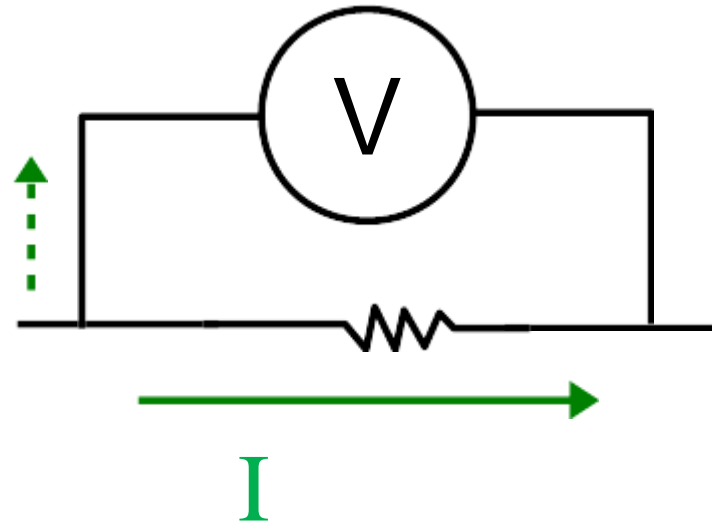# Lab 2: AC Circuits and Oscilloscope

Ideal meters

VOLTMETER: $I_{meter} \approx 0$

Example: 10x oscilloscope probe
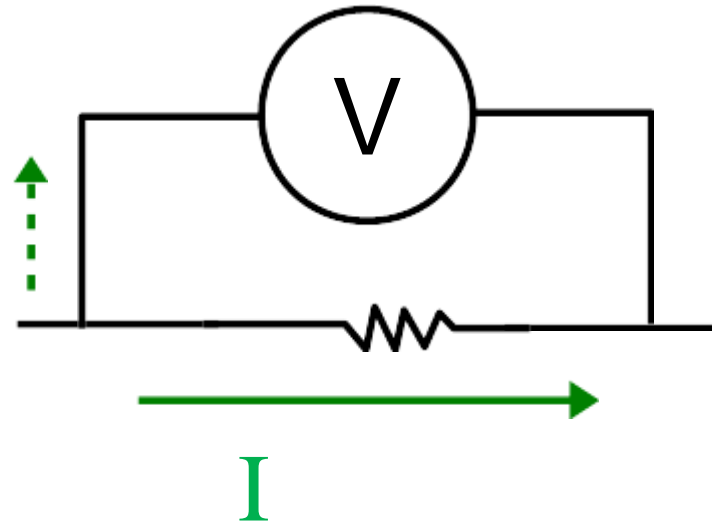
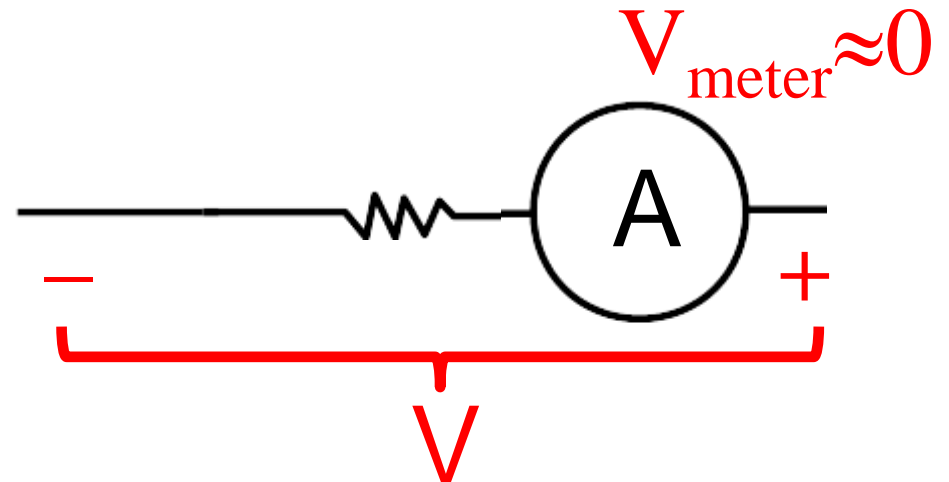# Ideal meters

VOLTMETER: $I_{meter} \approx 0$
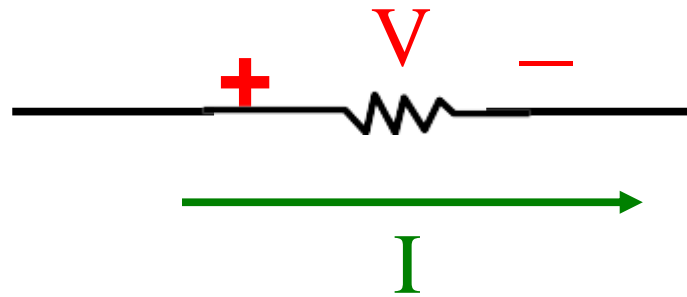
Example: 10x oscilloscope probe

I

AMMETER: $V_{meter} \approx 0$

V

Power Dissipation

Energy=VQ

Power=d(Energy)/dt

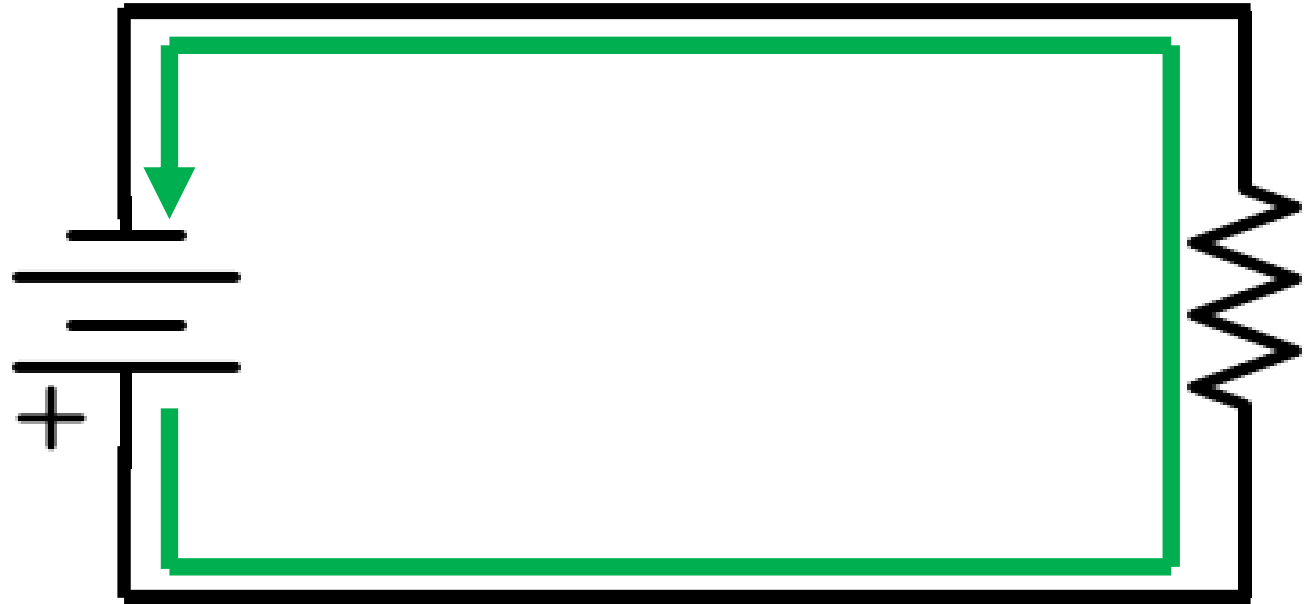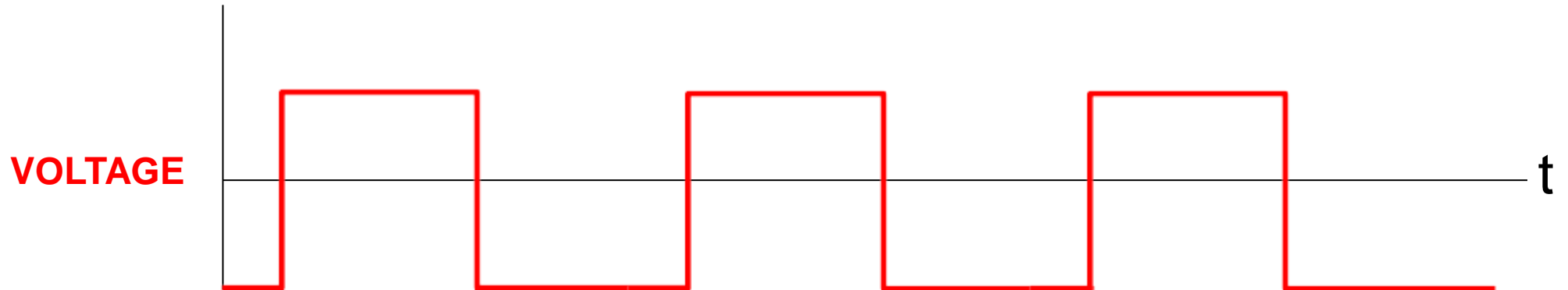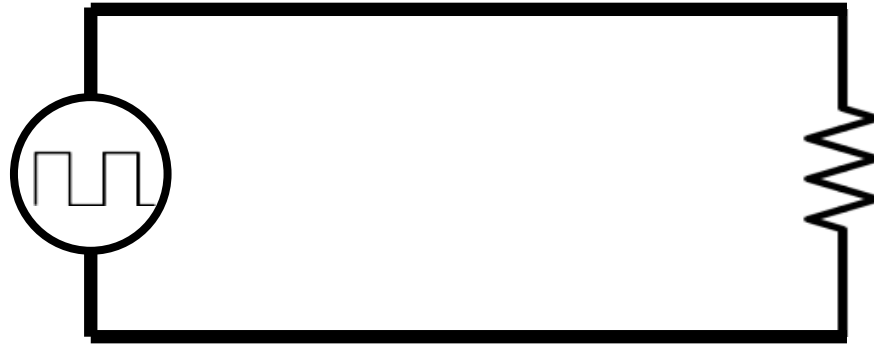Power dissipated $= \dfrac{V^2}{R} = I^2 R$

