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7.4 Connection example

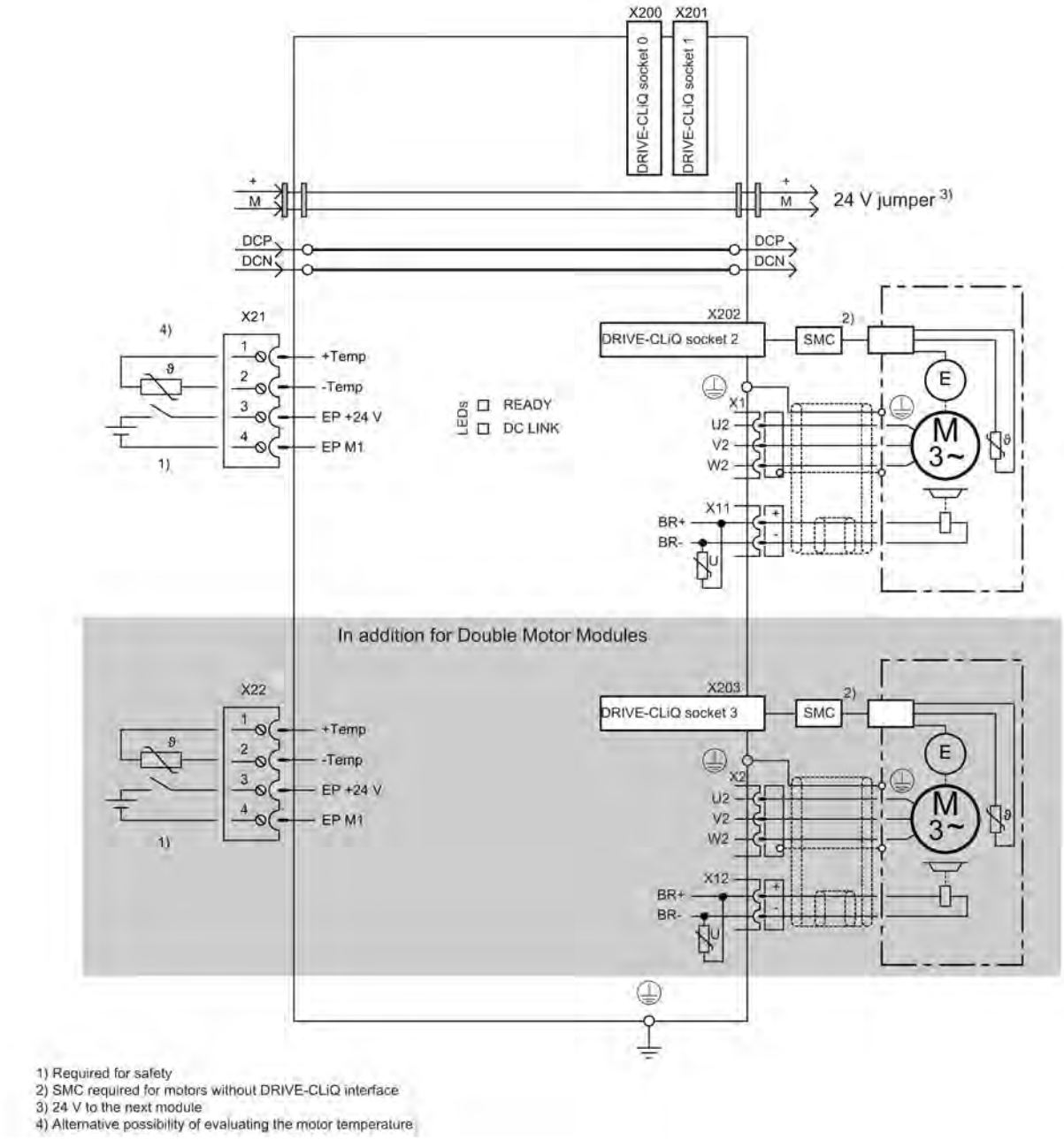


Figure 7-3 Connection example, Single Motor Modules Booksize Compact 3 A to 18 A and Double Motor Modules Booksize Compact 1.7 A to 5 A

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7.5 Meaning of LEDs

Table 7- 5 Meaning of the LEDs on the Motor Module booksize compact

Status		Description, cause	Remedy
RDY	DC LINK		
Off	Off	The electronics power supply is missing or outside the permissible tolerance range.	–
Green	–	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	–
	Red	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is outside the permissible tolerance range.	Check the line supply voltage.
Orange	Orange	DRIVE-CLiQ communication is being established.	–
Red	–	This component has at least one fault. **Note:** The LED is activated regardless of whether the corresponding messages have been reconfigured.	Resolve and acknowledge the fault.
Green/red (0.5 Hz)	–	Firmware is being downloaded.	–
Green/red (2 Hz)	–	Firmware download has been completed. The system waits for POWER ON.	Carry out a POWER ON.
Green/orange or red/orange	–	Component recognition via LED is activated[1)]. **Note:** Both options depend on the LED status when component recognition is activated using the parameter.	–

[1)] See SINAMICS S120/S150 List Manual for the parameters to activate the recognition of components via LED

⚠WARNING

Danger of death when live parts of the DC link are touched

Irrespective of the state of the LED "DC LINK", hazardous DC link voltages can be present. This means the touching of live parts can result in death or serious injury.

- Observe the warning information on the component.

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7.6 Dimension drawings

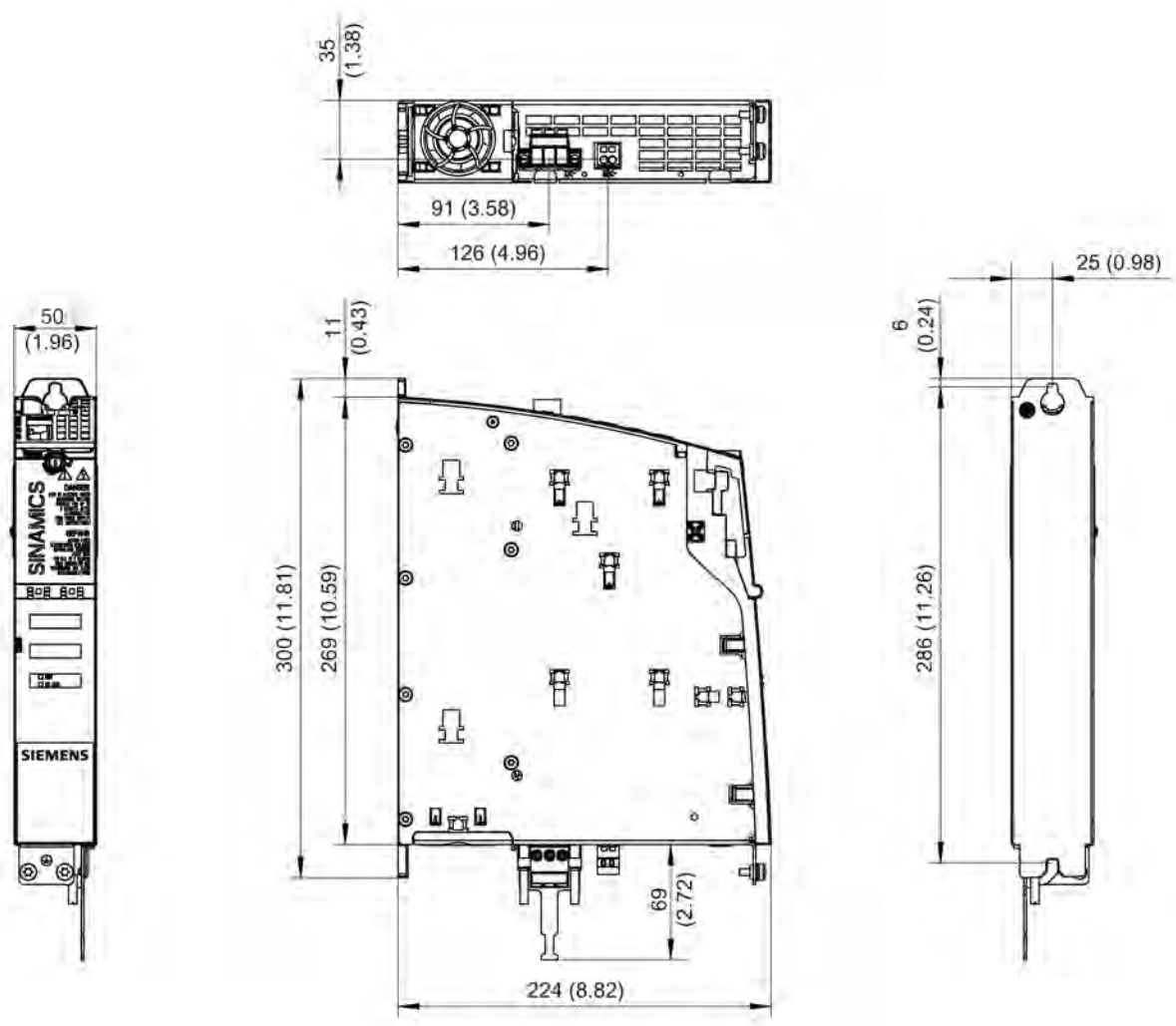


Figure 7-4 Dimension drawing of 3 A, 5 A, and 9 A Motor Modules Booksize Compact, all dimensions in mm and (inches); example: 5 A Single Motor Module

Table 7- 6 Motor Modules Booksize Compact 3 A, 5 A, and 9 A

Motor Module	Order number
Single Motor Module 3 A	6SL3420-1TE13-0AAx
Single Motor Module 5 A	6SL3420-1TE15-0AAx
Single Motor Module 9 A	6SL3420-1TE21-0AAx

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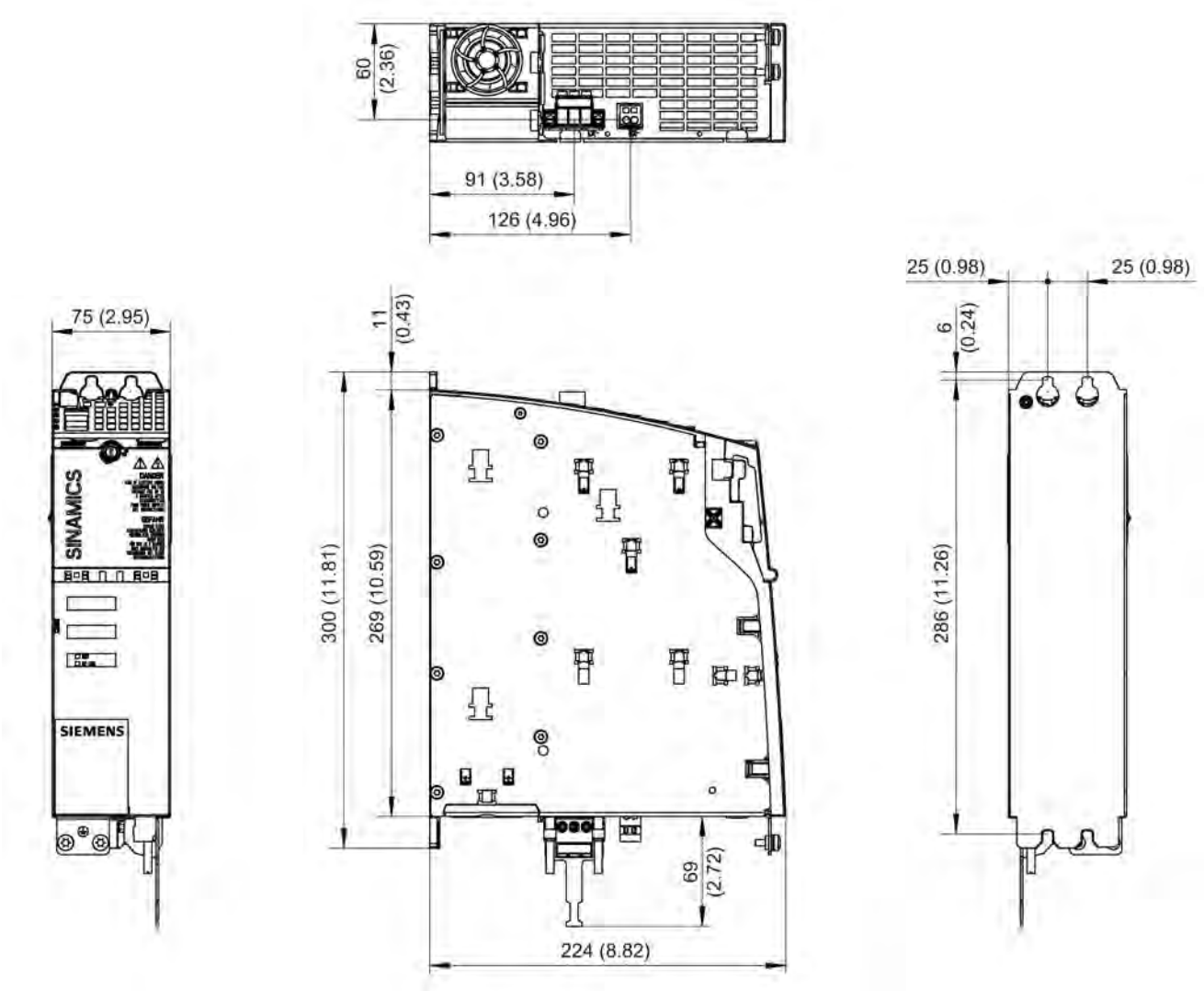


Figure 7-5 Dimension drawing of 18 A Motor Module Booksize Compact, all dimensions in mm and (inches)

Table 7- 7 Motor Module Booksize Compact 18 A

Motor Module	Order number
Single Motor Module 18 A	6SL3420-1TE21-8AAx

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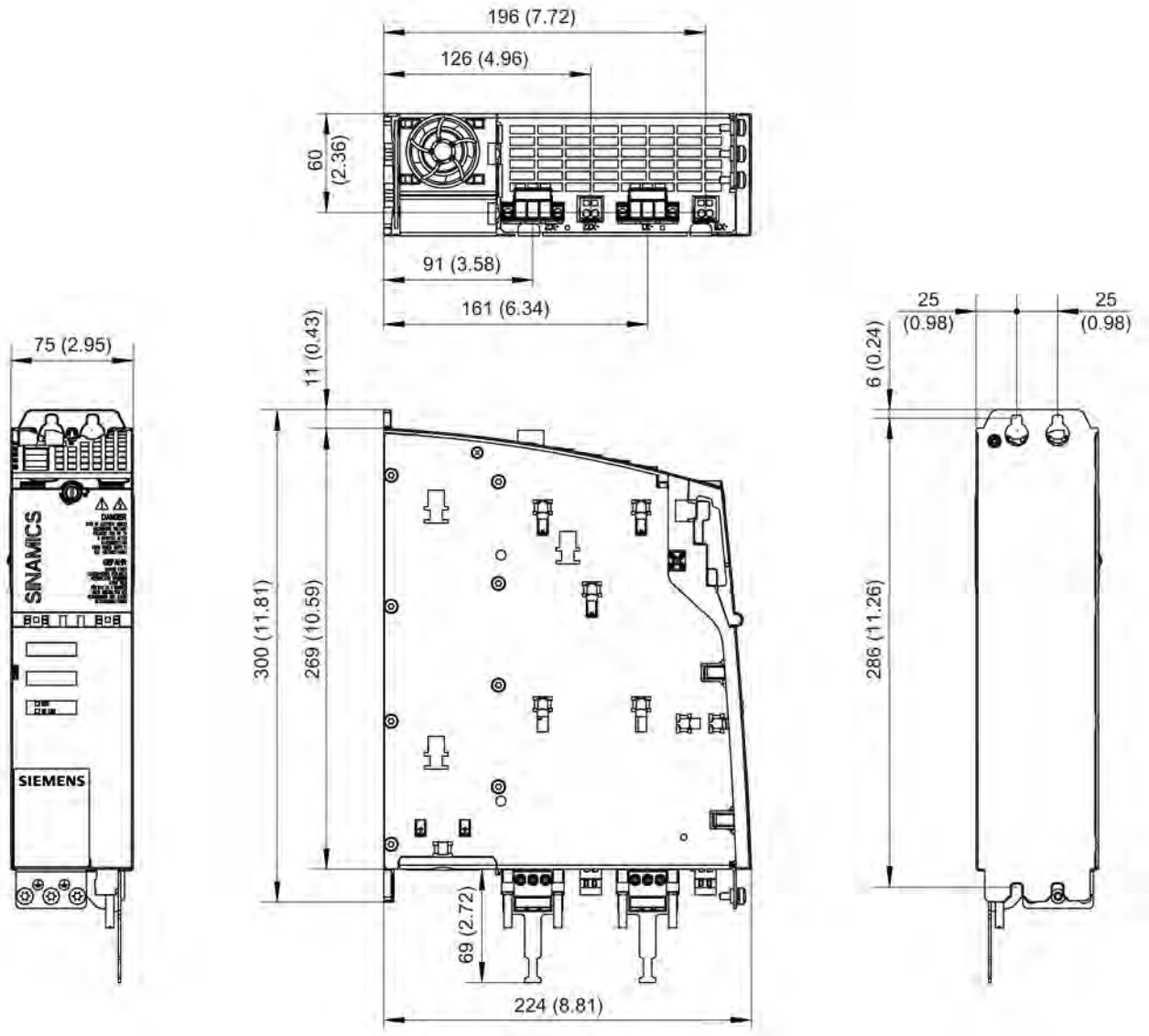


Figure 7-6 Dimension drawing of 2 x 1.7 A, 2 x 3 A, and 2 x 5 A Double Motor Modules Compact, all dimensions in mm and (inches); example: 2 x 5 A Double Motor Module

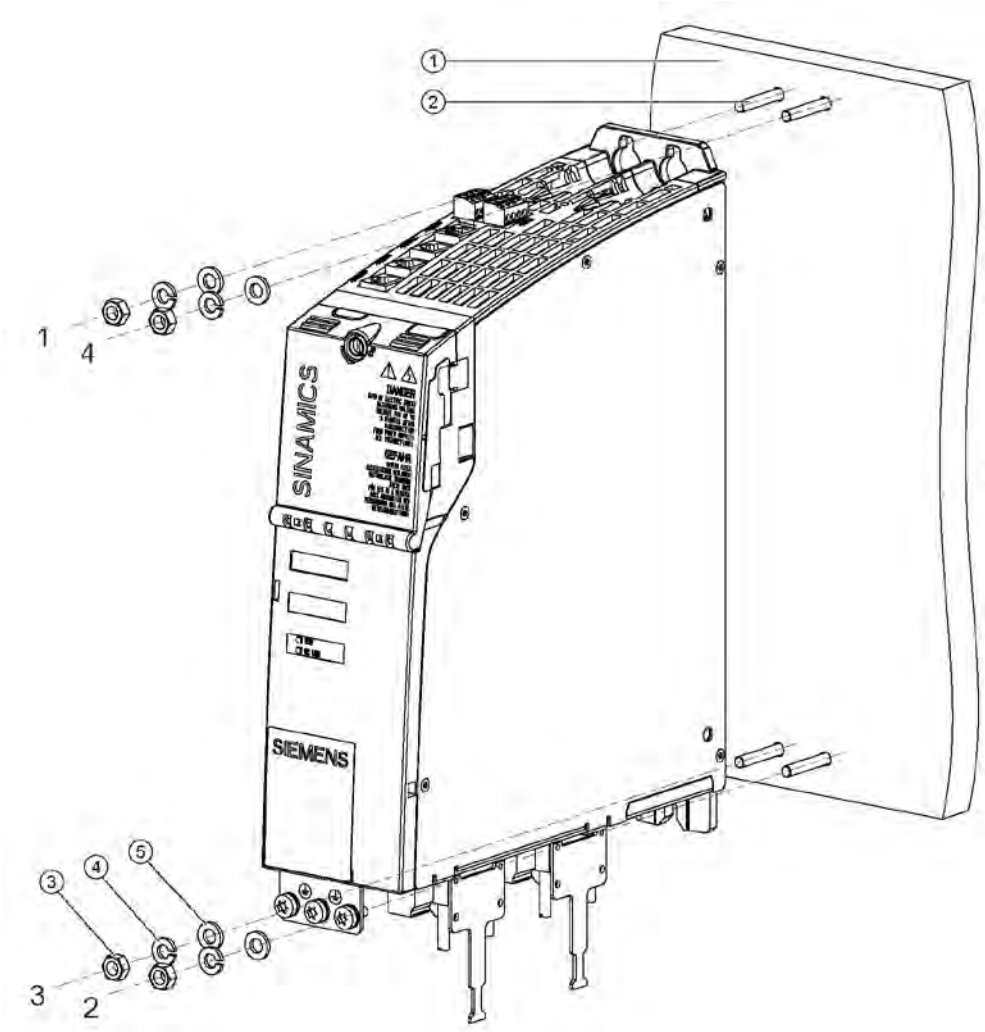
Table 7- 8 2 x 1.7 A, 2 x 3 A, and 2 x 5 A Double Motor Modules Booksize Compact

Double Motor Module	Order number
2 x 1.7 A Double Motor Module	6SL3420-2TE11-7AAx
2 x 3 A Double Motor Module	6SL3420-2TE13-0AAx
2 x 5 A Double Motor Module	6SL3420-2TE15-0AAx

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7.7 Mounting

Mounting a Motor Module Booksize Compact with internal air cooling



① Mounting wall
② M6 studs
③ M6 nut
④ Spring washer
⑤ Washer

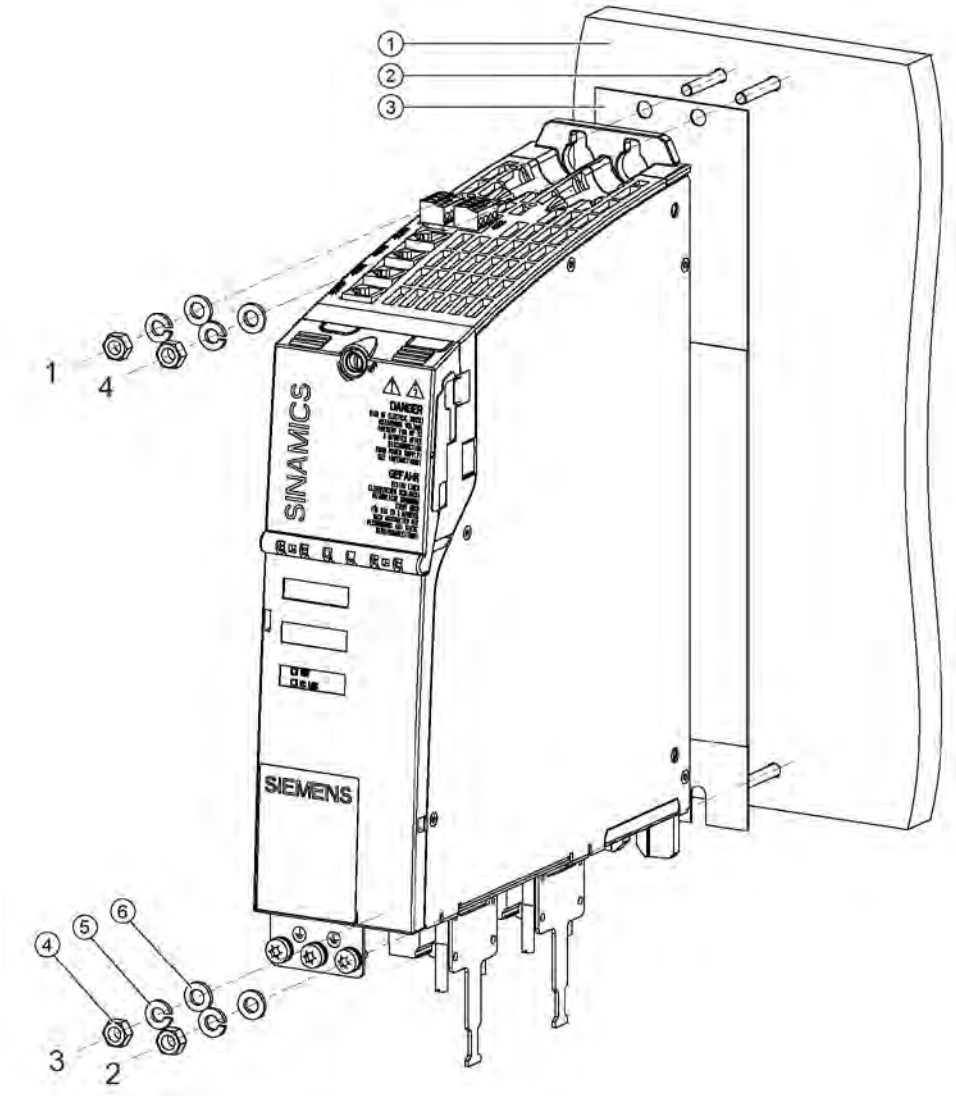
Figure 7-7 Mounting a Motor Module Booksize Compact with internal air cooling

Tightening torques:

- Firstly, only tighten the nuts by hand.
  Tightening torque: 0.5 Nm
- Then tighten the nuts in the specified sequence 1 to 4.
  Tightening torque: 6 Nm

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Mounting a Motor Module Booksize Compact on a cold plate



① Cold plate (air or liquid cooling)
② M6 studs
③ Heat-conducting foil
④ M6 nut
⑤ Spring washer
⑥ Washer

Figure 7-8 Mounting a Motor Module Booksize Compact on a cold plate

Tightening torques:

- Firstly, only tighten the nuts by hand.
  Tightening torque: 0.5 Nm
- Then tighten the nuts in the specified sequence 1 to 4.
  Tightening torque: 6 Nm

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Special points to note in relation to mounting on a cold plate

To improve heat transfer, a heat-conducting medium must be used. Special spherical-indented heat-conducting foil must be used for this purpose. Every Motor Module Booksize Compact is supplied with heat-conducting foil cut to the right size. Note the mounting position of the heat-conducting foil.

Note

- Also replace the heat-conducting foil when replacing a component.
- Only use heat-conducting foil released or supplied by Siemens.

	Order number
Heat-conducting foil, 50 mm	6SL3162-6FB01-0AA0
Heat-conducting foil, 75 mm	6SL3162-6FC01-0AA0

7.8 Technical data

7.8.1 Single Motor Modules

Table 7- 9 Technical data Single Motor Modules Booksize Compact (3 A to 18 A)

Motor Modules Booksize Compact	**6SL3420–**	**1TE13-0AAx**	**1TE15-0AAx**	**1TE21–0AAx**	**1TE21–8AAx**
Output current					
Rated current (I_n)	A_{ACrms}	**3**	**5**	**9**	**18**
Base-load current (I_H)	A	2,6	4,3	7,7	15,3
Intermittent duty current (I_{s6}) 40%	A_{ACrms}	3,5	6	10	24
Peak current (I_{max})	A_{ACrms}	9	15	27	54
Output voltage	V_{ACrms}	0 … 0.717 x DC-link voltage			
DC-link current $I_{d\ max}$	A_{DC}	3,6	6	11	22
DC-link voltage (up to 2000 m above sea level)	V_{DC}	510 … 720			
DC-link capacitance	µF	110	110	110	235
Overvoltage trip	V_{DC}	820 ± 2 %			
Undervoltage trip[1)]	V_{DC}	380 ± 2 %			
Electronics power supply	V_{DC}	24 (20,4 … 28,8)			
Electronics current consumption at 24 VDC					
For internal air cooling	A_{DC}	0,85	0,85	0,85	0,85
For cold plate cooling	A_{DC}	0,65	0,65	0,65	0,65
Current carrying capacity					
DC-link busbars	A_{DC}	100	100	100	100
Reinforced DC-link busbars	A_{DC}	150	150	150	150
24 VDC busbars	A_{DC}	20	20	20	20

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Motor Modules Booksize Compact	6SL3420–	1TE13-0AAx	1TE15-0AAx	1TE21–0AAx	1TE21–8AAx
Max. current motor brake	A	2	2	2	2
Unit rating[2)] Based on I_n (600 VDC; 4 kHz) Based on I_H	 kW kW	 1,6 1,4	 2,7 2,3	 4,8 4,1	 9,7 8,2
Total power loss (including electronics losses, see Power loss tables (Page 781)) Internal air cooling Cold plate int./ext.	 W W	 68 (8 kHz) 25.6/40	 98 (8 kHz) 30.6/65	 100.4 (4 kHz) 45.6/50	 185.4 (4 kHz) 80.6/100
Max. pulse frequency without derating with derating	 kHz kHz	 8 16	 8 16	 4 16	 4 16
Max. ambient temperature without derating with derating	 ° C ° C	 40 55			
Sound pressure level with internal air cooling	dB(A)	< 60	< 60	< 60	< 60
Cooling methods		Internal air cooling Cold plate cooling			
Cooling air requirement with internal air cooling	m^3/h	29,6	29,6	29,6	29,6
Max. permissible heatsink temperature For internal air cooling For cold plate cooling	 ° C ° C	 73 71	 82 75	 85 75	 90 77
Weight	kg	2,7	2,7	2,7	3,4

1) Default setting for 400 V line supplies, undervoltage trip threshold can be reduced by up to 80 V and is adjusted to the parameterized line voltage

2) Rated power of a typical standard induction motor at 400 V 3 AC.

7.8.2 Double Motor Modules

Table 7- 10 Technical data Double Motor Modules Booksize Compact (2 x 1.7 A to 2 x 5 A)

Double Motor Modules Booksize Compact	6SL3420-	2TE11-7AAx	2TE13-0AAx	2TE15-0AAx
Output current Rated current (I_n) Base-load current (I_H) Intermittent duty current (I_{S6}) 40% Peak current (I_{max})	 A_{ACrms} A A_{ACrms} A_{ACrms}	 **2 x 1.7** 2 x 1.5 2 x 2 2 x 5.1	 **2 x 3** 2 x 2.6 2 x 3.5 2 x 9	 **2 x 5** 2 x 4.3 2 x 6 2 x 15
Output voltage	V_{ACrms}	0 … 0.717 x DC-link voltage		
DC-link current $I_{d\ max}$	A_{DC}	4,1	7,2	12
DC-link voltage (up to 2000 m above sea level)	V_{DC}	510 … 720		
DC-link capacitance	µF	165	165	165
Overvoltage trip Undervoltage trip[1)]	V_{DC} V_{DC}	820 ± 2 % 380 ± 2 %		
Electronics power supply	V_{DC}	24 (20,4 … 28,8)		

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Double Motor Modules Booksize Compact	**6SL3420-**	**2TE11-7AAx**	**2TE13-0AAx**	**2TE15-0AAx**
Electronics current consumption at 24 VDC For internal air cooling For cold plate cooling	 A_{DC} A_{DC}	 1,15 0,9	 1,15 0,9	 1,15 0,9
Current carrying capacity DC-link busbars Reinforced DC-link busbars 24 VDC busbars	 A A A	 100 150 20	 100 150 20	 100 150 20
Max. current motor brake	A	2 x 2	2 x 2	2 x 2
Unit rating[2] Based on I_n (600 V, 8 kHz) Based on I_H	 kW kW	 2 x 0.9 2 x 0.8	 2 x 1.6 2 x 1.4	 2 x 2.7 2 x 2.3
Total power loss (including electronics losses, see Power loss tables (Page 781)) Internal air cooling Cold plate int./ext.	 W W	 114 (8 kHz) 42/72	 134 (8 kHz) 44/90	 194 (8 kHz) 59/135
Max. pulse frequency without derating with derating	 kHz kHz	 8 16	 8 16	 8 16
Max. ambient temperature without derating with derating	 ° C ° C	 40 55		
Sound pressure level with internal air cooling	dB(A)	< 60	< 60	< 60
Cooling methods		Internal air cooling with mounted fan Cold plate cooling		
Cooling air requirement with internal air cooling	m^3/h	29,6	29,6	29,6
Max. permissible heatsink temperature For internal air cooling For cold plate cooling	 ° C ° C	 84 71	 88 75	 93 75
Weight	kg	3,4	3,4	3,4

[1] Default setting for 400 V line supplies, undervoltage trip threshold can be reduced by up to 80 V and is adjusted to the parameterized line voltage

[2] Rated power of a typical standard induction motor at 400 V 3 AC.

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7.8.3 Characteristics

Rated duty cycles Motor Modules Booksize Compact

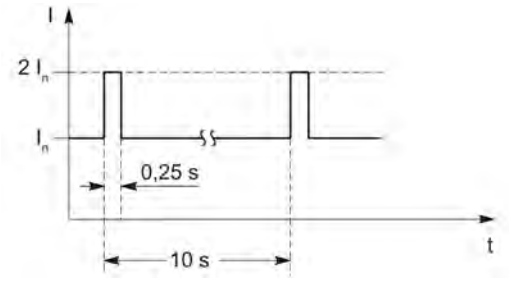


Figure 7-9 Duty cycle with initial load

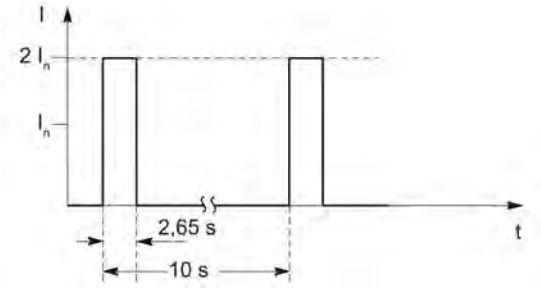


Figure 7-10 Duty cycle without initial load

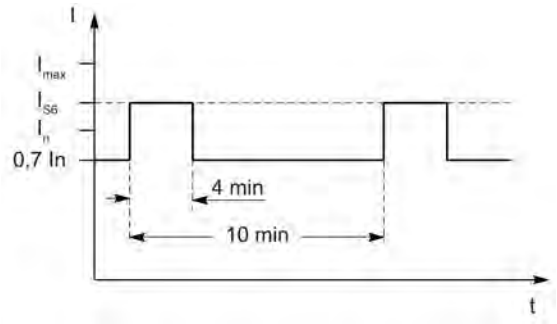


Figure 7-11 S6 duty cycle with initial load for a duty cycle duration of 600 s

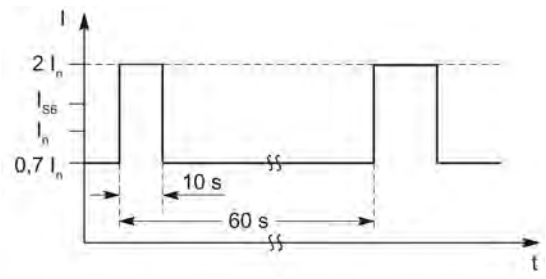


Figure 7-12 S6 duty cycle with initial load for a duty cycle duration of 60 s

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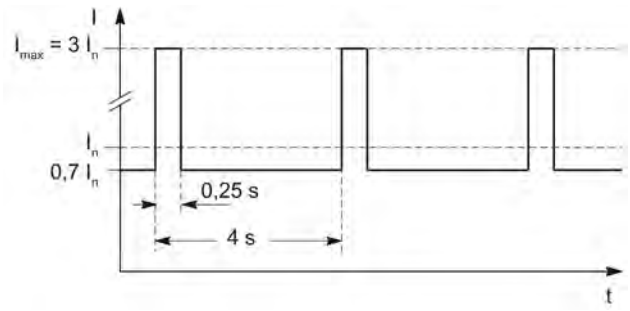


Figure 7-13 Peak current duty cycle with initial load

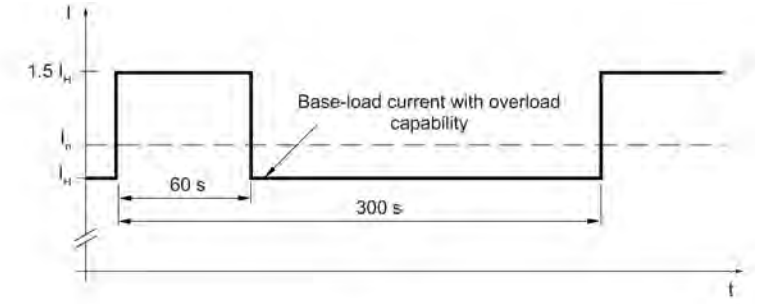


Figure 7-14 Duty cycle with 60 s overload for a duty cycle duration of 300 s

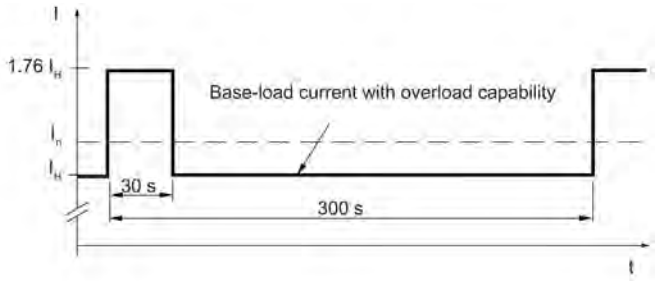


Figure 7-15 Duty cycle with 30 s overload for a duty cycle duration of 300 s

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Derating characteristics for Motor Modules Booksize Compact

Note

For additional information, see Chapter Derating as a function of the installation altitude and ambient temperature (Page 47).

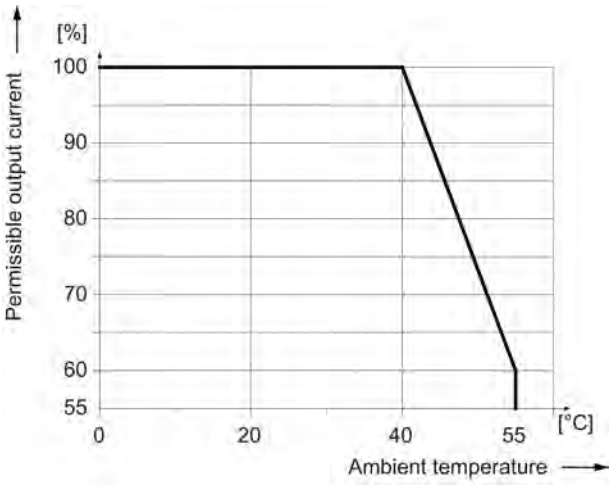


Figure 7-16 Output current as a function of the ambient temperature

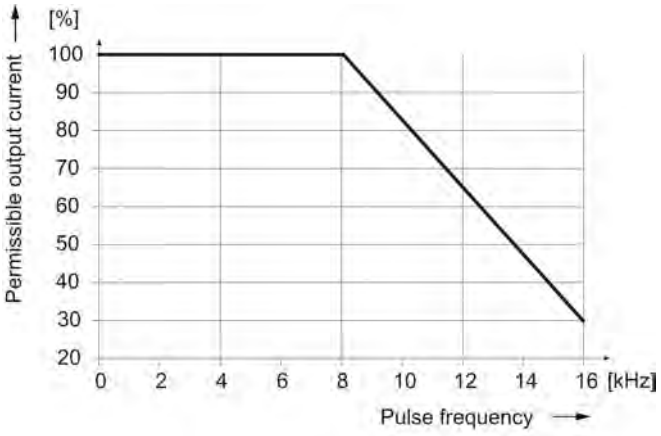


Figure 7-17 Output current as a function of the pulse frequency for the Motor Module ≤ 5 A

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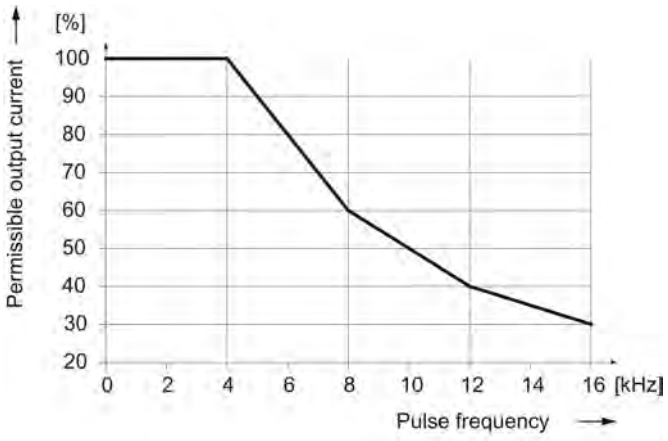


Figure 7-18 Output current as a function of the pulse frequency for the Motor Module ≥ 9 A

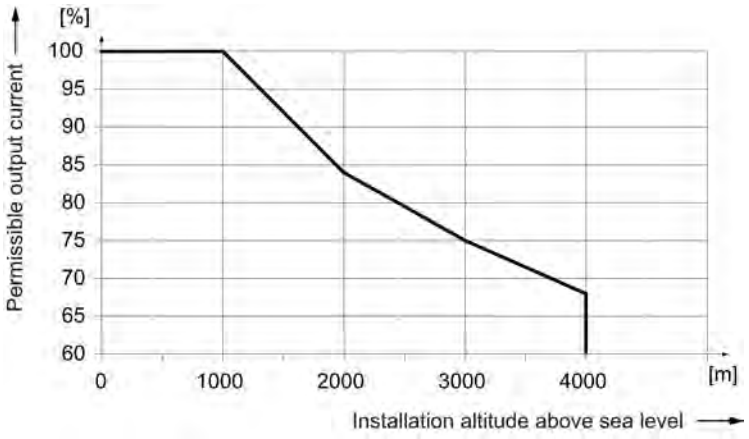


Figure 7-19 Output current as a function of the installation altitude

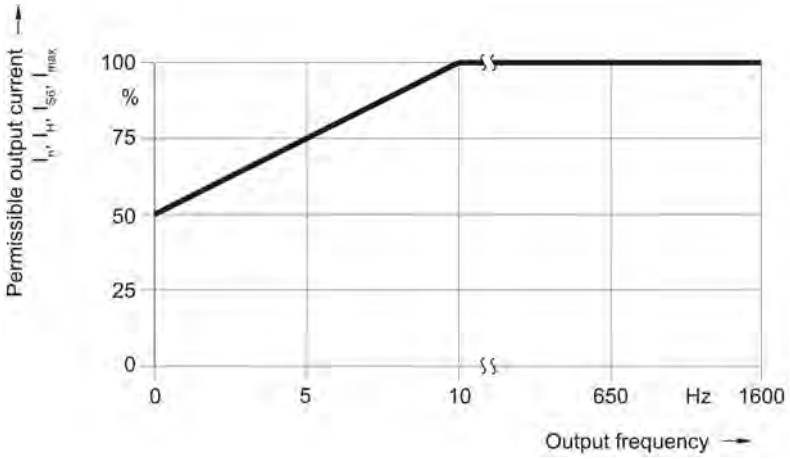


Figure 7-20 Current derating as a function of the output frequency

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DC link components

8

8.1 Safety instructions for DC link components

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.



⚠DANGER

Danger to life through electric shock due to the residual charge of the DC link capacitors

Because of the DC link capacitors, a hazardous voltage is present for up to five minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.



⚠DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Contact with live parts can result in death or serious injury.

- Only operate the components with closed protective cover.



⚠WARNING

Danger to life through electric shock due to incorrect connection to the DC link

Incorrect connections can lead to overheating and therefore a risk of fire. There is also a risk of an electric shock. This can result in serious injury or death.

- Only use adapters (DC link adapters and DC link rectifier adapters) released by Siemens for the connection to the DC link.

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WARNING

Danger to life through electric shock due to incorrectly installed DC link bridges

Incorrectly installed DC link bridges **at the left-hand end of the drive line-up** can cause an electric shock.

- For all 50 mm wide modules[1] (exception: Smart Line Module[2]), remove the DC link bridge, including the screws. Do not tighten the screws without the DC link bridges.
- For all components that are 75 mm wide or wider, the DC link bridges may neither be swung over to the left nor removed[3].

[1] For 50 mm wide modules, the DC link bridge cannot be swung inwards.
[2] Smart Line modules do not have a DC link bridge.
[3] The DC link bridge guarantees the mechanical stability of the DC link busbars.



WARNING

Danger to life through electric shock due to missing DC link side covers

There is a danger of an electric shock through contact when the side covers of the DC link are missing.

- Mount the side covers on the first and last component in the drive line-up.

You can order missing side covers (order number: 6SL3162-5AA00-0AA0).



WARNING

Danger to life due to high leakage currents caused by an interrupted external protective conductor

The drive components conduct a high leakage current via the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.

- Ensure that the external protective conductor satisfies at least one of the following conditions:
  - It has been laid so that it is protected against mechanical damage.[1]
  - If it is a single conductor, it has a cross-section of at least 10 mm² Cu.
  - If it is a conductor of a multi-conductor cable, it has a cross-section of at least 2.5 mm² Cu.
  - It has a second protective conductor in parallel with the same cross-section.
  - It complies with the local regulations for equipment with increased leakage current.

[1] Cables laid within control cabinets or closed machine housings are considered to be adequately protected against mechanical damage.

WARNING

Danger of an accident due to missing warning labels in the national language.

Missing warning labels in the national language can result in death or serious injury.

- Attach the component warning labels in the national language.

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NOTICE

Material damage due to loose power connections

Insufficient tightening torques or vibration can result in faulty electrical connections. This can cause fire damage or malfunctions.

- Tighten all power connections with the specified tightening torques, e.g. line supply connection, motor connection, DC link connections.
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

NOTICE

Damage to the equipment when performing a voltage test as a result of connections that are not disconnected

SINAMICS S components are subject to a voltage test as part of the routine test. Connected devices can be damaged.

- Disconnect or unplug all SINAMICS devices before the voltage test of the machine equipment according to EN 60204-1, Section 18.4.

NOTICE

Damage through use of incorrect DRIVE-CLiQ cables

Damage or malfunctions can occur on the devices or system when DRIVE-CLiQ cables are used that are either incorrect or have not been approved for this purpose.

- Only use suitable DRIVE-CLiQ cables that have been approved by Siemens for the particular application.

Note

Malfunctions due to polluted DRIVE-CLiQ interfaces

Malfunctions can occur in the system through the use of polluted DRIVE-CLiQ interfaces.

- Cover unused DRIVE-CLiQ interfaces with the supplied blanking covers.

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8.2 Braking Module Booksize

8.2.1 Description

The Braking Module Booksize is always used together with an external braking resistor. It has the following tasks:

- Specific stop of the drives in the event of a line failure
  (e.g. emergency retraction or EMERGENCY OFF category 1).
- Limit the DC link voltage for brief periods of generator operation (e.g. if the regenerative feedback capability of the Line Module is deactivated or is not adequately dimensioned).

The Braking Module includes the necessary power electronics and control. When the Braking Module is in operation, the power which is fed back into the DC link is dissipated via an external braking resistor.

External braking resistors

Braking resistors without thermostatic switch 6SN1113-1AA00-0DA0 (P_N = 0.3 kW) and 6SL3100-1BE31-0AA0 (P_N = 1.5 kW) can be operated at the Braking Module Booksize.
The cable lengths between the Braking Module and braking resistor is limited to a maximum of 10 m.
The scope of delivery of the braking resistor 6SN1113-1AA00-0DA0 includes a shielded connection cable (3 m, 3 x 1.5 mm^2).

Rapid discharge

Furthermore, the Braking Module Booksize can used with a braking resistor to quickly discharge the DC link capacitors The DC link is discharged in a controlled manner via the braking resistor once the infeed unit has been switched off and the line-up has been disconnected from the line supply (e.g. via the main switch or line contactor). The function can be activated via a digital input on the Braking Module. A quick discharge makes sense, for example, when maintenance tasks are to be performed at the Motor Module and/or motor installation (reduction of the discharge time).

NOTICE
Damage to the Motor Module or connected motors for a fast discharge For a fast discharge, the Motor Module or the connected motors can be damaged. • For a rapid discharge, fully disconnect the drive system from the line supply. • The motors must be at a standstill.

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Monitoring functions

- Automatic detection of braking resistors and braking power monitoring
- I^2t monitoring of the braking resistors.
- Temperature monitoring of the Braking Module
- Short circuit and overload detection
- Ground fault detection

8.2.2 Safety instructions for Braking Modules Booksize

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 80 mm clearances above and below the components.

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to braking resistors

Unshielded or incorrectly routed cables to braking resistors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables for cables to braking resistors.

NOTICE

Danger to life through the use of non-approved braking resistors

Braking resistors can be damaged when using braking resistors other than those specified in this Manual.

- Only use braking resistors approved by Siemens.

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8.2.3 Interface description

8.2.3.1 Overview

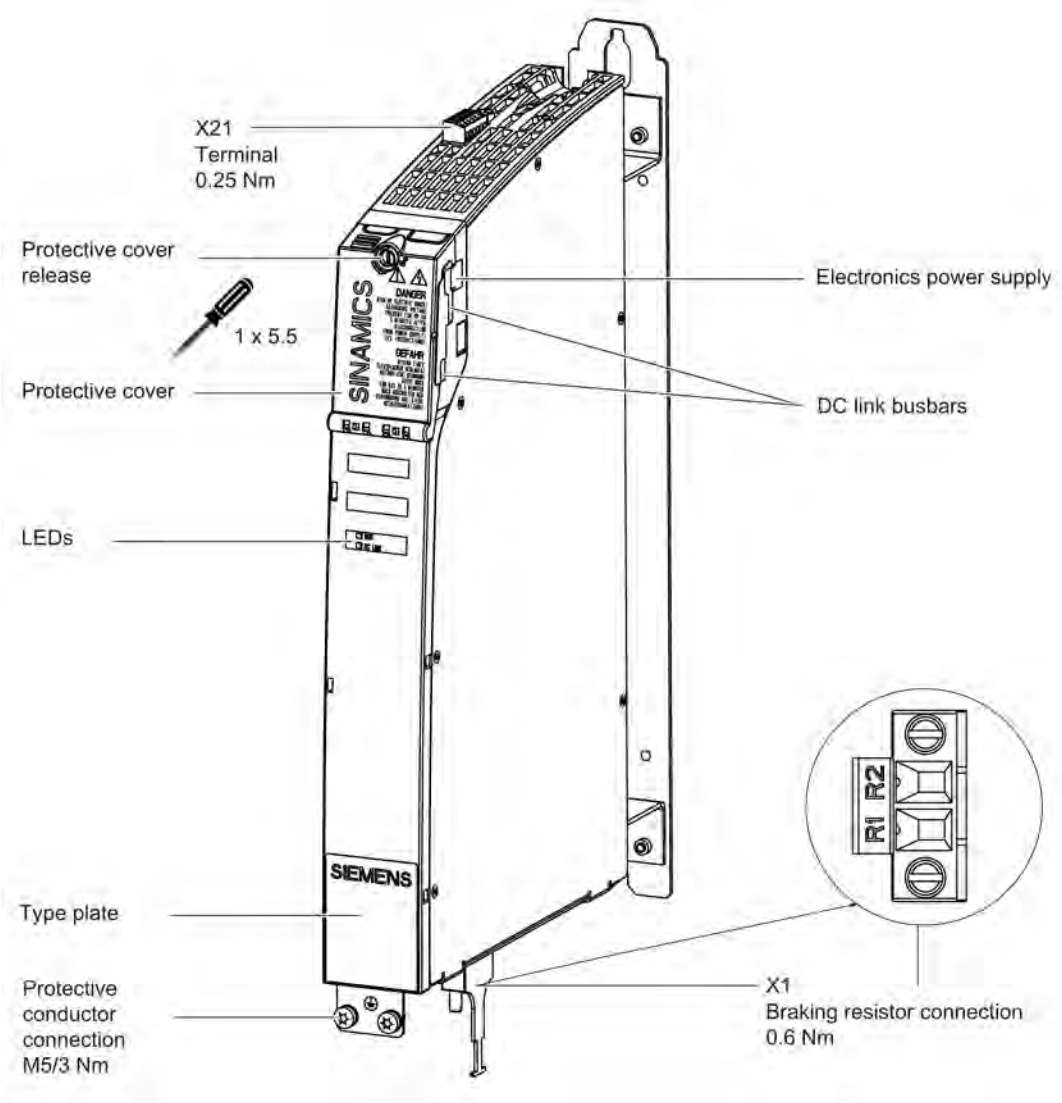


Figure 8-1 Interface overview, Braking Module Booksize

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8.2.3.2 X1 braking resistor connection

Table 8- 1 X1 braking resistor connection

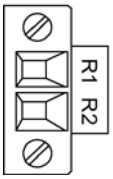
	Terminal	Designation	Technical data
	1	Braking resistor connection R1	Continuously short-circuit proof
	2	Braking resistor connection R2	
Type: Screw terminal 4 (Page 755) Max. cross-section that can be connected: 4 mm^2			

Table 8- 2 Braking resistors without a thermostatic switch for Braking Modules

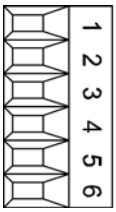
Braking resistor	R in Ω	P_N in kW	P_{max} in kW
6SN1113-1AA00-0DA0	17	0,3	25
6SL3100-1BE31-0AA0	5,7	1,5	100

For detailed technical information on the braking resistors, see the section entitled Braking resistors (Page 577).

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8.2.3.3 X21 digital inputs/outputs

Table 8- 3 X21 digital inputs/outputs

	Terminal	Designation[1]	Technical data
	1	DI low: Enable Braking Module DI high: inhibit/acknowledge Edge change, high → low: fault acknowledgement	Voltage: -3 … +30 V Typical current consumption: 10 mA at 24 V DC Level (incl. ripple) High level: 15 … 30 V Low level: -3 … +5 V
	2	DI low: braking resistor, not controlled manually DI high: Braking resistor controlled manually (quick discharge)[2]	
		If X21.1 and X21.2 are activated simultaneously, the Braking Module inhibit has priority.	
	3	DO high: no prewarning DO low: Prewarning, disconnection imminent	Max. load current per output: 100 mA Continuously short-circuit proof Voltage: 24 V DC
	4	DO high: ready for operation, no fault DO low: Fault	
	5	Ground	
	6		
Type: Screw terminal 1 (Page 755) Max. cross-section that can be connected 1.5 mm²:			

1) DI: digital input; DO: digital output; M: Electronics ground

2) The "fast discharge function" is used for discharging the capacitors in the DC link after the line supply has been interrupted. The function may only be used a maximum of once or twice per week.

Terminal X21.1 - inhibit/acknowledge

Applying a high signal to terminal X21.1 inhibits the Braking Module. Fault messages that are available are acknowledged with a falling edge.

Terminal X21.3 - prewarning

When a prewarning is sent, disconnection of the braking module is imminent. This may be due to the following causes:

- The temperature of the Braking Module is 80 % of the maximum value.
- 80 % of the maximum switch on duration of the braking resistor has been reached (I^2t monitoring).
- 80 % of the maximum braking energy of the braking resistor has been reached.
- An incorrect braking resistor is connected (only braking resistors approved by Siemens for this component are identified automatically).

Terminal X21.4 - fault

The fault can have the following causes:

- Electronics power supply is missing or outside permissible tolerance range
- Enable missing (input terminal)
- Overtemperature

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- Overcurrent trip
- I^2t monitoring has responded.
- Ground fault/short circuit

In the event of an overtemperature, the fault can only be acknowledged with X21.1 = high after a cooling-down time.



⚠WARNING

Danger to life as a result of a hazardous voltage at terminals X21

Death or serious injury can result when live parts are touched in the event of a fault.

- Only connect protective extra low voltages at terminals X21.

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8.2.4 Connection example

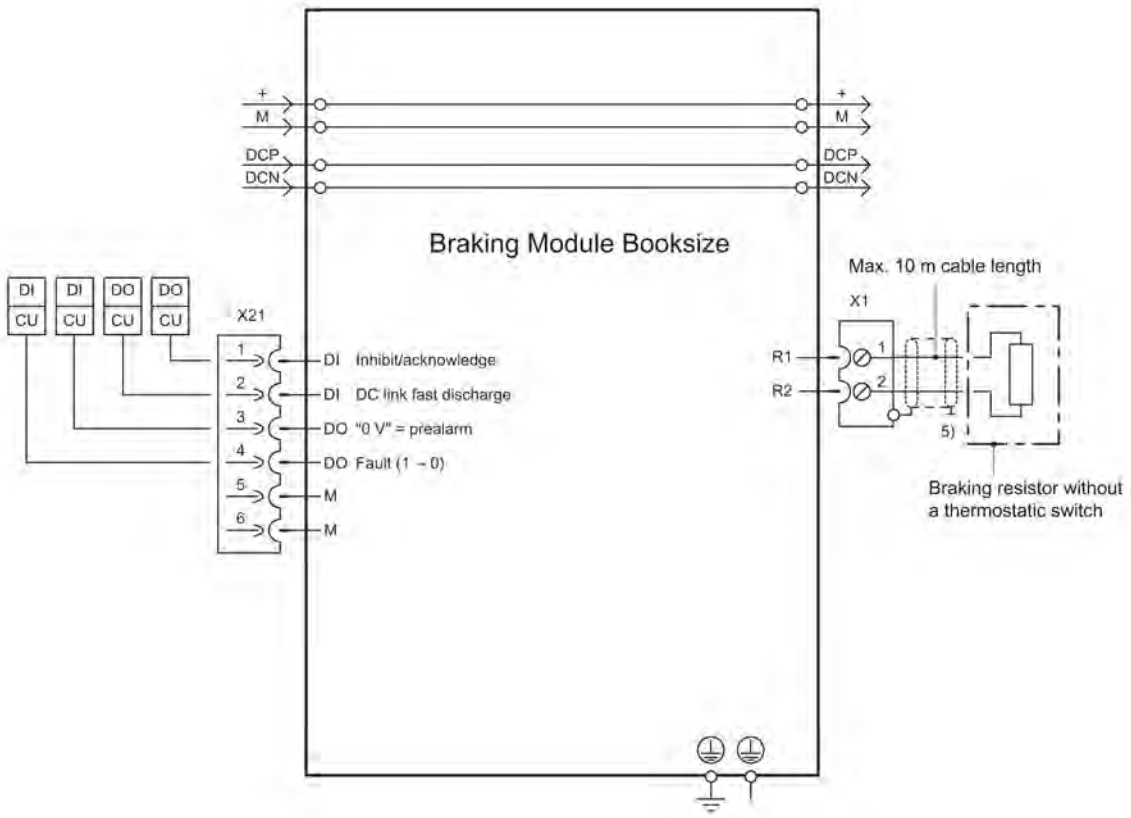


Figure 8-2 Connection example of a Braking Module Booksize

To parameterize the digital inputs or digital outputs, see the SINAMICS S120/S150 List Manual.

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8.2.5 Meaning of LEDs

Table 8- 4 Meaning of the LEDs on the Braking Module Booksize

LED	Color	Status	Description, cause	Remedy
READY	-	Off	The electronics power supply is missing or outside the permissible tolerance range. The component is deactivated via terminal.	–
	Green	Continuous light	The component is ready for operation.	–
	Red	Continuous light	Enable missing (input terminal) Overtemperature Overcurrent trip I^2t monitoring activated Ground fault/short circuit **Note:** In the event of an overtemperature, the error cannot be acknowledged until a cooling time has elapsed.	Troubleshoot the fault using the output terminals and acknowledge it using the input terminal.
DC LINK	-	Off	Only braking resistors approved by Siemens for this component are identified automatically. The component is not active.	–
	Green	Flashing light	The component is active (DC link is being discharged via the braking resistor).	–

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8.2.6 Dimension drawing

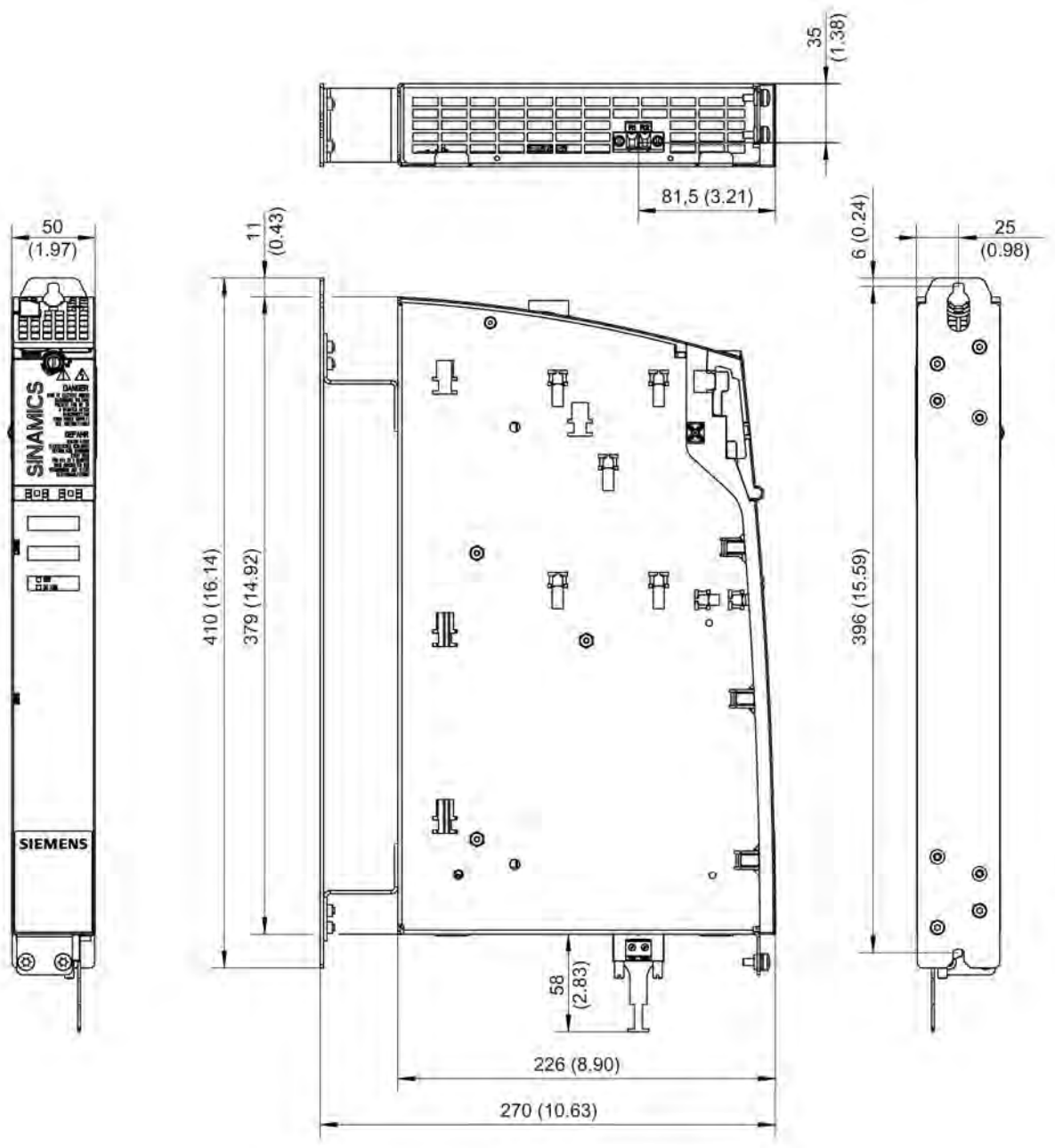
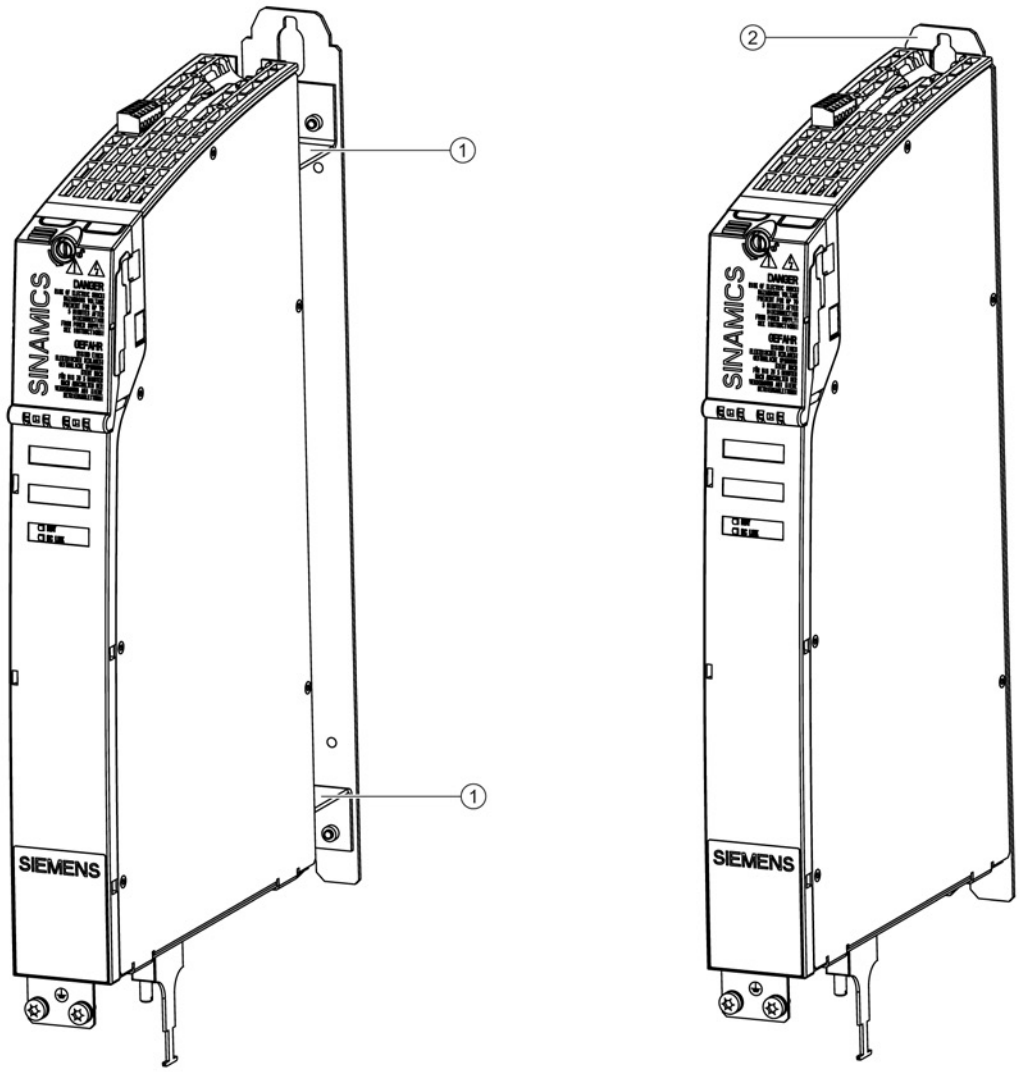


Figure 8-3 Dimension drawing of Braking Module, all dimensions in mm and (inches)

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8.2.7 Installation



① Delivery condition with spacer - mounting depth for drive line-up in booksize format with internal air cooling
② Spacer removed - mounting depth for drive line-up in booksize format with external air cooling

Figure 8-4 Methods of installing Braking Modules with/without spacer elements

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8.2.8 Technical data

Table 8- 5 Technical data

6SL3100-1AE31-0ABx		
DC link voltage	V_{DC}	510 … 720
DC link capacitance	µF	110
ON threshold	V	770
Electronics power supply	V_{DC}	24 (20.4 … 28.8)
Electronics current consumption (at 24 V DC)	A_{DC}	0.5
Current carrying capacity DC link busbars 24 V busbars	 A_{DC} A_{DC}	 100 20
Braking power Max. Continuous braking power	 kW kW	 100 1.5
Power loss (see power loss tables (Page 781))	W	20
Cooling method		Natural convection
Weight	kg	4.1

8.2.8.1 Characteristic curves

Duty cycle for braking resistors without a thermostatic switch

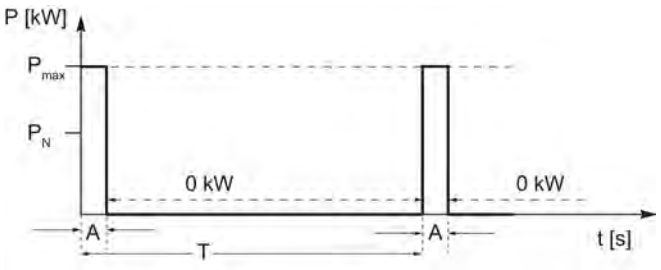


Figure 8-5 Duty cycle for braking resistors without a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [W] rated power (continuous power) of braking resistor

P_{max} [W] peak power of braking resistor (6 x P_N)

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Table 8- 6 Duty cycles

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0,1	0,4	1	2
T [s]	11,5	210	68	460

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

$P_{max\ total}$ = total P_{max} of single devices

8.2.9 Configuration instructions

DC link capacitance

To operate the Braking Modules, a minimum capacitance is required in the DC link. The DC link capacitance for each braking resistor is 440 µF.

The capacitance of the Braking Module of 110 µF is included in the total capacitance value.

Note

Only the components that are connected to each other via the DC link busbar can be included in the total capacitance.

DC link cable

In a two-row or distributed drive line-up, the DC links are connected to each other via a DC link cable. When using a Braking Module in the drive line-up, this cable must not be longer than 10 m. The DC link cable must be twisted and have a minimum cross-section of at least 10 mm^2.

Parallel connection

The Braking Module Booksize Compact 6SL3400-1AE31-0AAx is recommended for the parallel connection of Braking Modules.

Parallel connection of the Braking Module 6SL3100-1AE31-0AAx is not recommended because a power distribution between the modules is not guaranteed.

Note

When Braking Modules are connected in parallel, the DC link capacitance specified above must be available for each Braking Module.

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8.3 Braking Module Booksize Compact

8.3.1 Description

The Braking Module Booksize Compact is always used together with a braking resistor. It has the following tasks:

- Controlled stop of the drives in the event of a power failure (e.g. emergency retraction or EMERGENCY OFF Category 1).
- Limit the DC link voltage for brief periods of generator operation, for example, if the regenerative feedback capability of the Line Module is deactivated or is not adequately dimensioned.

The Braking Module includes the necessary power electronics and control. When the module is in operation, the power which is fed back into the DC link is dissipated via an external braking resistor.

The Braking Module can be operated on 200 V or 400 V line supply systems; the 4-pin DIP switch on the top of the module is used to select which one applies in each case. The factory setting is 400 V.

When spacers (6SL3462-1CC00-0AA0) are used, the Braking Module Booksize Compact can be integrated into a drive line-up in booksize format with internal air cooling.

External braking resistors

Braking resistors with or without a thermostatic switch can be used with the Braking Module Booksize Compact (List of braking resistors that can be connected (Page 532)). The DIP switch sets the type of braking resistor being used in each case. The factory setting is "braking resistor with a thermostatic switch".

The cable length between the Braking Module and the braking resistor is limited to 10 m.

Rapid discharge

Furthermore, the Braking Module Booksize Compact can be used with a braking resistor to quickly discharge the DC link. The DC link is discharged in a controlled manner via the braking resistor once the infeed unit has been switched off and the line-up has been disconnected from the line supply (e.g. via the main switch or line contactor). The function can be activated via a digital input on the Braking Module. A quick discharge makes sense, for example, when maintenance tasks are to be performed at the Motor Module and/or motor installation (reduction of the discharge time).

NOTICE
Damage to the Motor Module or connected motors for a fast discharge For a fast discharge, the Motor Module or the connected motors can be damaged. • For a rapid discharge, fully disconnect the drive system from the line supply. • The motors must be at a standstill.

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⚠DANGER

Danger to life when live parts are touched after rapid discharge

On completion of quick discharge, a voltage of 30 V is still present at the DC link. If quick discharge is canceled before it has been completed, this voltage can still be >60 V. Death or serious injury can result when live parts are touched.

- Check the DC link to ensure that it is in a no voltage state before starting any work.

Cooling methods

The Braking Module Booksize Compact can be operated with the following cooling methods:

- Internal air cooling
- Cold plate cooling

The required cooling method is set using the DIP switch The factory setting is "internal air cooling".

Internal fan

When the Braking Module is being used with internal air cooling, the internal fan starts up immediately and is subsequently controlled by the temperature.

If the DIP switch is set to cold plate cooling by mistake, the fan will still start up when a certain temperature threshold is reached, in order to prevent the Braking Module shutting down due to overtemperature. If this threshold is exceeded, an alarm is issued via the digital output "Prewarning". This ensures that an emergency stop can be performed if necessary.

Monitoring functions

- Automatic detection of braking resistors without thermostatic switch and corresponding braking power monitoring (only if the "Braking resistor without thermostatic switch" setting is used)
- I^2t monitoring of the Braking Module
- Temperature monitoring of the Braking Module
- Temperature monitoring of the connected braking resistor with thermostatic switch (only for setting "Braking resistor with thermostatic switch")
- Short-circuit and overload detection (for all braking resistors)
- Ground fault detection (for all braking resistors)

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Parallel operation

Several Braking Modules Booksize Compact can be connected in parallel to increase the braking power. In this case, the braking energy is divided between the modules. Formulas for calculating the parallel connection are given in Chapter Notes on configuration (Page 543).

A parallel connection of the Braking Module Booksize Compact to SINAMICS S120 Basic Line Modules 20 kW and 40 kW is also possible.

8.3.2 Safety instructions for Braking Modules Booksize Compact

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 80 mm clearances above and below the components.

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to braking resistors

Unshielded or incorrectly routed cables to braking resistors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables for cables to braking resistors.

NOTICE

Danger to life through the use of non-approved braking resistors

Braking resistors can be damaged when using braking resistors other than those specified in this Manual.

- Only use braking resistors approved by Siemens.

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8.3.3 Interface description

8.3.3.1 Overview

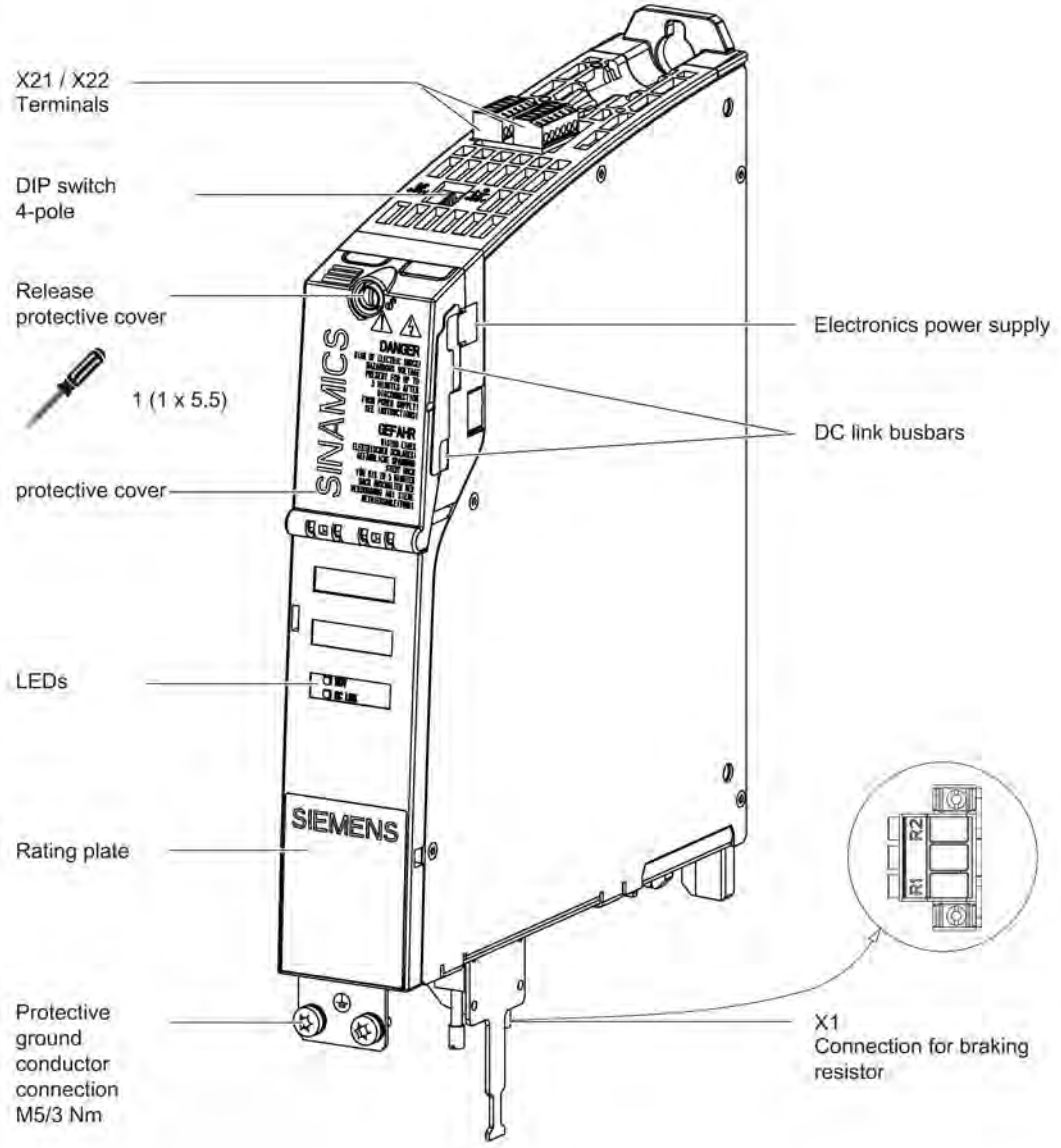
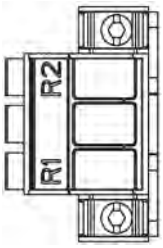


Figure 8-6 Interface overview, Braking Module Booksize Compact

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8.3.3.2 X1 braking resistor connection

Table 8- 7 X1 braking resistor connection

	Terminal	Designation	Technical data
	1	Braking resistor connection R1	Continuously short-circuit proof
	2	Not assigned	
	3	Braking resistor connection R2	
Type: Screw terminal 5 (Page 755) Max. cross-section that can be connected: 6 mm²			

Braking resistors without a thermostatic switch

The Braking Module Booksize Compact is only designed for operation with the braking resistors listed below.

Table 8- 8 Braking resistors without a thermostatic switch

Braking resistor	R in Ω	P_N in kW	P_{max} in kW
6SN1113-1AA00-0DA0	17	0,3	25
6SL3100-1BE31-0AA0	5,7	1,5	100

Braking resistors with a thermostatic switch

The Braking Module Booksize Compact is only designed for operation with the braking resistors listed below.

Table 8- 9 Braking resistors with a thermostatic switch

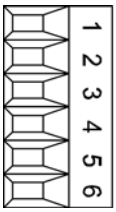
Braking resistor	R in Ω	P_N in kW	P_{20} in kW	P_{max} in kW
6SE7018-0ES87-2DC0	80	1,25	5	7,5
6SE7021-6ES87-2DC0	40	2,5	10	15
6SE7023-2ES87-2DC0	20	5	20	30

For detailed technical information on the braking resistors, see Chapter Braking resistors (Page 577).

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8.3.3.3 X21 digital inputs/outputs

Table 8- 10 X21 digital inputs/outputs

	Terminal	Designation[1]	Technical data
	1	DI low: Enable Braking Module DI high: inhibit/acknowledge Edge change, high → low: fault acknowledgement	Voltage: -3 … +30 V Typical current consumption: 10 mA at 24 V DC Level (incl. ripple) High level: 15 … 30 V Low level: -3 … +5 V
	2	DI low: braking resistor, not controlled manually DI high: Braking resistor controlled manually (quick discharge)[2]	
		If X21.1 and X21.2 are activated simultaneously, the Braking Module inhibit has priority.	
	3	DO high: no prewarning DO low: Prewarning:	Max. load current per output: 100 mA Continuously short-circuit proof Voltage: 24 V DC
	4	DO high: ready for operation, no fault DO low: Fault	
	5	Ground	
	6		
Type: Screw terminal 1 (Page 755) Max. cross-section that can be connected 1.5 mm²:			

1) DI: digital input; DO: digital output; M: Electronics ground

2) The "fast discharge function" is used for discharging the capacitors in the DC link after the line supply has been interrupted.

Terminal X21.1 - inhibit/acknowledge

Applying a high signal to terminal X21.1 inhibits the Braking Module. Fault messages that are available are acknowledged with a falling edge.

Terminal X21.3 - prewarning

When a prewarning is sent, disconnection of the braking module is imminent. This may be due to the following causes:

- The temperature switch braking resistor has triggered (only if the "Braking resistor with thermostatic switch" setting is used)
- The temperature of the Braking Module is 80 % of the maximum value.
- The I^2t counter of the Braking Module has reached 80 % of the maximum value.
- The braking resistor has reached 80 % of the maximum permissible braking energy (only for setting "Braking resistor without thermostatic switch").
- An incorrect braking resistor is connected (only if the "braking resistor without a thermostatic switch" setting is used).

Terminal X21.4 - fault

In the event of an overtemperature fault, I^2t monitoring, or braking power monitoring, the fault will be acknowledged automatically after a cooling phase. Manual acknowledgment is not necessary!

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⚠WARNING

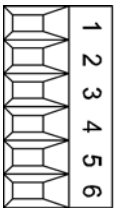
Danger to life as a result of a hazardous voltage at terminals X21

Death or serious injury can result when live parts are touched in the event of a fault.

- Only connect protective extra low voltages at terminals X21.

8.3.3.4 X22 digital output/temperature switch

Table 8- 11 X22 digital output/temperature switch, braking resistor

	Terminal	Designation [1]	Technical data
	1	+ Temp	Temperature switch of the braking resistor
	2	- Temp	
	3	Reserved	Not assigned!
	4	Reserved	
	5	DO high: 200 V supply system is selected DO low: 400 V supply system is selected	
	6	Reserved	Not assigned!
Type: Screw terminal 1 (Page 755) Max. cross-section that can be connected 1.5 mm²:			

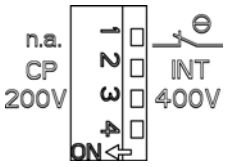
[1] DO: digital output

8.3.3.5 DIP switch

The 4-pin DIP switch is located at the top of the Braking Module and sets the braking resistor being used, the cooling method, and the line voltage.

Make the required settings before the Braking Module is mounted in the control cabinet; once the module is mounted, the DIP switch can no longer be accessed from the front.

Table 8- 12 DIP switch for Braking Module Booksize Compact

	Switch	Switch position	Function	Factory setting
	1	ON	Braking resistor without a thermostatic switch	OFF
		OFF	Braking resistor with a thermostatic switch	
	2	ON	Cold plate cooling	OFF
		OFF	Internal air cooling	
	3	ON	200 V line voltage	OFF
		OFF	400 V line voltage	
	4	ON	Reserved	OFF
		OFF		

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Note

Terminal assignment for "Braking resistor without a thermostatic switch" mode

For "braking resistor without a thermostatic switch" mode (switch 1 = ON) , terminals X22.1 and X22.2 must not be assigned for the Braking Module to work.

8.3.4 Connection examples

Braking resistor without thermostatic switch connected to a Braking Module Booksize Compact

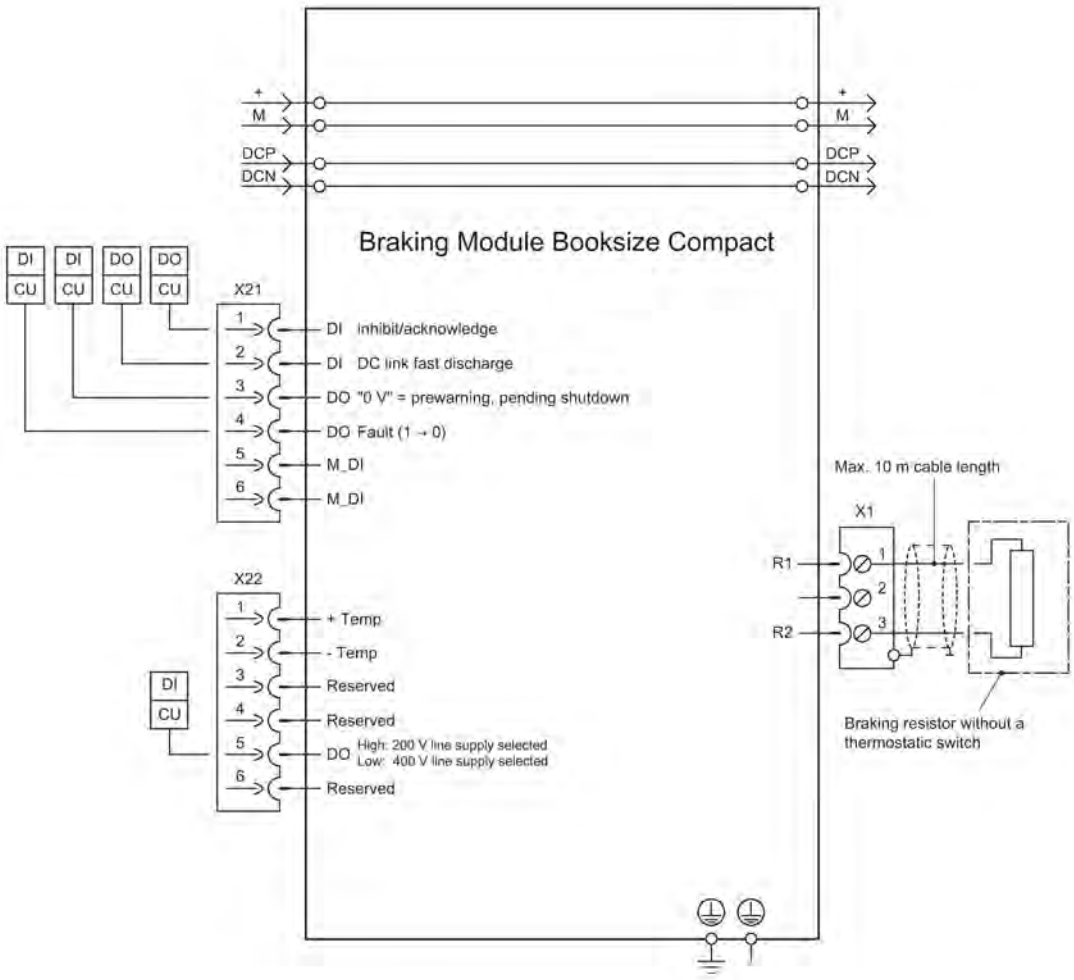


Figure 8-7 Connection example for Braking Module Booksize Compact and braking resistor without a thermostatic switch

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Note

The digital inputs DI are isolated and are referenced to M_DI (X21.5 and X21.6).
The reference point of the digital outputs DO is the ground GND of the 24 V supply.

The connections for the temperature switches (X22.1 and X22.2) must not be assigned for "braking resistor without a thermostatic switch" mode for the Braking Module to work.

Braking resistor with thermostatic switch connected to a Braking Module Booksize Compact

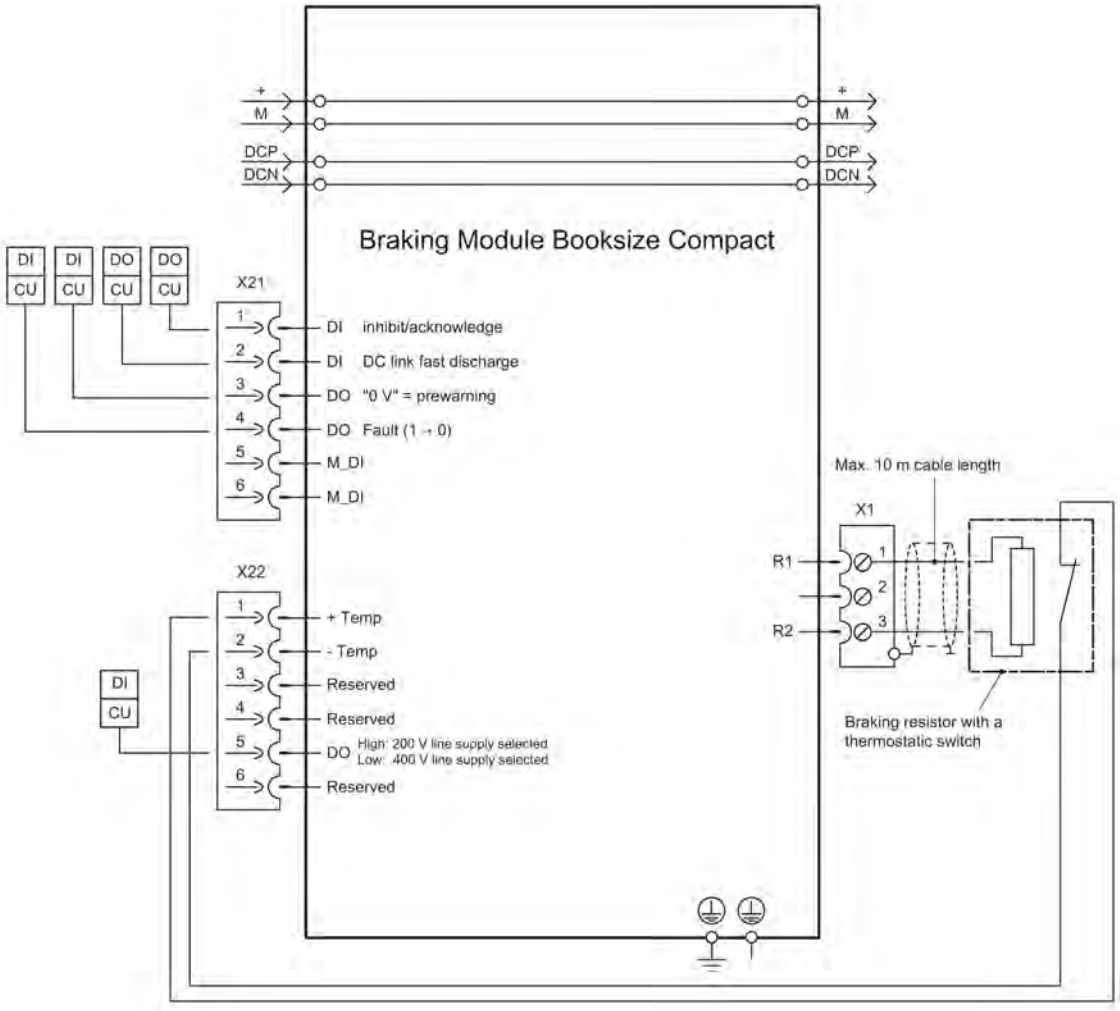


Figure 8-8 Connection example for Braking Module Booksize Compact and braking resistor with a thermostatic switch

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Note

The digital inputs DI are isolated and refer to M_DI (X21.5 and X21.6).
The reference point of the digital outputs DO is the ground GND of the 24 V supply.

To parameterize the digital inputs or digital outputs, see the SINAMICS S120/S150 List Manual.

