

Simulation Tab

Simulation Tab Explained

The Simulation tab provides visual analysis of your VIC circuit design. It generates frequency response curves, time-domain waveforms, and key performance metrics that help you understand and optimize circuit behavior.

Simulation Overview

The simulation performs several types of analysis:

1. Frequency Domain Analysis

Sweeps through a frequency range to show how the circuit responds at different frequencies.

2. Impedance Analysis

Shows how circuit impedance varies with frequency, identifying resonant points.

3. Time Domain Analysis

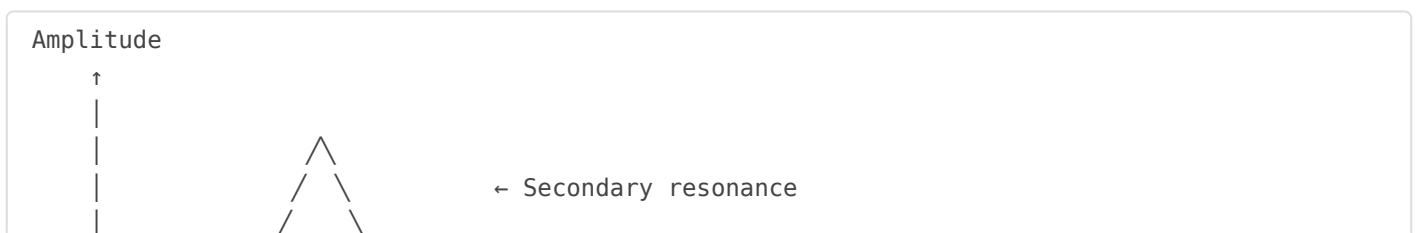
Simulates actual voltage and current waveforms during pulse operation.

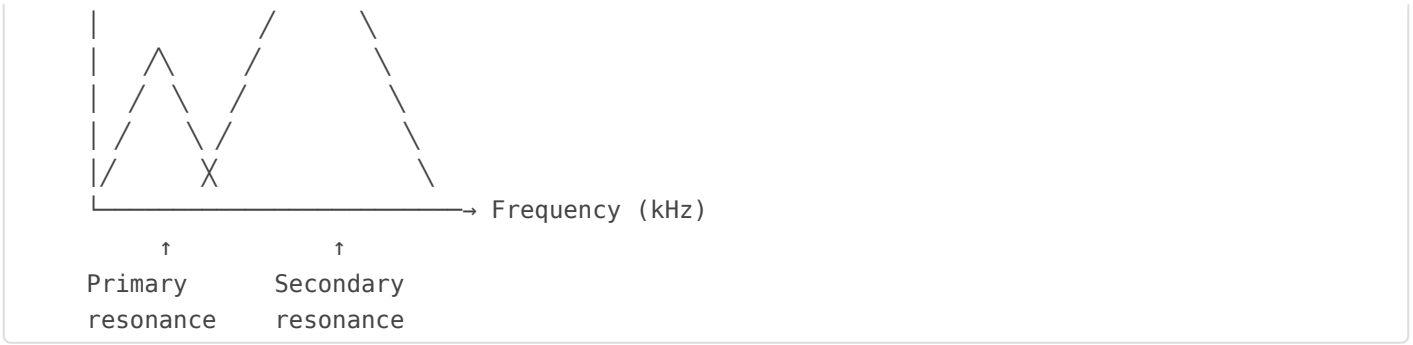
4. Ring-down Analysis

Shows how oscillations decay after excitation stops.

Frequency Response Display

The frequency response plot shows amplitude vs. frequency:





Key Features in Plot

Feature	What It Means	Ideal Characteristic
Peak Height	Voltage magnification at resonance	Higher = more voltage gain
Peak Sharpness	Q factor (sharp = high Q)	Depends on application
Peak Location	Resonant frequency f_0	Should match design target
-3dB Bandwidth	Frequency range at 70.7% of peak	Narrower = higher Q
Multiple Peaks	Primary and secondary resonances	Aligned for max transfer

Calculated Metrics

The simulation calculates and displays these key values:

Resonance Parameters

Primary f_0:	Resonant frequency of L1-C1 tank
Secondary f_0:	Resonant frequency of L2-C _{wfc} tank
Match Status:	How well primary and secondary are tuned

