



***DIACLAD - DIRECT CURRENT  
METAL CLAD SWITCHGEAR***

## THE DIACLAD SWITCHGEAR

The DIACLAD is a DC metal-clad switchgear, with full metal segregations, for medium voltage and indoor installation, designed and built in accordance with:

- the Italian standards CEI 17-13
- the European standards IEC 439
- the standards of main nations.

It is equipped with draw-out high-speed DC circuit breakers of the IR 6000 series. For detailed description of these breakers, refer to publication **IR 6000**.

### DESIGN CRITERIA

In the design of DIACLAD several aspects were taken into consideration so as to obtain the best results in terms of personnel and system safety, as the following points illustrate.

#### Personnel safety

In order to assure the absolute safety of normal running and maintenance operations, the following features have been provided:

- Careful analysis of the metal enclosure, component layout, the relative separations and the protection shutters for live components, in order to prevent accidental contacts.
- Completely independent access to the low voltage circuits and devices, which are entirely separate from the medium voltage ones.
- Extra ruggedness of the DIACLAD supporting structure and of the separating sheet-metal baffles.
- Careful analysis of cell fittings and locks so as to prevent incorrect actions that could harm the operator. The shutters are fail-safe, and close when the circuit breaker is extracted.
- Neutral grounding of the outer enclosure, the supporting structure, the metal separations, the doors and the draw-out elements for the duration of the disconnection.

#### System safety and fire prevention features

Maximum continuous running is guaranteed by the quality of the materials employed and by the technical solutions implemented, so as to adapt the DIACLAD to all service needs. From this standpoint, the main design features are:

- Careful selection of the isolating materials, chosen on the basis of their function within the cubicle. These materials are the best available and are guaranteed to be flameproof and arc-proof.
- The panels are all constructed in materials that satisfy the strictest user requirements in terms of reaction to fire, toxic gases and opaque smokes. These features make them ideal for use in subway line installations.
- Large section bus bars are used to increase resistance to electrodynamic stress.
- Mechanical interlocks are designed in such a way as to protect the operator and to prevent incorrect actions that could put the switchgear out of service. In particular, the auxiliary service connector has been fitted with an interlock that prevents the circuit breaker from being inserted or extracted if it has not been internally opened.
- Use of the IR 6000 high-speed circuit breaker, whose features guarantee a maximum reduction of the risk of fire, explosions and the triggering of internal arcs generated in the circuit breaker unit.



The DIACLAD after having been successfully subjected to tests at the CESI Laboratory

#### Compactness, ease of installation and maintenance

The quality and technology of the DIACLAD components have lead to the following important results:

- Limited dimensions due to the high performance of the isolating materials, careful study of the elementary cells and especially the extreme compactness of the IR 6000 circuit breakers (see dimension drawing).
- Reduced installation and connection costs to both low and high voltage circuits, due to reduced dimensions.
- Ease of maintenance because live components are completely separate, thus allowing access to high and low voltage devices even when adjacent cells are in operation.

#### Flexibility and versatility of use

The DIACLAD switchgear has been designed with standardized modular components that offer the following advantages:

- Designed for installation side-by-side with power converters.
- Flexibility due to the vast array of functional units available, such as: feeder arrival, connector, outgoing feeders. These units are inserted in the switchgear so as to offer the systems engineer the greatest possible implementation flexibility.

#### Certification

The DIACLAD has been successfully subjected to an exhaustive test cycle at the CESI Laboratory (Centro Elettrotecnico Sperimentale Italiano "G. Motta" in Milano).

The test certificates are available upon request.

## DIACLAD SWITCHGEAR DESCRIPTION

The DIACLAD metal-clad switchgear consists of a series of standardized units, in which the operating equipment and the control, measurement and protection devices are mounted, along with the power and auxiliary connections. The units are subdivided into elementary cells that can be combined in various ways and whose features are described as follows.

The normal degree of protection for DIACLAD is:

- IPH3 for the outer enclosure and the separation between the compartments and the cells
- IPH2 for the remaining separations, including shutters.

For different levels of protection, contact the Sales Office of EMC Traction - Vimodrone - Milano.



Complete switchgear for subway

### Circuit breaker cell

The cell, housing the IR 6000 circuit breaker, is located in the front part of the unit itself.

The following components are mounted in this cell:

- Fail-safe metal shutters, mechanically activated by the circuit breaker
- Mechanical and electrical interlocks
- Mechanical and/or electrical breaker travel mechanism, operable with door closed
- Auxiliary circuit connector
- Circuit breaker position signalling limit switch
- Circuit breaker grounding system
- Fixed metal-clad studs.

