Guide For Field Operations

- Planning
  - Choosing the site
  - Creating the configuration file
  - Configuration, gains and LPF
- Layout on site
  - Equipment and Tools
  - Set up the layout
  - Connecting GPS / Battery
  - Calibrating the equipment
    - Receiver calibration QC
    - Sensor calibration QC
- On Site
  - Setting up a survey site
  - Electric Channels
  - Magnetic Channels
- Testing
  - Checklist
  - Test Recording
    - Software Recommendations
- Best practices

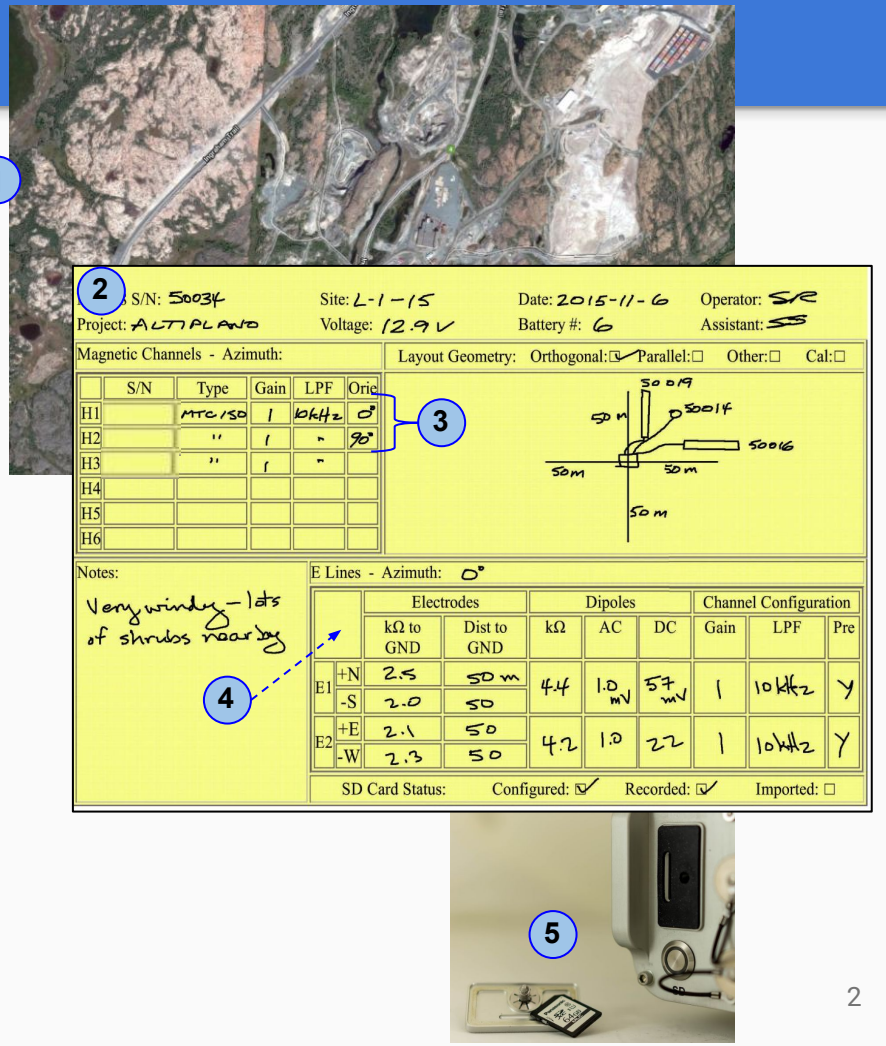
Choose the site

1. Choose the **Site(s)**
2. Configuration Layout
   E-lines orientation
   - True North
   - Magnetic North
   - Azimuth
3. Identify the magnetic declination
4. Define how your equipment will be allocated
5. Create the file configuration (config.json) SD Card

Avoid:

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

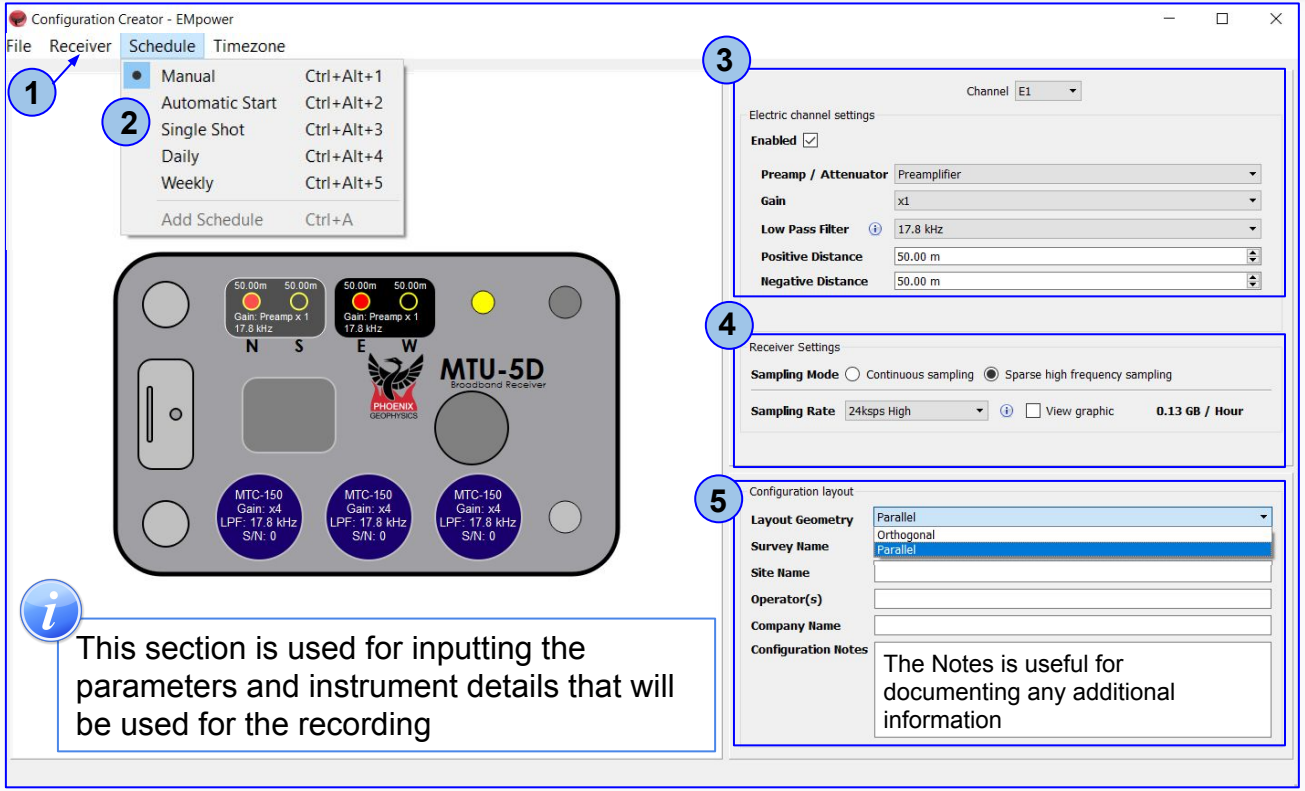
**Obtain permission to conduct the work on the site*



