

Technical note

Reliable electrical design and design tools



Maximum torque, minimum weight

Train manufacturers and operators require traction motors with a compact design and the lowest possible weight, while at the same time pushing the motor to the limit to generate maximum power and torque output over a lifetime of 20–30 years. Balancing these demands requires an extremely efficient and reliable electrical motor design.

Customized for actual operation

Each ABB traction motor is thermally and electrically designed based on its actual operating conditions. Close interaction with traction converter manufacturers and train manufacturers allows ABB to design motors that meet stringent traction requirements.

Optimizing motor and converter as a system

A traction motor is powered by a converter, which feeds the motor with voltage and frequency. During the design phase of the motor, it is essential to design the motor and converter as a system. In traction applications, the switching frequency of the converter is usually low making the harmonic effects in the motor more significant. By using FEM based design software developed specifically for electric motors, ABB is able to optimize the motor's design taking into account traction converter characteristics.

Withstanding stress on the stator insulation system

The stator insulation system is exposed to different types of stress. It must endure mechanical stress (e.g. vibrations), electrical stress (e.g. voltage spikes and fast voltage rises), and ambient stress (e.g. extreme climate conditions). A robust insulation system is therefore a crucial factor to maximize the motor's reliability.

The robustness of the insulation system depends on material characteristics as well as on the quality of the production process. Combining extensive experience in selecting suitable materials with renowned production processes enables ABB to minimize the impact of stress.

Accurately predicting the temperature rise of critical parts of the motor is essential to reduce thermal stress and to increase the motor performance and life time. See back of sheet for a description how ABB's design tools ensure reliable motor operation.

ABB design tools:

Accurately predicting the temperature rise of the motor

Accurate thermal and electrical calculations make it possible to design the motor based on train configuration, the train's operation cycle, available space, environmental conditions, grid voltage variations, wheel diameter differences, possible fault conditions and traction converter characteristics. It is particularly important to determine the thermal behavior of the motor when it is fed by a traction converter. The time harmonic losses in the motor depend on the switching strategy, switching frequency and DC bus voltage supplied by the converter.

Combining analytical and FEM based electrical motor design software with a 3-d lumped parameter thermal design software allows ABB to simulate the in-service motor temperature with great accuracy.

Inputs to the calculation routine are train effort, train speed and switching pattern versus time throughout the train's operation cycle. The figure below illustrates the main structure of the calculation routine.

