

# MARECHAL electric



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## *Technical Training Manual* *2009 - Part 5*

# APPLICABLE STANDARDS AND LEGAL REQUIREMENTS

## APPLICABLE STANDARDS

From one geographical area to another, methods of assessment and acceptance criteria of products vary, which leads them to display varying nominal characteristics.

According to IEC standards, for instance, the permissible temperature rise for plugs and socket-outlets is limited to 50 K. In North American plugs and receptacles standards, the permissible temperature rise is set to 30 K. As a consequence, a socket-outlet sold for 30 A in the rest of the world is sold for 20 A only in the U.S.A.

Standards define minimum levels of performance. One of the reasons for the success of **Marechal** products is that they outperforms all these minimum requirements.

To cater for some special applications which are common for them, our products have also been tested to particular standards regarding resistance to vibration, corrosion, salt fog, etc. They have a fire and smoke index (IFF).

Tables hereafter indicate the main requirements of major standards.

### IEC/EN 60309-1 standard Ed. 4.1

#### Plugs, Socket-outlets and Couplers for industrial purposes Part 1: General requirements

This standard applies to plugs, socket-outlets and couplers (referred to as accessories) with a rated operating voltage up to 690 V d.c. or a.c. and 500 Hz a.c. and a rated current up to 250 A, primarily intended for industrial use, either indoors or outdoors.

Its general requirements apply to all kind of accessories whatever the contact technology used.

Nominal current	Number of operations	
	Electrical endurance Making and breaking	Overload conditions Making and breaking
10 to 29 A	5 000 @ $I_n \times U_n \cos \varphi$ 0.6	50 @ $1.25 I_n \times 1.1 U_n \cos \varphi$ 0.6
30 to 59 A	1 000 @ $I_n \times U_n \cos \varphi$ 0.6	50 @ $1.25 I_n \times 1.1 U_n \cos \varphi$ 0.6
60 to 99 A	1 000 @ $I_n \times U_n \cos \varphi$ 0.6	20 @ $1.25 I_n \times 1.1 U_n \cos \varphi$ 0.6
100 to 199 A	250 @ $I_n \times U_n \cos \varphi$ 0.7	20 @ $1.25 I_n \times 1.1 U_n \cos \varphi$ 0.7
200 to 250 A	125 @ $I_n \times U_n \cos \varphi$ 0.8	10 @ $1.25 I_n \times 1.1 U_n \cos \varphi$ 0.8
Temperature rise	Terminals and contacts < 50 K	
Short-circuit withstand test	10 kA @ $U_n$ with gG type fuse rated at $I_n$	
Dielectric strength test	$2 \times U_n + 1\,000$ V / 1 minute	

Edition 4.1 of IEC 60309-1 standard introduces additional rating, including those of the decontactors. They appear in the tables as 'Other ratings'.

Nominal current A		
Preferred ratings		Other ratings
Series I	Series II	
		6
		10
16	20	
		25
32	30	
		40
		50
63	60	
		80
		90
125	100	
		150
		160
250	200	

### IEC/EN 60309-2 standard Ed. 4.1

#### Plugs, Socket-outlets and Couplers for industrial purposes Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories

This standard applies to accessories using pins and contact-tubes with standardized contact configurations up to 125 A.

Although these accessories must comply with the general requirements set in IEC/EN 60309-1, they benefit from some exemptions:

- "Clause 20 Breaking capacity: Plugs and appliance inlets are not to be tested."
- "Clause 21 Normal operation: Plugs and appliance inlets are not to be tested."
- "Clause 29 Conditional short-circuit current withstand test: Accessories manufactured according to this standard are considered to have a minimum prospective short-circuit current withstand of 10 kA.
- At very low voltages, there is no distinction between a.c. and d.c. products.
- Voltage ranges are not joined, in such a way that there is no standard product below 20 V or between 25 V and 40 V (and particularly for 28 V), and between 500 V and 600 V
- No product is standardised for uses above 50 Hz in 63 A and 125 A

- For 16 A and 32 A products, there is a single keying position for all voltages from 50 V up to 690 V between 300 Hz and 500 Hz,
- Moreover, it is not possible to have two non-intermateable products delivering the same supply, as required to distinguish between convenience outlets and outlets dedicated to a special purpose.

