

SINAMICS DCM

DC Converter

Application

SINAMICS DCM as field supply unit

Edition 03 - 1/2012



SINAMICS drives

SIEMENS

SINAMICS DCM

Application, SINAMICS DCM as field supply unit

Compact User Manual

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER
indicates that death or severe personal injury will result if proper precautions are not taken.

⚠ WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.

⚠ CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be adhered to. The information in the relevant documentation must be observed.

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1 Notes

Note

This application document does not claim to contain all details and versions of units, or to take into account all conceivable operational cases and applications.

The standard applications do not represent specific customer solutions, but are only intended to provide support in the implementation of typical applications. The operator is responsible for the correct operation of the products described.

Should you require further information or encounter specific problems which have not been handled in enough detail, please contact your local Siemens office.

The contents of this application document are not part of an earlier or existing contract, agreement or legal relationship, nor do they change such contracts, agreements or legal relationships. The contract of sale in each case outlines all the obligations of the I DT Drive Technologies Division of Siemens AG. The warranty conditions specified in the contract between the parties are the only warranty conditions accepted by the I DT Drive Technologies Division. Any statements contained herein neither create new warranties nor modify the existing warranty.

WARNING

The units listed here contain dangerous electric voltages, dangerous rotating machine parts (fans) and control rotating mechanical parts (drives). Failure to follow the relevant Operating Instructions may result in death, serious injury or extensive material damage.

Technical Support

You can also find help for technical issues through our Technical Support:
www.siemens.de/automation/support-request (German)
www.siemens.com/automation/support-request (English)

2 Applications

SINAMICS DCM units are used to supply the armature and field of DC motors. The half-controlled single-phase bridge circuit (fully-controlled single-phase bridge circuit as option) integrated in the field power unit allows motors to be supplied with a maximum of 40 A (85 A from 6RA8093, 1500–3000 A armature current as option) rated field current. If higher field currents are required, then a SINAMICS DCM 2Q unit can be used; whereby the pre-controlled three-phase bridge circuit, normally intended to supply the armature, is used to supply the field.

A distinction is made between four application cases in the following:

- Version 1:** The SINAMICS DCM unit operates completely independently, a fixed internal field current setpoint is entered. Field weakening is not possible.
- Version 2:** The SINAMICS DCM unit receives an external, analog field current setpoint. Field weakening can be realized using this setpoint entered externally.
- Version 3:** The field supply unit (slave) operates in conjunction with a SINAMICS DCM armature supply unit (master). Signals are exchanged via a peer-to-peer interface. The armature supply unit generates the current setpoint for the field supply unit and receives from the field supply unit the current actual value and fault signal. Field weakening is possible.
- Version 4:** The same as version 3, however, additionally with field reversal
A 4Q unit should be used for the field supply unit in order to permit contactless changeover!