8.3.5 Meaning of LEDs

Table 8- 13 Meaning of LEDs on the Braking Module Booksize Compact

LED	Color	Status	Description	Remedy
READY	-	Off	The electronics power supply is missing or outside the permissible tolerance range.	Check the electronics power supply.
	Green	Continuous light	The component is ready for operation.	-
	Red	Continuous light	Enable missing (input terminal) Overtemperature of IGBT/braking resistor Overcurrent trip I^2t monitoring activated Braking power monitoring triggered Ground fault/short circuit Note: In the event of overtemperature, I^2t monitoring or braking power monitoring, the fault will be acknowledged automatically after a cooling down phase. Manual acknowledgment is not possible.	Troubleshoot the fault using the output terminals and acknowledge it using the input terminal.
DC LINK	-	Off	The DC link voltage is not available, the electronics power supply is missing or is outside the permissible tolerance range. The component is not active.	
	Orange	Continuous light	The DC link voltage is present.	-
	Orange	Flashing light	The component is active. The DC link is being discharged via the braking resistor.	-

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8.3.6 Dimension drawing

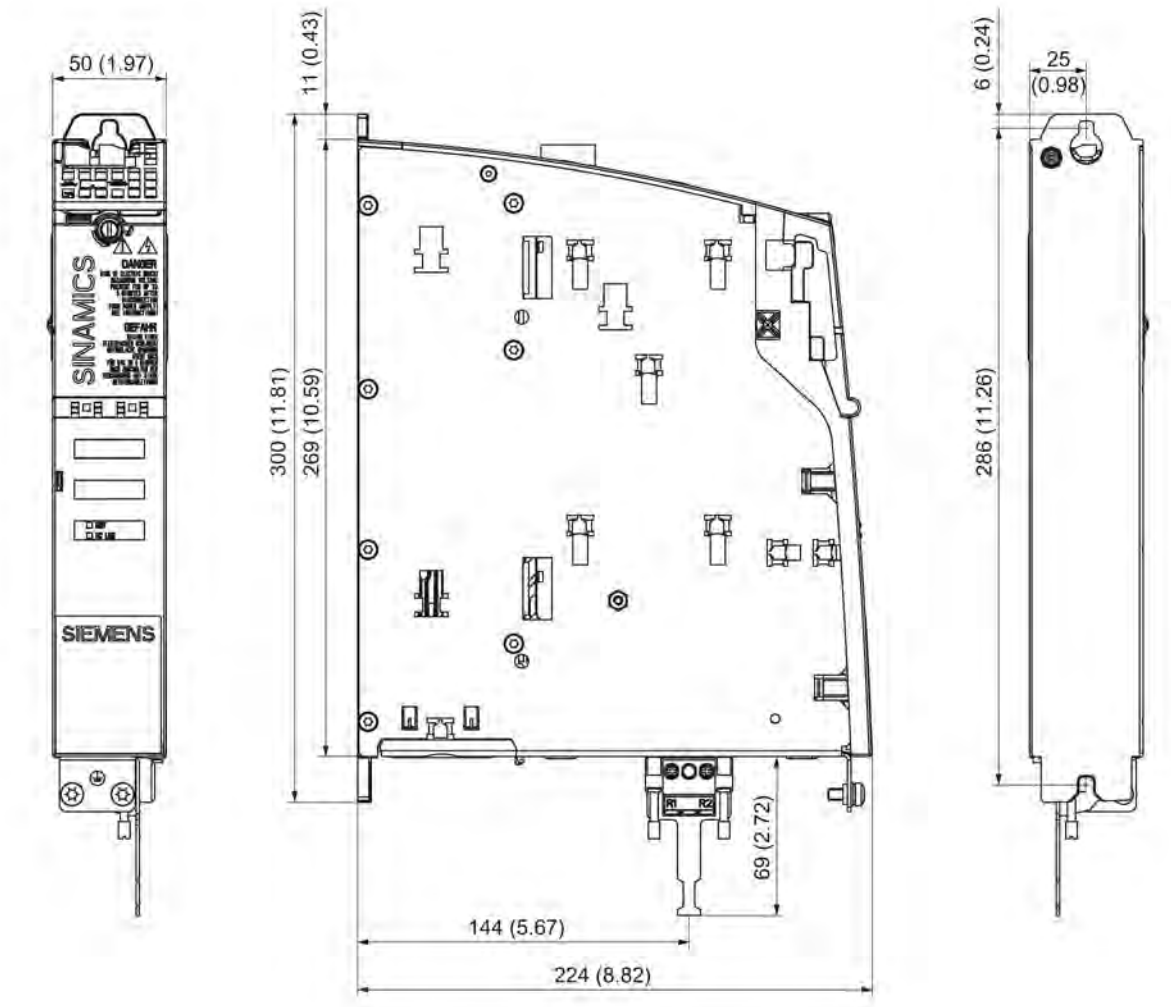
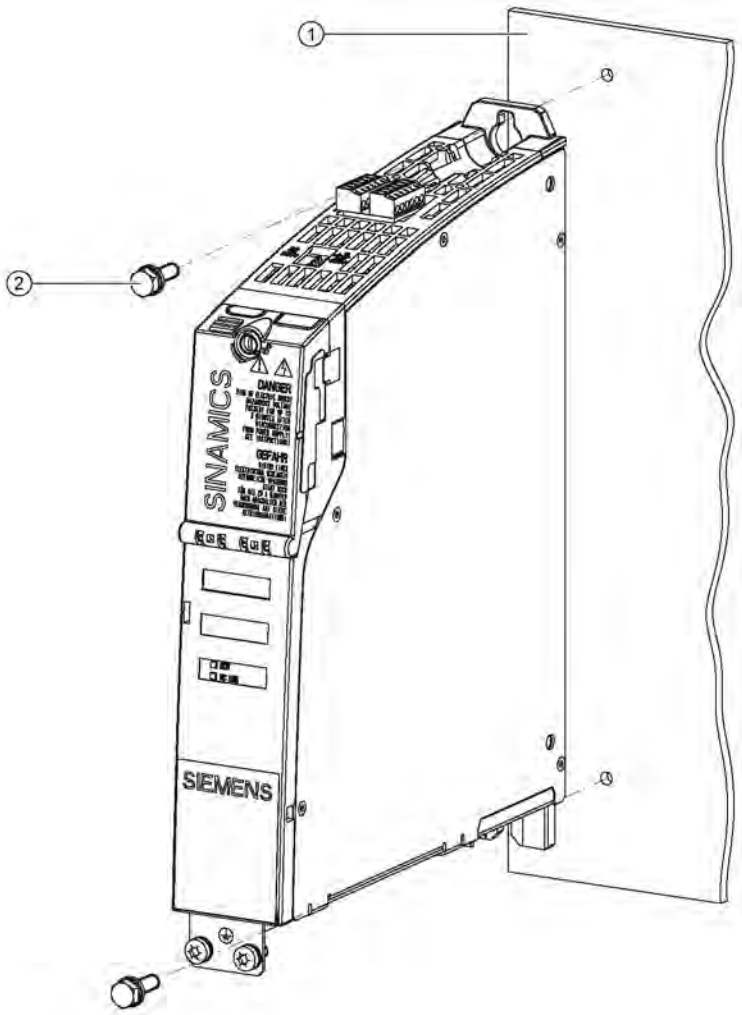


Figure 8-9 Dimension drawing of Braking Module Booksize Compact, all dimensions in mm and (inches)

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8.3.7 Mounting

Mounting a Braking Module Booksize Compact with internal air cooling



① Mounting wall
② M6 x 16 screw
Hex combination screw or hex screw with spring washer and plain washer

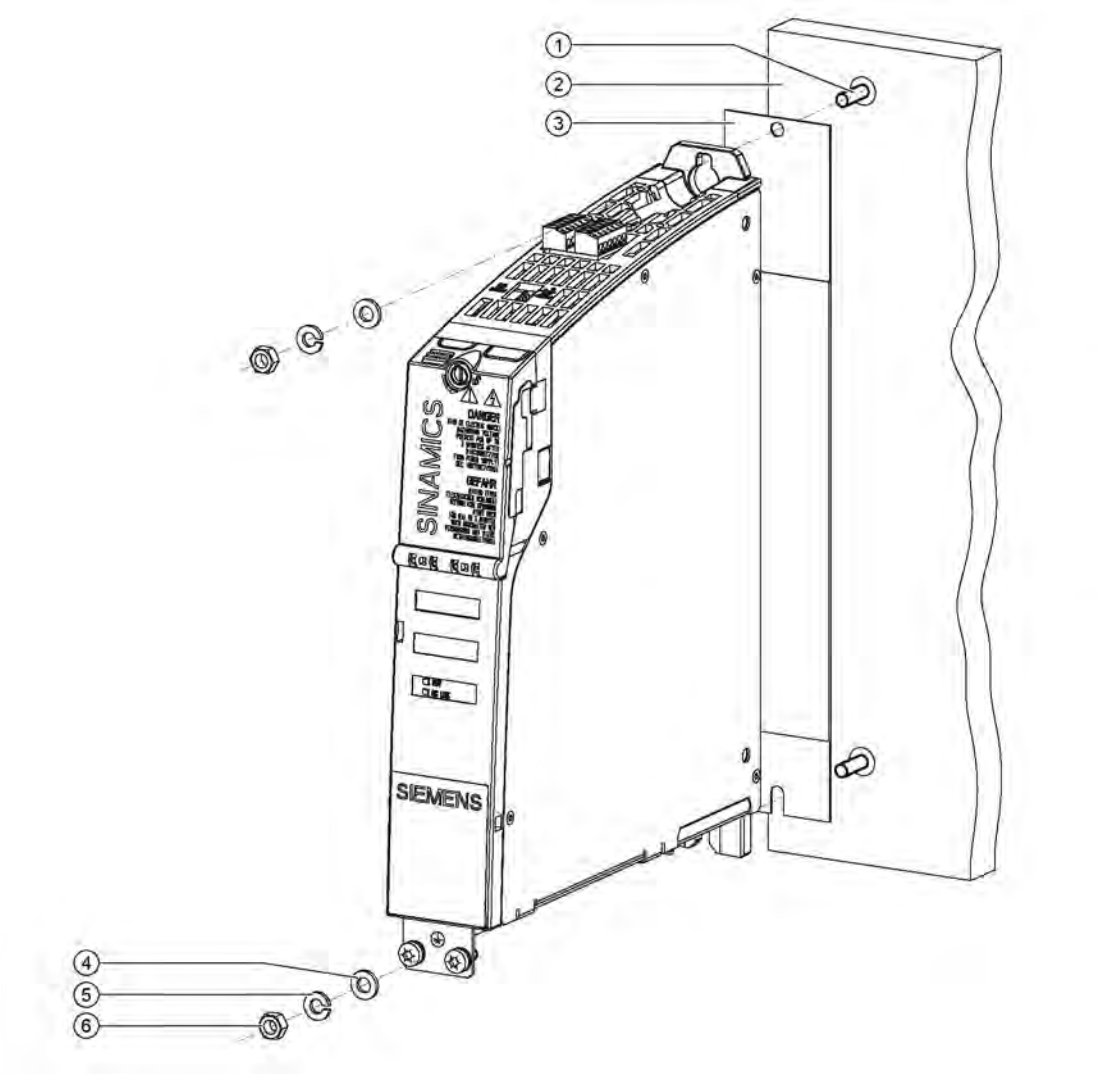
Figure 8-10 Mounting a Braking Module Booksize Compact with internal air cooling

Tightening torques:

- Firstly, tighten the nuts by hand.
  Tightening torque: 0.5 Nm
- Then tighten the nuts.
  Tightening torque: 6 Nm

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Mounting a Braking Module Booksize Compact with cold plate



① M6 studs
② Cold plate (air or liquid cooling)
③ Heat-conducting foil
④ Washer
⑤ Spring washer
⑥ M6 nut

Figure 8-11 Mounting a Braking Module Booksize Compact with cold plate

Tightening torques:

- Firstly, tighten the nuts by hand.
  Tightening torque: 0.5 Nm
- Then tighten the nuts.
  Tightening torque. 10 Nm

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Special points to note in relation to mounting on a cold plate

To improve heat transfer, a heat-conducting medium must be used. Special spherical-indented heat-conducting foil must be used for this purpose. Every Braking Module Booksize Compact is supplied with heat-conducting foil cut to the right size. Note the mounting position of the heat-conducting foil.

Note

- Also replace the heat-conducting foil when replacing a component.
- Only use heat-conducting foil released or supplied by Siemens.

	Order number
Heat-conducting foil, 50 mm	6SL3162-6FB01-0AA0

8.3.8 Technical specifications

Table 8- 14 Technical data

6SL3400-1AE31-0AAx			
Line supply		200 V	400 V
DC link voltage	V_{DC}	250 … 360	510 … 720
ON threshold	V_{DC}	400	760
Braking power Maximum[1)] Continuous braking power	 kW kW	 50 2,5	 100 5
Electronics power supply	V_{DC}	24 (20.4 … 28.8)	
Electronics current consumption (at DC 24 V) Standby mode	 A_{DC} A_{DC}	 0,2 0,4	
Current carrying capacity: DC link busbars 24 V busbar	 A_{DC} A_{DC}	 100 20	
Power loss (see power loss tables (Page 781)) Standby operation	 W W	 5 25	
Switching frequency	Hz	2000	
Cooling methods		Internal air cooling Cold plate cooling	
Max. ambient temperature	° C	55	
Weight	kg	2,7	

1) At the upper switch-on threshold

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8.3.8.1 Characteristic curves

Duty cycle for braking resistors without a thermostatic switch

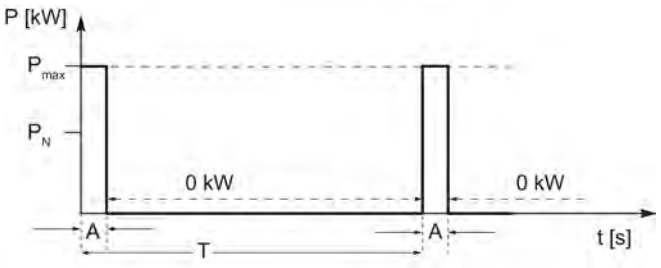


Figure 8-12 Duty cycle for braking resistors without a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [W] rated power (continuous power) of braking resistor

P_{max} [W] peak power of braking resistor (6 x P_N)

Table 8- 15 Duty cycles

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0,1	0,4	1	2
T [s]	11,5	46	68	136

Duty cycles for braking resistors with a thermostatic switch

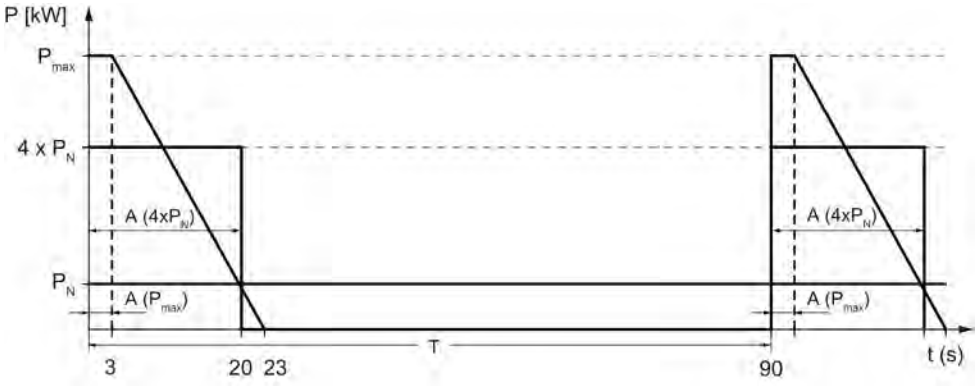


Figure 8-13 Duty cycles for braking resistors with a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [W] rated power (continuous power) of braking resistor

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P_{max} [W] peak power of braking resistor (6 x P_N)

4 x P_N [W] = power permitted every 90 s for 20 s

Table 8- 16 Duty cycles

	6SE7018-0ES87-2DC0		6SE7021-6ES87-2DC0		6SE7023-2ES87-2DC0	
	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_N
A [s]	3	20	3	20	3	20
T [s]	90	90	90	90	90	90

8.3.9 Configuration instructions

DC link capacitance

When configuring the drive line-up, please note that only one Braking Module Booksize Compact may be used per complete 500 µF DC link capacitance.

Table 8- 17 Configuration examples

DC link capacitance in µF	Max. number of Braking Modules
900	1
2400	4
9800	19

DC link cable

In a two-row or distributed drive line-up, the DC links are connected to each other via a DC link cable. When using a Braking Module Booksize Compact in the drive line-up, this cable must not be longer than 10 m. In all cases, the DC link cable must have low impedance and a cross-section of at least 10 mm^2.

Parallel operation

During configuration of parallel operation for Braking Modules Booksize Compact, dimensioning can only take 90% of the specified braking power into account. Only the peak powers may be added without derating.

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

4 x $P_{N\ total}$ = 0.9 x sum (4 x P_N) of single devices

$P_{max\ total}$ = total P_{max} of single devices

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8.4 Braking units for 100 kW Basic Line Modules

8.4.1 Description

Since Basic Line Modules 100 kW cannot feed power back into the supply system, an external braking unit together with a braking resistor is required for the following tasks:

- When the power fails, the drives are stopped in a controlled fashion (e.g. EMERGENCY OFF Category 1).
- The DC link voltage is limited during brief generator operation.

The MASTERDRIVES braking unit includes the necessary power electronics and control. When the braking unit is in operation, the power which is fed back into the DC link is dissipated via an external braking resistor.

For the operation of a Basic Line Module 100 kW, only MASTERDRIVES braking units with the following rated braking powers are permitted:

- 4 x P_N = 100 kW (order number 6SE7031-6EB87-2DA1)
- 4 x P_N = 170 kW (order number 6SE7032-7EB87-2DA1)

For detailed information about the MASTERDRIVES braking unit, see operating instructions "MASTERDRIVES braking unit" with order number 6SE7087-6CX87-2DA0.

8.4.2 Safety instructions for Braking Modules for the 100 kW Basic Line Module

⚠ WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠ WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 80 mm clearances above and below the components.

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NOTICE

Device failure as a result of unshielded or incorrectly routed cables to braking resistors

Unshielded or incorrectly routed cables to braking resistors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables for cables to braking resistors.

Note

Note the starting time for the electronics

The electronics of the Braking Module is supplied from the DC link. As long as no DC link voltage is present (< 360 V ± 2%), the electronics are not active and an external control or the Control Unit receives the "fault" signal from the fault output. This means that it is not just the 2 seconds that has to be taken into account, which the electronics requires to run up as soon as the DC link voltage is present.

NOTICE

Danger to life through the use of non-approved braking resistors

Braking resistors can be damaged when using braking resistors other than those specified in this Manual.

- Only use braking resistors approved by Siemens.

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8.4.3 Interface description

8.4.3.1 X3 DC link connection

Table 8- 18 X3: Connection for the DC link

Connection/Meaning	Remarks	Tightening torque [Nm]
C/L+ input (plus DC link)	Busbar C/L+	16
D/L- input (minus DC link)	Busbar D/L	16
 Protective conductor	Busbar PE 	16
Shield connection	M6 bolts at top of housing	8
NOTE		
Connection via	Cable lug without insulation With shrink-on sleeve Cable is connected using the supplied M8 x 25 screws	
AWG	Max. 2/0	

Note

After the DC link voltage is applied, fault output -X38/5 is "low" for approx. 2 seconds (self-test), i.e. in the "fault" state. The Control Unit must suppress this state when the system is switched on.

8.4.3.2 X6 braking resistor connection

Table 8- 19 X6: Connection for the braking resistor

Connection/Meaning	Remarks	Tightening torque [Nm]
G/R+ external braking resistor	Busbar G/R+	16
H/R external braking resistor	Busbar H/R	16
 Protective conductor	Busbar PE 	16
Shield connection	M6 bolts at bottom of housing	8
NOTE		
Connection via	Cable lug without insulation With shrink-on sleeve Cable is connected using the supplied M8 x 25 screws	
AWG	Max. 2/0	

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Note

The cable length between the braking unit and the braking resistor is limited to 15 m.

The following braking resistors are suitable for connecting to the MASTERDRIVES braking unit:

Table 8- 20 Braking resistors for MASTERDRIVES braking unit

Braking resistor	P_N in kW	P_{20} in kW	P_{max} in kW	R in Ω
6SE7031-6ES87-2DC0	25	100	150	4
6SE7032-7ES87-2DC0	42,5	170	255	2,35

8.4.3.3 Switch S1

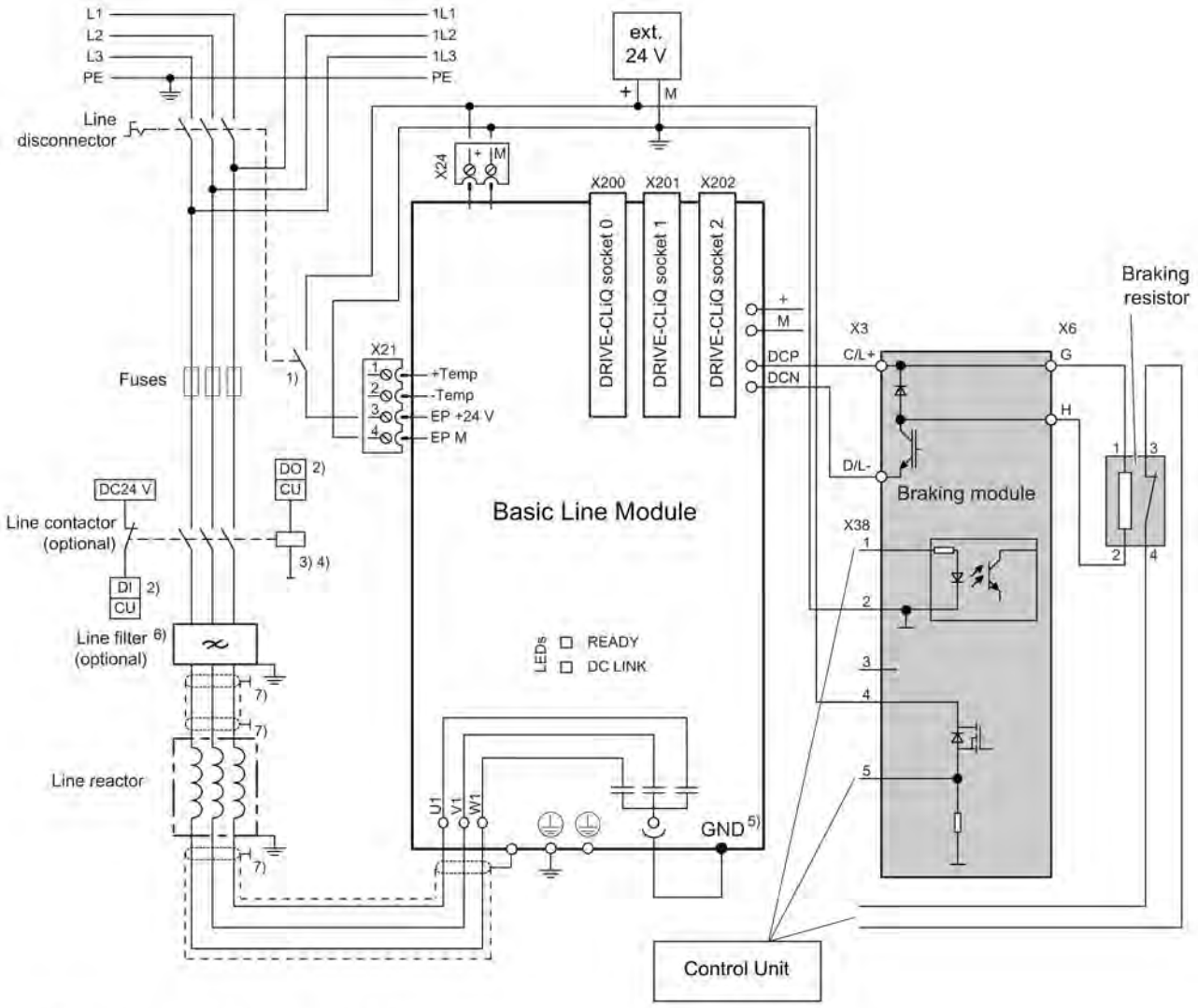
Switch S1 on the MASTERDRIVES braking unit is used to set the switch-on threshold. It is located behind the front panel.

Switch S1 should be set to "high" (factory setting) in order to operate the braking unit on a SINAMICS S120 drive line-up in booksize format. This means that the switch-on threshold is at 757 V DC.

For more information, refer to the operating instructions for the MASTERDRIVES braking unit.

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8.4.4 Connection example



1) 24 V DC and ground must be connected for operation.
2) DI/DO, controlled from the Control Unit.
3) No additional load permitted downstream of the line contactor!
4) The current carrying capacity of the DO must be observed; an output coupling device must be used if required.
5) The connection bracket must be removed when the component is connected to an IT line supply.
6) Line filter is required so that the radio interference voltage complies with Category C2.
7) Contact established via rear mounting panel or shield buses in accordance with the EMC installation guideline

Figure 8-14 Connection example for MASTERDRIVES braking unit

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8.4.5 Dimension drawing

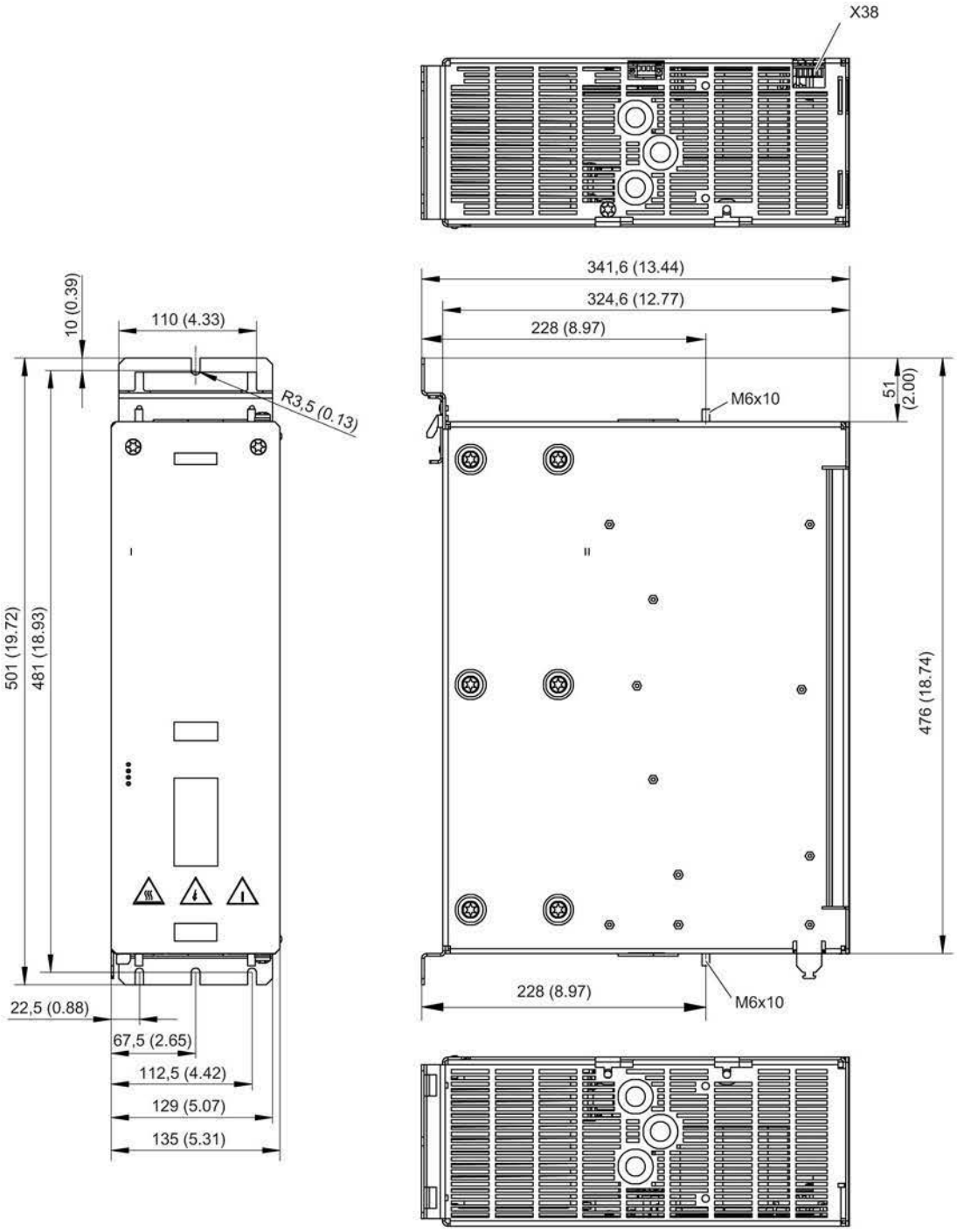


Figure 8-15 Dimension drawing of 100 kW and 170 kW MASTERDRIVES braking unit, all dimensions in mm and (inches)

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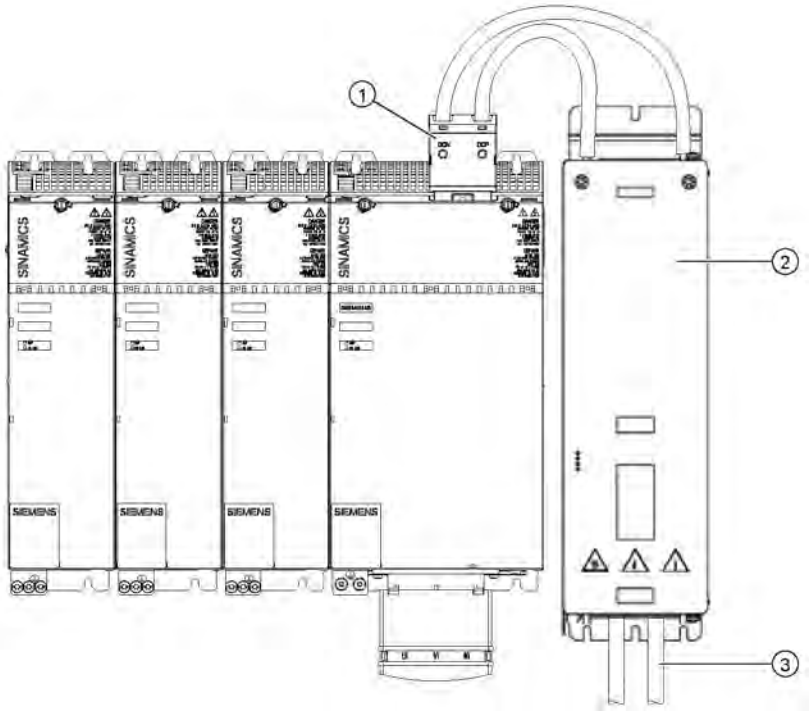
8.4.6 Connection to the Basic Line Module 100 kW

Connecting the braking unit to the DC link

The following adapters can be used to connect the MASTERDRIVES braking unit to a SINAMICS S120 line-up in booksize format:

- DC link rectifier adapter, order number 6SL3162-2BM00-0AA0
- DC link adapter, order number 6SL3162-2BM01-0AA0

The connecting cables used to connect the braking unit to the DC link rectifier adapter or DC link adapter must be kept as short as possible.
Please observe the instructions contained in Chapters DC link rectifier adapter (Page 651) and DC link adapter (Page 664).



① DC link rectifier adapter
② MASTERDRIVES braking unit
③ Cable routing to the braking resistor

Figure 8-16 Connecting a MASTERDRIVES braking unit via a DC link rectifier adapter

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Connecting the braking unit to the DC link adapter or DC link rectifier adapter

1. Connect the C/L+ connection on the braking unit to the DCP terminal on the DC link rectifier adapter or DC link adapter.
2. Connect the D/L- connection on the braking unit to the DCN terminal on the DC link rectifier adapter or DC link adapter.
3. Connect the protective conductor between the S120 drive line-up and the braking unit. The cross-section of the protective conductor connection must be at least 50 mm^2.

The connecting cable between the braking unit and the DC link rectifier adapter or DC link adapter must be dimensioned with a cross-section of 95 mm^2 in accordance with EN 60439-1 (short-circuit-proof cable routing). The electric strength of the cable must be rated to the line voltage. The maximum permissible length of the connecting cables to the DC link is 3 m.

NOTICE

Damage to the drive units or DC link terminals by interchanging or short-circuiting the DC link terminals

The drive equipment or braking unit may be damaged if the DC link terminals are interchanged or short-circuited.

- Carefully ensure that the DC link terminals are correctly connected.
- Do not short-circuit the DC link terminals.

CAUTION

Risk of burns as a result of the high braking unit temperature

The air discharge temperature of the braking units and the housing can become very hot. You can be slightly injured if you come into contact with them.

- Avoid coming into contact with the discharged air and the housing of the braking units.
- Mount the motor braking units so that they cannot be touched. If this is not possible, attach a clearly visible and understandable warning notice at hazardous positions.
- To prevent adjacent components from being damaged due to these high temperatures, maintain a clearance around all sides of the braking units.

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8.5 Capacitor Module

8.5.1 Description

Capacitor modules are used to increase the DC link capacitance to bridge momentary power losses.

Capacitor modules are connected to the DC link voltage via the integrated DC link busbars. Capacitor modules function autonomously.

Several capacitor modules can be operated in parallel.

8.5.2 Safety instructions for Capacitor Modules

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 80 mm clearances above and below the components.

Note

Maximum permissible DC link capacitance

The Capacitor Module is precharged by the Line Module.

- Observe the respective maximum permissible DC link capacitances of the Line Modules.

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8.5.3 Interface description

8.5.3.1 Overview

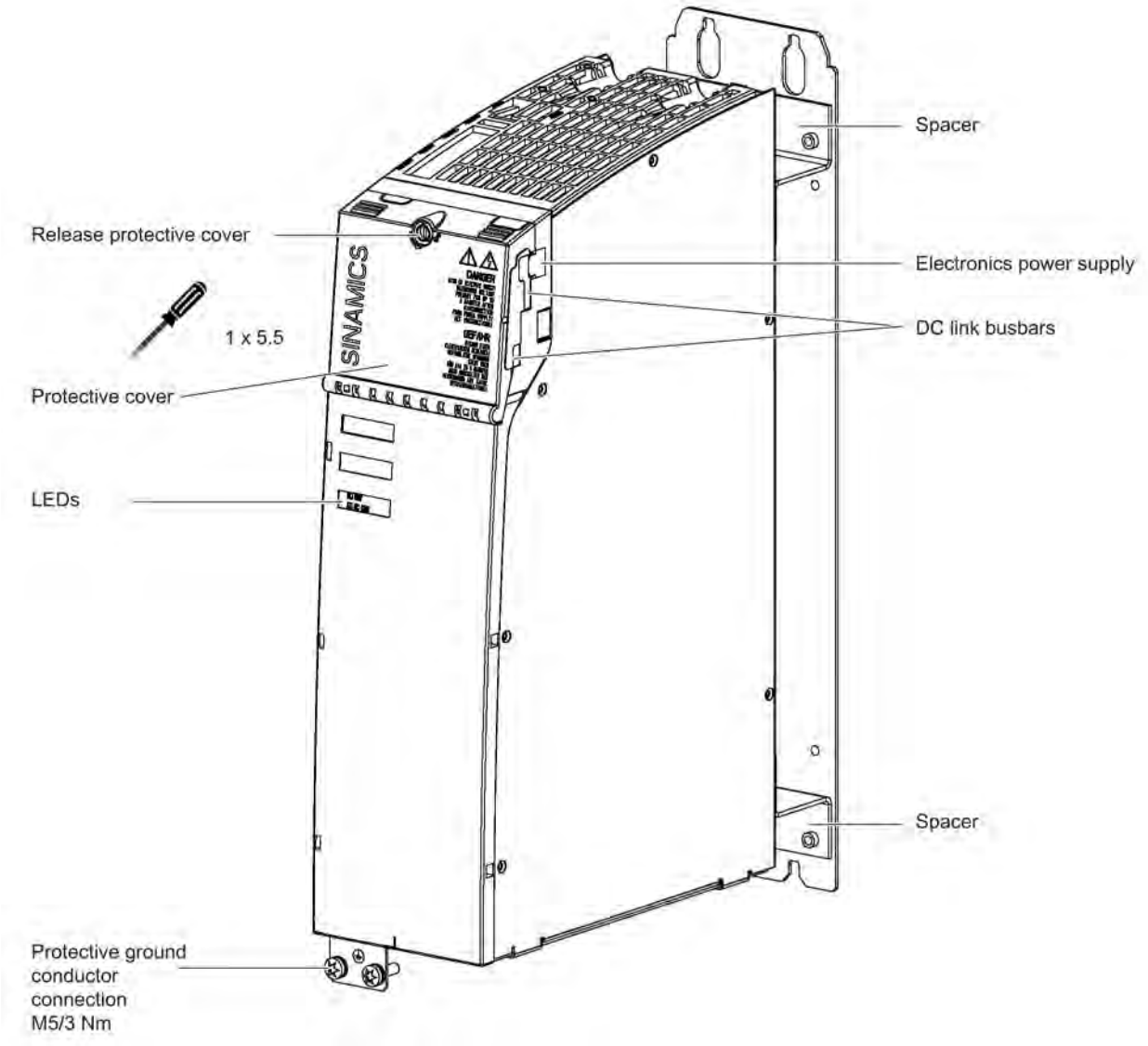


Figure 8-17 Interface overview, Capacitor Module

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8.5.4 Dimension drawing

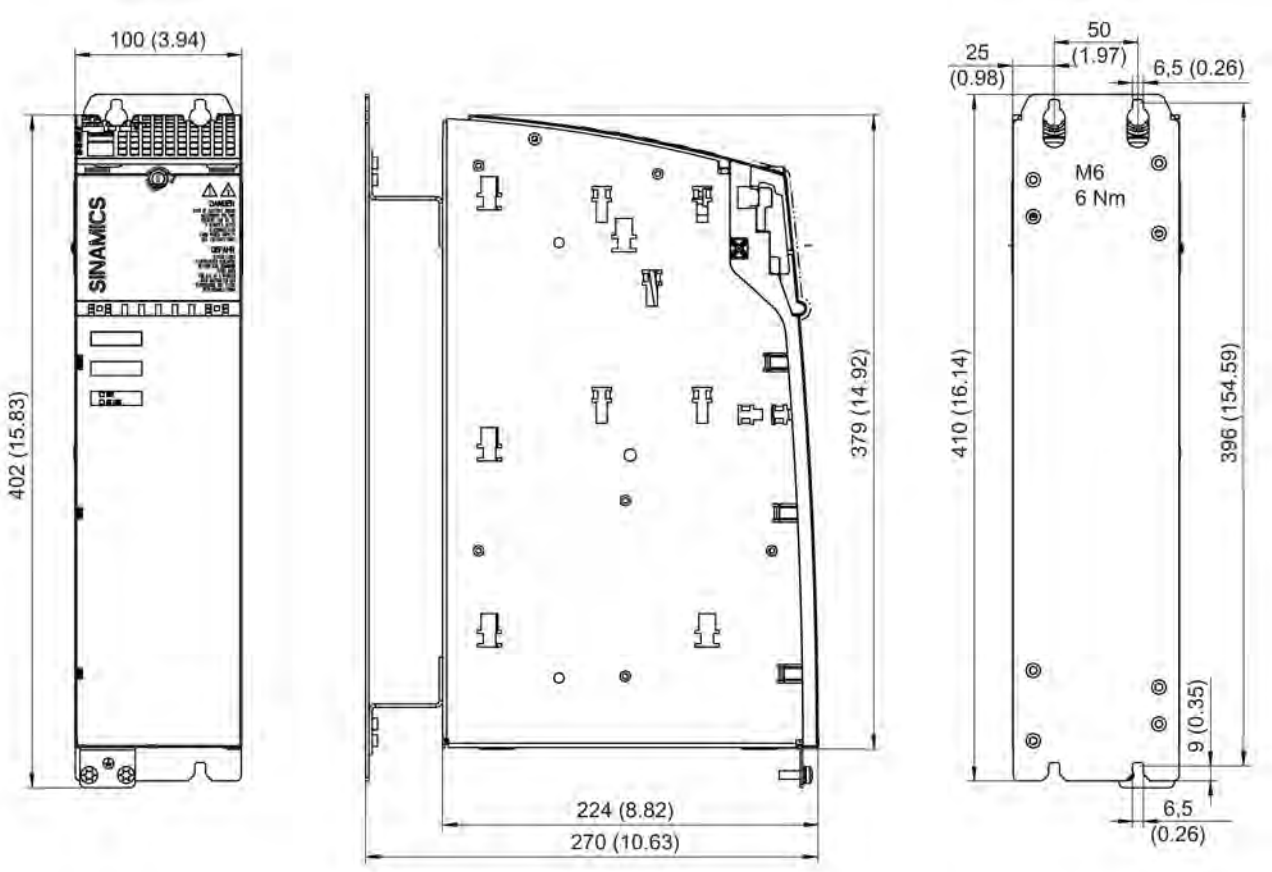
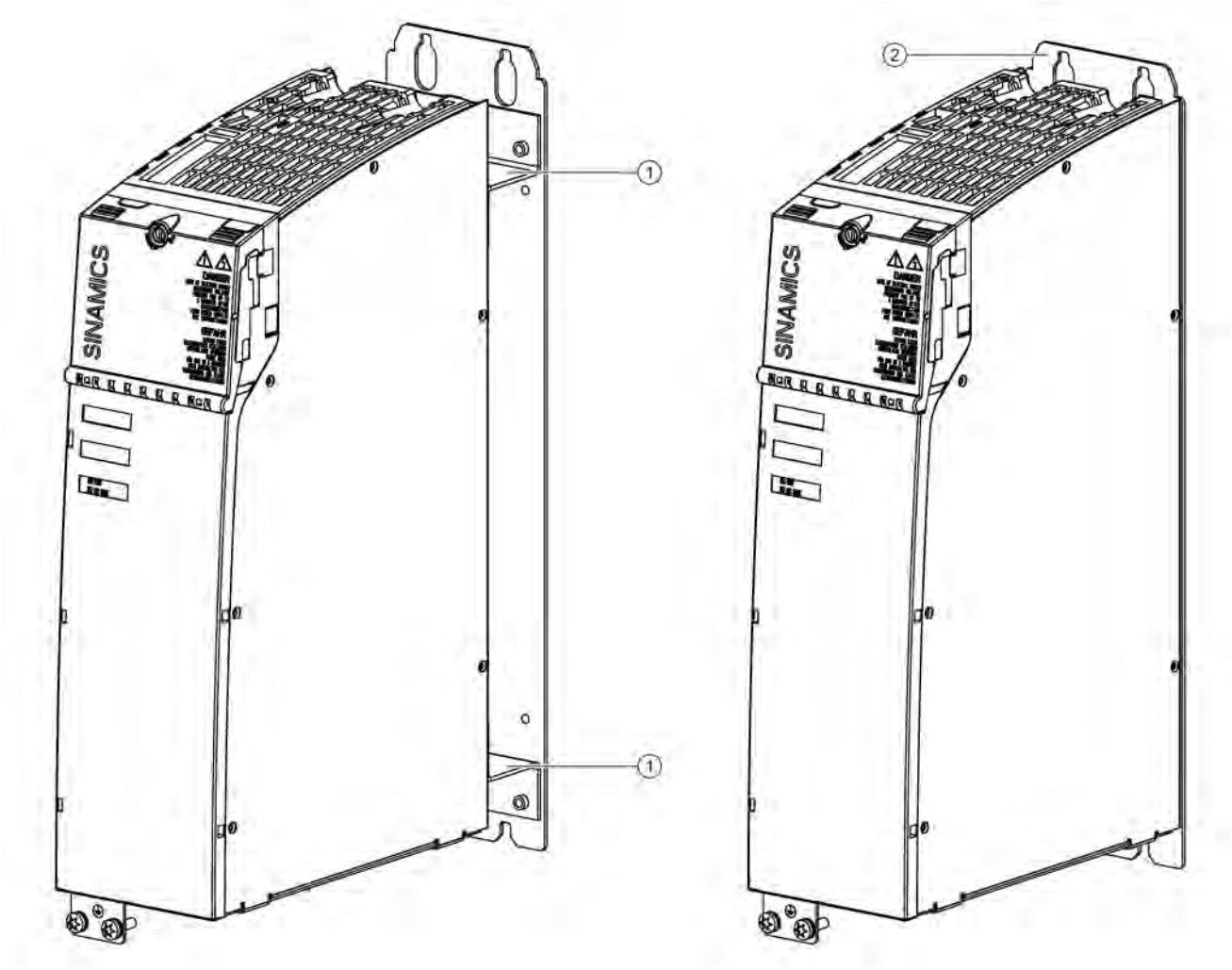


Figure 8-18 Dimension drawing of Capacitor Module, all dimensions in mm and (inches)

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8.5.5 Mounting



① Delivered with spacer - mounting depth for drive line-up in booksize format with internal air cooling
② Spacer removed - mounting depth for drive line-up in booksize format with external air cooling

Figure 8-19 Mounting methods for Capacitor Module with and without spacer elements

The Capacitor Module can be attached to the cabinet panel with or without spacer elements.

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8.5.6 Technical Specifications

Table 8- 21 Technical data

6SL3100-1CE14-0AA0		
DC link voltage	V_{DC}	510 … 720
Electronics power supply	V_{DC}	24 (20.4 … 28.8)
Capacitance	µF	4000
Current carrying capacity DC link busbar 24 V busbar	 A A	 100 20
Power loss (see power loss tables (Page 781))	W	25
Weight	kg	7.2

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8.6 Control Supply Module CSM

8.6.1 Description

The Control Supply Module provides an output voltage of 24 V - 28.8 V DC. The output voltage can be adjusted using an integrated potentiometer.

In normal operation, the Control Supply Module is supplied from the line voltage. When the power fails, the module automatically changes over to supply from the DC link. This makes it possible, for example, to execute retraction movements in the event of a power failure.

The Control Supply Module has safe electrical separation between the line potential and the DC link potential. This therefore ensures that the DC link is not unintentionally charged. The Control Supply Module can therefore remain connected to the supply if the Line Module is galvanically isolated from the line supply, for example using a line contactor.

The 24 V ground of the Control Supply Module is internally grounded.
The Control Supply Module is cooled using an internal fan.

Temperature and voltages are internally monitored.

Temperature monitoring:
In the event of an overtemperature in the Control Supply Module, a temperature advance warning is issued via a signaling contact. If the temperature falls below the limit value within the advance warning time, then the module remains operational and the signaling contact is de-energized. If the overtemperature condition persists, the module is switched off and restarted.

Voltage monitoring:
When the monitoring threshold (32 V) of the output voltage is exceeded for > 20 ms, the control supply module switches off and attempts a restart after 10 s. This is supplemented by a hardware-based overvoltage limiting. This prevents that more than 35 V can be output in the case of a fault.

The Control Supply Module can either be operated individually or in a parallel connection with a maximum of 10 devices. The switchover between single and parallel operation is realized in a no-current state using a DIP switch on the upper side of the module.

Note

Compatibility

The new Control Supply Module 6SL3100-1DE22-0AA1 with extended functions described here replaces Control Supply Module 6SL3100-1DE22-0AA0. The modules are downwards compatible (-0AA1 can be used as spare part for -0AA0).

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8.6.2 Safety instructions for Control Supply Modules

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.



⚠DANGER

Danger to life when live parts are touched when using the control supply module

The Control Supply Module has 2 supply circuits. Death or serious injury can result when live parts are touched.

- Switch off both supply circuits before you start any work.



⚠DANGER

Danger to life through electric shock due to the residual charge of the DC link capacitors

Due to the DC link capacitors, a hazardous voltage is present in the DC link for up to 5 minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.



⚠DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Contact with live parts can result in death or serious injury.

- Only operate the components with closed protective cover.



⚠WARNING

Danger to life through electric shock due to missing DC link side covers

There is a danger of an electric shock through contact when the side covers of the DC link are missing.

- Mount the side covers on the first and last component in the drive line-up.
  You can order missing side covers (order number: 6SL3162-5AA00-0AA0).

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⚠WARNING

Danger of an accident due to missing warning labels in the national language.

Missing warning labels in the national language regarding the DC link discharge time can result in death or serious injury.

- Attach the component warning labels in the national language.

⚠WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life for Line Modules.

- Maintaining 80 mm ventilation clearances above and below the component is essential.

NOTICE

Material damage due to loose power connections

Insufficient tightening torques or vibration can result in faulty electrical connections. This can cause fire damage or malfunctions.

- Tighten all the DC link busbar screws with the specified tightening torques (1.8 Nm tolerance +30 %).
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

NOTICE

Material damage due to loose power connections when using the 24 V terminal adapter

Insufficient tightening torques or vibration can result in faulty electrical connections. This can cause fire damage or malfunctions.

- When using the 24 V terminal adapter, it must be screwed onto the Control Supply Module. Tighten the enclosed EJOT-PT K30 x 16 screw with the specified tightening torque (0.5 Nm).
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

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8.6.3 Interface description

8.6.3.1 Overview

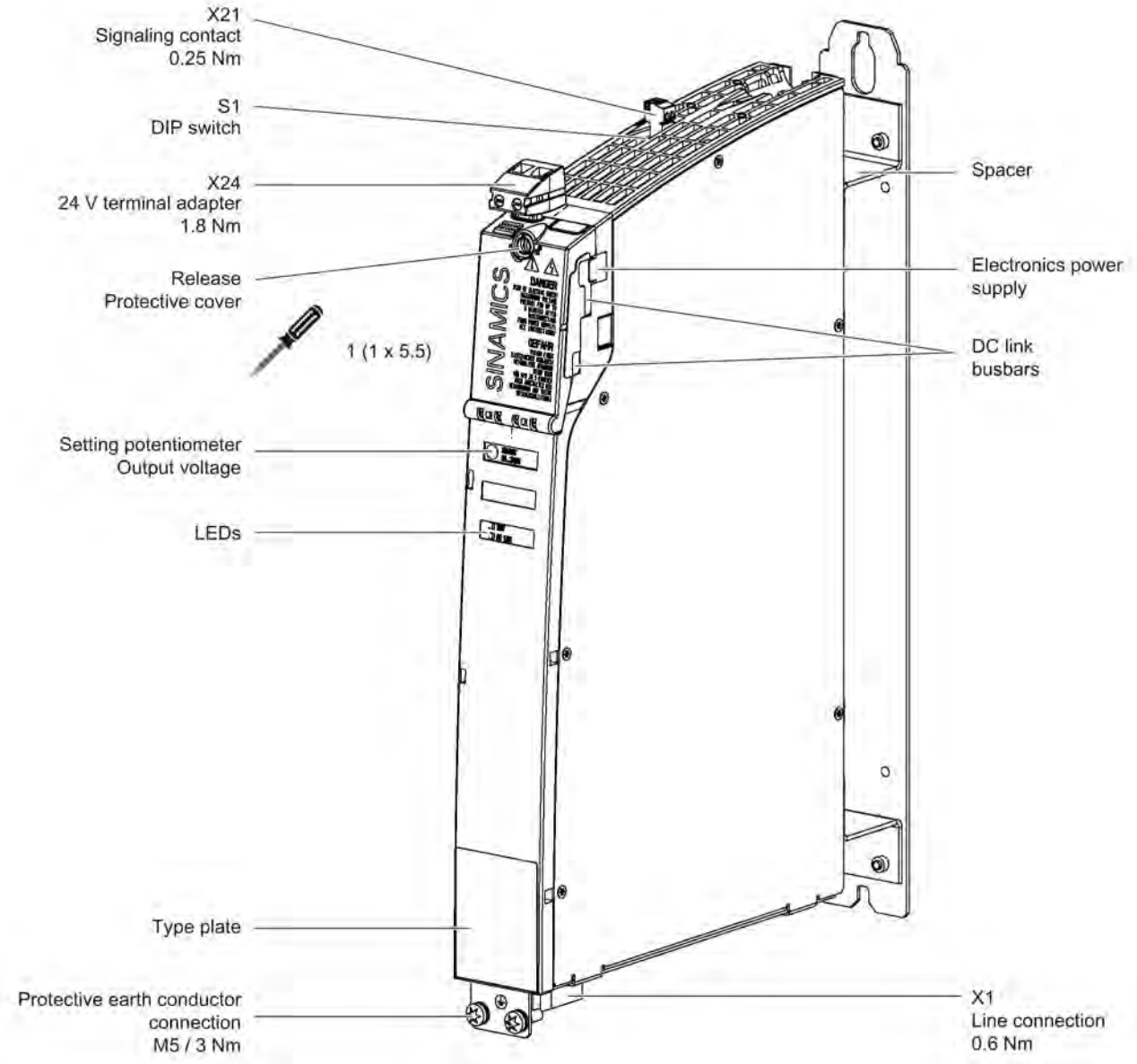
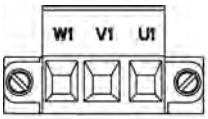
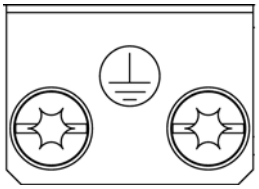


Figure 8-20 Interface overview, Control Supply Module

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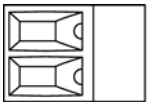
8.6.3.2 X1 line connection

Table 8- 22 X1 line connection

	Terminal	Technical data
	U1 V1 W1	Supply voltage: 3 AC 380 V … 480 V, 50 / 60 Hz Type: Screw terminal 4 (Page 755) Max. cross-section that can be connected: 4 mm² Tightening torque: 0.5 … 0.6 Nm
	PE connection	M5 screw / 3 Nm at the housing

8.6.3.3 X21 signaling contact

Table 8- 23 X21 signaling contact

	Terminal	Technical data
	1 2	Voltage: 24 V DC Max. load current: 0.5 A (ohmic load)
Type: Screw terminal 1_1 (Page 755) Max. cross-section that can be connected 1.5 mm²		

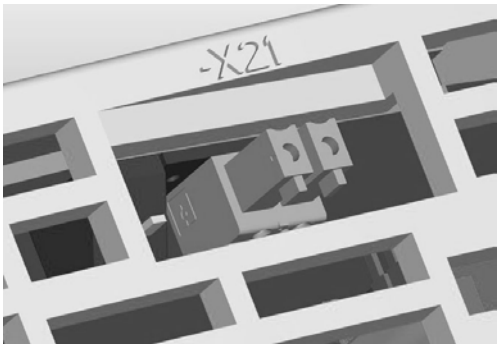
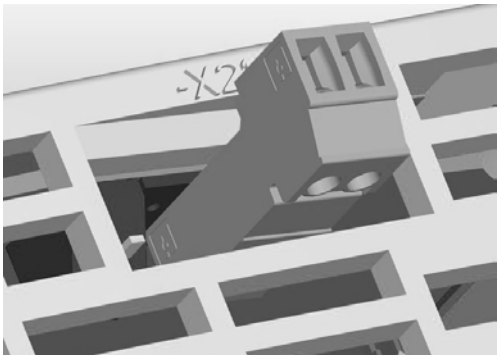
The 2-pole terminal connector for the signaling contact is included in the Completion Kit provided.

The signaling contact can be connected with a digital input (DI) on the Control Unit or other digital interface (PLC, SCADA). In parallel or redundant operation the failure of a Control Supply Module is indicated in order to initiate a service call, for example.

The signaling contact operates as an isolated NO contact. When the switch is closed, the Control Supply Module is "OK" and provides the output voltage. The switch opens in the event of a fault "Not OK" – when the overtemperature condition is still present, after a pre-warning, wire breakage, short-circuit etc. The Control Supply Module is correspondingly switched off.

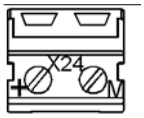
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Table 8- 24 Installing the signaling contact

	
Signaling contact without terminal connector in the delivery condition	Signaling contact, complete with terminal connector

8.6.3.4 X24 24 V terminal adapter

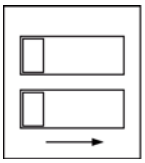
Table 8- 25 X24 24 V terminal adapter

	Terminal	Designation	Technical data
	+	24 V power supply	Supply voltage 24 ... 28.8 V DC
	M	Ground	Electronics ground
Type: Screw terminal 5 (Page 755) Max. cross-section that can be connected: 6 mm²			

The 24 V terminal adapter is included in the scope of supply.

8.6.3.5 S1 DIP switch

Table 8- 26 DIP switch S1

	Terminal	Designation	Technical data
	1	Changeover switch, single operation / parallel operation	Left: Single operation Right: Parallel operation
	2	Dummy contact (not used)	Changing over the output characteristic

It is only permissible to changeover when in the no-voltage state.

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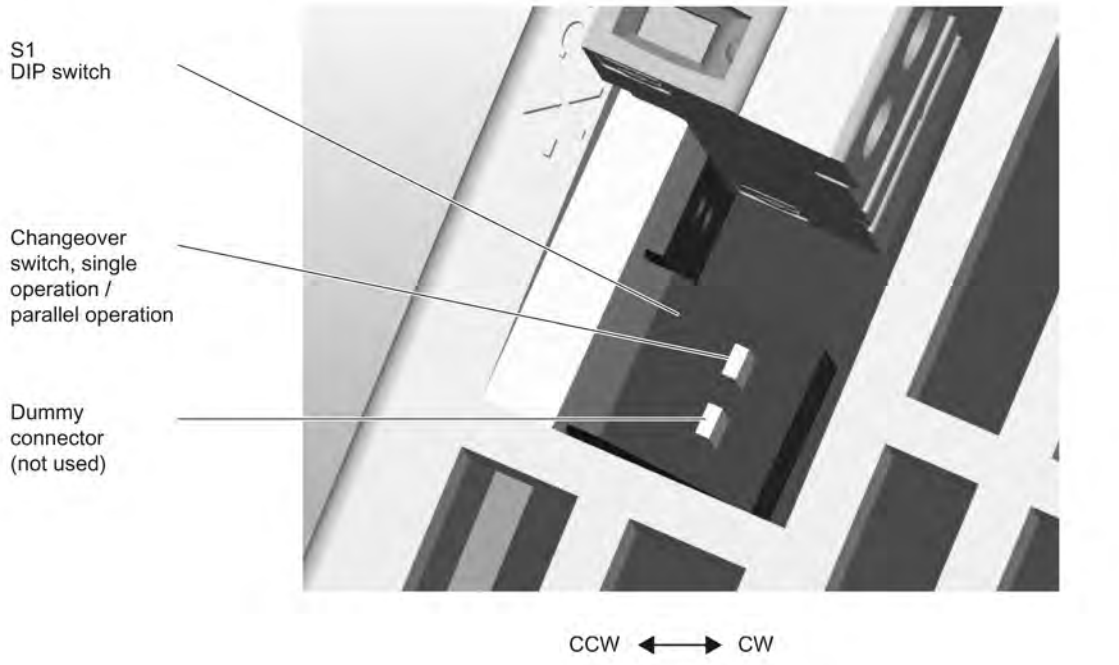


Figure 8-21 DIP switch on the upper side of the component

When delivered, "single operation" is set. Both switches are set to the left.

8.6.4 Connection examples

The Control Supply Module is connected to the line supply (3-ph. 380 V AC -10 % to 480 V AC +10 %) via interface X1 (screw terminals 0.2 to 4 mm²). This connection should preferably be made without using an isolating device (e.g. contactor).

The Control Supply Module has an internal line filter (Class A for TN systems), and the pre-charging circuit for the DC link inside the device is electrically isolated from the 24 V supply.

The Control Supply Module also features a current limitation function.

Note

If you use cables with a cross-section of 2.5 mm², no additional protection is required on the 24 V side for the following cable types:

- Cables of the XLPE type
- Cables of the EPR type
- Cable with a similar properties and which is thermally stable up to 90 °C

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Note

Observe the connection sequence

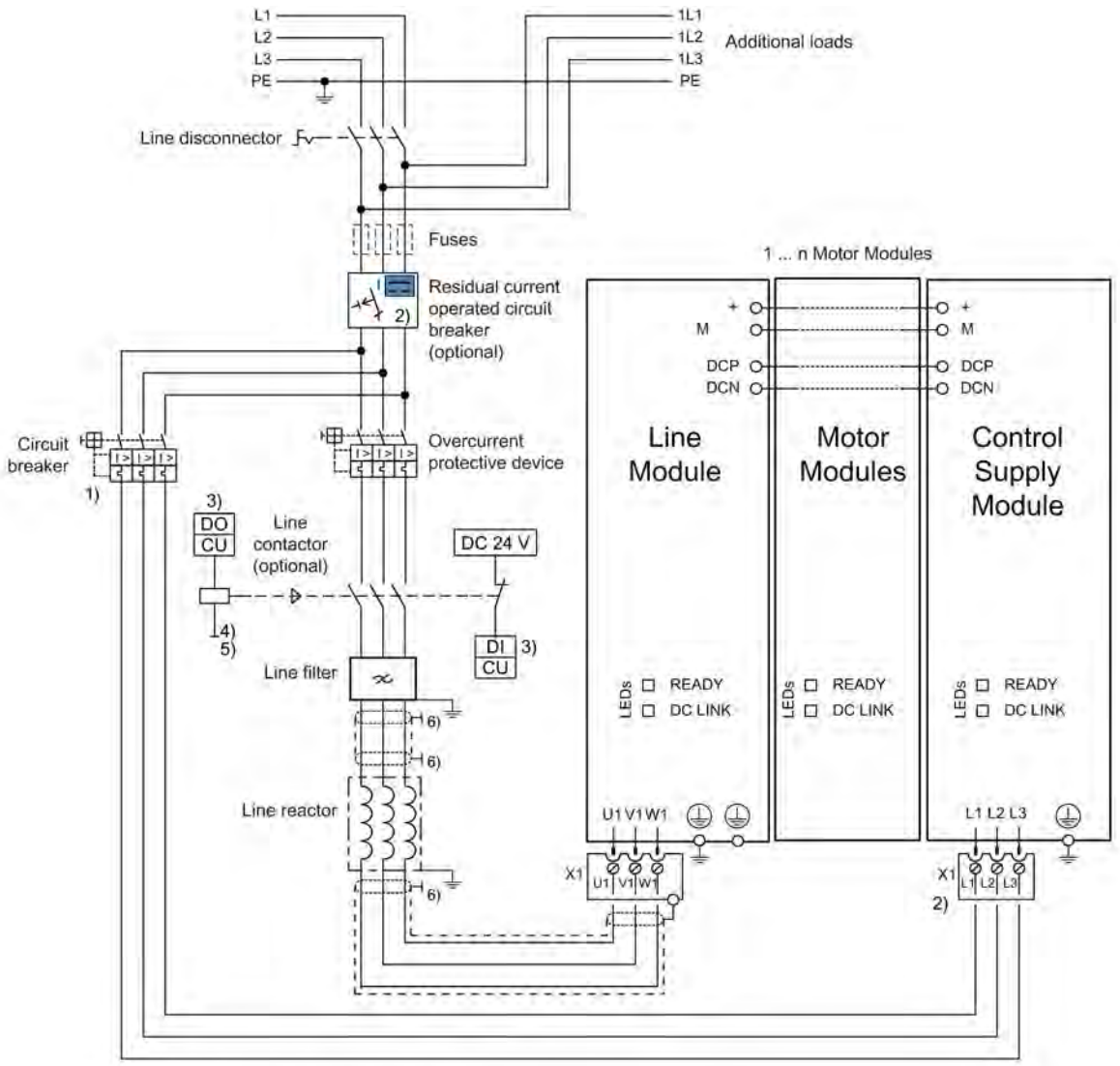
If a selectively tripping, AC/DC-sensitive RCCB is used for the drive line-up, the Control Supply Module must always be connected to the line supply downstream of this circuit breaker. Otherwise, the residual current operated circuit breaker will trip erroneously if the direct-current component is asymmetrically drawn in certain operating states.

8.6.4.1 Single operation

Within the drive line-up, the Control Supply Module must be connected to the drive line-up via the DC link busbars as well as the 24 V busbars. The red 24 V connector from the accessories pack provided must be inserted under all circumstances. The DIP switch on the Control supply Module must be set to "single mode" The connection can be established as shown below.

The supply for other 24 V loads outside the drive line-up using additional Control Supply Modules, whose outputs are not connected in parallel, must be realized using the 24 V terminal adapter (do not insert the red 24 V connector).

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1) Permissible types:
a) SIRIUS circuit breaker, 3RV 1021 1DA10, set to 3A
b) KTS-R-6-type branch circuit fuse (class RK1)
2) The line supply connection must always be available
3) DI/DO, controlled from the Control Unit.
4) No additional load permitted downstream of the line contactor!
5) The current carrying capacity of the DO must be observed; an output coupling device must be used if required.
6) Contact established via rear mounting panel or shielding buses in accordance with the EMC installation guideline

Figure 8-22 Connection example for Control Supply Module in single operation

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8.6.4.2 Parallel operation

A maximum of 10 Control Supply Modules can be connected in parallel.

The DIP switch of the Control supply Module must be set to "parallel mode". The same output voltage must be set for all modules at the potentiometer.

In the parallel mode, each Control Supply Module should supply the 24 V DC voltage via the 24 V terminal adapter. For this reason, the red 24 V connector must **not** be used (see connection examples).

For a parallel connection we recommend that a SITOP redundancy module (6EP1961-3BA20) is used. One SITOP redundancy module must be used for two Control Supply Modules in this case. Alternatively, a connection with external diodes to decouple the individual Control Supply Modules is possible. If a Control Supply Module fails, an alarm is generated and provided via the X21 signaling contact. The 24 V supply is maintained via the second module.

Note

Parallel connection

Only Control Supply Modules with order number 6SL3100-1DE22-0AA1 may be used for parallel connection.

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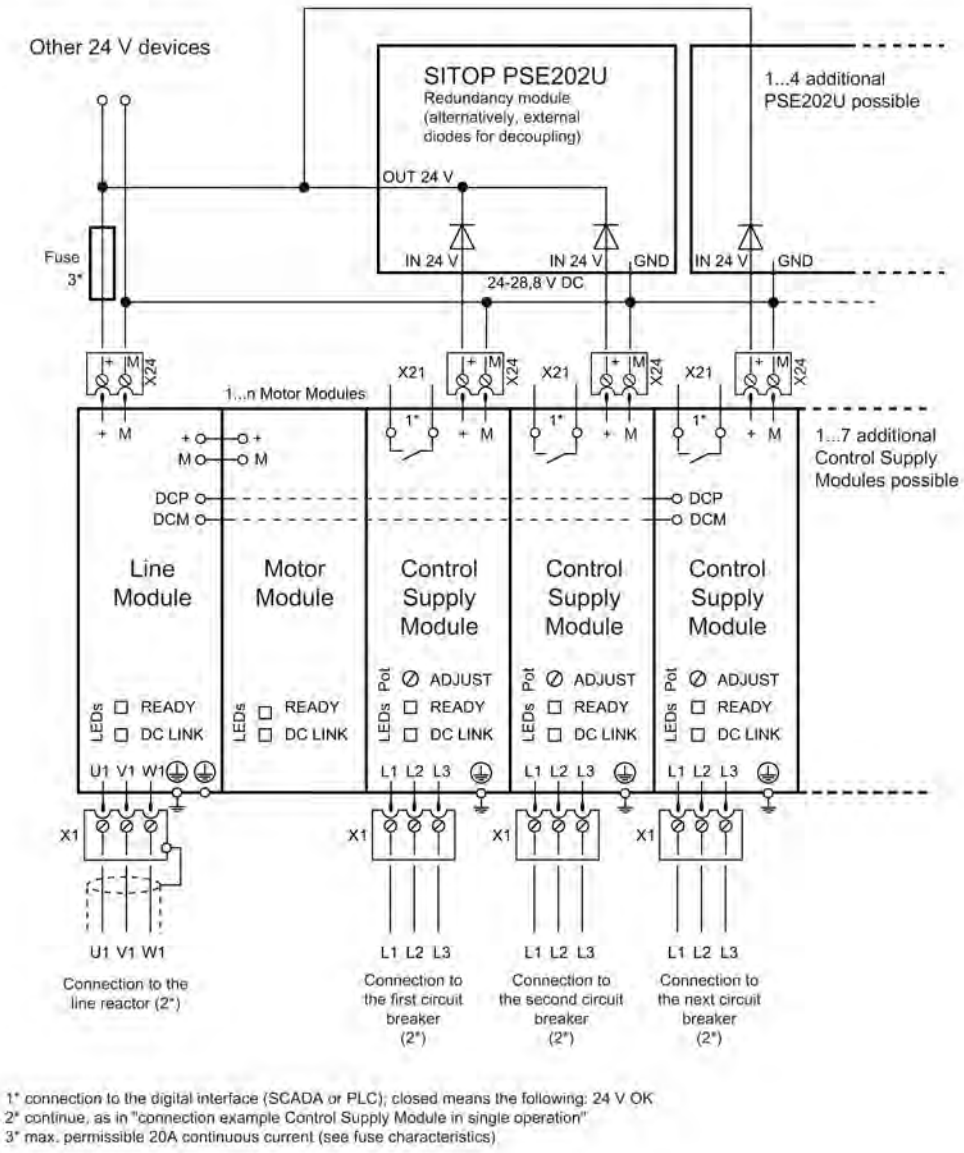
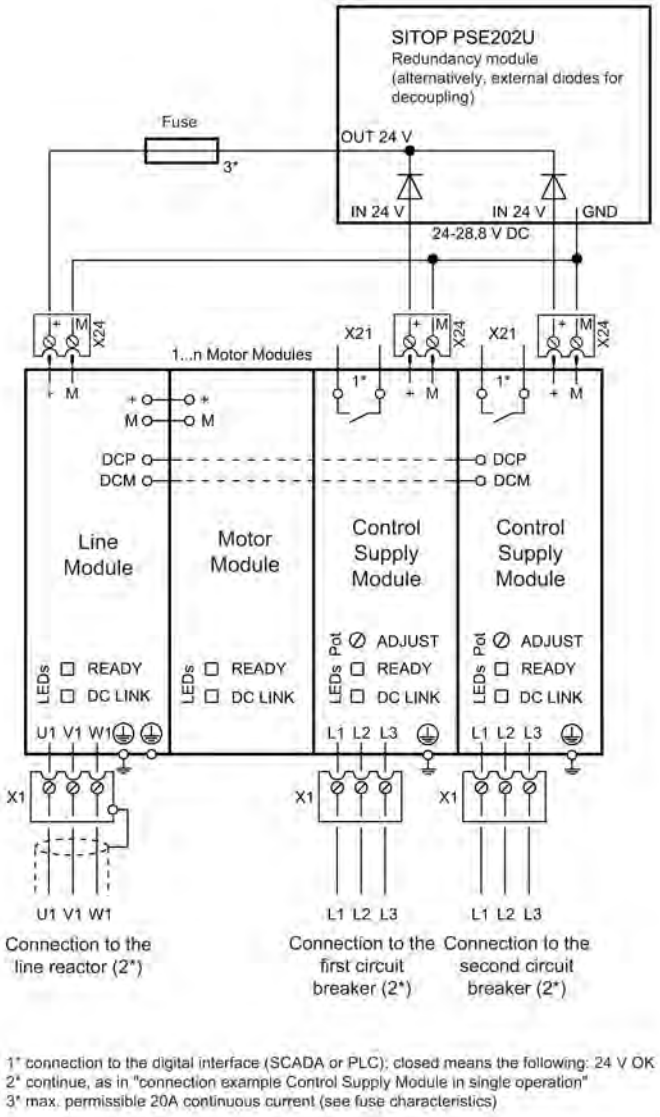


Figure 8-23 Connection example for parallel connection of 2 to 10 Control Supply Modules via a SITOP PSE202U redundancy module

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1* connection to the digital interface (SCADA or PLC); closed means the following: 24 V OK
2* continue, as in "connection example Control Supply Module in single operation"
3* max. permissible 20A continuous current (see fuse characteristics)

Figure 8-24 Connection example for a redundancy circuit with 2 Control Supply Modules via a SITOP PSE202U redundancy module

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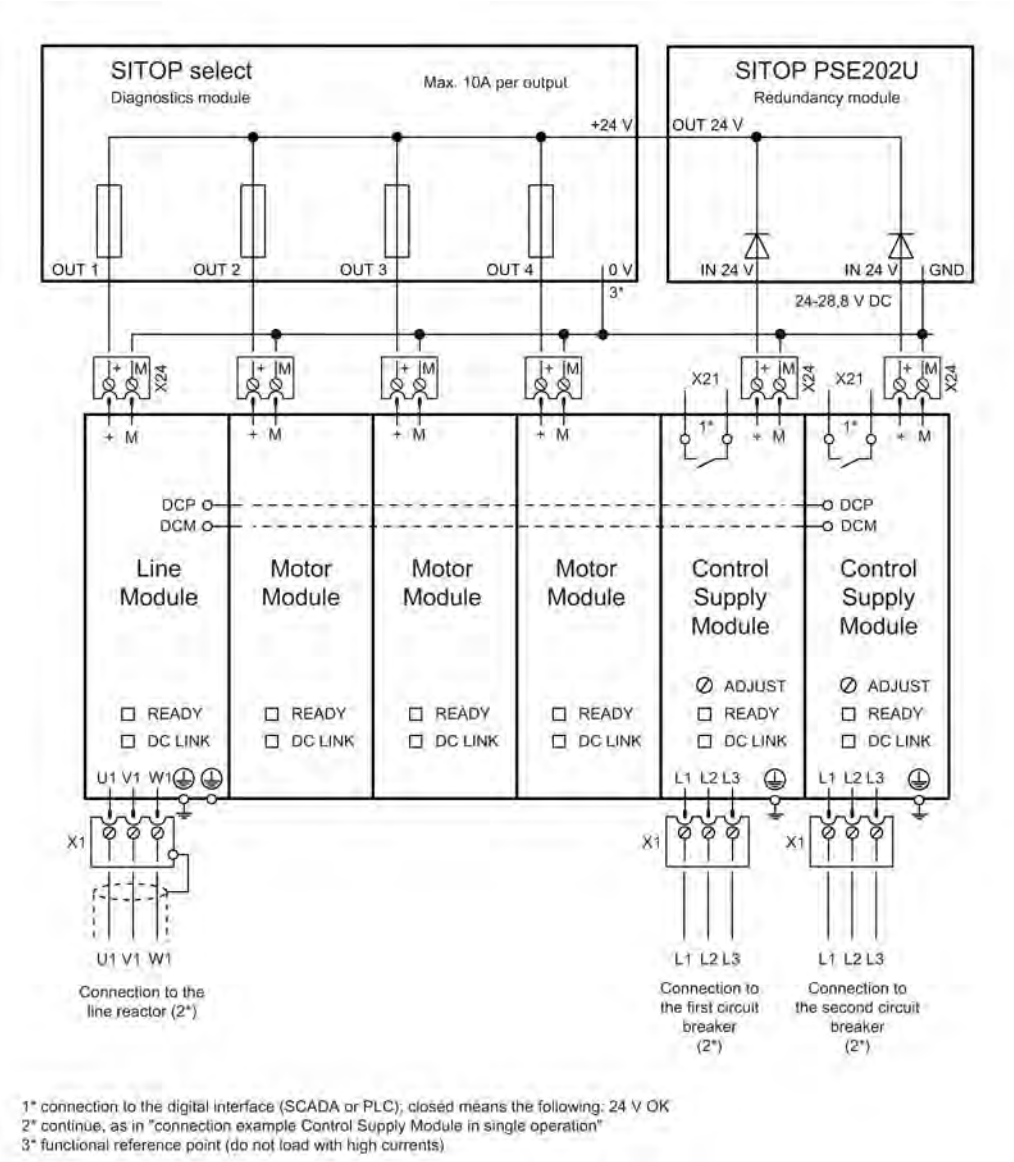


Figure 8-25 Connection example for parallel connection of Control Supply Modules via a SITOP PSE202U redundancy module and a SITOP select diagnostic module (6EP1961-2BA00)

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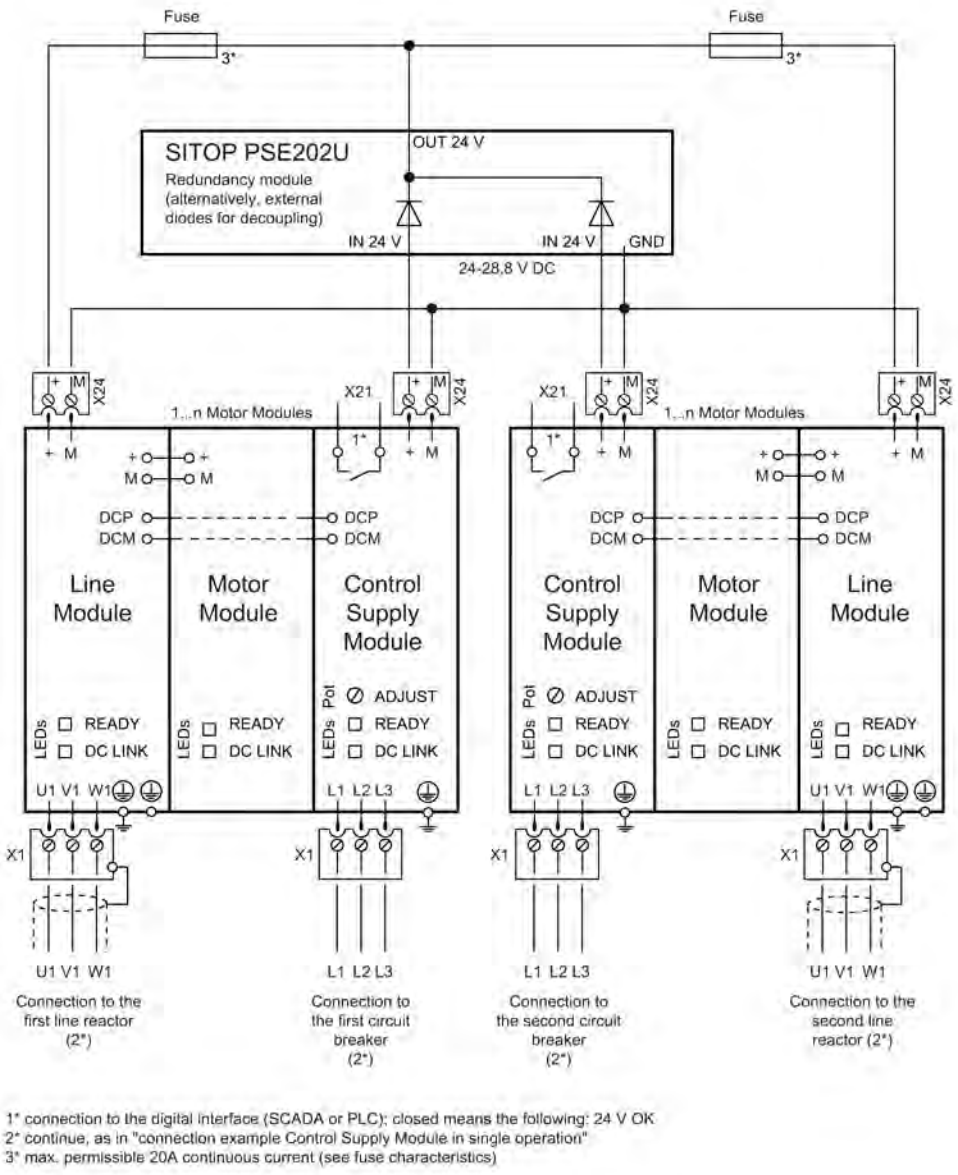


Figure 8-26 Connection example for operation of 2 units with Control Supply Modules via a SITOP PSE202U redundancy module

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8.6.5 Meaning of LEDs

Table 8- 27 Meaning of the LEDs on the Control Supply Module

LED	Color	Status	Description
READY	-	Off	The electronics power supply is outside the permissible tolerance range or the temperature prewarning is active.
	Green	Continuous light	Ready The output voltage is in the tolerance range and the temperature prewarning is inactive.
DC LINK	-	Off	DC input voltage $U_{E\ DC}$ < 280 ... 300 V Buffer operation is not possible.
	Yellow	Continuous light	DC input voltage in the range 360 ... 380 V < $U_{E\ DC}$ < 820 V ± 3 % Buffer operation is possible
	Red	Continuous light	DC input voltage outside the tolerance range: $U_{E\ DC}$ < 360 ... 380 V or $V_{E\ DC}$ > 820 V ± 3 %

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8.6.6 Dimension drawing

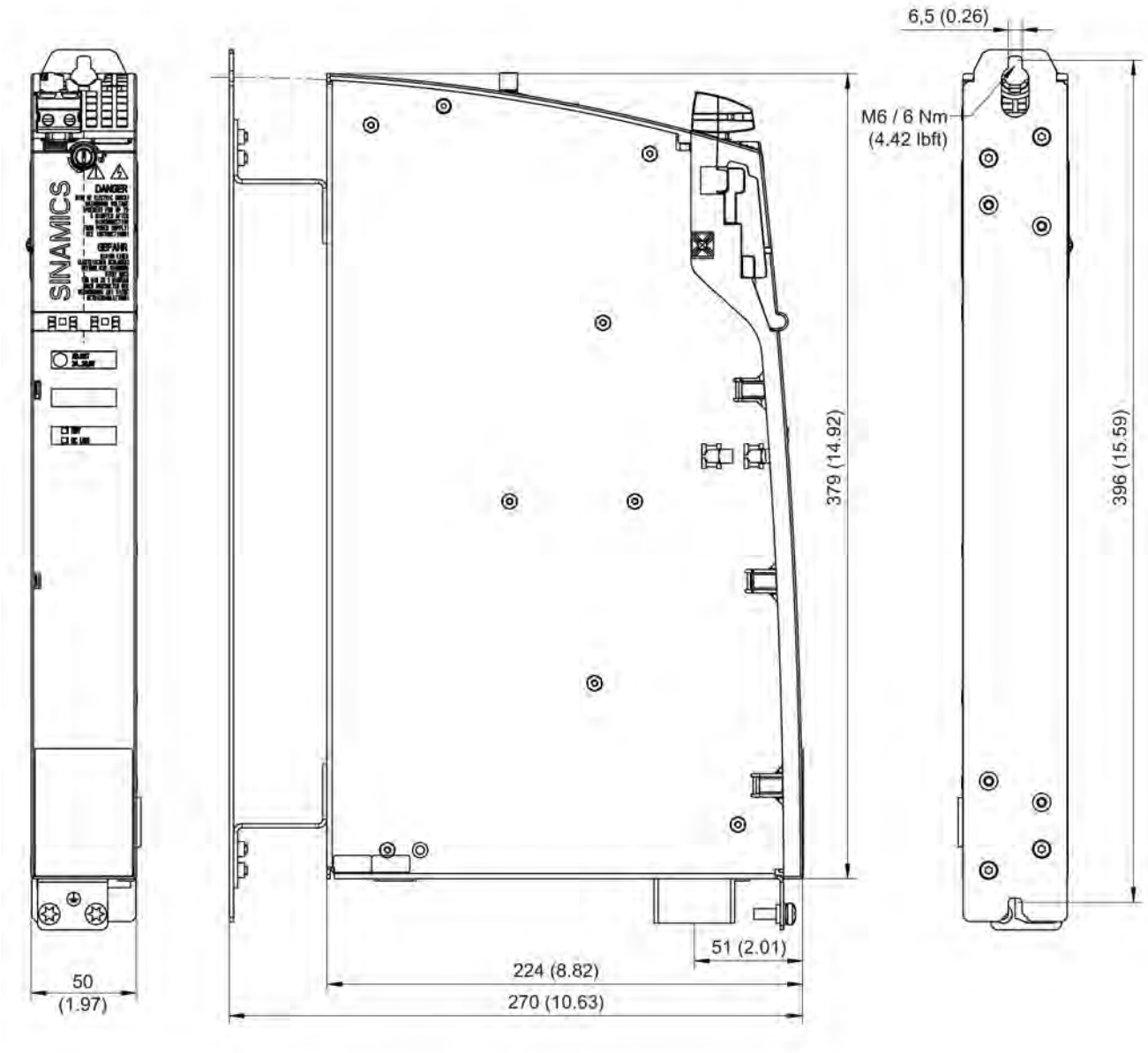
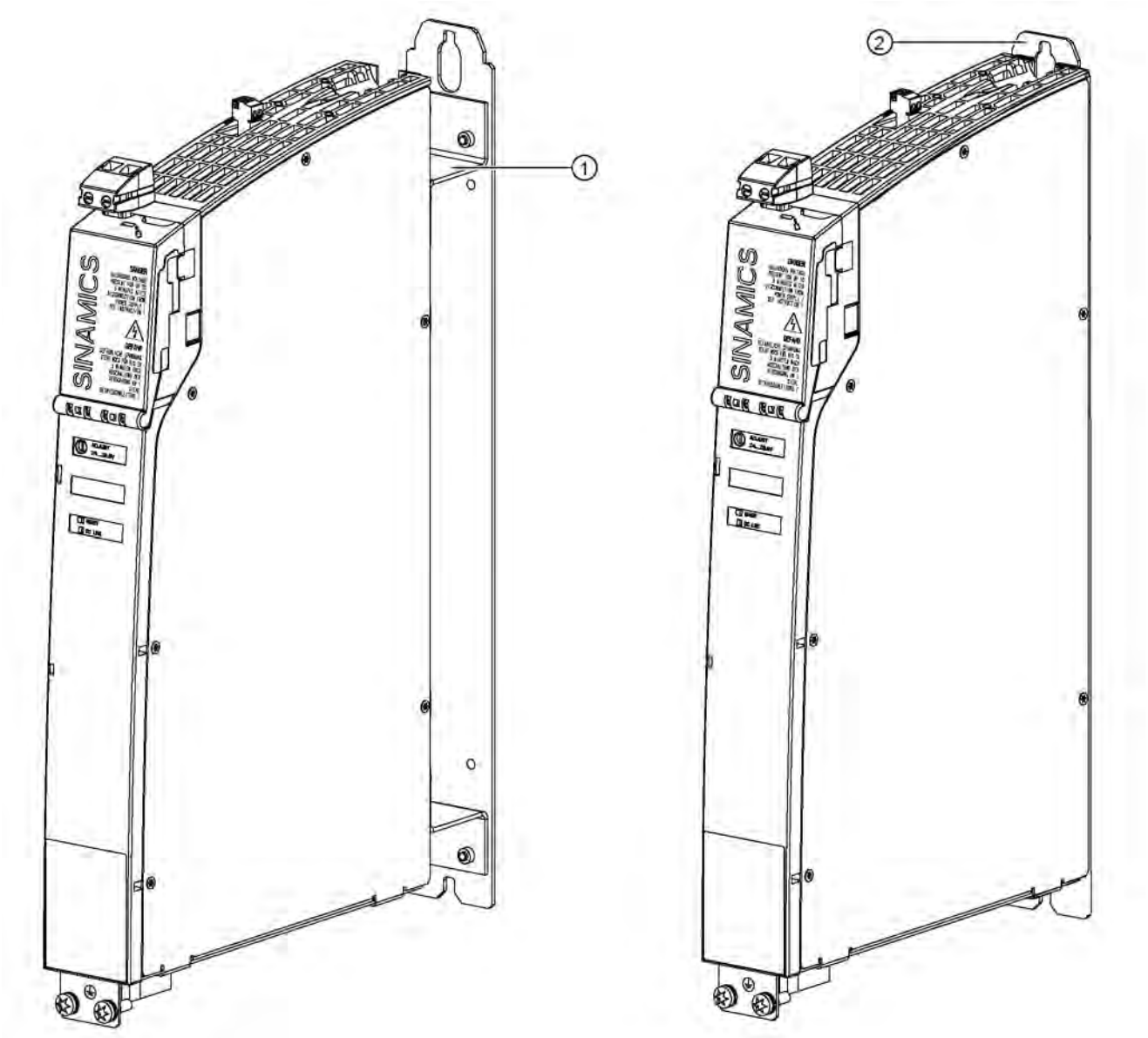


Figure 8-27 Dimension Control Supply Module, all dimensions in mm and (inches)

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8.6.7 Installation



① Delivered with spacer - mounting depth for drive line-up in booksize format with internal air cooling
② Spacer removed - mounting depth for drive line-up in booksize format with external air cooling

Figure 8-28 Methods of installing the Control Supply Module with and without spacer

The Control Supply Module can be attached to the control cabinet panel with or without spacers.

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8.6.8 Technical data

Table 8- 28 Technical data

6SL3100-1DE22-0AA1	Unit	Value
Input data, AC input		
Line voltage Line frequency	V_{AC} Hz	3 AC 380 … 480 ± 15 % 45 … 66
Rated input current Rated value (at $V_{E\ rated}$)	 A_{AC}	 ≤ 2
Starting current inrush	A_{AC}	≤ 28 at > 5 ms
Input data, DC input		
Rated input voltage	V_{DC}	600
Input voltage range	V_{DC}	300 … 882
DC link voltage (continuous input voltage)	V_{DC}	430 … 800 300 … 430 < 1 min 800 … 853 < 1 min 853 … 882 < 10 s
Supply current (at 600 V)	A_{DC}	1.1
Overvoltage tripping Undervoltage tripping	V_{DC} V_{DC}	> 882 280 ± 3 %
Output data		
Rated output voltage $V_{A\ rated}$	V_{DC}	24 … 28.8
Rated output current $I_{A\ rated}$[1)]	A_{DC}	20
Rated output power $P_{A\ rated}$	W	520
Overcurrent limitation for short-circuit	A_{DC}	Approx. 23
Surge suppression	V	< 35
Current carrying capacity of the 24 V busbar	A_{DC}	20
Residual ripple (clock frequency approx. 50 kHz)	mV_{pp}	< 100
Switching peaks (bandwidth 20 MHz)	mV_{pp}	< 200
Power loss ride-through (at 400 V AC)	ms	5
Power loss Line DC link (see Power loss tables (Page 781))	 W W	 70 65
Efficiency	%	> 83
Circuit breaker (UL) Type designation: Rated current: Resulting rated short-circuit current SCCR at 480 V AC:	 A kA	 3RV1021-1DA10 2.2 … 3.2 (setting value 3) 100
Fuses (UL) Class RK1, listed JDDZ Rated current: resulting rated short-circuit current SCCR at 480 V AC:	 A kA	 6 200

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6SL3100-1DE22-0AA1	Unit	Value
Cooling method		Internal air cooling
Max. ambient temperature without derating with derating as of 26 V output voltage	 ° C ° C	 ≤ 40 > 40 … 55
Weight	kg	4.8

1) Above 40° C, a linear derating of the output current above a 26 V output voltage and higher must be observed

8.6.8.1 Characteristics

Derating characteristic

For ambient temperatures > 40 °C, a linear derating for the output current must be observed as of 26 output voltage.

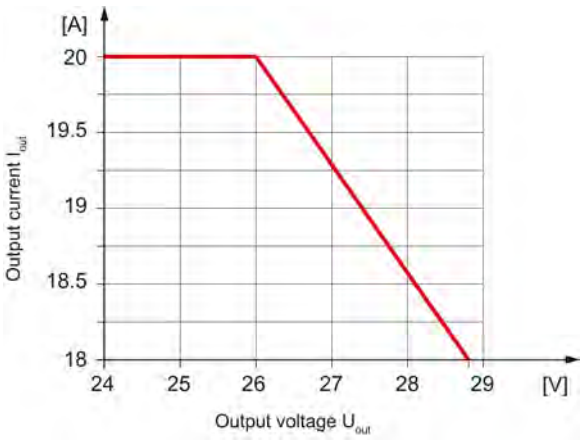


Figure 8-29 Current derating for ambient temperatures >40 °C as a function of the output voltage

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Braking resistors

9

9.1 Description

A braking resistor is used to dissipate the excess DC link energy in generator operation. The braking resistors can be connected to a Braking Module or directly to a 20 kW or 40 kW Basic Line Module.

Resistors with and without a thermostatic switch are available with various rated powers. The thermostatic switch monitors the braking resistors for overtemperature and issues a signal at an isolated contact if the limit value is exceeded.

Table 9- 1 Assignment of braking resistors

Braking resistor	Braking Module Booksize	Braking Module Booksize Compact	Basic Line Module 20 kW	Basic Line Module 40 kW
Braking resistors without a thermostatic switch				
6SN1113-1AA00-0DA0 Resistance: 17 Ω P_N: 0.3 kW	X	X		
6SL3100-1BE31-0AA0 Resistance: 5.7 Ω P_N: 1.5 kW	X	X		
Braking resistors with a thermostatic switch				
6SE7018-0ES87-2DC0 Resistance: 80 Ω P_N: 1.25 kW		X	X	X
6SE7021-6ES87-2DC0 Resistance: 40 Ω P_N: 2.5 kW		X	X	X
6SE7023-2ES87-2DC0 Resistance: 20 Ω P_N: 5 kW		X	X	X
6SE7028-0ES87-2DC0 Resistance: 8 Ω P_N: 12.5 kW				X

Installation

The braking resistors can be installed standing on the floor of the control cabinet or suspended. You must ensure that the braking resistors do not obstruct the flow of cooling air to the drive line-up.

Positioning the braking resistor outside the control cabinet or switchgear room enables the resulting thermal losses to be routed away. This reduces the level of air conditioning required.

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Connection cables

A shielded connecting cable (3 m, 3 x 1.5 mm^2) is supplied with braking resistor 6SN1113-1AA00-0DA0.

All other braking resistors are supplied without a connection cable. The maximum conductor cross-sections are listed in the technical data.

The maximum cable length for all braking resistors is 10 m.

9.2 Safety instructions for braking resistors

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Risk of fire due to ground fault/short-circuit

Inadequate installation of the cables to the braking resistor can result in a ground fault/short-circuit and place persons at risk as a result of the associated smoke and fire.

- Use the local installation regulations to avoid this fault.
- Protect the cables against mechanical damage.
- Also implement one of the following measures:
  - Use cables with double insulation.
  - Maintain adequate clearance, e.g. by using spacers.
  - Lay the cables in separate cable ducts or conduits.

⚠CAUTION

Risk of burns due to high surface temperatures

The braking resistor can become very hot. You can get seriously burnt when touching the surface.

- Mount the braking resistors so that contact is not possible. If this is not possible, attach a clearly visible and understandable warning notice at hazardous positions.
- To prevent adjacent components from suffering damage due to these high temperatures, maintain a clearance of 100 mm on all sides of the braking resistor.

