ELECTRONICS

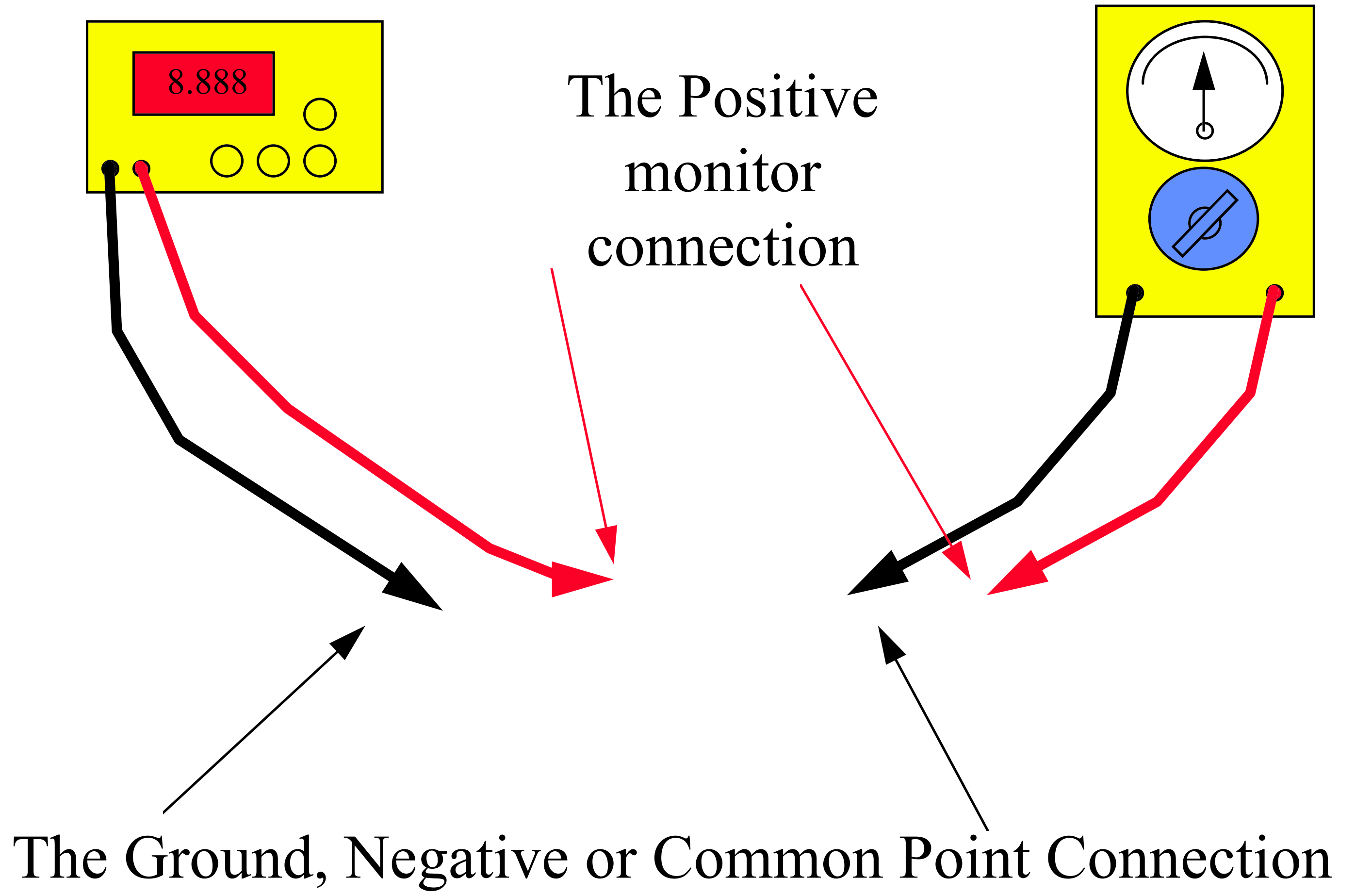
Practical

Experiment 1.

The Test Equipment.

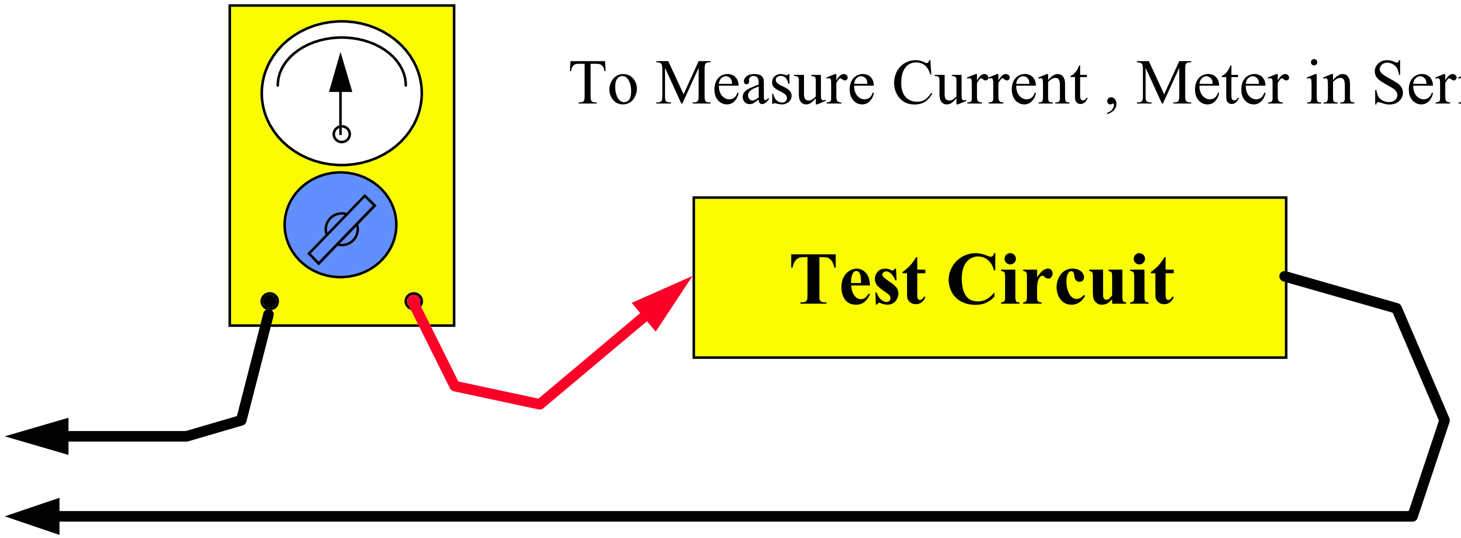
Digital Meter

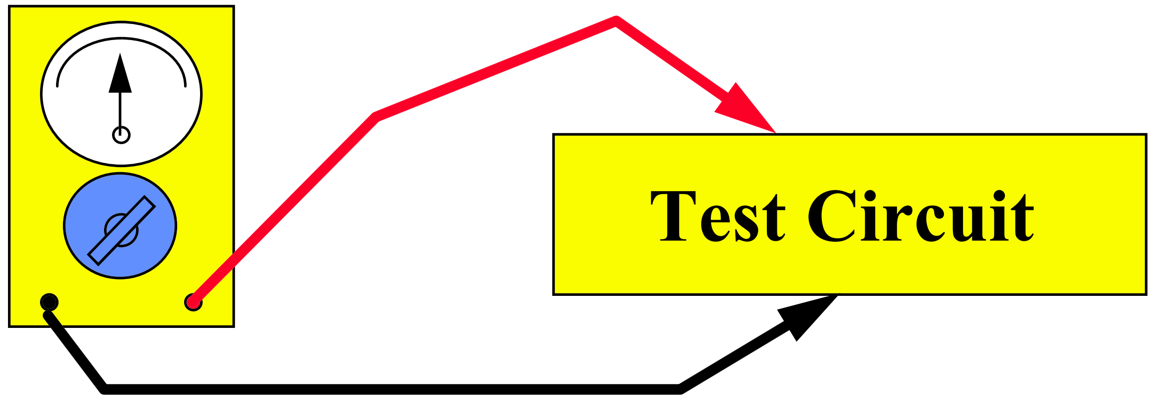
Analogue Meter



The Test Equipment.

To Measure Current , Meter in Series





To Measure Voltage , Meter in Parallel

The Test Equipment.

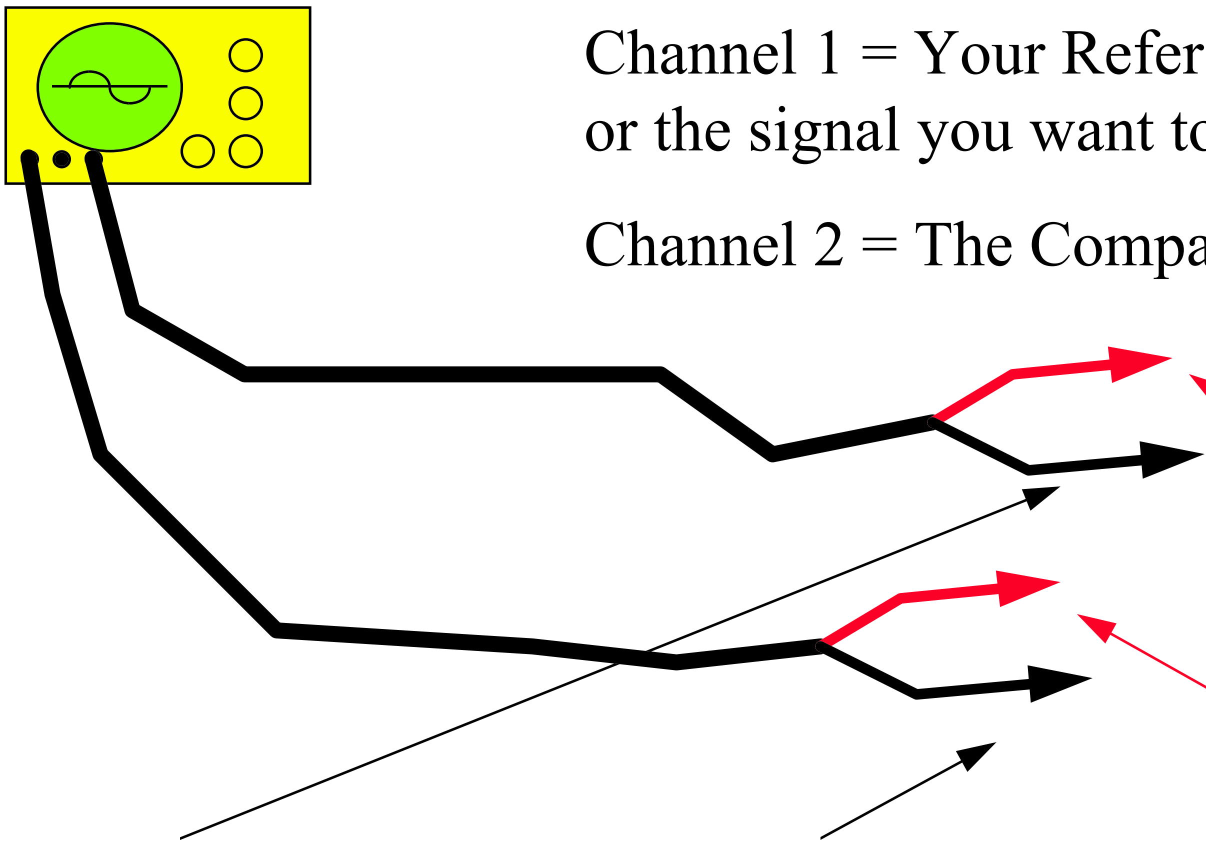
- Measuring an Unknown Current or Voltage **Set** meter to maximum value first. Then reduce settings until you get a valid reading.
- Current measurement in Series.
- Voltage measurement are in parallel with circuit/component.
- Always Check - AC setting for AC readings and DC settings for DC readings.

The Test Equipment.

The Oscilloscope

Channel 1 = Your Reference Signal or the signal you want to measure.

Channel 2 = The Compare Signal.



The Test Equipment.

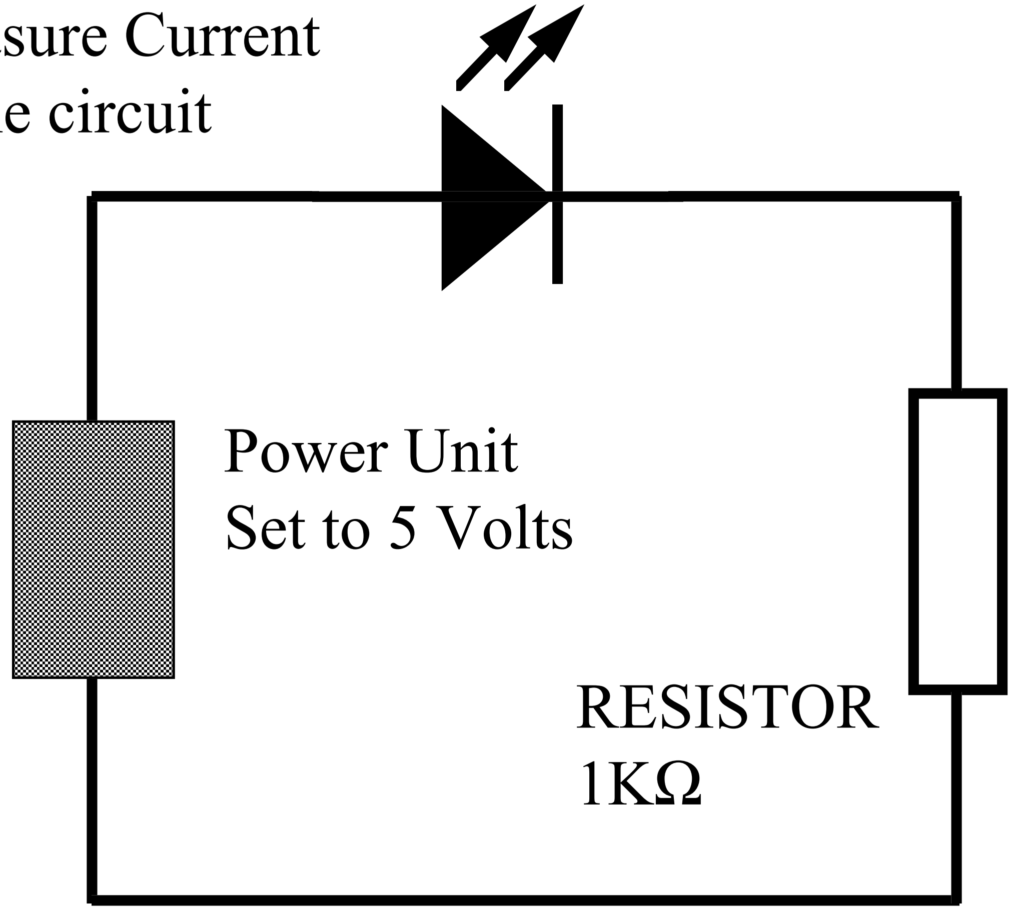
- The Cathode Ray Oscilloscope (CRO pronounced “crow”).
- Measures Voltage with respect to Time.
- The Timebase set the speed that the beams moves across the screen (One Screen unit per unit of time {the period})
- The trigger control help set a stable display.
- Voltage is measured by using the vertical amplifier settings so many screen units/Volt.

LED and Resistors.

- Build “Circuit 1”. Did LED light up ?
- What happens when LED is reversed ?
- What differences and problems did you notice when measuring voltages using the Analogue meter, Digital Meter, and the Cathode Ray Oscilloscope
  (CRO pronounced “crow”).
- How did you measure the current in the circuit. (Draw a diagram)

LED and Resistors.

Measure Current
in the circuit



Measure Voltage across every component in circuit.

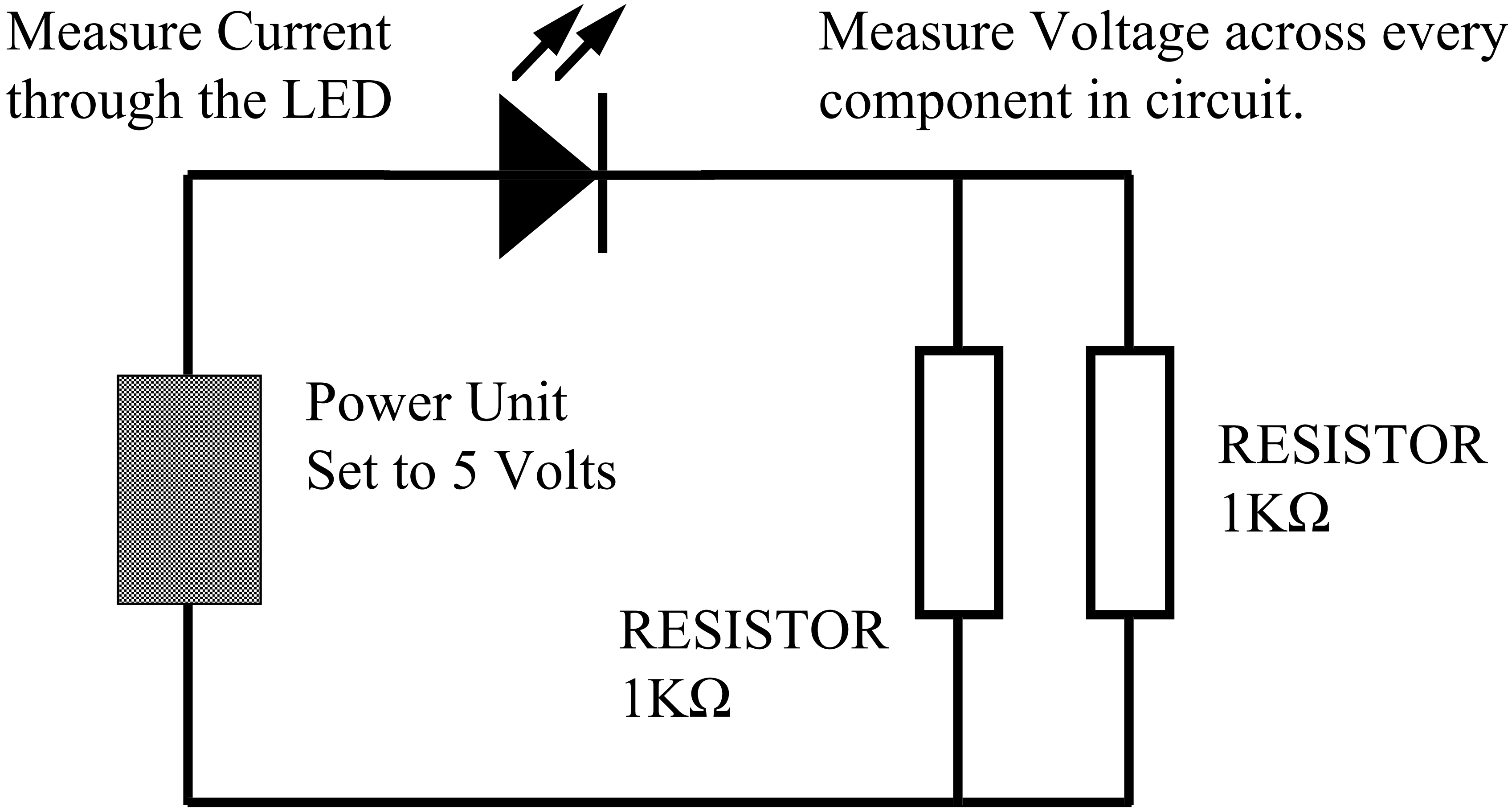
Mark Polarity of voltages around circuit when LED is lit up

Circuit 1

LED and Resistors.

- Modify your board to “Circuit 2”.
- What happened to LED brightness ?
- Record the Voltages around the circuit.
- Record the current used by the circuit.

LED and Resistors.

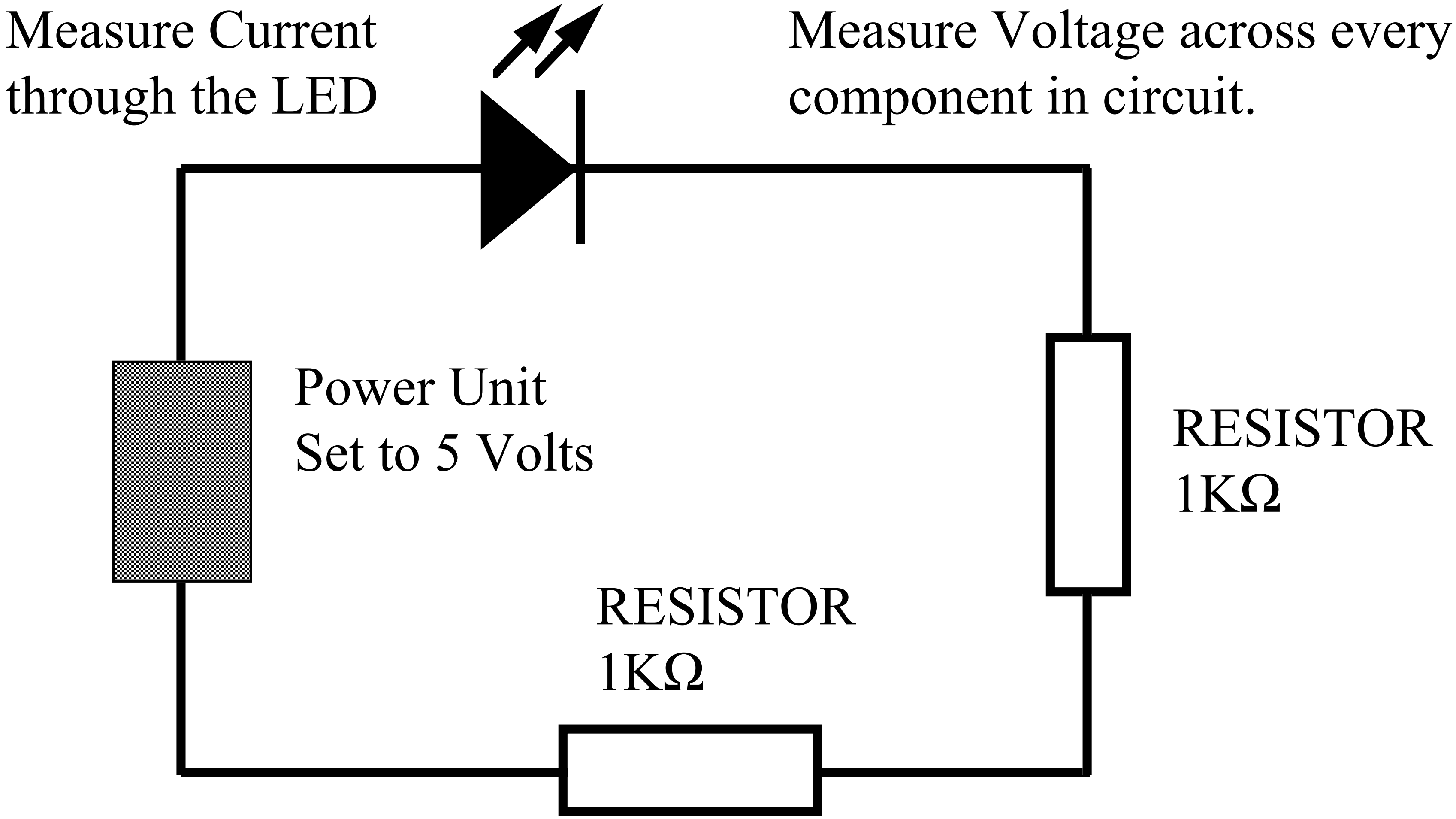


Circuit 2

LED and Resistors.

- Modify your board to “Circuit 3”.
- What happened to LED brightness ?
- Record the Voltages around the circuit.
- Record the current used by the circuit.

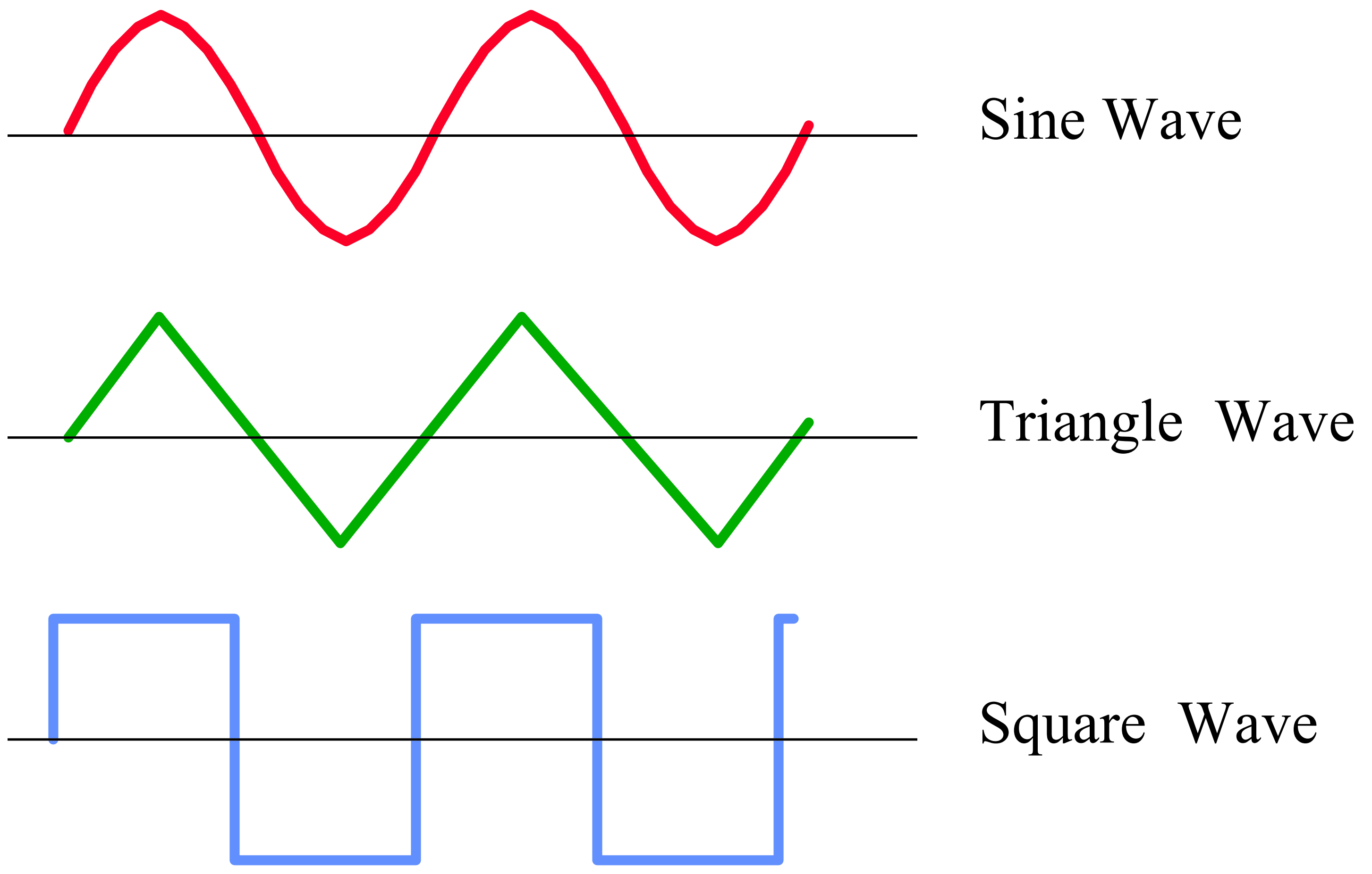
LED and Resistors.



Circuit 3

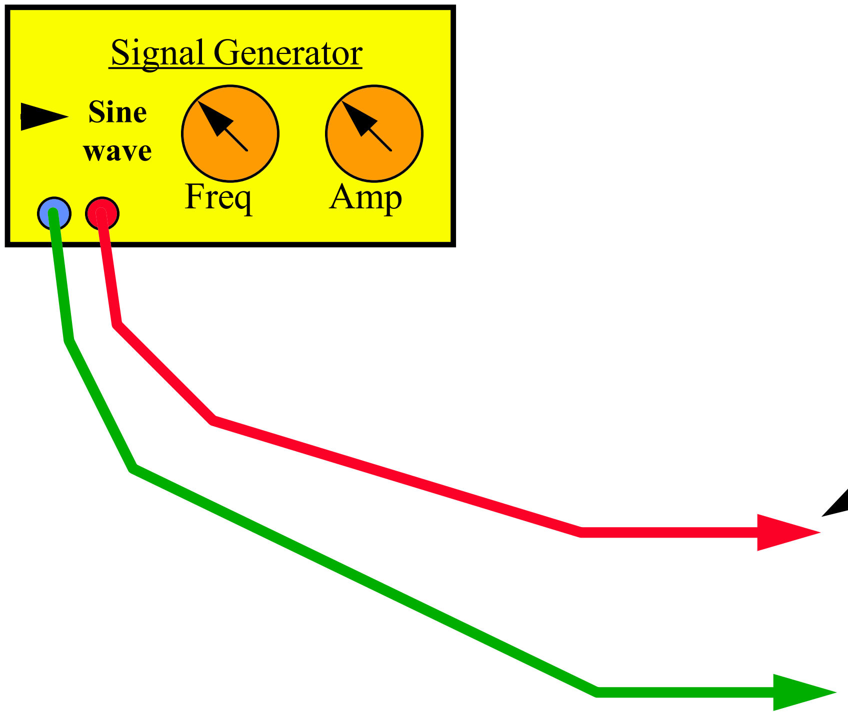
Experiment 2.

The Test Equipment.



Typical Signal Generator Waveshapes.

The Test Equipment.



The Signal Generator Output connection.

The Ground or Common Point Connection.

The Test Equipment.

- The Signal Generator.
- Used to produce various waveshapes
  Sine, Square and Triangle waves .
- Frequency of waveshapes can be adjusted from Hz to KHz.
- Amplitude (height of signal) can be adjusted. The attenuator is used to extend the range of the amplitude adjustment.

Frequency and Amplitude.

- Amplitude (Measure height of Signal).
- Frequency, Period Conversion.
- Period measure time units between two repeating points of a waveform.

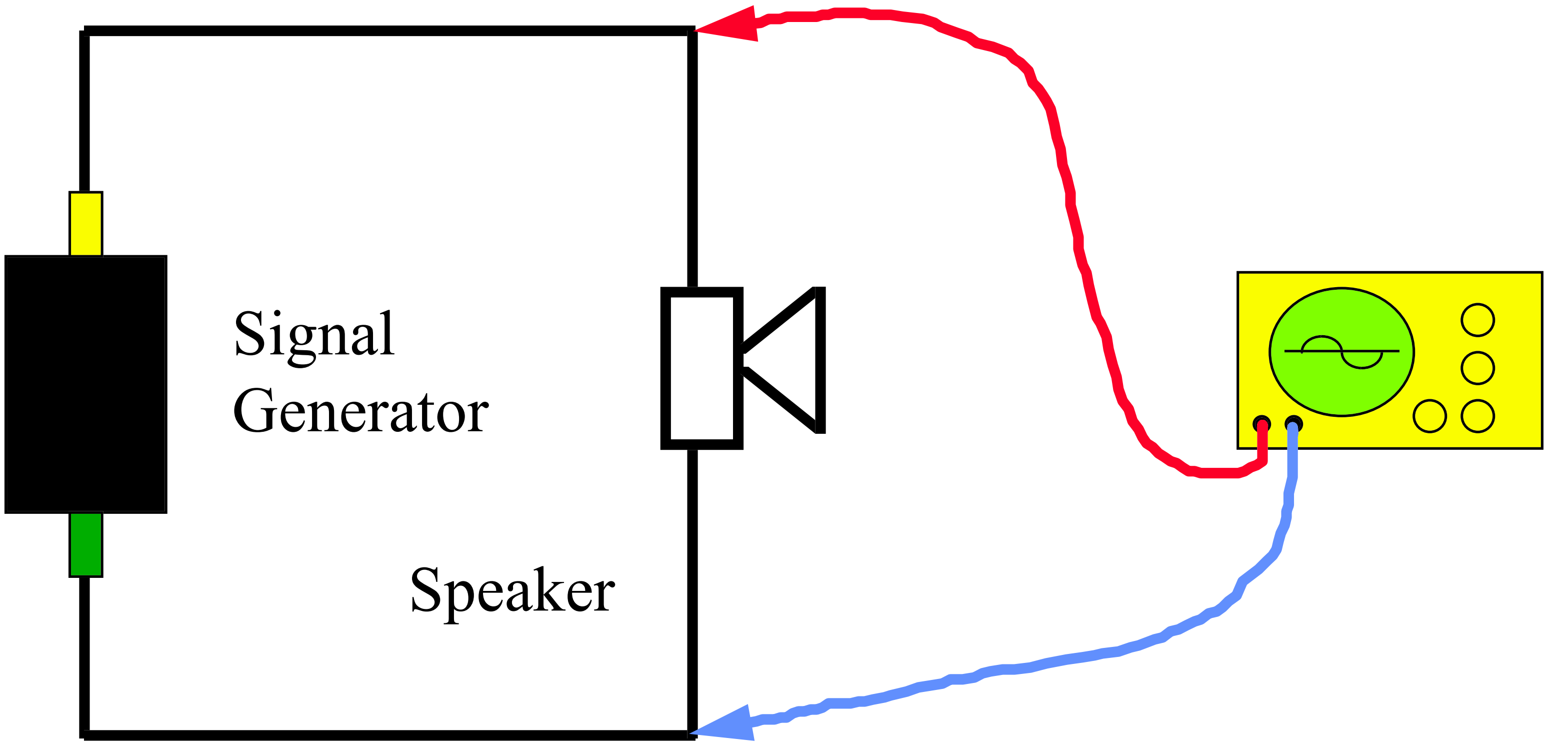
$$\text{Frequency} = \frac{1}{\text{Period}}$$

or

$$\text{Period} = \frac{1}{\text{Frequency}}$$

Frequency and Amplitude.

Set Signal generator to Sine wave with a frequency to 1000Hz and amplitude to 200mV



Circuit 1

Frequency and Amplitude.

- Build “Circuit 1”.
- With initial setting sketch CRO display.
- Increase Amplitude what is the effect on volume ?
- What is the lowest level of amplitude you can hear ?
- If you double the amplitude does volume double ?

Frequency and Amplitude.

- Adjust amplitude to comfortable level.
- Set frequency to 100Hz keeping amplitude the constant. What effect is noticed ?
- Set frequency to 10KHz keeping amplitude the constant. What effect is noticed ?
- What is lowest frequency you can hear.
- What is highest frequency you can hear.
- Change wave shape. What effect did this have ?

Frequency and Amplitude.

- On one or more diagrams.
- Mark where peak voltages occur.
- Mark where zero crossing occurs.
- Measure a Peak Voltage.
- Measure a Peak to Peak Voltage.
- Measure waveshape period.
- Relate waveshape period to frequency.
- Calculate an RMS and Average voltage from a peak value.

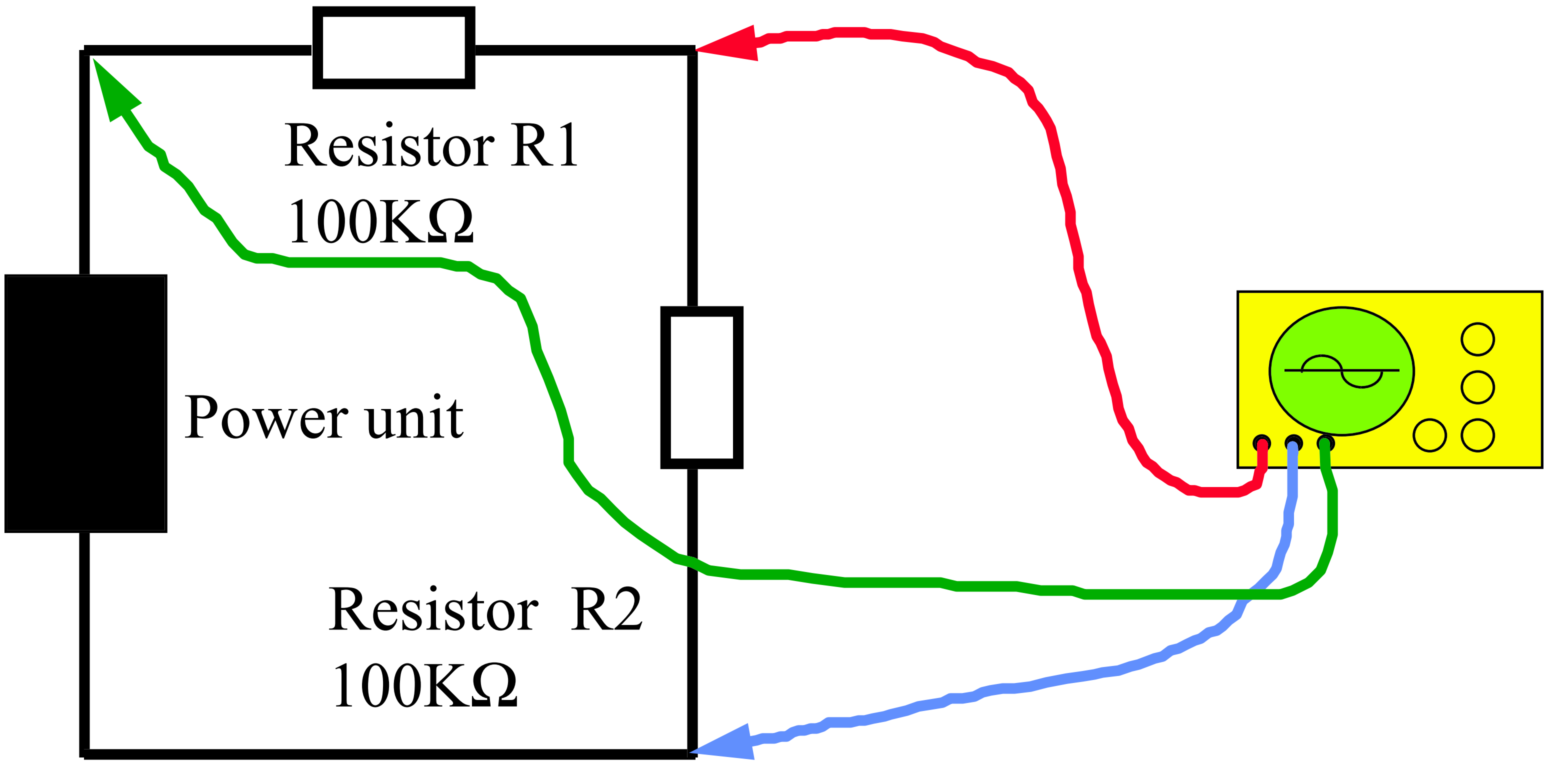
Experiment 3.

Voltage dividers 1.

- Build “Circuit 1”.
- Measure and record voltages across R1 & R2 with CRO then confirm readings using Digital meter then Analogue meter.
- Are readings consistent ?
- Change R1 & R2 to 1KΩ
- Repeat measurements and record voltages using CRO, Digital and Analogue meters.
- Are readings consistent ? (Explain)

Voltage dividers 1.

Set Power unit to 5V



Circuit 1

Voltage dividers 1.