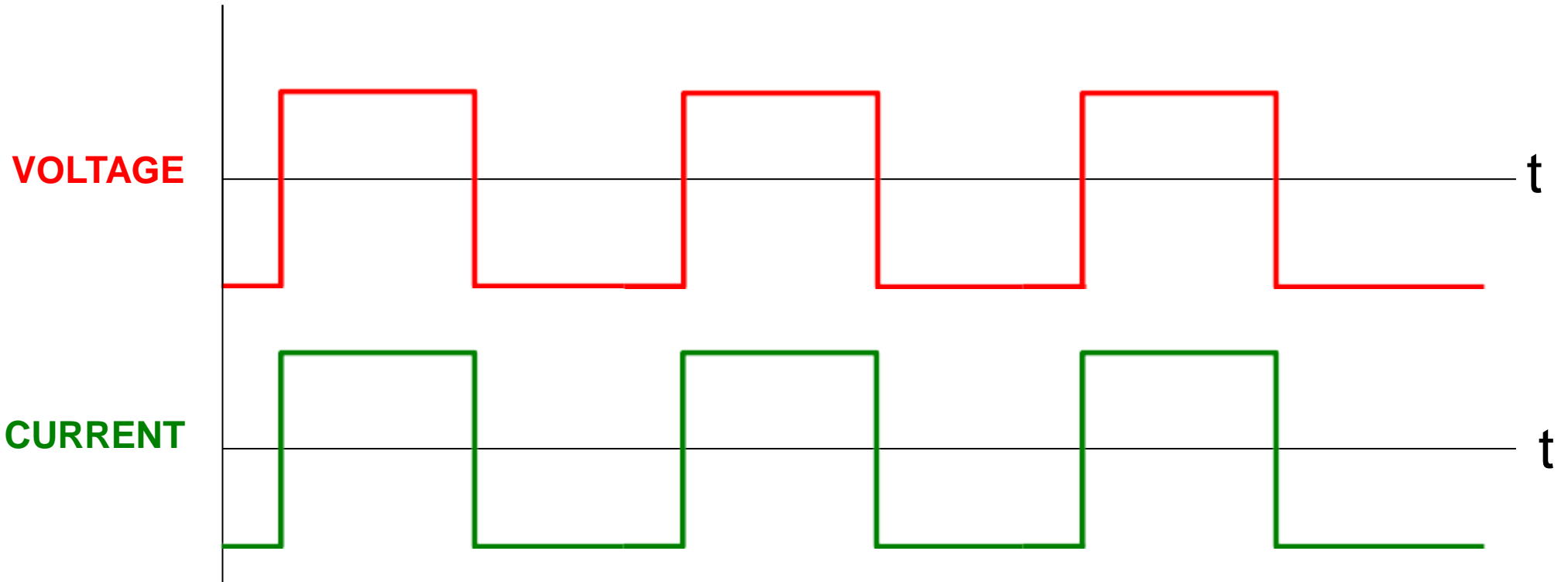# AC (Alternating Current) Circuits
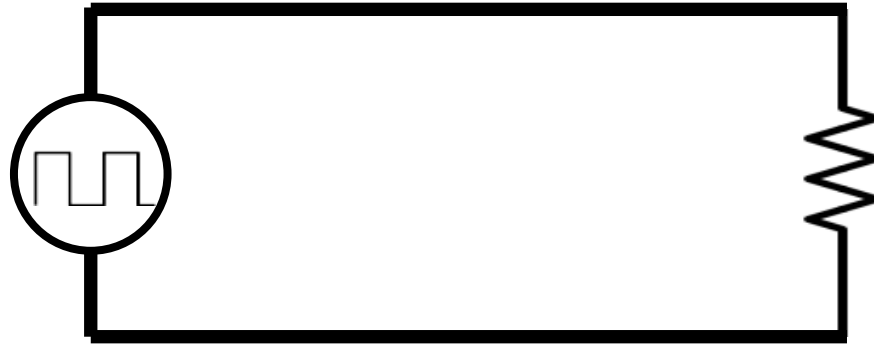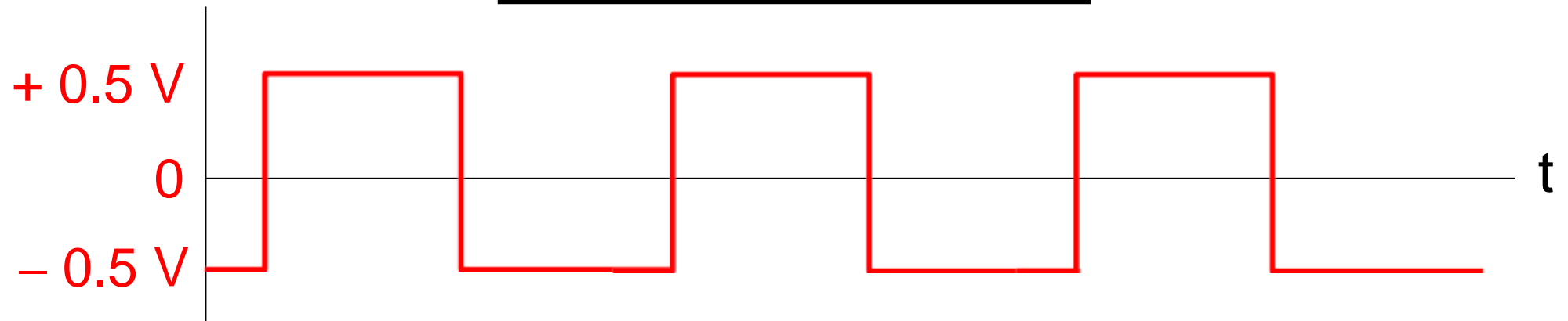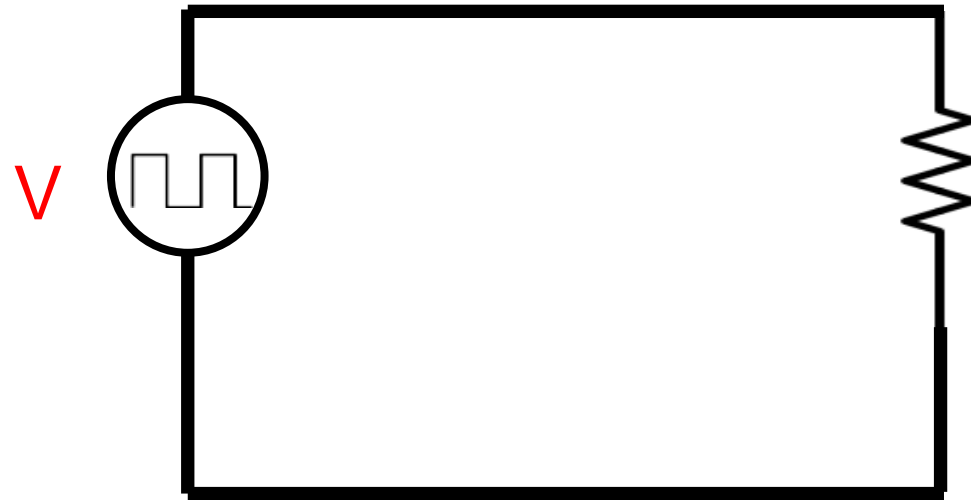

Current flow

AC (Alternating Current) Circuits

Current flow

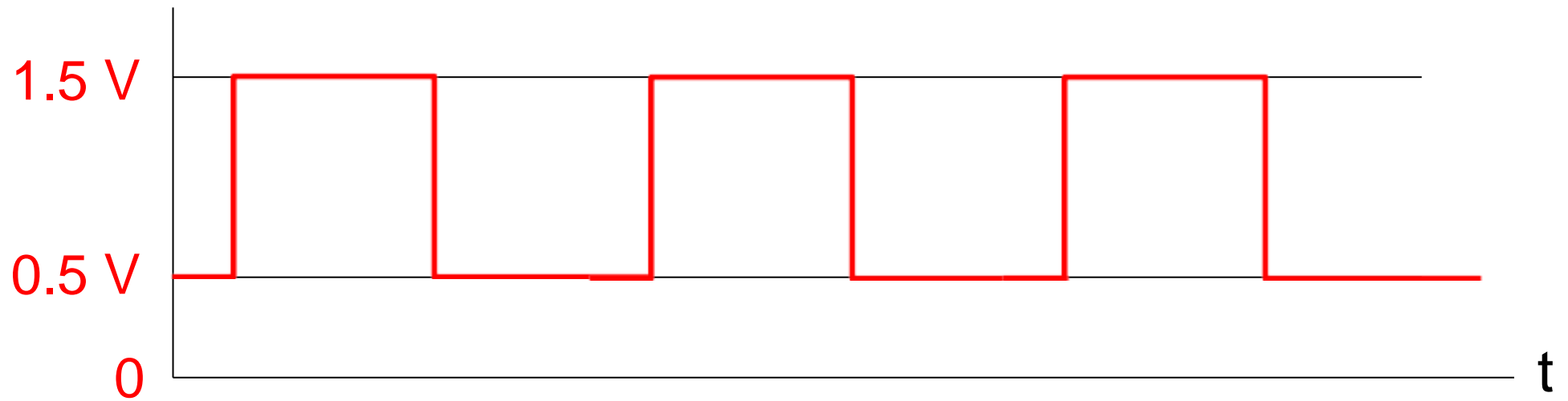# Square wave source

VOLTAGE

Square wave source

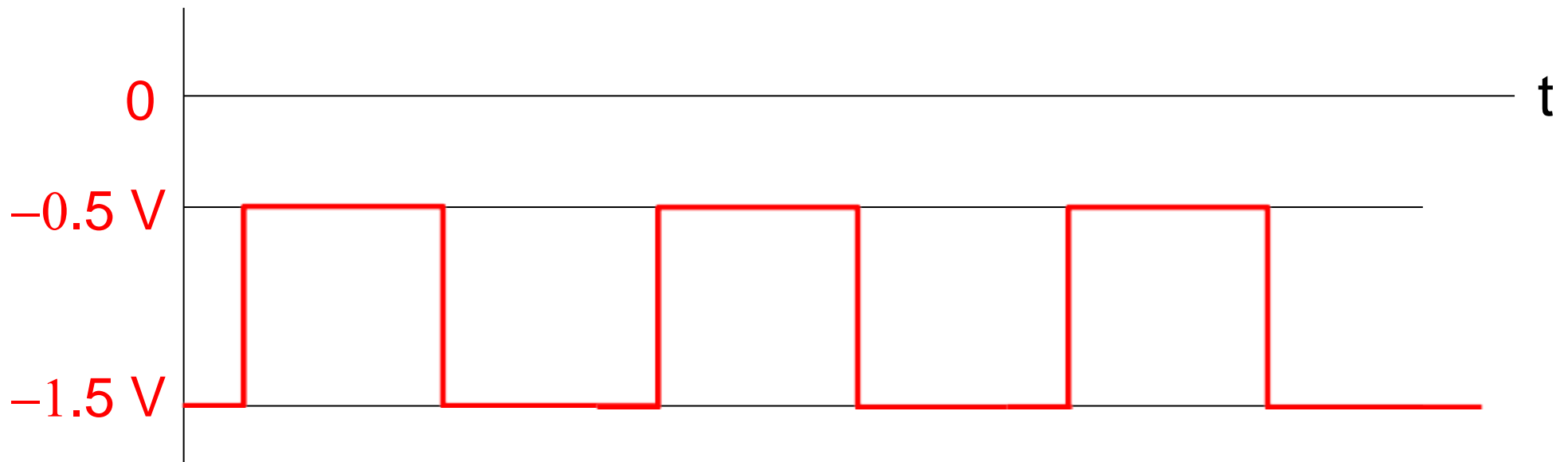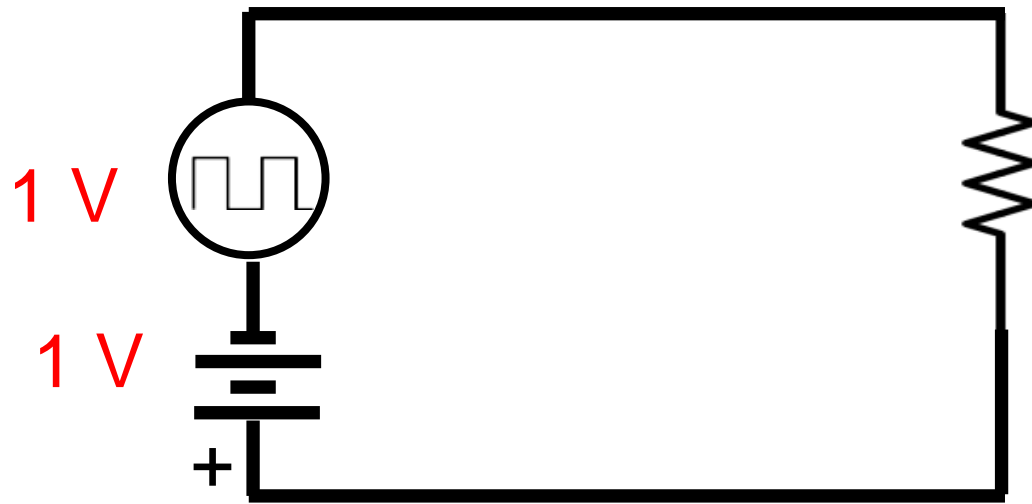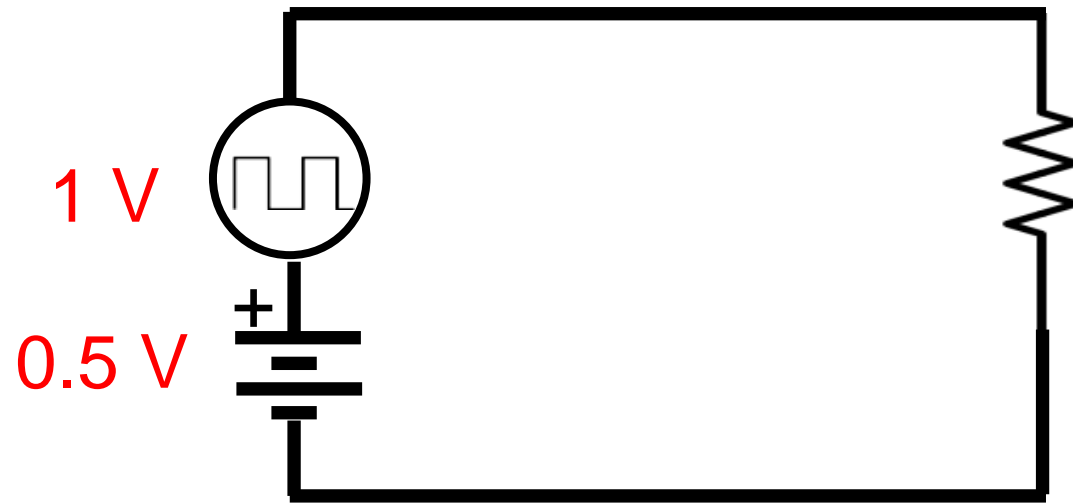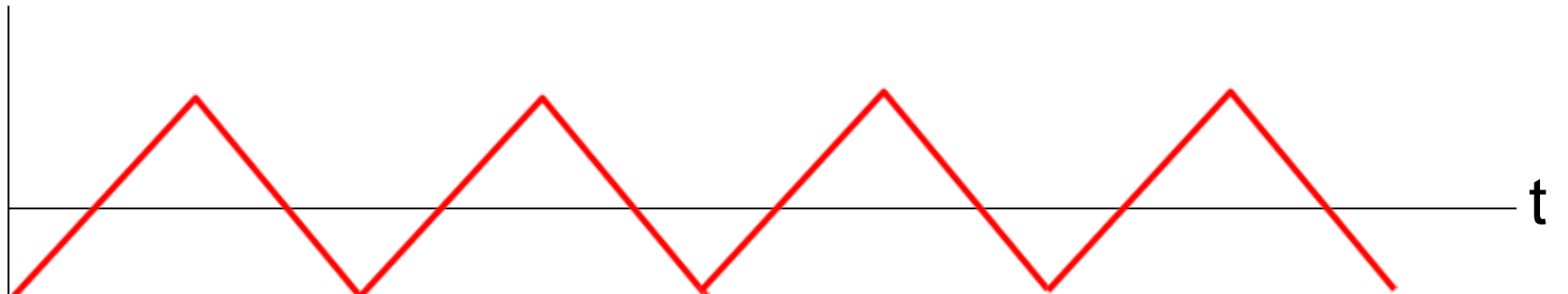**VOLTAGE**

