Core Specifications

Glossary of Terms

A comprehensive glossary of technical terms used throughout the VIC Matrix educational content and calculator.

A

A_L (Inductance Factor)
: A core specification in nH/turn² that allows quick calculation of inductance: $L = A_L \times N^2$

Alpha (α) - Cole-Cole
: Distribution parameter (0-1) in the Cole-Cole model. α=0 is ideal Debye relaxation; higher values indicate broader distribution of relaxation times.

Alpha (α) - Damping
: Damping factor in an RLC circuit: $\alpha = R/(2L)$. Determines how quickly oscillations decay.

Amplitude
: The maximum value of an oscillating quantity, such as voltage or current.

B

Bandwidth (BW)
: The frequency range over which a resonant circuit responds effectively. $BW = f_0/Q$ for a series RLC circuit.

Bifilar Winding
: A winding technique where two wires are wound together in parallel, creating tight magnetic coupling and significant inter-winding capacitance.

Blocking Electrode
: An electrode where no Faradaic (electrochemical) reactions occur, behaving purely as a capacitor.

C

Capacitance (C)

The ability to store electric charge. Measured in Farads (F). C = Q/V where Q is charge and V is voltage.

Characteristic Impedance (Z_0)

The ratio √(L/C) for an LC circuit. Represents the impedance level of the resonant system.

Charge Transfer Resistance (R_{ct})

The resistance associated with electron transfer at an electrode surface during electrochemical reactions.

Choke

An inductor used in a circuit to block or impede certain frequencies while allowing others to pass. In VIC context, the resonating inductors.

Cole-Cole Model

A mathematical model describing frequency-dependent dielectric behavior with distributed relaxation times.

Constant Phase Element (CPE)

A circuit element with impedance $Z = 1/[Q(j\omega)^n]$, used to model non-ideal capacitor behavior in electrochemical systems.

Coupling Coefficient (k)

A measure of magnetic coupling between inductors (0-1). $k = M/\sqrt{(L_1L_2)}$ where M is mutual inductance.

D

DCR (DC Resistance)

The resistance of an inductor measured with direct current. Primary contributor to inductor losses.

Debye Length (λ_D)

The characteristic thickness of the diffuse layer in an electrochemical double layer. Decreases with increasing ion concentration.

Diffuse Layer

The outer region of the electric double layer where ion concentration gradually returns to bulk values.

Dielectric

An insulating material that can be polarized by an electric field. Water is a dielectric with high permittivity ($\varepsilon_r \approx 80$).

Double Layer

See Electric Double Layer (EDL).

E

EDL (Electric Double Layer)

The structure formed at an electrode-electrolyte interface, consisting of a compact layer of ions and a diffuse layer extending into solution.

EIS (Electrochemical Impedance Spectroscopy)
: A technique for characterizing electrochemical systems by measuring impedance across a range of frequencies.

ESR (Equivalent Series Resistance)
: The resistive component of a capacitor's impedance, causing power dissipation.

F

Faradaic Reaction
: An electrochemical reaction involving electron transfer at an electrode, such as water electrolysis.

Ferrite
: A ceramic magnetic material used for inductor cores, suitable for high-frequency applications.

Frequency (f)
: The number of complete oscillation cycles per second. Measured in Hertz (Hz).

G-H

Helmholtz Layer
: The compact inner layer of the EDL, where ions are closest to the electrode surface.

Hysteresis
: Energy loss in magnetic materials due to the lag between applied field and magnetization.

I

Impedance (Z)
: The total opposition to alternating current, including both resistance and reactance. Measured in Ohms (Ω).

Inductance (L)
: The property of a conductor that opposes changes in current by storing energy in a magnetic field. Measured in Henries (H).

IHP (Inner Helmholtz Plane)
: The plane passing through the centers of specifically adsorbed ions in the EDL.

L-M

LC Circuit
: A circuit containing an inductor and capacitor, capable of oscillating at a resonant frequency.

Mutual Inductance (M)
: The inductance linking two coils, allowing energy transfer between them.

N-O

Nyquist Plot
: A plot of imaginary vs. real impedance (-Z'' vs Z') used in EIS analysis.

OHP (Outer Helmholtz Plane)
: The plane of closest approach for solvated (hydrated) ions in the EDL.

P

Parasitic Capacitance
: Unintended capacitance in an inductor, arising from turn-to-turn and layer-to-layer effects.

Permittivity (ε)
: A measure of how much electric field is reduced in a material compared to vacuum. $\varepsilon = \varepsilon_0\varepsilon_r$.

Permeability (μ)
: A measure of how well a material supports magnetic field formation. $\mu = \mu_0\mu_r$.

PLL (Phase-Locked Loop)
: A control system that maintains frequency lock with a reference signal, used to track resonance.

Q

Q Factor (Quality Factor)
: A dimensionless parameter indicating the "sharpness" of resonance. $Q = \omega L/R = Z_0/R$. Higher Q means narrower bandwidth and higher voltage magnification.

R

Randles Circuit
: An equivalent circuit model for electrochemical cells consisting of R_s, C_{dl}, R_{ct}, and Z_W.

Reactance
: The imaginary part of impedance. Inductive reactance $X_L = \omega L$; capacitive reactance $X_C = 1/(\omega C)$.

Resonance
: The condition where inductive and capacitive reactances are equal, resulting in maximum energy storage and voltage magnification.

Ringdown
: The decay of oscillations after excitation stops, characterized by the time constant $\tau = 2L/R$.

S

Self-Resonant Frequency (SRF)
: The frequency at which an inductor's parasitic capacitance resonates with its inductance. Above SRF, the inductor behaves as a capacitor.

Skin Effect
: The tendency of AC current to flow near the surface of a conductor, increasing effective resistance at high frequencies.

Solution Resistance (R_s)
: The ionic resistance of the electrolyte between electrodes.

Step Charging
: A technique using multiple resonant pulses to progressively build voltage on a capacitor.

Stern Layer
: The combined compact and diffuse layer model of the EDL.

T

Tank Circuit
: A parallel LC circuit that "tanks" or stores energy, oscillating between magnetic and electric forms.

Tau (τ) - Time Constant
: The characteristic time for decay. For an RLC circuit: $\tau = 2L/R$.

Toroidal Core
: A doughnut-shaped magnetic core providing a closed magnetic path and good field containment.

V

VIC (Voltage Intensifier Circuit)
: A resonant circuit configuration using chokes and capacitors to develop high voltage across a water fuel cell.

Voltage Magnification
: The ratio of voltage across a reactive element to the source voltage at resonance. Equals Q for a series RLC circuit.

W

Warburg Impedance (Z_W)
: Impedance arising from diffusion of electroactive species, characterized by 45° phase angle and $Z \propto 1/\sqrt{\omega}$.

WFC (Water Fuel Cell)
: An electrochemical cell where water serves as the medium between electrodes, acting as a capacitive-resistive load in VIC circuits.

Z

Z_0 (Characteristic Impedance)
: The natural impedance level of an LC circuit: $Z_0 = \sqrt{(L/C)}$. Also Q × R for a series RLC circuit.

Zero-Current Switching (ZCS)
: A switching technique where transistors turn off when current is zero, minimizing switching losses.

Glossary compiled for the VIC Matrix educational series.

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