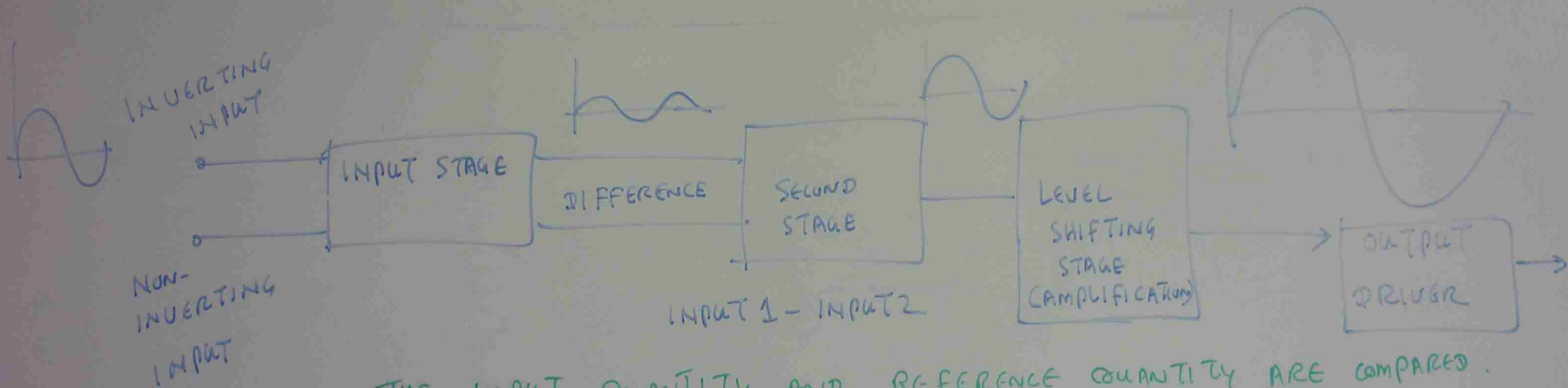


INTRODUCTION TO THE OPERATIONAL AMPLIFIER



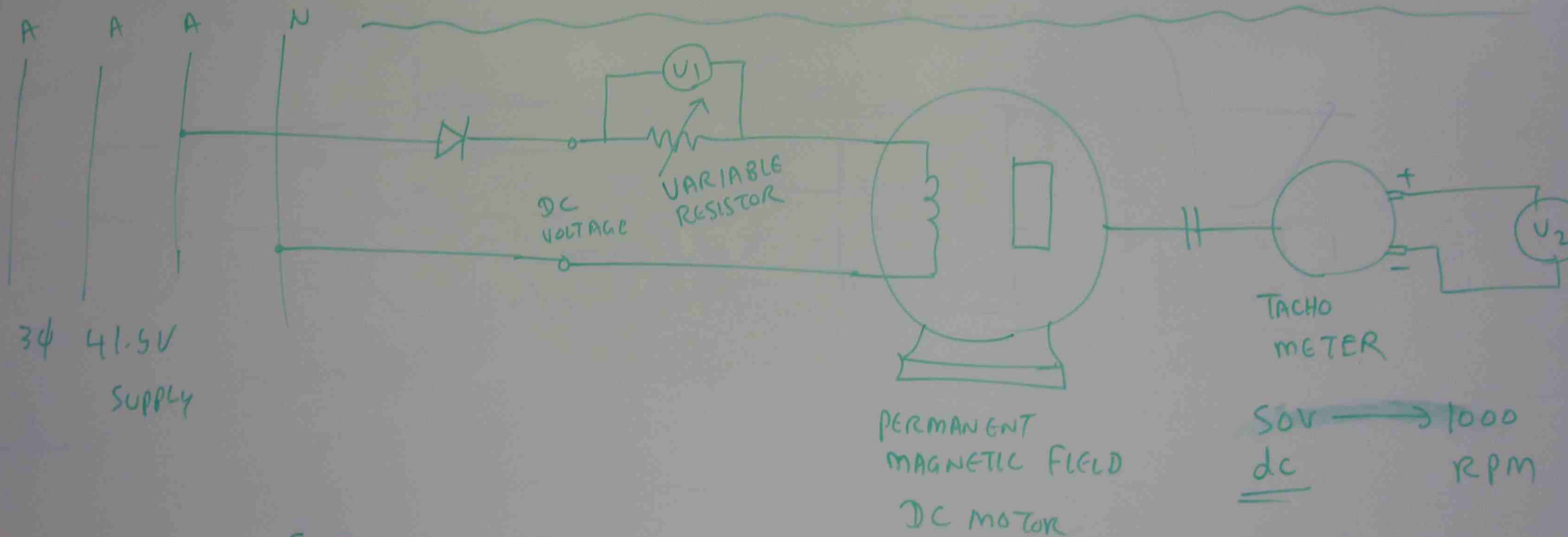
THE INPUT QUANTITY AND REFERENCE QUANTITY ARE COMPARED. THE DIFFERENCE IS FED INTO THE SECOND STAGE, WHICH DOES THE AMPLIFICATION. THE VOLTAGE LEVEL IS THEN SHIFTED AND IS FED TO OUTPUT DRIVER STAGE WHICH DRIVES THE OUTPUT CONTROL CIRCUITS.

ph
DETER
OF G



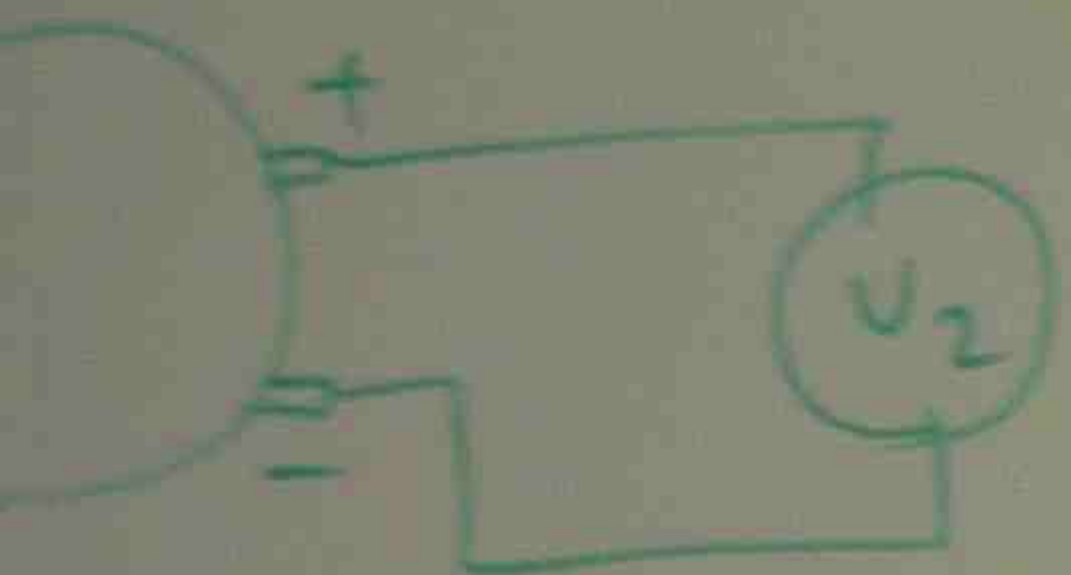
$$\begin{aligned}
 &= V_B - V_E \\
 &= 0 - 0.6 \\
 &= -0.6
 \end{aligned}$$

PRACTICAL (1) INVESTIGATING DC VARIABLE SPEED DRIVE SYSTEM
 TACHO METER / TRANSDUCER



SWITCH ON THE SUPPLY. OBSERVE THE ACTION OF DC MOTOR.
 FILL THE DATA IN TABLE

DRIVE SYSTEM



TER

→ 1000 RPM

OR

VARIABLE RESISTOR	V_1	V_2	$RPM = V_2 \times \frac{1000}{50}$	SPEED (SLOW OR) FACT
POSITION (1)				
POSITION (2)				
POSITION (3)				
POSITION (4)				



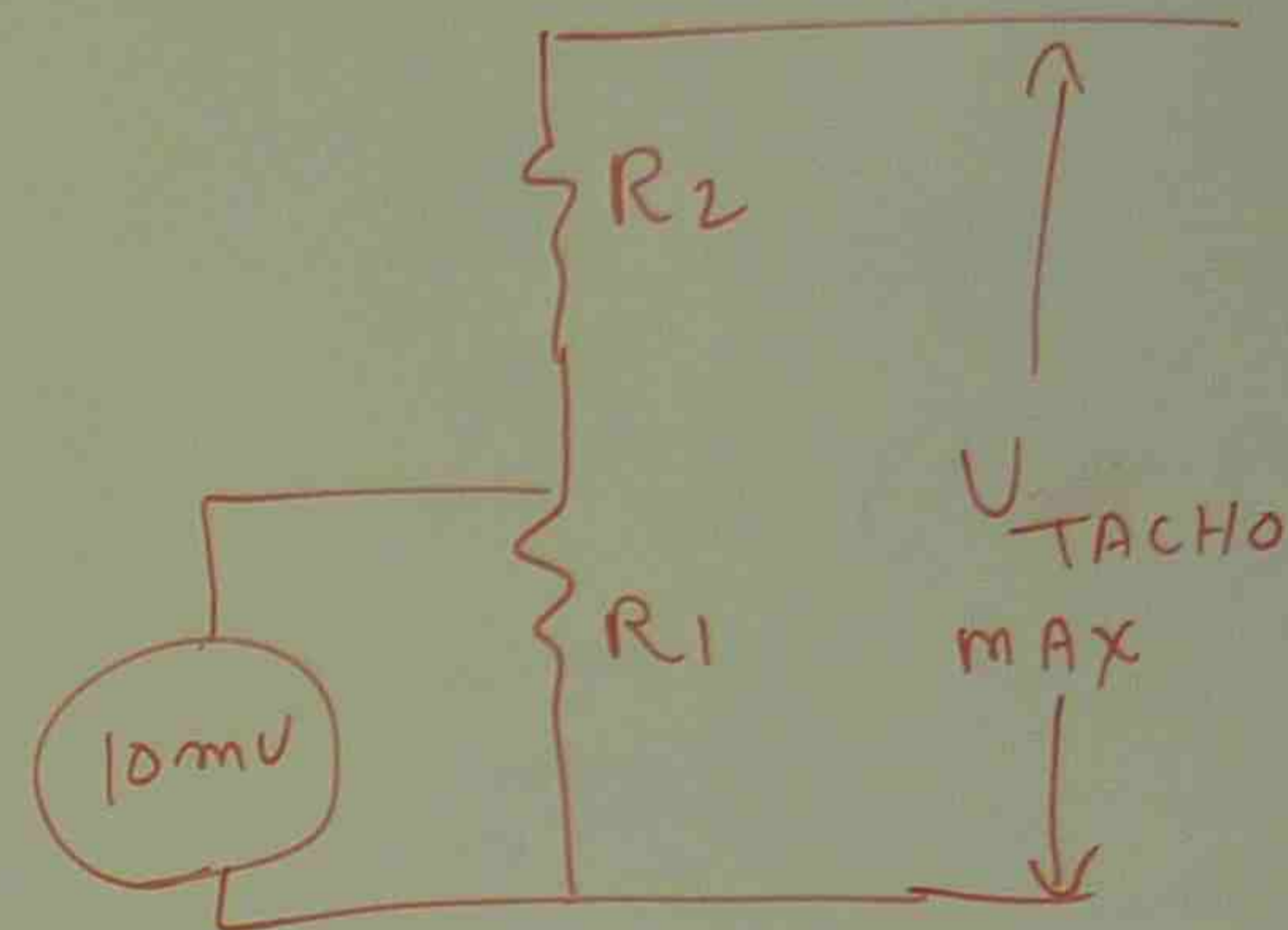
✓ ELECTRONIC

IF ELECTRONIC CIRCUIT CAN ONLY ACCEPT 10mV,
 TO CONTROL THE MAXIMUM SPEED, FIND THE RATIO OF POTENTIAL DIVIDER

V_2

$$Rpm = V_2 \times \frac{1000}{50}$$

SPEED (SLOW OR) FAST



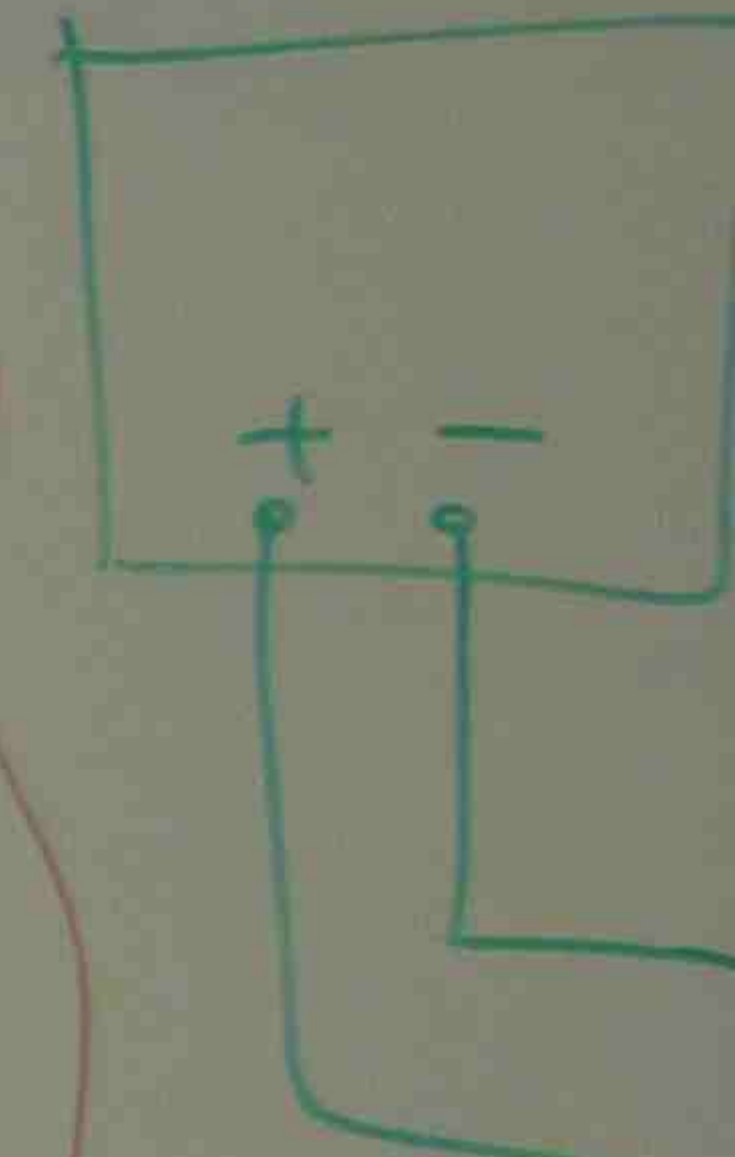
$$V_{\text{ELECTRONIC}} = V_{\text{TACHO MAX SPEED}} \times \frac{R_1}{R_1 + R_2}$$

$$\therefore \frac{R_1}{R_1 + R_2} = \frac{V_{\text{ELECTRONIC}}}{V_{\text{TACHO MAX}}}$$

THEN FIND $\frac{R_1}{R_2}$

ELECTRONIC CIRCUIT CAN ONLY ACCEPT 10mV.
THE MAXIMUM SPEED, FIND THE RATIO OF POTENTIAL DIVIDER

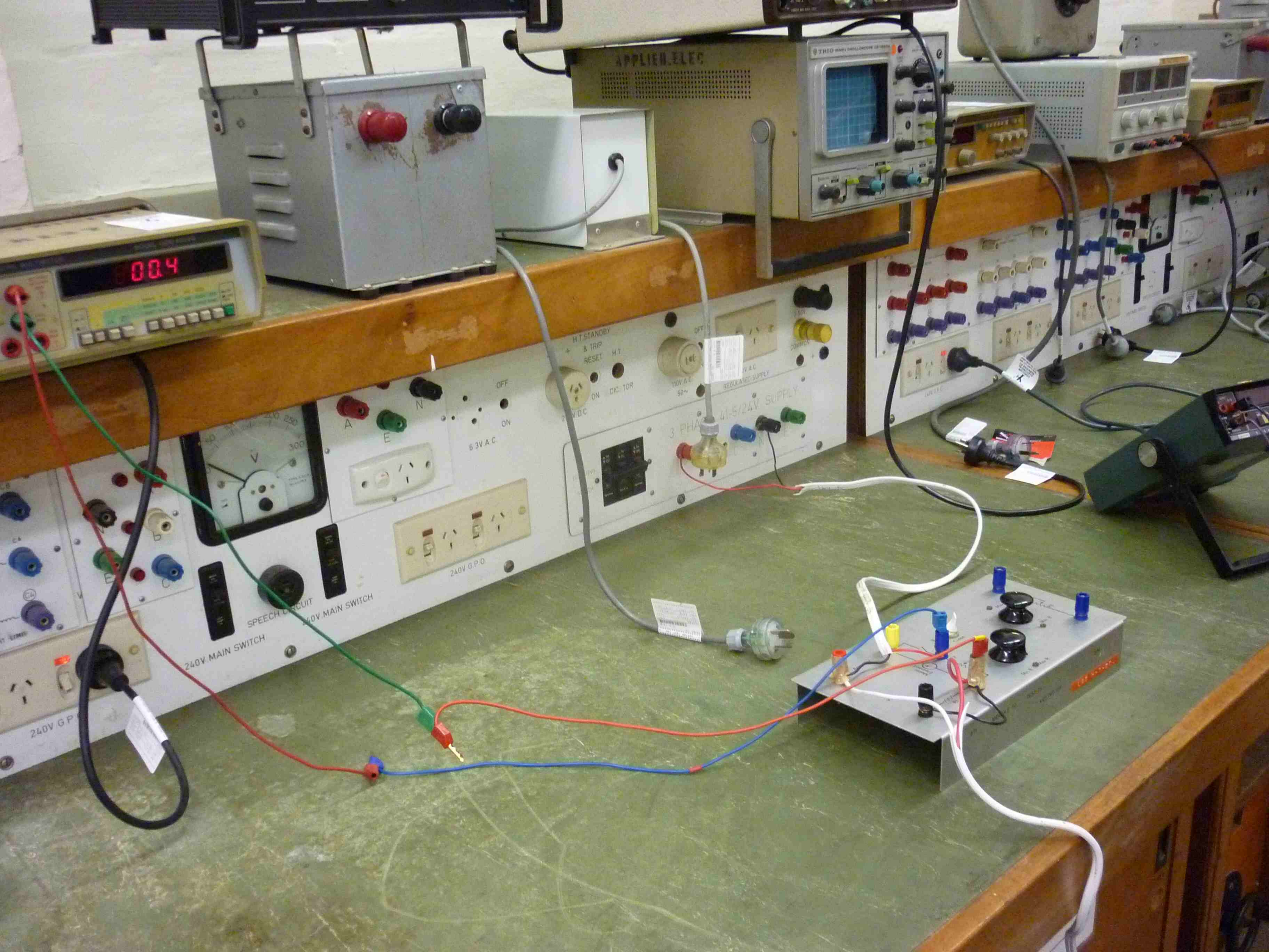
PRACT



SET TH

EM





Digital multimeter with a red LED display showing '00.4'. It has several colored test leads (red, green, black) plugged into its input ports.



240V MAIN SWITCH
SPEECH CIRCUIT
240V MAIN SWITCH

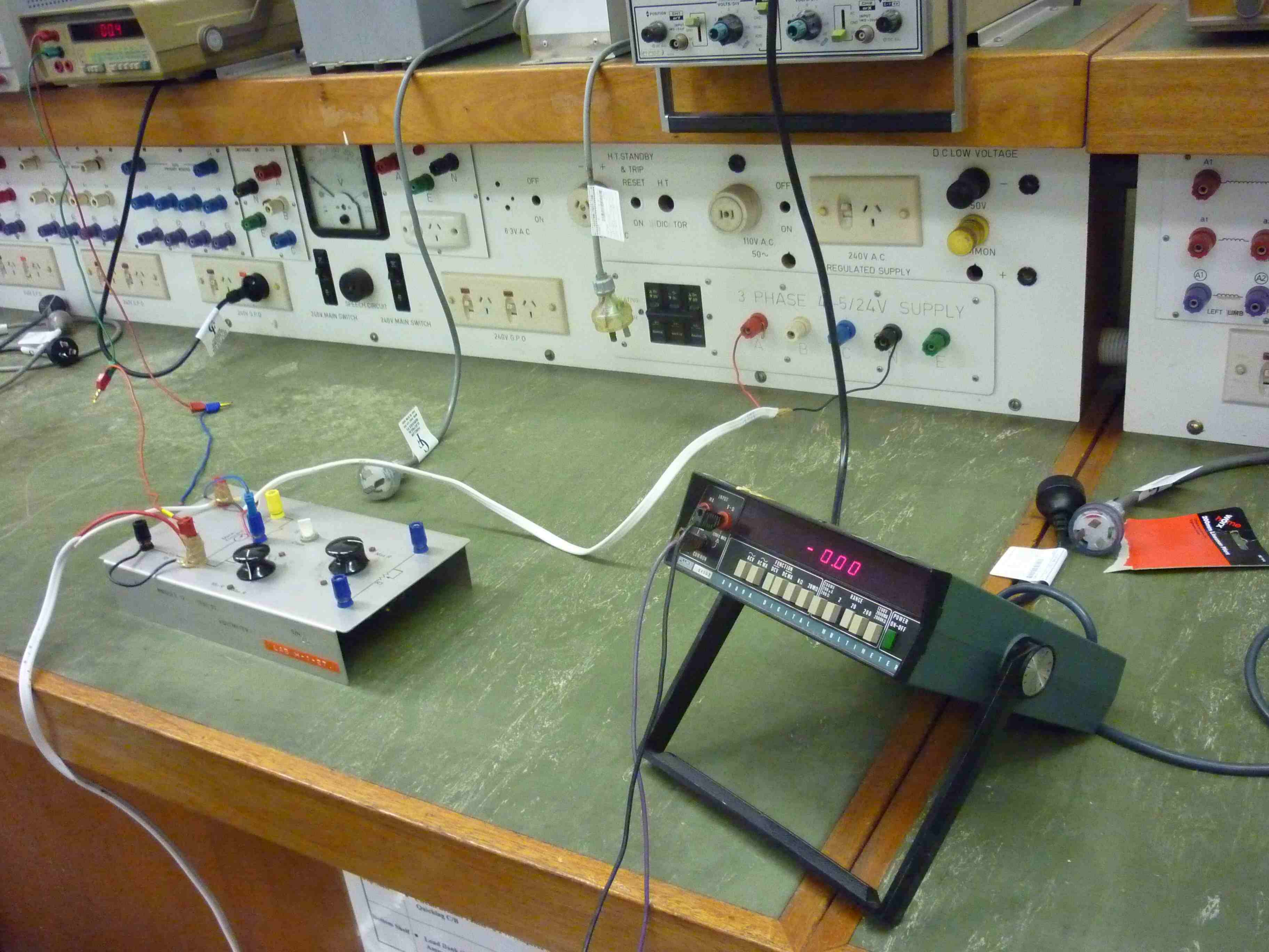
HT STANDBY & TRIP RESET H.T.
ON DIC TOR
110V A.C. 50~
REGULATED SUPPLY
3 PHASE 41-5/24V SUPPLY

Breadboard circuit on a green table surface. It features several integrated circuits, resistors, and jumper wires. A power supply cable is connected to it.

Oscilloscope with a blue screen showing a grid. It has various control knobs and input ports.

Grey metal cabinet with a red emergency stop button and a black control knob. It appears to be a power source or a specialized instrument.

Stack of electronic equipment, including what looks like a power supply or a specialized meter, with various knobs and switches.



Digital display showing 00.4

Control panel with knobs and switches, including labels like VOLTS/DIV and INPUT.

Panel with multiple colored jacks (blue, red, green) and switches, labeled with letters A through F.

Panel with a large analog meter and several switches, including labels like 240V MAIN SWITCH and 240V G.P.O.

Panel with a large knob and switches, labeled 3 PHASE 415/240V SUPPLY and 110V A.C. 50~.

Panel with a large knob and switches, labeled 240V A.C. REGULATED SUPPLY and D.C. LOW VOLTAGE.

Panel with several colored jacks and switches, labeled A1, A2, and LEFT LIMB.

Small grey electronic device with knobs, switches, and wires connected to it.

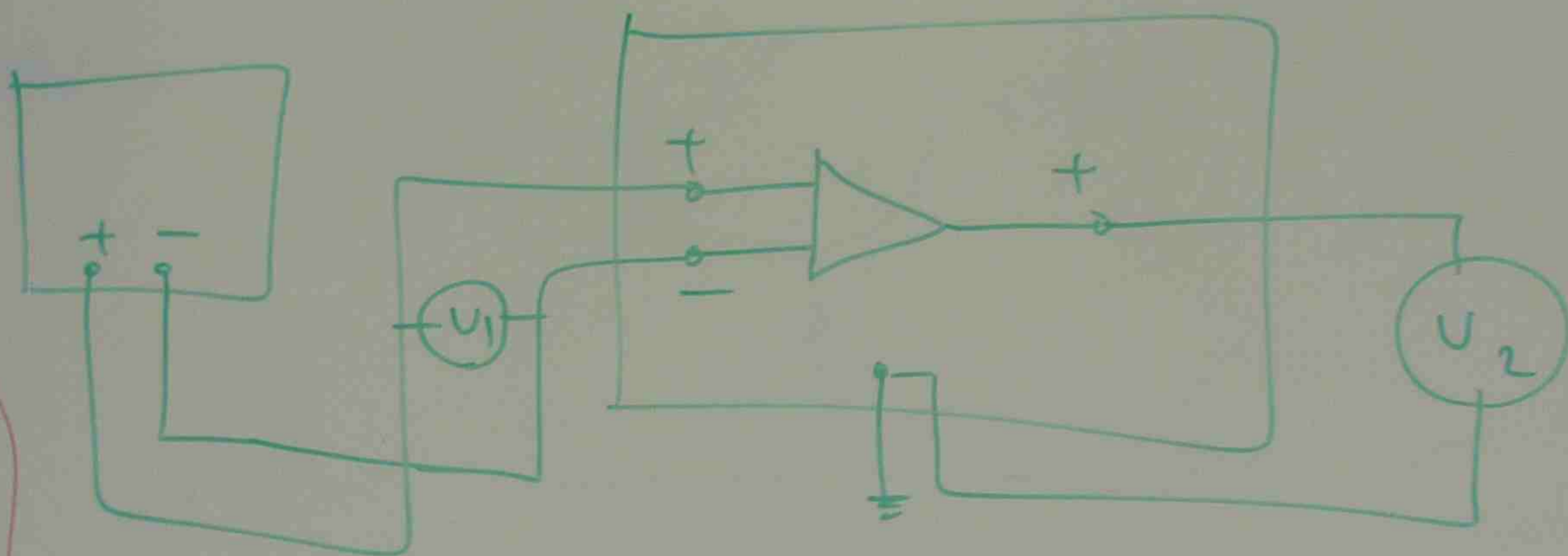
Digital multimeter on a stand, displaying -0.00 on its red LED screen.

Operating C/R
Load Desk



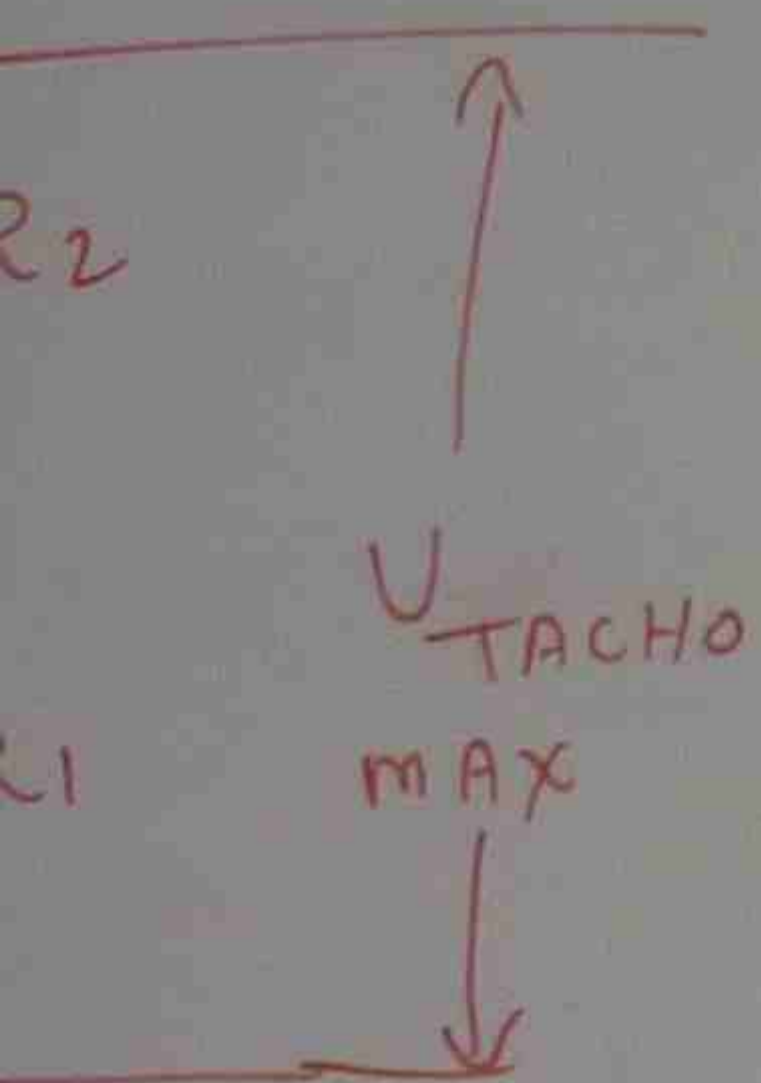
PRACTICAL (2)

AMPLIFIER GAIN



SET THE INPUT | OUTPUT VOLTAGE WITHOUT ADJUSTING

GAIN			
INITIAL CONDITION	U_1	U_2	$AU = \text{GAIN} = \frac{U_2}{U_1}$
GAIN ADJUSTMENT (1)			
GAIN ADJUSTMENT (2)			
GAIN ADJUSTMENT (3)			



$\times \frac{R_1}{R_1 + R_2}$

TACHO
MAX
SPEED

VELECTRONIC

U_{TACHO}
MAX

FIND $\frac{R_1}{R_2}$

EM



ANALOG ELECTRONICS
870543

PHILIPS
POWER SUPPLY

TRIO 15MHz OSCILLOSCOPE

BWD 880

TRIO 15MHz OSCILLOSCOPE

MINI-LAB
MOCK
REGULATED POWER SUPPLY

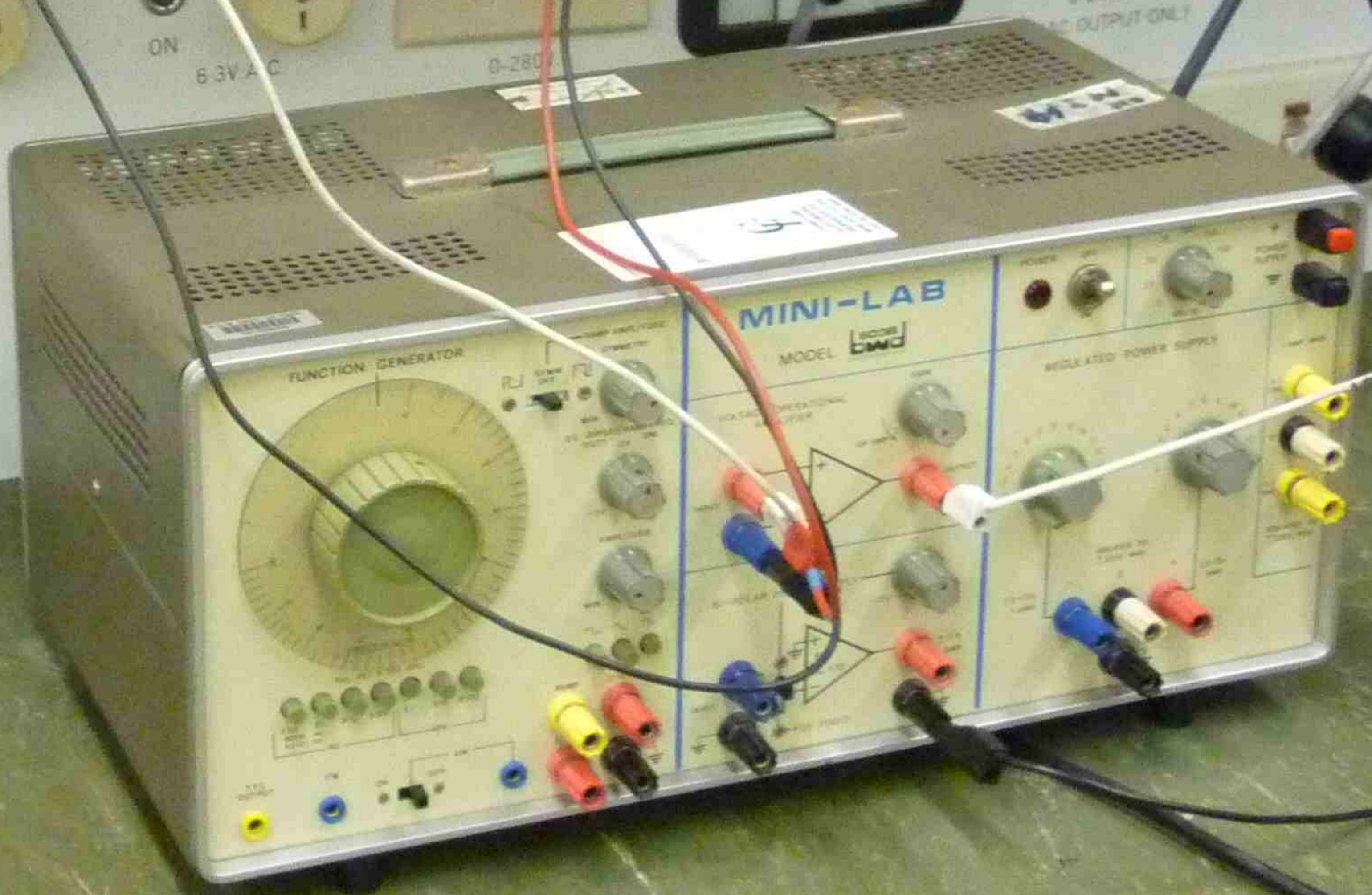
OSCILLOSCOPE

3 PHASE
A B

250V D
ON INDICATOR

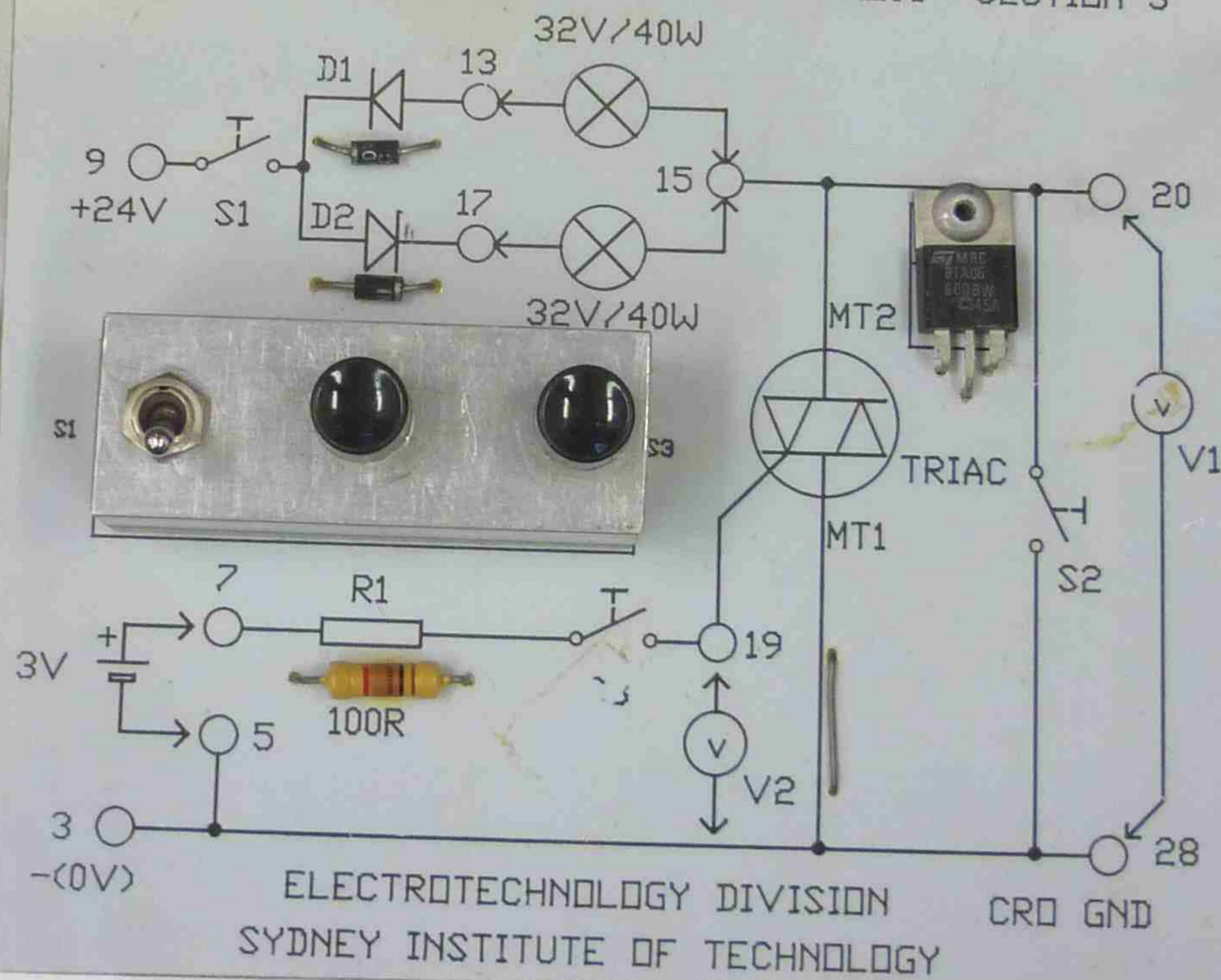
3 PHASE
REGULATED POWER SUPPLY

EMERGENCY STOP
OPERATION OF THIS BUTTON
WILL ISOLATE ALL POWER
IN THIS AREA



POWER CONTROL DEVICES

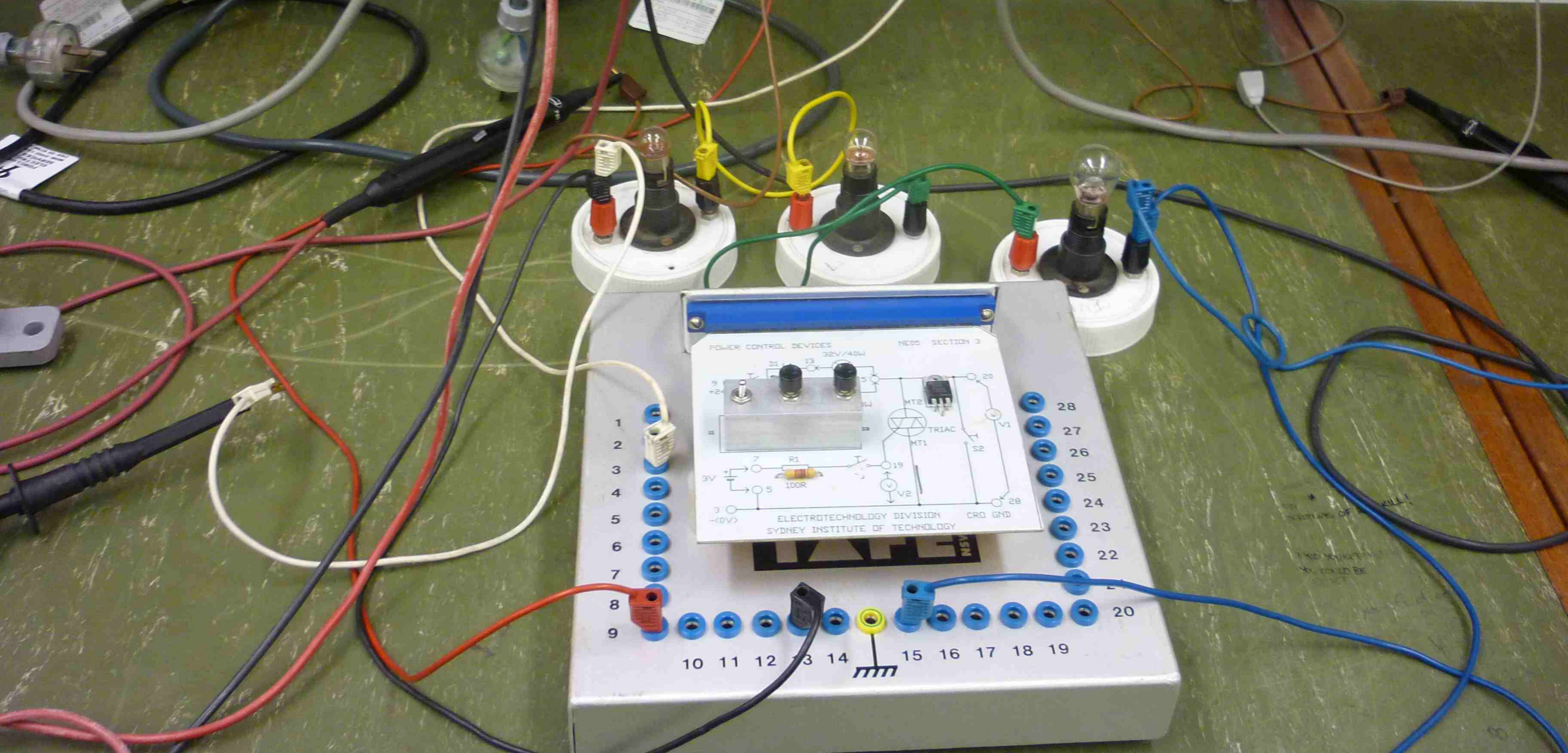
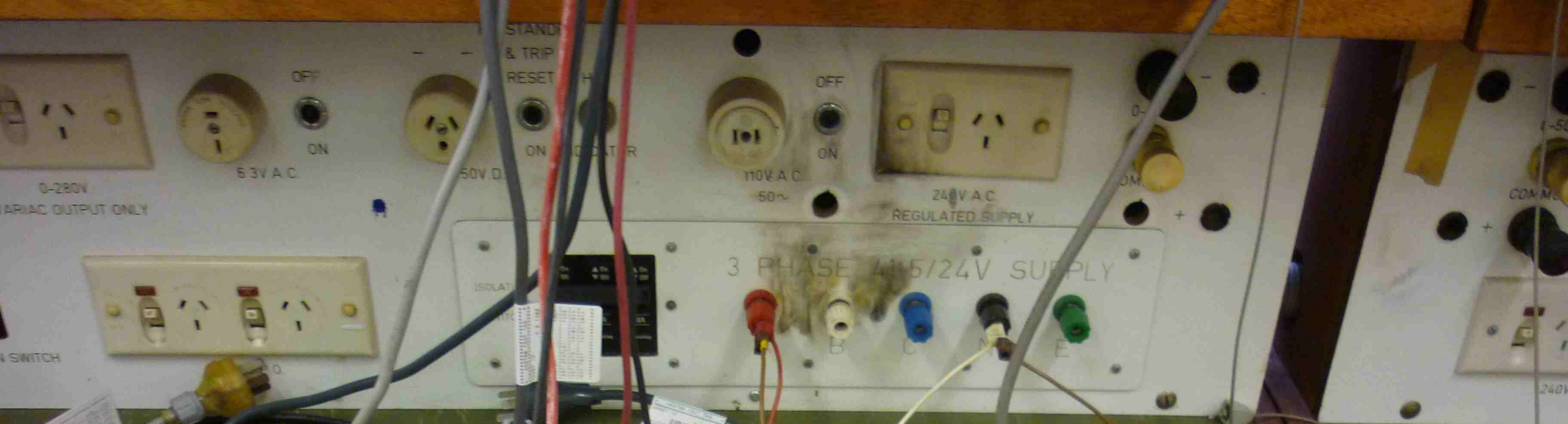
NE05 SECTION 3



ELECTROTECHNOLOGY DIVISION
SYDNEY INSTITUTE OF TECHNOLOGY

CRO GND

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28



BWD 880 POWERSCOPE

CH1 POSITION VOLTS / DIV: 10

DC AC GND

BAL CH SEL

CMR

CH2 POSITION VOLTS / DIV: 20

DC AC GND

BAL

CMR

CH3 POSITION VOLTS / DIV: 10

DC AC GND

BAL

CMR

CH4 POSITION VOLTS / DIV: 50

DC AC GND

BAL

PULL FOR OFFSET

CMR

±1000V MAX. EACH INPUT

READY

RESET SS PH DC

MAG LEVEL CH 3 4

ON-AUTO EXT 0° LINE

VERNIER SEC / DIV: 2

CH 3 4

CH 2 1 EXT 0°

CAL

COUNT UP STOP DOWN

DEGREES

PHASE ANGLE

EXTERNAL TRIG / PH

BEAM FIND 0° 180° 120° 240° ON

MARKER OFF

±500V MAX

CALIBRATE 10V 100V

ASTIG POWER

GRATICULE PWR OFF

FOCUS

INTENSITY

TRIO 15MHz OSCILLOSCOPE CS-1560A

POWER ILLUM

OFF

VARIABLE SWEEP TIME / DIV

mS 1.5 2.1 50 20 10 5 2 1 0.5 0.2 0.1 0.05 0.02 0.01

μS

SEC

POSITION PULL IN MAG

CAL

FL

WARNING
Young children can climb on the top of the oscilloscope and pull the power cord out of the wall outlet. They can also wrap cords around the oscilloscope. To avoid strangulation and electrocution, keep cords out of the reach of young children. Use safety devices that require the cord loop or reduce the cord length. Use safety devices that require the cord loop or reduce the cord length. Use safety devices that require the cord loop or reduce the cord length.

BWD 880 POWERSCOPE

Four channel oscilloscope with a large CRT display. The display shows a grid with a horizontal line and a vertical line intersecting at the center.

Inputs: CH1, CH2, CH3, CH4. Each channel has a POSITION VOLTS/DIV knob and a DC/AC GND selector.

Controls: BAL, CH SEL, CMR, CALIBRATE, ASTIG, GRATICULE, FOCUS, INTENSITY, PWR OFF, POWER, PHASE ANGLE (180°, 120°, 240° ON), BEAM FIND, REFERENCE, MARKER, OFF, EXTERNAL TRIG / PH.

Right side controls: READY, RESET, SS, PH, DC, LEVEL, CH 3, CH 2, CH 1, EXT, 0° LINE, VERNIER SEC/DIV, COUNT UP, STOP, DOWN, DEGREES.

TRIO 15M OSCILLOSCOPE CS-1560A

Two channel oscilloscope with a CRT display. The display shows a grid with a horizontal line and a vertical line intersecting at the center.

Inputs: CH1, CH2. Each channel has a POSITION VOLTS/DIV knob and a DC/AC GND selector.

Controls: POWER ILLUM, INTENSITY, FOCUS, ASTIG, TRIGGERING (LEVEL, PULL-AUTO, SYNC, TV, NOR), EXT TRIG, VARIABLE SWEEP TIME/DIV, POSITION (X-Y), MODE (CH1, CH2, ADD, SUB), CH1 POSITION, CH2 POSITION.

GW FUNCTION GENERATOR MODEL GFG-9000A

Function generator with a digital display showing 9.1919. It has various knobs and buttons for frequency, amplitude, and waveform selection.

