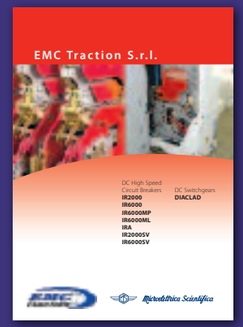

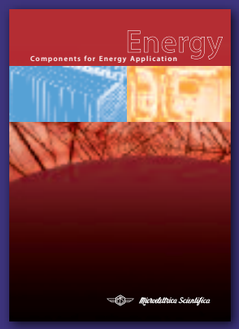

KNORR-BREMSE

For information on sales
network and products please visit

www.microelettrica.com

Official Microelettrica Scientifica dealer

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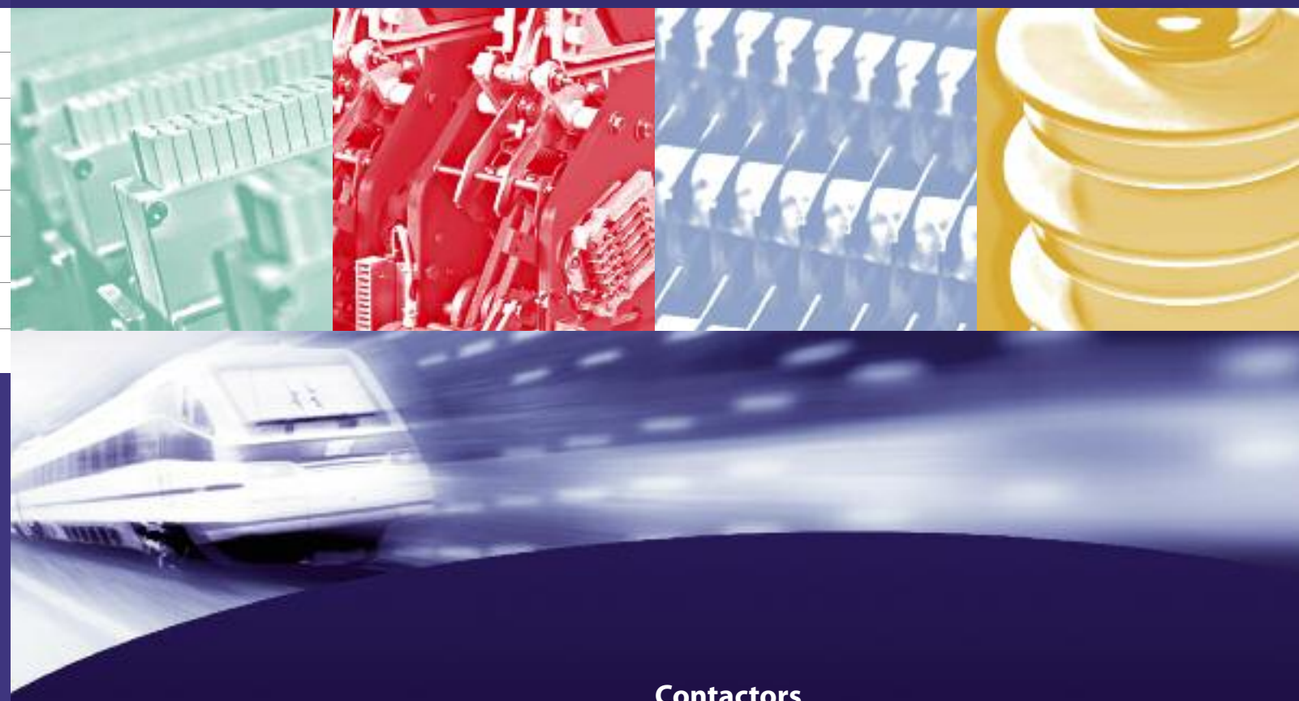
Railway

Components for Rail on Board Application

KNORR-BREMSE
WESTINGHOUSE *platform screen doors*
IFE Automatic Door Systems
merak
Microelettrica Scientifica
transportdata
ZELISKO
railservice



- Contactors
- Disconnectors
- DC High Speed Circuit Breakers
- Resistors
- High Voltage Transducers

Microelettrica Scientifica

Applications

- Locomotives
- High Speed Trains
- Electric Multiple Units
- Metros
- Trams/LRV
- Passenger Cars
- Trolleybuses

Traction innovation

For over 50 years, Microelettrica Scientifica products have accompanied and often anticipated the evolution of rail transport all over the world. Today, Microelettrica Scientifica contactors, disconnectors, power resistors and high voltage transducers, together with EMC Traction DC high speed circuit breakers have become the standard of reference for a growing number of highly qualified rail vehicle customers all over the world.

Know how in continuous evolution

The frontiers of power generation, transmission and distribution are changing continuously and Microelettrica Scientifica is evolving with them through continuous innovation of products and technologies.
All the steps of our processes, from product conception to product validation, from choice of materials to final routine tests, are accurately controlled to guarantee total safety of equipment, persons and lines, as well as full customers satisfaction, but more than that to constantly find innovative solutions that improve the cost/performance/features balance of our products.

We work together with our customers

Our industrial philosophy is to manage the evolution of our products in full coordination and collaboration with our customers. Since the first contacts, we are pleased to foster relations with them. In this way we can help in selecting the product from our wide range which better fits the requirements. And, in case of special requirements, we are always eager to develop custom-designed products: our company is well prepared to manage the most challenging projects and our factories will easily realize them.

