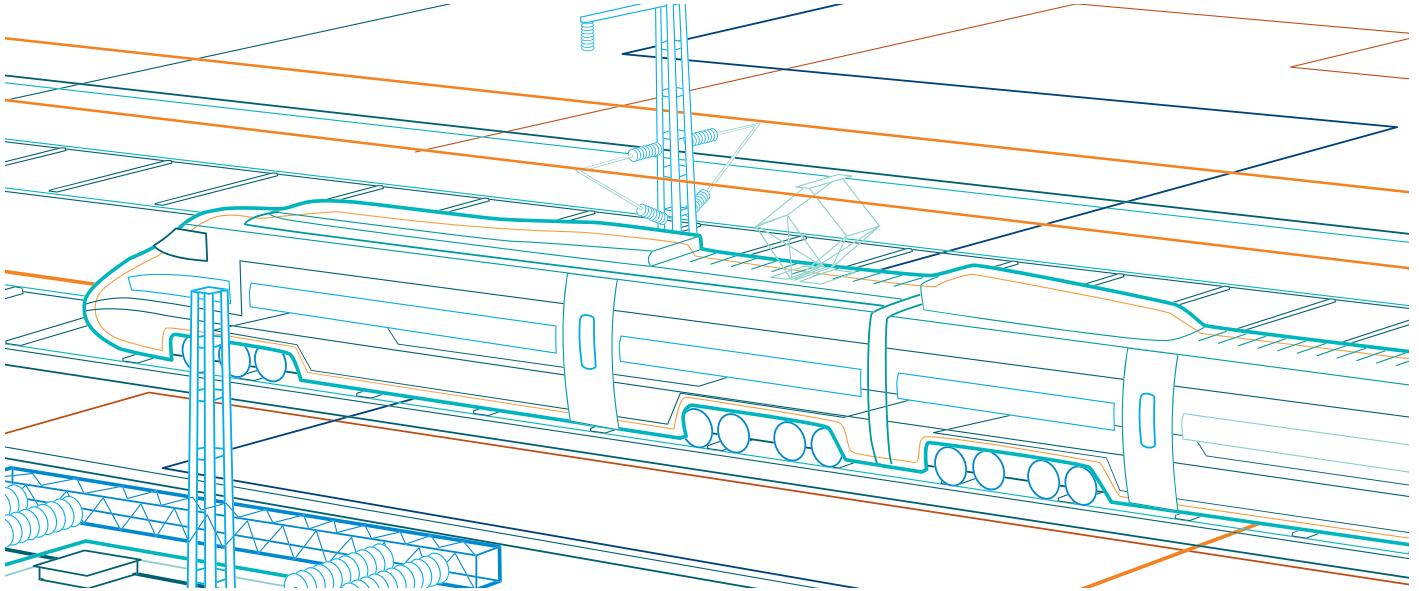




Traction systems for locomotives and high-speed applications

ABB – your partner of choice

Unrivalled flexibility



Large series of trains and locomotives fitted with ABB traction equipment are in reliable and economic operation every day and in every climate.

ABB is the expert for traction converters, motors, transformers, and complete traction chain solutions. In deep and trustful partnerships with vehicle builders, refurbishers, and rail operators, we supply state-of-the-art traction systems. Among traction specialists, ABB excels with the broadest traction portfolio and engineering capabilities for tailor-made solutions.

We combine decades of rail experience and a world-leading position in areas such as traction transformers with a wealth of cross-industry know-how in power electronics, motion control and project management. ABB is not only the leader in industrial drives, but also the most innovative supplier of power semiconductors.

The following pages offer many ideas of how ABB could contribute to your next locomotive and high-speed project. We hope to inspire you as to what is possible today in the areas of power management and energy efficiency, hybrid and multi-system technology, compactness and energy-density, reliability and robustness, control and adaptability.

One of the greatest strengths of ABB is our flexibility to create real value-adding innovations. Given a sound business opportunity, ABB is ready to quickly embark with you on a partnership for game-changing new solutions.