110V A.C. 50~

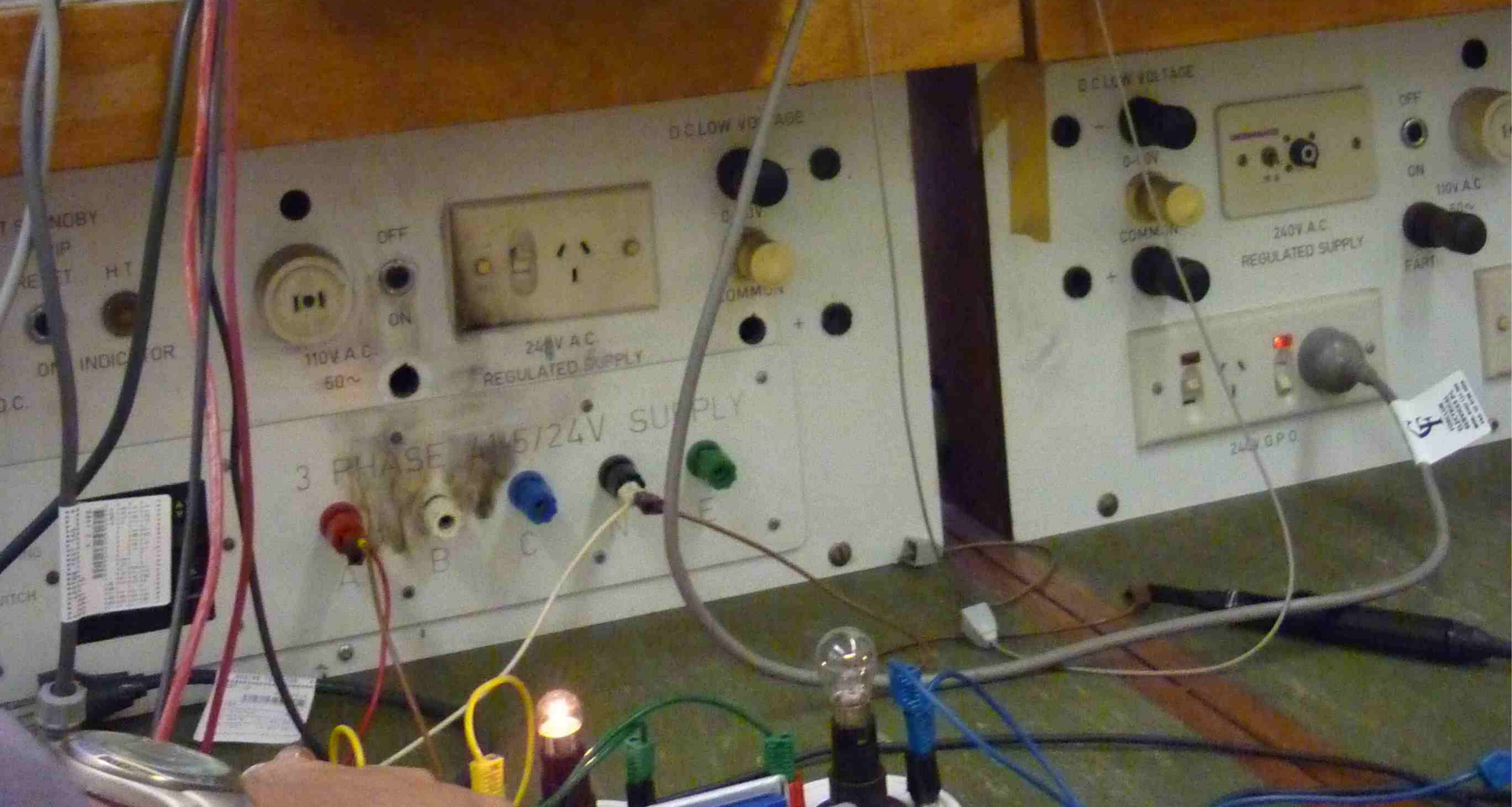
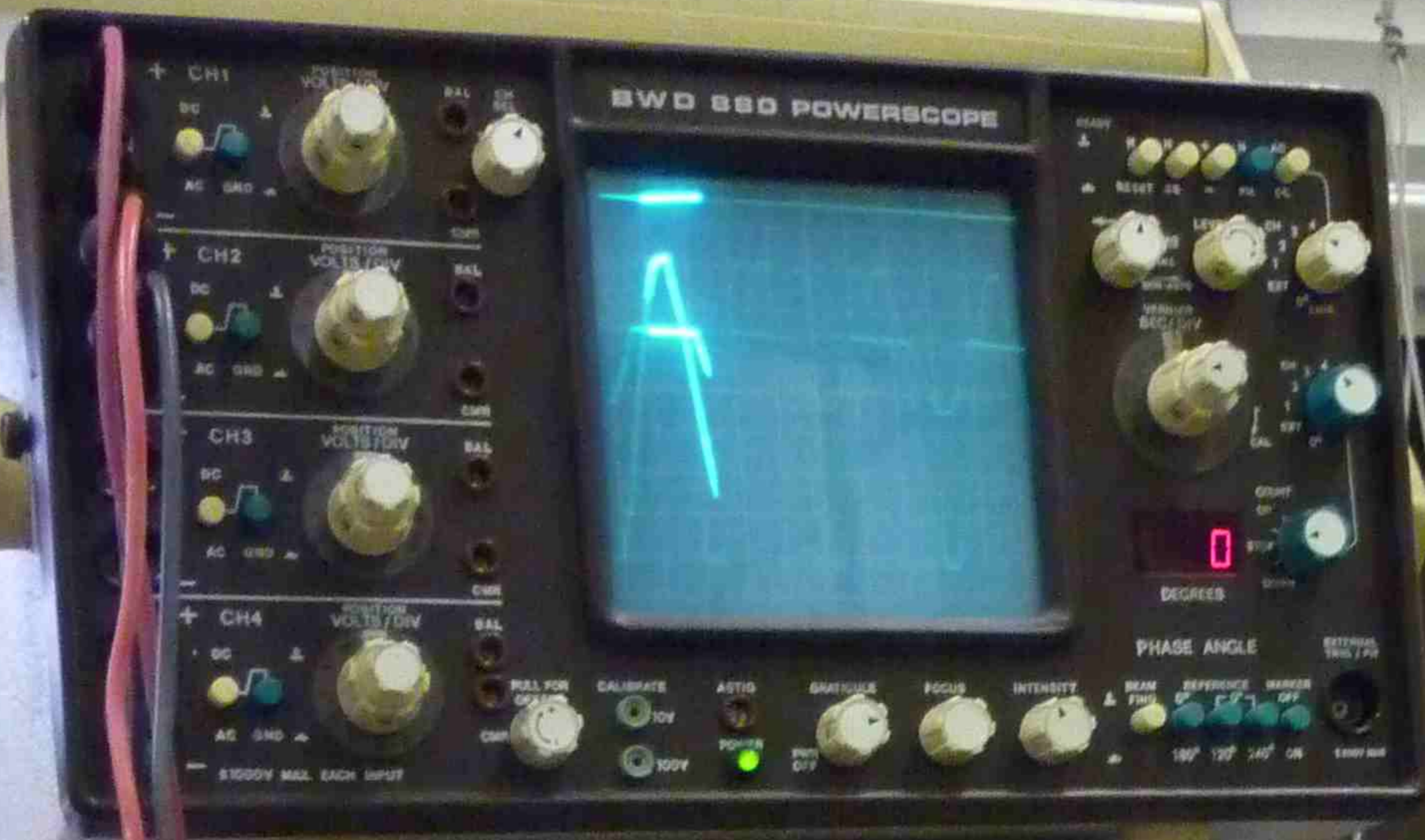
OFF ON

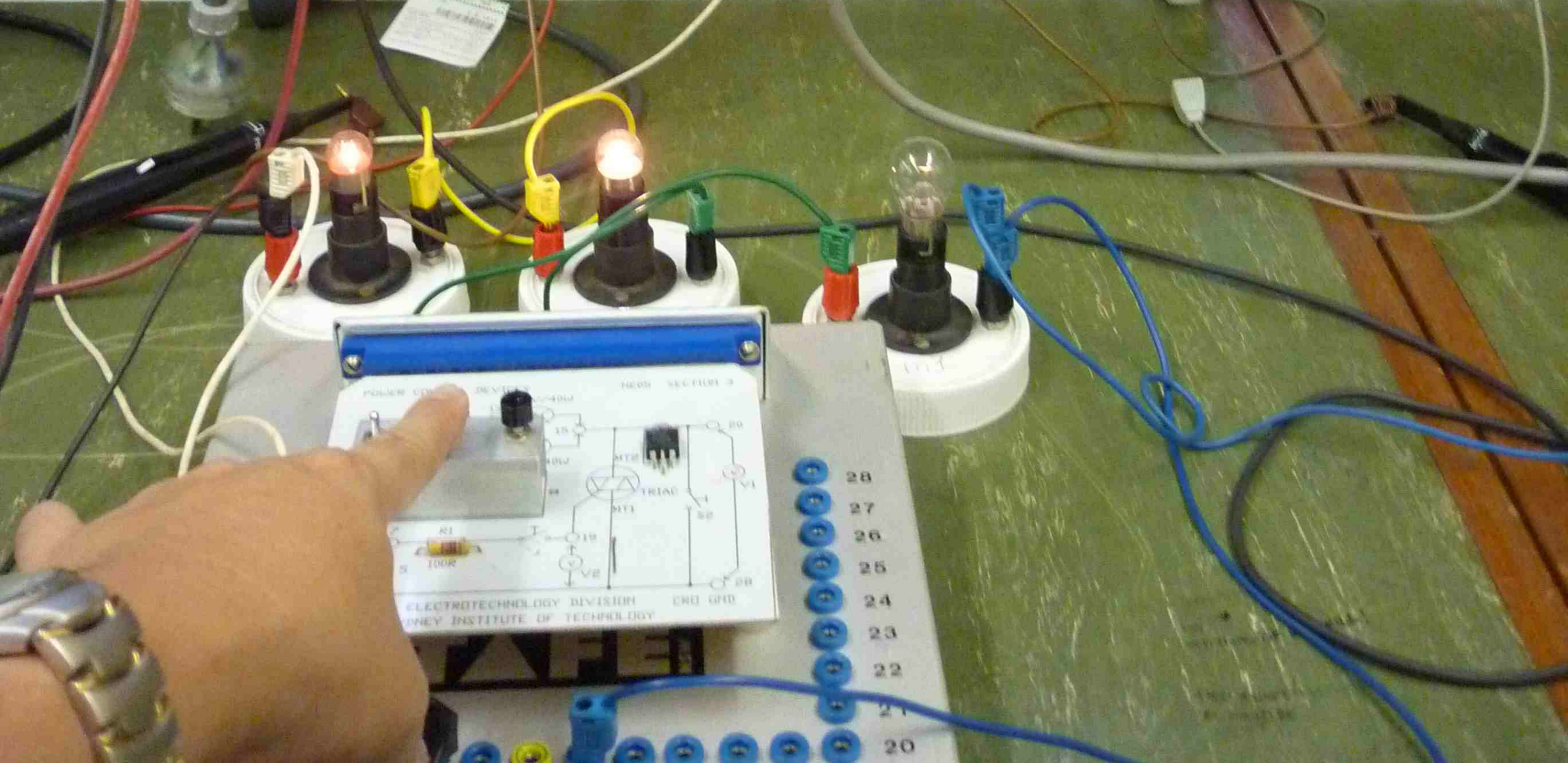
240V A.C.

0-50V

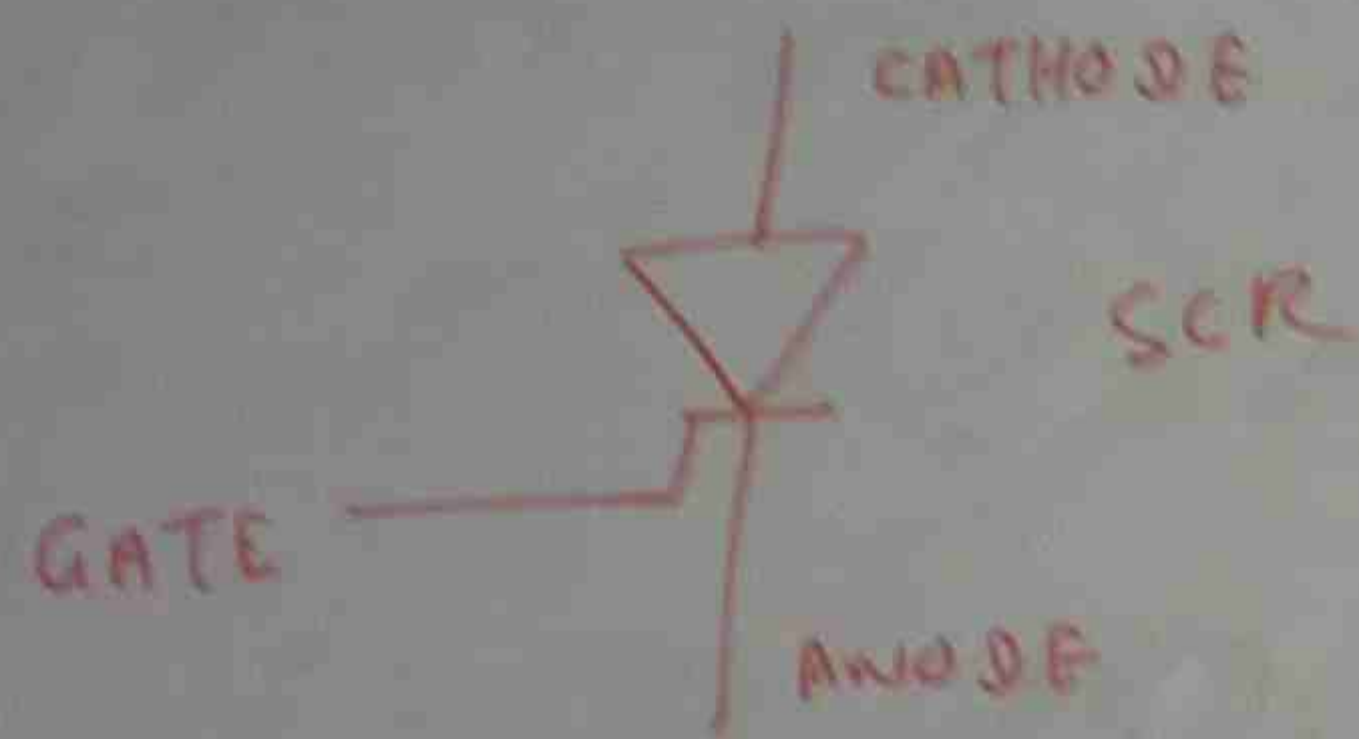
UNTERMINATED





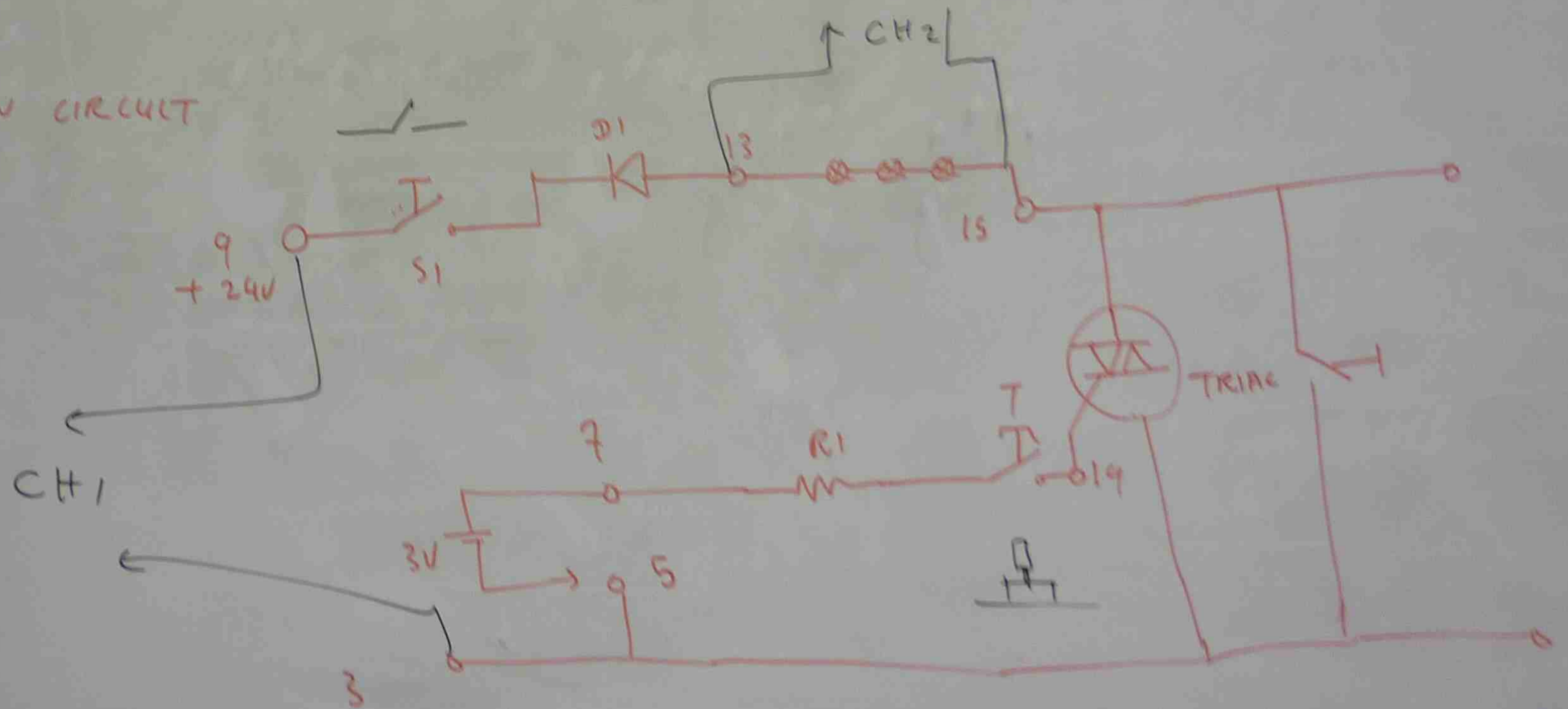


PRACTICAL (5) INVESTIGATING THE OPERATION OF SCR (SILICON CONTROLLED RECTIFIER) (THYRISTOR) CIRCUIT



SCR CONDUCTS WHEN THE GATE IS GIVEN THE SWITCHING SIGNAL

CONNECT THE GIVEN CIRCUIT



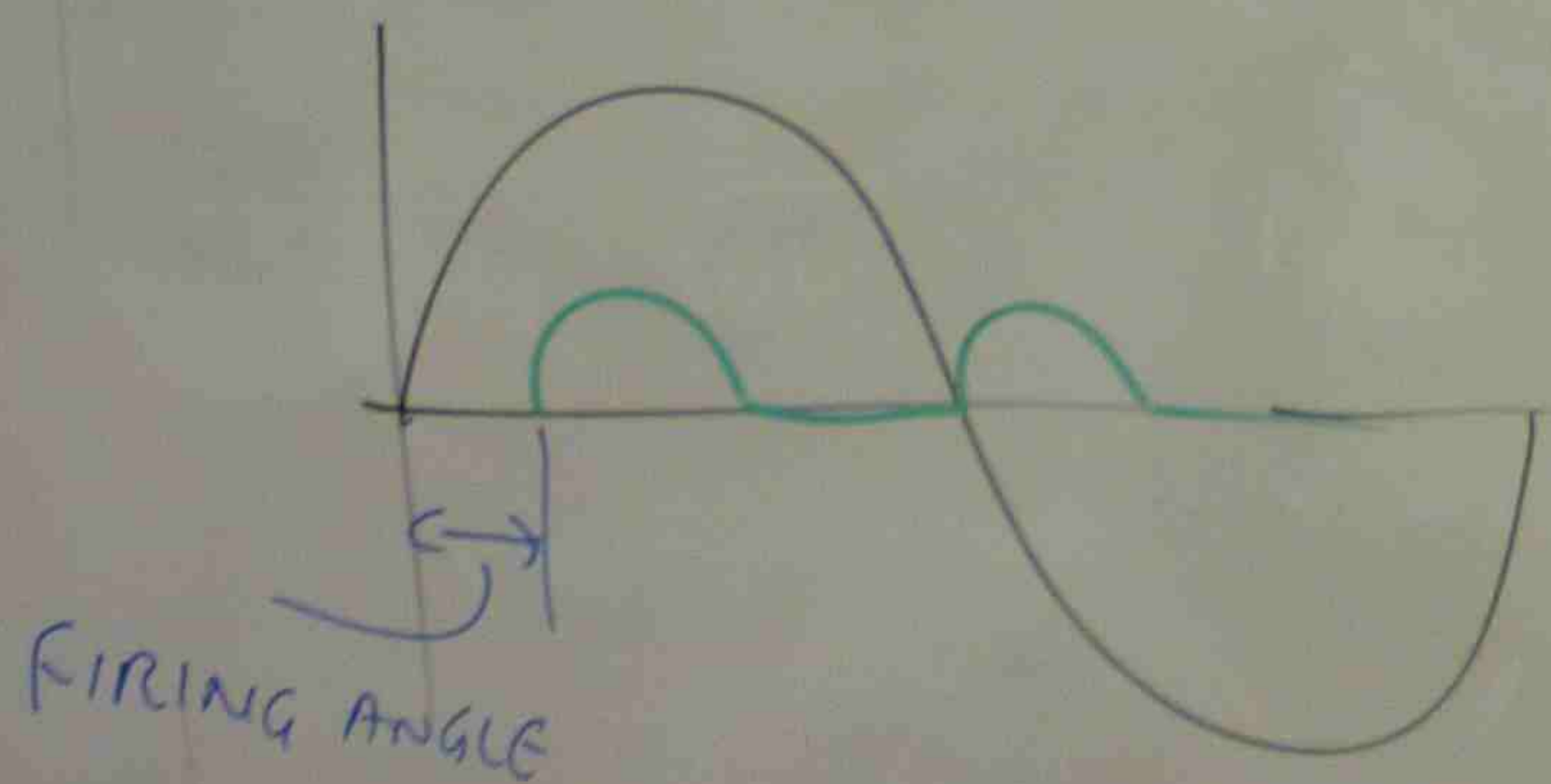
SWITCH
T
SKE
VO
FIRING

THYRISTOR)

SWITCH ON PUSH BUTTON SWITCH WHICH SUPPLIES THE TRIGGERING SIGNAL TO GATE OF TRIAC.

SKETCH THE MAIN WAVE (CH 1) & VOLTAGE ACROSS THE LOAD (CH 2)

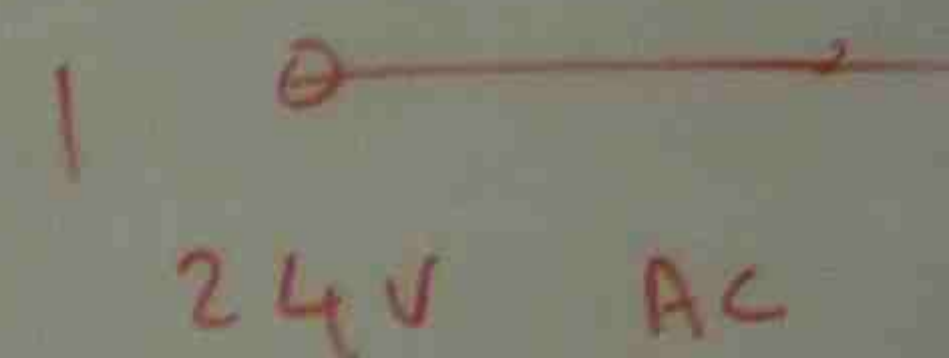
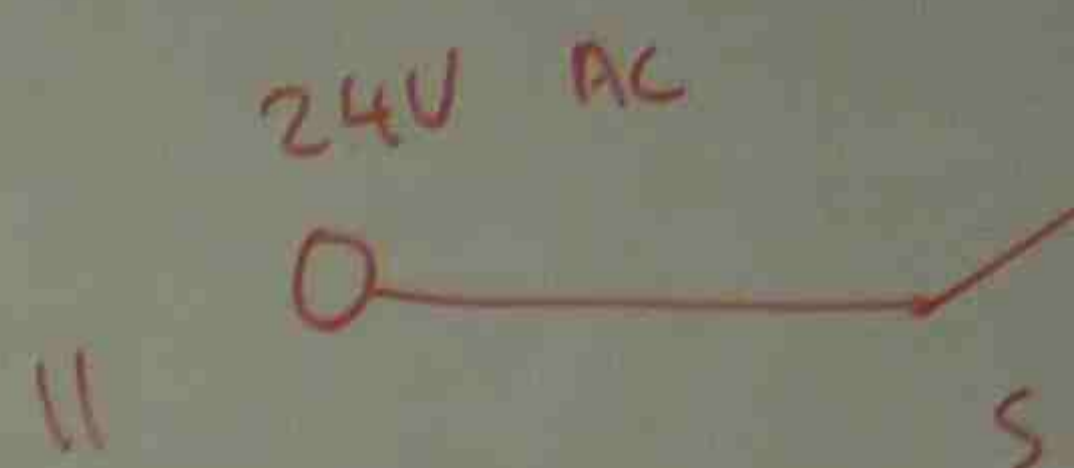
INDICATE THE FIRING ANGLE.

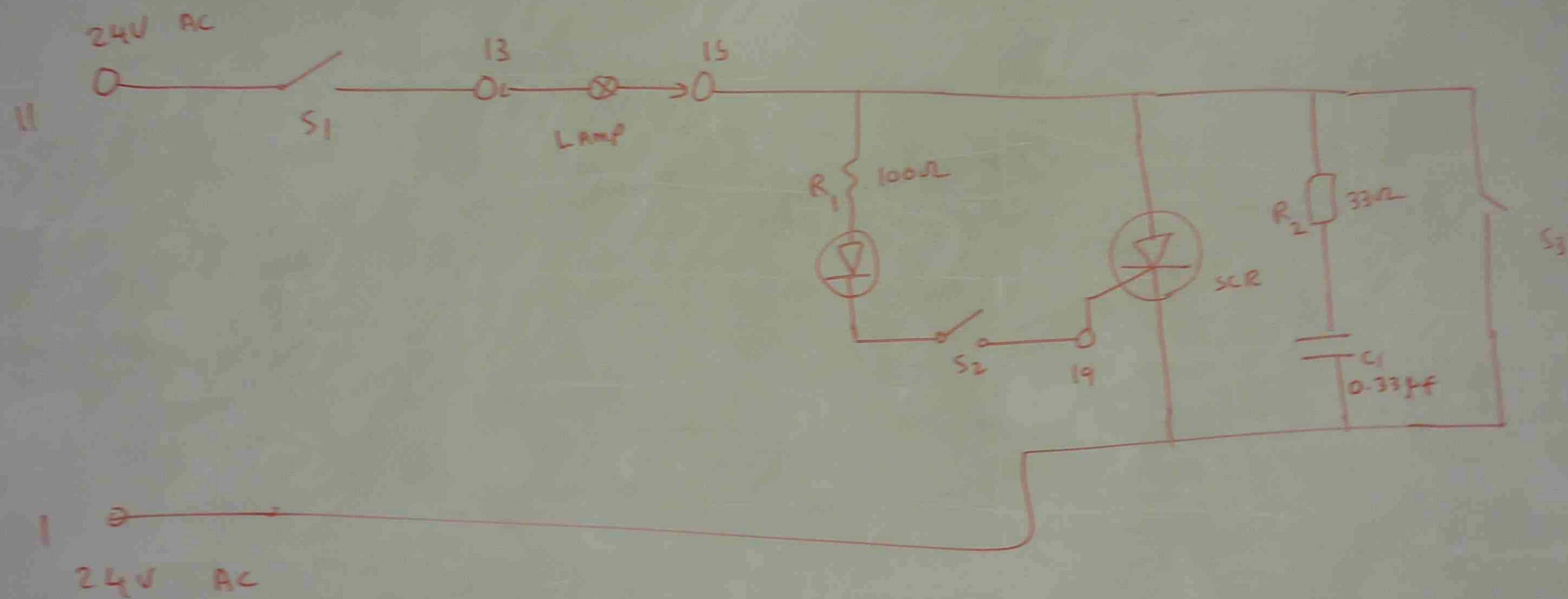


qTB

D4 500A

CO-48

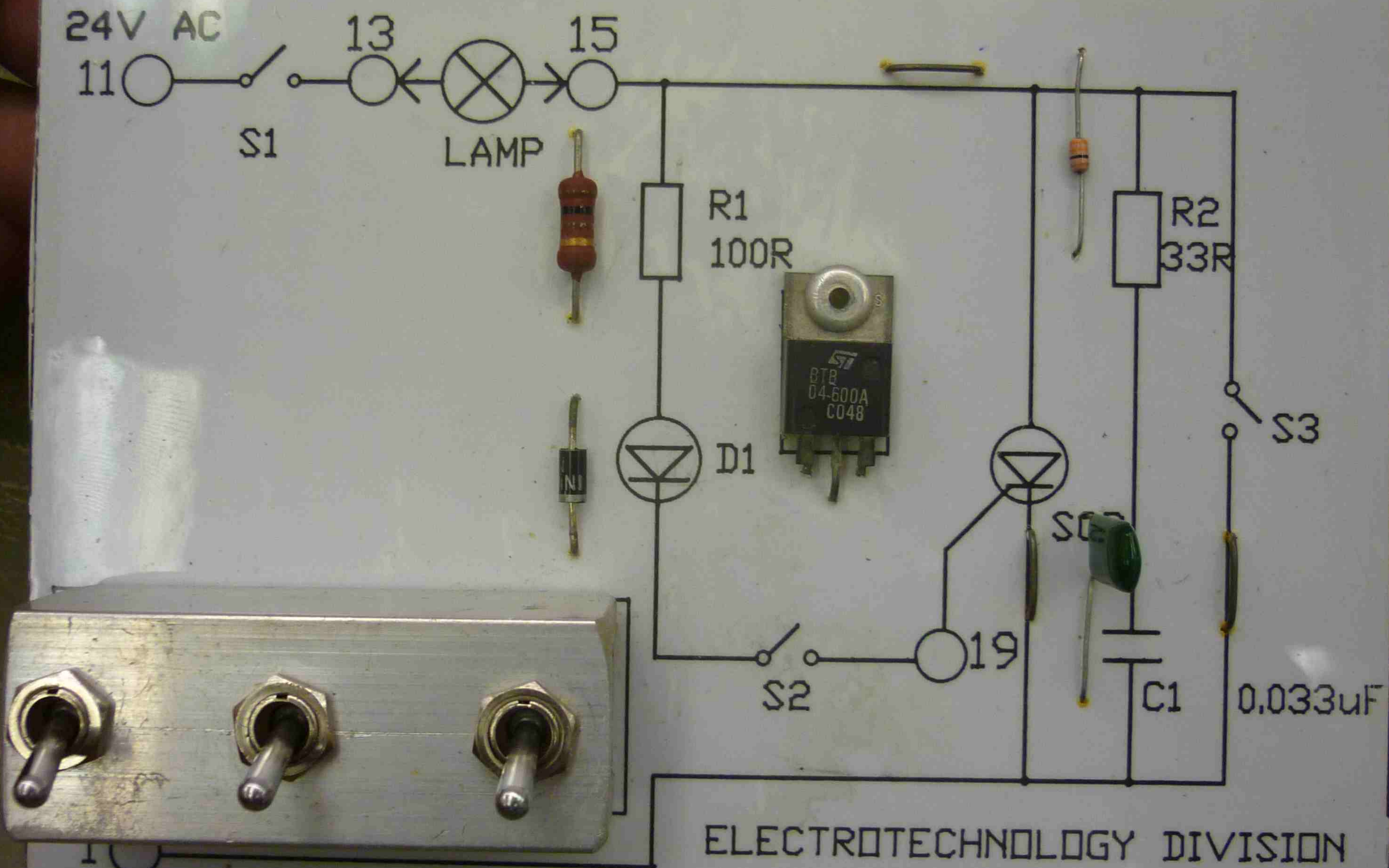




FIRING SIGNAL = DC.

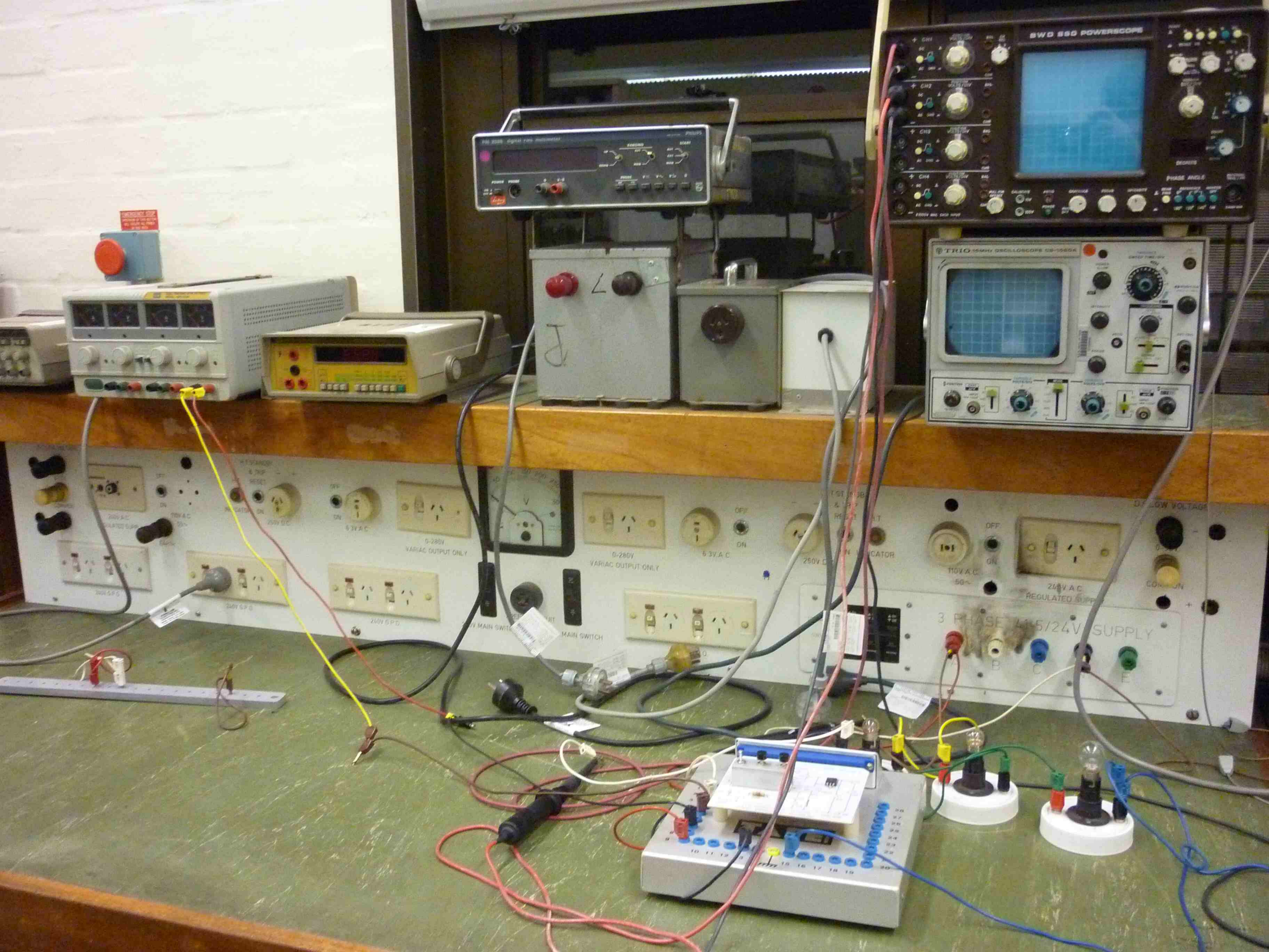
POWER CONTROL DEVICES

NE05 SECTION 2A



24V AC

ELECTROTECHNOLOGY DIVISION
SYDNEY INSTITUTE OF TECHNOLOGY



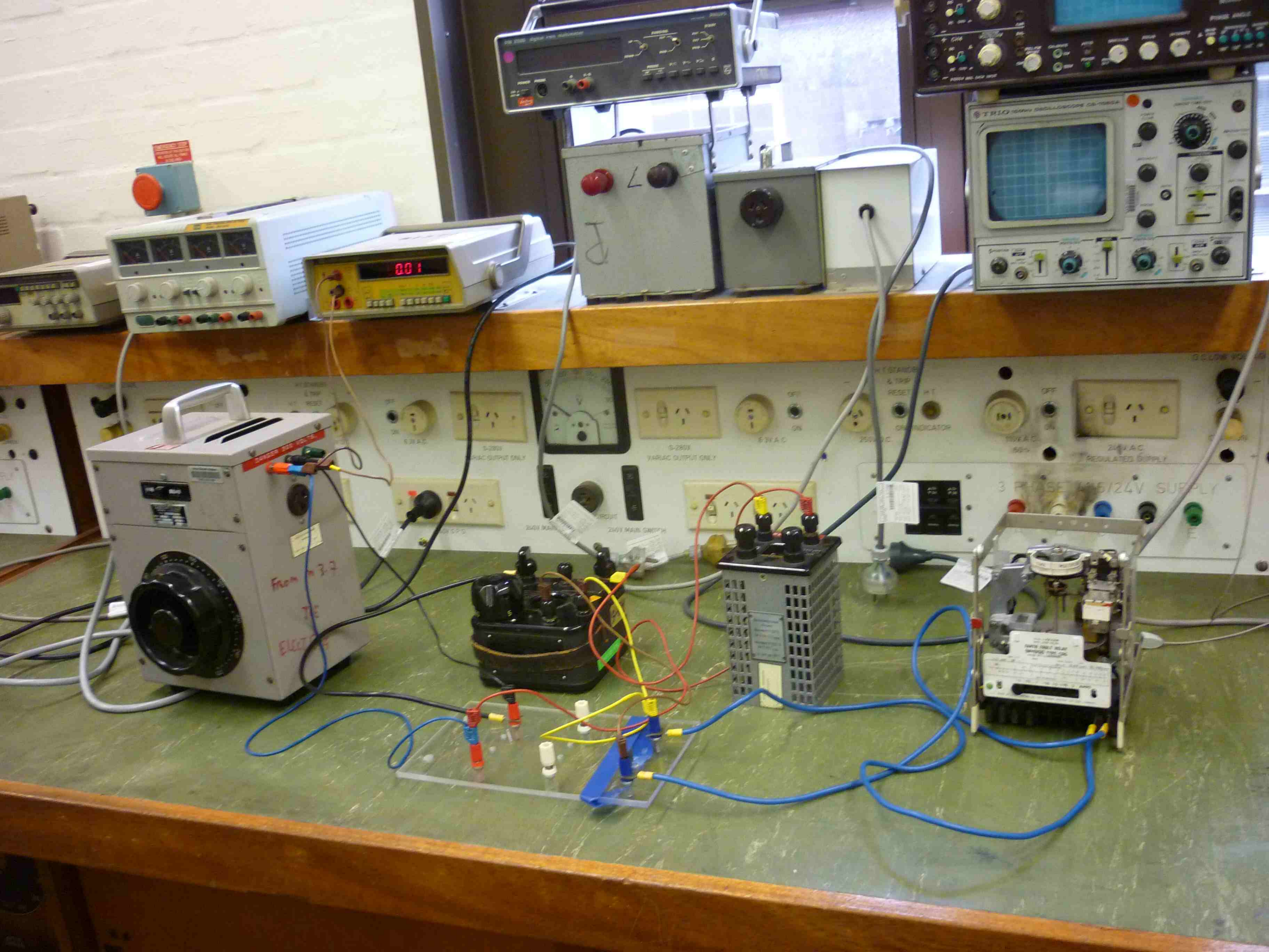
PHILIPS
PM 2000 digital rms multimeter

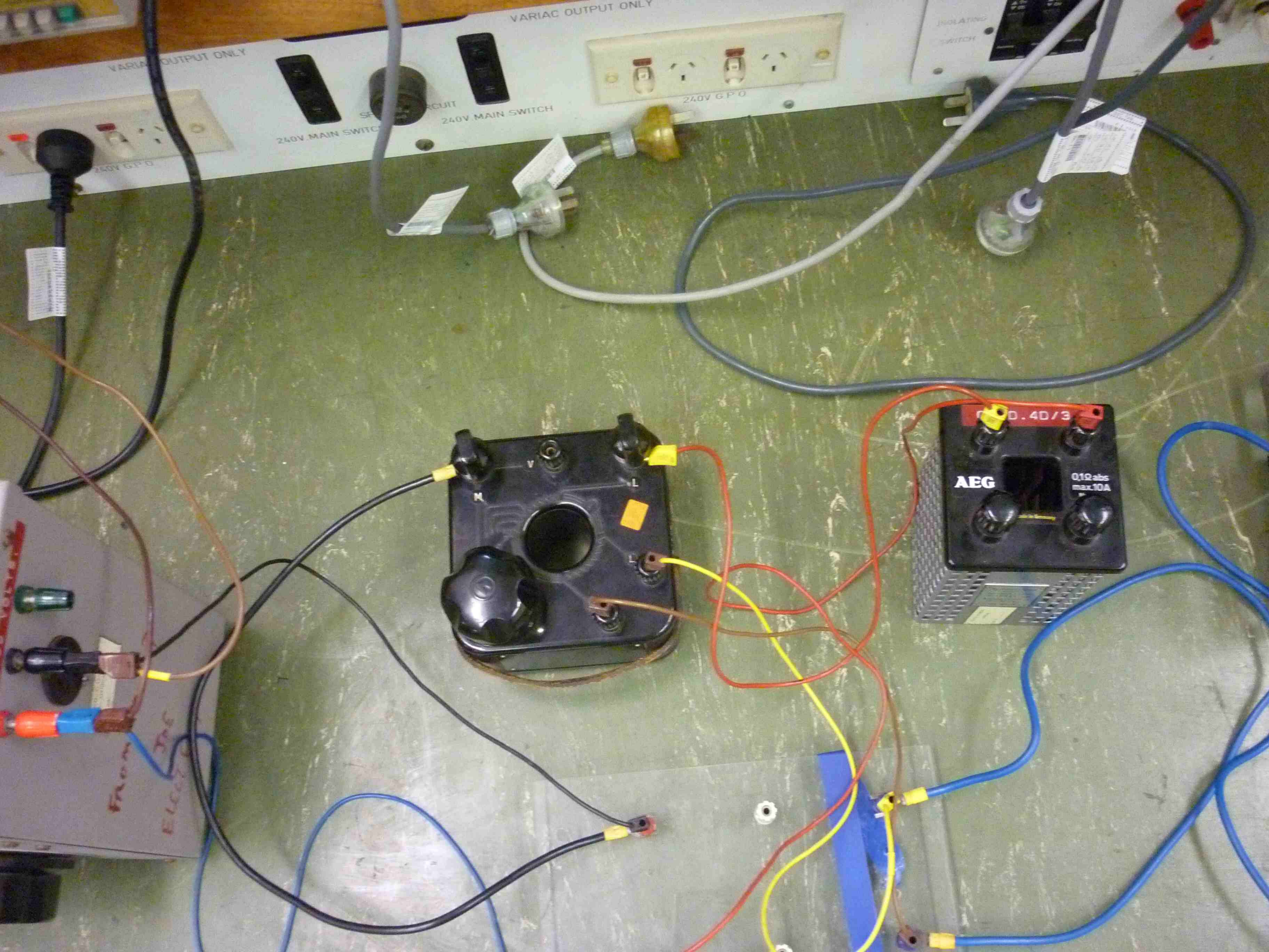
BWO 880 POWERSCOPE

TRIO 15MHz OSCILLOSCOPE OS-1580A

250V DC
0-280V VARIAC OUTPUT ONLY
0-280V VARIAC OUTPUT ONLY
250V D.C. INDICATOR
110V A.C. 50~
240V A.C. REGULATED SUPPLY
3 PHASE 415/240V SUPPLY

10 11 12 13 14 15 16 17 18 19 20





VARIAC OUTPUT ONLY

VARIAC OUTPUT ONLY

240V MAIN SWITCH

240V MAIN SWITCH

240V GPO

240V GPO

ISOLATING SWITCH

M

V

L

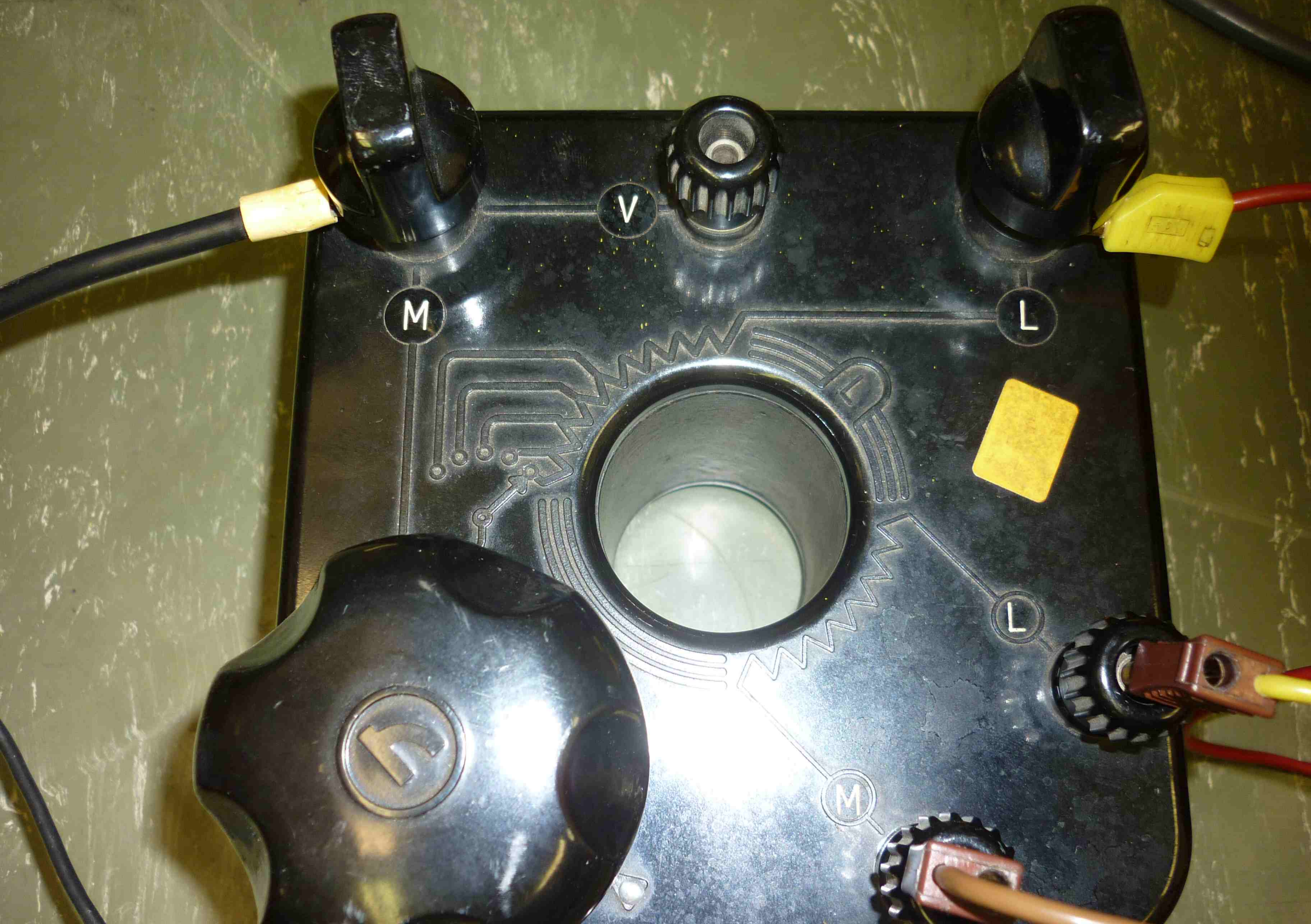
L

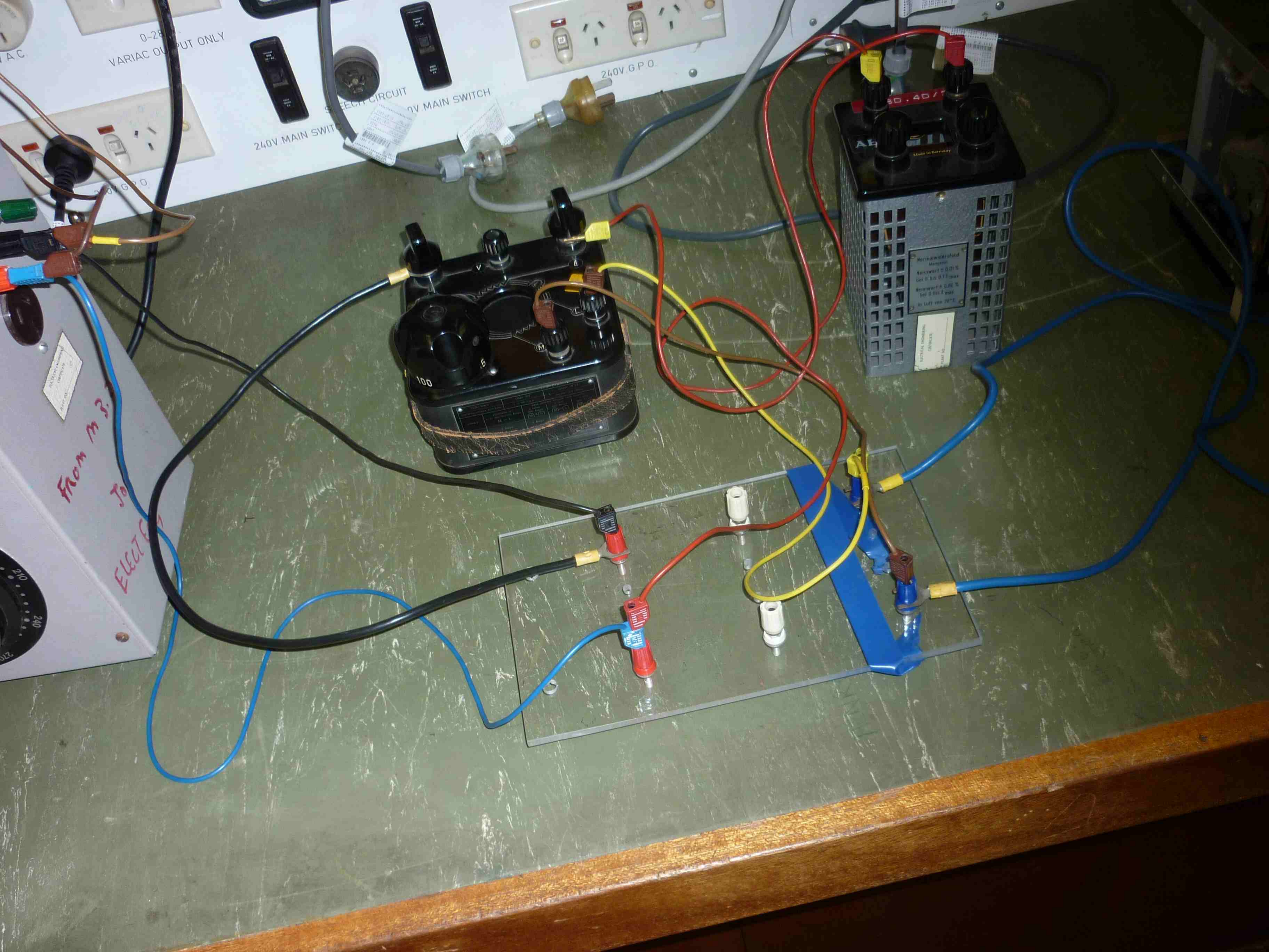
AEG

0.4D/3

0.1Ω abs
max 10A

FROM THE ELECT...





0-28
VARIAC OUTPUT ONLY

240V G.P.O.