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9.3 Dimension drawings

Braking resistors without a thermostatic switch

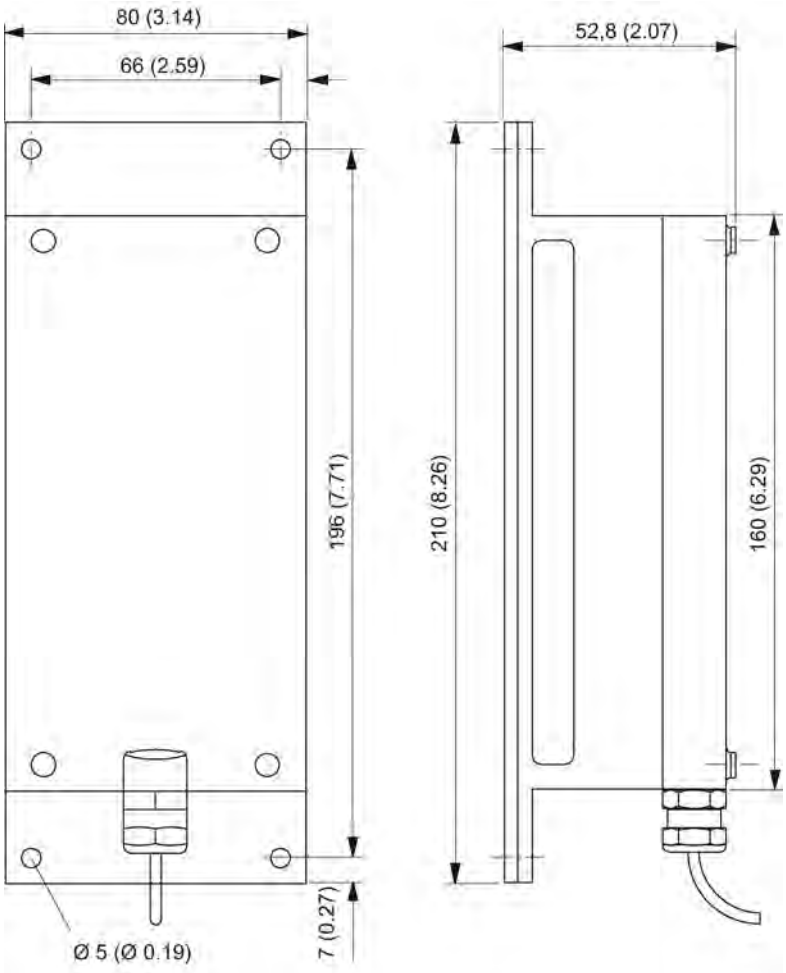


Figure 9-1 Dimension drawing of braking resistor 6SN1113-1AA00-0DA0 where P_n/P_{max} = 0.3 kW/25 kW, all dimensions in mm and (inches)

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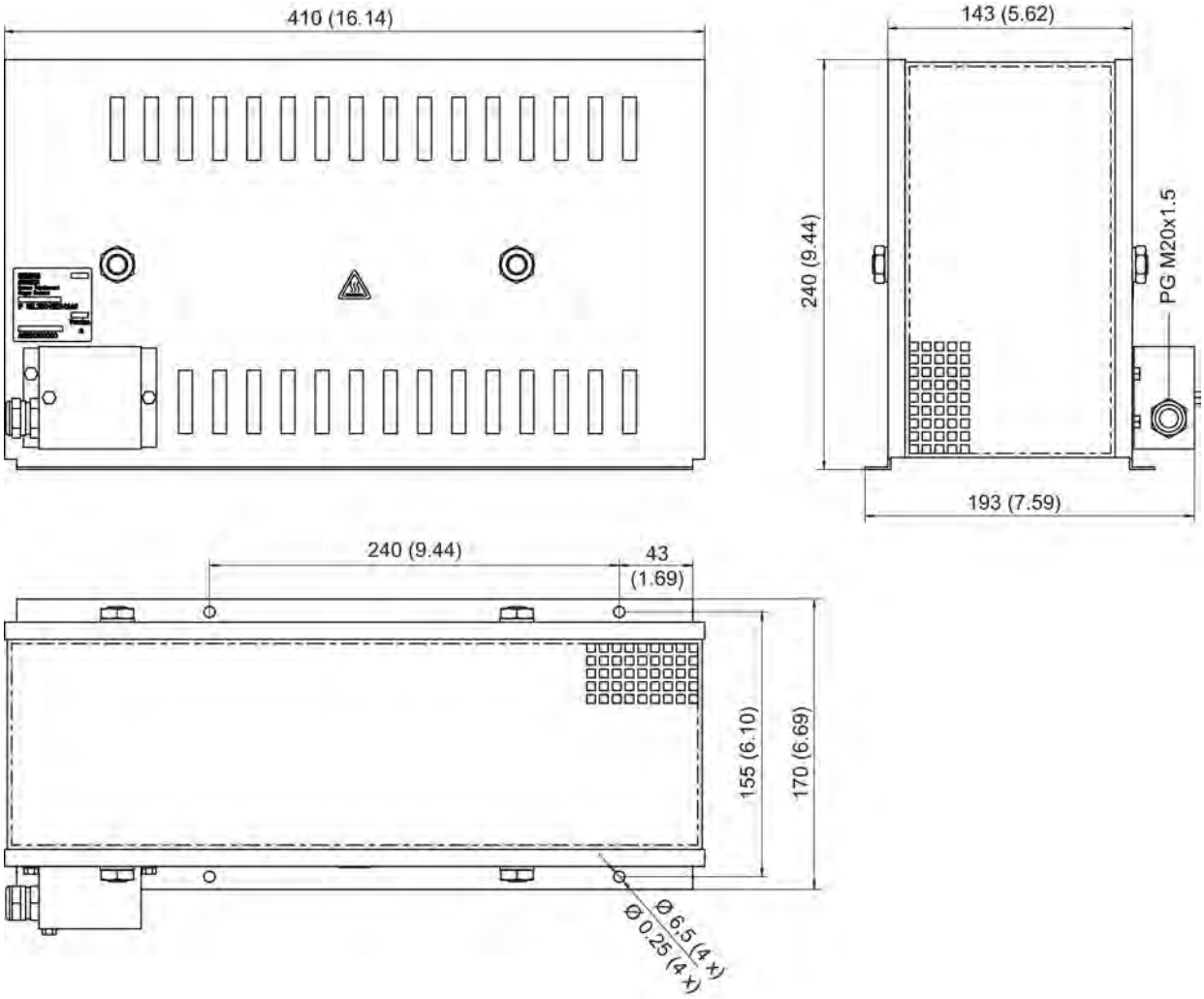


Figure 9-2 Dimension drawing of braking resistor 6SL3100-1BE31-0AA0 where P_n/P_{max} = 1.5 kW/100 kW, all dimensions in mm and (inches)

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Braking resistors with a thermostatic switch

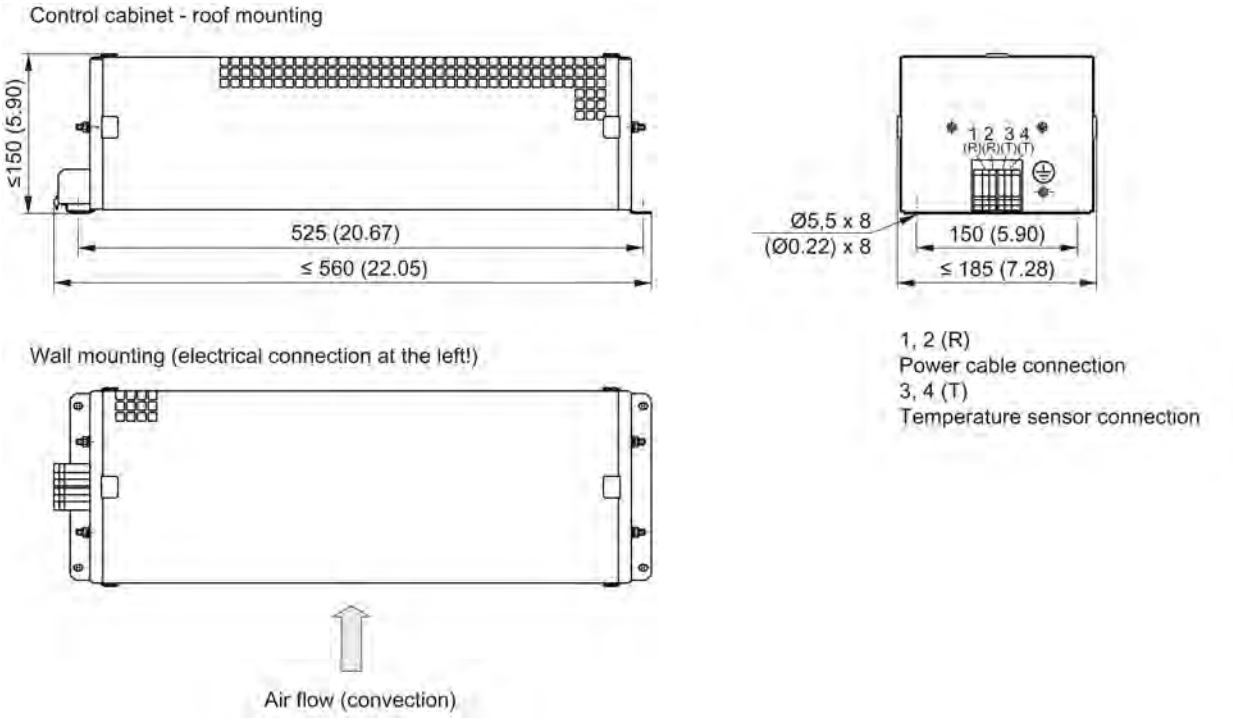


Figure 9-3 Dimension and installation drawing (roof and wall mounting) of braking resistor 6SE7018-0ES87-2DC0 where P_n/P_{max} = 1.25 kW/7.5 kW, all dimensions in mm and (inches)

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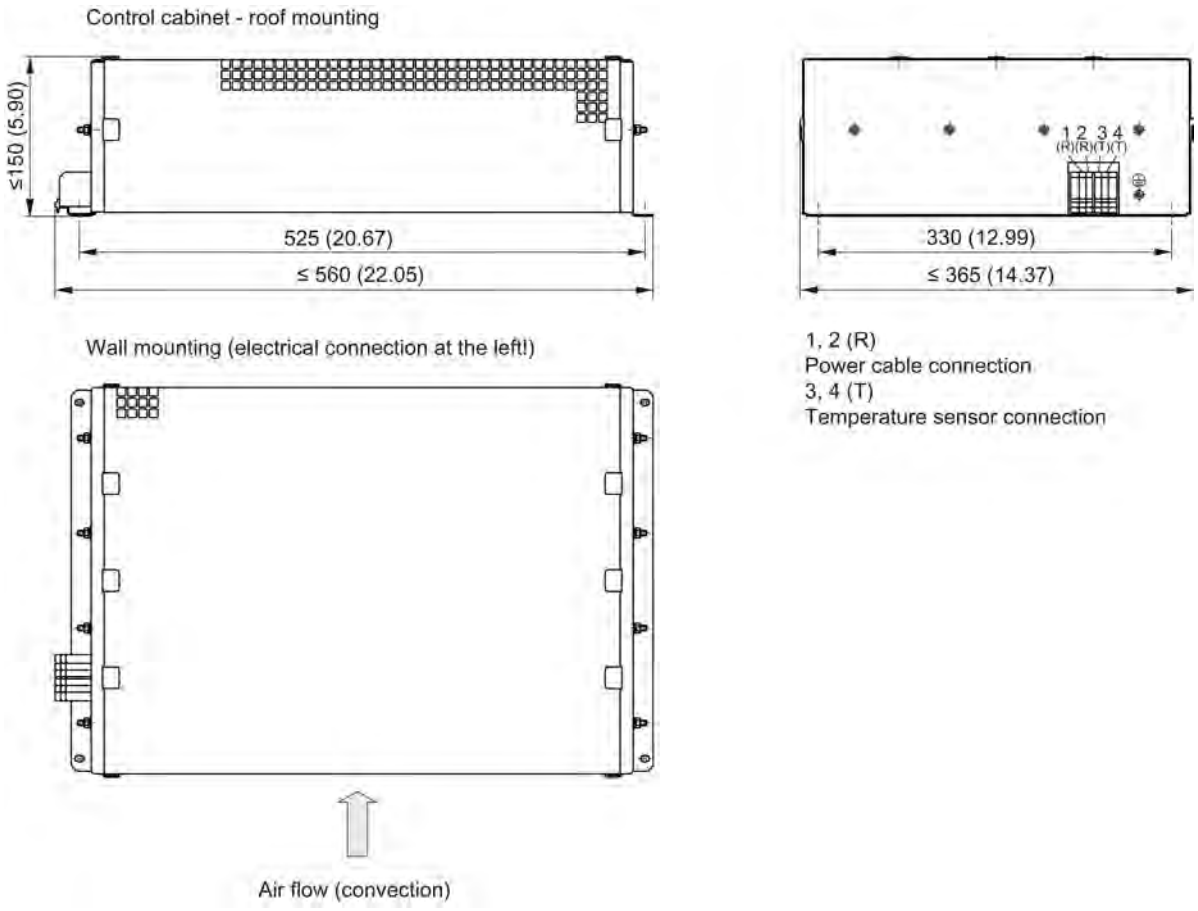
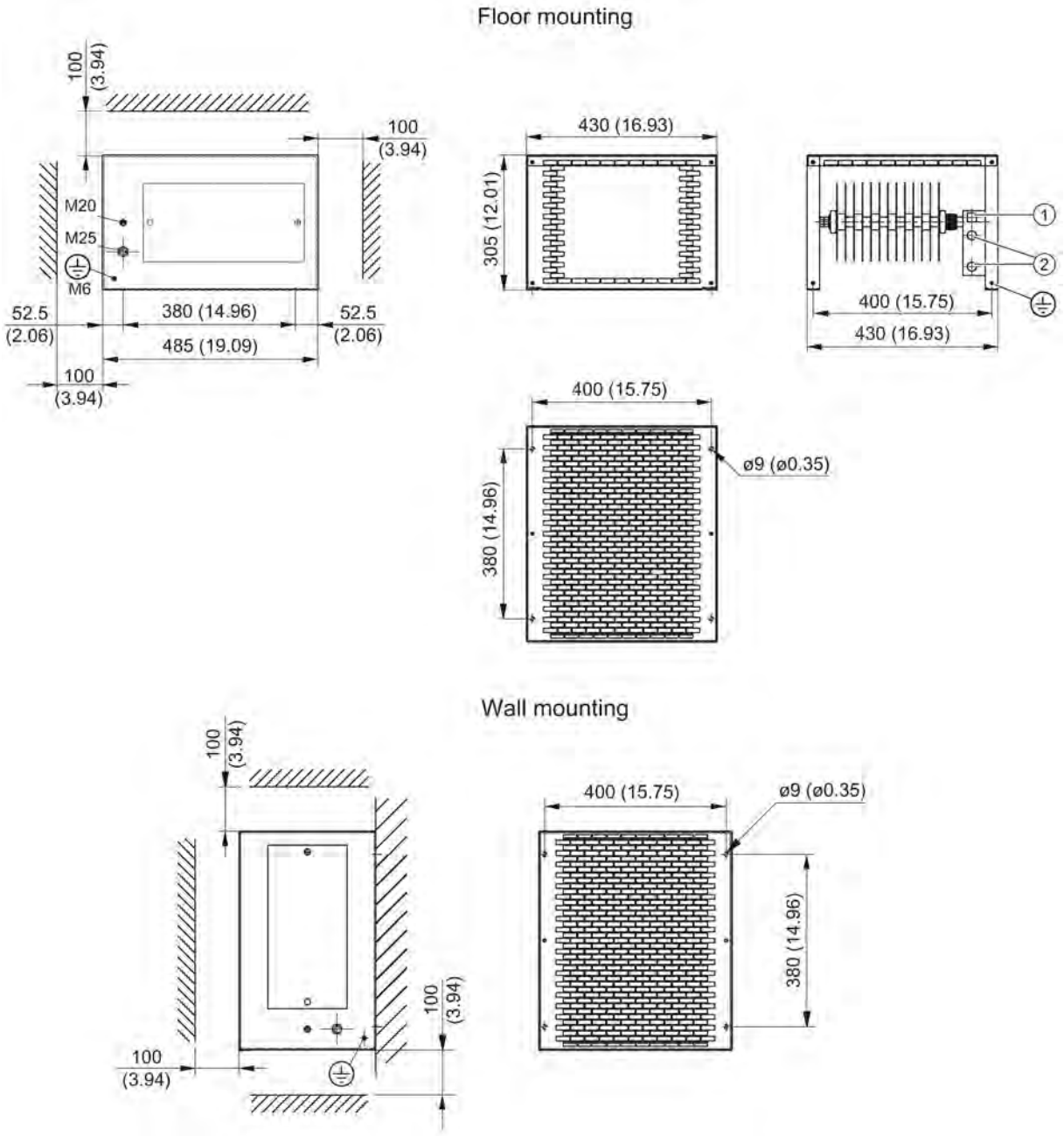


Figure 9-4 Dimension and installation drawing (roof and wall mounting) of braking resistor 6SE7021-6ES87-2DC0 where P_n/P_{max} = 2.5 kW/15 kW, all dimensions in mm and (inches)

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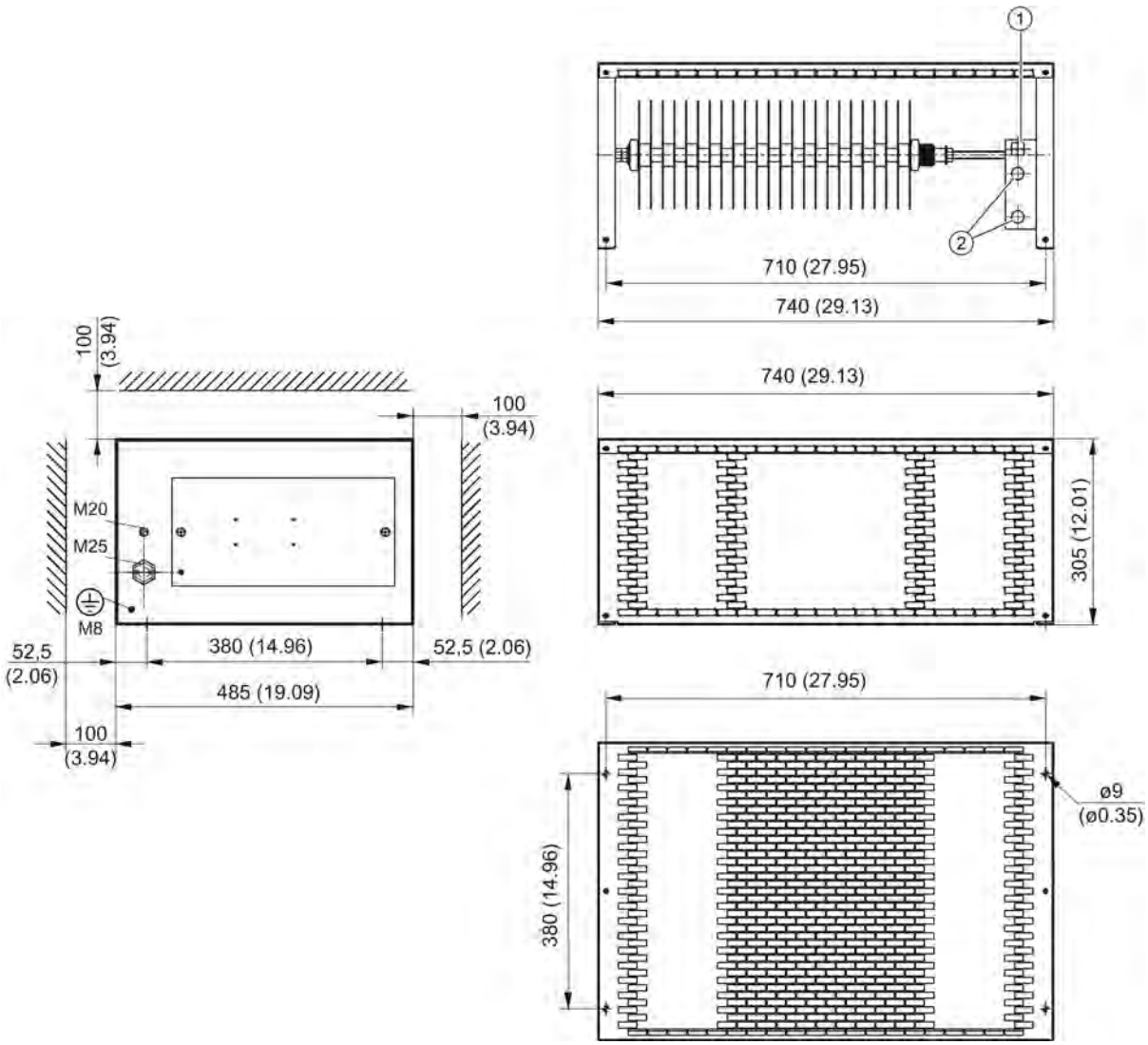


① Connection for thermostatic switch T1/T2 with conductor cross-section 2.5 mm²

② Connection for power cable, 2 x M6 bolts

Figure 9-5 Dimension and installation drawing (floor and wall mounting) of braking resistor 6SE7023-2ES87-2DC0 where P_n/P_{max} = 5 kW/30 kW, all dimensions in mm and (inches)

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① Connection for thermostatic switch T1/T2 with conductor cross-section 2.5 mm²

② Connection for power cable, 2 x M6 bolts

Figure 9-6 Dimension and installation drawing (floor mounting) of braking resistor 6SE7028-0ES87-2DC0 where P_n/P_{max} = 12.5 kW/75 kW, all dimensions in mm and (inches)

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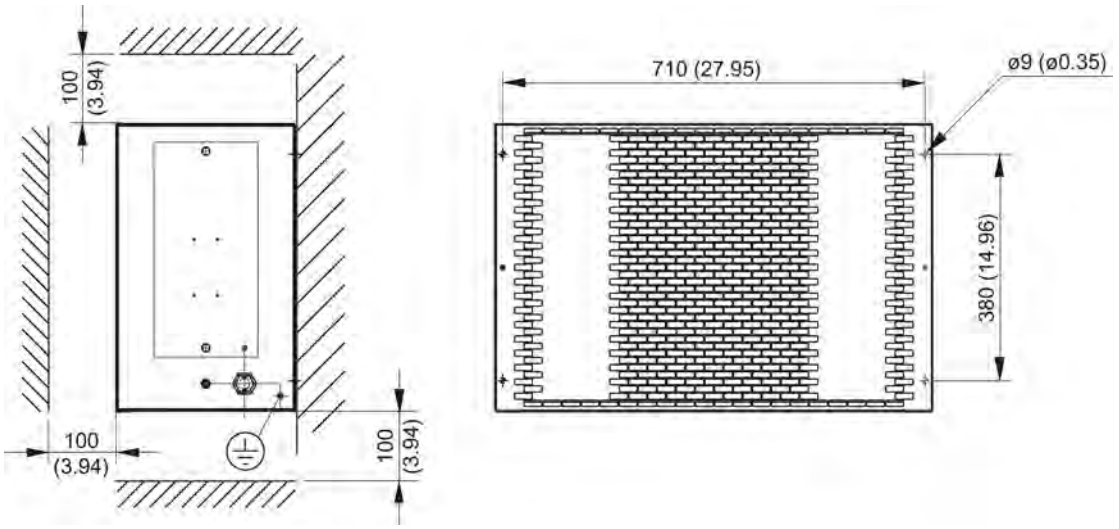


Figure 9-7 Installation drawing (wall mounting) of braking resistor 6SE7028-0ES87-2DC0 where P_n/P_{max} = 12.5 kW/75 kW, all dimensions in mm and (inches)

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9.4 Technical data

Table 9- 2 Technical data for braking resistors without a thermostatic switch

	Unit	6SN1113–1AA00–0DA0	6SL3100–1BE31–0AAx
Resistance R	Ω	17	5.7
Rated power P_N	kW	0.3	1.5
Peak power P_{max}	kW	25	100
Max. energy consumption E_{max}	kWs	7.5	200
Power cable connection		Included in the scope of delivery; length 3 m, 3 x 1.5 mm^2	Screw terminal[1], 4 mm^2
Weight	kg	3.4	5.6
Dimensions (W x H x D)	mm	80 x 210 x 53	193 x 410 x 240
Degree of protection according to EN 60529		IP54	IP20

[1] Recommended connection cross-section: 4 mm^2

Table 9- 3 Technical data for braking resistors with a thermostatic switch

	Unit	6SE7018-0ES87-2DC0	6SE7021-6ES87-2DC0	6SE7023-2ES87-2DC0	6SE7028-0ES87-2DC0
Resistance R	Ω	80	40	20	8
Rated power P_N	kW	1.25	2.5	5	12.5
Braking power 4 x P_N	kW	5	10	20	50
Peak power P_{max}[1]	kW	7.5	15	30	75
Max. energy consumption E_{max} at P_{max} at $4xP_n$	kWs kWs	22.5 100	45 200	90 400	225 1000
Thermostatic switch connection		Screw terminal[2], 4 mm^2	Screw terminal[2], 4 mm^2	Screw terminal, 2.5 mm^2	Screw terminal, 2.5 mm^2
Power cable connection		Screw terminal[3], 4 mm^2	Screw terminal[3], 4 mm^2	M6 screw bolt for ring cable lug[4]	M8 screw bolt for ring cable lug[5]
PE connection		M5 bolt	M5 bolt	M6 bolt	M8 bolt
Weight	kg	6	12	17	27
Dimensions (W x H x D)	mm	145 x 180 x 540	145 x 360 x 540	450 x 305 x 485	745 x 305 x 485
Degree of protection according to EN 60529		IP20	IP20	IP20	IP20

[1] Applies to a DC-link voltage of 760 V

[2] Recommended connection cross-section: 0.75 to 1.5 mm^2

[3] Recommended connection cross-section: 2.5 mm^2

[4] Recommended connection cross-section: 4 mm^2

[5] Recommended connection cross-section: 16 mm^2

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Recommendation

The MC500 or MC800 motor cable should be used as connecting cable.

9.4.1 Characteristic curves

Duty cycle for braking resistors without a thermostatic switch

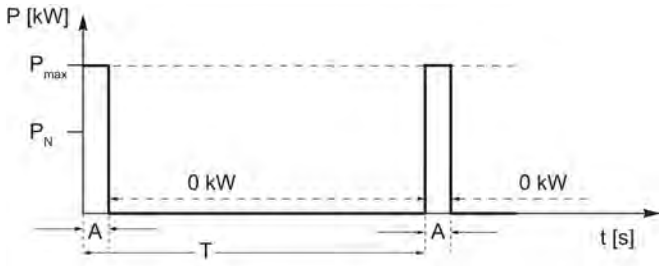


Figure 9-8 Duty cycle for braking resistors without a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [W] rated power (continuous power) of braking resistor

P_{max} [W] peak power of braking resistor (6 x P_N)

Table 9- 4 Duty cycles for Braking Module Booksize

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0,1	0,4	1	2
T [s]	11,5	210	68	460

Table 9- 5 Duty cycles for Braking Module Booksize Compact

	6SN1113–1AA00–0DA0		6SL3100–1BE31–0AAx	
	Short duty cycle	Long duty cycle	Short duty cycle	Long duty cycle
A [s]	0,1	0,4	1	2
T [s]	11,5	210	68	460

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

$P_{max\ total}$ = total P_{max} of single devices

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Duty cycles for braking resistors with a thermostatic switch

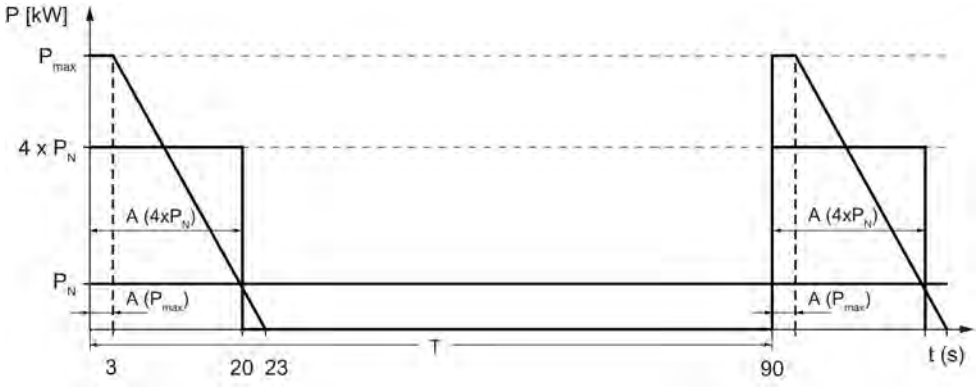


Figure 9-9 Duty cycles for braking resistors with a thermostatic switch

T [s] time period of braking duty cycle

A [s] load duration

P_N [W] rated power (continuous power) of braking resistor

P_{max} [W] peak braking power of the braking resistor

4 x P_N [W] = power permitted every 90 s for 20 s

Table 9- 6 Duty cycles

	6SE7018-0ES87-2DC0		6SE7021-6ES87-2DC0		6SE7023-2ES87-2DC0		6SE7028-0ES87-2DC0	
	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_N	Duty cycle P_{max}	Duty cycle 4 x P_{N0}	Duty cycle P_{max}	Duty cycle 4 x P_N
A [s]	3	20	3	20	3	20	3	20
T [s]	90	90	90	90	90	90	90	90

The following applies when connecting Braking Modules in parallel:

$P_{N\ total}$ = 0.9 x total P_N of single devices

4 x $P_{N\ total}$ = 0.9 x sum (4 x P_N) of single devices

$P_{max\ total}$ = total P_{max} of single devices

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Motor-side power components

10

10.1 Motor reactors

10.1.1 Description

Motor reactors reduce the voltage stress on the motor windings by reducing the voltage gradients at the motor terminals that occur when motors are fed from drive converters. At the same time, the capacitive charge/discharge currents that also occur on the output of the Motor Module when long motor cables are used are reduced.

Motor reactors can be operated in the VECTOR and SERVO control modes.

Prerequisites

- Ambient temperature 40 °C
- Pulse frequency f_{max} = 4 kHz.
- Output frequency f_{max} = 120 kHz.
- Supported in STARTER from Version 2.4 up to 1 motor reactor
- Supported in STARTER from Version 2.5 up to 3 motor reactors

Note

In SERVO control mode, the maximum output frequency of the converter must not be higher than the maximum motor reactor frequency.

10.1.2 Safety instructions for motor reactors

⚠ WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

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DANGER

Danger to life due to electric shock in the event of missing touch protection

Death or serious injury can result when live parts are touched.

- For the motor reactors, use touch protection according to IPXXA or corresponding to the local installation regulations.

WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel due to smoke and fire. This can also result in increased failure rates and a shorter service life of the components.

- Maintain the 100 mm clearances above and below the components.

CAUTION

Risk of burns due to high surface temperatures

The motor reactors can become very hot. You can get seriously burnt when touching the surface.

- Mount the motor reactors so that contact is not possible. If this is not possible, attach clearly visible and understandable warning notices at hazardous positions.
- To prevent adjacent components from suffering damage due to these high temperatures, maintain a clearance of 100 mm on all sides of the motor reactors.

Note

Maximum permissible output frequency

The maximum permissible output frequency when motor reactors are used is 120 Hz.

NOTICE

Damage caused by using incorrect motor reactors

When using motor reactors that have not been approved by Siemens for SINAMICS, the motor reactors can be damaged.

- Only use motor reactors that SIEMENS has approved for operation with SINAMICS.

Note

Maximum cable length of the connection cables

The connection cables to the Motor Module must be kept as short as possible (max. 5 m).

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10.1.3 Dimension drawings

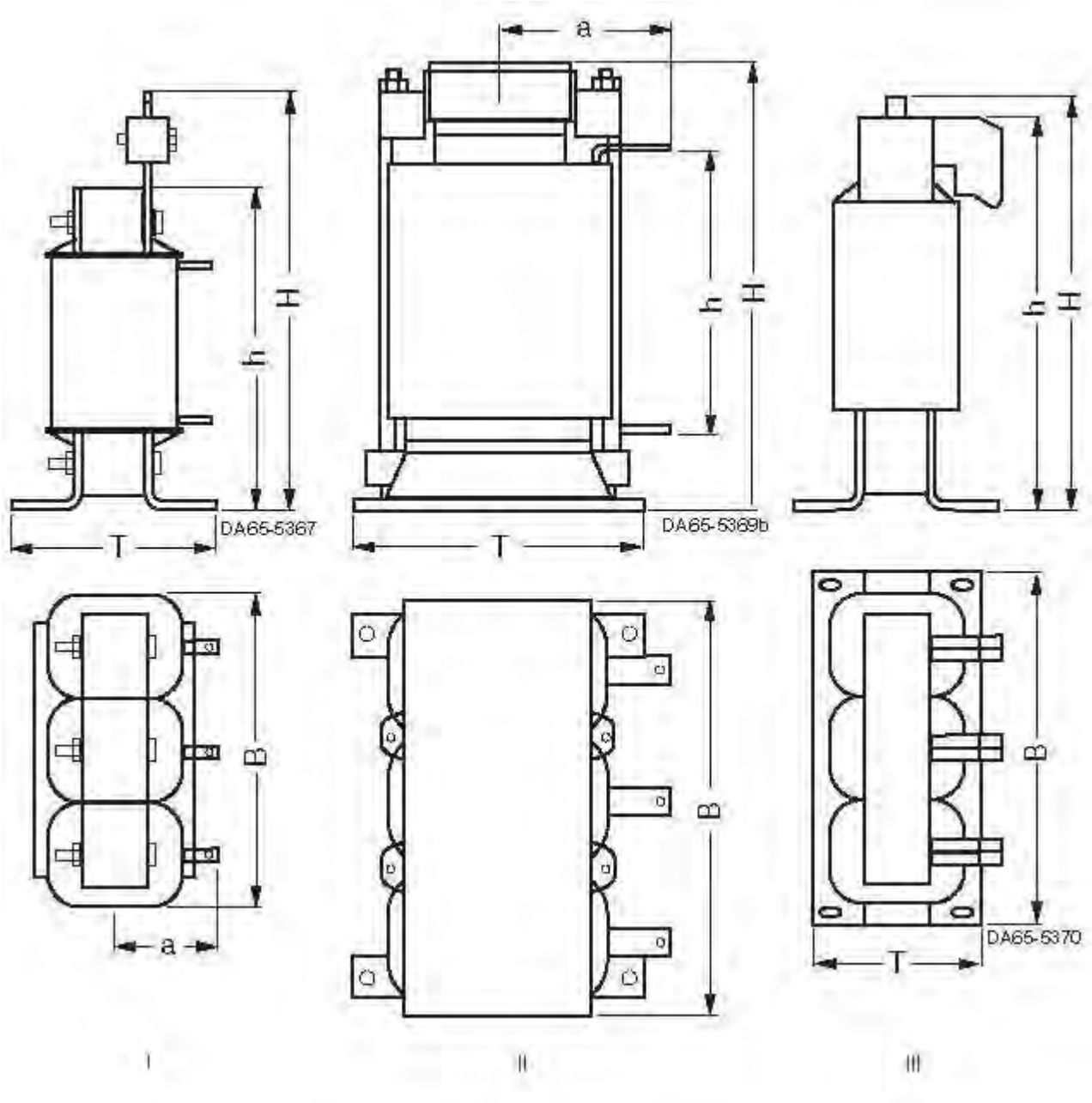


Figure 10-1 Dimension drawings of motor reactors

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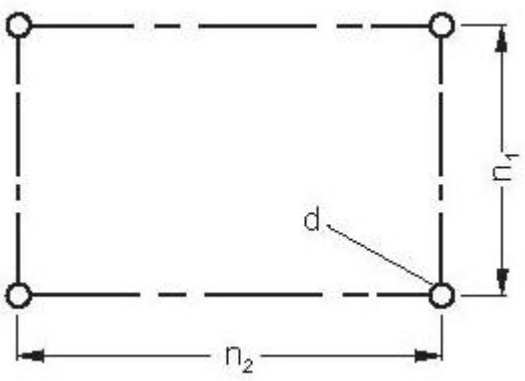


Figure 10-2 Mounting hole

Table 10- 1 Dimensions of motor reactors, all dimensions in mm and (inches)

	6SE7021-0ES87-1FE0	6SE7022-6ES87-1FE0	6SE7024-7ES87-1FE0	6SE7027-2ES87-1FE0
	Fig. III	**Fig. III**	**Fig. II**	**Fig. I**
B	178 (7.00)	219 (8.62)	197 (7.75)	267 (10.51)
H	153 (6.02)	180 (7.08)	220 (8.66)	221 (8.70)
T	88 (3.46)	119 (4.68)	104 (4.09)	107 (4.21)
a	-	-	69 (2.71)	77 (3.03)
h	146 (5.74)	181 (7.12)	103 (4.05)	206 (8.11)
n_1	68 (2.67)	89 (3.50)	70 (2.75)	77 (3.03)
n_2	166 (6.53)	201 (7.91)	176 (6.92)	249 (9.80)
d	M5	M6	M6	M6
Lengths n1 and n2 correspond to the distance between holes				

Table 10- 2 Dimensions of motor reactors, all dimensions in mm and (inches)

	6SE7031-5ES87-1FE0	6SE7031-8ES87-1FE0	6SE7032-6ES87-1FE0
	Fig. II	**Fig. II**	**Fig. II**
B	197 (7.75)	281 (11.06)	281 (11.06)
H	220 (8.66)	250 (9.84)	250 (9.84)
T	128 (5.03)	146 (5.74)	146 (5.74)
a	81 (3.18)	98 (3.85)	111 (4.37)
h	100 (3.93)	119 (4.68)	121 (4.76)
n_1	94 (3.70)	101 (3.97)	101 (3.97)
n_2	176 (6.92)	200 (7.87)	200 (7.87)
d	M6	M8	M8
Lengths n1 and n2 correspond to the distance between holes			

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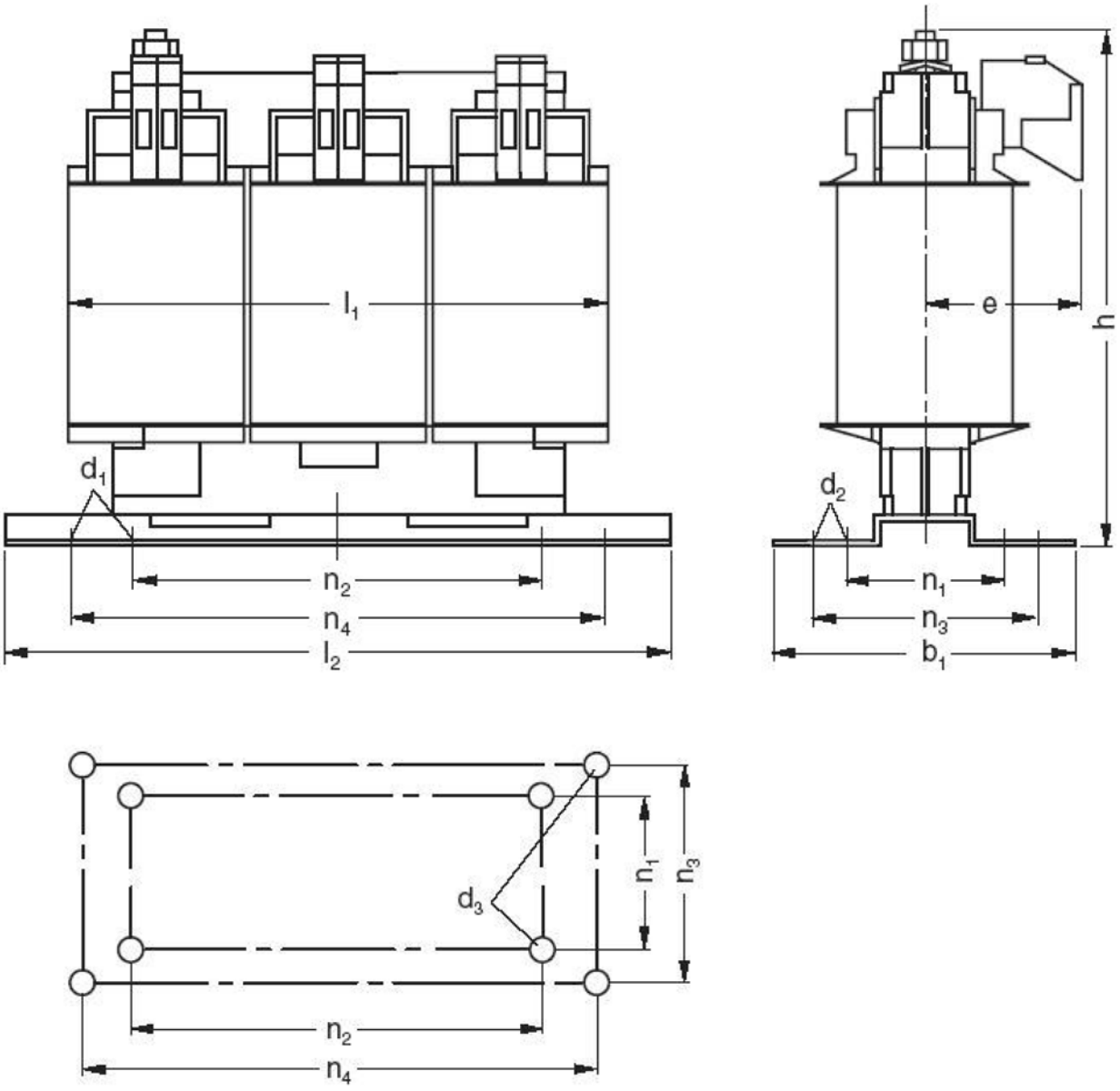


Figure 10-3 Dimension drawing and mounting hole of motor reactor 9 A (6SL3000-2BE21-0AA0)

Table 10- 3 Dimensions of motor reactor 9 A, all dimensions in mm and (inches)

6SL3000-2BE21-0AA0	
l_1	150 (5.90)
l_2	178 (7.00)
b_1	88 (3.46)
b_{max}	111 (4.37)
e	67 (2.63)
h	159 (6.25)
n_1	64 (2.51)

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6SL3000-2BE21-0AA0	
n_2	113 (4.44)
n_3	68 (2.67)
n_4	166 (6.53)
d_1	5,8 (0.22)
d_2	11 (0.43)
d_3	M5
PE	M6
Lengths n_1, n_2, n_3 and n_4 corresponds to the distance between holes	

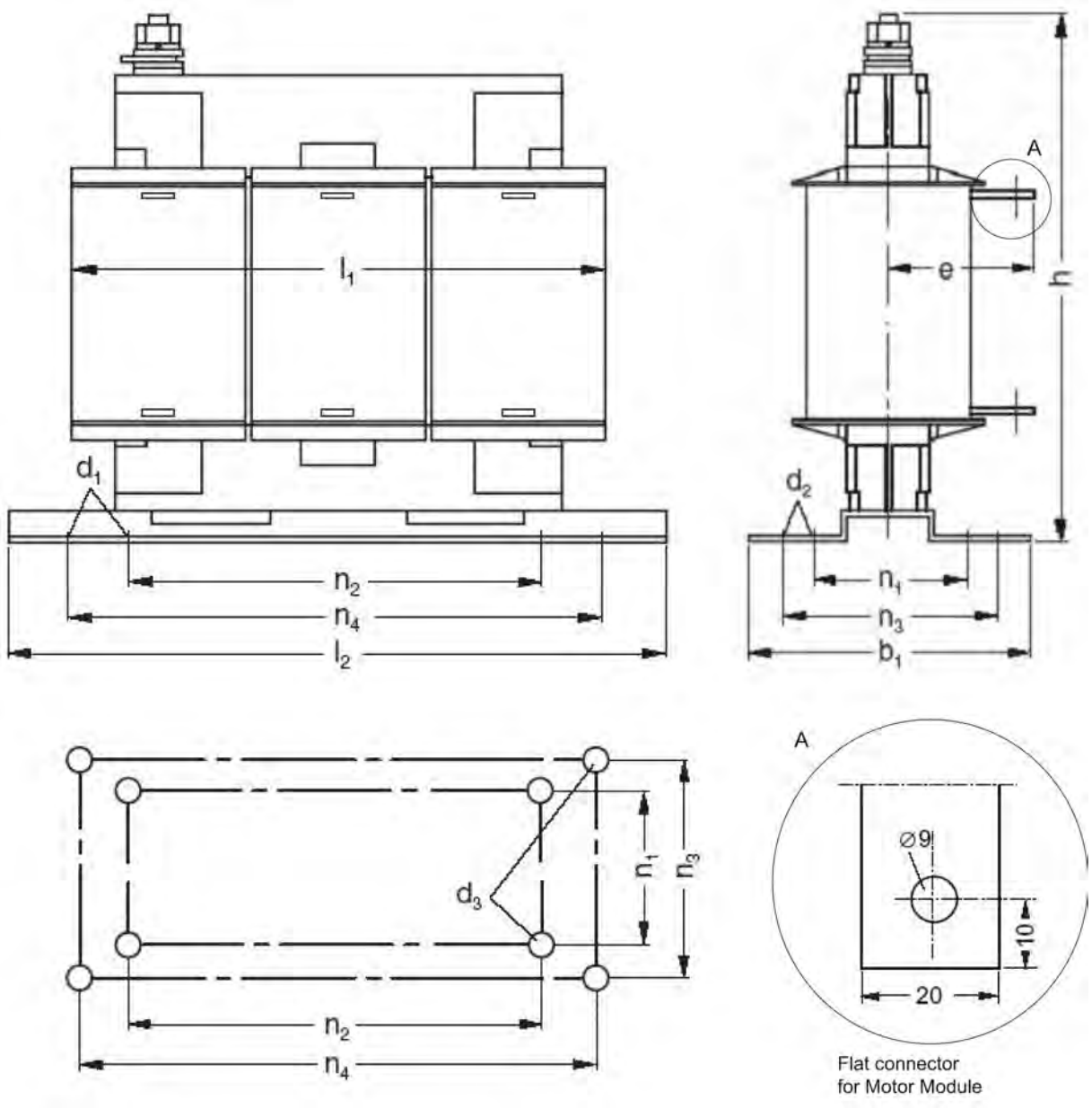


Figure 10-4 Dimension drawing and mounting hole of motor reactor 60 A (6SL3000-2BE26-0AA0)

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Table 10- 4 Dimensions of motor reactor 60 A, all dimensions in mm and (inches)

6SL3000-2BE26-0AA0	
l_1	Max. 228 (8.97)
l_2	267 (10.51)
b_1	107 (4.21)
b_{max}	125,5 (4.94)
e	72 (2.83)
h	220 (8.66)
h_1	56 (2.20)
h_2	100 (3.93)
n_1	70 (2.75)
n_2	176 (6.92)
n_3	77 (3.03)
n_4	249 (9.80)
d_1	36 (1.41)
d_2	3,5 (0.13)
d_3	M6
PE	M6
Lengths n_1, n_2, n_3 and n_4 corresponds to the distance between holes	

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10.1.4 Technical data

Table 10- 5 Technical data, motor reactors, part 1

Order number		**6SE7021-0ES87-1FE0**	**6SL3000-2BE21-0AA0**	**6SE7022-6ES87-1FE0**	**6SE7024-7ES87-1FE0**	**6SE7027-2ES87-1FE0**
Matching the Motor Module		6SL312x-1TE13-0AAx 6SL312x-2TE13-0AAx 6SL312x-1TE15-0AAx 6SL312x-2TE15-0AAx 6SL342x-1TE13-0AAx 6SL342x-2TE13-0AAx 6SL342x-1TE15-0AAx 6SL342x-2TE15-0AAx	6SL312x-1TE21-0AAx 6SL312x-2TE21-0AAx 6SL342x-1TE21-0AAx	6SL312x-1TE21-8AAx 6SL312x-2TE21-8AAx 6SL342x-1TE21-8AAx	6SL312x-1TE23-0AAx	6SL312x-1TE24-5AAx
Rated current	A	5	9	18	30	45
Inductance	µH	1243	1000	332	180	59
Power loss	W	80	90	110	190	200
Motor Module/motor connection		Screw-type terminals 4 mm^2	Screw-type terminals 16 mm^2	Screw-type terminals 16 mm^2	Flat connector for M8 screw	
PE connection		M6 studs				
Degree of protection		IP00	IP00	IP00	IP00	IP00
Weight	kg	5,5	4,8	7,8	13	11

Table 10- 6 Technical data, motor reactors, part 2

Order number		**6SL3000-2BE26-0AA0**	**6SE7031-5ES87-1FE0**	**6SE7031-8ES87-1FE0**	**6SE7032-6ES87-1FE0**
Matching the Motor Module		6SL312x-1TE26-0AAx	6SL312x-1TE28-5AAx	6SL312x-1TE31-3AAx	6SL312x-1TE32-0AAx
Rated current	A	60	85	132	200
Inductance	µH	62	29	23	16
Power loss	W	105	222	291	291
Motor Module/motor connection		Flat connector for M8 screw		Flat connector for M10 screw	
PE connection		M6 studs			
Degree of protection		IP00	IP00	IP00	IP00
Weight	kg	10,5	20,5	27,2	30,6

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Table 10- 7 Cable lengths, Part 1

Order number	6SE7021-0ES87-1FE0	6SL3000-2BE21-0AA0	6SE7022-6ES87-1FE0	6SE7024-7ES87-1FE0	6SE7027-2ES87-1FE0
Rated current [A]	5	9	18	30	45
Shielded cables					
Maximum motor cable length, 1 reactor	100	135	160	190	200
Maximum motor cable length, 2 reactors	-	-	320	375	400
Maximum motor cable length, 3 reactors	-	-	-	-	600
Unshielded cables					
Maximum motor cable length, 1 reactor	150	200	240	280	300
Maximum motor cable length, 2 reactors	-	-	480	560	600
Maximum motor cable length, 3 reactors	-	-	-	-	900

Table 10- 8 Cable lengths, Part 2

Order number	6SL3000-2BE26-0AA0	6SE7031-5ES87-1FE0	6SE7031-8ES87-1FE0	6SE7032-6ES87-1FE0
Rated current [A]	60	85	132	200
Shielded cables				
Maximum motor cable length, 1 reactor	200	200	200	200
Maximum motor cable length, 2 reactors	400	400	400	400
Maximum motor cable length, 3 reactors	600	600	600	600
Unshielded cables				
Maximum motor cable length, 1 reactor	300	300	300	300
Maximum motor cable length, 2 reactors	600	600	600	600
Maximum motor cable length, 3 reactors	900	900	900	900

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10.2 Voltage Protection Module VPM

10.2.1 Description

The Voltage Protection Module (VPM) is a component for limiting voltage. It is used for both 1FE1 and 2SP1 motors and those with an electromagnetic force (EMF) of between 800 V and 2000 V to limit DC-link voltage if a fault occurs.

The Voltage Protection Module is installed within the motor cable between the Motor Module and motor. If the line voltage fails at the maximum motor speed or the pulses at the Motor Module are canceled as a result of the power failure, the motor regenerates at high voltage into the DC link. The Voltage Protection Module recognizes that the motor voltage is too high (> 800 V) and uses an electronic switch to short-circuit the three phases of the motor at its supply lines. The power remaining in the motor is converted to heat via the short circuit between the Voltage Protection Module and motor cables.

The Voltage Protection Module is available in 3 versions.

Table 10- 9 Overview of the Voltage Protection Modules available

Designation	Rated current
VPM120	120 A
VPM200	200 A
VPM200 Dynamic	200 A

Table 10- 10 Interface overview for Voltage Protection Modules

Type	Number VPM120/VPM200	Number VPM200 Dynamic
Signaling interface	1	1
PE connection	2	4
Load connecting bolt, input	3	5
Load connecting bolt, output	3	5

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10.2.2 Safety instructions for Voltage Protection Modules

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.



⚠DANGER

Danger to life through electric shock due to the residual charge of the DC link capacitors

Due to the DC link capacitors of the converter, a hazardous voltage is present in the DC link for up to 30 minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Avoid contact with the Voltage Protection Module as long as it is under voltage.



⚠WARNING

Danger to life through electric shock due to high speed of the motor while the VPM is being ramped up

If the motor is operated with a speed higher than the field weakening threshold speed while the Voltage Protection Module is ramping up (see the technical data), the protection function of the VPM is inactive during this phase. As a consequence, high voltages can be injected into the DC link.

Contact with live parts can result in death or serious injury.

- Only operate the motor below the field weakening threshold speed while the VPM is ramping up.



⚠WARNING

Danger to life through electric shock due to the insulation voltage being exceeded

An excessively high voltage will damage the insulation resulting in death or severe injury.

- Do not connect any motors whose electromotive force (EMF) exceeds the permissible value at the highest speed used.
- Route the cables so that they are protected to rule out any damage.

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WARNING

Danger to life through electric shock when using third-party motors

VPM can be used with third-party motors. If, when using third-party motors, the VPM does not limit the DC link voltage, this can result in death or severe injury.

- Please observe the following when using third-party motors:
  - Carry out a risk analysis.
  - Ensure that the third-party motors correspond to the electrical properties of the specified Siemens components.
  - Check the correct functioning of the VPM.

WARNING

Danger to life through automatic start of the drive

An uncontrolled automatic start of the drive can result in fatal accidents.

- Take precautions against an automatic start of the drive.

NOTICE

Damage when using motors that are not short-circuit proof

Use of motors that are not short-circuit proof in conjunction with a Voltage Protection Module can result in their destruction.

- Only use motor that are short-circuit proof.

WARNING

Fire hazard due to overheating because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel through smoke development and fire. This can also result in more downtimes and reduced service lives of components.

- Maintain the 200 mm clearances above and below the components.

NOTICE

Damage to devices as a result of incorrect connecting cables

Using incorrect connecting cables for Voltage Protection Modules can damage the connected components.

- Use shielded MOTION-CONNECT 800PLUS motor cables, type 6FX8.

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10.2.3 Interface description

10.2.3.1 Overview

The drawings below show the basic positions of interfaces and the housing openings of the Voltage Protection Modules VPM120, VPM200 and VPM200 Dynamic.

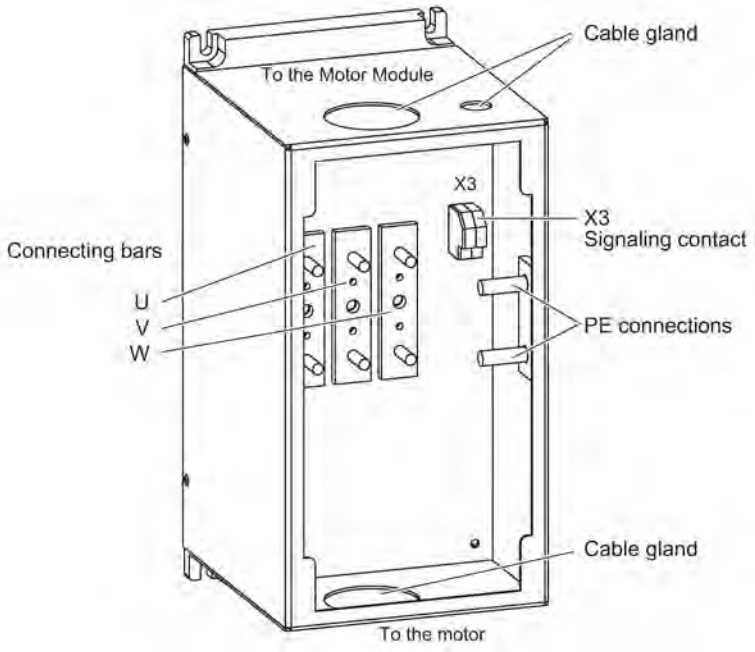


Figure 10-5 Interface overview, Voltage Protection Modules VPM120 (without cover)

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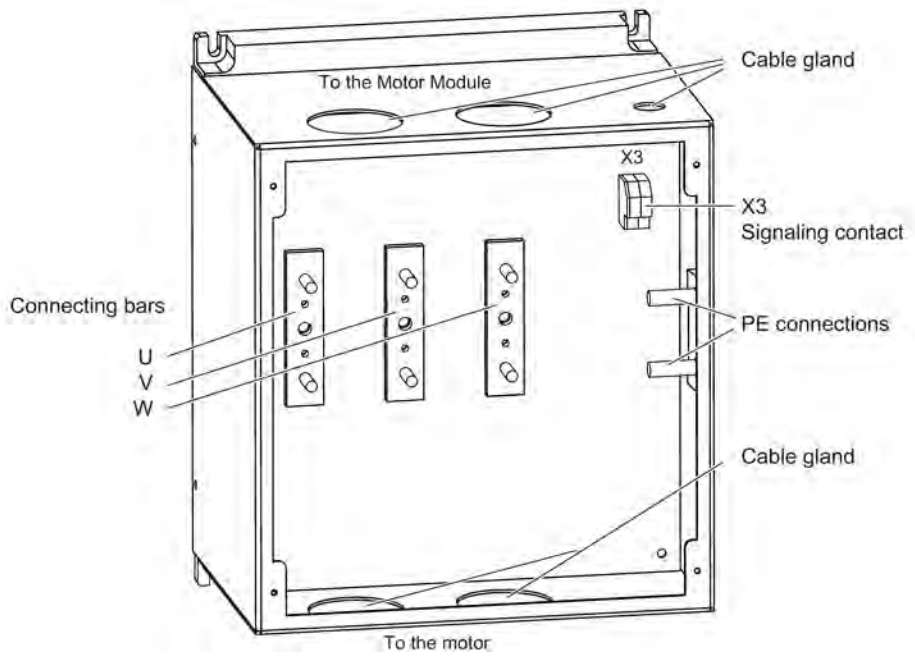


Figure 10-6 Interface overview, Voltage Protection Modules VPM200 (without cover)

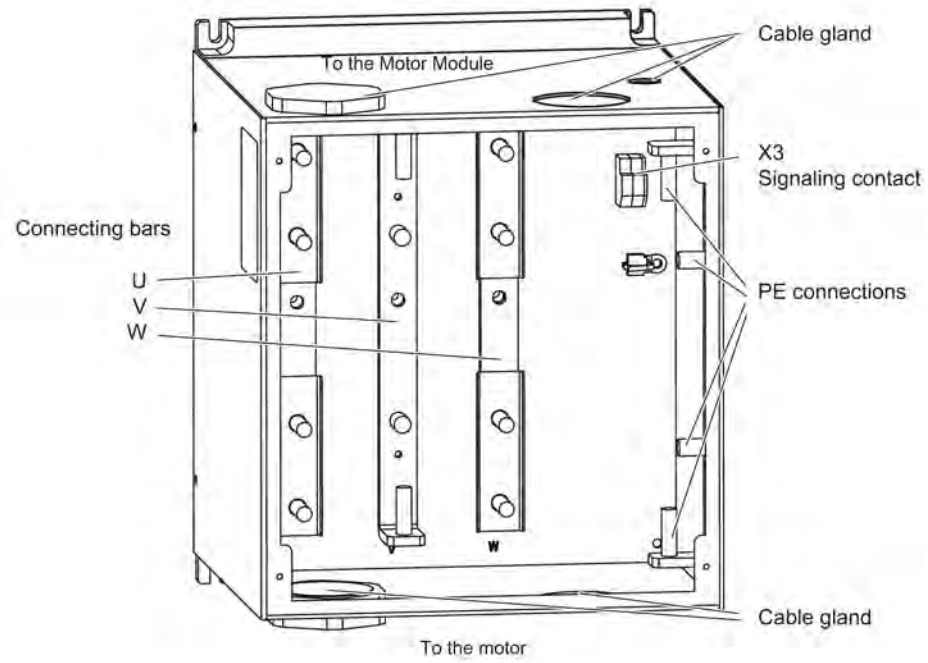


Figure 10-7 Interface overview, Voltage Protection Modules VPM200 Dynamic (without cover)

The housing is closed during operation to ensure the electrical terminals are covered.

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10.2.3.2 Signaling interface X3

The signaling interface has the following assignments:

Table 10- 11 Signaling interface X3

Terminal	Designation	Technical data
1	Operating message for Control Unit	• The cable shield is connected to the VPM housing via the cable entry. • Isolated contact, current carrying capacity: 30 V DC at 0.1 A
2	Operating voltage +24 V (from external source)	
Type: WAGO spring-loaded terminal, type 226-111 max. conductor cross-section: 1.5 mm², shielded cable		
Cable gland: Max. 9 mm ∅ Types VPM120, VPM200 and VPM200 Dynamic • Screwed joint: 1 x M16, e.g. from Pflitsch, order designation: UNI DICHT EMV 2165211S05 • Locknut M16: GM216PA		

Operating message via signaling contact X3

After a Voltage Protection Module response or in the event of a temperature error, signaling contact X3 opens and interrupts the inverter system's pulse enable.

The X3 signal contact automatically closes after t > 120 s or after resetting the temperature switch.

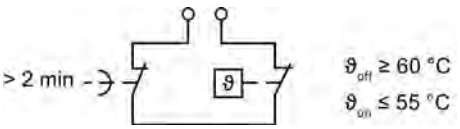


Figure 10-8 Signaling contact X3 of the Voltage Protection Module

⚠WARNING

Danger to life through automatic start of the drive

An uncontrolled automatic start of the drive can result in death or severe injury.

- Take measures to prevent the drive starting automatically, as signal contact X3 restores the pulse enable after 2 minutes.

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10.2.3.3 Connection bars U, V, W, PE

The cables to the Motor Module and motor are routed through the cable entry of the Voltage Protection Module and attached to the connection bars inside the unit.

Table 10- 12 Connections U, V, W, and PE

	VPM120	VPM200	VPM200 Dynamic
Connection bolt	8 x M6[1)]	8 x M8[1)]	14 x M8[2)]
Cable lug	Crimp-type cable lug M6	Crimp-type cable lug M8	Tubular cable lug M8, 90° angled
Cable cross-section	≤ 50 mm²	≤ 50 mm²	≤ 50 mm²
Tightening torque	10 Nm	25 Nm	25 Nm
Cable entry	For cables with max. 40 mm ∅		
Gland[3)]	2 x M50 e.g. from Pflitsch, order designation: UNI DICHT EMV 250584117 Locknut M50: GM250PA	4 x M50 e.g. from Pflitsch, order designation: UNI DICHT EMV 250584117 Locknut M50: GM250PA	4 x M50 e.g. from Pflitsch, order designation: UNI DICHT EMV 250584117 Locknut M50: GM250PA

1) There are 2 connection points for each phase and for PE.

2) There are 4 connection points for each of the phases U, W, and PE, and 2 connection points for phase V.

3) The glands must be separately ordered.

Note

Cable lengths with cross-sections of > 50 mm² between the Motor Module and the Voltage Protection Module or between the Voltage Protection Module and the motor are implemented using two cables connected in parallel.

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10.2.4 Connection examples

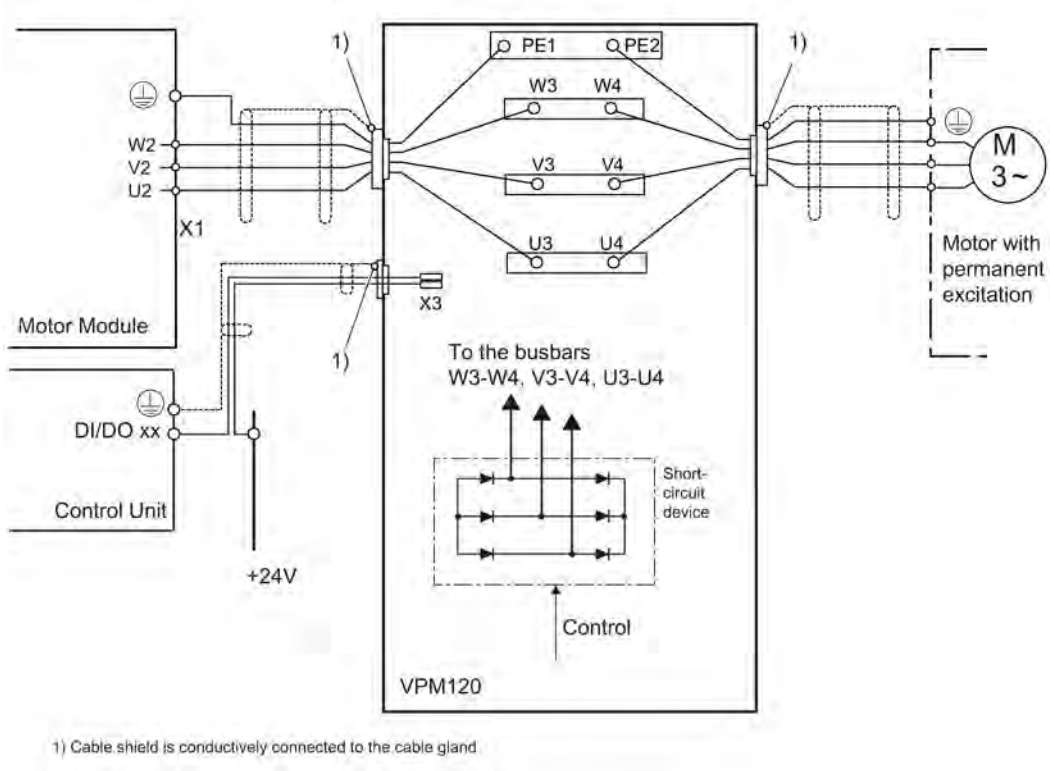


Figure 10-9 Connection example for Voltage Protection Module VPM120

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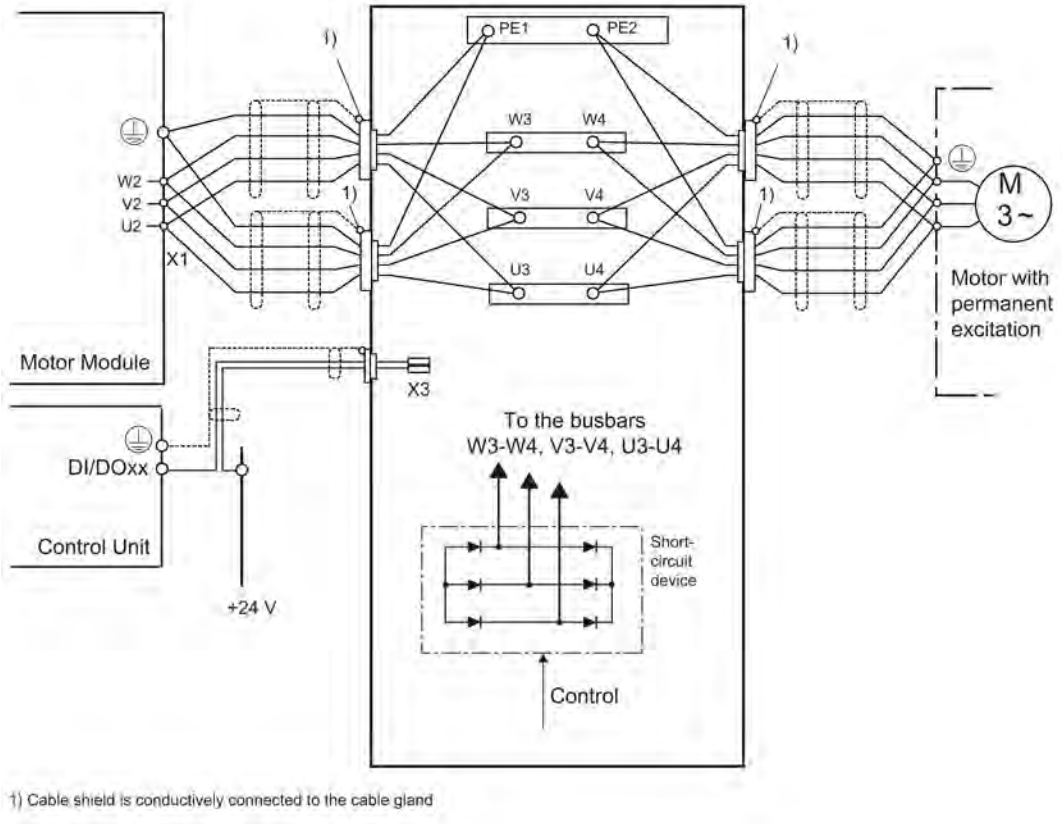


Figure 10-10 Connection example for Voltage Protection Module VPM200

Cable lengths

The maximum length of the power cable between the Motor Module and the Voltage Protection Module is 1.5 m and must not include any switching elements.
The power cable between the Voltage Protection Module and the motor must not exceed a length of 50 m.

The length of the signal cable must not exceed 10 m.

Signaling contact

Signaling interface X3 on the Voltage Protection Module is wired to a digital input (DI) on the Control Unit, which controls this spindle. If more than one Voltage Protection Module is used, each X3 terminal is wired to the respective Control Unit. If an armature short-circuit occurs, the pulses of the axis involved must remain inhibited. To do this, the connected digital input is interconnected to control bit OFF2 (pulse inhibit) (see SINAMICS S120/S150 List Manual). The signaling interface is operated with +24 V.

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10.2.5 Dimension drawings

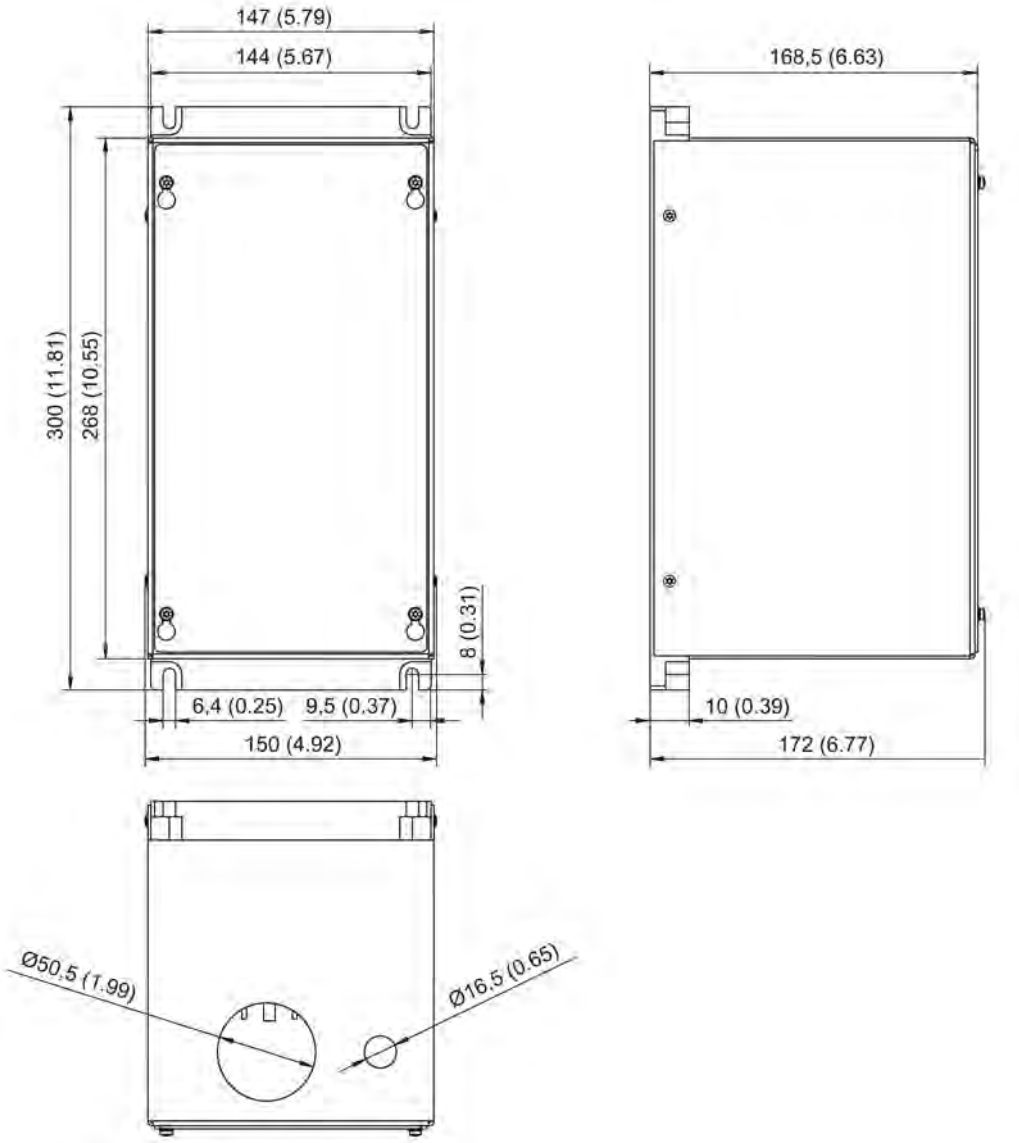


Figure 10-11 Dimension drawing of the Voltage Protection Module VPM120, all data in mm and (inches)

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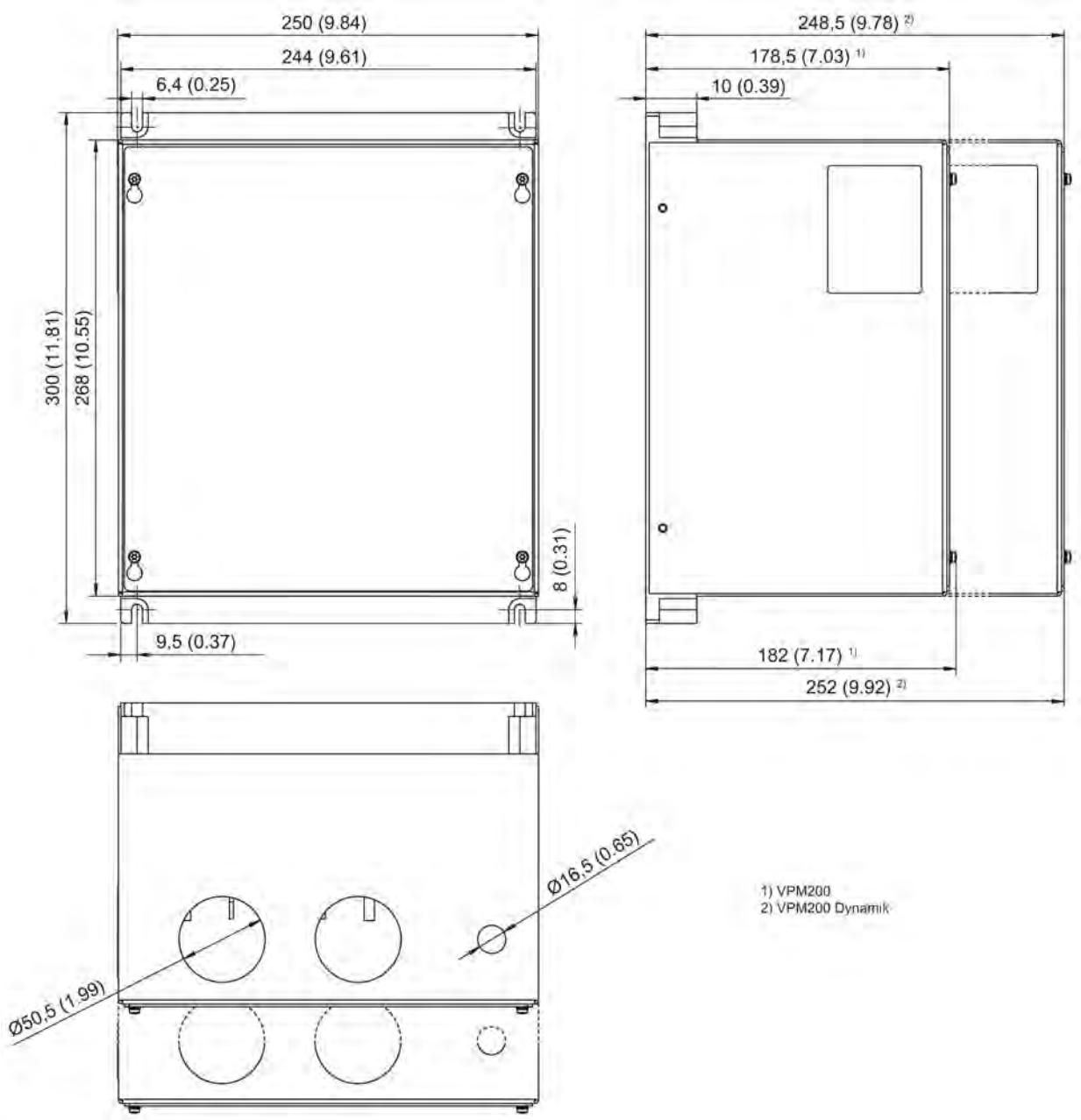


Figure 10-12 Dimension drawing of the Voltage Protection Module VPM200 and VPM200 Dynamic, all data in mm and (inches)

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10.2.6 Installation

The Voltage Protection Module is installed in the control cabinet close to the drive.

Note

Connecting motor reactors

Motor reactors may only be connected between the Voltage Protection Module and motor.

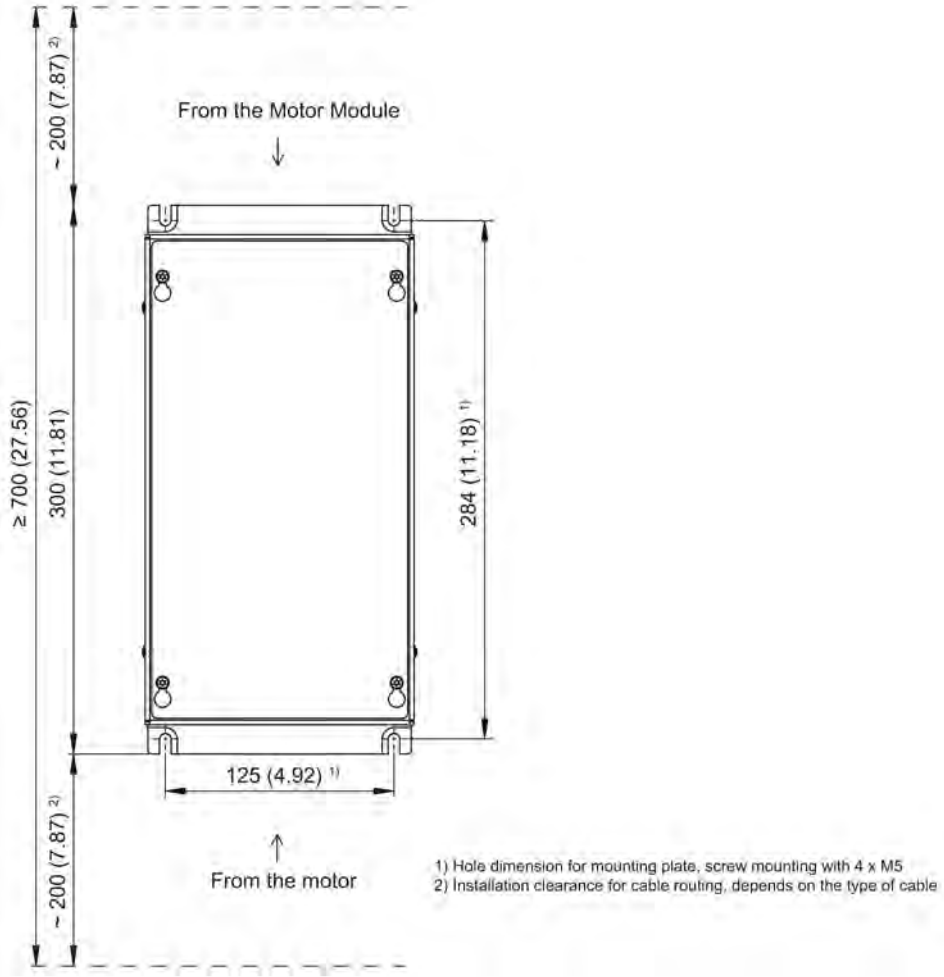


Figure 10-13 Mounting dimension for a Voltage Protection Module VPM120

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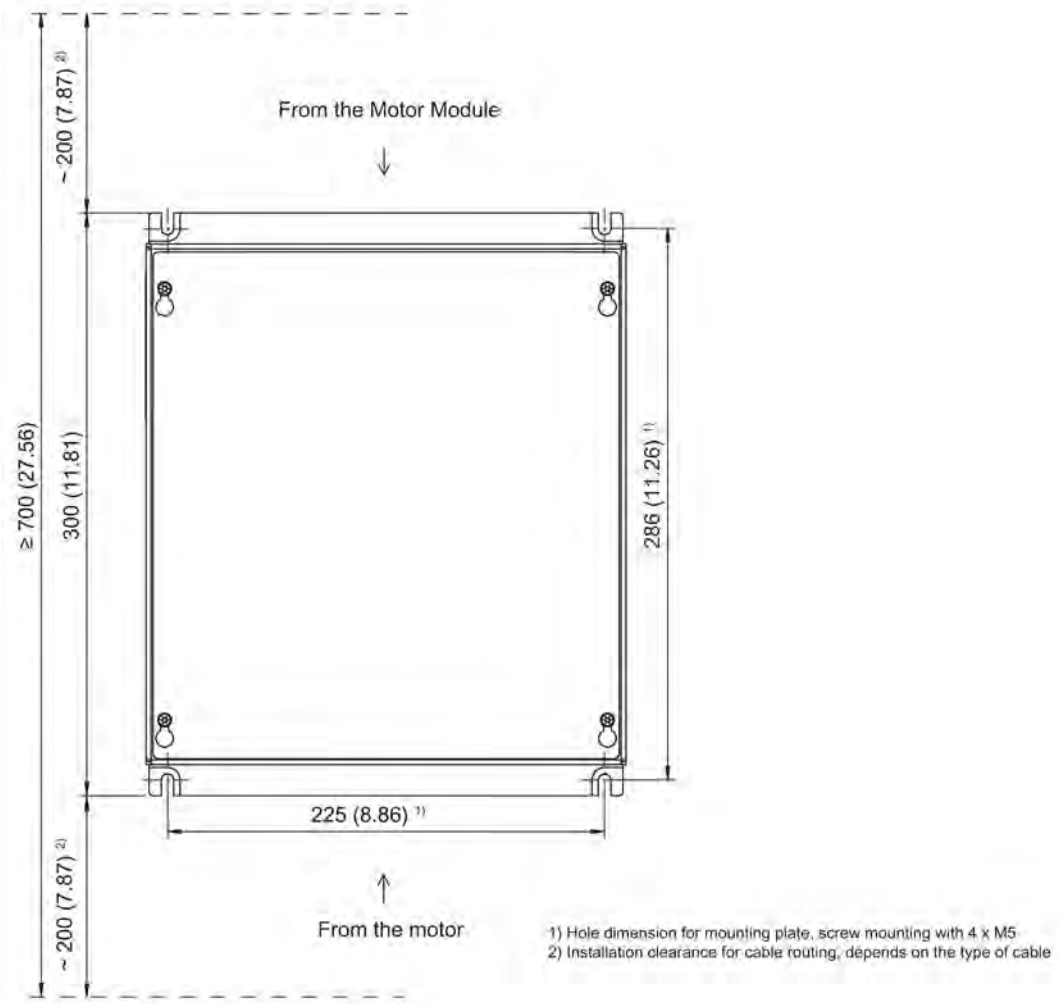


Figure 10-14 Mounting dimensions for a Voltage Protection Module VPM200

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10.2.7 Electrical connection

Note

Only the enclosure cover may be opened when electrically connecting the Voltage Protection Module.

Introduction

Various types of cabling work must be carried out in order to integrate a Voltage Protection Module into a motor feeder circuit. All connections must be set up inside the VPM housing. Cable cross-sections are determined by the rated motor power and may be as much as 2 x 50 mm^2 for each conductor. An installation sequence for individual conductors is outlined below. It is particularly relevant for larger cross-sections.



DANGER

Danger to life when live parts are touched

Death or serious injury can result when live parts are touched.

- Bring the system into a no-voltage condition by opening the main switch.
- Secure the energy sources against switching on again.

Preparation

The following preparations must be made before setting up connections:

- Loosen the 4 screws on the cover of the housing, so that the cover can be shifted in the cutouts.
- Move the enclosure cover to the point where the cutout widens out so it can be lifted over the screw heads.
- Attach the cable glands for the signal cable and power cables (2x for the VPM120, 4x for the VPM200) at the entries into the housing of the Voltage Protection Module.
- Remove 300 mm of the cable sheath of the power cables and expose the shield to match the housing gland being used.
- Remove the insulation at the ends of the individual conductors and attach cable lugs.
- Attach the signal cable to X3 and secure the cable with cable ties inside the Voltage Protection Module.

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10.2.7.1 Connecting signaling contact X3

The signaling contact X3 must be wired before connecting the power cables.



Figure 10-15 Connection of the signaling contact using the VPM200 as an example

The X3 signaling contact is routed via a bistable relay. The relay may shift to the other switching state if subjected to excessive movement during transportation and installation. This may prevent the system from starting.

NOTICE
Damage as the short-circuit thyristor is still conducting When a Voltage Protection Module is tripped and the short-circuit thyristor is still conducting before the converter is switched on again, then this can result in damage to the system. • The motor must have come to a standstill. • Signal contact X3 must have closed again. • Check that the thyristor is in a no voltage condition.

Cause and rectification of faults

The "Installation" sections in the documents referred to below contain additional information on the causes of faults and how they can be rectified:

Operating Instructions for Voltage Protection Module VPM120, Order No.: A5E00302281B

Operating Instructions for Voltage Protection Module VPM200, Order No.: A5E00777655A

Operating Instructions for Voltage Protection Module VPM200 Dynamic, Order No.: A5E00302261B

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10.2.7.2 Connecting power cables (using the VPM 200 Dynamik as an example)

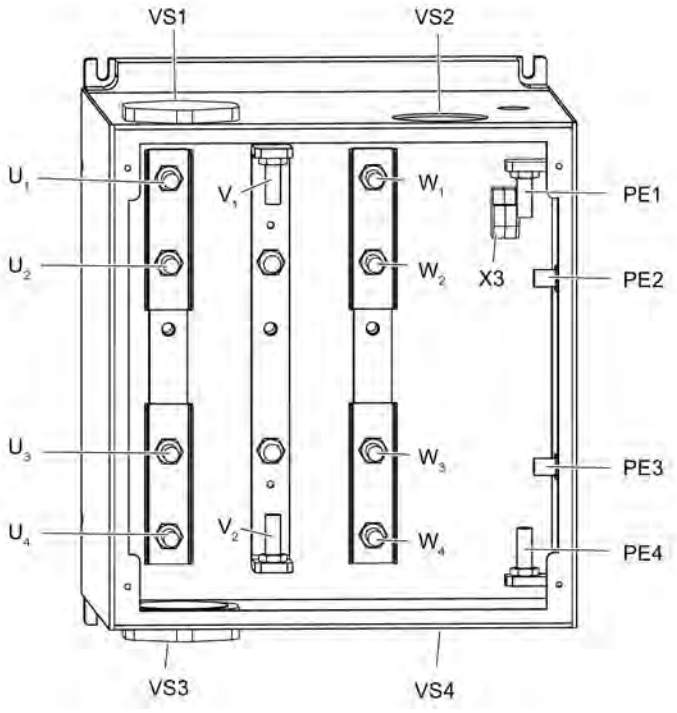


Figure 10-16 Connection points of the Voltage Protection Module VPM200 Dynamic

Table 10- 13 Short designations

Short designation	Explanation
VS1, VS2	Cable screwed joint 1 or 2 in the housing entry of the VPM, towards Motor Module
VS3, VS4	Cable screwed joint 3 or 4 in the housing entry of the VPM, towards motor
K1, K2	Cable 1 or 2 to the Motor Module
K3, K4	Cable 3 or 4 to the motor
U_1, U_2	Connection bolts on busbar U
U_3, U_4	Connection bolts on busbar U
V_1, V_2	Connection bolts on busbar V
W_1, W_2	Connection bolts on busbar W
W_3, W_4	Connection bolts on busbar W
PE_1, PE_2, PE_3, PE_4	Connection bolts on busbar PE
U	Busbar U in the VPM
V	Busbar V in the VPM
W	Busbar W in the VPM

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Figure 10-17 Wired Voltage Protection Module VPM200 Dynamic with short designations

Table 10- 14 Installation steps

Cable glands	Cable	Conductor/Phase	Installation step
VS1	K1	L_1, L_2, L_3, PE	Introduce the cable with all the conductors and shield, tighten the gland and lay conductors L_1 (black) and PE (green/yellow) on top of the other conductors.
VS2	K2	L_1, L_2, L_3, PE	Introduce the cable with all the conductors and shield, tighten the gland and lay conductors L_1 (black) and PE (green/yellow) on top of the other conductors.
	K1	L_2 (blue)	Lay L_2 on V1 and screw these together.
	K2	L_2 (blue)	Lay L_2 on V1 and screw these together.
	K2	PE (green/yellow)	Lay PE on PE1 and screw these together.
	K1	L_3 (brown)	Lay L_3 on W2 and screw these together.
	K2	L_1 (black)	Lay L_1 on U2 and screw these together.
	3 separate cable ends for cables K1 and K2 are connected later.		
VS3	K3	L_1, L_2, L_3, PE	Introduce the cable with all the conductors and shield, tighten the gland and lay conductors L_1 (black) and PE (green/yellow) on top of the other conductors.

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Cable glands	Cable	Conductor/Phase	Installation step
VS4	K4	L_1, L_2, L_3, PE	Introduce the cable with all the conductors and shield, tighten the gland and lay conductors L_1 (black) and PE (green/yellow) on top of the other conductors.
	K3	L_2 (blue)	Lay L_2 on V2 and screw these together.
	K4	L_2 (blue)	Lay L_2 on V2 and screw these together.
	K3	L_3 (brown)	Lay L_3 on W3 and screw these together.
	K4	PE (green/yellow)	Lay PE on PE4 and screw these together.
	K4	L_1 (black)	Lay L_1 on U3 and screw these together.
	K1	L_1 (black)	Lay L_1 on U4 and screw these together.
	K3	L_1 (black)	Lay L_1 on U1 and screw these together.
	K2	L_3 (brown)	Lay L_3 on W4 and screw these together.
	K4	L_3 (brown)	Lay L3 on W1 and screw these together.
	K3	PE (green/yellow)	Lay PE on PE3 and screw these together.
	K1	PE (green/yellow)	Lay PE on PE2 and screw these together.

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10.2.8 Technical data

Table 10- 15 Technical data

	VPM 120	VPM 200	VPM 200 Dynamic
Order number	6SN1113–1AA00–1JAx	6SN1113–1AA00–1KAx	6SN1113–1AA00–1KCx
Type of voltage	3-phase pulsed AC voltage, motor EMF		
Ramp-up time for VPM	1 s (from pulse enable)		
Normal range of the DC link voltage: - lower limit - upper limit	 490 V DC 795 V DC		
Operating range for VPM	830 … 2000 V (peak value)		
Motor EMF	< 1.4 kV_{rms}		
Clock frequency	3,2 ... 8 kHz		
Rated current	120 A_{rms}	200 A_{rms}	
Time range	Maximum permissible short-circuit current		
0 ... 10 ms 10 ... 500 ms 500 ms ... 2 min > 2 min	1500 A 255 A 90 A 0 A	2000 A 600 A 200 A 0 A	
Max. perm. short-circuit time	120 s		
Protection class in accordance with EN 61140	I		
Safe electrical separation	Between the signal contact and motor cables U, V, W, UL 508 C		
Degree of protection according to EN 60529	IP20		
Permitted humidity Humidity classification according to EN 60721-3-3	< 90 % Cl. 3K5, condensation and icing excluded Low air temperature 0 °C		
Permissible ambient temperature, min. / max.	0 °C / 55 °C		
Cooling method	Air-cooled, free convection		
Weight	Approx. 6 kg	Approx. 11 kg	Approx. 13 kg
Dimensions (H x W x D) [mm]	300 x 150 x 180	300 x 250 x 190	300 x 250 x 260

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Accessories

11

11.1 Shield connecting plates for power supply and motor cables

11.1.1 Description

Shield connection plates are available to connect the shields of line and motor power cables as well as brake cables for all Line Modules, Motor Modules, and Active Interface Modules.

A shield connection terminal and/or clamp is used to connect the cable shield to the shield connection plate. Shield supports must be properly arranged to ensure EMC compliance.

