



More power for railway lines

Maximum efficiency with proven system behavior

Technology Note – Rail SFC Light

For more than 40 years, Hitachi ABB Power Grids has been the reference in static frequency converters (SFC) for railway applications. Owing to this profound experience, Hitachi ABB Power Grids presents with Rail SFC Light the first IGCT based multilevel converter.

Benefits

- Maximum energy efficiency using IGCT semiconductor technology with multilevel topology
- Real redundancy in the power-electronics part makes it possible to design highly available systems
- Robust converter design guarantees maximum safety in case of failure
- Excellent and proven reaction to events in the railway and utility networks
- Well-thought-out converter concept leads to quick and very easy maintenance

Efficient, robust and intelligent

Hitachi ABB Power Grids presents the first IGCT-based multilevel SFC available on the market, expanding the proven PCS 6000 series.

The multilevel topology offers maximum energy efficiency with the help of the latest semiconductor technology. The converter's design results in a modular, robust and safe structure offering top availability.

The uncompromised implementation of the Hitachi ABB Power Grids control system philosophy for rail SFCs equips them with the best system behavior available on the market. This improves reliability and spares unnecessary interventions in case of normal grid events.



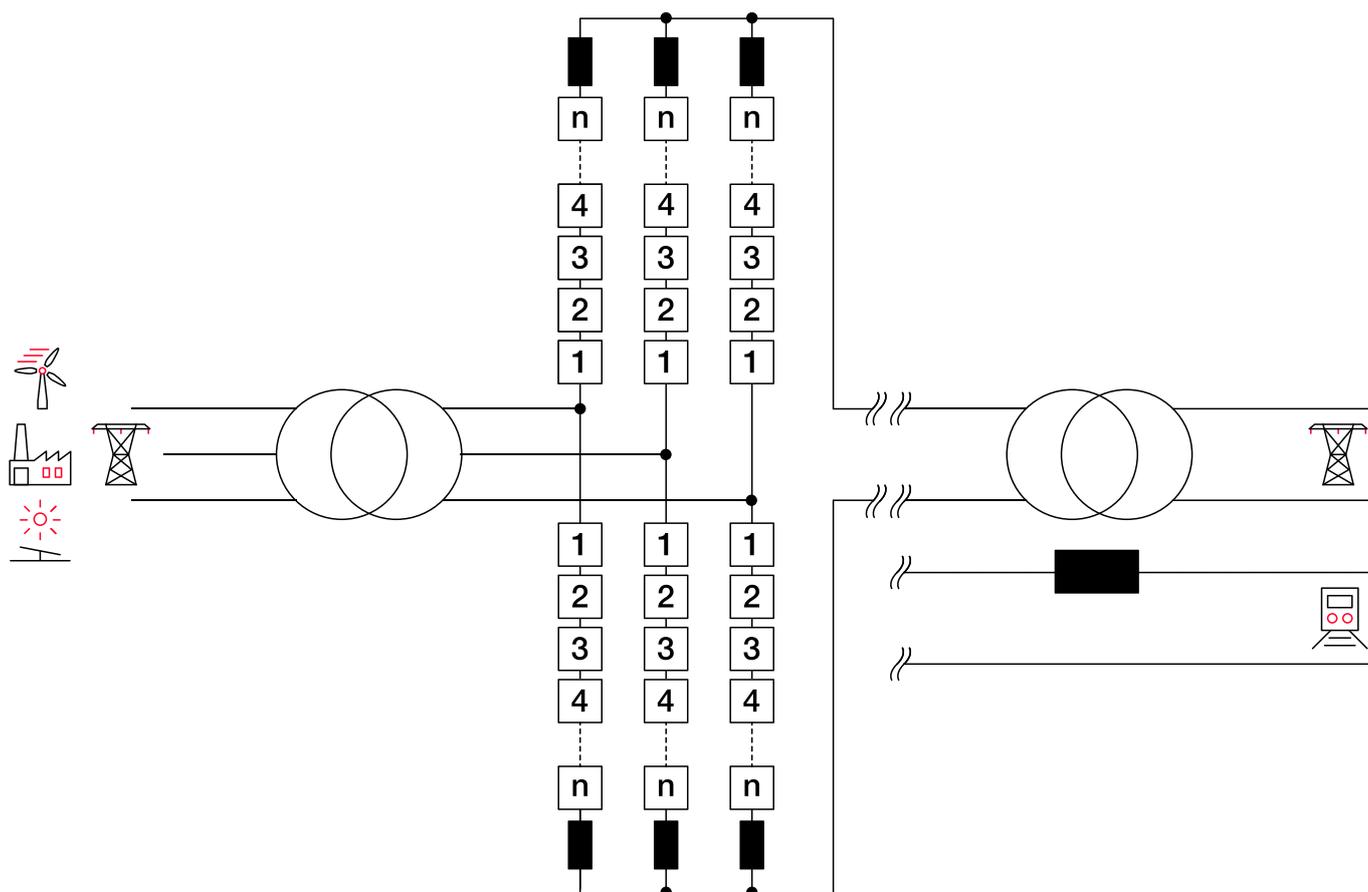
Rail SFC Light system

Rail SFC Light is based on the multilevel topology concept. The converter comprises two triphase legs that are each connected to a star point. The three phases of the supplying network are connected at the input. Between the two star points, the converter produces the output voltage for the railway network.

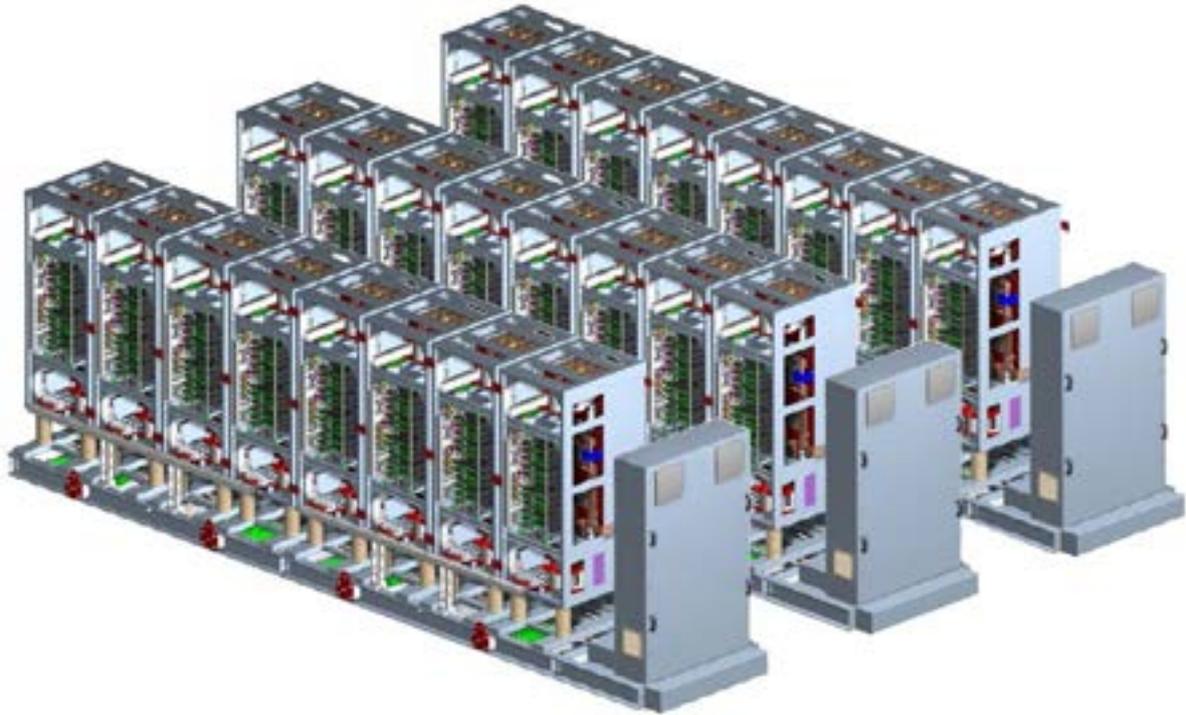
If the converter provides direct supply to the overhead line, the use of an output transformer is not needed. With Rail SFC Light, the necessary contact wire voltage can be produced directly. A line reactor is used to decouple and limit possible fault currents.

The power of the converter can be scaled with the number of the cells used, to optimize it for the project-specific values. Additional cells can provide redundancy in the power-electronics part of the system.