Configuration Creator

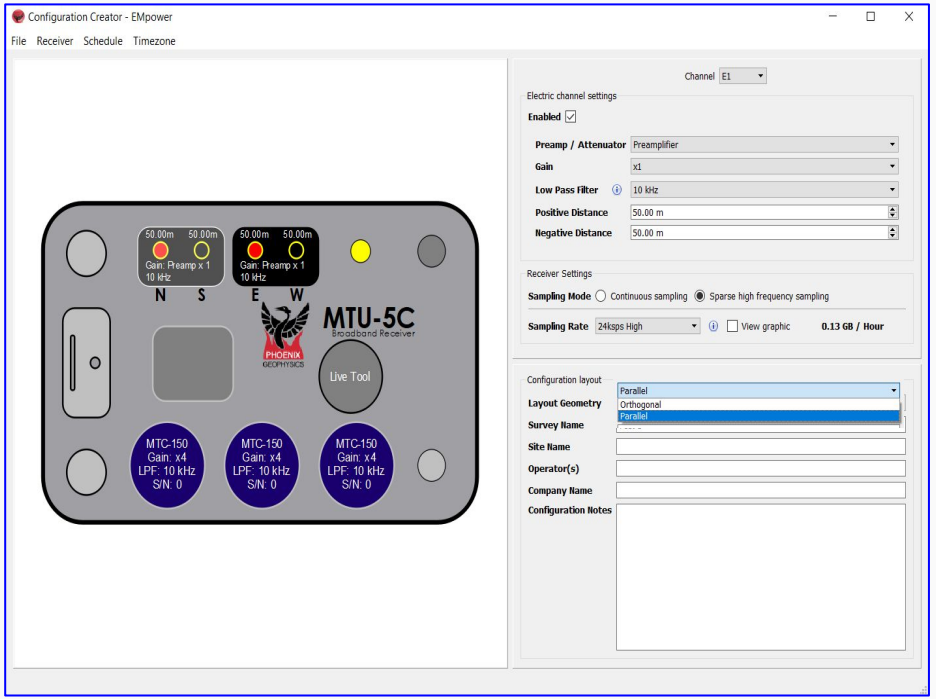
Complete the information:

1. Select that the **Receiver** type
2. Select the **Schedule**
3. **Channels Settings**
4. **Receiver Settings**
   - Define the **Sampling Mode and Rate**
5. **Configuration Layout**



Configuration, gains and LPF

- In electric channels prefer pre-amplifier **on**, and only turn it off if the channel saturates (lowers noise)
- For electric channels, set main gain x1, and increase if your first recording is too noisy and only uses <50% the dynamic range
- With MTC-150, prefer gain x4. Other sensors start at gain x1
- When using MTC-150 ensure that sensor type reads MTC-150 to prevent over-voltage to the sensor
- Set the LPF as low as possible to allow only frequencies of interest, based on sensor
- MTC-150 records a little past 10KHz, either choose 10KHz of 17.8 Khz LPF (Why, when?)



Equipment and Tools

Equipment

1. Configuration Layout Sheet
2. Laptop
3. EMpower + License
4. SD Card for each operation
   - Calibration Sensor
   - Calibration Receiver
   - Configuration File
     (Orthogonal, Parallel or White Noise)
5. Receiver
6. 12 V Battery
7. Power Cable and GPS Cable
8. Antenna
9. Magnetic Sensors and cables
10. Electrodes
11. E-line cable

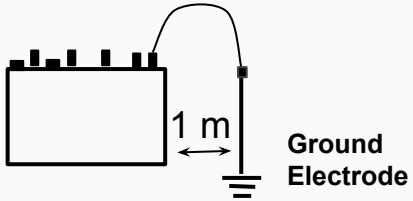
Tools & Supplies

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

Set up the layout

1. Ensure that you are at the right location as defined on the map
   - Use a handheld GPS compass
2. The site centre
   - Choose a dry spot
3. Stay clear of noise sources
4. For the ground electrode, choose the center spot less than 1 m from the receiver

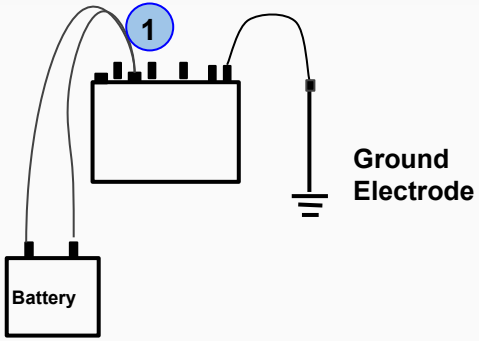
**keep the receiver at least 1 m away from the E-Lines, to avoid electromagnetic interference*

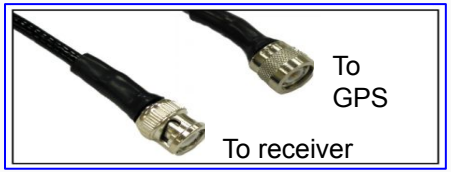


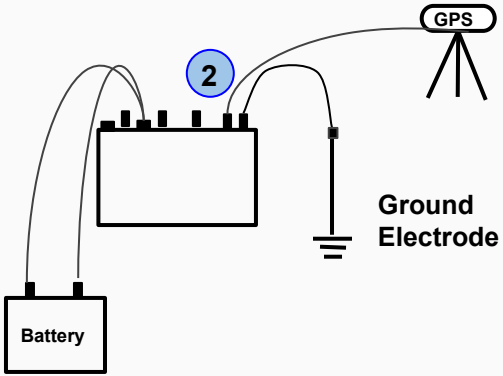
Connecting GPS / Battery

1. **Battery**
   - Connect the battery,
     - Red (+) positive
     - Black (-) negative
   - Fit the slotted connector (to the receiver's connector)

