Once finished, select “**Save Cfg. to Alt**” – for easy recall or “**Save Cfg. to Default**”. Note that Default Cfg. is loaded on system power on.



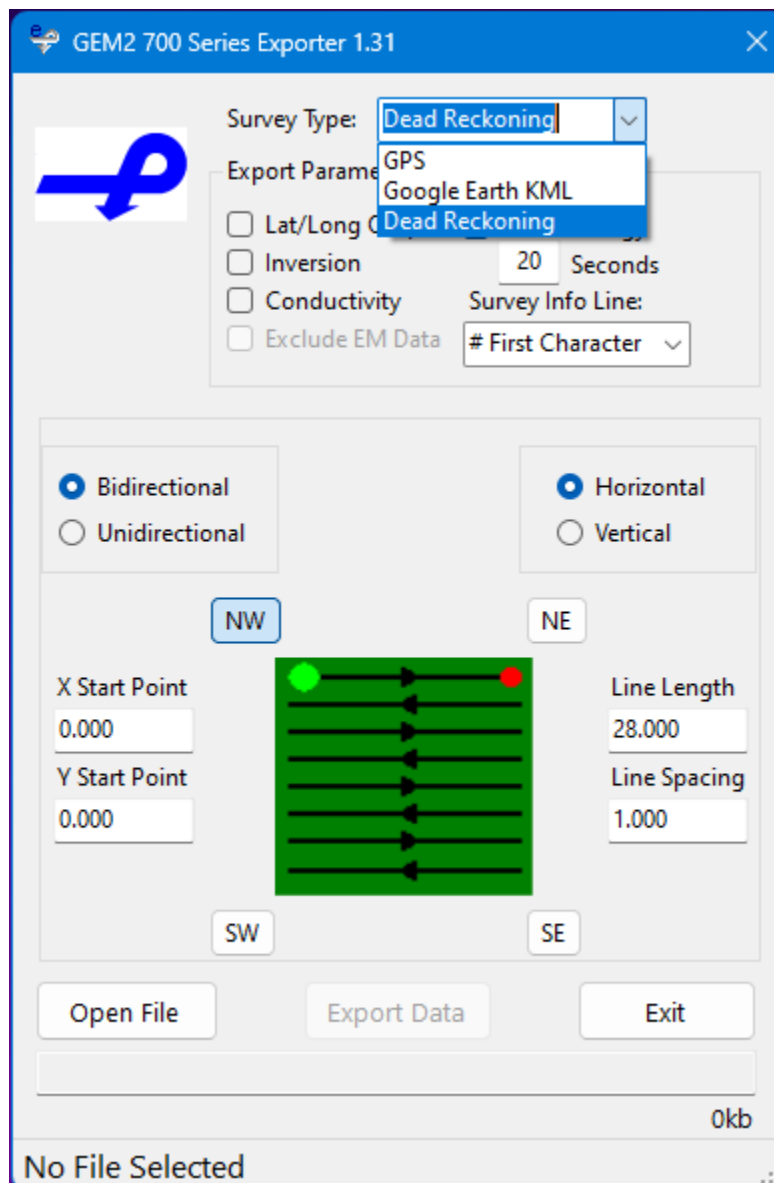
3 After the survey

3.1 Exporting Geophex data

The GEM stores all survey data in external USB memory providing a convenient way to transfer files to a PC for analysis. To keep the data files small, and to speed up data transfers, the data is stored in a compact binary format with extension “.gpx”.