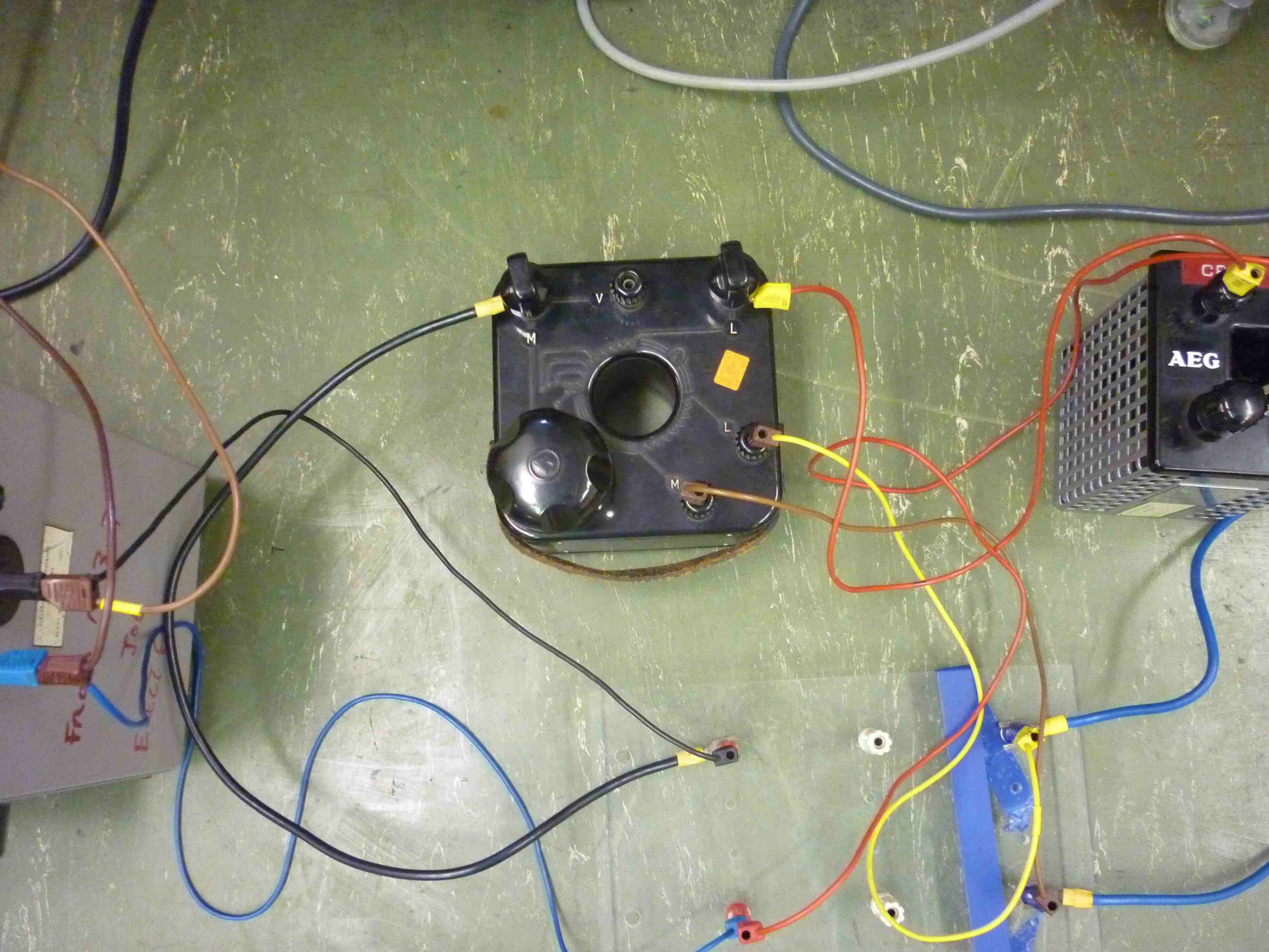
240V MAIN SWITCH
SELECT CIRCUIT
240V MAIN SWITCH

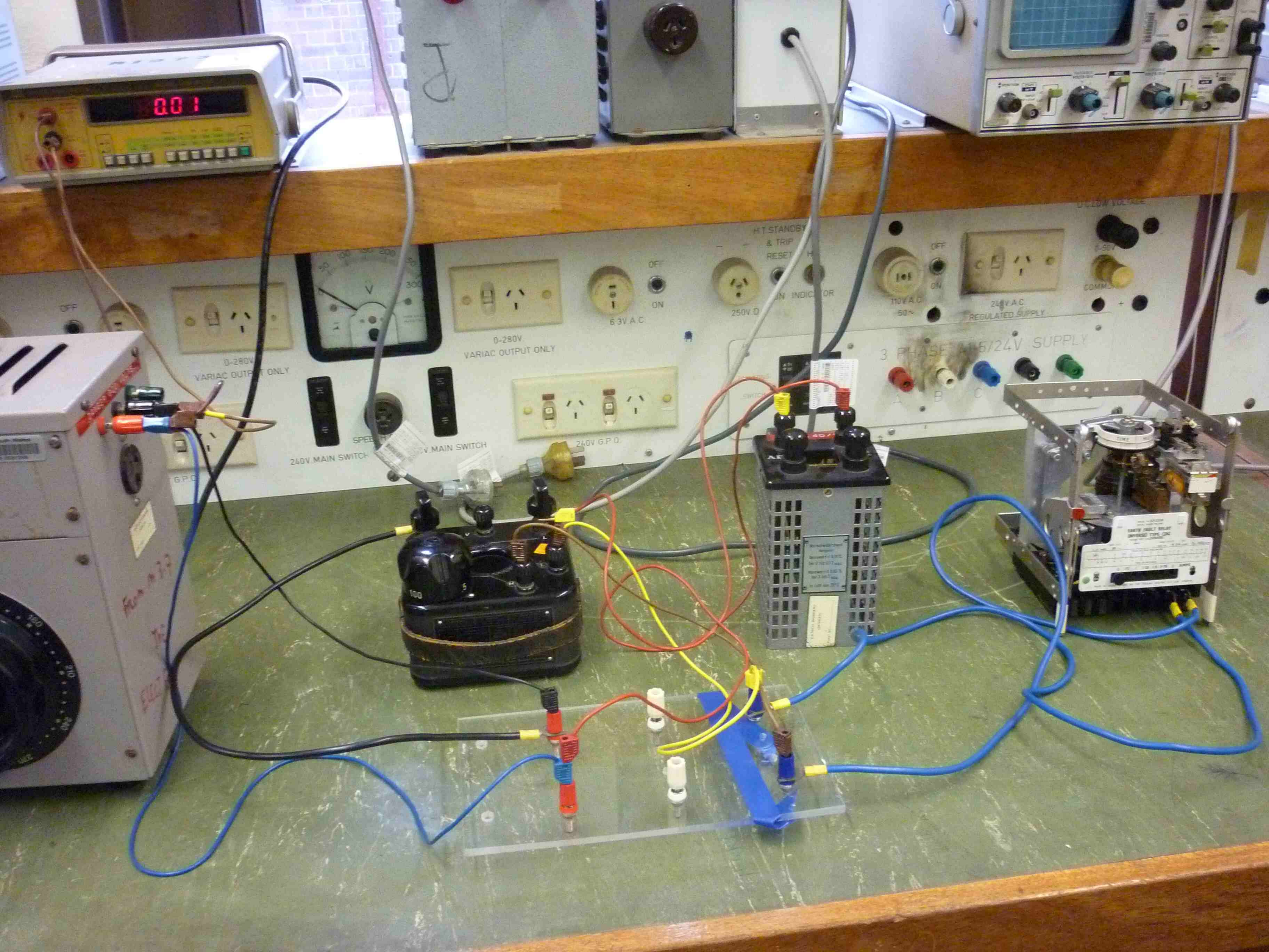
30.40/7
AB
Made in Germany
Normalwert stand
Messwert
Nennwert ± 0.01 %
bei 0 bis 0.1 max
Nennwert ± 0.02 %
bei 0 bis 1 max
in Luft von 20°C

100
5

From M.D.
To
ELECT

210
240
270





Digital Multimeter (DMM) showing a reading of 0.01. It has several control buttons and a red LED display.

Voltage meter with a scale from 0 to 300 V. The needle is positioned around 100 V.

0-280V VARIAC OUTPUT ONLY. Includes a switch and a 6.3V A.C. terminal.

250V D. 50~. Includes a 110V A.C. terminal and a 240V A.C. REGULATED SUPPLY terminal.

3 PHASE 480/240V SUPPLY. Includes terminals for A, B, C, and a common terminal. Also features a 240V A.C. REGULATED SUPPLY section.

Transformer with a primary winding and a secondary winding. It has a red and blue wire connected to the primary and a blue wire connected to the secondary.

Transformer with a primary winding and a secondary winding. It has a red and blue wire connected to the primary and a blue wire connected to the secondary.

Power supply unit with a black top and a silver bottom. It has several terminals and a label.

Relay assembly with a label that reads "EARTH FAULT RELAY INVERSE TIME COIL". It has several terminals and a label.

Terminal block with several wires connected to it. The wires are colored red, blue, yellow, and black.

3 PHASE 400V/24V SUPPLY

A B C N E

TIME MULTIPLIER

SERIAL NO. R.P.2308
INSTR. BOOK MS 3401
**EARTH FAULT RELAY
(INVERSE) TYPE CDG**
MODEL NO. CDG31EG4285

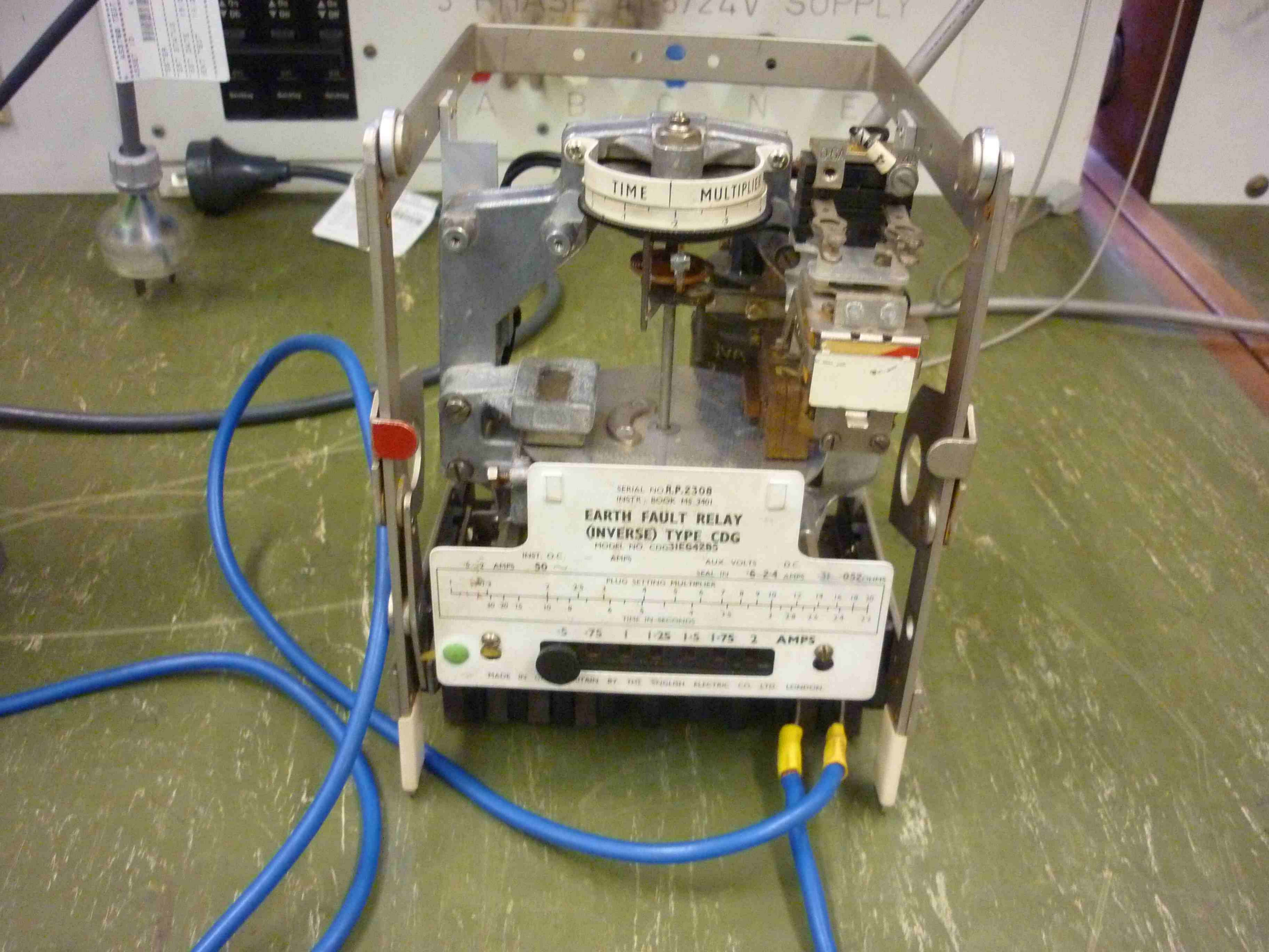
INST. O.C. 50 AMPS AUX. VOLTS D.C. 24 VOLTS

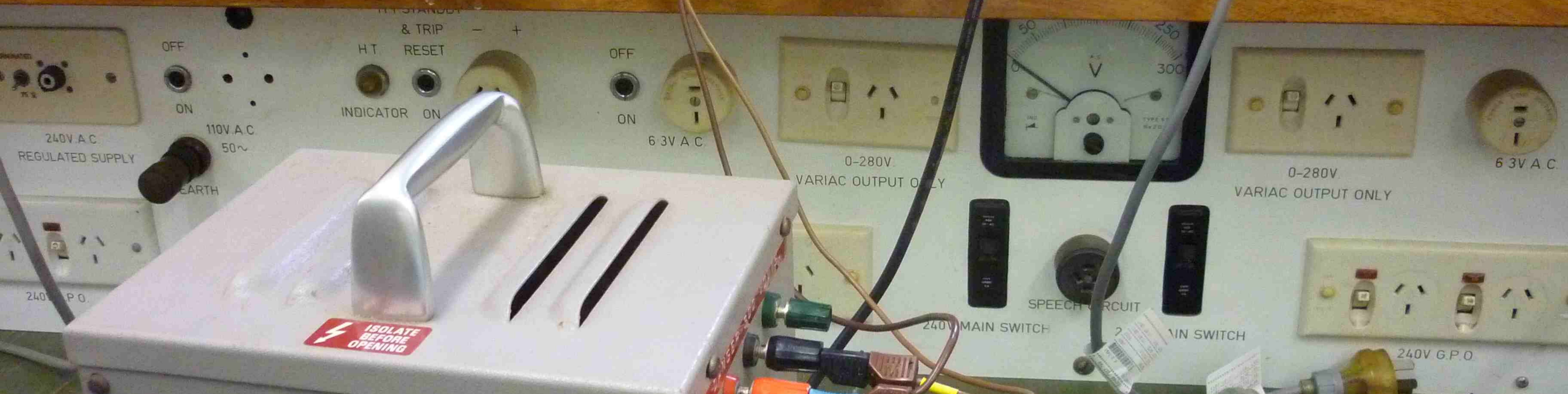
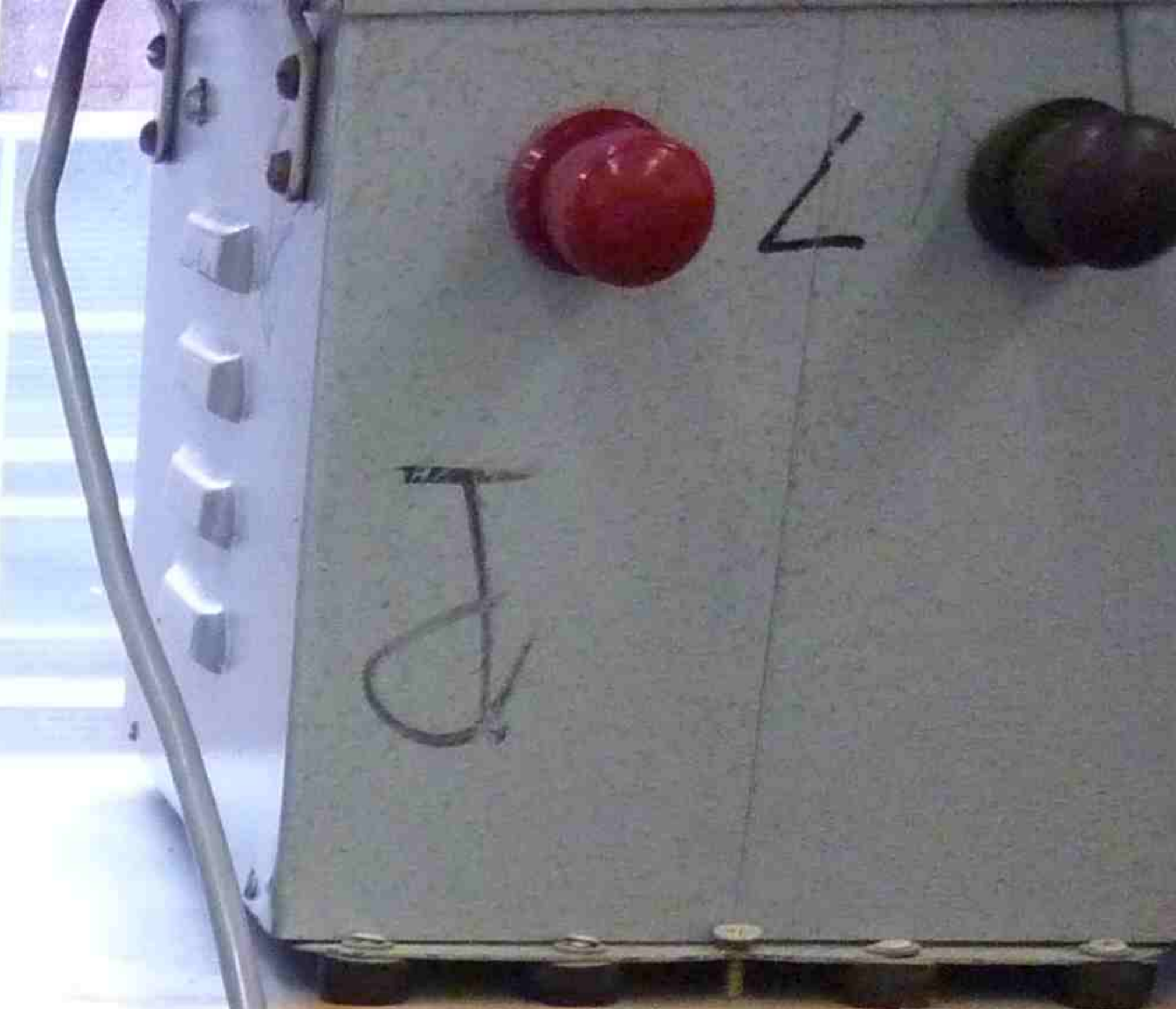
PLUG SETTING MULTIPLIER

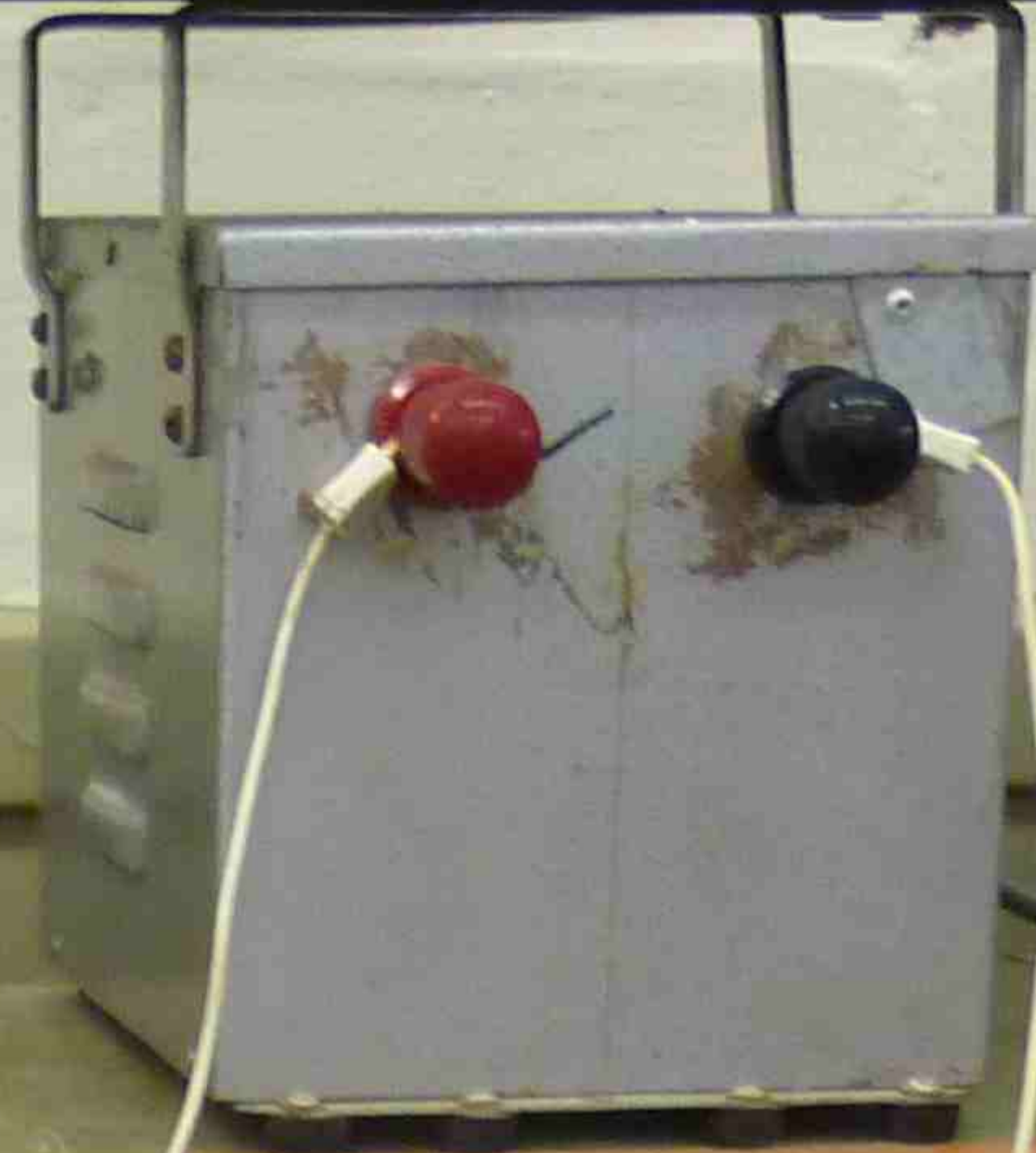
TIME IN SECONDS

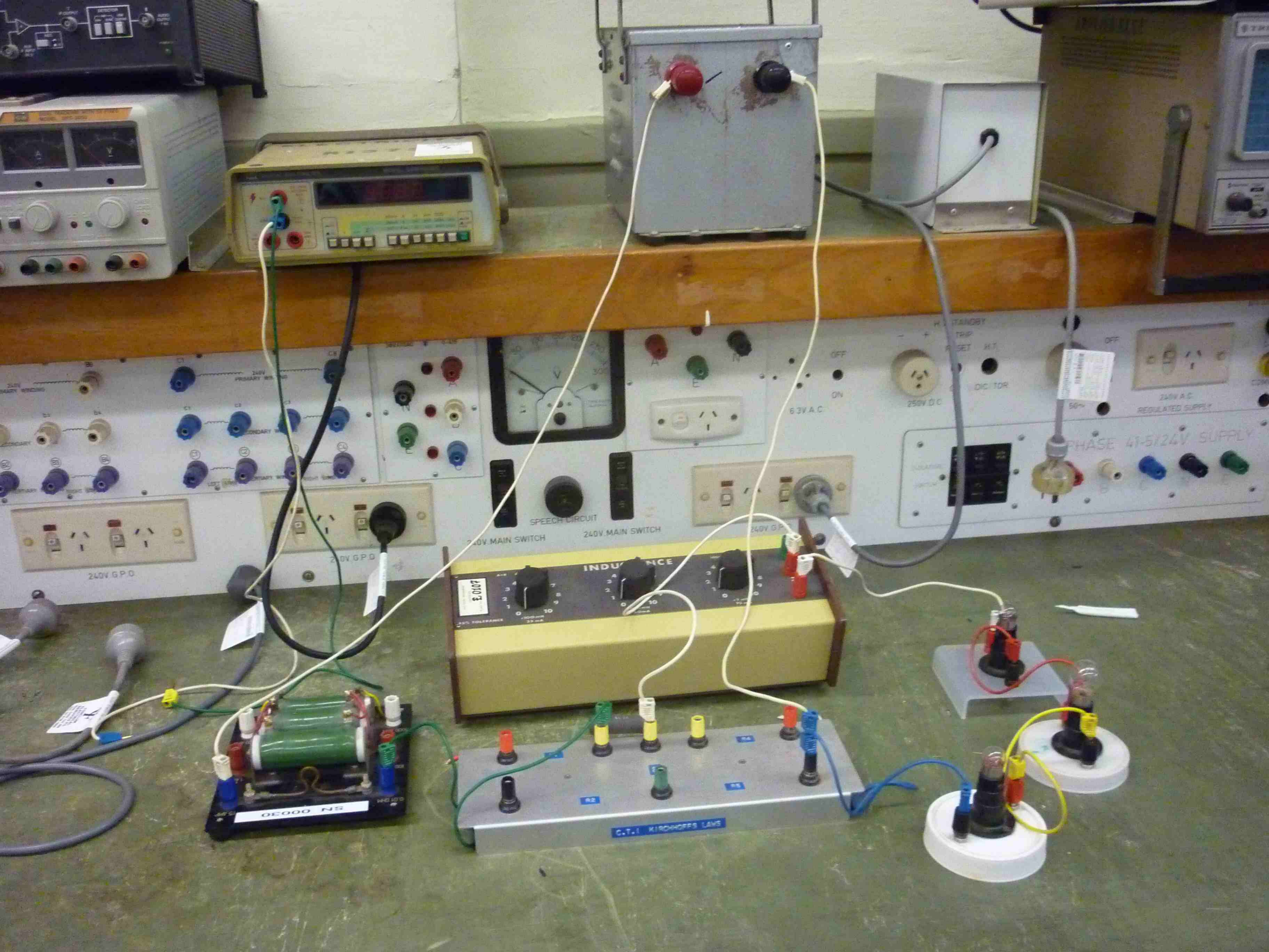
5 -75 1 1.25 1.5 1.75 2 AMPS

MADE IN ENGLAND BY THE ENGLISH ELECTRIC CO. LTD. LONDON









Top left equipment including a multimeter and a signal generator.

Yellow signal generator with a digital display and control knobs.

Grey metal box with two large knobs (red and black) and a white cable connected to it.

Small white rectangular box with a single cable connection.

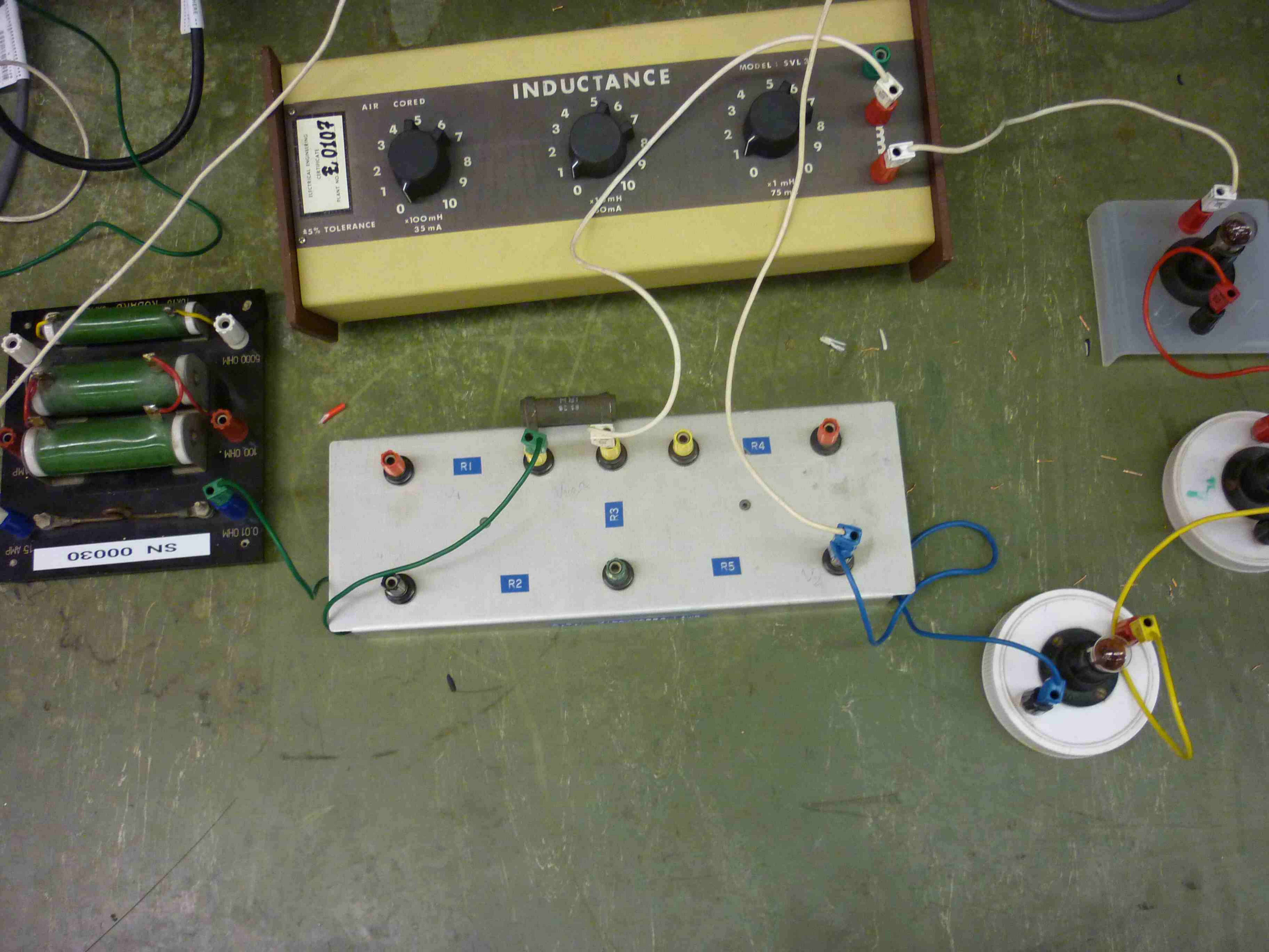
Main rack equipment including a 240V A.C. REGULATED SUPPLY, a 240V D.C. output section, and various input/output ports.

Yellow 'INDUCTANCE' box with two large black knobs and a digital display.

Breadboard with a green IC labeled '0E000 NS' and various electronic components.

Grey board labeled 'C.T.1 KIRCHHOFFS LAWS' with several resistors and connection points.

Three small white circular bases, each with a component and wires connected to it.



INDUCTANCE

AIR CORED

MODEL: SVL 3

PLANT NO. 20103

5% TOLERANCE

$\times 100 \text{ mH}$
35 mA

$\times 1 \text{ mH}$
75 mA

$\times 1 \text{ mH}$
75 mA

5000 OHM

100 OHM

0.01 OHM

15 AMP

SN 00030

R1

R2

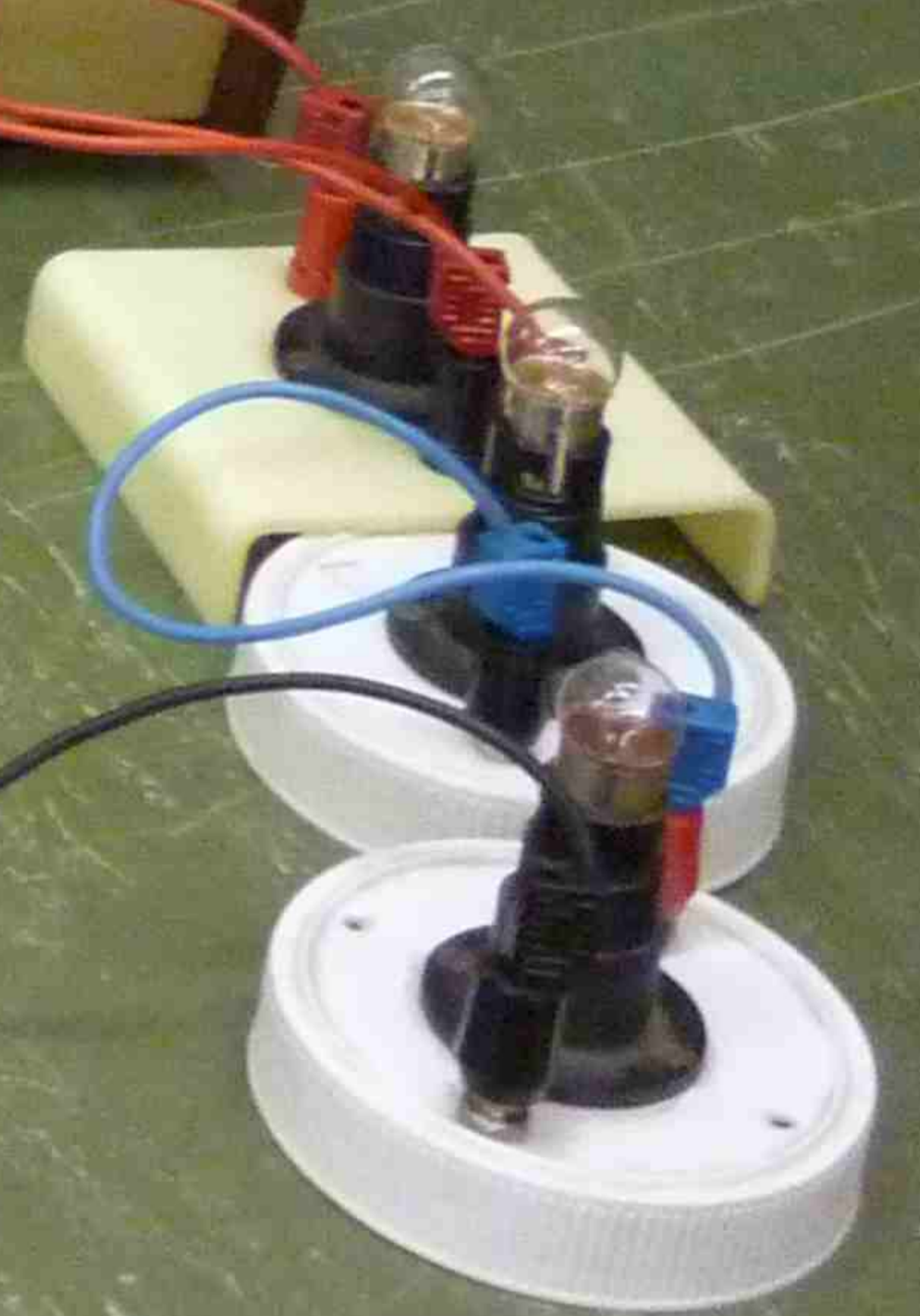
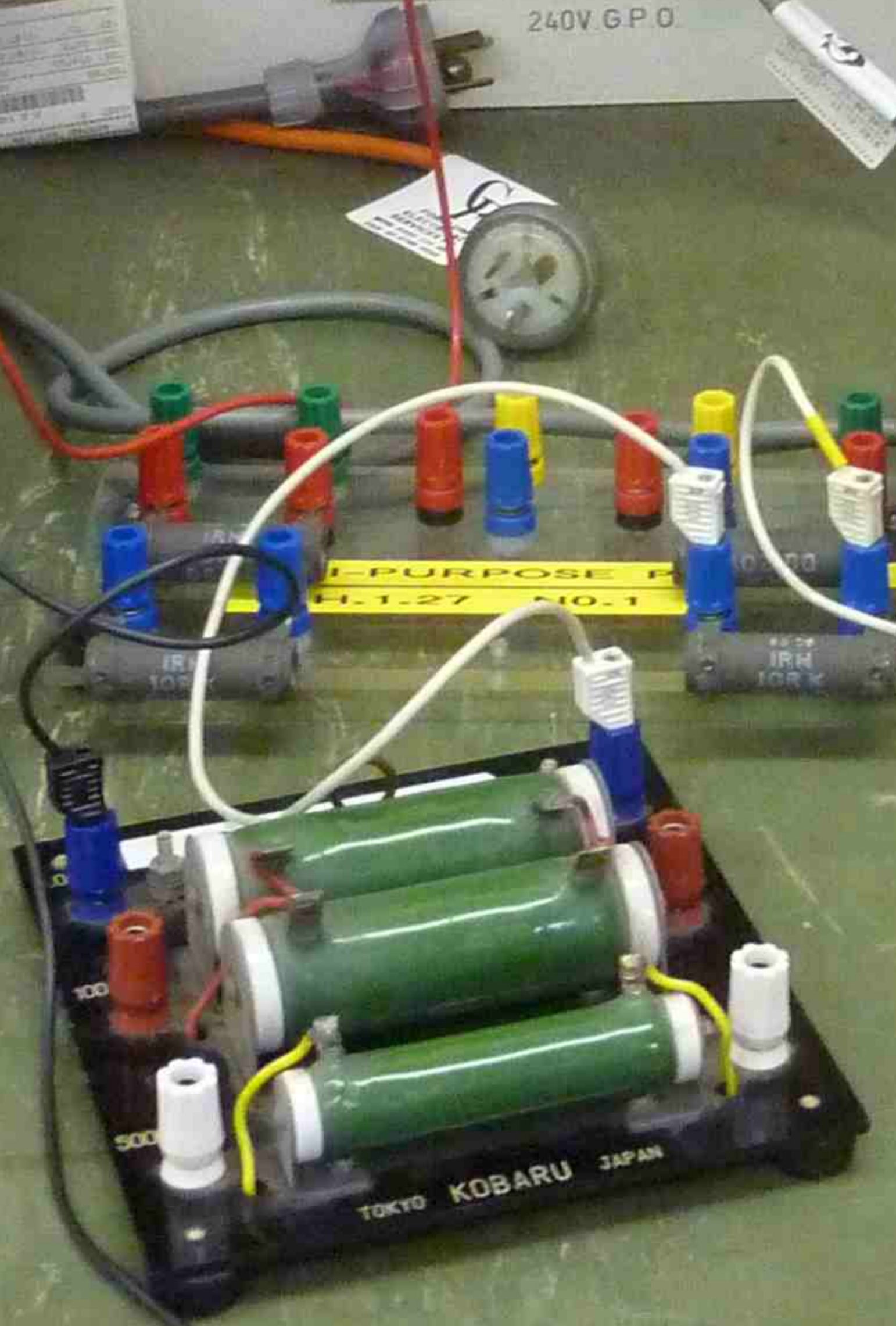
R3

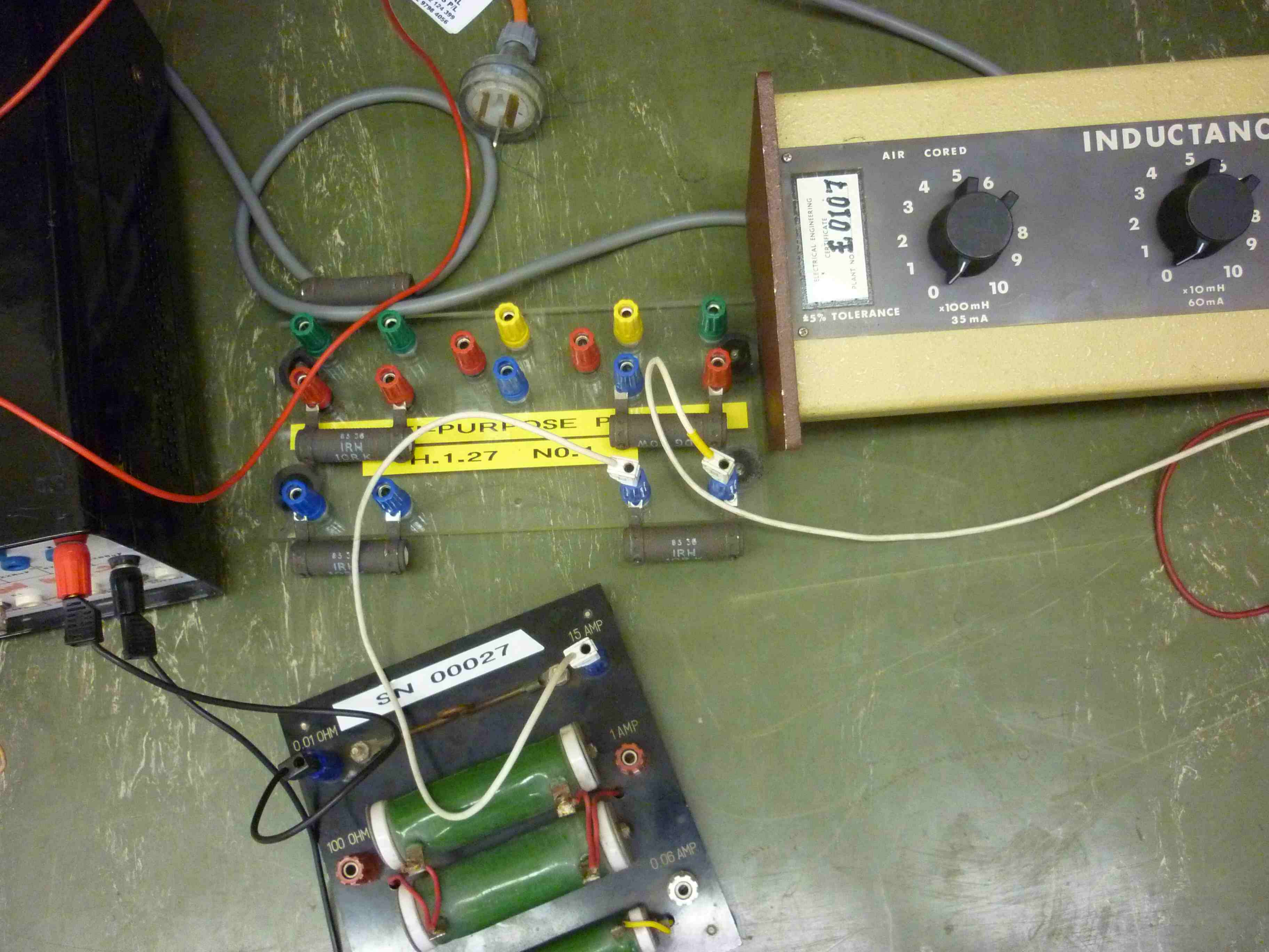
R4

R5

Incandescent bulb on a white base.

Incandescent bulb on a grey base.





INDUCTANCE

AIR CORED

ELECTRICAL ENGINEERING
CERTIFICATE
PLANT NO. **E0107**

±5% TOLERANCE

0 1 2 3 4 5 6 7 8 9 10
x100mH
35mA

0 1 2 3 4 5
x10mH
60mA

IRH 100K
PURPOSE P
H.1-27 NO.1

SN 00027

0.01 OHM

100 OHM

15 AMP

1 AMP

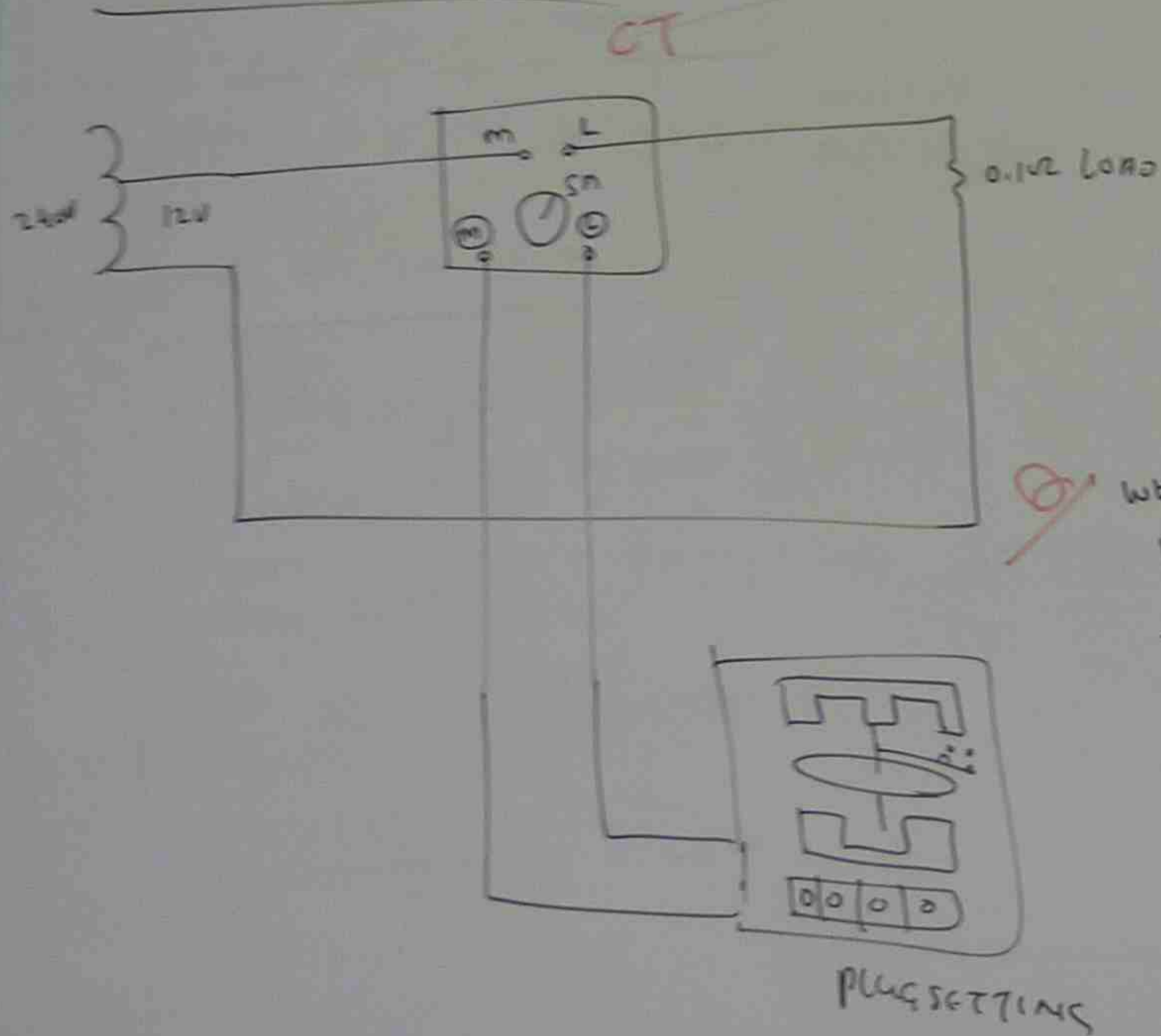
0.06 AMP

PLANT NO. 124 399 978 4056

PRACTICAL Q

INVESTIGATING THE OPERATION OF OVER CURRENT RELAY

CONNECT THE GIVEN CIRCUIT



- SET GA AT CT
- SET PLUG SETTINGS AT 0.5, 1.25, 2 A
- SWITCH ON AND OBSERVE THE RELAY'S PERFORMANCE
- ANSWER THE QUESTION

WHEN THE PLUG SETTING IS CHANGED FROM 0.5 A TO 1.25, 2 A, WHAT HAPPENS TO RELAY OPERATING TIME?

fault current
log

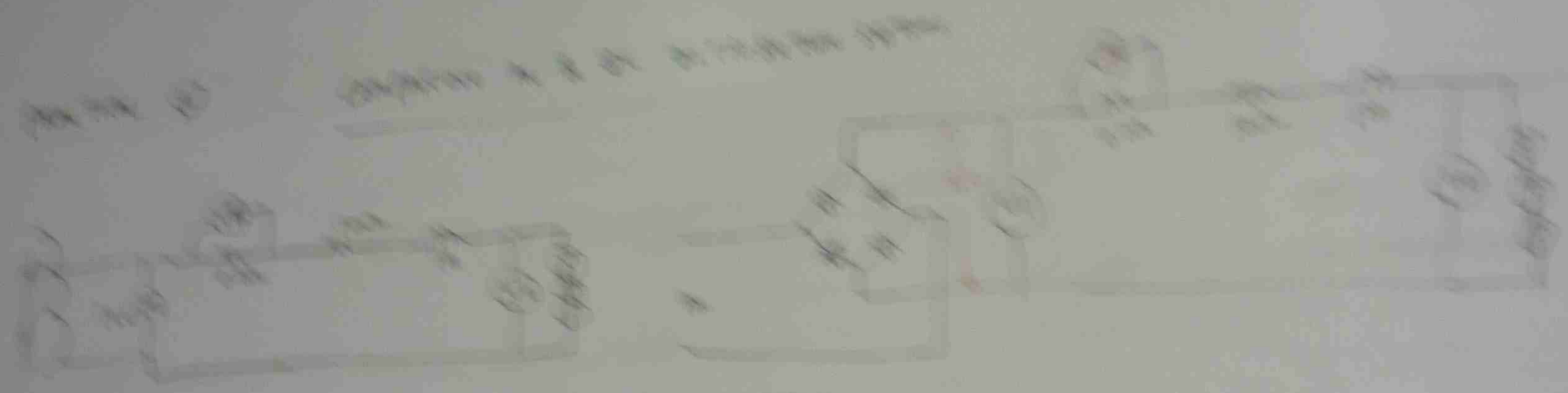
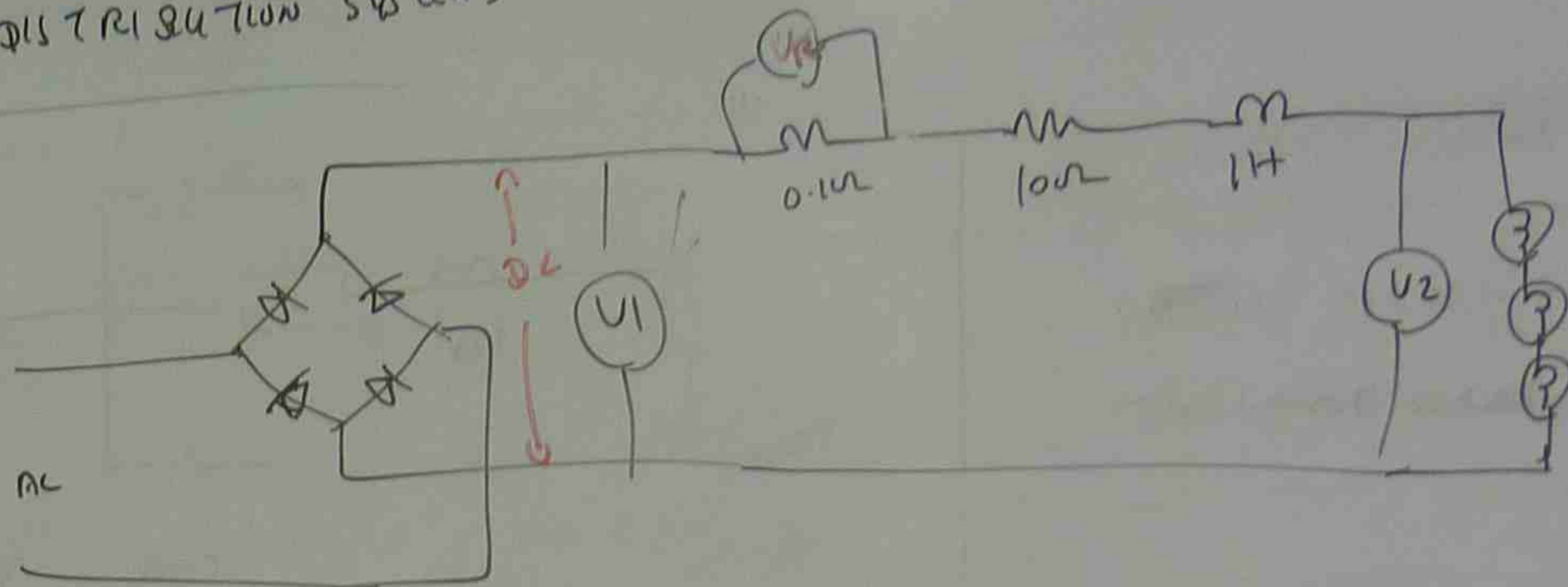
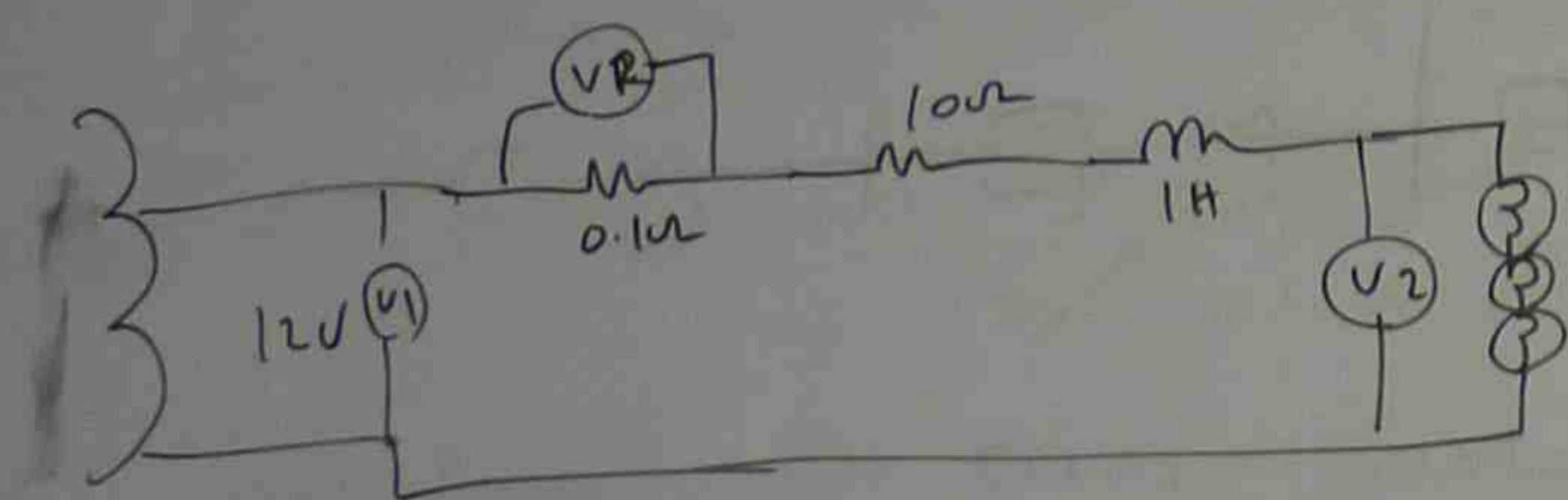


Table with 4 columns and 4 rows of handwritten text, likely a data table for an experiment.

