1.6 DC link options

1.6.1 Capacitor module with 2.8 mF, 4.1 mF or 20 mF

Description

The capacitor modules are used to increase the DC link capacitance. On one hand, a brief power failure can then be buffered, and on the other hand, the energy when braking can be buffered.

The modules differ as follows:

- Modules with 2.8 mF and 4.1 mF --> are used as dynamic energy storage devices
- Module with 20 mF --> is used to buffer power failures

The modules are available in the following versions:

- Central modules: 4.1 mF and 20 mF
  - SIMODRIVE housing type, are integrated in the system group.
- Distributed modules: 2.8 mF and 4.1 mF
  - New housing type, these are mounted decentrally in the cabinet and are connected to the SIMODRIVE DC link through an adapter terminal and cable.

The capacitor modules have a ready display which is lit above a DC link voltage of approx. 300 V. This allows internal fuse failures to be detected. This does not guarantee reliable monitoring of the charge condition.

The module with 2.8 mF or 4.1 mF does not have a pre–charging circuit. Because it is directly connected to the DC link, it can accept dynamic energy levels and can therefore operate as dynamic energy storage device. For these modules, the charge limits of the line supply modules must be observed.

Modules with 20 mF are pre–charged through an internal pre–charging resistor which limits the charge current and de–couples the module from the central pre–charging. This module cannot accept dynamic energy levels, as the pre–charging resistor limits the charge current. When the power fails, a diode couples this capacitor battery to the DC link of the system and supports this.

Note

The capacitor modules may only be used in conjunction with the line supply infeed modules of SIMODRIVE 611.

The central modules are suitable for internal and external cooling.

