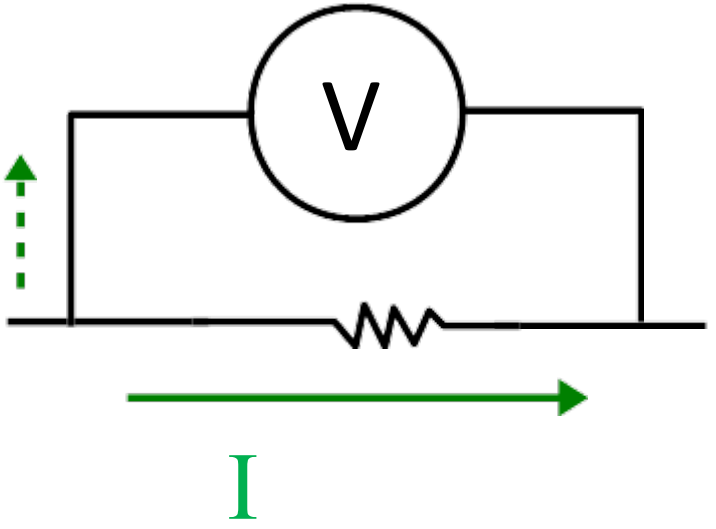
Lab 2: AC Circuits and Oscilloscope

Ideal meters

VOLTMETER:

$I_{meter} \approx 0$



Example: 10x oscilloscope probe

Ideal meters

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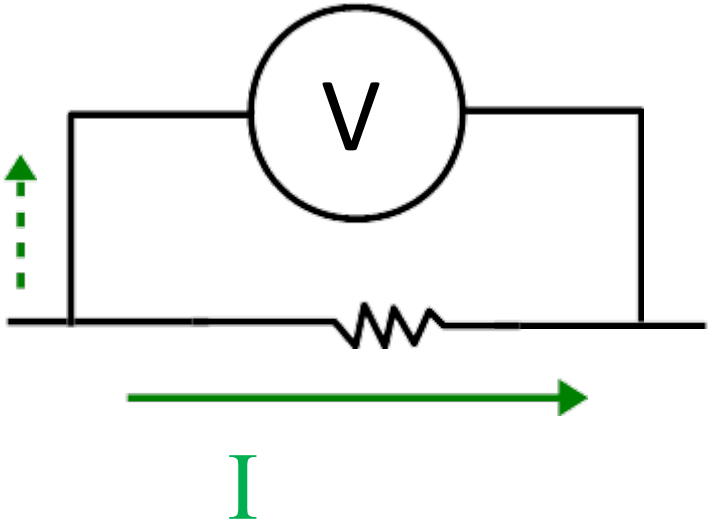
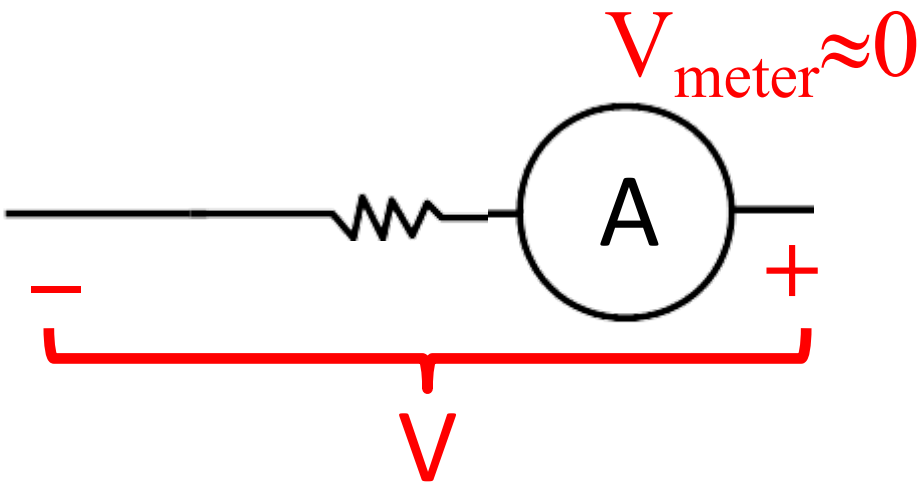


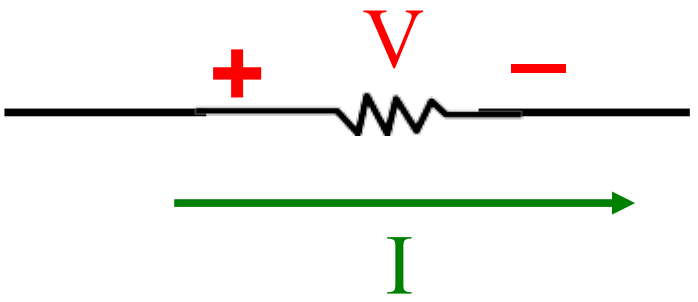
Example: 10x oscilloscope probe

AMMETER:

$V_{meter} \approx 0$



Power Dissipation

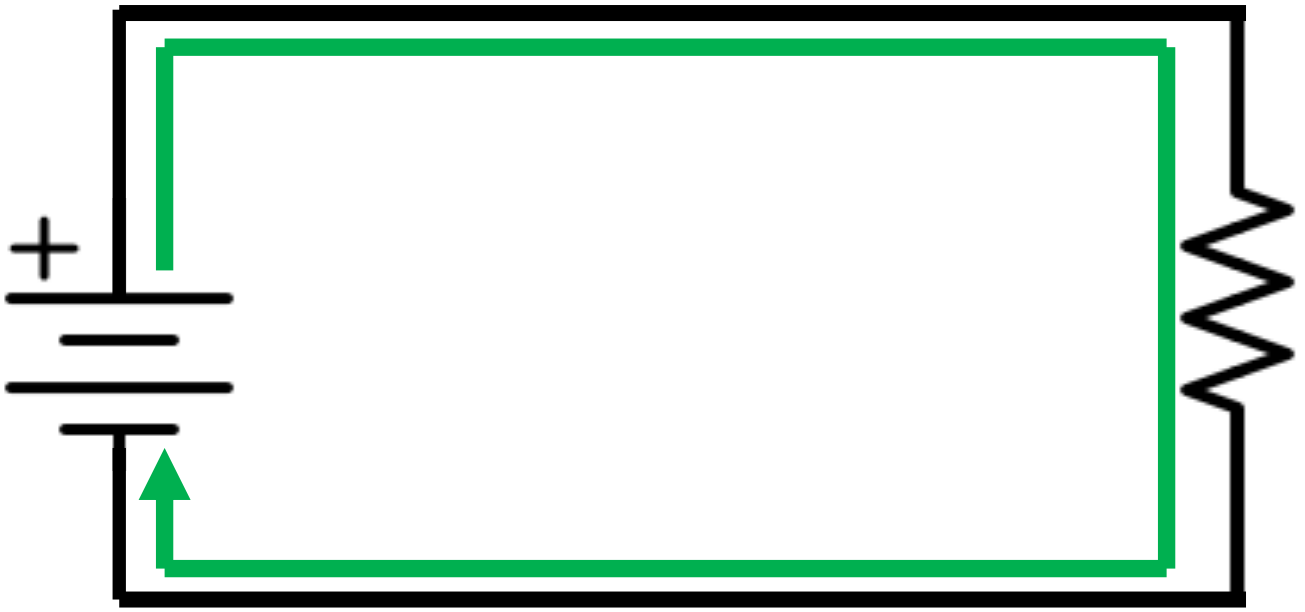


Energy=VQ

Power=d(Energy)/dt

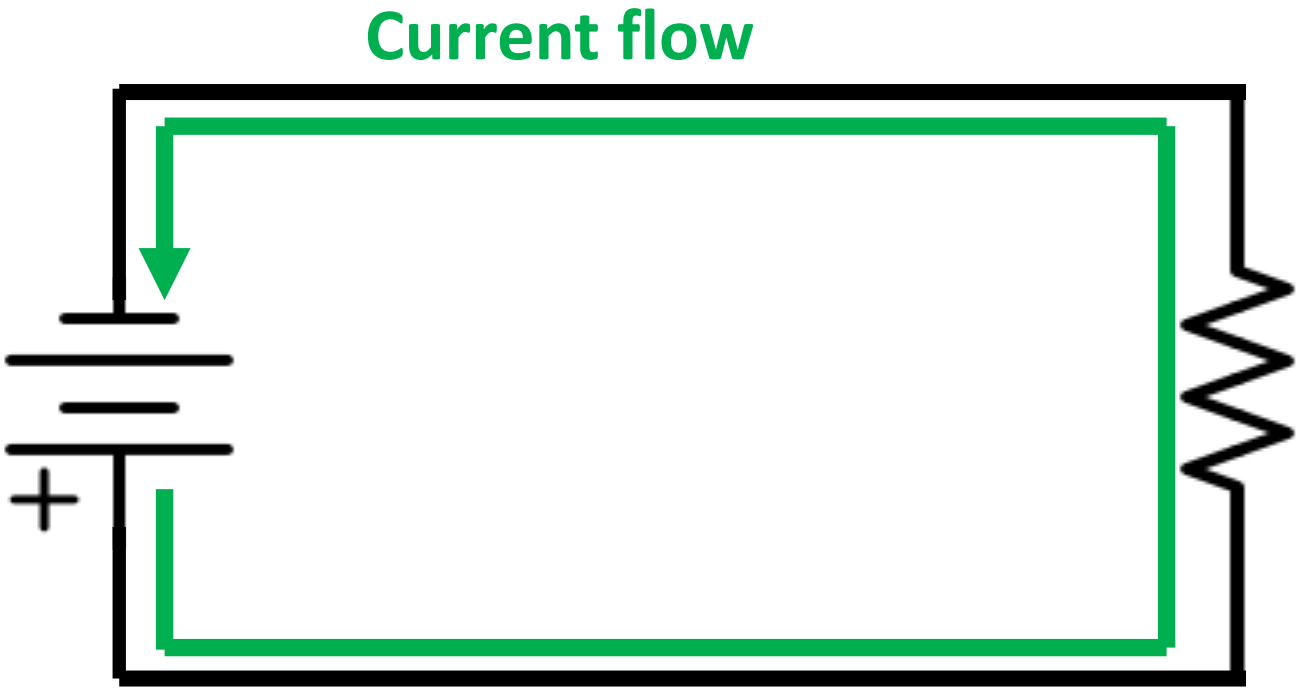
$$\text{Power dissipated} = \frac{V^2}{R} = I^2 R$$

