

Guide For MT Field Operations



Prepare a MT survey	2
Configuration Creator	3
Configuration, gains and LPF	4
Equipment and Tools	5
Equipment Layout	6
Connecting GPS / Battery	7
Receiver Calibration	8
Receiver calibration QC	9
Receiver calibration QC (MTU-5D)	10
Receiver calibration QC - Variations	11
Sensor Calibration	12
Sensor calibration QC	13
Sensor calibration QC - Noise	14
Sensor calibration QC - Bad curve	15
Setting up a survey site(s)	16
Electric Channels	17
Best Practices (Electric Channels)	18
Magnetic Sensors	19
Checklist	20
Start Recording	21
Verifying/Editing Recording Information	22
View Recording Details	23
Software Recommendations	24
Best practices	25

Prepare a MT survey

1. Choose the Site(s)

- Define the survey design (*2D, 3D, detailed, regional*), the site(s) location and the remote reference location as needed
- Prefer to have the survey lines perpendicular to the anomaly direction or to the geological strike direction
- Obtain permission to conduct the work on the site

2. Define a daily production and a survey calendar (*mod/demob, equipment tests and repeats*)

3. Prepare and test all the equipment (recommended)

- Prepare all E-lines to desired length and connect each E-line to an electrode
 - *Use tape to mark E-lines length and keep extra wire after each mark
- Calibrate receivers and sensors
- Run overnight Parallel Noise Test

4. Determine the North reference to be used for the site layout

- True North or Magnetic North

5. Determine the Declination of the survey area (*to be used for data processing*)

6. Create the configuration file (*config.json*) and save it to SD Card

Avoid:

- Hikers
- Industrial or transport activity
- Power lines or electric fences
- Protect the equipment from wild animals, livestock, and even from vegetation (*windy conditions can induce micro-vibrations that will add noise to the recording*)

Configuration Creator

1. Check that the **receiver selected** matches the equipment to be used
2. Select the **Schedule**
 - 2.1. **Manual** or **Automatic Start**
 - 2.2. For a specific schedule use, **Single Shot**, **Daily** or **Weekly**.
*Use the **Add Schedule** to define additional schedule(s)
3. **Live tool** (see the [Networking Settings manual](#))
4. Define the **Channels Settings**
5. Define the Receiver Settings **Sampling Mode** and **Sampling Rate**
6. **Configuration Layout**, complete the information as needed

Configuration Creator - EMpower

File Receiver **Schedule** Help

- Manual Ctrl+Alt+1
- Automatic Start Ctrl+Alt+2
- Single Shot Ctrl+Alt+3
- Daily Ctrl+Alt+4
- Weekly Ctrl+Alt+5
- Add Schedule Ctrl+A

1

2

2.1

2.2

3

4

5

6

Magnetic channel settings

Channel HZ

Enabled

Sensor Type MTC-150

Gain Normal

Low Pass Filter 10 kHz

Sensor S/N 0

Receiver Settings

Sampling Mode Continuous sampling Sparse high frequency sampling

Sampling Rate 24000 s/s View graphic 1.38 GB / Hour

Enhanced Sensor Stabilization Enable

Configuration layout

Layout Geometry Orthogonal

Survey Name

Site Name

Operator(s)

Company Name

Configuration Notes

Additional information

MTU-5

PHOENIX COMMUNICATIONS

Live Tool

MTC-150 Gain: Normal LPF: 10 kHz S/N: 0

MTC-150 Gain: Normal LPF: 10 kHz S/N: 0

MTC-150 Gain: Normal LPF: 10 kHz S/N: 0

i This section is used for inputting the parameters and instrument details that will be used for the recording

Configuration, gains and LPF

Electric Channels

1. Gain “Normal” is designed to get the optimal point between noise versus input range

- In case saturations are more than 2%, check for noise sources (*cable connections, electrodes etc.*) and try to eliminate them. If the saturation doesn't change, reduce dipole lengths
- If saturations persist, set a **Low** channel gain as last resort.

Magnetic Channels

2. Ensure that the correct sensor type is selected, to prevent over-voltage to the sensor
3. With MTC-150, prefer Gain “Normal” in most cases
4. Set the LPF which is compatible with the sensor frequency range

The screenshot shows the 'Configuration Creator - EMpower' software interface. The main window displays a hardware diagram of the MTU-5C Inboard Receiver with three MTC-150 sensors. A callout box (1) shows a dropdown menu for gain settings: Normal, Very Attenuated, Attenuated, Low, Normal, High, Very High. The configuration panel on the right shows the following settings for the magnetic channel:

- Channel: H2
- Enabled:
- Sensor Type: MTC-150
- Gain: Normal
- Low Pass Filter: 10 kHz
- Sensor S/N: 0

Receiver Settings:

- Sampling Mode: Continuous sampling Sparse high frequency sampling
- Sampling Rate: 24000 s/s View graphic 1.38 GB / Hour
- Enhanced Sensor Stabilization: Enable

Configuration layout:

- Layout Geometry: Orthogonal
- Survey Name: []
- Site Name: []

A callout box (2) highlights the magnetic channel settings panel, and a callout box (3) highlights the Gain dropdown menu.

Equipment and Tools

Equipment

1. Configuration Layout Sheet
2. Laptop
3. EMpower + License
4. SD Card with config file for each operation
 - Sensor Calibration
 - Receiver Calibration
 - Desired type of data recording (*Orthogonal or Parallel*)
5. Receiver
6. 12 V Battery
7. Power Cable and GPS Cable
8. Antenna
9. Magnetic Sensors and cables
10. Electrodes (IPX5)
11. E-line cable

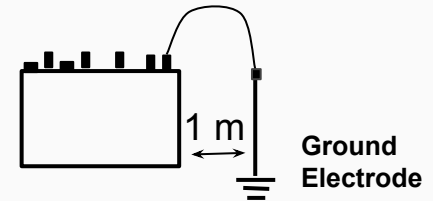


Tools & Supplies

1. Shovel
2. Container of salt water (50 g/L)
3. Handheld compass
4. Measuring tape
5. Multimeters (*Analog and digital*)
6. Pencil and permanent marker
7. Bubble Level
8. Wire cutters
9. Electrical tape / Flagging tape
10. Tarp