WARNING

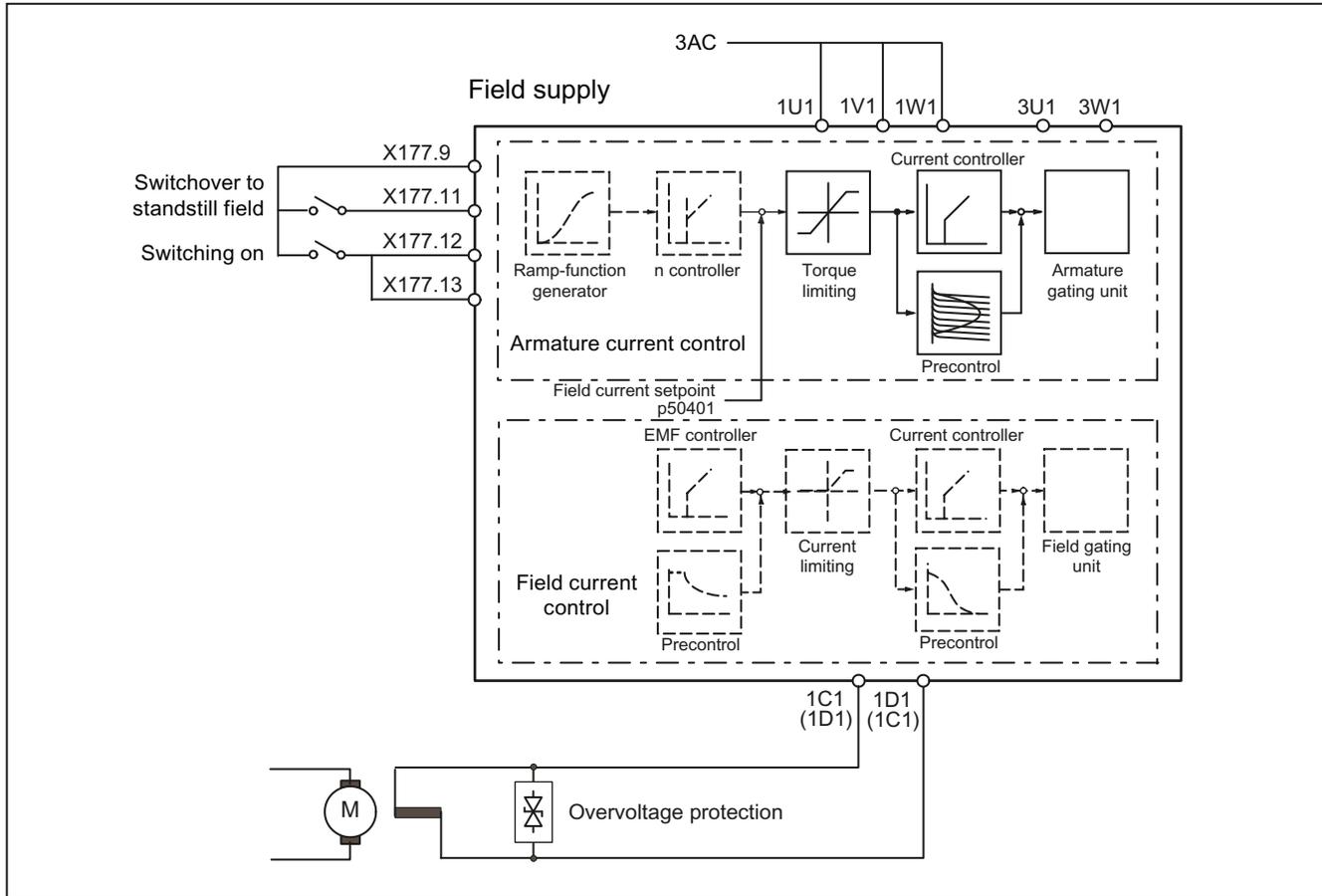
If the armature power unit is used to supply the field, then it is absolutely necessary to provide overvoltage protection for the converter power semiconductors. This is because if the input voltage is no longer present, then the energy in the field circuit cannot be dissipated.

For version 4 with field reversal, it is important to note that the overvoltage protection must be effective for both polarities!

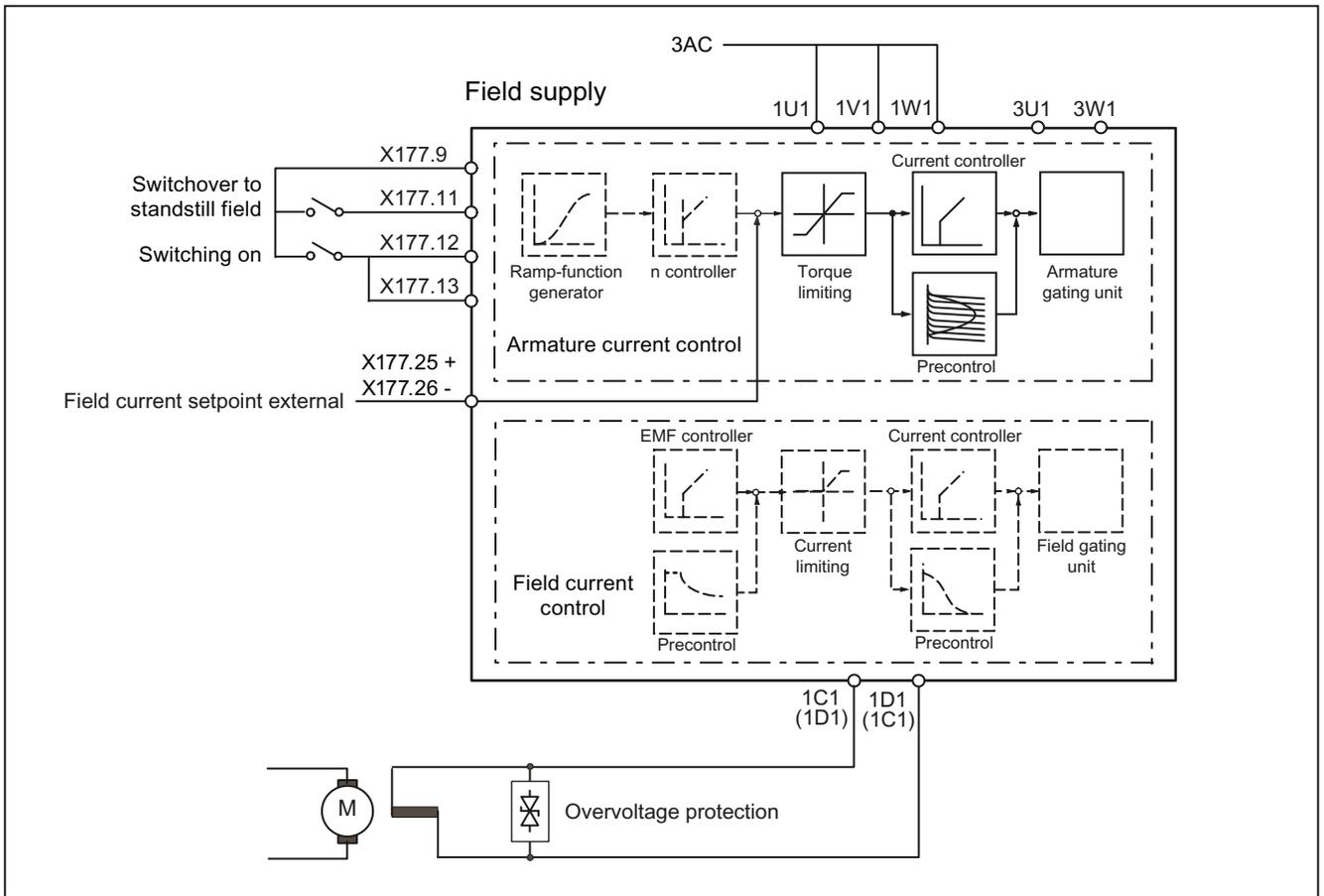
In order not to unnecessarily load the overvoltage protection, it should be ensured that when the pulses are inhibited, the field current is already 0; for example this can be achieved by activating the standstill excitation, as otherwise, the remaining field energy must be dissipated through the overvoltage protection device.