t

CURRENT

t

Square wave source +

Square wave source + voltage offset

Square wave source + voltage offset

Square wave source + voltage offset
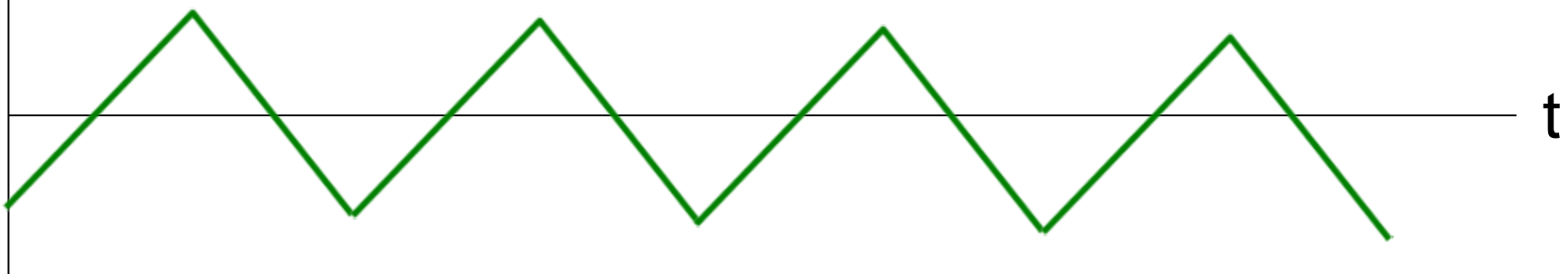
1 V

0.5 V
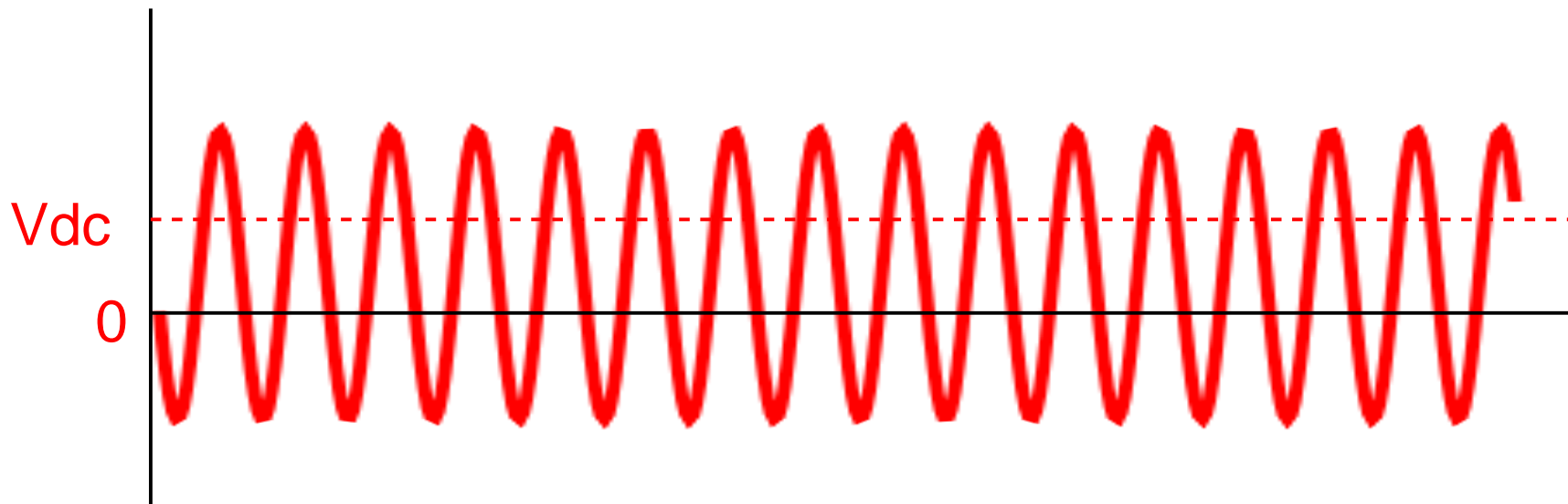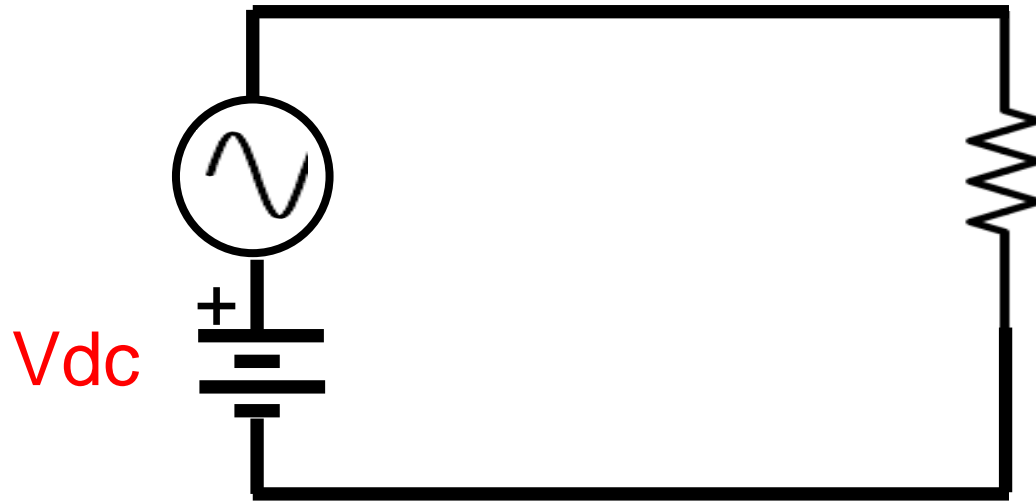
1.0 V

0

t

Triangle wave source

VOLTAGE

CURRENT

t

t

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

V_{dc}

R

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

V_{ac}

R

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

Root-mean-square (RMS)

Useful for determining power dissipated by an AC waveform

Allows comparison of power in AC and DC circuits

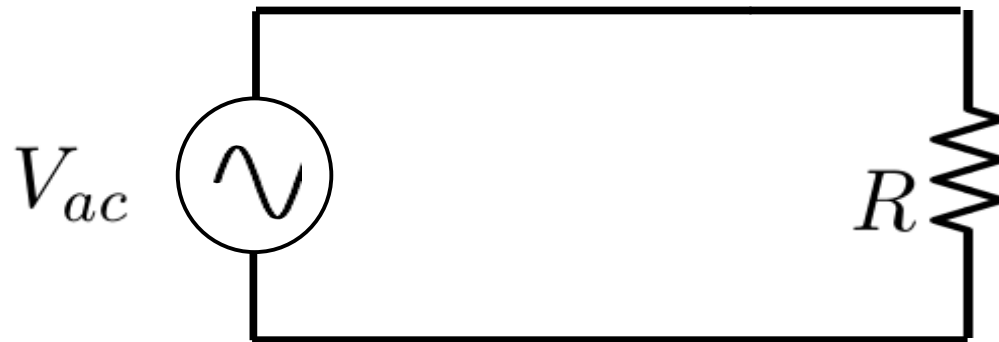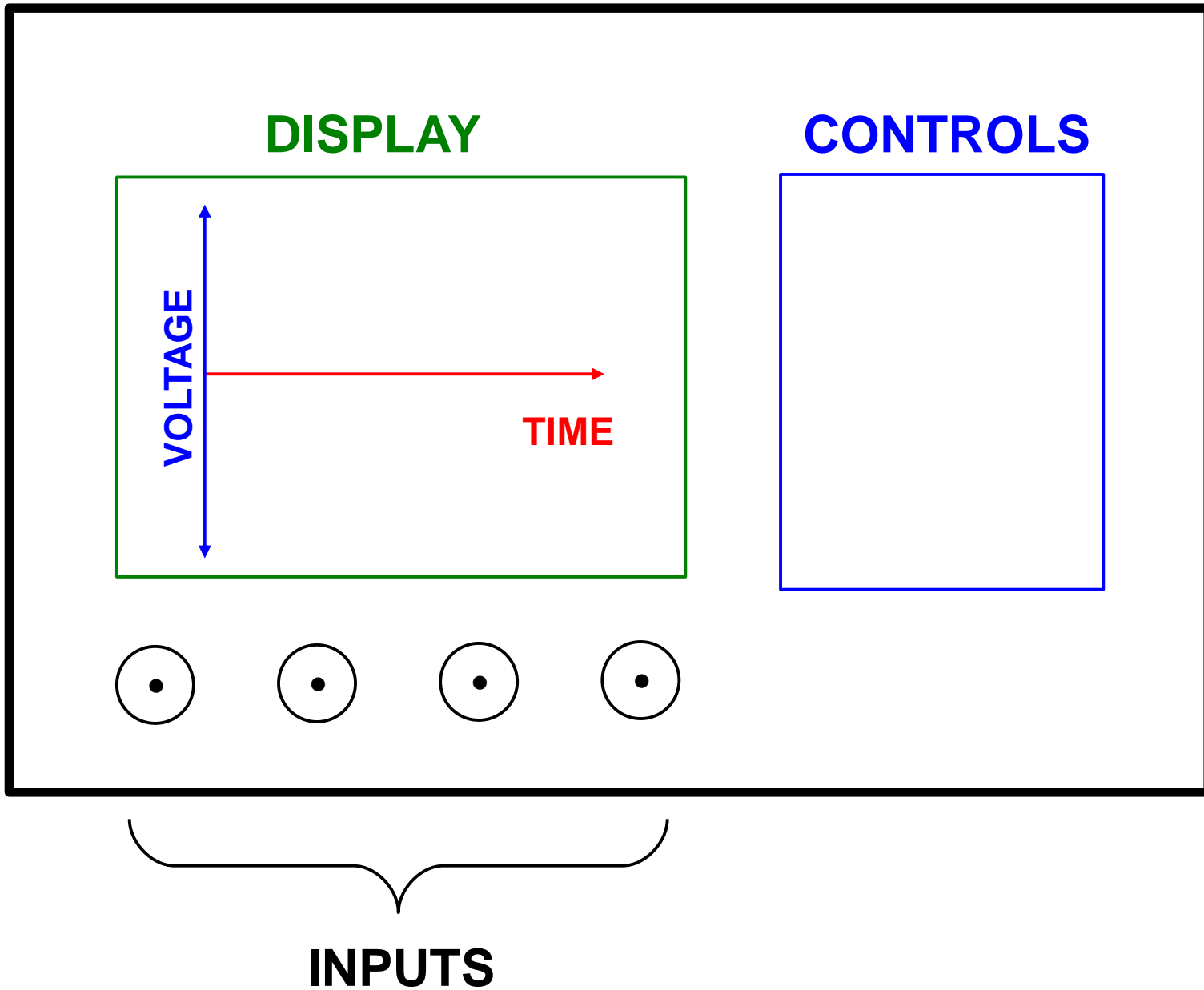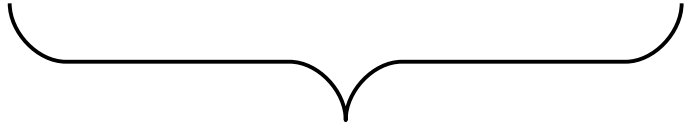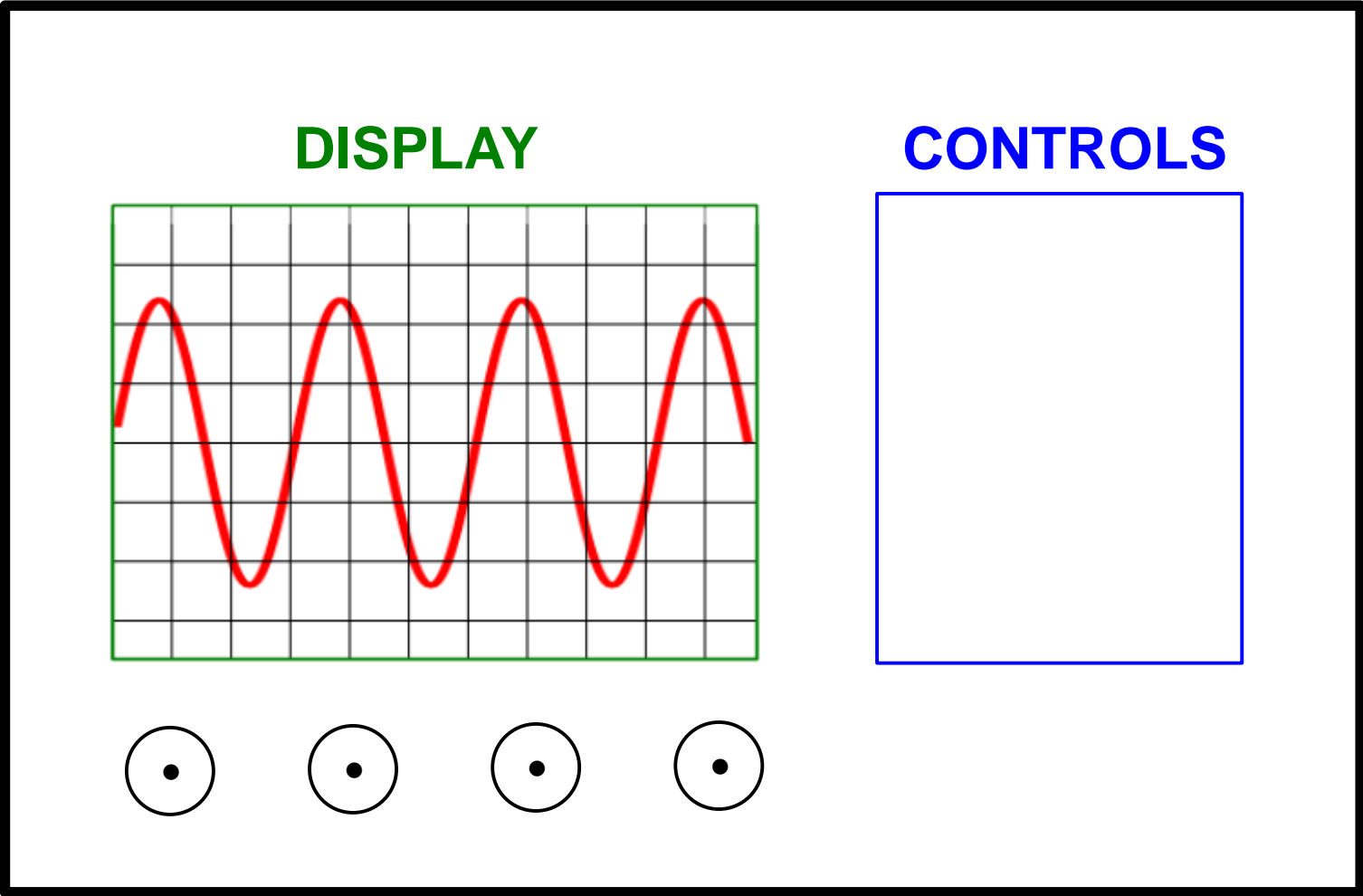$$\text{POWER} = \frac{V_{ac}^2}{R} = \frac{V_p^2}{2R} \implies V_{RMS} = \frac{V_p}{\sqrt{2}}$$

