

ENSC 220 Lab Tutorial

Fall 2008

Credits:

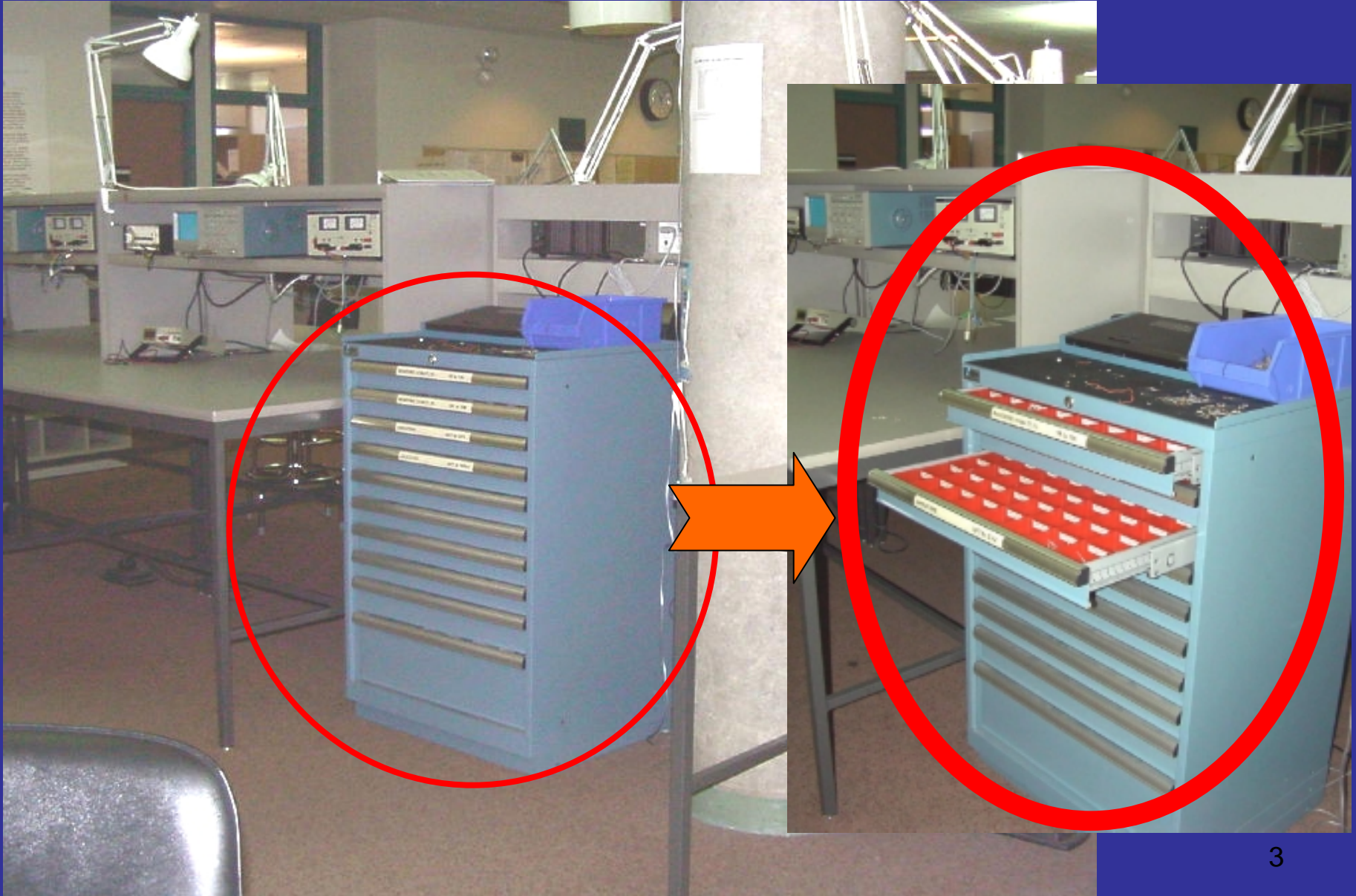
Dr. Ash Parameswaran, notes

Dr. Atousa Hajshirmohammadi, layout

ENSC LAB (9000 level)

