Guide For MT Field Operations

PHOENIX GEOPHYSICS

Version: 220412 ID: DAA22

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

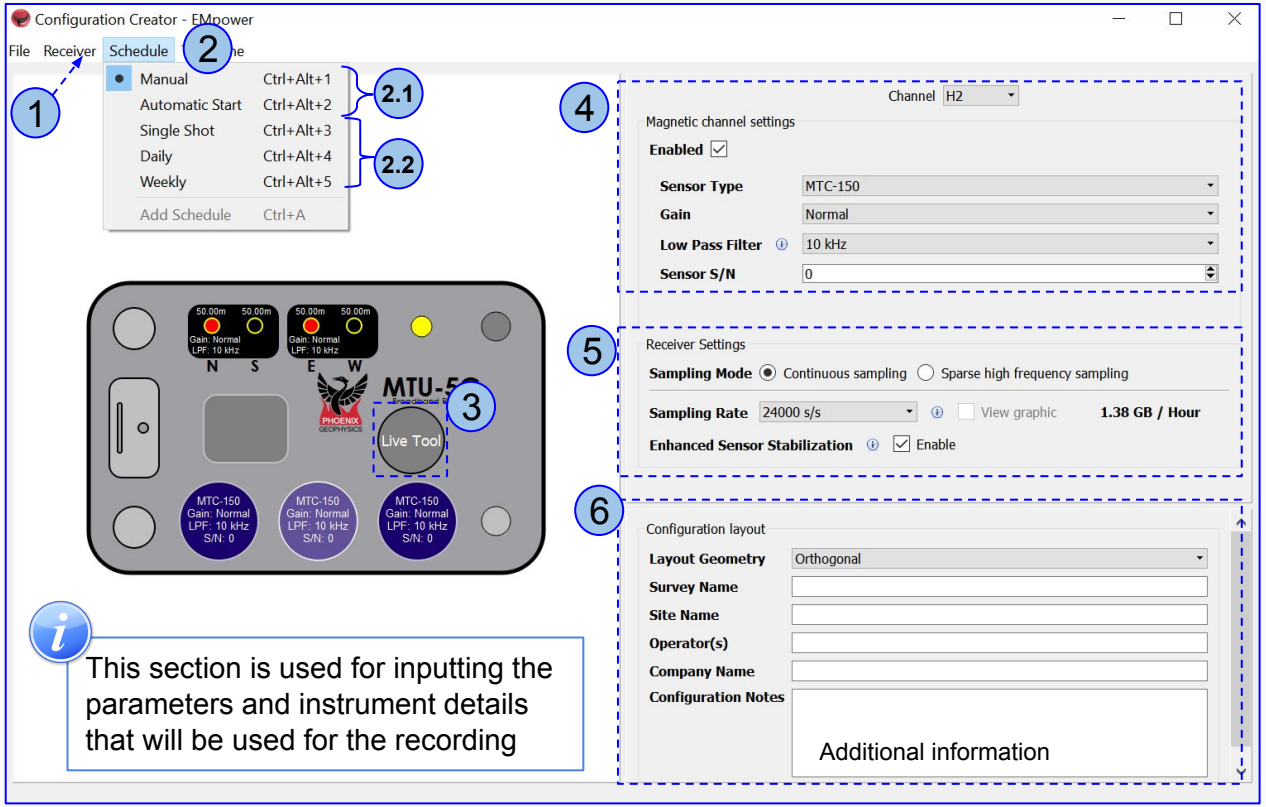
5. Determine the Declination of the survey area *(to be used for data processing)*