“We care for every detail, because we know the impact on the lifetime of the traction system.”

Complete product portfolio

ABB traction solutions

BORDLINE® traction converters and ABB traction solutions stand for comprehensive, flexible solutions with high performance and rewarding cost and energy savings over the life cycle.

Traction chain partner

As a major supplier of traction systems, ABB works with most of the leading rolling stock manufacturers. We also support transport operators throughout the whole life cycle of the traction chain, i.e. in the areas of service, maintenance, upgrades, and retrofit projects.

Benefits of comprehensive traction chain responsibility

- Single partner for the entire traction chain
- Optimization of component dimensions and interfaces
- Fast commissioning and homologation
- TCMS integration and system optimization
- Higher total energy efficiency and reduced life cycle cost

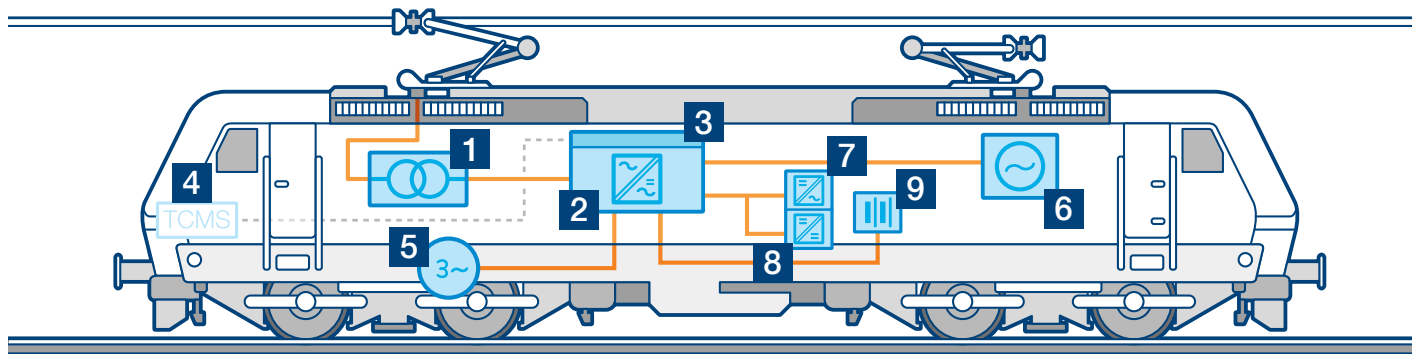
ABB traction solutions for all rail applications

Complete portfolio of traction chain solutions from a few 100 kW to more than 7 MW and for all types of locomotives (e.g. passenger, freight, shunting), power heads, and distributed propulsion systems.

Electric			Hybrid			Diesel-Electric
AC	DC	MS	DE/AC	DE/DC	DE/MS	
✓	✓	✓	✓	✓	✓	✓

Global presence

ABB is present in more than 100 countries and can provide strong local support to your project. With a truly global organization, we are committed to local competence and local service.



Overview of ABB's traction offerings

- [1] Traction transformer
- [2] Traction converter
- [3] Traction control
- [4] Train Control and Monitoring System
- [5] Traction motor
- [6] Diesel engine generator
- [7] Auxiliary converter
- [8] Battery charger
- [9] Energy storage

Proven traction components

Transformers, motors, generators

ABB traction transformers

- World market leader with unrivaled experience
- Minimum line harmonics and optimum total efficiency of the traction system
- State-of-the-art production technology as well as design and simulation software
- Tailor-made configurations for under-floor or machine-room installation
- Highly flexible design for compactness and optimized winding topology, being critical for multi-system (MS) vehicles to respect vehicle weight/axle restrictions

ABB traction motors

- Frameless induction traction motors designed to ensure reliable operation and high torque output
- Fully customizable motor concept to meet a broad range of requirements regarding e.g. output power, mounting arrangements and air duct position
- Broad design skills and experience to achieve a carefully calculated optimum solution for each application, whether tailor-made or based on a standard design