Equipment Layout

1. Ensure the right location as defined for the recording site
 - Use a handheld GPS
2. Choose an open/dry spot for the site layout centre
3. Stay clear of noise sources or try to find a location with non-coherent noise with the survey area
4. Choose the centre spot for the ground electrode, less than 1 m from the receiver



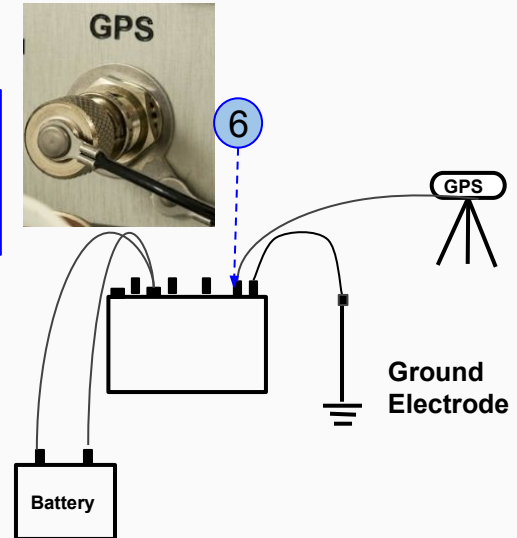
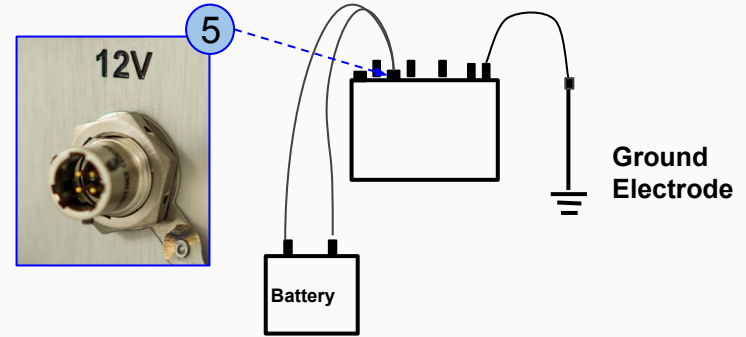
Connecting GPS / Battery

5. Battery

- Connect the battery
 - Red (+) positive
 - Black (-) negative
- Fit the slotted connector (to the receiver's connector)

6. GPS

- Connect the cables on the GPS antenna and Receiver
- Keep the GPS antenna in the receiver bag
 - In case of the reception is not good use the antenna tripod, if necessary tape the antenna tripod to a stake, post or large tripod



Receiver Calibration

7. Insert the SD Card with a valid Receiver calibration config file into the receiver
8. Turn on the Receiver
9. Start the Calibration Recording
 - o The calibration process should take place at the beginning of every survey
 - o Allow the calibration to finish on its own, the LED's will return to "Ready" state
10. Turn off the receiver

**Use EMpower (Field QC module) to view and quality control the calibration*

i

Indicators

- ■ Slow, equal pulses
- Solid color / Off
- Rapid, equal pulses
- ■ Short unequal pulses



7

8

Turn on the receiver

	Starting	Acquiring GPS	Ready
Power	■ ■	■■■■■	■■■■■
SD	■ ■ ■ ■ ■ ■ ■ ■	■■■■■	■■■■■

**For any problem with the SD Card, check the Troubleshooting manual*

9

Calibration Recording

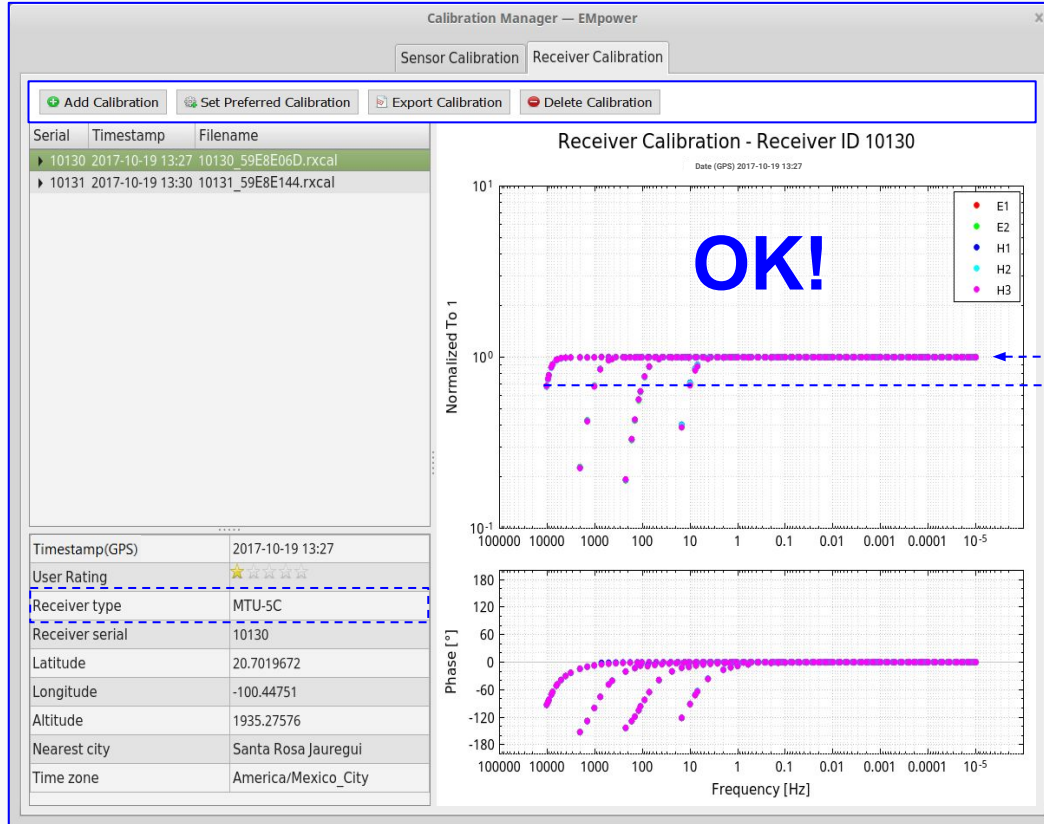
	Calibration	Closing	Ready
Power	■■■■■	■■■■■	■■■■■
SD	■ ■ ■ ■ ■ ■ ■ ■	■■■■■	■■■■■

