Guide For MT Field Operations

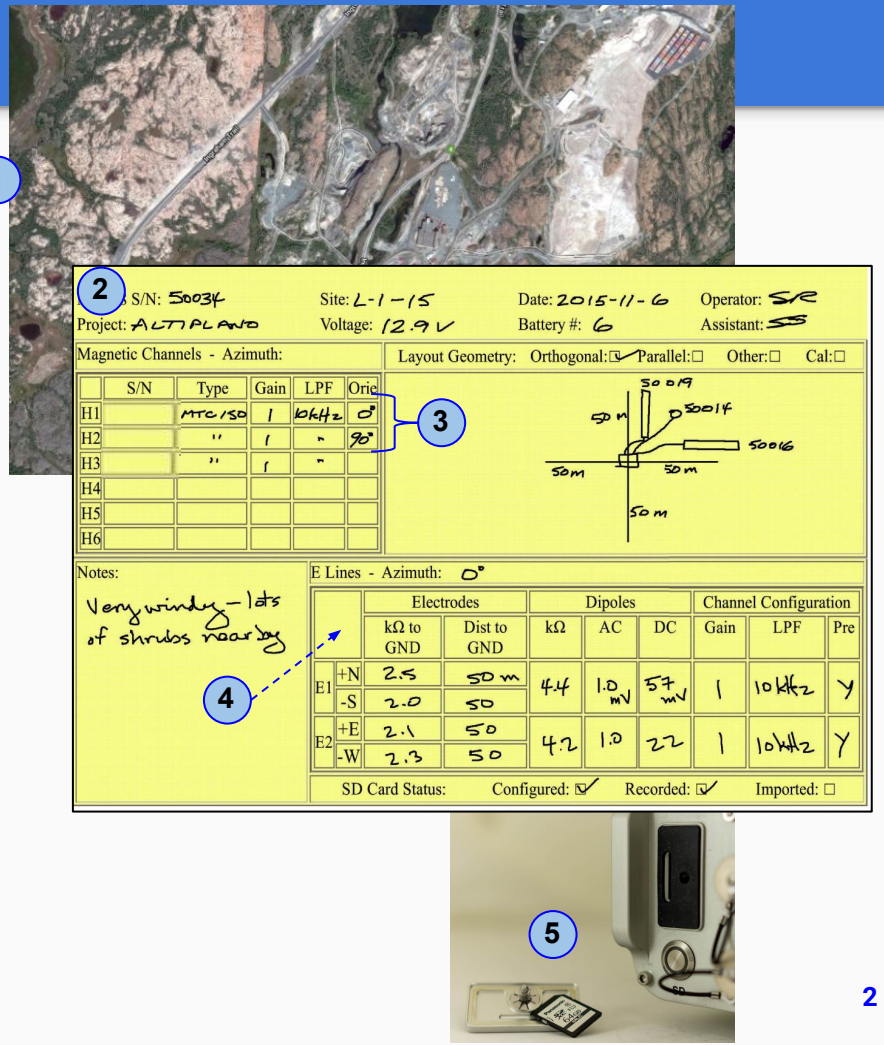
Choose the site

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)

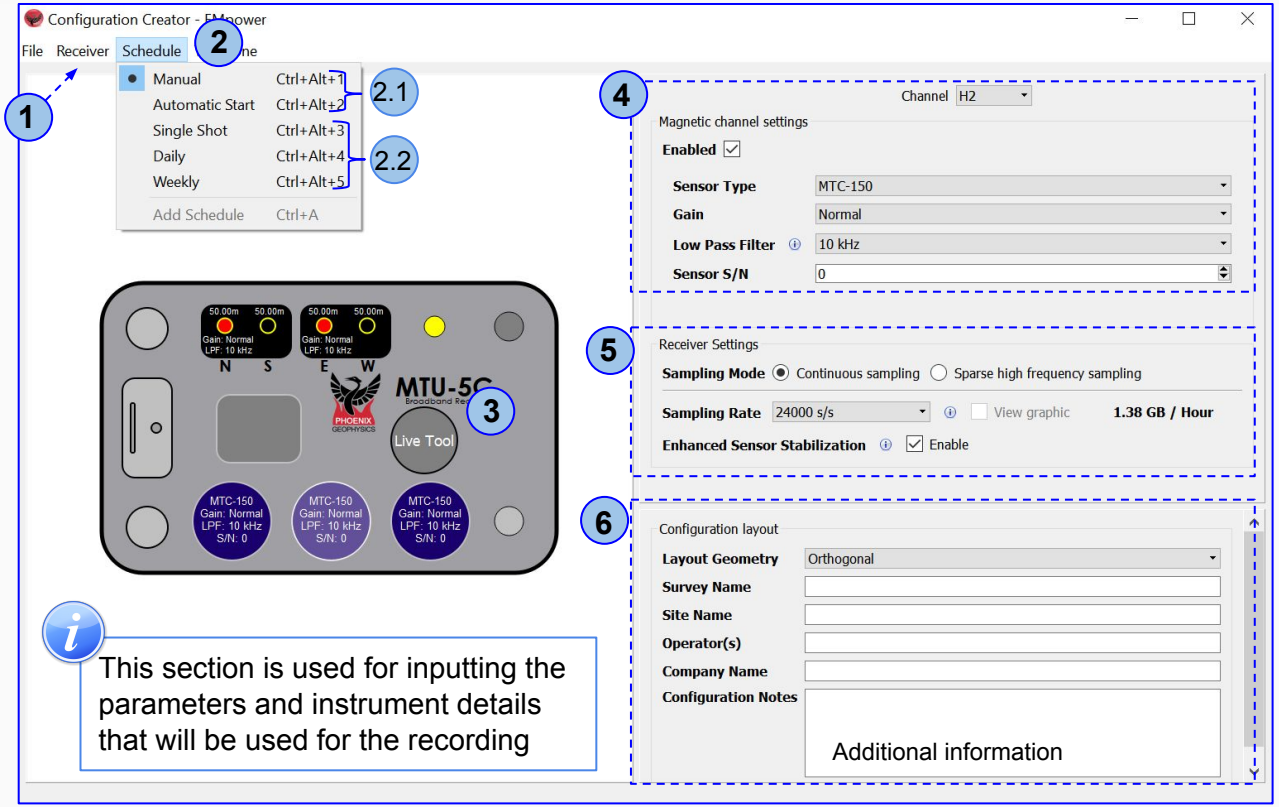
**Obtain permission to conduct the work on the site*