AC (Alternating Current) Circuits

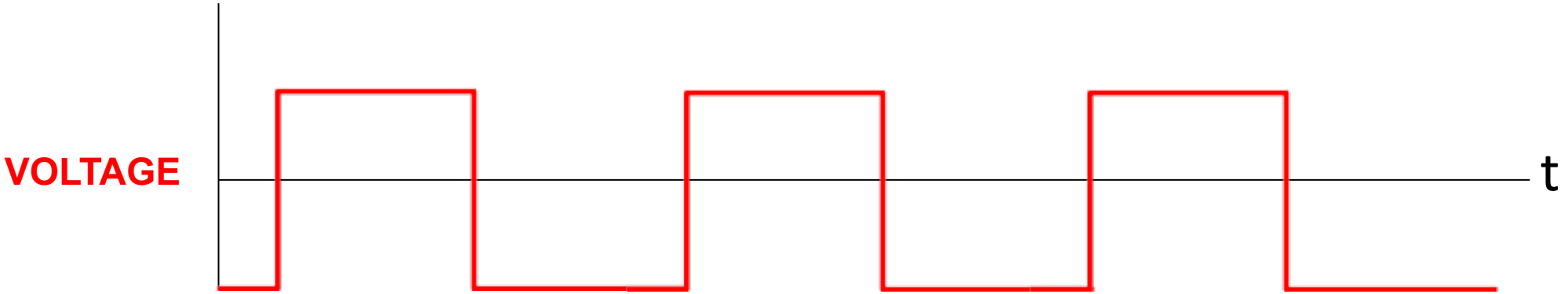


Current flow

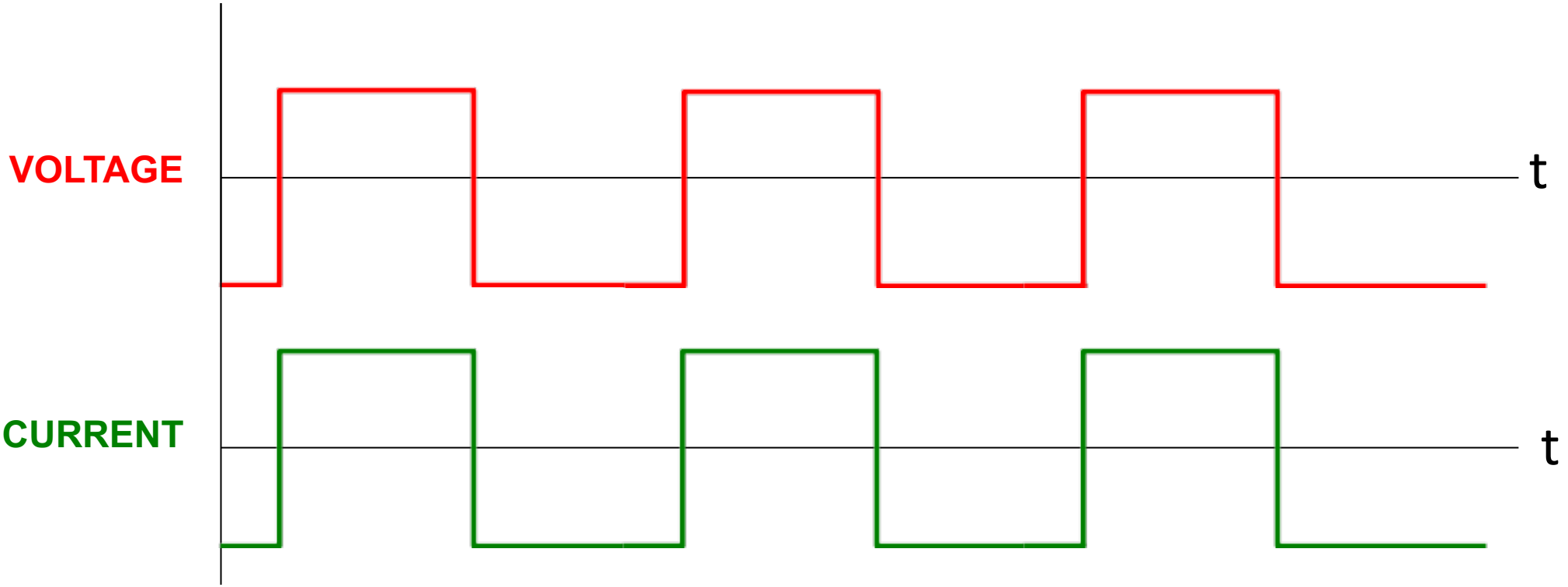
AC (Alternating Current) Circuits



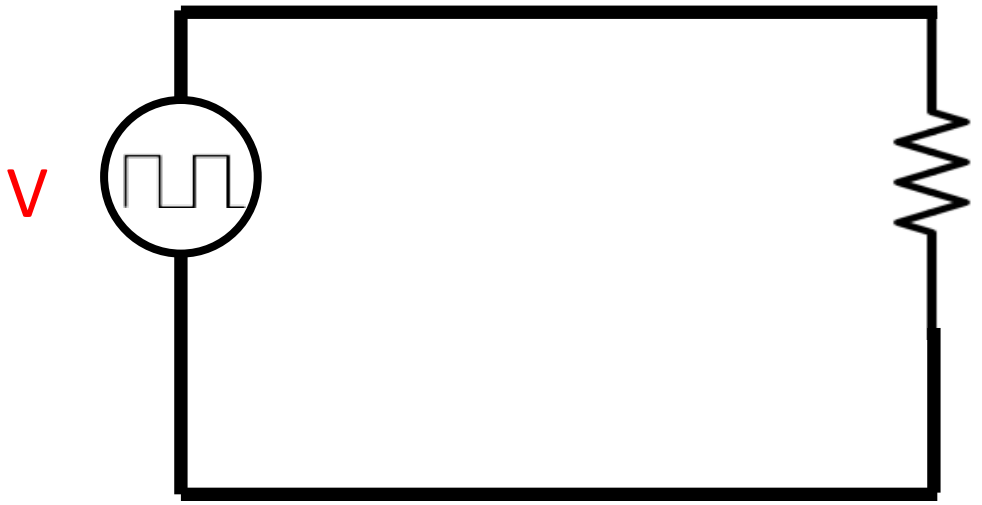
Square wave source

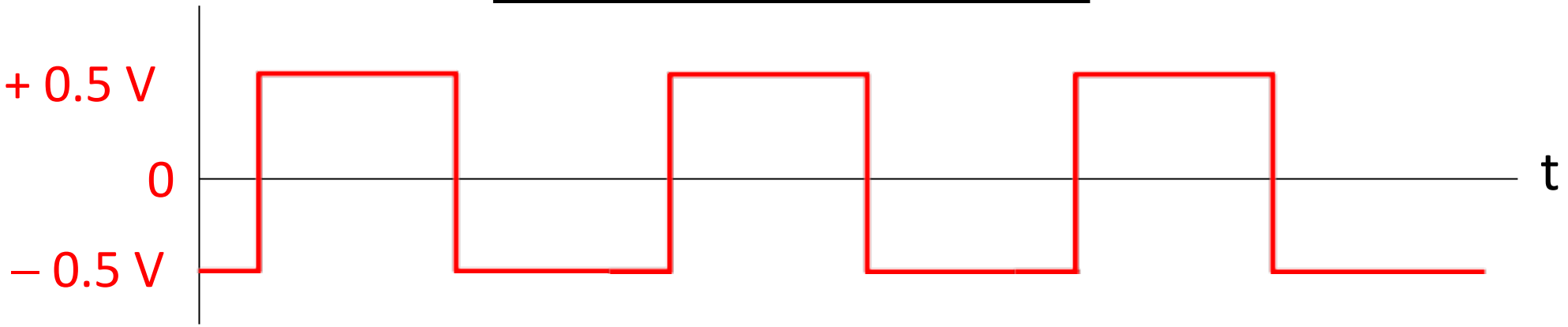


Square wave source

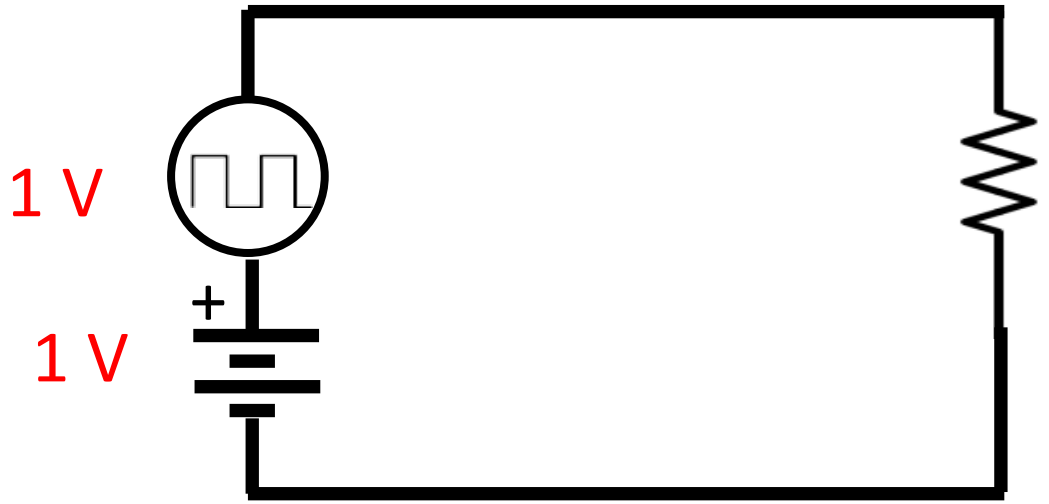


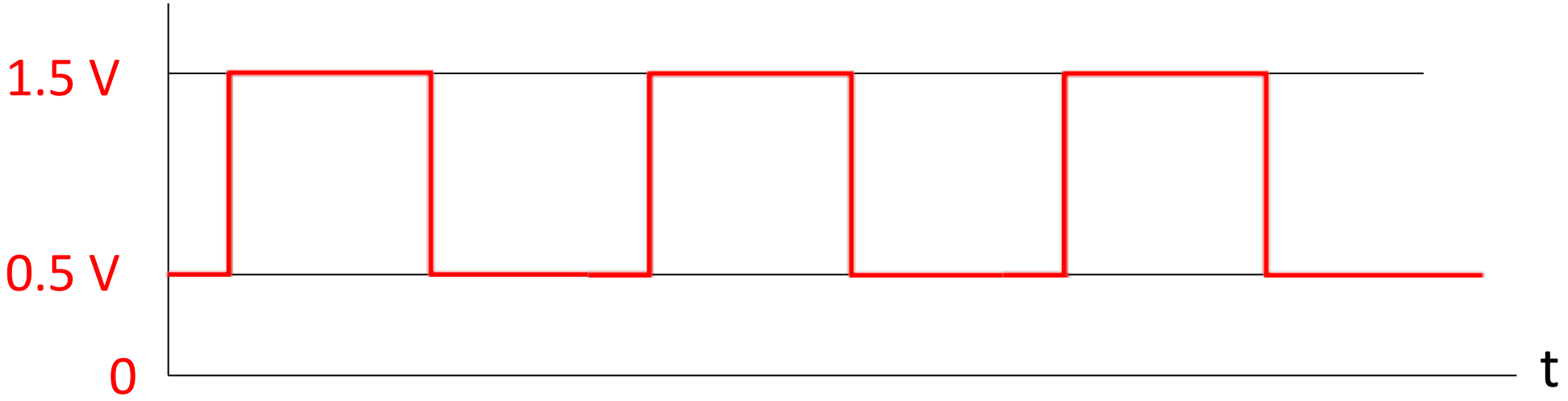
Square wave source +



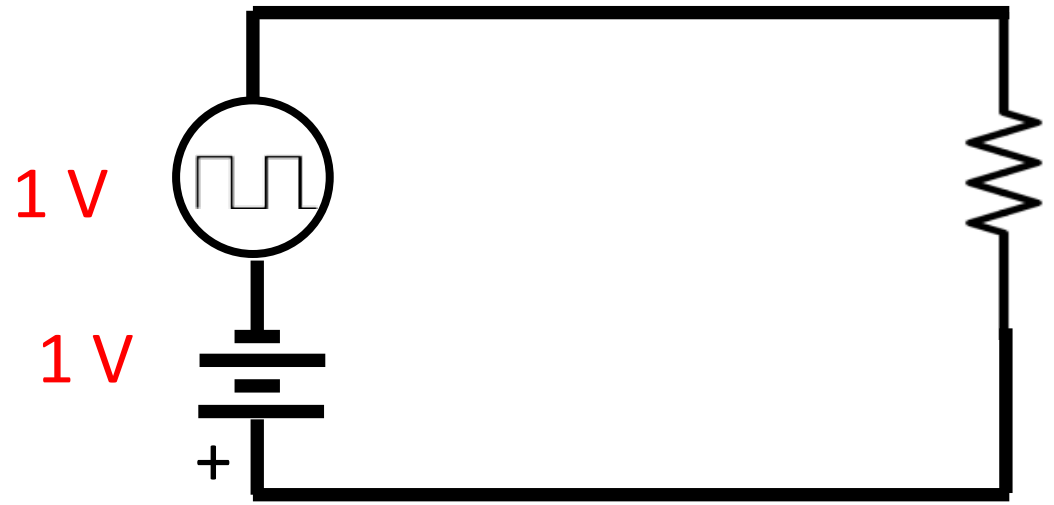


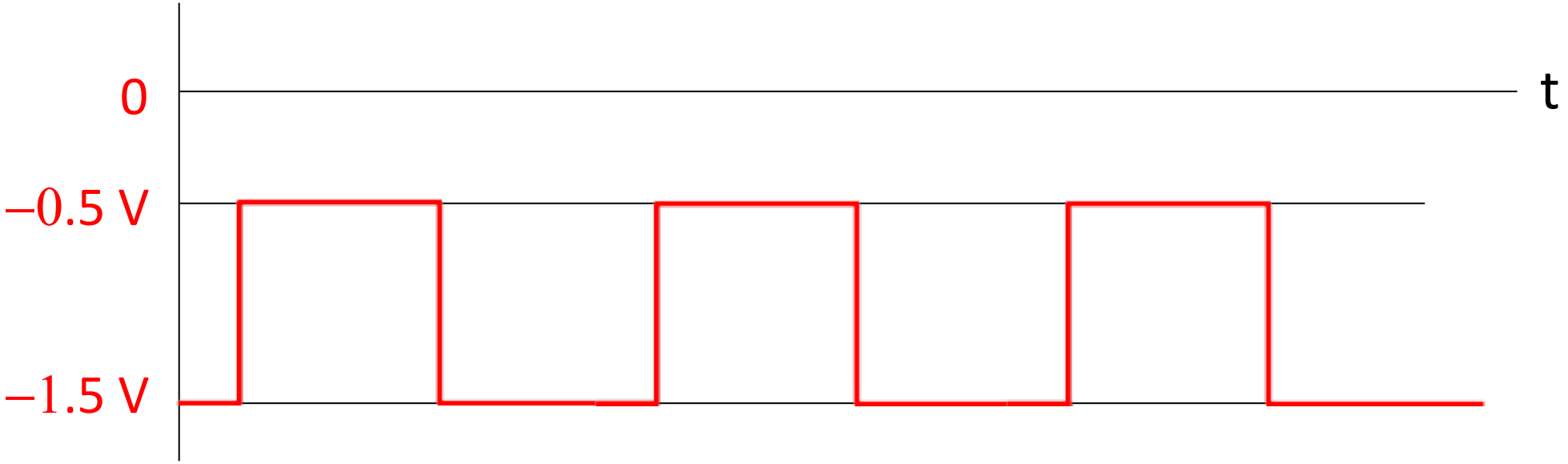
Square wave source + voltage offset



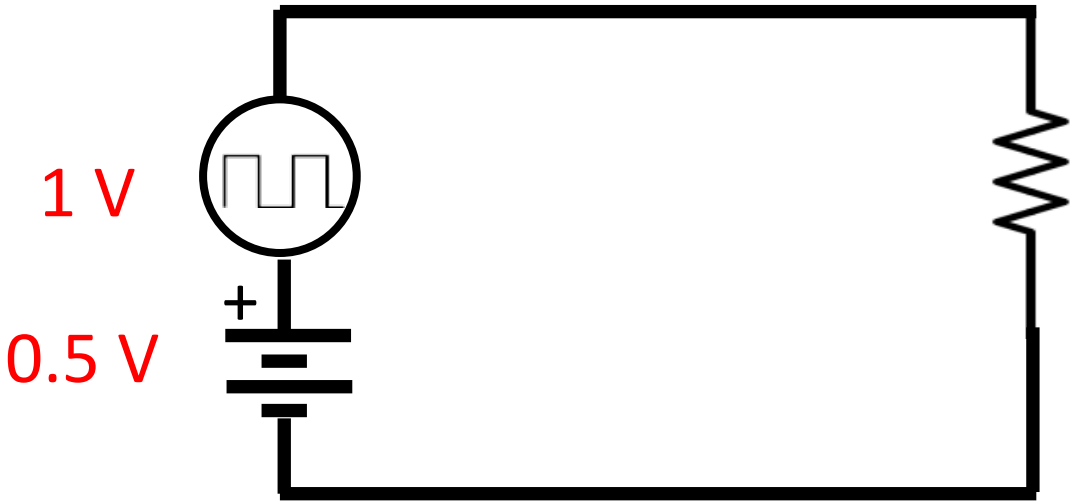


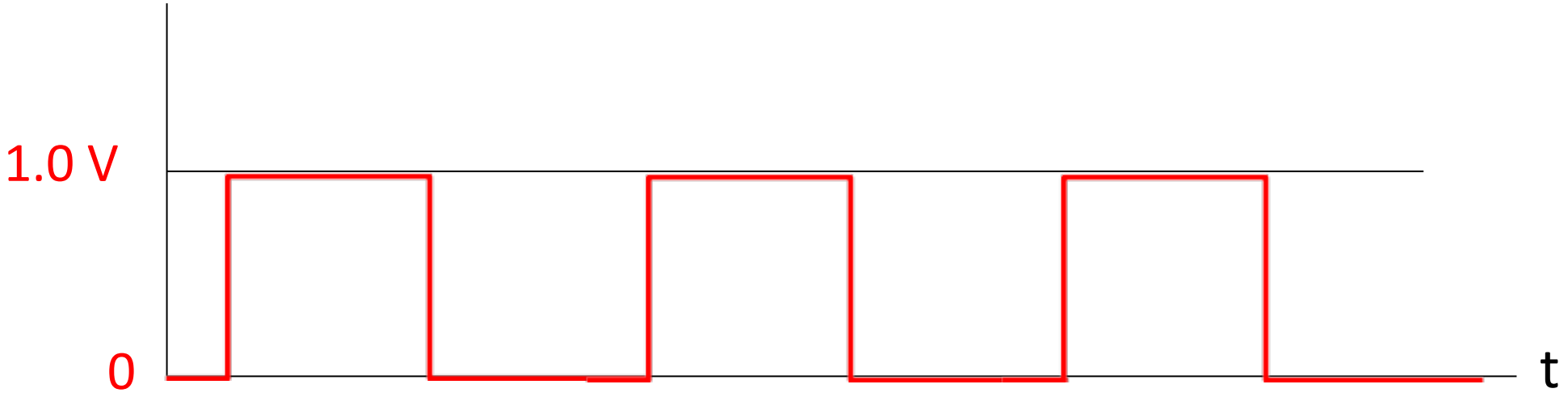
