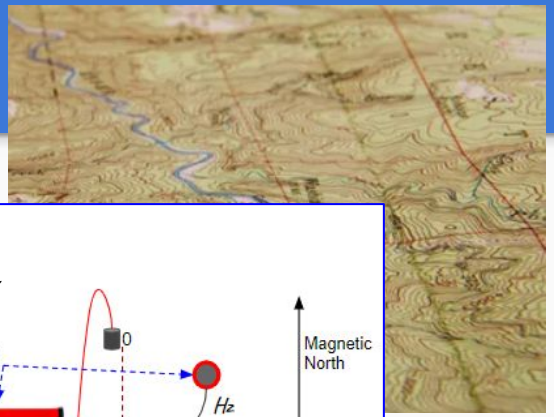
Guide For MT Field Operations

Version: 231214 ID: DAA22

Prepare a MT survey



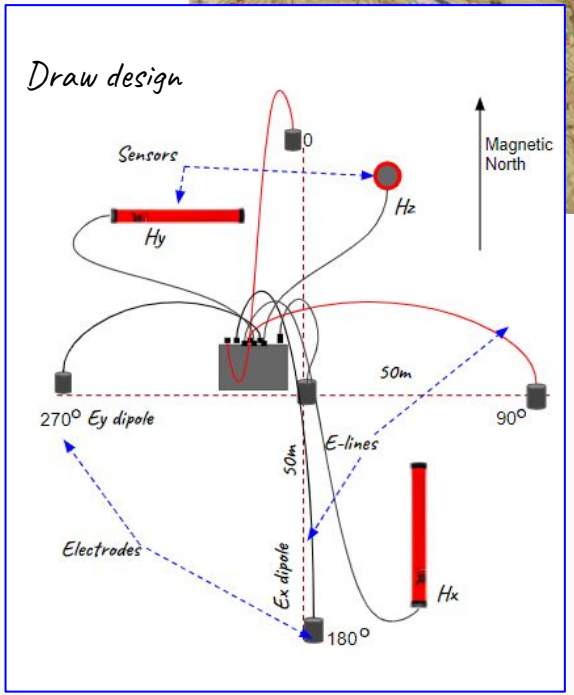
1. Choose the Sites Location
- Define the survey design *(2D, 3D, detailed, regional)*, the sites location, and the remote reference location, as needed
- Prefer to have the survey lines perpendicular to the anomaly direction or the geological strike direction
- Obtain permission to conduct the work on the sites
- Avoid as much as possible
  - Hikers trails
  - Industrial or transport activity
  - Power lines or electric fences

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

3. Prepare the equipment
- Calibrate receivers and sensors
- Run overnight Parallel Noise Test *(recommended)*
- Prepare all E-lines to the desired length and connect each E-line to an electrode *(always keep extra wire)*

4. Determine the North reference that will be used for the sites layout
- True North or Magnetic North

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



Protect the equipment from wildlife, livestock, and vegetation to prevent disturbances during recording, including noise induced by micro-vibrations caused by windy conditions.

Equipment and Tools

Required Equipment	
Layout Sheet	
Laptop *(with an SD card slot or USB card reader)*	
EMpower + License	
SD cards, each with a configuration file for each operation	Sensor Calibration
	Receiver Calibration
	Desired type of data recording (Orthogonal or Parallel)
Receiver	
12V Battery and power cable	
Antenna and GPS Cable	
Magnetic Sensors and cables	
Electrodes	
E-line cables	

Tools & Supplies	
Shovel	Pencil and permanent marker
Container of salt water (50 g/L)	Bubble Level
Handheld compass	Wire cutters
Measuring tape	Electrical tape and Flagging tape
Multimeters (Analog and digital)	Tarp

Check and test all the equipment before going to the field

Calibration - Config Files

To ensure accurate measurements, start by performing calibrations on the Receiver and Sensors. Calibration verifies the working condition of the equipment, enhancing the quality of records and the reliability of measurements. It is important to repeat the calibration process at every survey.

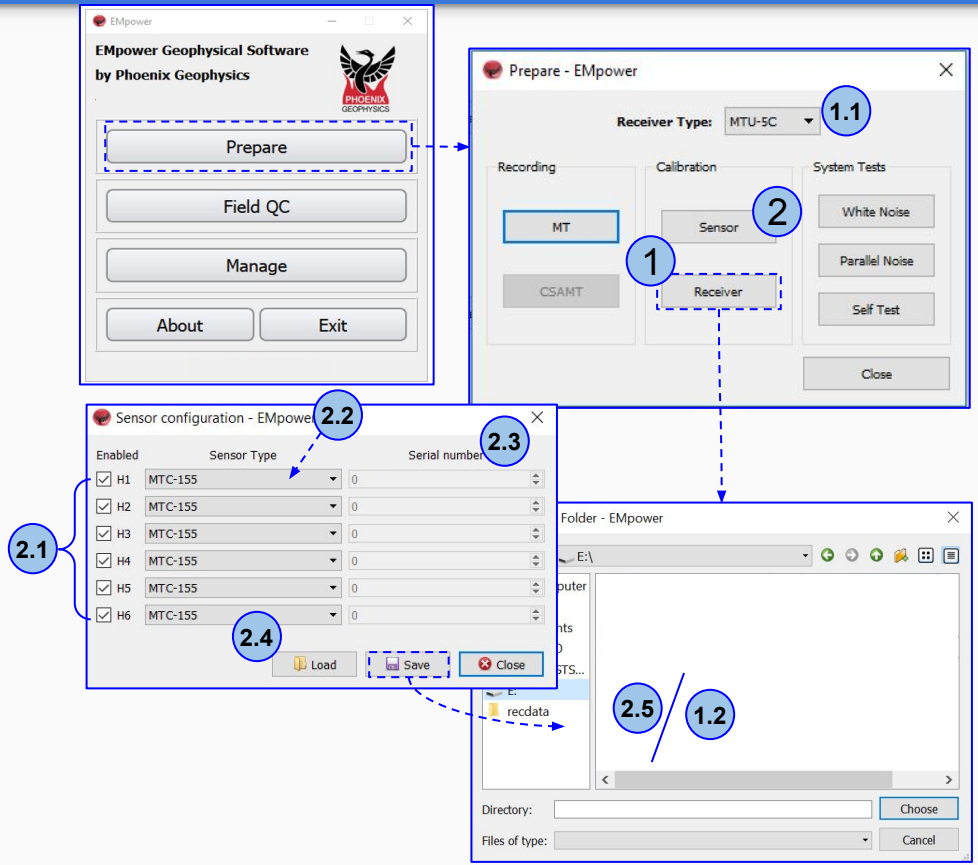
Open **EMpower** and select the **Prepare** module

1. Receiver *(Receiver Cal SD card)*

- **1.1.** Select the **Receiver Type and** click the **Receiver** button
- **1.2.** Save the configuration file *(config.json)* in the root folder of the SD card *(see next page)*

2. Sensor *(Sensor Cal SD card)*

- **2.1.** Click the Sensor button and choose the magnetic channels that will be used
- **2.2.** Select the **Sensor Type**
- **2.3.** Type the **Serial number**, *(not needed for MTC-155/MTC-185 sensors)*
- **2.4.** Or **Load** it from a previous config file
- **2.5.** Save the configuration file *(config.json)* in the SD card *(see next page)*



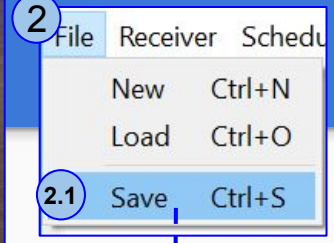
Saving the Config File

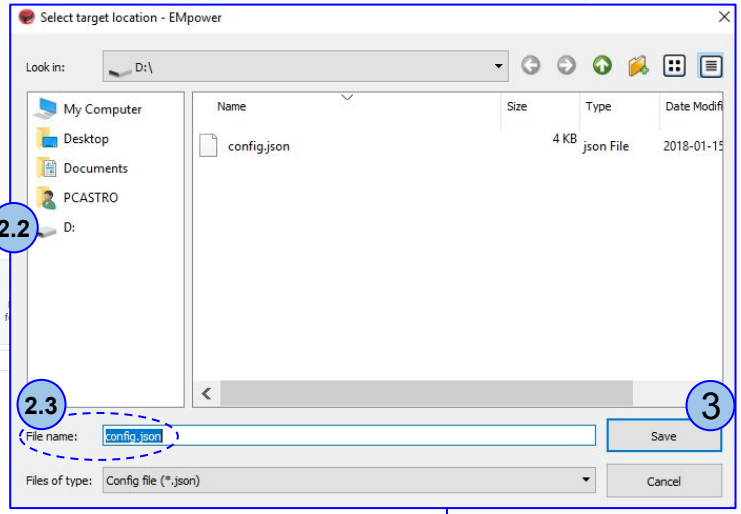
1. Insert the SD Card
- 1.1. The computer must be equipped with an SD card slot
- 1.2. Or use a USB card reader

