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SIMOREG DC-MASTER

6RA70 range
Converter units from 6 kW to 2,500 kW
for variable-speed DC drives

Load-balanced control application

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6RA70 range Load-balanced control application

Application Examples

6RA70 range

Converter units from 6 kW to 2,500 kW for variable-speed DC drives

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Safety Guidelines

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 device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

 WARNING
This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

Trademarks

All names identified by ® are registered trademarks of the Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

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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Warnings and information

Warnings



WARNING

Dangerous electrical voltages Rotating mechanical parts

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

Only qualified personnel, who are familiar with all the safety information contained in the Operating Instructions, as well as the assembly, operating and maintenance instructions, should carry out work on these units.

Perfect, safe and reliable operation of the units assumes that they have been professionally transported, stored, mounted, and installed, and have been carefully operated and maintained.

Notes

Note

No claim to completeness

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.

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

Note

The contents of this document are not part of contracts, agreements or legal relationships; warranty

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 A&D Variable-Speed Drives Division of SIEMENS AG.

Note

Warranty

The warranty specified in the contract between the parties is the only warranty accepted by the A&D Variable-Speed Drives Division. Any statements contained herein neither create new warranties nor modify the existing warranty.

SIMOREG® is a Siemens trademark.

Description

2.1 Prerequisite

To implement load-balanced control, blocks from technology software S00 are required.

S00 must be enabled in both units, which will be referred to in the following as "Drive 1" and "Drive 2".

The application requires software version **v1.9** or higher.

2.2 Field of application

This 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 subtracted. 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 compensation value. The polarities for this are opposite in each of the two drives, i.e., the compensation 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 reference variable. 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 reference variable, 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.

Entering a reference diameter (nominal roller diameter) and the actual diameter enables automatic compensation of the torque and speed differences that occur when, for example, rollers are exchanged for those with different diameters.

An adjustable skip frequency band can be used to ensure that the load-balanced controller is only activated via a particular 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.

The web velocity setpoint is guided to the ramp function integrator of drive 1 and then distributed across both drives. A velocity/speed calculator computes the correct setpoint of the motor speeds in each drive, using the web velocity setpoint in m/s, the current diameter of the rollers in mm, the transmission ratio, and the rated speed of the motor in rpm.

Note

Measuring the motor speed

The motor speed should be measured in such a way that the rated motor speed at the minimum diameter will not be exceeded when the basic speed setpoint and the additional speed setpoint are added. This ensures that the total setpoint for the speed controller does not exceed 100%.

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 intervention also tracks the web velocity setpoint, i.e., the level of intervention increases linearly with the web velocity.

A peer-to-peer network is responsible for connecting the necessary signals between drive 1 and drive 2.

For safety purposes, limit values for the maximum and minimum diameters can be specified. The plausibility of the diameter entered is checked and an error message output if the limits are exceeded.