Square wave source + voltage offset



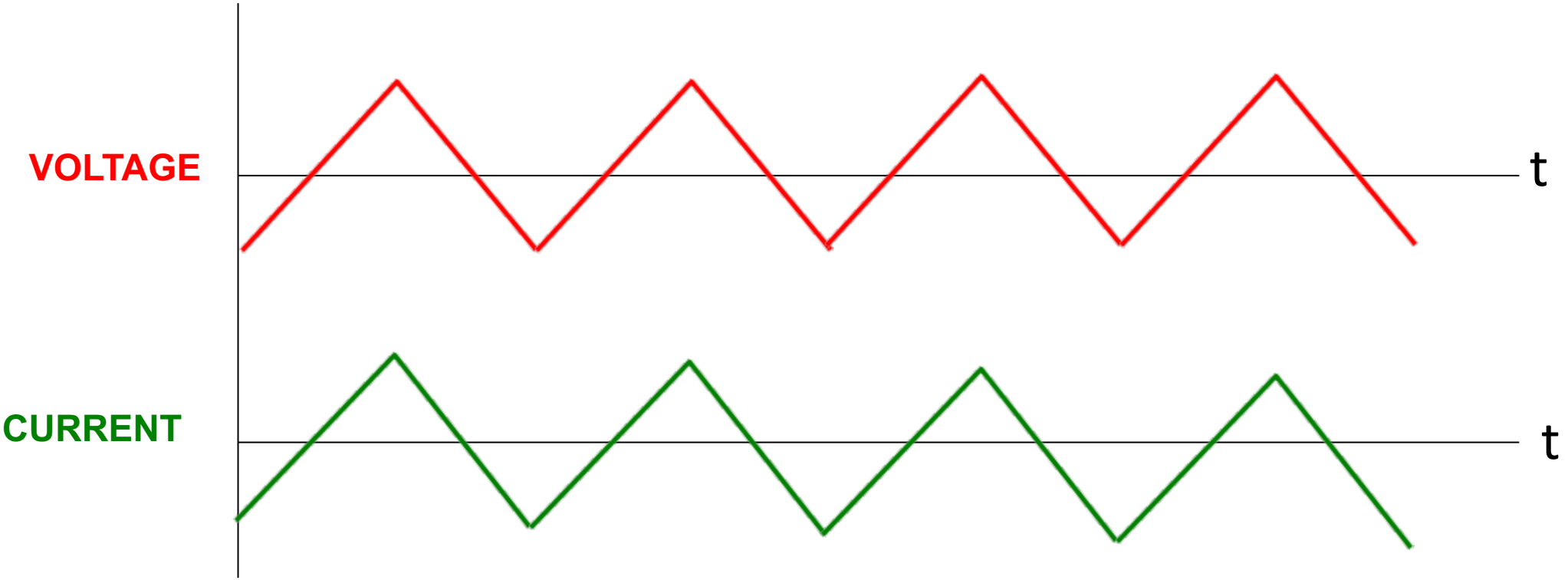


Square wave source + voltage offset

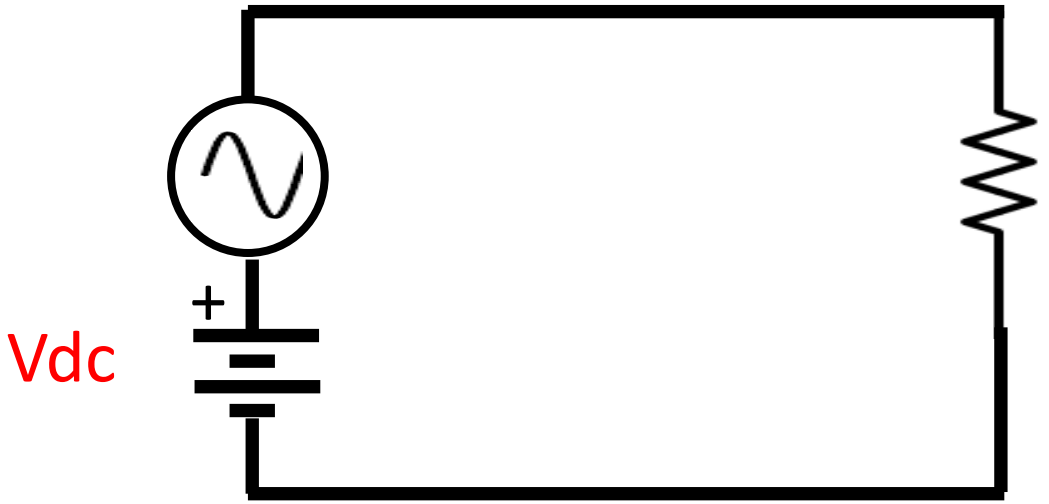


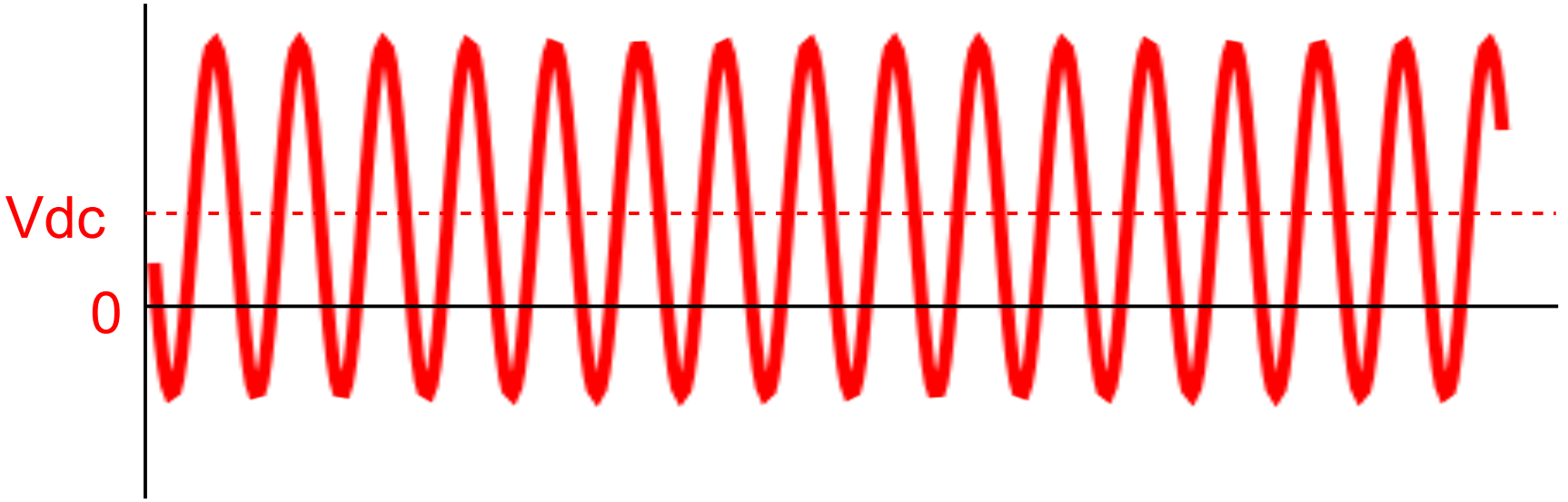


Triangle wave source

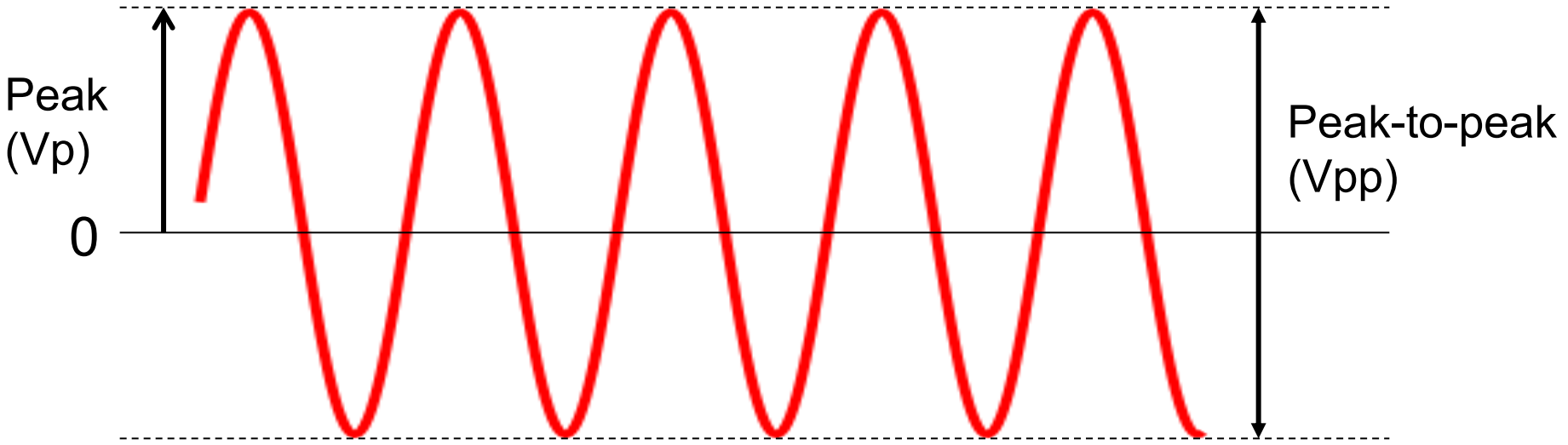


Sinusoidal wave source + dc offset





Characterizing an AC signal



$$V(t)=V_p \sin(\omega t+\phi)$$

Root-mean-square (RMS)

Useful for determining power dissipated by an AC waveform

Allows comparison of power in AC and DC circuits

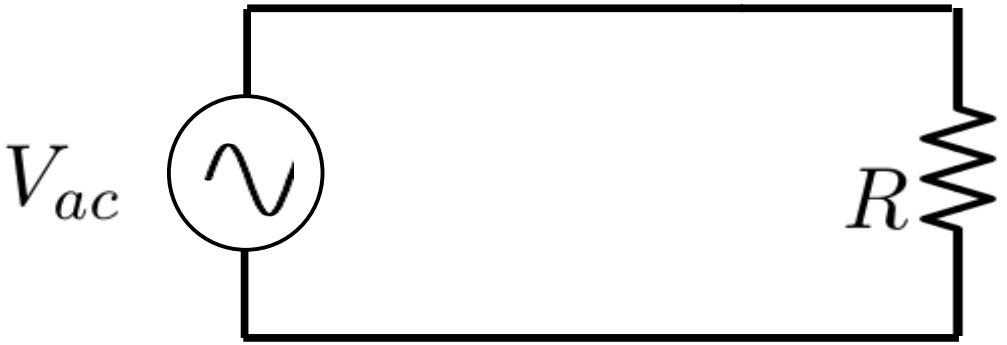
POWER = $\frac{V_{dc}^2}{R}$

POWER = $\frac{V_{ac}^2}{R}$

Root-mean-square (RMS)

