

SINAMICS DCM

DC converters from 6 kW to 2500 kW for
variable-speed direct-current drives

Application to improve the operational performance
of DC motors in low-load operation by regulating the
armature current to a minimum value

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SINAMICS drives

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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 Instructions

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 Introduction

Current is supplied to the armature of a DC motor by means of carbon brushes on the commutator. However, the carbon brushes do not begin to work satisfactorily until the current density on the brush reaches a specific minimum limit. The continuous current of the motor should be higher than 50 % of motor rated current.

On drives with power reserves, the brush current density can fail to reach this minimum value, resulting in increased brush wear and, in some cases, commutator scoring.

While it is possible to adjust the brush current density by reducing the number of brushes or using brush material which performs better under low-load conditions, modifications of this kind limit the capacity utilization of the machine.

This application describes how it is possible to regulate the continuous current of the armature to a minimum value by reducing the field current.

EMF-dependent field-weakening control is completely compatible with this solution.

3 Formal relationship

The counter-torque of the drive requires the application of a specific motor torque.

The motor torque is governed by the following formal relationship:

$$M = k \times \Phi \times I_A$$

M = motor torque

k = machine constant

Φ = motor flux

I_A = armature current

In order to increase the armature current with the same torque, the flux can now be reduced. This is achieved by decreasing the field current.

The armature current of the motor is regulated to a minimum value by means of the technology controller (available as of software V1.2) and free function blocks in SINAMICS DCM.

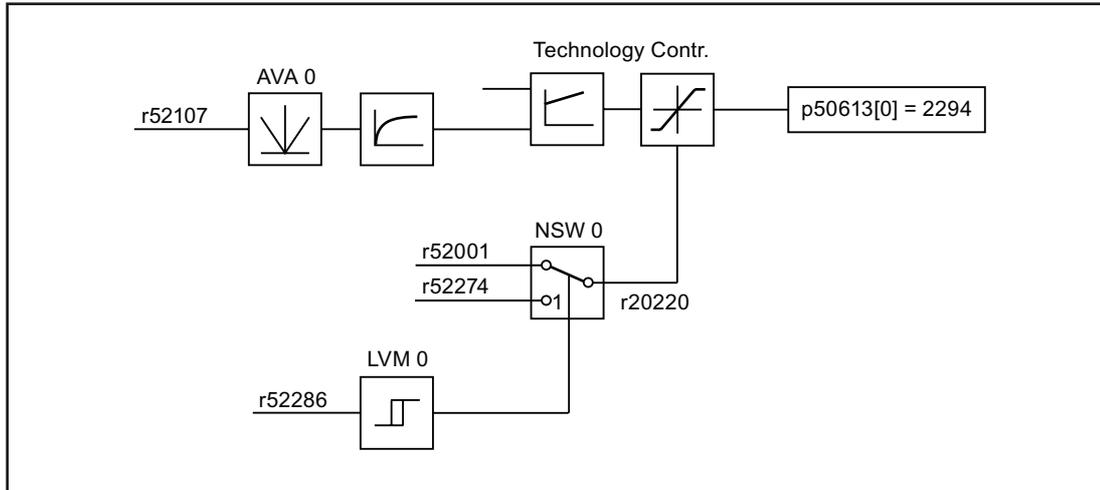
4 Implementation in the closed-loop control

The actual armature current value referred to the motor rated current (connector r52107) is compared to a setpoint (required minimum value of armature current) by means of the technology controller (List Manual, Chapter 2, Page 7958). If the setpoint is higher than the actual value, the technology controller output is reduced from 100 % down to zero. The value is now applied to the upper field current setpoint limit at p50613[0] and reduces the field current, causing the armature current to increase.

The EMF is scanned by a limit monitor. The lower limit of the technology controller is switched over by means of a changeover switch in such a way that the minimum current closed-loop control does not become operative until the actual EMF value reaches more than 30 % of its rated value.