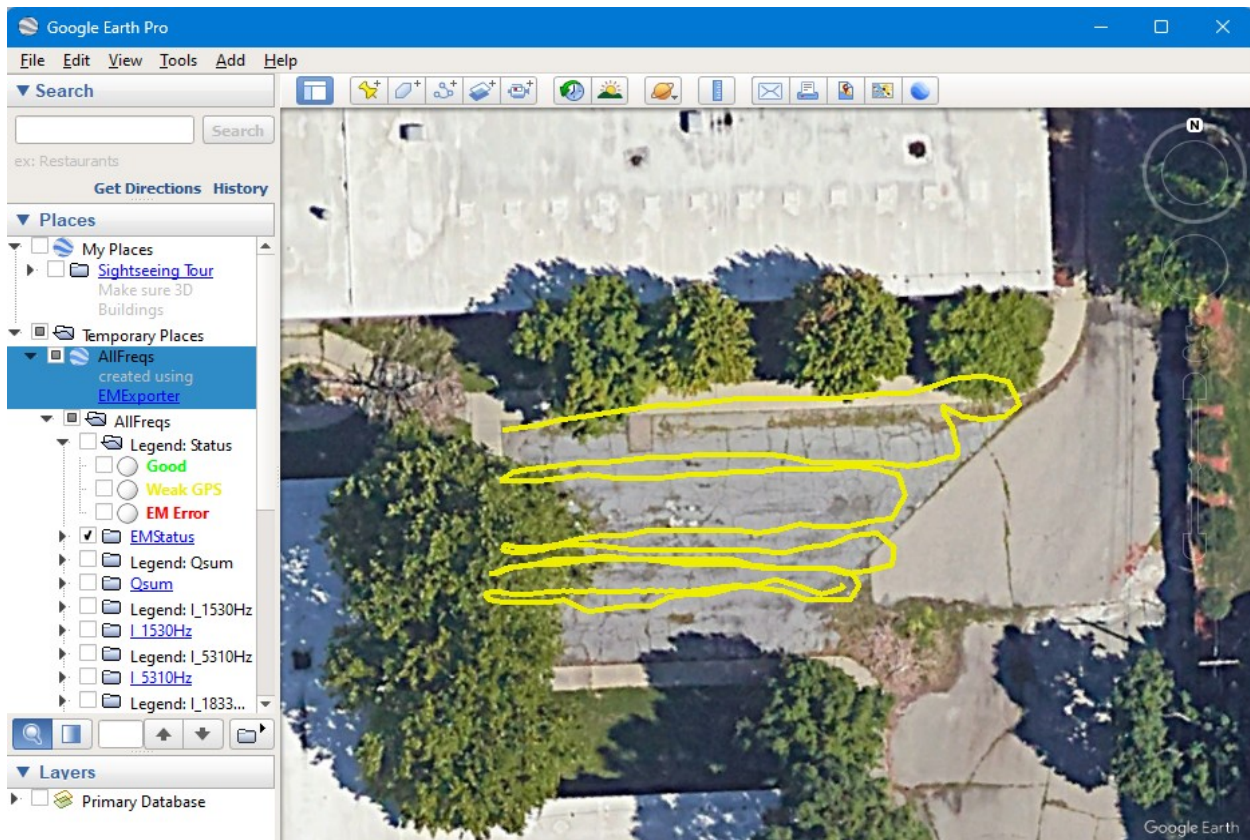
To convert “.gpx” files to a universal, text-readable “.csv” format, or for loading into other applications such as GoogleEarth, use a program provided by Geophex called GEM2Exporter, downloadable from the Geophex website in “resources/downloads” 700 series section.

Note: GEM2Exporter is to be installed on a PC running Windows after survey data is transferred from the USB memory stick.



3.2 Quick view of coverage path and quality of surveyed data

Exporting your survey data to Google Earth allows the user to quickly scan and evaluate survey area coverage, status of GPS and EM, and indicated lines needed to repeat. Just select “Google Earth KML” as Survey Type to create the app associated file. Note that you will need to have Google Earth installed to be able to load and view surveyed channels. The data will be overlaid on top of satellite imagery as shown below.



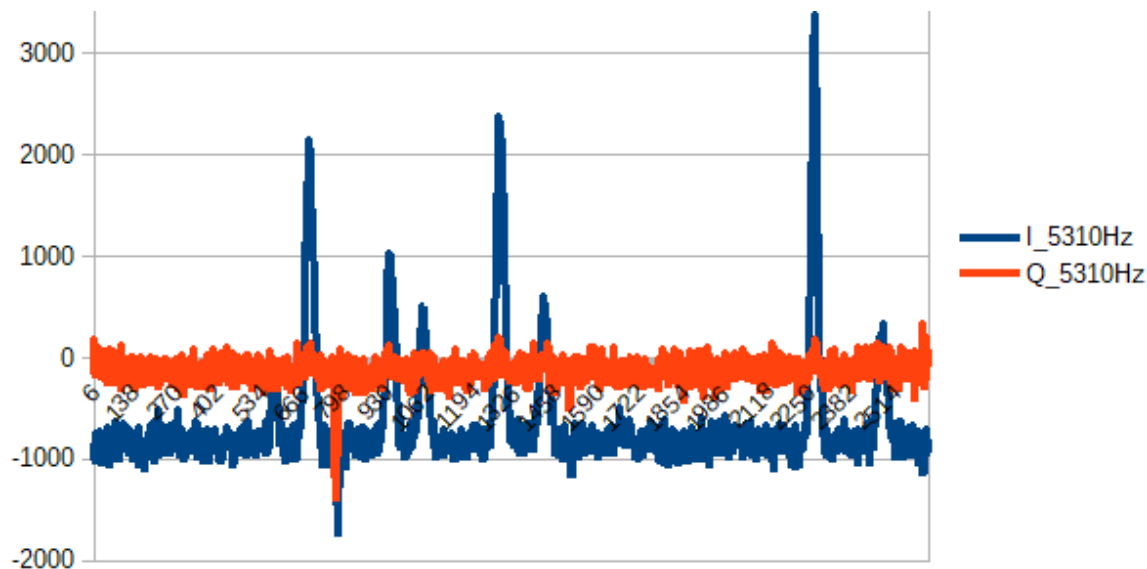
3.3 Converting the .gpx (geophex) survey files