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



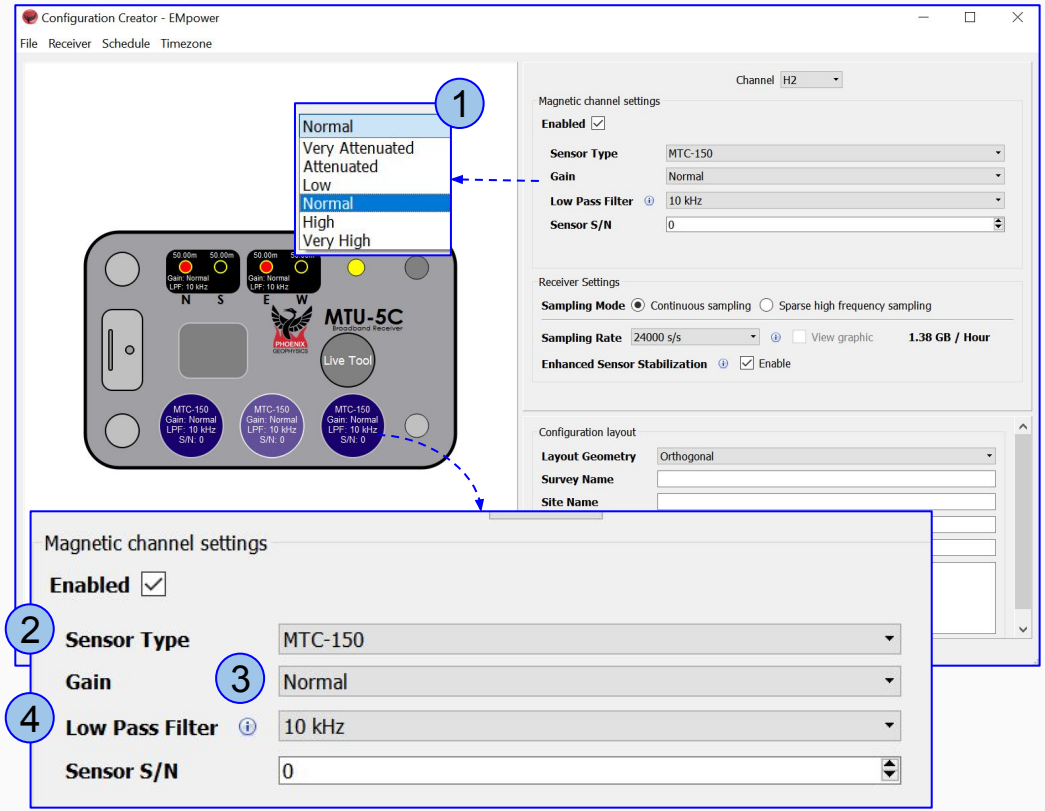
Configuration, gains and LPF

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



Equipment and Tools

Equipment

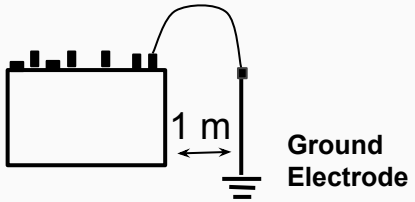
1. Configuration Layout Sheet
2. Laptop
3. EMpower + License
4. SD Card with config file for each operation
   - Sensor Calibration
   - Receiver Calibration
   - Desired type of data recording *(Orthogonal or Parallel)*
5. Receiver
6. 12 V Battery
7. Power Cable and GPS Cable
8. Antenna
9. Magnetic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



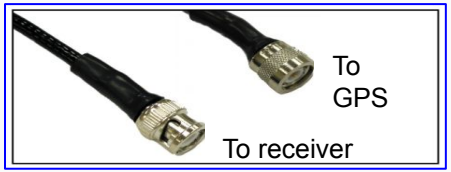
Connecting GPS / Battery

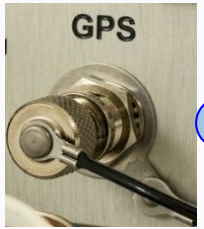
5. Battery

- 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

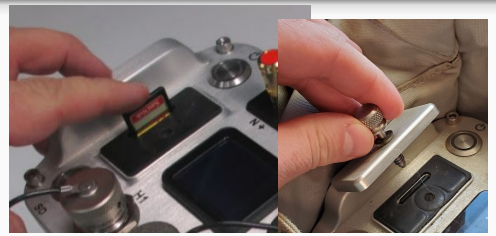
7. Insert the SD Card with a valid Receiver calibration config file into the receiver
8. Turn on the Receiver
9. Start the Calibration Recording
   - The calibration process should take place at the beginning of every survey
   - Allow the calibration to finish on its own, the LED's will return to "Ready"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