Note

Failure of a drive

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

2.4 Block diagram

2.4.1 Load-balanced control, drive 1

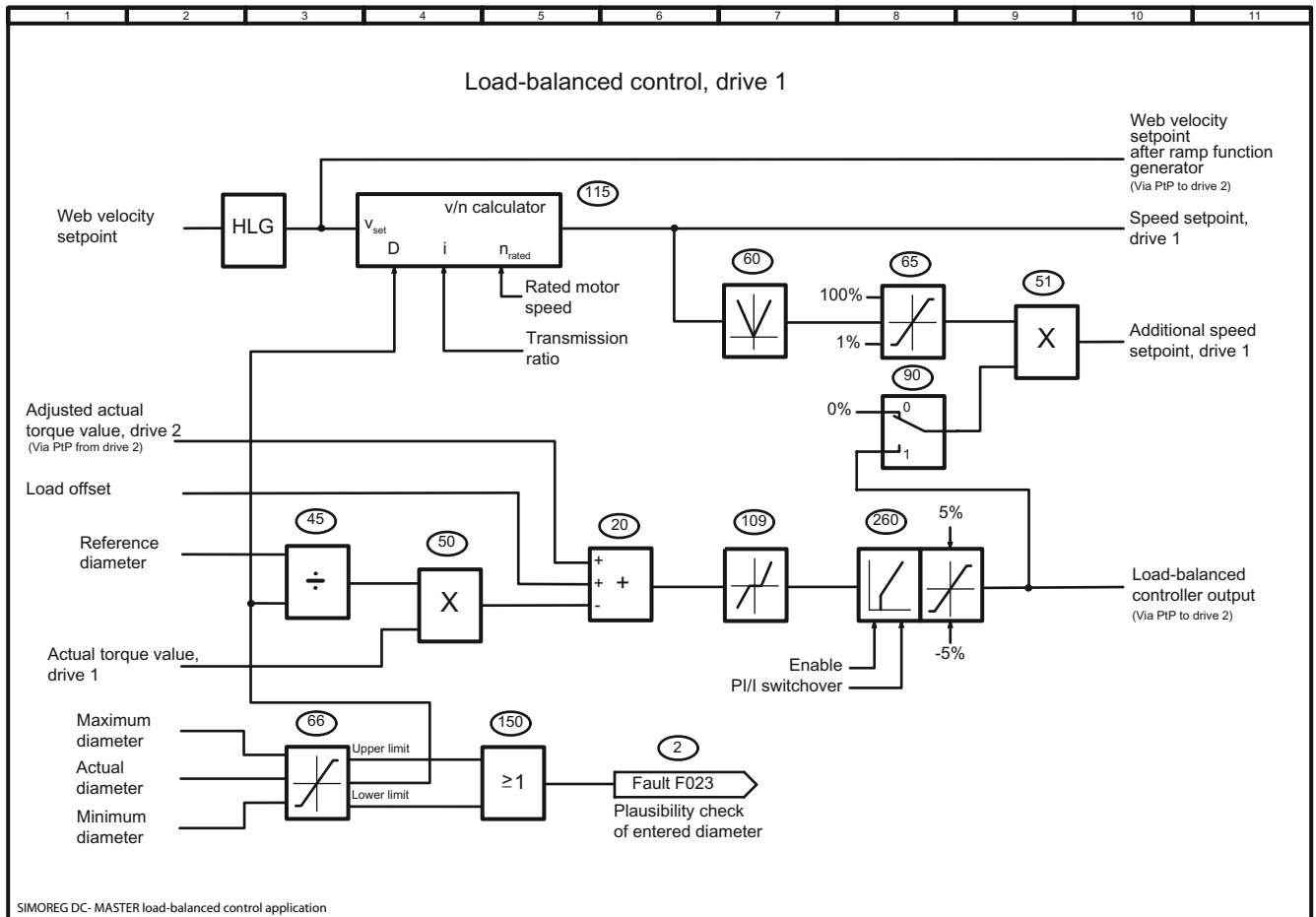


Figure 2-1 Load-balanced control, drive 1

2.4.2 Load-balanced control, drive 2

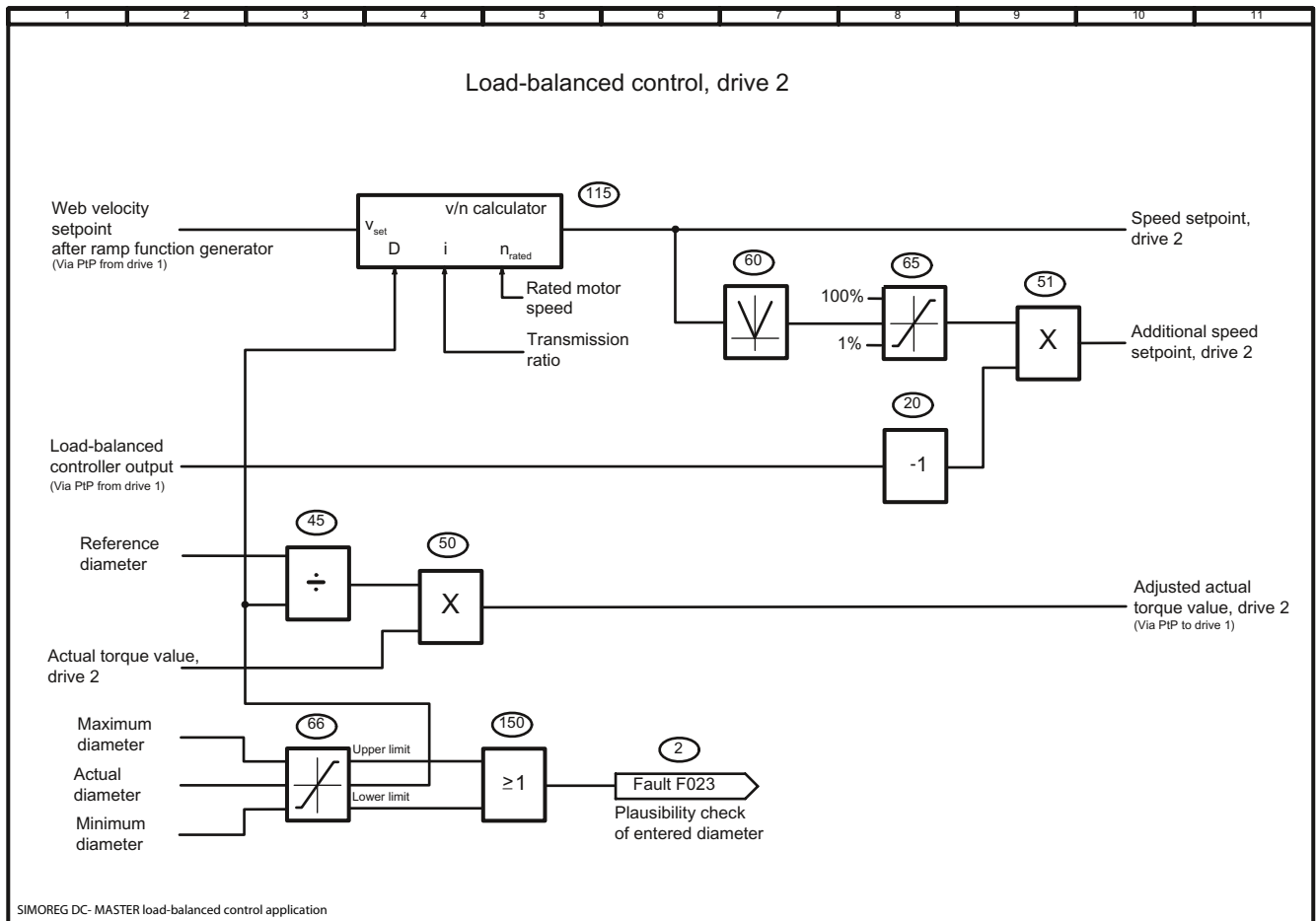


Figure 2-2 Load-balanced control, drive 2

Parameter list

Note

Applying the parameters

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
P412=xxxx Enter the actual diameter in mm.	P412=xxxx Enter the actual diameter in mm.
P413=xxxx Reference diameter in mm. Notice! P413 must be the same for drive 1 and 2.	P413=xxxx Reference diameter in mm. Notice! P413 must be the same for drive 1 and 2.
P414=xxxx Enter the largest permissible roller diameter in mm.	P414=xxxx Enter the largest permissible roller diameter in mm.
P415=xxxx Enter the smallest permissible roller diameter in mm.	P415=xxxx Enter the smallest permissible roller diameter in mm.
P634.01=K9257 Speed setpoint, drive 1	P634.01=K9257 Speed setpoint, drive 1
P634.02=K9151 Additional speed setpoint after ramp function generator	P634.02=K9151 Additional speed setpoint after ramp function generator