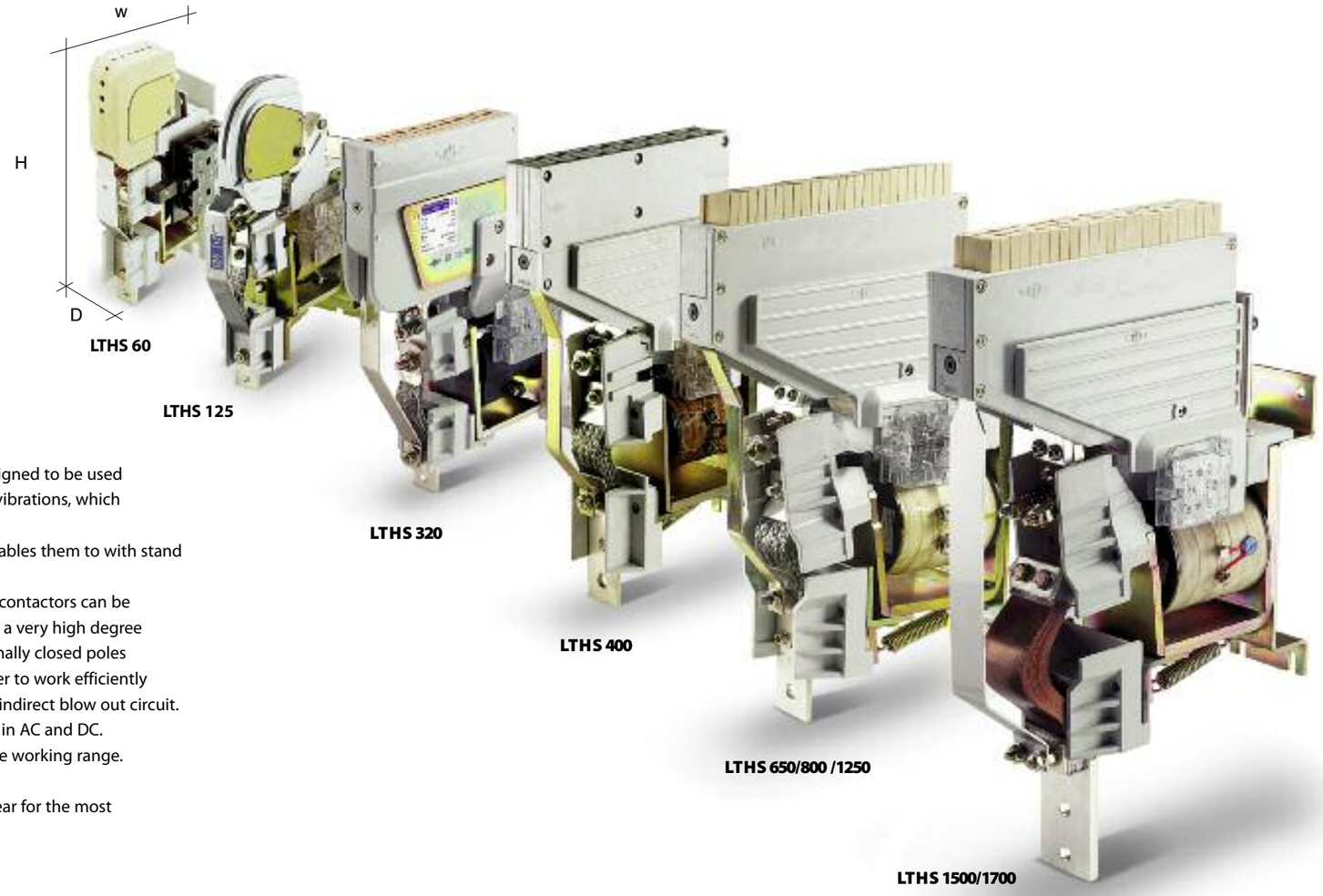
Made in Microelettrica Scientifica

To achieve the best results, Microelettrica Scientifica develops and produces the entire range of products in its own facilities in Rozzano and Lacchiarella, as well as the EMC Traction facility in Vimodrone, all very near to Milano. But we also run operations in USA, South Africa, France, India and China. Wherever in the world customers know they can always count on quality, excellence and accuracy in the realization of each single product and component, but also get supported locally.

Products

- Contactors
  Disconnectors
- DC High Speed Circuit Breakers
- Braking Resistors
  Resistors for Traction Control
- High Voltage Transducers

LTHS line



Applications

- Line contactor
- Power or auxiliary converter input
- Filter pre-charging
- Traction motors on-load disconnection
- Electromagnetic brakes
- Heating/Air conditioning systems

Microelettrica Scientifica contactors for railway applications are designed to be used onelectrical equipment in presence of the most severe shocks and vibrations, which occur on board of traction vehicles.
The LTHS series of contactors displays a traditional design which enables them to with stand the highest current ratings in harsh working conditions.
To accomplish most of the possible applications, all the LTHS series contactors can be manufactured in single or multipolar form and, upon request, allow a very high degree of customisation. For example, 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 both in AC and 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 deenergized.
More than 20.000 LTHS contactors are delivered worldwide every year for the most important projects.