ABB traction generators

- Synchronous brushless generators designed for high-powered diesel-electric locomotives
- Single bearing design for two couplings to be combined with the diesel engine crankshaft decreasing the size and weight of the gensets
- ABB UNITROL 1020 automatic voltage regulator generator, designed for reliable excitation control in traction applications
- Complete family of induction (asynchronous) generators suitable for medium power range applications
- Main advantages: simple, compact and reliable design

Examples of ABB traction components



Traction transformer LOT 1100
1.5 MW for 16 2/3 Hz high-speed double-deck trains



Traction transformer LOT 6500 / 6700
4.5 MW for 50 Hz AC locomotives



Traction transformer
4.8 MW for 16 2/3 Hz and 5.2 MW for 50 Hz high-speed trains



Traction motor
1.2 MW for cargo locomotives



Traction motor
600 kW for high power applications



Traction generator
2.65 MW for high power applications

Proven traction components

BORDLINE® CC – Compact Converters

ABB traction converters

- BORDLINE® CC Compact Converters: the heart and the brain of the traction system
- Two-level and three-level topologies for optimal energy efficiency, economic retrofit, and fast homologation
- Integrated auxiliary converters, battery chargers, and head-end power (HEP) converters fed from the DC link
- Large portfolio of optimized durable housing solutions: from lightweight all-aluminum machine room cabinets to stainless steel underframe constructions
- Most compact and economic multi-system converters
- Tailor-made configurations for under-floor or machine-room installation
- Environmentally friendly and highly efficient water cooling
- Easy handling of low weight replacable power electronic modules

Examples of ABB traction components



Compact Converter
2.2 MW for multi-system power heads



Compact Converter
0.75 MW for hybrid shunting locomotives



Compact Converter
3.6 MW for 50 Hz AC locomotives



Compact Converter
1.8 MW for diesel-electric locomotives

Proven traction components

BORDLINE® M – Auxiliary converters



Auxiliary converter
180 kVA



Battery charger
10 kW



Auxiliary converter
130/260 kVA



Battery charger
15 kW

Auxiliary converters and battery chargers

- Complete portfolio of auxiliary converters, converting power from 2 kW up to 1 MW, ranging from converters for individual loads or batteries, to full onboard power supply for a train
- BORDLINE® M: all stand-alone auxiliary converter types, battery chargers and head end power (HEP) converters
- BORDLINE® CC: Compact Converters for the traction chain with integrated auxiliary converters (and battery chargers) connected to the DC link

Powerful converter modules

Full flexibility for customized solutions

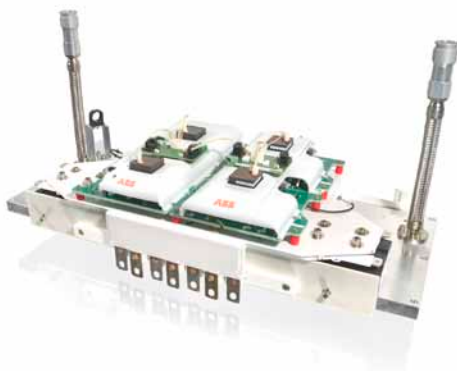


High-performance control module

- Key advantage of ABB traction solutions: the AC 800PEC control platform, probably the most powerful modular controller for high-speed performance on the market
- AC 800PEC control platform also used in ABB wind converters, high-power industrial drives, plant automation, high-power rectifiers and many other applications
- High volume and wide application diversity → high reliability
- Excellent range of control and communication functionality in cycle times extending from the sub-microsecond to the millisecond level
- Fast reaction times crucial to protect the traction system
- Complemented by a variety of input/output modules as well as engineering and service tools
- Tested under the most stringent environmental conditions
- Admired for the workmanship of the control wiring

