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Electronic System Design 3
Lecture 6.2: Designing Grounds

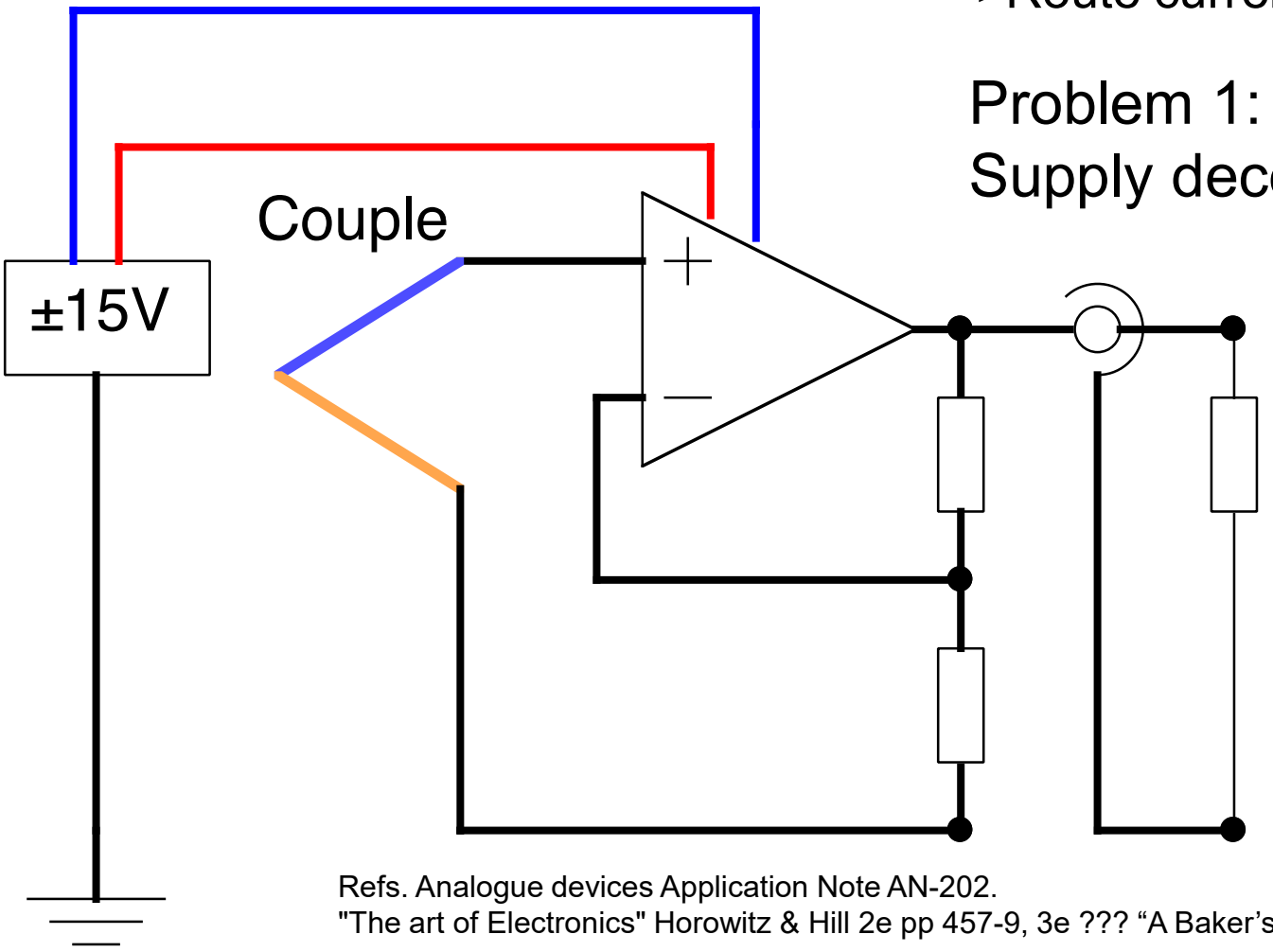
Dr Duncan Bremner

Designing ground

Think where the current will flow.
Put all signals onto a line with ~ no current flowing