- Calculate expected voltages and compare with actual readings.
- Change R1 to 10KΩ
- Calculate expected voltages and compare with actual DVM readings.
- Change R1 to 1KΩ and R2 to 10KΩ .
- Calculate expected voltages and compare with actual DVM readings.

Voltage dividers 1.

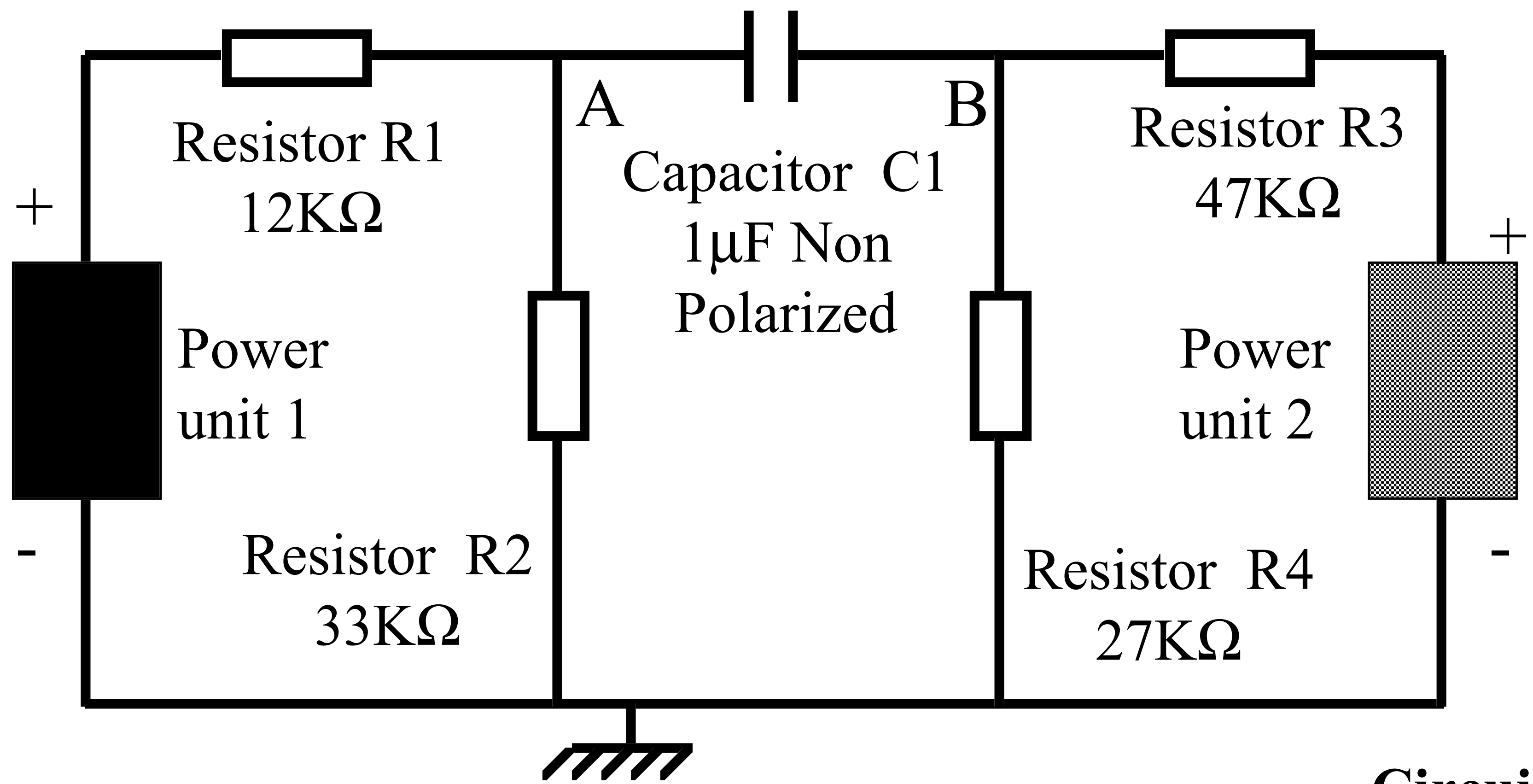
- Calculation method :-
  - RT = Resistance Total, Rn = Resistor ‘n’
  - V= Volts, I = current.

1. Calculate total circuit resistance (RT).
2. Calculate current flowing in RT. {V/RT}
3. Calculate voltage across Rn. {I*Rn}

Experiment 4.

Capacitors and Resistors.

Set Both Power Units to 5V



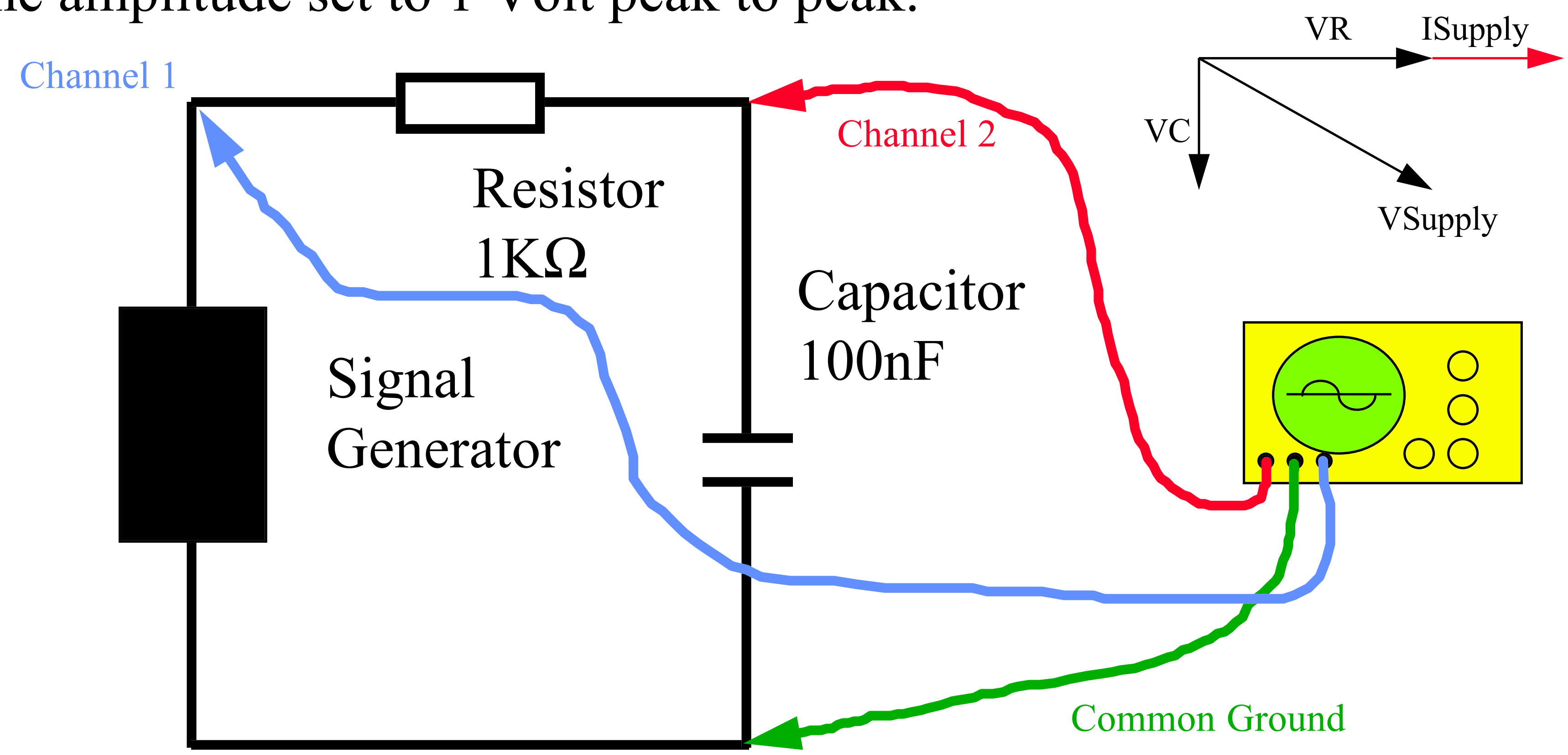
Circuit 1

Capacitors and Resistors.

- Build “Circuit 1”.
- Measure Voltage across all resistors using a DVM (Digital Volt Meter).
- Calculated expected voltages at points ‘A’ and ‘B’.
- Conclusion.
- Do Voltages agree with your calculations?
- Did capacitor effect the DC levels?

Capacitors and Resistors.

Set Signal generator to Sine wave with a frequency of 1000Hz and the amplitude set to 1 Volt peak to peak.



Circuit 2

Capacitors and Resistors.

- Build "Circuit 2".
- With initial setting sketch the CRO display.
- Increase frequency to 10KHz what is the effect on the voltage across the resistor ?
- Decrease frequency to 100Hz what is the effect on the voltage across the resistor ?
- Sketch the changes for all settings.

Capacitors and Resistors.

- Calculate value of Capacitor using the measurements taken with 1KHz Signal.
  - Calculate Voltage across resistor:-
    - VResistor = $\sqrt{Vsource^2 - VCapacitor^2}$.
  - Calculate Current through the Resistor and the Capacitor (they are in series):-
    - IResistor = ICapacitor = VResistor / Resistance.
  - Calculate Reactance of the Capacitor:-
    - Capacitor Reactance Xc = VCapacitor / ICapacitor.
  - Calculate Capacitance of the Capacitor:-
    - Capacitance C = 1 / (2 * π * f (frequency = 1KHz) Xc).

Capacitors and Resistors.

- Change capacitor in “Circuit 2” to 1uF.
- With initial setting sketch CRO display.
- Increase frequency to 10KHz what is the effect on the voltage across the resistor ?
- Decrease frequency to 100Hz what is the effect on the voltage across the resistor ?
- Sketch the changes for all settings.

Capacitors and Resistors.

- Conclusion:
- How do the measured results compare with the calculated values.
- How did the frequency effect the impedance of the CR network circuit.
- When a DC voltage was applied to the capacitor what impedance / resistance did it present.

Experiment 5.

Amplifiers.

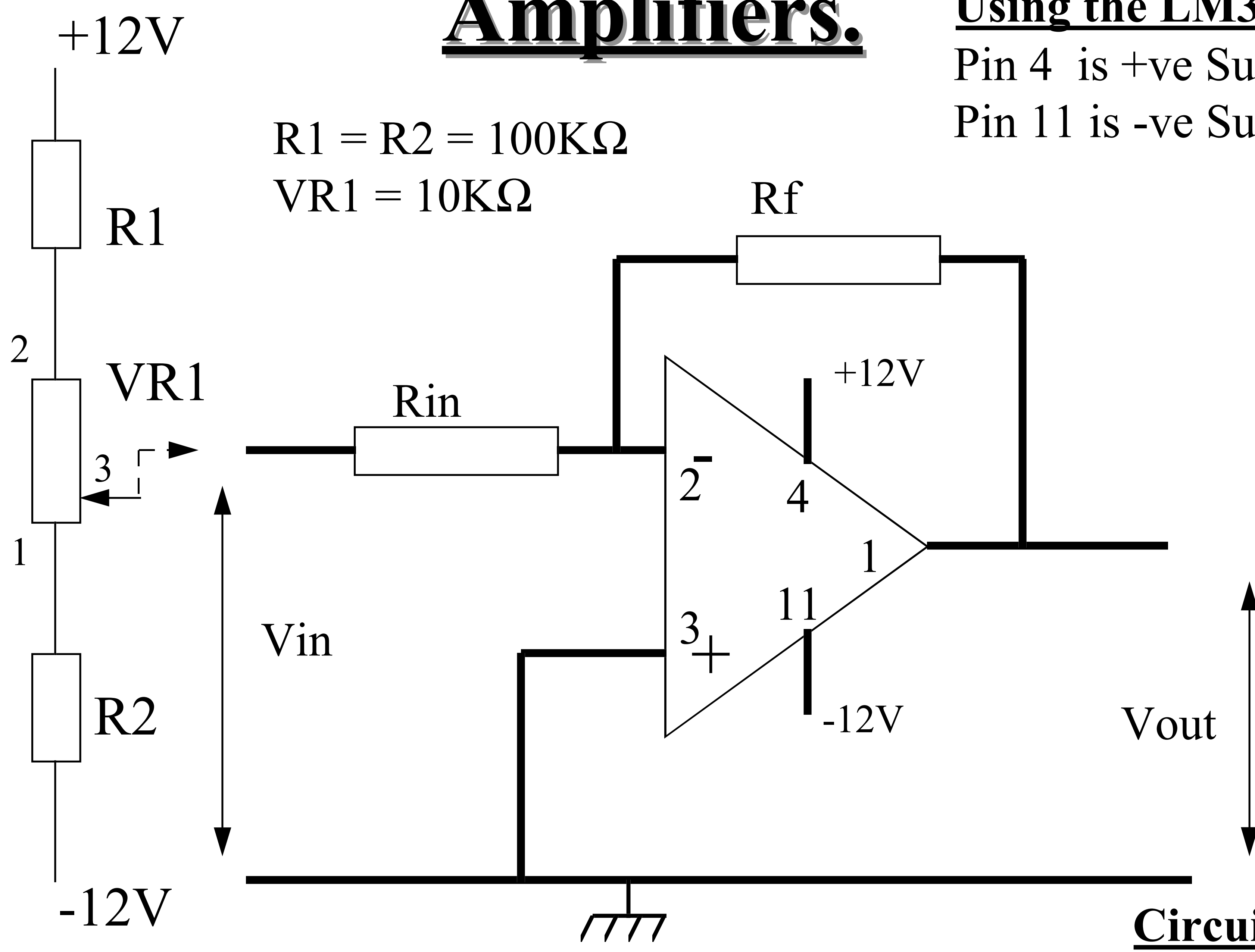
Using the LM324

Pin 4 is +ve Supply

Pin 11 is -ve Supply

R1 = R2 = 100KΩ

VR1 = 10KΩ



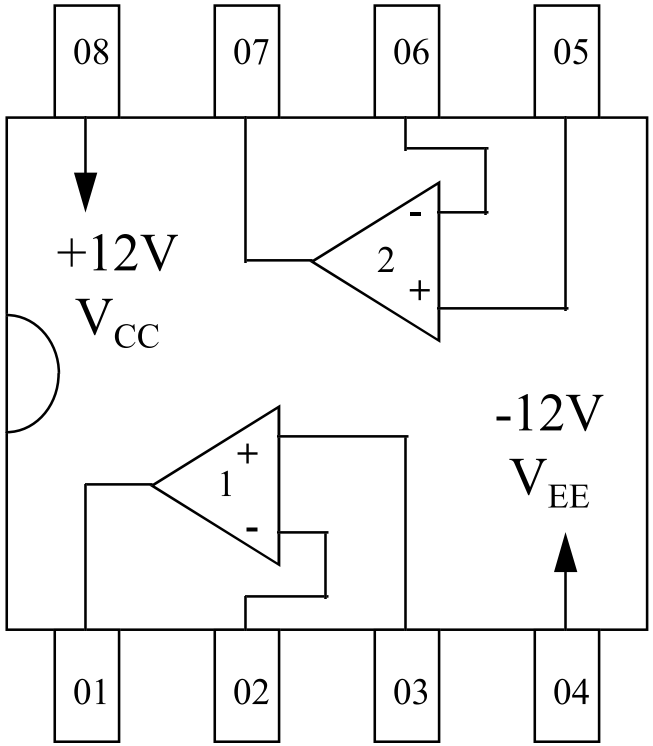
Circuit 1

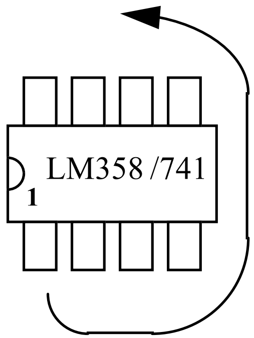
Amplifiers.

- DC Test 1 Build “Circuit 1”.
- Set Rin = 1KΩ and Rf = 10KΩ
- Adjust Vin from +10mV to -10mV in 1mV steps. (or as near as possible, record actual values)
- Monitor and record Vout.
- Set to Rf = 100KΩ , Repeat Vin changes.
- Monitor and record Vout.
- Set to Rf = 1MΩ , Repeat Vin changes.
- Monitor and record Vout.

Amplifiers.

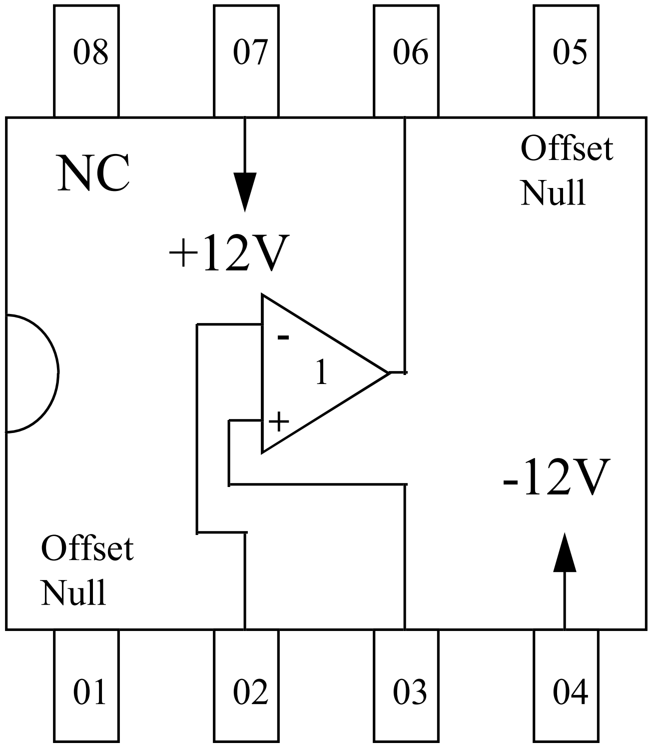
LM358





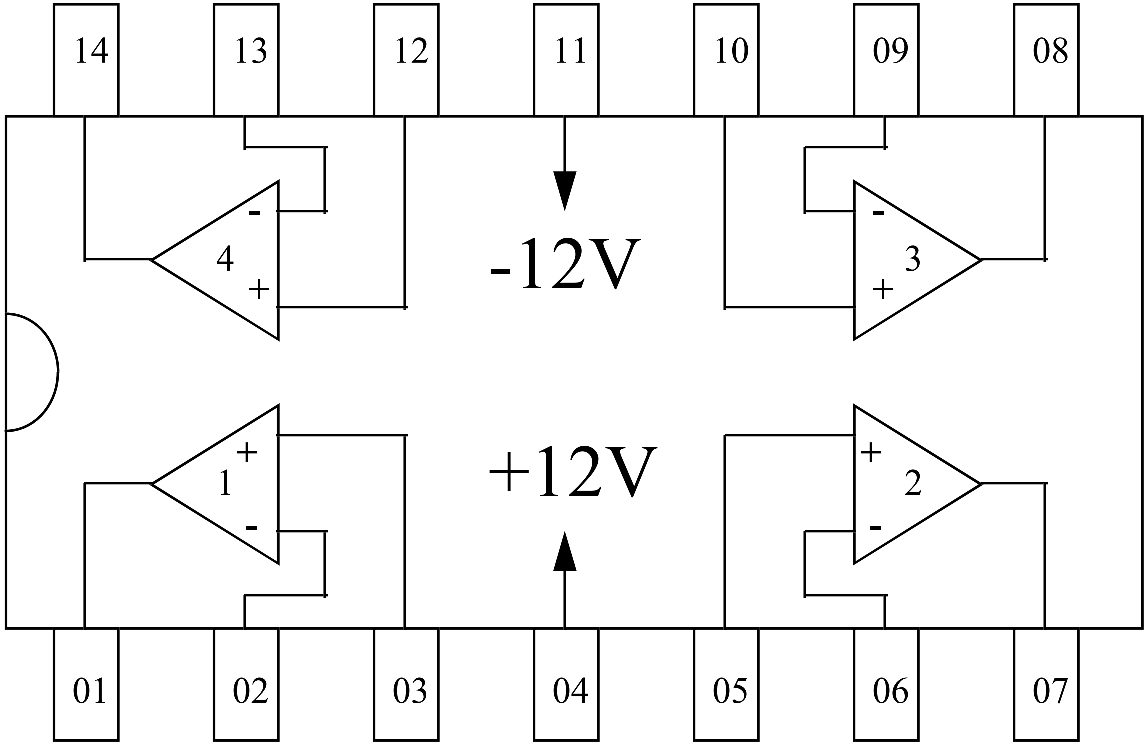
Count Pins in this direction

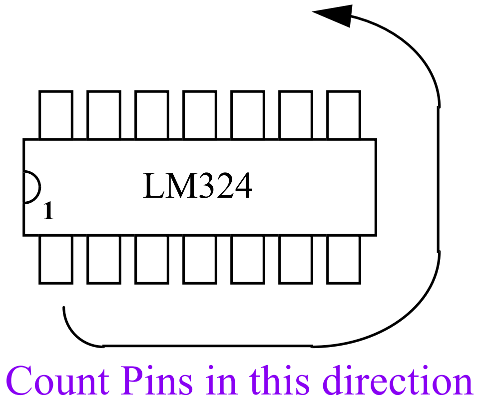
LM741



Physical Layout Diagrams for LM358 and LM741

Amplifiers.

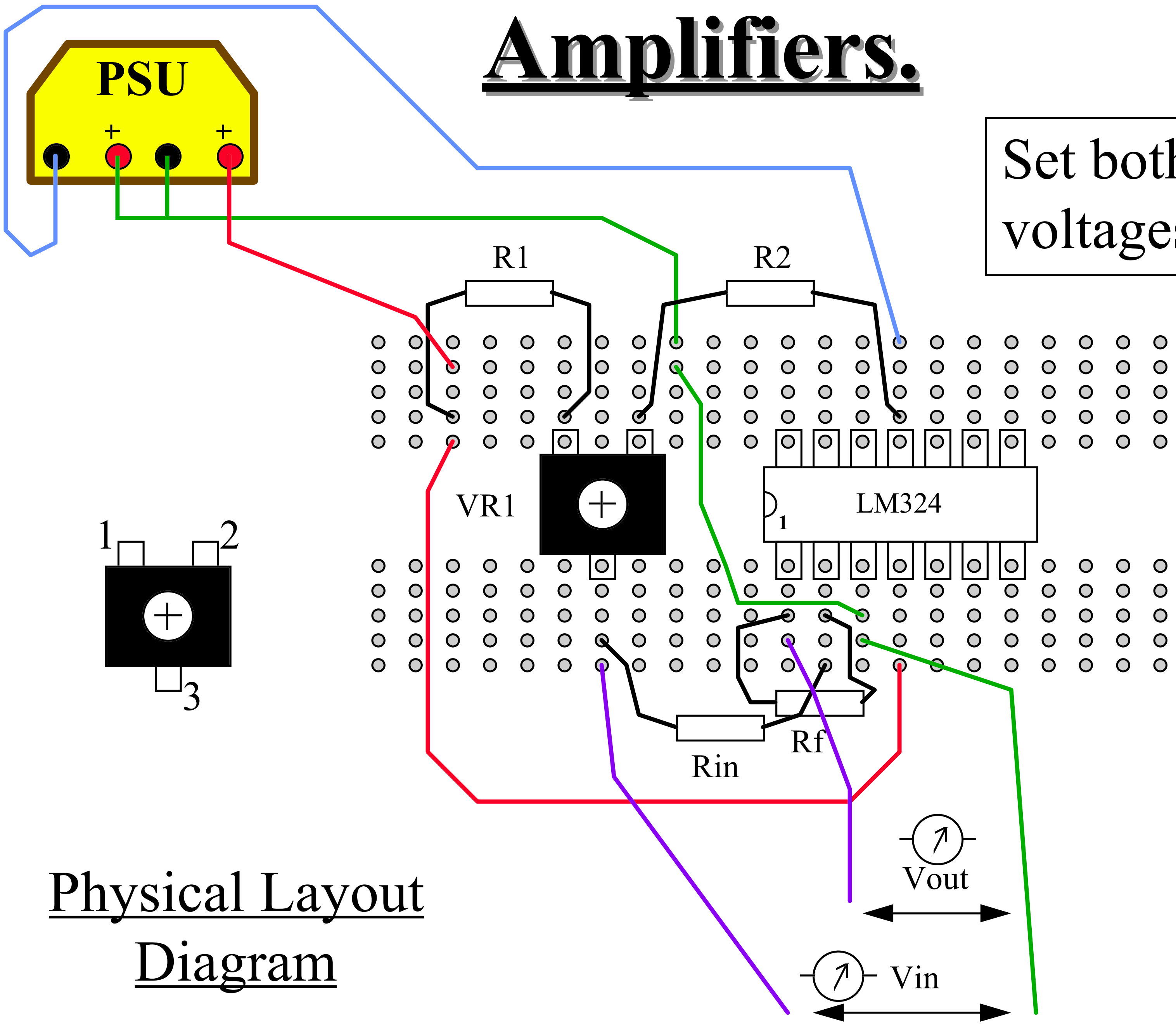




Physical Layout Diagram for LM324

Amplifiers.

Set both PSU voltages to 12V



Physical Layout Diagram

Circuit 1

Amplifiers.

Recording Results Example

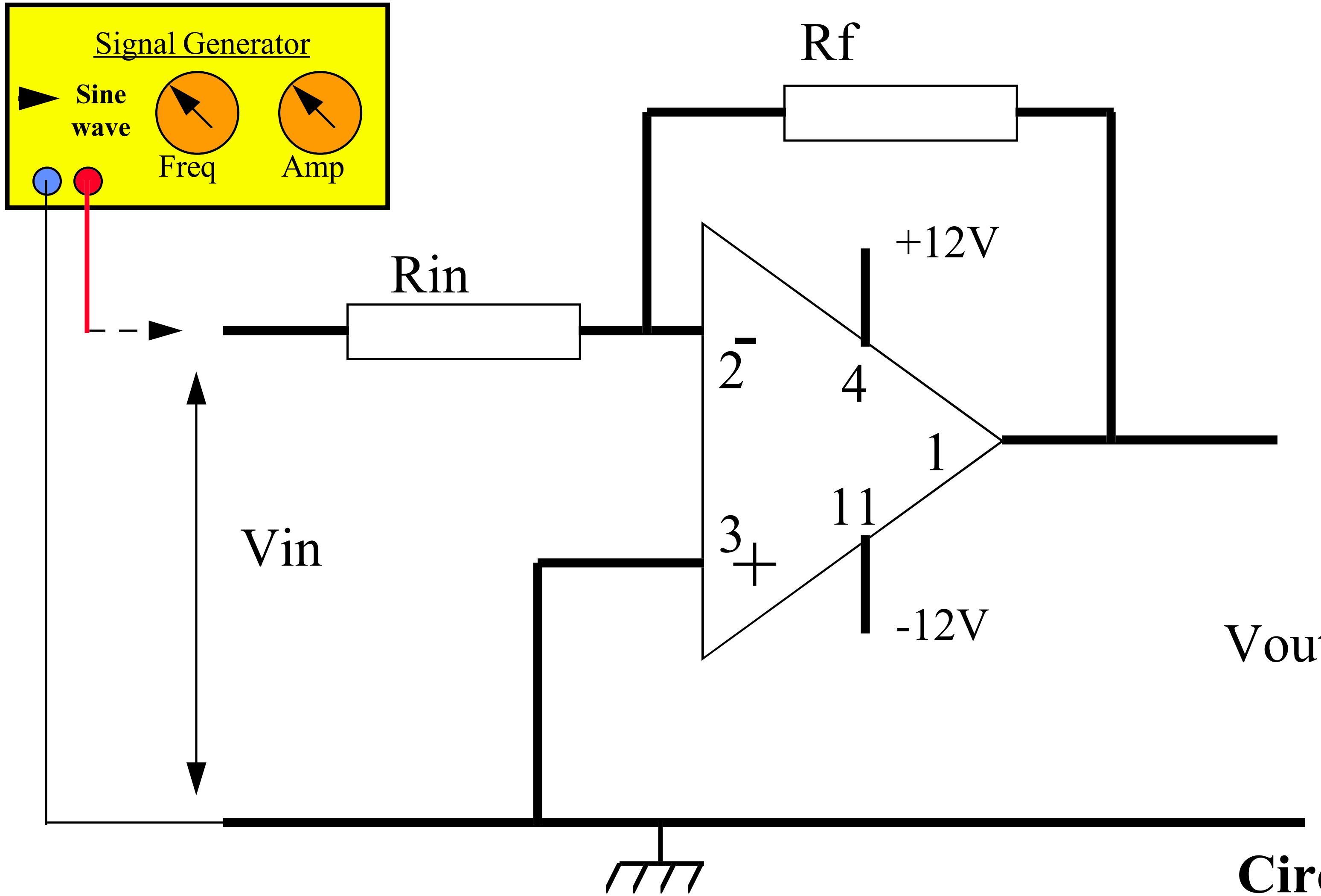
Vin (mV) Target	Vin (mV) Actual	Vout(mV) Actual
+10	+10.3	nnn
+9	+8.74	nnn
..	..	nnn
0	Not Possible to Adjust VR1 to get an exact reading.	
...	...	nnn
-5	-4.63	nnn
-10	-9.82	nnn

Amplifiers.

Using the LM324

Pin 4 is +ve Supply

Pin 11 is -ve Supply



Circuit 2

Amplifiers.

- AC Test 1 Build "Circuit 2".
- Set Rin = 1KΩ and Rf = 1KΩ
- Set Vin to Sine wave with a frequency to 100Hz and amplitude to 100mV
- Monitor Vout and sketch CRO display.
- Change Frequency to 1000Hz
- Monitor Vout and sketch CRO display.
- Change Frequency to 10KHz
- Monitor Vout and sketch CRO display.

Amplifiers.

- AC Test 2 Using “Circuit 2”.
- Set Rin = 1KΩ and Rf = 10KΩ
- Set Vin to Sine wave with a frequency to 100Hz and amplitude to 100mV
- Monitor Vout and sketch CRO display.
- Change Frequency to 1000Hz
- Monitor Vout and sketch CRO display.
- Change Frequency to 10KHz
- Monitor Vout and sketch CRO display.

Amplifiers.

- AC Test 3 Using "Circuit 2".
- Set Rin = 1KΩ and Rf = 100KΩ
- Set Vin to Sine wave with a frequency to 100Hz and amplitude to 100mV
- Monitor Vout and sketch CRO display.
- Change Frequency to 1000Hz
- Monitor Vout and sketch CRO display.
- Change Frequency to 10KHz
- Monitor Vout and sketch CRO display.

Amplifiers.

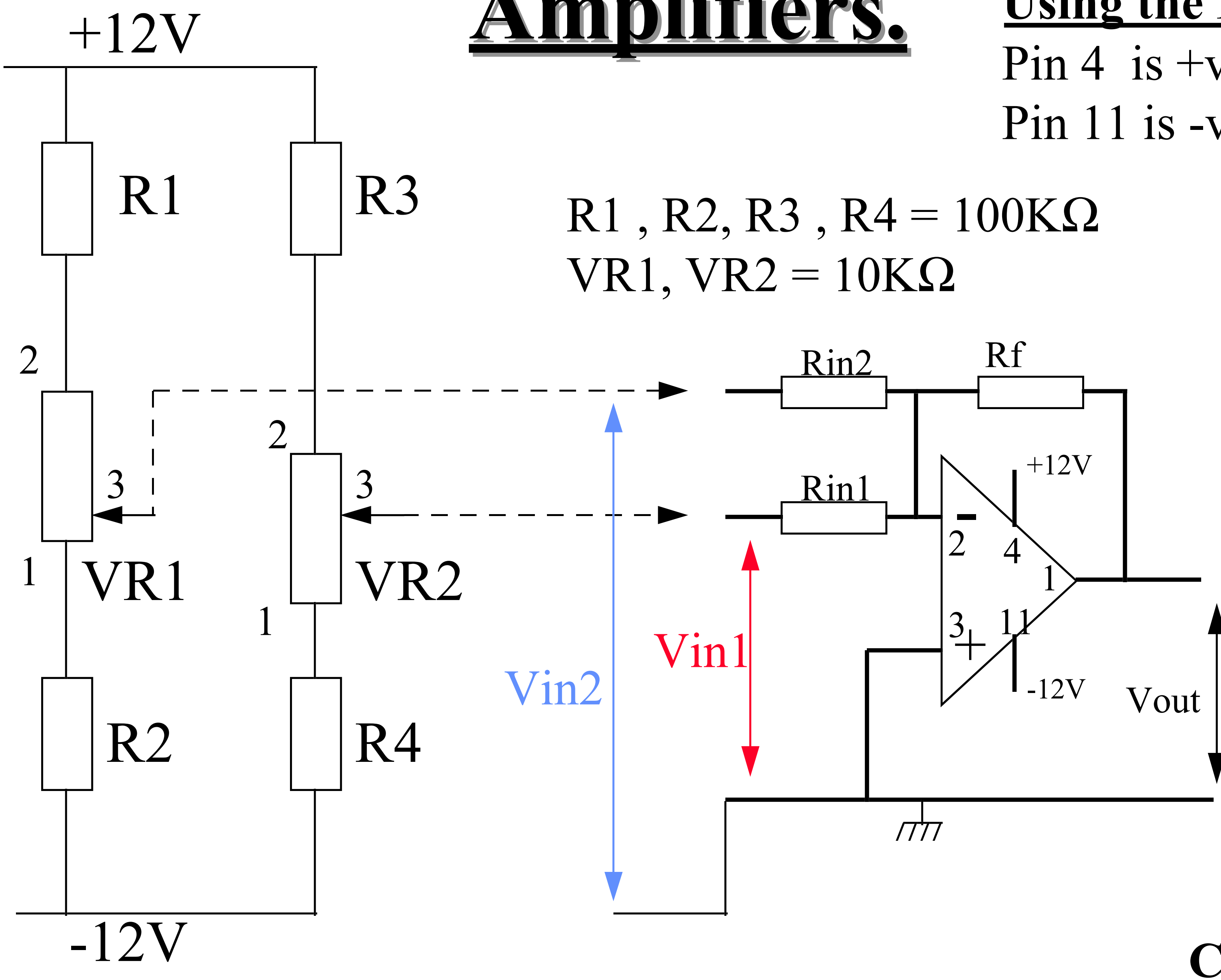
Using the LM324

Pin 4 is +ve Supply

Pin 11 is -ve Supply

R1 , R2, R3 , R4 = 100KΩ

VR1, VR2 = 10KΩ



Circuit 4

Amplifiers.

- DC Test 2 Build Circuit 4.
- Set Rin1 & Rin2 = 10KΩ and Rf = 100KΩ
- Adjust Vin1 from +10mV to -10mV in 2mV steps.(or as near as possible, record actual values)
- Adjust Vin2 from +10mV to -10mV in 5mV steps.(or as near as possible, record actual values) for each setting of Vin1.
- Monitor and record Vout.
- Note This will result in you taking about 55 readings.

Amplifiers.

Using the LM324

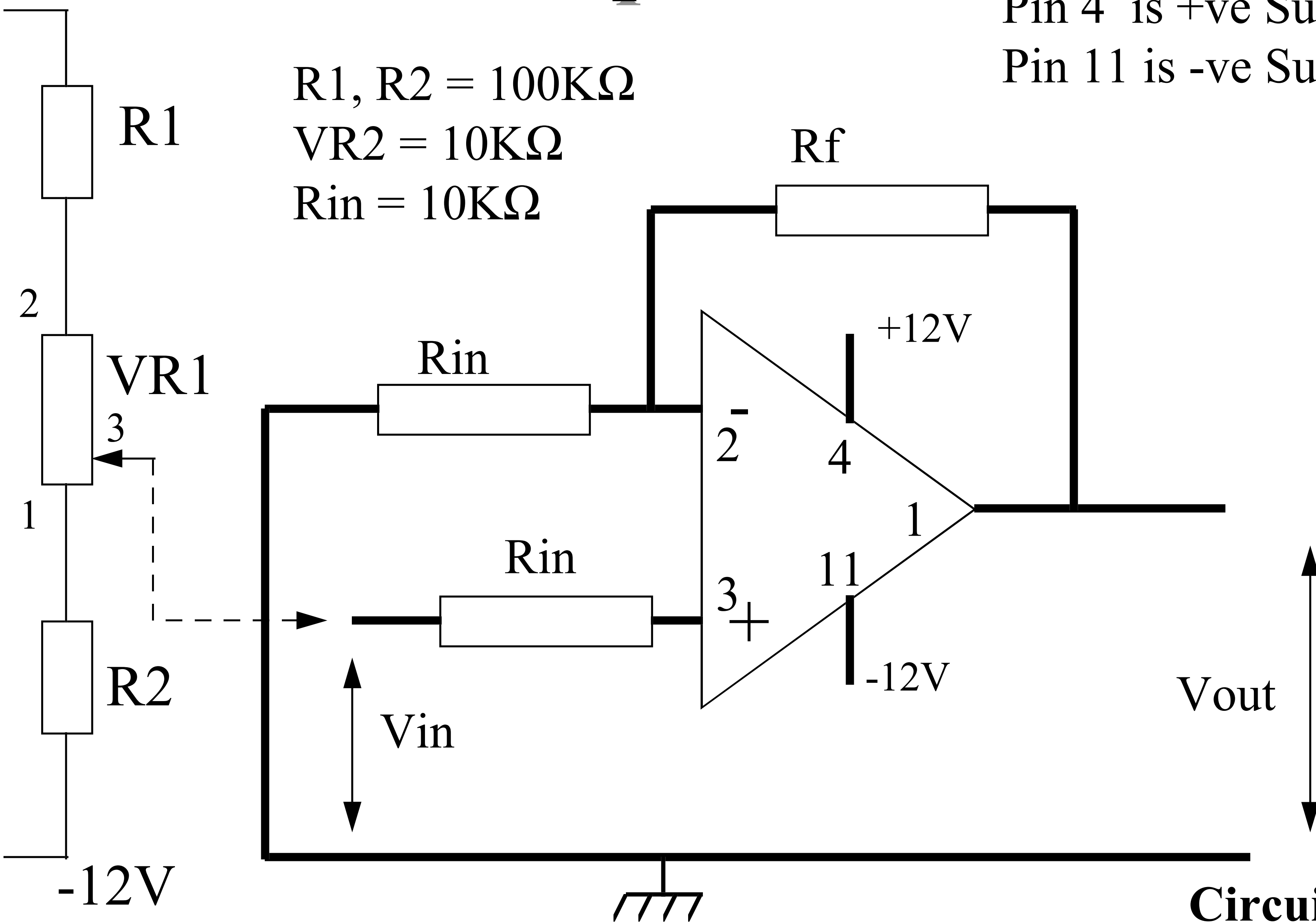
Pin 4 is +ve Supply

Pin 11 is -ve Supply

R1, R2 = 100KΩ

VR2 = 10KΩ

Rin = 10KΩ



Circuit 5

Amplifiers.

- DC Test 3 Build “Circuit 5”.
- **Warning** *Check the Pin numbers. . .*
- Set Rin = 1KΩ and Rf = 10KΩ
- Adjust Vin from +10mV to -10mV in 1mV steps.(or as near as possible, record actual values)
- Monitor and record Vout.
- Set to Rf = 100KΩ , Repeat Vin changes.
- Monitor and record Vout.

