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How to organise your workshop

Low-voltage Switchboard Standardization Production Workshop Guide

Machining workshop

The area of this workshop depends on:
- Working process
- Quantity of parts to be processed and manufactured
- Processing machinery (for shearing, punching, bending and welding, etc.) It is recommended to install a crane at this area for goods handling equipment maintenance and installation.

Part storage area

- To save ground space, it is recommended to use goods shelves. A forklift can be used to remove goods.
- The area of this region can be adjusted according to the quantity of parts in use.
- Note: this area may also include a container for holding and storing waste parts.

Busbar workshop and busbar storage area

- The area of this region can be adjusted according to the quantity of busbar to be stored (busbar length, quantity, considering supply time and demand amount).
- This area is a part of warehouse management, and the busbar shelves can be arranged along the warehouse and should be closed.

Warehouse

This area is closed most of the time (access restricted). The area of this area can be adjusted according to the quantity of components, parts, accessories and other goods. This area includes in-coming inspection and reception area and unused product separation area (products must be marked clearly).

Assembly and wiring area

The following areas should be all reduced or expanded properly according to the size of workload.

Framework assembly area

This area is specially used for assembling switchboard framework and installing busbar. Shelves for storing accessories and parts (e.g. framework, blot, cover plate, door plate, etc.) are necessary.

Functional unit assembly area

A special area is recommended for the assembly of functional unit. This area should be equipped with workbench and facilities for storing various parts and for operation.

Final assembly area

Switchboards are placed in row in this area, and enough space should be kept between switchboards for operation convenience (wiring and assembly).

Test area

This area should be physically separated from other areas, and chain separation tape or other methods can be used for separation. To avoid unexpected contact with charged body during test, visual signal (flashing lamps, etc.) should be set after equipment is electrified.
Technical guide

How to organise your workshop

Low-voltage Switchboard Standardization Production Workshop Guide

Low-voltage switchboard production workshop example 1

Busbar storage area
(Lock area)

Busbar workshop

Warehouse
(Access restricted lock area)

In-coming inspection area

Separation area

Framework assembly area

Functional unit assembly area

Final assembly area

Consumptive material area

Package and delivery area

Machining workshop

Part storage area

20 m

9 m

16 m

2 m
Technical guide

How to organise your workshop

- Consumables area (cable, bolt, etc.)
- Busbar tool area
- Storage area
- Assembly production line
- Quality assurance area

Workflow
Introduction

Storage area

Workflow

Assembly production line

Consumables area

Quality assurance area

Busbar tool area
Introduction

- Warehouse area
- Busbar processing workshop
- Part storage area
- Switchboard assembly area
- Functional unit assembly area
- Production line 1
- Production line 2
- Switchboard assembly area
- Package and delivery area
Tools and Equipment Required
The tools recommended in this section are basic tools required for the assembly, wiring and inspection of Prisma iPM cubicle body.

### Assembly and wiring tools

**Personal tool**

The tool kit of assembly and wiring personnel should at least include the following tools:

<table>
<thead>
<tr>
<th>Assembly type</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing switchboard: cubicle body, mounting plate and panel (except components for switchgear)</td>
<td>One ratchet wrench, One extension component 1”10mm and 1”13mm wrenches, One wrench driver socket, One portable jigsaw</td>
</tr>
<tr>
<td>Installing switchgear and tight connection wire (Compact NS, etc.)</td>
<td>7, 8, 10, 13, 16, 17 and 19 mm sockets, Hexagonal socket drivers of No.4, 5, 6, 8 and 10, Wrench drivers for cross recesses of No.1, 2 and 3</td>
</tr>
<tr>
<td>Switchboard wiring</td>
<td>One slotted screwdriver - 3.5mm - 4mm - 5.5mm, One cross screwdriver of No.2, One electrician knife, One pair of flat nose pliers, One pair of wire stripping pliers, One pair of cable shears, One cable crimping tool, One pair of diagonal cutting pliers</td>
</tr>
</tbody>
</table>

**Group tools**

- One torque wrench for tightening all electric connection installations to set torque (Maximum torque 50 Nm)
- One set of clippers for shearing soft busbars
- One joint punching machine for soft busbars
- One electric saw
- One drill
- One vacuum dust remover for cleaning switchboard

Note: When crimping connector lug, only pliers recommended by connector lug manufacturer can be used.

(1) For the cable terminal of sockets and spline end wrenches.

### Inspection tools

**Personal tools**

Basic tools required for inspection are same as the tools required for assembly and wiring. In addition, the following tools are required:

- One small mirror with hinge
- One electric lamp or portable lamp

**Group tools**

- One console
- One dielectric tester
- One multimeter
Assembling
### Delivery of components

#### Practical rules
- Check the number of packages received against the delivery slip.
- Check that the packing has not been damaged in a way which may have harmed the equipment inside. If necessary, the receiver should make a damage claim to the transporter. Should material damage be detected on any of the products, it must be witnessed by a representative of the transport firm.

#### Examples for Prisma iPM
- Most packages use plastic film allowing visual inspection of the equipment and the assembly manual.
- The Prisma iPM kit system offers additional storage space.

### Storage and preparation prior to assembly

- The components must be stored on indoor, ventilated and dust-free premises. They should, in so far as possible, be left in their packing until final installation as this will protect them against risks commonly encountered in the factory or on site (spraying, impacts, etc.). If they do need to be unpacked, the protective cover should be replaced until the switchboard is finally installed. For optimized organization of the factory, 3 separate areas are identified:
  - 1 storage area
  - 1 working area:
    - with dedicated receptacles for recovery of metal, plastic, cardboard waste, etc.
    - with working tables.
  - 1 test area.

- Storage temperature: -25 °C to +70 °C
- Relative humidity: 95 % at 55 °C

- Do not unpack all the packages. Follow the assembly order recommended in the assembly guide or manuals.

- Provide a table with non-aggressive panels for paintwork (plastic coating, mat), 90 cm high, for assembly of wall-mount and floor-standing enclosures.

- The packaging can be re-used in some cases (e.g. individual WM series cubicle body) for transport following on-site assembly.
Assembling the enclosures
### General

**Practical rules**

Whether supplied as a kit or in one piece, the structure of an electrical switchboard must be sufficiently rigid to withstand forces generated by:

- the weight of the devices
- the electro-mechanical forces due to a short-circuit
- transport.

**Examples for Prisma iPM**

Delivering enclosures in kit form simplifies, among other things, storage and transport.

Assembly is quick and reliable and can be carried out in the factory or on site.

### Assembling the structure

If the enclosure has been delivered in kit form, the structure must be assembled on a flat, clean surface or floor. Use the mounting hardware provided with the enclosure, following the assembly sequence and applying the tightening torques specified in the product technical manual.

Installation of a pair of rafters under each framework or on framework + plinth ensures, among other things:

- secure packing
- better vertical stability during mounting and cabling
- easy handling with a pallet truck
- prevention of damage to the protective paintwork.

The wall-mount and floor-standing enclosures are designed to be mounted and cabled horizontally on a work table to enhance cabling ergonomics.

The cubicle cross-members are drilled to secure the rafters under the framework. As an option a stabilizer can be supplied.

The class B-8 nuts and bolts supplied with the various components ensure tight and durable mechanical connections. The appropriate tightening torques for the various nut and bolt diameters were determined by testing, with an accuracy of ± 10%.

<table>
<thead>
<tr>
<th>Nut and bolt diameter</th>
<th>Tightening torque (in N.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>7</td>
</tr>
<tr>
<td>M6</td>
<td>13</td>
</tr>
<tr>
<td>M8</td>
<td>28</td>
</tr>
</tbody>
</table>
## General

**Practical rules**
The exposed conductive parts on a switchboard must be electrically connected to one another and to the main protective conductor.

**Examples for Prisma iPM**
The electrical connection is achieved by screws and bolts or by assembly design. For this purpose:
- Use only the components, screws, bolts and accessories delivered
- Comply with the assembly instructions given in the manuals
- Tighten to the required torque.

Solutions are tested and require no additional earthing braids.

## Electrical continuity for fixed parts

**Paint** reduces the electrical continuity of the assembled parts. Special devices must therefore be used:

A protective conductor (e.g. earthing wire) must be fitted to all metal moving parts (door, panels, hinged front plates) to which electrical components, other than class 2 components, are secured.

Standard IEC 60364-5-54 defines the minimum cross-sectional area of the connection as a function of the live conductors of the installed electrical equipment.

By design the Prisma iPM system ensures electrical continuity of moving parts by means of hinges. An earthing wire is supplied as standard for doors accommodating HSI (Human Switchboard Interface) electrical components. An earthing wire is supplied optionally for door mounted electrical components and for insertion of communication and low power circuit cables: analog, digital and telecom cables.

Connections between earthing wire and painted sheet metal:
Electrical continuity is ensured using special washers with teeth which cut through the paint to reach the metal.

Connections between earthing wires and welded studs:
The stud is not painted and can consequently be used to provide electrical continuity.

Connections between earthing wire and painted sheet metal:
Electrical continuity is ensured using special washers with teeth which cut through the paint to reach the metal.

Connections between earthing wires and welded studs:
The stud is not painted and can consequently be used to provide electrical continuity.
Technical guide

Assembling
Degree of protection: IP, IK

<table>
<thead>
<tr>
<th>Degree of protection</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard IEC 60439-1 distinguishes between assemblies intended for indoor or outdoor installation. The degree of protection is subject to agreement between the manufacturer and the user for all the enclosure surfaces. The floor and the walls cannot act as an enclosure component for compliance with the IP.</td>
<td>These enclosures are designed for indoor use, corresponding to the majority of installation requirements.</td>
</tr>
<tr>
<td>Degree of protection IP:</td>
<td>The enclosures are subjected to type tests corresponding to their IP level. Protection degrees of Prisma iPM WM series are as follows:</td>
<td>The enclosures are subjected to type tests corresponding to their IP level. Protection degrees of Prisma iPM WM series are as follows:</td>
</tr>
<tr>
<td></td>
<td>Standard IEC 60529 defines an IP code (degree of protection) which characterizes the ability of an enclosure to withstand the following external factors: penetrating solid objects (1st figure) and liquids (2nd figure), protection of persons. According to standard IEC 60439-1, no IP code can be given unless type tests are carried out or tested prefabricated enclosures used.</td>
<td>- IP0, for the protection degree of IP0.</td>
</tr>
<tr>
<td>Degree of protection IK:</td>
<td>A code, IK (EN 50-102), characterizes the withstand of the enclosures to external mechanical impacts (shocks).</td>
<td>- IK08, for the protection degree of IP30, IP31, IP40.</td>
</tr>
<tr>
<td>Protection of persons</td>
<td>The degree of protection of an electrical switchboard accessible to unqualified persons must always be equal to at least P2X.</td>
<td>- IK10, for the protection degree of IP54.</td>
</tr>
<tr>
<td></td>
<td>The cable gland guarantees the same degree of protection as the enclosure on which it is mounted.</td>
<td>The cable gland guarantees the same degree of protection as the enclosure on which it is mounted.</td>
</tr>
</tbody>
</table>

Cable cover plate on FS series cubicle body
Cable cover plate on WM series cubicle body of Model 28 and Model 32

IP30 WM series cubicle body

For Prisma Plus, the minimum degree of protection is IP30. The device control toggles can be operated without any danger. The front plates only allow access to equipment controls and not to their adjustment devices.
# Assembling Devices layout

**Technical guide**

## Temperature rise

<table>
<thead>
<tr>
<th>Practical rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard IEC 60439-1 § 7-3 stipulates checking of temperature rise. Devices which dissipate large amounts of heat should be located in the upper part of the enclosure to:</td>
</tr>
<tr>
<td>■ avoid overheating the other devices installed</td>
</tr>
<tr>
<td>■ maintain device performance without applying a derating coefficient (the reference temperature is complied with)</td>
</tr>
<tr>
<td>■ allow better legibility of the wiring diagram. Use edgewise connections, which encourage heat dissipation, wherever possible.</td>
</tr>
<tr>
<td><strong>NB:</strong> As a rule, the higher the degree of protection, the less heat is exchanged. In some cases, it is easier to air condition the technical room.</td>
</tr>
</tbody>
</table>

## Examples for Prisma iPM

So as to maintain the Merlin Gerin product reference temperatures:

- **Masterpact:** 50 °C to 60 °C
- **Compact:** 40 °C to 50 °C
- **Multi 9:** 40 °C.

The functional units have been designed and tested to operate together. The connections are optimized (length and cross-section) to limit temperature rise. Furthermore, use of distribution blocks is favorable to switchboard thermal balance. Solutions are available to eliminate temperature and hygrometry fluctuations:

- heating resistors preventing formation of condensation, corrosion and surface leakage currents
- **IP54** fan made up of an axial fan, a grill and a filter
- thermostat: installed with the heating devices or with a fan, it limits internal temperature.
## Ventilation

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural ventilation: Openings, which are compatible with the required degree of protection and permit natural convection, should not be blocked.</td>
<td>For most installation requirements, natural ventilation is sufficient to ensure that an electrical switchboard operates properly.</td>
</tr>
</tbody>
</table>

### Forced ventilation:

Under certain conditions (switchboard with a high packing density, high ambient temperature, high degree of protection (IP), etc.), overheating may occur inside the switchboard, preventing the devices from operating properly. Thermal balance calculations will determine whether or not it is necessary to use air-conditioning accessories such as:
- fans
- air conditioners...

or apply temperature derating coefficients.

Air should circulate upwards in the floor-standing enclosures.

The back of the IP30 enclosures is ventilated: a distance of 30 mm must be provided between the wall and the enclosure.

The roof can be equipped with a ventilation kit.

Heating resistors, which are normally used to prevent condensation inside the switchboard, should not be placed too close to the devices. Locate and secure conductors in such a way as to maintain them at a safe distance from any heating elements.
### Ergonomics

<table>
<thead>
<tr>
<th>Practical Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For easy operation of large devices, toggles and controls should be located at a height of between 0.8 m and 1.8 m from the ground.</td>
</tr>
<tr>
<td>2. Connection terminals should be at least 0.2 m off the ground.</td>
</tr>
<tr>
<td>3. Measurement devices requiring visual supervision should not be located above a height of 1.8 m. Their position on the switchboard is generally determined in consultation with the end-user.</td>
</tr>
</tbody>
</table>

### On-site connection of cables and busbar trunking

<table>
<thead>
<tr>
<th>Practical Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is necessary to establish, as soon as possible, the number, cross-section, and type of all incoming and outgoing cables.</td>
</tr>
<tr>
<td>2. Comply with the radius of cable curvature specified by the supplier.</td>
</tr>
<tr>
<td>3. This depends on: core type (Cu, alu, etc.), core cross-section, insulation type. Standards specify a radius of curvature 6 to 8 times cable diameter.</td>
</tr>
</tbody>
</table>

### Examples for Prisma iPM

Standard solutions allow for these ergonomic and standard-specified aspects.

Most connections take the form of prefabricated connections, for example:
- the "incoming connection block" incorporates the incoming connections/incoming unit in the tiniest possible space.
- The incoming unit/busbar connections provide connection from the right or left.

The functional units take into account the connection volumes, regardless of circuit breaker position.
Safety clearances

Practical rules
Comply with the safety clearances required for the devices, as specified by the manufacturer. This ensures that they will operate properly.

Examples for Prisma iPM
The various Prisma iPM installation configurations have been tested. These tests have made it possible to check safety distances:
- between live conductors
- with respect to the surrounding elements.

Distance between devices:

The safety clearances of the Schneider Electric circuitbreakers are given in the device assembly manuals and the catalogue.

The safety clearances of the Merlin Gerin circuitbreakers are given in the device assembly manuals and the catalogue.