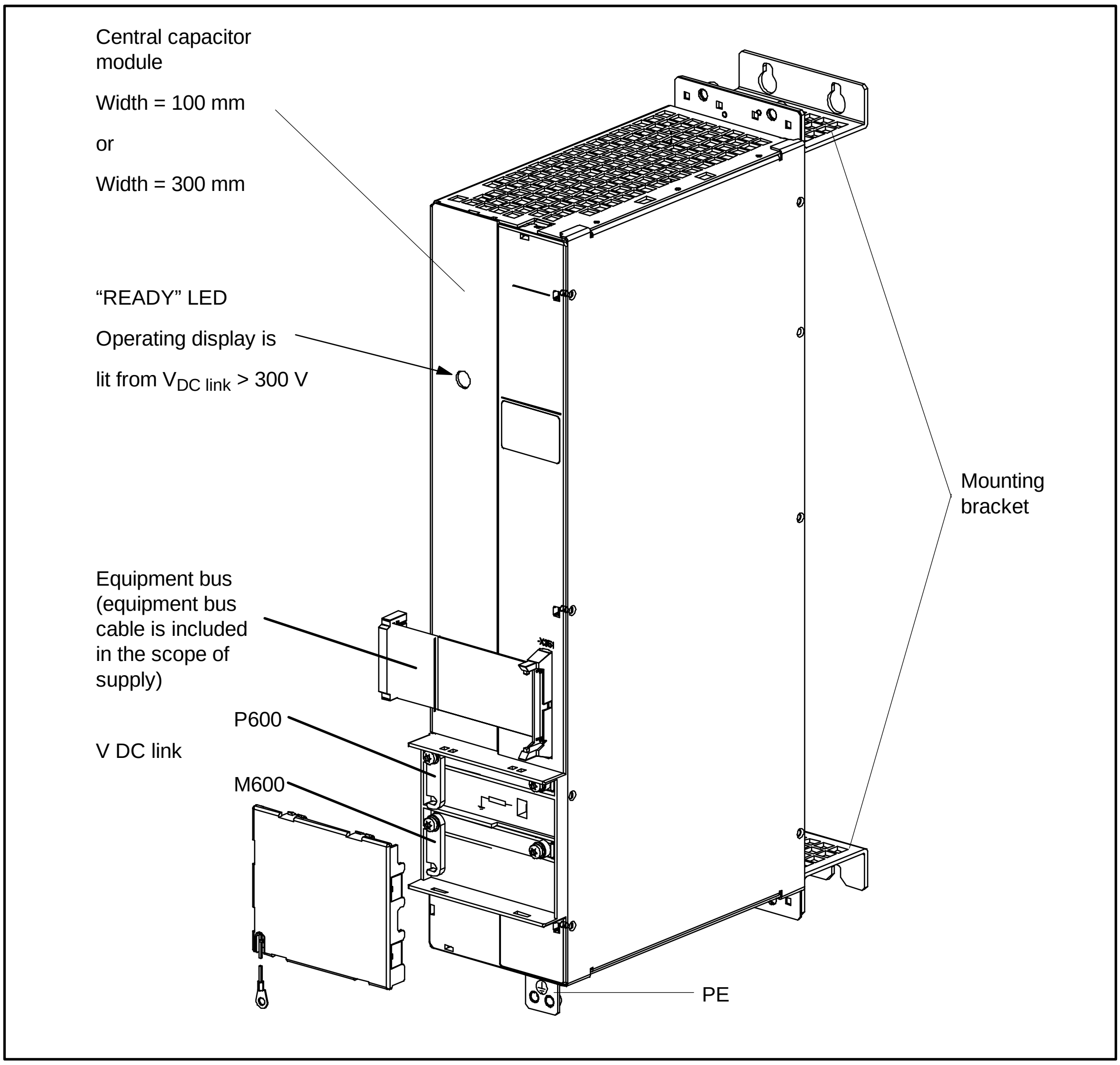

Fig.1-11 Central capacitor module 4.1 mF

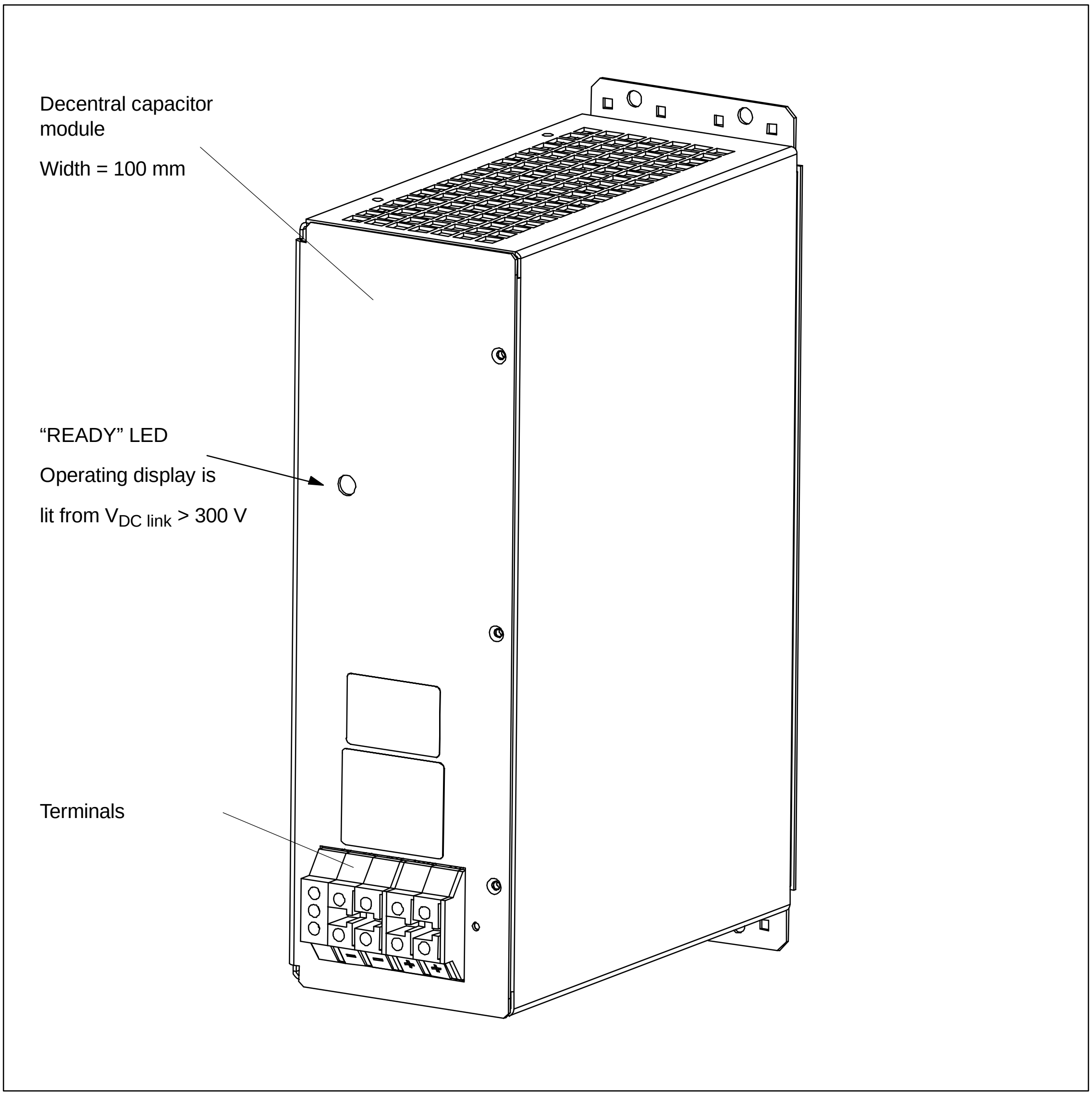

Fig.1-12 Decentral capacitor module 2.8 mF / 4.1 mF

Technical data

The following technical data apply:

Table 1-13 Technical data of the central capacitor modules

Designation	Central modules	
	4.1 mF	**20 mF**
Order No.	6SN1 112–1AB00–0BA0	6SN1 112–1AB00–0CA0
Voltage range	V_{DC} 350 to 750 V	
Energy storage capacity w = 1/2 x C x U^2	$V_{DC\ steady\ state}$ (examples) 600 V --> 738 Ws 680 V --> 948 Ws	$V_{DC\ steady\ state}$ (examples) 600 V --> 3 215 Ws 680 V --> 4 129 Ws Note: As a result of the internal pre–charging resistor, the voltage at the capacitors is only approximately 0.94 x V_{DC}.
Temperature range	0 °C to +55 °C	
Weight	approx. 7.5 kg	approx. 21.5 kg
Dimensions	W x H x D 100 x 480 x 211 [mm]	W x H x D 300 x 480 x 211 [mm]

Table 1-14 Technical data of the decentral capacitor modules

Designation	Decentral modules	
	2.8 mF	**4.1 mF**
Order No.	6SN1 112–1AB00–1AA0	6SN1 112–1AB00–1BA0
Voltage range	V_{DC} 350 to 750 V	
Energy storage capacity w = 1/2 x C x U^2	$V_{DC\ steady\ state}$ (examples) 600 V --> 504 Ws 680 V --> 647 Ws	$V_{DC\ steady\ state}$ (examples) 600 V --> 738 Ws 680 V --> 948 Ws