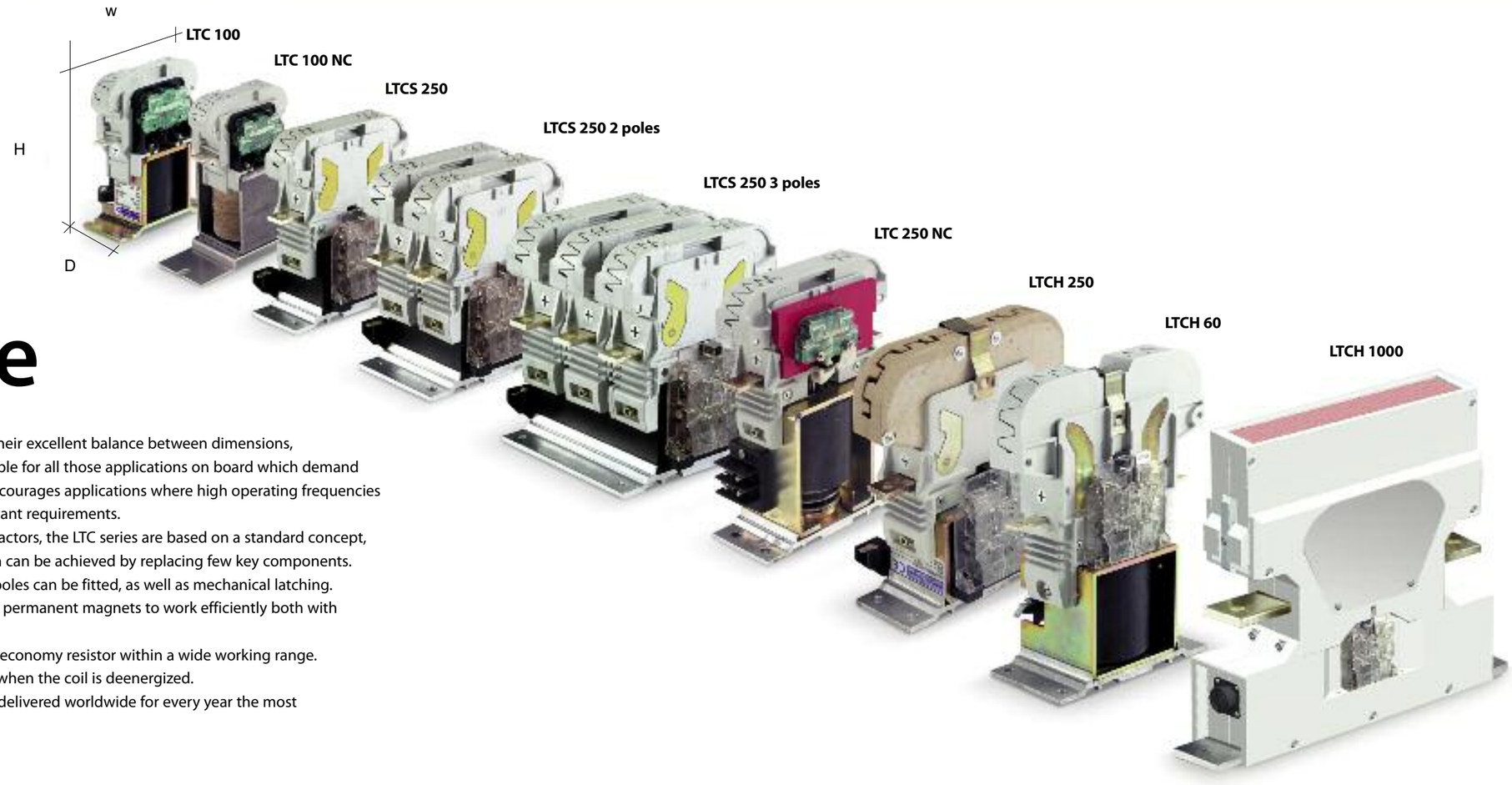
General Characteristics

- The long experienced extra heavy duty flexible line, up to 2000$V_{DC/AC}$ application, up to 1500A/pole
- On board and stationary application
- Combination of up to 3 NO or NC poles and auxiliary contact options
- High unit customization possible

Auxiliary Contact Blocks Type sk11

- Normally mounted on LTHS and LTC contactors
- Execution Makrolon, self extinguishing and transparent polycarbonate to allow contactors inspection
- Double interrupting, self cleaning, solid silver
- On request special execution with gold plated contacts

Type	Umax [$V_{AC/DC}$]	Ith [A]	W (mm)	H [mm]	D1/D2 [mm]
LTHS 60	1000	80	143	197	72/93
LTHS 125	1000	150	185	278	88/115
LTHS 320	1000	350	220	298	86/114
LTHS 400	2000	500	329	423	116/202
LTHS 650/800	2000	700/920	335	440	116/202
LTHS 1250	2000	1300	350	472	127/202
LTHS 1500	2000	1350	350	534	111/202
LTHS 1700	2000	1600	350	534	116/235



LTC line

Applications

- Auxiliary converter input
- Filter pre-charging
- Electromagnetic brakes
- Heating/Air conditioning systems
- Line contactor

The LTC series contactors, thanks to their excellent balance between dimensions, performances and strength, are suitable for all those applications on board 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 are based on a standard concept, but a very high level of customisation can be achieved by replacing 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 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 deenergized.
More than 20.000 LTC contactors are delivered worldwide for every year the most important projects.

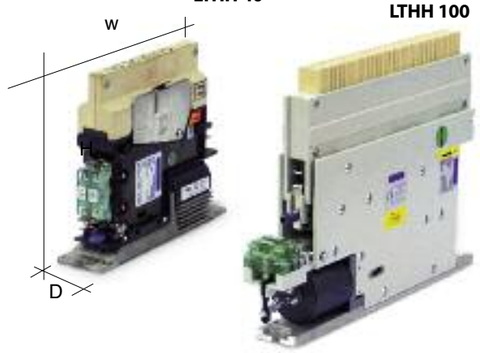
General Characteristics

- The modern and compact heavy duty line, up to 4000$V_{DC/AC}$ application, up to 1000A/pole
- On board and stationary application
- 1-2-3 pole configuration mostly available, NO and NC poles, permanent magnets or indirect arc blowouts
- Flexible control and auxiliary contacts options, customization possible

Auxiliary Contact Blocks Type rk11

- Contacts based on Reed relay technology
- Sealed tips, not affected by harsh environmental conditions
- Shielding case from external magnetic fields
- Same mechanical interface of standard SK11auxiliary blocks
- Power rating 10 VA

Type	Umax [$V_{AC/DC}$]	Ith [A]	W [mm]	H [mm]	D [mm]
LTC 100	1000	100	106	127,5	63
LTC 100 2 poles	1000	100/200	120	127	93
LTC 100 NC	1000	100	106	155	60
LTCS 250	1000	250	140	156,5	86
LTCS 250 2 poles	2000	250/500	140	156,5	109
LTCS 250 3 poles	2000	250	140	156,5	154
LTC 250 NC	2000	250	140	196	78
LTCH 250	1000	250	154	176	86
LTCH 60	4000	60	168	220	88
LTCH 60 2 poles	4000	60/120	220	168	125
LTCH 1000	2000	1000	385	300	93



LTHH 40

LTHH 100

LTHH 250

LTE/P 2-400/600

LTE/P 4-400/600

LTE/P 4-2000

LTHH/LTE/LTP line

Applications

- Auxiliary converter input
- Filter pre-charging
- Capacitor discharging
- Heating/Air conditioning systems
- Line contactor
- Train supply line
- Resistors based traction systems, for starting and braking of electric motors

The Microelettrica Scientifica LTHH/LTE(P) series contactors 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 ambient. 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 the possible applications, they are available both with electric and pneumatic control, and poles can be manufactured in normally open or normally closed configurations.
The indirect blow out circuit makes the LTHH contactors suitable to work both with high and low currents and with relatively high frequency (1500 Hz).
The DC control coil operates without economy resistor within a wide working range.
More than 10.000 LTHH contactors are delivered worldwide every year for the most important projects.