2. **GPS**
   - Connect the cables on the GPS antenna and Receiver
   - Open the antenna tripod, if necessary tape the antenna tripod to a stake, post or large tripod



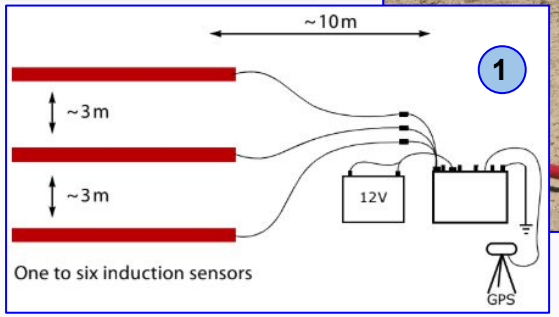


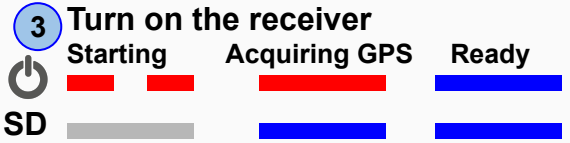


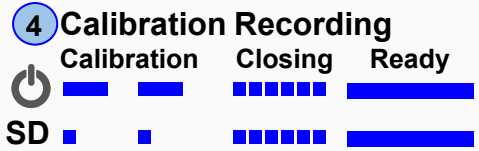
Calibrating Equipment

1. Connect the sensors (Sensors should only be calibrated outdoors and away from noise)
2. Insert the SD Card on the receiver
   - Config file for Receiver
   - Config file for Sensor
3. Turn on the Receiver
4. Start the Calibration Recording
5. Use the Manage module to view and quality control the calibration

**The calibration process should take place at the beginning of every survey (The sensors do not have to be buried to be calibrated)*