Temperature range	0 °C to +55 °C	
Weight	5.3 kg	5.8 kg
Dimensions	W x H x D 100 x 334 x 231 [mm]	W x H x D 100 x 334 x 231 [mm]
Connection	AWG 20 to AWG 6, finely stranded	
Degree of protection	IP 20	

Calculation examples

The energy storage capacity in dynamic operation and for regenerative braking is calculated as follows:

Formula: $w = ½ \times C \times (V^2_{DC\ linkmax} – V^2_{DC\ linkn})$

Assumptions for the example:

Capacitance of the capacitor battery C = 4.1 mF

Nominal DC link voltage $V_{DC\ linkn}$ = 600 V

Max. DC link voltage $V_{DC\ linkmax}$ = 695 V

--> $w = ½ \times 4.1 \times 10^{-3}\ F \times ((695\ V)^2 – (600\ V)^2) = 252\ Ws$

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The following applies for the energy storage capacity of the capacitor battery when the power fails:

Formula: $w = ½ \times C \times (V^{2DC\ link}{}_{n} – V^{2}{}_{DC\ linkmin})$

Assumptions for the example:

Capacitance of the capacitor battery C = 20 mF

Nominal DC link voltage $V_{DC\ linkn}$ = 600 V

Min. DC link voltage $V_{DC\ linkmin}$ = 350 V

--> $w = ½ \times 20 \times 10^{-3}\ F \times ((567\ V)^2 – (350\ V)^2) = 1990\ Ws$

For a DC link voltage of 680 V, the energy storage capacity increases to 2904 Ws.