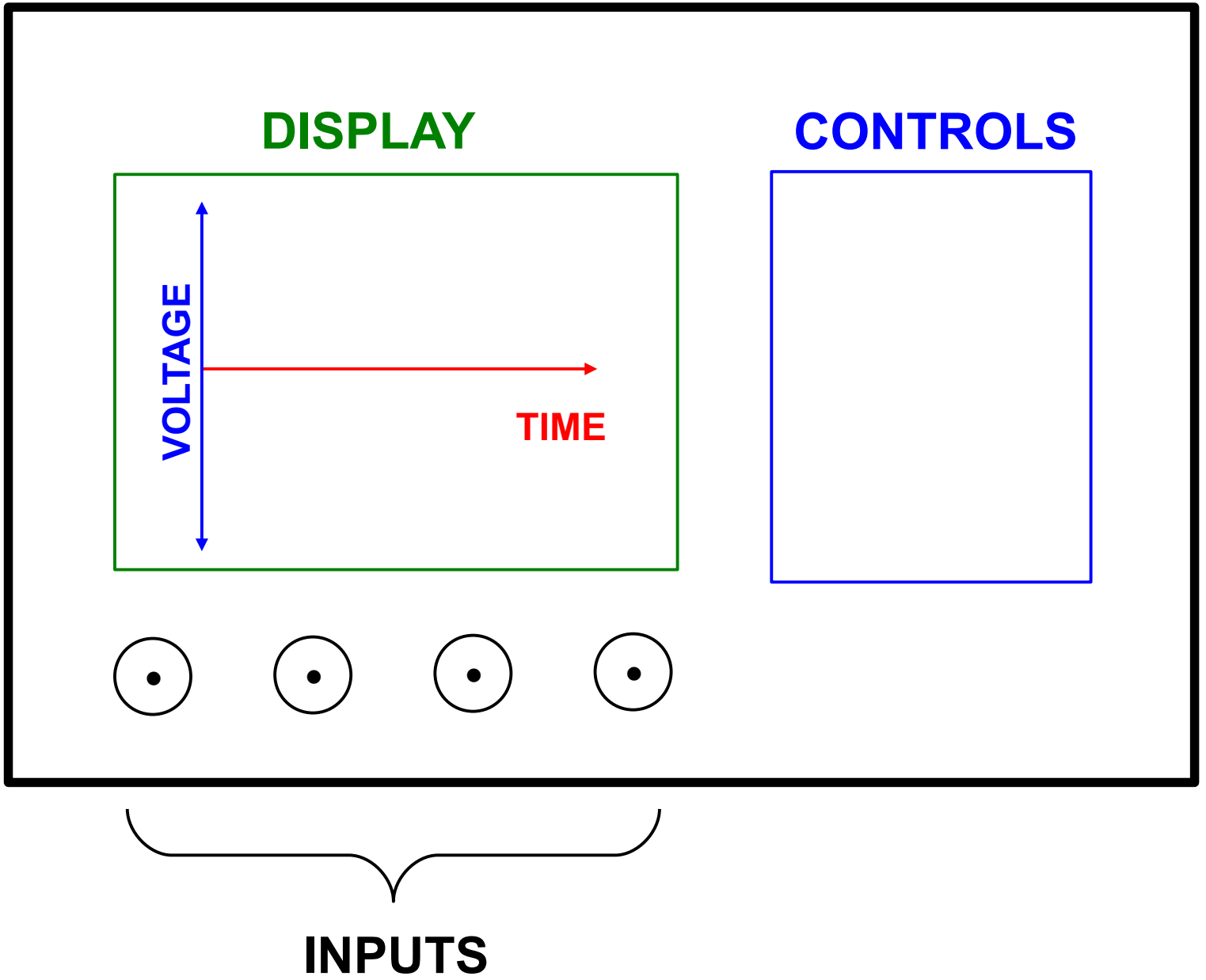
Useful for determining power dissipated by an AC waveform

Allows comparison of power in AC and DC circuits

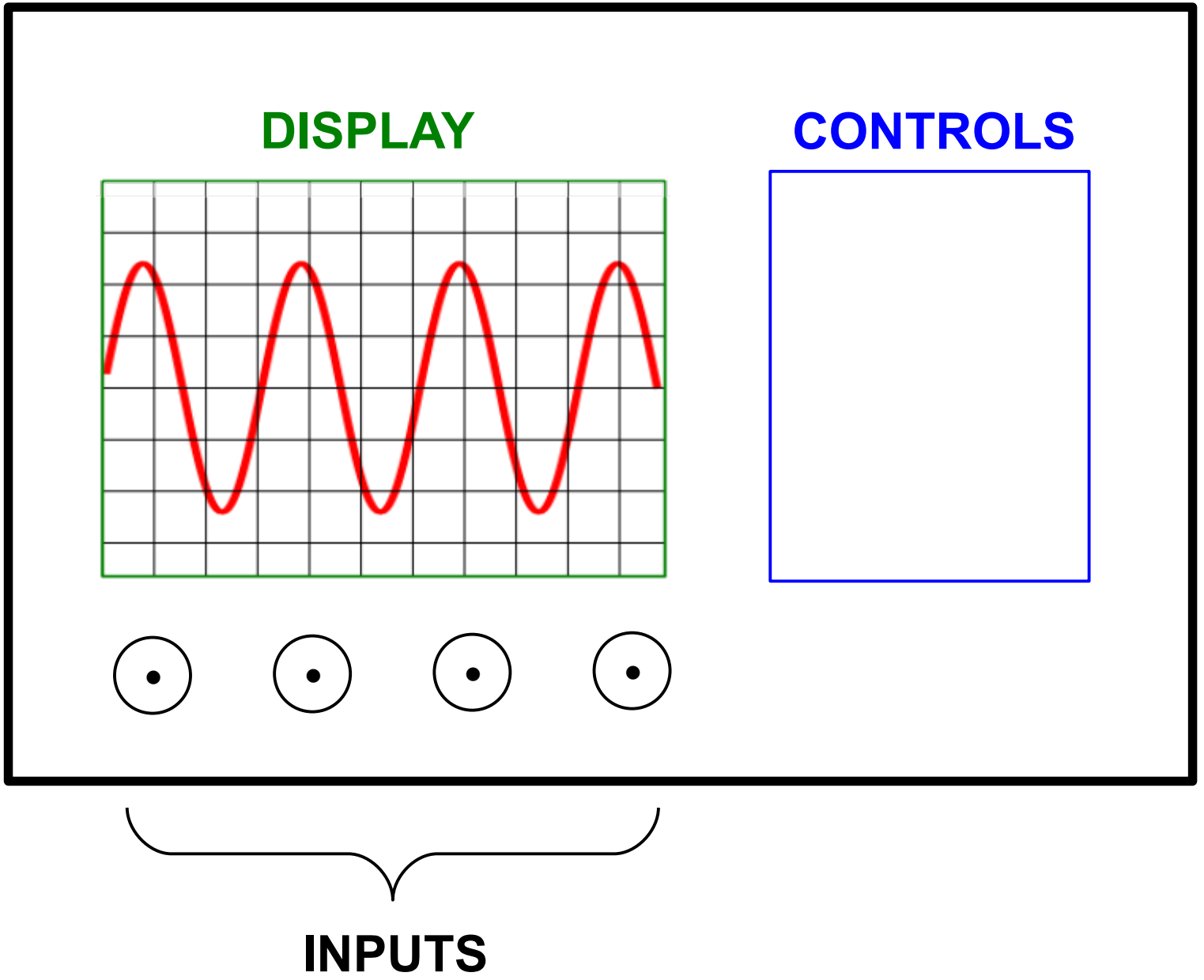


$$\text{POWER} = \frac{V_{ac}^2}{R} = \frac{V_p^2}{2R} \Rightarrow V_{RMS} = \frac{V_p}{\sqrt{2}}$$

OSCILLOSCOPE



OSCILLOSCOPE

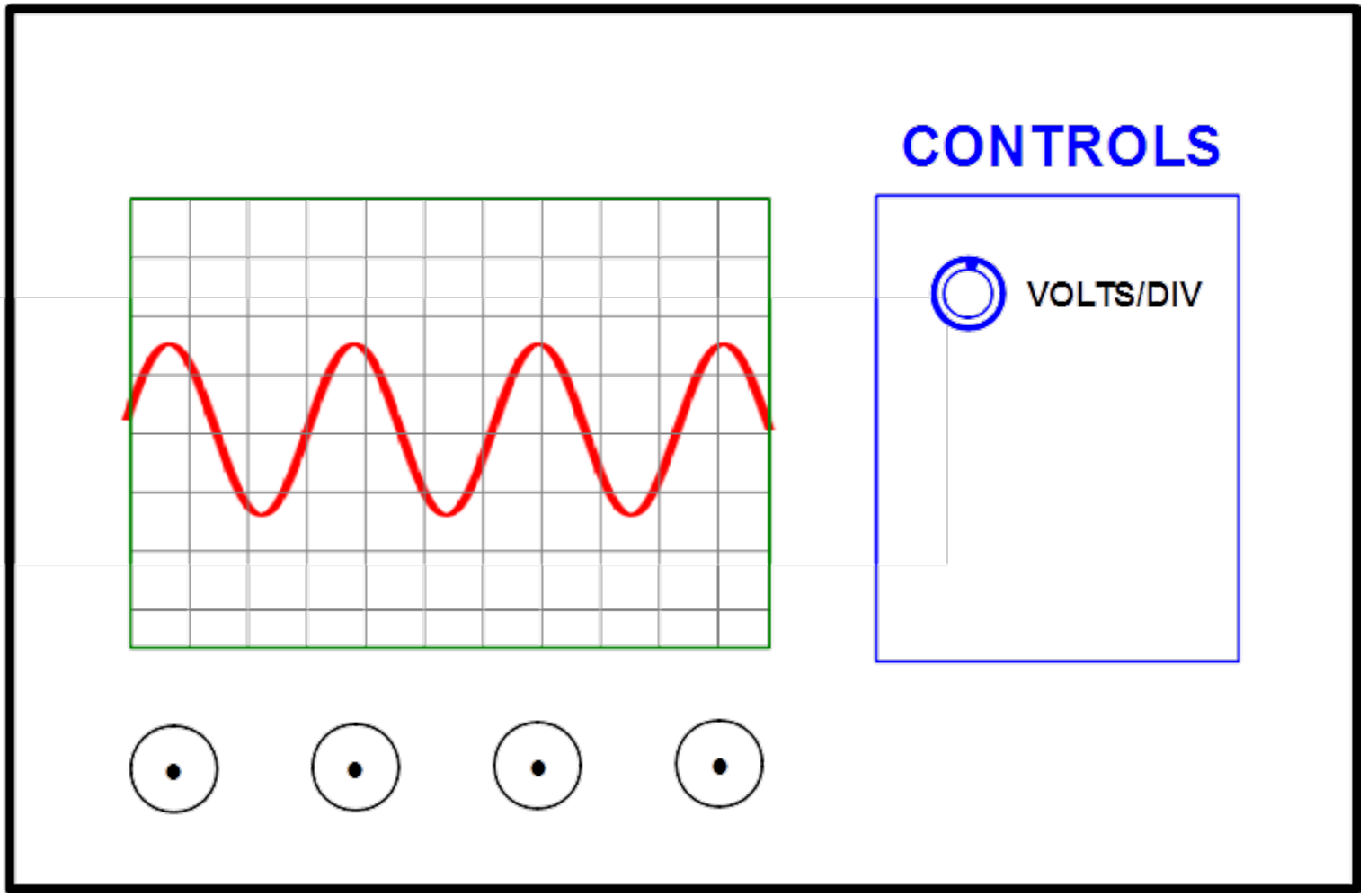


ANALOG: Cathode ray tube, swept electron beam

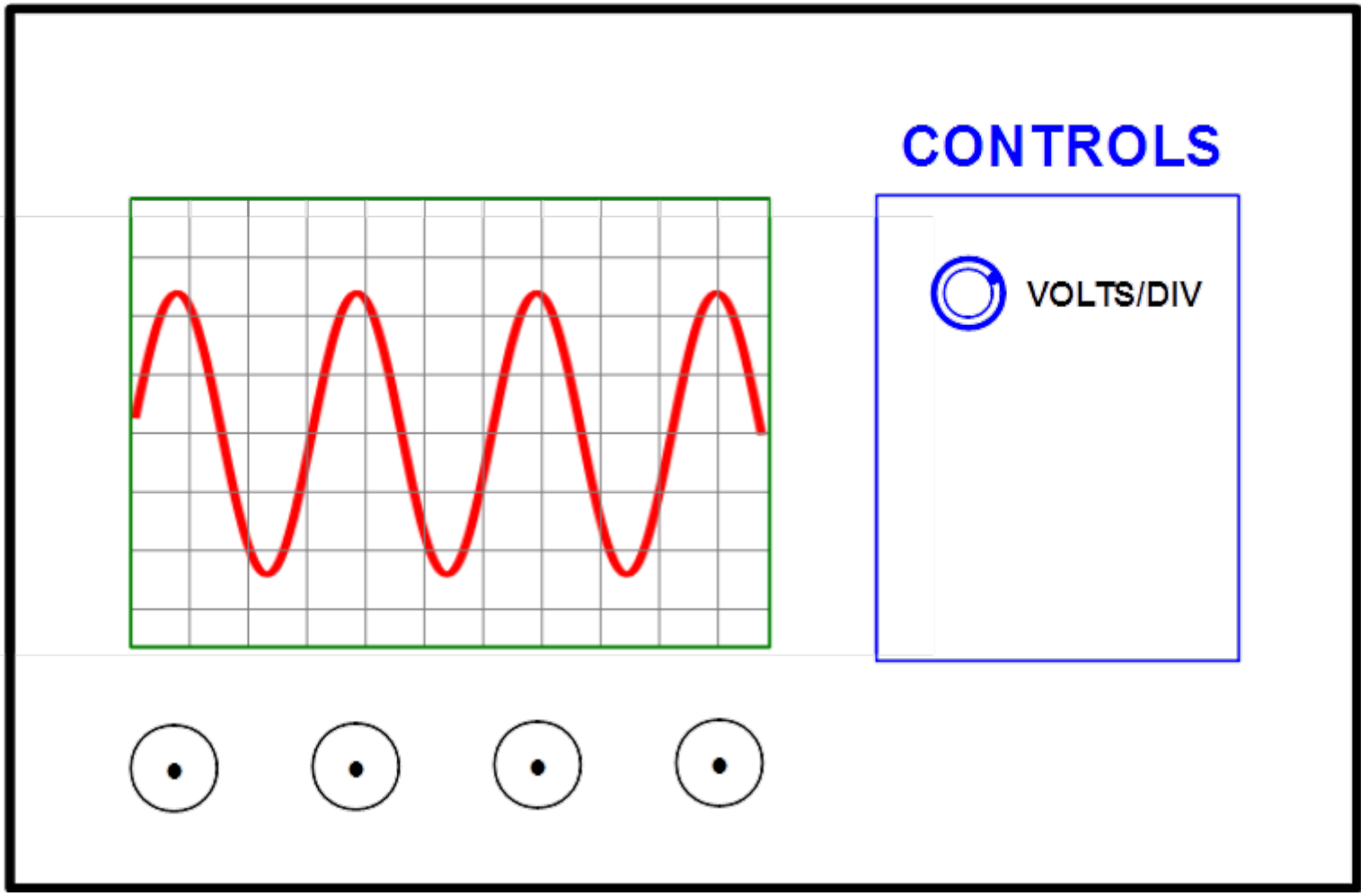
DIGITAL: A/D converter, LCD display

Although physical operation is completely different, controls are nearly identical

