Motor Starting Current: DOL, Star-Delta and Autotransformer

Line starting current and starting torque of an induction motor started direct on line, star-delta or by autotransformer, from its locked-rotor current and torque.

Method: Reduced-voltage starting relations (current and torque ∝ voltage², star 1/√3)

Input parameters

Unit system: SI

Parameter	Value	Unit
Full-load current	100.00	A
Locked-rotor current as a multiple of full-load current From the motor data sheet.	6.5000	
Locked-rotor torque as a share of full-load torque	180.00	%
Starting method	Star-delta	
Autotransformer tap (share of line voltage) Used for the autotransformer starter only.	65.000	%

Calculated results

Parameter	Value	Unit
Starting current drawn from the line	216.67	A
Starting current as a share of DOL current	33.333	%
Starting torque as a share of full-load torque	60.000	%
Voltage at the motor as a share of line voltage	57.735	%

Notes for this case

- DOL starting current I_DOL = k I_FL = 650 A.
- Check that the starting torque exceeds the load's breakaway torque with a margin; magnetising current and transition current peaks are not included.

Formula and method

$$I_{DOL} = kI_{FL}$$

$$\text{star}-\text{delta}: \; I_{st} = I_{DOL}/3,\; T_{st} = T_{LR}/3$$

$$\text{autotransformer}: \; I_{st} = a^2 I_{DOL},\; T_{st} = a^2 T_{LR}$$

Variables

I_{FL}	full-load current	A
k	locked-rotor current multiple	-
T_{LR}	locked-rotor torque as a share of full-load torque	-
method	starting method	-
a	autotransformer tap	-
I_{DOL}	direct-on-line starting current	A
I_{st}	line starting current	A
I_{st}/I_{DOL}	starting current as a share of DOL	-
T_{st}	starting torque as a share of full-load torque	-
U_m/U	voltage at the motor as a share of line voltage	-

Method and standards

Locked-rotor current is proportional to the voltage across the windings and torque to its square. Star connection puts 1/√3 of line voltage on each winding; an autotransformer at tap a puts a times line voltage on the motor and, neglecting magnetising current,

draws a² of the DOL current from the line.

Assumptions and limits

- Steady locked-rotor values; transients and magnetising current not included. The DOL current I_DOL is given in a note.
- An open-transition star-delta changeover can draw a peak above the DOL current; it is not included.
- Soft starters and VFDs limit current by control, not by a fixed ratio.

References

- Reduced-voltage starting relations (current and torque ≈ voltage², star 1/√3)

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/motors/motor-starting-current

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.