P790=5 Peer-to-peer communication	P790=5 Peer-to-peer communication
P791=4 Number of process data	P791=4 Number of process data
P793=9 56,700 baud (recommended)	P793=9 56,700 baud (recommended)
P794.01=K0030 Control word 1	P794.01=K0032 Status word 1
P794.02=K0190 Web velocity setpoint after ramp function generator	P794.02=K0000 Free
P794.03=K9304 Load-balanced controller output	P794.03=K9150 Adjusted actual torque value, drive 1
P794.04=K0031 Control word 2	P794.04=K0033 Status word 2
P795=1 Bus terminating resistor "ON"	P795=1 Bus terminating resistor "ON"
P797=2 Telegram failure time: 2 s	P797=2 Telegram failure time: 2 s
U100=B9380 F023 resolution if diameter entry implausible	U100=B9380 F023 resolution if diameter entry implausible
U120.01=K6003 Adjusted actual torque value, drive 2	
U120.02=xxxx Source for load offset entry	
U120.03=K9150 Adjusted actual torque value, drive 1	
	U135=K6003 Load-balanced controller output
U145.01=K0413 Reference diameter	U145.01=K0413 Reference diameter
U145.02=K9170 Limited actual diameter, drive 1	U145.02=K9170 Limited actual diameter, drive 2

