Rectifiers
DC High Speed Circuit Breakers
Contactors
Resistors
Protection Relays
Transducers
Fans
Energy
Microelettrica Scientifica’s extensive product ranges have become the standard of reference for a growing number of customers worldwide in the challenging Energy Market. Microelettrica Scientifica’s been evolving through innovation to support new technology in generation, renewable energy and smart grid.

Applications
- Photovoltaic interface relay
- Feeder and bus relay
- Generator relay
- Resistor for harmonic filters
- Neutral grounding resistors
- Load banks
- DC contactors for inverters and UPSs
- Photovoltaic string contactors
- Ground fault neutralizer system

Products
- Contactors
- Disconnectors
- DC High Speed Circuit Breakers
- Power Resistor
- Protection Relays
- Transducers
- Fans
- Rectifiers

Industry
During almost 30 years of operation, a close relationship with the Customers has been created. Microelettrica products are present in most of the industries such as Steel making, Cement, Glass, Chemical, Oil&Gas and Utilities.

Applications
- Motor and generator protection
- Feeder and bus bar relay
- Generator relay
- Resistor for harmonic filters
- Neutral grounding resistors
- Load banks
- DC contactors for inverters and UPSs
- Photovoltaic string contactors
- Ground fault neutralizer system
Components for Infrastructures

Today, Microelettrica Scientifica is a leading supplier of equipment for dc traction substations. We offer to our Customers a complete portfolio of DC Traction System components.

**Products**
- DC Switchgears and Switching Cubicles
- DC High Speed Circuit Breakers
- Feeder manager and DC Relays for Traction
- DC Transducers
- Contactors and Disconnectors
- Power Resistor for Line Testing
- Braking Resistors for Fixed Installation
- Fans
- Rectifiers

**Applications**
- DC Power Substations
- Traction lines
- DC Switchgears
- Depot
- Underground ventilation

**Made in Microelettrica Scientifica**
Always aiming for the best results, Microelettrica Scientifica develops and manufactures the entire range of products in Buccinasco close to Milan. We also run operations in U.S.A., South Africa, China, India, France, Brasil and Turkey through which our Customers have access to immediate local assistance and the possibility of localization of Microelettrica Scientifica products. Our Customers know they can always count on quality, excellence and accuracy of Microelettrica Scientifica Products and Services.
A tailored solution for every substation component need
substation component need

Bar DIN Contactor

Hall effect transducer

V-I Transducer

Braking Resistor

Transformer

Components for Infrastructure
A tailored solution for every industry component need
industry component need

DC Hall Effect Transducer
Breaker
G Base
Disconnector
Interface Protection
AC Low Frequency Contactor
Inverter DC Contactor

Components for Infrastructure
Traction Rectifier

Functions
Traction Rectifiers are used to convert AC power to DC power for railway traction applications using silicon diodes and aluminium heatsinks.

General characteristics
Traction Rectifiers could be convection cooled or forced-air cooled (using blowers), and are usually installed:
- In modular, metalclad enclosures
- As a self-contained, open-frame unit in a secured (inter-locked) area

Semiconductor Solutions, an ISO 9001:2008 company based in South Africa, designs and manufactures customised rectifiers in accordance with SANS60146 (IEC146), EN50328 standards and customer requirements, where constructive and technological principles are applied in a project specific mechanical layout.

Due to high demand for maintainability from our customer, our designs apply specific focus on these elements, for example:
- Easy maintenance, with direct accessibility to the diode modules due to open-frame construction
- Easy component replacement due to modular design and removal of individual power modules in less than 5 minutes

References
(Only approved supplier in South Africa on all 3.3 kV DC rail systems)

| Transnet Freight Rail/PRASA | Rectifier, Diode (4.5MW, Forced-air cooled) – [x120] |
| Transnet Freight Rail/PRASA | Rectifier, Diode (5MW, Forced-air cooled) – [x159] |
| Transnet Freight Rail/PRASA | Rectifier, Diode (6MW, Forced-air cooled) – [x10] |
| Transnet Freight Rail/PRASA | Rectifier, Diode (10MW, Forced-air cooled) – [x10] |

Main Characteristics
| Construction            | Open-frame / Metal-clad enclosure |
| Cooling type            | Natural convection / forced-air cooled |
## Technical Characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power [MW]</td>
<td>1 - 10</td>
</tr>
<tr>
<td>Rated DC output voltage [Vdc]</td>
<td>750, 1500, 3000</td>
</tr>
<tr>
<td>Rated AC input voltage [Vac]</td>
<td>555 - 2400</td>
</tr>
<tr>
<td>Rated frequency [Hz]</td>
<td>50 / 60</td>
</tr>
<tr>
<td>Duty class</td>
<td>To customer specification</td>
</tr>
<tr>
<td>Rectifier Connections</td>
<td>Series &amp; parallel bridges</td>
</tr>
<tr>
<td>No. of pulses</td>
<td>6 &amp; 12-pulse</td>
</tr>
<tr>
<td>Semiconductor type</td>
<td>Capsule diode (hockey-puck)</td>
</tr>
<tr>
<td>Redundancy</td>
<td>N-1 (Customer to specify)</td>
</tr>
<tr>
<td>Protection degree</td>
<td>IPxx (Customer to specify)</td>
</tr>
<tr>
<td>Ambient temperature [°C]</td>
<td>-5 / +50</td>
</tr>
<tr>
<td>Over-temperature protection</td>
<td>Included (Fibre-optically connected)</td>
</tr>
<tr>
<td>Diode fuse protection</td>
<td>Optional</td>
</tr>
<tr>
<td>Failed diode monitoring</td>
<td>Optional (Fibre-optically connected)</td>
</tr>
<tr>
<td>DC surge protection</td>
<td>Optional (Fuse protected)</td>
</tr>
<tr>
<td>Metering</td>
<td>Optional (Voltmeter &amp; Ammeter)</td>
</tr>
</tbody>
</table>

## Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode monitoring</td>
<td>Failed diode LED identification &amp; signal output via potential-free contact</td>
</tr>
<tr>
<td>Fan control</td>
<td>Fan controller card can be used to stop/start the fan/s via thermo-switches</td>
</tr>
<tr>
<td>Fan protection</td>
<td>Vane switch on each fan signals fan failure/stoppage</td>
</tr>
<tr>
<td>Maintenance &amp; repair</td>
<td>Quick &amp; easy diode module change-out</td>
</tr>
<tr>
<td>Connection</td>
<td>Many different rectifier connections/configurations possible</td>
</tr>
</tbody>
</table>
Industrial Rectifier

Functions
Industrial Rectifiers are used to convert AC power to DC power for many different applications and utilise silicon diodes for uncontrolled applications and thyristors for controlled.

General characteristics
Industrial Rectifiers could be convection cooled, forced-air cooled (using blowers), or water-cooled in conjunction with a cooling tower and are usually installed
- In modular, metalclad enclosures to customer specified protection rating (IPxx)
- As a self-contained, open-frame unit in a secured (inter-locked) area

Typical Applications:
Applications involved with to date include but are not limited to:
- electro-winning
- arc-furnace control
- haulage truck assist
- winder/elevator armature & field converters
- electro-plating
- soft starters
- heater control etc.

Semiconductor Solutions, an ISO 9001:2008 company based in South Africa, have built up extensive experience in the design and manufacture of customised rectifiers, in accordance with SANS60146 (IEC146) standards and customer requirements, for industry (e.g. mining operations & plating plants) in the last two decades.

References
(Extensive experience and know-how in forced-air and water-cooled, controlled, high current rating per mechanical volume systems)

<table>
<thead>
<tr>
<th>Industrial Rectifier</th>
<th>Thyristor (100V, 40kA, Water-cooled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haul-truck propulsion</td>
<td>Rectifier, Diode (2.5MW, 2.6kV, Forced-air cooled)</td>
</tr>
<tr>
<td>DC Arc-furnace supply</td>
<td>Rectifier, Thyristor (900V, 76kA, Water-cooled)</td>
</tr>
<tr>
<td>Hoist system DC drive</td>
<td>Rectifier, Thyristor (690V, 2kA, Forced-air cooled)</td>
</tr>
<tr>
<td>Electro-plating plants</td>
<td>Rectifier, Thyristor (760V, 40kA, Water-cooled)</td>
</tr>
</tbody>
</table>

Main Characteristics

<table>
<thead>
<tr>
<th>Construction</th>
<th>Open-frame / Metal-clad enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling type</td>
<td>Natural convection, forced-air &amp; water-cooled</td>
</tr>
</tbody>
</table>
### Technical Characteristics