10

Keep pressing the power button 3 sec and release

	Ready	Shutdown	Off
Power	■■■■■	■■■■■	■■■■■
SD	■■■■■	■■■■■	■■■■■

Receiver calibration QC - MTU-5C / MTU-8A / RXU-8A



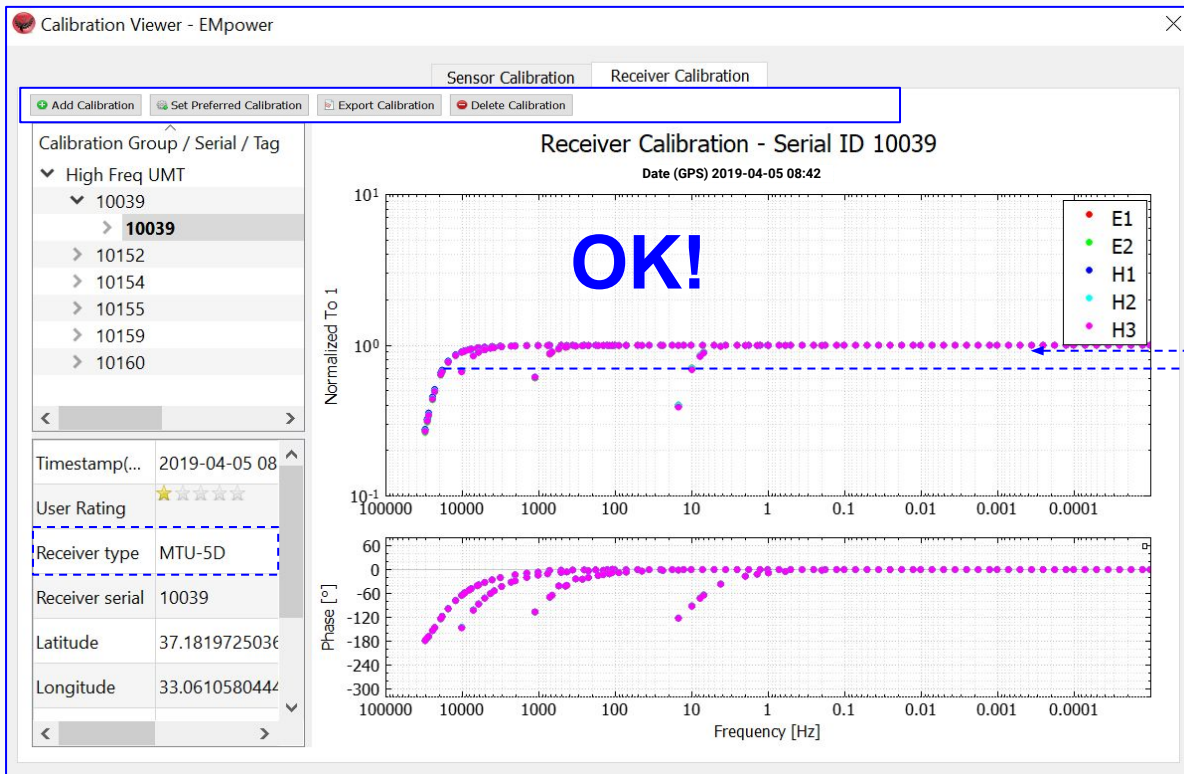
Horizontal level = 1
(or 10⁰)
→ OK



This calibration curve and cutoff frequencies apply only to receivers with a base sampling rate of 24 KSps, such as MTU-5C, MTU-8A and RXU-8A

Cut off
value ~ 0.7
@ 10kHz
@ 1KHz
@ 100Hz
@ 10Hz
→ OK

Receiver calibration QC - MTU-5D



This calibration curve and cutoff frequencies apply only to receivers with a base sampling rate of 96 KSps, such as MTU-5D

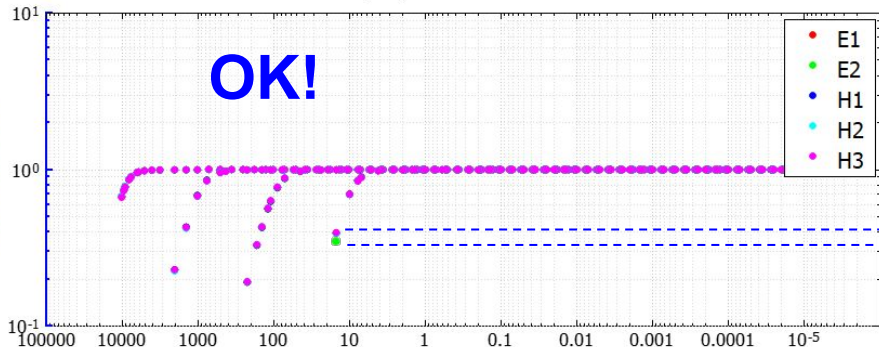
Horizontal level = 1
(or 10^0)
→ OK

Cut off value ~ 0.7
@ 10Hz
@ 1KHz
@ 10KHz
@ 17.8KHz

Receiver calibration QC - Variations

Date (GPS) 2017-11-29 14:43

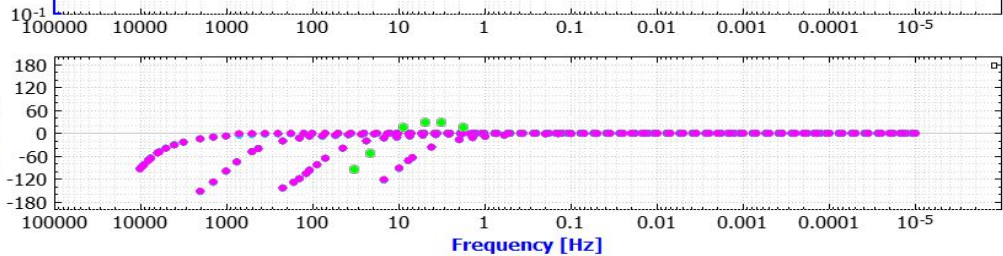
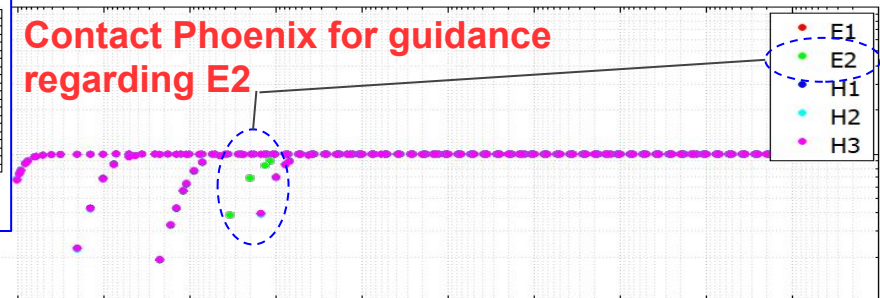
OK!