=>Route currents separately

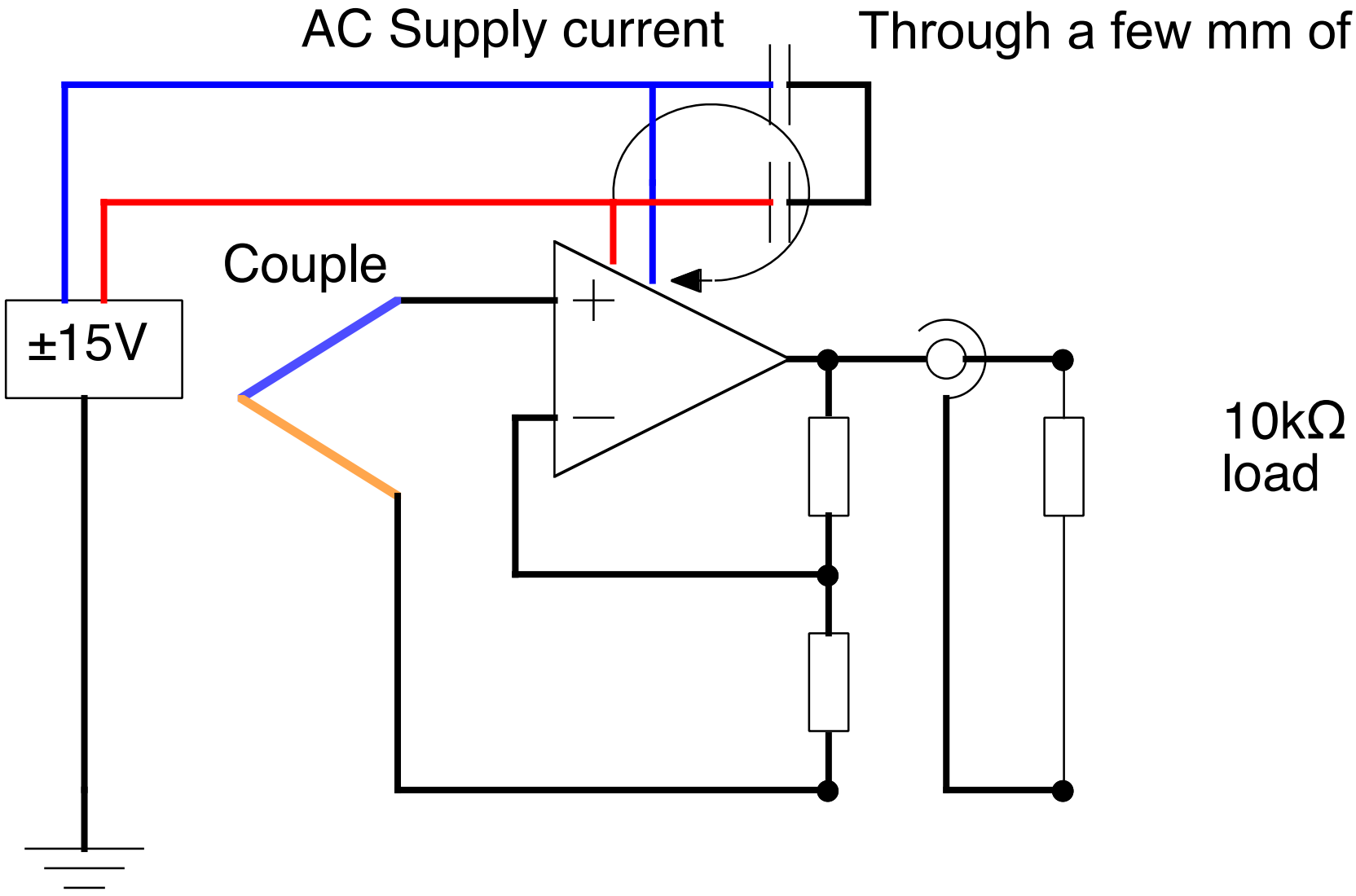
Problem 1:
Supply decoupling



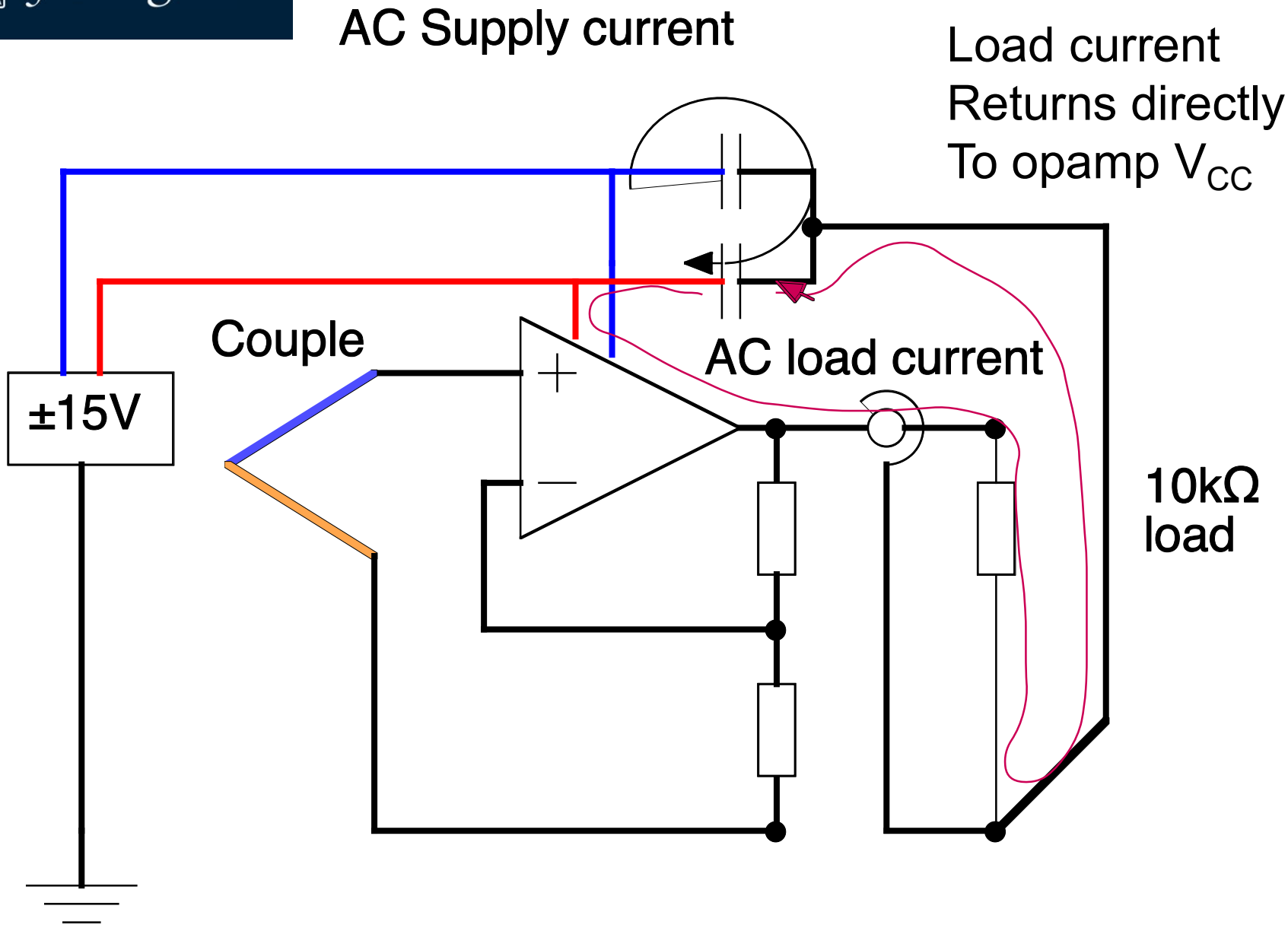
Refs. Analogue devices Application Note AN-202.
"The art of Electronics" Horowitz & Hill 2e pp 457-9, 3e ??? “A Baker’s Dozen” Chapter 11

Designing Ground (2)

Current only goes
Through a few mm of wire



Designing ground (3)