Robust, reliable, service-friendly power modules

- All BORDLINE® converters, offered in a multitude of configurations and designs, are built on a platform of a few optimized PEBBs (Power Electronic Building Blocks) with 1.7 kV, 3.3 kV, 4.5 kV, and 6.5 kV IGBTs (Insulated Gate Bipolar Transistor)
- High production quantity of standardized PEBBs:
 - Excellent reliability and field experience
 - Technical optimization (lifetime, switching behavior, power density)
 - Multiple sources for all PEBB components
 - High spare part availability at reasonable cost
- PEBBs also optimized for service aspects: easy to handle (small and lightweight) and to exchange
- Liquid-cooled PEBBs for high power converters (highest compactness and long lifetime)
- Air-cooled PEBBs for many types of auxiliary converters



Three-level power module



Two-level power module

Cutting-edge control technology

High-performance control software

State-of-the-art adhesion control

- Key for the quantitative performance of the locomotive or the train and for reducing maintenance cost due to less mechanical wear
- Superior determination of actual vehicle speed and perfect wheel-slip/slide control for all types of driven axle configurations (single axle or bogie control)
- Exceptional adhesion performance, see references on pages 12 and 14

Reduced mechanical wear of the vehicle

- Reduced wear of motors, gears, wheels, and the bogies
- Minimization of harmonics in the motor current for all speed-torque regimes
- Reduced vibrational oscillations
- Suppression of torsional oscillations of the driven axles in a bogie

Optimized line voltage impact

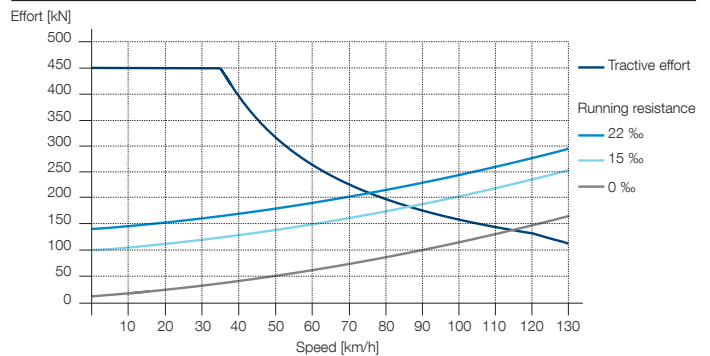
- Minimization of line harmonics
- Faster homologation
- Stabilization of the line voltage by active damping under weak line conditions, resulting in higher availability of vehicles with ABB traction

Examples of other innovative ABB software functions

- Various system control functions for reducing energy consumption in cooling, auxiliaries, and diesel engines
- Converter emergency operation mode to clear track even when TCMS is fault
- De-icing function for the catenary
- Integration of energy storage control



Traction diagram



Cutting-edge control technology

Excellence in software development

Control code consistency and traceability

- Simple, transparent and intuitive code, programmed in a modular and visual function block language
- Used consistently from the design phase through to detailed implementation, in real-time simulation tests and finally during fine-tuning under commissioning and homologation
- Perfect traceability of requirements and specifications to the operative version of the traction system software

Speeding up of commissioning and homologation

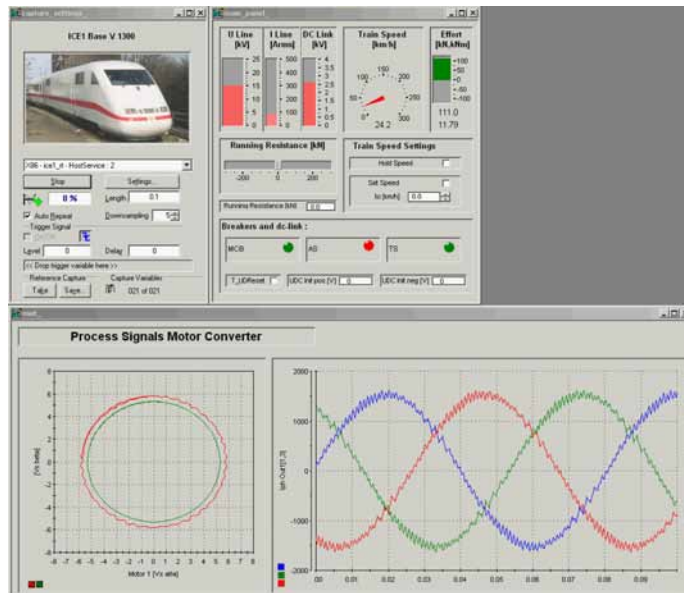
- Fast commissioning and homologation due to:
 - Quality and transparency of the software development
 - Simple adjustment of parameters during commissioning and homologation
 - Minimization of line harmonics
 - Rigorous and automated testing of the control software in a real-time simulation environment
- Reduced lead time between commissioning and first roll-out
- Faster project delivery and substantial cost savings as a result of shortened vehicle commissioning and homologation

