SINAMICS DCM

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

Load-balanced control application

Edition 01 - 12/2010

SINAMICS drives

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SINAMICS DCM
Load-balanced control application

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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Table of contents

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 Description

2.1 Requirement

Free function blocks in the software are used for the implementation of the load-balanced control.

The free function blocks and the technology controller must be selected in drive 1. In drive 2 it is sufficient to select only the free function blocks.

The application requires software version V1.2 or higher.

More complex applications can be implemented with DCC.

2.2 Applicability

This application document deals with the interaction between two drives that are mechanically coupled by webs of material, and for which load balancing is necessary.

This is particularly applicable to, e.g., S-rollers or upper/lower motors in roll stands.

The prerequisites for this are that the drive motors are constructed in the same way and that the roller diameters do not deviate from one another by more than ±10%.

2.3 Function

The actual torque values of the two drives are connected to the setpoint and actual value input of the technology controller. A PI controller (preferable for S-rollers) or an I controller (preferable for upper/lower motors) uses the resulting difference between the torques to form a speed correction value (implemented via the technology controller). The polarities for this are opposite in each of the two drives, i.e., the correction value is added for one drive and subtracted for the other, and vice versa. This enables both drives to achieve the same torque.

It should be noted that the effect of the compensation setpoint on both drives leads to deviation from the speed setpoint. If you do not wish this to happen, the effect of the compensation setpoint on drive 1 can be switched off. This means that drive 1 will always run rigidly at the speed setpoint, and load control only takes place due to the effect on drive 2.

If a static load offset ΔM between the two drives is required, this is achieved by adding an adjustable value to the torque difference.

For "Drive" operating mode, the following applies:

If ΔM is positive, the torque of drive 1 increases,

If ΔM is negative, the torque of drive 2 increases.

For "Brake" operating mode, the following applies:

If ΔM is positive, the torque of drive 2 increases,

If ΔM is negative, the torque of drive 1 increases.

In practice it has been shown that the PI/I controller should not intervene by more than 5%. When setting the integration time, it should be noted that this is at least four times as long as the longest integral time of the secondary speed controller. The peer-to-peer network is responsible for connecting the necessary signals between drive 1 and drive 2.

Calculation of the maximum speed adjustment for drive 1 and drive 2 from the path velocity:

The formal relationship between path velocity and motor speed is:

$v = n \times D$, thus:

$n_{max} = v_{max} \times 60 \times i \times 1000 / (D \times \pi)$

v_{max} = maximum path velocity in m/s at 100% speed setpoint

i = Gear ratio: Motor speed/load speed

D = Roller diameter in mm

π = 3,1416

n_{max} = Maximum speed (100% actual value) in revolutions per minute
Setting for incremental encoder in p2000, for analog tacho in p50741 (tacho voltage at n_{max}), for tacho-free operation in p50115

Recalculate if v_{max} or D ⇒ n_{max} changes.

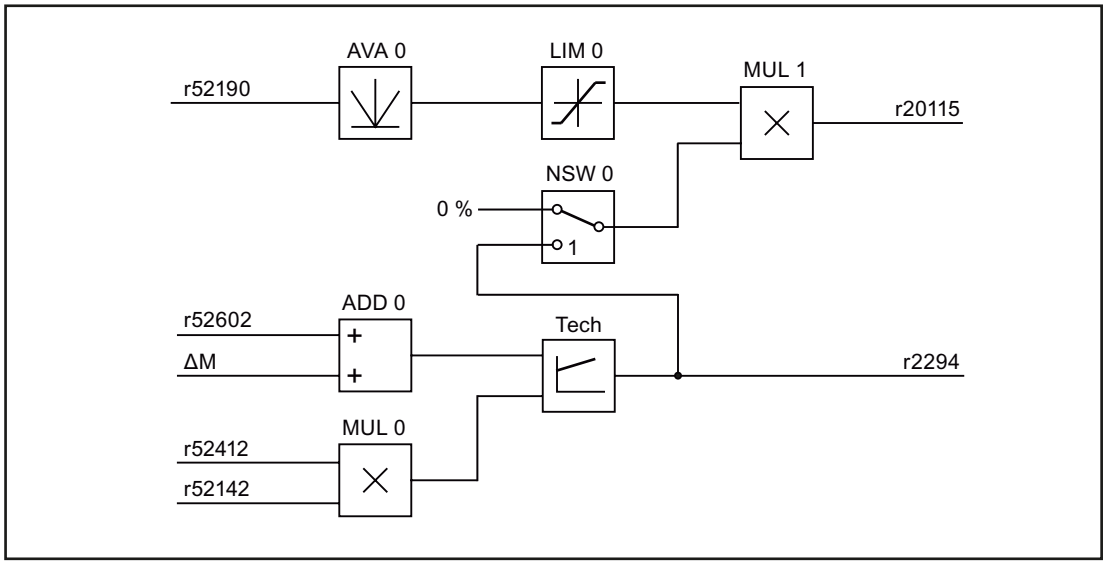
Note

If, in the event of a drive failing, you wish the other one to take on the entire load, you may not use fault bits to lock the drives against one another.