Reading	Reading	Reading	Reading
1.0	1.0	1.0	1.0
2.0	2.0	2.0	2.0
3.0	3.0	3.0	3.0
4.0	4.0	4.0	4.0

PRACTICAL ②

COMPARING AC & DC DISTRIBUTION SYSTEMS



AC

— CONNECT THE GIVEN CIRCUITS & INJECT VOLTAGE

AC	$V_1 =$	$V_R =$	$I = \frac{V_R}{0.1} =$	$V_2 =$
DC	$V_1 =$	$V_{IR} =$	$I = \frac{V_R}{0.1} =$	$V_2 =$

$$\% \text{ VOLTAGE REGULATION} = \frac{V_1 - V_2}{V_1} \times 100 =$$

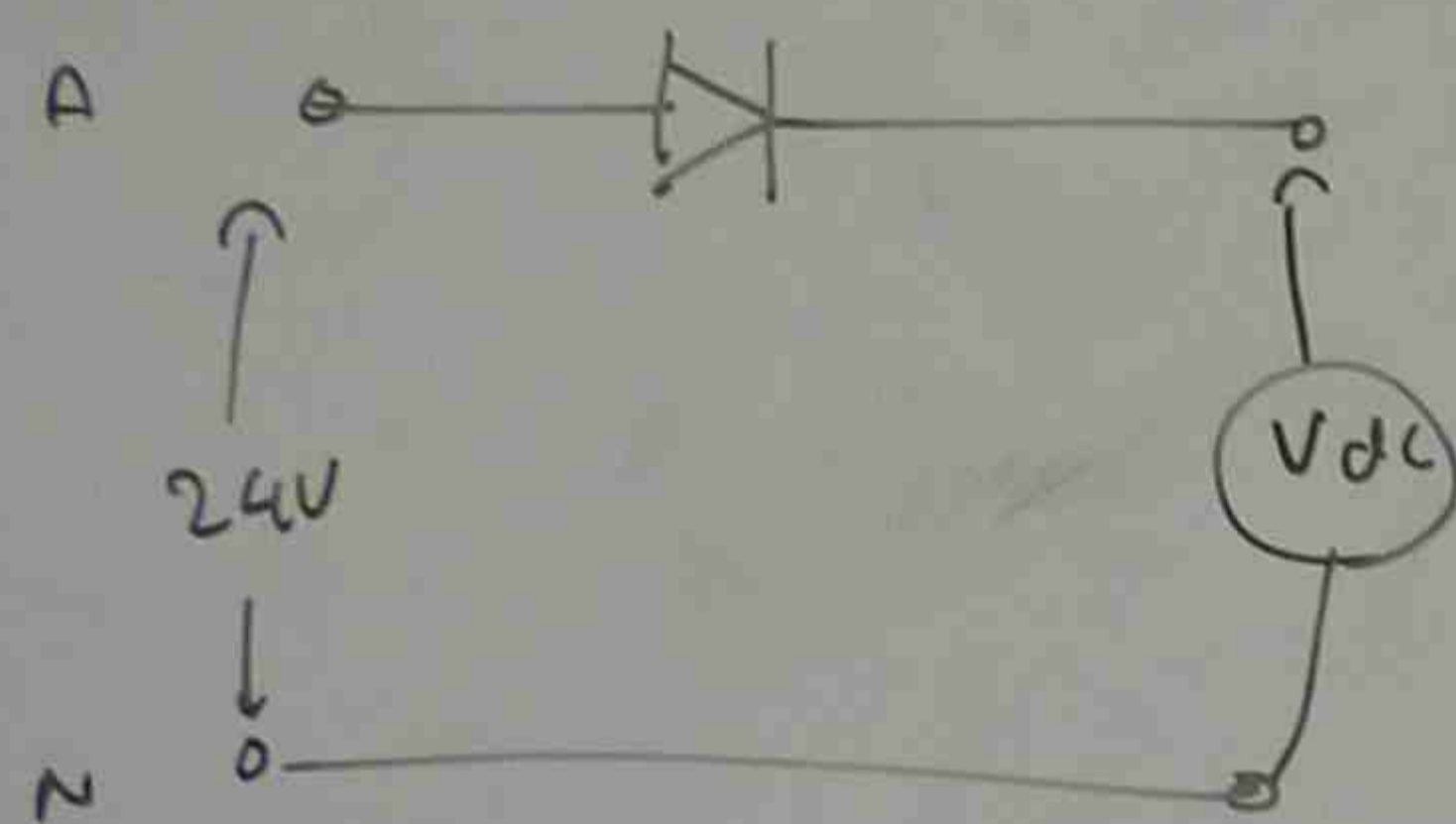
$$\% \text{ VOLTAGE REGULATION} = \frac{V_1 - V_2}{V_1} \times 100$$

QUESTION WHICH SYSTEM HAS HIGHER % VOLTAGE REGULATION

INVESTIGATING 1 ϕ & 3 ϕ RECTIFICATION

1 ϕ RECTIFICATION (HALF WAVE)

CONNECT THE GIVEN CIRCUIT



READ V_{dc}

WRITE THE RATIO OF
AC TO V_{dc}

FROM PRACTICAL

$$\text{RATIO} = \frac{V_{dc}}{V_{ac}}$$

COMPARE THE RATIO

$$V_{dc} = \frac{2 E_{max}}{\pi} \quad \text{FOR FULL WAVE}$$

$$V_{dc} = \frac{E_{max}}{\pi} \quad \text{FOR HALF WAVE}$$

$$E_{max} = \sqrt{2} E_{rms}$$

$$E_{rms} = 24V$$

$$\therefore V_{dc} = \frac{24 \times 1.4142}{3.1416} = 10.8V$$

$$\text{RATIO} = \frac{V_{dc}}{V_{ac}} = \frac{10.8}{24} = 0.45$$

FROM THEORY

Ratio

max for FULL WAVE

min for HALF WAVE

Errors

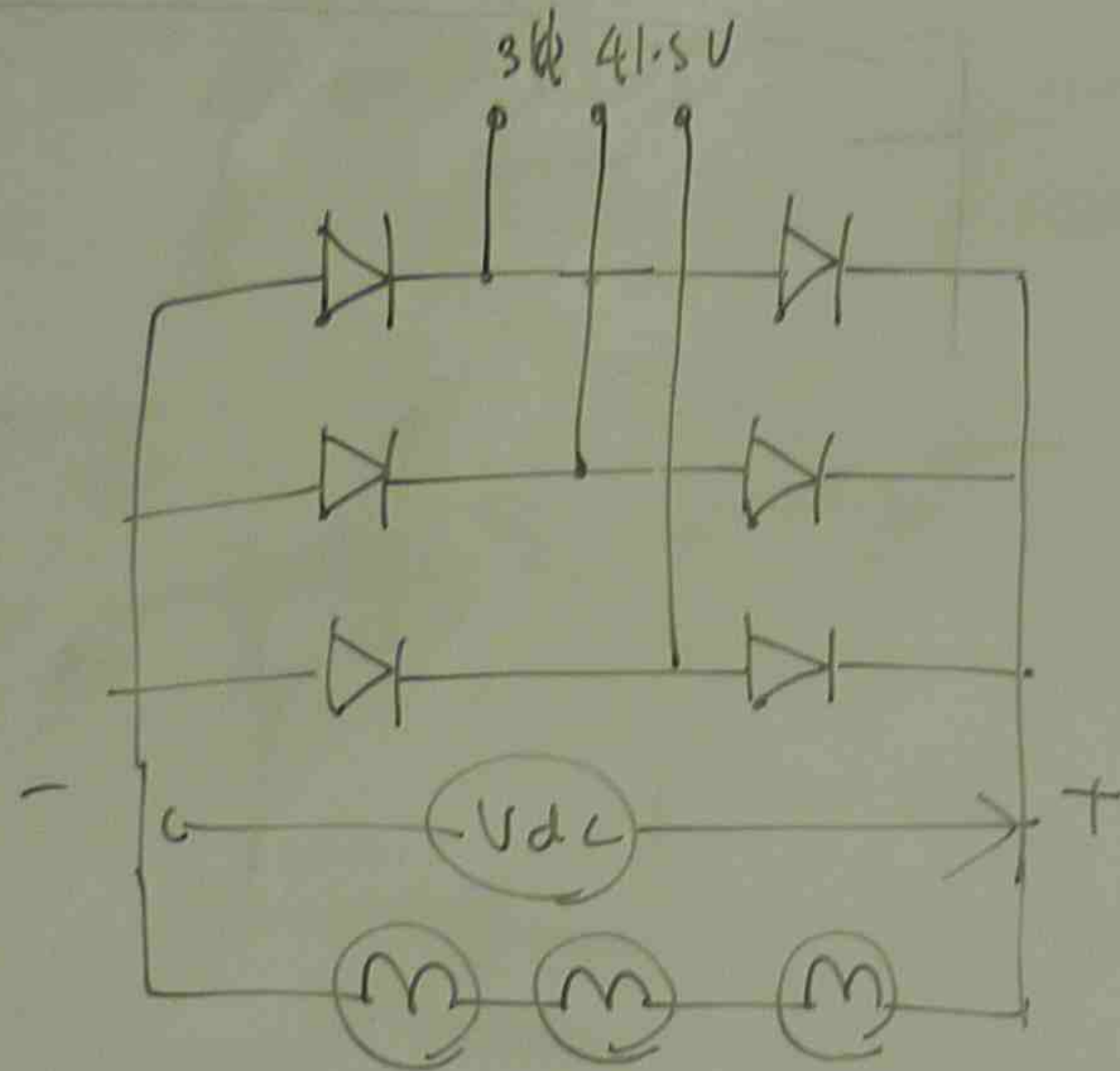
$$E_{rms} = 24V$$

$$\frac{24 \times 1.4142}{3.1416} = 10.8V$$

$$\frac{U_{dc}}{U_{ac}} = \frac{10.8}{24} = 0.45$$

24

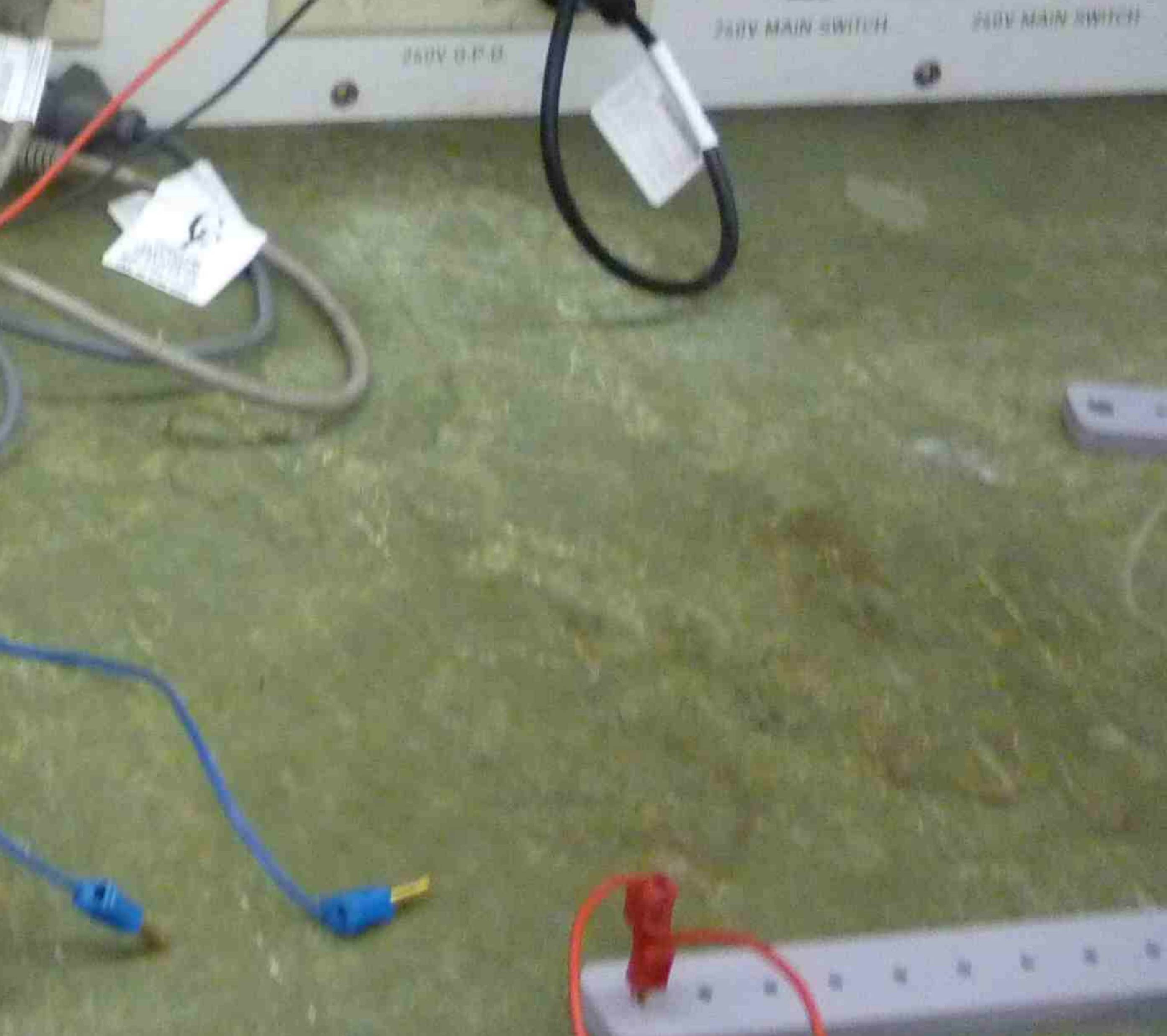
3φ BRIDGE RECTIFICATION



MEASURE U_{dc}

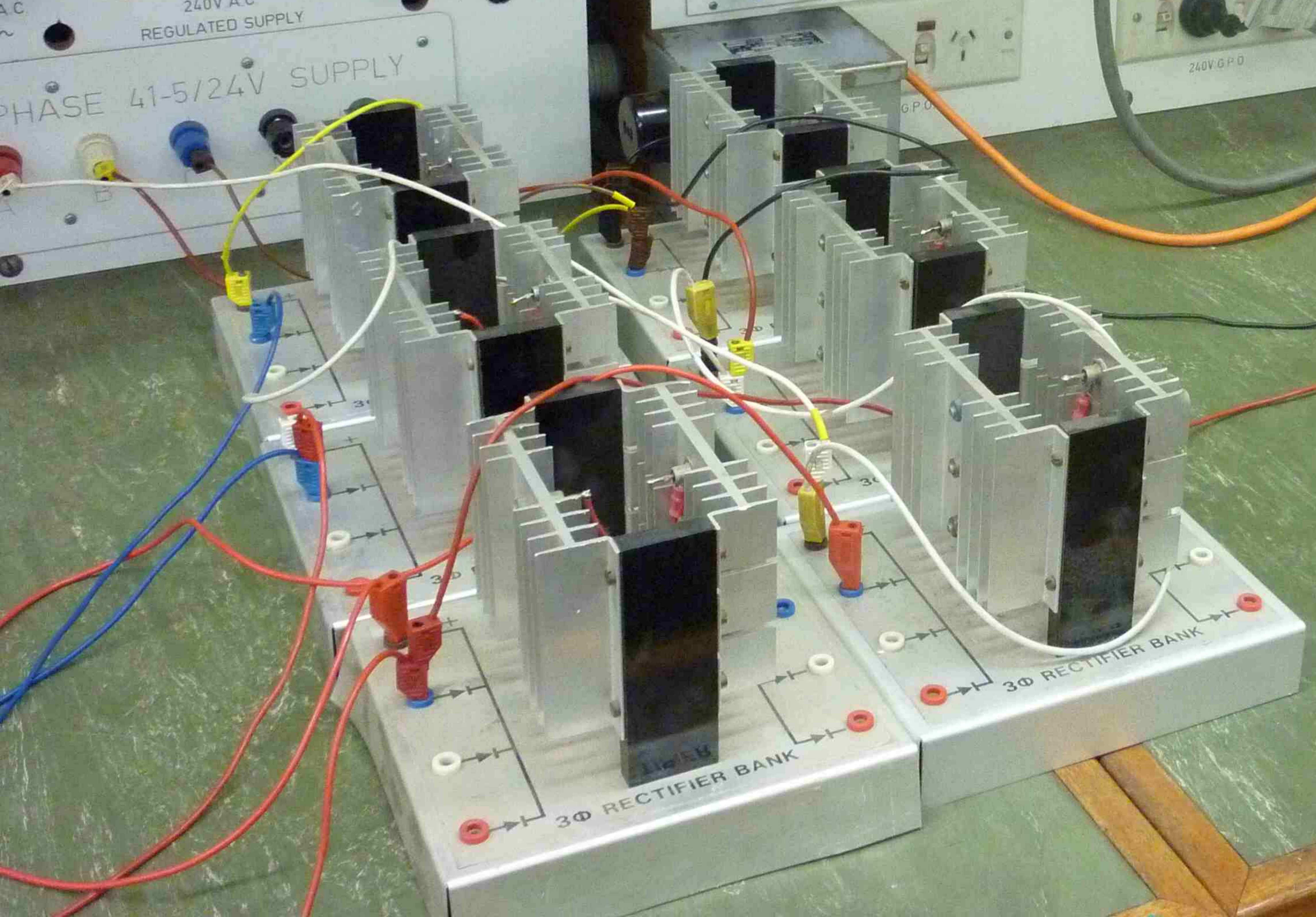
FIND THE RATIO OF $\frac{U_{dc}}{U_{ac}} = \frac{U_{dc}}{U_{ac} = 41.5V}$

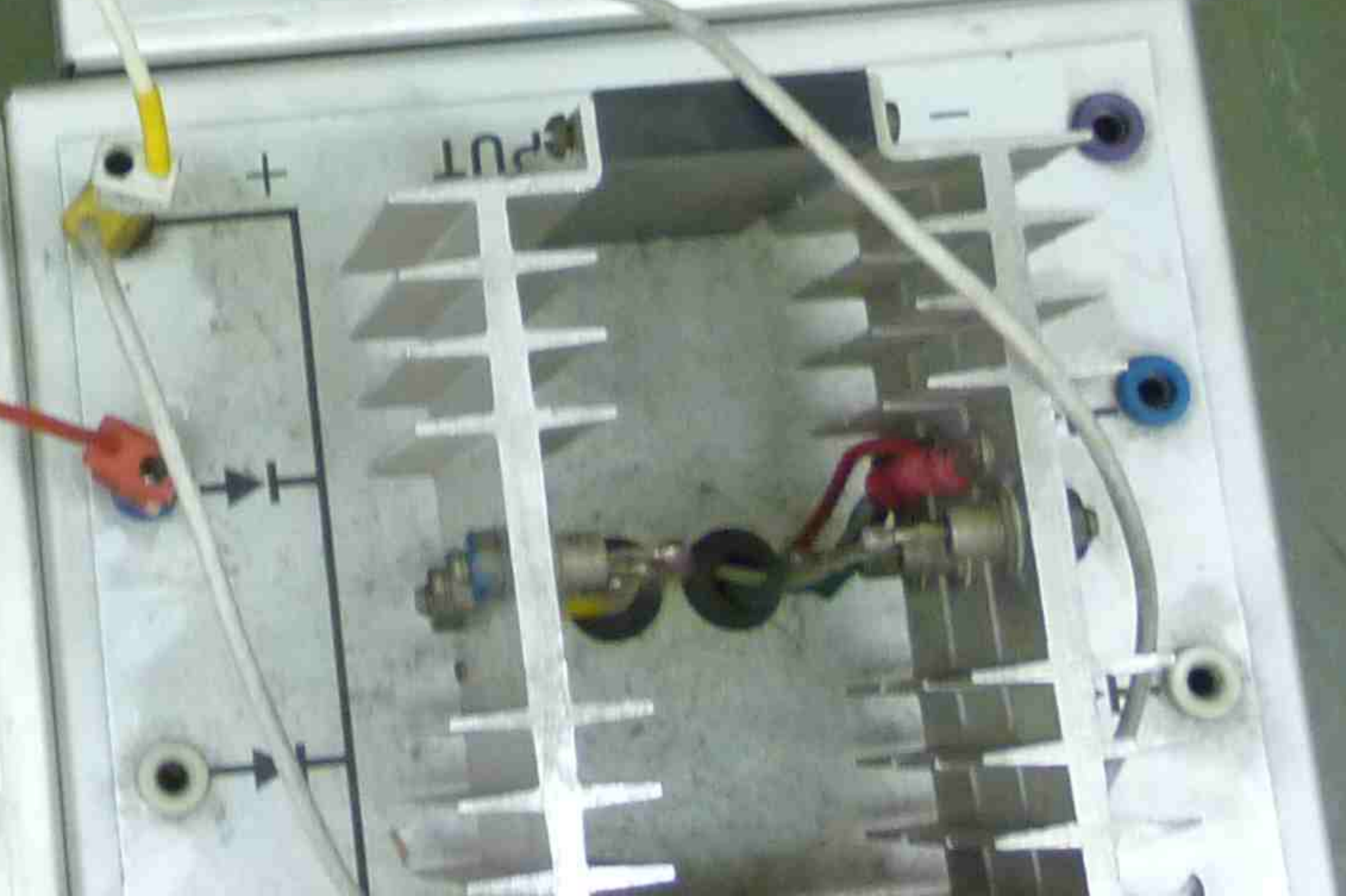
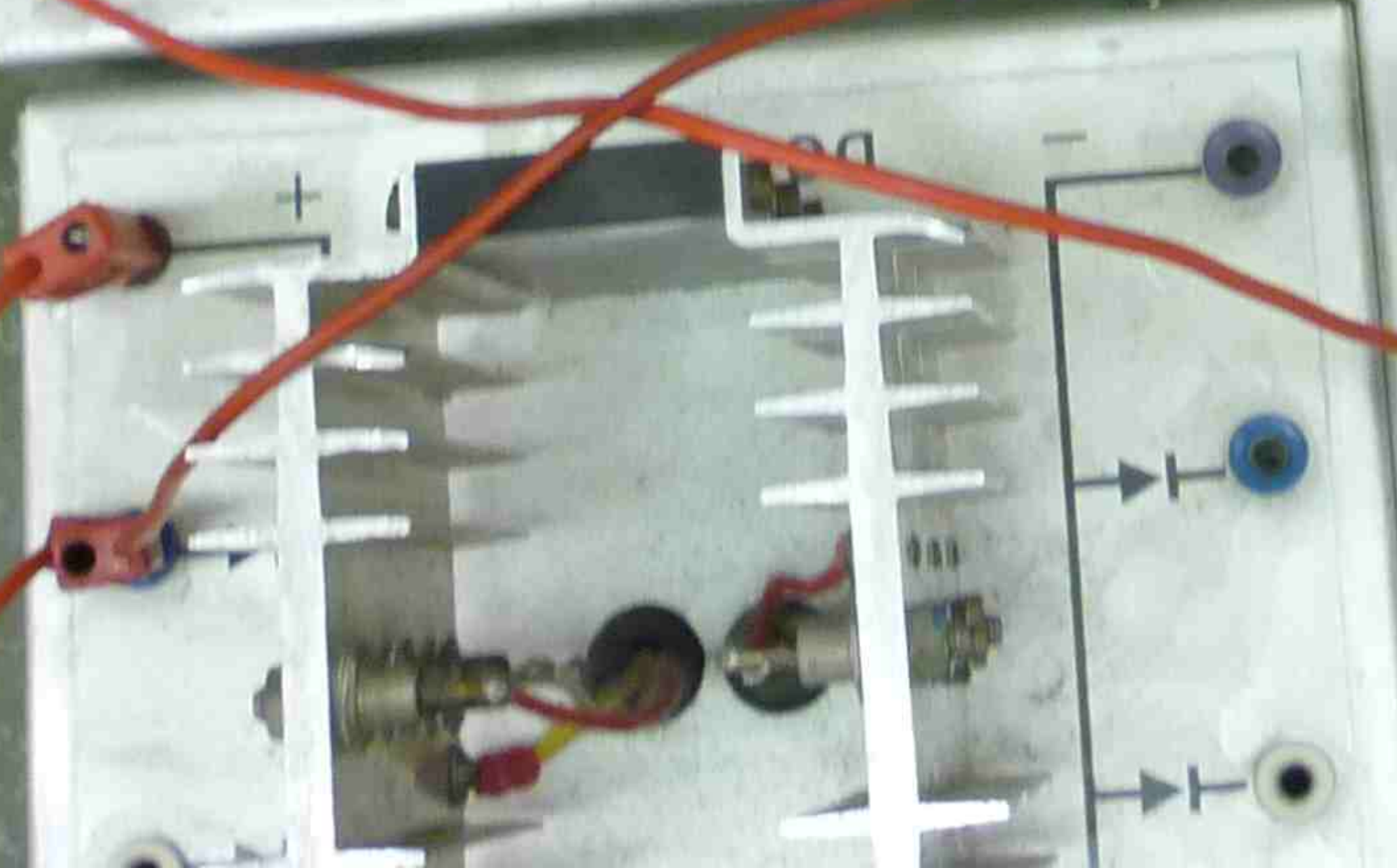
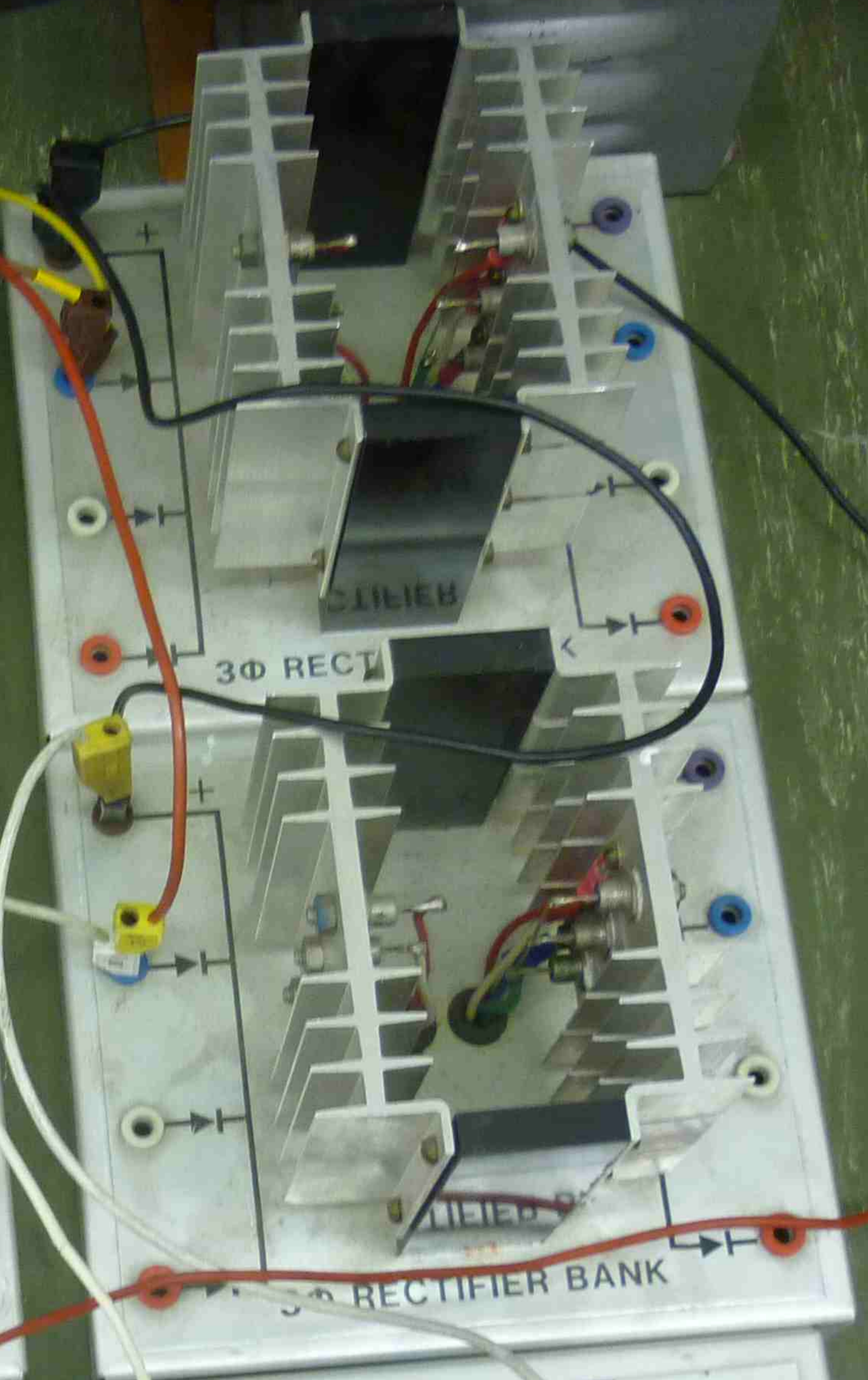
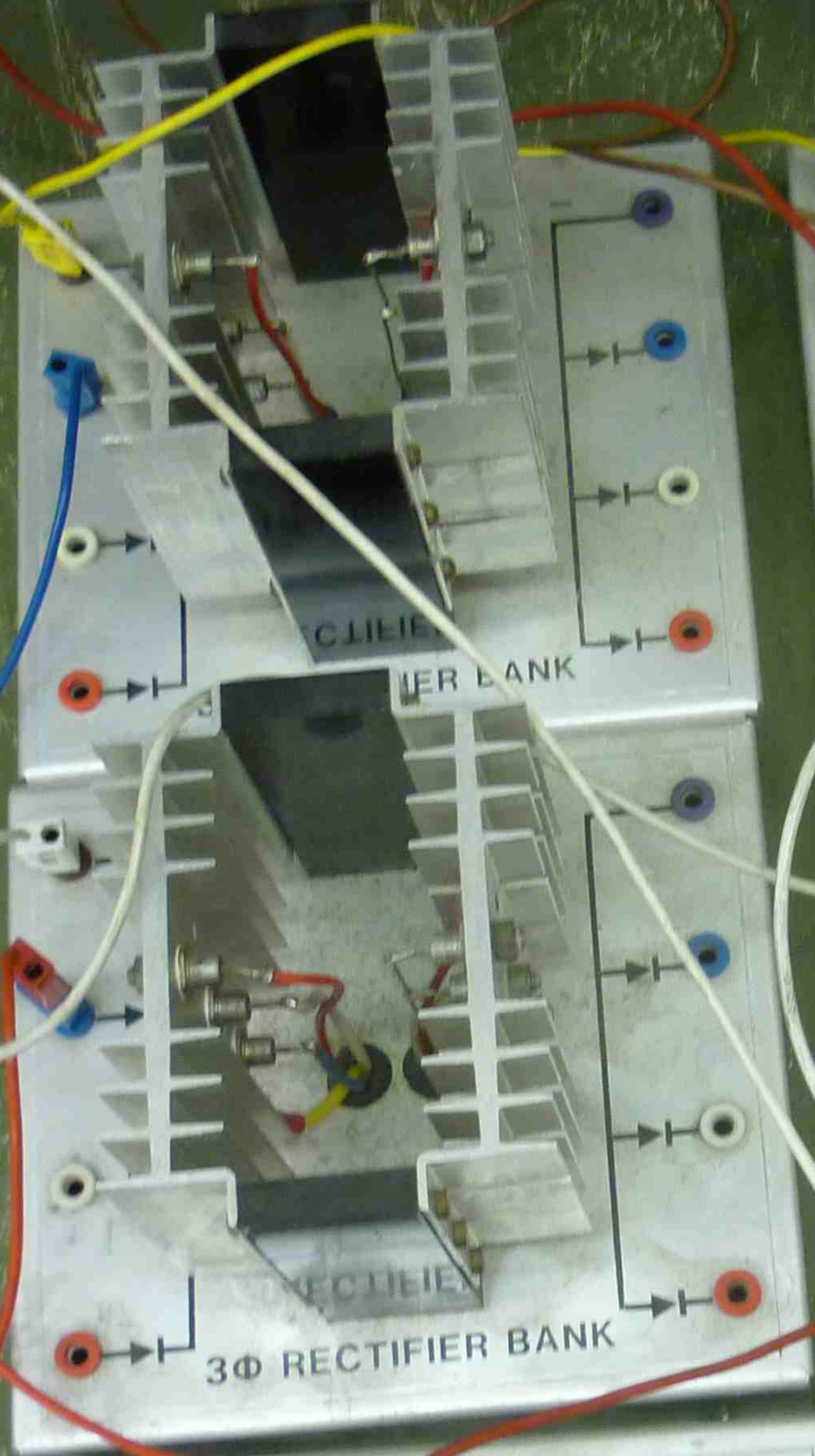
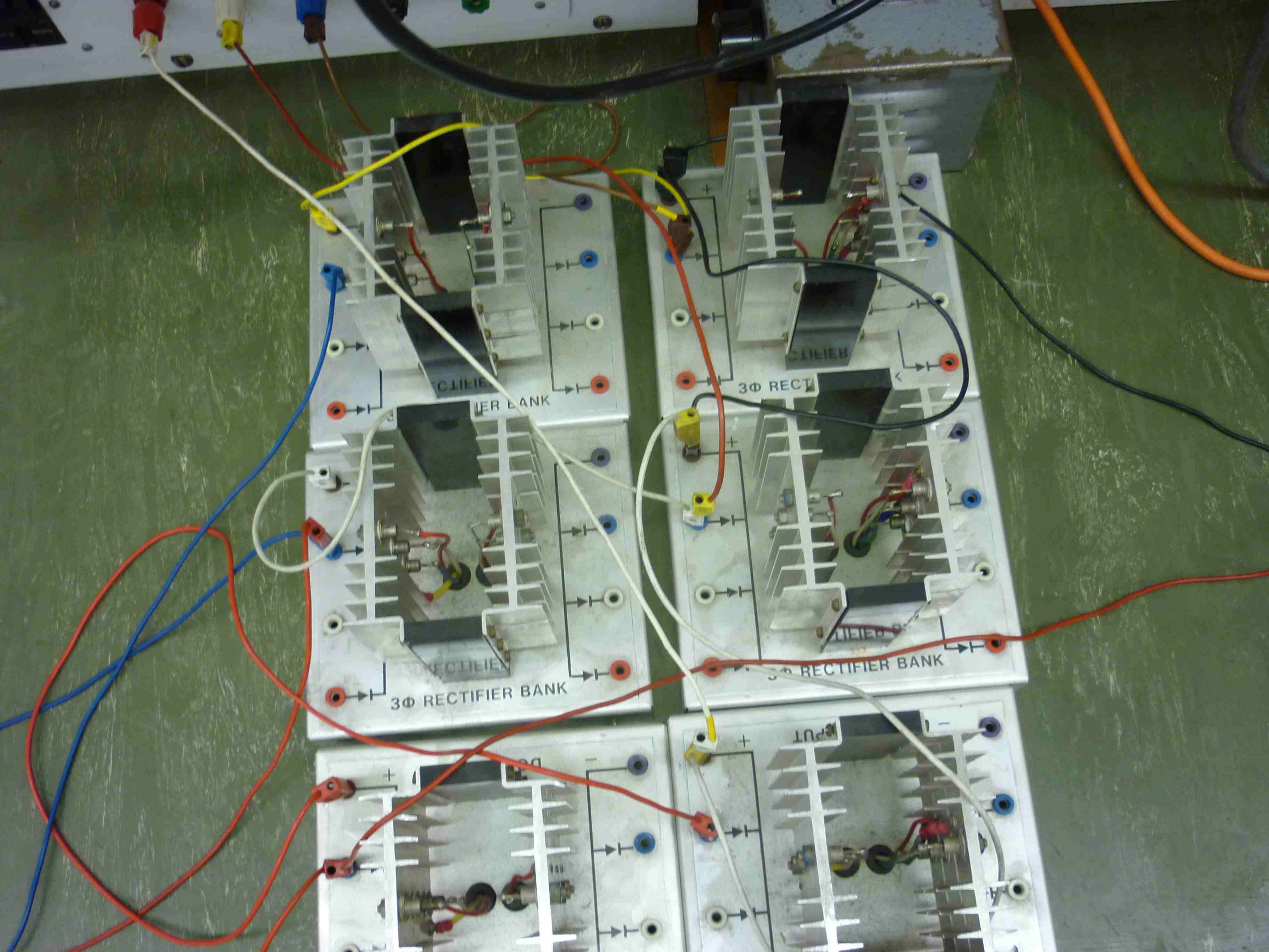
COMPARE WITH 1φ $\frac{1}{2}$ WAVE RECTIFICATION.

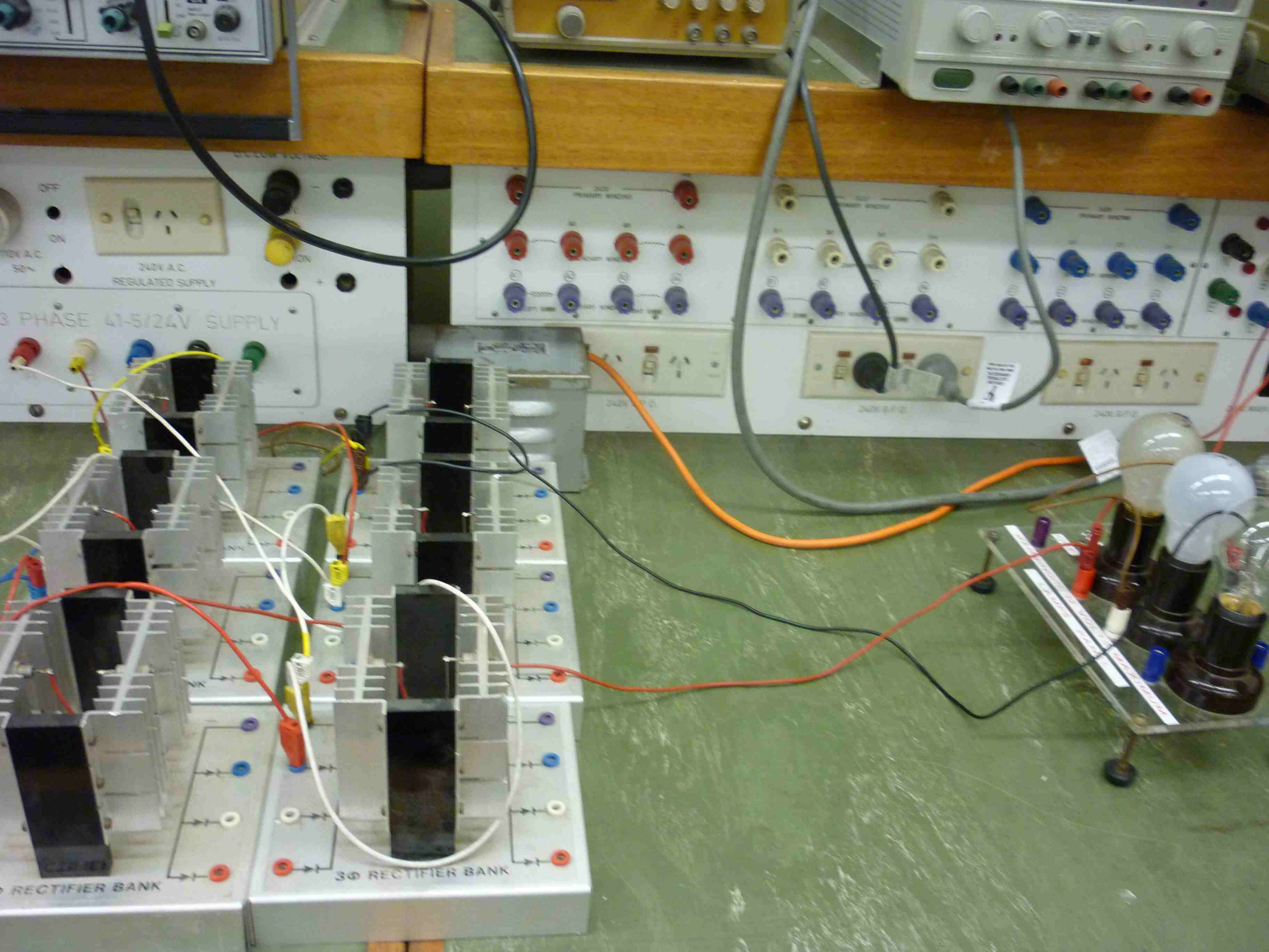




32 VOLTS ONLY







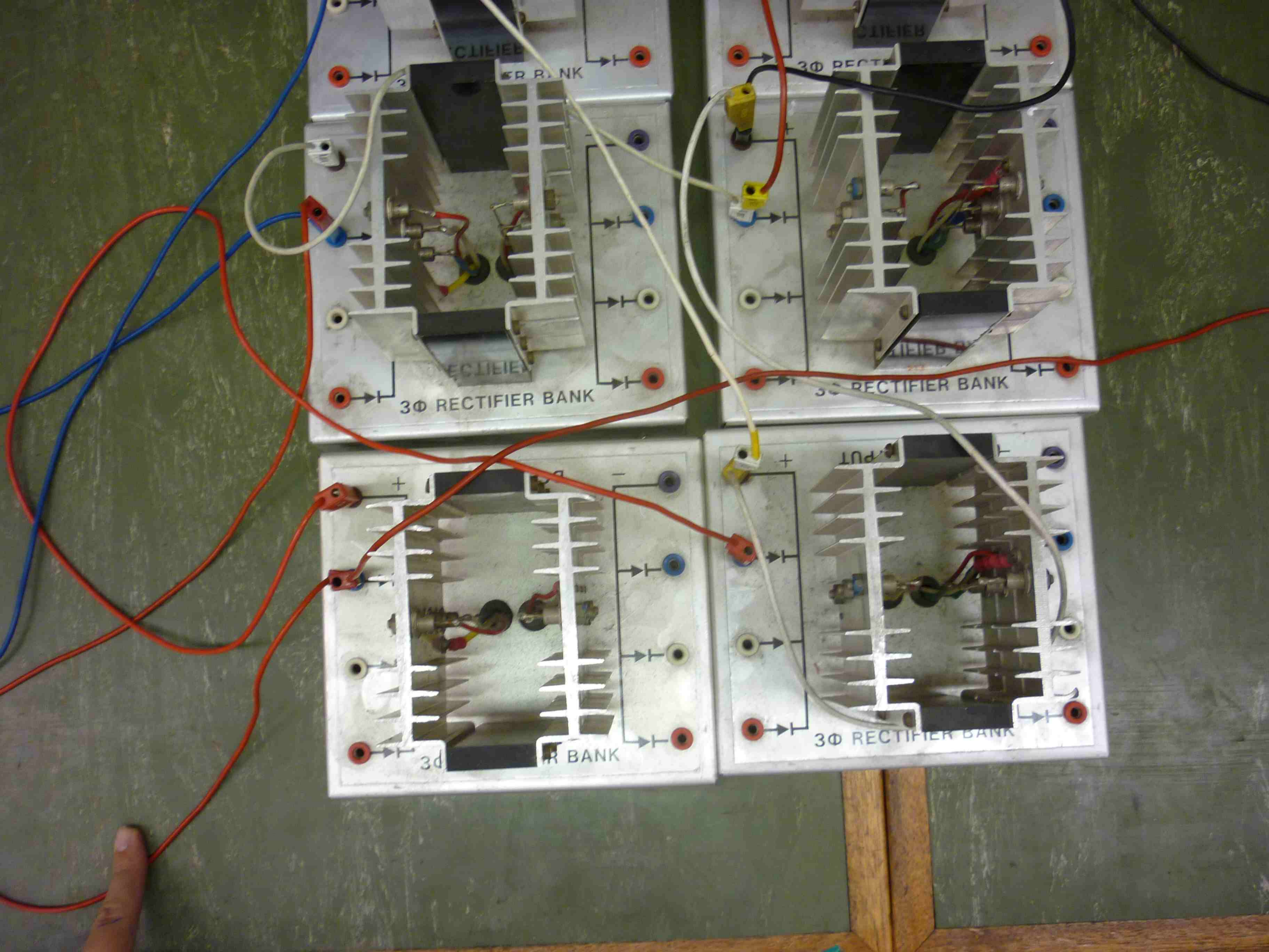
240V AC REGULATED SUPPLY
3 PHASE 415/240V SUPPLY

240V 50Hz

240V 50Hz

RECTIFIER BANK
3 ϕ RECTIFIER BANK

240V 50Hz



3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

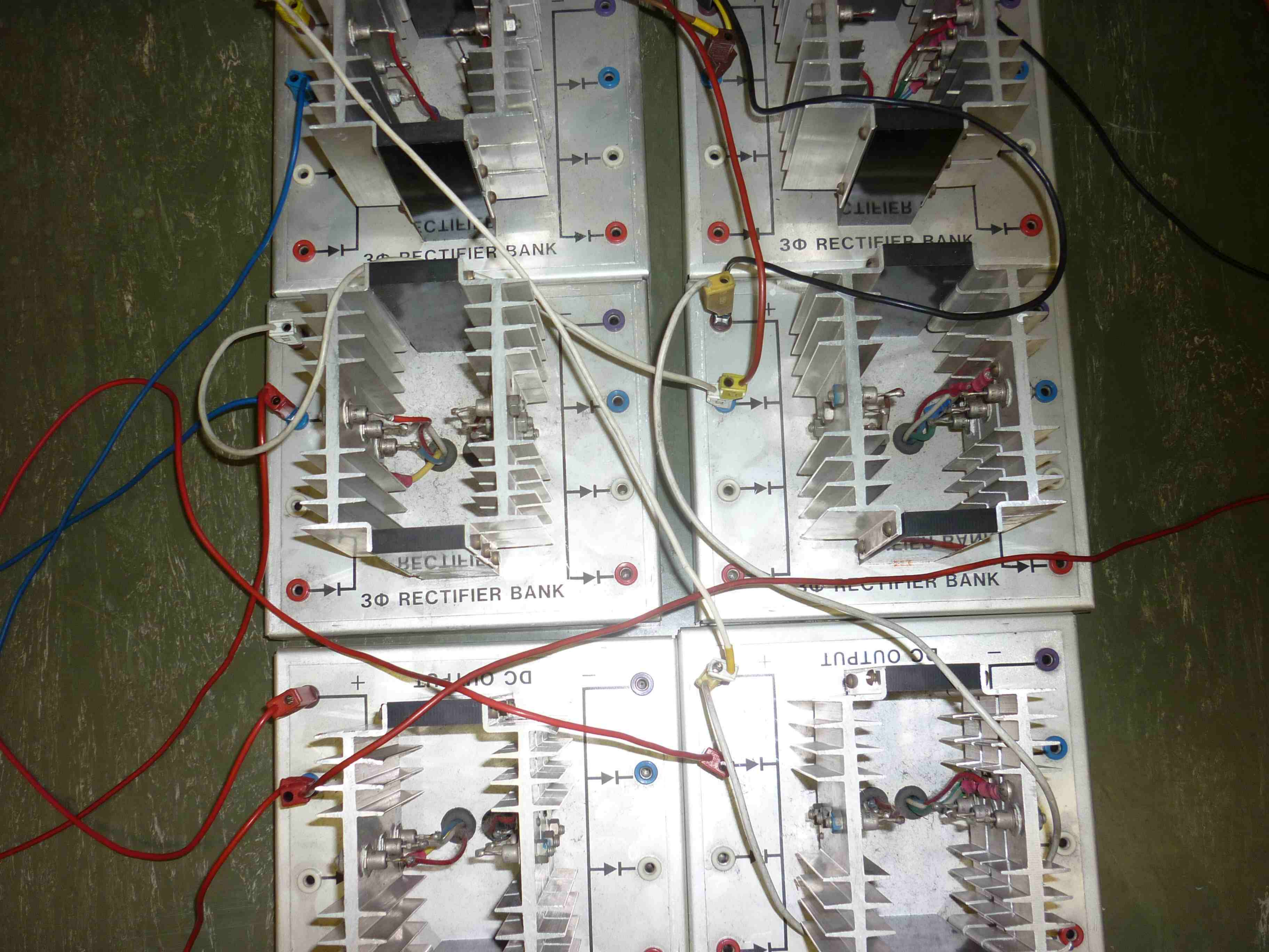
3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK



3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

3Φ RECTIFIER BANK

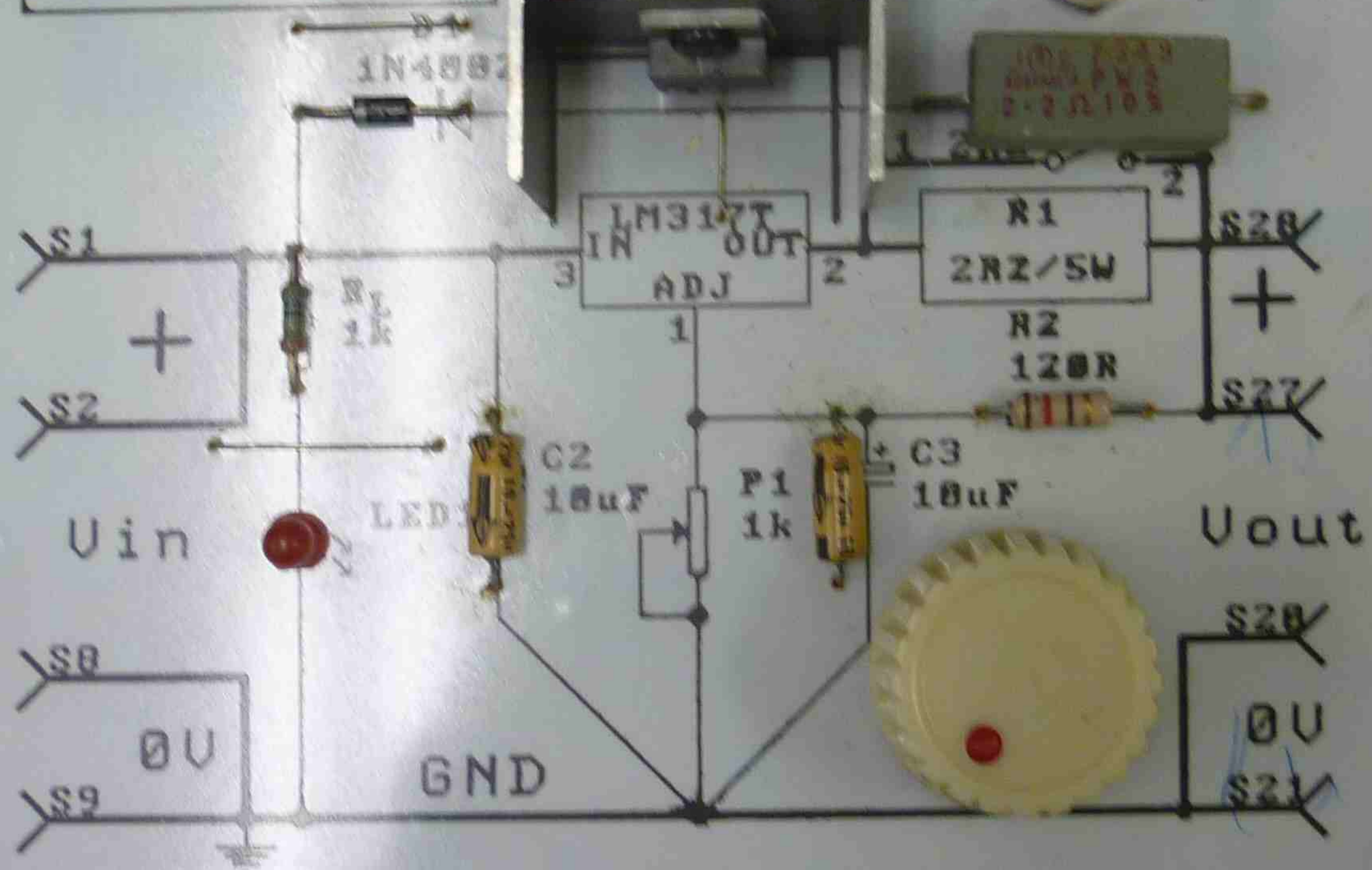
DC OUTPUT

DC OUTPUT

POWER CONTROL 1 WEEK-9
6016D

TREE TERMINAL
REGULATOR LM317T

R1 IN R1 OUT
1 ← → 2



SYDNEY INSTITUTE OF TECHNOLOGY
INDUSTRIAL ELECTRONICS DIVISION

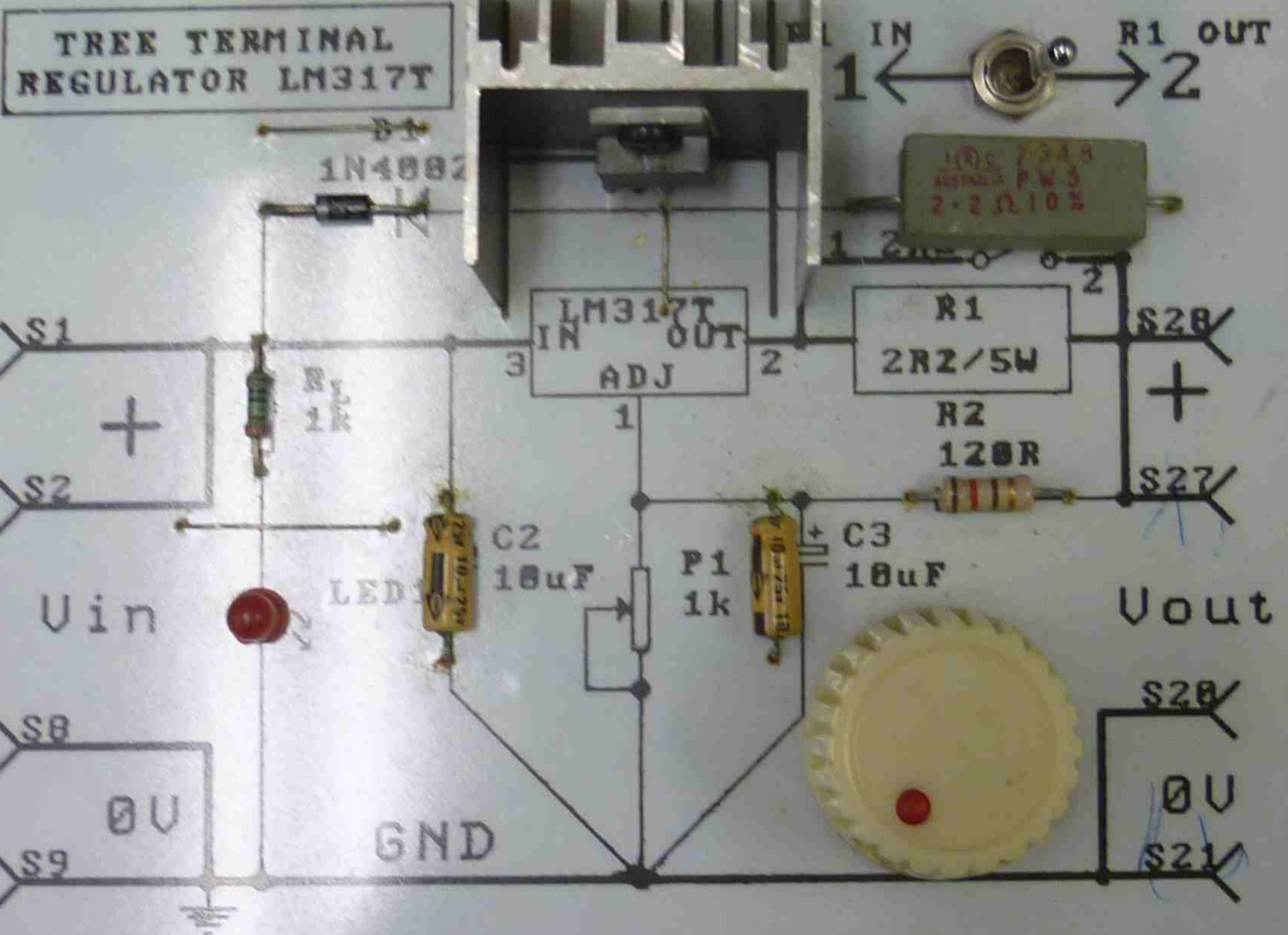
1
2
3
4
5
6
7
8
9

28
27
26
25
24
23
22
21
20

10 11 12 13 14 15 16 17 18 19



POWER CONTROL 1 WEEK-9
6016D



SYDNEY INSTITUTE OF TECHNOLOGY
INDUSTRIAL ELECTRONICS DIVISION

10 11 12 13 14 15 16 17 18 19

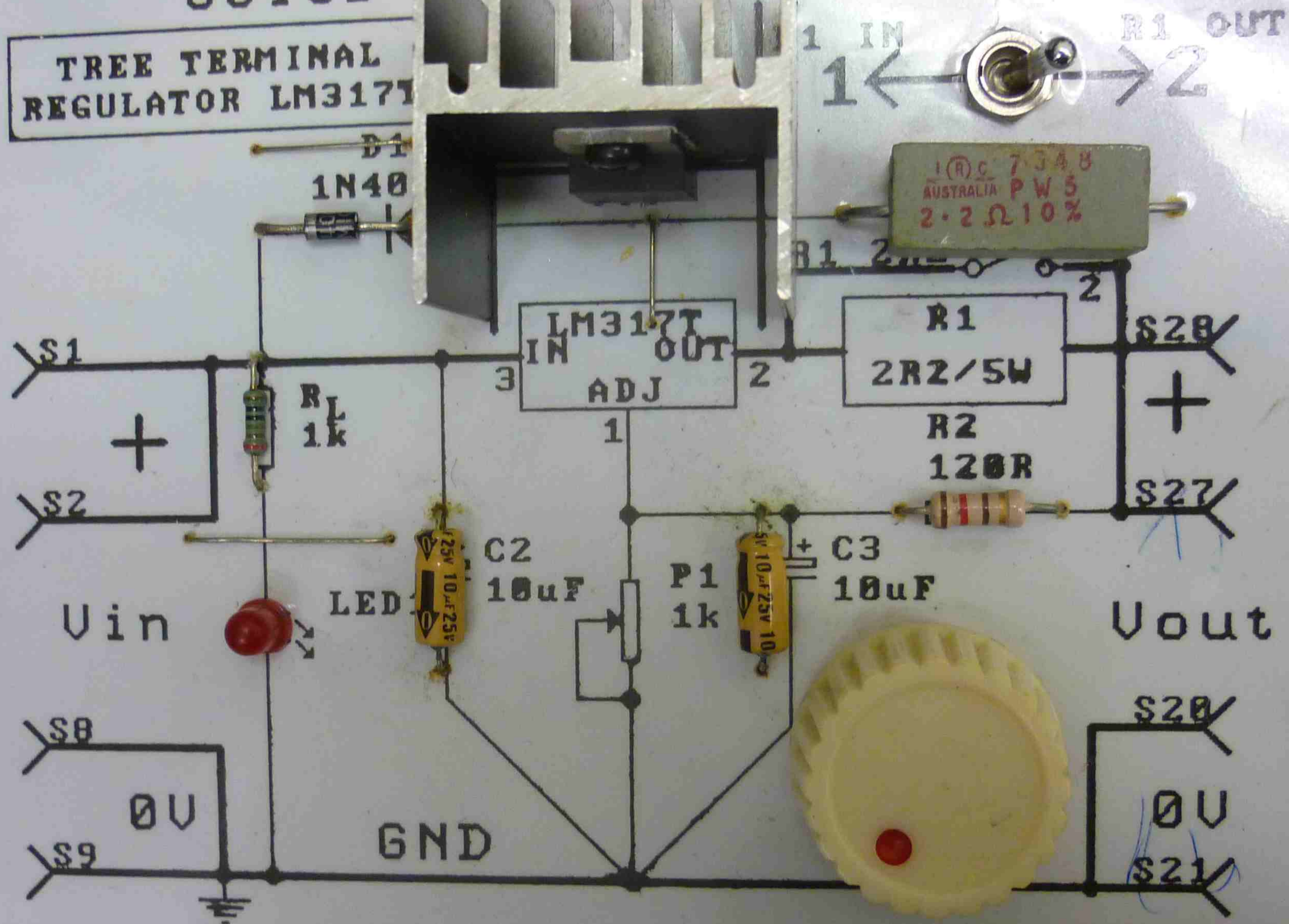
1
2
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28
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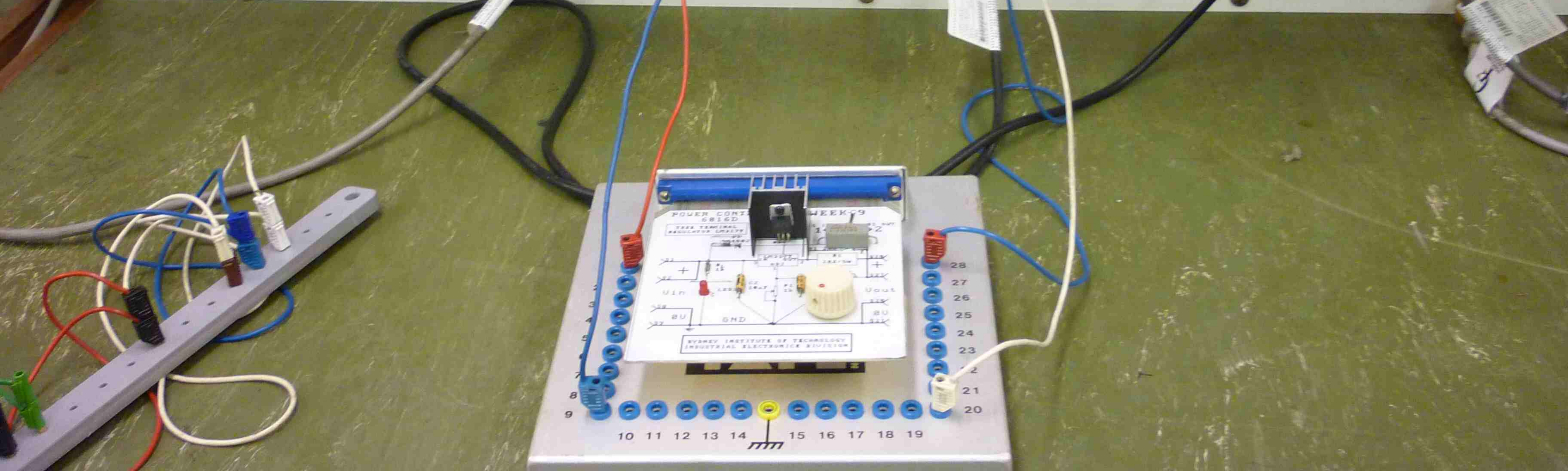
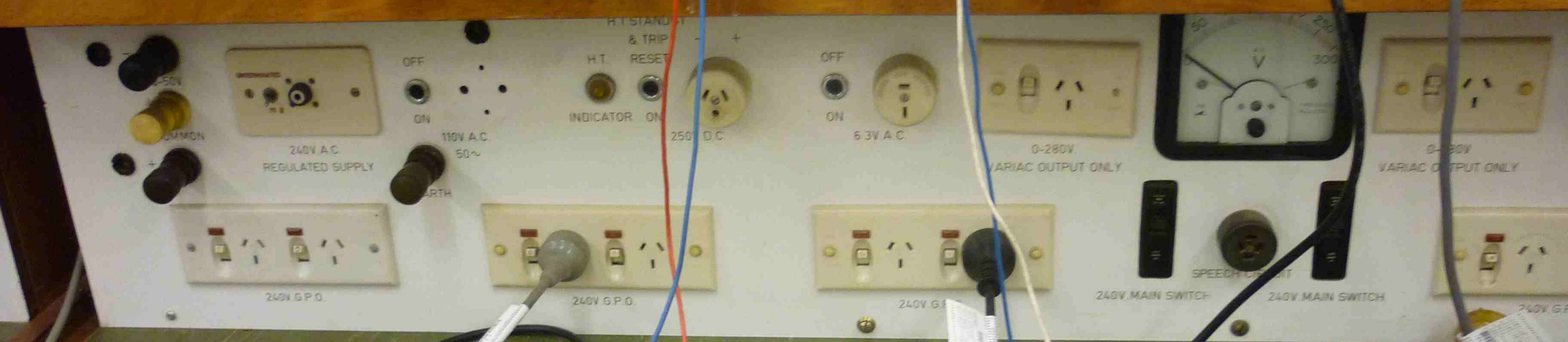
POWER CONTROL 1
6016D

WEEK-9

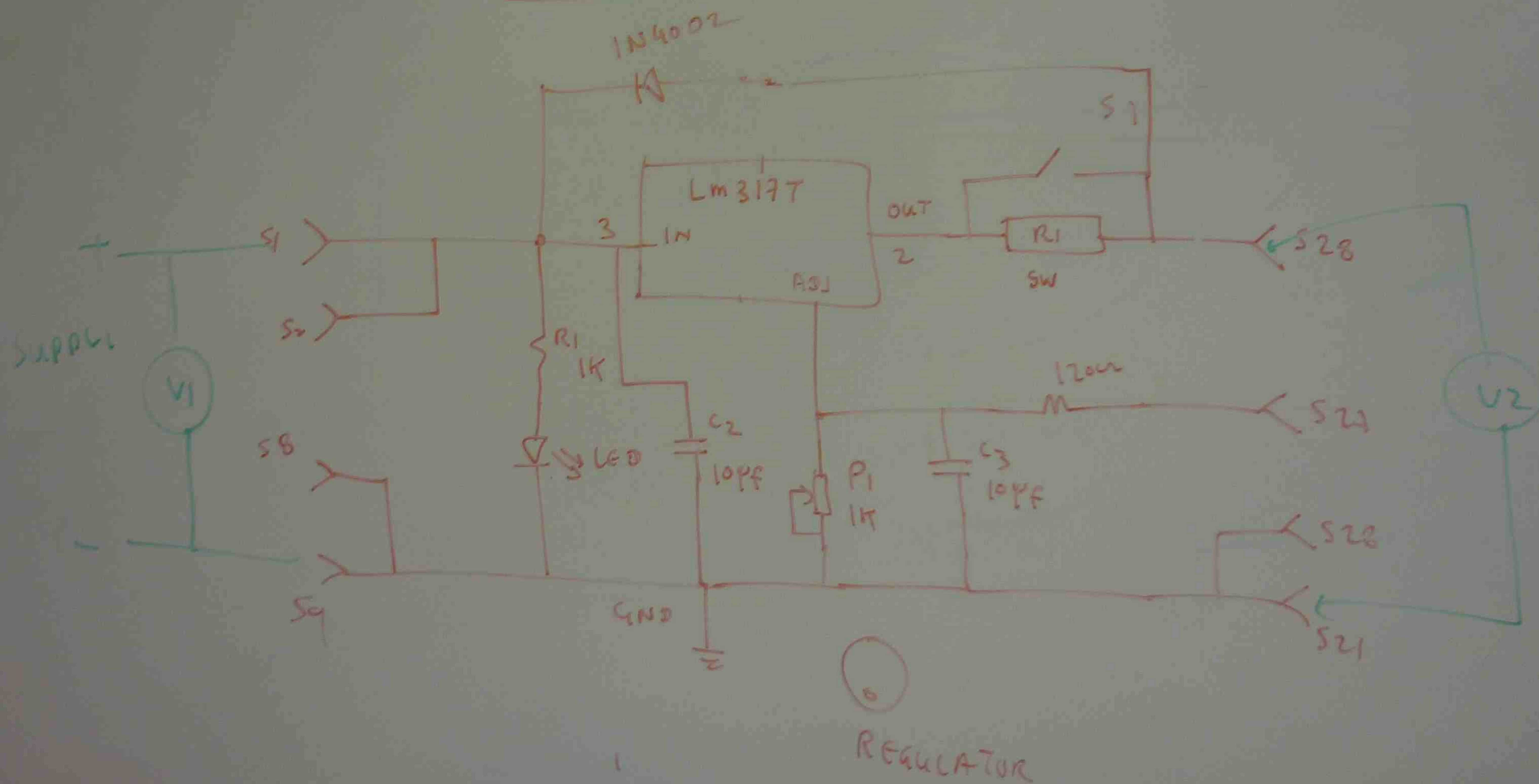
TREE TERMINAL
REGULATOR LM317T



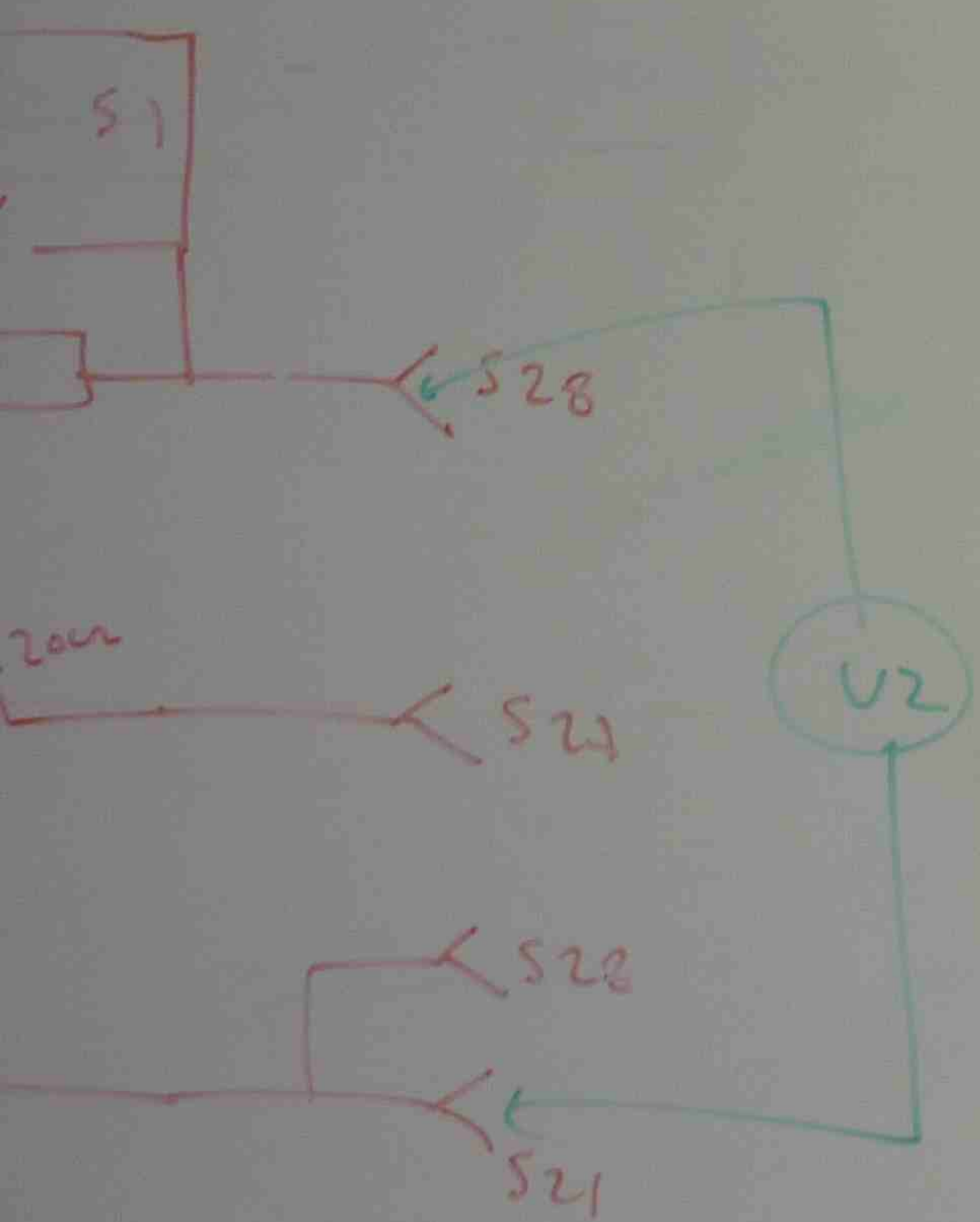
SYDNEY INSTITUTE OF TECHNOLOGY
INDUSTRIAL ELECTRONICS DIVISION



THREE TERMINAL REGULATOR LM317T CIRCUIT



TOR

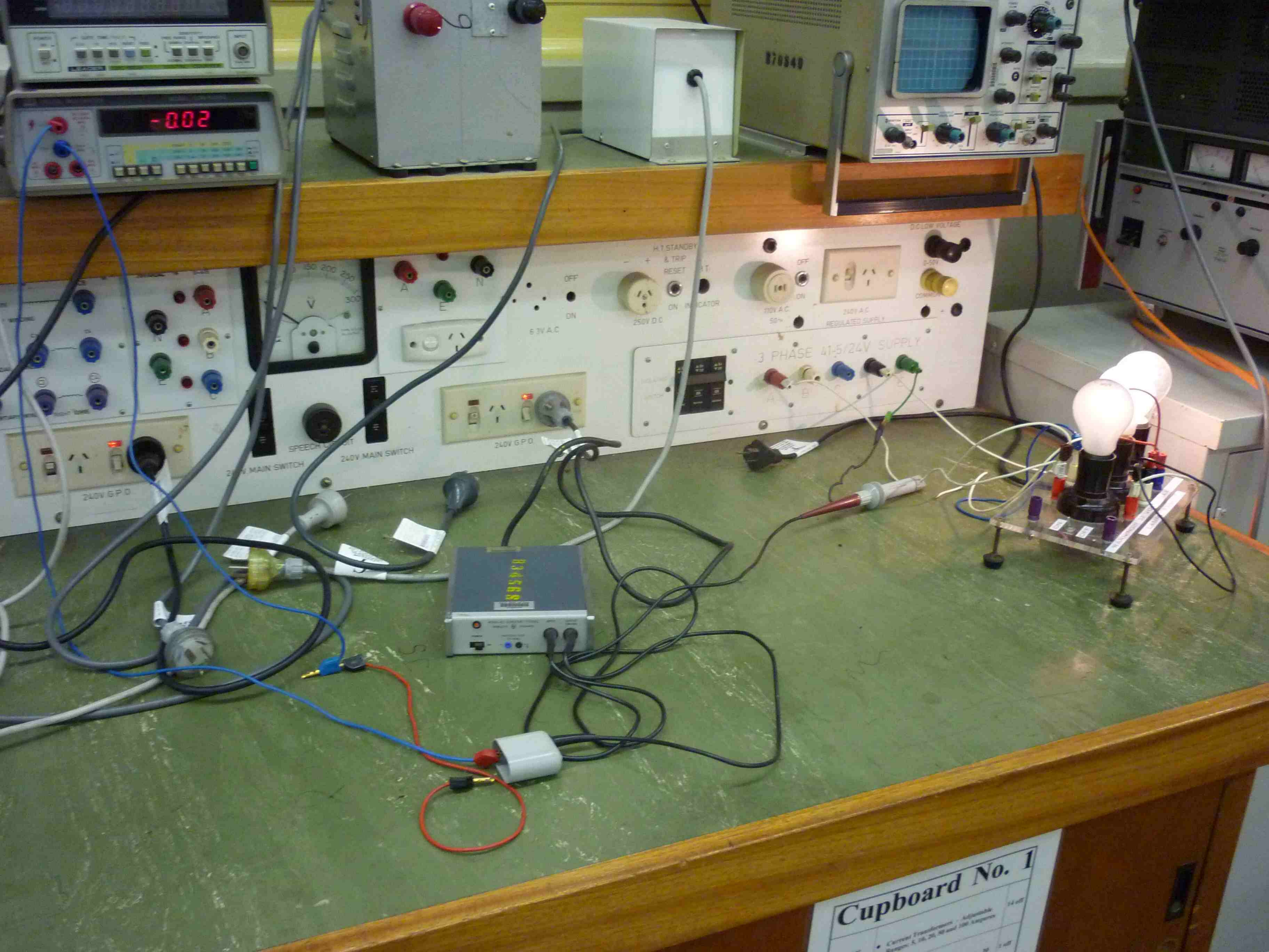


SWITCH ON THE CIRCUIT

SET THE REGULATOR AT CERTAIN VOLTAGE FOR U_2

FILL THE TABLE

U_2 (REF)	U_1	U_2
U_2 SET VOLTAGE (1)	0V	
	1V	
	2V	
	↓ 10V	
U_2 SET VOLTAGE (2)	0V	
	1V	
	2V	
	10V	
U_2 SET VOLTAGE (3)	0V	
	1V	
	2V	
	↓	
	↓ 10V	



Digital Multimeter (DMM) showing a reading of -0.02 .

Grey electrical control box with a red emergency stop button and a black knob.

White rectangular electrical component, possibly a transformer or filter.

Panel meter with a blue grid display and various control knobs and switches.

3 PHASE 41.5/24V SUPPLY unit with various input and output terminals, switches, and a voltmeter scale.

Small grey electronic device, possibly a motor controller or speed controller.

Transformer circuit with three incandescent light bulbs connected to the secondary winding.

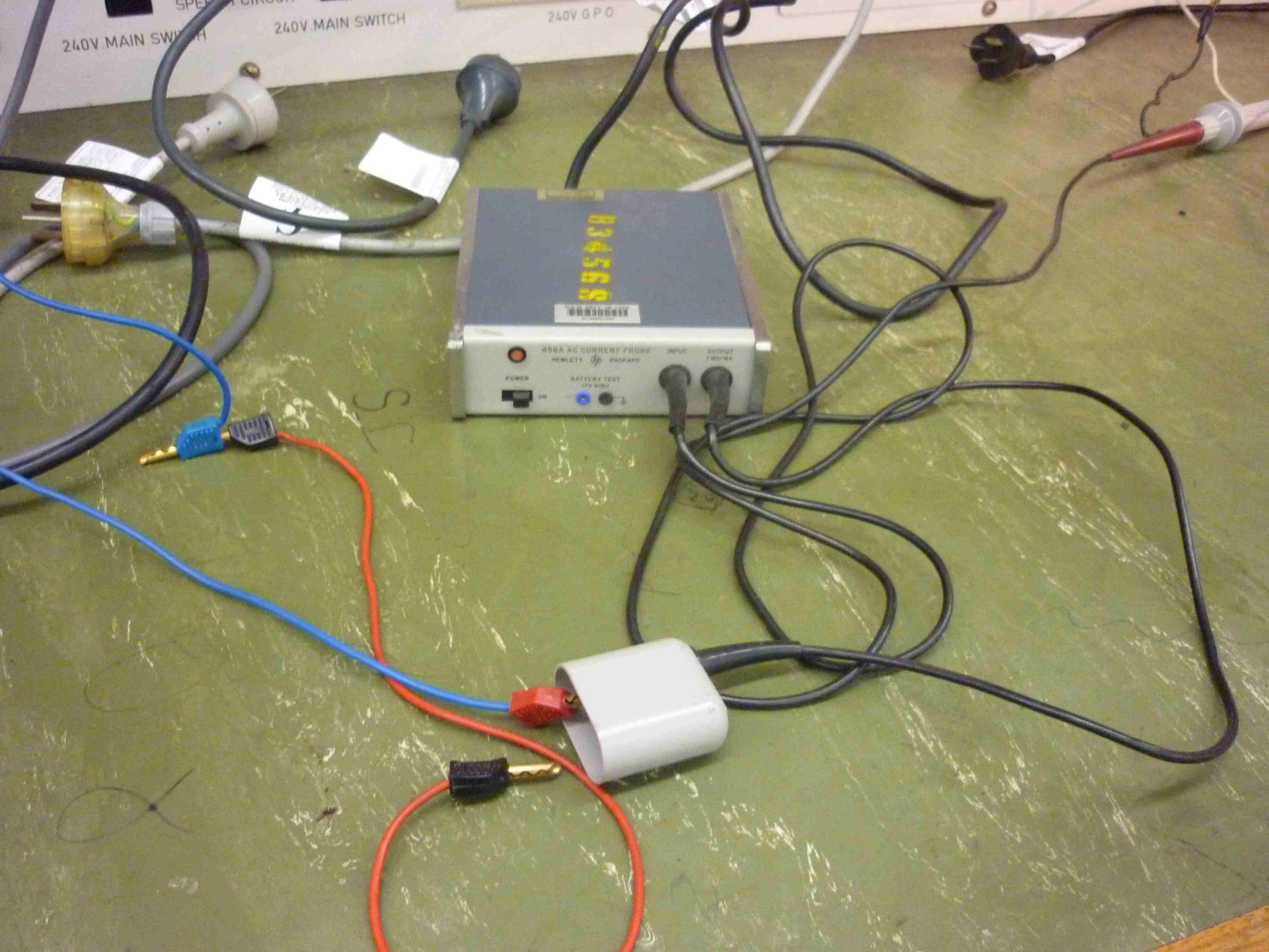
Cupboard No. 1

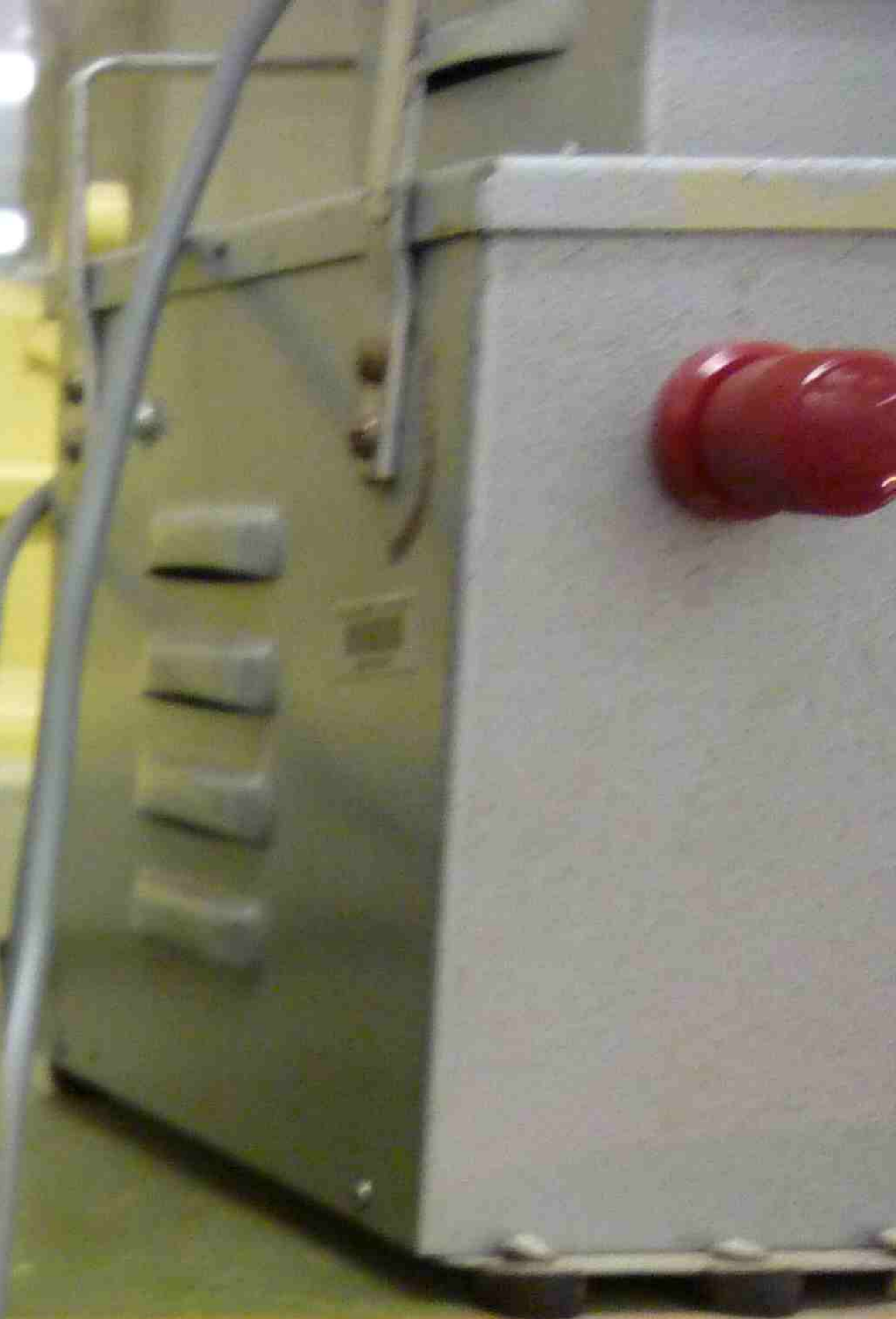
Current Transformer	Adjustable	14 V
Wattmeter	5, 10, 20, 50 and 100 Amperes	

240V MAIN SWITCH

240V MAIN SWITCH

240V G P O







BASYS
BENCHTOP ANALYZER

3 PHASE 250V 50/60Hz SUPPLY
150V AC
150V DC
100V AC
50V AC
100V DC
50V DC

100V AC
100V DC
50V AC
50V DC

456A AC CURRENT PROBE
HEWLETT  PACKARD

INPUT

OUTPUT
1 MV/MA

POWER



ON

BATTERY TEST
(7V MIN.)



REPAIR WORK ON THIS
AND ALL OTHER INSTRUMENTS
THE REPAIRMAN
WARRANTS TO BE
SATISFIED OR
REFUND



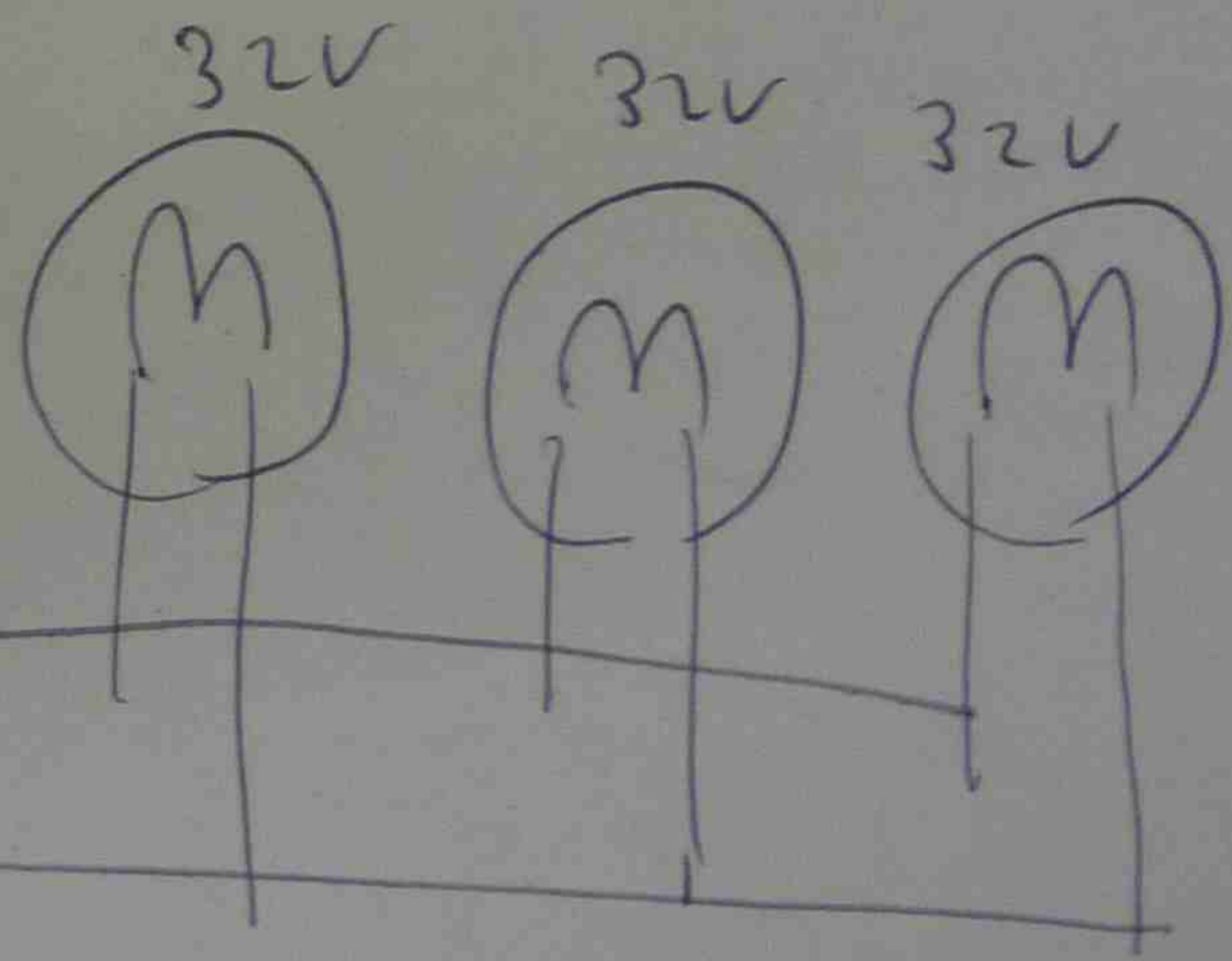
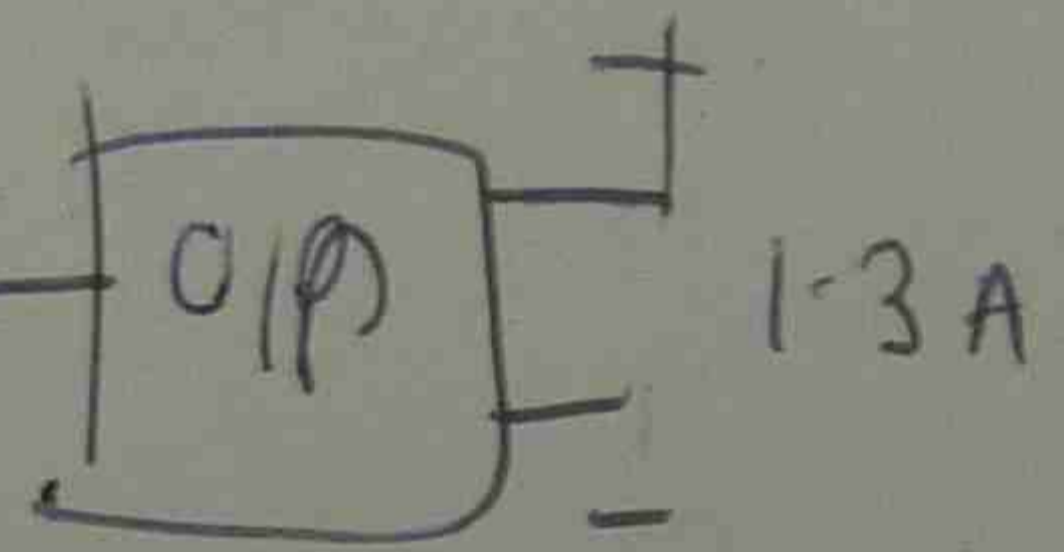
REPAIR WORK ON THIS
AND ALL OTHER INSTRUMENTS
THE REPAIRMAN
WARRANTS TO BE
SATISFIED OR
REFUND

456 AC current Probe

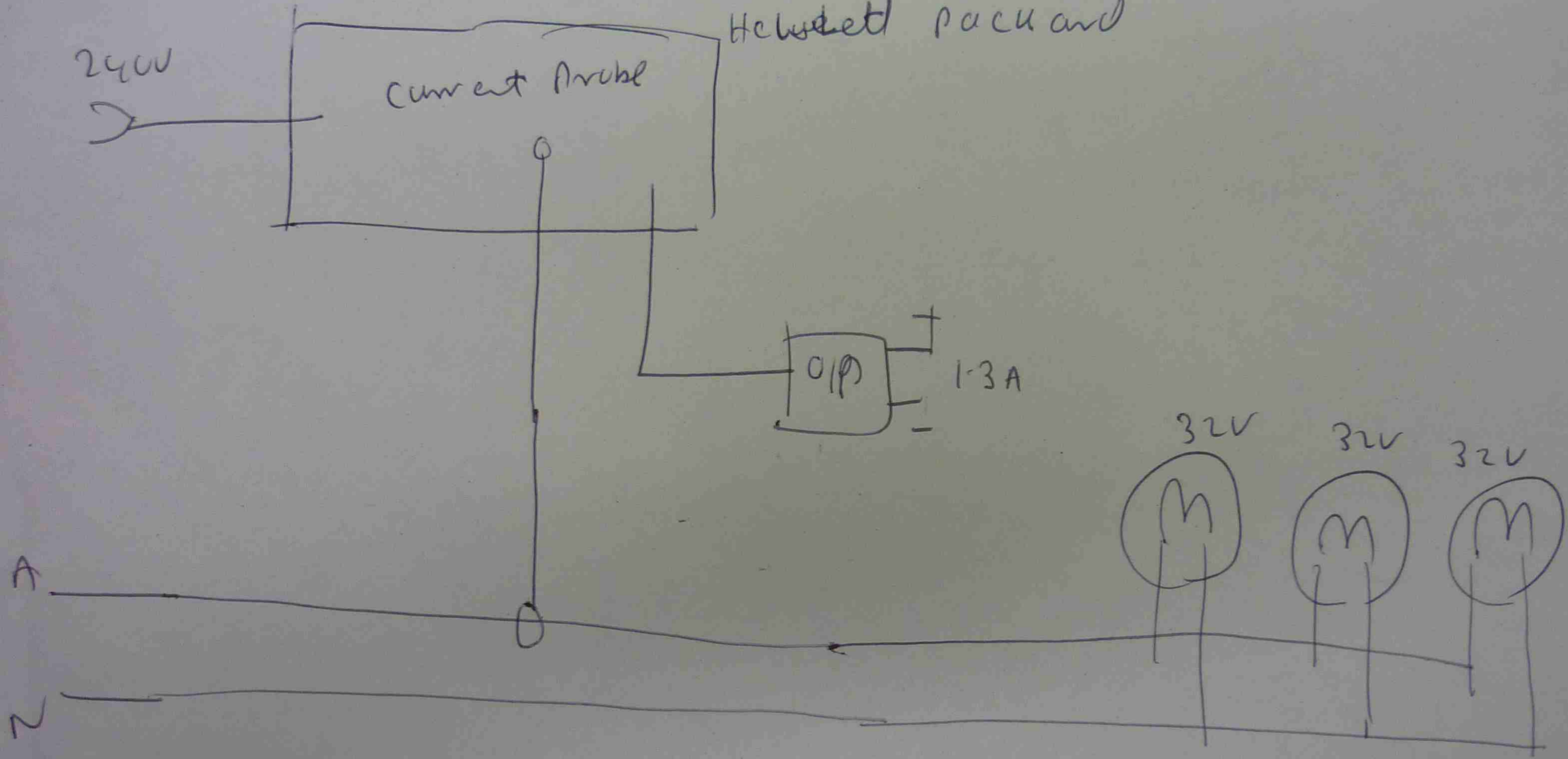
Helmholtz pack and

240V

Current Probe



A
N

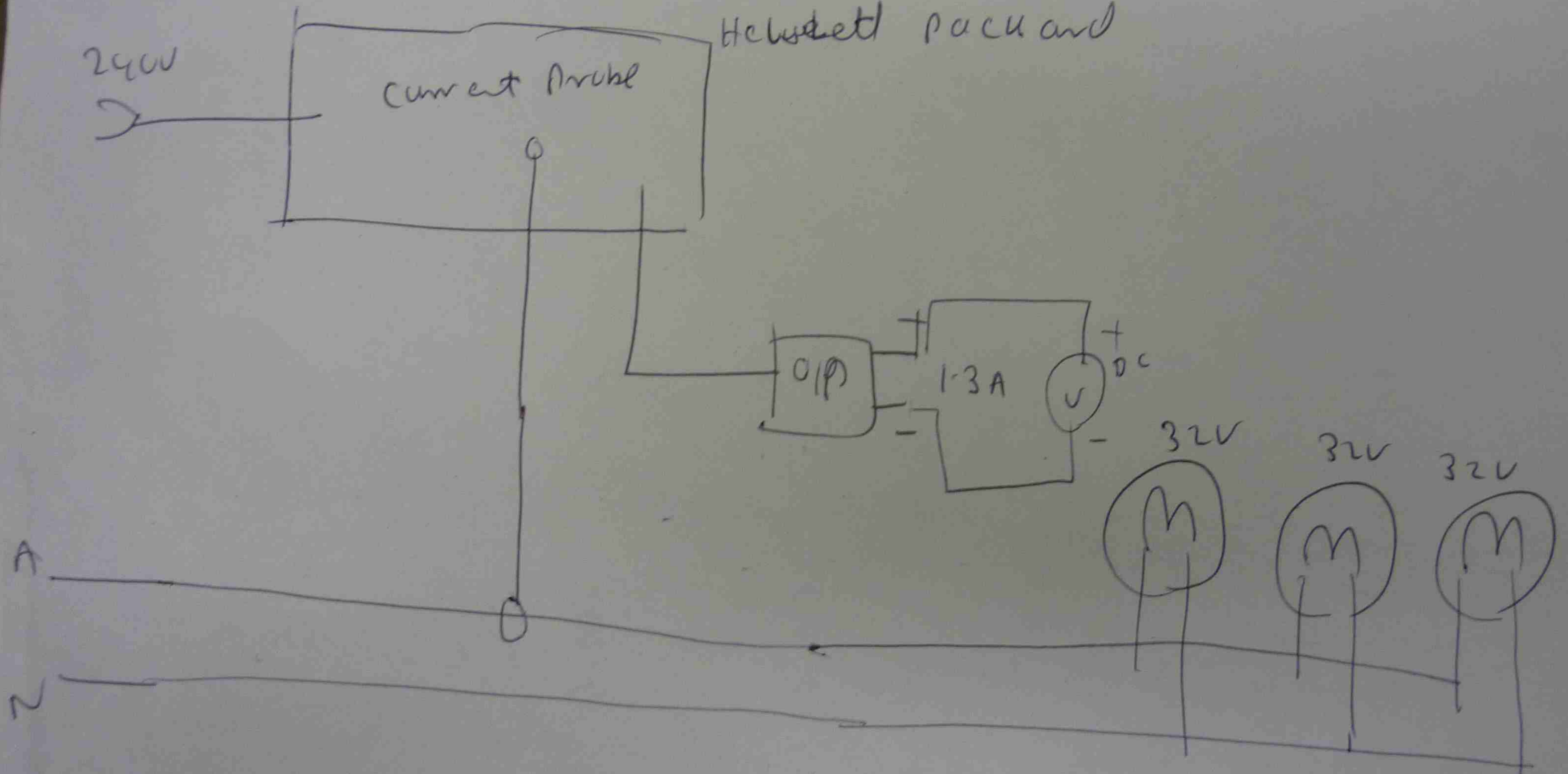


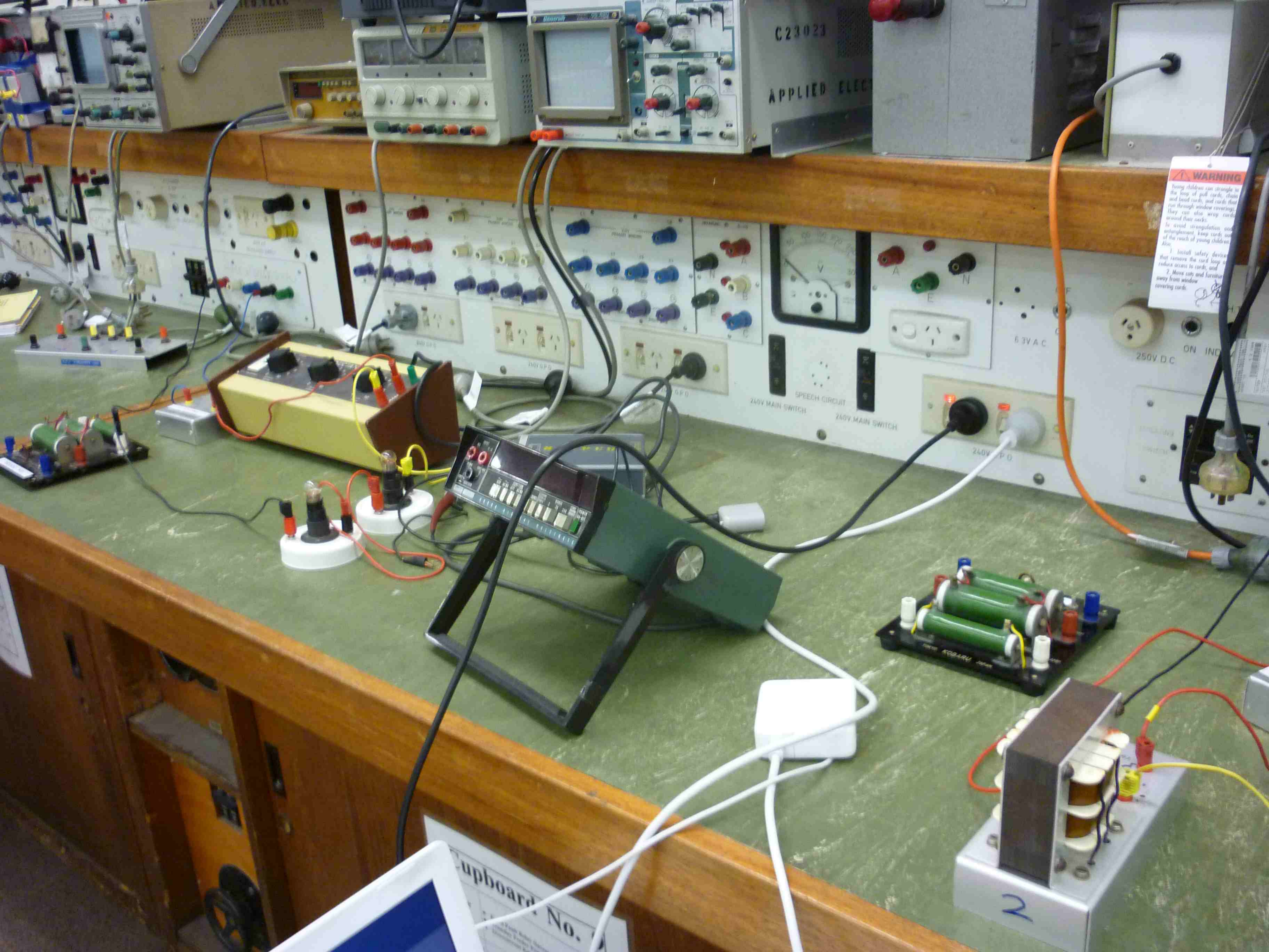
456 AC current probe

Helixetl packard

240V

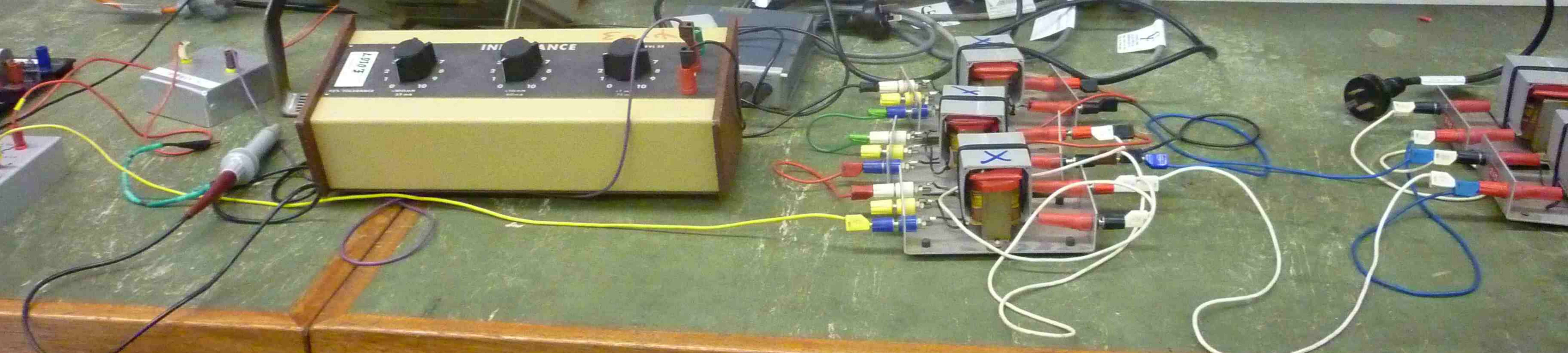
current probe





WARNING
Young children can strangle in the loop of pull cords, chain and lead cords, and cords that run through window coverings. They can also wrap cords around their necks.
To avoid strangulation and entanglement, keep cords out of the reach of young children. Also:
1. Install safety devices that remove the cord loop and reduce access to cords, and
2. Move coty and furniture away from window covering cords.

cupboard No. 2





Top left corner: A portion of a spectrum analyzer or similar high-frequency instrument with a blue screen and various control knobs.

