

SIMOREG DC-MASTER

6RA70 Series

Application

Improving the performance of DC motors during low-load operation by adopting a form of control that ensures a minimum armature current

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SIEMENS

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Application Examples

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Notes

Note

This application documentation does not purport to handle or take into account all of the equipment details or versions or to cover every conceivable operating situation or application.

If you require more detailed information, or if special problems occur, which are not handled in enough detail in this document, please contact your local Siemens office.

The contents of this application documentation are not part of an earlier or existing agreement or legal contract and neither do they change it. The actual purchase contract represents the complete liability of the A&D Variable-Speed Drives Group I DT LD of Siemens AG. The warranty conditions, specified in the contract between the two parties, form the only warranty which will be accepted by the A&D Variable-Speed

I DT LD Drives Group. The warranty conditions specified in the contract are neither expanded nor changed by the information provided in this application documentation.



WARNING

These converters contain hazardous electrical voltages and control rotating mechanical components (drives). Death, serious bodily injury or substantial damage to property will occur if the instructions in the relevant operating manuals are not observed.

Only qualified personnel who are thoroughly familiar with all safety notices contained in the operating instructions as well as erection, operating and maintenance instructions must be allowed to work on these devices.

Successful and safe operation of this equipment is dependent on careful transportation, proper storage and installation as well as correct operation and maintenance.

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1. Introduction

With DC motors, power is supplied to the armature via carbon brushes which make contact with the commutator.

However, a specific brush current density is required before the carbon brushes are able to function effectively. The motor's continuous current should be more than 50% of the rated motor current.

In the case of drives that have power reserves, this minimum brush current density can sometimes be undershot.

This results in increased brush wear and can lead to a certain amount of threading on the commutator.

Although it is possible to adapt the brush current density by reducing the number of brushes or by using a brush material that is better suited to low loads, these kinds of changes mean that the machine cannot be utilized to the full.

This application describes how the field current can be reduced in order to create a form of control that results in a minimum armature continuous current.

This does not impose any restrictions in terms of using a EMF-dependent form of field weakening control.

2. Formal correlation

The system's counter torque means that a specific motor torque needs to be applied.

The following formal correlation applies in respect of the motor torque:

$$M = k * \Phi * IA$$

M: Motor torque

k: Machine constant

Φ : Motor flux

IA: Armature current

To increase the armature current while keeping the torque the same, the flux can be reduced. This is achieved by reducing the field current.

The control method for ensuring a minimum motor armature current relies on the use of closed-loop PI controllers which form part of the Option S00 (free function blocks) available on the 6RA70.

3. Implementation in the control

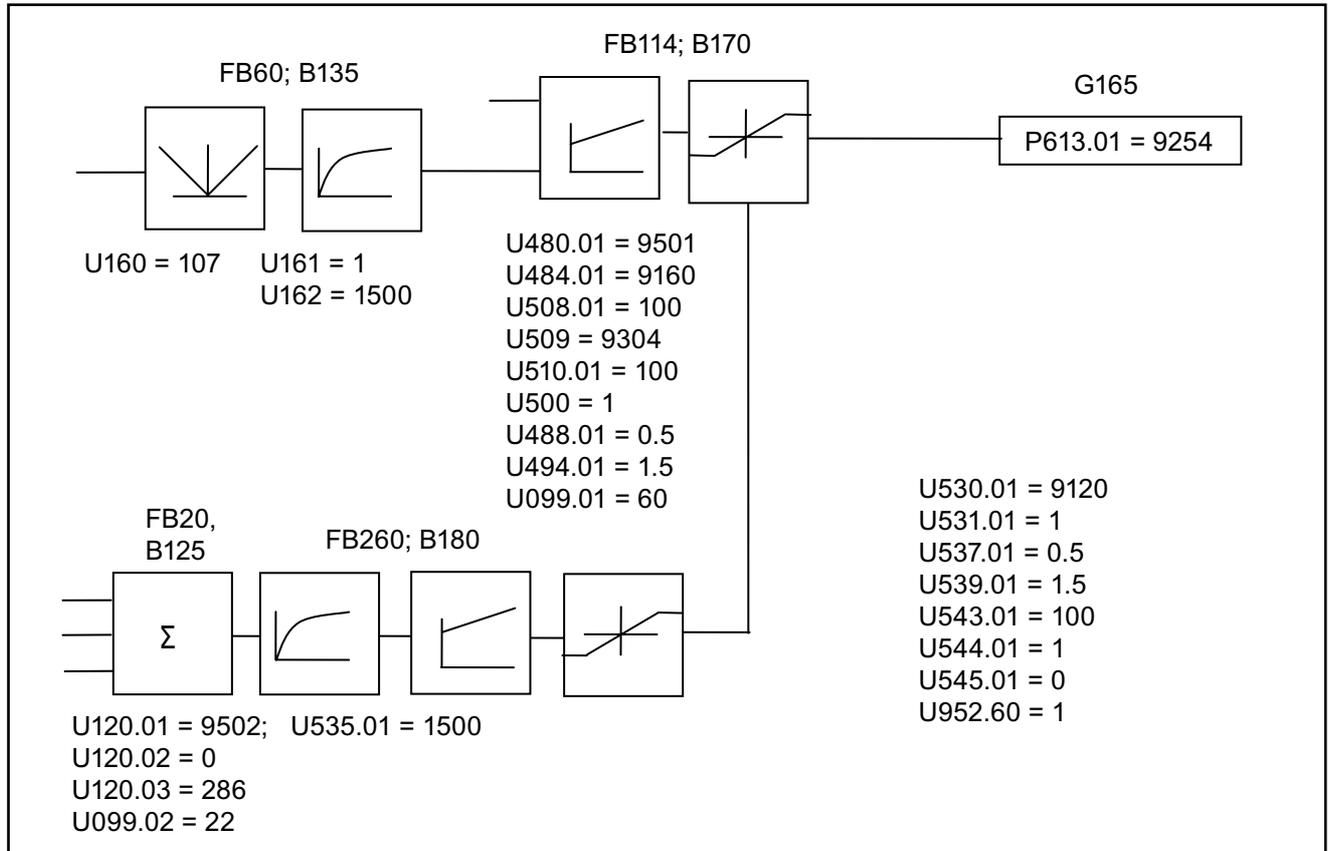
Using the FB114 technology controller (function block 114 of the free software modules), the armature current actual value, which is expressed in relation to the rated motor current (connector K0107) is compared with a setpoint (desired minimum value for the armature current). If the setpoint is greater than the actual value, the technology controller output will be weakened, starting from 100% and heading towards zero. This value will then be active on the upper field current setpoint limit at P613.01, thereby reducing the field current and increasing the armature current.