Parameter list

Drive 1	Drive 2
U150.01=K9145 Divider no. 45 output	U150.01=K9145 Divider no. 45 output
U150.02=K0142 Actual torque value, drive 2	U150.02=K0142 Actual torque value, drive 1
U151.01=K9167 Limiter no. 65 output	U151.01=K9167 Limiter no. 65 output
U151.02=K9210 Change-over switch no. 90 output	U151.02=K9135 Sign inversion no. 35 output
U160=K9257 Speed setpoint, drive 2	U160=K9257 Speed setpoint, drive 1
U161=1 Absolute-value generation	U161=1 Absolute-value generation
U175.01=K9160 Absolute-value generator no. 60 output	U175.01=K9160 Absolute-value generator no. 60 output
U175.02=K0001 Upper limit for evaluating the load-balanced controller output	U175.02=K0001 Upper limit for evaluating the load-balanced controller output
U175.03=K9165 Lower limit for evaluating the load-balanced controller output	U175.03=K9165 Lower limit for evaluating the load-balanced controller output
U176.01=1% Lower limit, can be set higher if required	U176.01=1% Lower limit, can be set higher if required
U177.01=K0412 Actual roller diameter	U177.01=K0412 Actual roller diameter
U177.02=K0414 Largest permissible roller diameter	U177.02=K0414 Largest permissible roller diameter
U177.03=K0415 Smallest permissible roller diameter	U177.03=K0415 Smallest permissible roller diameter
U290=K9120 Torque difference between drive 1 and drive 2	
U240.01=K0000 0%	
U240.02=K9304 Load-balanced controller output	
U241=0 or 1 0.....Switch off load-balanced controller on drive 2 only 1.....Switch off load-balanced controller on drive 1 and drive 2	
U291=0 Enter a dead zone (z) for the torque difference, if required.	
U516=K0190 Ramp generator output	U516=K6002 Ramp generator output
U517=K9170 Actual diameter, limited, in mm	U517=K9170 Actual diameter, limited, in mm
U518=10 Set to smallest possible value	U518=10 Set to smallest possible value
U519=xxxx Transmission ratio	U519=xxxx Transmission ratio
U520=xxxx Rated speed Notice! With pulse encoder, set to same value as P143. With analog encoder, enter the speed that corresponds to the tacho voltage (according to P741).	U520=xxxx Rated speed Notice! With pulse encoder, set to same value as P143. With analog encoder, enter the speed that corresponds to the tacho voltage (according to P741).
U522=xxxx Maximum web velocity in m/s, corresponds exactly to P516.	U522=xxxx Maximum web velocity in m/s, corresponds exactly to P516.
U523=16384 If the diameters are entered in mm/10 due to better resolution, U523 should be set to 1638.	U523=16384 If the diameters are entered in mm/10 due to better resolution, U523 should be set to 1638.
U530.01=K9232 Load-balanced controller input	
U531.01=xxxx Enable/disable source for the load-balanced controller signal.	
U537.01=0.1 kp for load-balanced controller must be optimized during commissioning	
U539.01=1s Tn for load-balanced controller must be optimized during commissioning	

Drive 1	Drive 2
U540.01=1 If the load-balanced controller is to be operated purely as an I controller, set P540.01 to "0".	
U543.01=5% Output limitation of the load-balanced controller.	
U350.01=K9152 Diameter at upper limit	U350.01=K9152 Diameter at upper limit
U350.02=K9153 Diameter at lower limit	U350.02=K9153 Diameter at lower limit

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A

Appendix

A.1 List of freely available function blocks (block number)

Block	Drive 1	Drive 2
Fault trigger	2	2
Adder/subtractor	20	
Sign reversal		35
Divider	45	45
Multiplier	50, 51	50, 51
Absolute-value generator with filtering	60	60
Limiter	65, 66	65, 66
Dead zone	109	
v/n calculator	115	115
PI controller	260	
OR	150	150

Free function blocks used

A.2 List of fixed values used (the same for both drives)

Parameter	Function
P412	Enter the actual diameter
P413	Enter the reference diameter
P414	Enter the maximum diameter
P415	Enter the minimum diameter

Fixed values used

A.3 Recommended order of execution

Drive 1: 115, 60, 65,45, 50, 20, 109, 260, 51, 66, 150, 2

Drive 2: 115, 60, 65, 35, 51, 45, 50, 66, 150, 2

A.4 Notes on downloading parameters

The DriveMonitor download files for drive 1 and 2 should only be downloaded following commissioning, according to the Operating Instructions.