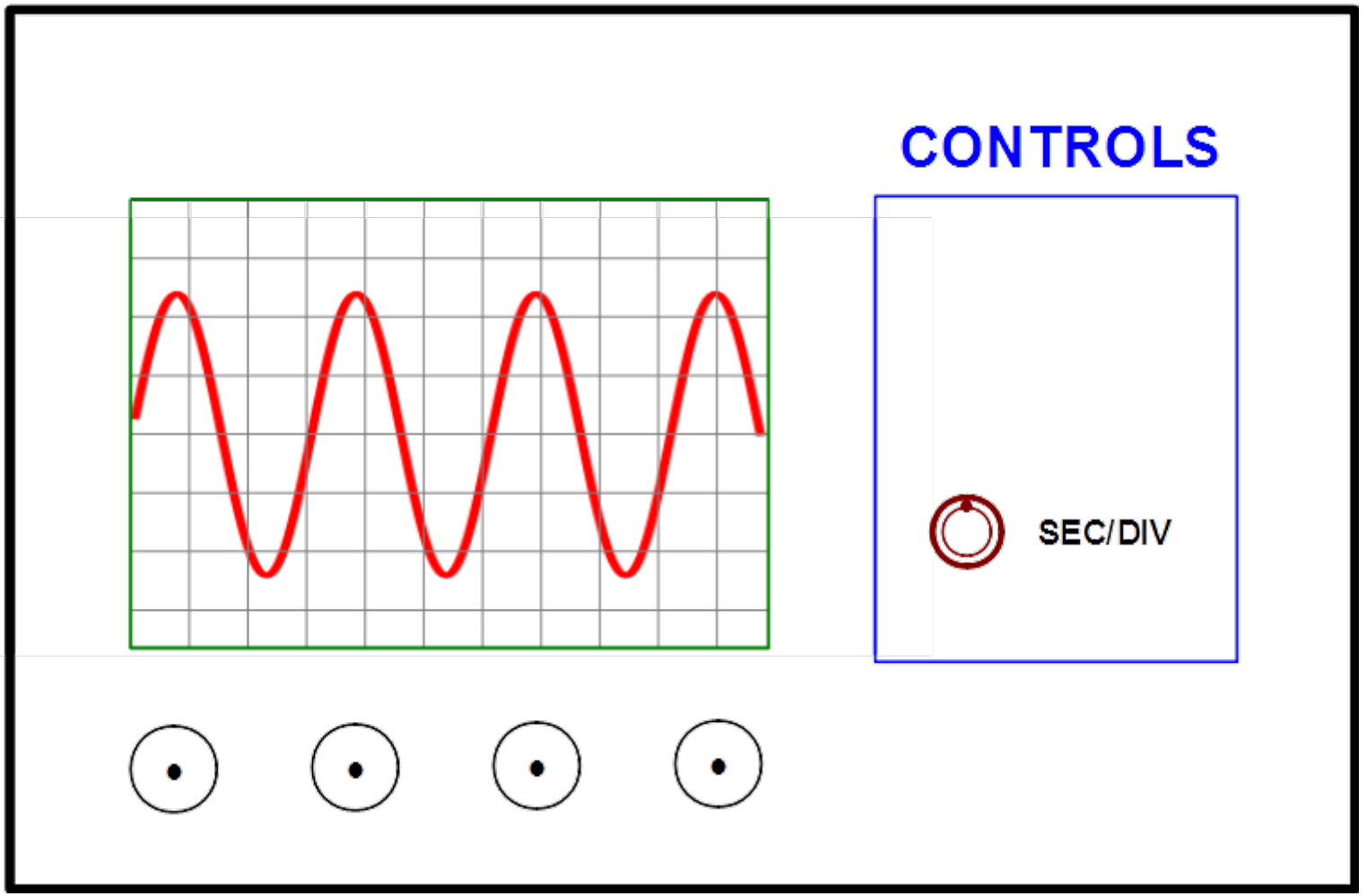
DISPLAY ADJUSTMENT



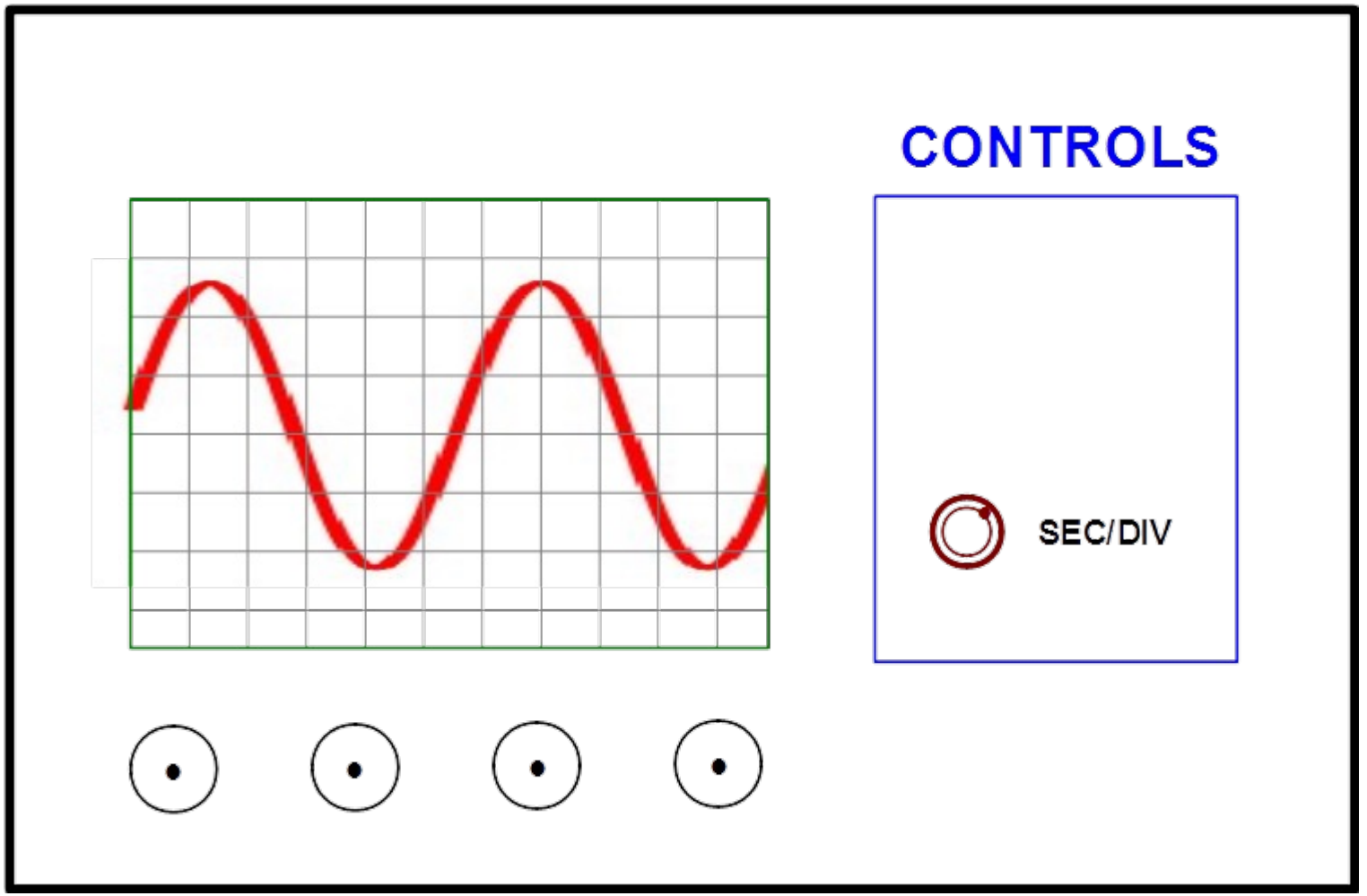
DISPLAY ADJUSTMENT



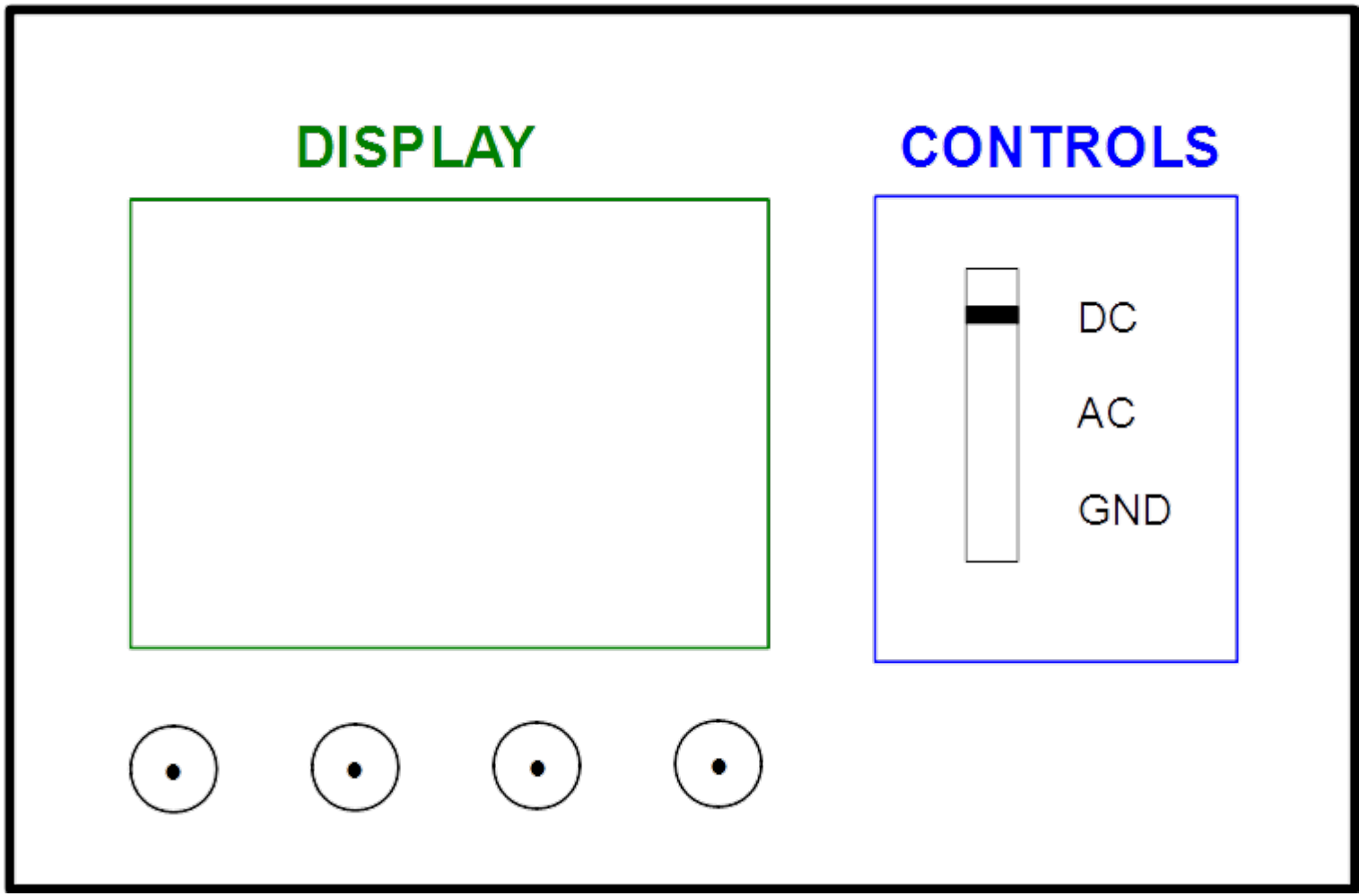
DISPLAY ADJUSTMENT



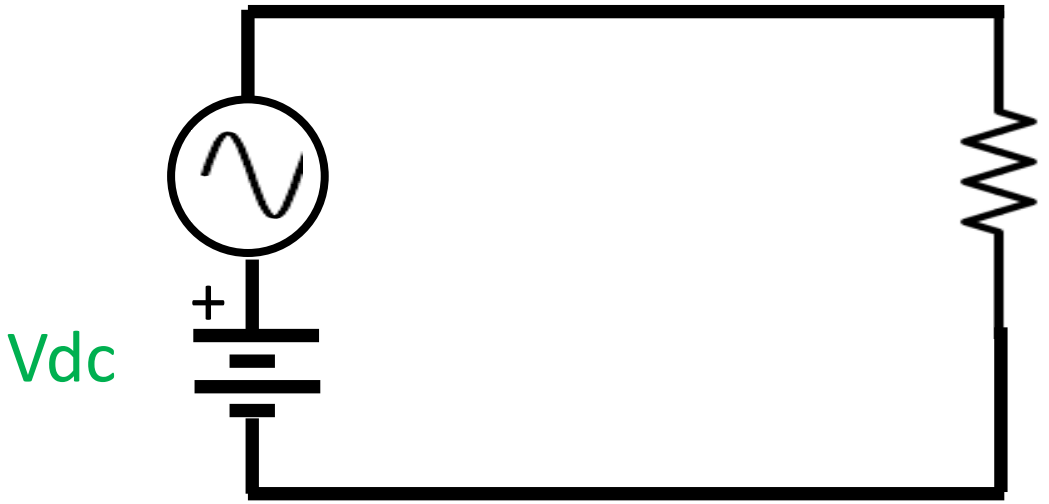
DISPLAY ADJUSTMENT