The solutions proposed in Prisma iPM do not always comply with safety distances as they have been validated by tests or completed by separating devices to optimize the installation.

Practical rules
Distance from surrounding elements:
This corresponds to the minimum acceptable clearance between a device and the surrounding elements (framework, mounting plate, panels). It is calculated and tested by the device manufacturer.

Examples for Prisma iPM
The Prisma iPM enclosures belong to class 1. Protection of persons is equivalent in class 1 and 2. The Schneider circuit-breakers have a class 2 (double insulation) front panel. They are installed side by side and are in immediate contact with a metal front plate or a door.

Classes 1 and 2:
- This classification is based on 2 considerations:
  - Insulation between the live parts and the accessible parts
  - Whether or not it is possible to connect the accessible metal parts to a protective conductor.
- Class 1 has a main insulation, but contains constructive measures designed to earth the accessible metal parts, i.e. to connect them to the system’s protective conductor.
- Class 2 has constructive measures so as to prevent faults between live parts and the accessible surface.

Use of painted sheetmetal and terminal shields considerably reduces safety clearances.
## Maintainability / upgradeability

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The layout of devices should permit subsequent work:</td>
<td>The design of the system and the installation and connection of the Schneider Electric devices allow any maintenance work which may be required during their service life:</td>
</tr>
<tr>
<td>■ installation of auxiliary switches</td>
<td>■ quick access to devices thanks to the removable front plates and panels, with opening by 1/4 turn screw</td>
</tr>
<tr>
<td>■ detection of any overheating at the connection points</td>
<td>■ device upgrading is facilitated by mounting auxiliaries on the front panel the connection accessories - distribution blocks and comb busbars - allow simple replacement and addition of outgoing devices.</td>
</tr>
<tr>
<td>■ replacement or addition of an outgoing device.</td>
<td></td>
</tr>
</tbody>
</table>

## Mounting devices

<table>
<thead>
<tr>
<th>Device supports must be sufficiently rigid:</th>
<th>The Prisma iPM mounting plates are designed to support Schneider Electric devices without deformation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ to withstand the weight of the device without deformation</td>
<td></td>
</tr>
<tr>
<td>■ to withstand vibrations generated during transport or in the event of tripping.</td>
<td></td>
</tr>
<tr>
<td>Devices should be mounted horizontally or vertically as specified by the manufacturer.</td>
<td></td>
</tr>
</tbody>
</table>

| The mounting instructions are indicated in the technical manuals supplied with the devices and mounting plates. |                                                                                                  |

| Devices should be mounted horizontally or vertically as specified by the manufacturer. | The mounting instructions are indicated in the technical manuals supplied with the devices and mounting plates. |

| Check that the toggles and controls can move freely. It must be possible to close the door with a withdrawable device in disconnected position. | The Schneider power devices can be withdrawn via the front plate. Withdrawal of the device does not prevent the door from being closed. |

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**Assembling**  
**Mounting the devices**

<table>
<thead>
<tr>
<th>Door mounted devices</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The door must be sufficiently rigid to support the weight of the devices. Standard EN 50-298 stipulates that the manufacturer must give the acceptable weight that can be applied on the door. The degree of protection provided by the device being installed must be equal, at least, to the degree of protection specified for the installation. Its installation must not reduce the original IP. An earthing conductor is compulsory for moving metal parts (door, panels, swivel front plates) supporting electrical components that do not belong to class 2.</td>
<td>By design the Prisma iPM system ensures the electrical continuity of moving parts by means of hinges. An earthing wire is supplied as standard with doors accommodating HSI (human/switchboard interface) electrical components. An earthing wire is delivered optionally for door mounted electrical components, as well as for insertion of low power and communication circuit cables: analog, digital and telecom cables.</td>
<td></td>
</tr>
</tbody>
</table>

| Available space | Standard IEC 60439-1 defines the following spaces within assemblies. Free space: an empty space in a switchboard section. Unequipped space: part of a section incorporating busbars only. Partially equipped space: a part of a section fully equipped except for the functional units. The functional units which can be installed are defined in number of modules and size. Fully equipped space: a part of a section fully equipped with functional units not assigned to a specific use. | The modular concept of the Prisma iPM switchboards allows electrical installations to be upgraded easily and new functional units or additional devices to be incorporated as and when required. The maintenance operations carried out when the switchboard is deenergized are both quick and comfortable thanks to 100% access to devices. |

The Prisma iPM enclosures have a top and bottom reference frame:  
- "m0" at the back of the wall-mount and floorstanding enclosures  
- slot (for measuring tape) on the cubicle uprights.  
These reference marks are used to mark mounting plate fixing, as per the instructions in the technical manuals and according to the installation (type of circuit-breaker, type of incomer: by cable or by busbar trunking, cables tied or not).
<table>
<thead>
<tr>
<th>Protection against direct contact</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective measures are required for the devices (barrier, terminal shields) to prevent access to the live parts during operation. Work carried out on the inside of a live switchboard is governed by regulations. Such work must be reserved for qualified personnel only and suitably rigid shielding should be placed around the live parts. The shielding should not prevent air from circulating properly around the devices.</td>
<td>Barriers in the vicinity of 3200 A conductors and barriers of 1P conductors &gt; 630 A must be made (either fully or partially) using nonmagnetic material to avoid any risk of overheating caused by eddy currents.</td>
<td>Operations inside an electrical switchboard must be carried out by qualified personnel complying with all safety measures stipulated. To ensure protection against direct contact, the use of a terminal shield upstream and downstream of Compact NS circuit breakers is compulsory, as is also installation of form 2 barriers on top and bottom horizontal busbars.</td>
</tr>
<tr>
<td><strong>NB</strong>: to make specific partitions or barriers, Schneider recommends use of sheets of selfextinguishing Polycarbonate at 960 °C, at least 1.5 mm thick.</td>
<td></td>
<td><strong>NB</strong>: to make specific partitions or barriers, Schneider recommends use of sheets of selfextinguishing Polycarbonate at 960 °C, at least 1.5 mm thick.</td>
</tr>
<tr>
<td>To increase operator safety still further, the devices are installed behind a protective front plate (operated by means of a special tool) leaving only the control or toggle uncovered. The doors come with a key or a closing system using a special tool.</td>
<td></td>
<td>To increase operator safety still further, the devices are installed behind a protective front plate (operated by means of a special tool) leaving only the control or toggle uncovered. The doors come with a key or a closing system using a special tool.</td>
</tr>
<tr>
<td>Additional internal protection devices (partitions, barriers) are used to produce forms 2, 3 or 4. They provide protection against direct contact on live parts.</td>
<td></td>
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</tr>
</tbody>
</table>
Cabling
### Principle

The type and cross-section of the busbars should be sufficient to carry the required current for a given temperature rise, thus ensuring that the electrical switchboard functions correctly.

### Type of materials

**Aluminium:**
Choose a quality of aluminium which is easy to use and which provides excellent conductivity and a surface coating guaranteeing electrical contact and good resistance to corrosion.

**Copper:**
Choose a quality of copper which is easy to use and which provides excellent conductivity and good resistance to corrosion.

The Linergy busbars have undergone surface treatment (anodisation) and the contact surface has been prepared. The Schneider Electric copper busbars are of the type Cu ETP (H12) conform to standards and are qualified.

### Busbar number and crosssection

Follow the manufacturer’s recommendations when determining the number and crosssection of the bars for each phase.

The acceptable cross-sections and currents of the busbars are given in the assembly manuals and the catalogue. Calculations allow for:
- the continuous current to be carried by the switchboard
- the short-circuit current
- the ambient temperature (35 °C as per IEC 60439-1)
- the degree of protection provided by the enclosure.

### Busbar position

**Edgewise bars:**
Preference should be given to this arrangement encouraging heat loss.

In most of our busbar installation solutions, busbars are arranged edgewise. This bar position is frequently used as it encourages cooling by convection.
### Bar position (continued)

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat bars: For flat bars, use the calculation aids defined for edgewise bars and apply a derating coefficient.</td>
<td>When using flat bars (transfers of an incoming device on busbar), a 0.8 derating coefficient is recommended. For example: Two 80 x 5 bars, operating in a comparable environment and with the same ambient temperature, carry:</td>
</tr>
<tr>
<td></td>
<td>■ 1600 A if the bars are edgewise</td>
</tr>
<tr>
<td></td>
<td>■ 1280 A (1600 x 0.8) if the bars are flat.</td>
</tr>
</tbody>
</table>

### Clearance

<table>
<thead>
<tr>
<th>Clearance is the shortest distance in the air between:</th>
<th>Standard, tested components can be used to produce electrical switchboards with a rated insulation voltage (Ui) and a rated impulse withstand voltage (Uimp) appropriate for the devices connected to them:</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ two live conductors</td>
<td>■ distribution busbar (Multi 9)</td>
</tr>
<tr>
<td>■ a live conductor and an exposed conductive part.</td>
<td>○ Uᵢ = 500 V</td>
</tr>
<tr>
<td></td>
<td>○ Uᵢmp = 6 kV</td>
</tr>
<tr>
<td></td>
<td>■ distribution busbar (Compact):</td>
</tr>
<tr>
<td></td>
<td>○ Uᵢ = 750 V</td>
</tr>
<tr>
<td></td>
<td>○ Uᵢmp = 8 kV</td>
</tr>
<tr>
<td></td>
<td>■ main busbar:</td>
</tr>
<tr>
<td></td>
<td>○ Uᵢ = 1000 V</td>
</tr>
<tr>
<td></td>
<td>○ Uᵢmp = 12 kV</td>
</tr>
</tbody>
</table>

Standard IEC 60439-1 specifies a rated impulse withstand voltage according to:
- the rated insulation voltage
- the location of the switchboard.

The same standards indicate the minimum clearances required to withstand, in all cases, impulse voltages for altitudes ranging from 0 to 2000 m.

The minimum clearance to be complied with is 14 mm (Uᵢ = 1000 V) between live parts. In Prisma Plus, the clearance between phases is 75 mm and the busbars are installed on insulating supports.

Tests were carried out as per the degree of protection against impacts IK of the Prisma Plus enclosures; they made it possible to ensure that clearance was maintained.
### Creepage distance

**Practical rules**
Creepage distance is the shortest distance along the surface of an insulator between:
- 2 live conductors
- 1 live conductor and an exposed conductive part.

Standard IEC 60439-1 specifies a value in mm for creepage distance. It depends on:
- the rated insulation voltage of the switchboard
- the type of insulating support (group of materials)
- the degree of pollution in the surroundings.

**Examples for Prisma Plus**
As the comparative tracking index (CTI) for the supports is 175 V, standard IEC 60439-1 specifies a minimum creepage distance of 16 mm for an operating voltage of up to 1000 V.

### Arrangement of the bars

If the installation requires several bars per phase, leave sufficient space between them to ensure normal ventilation of the busbar.

Leave at least the equivalent of a single bar thickness between two live conductors of the same phase.

The same support ensures that a 5 mm or 10 mm gap is left between the busbars according to bar thickness.
**Practical rules**

The number of supports and the distance between their centers depend on the following forces:
- electrical (prospective short-circuit current)
- mechanical (bar weight and position).

**Examples for Prisma Plus**

Each configuration has been determined according to the electro-dynamic forces produced in the event of a short-circuit and has been validated by tests carried out in compliance with standard IEC 60439-1.

The supports (or part of them) must be made of a non-magnetic material to avoid any temperature rise due to loop effects around conductors.

The busbar supports do not use metal countersupports.

The counter-supports of the bottom Linergy busbars are made of metal, but the fixing screws are made of non-magnetic material.

The supports of side Linergy busbars are made of completely insulated material.
<table>
<thead>
<tr>
<th>Busbar arrangement in the enclosure</th>
<th>Practical rules</th>
<th>Examples for Prisma Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>The connections must be accessible from the front when the switchboard is mounted against a wall.</td>
<td>The Linergy channelled busbar is installed sideways in the bar zone, to the left or right of the switchgear zone. Their staggered arrangement, due to the supports, means that all the connection points are accessible from the front of the switchboard.</td>
<td>Linergy level layout</td>
</tr>
</tbody>
</table>

The Linergy busbar offers a number of advantages over flat busbars:
- enhanced emissivity increasing heat radiation and reducing busbar temperature rise
- better moment of inertia, thus reducing the number of supports
- substantial weight savings.

Linergy busbar frame
Technical guide

Cabling

Protective conductor PE

It should be sufficiently sized and properly secured to the switchboard to withstand the thermal and electro dynamic forces produced by the fault current. Standard IEC 60439-1 defines a method for calculating the cross section of the protective conductor:

\[ \text{SPE} = \text{I} \times \frac{\text{t}}{\text{I}_0} \times k \]

- \( \text{SPE} \): cross-section of PE in mm²
- \( \text{I} \): value of the phase-to-earth fault current = 60 % of the phase-to-phase fault current (standard IEC 60439-1 § 8.2.4.2)
- \( \text{t} \): duration of the fault current in seconds
- \( k \): a factor depending on the conductor material. \( k = 143 \) for a PVC-insulated copper conductor. It should be earthed to the switchboard earthing terminal.

The PE protective conductor is normally installed in the cable compartment. It can be produced using the following materials:
- a Linergy busbar
- a vertical flat bar
- a horizontal flat bar, secured to the top or bottom of the switchboard (opposite the main busbar).

**Choix du PE**:

<table>
<thead>
<tr>
<th>Low Linergy busbar</th>
<th>cross-section</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (kA rms/1s)</td>
<td>Busbar (A)</td>
</tr>
<tr>
<td>≤ 40</td>
<td>630</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>800</td>
</tr>
</tbody>
</table>

**Choix du PE**:

Low Linergy busbar

<table>
<thead>
<tr>
<th>cross-section</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (kA rms/1s)</td>
</tr>
<tr>
<td>≤ 40</td>
</tr>
<tr>
<td>&gt; 40</td>
</tr>
</tbody>
</table>

Equipotential bonding

Accessible conductive parts of a device must be connected to the assembly protective circuit (for protective bonding) either by its own fastening means or by a conductor with a cross-section chosen from the table below:

In Prisma Plus, equipotential bonding of device exposed conductive parts is achieved by their means of fastening to their supports. Moreover, the supports (mounting plates, vertical and horizontal, frameworks) are bonded equipotentially by their assembly devices.

<table>
<thead>
<tr>
<th>Rated working current</th>
<th>Example: Unpainted Masterpact mounting plate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper wiring</td>
<td>Minimum cross section (mm²)</td>
</tr>
<tr>
<td>(Ie)</td>
<td>(S)</td>
</tr>
<tr>
<td>Ie ≤ 20</td>
<td>S</td>
</tr>
<tr>
<td>20 &lt; Ie ≤ 25</td>
<td>2.5</td>
</tr>
<tr>
<td>25 &lt; Ie ≤ 32</td>
<td>4</td>
</tr>
<tr>
<td>32 &lt; Ie ≤ 63</td>
<td>6</td>
</tr>
<tr>
<td>Ie &gt; 63</td>
<td>10</td>
</tr>
</tbody>
</table>

S = cross-section of the phase conductor
### PEN conductor

**Practical rules**

Cross-section:
The cross-section of a PEN conductor is determined in the same way as for a neutral conductor, in other words:
- for single-phase or three-phase circuits with a copper cross-section of \( y \) mm\(^2\) it must be equal to the phase conductor cross-section
- for three-phase circuits with a copper cross-section \( > 16 \) mm\(^2\) it may be:
  - equal to the phase conductor cross-section,
  - or less on condition that:
    - the current likely to flow through the neutral under normal operating conditions is lower than the permissible current in the conductor,
    - the power of the single-phase loads does not exceed 10% of total power.

Installation:
It must be readily accessible to:
- allow factory and on-site connections
- check tightening.