Top left: A white oscilloscope with a blue screen and multiple input channels.

Top left-center: A grey electronic device, possibly a transformer or a specialized power supply, with a glass window.

Top center-left: A yellow and grey oscilloscope with a digital display and control knobs.

Top center: A black AM radio receiver with a schematic diagram on its top panel.

Top center: A white multimeter with three analog dials and several input ports.

Top center-right: A yellow and white digital power supply or meter with a red LED display.

Top right: A black control panel for an RF generator or noise generator with multiple switches and knobs.

Top right: A grey metal cabinet with a red emergency stop button and a black control knob.

Middle left: A white power supply unit with a digital display and various output terminals.

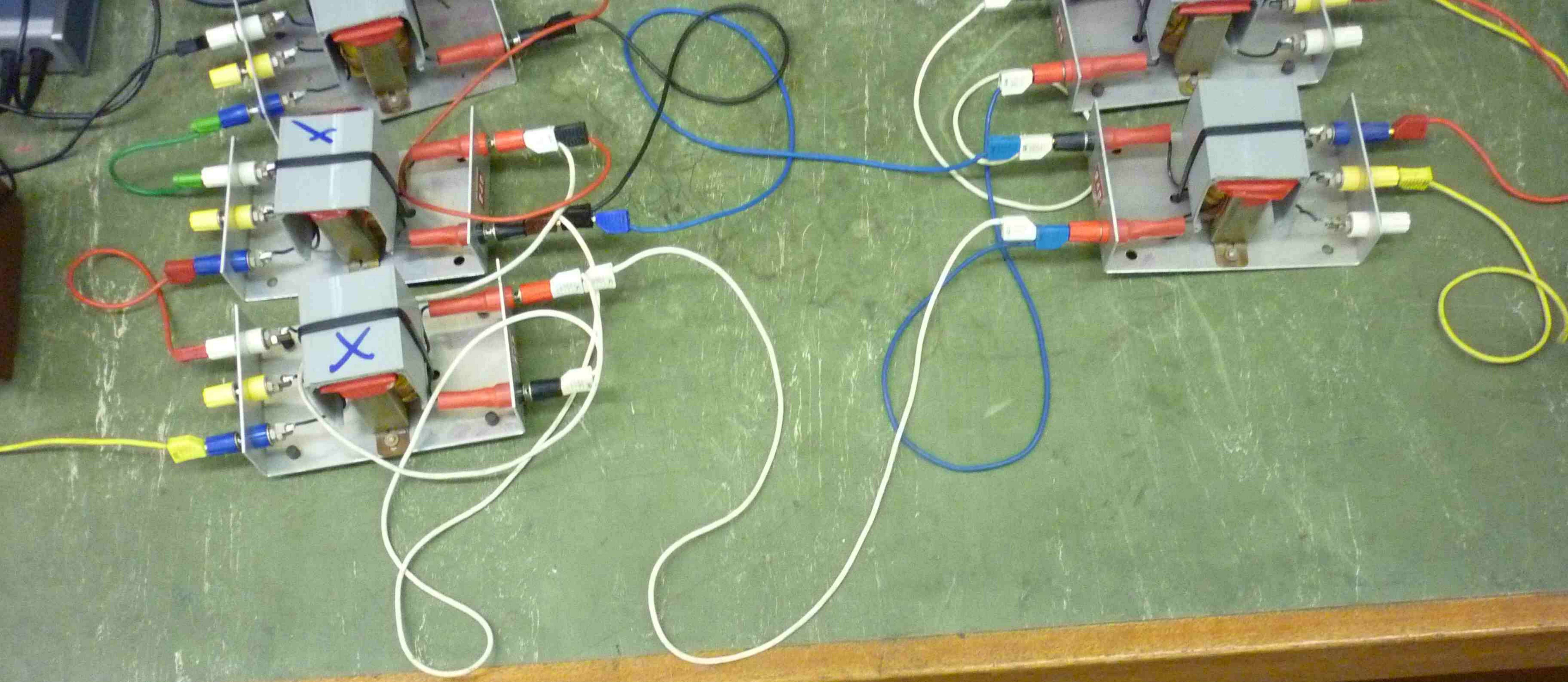
Middle center: A large white multi-channel power supply unit with multiple 240V GP D outlets and a 240V main switch.

Middle right: A white power supply unit with a large analog voltmeter and several output terminals.

Bottom left: A yellow and black variable autotransformer (Variac) with two large control knobs.

Bottom center: A transformer-based power supply circuit with multiple secondary windings and various output cables.

Bottom right: Another transformer-based power supply circuit, similar to the one in the center, with multiple secondary windings and output cables.



Panel of a 240V transformer with various terminals and controls. The terminals are labeled as follows:

- Primary Winding: B1, B2, B3, B4
- Secondary Winding: C1, C2, C3, C4
- Left Limb Secondary Winding: B1, B2, B3, B4
- Right Limb Secondary Winding: C1, C2, C3, C4

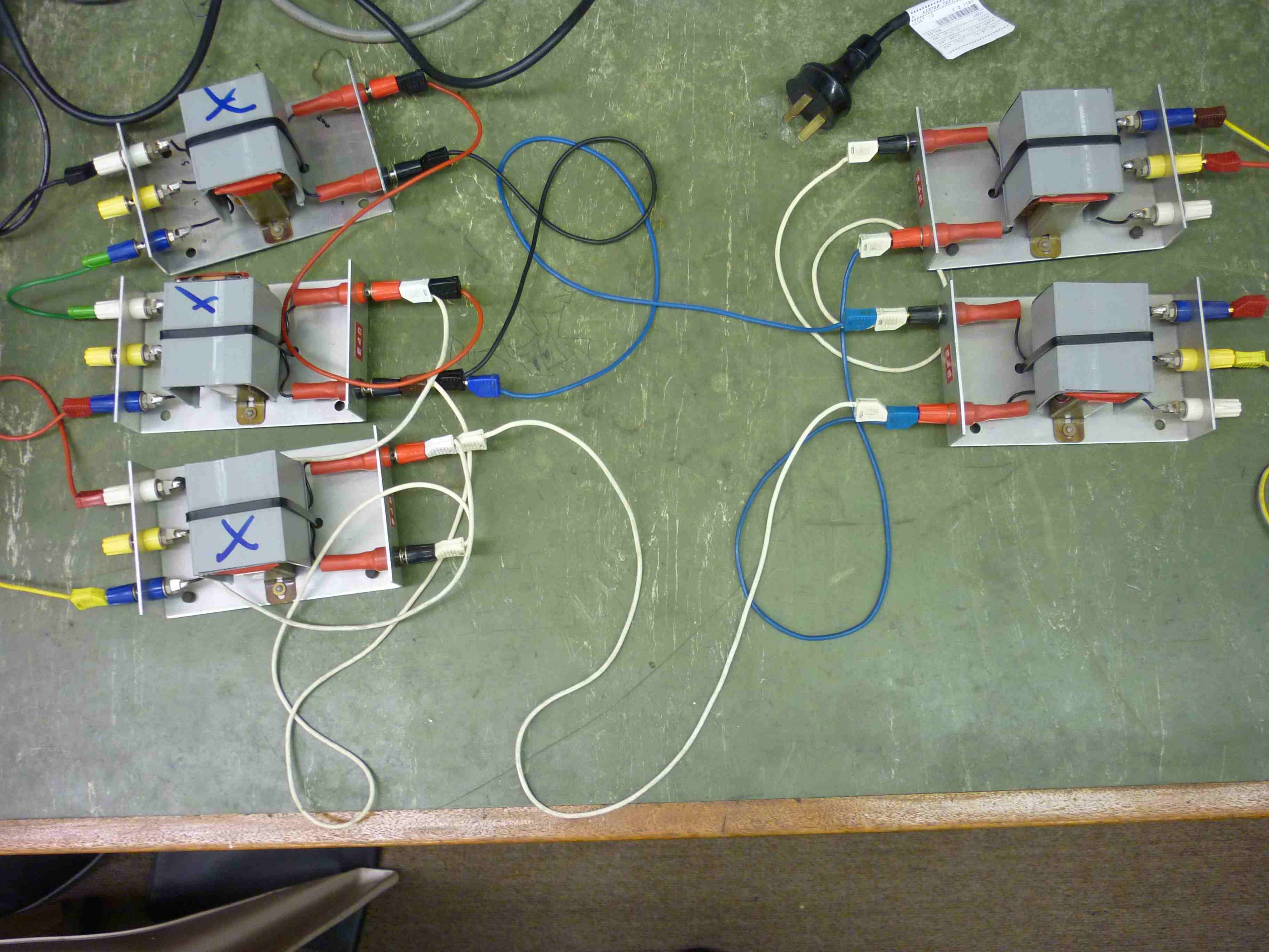
Controls and meters include:

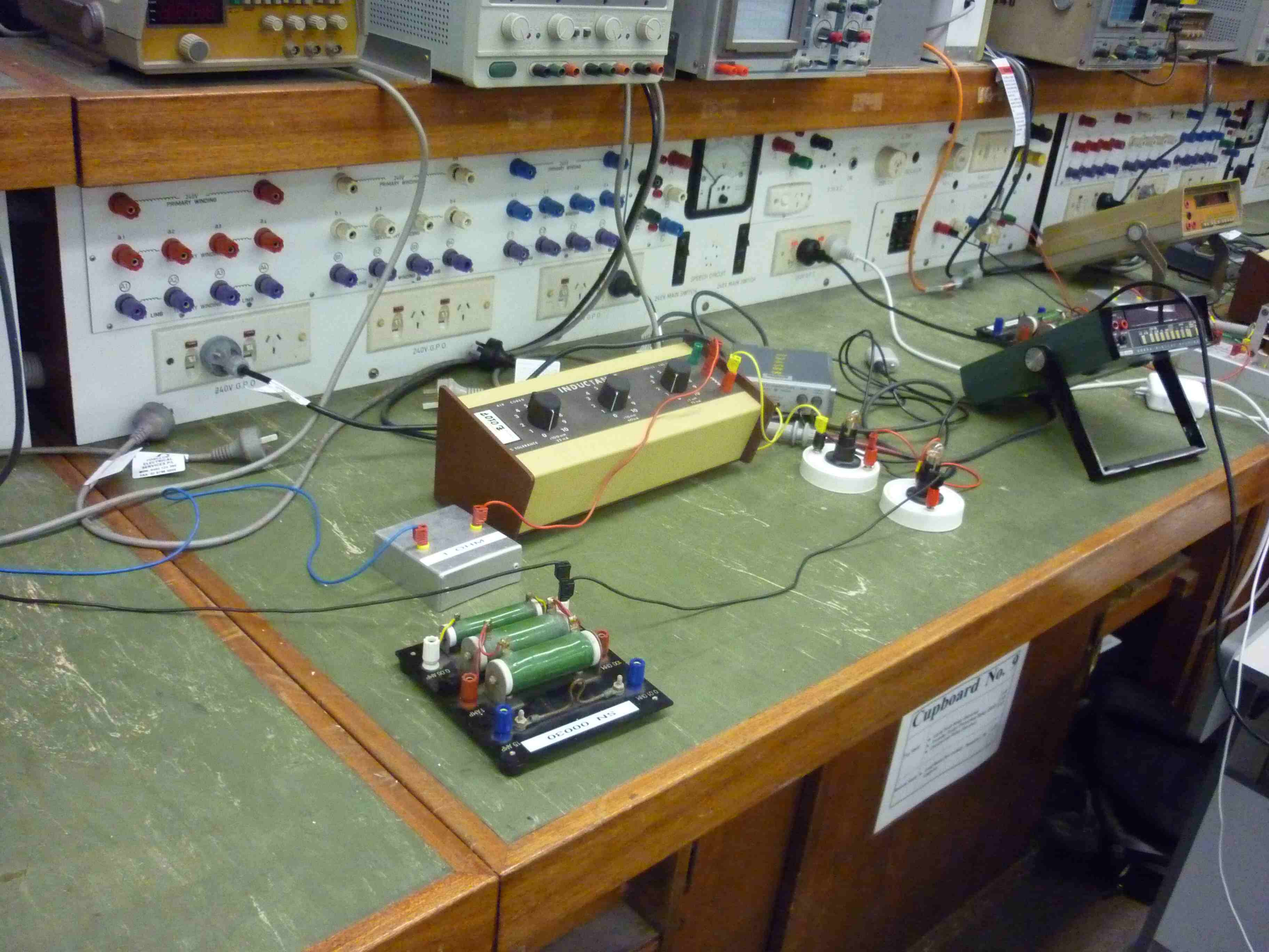
- A 30V VARIAC with a 0-40V scale.
- A voltmeter with a scale from 0 to 300V.
- A 6.3V A.C. power source with ON/OFF switch.
- Two 240V MAIN SWITCHES.
- Two 240V G.P.O. (Grounding Plug Outlet) sockets.
- A SPEECH CIRCUIT control.

Other labels include "240V P.O." and "240V G.P.O." near the outlets.

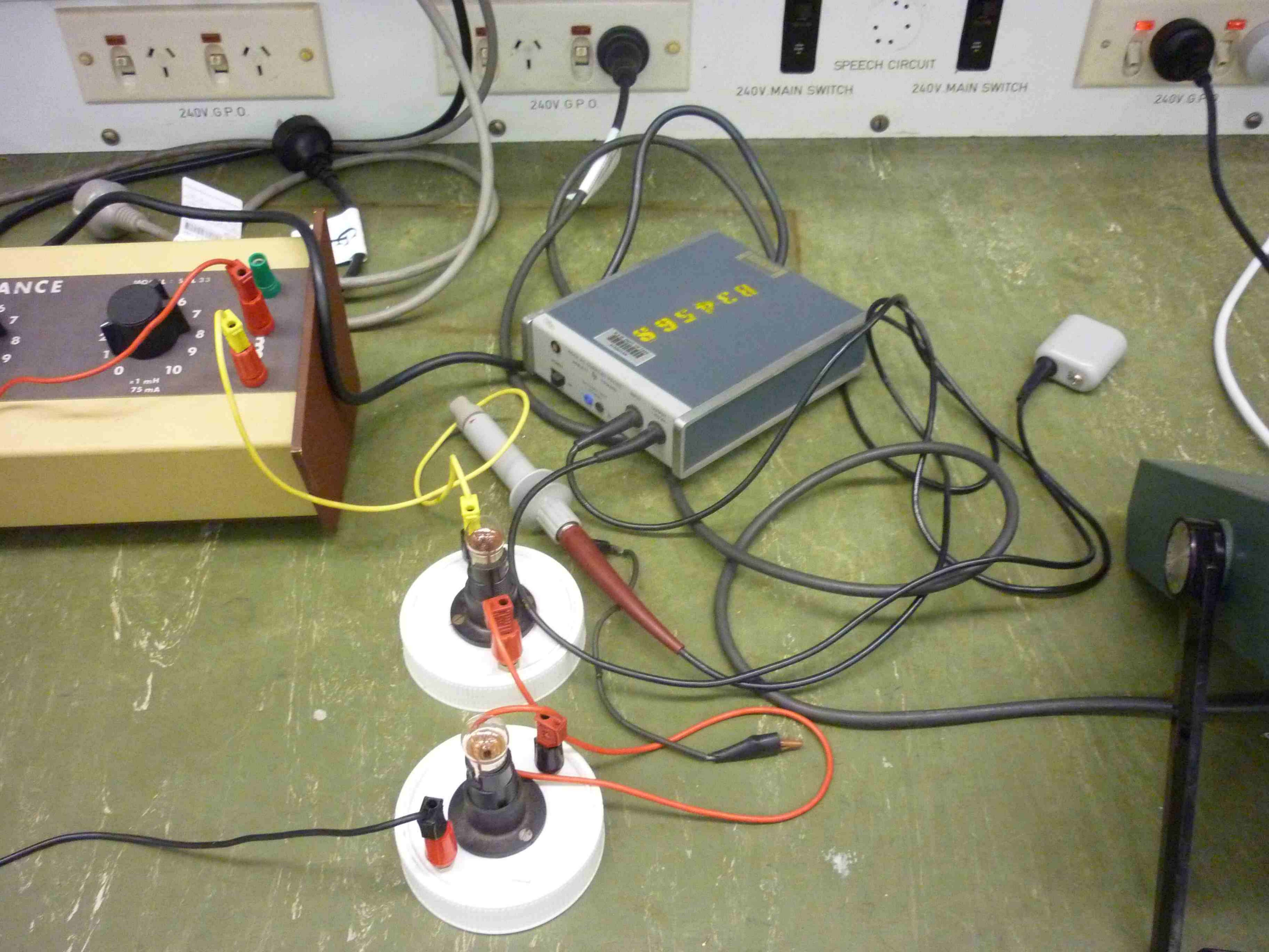
Two transformer assemblies on a green workbench, connected to the main transformer. Each assembly consists of a transformer core with multiple secondary windings. The windings are connected to various colored cables (red, blue, yellow, white) which are plugged into the secondary terminals of the main transformer. The transformer cores are marked with a blue 'X'.

A power cord with a ground symbol is plugged into one of the 240V G.P.O. outlets. A label on the cord reads "FORUM ELECTRICAL SERVICES".









240V G.P.O.

240V G.P.O.

240V MAIN SWITCH

240V MAIN SWITCH

240V G.P.O.

SPEECH CIRCUIT

IMPEDANCE

MODEL - 5133

±1 mH

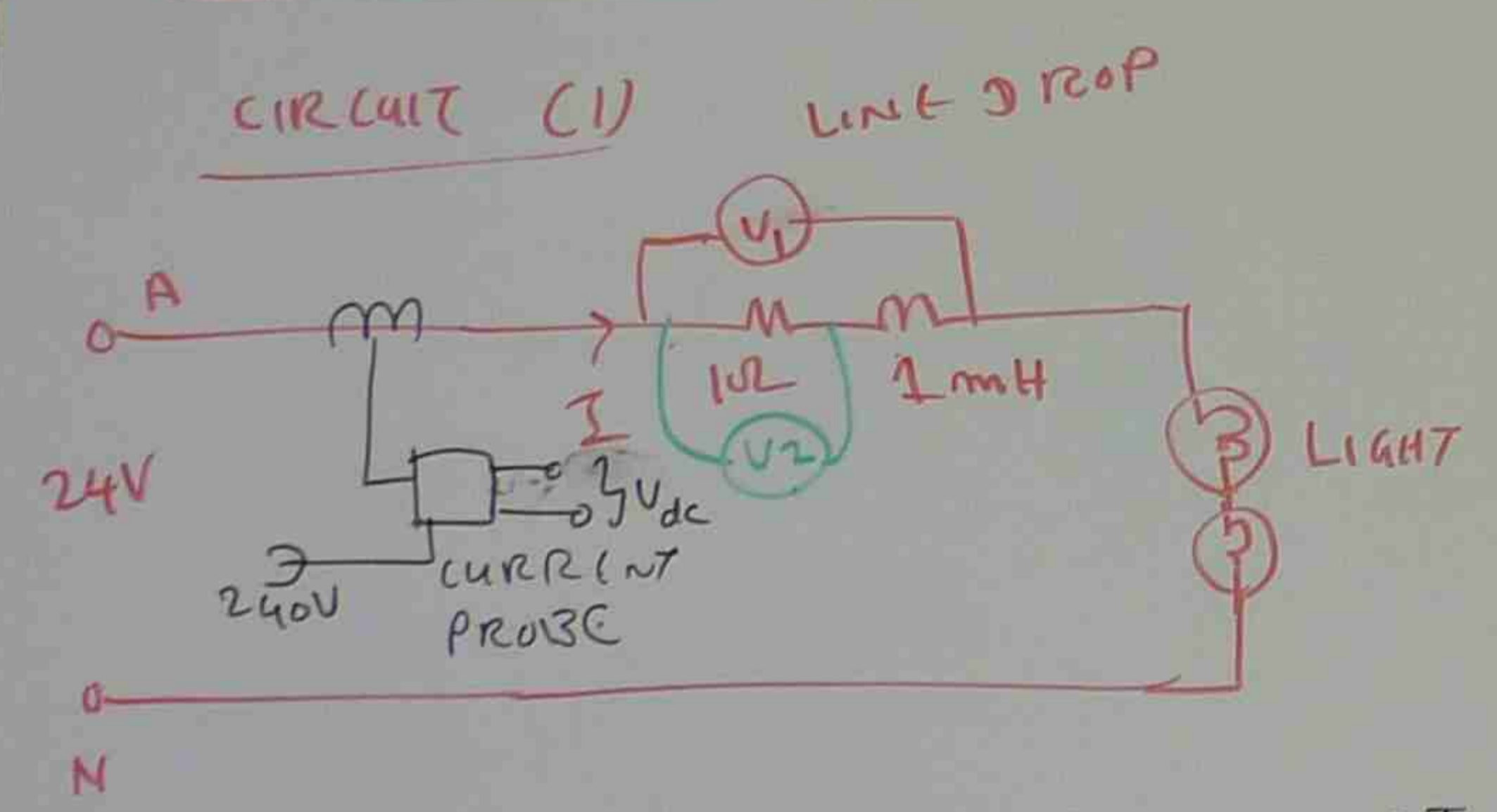
75 mA

SPEECH CIRCUIT

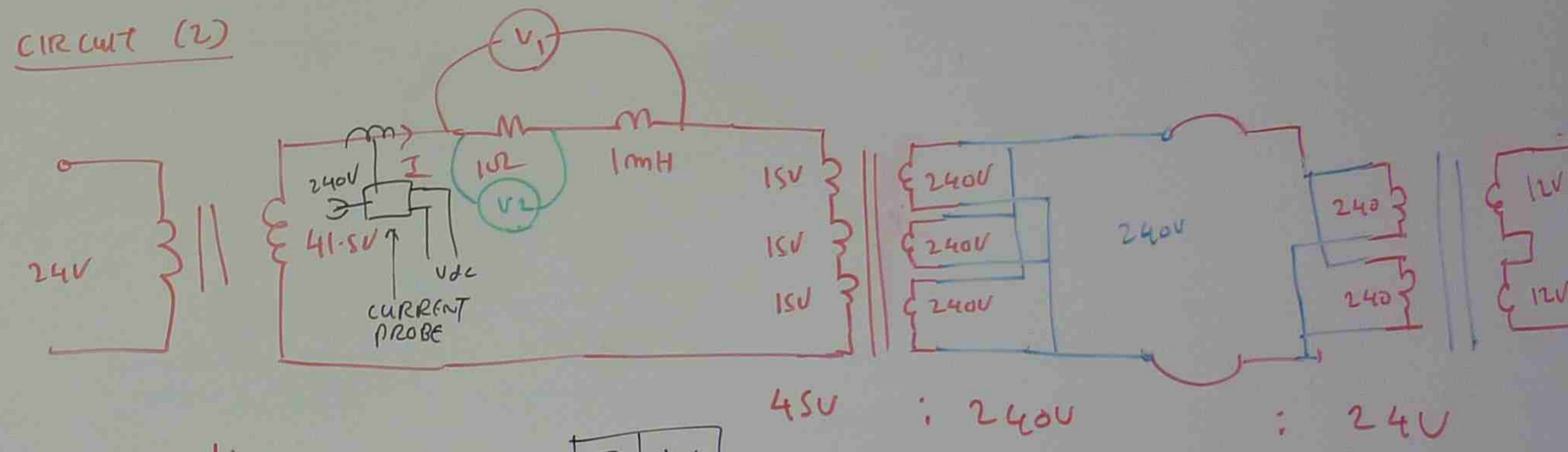
... WHILE SHORT
EXCESSIVE

PRACTICAL (6) EFFECT OF TRANSFORMER ON LINE LOSS AND
CONNECTING THE TRANSFORMER TO GET REQUIRED
VOLTAGE

CONNECT THE GIVEN CIRCUITS



CIRCUIT (2)



$V_1 =$
 $V_2 =$
 $I = \frac{V_2}{10\Omega}$
 POWER LOSS = $I^2 \times 10\Omega$

Vdc AT CURRENT PROBE = ?

I	Vdc

$V_1 =$
 $V_2 =$
 $I = \frac{V_2}{10\Omega}$
 POWER LOSS = $I^2 \times 10\Omega$

I	Vdc

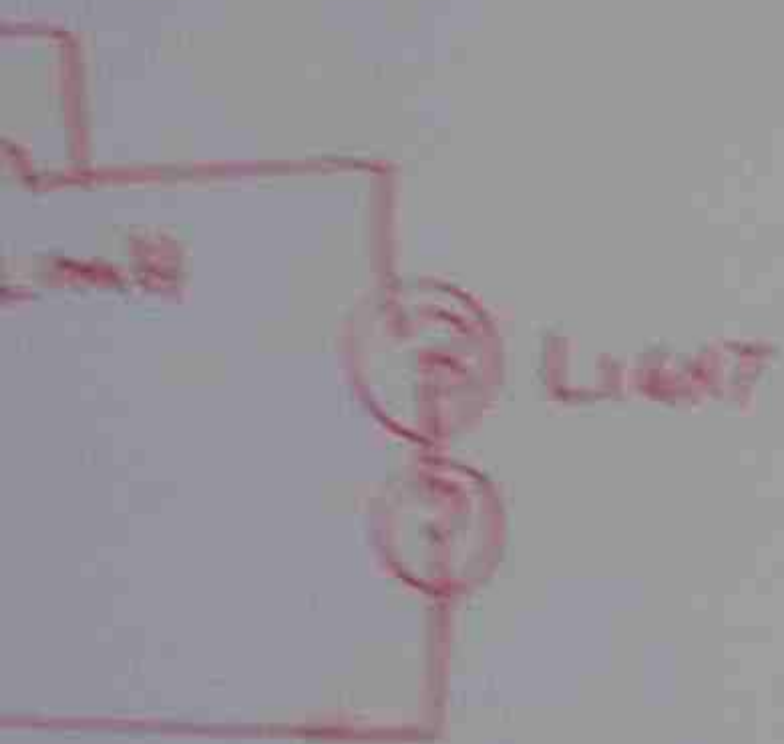
COMPARE POWER LOSS

45V : 240V : 24V

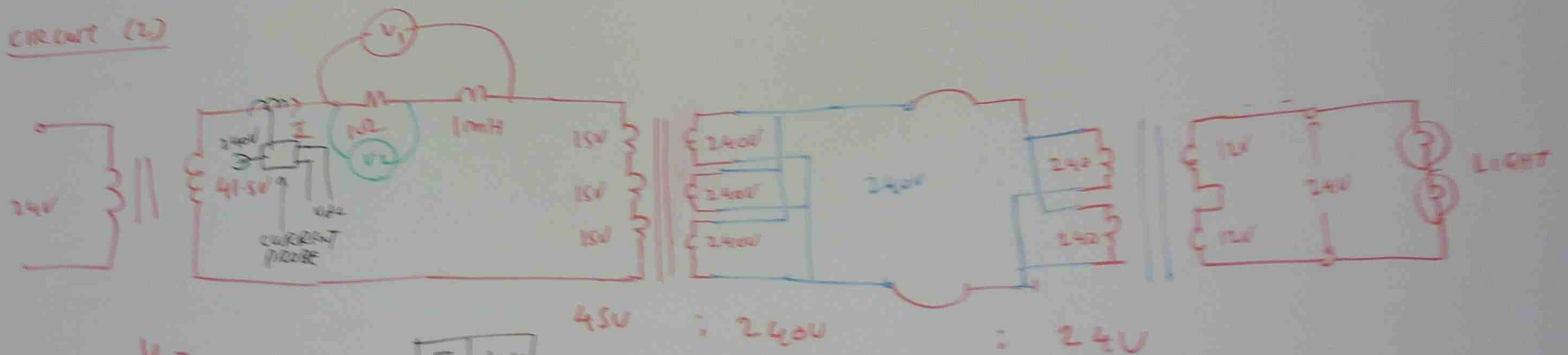
EFFECT OF TRANSFORMER ON LINE LOSS AND
CONNECTING THE TRANSFORMER TO GET REQUIRED
VOLTAGE

CIRCUITS

3 STEP



CIRCUIT (2)



45V : 240V : 24V

Vdc AT
CURRENT
PROBE = ?

I	Vdc

$$V_1 =$$

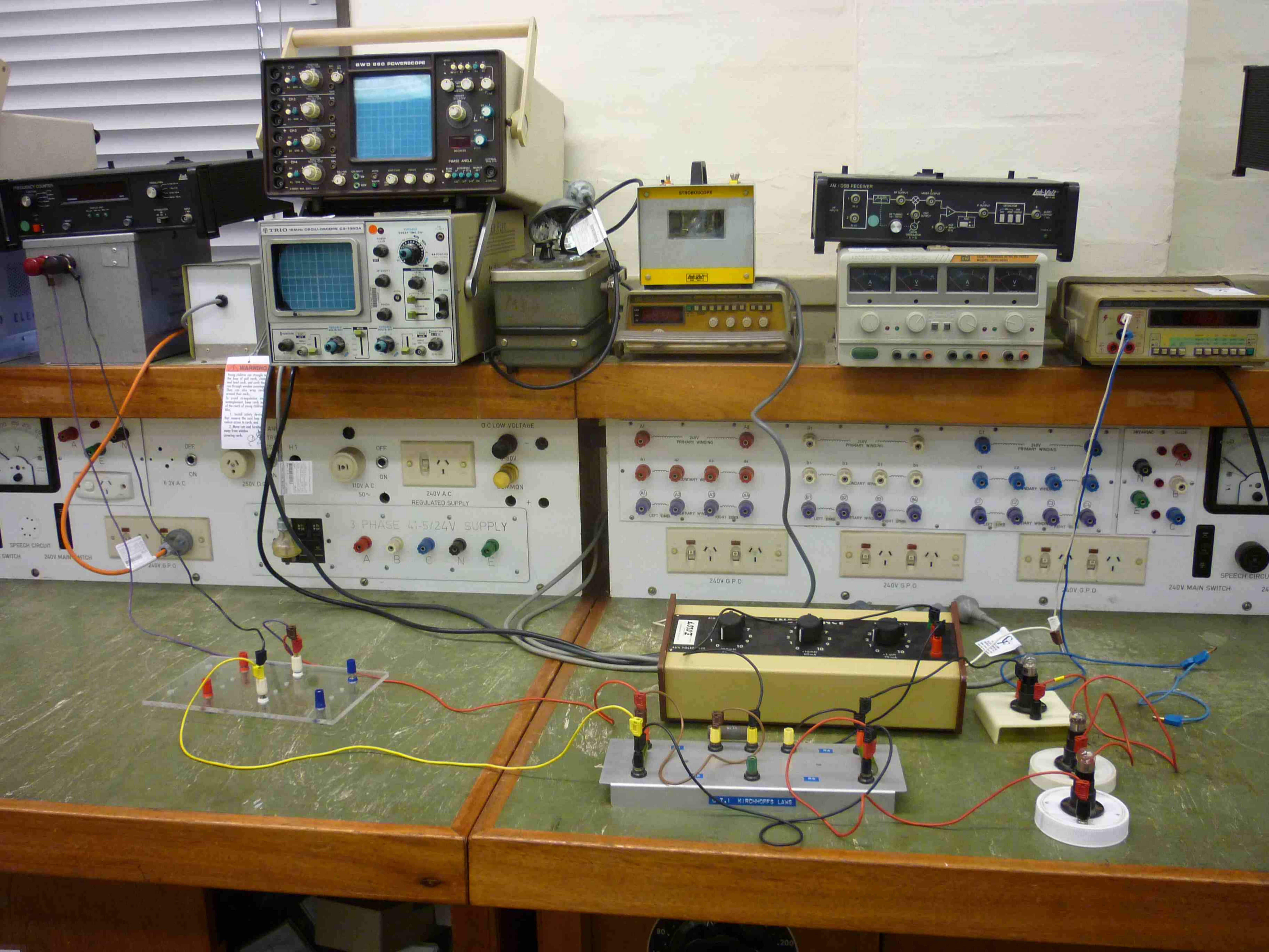
$$V_2 =$$

$$I = \frac{V_2}{1\Omega}$$

$$\text{POWER LOSS} = I^2 \times 1\Omega$$

I	Vdc

COMPARE POWER LOSS



BWD 660 POWERSCOPE

CH1 CH2 CH3 CH4

PHASE ANGLE

TRIO 10MHz OSCILLOSCOPE CB-1980A

TRIGGER

SWEEP TIME DIV

VERTICAL

STROBOSCOPE

Lab-Volt

AM / DSB RECEIVER

Lab-Volt

Digital Multimeter

3 PHASE 415/240V SUPPLY

D.C. LOW VOLTAGE

240V A.C. REGULATED SUPPLY

A B C N E

240V G.P.O.

PRIMARY WINDING

SECONDARY WINDING

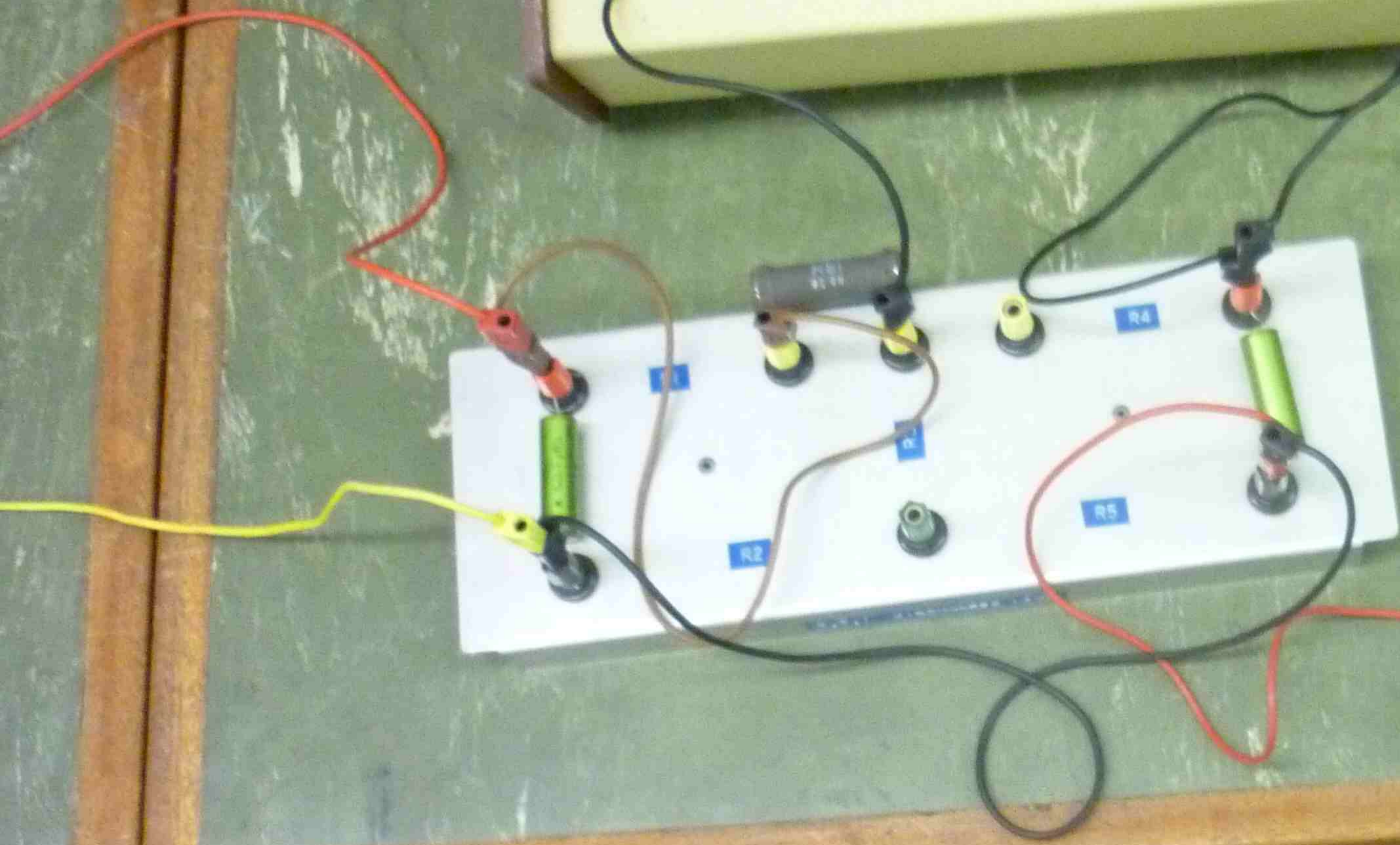
LEFT SIDE RIGHT SIDE

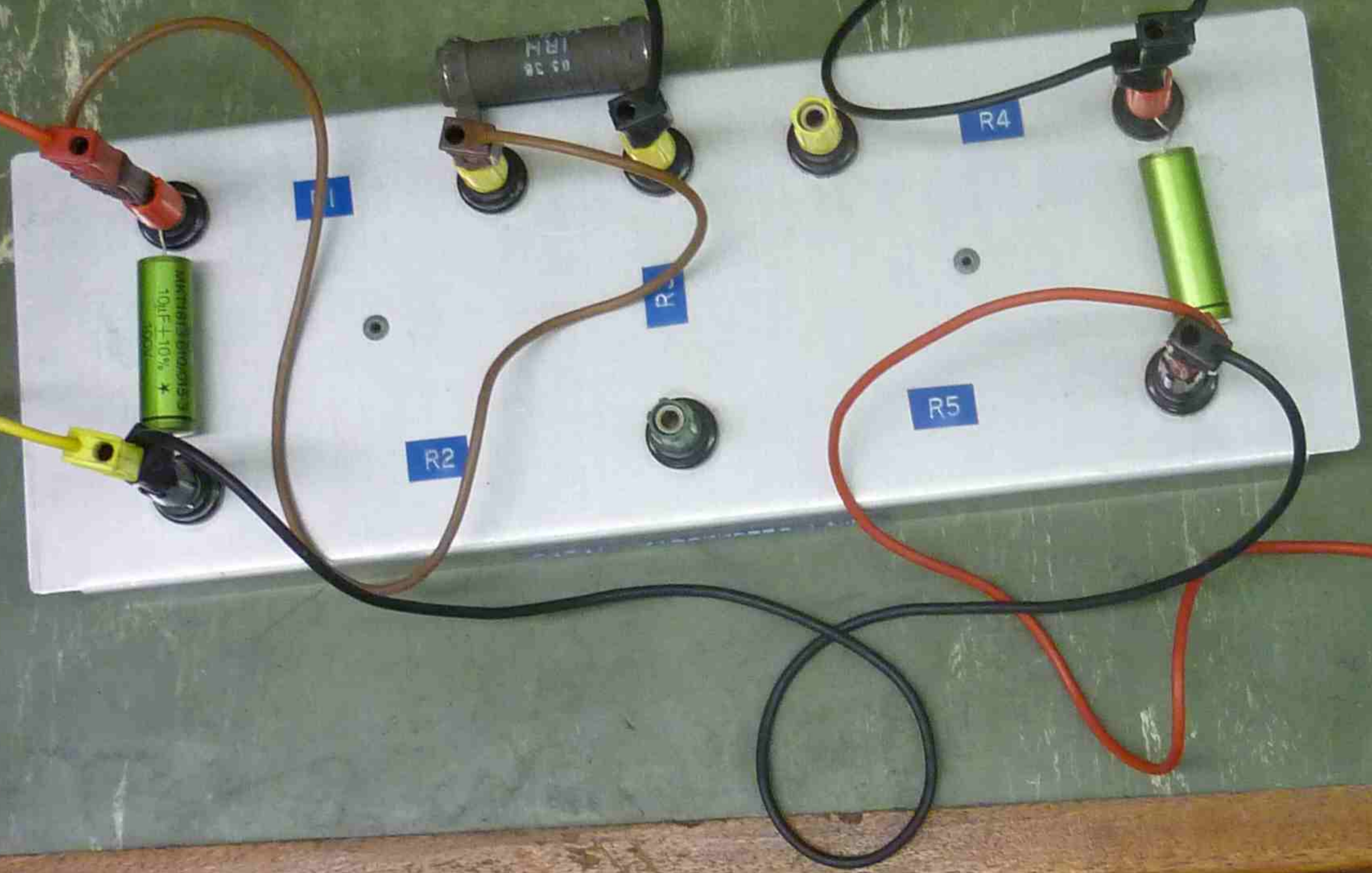
Breadboard circuit with resistors and jumper wires.

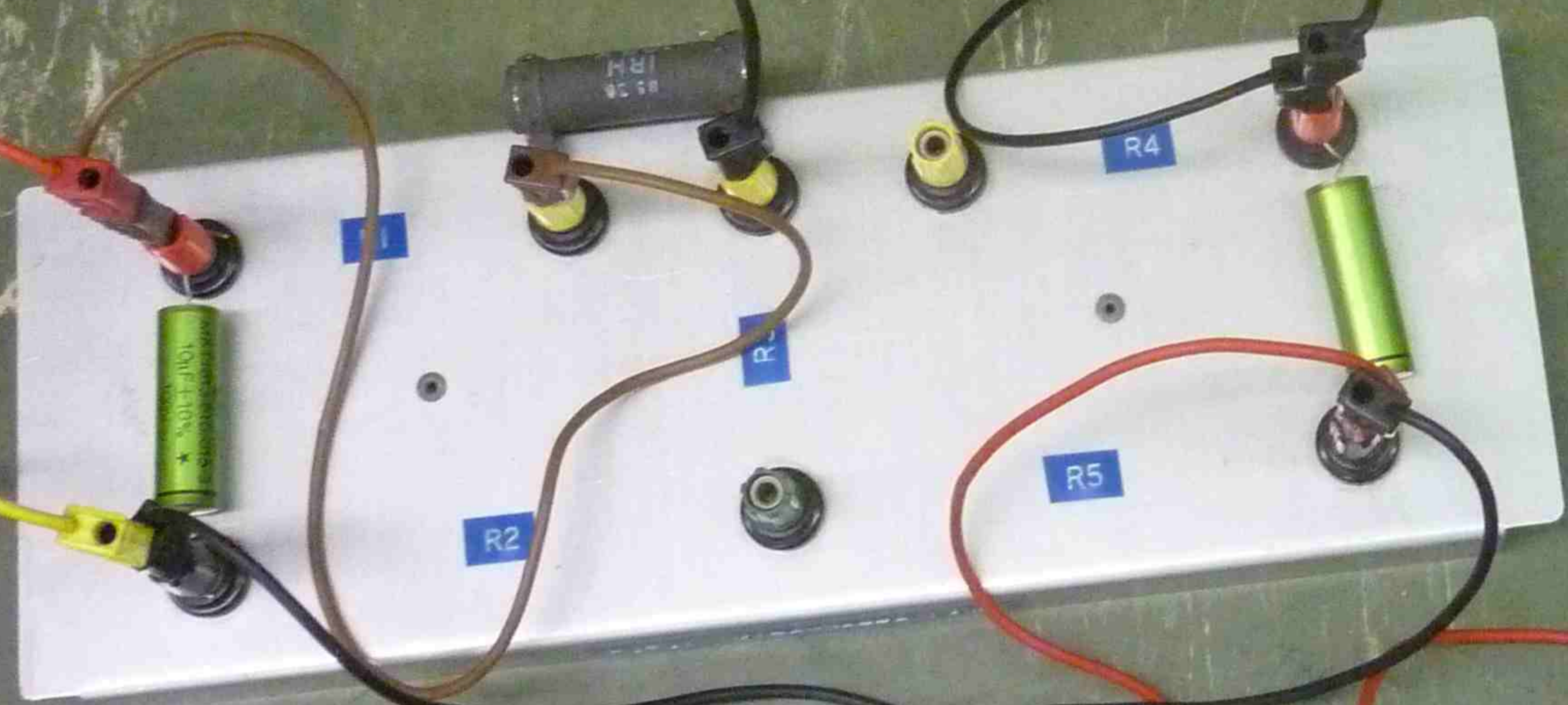
KIRCHHOFF'S LAWS

Variable autotransformer with potentiometer and terminals.

Two circular components, possibly relays or solenoids, with electrical connections.