Configuration Creator

1. Check that the **Receiver type** is **MTU-5C**
2. Select the **Schedule**
   - 2.1. **Manual** or **Automatic Start**
   - 2.2. Or for a specific schedule use, **Single Shot, Daily** or **Weekly** and click **Add Schedule** to define the time and date
3. **Live tool** *(see the [Networking Settings](#) manual)*
4. **Channels Settings**

1. Define the Receiver Settings **Sampling Mode and/or Sampling Rate**
5. **Configuration Layout**



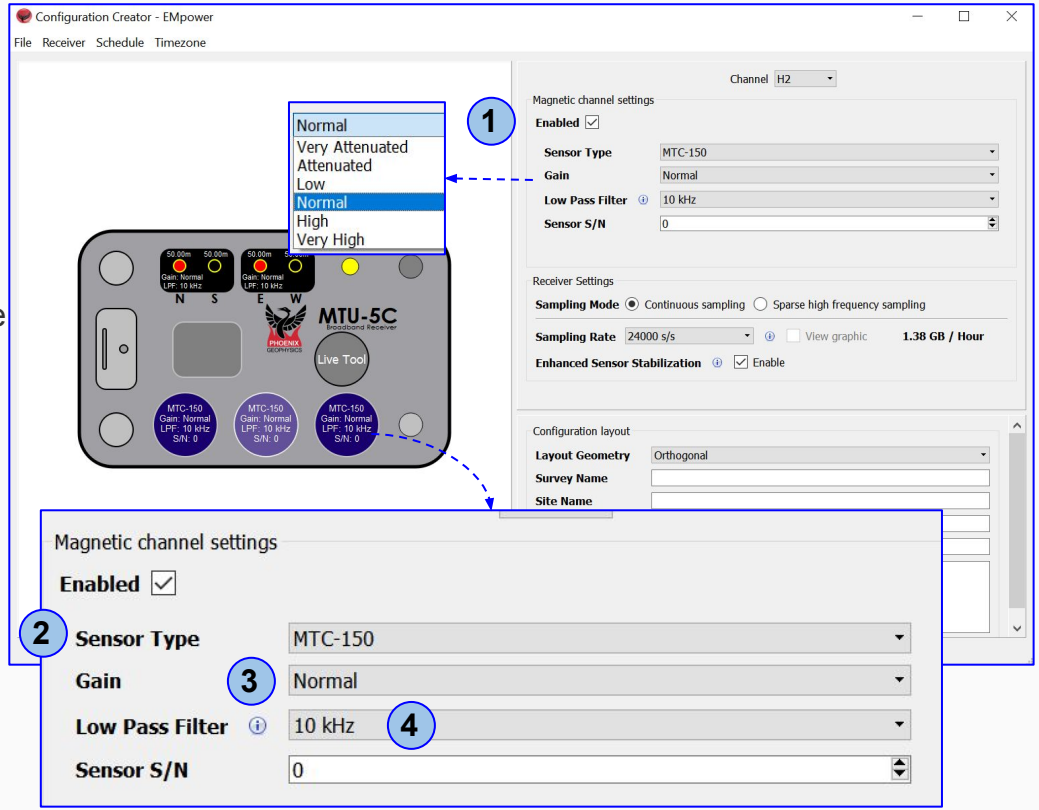
Configuration, gains and LPF

Electric Channels

1. Prefer **Gain** **“**Normal” in most cases
   - Only increase the gain when an overnight recording in the same area used less that 5% of the input range at all times
   - When there are more than 5% saturations, first check for noise sources and try to eliminate them. If not possible, prefer first reducing dipole lengths, and only reduce the channel gain as last resort.

Magnetic Channels

2. Ensure that sensor type reads the correct sensor to prevent over-voltage to the sensor
3. With MTC-150, prefer **Gain** **“**Normal”
4. Set the LPF as low as possible to allow only frequencies of interest, based on sensor



Equipment and Tools

Equipment

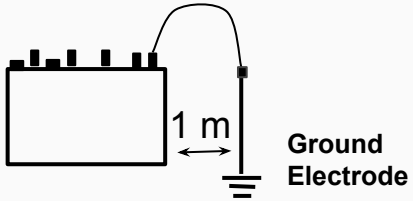
1. Configuration Layout Sheet
2. Laptop
3. EMpower + License
4. SD Card with config file for each operation
   - Sensor Calibration
   - Receiver Calibration
   - Desired type of data recording (Orthogonal or Parallel)
5. Receiver
6. 12 V Battery
7. Power Cable and GPS Cable
8. Antenna
9. Magnetic Sensors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

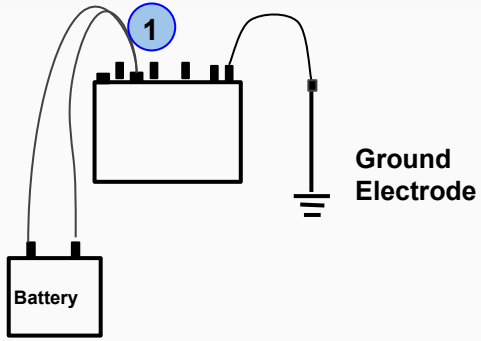
Set up the layout

1. Ensure the right location as defined for the recording site
   - Use a full GPS locator
2. Choose a dry spot for the site layout centre
3. Stay clear of noise sources
4. Choose the centre spot for the ground electrode, less than 1 m from the receiver

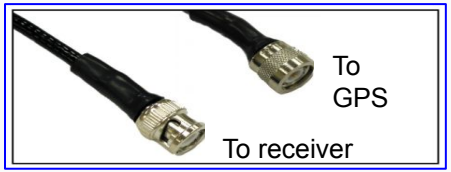


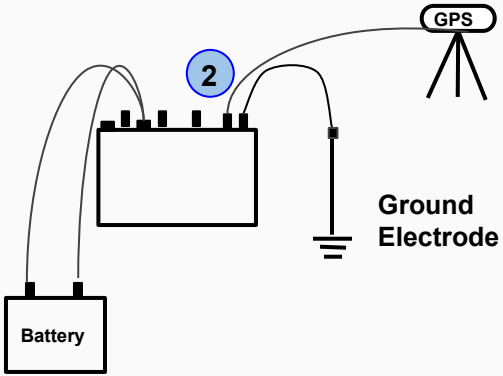
Connecting GPS / Battery

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
   - 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