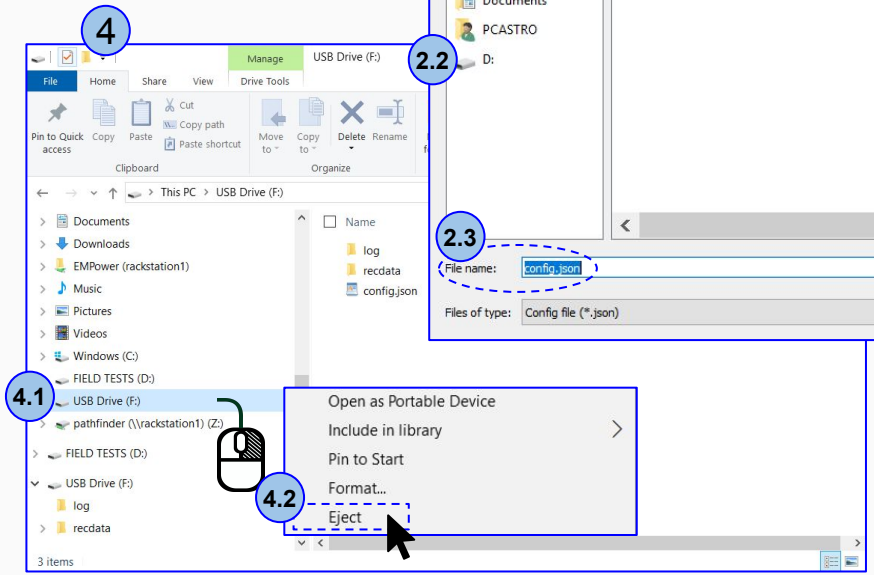
2. Click the **File** menu
- 2.1. Save or Ctrl+S
- 2.2. Select the SD card
- 2.3. EMpower will automatically create the file **“config.json”**

3. Save the configuration file *(**config.json**)* in the root folder of the SD card

4. Open the file explorer
- 4.1. Right click SD card drive
- 4.2. Select **Eject** option
- 4.3. Pull out the SD Card



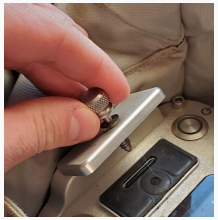




Receiver Calibration

1. Insert the SD Card with a valid Receiver calibration config file into the receiver
2. Turn on the Receiver
   - Wait until both LEDs buttons turn solid blue
3. Start the Calibration Recording by quickly pressing and releasing the power button
   - The calibration process should take place at the beginning of every survey
   - Allow the calibration to finish on its own, the LED's will return to "Ready" state
4. Press the power button to turn off the receiver and release it when the LED indicator flashes red.

1



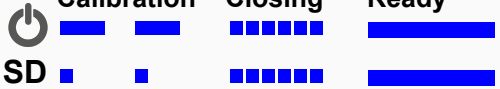
Indicators

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

2 **Turn on the receiver**

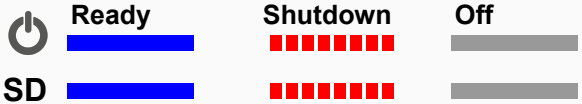
**For any problem with the SD Card, check the Troubleshooting manual*