### Implementing a PEN conductor in LV switchboards

According to standard IEC 60439-1 and French decree dated 14 November 1988, the rules for implementing a PEN conductor are as follows:

- at the entry to the assembly, the PEN connection point must be near that of the phases
- within the assembly, the PEN conductor need not be insulated from exposed conductive parts (except on premises where there is a fire or explosion hazard)
- the cross-section of the PEN conductor must be at least equal to that of the neutral
- a constant cross-section must be used on the main busbars
- the transition from a TN-C to a TN-S earthing system must be made at a single point in the switchboard, via a marked neutral disconnection bar, accessible and removable to facilitate fault loop impedance measurements
- from the point of transition to a TNS system, it is prohibited to recreate a TN-C system. The PE and neutral conductors must satisfy their specific requirements.

### Examples for Prisma Plus

The PEN conductor can take the place of the neutral. It must be connected to the protective conductor by a removable joint (using a special tool) to allow insulation measurements to be taken.
### Internal separation by barriers or partitions

**Practical rules**

The separations within an assembly are defined in section 7.7 of standard IEC 60439-1. They are subject to agreement between the manufacturer and the end-user. Four typical levels (forms) of internal separation are defined for protection against direct contact. The minimum separation IP is IP2X.

**Examples for Prisma iPM**

Prisma Plus handles the functional unit from the busbar to the external cable connection terminals. In most installations, Prisma Plus enclosures require no specific partitioning to guarantee protection of persons and the installation. However, Prisma Plus offers a variety of partitioning types to create separations within electrical switchboards (forms 2, 3 and 4) and facilitate and guarantee the safety of people authorized to perform operation and maintenance.

Protection is provided by:
- the presence of front plates that can only be opened by a special tool
- key-locking of doors accessing live parts
- covering of the upstream connection of the incoming unit.

For protection of persons, Schneider Electric recommends, in addition to the standard’s recommendations, systematic installation of the following:
- a form 2 barrier on the top or bottom horizontal busbar partitioning of the upstream connection of the incoming unit, so that operator safety is guaranteed at all points of the switchboard when the incoming unit is in the open position
- prefabricated connections with built-in plastic insulating cover or installation of upstream and downstream terminal shields on all devices.

### Form 1:

No separation inside the enclosure.

![Diagram](image.png)

- A Incoming unit
- B Main busbars
- C Distribution busbars
- D Outgoing unit
- E Terminals for external conductors
- F Enclosures (at least IP2X).
### Internal separation by barriers or partitions (continued)

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form 2a:</strong> The functional units are separated from the busbars, but not from the terminals.</td>
<td><strong>Prisma Plus</strong> proposes form 2b cubicles offering enhanced safety. This takes the form of physical separation between the horizontal and vertical busbars and the functional units, as per standard 60439-1. <strong>Prisma Ipm</strong> proposes metal barriers for wallmount and floor-standing enclosures in order to:</td>
</tr>
</tbody>
</table>
| ![Diagram](image1.png) G Partitioning at least IP2X. | ■ separate the functional units from one another  
■ separate the devices from a busbar or a distribution block in a duct. |
<p>| <strong>Form 2b:</strong> The functional units and the terminals are separated from the busbars. The terminals are not separated from one another. | <img src="image2.png" alt="Diagram" /> Form 2b horizontal barrier in a floor-standing enclosure. |</p>
<table>
<thead>
<tr>
<th>Internal separation by barriers or partitions (continued)</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 3a: The functional units are separated from one another and from the busbars, but not from the terminals.</td>
<td></td>
<td>Form 2b vertical barrier in a floor-standing enclosure.</td>
</tr>
<tr>
<td>Form 3b: The functional units are separated from one another and from the busbars. The terminals are separated from the busbars but not from one another.</td>
<td>Prisma iPM proposes form 3b cubicles, produced by separating from one another the functional units in a form 2 switchboard. The devices must be equipped with terminal shields downstream. Furthermore, the connection transfer assemblies create a separation between the connection terminals and the functional unit.</td>
<td></td>
</tr>
</tbody>
</table>
## Installation of current transformers

### Principle
Current transformers should be installed without compromising the insulation level or the reliability of the busbars. They can be installed either on the busbar or on the device transfer busbars.

### Practical rules
- Install current transformers on copper connections or on an easily removable busbar.
- Mount the current transformer so that the identification marking remains visible.
- If a bulky current transformer is involved, staggered mounting is advisable to avoid flashover between the fastening screws and excessive distances between the various phase conductors.

### Examples for Prisma iPM
- Schneider Electric component is provided with electric auxiliaries with built-in current transformer, thus making it unnecessary to install a current transformer on the busbar.
- The Merlin Gerin and Telemecanique devices include electrical auxiliaries with built-in CT, thus making it unnecessary to install a CT on the busbar.
### Principle

If they are fitted to vertical bars, attach the current transformers in such a way as to prevent them from sliding downwards (e.g. using a bolt or a pin).

### Practical rules

- To withstand the tightening forces when installing the current transformer
- To avoid any vibrations which might cause the current transformer to break.

### Examples for Prisma iPM

![Diagram of current transformer installation]

If there are several bars per phase, fit a spacer between the bars.

![Diagram of current transformer installation with spacer]
Cabling
Power connections
<table>
<thead>
<tr>
<th>Electrical connections of functional units</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
</table>
|                                          | Standard IEC 60439-1 defines a 3-letter code denoting the types of electrical connections of functional units:  
  ■ 1st letter: type of electrical connection of the main incoming circuit  
  ■ 2nd letter: type of electrical connection of the main outgoing circuit  
  ■ 3rd letter: type of electrical connection of the auxiliary circuits. The following letters must be used in technical documents:  
  - F : for fixed connections  
  - D : for plug-in connections  
  - W : for withdrawable connections. | The range of Schneider circuit-breakers available in fixed, plug-in and withdrawable versions, is particularly well suited to all situations. |

**Fixed circuit-breaker**

**Plug-in circuit-breaker**

**Withdrawable circuit-breaker**
# Connecting the power devices

## Principle
According to switchboard configuration (electrical power, distribution diagram, entry from top or bottom, etc.), the power devices can be connected by busbars and/or cables. These connections must be sufficiently sized to withstand electrical and thermal stresses. Tie devices should be fitted to cables inside and outside the switchboard to prevent application of excessive mechanical forces to the device terminals.

## Practical rules

<table>
<thead>
<tr>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Prisma iPM system offers a whole host of solutions for connection of the incoming and outgoing units.</td>
</tr>
</tbody>
</table>

*Entry by busbar trunking directly on the device*
### Transfer bars on the side

**Practical rules**
Use of transfer bars on the side simplifies front connection.

**Examples for Prisma iPM**
The transfer busbars must be secured to one another and fixed to the framework. Provide supports as close as possible to the device terminals. If necessary, follow the instructions given in the device technical documentation (Masterpact, etc.). The connection terminals are installed in the duct, to the left or right of the device.

Transfer connections often have a cross-section greater than that of the main busbar to allow for:
- temperature rises at the points of connection to the device (proximity effect)
- derating caused, in certain cases, by the orientation of the bars (edgewise or flat bars: see page 12).

Schneider recommends a derating coefficient with respect to the main busbars:
- 0.85 for edgewise bars
- 0.75 for flat bars.

Example: For a main 1000 A busbar installed in an IP30 switchboard, a copper bar with a cross-section of 400 mm² should be used.

The cross-sections for the transfer bars should be:
- edgewise bar: 400 mm²/0.85 = 470 mm² of copper, i.e. one 50 x 10 bar
- flat bar: 400 mm²/0.75 = 533 mm² of copper, i.e. one 60 x 10 bar. The distance between the supports is exactly the same as the one calculated for the main busbar.

Locate a support as close as possible to the device terminals.
### Direct connection by bars

#### Practical rules
- Connection bars can be secured, if possible, using free supports or, failing this, with insulating threaded rods.

#### Examples for Prisma iPM
- A busbar drawing can be supplied when the prefabricated connections are not available in the catalogue.
- On these drawings, the connections are shown with oblong holes (which help positioning) but to simplify you can make cylindrical holes.

### Connection to transfer busbars

#### In this case, use the derating coefficient (flat bars).

#### Copper connections of the same phase are separated by 5 mm spacers. Flat bars are secured using insulating bars.

#### The space required for connection to the busbar is allowed for in the device height requirements specified in the catalogue.

#### Linergy busbars: a continuous channel makes it possible to connect bars at any height, without holes drilled on the busbar.
Hole punching

Practical rules
Holes should be made if possible using a punch fitted with a spring-loaded stripper plate that allows the punch to be raised without deforming the bar.

Priming diameter depends on the bolts used.

<table>
<thead>
<tr>
<th>bolt max. diameter</th>
<th>punching diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>7</td>
</tr>
<tr>
<td>M8</td>
<td>10</td>
</tr>
<tr>
<td>M10</td>
<td>12</td>
</tr>
<tr>
<td>M12</td>
<td>14</td>
</tr>
</tbody>
</table>

Check regularly the cutting edge of the punch and the space between the punch and the die (0.5 mm) in order to avoid flash or deformation of the copper by creep.

Examples for Prisma iPM
For the best possible electrical connection, Schneider recommends that the holes be punched along a single line. Pressure is thus evenly spread out over the full contact surface (see page 47).

Prisma iPM solutions offer possibilities without drilling holes by tie systems.

Bending

Comply with the minimum bending radius to avoid cracking or tearing the metal.

Copper quality allows bends with a minimum radius of curvature equal to bar thickness (5 or 10 mm).

Do not straighten copper bars in order to re-use them. Do not bend bars where there are holes.
## Preparing contact surfaces

### Practical rules
Surfaces in contact must be clean, dry, flat and exhibit no deep scratches.

Carefully remove any flash on cuts and punch holes and then eliminate the resulting filings. If necessary, remove any grease from the bar and then sand contact surfaces lightly with a fine abrasive cloth.

### Examples for Prisma iPM
With Linergy channelled busbars, you no longer need to sand contact surfaces.

A rough, hard surface enhances the quality of the electrical connection by multiplying the contact points.
Electrical connections

Practical rules
The quality of the electrical connection is related to:
- the contact pressure between the bars
- the overlap area (size and quality).

Examples for Prisma iPM

Assembly hardware

Assemblies should be tightened using class 8-8 corrosion-resistant steel nuts and bolts, fitted with a contact washer on either side. If they are unscrewed, the contact washers must be replaced.

Class 8-8 zinc-coated steel (Zn8C) nuts and bolts are used. Once tightened to the appropriate torque, the nuts and bolts retain all their mechanical properties over time (elasticity), without deforming the material (creep), regardless of the temperature conditions inside the switchboard.

Bolt length should correspond to the total thickness of the bars + the washers (uncompressed) + the nut + two threads.

Recommended bolt length according to the quantity of copper bars to be assembled (5 or 10 mm in thickness)

<table>
<thead>
<tr>
<th>number of bars</th>
<th>min.</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>to assemble</td>
<td>(mm)</td>
<td>(mm)</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>6 and 7</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>8 and 9</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Linergy busbar bolts can be slid into the busbar channel to the required connection point. They are fitted with a ball that holds them in place on the busbar. A slot is used to check that it is positioned properly.
### Overlap

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proper procedures for the assembly of copper bars by covering aim at maintaining, for this assembly type, a temperature rise identical to that of a plain bar. Normally, the overlap is total.</td>
<td>In the Prisma Plus system, the solutions implemented in terms of bar covering have the same aim: a temperature rise identical to that of a plain bar, with long-term contact reliability. All these solutions have been tested, approved and optimized. Type tests have been carried out as per standard IEC 60439-1 and, furthermore, in extreme conditions reproducing contact point ageing. For 10 mm thick bars, a covering of 2.5 times thickness has been optimized.</td>
</tr>
</tbody>
</table>

However practical rules, normally applied, recommend a covering equal to 5 times the thickness of the derived bar, thus guaranteeing quality of a bolted joint. An example with a 5 mm bar: a 25 mm cover.

### Connection of Linergy channelled busbars to horizontal busbars

Linergy prefabricated connection.
For more than 1600 A, use two Linergy busbars.

For 3200 A switchboards, the connections between the two busbars are custom-made by the panel-builder.
### Contact pressure
Contact pressure depends on:

- the number of tightening points
- the type of nuts and bolts in use (quality, diameter)
- the tightening torque applied to these nuts and bolts.

### Practical rules

### Examples for Prisma iPM

Schneider has defined a certain number of tightening points (in line) for a connected bar using M8 nuts and bolts. The quality of the electrical connection obtained using class 8-8 nuts and bolts tightened to the required torque has been validated by laboratory tests.
**Technical guide**

**Cabling**

**Assembling the bars**

---

**Practical rules**

Use a calibrated torque wrench in order to guarantee contact pressure (20 to 30 N/mm²). Tightening torque depends on the diameter and quality of the nuts and bolts.

- tighten the nut in the case of a bolt or the screw for a tapped hole
- mark the bolts when tightened to the specified torque to allow operator inspection
- tightening tools should be checked at regular intervals
- after dismantling a busbar or its connections, new nuts and bolts should be used for subsequent mounting.

**Examples for Prisma iPM**

Tightening torques to be applied with class 8-8 nuts and bolts.

<table>
<thead>
<tr>
<th>bolt diameter</th>
<th>tightening torque (N.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>13</td>
</tr>
<tr>
<td>M8</td>
<td>28</td>
</tr>
<tr>
<td>M10</td>
<td>50</td>
</tr>
</tbody>
</table>

Thanks to the quality of the nuts and bolts, very precise tightening torques can be obtained, with a lasting contact pressure to within ±10% of the original value.

**NB** When the tightening torque is applied directly to the terminals of the devices, comply with the tightening torque indicated in the technical manual of the device in question.

Schneider recommends that nuts and bolts should be marked using coloured acrylic varnish, which is both indelible and heat resistant. This not only allows operator inspection, to check that the nut has been tightened properly, but also facilitates identification of any loose nuts.
Connecting with flexible bars

Flexible bar types

Practical rules
Flexible bars must comply with standard IEC 60332-1 which guarantees:
the electrical characteristics of the conducting core resistance to temperature and fire of the insulation.

Flexible bars must comply with standard IEC 60332-1, the following parameters must be considered:
location of the device within the enclosure sizes of the other circuits ambient temperature around the switchboard heat dissipated by the installed device temperature rise generated by the installed device connection length It is therefore necessary to respect the instructions provided by the electrical equipment manufacturer.

Examples for Prisma iPM
To determine the required cross-sections for flexible bars connecting a Merlin Gerin device inside a Prisma Plus enclosure, use the tables below.

Circuit-breakers, switches and fuses:
- in a Prisma Plus cubicle
- temperature inside switchboard: 60 °C.

<table>
<thead>
<tr>
<th>Device</th>
<th>s (mm)</th>
<th>Device</th>
<th>s (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN125</td>
<td>20 x 2</td>
<td>NS250(1)</td>
<td>20 x 3</td>
</tr>
<tr>
<td>IN160</td>
<td>20 x 2</td>
<td>NS400(1)</td>
<td>32 x 5</td>
</tr>
<tr>
<td>IN250</td>
<td>20 x 3</td>
<td>NS500</td>
<td>32 x 8</td>
</tr>
<tr>
<td>IN300</td>
<td>32 x 8</td>
<td>Fu400</td>
<td>32 x 5</td>
</tr>
<tr>
<td>IN100(1)</td>
<td>20 x 2</td>
<td>Fu630</td>
<td>32 x 6</td>
</tr>
<tr>
<td>NS100(1)</td>
<td>20 x 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) the values indicated for circuit-breakers also apply to contactors with the same ratings.