OSCILLOSCOPE

DISPLAY

CONTROLS

VOLTAGE

TIME

INPUTS
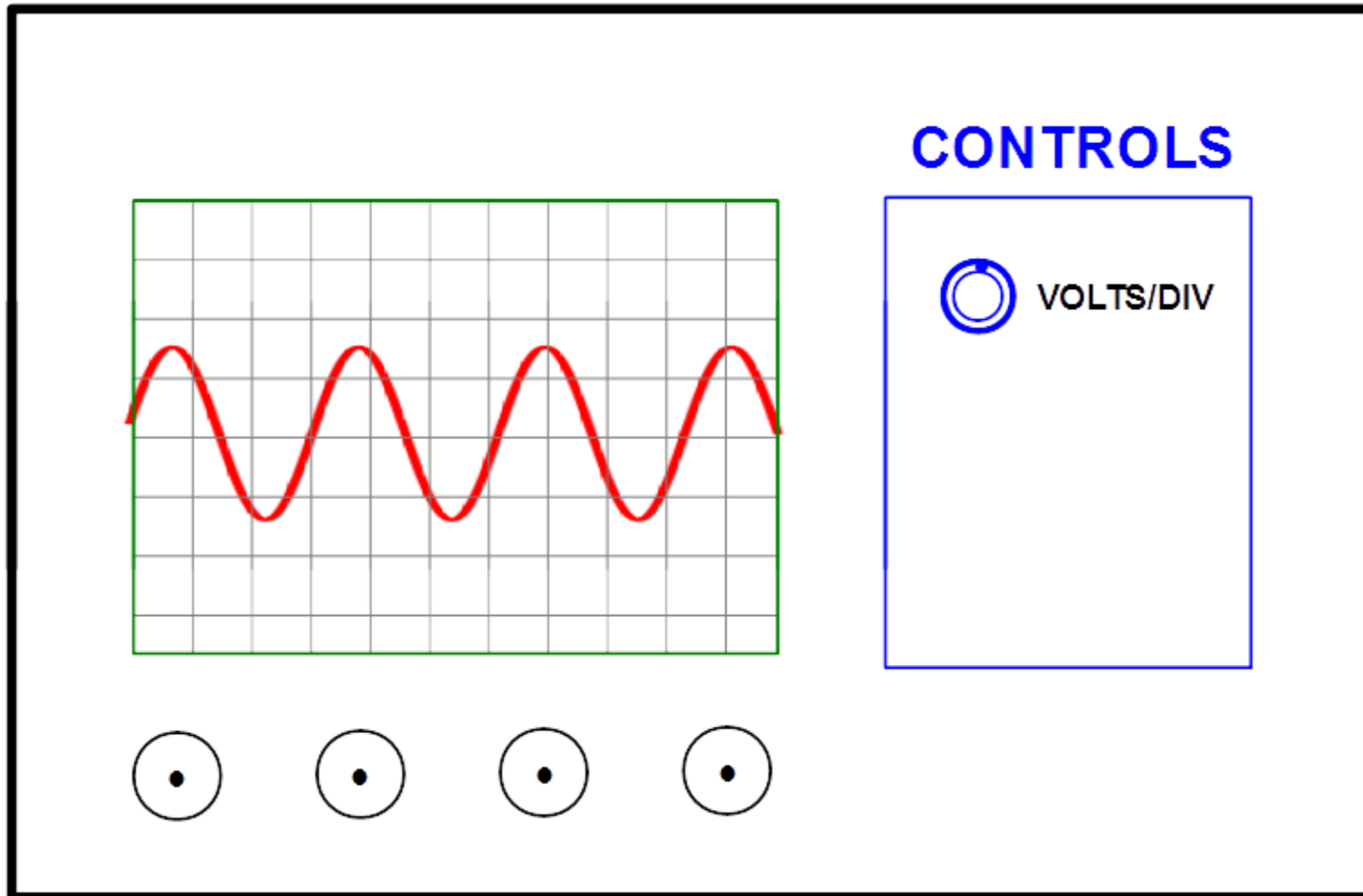
OSCILLOSCOPE

DISPLAY

CONTROLS

INPUTS

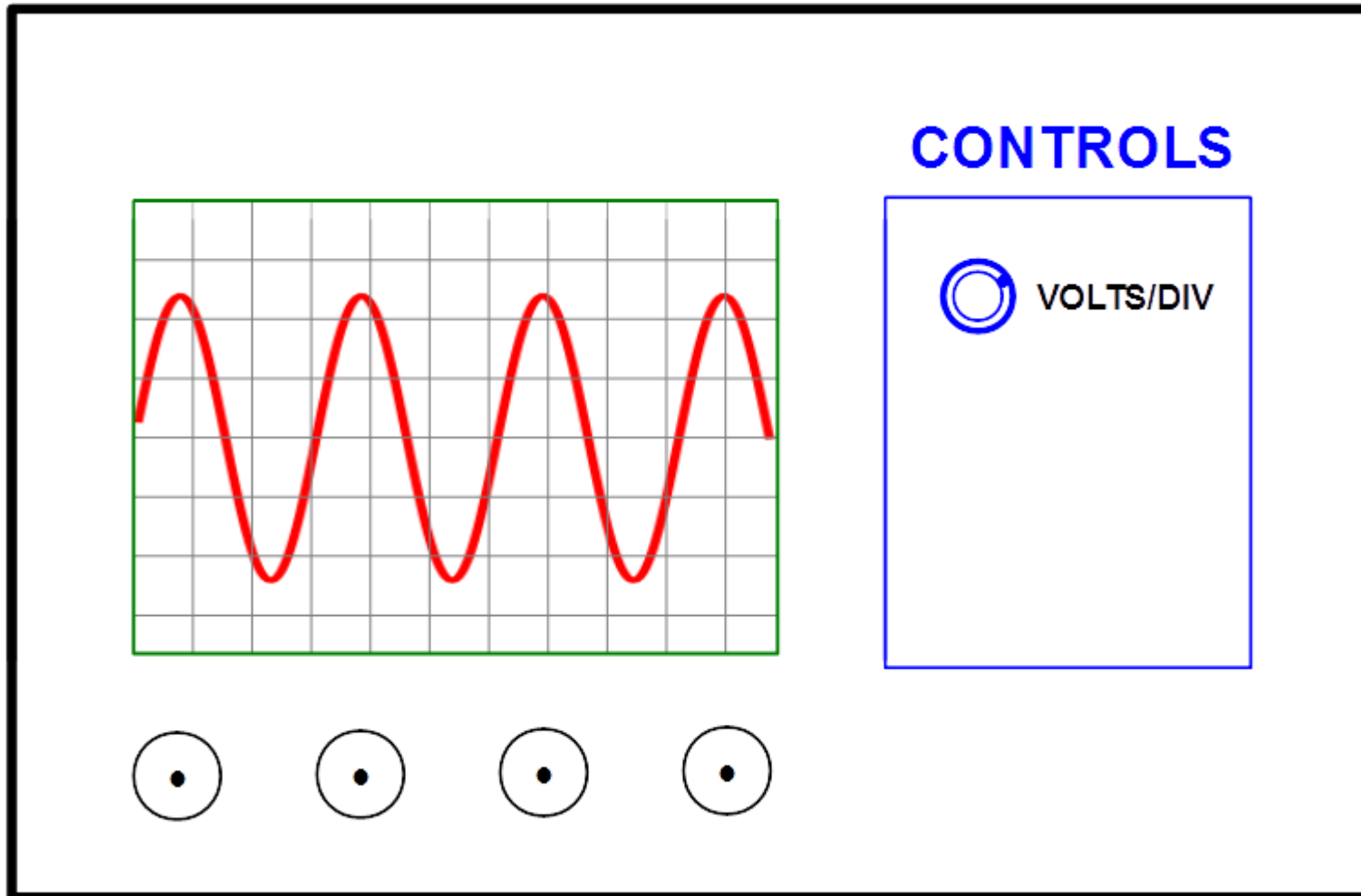**ANALOG**: Cathode ray tube, swept electron beam