Safe testing of non-standard operational modes

- Real-time simulator extending the software validation to situations inaccessible on the test track (e.g. speed limitations, very unlikely system failures)
- Faster project delivery

Flexible adaptation of the control software

- Control software change requests facilitated by leading-edge software development environment
- Sustainable quality of traction system control over the lifetime of the vehicle



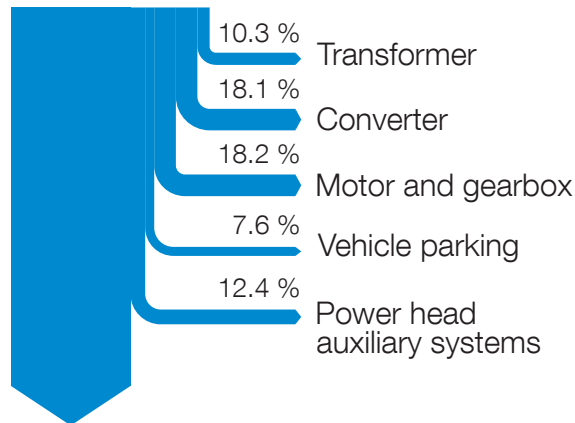
Retrofit and modernizations

Cooperation with operators

Project example for energy savings through retrofit

Old traction chain

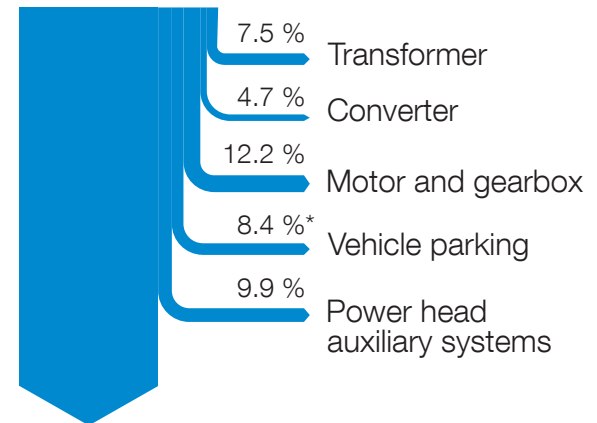
Energy input 167 %



Energy at wheel 100 %

New traction chain

Energy input 143 %



Energy at wheel 100 %

15 %
lower
losses

* Higher percentage value due to substantially reduced absolute losses

Energy losses in the traction chain of high-speed trains before and after retrofit with new IGBT converters

Interesting business cases for retrofit

- Need to replace converters or other traction chain components while the major part of the locomotive or high-speed train are fit for another 20 years of operation:
 - Availability and cost of spare parts
 - Unsatisfactory reliability and performance
- Additional benefits ('mid life crisis as a chance'):
 - Energy savings
 - Easy maintenance concepts
 - Lifetime extension for retained components, e.g. motors
 - Reduced heat and noise generation
 - Higher compactness and lower weight of new traction chain components
 - Optional change of fleet mission, e.g. hybrid or multi-system operation, higher speed or tractive effort, higher on-board power
- Return on investment scales with the size of the modernized fleet

ABB support for assessment

- Which traction chain components to keep, to upgrade or to replace
- Performance potential of the complete traction chain for new duty profiles
- RAMS (reliability, availability, maintainability, safety) potential

