

# THYRISTOR INVERTERS

EFFICIENT-**INV-T**



# 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 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-T high power thyristor 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
- Reduction or complete removal of braking resistors in the rolling stock

The design of the INV-T inverters is based on optimally sized and field-proven thyristors, offering particularly high performances and reliability. Thyristor press-pack technology also provides high overload capacity, allowing for natural air-cooled and low maintenance solutions.

The inverter design is adapted to find the best compromise between high power factor, low harmonic distortion and required output power.

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

## MAIN BENEFITS

- ✓ Braking energy recovery
- ✓ Compact and robust design with long MTBF using presspack thyristors
- ✓ High overload capability up to class VII
- ✓ Separate HV and LV compartments for easy maintenance
- ✓ Natural air cooling possible even at high power
- ✓ Cost-efficient at high power
- ✓ Safe and reliable

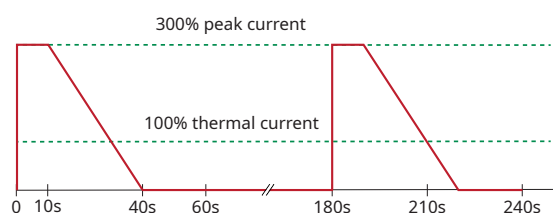
# MAIN CHARACTERISTICS

|                                   | Unit | Values   |               |
|-----------------------------------|------|--|---------------|
|                                   |      | 750 V  | 1 500 V       |
| <b>Standard inverter range</b>    |      |  |               |
| Rated DC voltage                  | [V]  | 750 - 1 000  | 1 500 - 1 950 |
| Rated power                       | [MW] | 0.5 - 2  | 1 - 3         |
| Maximum power                     | [MW] | 9  | 9             |
| Power frequency withstand voltage | [kV] | 4.6  | 9.2           |
| AC frequency                      | [Hz] | 50/60  |               |
| Efficiency                        | [%]  | > 98.5   |               |
| Power factor                      | -    | Up to 0.8 or 1 (with optional filter) <sup>(1)</sup> |               |
| THDi                              | [%]  | < 5 (with optional filter) <sup>(1)</sup>            |               |
| Cooling                           | -    | Natural air  |               |
| Temperature range                 | [°C] | -5 / +40 (without derating)                          |               |
| Maximum altitude                  | [m]  | < 1000 (without derating)                            |               |
| Protection degree                 | -    | Up to IP32   |               |
| Noise level                       | [dB] | < 65   |               |

<sup>(1)</sup>Note: In thyristor converters, the power factor and THDi are determined by the transformer's parameters.

## 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

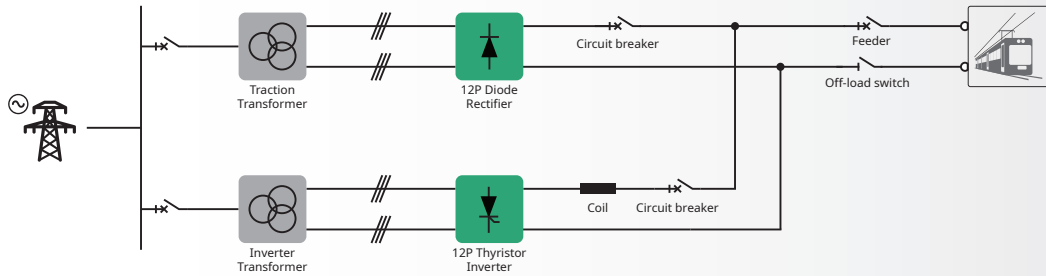
# STANDARDS

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

- **IEC 62497 (EN 50124)** | Railway applications – Insulation coordination
- **IEC 60146-1 (EN 60146-1)** | Semiconductor converters – Part 1: General requirements and line commutated 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