Disconnectors, terminal blocks and busbar/ busbar connections:
- in a Prisma Plus cubicle
- temperature inside switchboard: 60 °C.

<table>
<thead>
<tr>
<th>I max (A)</th>
<th>Area (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 A</td>
<td>0 x</td>
</tr>
<tr>
<td>500 A</td>
<td>0 x</td>
</tr>
<tr>
<td>520 A</td>
<td>32 x 5</td>
</tr>
<tr>
<td>660 A</td>
<td>32 x 8</td>
</tr>
</tbody>
</table>

Insulation of the Prisma Plus flexible bars withstands temperature of 125 °C.

NB in all cases, comply with the bar crosssections given in the manuals.

Cutting to length
Cutting, using shears if possible, should leave a clean cut, without flash. The cutting length is equal to the required final length of the bar + a safety margin (generally 10 mm) which allows for possible slippage between the individual copper layers when the bar is bent.

Bending
Flexible bars should be bent by hand, to avoid damaging the insulation, with a curvature radius equivalent to at least the thickness of the bar (see fig. 1). The copper layers, whose position in relation to each other may have changed during bending, are then cut off flush (see fig. 2).
**Insulation stripping**

Practical rules
Stripping should be carried out using a stripper or a sharp tool as close as possible to the connection point, to restrict the amount of live, exposed parts. Avoid damaging the copper layers, which could create the starting points for fractures.

Examples for Prisma iPM

**Drilling and punching**

This is carried out once the flexible bar has been bent.

Schneider recommends use of a punch fitted with a spring-loaded stripper plate that makes a clean cut and prevents layer deformation as the punch is withdrawn.

Drilling diameter depends on the diameter of the nuts and bolts used:

<table>
<thead>
<tr>
<th>bolt diameter</th>
<th>max. drilling diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>7</td>
</tr>
<tr>
<td>M8</td>
<td>10</td>
</tr>
<tr>
<td>M10</td>
<td>12</td>
</tr>
<tr>
<td>M12</td>
<td>14</td>
</tr>
</tbody>
</table>

**Busbars in wall-mount and floor-standing enclosures and cubicles**

According to standards IEC 60439-1 and IEC 60204-1, insulated conductors must not rest up against bare live parts or against sharp edges. Their maintenance must be carried out properly.

No sharp edges on busbars in Prisma iPM

- Flat busbar at the back of a wall-mount enclosure
### Securing the bars

**Practical rules**

Secure the flexible bars to the insulating supports. The distance between the ties depends on the electro-dynamic forces produced in the event of a short-circuit. Recommended distances between ties.

<table>
<thead>
<tr>
<th>Tie Type</th>
<th>Width (mm)</th>
<th>Load (kg)</th>
<th>Max. Ipk (kA)</th>
<th>Distance between ties (x) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipk</td>
<td>5</td>
<td>90</td>
<td>20</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>45</td>
<td>70</td>
</tr>
</tbody>
</table>

**Examples for Prisma IPM**

According to Merlin Gerin, the fixed ties should be secured to the framework every 400 mm at the most, and the free ties as per the value (x).

**Assembly**

In order to distribute tightening forces and avoid creep in the copper, locate a 2 mm thick flat washer between the contact washer and the bar.

Care should be taken to avoid pinching the insulation when tightening the connections.

---

**NB:**

The last tie should be located as close as possible to the connections.

In the event of stacking, form a separate stack for each circuit. Example: N, L1, L2, L3. To ensure that conductors are properly ventilated, a space should be left between the flexible bars, at each tie, using an insulating, self-extinguishing spacer.

---

In order to connect a flexible bar to a device, use the basic hardware delivered with the device and add a flat washer.

Apply the tightening torque specified in the device manual.
<table>
<thead>
<tr>
<th>Connection to the busbars</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If the busbars have several bars per phase, the connection points must be distributed over the various bars of the same phase.</td>
<td>Flexible bars should be connected without separating the copper layers.</td>
</tr>
</tbody>
</table>
Principle

Cables may be used for all medium power connections. However, above a certain power rating, cable connections become more difficult on account of requirements such as the crosssection of the cables, the number of conductors, the radius of curvature or the space available inside the enclosure.

Cable characteristics

As a rule, flexible or semi-rigid copper cables are used for wiring the inside of a switchboard. H05VK cables with 500 V insulation or H07VK cables with 750 V insulation can be used.

The standard cable has a resistant insulator at 105 °C.

Cable crosssection

Cable cross-section should be compatible with:

- the current to be carried
- the ambient temperature surrounding the conductors.

<table>
<thead>
<tr>
<th>Cross section (mm²)</th>
<th>Permissible current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>switchboard</td>
</tr>
<tr>
<td></td>
<td>IP≤30 (~60°C)</td>
</tr>
<tr>
<td>1.5</td>
<td>16</td>
</tr>
<tr>
<td>2.5</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>16</td>
<td>110</td>
</tr>
<tr>
<td>25</td>
<td>135</td>
</tr>
<tr>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>
### Bundles

**Practical rules**

Bundles are normally created circuit by circuit. The number of cables by bundle depends on cable diameter.

They must be assembled before being secured to their support.

Distance between securing centers:

(see page 57).

### Examples for Prisma Plus

Number of cables recommended according to their diameter.

<table>
<thead>
<tr>
<th>cross-section by bundle (in mm²)</th>
<th>cable number of cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 10</td>
<td>8</td>
</tr>
<tr>
<td>16–35</td>
<td>4</td>
</tr>
</tbody>
</table>

### Stripping

Use a wire stripper taking care to avoid cutting the strands or damaging the insulation.

The length stripped should allow for:

- the depth of the lug to be crimped.

For ≤ 6 mm² cross-sections, lugs offer better tightening, without risk of creep in the terminal. For cross-sections < 6 mm², Merlin Gerin prefers use of direct connection in the device terminal.

However, it also proposes a variety of connection types: steel terminals, multi-hole terminals, reduced lugs, etc.

- the depth of the connection tunnel on the device.
## Lug crimping

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>A lug should only contain a single power cable. All the strands of the conductor should be located inside the lug barrel.</td>
<td>Merlin Gerin recommends open barrel lugs which enable the operator to check cable penetration.</td>
</tr>
<tr>
<td>Use crimping tools, of a suitable size, as recommended by the lug manufacturer. Apply the tightening force specified by the manufacturer of the crimping tool. The tools should be checked at regular intervals.</td>
<td>Hexagonal crimping distributes the crimping force in a uniform manner around the lug.</td>
</tr>
<tr>
<td>Lugs must not be re-used, bent, reduced in width (space requirements) or countersunk.</td>
<td>Merlin Gerin proposes reduced lugs which are ideal for Compact devices from 100 to 1250 A for copper or aluminium cables.</td>
</tr>
<tr>
<td>Do not bind cables to one another in the vicinity of lugs to avoid damaging insulation and causing flashover.</td>
<td></td>
</tr>
</tbody>
</table>
Cable routing

Practical rules:
- General rules: Cables should never be in contact with live conductors, or located between them (copper bars, flexible bars, etc.) to avoid temperature rise. Sharp edges on the framework situated close to conductors should be protected to avoid risk of damage to cables. Use gaskets, grommets, etc.
- Cables must not run over the sheet metal thickness.

Examples for Prisma Plus:
- On all metal parts (mounting plates, frameworks, etc.), sharp edges are chamfered, parts are painted and tie devices are built into the plates.

Securing the cables

- If cables do not satisfy class 2 conditions, they should be secured to the insulating supports.
- The distance between ties depends on the electrodynamic forces involved and the type of tie.

1000 V insulation cables are treated as belonging to class 2 if they are used on an electrical switchboard with an operating voltage < 500 V.

- They may be secured directly to metal cable tiebars.

Recommended distances between ties:

<table>
<thead>
<tr>
<th>Tie type</th>
<th>max. Ipk (kA)</th>
<th>distance between ties (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>width: 4.5 mm, load: 22 kg</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>15</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>width: 9 mm, load: 80 kg</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>35</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>70</td>
<td></td>
</tr>
</tbody>
</table>

Ties should be located as close as possible to connection points. For cable cross-sections ≤ 50 mm², 9 mm wide ties should be used. They must be secured to the framework at most every 400 mm.
### Distribution blocks

#### Practical rules
Distribution blocks must withstand thermal stresses generated in the event of a short-circuit.

- **Spring terminal**: With connection accessories such as Multiclip, Polybloc, Distribloc, a spring terminal rather than a screw is used to tighten the cables.
- **Examples for Prisma Plus**: These accessories are all fully compatible with the breaking capacity of the Merlin Gerin devices.
  - Contact pressure of the spring is automatically adapted to conductor cross-section and does not depend on the operator.
  - Tightening is very reliable as it is not sensitive to vibrations or temperature variations, and is guaranteed over time.

- **Tighten taking care not to cut the conductor strands.** In the case of terminals with pointed screws, it is advisable to fit ferrules on the ends of multi-strand conductors.
- **The ferrules must be adapted to cable cross-sections and terminal dimensions and crimped using suitable tools for the purpose.** For spring terminals, comply with the stripping lengths and tightening torques of the various connection types.

- **Do not fit ferrules on spring terminals. Each terminal can only take a single wire.** Use a flat screwdriver with cylindrical cross-section only to open the spring.
- **Tests have been carried out on terminals both alone and in association with Merlin Gerin devices. They are shown to comply with standards IEC 60947-7 (cable withstand tests) and IEC 60439-1 (temperature rise and electrodynamic tests).**

- **Tunnel terminal**: This connection type such as on additional block or Multiclip allows several cables to be connected.
  - However it is best not to use a ferrule.
  - Tunnel terminals are used mainly for supplying the various distribution blocks and certain circuit-breakers (Multi 9).

- **Tunnel terminals on Multiclip distribution block**
Cabling
Auxiliary and low power circuits
<table>
<thead>
<tr>
<th>Principle</th>
<th>Practical rules</th>
<th>Examples for Prisma Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside the enclosures, the auxiliary and low power circuit cables must run freely in straps or trunking, which provide more effective mechanical protection and cable ventilation than if cables are mounted in bundles. The intermediate connection terminals must be installed outside the wiring conduits.</td>
<td><strong>Separate power cables from auxiliary wires:</strong> Bus cables and the other &quot;fine wiring&quot; cables (connected to auxiliary power supplies for relays, contactor controls, PLC inputs/outputs, etc.) can exist side by side, but must be placed in trunking for separation from power cables. A bus line is &quot;ELSV&quot;, thus with double or enhanced insulation with respect to mains. Consequently a bus cable must not touch a bare power bar.</td>
<td>In Prisma Plus, running and connection of auxiliary and low power circuit cables inside the enclosure is functionalized.</td>
</tr>
<tr>
<td>Running through straps</td>
<td>Cables running through straps must not be tied, in order to encourage heat loss. Fit a sufficiently large number of straps (normally 1 strap every 100 mm) to ensure that wires are properly held in place.</td>
<td>In Prisma Plus, the possibility of installation of horizontal and vertical cable straps ensures optimization and legibility of wiring running.</td>
</tr>
<tr>
<td>Running in trunking</td>
<td>Use trunking for cables with crosssections $\geq 6 \text{ mm}^2$. If cables are used which do not comply with class 2 conditions (cable insulation voltage $&gt;\times$ twice operating voltage), trunking should be secured using rivets or plastic screws which cannot damage the cables and which preserve the double insulation of the conductors in relation to the metal parts supporting the trunking. The distance between trunking fixing centres must not exceed 600 mm. Trunking packing density must not exceed 70%. Do not tie cables in the trunking. This encourages heat loss. Free rows must be provided for future extensions.</td>
<td>In Prisma IPM, the possibility of installation of horizontal and vertical cable straps ensures optimization and legibility of wiring running.</td>
</tr>
<tr>
<td>Running to auxiliary devices installed on doors</td>
<td>Cables running to the door run via a bundle. This bundle must be produced to prevent mechanical damage to conductors following panel or door movement.</td>
<td></td>
</tr>
</tbody>
</table>
Running between columns

**Practical rules**

For wiring running between cubicles (auxiliary supplies, etc.) that must be separable (transport, etc.), preference should be given to use of terminal blocks to connect the various cables.

**Examples for Prisma Plus**

For wiring running between cubicles (auxiliary supplies, etc.) that must be separable (transport, etc.), preference should be given to use of terminal blocks to connect the various cables.

### Power supplies

The auxiliary power supply and its protection must be clearly identifiable in the switchboard.

### Cable bundle

Cables should never be in contact with live conductors, or located between them (copper bars, flexible bars, etc.) to avoid temperature rise.

If cables do not comply with class 2 conditions, the cable bundles should be fixed on insulation support.

**Note:**

Usually, auxiliary circuit cable bundles with lower voltage (lower than half of cable insulation voltage) can be directly fixed on metal support.

Sufficient cable bundling strips should be used. Distance between bundling points depends on the diameter of cable bundles.

<table>
<thead>
<tr>
<th>Cable bundle diameter D (mm)</th>
<th>Lmin (mm)</th>
<th>Lmax (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>20-30</td>
<td>70</td>
<td>140</td>
</tr>
<tr>
<td>30-45</td>
<td>90</td>
<td>180</td>
</tr>
<tr>
<td>45-75</td>
<td>125</td>
<td>200</td>
</tr>
</tbody>
</table>

For cable bundles led out of components mounted on door or trap door, must consider the free movement of various plates which should not have any damage on cables during movements.

**Note:**

Compared with cable bundling mode, consider the priority use of cable rack for cables after being bundled are hard to change.

One tube type or spiral plastic wire duct can also be used to protect cable bundles.
<table>
<thead>
<tr>
<th>Connection to terminals</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>All stranded conductors must be placed into holes on terminals.</td>
<td>With Merlin Gerin terminals and terminal blocks, a spring system rather than a screw is used to tighten the cables. The contact pressure of the spring is automatically adapted to the crosssection of the conductor. Tightening is very reliable as it is not sensitive to vibrations or temperature variations.</td>
<td>Do not fit ferrules on terminal blocks equipped with springs. Each spring terminal may only take a single wire.</td>
</tr>
<tr>
<td>Do not cut stranded conductors during tightening. If terminals are provided with pointed screws, it is better to use ferrules. Spacers should be used for the separation no matter it is power connection distribution module or in-coming and out-coming power distribution module.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use of ferrules</th>
<th>To guarantee proper tightening ensuring good contact, choose ferrules to suit the cable crosssection and the space available in the device connection tunnel through which it will run.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip the cables to the recommended lengths. All the conductor strands must be placed inside the barrel of the ferrule. The tunnel of the device can only accommodate a single cable with a ferrule.</td>
<td>Tunnel terminals on Merlin Gerin devices are designed to accommodate flexible cables without a ferrule. Tests have shown that tunnel terminals used with stripped cables give the best results (pullout resistance and temperature rise). The absence of a ferrule increases the area in contact. The tunnels on Merlin Gerin devices can accommodate two flexible, stripped cables (without ferrules) of identical crosssection. The Telemecanique stirrup terminals require use of ferrules.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cable crosssection</th>
<th>Unless otherwise specified in the specification, Merlin Gerin recommends the following cable crosssections for auxiliary wiring:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- 1.5 mm² for voltage auxiliary circuits</td>
</tr>
<tr>
<td></td>
<td>- 2.5 mm² for current auxiliary circuits</td>
</tr>
</tbody>
</table>
Communication circuits

Practical rules
Communication equipment must satisfy the requirements of the relevant immunity and emission standards. The following cabling rules are general and do not replace the cabling directives laid down by the manufacturer of the incorporated equipment.