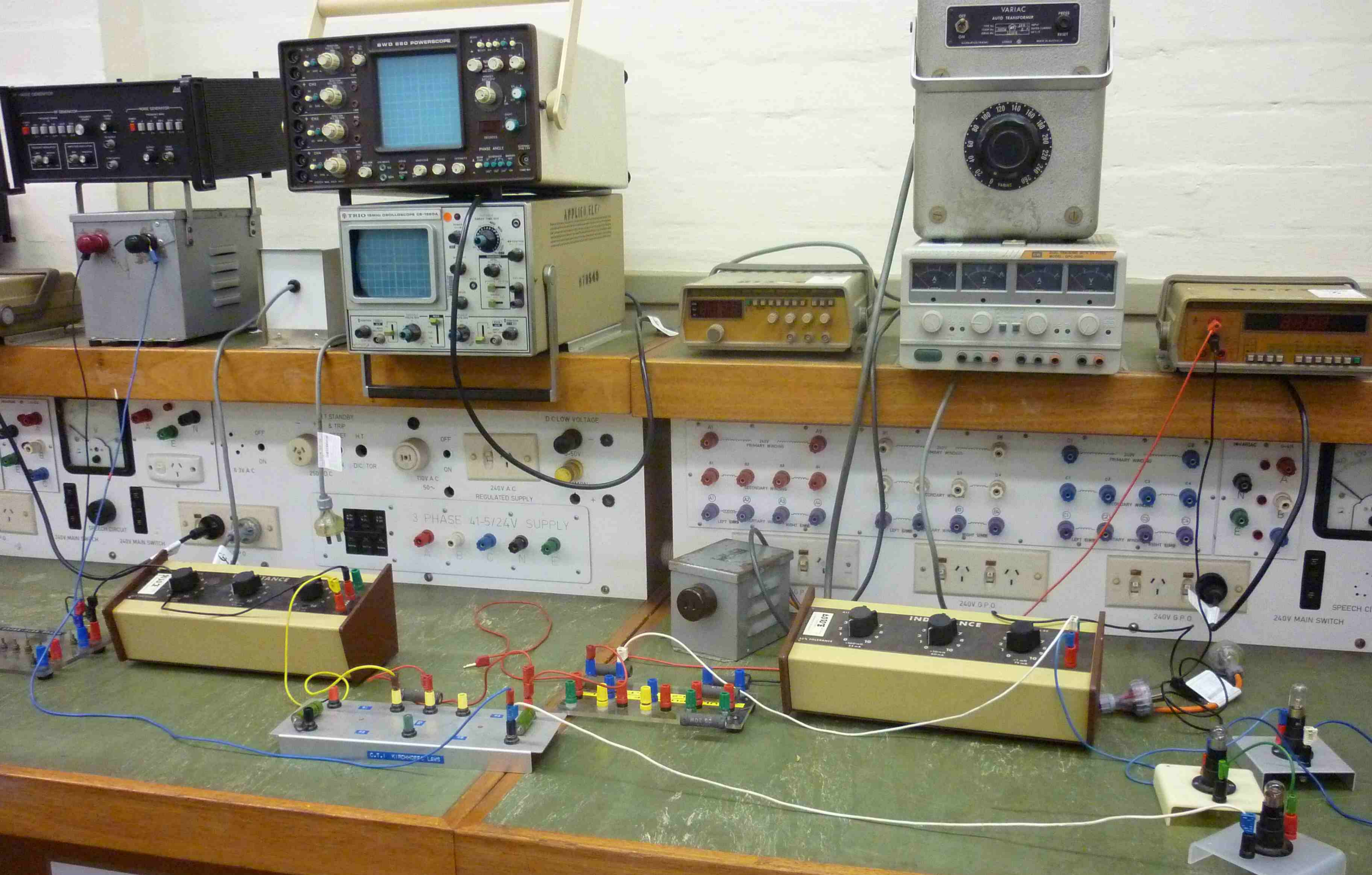
CH4
100V
50
PHASE ANGLE

TRIO 15MHz OSCILLOSCOPE CS-1580A

240V A.C. REGULATED SUPPLY
PHASE 41-5/24V SUPPLY

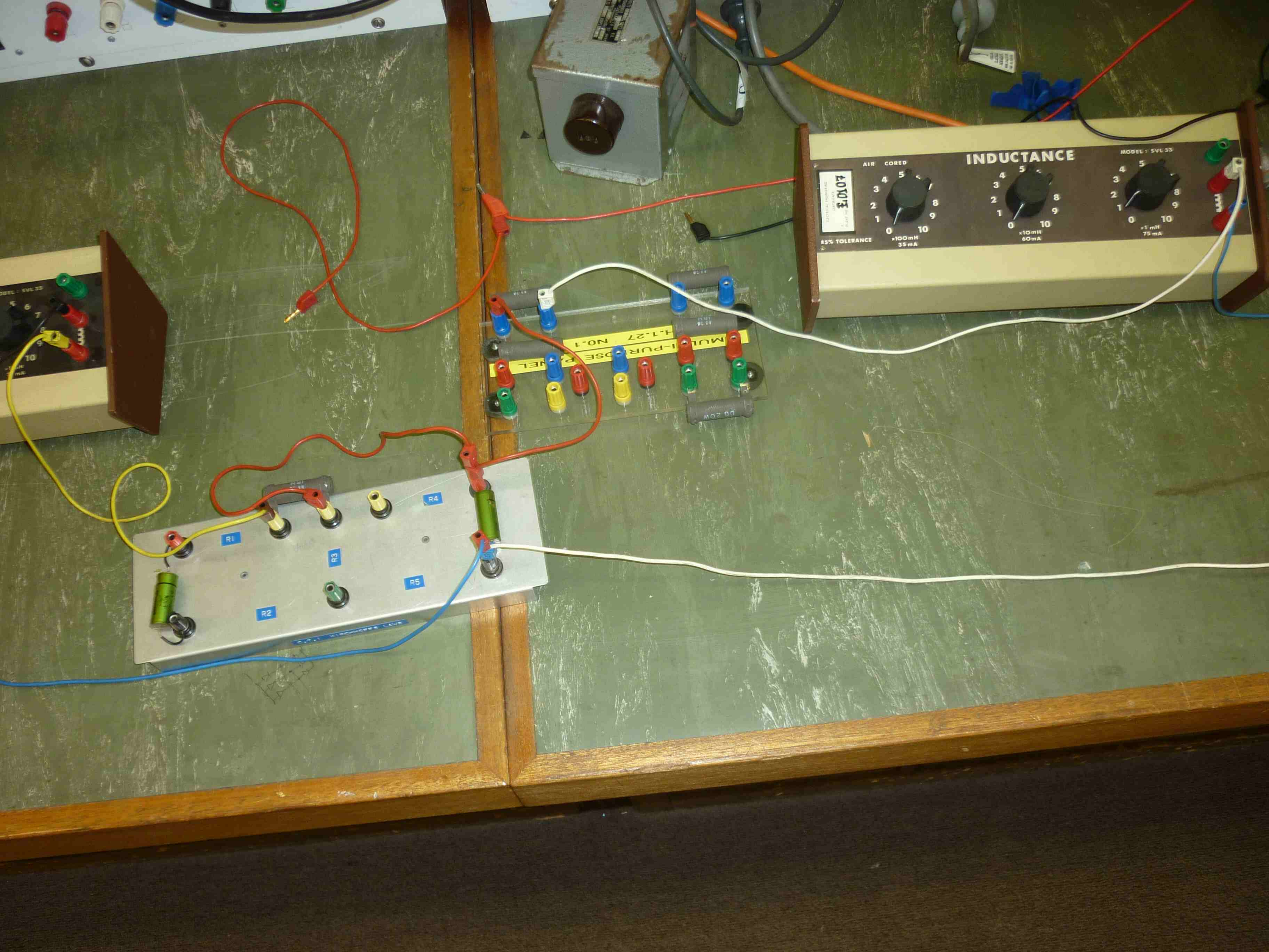
INDUCTIVE
E010

CROSS-OVER BOARD



Cupboard No. 8

Top Shelf	• Circuit Breaker Panels - 6 x 10 Amperes 8 off Quicklog C/B
Bottom Shelf	• Load Bank (fan cooled) - Resistive - 30 Amperes 1 off



INDUCTANCE MODEL: SVL 33

AIR CORED

40107

85% TOLERANCE

x100mH 35mA

x10mH 60mA

x1mH 75mA

0 1 2 3 4 5

0 1 2 3 4 5

0 1 2 3 4 5

MULTI-PURPOSE PANEL

L-1-27 NO.1

0.05W

0.1W

0.25W

0.5W

1W

2W

5W

10W

20W

50W

100W

R1

R2

R3

R4

R5

0.1W

0.25W

0.5W

1W

2W

5W

10W

20W

50W

100W

MODEL: SVL 33

5

6

7

8

9

10

0.1W

0.25W

0.5W

1W

2W

5W

10W

20W


50W

100W

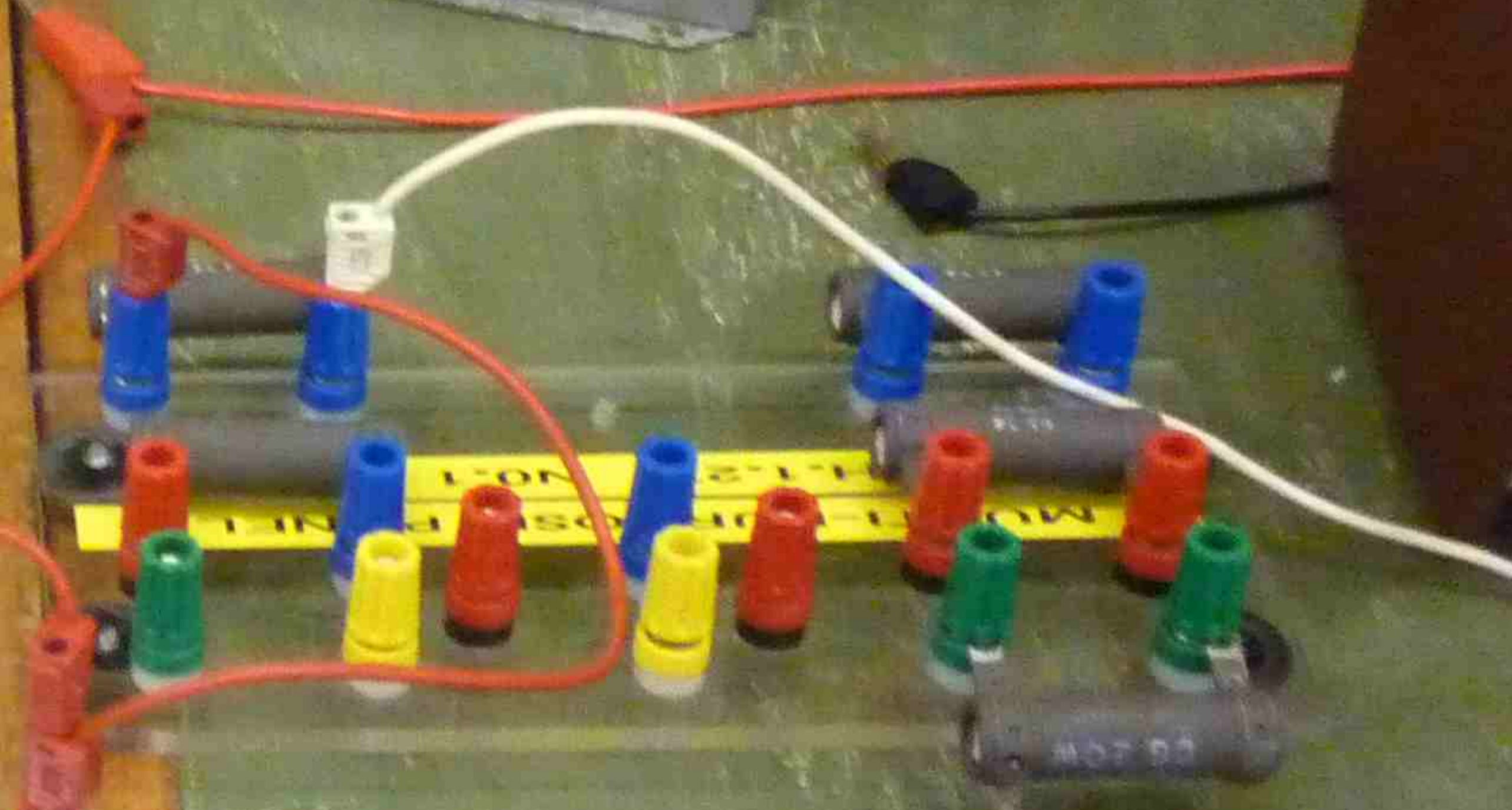
3 PHASE 41-5/24V SUPPLY
REGULATED SUPPLY
110V A C 50~
240V A C



240V PRIMARY WINDING
PRIMARY WINDING
LEFT WINDING
RIGHT WINDING

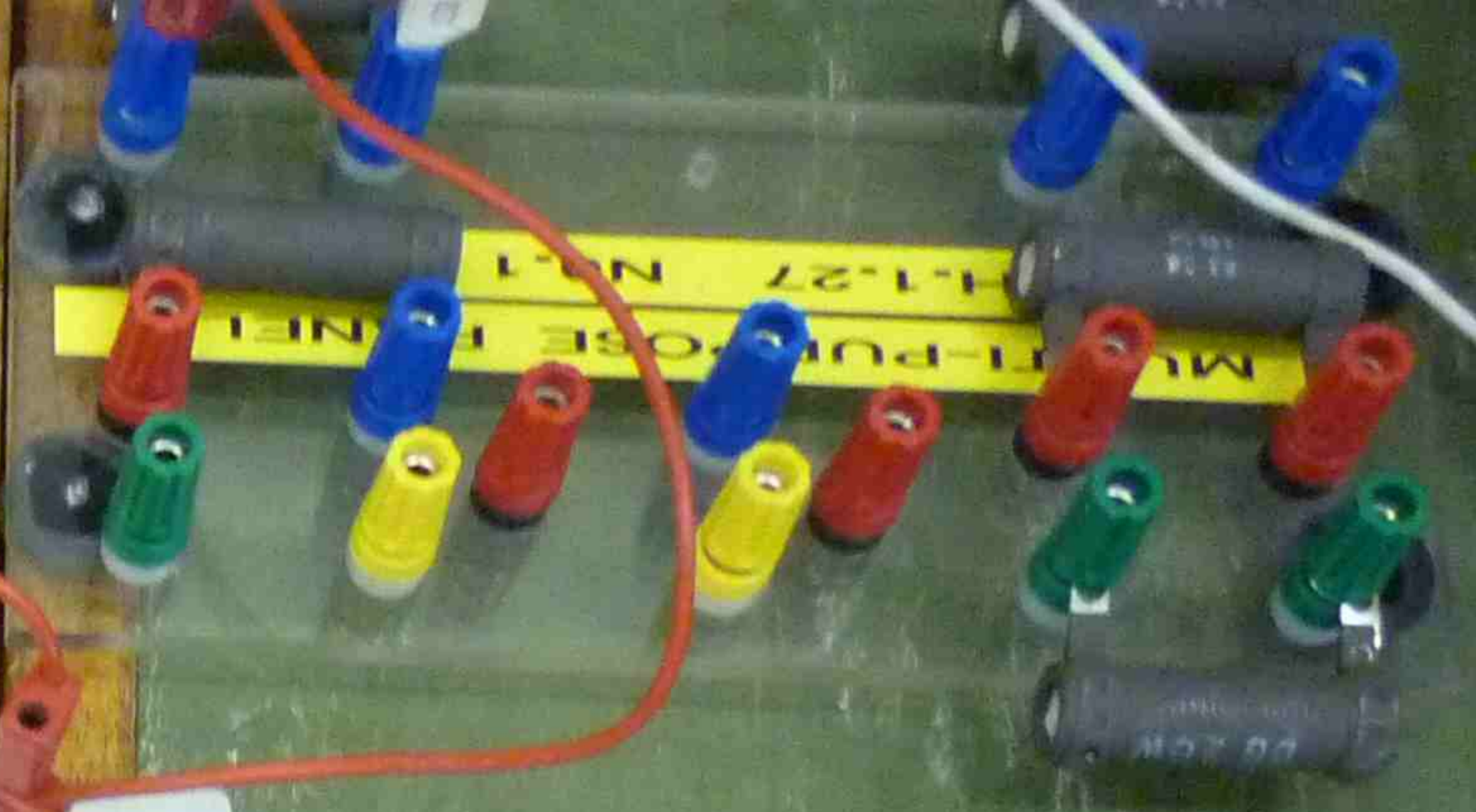


INDUCTANCE

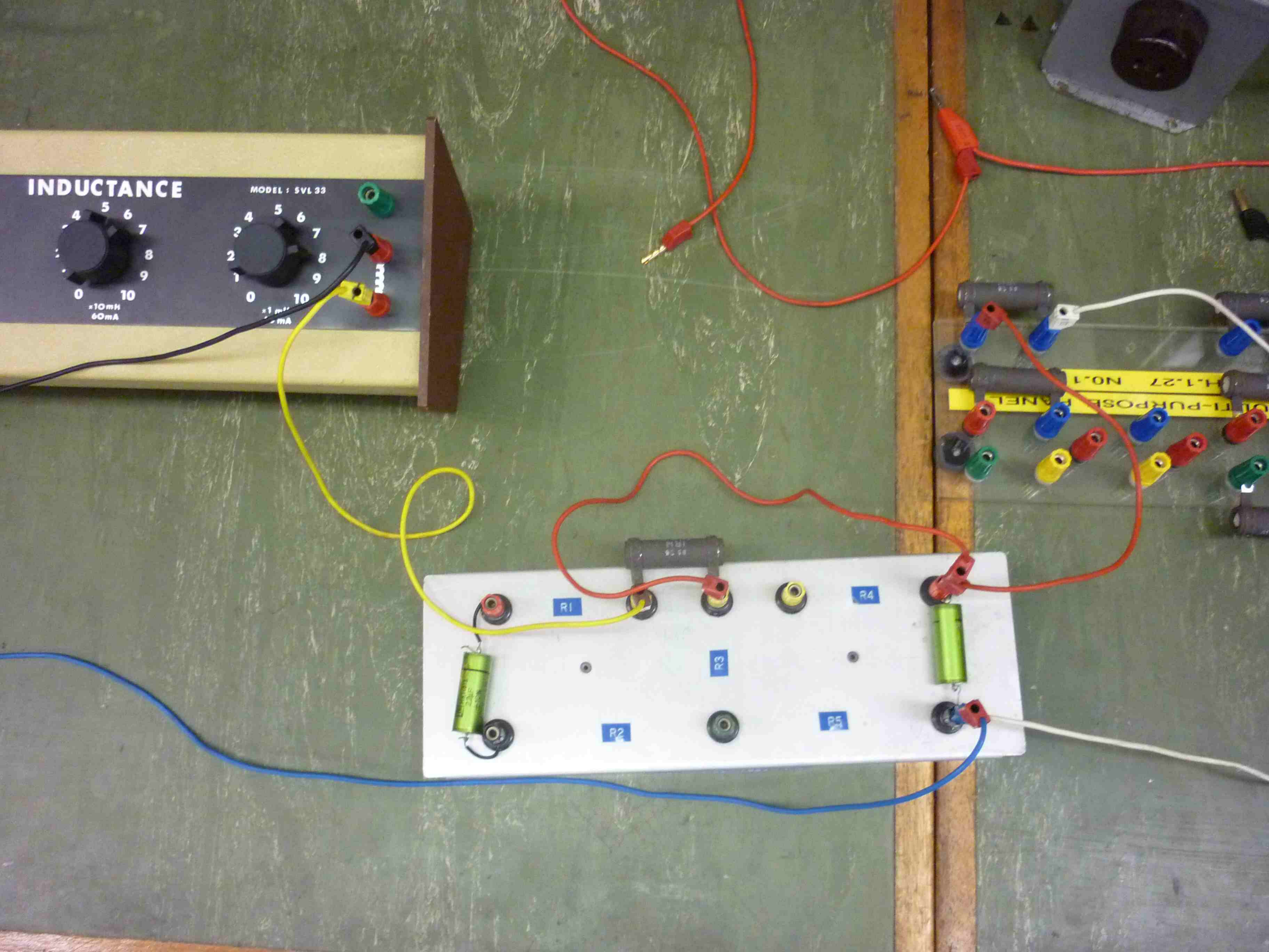
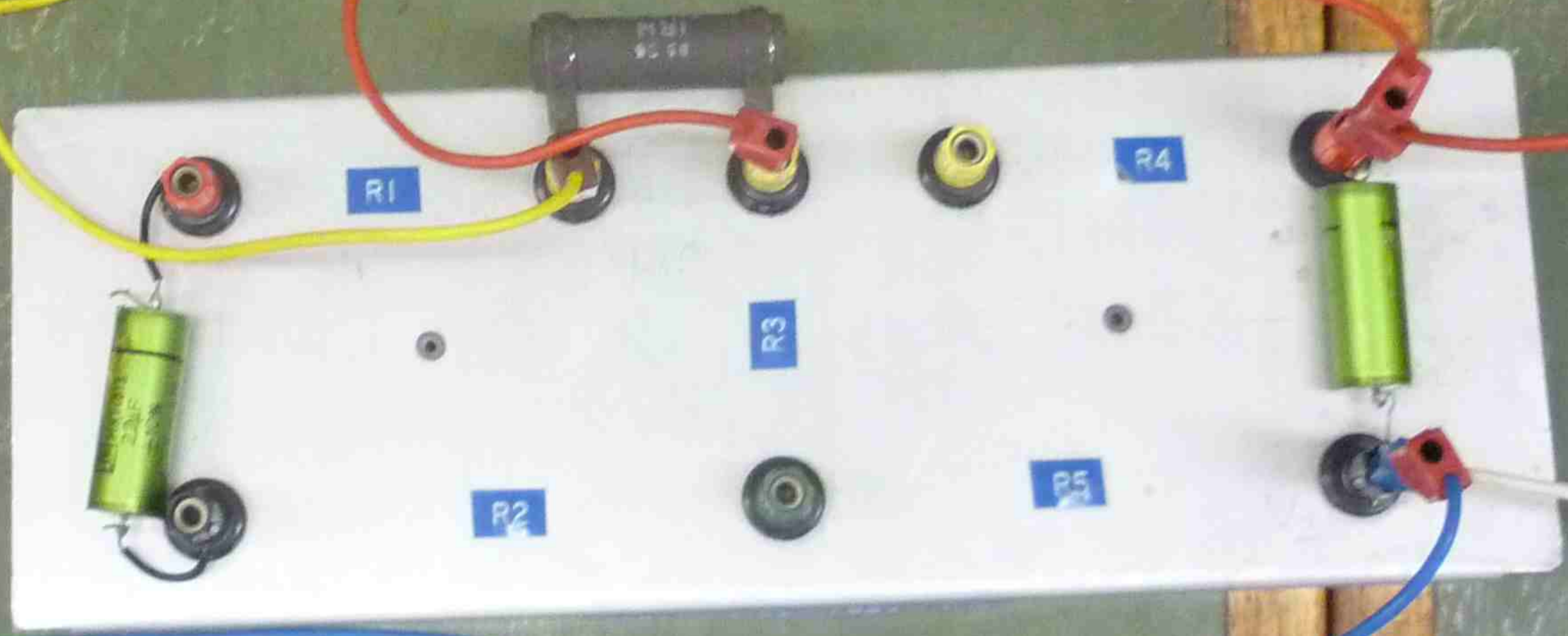
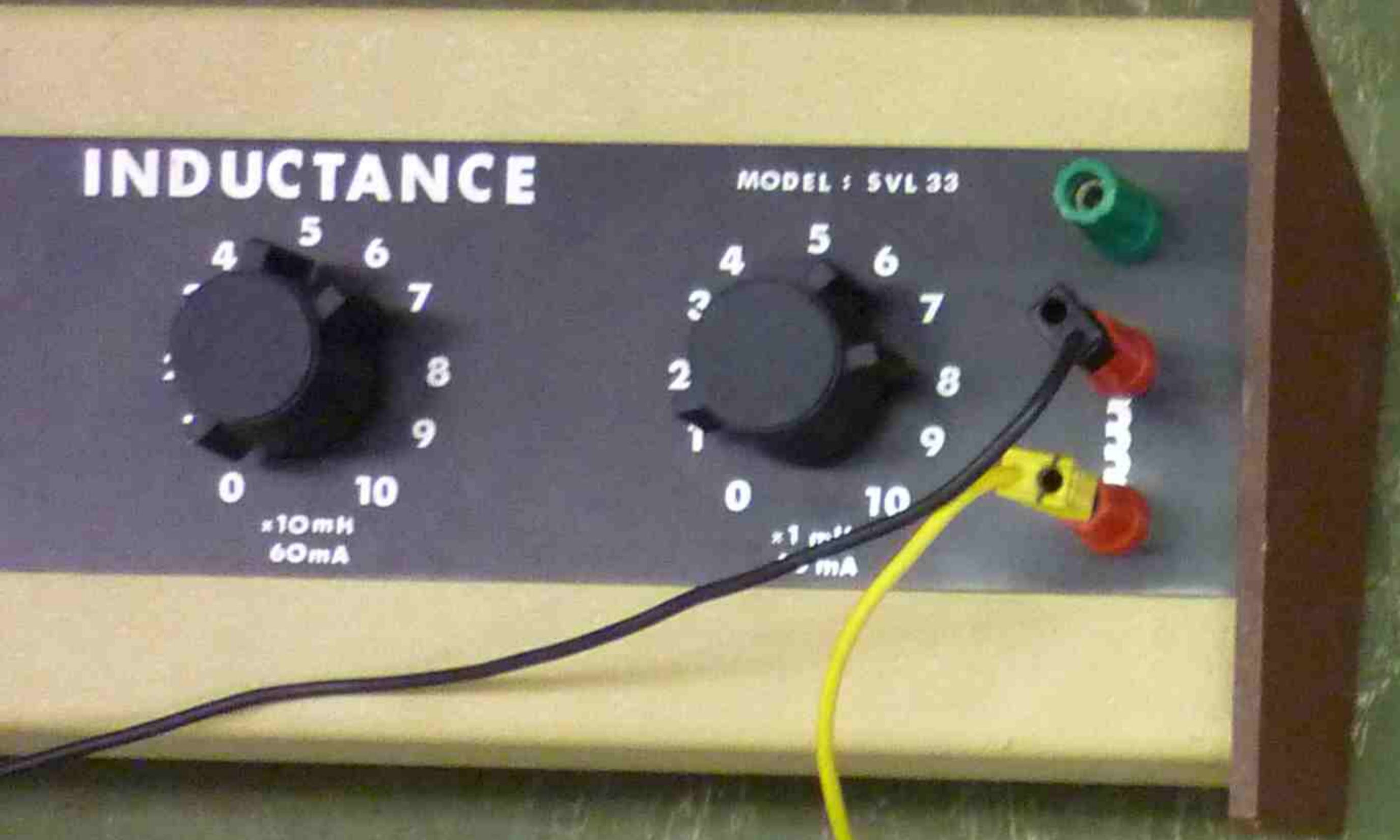


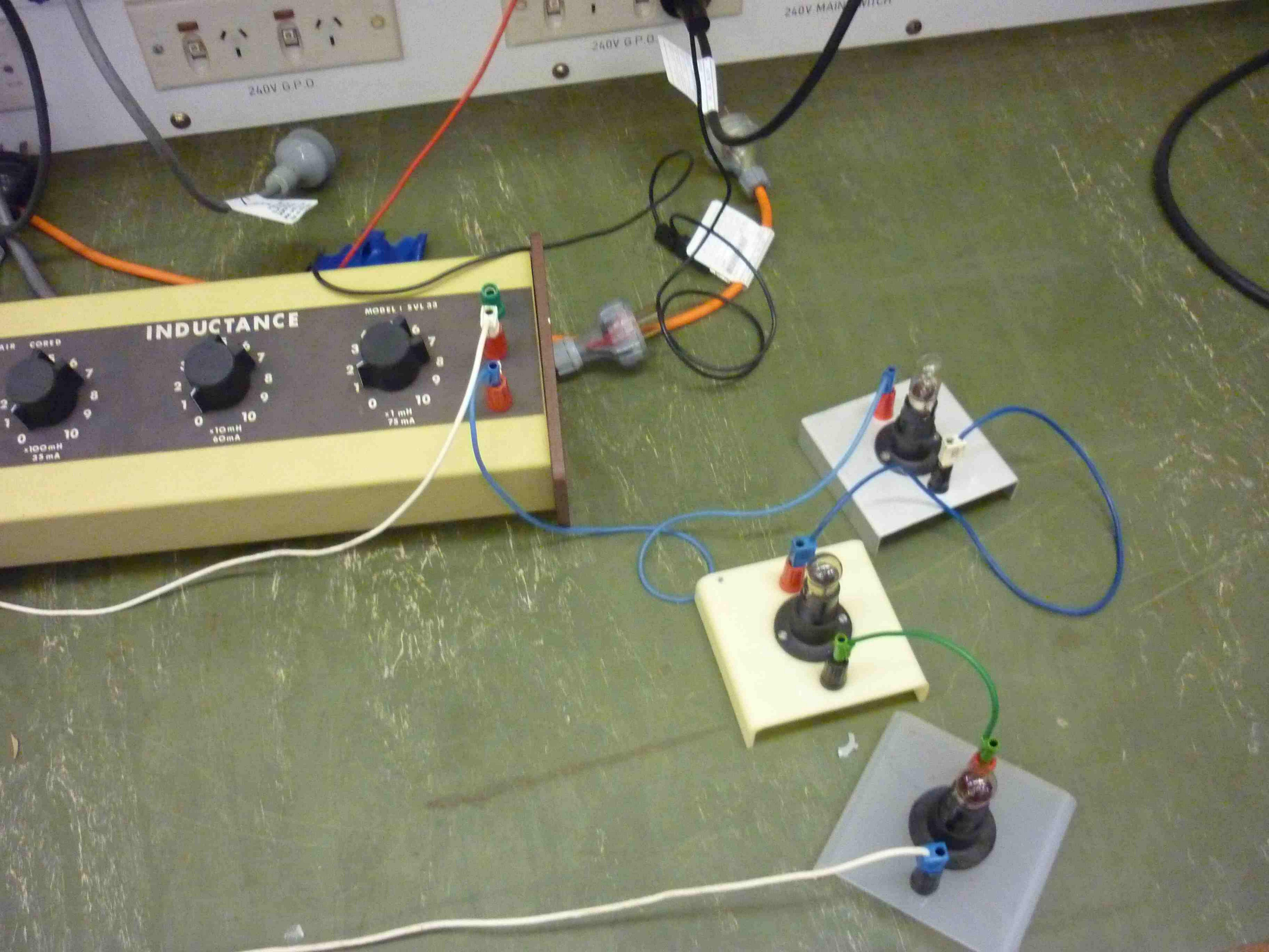
C.T.1 KIRCHHOFF'S LAWS





$V = IR$





240V G.P.O.

240V G.P.O.

240V MAIN SWITCH

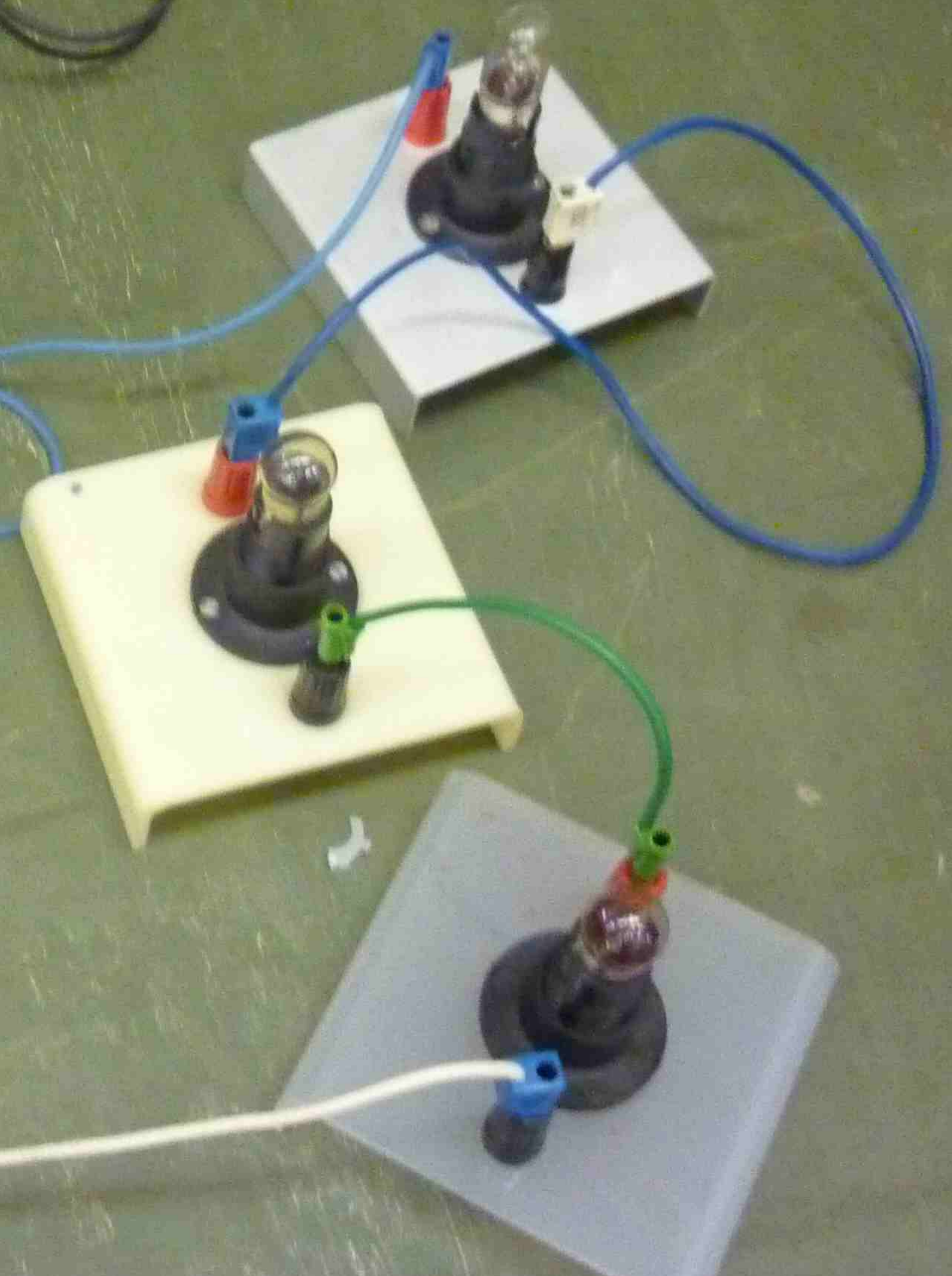
INDUCTANCE

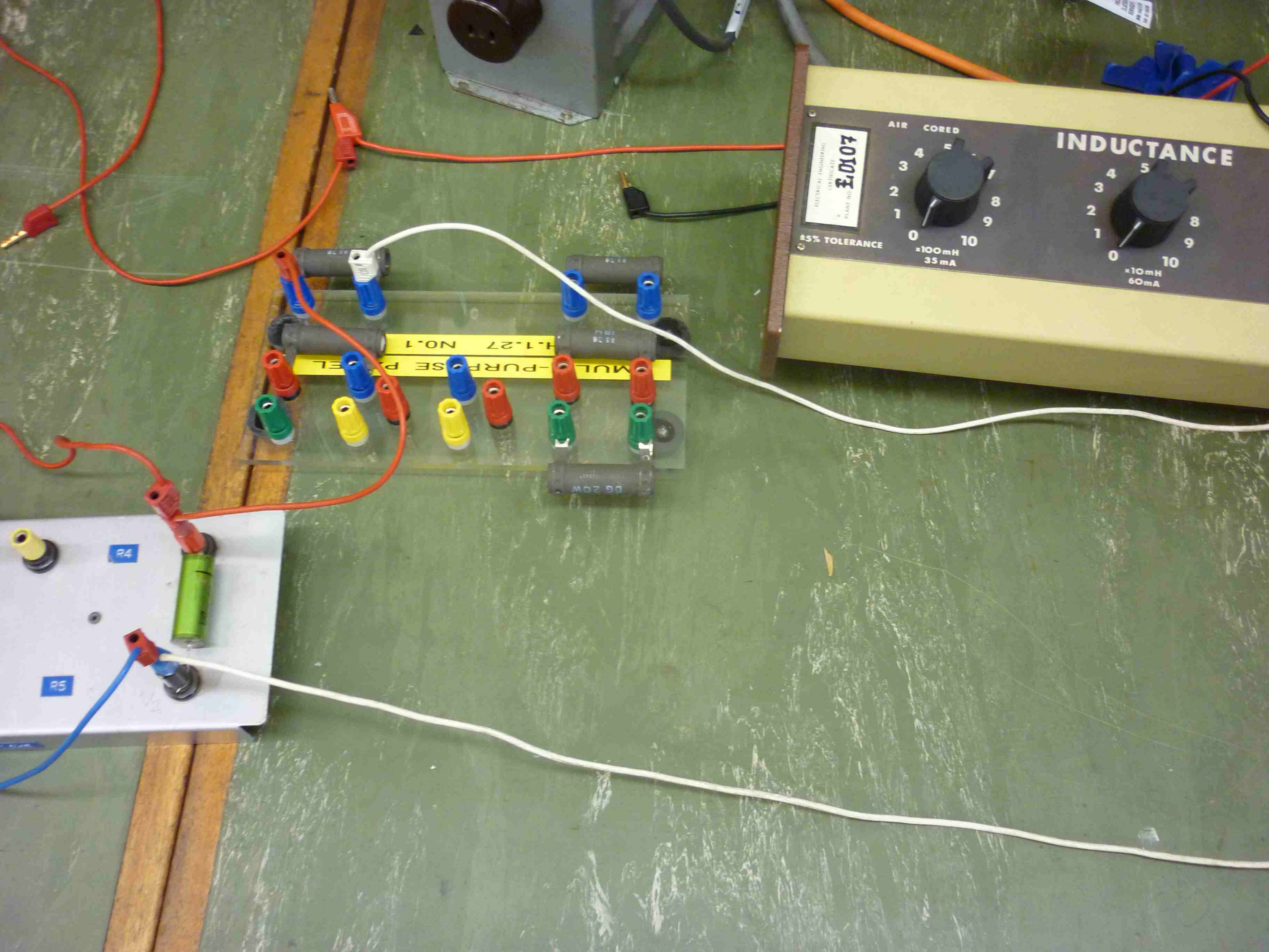
MODEL I 5VL 01

AIR CORED
0 1 2 3 4 5 6 7 8 9 10
100 mH
35 mA

0 1 2 3 4 5 6 7 8 9 10
10 MH
60 mA

0 1 2 3 4 5 6 7 8 9 10
1 MH
75 mA





ELECTRICAL ENGINEERING
CERTIFICATE
PLANT NO. **E0107**

AIR CORED

4 5 7 8 9 10
3 2 1 0

±5% TOLERANCE

x100mH
35mA

INDUCTANCE

4 5 7 8 9 10
3 2 1 0

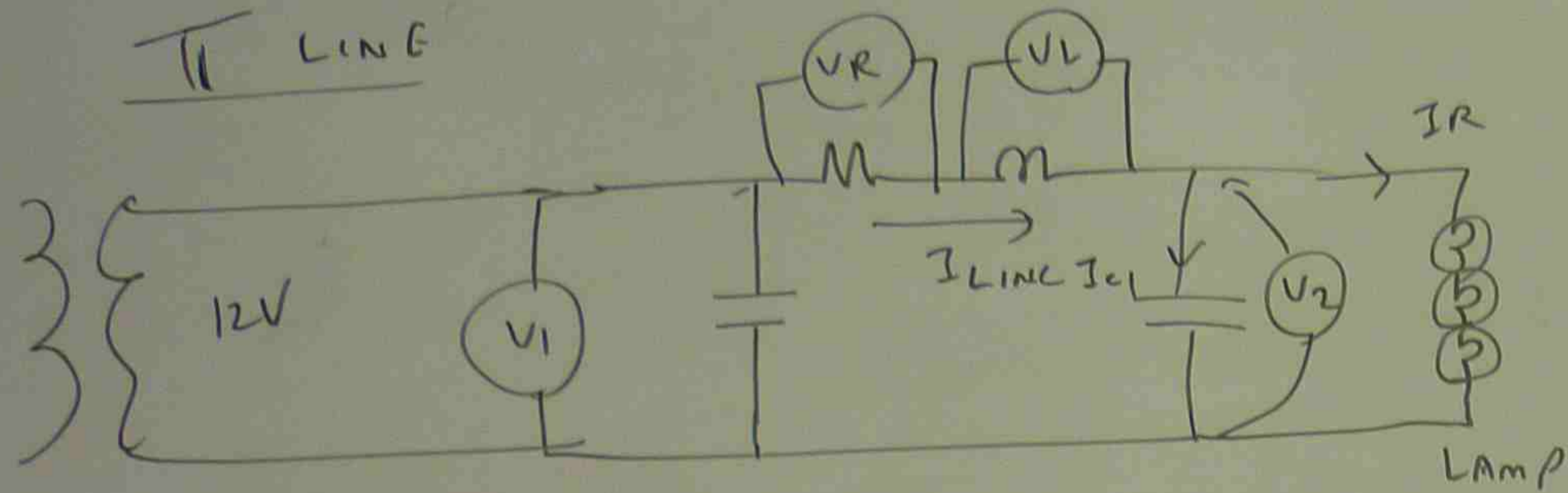
x10mH
60mA

1.1.27 NO.1
MUL-PURPOSE PANEL

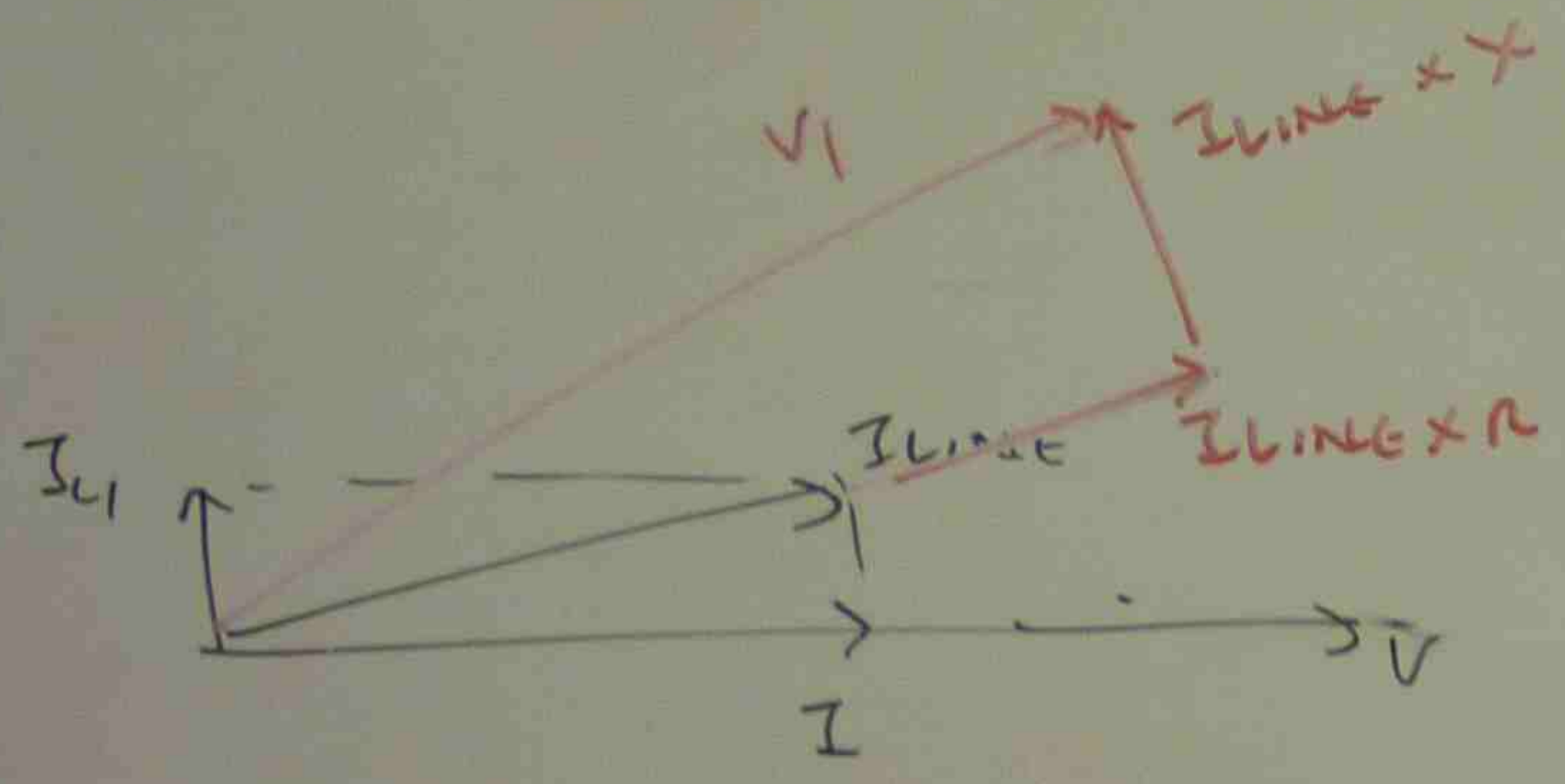
P4

P5

T AND π EQUIVALENT TRANSMISSION LINES

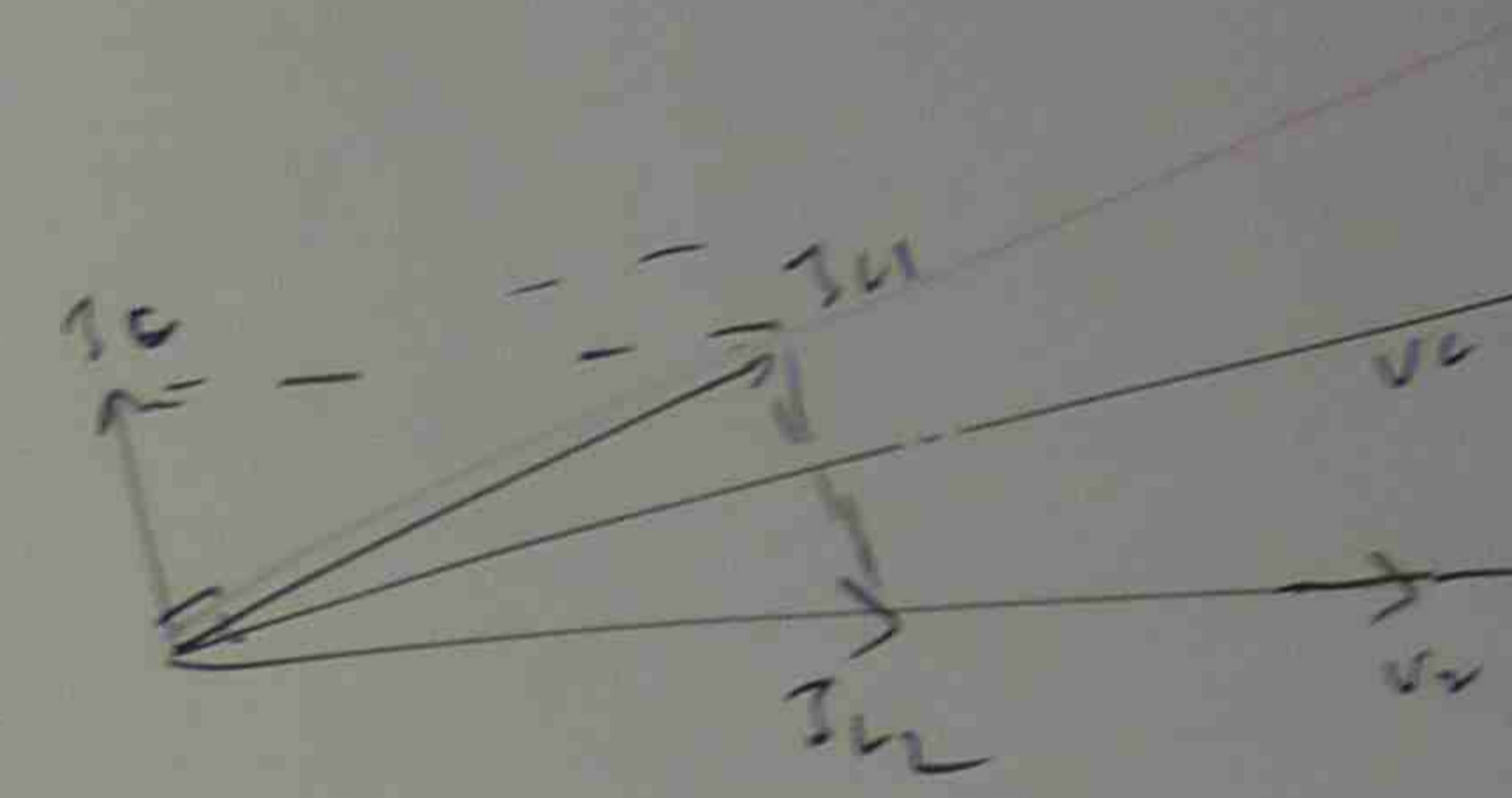
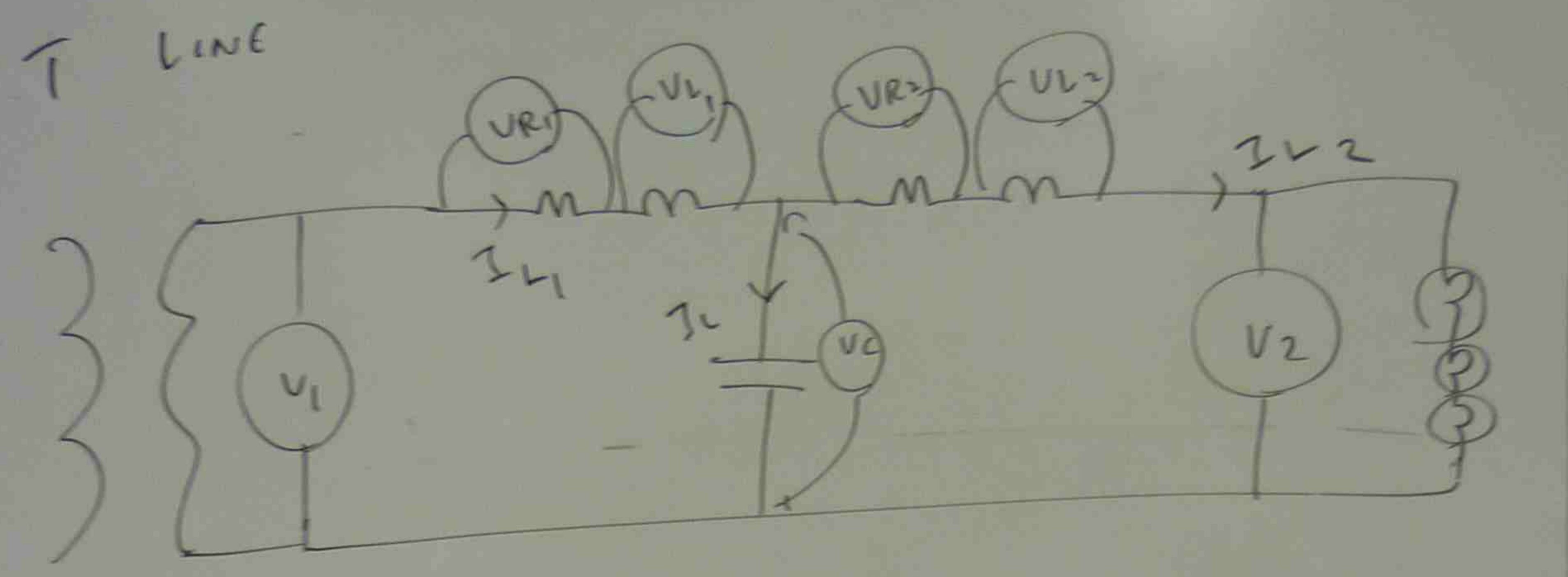


V_1	V_2	V_R	V_L	% REGULATION = $\frac{V_1 - V_2}{V_2} \times 100$



WHICH MODEL GIVE BETTER % VOLTAGE REGULATION?