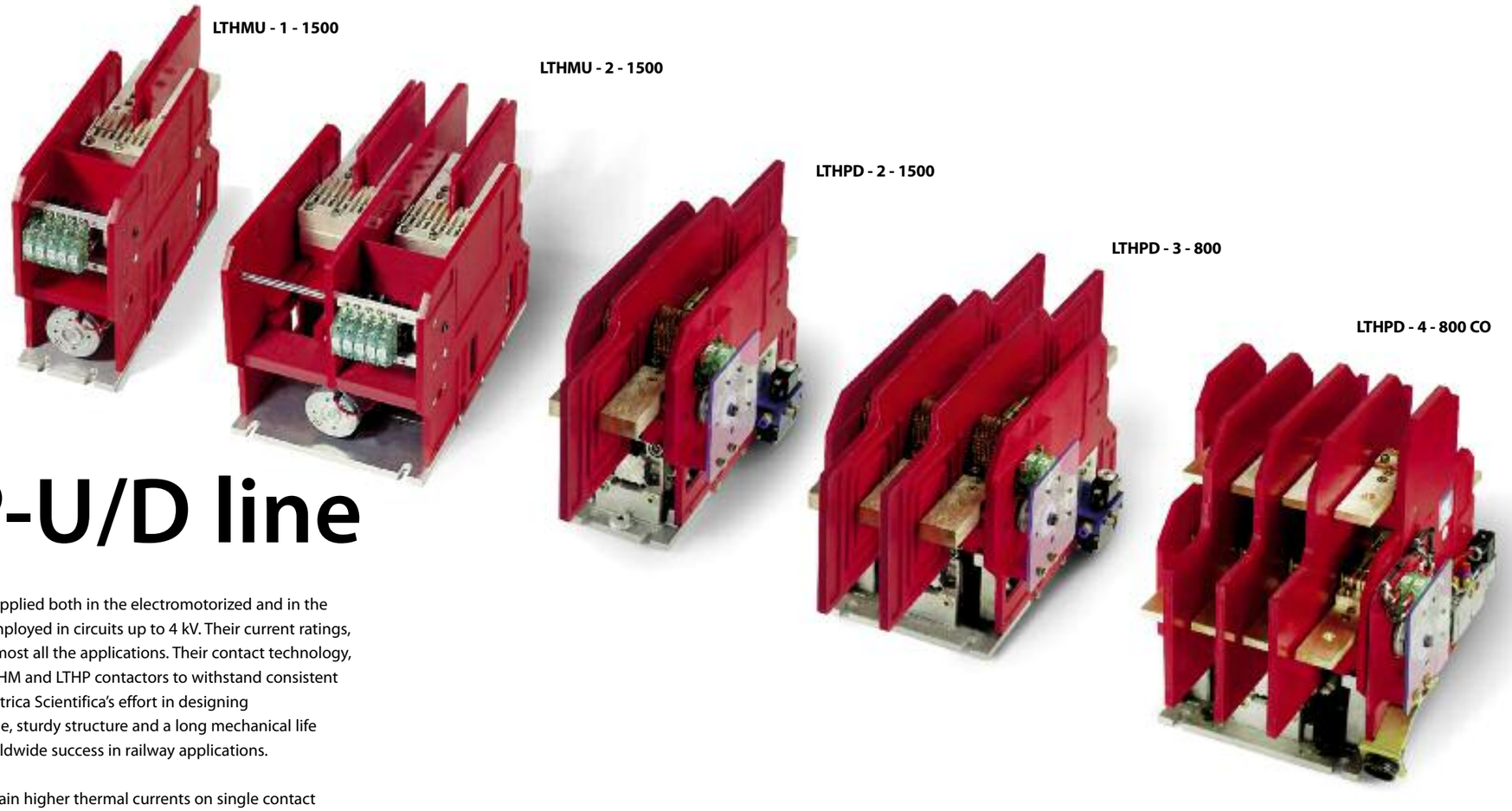
General Characteristics

- The higher voltage single pole heavy duty line, up to 4000$V_{DC/AC}$ application, up to 1300A/pole
- On board and stationary application
- Multipole assembles, NO and NC poles, indirect arc blow out
- Flexible control and auxiliary contacts options, high unit customization possible

Auxiliary Contact Blocks Type SJ11

- Normally mounted on LTHH contactors and on disconnectors/changeovers
- Execution in Makrolon, self extinguishing and transparent polycarbonate
- Double interrupting, self cleaning, solid silver, snap action contacts
- On request, special execution with gold plated contacts

Type	Umax [$V_{AC/DC}$]	Ith [A]	W [mm]	H [mm]	D1/D2 [mm]
LTHH 40	2000	60	200	162	48/106
LTHH 100	4000	120	377	274	60/130
LTHH 250	4000	300	377	295	70/160
LTE/P 2-400/600	2000	900	404	370	80/220
LTE/P 4-400/600	4000	900	403	394	85/220
LTE/P 4-2000	4000	1350	500	473	119/-



LTHM/P-U/D line

Applications

- Traction circuit configuration change in multi-system locos
- Isolation of power converter
- Isolation of traction motors

Microelettrica Scientifica disconnectors, supplied both in the electromotorized and in the pneumatic versions, are designed to be employed in circuits up to 4 kV. Their current ratings, up to 1500 A per pole, allow them to fit almost all the applications. Their contact technology, based on multi-finger jaws, enables the LTHM and LTHP contactors to withstand consistent dynamic currents (up to 220 kA). Microelettrica Scientifica's effort in designing a product range with reduced space outline, sturdy structure and a long mechanical life (over 100,000 operations), has led to a worldwide success in railway applications.

- Poles can be connected in parallel to obtain higher thermal currents on single contact (up to 6,000 Amps)
- On D versions, poles can be reversed forming NC poles, or single-double pole changeover without additional structure
- On D versions, additional upper structure is available to create 1 to 4 changeover poles
- 24 combinations are available with more than 130 pole configurations
- Several options available for control circuits and for auxiliary contacts connection
- Integrated solutions: multiple switches are assembled on frame with customised busbar system and integrated control circuits

General Characteristics

- The long experienced heavy duty line for DC and AC application up to 4000V
- On board and stationary application, 2 thermal current rating per pole: 800 or 1500A
- Normally open, normally closed, changeover poles from 1 to 4 poles units with single control
- Electric DC motor or pneumatic cylinder control, with customized auxiliary contacts execution
- High customization level is possible and mostly used
- Integrated multifunctional units designed and customized on request

Auxiliary Connections

- To meet all customer requirements, special connections and cabling can be supplied both on the high voltage and on the low voltage circuits. On the HV side, poles can be connected in series or parallel. Terminals can be shaped according to customers' requirements
- LV circuits can be cabled to perform different logical functions. Any kind of connector available in commerce can be fitted to these circuits