DIGITAL: A/D converter, LCD display

Although physical operation is completely different, controls are nearly identical
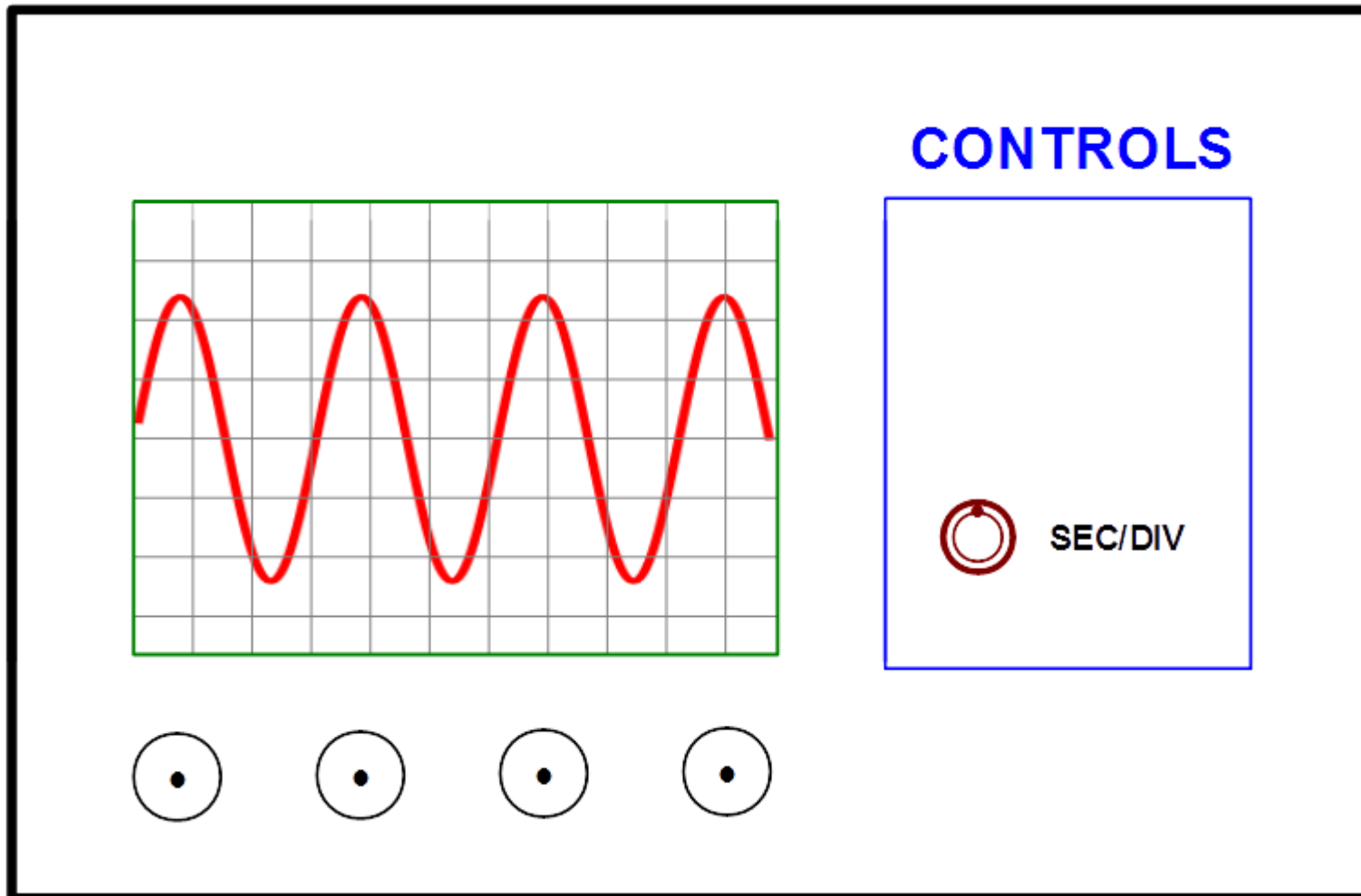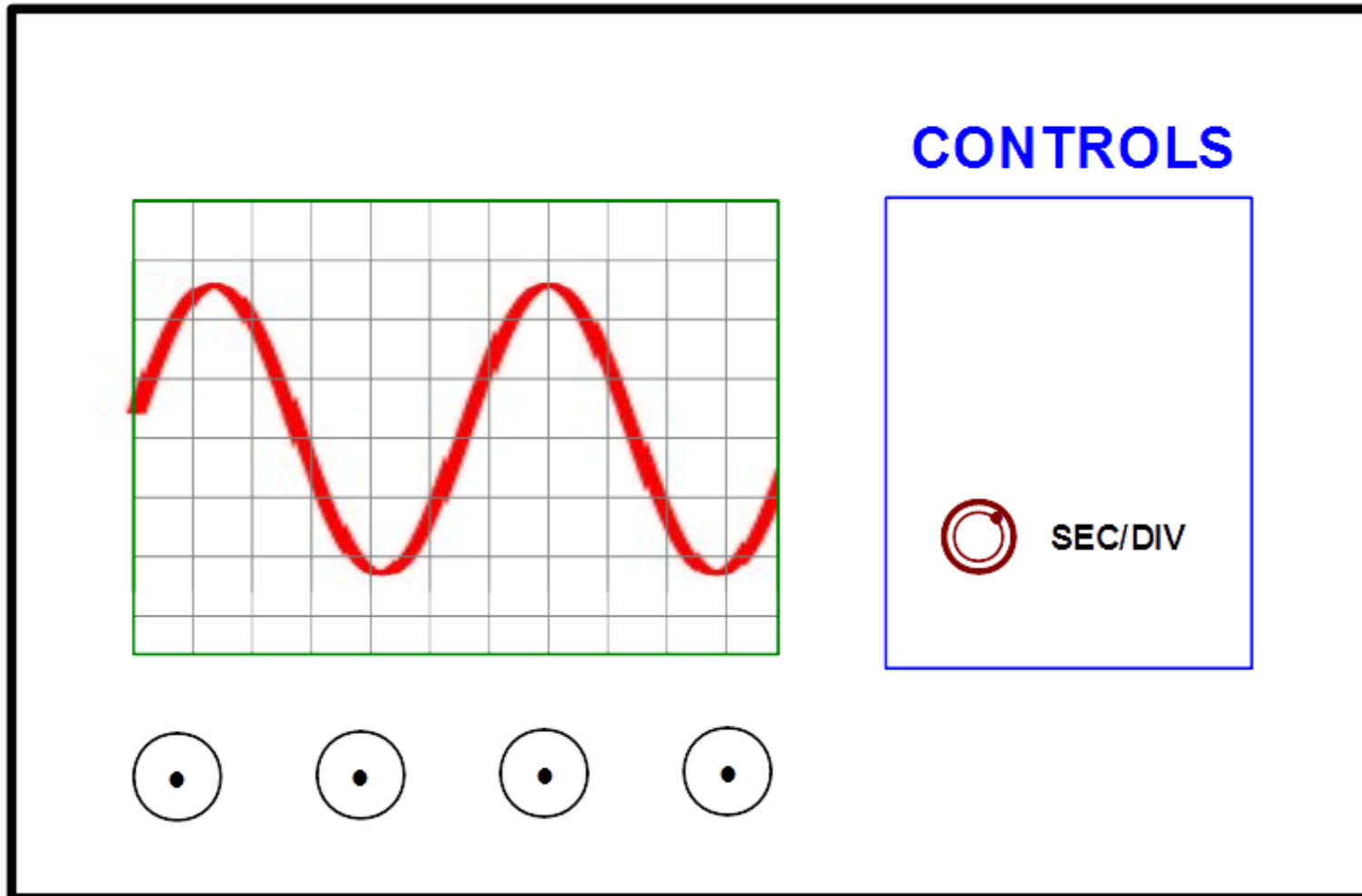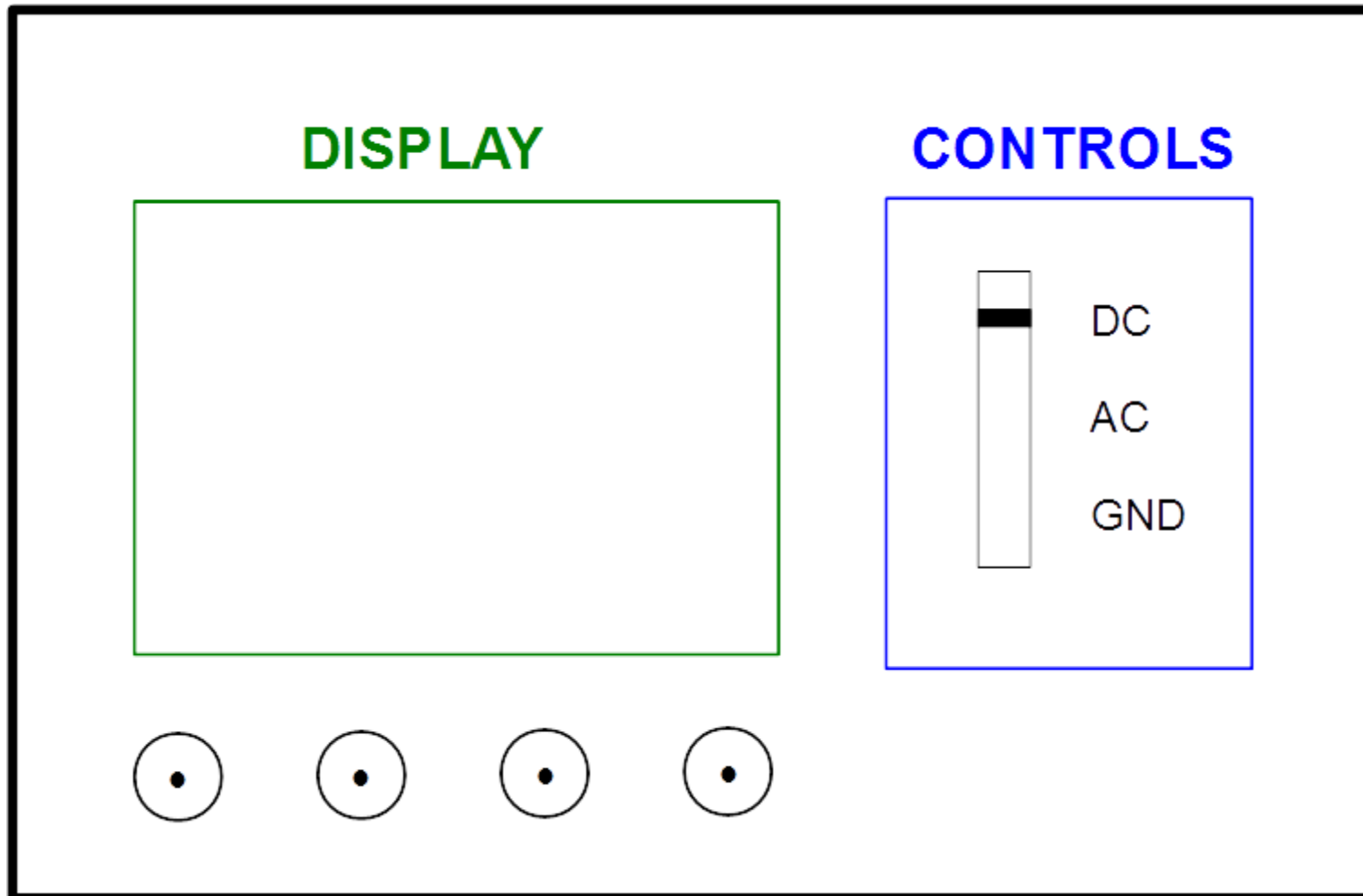
DISPLAY ADJUSTMENT