After transferring the download files, parameter U969 must be set manually to 4 for both drives. This ensures that the non-wired function blocks will be deselected and the wired ones selected (activated), as long as they have not been selected prior to this.

A.5 Detailed block diagrams

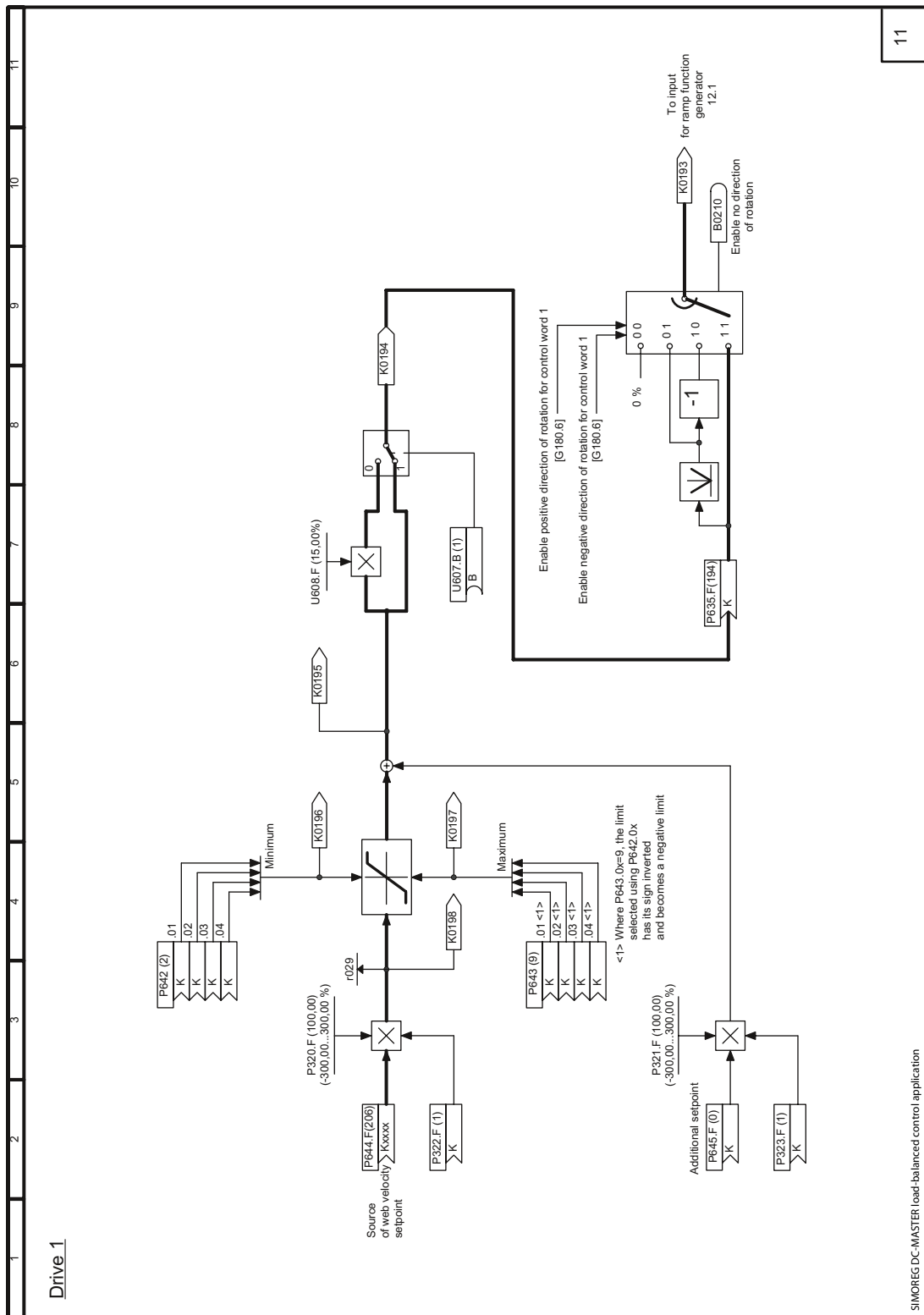


Figure A-1 Drive 1 - Sheet 1 (11)