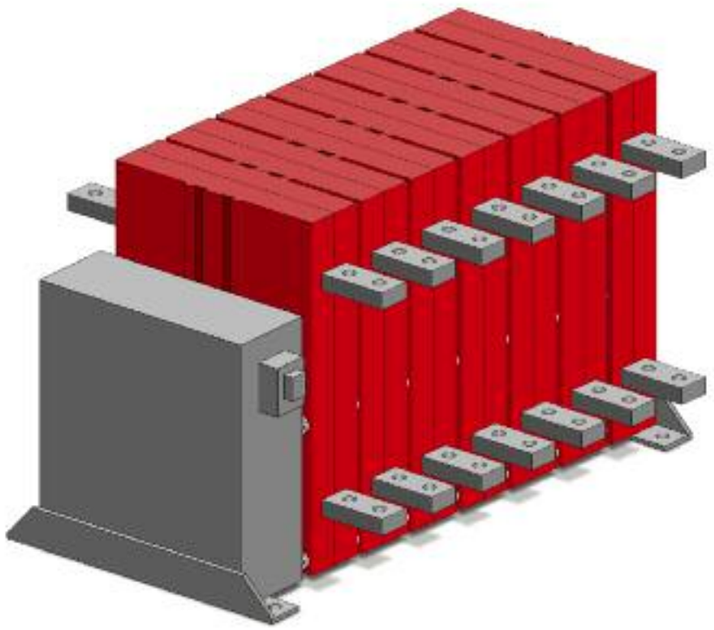
LTH	M	U	1	800
LTH	M	U	1	1500
LTH	M	U	2	800
LTH	M	U	2	1500

LTH	P	U	1	800
LTH	P	U	1	1500
LTH	P	U	2	800
LTH	P	U	2	1500

LTH	M	D	1	800
LTH	M	D	1	1500
LTH	M	D	2	800
LTH	M	D	2	1500
LTH	M	D	3	800
LTH	M	D	3	1500
LTH	M	D	4	800
LTH	M	D	4	1500

LTH	P	D	1	800
LTH	P	D	1	1500
LTH	P	D	2	800
LTH	P	D	2	1500
LTH	P	D	3	800
LTH	P	D	3	1500
LTH	P	D	4	800
LTH	P	D	4	1500

- M/P: Electromotorized or Pneumatic bistable control
- U/D: Power terminals on same side or on opposite side
- 1/2/3/4: Number of poles
- 800/1500: Thermal current of each pole (in Amps)



LTMP line

Applications
Traction circuit configuration change in multi-system locos
Isolation of power converter
Isolation of traction motors

Modular Multipole-Multiposition Off-Load Disconnector with Binary Control Option

Main Features of each Pole:
- 2 versions: 1000 or 2000 A thermal current
- 3 configurations: NO or NO+NC or CO
- Integrated control device for command logic
- Fully modular construction, up to 12 poles
- Visual indication of pole status
- Maintenance-free

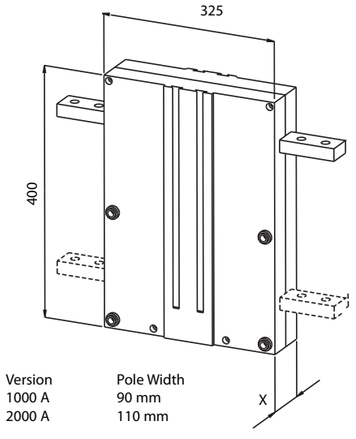
Main Features Control:
- Electric motor actuated
- Electronic control of poles positions
- Virtually infinite combinations of poles positions
- Predetermined positions accessed sequentially or by dedicated control signal

Options:
- Binary control code module (No. of digits = No. of poles)

Technical Data

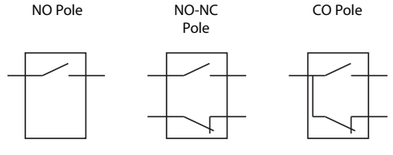
Rated Voltage (Un)	3000 V	
Rated Max Voltage (Umax)	4000 V	
Insulation Reference Voltage (Ui)	4000 V	
Rated Operational Current (Ie)	1000 A	2000 A
Rated Short Circuit Withstand for 15ms (Icc)	160 kA	220 kA
Rated Breaking Current at 4000V$_{DC}$	400mA	
Position Change Time at Uc	Max 5 sec	
Mechanical Endurance	> 500'000 operations	
Contact Opening Distance	> 40mm	
Dielectric Test Voltage	HV to ground 12000V Aux to ground 2000V Bwn open contacts 9500V	
Auxiliary Contacts (type SJ 11)	1NO+1NC per pole	
Control Module Weight	5 kg	
NO Pole Weight (per pole)	6.2 kg	7 kg
CO Pole Weight	7.5 kg	8.5 kg
NO-NC Pole Weight	8.2 kg	9 kg
Operating Temperature Range	-50°C ÷ +85°C	
Control Voltage (Uc)	24 / 72 / 110 V$_{DC}$	
Control Voltage Working Range at +85°c	± 30%	
Absorbed Power at 20°c and Uc	Max 150W	

Dimensions



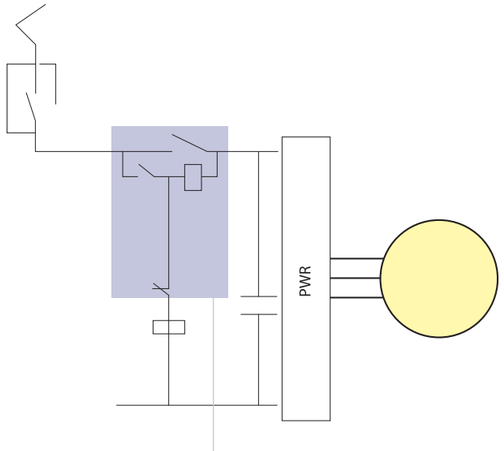
Version	Pole Width
1000 A	90 mm
2000 A	110 mm