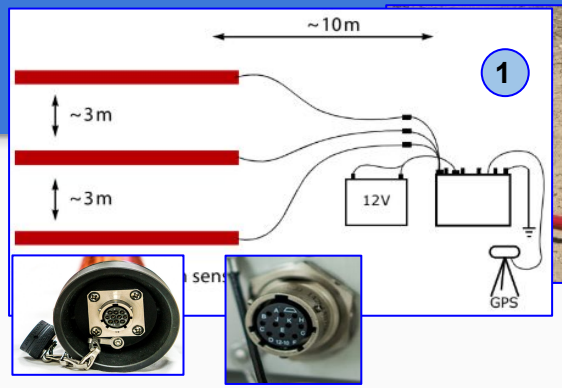


Sensors Calibration

1. Connect the battery
2. Connect the sensors (Sensors should only be calibrated outdoors and away from noise)
3. Insert the SD Card on the receiver
   - Config file for Sensor

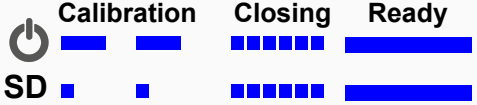
   **For any problem with the SD Card, check the Troubleshooting manual*
4. Turn on the Receiver
5. Start the Calibration Recording
   - *The calibration process should take place at the beginning of every survey (The sensors do not have to be buried to be calibrated)*
6. To avoid this warning, wait until the calibration is completed. When the calibration process is interrupted before the calibration is completed, it can not be imported into EMpower

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



3 Turn on the receiver

4 Calibration Recording



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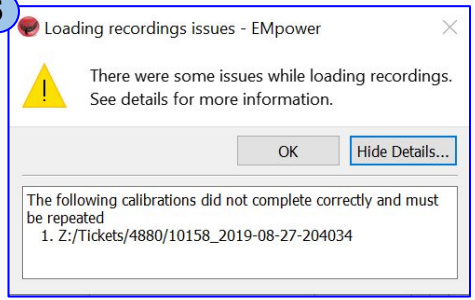

Indicators

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

Receiver Calibration

1. Connect the battery
2. Insert the SD Card on the receiver
   - Config file for Receiver

   **For any problem with the SD Card, check the Troubleshooting manual*
3. Turn on the Receiver
4. Start the Calibration Recording
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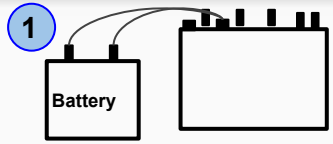
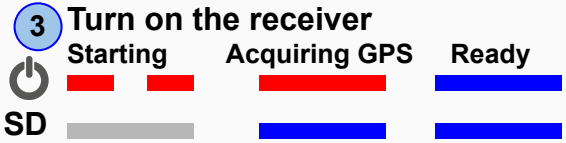
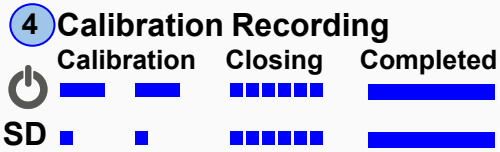
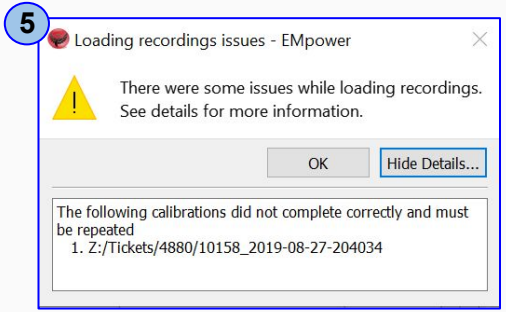
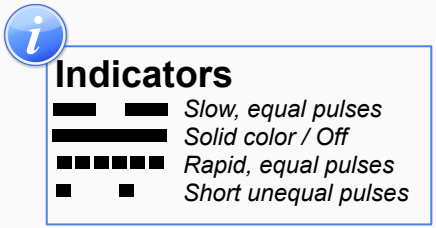