11.1.2 Shield connecting plates

Table 11- 1 Shield connection for components with internal air cooling

Component	Power	Total width of component	Shield connection plate	Recommended shield connection
Line Module	5 kW / 10 kW	50 mm	Included in the scope of delivery	
	16 kW	100 mm	Included in the scope of delivery	KLBÜ CO4[1)]
	36 kW	150 mm	6SL3162-1AF00-0AA1	KLBÜ CO4[1)]
	55 kW	200 mm	6SL3162-1AH01-0AA0	Clamps
	80 kW / 120 kW	300 mm	6SL3162-1AH00-0AA0	Clamps
Motor Module	3 … 18 A 2 x 3 A … 2 x 9 A	50 mm	Integrated in the motor connector	
	18 A (compact) 2 x 1.7 A ... 2 x 5 A	75 mm	Integrated in the motor connector	
	30 A and 2 x 18 A	100 mm	Included in the scope of delivery	KLBÜ CO4[1)]
	45 A and 60 A	150 mm	6SL3162-1AF00-0AA1	KLBÜ CO1[1)] for the brake cable KLBÜ CO4[1)] for the motor cable
	85 A	200 mm	6SL3162-1AH01-0AA0	KLBÜ CO1[1)] for brake cable clamps for motor cable
	132 A and 200 A	300 mm	6SL3162-1AH00-0AA0	KLBÜ CO1[1)] for brake cable clamps for motor cable

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Component	Power	Total width of component	Shield connection plate	Recommended shield connection
Active Interface Module	16 kW	100 mm	Integrated in the motor connector	
	36 kW	150 mm	6SL3163-1AF00-0AA0	KLBÜ CO4[1)]
	55 kW	200 mm	6SL3163-1AH00-0AA0	Clamps
	80 kW / 120 kW	300 mm	6SL3163-1AM00-0AA0	Clamps

[1)] Shield connection terminal, Weidmüller Company

Table 11- 2 Shield connection for components with external air cooling

Component	Power	Total width of component	Shield connection plate	Recommended shield connection
Line Module	5 kW / 10 kW	50 mm	Included in the scope of delivery	
	16 kW	100 mm		KLBÜ CO4[1)]
	36 kW	150 mm	6SL3162-1AF00-0BA1	KLBÜ CO4[1)]
	55 kW	200 mm	6SL3162-1AH01-0BA0	Clamps
	80 kW / 120 kW	300 mm	6SL3162-1AH00-0AA0	Clamps
Motor Module	3 … 18 A 2 x 3 A … 2 x 9 A	50 mm	Integrated in the motor connector	
	30 A and 2 x 18 A	100 mm	Included in the scope of delivery	KLBÜ CO4[1)]
	45 A and 60 A	150 mm	6SL3162-1AF00-0BA1	KLBÜ CO1[1)] for the brake cable KLBÜ CO4[1)] for the motor cable
	85 A	200 mm	6SL3162-1AH01-0BA0	KLBÜ CO1[1)] for brake cable clamps for motor cable
	132 A and 200 A	300 mm	6SL3162-1AH00-0AA0	KLBÜ CO1[1)] for brake cable clamps for motor cable

[1)] Shield connection terminal, Weidmüller Company

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Table 11- 3 Shield connection for components with cold plate

Component	Power	Total width of component	Shield connection plate	Recommended shield connection
Line Module	5 kW / 10 kW	50 mm	Included in the scope of delivery	
	16 kW	100 mm		KLBÜ CO4[1)]
	36 kW	150 mm	6SL3162-1AF00-0BA1	KLBÜ CO1[1)] and KLBÜ CO4[1)]
	55 kW	200 mm	6SL3162-1AH01-0BA0	Clamps
	80 kW / 120 kW	300 mm	6SL3162-1AH00-0AA0	Clamps
Motor Module	3 … 18 A 2 x 3 A … 2 x 9 A	50 mm	Integrated in the motor connector	
	18 A (compact) 2 x 1.7 A ... 2 x 5 A	75 mm		
	30 A and 2 x 18 A	100 mm	Included in the scope of delivery	KLBÜ CO4[1)]
	45 A and 60 A	150 mm	6SL3162-1AF00-0BA1	KLBÜ CO1[1)] for the brake cable KLBÜ CO4[1)] for the motor cable
	85 A	200 mm	6SL3162-1AH01-0BA0	KLBÜ CO1[1)] for brake cable clamps for motor cable
	132 A and 200 A	300 mm	6SL3162-1AH00-0AA0	KLBÜ CO1[1)] for brake cable clamps for motor cable

[1)] Shield connection terminal, Weidmüller Company

Table 11- 4 Shield connection for liquid-cooled components

Component	Power	Total width of component	Shield connection plate	Recommended shield connection
Line Module	120 kW	300 mm	6SL3162-1AH00-0AA0	Clamps
Motor Module	200 A	300 mm	6SL3162-1AH00-0AA0	KLBÜ CO1[1)] for brake cable clamps for motor cable

[1)] Shield connection terminal, Weidmüller Company

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11.1.3 Overview examples

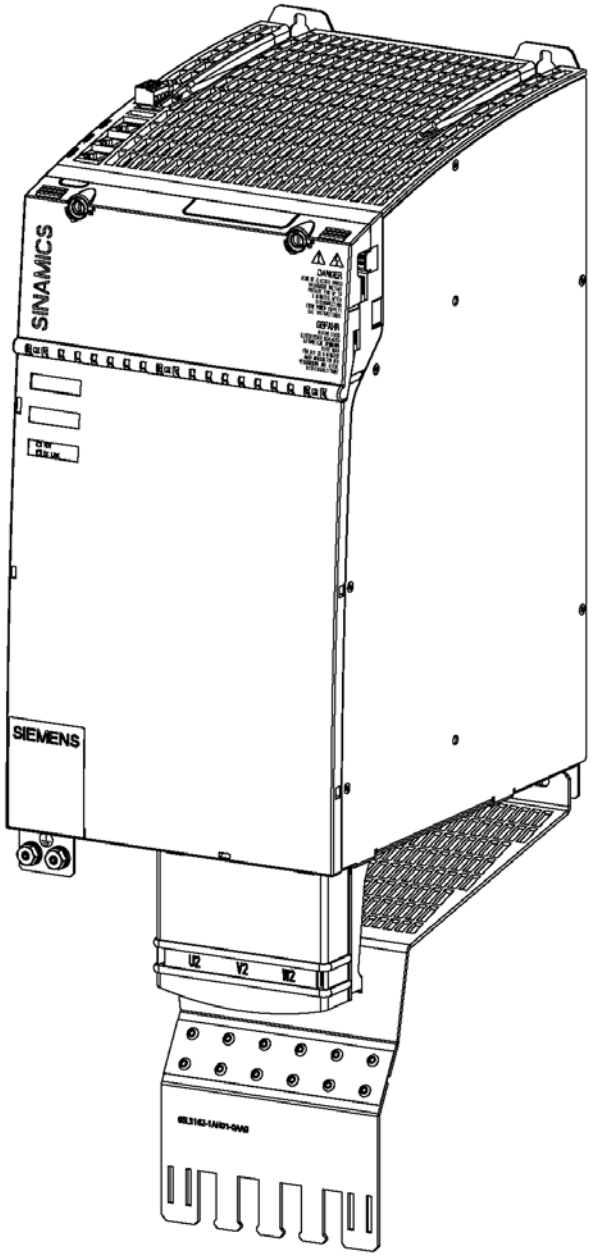


Figure 11-1 Shield connecting plate for a 200 mm module with internal air cooling

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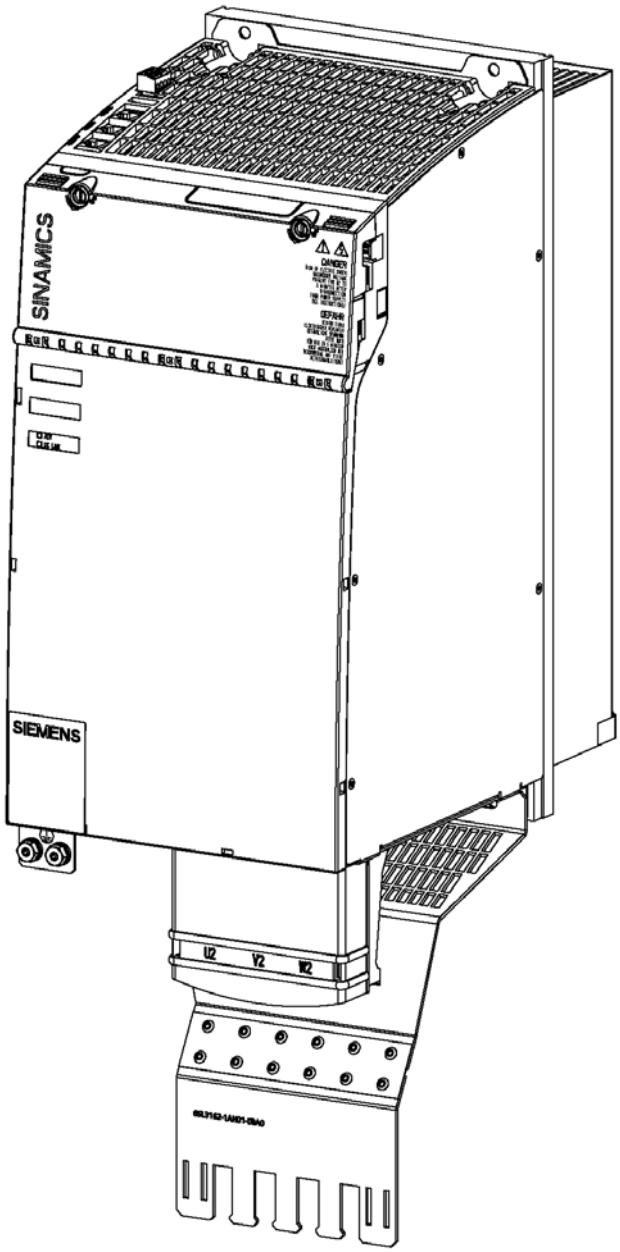


Figure 11-2 Shield connecting plate for a 200 mm module with external air cooling

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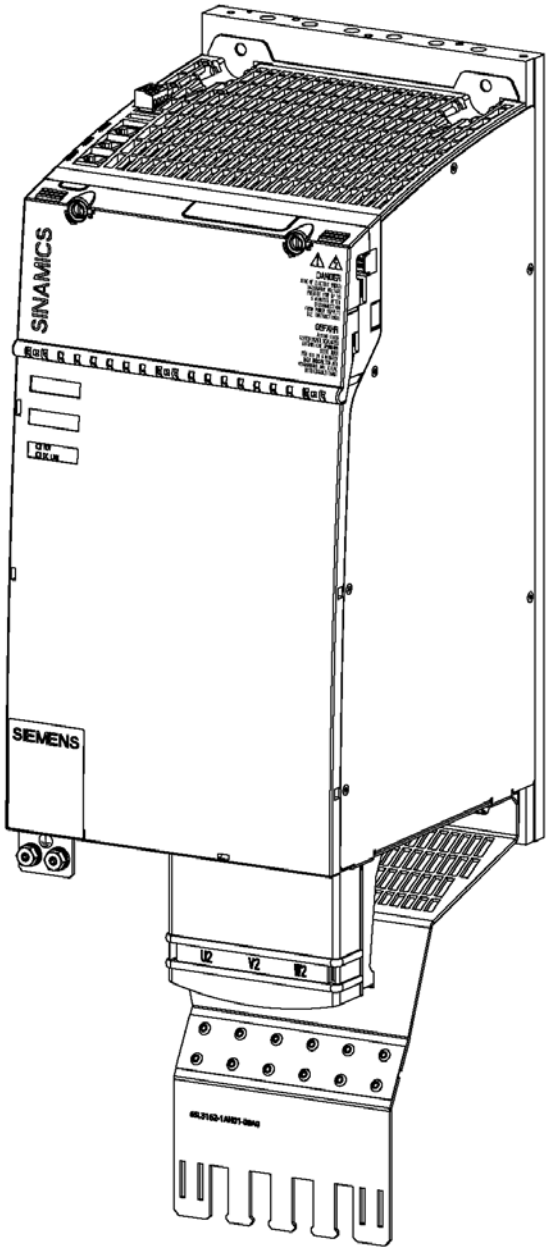


Figure 11-3 Shield connecting plate for a 200 mm module with a cold plate

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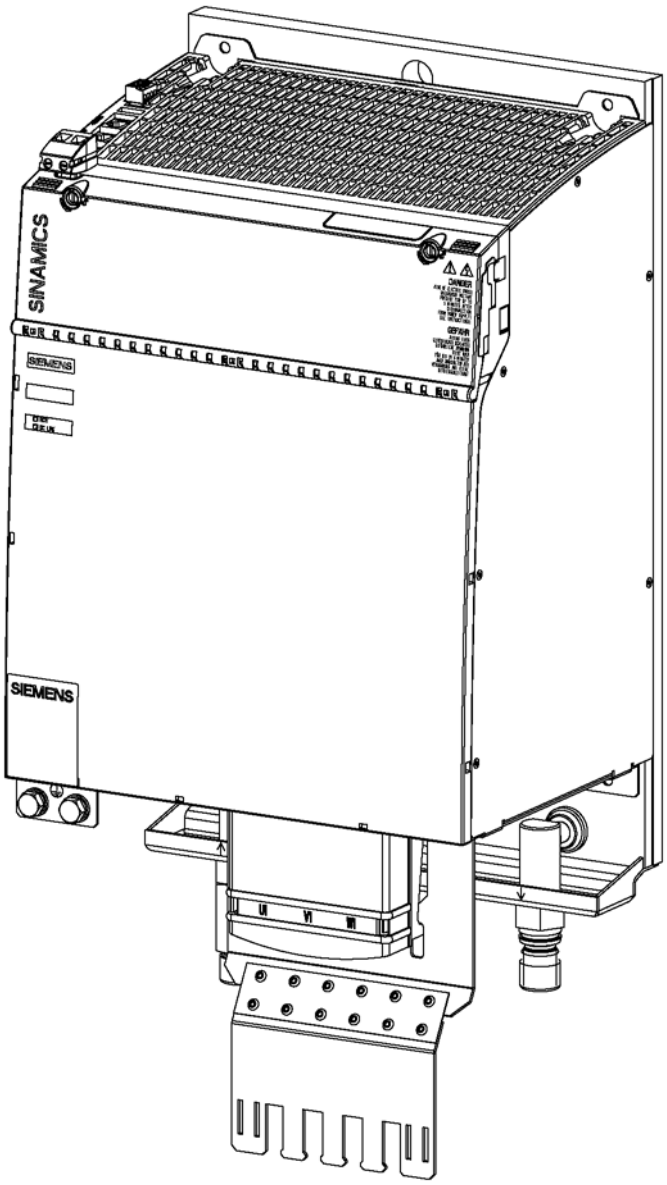


Figure 11-4 Shield connecting plate on a 300 mm module Liquid Cooled

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11.1.4 Dimension drawings

11.1.4.1 Line Modules and Motor Modules with internal air cooling

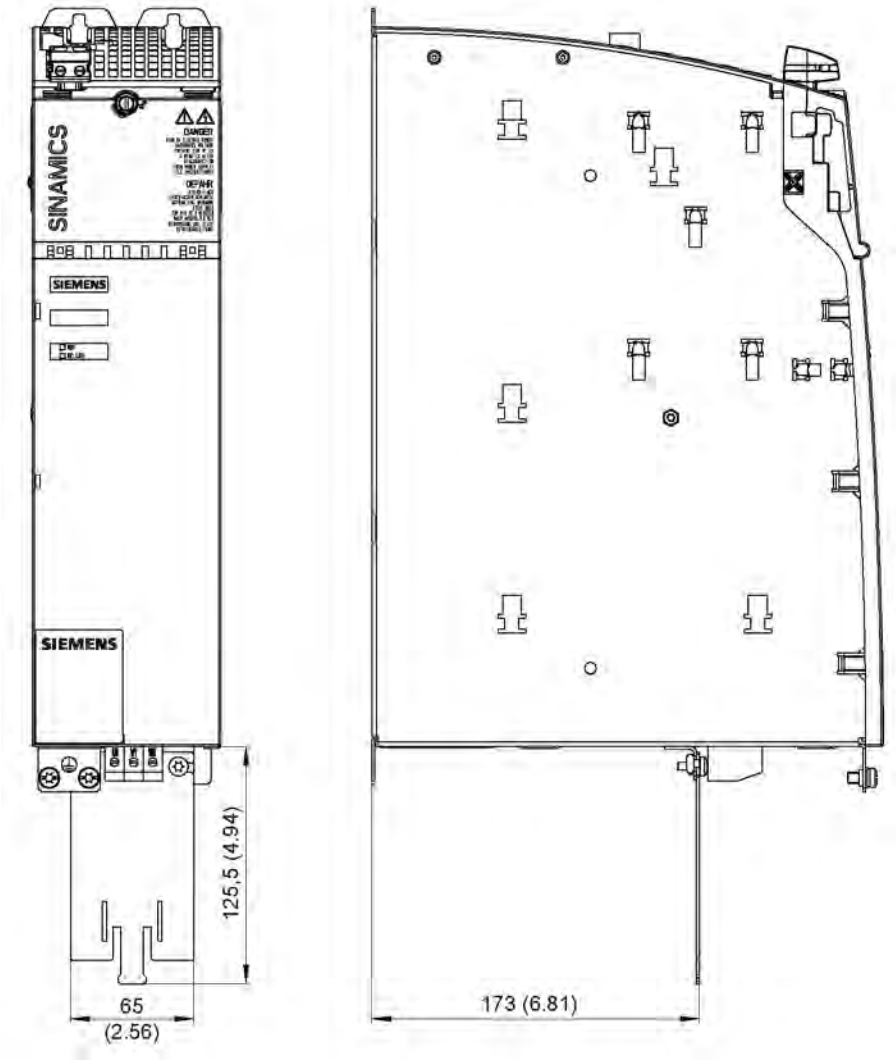


Figure 11-5 Dimension drawing of shield connecting plate on a 100 mm component with internal air cooling, all dimensions in mm and (inches)

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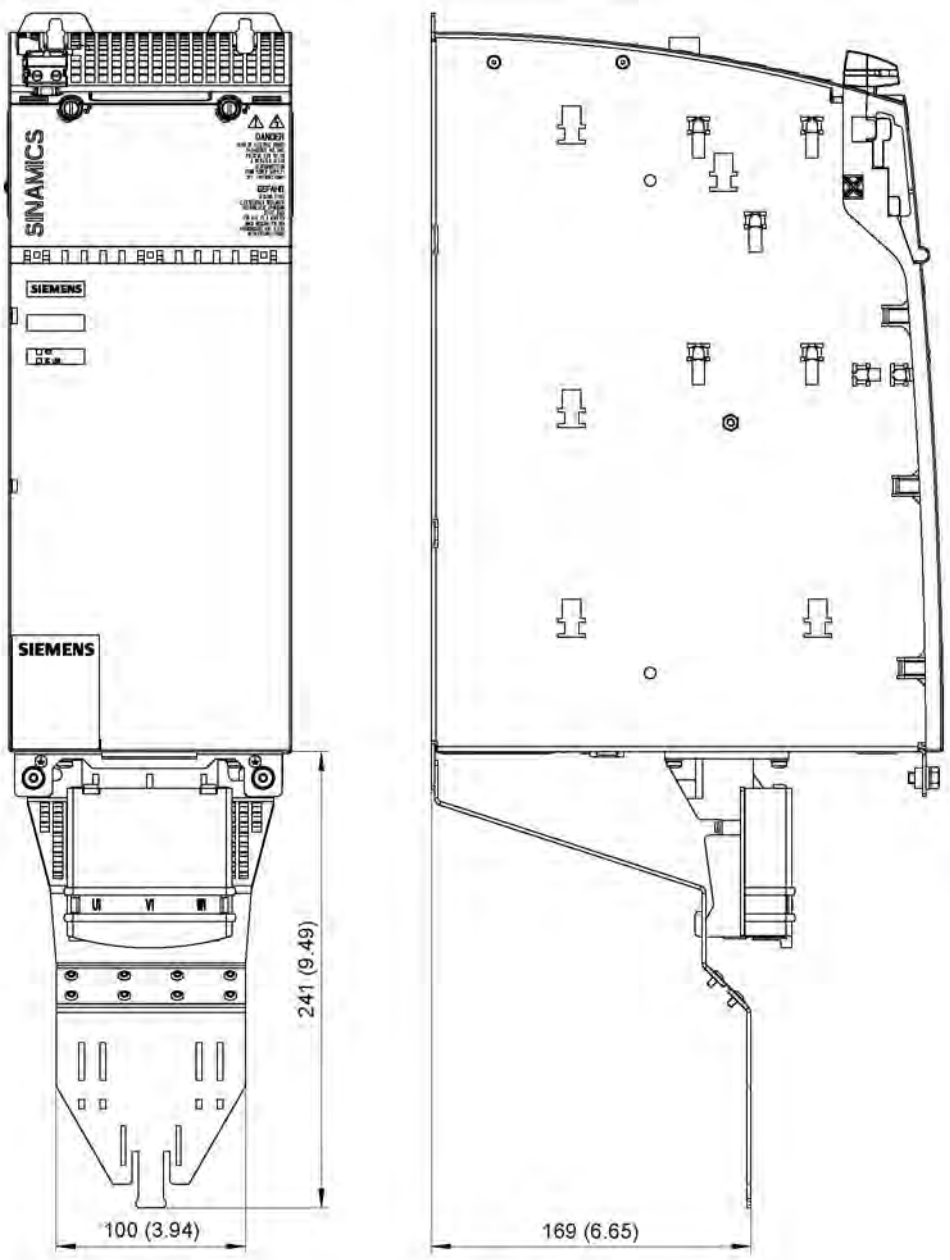


Figure 11-6 Dimension drawing of shield connecting plate on a 150 mm component with internal air cooling, all dimensions in mm and (inches)

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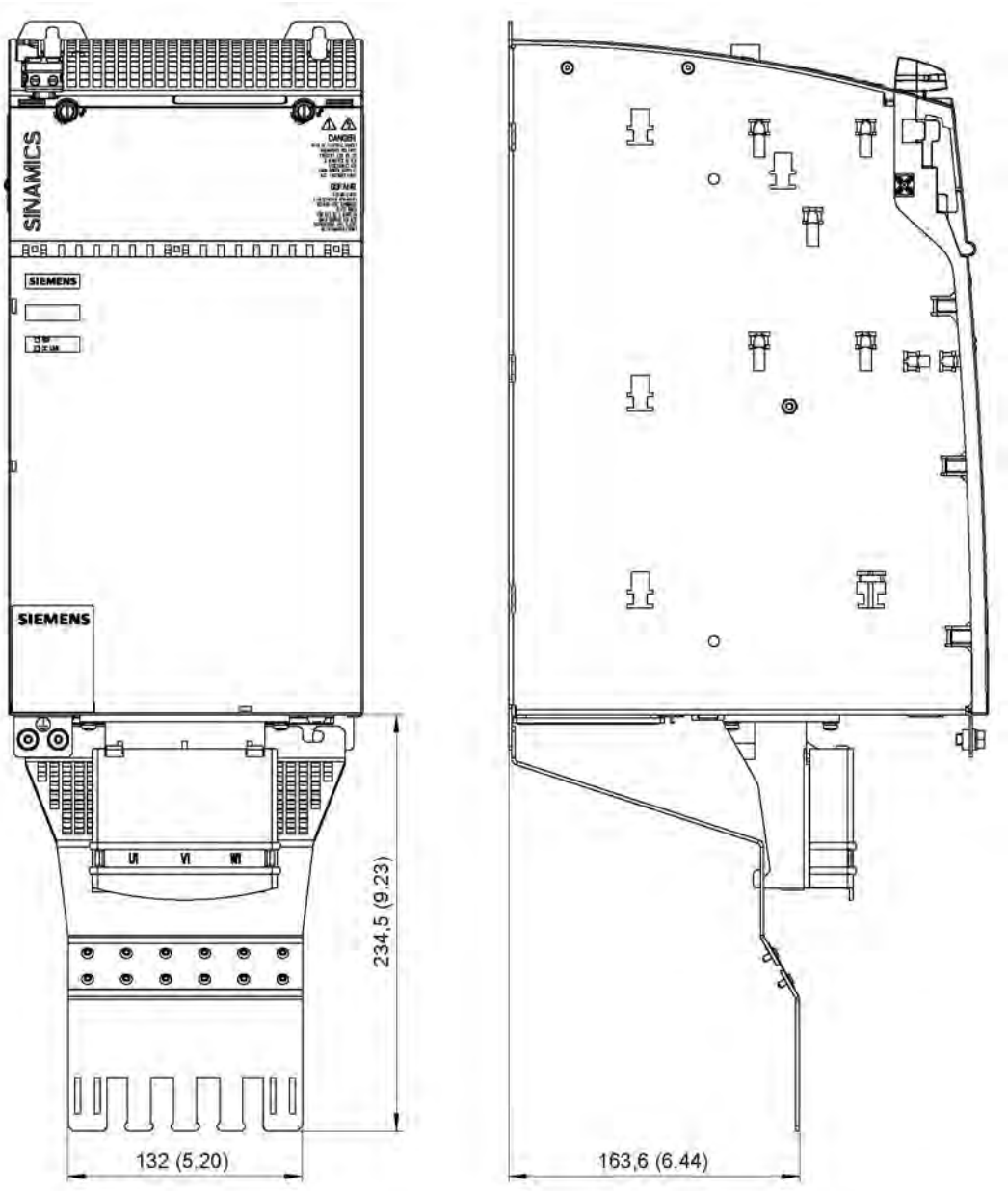


Figure 11-7 Dimension drawing of shield connecting plate on a 200 mm component with internal air cooling, all dimensions in mm and (inches)

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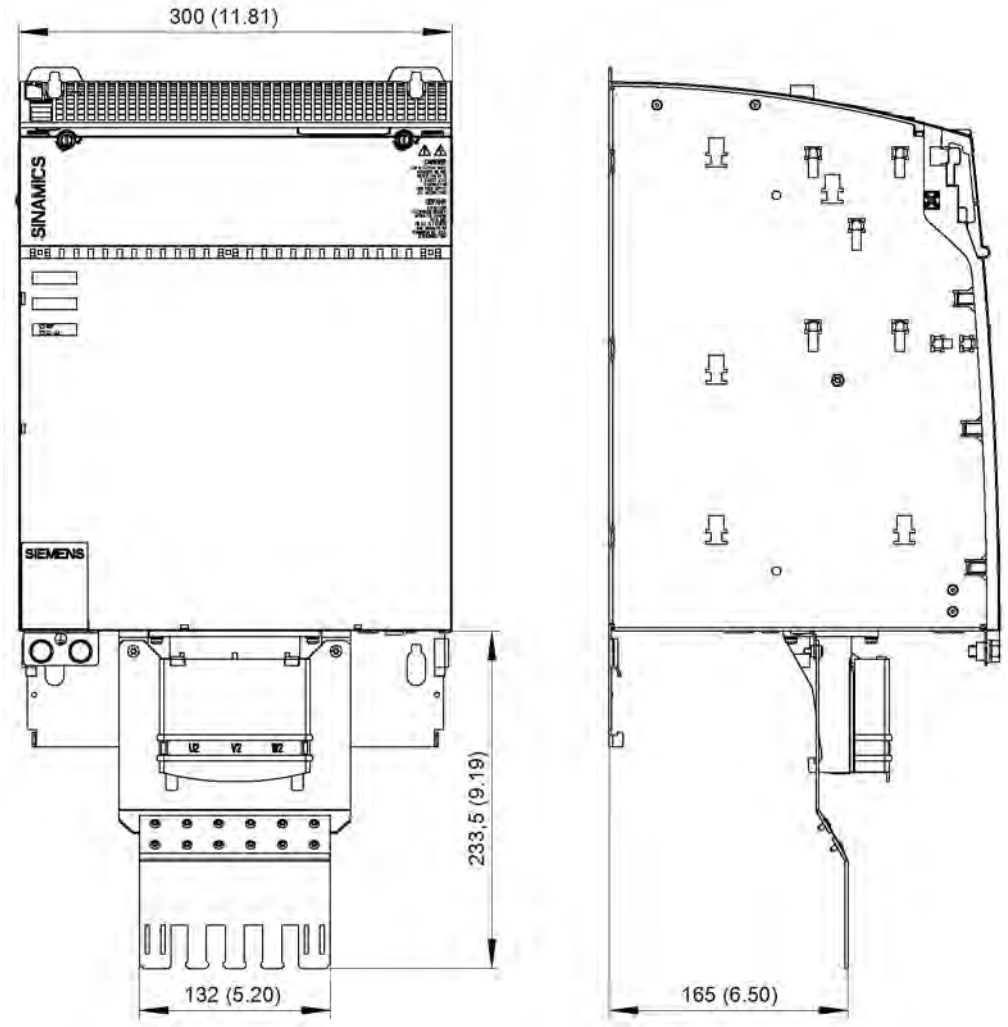


Figure 11-8 Dimension drawing of shield connecting plate on a 300 mm component with internal air cooling, all dimensions in mm and (inches)

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11.1.4.2 Line Modules and Motor Modules with external air cooling

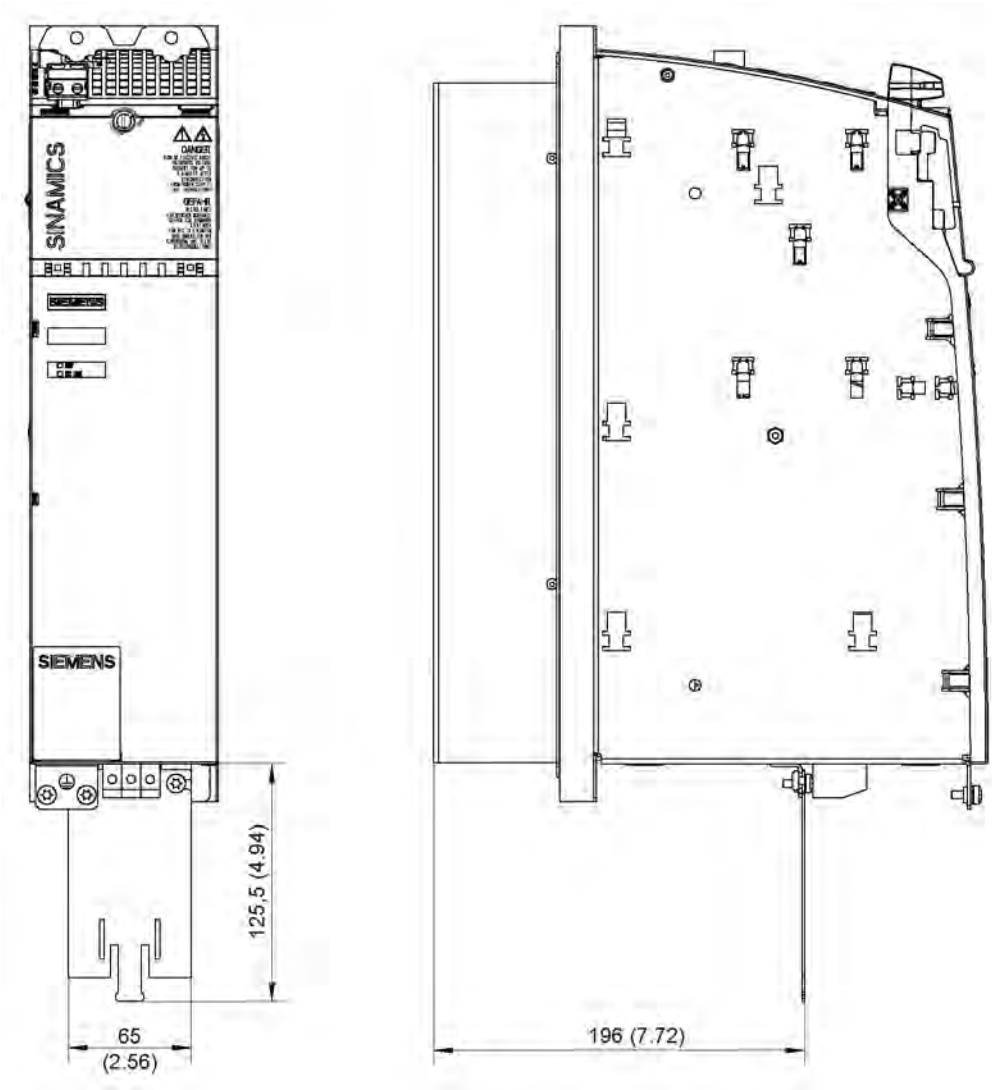


Figure 11-9 Dimension drawing of shield connecting plate on a 100 mm component with external air cooling, all dimensions in mm and (inches)

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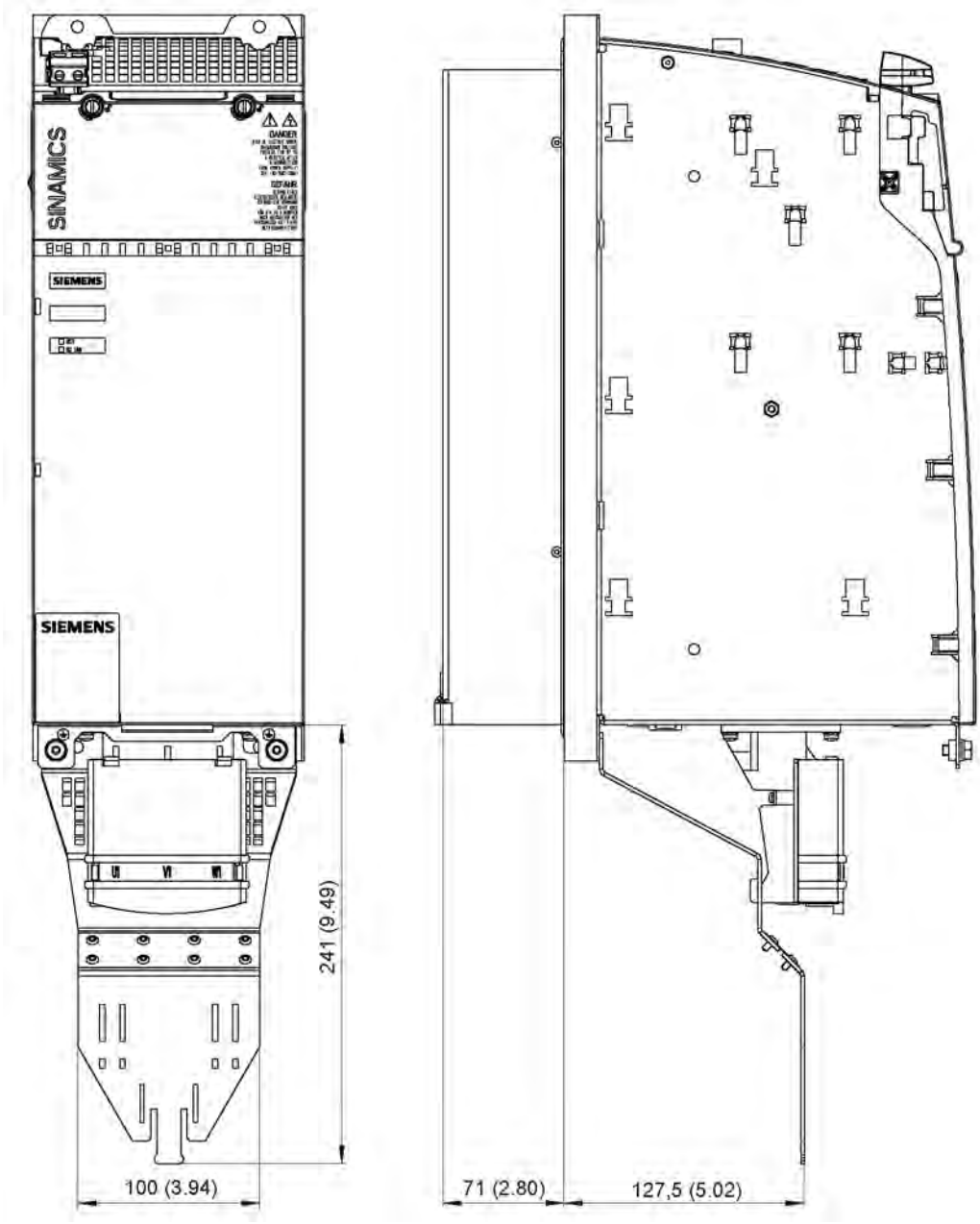


Figure 11-10 Dimension drawing of shield connecting plate on a 150 mm component with external air cooling, all dimensions in mm and (inches)

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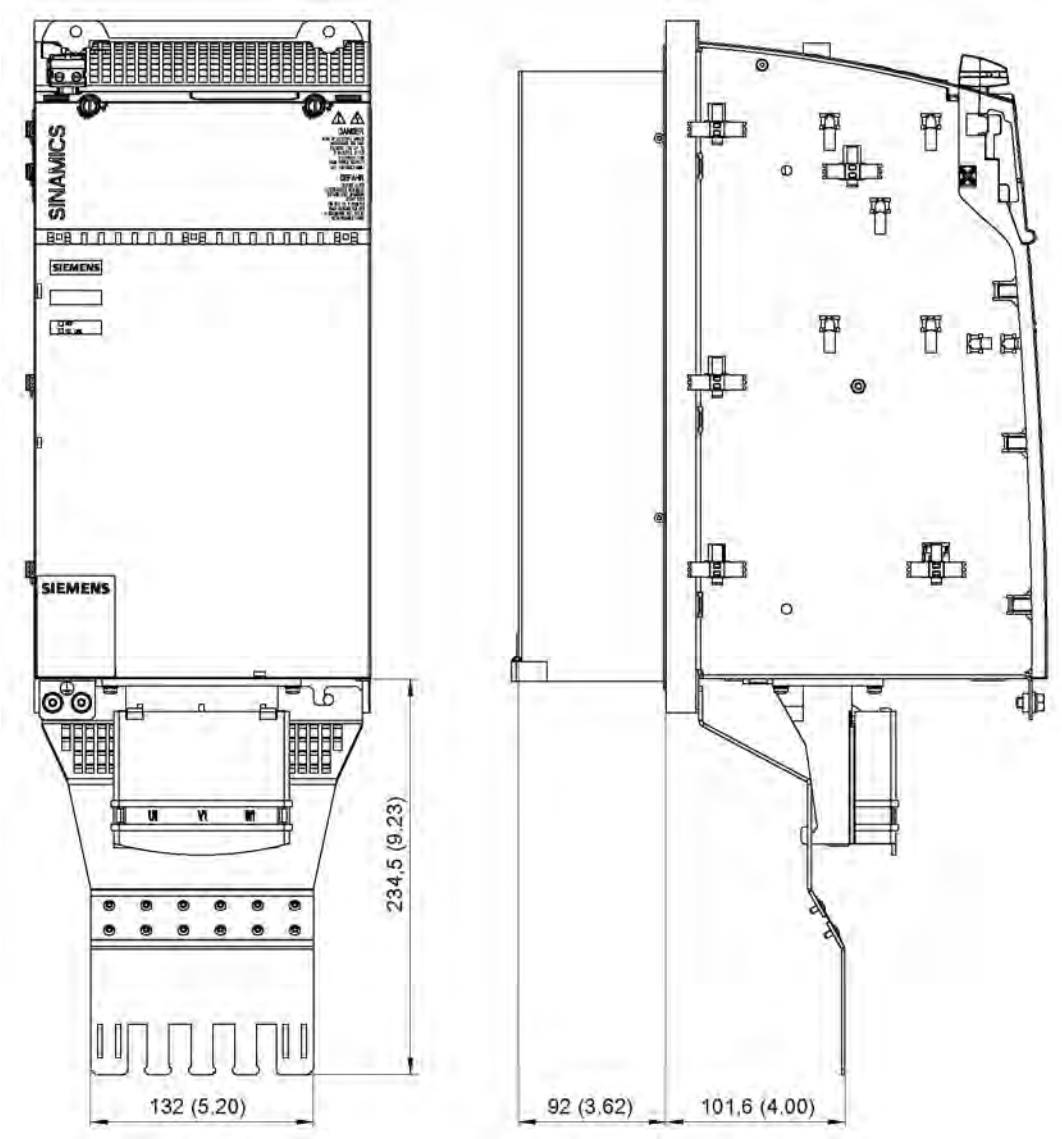


Figure 11-11 Dimension drawing of shield connecting plate on a 200 mm component with external air cooling, all dimensions in mm and (inches)

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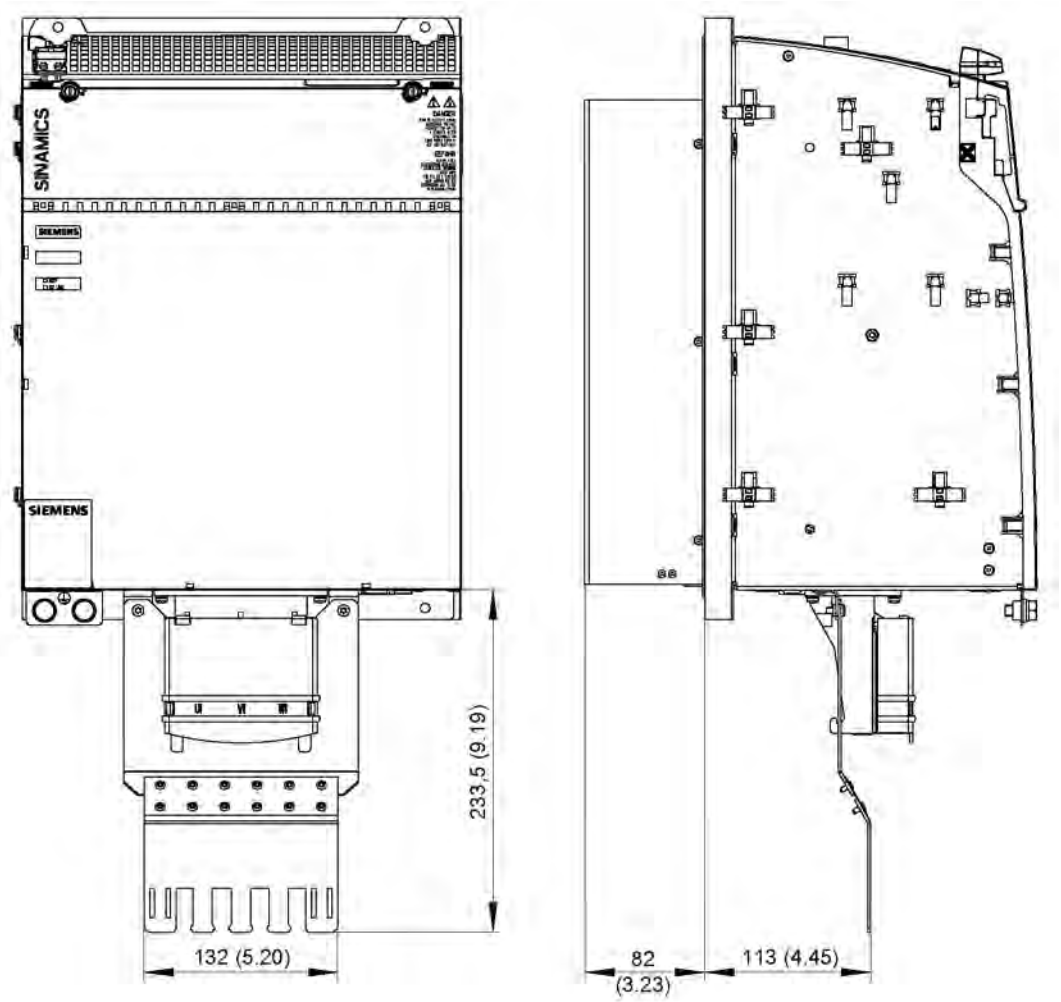


Figure 11-12 Dimension drawing of shield connecting plate on a 300 mm component with external air cooling, all dimensions in mm and (inches)

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11.1.4.3 Line Modules and Motor Modules with cold plate

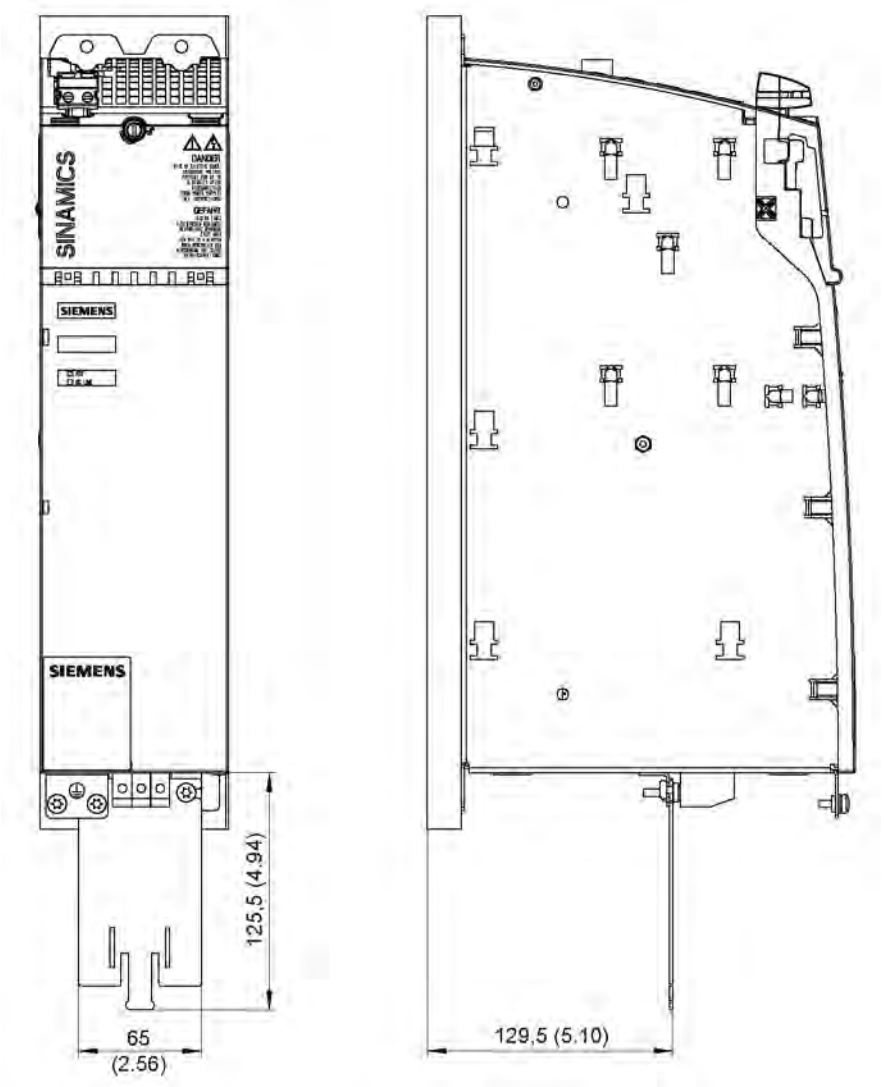


Figure 11-13 Dimension drawing of shield connecting plate on a 100 mm component with cold plate, all dimensions in mm and (inches)

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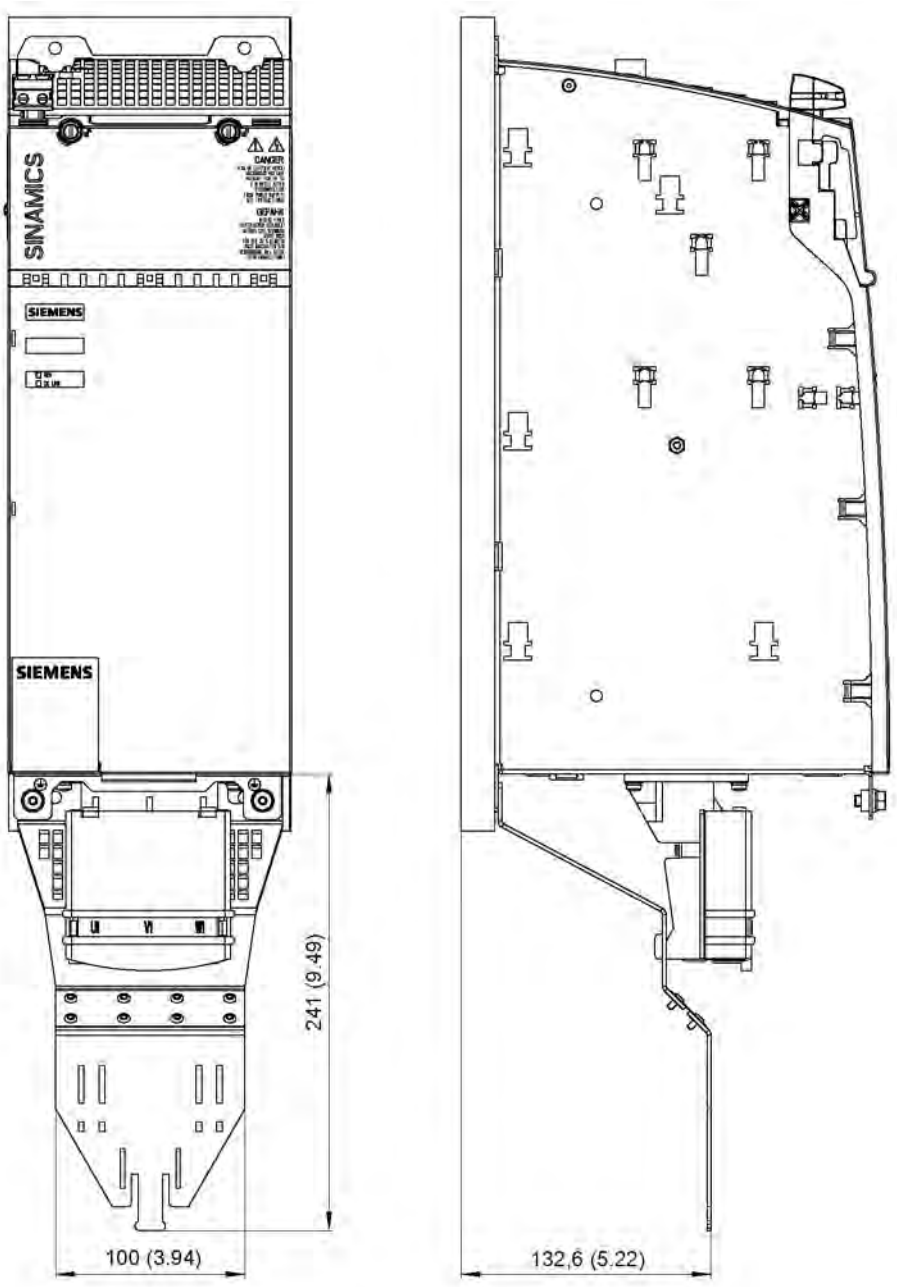


Figure 11-14 Dimension drawing of shield connecting plate on a 150 mm component with cold plate, all dimensions in mm and (inches)

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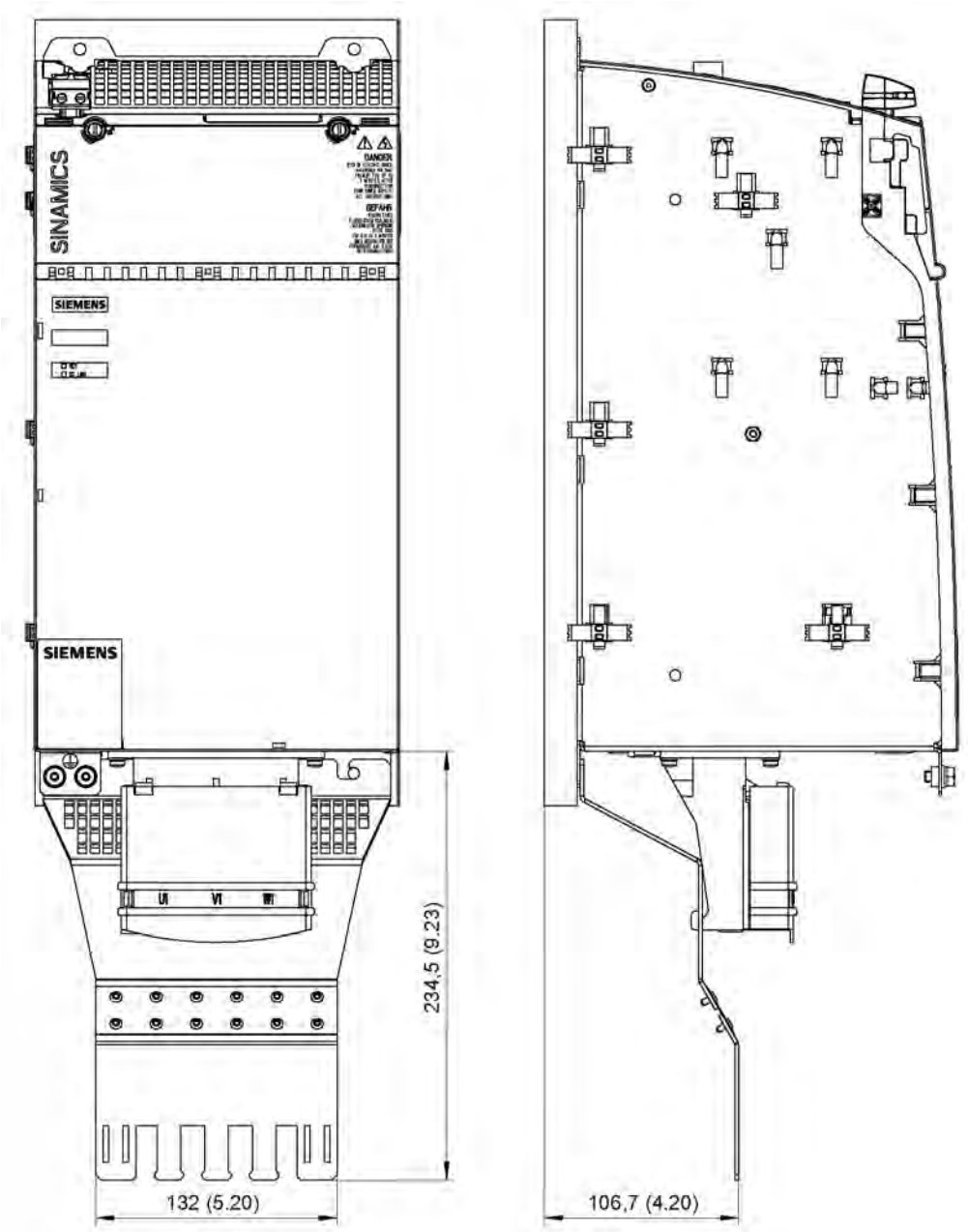


Figure 11-15 Dimension drawing of shield connecting plate on a 200 mm component with cold plate, all dimensions in mm and (inches)

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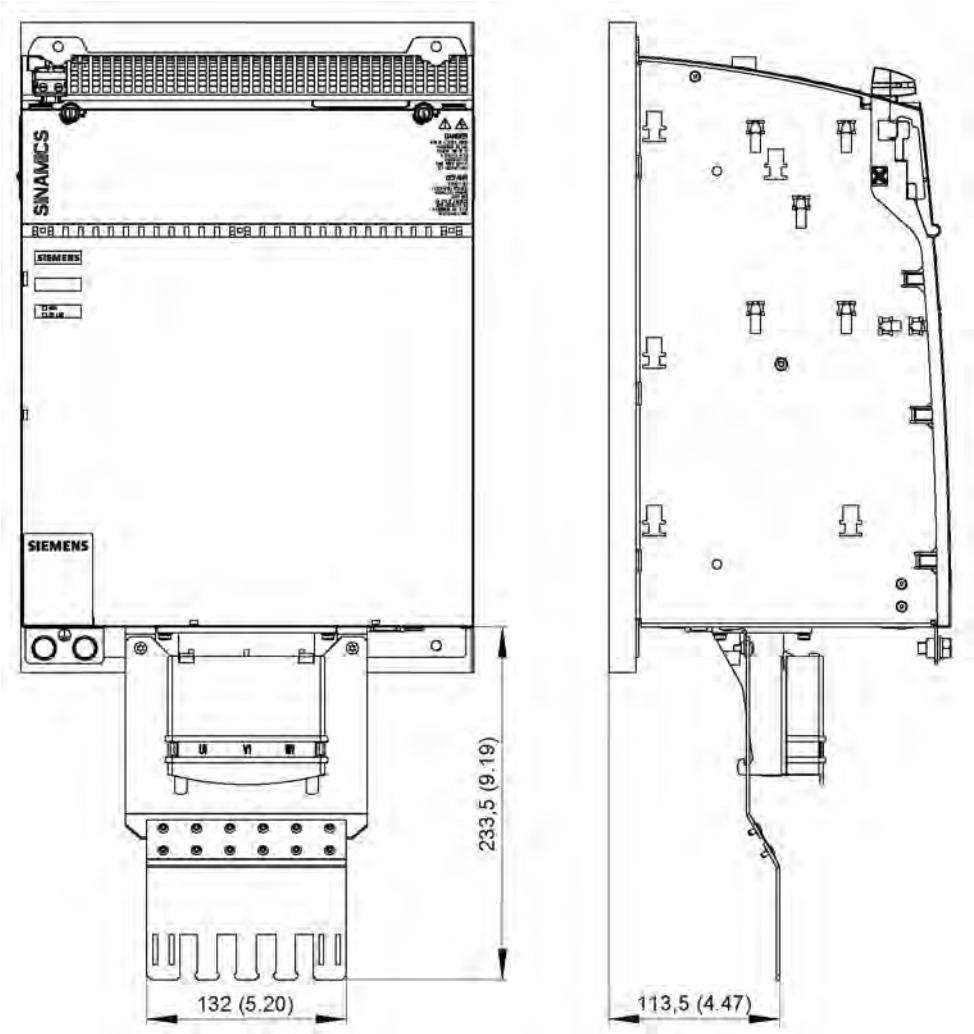


Figure 11-16 Dimension drawing of shield connecting plate on a 300 mm component with cold plate, all dimensions in mm and (inches)

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11.1.4.4 Line Modules and Motor Modules, Liquid Cooled

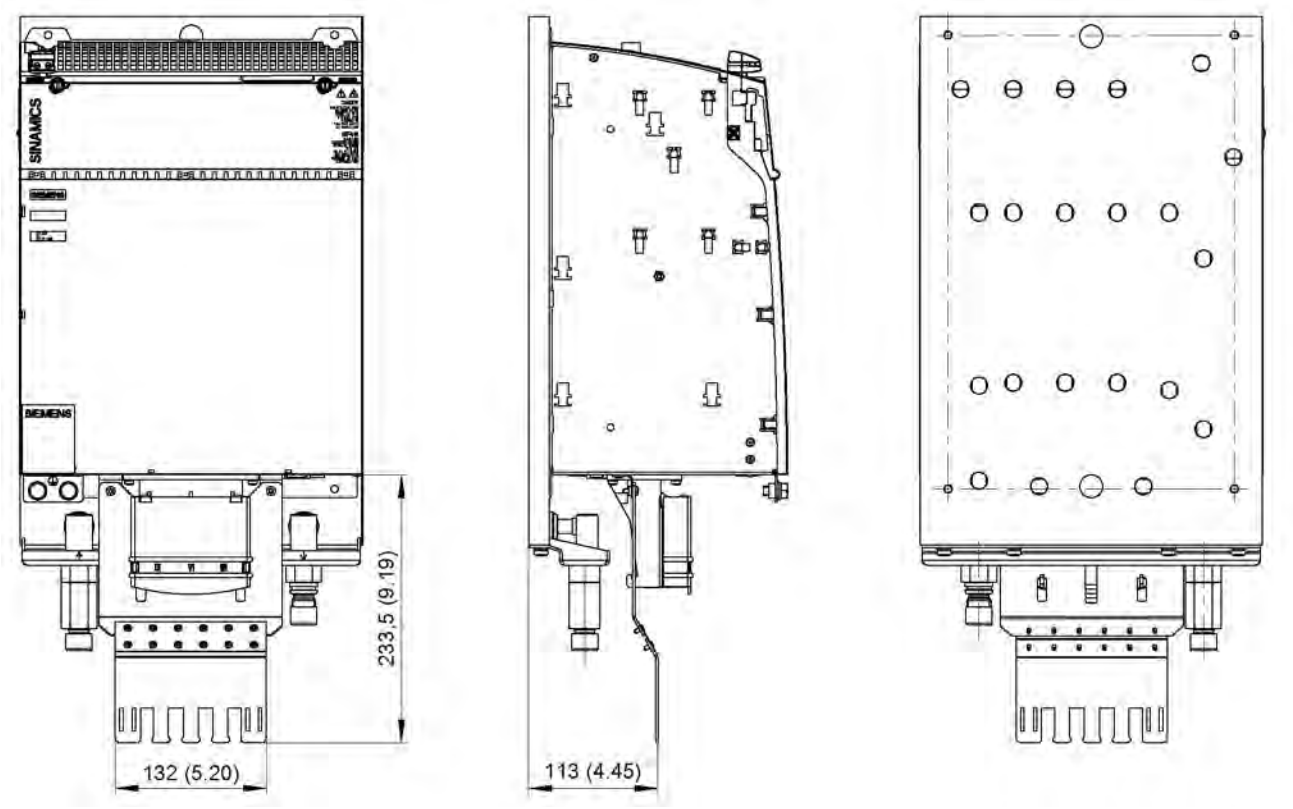


Figure 11-17 Dimension drawing of shield connecting plate on a 300 mm Liquid Cooled component, all dimensions in mm and (inches)

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11.1.4.5 Active Interface Modules

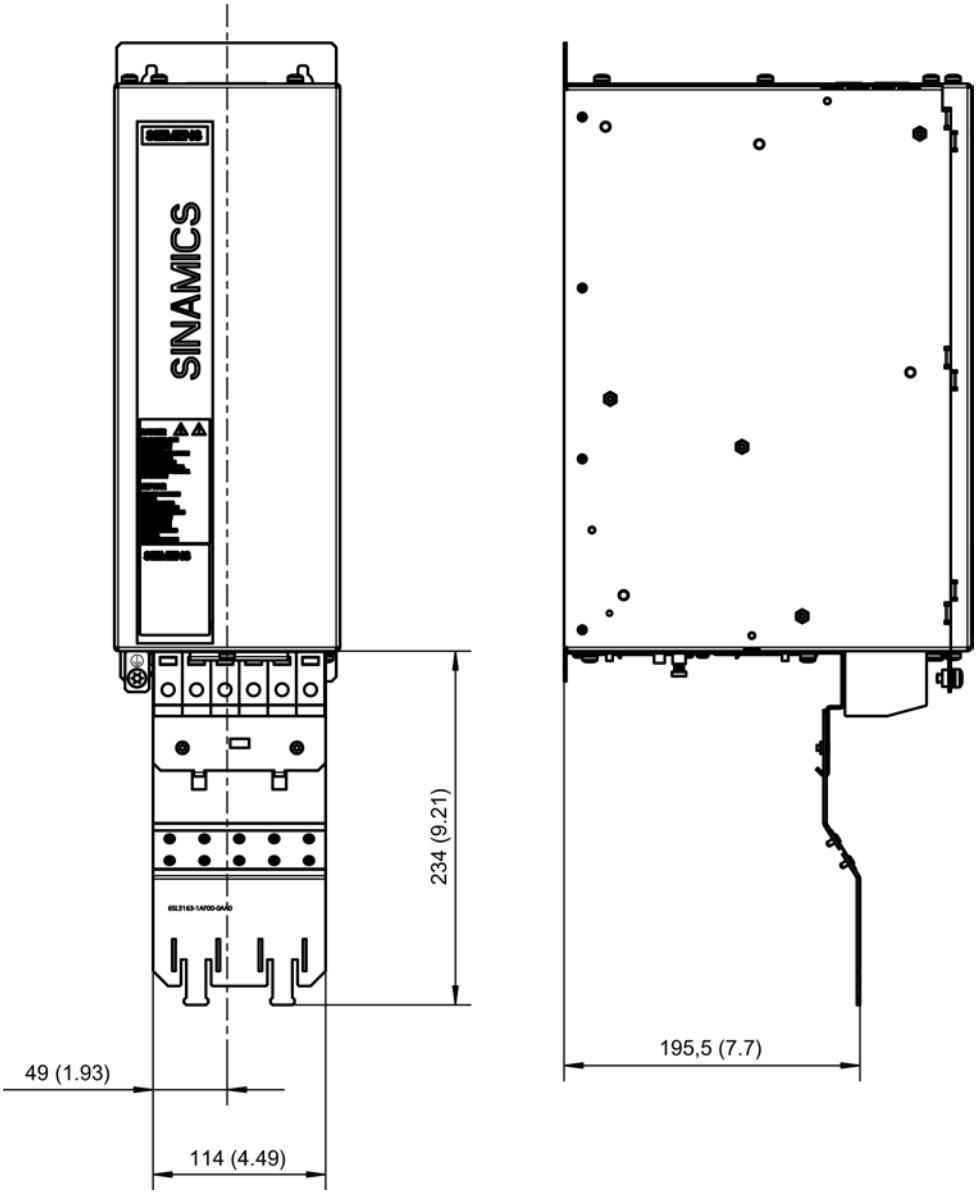


Figure 11-18 Dimension drawing of shield connecting plate on the 36 kW Active Interface Module, all dimensions in mm and (inches)

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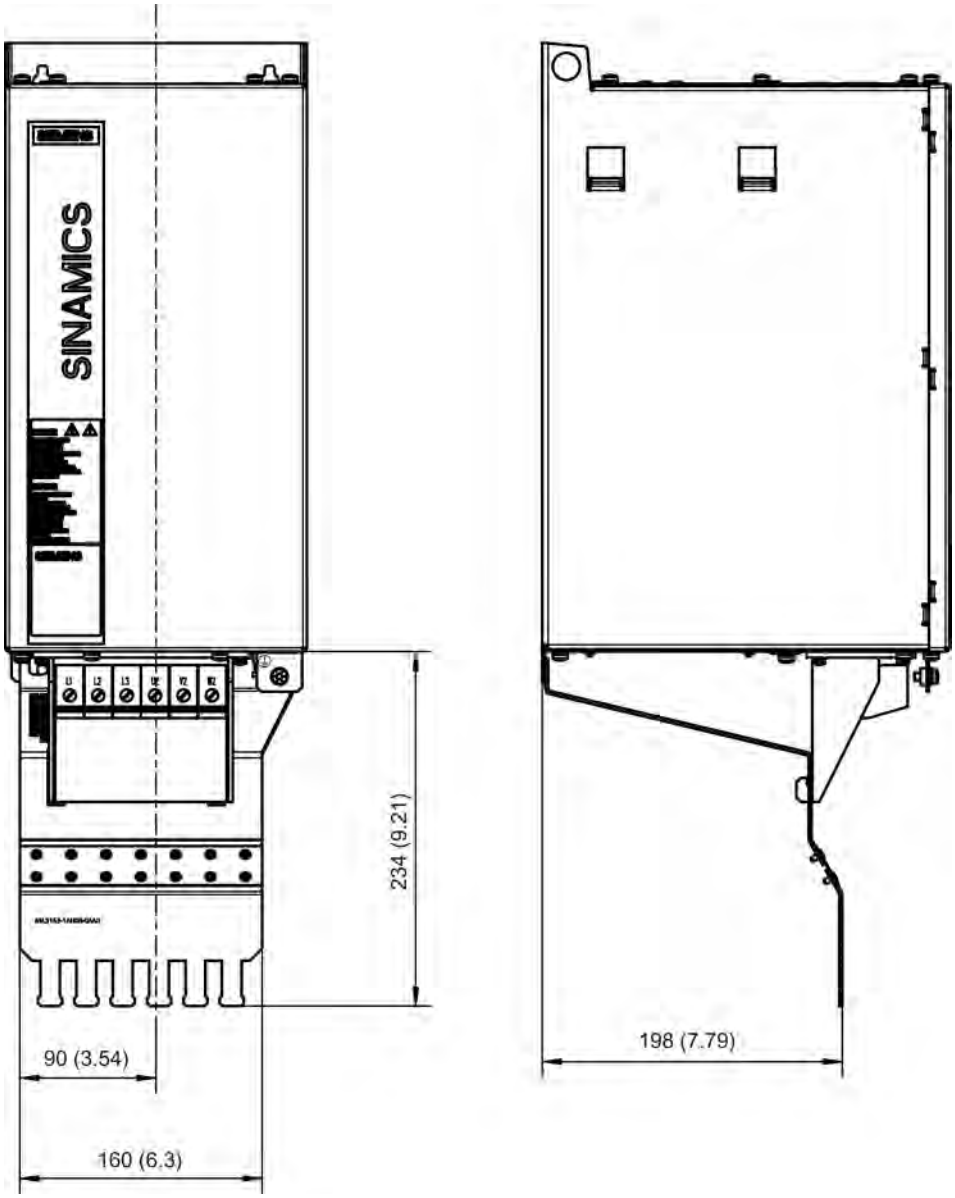


Figure 11-19 Dimension drawing of shield connecting plate on the 55 kW Active Interface Module, all dimensions in mm and (inches)

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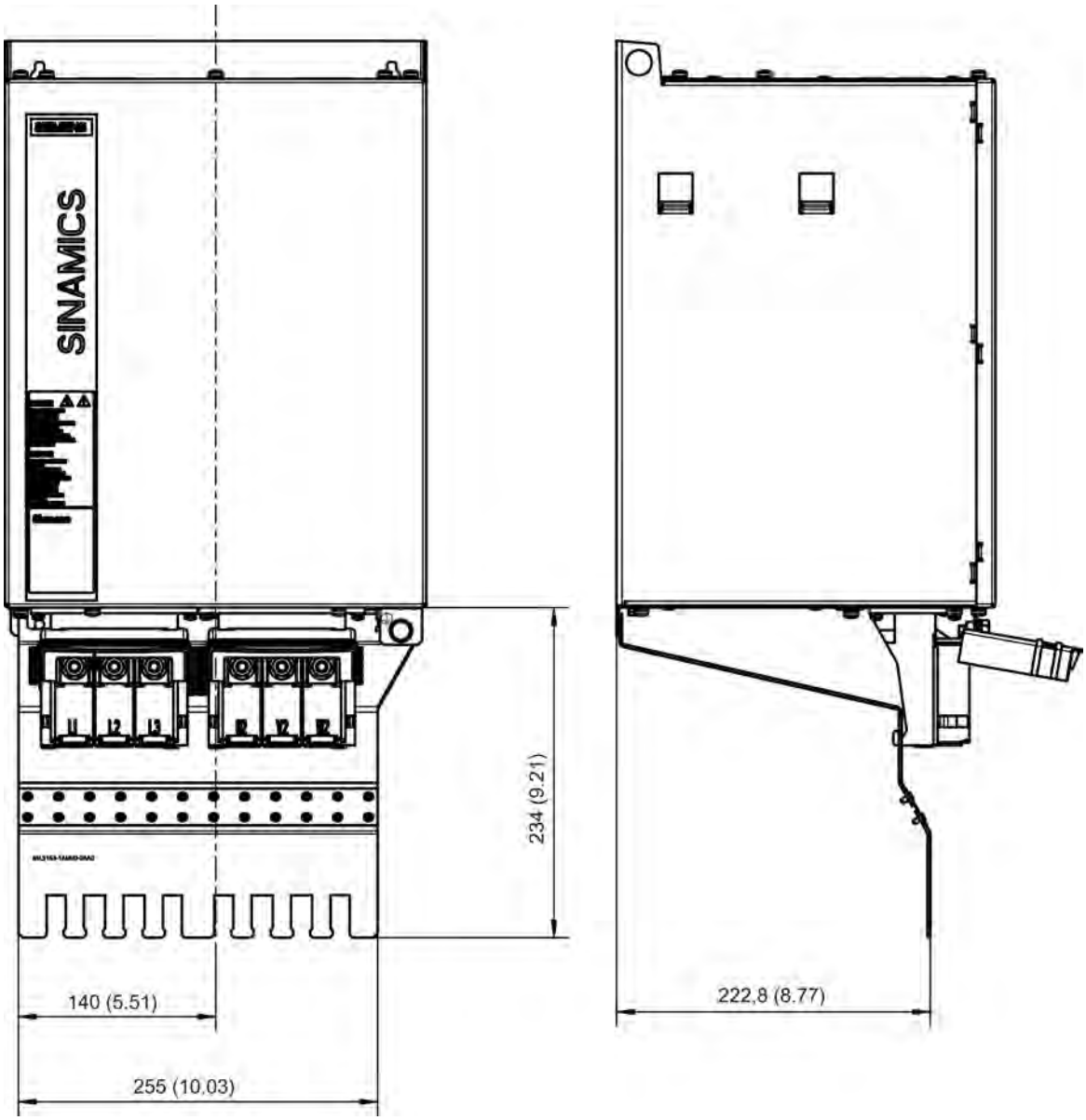


Figure 11-20 Dimension drawing of shield connecting plate on the 80 and 120 kW Active Interface Module, all dimensions in mm and (inches)

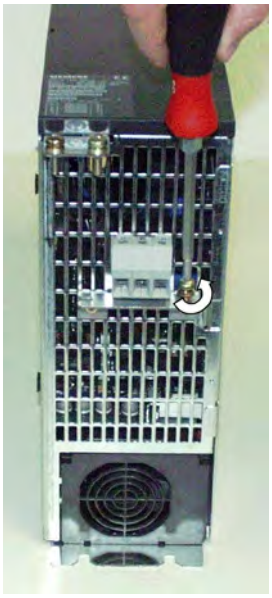
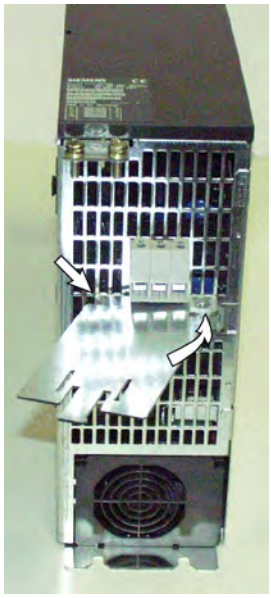
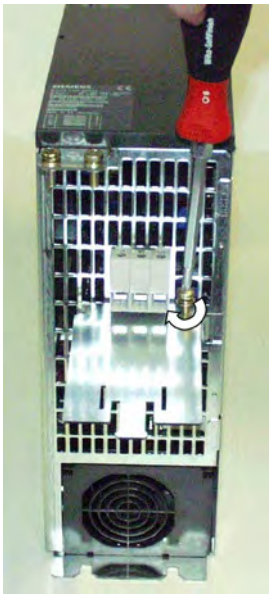
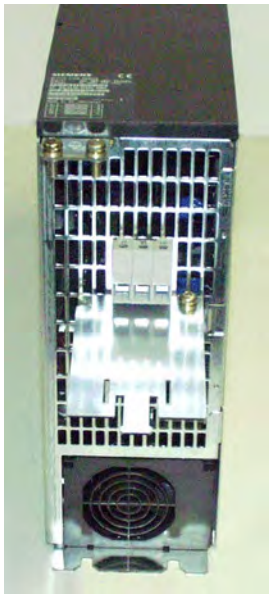
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11.1.5 Installation

Tools required:

- Torx screwdriver T25 for shield connecting plate

Table 11- 5 Installing the shield connecting plate to a 100 mm wide component using as an example, internal air cooling

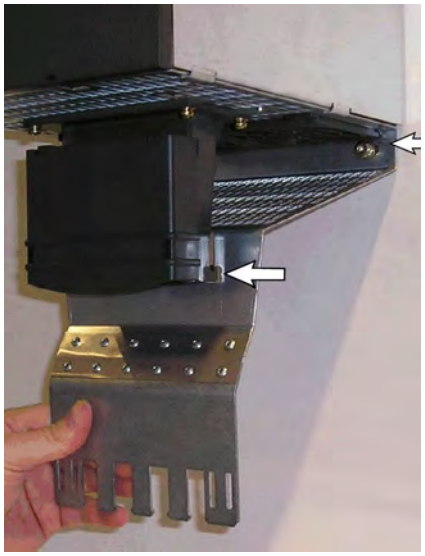
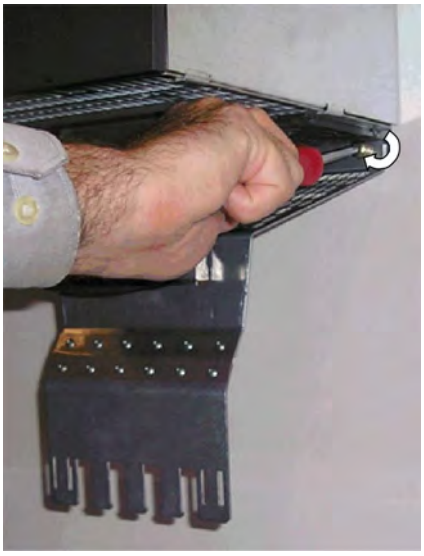
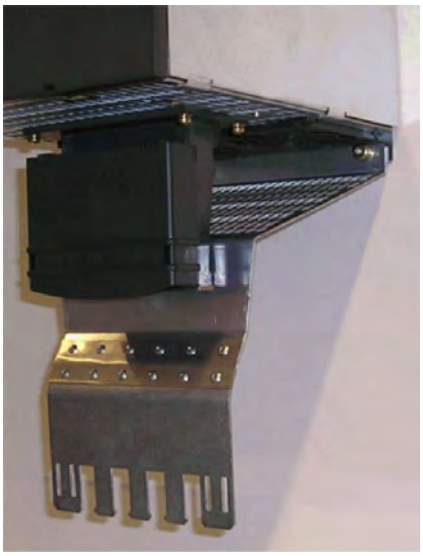
			
Remove the screw.	Engage the shield connecting plate.	Tighten the shield connecting plate. Tightening torque: 3 Nm	Installed shield connecting plate

Tools required:

- Screwdriver for fixing screws used

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Table 11- 6 Installing the shield connecting plate to a 200 mm wide component using as an example internal air cooling

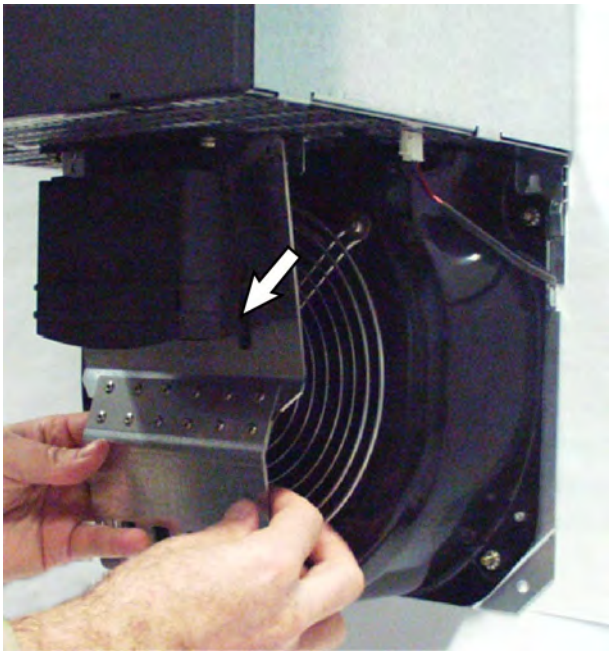
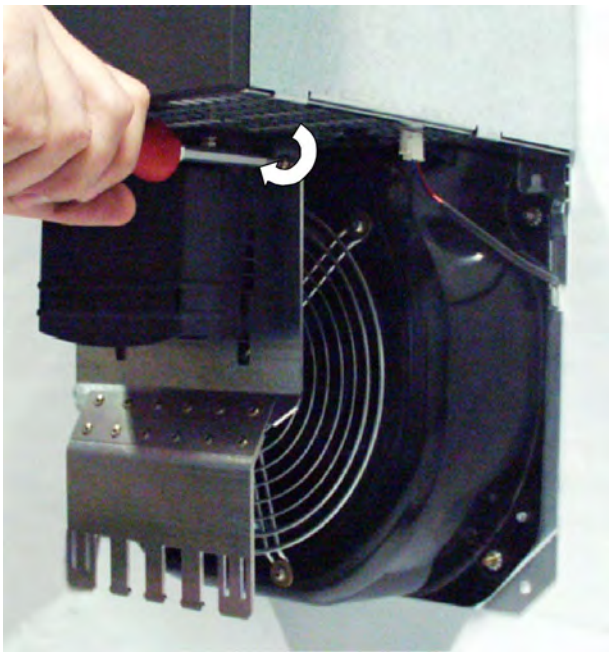
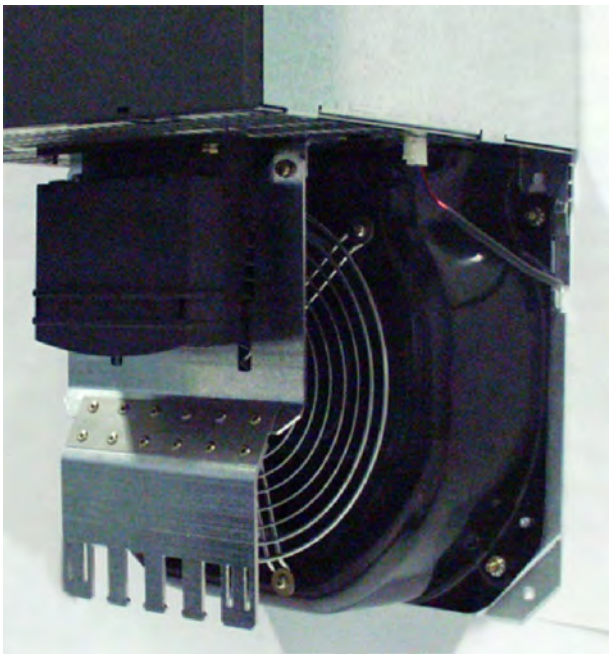
		
Loosen the lower screw.	Engage the shield connecting plate into the screws and at the line/motor connection	Secure the shield connecting plate by pulling it to the left
		
Tighten the shield connecting plate. Tightening torque: 6 Nm	Installed shield connecting plate	

Tools required:

- Torx screwdriver T25 for shield connecting plate

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Table 11- 7 Installing the shield connecting plate to a 300 mm wide component using as an example internal air cooling

	
Remove the screw.	Engage the shield connecting plate into the line/motor connection
	
Tighten the shield connecting plate. Tightening torque: 3 Nm	Installed shield connecting plate

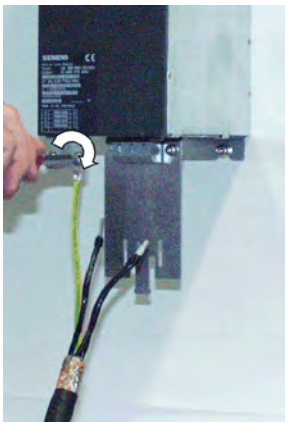
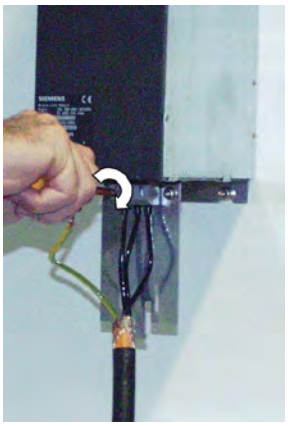
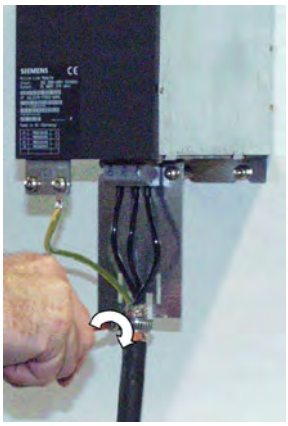
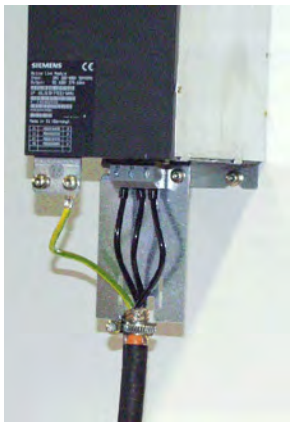
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11.1.6 Connecting the power cables

Required tools:

- Torx screwdriver T25 for protective conductor connection (Torx slot)
- Flat-bladed screwdriver size 4 for power cables
- Flat-bladed screwdriver for hose clamp

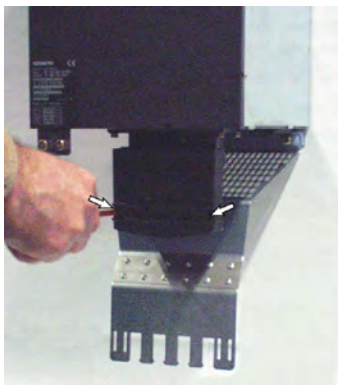
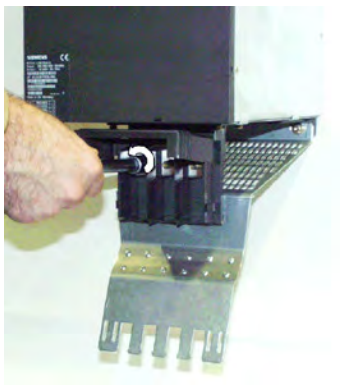
Table 11- 8 Connecting power cables for a 100 mm wide component using internal air cooling as an example

			
Attach the protective conductor (PE) Tightening torque: 3 Nm	Attach the power cable. Tightening torque: 1.8 Nm	Tighten the hose clamp at the shield connecting plate.	The power cable is connected.

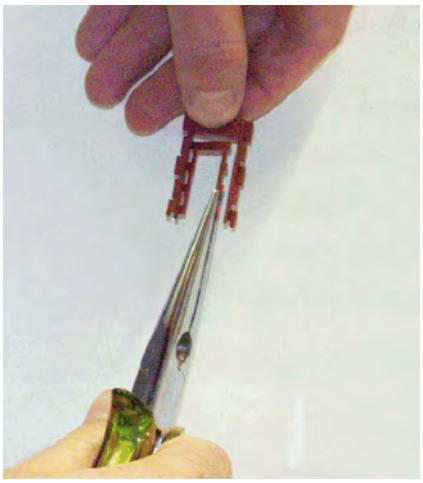
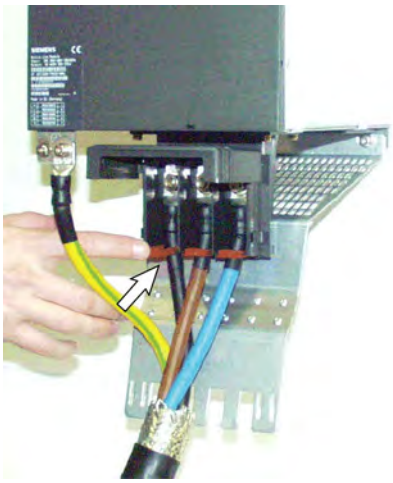
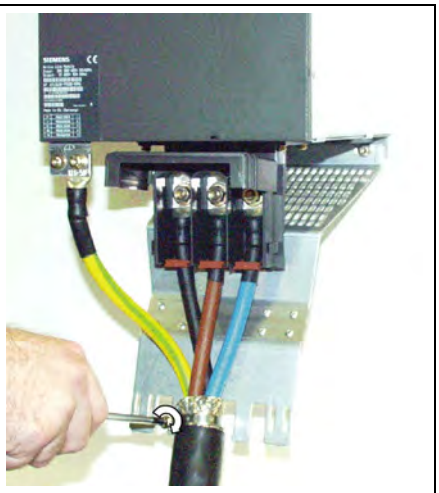
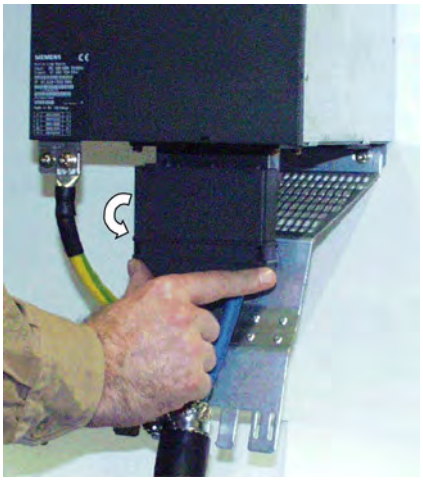
Required tools:

- Torx screwdriver T25 for protective conductor connection (Torx slot)
- (Torque) wrench M8 for power cables
- Flat-bladed screwdriver for hose clamp

Table 11- 9 Connecting power cables for a 200 mm wide component using internal air cooling as an example

		
Release and open the cover of the terminal strip.	Remove the M8 screws.	Attach the protective conductor and the power cable. Tightening torque: 13 Nm

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Adapt a restrictor collar (using a suitable tool) for the touch protection.	Push on the reduction collar.	Tighten the hose clamp at the shield connecting plate.
		
Close the cover of the terminal strip.		

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11.2 Releasing the DC link protective cover

The protective covers for the DC link on the SINAMICS S120 components feature an interlocking mechanism, which is operated using a flat bladed screwdriver (1 x 5.5).

Table 11- 10 Opening the protective cover for the DC link using a screwdriver

		
Protective cover with interlock mechanism	To open the protective cover, use the screwdriver to slightly turn the interlocking screw in the direction of the arrow (counter-clockwise)	Opened protective cover

To lock, press the protective cover back on until you hear the interlock engage.

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11.3 Reinforced DC link busbars

11.3.1 Description

Reinforced DC-link busbars are available for 50 mm and 100 mm wide components of the Booksize and Booksize Compact series. They are used to increase the current carrying capacity of the components used to conduct the DC-link current from 100 A to 150 A.

Table 11- 11 Reinforced DC-link busbars

Reinforced DC-link busbars	Order number
Suitable for 50 mm components	6SL3162-2DB00-0AAx
Suitable for 100 mm components	6SL3162-2DD00-0AAx

Notes on configuration and arrangement of the components in the drive line-up can be found in the Chapter, Arrangement of components and devices (Page 696).

Note

DC-link rectifier adapter / DC-link adapter

The following must be taken into account when using reinforced DC-link busbars:

- It is not possible to use a DC-link rectifier adapter!
- Use DC-link adapter 6SL3162-2BM10-0AA0 (2-hole adapter).

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11.3.2 Safety instructions for reinforced DC link busbars

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.



⚠DANGER

Danger to life through electric shock due to the residual charge of the DC link capacitors

Because of the DC link capacitors, a hazardous voltage is present for up to five minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.



⚠DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Contact with live parts can result in death or serious injury.

- Only operate the components with closed protective cover.



⚠WARNING

Danger to life through electric shock due to incorrectly installed DC link bridges

Incorrectly installed DC link bridges **at the left-hand end of the drive line-up** can cause an electric shock.

- For all 50 mm wide modules[1] (exception: Smart Line Module[2]), remove the DC link bridge, including the screws. Do not tighten the screws without the DC link bridges.
- For all components that are 75 mm wide or wider, the DC link bridges may neither be swung over to the left nor removed[3].

[1] For 50 mm wide modules, the DC link bridge cannot be swung inwards.
[2] Smart Line modules do not have a DC link bridge.
[3] The DC link bridge guarantees the mechanical stability of the DC link busbars.

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11.3.3 Dimension drawings

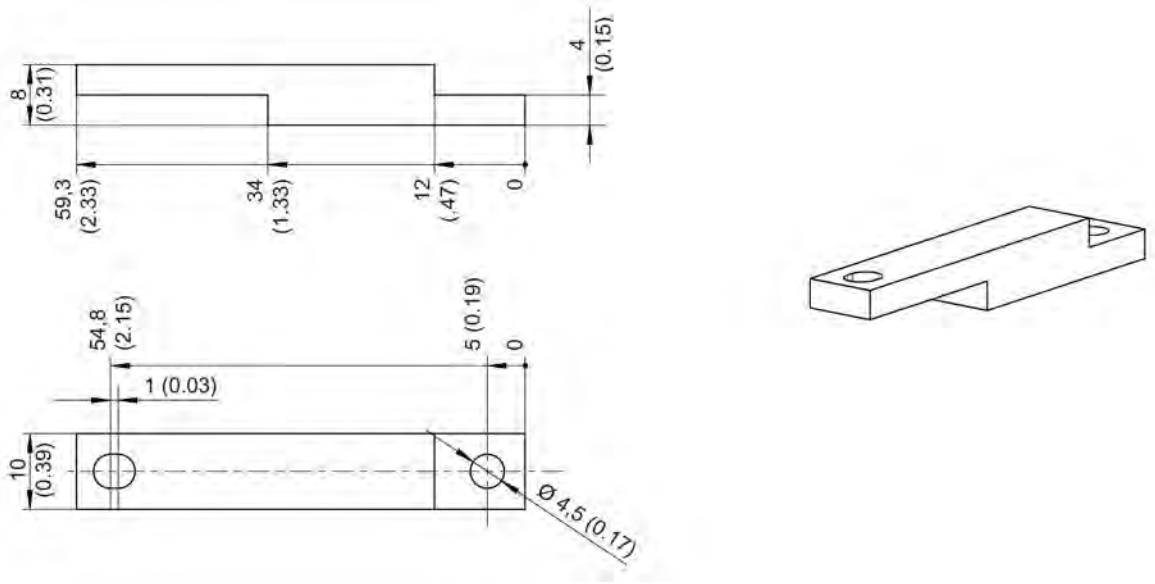


Figure 11-21 Dimension drawing of reinforced DC link busbar 50 mm, all dimensions in mm and (inches)

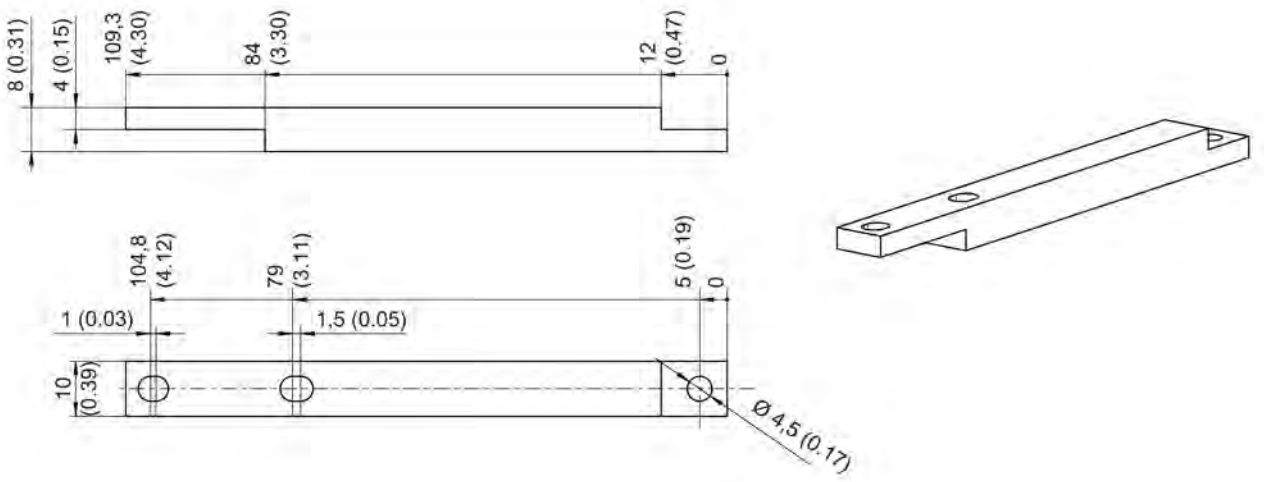


Figure 11-22 Dimension drawing of reinforced DC link busbar 100 mm, all dimensions in mm and (inches)

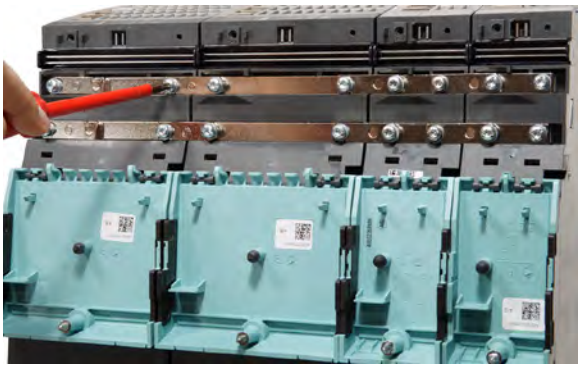
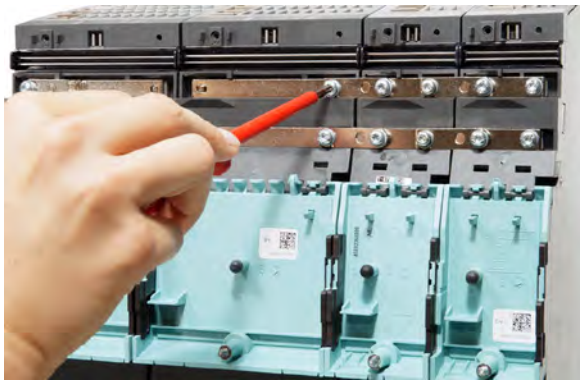
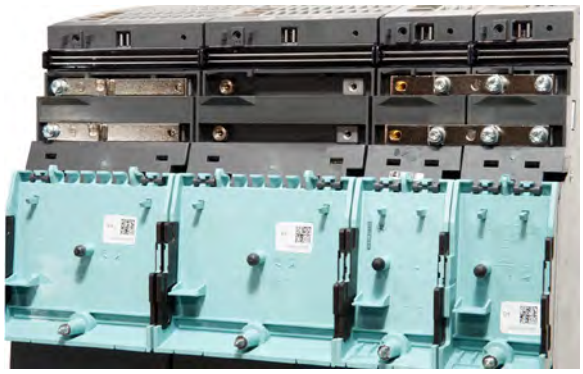
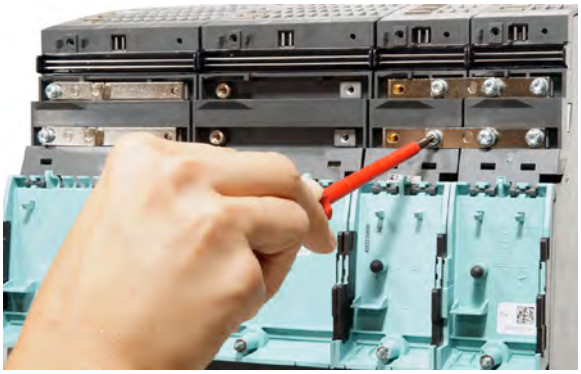
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11.3.4 Removing the DC link busbars

Required tools:

- Torx screwdriver T20 for DC link screws (Torx slot)

Table 11- 12 Removing the DC link busbars

	
Remove the installed DC link bridges and busbars, starting at the second component. Do not remove the DC link bridge and the busbars of the first component.	Loosen the screws and remove the installed DC link bridge of the component.
	
