

# REVERSIBLE GROUP BOOST CONVERTERS

EFFICIENT-**BOOST**



# EFFICIENT

## POWER CONVERSION



Using experience accumulated over more than 100 years working in the field of traction power substations, Sécheron has designed the EFFICIENT product category from the ground up to cover all the customer needs for DC supplies.

All EFFICIENT products are built specifically to comply with the most stringent requirements of usability, maintainability and durability in traction power application environments, maximising the return on investment for our customers. These reliable and field-proven building blocks are also the basis for custom applications upon specific requests.

## GENERAL INFORMATION

Sécheron's BOOST technology offers a unique solution for fully reversible traction power substations.

The BOOST uses an IGBT inverter (INV-I), which is connected to the secondaries of a traction transformer. When energy flows from the DC network during train deceleration, the INV-I recovers it as usual.

During train acceleration, the INV-I injects reactive power into the transformer secondaries, thereby boosting the AC and DC voltage at the rectifier output.

This innovative operating principle offers the following advantages:

- Utilising a robust diode rectifier
- Having complete control over the traction power substations by including an energy recovery system
- Repurposing existing inverter modules designed for energy recovery
- Improved characteristics compared to a thyristor rectifier:
  - Enhanced power factor
  - Decreased harmonics
  - Reduced transformer power

## MAIN BENEFITS

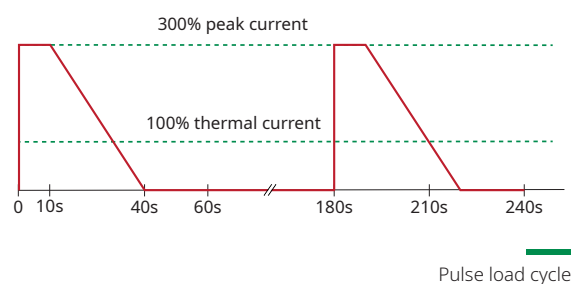
- ✓ Energy recovery
- ✓ Voltage control, loss reduction in the DC line and increased train speed
- ✓ Independent rectifier and inverter modes
- ✓ Possible installation in existing traction power substations as an upgrade
- ✓ Increase of distance between traction power substations
- ✓ Improved power factor in medium voltage network
- ✓ Reduction of transformer power
- ✓ Reduction of no-load voltage in the DC line
- ✓ Based on well-known technologies

# MAIN CHARACTERISTICS

Standard converter range	Unit	Values			
		750 V		1 500 V	
		Rectifier	Inverter	Rectifier	Inverter
Rated DC voltage	[V]	750 - 1 000	750 - 1 000	1 500 - 1 950	1 500 - 1 950
Rated power	[MW]	1 - 4	0.5 - 1.2	1 - 4	0.5 - 1.2
Maximum power	[MW]	3 - 12	1.5 - 3.6	3 - 12	1.5 - 3.6
Power frequency withstand voltage	[kV]	4.6	4.6	5.5	5.5
Overload	-	Class VI according to IEC 62590			
AC frequency	[Hz]	50/60	50/60	50/60	50/60
Efficiency	[%]	> 98.5	> 97	> 98.5	> 97
Power factor	-	Up to 0.97	≈ 1	Up to 0.97	≈ 1
THDi	[%]	< 5	< 5	< 5	< 5
Control	-	Uncontrolled	PWM	Uncontrolled	PWM
Cooling	-	Natural air	Forced air	Natural air	Forced air
Temperature range (without derating)	[°C]	-5 / +40	-5 / +40	-5 / +40	-5 / +40
Protection degree	-	Up to IP32	Up to IP32	Up to IP32	Up to IP32
Noise level	[dB]	65	75	65	75

## Overload capacity

- Up to Class VII
- Customer requirements are analysed to provide the optimal solution
- Special load cycles on demand
- Rectifier load cycles are available according to IEC 62590 standard
- Inverters load cycles available according to customer specifications



