Six-Pulse Thyristor Converter: DC Voltage, Overlap and Power Factor

DC output voltage of a three-phase thyristor bridge for a firing angle and load current, with commutation overlap, displacement factor and AC current.

Method: Three-phase fully controlled bridge with commutation overlap

Input parameters

Unit system: SI

Parameter	Value	Unit
AC line-to-line voltage (RMS)	415.00	V
Supply frequency	50.000	Hz
Firing (delay) angle	30.000	°
DC current	200.00	A
Commutating inductance per phase	0.10000	mH

Calculated results

Parameter	Value	Unit
Ideal no-load DC voltage at α = 0	560.45	V
DC output voltage	479.36	V
Commutation overlap angle	2.3694	°
DC power	95.872	kW
Displacement factor	0.85532	
Fundamental AC line current	155.94	A

Notes for this case

• A six-pulse bridge gives V_d0 = (3√2/π)V_LL ≈ 1.35V_LL; delaying the firing by α scales it by cos α, and above 90° the bridge inverts (negative V_d). The supply inductance makes each commutation last an overlap angle μ, with cos(α + μ) = cos α − 2ωL_cI_d/(√2V_LL), and costs a voltage 3ωL_cI_d/π. The displacement factor is about [cos α + cos(α + μ)]/2 and the fundamental line current (√6/π)I_d for a smooth DC current, so phase-controlled rectifiers draw much reactive power at large α.

Formula and method

$$V_d = \frac{3\sqrt{2}}{\pi} V_{LL} \cos\alpha - \frac{3\omega L_c}{\pi} I_d, \quad \cos(\alpha+\mu) = \cos\alpha - \frac{2\omega L_c I_d}{\sqrt{2}\, V_{LL}}$$

Variables

V_{LL}	AC line-to-line voltage (RMS)	V
f	Supply frequency	1/s
α	Firing (delay) angle	rad
I_d	DC current	A
L_c	Commutating inductance per phase	H
V_{d0}	Ideal no-load DC voltage at α = 0	V
V_d	DC output voltage	V
μ	Commutation overlap angle	rad
P_d	DC power	W
$\cos\varphi_1$	Displacement factor	-

I_1	Fundamental AC line current	A

Method and standards

Thyristor bridge.

Assumptions and limits

- Smooth (continuous) DC current; balanced sinusoidal supply; ideal thyristors.

References

Three-phase fully controlled bridge with commutation overlap

Report details

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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/six-pulse-converter-dc-voltage

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Reopens the calculator with the inputs of this report.