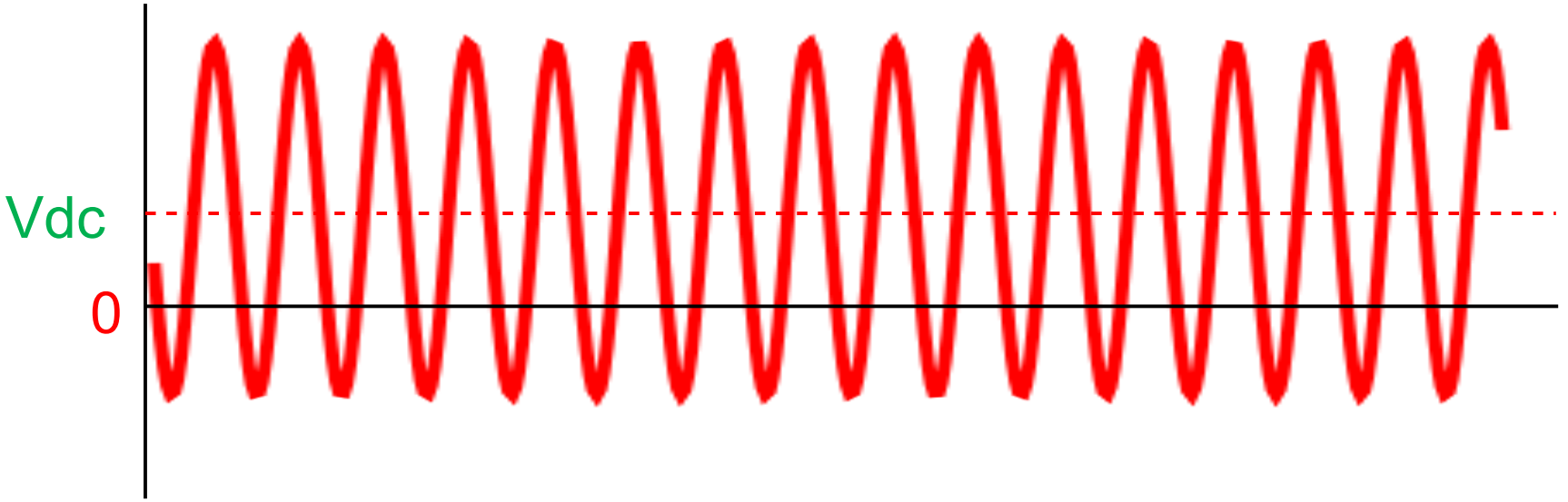


DC coupling, AC coupling, and Ground

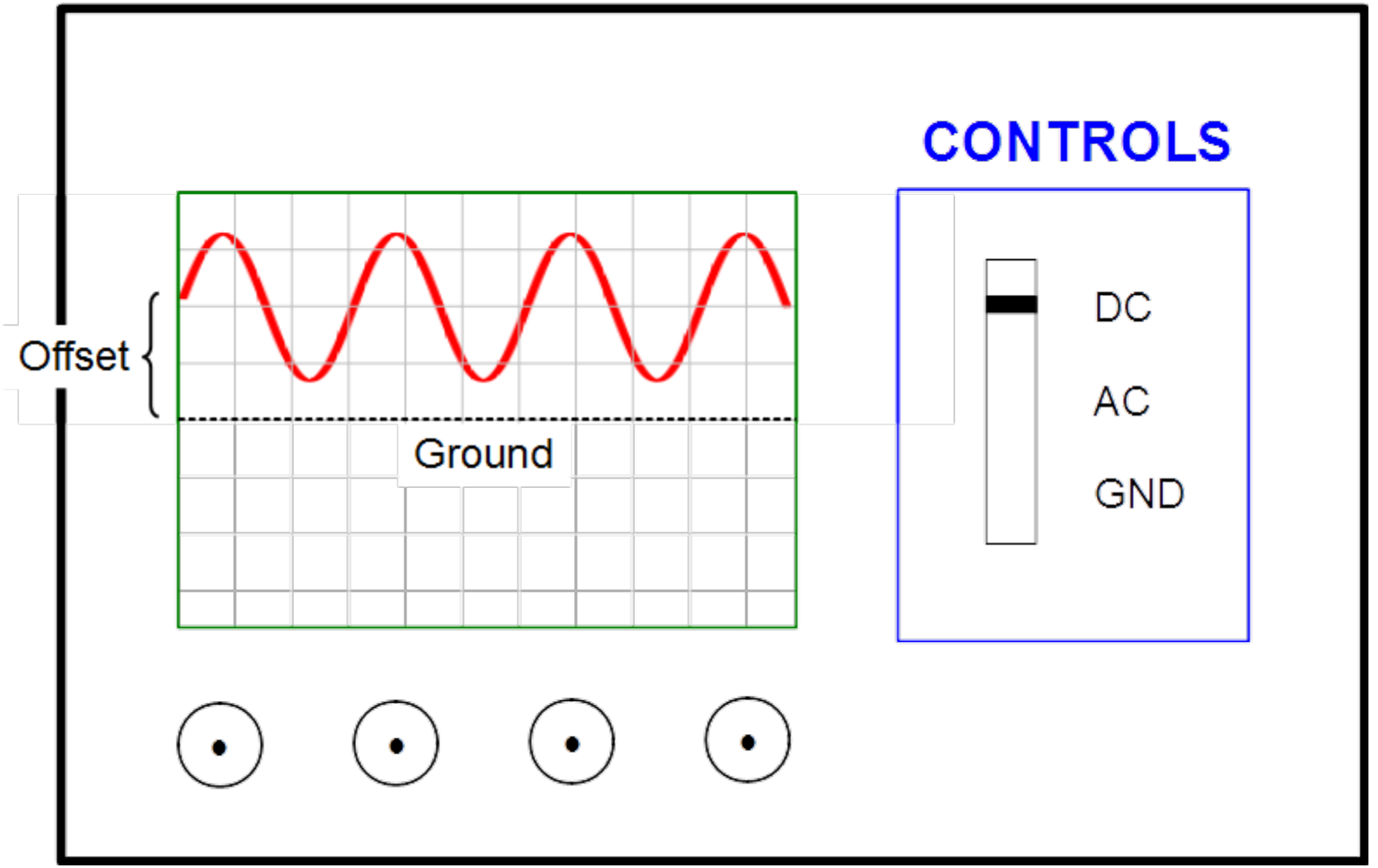


Sinusoidal wave source + dc offset

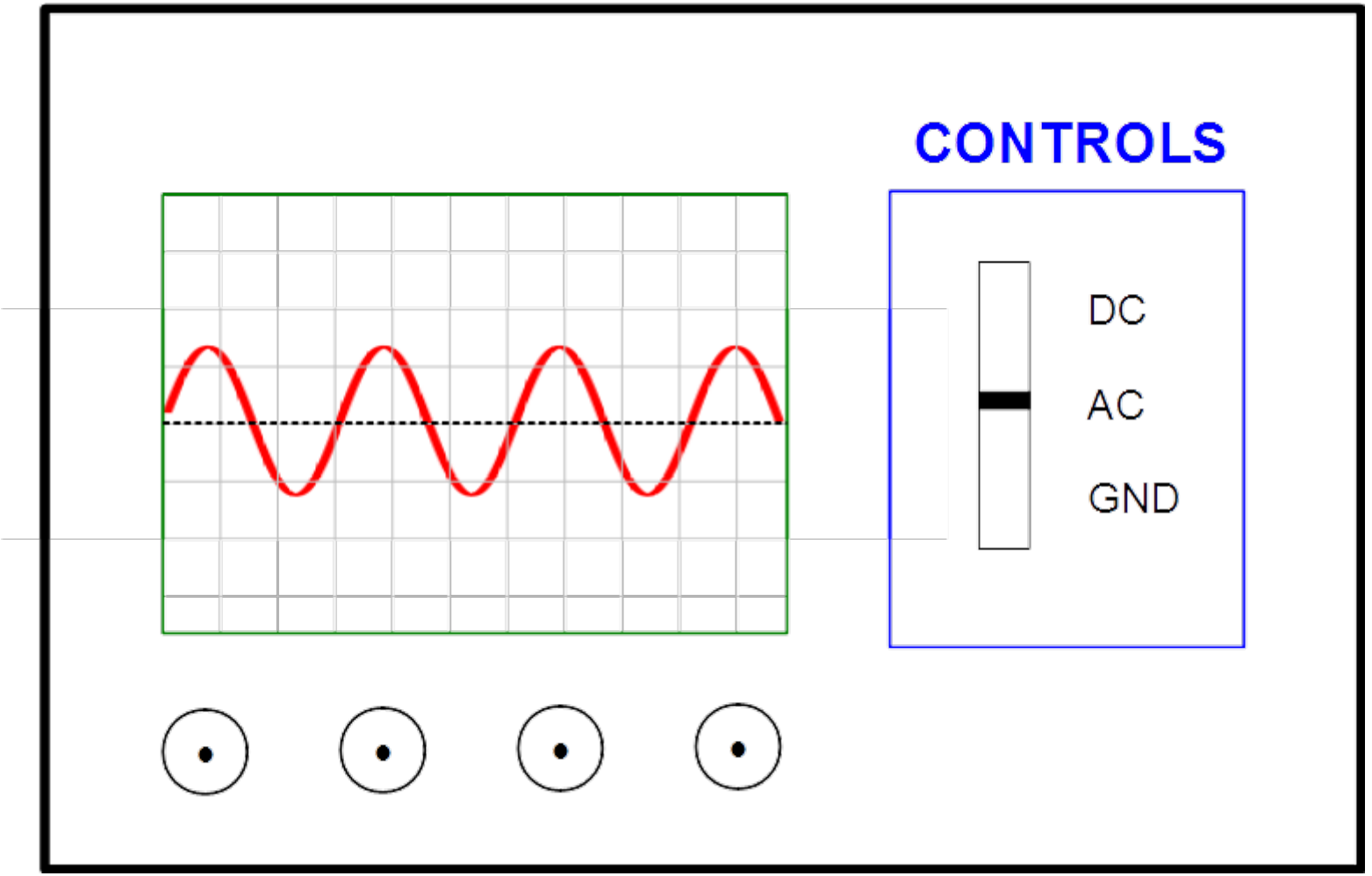




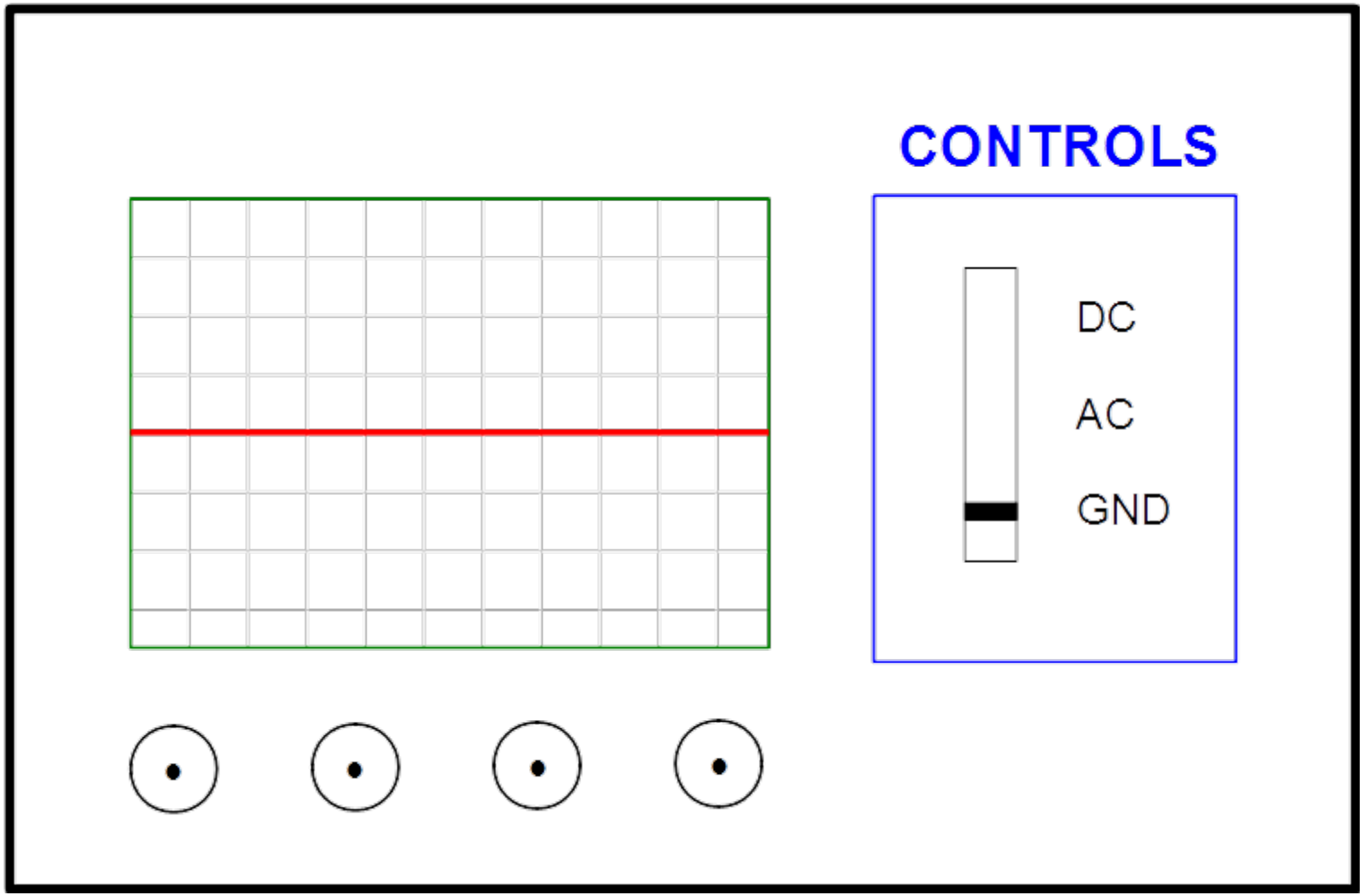