Caution

$V_{DC\ linkmin}$ must be ≧ 350 V.

For voltages below 350 V, the switched-mode power supply for the electronics shuts down.

The possible buffer time $t_Ü$ is calculated using the output DC link power $P_{DC\ link}$ as follows:

$t_Ü = w / P_{DC\ link}$

Dynamic energy

DC link capacitors should be considered as battery. The capacitance and the energy storage capability are increased as a result of the capacitor module.

To evaluate the capacity required for a specific requirement in a certain application, the energy balance should be determined.

The energy balance depends on the following:

- All moved masses and moments of inertia
- Velocity, speed (and its change, acceleration, deceleration)
- Efficiency: Mechanical system, gearbox, motor, inverter (driving/braking)
- Buffer time, buffering
- DC link voltage and the permissible change, output value upper/lower limit value.

Often, in practice, there is no precise data about the mechanical system. If the mechanical system data are determined by making rough calculations or using estimated values, the adequate capacitance of the DC link capacitors can only be determined by carrying-out tests during the commissioning phase.

The energy for dynamic operations is obtained as follows:

When a drive brakes or accelerates within time t_V from one speed/velocity to another, then the following applies:

$$w = ½ \times P \times t_V$$

for rotating drives with

$$P = \frac{M_{Mot} \times (n_{Mot\,max} - n_{Mot\,min})}{9\,550} \times \eta_G$$

for linear drives with

$P = F_{Mot} \times (V_{Mot\,max} - V_{Mot\,min}) \times 10^{-3} \times \eta_G$

with η_G:

Braking	$\eta_G = \eta_M \times \eta_{WR}$
Acceleration	$\eta_G = 1/(\eta_M \times \eta_{WR})$

w [Ws]	Energy
P [kW]	Motor output
t_V [s]	Duration
M_{Mot} [Nm]	Max. motor torque when braking or accelerating
F_{Mot} [N]	Max. motor force when braking or accelerating
$n_{Mot\,max}$ [RPM]	Max. speed at the start or end of the operation
$n_{Mot\,min}$ [RPM]	Min. speed at the start or end of the operation
$v_{Mot\,max}$ [m/s]	Max. velocity at the start or end of the operation
$v_{Mot\,min}$ [m/s]	Min. velocity at the start or end of the operation
η_G	Efficiency, overall
η_M	Efficiency, motor
η_{WR}	Efficiency, inverter

The torque M and force F which are generated depend on the moved masses, the load and the acceleration in the system.

If there is no precise data for the factors specified above, then generally the nominal/rated data is applied.

Engineering information

The central capacitor module should preferably be located at the righthand end of the system group. It is connected through DC link busbars.

