Reading plots

This page is a cheat sheet for the three kinds of plot that analog engineers read every day, along with the mistakes people usually make when reading each one.

1. Waveform (time domain)

On a waveform the horizontal axis is time, and the vertical axis is voltage (or current).

Mark this	How
Period T	The time between matching points on consecutive cycles
Frequency f	$1/T$
Peak-to-peak	The top of the swing minus the bottom
Amplitude A	For a sine, half the peak-to-peak value, measured from the center line
DC offset	The vertical position of the center line
Phase / delay	The horizontal shift between two traces

The usual misreads are taking the peak value for the peak-to-peak value, which puts you off by a factor of 2, and reading the frequency from a zoomed-in window that shows only a fraction of a cycle.

2. Spectrum (frequency domain)

On a spectrum the horizontal axis is frequency (in Hz), and the vertical axis is magnitude, on either a linear or a dB scale.

Feature	Meaning
Spike / stem	A tone (or a harmonic) at that frequency
Height	How strong that tone is relative to the others
Noise floor	Sets the smallest feature you can see
Comb of odd harmonics	A square-ish or clipped waveform
Sidebands around a carrier	Modulation (AM, for example)

The usual misread is expecting the clean, thin sticks of a textbook spectrum. A real FFT has a finite bin width and leakage, so each spike has some width and spreads a little into the bins around it. When you compare large and small tones on one plot, use dB, so that the small tones are still visible next to the large ones.

dB conversion table

Linear ratio	dB ($20 \log_{10}$)
×10	+20
×2	≈ +6

Linear ratio	dB ($20 \log_{10}$)
×1	0
×0.707 ($1/\sqrt{2}$)	−3
×0.5	≈ −6
×0.1	−20

3. Bode plot (system response)

A Bode plot is two graphs stacked one above the other, both plotted against log frequency:

1. Magnitude in dB
2. Phase in degrees

Feature	Meaning
Flat magnitude	The passband
−3 dB crossing	The cutoff frequency f_c
−20 dB/decade	A first-order roll-off
−45° at f_c	The signature of a single RC low-pass
Phase ⟶ −90°	The high-frequency limit of a single RC

The usual misreads are treating a plot with a linear frequency axis as a Bode plot (a Bode plot always uses log frequency), and confusing gain in dB with gain as a plain ratio.

Quick mental model

```
signal itself     →  waveform + spectrum
what a circuit
does to signals   →  Bode plot
```

Labs: Lab 01 · Lab 02 · Lab 03 · Lab 04 · Lab 05