3 **Calibration Recording**

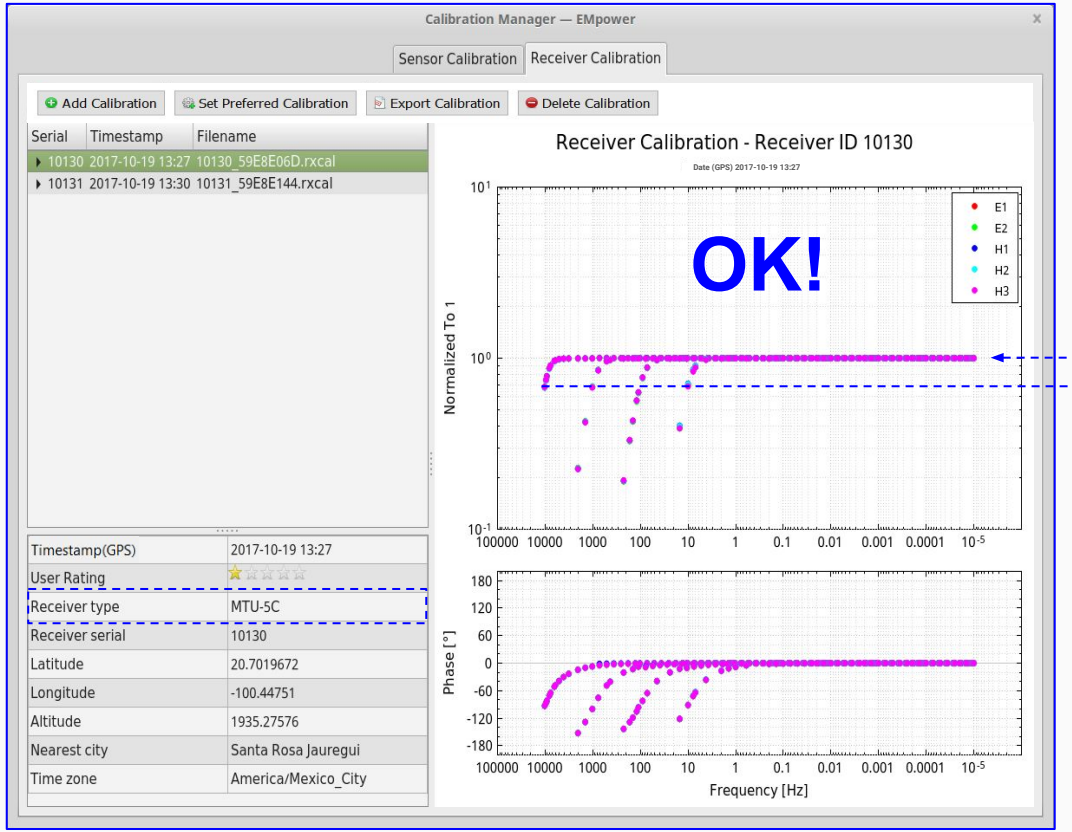


**Use EMpower (Field QC module) to view and quality control the calibration*

4 Keep pressing the power button 3 sec and release



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

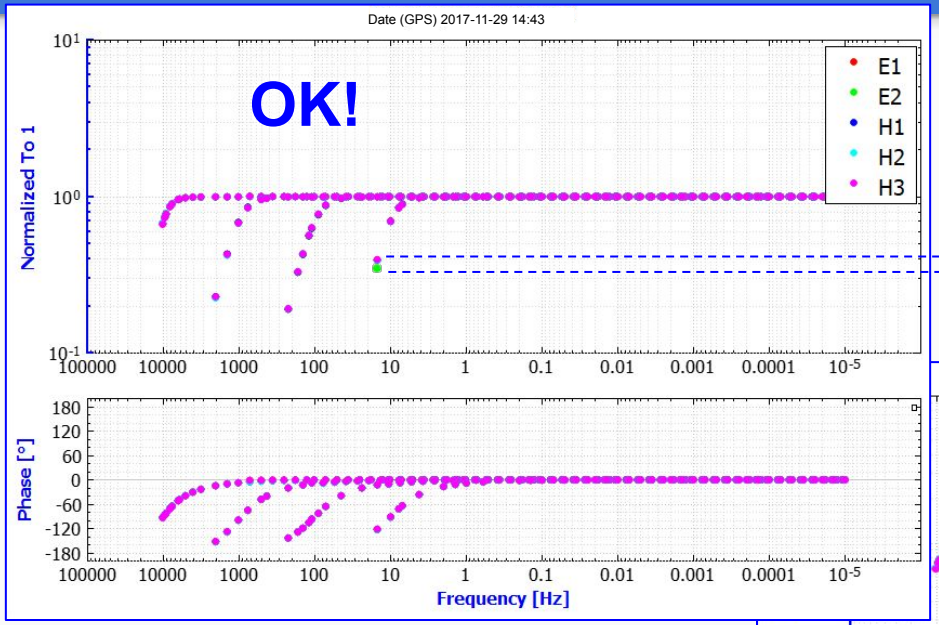


Horizontal level = 1
(or 10^0)
→ OK

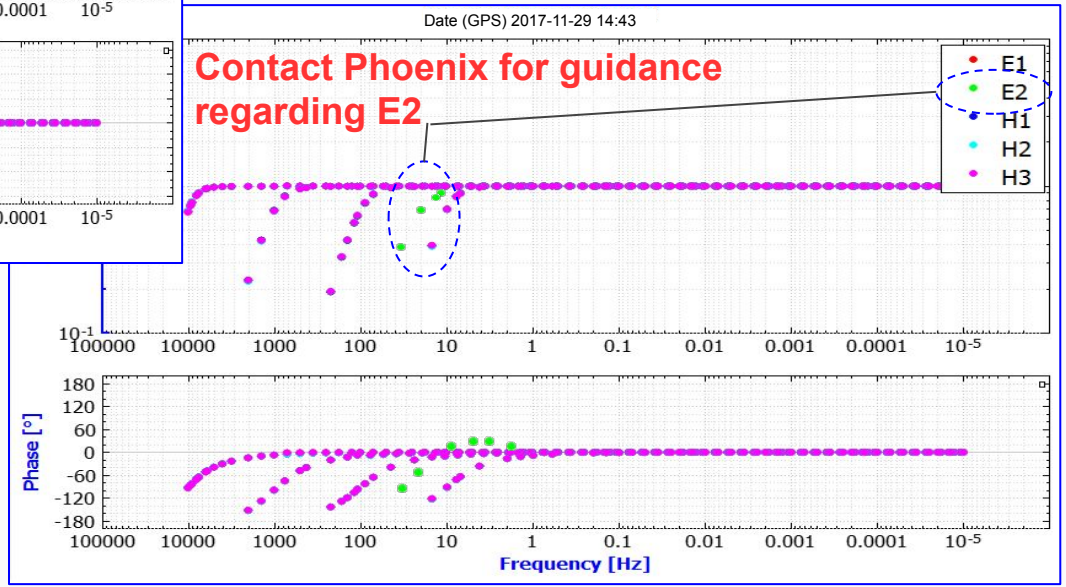
Cut off
value ~ 0.7
@ 10kHz
@ 1KHz
@ 100Hz
@ 10Hz
→ OK

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

Receiver calibration QC - Variations



Small variations out of the flat part → OK



Sensors Calibration

Ensure the model and serial numbers match the connected sensor. Any discrepancies, including a sensor not being connected, may stop the calibration routine *(consult the Troubleshooting manual)*

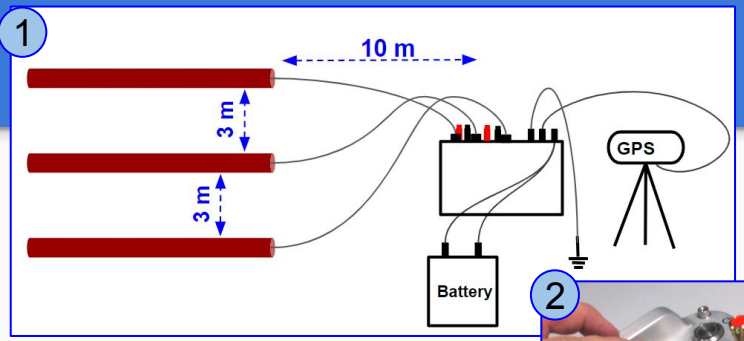
1. Connect the sensors
- Perform the calibration process outdoors and away from noise for accurate results
- For best results, especially in windy conditions, it is recommended to bury the sensors during calibration

2. Insert the SD Card
- If the type is incorrect in the configuration file, the receiver will display a warning message.

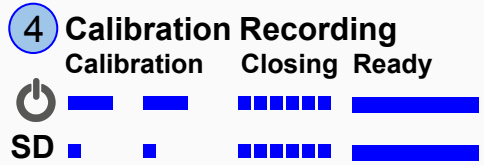
3. Turn on the Receiver
- Wait until both LEDs buttons turn solid blue *(Ready)*

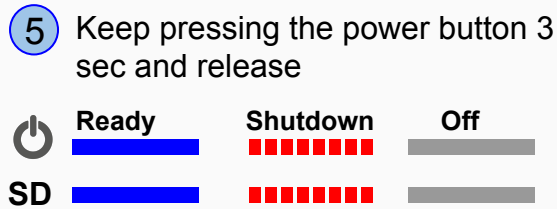
4. Start the Calibration Recording by clicking the power button
- The calibration process should take place at the beginning of every survey
- Allow the calibration to finish on its own, the receiver LEDs will go back to the 'Ready' state

5. Turn off the Receiver

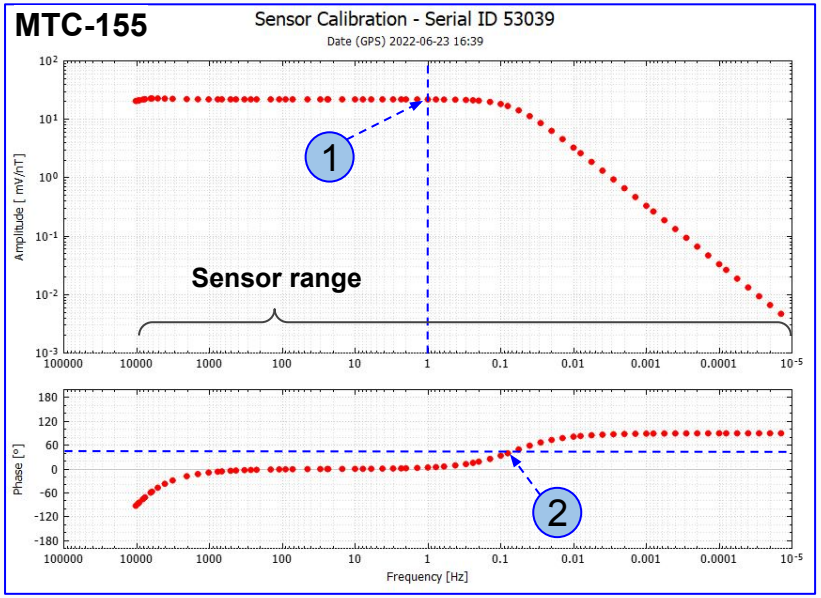


**Use EMpower (Field QC module) to view and quality control the calibration*



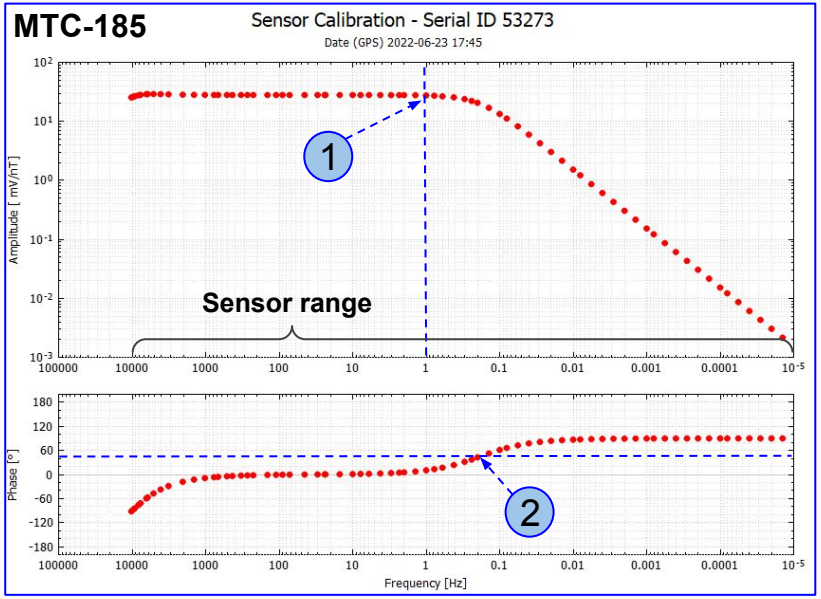


MTC-155 / MTC-185 Sensor calibration QC



1. For MTC-155, the values should be between 25-30 mV/nT for frequencies higher than the corner frequency

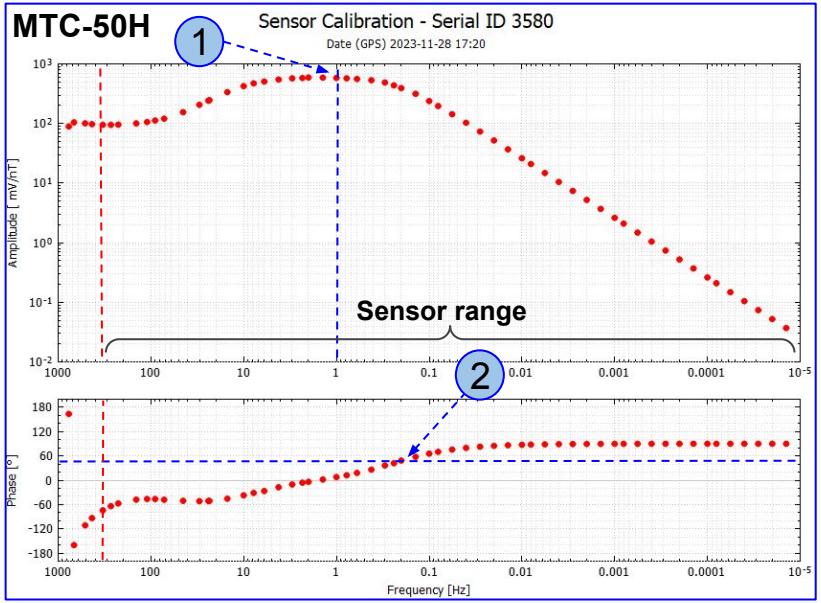
2. For MTC-155, the corner frequency is ~0.07 Hz *(Value at 45 degrees phase)*