Version 1.2 or higher of the drive software must be installed, see parameter r50060[6].

5 Block diagram of the closed-loop control



6 Parameter settings

Selection of technology controller and free function blocks

Parameter	Meaning
	These parameters are in DO1, can also be set with BOP20
p003 = 3	Expert
p009 = 2	Definition of drive type / function module
p108[1]	Bit 16 Technology controller Bit 18 Free function blocks Bit 31 Profinet 00050000 Hex: Bit 16 + bit 18; 80050000 Hex: Bit 16 + bit 18 + bit 31
p009 = 0	This setting re-initializes the device
	The following parameters are in DO2
p20000[0] = 8	Runtime group 0 is computed in an 8 ms cycle

Settings for the field current setpoint

Parameter	Meaning
p50102[0] = xxx	Rated current of motor field acc. to motor rating plate
p50103[0] = yyy	Setting of the minimum field current according to motor rating plate (or as stated in Operating Instructions) If no value is stated on the rating plate, set to approximately 50 % of p50102

Absolute-value generator AVA 0 for actual motor current

Parameter	Meaning
p20128 = 52107	Connects the measured motor current to the input of AVA 0
p20131 = 0	Runtime group 0 for absolute-value generator AVA 0
p20132 = 1000	Run sequence for AVA 0

Technology controller (DO2, r108.16 = 1) for limitation of field current setpoint

Parameter	Meaning
p2264[0] = 52401	The fixed value from p50401, r52401 (armature current setpoint) is applied to the actual-value input of the technology controller
p2254[0] = 20129	The absolute actual armature current value from AVA 0 is applied to the setpoint input of the technology controller
p2280 = 0.5	Proportional gain value of the technology controller, optimize according to plant conditions
p2285 = 1.5	Integral time of the technology controller, optimize according to plant conditions
p2200 = 00001	Set technology controller enable signal permanently to High
p2298[0] = 20220	The output of the free changeover switch NSW 0 is applied to the negative limit of the technology controller. 100% is operative when EMF < 30 %. When EMF > 30 %, the minimum field current setpoint is operative as a negative limit.
p50401 = 60.0	Enter 60 % (applied to r52401) as the armature current setpoint (guide value 50 % to 100 %)
p50613[0] = 2294	The technology controller output is applied to the upper field current setpoint limit
p2257 = 0.00	Ramp-up time of ramp-function generator for the setpoint input = 0
p2258 = 0.00	Ramp-down time of ramp-function generator for the setpoint input = 0
p2261 = 0.5	Filter time for the setpoint input is 0.5 s

Limit monitor LVM 0 for scanning the actual EMF value

Parameter	Meaning
p20266 = 52286	The absolute value of the measured EMF at the input of LVM 0
p20267 = 0.0	LVM 0 average interval value M
p20268 = 0.22	22 % LVM 0 interval limit L Value L = $p50101 \times 0.96 \times 0.30 / (1.35 \times p50078[0])$ The armature current is not regulated to a minimum value until actual EMF exceeds 30 % of rated value
p20269 = 0.05	5 % LVM 0 hysteresis HY
p20273 = 0	Runtime group 0 for LVM 0
p20274 = 1010	Run sequence for LVM 0

Changeover switch NSW 0 for switching over the limit of the technology controller

Parameter	Meaning
p20218[0] = 52001	Connects the value 100 % with X0 of NSW 0
p20218[1] = 52274	Connects the minimum field current setpoint limit with X1 of NSW 0
p20219 = 20270	Configures r20270 (output above the interval of LVM 0) as "actuate changeover switch"
p20221 = 0	Runtime group 0 for NSW 0
p20222 = 1020	Run sequence for NSW 0

7 Commissioning

1. Commission the SINAMICS DCM as described in chapter 8 of the Operating Instructions, including field characteristic initialization p50051 = 27
2. Set technology parameters
3. Set parameters above and test minimum armature current control, optimize the above PI controller again if necessary.

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Disclaimer of Liability

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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