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

Indicators

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

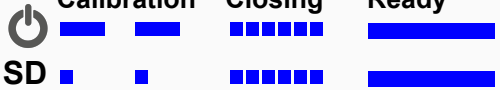
7



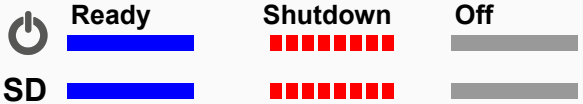
8 **Turn on the receiver**

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

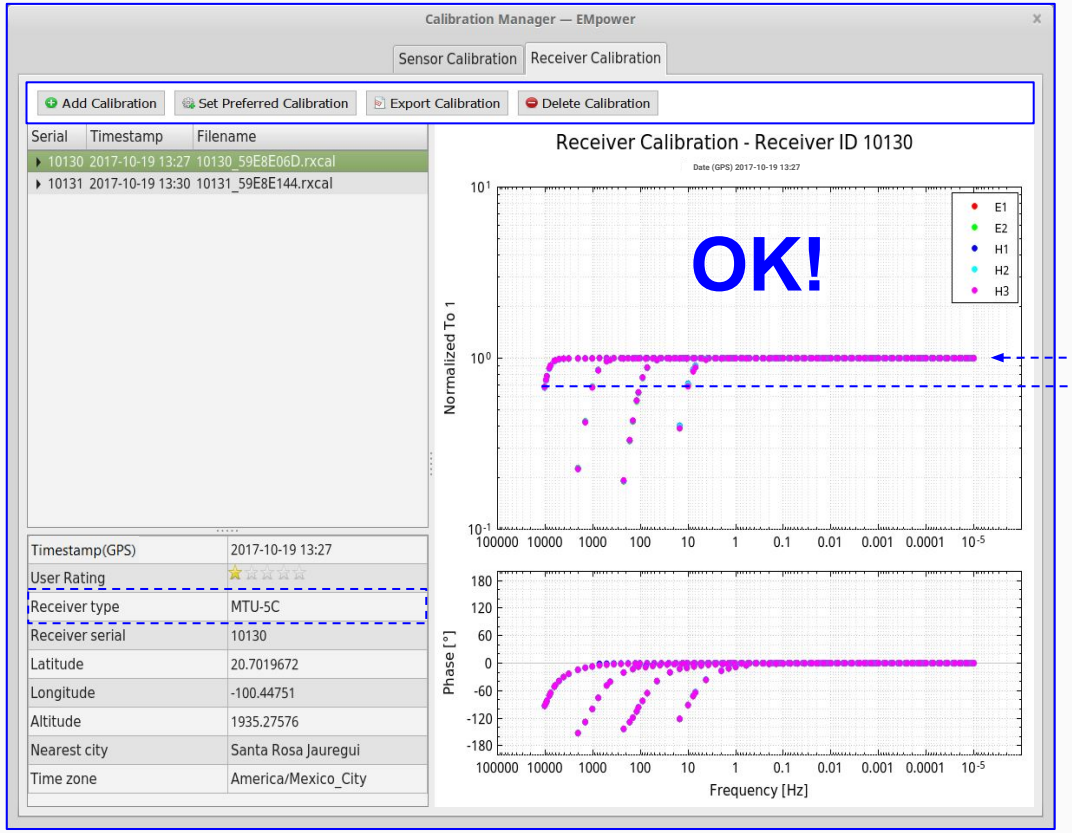
9 **Calibration Recording**



10 Keep pressing the power button 3 sec and release



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

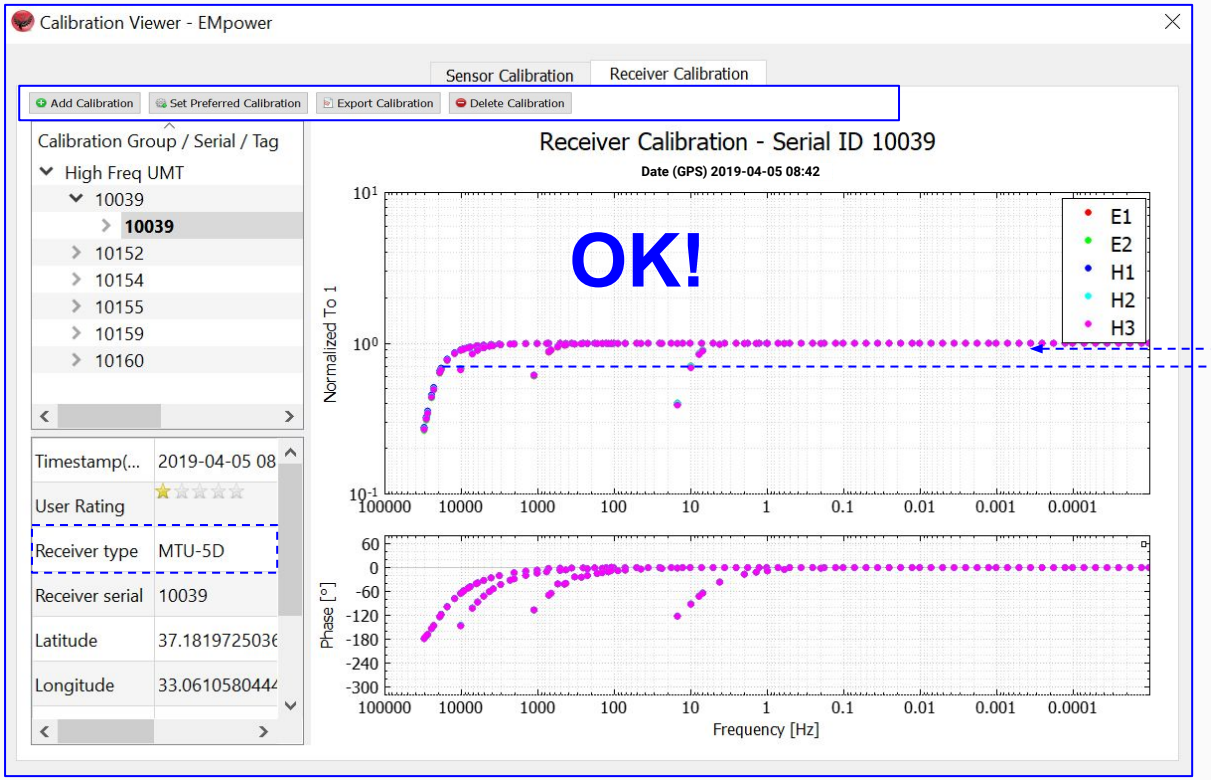


Horizontal level = 1
(or 10^0)
→ OK

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 - MTU-5D

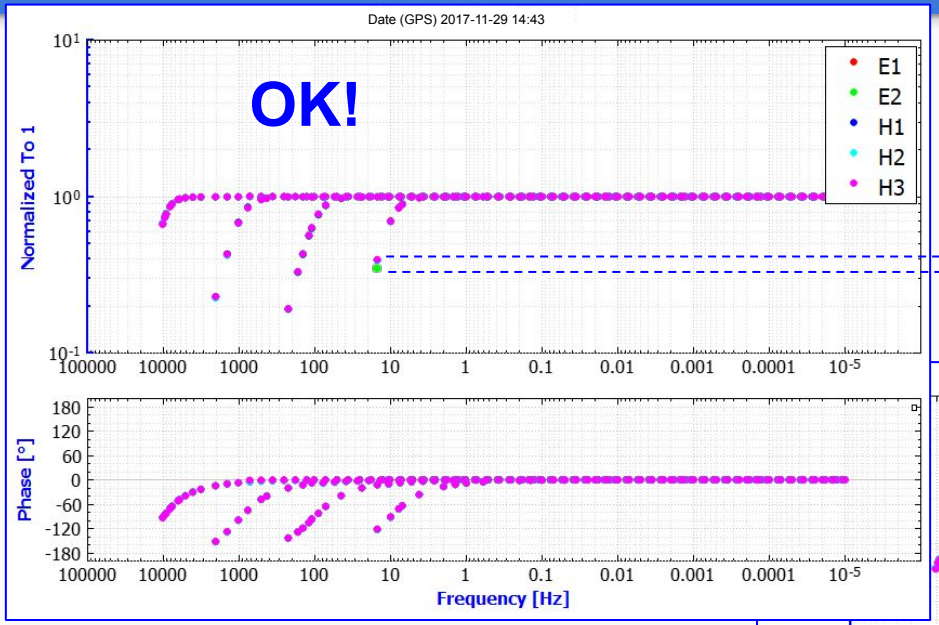


This calibration curve and cutoff frequencies apply only to receivers with a base sampling rate of 96 KSps, such as MTU-5D