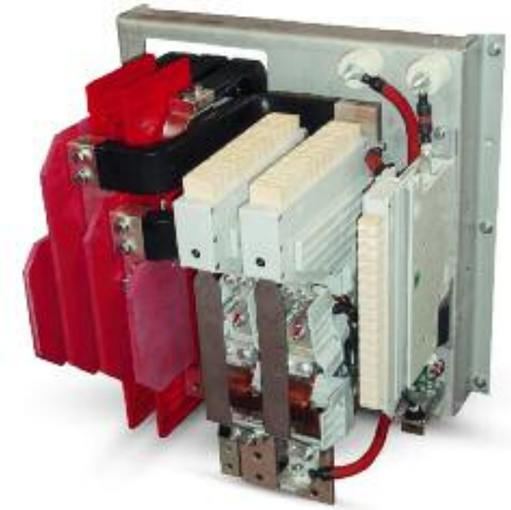
Pole Configuration

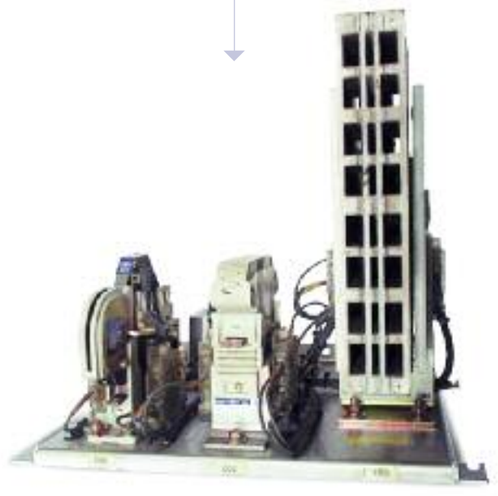


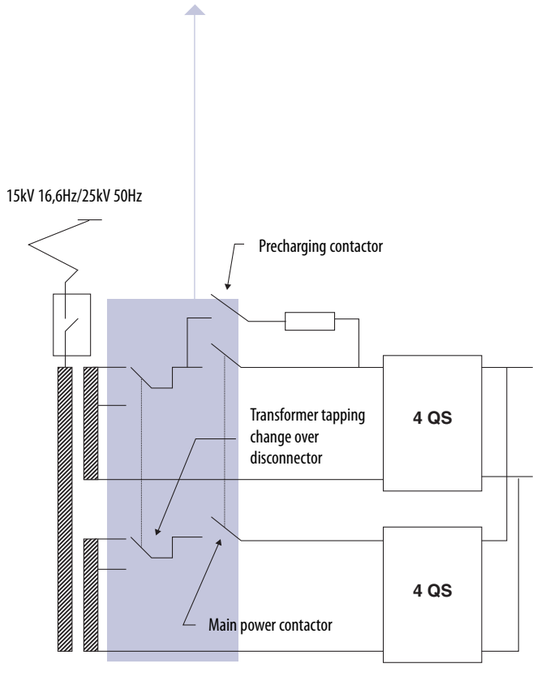
Integrated Functional Units

A key of Microelettrica Scientifica success is the ability to provide specific solutions to meet customers' requirements. One of these are LRUs: different Microelettrica Scientifica contactors and disconnectors are supplied already assembled on a structure. A few solutions have been supplied also including charging and discharging resistors on the same frame. In this way customers do not have to worry of installing several components on a vehicle: it's just a matter of inserting the whole assembly in its own cubicle and tightening some screws. For example, all the traction circuit switchgear can be part of just one LRU. Such a solution helps also in case of maintenance: a LRU is removed from the train in a short time and is replaced with another assembly, to speed up processes. Then, the removed LRU can be checked and revamped in the workshop, with no concerns of time and space.









Special product LTRM 300

- New 300A 4 kV motorized reverser with 4 NO/NC poles
- Expandable number of poles
- Poles can also be used as auxiliary lower current contacts on LTHM (P) disconnectors

IRA series

High Speed Circuit Breaker Type IRA With Holding Coil for Substations and Industrial Applications or Closing Pneumatic Mechanism for Locomotives

Applications
DC Substation
Industry
Locomotives
EMU

The IRA series are single pole, magnetic blow out, trip free, air circuit breakers.
The breaker closing device is electromagnetic (for Substation and Industry applications) or electropneumatic (for Locomotives) type.
The breaker is held closed by an holding coil and is equipped with a direct acting unidirectional over-current trip device.

Technical Data

Type		IRA Magnetic	IRA Magnetic/Pneumatic
Rated Voltage [V]	U_n	1500	3000
Rated Current [A]	I_n	Up to 3000	Up to 3000
Short Circuit Breaking Capacity (EN 50123) (IEC77)	U_e	1800 [V]	3600 [V]
	I_{cc}	100 [kA]-Peak	60 [kA]-Peak
	I_{cc}	60 [kA]-Steady State	40 [kA]-Steady State
Rated Voltage Auxiliary Circuit [V_{DC}]	U_n	24 ÷250	24 ÷250

IR6000 SV series

High Speed Circuit Breaker Type IR6000 SV
Permanent Magnet or Electromagnetic Latch Single or Dual Voltage for Locomotives and EMU

Applications

Locomotives

EMU

The IR6000 SV series are single pole, magnetic blow out, trip free, magnetic latch, air circuit breakers.
The breaker closing mechanism is an independent motor operated type.
The breaker is held closed by holding coil or by a permanent magnet and is equipped with a direct acting over-current trip device which may be either unidirectional or bidirectional.
The breaker may be operated as single voltage (1500, 3000V) or dual voltage (1500/3000V).
The breaker conforms to EN60077 Standard.

Technical Data

Type		**IR6000 SV VERTICAL**		**IR6000 SV HORIZONTAL**	
Rated Voltage [V]	U_n	1500	3000	1500	3000
Rated Current [A]	I_n	Up to 4000	Up to 4000	Up to 2500	Up to 2500
Short Circuit Breaking Capacity (CEI EN 60077)	U_e	1800 [V]	3600 [V]	1800 [V]	3600 [V]
	I_{cc}	100 [kA]-Peak	60 [kA]-Peak	100 [kA]-Peak	60 [kA]-Peak
	I_{cc}	70 [kA]-Steady State	40 [kA]-Steady State	70 [kA]-Steady State	40 [kA]-Steady State
Rated Voltage Auxiliary Circuit [V_{DC}]	U_n	24 ÷110	24 ÷110	24 ÷110	24 ÷110

DC High Speed Circuit Breakers

EMC Traction

IR2000 SV series

High Speed Circuit Breaker Type IR2000 for Vehicles

Applications
Trolleybuses
Metros
Trams

The IR2000 series are single pole, magnetic blow out, trip free, air circuit breakers.
The breakers closing mechanism is an indipendent motor operated type.
The IR2000 Circuit Breaker is held closed by holding coil or by permanent magnet and is equipped with a direct acting over-current trip device which may be either unidirectional and bidirectional.
This breaker for on-board application is available with or without metallic or insulating enclosure.
The breaker may operate with single voltage (750, 1500V) or dual voltage (750/1500V).
The breaker conforms to EN60077 Standard.