<table>
<thead>
<tr>
<th>Sensitivity of the various cable families</th>
</tr>
</thead>
<tbody>
<tr>
<td>family</td>
</tr>
<tr>
<td>analog sensor measurement and supply circuits</td>
</tr>
<tr>
<td>sensitive signals</td>
</tr>
<tr>
<td>digital circuits and data bus</td>
</tr>
<tr>
<td>these signals are sensitive. They are also disturbing for family 1</td>
</tr>
<tr>
<td>relay dry contact circuits with re-arcing risk</td>
</tr>
<tr>
<td>these signals are disturbing for families 1 and 2</td>
</tr>
<tr>
<td>power supply power and power supply circuits</td>
</tr>
<tr>
<td>these signals are disturbing</td>
</tr>
</tbody>
</table>

Use shielded cables or oversheilded bundles to protect circuits against radiated disturbances. Metal shielding must be properly earthed. All conductors free in a cable (except for family 1) must be systematically earthed at both ends.

Earthing terminals with metal fastening system using a DIN rail

Keep cables as short as possible and avoid forming loops which may produce interference due to magnetic fields.

Schneider Electric devices are immunised.
<table>
<thead>
<tr>
<th>Communication circuits (continue)</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The presence of many earthing structures in floor-standing enclosures procures an optimum protective effect. When wires run to a door, run the communication cable near a hinge or an earthing wire.</td>
<td>Protective effect inside a floor-standing enclosure: - all cables must be flattened up against earthing structures - plastic cabling trunking is allowed as installed on DIN rails connected to the enclosure exposed conductive parts. Cables must run close to assembly points (hinges) or be backed up by an earthing wire.</td>
<td></td>
</tr>
</tbody>
</table>

Respectively bundle and lay the following groups of cables in switchboard: - relay, variable speed drives, supply and power - analog, digital and telecommunication signals. |

To preserve a protective effect, we recommend that you comply with a ratio of Distance between cables/Radius of largest cable of more than 5. |

### Use of toroids

Toroids detect leakage currents and transmit a proportional signal to the associated receiver. |

Placing a soft steel sleeve tube around the cable significantly reduces interference signals caused by the asymmetrical configuration of the conductors in the toroid. |

Use a toroid with a diameter considerably larger than the cable passing through it. It should be fitted to a straight length of cable. The cable should be centred in the toroid. |

Toroids are used together with Merlin Gerin VigiOhm System products for measurement and monitoring of installations. |

Earth leakage protection devices of the Vigi module type or residual current circuit-breakers incorporate the insulation monitoring toroid.
Quality inspection
Relying on its rich experiences, Schneider is always devoted to making quality equipment. However, what do we mean by quality?

Standard is defined as follows in NFX50-120 standard definition:
“A collection of properties and characteristics which make a certain product or service meet implied or express requirements (NFX50-120).”

To a certain extent some problems can be detected in final inspection (due to the reason that we do not carry out necessary quality control on the entire assembly process), it is still an extreme important link in equipment manufacture.

This stage must be patiently and carefully performed in accordance with user specification (express requirements) and correct operation specification (implied requirements) to ensure compliance with consumer needs.

Quality is the final pursuit of managers and entire staff with the hope of meeting consumer requirements. This manual will be very helpful in this regard and will ensure good performance of equipment.

Thank you for your great support.
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<thead>
<tr>
<th>Table of contents</th>
<th>Page</th>
</tr>
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<td>Inspection on purchased goods</td>
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<td>Purpose of inspection on purchased goods</td>
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<td>Qualification inspection</td>
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<td>switchgear</td>
<td>15</td>
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<td>PE and/or PEN protection bus</td>
<td>18</td>
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<tr>
<td>Cable</td>
<td>18</td>
</tr>
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<td>Conducting final inspection</td>
<td>19</td>
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<td>Connection</td>
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<td>Mechanical inspection</td>
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<td>Electrical inspection</td>
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<td>Dielectric bear capacity (per IEC 60439.1 standard 8.3.2)</td>
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<td>Inspection tools list and detection</td>
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<td>Equipments outside accuracy class</td>
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<td>Equipment list</td>
<td>31</td>
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<td>Tool of quality inspector</td>
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<td>33</td>
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<td>List of inspection procedure</td>
<td>33</td>
</tr>
<tr>
<td>Example of quality inspection document</td>
<td>35</td>
</tr>
</tbody>
</table>
Specification

“A collection of management properties and organization rules for the achievement of specific result” (see Petit Robert dictionary)

“A specified manner for completing a certain activity” (see ISO9001)
Complexity, massive human intervention and relating fault risk of low voltage equipment are the main causes for quality inspection. In addition, this is also required in standard (see I.E.C.60-439.1), which requires three routine tests (or single test) so as to comply with type test:

- Add TTA tag on equipment (Type Tested Assembly)
- And contents which are within the responsibilities of switchgear manufacturer.

These three single tests are:

- Electrical test
- Dielectric test and insulation resistance measuring
- Inspect the consistence of earthing of protective circuit

Quality inspection is intended to achieve the following purposes:

- Fault detection.

Design and assembly of electrical equipment involves major human invention, which is also the major source of fault in this field. As result, every step needs to be inspected.

Research shows that cost can be reduced to 1% to 1‰ (see the figure below) if a certain defect is detected during the design phase of switchboard.

Therefore quality inspection is helpful to:

- Ensure quality of Schneider equipment:
- Maintain brand image of the company,
- Guide training based on the abnormalities detected.
- Ensure safety of personnel and equipment,
- Ensure economic benefit of the company.
Functions for quality inspection

- Conduct inspection on the following contents:
  - Project document and user document,
  - Schneider specification and project,
  - IEC standard.
- Carry out acceptance test with the presence of user.
- Conduct quality follow-up and corrective measure.

Duties of quality inspection

- Directly under management, independent of manufacture,
- Delivery can be delayed and rework can be requested to ensure compliance.
- Adopt corrective measure,
- In occurrence of dispute, department manager with the authority to make independent decision shall be informed.
- Be responsible for safety of all personnel working in the quality inspection area.

Requirements on quality inspector

- Mechanical and electrical training (B.T.S or equivalent training: senior technician certification),
- Comprehensive,
- Good understanding of Schneider equipment,
- With the following qualification for working near current
  - Current risk knowledge,
  - Authorization from certified training course,
  - Basic first aid knowledge

Quality inspection area

- Independent of production process,
- Physical isolation from other departments:
  - Considering risks related to current,
  - For protection of personnel and equipment,
  - Apparent indication (zone, isolation);
  - Apparent warning (warning sign, lamp flicker).

Necessary documents

In order to carry out various inspections, quality inspector must have updated documents of complete project and user technical specifications.

Special materials and tools

- Quality inspector must:
- Have necessary inspection tools (mechanical and electrical):
  - Test desk, power supply with adjustable current and voltage,
  - Tester, and peak value requirements,
  - Dielectrometer, and insulation detector,
  - Tools,
  - Mounting plate,
  - Relevant documents.
  - Equipment for regular validation.

Necessary human resources

In the equipment department of the group, inspectors take up about 10% of the all employees, which means 1 quality inspectors for 8 to 10 wiring workers and assemblers.
Applicable for external or internal product or assembly part. If the assembly part or product is manufactured by the company, internal procedure can be applied to carry out final inspection on a certain production process, in the same time, another inspection on purchased goods can be conducted.

Purpose of inspection on purchased goods

As the last procedure before assembly, this quality inspection plays an important role in ensuring final quality and obtaining product income. The purpose of inspection on purchased goods is to ensure that purchased material and part comply with:

- Specification in purchase order (color)
- Standard
- Product specification
- Professional rules

Procedure

Verification

Product quantity and appearance inspection can be done by consignee agent. Quality inspection shall be done by quality inspector. Sampling inspection can be done for large batch of products. All products arriving at the delivery site shall be received and stored under the perfect condition before the final installation.

Handling of nonconformity

All nonconforming products will be:

- Separately stored
- Registered as nonconforming products and marked clearly

Preventive measure shall be taken to prevent nonconforming goods from entering delivery site again.
Methods

- Process inspection includes inspection on the entire manufacturing process, in the following form:
  - Operator inspection is intended to make every operator responsible for his/her work quality. Guideline about every manufacturing process is given to operator; inspection can be defined formally (see ISO900).
  - System inspection or sampling, this is the component of quality inspection and is conducted during manufacturing process.
  - Follow-up card must be used to record inspection status which has been conducted.
  - Various inspections shall be done according to the figure below.
  - This figure shows the operation in process inspection, which clearly indicates several phases of operator inspection and follow-up quality inspection.

Note:
Even though every phase is inspected by operator, final inspection is still necessary. It can be reduced but cannot be cancelled. It is specially stressed in IEC60-439.1.
Final inspection can ensure product operation and its compliance with requirements in drawing and standard. It is carried out by Q.I. department of this unit.

This project will use a document which contains user requirements and technical specification for reference during in-assembly and final inspection. It is the first reference document (project document).

Final inspection will be carried out as follows:
- Conduct qualification inspection
- Conduct test
- Modify project design document, add all necessary explanations (entire test)
- List all nonconforming items:
  - Draft list of missing parts
  - Mark all faults
- Draft report
- Carry out rework to ensure qualification
- If customer acceptance is planned, please receive customer and customer representative in the quality inspection area, and conduct test. Ask customer to sign the report after completion of inspection, check status of final version, and indicate version to ensure project design document is updated correctly
- Sign document, especial report
- Filing of final inspection document

List of tests of final inspection:

a. Qualification inspection:
- Casing
  - Appearance
  - Component
- Frame
- Equipment
- Busbar
- PE and (or) PEN protection bus
- Cable
- Connection

b. Mechanical inspection:
Mechanical inspection includes testing of mechanism and manual control to check whether they can operate normally, testing of switchgear robustness, and checking whether equipment identification device is in the right position as its code shows.

c. Electrical inspection:
- Operation test
- Dielectric endurance capacity
- Earthing consistency of protective circuit
- Insulation resistance
Operation rule can be formed by following the figure below:

The figure below explains how to handle various nonconforming problems.
In final inspection, any fault or nonconforming item must be marked in a form of “nonconforming input”. It is a standard form and can be modified according to actual need.

<table>
<thead>
<tr>
<th>Internal position/fault category</th>
<th>Performer of correction</th>
<th>Time</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus assembly</td>
<td>X</td>
<td></td>
<td>Jean</td>
</tr>
<tr>
<td>E1 CB2 cable fault</td>
<td></td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>E2 missing bus holder</td>
<td>X</td>
<td></td>
<td>Alain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 hour</td>
<td></td>
</tr>
</tbody>
</table>

(Code: quality indicator form)

The following form tells the average time for you to finish final inspection based on the switchboard type to be inspected.

The following information is given with hour as unit for each cubicle.

<table>
<thead>
<tr>
<th>Power distribution cubicle</th>
<th>Motor control cubicle</th>
<th>Performer of correction</th>
<th>Time</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard item</td>
<td>Simple item</td>
<td>A little complex</td>
<td></td>
<td>Complex</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Upon completion of final inspection, a tag declaring conformity of equipment shall be attached to the inside of cubicle. (Tag sample)

Performance of manufacture

<table>
<thead>
<tr>
<th>Date: / /</th>
<th>Quality inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project number:</td>
<td></td>
</tr>
<tr>
<td>Switchboard: inspector:</td>
<td></td>
</tr>
<tr>
<td>Column number: data: / /</td>
<td></td>
</tr>
</tbody>
</table>

Only cubicle receiving complete inspection can be delivered. Use tag similar to the form below to mark it.

Final inspection sheet, ready for delivery

<table>
<thead>
<tr>
<th>Customer:</th>
<th>Customer order number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project:</td>
<td>Factory order number:</td>
</tr>
<tr>
<td>Report number:</td>
<td>To:</td>
</tr>
<tr>
<td>Quality inspection</td>
<td>Date:</td>
</tr>
<tr>
<td>Name:</td>
<td></td>
</tr>
<tr>
<td>Signature:</td>
<td></td>
</tr>
</tbody>
</table>
After final inspection, quality inspector, sales engineer and customer together will conduct inspection on project. This is called user acceptance, user will confirm technical specification.

Note:
The following information is quoted from factory specification in Pontcharra region in Merlin Gerin Alpes French.

The following work needs to be done after final inspection:
- Check whether all "ITP" (inspection and test procedure) grids have been filled,
- Check rework marked on "nonconforming input" and whether it is in corresponding grid,
- Signature within grid,
- Keep record and draft report (final inspection report),
- Ask quality manager to confirm this report,
- Mark this report number on ITP.
Quality inspection
Introduction

(Instruction) (Definition in dictionary)
“Oral or written instruction prepared for personnel taking specific task”
Technical guide

Quality inspection
Conducting in-process inspection

Attention
The purpose of in-process inspection is to ensure product quality after each production operation.

Composition
- One assembly follow-up sheet shall be filled for each cubicle.
- Applicable for initial assembly till final inspection.
- After each procedure is carried out, operator shall conduct inspection and sign this sheet to declare conformity of product, and indicate any condition the operator has detected.
- After completion of inspection, file one duplicate of this sheet (see example in appendix).
Quality inspector must:
- Put switchboard which is waiting to be inspected and delivered in special area.
- Inspect project design document.
- Inspect observation content and information listed in assembly follow-up sheet.
- Conduct final inspection based on test list.
Quality inspection
Qualification inspection

Casing

- Appearance:
  - Paint color and code:
    Use color palette to ensure that code specified in project document matches with the color of cubicle.
  - Uniformity:
    Carry out visual inspection to ensure uniformity of color of each switchboard component (gate/panel).
  - Front panel:
    Carry out visual inspection to check whether front panel is accordant with drawing in project design document.
  - Fineness:
    Basic visual inspection, ensure there is no scratch/deformation in appearance.

- Composition
  - Quantity and sequence of cubicle:
    Use front panel arrangement diagram to ensure compliance with requirements on quantity and sequence of cubicle.
  - Dimension
    Measure and compare cubicle dimension (height/width/length/depth), and compare them to values in project design document.
  - Type of division:
    Confirm type of division according to project design document.
  - Mimic diagram:
    Check whether mimic diagram is consistent by referring to dynamic drawing.
  - Project identification tag:
    - Check whether there is tag/whether it is in the right position (general on top of switchboard).
    - Confirm that information listed in tag is accordant with project document.
  - Cubicle identification mark:
    - Check whether each switchboard cubicle has identification mark which is usually a self-adhesive tag.
    - Make sure this tag includes registration number, signature, switchboard number, and updated version number.
    - After completion of final inspection, quality inspector must keep its registration number or signature, and indicate date of inspection.
Frame

- **Fastening on floor:**
  Use project design drawing to check position of fastening point on floor and layout of each cubicle in the project.

- **Wiring of cable:**
  Examine special equipment for cable wiring (top or bottom) or bus duct.

- **Fastening of mounting plate, protection screen, partition or air plate:**
  Check whether bolts (and picot gasket) for fastening these components are available, and whether they are correctly fastened.

- **Auxiliary bolt:**
  Check whether bolts for cubicle connection and fishplate and top plate mounting are available.

- **Warning boards of “Danger” and “live outgoing line”:**
  If they are required by product or customer, make sure they are installed.

- **Equipment:**
  Use project design document to check and make sure that cubicle equipment is complete and mounted correctly (cap, base plate, cable duct, and canopy).

- **Cover plate:**
  Ensure availability and correct installation:
  - Front, back, and side cover,
  - Top plate and base plate (steel, aluminum),
  - Door (common, transparent door).

- **Eligibility of plate openings:**
  Check whether there are all openings for installing fishplate of transfer bus in top plate and partition by referring to the drawing.

- **Check lockset:**
  Check whether model and quantity of lockset are accordant with project design document.