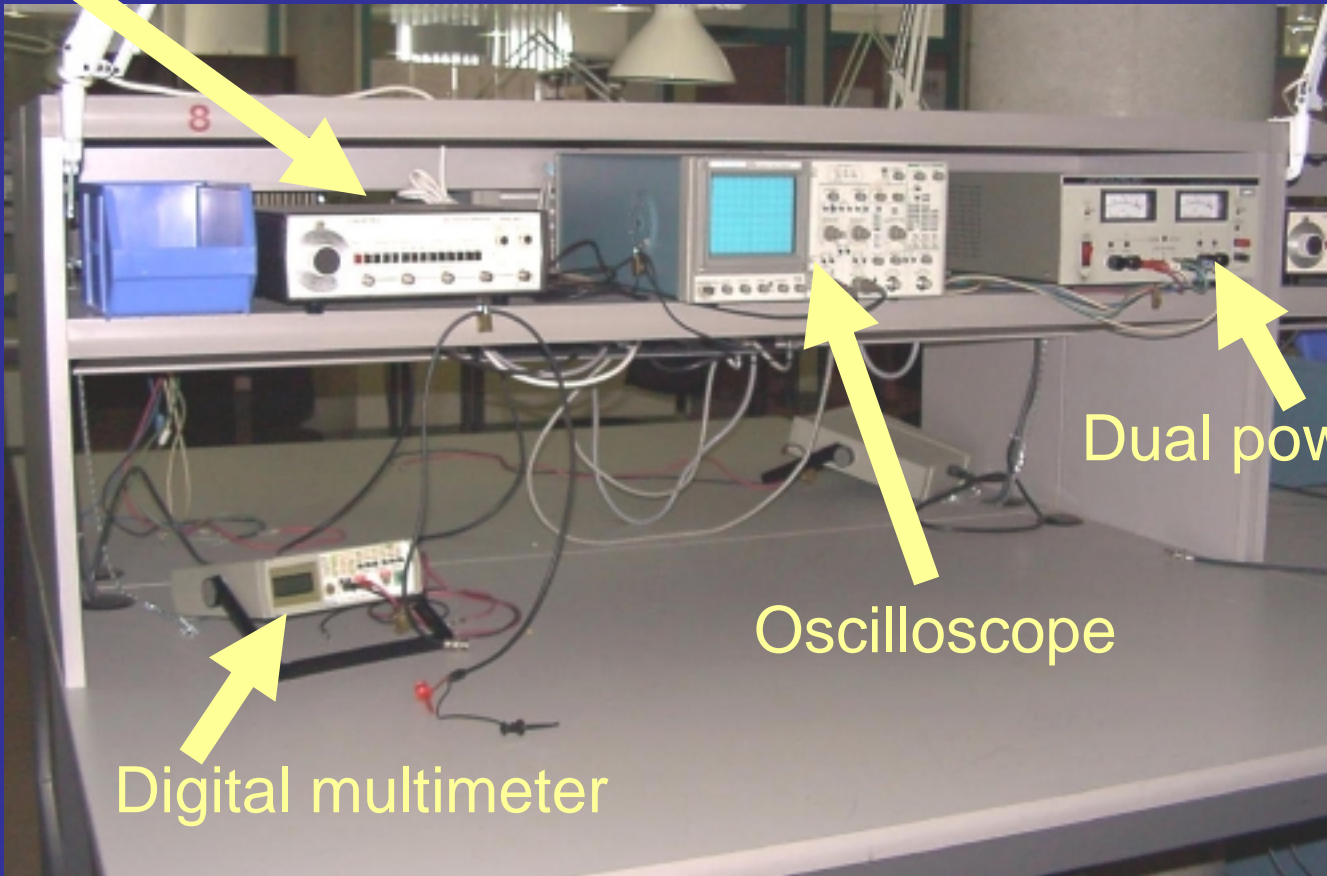


Component rack



Lab bench

Function generator



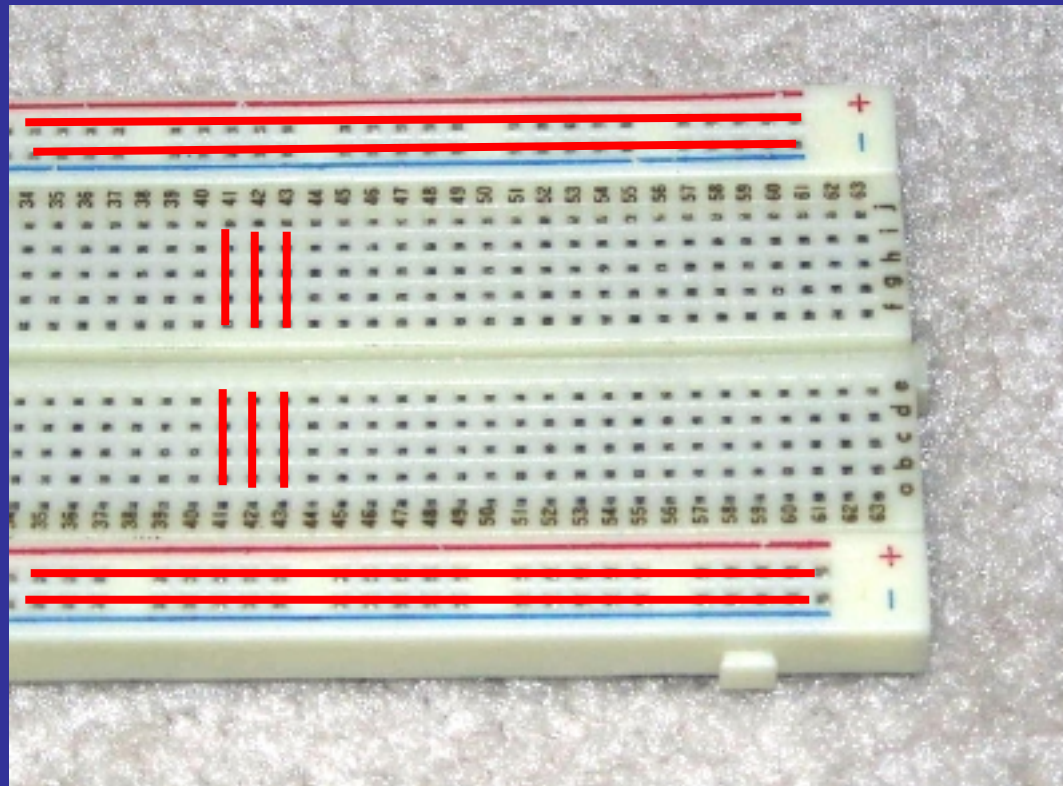
Dual power supply

