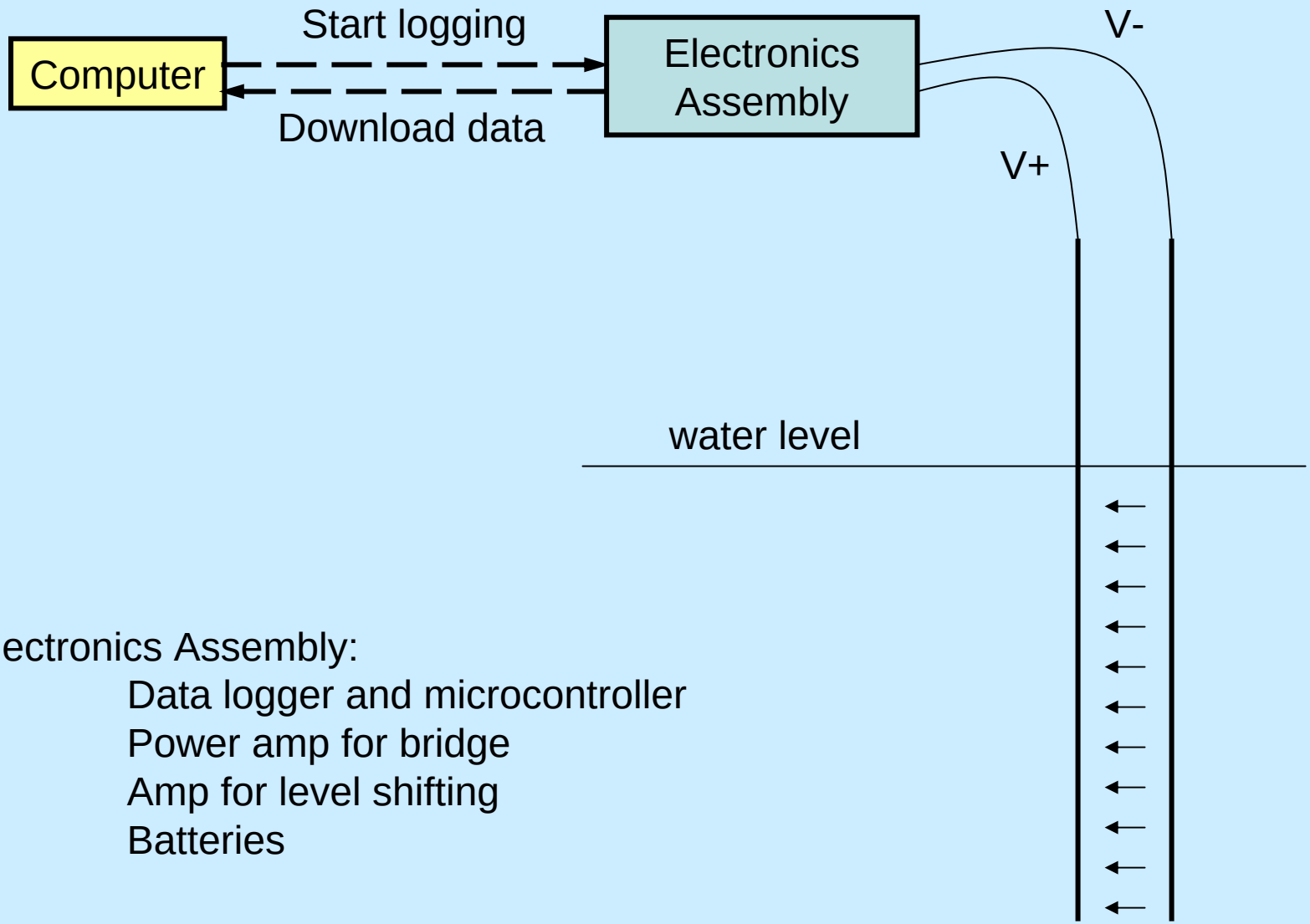
Building a Resistive Wave Probe

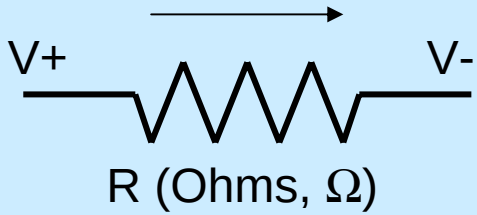


Electronics Assembly:

- Data logger and microcontroller
- Power amp for bridge
- Amp for level shifting
- Batteries

Resistance R = Volts loss per Ampere driven through the “device”

R is <u>not</u> a property of bulk material!
Conductance = 1 / Resistance



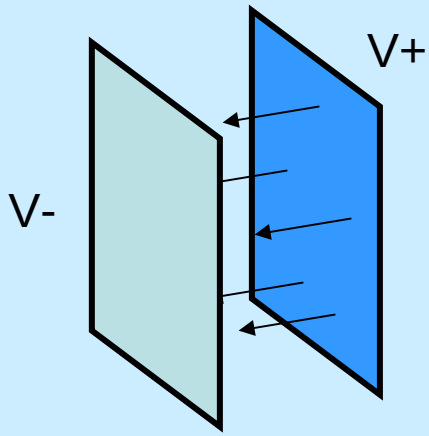
Conductivity of seawater: K ~ 4 S/m, where

1 S = 1 Siemen = 1 Ampere per Volt:
One Volt across opposing plates of area $1m^2$ drives one Ampere

1 S/m means one Volt drives one Ampere, when the distance between electrodes is one meter

Conductivity is a property of bulk material!
Resistivity = 1 / Conductivity

Equivalent resistance through seawater:
R = distance / [area x K]