DC COUPLING



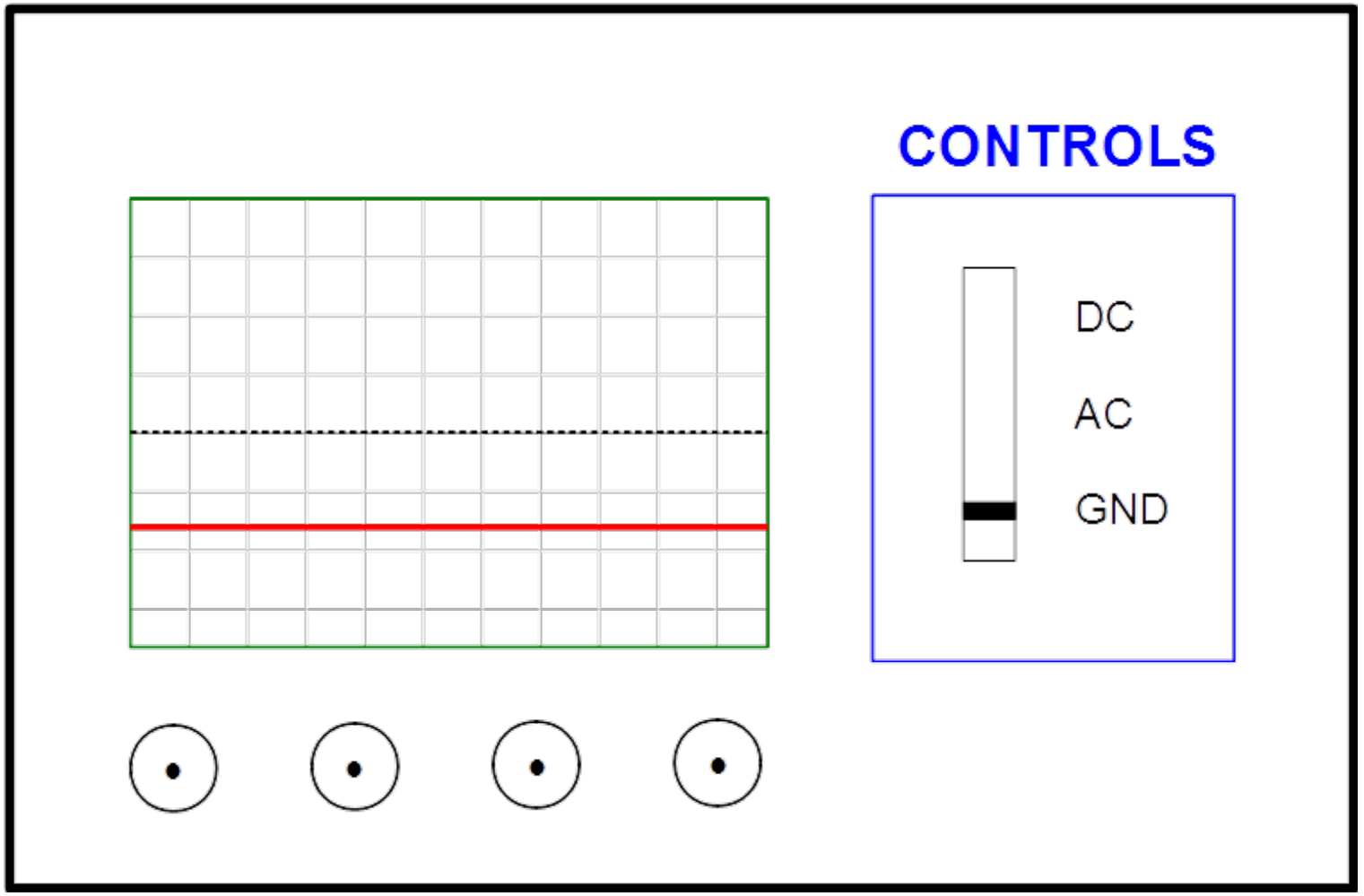
AC COUPLING



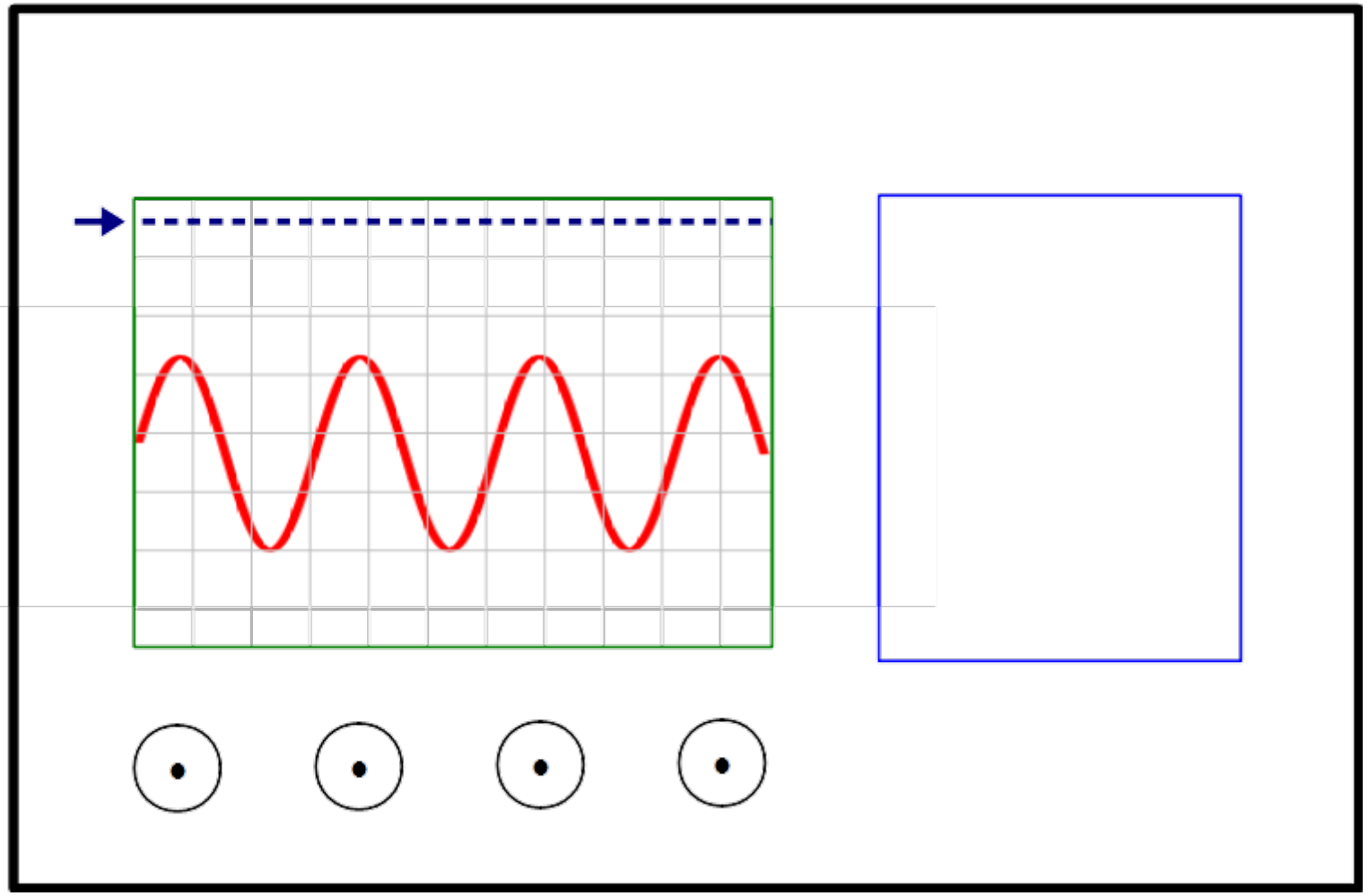
GROUND: Defines location of 0 Volts



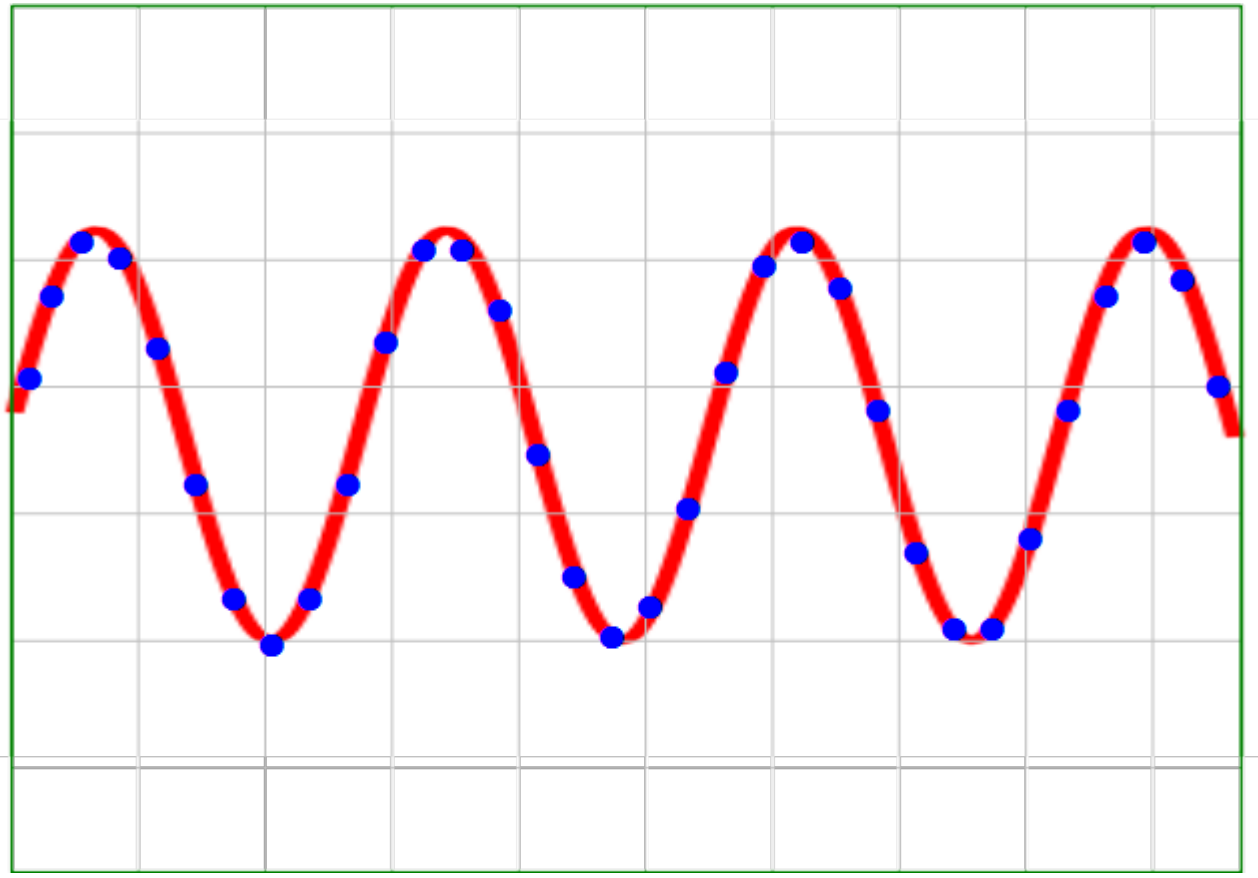
GROUND can be positioned at any convenient level