Oscilloscope

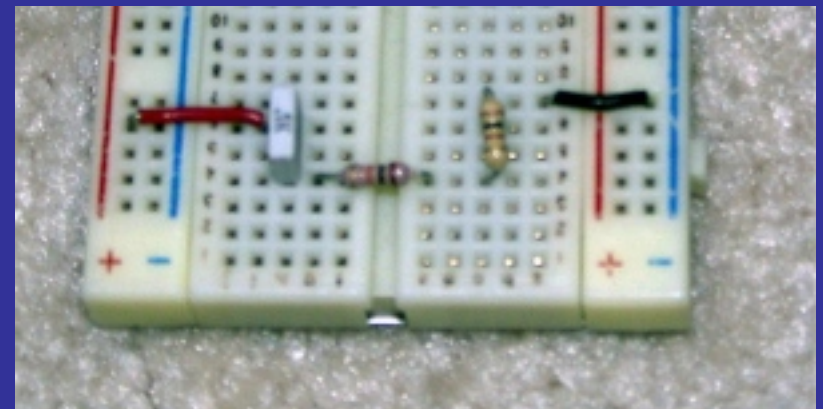
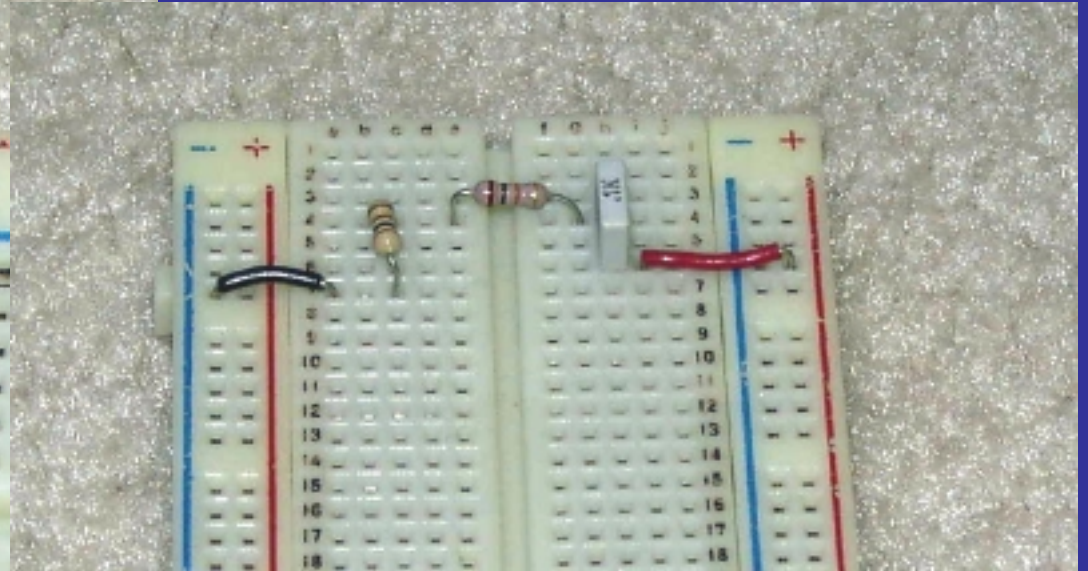
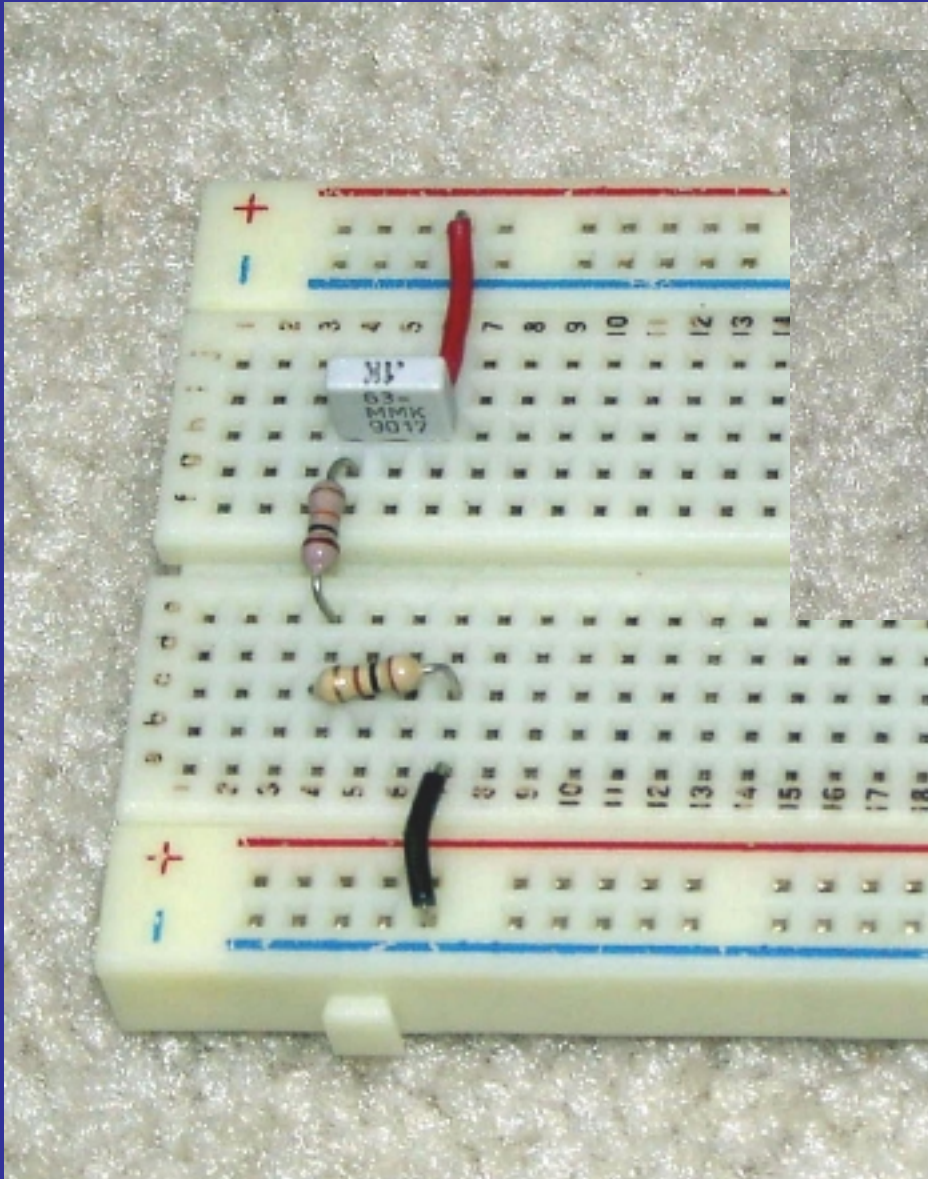
Digital multimeter