Remove the DC link busbar of the component.	
	
Release the screws and remove the DC link bridges and busbars at all of the other components.	View with the DC link busbars removed

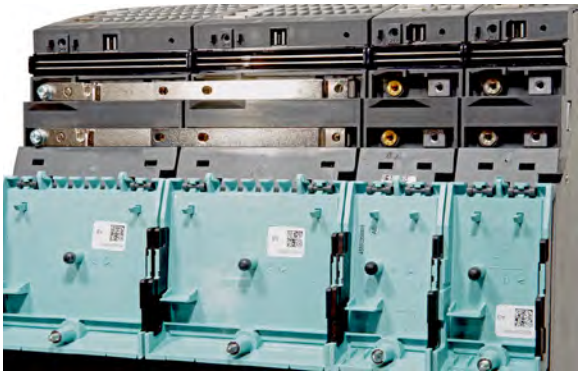
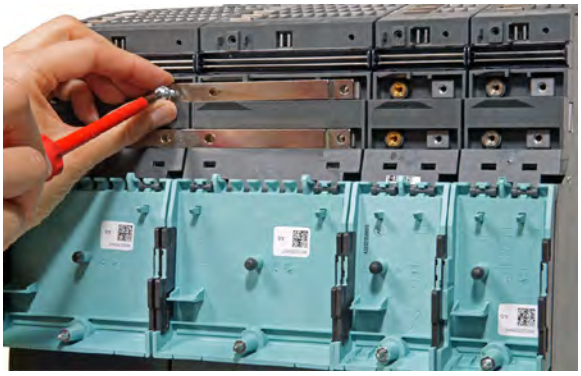
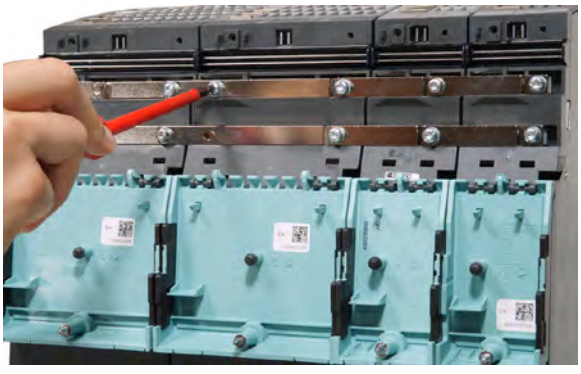
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11.3.5 Installing the reinforced DC link busbars

Required tools:

- Torx screwdriver T20 for DC link screws (Torx slot)

Table 11- 13 Installing the reinforced DC link busbars

	
Install the reinforced DC link busbars, starting at the left.	
	
Attach the DC link busbars using the original M4x20 screws at the right-hand side of the component. Do not tighten the screws with their final tightening torque.	Install the reinforced DC link busbars, and attach these at the right-hand side of all of the remaining components.
	
For 100 mm wide components, additionally attach the DC link busbars using the original M4x16 screws at the left-hand side of the component. Finally tighten the screws with 1.8 Nm + 30 %.	View of the mounted reinforced DC link busbars with 24 V connectors and 24 V terminal adapter

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Note

To connect the 24 V busbars of the individual components, use the red 24 V connector provided in the accessories pack.

11.4 DC link rectifier adapter for Booksize format

11.4.1 Description

The DC link rectifier adapter supplies the DC link voltage directly. It is best used for supplying an individual component. With a direct supply, each component is connected to the DC link separately. The internal DC link busbar is not used here.

If the DC link rectifier adapter is to be used for supplying several components, it is important to remember that it can only be installed on the component on the far right. The choice of connection cable diameter should be based on the required summation current for all the connected components.

The connection cables must be fused accordingly.

Mounting on components with reinforced DC link busbars is **not** possible.

Note

When a DC link rectifier adapter and DC busbars are used, the limit values for radio interference suppression under Category C2 according to EN 61800-3 can no longer be observed.

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Table 11- 14 Available DC link rectifier adapters

Order number	Screw terminals	Used for Line/Motor Modules with these sizes
6SL3162-2BD00-0AA0	0.5 … 10 mm²	50 mm, 100 mm
6SL3162-2BM00-0AA0	35 … 95 mm²	150 mm, 200 mm, 300 mm



DC link rectifier adapter
6SL3162-2BD00-0AA0



DC link rectifier adapter
6SL3162-2BM00-0AA0

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11.4.2 Safety instructions for DC link rectifier adapters

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.



⚠DANGER

Danger to life through electric shock due to the residual charge of the DC link capacitors

Because of the DC link capacitors, a hazardous voltage is present for up to five minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.



⚠DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Contact with live parts can result in death or serious injury.

- Only operate the components with closed protective cover.



⚠WARNING

Danger to life through electric shock due to incorrectly installed DC link bridges

Incorrectly installed DC link bridges **at the left-hand end of the drive line-up** can cause an electric shock.

- For all 50 mm wide modules[1] (exception: Smart Line Module[2]), remove the DC link bridge, including the screws. Do not tighten the screws without the DC link bridges.
- For all components that are 75 mm wide or wider, the DC link bridges may neither be swung over to the left nor removed[3].

[1] For 50 mm wide modules, the DC link bridge cannot be swung inwards.
[2] Smart Line modules do not have a DC link bridge.
[3] The DC link bridge guarantees the mechanical stability of the DC link busbars.

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⚠WARNING

Fire hazard and device damage through ground fault / short-circuit

The DC link connection cables must be laid so that a ground fault or short-circuit is impossible. A ground fault can cause a fire with smoke development.

- Use the local installation regulations to avoid this fault.
- Protect the cables against mechanical damage.

Also implement one of the following measures:

- Use cables with double insulation.
- Maintain adequate clearance, e.g. by using spacers.
- Lay the cables in separate cable ducts or conduits.

⚠WARNING

Fire hazard due to overheating when permissible cable lengths are exceeded

Excessively long cable lengths can cause components to overheat with the associated risk of fire and development of smoke.

- The total length of the DC link (including the connection cables) must not exceed 10 m.



⚠WARNING

Danger to life through electric shock due to incorrectly laid 24 V supply cables

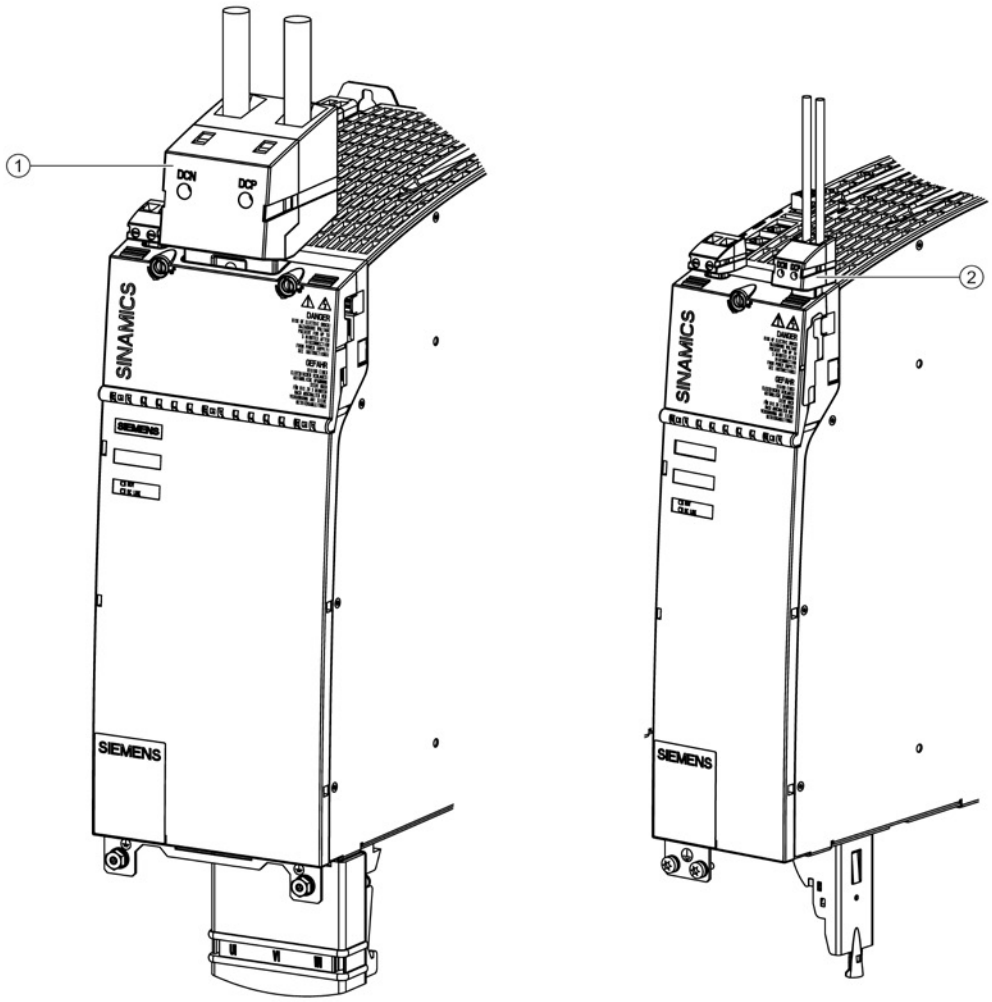
If supply cables are laid without safe electrical separation, the insulation can fail with an electric shock.

- Maintain a clearance of at least 100 mm between the 24 V supply cables and the DC link connecting cables.
- Or use cables with double insulation (e.g. sheathed cables) for the 24 V supply cables.

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11.4.3 Interface description

11.4.3.1 Overview



① DC link rectifier adapter (35 to 95 mm²) on a 150 mm component
② DC link rectifier adapter (0.5 to 10 mm²) on a 100 mm component

Figure 11-23 Installed DC link rectifier adapter, using the example of components with a width of 100 mm and 150 mm

11.4.3.2 DC link connection

Table 11- 15 DC link rectifier adapter – description of the terminals

Terminal	Function	Technical data
DCP	DC link positive	**Supply voltage:** 720 V-VDE/600 V-UL
DCN	DC link negative	

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11.4.4 Dimension drawings

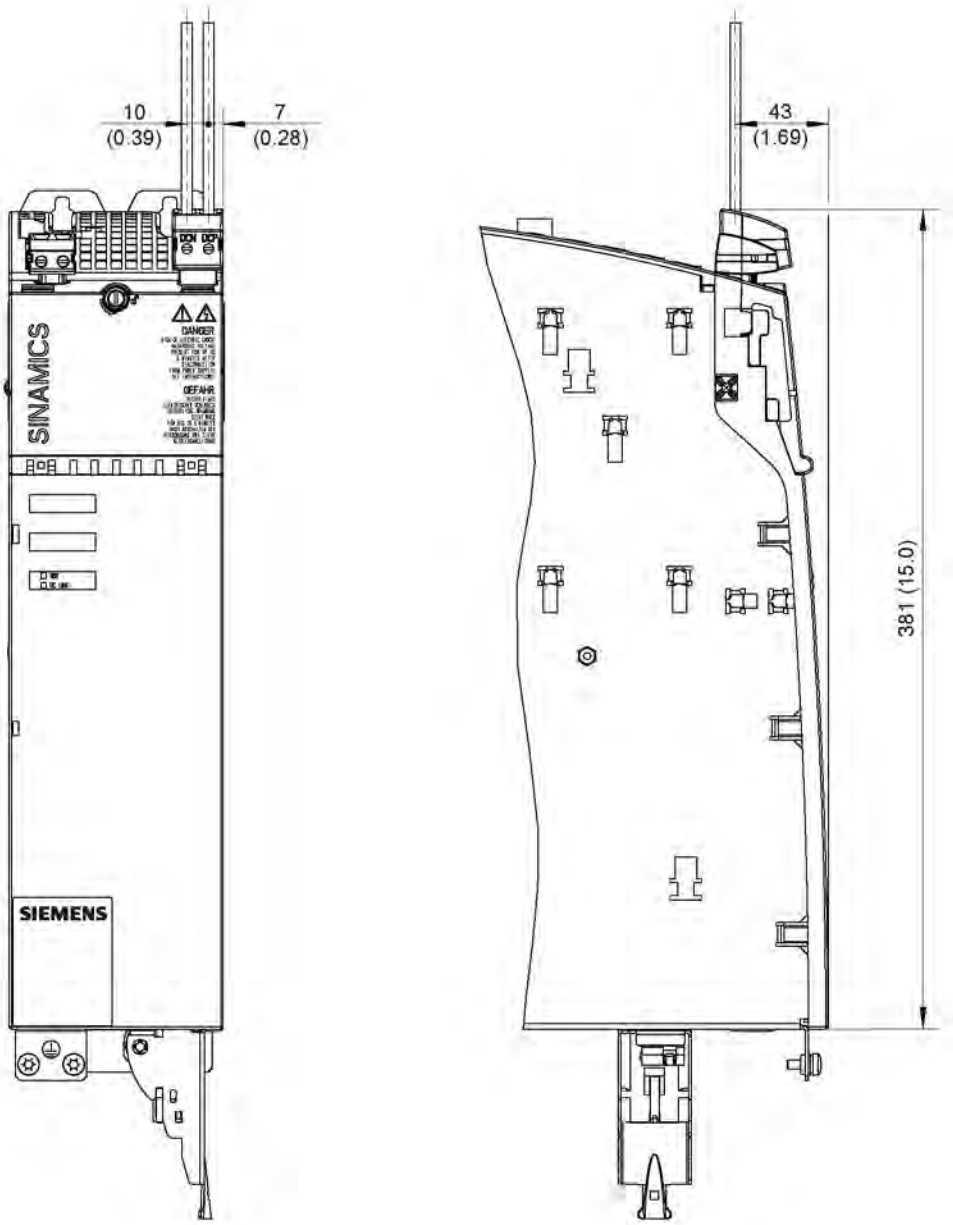


Figure 11-24 Dimension drawing of 100 mm wide component with DC link rectifier adapter for 0.5 to 10 mm², all dimensions in mm and (inch)

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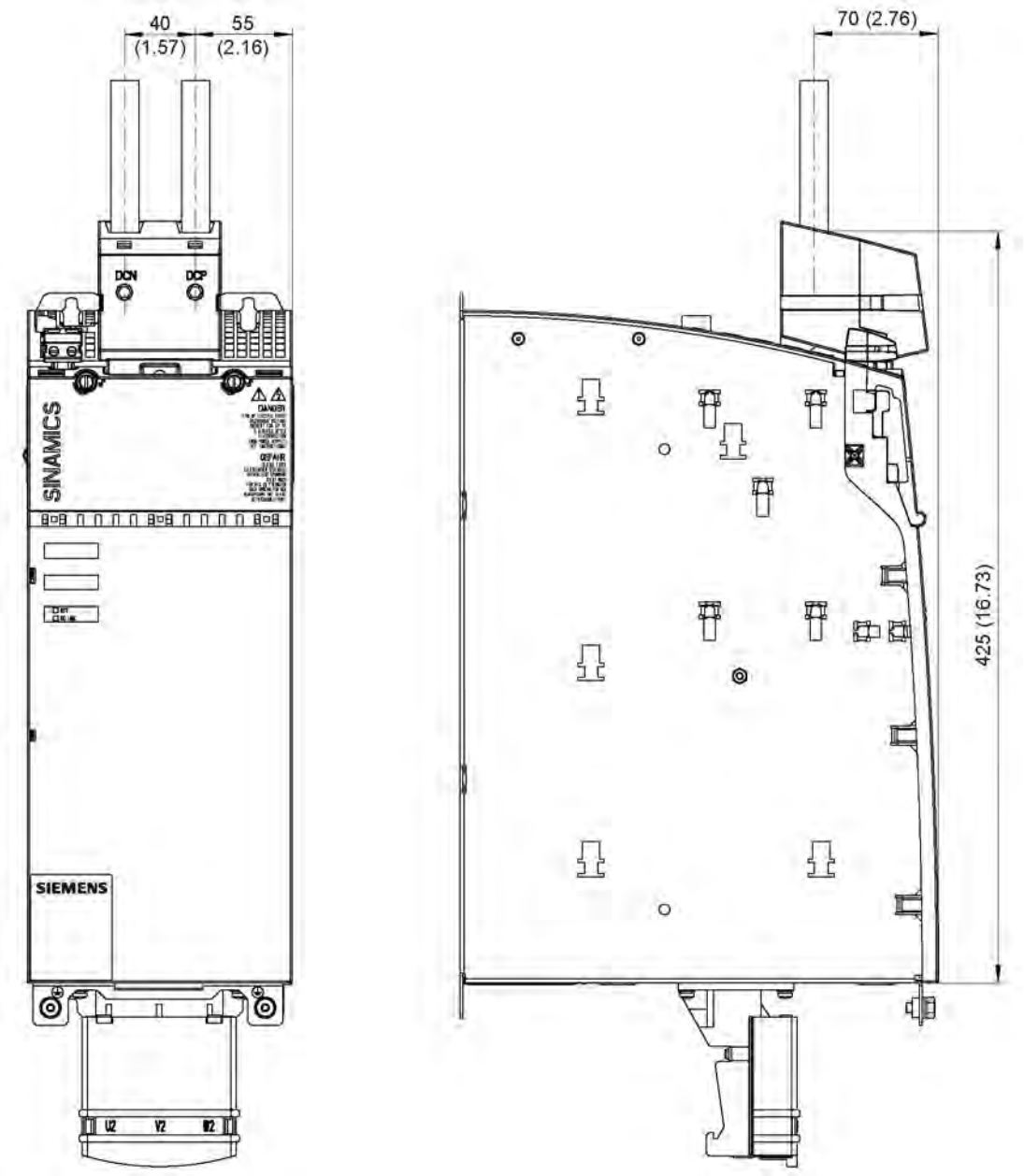


Figure 11-25 Dimension drawing of 150 mm wide component with DC link rectifier adapter for 35 to 95 mm², all dimensions in mm and (inch)

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11.4.5 Mounting



WARNING

Danger to life through electric shock if the cutout in the protective cover has been broken out

If the 24 V terminal adapter or the DC link infeed adapter is removed, and you touch live parts this will result in death or severe injury.

- Replace the protective cover with the broken out cutouts by a new protective cover.

11.4.5.1 Installation on components that are 50 mm and 100 mm wide

Required tools:

- Slot-head screwdriver (1 x 5.5) for releasing the protective cover
- Torx T10 screwdriver to fasten the 24 V terminal adapter
- Torx screwdriver T20 for DC link screws (Torx slot)
- Pliers for breaking out the cutouts

Table 11- 16 Removing the DC link busbars

		
Release and open the protective cover.	Remove the upper left-hand screw and the DC link bridge	Remove the lower left-hand screw and the DC link bridge

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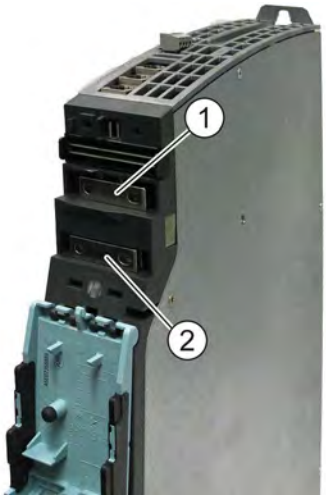
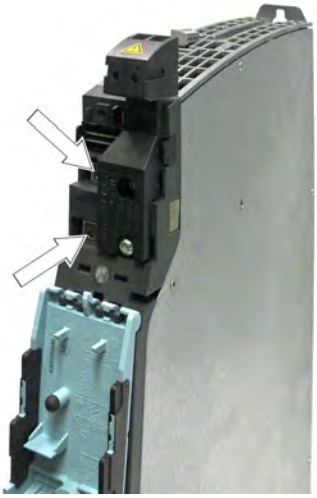
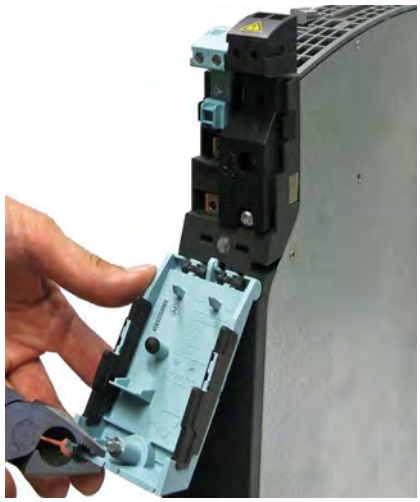
		To install the DC link rectifier adapter, it is essential to leave the DC link busbars ① and ② in the components (hold firmly to prevent them falling out).
Remove the upper and lower right-hand DC link screws.		

Table 11- 17 Installing the DC link rectifier adapter and 24 V terminal adapter

		
Attach and screw (upper and lower screws) the DC link rectifier adapter at the right-hand side of the component using the original M4x20 screws.	Do **NOT** use the screw holes at the left-hand side of the component.	Attach and screw on the 24 V terminal adapter using the associated screw (provided in the accessories pack).

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Break out the cutouts in the protective cover.	Close the protective cover until you hear it snap into place.	Component with installed DC link rectifier adapter and 24 V terminal adapter

11.4.5.2 Installation on components that are 150 mm, 200 mm and 300 mm wide

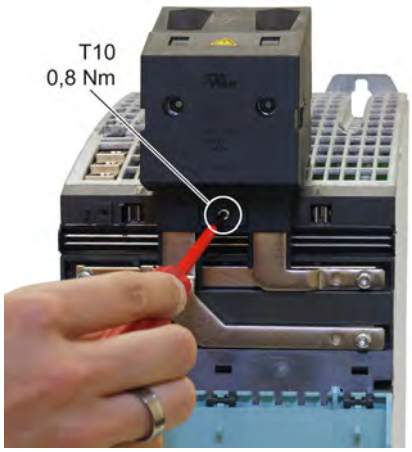
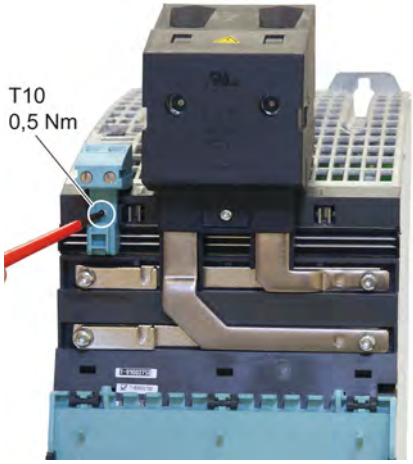
Required tools:

- Slot-head screwdriver (1 x 5.5) for releasing the protective cover
- Torx T10 screwdriver to attach the adapter
- Torx screwdriver T20 for DC link screws (Torx slot)
- Pliers for knocking out the cutouts

Table 11- 18 Installation of the DC link rectifier adapter for 150 mm, 200 mm and 300 mm components

		
Release and open the protective cover.	Remove the DC link screws.	Engage the adapter in the grille.

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Attach the adapter busbars using the previously removed DC link screws.	Attached the adapter with the associated screw (accessories pack).	Insert and screw on the 24 V terminal adapter using the associated screw (provided in the accessories pack).
		
Break out the cutouts in the protective cover.	Close the protective cover until you hear it snap into place.	

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11.4.6 Electrical connection

Required tools:

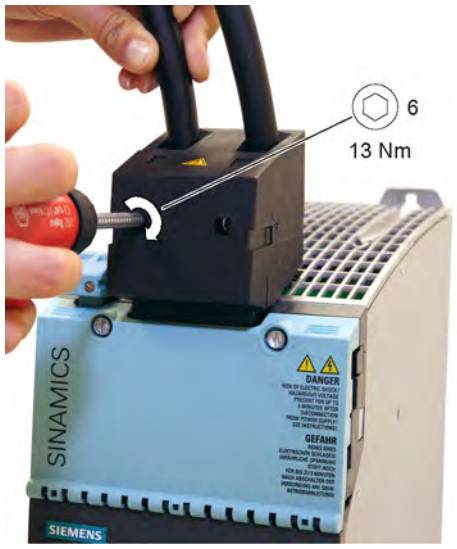
- Flat-bladed screwdriver (0.8 x 4.0) for 50 mm and 100 mm components
- Size 6 Allen key for 150 mm, 200 mm and 300 mm components

Table 11- 19 Electrically connecting the DC link rectifier adapter for 50 mm and 100 mm components

	
Install the cables at the DC link rectifier adapter (0.8 x 4.0).	Connected DC link rectifier adapter

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Table 11- 20 Electrically connecting the DC link rectifier adapter for 150 mm, 200 mm and 300 mm components

	
Install the cables at the DC link rectifier adapter (hexagon socket-head screw)	Connected DC link rectifier adapter

11.4.7 Technical specifications

Table 11- 21 Technical data DC link rectifier adapter

DC link rectifier adapter	Unit	6SL3162-2BD00-0AA0	6SL3162-2BM00-0AA0
Current carrying capacity	A	43	240
Connection cross-section	mm²	0.5 … 10	35 … 95
Stripped length	mm	11	27
Attaching - Terminals - DC link busbars		 Slotted screw (0.8 x 4.0) Torx screw T20	 Hexagonal screw, size 6 Torx screw T20
Tightening torque - Terminals - DC link busbars	 Nm Nm	 1,8 1,8	 13 1,8

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11.5 DC link adapter

11.5.1 Description

DC-link adapters are required if the drive line-up is to be subdivided between two or more rows.

The 6SL3162-2BM01-0AA0 DC-link adapter can be mounted on all Line Modules and Motor Modules in the Booksize format without reinforced DC-link busbars.

The 6SL3162-2BM10-0AA0 DC-link adapter can be mounted on 50 mm and 100 mm wide Line Modules and Motor Modules in the Booksize format with reinforced DC-link busbars.

To connect the various sub line-ups, use shielded individual conductors that are mechanically secured.



DC-link adapter
6SL3162-2BM01-0AA0

(4-hole adapter)



DC-link adapter
6SL3162-2BM10-0AA0
for installation using reinforced DC-link busbars
(2-hole adapter)

11.5.2 Safety instructions for DC link adapters

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

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DANGER

Danger to life through electric shock due to the residual charge of the DC-link capacitors

Because of the DC-link capacitors, a hazardous voltage is present for up to five minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until five minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC-link terminals.



DANGER

Danger to life through electric shock when the protective cover of the DC link is open

Contact with live parts can result in death or serious injury.

- Only operate the components with closed protective cover.



WARNING

Danger to life through electric shock due to incorrectly installed DC-link bridges

Incorrectly installed DC-link bridges **at the left-hand end of the drive line-up** can cause an electric shock.

- For all 50 mm wide modules[1)] (exception: Smart Line Module[2)]), remove the DC-link bridge, including the screws. Do not tighten the screws without the DC-link bridges.
- For all components that are 75 mm wide or wider, the DC-link bridges may neither be swung over to the left nor removed[3)].

[1)] For 50 mm wide modules, the DC-link bridge cannot be swung inwards.
[2)] Smart Line Modules do not have a DC-link bridge.
[3)] The DC-link bridge guarantees the mechanical stability of the DC-link busbars.



WARNING

Danger to life through electric shock due to missing DC-link side covers

There is a danger of an electric shock through contact when the side covers of the DC link are missing.

- Mount the side covers on the first and last component in the drive line-up.

You can order missing side covers (order number: 6SL3162-5AA00-0AA0).



WARNING

Danger to life through electric shock due to incorrect connection to the DC link

Incorrect connections can lead to overheating and therefore a risk of fire. There is also a risk of an electric shock. This can result in serious injury or death.

- When connecting to the DC link, only use the adapter that has been approved by Siemens (DC-link adapter).

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⚠WARNING

Risk of fire and damage to equipment due to short-circuit /ground fault

The DC-link connection cables must be laid so that a ground fault or short-circuit is impossible. A ground fault can cause a fire with smoke development.

- Protect the cables against mechanical damage.
- Use the local installation regulations to avoid this fault.

Also implement one of the following measures:

- Use cables with double insulation.
- Maintain adequate clearance, e.g. by using spacers.
- Lay the cables in separate cable ducts or conduits.

⚠WARNING

Fire hazard due to overheating when permissible cable lengths are exceeded

Excessively long cable lengths can cause components to overheat with the associated risk of fire and development of smoke.

- Ensure that the total length of the DC link including the connecting cables does not exceed 10 m.

NOTICE

Material damage due to loose power connections

Insufficient tightening torques or vibration can result in faulty electrical connections. This can cause fire damage or malfunctions.

- Tighten all power connections with the specified tightening torques, e.g. line supply connection, motor connection, DC-link connections.
- Check the tightening torques of all power connections at regular intervals and tighten them when required. This applies in particular after transport.

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11.5.3 Interface description

11.5.3.1 Overview

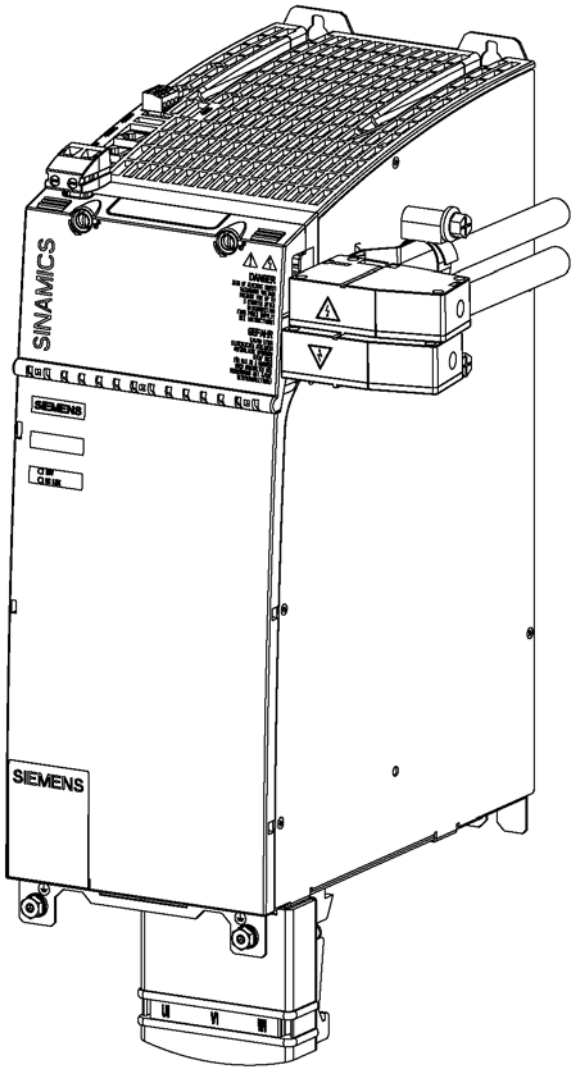


Figure 11-26 150 mm wide components with DC link adapter for multi-tier configurations

11.5.3.2 DC link connection

Table 11- 22 DC link connection

Terminal	Function
DCP	DC link positive
DCN	DC link negative

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⚠WARNING

Danger to life due to electric shock and risk of fire when the necessary clearances and creepage distances are not complied with

When using non-insulated end sleeves, the required clearances and creepage distances are not complied with! This can result in flashover between the cables and the undesirable formation of arcs. As a consequence, there is a risk of electric shock and fire.

- Only use DC link connecting cables with insulated end sleeves.

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11.5.4 Dimension drawing

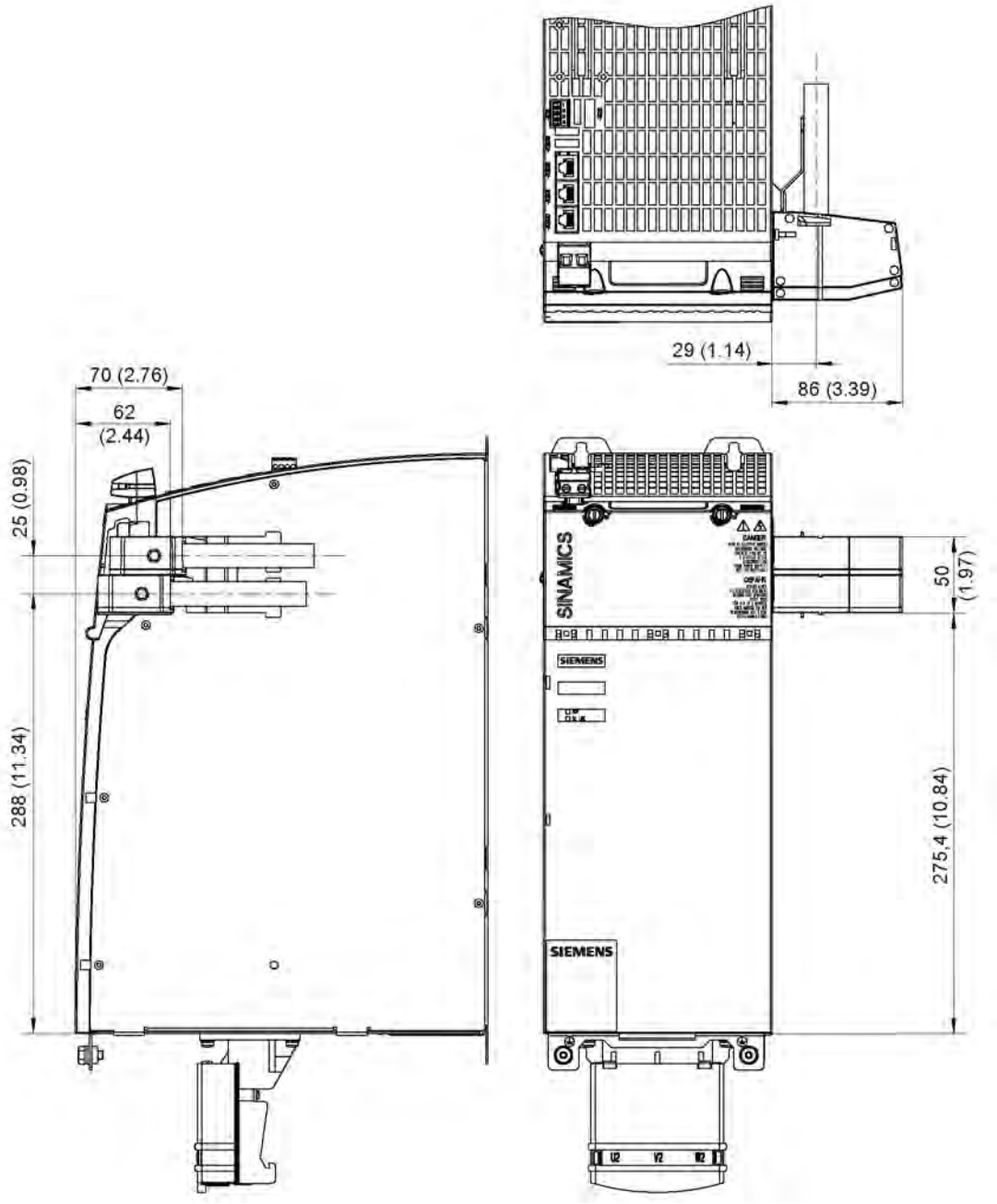


Figure 11-27 Dimension drawing of a 150 mm wide component with DC link adapter, all dimensions in mm and (inches)

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11.5.5 Installation

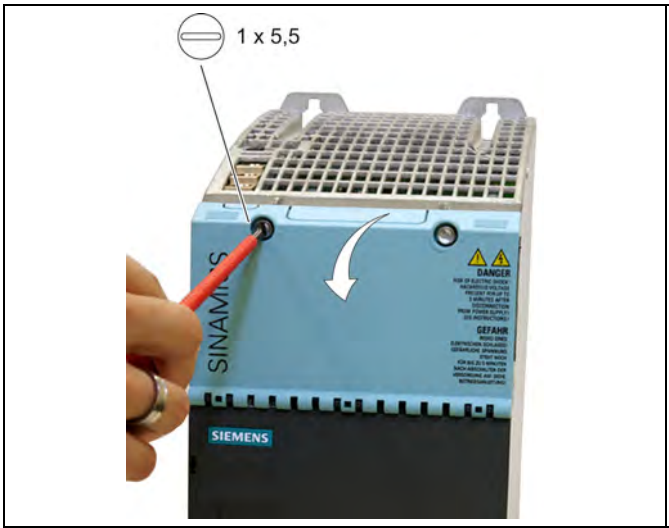
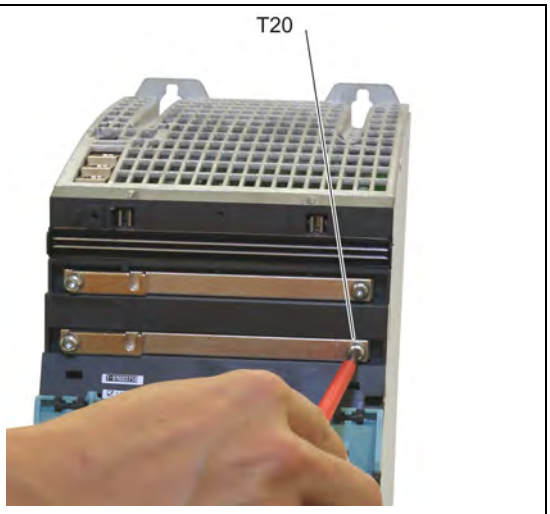
Note

By moving the adapter housing, the DC-link adapter can be fitted on either the left-hand or right-hand side of the component. This configuration is possible for all Active Line Modules.

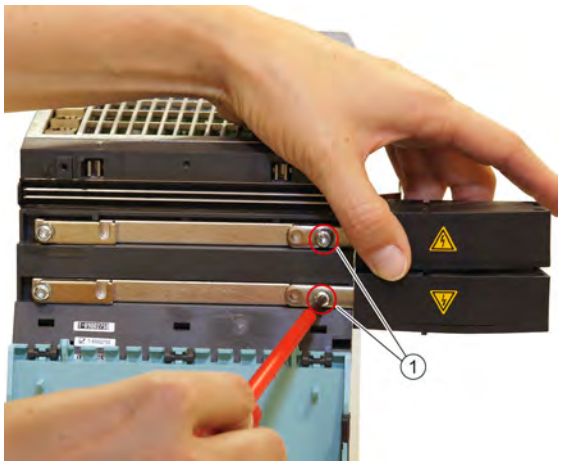
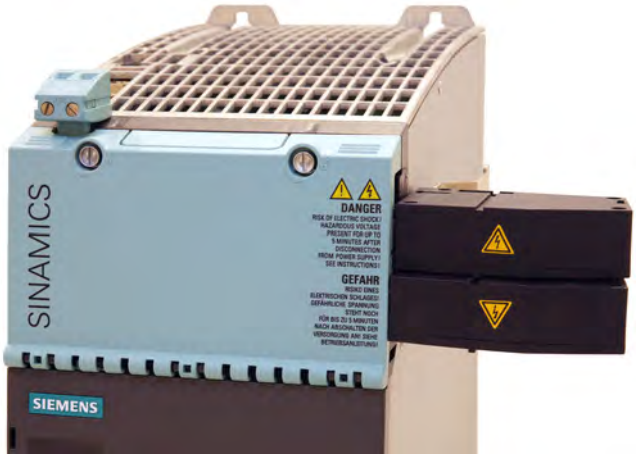
Required tools:

- Slot-head screwdriver (1 x 5.5) for releasing the protective cover
- Torx screwdriver T20 for DC-link screws (Torx slot)

Table 11- 23 Mounting the DC-link adapter

	
Release and open the protective cover of the DC link.	Remove the DC-link screws.

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<table>
<tr><td>
</td><td></td></tr>
<tr><td>Attach the DC-link adapter (1.8 Nm) with the DC-link screws that were previously removed[1)].
Use the right-hand holes ① when using two screws for mounting.
[1)] Observe the special issues when using reinforced DC-link busbar (refer below)</td><td>Remove the DC-link side cover, install the 24 V terminal adapter (if required) and close the protective cover until it audibly clicks into place.</td></tr>
<tr><td>
</td><td></td></tr>
<tr><td>Installed DC-link adapter and
24 V terminal adapter</td><td></td></tr>
</table>

DANGER

Danger to life through electric shock when touching the DC-link busbars

Contact with live parts can result in death or serious injury.

- The DC-link adapters must be installed so that after closing the DC-link cover they cannot be touched!

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⚠WARNING

Danger to life through electric shock due to incorrectly installed DC-link bridges

Incorrectly installed DC-link bridges at the left-hand end of the drive line-up can cause an electric shock.

- For all 50 mm wide modules (exception: Smart Line Modules), remove the DC-link bridge, including the screws. Do not tighten the screws without the DC-link bridges.
- For all components that are 75 mm wide or wider, the DC-link bridges must neither be moved to the left nor swung out from the module.

Note

- When mounting with only two screws, use the inner hole of the adapter busbar.

NOTICE

Damage when mounting using two screws

For DC-link adapters that are mounted using only two screws, currents above 150 A result in a high temperature rise. This can damage the DC-link adapter or the component.

- If the DC-link adapter is only mounted using two screws, then you must limit the current to150 A.

Using washers when mounting the DC-link adapter

⚠WARNING

Danger to life as a result of overheating and risk of fire when mounting the DC-link adapter without washers

When mounting the DC-link adapter with combination screws M4x20 without using the washers provided, can result in the DC-link busbar overheating and causing a fire. This can result in death or severe injury.

- Use one of the washers provided for each screw.

DC-link adapters are supplied with washers, which are attached using a securing strap at the inner hole of the DC-link busbar. These washers must be used if a DC-link adapter is mounted on the left-hand side of a 150 to 300 mm wide module (one for each screw). It is not permissible that they are used for other mounting scenarios.

	DC-link adapter connection	
Module width	Left	Right
50 - 100 mm	No washers	No washers
150 - 300 mm	Washers	No washers

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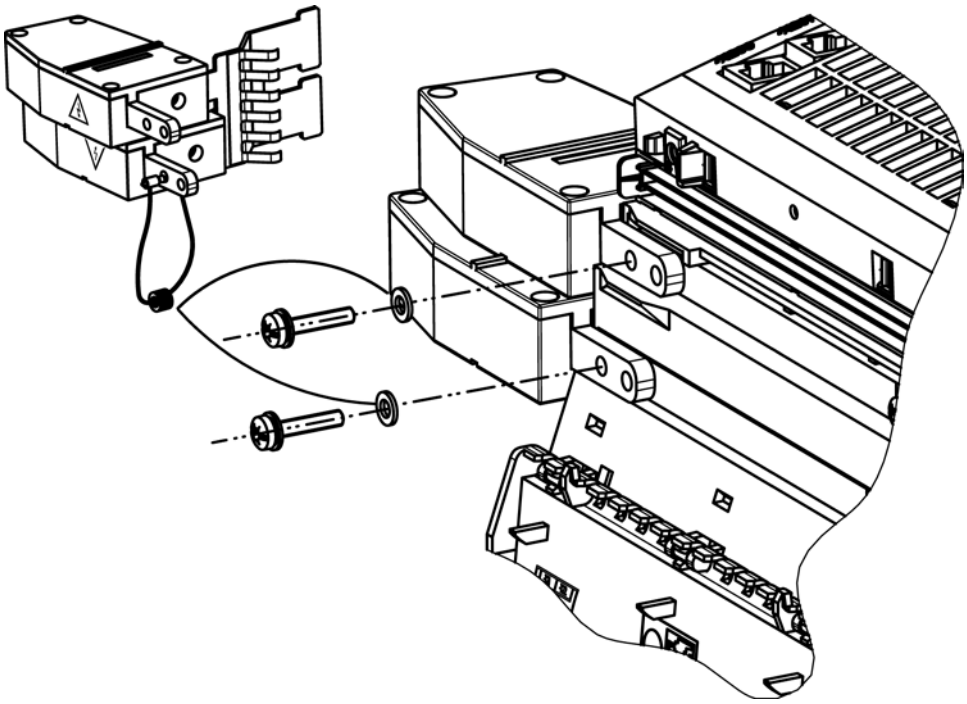


Figure 11-28 Mounting a DC-link adapter on the left-hand side for module widths of 150 to 300 mm using two screws

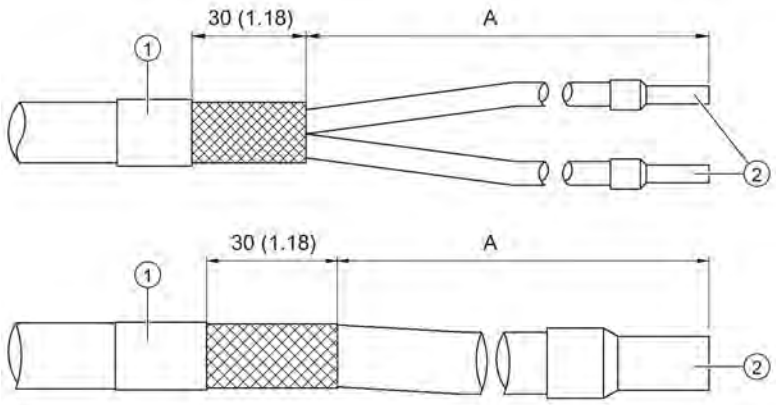
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11.5.6 Electrical connection

11.5.6.1 Preparing the cables

Prepare the DC link connecting cables as shown below.

Only use shielded cables with insulated end sleeves.



① Protective braided shield folded back and fixed using shrink-on sleeve
② Insulated end sleeve

Figure 11-29 Single-core and two-core DC link connecting cable with insulated end sleeves, all dimensions in mm and (inch)

Refer to the table below for dimension A:

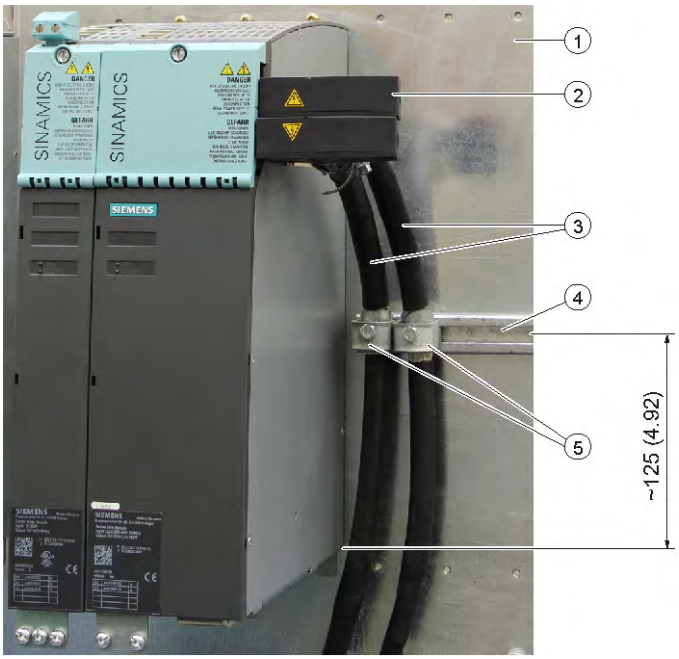
Conductor cross-section [mm²]	Mounting location of the DC link adapter at the drive line-up	Connection	A [mm]
50 / 70 / 95	Left	DCP	70
		DCN	60
	Right	DCP	60
		DCN	70

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11.5.6.2 Fixing the cables to the rear cabinet panel

Fix the DC link connecting cables directly next to the last component at the rear control cabinet panel. To do this, use C profile rails and matching cable clamps from the Rittal company. The distance between the C profile rail and the lower side of the component is approximately 125 mm.

Appropriately insulate the cable cores at the connection location before mounting.



① Control cabinet panel
② DC link adapter
③ Cores of the DC link connecting cable
④ C profile rail from the Rittal company (order number 7831.570 / 7831.571)
⑤ Cable clamps for C profile rails from the Rittal company

Figure 11-30 Fixing the DC link connecting cable to the control cabinet panel, dimensions in mm and (inch)

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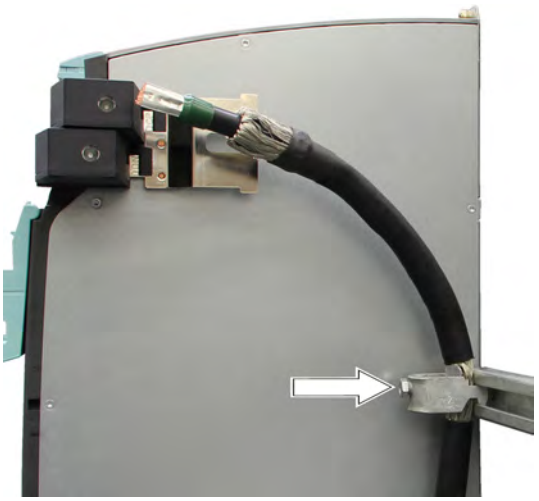
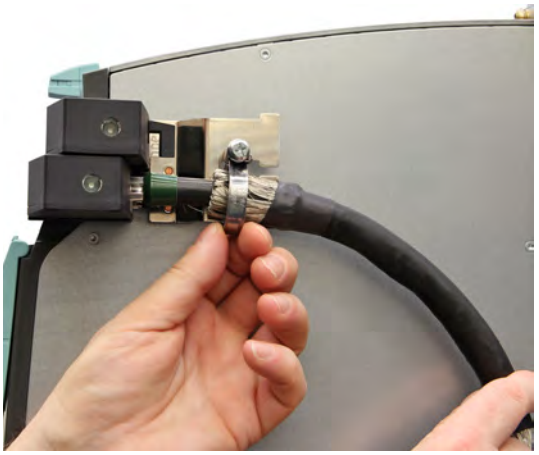
11.5.6.3 Cable connection and shield support

In order to simplify installing the DC link connecting cables at the DC link adapter, first fix the cables to the control cabinet panel (also see Chapter Fixing cables to the control cabinet panel (Page 675)).

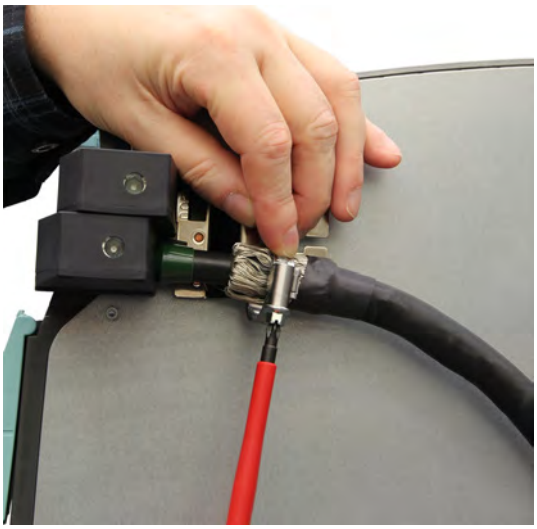
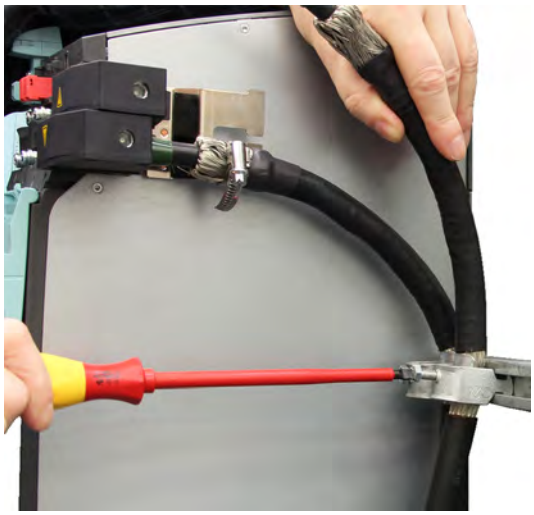
Required tools:

- Size 6 Allen key to attach the cables
- Suitable tool for hose clamps, e.g. flat-bladed screwdriver

Table 11- 24 Connecting the DC link connecting cables to the DC link adapter

	
1. Fix the first core of the DC link connecting cable to the profile rail using a cable clamp.	2. Route the cable end through an appropriate cable clamp.
	
3. Slide the cable clamp onto the tongue, and then insert the end of the cable into the DCN connection of the DC link adapter.	4. Tighten the cable using an Allen key.

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5. Tighten the screw of the hose clamp using a suitable screwdriver.	6. Fix the second core of the DC link connecting cable to the profile rail using a cable clamp. Connect the cable for the DCP connection as described under Points 2 to 5.
	The installed DC link connecting cable is shown in the adjacent diagram.

Note

After installing the cables, ensure that the EMC tongues of the DC link adapter are in contact with the side panel of the component.

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11.5.7 Technical specifications

Table 11- 25 Technical data DC link adapter

6SL3162-	Unit	2BM01-0AA0	2BM10-0AA0
Current-carrying capacity – attached using 2 screws – attached using 4 screws	 A A	 150 240	 150 ---
Connection cross-section	mm²	35 … 95	35 … 95
Stripped length	mm	27	27
Tightening torque – terminals – DC link busbars	 Nm Nm	 13 1.8	 13 1.8
Weight	kg	0.34	0.33

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11.6 DRIVE-CLiQ cabinet bushings

11.6.1 Description

A DRIVE-CLiQ cabinet bushing is used to connect the DRIVE-CLiQ cables between the inside and outside of the control cabinet. It is used in a control cabinet panel. The data lines and the voltage supply contacts of the DRIVE-CLiQ are also routed through the bushing. The DRIVE-CLiQ cabinet bushing for DRIVE-CLiQ cables is available with DRIVE-CLiQ connector and M12 connector/socket.

DRIVE-CLiQ cabinet bushing for DRIVE-CLiQ connectors

The cabinet bushing has degree of protection IP54 according to EN 60529 from the outside towards the inside. Inside the control cabinet, a connection is established according to degree of protection IP20 or IPXXB acc. to EN 60529. So that the complete outside of the cabinet bushing, including the DRIVE-CLiQ interface, has degree of protection IP54, a DRIVE-CLiQ cable must be used, which as a minimum must also have degree of protection IP54.

DRIVE-CLiQ cabinet bushing for M12 plug/socket

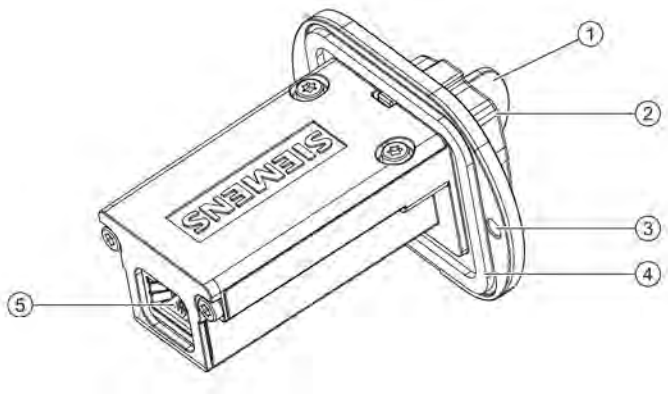
The cabinet bushing has degree of protection IP67 according to EN 60529 from the outside towards the inside. Inside the cabinet a connection according to degree of protection IP67 in compliance with EN 60529 is realized.

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11.6.2 Interface description

11.6.2.1 Overview

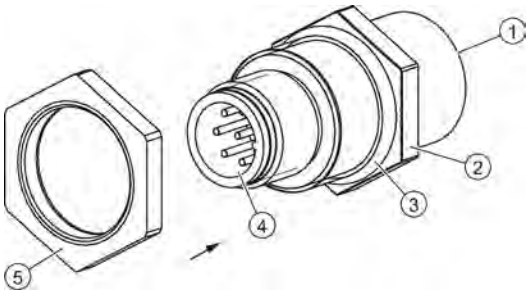
DRIVE-CLiQ cabinet bushing for DRIVE-CLiQ cables with DRIVE-CLiQ connectors



① Protective cap, Yamaichi, order number: Y-ConAS-24-S
② DRIVE-CLiQ interface on the outside (to connect DRIVE-CLiQ signal cables MOTION-CONNECT with IP67 degree of protection)
③ Mounting holes
④ Flange-type seal to ensure degree of protection IP54 on the outside of the control cabinet
⑤ DRIVE-CLiQ interface on the inside (to connect DRIVE-CLiQ signal cables MOTION-CONNECT with IP20 degree of protection)

Figure 11-31 Interface overview, DRIVE-CLiQ cabinet bushing

DRIVE-CLiQ cabinet bushing for DRIVE-CLiQ cables with M12 plug/socket



① DRIVE-CLiQ interface with M12 socket (8-pin)
② Flange, SW18
③ Seal
④ DRIVE-CLiQ interface with M12 plug (8-pin)
⑤ O ring, SW20, tightening torque: 3 to 4 Nm

Figure 11-32 Interface overview, DRIVE-CLiQ cabinet bushing M12

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11.6.3 Dimension drawings

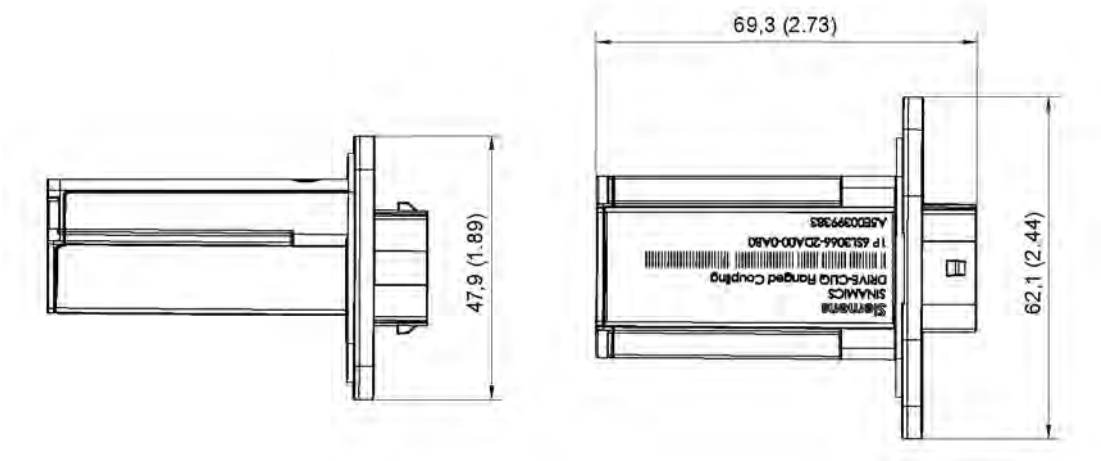
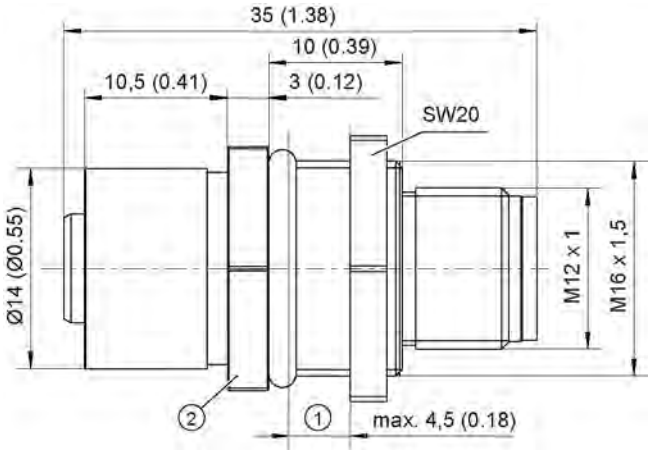


Figure 11-33 Dimension drawing of the DRIVE-CLiQ cabinet gland, all dimensions in mm and (inches)



① Cabinet panel
② Flange, SW18

Figure 11-34 Dimension drawing of the DRIVE-CLiQ cabinet bushing M12, all dimensions in mm and (inches)

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11.6.4 Mounting

11.6.4.1 DRIVE-CLiQ cabinet bushing for cables with RJ45 connectors

In order to install the DRIVE-CLiQ cabinet gland, you must make a cutout in the control cabinet panel as shown in the diagram below.

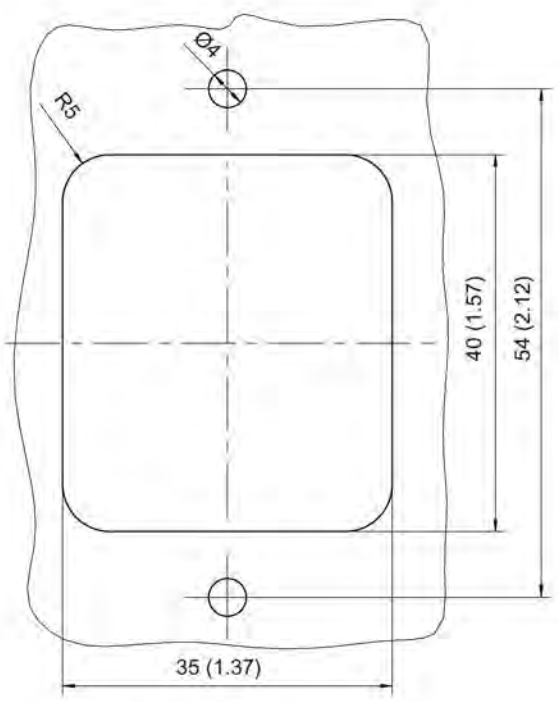
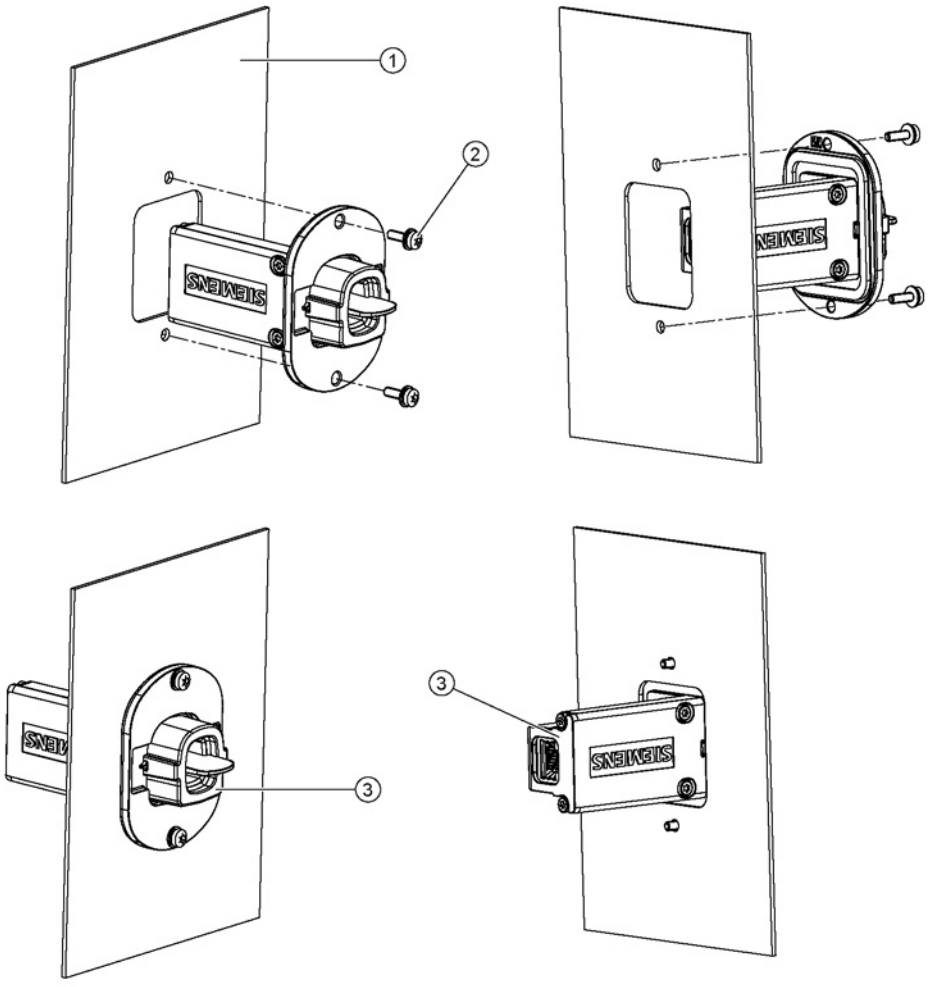


Figure 11-35 Cutout in the control cabinet, all dimensions in mm and (inches)

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Installation

1. Insert the DRIVE CLiQ cabinet bushing from the outside of the control cabinet through the cutout in the control cabinet.
2. Attach the DRIVE-CLiQ cabinet bushing to the outer control cabinet panel using 2 M3 screws and 2 nuts. In order to ensure good electromagnetic compatibility, a good electrical connection must be established between the DRIVE-CLiQ cabinet gland and the cabinet panel over a large surface area.



① Control cabinet panel
② M3 screw, tightening torque 0.8 Nm
③ DRIVE-CLiQ cabinet bushing

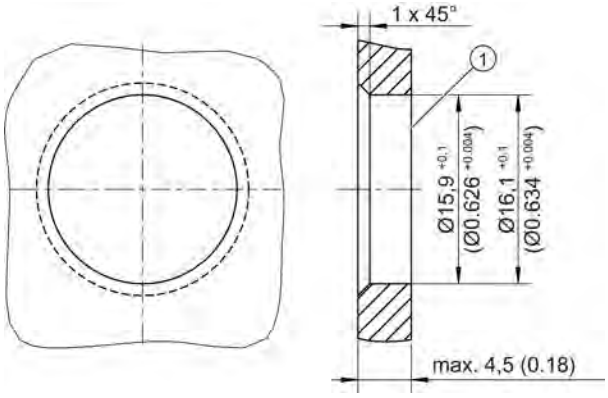
Figure 11-36 Installing the DRIVE-CLiQ cabinet bushing for cables with DRIVE-CLiQ connectors

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11.6.4.2 DRIVE-CLiQ cabinet bushing for cables with M12 plug/socket

Prepare the cabinet panel for mounting the DRIVE-CLiQ cabinet bushing M12 as shown below. The removable O ring can be screwed from the inside or the outside.

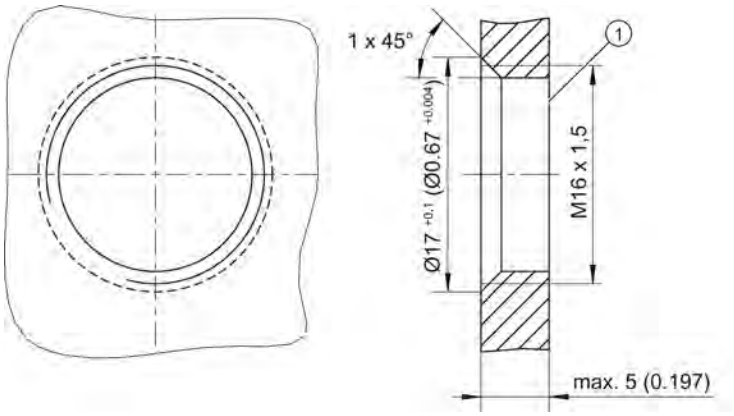
Mounting from the inside using an O ring that can be screwed



① Through-hole with chamfer

Figure 11-37 Through-hole for mounting the DRIVE-CLiQ cabinet bushing M12 with an O-ring that can be screwed from the inside

Mounting from the outside using an O ring that can be screwed



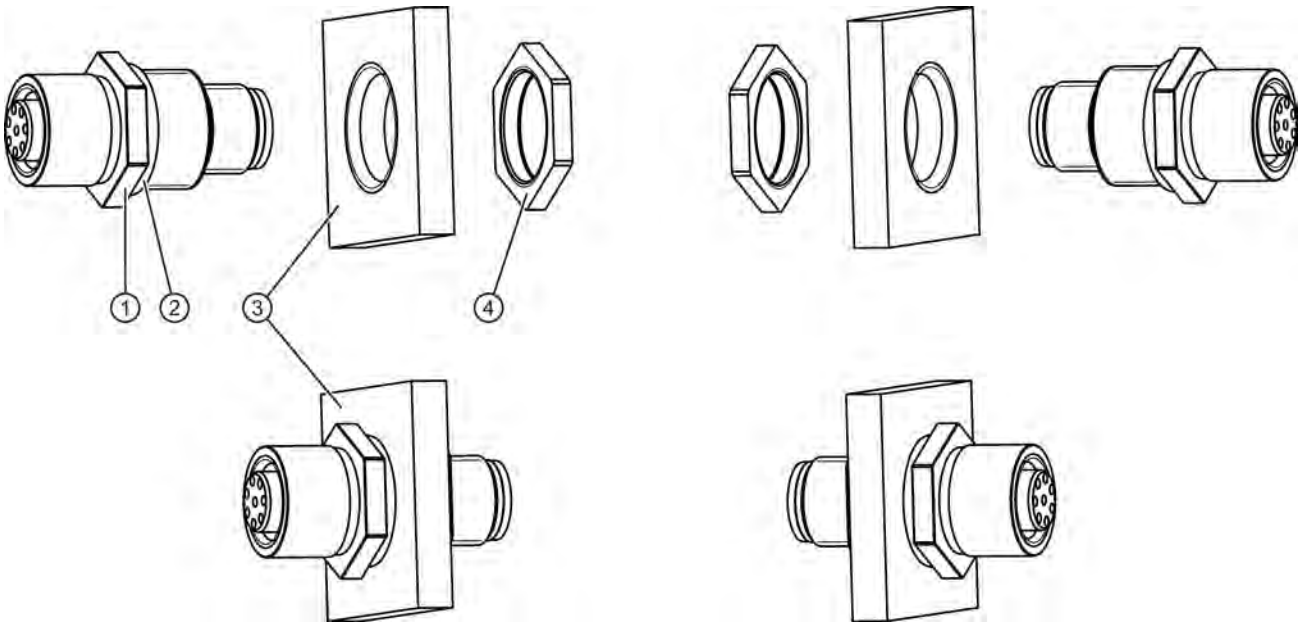
① Threaded hole with chamfer

Figure 11-38 Threaded hole for mounting the DRIVE-CLiQ cabinet bushing M12 with an O-ring that can be screwed from the outside

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Installation

1. Insert the DRIVE-CLiQ cabinet bushing through the opening in the cabinet.
2. Fasten the DRIVE-CLiQ cabinet bushing using the associated O ring with a tightening torque of 3 to 4 Nm



① Flange, SW18
② Seal
③ Cabinet panel
④ O ring, SW20, tightening torque: 3 to 4 Nm

Figure 11-39 Mounting DRIVE-CLiQ cabinet bushings for cables with M12 connectors

11.6.5 Technical data

Table 11- 26 Technical data of DRIVE-CLiQ cabinet bushings

	Unit	6SL3066-2DA00-0AA0 DRIVE-CLiQ	6FX2003-0DT67 M12
Weight	kg	0.165	0.035
Degree of protection according to EN 60529		IP54 outside the control cabinet IP20 or IPXXB inside the control cabinet	IP67

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11.7 DRIVE-CLiQ coupling

11.7.1 Description

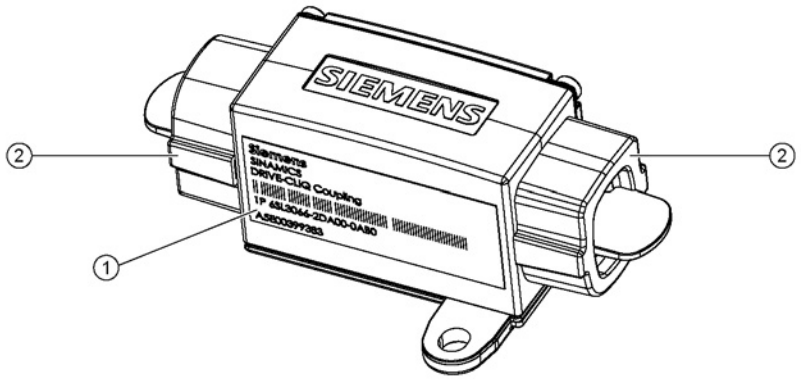
The DRIVE-CLiQ coupling is used to connect 2 DRIVE-CLiQ cables in accordance with degree of protection IP67 acc. to EN 60529.

In addition to the data lines, the power supply contacts of DRIVE-CLiQ are also routed via the coupling.

You can find information on the permissible cable length in Chapter DRIVE-CLiQ signal cables (Page 731)

11.7.2 Interface description

11.7.2.1 Overview



① Rating plate
② Protective cap, Yamaichi, order number: Y-ConAS-24-S

Figure 11-40 Interface overview, DRIVE-CLiQ coupling

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11.7.3 Dimension drawing

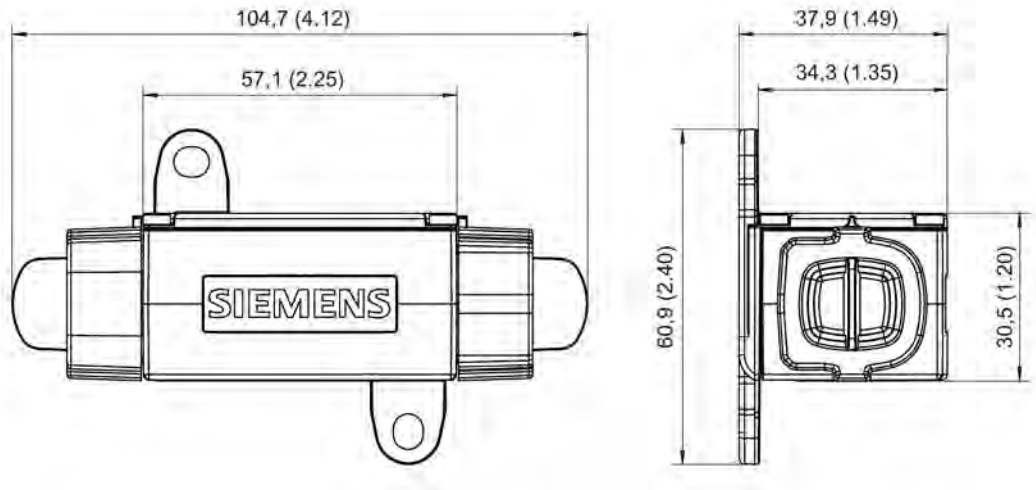
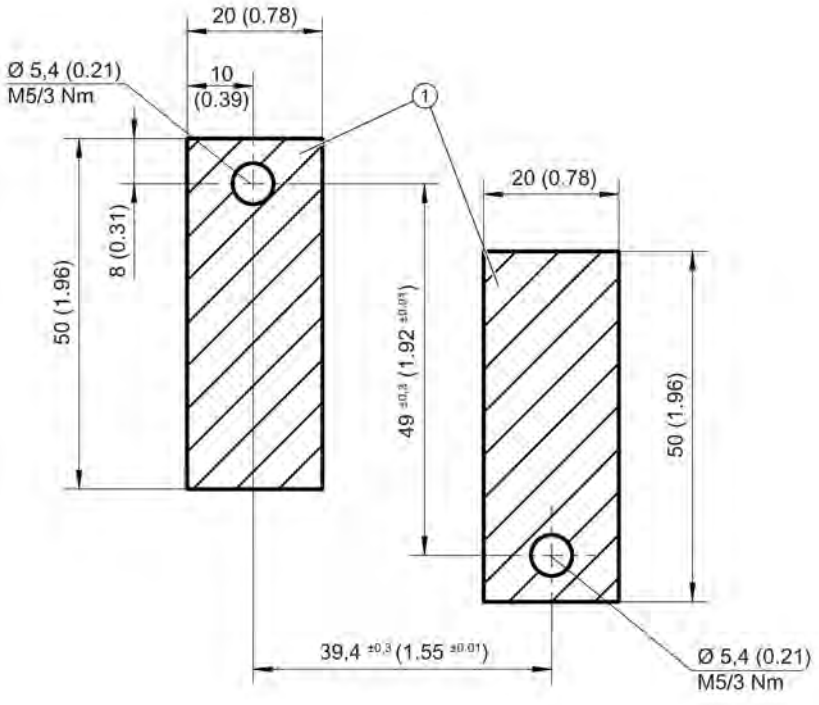


Figure 11-41 Dimension drawing of the DRIVE-CLiQ coupling, all dimensions in mm and (inches)

11.7.4 Mounting



① Contact surface

Figure 11-42 Hole drilling pattern for installation

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Installation

1. Attach the DRIVE-CLiQ coupling to the mounting surface as shown in the drilling pattern.
2. Remove the protective caps of the DRIVE-CLiQ coupling.
3. Latch the DRIVE-CLiQ connectors at both sides of the DRIVE-CLiQ coupling.

11.7.5 Technical data

Table 11- 27 Technical data

DRIVE-CLiQ coupling 6SL3066-2DA00-0AB0	Unit	
Weight	kg	0,272
Degree of protection	IP67 acc. to EN 60529	

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11.8 Spacing bolt for Booksize Compact components

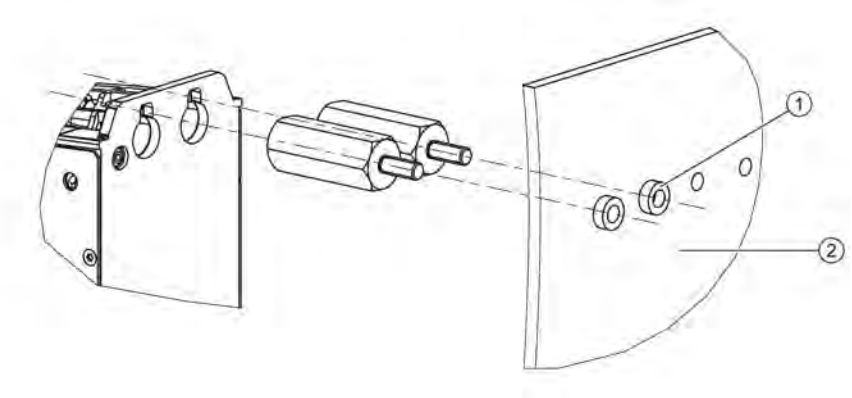
To increase the mounting depth of modules in Booksize Compact format, use spacing bolts (order number: 6SL3462-1CC00-0AA0). In this way, it is possible to combine modules in Booksize Compact format directly with booksize modules with internal air cooling.

Table 11- 28 Number of spacing bolts and holes for various module widths

Module width in [mm]	Number of spacing bolts	Number of holes/press-in nuts
50	2	2
75	4	4
100	4	4

Mounting the spacing bolts with press-in nuts

- Inserting M6 press-in nuts into the mounting panel
- Distance 25 mm ± 0.15 mm for module width 75 mm
- Distance 50 mm ± 0.15 mm for module width 100 mm



① M6 press-in nuts
② Mounting wall

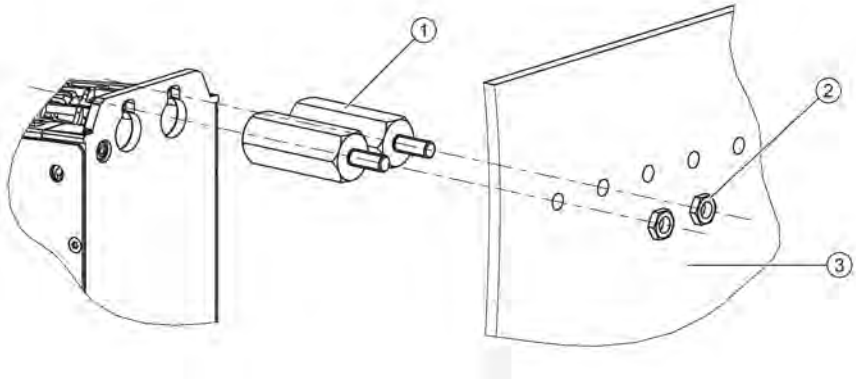
Figure 11-43 Mounting the M6 press-in nuts on the rear of the mounting panel

As an alternative to press-in nuts, you can secure spacing bolts with M6 nuts to the rear of the mounting panel.

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Mounting spacing bolts with nuts

- Drill Ø 6.5 mm holes for spacing bolts
- Distance 25 mm ± 0.15 mm for module width 75 mm
- Distance 50 mm ± 0.15 mm for module width 100 mm



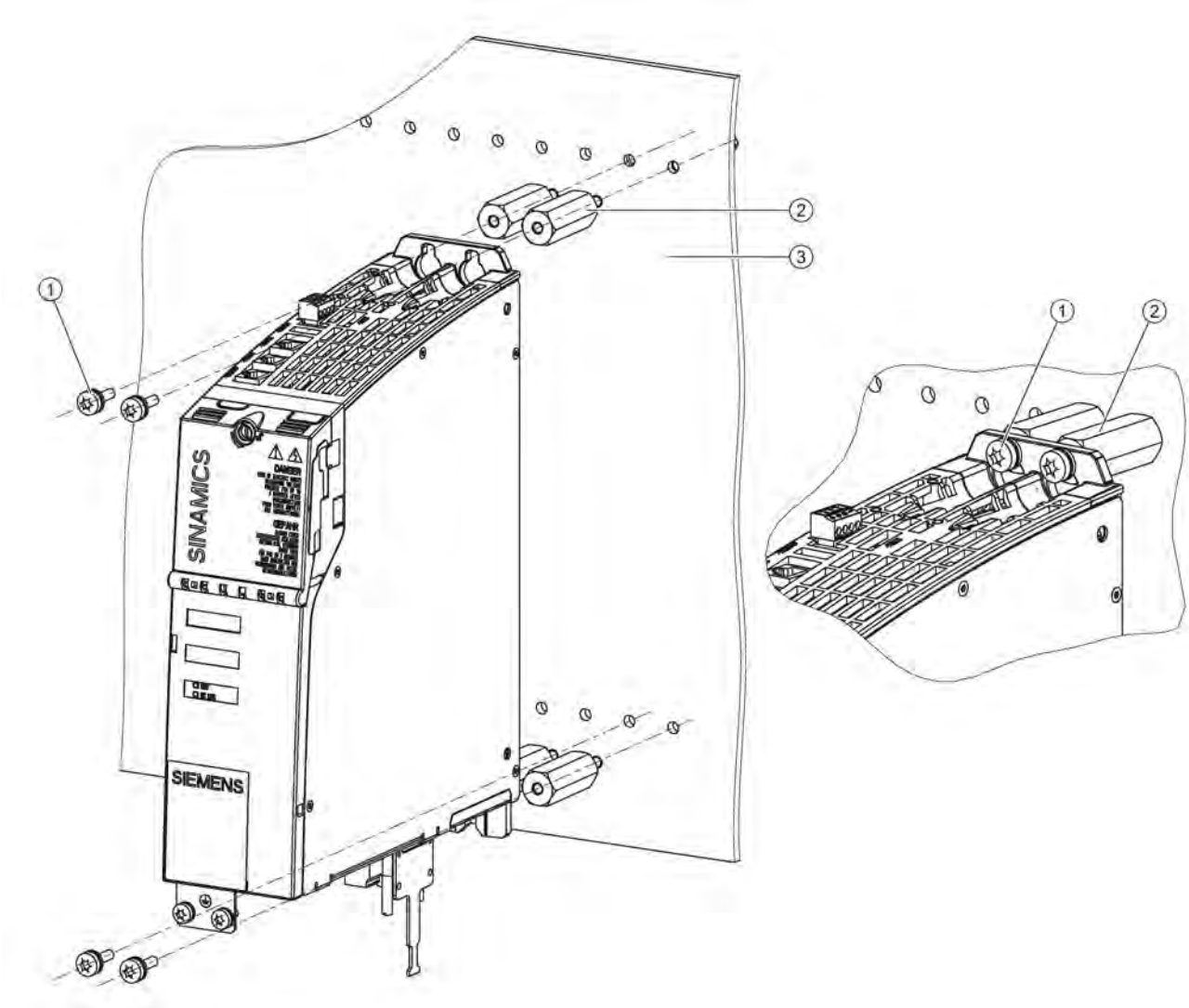
Spacing bolt
M6 nuts
Mounting wall

Figure 11-44 Mounting the spacing bolts with M6 nuts on the rear of the mounting panel

Tightening torque: 6 Nm

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Mounting a component in booksize compact format with spacing bolts



1 M6 x 20 screw, Torx T27

2 Spacing bolts, SW 17 (6SL3462-1CC00-0AA0)

3 Mounting wall

Figure 11-45 Mounting a component in booksize compact format with spacing bolts (example: Motor Module Booksize Compact, 18 A)

Tightening torque: 6 Nm

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Cabinet design and EMC Booksize 12

12.1 General information

The SINAMICS S components are designed in accordance with degree of protection IP20 or IPXXB according to EN 60529 and as open-type devices to UL 50. This ensures protection against electric shocks.

To ensure protection against mechanical stress and climatic conditions too, the components should only be operated in housing, cabinets or enclosed electrical operating areas that fulfill at least degree of protection IP54 and, as enclosure type 12, are designed to UL 50.

Prefabricated MOTION-CONNECT cables are recommended.

Note

Functional safety of SINAMICS components

Installation in a cabinet with degree of protection IP54 according to EN 60529 is recommended to ensure the safety functions of Safety Integrated are not compromised.

Low-voltage switchgear and controlgear assemblies

If the SINAMICS S drive line-up is used for the electrical equipment of machines, the applicable requirements of EN 60204-1 must also be adhered to.

Safety of machinery

Electrical equipment of machines

All information for device selection in this section applies to

- Operation on TN and TT line supply systems with grounded neutral point and grounded protective conductor as well as to IT line supply systems
- Operating voltage range from 360 V 3 AC to 440 V 3 AC

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12.2 Safety instructions when mounting and installing the control cabinet

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Risk of injury as a result of foreign bodies in the device

Parts (e.g.: drilling chips, end sleeves) falling into the device can cause short-circuits and damage the insulation. This can result in severe injury (arcing, loud bang, parts that are flung out).

- Only perform installation and other work when the devices are current-free.
- Cover the ventilation slots when mounting and installing the control cabinet and remove the cover before switching on.

12.3 Directives

The product satisfies the protection targets of the following EU Directives applicable within the European Economic Area (EEA):

Table 12- 1 Directives

Directive	Description
2006/95/EC	Directive of the European Parliament and Council of December 12, 2006, on the approximation of the laws of the member states relating to electrical equipment designed for use within certain voltage limits (Low-Voltage Directive).
2004/108/EC	Directive of the European Parliament and Council of December 15, 2004, which repeals directive 89/336/EEC, on the approximation of laws of the member states relating to electromagnetic compatibility (EMC Directive).

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12.4 Notes on electromagnetic compatibility (EMC)

Requirements to implement the EMC are listed in EN 61000-6-2, EN 61000-6-4, EN 61800-3, EN 60204-1 and in the Configuration Manual "EMC Installation Guideline" (order number 6FC5297-0AD30-0□P□). Conformance with the EMC Directive of the EC is ensured by following the measures described in the Configuration Manual, "EMC installation guideline". When installing components in cabinets, in order to fulfill the EMC Directive, the following conditions must be additionally observed:

- Operation on TN and TT line supply systems with grounded neutral point and grounded protective conductor as well as to IT line supply systems
- Observance of information about cable shielding and equipotential bonding
- Use of the recommended power and signal cables from Siemens.
- Only use Siemens cables for the DRIVE-CLiQ connections.

Note

Radio service interference due to radio disturbances in residential environments

In a residential environment this product can cause radio disturbances, which may make interference suppression measures necessary.

This device is not designed for unrestricted operation in the first environment (residential environment) and may not be used in the first environment without suitable interference suppression measures.

- Have qualified personnel carry out the installation and commissioning with suitable interference suppression measures.

Note

Malfunctions when not using original Siemens accessories

Malfunctions can occur if accessories are used that are not original.

- For DRIVE-CLiQ connections only use the DRIVE-CLiQ coupling and DRIVE-CLiQ cabinet bushing described in Chapter Accessories (Page 617)

Note

Faulty operation of the machine due to incorrect shielding or cables that are too long

The machine can malfunction if the shielding is incorrect or the cables are too long.

- Always follow the correct procedures for the shielding and the specified cable lengths.

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12.5 Arrangement of components and equipment

12.5.1 General information

The arrangement of the components and equipment depends on the following conditions:

- Space requirements
- Cable routing
- Bending radii of the connecting cables
  MOTION-CONNECT cables, refer to catalog PM21 or NC61
- Heat dissipation
- EMC

The components of the drive line-up should preferably be installed on a conductive mounting surface to ensure low impedance between the component and the mounting surface. Mounting plates with a galvanized surface are suitable.

Components are usually located centrally in a cabinet. The necessary mounting and installation clearances above and below the components can possibly exceed the minimum clearances specified in the product documentation.

The components can be arranged in one or more tiers. In a multiple-tier arrangement, vertical mounting or, in a cabinet row, side-by-side mounting in different cabinet sections is possible.

To determine the cross-section, the DC-link busbar current carrying capacity is used as basis, which is specified in the relevant technical data.

A ventilation clearance of 100 mm must be maintained around the line reactor (not including the mounting surface).

12.5.2 Current carrying capacity of the DC link busbar

The current carrying capacity of the DC link busbar must be observed for the configuration and arrangement of the drive line-up. The maximum current carrying capacity of the DC link busbar differs for the various module widths.

Table 12- 2 Maximum current carrying capacity of the DC link busbar

Current carrying capacity of the DC link busbar	Components
100 A	• Motor Modules from 50 mm to 100 mm wide • DC link components
150 A	• Motor Modules from 50 to 100 mm wide with reinforced DC link busbars
200 A	• Motor Modules from 150 to 300 mm wide

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To calculate the load of the DC link busbar, add the DC link currents I_d of the connected Motor Modules. If the current carrying capacity of the DC link busbars is exceeded for the planned configuration, two solutions are possible:

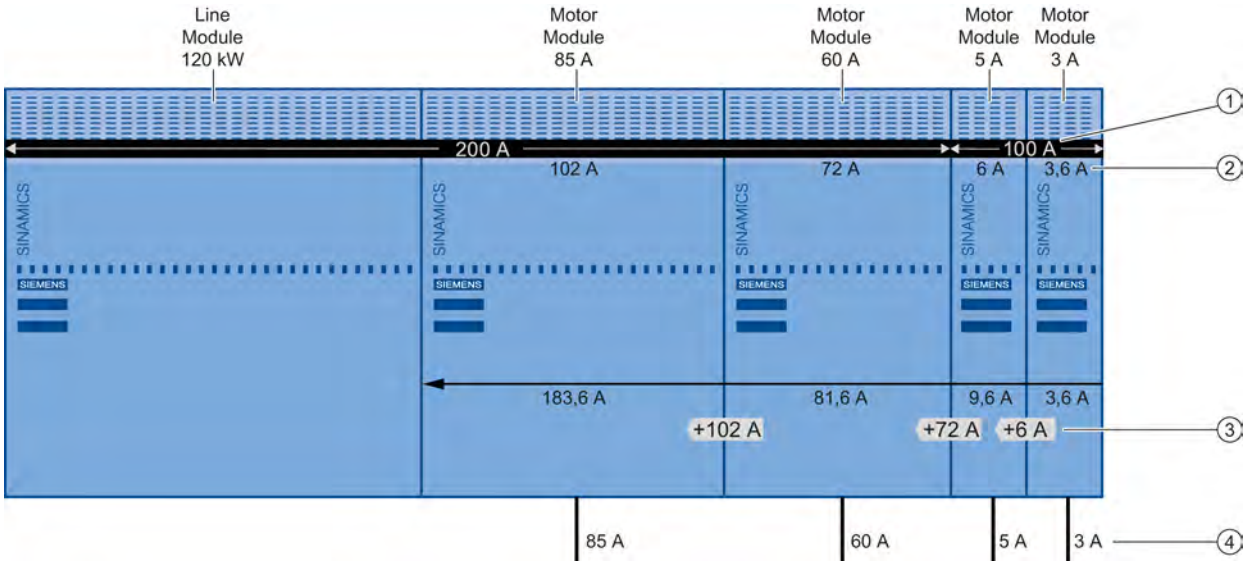
- Center infeed: Arrangement of the drive line-up with infeed to the left and right (example 2)
- Use of another Line Module

Note

The following examples are based on the simultaneous use and loading of the Motor Modules with the rated current I_n. The values of the DC link current were taken from the technical data of the Motor Modules in the Power Units Booksize Manual.

