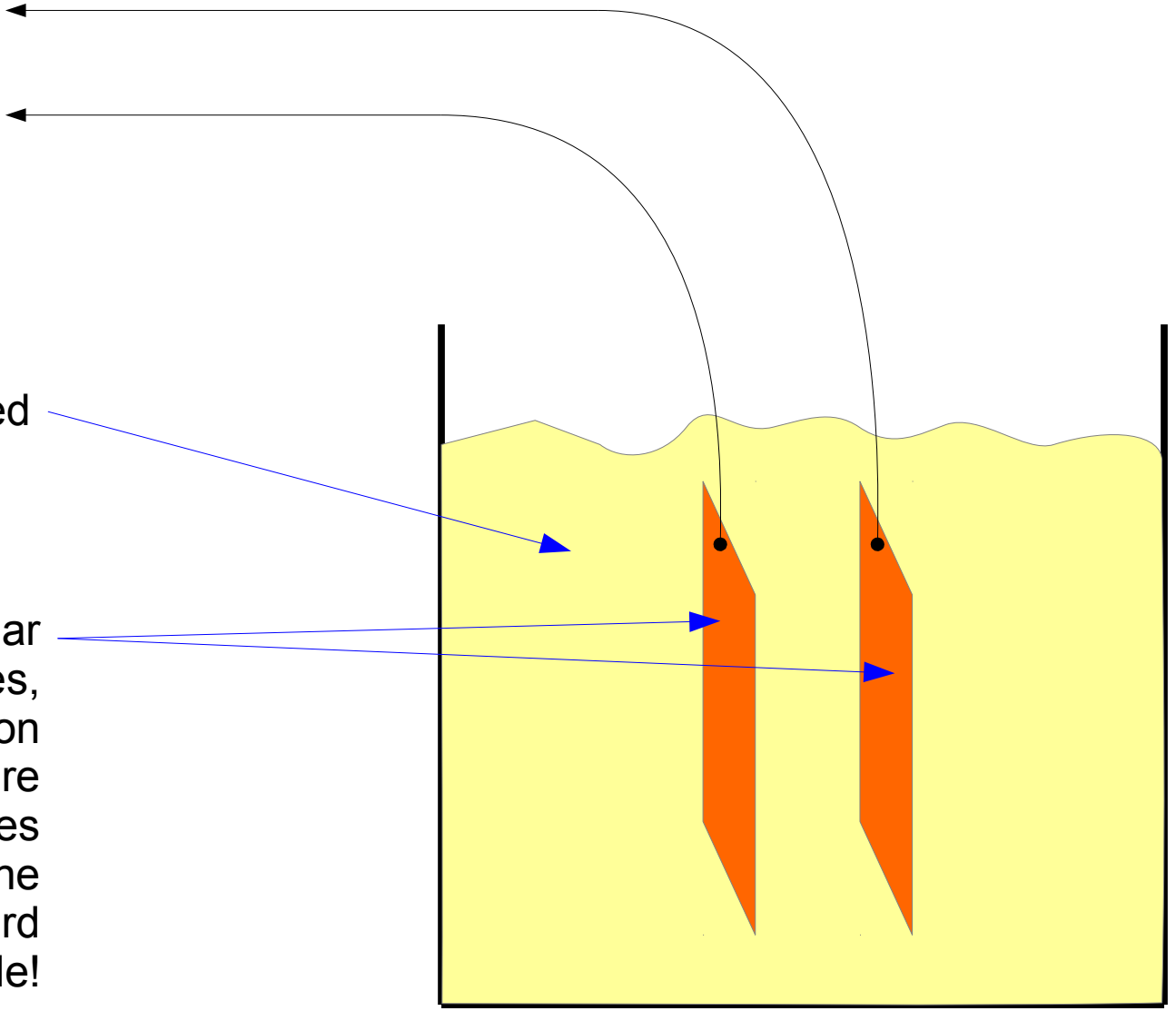
Soil Moisture Sensor Schematic

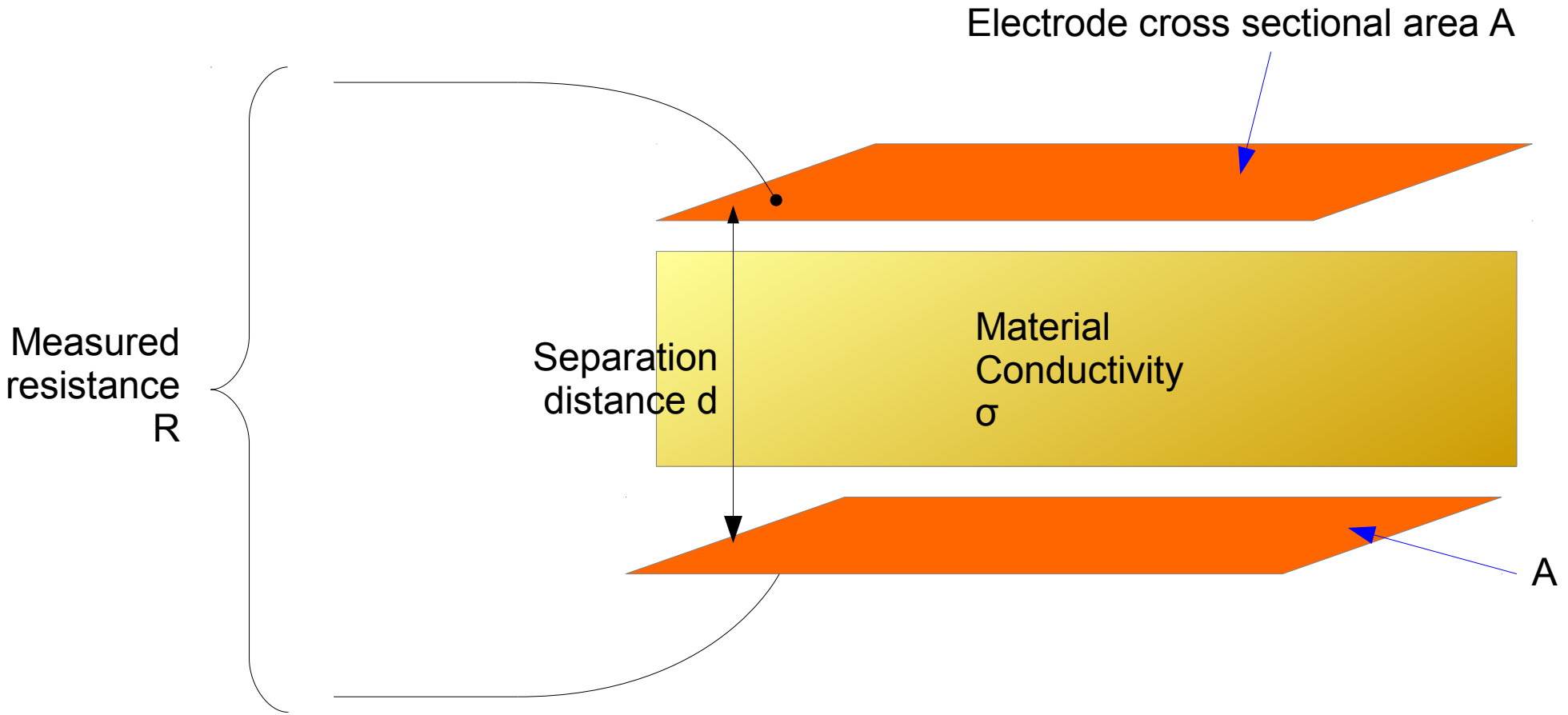
Attached wire leads to conductivity sensor circuit. Solder onto Cu cladding on probe boards.

Soil and water to be sampled

Two parallel rectangular conducting electrode plates, for example Cu cladding on pieces of circuit board. Be sure to face the copper plated sides toward each other on the inside, and the insulated board sides to the outside!