1. For MTC-185, the values should be between 25-30 mV/nT for frequencies higher than the corner frequency

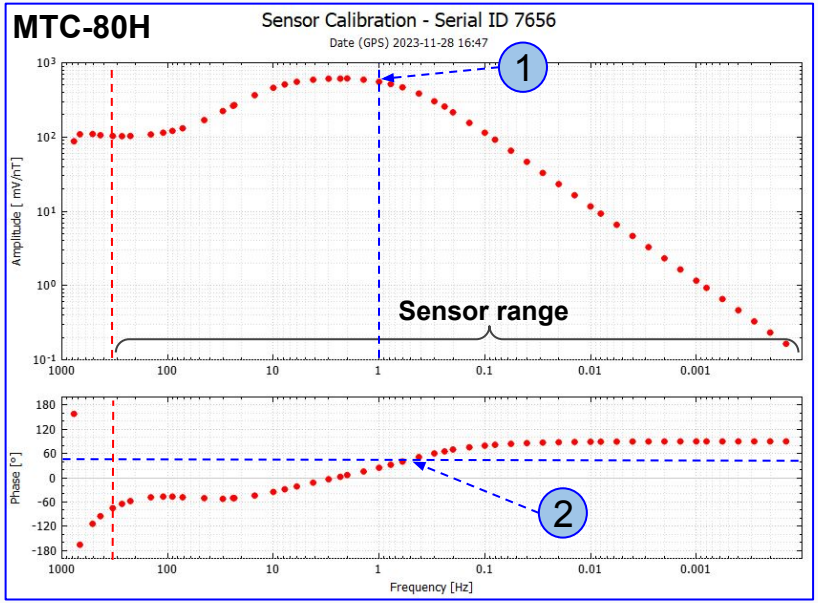
2. For MTC-185, the corner frequency is ~0.12 Hz *(Value at 45 degrees phase)*

MTC-50H / MTC-80H Sensor Calibration QC



1. For MTC-50H, the values should be ~580 mV/nT for frequencies higher than the corner frequency

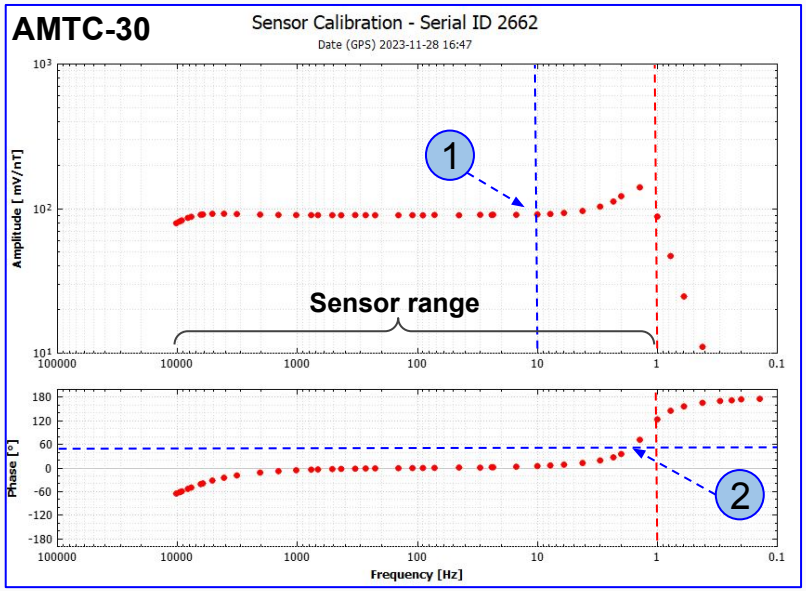
2. For MTC-50H, the corner frequency is ~0.22 Hz
   (Value at 45 degrees phase)



1. For MTC-80H, the values should be ~580 mV/nT for frequencies higher than the corner frequency

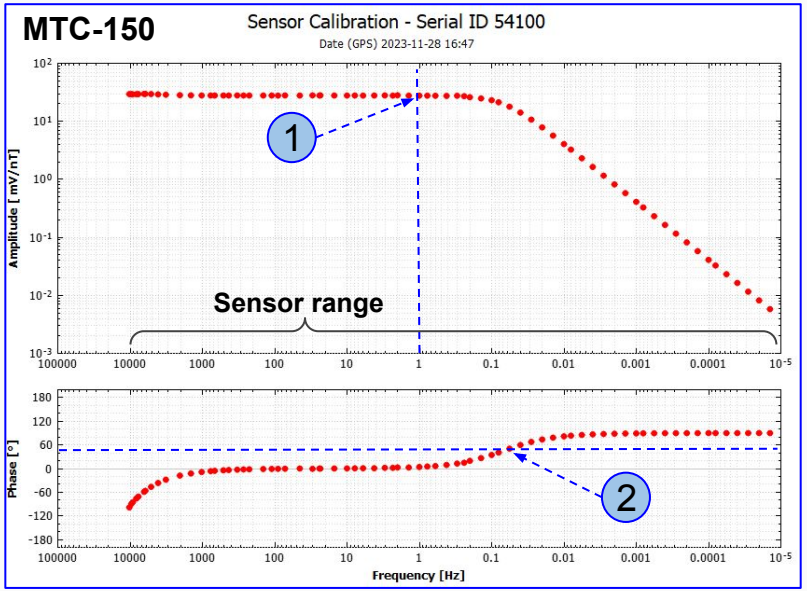
2. For MTC-80H, the corner frequency is ~0.51 Hz
   (Value at 45 degrees phase)

AMTC-30 / MTC-150 Sensor Calibration QC



1. For AMTC-30, the values should be ~91 mV/nT for frequencies higher than the corner frequency

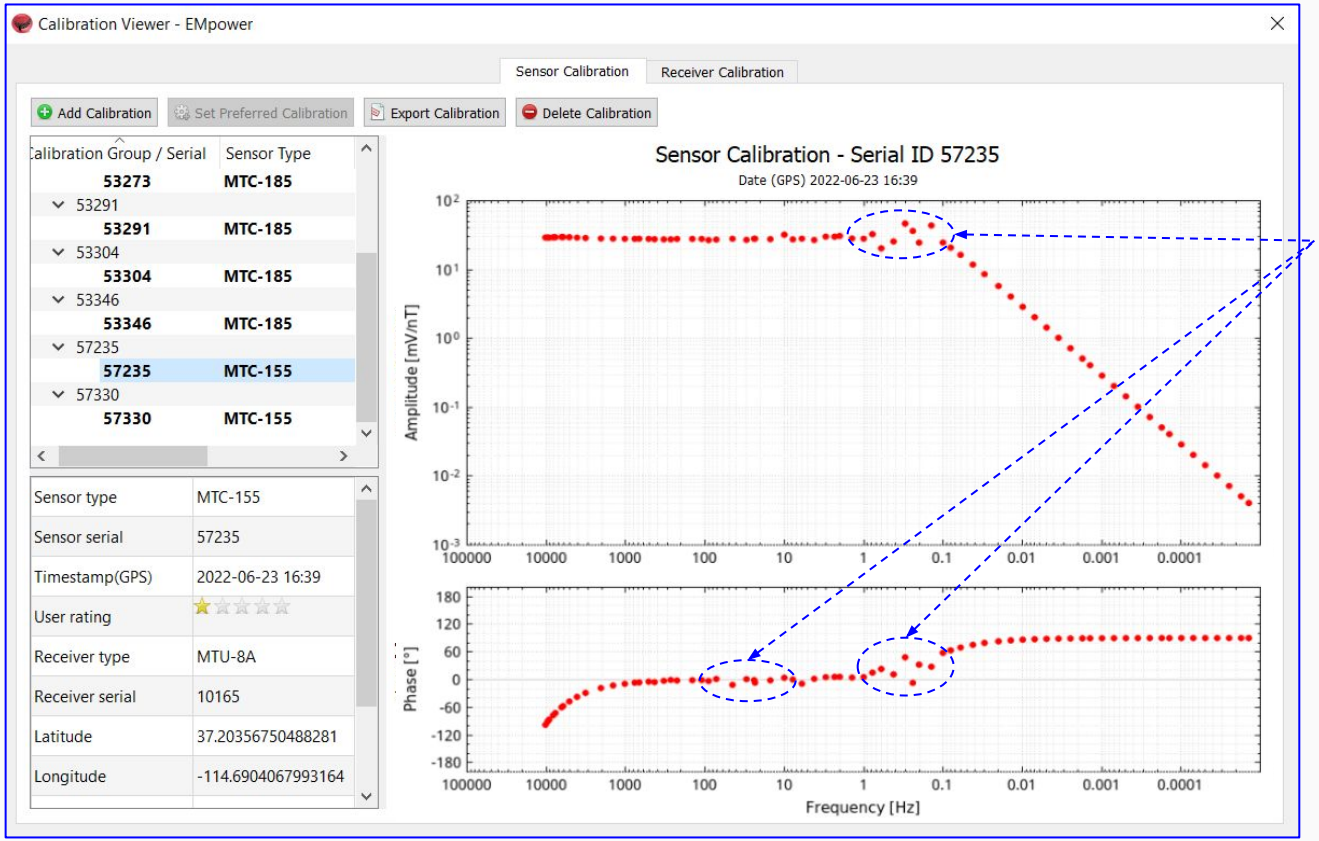
2. For AMTC-30, the corner frequency is ~1.8 Hz *(Value at 45 degrees phase)*