GEM2Exporter gives you options to output positioned EM data in ppm units for in-phase and quadrature and/or compute electrical conductivity for each frequency or total apparent conductivity (available in real-time during survey as well). Multi-layered resistivity profiling is available as well.

3.4 CSV file inspection

After export, the survey data is in a .csv file. The .csv file can be manually examined at this point to make sure there are not any obvious problems with the survey data. If this is done before leaving the survey site, it might save the trouble of having to travel back to the survey site to repeat the survey.

Open the file in Excel (or equivalent), select one or more columns of frequency data, and insert a line chart (graph) of the values. It might look like this: (2 columns shown)



Does it look like any data got collected? How noisy is the data? Also, are there targets visible? Is there a systematic drift to the data? Are there any unexplained jumps in the data. Are there data points that should be deleted?

You can also look in more detail at the data to decide if you want to apply some filtering or other processing before continuing.

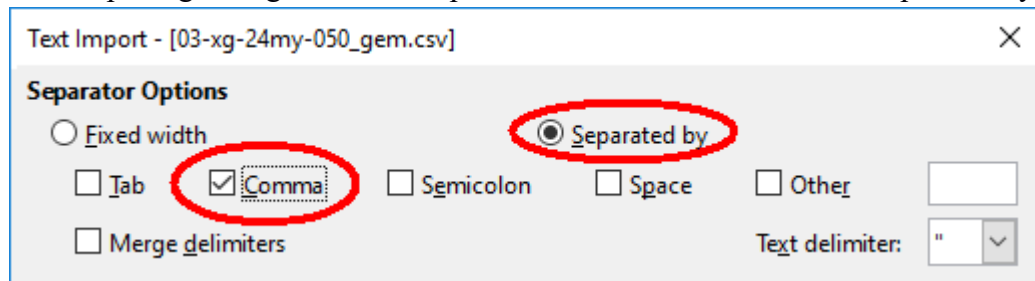
The .CSV file format

After export, the survey data is in a .csv file. The .csv (comma separated values) file format is a very old and simple database file format, which is understood by many programs. A .csv file is a text file. All the values for one data point are on a single line; with the values separated by commas. The data values must NOT contain a comma, and if a field is missing, there would appear 2 commas in a row because the commas are needed to keep track of the order of the values.

In the terminology of databases, each line is a *record*, and each *record* is composed of *fields* which are separated by commas.

The file can be opened in a text editor, but it is much clearer to open the file with a spreadsheet program such as Excel or LibreOffice Calc. These programs understand the .CSV format and can line up the field into columns. Depending on the PC you might be able to simply double-click the CSV file, or start the spreadsheet program and do a **File...Import** or **File...Open**.