Amplifiers.

Using the LM324

Pin 4 is +ve Supply

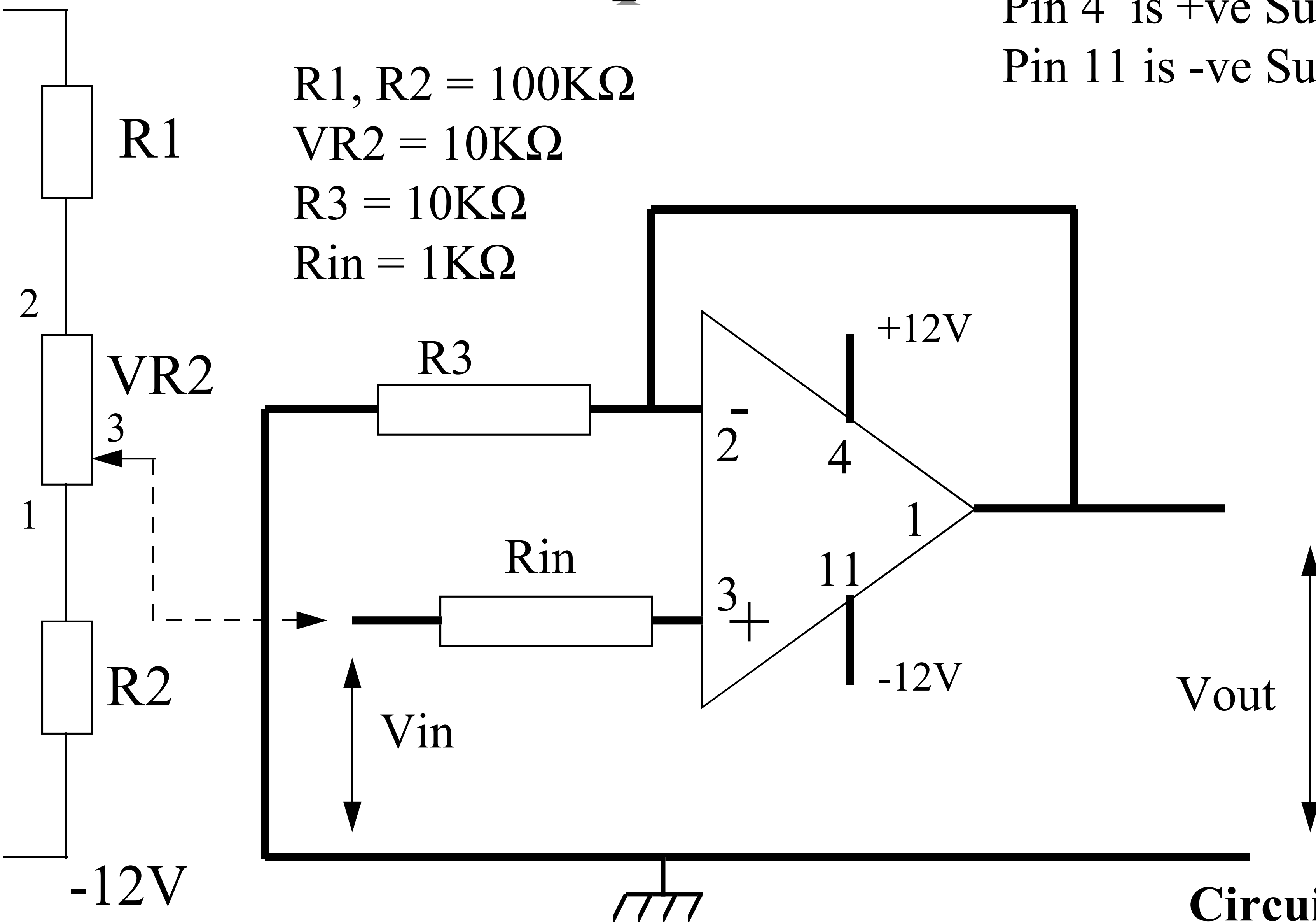
Pin 11 is -ve Supply

R1, R2 = 100KΩ

VR2 = 10KΩ

R3 = 10KΩ

Rin = 1KΩ



Circuit 6

Amplifiers.

- DC Test 4 Build "Circuit 6".
- Set Rin = 1KΩ
- Adjust Vin from +10mV to -10mV in 1mV steps.(or as near as possible, record actual values)
- Monitor and record Vout.
- Set Rin = 10KΩ
- Adjust Vin from +10mV to -10mV in 1mV steps.(or as near as possible, record actual values)
- Monitor and record Vout.

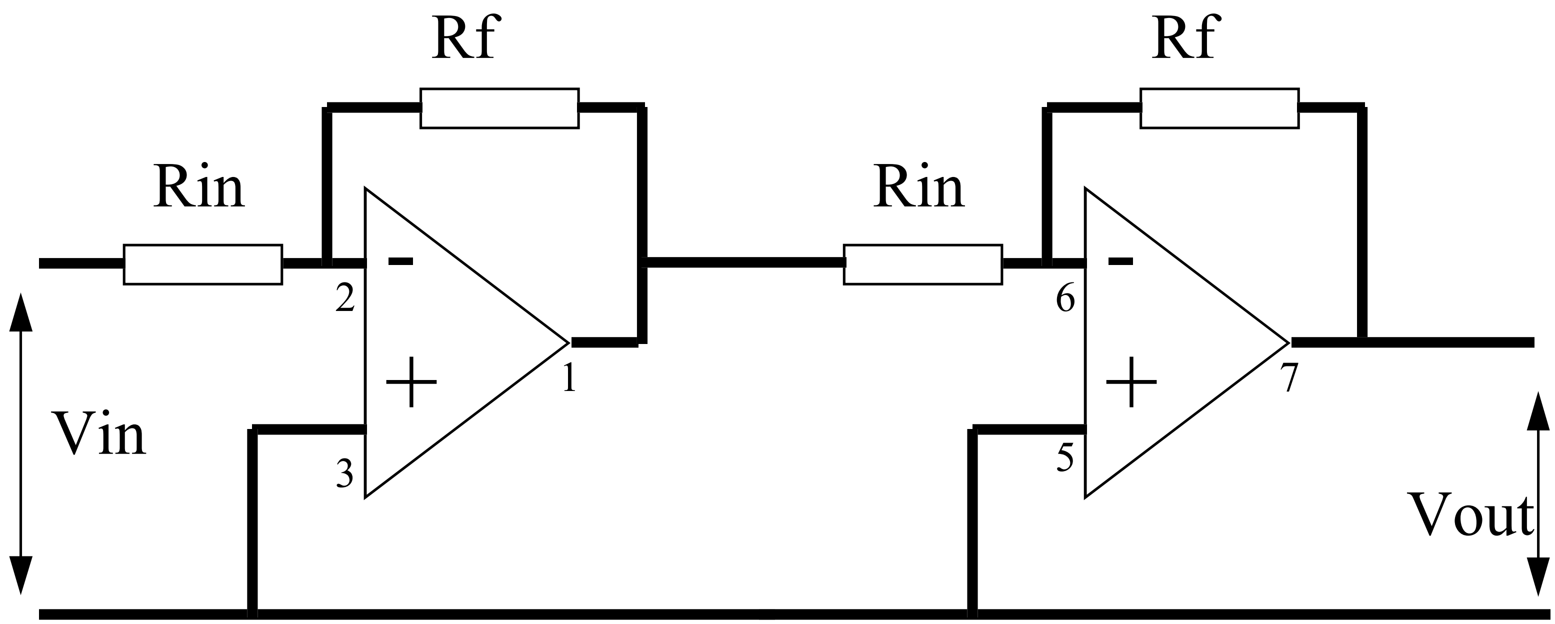
Amplifiers.

Using the LM324

Pin 4 is +ve Supply

Pin 11 is -ve Supply

Amp 1	+ = 2	, - = 3	, O/P = 1
Amp 2	+ = 5	, - = 6	, O/P = 7
Amp 3	+ = 10	, - = 9	, O/P = 8
Amp 4	+ = 12	, - = 13	, O/P = 14



Circuit 3

Amplifiers.

- AC Test 4 Build Circuit 3.
- Set Rin = 1KΩ and Rf = 10KΩ
- Set Vin to Sine wave with a frequency to 100Hz and amplitude to 100mV
- Monitor Vout and sketch CRO display.
- Change Frequency to 1000Hz
- Monitor Vout and sketch CRO display.
- Change Frequency to 10KHz
- Monitor Vout and sketch CRO display.

Amplifiers.

- Order to complete Activities :-
  - DC Test 1
  - AC Test 1
  - AC Test 2
  - AC Test 3
  - DC Test 2
  - DC Test 3
  - DC Test 4
  - AC Test 4 (Optional if time allows)

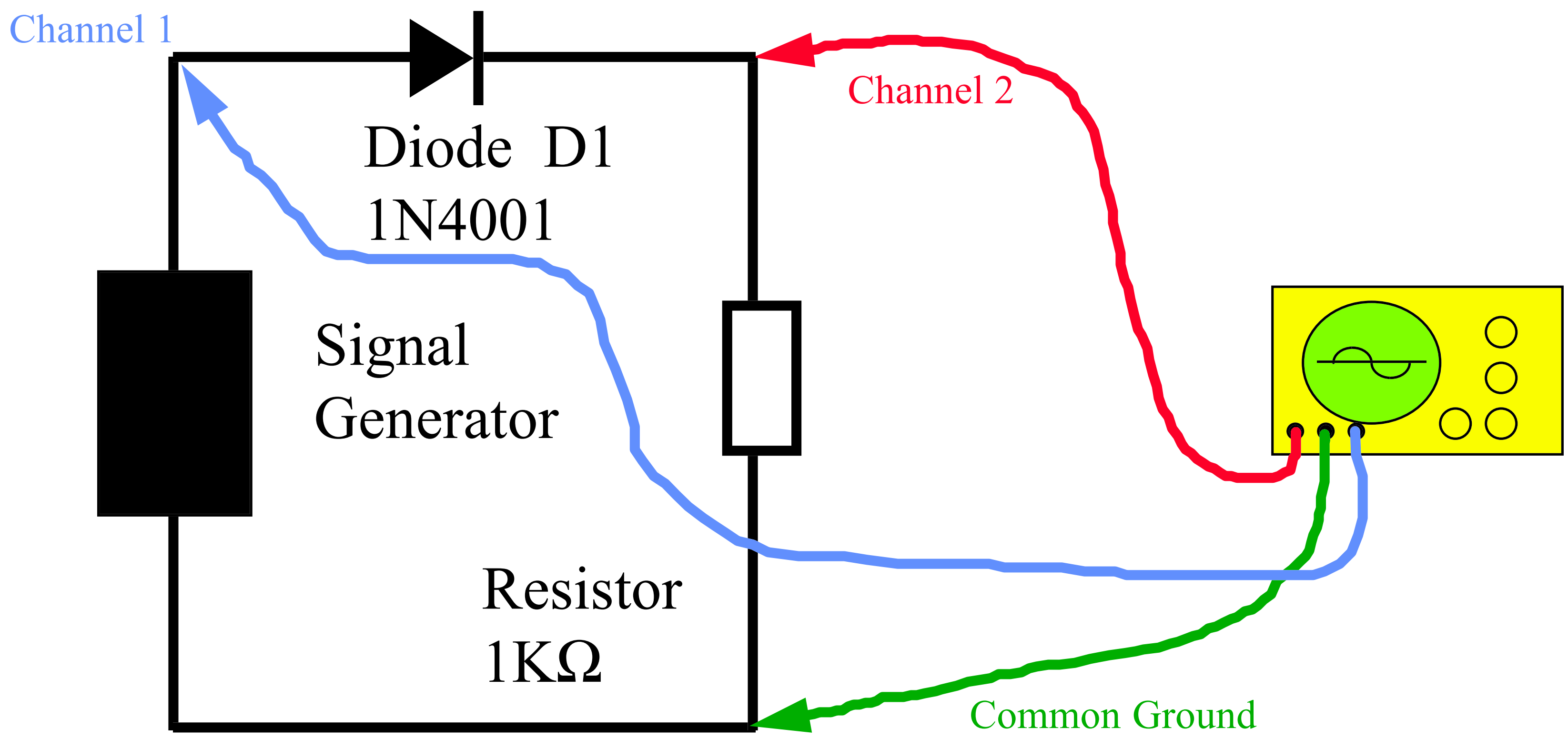
Experiment 6.

Diode Circuits.

- Build “Circuit 1”.
- With initial setting sketch CRO display.
- Reverse Diode D1
- Sketch CRO display.

Diode Circuits.

Set Signal generator to Sine wave with a frequency to 1000Hz and amplitude to 2 Volts

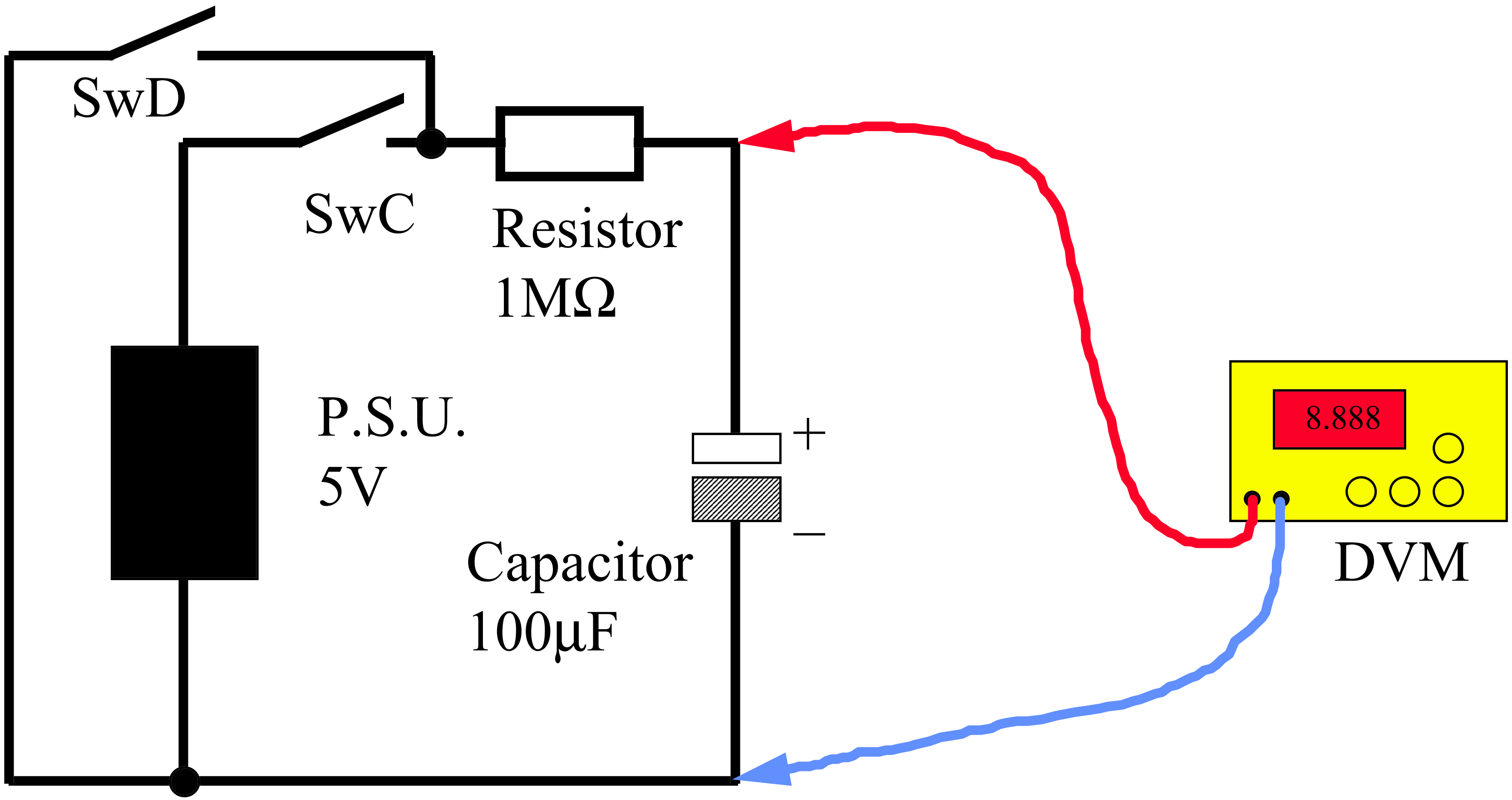


Circuit 1

Experiment 7.

Capacitors and Resistors.

Initially discharge the capacitor (SwC Open and SwD Closed)



Circuit 1

Capacitors and Resistors.

- Build “Circuit 1” and Discharge Capacitor.
- Open SwD when capacitor fully discharged.
- Close SwC and record voltage across the capacitor at the following time intervals.
- 0, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160 seconds , 3, 3.5, 4, 5, 6, 7 minutes.
- Open SwC , Close SwD and record voltage across the capacitor at the following time intervals.
- 0, 10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160 seconds , 3, 3.5, 4, 5, 6, 7 minutes.

Capacitors and Resistors.

- Change capacitor to 22μF and discharge it.
- Open SwD when capacitor fully discharged.
- Close SwC and record voltage across the capacitor at the following time intervals.
- 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 80, 100 seconds, 2, 3, 5 minutes.
- Open SwC , Close SwD and record voltage across the capacitor at the following time intervals.
- 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 80, 100 seconds, 2, 3, 5 minutes.

Capacitors and Resistors.

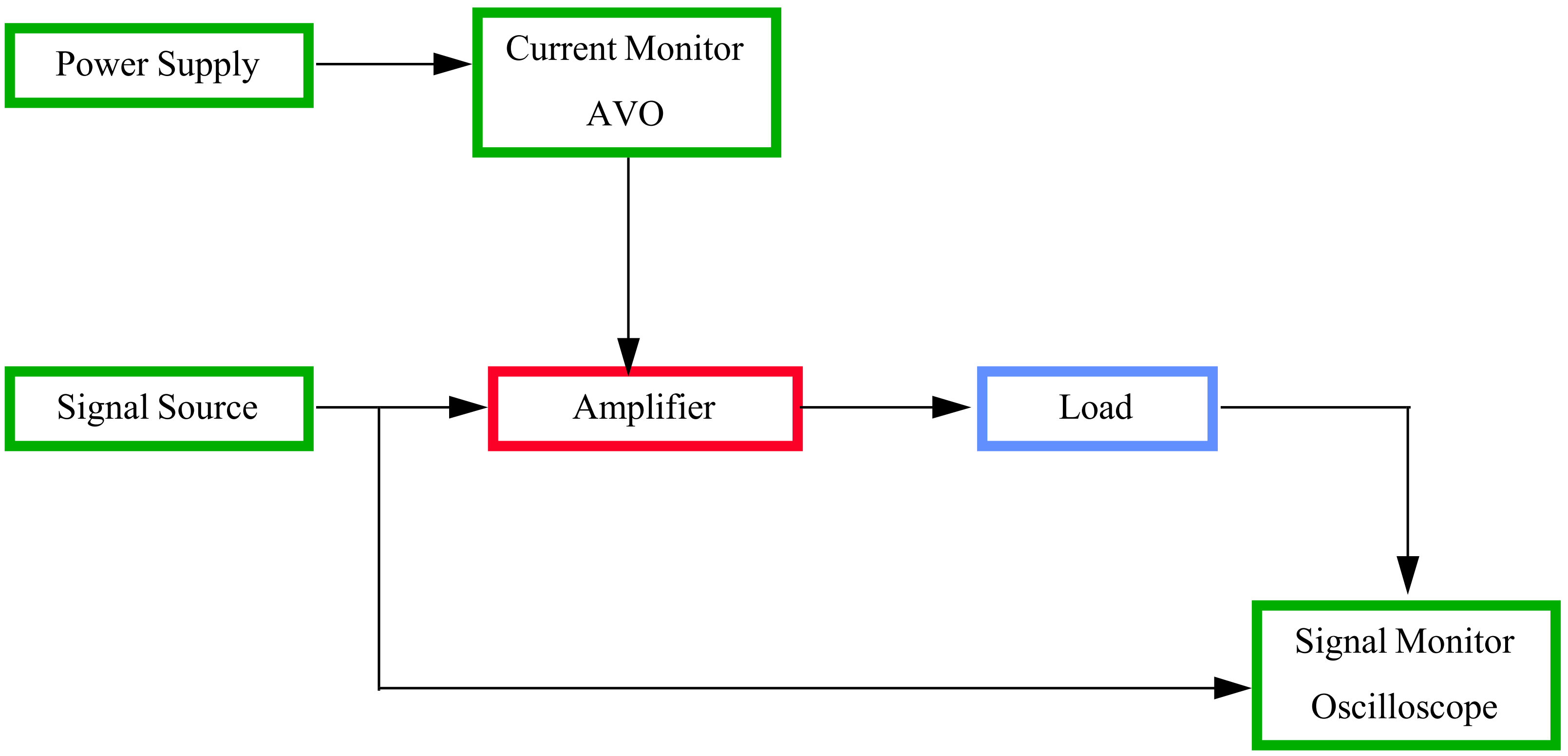
- Change capacitor to 10μF and discharge it.
- Open SwD when capacitor fully discharged.
- Close SwC and record voltage across the capacitor at the following time intervals.
- 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 80, 100 seconds, 2, 3, 5 minutes.
- Open SwC , Close SwD and record voltage across the capacitor at the following time intervals.
- 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 80, 100 seconds, 2, 3, 5 minutes.

Capacitors and Resistors.

- Plot the family of curves of the reading.
- Calculate then mark on each curve the 63% point of the final steady state voltage.
- Calculate the time constant (τ {tor})
- $\tau = R*C$ seconds where R=1M & C=100μF
- Therefore $\tau = 1*10^{6} * 100*10^{-6} = 100$secs
- Repeat for the 10μF and 22μF capacitors.
- How do the theory and practical values match?

Experiment 8.

Amplifier AC and DC Tests.



Block Diagram.

Amplifier Input Power Test.

Control Conditions

Load 50Ω Input Signal 1KHz Supply +/-9V

Volume control set to minimum attenuation.

Input current in mA	Input Signal in mV P/P	Output Signal % Undistorted	Output Voltage in Volts P/P
40 mA	520 mV P/P	Max or 100%	13 Volts P/P
29mA	400 mV P/P	75% Undistorted	10 Volts P/P
22mA	300 mV P/P	50% Undistorted	6.5 Volts P/P
12.5mA	250 mV P/P	25% Undistorted	3.25 Volts P/P
6 mA	0 mV P/P	0 % Undistorted	0 Volts P/P

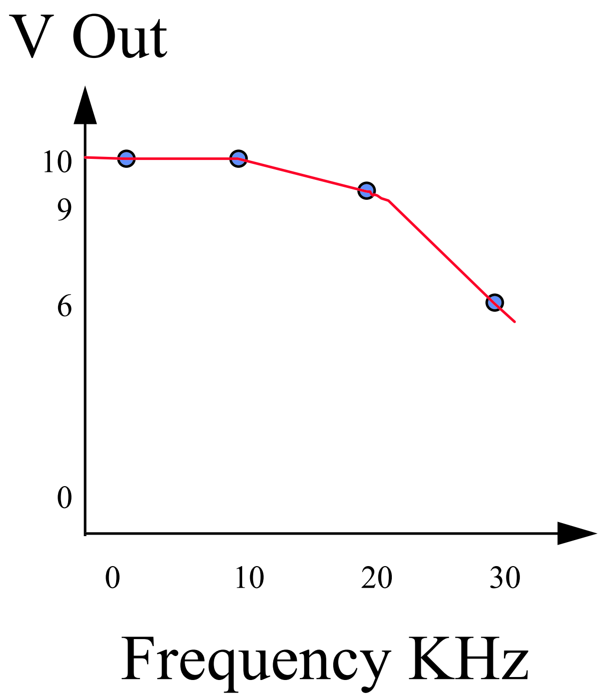
Quiescent , Standing or Bias Current

Amplifier AC Frequency Test.

Control Conditions

AC Input Signal Amplitude 200mV P/P per channel.

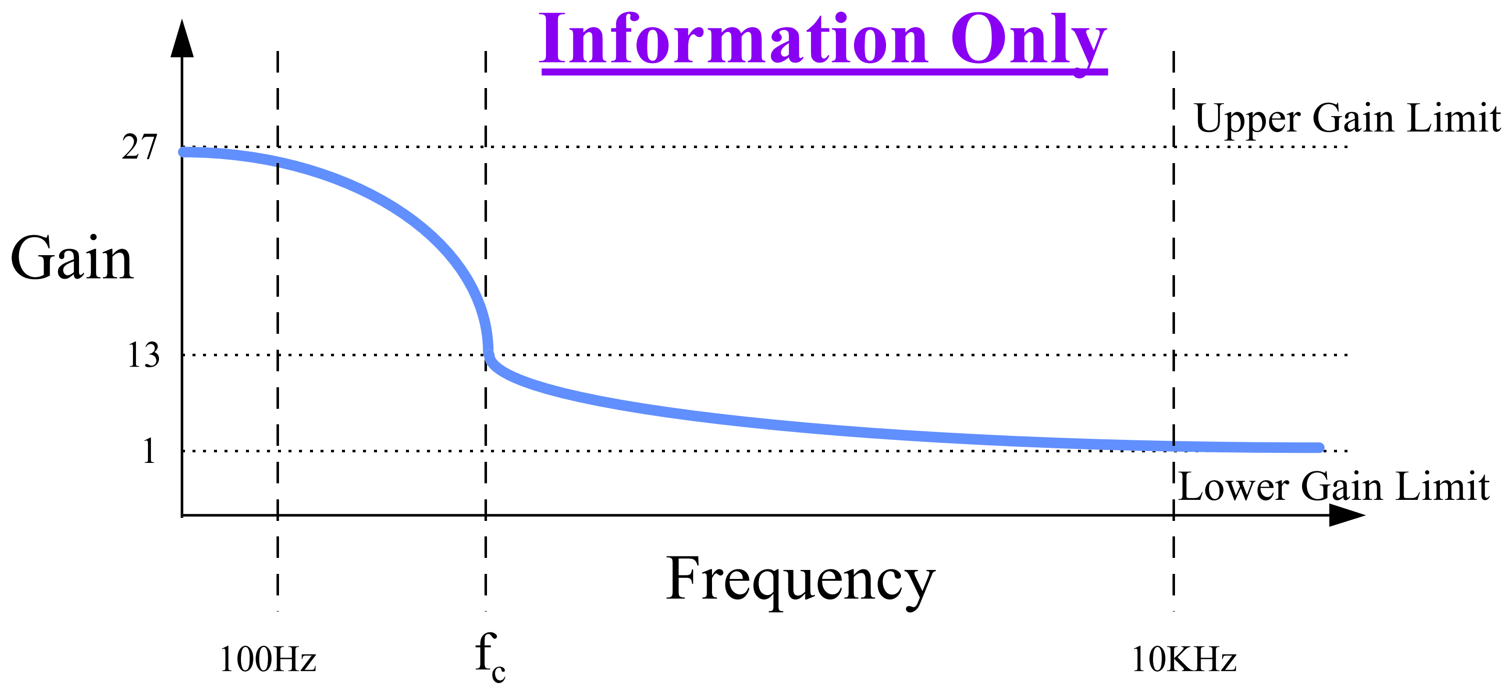
Input Frequency in Hz	Output Voltage Volts P/P
100 Hz	10V P/P
500 Hz	10V P/P
1000 Hz	10V P/P
2000 Hz	10V P/P
10000 Hz	10V P/P
20000 Hz	9V P/P
30000 Hz	6V P/P



Amplifier Theory.

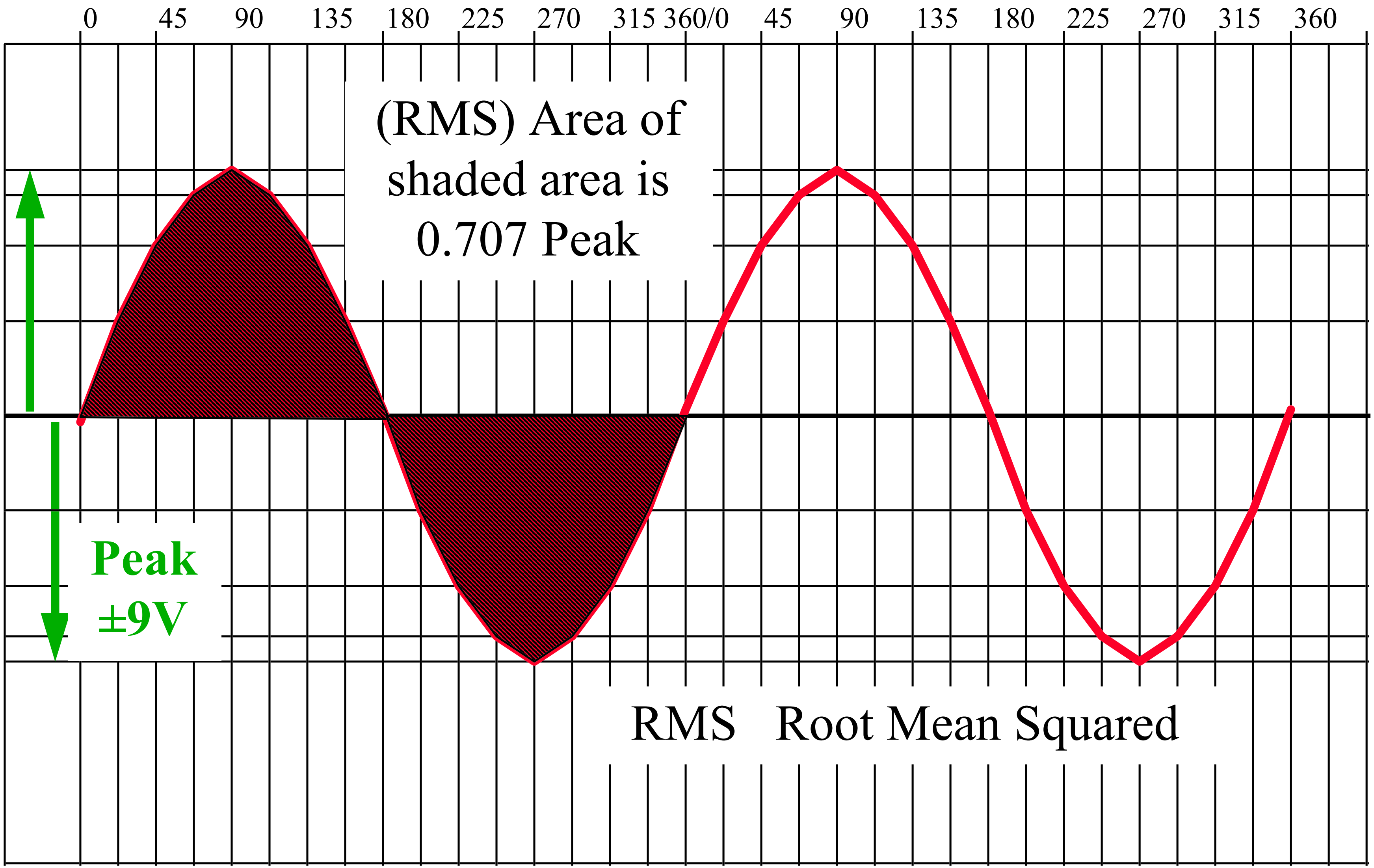
The Gain / frequency relationship graph of the Base Boost Circuit.

Note That the cutoff frequency of a simple filter is the point where Impedance and resistance are the same.



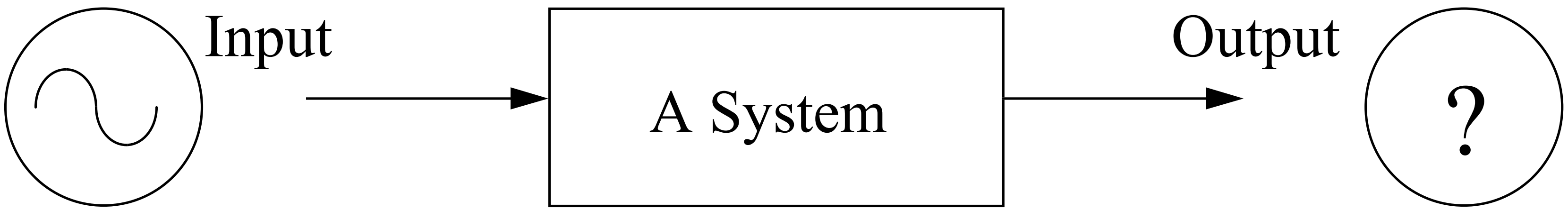
Base Boost (Gain Modifier) Calculations.

Amplifier Theory.



Amplifier Theory.

- When we analyze a System we often look at it as a block or series of independent blocks
- We are often quite interested what would happen to the system :-
  - If we applied a particular control to the Input ?
  - What Output would result if that control was applied ?
- The “Transfer characteristic” is a graphical representation of a system showing the relationship between Input and Output

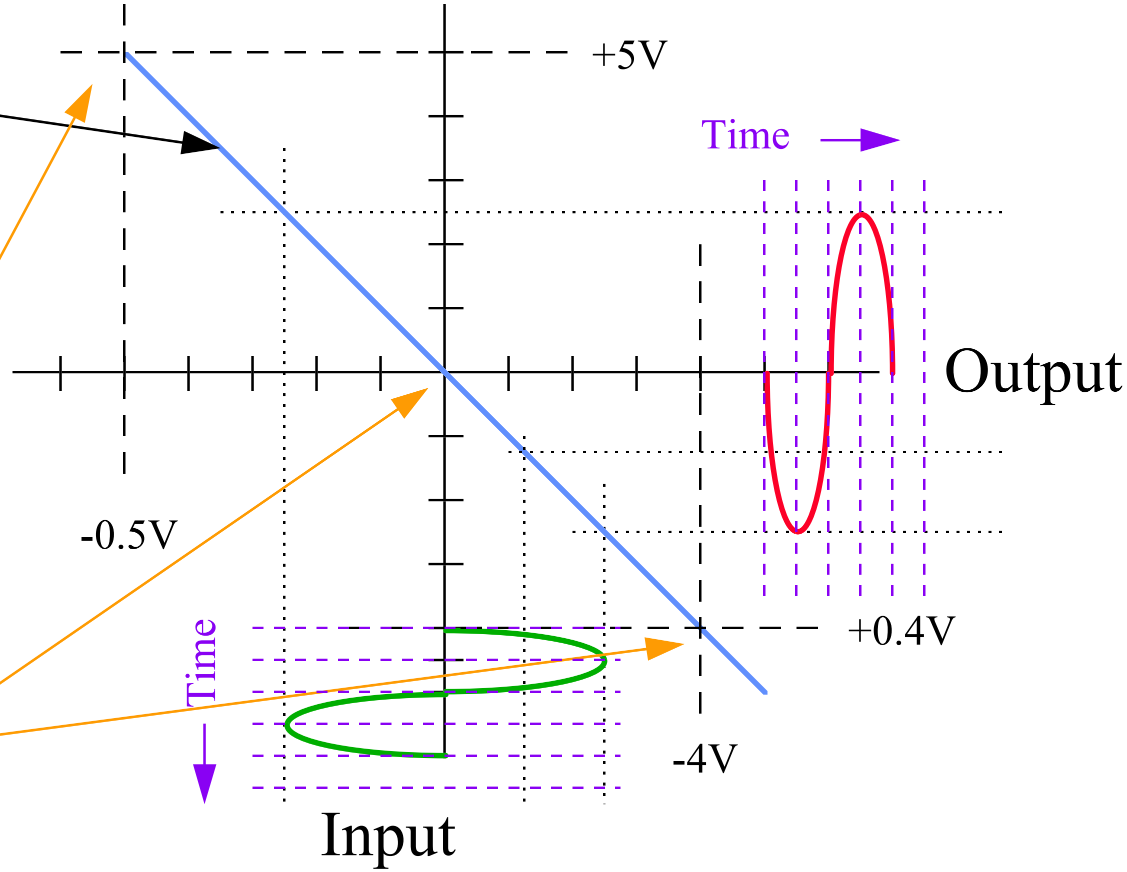


Amplifier Theory.

Graph of Transfer Equation.

Produced from the values in results table.

Results	
Input	Output
0.5V	-5V
0.4V	-4V
0V	0V
-0.3V	+3V
-0.5V	+5V

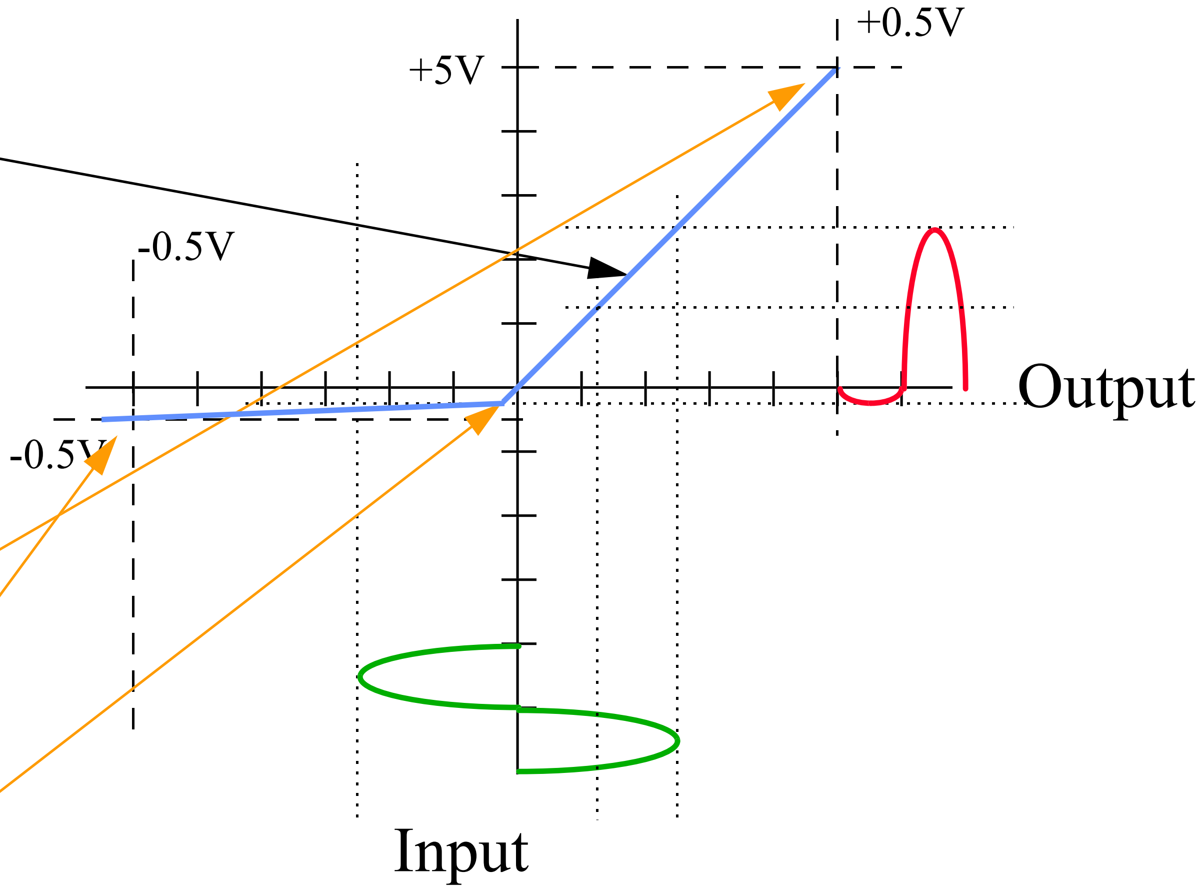


A times ten gain Inverter Amplifier "Transfer Characteristic".