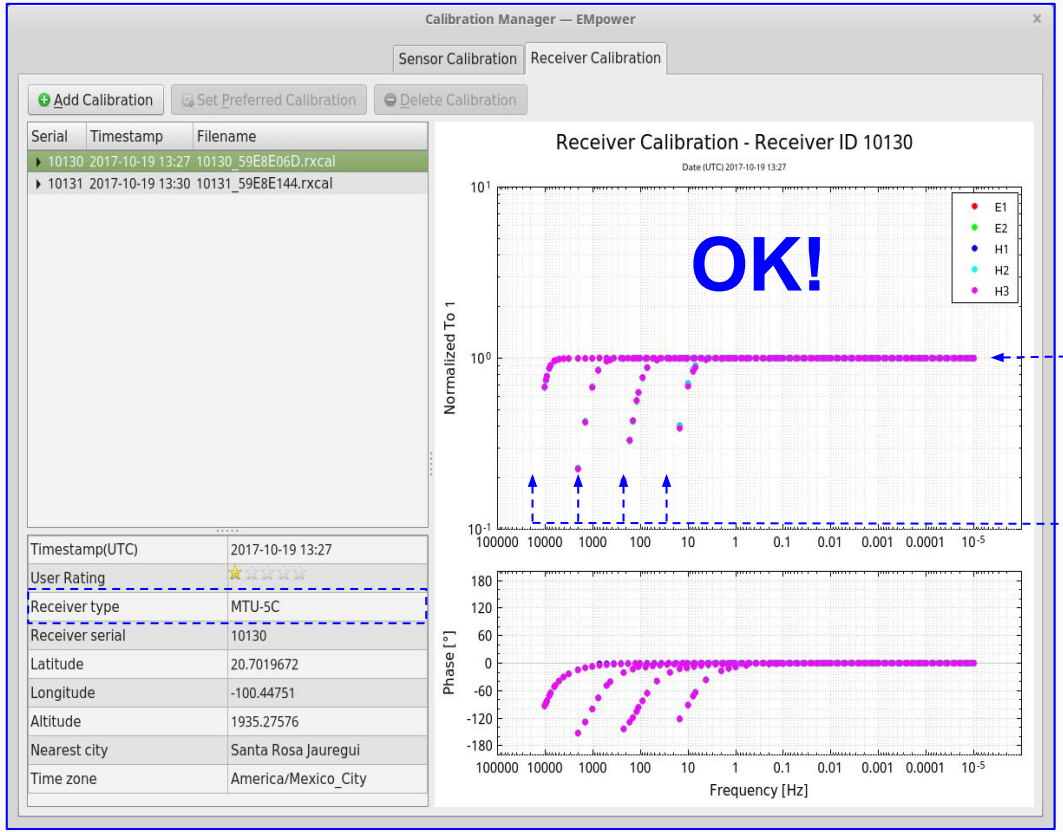




Indicators

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

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

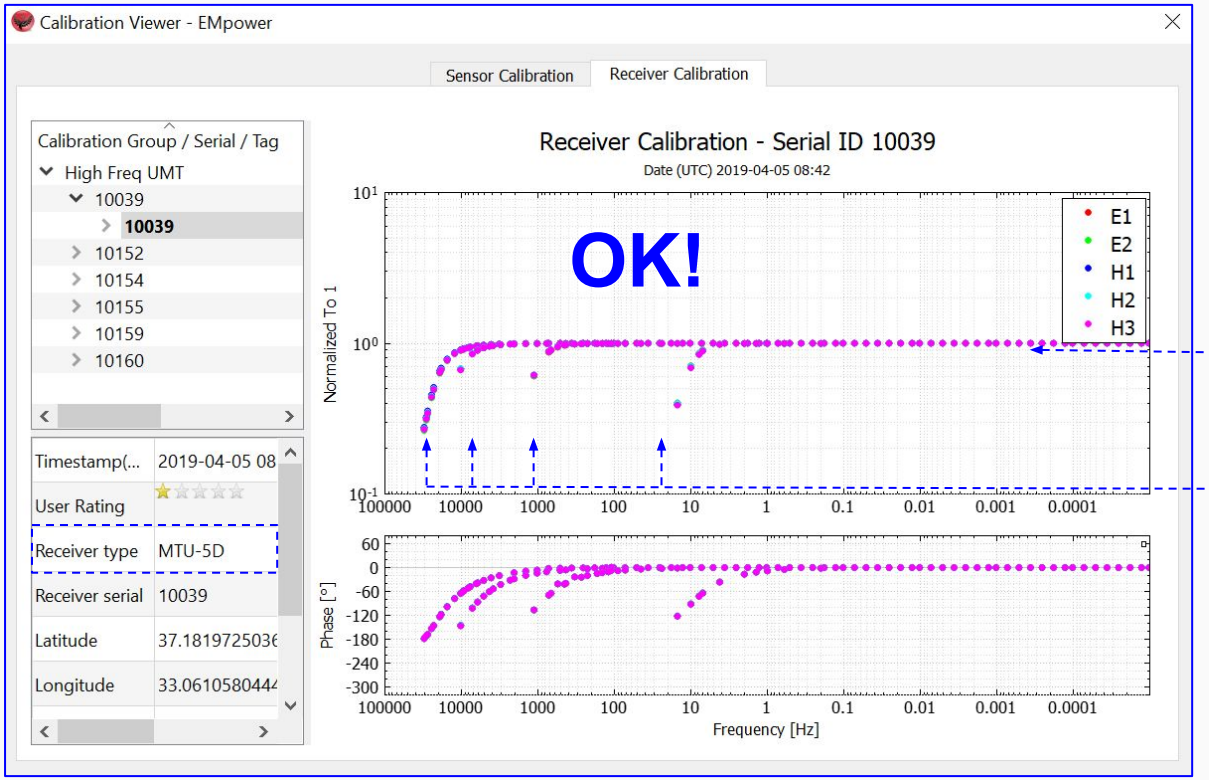


Value = 1
(or 10^0)
→ OK

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

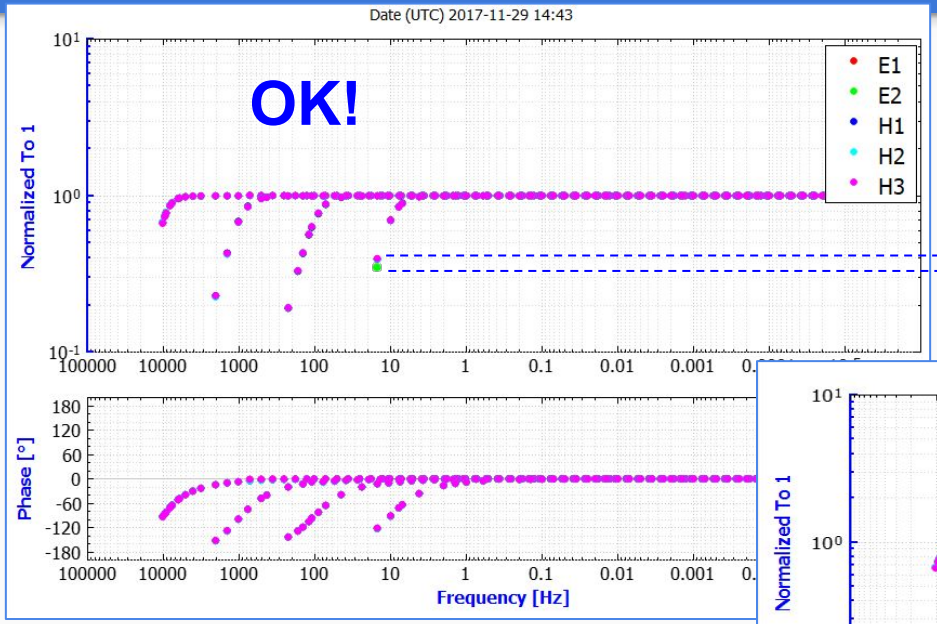


This calibration curve and cutoff frequencies apply only to receivers with a base sampling rate of 96 KSps, such as MTU-5D