The circuit breaker may be in one of the following positions in the cell:

- **Connected:** normal operating position, with main and auxiliary circuits connected
- **Disconnected for testing:** power circuits are disconnected while auxiliary circuits are connected

- **Disconnected, off-line:** power circuits and auxiliary circuits are disconnected.

The "disconnected for testing" and the "disconnected, off-line" positions are in the same physical position: it is possible to pass from one to the other by disconnecting the auxiliary circuits' connector.

The circuit breaker can be moved into the various different positions when the door is closed. The positions are delimited by stops: the circuit breaker is mechanically locked in each position. Between the connected and disconnected positions the truck is grounded by means of sliding contacts.

The position of the circuit breaker is signalled visually through a slot on the cell door. Signalling is mechanical to ensure reliability.

The three positions are:

- **Disconnected:** corresponds to the "disconnected for testing" and the "disconnected, off-line" positions
- **Red indicator:** signals that the circuit breaker is in an intermediate position, between connected and disconnected
- **Connected:** operating position.



The circuit breaker cell



Interior of circuit breaker and connector cells

The cell is provided with a series of interlocks to prevent incorrect operations and insure that they are carried out at the correct rate. These mechanical interlocks are sized using deformation and breakage safety coefficients no lower than those used for the relative governing devices, and are

- Device to lock the circuit breaker truck in the connected and disconnected positions
- Lock that prevents the insertion and extraction of the truck when the circuit breaker is closed
- Lock that prevents the circuit breaker from closing when the truck is in an intermediate position between connected and disconnected
- Lock that prevents the accidental opening of the shutters when the circuit breaker has been extracted
- Lock that prevents the circuit breaker from being moved into connected position if the ground switch is closed, and prevents the ground switch from closing if the circuit breaker is in a position other than disconnected

- Lock that prevents circuit breakers with different features from those originally considered from being inserted into the same cell.

#### Low voltage cell

Accessible from the front of the compartment, it is completely separate from the circuit breaker cell and contains the low voltage equipment:

- A panel in the upper section houses control circuits, terminal boards and auxiliary equipment, such as fuses, control switches, etc.
- Protection relays, measuring instruments, switches and optical indicators (suitably protected against accidental contacts with door open) are mounted on the door
- All the equipment has a protection level of IPH20 with door open



Cell with draw-out CS 6000 isolator



Rectifier cell for Genoa subway

## PROTECTION FEATURES

Each compartment can be equipped with the following accessories, according to its function:

- DIAL-LP/IM line-test relay: it allows to check that the contact line is undamaged before closing the circuit breaker, to prevent circuit breaker operation during line short circuits.