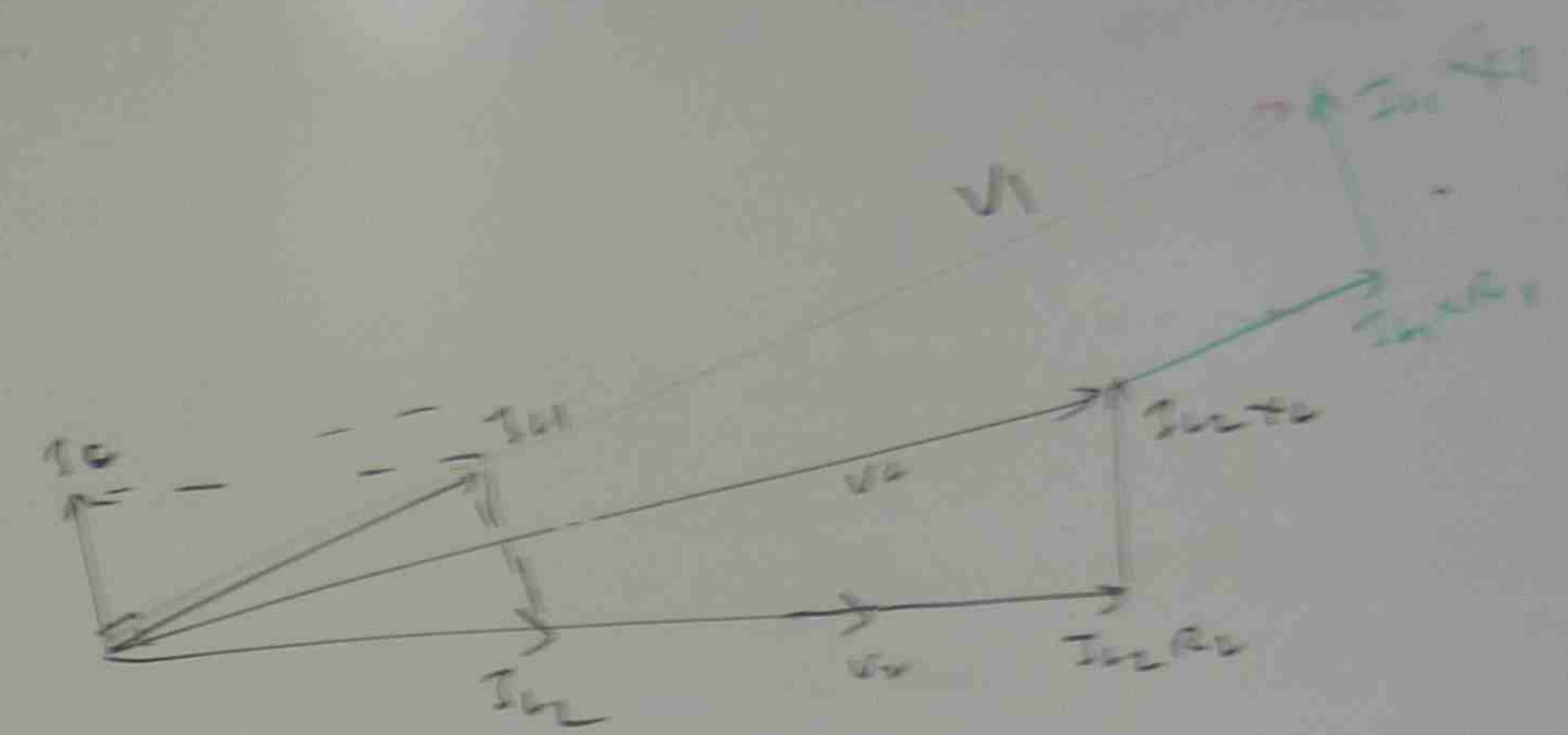
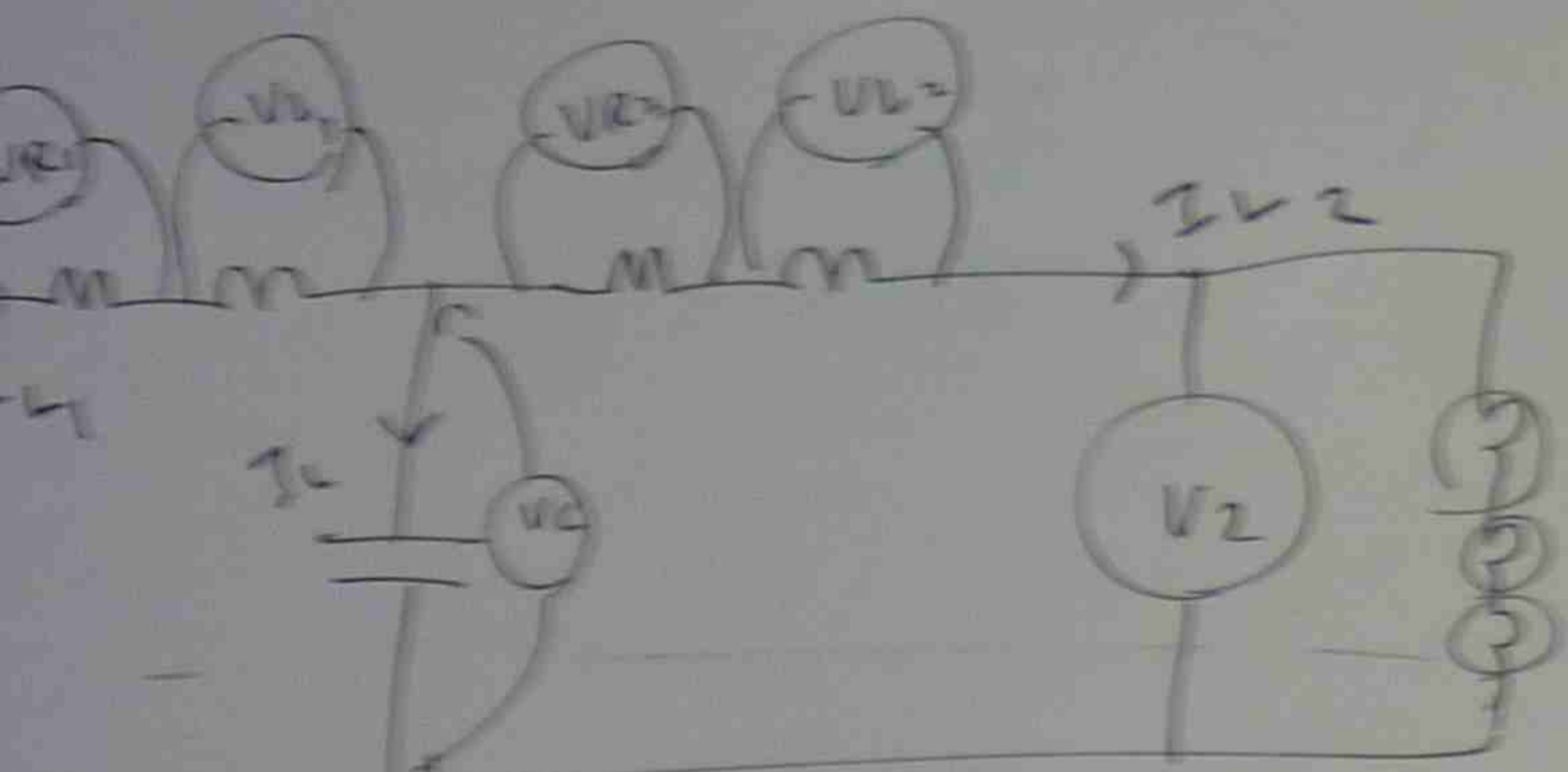
REGULATION = $\frac{V_1 - V_2}{V_2} \times 100$



V_1	V_2	V_{R1}	V_{L1}	V_{R2}	V_{L2}	V_0	$\% \text{REG} = \frac{V_1 - V_2}{V_2} \times 100$

PER % VOLTAGE

AY



DISTANCE PROD



$$Z = \frac{V}{I}$$

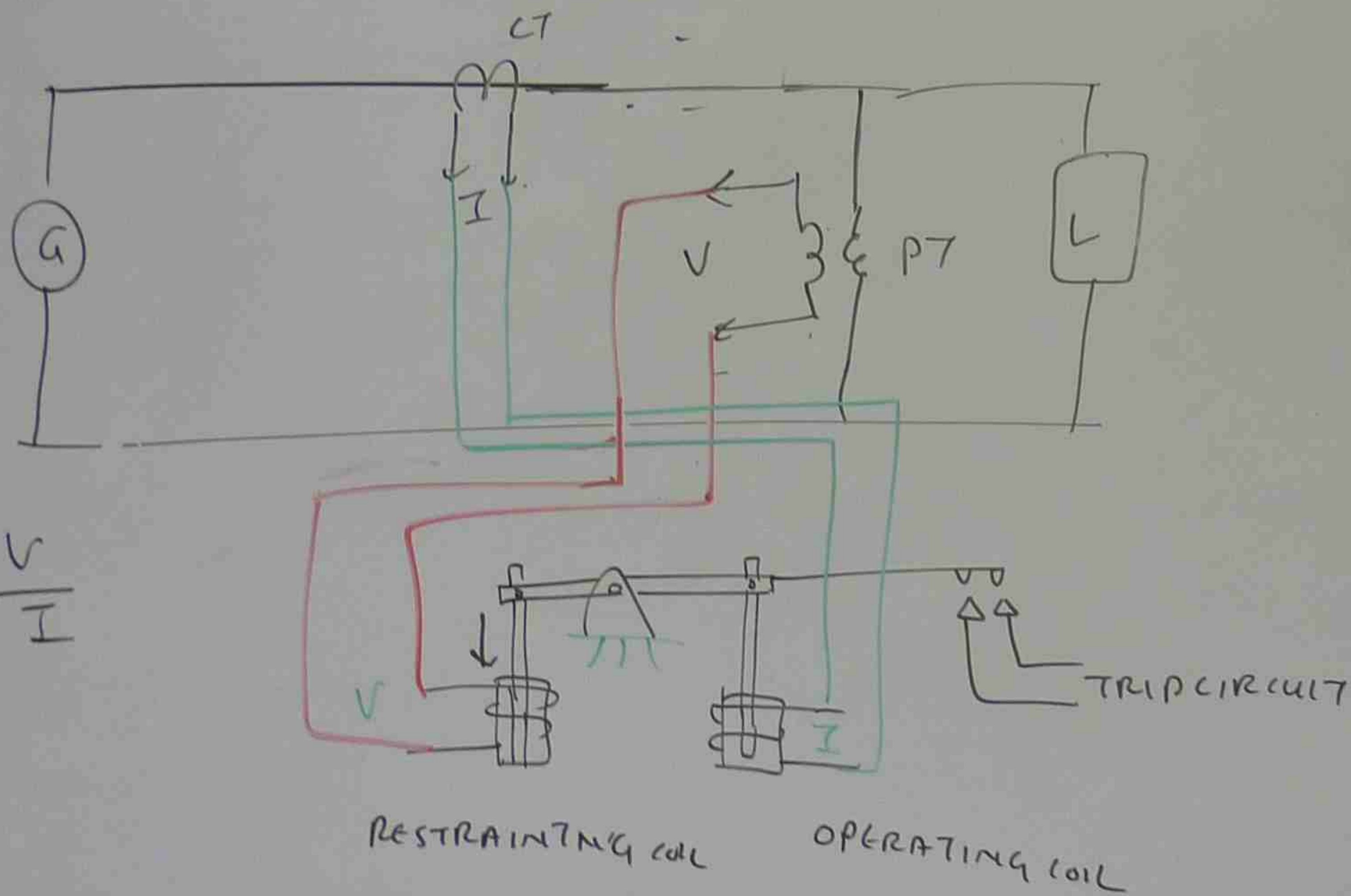
NORMAL V IS
Z IS

$$Z = \frac{V}{I} \Rightarrow Z$$

V_{R2}	V_{L2}	V_0	$\%REG = \frac{V_1 - V_2}{V_2} \times 100$

44

DISTANCE PROTECTION



$$Z = \frac{V}{I}$$

NORMAL

V IS HIGH
I IS LOW

RESTRAINING COIL
MAGNETIZATION

OPERATING COIL
MAGNETIZATION

$$Z = \frac{V}{I} \Rightarrow Z \text{ IS HIGH}$$

RELAY DOES NOT OPERATE.

FAULT

I IS HIGH
V IS LOW

OPERATING COIL
MAGNETIZATION

RESTRAINING COIL
MAGNETIZATION

$$Z = \frac{V}{I}$$

Z IS LOW

RELAY OPERATES

Z VALUE DETERMINES THE RELAY OPERATION

$Z < \text{DISTANCE} \Rightarrow \text{DISTANCE RELAY}$

INDUCTANCE
TOLERANCE
10mH 60mA
10
1 2 3 4 5 6 7 8 9
10
10mH 75mA
1 2 3 4 5 6 7 8 9 10

R4

NORMAL

FAULT

I/P

C1

C2

C3

C4

C5

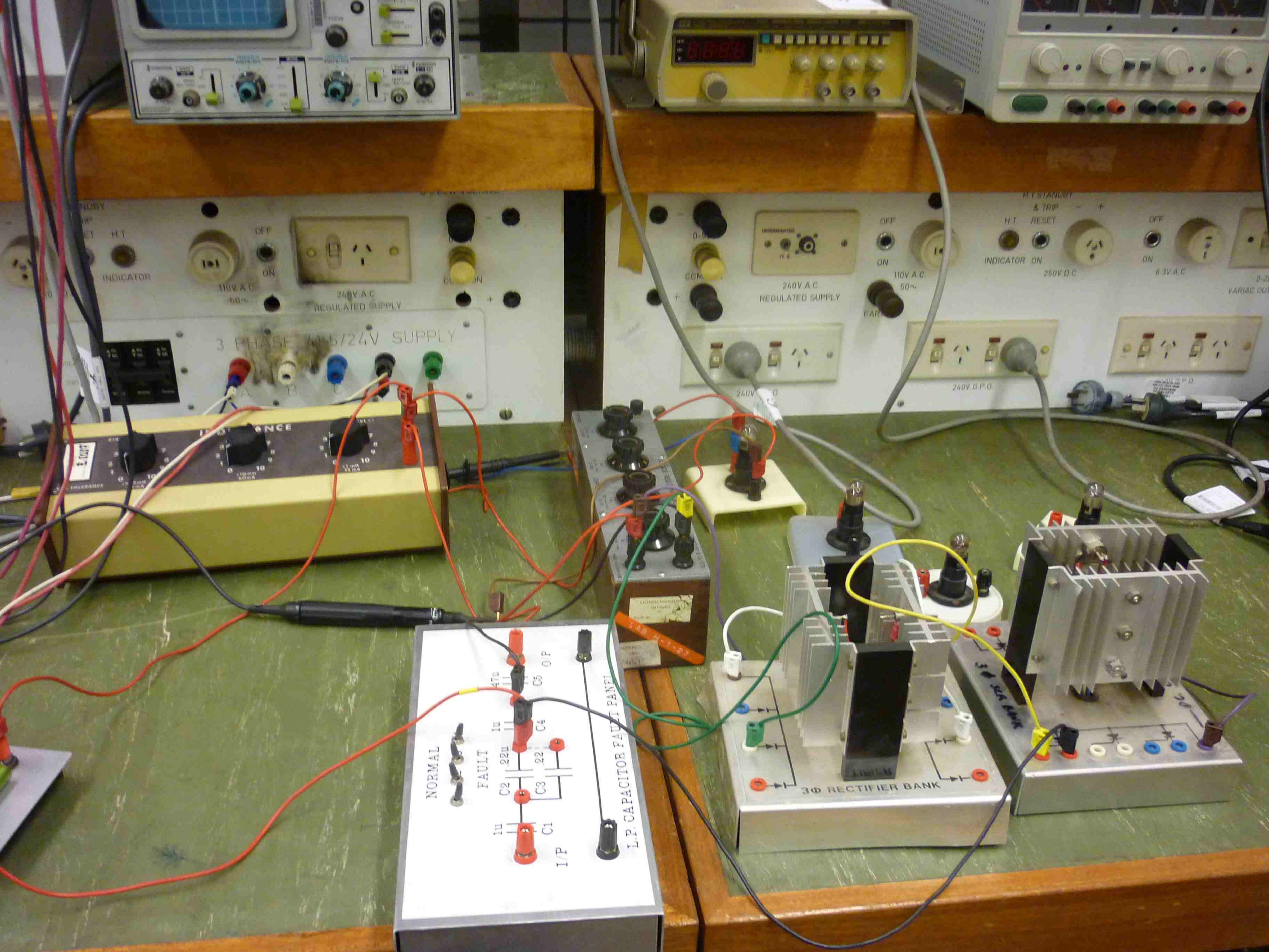
O/P

L.P. CAPACITOR FAULT PANEL

3Φ RECTIFIER BANK

WIDE RESISTANCE BOX

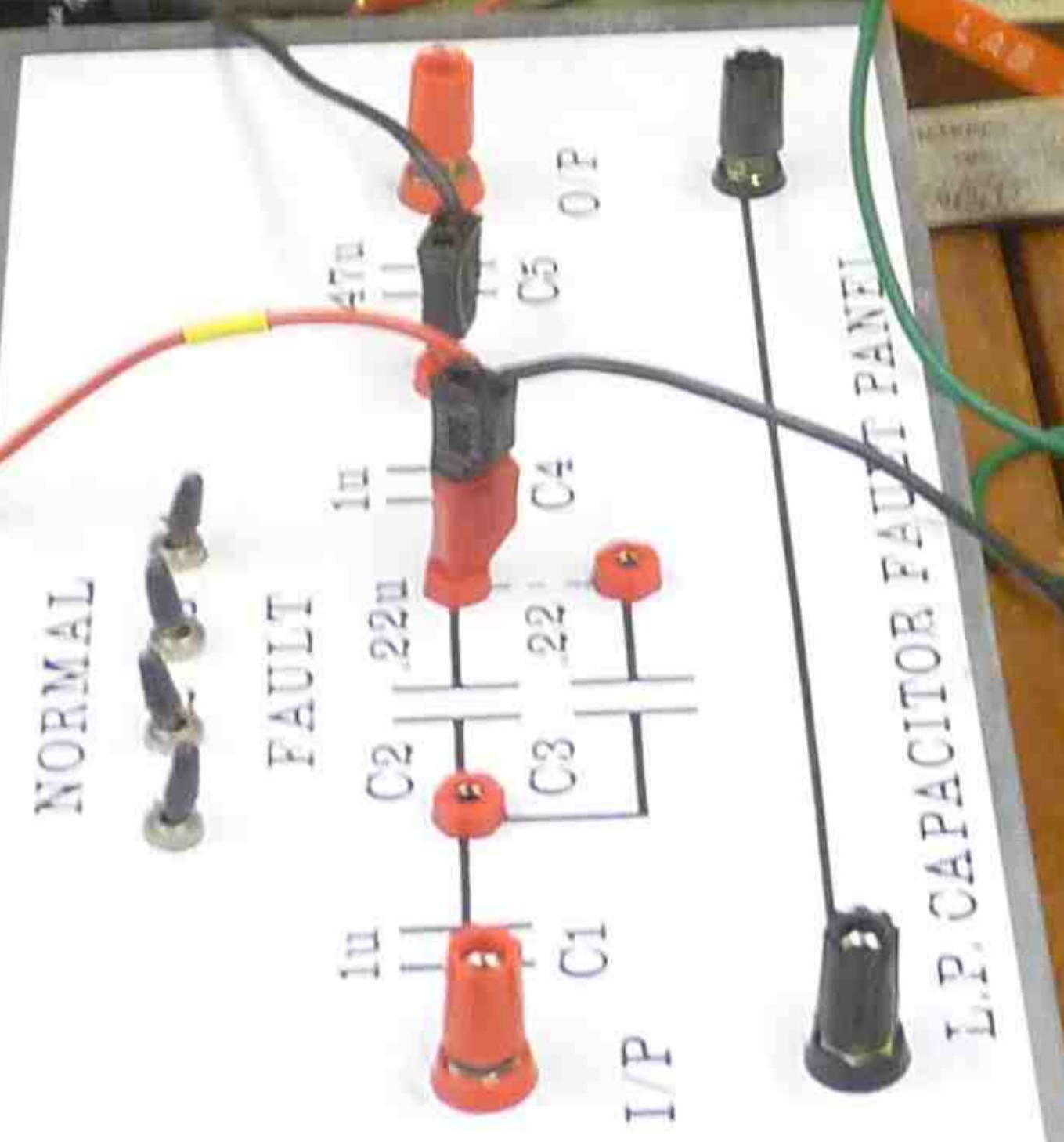
3Φ RECTIFIER BANK



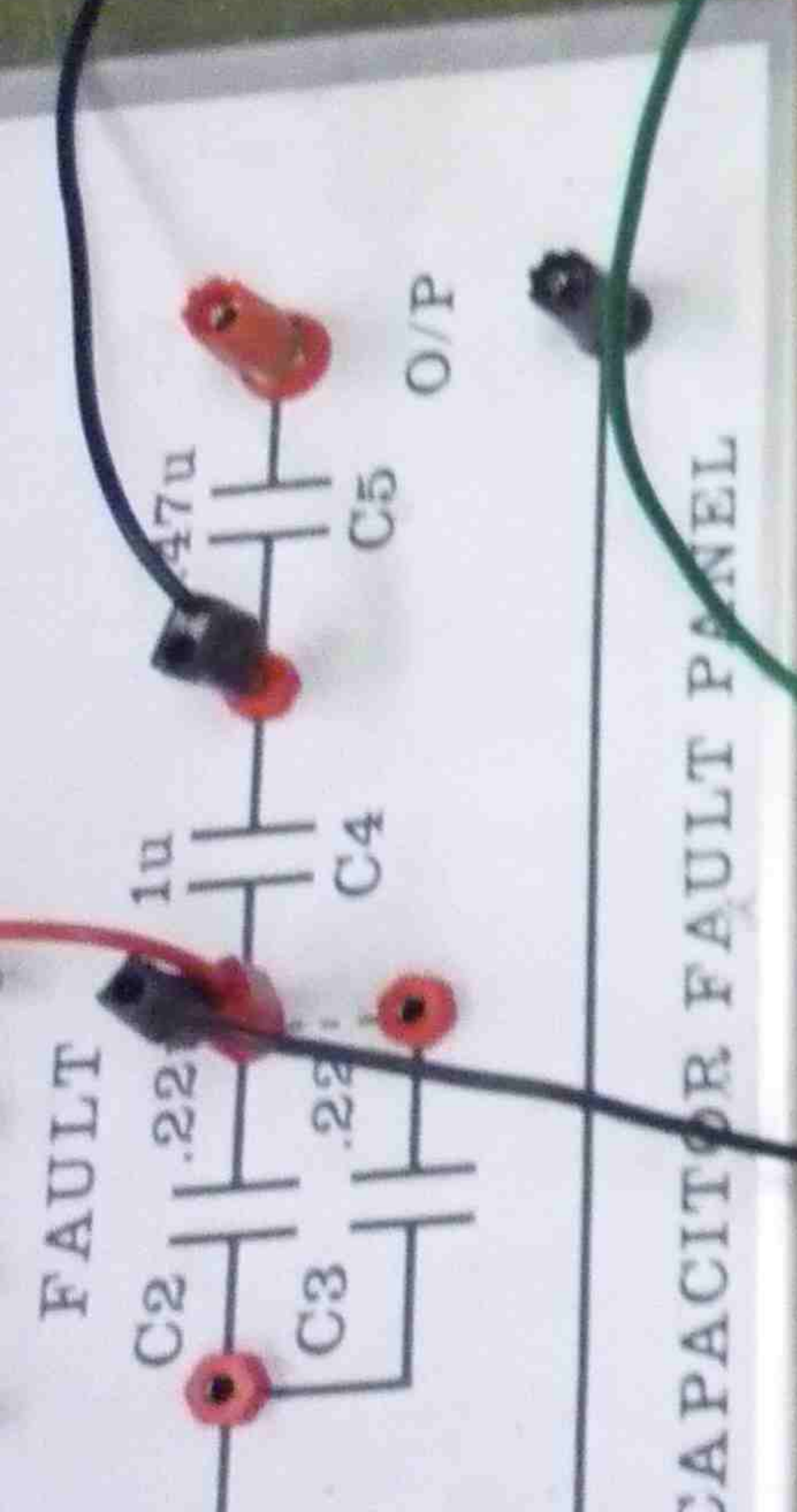
3 PHASE 415/240V SUPPLY

240V A.C. REGULATED SUPPLY

250V D.C. 6.3V A.C.



3Φ RECTIFIER BANK



CAPACITOR FAULT PANEL

A grey PCB with several potentiometers. A label on the board reads "XO8 RESISTANCE BOX".

A 3-phase rectifier bank module. It contains a transformer and three diodes. The label reads "3Φ RECTIFIER BANK".

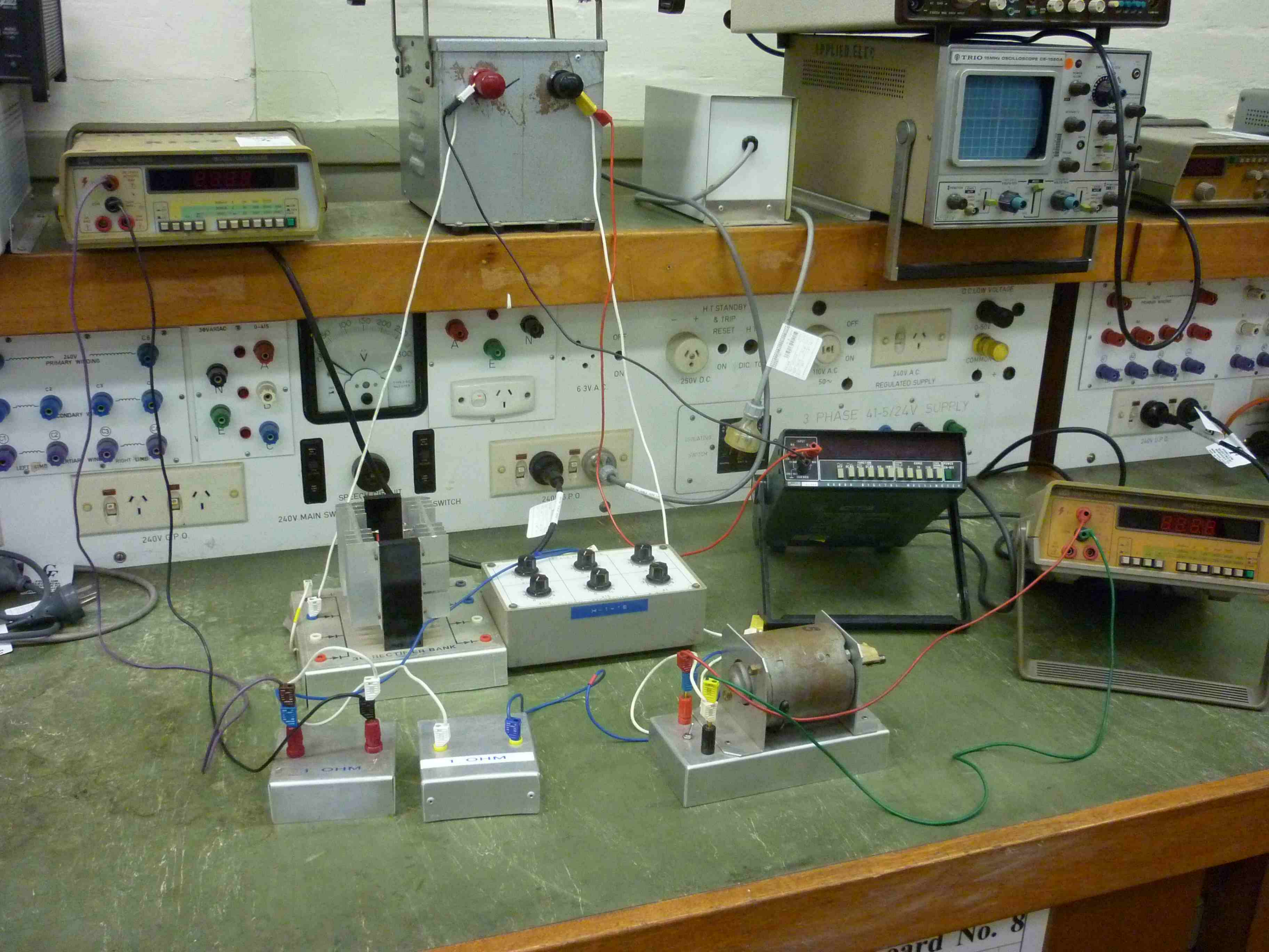
A 3-phase SCR bank module. It contains three thyristors and three diodes. The label reads "3Φ SCR BANK".

A component on a yellow base, featuring a potentiometer and a resistor.

A component on a grey base, featuring a potentiometer.

A component on a white circular base, featuring a potentiometer and two resistors.

A component on a yellow base, featuring a potentiometer and two resistors.



Digital multimeter with a red display showing 0.00. It has several colored input jacks (red, black, green, yellow) and a row of buttons at the bottom.

A grey metal box with two large terminals on top, one red and one black. A white cable is connected to the red terminal, and a yellow and black cable is connected to the black terminal.

A small white rectangular box with a single cable connected to its side.

TRIO 15MHz Oscilloscope CE-150CA. It features a blue screen, various knobs, and input ports. The brand name "TRIO" and model "CE-150CA" are visible.

240V D.C. Regulated Supply. It has multiple output terminals labeled C1, C2, C3, C4, C5, C6, C7, C8 and a voltmeter. The text "240V D.C. REGULATED SUPPLY" is printed on the front.

100V AC Voltmeter. It has a circular scale with markings from 0 to 100 and a needle. The text "100V AC" is visible.

240V A.C. 6.3V A.C. 250V D.C. It has several terminals and a switch. The text "240V A.C.", "6.3V A.C.", and "250V D.C." are visible.

3 PHASE 41-5/24V SUPPLY. It has a large dial and several terminals. The text "3 PHASE 41-5/24V SUPPLY" is printed on the front.

240V A.C. REGULATED SUPPLY. It has a large dial and several terminals. The text "240V A.C. REGULATED SUPPLY" is printed on the front.

240V A.C. REGULATED SUPPLY. It has several terminals and a dial. The text "240V A.C. REGULATED SUPPLY" is printed on the front.

3 PHASE RECTIFIER BANK. It has several terminals and a switch. The text "3 PHASE RECTIFIER BANK" is printed on the front.

1000 OHM Resistor. It has several terminals and a dial. The text "1000 OHM" is printed on the front.

1000 OHM Resistor. It has several terminals and a dial. The text "1000 OHM" is printed on the front.

1000 OHM Resistor. It has several terminals and a dial. The text "1000 OHM" is printed on the front.

Motor on a stand. It has several terminals and a dial. The text "1000 OHM" is printed on the front.

Digital multimeter with a red display showing 88.88. It has several colored input jacks and a row of buttons at the bottom.

Card No. 8

3 ϕ RECTIFIER BANK

DECADE RESISTANCE

x100K x10K x1K

x100 x10 x1

ELECTRICAL ENGINEERING

INPUT MA V- Ω

20V MAX 1200V

FUNCTION ACV AC MA DCV DC MA KI ZOM Ω

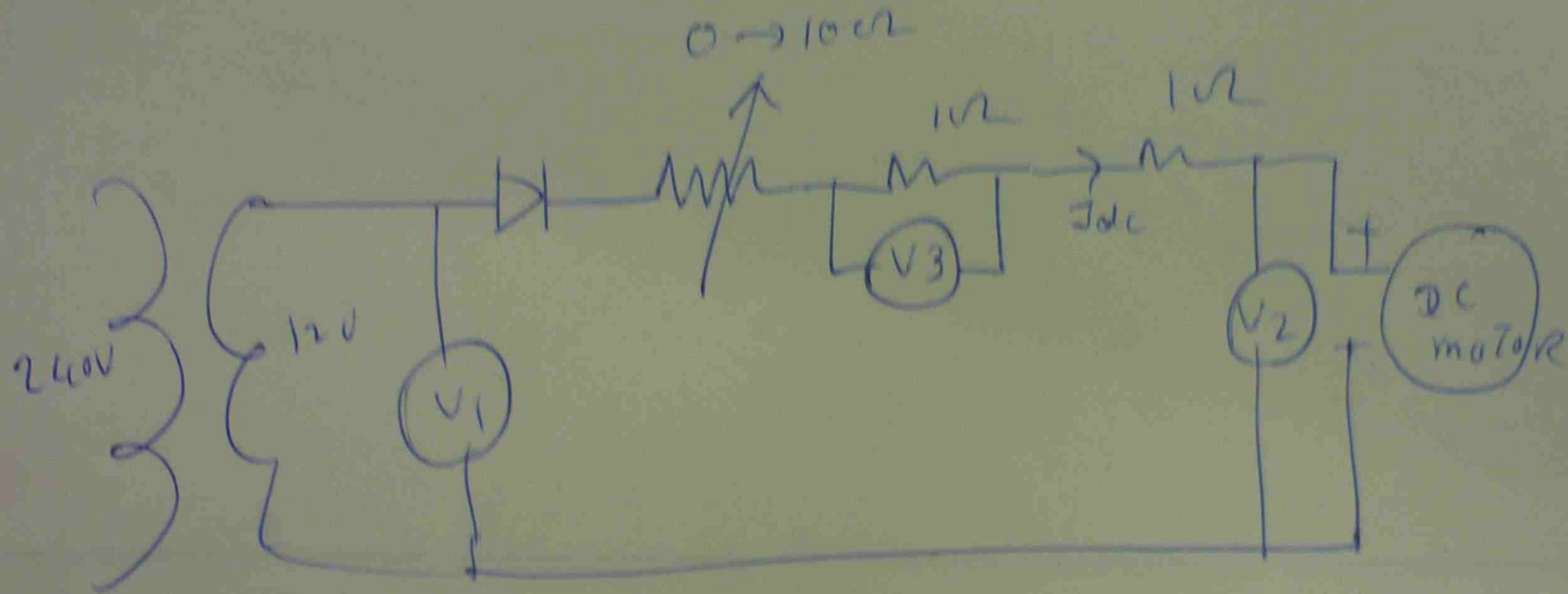
RANGE 2000A DIGITAL MULTIMETER

1 OHM

1 OHM

3

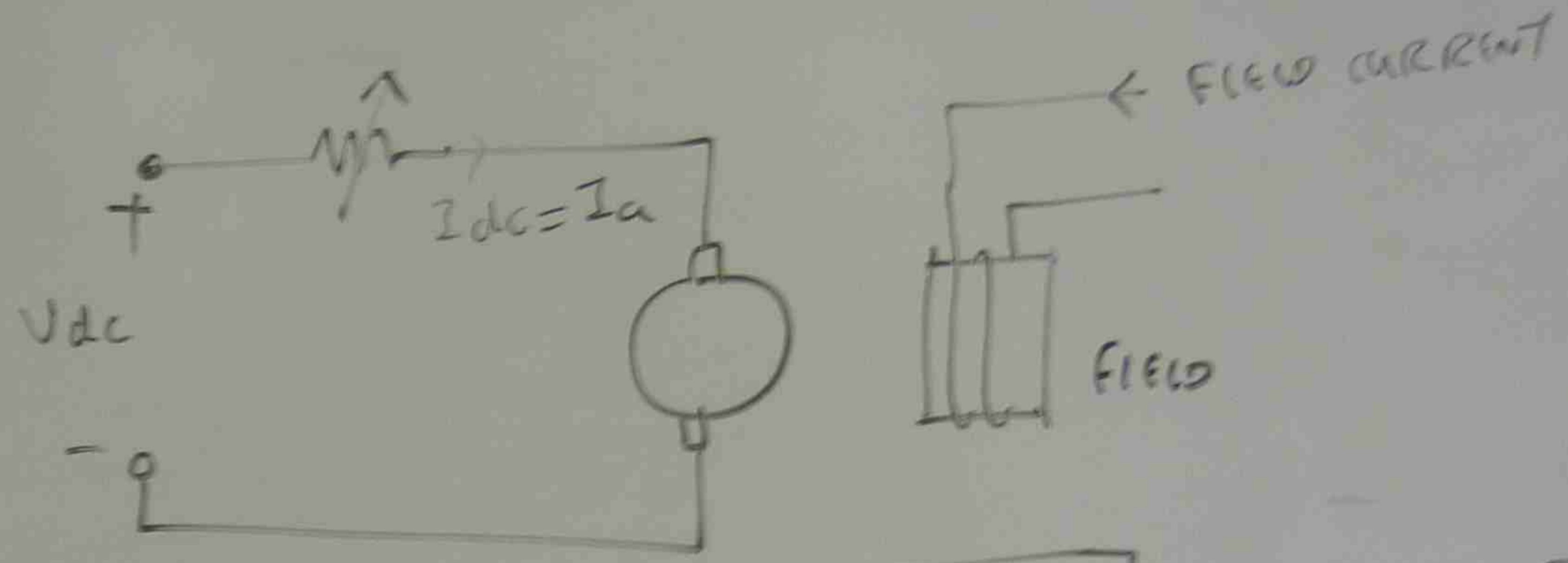
Variable dc drive with Rectifier.



$$I_{dc} = \frac{V_3}{1\Omega}$$

Resistor	V1	V2	V3	I_{dc}	OR speed

VARIABLE DC DRIVE WITH RECTIFIER



FIELD CURRENT & FIELD FLUX (ϕ) \propto SPEED

$$T = \frac{\phi Z I_a}{2\pi a}$$

$$E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$$

E_g = VOLTAGE

Z = CONDUCTOR

P = NO. OF POLES

T = TORQUE

ϕ = FLUX

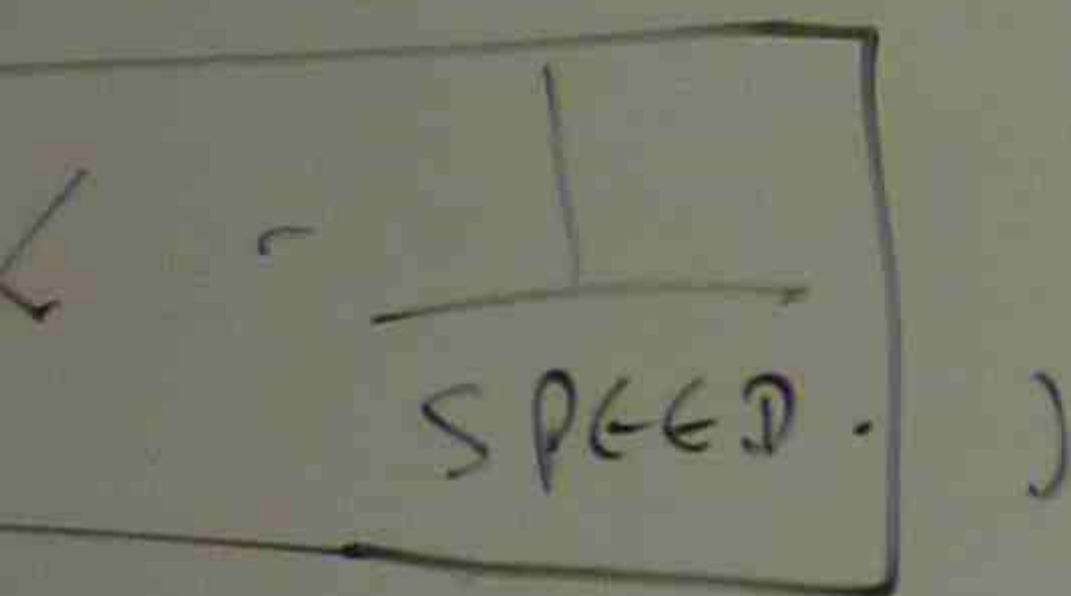
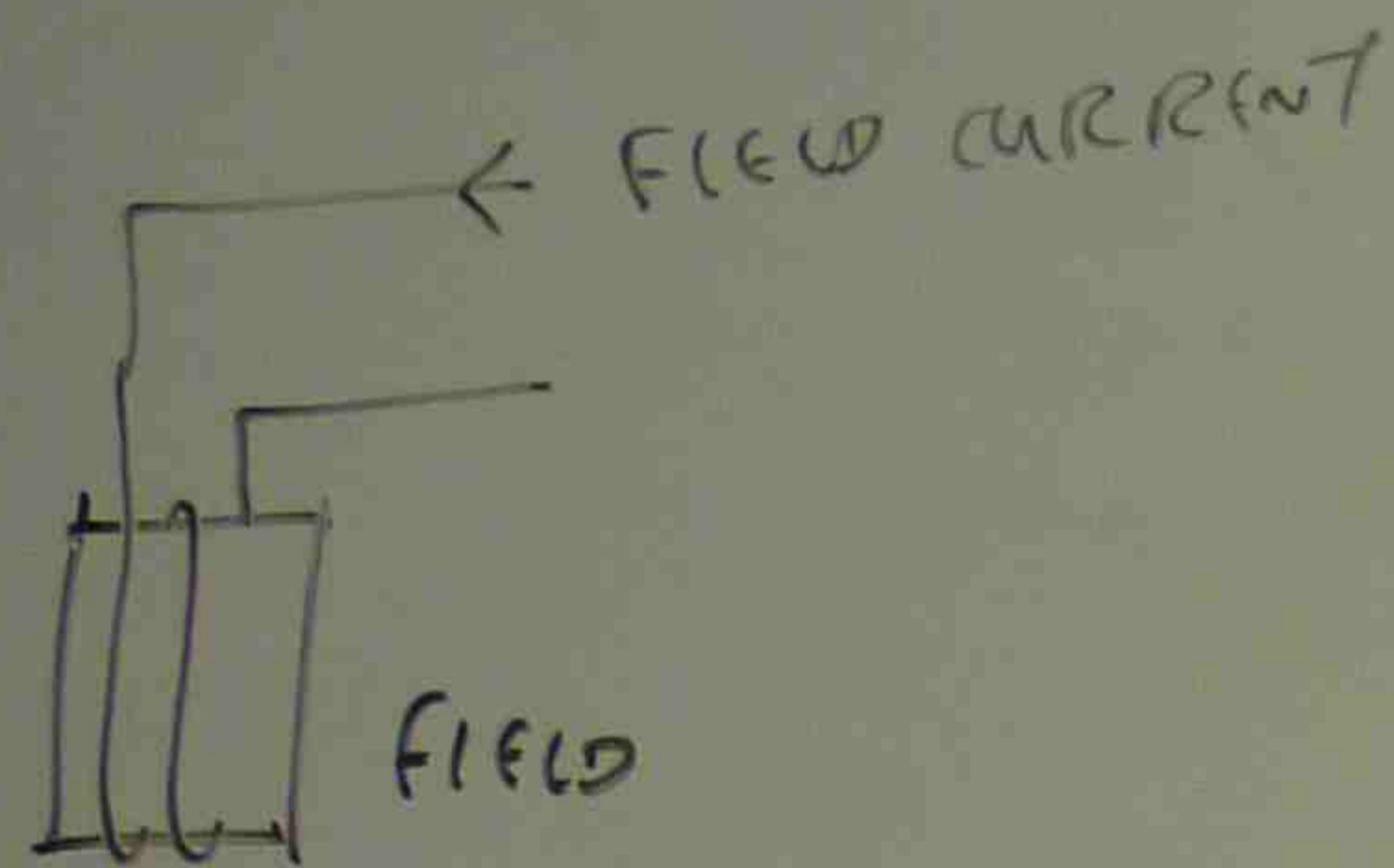
N = SPEED

a = NO. OF ARMATURE PARALLEL PATHS

I_a = ARMATURE

$I_a \propto$
 BY INCREASING
 FLUX CAN
 CASE BE

DRIVE WITH RECTIFIER



$$T = \frac{\phi Z I_a}{2\pi a}$$

$$I_a \propto \frac{1}{\phi} \propto N$$

By increasing armature current,
flux can be lowered and speed
can be higher

T = Torque

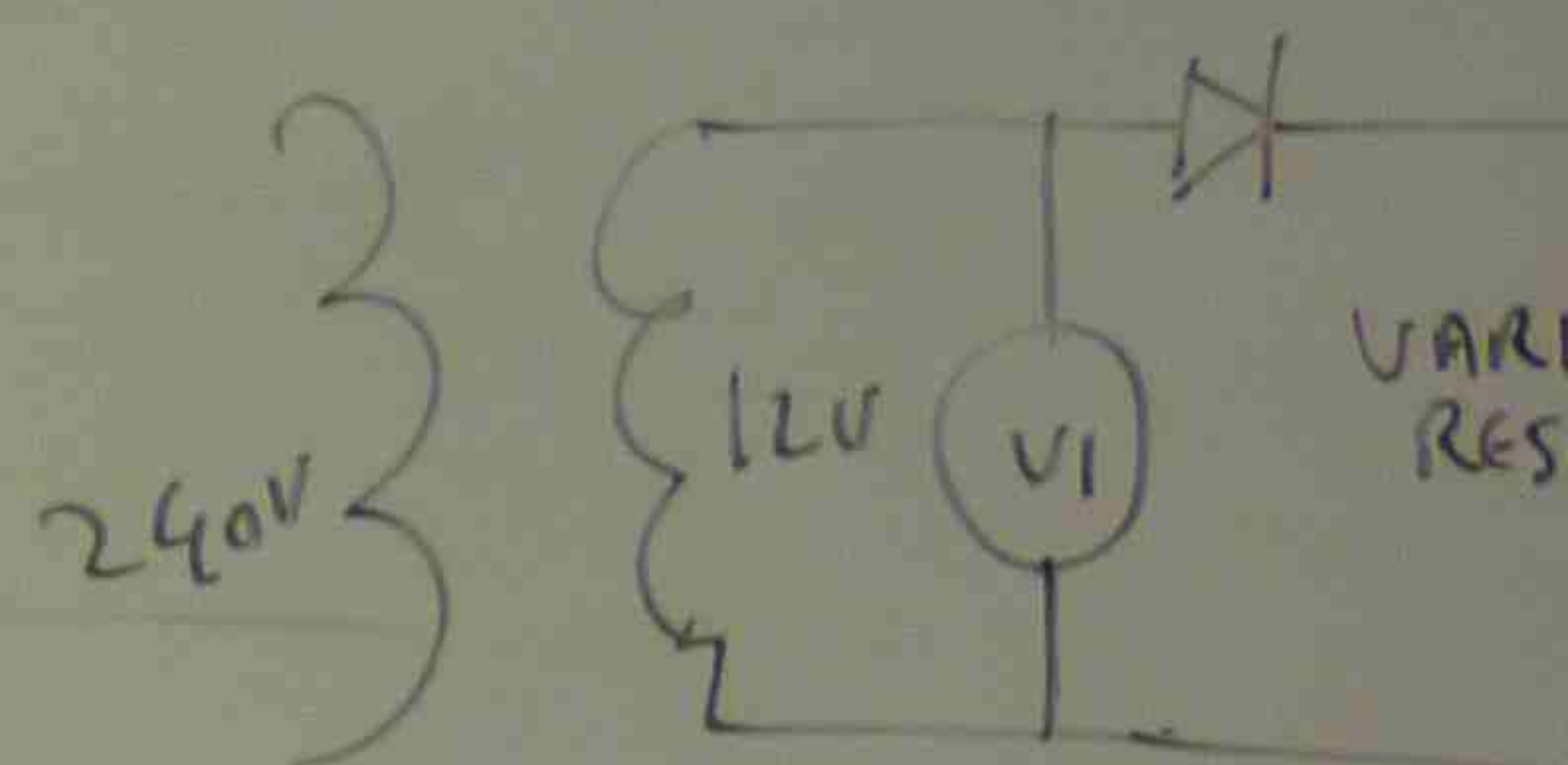
I_a = Armature current.

P = No. of poles

a = No. of
armature
parallel paths.

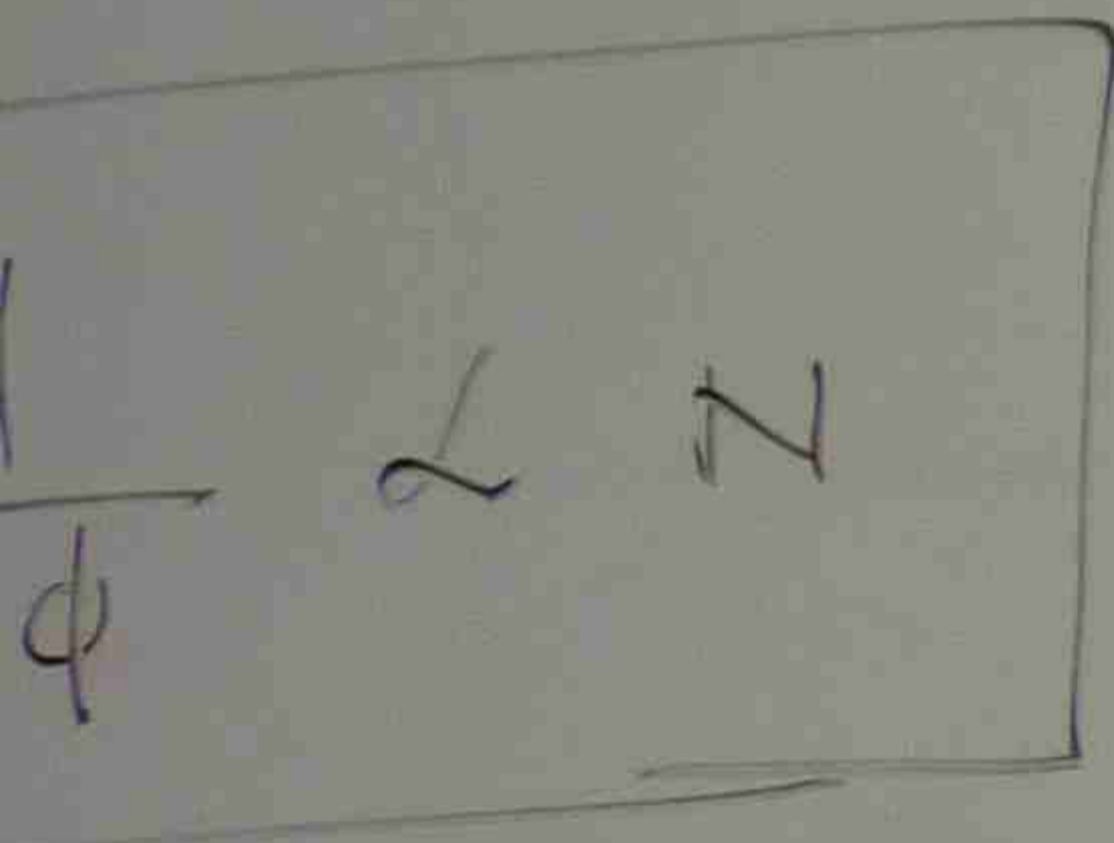
PROCEDURE

— CONNECT THE GIVEN



$I_{dc} =$

VARIABLE RESISTOR	V_1	V_2

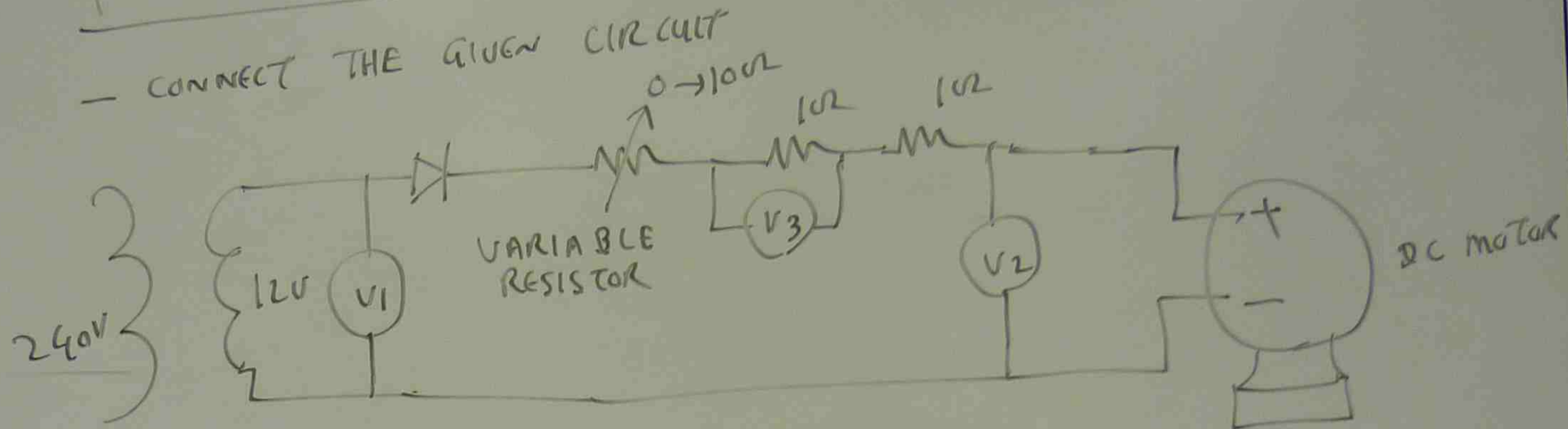


ARMATURE CURRENT,
LOWERED AND SPEED
HIGHER

CURRENT.

PROCEDURE

- CONNECT THE GIVEN CIRCUIT



$$I_{dc} = \frac{V_3}{10\Omega}$$

VARIABLE RESISTOR	V ₁	V ₂	V ₃	$I_{dc} = \frac{V_3}{10\Omega}$	OBSERVATION OF SPEED