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current [kA]</td>
<td>Up to 75</td>
</tr>
<tr>
<td>Rated DC output voltage [Vdc]</td>
<td>0 - 3000</td>
</tr>
<tr>
<td>Rated AC input voltage [Vac]</td>
<td>0 - 2400</td>
</tr>
<tr>
<td>Rated frequency [Hz]</td>
<td>50 / 60</td>
</tr>
<tr>
<td>Heatsink</td>
<td>Aluminium (air-cooled) / copper (water-cooled)</td>
</tr>
<tr>
<td>Duty class</td>
<td>To customer specification</td>
</tr>
<tr>
<td>Rectifier Connections</td>
<td>Series &amp; parallel bridges, hexa-phase</td>
</tr>
<tr>
<td>No. of pulses</td>
<td>6 &amp; 12-pulse</td>
</tr>
<tr>
<td>Semiconductor type</td>
<td>Capsule diode or thyristor (hockey-puck)</td>
</tr>
<tr>
<td>Redundancy</td>
<td>N-1 (Customer to specify)</td>
</tr>
<tr>
<td>Protection degree</td>
<td>IPxx (Customer to specify)</td>
</tr>
<tr>
<td>Ambient temperature [°C]</td>
<td>-5 / +50</td>
</tr>
<tr>
<td>RC snubber</td>
<td>Normally included</td>
</tr>
<tr>
<td>Over-temperature protection</td>
<td>Included (Fibre-optically connected)</td>
</tr>
<tr>
<td>Diode fuse protection</td>
<td>Optional</td>
</tr>
<tr>
<td>Failed diode monitoring</td>
<td>Optional (Fibre-optically connected)</td>
</tr>
<tr>
<td>DC surge protection</td>
<td>Optional (Fuse protected)</td>
</tr>
<tr>
<td>Metering</td>
<td>Optional (Volmeter &amp; Ammeter)</td>
</tr>
</tbody>
</table>

### Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode monitoring (optional)</td>
<td>Failed diode LED identification &amp; signal output via potential-free contact</td>
</tr>
<tr>
<td>Maintenance &amp; repair</td>
<td>Quick &amp; easy diode module change-out</td>
</tr>
<tr>
<td>Connection</td>
<td>Many different rectifier connections/configurations possible</td>
</tr>
</tbody>
</table>
The IR3000F series are single pole, magnetic blow out, trip free, air circuit breakers. The closing mechanism is an independent motor operated type. The IR3000 Circuit Breaker is held closed by holding coil or by permanent magnet device and is equipped with a direct acting over-current trip device which may be either unidirectional and bidirectional. The arc chute is made in ceramic material for a longer life and reduced maintenance. The use of arcing contacts ensure a long duration in electrical life. The breaker conforms to IEC61992; IEEE C37-14; IEEE C37-16. Different solutions of arc chutes help the cubicle designers for the optimization of the space.
<table>
<thead>
<tr>
<th>Type</th>
<th>Umax [V]</th>
<th>I [A]</th>
<th>W [mm]</th>
<th>H [mm]</th>
<th>L [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR3000F 900</td>
<td>900</td>
<td>3000</td>
<td>220</td>
<td>395</td>
<td>530</td>
</tr>
<tr>
<td>IR3000F 1800</td>
<td>1800</td>
<td>3000</td>
<td>220</td>
<td>478</td>
<td>530</td>
</tr>
<tr>
<td>IR3000F Vertical</td>
<td>up to 1800</td>
<td>3000</td>
<td>220</td>
<td>720</td>
<td>530</td>
</tr>
</tbody>
</table>
IR4000 line

The IR4000 Line is single pole air High Speed Circuit Breakers for DC applications with rated voltages of 900, 1800 or 3600 Vdc and thermal currents up to 4,5kA. Based on ceramic fins technology, IR4000 are designed to protect the downstream power circuits from overcurrent and short circuit.

The IR4000 Circuit Breaker is an independent motor operated type and held close by holding coil or permanent magnet. It is the latest generation of the well-known IR6000 line because it integrates all improvements resulting from a long experience in many worldwide rail and industry applications. It replaces easily the first generation IR6000 for both electrical and mechanical aspects. A compact and robust platform allows to withstand very harsh conditions in order to face all working requirement for onboard applications (IR4000V) as well as fixed installations (IR4000F).

The IR4000 Line is the right solution if high or very high power load protection is required. In order to fit limited space available on vehicles the IR4000 can be mounted:

- Inside the cubicle in vertical mounting position : IR4000VV
- Under the frame as well as on the roof in horizontal mounting position: IR4000VH

Standard Characteristics

- Thermal current rating 3000 or 4500A.
- Rated voltages of 900, 1800 or 3600 Vdc
- Single pole, magnetic blow out, trip free, air circuit breakers
- The closing motor is an independent motor operated type.
- Held closed by holding coil or permanent magnet device.
- Bidirectional direct acting over-current trip device.
- Ceramic arc chute guarantees a longer life and reduced maintenance.
- Arcing contacts ensure a long duration in electrical life.
- Reed type auxiliary contacts

Customization Available

- Monodirectional direct acting over-current trip device.
- Dual voltage arc chute
- IP65 Metal enclosure for roof or under frame application
- Fast opening device for fixed application
## Components for Infrastructures

<table>
<thead>
<tr>
<th>Fixed Application</th>
<th>IR4000 F Line</th>
<th>Holding System</th>
<th>Ith (A) @ 40°C</th>
<th>Ue (Vdc) = 900Vdc</th>
<th>Ue (Vdc) = 1800Vdc</th>
<th>Ue (Vdc) = 3600Vdc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IR4030FC09M</td>
<td>Holding Coil</td>
<td>3000</td>
<td>125 / 100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4030FP09M</td>
<td>Permanent Magnet</td>
<td>3000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4045FC09M</td>
<td>Holding Coil</td>
<td>4500</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4045FP09M</td>
<td>Permanent Magnet</td>
<td>3000</td>
<td>-</td>
<td>90 / 63</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4030FC18M</td>
<td>Holding Coil</td>
<td>3000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4030FP18M</td>
<td>Permanent Magnet</td>
<td>3000</td>
<td>-</td>
<td>90 / 63</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4045FC18M</td>
<td>Holding Coil</td>
<td>4500</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4045FP18M</td>
<td>Permanent Magnet</td>
<td>4500</td>
<td>-</td>
<td>-</td>
<td>70 / 63</td>
</tr>
<tr>
<td></td>
<td>IR4030FC36M</td>
<td>Holding Coil</td>
<td>3000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4030FP36M</td>
<td>Permanent Magnet</td>
<td>3000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4045FC36M</td>
<td>Holding Coil</td>
<td>4500</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IR4045FP36M</td>
<td>Permanent Magnet</td>
<td>4500</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Max Breaking current (kA/ms) according to IEC61992**
The IR6000 series are single pole, magnetic blow out, trip free, air circuit breakers. The closing mechanism is an independent motor operated type. The IR6000 Circuit Breaker is held closed by holding coil or by permanent magnet device and is equipped with a direct acting over-current trip device which may be either unidirectional and bidirectional. The arc chute is made in ceramic material for a longer life and reduced maintenance. The use of arching contacts ensure a long duration in electrical life. The breakers can be used in single voltage or dual voltage applications, where multisystem solution is required (ex 1800/3600V).
The breaker conforms to IEC61992; IEEE C37-14; IEEE C37-16
A special version of the IR6000F is with mechanical latching. This ensures an high withstand capability to the short circuit currents up to 150kA

<table>
<thead>
<tr>
<th>Type</th>
<th>Umax [V]</th>
<th>I [A]</th>
<th>W [mm]</th>
<th>H [mm]</th>
<th>L [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR6000F Mechanical</td>
<td>up to 1200 (IEEE)</td>
<td>8000</td>
<td>340</td>
<td>1030</td>
<td>650</td>
</tr>
<tr>
<td>IR6080F</td>
<td>up to 3600</td>
<td>8000</td>
<td>340</td>
<td>1030</td>
<td>650</td>
</tr>
<tr>
<td>IR6040F</td>
<td>up to 3600</td>
<td>4000</td>
<td>300</td>
<td>1030</td>
<td>650</td>
</tr>
</tbody>
</table>
LTX line

LTX line contactors are the right solutions where high voltage rating, high thermal current and high breaking capacity (up to 4 kV) are required. The creepage and clearance distances are widely dimensioned for safe application in polluted environments and the narrow outline is especially conceived for applications where space is a critical issue. The innovative design of LTX line combines the traditional technology of the arc chute (ceramic fins) with a new blow out system. Ceramic arc chute enables to withstand the highest current ratings and the new blowout system guarantees a high reliability with critical currents. Contacts open with double speed and the new mechanism guarantees also a higher distance between them. An electronic control of the main coil allows to combine a high closing power with a reduced power consumption during the holding phase. The main electric connections can be placed in several positions to cover all the possible market applications. A contactor status indicator is available and an IP67 Auxiliary contact are provided as a standard. The LTX is available in 1, 2 or 3 poles configuration and poles can be easily coupled side by side thanks to a modular approach.