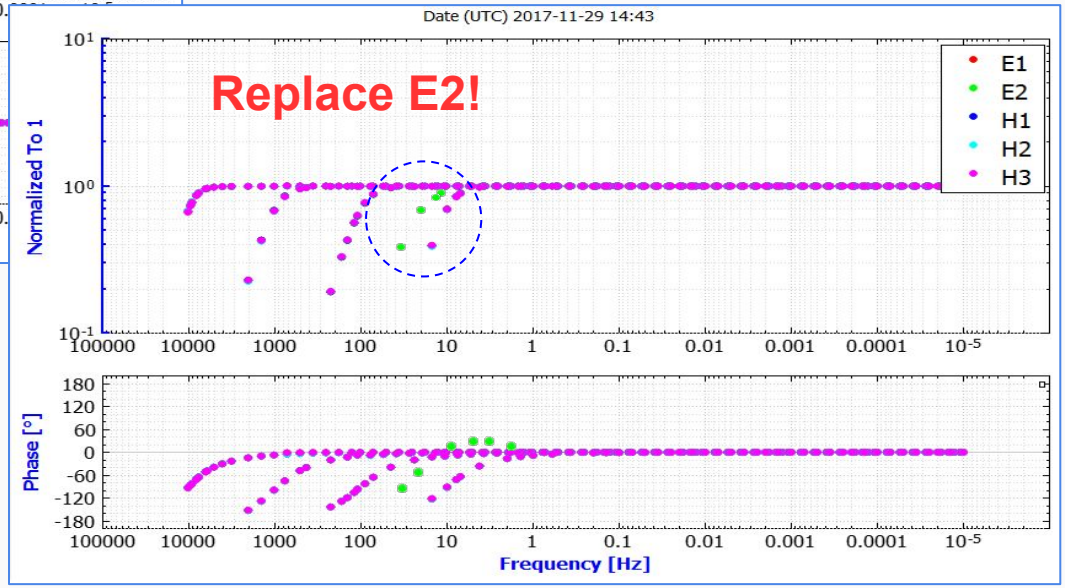
Value = 1
(or 10^0)
→ OK

Cut off
(value ~ 7)
@ 10Hz
@ 1KHz
@ 10KHz
@ 17.8KHz

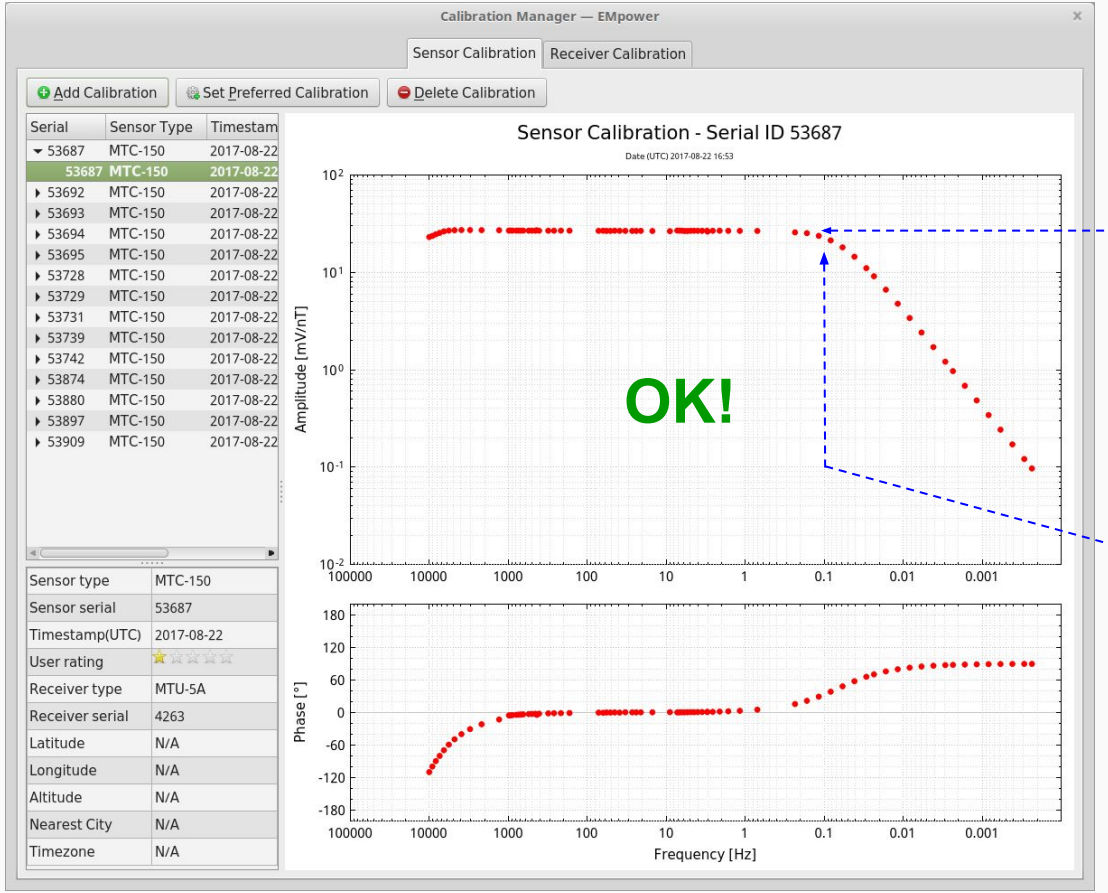
Receiver calibration QC



Small variations out of the flat part → OK



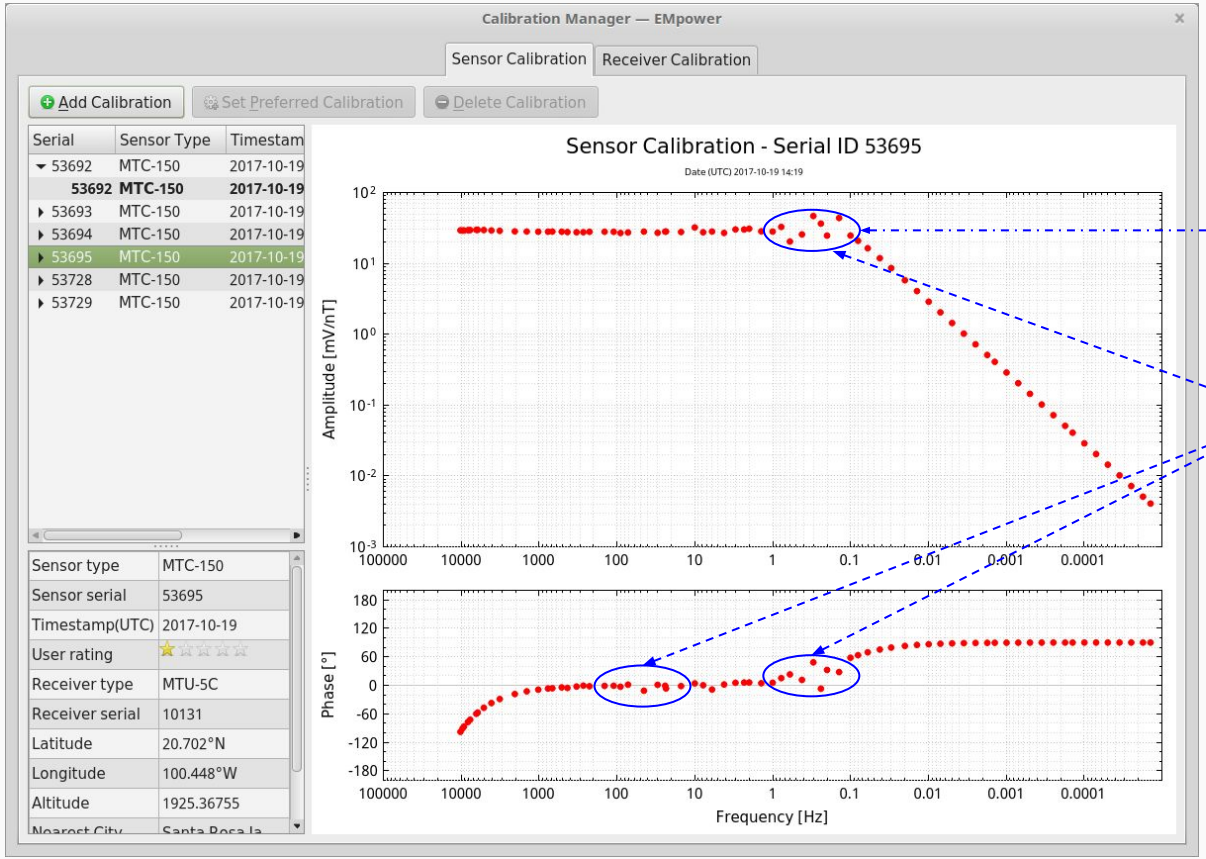
Sensor calibration QC



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

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

Sensor calibration QC

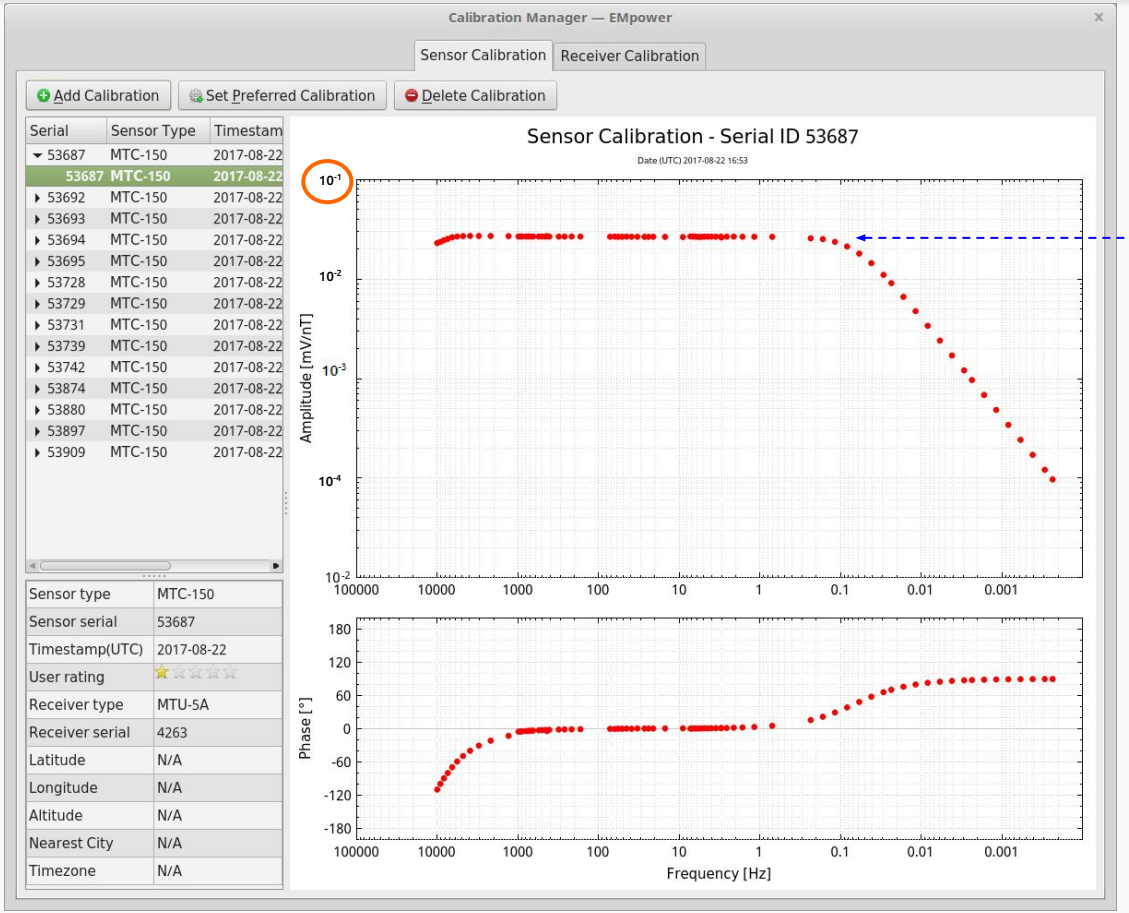


MTC-150, value should between 20-30. OK

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

Sensor might be OK, but cultural noise

Sensor calibration QC