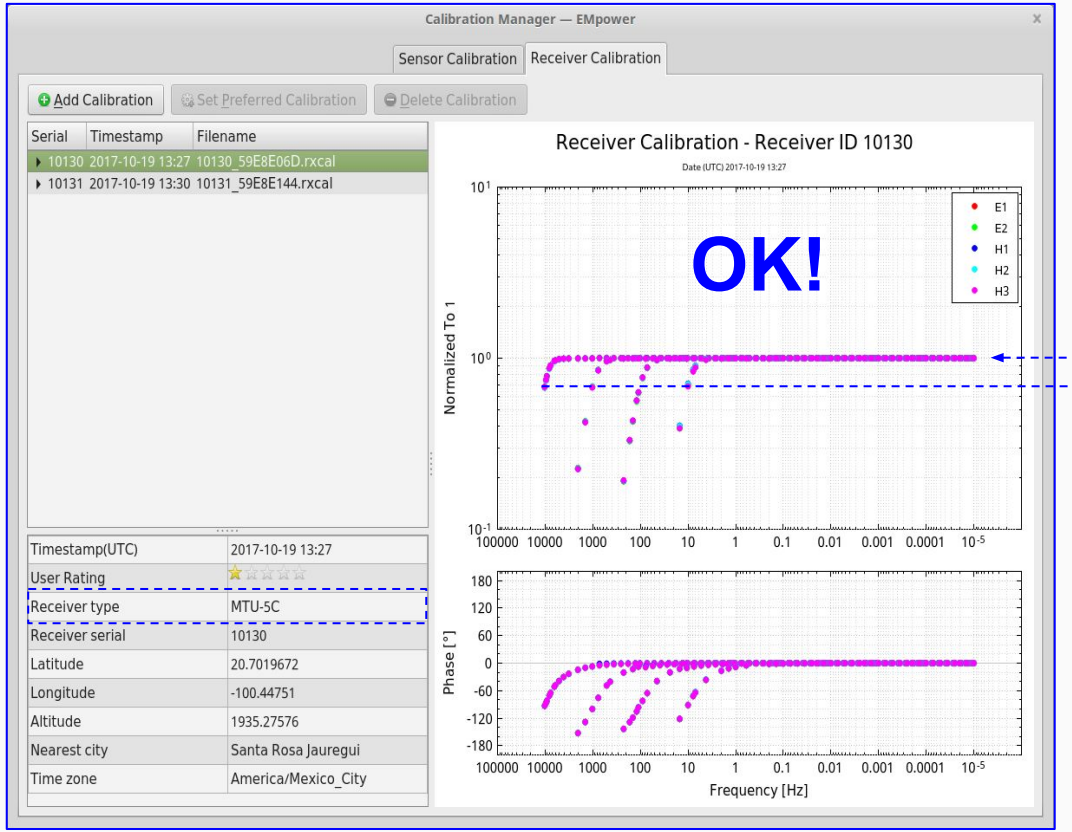








Receiver calibration QC - MTU-5C / MTU-8A / RXU-8A

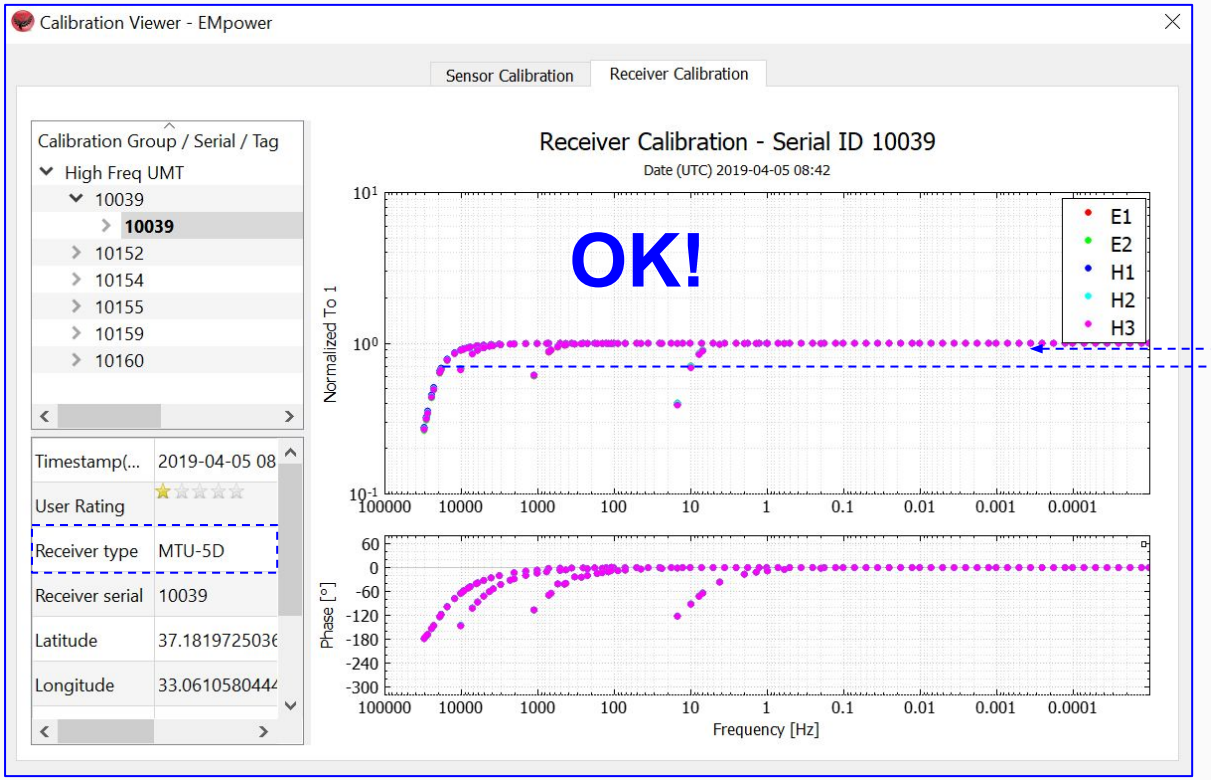


Horizontal level = 1
(or 10^0)
→ OK

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

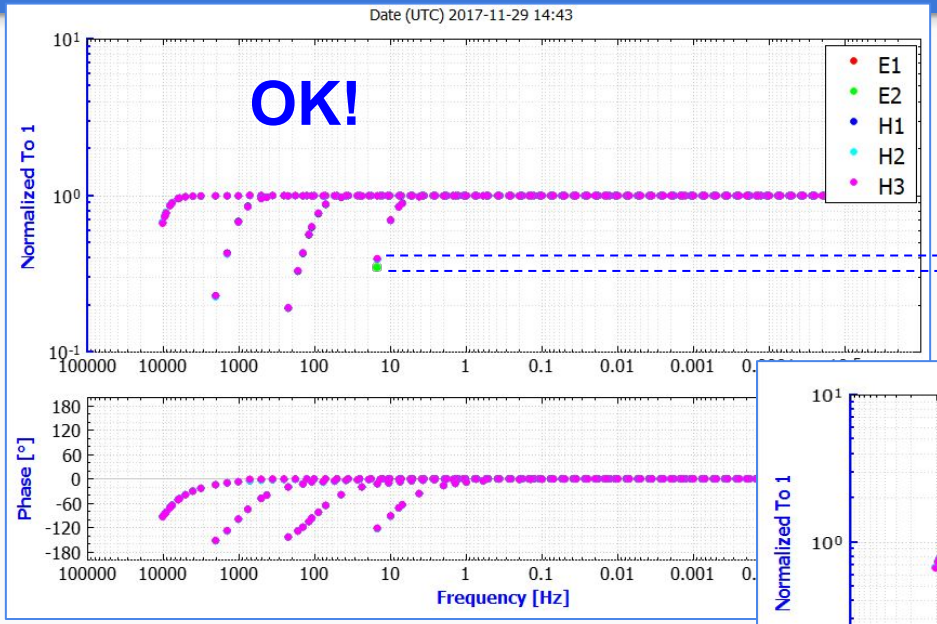


This calibration curve and cutoff frequencies apply only to receivers with a base sampling rate of 96 KSps, such as MTU-5D