The LTX Line is protected by International PATENT

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General Characteristics

- LTX is the latest generation of the well-known MS contactors. It integrates all improvements resulting from a long experience in many worldwide rail and industry applications.
- The same sturdy working principle is adapted to different applications in order to fulfil all requested field-related standards.
- Ratings up to 400 Vdc/ac and up to 1600 A/pole application
- Multi-pole combination
- Very high level of customization available

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Auxiliary contact blocks type PBX

- Normally mounted on LTX Line
- 1 NO + 1 NC block version
- IP67 protection degree
- Double interrupting, self-cleaning, solid silver, snap action contacts
<table>
<thead>
<tr>
<th>Type</th>
<th>Umax [Vdc]</th>
<th>Ith [A]</th>
<th>W [mm]</th>
<th>H [mm]</th>
<th>D [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTX040 1P</td>
<td>900 - 1800 - 3600</td>
<td>450</td>
<td>113</td>
<td>345 - 360 - 440</td>
<td>295 - 320 - 360</td>
</tr>
<tr>
<td>LTX060 1P</td>
<td>900 - 1800 - 3600</td>
<td>600</td>
<td>113</td>
<td>345 - 360 - 440</td>
<td>295 - 320 - 360</td>
</tr>
<tr>
<td>LTX090 1P</td>
<td>900 - 1800 - 3600</td>
<td>900</td>
<td>113</td>
<td>345 - 360 - 440</td>
<td>295 - 320 - 360</td>
</tr>
<tr>
<td>LTX120 1P</td>
<td>900 - 1800 - 3600</td>
<td>1200</td>
<td>143</td>
<td>345 - 360 - 440</td>
<td>295 - 320 - 360</td>
</tr>
<tr>
<td>LTX150 1P</td>
<td>900 - 1800 - 3600</td>
<td>1500</td>
<td>143</td>
<td>345 - 360 - 440</td>
<td>295 - 320 - 360</td>
</tr>
<tr>
<td>LTX180 1P</td>
<td>900 - 1800 - 3600</td>
<td>1800</td>
<td>143</td>
<td>345 - 360 - 440</td>
<td>295 - 320 - 360</td>
</tr>
</tbody>
</table>

NOTE: Main terminals are fully customizable. These dimensions are considered without terminals.
LTHS line

Microeletrtrica Scientifica contactors for industrial applications are designed to be used on electrical equipment in presence of the most severe conditions, such as shocks and vibrations, which occur on on-board traction vehicles.

The LTHS Line displays a traditional design which enables them to withstand the highest current ratings in harsh working conditions.

To accomplish most of the possible applications, all the LTHS contactors can be manufactured in single or multipolar form and, upon request, allow a very high degree of customization. Versions with normally open or normally closed poles are manufactured, and mechanical latching can be supplied. In order to work efficiently both with high and low currents, the contactors are equipped with indirect blow out circuit. This arc-extinguishing technology allows to work indifferently in AC as well as DC.

The DC control coil operates without economy resistor within a wide working range. A “varistor” cuts off the peak voltage when the coil is de-energized.

More than 20000 LTHS contactors are delivered every year for the most demanding projects and applications worldwide.

General Characteristics

- The most experienced extra heavy duty line
- Designed for on-board applications according to IEC 61992-60947
- Ratings up to 2000 VDC/AC and up to 1600 A/pole application
- Direct or indirect arc blow-out systems available according specific application requirements
- Multi-pole combination up to 4 NO or NC poles
- Very high level of customization available
<table>
<thead>
<tr>
<th>Type</th>
<th>Umax [V AC/DC]</th>
<th>Ith [A]</th>
<th>W [mm]</th>
<th>H [mm]</th>
<th>D1/D2 [mm] (1/2 poles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTHS 60</td>
<td>1000</td>
<td>80</td>
<td>143</td>
<td>197</td>
<td>72/93</td>
</tr>
<tr>
<td>LTHS 125</td>
<td>1000</td>
<td>150</td>
<td>185</td>
<td>276</td>
<td>86/114</td>
</tr>
<tr>
<td>LTHS 320</td>
<td>2000</td>
<td>350</td>
<td>220.5</td>
<td>300.5</td>
<td>86/114</td>
</tr>
<tr>
<td>LTHS 380</td>
<td>2000</td>
<td>380</td>
<td>220.5</td>
<td>300.5</td>
<td>86/114</td>
</tr>
<tr>
<td>LTHS 400</td>
<td>2000</td>
<td>500</td>
<td>329</td>
<td>423</td>
<td>115.5/202</td>
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<tr>
<td>LTHS 650/800</td>
<td>2000</td>
<td>700/920</td>
<td>335</td>
<td>438(D1)/441(D2)</td>
<td>119/206.5</td>
</tr>
<tr>
<td>LTHS 1250</td>
<td>2000</td>
<td>1300</td>
<td>350</td>
<td>473(D1)/476(D2)</td>
<td>127.2/206.5</td>
</tr>
<tr>
<td>LTHS 1500</td>
<td>2000</td>
<td>1350</td>
<td>350</td>
<td>533.5(D1)/536.5(D2)</td>
<td>111/215</td>
</tr>
<tr>
<td>LTHS 1700</td>
<td>2000</td>
<td>1600</td>
<td>350</td>
<td>533.5(D1)/536.5(D2)</td>
<td>127/235</td>
</tr>
</tbody>
</table>
LTC line

The LTC Series contactors, thanks to their excellent balance between dimensions, performances and robustness, are suitable for all those on-board applications which demand a small, smart device. Their design encourages applications where high operating frequencies and small available spaces are important requirements.

Like all Microelettrica Scientifica contactors, the LTC Series is based on a standard concept, but a very high level of customization can be achieved by replacing a few key components. Normally open and normally closed poles can be fitted, as well as mechanical latching. The breaking circuit is equipped with permanent magnets or indirect arc blow out coil to work efficiently both with high and low currents.

The DC control coil operates without economy resistor within a wide working range. A “varistor” cuts off the peak voltage when the coil is de-energized.

More than 20000 LTC contactors are delivered every year for the most demanding projects and applications worldwide.

General Characteristics

- The most compact and modern heavy duty line
- Designed for on-board applications according to IEC 61992-60947
- Ratings up to 4000 VDC/AC and up to 1000 A/pole application
- Permanent magnet or indirect arc blowout systems available according specific application requirements
- Multi-pole combination up to 4 NO or NC poles
- Very high level of customization available
## Switches

<table>
<thead>
<tr>
<th>Type</th>
<th>Umax [V_{acdc}]</th>
<th>Ith [A]</th>
<th>W [mm]</th>
<th>H [mm]</th>
<th>D [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC 100</td>
<td>1000</td>
<td>100</td>
<td>106</td>
<td>127.5</td>
<td>63</td>
</tr>
<tr>
<td>LTC 100 2 poles</td>
<td>1000</td>
<td>100/200</td>
<td>120</td>
<td>127</td>
<td>93</td>
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<tr>
<td>LTC 100 NC</td>
<td>1000</td>
<td>100</td>
<td>106</td>
<td>155</td>
<td>60</td>
</tr>
<tr>
<td>LTCS 250/300</td>
<td>2000</td>
<td>250</td>
<td>140</td>
<td>156.5</td>
<td>86</td>
</tr>
<tr>
<td>LTCS 250/300 2 poles</td>
<td>2000</td>
<td>250/500</td>
<td>140</td>
<td>156.5</td>
<td>109.2</td>
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<tr>
<td>LTCS 250/300 3 poles</td>
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</tr>
<tr>
<td>LTCH 60</td>
<td>4000</td>
<td>60</td>
<td>168</td>
<td>221</td>
<td>88</td>
</tr>
<tr>
<td>LTCH 60 2 poles</td>
<td>4000</td>
<td>60/120</td>
<td>168</td>
<td>221</td>
<td>125</td>
</tr>
<tr>
<td>LTCH 1000</td>
<td>2000</td>
<td>1000</td>
<td>385</td>
<td>300</td>
<td>93</td>
</tr>
</tbody>
</table>
The Microeletrica Scientifica LTHH/LTE/LTP Lines for electric traction are supplied to railways and underground systems throughout the world. Where high voltage ratings are required, the LTHH Series contactors are the right solution. The creepage and clearance distances are widely dimensioned for safe application in polluted environments. Their narrow outline is especially conceived for applications where space is a critical issue - as more and more often happens on railway vehicles.

To meet all possible applications, they are available both with electric (LTHH/LTE) and pneumatic (LTP) control, and poles can be manufactured in normally open or normally closed configurations.

The direct or indirect blow out circuit makes the LTHH contactors suitable to work both with high and low currents.

The DC control coil operates without economy resistor within a wide working range. More than 10000 LTHH contactors are delivered every year for the most demanding projects and applications worldwide.

