

Dimensioning the protective conductors

Table of contents

| | | |
|-----|--|---|
| 1. | General information..... | 1 |
| 2. | Installation regulation in the area of validity of UL/CSA (NEC for USA / CEC for Canada)..... | 2 |
| 2.1 | Basic regulation..... | 2 |
| 2.2 | Overview minimum cross-sections for UL/CSA | 2 |
| 3. | Installation regulations in the area of validity of IEC/EN..... | 3 |
| 3.1 | Basic regulation..... | 3 |
| 3.2 | Alternative dimensioning | 3 |
| 3.3 | Overview – minimum cross-sections for IEC/EN | 4 |

1. General information

A S120 booksize drive system generally comprises a Line Module, several Motor Modules and supplementary power components. The protective conductor of the power modules is dimensioned based on the rated current of the Line Module being used and the line-side protective device being used (fuses or circuit breaker). The local installation regulations that must be complied with are explained in more detail in this document.

2. Installation regulation in the area of validity of UL/CSA (NEC for USA / CEC for Canada)

2.1 Basic regulation

The relevant National Electrical Code applies in the US and Canada. The minimum cross-section of the protective conductor should be dimensioned according to the rated current of the corresponding protective device. The protective devices that can be used are described in the SINAMICS S120 equipment manual "Power Units Booksize" or the product information "Protective Devices for SINAMICS S120 Line Modules Booksize".

| Rated current of the protective device [A] | Protective conductor cross-section [AWG Cu] | Protective conductor cross-section [mm ² Cu] |
|--|---|---|
| 15 | 14 | 2,5 |
| 20 | 12 | 4 |
| 60 | 10 | 6 |
| 100 | 8 | 10 |
| 200 | 6 | 16 |
| 300 | 4 | 25 |

2.2 Overview minimum cross-sections for UL/CSA

The following minimum cross-sections for the protective conductor are obtained from the previously mentioned installation regulation, taking into account the protective devices specified in the SINAMICS S120 equipment manual "Power Units Booksize" or the product information "Protective Devices for SINAMICS S120 Line Modules Booksize".

| Line Module | Article number | Max. rated current of the protective device [A] | S min [AWG Cu] | S min [mm ² Cu] |
|----------------------|--|---|----------------|----------------------------|
| SLM 5kW | 6SL313x-6AE15-0Axx | 20 | 12 | 4 |
| SLM 10kW | 6SL313x-6AE21-0Axx | 40 | 10 | 6 |
| ALM 16kW SLM 16kW | 6SL313x-7TE21-6AAx 6SL313x-6TE21-6Axx | 40 | 10 | 6 |
| BLM 20kW | 6SL313x-1TE22-0AA0 | 60 | 10 | 6 |
| | | 65 | 8 | 10 |
| ALM 36kW SLM 36kW | 6SL313x-7TE23-6AAx 6SL313x-6TE23-6Axx | 90 | 8 | 10 |
| BLM 40kW | 6SL313x-1TE24-0AA0 | 100 | 8 | 10 |
| ALM 55kW SLM 55kW | 6SL313x-7TE25-5AAx 6SL313x-6TE25-5AAx | 125 | 6 | 16 |
| ALM 80kW | 6SL313x-7TE28-0AAx | 175 | 6 | 16 |
| BLM 100kW | 6SL313x-1TE31-0AA0 | 250 | 4 | 25 |
| ALM 120kW | 6SL313x-7TE31-2AAx | 250 | 4 | 25 |

3. Installation regulations in the area of validity of IEC/EN

3.1 Basic regulation

IEC 61800-5-1, Chapter 4.3.5.4, Table 5 (see also IEC 60364-5-54 Table 54.2) is the basic regulation, which specifies the minimum cross-section depending on the cross-section of the line conductor of the line feeder cable to the Line Module being used:

| Cross-section of the line conductor of the PDS/CDM/BDM S mm ² Cu | Minimum cross-section of the corresponding protective conductor S_p mm ² Cu |
|--|---|
| $S \leq 16$ | S |
| $16 < S \leq 35$ | 16 |
| $35 < S$ | $S/2$ |

The values listed in this table are only applicable if the protective conductor is manufactured out of the same metal as the line conductors. If this is not the case, then the protective conductor cross-section must be determined so that a level of conductivity is obtained that is the same as the data listed in this table.

3.2 Alternative dimensioning

Alternatively, the protective conductor can be dimensioned according to IEC 60364-5-54, Chap. 543.1.2. Based on the main parameters of the protective device being used, the protective conductor can be dimensioned according to the procedure subsequently described:

$$S = \frac{\sqrt{I^2 t}}{k}$$

- S: Protective conductor cross-section in mm²
- I: rms value of the short-circuit current in A, which causes the protective device to respond within time t
- t: Interrupting time of the protective device in s for current I
- k: Factor for the cable, depending on the cable material, insulating material and temperature

According to IEC60364-5-54 table A.54.2, the factor $k = 143$ can be assumed for a copper wire with PVC insulation.

The values for $I^2 t$ can be determined from the main parameters of the corresponding protective device. For the protective devices specified in the SINAMICS S120 equipment manual "Power Units Booksize", the corresponding values for LV HRC line fuses and 3VL and 3RV circuit breakers can be found in the Siemens Support Tool under Characteristics.