In the opening dialog choose the option that indicates the fields are separated by commas:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Line	Sample	X	Y	Mark	Status	GPSStat	GPSalt	Time[ms]	Time[h:mm:ss.sss]	PowerLn	I_450Hz	Q_450Hz	I_1530Hz	Q_1530Hz	I_63030Hz	Q_63030Hz	QSum					
2	0	8	711903.13	3960061.35	0	0	2	92.4	50705683.9	140505.6839	78.2	-176.712	-307.618	-399.529	-454.61	-877.2	-2911.93	3137.87					
3	0	9	711903.13	3960061.35	0	0	2	92.4	50705783.9	140505.7839	68.5	-221.82	-404.037	-356.712	-318.755	-877.2	2873.88	3191.78					
4	0	10	711903.13	3960061.35	0	0	2	92.4	50705883.9	140505.8839	91.4	134.223	-813.416	-127.347	-235.601	-877.2	2951.28	2952.11					
5	0	11	711903.13	3960061.35	0	0	2	92.4	50705983.9	140505.9839	77.6	-242.149	-387.868	-213.972	-356.712	-877.2	3259.25	3459.91					
6	0	12	711903.13	3960061.35	0	0	2	92.4	50706083.9	140506.0839	79.1	-301.147	-163.751	-470.262	-389.529	-19.8841	3463.75	3649.85					
7	0	13	711903.13	3960061.35	0	0	2	92.4	50706183.9	140506.1839	75.9	-47.1428	-344.711	-315.037	-315.037	33.6721	3271.13	3251.56					
8	0	14	711903.13	3960061.35	0	0	2	92.4	50706283.9	140506.2839	81.5	-1.55198	-378.95	-274.727	-315.037	90.9971	3217.98	3266.74					
9	0	15	711903.13	3960061.35	0	0	2	92.4	50706383.9	140506.3839	80.2	28.7121	-433.883	-387.676	-489.529	148.537	3605.85	3586.23					
10	0	16	711903.13	3960061.35	0	0	2	92.4	50706483.9	140506.4839	77.7	49.7443	-365.454	-262.682	-465.529	181.306	3631.88	3736.26					
11	0	17	711903.13	3960061.35	0	0	2	92.4	50706583.9	140506.5839	77.7	106.657	-115.87	-303.888	-408.529	95.12	3215.89	3292.86					

The columns (fields) in the lines are:

- **Line:** Line counter, gets incremented by a **Log** start and **Log** end; mainly for dead reckoning surveys
- **Sample:** sequence number
- **X:** x position, in meters if using UTM coordinates
- **Y:** y position, in meters if using UTM coordinates
- **Mark:** increments each time the **Mark** button is WinGEM2 is pressed. Used to mark specific points in a survey area.
- **Status:** Error staus code for WinGEM2, 0 is OK, 1-overload, 2-tx error,4-memory
- **GPSStat:** GPS status, 2 is WAAS differential corrected fix, 1-floating fix, 0-not position (if a different GPS is used, consult GPS manual)
- **GPSalt:** GPS altitude, usually not very accurate
- **Time[ms]:** number of milliseconds after midnight or since powering the GEM (if no GPS sync happend).
- **Time[h:mm:ss.sss]** corresponds to Time[ms] time code accurate to millisecond
- **PowerLn:** reading at the power line frequency (50 or 60 Hz), a measure of ambient power line field strength in nT.

- **I_nnHz**: for each frequency, the in-phase PPM value for that frequency
- **Q_nnHz**: for each frequency, the quadrature PPM value for that frequency
- **I** and **Q** pairs are repeated for each frequency
- **Qsum**: Sum of the Q values for all frequencies surveyed, a way to express all the quadrature values as a single number, practical for metal detection.

