Power transformers
Special transformers
Railway
A leader in railway systems

Our compact and low-weight transformers fully comply with the customer’s specifications. The products are developed together with the clients, ensuring that the requirements of a special pre-qualification process, railway profile requirements and the extreme overload requirements according to EN50239 are always met.

The high quality of our reliable products provides an outstanding capacity to withstand short circuits, which are common in electric railways. Special type tests and quality control ensure safe operation, while ABB’s product support and service network guarantee free-and-easy use of the products. Special insulating liquids, Midel® can be used for improved environmental safety and reduced fire risk. The railway transformers are also protected against vandalism.

Railway systems and equipment used in the world are often bound by local national requirements and building practices. Therefore, the components must be specially designed and type-tested for each railway for an optimal solution. ABB offers its expertise and experience for the railroad builders worldwide for finding the best solutions with ABB equipment.

Railway transformers manufactured by ABB:
- Autotransformers
- Booster transformers
- AC traction feeder transformers
- DC traction feeder transformers
- Traction static converter transformers
- Auxiliary transformers
- Isolation transformers

Standards
The following standards govern the railway transformers and their application field:
- IEC 60076, transformer standard
- EN 50329, EU standard for railway fixed installation transformers
- EN 50121-5, EU standard for EMC (Electro Magnetic Compatibility) for railway applications
- EN 50122-1, EU standard for earthing safety regulations for railway applications
- EN 50124-1, insulation coordination for railway applications

Testing
Extensive and heavy type testing programs have been performed for each design of the transformers to fulfill the special requirements of the railway companies.

References
ABB has supplied railway transformers to the following countries:
- Finland
- Sweden
- Norway
- Denmark
- Germany
- Belgium
- UK
- Italy
- Mexico
- USA
- Spain
- Turkey
- South Africa
- Israel
- Algeria
- Malaysia
- India
- China
- Switzerland
- Austria
- Zimbabwe
- HongKong
Catenary autotransformers

Application
The electric energy for railways is supplied in high voltage to catenary feeder substations, where the voltage is reduced to a suitable level and fed to the railway catenary conductors to be used by locomotives and trains.

Catenary autotransformers are used in modern high-power railway catenary systems fed with two phases with a 180° phase shift, with the mid-point connected to the earth. They are applied to all new high-speed train systems.

Purpose
In railways, the electric current is taken from the catenary conductor to the locomotive, where the energy is used by electric motors and fed to the earth connected rails, which are part of the return circuit. In a two-phase fed catenary system, the rail and the earthed return conductor are connected to the mid point of the catenary autotransformer.

One pole of the autotransformer is connected to the catenary phase, and the other pole to the negative phase conductor. With this connection, the power is fed to the locomotive with double voltage compared to the voltage of the locomotive itself.

This means that the phase currents are reduced to half and the feeder losses to the fourth part compared to the single-phase feeder. The task of the autotransformers along the catenary line is to balance the voltages between the catenary and the earth, and the negative phase conductor and the earth, and then distribute the return current evenly between the two phases.

The advantages that are obtained with this connection compared with single-phase feeding and booster transformers are among the following, depending on the objectives:

- Lower losses due to higher voltage
- Longer distance between catenary feeder substations
- Better collection of returning stray currents
- Reduced interference for communications

Description
Catenary autotransformers are basically single-phase auto-connected transformers. The primary winding is connected between the two phases and the secondary winding between the catenary phase and the earthed return conductor. The secondary voltage is the catenary voltage against earth, and the primary voltage is two times that.

The requirements for transformers used in electric railways are demanding and special. The impedances of autotransformers are very low; the transformers must tolerate quite high temporary overloading and be resistant to a great number of short circuits.

Frequencies in AC-fed electric railways are 16.67 Hz, 25 Hz, 50 Hz or 60 Hz, and the power ratings are 4-15 MVA.

An ABB specialty in catenary autotransformers is the kiosk mounting with an integrated oil sump. The transformer tanks are either hermetically sealed, corrugated and flexible, or vacuum resistant types with detachable radiators and oil conservators.
Booster transformers

Application
Booster transformers are used in electric railway AC catenary feeders to collect the return current from the rails and the earth to the return conductor.