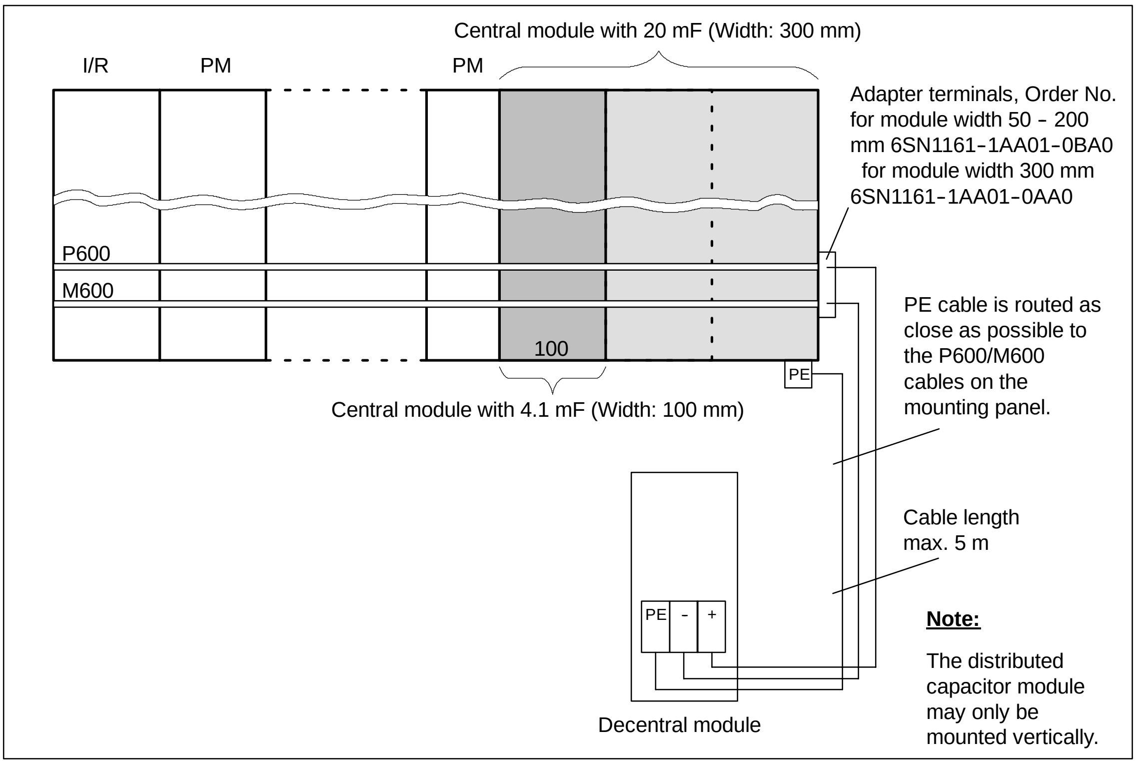

Fig.1-13 Capacitor module mounting location

Several capacitor modules can be connected in parallel depending on the line supply infeed used.

For capacitor modules with 2.8 mF and 4.1 mF, the total charge limit of the line supply infeed may not be exceeded (refer to Catalog NC 60, Section 10).

Table 1-15 Maximum number of capacitor modules

Infeed unit	Capacitor modules which can be connected			
5 kW UI	None			
		Monitoring module 1)		
		Without	1	2–max.3
10 kW UI 16 kW I/R	Module 2.8 mF	2	2	2
	Module 4.1 mF (central/decentral)	1	1	1
	Module 20 mF	3	1	0
28 kW UI 36–120 kW I/R	Module 2.8 mF	7	7	7
	Module 4.1 mF (central/decentral)	4	4	4
	Module 20 mF	3	1	0

1) When the monitoring modules are directly connected to the line supply without DC link connection, the monitoring modules do not have to be taken into account.

If, for direct line connection and simultaneous DC link connection (P500–P600 and N500–N600) the monitoring modules are connected to the same line supply as the line supply infeed, then the monitoring modules must also be taken into account.
A maximum of three monitoring modules may be connected

The "without monitoring module" column is valid for the number of capacitor modules.

Charge times, discharge times, discharge voltage

It should be carefully checked that the DC link is in a no–voltage condition before carrying–out any commissioning or service work.

Table 1-16 Charge/discharge times, discharge voltage

Capacitor module	Charge time for each module	Discharge time for each module to a DC link voltage of 60 V at 750 V DC
2.8 mF/4.1 mF	as for the power modules n	approx. 30 min
20 mF	approx. 2 min	approx. 40 min

If the system includes a pulsed resistor, in order to shorten the discharge time, after opening terminal 42, a fast DC link discharge can be initiated using terminals X221:19 and 50 (jumper).

Warning

The pulsed resistor modules can only convert a certain amount of energy into heat (refer to Table 1-18). The energy to be converted depends on the voltage.

Caution

In order to avoid causing damage to the infeed circuit of the supply infeed modules, when energizing terminal X221 terminals19/50, it must be ensured that terminal 48 of the supply infeed module is de–energized (electrical isolation from the line supply).

The checkback signal contacts of the supply infeed module main contactor must be evaluated to evaluate whether this has dropped–out (X161 term.111, term.113, term.213).