Optional enclosure metallic/insulated box

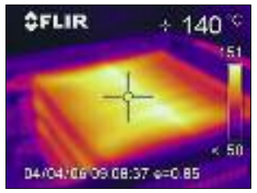
Technical Data

Rated Voltage [V]	U_n	750	1500
Rated Current [A]	I_n	Up to 3000	Up to 3000
Short Circuit Breaking Capacity (IEC 60077)	U_e	900 [V]	1800 [V]
	I_{cc}	50 [kA]-Peak	45 [kA]-Peak
	I_{cc}	30 [kA]-Steady State	25 [kA]-Steady State
Rated Voltage Auxiliary Circuit [V_{DC}]	U_n	24 ÷110	24 ÷110

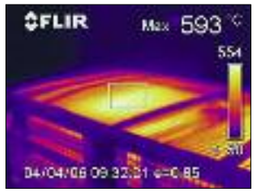
Braking

Braking Resistors are used to transform kinetic energy of the vehicle into heat by/means/of electric braking.

Braking Resistors are usually installed:
- On the roof of a vehicle, where hot exhaust air is released upwards
- Under frame, where the hot air released is exhausted sideways when the vehicle is in motion or using a blower
- Inside the vehicle, where the resistors are usually forced air cooled, where fresh air is taken from the bottom of the vehicle and hot air is expelled from the top



Resistor elements are assembled in banks by means of strong rods and ceramic spacers. The banks are contained in strong shoulders or support frame of AISI 304 stainless steel.



Stainless steel is also used for bolts, nuts and washers. The resistors are designed to avoid disturbing noises caused by pulsating current.
Resistors are designed by our engineers with a sophisticated 3D model in order to find the best solution for customers and to withstand shocks and vibrations that normally occur in operation. Design and all production, strictly follow ISO 9001-2008 quality standards and the most severe international specifications.

All our resistors are type tested at our test room where real service conditions can be reproduced via mock-up and motion air fow simulation. All Microelettrica Scientifica sites are equipped with dedicated testing facilities to guarantee product compliance with spec requirements.

A Railway Resistor is a 100% custom made product, where a few constructive and technological principles are applied in a project-specific mechanical frame layout.

Applications

Rail on Board

Continuos Duty Control Resistors

- Damping
- Filter

Applications

Rail on Board

Auxiliary resistors are designed and optimized in order to adapt to the available space on the vehicle.
Damping Resistors are used to limit current and voltage peaks in a power circuit.
Filter Resistors are used to remove harmonic voltage distortion caused by the ever-increasing use of power electronics and other solid state devices.
Harmonics can be reduced to acceptable levels by passive filter circuits, where the currents are dissipated as heat.

Small resistors size and high ohmic value are available.
Resistors are designed by our engineers with a 3D model in order to find the best solution for customers and to withstand shocks and vibrations that normally occur in operation without being damaged. Design and all production strictly follow ISO 9001-2008 quality standards and the most severe international specifications.

Impulsive Duty Control Resistors

- Crowbar
- Charging
- Discharging

Applications

Rail on Board

Control Resistors are designed and optimized in order to adapt to the available space on the vehicle.
Charging and Discharging Resistors are used to limit inrush currents to the capacitors during charging and also to discharge them safely when required.
Crowbar Resistors are used in traction power supply circuits in order to deal with the effects of transient or longer lasting over-voltage conditions.

Resistors are designed by our engineers with a 3D model in order to find the best solution for customers and to withstand shocks and vibrations that normally occur in operation without being damaged. Design and all production strictly follow ISO 9001-2008 quality standards and the most severe international specifications.

Eurometer

General Characteristics

EUROMETER is a compact solution that allows the measurement of the voltage of the catenary line and in combination with its interface (IRTL) distributes the information through the whole train. Having just one certified product that integrates so many functions, allows easy communication and interchange of datas, with the maximum control on the whole productive process.

Functions

EUROMETER's functions are highly customized according to our customers' needs or suggestions coming from our experience:

- Detection and measurement of the instantaneous catenary AC and DC voltages
- Analog and/or digital output signals
- Insulated optical fiber output
- On-line diagnostic

Possible options may include:

- Measurement of harmonics
- Measurement of energy consumption

Environmental Performance

The device is compliant with all the regulations of the rail market. All the components are homologated for the industrial temperature range (from -45°C to +80°C - Class TX - EN 50125-1) and ensure a proper working in the worst environmental conditions.