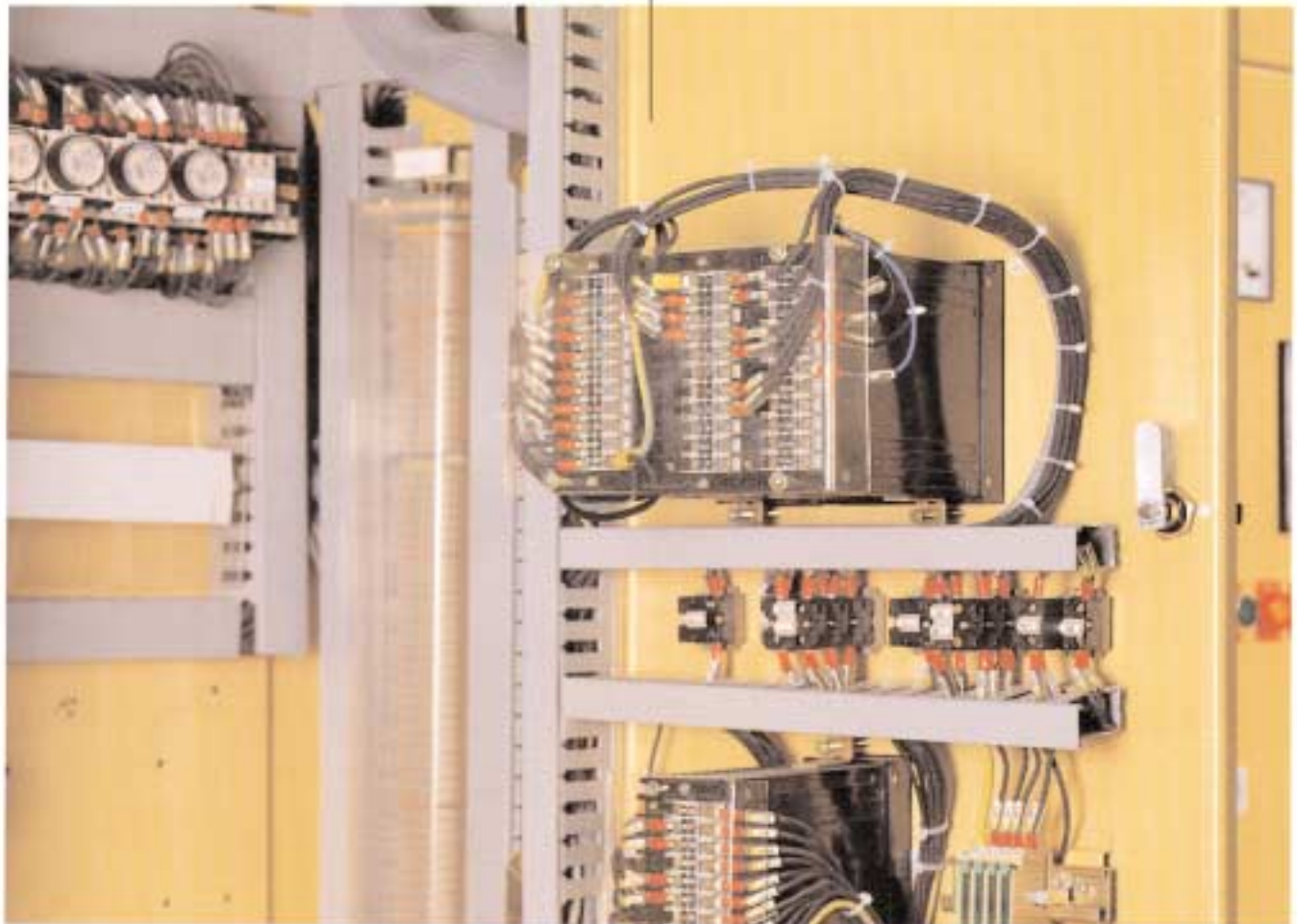
- DIA-IGT diagnostic relay: it monitors the circuit breaker wear in order to signal when maintenance operations are necessary.
- DIA-IGT gradient relay: it monitors the current gradient in order to discriminate motor start-ups from any other type of possible line breakdowns.
- DIA-IGT thermal image relay: it monitors the current and signals any unacceptable overload conditions, especially with regard to the circuit breaker and rectifier.



Protection and diagnostic relay



Line-test relay



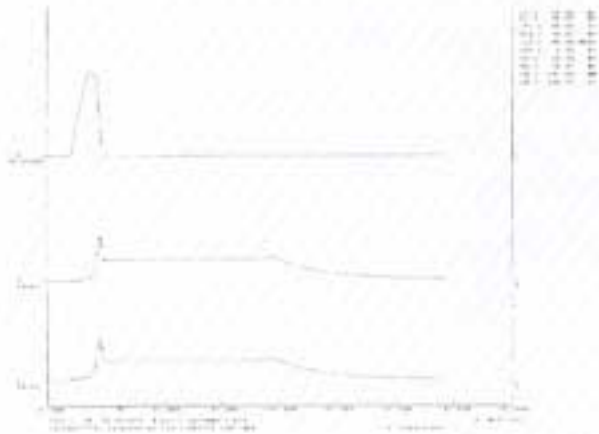
Low voltage cell

## TECHNICAL FEATURES

CIRCUIT BREAKER	IR 6015 <sup>(1)</sup>			IR 6025 <sup>(1)</sup>			IR 6030 <sup>(1)</sup>			IR 6040 <sup>(1)</sup>			IR 6050 <sup>(1)</sup>					
	IR 6001 <sup>(2)</sup>			IR 6002 <sup>(2)</sup>			IR 6003 <sup>(2)</sup>			IR 6005 <sup>(2)</sup>								
Rated voltage V <sub>cc</sub>	750	1500	3000	750	1500	3000	750	1500	3000	750	1500	3000	750	1500	3000			
Breaking capacity kA	120	90	70	120	90	70	120	90	70	120	90	70	120	90	70			
Test voltage 50 Hz for 1 minute • between main contacts kV • main circuits to auxiliary circuits and ground • auxiliary circuits to ground kV	7			15			7			15			7			15		
Rated current A	1500			2500			3150			4000			5000					
Exceptional overloads • for 2 hours A • for 7 minutes A • for 40 seconds A	1800			3000			3800			4800			6000					
	2500			5000			6300			8000			10000					
	4500			10000			12000			15000			19000					

(1) Breaker with self-extinguishing isolating materials, free of halogens, white smokes.