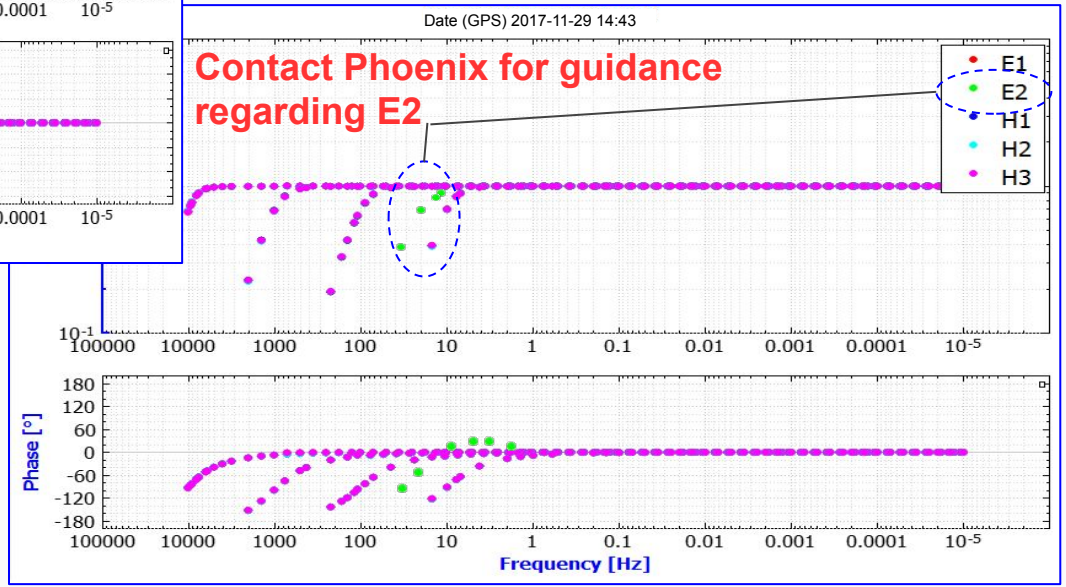
Horizontal level = 1
(or 10^0)
→ OK

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

Receiver calibration QC - Variations



Small variations out of the flat part → OK



Sensors Calibration

11. Connect the sensors
- Sensors should only be calibrated outdoors and away from noise

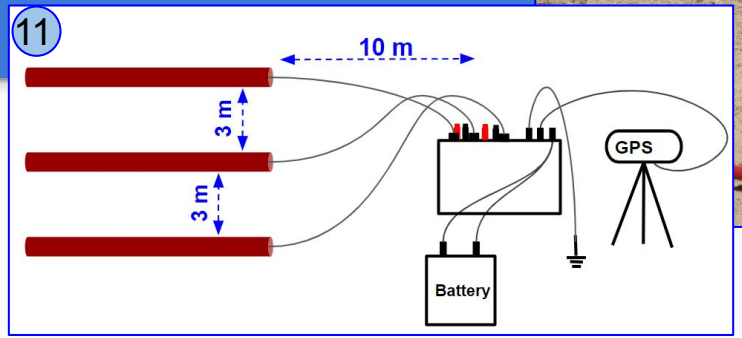
12. Insert the SD Card with a valid Sensor calibration config file into the receiver
**For any problem with the SD Card, check the Troubleshooting manual*

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"

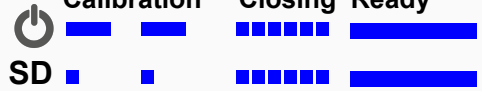
15. Turn off the Receiver

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

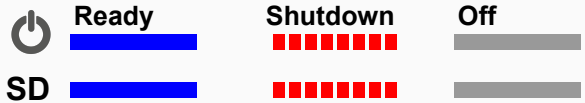


13 Turn on the receiver

14 Calibration Recording



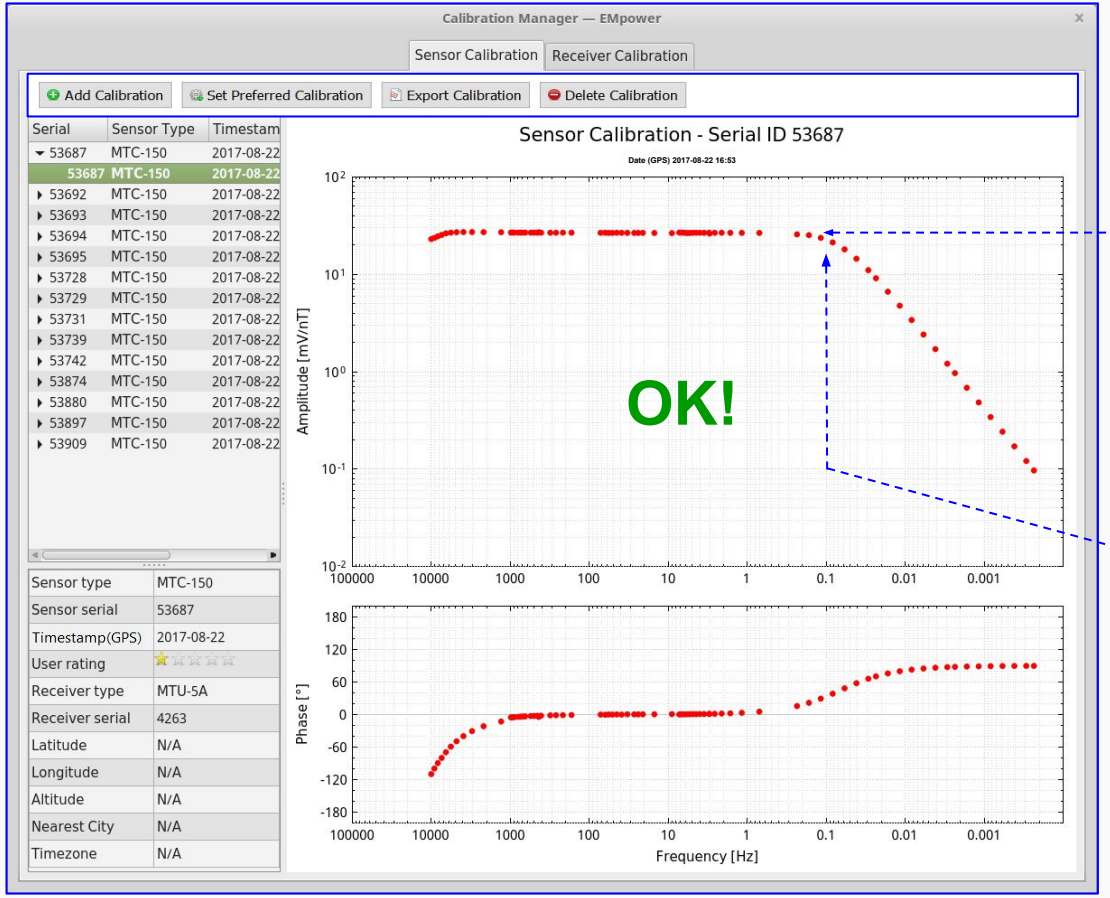
15 Keep pressing the power button 3 sec and release



