# Adjusting the FMES Seismometer

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There are two things you need to accomplish when adjusting the FMES.

First, the sensor electrodes at each end should penetrate the fluid surface by about 1mm. If they are too deep, the sensitivity will be too low, and if not deep enough it will be too high. Their depth is adjusted by adding or removing small amounts of the electrolyte fluid.

Second, like any horizontal seismometer, the FMES needs to be *very* precisely leveled. The sensor electrodes should be at exactly the same depth, making the sensor-electrode resistances equal at the two ends.

The FMES detects ground motion as horizontal acceleration which causes the fluid to rise at one end and fall at the other. This causes the sensor electrode resistances to change, one increasing and the other decreasing. The resistance at each electrode is proportional to 1/(electrode depth) as well as to the electrolyte resistivity. The damping orifice modifies the instrument response so that it is proportional to ground velocity rather than to acceleration. Like most commercial broad band seismometers the FMES was designed to have a frequency response which is constant over its working frequency range, proportional to ground velocity.

Since the electrode depth is not visible after the FMES is assembled, it must be determined indirectly. If the standard electrolyte mix is used, we know in advance what the sensor resistance should be when the fluid level or electrode depth is correct. A circuit on the FMES board makes a signal which tracks the electrode resistances and extinguishes two pairs of LEDs when the depth is correct at both ends. The resistance values required to switch the lights may be adjusted, using pot. R15, in order to match the resistivity of the particular electrolyte formula in use.

The best FMES electrolyte formula found so far, consists of 50% by volume pure Propylene Glycol and 50% of 0.05molar diPotassium Phosphate ($K_2HPO_4$). The 0.05molar solution may be made by dissolving pure $K_2HPO_4$ in distilled water, at a rate of 8.71g per liter. The Glycol and $K_2HPO_4$ components should be mixed very thoroughly before the electrolyte is first used. Sometimes, even after many minutes, there are slight variations in the concentrations within the mixture, which could cause erratic performance. Give it plenty of time and mix well.

Every effort should be made to prevent dust particles in the air from getting into the electrolyte. We have found that adding a filter to the syringe used to fill the FMES can help keep out any particles which may have gotten into the solution. First, fill the syringe, add the filter, then inject the electrolyte through it into the FMES. Note: don't fill the syringe with the filter attached. In addition, before filling the FMES, it should be thoroughly rinsed to flush out any small particles which may be inside.

# Procedure

**1. Cleaning:**

Flush out a new FMES by repeatedly injecting pure distilled water into one fill port, shaking the instrument well, then letting the water flow back out. If both ends have fill ports, it may work best to inject water into one port and let it flow out the other. Time spent flushing the instrument at the beginning will reduce the chances of its becoming noisy some time later.

**2. Initial Filling:**

Connect the FMES amplifier board to the two sensor electrodes (the short ones) and to the (longer) reference electrodes. Referring to the circuit board, mark the N/E ends of the instruments. These are the ends which will be oriented either to the North or East when the instruments are in their final locations. Apply power to the board. Initially, the 'N/E Fluid Low' and 'S/W Fluid Low' LED's will be lighted. With the FMES roughly level, slowly inject approximately 25ml of electrolyte, allowing the fluid levels to equalize at both ends, until the two 'Fluid Low' lights are out. Disconnect power from the circuit board and slowly tilt the instrument back and forth, (about 30°) so that the fluid goes from one end to the other. This will help dislodge any small bubbles which may have been become trapped in corners during the filling process. Unless all bubbles are gone, the FMES will be noisy.

**3. Initial Tilt Adjustment:**

Re-connect power to the circuit board. Roughly adjust the tilt by raising or lowering the N/E end of the instrument until the Fluid Level LED's for both ends appear the same, both indicating 'High' or 'Low' or all off. If any of the four Fluid Level LED's are still on, do step 4. If all four are off, the FMES is properly filled and you can replace the Fill Port screw(s) and go on to step 5.

**4. Adjust the fluid level:**

If any of the 'Fluid Level' LED's are still on, adjust the tilt, as neeeded, until the LED's for both ends appear the same. Then either add or remove small amounts of fluid, waiting for the levels to equalize, until all four stay off. The FMES is now properly filled and you can replace the Fill Port screw(s).

**5. Final Tilt Adjustment:**

With the instrument fully assembled in its case and sitting in its final location, it should be precisely leveled. Carefully adjust the height of the N/E end until the two very sensitive Tilt LED'a are both off. It will be necessary to wait a few seconds after each small adjustment to allow the fluid levels to equalize at both ends. Now, with all 6 LED's off, the FMES is ready to run.

**6. Maintenance:**

It would not be surprising if the tilt and fluid level would have to be corrected slightly after the instrument has been running for a few weeks and has settled down.