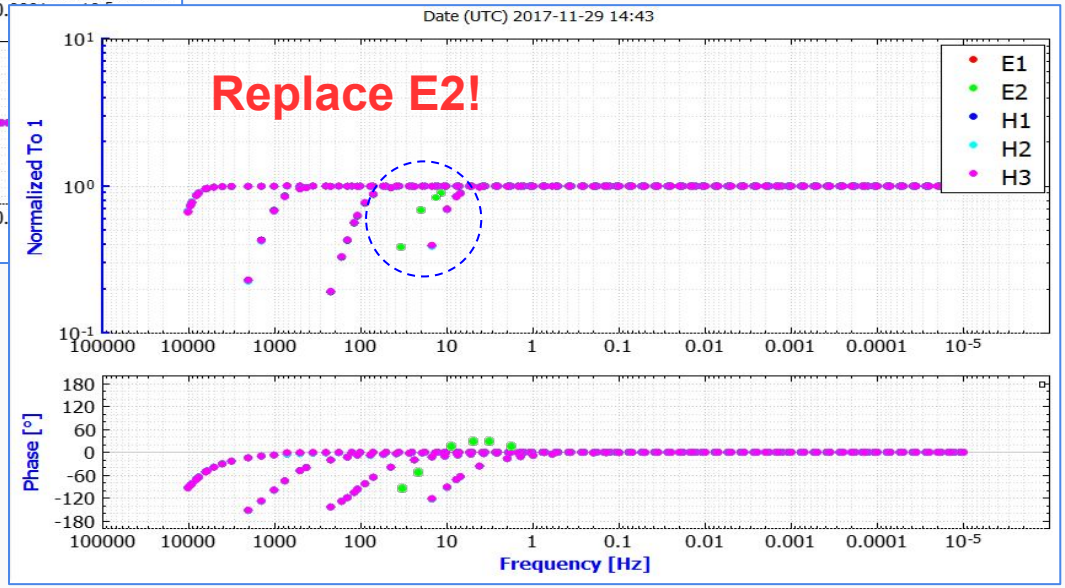
Horizontal level = 1
(or 10^0)
→ OK

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

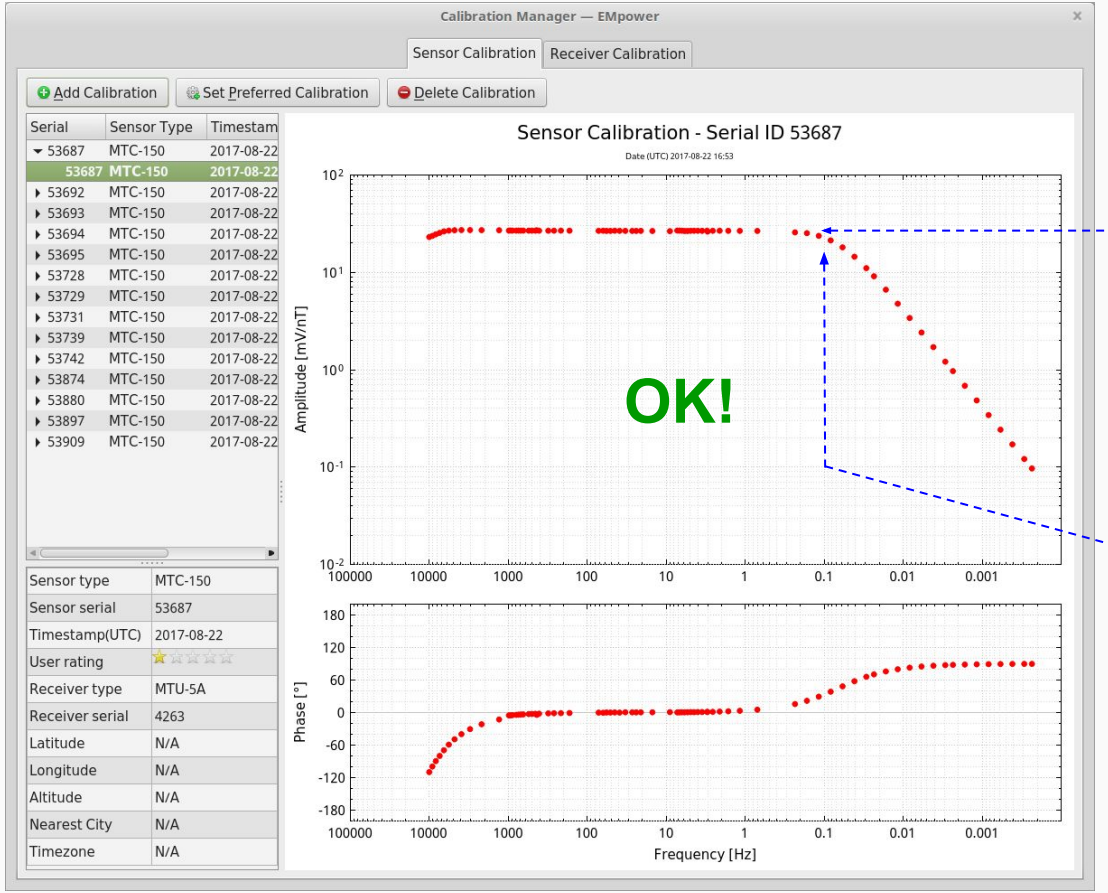
Receiver calibration QC



Small variations out
of the flat part → OK



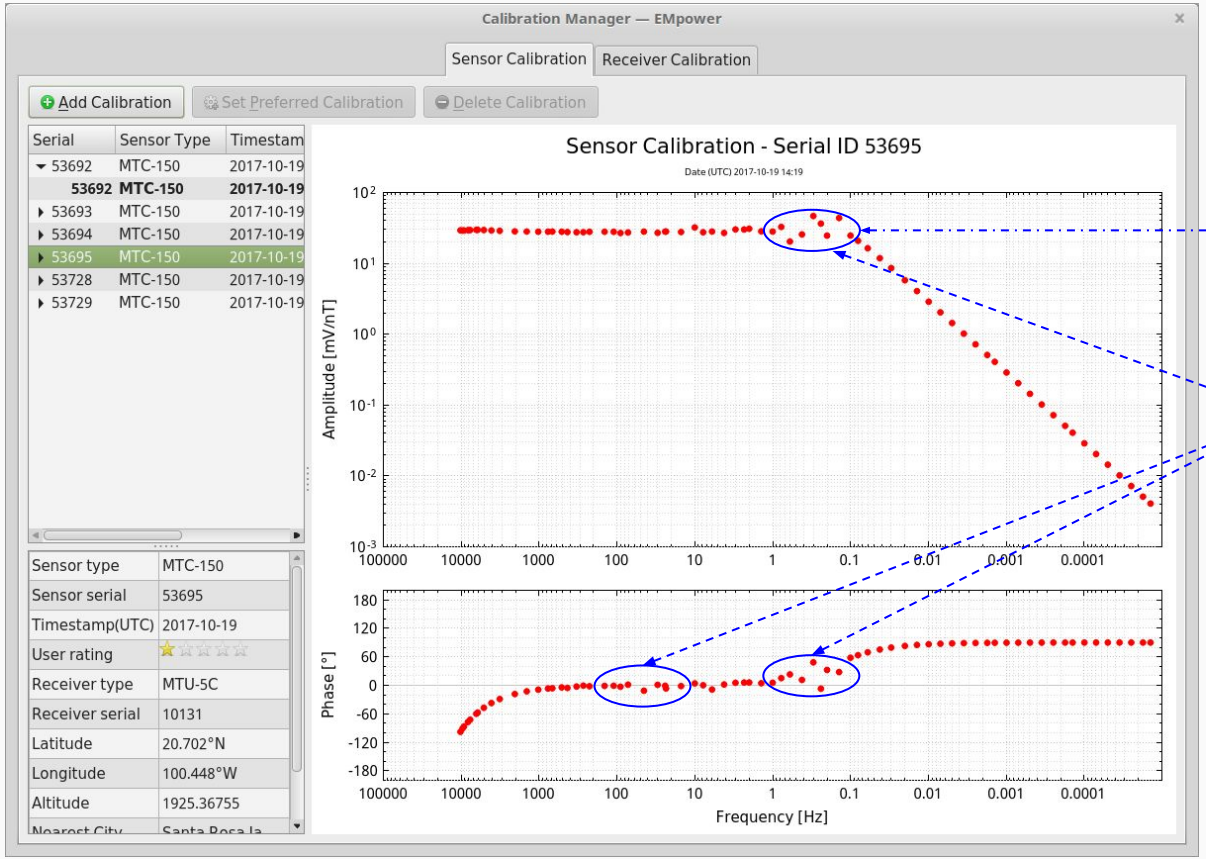
Sensor calibration QC



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

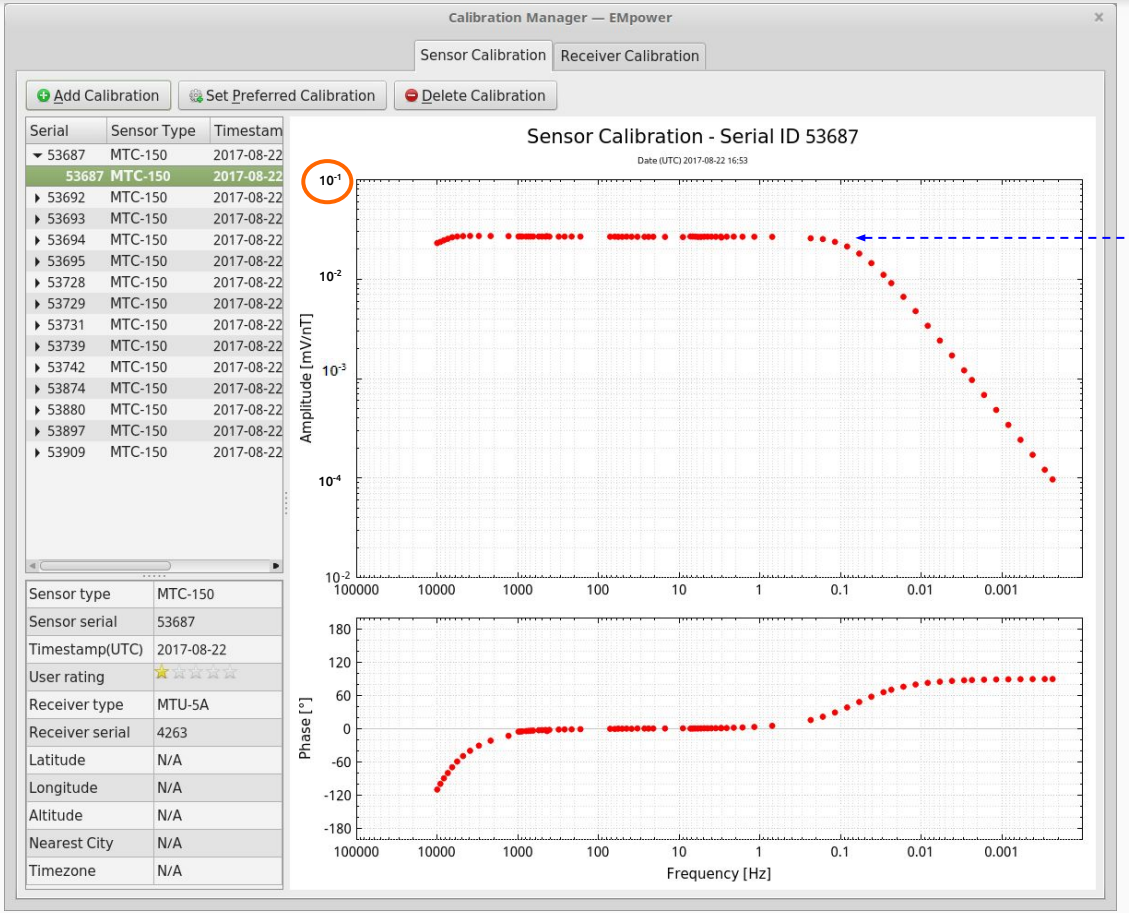


MTC-150, value should between 20-30. OK

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