Bread board

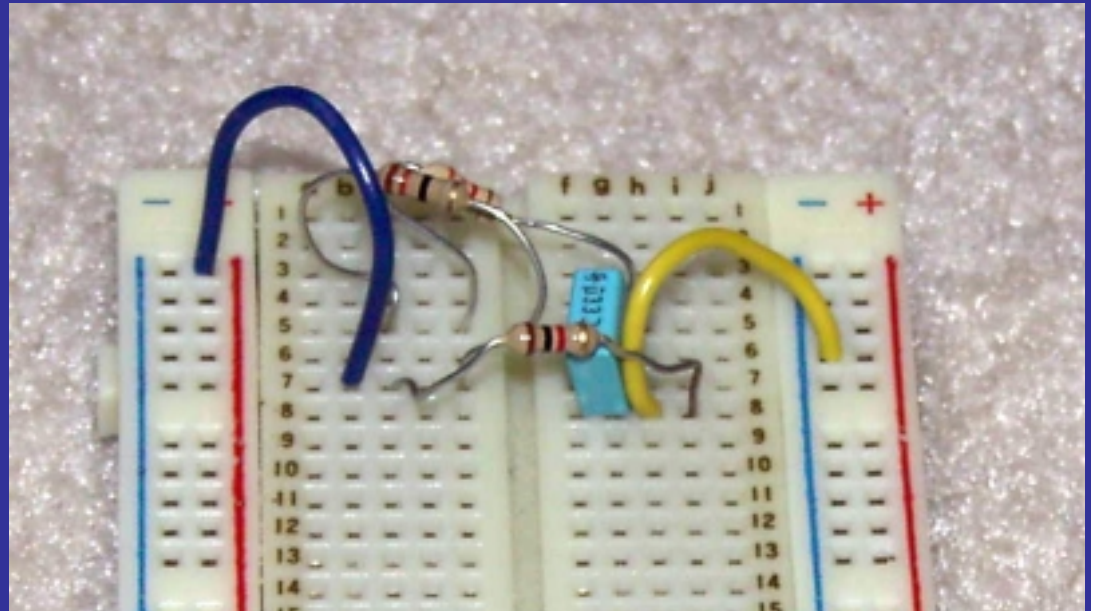
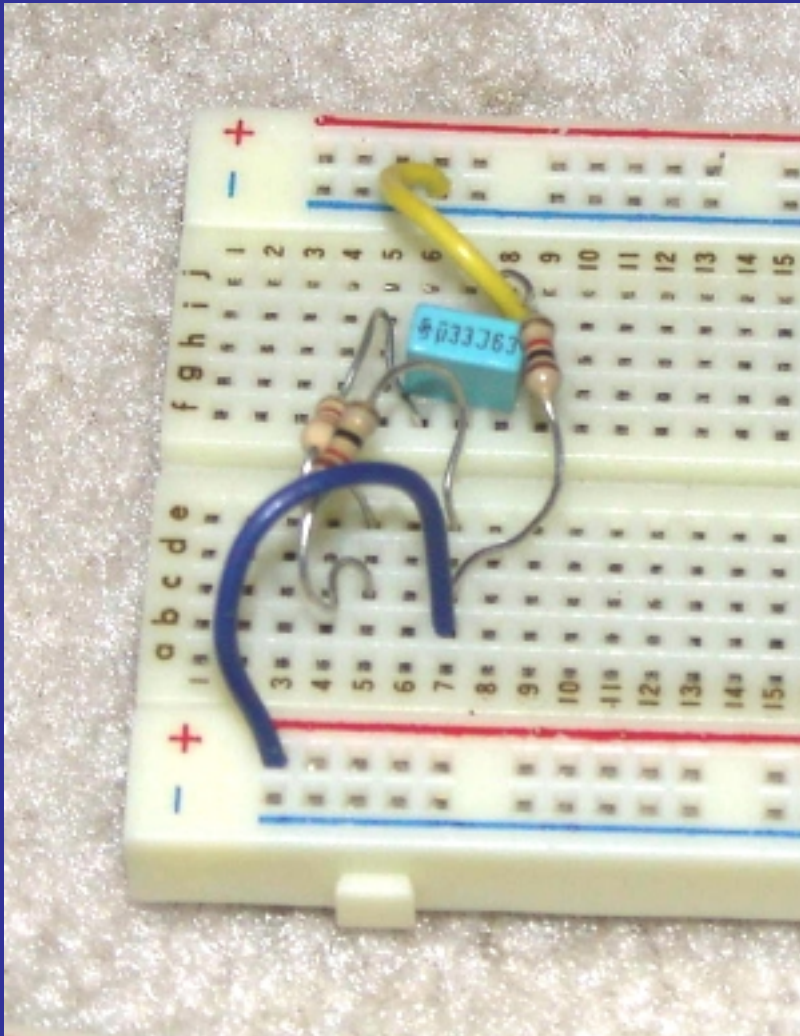
The red lines indicate holes that are electrically connected