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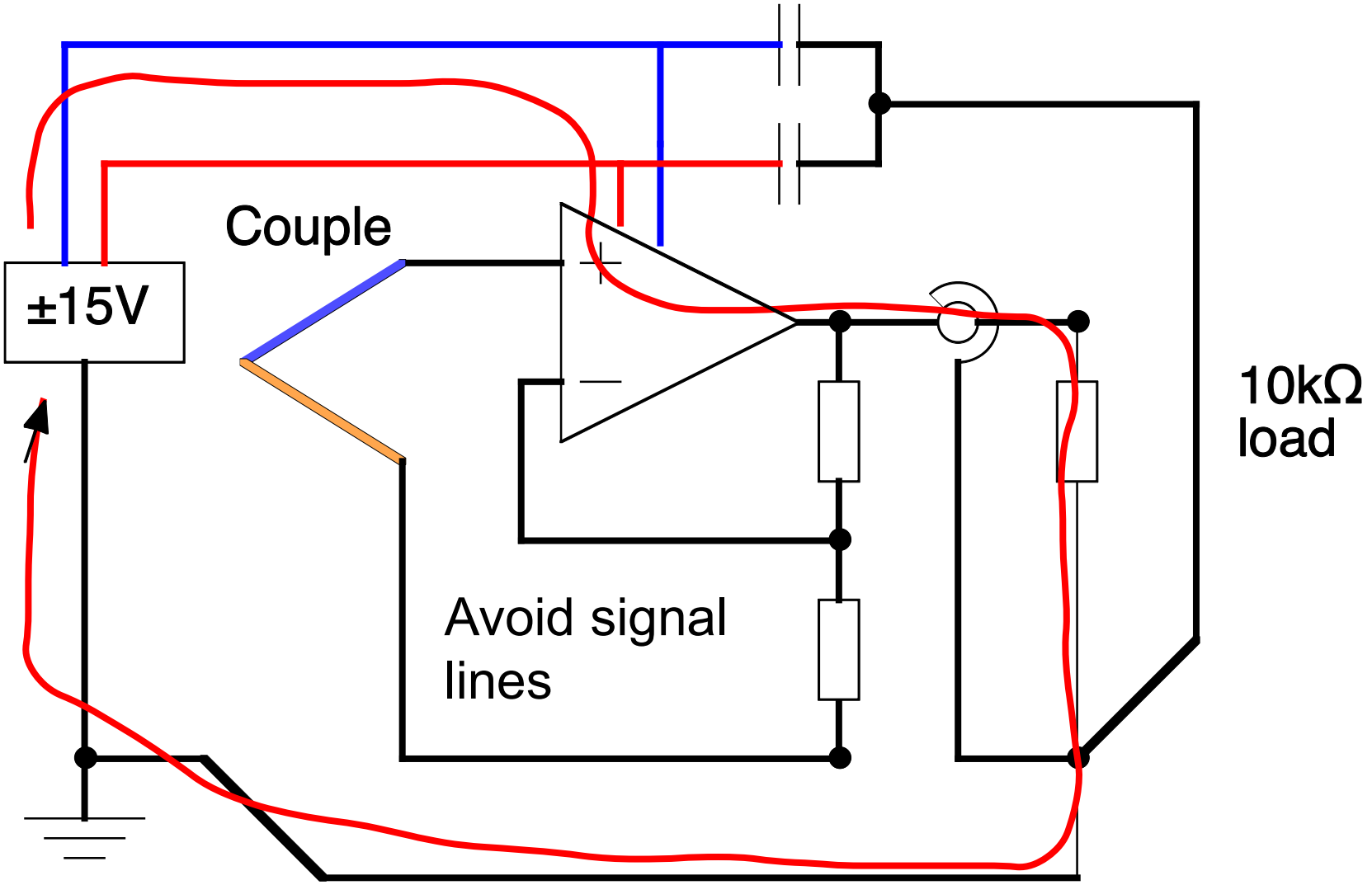
Designing Ground (4)