Example 1:

Connection of several Motor Modules with different current carrying capacity of the DC link busbar to a Line Module.



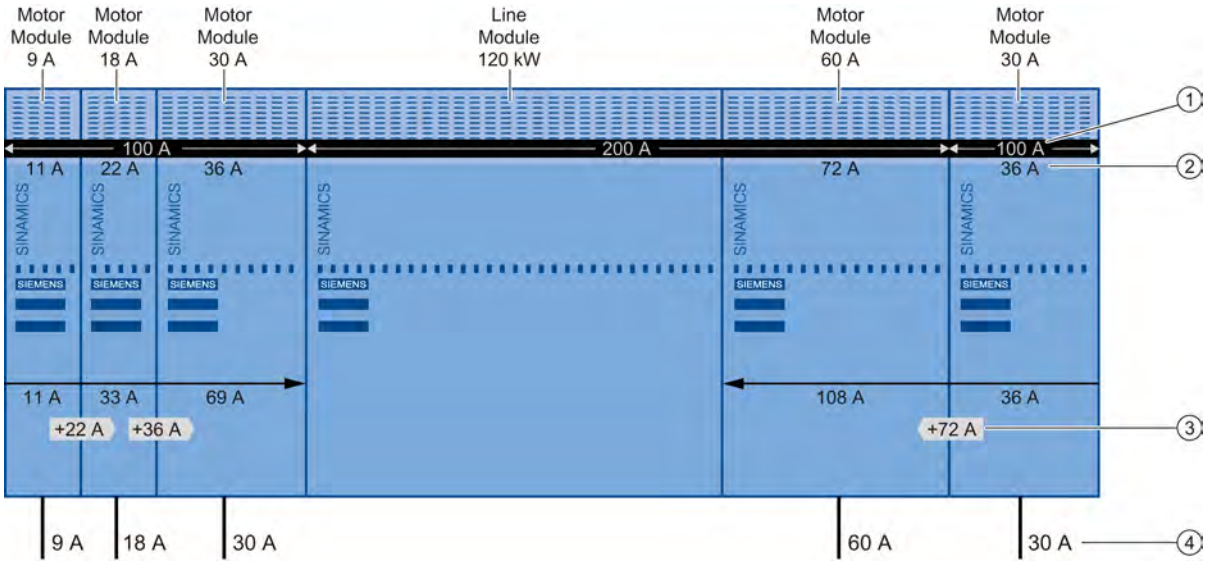
① DC link busbar current carrying capacity
② DC link busbar load: DC link current I_d at the rated current I_n of the Motor Module
③ Increased load of the DC link busbar
④ Motor current = rated output current I_n of the Motor Module

Figure 12-1 Regular arrangement with infeed to the right of the DC link, DC link busbar not overloaded

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Example 2:

Connection of several Motor Modules with different current carrying capacity of the DC link busbar to a Line Module with center infeed



① DC link busbar current carrying capacity
② DC link busbar load: DC link current I_d at the rated current I_n of the Motor Module
③ Increased load of the DC link busbar
④ Motor current = rated output current I_n of the Motor Module

Figure 12-2 Center infeed - infeed from left and right to the DC link

A center infeed with Motor Modules to the right and left of the Line Module can be configured for all Line Modules in compliance with current carrying capacity.
Exception: Smart Line Modules 5 kW and 10 kW

Note

For Smart Line Modules 5 kW and 10 kW, the arrangement of the drive line-up must be made to the right!

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12.5.3 Single-tier drive line-up

Due to the current carrying capacity of the DC-link busbars and their function in particular, the components should be arranged according to the following rule. From left to right:

- Line Module
- Motor Modules in order of power from the highest power to the lowest power
- DC link components, e.g. Braking Module, Control Supply Module, Capacitor Module

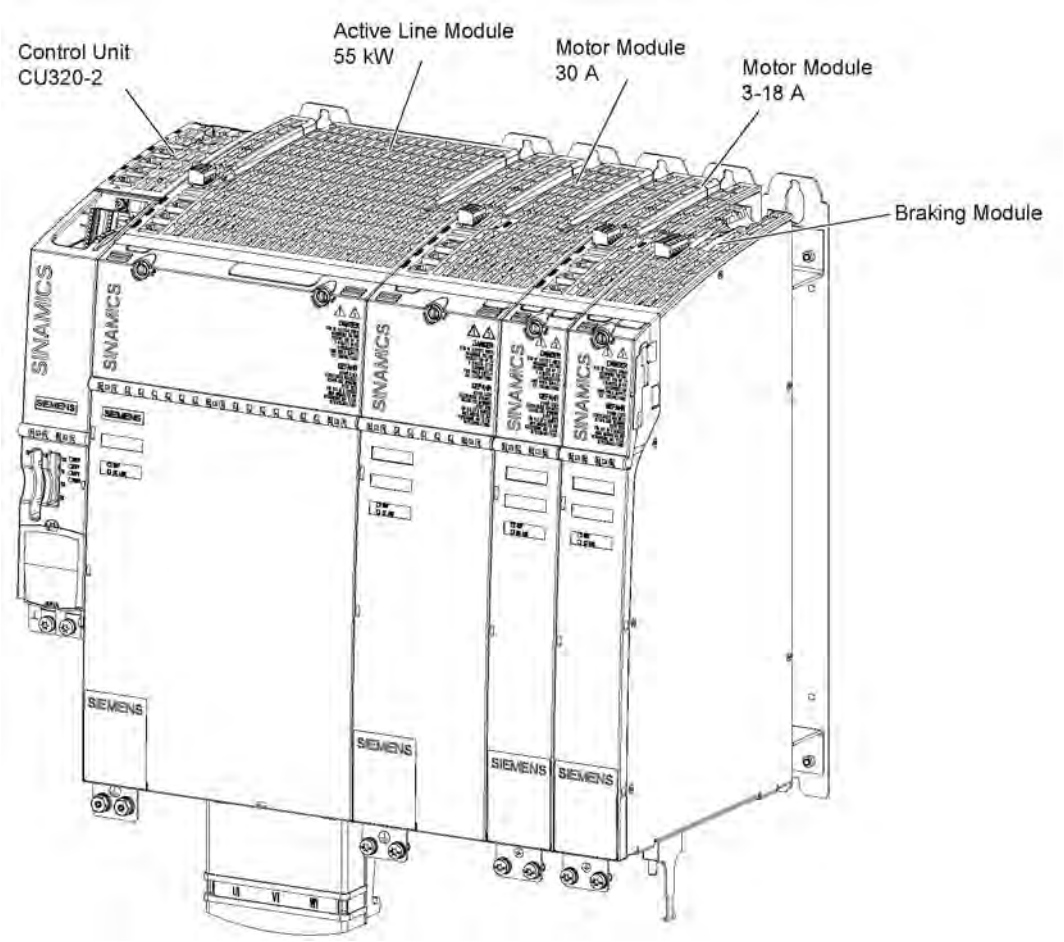


Figure 12-3 Example of a single drive line-up with internal air cooling

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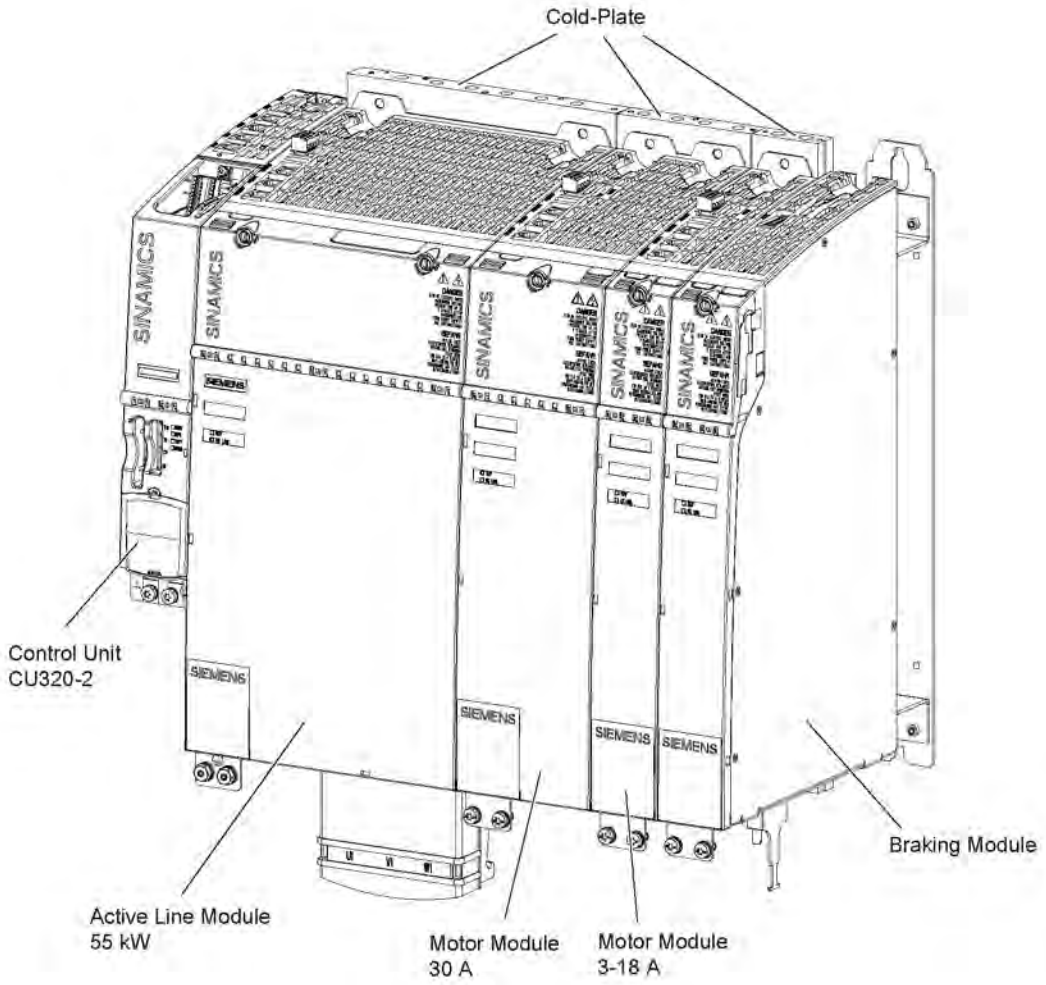


Figure 12-4 Example of a single drive line-up with cold plate

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12.5.4 Multi-tier drive line-up

12.5.4.1 Arrangement rules

The following points must be observed for the arrangement of a multi-tier drive line-up:

- The individual wires must be shielded, and the shield must be attached at both ends.
- The DC link is continued outside the components using the DC link adapter (for information on mounting, see Chapter Accessories (Page 617)) and single conductor, finely-stranded, shielded cables.
  The cables must be laid according to IEC 61800-5-2 so that a ground fault or short-circuit is completely ruled out.
- The distance between the tiers of modules primarily depends on the wiring, the cable cross-section and the bending radius of the power cables to be connected.
- The inlet temperature of the air sucked in for cooling the module must not exceed 40° C (with derating, it must not exceed 55° C). This must be ensured by means of suitable air guidance, the distance between the module rows, or by air baffle plates.

Note

Operating faults due to incorrectly laid cables

Particularly with regard to satisfying the EMC requirements, signal cables should not be laid parallel to power cables.

Note

Arrangement of the components for infeed of the DC link voltage from the right

If the infeed is on the right-hand side of the drive line-up (e.g. in a multi-tier configuration), the rules described in Chapter Single-tier drive line-up (Page 699) apply in the inverse sequence.

This means:

- Arrangement of the Motor Modules depending on their power, starting with the highest power
- DC link components, such as Braking Modules, at the end of the tier

Note

Wiring rules for DRIVE-CLiQ

Refer to the Commissioning Manual.

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12.5.4.2 Selecting the DC link rectifier adapter and DC link adapter

Table 12- 3 Overview of the DC link rectifier adapter and DC link adapter

	Suitable for module width	Max. connectable cross-section	Max. current carrying capacity
DC link rectifier adapter (cable outlet on top)			
6SL3162-2BD00-0AAx	50 mm, 100 mm	10 mm^2	43 A
6SL3162-2BM00-0AAx	150 mm, 200 mm, 300 mm	95 mm^2	240 A
DC link adapter (cable outlet on side)			
6SL3162-2BM01-0AAx	All module widths	95 mm^2	240 A
6SL3162-2BM10-0AAx	50 mm, 100 mm	95 mm^2	150 A

Note

Using DC link adapters

DC link adapters are only required to configure a multi-tier drive line-up.

12.5.4.3 Connection versions for the DC link adapter

Depending on the technical requirements and the space available in the control cabinet, for multi-tier drive line-ups, there are different options when it comes to connecting the DC-link adapter.

Note

Special feature: Short DC-link screws

Because of the compact construction and the required voltage separations, the left-hand DC-link screws are shorter (16 mm) than the other DC-link screws (20 mm) for modules with 50-100 mm installation width.

Note

Special feature: Different number of DC-link screws

Modules with an installation width of 200 mm or larger require two screws per DC-link busbar on the right-hand DC-link connection side in order to carry the higher amperages.

Note

Special feature: Washers during installation of the DC-link adapter

The supplied washers must also be installed on the left-hand side during the installation of the DC-link adapter for modules with an installation width of 150 mm or greater.

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Table 12- 4 Comparison of the connection versions

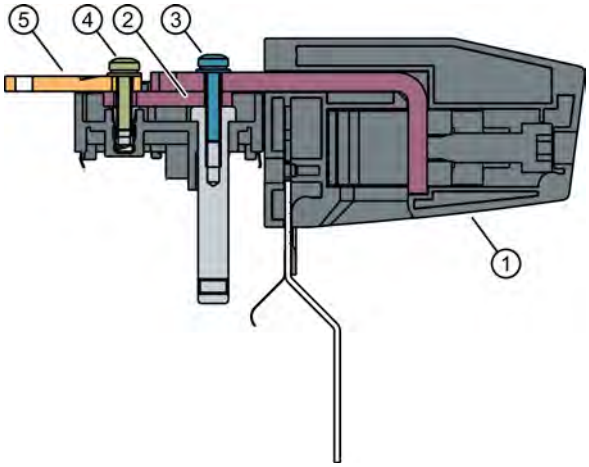
Var.	Module width [mm]	Installation	Current-carrying capacity of the DC-link busbar [A]	DC-link adapter 6SL3162-...	DC-link busbar	Fastening of the DC-link adapter to two DC-link busbars	Screws	Washers
1	50 ... 100	Right	≤ 100	2BM01-0AA0	Standard	2 screws	M4x20	No
2	50 ... 100	Right	≤ 150	**2BM10-0AA0**	**Reinforced**	2 screws	M4x20	No
3	50 ... 100	Left	≤ 100	2BM01-0AA0	Standard	2 screws	**M4x16**	No
4	150	Right	≤ 150	2BM01-0AA0	Standard	2 screws	M4x20	No
5	150 ... 300	Left	≤ 150	2BM01-0AA0	Standard	2 screws	M4x20	**Yes**
6	200 ... 300	Right	≤ 200	2BM01-0AA0	Standard	**4 screws**	M4x20	No

Connections as cross-sectional drawings (view from below)

Note

The different connection versions of the DC-link adapter are shown in the following cross-sectional drawings. Special features are highlighted in bold in the table above.

Variant 1: Module width 50-100 mm, connected to the drive line-up from the right, standard DC-link busbar

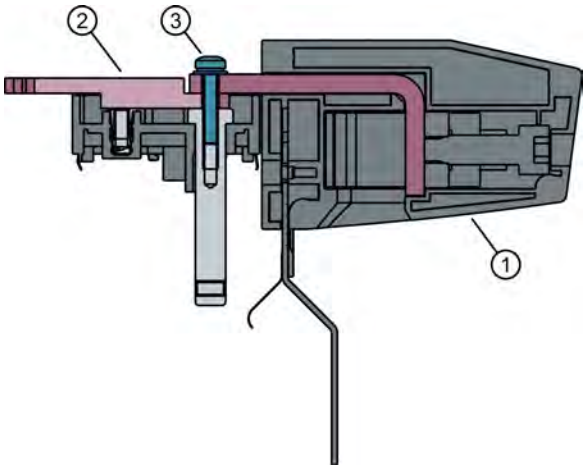


① DC-link adapter 6SL3162-2BM01-0AA0 (4 hole)
② Standard DC-link busbar (4 mm)
③ Connecting the DC-link adapter to the module using 2 M4x20 screws
④ Connecting the DC-link busbar to the module using 2 M4x16 screws
⑤ DC-link bridge

Figure 12-5 Variant 1 (representation from below)

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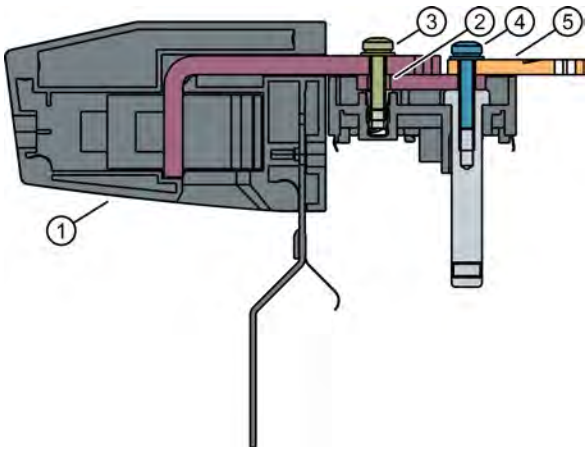
Variant 2: Module width 50-100 mm, connected to the drive line-up from the right, reinforced DC-link busbar



① DC-link adapter 6SL3162-2BM10-0AA0 (2 hole)
② Reinforced DC-link busbar (8 mm)
③ Connecting the DC-link adapter to the DC-link busbar using 2 M4x20 screws

Figure 12-6 Variant 2 (representation from below)

Variant 3: Module width 50-100 mm, connected to the drive line-up from the left, standard DC-link busbar

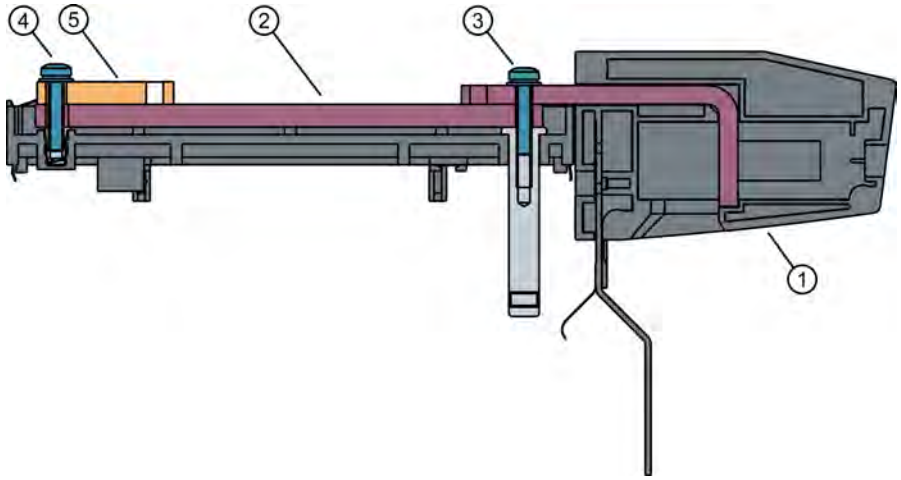


① DC-link adapter 6SL3162-2BM01-0AA0 (4 hole)
② Standard DC-link busbar (4 mm)
③ Connecting the DC-link adapter to the module using 2 M4x16 screws
④ Connecting the DC-link busbar to the module using 2 M4x20 screws
⑤ DC-link bridge

Figure 12-7 Variant 3 (representation from below)

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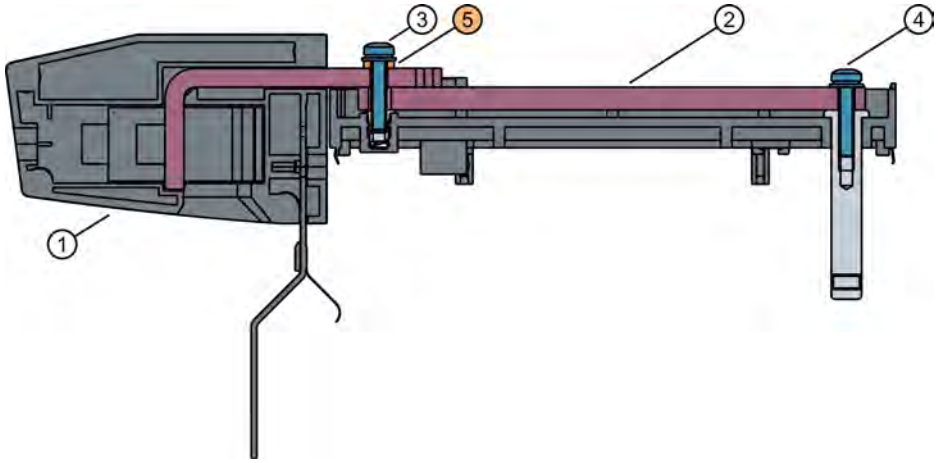
Variant 4: Module width 150 mm, connected to the drive line-up from the right, standard DC-link busbar



① DC-link adapter 6SL3162-2BM01-0AA0 (4 hole)
② Standard DC-link busbar (6 mm)
③ Connecting the DC-link adapter to the module using 2 M4x20 screws
④ Connecting the DC-link busbar to the module using 2 M4x20 screws
⑤ DC-link bridge

Figure 12-8 Variant 4 (representation from below)

Variant 5a: Module width 150 mm, connected to the drive line-up from the left, standard DC-link busbar

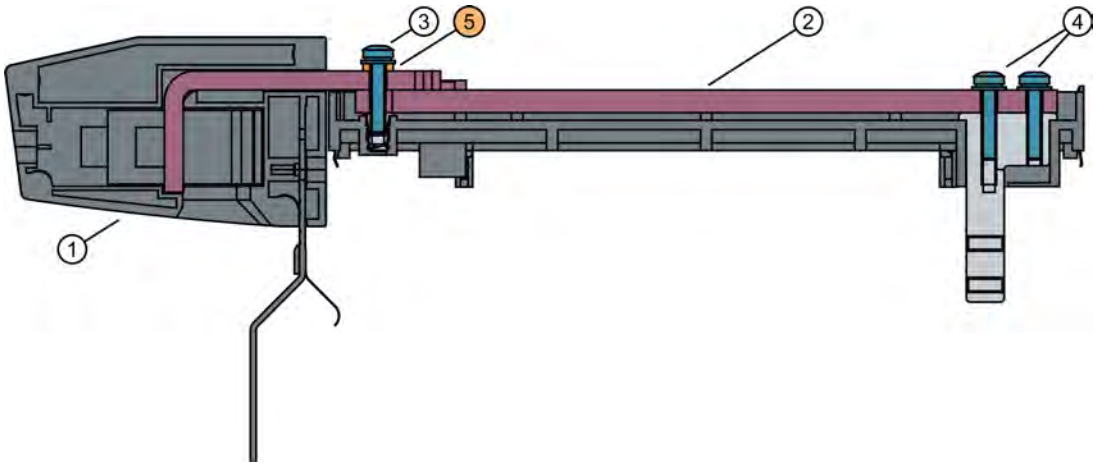


① DC-link adapter 6SL3162-2BM01-0AA0 (4 hole)
② Standard DC-link busbar (6 mm)
③ Connecting the DC-link adapter to the module using 2 M4x20 screws
④ Connecting the DC-link busbar to the module using 2 M4x20 screws
⑤ Washer

Figure 12-9 Variant 5a (representation from below)

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Variant 5b: Module width 200-300 mm, connected to the drive line-up from the left, standard DC-link busbar

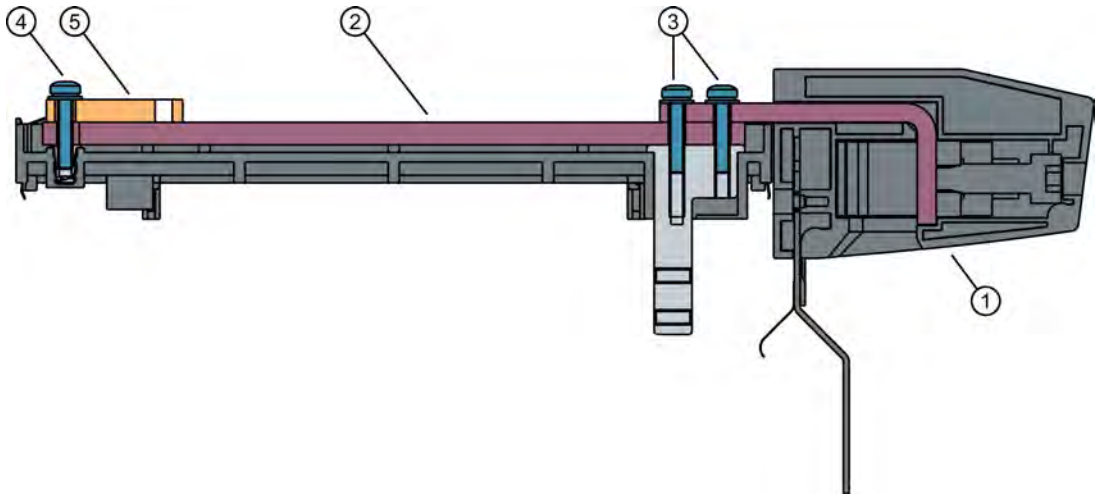


① DC-link adapter 6SL3162-2BM01-0AA0 (4 hole)
② Standard DC-link busbar (6 mm)
③ Connecting the DC-link adapter to the module using 2 M4x20 screws
④ Connecting the DC-link busbar to the module using 4 M4x20 screws
⑤ Washer

Figure 12-10 Variant 5b (representation from below)

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Variant 6: Module width 200-300 mm, connected to the drive line-up from the right, standard DC-link busbar

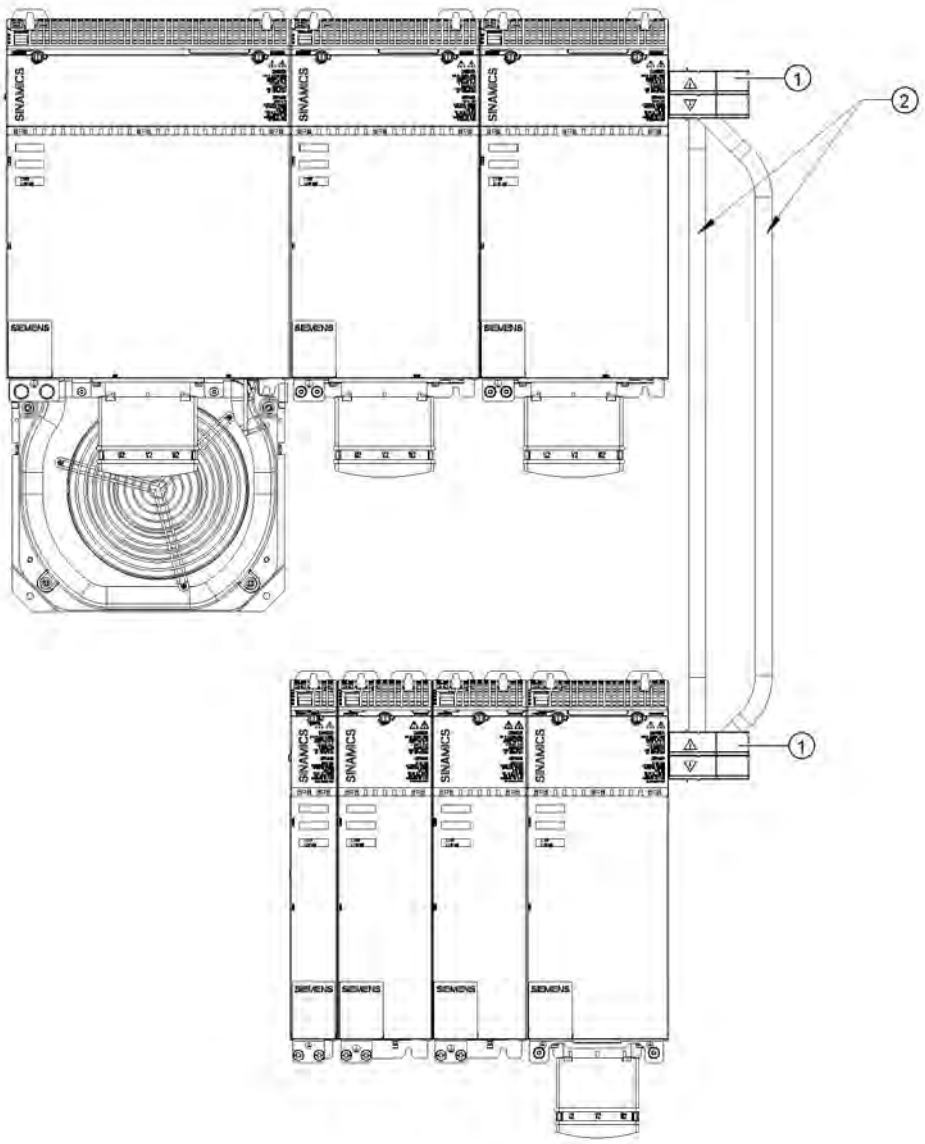


① DC-link adapter 6SL3162-2BM01-0AA0 (4 hole)
② Standard DC-link busbar (6 mm)
③ Connecting the DC-link adapter to the module using 4 M4x20 screws
④ Connecting the DC-link busbar to the module using 2 M4x20 screws
⑤ DC-link bridge

Figure 12-11 Variant 6 (representation from below)

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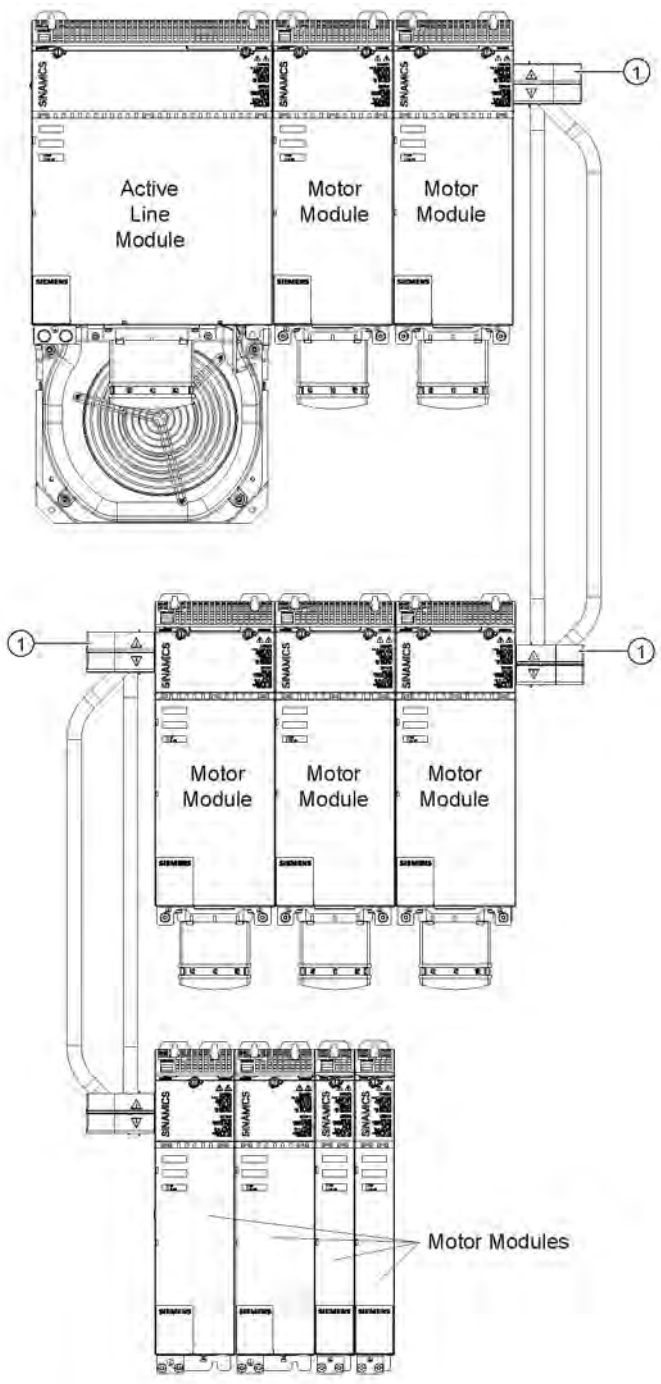
12.5.4.4 Examples of a multi-tier configuration



① DC link adapter
② Power cable shielded

Figure 12-12 Example of a two-tier configuration for a drive line-up with internal air cooling

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① DC link adapter

Figure 12-13 Example of a three-tier configuration for a drive line-up with internal air cooling

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12.5.4.5 Connection example

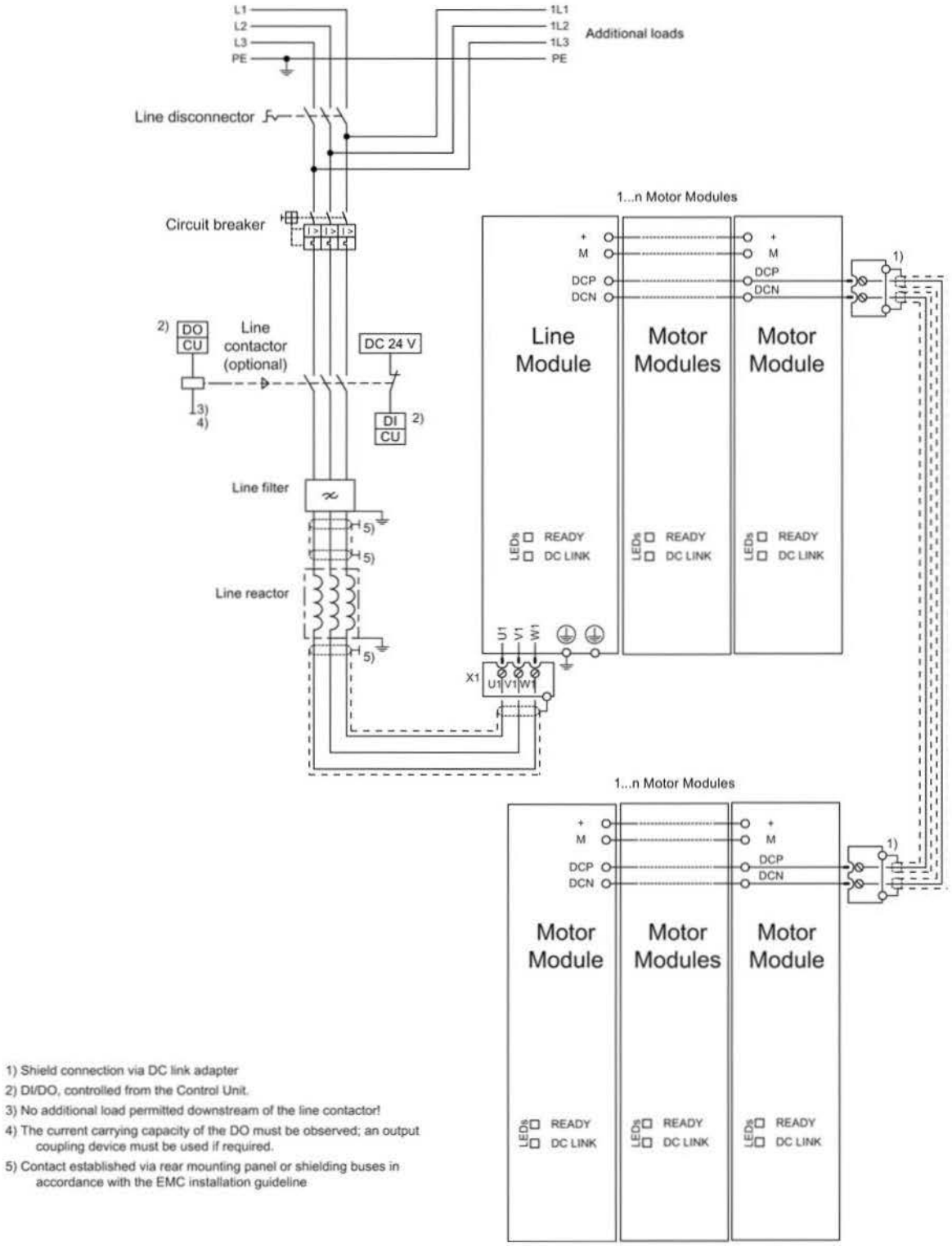


Figure 12-14 Connection example for a two-tier drive line-up

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12.6 Electrical connection

12.6.1 Connecting DC link busbars

The DC-link busbars and 24 V busbars of the components must be connected in a drive line-up before commissioning. Note the information about the arrangement of the components as well as the current carrying capacity of the DC-link busbars in the previous sections. The connection of components with reinforced DC-link busbars is described in Chapter Reinforced DC-link busbars (Page 646).



WARNING

Danger to life through electric shock due to incorrectly installed DC-link bridges

Incorrectly installed DC-link bridges **at the left-hand end of the drive line-up** can cause an electric shock.

- For all 50 mm wide modules[1] (exception: Smart Line Module[2]), remove the DC-link bridge, including the screws. Do not tighten the screws without the DC-link bridges.
- For all components that are 75 mm wide or wider, the DC-link bridges must not be moved to the left or removed[3].

[1] For 50 mm wide modules, the DC-link bridge cannot be swung inwards.
[2] Smart Line Modules do not have a DC-link bridge.
[3] The DC-link bridge guarantees the mechanical stability of the DC-link busbars.

NOTICE

Possible damage of the devices caused by the use of unsuitable screws

Using unsuitable screws to attach the DC-link busbar for components with widths of between 50 and 100 mm can result in damage to the devices.

- Only use the original M4x16 screws on the left-hand side of the module.
- Only use the original M4x20 screws on the right-hand side of the module.

The connection of a Line Module to a Motor Module is shown in the following.



Figure 12-15 Line Module and Motor Module as delivered

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Connecting DC-link busbars

Always connect the lower DC-link busbars first and then the upper DC-link busbars.

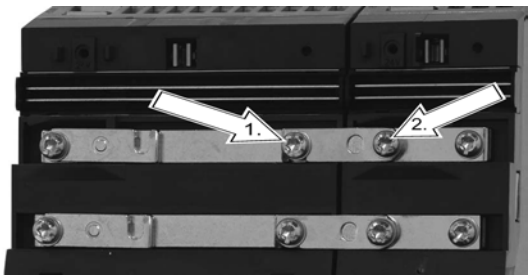
Tool: Screwdriver Torx T20

Working steps:

- Loosen the DC-link busbar screws.
- Turn over the DC-link bridge.
- Screw the DC-link busbar screws tight. It is important that you follow the sequence shown below (1 and 2).
  Tightening torque: 1.8 Nm

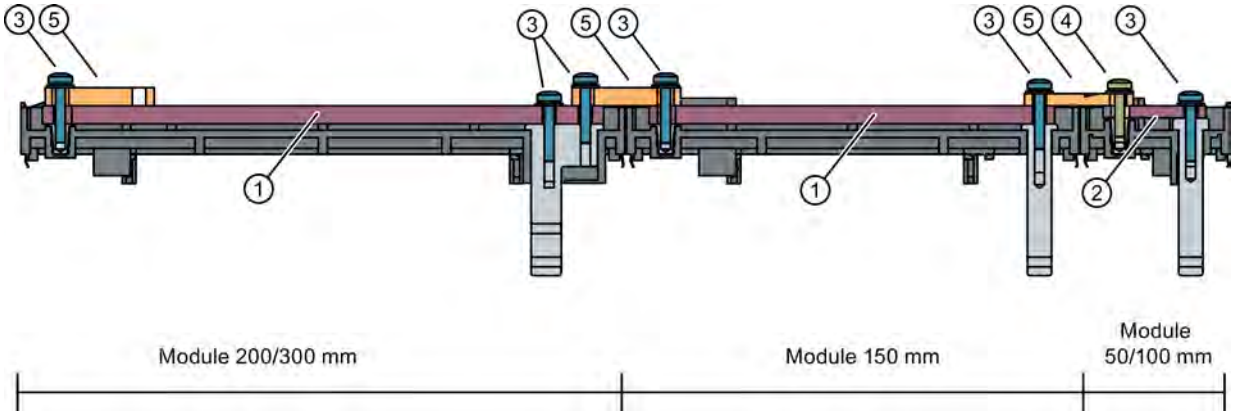


1. Connection of the lower DC-link busbars



2. Connection of the upper DC-link busbars

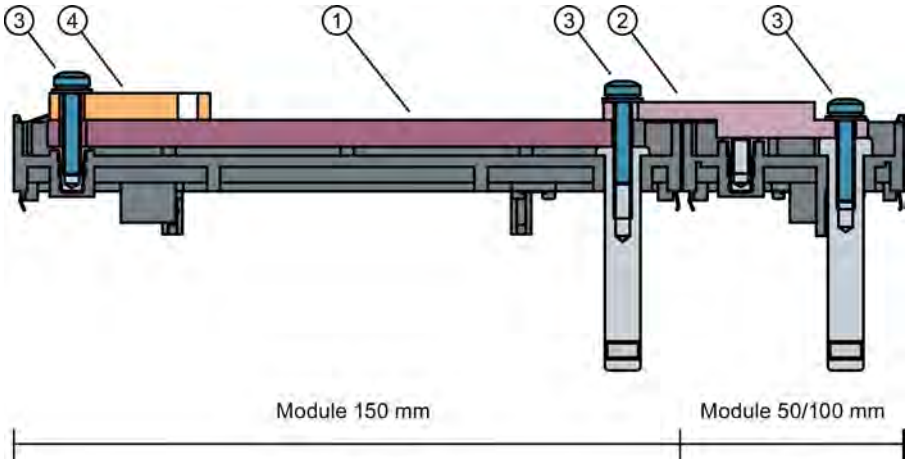
DC-link connections as cross-sectional drawings (view from below)



① Standard DC-link busbar (6 mm)
② Standard DC-link busbar (4 mm)
③ Connecting the DC-link busbar to the module using a M4x20 screw
④ Connecting the DC-link busbar to the module using a M4x16 screw
⑤ DC-link bridge

Figure 12-16 DC-link busbar connection using a standard DC-link busbar at a 50/100 mm module

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① Standard DC-link busbar (6 mm)
② Reinforced DC-link busbar (8 mm)
③ Connecting the DC-link busbar to the module using a M4x20 screw
④ DC-link bridge

Figure 12-17 DC-link busbar connection using a reinforced DC-link busbar at a 50/100 mm module

12.6.2 Connection of the 24 V busbars

Connection of the 24 V busbars

The 24 V busbars of the components are connected using the red 24 V connectors in the accessories pack. A 24 V connector must be plugged onto the 24 V busbars between the Line Module, Motor Module and DC-link component. The 24 V connectors must be attached before the drive line-up is commissioned!

Working steps:

- Place the 24 V connectors on to the 24 V busbars.
- Press the 24 V connectors down until they click into place.
- If required, mount the 24 V terminal adapter to supply the 24 VDC.

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① Mounted 24 V terminal adapter (Torx T10, tightening torque 0.5 Nm)
② Mounted 24 V connector

WARNING

Fire hazard for 24 V connectors and unconnected DC-link busbars

The red 24 V connectors may only be used when the DC-link busbars of the components are also connected. Otherwise the 24 V connectors can burn and cause severe injury or death as result of fire or smoke.

- If the DC-link busbars of the components are not connected, each component must be supplied with 24 V separately via a 24 V terminal adapter.



WARNING

Danger to life due to electric shock when connecting and disconnecting 24 V connections in operation

When opening plug connections in operation, arcs can result in severe injury or death.

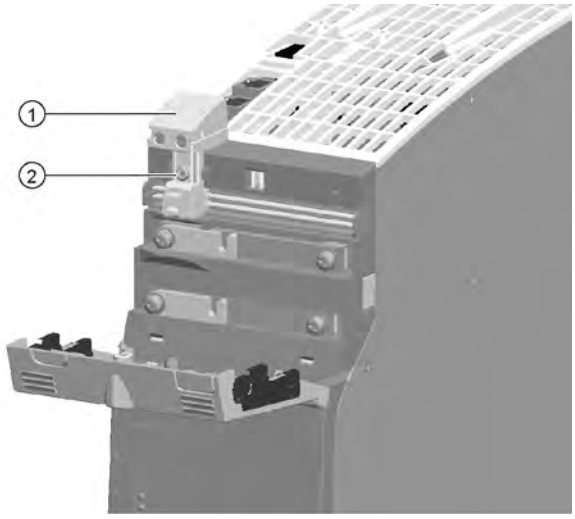
- Only withdraw or insert the 24 V connectors in a no-voltage state.

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12.6.3 Installation of the 24 V terminal adapter

The 24 V terminal adapter can be installed in every Line Module, Motor Module and Control Supply Module.

The 24 V terminal adapter is suitable for connecting cable cross-sections of 0.5 up to 6 mm^2. The 24 V terminal adapter is included in the scope of delivery of Line Modules and Control Supply Modules. It can be ordered as a spare part (order number: 6SL3162-2AA00-0AA0).



① 24 V terminal adapter
② Screw for fixing: SHR, PT-TORX K30-3, 0X16-ST-A2F WN1452 / from the EJ company

NOTICE

Damage to the 24 V connector as a result of incorrect insertion/withdrawal

Incorrect insertion/withdrawal of the 24 V connector can damage it.

- Only withdraw the 24 V terminal adapter vertically in relation to the front plate.
- It is only permissible to withdraw or insert the 24 V connectors a maximum of 5 times.

You require the following tools to install the 24 V terminal adapter:

- Slot-head screwdriver 1 x 5.5 for releasing the protective cover
- Torx T10 screwdriver to fasten the 24 V terminal adapter
- Suitable pliers to break out the cutout in the protective cover

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Table 12- 5 Installing the 24 V terminal adapter using an Active Line Module (36 kW) as example

		
Release the protective cover.	Open the protective cover.	Clip the 24 V terminal adapter on to the 24 V busbars. Screw the 24 V terminal adapter tight with the supplied screw. **Tightening torque:** 0.5 Nm

	
Break out the cutout in the protective cover.	Close the protective cover. The protective cover must latch into place audibly.

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WARNING

Danger to life through electric shock if the cutout in the protective cover has been broken out

If the 24 V terminal adapter or the DC link infeed adapter is removed, and you touch live parts this will result in death or severe injury.

- Replace the protective cover with the broken out cutouts by a new protective cover.

Note

The 24 V terminal adapter should always be installed to the left of the component located at the far left, because if it is positioned anywhere else there may not be enough space for the red 24 V jumpers.

If necessary, the 24 V terminal adapter can also be located at the right for 50 mm and 100 mm modules.

12.6.4 Attaching the motor cable

The Motor Modules are ideal for the operation of Siemens motors.

NOTICE

Damage to the components caused by switching overvoltages when third-party motors are used

If the brake is controlled using the brake connection of the Motor Module, overvoltages can result when the brake is switched off. These overvoltages can damage connected components.

- To prevent switching overvoltages, deploy a free-wheeling diode for third-party motors.

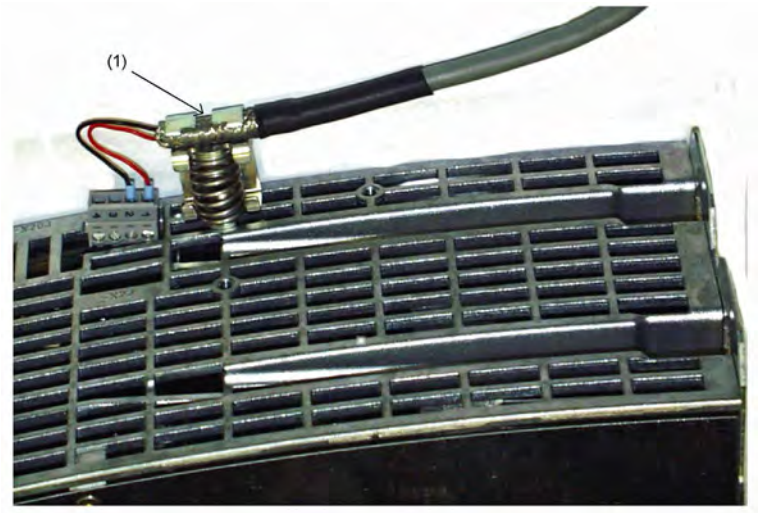
Note

Connections with free-wheeling diodes extend the switching times of the brakes.

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12.6.5 Shield connection for terminals X21/X22 on the Motor Module

The diagram below shows a typical shield connection terminal for the shield support of the cables to terminal X21.



① Shield connection clamp: Weidmüller, type KLBÜ 3-8 SC

Figure 12-18 Shield connection terminal for the shield support



⚠WARNING

Danger to life due to electric shock when using screws with the incorrect length

Excessively long screws can come into contact with live parts and can therefore result in death or serious injury.

- Only use screws with a permissible insertion depth of 4 - 6 mm.

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12.7 24 V DC supply voltage

12.7.1 General information

The 24 V DC voltage is required for:

- To supply the electronics of the SINAMICS components via the integrated 24 V busbar
- To supply the electronics of the Control Units, Option Boards, Sensor Modules, and Terminal Modules, as well as the process voltage of their digital inputs
- To supply the load voltage of the digital outputs
- To supply the motor holding brakes

Other loads can be connected to these power supply units if they are separately protected from overcurrent.

Note

The electronics power supply should be implemented by the user, as described in Chapter System data (Page 45).

When connecting a DC power supply as specified in EN 60204-1:1997, Sect. 4.3.3, malfunctions may occur due to the voltage interruptions permitted for them.



WARNING

Danger to life through electric shock due to incorrectly laid brake cables

If brake cables are laid without safe electrical separation, the insulation can fail and cause an electric shock.

- Connect the holding brake with the specified MOTION-CONNECT cable.
- Only use third-party cables with safe electrically separated brake cores or lay the brake cores with safe electrical separation.

NOTICE

Damage to other loads as a result of overvoltage

Overvoltages of switched inductances (contactors, relays) can damage connected loads.

- Install suitable overvoltage protection circuits and devices.

Note

Malfunction because 24 V supply voltage is too low

If the 24 V supply voltage falls below the specified minimum value on a device in the assembly, a malfunction can occur.

- Select an input voltage that is high enough for there to be sufficient voltage at the last device. Do not exceed the maximum value for the supply voltage. If required, supply the voltage to the assembly at various locations in the lineup.

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Note

A regulated DC power supply is required to operate motors with a built-in holding brake. The voltage is supplied via the internal 24 V busbars. The voltage tolerances of the motor holding brakes (24 V ± 10%) and the voltage drops of the connection cables must be taken into account.

The DC power supply should be set to 26 V. The Control Supply Module supplies 26 V. This ensures that the supply voltage for the brake remains within the permissible range when the following conditions are fulfilled:

- Siemens three-phase motors must be used
- Siemens MOTION-CONNECT power cables are used
- Motor cable lengths, max. 100 m

12.7.2 Options for the 24 V supply of the components

In a drive line-up, the Line Modules, Motor Modules and DC link components are connected to the 24 V power supply via the integrated 24 V busbars. The current carrying capacity of these busbars is 20 A. The 24 V infeed can be realized in two ways:

1. Using a Control Supply Module

When a Current Supply Module is used, the 24 V supply is directly established via the busbars. The electronic current limiting function integrated in the Control Supply Module protects the busbar system when a fault occurs. Additional loads can be connected via the 24 V terminal adapter.

Note

If you use cables with a cross-section of 2.5 mm^2, no additional protection is required on the 24 V side for the following cable types:

- Cables of the XLPE type
- Cables of the EPR type
- Cable with a similar properties and which is thermally stable up to 90 °C

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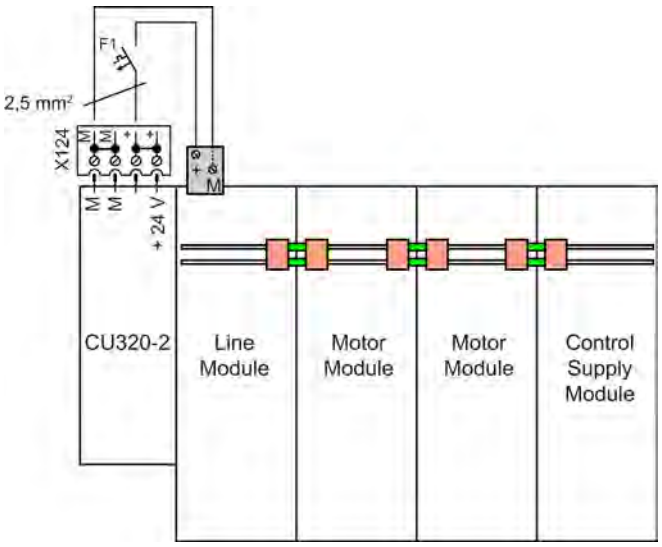


Figure 12-19 Example of a 24 V supply via a Control Supply Module

2. Using an external 24 V power supply

When using an external 24 V power supply, e.g. SITOP, the 24 V terminal adapter must be used. The external power supply should be located very close to the load (max. cable length 10 m). We recommend using miniature circuit breakers with tripping characteristic D as overcurrent protection devices for the cables and busbars. The ground potential M must be connected to the protective conductor system (PELV/SELV).

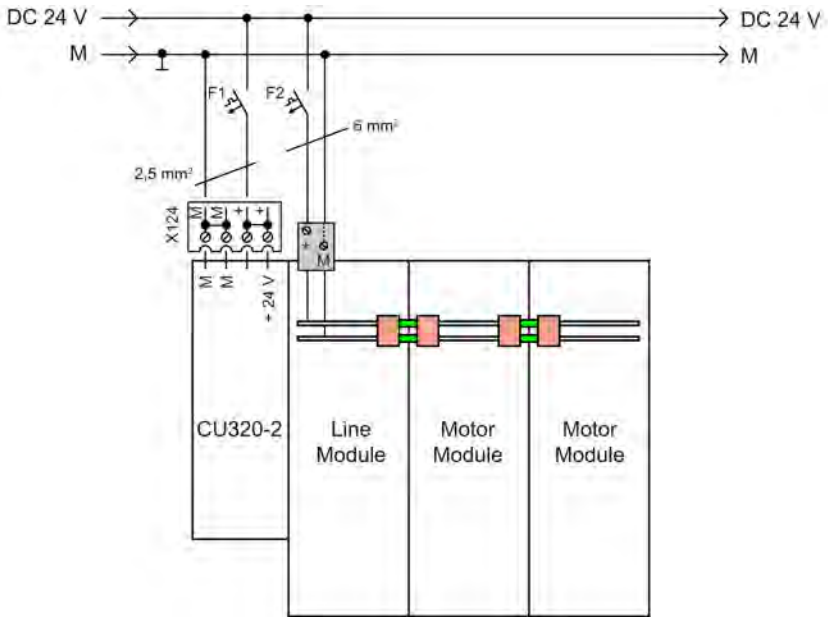


Figure 12-20 Example of a 24 V supply via an external power supply

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12.7.3 Overcurrent protection

The cables on the primary and secondary sides of the 24 V power supply unit must be protected against overcurrent.

Primary side protection must be implemented according to the manufacturer's instructions.

Secondary side protection depends on the prevailing situation. Please note the following:

- Loading due to loads, including simultaneity factor depending on machine operation
- Current carrying capacity of the conductors used and cables in normal and short-circuit conditions
- Ambient temperature
- Cable bundling (laying cables in a common duct)
- Type of cable routing

The overcurrent protection devices can be determined according to EN 60204-1, Section 14.

Circuit breakers from the Siemens "NSK" catalog are recommended as overcurrent protection devices on the primary side.
Miniature circuit breakers or SITOP select (order number 6EP1961-2BA00) are recommended as overcurrent protection devices on the secondary side. The MCBs can be selected according to Siemens catalog "BETA Modular Installation Devices - ET B1".

When selecting the miniature circuit breaker, local installation regulations must be carefully complied with.

Table 12- 6 MCBs by conductor cross-section and temperature

Conductor cross-section	Max. value up to 40 °C	Max. value up to 55 °C
1.5 mm^2	10 A	6 A
2.5 mm^2	16 A	10 A
4 mm^2	25 A	16 A
6 mm^2	32 A	20 A
24 V busbar	20 A	20 A

The trip characteristic of the MCBs must be selected to match the loads to be protected and the max. current provided by the power supply unit in the event of a short-circuit.

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12.7.4 Overvoltage protection

Overvoltage protection devices are needed if long cables are used.

- Supply cables > 10 m
- Signal cables > 30 m

The following Weidmüller overvoltage protectors are recommended for protecting the components' 24 V power supply and the 24 V signal cables from overvoltage:

Table 12- 7 Recommendations for overvoltage protection

DC power supply	24 V signal cables
Weidmüller Item No.: PU III R 24V Order number: 8860360000	Weidmüller Item No.: MCZ OVP TAZ Order number: 844915 0000

The overvoltage protection components must always be placed next to the area to be protected, e.g. at the entry point to the control cabinet. All 24 V cables which exit the protected area must be routed through an overvoltage protection element.
The diagram below uses a CU320-2 DP as an example to show how the overvoltage protection components are connected.

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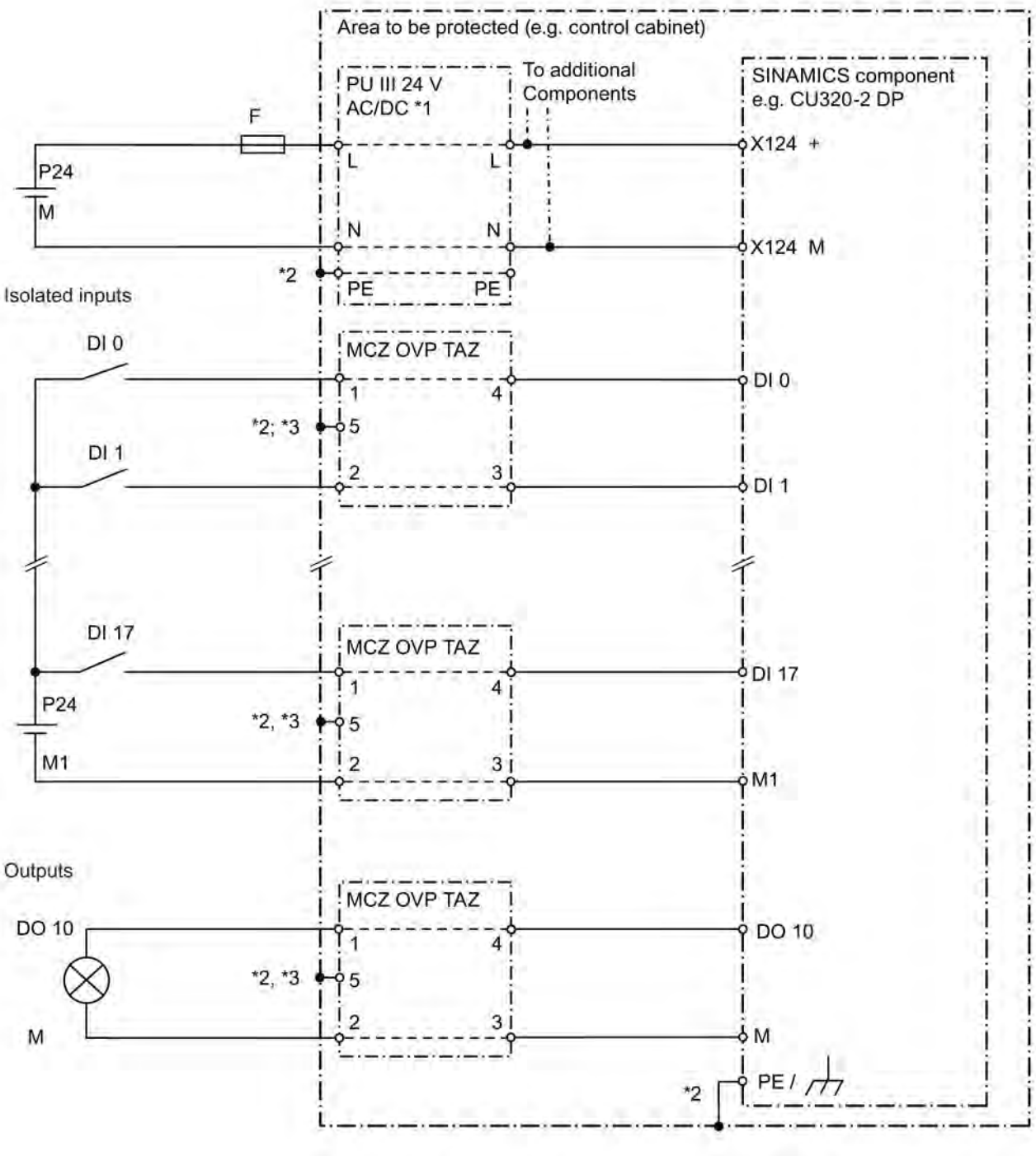


Figure 12-21 Connection example: Overvoltage protection components from Weidmüller connected to SINAMICS components

*1 Terminals 11, 12, 14 of the "PU III 24 VAC/DC" are isolated monitoring contacts (11 C, 12 NC, 14 NO). In the case of a thermal overload of the varistor installed, contacts 11-12 are opened and contacts 11-14 are closed.

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*2 The metallic enclosure of the SINAMICS components and the PE connection of the overvoltage protector must be interconnected in a manner that ensures good conductivity (equipotential bonding). This can be achieved by installing the SINAMICS components on a metallic mounting plate and connecting the PE connections of the overvoltage protection elements as directly as possible to the mounting plate.

*3 Snap the overvoltage protector (MCZ OVP TAZ) onto the metallic DIN rail to make the PE connection (terminal 5) to the rail. It is then sufficient to establish a good conductive connection between the DIN rail and the metallic enclosure of the SINAMICS component (equipotential bonding). This is the case when both the DIN rail and the SINAMICS component are mounted on a common metal mounting plate.

12.7.5 Typical 24 V current consumption of the components

A separate 24 V power supply must be used for the SINAMICS S120 drive line-up.

The following table can be used to calculate the 24 V DC power supply for the components. The values for typical current consumption are used as a basis for configuration.

Table 12- 8 Overview of the 24 V DC current consumption

Component	Typical current consumption [A_{DC}]
Control Units	
CU320-2 (without load) Per digital output	1,0 0,1
Sensor Modules Cabinet	
SMC10 without/with encoder system	0,20 / 0,35
SMC20 without/with encoder system	0,20 / 0,35
SMC30 without/with encoder system	0,20 / 0,55
SMC40 without/with encoder system	0,1 / 0,3
Sensor Modules External	
SME20 without/with encoder system	0,15 / 0,25
SME25 without/with encoder system	0,15 / 0,25
SME120 without/with encoder system	0,20 / 0,30
SME125 without/with encoder system	0,20 / 0,30

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Component	Typical current consumption [A_{DC}]
Terminal Modules	
TM15 (without digital outputs, without DRIVE-CLiQ) Per digital output / DRIVE-CLiQ	0,15 0,5
TM31 (without digital outputs, without DRIVE-CLiQ) Sum of all digital outputs Per DRIVE-CLiQ	0,2 0.1/1 (with switchover to current limitation) 0,5
TM41 (without digital outputs, without DRIVE-CLiQ) Per digital output / DRIVE-CLiQ	0,2 0,5
TM54F (without digital outputs, without DRIVE-CLiQ) Per digital output / DRIVE-CLiQ	0,2 0,5
TM120 (without DRIVE-CLiQ) Per DRIVE-CLiQ	0,1 0,5
TM150 (without DRIVE-CLiQ) Per DRIVE-CLiQ	0,07 0,5
Additional system components	
TB30 (without digital outputs) Per digital output	< 0,05 0,1
DMC20 (without DRIVE-CLiQ) Per DRIVE-CLiQ	0,15 0,5
DME20 (without DRIVE-CLiQ) Per DRIVE-CLiQ	0,15 0,5
VSM10 (without DRIVE-CLiQ) DRIVE-CLiQ	0,3 0,5
CBC10	0,1
CBE20	0,1
Active Interface Modules	
16 kW	0,25
36 kW	0,49
55 kW	0,6
80 kW	1,2
120 kW	1,2
Active Line Modules (internal/external air cooling)	
16 kW	0,95
36 kW	1,5
55 kW	1,9
80 kW	1,4
120 kW	1,8

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Component	Typical current consumption [A_{DC}]
Active Line Module (cold plate)	
16 kW	0,85
36 kW	1,05
55 kW	1,15
80 kW	1,4
120 kW	1,8
Active Line Module (liquid-cooled)	
120 kW	1,8
Smart Line Modules (internal/external air cooling)	
5 kW	0,8
10 kW	0,9
16 kW	0,95
36 kW	1,5
55 kW	1,9
Smart Line Modules (cold plate)	
5 kW	0,6
10 kW	0,7
Smart Line Modules Booksize Compact	
16 kW (internal air cooling)	0,95
16 kW (cold plate cooling)	0,85
Basic Line Modules (internal/external air cooling)	
20 kW	1
40 kW	1,4
100 kW	2
Basic Line Modules (cold plate)	
20 kW	0,9
40 kW	1,1
100 kW	1,6
DRIVE-CLiQ and brake	
DRIVE-CLiQ (e.g. motors with DRIVE-CLiQ interface)	0,19
Brake (e.g. motor holding brake)	Typ. 0.4 to 1.1; max. 2
Single Motor Modules (internal/external air cooling)	
3 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
5 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
9 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
18 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
30 A (+1 x DRIVE–CLiQ; +1 x brake)	0,8
45 A (+1 x DRIVE–CLiQ; +1 x brake)	1,05
60 A (+1 x DRIVE-CLiQ; +1 x brake)	1,05
85 A (+1 x DRIVE–CLiQ; +1 x brake)	1,5
132 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
200 A (+1 x DRIVE–CLiQ + 1 x brake)	0,85

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Component	Typical current consumption [A_{DC}]
Single Motor Modules (cold plate)	
3 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
5 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
9 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
18 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
30 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
45 A (+1 x DRIVE–CLiQ; +1 x brake)	0,75
60 A (+1 x DRIVE–CLiQ; +1 x brake)	0,75
85 A (+1 x DRIVE–CLiQ; +1 x brake)	0,8
132 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
200 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
Single Motor Modules (liquid-cooled)	
200 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
Single Motor Modules Booksize Compact (internal air cooling)	
3 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
5 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
9 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
18 A (+1 x DRIVE–CLiQ; +1 x brake)	0,85
Single Motor Modules Booksize Compact (cold plate)	
3 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
5 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
9 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
18 A (+1 x DRIVE–CLiQ; +1 x brake)	0,65
Double Motor Modules (internal and external air cooling)	
2 x 3 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15
2 x 5 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15
2 x 9 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15
2 x 18 A (+2 x DRIVE–CLiQ; +2 x brake)	1,3
Double Motor Modules (cold plate)	
2 x 3 A (+2 x DRIVE–CLiQ; +2 x brake)	1,0
2 x 5 A (+2 x DRIVE–CLiQ; +2 x brake)	1,0
2 x 9 A (+2 x DRIVE–CLiQ; +2 x brake)	1,0
2 x 18 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15
Double Motor Modules Booksize Compact (internal air cooling)	
2 x 1.7 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15
2 x 3 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15
2 x 5 A (+2 x DRIVE–CLiQ; +2 x brake)	1,15

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Component	Typical current consumption [A_{DC}]
Double Motor Modules Booksize Compact (cold plate)	
2 x 1.7 A (+2 x DRIVE–CLiQ; +2 x brake)	0,9
2 x 3 A (+2 x DRIVE–CLiQ; +2 x brake)	0,9
2 x 5 A (+2 x DRIVE–CLiQ; +2 x brake)	0,9
Braking Module Booksize	0,5
Braking Module Booksize Compact	0,4

If no other specifications are made to the contrary, the Line Modules and Motor Modules listed here are components in booksize format.

Example: Calculating the 24 V current requirement

Table 12- 9 Example of 24 V current requirements

Component	Quantity	Current consumption [A]	Total current consumption [A]
CU320-2 8 digital outputs	1 8	1,0 0,1	1,0 0,8
Active Line Module 36 kW	1	1,5	1,5
Motor Module 18 A	2	0,85	1,7
Motor Module 30 A	3	0,8	2,4
Encoders	5	0,25	1,25
Brake	5	1,1	5,5
Total:			14,15

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12.7.6 Selecting power supply units

You are advised to use the devices in the following table. These devices meet the applicable requirements of EN 60204-1.

Table 12- 10 Recommended SITOP Power

Rated output current [A]	Phases	Rated input voltage [V] Operating voltage range [V]	Short-circuit current [A]	Order number
5	1 / 2	AC 120 … 230 / 230 … 500 85 … 264 / 176 … 550	Approx. 5.5 (power up) Typ. 15 for 25 ms (operation)	6EP1333-3BA00-8AC0
10	1 / 2	AC 120 … 230 / 230 … 500 85 … 264 / 176 … 550	Approx. 12 (power up) Typ. 30 for 25 ms (operation)	6EP1334-3BA00-8AB0
20	1 / 2	AC 120 / 230 85 … 132 / 176 … 264	Approx. 23 (power up) Typ. 60 for 25 ms (operation)	6EP1336-3BA00-8AA0
	3	3 AC 230 / 400 … 288 / 500 320 … 550		6EP1436-3BA00-8AA0
40	1 / 2	AC 120 / 230 85 … 132 / 176 … 264	Approx. 46 (power up) Typ. 120 for 25 ms (operation)	6EP1337-3BA00-8AA0
	3	3 AC 230 / 400 … 288 / 500 320 … 550		6EP1437-3BA00-8AA0

Table 12- 11 Recommendation for Control Supply Module

Rated output current [A]		Input voltage range [V]	Short-circuit current [A]	Order number
20	3	380 V 3 AC -10 % (-15 % < 1 min) to 480 V 3 AC +10% DC 300 … 800	< 24	6SL3100-1DE22-0AAx

Refer also to Catalog PM21 or NC61.



⚠WARNING

Danger to life through a hazardous voltage when connecting an unsuitable power supply

Touching live components can result in death or severe injury.

- Connect the ground potential to the protective conductor connection.
- Mount the power supply close to the drive lineup.

  Ideally, they should be mounted on a common mounting plate. If different mounting plates are used, their electrical interconnection must comply with the EMC installation guideline.

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12.8 Connection systems

12.8.1 DRIVE-CLiQ signal cables

12.8.1.1 Overview

To connect DRIVE-CLiQ components, various pre-assembled and non-assembled DRIVE-CLiQ signal cables are available. The following pre-assembled DRIVE-CLiQ signal cables will be discussed in more detail in the next sections:

- Signal cables without 24 V cores with RJ45 connectors
- MOTION-CONNECT signal cables with DRIVE-CLiQ connectors
- MOTION-CONNECT signal cables with DRIVE-CLiQ connector and M12 socket

Table 12- 12 Overview of pre-assembled DRIVE-CLiQ signal cables

Type of DRIVE-CLiQ signal cable	24 V cores	Degree of protection		Connector type
		IP20	IP67	
6SL3060-4A.. 6FX2002-1DC..	--	x	x	RJ45
6FX5002-2DC00.. to .. -2DC20.. 6FX8002-2DC00.. to .. -2DC20..	x	x	x	DRIVE-CLiQ
6FX5002-2DC30.. 6FX8002-2DC30..	x	X (DRIVE-CLiQ)	X (M12)	DRIVE-CLiQ / M12

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12.8.1.2 DRIVE-CLiQ signal cables without 24 V DC cores

Pre-assembled DRIVE-CLiQ signal cables without 24 V DC cores are used to connect components with DRIVE-CLiQ connection, which have a separate or external 24 V DC power supply. They are mainly intended for use in control cabinets. The signal cables are available with RJ45 connectors in degrees of protection IP20 and IP67.

Table 12- 13 Actual lengths of the DRIVE-CLiQ jumpers for Line Modules and Motor Modules

DRIVE-CLiQ bridge	Cable length L [1]
50 mm	110 mm
100 mm	160 mm
150 mm	210 mm
200 mm	260 mm
250 mm	310 mm
300 mm	360 mm
350 mm	410 mm

[1] Cable length without connector

Cable lengths from 600 mm and higher are used to connect to other applications (e.g. establish a 2nd line in the drive line-up, establish wiring in a star configuration etc.)

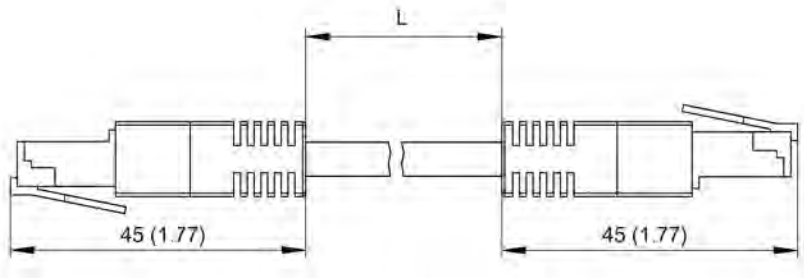


Figure 12-22 DRIVE-CLiQ signal cables without 24 V DC cores (IP20)

12.8.1.3 DRIVE-CLiQ signal cables MOTION-CONNECT with RJ45 connectors

The MOTION-CONNECT DRIVE-CLiQ signal cables with RJ45 plugs have 24 V cores. They are used for components with DRIVE-CLiQ connection if higher requirements must be complied with, such as mechanical stress and resistance to oil. For example, the signal cables are used for connections outside the control cabinet:

- Connections between Motor Modules and Sensor Modules
- Connections between Motor Modules and motors with DRIVE-CLiQ interface

The maximum length of the DRIVE-CLiQ MOTION-CONNECT signal cables with RJ45 plugs is:

- 100 m for MOTION-CONNECT 500 cables
- 75 m for MOTION-CONNECT 800PLUS cables

The signal cables are available in degrees of protection IP20 and IP67.

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Note

DRIVE-CLiQ cabinet bushing for RJ45 connectors

For information on the cabinet bushings, see Chapter DRIVE-CLiQ cabinet bushings (Page 679).

12.8.1.4 DRIVE-CLiQ signal cables MOTION-CONNECT with RJ45 plug and M12 socket

The MOTION-CONNECT DRIVE-CLiQ signal cables with RJ45 plug and M12 socket have 24 VDC cores. They establish the connection between components with a DRIVE-CLiQ connection and a direct measuring system equipped with DRIVE-CLiQ ASIC with 8-pin M12 connector. Measuring systems from third-party manufacturers can be directly connected to the SINAMICS S120.

Basic cable

The pre-assembled basic cable has eight cores, of which four are used for data transmission and two for the 24 V supply. It is used to convert from a RJ45 plug (IP20) to an M12 socket (IP67).



Figure 12-23 DRIVE-CLiQ basic cable with RJ45 plug and M12 socket

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Extension

The pre-assembled extension of a basic cable has an M12 plug (IP67) and an M12 socket (IP67).



Figure 12-24 DRIVE-CLiQ extension with M12 plug and M12 socket

Note

Maximum permissible total cable length

The maximum permissible total cable length between the measuring system and the RJ45 socket of the SINAMICS S120 device is 30 m. For a longer total cable length data transfer errors may occur. This is the reason that no additional extension can be connected to a 30 m long basic cable.

Note

Maximum number of extensions

A maximum of two extensions can be used. More than two extensions can result in data transfer errors.

Note

DRIVE-CLiQ cabinet bushing with M12 plug

For information on the cabinet bushings, see Chapter DRIVE-CLiQ cabinet bushings (Page 679).

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12.8.1.5 Comparison of DRIVE-CLiQ signal cables

DRIVE-CLiQ signal cables are designed for various applications. The following table provides an overview of the most important properties.

Table 12- 14 Properties of DRIVE-CLiQ signal cables

DRIVE-CLiQ signal cable	DRIVE-CLiQ	DRIVE-CLiQ MOTION-CONNECT 500	DRIVE-CLiQ MOTION-CONNECT 800PLUS
Approvals			
VDE cURus or UR/CSA UR-CSA File No.[1] in conformance with RoHS	Yes UL STYLE 2502/CSA-N.210.2-M90 Yes Yes	Yes UL STYLE 2502/CSA-N.210.2-M90 Yes Yes	Yes UL STYLE 2502/CSA-N.210.2-M90 Yes Yes
Rated voltage V_0/V in accordance with EN 50395	30 V	30 V	30 V
Test voltage, rms	500 V	500 V	500 V
Operating temperature at the surface			
Permanently installed Moveable	-20 … +80 °C -	-20 … +80 °C 0 … 60 °C	-20 … +80 °C -20 … +60 °C
Tensile load, max.			
Permanently installed Moveable	45 N/mm² –	80 N/mm² 30 N/mm²	50 N/mm² 20 N/mm²
Smallest bending radius			
Permanently installed Moveable	50 mm -	35 mm 125 mm	35 mm 75 mm
Torsional stress	-	30°/m absolute	30°/m absolute
Bending operations	-	100000	10 million
Max. moving speed	-	30 m/min	300 m/min
Max. acceleration	-	2 m/s²	50 m/s² (3 m distance moved through)[2]
insulation material	CFC/silicone-free	CFC/silicone-free	CFC/halogen/silicone-free IEC 60754-1 / DIN VDE 0472-815
Oil resistance	EN 60811-2-1	EN 60811-2-1 (mineral oil only)	EN 60811-2-1
Protective jacket	PVC Gray RAL 7032	PVC DESINA color green RAL 6018	PUR, HD22.10 S2 (VDE 0282, Part 10) DESINA color green, RAL 6018
Flame retardant	EN 60332-1-1 to 1-3	EN 60332-1-1 to 1-3	EN 60332-1-1 to 1-3

1) The file number is printed on the cable jacket.

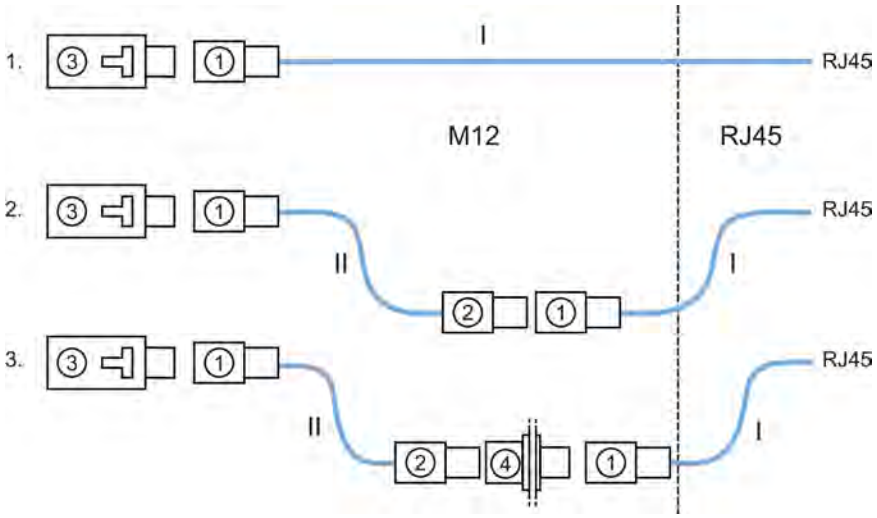
2) Characteristic curves for accelerating can be found in Catalog "D31" in Chapter "MOTION-CONNECT connection system".

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12.8.1.6 Connecting a direct measuring system

The various options of connecting a direct measuring system with DRIVE-CLiQ ASIC and M12 plug via MOTION-CONNECT cables to a DRIVE-CLiQ component are shown in the following diagram.

1. Direct connection via the basic cable
2. Basic cable and 1-2 extensions
3. Basic cable, cabinet bushing and a maximum of one extension



① M12 socket (IP67) connected to a MOTION-CONNECT DRIVE-CLiQ signal cable
② M12 plug (IP67) connected to a MOTION-CONNECT DRIVE-CLiQ signal cable
③ M12 plug (IP67) connected to a third-party measuring system
④ DRIVE-CLiQ cabinet bushing M12
I Basic cable
II Extension

Figure 12-25 Connecting a direct measuring system with M12 plug to a DRIVE-CLiQ component with RJ45 socket (IP20)

12.8.1.7 Combined use of MOTION-CONNECT 500 and MOTION-CONNECT 800PLUS

In principle, MOTION-CONNECT 500 cables and MOTION-CONNECT 800PLUS cables be used together.

Basic cables and extensions for MOTION-CONNECT cables with DRIVE-CLiQ connector and M12 socket can be combined without any restrictions.

For the combined use of MOTION-CONNECT cables with DRIVE-CLiQ connectors, the conditions below apply.

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Use of DRIVE-CLiQ couplings

DRIVE-CLiQ couplings are used to combine MOTION-CONNECT 500 cables and MOTION-CONNECT 800PLUS cables with DRIVE-CLiQ connectors. The maximum permissible cable length is calculated as follows:

ΣMC500 + 4/3 * ΣMC800PLUS + n_c * 5 m ≤ 100 m

ΣMC500: Total length of all MC500 cable segments (fixed routing)

ΣMC800PLUS: Total length of all MC800PLUS cable segments (tow chain)

n_c: Number of DRIVE-CLiQ couplings (0 to max. of 3)

With this combination, DRIVE-CLiQ cables with a maximum length of over 75 m can also implemented for applications involving a tow chain.

Table 12- 15 Examples of maximum cable lengths when using a DRIVE-CLiQ coupling

ΣMC500 (fixed routing)	87 m	80 m	66 m	54 m	40 m	30 m	20 m	10 m	5 m
ΣMC800PLUS (tow chain)	5 m	10 m	20 m	30 m	40 m	48 m	55 m	63 m	66 m
ΣMC500+ ΣMC800PLUS	92 m	90 m	86 m	84 m	80 m	78 m	75 m	73 m	71 m

Using a DRIVE CLiQ Hub Module

A DRIVE-CLiQ Hub Module (DMC20 or DME20) can be used to double the maximum permissible cable length for MOTION-CONNECT cables with DRIVE-CLiQ connectors. After the hub, the same length conditions apply as before the hub.

ΣMC500 + 4/3 * ΣMC800PLUS + n_c * 5 m ≤ 100 m before the hub

ΣMC500 + 4/3 * ΣMC800PLUS + n_c * 5 m ≤ 100 m after the hub

It is possible to connect two DRIVE-CLiQ Hub Modules in series (cascade connection).

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12.8.2 Power cables for motors

12.8.2.1 Configuring the cable length

Where a long motor cable is required, a higher rating of Motor Module must be selected or the permissible continuous output current $I_{continuous}$ must be reduced in relation to the rated output current I_{rated}. The configuring data for booksize format Motor Modules are given in the following table:

Table 12- 16 Permissible cable lengths for shielded motor cables

Motor Module	**Length of motor cable (shielded)**			
Rated output current I_N	**> 50 … 100 m**	**> 100 … 150 m**	**> 150 … 200 m**	**> 200 m**
3 A/5 A	Use 9 A Motor Module	Use 9 A Motor Module	Not permissible	Not permissible
9 A	Use 18 A Motor Module	Use 18 A Motor Module	Not permissible	Not permissible
18 A	Use 30 A Motor Module or $I_{max} \le 1.5 \times I_{rated}$ $I_{continuous} \le 0.95 \times I_{rated}$	Use 30 A Motor Module	Not permissible	Not permissible
30 A	Always permitted	$I_{max} \le 1.35 \times I_{rated}$ $I_{continuous} \le 0.9 \times I_{rated}$	$I_{max} \le 1.1 \times I_{rated}$ $I_{continuous} \le 0.85 \times I_{rated}$	Not permissible
45 A/60 A	Always permitted	$I_{max} \le 1.75 \times I_{rated}$ $I_{continuous} \le 0.9 \times I_{rated}$	$I_{max} \le 1.5 \times I_{rated}$ $I_{continuous} \le 0.85 \times I_{rated}$	Not permissible
85 A/132 A	Always permitted	$I_{max} \le 1.35 \times I_{rated}$ $I_{continuous} \le 0.95 \times I_{rated}$	$I_{max} \le 1.1 \times I_{rated}$ $I_{continuous} \le 0.9 \times I_{rated}$	Not permissible
200 A	Always permitted	$I_{max} \le 1.25 \times I_{rated}$ $I_{continuous} \le 0.95 \times I_{rated}$	$I_{max} \le 1.1 \times I_{rated}$ $I_{continuous} \le 0.9 \times I_{rated}$	Not permissible

When using a motor holding brake, the maximum motor cable length is 100 m.

The permissible cable length for an unshielded motor cable is 150 % of the length for a shielded motor cable.

Motor reactors can also be used on motors operating in vector and V/f control modes to allow the use of longer motor cables.

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12.8.2.2 Comparison of MOTION-CONNECT power cables

MOTION-CONNECT 500 power cables are mainly suitable for permanent routing. MOTION-CONNECT 800PLUS power cables fulfill all of the high mechanical requirements for use in tow chains. They are resistant to cutting oils.

Table 12- 17 Comparison of the MOTION-CONNECT 500 and MOTION-CONNECT 800PLUS power cables

Power cable	MOTION-CONNECT 500	MOTION-CONNECT 800PLUS
Approvals		
VDE[1)] cURus or UR/CSA UR-CSA File No.[2)] in conformance with RoHS	Yes UL758-CSA-C22.2-N.210.2-M90 Yes Yes	Yes UL758-CSA-C22.2-N.210.2-M90 Yes Yes
Rated voltage V_0/V in accordance with EN 50395		
Supply conductors Signal conductors	600 V / 1000 V 24 V (EN) 1000 V (UL/CSA)	600 V / 1000 V 24 V (EN) 1000 V (UL/CSA)
Test voltage, rms		
Supply conductors Signal conductors	4 kV 2 kV	4 kV 2 kV
Operating temperature at the surface		
Permanently installed Moveable	-20 … +80 °C 0 … 60 °C	-50 … +80 °C -20 … +60 °C
Tensile load, max.		
Permanently installed Moveable	50 N/mm² 20 N/mm²	50 N/mm² 20 N/mm²
Smallest bending radius		
Permanently installed Moveable	5 x D_{max} approx. 18 x D_{max}	4 x D_{max} approx. 8 x D_{max}
Torsional stress	30°/m absolute	30°/m absolute
Bending operations	100000	10 million
Max. moving speed	30 m/min	Up to 300 m/min
Max. acceleration	2 m/s²	50 m/s² (3 m)[3)]
insulation material	CFC/silicone-free	CFC/halogen/silicone-free IEC 60754-1 / DIN VDE 0472-815
Oil resistance	EN 60811-2-1 (mineral oil only)	EN 60811-2-1
Protective jacket	PVC DESINA color, orange RAL 2003	PUR, HD22.10 S2 (VDE 0282, Part 10) DESINA color, orange, RAL 2003
Flame retardant	EN 60332-1-1 to 1-3	EN 60332-1-1 to 1-3

1) The registration number is printed on the cable jacket.

2) The file number is printed on the cable jacket.

3) Characteristic curves for accelerating can be found in Catalog "D31" or "PM21" in Chapter "MOTION-CONNECT connection system".

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12.8.3 Current-carrying capacity and derating factors for power cables and signal cables

The current carrying capacity of PVC/PUR-insulated copper cables is specified for routing types B1, B2 and C under continuous operating conditions in the table below with reference to an ambient air temperature of 40° C. For other ambient temperatures, the values must be corrected by the factors listed in the "Derating factors for deviating ambient temperatures" table.

Routing types

B1	Cables in conduits or cable ducts
B2	Multi-conductor cables in conduits or cable ducts
C	Cables along walls, without conduits or cable ducts

Table 12- 18 Current carrying capacity according to EN 60204-1 for 40° C ambient temperature

Cross-section	Current carrying capacity, effective; AC 50/60 Hz or DC For routing type		
mm²	B1 A	B2 A	C A
Signal cables			
0,20	–	4,3	4,4
0,50	–	7,5	7,5
0,75	–	9	9,5
Power cables			
0,75	8,6	8,5	9,8
1,00	10,3	10,1	11,7
1,50	13,5	13,1	15,2
2,50	18,3	17,4	21
4	24	23	28
6	31	30	36
10	44	40	50
16	59	54	66
25	77	70	84
35	96	86	104
50	117	103	125
70	149	130	160
95	180	165	194
120	208	179	225

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Table 12- 19 Current carrying capacity according to IEC 60364-5-52 for 40° C ambient temperature

Cross-section	**Current carrying capacity, effective; AC 50/60 Hz or DC** **For routing type**		
mm²	**B1** **A**	**B2** **A**	**C** **A**
Power cables			
150	–	–	344
185	–	–	392
> 185	Values must be taken from the standard		

Table 12- 20 Derating factors for deviating ambient temperatures

Ambient air temperature [° C]	**Derating factor according to EN 60204-1, Table D1**
30	1,15
35	1,08
40	1,00
45	0,91
50	0,82
55	0,71
60	0,58

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12.8.4 Maximum cable lengths

The table below provides an overview of the maximum permissible cable lengths for signal and supply cables, power cables, and DC link cables.

Table 12- 21 Maximum cable lengths

Type	Maximum length [m]
24 V DC supply cables[1)]	10
24 V signal cables[1)]	30
DRIVE-CLiQ signal cables MC500 (RJ45)	100
DRIVE-CLiQ signal cables MC500 (M12)	30
DRIVE-CLiQ signal cables MC800PLUS (RJ45)	75
DRIVE-CLiQ signal cables MC800PLUS (M12)	30
DC link, including extensions	10
Total cable length for Active Line Modules 16 ... 36 kW with Active Interface Module[4)]	630 (shielded)[3)]
Total cable length for Active Line Modules 55 ... 120 kW with Active Interface Module[4)]	1000 (shielded)[3)]
Total cable length for Active Line Modules with line reactor[4)]	350 (shielded)[3)]
Total cable length for Basic Line Modules[4)]	630 (shielded)[3)]
Total cable length for Smart Line Modules[4)]	350 (shielded)[3)]
Power cable between line filter and line reactor	10 (shielded/unshielded)[2)]
Power cable between line reactor and Line Module	10 (shielded/unshielded)[2)]
Power cable between motor and Motor Module up to I_n = 9 A	50 (shielded) 75 (unshielded)
Power cable between motor and Motor Module I_n = 18 A	70 (shielded) 100 (unshielded)
Power cable between motor and Motor Module $I_n \geq 30$ A	100 (shielded) 150 (unshielded)
Cable between the Braking Module and braking resistor	10

1) For longer lengths, the user must connect a suitable protective circuit in order to provide overvoltage protection (refer to the chapter "Overvoltage protection" under "24 V DC supply")

2) To comply with EMC limit values, shielded cables (preferably MOTION CONNECT cables) must be used.

3) Restrictions regarding the total cable length and the secondary conditions required to comply with the corresponding radio interference suppression category are listed in Chapter "Possible line reactor and line filter combinations".

4) The total lengths specified for power cables in the drive line-up include motor cables, DC link cables, and the line feeder cable, line filter to the Line Module.

Note

Total cable lengths

also referred to Basic Line filter for Active Line Modules (Page 62) as well as Possible line reactor and line filter combinations (Page 136).

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12.8.5 Connectable conductor cross-sections and tightening torques for motor and power cables

Table 12- 22 Connectable conductor cross-sections Part 1: Line cable / motor cable

			Connection cross-section [mm²]					
Component	**Terminal type / tightening torque**		**1,5**	**2,5**	**4**	**6**	**10**	**16**
Motor Module Booksize 3 … 30 A 2 x 3 A … 2 x 18 A	Motor connection connector 30 A, 3+2 pole	Crimped connector	X	X	X	X	X	
		Screw connector	X	X	X	X		
Motor Module Booksize Compact 1.7 A ... 18 A	Screw terminal 1.2 ... 1.5 Nm		X	X	X	X		
Motor Module 45 … 60 A	Threaded bolts M6 6 Nm[1)]					X	X	X
Motor Module 85 A	Threaded bolts M8 13 Nm[2)]							X
Smart Line Module Booksize 5 ... 10 kW	Screw terminal 1.2 ... 1.5 Nm		X	X	X	X		
Smart Line Module Booksize Compact 16 kW	Screw terminal 1.5 ... 1.8 Nm					X	X	X
Active Line Module 16 kW Smart Line Module 16 kW	Screw terminal 1.5 ... 1.8 Nm					X	X	
Active Line Module 36 kW Smart Line Module 36 kW	Threaded bolts M6 6 Nm[1)]							X
Active Interface Module 16 kW	Screw terminal 1.7 Nm					X	X	X
Active Interface Module 36 kW	Screw terminal 6 Nm							X[3)]

1) For ring cable lugs without insulation
clamping area ensured for flexible cable with end sleeve, ring cable lug M6 or M8
IP2xB according to EN 60529; Note: The restrictor collar installed as standard for the purpose of touch protection must be used or adapted as required

2) Alternatively, two ring cable lugs without insulation for the parallel connection of two cables with a maximum cross-section of 50 mm² can also be connected to the threaded bolts respectively. Both cable lugs should be mounted "back to back".

3) The connection terminals of the 36 kW Active Interface Module are only certain to be safe from touch protection according to EN 60529 if cables with a minimum cross-section of 25 mm² and insulated end sleeves are used.