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

Verify coil, coil cable, channel

Setting up a survey site

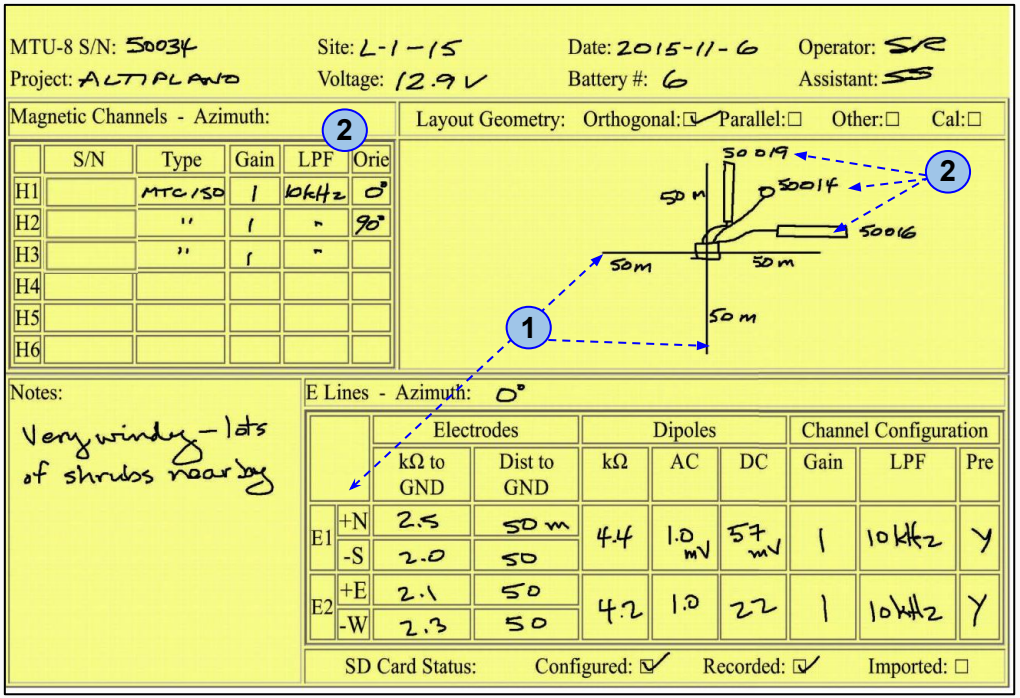
1. Following the Configuration Layout, use a compass to orient the electrodes place to the north, south, east, and west to layout the E-lines
   - Use coloured adhesive tape to mark the length of half the desired dipole on precut E-line cables

colour-coded:

- Red for north - Black for south
- Yellow for east - Blue for west

2. Using the position of the electrodes orient the Sensors place following the Configuration Layout
   - Try to order by serial number where the minor number is for Hx