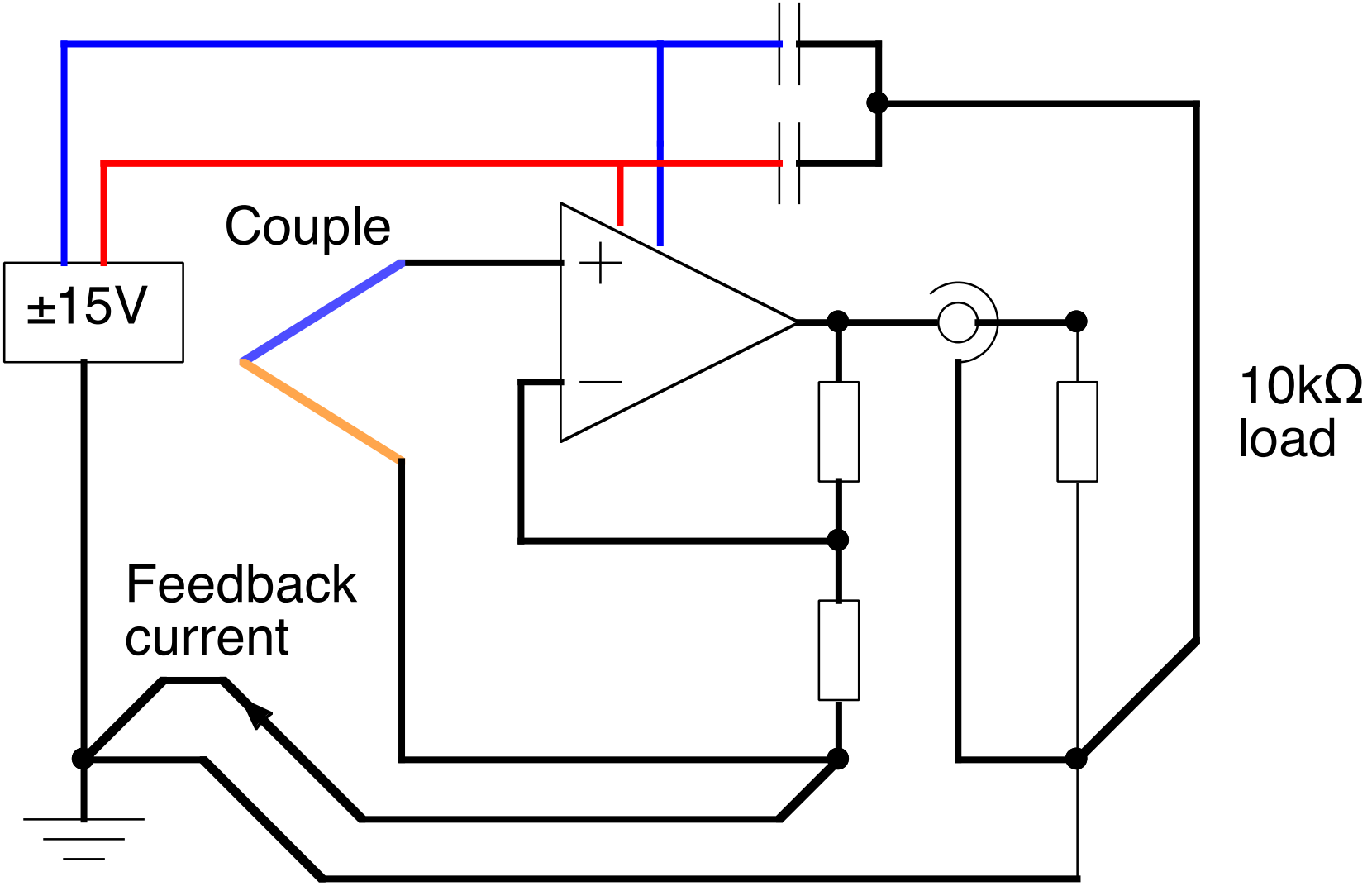
Connect cold end of load directly to PSU