The prerequisite for this is that the dimensioning of each drive (according to its performance) also permits this.

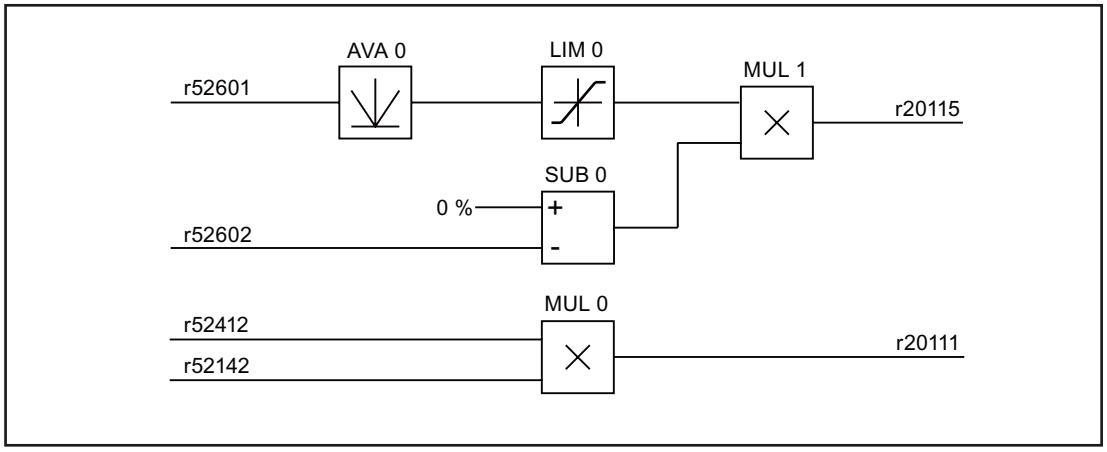
2.4 Block diagram

Load-balanced control, drive 1



r52190 Speed setpoint of drive 1 behind ramp-function generator
r52602 Diameter evaluated actual torque value of drive 2 via peer-to-peer word 2
ΔM Load offset, r52401, set value in p50401[0] in %
r52412 Diameter evaluation, actual torque value, drive 1 (setting in p50412[0])
r52142 Actual torque value, drive 1
Tech Technology controller
r2294 Output, load-balanced controller (technology controller)
r20115 Value of load-balanced control as additional speed setpoint of drive 1

Load-balanced control, drive 2



r52601 Speed setpoint behind ramp-function generator of drive 1 via peer-to-peer word 1
r52602 Technology controller output, drive 1 via peer-to-peer word 2
r52412 Diameter evaluation (setting in p50412[0]) for actual torque value, drive 2
r52142 Actual torque value, drive 2
r20111 Actual torque value, drive 2, diameter evaluated
r20115 Value of load-balanced control as additional speed setpoint of drive 2
SUB 0 Subtracter 0 works as an inverter

3 Parameter list

Note

The parameter settings specified in the following table only refer to the functions shown in the block diagrams.

Other necessary settings, such as selection of the actual speed value source, the type of control (torque, current control), jogging, etc., must be made by the user in accordance with the Operating Instructions.

Drive 1		**Drive 2**	
Selection of technology controller and free function blocks		**Selection of free function blocks**	
These parameters are also possible in DO1, setting with the BOP 20		These parameters are also possible in DO1, setting with the BOP 20	
p003=3	Expert	p003 = 3	Expert
p009=2	Defining the drive type/function module	p009 = 2	Defining the drive type/function module
p108[1]	Bit 16: Technology controller Bit 18: Free function blocks Bit 31: Profinet Bit 16+Bit 18=00050000 Hex Bit 16+Bit 18+Bit 31=80050000 Hex	p108[1]	Bit 18: Free function blocks Bit 31: Profinet Bit 18=00040000 Hex Bit 18+Bit 31=80040000 Hex
p009=0	The device is now reinitialized	p009=0	The device is now reinitialized
The following parameters are in DO2		The following parameters are in DO2	
p20000[0]=8	Runtime group 0 is counted in 8 ms	p20000[0]=8	Runtime group 0 is counted in 8 ms
Peer-to-peer communication		**Peer-to-peer communication**	
p50790=5	Peer-to-peer communication	p50790=5	Peer-to-peer communication
p50791=2	Quantity of process data	p50791=2	Quantity of process data
p50793=9	56700 baud (recommended)	p50793=9	56700 baud (recommended)
p50794[0]=52190	Speed setpoint behind ramp-function generator	p50794[0]=0	Free
p50794[1]=2294	Output, load-balanced controller (= output, technology controller)	p50794[1]=20111	Actual torque value, diameter evaluated, drive 2
p50795=1	Bus terminating resistor ON	p50795=1	Bus terminating resistor ON
p50797=2	Message frame downtime 2 s	p50797=2	Message frame downtime 2 s
Speed setpoint		**Speed setpoint**	
p50634[0]=52190	Speed setpoint, ramp-function generator output, drive 1	p50634[0]=52601	Speed setpoint, ramp-function generator output, drive 1 via peer-to-peer word 1
p50634[1]=20115	Value of load-balanced control as additional speed setpoint of drive 1	p50634[1]=20115	Value of load-balanced control as additional speed setpoint of drive 2
Absolute value generator AVA 0		**Absolute value generator AVA 0**	
p20128=52190	Ramp-function generator output as AVA 0 input	p20128=52601	Word 1 of peer-to-peer as AVA 0 input (speed setpoint behind ramp-function generator of drive 1)
p20131=0	Runtime group 0 for AVA 0	p20131=0	Runtime group 0 for AVA 0
p20132=1030	Run sequence AVA 0	p20132=1030	Run sequence AVA 0

