EV Motor Tractive Force Envelope and Gradeability

Base speed, top speed limit, tractive force at a chosen speed and maximum gradeability of an electric vehicle from motor torque, power, speed limit and gearing.

Method: Electric drive tractive characteristic

Input parameters

Unit system: SI

Parameter	Value	Unit
Motor peak power	150.00	kW
Motor peak torque	310.00	N·m
Motor maximum speed	16,000	rpm
Reduction gear ratio	9.0000	
Rolling radius	330.00	mm
Drivetrain efficiency	92.000	%
Vehicle mass	1,800.0	kg
Rolling resistance coefficient	0.010000	
Speed of interest	80.000	km/h

Calculated results

Parameter	Value	Unit
Motor base speed	4,620.6	rpm
Vehicle speed at base speed	63.871	km/h
Speed at maximum motor speed	221.17	km/h
Tractive force at the chosen speed	6.2100	kN
Level acceleration at that speed (no drag)	3.3519	m/s²
Maximum gradeability	47.849	%

Notes for this case

- Constant torque up to base speed P/T, constant power above it. Gradeability from F_0 = mg(sinθ + f·cosθ); start-off on steep grades also needs traction and thermal margin.

Formula and method

$$\omega_b = \frac{P_m}{T_m}, \quad F_x = \frac{T(\omega) i \eta}{r}, \quad F_0 = mg(\sin\theta + f\cos\theta)$$

Variables

P_m	Motor peak power	W
T_m	Motor peak torque	N·m
n_{max}	Motor maximum speed	1/s
i	Reduction gear ratio	-
r	Rolling radius	m
η	Drivetrain efficiency	-
m	Vehicle mass	kg
f_r	Rolling resistance coefficient	-
v	Speed of interest	m/s

n_b	Motor base speed	1/s
v_b	Vehicle speed at base speed	m/s
v_{max}	Speed at maximum motor speed	m/s
F_x	Tractive force at the chosen speed	N
a	Level acceleration at that speed (no drag)	m/s²
G_{max}	Maximum gradeability	-

Method and standards

Tractive envelope.

Assumptions and limits

- Ideal constant-torque/constant-power motor.

References

Electric drive tractive characteristic

Report details

Report reference	FCC-4A8J-Y4AJ (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/automotive/electric-vehicles/ev-motor-tractive-envelope

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.