Small variations out of the flat part → OK

Date (GPS) 2017-11-29 14:43

Contact Phoenix for guidance regarding E2



Sensors Calibration

11. Connect the sensors

- Sensors should only be calibrated outdoors and away from noise

12. Insert the SD Card with a valid Sensor calibration config file into the receiver

**For any problem with the SD Card, check the Troubleshooting manual*

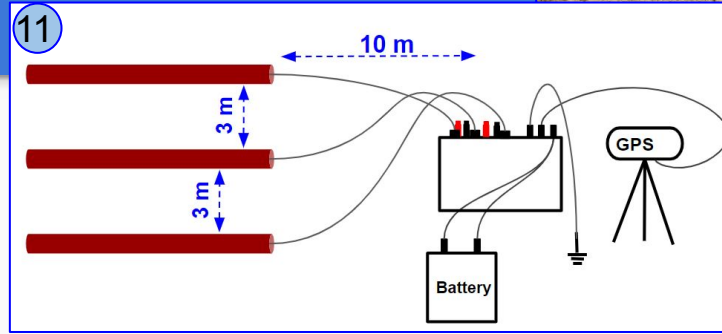
13. Turn on the Receiver

14. Start the Calibration Recording

- The calibration process should take place at the beginning of every survey (*For best results, specially under windy conditions it is best to bury the sensors during calibration*)
- Allow the calibration to finish on its own, the receiver LEDs will go back to the 'Ready' state"

15. Turn off the Receiver

**Use EMpower (Field QC module) to view and quality control the calibration*



13 Turn on the receiver

	Starting	Acquiring GPS	Ready
Power	Red bar	Red bar	Blue bar
SD	Grey bar	Blue bar	Blue bar

14 Calibration Recording

	Calibration	Closing	Ready
Power	Blue bar	Blue bar	Blue bar
SD	Blue bar	Blue bar	Blue bar

15 Keep pressing the power button 3 sec and release

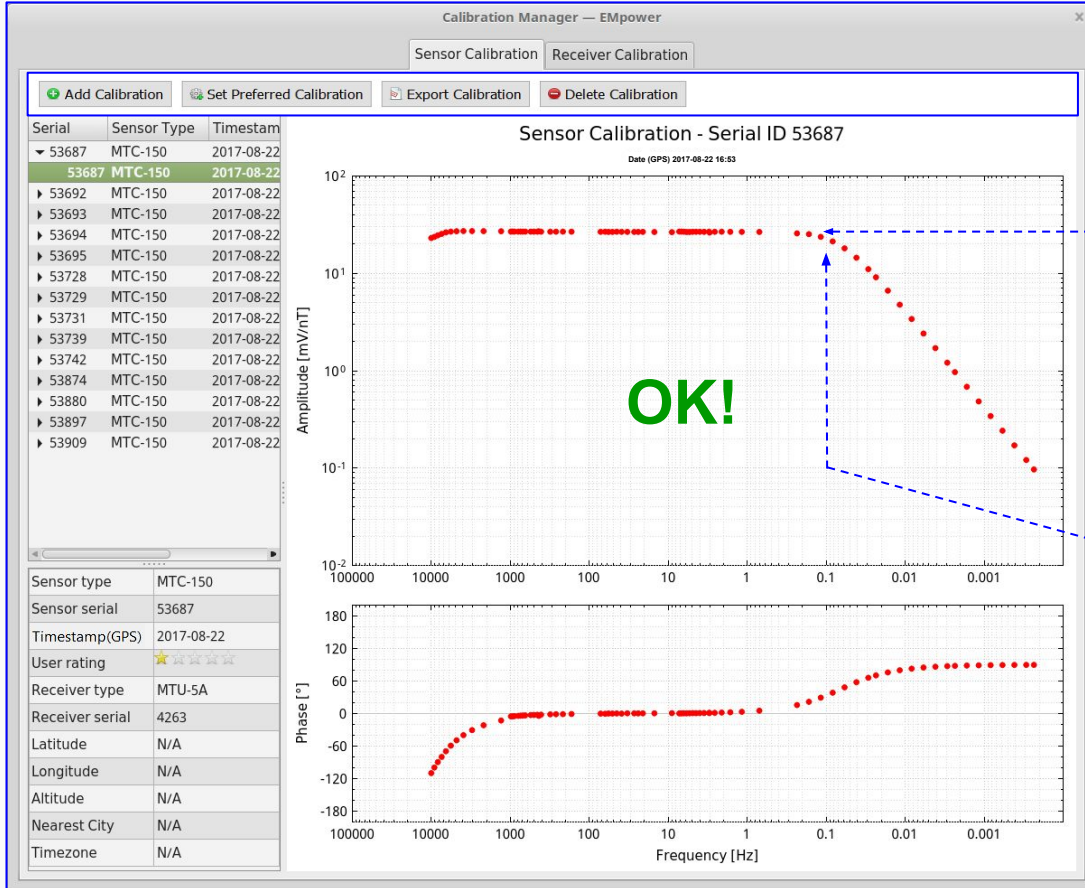
	Ready	Shutdown	Off
Power	Blue bar	Red bar	Grey bar
SD	Blue bar	Red bar	Grey bar



Indicators

- ■ Slow, equal pulses
- Solid color / Off
- ■ ■ ■ ■ Rapid, equal pulses
- ■ Short unequal pulses