The Transfer Characteristic.

Amplifier Theory.

Graph of Transfer Equation



Results	
Input	Output
0.5V	+5V
0.3V	+3V
0V	0V
-0.3V	-0.3V
-0.5V	-0.5V

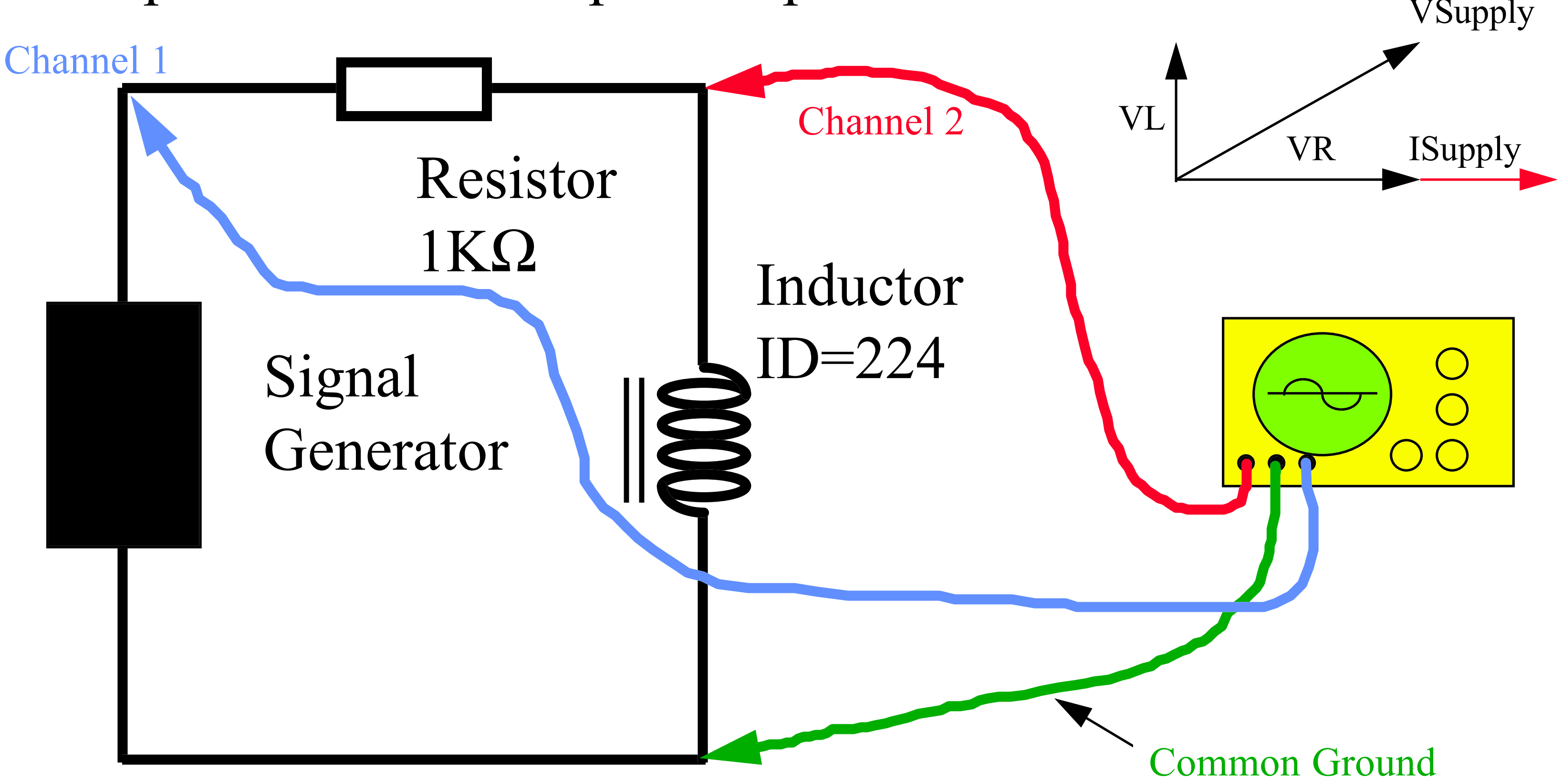
An example of an asymmetrical "Transfer Characteristic".

The Transfer Characteristic.

Experiment 9.

Inductors and Resistors.

Set Signal generator to a Sine wave with a frequency of 600KHz and an amplitude of 2 Volts peak to peak.



Circuit 1

Inductors and Resistors.

- Build "Circuit 1".
- With initial settings sketch the CRO display.
- Increase frequency to 900KHz what is the effect on the voltage across the Inductor ?
- Decrease frequency to 200KHz what is the effect on the voltage across the Inductor ?
- Sketch the changes for all settings.
- Create a table of your measurements.
- Add to the table the value of the Inductors reactance at the different frequencies.

Inductors and Resistors.

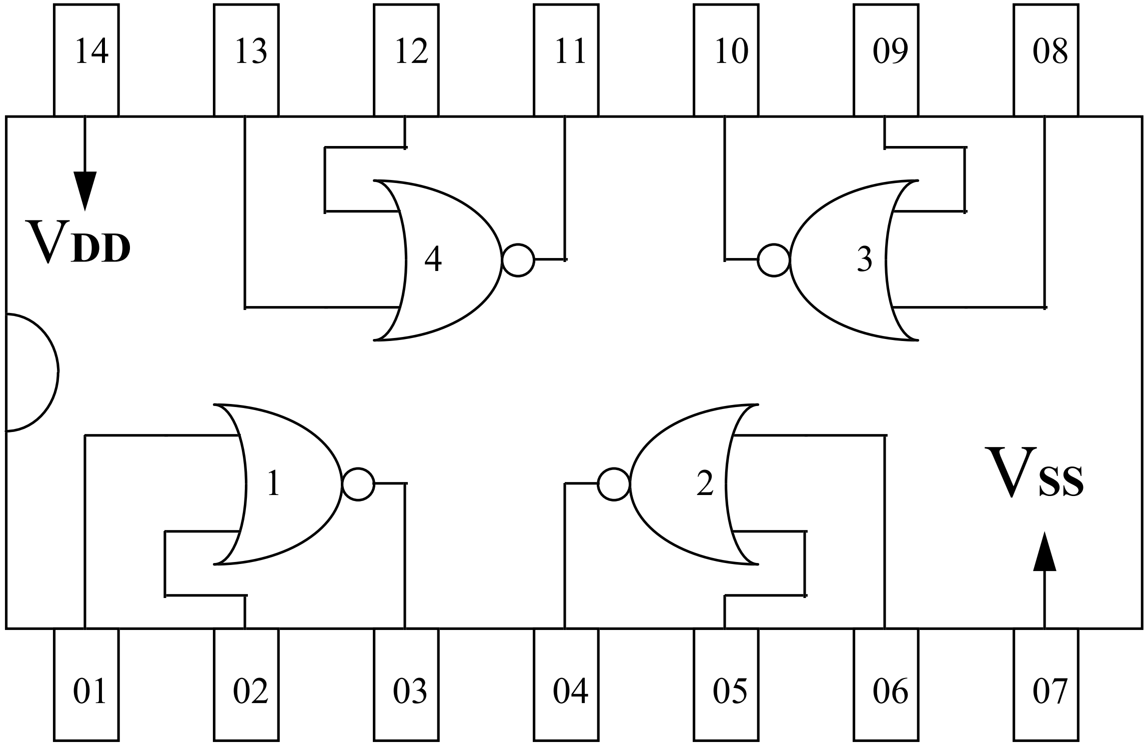
- Calculate value of Inductance using the measurements taken with 200KHz Signal.
  - Calculate Voltage across resistor:-
    - VResistor = $\sqrt{Vsource^2 - VInductor^2}$.
  - Calculate Current through the Resistor and the Inductor (they are in series):-
    - IResistor = IInductor = Vresistor / Resistance.
  - Calculate Reactance of the Inductor:-
    - Inductor Reactance X*l* = VInductor / IInductance.
  - Calculate Inductance of the Inductor:-
    - Inductance *l* = X*l* / (2 * π * f (frequency = 200KHz)).

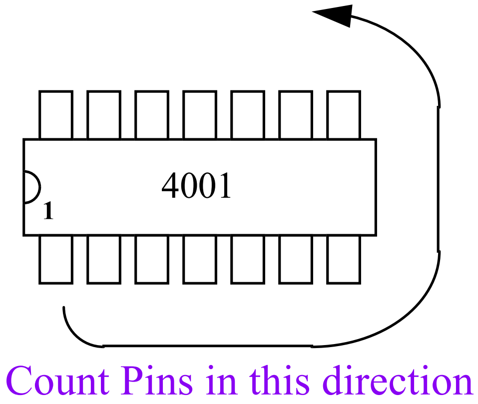
Inductors and Resistors.

- Conclusion:-
- What did you notice about the position of the Source Voltage with respect to the Voltage across the Inductor?
  - Did frequency effect this position/phase and if so how did it effect it?
- In what way did the frequency have an effect on the reactance of the Inductor?
- What was the resistance rather than the reactance of the Inductor (Measure it)?

Experiment 10.

Digital Logic.



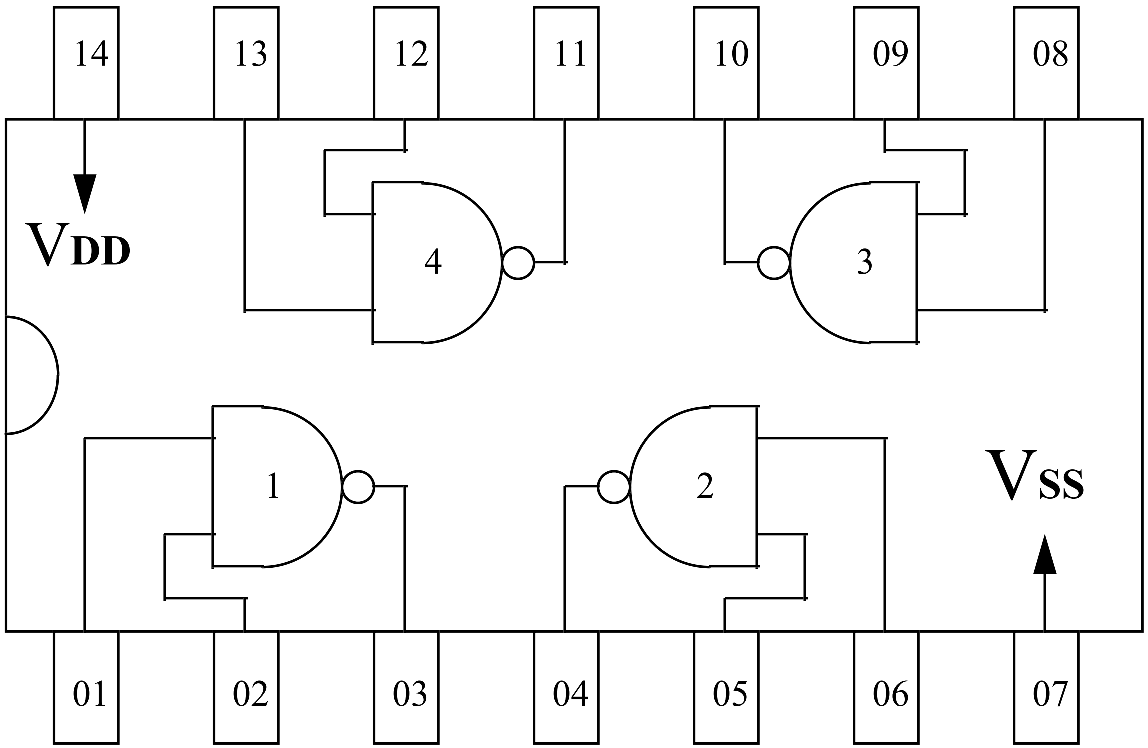


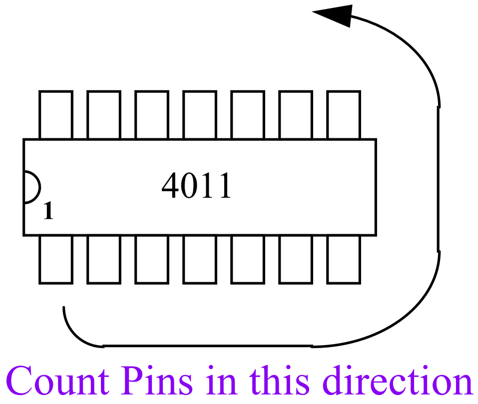
$V_{DD} = +5V$

V_{ss} = Ground / 0V

Physical Layout Diagram for 4001

Digital Logic.



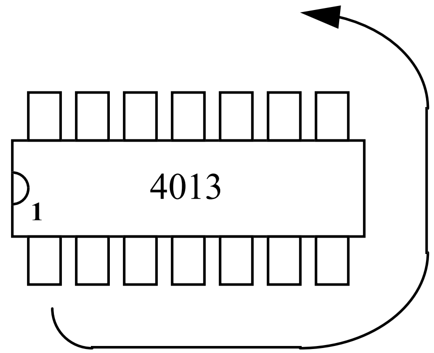


VDD = +5V

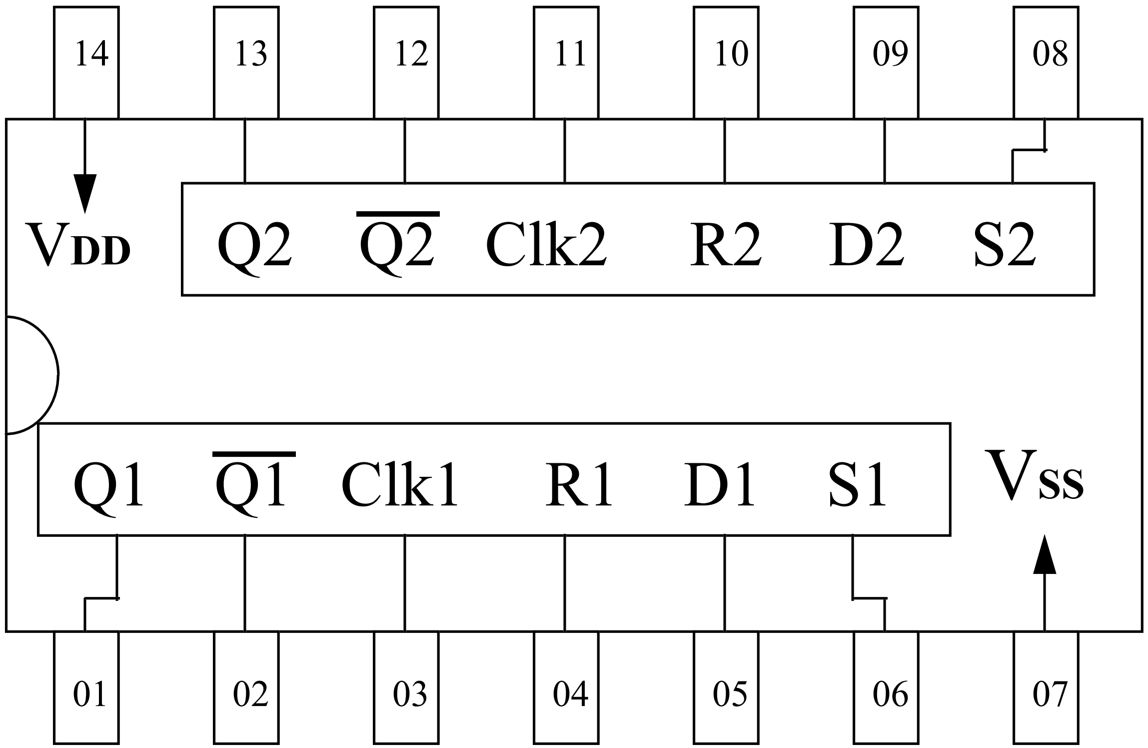
Vss = Ground / 0V

Physical Layout Diagram for 4011

Digital Logic.



Count Pins in this direction



Q = Output

R = Reset

S = Set

D = Input

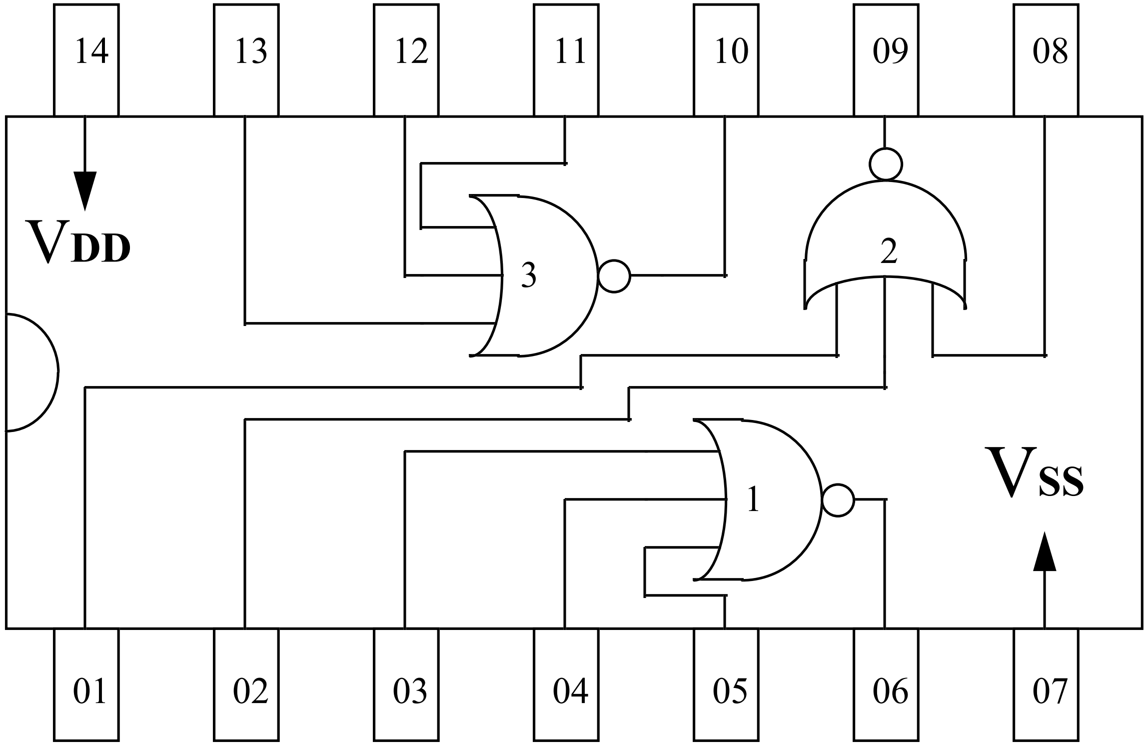
Clk = Clock

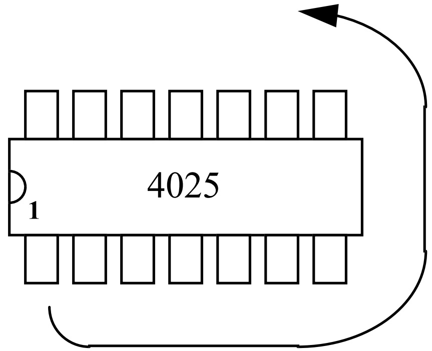
VDD = +5V

Vss = Ground / 0V

Physical Layout Diagram for 4013

Digital Logic.





VDD = +5V

Vss = Ground / 0V

Physical Layout Diagram for 4025

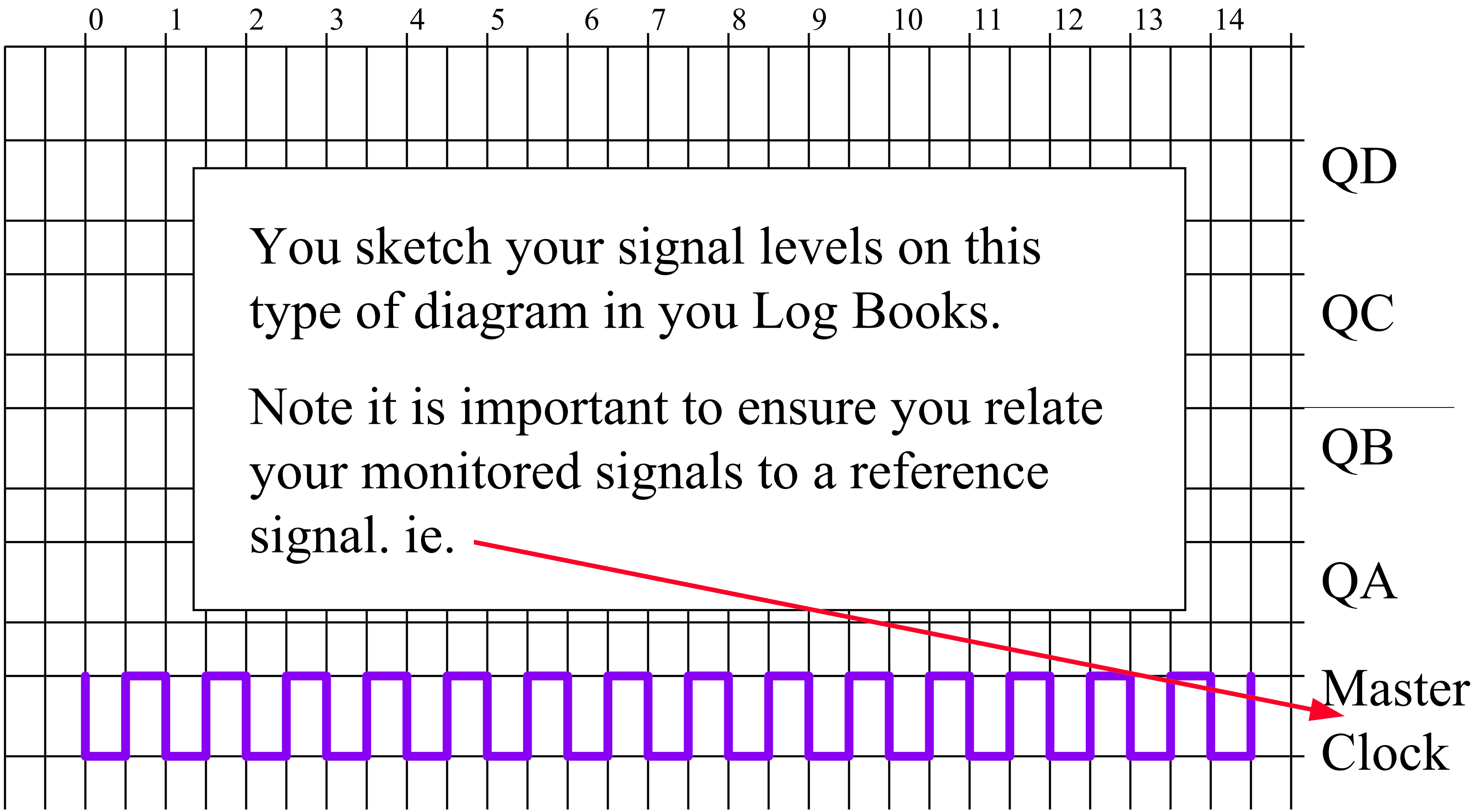
Digital Logic.

Example Layout of a Truth Tables that will be entered in Log Book.

Inputs			Output	Comments
A	B	C	O/P	
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

You fill in this area

Logic Functions.



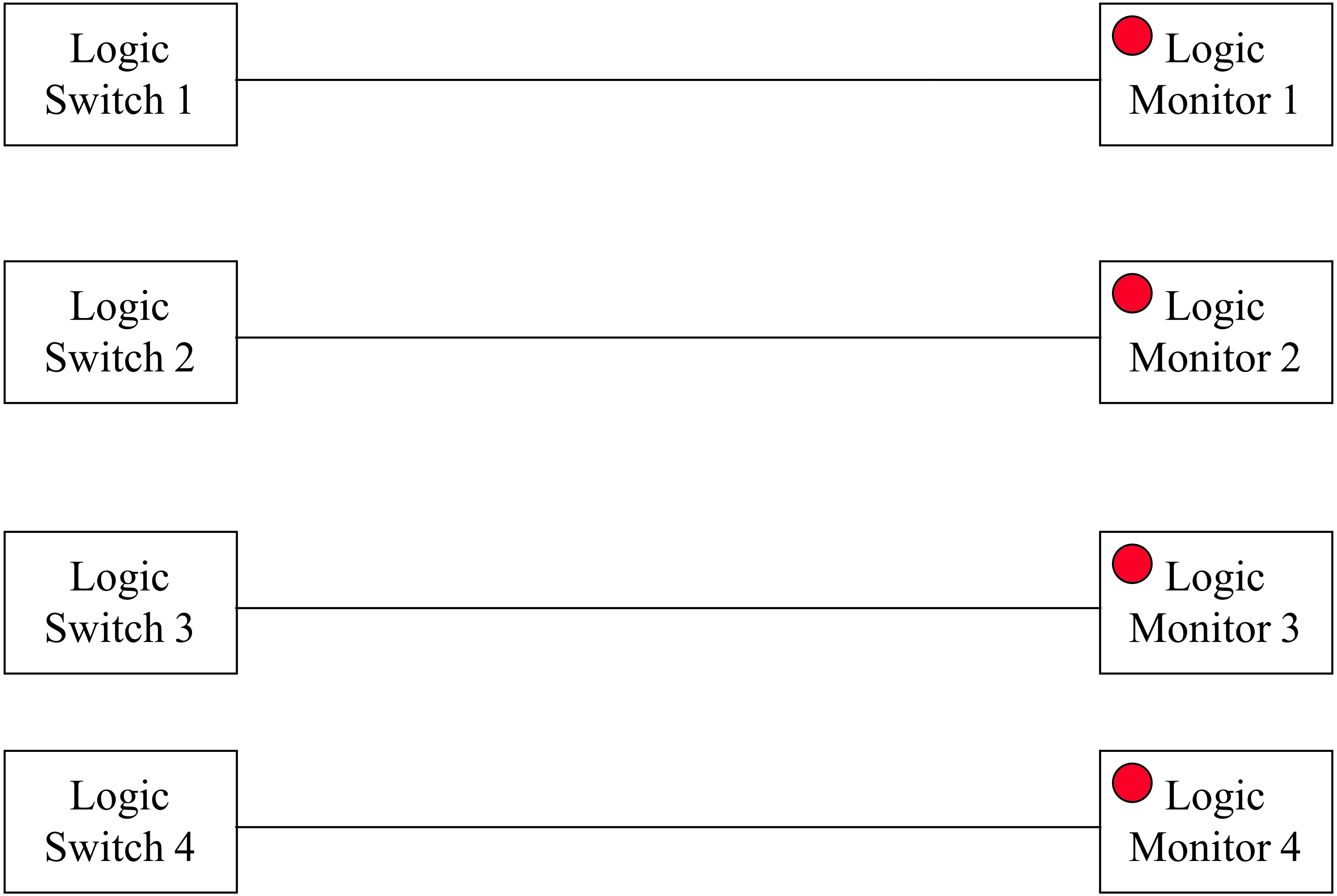
A Example of a Signal Level or State Diagram.

Digital Logic.

- Using the Logic Box. See Circuit 1.
- Connect Logic State Input Switches to the LED Logic State Output Monitor Points.
- Note Switch **up** indicates a LOGIC “1” the Switch **down** is a LOGIC “0”
- Monitor and record on a truth table in you Log Book the Output state for all combinations of Logic Inputs.
- Note LED **on** indicates a LOGIC “1” the LED **off** is a LOGIC “0”

Circuit 1

Digital Logic.

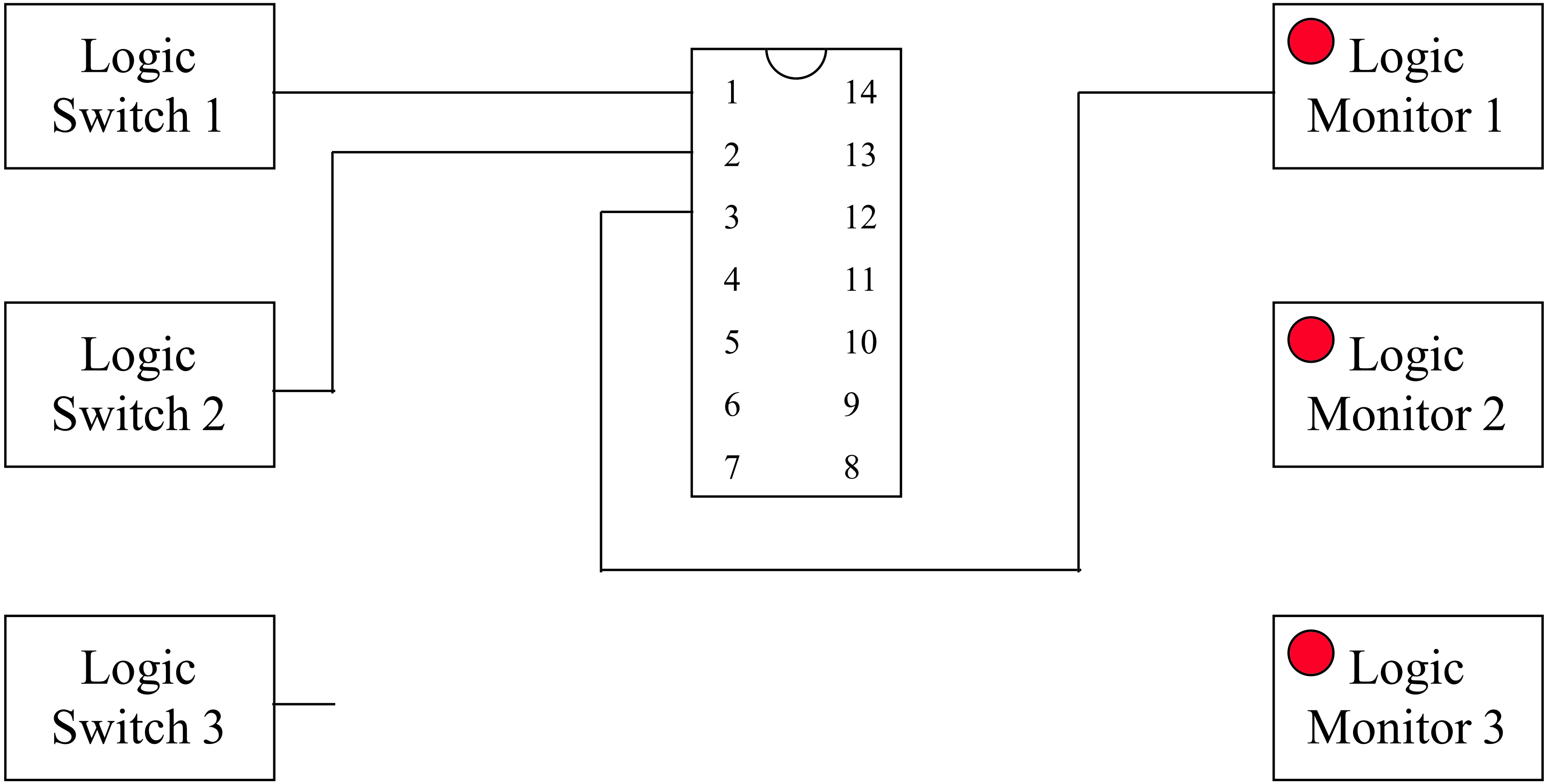


Digital Logic.

- Gates Test 1 Use Chip 4011.
- Using Circuit 2 as an example Connect Switch Logic levels to Pins 1 and 2 of the 4011 Integrated circuit chip.
- Monitor and record on a truth table the output state for all combinations of Logic Input.
- Conclusion Does the truth table you have drawn match the expected results ?

Circuit 2

Digital Logic.



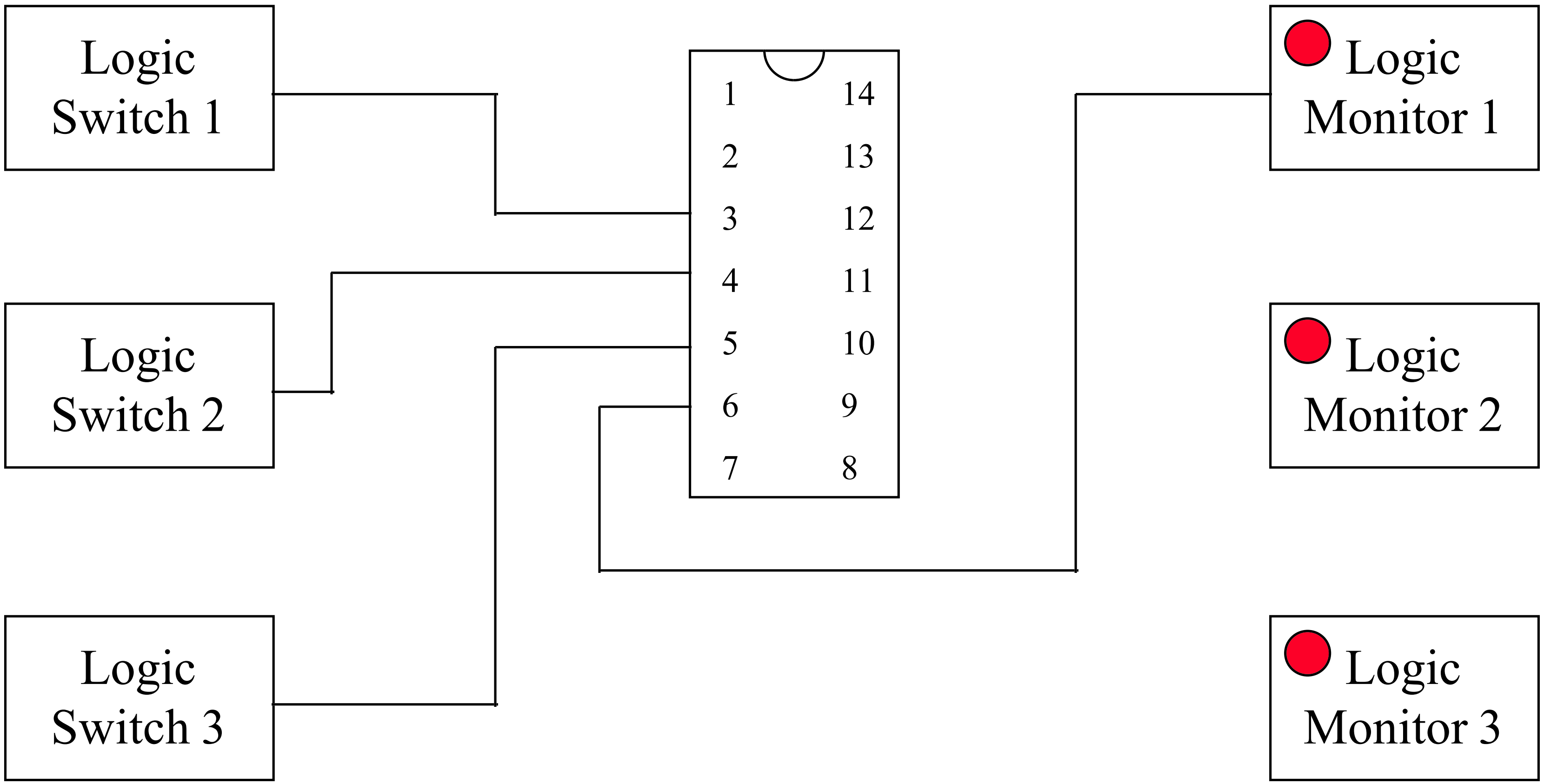
Apply +5V to Pin 14 and 0V or Ground to Pin 7

Digital Logic.

- Gates Test 2 Use Chip 4025.
- Using Circuit 3 as an example Connect Switch Logic levels to Pins 1, 2 and 3 of the 4025 Integrated circuit chip.
- Monitor and record on a truth table the output state for all combinations of Logic Input.
- Conclusion Does the truth table you have drawn match the expected results ?

Circuit 3

Digital Logic.



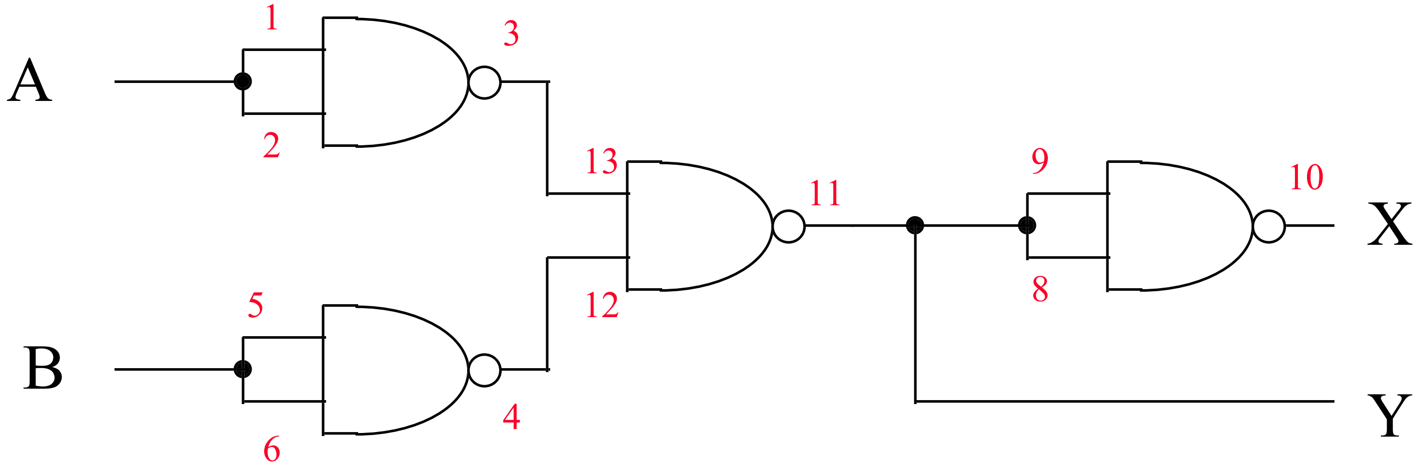
Apply +5V to Pin 14 and 0V or Ground to Pin 7

Digital Logic.

- Gates Test 3 Use Chip 4011.
- Build the circuit shown in Circuit 4.
- Monitor and record on a truth table the output state for all combinations of Logic Input.
- Conclusion Does the truth table you have drawn match the expected results ?
- What logic functions has been created by this gate combination.

Circuit 4

Digital Logic.