1. For MTC-150, the values should be between 25-30 mV/nT for frequencies higher than the corner frequency

2. For MTC-150, the corner frequency is ~0.07 Hz *(Value at 45 degrees phase)*

Sensor calibration QC - Noise

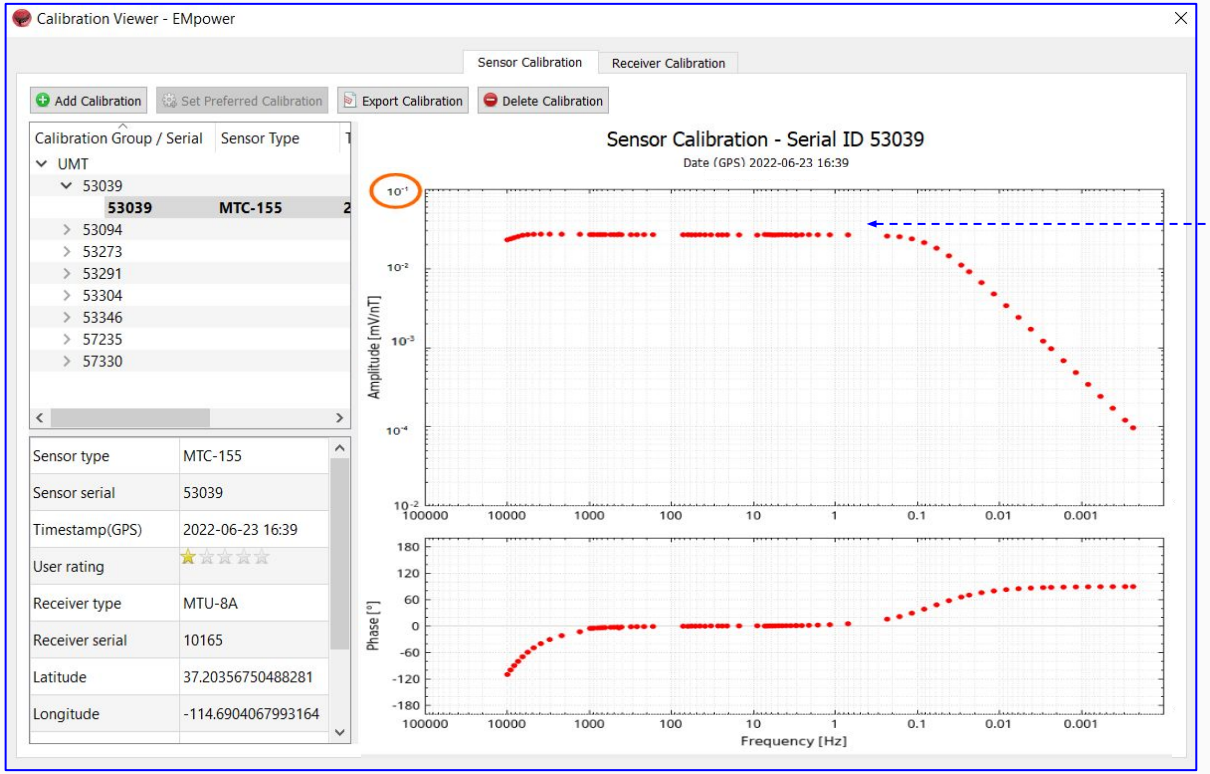


Curves somehow good, but show noise “ringing” around 50/60Hz or at low frequencies

Sensor might be OK, and it could be cultural noise.

1. Ensure the sensors are set in a noise free environment.
2. Repeat the calibration
3. If the calibration still fails, verify the coil, the coil cable, and the magnetic channel.

Sensor calibration QC - Bad curve



In this example the amplitude is under the expected range of the sensor *(see page 10-12)*, or produces odd calibration plots

1. Repeat the calibration.
2. If the calibration still fails, verify the coil, the coil cable, and the magnetic channel.

Configuration Creator

1. Click **Prepare** and select the **Receiver type** and click the **MT** button

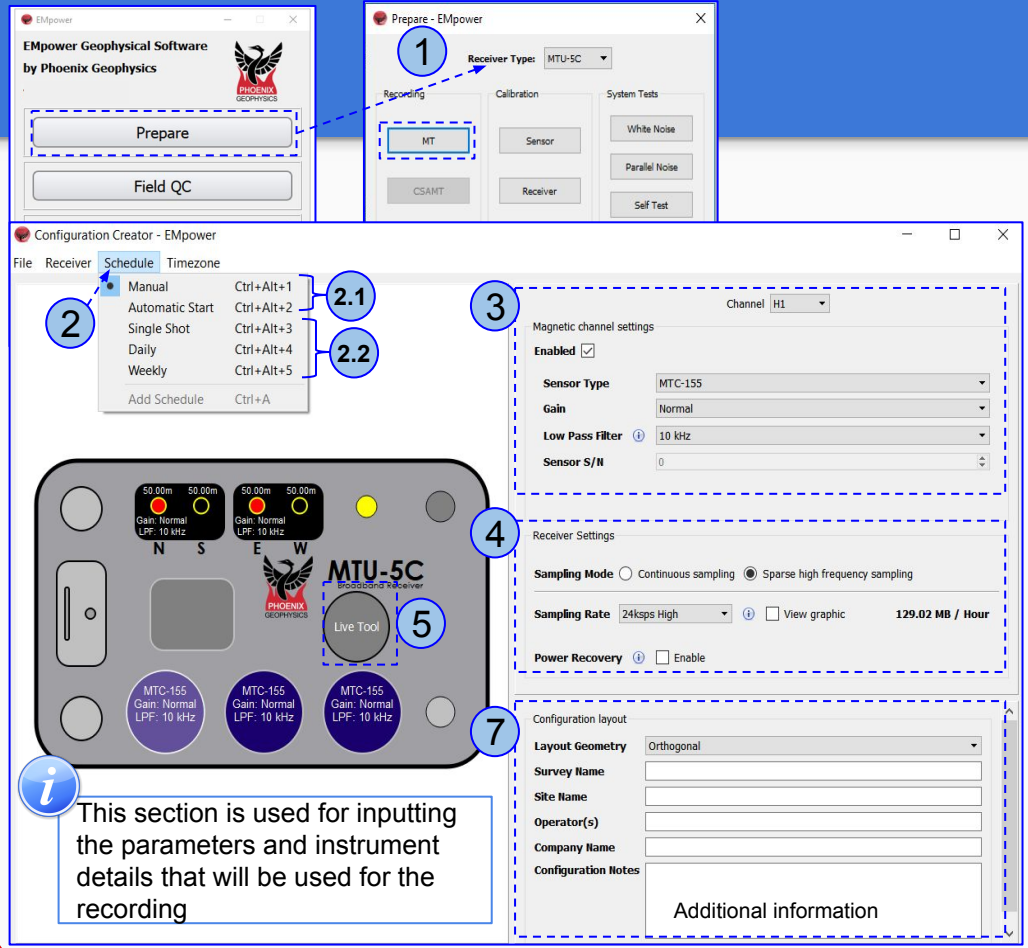
2. Select the **Schedule**
   - **2.1. Manual** or **Automatic Start**
   - **2.2.** For a specific schedule, select **Single Shot**, **Daily** or **Weekly**, and set the desired time and date, and **Save**
     - To add additional schedules, click on **Add Schedule** and define the specific time and/or date

3. Define the **Channels Settings**

4. Define the **Receiver Settings**
   - **Sampling Mode**
   - **Sampling Rate**
   - **Power Recovery,** receiver will power off when the battery connected gets too low *(see the Power Recovery (DAA35) manual)*

5. **Ethernet port** *(see the Networking Settings manual)*

6. **Configuration Layout**



To use the magnetic sensor data from a different recording or use a remote reference, all recordings **must** have a matching Sampling Mode and Sampling Rates. Otherwise, EMpower will not allow to process data using borrowed channels or remote reference