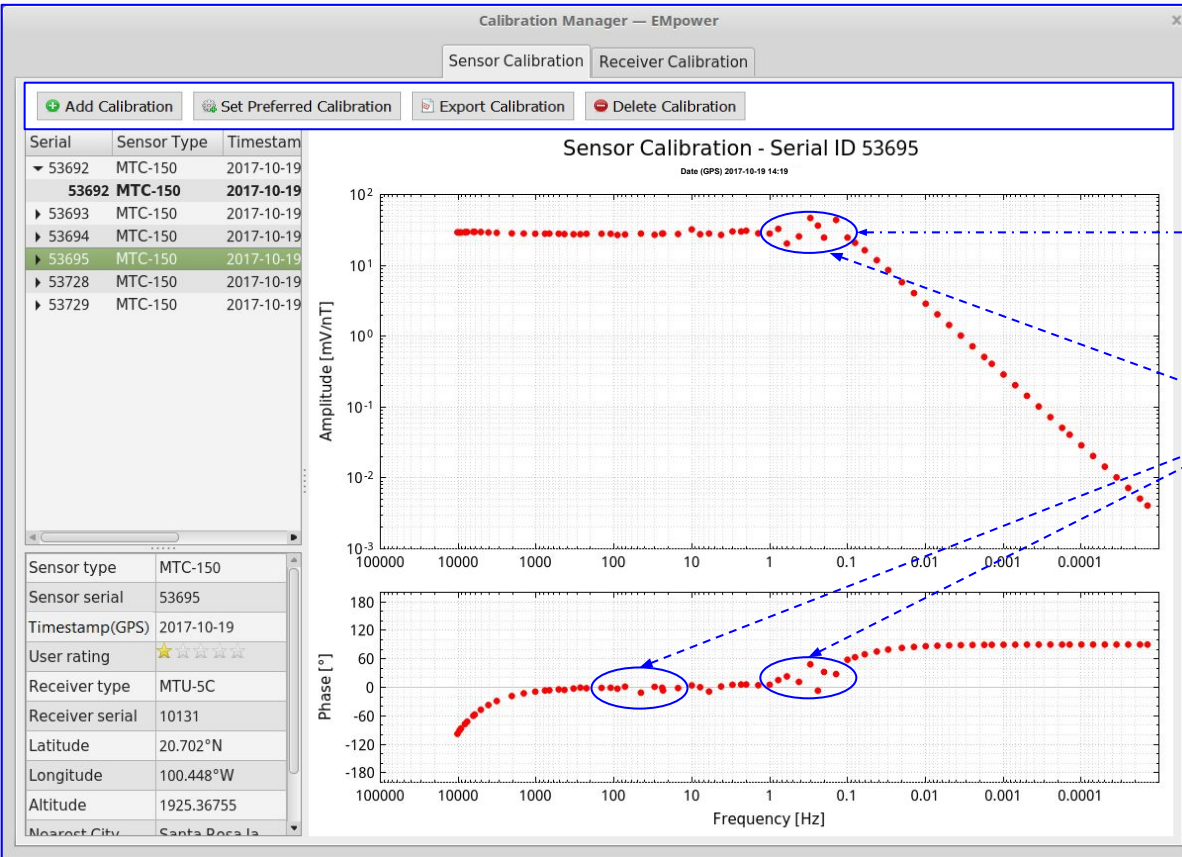
Sensor calibration QC



For MTC-150 the value of the horizontal part should be between 20-30 mV/nT

For MTC-150 the curve should bend at around ~ 0.1 Hz

Sensor calibration QC - Noise

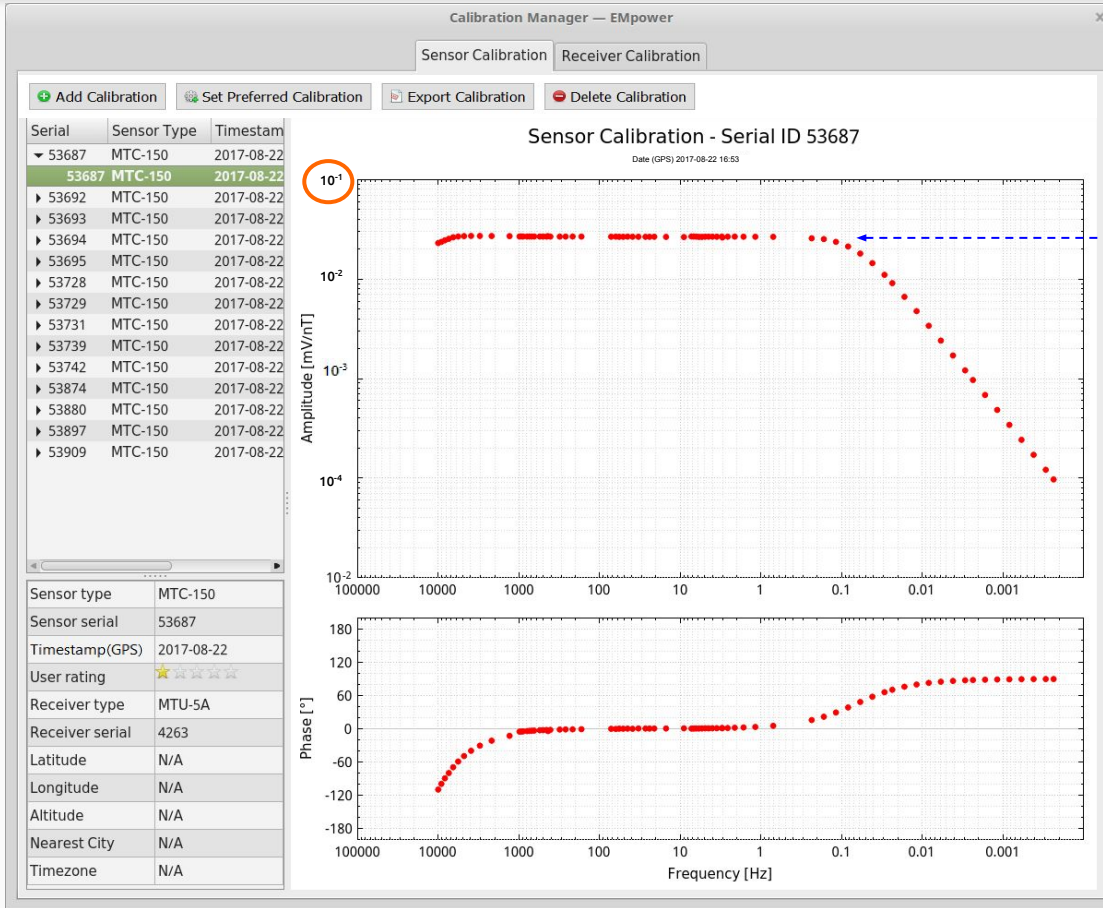


MTC-150, value should be between 20-30 mV/nT. **OK**

Curves somehow good, but show noise "ringing" around 50/60Hz or at low frequencies

