Soft Starter Current Limit: Motor Torque and Start Time

Motor torque at a soft starter's current limit, the resulting voltage, acceleration time with a load, and the lowest current limit that still starts the load.

Method: Reduced-voltage torque scaling (T ∝ U², I ∝ U)

Input parameters

Unit system: SI

Parameter	Value	Unit
Motor rated torque	715.00	N·m
Locked-rotor current ratio	6.5000	
Locked-rotor torque ratio	2.2000	
Current limit setting	3.5000	
Average load torque during start	35.000	%
Total moment of inertia	25.000	kg·m²
Full speed	1,480.0	rpm

Calculated results

Parameter	Value	Unit
Motor voltage at the current limit	53.846	%
Motor torque at the limit	456.08	N·m
Accelerating torque	205.83	N·m
Start time	18.825	s
Lowest current limit that starts the load	2.5926	

Notes for this case

• A soft starter lowers the voltage; induction motor current falls in proportion to voltage and torque with its square. Holding current at k × I_n therefore gives about U/U_n = k/(I_LR/I_n) and T = T_LR(U/U_n)², taken here as constant during the run-up (an approximation; torque actually varies with speed). Start time = Jω/(T_m − T_L). Keep at least 10–20 % accelerating margin and check starts per hour against the starter's thermal rating.

Formula and method

$$\frac{U}{U_n} = \frac{k}{I_{LR}/I_n}, \quad T_m = T_{LR}\left(\frac{U}{U_n}\right)^2, \quad t_{st} = \frac{J\omega}{T_m - T_L}$$

Variables

T_n	Motor rated torque	N·m
I_{LR}/I_n	Locked-rotor current ratio	-
T_{LR}/T_n	Locked-rotor torque ratio	-
I_{lim}/I_n	Current limit setting	-
T_L/T_n	Average load torque during start	-
J	Total moment of inertia	kg·m²
n	Full speed	rad/s
U/U_n	Motor voltage at the current limit	-
T_m	Motor torque at the limit	N·m
T_a	Accelerating torque	N·m

t_{st}	Start time	s
$(I_{lim}/I_n)_{min}$	Lowest current limit that starts the load	-

Method and standards

Soft starting.

Assumptions and limits

- Constant motor torque during run-up; average load torque.

References

Reduced-voltage torque scaling (T ∝ U², I ∝ U)

Report details

Report reference	FCC-0H71-7PDF (the same inputs always give the same reference)
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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/soft-starter-start-time

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Reopens the calculator with the inputs of this report.