### IEC/EN 60309-4 Ed. 1.0 standard

Plugs, Socket-outlets and Couplers for industrial purposes

Part 4: Switched Socket-outlets and Connectors with or without interlock

This standard covers accessories with a switching device, including those with **integral switching**.

Deconnectors are therefore covered by this standard

### IEC / EN 60947-3 standard Ed 3.0

Low-voltage switchgear and controlgear

Part 3: Switches, Disconnectors, Switch-disconnectors and Fuse-combination units

Utilisation category	A.C. applications	Nominal current A	Number of operations			
			Mechanical endurance	Electrical Endurance Making and breaking operation	Overload conditions	
					Making	Breaking
AC-22	Switching of mixed resistive and inductive loads including moderate overloads	I ≤ 100	AC-22A: 8 500	1 500 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.8	5 operations @ 3 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.65	
			AC-22B: 1 700	300 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.8		
		100 < I ≤ 315	AC-22A: 7 000	1 000 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.8		
			AC-22B: 1 400	200 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.8		
AC-23	Switching of motor loads or other highly inductive loads	I < 100	AC-23A: 8 500	1 500 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.8	5 @ 10 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.45	5 @ 8 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.45
			AC-23B: 1 700	300 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.65		
		100 < I ≤ 315	AC-23A: 7 000	1 000 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.65	3 @ 10 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.35	3 @ 8 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.35
			AC-23B: 1 400	200 @ I <sub>n</sub> x U <sub>n</sub> cos φ 0.65		
Temperature rise		< 80 K				

Utilisation category	A.C. applications	Nominal current A	Number of operations			
			Mechanical endurance Making and breaking operation	Electrical Endurance Making and breaking operation	Overload conditions	
					Making	Breaking
AC-2	Slip-ring motors: starting, reversing, switching off	All values	Preferred values: 1 000 3 000 10 000 30 000	6 000 times @ 2 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.65	50 operations @ 4 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.65	
AC-3	Squirrel cage motors: starting, switching off during running	I ≤ 100 A	300 000 1 000 000	6 000 times @ 2 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.45	50 @ 10 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.45	50 @ 8 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.45
		I > 100 A		6 000 times @ 2 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.35	50 @ 10 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.35	50 @ 8 I <sub>n</sub> x 1.05 U <sub>n</sub> cos φ 0.35
Temperature rise		< 80 K				

## IEC 61984 standard Ed. 2.0

### Connectors - Safety requirements and tests

Essential requirements of this standard with regards to the deconnectors mainly concern additional markings, in addition to usual markings. These markings must appear at least in the technical literature or in the catalogue of the manufacturer, and not necessarily on the product itself:

Minimum markings - Example of the DS6	P/N° 31-64227
Assigned voltages between phase and neutral and between phases	577 V-1000 V
Withstand voltage, if any specified	3 kV
Pollution degree	3
Product temperature range, temperature rise included	-40 °C/+100 °C
Type of terminal	Screw type
Size of connectable conductors	25 mm <sup>2</sup> flexible / 35 mm <sup>2</sup> stranded
Reference to the current standard	CEI 61984

## IEC 60204-1 standard Ed 5.0

### Safety of machinery - Electrical equipment of Machines - Part 1: General requirements

#### Supply disconnecting (isolating) device

The supply disconnecting device may be a plug/socket combination.

When the supply disconnecting device is a plug/socket combination it shall have the switching capability, or be interlocked with, a switching device that has a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor.

*NOTE: A suitably rated plug and socket-outlet, cable coupler, or appliance coupler, in accordance with IEC 60309-1 can fulfil these requirements.*

Where the plug/socket combination is rated at 30 A or greater, it shall be interlocked with a switching device so that the connection and disconnection is possible only when the switching device is on the OFF position.