**The longer the dipole, the better signal-to-noise ratio but the greater the AC the voltage included by the local power grid*



MTU-8 S/N: 50034 Site: L-1-15 Date: 2015-11-6 Operator: SR
Project: ALTIPLANO Voltage: 12.9 V Battery #: 6 Assistant: SS

Magnetic Channels - Azimuth:

	S/N	Type	Gain	LPF	Orie
H1		MTC150	1	10kHz	0°
H2		"	1	"	90°
H3		"	1	"	
H4					
H5					
H6					

Layout Geometry: Orthogonal:☑ Parallel:☐ Other:☐ Cal:☐

50019 50014 50016 50 m 50m 50 m 50 m 1 2

Notes:
Very windy - lots of shrubs nearby

E Lines - Azimuth: 0°

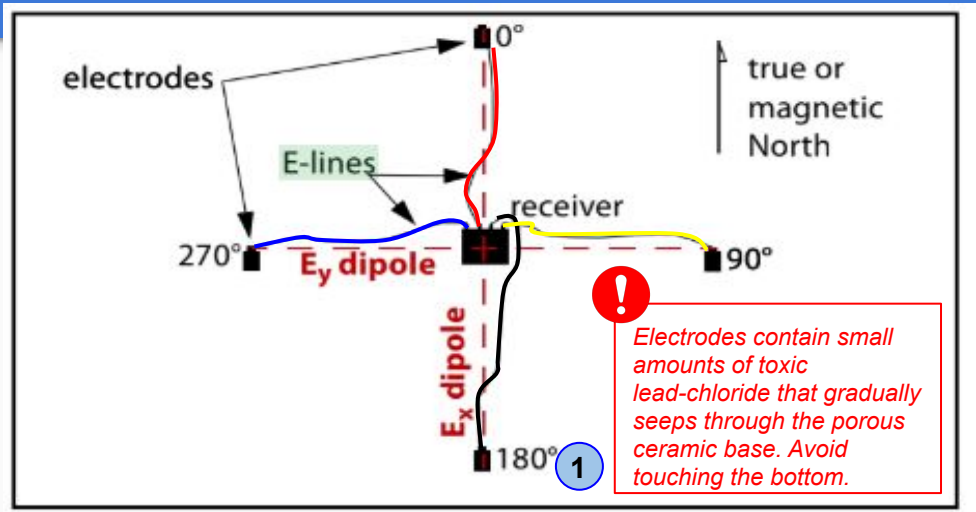
		Electrodes		Dipoles			Channel Configuration		
		kΩ to GND	Dist to GND	kΩ	AC	DC	Gain	LPF	Pre
E1	+N	2.5	50 m	4.4	1.0 mV	57 mV	1	10kHz	Y
	-S	2.0	50						
E2	+E	2.1	50	4.2	1.0	22	1	10kHz	Y
	-W	2.3	50						

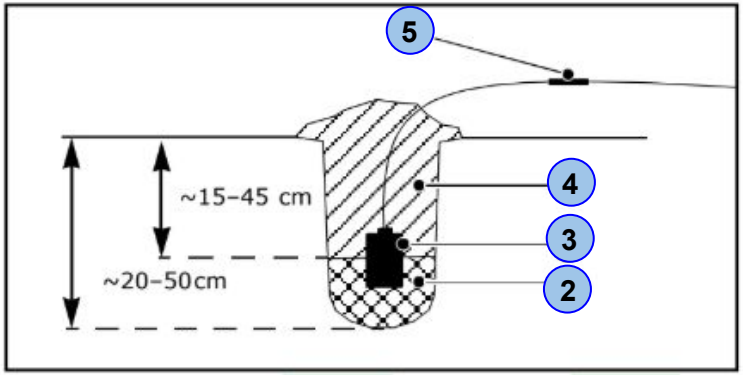
SD Card Status: Configured: ☑ Recorded: ☑ Imported: ☐

For any adjust on the E-lines or Sensors installation (See troubleshooting section)

Electric Channel

1. Register the electrode number and /or cable number on the Layout Sheet
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, Leave the electrode cable extended outside the hole (5)
4. Cover the electrode completely with the loose dirt
5. Connect E-lines to electrodes

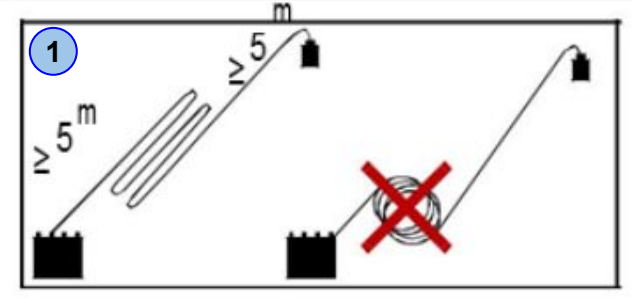


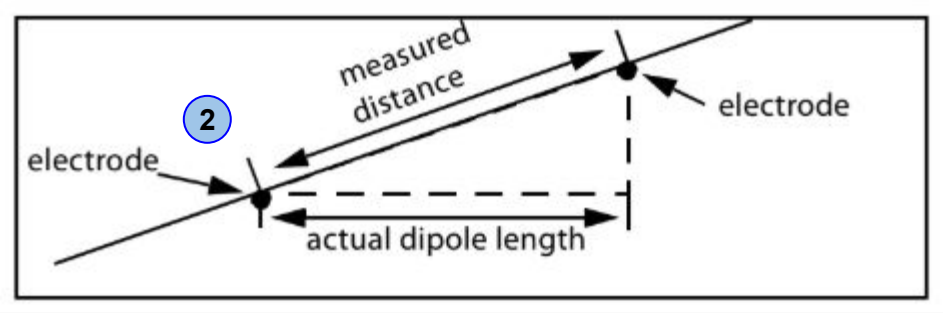


Best practices

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

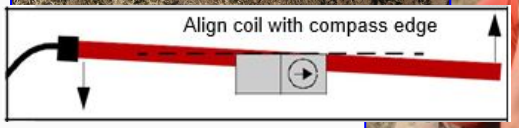
Magnetic Sensors

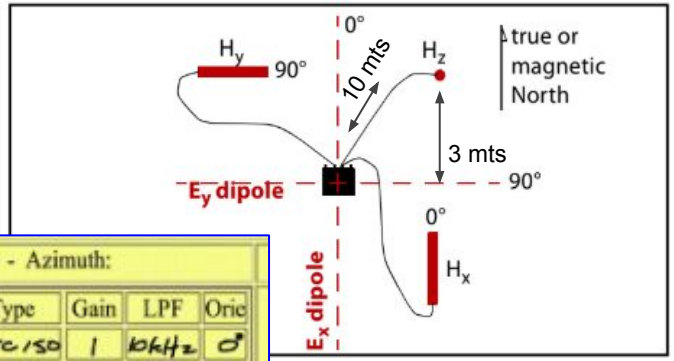
Alignment of the sensors

1. **Horizontal (Hx, Hy)**
   - The free end of **Hx** points North (connector points south)
   - The free end of Hy points East (connector points west)
   - 40 cm deep x 15 cm from each end
   - 10-15 cm from each side
2. **Vertical (Hz)**
   - Dig a narrow hole deep enough to completely bury the sensor