(2) Breaker with standard isolating materials.



Test oscillogram at 1050 kV DC, 120 kA

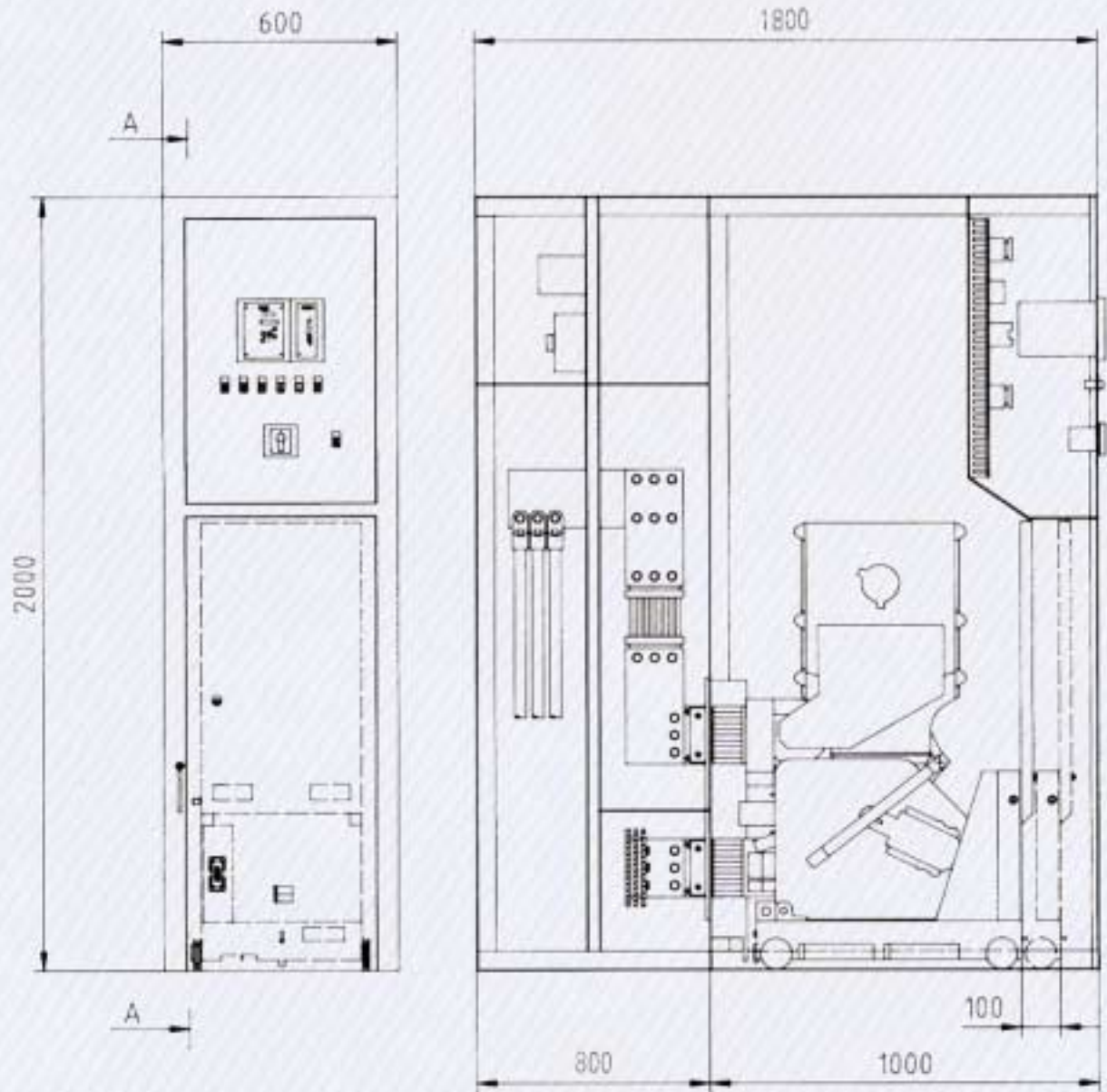


Operation for the circuit breaker insertion



Draw-out IR 6000 high-speed circuit breaker

# OVERALL DIMENSIONS OF THE TYPICAL UNIT



SEZ. A-A

Dimensions in millimeters