i Sensor might be OK, but cultural noise

Sensor calibration QC - Bad curve



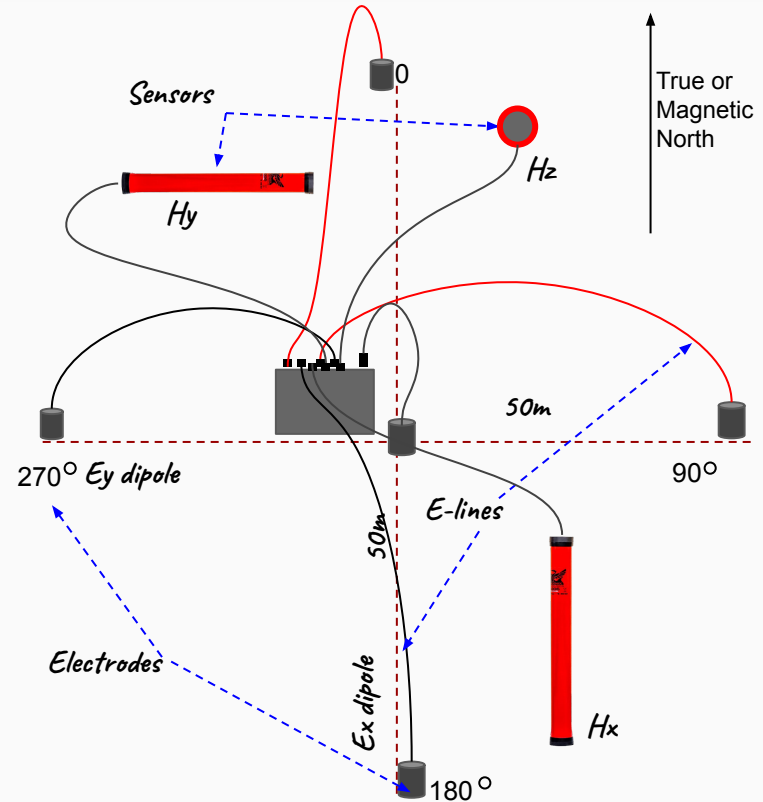
For MTC-150 value not between 20-30 mV/nT, or odd curve shape

!
Verify coil,
coil cable, channel

Setting up the Survey site(s)

Use the same steps to setup the Remote Reference and Survey site(s)

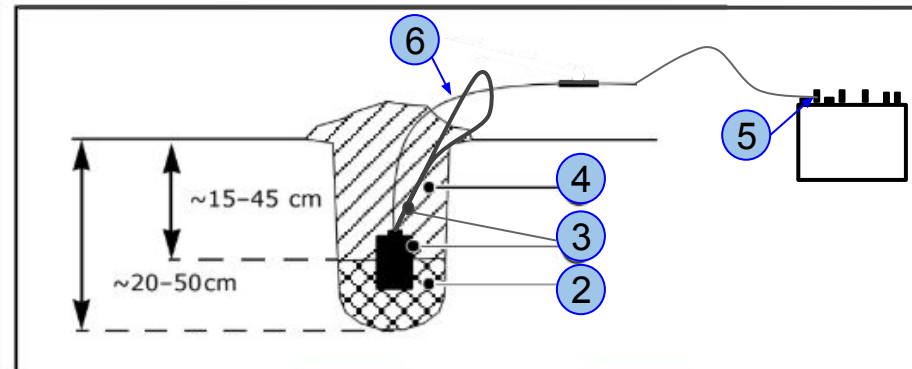
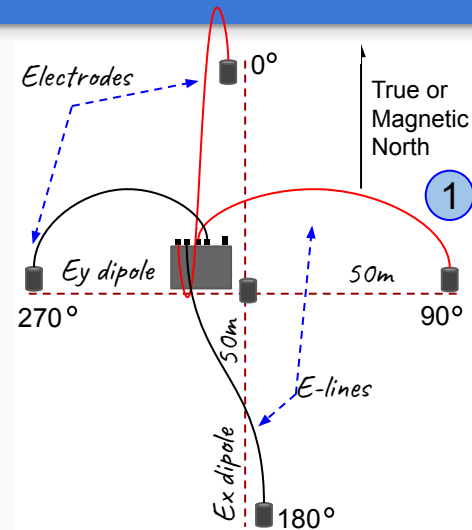
1. Following the illustration, use a compass to orient the electrodes to the north, south, east, and west of the ground electrode to layout the E-lines
 - Using longer dipoles increases the signal being input to the receiver and helps to overcome the internal noise of the receiver. This helps when there is a very small signal amplitude. Care must be taken with this approach, since increasing the dipole length also increases the amplitude of the noise received from nearby sources such as power lines and electric fences.
2. Orient the Sensors following the illustration
 - Try to order the sensors by serial number where the lowest number is for Hx



For any layout error on the E-lines or on the Sensors installation (See [Troubleshooting manual](#))

Electric Channel

1. Register the electrode number and /or cable number
2. Dig a small hole about 20-50 cm deep removing any sizeable rocks
 - Loosen the dirt at the bottom of the hole
 - Pour in at least 1 liter of salt water and mix it with the dirt to form a uniform mud
3. Place the electrode upright in the hole rotating it back and forth to position it solidly in the mud, and leave the electrode cable and rope extended outside the hole (*number 6 in the graphic*)
4. Cover the electrode completely with the loose dirt
5. Connect E-lines to the receiver