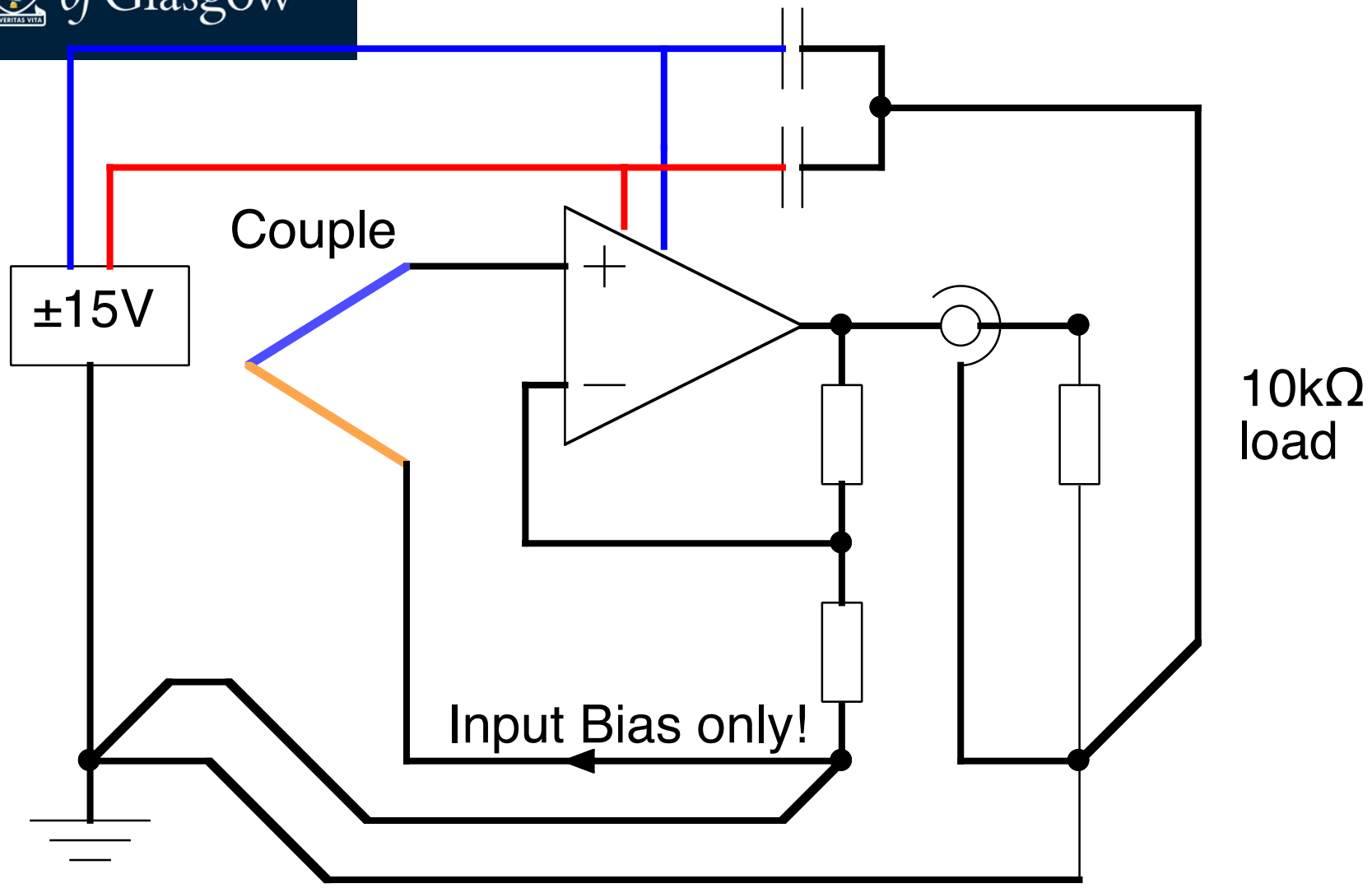
DC Load current

Designing ground (5)