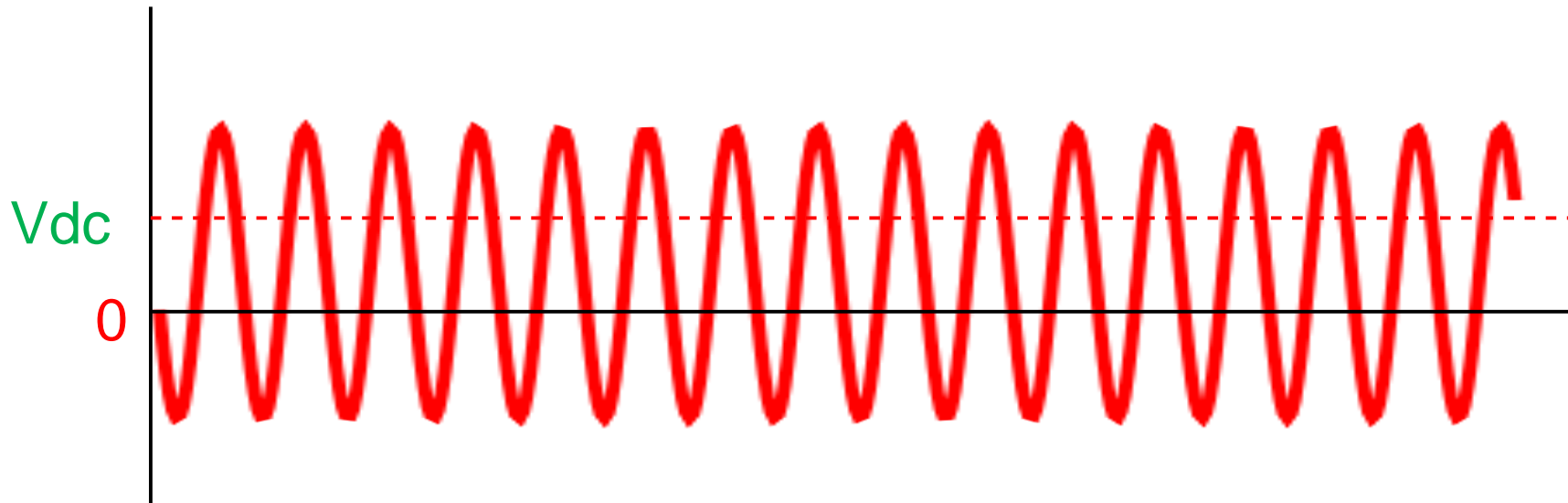# DISPLAY ADJUSTMENT
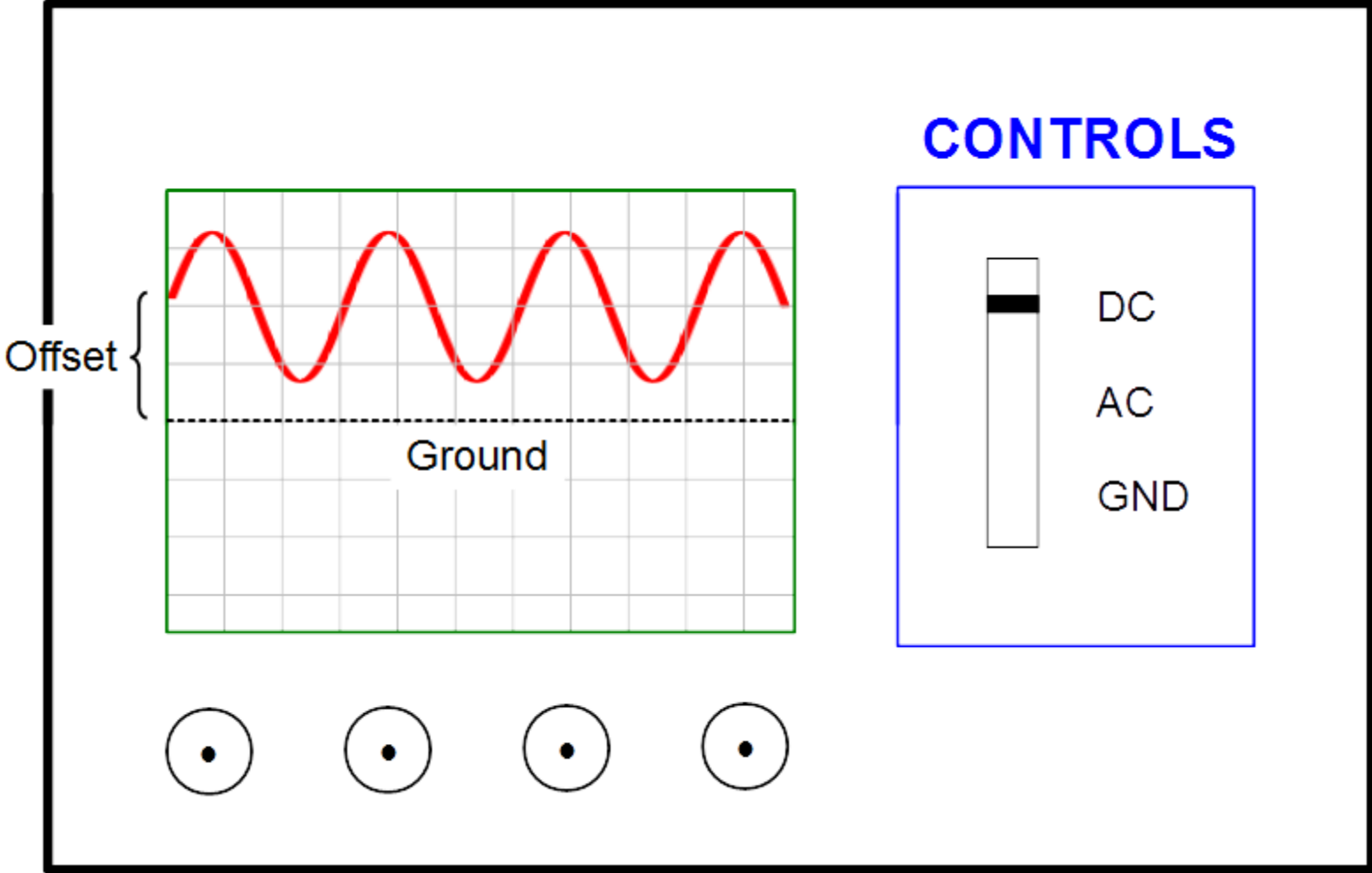
DISPLAY ADJUSTMENT
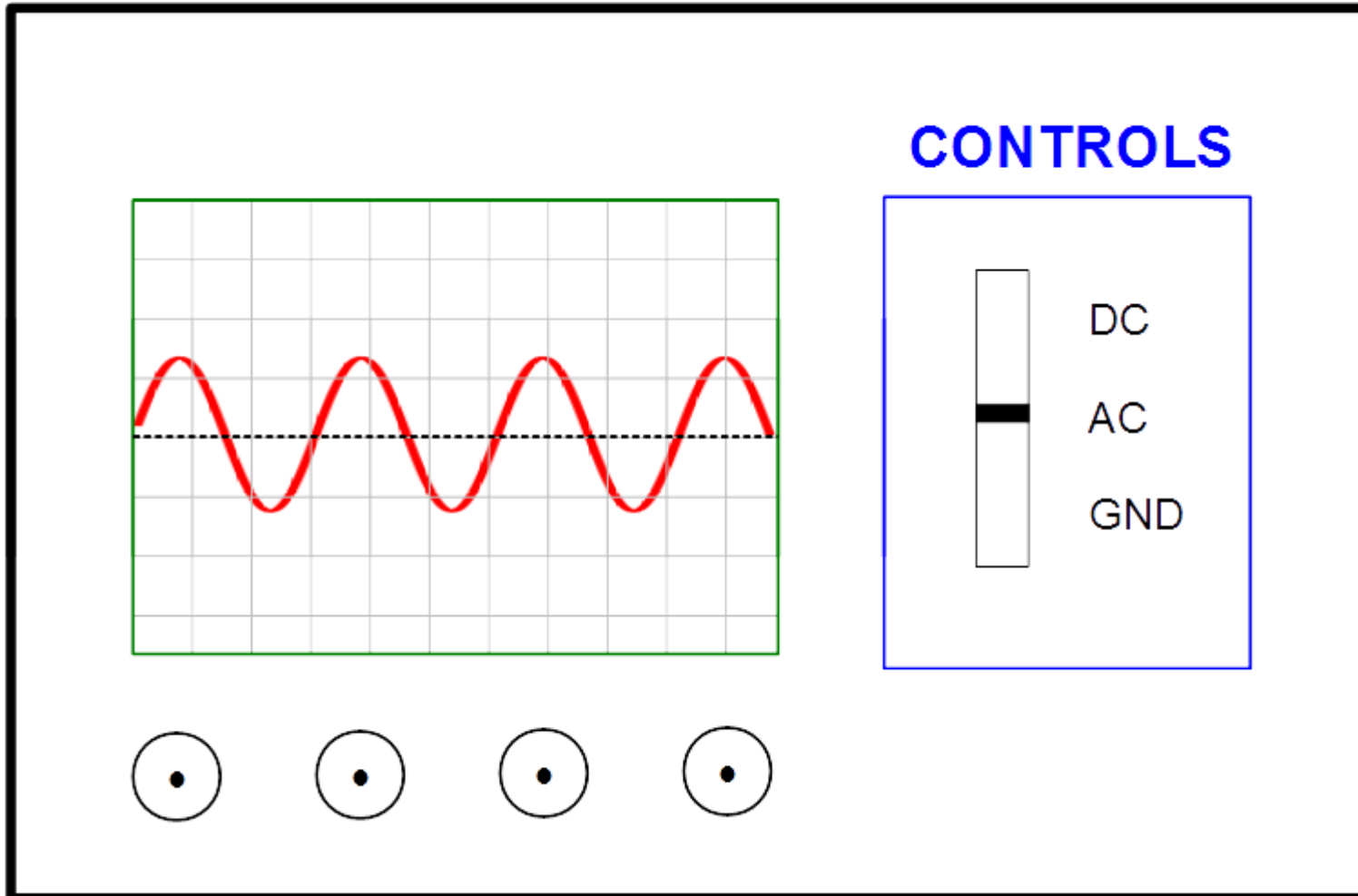
DISPLAY ADJUSTMENT