<https://support.industry.siemens.com/cs/ww/en/ps>

3.3 Overview – minimum cross-sections for IEC/EN

The following minimum cross-sections for the protective conductor are obtained from the previously mentioned installation regulation, taking into account the specified protective devices:

| Line Module | Article number | Protective device | I ² t PD [A ² s] | S min [mm ² Cu] | S min [AWG Cu] |
|----------------------|--|-------------------|--|----------------------------|----------------|
| SLM 5kW | 6SL313x-6AE15-0Axx | 3NA3805, 16A | 1000 | 1,5 | 16 |
| | | 3RV1021-4BA10 | 50000 | 1,5 | 16 |
| | | 3RV2021-4BA10 | 50000 | 1,5 | 16 |
| | | 3RV2711-4AD10 | 50000 | 1,5 | 16 |
| SLM 10kW | 6SL313x-6AE21-0Axx | 3NA3814, 35A | 9300 | 1,5 | 16 |
| | | 3RV1031-4FA10 | 150000 | 2,5 | 14 |
| | | 3RV2031-4UA10 | 150000 | 2,5 | 14 |
| | | 3VA1132-6EE | 314000 | 4 | 14 |
| | | 3VA5135-6E | 280000 | 4 | 14 |
| ALM 16kW SLM 16kW | 6SL313x-7TE21-6AAx 6SL313x-6TE21-6Axx | 3NA3814, 35A | 9300 | 1,5 | 16 |
| | | 3RV1031-4FA10 | 150000 | 2,5 | 12 |
| | | 3RV2031-4UA10 | 150000 | 2,5 | 12 |
| | | 3VA1140-6EE | 427000 | 6 | 12 |
| | | 3VA5140-6E | 280000 | 4 | 12 |
| BLM 20kW | 6SL313x-1TE22-0AA0 | 3NA3822, 63A | 26500 | 1,5 | 14 |
| | | 3RV1041-4JA10 | 300000 | 4 | 10 |
| | | 3RV2031-4JA10 | 240000 | 4 | 10 |
| | | 3VA1163-6EE | 427000 | 6 | 10 |
| | | 3VA5160-6E | 280000 | 4 | 10 |
| ALM 36kW SLM 36kW | 6SL313x-7TE23-6AAx 6SL313x-6TE23-6Axx | 3NA3824, 80A | 43000 | 2,5 | 14 |
| | | 3RV1041-4LA10 | 400000 | 6 | 10 |
| | | 3RV2031-4RA10 | 300000 | 4 | 10 |
| | | 3VA1180-6EE | 427000 | 6 | 10 |
| | | 3VA5190-6E | 280000 | 4 | 10 |
| BLM 40kW | 6SL313x-1TE24-0AA0 | 3NA3830, 100A | 80000 | 2,5 | 12 |
| | | 3RV1041-4MA10 | 420000 | 6 | 8 |
| | | 3VL2710-1DC33 | 2200000 | 16 | 6 |
| | | 3VA1110-6EE | 533000 | 6 | 10 |
| | | 3VA5110-6E | 540000 | 6 | 10 |
| | | 3VA5210-7E | 1400000 | 10 | 8 |
| ALM 55kW SLM 55kW | 6SL313x-7TE25-5AAx 6SL313x-6TE25-5AAx | 3NA3132, 125A | 130000 | 4 | 12 |
| | | 3VL2712-1DC33 | 2200000 | 16 | 6 |
| | | 3VA1112-6EE | 533000 | 6 | 10 |
| | | 3VA5112-6E | 540000 | 6 | 10 |
| | | 3VA5212-7E | 1400000 | 10 | 8 |
| ALM 80kW | 6SL313x-7TE28-0AAx | 3NA3136, 160A | 223000 | 4 | 10 |
| | | 3VL3720-1DC33 | 2000000 | 16 | 6 |
| | | 3VA1116-6E | 533000 | 6 | 10 |
| | | 3VA1220-6EF | 1800000 | 10 | 6 |
| | | 3VA5217-7E | 1400000 | 10 | 8 |
| BLM 100kW | 6SL313x-1TE31-0AA0 | 3NA3144, 250A | 780000 | 10 | 8 |
| | | 3VL3725-1DC33 | 2000000 | 16 | 4 |
| | | 3VA1225-6EF | 1800000 | 10 | 6 |
| | | 3VA5225-7E | 1400000 | 10 | 8 |
| ALM 120kW | 6SL313x-7TE31-2AAx | 3NA3144, 250A | 780000 | 10 | 8 |
| | | 3VL3725-1DC33 | 2000000 | 16 | 4 |
| | | 3VA1225-6EF | 1800000 | 10 | 6 |
| | | 3VA5225-7E | 1400000 | 10 | 8 |

PD: Protective Device,

S min: Minimum protective conductor cross-section

When using protective devices other than those listed in the table above, then the protective conductor must be dimensioned according to Chapter 3.1 (Page 4) or alternatively, according to 3.2 (Page 4).

When using protective devices of the type 3VA10..., the protective conductor has to be the same size as when using the appropriate 3VA11.. type.