The number of cells in a converter results in high switching frequencies, as the individual stages add up. As a result, the use of additional network-side filters can be avoided. The Rail SFC Light system, however, is prepared for the installation of possible filters to tackle special network conditions.



01 Rail SFC Light system



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System layout

The converters hardware, control and water cooling units are typically integrated in a building. The remaining components of the system – such as chokes, transformers, precharging unit, heat exchangers – are designed for outdoor installation. Rail SFC Light is prepared such that the arrangement of main components can be planned flexibly. This makes it possible to adapt the layout to the space available.

- 02 IGCT converter
- 03 Multilevel PEBB (Power Electronic Building Block)
- 04 Hitachi ABB Power Grids RG-IGCT
- 05 Short-circuit start in island operation
- 06 Short-circuit end in island operation

Converter

Hitachi ABB Power Grids uses RC-IGCT and integrates them in converter cells. Two cells are put together in a PEBB design unit, based on the PCS 6000 stack concept. Thus, all the important advantages of proven converter design are included again in the new converter.

A simple and robust thyristor switch is mechanically integrated in the semiconductor stack. With it, in case of a fault, the cell can be very quickly short-circuited and thus reliably protected.

The design of the converter (like that of PCS 6000) offers a clamp circuit that limits cell-internal fault currents running through semiconductors in case of a fault in the stack.



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RC-IGCT technology

For the new generation of converters, Hitachi ABB Power Grids developed a new platform technology with “reverse conducting integrated gate turn-off thyristors” (RC-IGCT). The integrated diode in RC-IGCT reduces the number of converter components.

The RC-IGCT technology in combination with the multilevel topology offers significant advantages in terms of losses.



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Reliable system behavior

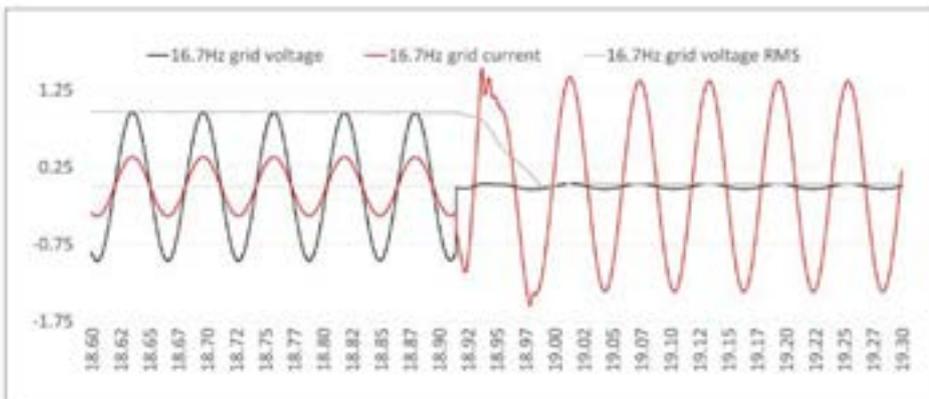
The single-phase short-circuit behavior is an important function of the rail SFCs for designing the network protection. The transient behavior into the short-circuit operation should take place without interruptions, and the current should build up within half a period. Like a substation transformer or a rotary converter, the traction current converter must behave as a phase and frequency-stable sinusoidal voltage source behind its transformer.

Hitachi ABB Power Grids has successfully migrated its experience and especially the control system that has been developed over 20 years from PCS 6000 to Rail SFC Light. As a result, the multilevel-based systems can retain the same important and decisive properties and meet the aforementioned requirements without difficulty.