Conductivity and Resistance

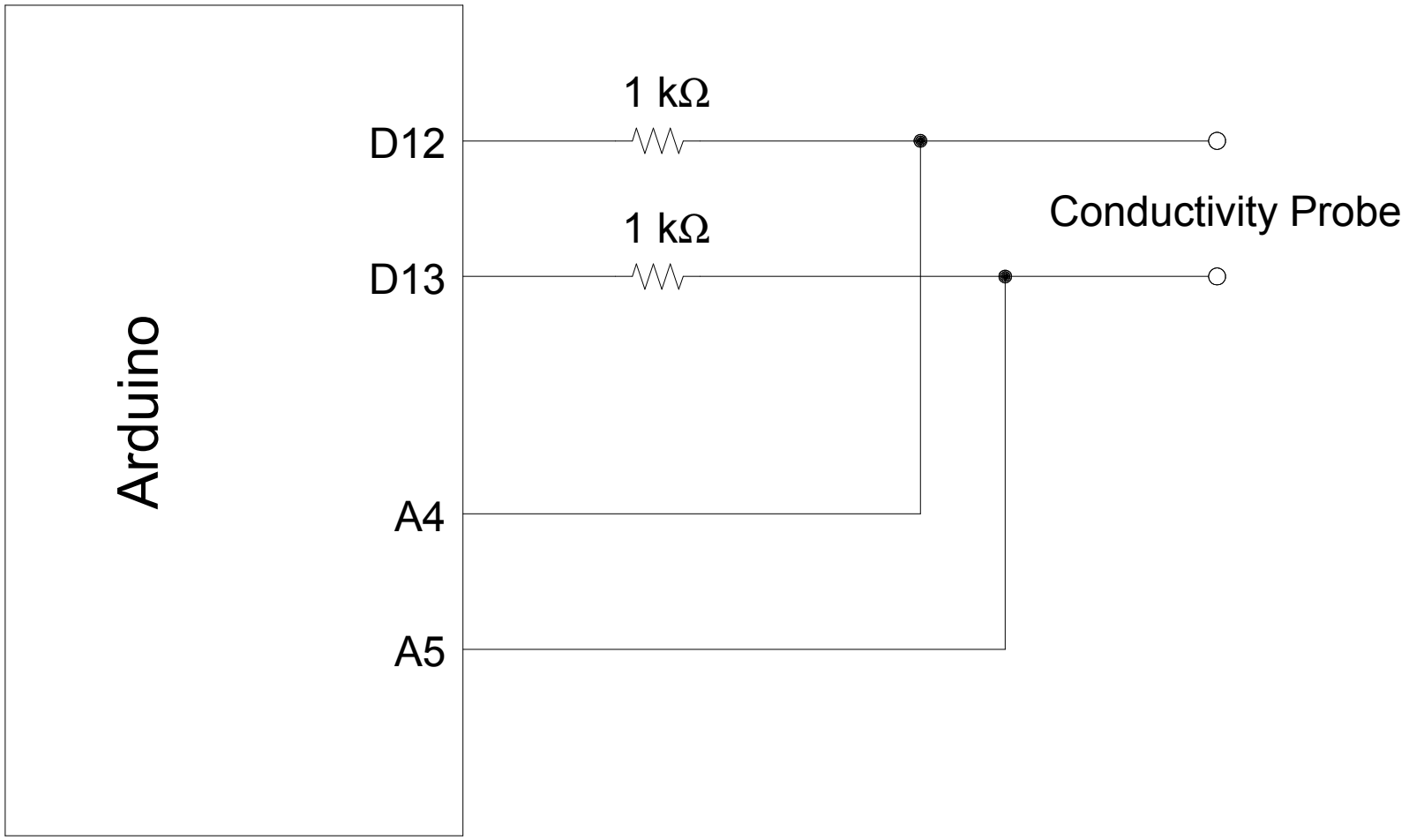


The sensor uses an electrical resistance test to determine the conductivity and therefore the water content of the soil. The higher the water content of the soil, the higher the conductivity and the lower the resistance measured between the two rectangular electrodes. Conductivity and resistance are related by the approximate formula