3 Block diagrams

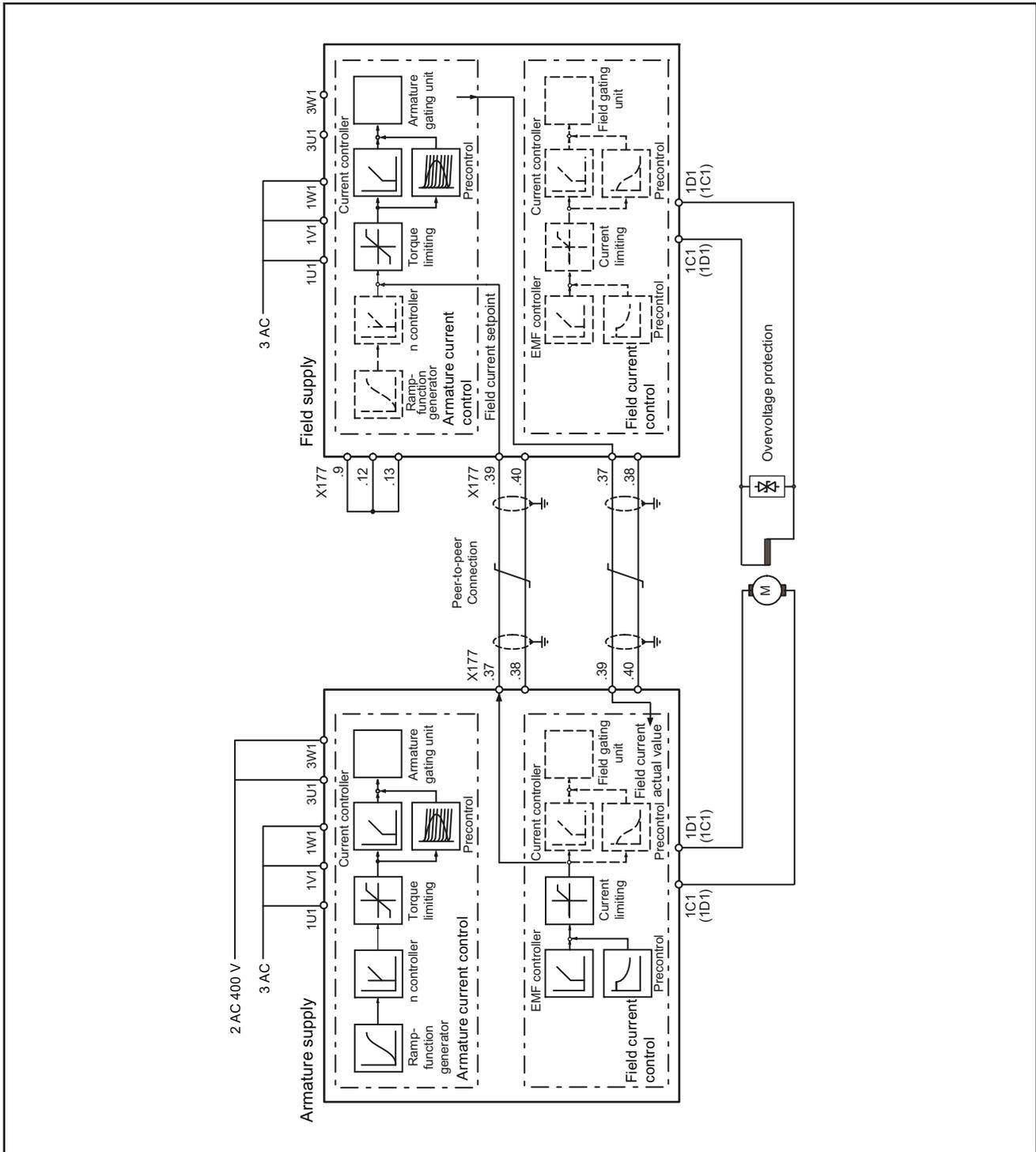
3.1 Version 1: Field supply with internal setpoint