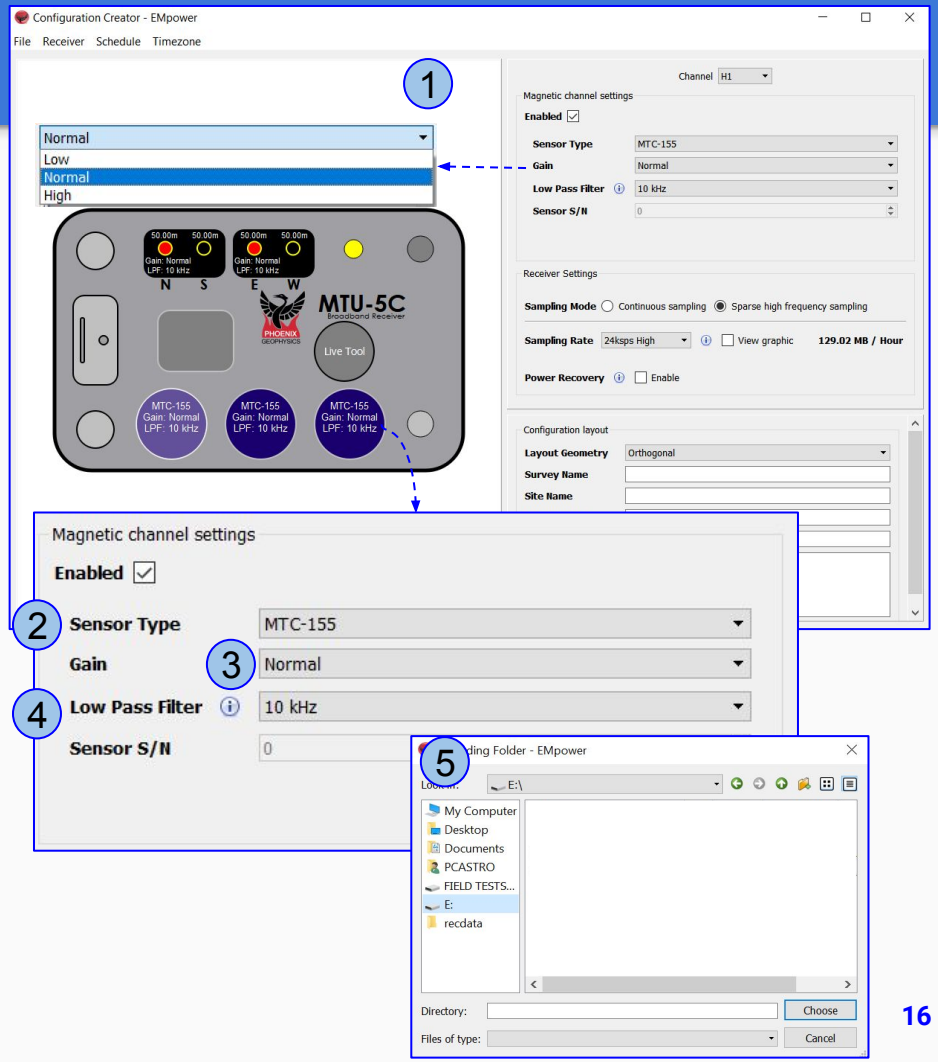
Configuration, gains and LPF

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 a last resort

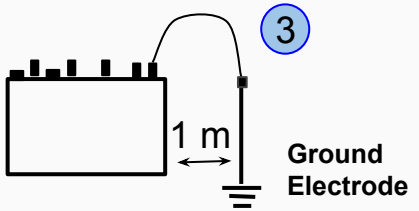
Magnetic Channels

2. Select the correct sensor type to avoid over-voltage issues
3. With MTC-155, prefer Gain “**Normal**” in most cases
   - The new generation (MTC-155 / MTC-185) has a serial/model number auto-detection feature
4. Set the LPF which is compatible with the sensor frequency range
5. Save the config file *(see Saving the Config File)*



Equipment Layout

1. Ensure the right location as defined for the recording site
   - Use a handheld GPS device to accurately determine the site location
2. Select an open and dry spot as the center for the site layout
   - Avoid noise sources and try to find a location within the survey area with minimal non-coherent noise
3. Choose the center spot for the ground electrode, ensuring it is less than 1 meter away from the receiver

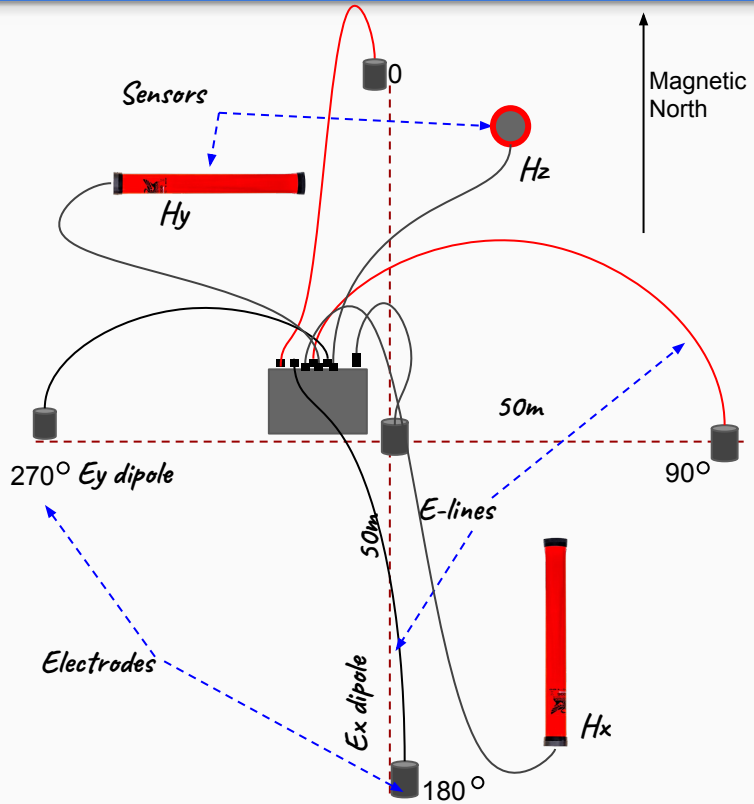


Setting up MT Survey site(s)

After completing the calibrations and ensuring the equipment is in the correct state.

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 amplifies the signal input to the receiver, and helps to overcome the internal noise of the receiver. This is beneficial for very small signal amplitudes. However, caution must be exercised as longer dipole lengths also amplify noise from nearby sources like 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
   - Putting the sensor in the wrong direction will result in a reverse polarity (for more details see DAA15 manual)

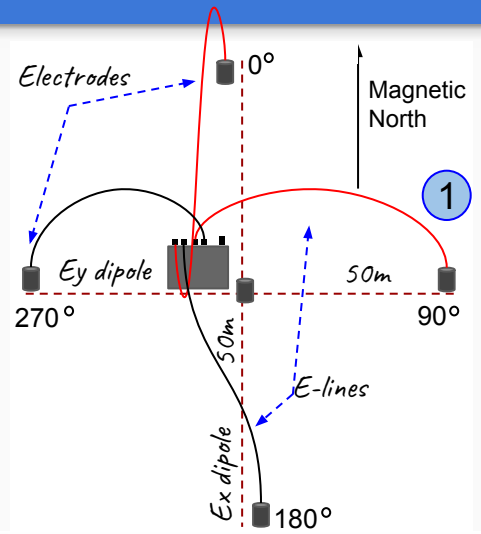
Use the same steps to setup the Remote Reference and Survey site(s)

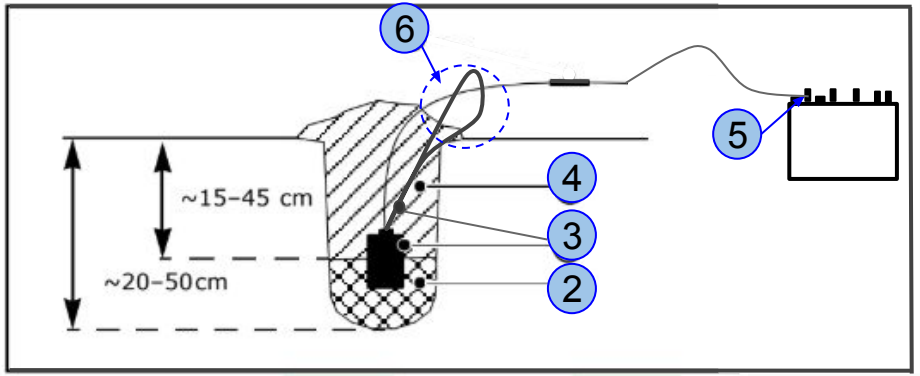


For any layout error on the E-lines or on the Sensors installation *(See Troubleshooting manual)*