**General Characteristics**

- The highest voltage single pole heavy duty line
- Designed for on-board applications according to IEC 61992-60947
- Ratings up to 4000 VDC/AC and up to 1350 A/pole application
- Direct or indirect arc blow-out systems available according specific application requirements
- Multi-pole assemblies, NO or NC poles
- Very high level of customization available
<table>
<thead>
<tr>
<th>Type</th>
<th>Umax [V~]</th>
<th>Ith [A]</th>
<th>W [mm]</th>
<th>H [mm]</th>
<th>D1/D2 [mm]</th>
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</thead>
<tbody>
<tr>
<td>LTHH 40</td>
<td>2000</td>
<td>60</td>
<td>200(D1)/244(D2)</td>
<td>162.5(D1)/174.5(D2)</td>
<td>48/106</td>
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<tr>
<td>LTHH 100</td>
<td>4000</td>
<td>120</td>
<td>377(D1)/410(D2)</td>
<td>274(D1)/279(D2)</td>
<td>60/130</td>
</tr>
<tr>
<td>LTHH 250</td>
<td>4000</td>
<td>300</td>
<td>380.5(D1)/424(D2)</td>
<td>297(D1)/302(P2)</td>
<td>70/160</td>
</tr>
<tr>
<td>LTHH 400</td>
<td>4000</td>
<td>400</td>
<td>380.5(D1)/424(D2)</td>
<td>297(D1)/302(P2)</td>
<td>70/160</td>
</tr>
<tr>
<td>LTE 2-400</td>
<td>2000</td>
<td>900</td>
<td>428</td>
<td>367</td>
<td>80/-</td>
</tr>
<tr>
<td>LTE 2-600</td>
<td>2000</td>
<td>900</td>
<td>430</td>
<td>370(D1)/365(D2)</td>
<td>80/220</td>
</tr>
<tr>
<td>LTP 2-400</td>
<td>2000</td>
<td>900</td>
<td>402</td>
<td>367</td>
<td>80/-</td>
</tr>
<tr>
<td>LTP 2-600</td>
<td>2000</td>
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<td>402</td>
<td>370</td>
<td>80/-</td>
</tr>
<tr>
<td>LTE 4-400</td>
<td>4000</td>
<td>900</td>
<td>429.4(D1)/379.3(D2)</td>
<td>394</td>
<td>85/175</td>
</tr>
<tr>
<td>LTE 4-600</td>
<td>4000</td>
<td>900</td>
<td>429.4</td>
<td>423</td>
<td>85/-</td>
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<tr>
<td>LTP 4-400</td>
<td>4000</td>
<td>900</td>
<td>402</td>
<td>394</td>
<td>85/-</td>
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<tr>
<td>LTP 4-600</td>
<td>4000</td>
<td>900</td>
<td>402</td>
<td>423</td>
<td>85/-</td>
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<td>4000</td>
<td>1350</td>
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<td>LTP 4-2000</td>
<td>4000</td>
<td>1350</td>
<td>501</td>
<td>473</td>
<td>151.5/-</td>
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</tbody>
</table>
Microeletrtica Scientifica LTNS series have been developed to answer to the constantly increasing market need of reduced dimensions and weight, taking most of the huge know-how in designing and manufacturing of industrial bar mounted contactors. These contactors have been designed starting from the N series electric arc management concept, grafted on the light and compact structure of a rail unit, developed around the control electromagnet.

The LTNS contactors, characterised by a nominal voltage of 750V, are available in a wide range of current ratings, from 80A up to 1300A (up to 3 poles). They can be configured in any combination of Normally Open or Normally Closed poles, with a common rating. They have been designed and tested according to the international standard IEC 60947-4-1 and are suitable for almost any industrial low voltage application, such as: cranes, rolling mills, electric energy production and transformation, photovoltaic panels, induction furnaces, galvanic treatments.

**General Characteristics**
- The extra heavy duty flexible line, up to 1000V<ac:application, up to 1500A/pole
- Stationary application only, derived from LTHS line
- 1-2-3 pole configuration, NO and NC poles indirect or direct arc blow out options available
- Flexible control and auxiliary contacts options, high unit customization possible
## Switches

<table>
<thead>
<tr>
<th>Type</th>
<th>Ith [A]</th>
<th>Rated Nominal Voltage Ue [V]</th>
<th>Rated Insulation Voltage Ui [V]</th>
<th>D1/D3 [mm] Length (1-3 poles)</th>
<th>W [mm]</th>
<th>H [mm]</th>
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</thead>
<tbody>
<tr>
<td>LTNS 60</td>
<td>80</td>
<td>600</td>
<td>750</td>
<td>72-130</td>
<td>193</td>
<td>138</td>
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<tr>
<td>LTNS 125</td>
<td>150</td>
<td>750</td>
<td>1000</td>
<td>86-169</td>
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<td>LTNS 320</td>
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<td>750</td>
<td>1000</td>
<td>105-277</td>
<td>350</td>
<td>260</td>
</tr>
<tr>
<td>LTNS 450</td>
<td>450</td>
<td>750</td>
<td>1000</td>
<td>105-277</td>
<td>360</td>
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<tr>
<td>LTNS 650</td>
<td>700</td>
<td>750</td>
<td>1000</td>
<td>105-277</td>
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<td>LTNS 800</td>
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<td>LTNS 1250</td>
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<td>750</td>
<td>1000</td>
<td>125-340</td>
<td>459</td>
<td>350</td>
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</tbody>
</table>
Microelettrica Scientifica N series bar mounted contactors, in spite of their 60 years old technical concept are still state of the art for many industrial, low voltage, heavy duty applications. These contactors are designed and tested according to the standard IEC 60947-4-1. They provide excellent operational performances, making them the best choice for high power load connection, often covering the function of a fault clearing protection device.

The N series contactors are characterised by modular design so that their configuration can be tailored to the specific requirements of each application. In fact, the pole ratings cover a wide range, from 85A up to 6000A, and can be mounted side by side regardless of their size and number on a customisable length shafts set, this way offering custom solutions to a wide range of technical needs.

The maintenance is simplified by direct accessibility to all parts due to open construction so that, in most cases, it is not necessary to remove the contactor from the cabinet. Microelettrica Scientifica has been certified since 1993 according to the International Quality Standard UNI EN ISO 9001:2008. Microelettrica has always paid great attention to the environment and is certified according to the standard UNI EN ISO 14001:2004 and all materials used are RoHS compliant.

### Applications
- Transit and railway systems
- Power generation
- Control high power motors
- Heavy industries
- Crane control

### Type | Thermal Current Ith [A] | Rated Nominal Voltage Ue [V] | Rated Insulation Voltage Ui [V] | D1/D4 [mm] Length (1-4 poles) | H [mm] | W [mm]
--- | --- | --- | --- | --- | --- | ---
N 85 | 85 | 600 | 1000 | 250-400 | 165 | 155
N 125 | 125 | 600 | 1000 | 250-400 | 175 | 155
N 190 | 190 | 600 | 1000 | 250-400 | 205 | 170
N 270 | 270 | 600 | 1000 | 250-500 | 265 | 215
N 350 | 350 | 600 | 1000 | 250-500 | 275 | 215
N 550 | 550 | 600 | 1000 | 105-277 | 300 | 160
N 650 | 650 | 600 | 1000 | 300-600 | 320 | 160
N 800 | 800 | 600 | 1000 | 350-650 | 365 | 300
N 1000 | 1000 | 600 | 1000 | 350-650 | 365 | 300
N 1250 | 1250 | 600 | 1000 | 350-700 | 380 | 345
N 1600 | 1600 | 600 | 1000 | 350-800 | 420 | 420
N 2000 | 2000 | 600 | 1000 | 350-800 | 425 | 420
N 3000 | 3000 | 600 | 1000 | 400-1000 | 475 | 470
N 4000 | 4000 | 600 | 1000 | 500-1250 | 425 | 420
N 6000 | 6000 | 600 | 1000 | 600-1500 | 475 | 470
The bar mounted modular extra heavy duty line, up to 1000V DC/AC application, up to 6000A/pole
- Stationary application only
- Up to 6 poles configuration, NO and NC poles direct arc blow out various aux contacts options
- Flexible control and adjustment configurations, total unit customization possible

### General Characteristics

- **N 85**
  - 440 V: 1600, 700, 600
  - 750 V: 1700, 1000, 800
  - Making capacity: 2750
  - Consumption: A.C. [VA]: 350, D.C. [W]: 50
  - Operation time: 110 ms
  - Mech. endurance: 15 million operations

- **N 125**
  - 440 V: 2100, 1000, 900
  - 750 V: 2500, 1500, 1000
  - Making capacity: 3500
  - Consumption: A.C. [VA]: 450, D.C. [W]: 60
  - Operation time: 130 ms
  - Mech. endurance: 15 million operations

- **N 190**
  - 440 V: 2500, 1600, 1300
  - 750 V: 3000, 2000, 1400
  - Making capacity: 4200
  - Consumption: A.C. [VA]: 450, D.C. [W]: 60
  - Operation time: 130 ms
  - Mech. endurance: 15 million operations

- **N 270**
  - 440 V: 4300, 2500, 2000
  - 750 V: 4500, 3000, 2500
  - Making capacity: 7000
  - Consumption: A.C. [VA]: 1300, D.C. [W]: 110
  - Operation time: 180 ms
  - Mech. endurance: 15 million operations

- **N 350**
  - 440 V: 4800, 3000, 2500
  - 750 V: 5000, 3500, 3000
  - Making capacity: 8500
  - Consumption: A.C. [VA]: 1300, D.C. [W]: 110
  - Operation time: 180 ms
  - Mech. endurance: 15 million operations

- **N 550**
  - 440 V: 6000, 4500, 3900
  - 750 V: 7000, 5000, 4000
  - Making capacity: 10000
  - Consumption: A.C. [VA]: 1500, D.C. [W]: 110
  - Operation time: 300 ms
  - Mech. endurance: 15 million operations