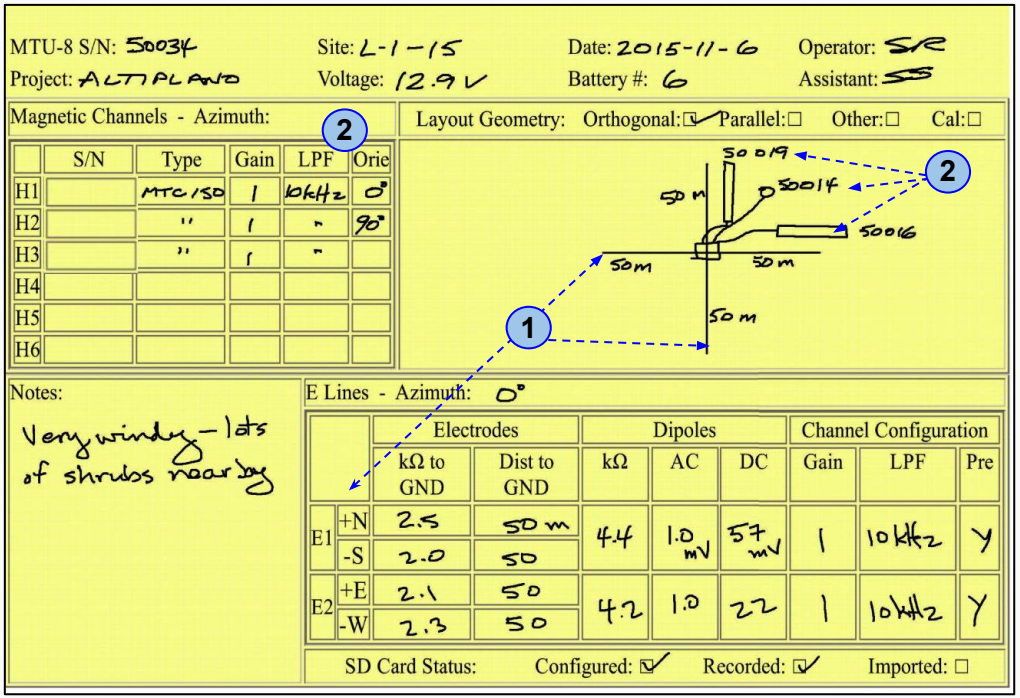
1. Following the Configuration Layout, use a compass to orient the electrodes to the north, south, east, and west of the ground electrode to layout the E-lines
   - Use coloured adhesive tape to mark the length of half the desired dipole on precut E-line cables

colour-coded:

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

2. Orient the Sensors following the Configuration Layout