Plug/socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked that they are not intended to be disconnected under load.

Where more than one plug/socket combination is used in the same electrical equipment, the associated combinations shall be clearly identifiable. It is recommended that mechanical coding be used to prevent incorrect insertion.

Plug/socket combinations intended for household and similar general purposes shall not be used for control circuits. In plug/socket combinations in accordance with IEC 60309-1 only those contacts shall be used for control circuits which are intended for those purposes

#### Protection against unauthorized, inadvertent and/or mistaken connection

When a plug/socket combination is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing need not be provided.

## UL 2682 standard Ed. 1.0

### Switch-rated plugs and receptacles

This standard applies to non-interlocking plugs, receptacles, power inlets and connectors for use in switching applications, rated up to 800 A and up to 600 V a.c. or d.c.

Rating	Number of operations
Motor starting	Insulator other than ceramic: 250 @ $6 I_n \times U_n \cos \Phi_{0.4-0.5}$ and 6 000 @ $I_n \times U_n \cos \Phi_{0.75-0.8}$
General purpose	Insulator other than ceramic: 250 @ $1.5 I_n \times U_n \cos \Phi_{0.75-0.8}$ et 6 000 @ $I_n \times U_n \cos \Phi_{0.75-0.8}$
Temperature rise	< 30 K at terminals
Dielectric strength	Up to 300 V: 2 kV / 1 minute From 301 V to 600 V: 3 kV / 1 minute
Resistance to short-circuit	Up to 200 A: 10 kA $\cos \Phi_{0.4-0.5}$ 201 to 400 A: 18 kA $\cos \Phi_{0.25-0.30}$ 401 to 600 A: 30 kA $\cos \Phi \leq 0.15$ 601 to 643 A: 42 kA $\cos \Phi \leq 0.15$

## UL 1682 Ed. 3 and CSA C22.2 No. 182.1-07

### Plug and receptacle standard

Rating	Number of operations	
	Electrical endurance Making and breaking	Overload conditions Making and breaking
10 to 20 A	5 000 @ $I_n \times U_n \cos \Phi_{0.75-0.8}$	50 @ $1.5 I_n \times U_n \cos \Phi_{0.75-0.8}$
21 to 63 A	1 000 @ $I_n \times U_n \cos \Phi_{0.75-0.8}$	50 @ $1.5 I_n \times U_n \cos \Phi_{0.75-0.8}$
64 to 250 A	250 @ $I_n \times U_n \cos \Phi_{0.75-0.8}$	20 @ $1.5 I_n \times U_n \cos \Phi_{0.75-0.8}$
251 to 800 A	N/A	N/A
Temperature rise	< 30 K at terminals	
Dielectric strength test	Up to 300 V: 2 kV - from 301 V up to 600 V: 3 kV / 1 minute	
Short-circuit test	N/A	

## AS 3123 standard

### Plugs and Socket-outlets

Electrical endurance Making and breaking capacity	Under consideration	
Mechanical endurance	Up to 20 A:	1 000 operations
	21 to 99 A:	500 operations
	Above 100 A:	100 operations
Temperature rise tests	Terminals and contacts < 50 K	
Dielectric strength test	$2 U_n + 1 000$ V with max. 2 000 V	

## AS 3133 standard

### Air-break switch

Rating	Number of operations
	<b>Electrical endurance</b>
	<b>Making and breaking capacity</b>
Up to 10 A	12 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
15 A	10 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
20 A	9 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
30 A	8 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
40 A	7 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
50 A	6 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
60 A	5 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
80 A	4 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
90 A	3 500 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
100 A	3 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
150 A and above	1 000 @ $I_n \times U_n \cos \varphi$ 0.75-0.8
Temperature rise test	Terminal and contacts < 40 K
Dielectric strength test	$2 \times U_n + 1\,000$ V with max. 2 000 V
Motor rating	50 times locked rotor current @ $U_n \cos \varphi$ 0.5