3.2 Version 2: Field supply with external setpoint



3.3 Version 3: Field supply + armature supply



4 Parameter lists

4.1 Version 1: Field supply with internal setpoint

Field supply unit	
p50076[0]	Adaptation of the rated unit DC armature current (= scaling of the actual field current)
p50076[1]	Adaptation of the rated unit DC field current. Setting is not important as it is not used.
p50078[0]	Setting of the rated line-to-line supply voltage for the power unit
p50079 = 1	Enables the long pulses for armature gating unit. This is necessary for field supply from the armature terminals.
p50082 = 0	Internal field is not used
p50083 = 4	Speed actual value can be freely connected
p50084 = 2	Closed-loop current-controlled operation
p50100	Rated armature current = in this case, the motor excitation current
p50102	Setting is not important as it is not used
p50153 = 3	Required for high inductances connected to the armature terminals
p50179 > 0	Additional alpha W pulses (approx. 3...n), dependent on the size of the inductance.
p50192 = 1	Alpha W always p50151
p50401	Setpoint operating field; 100 % = rated unit current of the armature circuit
p50402	Setpoint standstill field; 100 % = rated unit current of the armature circuit
p50430[0] = 53010.0	Switches-in the standstill field via binary input, terminal X177.11; 1...standstill field
p50431[0] = 52402	Setpoint routing for the standstill field
p50433[0] = 52401	Setpoint routing for the operating field
p50601[2] = 52209	Excitation current setpoint routing
p50609 = 52000	Source actual speed value 0%
p2118.0 = 60042	Selects that the fault message "Tachometer fault" is suppressed
p2118.1 = 60035	Selects that the fault message "Motor locked" is suppressed
p2119.0 = 3	Suppresses the fault message "Tachometer fault"
P2119.1 = 3	Suppresses the fault message "Motor locked"

4.2 Version 2: Field supply with external setpoint

Field supply unit	
p50076[0]	Adaptation of the rated unit DC armature current (= scaling of the actual field current)
P50076[1]	Adaptation of the rated unit DC field current. Setting is not important as it is not used.
p50078[0]	Setting of the rated line-to-line supply voltage for the power unit
p50079 = 1	Enables the long pulses, armature gating unit This is necessary for field supply from the armature terminals
p50082 = 0	Internal field is not used
p50083 = 4	Speed actual value can be freely connected
p50084 = 2	Closed-loop current-controlled operation
p50100	Rated armature current = in this case, the motor excitation current
p50102	Setting is not important as it is not used
P50153 = 3	Required for high inductances connected to the armature terminals
p50179 > 0	Additional alpha W pulses (approx. 3...n), dependent on the size of the inductance.
p50192 = 1	Alpha W is always p50151
p50402	Current setpoint for standstill field; 100 % = rated unit current of the armature circuit
p50430[0] = 53010.0	Switches-in the standstill field via binary input, terminal X177.11; 1...standstill field

Field supply unit	
p50431[0] = 52402	Setpoint routing for the standstill field
p50433[0] = 52011	Setpoint routing, operating field; analog setpoint from terminal X177.25
p50601[2] = 52209	Excitation current setpoint routing
p50609 = 52000	Source actual speed value
p2118.0 = 60042	Selects that the fault message "Tachometer fault" is suppressed
p2118.1 = 60035	Selects that the fault message "Motor locked" is suppressed
p2119.0 = 3	Suppresses the fault message "Tachometer fault"
P2119.1 = 3	Suppresses the fault message "Motor locked"