   - Try to order the sensors 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 induced 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:☐

Notes:
Very windy – lots of shrubs nearby

E Lines - Azimuth: 0°

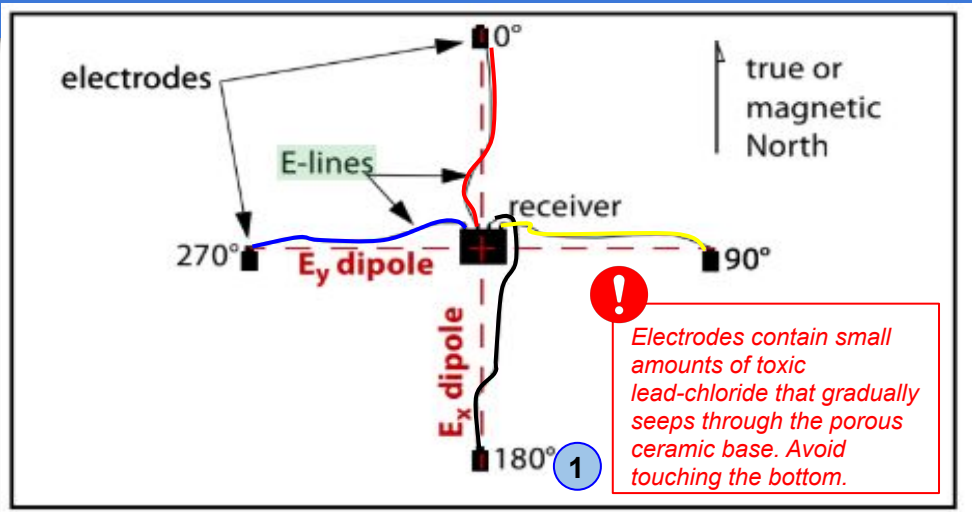
		Electrodes		Dipoles			Channel Configuration		
		kΩ to GND	Dist to GND	kΩ	AC	DC	Gain	LPF	Pre
E1	+N	2.5	50 m	4.4	1.0 mV	57 mV	1	10kHz	Y
	-S	2.0	50						
E2	+E	2.1	50	4.2	1.0	22	1	10kHz	Y
	-W	2.3	50						

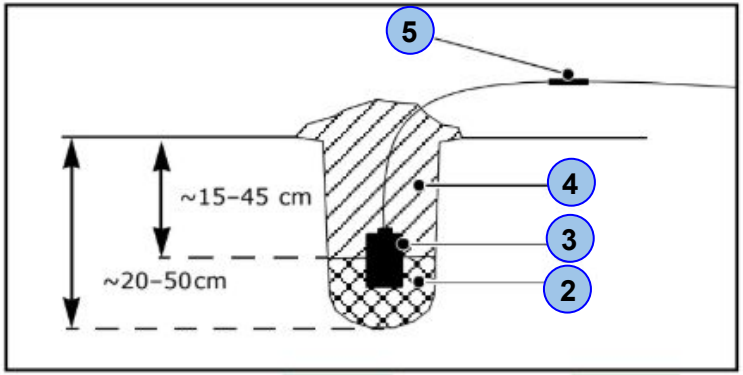
SD Card Status: Configured: ☑ Recorded: ☑ Imported: ☐