Electric Channel

1. Register the electrode number and /or cable number
2. Dig a small hole about 20-50 cm deep, ensuring to remove any large rocks
   - Loosen the dirt at the bottom of the hole
   - Pour in at least 1 liter of saltwater
   - Mix saltwater with the dirt until a uniform mud is formed
3. Place the electrode upright in the hole
   - Rotate the electrode back and forth to firmly position it in the mud
   - Ensure that the electrode cable and rope remain outside the hole as show in number **6** in the graphic
4. Cover the electrode completely with the loose dirt
5. Connect E-lines to the receiver





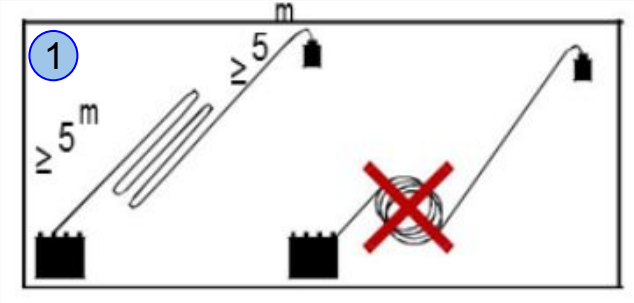
Best practices

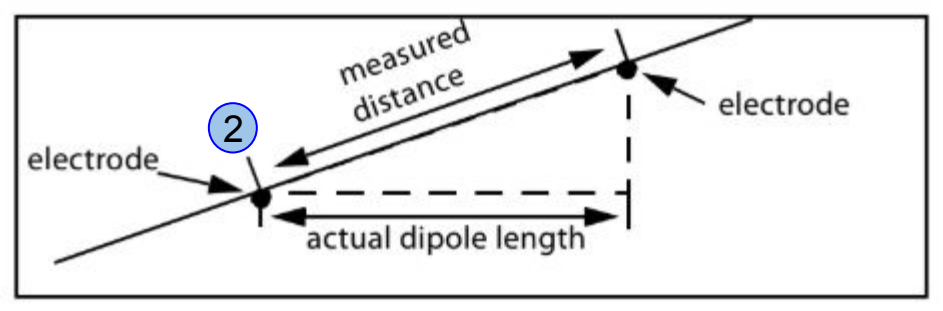
1. Excess cable:

- 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 (Hx / Hy)** 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 **Hx** points North ***(connector must points south)***

2.2. The free end of **Hy** points East ***(connector must points west)***

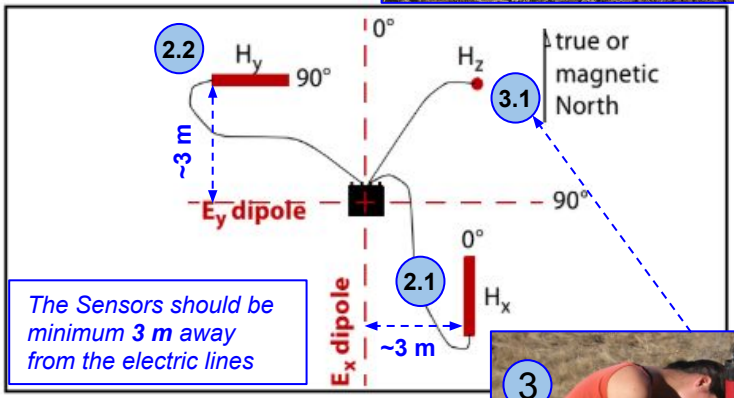
**Properly align and level each sensor using a compass and a level. Once done, cautiously cover the sensors with loose soil*

3. **Vertical (Hz)**

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.



Protect the equipment from wild animals, livestock, and even from vegetation (windy conditions can induce micro-vibrations that will add noise to the recording)

Checklist

1. Battery 12V
- Red (+) positive and Black (-) negative
- Fit the slotted connector *(to the receiver's connector)*

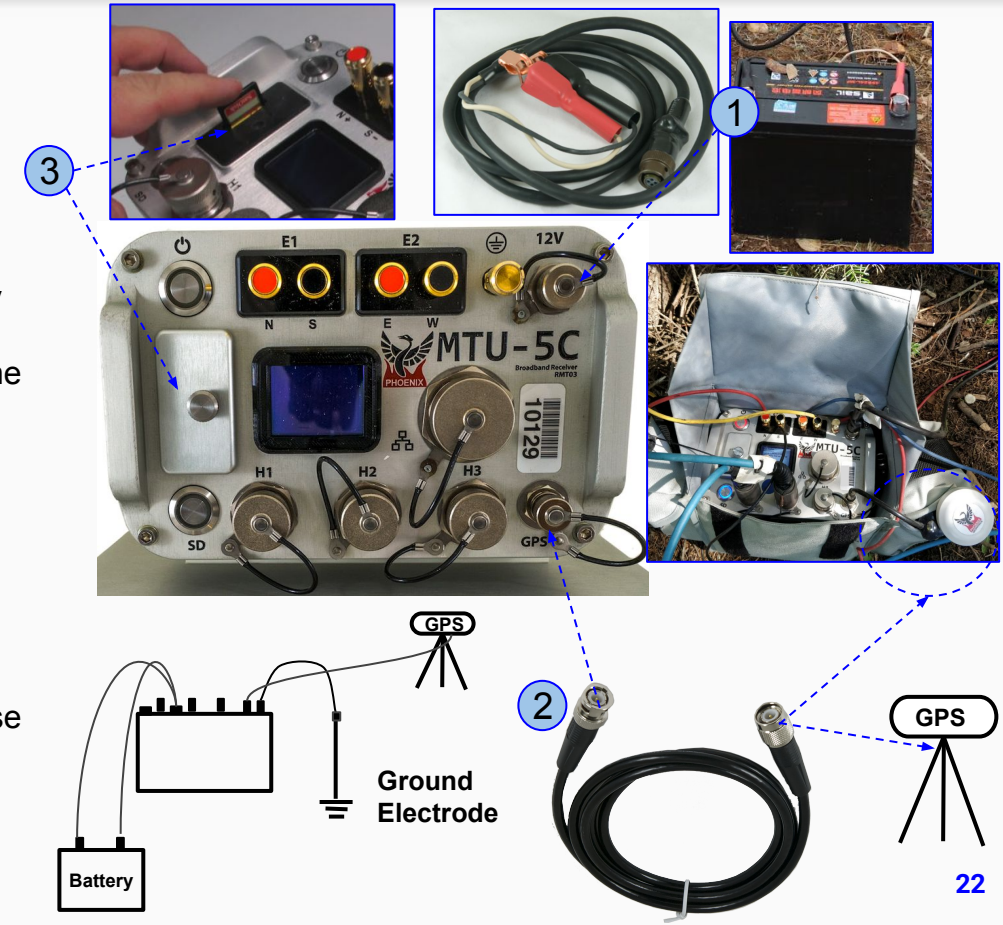
2. GPS antenna
- Connect the GPS
- Keep the GPS antenna in the receiver bag, in case the reception is not good use the antenna tripod, if necessary tape the antenna tripod to a stake, post, or large tripod
- Ensure clear sight-lines between the GPS antenna and the sky

3. Measure electric line voltage

4. Orient both electric line and sensors
- Take note of terrain incline if >20 degrees

5. Keep cables flat on the ground
- Not draped over plants or obstacles
- Bury or weigh the cables if necessary to reduce wind noise

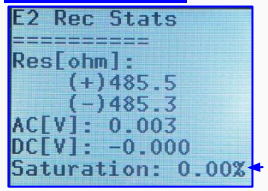
6. Run a test Recording *(see next page)*



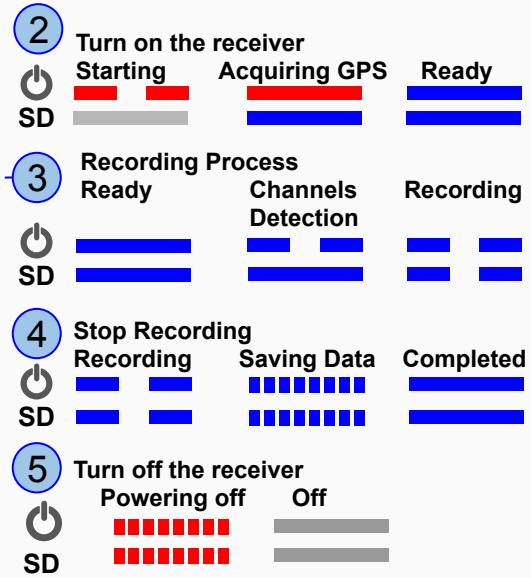
Start Recording

1. Insert the **SD Card** and close the lid
2. Turn on the **receiver**
   - For the new sensor, the receiver will detect the model and serial number. View the information on the receiver screen right after right after power on.
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