3.5 Compute conductivity/susceptibility (optional)

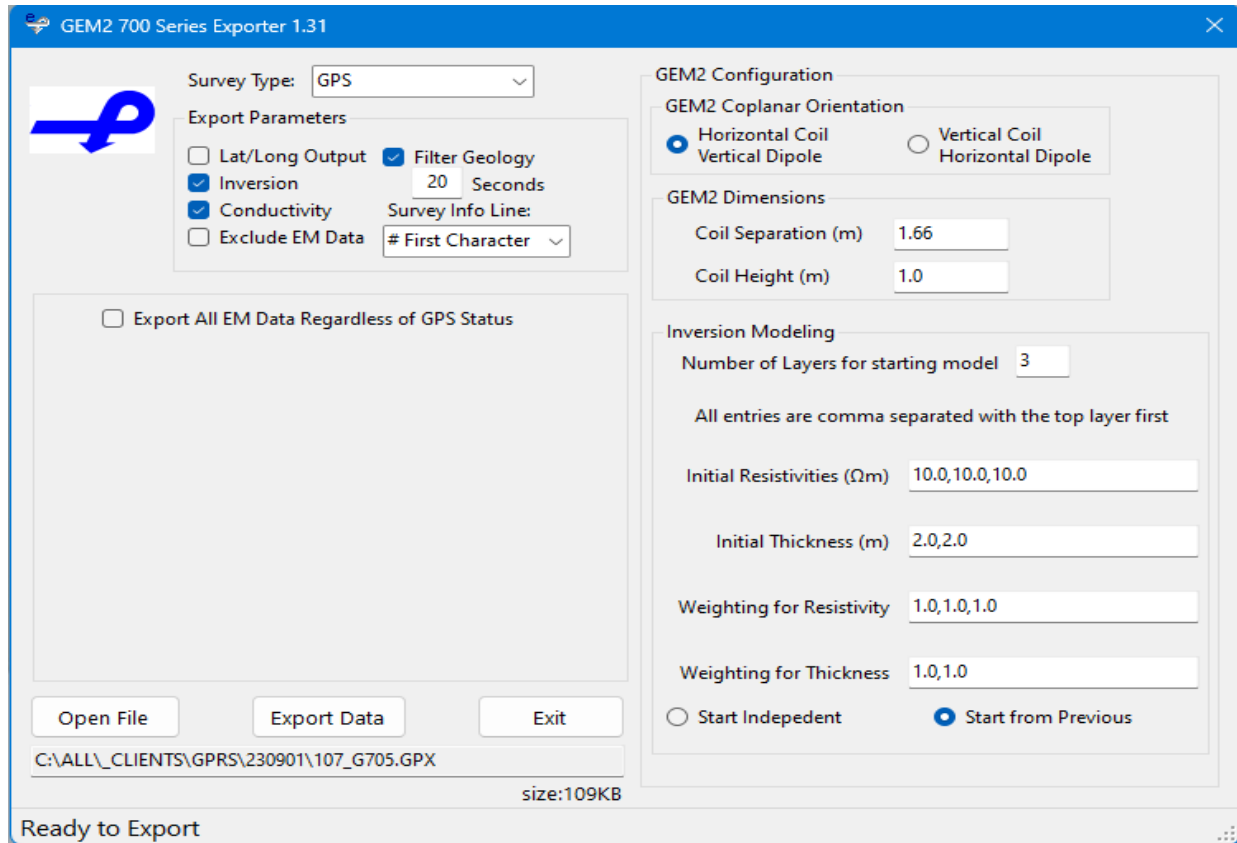
Inversion is a mathematical process of converting in-phase and quadrature readings into other quantities. There are many types of inversion available as open-source and commercial products for various applications. One source is the University of British Columbia in Canada (<https://gif.eos.ubc.ca/software>).

GEM2Exporter offers an exporting simple inversions which uses I and Q survey data to calculate equivalent values of electrical conductivity and magnetic susceptibility.

Check the “Inversions” if multi-layered modeling of resistivity map and layer thickness is desired to compute. Currently this is available for GEM2 sensors only.

The default settings of **Horizontal co-planar** is correct for a GEM-2 held horizontally. The coil separation is 1.66 m is also correct for a GEM-2.

Sensor height can be adjusted as required, 1 meter is typical.



The output file is basically the same as the original .csv file, but with additional columns of computed data appended on the right side. For survey with n frequencies, there will be $2n+1$ additional columns added. The additional columns are:

- one column of electrical conductivity for each frequency (e.g. **EC450Hz[mS/m]** for 450 Hz)
- a single column of total conductivity **TotalEC[mS/m]**
- one column of magnetic susceptibility for each frequency (e.g. **MSusc450Hz[1/1000]** for 450 Hz)

this data can be plotted like any other column in the spreadsheet.

3.6 Plotting the data as an X-Y map

Many programs are available for producing X-Y plots. For this example we will use Surfer 8, a commercial product from Golden Software Inc. ([www. Golden Software.com](http://www.GoldenSoftware.com))

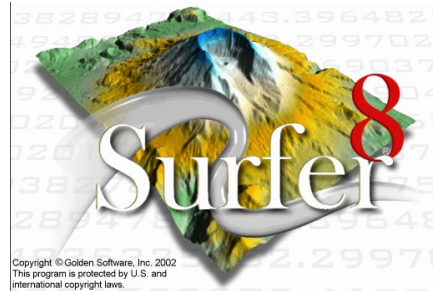
There are 2 stages to producing maps. First, each source of data (for example, one column of data) is converted to a .grd (grid) file. So if we want to map both the in-phase and quadrature

response for 5 frequencies, 10 grid files are needed. It is important to name the files carefully to avoid confusion.

