Dos, don’ts and precautions in wiring cables and conductors inside low-voltage switchboard

Wiring low-voltage switchboard

To be clear from the very beginning of this article, there is no standard model for wiring low voltage switchboards and panelboards. However, for the wide variety of installations and ranges of power ratings, there are local work practices, regulations and of course international standards. There are numerous types of the conductor in the LV switchboard. The best choice depends on what they are to be used for, which is clearly defined for installations.

However, this is not always the case for distribution switchboards. In addition to the current-carrying capacity, this choice is dependent on the requirements relating to the panel, the rated voltage, the installation method, the type of insulation, the types of application, etc.

I always like to see is the proper “wiring hygiene” when looking at the switchboard. If the wiring is done properly and clean, it will make much easier troubleshooting and maintenance in the future.

This technical article covers recommendations for choosing cross-sections of the wiring conductors inside switchboards, their connection methods, various wiring dos, don’ts and precautions in protecting from short-circuit and magnetic effect.

1. Cross-sections of the wiring conductors inside switchboards

The choice of conductors to be used inside the switchboard and their cross-sections are the responsibility of the original manufacturer. The conductors must have a minimum cross-section conforming to IEC 60364-5-52. Examples of how to adapt this standard for the conditions inside the switchboard are given in the following table which is taken from IEC 61439-1.

There are two types of conductor:

1. PVC for conductors with PVC or rubber insulation, generally used for wiring conductors up to 35 mm²
2. PR for conductors with polyethylene or elastomer insulation. In practice these are usually reserved for cross-sections greater than 35 mm²

The installation and ambient temperature conditions have been named empirically:

- **IP < 30** for conductors installed with good cooling conditions (enclosure open or naturally ventilated, low to medium wiring density, enclosure internal temperature similar to the ambient temperature up to 35°c)
- **IP > 30** for conductors installed in poor cooling conditions (sealed enclosure, high wiring density, multi-core cables, enclosure internal temperature that may reach 50°c)

Table 1 – Guide values for minimum cross-sections (in mm^2)

			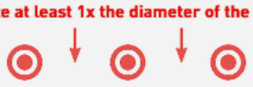	
Manufacturer's specification	Single-core cables exposed in the open air or placed in a perforated cable tray. 6 cables (2 three-phase circuits) continuously loaded.		Single-core cables placed horizontally and separated in the open air	
	35°C	55°C	35°C	55°C
Conductor cross-section mm^2	Maximum current-carrying capacity Imax[c] A		Maximum current-carrying capacity Imax[b] A	
1.5	14	9	23	15
2.5	20	13	32	21
4	28	18	43	28
6	35	23	55	36
10	49	32	77	50
16	68	44	103	67
25	91	59	137	89
35	113	74	170	110
50	138	90	206	134
70	179	116	264	171
95	218	-	321	208
120	255	-	372	242

Table 1 – Guide values for minimum cross-sections (in mm2)

Where:

- **Imax[c]** – Current-carrying capacity I_{30} for a three-phase circuit from IEC 60364-5-52, table B.52.10, column 5 (installation method: point F in table b.52.1). Values for cross-sections less than 25 mm^2 calculated according to IEC 60364-5-52 Annex D. k_2= 0.88 (point 4 in table B.52.17, two circuits)
- **Imax[d]** – Current-carrying capacity I_{30} for a three-phase circuit from IEC 60364-5-52, table B.52.10, column 7 (installation method: point G in table B.52.1). Values for cross-sections less than 25 mm^2 calculated according to IEC 60364-5-52 Annex D. (k_2= 1)

Column 1 applies when conductors from different circuits are installed touching one another and grouped together (for example, installation in trunking or in strands).

Figure 1 – Several circuits in the same trunking and all wiring in vertical and horizontal trunking: Column 1 installation

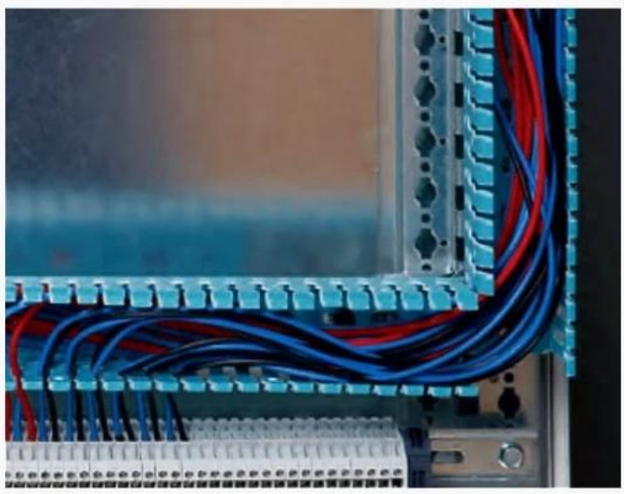

Figure 1 – Several circuits in the same trunking and all wiring in vertical and horizontal trunking: Column 1 installation

Column 2 applies when the conductors or cables are **separated in the open air** (see Figure 2 below).

Figure 2 – Conductors not touching, held in place with guide rings: Column 2 installation

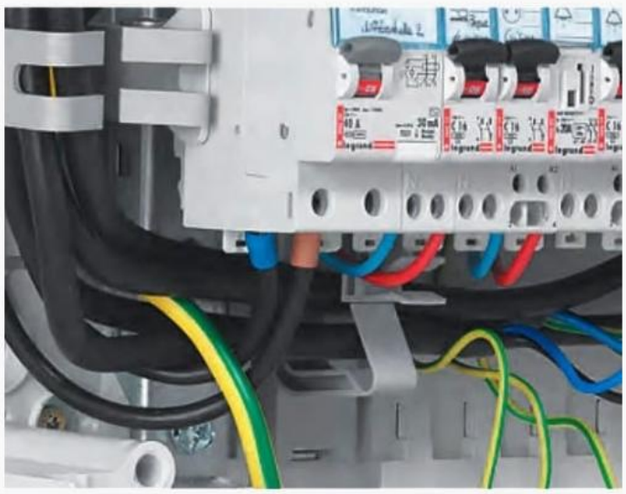

Figure 2 – Conductors not touching, held in place with guide rings: Column 2 installation

Figure 3 – Horizontal circulation "**in the open air**", only the vertical conductors are grouped in trunking: column 2 installation as here. If the packing ratio of the vertical trunking is high: column 1 installation

The usual cross-sections of protective conductors (PE) in switchboards are given below.

Table 2 – Cross-sections of protective conductors in switchboards according to the current

I (A)	S_{PE} (mm^2)
10	1.5
16	2.5
20	4
25	4
32	6
40	10
63	16
80	16
100	16
125	25
160	35
200	50
250	70
315	95

400	120
500	150
630	185
800	240
1000	185 or 2×150
1250	240 or 2×165
1600	240 or 2×240
> 1600	$S_{PE}/4$

The cross-sections of the conductors to be used for wiring inside switchboards are not covered in a single standard document.

Standard IEC 60364

Standard IEC 60364 recommends that the cross-sections are determined **according to installation methods 31 and 32**. In fact, the method is difficult to apply as it requires, for the application of the correction factors, information that will only be known after the installation has been carried out:

- Parts which run vertically,
- Parts which run horizontally,
- Groups,
- Number of layers,
- Separate conductors or cables, as well as
- Knowledge of the ambient temperature in the enclosure, which is always difficult.

Standard IEC 61439-1

Standard IEC 61439-1 does not recommend cross-sections but stipulates a “**current range**” for the temperature rise tests. The conductors taken into consideration have PVC insulation and the ambient temperature is not specified. These conditions do not therefore cover all applications.