# STANDARDS

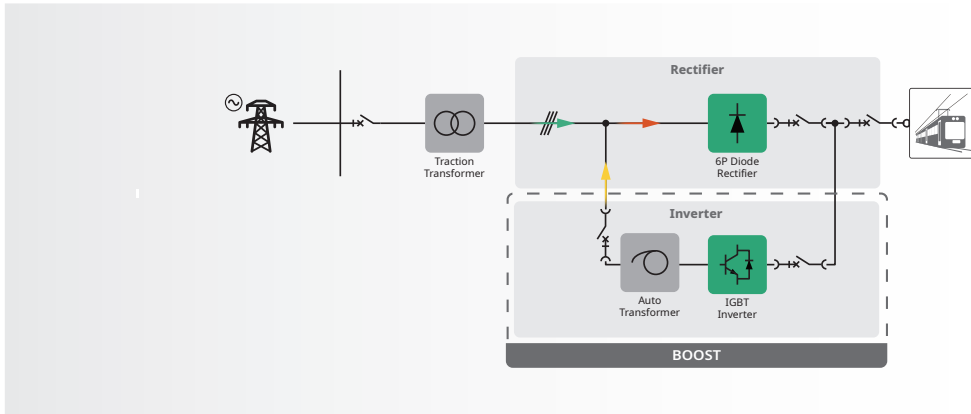
Our BOOST converters are fully compliant and type tested according to the following standards:

- **IEC 62497 (EN 50124)** | Railway applications – Insulation coordination
- **IEC 60146-1 (EN 60146-1)** | Semiconductor converters – General requirements and line commutated converters – Part 1: Specification of basic requirements
- **IEC 60146-2 (EN 60146-2)** | Semiconductor converters – Part 2: Self-commutated semiconductor converters including direct DC converters
- **IEC 62590 (EN 50328)** | Railway applications – Fixed installations – Electronic power converters for substations
- **IEC 60850 (EN 50163)** | Railway applications – Supply voltages of traction systems
- **IEC 62236 (EN 50121)** | Railway applications – Electromagnetic compatibility
- **IEC 60076 (EN 60076)** | Power transformers
- **IEEE 519** | Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

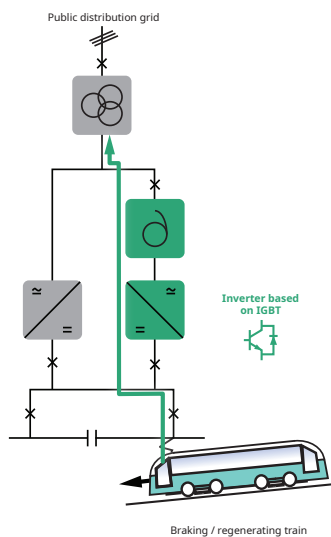
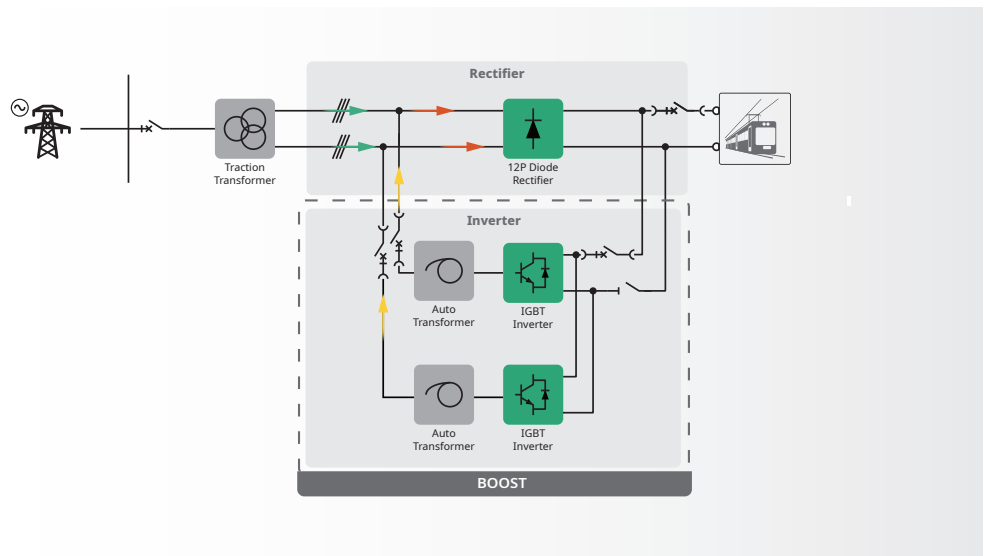
# TYPICAL APPLICATION