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Table 12- 23 Connectable conductor cross-sections Part 2: Line cable / motor cable,

		Connection cross-section [mm²]					
Component	**Terminal type / tightening torque**	**25**	**35**	**50**	**70**	**95**	**120**
Motor Module 45 … 60 A	Threaded bolts M6 6 Nm[1)]	X	X	X			
Motor Module 85 A	Threaded bolts M8 13 Nm[2)]	X	X	X	X	X	X
Motor Module 132 … 200 A	Threaded bolts M8 13 Nm[2)]	X	X	X	X	X	X
Active Line Module 36 kW Smart Line Module 36 kW	Threaded bolts M6 6 Nm	X	X	X			
Active Line Module 55 kW Smart Line Module 55 kW	Threaded bolts M8 13 Nm[2)]		X	X	X	X	X
Active Line Module 80 … 120 kW	Threaded bolts M8 13 Nm[2)]				X	X	X
Active Interface Module 36 kW	Screw terminal 6 Nm	X	X	X			
Active Interface Module 55 kW	Screw terminal 6 Nm		X	X			
Active Interface Module 80 … 120 kW	Threaded bolts M8 13 Nm[2)]				X	X	X

1) For ring cable lugs without insulation
clamping area ensured for flexible cable with end sleeve, ring cable lug M6 or M8
IP2xB according to EN 60529; Note: The restrictor collar installed as standard for the purpose of touch protection must be used or adapted as required

2) Alternatively, two ring cable lugs without insulation for the parallel connection of two cables with a maximum cross-section of 50 mm² can also be connected to the threaded bolts respectively. Both cable lugs should be mounted "back to back".

Table 12- 24 Connectable conductor cross-sections Part 3: Line cable / connection for braking resistor

		Connection cross-section [mm²]					
Component	**Terminal type / tightening torque**	**1,5**	**2,5**	**4**	**6**	**10**	**16**
Basic Line Module 20 kW Line cable connection	Screw terminal 1.5 ... 1.7 Nm				x	x	x
Basic Line Module 20 kW Braking resistor connection	Screw terminal 0.5 ... 0.6 Nm	x	x	x			
Basic Line Module 40 kW Braking resistor connection	Screw terminal 1.5 ... 1.8 Nm			x	x	x	

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Table 12- 25 Connectable conductor cross-sections Part 4: Line supply cable

		Connection cross-section [mm²]					
Component	**Terminal type / tightening torque**	**25**	**35**	**50**	**70**	**95**	**120**
Basic Line Module 40 kW Line cable connection	Screw terminal 6 Nm	x	x	x			
Basic Line Module 100 kW Line cable connection[1)]	Threaded bolts M8 13 Nm				x	x	x

1) Alternatively, two ring cable lugs without insulation for the parallel connection of two cables with a maximum cross-section of 50 mm² can also be connected to the threaded bolts respectively. Both cable lugs should be mounted "back to back".

WARNING

Danger to life as a result of overheated motor cables if permissible cross-sections are fallen below

Motor cables with inadequate cross-section can cause components to overheat. This can result in severe injury or death due to fire and smoke.

- Use cables that correspond to the Motor Module currents.
- If smaller cross-sections are selected, you must ensure the appropriate level of conductor protection in another way, e.g. by suitably setting the control parameters.

Note

Compliance with the IP20 degree of protection for Basic Line Modules 40 kW

The 40 kW Basic Line Module only has an IP20 degree of protection when used with power cables with insulated end sleeves and a cross-section > 25 mm².

Note

Cross-section of the protective conductor

The cross-section of the PE conductor must be selected according to DIN EN 60204-1, DIN EN 61800-5-1 and VDE 0100-540 (IEC 60364-5-54). Some components result in an increased leakage current. In this case, regulation EN 61800-5-1 must be taken into account.

Note

Selection of the line supply conductor

When selecting the line supply conductor, note the loop resistance so that the relevant protective components (line fuse, RCCB, etc.) function properly and that no hazardous shock currents or voltages occur in the event of a fault.

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12.8.6 Motor connection connector

Motor Modules 3 A to 30 A are supplied without a motor connector. Prefabricated MOTION-CONNECT power cables with pre-assembled motor connectors or unassembled power cables can be used to connect motors. In this case, the motor connector must be ordered separately.

The motor connector is equipped with a locking mechanism. Mounting on the Motor Module is described in the following.

12.8.6.1 Mounting on the Motor Module

Motor connectors with locking mechanism are available in two versions:

- Crimp plug for pre-assembled motor cables
- Screw connector for motor cables that need to be assembled

The way in which motor connectors are installed depends on the type of Motor Module used.

Note

With Double Motor Modules, the rear motor connector must be installed first and then locked.

Installation on Motor Modules without pre-assembled interlock bolt

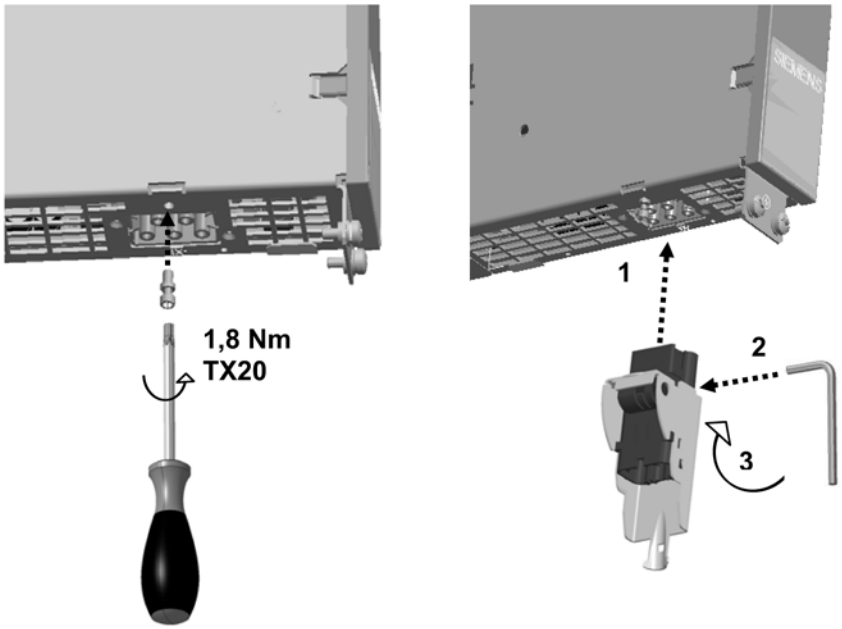


Figure 12-26 Installation example: Crimp plug

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1. Screw the interlocking bolts into the thread provided in the housing.
2. Insert the connector, including the motor cable, and lock it in place using a screwdriver or size 4 hexagon socket-head screw clockwise by turning a ¼ turn (90°).

Installation on Motor Modules with pre-assembled interlock bolt

If Motor Modules with a pre-assembled interlock bolt are used, step 1 described above can be omitted.

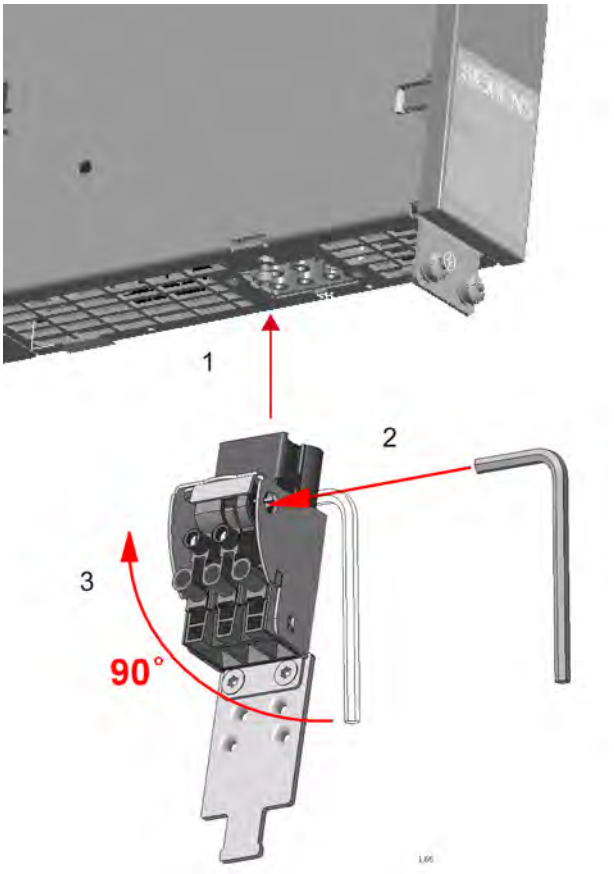


Figure 12-27 Installation example: Screw connector

Simply insert the connector, including the motor cable, and lock it in place using a screwdriver or size 4 hexagon socket-head screw clockwise by turning a ¼ turn (90°).

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12.8.6.2 Attaching the motor connector to self-fabricated cables

Preparing the power cable

Non-assembled power cables must be appropriately prepared before the motor connector is connected.

1. Remove the cable sheath to 200 mm ± 5 mm.
2. Fix the braided shield, e.g. with heat-shrink tubing
3. Remove the insulation from the individual U, V, W conductors and the motor holding brake connecting cables and shorten these corresponding to the drawing shown below.
4. Remove the insulation from the single PE conductor, and crimp this with a ring cable lug without insulation.

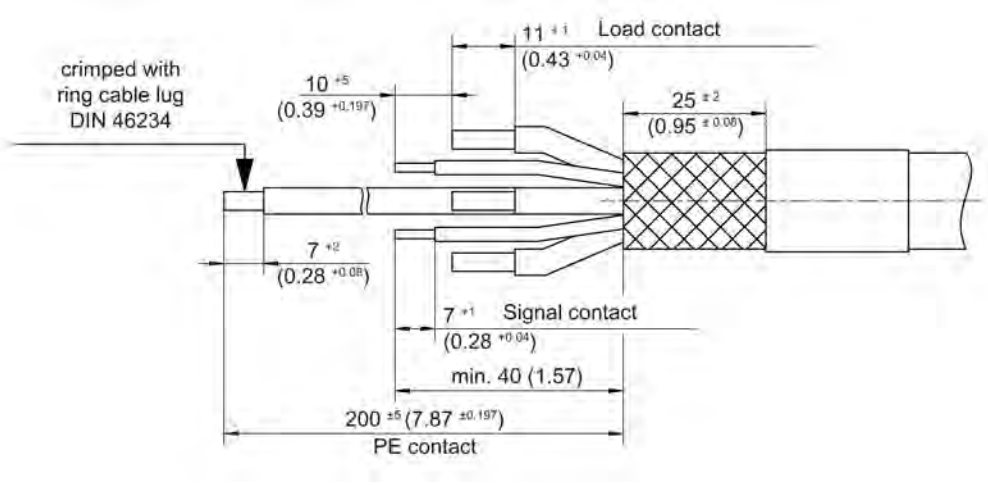
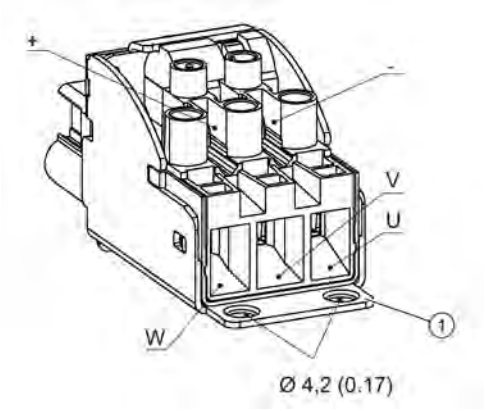


Figure 12-28 Stripped lengths for self-fabricated motor power cables, all data in mm and (inches)

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Attaching the motor connector

The connections for the single conductors at the motor connector can be taken from the following diagram.

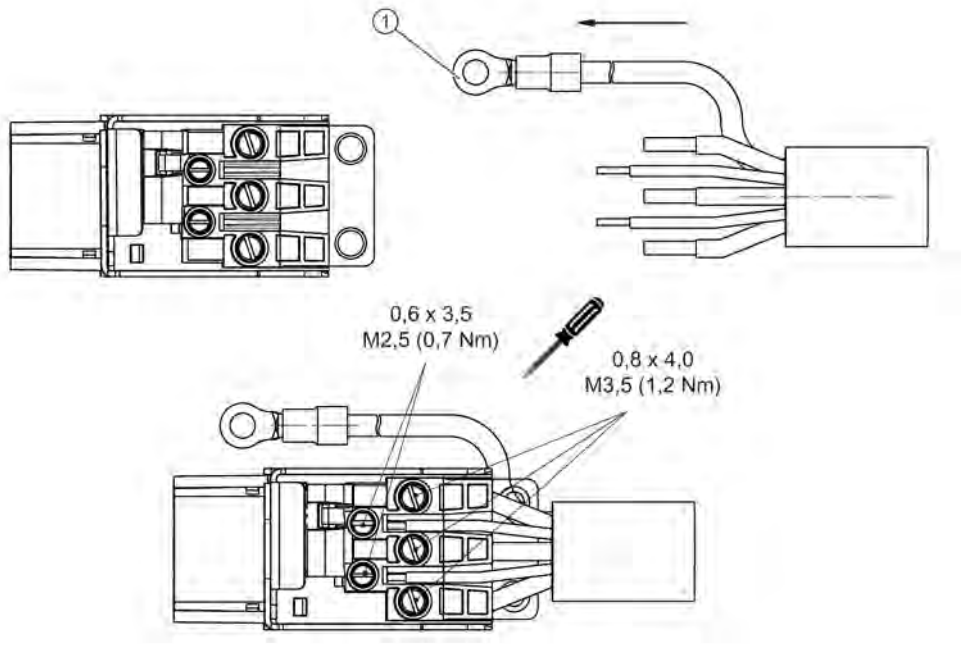


① Connection for shield plate supplied with the equipment

Figure 12-29 Connections at the motor connector, screw version

The motor connector is connected as shown below.

1. Insert the individual U, V, W conductors into the associated terminals of the motor connector (maximum cross-section for cables with end sleeves: 6.0 mm²).
2. Insert the individual conductors of the motor holding brake into the associated terminals of the motor connector (maximum cross-section for cables with end sleeves: 2.5 mm²).



① Insulated ring cable lug

Figure 12-30 Attaching the motor connector screw version

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12.8.6.3 Removing the motor connector from prefabricated power cables

The motor connector of a pre-assembled motor cable might have to be removed if the cable needs to be routed through narrow cable glands, for example.

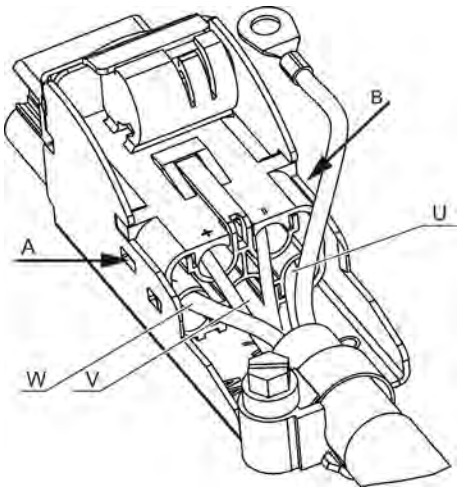


Figure 12-31 Motor connector, crimped version

Removing the motor connector

1. First loosen the clamp.
2. Simultaneously press the tabs A and B on both sides of the connector using a screwdriver.
3. Keep both tags pressed and lift the interlock mechanism e.g. using a screwdriver.
4. Remove the Insert and withdraw the motor cable out of the connector.

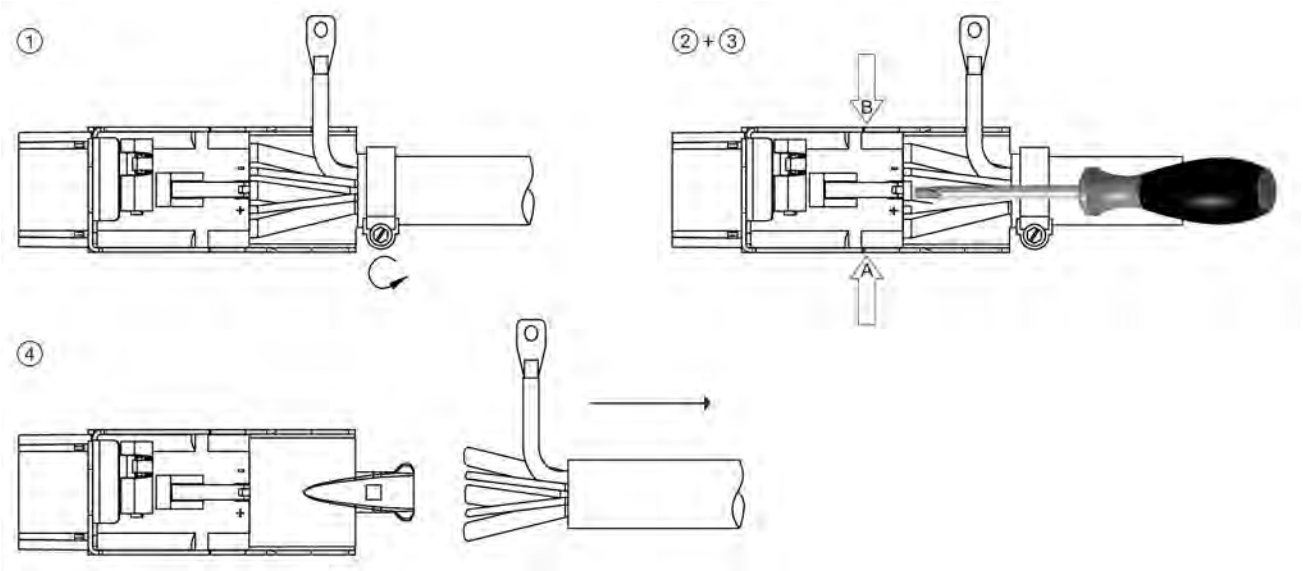


Figure 12-32 Removing the motor connector, crimped version

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12.8.6.4 Coding

The motor connector is coded using coding plugs. The coding plugs are included in the scope of supply of the motor connector. Coding can be used to prevent motor cables being incorrectly connected, particularly in the case of Double Motor Modules.

The coding of a motor connector is illustrated below, using the example of a connector with screwed joint.



Motor connector with associated coding plugs



Motor connector with coding plugs inserted from the accessories pack

12.8.6.5 Shield connection

The following options are available for cable shield support:

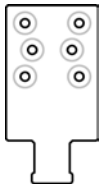
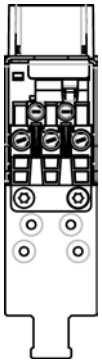
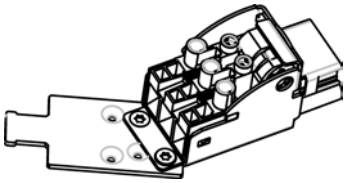
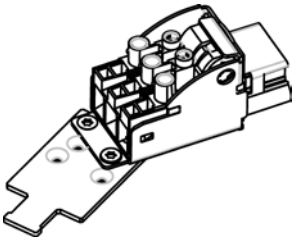
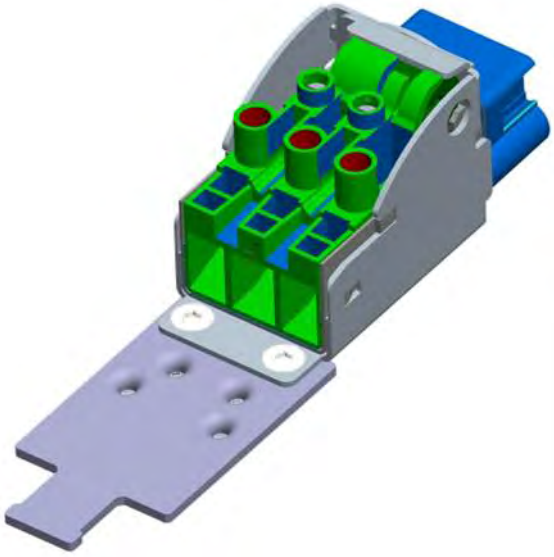
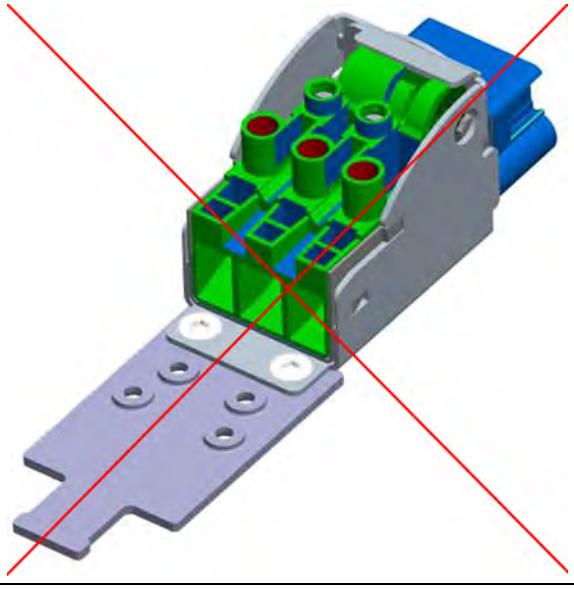
1. Shield support with shield plate supplied
2. Shield support on a toothed rail
3. Fixing your own shield support at the shield connection of the motor connector

Shield support with shield plate supplied

A shield plate is always provided with the screw version of the motor connector. The shield of a prefabricated motor power cable should be preferably connected at this shield plate that is provided.

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Table 12- 26 Possible installations of the shield plate

	
Shield plate supplied for the motor connector	Frontal alignment of the shield plate
	
Lateral alignment of the shield plate	Lateral alignment of the shield plate
Mount the shield plate with the recesses facing upwards. Otherwise the shield plate will not be able to be tightened. It is then no longer guaranteed that the shield plate is mounted so that there is a reliable electrical connection.	
	
Correct	Incorrect

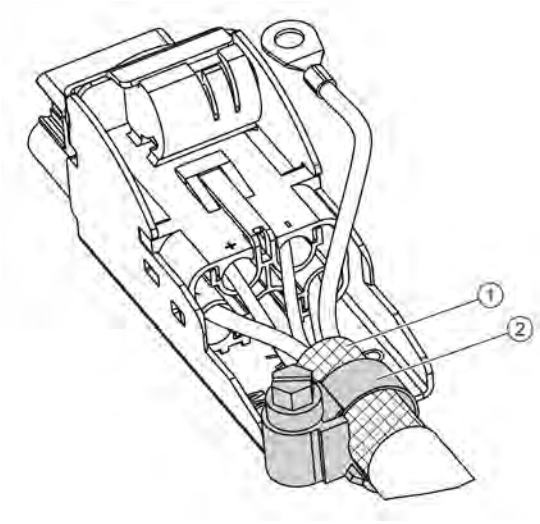
The shield plate can be mounted at various angles at the motor connector using two screws (M4) that are provided (tightening torque: 1.8 Nm).

Note

In order to guarantee that the cable shield is connected through a large surface area, the motor power cable is attached with a steel hose clamp at the shield plate.

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The shield is connected as shown below.



① Protective braided shield
② Steel hose clamp

Figure 12-33 Shield connection using a motor connector, crimped version, as example

Shield support on a toothed rail

The toothed rail should be mounted at a distance of ≤ 150 mm below the drive line-up to ensure a good contact. Wherever possible, the brake cores must be kept physically separate from U/V/W connections.

Note

Measures must be taken on site to relieve strain on the cables.
The maximum permissible tensile load in the insertion direction is 100 N.

With these versions, the shield for the brake connection conductors must be routed together with the cable shield.

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12.8.7 Spring-loaded terminals

The type of spring-loaded terminal can be taken from the interface description of the particular component.

Table 12- 27 Connectable conductor cross-sections for spring-loaded terminals

Spring-loaded terminal type			
1	Connectable cable cross-sections	Rigid Flexible Flexible with end sleeve without plastic sleeve AWG/kcmil	0.14 … 0.5 mm^2 0.14 … 0.5 mm^2 0.25 … 0.5 mm^2 26 … 20
	Stripped length	8 mm	
2	Connectable cable cross-sections	Flexible	0.08 … 2.5 mm^2
	Stripped length	8 … 9 mm	
3	Connectable cable cross-sections	Rigid Flexible Flexible with end sleeve without plastic sleeve Flexible with end sleeve with plastic sleeve AWG/kcmil	0.2 … 1.5 mm^2 0.2 … 1.5 mm^2 0.25 … 1.5 mm^2 0.25 … 0.75 mm^2 24 … 16
	Stripped length	10 mm	
4	Connectable cable cross-sections	 AWG	25 … 95 mm^2 4 … 4/0
	Stripped length	35 mm	
5	Connectable cable cross-sections	Rigid Flexible Flexible with end sleeve without plastic sleeve Flexible with end sleeve with plastic sleeve AWG/kcmil	0.2 … 10 mm^2 0.2 … 6 mm^2 0.25 … 6 mm^2 0.25 … 4 mm^2 24 … 8
	Stripped length	15 mm	

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12.8.8 Screw terminals

The type of screw terminal can be taken from the interface description of the particular component.

Table 12- 28 Connectable conductor cross-sections and tightening torques for screw terminals

Screw terminal type			
1	Connectable cable cross-sections	Rigid, flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve	0.08 … 1.5 mm^2 0.25 … 1.5 mm^2 0.25 … 0.5 mm^2
	Stripped length	7 mm	
	Tool	Screwdriver 0.4 x 2.0 mm	
	Tightening torque	0.22 … 0.25 Nm	
1_1	Connectable cable cross-sections	Rigid, flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve	0.14 … 1.5 mm^2 0.25 … 1.5 mm^2 0.25 … 0.5 mm^2
	Stripped length	7 mm	
	Tool	Screwdriver 0.4 x 2.5 mm	
	Tightening torque	0.22 … 0.25 Nm	
2	Connectable cable cross-sections	Rigid, flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve AWG / kcmil	0.2 … 2.5 mm^2 0.2 … 2.5 mm^2 0.2 … 1.5 mm^2 22 … 12
	Stripped length	6 … 7 mm	
	Tool	Screwdriver 0.5 x 3 mm	
	Tightening torque	0.4 … 0.5 Nm	
3	Connectable cable cross-sections	Flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve	0.2 … 2.5 mm^2 0.25 … 1 mm^2 0.25 … 1 mm^2
	Stripped length	9 mm	
	Tool	Screwdriver 0.6 x 3.5 mm	
	Tightening torque	0.5 … 0.6 Nm	
4	Connectable cable cross-sections	Flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve	0.2 … 4 mm^2 0.25 … 4 mm^2 0.25 … 4 mm^2
	Stripped length	7 mm	
	Tool	Screwdriver 0.6 x 3.5 mm	
	Tightening torque	0.5 … 0.6 Nm	
5	Connectable cable cross-sections	Flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve	0.5 … 6 mm^2 0.5 … 6 mm^2 0.5 … 6 mm^2
	Stripped length	12 mm	
	Tool	Screwdriver 1.0 x 4.0 mm	
	Tightening torque	1.2 … 1.5 Nm	

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Screw terminal type			
6	Connectable cable cross-sections	Flexible With end sleeve, without plastic sleeve With end sleeve, with plastic sleeve	0.5 … 10 mm^2 0.5 … 10 mm^2 0.5 … 10 mm^2
	Stripped length	11 mm	
	Tool	Screwdriver 1.0 x 4.0 mm	
	Tightening torque	1.5 … 1.8 Nm	
7	Connectable cable cross-sections	0.5 … 16 mm^2	
	Stripped length	14 mm	
	Tool	Screwdriver 1.0 x 4.0 mm	
	Tightening torque	1.5 … 1.7 Nm	

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12.8.9 Handling restrictor collars for touch protection

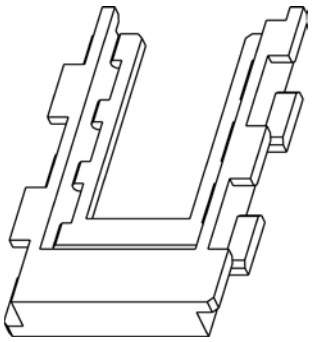
Handling restrictor collars for touch protection and when connecting cables

Restrictor collars are used to provide touch protection in accordance with EN 60529. They must be removed and adapted if necessary before the line supply conductor and/or motor cable is connected, after which they must be reattached. To adapt the touch protection, see Connecting the power cables (Page 643).

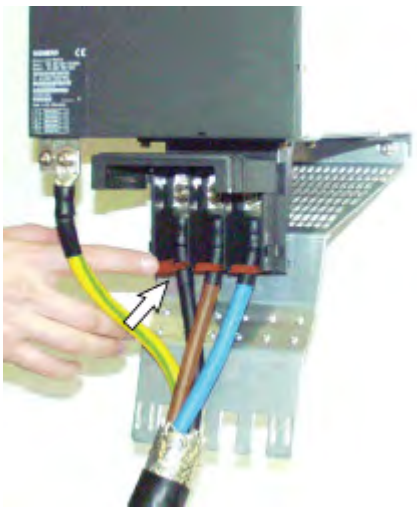
Exception: The cross-section of the connected cables is large enough to ensure that the threaded bolts and the ends of the cables cannot be touched when the cover is closed.

The following components are supplied with restrictor collars as standard:

- Active Line Modules 36 kW and higher
- Smart Line Modules 36 kW and higher
- Basic Line Modules 100 kW and higher
- Motor Modules 45 A and higher
- Active Interface Modules 80 kW and higher



Restrictor collar



Power unit with cables and restrictor collars attached

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12.9 Cable shielding and routing

In order to comply with the EMC requirements, certain cables must be routed apart from other cables and from certain components. To satisfy EMC requirements, the following cables must be used with shields:

- Line supply conductors from line filter via line reactor to Line Module
- All motor cables (if necessary, including cables for motor holding brake)
- Cables for "fast inputs" of the Control Unit
- Cables for analog direct voltage/current signals
- Signal cables for sensors
- Cables for temperature sensors

Alternative measures (e.g. routing behind mounting plates, suitable clearances) can also be used provided they have similar results. This excludes measures that relate to the design, installation, and routing of motor power cables and signal cables.

If unshielded cables are used between the line supply connection point and line filter, make sure that no interfering cables are routed in parallel.

Power and signal cables must always be routed separately. For this purpose, it is practical to arrange the various cables according to cable groups. Cables belonging to a group can be combined in a bundle. The various cable groups must be routed with the necessary clearance between them. A minimum clearance of 20 cm has proven itself in practice. As an alternative, shielding plates with the appropriate contacts at several locations can be used between the cable bundles.

All cables inside the cabinet must be routed as closely as possible to parts connected with cabinet ground, such as a mounting plate or cabinet wall. Ducts made of sheet steel or cables routed between steel sheets (e.g. between the mounting plate and back wall) should provide adequate shielding.

All cables must be kept as short as possible, to minimize the antenna effect.

Signal and power cables may cross each other (if absolutely necessary), but must never be routed closely to one and other in parallel over longer distances.

Signal cables must be routed with a minimum clearance of 20 cm from strong magnetic fields (motors, transformers). Alternatively, shield plates with the appropriate contacts at several locations along their length can be used to provide the appropriate clearance.

Note: Cables for the 24 V supply should be treated just like signal cables.

Avoid, where possible, routing unshielded cables, connected to the drive line-up, in the immediate vicinity of noise sources, e.g. transformers. Signal cables (shielded and unshielded) connected to the drive line-up must be laid at a great distance from strong external magnetic sources (e.g. transformers, line reactors). In both cases, a distance of ≥ 300 mm is usually sufficient.

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WARNING

Danger to life due to high leakage currents caused by an interrupted external protective conductor

The drive components conduct a high leakage current via the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.

- Ensure that the external protective conductor satisfies at least one of the following conditions:
  - It has been laid so that it is protected against mechanical damage.[1)]
  - If it is a single conductor, it has a cross-section of at least 10 mm² Cu.
  - If it is a conductor of a multi-conductor cable, it has a cross-section of at least 2.5 mm² Cu.
  - It has a second protective conductor in parallel with the same cross-section.
  - It complies with the local regulations for equipment with increased leakage current.

[1)] Cables laid within control cabinets or closed machine housings are considered to be adequately protected against mechanical damage.

Shield connection

The cable shields must be connected as close to the conductor terminal connections as possible to ensure a low-impedance connection with cabinet ground. For power cables from Siemens in which the shield is connected to the connector shell (see relevant catalog), this is a sufficiently good shield support.

For components that do not have any special shield connection or where the shield connection is not sufficient, the cable shields can be connected to the metal mounting plate using hose clamps and toothed rails. The cable length between the shield contact point and the terminals for cable conductors must be kept as short as possible.

Shield contact plates with pre-prepared clip contacts are available for contacting the shields for power cables of Line Modules and Motor Modules. Up to a module width of 100 mm (inclusive), these plates are part of the scope of delivery of the components, or they are integrated in the connector.

Routing 24 V cables

When routing 24 V cables, the following must also be observed:

- A maximum of one conductor pair may be bundled together.
- 24 V conductors must be routed separately from other cables and conductors that could conduct the operating current.
- 24 V cables must never be routed parallel to power cables.
- 24 V cables as well as power cables should be routed to the components so that they never cover ventilation slots.

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Conditions of use for 24 V cables

- Ambient temperature 55° C
- Conductor temperature limit ≤ 70° C for operation with the rated load current
- Max. cable length:
  - 10 m for the 24 V supply cables
  - 30 m for signal lines without additional connections

12.10 Protective connection and equipotential bonding

Protective connections

The SINAMICS S Booksize drive system is designed for use in cabinets with a PE conductor connection.

The protective conductor connection of the SINAMICS components must be connected to the protective conductor connection of the control cabinet as follows:

Table 12- 29 Conductor cross-section for copper protective connections

Line supply cable in mm²	Copper protective connection in mm²
Up to 16 mm²	The same as the line supply cable
From 16 mm² to 35 mm²	16 mm²
From 35 mm²	0.5 x line supply cable

For materials other than copper, the cross-section should be increased so that as a minimum, the same conductivity is attained.

All system components and machine parts must be incorporated in the protection concept.

The protective connection (PE connection) for the motors used must be established through the motor cable. For EMC reasons, the shield of the motor cable should be connected through a large surface area both at the Motor Module as well as at the motor.

The drive line-up must be arranged on a common bright mounting plate in order to comply with the EMC limit values. The mounting plate must be connected to the protective conductor connection of the control cabinet through a low impedance.

Copper cables with appropriate cross-sections (> 2.5 mm²) must be used for the ground connection of PROFIBUS nodes.

For more information about grounding PROFIBUS, see:
http://www.profibus.com/fileadmin/media/wbt/WBT_Assembly_V10_Dec06/index.html

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DANGER

Danger to life when live parts are touched

Death or serious injury can result when live parts are touched.

- Only operate the components in electrical equipment rooms or control cabinets that can be securely locked.



WARNING

Danger to life due to high leakage currents caused by an interrupted external protective conductor

The drive components conduct a high leakage current via the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.

- Ensure that the external protective conductor satisfies at least one of the following conditions:
  - It has been laid so that it is protected against mechanical damage.[1)]
  - If it is a single conductor, it has a cross-section of at least 10 mm² Cu.
  - If it is a conductor of a multi-conductor cable, it has a cross-section of at least 2.5 mm² Cu.
  - It has a second protective conductor in parallel with the same cross-section.
  - It complies with the local regulations for equipment with increased leakage current.

[1)] Cables laid within control cabinets or closed machine housings are considered to be adequately protected against mechanical damage.

Functional equipotential bonding

A mounting plate, which is connected with the protective conductor connection of the control cabinet through a low impedance connection, simultaneously serves as the functional equipotential bonding surface. This means that no additional functional equipotential bonding is required within the drive line-up.

If a common bright mounting plate is not available, then equally good functional equipotential bonding must be established using cable cross-sections as listed in the table above or, as a minimum, with the same conductivity.

When mounting components on standard mounting rails, the data listed in the table also apply to the functional equipotential bonding. If only smaller conductor cross-sections are permissible on components, the largest cross-section must be used (e.g. 6 mm² for TM31 and SMC). These requirements also apply to distributed components located outside the control cabinet.

No functional equipotential bonding conductors are required for PROFIBUS inside a control cabinet. For PROFIBUS connections between different buildings or parts of buildings, a functional equipotential bonding must be routed in parallel to the PROFIBUS cable.

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The following cross-sections must be observed in accordance with IEC 60364-5-54:

- Copper 6 mm²
- Aluminum 16 mm²
- Steel 50 mm²

Additional information about equipotential bonding for PROFIBUS can be found at:
http://www.profibus.com/fileadmin/media/wbt/WBT_Assembly_V10_Dec06/index.html

Note

PROFINET

For installation guidelines and information of protective grounding and equipotential bonding for all PROFINET types and topologies, refer to DOWNLOADS at:
http://www.profibus.com

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12.11 Information on cold plate cooling

12.11.1 General information

Cold plate cooling is a cooling method that can be used for SINAMICS S120 power units in booksize format. The flat aluminum cold plate (cold plate), which is located on the rear of the device, acts as a thermal interface in cold plate cooling.

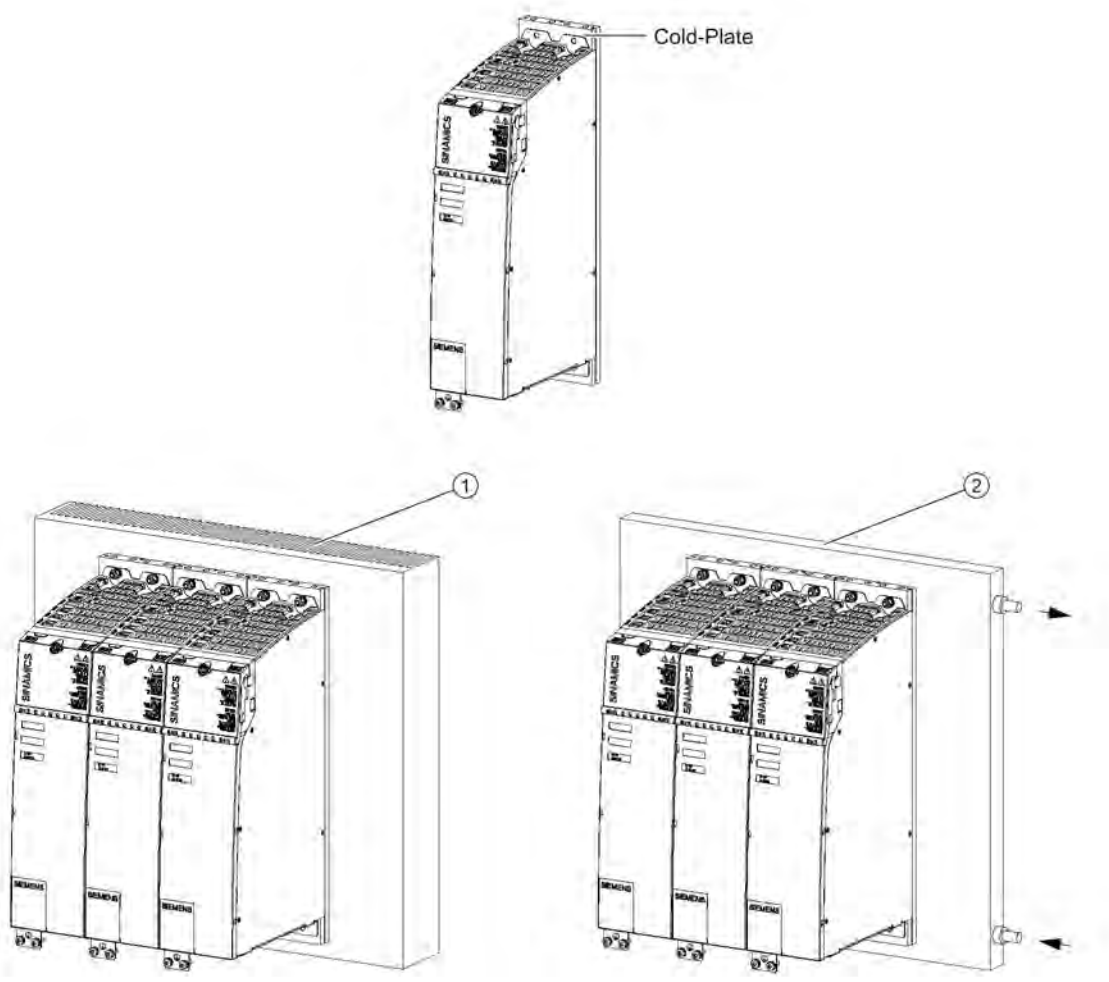
The cold plate cooling is especially suitable for the following machine concepts:

- Plants and systems with high degree of pollution in the vicinity of the machine (e.g. in the textiles or timber industry).
  - Reducing cabinet-internal thermal losses facilitates cooling within a sealed cabinet (IP54).
- Plants and systems where liquid cooling is already being used in the process.
  - The existing cooling circuit can be used to externally cool the power components with cold plate.

There are two ways of configuring this type of cooling:

1. Cold plate cooling with an external air heat sink
   The components of the drive line-up are typically all screwed on to the cooling fins of an air heat sink located outside the control cabinet.
2. Cold plate cooling with an external liquid heat sink
   The components of the drive line-up are typically all screwed on to a liquid heat sink located outside the control cabinet.

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① Cold plate components on an external air heat sink
② Cold plate components on an external liquid heat sink

Figure 12-34 Overview of cooling types for drive line-ups with cold plate

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12.11.2 Cold plate with external air heat sink

12.11.2.1 Configuration and conditions

The conditions described below must be taken into account when cooling a cold-plate drive line-up by means of an external air heat sink.

General conditions to be observed:

1. The maximum temperature within the cabinet is 40 °C
   (inlet air temperature of the power sections). The maximum temperature inside the cabinet for derating is 55 °C. For the relevant specifications, refer to the "Technical data".
2. The maximum permissible heat-sink temperature is module-dependent. Refer to the "Technical data" for more information. A temperature sensor in the power unit measures the temperature and can be read via parameter (see SINAMICS S120/S150 List Manual).
3. The customer must take measures to protect the devices against condensation (see Anti-condensation measures (Page 807)).

Note

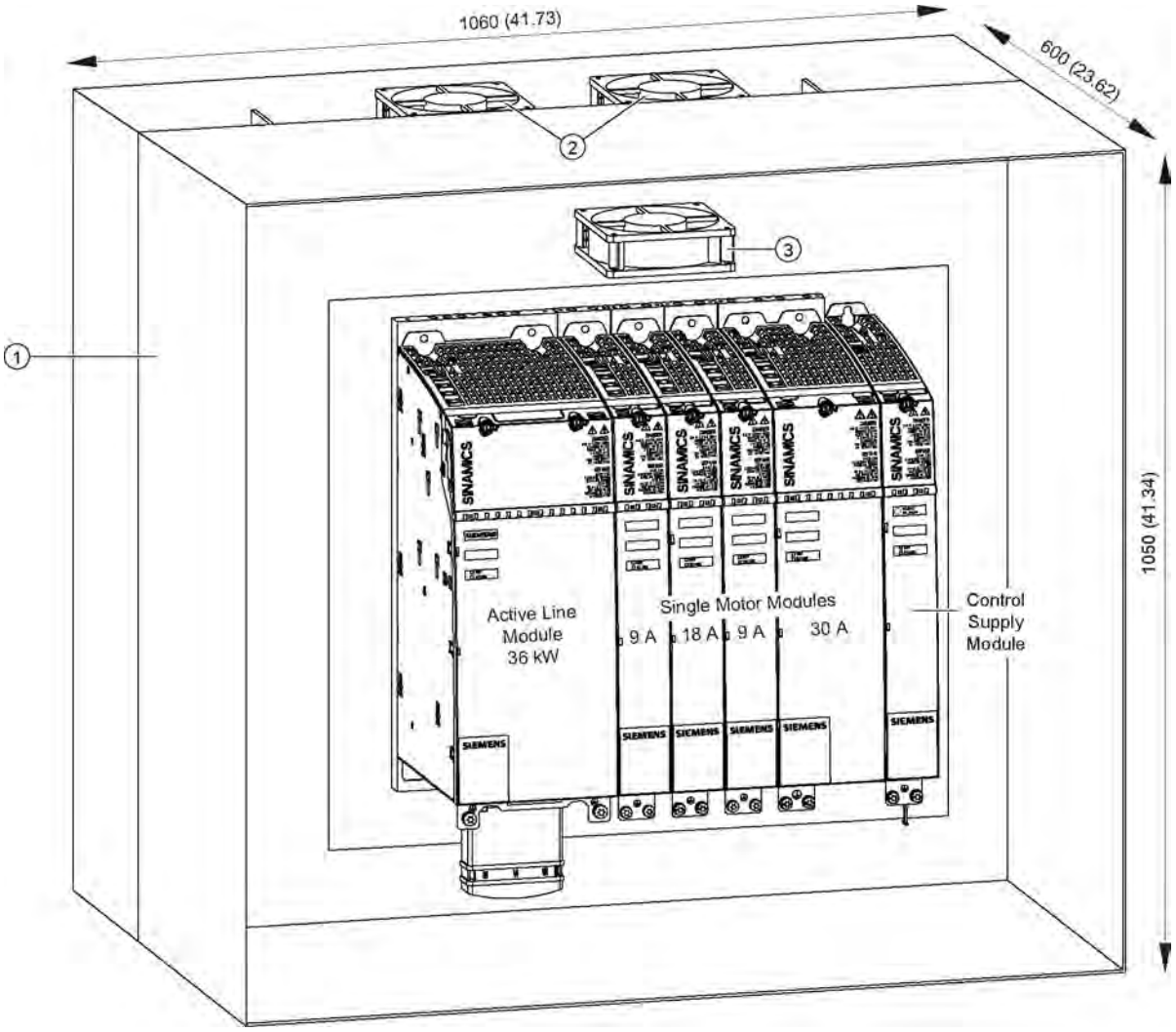
If the components are installed in a sealed cabinet, an internal fan must be installed to prevent hot spots. It is best to install the fan above the modules to optimize the air flow (suction).

If the conditions in the plant do not allow the temperature in the cabinet to be limited to a maximum of 40 °C, further measures must be taken. Please contact the hotline for more information (see the Preface).

The power units must be arranged in such a way that the power (loss) is distributed equally. The permissible current carrying capacities of the DC link busbars in the different modules must be taken into account (see "Technical data" for the various modules).

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12.11.2.2 Setup example, drive line-up, cold plate with external air heat sink



① Control cabinet
② External fan
③ Internal fan

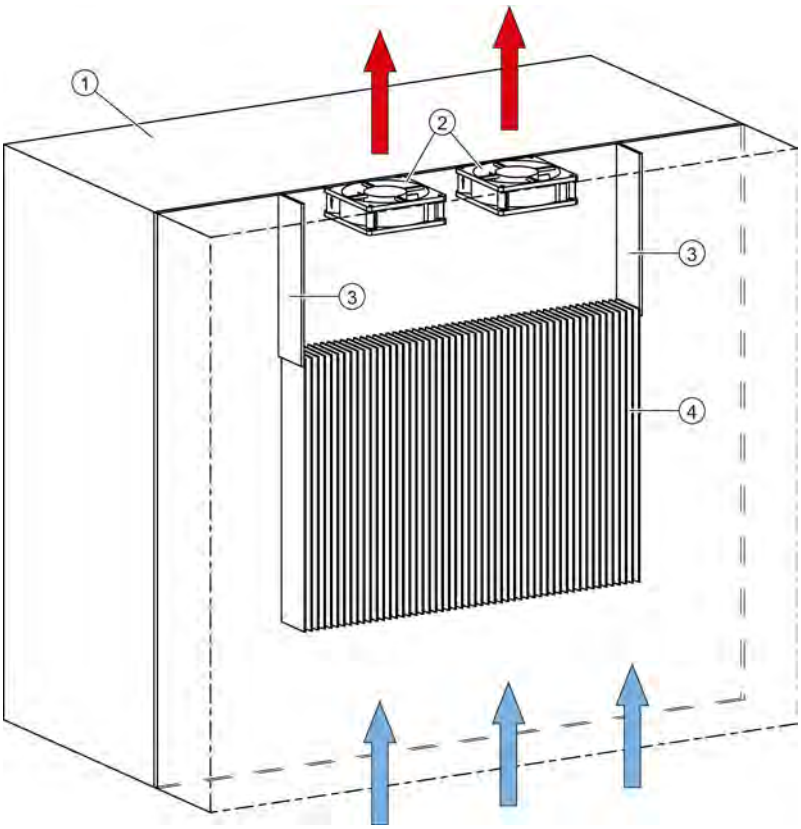
Figure 12-35 Front view of a control cabinet with drive line-up, cold plate and external air heat sink

Setup:

- Infeed: Active Line Module 36 kW
- 4 Single Motor Modules
- Control Supply Module for 24 V supply
- Internal fan at the top of the control cabinet
- One shared external air heat sink

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To optimize usage of the external air heat sink, it is best to arrange the components in such a way that the heat is dissipated equally over the surface of the external heat sink. This means that, if possible, a large power section should be situated next to a smaller one. The current carrying capacity of the DC-link busbars must be taken into account here.



① Control cabinet
② External fan
③ Air baffle plates
④ External air heat sink

Figure 12-36 Rear view of a control cabinet with drive line-up, cold plate and external air heat sink

In this example, two axial fans with a diameter of 150 mm ensure forced convection. The ribbed heat sink, which is attached to the rear, is located in an air duct (approx. 150 mm deep). Additional air guides at the sides improve air guidance and significantly optimize the power unit cooling.

Note

The external heat sink must be sealed with respect to the control cabinet in accordance with IP65.

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Example: external air heat sink

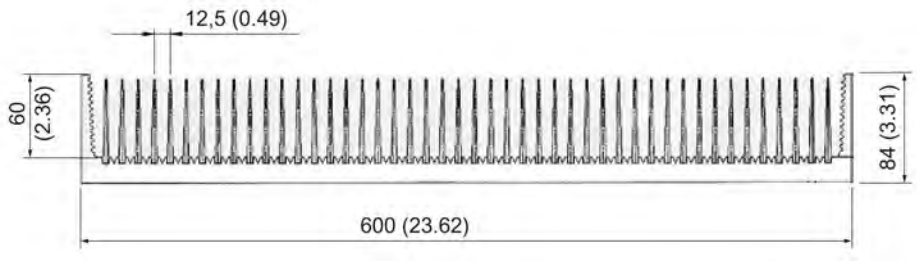


Figure 12-37 External air heat sink, all data in mm and (inches); height: 500 mm (19.69 inch)

Aluminum air heat sinks are recommended.
The heat sinks and fans must be dimensioned for the power loss to be dissipated. For the component-specific power loss in rated operation, refer to "Technical data". (Mean power loss in periodic duty is lower.)
The heat sinks and fans are not part of the scope of supply.
Recommended suppliers for heat sinks include:

- Alcan company, Singen:
- Sykatec company, Erlangen:

Note

The mounting surface for the heat sink (roughness, evenness) must fulfill the requirements for the corresponding cold plate component described in the chapter titled "Installation".

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12.11.3 Cold plate with an external liquid heat sink

12.11.3.1 Configuration and conditions

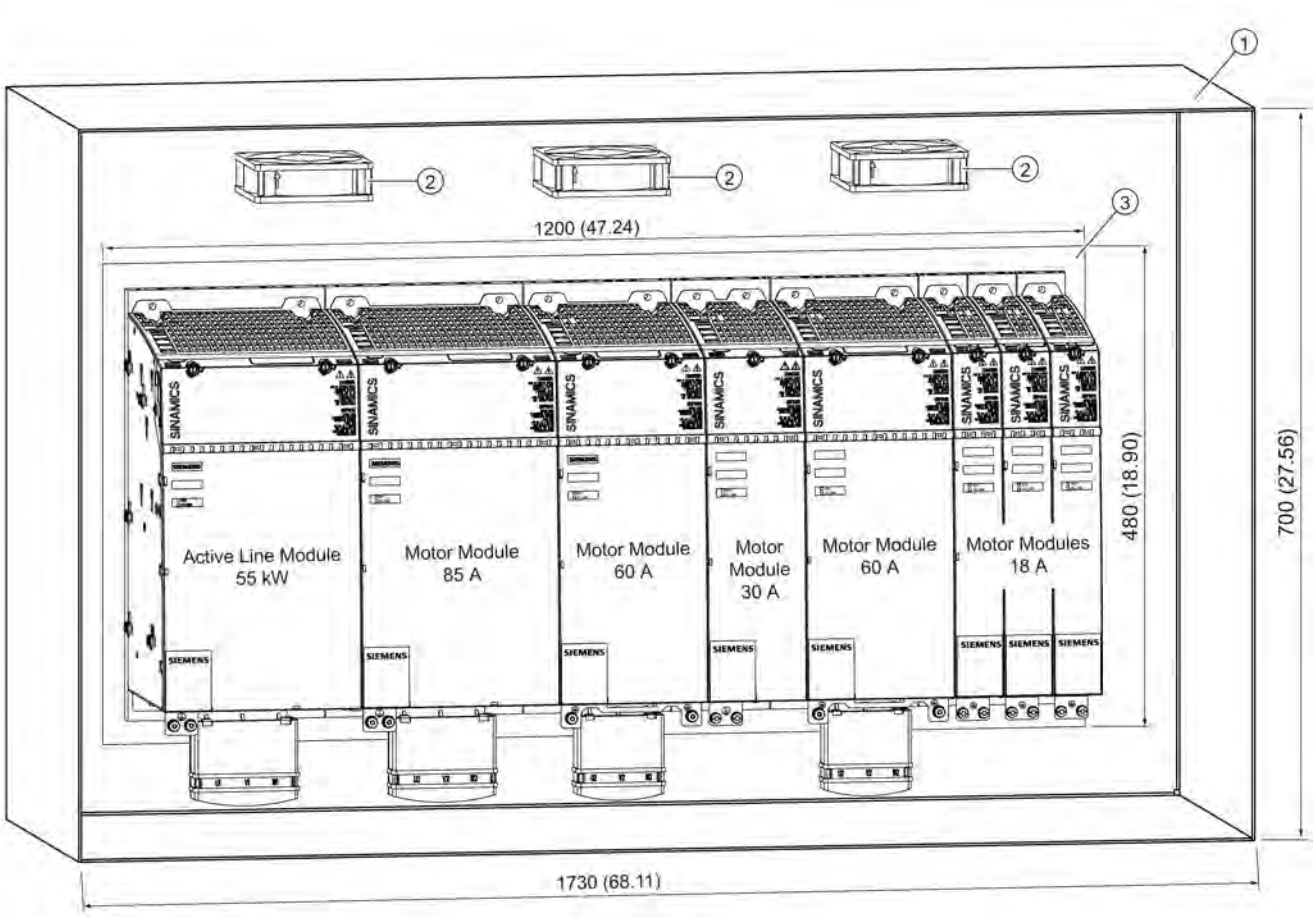
When an external liquid heat sink is used, the power sections are all installed on a plate through which cooling water flows to cool the power units. The size of the liquid heat sink can be adjusted in line with the size of the drive line-up.

General conditions to be observed

1. The maximum temperature within the cabinet is 40 °C
   (inlet air temperature of the power sections). The maximum temperature inside the cabinet for derating is 55 °C. For the relevant specifications, refer to the "Technical data".
2. The maximum permissible heat-sink temperature is module-dependent. Refer to the "Technical data" for more information. A temperature sensor in the power unit measures the temperature and can be read via parameter (see SINAMICS S120/S150 List Manual).
3. The customer must take measures to protect the devices against condensation (see Anti-condensation measures (Page 807))

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12.11.3.2 Setup example, drive-line-up, cold plate with external liquid heat sink



① Control cabinet
② Fan inside the control cabinet
③ External liquid heat sink

Figure 12-38 Example: cold plate drive line-up with external liquid cooling

Setup:

- Infeed: Active Line Module 55 kW
- 7 Single Motor Modules
- 3 internal fans at the top of the control cabinet
- 1 common external liquid heat sink (1200 mm x 480 mm)

The heat sinks and fans are not part of the scope of supply.
Recommended suppliers for liquid heat sinks include:

- Company DAU Ges.m.b.H & CO.KG., Ligist (Austria)
- Company Rittal GmbH & Co. KG, Herborn

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12.12 Notes on electrical cabinet cooling

12.12.1 Control cabinet cooling options

The following options are available for cooling the control cabinet:

- Filter fans
- Heat exchangers
- Cooling unit
- Liquid cooling
- External air cooling
- External liquid cooling

The prevailing environmental conditions and the cooling power required define the method used to cool the control cabinet.

The air routing within the control cabinet and the cooling clearances specified must be observed. No components may be mounted and no cables routed in the cooling clearance spaces.

Note

Reduction of the component service lives through incorrect mounting

If you do not observe the guidelines for mounting SINAMICS components in the cabinet, this can reduce the service life of the equipment and result in premature component failure.

You must take into account the following specifications when installing a SINAMICS drive line-up:

- Ventilation clearance
- Wiring and cabling
- Air guidance, air-conditioner

12.12.2 General information on ventilation

SINAMICS components are force-ventilated using integrated fans, and in some cases through natural convection. The fans are not equipped with temperature-dependent speed control; only the states "on" or "off" exist.

Fan operation up to firmware version 2.5

The fans are switched on and switched off as a function of the heat sink temperature.

The fans start to run at a specific heat sink temperature for the particular device. They switch themselves off with a small hysteresis as soon as the heat sink temperature falls below this threshold. The run-on time of the fan depends on various factors such as ambient temperature, output current, duty cycle and, therefore, cannot be determined directly.

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Fan operation as of firmware version 2.6

The fans can be controlled as a function of the heat sink temperature.

The fans start to run at a specific heat sink temperature for the particular device – or when a pulse enable is set. They switch themselves off with a small hysteresis as soon as the heat sink temperature, which has been saved, is fallen below and there is no pulse enable. The fan run on time can be parameterized (see SINAMICS S120/S150 List Manual).

Note

For the 5 kW and 10 kW Smart Line Modules, the fan runs permanently.

The cooling air must flow through the components vertically from bottom (cooler region) to top (region heated by operation).

If filtered fans, heat exchangers, or air conditioners are used, you must ensure that the air is flowing in the right direction. You must also ensure that the warm air can escape at the top. A ventilation clearance of at least 80 mm above and below must be observed.

⚠WARNING

Danger to life if the fundamental safety instructions and remaining risks are not carefully observed

If the fundamental safety instructions and remaining risks in Chapter 1 (Page 25) are not observed, accidents involving severe injuries or death may occur.

- Adhere to the fundamental safety instructions.
- When assessing the risk, take into account residual risks.

NOTICE

Damage caused by overheating resulting from covered ventilation slots

Covered ventilation slots can cause the system to overheat.

- Route the connected signal and power cables to the components in such a way that they do not cover the ventilation slots.

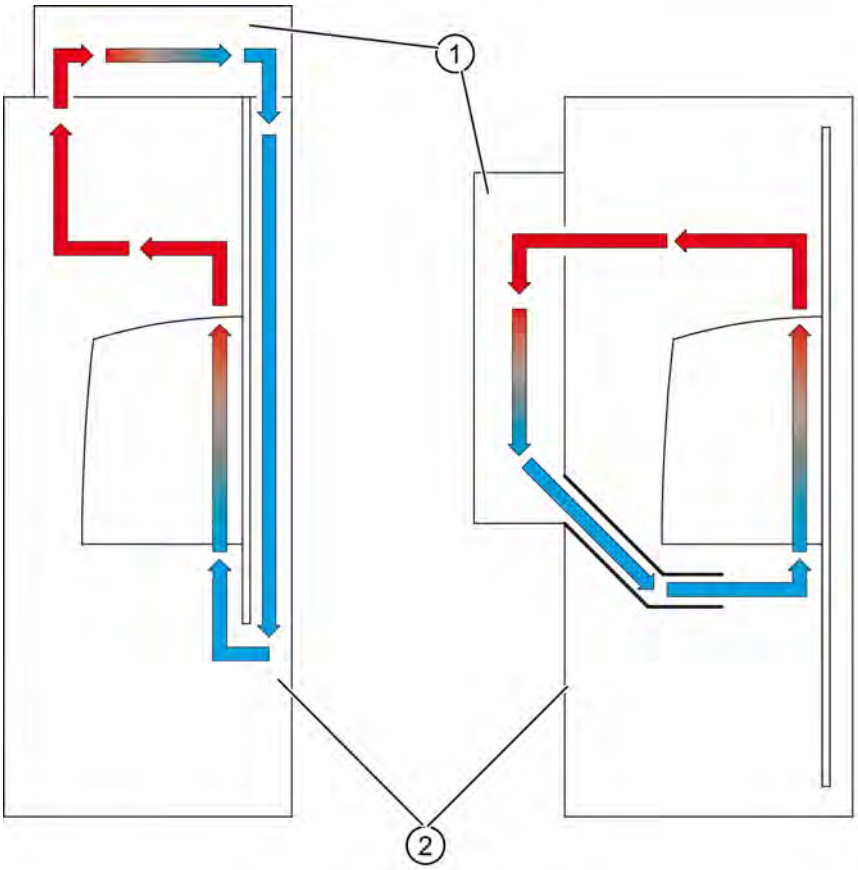
Note

The distance between the discharge opening of the air condition equipment and the electronic equipment must be at least 200 mm.

Note

If the components are mounted in a sealed cabinet, an internal air cooling system must be installed to circulate the air and prevent hot spots. It is best to mount the fan above the components to optimize the air flow (suction).

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① Cooling unit
② Control cabinet

Figure 12-39 Examples of cabinet ventilation

NOTICE
Damage to the component through condensation Condensation on the components can result in their failure. • Select the air circuit and arrangement of the cooling equipment in such a way that no condensation can form on the components. • If required, an anti-condensation heater must be installed in the cabinet.

If air conditioners are used, the relative air humidity of the expelled air increases as the air in the air conditioner cools and may exceed the dew point. If the relative humidity of the air entering the SINAMICS components is over 80% for an extended period of time, it can be assumed that the insulation of the components will fail as a result of electrochemical reactions (see System overview (Page 33)). Using air baffle plates, for example, you must ensure that the cold air expelled from the air conditioner mixes with warm air in the cabinet before it enters the components. This reduces the relative air humidity to uncritical values.

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12.12.3 Cooling clearances

Table 12- 30 Cooling clearances required above and below SINAMICS components

Component	Clearance [mm]
CU320-2	80
Sensor Modules Cabinet-Mounted SMCxx	50
Terminal Modules TMx	50
Line filter for Line Modules	100
Active Interface Modules	80
Line reactors for Line Modules	100
Active Line Modules 16 … 55 kW 80 … 120 kW	 80 80 (additional 50 in front of fan)
Smart Line Modules Booksize	80
Smart Line Modules Booksize Compact	80
Basic Line Modules	80
Motor Modules Booksize < 132 A 132 A/200 A	 80 80 (additional 50 in front of fan)
Motor Modules Booksize Compact	80
Braking Module Booksize	80
Braking Module Booksize Compact	80
Control Supply Module	80
Capacitor Module	80

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Drive line-up with internal air cooling

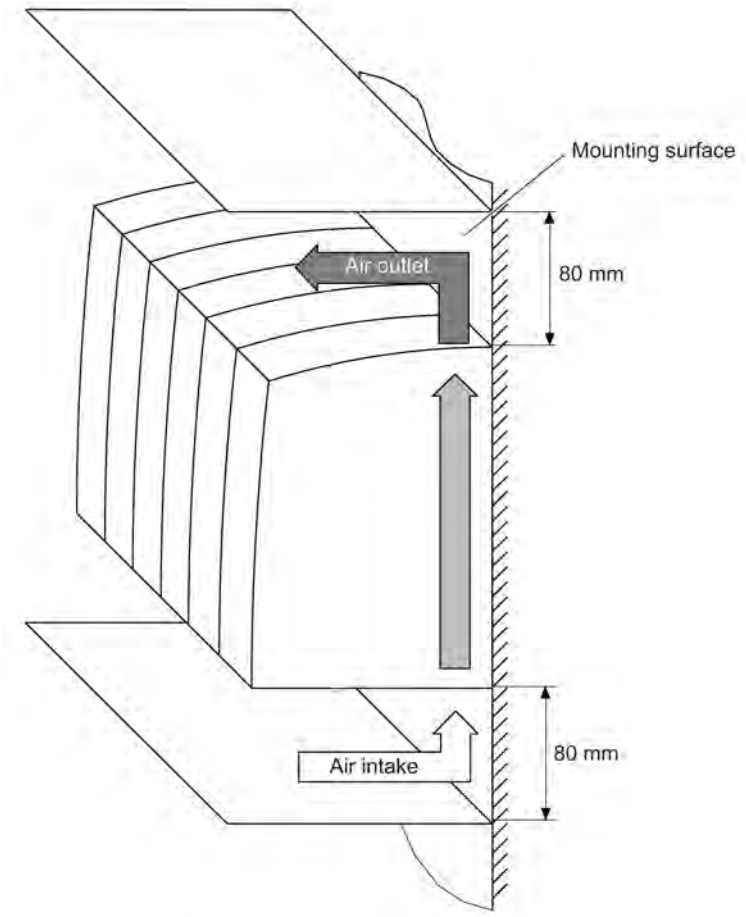


Figure 12-40 Cooling clearances for a drive line-up with internal air cooling (components up to 200 mm width)

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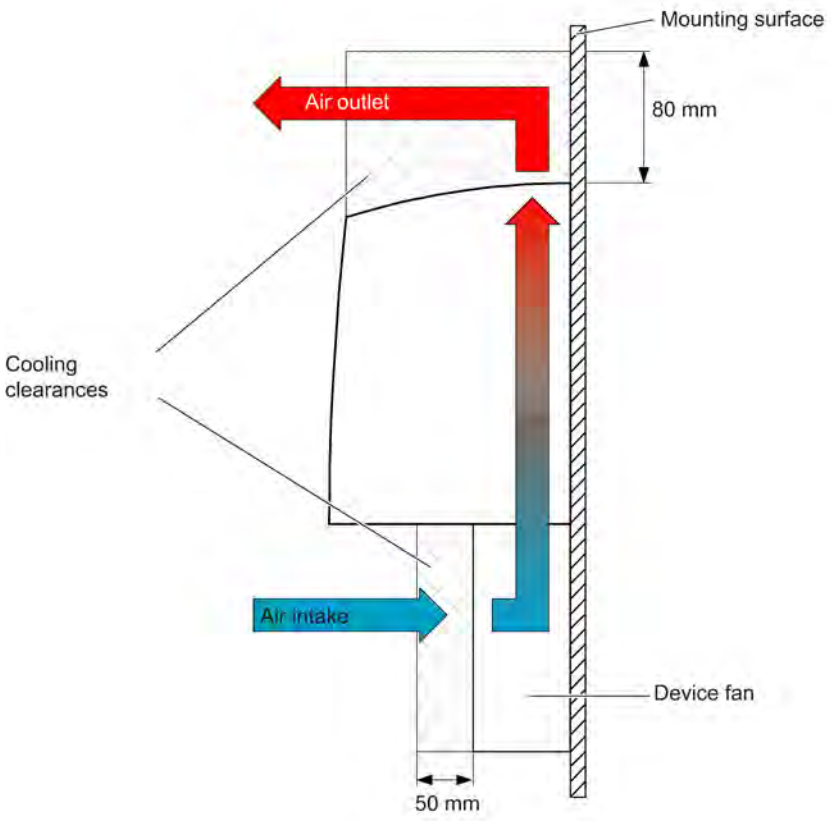


Figure 12-41 Cooling clearances for 300 mm wide components with internal air cooling with mounted unit fan

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Drive line-up with external air cooling

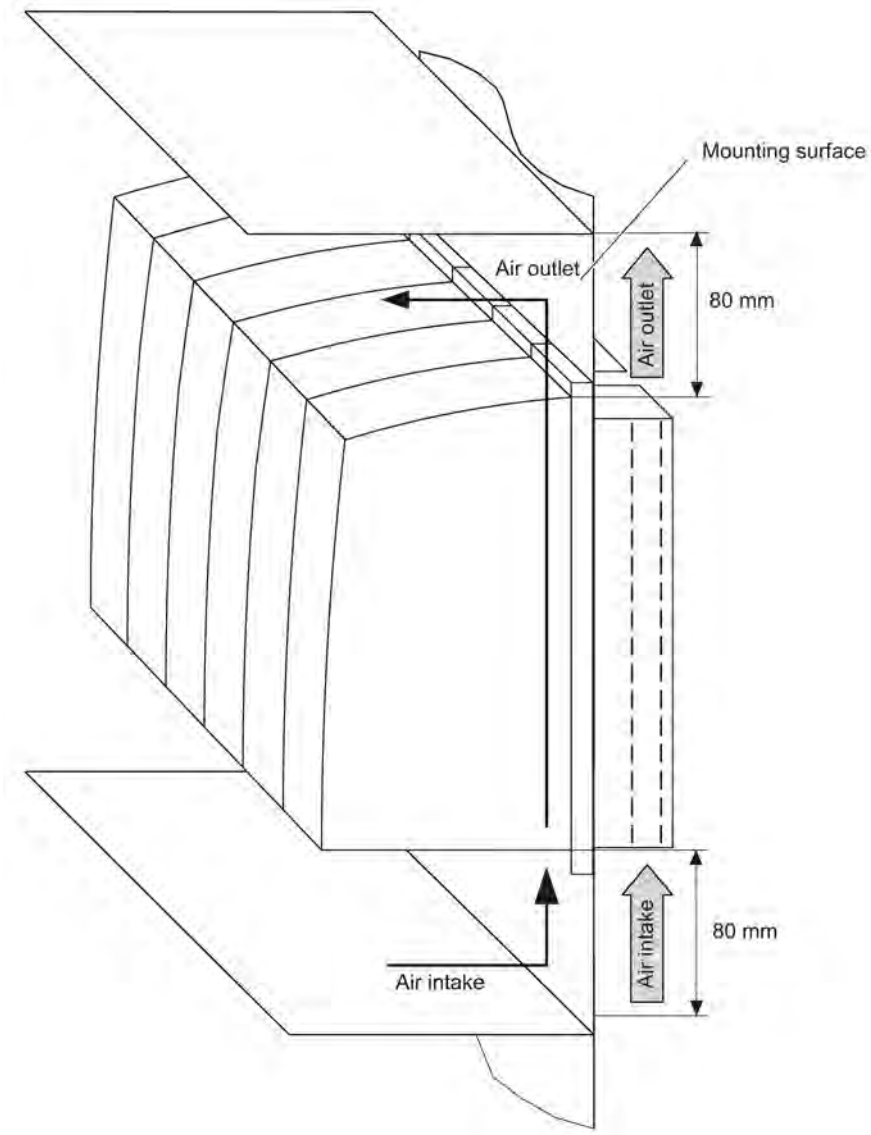


Figure 12-42 Cooling clearances for a drive line-up with external air cooling (components up to 200 mm width)

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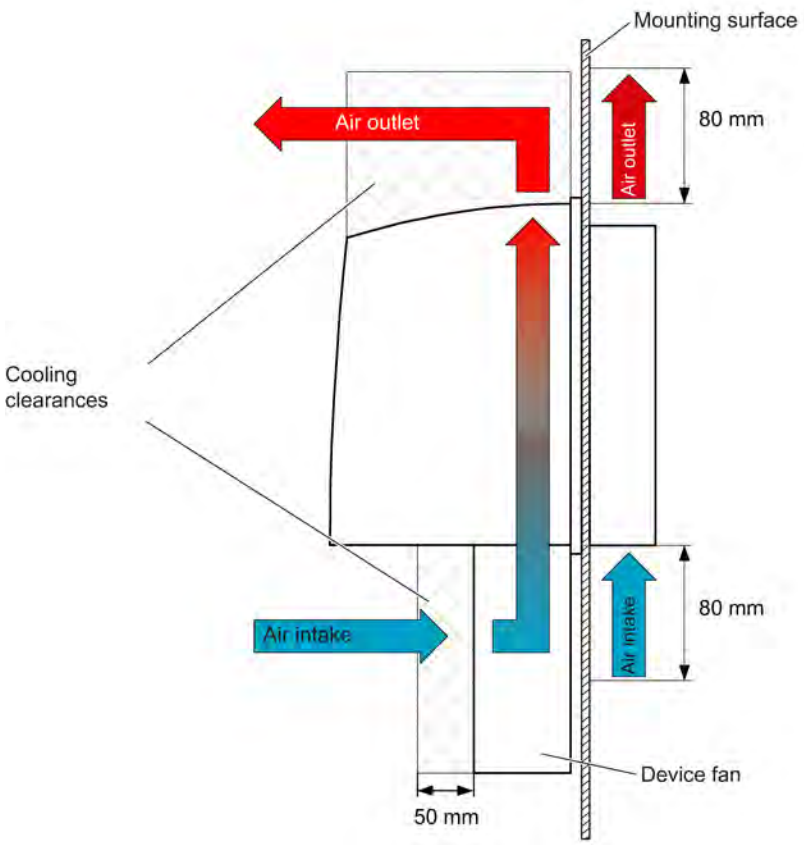


Figure 12-43 Cooling clearances for 300 mm wide components with external air cooling with mounted unit fan

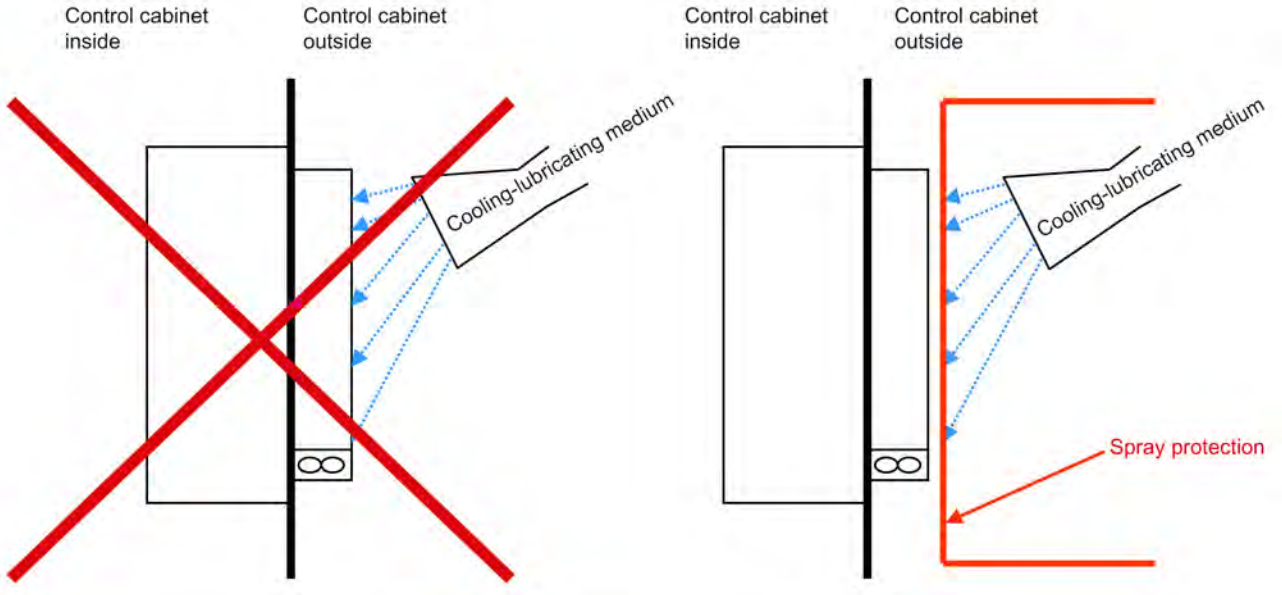


Figure 12-44 Spray protection for a drive line-up with external air cooling

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Rail-mounted components

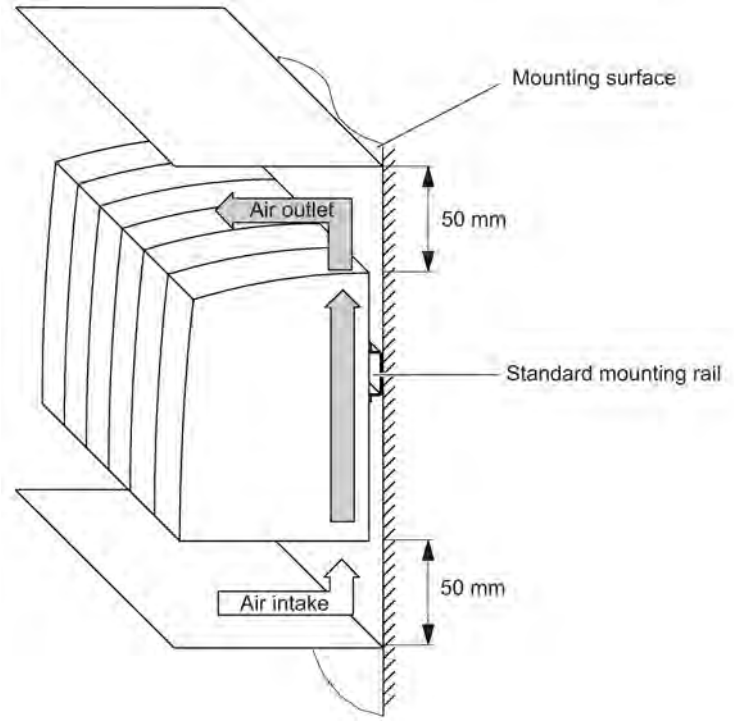


Figure 12-45 Cooling clearances for rail-mounted components (e.g. VSM, SMC, TM, DMC)

12.12.4 Notes on ventilation with cold plate

Notes on ventilation with cold plate

With cold-plate cooling, the SINAMICS devices must always be ventilated separately by means of a fan in the cabinet. Other suitable measures can be alternatively employed.

When using an external air heat sink, fans located outside the control cabinet must be additionally used. Other suitable measures can be alternatively employed.

Temperature measurement

The temperature of the power units can be read out using a parameter (see the SINAMICS S120/S150 List Manual).

Temperature limits

1. For the maximum heat sink temperature, see the "Technical data" for the power units.
2. For the maximum temperature inside the control cabinet, see the "Technical data" for the power units.

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Measures for remaining within temperature limits

1. One or more fans should be installed.
2. If necessary, the drive line-up can be operated with derating.

12.12.5 Dimensioning Climate Control Equipment

Cabinet manufacturers provide calculation programs for selecting climate control equipment. It is always necessary to know the power loss of the components and equipment installed in the cabinet.

The physical relationship is shown in the following example.

$q = Q - k \times A \times \Delta T$

Formula to calculate the power loss

q = thermal power that has to be dissipated through a cooling unit [W]

Q = power loss [W]

ΔT = temperature difference between the room and cabinet interior [K]

k = thermal resistance coefficient [W / (m^2 * K)] (example: Painted sheet steel k = 5.5 W / (m^2 * K))

A = free-standing cabinet surface area [m^2]

Table 12- 31 Example, calculating the power loss of a drive configuration

Component	Quantity	Total power loss [W] (including electronic losses)	Total power loss [W]
CU320-2	1	24	24
Basic Line Filter for AIM / ALM 36 kW	1	26	26
Active Interface Module	1	340	340
Active Line Module 36 kW	1	666	666
Motor Module 18 A	2	185.4	370.8
Motor Module 30 A	3	309.2	927.6
SMC	5	10	50
SITOP 20	1	53	53
Line contactor	1	12	12
Total:			**2469.4**

Assumption:

Free-standing cabinet surface area A = 5 m^2

Temperature difference between the room and cabinet interior ΔT = 10 K

q = 2469.4 W - 5.5 W / (m^2 K) * 5 m^2 * 10 K = 2194.4 W

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12.13 Power losses of the components

12.13.1 General information

The tables below provide an overview of the power loss of all components during rated operation. The characteristic values apply for the following conditions:

- Line voltage for Line Modules 400 V
- Pulse frequency of the Motor Modules 4 kHz
- Rated pulse frequency of the Active Line Modules 8 kHz
- Operating components at their rated power

The total losses of the relevant power unit (Line Module, Motor Module) are calculated from the power loss and the corresponding electronics loss of the power unit.

12.13.2 Power loss for Control Units, Sensor Modules, and other system components

Table 12- 32 Overview of power loss during rated operation for Control Units, Sensor Modules, and other system components

	Unit	Power loss
Control Units and Option Boards		
CU320-2	W	24
TB30	W	< 3
CBC10	W	< 3
CBE20	W	2.8
Sensor Modules		
SMC10	W	< 10
SMC20	W	< 10
SMC30	W	< 10
SME20/25	W	≤ 4
SME120/125	W	≤ 4.5
Terminal Modules		
TM15	W	< 3
TM31	W	< 10
TM41	W	12
TM54F	W	4.5
Additional system components		
VSM10	W	< 10

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	Unit	Power loss
DC link components		
Braking Module Booksize	W	20
Braking Module Booksize Compact	W	< 40
Capacitor Module	W	25
Control Supply Module Line DC link	W	 70 65

12.13.3 Power loss for line filters and line reactors

Table 12- 33 Overview of power loss during rated operation for line filters and line reactors

	Unit	Power loss
Basic Line Filters for Active Line Modules		
16 kW	W	16
36 kW	W	26
55 kW	W	43
80 kW	W	56
120 kW	W	73
Basic Line Filter for Active Line Modules with Active Interface Module		
16 kW	W	16
36 kW	W	26
55 kW	W	43
80 kW	W	56
120 kW	W	73
Wideband Line Filter for Active Line Modules		
16 kW	W	70
36 kW	W	90
55 kW	W	110
80 kW	W	150
120 kW	W	200
Basic Line Filter for Smart Line Modules		
5 kW	W	5
10 kW	W	9
16 kW	W	16
36 kW	W	26
55 kW	W	43
Basic Line Filter for Basic Line Modules		
20 kW	W	16
40 kW	W	26
100 kW	W	73

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	Unit	Power loss
Active Interface Modules		
16 kW	W	270[1)]
36 kW	W	340[1)]
55 kW	W	380[1)]
80 kW	W	490[1)]
120 kW	W	585[1)]
Line reactors for Active Line Modules		
16 kW	W	170
36 kW	W	250
55 kW	W	350
80 kW	W	450
120 kW	W	590
Line reactors for Smart Line Modules		
5 kW	W	62
10 kW	W	116
16 kW	W	110
36 kW	W	170
55 kW	W	200
Line reactors for Basic Line Modules		
20 kW	W	130
40 kW	W	270
100 kW	W	480

1) Referred to $U_{DC\ link}$ = 600 V

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12.13.4 Power loss for power units with internal air cooling

Table 12- 34 Overview of power loss at rated operation for power units with internal air cooling (including electronics losses)

	Unit	Power loss
Active Line Modules		
16 kW	W	282.8
36 kW	W	666
55 kW	W	945.6
80 kW	W	1383.6
120 kW	W	2243.2
Smart Line Modules Booksize		
5 kW	W	79.2
10 kW	W	141.6
16 kW	W	187.8
36 kW	W	406
55 kW	W	665.6
Smart Line Modules Booksize Compact		
16 kW	W	187.8
Basic Line Modules		
20 kW	W	144
40 kW	W	283.6
100 kW	W	628
Single Motor Modules Booksize		
3 A	W	50.4
5 A	W	73.4
9 A	W	100.4
18 A	W	185,4
30 A	W	309.2
45 A	W	455.2
60 A	W	615.2
85 A	W	786
132 A	W	1270.4
200 A	W	2070.4
Single Motor Modules Booksize Compact		
3 A	W	68[1)]
5 A	W	98[1)]
9 A	W	100.4
18 A	W	185.4

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	Unit	Power loss
Double Motor Modules Booksize		
3 A	W	97.6
5 A	W	132.6
9 A	W	187.6
18 A	W	351.2
Double Motor Modules Booksize Compact		
1.7 A	W	114[1)]
3 A	W	134[1)]
5 A	W	194[1)]

[1)] Power loss at 8 kHz

12.13.5 Power loss for power units with external air cooling

Table 12- 35 Overview of power loss at rated operation for power units with external air cooling (including electronics losses)

	Unit	Internal Power loss[1)]	External power loss	Total power loss
Active Line Modules				
16 kW	W	82.8 (60 + 22.8)	200	282.8
36 kW	W	171 (135 + 36.0)	495	666
55 kW	W	245.6 (200 + 45.6)	700	945.6
80 kW	W	338.6 (305 + 33.6)	1045	1383.6
120 kW	W	533.2 (490 + 43.2)	1710	2243.2
Smart Line Modules				
5 kW	W	41.2 (22 + 19.2)	38	79.2
10 kW	W	66.6 (45 + 21.6)	75	141.6
16 kW	W	64.8 (42 + 22.8)	123	187.8
36 kW	W	116 (80 + 36)	290	406
55 kW	W	185.6 (140 + 45.6)	480	665.6
Single Motor Modules				
3 A	W	35.4 (15 + 20.4)	15	50.4
5 A	W	43.4 (23 + 20.4)	30	73.4
9 A	W	55.4 (35 + 20.4)	45	100.4
18 A	W	95.4 (75 + 20.4)	90	185.4
30 A	W	99.2 (80 + 19.2)	210	309.2
45 A	W	135.2 (110 + 25.2)	320	455.2
60 A	W	160.2 (135 + 25.2)	455	615.2
85 A	W	196 (160 + 36.0)	590	786
132 A	W	270.4 (250 + 20.4)	1000	1270.4
200 A	W	455.4 (435 + 20.4)	1615	2070.4

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	Unit	Internal Power loss[1)]	External power loss	Total power loss
Double Motor Modules				
3 A	W	62.6 (35 + 27.6)	35	97.6
5 A	W	72.6 (45 + 27.6)	60	132.6
9 A	W	92.6 (65 + 27.6)	95	187.6
18 A	W	111.2 (80 + 31.2)	240	351.2

1) Power loss of the power electronics + power loss of the 24 V electronics

12.13.6 Power loss for power units with cold plate

With cold-plate cooling, only part of the power loss remains in the cabinet.
The table below shows the internal and external power loss of the components.

Table 12- 36 Overview of power loss at rated operation for power units with cold plate (including electronics losses)

	Unit	Internal power loss[1)]	External power loss	Total power loss
Active Line Modules				
16 kW	W	70.4 (50 + 20.4)	210	280.4
36 kW	W	135.2 (110 + 25.2)	520	655.2
55 kW	W	187.6 (160 + 27.6)	740	927.6
80 kW	W	283.6 (250 + 33.6)	1100	1383.6
120 kW	W	443.2 (400 + 43.2)	1800	2243.2
Smart Line Modules Booksize				
5 kW	W	34.4 (20 + 14.4)	40	74.4
10 kW	W	56.8 (40 + 16.8)	80	136.8
Smart Line Modules Booksize Compact				
16 kW	W	56.6 (36.2 + 20.4)	130	186.6
Basic Line Modules				
20 kW	W	46.6 (25 + 21.6)	95	141.6
40 kW	W	71.4 (45 + 26.4)	205	276.4
100 kW	W	168.4 (130 + 38.4)	450	618.4
Single Motor Modules Booksize				
3 A	W	27.6 (12 + 15.6)	18	45.6
5 A	W	35.6 (20 + 15.6)	35	70.6
9 A	W	45.6 (30 + 15.6)	50	95.6
18 A	W	80.6 (65 + 15.6)	100	180.6
30 A	W	85.6 (70 + 15.6)	220	305.6
45 A	W	108 (90 + 18.0)	340	448
60 A	W	128 (110 + 18.0)	480	608
85 A	W	149.2 (130 + 19.2)	620	769.2

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	Unit	Internal power loss[1)]	External power loss	Total power loss
132 A	W	220.4 (200 + 20.4)	1050	1270.4
200 A	W	370.4 (350 + 20.4)	1700	2070.4
Single Motor Modules Booksize Compact				
3 A	W	25.6 (10 + 15.6)	40	65.6
5 A	W	30.6 (15 + 15.6)	65	95.6
9 A	W	45.6 (30 + 15.6)	50	95.6
18 A	W	80.6 (65 + 15.6)	100	180.6
Double Motor Modules Booksize				
2x3 A	W	55.6 (34 + 21.6)	36	91.6
2x5 A	W	61.6 (40 + 21.6)	65	126.6
2x9 A	W	81.6 (60 + 21.6)	100	181.6
2x18 A	W	95.2 (70 + 25.2)	250	345.2
Double Motor Modules Booksize Compact				
2x1.7 A	W	42 (20.4 + 21.6)	72	114
2x3 A	W	44 (22.4 + 21.6)	90	134
2x5 A	W	59 (37.4 + 21.6)	135	194

1) Power loss of the power electronics + power loss of the 24 V electronics

Note

Lower average power losses are obtained for intermittent duty.