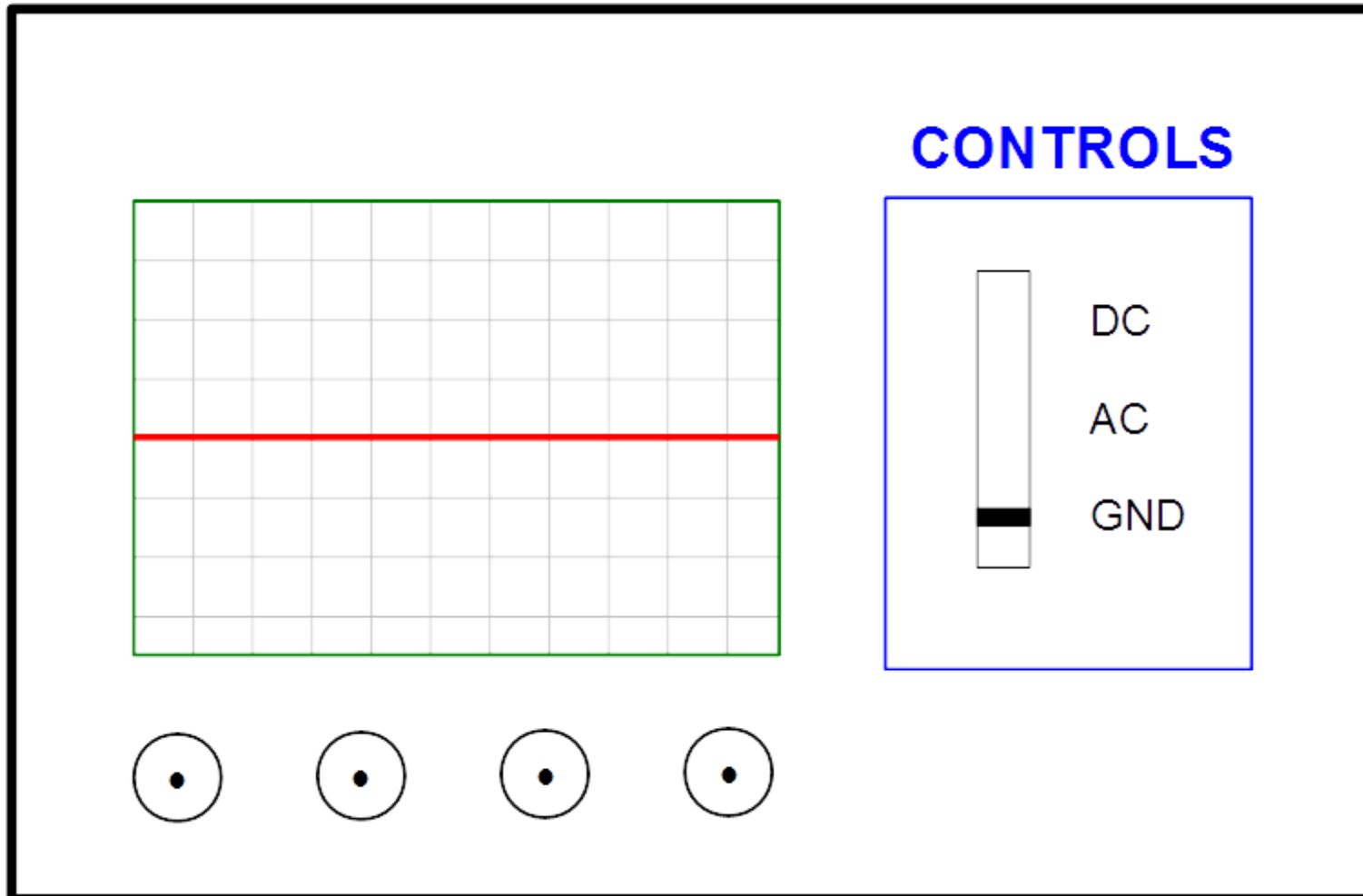# DC coupling, AC coupling, and Ground

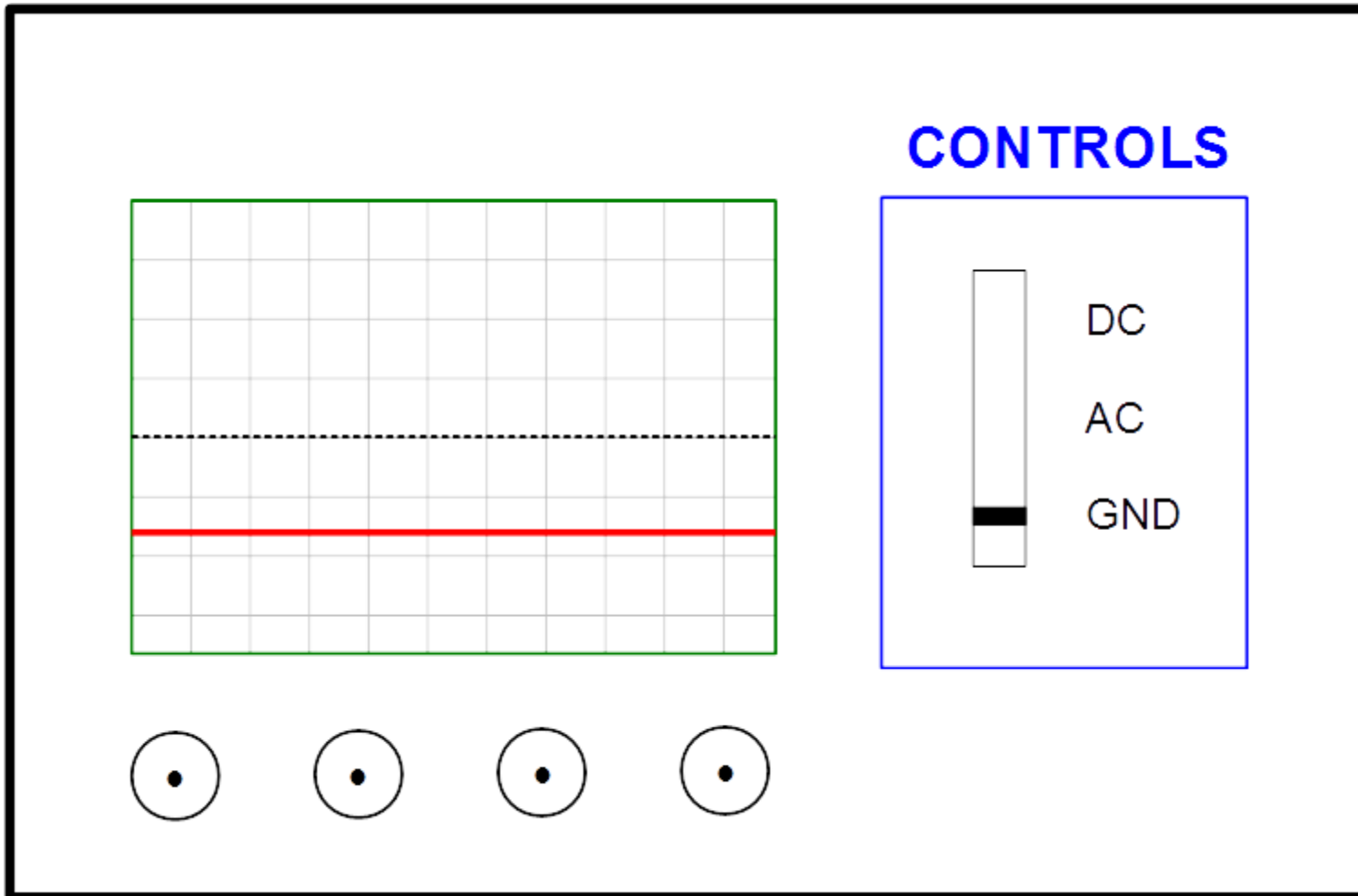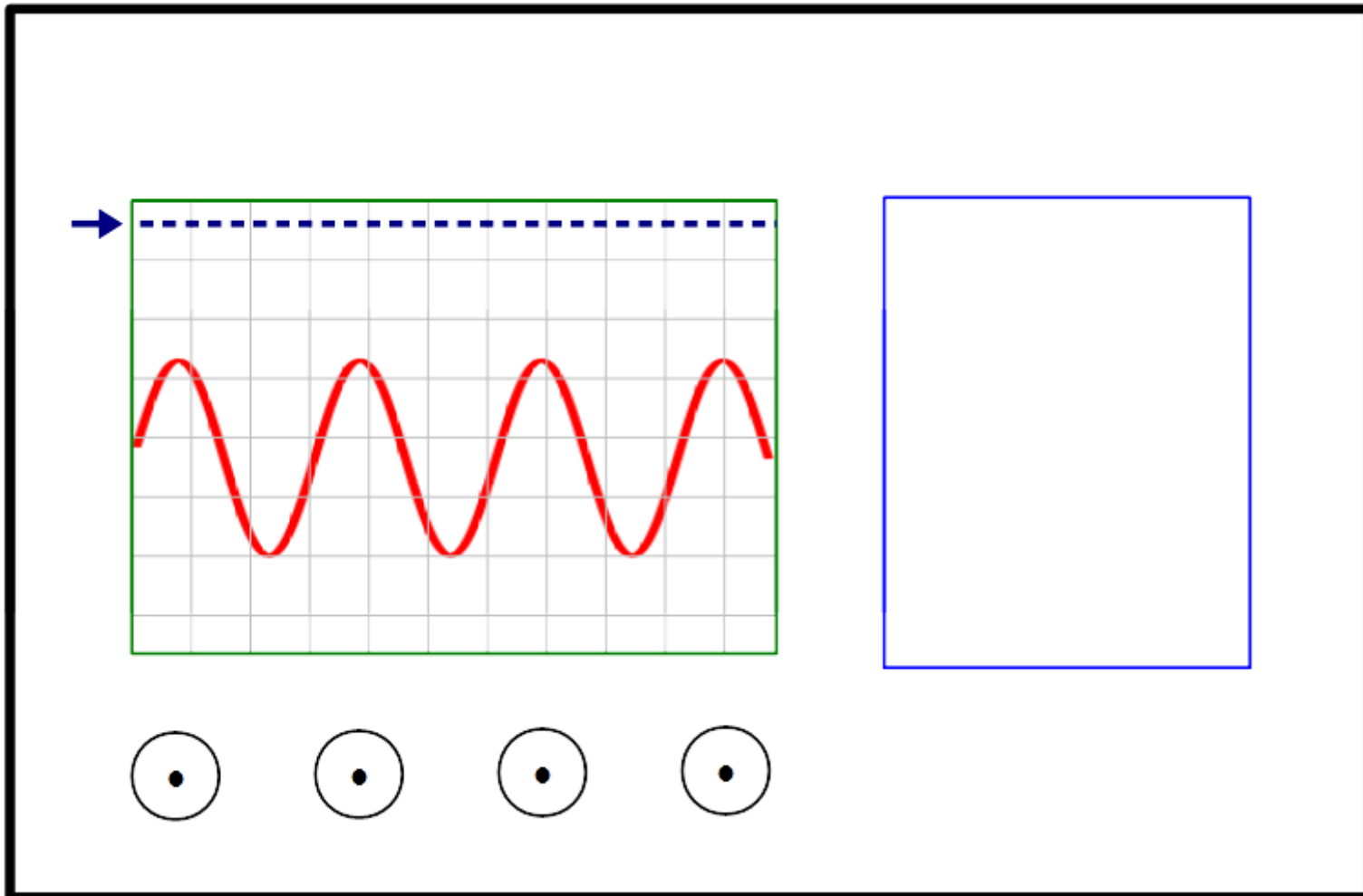# Sinusoidal wave source + dc offset

DC COUPLING

AC COUPLING

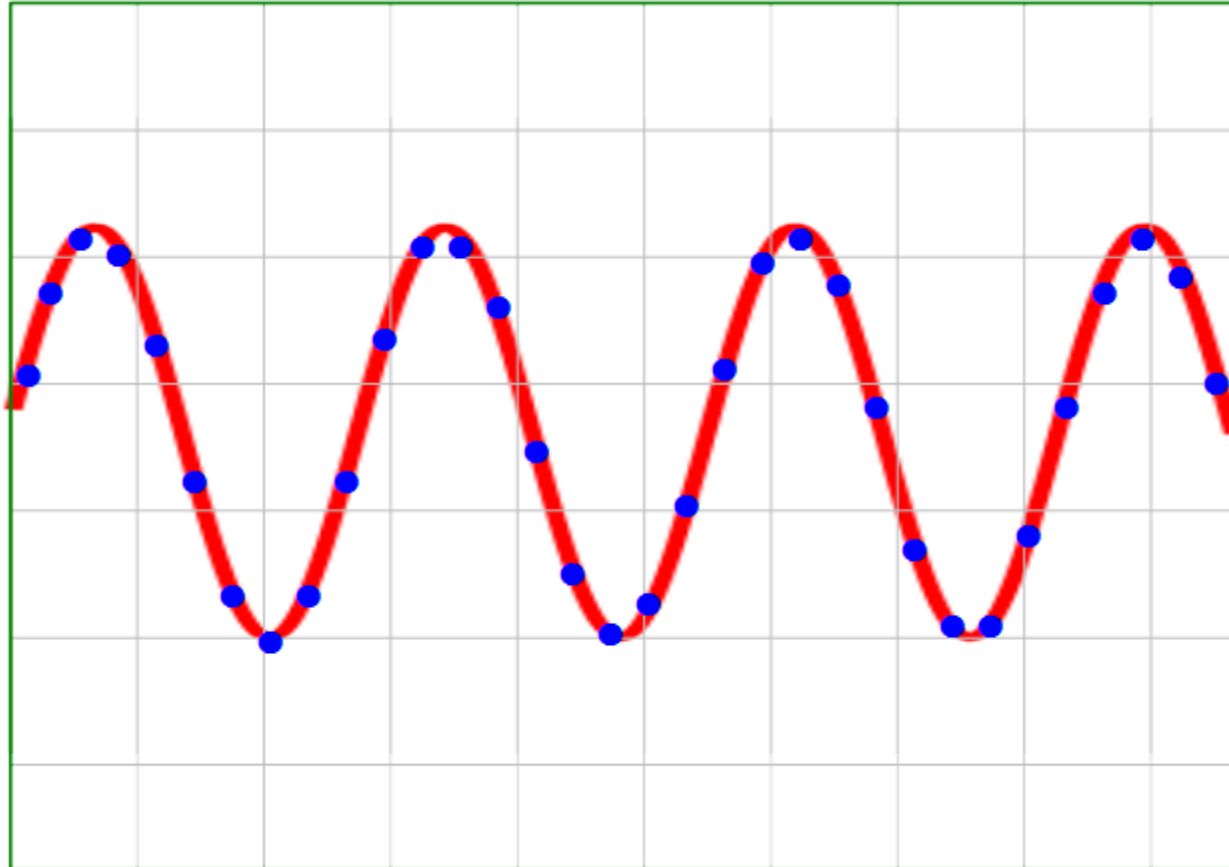# GROUND: Defines location of 0 Volts

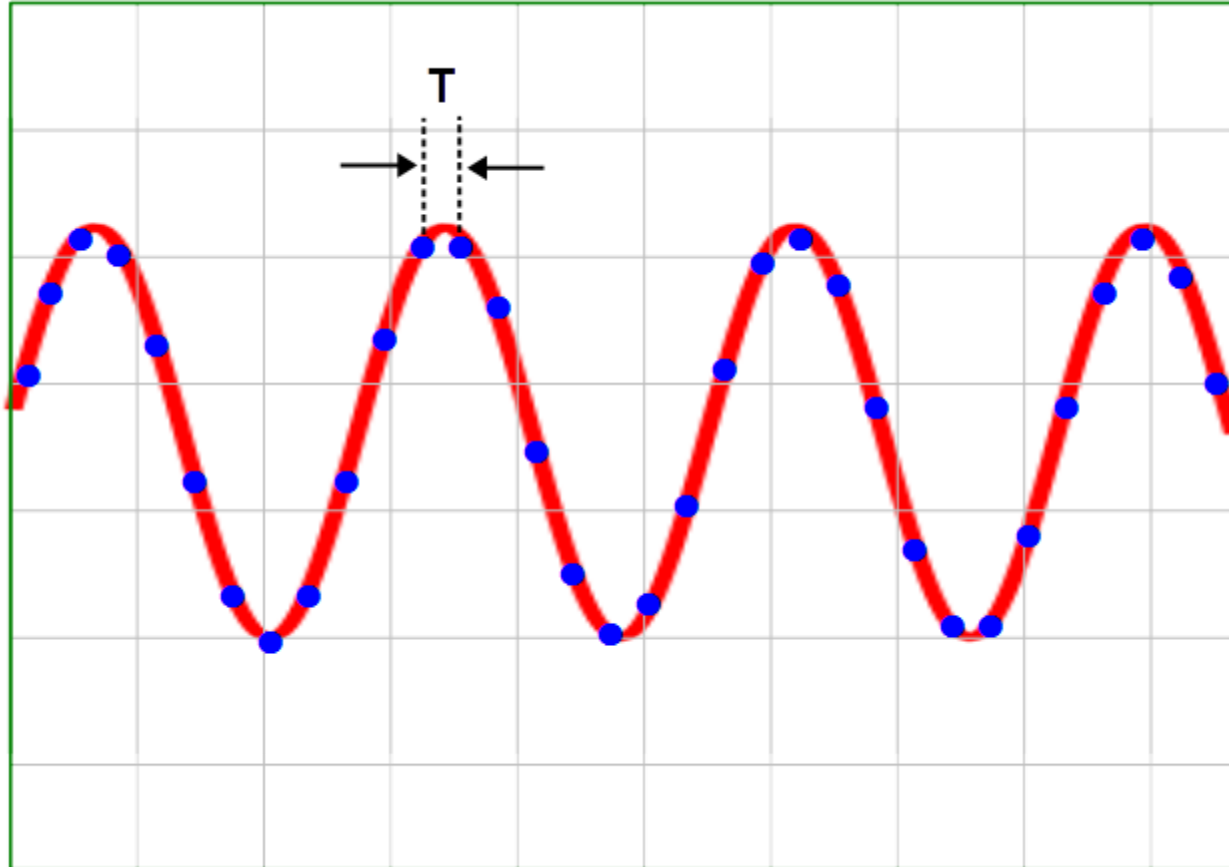# GROUND can be positioned at any convenient level