Connect small, known current paths separately to PSU

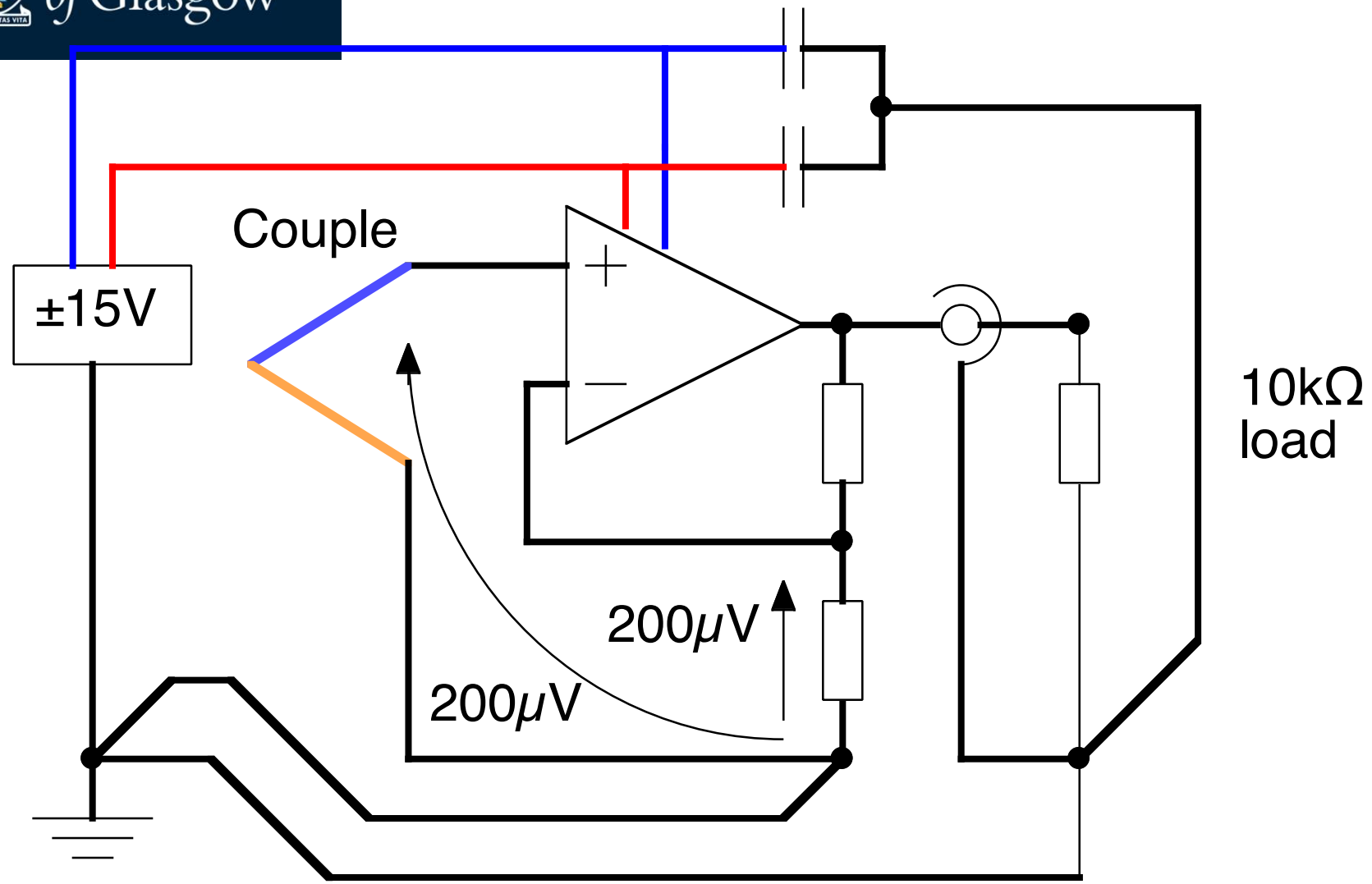


Designing ground (6)



Success! Thermocouple is at same voltage as bottom of Feedback resistors. Error is I_B x 0.1Ω ~ 0.1nV!!!

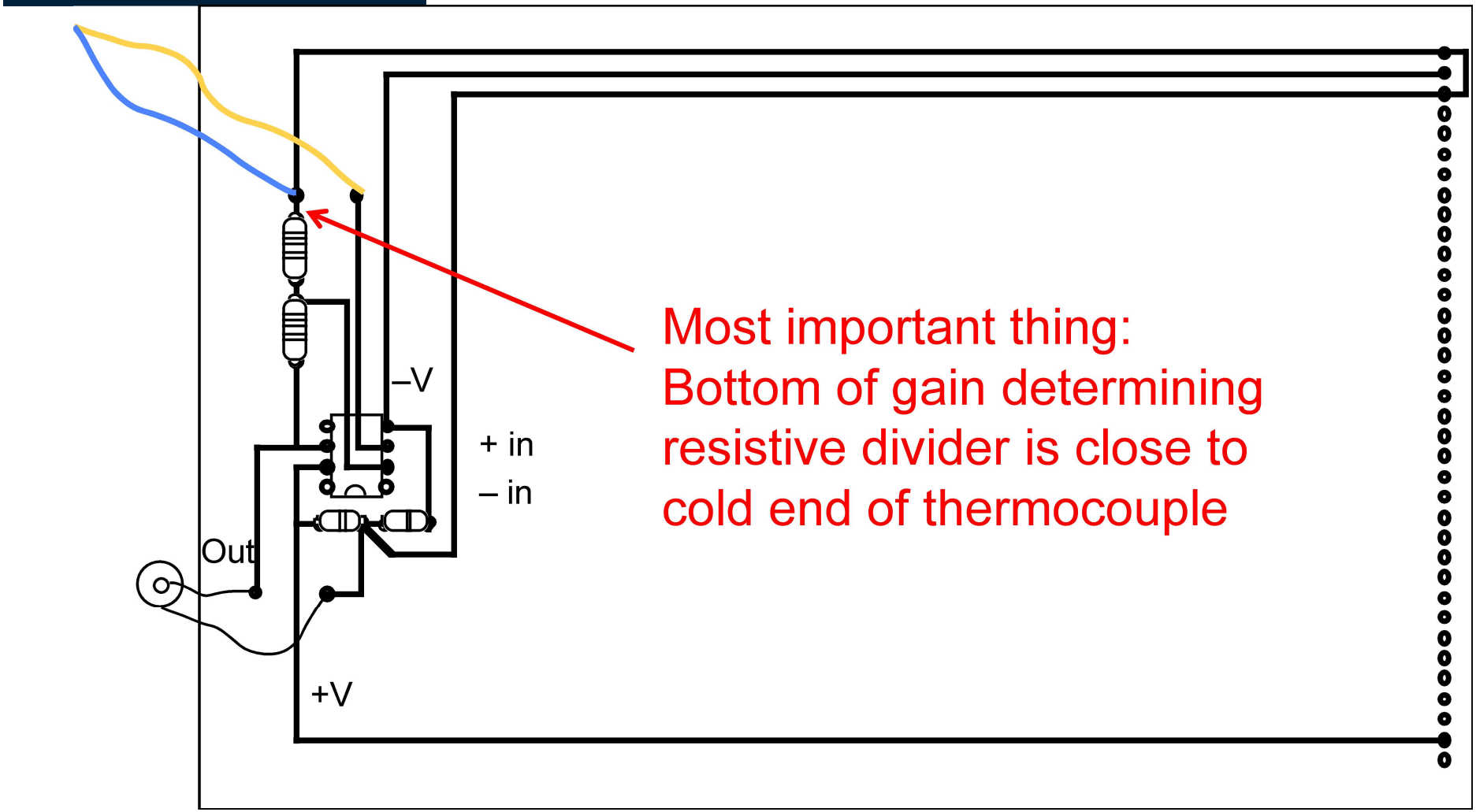
Designing Ground (7)