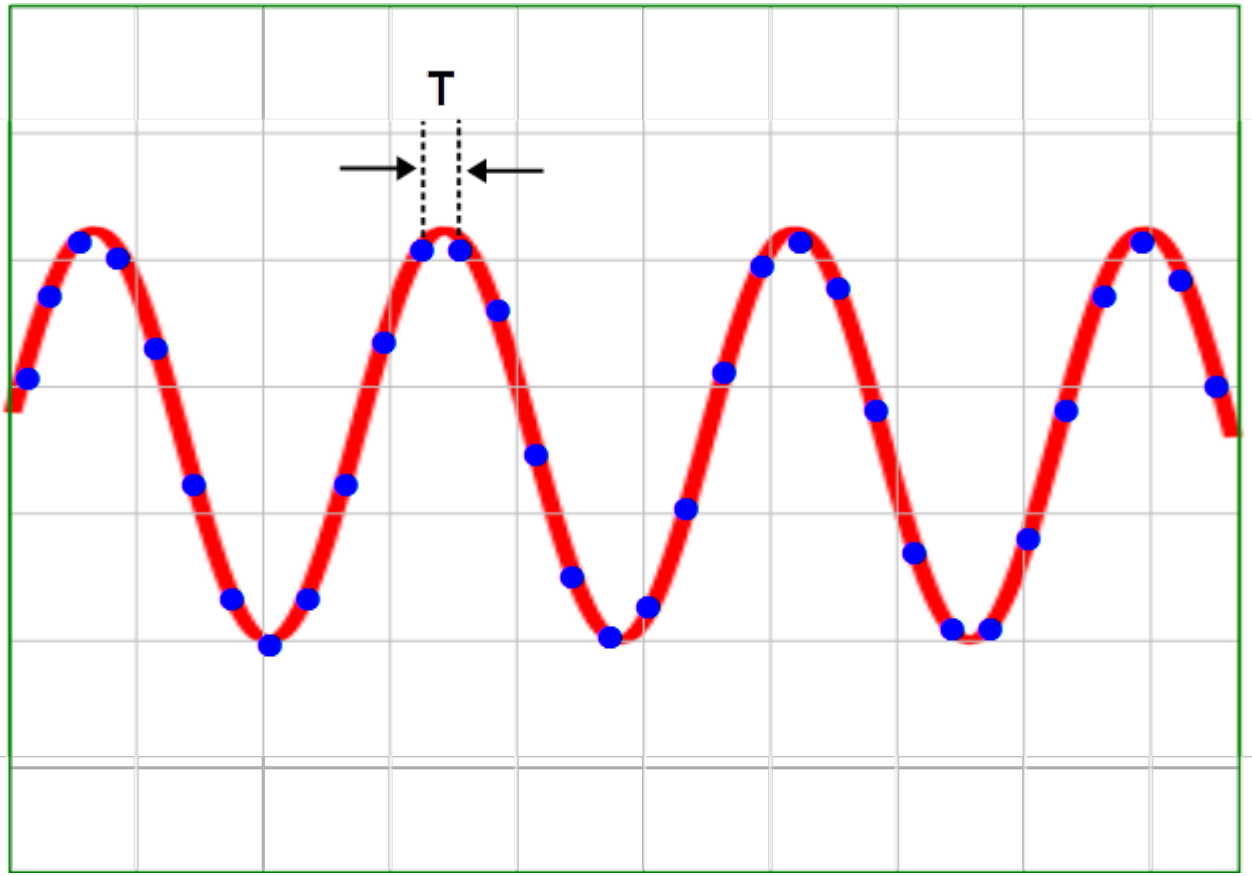
Trigger level



SAMPLING BANDWIDTH



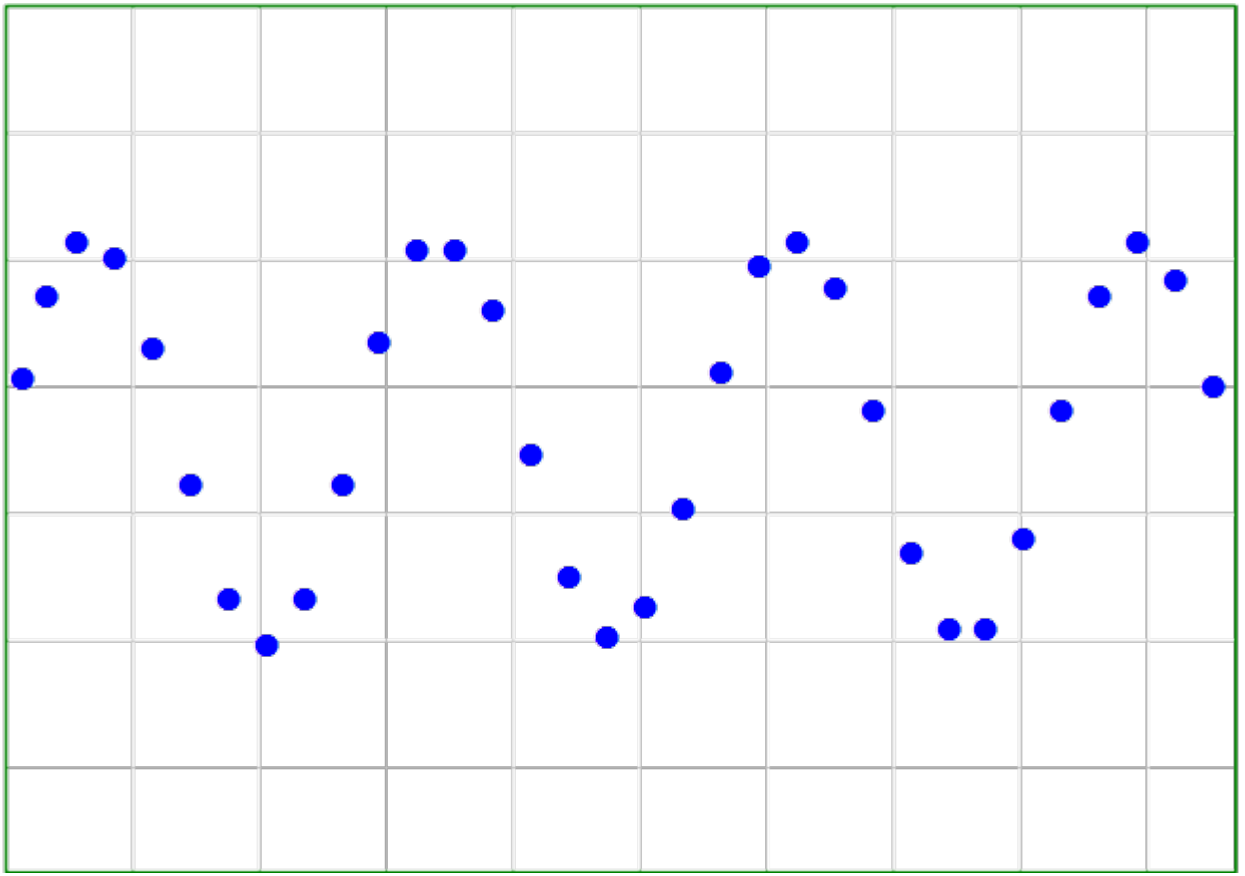
SAMPLING BANDWIDTH



Sample spacing: **T** (sec)

Sampling bandwidth = 1 / **T** (samples/sec)

SAMPLING BANDWIDTH



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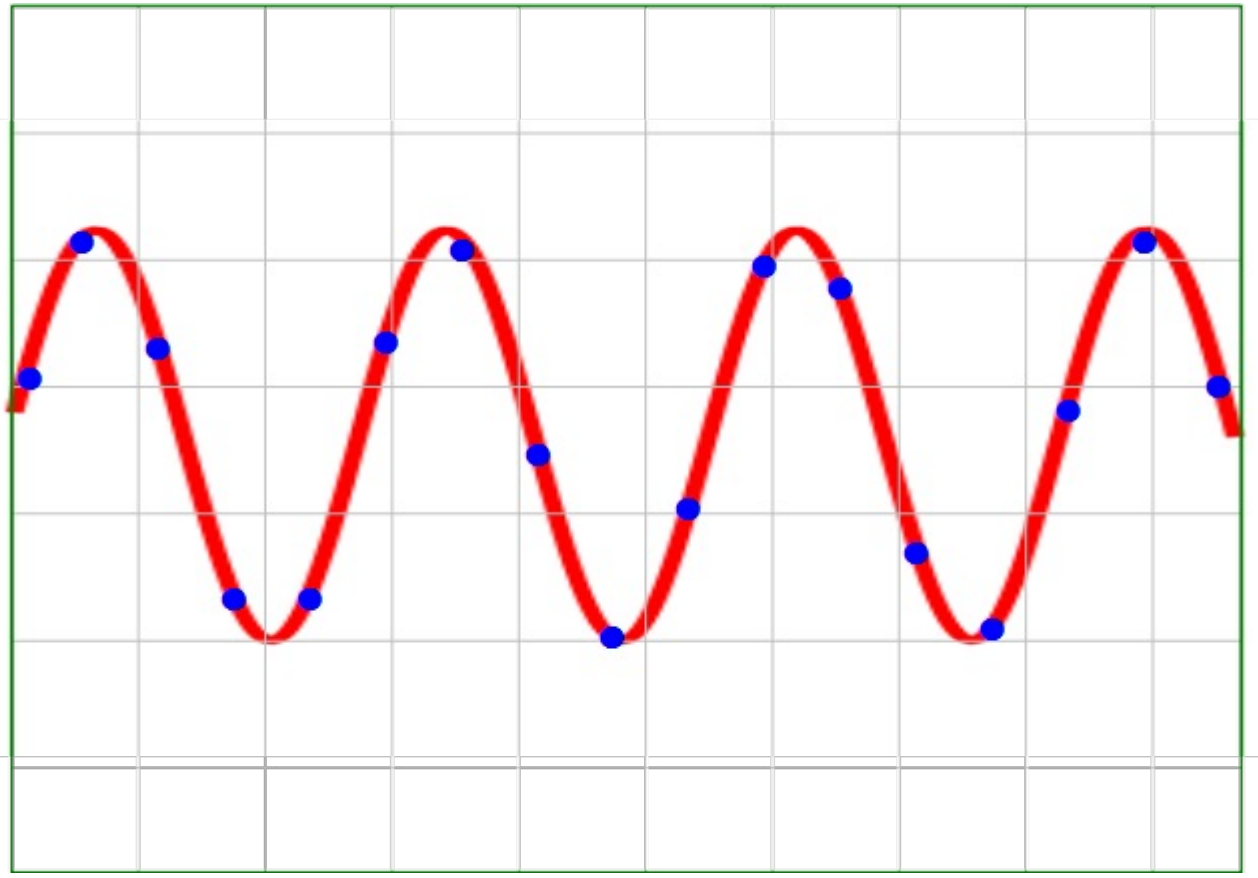
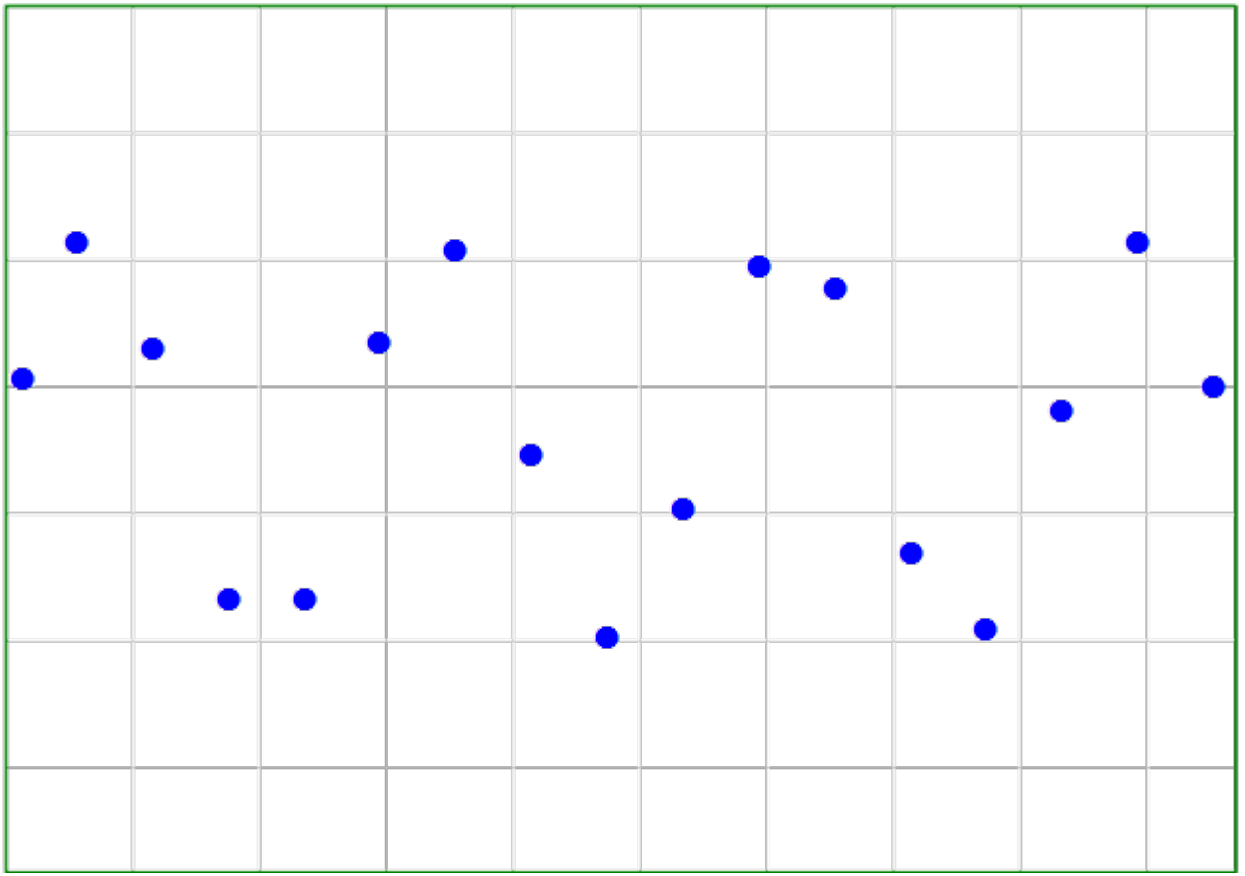
SAMPLING BANDWIDTH



Reduce sample bandwidth 2x ⇨ Increase time spacing 2x

SAMPLING BANDWIDTH



Reduce sample bandwidth 2x ⇨ Increase period 2x

ANALOG BANDWIDTH ≠ SAMPLING BANDWIDTH