- **N 650**
  - 440 V: 8000, 5500, 4500
  - 750 V: 9000, 6000, 5000
  - Making capacity: 12000
  - Consumption: A.C. [VA]: –, D.C. [W]: 300
  - Operation time: 300 ms
  - Mech. endurance: 15 million operations

- **N 800**
  - 440 V: 9500, 6500, 6000
  - 750 V: 10000, 7000, 6000
  - Making capacity: 16000
  - Consumption: A.C. [VA]: –, D.C. [W]: 650
  - Operation time: 650 ms
  - Mech. endurance: 16 million operations

- **N 1000**
  - 440 V: 12500, 8000, 7000
  - 750 V: 13000, 9000, 7500
  - Making capacity: 21000
  - Consumption: A.C. [VA]: –, D.C. [W]: 650
  - Operation time: 650 ms
  - Mech. endurance: 16 million operations

- **N 1250**
  - 440 V: 15000, 10000, 9000
  - 750 V: 16000, 12000, 10000
  - Making capacity: 30000
  - Consumption: A.C. [VA]: –, D.C. [W]: 1000
  - Operation time: 1000 ms
  - Mech. endurance: 10 million operations

- **N 1600**
  - 440 V: 20000, 15000, 10000
  - 750 V: 25000, 16000, 12000
  - Making capacity: 35000
  - Consumption: A.C. [VA]: –, D.C. [W]: 1000
  - Operation time: 1000 ms
  - Mech. endurance: 11 million operations

- **N 2000**
  - 440 V: 20000, 15000, 10000
  - 750 V: 30000, 20000, 15000
  - Making capacity: 35000
  - Consumption: A.C. [VA]: –, D.C. [W]: 1000
  - Operation time: 1000 ms
  - Mech. endurance: 11 million operations

- **N 3000**
  - 440 V: 30000, 15000, 10000
  - 750 V: 35000, 25000, 18000
  - Making capacity: 50000
  - Consumption: A.C. [VA]: –, D.C. [W]: 1500
  - Operation time: 1500 ms
  - Mech. endurance: 10 million operations

- **N 4000**
  - 440 V: 35000, 20000, 10000
  - 750 V: 40000, 30000, 20000
  - Making capacity: 50000
  - Consumption: A.C. [VA]: –, D.C. [W]: 1500
  - Operation time: 1500 ms
  - Mech. endurance: 10 million operations

- **N 6000**
  - 440 V: 40000, 20000, 10000
  - 750 V: 40000, 35000, 20000
  - Making capacity: 80000
  - Consumption: A.C. [VA]: –, D.C. [W]: 2500
  - Operation time: 1000 ms
  - Mech. endurance: 10 million operations
Neutral Grounding

Short circuits between phase and ground can result in irreversible damage to networks and equipments; it is therefore of the utmost importance to be able to control and reduce their effects: Grounding Resistors limit the fault current that arises due to phase-neutral short circuits. Grounding through resistor offers several advantages with respect to alternative methods (such as insulated grounding, direct grounding or grounding through a reactance). The main advantages are: easier detection of fault location, limitation of fault current, no transient over voltages.

Relevant parameters in the design of a Neutral Grounding Resistor may vary greatly: Microeletrtica has developed a line of standard products (for the most common requirements) along with tailored products, each developed and customised according to the required project characteristics. Our products range from Low Voltage systems (<1kV) to High Voltage (132kV insulation class), and from very low fault current values (tens of Amps) to very high (>10kA).

The essential parameters needed to design a Grounding Resistor are:
- Nominal Voltage
- Fault Current
- Fault Duration (10s is customary)
Other relevant parameters are:

- Protection degree of enclosure: from IP00 - i.e. no enclosure - to IP55, standard solution IP23
- Enclosure finish: our standard is mild galvanised, but different stainless steel grades (such as AISI304 or AISI316) are available. Painting in the desired RAL colour is also an option
- Continuous current rating; it may affect significantly the performance of the resistor, especially when high IP degrees are required
- Environment and Elevation: we design resistors for the harshest industrial or natural settings
- Auxiliary components: during our many years of operation we have selected a number of trusted suppliers for a wide choice of components, such as Current Transformers, Switches, Disconnectors, etc.
Quality of power is becoming ever more important for both suppliers and end users, as the number of devices that may feed harmonics into power systems is increased, resulting in higher line losses, interferences and resonances.

Harmonic Filters - made up by capacitors, inductors and resistors - help eliminating harmonics which inevitably tends to occur. The LC circuit filters all spurious frequencies and only let the fundamental frequency through, while the Harmonic Filter Resistors (also referred to as Damping Resistors) dissipate harmonic currents into heat.

Typical applications for Harmonic Filters Resistors are HVDC networks and electrical induction furnaces.

Our team of experienced engineers designs the best solution for the different characteristics required and for the most diverse environmental conditions. Microelettrica can custom design Harmonic Filter Resistors from a few kW rating up to tens of MW, as well as B.I.L. up to 600kV. Our Harmonic Filter Resistors employ non-magnetic low temperature-coefficient elements, to minimise Ohmic value drift thus preventing excessive power increase. They also have low parasitic inductance values, which is a key feature for the effective design of damping elements.
The essential parameters needed to design a Harmonic Filter Resistor are:

• Nominal Voltage
• Current or Power
• Ohmic Value (with tolerance in %)

Other relevant parameters are:

• B.I.L.
• Required Insulation Level: HV terminal to hearth, LV terminal to earth, between terminals
• Clearance and Creepage
• Enclosure finish: our standard is mild galvanised, but different stainless steel grades (such as AISI304 or AISI316) are available. Painting in the desired RAL colour is also an option
• Environment: we design resistors for the harshest industrial or natural settings
• Maximum Inductance
• Bushing Layout: top or side mounted
• Mounting: three-phase stacked, side by side, others
Load Banks

Load Banks allow to effectively check the efficiency of emergency sets (generators, Uninterruptible Power Supplies) and can be employed as dummy loads to prevent wet stacking on diesel engines. They represent a reliable and economic way to extend the lifetime of extremely expensive and important equipment. Microelettrica custom designs Load Banks to satisfy all requirements, both in terms of power to be dissipated (from tens of kW to tens of MW), insulation level (from hundreds of Volts up to 36kV insulation class) and integration of the most diverse power steps, thanks to the wide variety of grid element types designed and produced by Microelettrica itself. Thanks to its many years of experience in both industrial and railway fields, Microelettrica has also developed reliable ventilation curves, and can therefore offer forced-ventilated Load Banks, which main advantage is that of allowing higher power-per-element and thus smaller size. Microelettrica Load Banks are suitable for indoor and/or outdoor use; they are placed in enclosures with up to IP23 protection degree. Ventilation can be horizontal or vertical.
Microeletrica Load Banks can be controlled either locally or remotely (on request), through switches (also manufactured by Microeletrica Scientifica).

The essential parameters needed to design a Load Bank are:
- Nominal Voltage
- Power
- Number and type of steps, if any
- Type of ventilation (natural or forced)

Other relevant parameters are:
- Maximum Ohmic value drift: in case it is necessary to contain the thermal drift of the resistance value, alloys with extremely low temperature coefficients can be used
- Protection degree of enclosure: up to IP23, standard IP20 (vertical ventilation) or IP21 (horizontal ventilation, only for forced air cooled Load Banks)
- Enclosure finish: our standard is mild galvanised, but different stainless steel grades (such as AISI304 or AISI316) are available. Painting in the desired RAL colour is also an option
- Environment and Elevation: we design resistors for the harshest industrial or natural settings
- Auxiliary components: contactors for step switching, also manufactured by Microeletrica
Starting and Braking Resistors are widely employed for controlling motors during start and/or stop.

**Starting Resistors** may be used for wound rotor induction motor and DC wound motor (this last type of motor is less and less common): adding a series resistor to each rotoric phase reduces the current and improves the starting torque. Starting Resistors may also be employed for squirrel cage induction motors, where series resistors added to the stator, limit initial current to three times its nominal value. Starting Resistors for squirrel cage motors are also known as Ballast Resistors.

The essential parameters needed to design a Starting Resistor are:

- Horsepower
- Rotor/Stator Voltage
- Rotor/Stator Current
- RPM
- Application: different applications require different solutions

Crane control is a quite common application for **Braking Resistors**: during descent the load, especially if heavy, may cause the motor to generate power. Resistors are thus used to avoid unwanted and uncontrolled acceleration.
Braking Resistors for large motors are customised to best comply with any requirement: we have developed special Braking Resistors for important research institutes (among them Max Planck Institute) and for energies in excess of 3400MJ.

De-excitation of large capacitors and inductors must be carried out with care to avoid impulsive currents that could damage them permanently. **Discharge Resistors** limit the peak current and protect the capacitive/inductive device.