Drive 1		Drive 2	
Limiter LIM 0		**Limiter LIM 0**	
p20228=20129	Output of AVA 0 as input of LIM 0	p20228=20129	Output of AVA 0 as input of LIM 0
p20229=100.0	Upper limit 100%	p20229=100.0	Upper limit 100%
p20230=1.0	Lower limit 1%, can be set higher if required	p20230=1.0	Lower limit 1%, can be set higher if required
p20234=0	Runtime group 0 for LIM 0	p20234=0	Runtime group 0 for LIM 0
p20235=1040	Run sequence LIM 0	p20235=1040	Run sequence LIM 0
Multiplier MUL 1		**Multiplier MUL 1**	
p20114[0]=20231	Output LIM 0 as input X0 of MUL 1	p20114[0]=20231	Output LIM 0 as input X0 of MUL 1
p20114[1]=20220	Output NSW 0 as input X1 of MUL 1	p20114[1]=20103	Output SUB 0 as input X1 of MUL 1
p20114[2]=1	100% as X2 of MUL 1	p20114[2]=1	100% as X2 of MUL 1
p20114[3]=1	100% as X3 of MUL 1	p20114[3]=1	100% as X3 of MUL 1
p20116=0	Runtime group 0 for MUL 1	p20116=0	Runtime group 0 for MUL 1
p20117=1050	Run sequence for MUL 1	p20117=1050	Run sequence for MUL 1
Multiplier MUL 0		**Multiplier MUL 0**	
p20110[0]=52412	X0 as diameter evaluation of the actual torque value, drive 1 (setting in p50412[0])	p20110[0]=52412	X0 as diameter evaluation of the actual torque value, drive 2 (setting in p50412[0])
p20110[1]=52142	Actual torque value, drive 1, X1 MUL 0	p20110[1]=52142	Actual torque value, drive 2, X1 MUL 0
p20110[2]=1	100% as X2 on MUL 0	p20110[2]=1	100% as X2 on MUL 0
p20110[3]=1	100% as X3 on MUL 0	p20110[3]=1	100% as X3 on MUL 0
p20112=0	Runtime group 0 for MUL 0	p20112=0	Runtime group 0 for MUL 0
p20113=1000	Run sequence for MUL 0	p20113=1000	Run sequence for MUL 0
p50412[0]=xx	Diameter evaluation of the actual torque value, drive 1	p50412[0]=xx	Diameter evaluation of the actual torque value, drive 2
xx = (diameter, roller, drive 1 + diameter, roller, drive 2) / (2×diameter, roller, drive 1)		xx = (diameter, roller, drive 1 + diameter, roller, drive 2) / (2×diameter, roller, drive 2)	
Change-over switch NSW 0		**Subtracter SUB 0 as an inverter**	
p20218[0]=0	0% on input X0 of NSW 0	p20102[0]=0	0% as X1 of SUB 0
p20218[1]=2294	Output of load-balanced controller on X1 of NSW 0	p20102[1]=52602	Word 2 of peer-to-peer as X2 of SUB 0 (output of technology controller/load-balanced controller)
p20219	= 0 load-balanced controller affects only drive 2 = 1 load-balanced controller affects drives 1+2	p20104=0	Runtime group 0 for SUB 0
p20221=0	Runtime group 0 for NSW 0	p20105=1010	Run sequence SUB 0
p20222=1020	Run sequence NSW 0		

Drive 1		Drive 2	
Adder ADD 0			
p20094[0]=52602	Word 2 peer-to-peer diameter evaluated actual torque value of drive 2 as X0 on ADD 0		
p20094[1]=52401	(p50401[0] value adjustable) ΔM as X1		
p20094[2]=0 p20094[3]=0	0% on X2 and X3		
p20096=0	Runtime group 0 for ADD 0		
p20097=1010	Run sequence for ADD 0		
p50401[0]=xx	Value of load offset ΔM in %		
Technology controller as load-balanced controller			
p02253[0]=20095	Output ADD 0 as technology controller setpoint		
p02257=0	Ramp-up time setpoint = 0		
p02258=0	Ramp-down time setpoint = 0		
p02264[0]=20111	Output MUL 0 as technology controller actual value		
p02280=0.1	KP technology controller, optimize according to system conditions		
p02285=1 s	TN technology controller, optimize according to system conditions		
p02291=5.0	5.0% upper limit, technology controller		
p02292=-5.0	-5.0% lower limit, technology controller		
p02200[0]= 53010.00	Technology controller enable via terminal X177.11		

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