4.3 Version 3: Armature supply + field supply

Armature supply unit		Field supply unit	
p50076[0]	Adaptation of the rated unit DC armature current	p50076[0]	Adaptation of the rated unit DC armature current. = scaling of the actual field current
p50076[1]	Adaptation of the rated unit DC field current NOTICE: Keep the factory setting!	p50076[1]	Adaptation of the rated unit DC field current. Setting is not important as it is not used.
p50078[0]	Adaptation of the rated line-to-line supply voltage of the power unit	p50078[0]	Adaptation of the rated line-to-line supply voltage of the power unit
p50078[1]	Not used	p50078[1]	Not used
		p50079=1	Enables the long pulses, armature gating unit. This is necessary for field supply from the armature terminals
p50081=0 or 1	when required, field weakening dependent on the EMF		
p50082=24	External field unit, ON via the "Auxiliaries ON" signal	p50082=0	Internal field is not used
		p50083=4	Speed actual value can be freely connected
p50084=1	Closed-loop speed-controlled mode	p50084=2	Closed-loop current-controlled operation
p50094	Switch-off delay of the auxiliaries The time set here must be longer than the time entered in p50258 for the field current reduction.		
p50097	= 0: Field current setpoint set to zero for a fault signal = 1 field current setpoint not zero for a fault signal, however, it is not permissible to increase the field current setpoint		
p50102	Rated field current	p50102	Setting is not important as it is not used
		p50153=3	Required for high inductances connected to the armature terminals
		p50179>0	Additional alpha W pulses when a second pulse is enabled (approx. 3...n) Dependent on the size of the inductance.

Armature supply unit		Field supply unit	
		p50192=1	Alpha W always p50151
p50257	Standstill field The value should be kept at the factory setting = 0.0; the reason for this is that when the field supply unit is switched-off, energy does not have to be dissipated via the overvoltage protection.		
p50258	Delay time for automatic field current reduction The time set here must be shorter than the time entered in p50094 for the switch-off delay of the auxiliaries.		
		p50601[2]=52601	Excitation current setpoint
		p50609=52000	Source actual speed value
p50612=52601	Excitation current actual value from the field supply unit via peer-to-peer		
		p0840[0]=52607.0	On command
		p0852[0]=52607.0	Pulse enable
p0844[0]=52607.0	"OFF2" initiated when the field supply unit has a fault condition		
p50790=5	Peer-to-peer selection	p50790=5	Peer-to-peer selection
p50791=2	Number of words transferred	p50791=2	Number of words transferred
p50793=8	Recommended baud rate	p50793=8	Recommended baud rate
p50795=1	Bus terminator on	p50795=1	Bus terminator on
p50794[0]=52268	Excitation current setpoint	p50794[0]=52116	Absolute excitation current actual value
p50794[1]=52620	Routing, auxiliaries on	p50794[1]=52620	Routing, fault bit
p50797=0.3...0.5 s	Telegram failure time. If a fault occurs when switching-on the electronics power supply during the initialization→ set a longer time.	p50797=0.3...0.5 s	Telegram failure time. If a fault occurs when switching-on the electronics power supply during the initialization→ set a longer time.
p51117[0]=53210.2	Auxiliaries on	p51117[0]=2139.3	Routing, fault bit
		p51118.0=1	Fault bit inversion
p51838=xxxx	Rated DC current of the external field device corresponding to parameter r50072.2 of the external field device	p2118.0=60042	Selects that the fault message "Tachometer fault" is suppressed
		p2118.1=60035	Selects that the fault message "Motor locked" is suppressed
		p2119.0=3	Suppresses the fault message "Tachometer fault"
		P2119.1=3	Suppresses the fault message "Motor locked"

NOTICE

If field supply unit fault occurs, then the armature supply unit is shut down with OFF2 (the voltage is disconnected).

4.4 Armature supply + field supply + field reversal

A 4Q unit is used for the field supply for this particular application.

In addition to the settings listed under Point 4.3, the following settings must be made:

Armature supply unit		Field supply unit	
		p50086=0	Deactivate the automatic restart, so that the device does not switch to a conducting thyristor of the protection circuit
		p50150=5	Set the Alpha G limit to 5 degrees
		p50180[0]=100 %	+100 % positive current limit for field direction 1
		p50181[0]=0 %	0 % negative current limit for field direction 1
		p50182[0]=0 %	0 % positive current limit for field direction 2
		p50183[0]=-100 %	-100 % negative current limit for field direction 2
		p50500[0]=52193	Excitation current setpoint after limiting
p50580[0]=BOxxx	Source for the command "Direction of rotation reversal by reversing the field" From software version 1.2 and higher		
p50581[0]=BOxxx	Source for the command "Braking by reversing the field" From software version 1.2 and higher		
		p50601[2]=52134	Deviating from Point 4.3, here, set the factory setting value 52134
		p50433[0]=52601	Excitation current setpoint from the armature unit
		p50671[0]=52607.2	BO53195.1 from the armature unit, Enable negative direction of rotation
		p50672[0]=52607.1	BO53195.0 from the armature unit, Enable positive direction of rotation
		p50694[0]=52607.2	BO53195.1 from the armature unit, Changeover torque limits
p51117[1]=53195.0	Select field torque direction 1		
p51117[2]=53195.1	Select field torque direction 2		
		p50609[0]=52403	actual speed value from p50403
		p50403[0]=3	3 % for r52403
		p505370[0]=5	n<nmin threshold at 5 %
		p50272=1	prevents F60043