Indicators

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

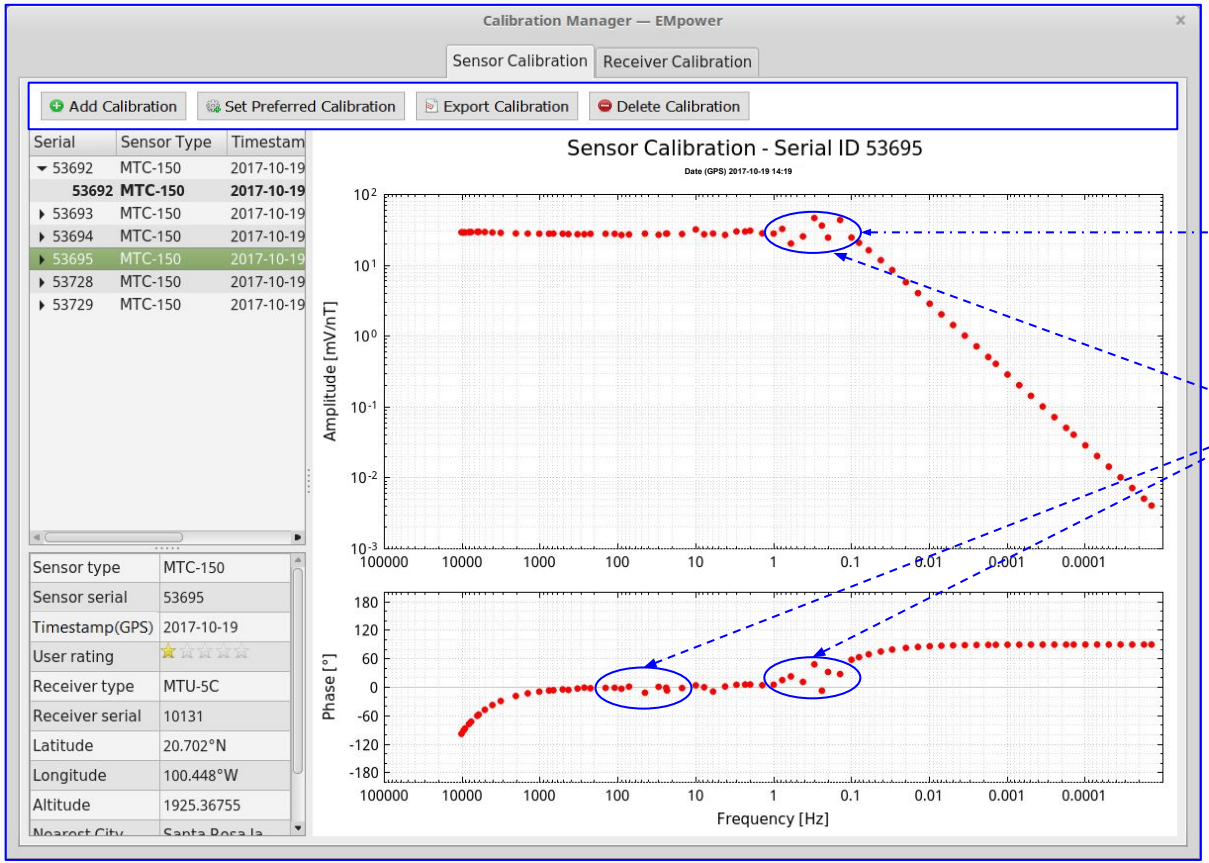
Sensor calibration QC



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

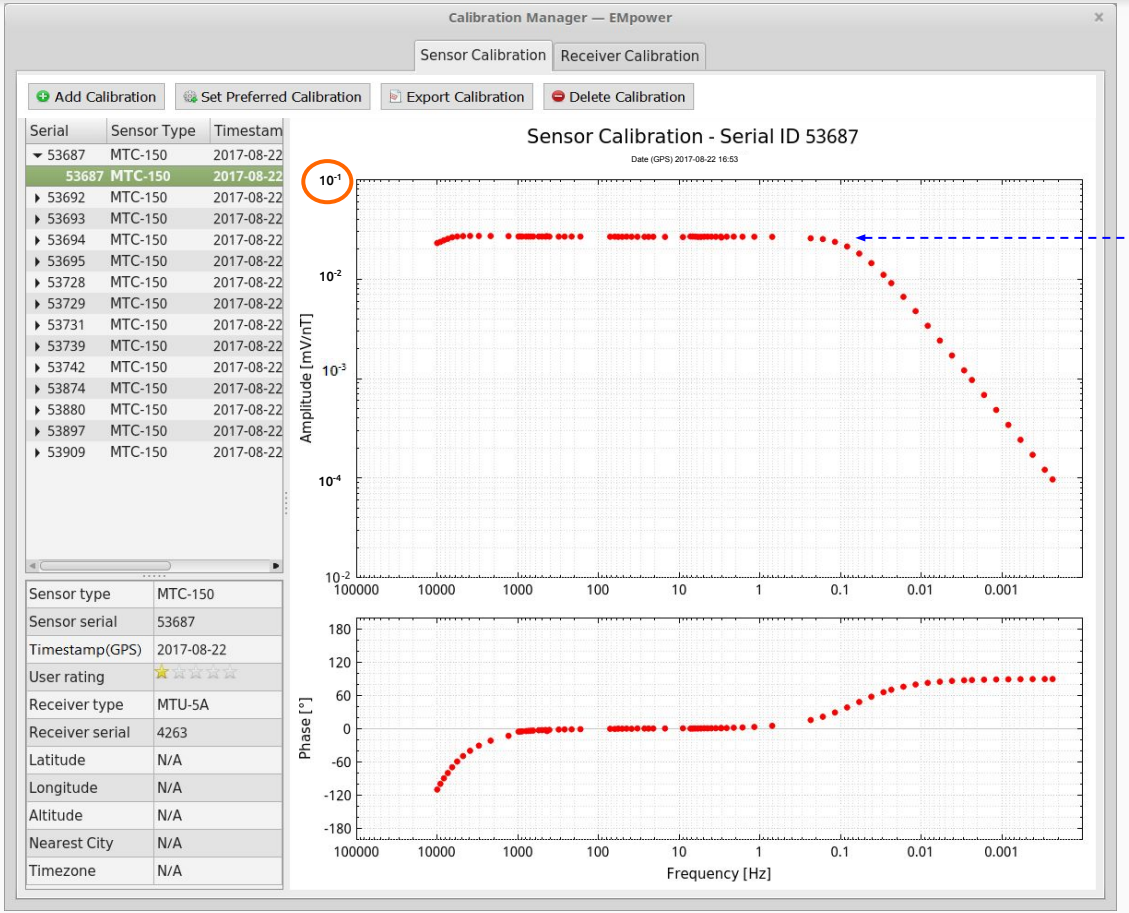


MTC-150, value should between 20-30 mV/nT. OK

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

Sensor might be OK, but cultural noise

Sensor calibration QC - Bad curve



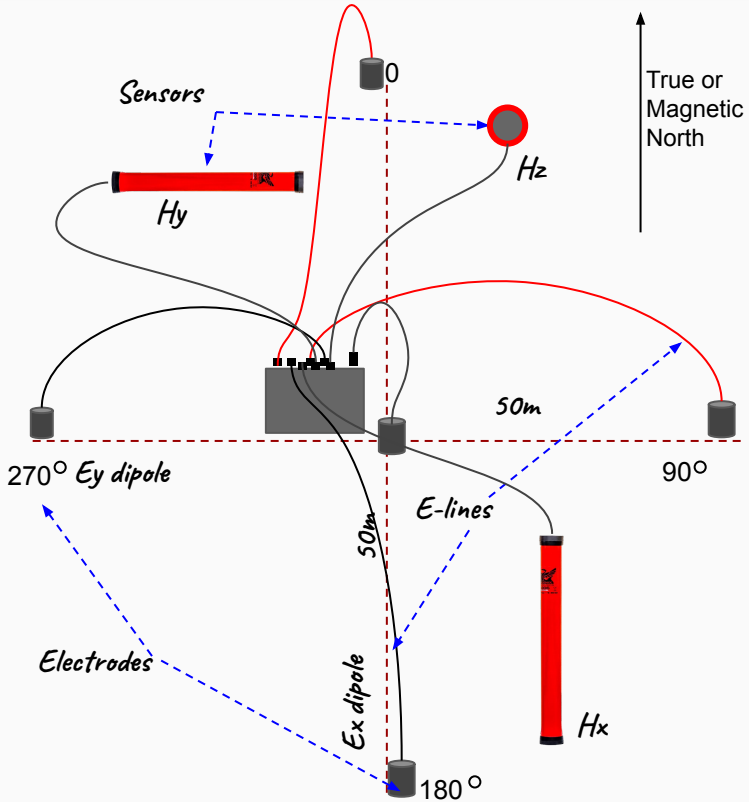
For MTC-150 value not between 20-30 mV/nT, or odd curve shape

Verify coil, coil cable, channel

Setting up the Survey site(s)