Neatly done wiring



Poorly done wiring



If you wire your circuit this manner, please do not bring it to us for troubleshooting.

Dual power supply

Voltage or current display



Tracking
(or)
independent

Power
switch

Voltage
knob

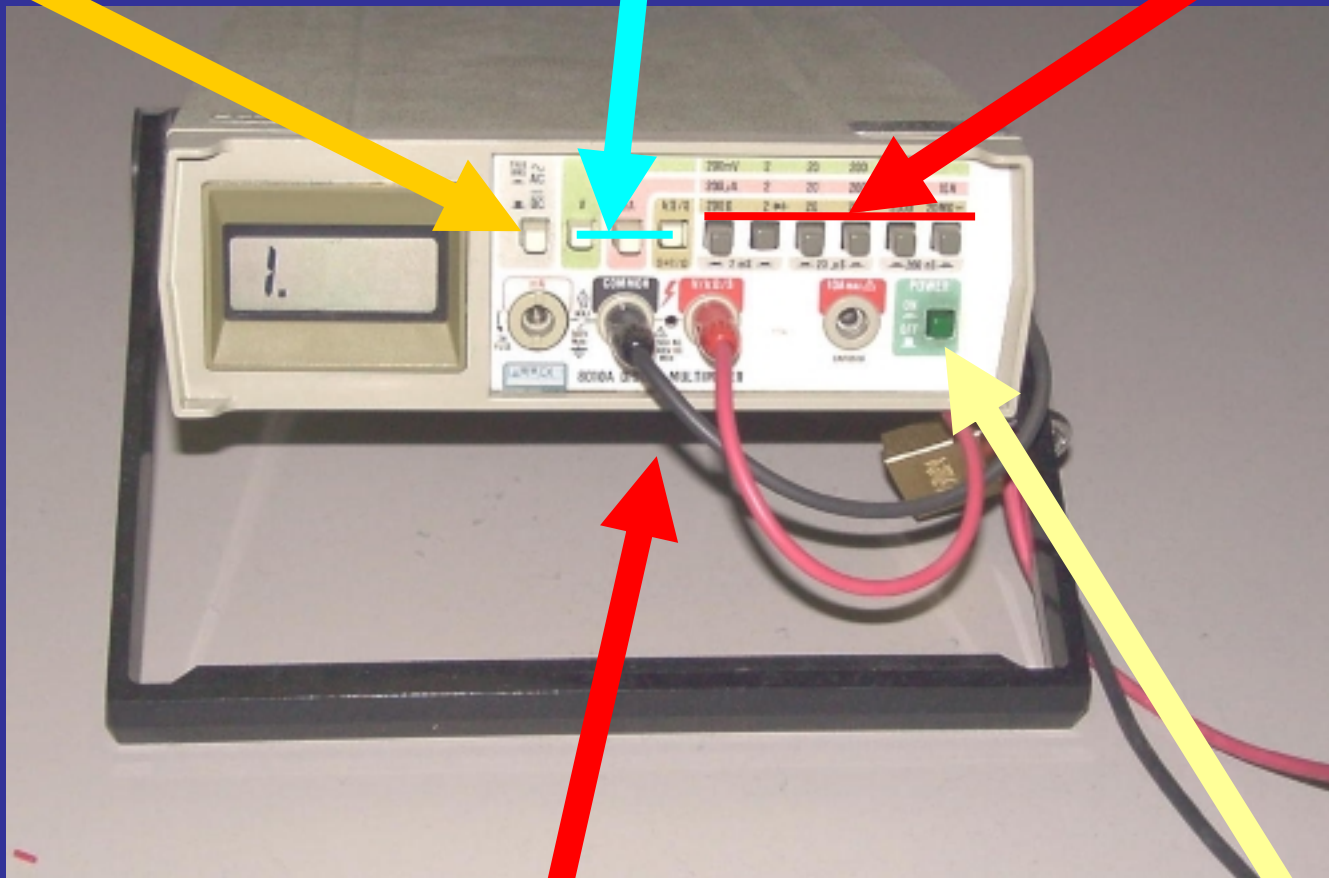
Current
limit

Digital multimeter

AC/DC
measurement

Mode select

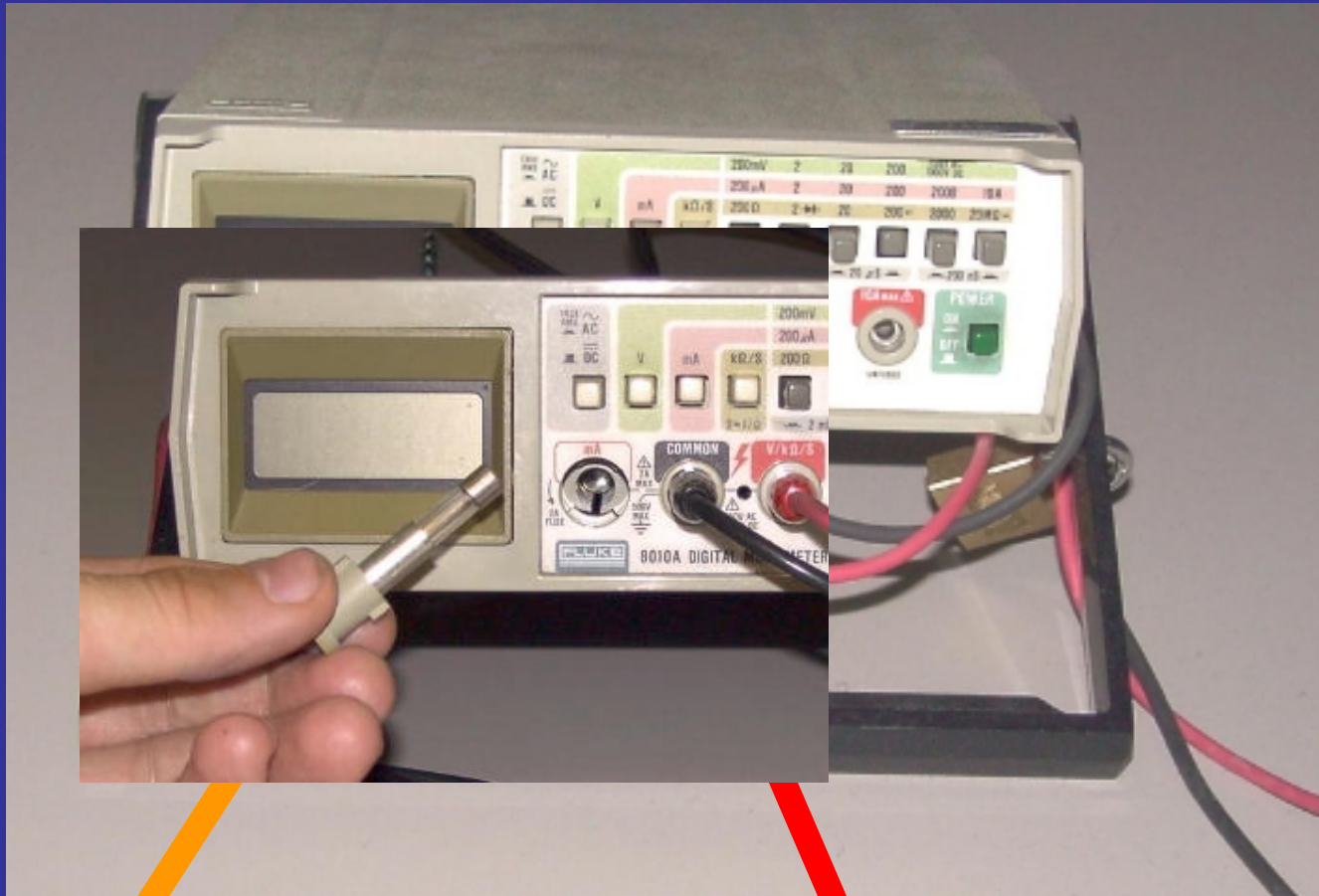
Range select



Voltage/resistance
measurement

Power switch

Digital multimeter (current measurement)



Fuse is inside this
socket

Current measurement

DMM specs



FLUKE 8010A DIGITAL MULTIMETER OPERATOR'S GUIDE
SUMMARY SPECIFICATIONS

ACCURACY: \pm (% OF READING + DIGITS) 1 YEAR - 18°C-28°C (64°F-82°F)

DC VOLTAGE: (0.1 + 1) | **DC CURRENT:** (0.3 + 1) EX (0.5 + 1 @ 10A)

AC VOLTAGE AND CURRENT: (BETWEEN 5% OF RANGE AND FULL RANGE)

RANGE	45 Hz - 10 kHz	10 kHz - 20 kHz	20 kHz - 50 kHz
200V AND BELOW	(0.5 + 2)	(1.0 + 2)	(5.0 + 3)
750V	(0.5 + 2), 45 Hz - 1 kHz ONLY		
200 mA AND BELOW	(1.0 + 2)	(2.0 + 2)	
2000 mA, 10A	(1.0 + 2), 45 Hz - 2 kHz ONLY		

RESISTANCE		CONDUCTANCE	
200k Ω AND BELOW	(0.2 + 1)	2 mS, 20 μ S	(0.2 + 1)
2000k Ω , 20 M Ω	(0.5 + 1)	200 nS	(1.0 + 10)

MAXIMUM RATINGS

VOLTAGE: 1000V DC OR PK AC, 750V RMS AC < 10 SEC, 200 mV, 2V RANGES

CURRENT: 2000 mA AND BELOW, 2A (FUSED); 10A, 12A MAX (UNFUSED)

RES-COND: ALL RANGES, 300V DC OR RMS AC

COMMON MODE VOLTAGE: (LO TERM TO GND) 500V DC OR PK AC

OPERATING NOTES

1. SELECT mA/A FCN, COMMON JACK AND 10A JACK FOR 10A CURRENT MEAS.
2. SELECT k Ω /S FCN, FOR ALL Ω , k Ω , M Ω & CONDUCTANCE MEAS.
3. SELECT INDICATED PAIRS OF RANGE BUTTONS FOR CONDUCTANCE
4. SELECT 2k Ω RNG FOR DIODE TEST (200k Ω AND 20M Ω MAY ALSO TURN ON DIODE)

POWER REQUIREMENTS

VOLTAGE: 90 TO 132 VAC 200 TO 264 VAC

FREQUENCY: (FOR BEST NOISE REJECTION)

50 Hz 60 Hz

-01 BATTERY MODEL (LINE FUSE, MDL 1/32A, INSIDE CASE)

POWER: 4 WATTS MAXIMUM

SPECIAL - SEE MANUAL ADDENDA FOR MODIFIED SPECS

JOHN FLUKE MFG. CO., INC. SEATTLE, WA MADE IN U.S.A.

Specification and accuracy

Meter accuracy

DC Volts $\pm (0.1\% \text{ of the reading} + 1 \text{ digit})$

DC Amps $\pm (0.3\% \text{ of the reading} + 1 \text{ digit})$

Resistance $\pm (0.2\% \text{ of the reading} + 1 \text{ digit})$

What does the +1 digit mean?

Range	Display
200 mV	00.0
2 V	0.000
20 V	0.00
200 V	00.0



If in a circuit, we read 0.812 Volts using the 2 V range setting:

The accuracy is $\pm (0.1\% \text{ of the reading} + 1 \text{ digit})$

Hence, the accuracy is $\pm 0.000812 \text{ V}$

However the meter can only display 3 digits beyond the decimal point (2V range)