The essential parameters needed to design a Discharge Resistor are:
- Nominal Voltage
- Discharge Current
- Discharge Duration

Discharge Resistors are often used by research institutes and they require a very high level of customisation, sometimes also leading to the development of new technologies for resistive elements. Microelettrica has cooperated with Universities all over the world and with the most prestigious research centers (among them, CERN in Geneve).
Line Test

High Speed DC circuit breakers are valuable components which must be protected against wear and tear and excessive current flow. Before closing High Speed Circuit Breaker on a power line, it is therefore advisable to test whether a short circuit is occurring by means of line test resistors. The resistor is electrically connected through a contactor - if no fault current is detected - then it is safe to activate the circuit breaker; otherwise, there is a fault somewhere on the line. It is as well possible that activating the resistor for a few times in a row (On - Off cycles with the desired number of consecutive on steps) may help in getting rid of the physical cause of the short circuit.

The essential pieces of information needed to design a Line Test Resistor are:
- Nominal Voltage
- Test Current
- Duty cycle
Compact Resistors

Compact and modern design, low inductance, can be subjected to pulse loads.

**Resistance material support:** moulded ceramic base  
**Resistance wire:** NiCr-alloy special heat sink casing  
**Degree of protection:** IP64 up to IP66

**Load and testing resistors:**  
- In test bays  
- In narrow spaces  
- In dusty and splash water environments

**Applications**

- Braking/chopper resistors for variable speed drives, in particular in the fields of:  
  - Hoisting and conveying equipment  
  - Printing and paper  
  - Packing, plastic, textile  
  - Wire and wood processing
Frame Resistors

Flat modular design, high energy absorption capacity, low-inductance versions, can be subjected to pulse loads.

**Resistance material support**: grooved ceramic insulators fixed on both longitudinal sides of a metal or temperature-resistant insulating material frame

**Resistance wire**: CuNi 44 or NiCr alloy

**Taps (tapping eyes)**: on request

**Degree of protection**: IP00 - IP23 possible
Components for Infrastructure

Resistors

HEINE®
Resistors GmbH
**G - Base**

**THREE PHASE + NEUTRAL CURRENT PROTECTION RELAY**

**General Characteristics**

G-Base is the new generation of Microelettrica Scientifica’s base-performance protection relays. This range is the ideal solution for protection and automation, thanks to its high configurability. It is based on the same powerful microprocessor adopted on high-performance G-Pro range. G-Base platform is based on a four-channel configuration, allowing it to be used for current and voltage protection functions. GB310, part of the G-Base range, is a relay designed for the interface to the power distribution grid.

**Protective Functions**

- F49 : Thermal Image (one element)
- F50/51 : Overcurrent, with standard IEC inverse time curves (three elements)
- F50N/51N : Earth Fault, with standard IEC inverse time curves (three elements)
- F46 : Inverse sequence (two elements)
- 74TCS : Trip circuit supervision
- F51BF : Breaker Failure protection
- F79 : Four-shot programmable autoreclosing, with reclosing sequence coordination and reclosing disabling push button
- Two complete setting programs, switchable locally or remotely

**Measurements**

- Real Time Measurements (IA - IB - IC - Io)
- Maximum Demand and Inrush Recording (IA - IB - IC - Io)
- Trip Recording

**Hardware**

- 8 Output Relays
- 8 Digital Inputs
- Hi-resolution graphic dispaly (240*128)
- 10 Leds for signalization
- 6 programmable push buttons
- Two-piece plastic enclosure, IP44 protection degree (IP54 available on request)

**Firmware**

- Time tagged multiple event recording and journal
- Oscillographic wave form capture up to 40 sec.
- Complete autodiagnostic program
- Blocking Outputs and Blockings Input for pilot wire selectivity coordination

**Power Supply Ratings**

- Type 1 : 24V(-20%) / 110V(+15%) a.c. - 24V(-20%) / 125V(+20%) d.c.
- Type 2 : 80V(-20%) / 220V(+15%) a.c. - 90V(-20%) / 250V(+20%) d.c.

**Communications**

- RS485 Serial communication port on rear side
- USB communication port on front panel
- Modbus RTU / IEC870-5-103 Communication Protocols

**Software**

- MSCom2 Program interface for device management
Typical Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy at reference value of influencing factors</td>
<td>2% ( \text{In} ) - 0.2% ( \text{On} ) for measurements</td>
</tr>
<tr>
<td></td>
<td>2% + (( \text{to} = 20 \div 30 \text{ms} ) @ 2x( \text{Is} )) for times</td>
</tr>
<tr>
<td>Rated Current</td>
<td>( \text{In} = 1\text{A}/5\text{A} ) - ( \text{On} = 1\text{A}/5\text{A} )</td>
</tr>
<tr>
<td>Current Overload</td>
<td>500A for 1 sec; 20A continuous</td>
</tr>
<tr>
<td>Burden on current input</td>
<td>0.1VA a ( \text{In} = 1\text{A} ); 0.3VA a ( \text{In} = 5\text{A} )</td>
</tr>
<tr>
<td>Average power supply consumption</td>
<td>( \leq 7\text{VA} )</td>
</tr>
<tr>
<td>Output relays</td>
<td>Rating 6 A; ( \text{Vn} = 250\text{V} )</td>
</tr>
<tr>
<td></td>
<td>A.C. resistive switching = 1500W (400V max)</td>
</tr>
<tr>
<td></td>
<td>make = 30 A (peak) 0.5 sec;</td>
</tr>
<tr>
<td></td>
<td>break = 0.3 A, 110 Vcc,</td>
</tr>
<tr>
<td></td>
<td>L/R = 40 ms (100,000 op.)</td>
</tr>
</tbody>
</table>
MC line

General Characteristics
The MC line has been designed to offer to the market a very competitive protective relay responding to the latest requirements in terms of control and communication capabilities with an extremely high level of modularity. Each relay includes a limited number of protective functions but, thanks to their very compact sizes, different units can be combined in a modular enclosure to satisfy the most demanding needs.

Measurements
- Real Time Measurements
- Trip Recording
  (last 20 trips with date & time)
- Event recording (last 10 trips)

Control
- 4 Output Relays (programmable)
- 3 Digital Inputs
- Time tagged multiple event recording
- Oscillographic wave form capture
- Blocking Outputs and Blocking Input for pilot wire selectivity coordination
- Associate C.B. control

Technical Characteristics
- Complete self diagnosis program
- Display LCD 16 (2x8) characters
- 4 Leds for signalization

Communications
- 1 RS485 Serial communication port on rear side
- 1 RS232 Serial communication port on front panel
- Modbus RTU/IEC870-5-103/IEC61850 Communication Protocols

Expansion Modules (optional)
- “UX10-4” 10 Digital Input and 4 Output Relays
- “14DI” 14 Digital Inputs
- “14DO” 14 Output Relays

Execution
- 1 Module box (2 modules with expansion)
- Totally draw-out execution
- IP44 protection case (on request IP54)

Software
- MSCom2 Program interface for device management

Relays Type

<table>
<thead>
<tr>
<th>Relays Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1V</td>
<td>Multifunction Single Phase Overvoltage/Undervoltage Relay: 59, 27, 81&gt;, 81&lt;</td>
</tr>
<tr>
<td>MC3V</td>
<td>Multifunction Three Phase Overvoltage/Undervoltage Relay: 59, 27, 81&gt;, 81&lt;, 59V0, 59V2, 27V1</td>
</tr>
<tr>
<td>MC20</td>
<td>Overcurrent &amp; Earth Fault Relay: 50/51, 50N/51N, 51BF</td>
</tr>
<tr>
<td>MC30</td>
<td>Three Phase Overcurrent &amp; Earth Fault Relay: 49, 50/51, 50N/51N, 51BF</td>
</tr>
<tr>
<td>MC40</td>
<td>Three Phase Overcurrent &amp; Earth Fault (connection with 4 CT’s): 49, 50/51, 50N/51N, 51BF</td>
</tr>
<tr>
<td>MC20-R</td>
<td>Overcurrent &amp; Earth Fault Relay: 50/51, 50N/51N, 51BF, 79</td>
</tr>
<tr>
<td>MC30-R</td>
<td>Three Phase Overcurrent &amp; Earth Fault with reclosing function Relay: 50/51, 50N/51N, 51BF, 79</td>
</tr>
<tr>
<td>MC30-BC</td>
<td>Three Phase Overcurrent &amp; Earth Fault + Broken Conductor Relay: 50/51, 50N/51N, 51BF, BC (12/12)</td>
</tr>
<tr>
<td>MCDC-I</td>
<td>D.C. Current Relay: 76/32, 49, 51BF</td>
</tr>
<tr>
<td>MCDC-V</td>
<td>D.C. Voltage Relay: 45, 80</td>
</tr>
<tr>
<td>MCM</td>
<td>Motor Protection Relay: 37, 46, 47, 48, 49, 50/51, 51LR, 64S, 66, 68</td>
</tr>
</tbody>
</table>
Components for Infrastructure

Electronics

Wiring Diagram

Overall Dimensions: mm

1 MODULE PANEL CUT-OUT 64X137 (LXH)
ULTRA line

General Characteristics
ULTRA is the top line of Microelettrica Scientifica protective relays; it has been designed to meet the most demanding specifications for any application in Transmission, Distribution and Industrial plants. The ULTRA relays are used in all the applications where, besides the protection, a complete measuring system is needed. Each relay is a multifunctional unit combining protection, measurements and control. Thanks to the CAN BUS communication port and to a complete range of additional modules, the relays of this line can perform a complex input/output logic for interlocking substation system avoiding the use of an additional PLC. The multiprotocol makes the relay very versatile and suitable to be implemented in the most common DCS and SCADA systems.

