Flyback Converter: Duty Cycle, Primary Inductance and Stresses

Duty cycle, critical primary inductance, peak primary current and switch voltage of a flyback converter at the boundary of continuous conduction.

Method: Flyback converter at the conduction boundary

Input parameters

Unit system: SI

Parameter	Value	Unit
Lowest input voltage	100.00	V
Highest input voltage	375.00	V
Output voltage	12.000	V
Output diode forward drop	0.50000	V
Turns ratio N_p/N_s	8.0000	
Output power	0.036000	kW
Switching frequency	100.00	kHz
Efficiency	85.000	%

Calculated results

Parameter	Value	Unit
Duty cycle at the lowest input	50.000	%
Primary inductance for boundary conduction at full load	295.14	µH
Peak primary current	1.6941	A
Switch voltage at the highest input (before leakage spike)	475.00	V
Reflected output voltage	100.00	V

Notes for this case

• The output voltage reflected to the primary, V_R = n(V_o + V_F), and volt-second balance give the duty cycle D = V_R/(V_in + V_R). At the boundary between continuous and discontinuous conduction the primary current ramps from zero to I_pk = 2P_in/(V_in D) each cycle, which needs L_p = V_in D/(I_pk f_s), equivalent to L_p = (V_in D)²/(2P_in f_s). A larger inductance runs continuous (lower peak current); a smaller one discontinuous. The switch sees V_in + V_R plus a leakage-inductance spike that the clamp must absorb.

Formula and method

$$V_R = n(V_o + V_F), \quad D = \frac{V_R}{V_{in} + V_R}, \quad I_{pk} = \frac{2P_{in}}{V_{in} D}, \quad L_p = \frac{V_{in} D}{I_{pk} f_s}$$

Variables

$V_{in,min}$	Lowest input voltage	V
$V_{in,max}$	Highest input voltage	V
V_o	Output voltage	V
V_F	Output diode forward drop	V
n	Turns ratio N_p/N_s	-
P_o	Output power	W
f_s	Switching frequency	1/s

η	Efficiency	-
D	Duty cycle at the lowest input	-
L_p	Primary inductance for boundary conduction at full load	H
I_{pk}	Peak primary current	A
V_{DS}	Switch voltage at the highest input (before leakage spike)	V
V_R	Reflected output voltage	V

Method and standards

Flyback converter.

Assumptions and limits

- Boundary conduction at the lowest input and full load; ideal transformer.

References

Flyback converter at the conduction boundary

Report details

Report reference	FCC-TQP4-5FTW (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/electronics/flyback-converter-design

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.