Voltage across lower R is same as Voltage across couple

This is the voltage which is amplified

PCB Layout


Thermocouple
–V
+ in
– in
Out
+V
Most important thing:
Bottom of gain determining
resistive divider is close to
cold end of thermocouple

Designing Ground (8)

Summary:

- Decouple supply currents close to the IC first
- Bring "Decoupling" grounds together and route separately to PSU
- Decouple Logic Close to chip
- Keep "logic ground" separate from others and route separately to PSU
- Design "Signal" ground so that no currents flow through connections of low voltage

"Signal Ground" is a signal which is ~ 0V,

not "The ground for the signals"

Designing Ground (9)

Good thing about this method:

- System manufacturing cost is unchanged

Bad things about this method:

- System design cost is (much) higher
- Full analysis is complicated (coupling, radiation…)
- Complex ICs may not give adequate access to signals
- Only appropriate to small systems / sub-systems
- Incompatible with most layout tools (they only ‘know’ about a single ground connection…)

Generally this method is a help, but not a complete solution

Common-Mode Rejection

Problem with previous circuit is that ground is a signal level...

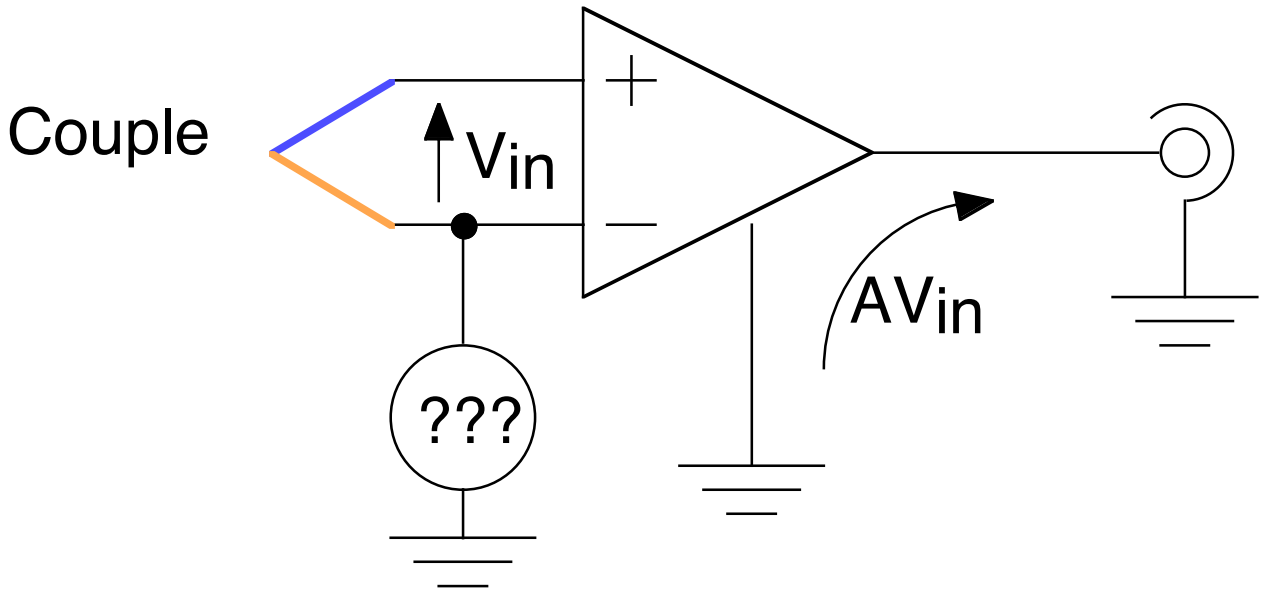
And a sewer for random stray currents

Use PLAN B

Measure the **difference** between the two leads and let 'em vary
With respect to "Ground" however they like

Common-Mode Rejection (2)

Component “X” = Instrumentation Amplifier



Component X

- Has a big gain (O/P is big, so no more problems)
- Doesn't care what ground potential “???” Is
  = Common-mode rejection
- Produces an output voltage with respect to an explicit third (output ground) input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Thank you
谢谢
INSPIRING PEOPLE