Your Wave Probe

d = wire diameter

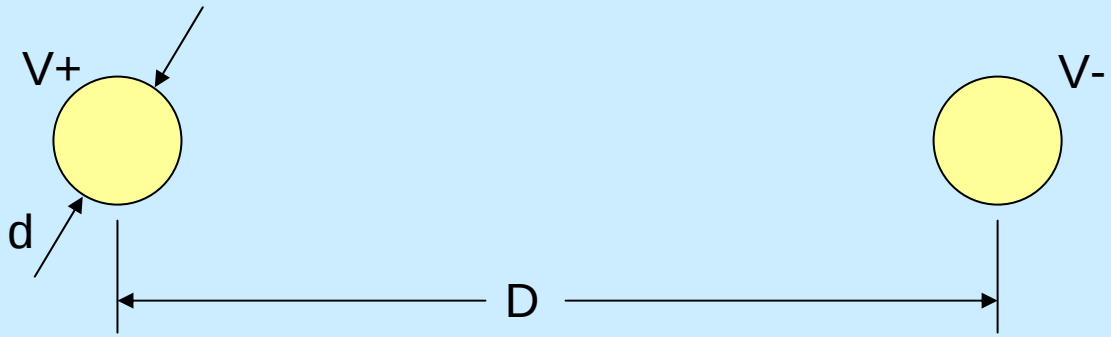
z = immersion depth

D = separation distance

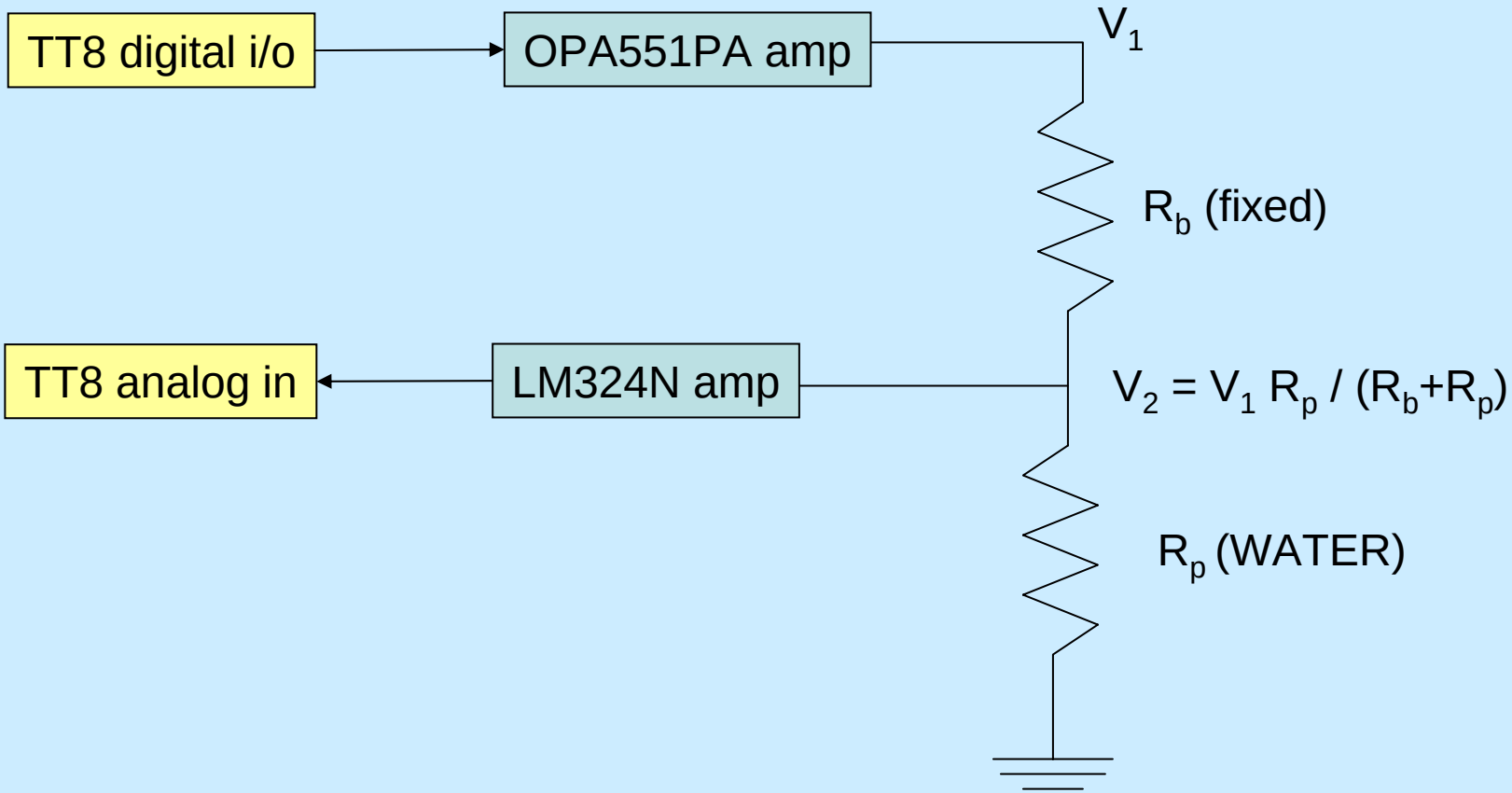
Two wires of immersed surface area πdz:

Then **$R = D / [\pi d z K]$**

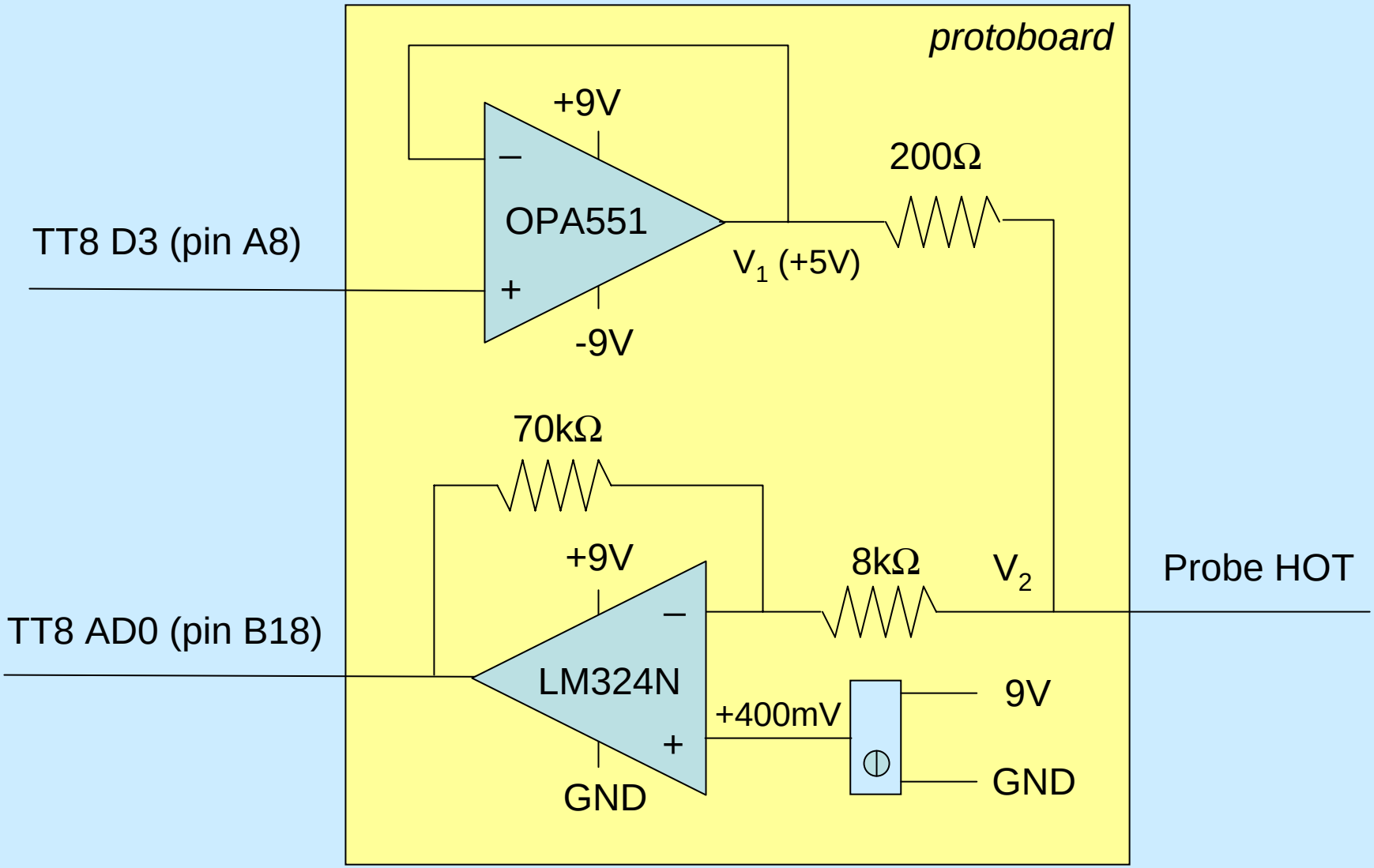
$\sim 0.10m / [\pi \times 0.001m \times 1m \times 4S/m] = 8\Omega$



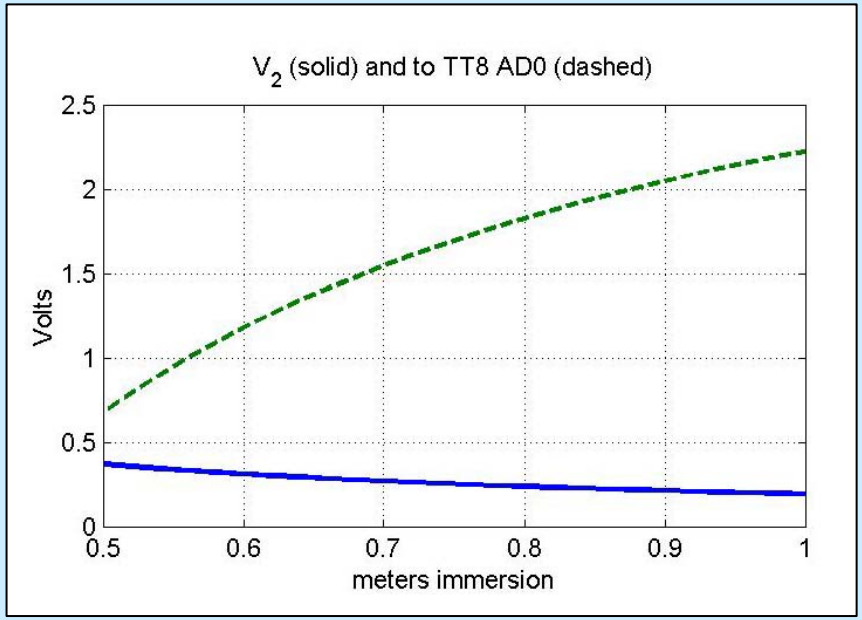
Voltage Divider



Wave Probe Electronics Schematic



Check the Math!