Use Chip 4011

Apply +5V to Pin 14 and 0V or Ground to Pin 7

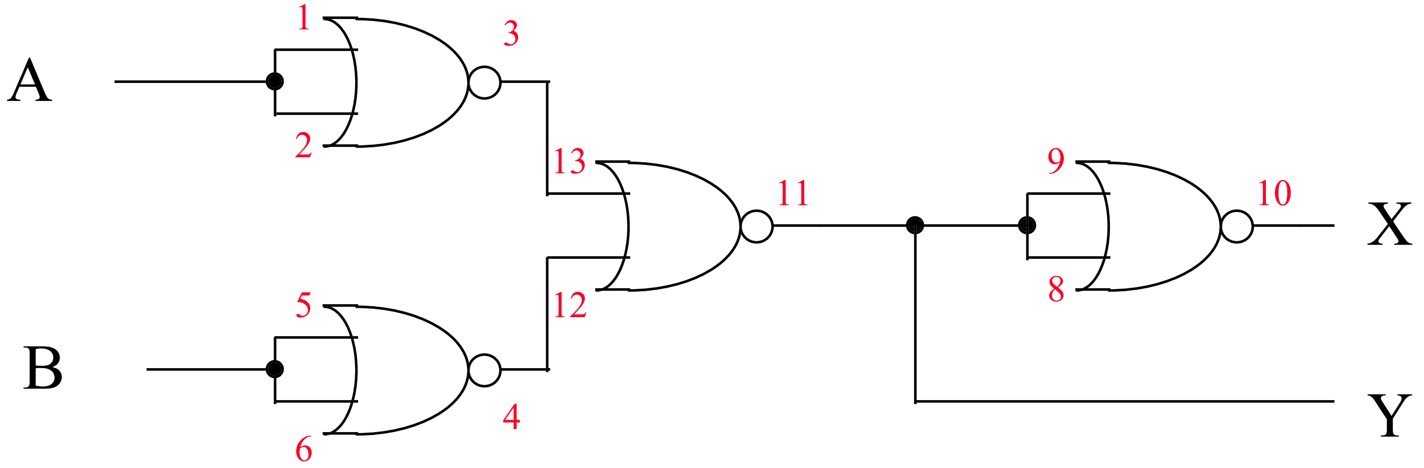
Suggested Pin configuration

Digital Logic.

- Gates Test 4 Use Chip 4001.
- Build the circuit shown in Circuit 5.
- Monitor and record on a truth table the output state for all combinations of Logic Input.
- Conclusion Does the truth table you have drawn match the expected results ?
- What logic functions has been created by this gate combination.

Circuit 5

Digital Logic.



Use Chip 4001

Apply +5V to Pin 14 and 0V or Ground to Pin 7

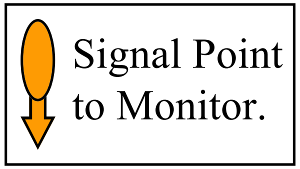
Suggested Pin configuration

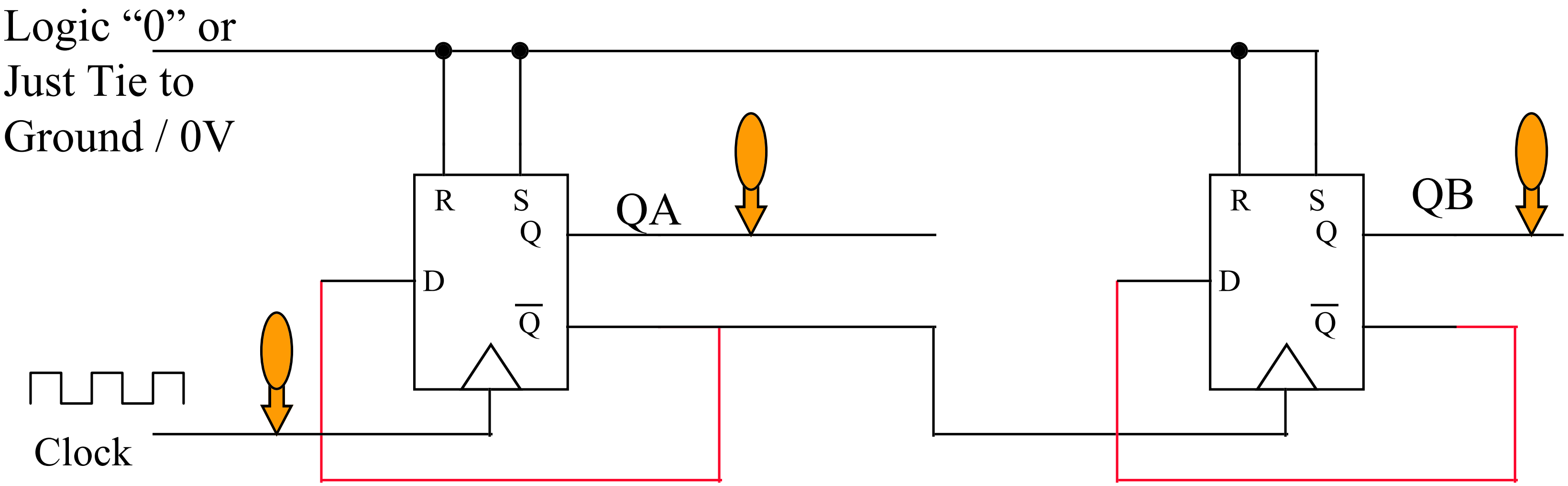
Digital Logic.

- Counters Test 1 Use Chip 4013.
- Build the circuit shown in Circuit 6.
- Monitor and record on a Signal State Diagram the Output state of all the indicated monitor points.
- Conclusion What does the Signal State Diagram indicate to you ?

Circuit 6

Logic Functions.





Set Clock to 1Hz, If speed too fast to see what is happening then create a manual Clock using a Debounce Logic Switch. Toggle it at an appropriate speed to record results.

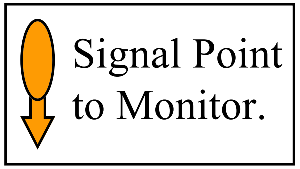
Apply +5V to Pin 14 and 0V or Ground to Pin 7

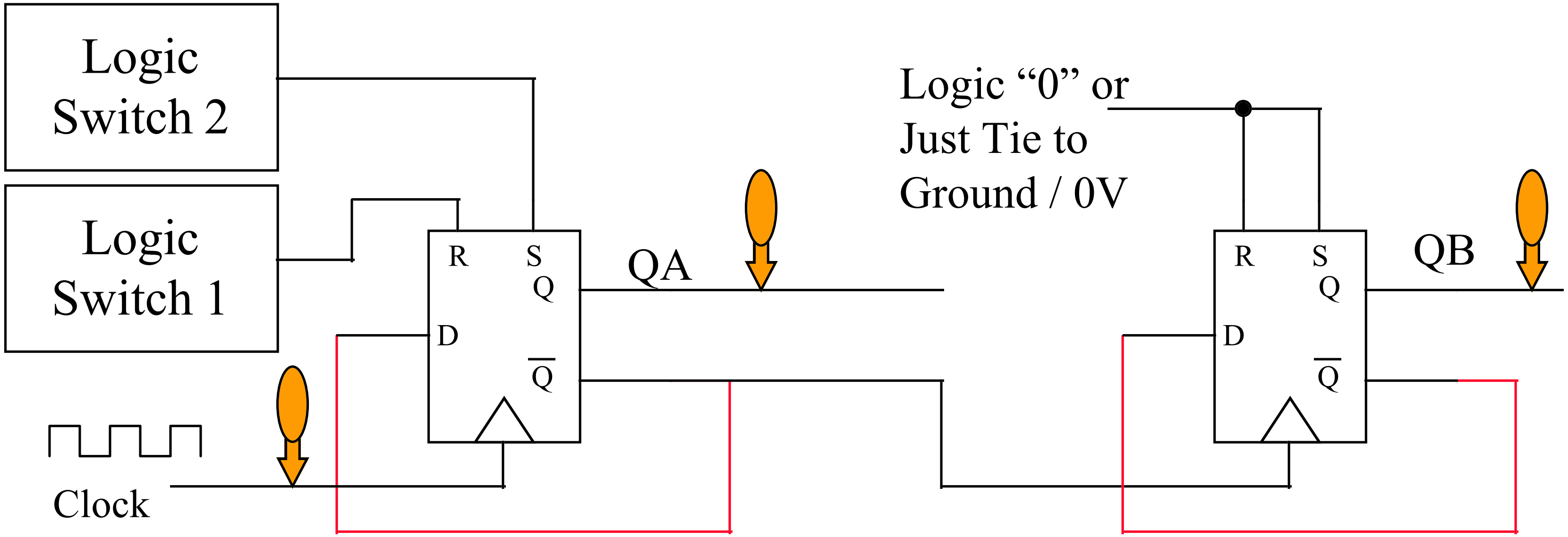
Use Chip 4013

Digital Logic.

- Counters Test 2 Use Chip 4013.
- Build the circuit shown in Circuit 7.
- Toggle the R and S logic inputs. Monitor and record on a Signal State Diagram or truth table the Output state of the indicated monitor points.
- Conclusion What effect do the R & S inputs have on the circuit ?

Circuit 7 Logic Functions.





Set Clock to 1Hz.

Apply +5V to Pin 14 and 0V or Ground to Pin 7

Use Chip 4013

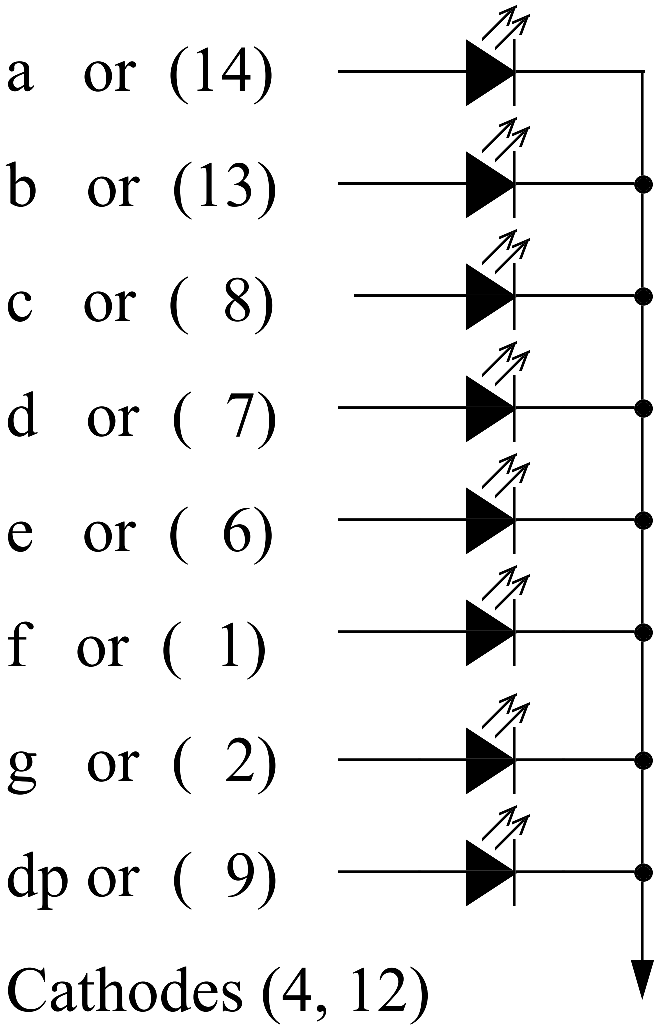
Digital Logic.

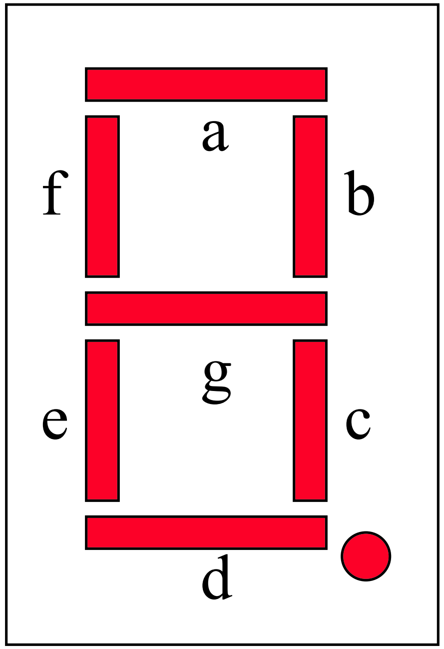
- Counters Test 3 Use Chip 4013.
- Build two copies of the the circuit shown in Circuit 6. Chain the two circuits together.
- Monitor and record on a Signal State Diagram the Output state of all the indicated monitor points.
- With the information gained in this circuit and Circuit 7. Create a counter that divides an input clock by TEN.

Digital Logic.

- Decoder Test 1   Use Seven Segment LED.
- Use a Switch Logic "1" to display a "1" on a Seven Segment Display.
- Use a Switch Logic "0" to display a "0" on a Seven Segment Display.
- **Note**   You need to define what Segments need to be lit for each logic state before you attempt to wire up circuit.
- **Note**   Some segments are not connected.

Digital Logic.





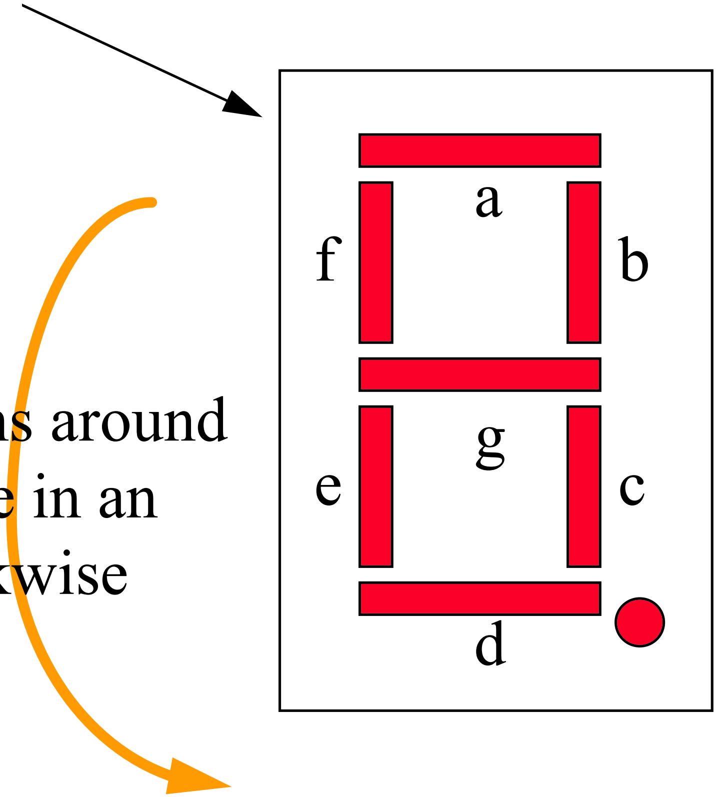
N/c Pins are (3,5,10 and 11)

(The Common Cathode) Seven Segment Display.

Digital Logic.

Pin 1 is at the Top Left hand Corner.

Count pins around the device in an anti-clockwise direction.



N/c Pins are (3,5,10 and 11)

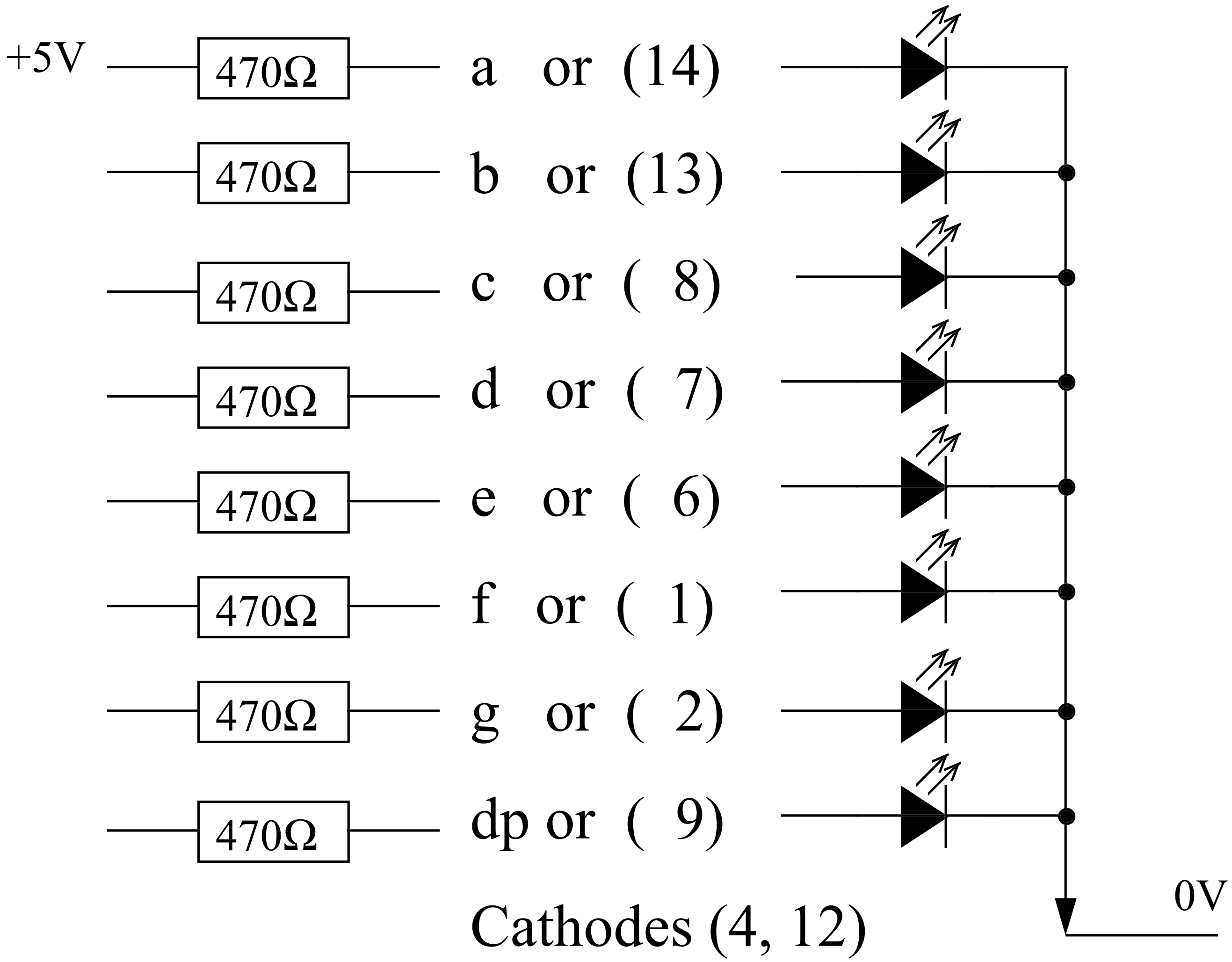
(The Common Cathode) Seven Segment Display.

Digital Logic.

+5V to Switch ON

or

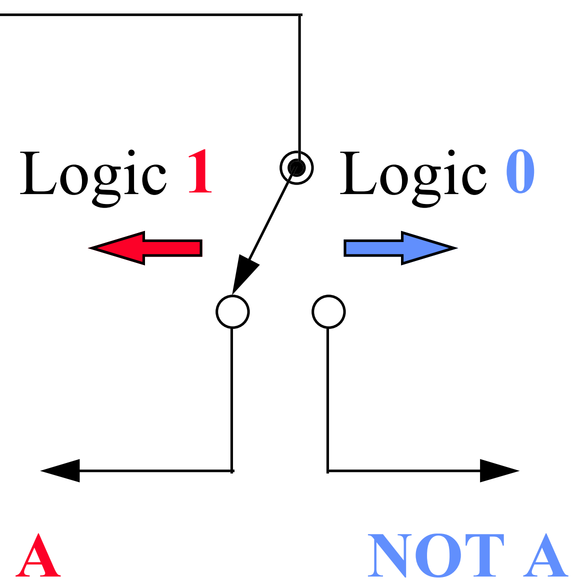
0V to Switch OFF.



(The Common Cathode) Seven Segment Display.

Digital Logic.

+5V

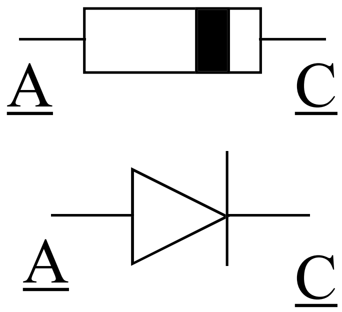


Use "**A**" to Display a ONE character and use "**NOT A**" to Display a ZERO on the Seven Segment Display.

0V

Switch Logic Options.

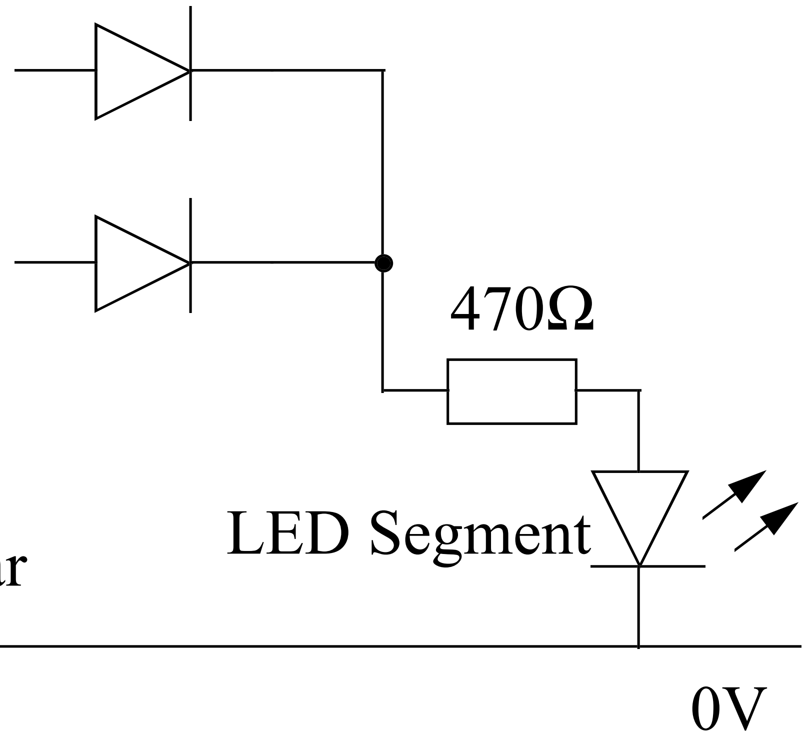
Digital Logic.



Repeat these circuit elements as required.

Segment Choice “0” if required.

Segment Choice “1” if required.

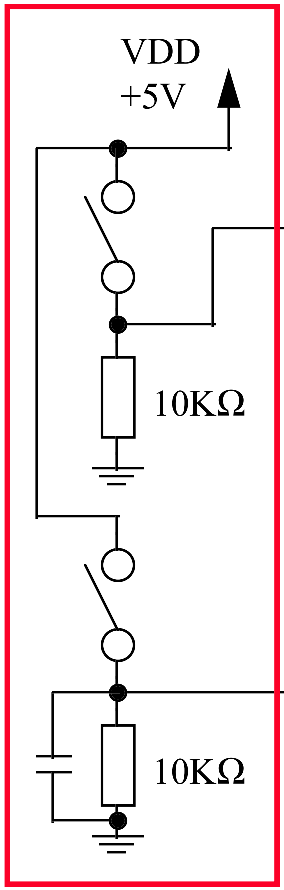


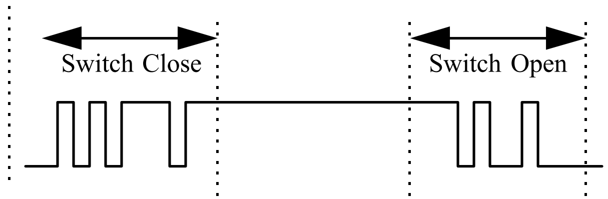
Diodes are 1N4001 or similar

Digital Logic.

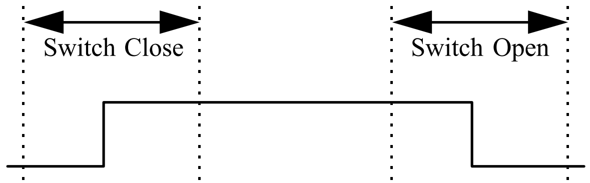
- One Shot Test 1 Use Chip 4013.
- Build the circuit shown in Circuit 8.
- Monitor and record on a Signal State Diagram the Output state of all the indicated monitor points.
- Conclusion How might this circuit be used to control a 4026 chip ? What would happen if the following clock signal was applied to this circuit after a Reset signal.

Logic Functions.

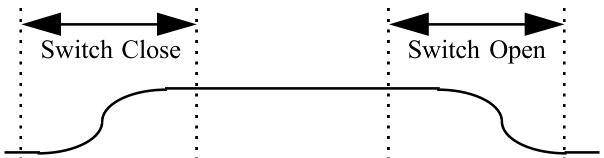




Switch without Debounce.



Ideal Debounce Output.

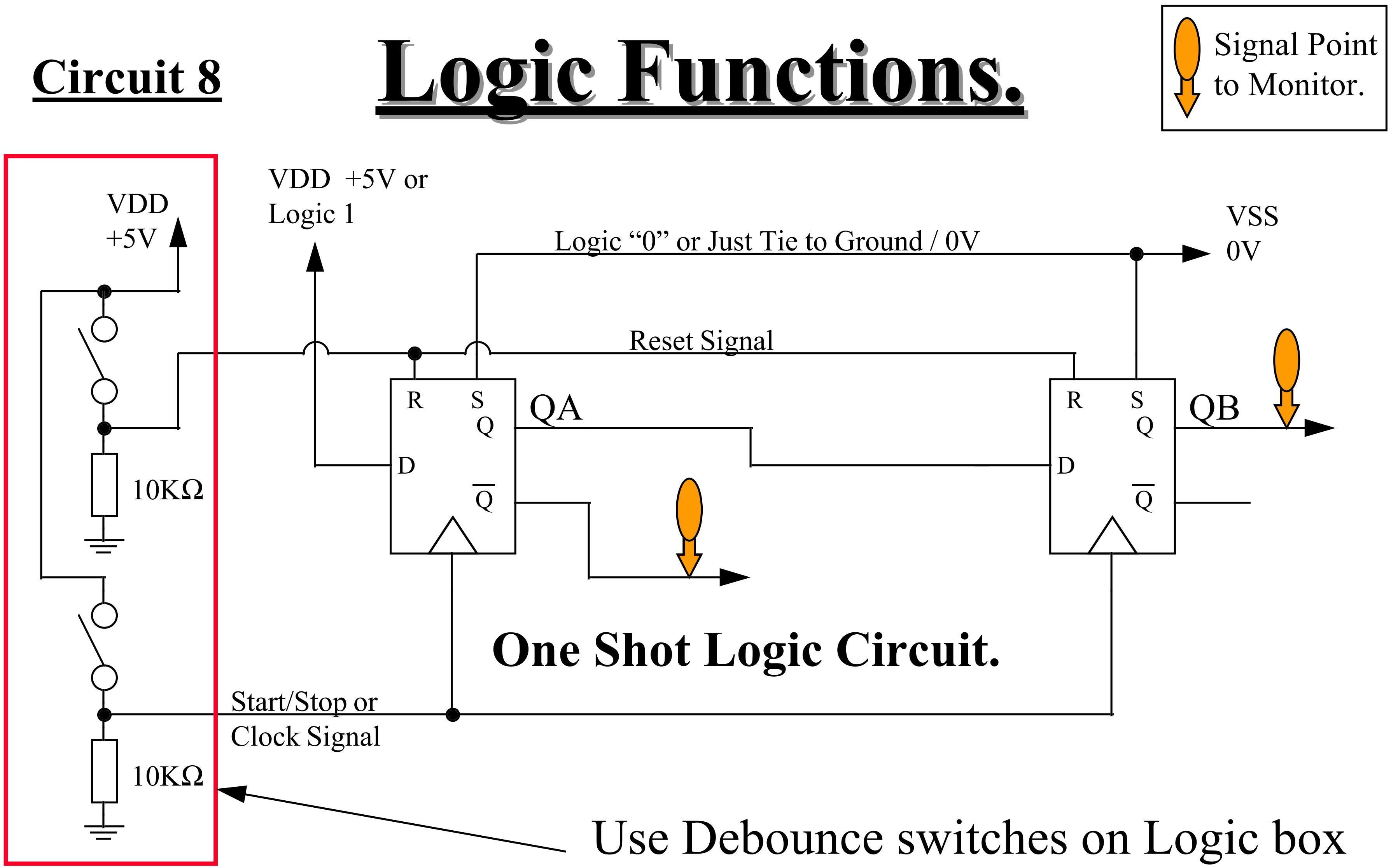


Switch with Capacitor Debounce.

Debounce Switches on Logic Box.

Circuit 8

Logic Functions.

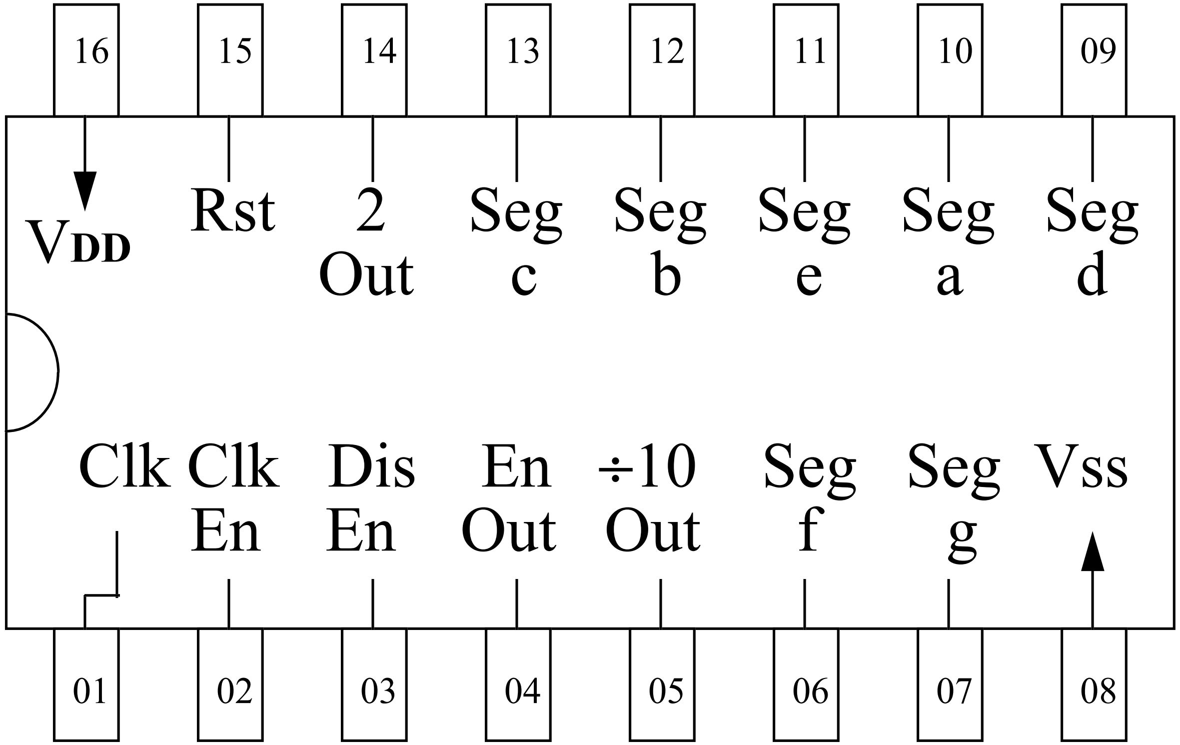


Use Debounce switches on Logic box to simulate these circuits

Use Chip 4013

Remember to Apply +5V to Pin 14 and 0V or Ground to Pin 7

Digital Logic.



Seg = Segment

Rst = Reset

÷10 = Clk/10

Dis = Display

En = Enable

Clk = Clock

V_{DD} = +5V

Vss = Ground / 0V

Physical Layout Diagram for 4026

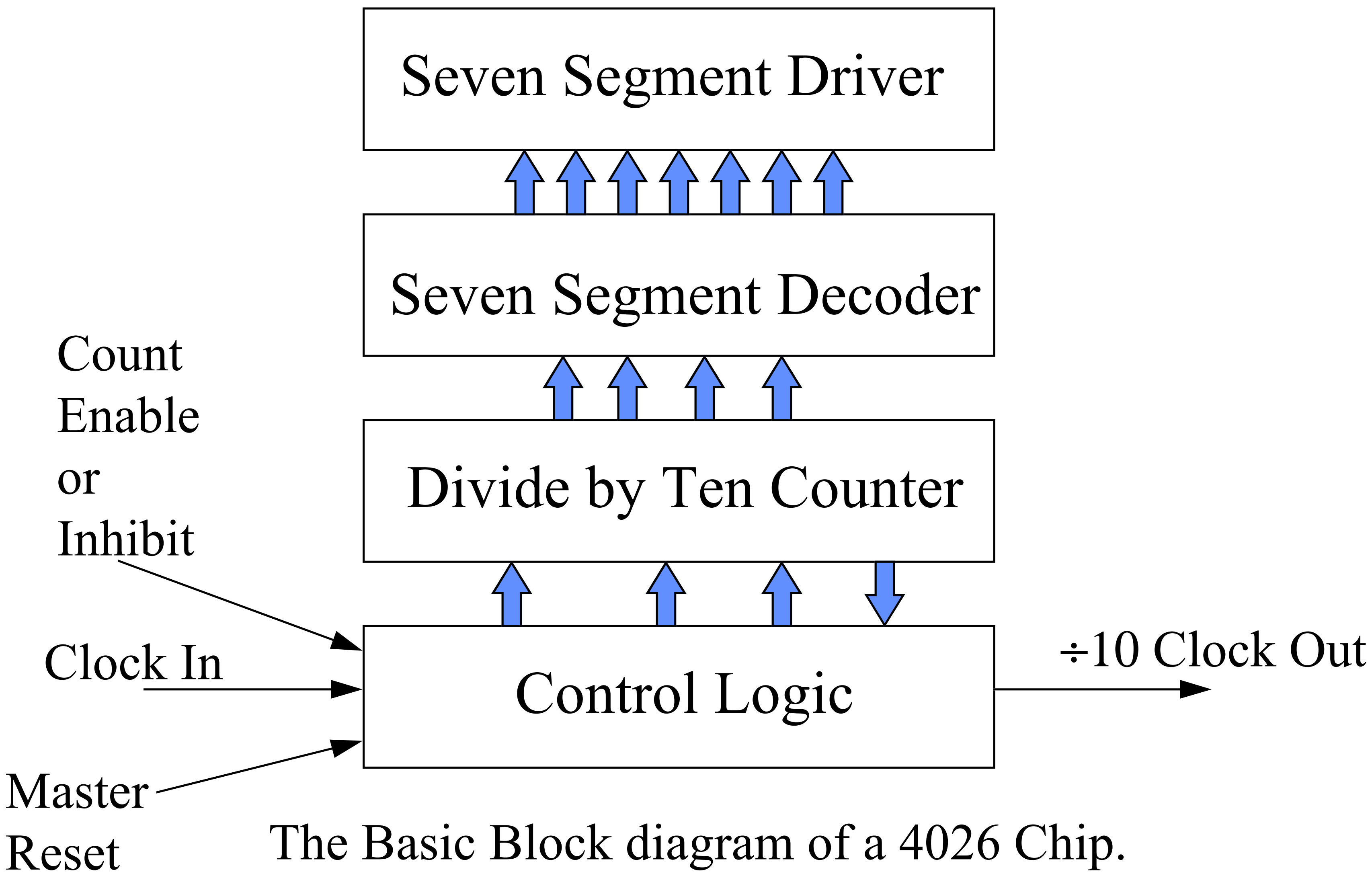
Digital Logic.

Control Signals of the 4026 Chip.

Reset	Count Enable	Effect
1	Dont Care	Chip Reset, Count=0
0	1	Counting Inhibited
0	0	Counting Permitted

Display Enable = 0 = Display off
Display Enable = 1 = Display on

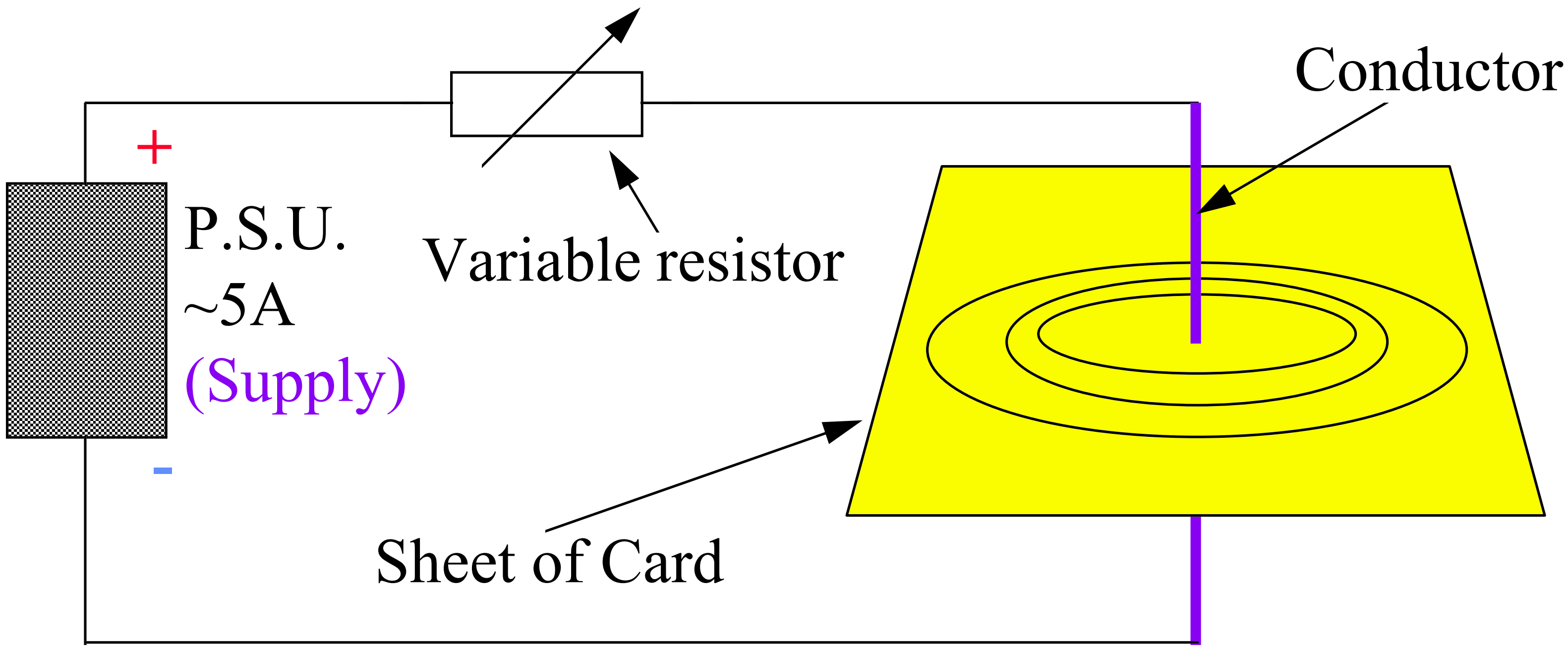
Digital Logic.



The Basic Block diagram of a 4026 Chip.