- **Check protection grade:**
  - Check whether there is component ensuring IP grade specified in project design document. It will differ with different IP grade requirements: canopy, enclosure, and front plate (provide information in product catalogue or manual).
  - If sealing strip is used, ensure its correct location and continuity.
**Switchgear**

- **Position/identification:**
  Use design drawing in project design document to ensure that equipment is correctly positioned and identified (QF1, QF2). In the mean time, tag and text content related to equipment can be inspected by referring to project design document drawing.

- **Fastening of switchgear:**
  Check fastening of equipment on mounting plate, door, auxiliary partition door, or front panel (check whether they are correctly fastened and all necessary bolts are fastened).

- **Accessories:**
  Conduct visual inspection on the following accessories:
  - Handle for drawing breaker,
  - Lockset of door,
  - Clamp for drawing fuse,
  - Pins for fixing some relays,
  - And so on.

- **Technical data:**
  - For breaker:
    - Inspect model, rated value, breaking capacity, and number of poles. Also check whether accessories are available and their technical data (Vigi, SD switch, tripping component).
    - Check or carry out equipment setting, such as thermomagnetic tripper, time relay.
  - Check voltage of power supply:
    - Coil (contactor, relay, pulse relay, under-voltage or Compact, Masterpact and Multi9 shunt coil),
    - Motor mechanism of switchgear;
    - Indicating lamp
    - All electronic equipment
  - Inspection on all these items shall be conducted according to project design document.
  - Zero sequence transformer:
    - Examine technical data and user connecting cable of each zero sequence transformer in accordance with project design document. In the same time, correct mounting direction shall be ensured; arrow shows current direction.
  - Current transformer (CT):
    - Examine technical data and power supply direction of each current transformer in accordance with project design document. For example, some manufacturers require that current must flow in through P1 and flow out thorough P2 of transformer.
    - Check coordination between current transformer and related equipment (ampere meter, instrument), ensure output current from its secondary circuit is compatible with equipment.
    - Check the gap between fixing bolt and connecting bolt of current transformer, especially those bolts near to live conductor of metal component.
  - Shunt:
    - Check connection between shunt and measuring device.
    - Display position after fault tripping:
      - Trip equipment, and examine display position.
    - Insert protective masking:
      - Examine whether protective masking is inserted.
  - Insulating screen/split-phase partition:
    - If necessary, check whether they are installed.
  - Operability:
    - Check operability of equipment, set, standby HPC fuse, and coil.
  - Safe clear distance:
    - Check safe clear distance according to installation manual of breaker, if necessary, check various accessories which are necessary for correct operation.
  - Pre-tripping of equipment during inserting and pulling process:
    - Carry out pre-tripping for draw-out equipment on base plate or frame, check operation condition of mechanical system.
**Bus**

- **Type:**
  Check whether type of bus (Linergy, flat bus) is accordant with drawing of project design document.

- **Cross section:**
  Check whether cross section area meets the value given in technical manual of switchboard based on the rated current (In), short circuit current (Isc), and breaking time of breaker.

- **Coating:**
  Check the type of bus coating (bare copper, tinned copper, bus with protective layer, epoxy resin coating, silver coating).

- **Arrangement:**
  Use design drawing of project design document to examine its position (horizontal, vertical). Ensure bus arrangement will not affect cabling. Ensure expansion of bus according to specific need.

- **Tag:**
  □ Check whether tag type is accordant with project design document.
  □ Check whether tag sequence (phase 1, 2, and 3, neutral line and PE) meet requirement of design drawing. Phase sequence shall be checked at later stage.

- **Type of holder:**
  Check the type by referring to technical manual of switchboard.

- **Clear distance/creep distance:**
  Conduct inspection according to technical manual of switchboard.

- **Gap between and quantity of bus holder:**
  Check gap between bus holder according to technical manual (according to bus cross section area and Isc).

- **Bus fishplate:**
  Use technical manual to check:
  □ Cross section area of fishplate (the same with bus),
  □ Quantity and sufficient length.

- **Incoming line and outgoing line:**
  Examine direction of incoming line and outgoing line.

- **Linergy bus:**
  Examine position and operability of connecting bolt.

---

**Quality inspection**

**Qualification inspection**

- **Quality of connection Inspection**
  □ Quantity and length of bolt (according to bus dimension),
  □ Quality of bolt (8/8 grade),
  □ Poring quality and fineness of surface (without blur and oil stain).
  □ Pressure surface: \( R = 5 \times e \)
  According to relevant rules, it must be five times of thickness of single bus in order to form a proper pressure welding surface.

- **Bending radius:**
  The minimum radius of curve is \( r = 1.5 \times e \).
  If \( r \geq 1.5 \times e \), then radius meets requirement. If copper quality is excellent (CuETP), \( r \geq e \) can be accepted.
**Quality inspection**

**Qualification inspection**

**PE and/or PEN protection bus**

- Cross section area: check it according to technical manual.
- There is fishplate between cubicles, inspect cross section: make sure that cross section area of fishplate is at least equal to cross section area of bus to be connected (see technical manual).
- In certain configuration (earthing system, TNC, TNS), check whether there is PEN/PE connection.
- Green/yellow sign: check whether there is green/yellow sign and PE or PEN rhombus on conductor.
- Earthing fishplate: check availability and cross section area of fishplate, then check whether its cross section is the same with that of earthing bus (for PEN).

**Cable**

- Cross section areas of motive power cable, auxiliary and protective cables: Check these cross section areas according to technical manual of switchboard.
- Property of cable: Ensure the cable is insulated against U1 1000 V, with operating temperature of<105°C and capability of automatic flameout (recommended by Schneider).
- Cable protection: Ensure cable is not laid on sharp edge, mobile part or near to exposed live part.
- Bending radius: Ensure bending radius of cable is about 6 to 8 times of cable diameter.
- Quantity of cable per bundle: See application manual of switchboard.
- Separation of wire harness: Check whether motive power wire harness and control wire harness and wire harness of auxiliary voltage above 500V AC-DC are separated from each other.
- Wiring slot: Ensure that there is more than 20% space reserved in wiring slot, fastener shall be made of insulated accessories (for example PC bolt). The maximum distance between fasteners of two wiring slots shall not exceed 600mm. No cable shall be inserted between motive power line banks.
- Fastening of cable: Use technical manual to check quantity of fixing holder, ensure quality of binding tape and corrective binding according to Isc.
Connection

- Carry out three categories of inspection based on connection:
  - Visual inspection (A):
    - Pressure welding groove (quality, pressure),
    - Correct insertion of cable,
    - Position of cable core within axis of connector post, cross section area of cable, corresponding cross section area of connector post.
  - Conduct mechanical inspection thorough manual drawing (B) (random sampling).
  - Conduct visual inspection (C) to check availability of contact gasket (on the oblong hole, flat gasket + “contact” gasket) and its direction, and check whether there is varnish sign to indicate fully fastening to the correct torque (see visible connection).

When there is any question (for the same type of connection, bolt of the same length may be different in number of extra threads which exceed the nut threads, contact gasket may be squeezed or moving), sampling inspection shall be conducted.

If a certain amount of problems are detected, installation workers shall be asked to repair the low voltage switchboard.

The table below lists inspection items according to the type of connection used:

<table>
<thead>
<tr>
<th>Connection</th>
<th>Motive power</th>
<th>Other circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable socket</td>
<td>A+C</td>
<td>B+C</td>
</tr>
<tr>
<td>Splice</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Cable connection</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Terminal</td>
<td>B+C</td>
<td>B</td>
</tr>
<tr>
<td>Nut gasket contact</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

Where, A, B, and C represents different inspection types.
A=visual inspection
B=mechanical inspection
C=check availability and its position

- Operability of motive power connection point and terminal board:
  Check the operability of connection point so that user can connect according to bending radius of cable.

- Possibility of connecting cable on switch terminal or terminal board:
  See technical manual and project design document.
  - Check whether quantity of openings is accordant with quantity of user cables.
  - Check cross section area and quantity of cable and ensure compliance of creep distance.
Mechanical inspection

- Operation of door and mechanical accessories:
  Operate manual control equipment to ensure its correct operation.

- Manual control of mechanism:
  Operate it to check its operation condition.

- Reset after fault:
  Check whether breaker is reset after electrical fault tripping or pressing tripping test button.

- Block system:
  a. Interlock:
     Check whether closing of one breaker will prevent closing of other breakers.
     - Rod linkage:
       Examine its mechanical fastener.
     - Cable linkage:
       Check its bending radius according to installation manual, and ensure they are not fixed near to exposed live part.
     - Lock its key, and inspect:
       - Type and order number of key lock.
       - Key lock can prevent equipment operation.
  b. Insert/draw-out:
     - Ensure that equipment cannot operate when it is closed.
     - Check pre-tripping of equipment during inserting or drawing out.
     - Use applicable tool to check how deep contact is inserted to power supply and load bus end.
  c. Ensure robustness of various locking system:
     - Prevent false adaptation:
       Check whether position of slot for preventing false adaptation is accordant with technical specification.
       For switchgear, check its code for preventing false adaptation by referring to manual for preventing false adaptation of equipment.
**Operation inspection**

- Examine motive power circuit:
  - Preparation for inspection:
    - Use control console to supply power to bus, ensure that rotation direction of phase meets requirement.
    - Connect neutral line and earth wire.
    - Before electrifying, break protective breaker of auxiliary circuit (relay, measuring instrument, coil).
  - Operation:
    Use built-in test instrument within control console to examine phase sequence. In general, outgoing line of breaker shall be tested so as to check its polarity in the same time. Different method or equipment can be used.
    - Break all breakers.
    - Mount pin end in bus (N, L1, L2, L3) to test it and check whether it is accordant with sign.
    - Close one by one from incoming end to load end to check whether phase of each breaker is correct (see the example below).

When incoming line of certain breaker is connected to terminal board, conduct inspection on terminal board.

- Examine control terminal:
  Examine phase sequence of corresponding protective relay to check motive power supply of auxiliary circuit.

- Remote/local operating mechanism:
  Check its operation, accessories (pin end, small box with button, and indicating lamp) can be used if necessary.

- Power supply circuit:
  Use measuring instrument (voltage meter) to systematically examine switchgear, power supply circuit and direct current circuit of equipment.

- Electrical indication:
  - Check whether power supply is available for indicating lamp.
  - Check functioning of these indicating lamps.
  - Ensure that they are consistent with corresponding equipment (“on” lamp shall correspond to “on” position.

- Information supplied to connecting terminal:
  - Check contact state (break or close according to required action when closing or disconnecting is to be carried out).
  - Use proper equipment to measure and examine other information (voltage, current).

- Motor structure (contact, relay):
  - Close protection equipment to be inspected.
  - Use button or relay to activate operating mechanism of the equipment.

- Electrical interlock:
  Ensure that equipment with one interlock contact will not close.

- Measuring circuit:
  In order to examine measuring circuit, the secondary side of current transformer must be supplied with converter box (or else, you can use other equipment with scale to perform the same function).

  - Example of execution of operation:
    - Select power supply voltage,
    - Adjust maximum current value flowing to secondary circuit,
    - Inject current to one pole of them or three poles of circuit simultaneously to check cable connection.

- Examine test function:
  Conduct a series of inspection on equipment based on the specific equipment type to check the operation condition of breaker:
  - Test module of electrical leakage of earth wire (Multi 9 series, NS series):
    - Close breaker.
    - Press test button of Vigilohm component. This test simulates earth wire fault to perform routine tripping inspection.
  - Test of tripper (NS and Masterpact series):
    - Close breaker.
    - Connect conductor of testing cassette to special receptacle on the front panel of tripper component to trip it.
    - Please repeat this operation for higher reliability of inspection.
  - Test mechanical component:
    - Press test button (usually red).
    - Check whether breaker is tripped.
    - If breaker trips every time a test is done, the equipment is normal.

- Voltage relay, time relay, and fault detection equipment:
  - For voltage relay, check whether the contact is in the state defined in project design document.
  - For time relay, check whether time relay operates normally.
  - For fault detection equipment, create a fault, check whether equipment can detect and indicate the fault.
In order to generate a fault, a resistor cartridge can be connected according to the following diagram:

According to the features of zero-sequence transformer, preset the resistance which is needed for generating a fault. Reduce its value to make it change. When reduced below the preset value, the equipment must indicate a fault.

Time relay setting:
Check whether these settings conform to the project design document.

Dielectric bear capacity
(IEC60439.1 Standard, 8.3.2)

Preparation
☐ Dielectric test is always conducted after the insulation test.
☐ Don't forget to dismantle the cover plate on the Vigi module of CompactNS.
☐ Before testing, ensure that it has already been disconnected:
  - Surge suppressor (if have),
  - Electrical control motor,
  - Vigilohm
  - And all other equipments that cannot bear the applied voltage (electronic switch equipment, contactor coil, indicator lamp, microrelay, horn, meter etc.). So the circuit breaker which supplies power to ancillary circuit should be disconnected.
☐ The interference suppression capacity which is installed between active part and frame cannot be switched out, but can bear the test voltage.
☐ If there are the following situations, the ancillary circuit that not connect to the main bus-bar needs no test:
  - Protected by the equipment with rated value <16A,
  - The operation test has been conducted.

Note:
For specific auxiliary parts, whether the inspection has left unprotected connection. Otherwise, these connections should be switched out. For example: Neutral line connecting wire should be dismantled for PIM.
Operation mode:
- Use the dielectric test instrument which is designed for exporting 0-5000AC variable voltage (or dielectric test instrument) to conduct this test.
- Take turns to apply voltage on each phase and another phase which is interconnected to the switchboard framework.
- Standard stipulates that this voltage must maintain 1 second. However, it can be customized as maintaining 1 minute.
- Record the test results.

<table>
<thead>
<tr>
<th>Ui</th>
<th>Test voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>890V</td>
<td>2500V</td>
</tr>
<tr>
<td>1000V</td>
<td>3500V</td>
</tr>
<tr>
<td>Ui&lt;60V</td>
<td>500V</td>
</tr>
<tr>
<td>Ui&gt;60V</td>
<td>(2Ui+100)V</td>
</tr>
<tr>
<td></td>
<td>Minimum 1500V</td>
</tr>
</tbody>
</table>

Ui= Switchboard rated insulation voltage

Note:
If because any reason, the dielectric test must be conducted repeatedly, the voltage must be reduced below the 85% of preceding value.

Conduct operation:
Example of neutral line test for 4P equipment:
- Close all circuit breakers,
- Connect phase lines and other phase line to the switchboard framework,
- Interconnect all switch cubicle frameworks and make them earthing.
- Connect the ground wire of measuring instrument to switchboard framework,
- Contact the tested circuit with test pen, gradually boost the voltage to required value,
- Maintain this voltage for 1 minute,
- Gradually reduce this voltage before shutoff,
- Record results and mark them on the measurement sheet,
- After this test is completed, conduct test for other conducting wires repeatedly.

Conclusion:
If there is no flash over, destruction of insulation or puncture, the test results can be considered as satisfactory.

Insulation resistance

Inspection preparation:
Disconnection:
- Circuit breaker control motor and Vigilohms together with all other equipments that cannot bear the applied voltage.
- Certain equipments, the purpose is to make no connection happened between charged conductors (such as coil, relay, indicator lamp, contactor electromagnet etc.) and load of measuring instrument, etc.

Operation mode:
Use insulation measuring instrument (megohmmeter) to measure insulation resistance below 500V DC. Conduct this measurement between each live conductor and another two or three conducting wires which are connected to the switchboard framework.

Conduct operation:
Specifications are the same with dielectric bear capacity.

Conclusion:
If the insulation resistance between circuit and framework is at least 1000W/V with respect to the voltage of this circuit, the test conclusion is correct (Note: usually for our switchboard).
It can be visual inspection or electrical inspection according to the customer’s requirements.

