Choke Fundamentals

Inductor/Choke Fundamentals

Inductors, commonly called "chokes" in VIC terminology, are the workhorses of the resonant circuit. They store energy in their magnetic field and, together with capacitors, determine the resonant frequency and voltage magnification capability of the VIC.

What is an Inductor?

An inductor is a passive electrical component that stores energy in a magnetic field when current flows through it. The fundamental properties are:

Inductance (L):

Measured in Henries (H), inductance quantifies the magnetic flux linkage per unit current:

$$L = N?/I = N^2?A/l$$

Where:

> - N = number of turns
> - Φ = magnetic flux
> - I = current
> - μ = permeability of core material
> - A = cross-sectional area of core
> - l = magnetic path length

Key Inductor Parameters

Parameter	Symbol	Units	Importance

Inductance	L	Henry (H)	Determines resonant frequency with C
DC Resistance	DCR, R_{dc}	Ohms (Ω)	Limits Q factor and causes losses
Self-Resonant Frequency	SRF	Hz	Must be > operating frequency
Quality Factor	Q	Dimensionless	Ratio of reactance to resistance
Saturation Current	I_{sat}	Amps (A)	Max current before inductance drops

Inductor Construction

A practical inductor consists of:

1. **Wire:** Conductor wound into coils (turns)
2. **Core:** Material inside the coil (air, ferrite, iron, etc.)
3. **Form:** Structure that holds the winding

Types of Cores

Core Type	Permeability	Frequency Range	VIC Application
Air core	1 (reference)	Any (no losses)	High-Q, low inductance
Iron powder	10-100	Up to ~10 MHz	Good for VIC frequencies
Ferrite	100-10000	10 kHz - 100 MHz	Most common for VIC
Laminated iron	1000-10000	50/60 Hz to ~10 kHz	Lower VIC frequencies

Inductance Formulas

Single-Layer Solenoid (air core):

$L = (N^2??A)/l = (N^2r^2)/(9r + 10l)$ μH

Where r and l are in inches (Wheeler's formula)

With Magnetic Core:

$L = A_L \times N^2$ (nH)

Where A_L is the inductance factor of the core (nH/turn²)

Toroidal Core:

$L = (???_r N^2 A) / (2?r_{mean})$

DC Resistance (DCR)

The DC resistance is determined by the wire properties:

$R_{dc} = ? \times l_{wire} / A_{wire}$

Where:

- ρ = resistivity of wire material (Ω·m)
- l_{wire} = total wire length ≈ N × π × d_{coil}
- A_{wire} = wire cross-sectional area

Q Factor of Inductors

Inductor Q Factor:

$Q = ?L/R = 2?fL/R_{total}$

R_{total} includes:

- DC resistance of wire
- Skin effect losses (increases with frequency)
- Proximity effect losses
- Core losses (hysteresis + eddy currents)

Self-Resonant Frequency (SRF)

Every inductor has parasitic capacitance between turns and layers:

$SRF = 1 / (2??(LC_{parasitic}))$

Design Rule:

SRF should be at least 10× the operating frequency.

At frequencies above SRF, the inductor acts like a capacitor!

VIC Choke Design Goals

1. **Target inductance:** Sets resonant frequency with capacitor
2. **Low DCR:** Maximizes Q factor
3. **High SRF:** Ensures proper operation at intended frequency
4. **Adequate current rating:** Won't saturate or overheat
5. **Appropriate core:** Low losses at operating frequency

Key Tradeoff: More turns = more inductance, but also more wire = more DCR. The design challenge is achieving the target inductance with minimum resistance, which means selecting appropriate wire gauge, core material, and winding technique.

Next: Core Materials & Properties →

Revision #1
Created 2026-01-01 20:41:10 UTC by Chris Bake
Updated 2026-01-01 20:41:21 UTC by Chris Bake