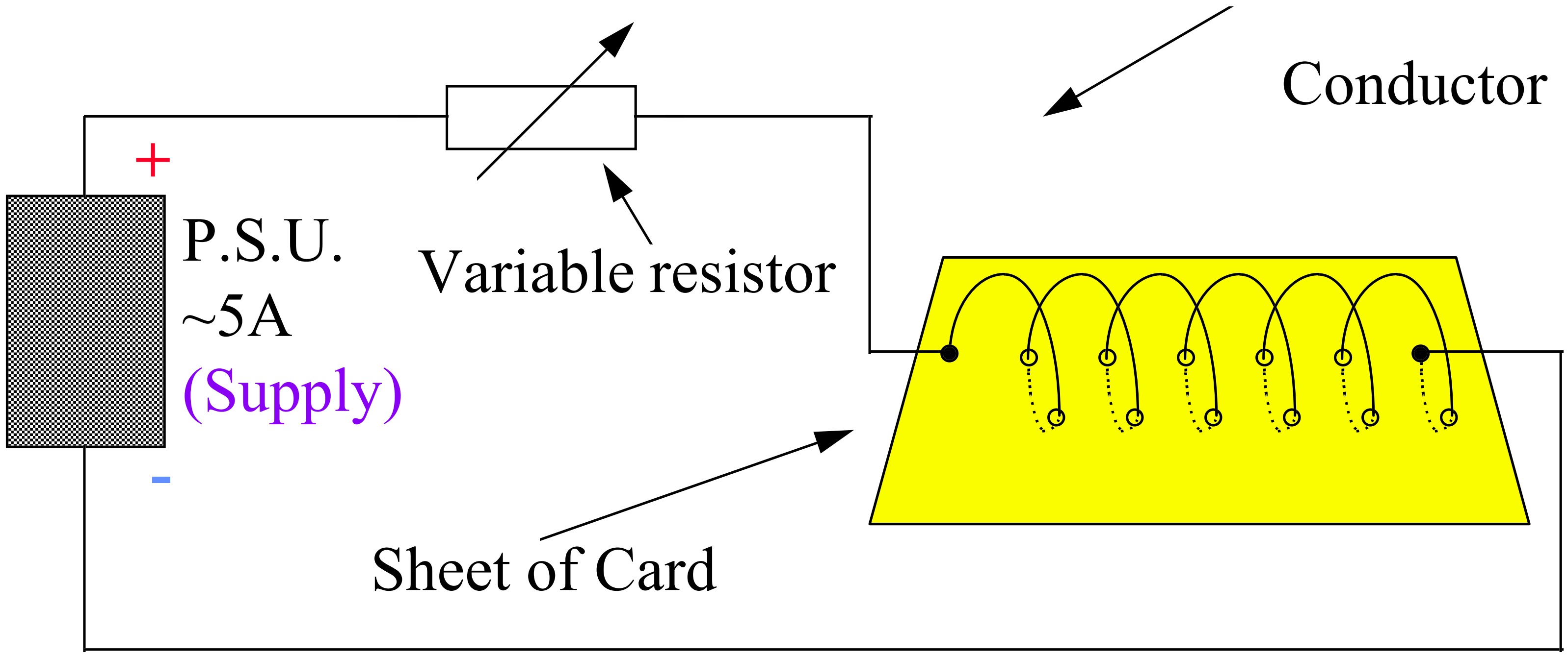
Experiment 11.

Magnetic Flux Experiments.



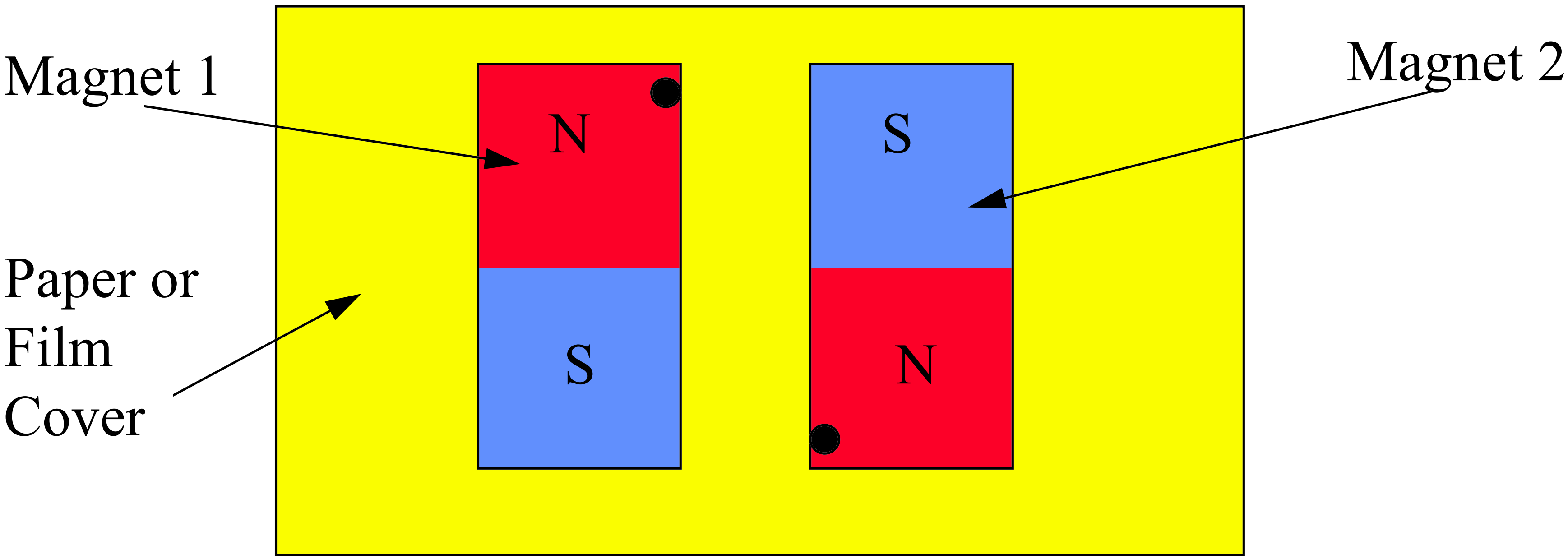
1. Apply/dust Iron filings on the card.
2. Apply current to the conductor (to set up a magnetic field)
3. Gently tap card so Iron filings mark the lines of flux
4. Sketch patterns the Iron filings make on the card.

Magnetic Flux Experiment 1.



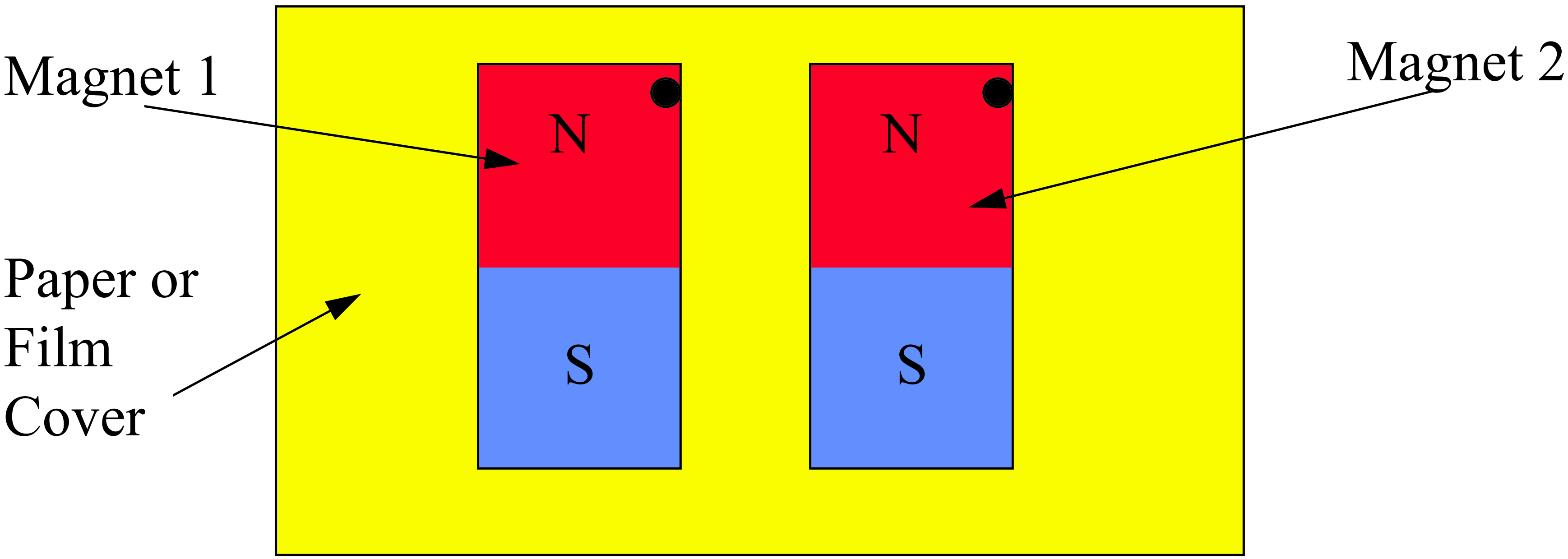
1. Apply/dust Iron filings on the card.
2. Apply current to the conductor (to set up a magnetic field)
3. Gently tap card so Iron filings mark the lines of flux
4. Sketch patterns the Iron filings make on the card.

Magnetic Flux Experiment 2.



1. Position magnets in holder as shown above.
2. Protect magnets with cover.
3. Apply/dust Iron filings on the card.
4. Gently tap card so Iron filings mark the lines of flux
5. Sketch patterns the Iron filings make on the card.

Magnetic Flux Experiment 3.



1. Position magnets in holder as shown above.
2. Protect magnets with cover.
3. Apply/dust Iron filings on the card.
4. Gently tap card so Iron filings mark the lines of flux
5. Sketch patterns the Iron filings make on the card.

Experiment 12.

Motors.

- Questions concerning the powering of a mechanical device using an electrical motor.

- How are we going to find how much Power is used by the electric motor that drives the mechanical device ?
- How are we going to find how much Power is developed by the electric motor that is driving the mechanical device ?

Motors.

- Most motors are reversible that is to say:

(1) They can convert electrical energy into mechanical power.

and conversely

(2) They can convert mechanical power into electrical energy.

Motors.

- We can measure electrical power easily:

(1) Use a meter to measure Voltage in Volts.

and

(2) Use a meter to measure Current in Amps.

(3) Power = Volts * Current

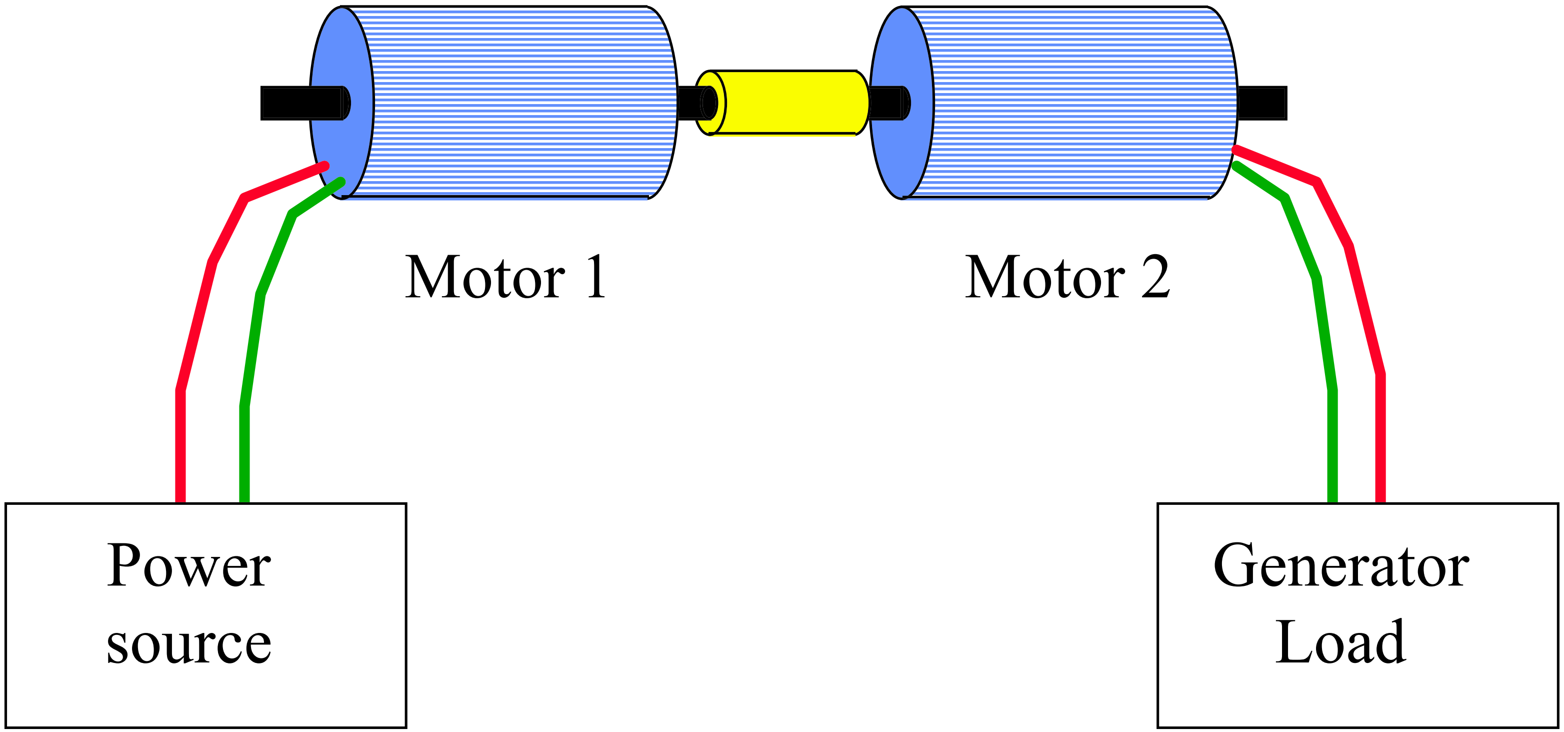
Motors.

- Purpose of the Experiment:
- To find how efficiently a motor converts electrical energy into mechanical energy.
- Assumptions:
- Any losses in the system will be equally divided between the motor and the generator.

Motors.

Connect motors as follows:

One motor will drive the shaft and the other motor will act as a power generator.



Motors.

(1) Power = Volts * Current

(2) Current = Voltage / Resistance

Substitute (2) into (1)

Power = Voltage * Voltage / Resistance

or

Power = Voltage^2 / Resistance

Motors.

Method (part 1)

1. Measure Power used by the motor.
2. Measure Power created by the generator.

Use Loads in table and then calculate efficiency η {Eta} as a percentage.

$$\eta = \frac{\text{Shaft Power}}{\text{Input Power}} = \frac{\text{Input Power - Losses * 100\%}}{\text{Input Power}}$$

Motors.

Method (Part 2)

Calculate:

Power Loss= Input Power - Output Power

Power Loss per Motor = Power Loss /2

Motors.

I/P Voltage	I/P Current	Load Resistance	O/P Voltage
12V		50Ω	
12V		100Ω	
12V		200Ω	
12V		300Ω	
12V		400Ω	

Motors.

Load Resistance	I/P Power	O/P Power	Losses
50Ω			
100Ω			
200Ω			
300Ω			
400Ω			

Motors.

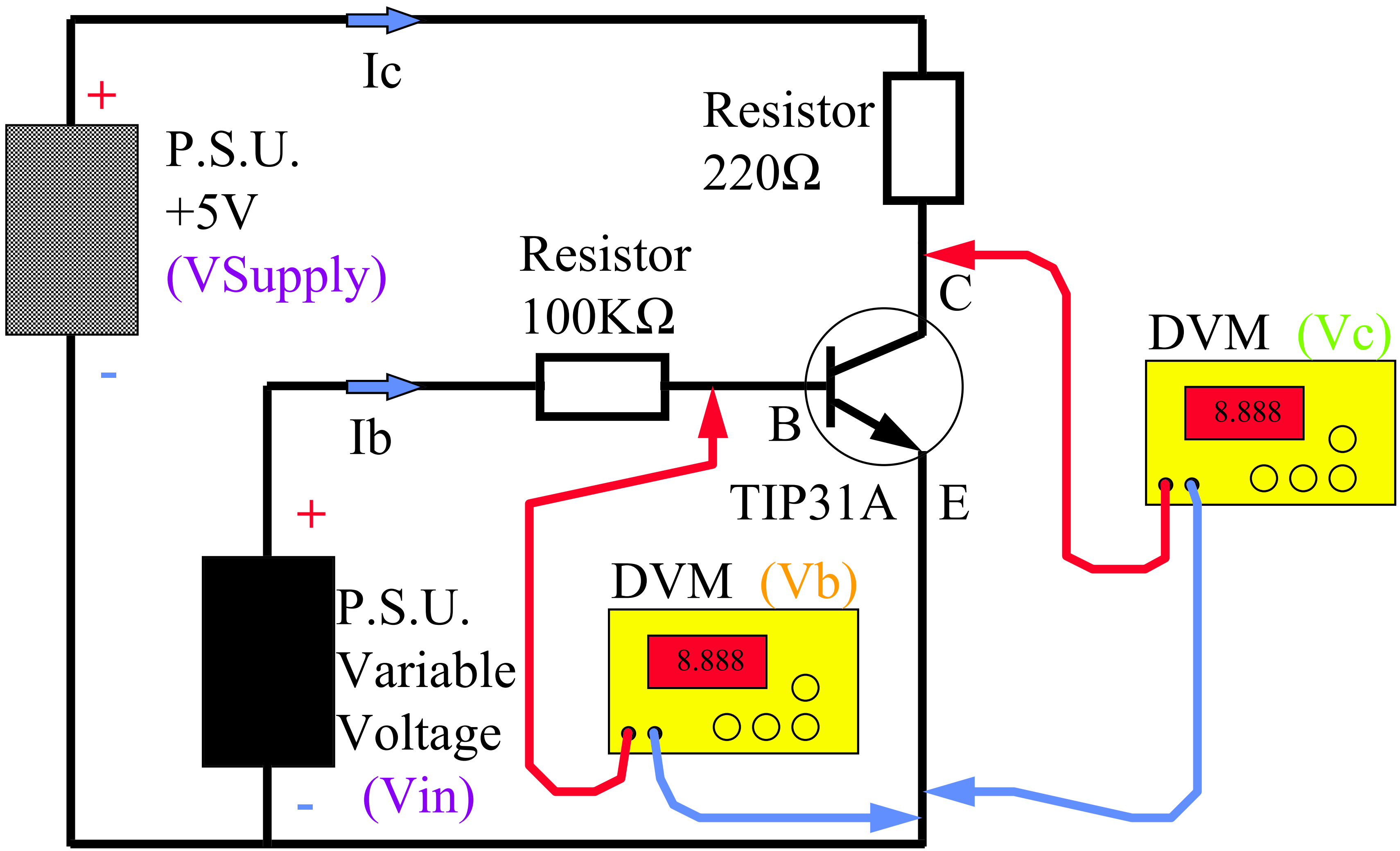
Load Resistance	I/P Power	Losses/2	Efficiency %
50Ω			
100Ω			
200Ω			
300Ω			
400Ω			

Experiment 13.

Transistors.

- Build “Circuit 1”.
- Monitor the Base Voltage.
- Adjust (Vin) from 1.5V to 25V.
- On your worksheet:-
  - Record Voltage level (Vb) when Collector Voltage (Vc) starts to change.
  - Record Voltage level of (Vb) when (Vin) reaches 25V.
- What happened to (Vc) as (Vb) approached 0.5V as (Vin) was adjusted from 1.5V ?

Transistors.

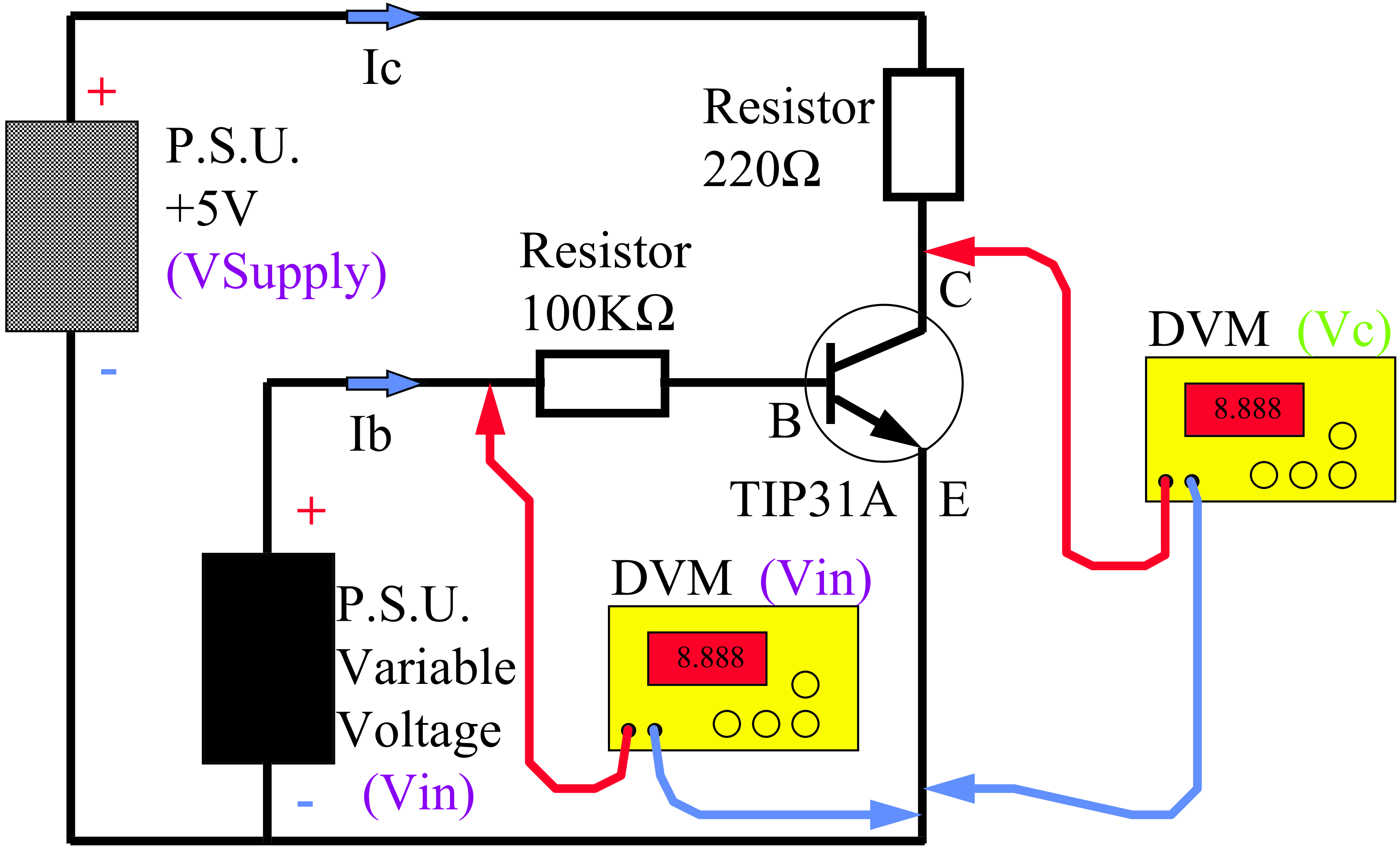


Circuit 1

Transistors.

- Build “Circuit 2”.
- Monitor the Collector Voltage (Vc).
- Adjust (Vin) from 0V to 29V in 1V steps.
- On your worksheet:-
  - Record Voltage level at the Collector for each change of (Vin). and enter them into the spreadsheet.
  - Identify on your graph where the Transistor becomes saturated.
  - Show how you may use your graph to calculate the current gain of the transistor.

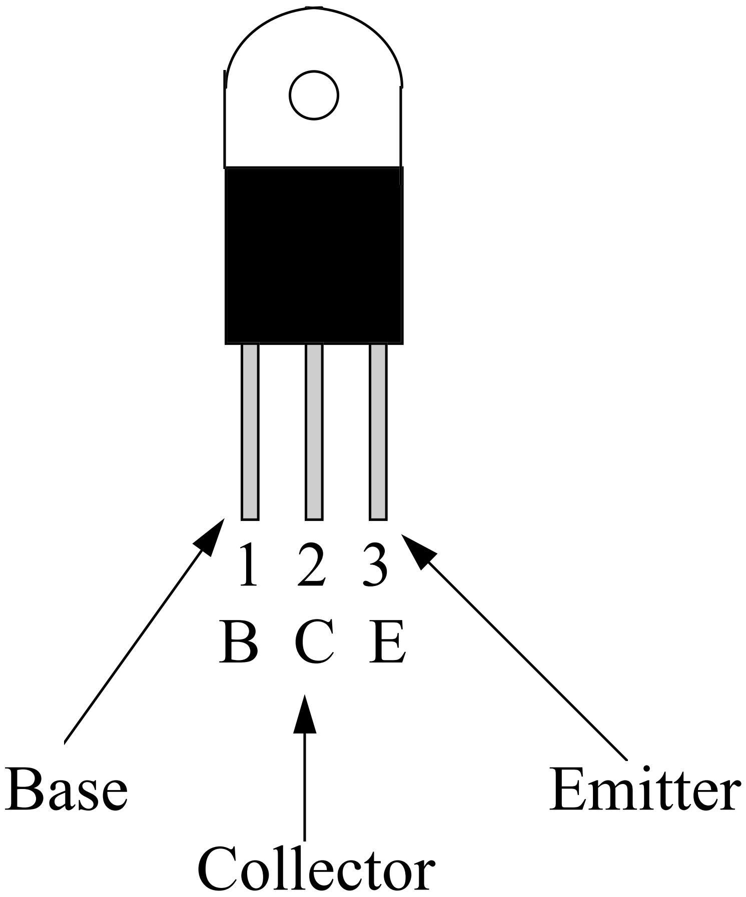
Transistors.



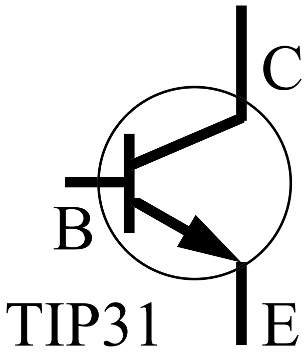
Circuit 2

Transistors.

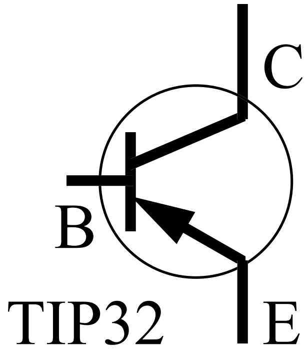
Face on View



NPN Transistor



PNP Transistor

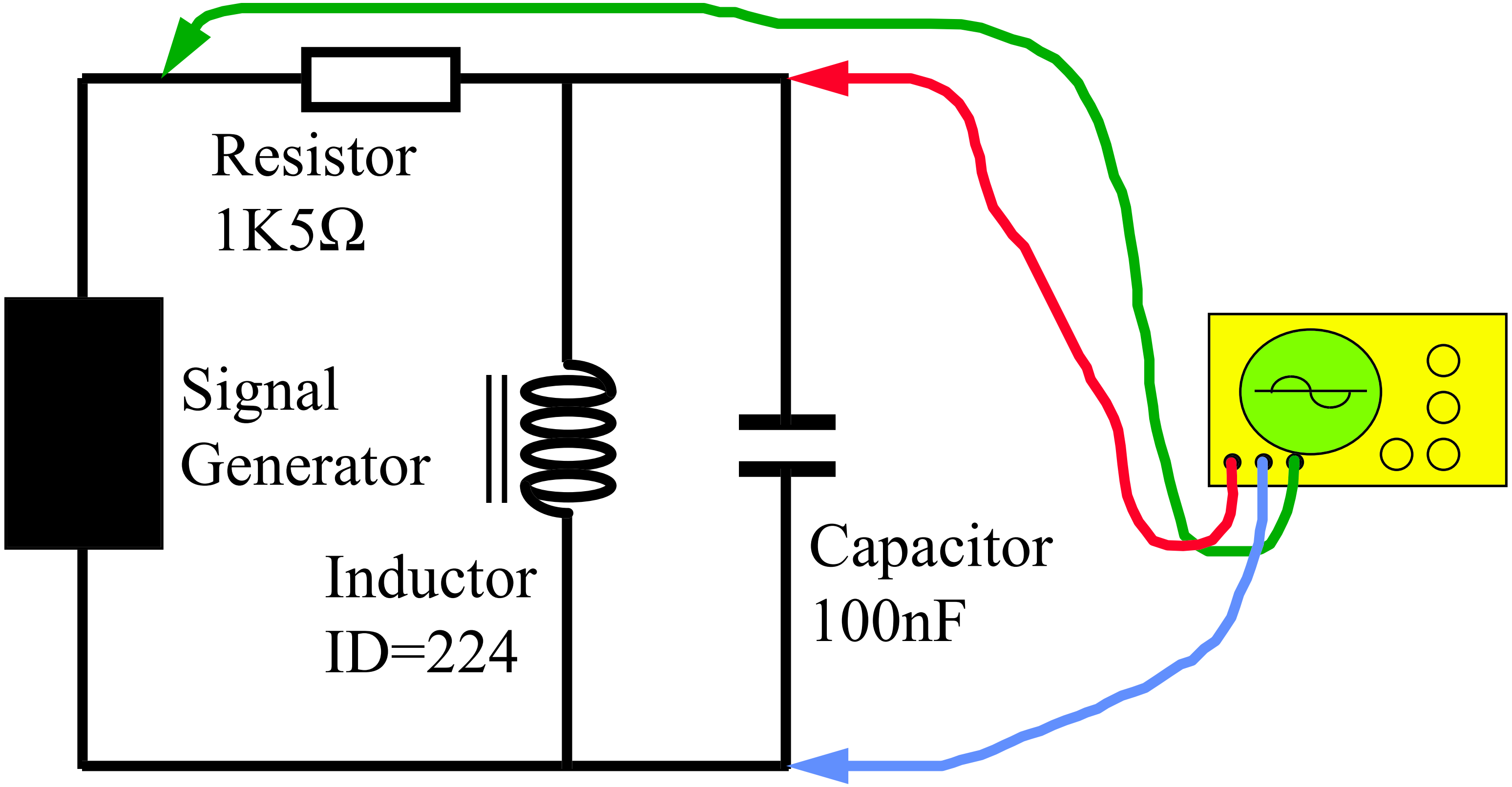


Pin Layout for these particular transistors.

Experiment 14.

Inductors and Capacitors.

Set Signal generator to a Sine wave with a frequency of 30KHz and an amplitude of 2 Volts peak to peak.



Circuit 1

Inductors and Capacitors.

- Build “Circuit 1”.
- With initial settings sketch the CRO display.
- Increase frequency to 40KHz sketch the CRO display.
- Decrease frequency to 30KHz in 1KHz steps. Record the amplitude of the the voltage across the Inductor.
- Plot a graph of the amplitude recordings against frequencies .

Inductors and Capacitors.

- If the value of Inductance was 0.22mH calculate the frequency where X*l* = Xc using the formulae.

$$\text{Frequency } f = \frac{1}{2\pi\sqrt{LC}}$$

Inductors and Capacitors.

- Conclusion:-
- What did you notice about the position of the Source Voltage with respect to the Voltage across the Capacitor, Inductor?
  - Did frequency effect this position/phase and if so how did it effect it?
- In what way did the frequency have an effect on the reactance of the Capacitor, Inductor circuit?
- What happened at frequency where $X_c = X_l$?

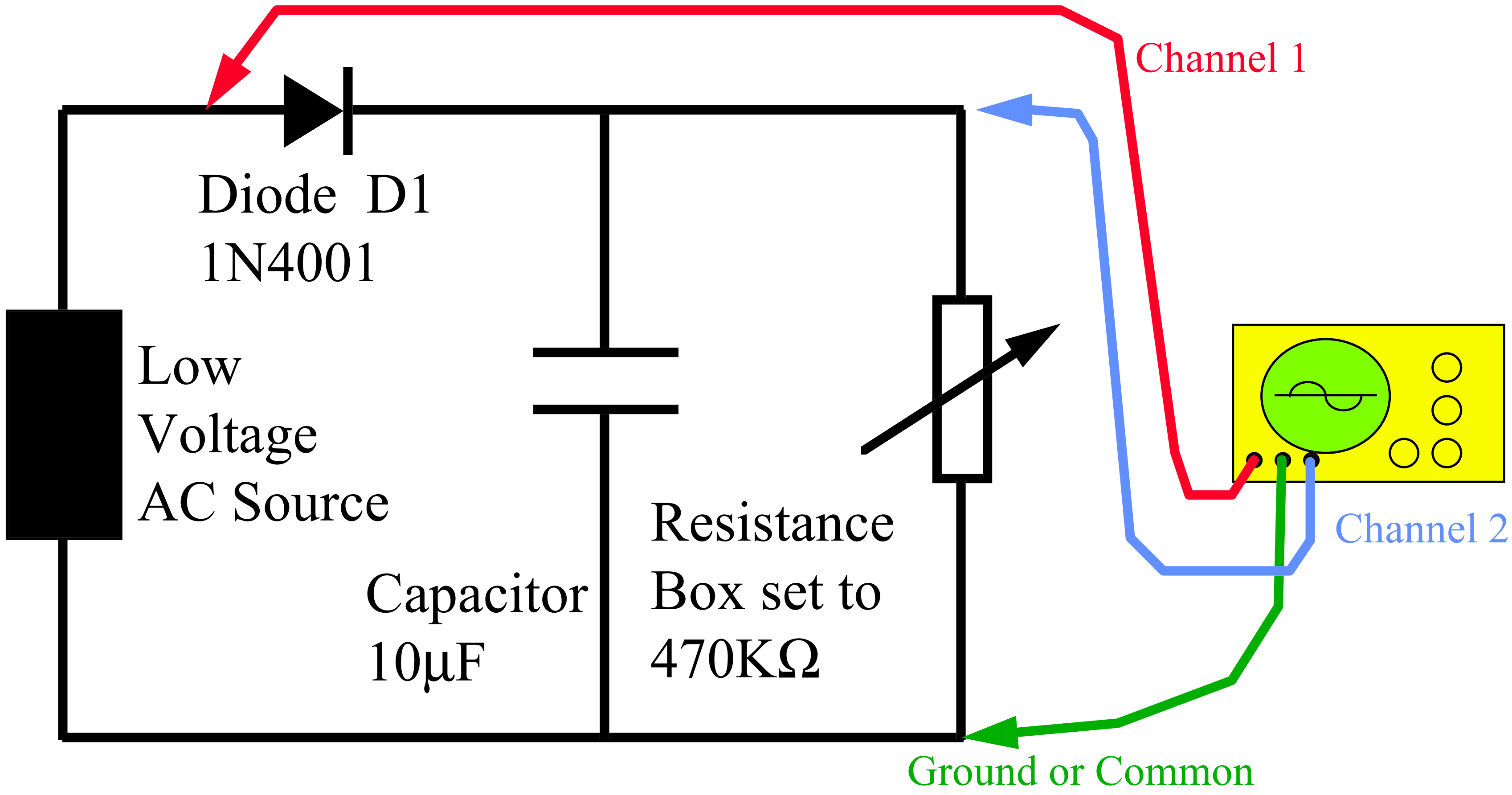
Experiment 15.

Power Units.

- Build "Circuit 1".
- With initial setting sketch CRO display.
- Reduce the Resistance Box value in steps to its lowest value and produce a table of measured Output voltage against Switched Resistance value.
- Sketch the CRO display on lowest resistance setting.
- Reset Resistance Box value back to 470KΩ.

Power Units.

Using a Transformer module to supply the Low Voltage AC Source build circuit shown below:-



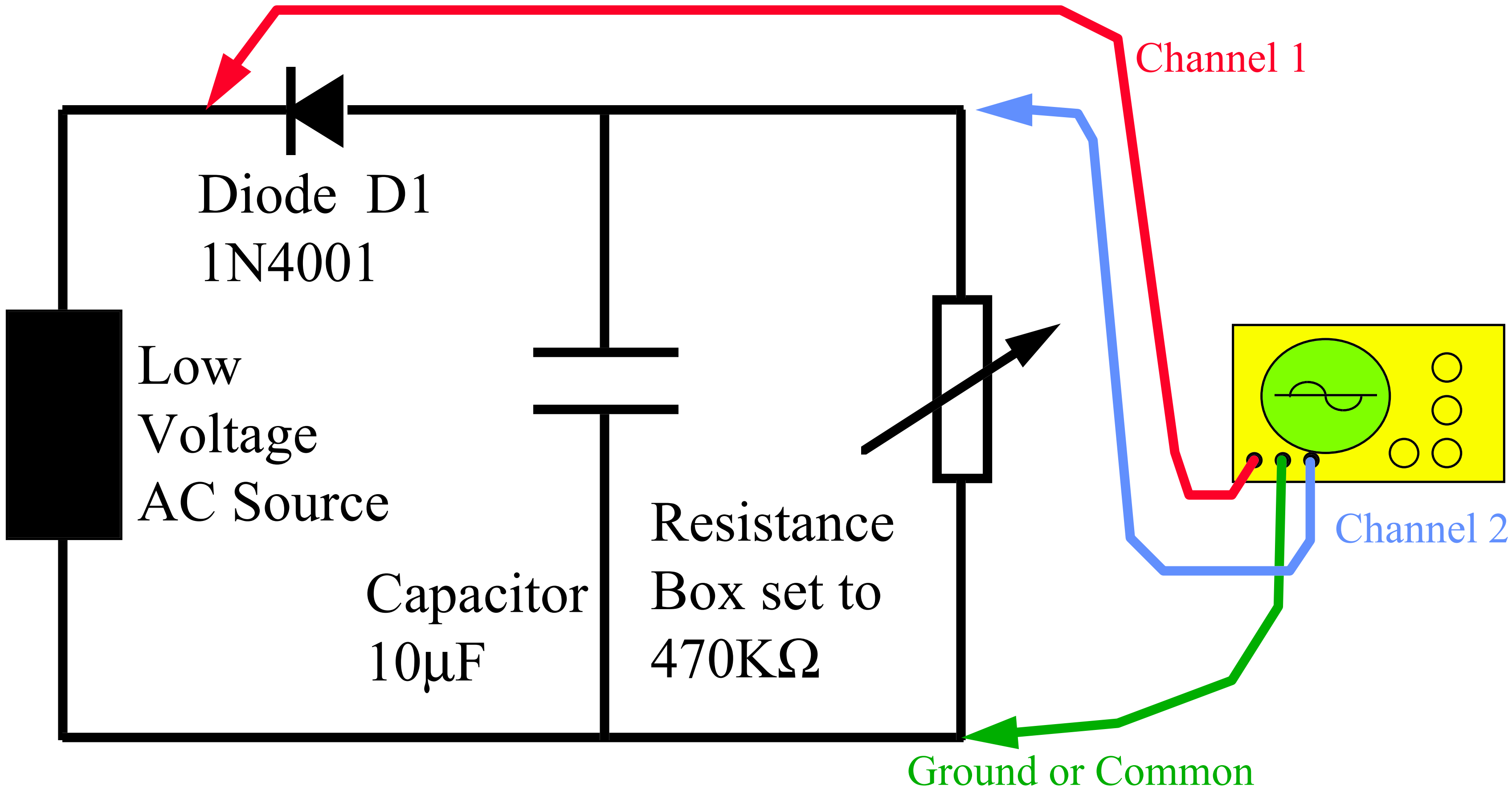
Circuit 1

Power Units.

