Relay and Contactor Coil Suppression: Spike and Release Time

Coil current, stored energy, voltage spike and release delay of a DC relay or contactor coil switched off with a flyback diode or a suppression resistor.

Method: RL decay with clamping

Input parameters

Unit system: SI

Parameter	Value	Unit
Coil supply voltage	24.000	V
Coil resistance	160.00	Ω
Coil inductance	800.00	mH
Suppression resistor across the coil	470.00	Ω
Drop-out current as a share of holding current	15.000	%

Calculated results

Parameter	Value	Unit
Coil current	150.00	mA
Stored magnetic energy	9.0000	mJ
Coil voltage spike with the resistor	70.500	V
Voltage across the opening switch	94.500	V
Release delay with a diode	9.4856	ms
Release delay with the resistor	2.4090	ms

Notes for this case

• When the drive opens, the coil current cannot stop instantly: unsuppressed, it drives a spike of hundreds of volts into the switch. A diode clamps the coil at about −0.7 V and lets the current decay slowly with τ = L/R_c, delaying release until it falls to the drop-out level. A resistor clamps at I·R_s and the current decays faster with τ = L/(R_c + R_s), so the switch must withstand V + IR_s. A Zener in series with the diode gives a fast release with a defined spike. The coil inductance is higher with the armature closed; use the closed value.

Formula and method

$$I = \frac{V}{R_c}, \quad V_{spike} = IR_s, \quad t_r = \frac{L}{R_c + R_s} \ln \frac{I}{I_{do}}$$

Variables

V	Coil supply voltage	V
R_c	Coil resistance	Ω
L	Coil inductance	H
R_s	Suppression resistor across the coil	Ω
I_{do}/I	Drop-out current as a share of holding current	-
I	Coil current	A
E	Stored magnetic energy	J
V_{spike}	Coil voltage spike with the resistor	V
V_{sw}	Voltage across the opening switch	V
$t_{r,diode}$	Release delay with a diode	s

$t_{r,R}$	Release delay with the resistor	s

Method and standards

Coil suppression.

Assumptions and limits

- Constant inductance; ideal diode; drop-out at a fixed current.

References

RL decay with clamping

Report details

Report reference	FCC-ZG1T-E0D2 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/circuits/relay-coil-suppression

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.