**The Sensors should be 10 meters away from the receiver and 3 meters between each sensor*

3. Register on the layout the serial numbers of the coils (Sensors) before burying them





3

Magnetic Channels - Azimuth:

	S/N	Type	Gain	LPF	Orie
H1		MTC/150	1	10kHz	0°
H2		"	1	"	90°
H3		"	1	"	
H4					
H5					
H6					

Working with six sensors:
Ensure to put H1 to H3 sensors well separated in one quadrant, and H4 to H6 sensors well separated in the opposite quadrant.

Checklist

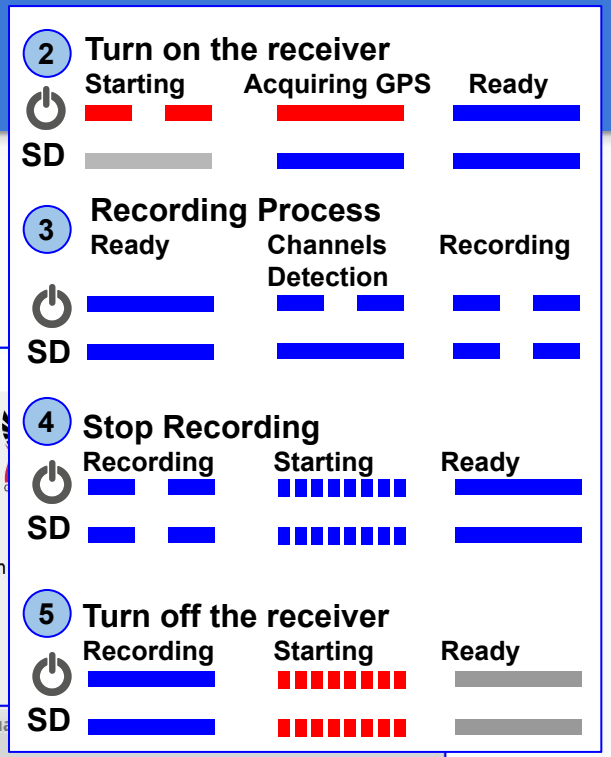
- Battery
- GPS antenna
- Inserting the SD card
- GPS synchronization
- Measure and orient electrode and sensor
- Keep cables flat on the ground, (not draped over plants or obstacles). Bury or weight the cables if necessary to reduce wind noise
- Ensure clear sight-lines between the GPS antenna and the sky
- Test Recording (see next page)

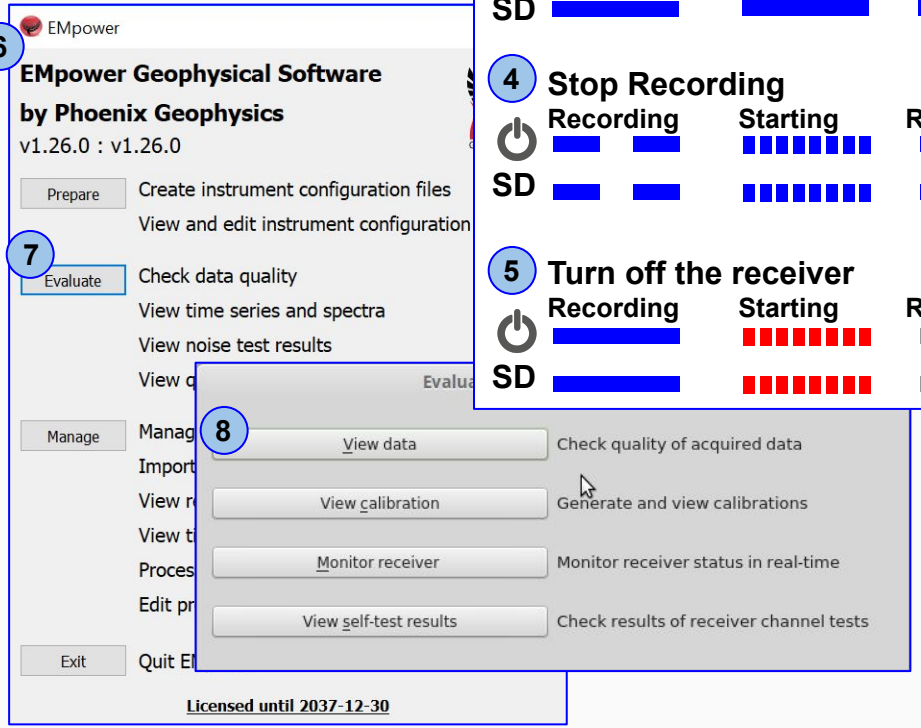
Keep accurate records on a layout sheet.

Test Recording

1. Insert the **SD Card**
2. Turn on the **receiver**
3. Recording data test (no longer than 10 minutes)
4. Stop the recording
5. Turn off the receiver
6. Open Empower
7. Click the Evaluate button
8. Select View data
   - Select the SD card (The recording process creates two folders, log and recdata)
   - Open recdata folder and select the recording file and click Choose
   - Review the information recording

**Verify that there was not a warning icon on the left of the channels or next to the Recording ID*





Software Recommendations

- Use evaluate 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 it 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 screen button when instrument is detecting sensors (top LED flash blue, bottom solid blue)
- Check for caps touching electrodes, they can introduce wide-band noise
- Electric binding post order is different from MTU-5A
- GPS antenna stores nicely in the pocket!
- Alway close the SD door (keep sand and water away)
- Use bag flap as sun shade and water protection