Trains are frequently custom made to accommodate the individual technical specifications of different rail service providers. Each new design requires a variety of unique, train-specific components that are supplied by additional independent original equipment manufacturers (OEMs). Traditionally the traction motor is among the many custom made components required by train manufacturers. These motors are intensively engineered to ensure function and quality, which results in increased complexity throughout the value chain and adversely affects their manufacturing lead time. To overcome these problems, ABB has developed a new range of induction traction motors with built-in flexibility so that customer-specific requirements can be met using a single modular design.

ABB’s innovative modular induction traction motor sets new heights in adaptability.

Standardizing the traction motor
ABB’s new series of traction motors has an innovative modular design that provides flexible customized construction. From standardized modular components. This provides a standard structure for traction motors with different cooling methods so that the service and access to spare parts is simplified.

Highly adaptable
To accommodate a variety of performance demands, ABB’s new series of traction motors has an innovative modular design that provides flexible customized construction. A major feature of its adaptability is that drive and non-drive ends of the motor are not predefined. In addition the length of the motor can be adjusted to meet specific space and operation demands and the position of the terminal box and air in-take and outlet ducts can be adjusted to optimize performance and space constraints. Furthermore, the unit can be cooled either by open self ventilation (OSV) or by open forced ventilation (OFV) according to the customer’s wishes. The flexible design means that an OFV can be converted to an OSV simply by adding an elongation ring and a fan and extending the shaft, providing customized traction motors.

Flexible mounting
The modular induction traction motor range has mounting brackets that can be fitted in a variety of positions so that vehicle builders are free to fit motors by any method (suspended or non-suspended) to any bogie. This means the optimal position of the motor can be found to integrate the motor within the least amount of space giving train manufacturers and OEMs the freedom to fit or retrofit ABB traction motors to both new and existing designs. The whole structure including the brackets and their associated attachment is designed to fulfill IEC 61373 (shock and vibration) standards without having to reduce the motor’s mechanical performance.

Durable and versatile
The modular induction traction motor series is designed to be durable and versatile. Many parts have integrated functions to help reduce the number of components and ensure the product is compact and robust. They are designed to endure extreme temperatures and polluted environments.

Customers want traction motors with the lowest possible weight and compact design, while at the same time providing a
The traction motor features a new electrical design, optimized for high energy efficiency and a competitive performance/weight ratio.

The traction motor fulfills very high specifications designed to meet precise requirements. In traction applications the switching frequency of the converter is usually low, which makes the harmonic effects in the motor more pronounced. With the help of state-of-the-art FEM (finite element method) software (developed by the Helsinki University of Technology and optimized solely for electrical machines), it was possible to get the best electrical design for the converter by taking into account its characteristics and certain optimization criteria:

- Torque ripple minimization
- Low noise and vibrations
- High efficiency
- Low current
- Efficient cooling capability

The traction motor and traction converters fulfill very high specifications designed to meet precise requirements. In traction applications, the switching frequency of the converter is usually low, which makes the harmonic effects in the motor more pronounced. With the help of state-of-the-art FEM (finite element method) software (developed by the Helsinki University of Technology and optimized solely for electrical machines), it was possible to get the best electrical design for the converter by taking into account its characteristics and certain optimization criteria:

- Torque ripple minimization
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- High efficiency
- Low current
- Efficient cooling capability

**Thermodynamic design**

The temperature rise and thermal design is critical in traction motor applications. Very accurate estimations of the temperature rise of critical parts of the motor are crucial to its reliability. By coupling analytical electrical design software, FEM-electrical design software and 3-D thermodynamic network software it is possible to simulate the expected motor temperature during its service with great accuracy. The structure of the software can be seen in ➔ 2. Inputs are the line simulation of the train and the switching characteristics of the converter and outputs are the temperature rise of critical motor parts, such as stator winding and bearing temperature.

Special effort has been made to decrease harmonic losses, noise and torque pulsations, in a robust design and with production methods that ensure high quality standards. The insulation system contains corona resistant materials, has low water absorption properties, complies with temperature class 200, and takes advantage of ABB’s knowledge and experience having delivered traction motors since 1909.

**Computational fluid dynamics (CFD)**

Special care was taken to optimize thermal design. The output of the motor is thermally limited and the motor needs to be cooled efficiently. Cooling ducts (stator and rotor) and the fan have been optimized with respect to cooling efficiency as well as noise. Using CFD modeling, along with the electromagnetic computations, it was possible to predict the likely

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**Footnotes**

2 The amount of torque measured by subtracting the minimum torque during one revolution from the maximum torque from the same motor revolution.

3 A corona resistant insulation material has higher resistance against deterioration when a high-voltage electrostatic field ionizes.

4 Temperature classification (also known as temperature class) defines the maximum continuous temperature that an insulation system can sustain in degrees Celsius.
location of hot spots in the event of motor overload, which helped identify areas in which modifications were made to improve cooling and reduce losses.

Furthermore CFD simulation of a fan provides a complete picture of its operation. It can identify areas where there are recirculation problems and determine the flow rate, but more importantly, it can help establish the cause of problems and reliably direct design improvements. The fan design can then be optimized to minimize energy consumption, lower losses, reduce noise levels, optimize blade number, prolong component life and provide greater flexibility in the traction motor system.

Optimized design
The structural design of the product provides a variety of options to further enhance or monitor the performance of the motor. ABB provides all types of bearing solutions from the traditional c4 steel bearings to more advanced hybrid bearings with ceramic ball and roller elements, including HUB solutions (hybrid bearings greased for life). New air filtering techniques are under development and thermal sensors can be placed in a variety of positions, eg, in the windings, stator core or bearings, the latter providing early indications of bearing failure. Integrated speed sensors help keep the motor compact, while allowing the sensors to be replaced without detaching the motor from the bogie. The modular design simplifies maintenance procedures for all parts. By taking into account the service needs of a bogie-mounted motor at the design stage and standardizing spare parts, the new traction motor can be partly serviced in the bogie helping to reduce operational downtime and costs over the product’s life cycle.

Currently ABB is working to extend traction motor products to serve a range of transport needs from LRV (light rail vehicles) to locomotives. The focus is to further standardize the structure, increase the energy efficiency and reduce maintenance. Synchronous motor topologies are also under development, eg, permanent magnet motors, but despite the obvious advantages of such topology (ie, energy efficiency and torque density) there are also several disadvantages. These include greater sensitivity to shock, overheating, and complex production and maintenance procedures. ABB aims to strengthen the advantages and minimize the disadvantages with its future synchronous products.

ABB has been manufacturing industrial motors for more than 130 years; traction motors for 100 years and has supplied more than 30,000 traction installations during the last few decades. These installations range from heavy locomotives for intercity expresses through to light metropolitan tramways. The new series of modular induction traction motors will add to ABB’s reputation as a global leader in power and automation technologies, providing a truly versatile traction motor designed to fit a wide variety of locomotives, enabling rail operators to improve performance while lowering their environmental impact.

The ABB series of traction motors with their wide range of specifications and modular design are poised to meet increasing demand for energy efficient electric traction motors in the rail industry.

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