Best practices

1. Excess cable:

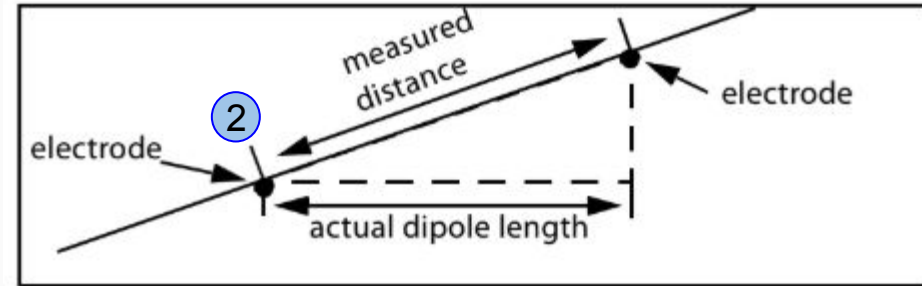
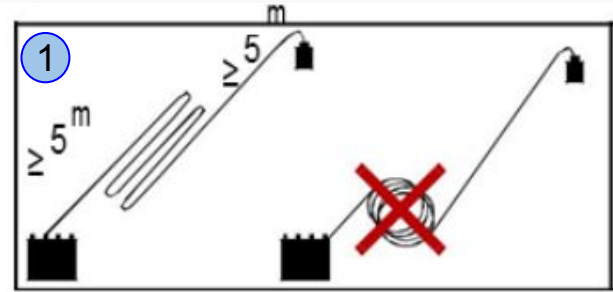
- Always lay excess cable in elongated S-shapes, no closer than 5m from the ends

2. Slope:

- E-lines laid out down a steep slope can also create a problem: the measured distance between the electrodes no longer equals the actual horizontal length of the dipole. Instead, the measured distance is a vector resulting from both horizontal and vertical displacement

**If you encounter inclines of 20°, you must compensate using trigonometry*

- One way is to calculate how much to lengthen the E-lines when laying out the site so that the horizontal component of the vector is the desired dipole length
- Alternatively, you can make no compensation in the field, and instead calculate the actual horizontal dipole length before processing the data

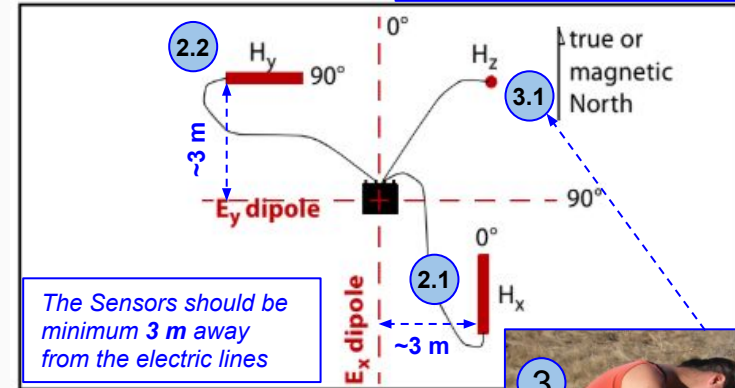


To minimize wind-induced noise, ensure that the sensors cables lie flat on the ground. Place weights on them every meter or so if necessary

Magnetic Sensors

Alignment of the sensors

- 1. Record** the serial numbers of the coils (*Sensors*) before burying them
- 2. Horizontal (H_x / H_y)** dig a hole to lay out the sensor 40 cm deep x 15 cm from each end and 10-15 cm from each side.
 - 2.1. The free end of H_x points North (*connector points south*)
 - 2.2. The free end of H_y points East (*connector points west*)
**Properly align and level each sensor using a compass and a level. Once done, cautiously cover the sensors with loose soil*
- 3. Vertical (H_z)**
 - 3.1. Dig a vertical hole deep enough to fully bury the sensor.
**Level the sensor while adding loose soil in the hole, and do the last check when you are done burying it*
**If you can't dig deep enough to fully bury the vertical sensor, create a dome around the sensor using loose soil and ensure that the sensor and cable are steady and stable*



Working with six sensors:

Sensors can be installed in any quadrant, ensure to keep a minimum distance of ~1.5 m between them.

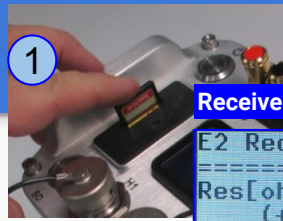
Checklist

- Battery
- GPS antenna
- Insert an SD card with a valid configuration file
- GPS synchronization
- Measure electric line, and orient both electric line and sensors
 - Take note of terrain incline if >20 degrees
- Keep cables flat on the ground
 - Not draped over plants or obstacles
 - Bury or weight the cables if necessary to reduce wind noise
- Ensure clear sight-lines between the GPS antenna and the sky
- Run a test Recording (*see next page*)



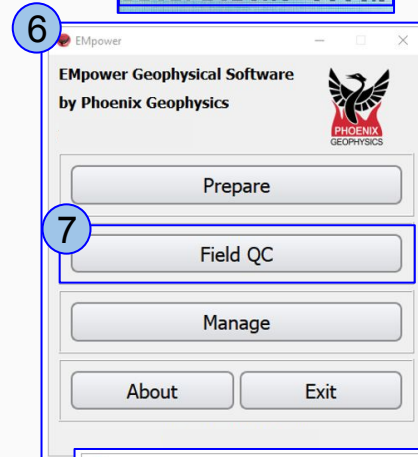
Start Recording

1. Insert the **SD Card** and close the lid
**For any problem with the SD Card, check the Troubleshooting manual*
2. Turn on the **receiver**
3. Start recording data
 - Check the saturation for all channels, using the receiver screen. If the saturation is more than 2% follow the steps on ([Configuration, gains and LPF](#))
4. Stop the recording after the acquisition completed
5. Turn off the receiver and extract the SD Card
6. Insert the SD Card in the computer and open **EMpower**
7. Click the Field QC button
8. Select View data
 - Select the SD card (*The recording process creates two folders, log, and recdata*)
 - Open recdata folder and select the desired recording folder and click Choose
 - Review the recording information