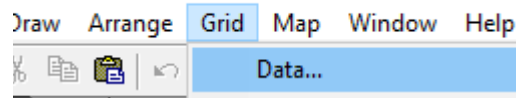
Secondly, each .grd file can be used to produce a map.

Before starting, decide which *.csv file you want to plot. Examine the file and note which 3 columns contain the X and Y position values, and which column(s) holds the data to be plotted..

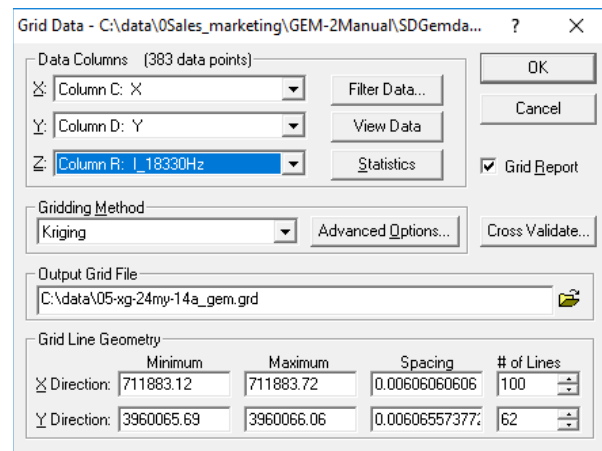
Start the Surfer program.



Use **Grid, Data...** to find and open the appropriate .csv file.



Select the X,Y and data (Z) columns for the plot. For the Gridding Method, choose Kriging.

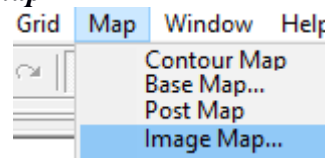


Choose a useful name and location for the .grd file output. Click **OK**. Remember to use a new name for each data set, otherwise Surfer will overwrite a previous file.

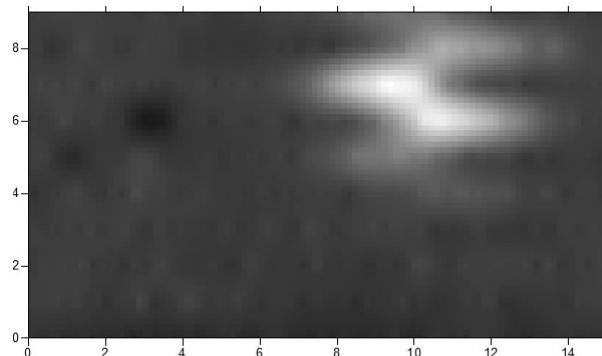
A dialog box will confirm the creation of the .grd file.

The .grd files have been created, now let's make a map

On the menu bar, select **Map, Image Map...**, then select one of your .grd files.



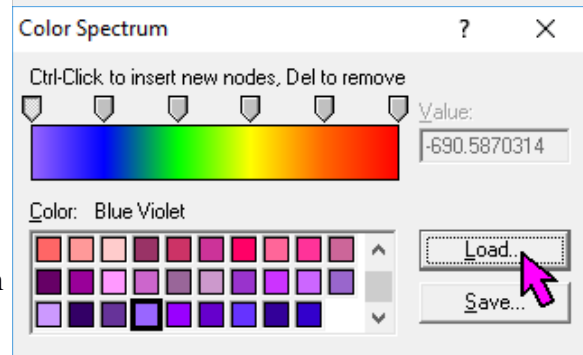
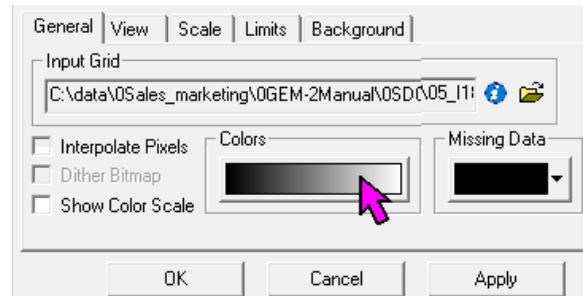
You might get something like this ...