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

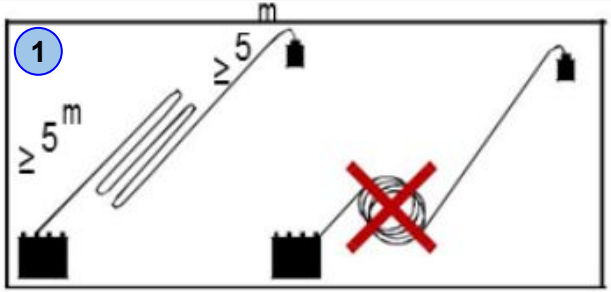


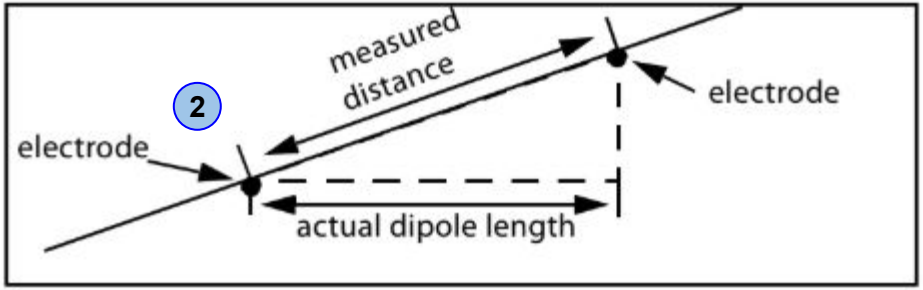


Best practices

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



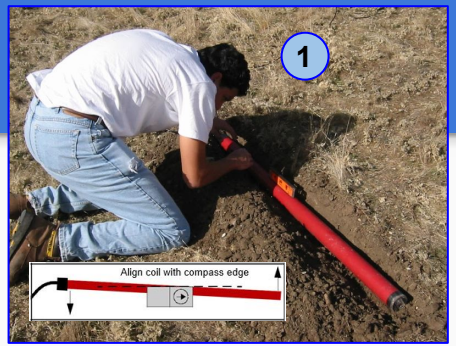


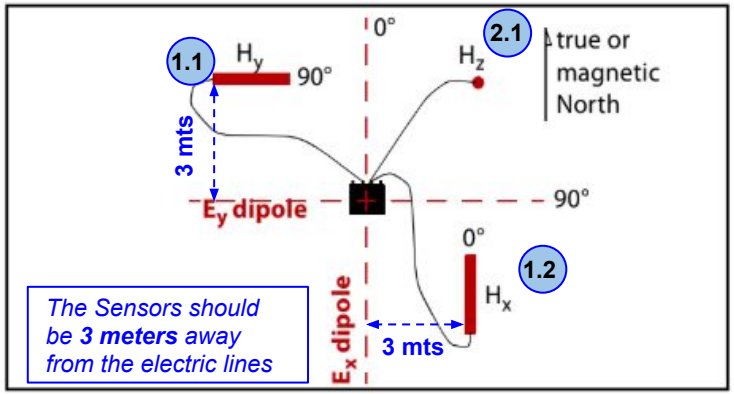
To minimize wind-induced noise, ensure that the sensors cables lie flat on the ground. Place weights on them every meter or so if necessary

Magnetic Sensors

Alignment of the sensors

1. **Horizontal (Hx / Hy),** dig a hole to lay out the sensor 40 cm deep x 15 cm from each end and 10-15 cm from each side
   - 1.1. The free end of **Hy** points East (connector points west)
   - 1.2. The free end of **Hx** points North (connector points south)
2. **Vertical (Hz)**
   - 2.1. Dig a narrow hole deep enough to completely bury the sensor
3. Record the serial numbers of the coils (Sensors) on the layout sheet 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

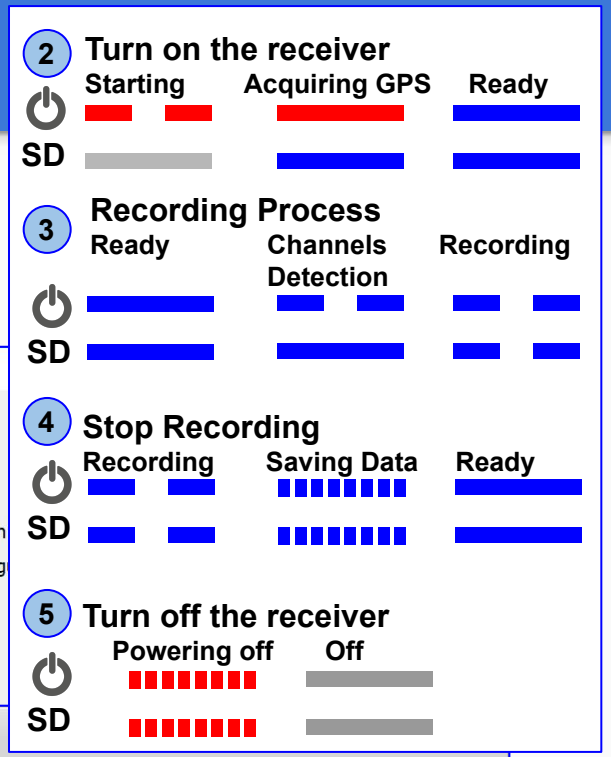
- Battery
- GPS antenna
- Insert an SD card with a valid configuration file
- GPS synchronization
- Measure electric line, and orient both electric line and sensors
    - Take note of terrain incline if >20 degrees
- Keep cables flat on the ground, (not draped over plants or obstacles). Bury or weight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

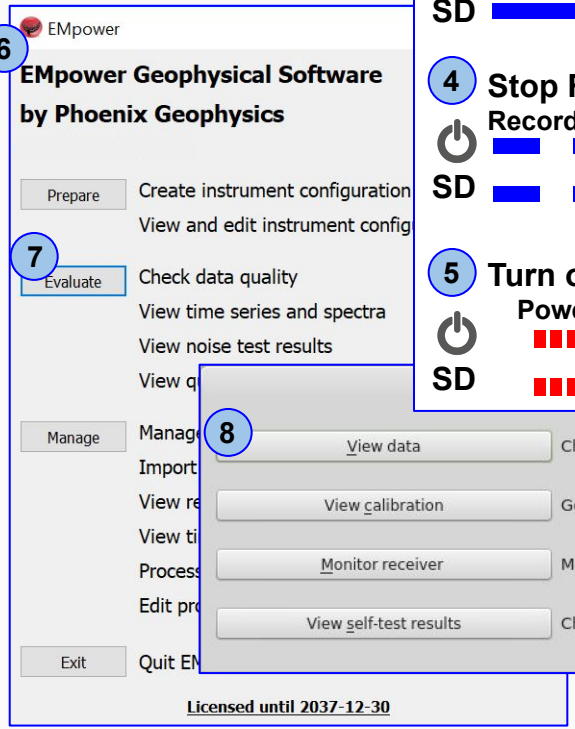
**Keep accurate records on a layout sheet.*

Test Recording

1. Insert the **SD Card**
2. Turn on the **receiver**
   **For any problem with the SD Card, check the Troubleshooting manual*
3. Record test data (no longer than 10 minutes)
4. Stop the recording
5. Turn off the receiver and extract the SD Card
6. Insert the SD Card in the computer and 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 desired recording folder and click Choose
   - Review the recording information

**Verify that there is 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 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 electrodes, they can introduce wide-band noise
- Note that the 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