5 Commissioning, optimization runs

5.1 Version 1: Field supply with internal setpoint

- Set the parameters according to the list from Point 4.1
- Carry-out an optimization run for the precontrol and current controller (p50051=25)
Refer to the SINAMICS DCM operating instructions, Chapter 8, for the procedure

5.2 Version 2: Field supply with external setpoint

The same procedure as for Point 5.1

5.3 Version 3: Armature supply + field supply

Set the parameters according to the list from Point 4.3

When carrying out the automatic optimization runs, the following sequence should be observed:

Field supply unit

Procedure:

- Initiate the optimization run for precontrol and current controller, i.e. set **p50051=25**
- Enter the "Switch-on" and "Operating enable" commands
- Wait until the optimization run has been completed
- Optimally set p50179, for the calculation, see Chapter 6
- Check the settings of the automatic optimization run, when required, subsequently optimize by evaluating the step response – or by recording the control loop parameters using an oscilloscope or the trace monitor.

Armature supply unit

Procedure:

- **p50082=0** Set for the duration of the optimization run p50051=25
- Ensure that the field control unit cannot be switched-on by opening X177.12
- **p50051=25** Carry-out an optimization run for the precontrol and current controller (armature).
- Reset p50082 to the original value.
- Switch-on the field unit again
- **P051=26, 27, 28** When required, carry out the optimization runs for the speed controller, field weakening and friction or moment of inertia compensation (see SINAMICS DCM operating instructions, Chapter 8)
- Check the settings of the automatic optimization runs, when required, subsequently optimize by evaluating the step response – or by recording the control loop parameters using an oscilloscope or the trace monitor.
- Additional settings depending on the particular requirement, commissioning the technological process.

6 Setting the additional Alpha W pulses

For highly inductive loads, in spite of the fact that the Alpha W firing angle has been set (full counter voltage to reduce the current in the inductance), a certain time is required until the current has been completely reduced down to zero. Especially for 4Q operation it is necessary that the current is zero and that the active thyristor reliably blocks before a torque direction change is made (firing the anti-parallel bridge circuit to reverse the current). If the anti-parallel thyristor bridge is fired before the previous one is reliably blocked, then a circulating current flows and the appropriate fuses blow.

As a result of the low inductance, for motor operation, it is sufficient if the zero current signal is present (the zero current signal is 1% of the actual rated unit current: \bar{U} parameter r50072[1]) to inhibit the pulses and after a short delay time, to enable the opposite torque direction.

Motor/generator fields or lifting solenoids often have inductance values of 10 H or higher. This means that after the zero current signal is present, a certain number of additional Alpha W pulses must be issued (the number can be set using parameter p50179) until the current is zero.

It is absolutely necessary to make a theoretical check using the appropriate calculations. This is especially necessary in order to take into account a line supply undervoltage that may exist – or for rated unit currents >60 A - the resolution of the current actual value sensing referred to the thyristor holding current (approximately 100 mA).

Calculation example:

$$V = L \times \Delta i / \Delta t;$$
$$\Delta t = L \times \Delta i / V$$

V = DC output voltage of the SINAMICS DCM for a line supply undervoltage threshold and Alpha W:

$$V = p50078[0] \times (1 + p50351 / 100) \times 1.35 \times \cos(\text{Alpha W})$$

$$\Delta i = 1 \% \text{ of the actual rated unit current } r50072[1]$$

From the zero current signal (1 % of r50072[1]), the additional Alpha W pulses are output.

Δt = minimum time for Alpha W pulses,

$$1 \text{ pulse} = 3.33 \text{ ms for } 50 \text{ Hz, or } 2.78 \text{ ms for } 60 \text{ Hz}$$

Example:

L = 1 H, p5078[0] = 400 V (rated line supply voltage);

V = p50078[0] × (1 + p50351/100) × 1.35 × cos (Alpha W) ... for three-phase operation

V = p50078[0] × (1 + p50351/100) × 0.9 × cos (Alpha W) ... for single-phase operation

p50351 = -30 % (undervoltage threshold line supply), $\Delta i = r50072[1] \times 0.01$

r50072[1] = 1200 A (actual rated unit current), Alpha W = 150 degrees (p50151)

$$\Delta t = 1 \times 12 / [400 \times (1 + (-30) / 100) \times 1.35 \times 0.866] = 0.037 \text{ s}$$

Minimum number of additional Alpha W pulses at 50 Hz = 37 ms / 3.33 ms = 12

20 % allowance = 12 × 1.2 = 14.4 → set p50179 = 14.