Receiver Screen



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



Open the recording

The layout and recording information can be consulted and edited. Use the **Field QC** module for ultra-fast quality control in the field *(no need to transfer data, response in seconds)*

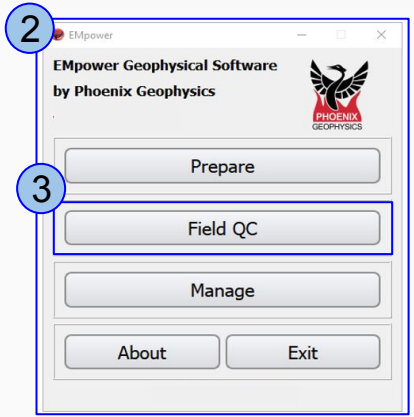
1. Insert the SD Card in the computer

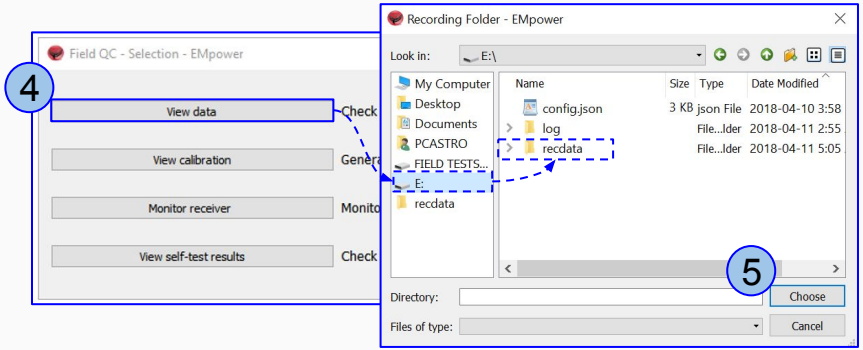
2. Open **EMpower**

3. Click the **Field QC** button

4. Select **View data**
- Select the SD card
- Open **recdata** folder and select the desired recording folder

5. Click **Choose**
- Review the recording information





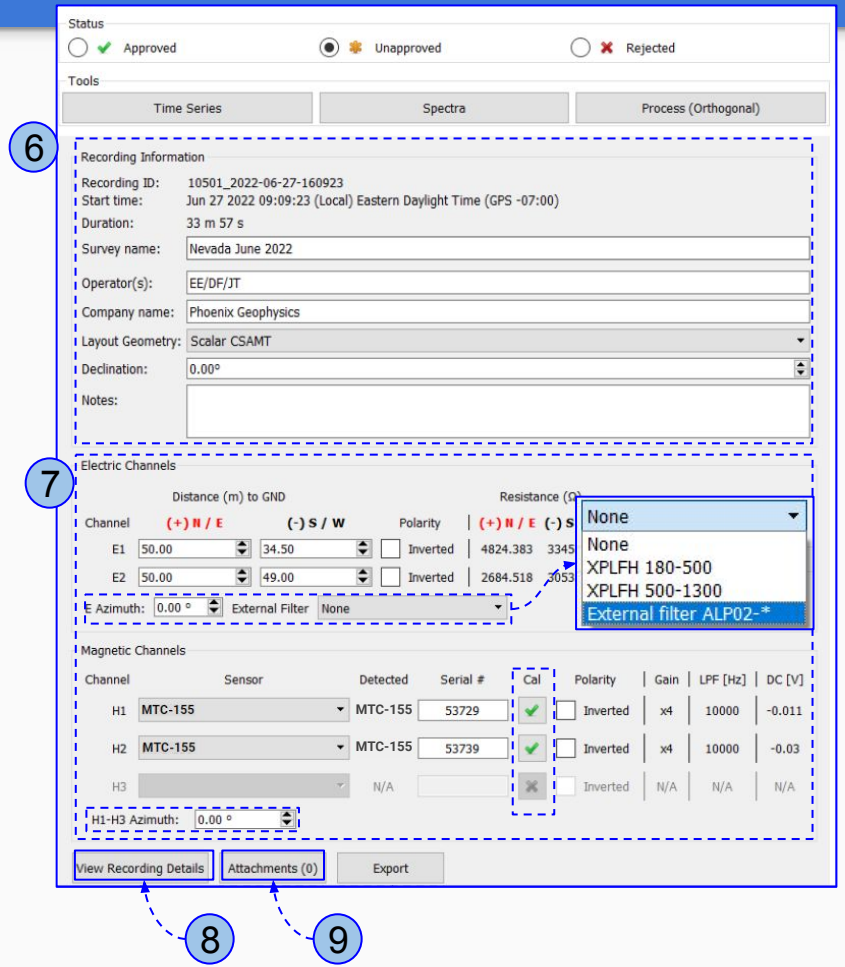
Verifying/Editing Recording Information

6. Review the Recording Information
- Edit the enabled fields, if required
- ⚠ If a warning is found, consult the troubleshooting manual

7. 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

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

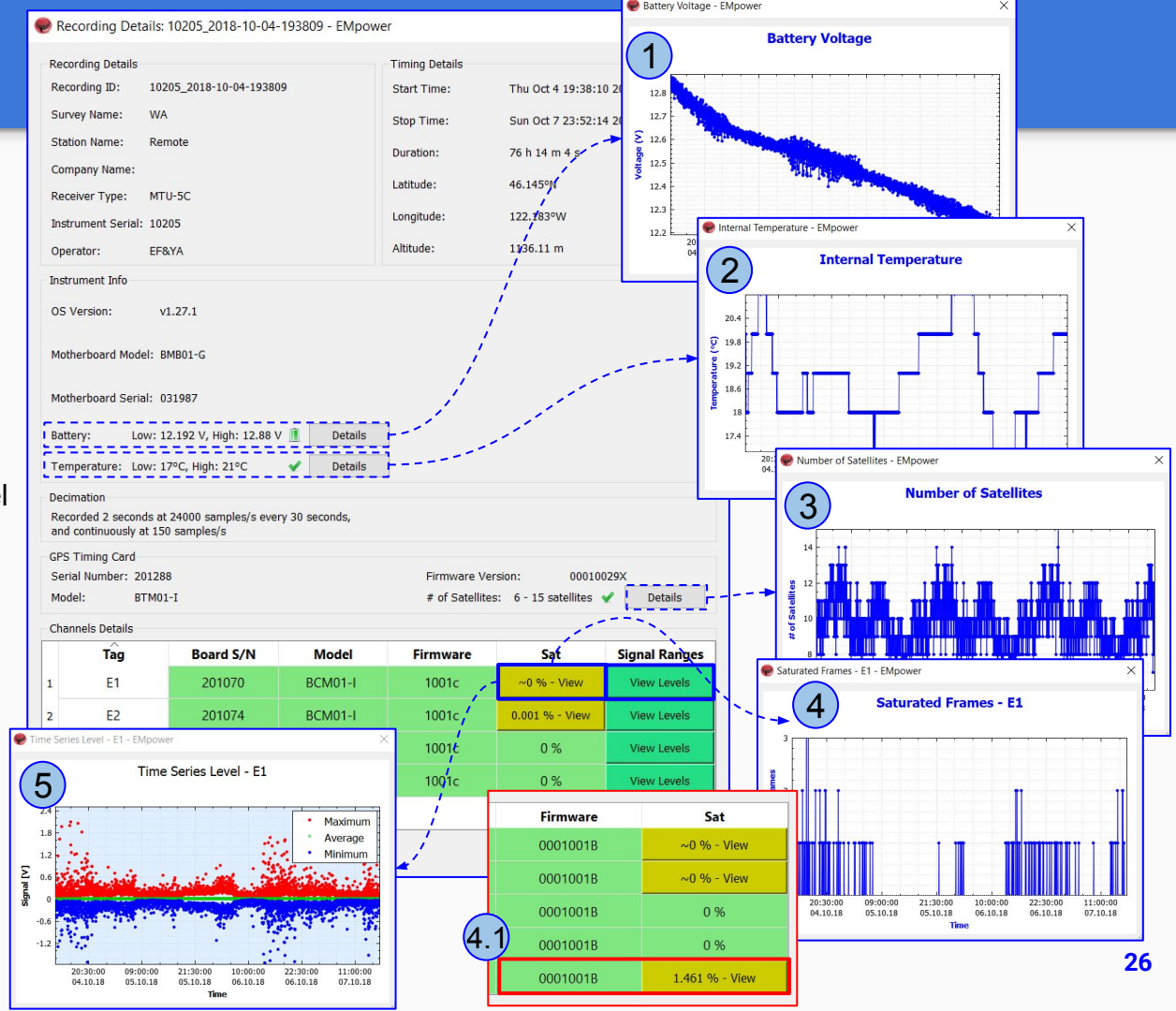
9. To add more information *(such as pictures, documents, etc.)* click the **Attachments** button



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**
   - **4.1.** 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
5. **Time Series Level**



Best Practices

- Do not push the SD/screen button when the 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*