Demanding tailor-made engineering

- Traction chain retrofit engineering for an existing vehicle by far more challenging than for new designs
- ABB with a wealth of experience in engineering and project management

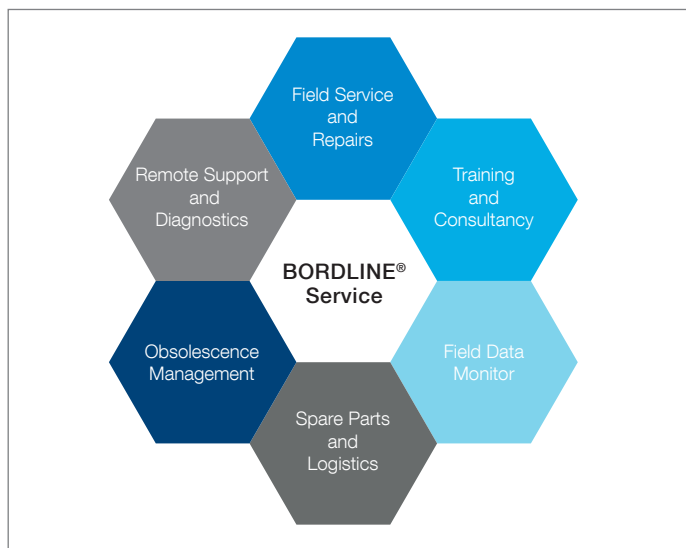
Deep partnership with the customer

- Flexible to utilize the customer's workshop capacities for the retrofit project
- Training and empowerment of the customer's operations and maintenance staff



Service and support

New era of industry partnership



Empowering the customer

- Pragmatic maintenance concept for efficient adoption of on-site maintenance by customer's service personnel:
 - Customized trainings
 - Strong diagnostic tools
 - Modular repair
 - Commissioning support
 - Product maintenance
 - Upgrades
- Commitment to customer support with flexible ABB service contracts spanning multi-year periods:
 - Clever spare part logistics
 - Repairs, on-site service
 - Field operating statistics and analysis
 - Support line and expert support
- The BORDLINE® Service philosophy:
 - Deep partnership with the customer's service organization, providing focused services in areas of the industrial partner's expertise
 - Smooth commissioning and early operation phase
 - Guaranteeing high converter availability after the warranty period and through the entire life cycle

Reinventing spare parts logistics

- No more stocking of obsolete spare parts, no more waiting for spares
- BORDLINE® Service concept: The right spare parts — at the right site — at the required time
- Containerized consignment stocks with automatic replenishment, optimized to suit the fleet requirements

Service program for motors, generators, and transformers

- Please refer to service brochures TransForLife Solutions™ and motor/generator service

Unique service network

- Global network of skilled experts and service sites for converters, motors, generators, and transformers

Selected references

Locomotives



BORDLINE® CC1500 AC | LOT 6500 / 6700 | BORDLINE® M130 / 260

Locomotives WAG 9 / WAP 7 / WAP 5, Indian Railways

Customer need

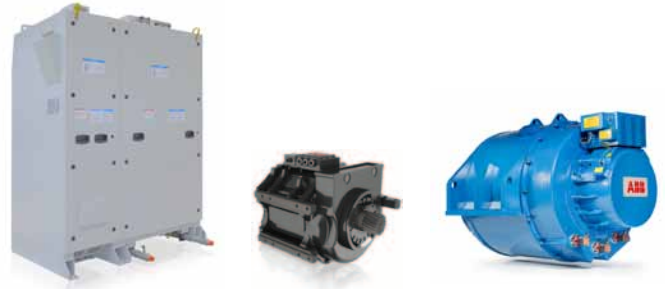
- Replacement of GTO (Gate Turn-Off thyristor) converters without any modification to mechanical loco design, interfaces, control, transformer, and traction motor
- Design suitable for old as well as new locomotives
- Resistant to high temperatures
- Service-friendly solution