Q Factor Metrics

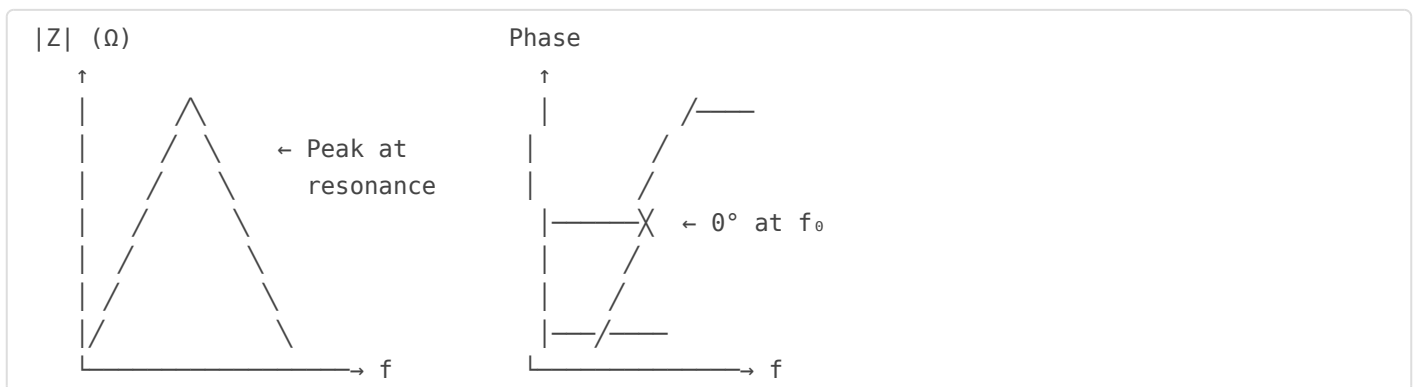
Primary Q:	Q factor of primary circuit
Secondary Q:	Q factor of secondary circuit
System Q:	Effective Q of coupled system

Performance Metrics

Voltage Magnification:	V_{out}/V_{in} at resonance
Bandwidth:	-3dB frequency range
Ring-down Time:	Time constant $\tau = 2L/R$
Ring-down Cycles:	Oscillation cycles during decay

Impedance Plot

Shows circuit impedance magnitude and phase vs. frequency:



Interpreting Impedance

- **Peak impedance:** Maximum at parallel resonance
- **Minimum impedance:** At series resonance points

- **Phase = 0°:** Indicates resonant frequency
- **Positive phase:** Inductive behavior (current lags)
- **Negative phase:** Capacitive behavior (current leads)

Time Domain Waveforms

The time-domain view shows actual voltage and current over time:

Waveforms Displayed:

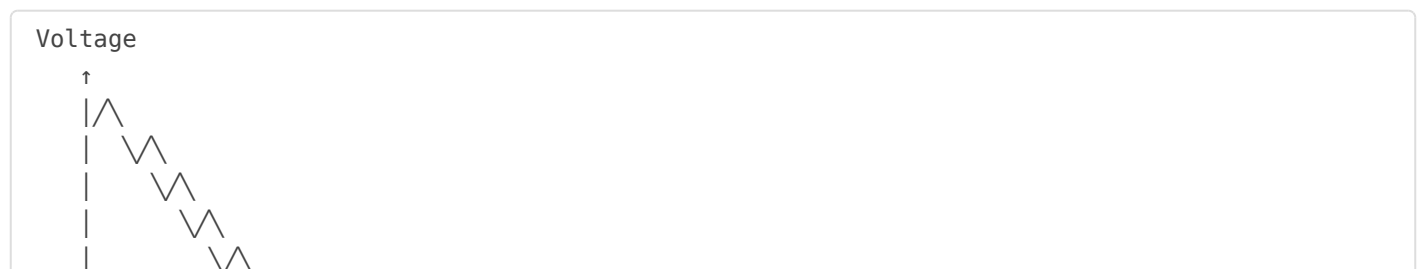
- **Input Voltage:** The driving pulse waveform
- **Primary Current:** Current through L1
- **WFC Voltage:** Voltage across the water cell
- **WFC Current:** Current through the cell

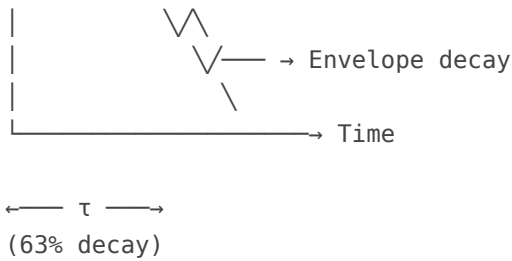
What to Look For:

- Voltage build-up during resonance
- Ring-down oscillations after pulse ends
- Phase relationship between V and I
- Settling time and stability

Ring-Down Display

Shows oscillation decay after excitation stops:





Ring-Down Metrics

Metric	Formula	Significance
Time Constant (τ)	$\tau = 2L/R$	Time to decay to 37%
Ring-down Cycles	$n \approx 0.733 \times Q$	Oscillations before decay
Settling Time	$\sim 5\tau$ for 99% decay	Time to reach steady state

Warning Indicators

The simulation flags potential issues:

Warning	Meaning	Action
⚠ Near SRF	Operating frequency close to choke SRF	Reduce frequency or redesign choke
⚠ Low Q	Q factor below recommended threshold	Reduce losses (DCR, water R)
⚠ Frequency Mismatch	Primary and secondary not aligned	Adjust C1 or component values
⚠ High Voltage	Magnified voltage exceeds safe limits	Verify insulation ratings

Using Simulation Results

Design Iteration Process:

1. Run initial simulation with your component values

2. Check if resonant frequency matches your target
3. Evaluate Q factor—is it sufficient for your goals?
4. Look for warnings and address them
5. Adjust parameters and re-simulate
6. Compare before/after to verify improvements

Pro Tip: Save your circuit profile before making changes. This allows you to compare different configurations side-by-side and roll back if needed.

Next: Circuit Optimization Strategies →

Revision #1

Created 2026-01-01 20:45:26 UTC by Chris Bake

Updated 2026-01-01 20:45:37 UTC by Chris Bake