The value of the field circuit resistance R and the field circuit inductance L can be taken from the SINAMICS DCM parameters after the current controller optimization run.

p50110 = field circuit resistance in Ω

p50111 = field circuit inductance in mH

7 Overvoltage protection

7.1 General information

WARNING

Overvoltage protection is absolutely necessary for this application, as, for example, for a three-phase voltage failure, the thyristors could be blocked and an overvoltage could occur as a result of the energy contained in the field (switching-off an inductance). This overvoltage can destroy the thyristors in the SINAMICS DCM unit.

Therefore, the overvoltage protection has the task to limit the voltage to a defined value and to dissipate the energy in the field.

The following protective circuits are available

- SIOV metal oxide varistors (for low field currents)
- Thyristor modules

NOTICE

Metal oxide varistors (SIOV, MOV, ZnO, ...) are designed to discharge high pulse energies in extremely short times. The energy that is discharged is converted into heat, stored in the varistor assembly and then slowly dissipated to the environment through the surface of the device. As a result of the poor thermal conductivity and the higher temperature sensitivity under overload conditions, metal oxide varistors can only be used with some significant restrictions for the high energy levels and the long time constants that occur when dissipating the energy in the field circuit. (When thermally overloaded, the varistor limit voltage permanently decreases. If this frequently occurs, then the varistor could be destroyed as there is a potential danger that the voltage limit could drop down to the range of the operating voltage.)

Further, a damping resistor R_s should be used to dampen overvoltages, which can occur due to the pulsating current being interrupted, oscillations or when the protection thyristor holding current is fallen below.

Maximum voltage limit to dimension the overvoltage protection

Maximum permissible voltage limit – dependent on the motor field winding and the rated supply voltage of the converter. The lower value should be selected.

For Siemens motors, maximum voltage limit = 2000 V

Rated line supply voltage for the SINAMICS DCM converter at 1U1, 1V1, 1W1	DC voltage limit
3-ph. 400 V AC	1350 V
3-ph. 480 V AC, 3-ph. 575 V AC	1550 V
3-ph. 690 V AC	1700 V
3-ph. 830 V AC	2100 V
3-ph. 950 V AC	2500 V

Magnetic energy content of the field winding to dimension the overvoltage protection.

For Siemens motors, the energy content can be taken from Chapter 7.5. If the energy content is not known, then the field winding inductance is required to calculate it.

$$W = L \times I_{exc}^2 / 2 \quad R_{exc} = V_{exc} / I_{exc} \quad L = 2 \times W / I_{exc}^2$$

W Magnetic energy content in Watt seconds

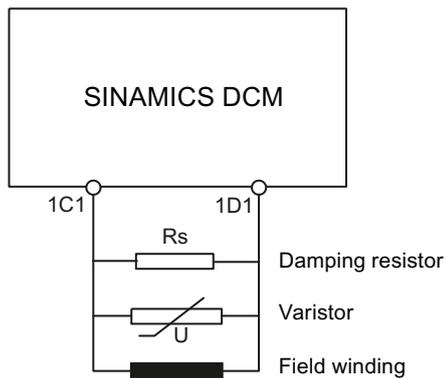
L Inductance of the field winding in Henry

I_{exc} Rated excitation current in amps (refer to the motor rating plate)

R_{exc} Excitation winding resistance in Ohm

V_{exc} Rated excitation voltage in volts (refer to the motor rating plate)

7.2 Protection using varistors



Metal oxide varistors for low energy content of the field winding:

Manufacturer Epcos company (www.epcos.com)

Up to 420 V rated line supply voltage (for 400 V SINAMICS DCM)

up to 400 Ws: Varistor SIOV-B32K460

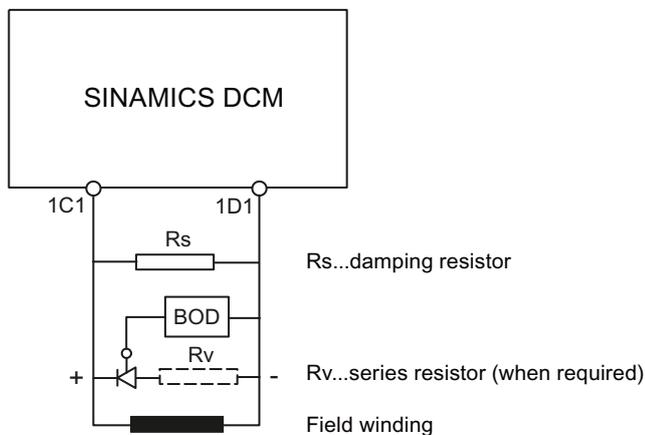
up to 2000 Ws: Varistor SIOV-B80K460

Up to 500 V rated line supply voltage (for 480 V and 575 V SINAMICS DCM)

up to 400 Ws: Varistor SIOV-B32K550

up to 2000 Ws: Varistor SIOV-B80K550

7.3 Protection using a thyristor protection module



Thyristor protection modules that can be supplied from Siemens:

The following thyristor protection modules are used for fields with an energy content >2000 Ws and field currents up to approx. 2000 A.