- **Visual inspection:**
  - Check whether necessary components such as sawtooth washer, earthing braided tape and so on exist.
  - For earthing braided tape, check whether it has sawtooth washer (see electrical switchboard application guide) and its direction, apply slight pressure on its connection to detect its bear capacity.

- **Electrical inspection:**
  - Note: No equipment is conducted with this continuity inspection. The given method is only prompting message.
  - **Operation mode:**
    Use one direct current source, its electromotive force is lower than 6V. 2A electric current is injected between earthing wire row and injected part (door, front board, framework, etc.).

![Diagram showing electrical inspection setup](image)

**Measured resistance:**

\[ R = \frac{U}{I} \]

- **Conclusion:**
  If the measured resistance is less than 0.1 ohm, the inspection results can be considered as satisfactory.
Purpose

The purpose of this table is to measure quality performance and conduct necessary improvement and correction.

Principle

Quality assurance manager will publish a quality report every month, which is named as “Quality Index Table”. The purpose of this document is to deliver it to the department manager of this company, local department manager and quality assurance manager of this product.

Scope

In Schneider Group, use the following four targets to conduct assessment for performance:

- PNQ: Purchase "disqualification”.
- PNQ: Production "disqualification”.
- SNQ: Service "disqualification”.
- ENQ: Customer complaints.

Disqualification index:
- The target which is used for detecting unqualified change,
- Determine target,
- Reveal weakness in various operations, allow to take relevant measures.
- These unqualified indexes can be calculated using special formula in Quality Index Table.

With respect to quality inspection, the index which is directly related to final inspection is production disqualification.

- Purchase disqualification is monitored by 3 indexes:
  - Global rate,
  - Outside Group rate,
  - Schneider rate
- Outside disqualification:
  Consideration of customer complaints (intermediate or final customer).
Production disqualification

- This index is calculated by quality inspector in final inspection.

- Use the following formula to calculate:
  Disqualification index = fault weighting number/cubicle quantity*

- According to the generation source, the faults discovered in quality inspection can be imputed to production, project design department or subcontractor.

- Faults are divided into 3 categories:
  - Serious fault
    According to judgment and experience, certain fault may lead to safety reduction or customer’s accident hazard. It may lead to actual danger towards person and equipment.
  - Major fault:
    The fault danger in switchboard operation is reduced obviously.
  - Minor fault:
    Belonging to unqualified fault.

- Weight:
  The weights used for the 3 categories of fault are:
  - Serious fault =10
  - Major fault =3
  - Minor fault =1
  Production disqualification is expressed by the index of each type of product and a global index.

* Notes
Note 1: In power distributing cubicle (PCC), the referred cubicle number is corresponding to the cubicle number of production.
Note 2: In motor control cubicle (MCC), the rules are as follows:
- Cubicle =0.2
- Drawer <=125A =0.1 cubicle
- Drawer >=125A =0.2 cubicle

Example of MCC cubicle composition:
1 framework (1X0.2) =0.2
2 drawers >125A (2X0.2) =0.4
8 drawers >125A (8X0.1) =0.8

Sum =1.4
In cubicle number corresponding to = 1.4.
Testification of switchboard production disqualification index

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
<th>Disqualification number</th>
<th>Fault A</th>
<th>Fault B</th>
<th>Fault C</th>
<th>Total weight</th>
<th>Responsibility Production External Department</th>
<th>Production design department</th>
<th>Weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment 1</td>
<td>12.0</td>
<td>3</td>
<td>25</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>11</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Equipment 2</td>
<td>5.5</td>
<td>4</td>
<td>80</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>22</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Equipment 3</td>
<td>8.0</td>
<td>4</td>
<td>50</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>14</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>25.0</td>
<td>11</td>
<td>44</td>
<td>12</td>
<td>5</td>
<td>2</td>
<td>11</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

A: Minor = 1.
B: Important = 3.
C: Serious = 10.

Graphic example of disqualification index

The peak value displayed in the above diagram may depend on:
- Number of processed project,
- Complexity of specific project (complicated operation order),
- Lack of personnel training,
- Individual susceptibility,
- Bad supplier control,
- Bad quality of project design document.
Purpose

The purpose of this section is to control the inspection and production tools used in departments.

Fundamental principle prompt

**Inspection tool**

List and identify inspection tool,
According to measurement precision, conduct examination for it by an approved international or national organization with certain time interval time interval. (For example, French organization is B.N.M- National Metrology Bureau)
This equipment is not used for measurement directly, which is marked with "not followed up in calibration" label, (for example power installation of checkout equipment).
☐ Under the condition of ensuring correct operation and accuracy class, store, use and transport these tools.
☐ Correct the items that delivered and inspected with unqualified measuring instrument.

- Production tools.
- Torque wrench.
- Pressure connector.

Responsibility

The inspection and production tool manager appointed by quality manager takes charge:

- List and identify these tools,
- Implement and monitor these inspections,
- Make decision after inspection,
- File the document.

Ordinary flow chart

[Flow chart image]
Application rules

Tool selection
Inspection tool is selected according to the following:
- Measurement type,
- Theoretical value of the value to be tested,
- Required accuracy.

Tool classification
- With regard to follow up inspection:
  Mark and detect all inspection tools in examination process.
- The equipments which are marked with "non-calibration equipment", and listed in relevant document, only used as instruction.

Note: Electrical test board is checked and approved by QI manager.

Inspection frequency
- Inspection tool
  The adopted normal frequency is:
  - For normally used inspection tool (type: dielectric test instrument, etc.), 1 time a year,
  - For rarely used inspection tool (such as oscillograph, etc.), 1 time 2 years.
- Production tool
  - Torque wrench: at least calibrate 1 time a year.
  - Pressure connector: must 1 time a year.

Inspection tools list and detection
- Inspection tools list and inspection schedule are renewed by manager.
- Each kind of inspection tool has a life sheet, which is opened by manager at the beginning of each inspection, and is completed by manager after inspection.
- A label approved and issued by an authority organization is placed on each kind of inspection tool, such as French BNM. It gives the inspection date and the date on which the next inspection will be conducted.
- The inspection report, measurement reading, as well as disqualification sheet and life sheet transmitted by this organization will be filed together.

Casual inspection
These inspections must be conducted after the following works:
- Obtain new inspection tools (without confirmation or qualification certificate),
- Impact,
- Repair,
- Lending,
- Unused for a long term.

Equipments outside accuracy class
If standardization organization declares that this inspection tool withdraws from accuracy class, managers should isolate it, and make following decisions:
- Repair,
- Dropped to an inspection tool which is not used for measurement,
- Abandonment.
He also must decide whether start disqualification notice (NNC) for the following calibrated and delivered project equipments, this project used problematic tool to conduct inspection:
Calibration manager
Quality department manager
* Please see the example of disqualification notice

- Prepare NNC
- Analysis
- Effects on product operation or
  - List the items which have been delivered and tested with faulty tools
- Contact customer
- Establish intervention plan
- Deal with NNC after correction
- Deal with NNC*
Tool of quality inspector

These are switchboard assembly crewman’s tools (screwdriver, wrench, etc.), in addition need to add:

- Small ruler used for checking clearance,
- Lamp,
- Articulated mirror.

Universal device for quality inspection

- Console,
- Dielectric test instrument or dielectrimeter,
- Megohmmeter,
- Multimeter/phase sequence test instrument,
- Quality inspector should have mounting plate, testing wire and various plugs, power line or other connected system in its configuration,
- Some equipments are rarely used, only used as instruction (such as oscillograph, cubicle scale, etc.).
## Quality inspection

### Precision distance of measurement tool

<table>
<thead>
<tr>
<th>Measurement type</th>
<th>Type of used equipment</th>
<th>Required accuracy</th>
<th>Equipment accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage measurement:</td>
<td>- Alternating current: 0-650V</td>
<td>5%</td>
<td>- 0.5%</td>
</tr>
<tr>
<td></td>
<td>- Direct current: 0-250V</td>
<td></td>
<td>- Figure 0.1%</td>
</tr>
<tr>
<td></td>
<td>◦ Multimeter</td>
<td></td>
<td>- Simulation 1.5%</td>
</tr>
<tr>
<td></td>
<td>◦ MX522 (Metrix).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ MX570 (Metrix).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current measurement</td>
<td>- 0-10A</td>
<td>5%</td>
<td>- 1%</td>
</tr>
<tr>
<td></td>
<td>- 0-50A</td>
<td></td>
<td>- 0.5%</td>
</tr>
<tr>
<td></td>
<td>◦ Mallette DHF MTM 3US2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Multimeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ MX522 (Metrix).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ MX570 (Metrix).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance measurement</td>
<td>◦ Mallette DHF MTM 3US2</td>
<td>5%</td>
<td>- 1%</td>
</tr>
<tr>
<td></td>
<td>◦ Multimeter</td>
<td></td>
<td>- 0.5%</td>
</tr>
<tr>
<td></td>
<td>◦ MX522 (Metrix).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation measurement</td>
<td>◦ MX570 (Metrix).</td>
<td></td>
<td>- Figure 0.1%</td>
</tr>
<tr>
<td></td>
<td>◦ Megger BM6.</td>
<td></td>
<td>- Simulation 1.5%</td>
</tr>
<tr>
<td></td>
<td>◦ Chauvin Arnoux Isoca.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ ELK VH 27.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Bouchet A 509.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Sefelec MG50.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature measurement</td>
<td>Metrix HA 1159.</td>
<td>5%</td>
<td>- 2° from 0 to 70</td>
</tr>
<tr>
<td>Length measurement</td>
<td>◦ Vernier calliper:</td>
<td>0.1mm</td>
<td>- 3° from 70 to 120°</td>
</tr>
<tr>
<td></td>
<td>◦ Mitutoyo CD 15D</td>
<td>(Size measurement below 200mm)</td>
<td>- 0.02mm</td>
</tr>
<tr>
<td>Thickness measurement of ferrous and nonferrous coating</td>
<td>◦ Disturbance Eicometre 345-022322</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Signal reading:</td>
<td>◦ Merlin oscillograph</td>
<td>0.1mm</td>
<td></td>
</tr>
<tr>
<td>Circuit breaker trip test:</td>
<td>◦ Merlin Gerin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dielectric bear capacity:</td>
<td>◦ Bouchet A507 (or A884)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Chauvin Arnoux MC5B.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Coating on steel plate: 10 µm</td>
<td></td>
<td>0.01mm</td>
</tr>
<tr>
<td></td>
<td>◦ Nickel and zinc coating: 3% of 2µm reading</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
List of inspection specifications

This table includes all tests required to be conducted. If inspection operation needs to be carried out in final inspection, it will be very useful.

<table>
<thead>
<tr>
<th>Customer No.:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Document:</td>
<td></td>
</tr>
<tr>
<td>Project identification:</td>
<td></td>
</tr>
<tr>
<td>Inspector:</td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td></td>
</tr>
<tr>
<td>Signature:</td>
<td></td>
</tr>
<tr>
<td>Reference standard IEC 60 439-1:</td>
<td></td>
</tr>
</tbody>
</table>

Protection class

Composition
- Cubicle number
- Cubicle order
- Cubicle name
- Separation form 1/2/3/4
- Cubicle ID/nameplate/date/No./signature
- Position/content of cubicle label
- Simulation diagram
- Warning board

Appearance
- Coating color and label
- Smooth, uniformity
- No scratch or deformation
- Compliance of panel arrangement

Frame
- Size inspection: Length - width - depth - fixed point
- Position of external busway
- Position of external cable trough
- Bolt/washer/nut Grade 8.8
- Door panel/ windage resistance quantity/position
- Door panel/ windage resistance opening
- Operation of door
- Operation of mechanical accessory
- Inspection of door lock and key quantity
- Inspection of protection class
- Inspection of door/side plate pressure
- Inspection of sealed strip
- IP of inlet and outlet hole
- Protection of voltage meter terminal

Horizontal bus (including N line)
- Sectional area (according to Ics/In)
- Coating
- Type of bus support
- Distance of bus support (Ics)
- Sign
- Directions of inlet and outlet
- Limit of overhang length (50mm:)

Vertical bus
- Linergy bus
- Sectional area 800/1000/1250/1600A
- Coating
- Distance of bus support (3/60KA, 4/66KA, 6/85KA)
- Type of bus support
- Limit of overhang length (50mm)

Connecting bus
- Sectional area (Ics/In)
- Coating
- Type of bus support
- Distance of bus support (Ics)
- Sign
- Interference
- Bending radius >=1.5e

PE bus
- Sectional area (Icc<50KA,1x25x5;Icc>=50KA,1x50x5)
- Coating
- Yellow green sign

PEN bus
- Sectional area (according to 60%Ics)
- Coating
- Yellow green sign

Fish plate
- Sectional area
- Length
- Quantity
**Quality inspection**

**Example of control inspection list**

### Cable inspection

- Feature 1000V, 1050C
- Sectional area
- Bending radius >6~8D
- Do not contact charged conductor directly
- Do not contact sharp edge directly
- Moving parts have surplus
- Fixed spacing of power cable
- Fixed spacing of subsidiary cable 400
- Fixed spacing of trough 600MM
- Trough 20% redundancy
- Quantity of each bundle of cable
- Power cable is separated from subsidiary cable
- Size and quantity of cable inlet and outlet hole
- Flexible circuit conductor

### Connection

- Bolt/nut/washer Grade 8.8
- Bolt length
- Contact surface (using standard part)
- Quality of contact surface
- Nut is coated with red paint
- Auxiliary line nose/terminal/cable/plug-in unit is plugged randomly
- Power line nose/cable visual pressure inspection
- Power line terminal/plug-in unit is plugged randomly
- Clear distance of inlet and outlet connection
- Accessibility
- Using O shape line nose

### Equipment

- Technical data
  - Type/rated value/series
  - Section breaker
  - Set value
  - Circuit breaker
  - Relay
  - Fuse

- Voltage class
  - Accessory
  - Coil
  - Lamp
  - Electronic equipment

- Mutual inductor
  - Ratio of transformation
  - Current wiring direction
  - Coordinate with ammeter

- Plug-in safety release device
- Manual control of mechanism
- Interlocking
- Rod linkage
- Cable linkage
- Key linkage
- Fault trip can be reset

### Electrical inspection

- Phase sequence inspection
  - Power circu
  - Auxiliary circuit

- Electrical operation
  - On site
  - Remote control

- Electrical lock
- Power circuit switching-on
- Indication
- Measurement inspection
  - Switch
  - Voltage
  - Current
  - Electric work
  - Communication

- Test check
  - 1 release NS
  - 1 release MT
  - 1 release VIGI
  - Voltage relay
  - Time relay

- Electric clearance
  - Electric clearance 14mm/8mm
  - Tracking resistance 16mm/12.5mm
Dielectric strength test

- Insulation resistance inspection >1M

<table>
<thead>
<tr>
<th>Measure circuit</th>
<th>Ph1</th>
<th>Ph2</th>
<th>Ph3</th>
<th>Ph4</th>
<th>Ph5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Result</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Pressure test /1S<100mA

<table>
<thead>
<tr>
<th>Measure circuit</th>
<th>j1</th>
<th>j2</th>
<th>j3</th>
<th>j4</th>
<th>j5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leakage current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Result</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Protection continuity inspection
- Visual inspection
  - Braided wire >=6mm²
  - Braided wire >=6mm³
  - Braided wire >=6mm⁴
  - Test <0.1 ohm

Inspection before delivery
- Packing inspection
- Document inspection
- Door key
- Cubicle binding screw
- Cubicle fastening screw
- Hoisting accessories
- Delivery equipment list

Example of quality inspection document
- Final inspection report.
- Assembly tracking loose-leaf.
- Not shipped components list of project.
- Missing components tracking after the project is finished.
  - Missing components after assembly is finished.
  - Missing components after inspection is finished.
- Notify sales department.
- Requirements of correction measures.
- Project design documents.
Quality inspection
Example of control inspection list
### Example of control inspection list

<table>
<thead>
<tr>
<th>Cubicle assembly</th>
<th>Operator</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framework assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cubicle module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paint appearance (scuffing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Door and cover plate lock top equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separation locking equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Door assembly and operation, ground wire connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP conformity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulation diagram</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOGO sign assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly of inner arc accessory (see 7041xxx.pdf, Chapter 2.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mw cubicle assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cubicle module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The size of reset axle is easy to operate, can avoid mechanical percussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawer operation (insertion, test, drawing out position)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawer locking (padlock)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetrability of power feeler on vertical bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cubicle equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment assembly and arrangement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current transformer assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal bus assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal bus support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical bus assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical bus support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mw insulation distance on vertical bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outlet bus assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolt fastening and sign</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power cable connection (1000V, 105°C, crimping, fastening)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary cable connection (1000V, 105°C, crimping, fastening)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage bus wiring (independent cable connect channel, protective equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute angle protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trough connection capacity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 1. Missing components list

<table>
<thead>
<tr>
<th>Project</th>
<th>Signature</th>
<th>Quantity</th>
</tr>
</thead>
</table>

Quality control  
Date:

## 2. Missing components tracking when the project is finished

### 1. Missing when assembly is finished

Sender: Manufacture -> Internal management -> Delivery -> Internal management  
Date: (cc)-> I.Q.