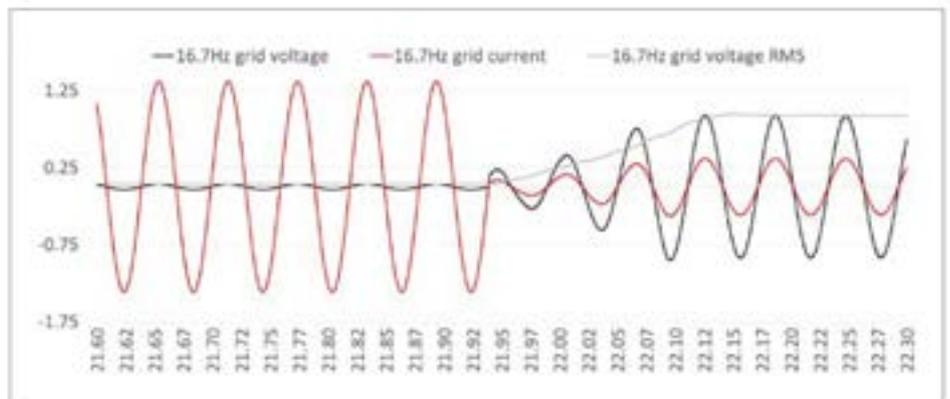
Island operation and black start

With the multilevel topology, the control software offers the same robust and reliable system behavior as known from the PCS 6000. Transitions from interconnected operation into island operation and backward take place without sequences, without switching control modes and without interruptions.

The control system is designed such that the rail SFCs control does not need any knowledge about the current configuration of the rail network. Local and remote subnetworks, other rotating converters or SFCs can be switched on and off as necessary without informing the Hitachi ABB Power Grids converter. It will adapt to the new network conditions, stabilize and control frequency, voltage and power according to the actual setpoint characteristics.



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07 Converter unit with an optional earthing arm

08 AC 800PEC platform devices

09 TIMELINE tool

10 16.7 Hz references since 2000

Safe and easy

Safety is an important property of a system. With MMC (multilevel modular converters) topology, the discharge and earthing of individual cells sets stricter requirements for the operating personnel.

For this reason, Hitachi ABB Power Grids has developed an optional dis-charge and earthing mechanism that makes it possible to discharge and earth all the cells automatically. Beside the resulting time savings, the local personnel does not have to carry out manual work with earthing ropes on ungrounded converter parts.

With the combination of the aforementioned clamp choke and bypass thyristor, the current converter can be arranged as an open and accessible stack. Fault currents are limited, and a defective cell can be reliably switched out. Unlike IGBT current converters, explosion protection is not necessary here.



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Maintenance and servicing

The proven stack design provides very easy access to all current converter components from the front side. The maintenance-free DC capacitors are accessible from the rear side. Replacing individual semi-conductor elements is easy and possible without interfering with the water cooling. To do this, the stacks spring is released and the semiconductor is pulled out using a spreading tool. The ability to replace components quickly and individually results in lower costs of fault elimination and higher availability. The maintenance concept makes it possible for the operating personnel to replace very easy single components.

Lifecycle requirements

The converter's well-thought-out concept makes a long service life possible. Hitachi ABB Power Grids has compiled based on its extensive experience a detailed schedule that offers transparent and well-founded information on the expected costs for different required lifespan.

An additional decisive factor for a long lifespan is the availability of platform-based control electronics. This guarantees the long availability of spare parts as well as successor models as replacements. During the service life of a rail SFC, the electronics used in it must be regularly updated. The platform additionally guarantees that the know-how and the required tools are continuously worked on, so that software and interface adjustments are easily possible even years into the future. This results in lower retrofit costs and a longer service life.

Hitachi ABB Power Grids has created the best conditions for this with its AC 800PEC platform. This platform exists since 2004 and is actively managed. Meanwhile, third-generation AC 800PEC are used.



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Troubleshooting and protection testing

A quick fault analysis is indispensable for converter systems. This requires an analysis tool that corresponds to the current state of the art, immediately providing the processed data to all users.

Hitachi ABB Power Grids has developed the TIMELINE tool for this purpose. This optional available software is installed in the converter system, and it is accessible via a web browser. The tool shows the transient recorder data in combination with the corresponding alarm and event messages. Predefined views make it easy to carry out a quick case-oriented fault analysis.

The TIMELINE tool also offers a user interface for the end client for testing of the protection systems of a rail SFC system.



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Experience matters

Hitachi ABB Power Grids has more than 40 years of experience in the field of rail SFCs. The company's first converters were commissioned in Sweden, in 1972.

For more than 20 years, the Swiss team has been providing the market with converters for supplying railways. Owing to the long-standing, detailed sys-

tem know-how, Hitachi ABB Power Grids can meet the high requirements of this market. Combined with innovative technical solutions, this know-how trickles down into our converter systems that function to full customer satisfaction in any operating mode.

Since 2000, ABB has successfully used the PCS 6000 converter platform for implementing rail SFCs.





Hitachi ABB Power Grids Ltd
power-grids@hitachi-powergrids.com
www.hitachiabb-powergrids.com