## BOOST converter used with a traction transformer group

### 6-pulse

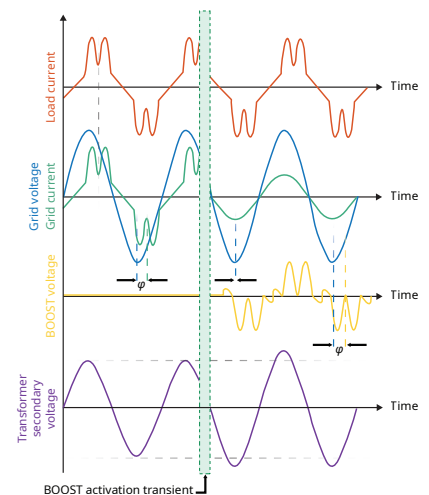


### 12-pulse

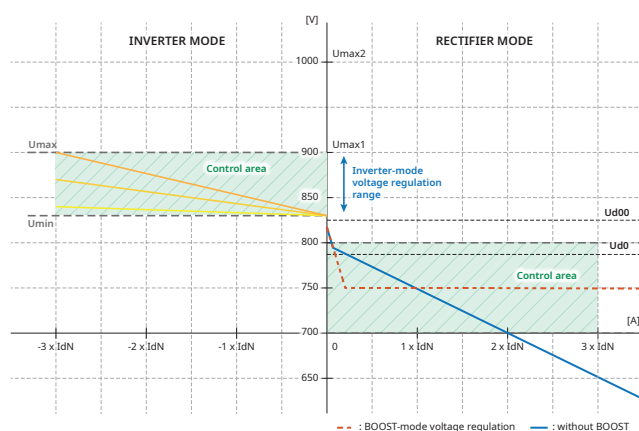


The BOOST converter adds reactive power to offset the naturally absorbed reactive power by the traction transformer group, which reduces the line current.

The BOOST does not transfer active power from the AC to the DC side to accelerate the train. Thus, the traction functionality remains even when the INV-I is out of service, thanks to the diode rectifiers in the system.



# CONTROL MODE



## Voltage control

The modulation width is regulated at any time to maintain the DC voltage at a defined level. The voltage/current characteristic is adapted depending on the rolling stock requirements.

Pulse width modulation control also enables limiting the harmonic content by choosing the appropriate modulation technique. The switching frequency can be adapted to the train signalling system and to AC network requirements.

# PROTECTIONS

## OVERVOLTAGE PROTECTION

External overvoltages are essentially due to lightning strikes on the line and interrupted short-circuits. The control board's fast protections prevent the IGBTs from switching in the presence of an over-voltage. Capacitors located close to the IGBTs protect them by absorbing excess energy. A DC surge arrester can be installed between the inverter's output terminals on demand.

## SHORT-CIRCUIT PROTECTION

BOOST converters are designed to withstand internal and external short circuits without damaging the AC or the DC side thanks to the fast detection provided by the control board and to the desaturation protection provided by the IGBT's gate drivers. In addition, the gate drivers provide an active clamping that assures soft turn-off in case of surge.

## OTHER PROTECTIONS

### Over-temperature

Over-temperature detection devices are provided with the equipment to avoid failures due to an abnormal temperature. Fans are only turned-on beyond a given heatsink temperature to prevent clogging and decrease maintenance rate.