## UL 98-508 standard

### Non-fused disconnect switches - Manual motor controller - Branch circuit disconnect

Rating 20-200 A	Number of operations - Making and breaking
Motor starting	50 @ $6 I_n \times U_n \cos \varphi$ 0.4-0.5
	1 000 @ $2 I_n \times U_n \cos \varphi$ 0.4-0.5
	1 time withstand @ 10 kA 600 V a.c. $\cos \varphi$ 0.49 with RK5 fuses rated @ 400%
General use	50 @ $1.5 I_n \times U_n \cos \varphi$ 0.7-0.8
	6 000 @ $I_n \times U_n \cos \varphi$ 0.7-0.8
	1 time withstand @ 10 kA 600 V a.c. $\cos \varphi$ 0.4-0.5 with RK5 fuses rated @ 300%
Temperature rise test	< 50 K

## IEC 61892-3 standard

### Mobile and fixed Offshore units – Electrical Installations – Part 3: Equipment

#### “Clause 16.4 Socket-outlets and plugs

16.4.1 Socket-outlets and plugs shall comply with the relevant requirements of IEC 60309, IEC 60884 and IEC 60906.

16.4.5 Socket-outlets for a rated current in excess of 16 A shall be **interlocked with a switch** or **have integral switching** so that a plug cannot be inserted or withdrawn when the switch is on the ON position.”

The deconnector fulfils this condition as the contacts that perform the switching operation are necessarily and inevitably open when the plug is inserted or withdrawn.

## WORKERS' PROTECTION

In France, by decree, plugs, socket-outlets and couplers with a rated current above 32 A may not be separated under load. In Belgium and the Netherlands, a similar requirement applies above 16 A. In Italy, this requirement starts at 1 kW (i.e.  $\approx 5$  A under 230 V).

This can be performed in three different ways only.

1 - Using a socket-outlet that is **mechanically interlocked** with a hand-operated switch:

The switch combined with the socket-outlet has a locking mechanism that prevents its manual operation as long as a plug is not fully inserted. When the switch is closed, the plug cannot be withdrawn.

The size of such a design is anyhow not practical for a connector and a welded switch contact may remain unnoticed.



2 - Using a socket-outlet that is **electrically interlocked** with a contactor. This requires a plug and socket-outlet with ‘pilot’ contact(s), a cable with ‘pilot’ conductor(s) and an additional contactor.

The coil of the contactor is supplied through the pilot contact(s) and conductor(s). The contactor automatically closes when the plug is almost fully mated in the socket-outlet. It automatically opens before the plug is withdrawn.

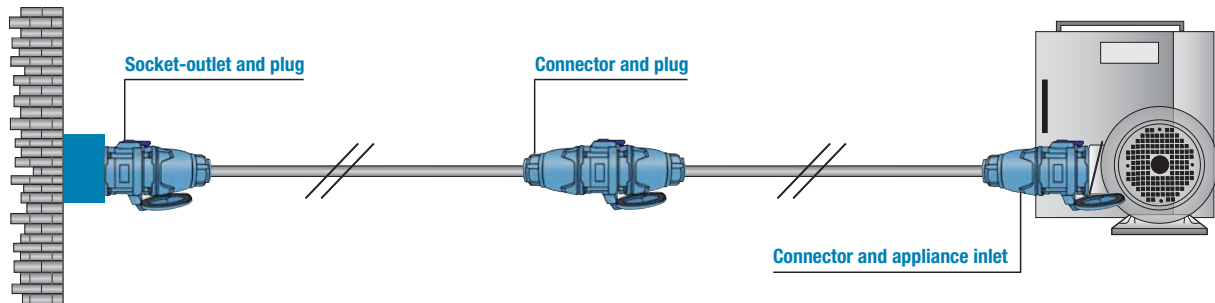
Though safe, it is not cost-effective. A welded contact in the contactor may remain unnoticed.

For more details on electrical interlock, see:

### Part 1: Historical overview of plugs and socket-outlet contact technologies

3 - Using a socket-outlet with **integral switching** such as the decontactor.