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

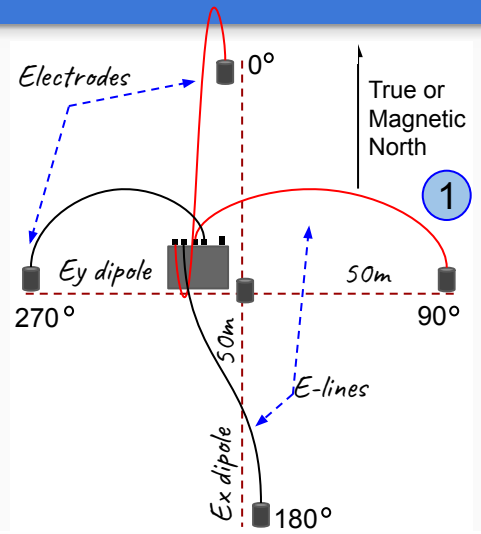
1. Following the illustration, use a compass to orient the electrodes to the north, south, east, and west of the ground electrode to layout the E-lines
   - Using longer dipoles increases the signal being input to the receiver and helps to overcome the internal noise of the receiver. This helps when 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

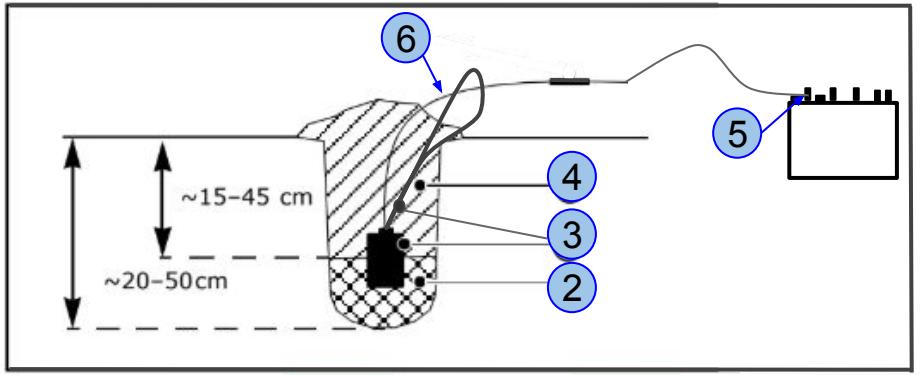


For any layout error on the E-lines or on the Sensors installation *(See Troubleshooting manual)*