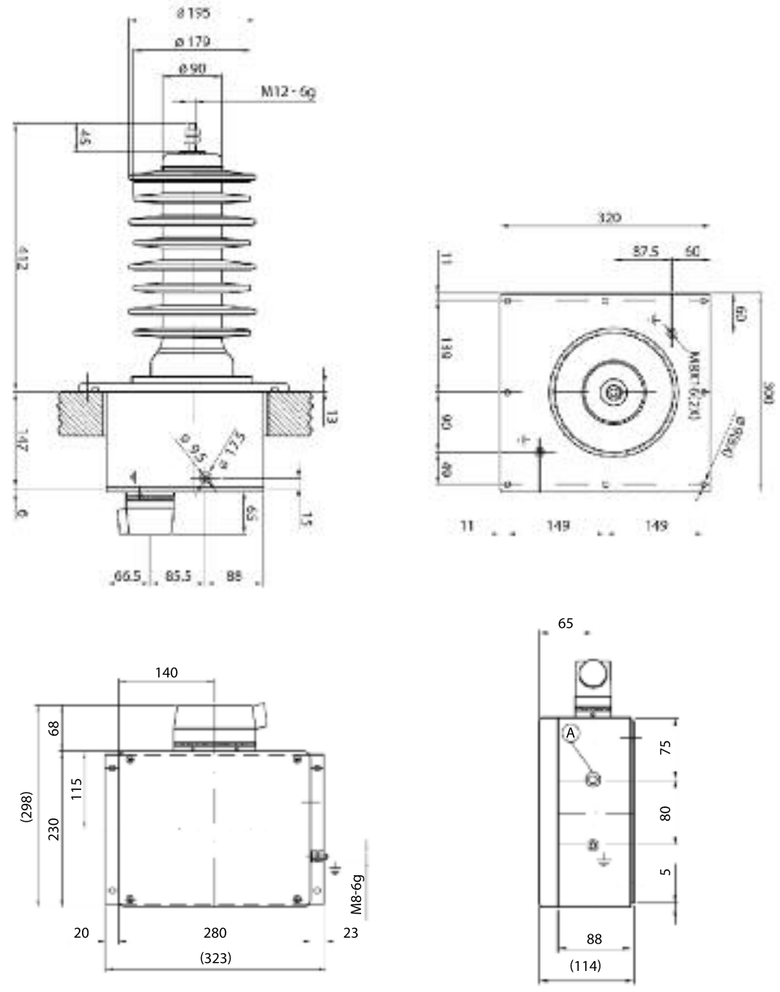
Maximum Speed of the rolling stock (on which the device is installed)	350 km/h
Storage temperature	from -45°C to +80°C
Class of air temperature (EN50125-1)	TX (from -45°C to +75°C)
Class of altitude range (EN50125-1)	A1 (up to 1400m)
Relative humidity at 40°C	95%
Maximum solar radiation (EN50125-1)	1120W/m2
Protection level for terminal box (EN60529)	IP 66 (RTL); IP 54 (IRTL)
Transvers acceleration (EN50125-1)	GT1
Longitudinal acceleration	GL1
Shock and vibrations	EN 61373
Contamining fluids (60721-3-5)	5F3
Lateral wind withstand	up to 25m/s, gusts up to 40 m/s 1s
Weight	18kg (RTL) + 7.5kg (IRTL)

Electrical Performances

The EUROMETER operates under the following four different power supply systems (EN 50163 - Railway Systems Supply Voltages).

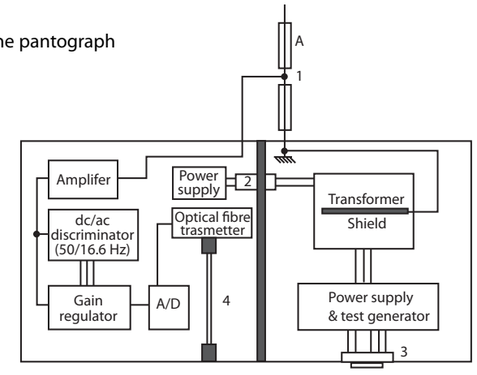
Electrification System/Nominal Voltage	**Working Range**	
DC 1.5 kV	900 ÷ 2.200	V_{DC}
DC 3kV	2.000 ÷ 4.000	V_{DC}
AC 15kV 16 2/3 Hz	10.000 ÷ 19.000	V_{AC}
AC 25kV 50 Hz	17.000 ÷ 30.000	V_{AC}

Overall Dimensions (mm)



Functional Scheme

Terminal A is connected to the pantograph



1. High voltage divider
2. Connector for communication between two separate internal compartments
3. Power supply connector
4. Internal optical fibre

Integrameter

General Characteristics
INTEGRAMETER is the last born in our line of on-board metering products and integrates in a single product many functions that were previously divided into multiple components from different suppliers. Thanks to this patent, Microelettrica has become the one supplier in the world to create and deliver a compact and fully integrated device whose characteristics, both in the high voltage section and in the low voltage metering section, offer maximum reliability and safety.

Functions
INTEGRAMETER's functions are highly customized according to our customers' needs or suggestions coming from our experience:
- Detection and measurement of the instantaneous catenary AC and DC voltages
- Detection and measurement of the instantaneous catenary AC and DC currents
- Measurement of energy consumption
- Analog and/or digital output signals
- RS422 or RS485 serial outputs
- On-line diagnostic through optical fibre

Possible options may include:
- Measurement of harmonics
- GSM communication
- GPRS on board

Environmental Performance
The device is compliant with all the regulations of the rail market. All the components are homologated for the industrial temperature range (from -45°C to +80°C - Class TX - EN 50125-1) and ensure a proper working in the worst environmental conditions.

Maximum Speed of the rolling stock on which the device is installed	350 km/h
Storage temperature	from -45°C to +80°C
Class of air temperature (EN50125-1)	TX (from -45°C to +75°C)
Class of altitude range (EN50125-1)	A1 (up to 1400m)
Relative humidity at 40°C	95%
Maximum solar radiation (EN50125-1)	1120W/m2
Protection level for terminal box (EN60529)	IP 66
Transverse acceleration (EN50125-1)	GT1 (2 m/s2 for less than 50ms, 1m/s2 for more than 50ms)
Longitudinal acceleration	GL1 (max 2 m/s2)
Shock and vibrations	EN 61373
Contamining fluids (60721-3-5)	5F3
Lateral wind withstand	up to 25m/s, gusts up to 40 m/s 1s
Weight	58kg

Electrical Performances
The INTEGRAMETER operates under the following power supply systems (EN 50163 – Railway Systems Supply Voltages).

Electrification System/Nominal Voltage	**Working Range**	
DC 1.5 kV	900 ÷ 2.200	V_{DC}
DC 3kV	2.000 ÷ 4.000	V_{DC}
AC 15kV 16 2/3 Hz	10.000 ÷ 19.000	V_{AC}
AC 25kV 50 Hz	17.000 ÷ 30.000	V_{AC}

The basic configuration includes up to:
- 8 redundant analog outputs are available for the measurement of the catenary voltages
- 2 analog outputs for catenary AC currents
- 10 redundant digital outputs (relays) for detection of the catenary line system or for diagnosis (see appendix 2)
- Serial ports allow both a redundant serial transmission of voltage and current (RS422 in the basic configuration) and energy measurement (RS485)
- Testing port it is possible to activate a TEST function to check the INTEGRAMETER's proper voltage and current output generation
- Precision. 1% class TX

Connections
The INTEGRAMETER is supposed to be mounted on the vehicle's roof, by the pantograph.
A terminal is connected to the pantograph while the other is directly connected to the AC High Speed Vacuum Circuit Braker.
A third terminal is directly connected to the DC High Speed Circuit Braker with an external device that provides the measurement of the current under 3kV$_{DC}$ lines.