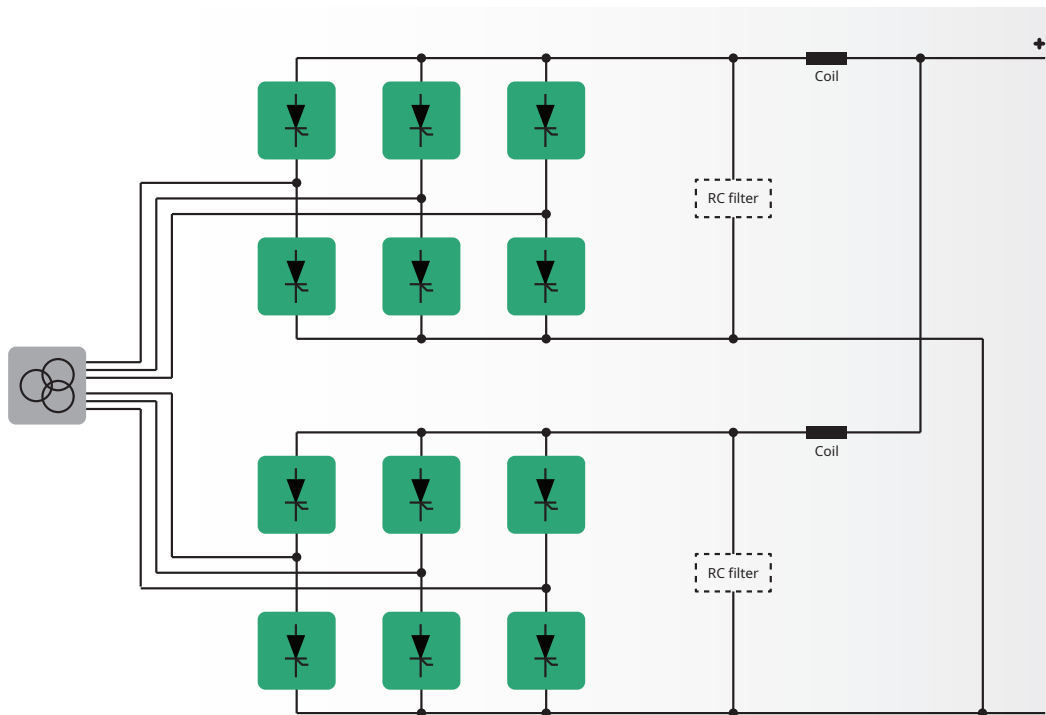
# CONNECTIONS

## // Inverter in parallel with controlled or uncontrolled rectifier

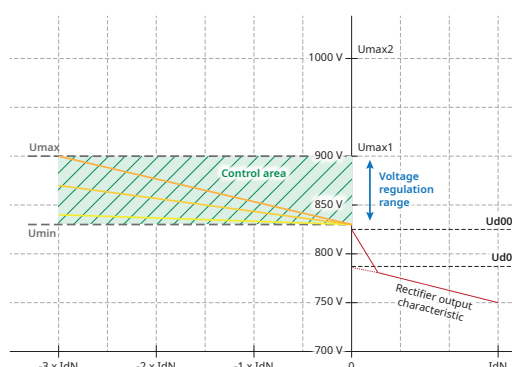


## // 12-pulse - Up to 1 500 VDC

- Connection n°9 according to IEC 60146-1-2



# CONTROL MODE



## Voltage control

The firing angle is regulated at any time to maintain the DC output voltage at a defined level.

# PROTECTIONS

## OVERVOLTAGE PROTECTION

### Internal overvoltage

During turn-off, the load current of the thyristor does not stop flowing immediately but continues briefly in reverse direction as reverse recovery current. This peak reverse recovery current causes a voltage peak which is eliminated by an individual snubber circuit mounted in parallel with each thyristor.

### External overvoltage

External overvoltages are essentially due to lightning strikes on the line and interrupted short-circuits. While RC filters are capable of absorbing a significant surge, snubbers share the voltage between thyristors and protect them individually.

## SHORT-CIRCUIT PROTECTION

INV-T inverters are designed to withstand internal and external short circuits without damaging the AC or the DC side thanks to circuit breakers.

## OTHER PROTECTIONS

### Over-temperature

Over-temperature detection devices are provided with the equipment to avoid failures due to an abnormal increase of temperature.

### 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.

### Surge protection device (optional)

The inverter is optionally equipped with surge arresters.

### Auxiliary supply failure

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

### Over-current

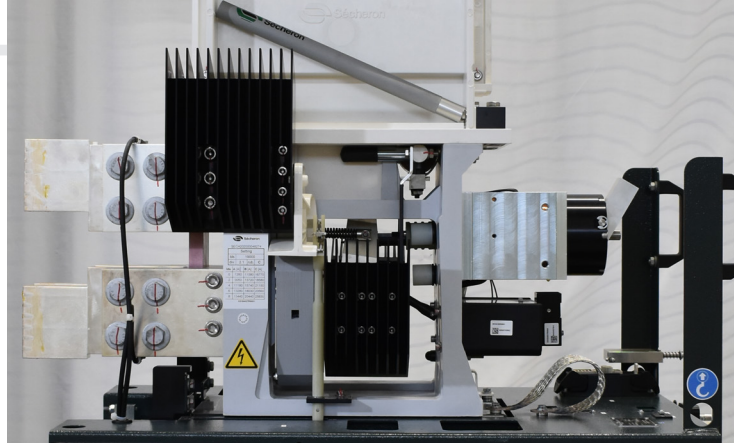
Inverter over-current causes tripping of the AC circuit breaker and of the inverter DC HSCB.

# 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 upon request.

## /// 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 and other protective devices are configured to ensure safety and to preserve the acquired assets.



## /// Remote control monitoring & diagnostics

The inverter includes a SEPCOS system, allowing connection to all types of communication bus and protocols.

## /// Reduced maintenance

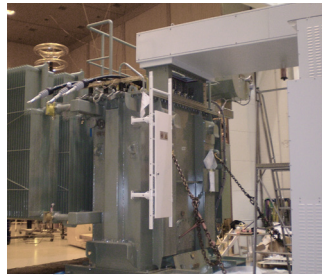
The high thermal inertia means that forced air cooling is not required thanks to thyristor presspack technology, reducing maintenance requirements.



# TRANSFORMER-INVERTER GROUP

Based on a strong 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 transformer-inverter group



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

## RELATED PRODUCTS

### REV & INV-I

#### REVERSIBLE CONTROLLED CONVERTERS & IGBT INVERTERS

Sécheron's INV-I provides improved power factor and harmonics. It can be combined with the REC-T, obtaining a fully controlled, reversible substation.



Refer to **Brochure REV** · SG847024BEN  
Refer to **Brochure INV-I** · SG839109BEN



### REC-D & REC-T

#### DIODE & THYRISTOR RECTIFIERS

Sécheron's INV-T is designed for optimal coordination with REC-D and REC-T, ensuring compatibility for protection and operation.



Refer to **Brochure REC-D** · SG825863BEN  
Refer to **Brochure REC-T** · SG841750BEN



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