- Output of OPA551 is zero (bridge not energized) or five Volts (energized).
- The voltage divider splits the fixed 200Ω with about 10Ω in the water, so V_2~250mV.
- The TT8 AD0 sees about:

  (70kW+8kΩ)/8kΩ*400mV – 70kΩ/8kΩ*V_2

  ~ 3.9V – 8.8 V_2

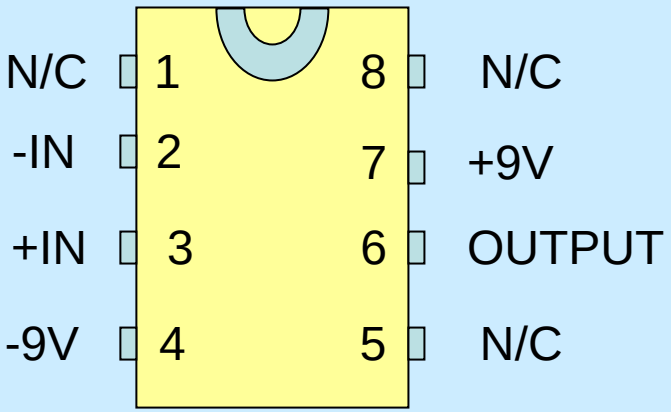
  ~ 1.7V if V_2 = 250mV **OK**

Guidelines to Building

- Run the TT8 with a 12V battery – always double check polarity! RED IS POSITIVE
- You'll run the program *slogger*; the output will always be written to output.dat. Use `ren output.dat myfile.dat` to rename the file.
- Tie the analog and digital grounds of the TT8 to the protoboard.
- Tie the middle of the two 9V cells to ground; the batteries supply +9V and -9V.
- Start by building up the OPA551; confirm that V_1 is zero when input is zero, and V_1 is 5V when input is 5V.
- When the circuit is complete, use a resistor of around 10Ω in place of the probe to check the LM324N output. It should be about +1.5V to +2V.
- When you can log the test circuit output using *slogger*, you're ready to go in the water!
- When you calibrate, the curve should have the form $V = k_1 + k_2 / z$
- TT8 can read 0 to +4095mV, in units of one milliVolt

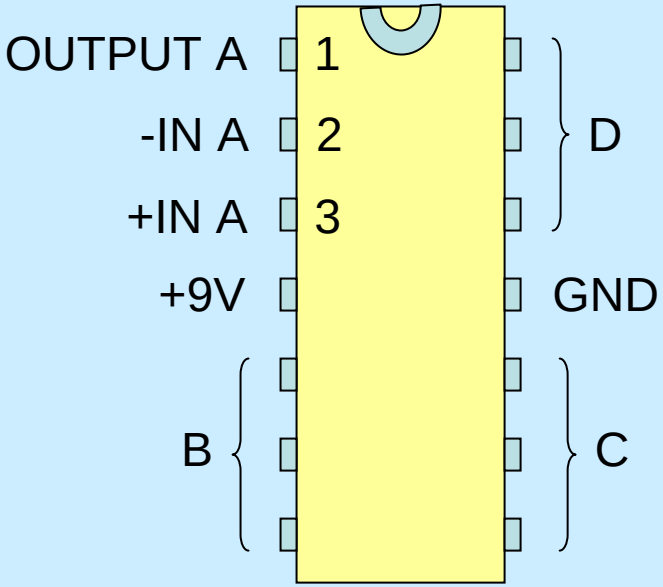
Hooking up the amps

OAP551
High Voltage
High Current



8-DIP (dual in-line pin)

LM324N
Low-Power
Quad



14-DIP