<table>
<thead>
<tr>
<th>Project</th>
<th>Project Coordination No.</th>
<th>Quantity</th>
<th>Notified delivery cycle</th>
</tr>
</thead>
</table>

### 2. Missing when inspected/ received by customer

Sender: Quality inspection -> Internal management -> Delivery -> Internal management -> Sale -> Internal management -> Sale  
Date: (cc)->I.Q.  
(cc)-> Warehouse

<table>
<thead>
<tr>
<th>Project</th>
<th>Quality inspector</th>
<th>Quantity</th>
<th>Goods delivery time</th>
</tr>
</thead>
</table>

## 3. Sales department notification

Can items be sent together with missing components?  
Yes ☐ No ☐

Missing components must be sent partially?  
Yes ☐ No ☐

Which?  
Missing components  
Sending address:  
Project on-site delivery date:
# Requirements of correction measure

<table>
<thead>
<tr>
<th>A. R. of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>From:</td>
</tr>
<tr>
<td>To:</td>
</tr>
<tr>
<td>CC:</td>
</tr>
</tbody>
</table>

Disqualification checked by customer  
Internal testing

Problematic product  
Project No.:  

<table>
<thead>
<tr>
<th>Confirmer</th>
<th>Date:</th>
<th>Customer:</th>
</tr>
</thead>
</table>

Explanation of disqualification phenomenon:

All suggestions:

Reply:

<table>
<thead>
<tr>
<th>Correction</th>
<th>Executor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

RCA Settled  
Date  
A.Q. signature
Shipment
### Cleaning

**Practical rules**
Clean the switchboard prior to packing:
- remove any dust from the inside using a vacuum cleaner: blow cleaning may cause shavings and detritus to accumulate in an area that will subsequently be live.
- dust the outside.
- if necessary, use a neutral solvent which will not damage the paint
- repaint, where necessary
- check that there are no foreign objects inside the switchboard (tools, nuts and bolts) which could prevent it from operating properly.

### Accessories

Include the following on the inside of the switchboard:
- any joints for the busbars
- additional mounting hardware
- panels for installation after on-site connection: roof panel, gland plates
- a set of drawings
- the device technical manuals.

### Precautions

Check that all withdrawable or plugin devices are inserted and locked.

Heavy equipment can be dispatched separately. This prevents the risk of the cradle being damaged in the event of shocks and ensures greater enclosure stability during transport.

**Examples for Prisma iPM**

Large draw-out circuit-breakers (Masterpact) installed in the top part of a floor-standing enclosure are generally delivered separately.
## Type of packing

<table>
<thead>
<tr>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
</table>
| Packing depends on the following factors:  
- switchboard weight  
- the conditions under which it will be stored (temperature, humidity, weather, dust, shocks)  
- storage duration  
- lifting techniques (fork-lift, cranes, etc.)  
- transport type and conditions (lorry, container, ship, etc.) and transit countries.  
Packing must provide optimum protection of the front panel and bear the following essential information:  
- fragile (glass)  
- not waterproof (umbrella)  
- position: top, bottom (arrows) and if appropriate:  
- centre of gravity (G) lifting points (chains).  
Two main types of packing are normally used for packing electrical switchboards:  
- overland packing:  
The enclosure is protected by a plastic cover and housed in a crate.  
- seaworthy packing:  
The enclosure, which contains bagged desiccants, is protected by a plastic cover and housed in a ventilated, wooden or plywood case. |

## Important

Check with the transporter that packing is compatible with the lifting system in use: points for attaching slings, rafters, etc. (see chapter 10 "handling").  
Check with the customer that the switchboard, once packed, can access the site (height and width of doors, etc.).  
If necessary, pack each cubicle separately and identify each package with respect to the overall switchboard layout.
### General

**Practical rules**
The dispatch file should be sent by post to the customer. It includes:
- a copy of the delivery slip
- a duplicate copy of the set of drawings updated at the end of inspection
- the assembly manuals:
  - for the switchgear
  - for the enclosure

The inspection and test reports will be supplied on request.

**NB:**
Before dispatch, check that the customer is ready to receive the equipment and choose the appropriate delivery and acceptance procedure (location, on-site facilities, delivery date, name of person to be contacted, his telephone number, email address, etc.).

### Examples for Prisma iPM
<table>
<thead>
<tr>
<th>Principle</th>
<th>Practical rules</th>
<th>Examples for Prisma iPM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lifting from the bottom</strong></td>
<td>The frameworks and supports for the devices have been designed for switchboard operation in an upright position. To avoid abnormal mechanical stresses during transport, the floor-standing enclosures must remain upright under all circumstances.</td>
<td>On the Prisma iPM floor-standing enclosure, rafters are attached directly to the base of the framework or to the plinth. They contribute to the stability of the enclosure during movement in the factory and are also used to secure the packing panels.</td>
</tr>
<tr>
<td></td>
<td>As a rule, a pallet-mover or fork-lift is used for handling. Packing should include rafters or the like to allow lifting by the forks.</td>
<td>Move wall-mount enclosures either flat down on a wooden pallet or using a 2-wheeled truck.</td>
</tr>
<tr>
<td></td>
<td>On the Prisma iPM floor-standing enclosure (W = 900) with a bar duct, the lifting points are shifted towards the busbars.</td>
<td>For a Prisma Plus floor-standing enclosure (W = 900) with a bar duct, the lifting points are shifted towards the busbars.</td>
</tr>
<tr>
<td></td>
<td>The enclosures should be lifted at resistant points selected according to the centre of gravity of the enclosure.</td>
<td></td>
</tr>
</tbody>
</table>
### Lifting from the bottom (continued)

**Practical rules**

Floor-standing enclosures moved using a fork-lift should be lifted with care and steadied by hand or strapped to the fork-lift during transport.

---

### Lifting from the top

If a crane or overhead hoist is used requiring lifting from the top, only slings which are both strong enough and in good condition should be used. They must be attached to the lifting rings, specific to the enclosure, and laid out as specified by the manufacturer. Slings should be adjusted to suit the size of the switchboard.

As a rule, lifting is for one cubicle at a time. When adjacent cubicles cannot be separated, check the strength of the mechanical connections between the two and use a lifting beam.

For switchboards containing a number of cubicles:
- mechanical connections between cubicles must be reinforced using angle irons or stiffeners
- wherever possible, use a lifting beam directly attached to the switchboard base, after first checking that the base is sufficiently rigid.

---

**Examples for Prisma iPM**

The maximum load that can be withstood by lifting rings is given in the assembly.

Schneider Electric recommends a combination of 2 cubicles maximum.
Lifting from the bottom (continued)

Practical rules

After loading the enclosure, check that it is properly chocked and attached on the lorry, to avoid all risk of damage during transport.

The wall-mount and floor-standing enclosures should preferably be laid flat for transport.

wall-mount enclosure
Site installation
Site information
- Prisma iPM installation site must be clean.
- The ground must be level, and meet requirement of gradient (≤ 2 mm/meter), if floor flatness >2mm/m, >2mm/m, U or I type section bar bracket must be provided, and straightness and flatness shall be checked in both directions.
- For Prisma iPM series cubicle installation, it is also required that the wall surface must be level, ± 6mm/m.

Cubicle position
- For Prisma iPM series cubicles, there shall be at least 1000mm space in front of switchboard so that the door can be fully opened, and the forklift shall be used for equipment operation.

The door shall be installed according to direction of component to be disassembled.
For Prisma iPM series cubicles, there shall be at least 1000mm space in front of switchboard so that the door can be fully opened; and forklift shall be used for equipment operation. As there are many installation components, it is recommended to maintain at least 100 mm spacing at back of switchboard, to ensure good ventilation. The door shall be installed according to direction of component to be disassembled.

It is recommended to use sectional bar bracket systematically, to simplify mechanical connection between FS series cubicles and busbar fish plates. If possible, dustproof paint shall be applied on the floor to reduce pollution in switchboard. If any expansion is planned to be conducted in the future, adequate space shall be set aside.

### Aperture

<table>
<thead>
<tr>
<th>Cubicle width (mm)</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 and 800</td>
<td>180 °</td>
</tr>
<tr>
<td>200 and 300</td>
<td>130 °</td>
</tr>
</tbody>
</table>
Site installation
Site preparation

Top incoming line
- For Prisma iPM WM series cubicles, there shall be at least a space of 500mm (600mm recommended) upon switchboard, so that electrical cable can be led in (in accordance with bend radius of electrical wire).

There is mark on top to indicate the position where electrical cable penetrates the cubicle.

- For Prisma iPM FS series cubicles, there shall be at least a space of 600mm upon switchboard, so that electrical cable can be led in (in accordance with bend radius of electrical wire) and/or horizontal busbar can be connected. Dismantling FS series cubicle head beam for wiring.

Bottom incoming line
- Incoming cable shall be arranged:
  - In cable recess under cubicle
  - Or under cubicle supporting floor(for FS series and WM series cubicles of 28-module, 32-module)

- If there is a cable recess in the floor, its width must be less than cubicle depth, or it must include cross rail or section bar bracket (which must be used during back-to-back cubicle combination)

- If supporting floor is used, the switchboard must be installed on a metal chassis, to support cubicle weight. Adjustment shall be made to plate layer supporting the floor to reach the degree of protection of switchboard.

- All flat electrical cable cover plates shall be cut for 30mm from plate edge.
Maintenance
Prisma iPM equipment inspection shall be conducted in accordance with application requirement. Prisma iPM equipment shall be maintained at least once a year, details can be defined in accordance with site operation condition and requirements of maintenance contract.

**Frequency of preventive maintenance**

Frequency of preventive maintenance mainly depends on operating condition of switchboard.

For operating condition in common environment, maintenance frequency is shown in the following table. If the equipment operates in specially clean environment, and operation intensity is not high, maintenance frequency should be lower. On the other hand, if the equipment operates in especially rugged environment (dusts, moisture, corrosive steam, warm gas) or operation intensity is very high, maintenance frequency should be higher.

<table>
<thead>
<tr>
<th>Type</th>
<th>Measure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>General inspection</td>
<td>Visual check and general cleaning</td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Visual check of busbar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Running test</td>
<td></td>
</tr>
<tr>
<td>Maintenance of functional unit</td>
<td>Check of connecting point</td>
<td>Once every 5 years</td>
</tr>
<tr>
<td>Maintenance of ventilation</td>
<td>Filter cleaning</td>
<td>Once every six months</td>
</tr>
<tr>
<td>system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance of components</td>
<td>In accordance with specific product operation manual</td>
<td></td>
</tr>
<tr>
<td>and parts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preventive maintenance of switchboard**

General maintenance operation of this product.

- Check whether humidity or foreign matter exists inside and outside cubicle, and maintain switchboard clean.
- Use vacuum cleaner to clean. Clean ventilation system, replace filter screen when necessary.
- Eliminate original grease on mechanical parts, repaint grease (refer to grease recommended for use in 53 page).
- Check external surface of cubicle. Re-spray scratched part and replace rusty components when necessary.
- Inspect insulation monitoring devices.
- Test some indicated systems.
- Visual estimation of busbar system
- If red paint used for marking correct fastening is undamaged, bolt re-fastening is not required.
- Check whether obvious heat generating point exists in bus connection part (color of this point changes). If any heat generating point is found, corresponding part shall be dismantled. Clean this part, use abrasive paper ( No. 400 abrasive paper ) to polish contact surface. During reinstallation:
  - completely new and unanimous fasteners ( grade 8.8) (bolts, nuts, washers) shall be used;
  - Fastening shall accord to requirements of following table correctly;
  - Red paint mark shall be signed.
- Clean ventilation filter.
- For standard or fine filter, clean in accordance with the following methods.
  - Wash with water (high quality cleansing agent is preferred);
  - Remove dusts through plucking, vacuum cleaner or compressed air blowing;
  - Replace the filter in case of any oil sludge,
- Visual estimation of bus supporting situation, including fastening situation.
- Inspect fastening situation of customer’s cable.
- Inspect component situation.
- Inquire corresponding manual.
Note

- Do not use compressed air to clean the switchboard, to avoid blowing pollutants to other positions of switchboard.
- Use dry cloth or alcohol to clean cubicle enco cloth with denatured alcohol. Other manners are prohibited.
- Avoid contact of plastics piece (bus support or plug) with grease or cleansing agent absolutely.

Tightening torque form
The following table indicates grade 8.8 bolt + nut + washer used.

<table>
<thead>
<tr>
<th>Nominal diameter of bolt</th>
<th>Tightening torque (Newton meter)</th>
<th>Nut + contact washer</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM3</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>HM4</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>HM5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>HM6</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>HM8</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>HM10</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>HM12</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>HM14</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>HM16</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>HM18</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>HM20</td>
<td>370</td>
<td></td>
</tr>
</tbody>
</table>

UCHOFFF UCHON Prisma iPM FS series cubicle

Inspection before electrification
- Inspect earthing continuity of exposed conductive parts
- Inspect equipotential connection.
- Test insulating property.

Maintenance after failure occurrence
Large current caused by failure may cause damages of framework, component, busbar and cable.
In case of any failure, please contact equipment provider.

Heat generating point
- Find out reasons: generally caused by released connection.
- Dismantling installation.
- Clean and polish contact surface.
- Make reconnection.

Danger
Danger of electric shock, fire or explosion
In order to prevent dangerous contact with live parts, all devices must be powered off or isolated before maintenance. Before operation on equipment, whether any voltage exists in circuit breaker, incoming line and outgoing line terminals of contactor and starter in cubic le shall be inspected. All inspection and maintenance operation must be conducted by personnel with qualifications, and relevant safe operation steps must be followed.
If this guide is not followed, serious personal injury, even death may be caused.
Modular design of Prisma iPM allows us to increase expansion or modify a functional unit through the following manners:
- Use new functional unit of same module to replace existing functional unit;
- Increase an additional functional unit in spare space;
- Increase a new cubicle to obtain more installation space;

The following information is required during ordering:
- Load type;
- Service voltage and frequency;
- Control circuit voltage and frequency;
- Optional accessories (control transformer, button indicator, option switch etc.);
- Special characteristics;

During ordering new cubicle, the following information shall be considered:
- Rated current of horizontal and vertical bus, material and surface treatment;
- Cubicle size.