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

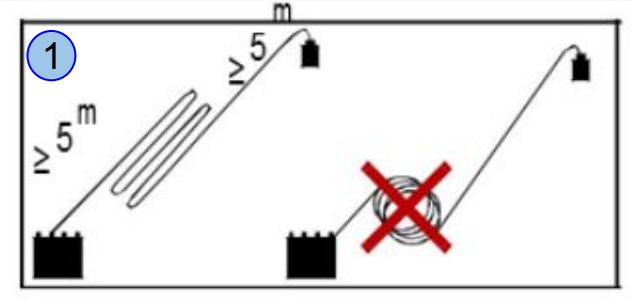




Best practices

1. Excess cable:

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

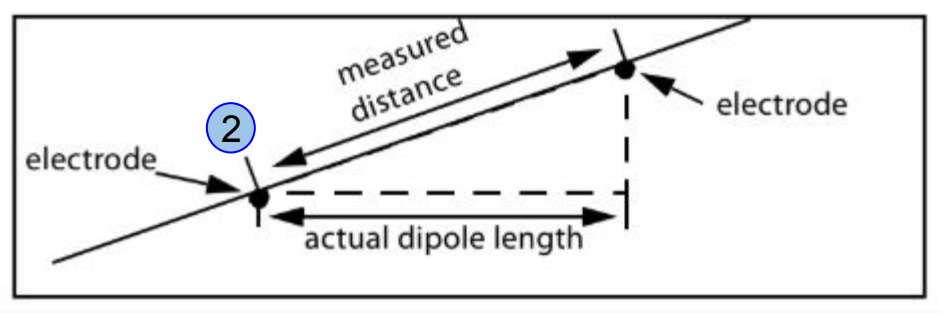


2. Slope:

- 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

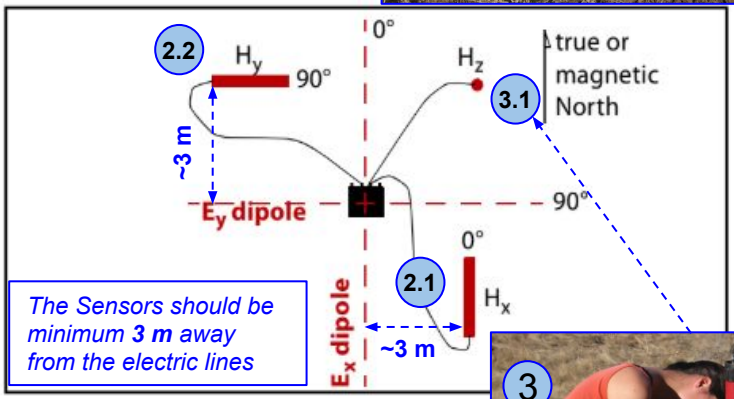
Magnetic Sensors

Alignment of the sensors

1. **Record** the serial numbers of the coils *(Sensors)* before burying them

2. **Horizontal (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 points south)*
   2.2. The free end of **Hy** 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 (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.

Checklist

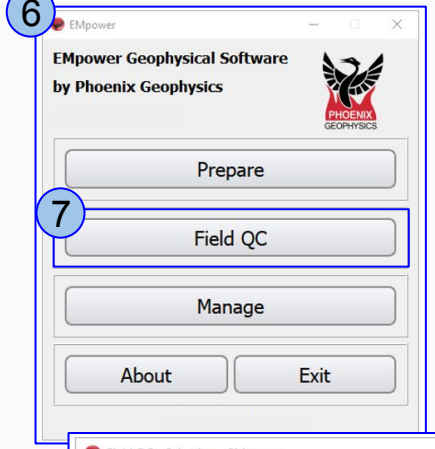
- Battery
- GPS antenna
- Insert an SD card with a valid configuration file
- GPS synchronization
- Measure electric line, and orient both electric line and sensors
  - Take note of terrain incline if >20 degrees
- Keep cables flat on the ground
  - Not draped over plants or obstacles
  - Bury or weight 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)*