12.13.7 Power loss for liquid-cooled power units

Table 12- 37 Overview of power loss during rated operation for liquid-cooled power units (including electronics losses)

	Unit	Internal power loss[1)]	External power loss	Total power loss
Active Line Modules				
120 kW	W	443.2 (400 + 43.2)	1800	2243.2
Single Motor Modules				
200 A	W	370.4 (350 + 20.4)	1700	2070.4

1) Power loss of the power electronics + power loss of the 24 V electronics

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12.13.8 Electronics losses of power units

Table 12- 38 Electronics losses for power units with internal/external air cooling

Component		Internal/external air cooling Power loss [W]
Single Motor Modules	3 A	20.4
	5 A	20.4
	9 A	20.4
	18 A	20.4
	30 A	19.2
	45 A	25.2
	60 A	25.2
	85 A	36.0
	132 A	20.4
	200 A	20.4
Single Motor Modules Booksize Compact	3 A	20.4
	5 A	20.4
	9 A	20.4
	18 A	20.4
Double Motor Modules	3 A	27.6
	5 A	27.6
	9 A	27.6
	18 A	31.2
Double Motor Modules Booksize Compact	1.7 A	27.6
	3 A	27.6
	5 A	27.6
Active Line Modules	16 kW	22.8
	36 kW	36.0
	55 kW	45.6
	80 kW	33.6
	120 kW	43.2
Basic Line Modules	20 kW	24
	40 kW	33.6
	100 kW	48
Smart Line Module	5 kW	19.2
	10 kW	21.6
	16 kW	22.8
	36 kW	36.0
	55 kW	45.6
Smart Line Module Booksize Compact	16 kW	22.8

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Table 12- 39 Electronics losses for power units with cold plate

Component		Cold plate Power loss [W]
Motor Modules Booksize	3 A	15.6
	5 A	15.6
	9 A	15.6
	18 A	15.6
	30 A	15.6
	45 A	18.0
	60 A	18.0
	85 A	19.2
	132 A	20.4
	200 A	20.4
	2x3 A	21.6
	2x5 A	21.6
	2x9 A	21.6
	2x18 A	25.2
Motor Modules Booksize Compact	3 A	15.6
	5 A	15.6
	9 A	15.6
	18 A	15.6
	2x1.7 A	21.6
	2x3 A	21.6
	2x5 A	21.6
Active Line Modules	16 kW	20.4
	36 kW	25.2
	55 kW	27.6
	80 kW	33.6
	120 kW	43.2
Smart Line Module Booksize	5 kW	14.4
	10 kW	16.8
Smart Line Module Booksize Compact	16 kW	20.4
Basic Line Modules	20 kW	21.6
	40 kW	26.4
	100 kW	38.4

Table 12- 40 Electronics losses for liquid-cooled power units

Component		Liquid cooled Power loss [W]
Motor Module	200 A	20.4
Active Line Module	120 kW	43.2

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12.13.9 Maximum power losses in the partial load range

Losses in the partial load range for Line Modules and Motor Modules

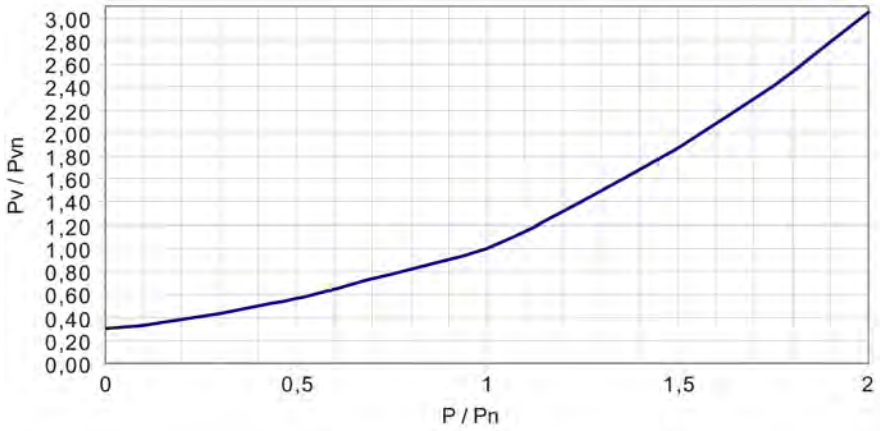


Figure 12-46 Losses in the partial load range for Active Line Modules and Smart Line Modules

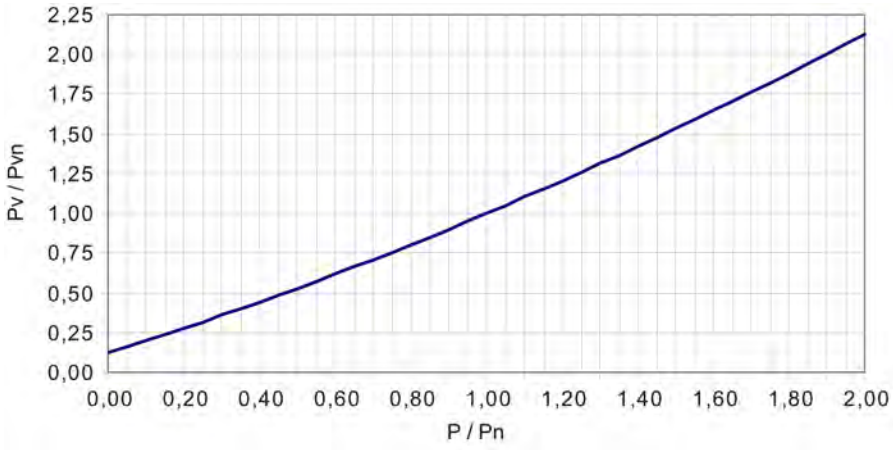


Figure 12-47 Losses in the partial load range for Basic Line Modules

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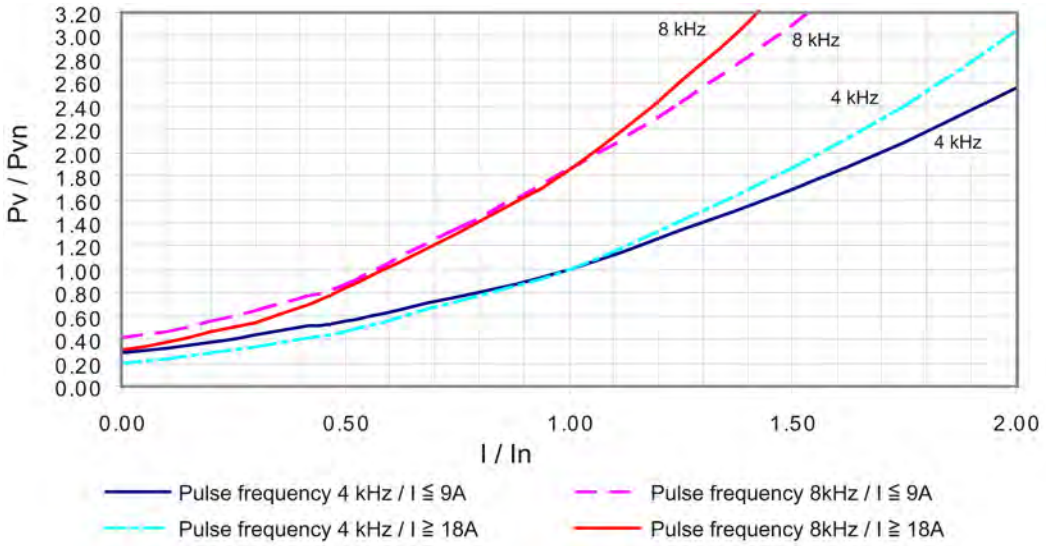


Figure 12-48 Losses in the partial load range for Motor Modules

Losses in the partial load range for line reactors and Active Interface Modules

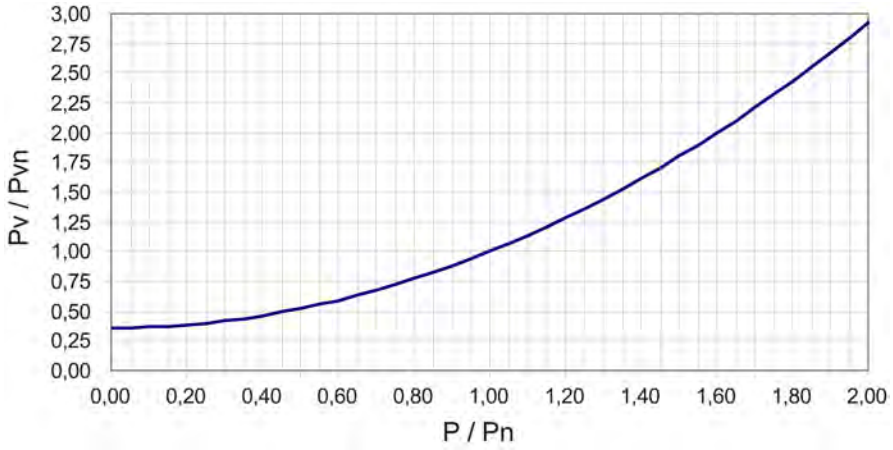


Figure 12-49 Losses in the partial load range for Active Interface Modules

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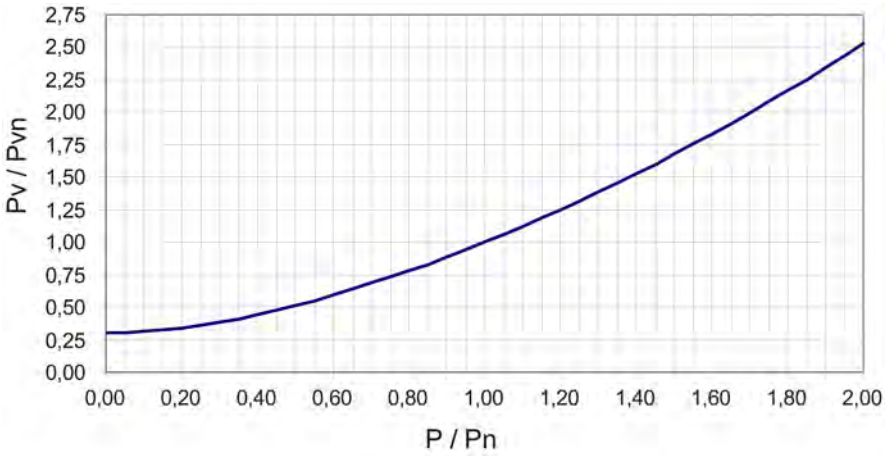


Figure 12-50 Losses in the partial load range for line reactors for Smart Line Modules

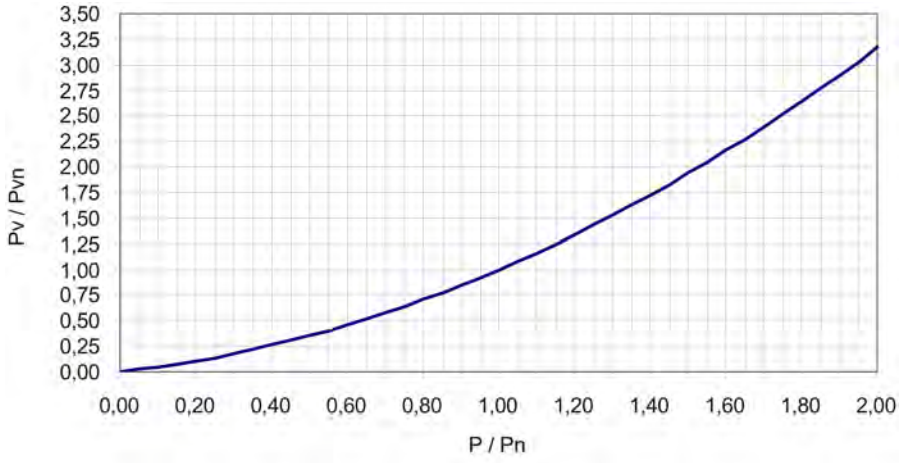


Figure 12-51 Losses in the partial load range for line reactors for Basic Line Modules

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12.13.10 Typical power losses for Motor Modules

The information on the power losses in the previous chapters are maximum values, which occur in the most unfavorable case. For typical applications, the losses are lower.

The following applies as typical application:

- Maximum motor cable length, 30 m
- 4 kHz pulse frequency
- DC link voltage 540 V - 600 V

The power loss for typical applications can be calculated using the following formula:

$P_V [W] = a + S_1 \bullet (I_1 + I_2) + S_2 \bullet (I_1^2 + I_2^2)$

a	Electronics losses of the Motor Module
S_1, S_2	Coefficients to calculate power loss
I_1	Current (arithmetic mean value) of the 1st axis
I_2	Current (arithmetic mean value) of the 2nd axis

Overview of required coefficients

Table 12- 41 Coefficients to calculate the power loss in the control cabinet for internally cooled Motor Modules for typical applications

Motor Module	a [W]	S_1 [W/A]	S_2 [W/A^2]
Single Motor Module 3 A	14	3.29	0.205
Single Motor Module 5 A	14	3.29	0.205
Single Motor Module 9 A	14	3.29	0.205
Single Motor Module 18 A	14	3.29	0.205
Single Motor Module 30 A	20	4,71	0,113
Single Motor Module 45 A	25	5,50	0,054
Single Motor Module 60 A	25	5,50	0,054
Single Motor Module 85 A	36	6,11	0,030
Single Motor Module 132 A	150	6,01	0,018
Single Motor Module 200 A	150	6,01	0,017
Double Motor Module 3 A	19	5,20	0,200
Double Motor Module 5 A	19	5,20	0,200
Double Motor Module 9 A	19	5,18	0,247
Double Motor Module 18 A	22	5,57	0,091

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Table 12- 42 Coefficients to calculate the power loss in the control cabinet for externally cooled Motor Modules for typical applications

Motor Module	a [W]	S_1 [W/A]	S_2 [W/A²]
Single Motor Module 3 A	10	2,30	0,100
Single Motor Module 5 A	10	2,30	0,100
Single Motor Module 9 A	10	2,30	0,100
Single Motor Module 18 A	10	2,34	0,101
Single Motor Module 30 A	16	1,29	0,057
Single Motor Module 45 A	21	1,31	0,015
Single Motor Module 60 A	27	1,37	0,006
Single Motor Module 85 A	32	1,37	0,006
Single Motor Module 132 A	50	1,06	0,004
Single Motor Module 200 A	50	1,06	0,004
Double Motor Module 3 A	15	1,37	0,240
Double Motor Module 5 A	15	1,37	0,240
Double Motor Module 9 A	15	1,37	0,240
Double Motor Module 18 A	18	1,56	0,056

Overview of typical power losses at the rated operating point

Table 12- 43 Typical power losses in the control cabinet for operation at the rated operating point for internally and externally cooled Motor Modules

Motor Module	P_{Vn} [W] internal air cooling	P_{Vn} [W] external air cooling
Single Motor Module 3 A	26	18
Single Motor Module 5 A	36	24
Single Motor Module 9 A	60	39
Single Motor Module 18 A	140	85
Single Motor Module 30 A	263	106
Single Motor Module 45 A	382	110
Single Motor Module 60 A	550	130
Single Motor Module 85 A	772	192
Single Motor Module 132 A	1257	260
Single Motor Module 200 A	2032	422
Double Motor Module 3 A	54	28
Double Motor Module 5 A	81	41
Double Motor Module 9 A	152	79
Double Motor Module 18 A	281	110

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Cooling circuit and coolant properties 13

13.1 Cooling circuit requirements

13.1.1 Technical cooling circuits

Technical cooling circuits can be divided into three systems:

1. **Closed cooling circuits (recommended)**
   In closed systems, the circuit coolant is separated from the surrounding atmosphere, which prevents the ingress of oxygen. The coolant is only routed through SINAMICS devices, the components required for cooling and, if necessary, a motor. The heat is dissipated to the atmosphere indirectly by means of heat exchangers. The system should ideally function without losing any coolant and, once filled, should not need any water to be added. The composition of the coolant can be adjusted as required (e.g. by using desalinated water and adding anti-corrosion agents). It either does not change at all during operation, or changes only in a defined manner.
   The closed cooling circuit is recommended as a standard solution.
2. **Open cooling circuit**
   The coolant is routed not only through the SINAMICS devices and components required for cooling, but also through external devices.
   The heat transferred to the circuit coolant evaporates via a cooling tower. This evaporation causes the coolant to become more concentrated (densification) because water molecules escape, while dissolved substances remain in the coolant. During operation, therefore, the composition of the coolant changes significantly, which means that it must be monitored and topped up continuously.
3. **Semi-open cooling circuit**
   Oxygen can only enter the coolant via the pressure compensator. Otherwise, see 1.
   Semi-open cooling circuits are permitted.

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13.1.2 Cooling system requirements

Open cooling systems must never be used for liquid-cooled power units. A closed cooling circuit with a membrane expansion tank, safety valve, and heat exchanger is recommended, which connects the cooling circuit to an external cooler (refer also to Chapter Using heat exchangers (Page 808)).

Requirements

- A particle filter (particle size < 100 µm) must be installed in the cooling circuit to prevent foreign particles from being washed in.
- Mixed installations should be avoided wherever possible.
- The permissible pressures in the cooling system must be observed.
- Cavitation must be prevented in the cooling system.
- Equipotential bonding must be provided between the components in the cooling system.
- The customer must take measures to protect the devices against condensation.
- An anti-corrosion agent and, if necessary, a biocide should be mixed into the coolant.
- If there is a risk of frost, preventive measures must be taken during operation, storage, and transportation (e.g. emptying and blowing out with air, additional heating).
- The requirements of the coolant in terms of its properties (temperature, chemical characteristics, etc.) must be observed.

Recommendations

- To ensure mechanical decoupling, the devices should be connected by means of hoses.
- To prevent blockages and corrosion, you are advised to install a flushback filter in the circuit (so that residues can be rinsed out when the system is running).
- The power units should be connected to the cooling circuit by means of shut-off fittings so that they can be disconnected from the cooling circuit for servicing or repair without having to empty the entire cooling system. A cooling water hose (EPDM) can be used to connect the shut-off fitting to the power unit. The coolant connections must never be closed if cooling liquid is still present in the device. Reason: If the cooling fluid expands due to heat, the pressure can build up beyond permissible levels and cause the heat sink to burst.

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13.1.3 Cooling circuit configuration

The liquid-cooled power units are designed to be connected in parallel to the cooling circuit. The pressure drop in the joint supply and return lines is to be kept at negligible levels by choosing a sufficiently large pipe diameter. The supply line has a differential pressure p compared to the return line; this pressure is usually generated by a pump.

The pressure of a pump depends on the flow rate. Therefore, depending on the number of connected components, a different pressure is obtained. At the minimum differential pressure p1 (measured between the supply and return lines of the individual component), the volume of coolant required to enable the component to achieve its rated power or rated current is to flow through each component. At the maximum differential pressure p2 (measured between the supply and return lines of the individual component), the volumetric flow must not result in damage to the component, for example, by means of cavitation. If necessary, pressure reducing valves such as baffle plates will have to be installed in the piping; these must be easy to access, clean, and/or replace.

When the pump is switched off, static pressure occurs in the system. The static pressure can be influenced by the primary pressure of the membrane expansion tank and should be at least 30 kPa on the pump's suction side. If the static pressure is too low, there is the risk that the pump will be damaged by cavitation when operational. Otherwise, minimum pressure values different than those specified by the pump manufacturer must be observed. When components are installed at different heights, the geodesic pressure caused by the height difference must be taken into account (1 m height difference corresponds to 10 kPa).

When the pump is switched on, a (location-dependent) flow pressure is present in the cooling circuit, which must be determined from the pump characteristic curve and the volume-flow-dependent pressure drop. The pressure drop in the filter and, if applicable, an additional pressure drop in the connection pipes must be added to the pressure drop of the liquid-cooled power units (70 kPa for H2O). Up to 50 kPa must be added for the pressure drop in a (contaminated) filter and in connection pipes. The intersection of the pump characteristic curve and the pressure drop of the whole cooling system yields the volumetric flow Vn of the coolant at this operating point.

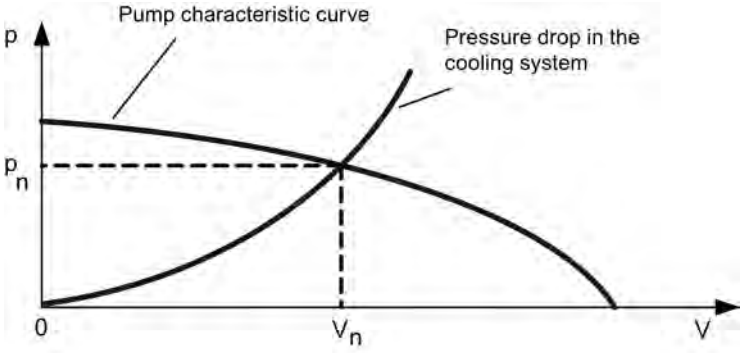


Figure 13-1 Pump characteristic curve

Permissible system pressure

The maximum permissible system pressure is 600 kPa.
If a pump that is capable of exceeding this maximum permissible system pressure is used, the customer must take steps (e.g. safety valve p ≤ 600 kPa, pressure control, or similar) to ensure that the maximum pressure limit is not exceeded.

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Permissible pressure difference

The maximum permissible pressure difference for a heat sink is 200 kPa. Higher pressure differences significantly increase the risk of cavitation and abrasion. The lowest possible differential pressure between the coolant in the supply and return lines should be selected to allow pumps with a flat characteristic to be used.

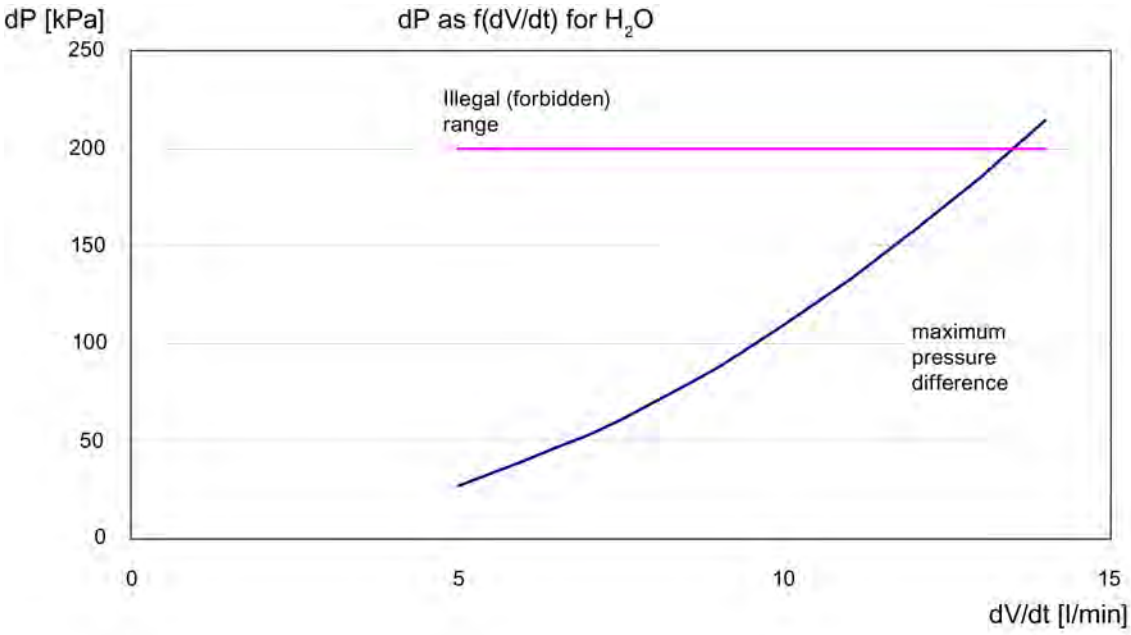


Figure 13-2 Pressure difference as a function of volumetric flow

Pressure difference and pressure drop when using coolant mixtures

If a mixture of Antifrogen N and H_2O is used as a coolant, the rated pressure must be calculated according to the mixing ratio. The following table specifies the pressure drop across components at different coolant temperatures for a coolant with mixing ratio 45 % Antifrogen N.

Table 13- 1 Pressure drop at different coolant temperatures for Antifrogen N/H_2O: 45 %

dV/dt H_2O [l/min]	dP H_2O [kPa]	dP Antifrogen N 0 °C [kPa]	dP Antifrogen N 20 °C [kPa]	dP Antifrogen N 45 °C [kPa]	dP Antifrogen N 50 °C [kPa]
8	70	121	97	81	78

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The characteristic curves for the pressure drop across the heatsinks as a function of volumetric flow vary depending on the temperature and the Antifrogen N / water coolant mix.

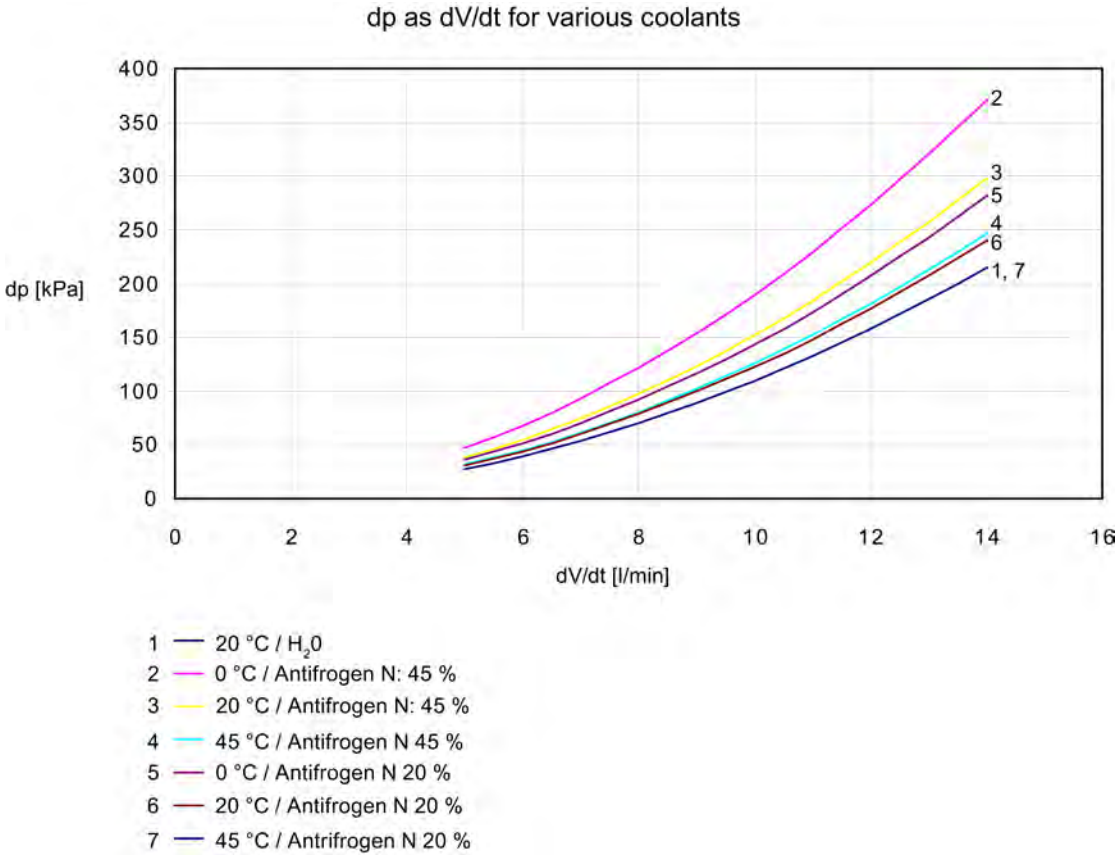


Figure 13-3 Pressure difference as a function of volumetric flow

Operating pressure

The **operating pressure** must be set according to the flow conditions in the supply and return lines of the cooling circuit. The required coolant flow rate per time unit must be set according to the technical data of the components. The components are normalized to a rated pressure of 70 kPa (for coolant type H_2O) via a baffle plate.

Layout of the components

The components should be arranged in the system in such a way that the overall length of the supply and discharge lines is the same for every SINAMICS component.

Water cooling systems with series-connected SINAMICS devices are not permitted.

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Dimensioning the cooling circuit

Recommendation for dimensioning the cooling circuit:

The differential pressure between the supply and return lines should be selected so that:

$\Sigma dPi < dP_{Syst} < \Sigma dPi + 30$ kPa

The individual pressure drops Pi represent the pressure drops of components (heat exchanger, piping, 70 kPa for the SINAMICS devices connected in parallel, valves, dirt traps, pipe bends, etc.).

Coolant pipes must be routed with extreme care. The pipes must never come into contact with electrically live components. An insulation clearance of > 13 mm must always be maintained between pipes and live parts. The pipes must be securely mounted and checked for leaks.

13.1.4 Installation

A closed stainless-steel cooling circuit, preferably combined with monitoring of the coolant quality, is strongly recommended to ensure the longest possible service life for the heat sink.

NOTICE
Damage caused by incorrectly routed coolant lines Leaking coolant can cause a short circuit. • Route the coolant pipes very carefully. • Fix the pipes securely and check them for leaks. • Ensure that the pipes never come into contact with live components.

Materials and connections

Stainless-steel pipes are used to route the coolant through the cooling plates on the liquid-cooled power units. For power units with cold plate, the coolant is routed by means of integrated channels in the aluminum cold plate.

To minimize the electrochemical processes taking place in the cooling system, the materials must be coordinated with one another accordingly. Mixed installations, i.e. a combination of different materials, such as copper, brass, iron, or halogenated plastic (PVC hoses and seals), should therefore be avoided or limited to the absolutely essential minimum.

The valves and connections required in the cooling system must be made of stainless steel (V2A or V4A steel; NIROSTA austenite).

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The following materials can be used for the cooling system piping:

- Pipes and corrugated piping made of stainless steel (V2A or V4A steel; NIROSTA austenite)
- Hoses made of EPDM/EPDM with an electrical resistance $<10^9$ ohms (e.g. Semperflex FKD; the Semperit company ,Wimpassing - Austria)
- DEMITEL® hoses made of PE / EPDM (the Telle company, Nuremberg)
- Clips according to DIN 2871, available for example from Telle.

All control cabinets must be designed with a PE busbar and a good electrical connection must be established between them.

Note

The sealing materials must be free of chlorides, graphite, and carbon (Viton® or EPDM).

Teflon-based seals are not permitted.

Note

When non-conductive hoses are used, particular attention must be paid to the equipotential bonding of all components (refer to Chapter Equipotential bonding in the cooling system (Page 808))

Note

- Check the cooling system for tightness after installation.

13.1.5 Preventing cavitation

The following applies to all cooling circuits:

- The cooling circuit must always be designed in such a way that the pressure compensator is located on the suction side of the pump (if possible, directly at the pump).
- The minimum pressure on the suction side of the pump must be approximately 30 kPa, or the geodesic height from the reservoir to the pump suction side must be > 3 m.
- The pressure drop across a SINAMICS device must not exceed 200 kPa in continuous operation, otherwise the high volumetric flow can increase the risk of cavitation and/or abrasion damage.
- The guidelines given in Chapter Cooling circuit configuration (Page 797) regarding series connections and maximum pressure must also be followed.

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13.1.6 Commissioning

When commissioning the cooling water circuit, the following sequence must be observed:

- Ventilate the heat sink the first time the devices are filled.
- Remove the fixing glands located in front of the vent valve.
- Perform ventilation.
- Close the vent valve.
- Screw the fixing glands tight again.
- Check the seals.
- Set the operating pressure according to the flow conditions of the cooling water system in the supply and return lines.
- Set the required cooling water flow rate per time unit.



⚠WARNING

Danger to life through electric shock due leaking coolant

Death or serious injury can result when coolant is touched that is at a specific voltage (i.e. is live).

- Before venting, switch the plant or system into a no-voltage condition.

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13.2 Coolant requirements

13.2.1 Coolant properties

Properties of the cooling medium

Water or a water/anti-freeze mixture that meets the relevant requirements can be used as a cooling medium. The cooling medium must be chemically neutral, clean, and not contain any solids.

The cooling water must fulfill the following requirements over the long term:

Table 13- 2 Cooling water specifications

		Liquid Cooled
Properties		Chemically neutral, clean, free of solids
Max. inlet temperature (in operation)	° C	45 (55 with derating)
Max. coolant temperature	° C	55
Operating pressure	kPa	100 … 600
System pressure (with respect to the atmosphere)	kPa	600
Test pressure (with respect to the atmosphere)	kPa	1200
Minimum differential pressure p1	kPa	70
Nominal differential pressure p_n	kPa	100
Maximum differential pressure p2	kPa	200
Flow rate	l/min	5 … 8
Max. size of any particles in the coolant	mm	0,1
pH value		6,5 … 9
Chloride	ppm	< 200
Sulfate	ppm	< 240
Nitrate	ppm	< 50
Dissolved solids	ppm	< 340
Total hardness	ppm	< 170
Electrical conductivity	µS/cm	< 2000

NOTICE

Damage to the component through condensation

Condensation on the components can result in their failure.

- Appropriately control the cooling water temperature.

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NOTICE
Cooling circuit damage caused by seawater The heat sink material is damaged by seawater. • Do not use seawater as coolant.

Note

As a general rule, tap water is not suitable for use in the cooling circuit,
although it can be mixed with de-ionized water. Losses must always be replenished with de-ionized water.

Note

The flow created when the heat sinks are filled results in automatic ventilation, so there is no need for the devices to be ventilated separately.

The coolant should be checked 3 months after the cooling circuit is filled for the first time and, subsequently, once a year. If the cooling water becomes cloudy, is colored, or becomes contaminated by mould spores, the cooling circuit must be cleaned and refilled.

An inspection glass should be provided in the cooling circuit to make it easier to check the cooling water.

13.2.2 Corrosion Inhibitor Additive (Inhibiting)

Nalco 00GE056 (Nalco company) is recommended as anti-corrosion agent. The concentration of anti-corrosion agent in the cooling water must be at least 2500 ppm (250 ml/100 liters cooling water).
The water quality must correspond to Chapter Coolant properties (Page 803), or the water used must be de-ionized.

Note

Corrosion inhibitor does not need to be added if the anti-freeze Antifrogen N is used in the right concentration (refer to Chapter Anti-Freeze Additive (Page 805))

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13.2.3 Anti-Freeze Additive

Antifrogen N (the Clariant company) is recommended as antifreeze. The percentage of antifreeze must be between 20% and 30%. This ensures frost protection down to a temperature of at least -10 °C.

NOTICE

Damage caused by overheating when using antifreeze

The cooling system no longer functions if an excessively high percentage of antifreeze is used.

- The maximum percentage of antifreeze must not exceed 30 %.



⚠WARNING

Danger to life through electric shock caused by a cooling system leak

Cooling water mixtures with Antifrogen N are highly conductive. If the insulation does not function, this will result in death or severe injury if you come into contact with it.

- After a coolant leak, clean the insulation system.

NOTICE

Damage to EPDM hoses as a result of additives containing oil

EPDM is destroyed by anticorrosion agents.

- When using EPDM hoses, do not use oily anticorrosion agents.

Note

Adapting the pump power

The kinematic viscosity of the cooling water is changed when adding antifreeze.

- Correspondingly adapt the pump power.

13.2.4 Biocide additives (only if required)

Closed cooling circuits with soft water (°DH > 4) are susceptible to microbes. The risk of corrosion caused by microbes is virtually non-existent in chlorinated drinking water systems.

If Antifrogen N antifreeze is used with a concentration of 20% or higher, it can be assumed that there is an adequate biocide effect.

The following types of bacteria are encountered in practice:

- Bacteria that cause the formation of slime
- Corrosive bacteria
- Bacteria that cause deposits of iron

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The type of bacteria determines the suitability of a biocide. A water analysis must be carried out once a year to determine the number of bacterial colonies. Suitable biocides are available, for example, from Nalco.

Recommendation

Twice a month Nalco N 77352 is added intermittently. The dosing quantity is 5 to 15 mg/100 liters of cooling water. This product has no adverse effect on Nalco 00GE056 corrosion inhibitor.

Note

The type of bacteria determines the biocide.

The manufacturer's recommendations must be followed regarding the dosage and compatibility with any inhibitor used.

It is not permissible that biocides and Antifrogen N are mixed.

Antifrogen N has a biocidal effect even at the minimum required concentration of > 20%.

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13.3 Anti-condensation measures

The customer must take measures to protect the devices against condensation

Condensation occurs when the inlet temperature of the cooling medium is significantly lower than room temperature (ambient temperature). The permissible temperature difference between coolant and air varies as a function of the relative humidity Φ of the ambient air. The air temperature at which the aqueous phase precipitates is referred to as the "dew point".

The table below shows the dew points (in °C) for an atmospheric pressure of 100 kPa (≈ installation altitude, 0 to 500 m). If the temperature of the coolant is below the specified value, condensation may occur (i.e. the coolant temperature must always be ≥ the dew point temperature).

Table 13- 3 Dew point temperature as a function of the relative air humidity (Φ) and the room temperature at an installation altitude of between 0 and 500 m

T_{room} [°C]	Dew point temperature in °C at a relative humidity Φ in %										
	20 %	30 %	40 %	50 %	60 %	70 %	80 %	85 %	90 %	95 %	100 %
10	< 0	< 0	< 0	0,2	2,7	4,8	6,7	7,6	8,4	9,2	10
20	< 0	2	6	9,3	12	14,3	16,4	17,4	18,3	19,1	20
25	0,6	6,3	10,5	13,8	16,7	19,1	21,2	22,2	23,2	24,1	25
30	4,7	10,5	14,9	18,4	21,3	23,8	26,1	27,1	28,1	29,1	30
35	8,7	14,8	19,3	22,9	26,1	28,6	30,9	32,1	33,1	34,1	35
38	11,1	17,4	22	25,7	28,8	31,5	33,8	34,9	36,1	36,9	38
40	12,8	19,1	23,7	27,5	30,6	33,4	35,8	36,9	37,9	38,9	40
45	16,8	23,3	28,2	32,1	35,3	38,1	40,6	41,8	42,9	43,9	45
50	20,8	27,5	32,6	36,6	40,1	42,9	45,5	46,6	47,8	48,9	50
55	24,9	31,9	37,1	41,2	44,7	47,7	50,4	51,7	52,8	53,9	55

The dew point also depends on the absolute pressure (i.e. the installation altitude).

The dew points for lower atmospheric pressures lie below the dew points for a height=0 m. Therefore, selecting the coolant intake temperature for a height 0 m always sufficient.

Various measures can be taken to prevent condensation:

1. Temperature-controlled valves in the supply line.
   In the cooling circuit, a temperature-controlled valve must be provided in the supply line.
2. Water temperature control.
   The water temperature is adjusted depending on the room temperature. This is the preferred method with high room temperatures, low water temperatures, and high air humidity.
3. Physical dehumidification.
   A physical dehumidification is only effective in closed spaces. This method involves condensing the air humidity in an air-to-water heat exchanger, which is continuously operated using the cold cooling water.
4. Installing a heater with a sufficient capacity in the cabinet.

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To prevent condensation, a humidity detector can be used to monitor the air humidity. The humidity detector is not included in the scope of delivery.

13.4 Equipotential bonding in the cooling system

Equipotential bonding between the components in the cooling system is required (SINAMICS S120, heat exchanger, piping, pump, etc.). This must be effected using a copper bar or stranded copper with the appropriate conductor cross-sections to prevent the electrochemical processes.

All cabinets must be bolted together in such a way as to ensure good conductivity (e.g. cabinet beams directly connected to ensure a good electrical connection) to prevent potential differences and, in turn, avoid the risk of electrochemical corrosion. As a consequence, a PE bar must also be installed in all the cabinets, including the cooling system.

13.5 Using heat exchangers

13.5.1 Water-to-water heat exchanger

If a cooling circuit that does not exceed 35 °C but does not fulfill the cooling water requirements is already installed in the system, the two cooling circuits can be linked via a water-to-water heat exchanger.

The coolers for the Line Modules are attached via a distributor in such a way as to ensure the required flow rate without exceeding the maximum permissible pressure. Conditions, such as height differences and distances, must be taken into account here.

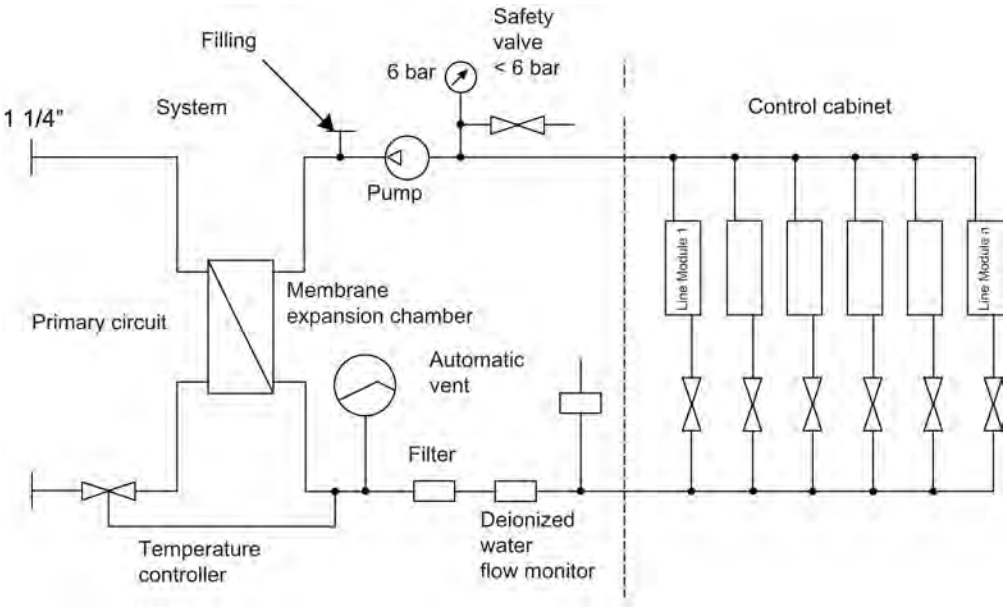


Figure 13-4 Water-to-water heat exchanger

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13.5.2 Air-to-water heat exchanger

If no process water is available, but it is nonetheless best to use water-cooled Line Modules, an air-to-water cooling system can be used. The temperature of the ambient air must not be excessively high, e.g. > 35°C (in accordance with the technical data for the air-to-water heat exchanger).

During setup, you must ensure that a primary air cooling circuit and not a process water circuit is installed.

Measures to prevent excessive cooling must only be taken on the secondary side by means of closed-loop temperature control involving a thermostat or a solenoid valve.

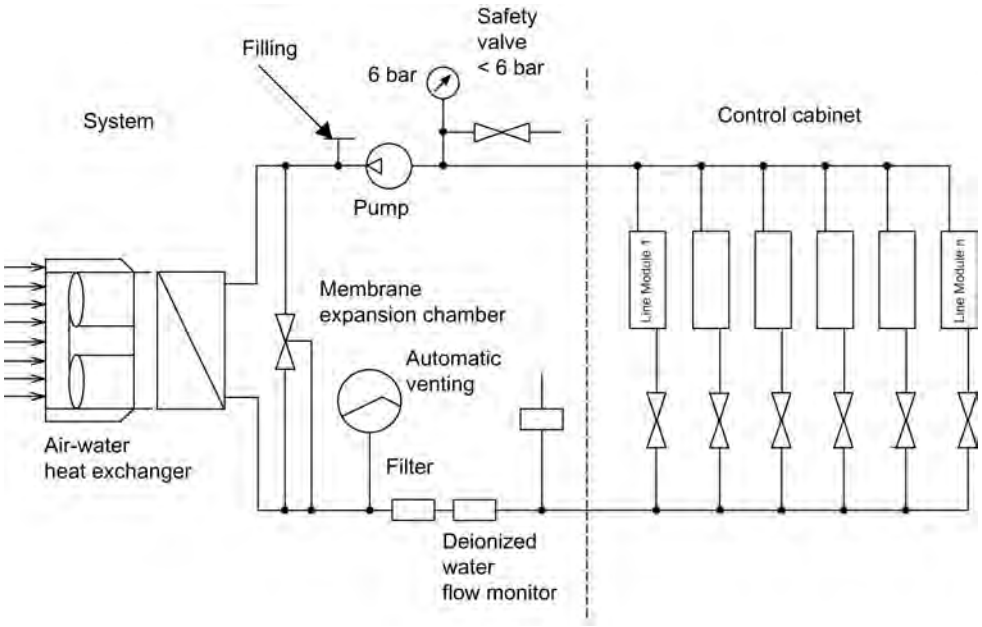


Figure 13-5 Air-to-water heat exchanger

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13.5.3 Active cooling unit

If no process water is available and the ambient air is > 35 °C (35 °C < ϑ < 40 °C), an active cooling unit can be used. This unit works in the same way as a refrigerator.

The following diagram shows the configuration of the cooling circuit in respect of Line Modules.

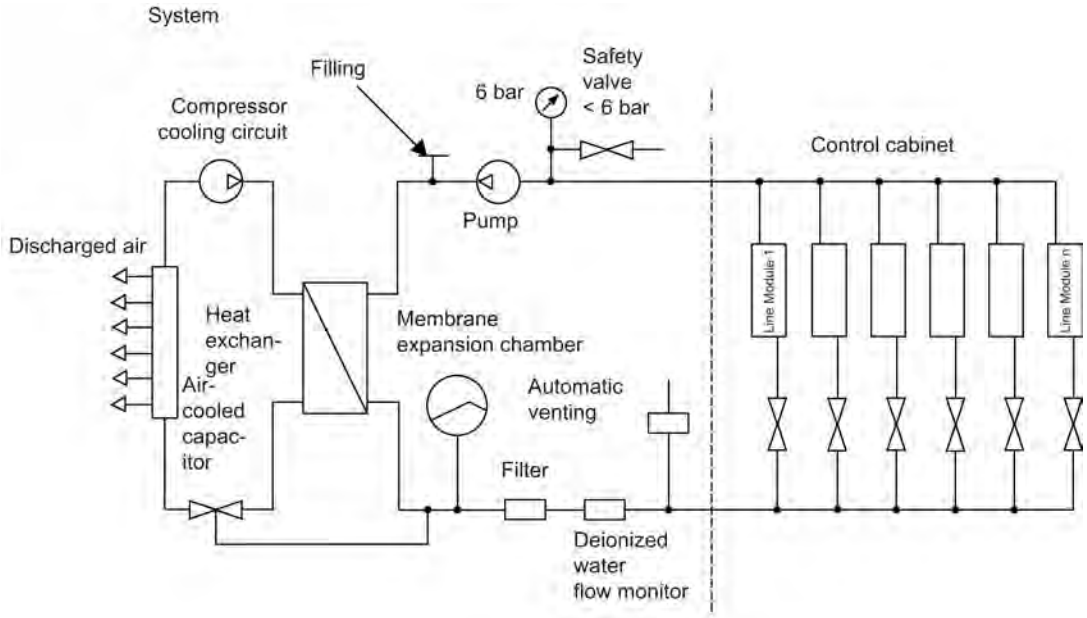


Figure 13-6 Active cooling unit

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Service and Support Booksize

14

14.1 Spare parts

Spare parts are available on the Internet at:

http://support.automation.siemens.com/WW/view/de/16612315

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14.2 Replacing the fan

14.2.1 Safety instructions when replacing a fan



⚠DANGER

Danger to life when live parts are touched

Before replacing the fan, you must switch off the power supplies (400 VAC and 24 VDC). A hazardous voltage is still present for up to five minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Remove the device cover or the fan cover only after a certain time.
- Check for zero voltage before removing the component.

Note

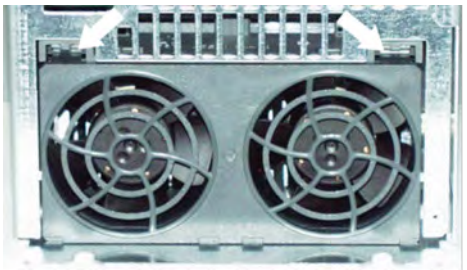
When replacing the fan, you must observe the ESD regulations (Page 29).

Only qualified personnel are permitted to install spare parts.

14.2.2 Replacing the fan for components with internal and external air cooling

Replacing the fan for components, sizes 50 to 200 mm

Table 14- 1 Removing the fan

Size 50 mm	Size 100 mm	Sizes 150 mm and 200 mm
• Remove the module from the drive line-up. • Release the catches to open the fan cover.		
		

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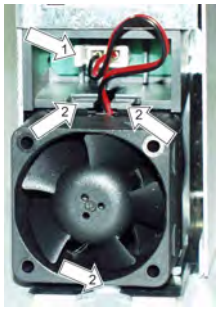
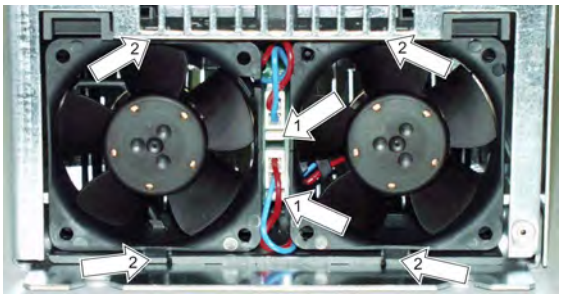
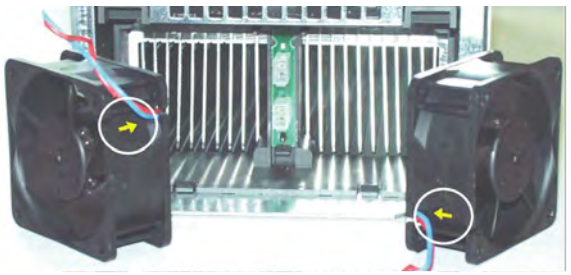
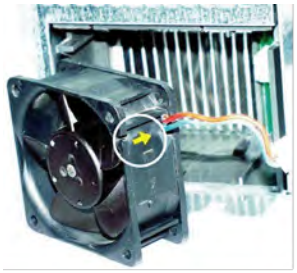
• Release and withdraw the connector (1). • Release the catch (2) and remove the fan.
  
  

Table 14- 2 Installing a fan

Size 50 mm	**Size 100 mm**	**Sizes 150 mm and 200 mm**
• Before installing the fan, please note the airflow direction. The arrow on the fan must point toward the cooling ribs.		
		
• Push the fan into a position where it is completely latched. **Caution:** Do not crush the connecting cables! • Insert the connector until it latches into place. • Attach the fan cover.		

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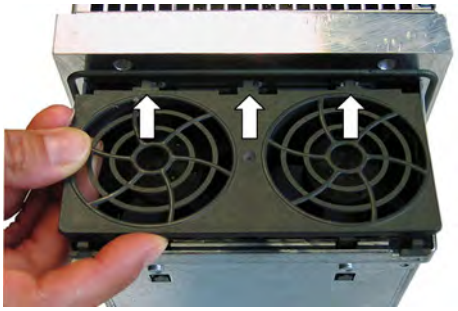
Note

The spare parts pack for components sized 150 mm and 200 mm contains two different fan covers:

- One fan cover for components with internal air cooling
- One fan cover for components with external air cooling

Make sure you use the right fan cover!

Table 14- 3 Attaching the fan cover on components, sizes 150 mm and 200 mm

Internal air cooling	External air cooling
 Fan cover for components with internal air cooling.	 Fan cover with three installation lugs for components with external air cooling.
 Attach the fan cover.	 Attach the fan cover (the lugs first).
 Press on the fan cover until the catches engage.	 Press on the fan cover until the catches engage.

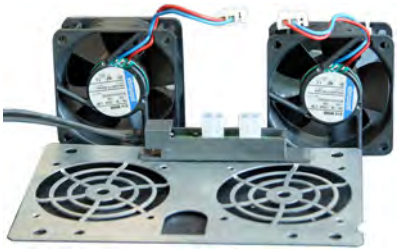
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Replacing the fan for components, size 300 mm

Installing the fan module on 300 mm wide components is described in Chapter "Installation" of the respective component. The fan module is removed in the inverse sequence to installing.

14.2.3 Replacing the fan on an Active Interface Module

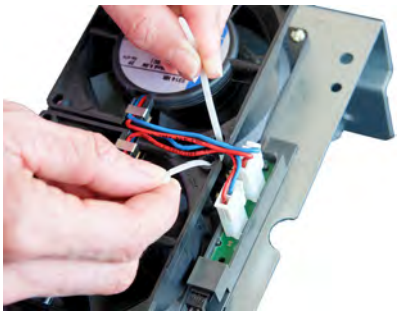
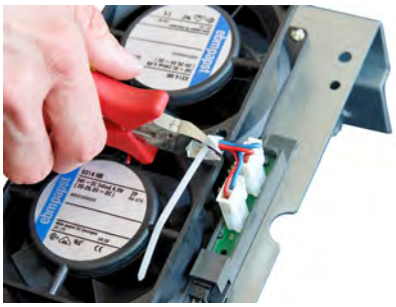
Table 14- 4 Replacing the fan in an Active Interface Module, 16 kW

	
Open the fan cover. To do this, release the combination screws M5 (3 Nm).	Open the fan cover and release the connector.
	
Push out the 8 expansion rivets.	Remove the fan.
	
Fix the fan with 8 new expansion rivets.	

To install, carry out the above steps in reverse order. The torques must be carefully observed.

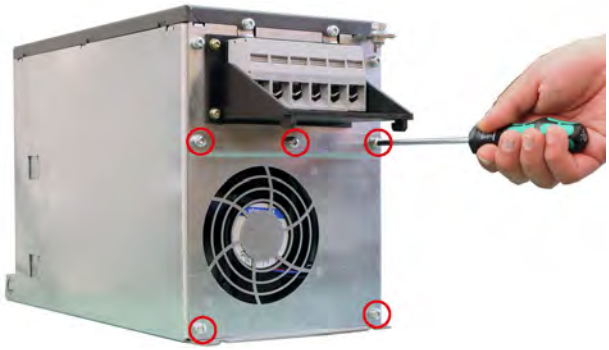
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Table 14- 5 Replacing the fan in an Active Interface Module, 36 kW

	
Open the fan cover. To do this, remove the combination screws M5 (3 Nm).	Open the fan cover and release the connector.
	
Remove the connecting cable.	Remove the 7 expansion rivets.
	
Remove the fan.	Fix the fan with 7 new expansion rivets.
	
Use a cable tie to tie up the connecting cables.	Cutoff excess cable tie length.

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Table 14- 6 Replacing the fan in an Active Interface Module, 55 kW

	
Open the fan cover. To do this, release the combination screws M5 (3 Nm).	Open the fan cover and release the connector.
	
Release the M3 screws (1.8 Nm).	Remove the fan.

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Table 14- 7 Replacing the fan in an Active Interface Module, 80 kW, 120 kW

		
Open the fan cover. To do this, release the combination screws M5 (3 Nm).	Open the fan cover.	Release the connector.
		
Release the M3 screws (1.8 Nm).	Remove the connecting cable.	Remove the fan.

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14.2.4 Replacing the fan on the Control Supply Module

Replacement fan (Order. No. 6SL3160-0AB00-0AA0)



⚠WARNING

Danger of death when live parts with several supply circuits are touched

Death or serious injury can result when live parts are touched.

- Switch off all of the supply circuits before you start any work.

Table 14- 8 Removing the fan

- Remove the component from the drive line-up.
- Remove the 6 screws (Torx T10) from the enclosure cover and open the component.



• Release and withdraw the connector.	• Release the 2 screws on the fan (Torx T20).	• Remove the fan.
		

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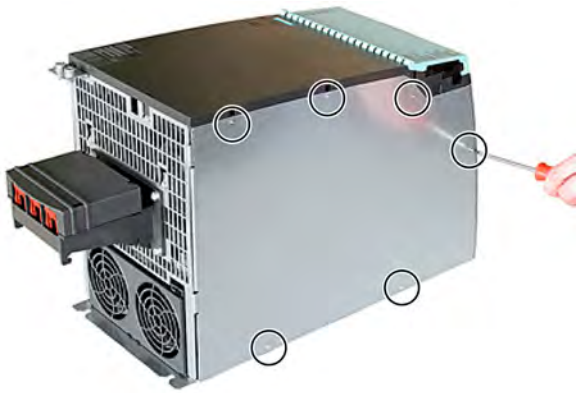
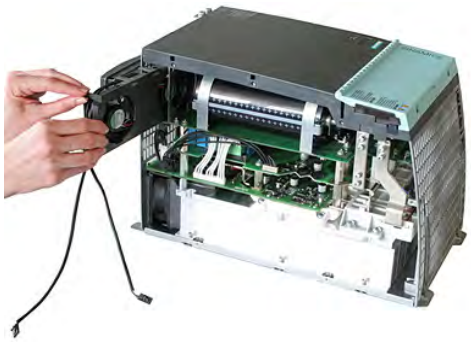
Installing a fan

1. Check the air flow direction before installing the fan (the arrow on the fan must point towards the cooling ribs).
2. Insert the connector until it latches into place.
3. Screw the 2 screws on the fan (Torx T20).
   Tightening torque: 1.2 Nm
4. Close the enclosure cover and tighten the 6 screws (Torx T10).
   Tightening torque: 0.8 Nm

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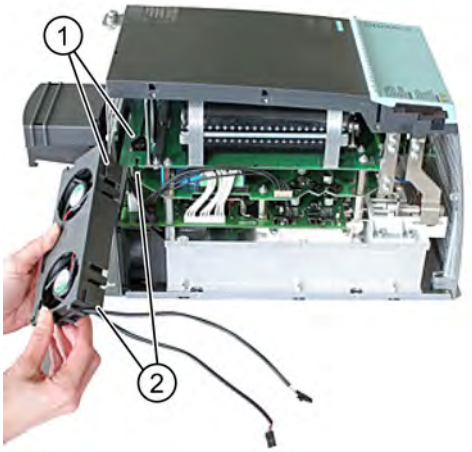
14.2.5 Replacing the fan on the 100 kW Basic Line Module for capacitor cooling

Table 14- 9 Removing the fan

	
Open the right housing cover by loosening the six marked screws.	Withdraw the first fan cable by lightly pressing the connector together.
	
Withdraw the second fan cable.	Release the fan unit.
	
Completely remove the fan unit.	Slightly expand the fan holding mechanism and remove the fan.

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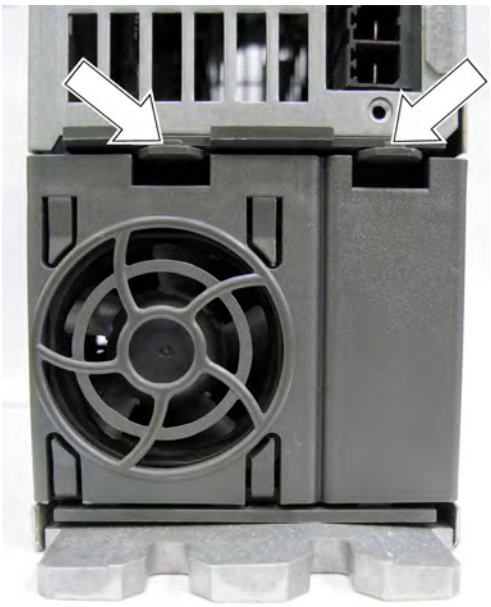
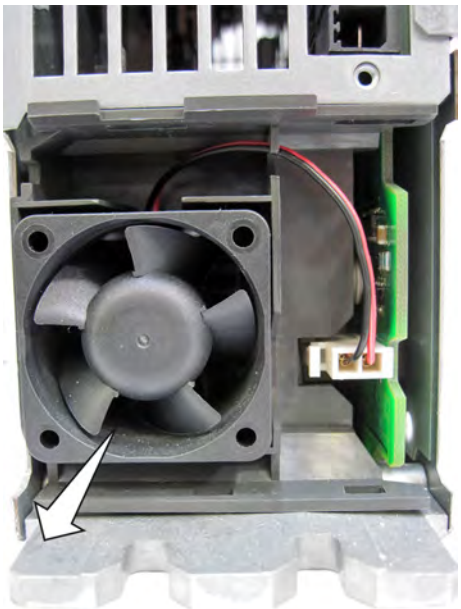
Table 14- 10 Installing a fan

	
When using the new fan, observe the marking for the airflow direction.	Observe the cable routing.
	Connect the second fan cable. Close the housing cover and tighten the six screws. Tightening torque: 0.8 Nm
Insert the fan holding mechanism in the guide rails ① and ②.	

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14.2.6 Replacing the fan for Booksize Compact components

Table 14- 11 Removing the fan

Size 50 mm	Size 75 mm
• Remove the component from the drive line-up.	
	
• Remove the fan cover at the lower side of the component by releasing the catches.	
	
• Carefully withdraw the fan.	

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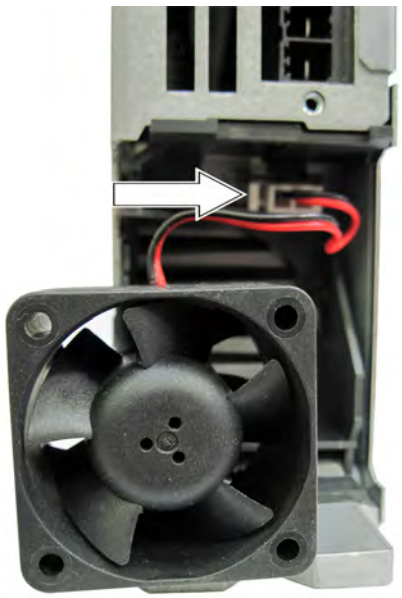
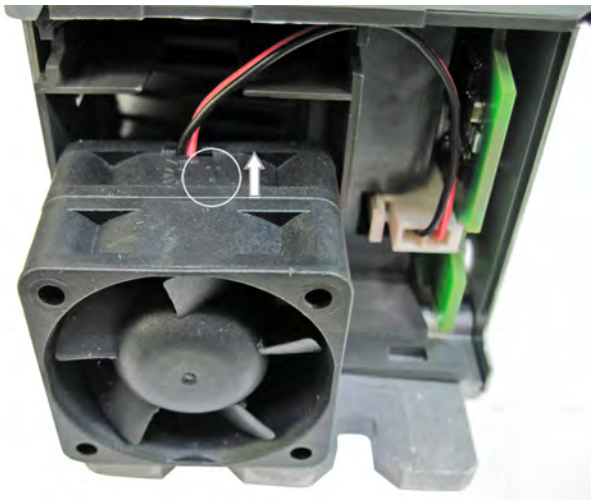
	
• Release the connector and remove the connecting cable.	

Table 14- 12 Installing a fan

Size 50 mm	**Size 75 mm**
	
• Observed the air flow direction before installing the fan (the arrow on the fan must point towards the cooling ribs). • Insert the connector until it latches into place. • Install the fan. **Notice**: Do not crush the connecting cables! • Attach the fan cover.	

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14.3 Forming the DC link capacitors

Description

If the Line Modules and Motor Modules are kept in storage for more than two years, the DC-link capacitors have to be reformed. If this is not performed, the units could be damaged when they are switched on.

If the cabinet is commissioned within two years of its date of manufacture, the DC-link capacitors do not need to be reformed. The date of manufacture can be taken from the serial number on the rating plate.

Note

The storage period is calculated from the date of manufacture and not from the date that the equipment was shipped.

Rating plate

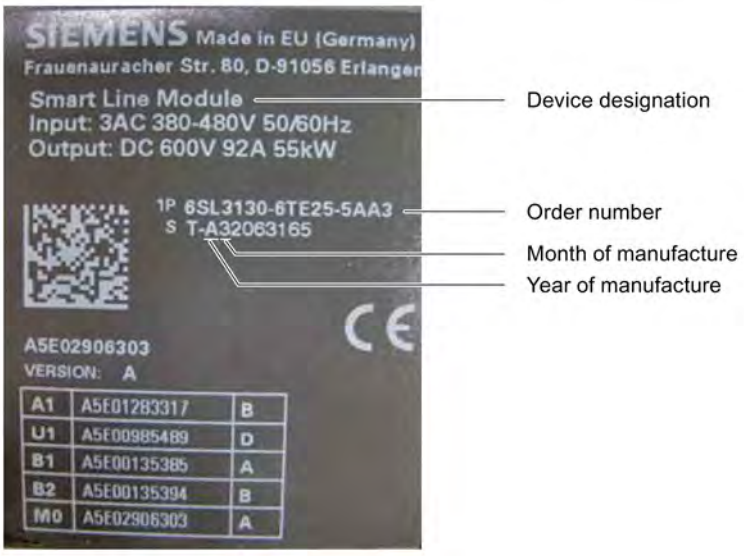


Figure 14-1 Rating plate using a Smart Line Module as example

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Date of manufacture

The date of manufacture can be determined as follows:

Table 14- 13 Production year and month

Character	Year of manufacture	Character	Month of manufacture
S	2004	1 to 9	January to September
T	2005	O	October
U	2006	N	November
V	2007	D	December
W	2008		
X	2009		
A	2010		
B	2011		
C	2012		
D	2013		
E	2014		
F	2015		

The serial number is found on the rating plate.

Forming circuit

A defined voltage and a limited current are applied to the DC-link capacitors when forming them. As a consequence, the internal relationships required for the DC-link capacitors to function correctly are re-established.

The forming circuit is configured using incandescent lamps or alternatively, PTC resistors.

Components required (recommendation)

- 1 fuse switch 3-phase 400 V / 10 A
- Cable 1.5 mm^2
- 3 PTC resistors 350 Ω / 35 W
  (recommendation: PTC-35W PTC800620-350 Ohm, Michael Koch GmbH)
- 3 incandescent lamps 230 V / 100 W
- Various small components, such as lamp socket, etc.



DANGER

Danger to life through electric shock due to the residual charge of the DC-link capacitors

Due to the DC-link capacitors, a hazardous voltage is present in the DC link for up to five minutes after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Do not open the protective cover of the DC link until five minutes have elapsed.
- Check that the cabinet is de-energized.

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Note

Line Modules are formed by means of a connected Motor Module. See Forming circuits of Line Modules.

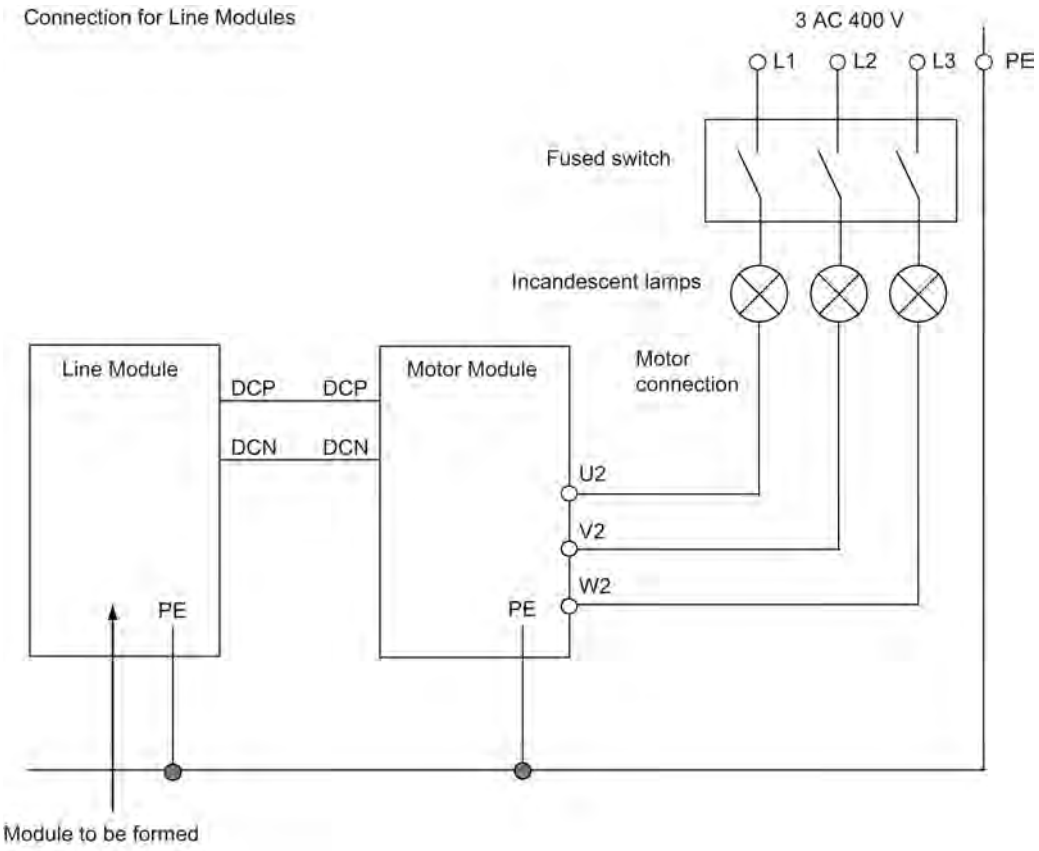


Figure 14-2 Forming circuit for Line Modules with incandescent lamps

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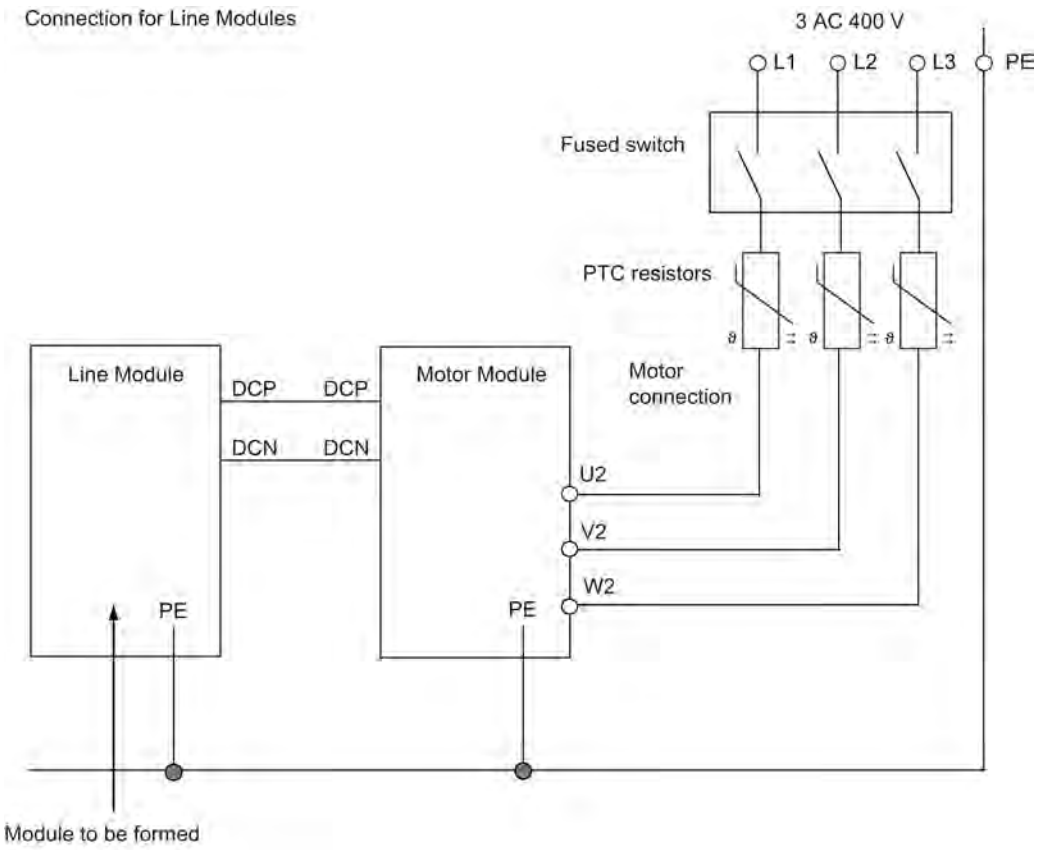


Figure 14-3 Forming circuit for Line Modules with PTC resistors

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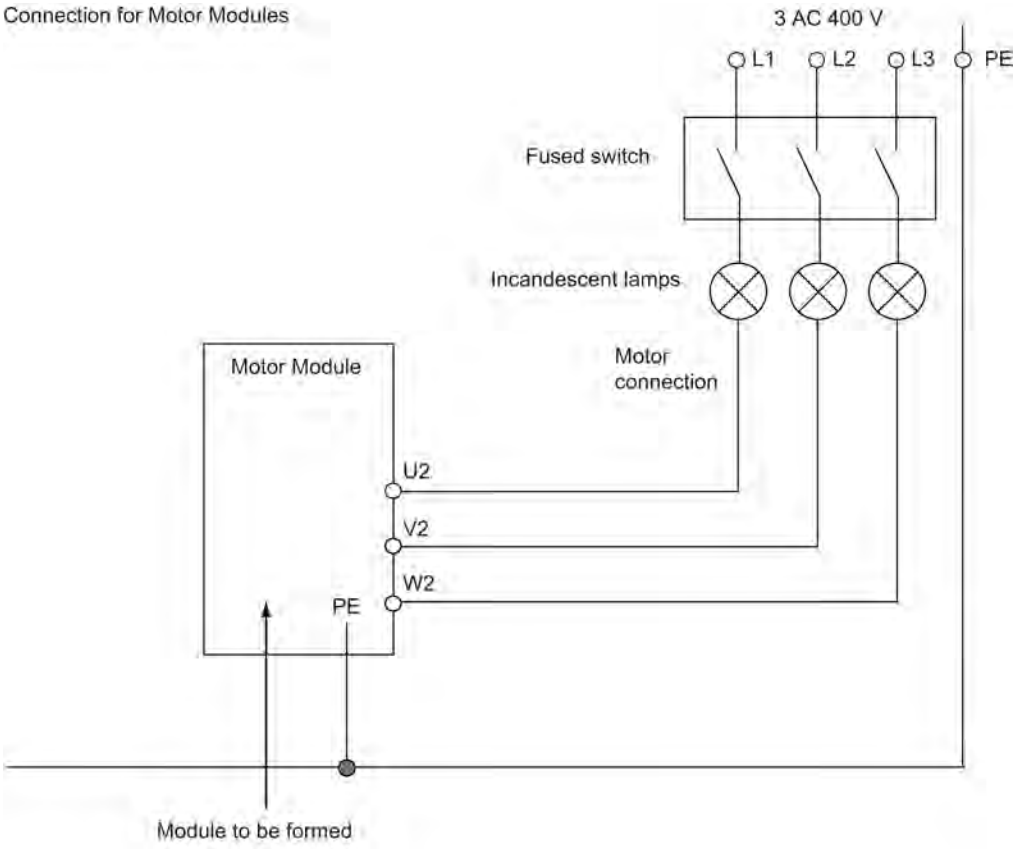


Figure 14-4 Forming circuit for Motor Modules with incandescent lamps

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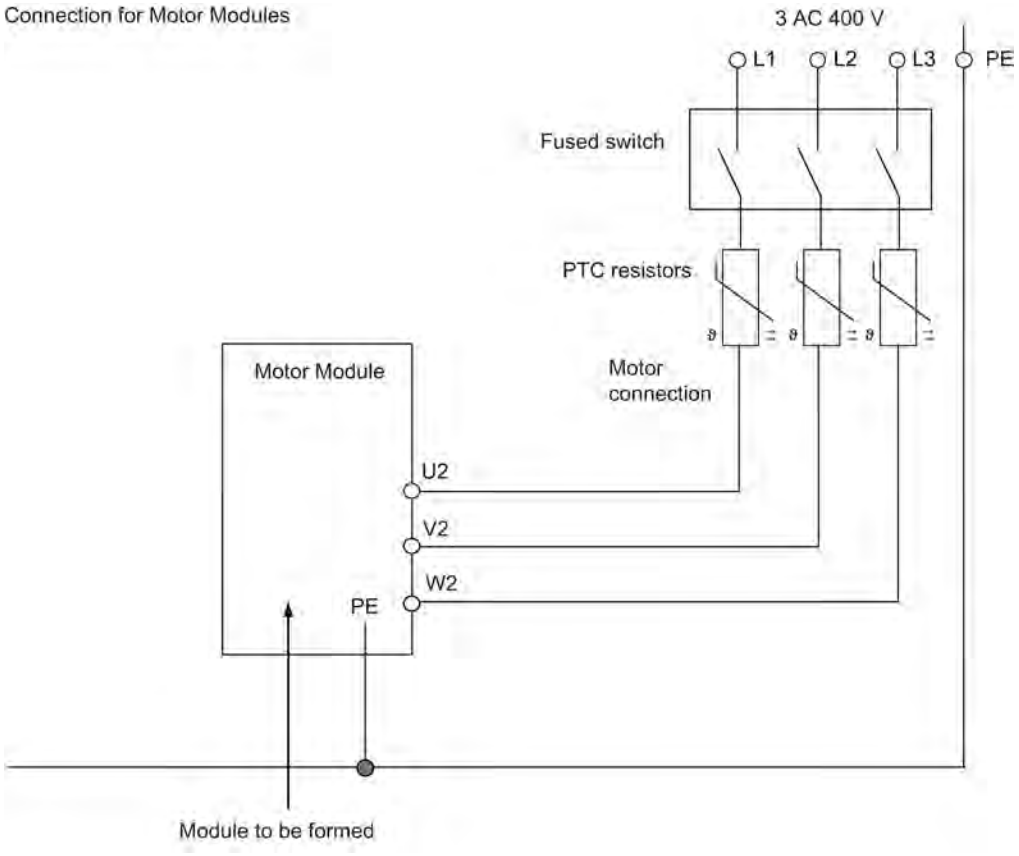


Figure 14-5 Forming circuit for Motor Modules with PTC resistors

Procedure

- Be sure to remove the DC-link bridge before forming the DC-link capacitors.
- Make sure that the device **does not** receive a switch-on command (e.g. from the keyboard, BOP20 or terminal block).
- Connect the forming circuit.
- While forming, the incandescent lamps must become less bright or go completely dark. If the incandescent lamps continue to be brightly lit, a fault has occurred in the drive unit or in the wiring.
- For forming using PTC resistors, the modules must remain in the circuit for approx. 1h. The resistors will become very hot if there is a fault in the unit (surface temperature > 80° C).

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14.4 Recycling and disposal

Dispose of the product according to the applicable national regulations.

The products described in this Equipment Manual are extensively recyclable on account of the low-toxic composition of the materials used. To recycle and dispose of your old device in an environmentally friendly way, please contact a company that disposes of electronic waste.

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Appendix

A

A.1 List of abbreviations

Note

The following list of abbreviations includes all abbreviations and their meanings used in the entire SINAMICS family of drives.

Abbreviation	Source of the abbreviation	Meaning
A		
A...	Alarm	Alarm
AC	Alternating Current	Alternating current
ADC	Analog Digital Converter	Analog-digital converter
AI	Analog Input	Analog input
AIM	Active Interface Module	Active Interface Module
ALM	Active Line Module	Active Line Module
AO	Analog Output	Analog output
AOP	Advanced Operator Panel	Advanced Operator Panel
APC	Advanced Positioning Control	Advanced Positioning Control
AR	Automatic Restart	Automatic restart
ASC	Armature Short-Circuit	Armature short-circuit
ASCII	American Standard Code for Information Interchange	American standard code for information interchange
AS-i	AS-Interface (Actuator Sensor Interface)	AS interface (open bus system in automation technology)
ASM	Asynchronmotor	Induction motor
B		
BB	Betriebsbedingung	Operating condition
BERO	-	Proximity switch
BI	Binector Input	Binector Input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit	BG Institute for Occupational Safety and Health
BICO	Binector Connector Technology	Binector connector technology
BLM	Basic Line Module	Basic Line Module

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Abbreviation	Source of the abbreviation	Meaning
BO	Binector Output	Binector output
BOP	Basic Operator Panel	Basic Operator Panel
C		
C	Capacitance	Capacitance
C...	-	Safety message
CAN	Controller Area Network	Serial bus system
CBC	Communication Board CAN	Communication Board CAN
CBE	Communication Board Ethernet	PROFINET communication module (Ethernet)
CD	Compact Disc	Compact disk
CDS	Command Data Set	Command data set
CF Card	CompactFlash Card	CompactFlash card
CI	Connector Input	Connector Input
CLC	Clearance Control	Clearance control
CNC	Computer Numerical Control	Computerized numerical control
CO	Connector Output	Connector output
CO/BO	Connector Output/Binector Output	Connector/binector output
COB ID	CAN Object-Identification	CAN object identification
CoL	Certificate of License	Certificate of License
COM	Common contact of a change-over relay	Center contact on a changeover contact
COMM	Commissioning	Commissioning
CP	Communication Processor	Communications processor
CPU	Central Processing Unit	Central processing unit
CRC	Cyclic Redundancy Check	Cyclic redundancy check
CSM	Control Supply Module	Control Supply Module
CU	Control Unit	Control unit
CUA	Control Unit Adapter	Control Unit Adapter
CUD	Control Unit DC MASTER	Control Unit DC MASTER
D		
DAC	Digital Analog Converter	Digital-analog converter
DC	Direct Current	Direct current
DCB	Drive Control Block	Drive Control Block
DCBRK	DC Brake	DC braking
DCC	Drive Control Chart	Drive Control Chart
DCN	Direct Current Negative	Direct current negative
DCP	Direct Current Positive	Direct current positive
DDS	Drive Data Set	Drive data set
DI	Digital Input	Digital input
DI/DO	Digital Input/Digital Output	Bidirectional digital input/output
DMC	DRIVE-CLiQ Hub Module Cabinet	DRIVE-CLiQ Hub Module Cabinet
DME	DRIVE-CLiQ Hub Module External	DRIVE-CLiQ Hub Module External

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Abbreviation	Source of the abbreviation	Meaning
DMM	Double Motor Module	Double Motor Module
DO	Digital Output	Digital output
DO	Drive Object	Drive object
DP	Decentralized Peripherals	Distributed I/O
DPRAM	Dual Ported Random Access Memory	Dual-Port Random Access Memory
DQ	DRIVE-CLiQ	DRIVE-CLiQ
DRAM	Dynamic Random Access Memory	Dynamic Random Access Memory
DRIVE-CLiQ	Drive Component Link with IQ	Drive Component Link with IQ
DSC	Dynamic Servo Control	Dynamic Servo Control
DTC	Digital Time Clock	Timer
E		
EASC	External Armature Short-Circuit	External armature short-circuit
EDS	Encoder Data Set	Encoder data set
EEPROM	Electrically Erasable Programmable Read-Only Memory	Electrically Erasable Programmable Read-Only-Memory
ESD	Elektrostatisch gefährdete Baugruppen	Electrostatic sensitive devices
ELCB	Earth Leakage Circuit Breaker	Residual current operated circuit breaker
ELP	Earth Leakage Protection	Ground-fault monitoring
EMC	Electromagnetic Compatibility	Electromagnetic compatibility
EMF	Electromotive Force	Electromotive force
EMK	Elektromotorische Kraft	Electromotive force
EMV	Elektromagnetische Verträglichkeit	Electromagnetic compatibility
EN	Europäische Norm	European standard
EnDat	Encoder-Data-Interface	Encoder interface
EP	Enable Pulses	Enable pulses
EPOS	Einfachpositionierer	Basic positioner
ES	Engineering System	Engineering System
ESB	Ersatzschaltbild	Equivalent circuit diagram
ESD	Electrostatic Sensitive Devices	Electrostatic sensitive devices
ESM	Essential Service Mode	Essential service mode
ESR	Extended Stop and Retract	Extended stop and retract
F		
F…	Fault	Fault
FAQ	Frequently Asked Questions	Frequently asked questions
FBLOCKS	Free Blocks	Free function blocks
FCC	Function Control Chart	Function control chart
FCC	Flux Current Control	Flux current control
FD	Function Diagram	Function diagram
F-DI	Failsafe Digital Input	Fail-safe digital input
F-DO	Failsafe Digital Output	Fail-safe digital output

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Abbreviation	Source of the abbreviation	Meaning
FEM	Fremderregter Synchronmotor	Separately excited synchronous motor
FEPROM	Flash-EPROM	Non-volatile write and read memory
FG	Function Generator	Function generator
FI	-	Residual current
FOC	Fiber-Optic Cable	Fiber-optic cable
FP	Funktionsplan	Function diagram
FPGA	Field Programmable Gate Array	Field programmable gate array
FW	Firmware	Firmware
G		
GB	Gigabyte	Gigabyte
GC	Global Control	Global control telegram (broadcast telegram)
GND	Ground	Reference potential for all signal and operating voltages, usually defined as 0 V (also referred to as M)
GSD	Gerätestammdatei	Generic station description: describes the features of a PROFIBUS slave
GSV	Gate Supply Voltage	Gate supply voltage
GUID	Globally Unique Identifier	Globally Unique Identifier
H		
HF	High frequency	High frequency
HFD	Hochfrequenzdrossel	High-frequency reactor
HLA	Hydraulic Linear Actuator	Hydraulic linear drive
HLG	Hochlaufgeber	Ramp-function generator
HM	Hydraulic Module	Hydraulic Module
HMI	Human Machine Interface	Human machine interface
HTL	High-Threshold Logic	Logic with high fault threshold
HW	Hardware	Hardware
I		
i. V.	In Vorbereitung	Under development: This property is currently not available
I/O	Input/Output	Input/output
I2C	Inter-Integrated Circuit	Internal serial data bus
IASC	Internal Armature Short-Circuit	Internal armature short-circuit
IBN	Inbetriebnahme	Commissioning
ID	Identifier	Identification
IE	Industrial Ethernet	Industrial Ethernet
IEC	International Electrotechnical Commission	International Electrotechnical Commission
IF	Interface	Interface
IGBT	Insulated Gate Bipolar Transistor	Bipolar transistor with insulated control electrode
IGCT	Integrated Gate-Controlled Thyristor	Semiconductor power switch with integrated control electrode

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Abbreviation	Source of the abbreviation	Meaning
IL	Impulslöschung	Pulse suppression
IP	Internet Protocol	Internet Protocol
IPO	Interpolator	Interpolator
IT	Isolé Terre	Non-grounded three-phase line supply
IVP	Internal Voltage Protection	Internal voltage protection
J		
JOG	Jogging	Jog
K		
KDV	Kreuzweiser Datenvergleich	Crosswise data comparison
KHP	Know-how protection	Know-how protection
KIP	Kinetische Pufferung	Kinetic buffering
Kp	-	Proportional gain
KTY	-	Special temperature sensor
L		
L	-	Symbol for inductance
LED	Light Emitting Diode	Light emitting diode
LIN	Linearmotor	Linear motor
LR	Lageregler	Position controller
LSB	Least Significant Bit	Least significant bit
LSC	Line-Side Converter	Line-side converter
LSS	Line-Side Switch	Line-side switch
LU	Length Unit	Length unit
FO cable	Lichtwellenleiter	Fiber-optic cable
M		
M	-	Symbol for torque
M	Masse	Reference potential for all signal and operating voltages, usually defined as 0 V (also referred to as GND)
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDI	Manual Data Input	Manual data input
MDS	Motor Data Set	Motor data set
MLFB	Maschinenlesbare Fabrikatebezeichnung	Machine-readable product code
MM	Motor Module	Motor Module
MMC	Man-Machine Communication	Man-machine communication
MMC	Micro Memory Card	Micro memory card
MSB	Most Significant Bit	Most significant bit
MSC	Motor-Side Converter	Motor-side converter
MSCY_C1	Master Slave Cycle Class 1	Cyclic communication between master (class 1) and slave

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Abbreviation	Source of the abbreviation	Meaning
MSC	Motorstromrichter	Motor-side converter
MT	Messtaster	Probe
N		
N. C.	Not Connected	Not connected
N...	No Report	No report or internal message
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie	Standardization association for measurement and control in chemical industries
NC	Normally Closed (contact)	NC contact
NC	Numerical Control	Numerical control
NEMA	National Electrical Manufacturers Association	Standardization body in the US
NM	Nullmarke	Zero mark
NO	Normally Open (contact)	NO contacts
LSC	Netzstromrichter	Line-side converter
NVRAM	Non-Volatile Random Access Memory	Non-volatile read/write memory
O		
OA	Open Architecture	Software component (technology package) which provides additional functions for the SINAMICS drive system
OAIF	Open Architecture Interface	Version of the SINAMICS firmware from which the OA-application can be used
OASP	Open Architecture Support Package	Expands the STARTER commissioning tool by the corresponding OA-application
OC	Operating Condition	Operating condition
OEM	Original Equipment Manufacturer	Original equipment manufacturer
OLP	Optical Link Plug	Bus connector for fiber-optic cable
OMI	Option Module Interface	Option Module Interface
P		
p...	-	Adjustable parameters
P1	Processor 1	CPU 1
P2	Processor 2	CPU 2
PB	PROFIBUS	PROFIBUS
PcCtrl	PC Control	Master control
PD	PROFIdrive	PROFIdrive
PDS	Power unit Data Set	Power unit data set
PE	Protective Earth	Protective ground
PELV	Protective Extra Low Voltage	Safety extra-low voltage
PEM	Permanenterregter Synchronmotor	Permanent-magnet synchronous motor
PG	Programmiergerät	Programming device
PI	Proportional Integral	Proportional integral
PID	Proportional Integral Differential	Proportional integral differential
PLC	Programmable Logical Controller	Programmable logic controller

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Abbreviation	Source of the abbreviation	Meaning
PLL	Phase-Locked Loop	Phase-locked loop
PM	Power Module	Power Module
PN	PROFINET	PROFINET
PNO	PROFIBUS Nutzerorganisation	PROFIBUS user organization
PPI	Point to Point Interface	Point-to-point interface
PRBS	Pseudo Random Binary Signal	White noise
PROFIBUS	Process Field Bus	Serial data bus
PS	Power Supply	Power supply
PSA	Power Stack Adapter	Power Stack Adapter
PTC	Positive Temperature Coefficient	Positive temperature coefficient
PTP	Point To Point	Point-to-point
PWM	Pulse Width Modulation	Pulse width modulation
PZD	Prozessdaten	Process data
Q		
R		
r...	-	Display parameters (read only)
RAM	Random Access Memory	Read/write memory
RCCB	Residual Current Circuit Breaker	Residual current operated circuit breaker
RCD	Residual Current Device	Residual current operated circuit breaker
RCM	Residual Current Monitor	Residual current monitor
RFG	Ramp-Function Generator	Ramp-function generator
RJ45	Registered Jack 45	Term for an 8-pin socket system for data transmission with shielded or non-shielded multi-wire copper cables
RKA	Rückkühlanlage	Cooling unit
RLM	Renewable Line Module	Renewable Line Module
RO	Read Only	Read only
ROM	Read-Only Memory	Read-only memory
RPDO	Receive Process Data Object	Receive Process Data Object
RS232	Recommended Standard 232	Interface standard for cable-connected serial data transmission between a sender and receiver (also known as EIA232)
RS485	Recommended Standard 485	Interface standard for a cable-connected differential, parallel, and/or serial bus system (data transmission between a number of senders and receivers, also known as EIA485)
RTC	Real Time Clock	Realtime clock
RZA	Raumzeigerapproximation	Space vector approximation
S		
S1	-	Continuous duty
S3	-	Intermittent duty
SAM	Safe Acceleration Monitor	Safe acceleration monitoring

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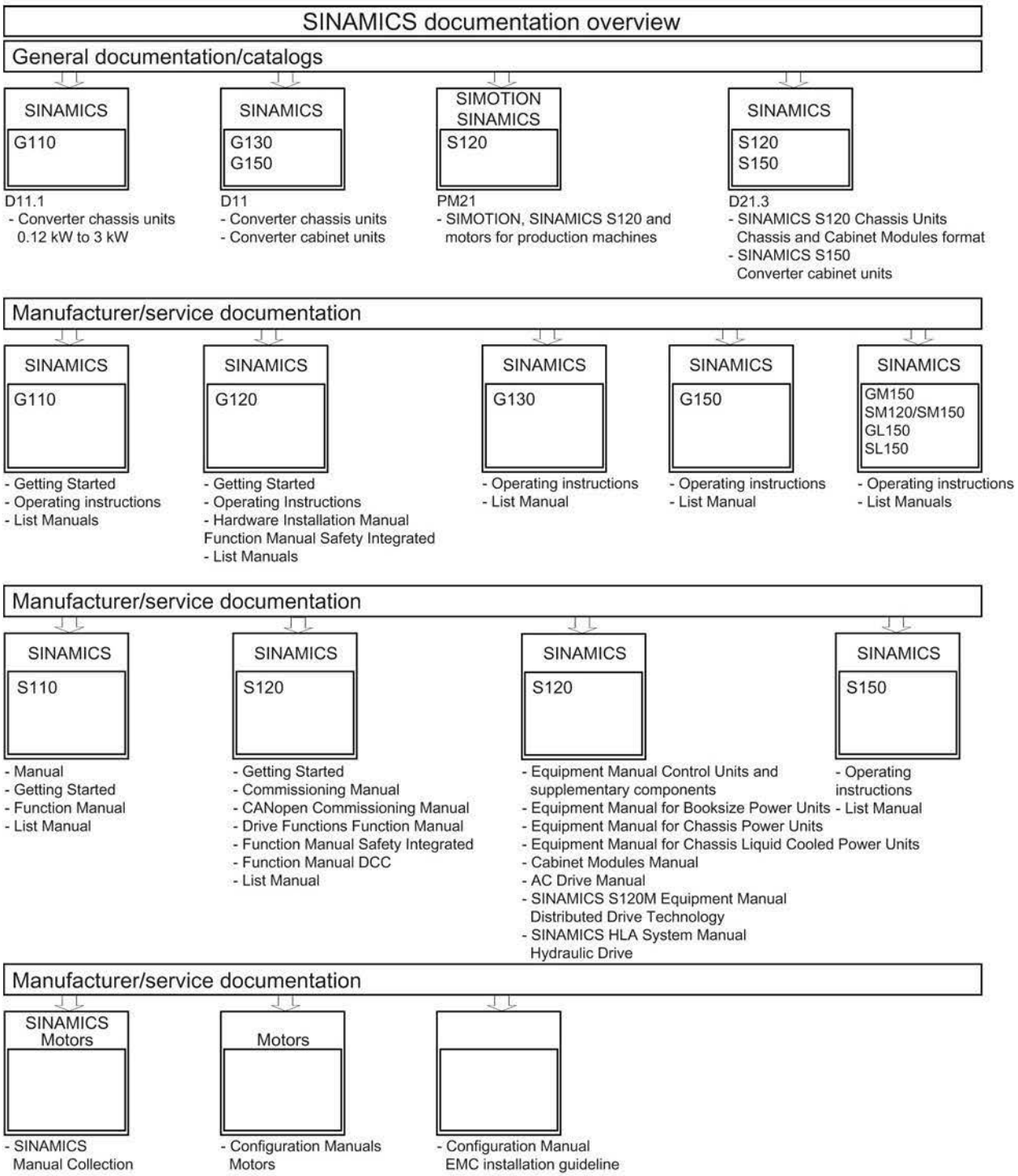
Abbreviation	Source of the abbreviation	Meaning
SBC	Safe Brake Control	Safe brake control
SBH	Sicherer Betriebshalt	Safe operating stop
SBR	Safe Brake Ramp	Safe brake ramp monitoring
SBT	Safe Brake Test	Safe brake test
SCA	Safe Cam	Safe cam
SD Card	SecureDigital Card	Secure digital memory card
SDI	Safe Direction	Safe motion direction
SE	Sicherer Software-Endschalter	Safe software limit switch
SG	Sicher reduzierte Geschwindigkeit	Safely-limited speed
SGA	Sicherheitsgerichteter Ausgang	Safety-related output
SGE	Sicherheitsgerichteter Eingang	Safety-related input
SH	Sicherer Halt	Safe standstill
SI	Safety Integrated	Safety Integrated
SIL	Safety Integrity Level	Safety Integrity Level
SLM	Smart Line Module	Smart Line Module
SLP	Safely-Limited Position	Safely-limited position
SLS	Safely-Limited Speed	Safely-limited speed
SLVC	Sensorless Vector Control	Vector control without encoder (sensorless)
SM	Sensor Module	Sensor Module
SMC	Sensor Module Cabinet	Sensor Module Cabinet
SME	Sensor Module External	Sensor Module External
SMI	SINAMICS Sensor Module Integrated	SINAMICS Sensor Module Integrated
SMM	Single Motor Module	Single Motor Module
SN	Sicherer Software-Nocken	Safe software cam
SOS	Safe Operating Stop	Safe operating stop
SP	Service Pack	Service pack
SP	Safe Position	Safe position
SPC	Setpoint Channel	Setpoint channel
SPI	Serial Peripheral Interface	Serial peripheral interface
SPS	Speicherprogrammierbare Steuerung	Programmable logic controller
SS1	Safe Stop 1	Safe stop 1 (monitored for time and ramping up)
SS2	Safe Stop 2	Safe Stop 2
SSI	Synchronous Serial Interface	Synchronous serial interface
SSM	Safe Speed Monitor	Safe feedback from speed monitor
SSP	SINAMICS Support Package	SINAMICS support package
STO	Safe Torque Off	Safe torque off
STW	Steuerwort	Control word

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Abbreviation	Source of the abbreviation	Meaning
T		
TB	Terminal Board	Terminal board
TIA	Totally Integrated Automation	Totally Integrated Automation
TM	Terminal Module	Terminal Module
TN	Terre Neutre	Grounded three-phase line supply
Tn	-	Integral time
TPDO	Transmit Process Data Object	Transmit process data object
TT	Terre Terre	Grounded three-phase line supply
TTL	Transistor-Transistor-Logic	Transistor-transistor logic
Tv	-	Rate time
U		
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
UPS	Uninterruptible Power Supply	Uninterruptible power supply
UPS	Unterbrechungsfreie Stromversorgung	Uninterruptible power supply
UTC	Universal Time Coordinated	Universal time coordinated
V		
VC	Vector Control	Vector control
Vdc	-	DC-link voltage
VdcN	-	Partial DC link voltage, negative
VdcP	-	Partial DC link voltage, positive
VDE	Verband Deutscher Elektrotechniker	Verband Deutscher Elektrotechniker [Association of German Electrical Engineers]
VDI	Verein Deutscher Ingenieure	Verein Deutscher Ingenieure [Association of German Engineers]
VPM	Voltage Protection Module	Voltage Protection Module
Vpp	Volt peak to peak	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module
W		
WEA	Wiedereinschaltautomatik	Automatic restart
WZM	Werkzeugmaschine	Machine tool
X		
XML	Extensible Markup Language	Extensible markup language (standard language for web publishing and document management)
Y		
Z		
ZK	DC Link	DC Link
ZM	Zero Mark	Zero mark
ZSW	Status word	Status word

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A.2 Documentation overview



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