Therefore, actual reading accuracy is $\pm 0.001 \text{ V}$

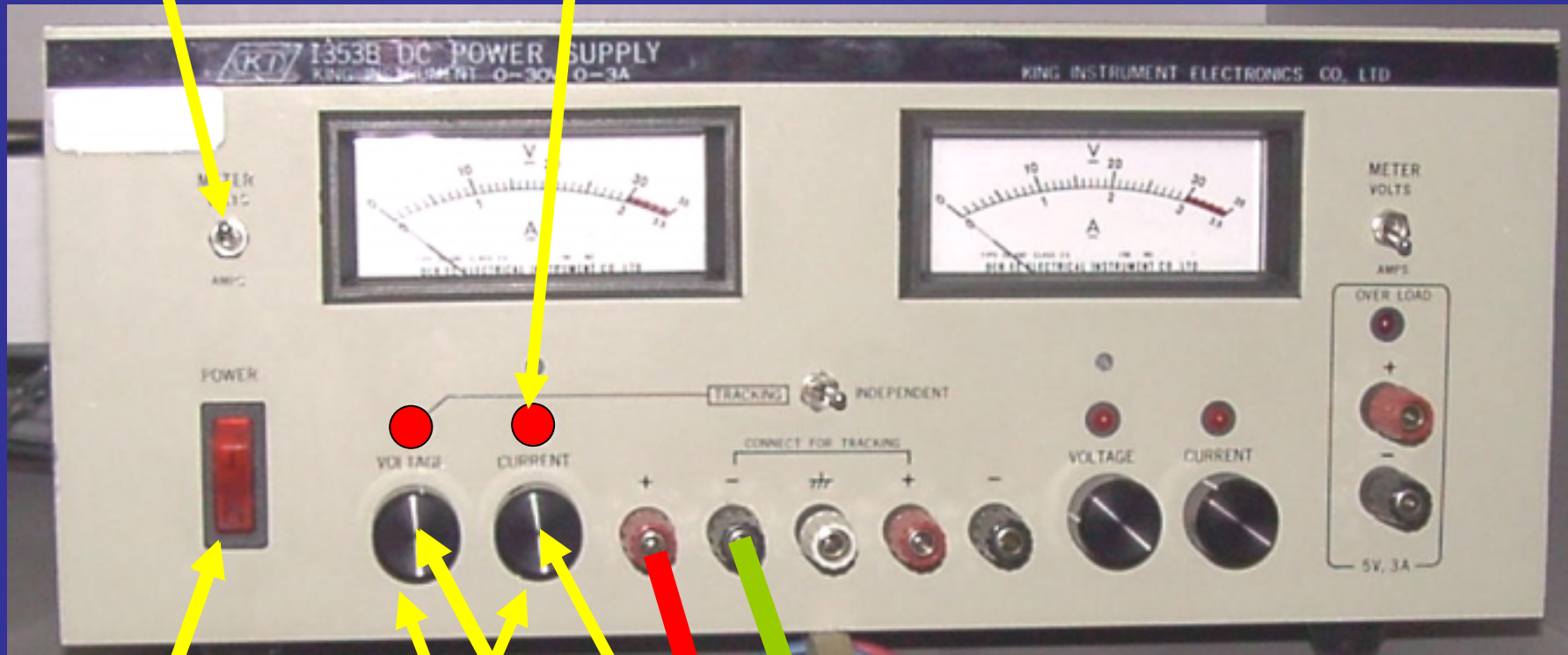
For this measurement, the value is $[0.812 \pm 0.001] \text{ V}$

\swarrow 0.813 V
 \searrow 0.811 V¹³

How to set-up power supply: single supply (source)

Flick this
switch to
measure
current

This LED lights-up



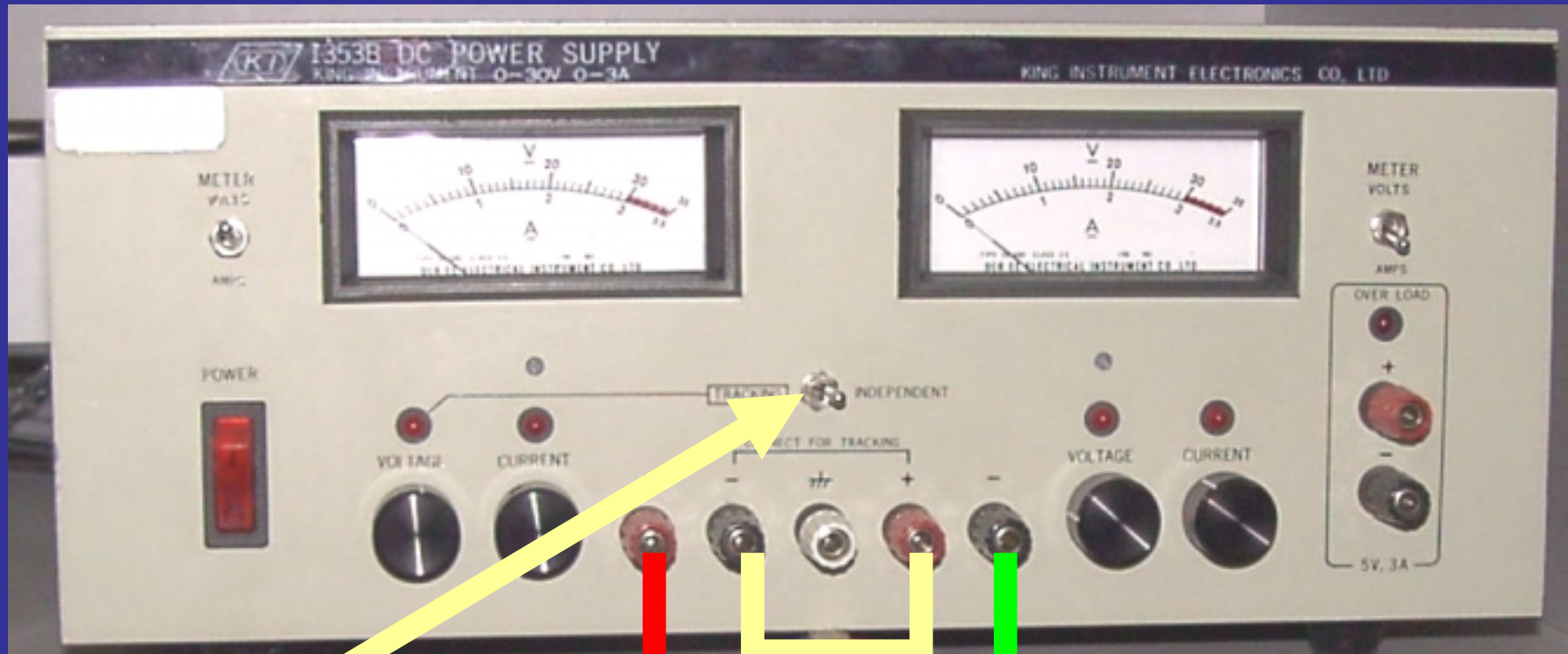
Turn on
the switch
is off

Rotate the voltage knob
anticlockwise one turn
Rotate these two knobs
clockwise and anticlockwise
voltage current

Remove this short

How to set-up power supply: dual supply (source)

Set current limit for both sides as already described



Set this switch for tracking when you wish both supplies to have equal magnitude

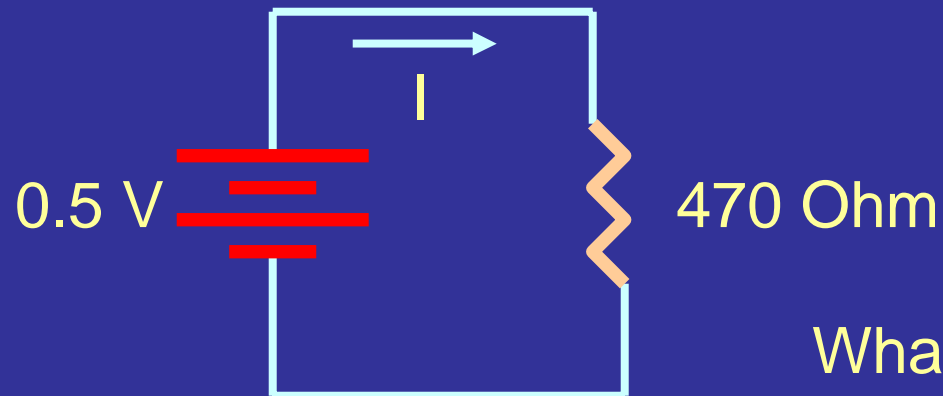
+

Gnd

-

Sample experiment

Circuit:



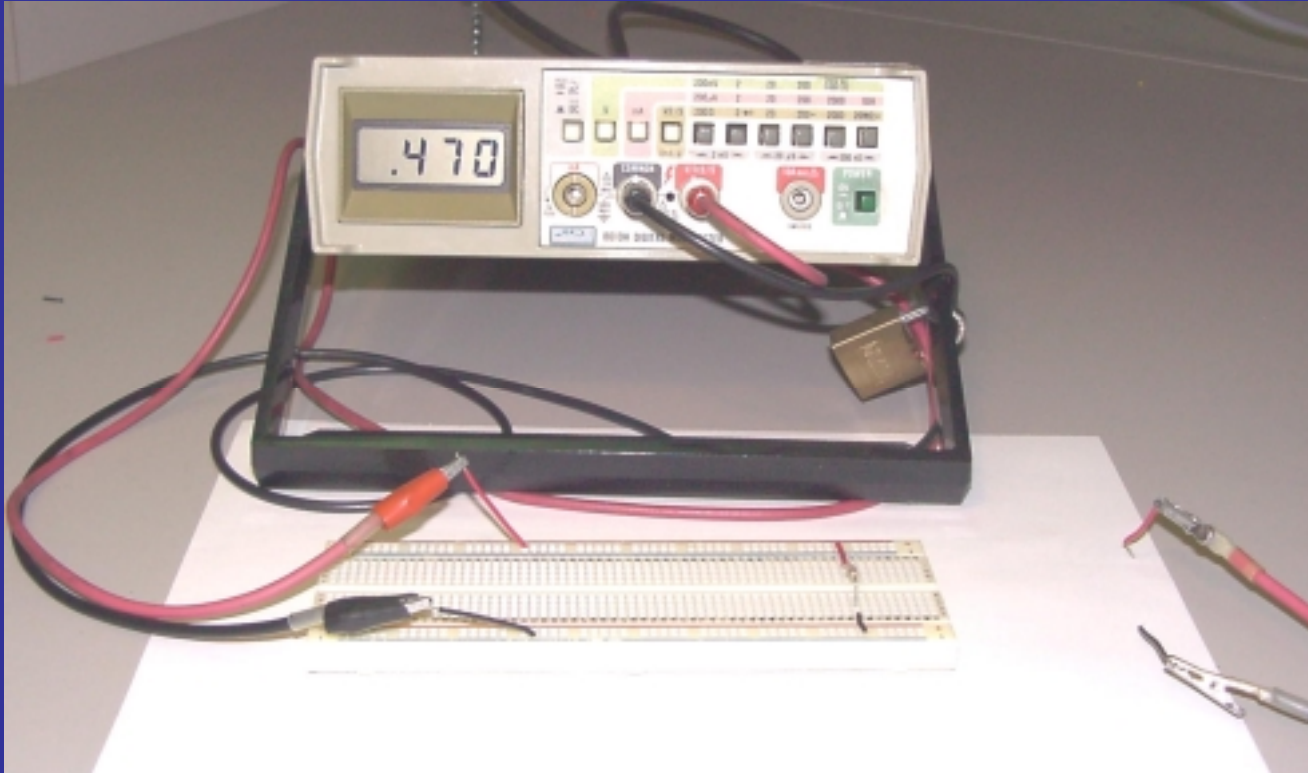
What is the value of I ?

Theoretical value:

$$\frac{0.5 \text{ V}}{470 \text{ Ohm}} = 1.063829 \text{ mA}$$

First level experiment/calculation

Measure the resistance using an Ohm-meter

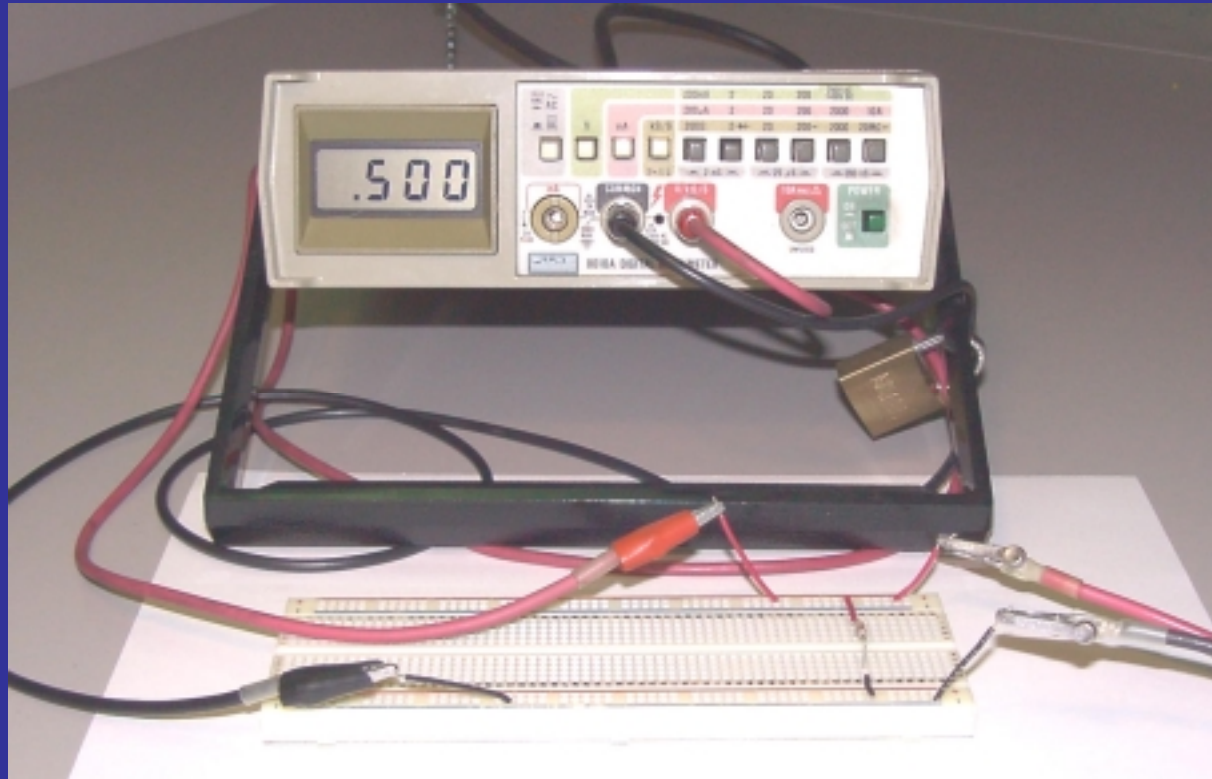


2 kOhm range, therefore the value is 0.470 ± 0.001 kOhm

Max value = 471 Ohm, Min value = 469 Ohm

First level experiment/calculation (continued)