Purpose
In railways, the electric current is taken from the catenary conductor to the locomotive, where the energy is used by electric motors, and fed to the earth connected rails, which are part of the return circuit. From the rails, however, the return current may deviate around to unintended or harmful places like metallic pipelines, bridges, communication cables, etc. The stray currents bring about interference in communication systems and other electronic devices due to passing trains. Booster transformers are used to eliminate the stray currents and the disturbances, obliging the return current to flow to the return conductor. The use of booster transformers is growing due to new EMC regulations and the increasing amount of sensitive electronic appliances. Booster transformers are often used to improve old railway feeder systems.

Description
Booster transformers are single-phase transformers with the ratio 1:1. They have low impedance values, but despite that, they must tolerate the stresses of short-circuit currents. Primary voltages are typically 15 kV or 25 kV, which are the usual nominal AC voltages of catenary feeders in railways around the whole world. The nominal current is usually between 200A and 800 A. Frequencies in electric railways are 16.67 Hz, 25 Hz, 50 Hz or 60 Hz, and the power ratings of booster transformers are 100-800 kVA.

The transformer tank is hermetically sealed, corrugated and flexible, permitting liquid volume variation despite being totally filled. The booster transformer tank is usually hotdip galvanized for corrosion protection. The liquid immersed booster transformer is designed for outdoor installation. The usual style of installation is pole mounting in the catenary supporting steel poles near the catenary and return conductors. An ABB specialty in booster transformers is the kiosk mounting with an integrated oil sump. Pole and ground mountings are also possible.
AC traction feeder transformers

**Application**
AC traction feeder transformers are used between normal three-phase AC networks and single-phase catenary systems. Single and double voltage systems are used as in autotransformer and booster transformer applications. Railway companies possess their own single-phase HV lines. Singlephase feeder transformers are also used to reduce the voltages to the catenary level.

**Description**
AC traction feeder transformers are often equipped with an on-load tap changer (OLTC). Their strong structure is specially designed to resist repeated short circuits during the operation, which are common in electric railways.

The power ratings of the AC traction feeder transformers are usually 7.5-25 MVA (up to 60 MVA in central Europe), and the high voltage runs up to 400 kV.
16.67 Hz and 25 Hz systems are supplied from three-phase commercial AC systems with stationary converters of 50/16.67 Hz or 60/25 Hz. On the network side, these converters always contain a three-phase input converter transformer and a single-phase special output transformer on the catenary side. These transformers are specially designed for the converter technology and follow generally the principles explained in our brochure for the variable speed drive transformers.

**Application**
DC traction feeder transformers are used to feed rectifiers from normal three-phase AC networks. Rectifiers supply DC current to a catenary or third rail.

**Description**
Due to high currents and performance guarantees, DC traction feeder transformers are normally closely integrated with rectifiers. Therefore, they are specially designed and fitted together to match with the connection of the rectifier.

The power ratings of the DC traction feeder transformers are below 1000 kVA (tram supply), below 2000 kVA (metro supply) and 2000-8000 kVA (train supply with high currents up to 5000 A). Typical DC voltages are 3 kV, 1.5 kV and 0.75 kV DC, and 0.6 W DC.

DC traction feeder transformers are designed for tightly coupled series or parallel diode bridges (IPT), and they are supplied for 6-, 12- or 24-pulse connections.
**Auxiliary transformers**

**Application**
Auxiliary transformers are used in three-phase auxiliary networks along the tracks (owned by railway companies) or powered from the catenary for lighting and other purposes.

**Description**
Auxiliary transformers are used eg, for lighting purposes, heating the train wagons or for producing single-phase auxiliary for the safety systems supply or the substation’s own supply.

Voltage levels normally follow the catenary systems below 36 kV and the power ratings are below 2 MVA for the track side three-phase systems.

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**Isolation transformers**

**Application**
Isolation transformers are special transformers, which are used to isolate the AC network from the DC leakage currents caused by DC rails in close proximity of AC rails.

These transformers are typically 25/25 kV or 16/16 kV single-phase transformers, and the power ratings run up to 10 MVA.

Due to the DC immunity requirements, an air gapped core design is needed in the isolation transformers. Therefore, strong test system is required in the factory. A lightning impulse test is always done as a routine test.

Overvoltages are higher than normally, due to the air gapped core and the DC currents, which are present at switching when the train passes cut-off sections.
Contact us

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