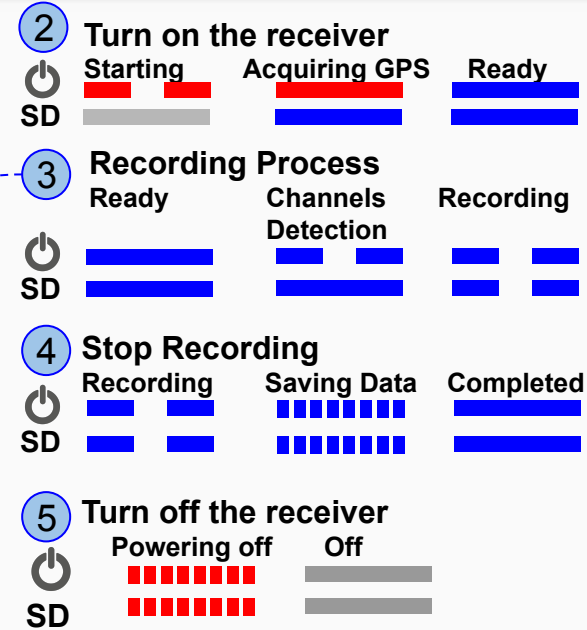
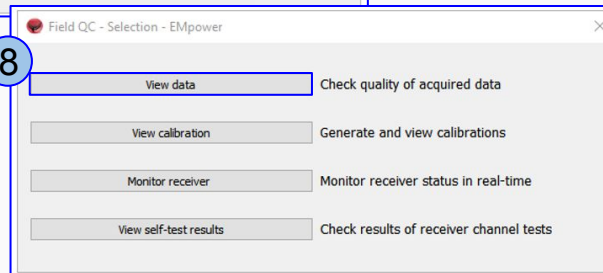


Receiver Screen

```
E2 Rec Stats
-----
Res[ohm]:
 (+)485.5
 (-)485.3
AC[V]: 0.003
DC[V]: -0.000
Saturation: 0.00%
```



8



Verifying/Editing Recording Information

The layout and recording information can be consulted and edited using the recording list

1. Review the Recording Information

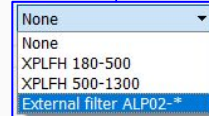
- Edit the enabled fields, if required
- ⚠ If a warning is found, consult the troubleshooting manual

2. Review the following information:

- Declination
- Dipole length
- The **Azimuth** at which the E and H sensors were laid out
- Use the External filter selector to indicate if an accessory was used during the recording. For details about each specific accessory, consult the manual of such accessory.
- The correct **Calibration** sensor will show a green mark

3. Review the information on **View Recording Details** (see next page)

4. To add more information (such as pictures, documents, etc.) click the **Attachments** button



The screenshot shows the 'Remote (24 h 3 m)' recording information interface. It includes a status bar (Approved, Unapproved, Rejected), tool tabs (Time Series, Spectra, Process), and a 'Recording Information' section with fields for ID, start time, duration, survey name, station name, operator, layout geometry, and declination. Below this is the 'Electric Channels' table, followed by 'Magnetic Channels' and an 'Attachments' button. Numbered callouts 1-4 point to the recording info, electric channels, recording details, and attachments buttons respectively.

Channel	(+) N / E	(-) S / W	Polarity	(+) N / E	(-) S / W	Gain	LPF [Hz]	DC [V]
E1	50.00	34.50	<input type="checkbox"/> Inverted	5335	3894.07	4 x 1 = x4	10000	-0.021
E2	50.00	49.00	<input type="checkbox"/> Inverted	3623.18	4096.92	4 x 1 = x4	10000	-0.021

Channel	Sensor	Detected	Serial #	Cal	Polarity	Gain	LPF [Hz]	DC [V]
H1	MTC-150	MTC-150	53731	<input checked="" type="checkbox"/>	<input type="checkbox"/> Inverted	x4	10000	-0.011
H2	MTC-150	MTC-150	53880	<input checked="" type="checkbox"/>	<input type="checkbox"/> Inverted	x4	10000	-0.029
H3				<input type="checkbox"/>	<input type="checkbox"/> Inverted	N/A	N/A	N/A

View Recording Details

Review that the following levels are within valid limits for quality control:

1. Battery Voltage
2. Internal Temperature
3. Number of Satellites
4. Saturated Frames

- If saturation is > 2%, review the channel gain, which might be too high and /or there might be an artificial noise source on the site

Firmware	Sat
0001001B	~0 % - View
0001001B	~0 % - View
0001001B	0 %
0001001B	0 %
0001001B	1.461 % - View

5. Time Series Level

Recording Details: 10205_2018-10-04-193809 - EMapower

<p>Recording Details</p> <p>Recording ID: 10205_2018-10-04-193809</p> <p>Survey Name: WA</p> <p>Station Name: Remote</p> <p>Company Name:</p> <p>Receiver Type: MTU-SC</p> <p>Instrument Serial: 10205</p> <p>Operator: EF&YA</p>	<p>Timing Details</p> <p>Start Time: Thu Oct 4 19:38:10 2018</p> <p>Stop Time: Sun Oct 7 23:52:14 2018</p> <p>Duration: 76 h 14 m 4 s</p> <p>Latitude: 46.1459°N</p> <p>Longitude: 122.783°W</p> <p>Altitude: 1136.11 m</p>
--	--

Instrument Info

OS Version: v1.27.1

Motherboard Model: BMB01-G

Motherboard Serial: 031987

Battery: Low: 12.192 V, High: 12.88 V Details

Temperature: Low: 17°C, High: 21°C Details

Battery Voltage - EMapower

Internal Temperature - EMapower

Number of Satellites - EMapower

Saturated Frames - E1 - EMapower

Decimation
Recorded 2 seconds at 24000 samples/s every 30 seconds, and continuously at 150 samples/s

GPS Timing Card

Serial Number: 201288 Firmware Version: 00010029X

Model: BTM01-1 # of Satellites: 6 - 15 satellites Details

Channels Details

Tag	Board S/N	Model	Firmware	Sat	Signal Ranges
1	E1	201070	BCM01-I	1001c	~0 % - View View Levels
2	E2	201074	BCM01-I	1001c	0.001 % - View View Levels
3	H1				View Levels
4	H2				View Levels

Time Series Level - E1 - EMapower

Software Recommendations

- Use Field QC for ultra-fast quality control in the field (no need to transfer data, response in seconds)
- Do not copy data to your computer, instead create a project where you want the data, and import the data into the project from the card
- Use parallel tasks
 - Import data in parallel
 - Process several sites in parallel
- When editing, prefer starting with robust and only clear details manually after



Best Practices

- Do not push the SD/screen button when instrument is detecting sensors (top LED flash blue, bottom solid blue)
- Prevent connector caps from touching the electric binding posts in the receiver, this can introduce wide-band noise
- Note that the electric binding post order is different from MTU-5A
- GPS antenna stores nicely in the pocket!
- Always close the SD card door (to keep sand and water away)
- Use bag flap as sun shade and water protection



Please check out the [FAQs](#)

<https://phoenixgeophysics.freshdesk.com/>

Or email us at: support@phoenix-geophysics.com