- Build “Circuit 2”.
- With initial setting sketch CRO display.
- Reduce the Resistance box values in steps to its lowest value and produce a table of measured Output voltage against Switched Resistance value.
- Sketch the CRO display on lowest resistance setting.

Power Units.

Using a Transformer module to supply the Low Voltage AC Source build circuit shown below:-



Circuit 2

Power Units.

- Conclusion.
- When you reversed the Diode in Circuit 2 what happened to the output voltage ?
- What happened to the output voltage as the Resistance box value changed from 470KΩ down to ...KΩ?
- What frequency was the ripple on the output voltage and what effect might this have on audio equipment ?

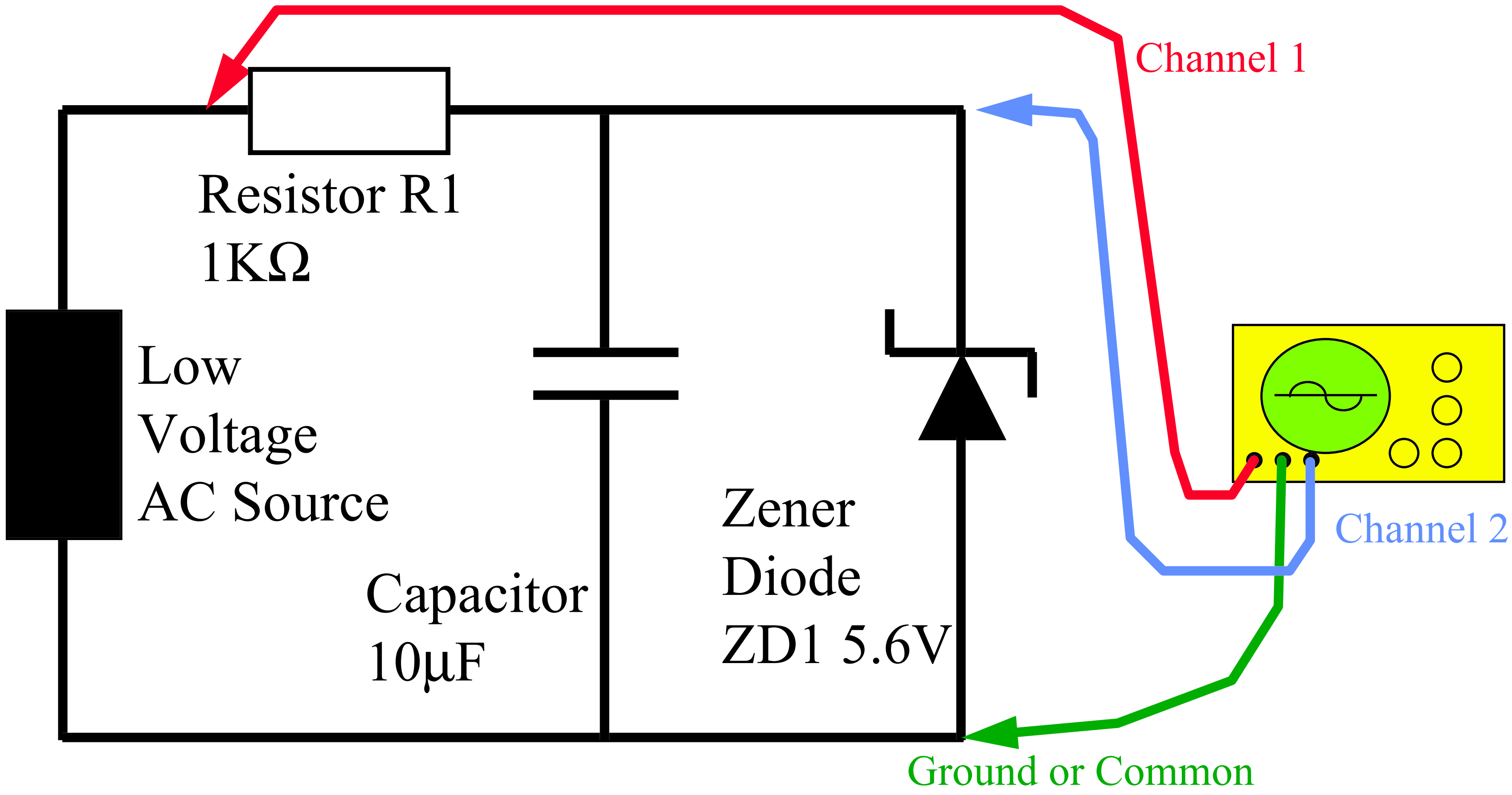
Experiment 16.

Power Units.

- Build “Circuit 1”.
- With initial setting sketch CRO display.
- Measure voltage across ZD1.
- Measure and calculate voltage across R1.
- Calculate current flowing through R1.

Power Units.

Using a Transformer module to supply the Low Voltage AC Source build circuit shown below:-



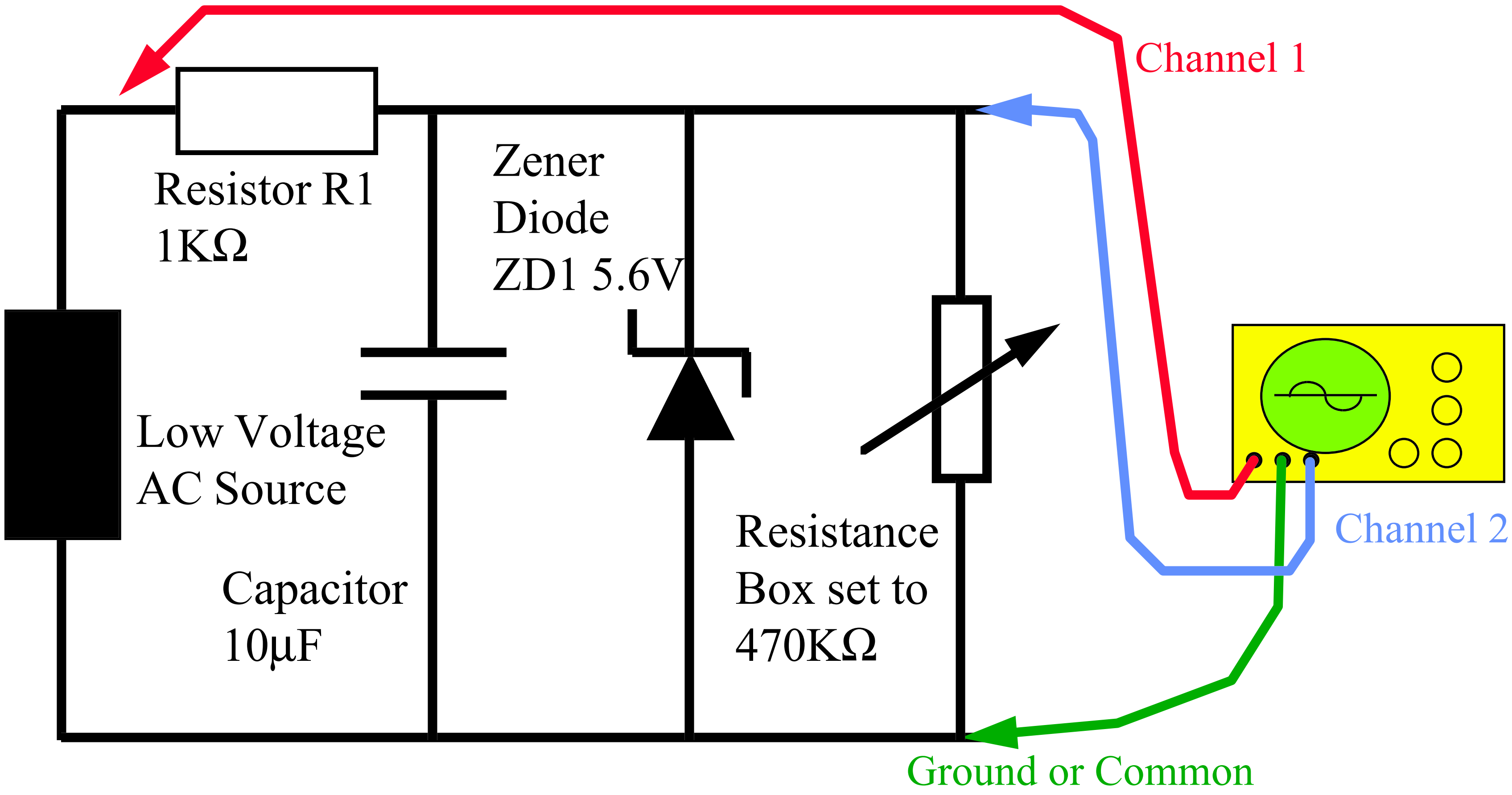
Circuit 1

Power Units.

- Build “Circuit 2”.
- With initial setting sketch CRO display.
- Measure voltage across ZD1.
- Measure voltage across R1.
- Reduce value of the Resistance box to less than circa 1000Ω and record what happens to the output voltage.
- Conclusion: explain your observations.

Power Units.

Using a Transformer module to supply the Low Voltage AC Source build circuit shown below:-



Circuit 2

Experiment 17.

Comparator.

Using the LM324

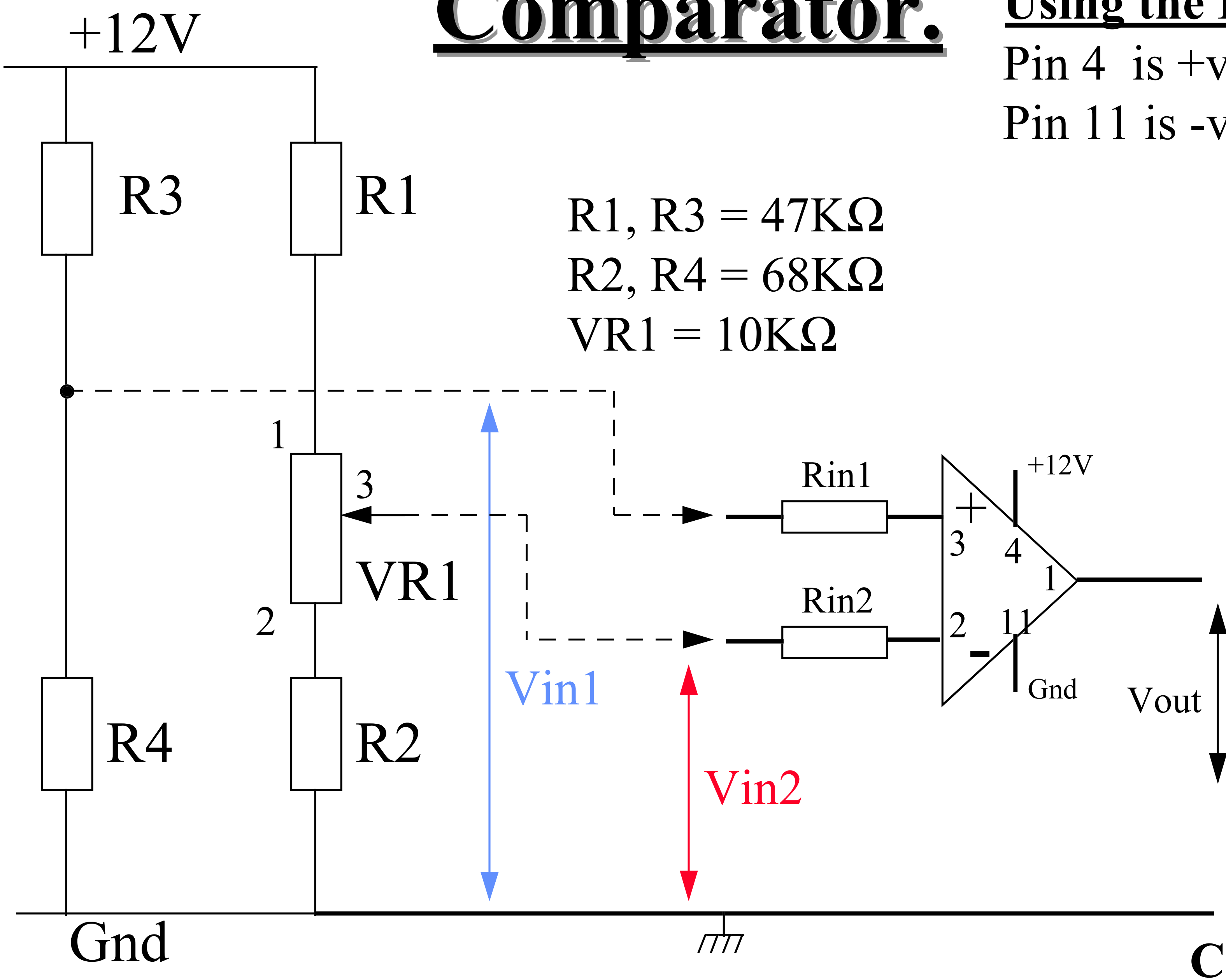
Pin 4 is +ve Supply

Pin 11 is -ve Supply

R1, R3 = 47KΩ

R2, R4 = 68KΩ

VR1 = 10KΩ



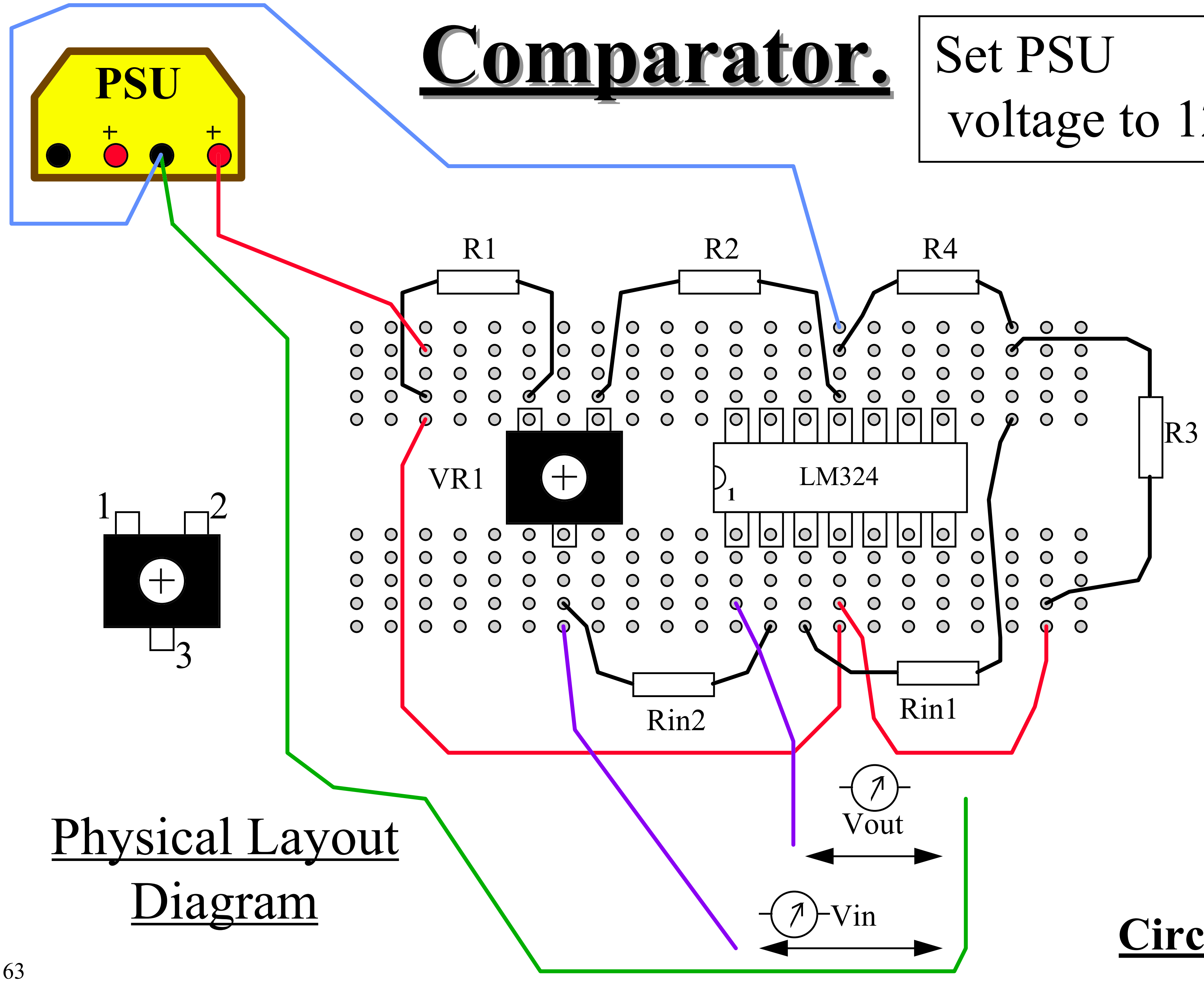
Circuit 1

Comparator.

- DC Test 1 Build “Circuit 1”.
- Set Rin1 and Rin2 = 10KΩ
- Measure and record the voltage across R4.
- Measure and record the voltage across R3.
- Adjust VR1 in approximately 30° Steps covering the devices whole rotational range.
- Monitor and record voltages Vin and Vout for each adjustment of VR1.

Comparator.

Set PSU voltage to 12V



Physical Layout Diagram

Circuit 1

Comparator.

- DC Test 2 Build "Circuit 2".
- Set Rin1 and Rin2 = 10KΩ
- Measure and record the voltage across R4.
- Measure and record the voltage across R3.
- Adjust VR1 to the point where the LED changes from OFF to ON State.
- Monitor and record voltage Vin where the LED just switches OFF.
- Monitor and record voltage Vin where the LED just switches ON.

Comparator.

Using the LM324

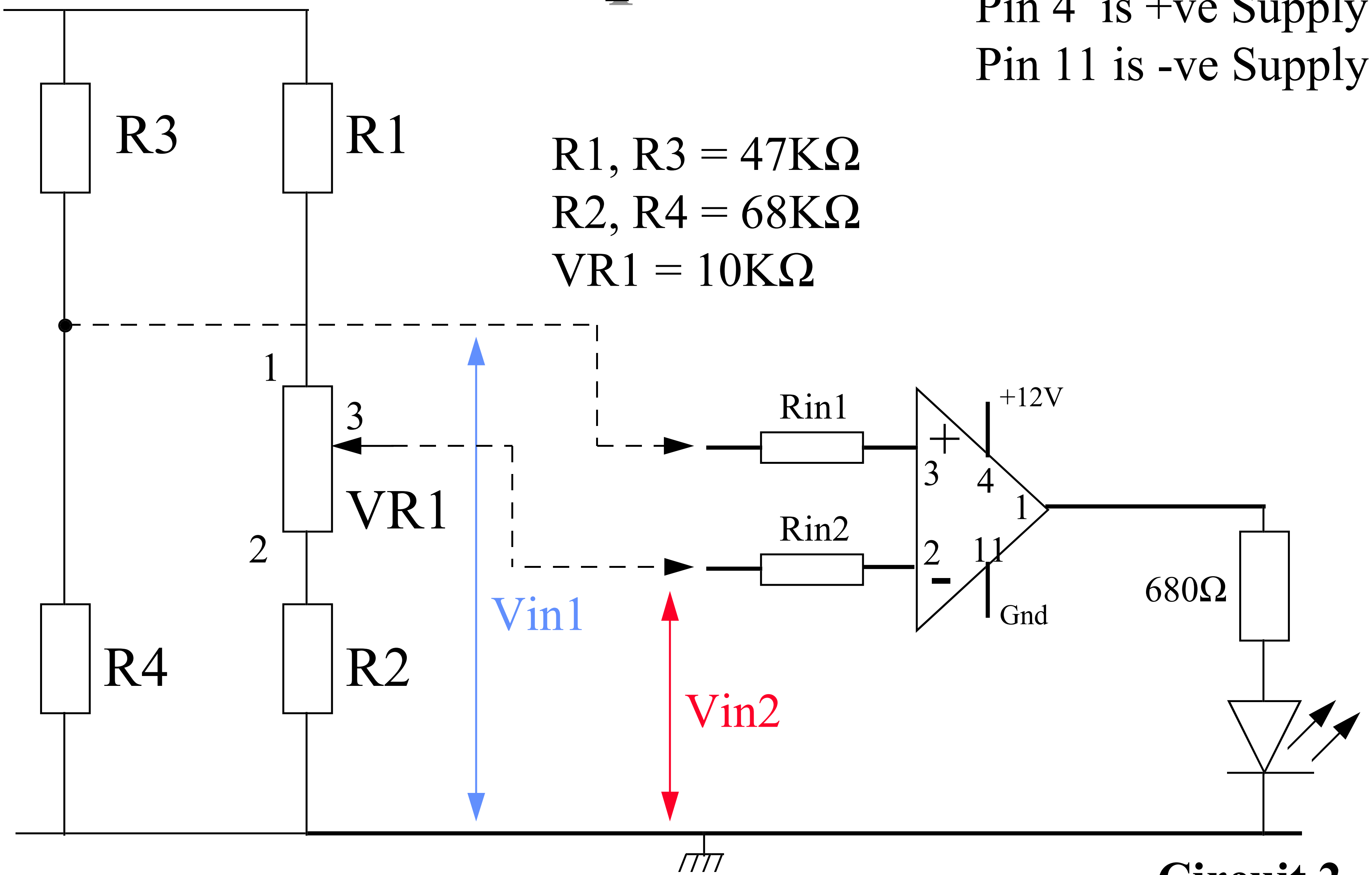
Pin 4 is +ve Supply

Pin 11 is -ve Supply

R1, R3 = 47KΩ

R2, R4 = 68KΩ

VR1 = 10KΩ



Circuit 2

Comparator.

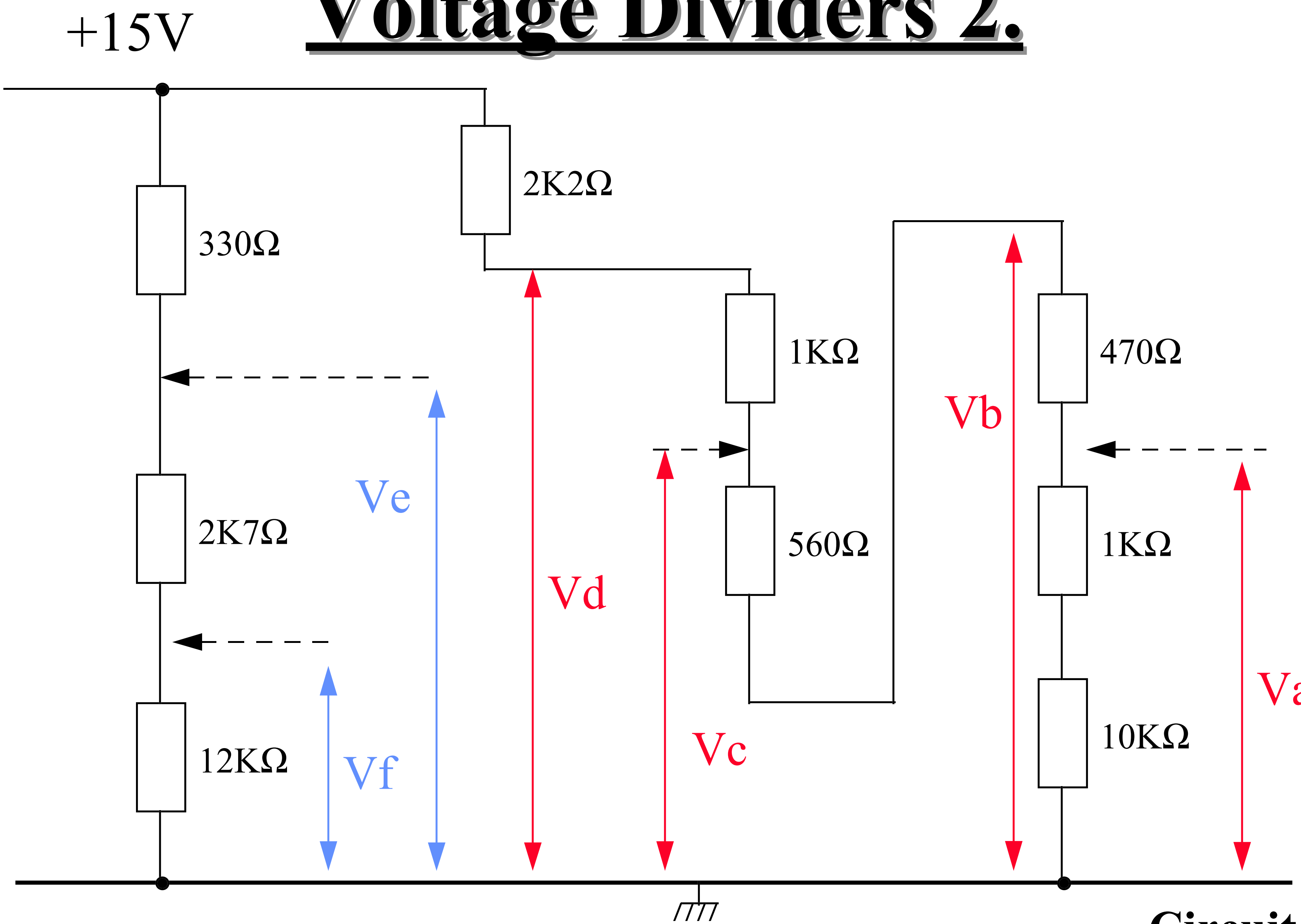
- DC Test 3 Using “Circuit 2”.
- Set R3 and R1 = 33KΩ
- Measure and record the voltage across R4.
- Measure and record the voltage across R3.
- Adjust VR1 to the point where the LED changes from OFF to ON State.
- Monitor and record voltage Vin where the LED just switches OFF.
- Monitor and record voltage Vin where the LED just switches ON.

Comparator.

- Conclusion
- Calculate the voltages across R3 and R4 when R3= 47KΩ and R4= 68KΩ .
- Calculate the voltages across R3 and R4 when R3= 33KΩ and R4= 68KΩ .
- Compare you calculated values with the measured values.

Experiment 18.

Voltage Dividers 2.



Circuit 1

Voltage Dividers 2.

- DC Test 1 Build “Circuit 1”.

(1) Calculate expected voltages for Va to Vf.

(2) Measure and record all the marked voltage points Va to Vf.

(3) What is the voltage difference between the points Vf and Vc.

- Reduce the supply voltage to +5.6V
- Repeat activities (1),(2) and (3) above.
- Conclusion what happened to Vf and Vc

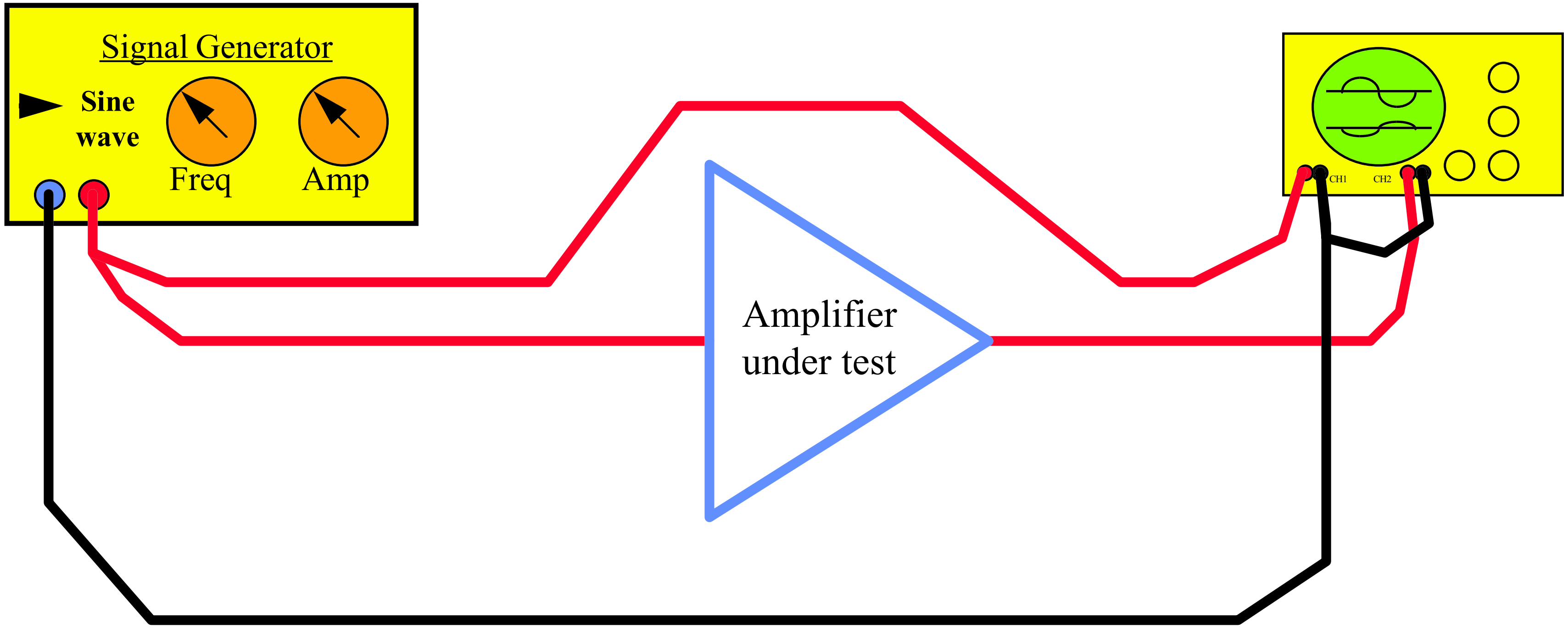
Experiment 19.

Amplifier Gain Bandwidth Tests.

Test Conditions Set AC Input Signal Amplitude to 50mV P/P.

Set test frequencies at 100Hz, 1KHz, 10KHz, 30KHz and 100KHz.

Set Amplifier gain to (Times 10), (Times 100) and (Times 470).



Amplifier Gain Bandwidth Tests.

Control Conditions

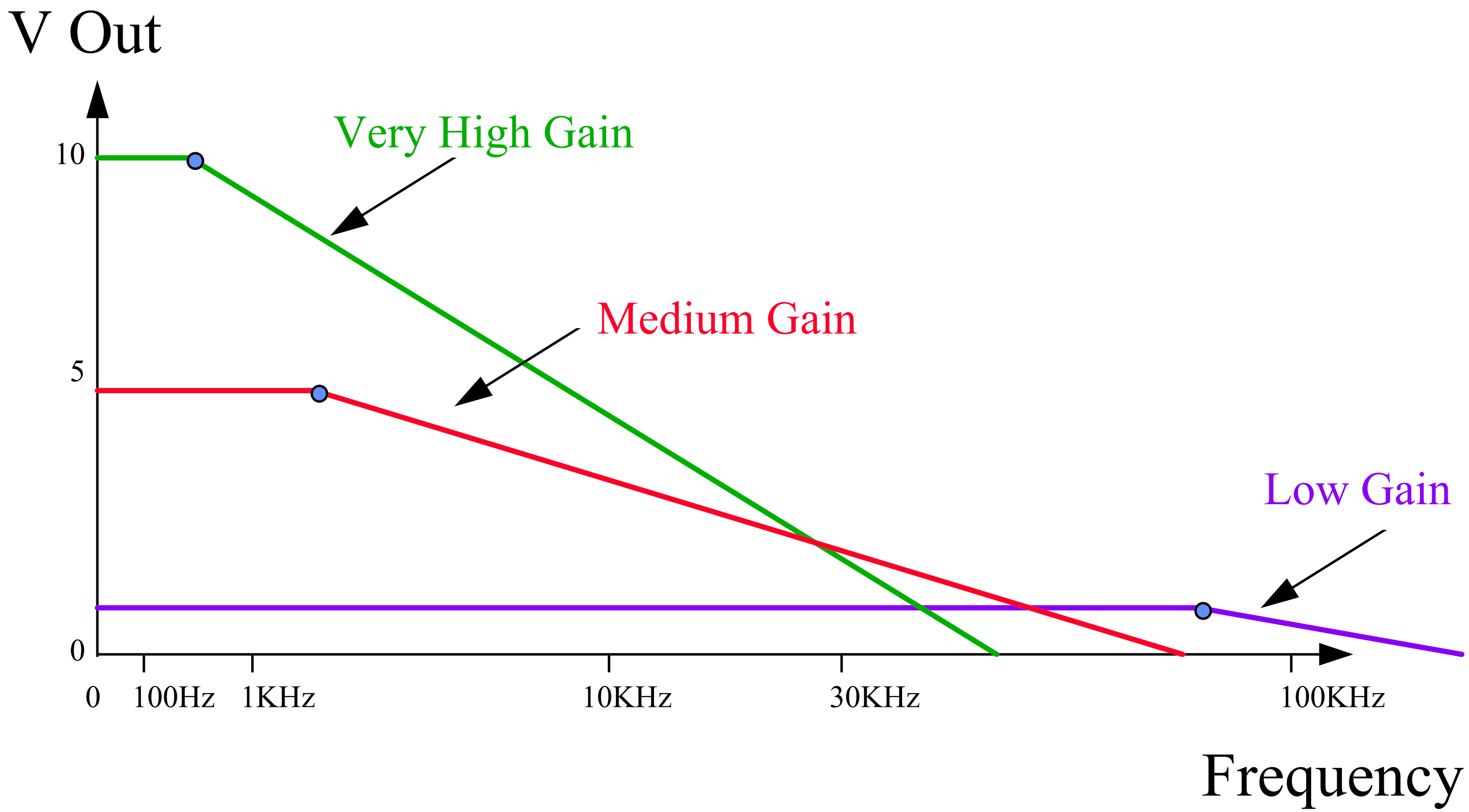
AC Input Signal Amplitude 50mV Peak to Peak.

Set Rin to 1KΩ and therefore Rf = 10KΩ , 100KΩ and 470KΩ

Input Frequency in Hz	Output Voltage Volts P/P Gain = *10	Output Voltage Volts P/P Gain = *100	Output Voltage Volts P/P Gain = *470
100 Hz	? mV P/P	? mV P/P	? V P/P
1000 Hz	? mV P/P	? mV P/P	? V P/P
10000 Hz	? mV P/P	? mV P/P	? V P/P
30000 Hz	? mV P/P	? mV P/P	? V P/P
100000 Hz	? mV P/P	? mV P/P	? mV P/P

Amplifier Gain Bandwidth Tests.

Typical Graph



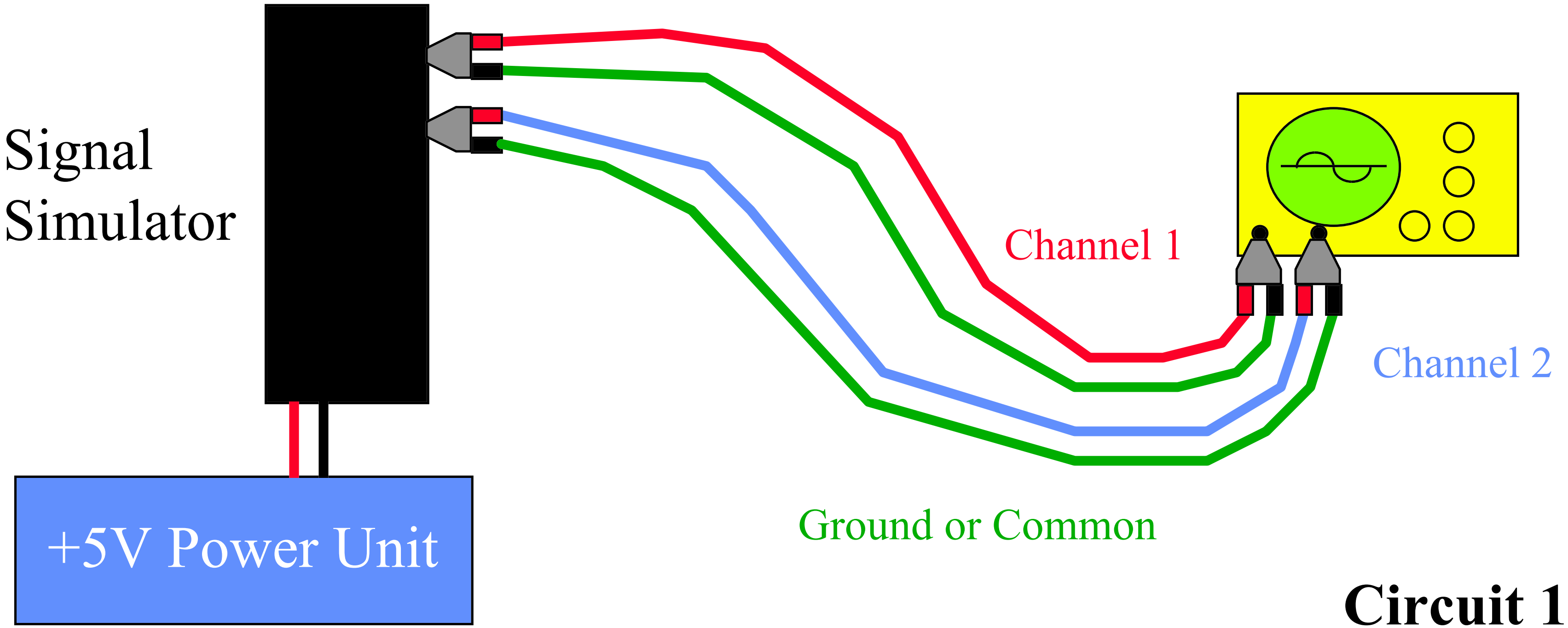
Experiment 20.

Using the Oscilloscope.

Using the Scope Signal Simulator connected as below:-

Use scope worksheet to record and analyse waveforms.