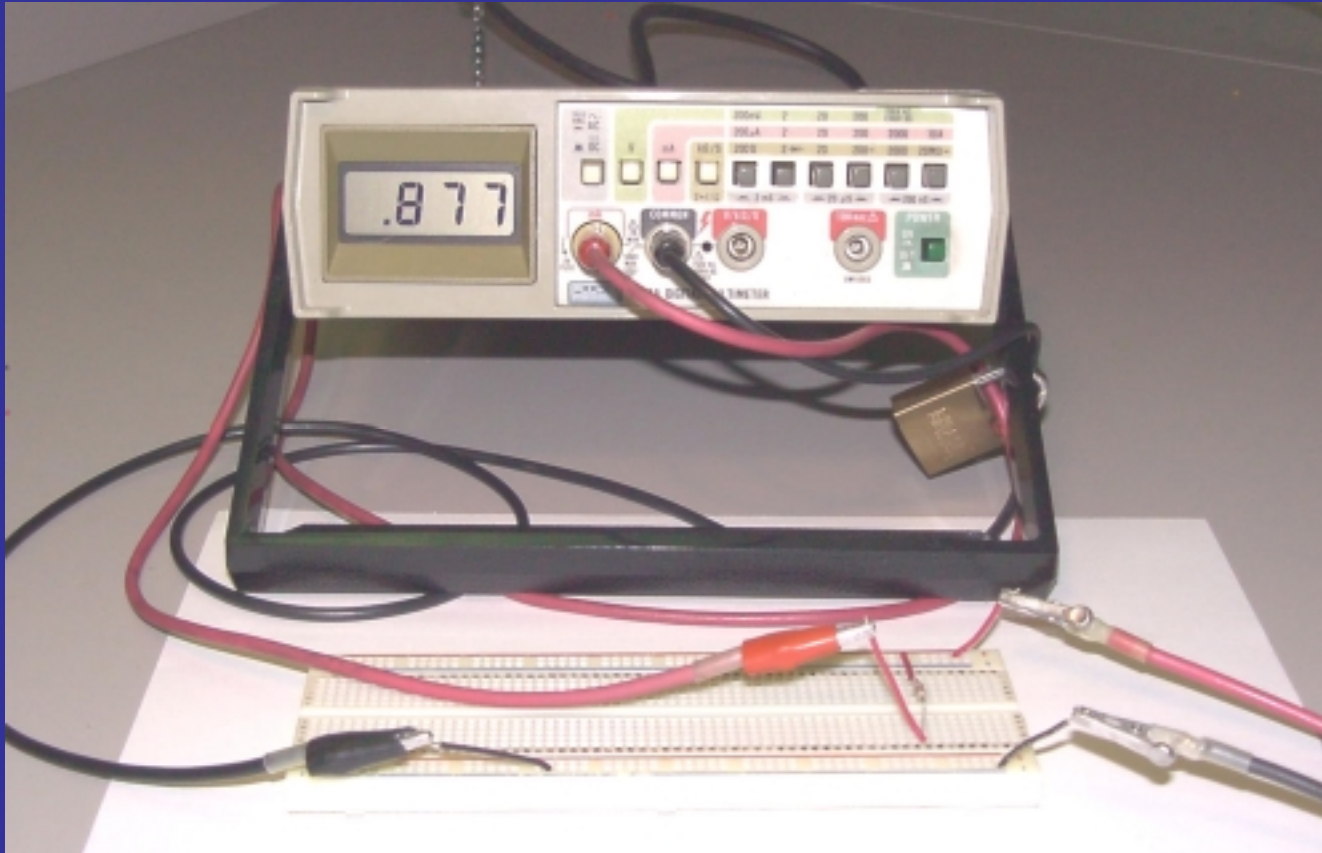
Measure the voltage of the supply



2 V range, therefore the value is 0.500 ± 0.001 V

Max value = 0.501 V, Min value = 0.499 V

Measure current



2 mA range, therefore the value is 0.877 ± 0.003 mA

Max value = 0.880 mA, Min value = 0.874 mA

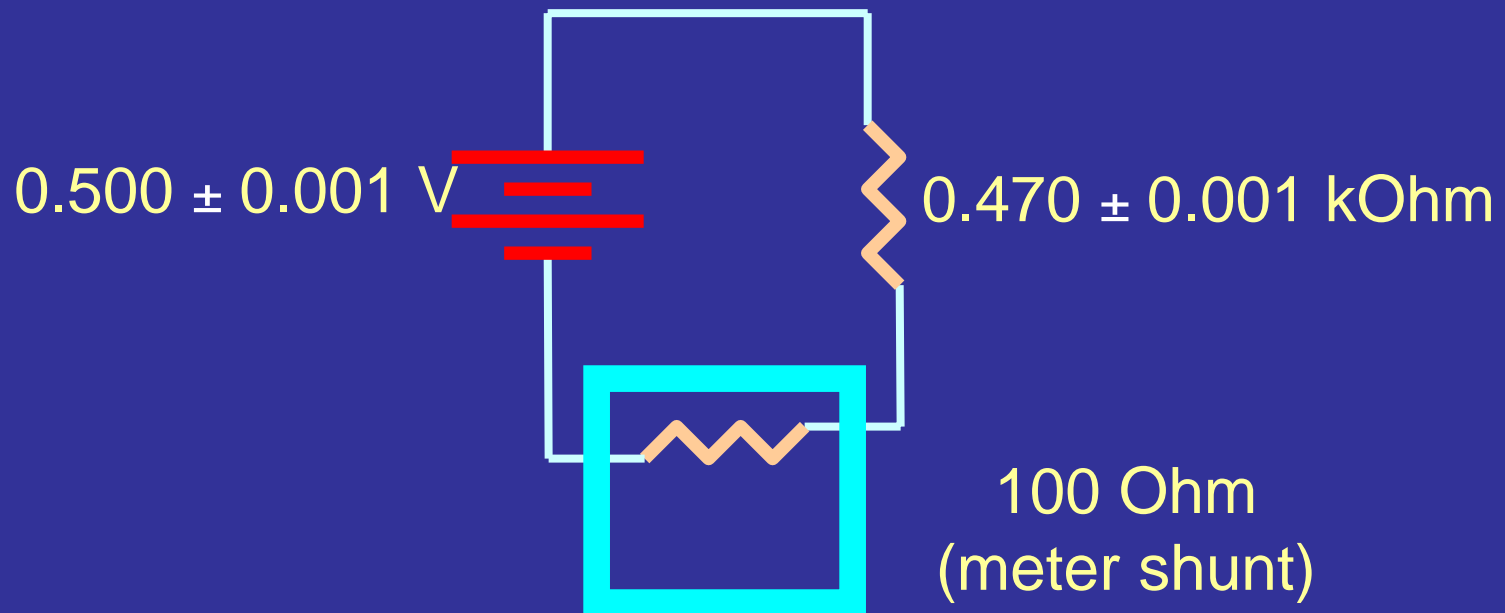
Our theoretical value is = 1.063829 mA

Something strange is happening here!

Internal resistance of the meter (shunt)

2 mA	100 Ohm
20 mA	10 Ohm
200 mA	1 Ohm

Realistic circuit model:



Reconcile measurement results with expected values

Voltage measurement:

Max value = 0.501 V, Min value = 0.499 V

Resistance measurement:

Max value = 471 Ohm, Min value = 469 Ohm

plus 100 Ohm

Calculated current:

$$\text{Max value} = \frac{0.501 \text{ V}}{569 \text{ Ohms}} = 0.8804 \text{ mA}$$

$$\text{Min value} = \frac{0.499 \text{ V}}{571 \text{ Ohms}} = 0.8739 \text{ mA}$$

Measured current:

Max value = 0.880 mA

Min value = 0.874 mA

Excellent reconciliation when the calculated
and measured values match well within the meter's accuracy