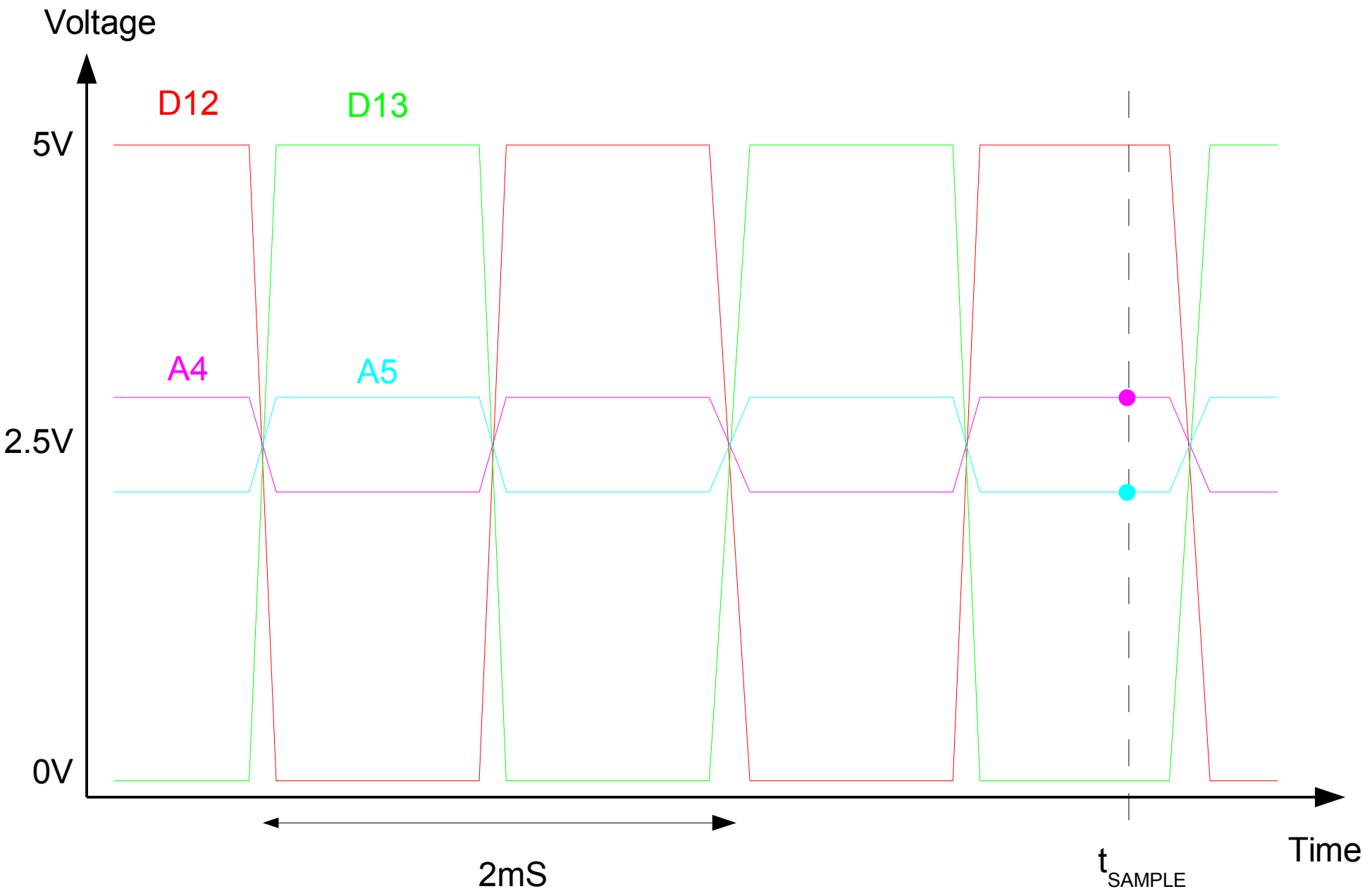
$$\sigma \approx \frac{d}{R\,A}$$

Resistance ***cannot*** be measured by passing a DC current through the water in the soil sample, as an electrochemical reaction will occur that distorts the measured voltage. Instead, an AC square wave current at 500Hz is generated by the Arduino and the voltage across the electrodes is sampled just at the end of one cycle.

Wiring to the Arduino



Resistance Measurement Waveforms



Returned Resistance Reading

When you call the getConductivity() method from your Java code, firmware in the Arduino samples the analog voltages at A4 and A5 at the time indicated on the plot on the previous page, and an analog-to-digital converter converts them to digital codes. The codes range from 0 to 1023 corresponding to 0 to 5V. The digital difference between the codes is returned as a reading. This difference represents the amplitude of the square wave voltage across the conductivity probes, and therefore is related to the resistance between the electrodes, as shown in the formula

$$\text{ADC Code} = \frac{R}{R + 2000\,\Omega}$$

Your laptop program must translate this reading into a conductance, knowing your electrode cross sectional areas *A* and their separation distance *d*.

This circuit will measure resistances over a range of about 250 to 5000 ohms. Design the separation distance of the electrodes in your probe to cover a range of soil water content within this resistance range. You will have available materials and mass scales to produce standard soil samples with known water mass content with which to calibrate your digital readings.

Resistance versus Return Code Relationship