Up to 420 V rated line supply voltage (for 400 V SINAMICS DCM)

Order number

E89110-F2439-L1 for field currents up to approx. 400 A (suitable for both current directions, 4Q)

7VV3003-5BG32 *) for field currents > 400 A (suitable for both current directions)

Up to 500 V rated line supply voltage (for 480 V and 575 V SINAMICS DCM)

Order number

E89110-B2350-L1 for field currents up to approx. 500 A (suitable for a current direction 2Q, for 4Q use two in an anti-parallel connection).

7VV3003-5CG32 *) for field currents > 500 A (suitable for both current directions)

*) → Operating instructions 7VV3003 (<http://support.automation.siemens.com/WW/view/en/17635427/133300>)

Resistors R_S and R_V are not included in the scope of delivery of the thyristor protection modules.

They are only suitable for providing protection in the case of a fault. When an overvoltage occurs, the thyristor is fired by a BOD element (break-over diode) and it remains conductive until the field energy has been dissipated and the thyristor holding current has been fallen below. In order to prevent the field unit supplying the fired thyristor when the line supply returns, the automatic SINAMICS DCM restart function should be deactivated (set p50086=0).

The following values are required to dimension the protection circuit:

- The highest load current that flows in operation
- Time constant τ of the free-wheeling circuit

$$\tau = \frac{L}{R}$$

L Inductance of the motor field winding [H]

R Total resistance of the field winding + feeder cables + series resistance (when required) [Ω]

τ Time constant [s]

The magnitude of the current and the time for which the current flows together determine the thermal load of the protective thyristor. The permissible currents as a function of the time constant and notes on dimensioning a series resistance can be taken from the operating instructions for the E89110 overvoltage protection module.

The appropriate documents can be requested from:

Siemens ERL F98
I IS MS EDM ERL

Frauenauracherstrasse 98
D 91056 Erlangen

Telephone: +49 (0)9131 18 82329
Fax: +49 (0)9131 18 80604

7.4 Damping resistor R_S

Dimensioning for a B6C connection:

$$R_S [\Omega] \leq \frac{1.35 \times U_L [V]}{0.5 [A]}$$

$$P_V [W] = 2 \dots 3 \times \frac{U_{FN}^2 [V]}{R_S [\Omega]}$$

U_L Line-to-line voltage at the three-phase connection of the converter

P_V Power loss of R_S

U_{FN} Rated field voltage

7.5 Magnetic field energy for Siemens motors

Average values of the magnetic field energy [Ws] when fully excited and with forced ventilation:

1GF. ... 1GG. ... 1GH. ...	Ws	1GF. ... 1GG. ... 1GH. ...	Ws	1GF. ... 1GG. ... 1GH. ...	Ws	1GF. ... 1GG. ... 1GH. ...	Ws	1GF. ... 1GG. ... 1GH. ...	Ws
...5 102	3.5	...5 112	5.5	...5 132	21	...5 162	45	...6 162	115
...5 104	5	...5 114	8.5	...5 134	30	...5 164	60	...6 164	150
...5 106	7	...5 116	12	...5 136	35	...5 166	75	...6 166	190
...5 108	10								

1GG. ... 1GH. ...	Ws								
...5 182	100	...6 186	185	...5 252	340	...6 256	540	...5 312	730
...5 184	125	...6 188	220	...5 254	430	...6 258	690	...5 314	910
...5 202	140	...6 206	250	...5 282	480	...6 256	780	...5 352	980
...5 204	170	...6 208	300	...5 284	600	...6 258	950	...5 354	1190
...5 222	220	...6 226	360						
...5 224	280	...6 228	450						

1GG. ... 1GH. ...	Ws								
...7 351	850	...7 401	1400	...5 402	1220	...7 451	1350	...5 500	1260
...7 352	960	...7 402	1650	...5 404	1500	...7 452	1650	...5 501	1740
...7 353	1200	...7 403	1850	...5 406	1700	...7 453	2000	...5 502	2060
...7 354	1380	...7 404	2200			...7 454	2400	...5 503	2480
...7 355	1710	...7 405	2700			...7 455	3100	...5 504	3070
								...5 631	2740
								...5 632	3430
								...5 633	4140
								...5 634	4680
								...5 635	5890

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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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