Recording
• Event Recording (last 100 events)
• Trip Recording (last 20 trips) complete with cause of tripping and values of the input quantities at the moment of trip
• Oscillographic recording of input quantities (8 channels, 32 sample/cycle, 3 sec each)

Control
• 6 Output Relays user programmable
• 4 Digital Inputs user programmable
• Blocking input and Blocking output for pilot wire selectivity coordination
• Time tagging resolution 1ms
• Trip circuit supervision
• Associated Circuit Breaker control (OPEN/CLOSE)

Technical Characteristics
• Graphical Display (128x64 dot)
• 4 Leds for signalization
• Multilanguage Display (English/Italian standard, available - others on request)
• Complete self diagnosis program with dedicated relay

Communications
• 1 RS485 Serial communication port on rear side
• 1 RS232 Serial communication port on front panel
• Modbus RTU/IEC870-5-103/IEC61850/ TCP-IP Modbus Communication Protocols
• Canbus port for external additional modules

Expansion Modules (optional)
• “UX10-4” 10 Digital Inputs and 4 Output Relays
• “14Di” 14 Digital Inputs
• “14DO” 14 Output Relays

Execution
• 2 Module box (3 modules with 1 expansion, 4 modules with 2 expansion)
• IP44 protection case (on request IP54)
• Totally draw-out execution

Software
• MSCom2 Program interface for device management
Wiring Diagram

Overall Dimensions: mm
N-DIN line

General Characteristics
The N-DIN line has been conceived to obtain the most efficient space/performance as well as cost/performance ratio. The execution of the relay is for DIN Rail, but its Front Face Panel (FFP) - including Controls, Signals and Display - is removable and can be flush mounted apart from the Relay Main Body (RMB), on the front panel of the switchboards or the motor control centres. One FFP only can control up to 31 RMB units. The relay main body RMB can also be used as a stand-alone unit, without the front panel FFP.

Measurements
• Real Time Measurements
• Trip Recording (last 5 trips with date & time)
• Load Profile recording

Technical Characteristics
The Relay Main Body (RMB) includes:
• 2 Self powered programmable Digital Inputs for remote controls (start, stop, rev., ETC)
• 1 RTD input or User available Digital Input
• 2 Programmable output relays each with one N.O. contact rating 6A
• 1 RS485 port for connection to the communication serial bus (Modbus RTU)
• 1 RS485 port for communication to the Front Face Panel
• 2 Signal Leds, 1 Reset button
The Front Face Panel (FFP) includes:
• 2x16 characters LCD display
• Four Key buttons for local relay management, Four signal leds
• One RS232 port for connection to a local PC (on front side)
• One RS485 port for interconnection with the RMB (on back side)
• Complete self diagnosis program

Mounting
• DIN46227 (EN50022)

Relays Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-DIN-MA</td>
<td>Motor Protection Relay: 37, 46, 49, 51, 51LR, 64/51N, 66</td>
</tr>
<tr>
<td>N-DIN-F</td>
<td>Feeder Protection Relay: 46, 49, 51, 50N/51N, 51BF</td>
</tr>
<tr>
<td>N-DIN TO64</td>
<td>D.C. Current Relay with High Sensitivity Hall Effect Transducer: 64, 51BF</td>
</tr>
</tbody>
</table>

Accessories

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX-I/O</td>
<td>Input/Output Expansion Module</td>
</tr>
<tr>
<td>CPB</td>
<td>Profibus Converter Module</td>
</tr>
<tr>
<td>TA-DIN</td>
<td>Current Transformer</td>
</tr>
<tr>
<td>TAR-DIN</td>
<td>Current Transformer</td>
</tr>
</tbody>
</table>
Wiring Diagram

Overall Dimensions: mm

- REMOVABLE FRONT FACE (FFP)
  - Height = 16

- TRASPARENT COVER
  - Dimension 45x108
  - Height = 9

- DIN 46277 (EN 50022)

- PANEL CUT-OUT
  - Width = 96
  - Height = 90
The MHCO line includes three models:

- **TRANSDUCER-TV**
  For VOLTAGE measurement. Directly connected to the high voltage line up to 6kV through internal voltage divider.

- **TRANSDUCER-TI**
  For CURRENT measurement. Connected to the high voltage line through a dedicated shunt (not supplied).

- **TRANSDUCER-TI**
  For CURRENT measurement. Connected to the high voltage line through a dedicated shunt (not supplied). For combined CURRENT & VOLTAGE measurement. Connected to the high voltage line up to 6kV through internal voltage divider & through a dedicated shunt (not supplied).

**Highlights**
- HV Transducer for Current & Voltage measurement
- Direct Connection up to 6kV
- Fibre Optic connection between HV transmitter and LV receiver
- Measuring channel fully redundant
- Autoranging Multivoltage Power supply (self-powered version available as optional)
- Compatible with traction application standard

**Transmitter Unit**
Three different models available, one for each type of transducers (current, voltage and current/voltage). Directly connected to the High Voltage DC system acquires the input signals by a redundant input channel and transmit them, after comparison and confirmation of validity, to the receiver unit through dedicated Fibre Optic connections. It has an autoranging multivoltage Power supply. As option a self powered version is available; in this case the power supply is directly taken from the line voltage through a set of dumping resistors.
Receiver Unit
Two models available, respectively suitable to be connected to the current and to the voltage transmitter by means of a dedicated Fibre Optic connection. The input signal is converted into 4 linear analogue output signals independently programmable (i.e. 0-20/4-20mA etc.). The setting of this unit can be easily done using our MSCom2 software tool.

The receiver is equipped with two output relays: one relay is used for self diagnosis (it trips in case of interruption of the Fibre Optic channels or internal failure of the receiver unit, including power supply failure or as alarm for measurement discrepancy between the two transmitter channels); the second relay can be programmed as alarm for under/over voltage and/or current level. Optionally a Front face display and Keyboard panel is available for local measurement and programming.

Fibre Optic Link
Transmitter and Receiver units are connected by means of a Fibre Optic link which guarantee a very high insulation level. Two Fibre Optic type are available both provided with standard ST connectors:

PLASTIC FIBRE: 62.5/125µ
GLASS FIBRE: 200 m HSC

The standard length of the fibre optic connection is 5 meters, other lengths are available on request.

Characteristics Transmitter/Receiver
Measurement solution: 0.1% of full scale @ (20/+70)°C
Responce time: 200ms
Connection: Fiber optic type 200.230.500m HCS (plastic) or 62.5/125m (glass) connection type ST
Fiber optic standard length 5m (max 1 km with glass fiber)

Wiring Diagram
DC-Pro
HIGH PERFORMANCE PROTECTION RELAY

General Characteristics
DC-Pro protection relay provides top-performance in terms of protection functions, memory and communication characteristic. Designed for DC railway applications, is the best solution for the most demanding protection and control tasks.

Communication
- IEC61850 server with GOOSE messages.
- “Internet ready” with multiple connections
  - FTP server (File Transfer) to download/upload files from/to internal memory, or from external USB memory stick.
  - Web server provides information on protection status. DHCP/AUTO IP/STATIC IP / Telnet / UDP
- Modbus on TCP, MODBUS RTU on RS485 and USB, IEC103 / NTP (time sync), NMEA (GPS), IRIG-B

Hardware
- New 32 bit microprocessor, extremely short response time and high memory capacity.
- Analogue inputs fully programmable to accept a wide range of transducers (insulation amplifier, hall effect sensor, etc…)
- Two fiber optic inputs and two fiber optic output for direct connection with Microelettrica transducers.
- Four fully programmable analog outputs for SCADA or analog instrumentation.
- 7” capacitive touch screen with 10 programmable LEDs.
- 24 digital inputs and 14 digital outputs available on the module.

Firmware
- Four independent setting groups
- PLC functionality: logical operator between inputs and outputs (logical and physical).
- Complete set of protection functions able to cover all requirement in DC traction switchgear.
- Intertripping logic: through digital IO or communication protocol (GOOSE messages).
- Events, trips and oscillographic recorder.
Components for Infrastructure

Local Display Version

Remote Display One-to-One Version

One Display for all Substation Relay

Overall Dimensions (mm)

280

180

41

170

272

183.5

110
AF/LA Series

The medium performance “AF” and “LA” fan Series were designed to meet the majority of cooling and ventilation requirements typical of industrial applications. They were conceived to provide the best mix of reliability, versatility, performance, quality, environmental impact and cost. All of these products have features making them easily compliant with the most widespread technical specifications and allowing significant modification based on specific customer requirements. Direct-coupling solutions with motors from 2 to 16 poles are available, to suit fan performance and noise requirements. Belt-driven solutions with larger diameters and selected speed are also available (see “AFT”).

The “AF” and “LA” Series are versatile and reliable, characteristics that make them the COMET’s most successful products, suitable for the most frequent ventilation needs. COMET “AF” and “LA” Series of fans have proved their efficiency every day in over 60 countries worldwide, in extreme climates, harsh environments and a wide range of temperatures for the most demanding operations.