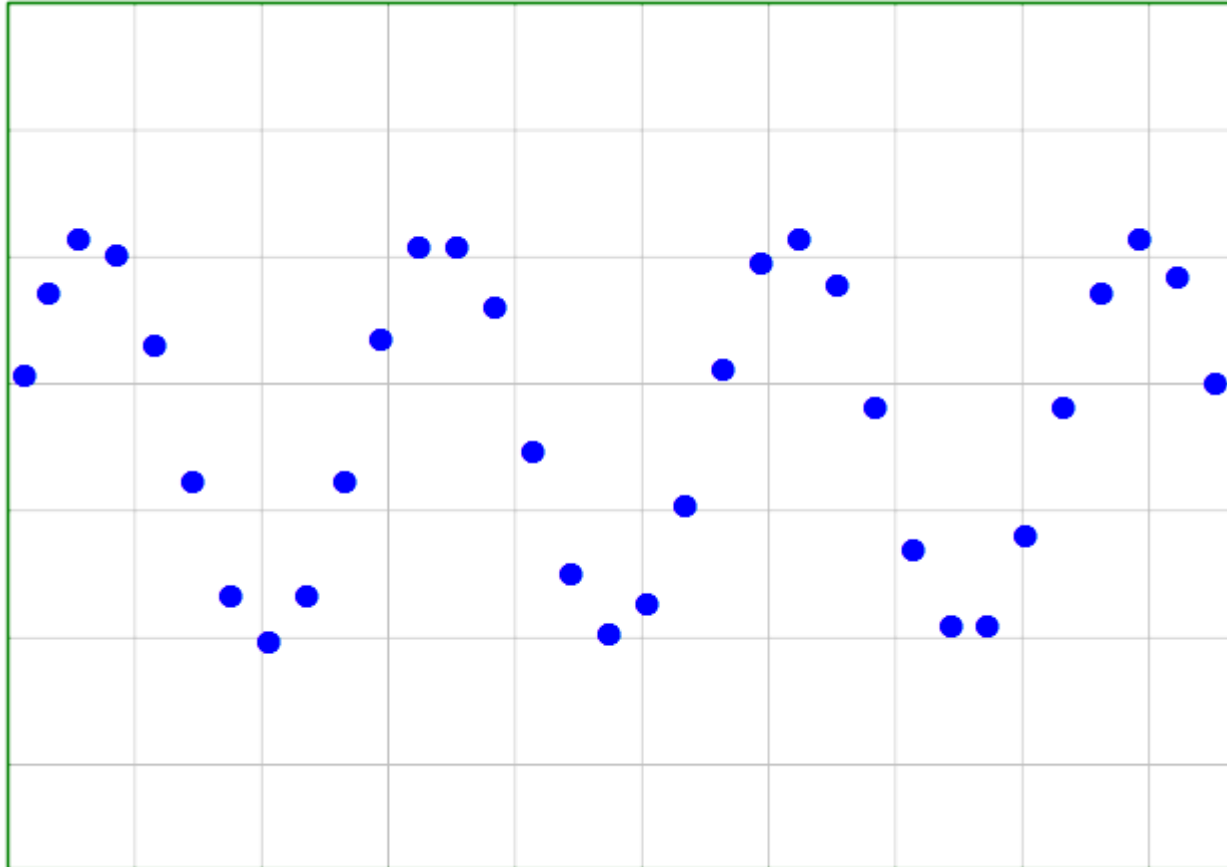# Trigger level

SAMPLING BANDWIDTH

SAMPLING BANDWIDTH

Sample spacing: **T** (sec)
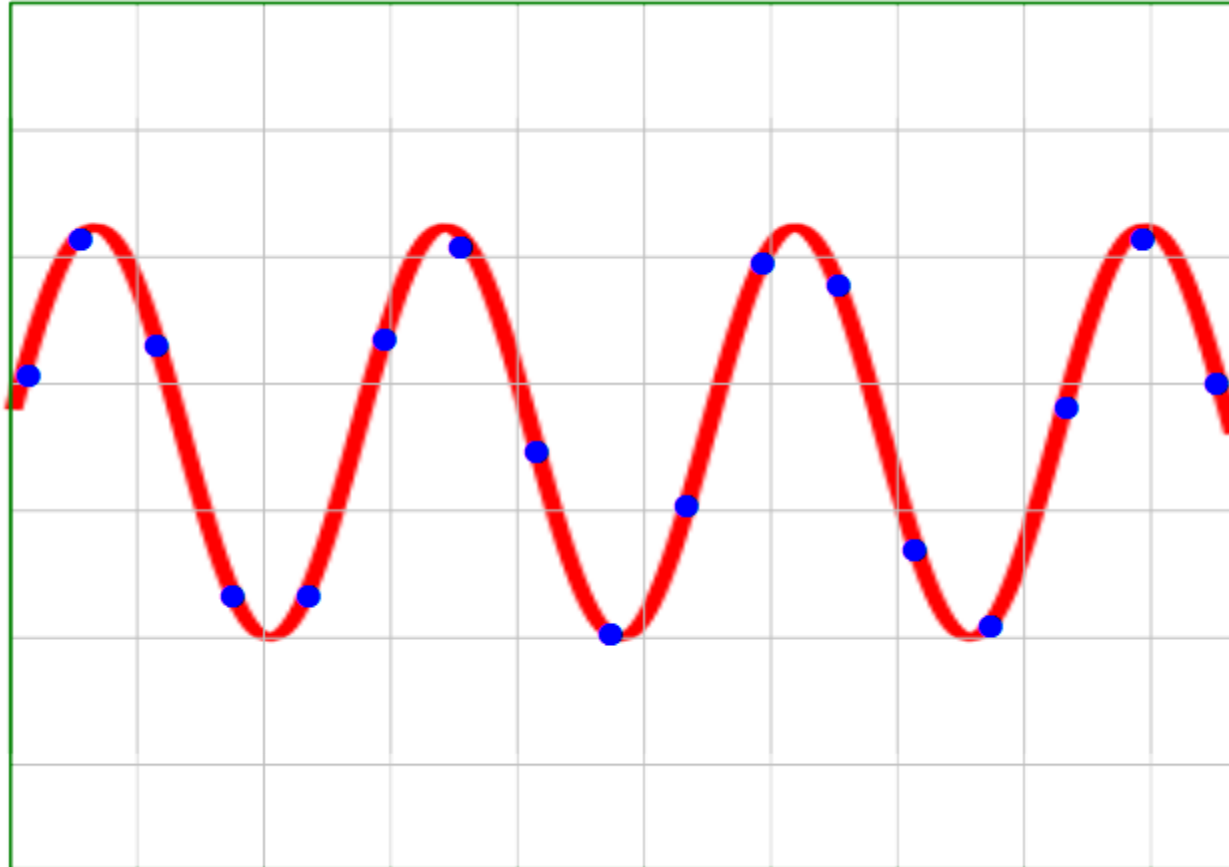
Sampling bandwidth = 1 / **T** (samples/sec)
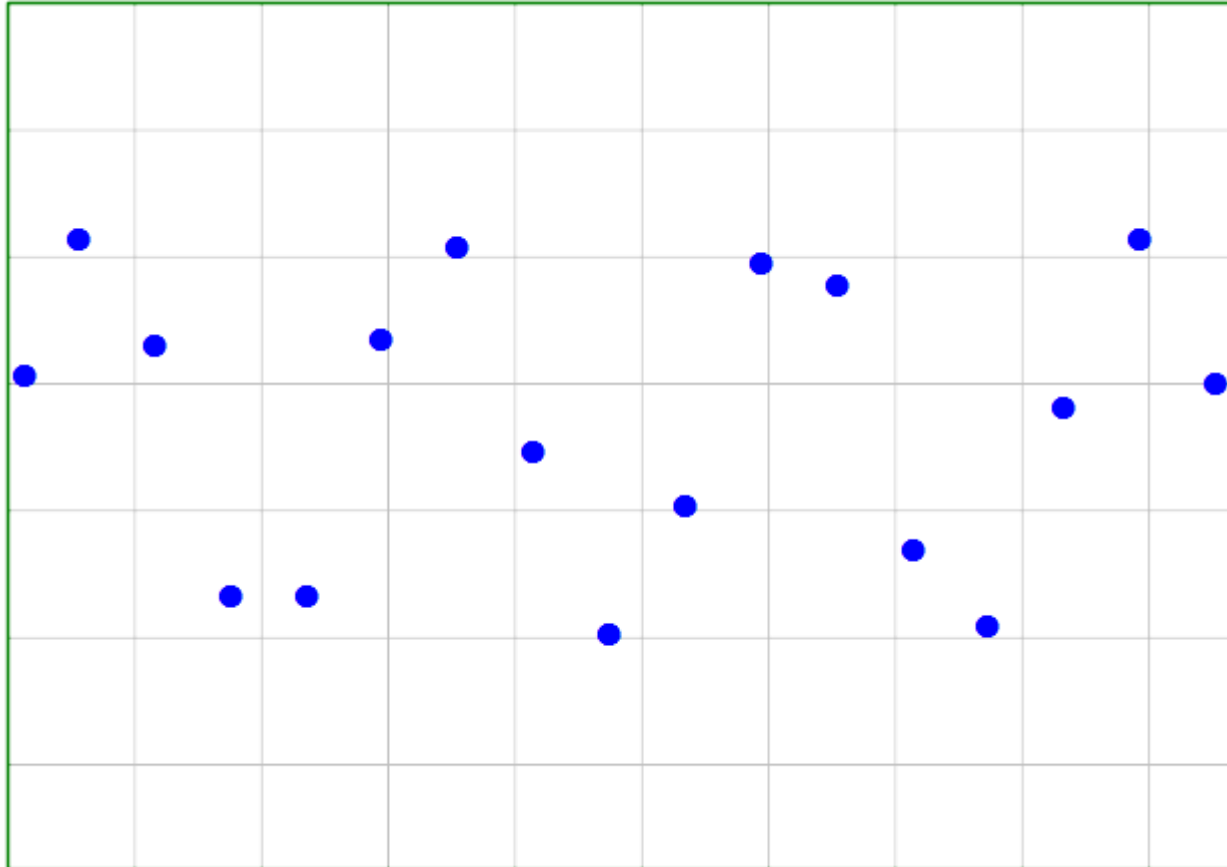
SAMPLING BANDWIDTH

Sample spacing: **T** (sec)

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

SAMPLING BANDWIDTH

Reduce sample bandwidth 2x ⟹ Increase period 2x

SAMPLING BANDWIDTH

Reduce sample bandwidth 2x ⟹ Increase period 2x

ANALOG BANDWIDTH ≠ SAMPLING BANDWIDTH

Analog amplification
(Bandwidth limited)

Analog-Digital
Conversion
ADC

(Sample rate limited)

DISPLAY
(Record length limited)