

IGBT INVERTERS

EFFICIENT-**INV-I**



EFFICIENT

POWER CONVERSION



Using experience accumulated over more than 50 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 the EFFICIENT products are built specifically to comply with the most stringent requirements of usability, maintainability and durability in traction power application environments, maximizing the return of investment for our customers. These reliable and field-proven building blocks are also the basis for custom applications upon specific requests.

GENERAL INFORMATION

Answering to increasing energy efficiency requirements of rail transportation, the INV-I high power IGBT inverters have been designed to recover the excess braking energy present in the system.

Fully recovering the energy of decelerating vehicles instead of wasting it as heat in braking resistors offers the following advantages:

- Reduction of total energy consumption
- Reduction of heat in tunnels limiting air conditioning
- Reduction or complete removal of braking resistors in the rolling stock

The design of the INV-I inverters is based on the latest IGBT module technology, combining both high efficiency and reliability.

The INV-I inverters are designed in accordance with customer specifications and International, European or American standards.

MAIN BENEFITS

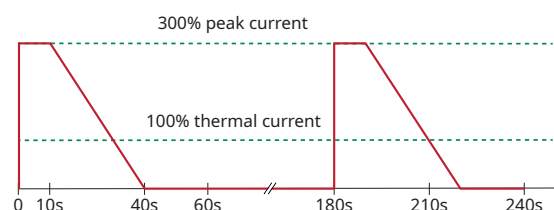
- ✓ Braking energy recovery
- ✓ Modular design to fit any power requirements
- ✓ Withdrawable stacks for easy maintenance
- ✓ Unity power factor optimizes transformer rated power
- ✓ Reduced harmonic content thanks to pulse width modulation
- ✓ Fast DC voltage control, easy to set up even in the most challenging braking scenarios
- ✓ Requires a simple 2-winding transformer
- ✓ May also be connected with an autotransformer to traction transformer
- ✓ Retrofitting installations using controlled or uncontrolled rectifiers possible

MAIN CHARACTERISTICS

		Unit	Values	
Standard inverter range			750 V	1500 V
Rated DC voltage	[V]		750 - 1000	1500 - 1950
Rated power	[MW]		0.5 - 1.5	1 - 3
Maximum power	[MW]		4.5	9
AC frequency	[Hz]		50/60	
Efficiency	[%]		> 97	
Power factor	-		1 (fully controllable)	
THDi	[%]		< 5	
Cooling	-		Forced air	
Maximum ambient temperature	[°C]		40 (without derating)	
Maximum altitude	[m]		< 1000 (without derating)	
IP degree	-		Up to IP32	
Noise level	[dB]		< 75	
Power frequency withstand voltage	[kV]		4.6	9.2

Load cycle

- Up to Class VI
- Customer requirements are analysed to provide the optimal solution
- Special load cycles on demand



Example of a pulse load cycle

STANDARDS

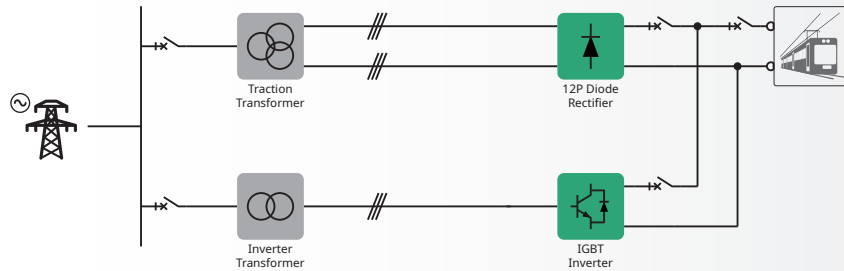
Our inverters are fully compliant and type tested according to the following standards:

- **IEC 62497 (EN 50124)** | Railway applications – Insulation coordination
- **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