These Series of fans are selected using COMET’s dedicated software, based upon the results of a huge number of tests performed by COMET on test tunnels and actual installations. The selection is based on five blade profiles in aluminium alloy, and others in fibreglass or polypropylene, with number of blades varying between 3 and 12 blades.

General Characteristics

AF
- Impellers with aerofoil profile blades in extruded aluminium alloy low-noise type
- Adjustable blade pitch when standstill
- Three-phase motors IP55 with Class F or H insulation, 50/60Hz, 2-16 pole, from the best European manufacturers
- Casings in carbon steel, electro-welded, with anti-corrosive finishing by hot-dip galvanization

Wide range of ancillary parts and customizations
Special versions with special materials, certified components, motors according to customer’s specifications.
Impellers in PPG, FRP or steel are available upon request

LA
- Impellers with aerofoil profile blades in PPG, low-noise type
- Three-phase motors IP55 with Class F insulation
- Casings in carbon steel, electro-welded
- Finishing by hot-dip galvanization: longer durability in harsh environment
Technical Data

<table>
<thead>
<tr>
<th>Series</th>
<th>Diameter [mm]</th>
<th>Air Flow</th>
<th>Pressure [Pa]</th>
<th>Power [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF</td>
<td>400 ÷ 2400</td>
<td>up to 400000mc/h</td>
<td>up to 1500Pa</td>
<td>0.55 ÷ 90</td>
</tr>
<tr>
<td>LA</td>
<td>310 ÷ 800</td>
<td>up to 35000mc/h</td>
<td>up to 800Pa</td>
<td>0.25 ÷ 7.5</td>
</tr>
</tbody>
</table>
Belt-driven axial fans

## AFT Series

The “AFT” Series fans are designed for applications requiring very high air flows and medium-low pressures, when it is impossible or unadvisable to couple the impeller direct to the motor.

They are normally used in the presence of:
- large diameters (air coolers, heat exchangers, cooling towers)
- dusty atmospheres
- high temperatures of the air flow
- low noise installations
- need to set the motor outside the air flow for access

Supports and drives are sized by COMET according to criteria based on 20 years of experience and hundreds of installations. For some models the bearing blocks are designed and built entirely by COMET.

The “AFT” Series fans are selected using the COMET’s dedicated software, which provides a clear and concise data sheet with operating curves, including electrical and noise level data, as well as preliminary outline drawing. The selection is based on five blade profiles, with number of blades varying between 3 and 12 blades. This versatility gives unrivalled design options when selecting a fan unit.

### General Characteristics

- Impellers with aerofoil profile blades in extruded alluminium alloy low-noise type
- Adjustable blade pitch when standstill, or autovariable in operation
- Three-phase motors IP55 with Class F or H insulation, 50/60Hz, 2-16 pole, from the best European manufacturers
- Casings in carbon steel, electro-welded, with anti-corrosive finishing by hot-dip galvanization
- V-belt or toothed belt drive, with heavy-duty bearing blocks and external grease lines

Wide range of ancillary parts and customizations

Versions with special materials, special dimension, motors according to customer’s specifications.

Impellers in PPG, FRP or fitted with anti-corrosion coatings are available upon request.
### Technical Data

<table>
<thead>
<tr>
<th>Series</th>
<th>Diameter [mm]</th>
<th>Characteristics</th>
<th>Power [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFTE</td>
<td>800 ÷ 2240</td>
<td>Motor mounted outside the fan and the airflow</td>
<td>0.55 ÷ 45</td>
</tr>
<tr>
<td>AFTS</td>
<td>2000 ÷ 4800</td>
<td>With vertical axis, motor mounted under the fan ring on a bridge (for aircoolers)</td>
<td>0.55 ÷ 90</td>
</tr>
<tr>
<td>AFTN</td>
<td>1600 ÷ 2240</td>
<td>Motor mounted inside the fan casing, fully enclosed</td>
<td>0.55 ÷ 55</td>
</tr>
</tbody>
</table>
MAP/AVP/MF/XF Series

COMET aluminium impellers come in 4 different construction types, aimed at satisfying numerous industrial applications. COMET manufactures 10 different blade profiles and three different impeller designs, giving rise to one of the most extensive and efficient product ranges available on the market.

The larger Series can be selected for large installations with diameters up to 12 metres. The smaller Series are suitable for installation on equipments, machineries or in environments requiring ventilation or cooling, and on small and medium fan units with diameters starting from 350mm.

The “MAP” and “AVP” Series impellers have high-efficiency and low-noise blades made of extruded aluminium alloy. All “MAP” models have variable pitch blades with motor stopped, while “AVP” impellers have variable pitch blades in operation. They were designed to provide precise and continuous adjustment of the air flow as the thermal conditions of the system vary. The blade pitch variation is controlled pneumatically and these impellers are supplied complete with rotating joint for connection to the line and with precision position valve.

Special versions of all COMET impeller Series are available for critical operating conditions or special environments.

The extensive production in aluminium is supported by “MF” and “XF” Series of impellers, with blades made of fiberglass-reinforced plastic (FRP-GRP-PPG). These Series have Very Low-Noise characteristics and are suitable for corrosive environments.

By using COMET selection software, it is possible to select the most advantageous combination of speed, number of blades and blade profile to obtain the best results in terms of noise and power consumption.

### Technical Data

<table>
<thead>
<tr>
<th>Series</th>
<th>Blade Material</th>
<th>Hub Type</th>
<th>Blade Series</th>
<th>Diameter Range [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP</td>
<td>Aluminium</td>
<td>F</td>
<td>12 / 1N</td>
<td>350 ÷ 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P</td>
<td>1N / 2N / 3N / 31</td>
<td>500 ÷ 3100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>2N / 3N / 4N / 8N / 31 / 51</td>
<td>1000 ÷ 12000</td>
</tr>
<tr>
<td>AVP</td>
<td>Aluminium</td>
<td>P</td>
<td>1N / 2N / 3N / 31</td>
<td>1120 ÷ 3100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>2N / 3N / 4N / 8N / 31 / 51</td>
<td>2000 ÷ 8000</td>
</tr>
<tr>
<td>MF</td>
<td>FRP – GRP</td>
<td>D</td>
<td>MF</td>
<td>1200 ÷ 10000</td>
</tr>
<tr>
<td>XF</td>
<td>FRP – GRP</td>
<td>D</td>
<td>XF</td>
<td>2000 ÷ 12000</td>
</tr>
</tbody>
</table>
For classified areas (Zone 1/21 and 2/22)

**ATEX Fans**

Most of COMET’s fans can be supplied in the ATEX certified version (Directive 94/9/EC). Series AF/AFT/AFH/AFTH/CNX are always available in ATEX versions.

All these fans are equipped with motors and components of leading brands and are rigorously certified.

Materials and components are checked and recorded for complete traceability.

Design, manufacture and testing are carried out by COMET in accordance with the procedures established by the COMET ATEX Technical File, filed with ICIM (ATEX Notified Body).

COMET products are certified for the following categories:

- Group II, category 3G
- Group II, category 3D
- Group II, category 2G
- Group II, category 2D

The general characteristics and the performances of the products do not vary when they are produced in the ATEX versions. At the same time, it is still available an high grade of customization according to the installation needs and the project specifications.

**General Characteristics**

- Impellers in carbon steel, stainless steel, alluminium, FRP or PAGAS
- Three-phase motors IP55/IP65, with Class F or H insulation, T3 / T4, Ex-N / Ex-d, 50/60Hz, suitable for inverter supply
- Casings in carbon steel or stainless steel, electro-welded, with bolted anti-spark track
- Finishing by 3-layers epoxy-pack painting, certified for 500 hours salt mist test resistance, or hot-dip galvanization
- Cables and electrical components made by leading brands and certified
- ATEX certificate and running test report is supplied with each unit

Wide range of ancillary parts and customizations

Versions with special materials, special dimension, motors according to customer’s specifications.
ATEX

For classified areas (Zone 1/21 and 2/22)

Technical Data

<table>
<thead>
<tr>
<th>Series</th>
<th>Diameters [mm]</th>
<th>Characteristics</th>
<th>Power [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF-Ex</td>
<td>400 ÷ 2400</td>
<td>Medium-performance direct drive Axial</td>
<td>0.55 ÷ 90</td>
</tr>
<tr>
<td>AFT-Ex</td>
<td>1000 ÷ 4800</td>
<td>Belt driven Axial</td>
<td>1.5 ÷ 75</td>
</tr>
<tr>
<td>AFH-Ex</td>
<td>400 ÷ 1800</td>
<td>High Performance Axial</td>
<td>1.1 ÷ 90</td>
</tr>
<tr>
<td>AFTH-Ex</td>
<td>200 ÷ 700</td>
<td>Belt-Driven High Performance Axial</td>
<td>0.55 ÷ 30</td>
</tr>
<tr>
<td>CNX-Ex</td>
<td>400 ÷ 1400</td>
<td>CentrAxisal</td>
<td>1.5 ÷ 55</td>
</tr>
</tbody>
</table>