Using the FB260 closed-loop PI controller, the motor's EMF actual value is compared with a setpoint (30% of the rated source voltage). The closed-loop PI controller output affects the technology controller's negative output limitation in such a way as to ensure that the field current reduction involving the technology controller only takes effect when the motor EMF exceeds 30% of the rated value.

Control block diagram

FBxxx: Function block xxx of the free software modules

Byyy: Sheet Byyy of the function block diagrams (Chapter 8 of the Operating Instructions)



4. Parameter settings

Settings for the field current setpoint

Parameter	Significance
P102.01 = xxx	Motor field rated current in accordance with motor name plate
P103.01 = yyy	Minimum field current setting in accordance with motor name plate (or in accordance with operating instructions). If this information is not specified on the name plate, set approx. 50% of P102.

Absolute value generator FB60 for the motor current actual value

Parameter	Significance
U160 = 107	The motor current actual value (connector K0107) is connected to absolute value generator FB60
U161 = 1	FB60 generates the absolute value from input K0107
U162 = 1500	The filter time set here for the PT1 element is active at the absolute value generator's output. Set the same time as used for the integral time of technology controller U494.01. Please note that the value of U494 is in seconds and the value of U162 is in milliseconds.

Technology controller FB114 for field current setpoint limitation

Parameter	Significance
U480.01 = 9501	The fixed value from U099.01, K9501 (armature current setpoint) is connected to the actual value input of technology controller FB114
U484.01 = 9160	Once filtered, the absolute armature current actual value from FB60 is connected to the setpoint input of technology controller FB114
U488.01 = 0.5	Optimize the technology controller KP value in accordance with the system conditions.
U494.01 = 1.5	Optimize the technology controller TN in accordance with the system conditions
U500 = 1	Set the technology controller enable permanently to H
U509 = 9304	The output of closed-loop PI controller 1 FB260 is connected to the technology controller's negative output limitation (Limitation effective in accordance with motor EMF)
U099.01 = 60	Specify 60% (active on K9501) as the armature current setpoint (Guide value: 50% to 100%)
P613.01 = 9254	The technology controller output affects the field current setpoint limitation

Closed-loop PI controller 1 used for source-voltage-dependent negative limitation of the technology controller

Parameter	Significance
U120.01 = 9502	The fixed value from U099.02, K9502 (setpoint for motor source voltage) is connected to the + input of summatior FB20
U120.02 = 0	0% applied to 2nd + input of FB20
U120.03 = 286	The motor absolute EMF value is connected to the minus input of FB20 for the purpose of generating the set/actual difference
U099.02 = 22	22% fixed value (active on K9502) defined as setpoint for the motor source voltage Value $U099.02 = P101 * 0.96 * 30\% / (1.35 * P78.01)$ The control function for ensuring a minimum armature current is only activated with a EMF of 30% or higher %
U530.01 = 9120	The FB20 output is connected to the input of closed-loop PI controller FB260
U531.01 = 1	Set enable of closed-loop PI controller 1 permanently to H
U537.01 = 0.5	Optimize the KP of closed-loop PI controller 1 in accordance with the system conditions
U539.01 = 1.5	Optimize the TN of closed-loop PI controller 1 in accordance with the system conditions
U535.01 = 1500	The filter time set here for the PT1 element is active at the input of closed-loop PI controller 1. Set the same time as used for the integral time of closed-loop PI controller U539.01. Please note that the value of U539 is in seconds and the value of U535 is in milliseconds.
U543.01 = 100	Set 100% as the positive output limitation for closed-loop PI controller 1
U544.01 = 1	100% effective at multiplier for the negative limitation of closed-loop PI controller 1%
U545.01 = xxx	Negative limitation: Set the value $U545.01 = P103.01 * 100 / r073.02$

Sampling time of the free blocks

Parameter	Significance
U950.20 = 1	FB20 is calculated in time slice 1
U950.60 = 1	FB60 is calculated in time slice 1
U951.14 = 1	FB114 is calculated in time slice 1
U952.60 = 1	FB260 is calculated in time slice 1

5. Commissioning

- 1 Commission the SIMOREG in accordance with Section 7.5 of the Operating Instructions; this should include a field characteristic test (P051 = 27)
- 2 Set the technological parameters
- 3 Set the parameters above and test the minimum armature current control; if necessary, optimize the closed-loop PI controller referred to above

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