The decontactor uses butt contacts on silver-nickel tips similar to those used for electrical switchgears. The same contact is used for both carrying and switching the current, which minimises the size and the number of parts involved. This product combines the simplicity and economy of conventional wiring - without contactors and special cables - with the respect for the toughest safety imperatives.



It can easily be surface or panel-mounted or used as a coupler up to 250 A.



## THE EUROPEAN LOW VOLTAGE DIRECTIVE (LVD) 2006/95/CE

The aim of the European legislation is to harmonise products of its Member States, in order to facilitate its free circulation within the single market. The European Low Voltage Directive sets compulsory **essential safety requirements** in order to guarantee the safety of users and installations against the dangers of electricity.

### Dangers of electricity

The consequences of a corporal contact with electricity go from first to third degree burns to ventricular fibrillation, breathing stopped or heart attack. A current of a few mA across the heart is enough to cause death. Such a current can be generated by a voltage of approximately 100 V. Practically, any voltage above 50 V a.c. is considered potentially hazardous. The LVD covers all electrical appliances with operating voltages between 50 and 1 000 V a.c. (and 75 and 1 500 V d.c.).

### Safety requirements

They are given in Clause 2: *The Member States shall take all appropriate measures to ensure that electrical equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in safety matters in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made.*

This means that the manufacturer is responsible for the conformity of the product at the design stage and then in its manufacture. It also engages its responsibility for the information to the user with regards to the installation, maintenance and use of the product.

### Responsibility and duties of the manufacturer

The LVD imposes to the manufacturer and holds him responsible for:

- Designing and manufacturing a product which complies with the essential safety requirements,
- Following up the procedures of evaluation and assessment of this conformity,
- Retaining control and responsibility for the various operations necessary to the design and manufacture, even when this implies sub-contractors or external suppliers.

### Industrial principles to guarantee the safety of a product

At the design stage, the state-of-the-art in terms of safety must be followed. When a product complies with the requirements and the quality specifications of a standard, it benefits from no more than a presumption of conformity to the

essential safety requirements of the LVD (Clause 5).

At the manufacturing stage, each and every copy of the product must comply with the design specifications that are used as a reference. This is one of the aims of quality control standard ISO 9000.

### Evaluation of conformity

Clause 8 §1 describes the method for evaluation of the conformity which requires the elaboration of a technical documentation and the implementation of a quality control system.

### Elaboration of a technical documentation

The technical documentation is used as a reference. It is used to evaluate the conformity of the product to the essential safety requirements of the Directive. The technical documentation covers both the design and the manufacture and must contain:

- A general description of the product,
- Design and manufacturing drawings,
- Descriptions and explanations necessary to the understanding of the drawings,
- Results of design calculation and controls carried out,
- Test reports.

It is the manufacturer and the manufacturer only who elaborates the technical documentation that must be kept at the disposal of the administration for 10 years.



## Checking of the design

The manufacturer must check the conformity of what he has designed by means of 'type tests' carried out on representative samples of the designed product. The evidence of these tests must be included in the technical documentation.

## Internal manufacturing control

The manufacturer must implement all the necessary measures to guarantee that the products he manufactures comply with the technical documentation.

## CE marking

The manufacturer may then affix the CE marking. This CE marking materialises the fact that the person or company that affixed it has checked that the product fulfils the requirements of the LVD in terms of electrical safety, has been submitted to the procedure of evaluation of this conformity and has been manufactured in the frame of a quality control system.

## BECMA

BECMA (the Butt-contact Electrical Connectors Manufacturers' Association - becma.ch) guarantees that all products using the [Marechal](#) technology do comply with a technical documentation that is common to all manufacturers, and are manufactured according to manufacturing processes covered by an ISO 9000 Quality Management System. [Marechal](#) products comply then with the Low Voltage Directive.

This also guarantees the compliance with the Low Voltage Directive of hybrid assemblies made of accessories from two different manufacturers.