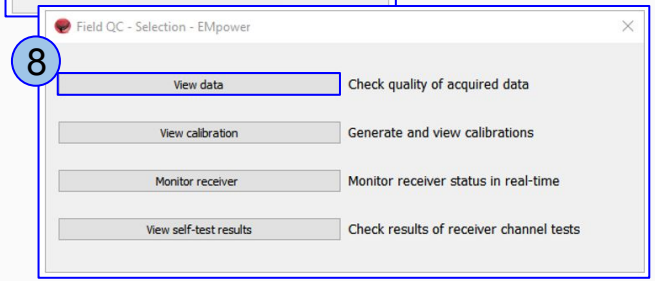
Start Recording

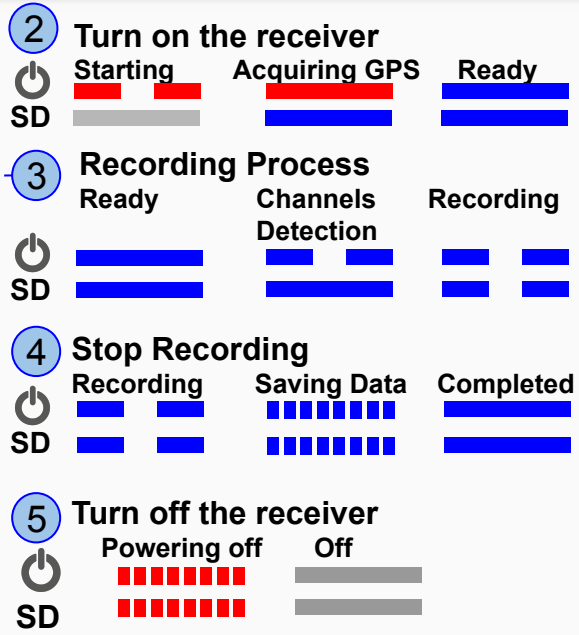
1. Insert the **SD Card** and close the lid
   **For any problem with the SD Card, check the Troubleshooting manual*
2. Turn on the **receiver**
3. Start recording data
   - Check the saturation for all channels, using the receiver screen. If the saturation is more than 2% follow the steps on *(Configuration, 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%
```



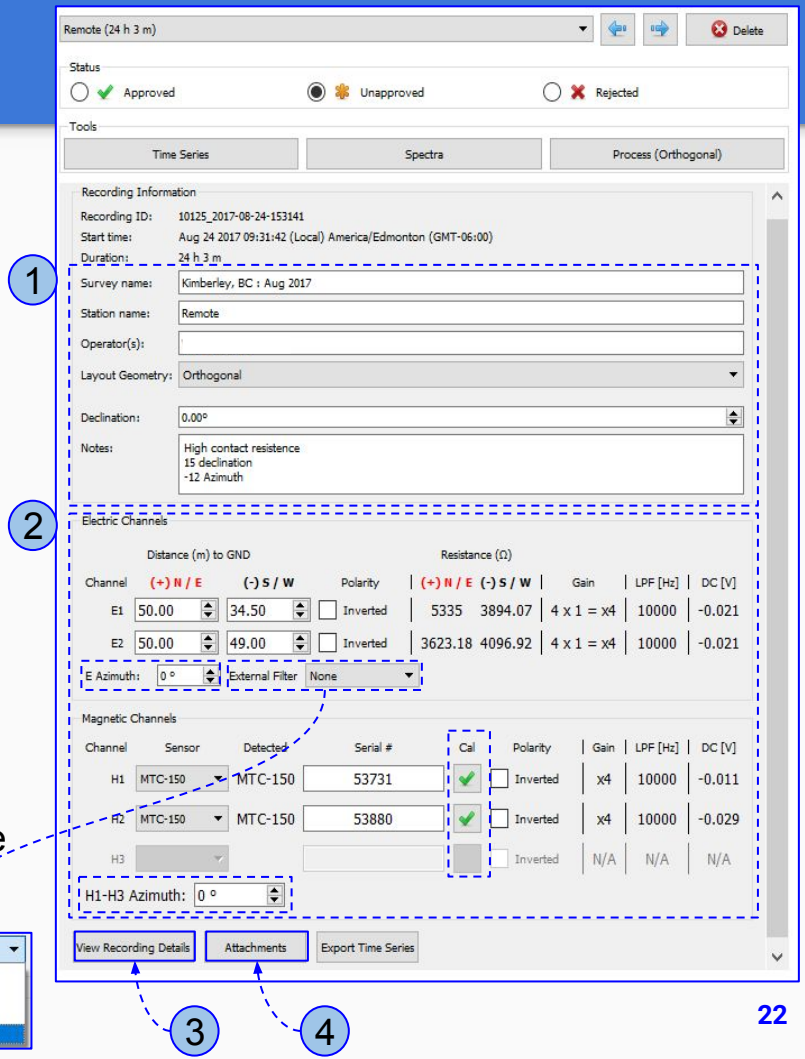




Verifying/Editing Recording Information

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 **Cal**ibration 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



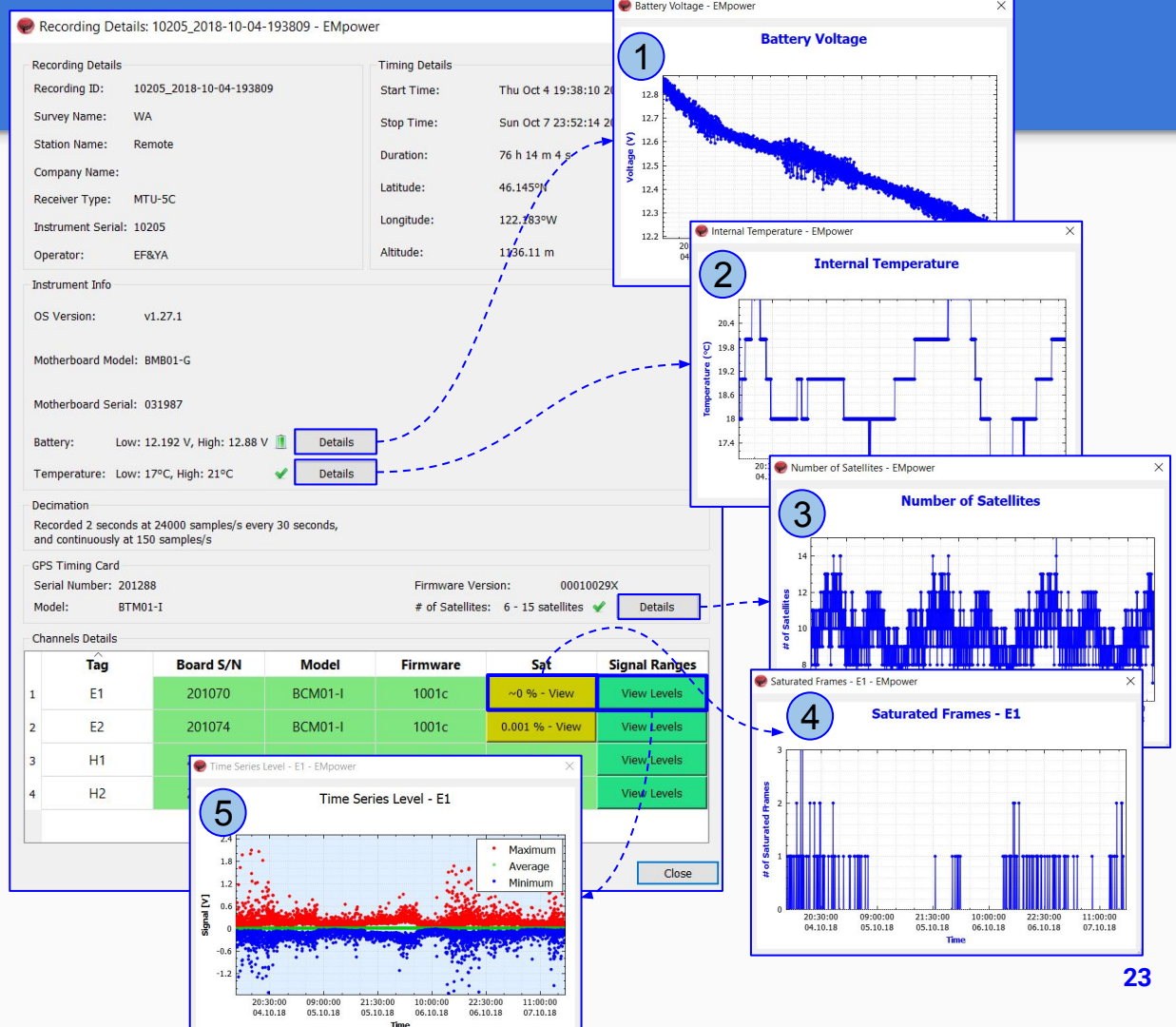
View Recording Details

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**



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*