ABB solution

- Design of new tailor-made IGBT-based (Insulated Gate Bipolar Transistor) converters
- High energy efficiency by reducing losses in the transformer and motors
- New generation adhesion control embedded in converter control
- Conversion from bogie control to single axle control

Customer benefits

- IGBT converters fully interchangeable with GTO converter series
- Significantly improved tractive effort under all conditions
- Haulage increased by 9% to 5'500 tons
- Better energy-efficiency and less heat generation
- Higher redundancy in case of motor failure
- Easy maintenance and reduction of operating cost
- Reliable long-term supply for traction transformers



BORDLINE® CC1500 DE | Traction motor | Traction generator

Diesel-electric locomotive EUROLIGHT, Vossloh

Customer need

- Reliable traction chain partner
- Minimum weight of traction chain for diesel-electric propulsion

ABB solution

- Optimized system of generator, compact converters, and traction motors
- New traction chain platform, configurable for Bo-Bo locomotive with head end power / Co-Co locomotive

Customer benefits

- High adhesion coefficient utilization reducing sand consumption and mechanical wear significantly
- The EUROLIGHT is currently the only diesel-electric locomotive available on the market that combines a low axle-load (< 20 t) with a high power rating, resulting in high operational flexibility and low operating cost



Selected references

High-speed trains



LOT 1100 | BORDLINE® CC1500 AC | BORDLINE® M10

High-speed double-deck train KISS, Stadler Rail

Customer need

- Highest reliability and availability, based on proven technologies
- High acceleration
- Minimum weight and space for traction equipment

ABB solution

- Further optimization of well-proven low-voltage IGBT compact converter platform
- Robust all-aluminum cabinet
- Optimized transformer

Customer benefits

- Very high reliability
- High energy-efficiency due to high switching frequency
- More comfort and space for passengers
- Traction converter with highest power density (1.5 MW/t) on the market



BORDLINE® CC1500 AC

Retrofit of ICE 1 high-speed power head, Deutsche Bahn

Customer need

- Replacement of old thyristor converters without any modification to mechanical power head design, interfaces, control, transformer, and traction motors
- Significant increase in energy efficiency and availability

ABB solution

- Development and production of new IGBT-based propulsion converter for 4.8 MW power head within 13 months
- Innovative three-level converter technology
- Service concept for easy maintenance
- Reliable delivery of one power head retrofit kit per week

Customer benefits

- Reliable partnership for quick refurbishment of 38 power heads in the workshop of DB
- Energy consumption cut by at least 15 %
- Massive reduction in operating cost
- Massive gain in reliability and availability



Selected references

Locomotives



BORDLINE® CC750 MS

Hybrid shunting locomotive Eem 923, Stadler Rail

Customer need

- Hybrid system: 11/15/25 kV_{AC} and diesel-electric for 'last mile' operation
- High energy-efficiency

ABB solution

- Very compact and lightweight tailor-made traction transformer and two independent traction converters
- Superb adhesion control system
- Low noise emission

Customer benefits

- CO₂ emissions will be reduced by more than 4'000 tons per year with a first order of 30 shunters for SBB Cargo
- Significant reduction of operating costs



BORDLINE® CC750 DC

Rack and adhesion locomotive, Stadler Rail

Customer need

- High-power 3kV_{DC} traction equipment controlling individually six motors
- 5 MW locomotive power
- Recuperation at full load (downhill)
- Easy maintenance

ABB solution

- Highly redundant traction system (six converters per locomotive)
- Well proven three-level medium voltage technology

Customer benefits

- Massive energy savings due to energy recuperation capability
- 780 kN tractive effort on ramps up to 104 ‰
- Remote diagnosis system for easier service



Partnering with ABB

Major benefits

- High flexibility and innovation to realize your project vision
- Large global corporation and technology leader with a long-term strategic commitment to the rail industry
- ABB as a pure traction chain and electrical partner for train builders and operators
- Competent local service and support wherever your project is

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