### Auxiliary supply failure

The system monitors the health of the auxiliary control power source.

### Over-current

Inverter over-current causes fast tripping of the AC circuit breaker and of the inverter DC HSCB.

### Enclosure frame leakage (optional)

The inverter enclosure is isolated from the floor and connected to the station's ground via the frame leakage current relay.

### Degraded operation mode

When the inverter part of the BOOST is in maintenance, the diode rectifier will continue to operate normally.

### Solenoid door interlocks (optional)

Solenoid door interlocks prevent the opening of enclosure doors if there is AC or DC voltage in the system for safety.

# OPTIMISED INVESTMENT

Sécheron provides engineering support to ensure an optimised investment in fixed installation assets based on customer specifications. Sécheron can calculate Return On Investment.

Sécheron also has ample experience performing real time and traction power simulations to ensure design compatibility and calculate return on investment.

## /// Safety & reliability

Based on Sécheron's ample experience, the protective devices in the BOOST converter and the complete substation are carefully coordinated to ensure optimal protection. Breakers, brake choppers and other protective devices are configured to ensure safety and preserve the acquired assets.



## /// Remote control monitoring & diagnostics

The BOOST converter includes a SEPCOS system, allowing connection to all types of communication buses and protocols.

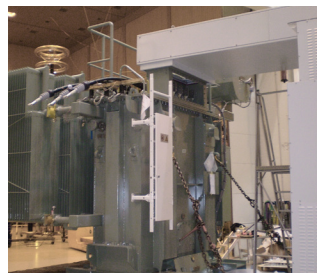
# RECTIFIER-INVERTER TRANSFORMER GROUP

Based on solid experience, Sécheron provides engineering and consulting support services for transformers according to standards IEC 62695 (EN 50329) and IEEE 1653.1:

- Technical specification
- Monitoring during manufacturing process with the supplier
- Assistance during factory acceptance tests
- Assistance during combined tests of the complete rectifier-inverter transformer group

The inverter is connected to the rectifier transformer with an autotransformer.

The withdrawable LV AC-circuit breaker that replaces MV-switchgear also acts as a disconnecter.



To ensure the compatibility of rectifier and transformer, Sécheron can provide the complete rectifier-inverter transformer group.


# RELATED PRODUCTS

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## REV

### REVERSIBLE CONTROLLED CONVERTERS

Sécheron's REV combines a thyristor rectifier and an IGBT inverter to handle the asymmetrical power flow while maintaining a constant DC voltage.

 Refer to **Brochure REV** • SG847024BEN

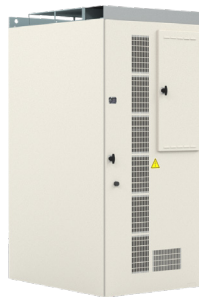


## INV-I

### IGBT INVERTERS

Sécheron's INV-I provides improved power factor and harmonics compared to thyristor-based inverters.

 Refer to **Brochure INV-I** • SG839109BEN



## REC-D

### DIODE RECTIFIERS

Sécheron's REC-D are widely used since they can provide different levels of redundancy to supply DC voltages from 750V to 3000V in a wide power range. Using press pack semiconductors, they are robust and reliable. They can be used in conjunction with inverters and BOOST.

 Refer to **Brochure REC-D** • SG825863BEN



## ON-SITE SUPPORT

### ENGINEERING SERVICES

Sécheron on-site commissioning services ensure that your equipment is erected and put into service quickly and efficiently.

 Refer to **Brochure ENGINEERING SERVICES / On-site support** • SG829380BEN





**Sécheron SA**

Rue du Pré-Bouvier 25  
1242 Satigny - Geneva  
CH-Switzerland

**[www.secheron.com](http://www.secheron.com)**

Tel: +41 22 739 41 11  
Fax: +41 22 739 48 11  
[tps@secheron.com](mailto:tps@secheron.com)

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