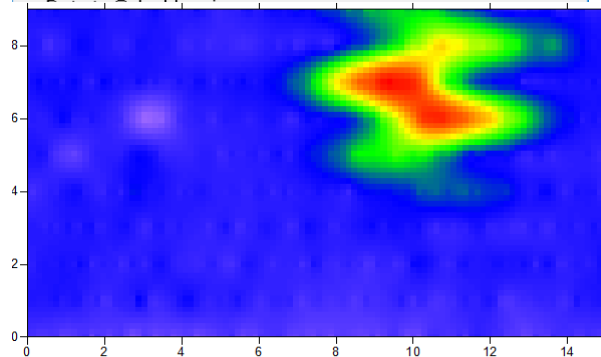
Right-click on the map and choose **Properties**.

On the **General** tab, click on the **Colors** box.

The easiest way to define the color choices is to select one of Surfer's predefined color schemes. Click on the **Load...** button and select the "rainbow.clr" file. (You may need to navigate to Surfer8's Samples folder in Program Files folder to find the .CLR files. Once you find them, you can make copies in a more convenient location on your hard drive.)

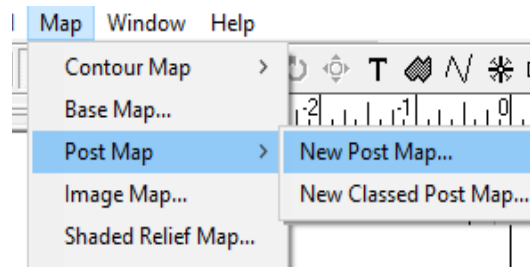


The map will now look something like this:



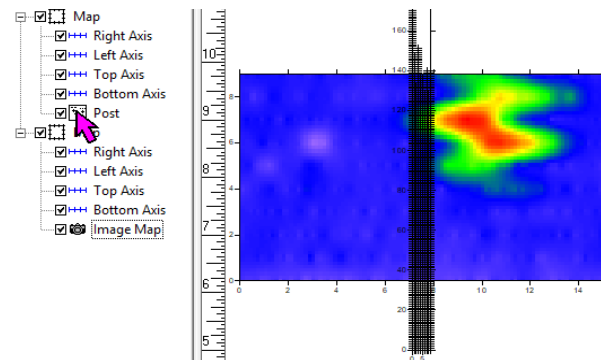
It can be helpful to overlay the path that way taken in collecting the data.

On the menu bar, select **Map, Post Map, New Post Map...**, then select the original ".csv" file that was the source for the current map.



The initial result might look strange, no problem.

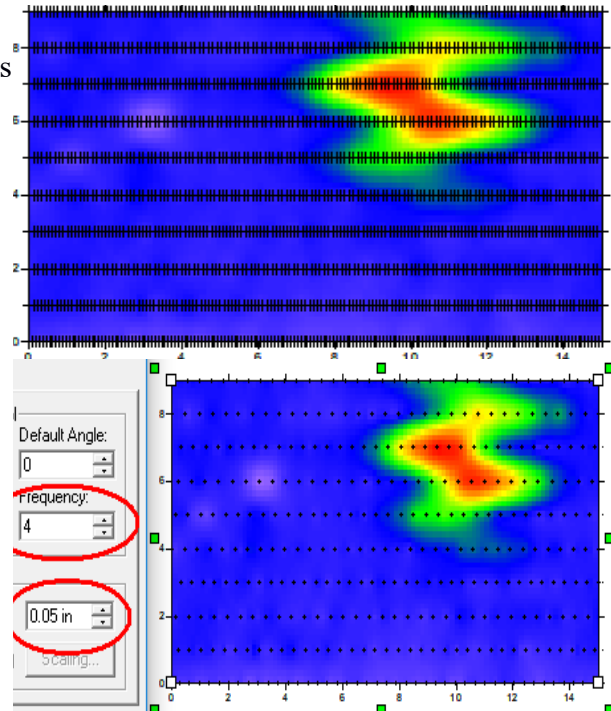
We just need to correctly define the X and Y Coordinates.



Right click on the Post item in the left window and choose **Properties**. Select the correct columns for the **X Coord.** and **Y Coord** columns.

Click **Apply** or **OK**. The map now shows the location of the data points.

Optionally, you can experiment with the **Frequency** and **Symbol Size** parameters to make the map less cluttered.



Finally, you can save your work using **File, Save As...** and choosing a suitable name and folder. You can get a picture using **File, Export...**, and selecting name, folder and suitable file type. GIF may be a good choice.

3.6.1 Other plotting methods

The website <http://www.gpsvisualizer.com/> offers a free online tool for generating a .kmz file from one of the data files. This can then be used in Google Earth to overlay a survey map on top of satellite imagery.

Happy Surveying.....