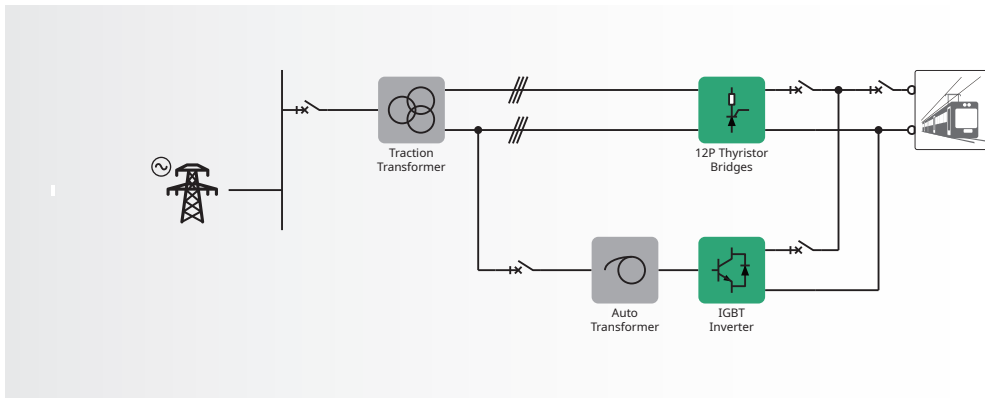
CONNECTIONS

Two connection options

With dedicated transformer

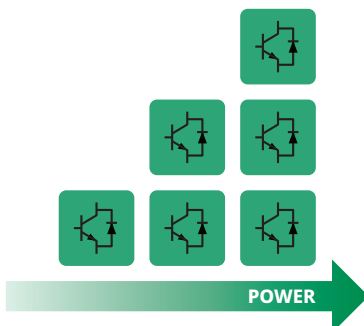


With autotransformer



Modular concept

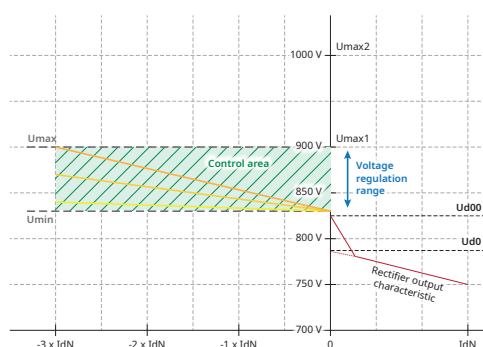
With standardized and tested parallel inverter modules.



IGBT phase leg



CONTROL MODE



Voltage control

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

PWM 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. Inverter activation takes less than 1 ms.

PROTECTIONS

OVERVOLTAGE PROTECTION

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

SHORT-CIRCUIT PROTECTION

INV-I inverters 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.

Enclosure frame leakage (optional)

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

Over-current

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

Solenoid door interlocks (optional)

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

OPTIMIZED INVESTMENT

Sécheron provides engineering support to ensure an optimized investment in fixed installation assets based on customer specifications. Return On Investment can be calculated by Sécheron.

/// Safety & reliability

Based on Sécheron's ample experience, the protective devices present in the inverter 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 inverter includes a SEPCOS system, allowing connection to all types of communication bus and protocols.



TRANSFORMER-INVERTER GROUP

Depending on the substation characteristics, the inverter may be connected to the rectifier transformer with an autotransformer. Autotransformers present the advantage of saving about 70% of copper compared with a transformer, saving material resources and lowering the inverter cost. The withdrawable LV AC-circuit breaker that replaces MV-switchgear also acts as a disconnecter. Alternatively, the inverter is directly connected to the inverter transformer.

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

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



To ensure the compatibility of inverter and transformer, Sécheron is able to provide the complete transformer-inverter group.

RELATED PRODUCTS

REV

REVERSIBLE CONTROLLED CONVERTERS

REV combine 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-T

THYRISTOR INVERTERS

INV-T offer a robust design using presspack semiconductors allowing natural air cooling. They represent a cost-effective solution for energy recovery.

 Refer to **Brochure INV-T** • SG839110BEN

REC-D

DIODE RECTIFIERS

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 presspack semiconductors, they are robust and reliable. They can be used in conjunction with INV-I and INV-T.


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



REC-T

THYRISTOR CONTROLLED RECTIFIERS

REC-T can compensate voltage drops to maintain a constant DC output voltage over the whole load range. When combined with INV-I, they form a reversible DC substation.

 Refer to **Brochure REC-T** • SG841750BEN



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