Note: Record status of Switch settings on simulator so you can repeat experiment if required

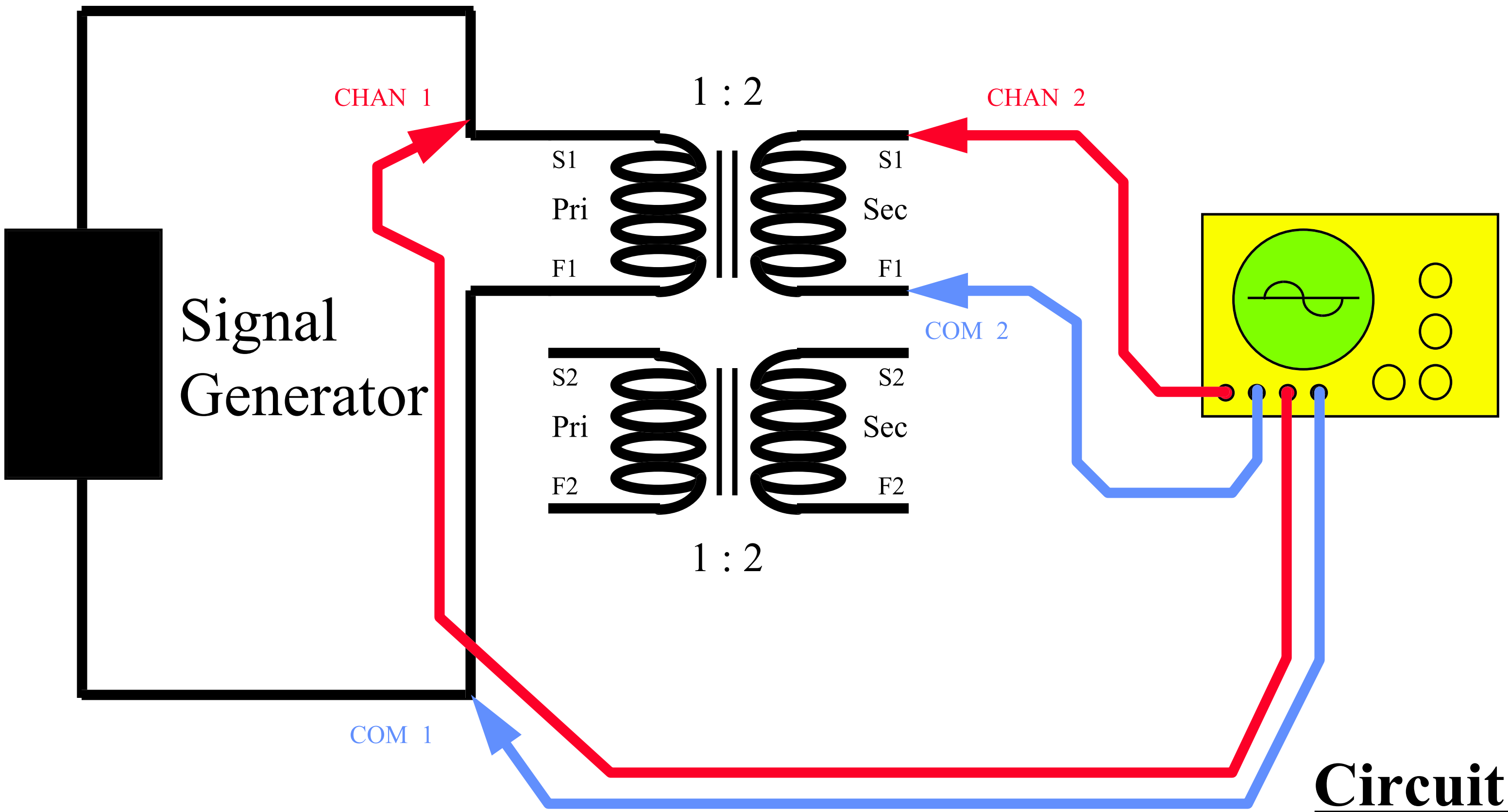


Circuit 1

Experiment 21.

Transformers.

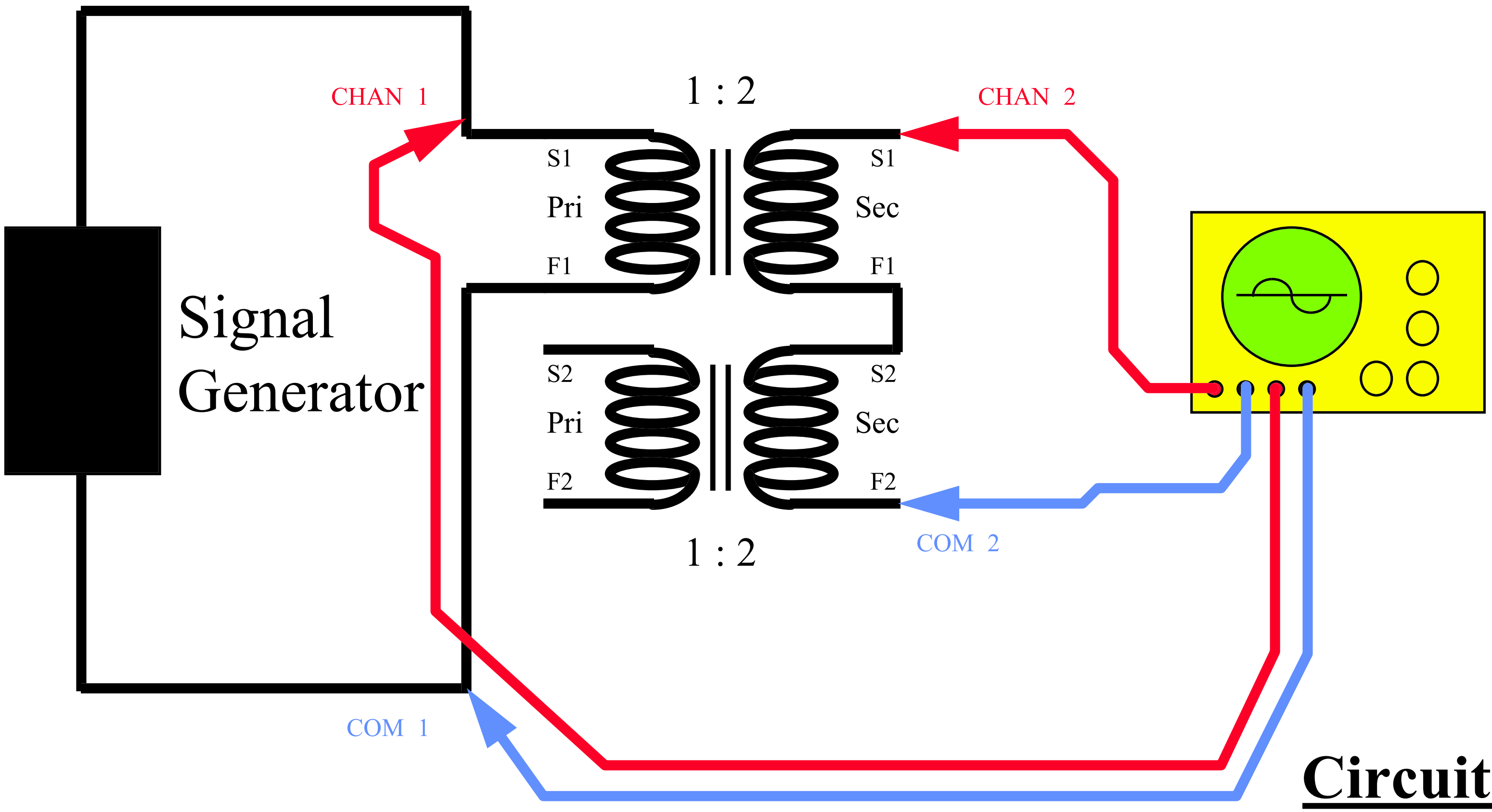
1. Set Signal generator to a Sine wave at a frequency of 1KHz and an amplitude of 2 Volts peak to peak.
2. Calculate and Measure and sketch Secondary Voltage.



Circuit 1

Transformers.

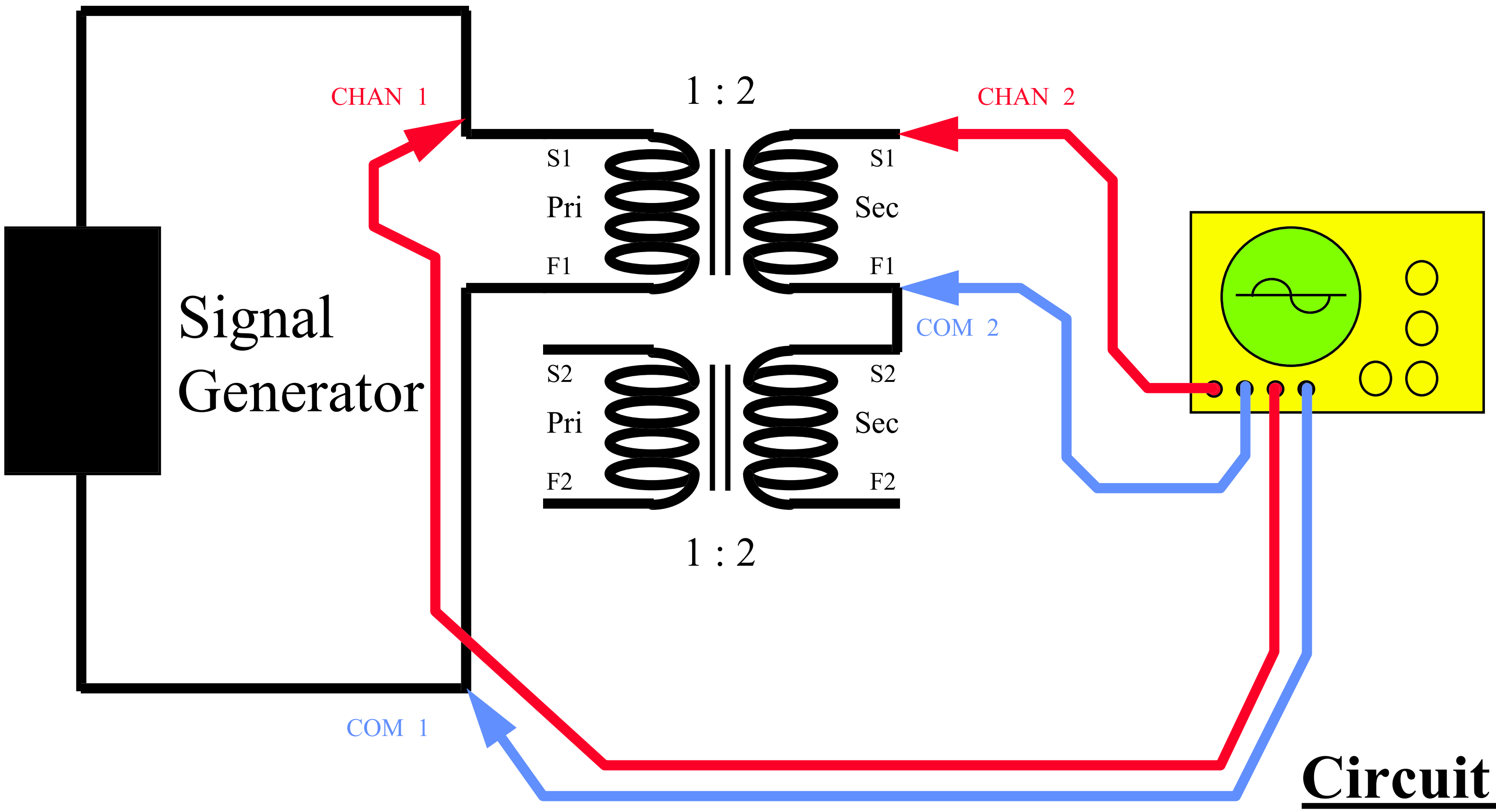
1. Set Signal generator to a Sine wave at a frequency of 1KHz and an amplitude of 2 Volts peak to peak.
2. Calculate and Measure and sketch Secondary Voltage.



Circuit 2

Transformers.

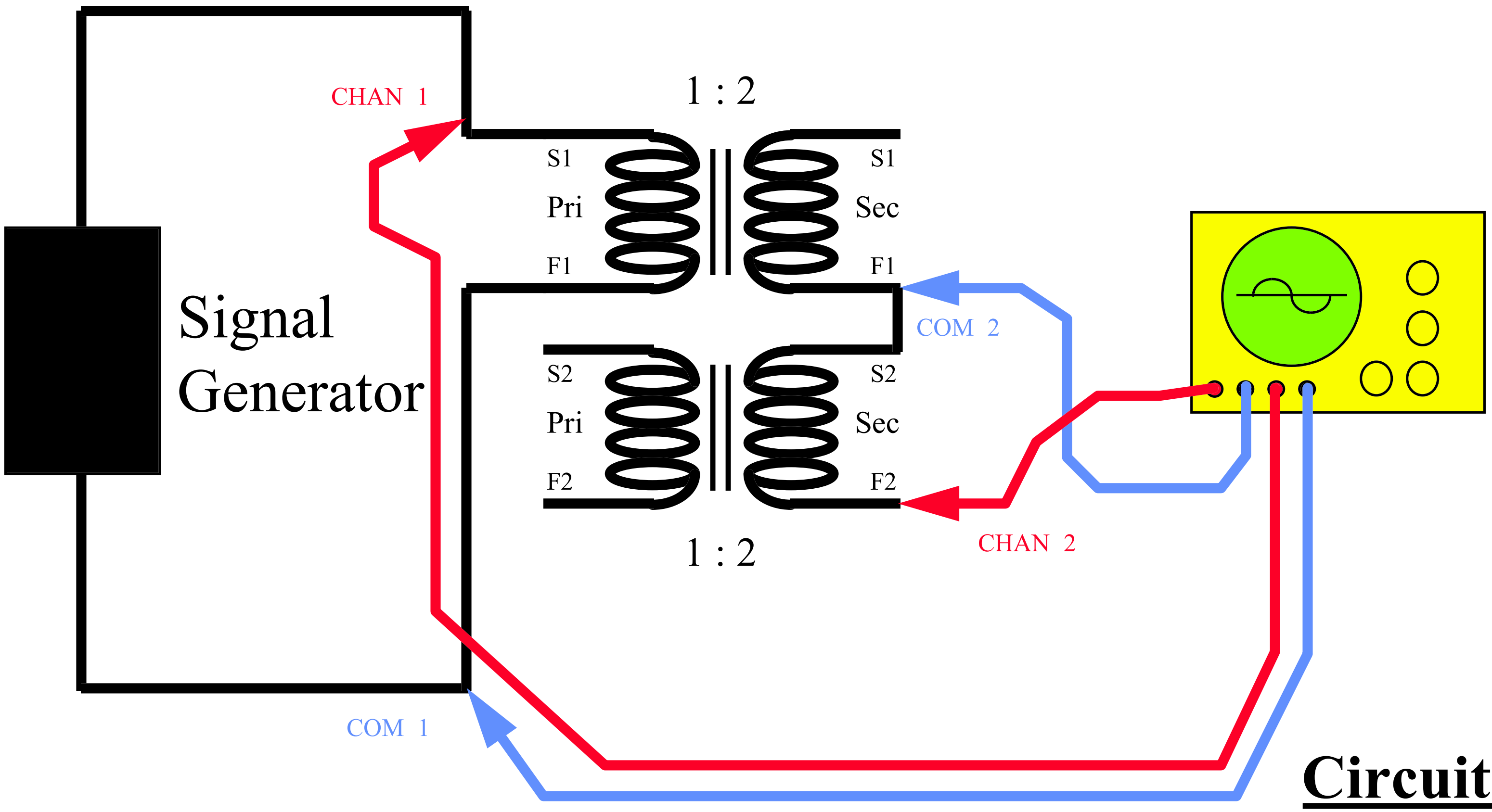
1. Set Signal generator to a Sine wave at a frequency of 1KHz and an amplitude of 2 Volts peak to peak.
2. Calculate and Measure and sketch Secondary Voltage.



Circuit 3

Transformers.

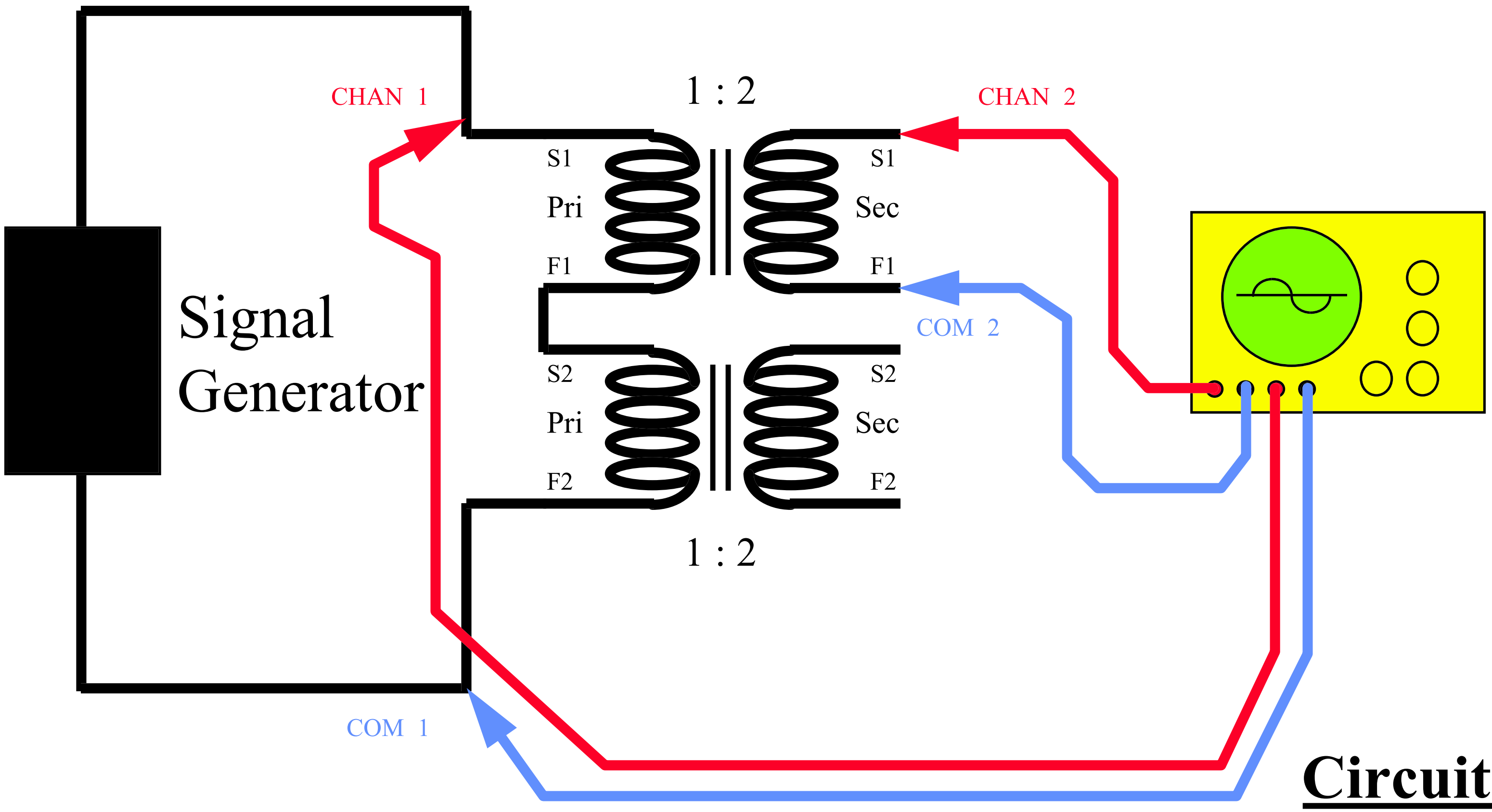
1. Set Signal generator to a Sine wave at a frequency of 1KHz and an amplitude of 2 Volts peak to peak.
2. Calculate and Measure and sketch Secondary Voltage.



Circuit 4

Transformers.

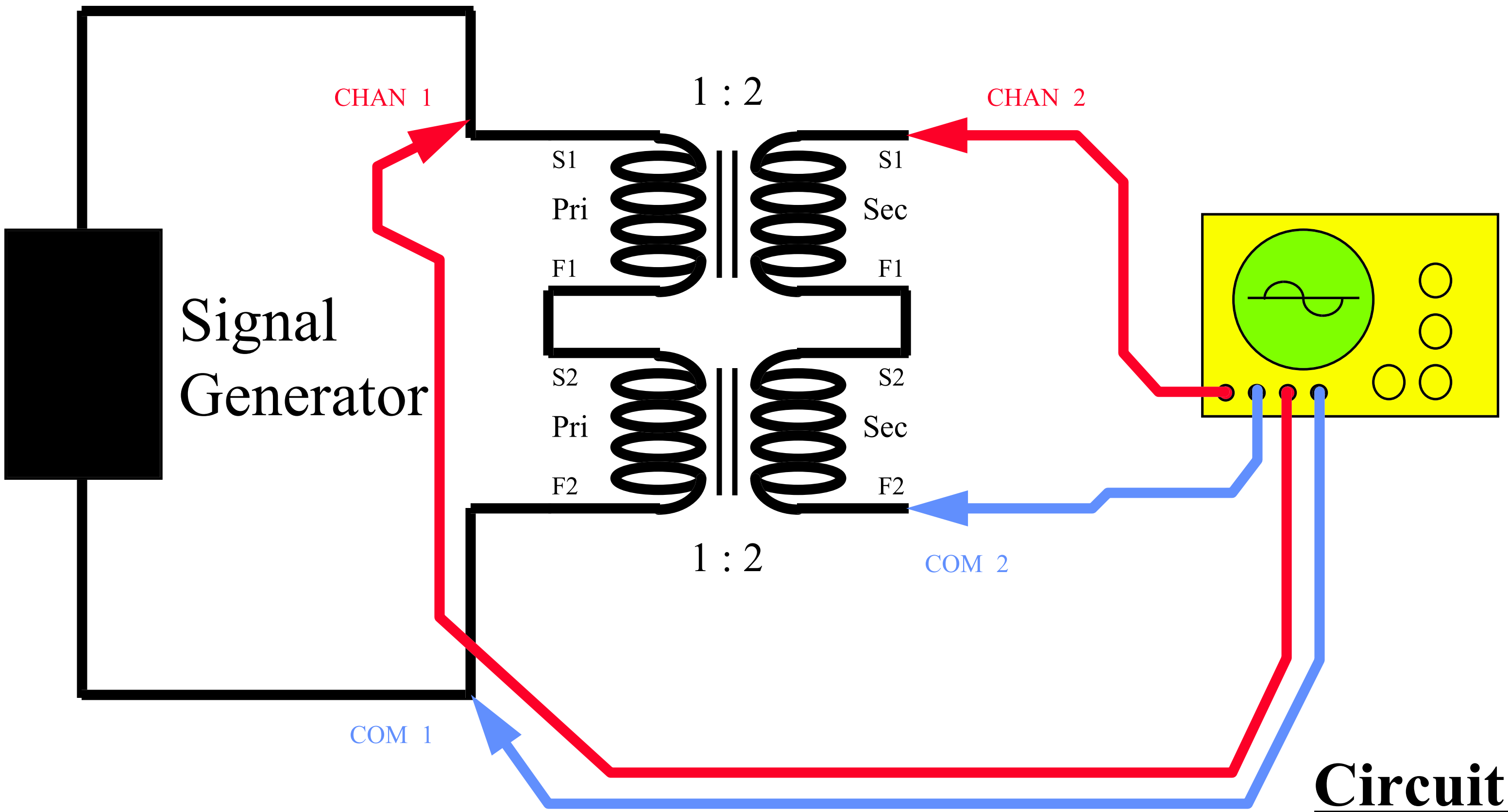
1. Set Signal generator to a Sine wave at a frequency of 1KHz and an amplitude of 2 Volts peak to peak.
2. Calculate and Measure and sketch Secondary Voltage.



Circuit 5

Transformers.

1. Set Signal generator to a Sine wave at a frequency of 1KHz and an amplitude of 2 Volts peak to peak.
2. Calculate and Measure and sketch Secondary Voltage.



Circuit 6

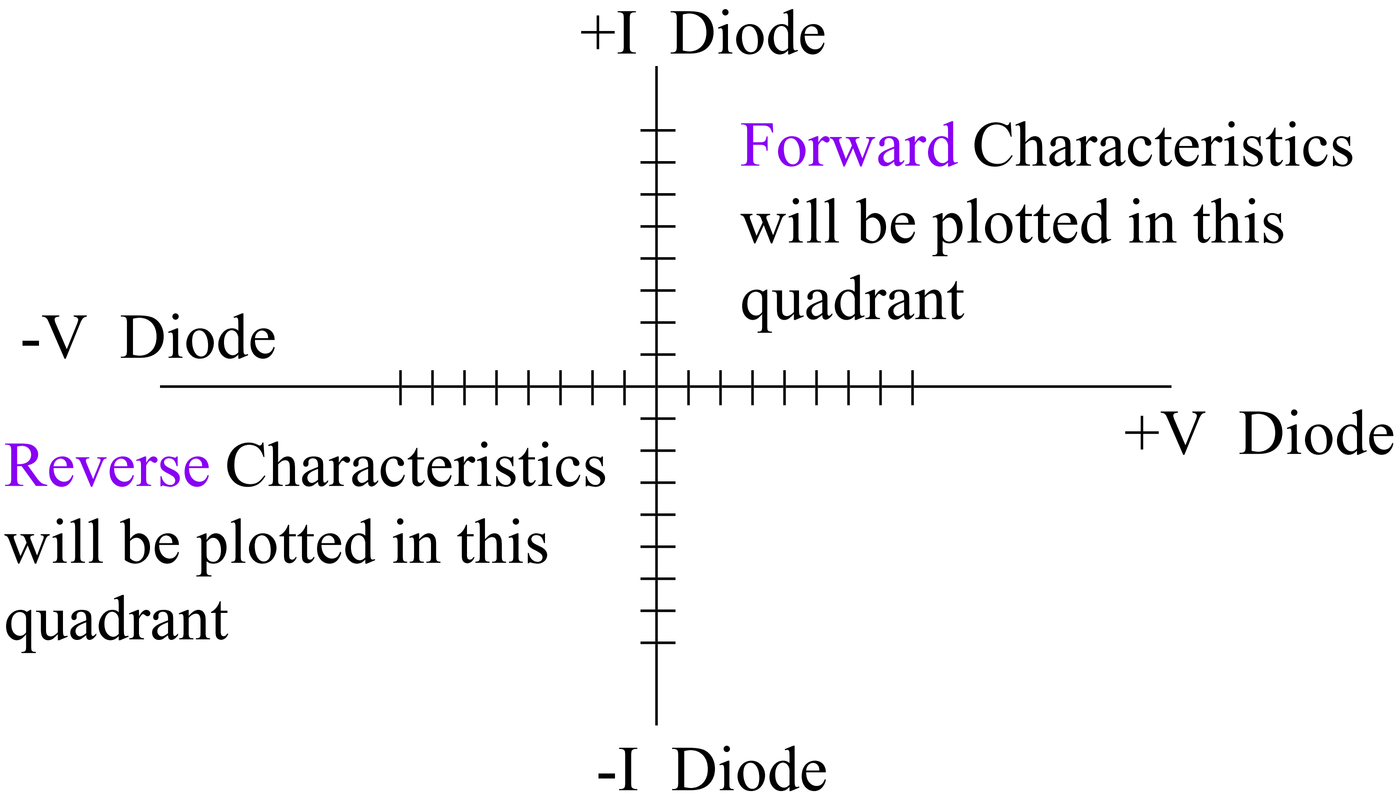
Experiment 22.

Plot Diode Characteristics.

- Use the process described in the following slides to plot the characteristics of the diodes identified below :-
  - a Germanium Diode.
  - a Silicon Diode.
  - a Zener Diode.
  - a Red Light Emitting Diode (LED).
  - a Yellow Light Emitting Diode (LED).
  - a Green Light Emitting Diode (LED).

Plot Diode Characteristics.

Prepare your graph paper as shown :-



Remember to mark all scales and units on your graph.

Plot Diode Characteristics.

- To calculate Diode Current :-

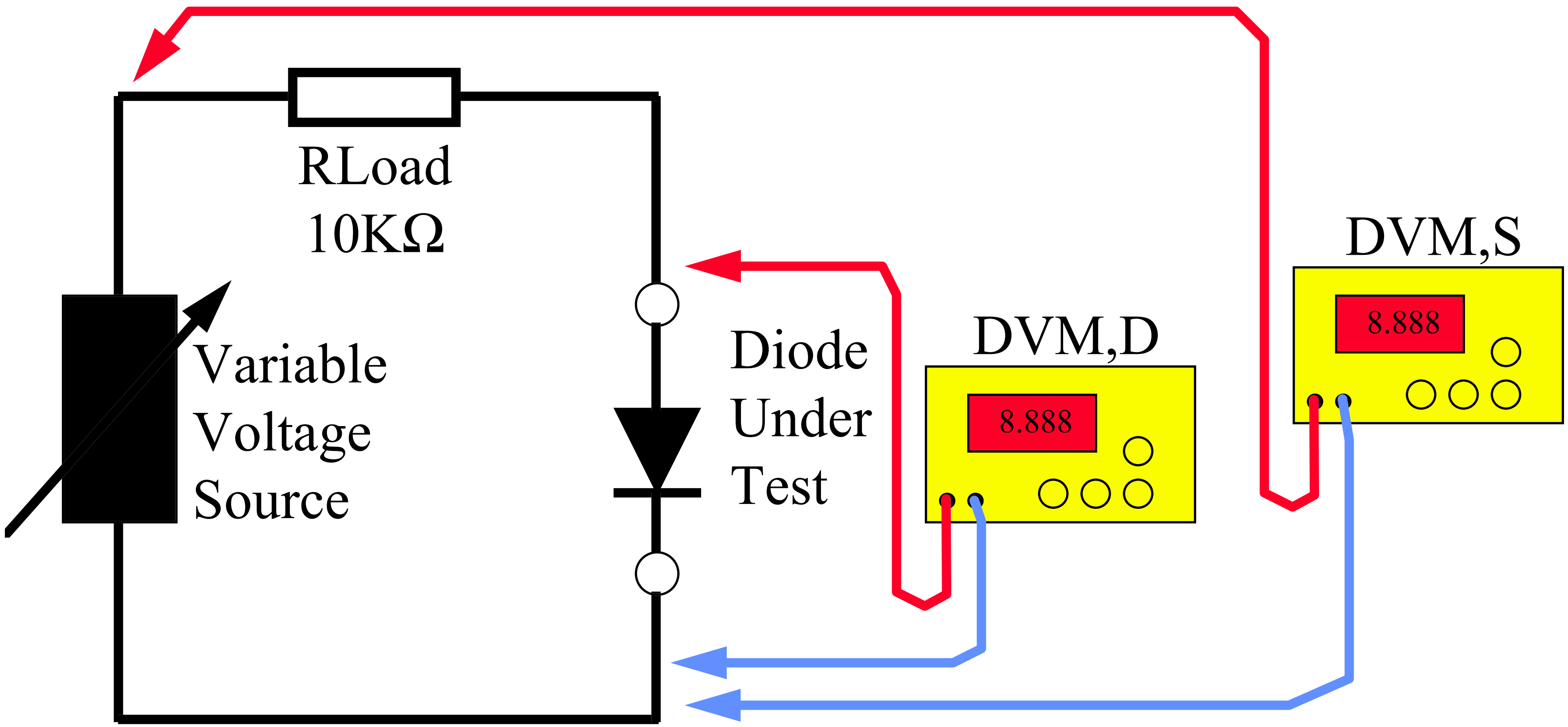
- Calculate voltage across RLoad
- VRLoad = VSupply DVM,S - VDiode DVM,D.

- Calculate current flowing through RLoad which is also the current flowing through the Diode.
- IRLoad = VRLoad / 10KΩ

- Diode Current = IRLoad

Plot Diode Characteristics.

Using a Variable Voltage DC Source build circuit shown below:-



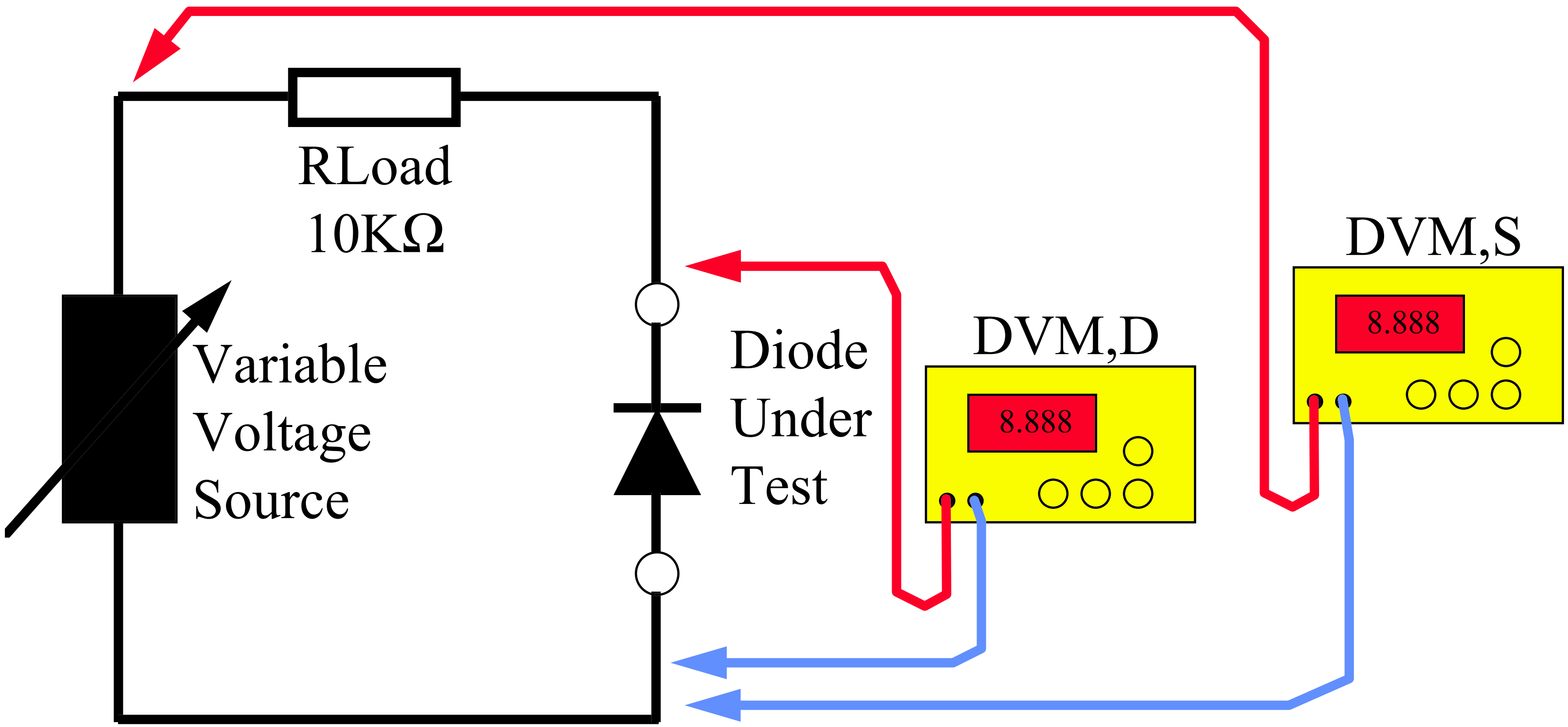
Circuit 1

Plot Diode Characteristics.

- Forward Characteristics   Build "Circuit 1".
- Adjust the variable voltage supply in small increments as indicated of record sheet.
- Measure and record the +Diode voltage DVM,D and its associated +Supply voltage DVM,S after each adjustment .
- Using the above results calculate the +Diode current that flows in the circuit.
- Plot +Diode current (Y Axis) against +Diode voltage (X axis) on Circuit 1 graph.

Plot Diode Characteristics.

Using a Variable Voltage DC Source build circuit shown below:-



Circuit 1

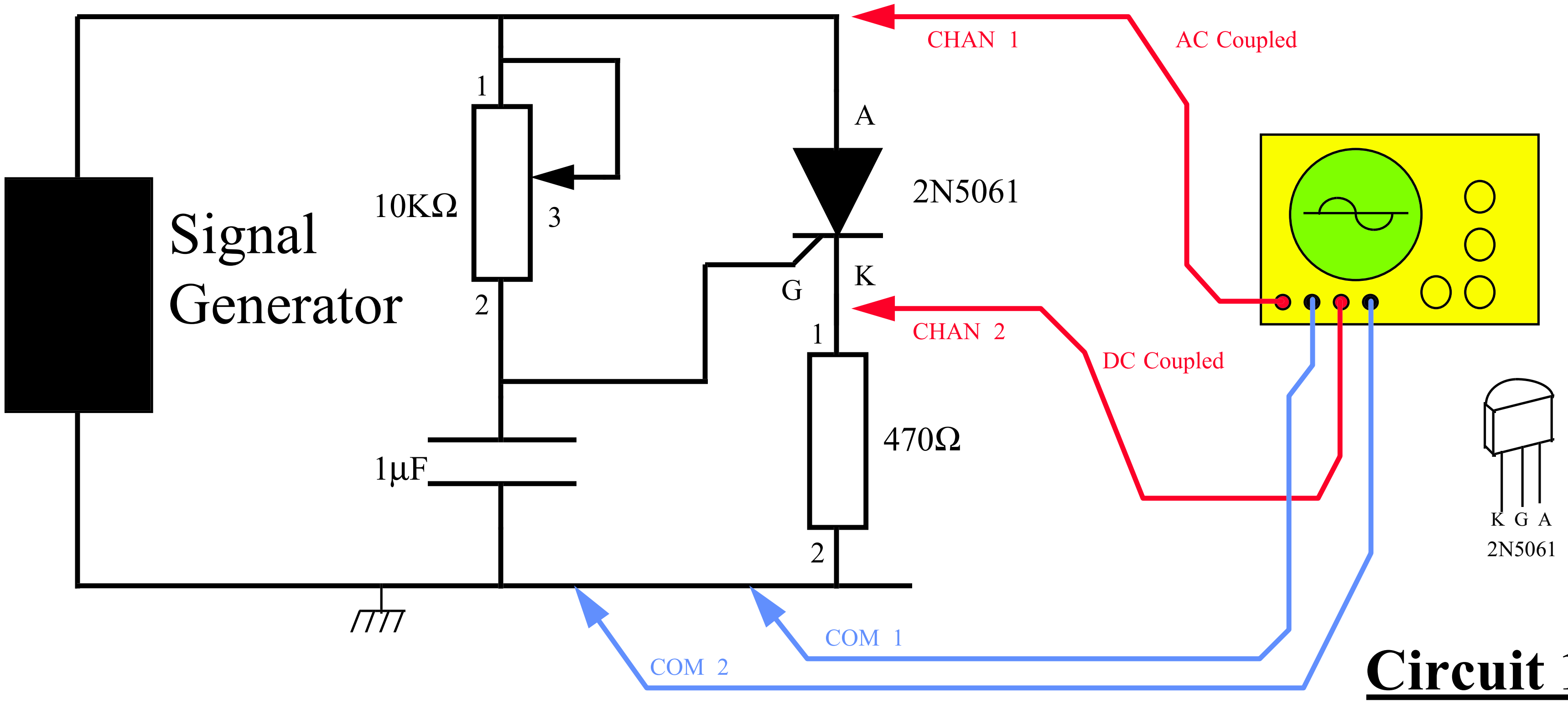
Plot Diode Characteristics.

- Reverse Characteristics   Build "Circuit 2".
- Adjust the variable voltage supply in small increments as indicated of record sheet.
- Measure and record the -Diode voltage DVM,D and its associated -Supply voltage DVM,S after each adjustment .
- Using the above results calculate the -Diode current that flows in the circuit.
- Plot -Diode current (Y Axis) against -Diode voltage (X axis) on Circuit 1 graph.

Experiment 23.

Thyristors - SCRs.

1. Build Circuit 1 shown below.
2. Set Signal generator to a Sine wave at a frequency of 200Hz and an amplitude of 10 Volts peak to peak.
3. Adjust VR1 to give firing angles 0^o, 90^o and 180^o sketching Input and Output Waveforms and Annotate points of interest .



Circuit 1

End Slide

Revision Page

Title	Laboratory Experiments
Author	R. J. Spriggs
Last Update	11/March/2007
Version	2.30
Edit	0209