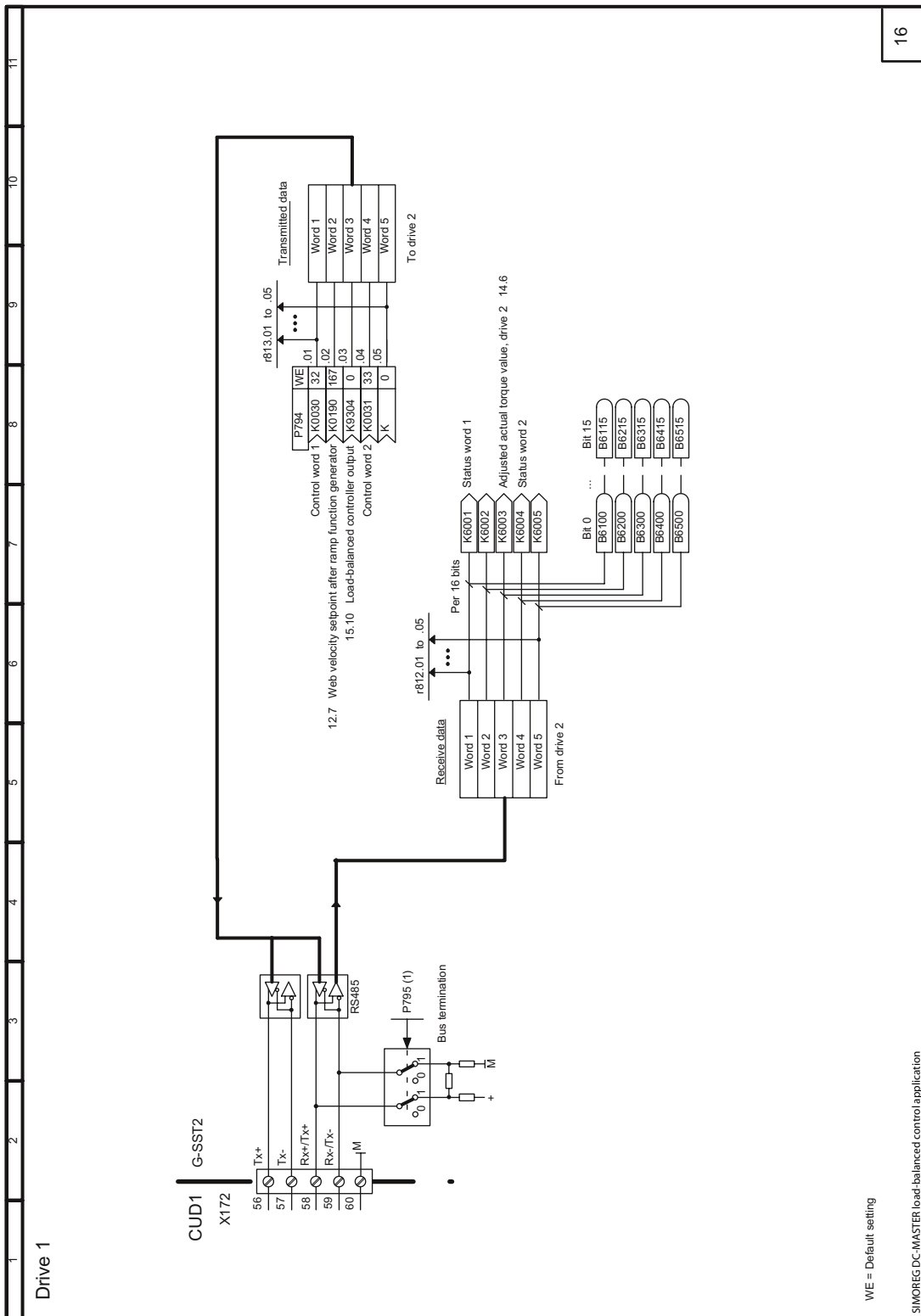


Figure A-6 Drive 1 - Sheet 6 (16)

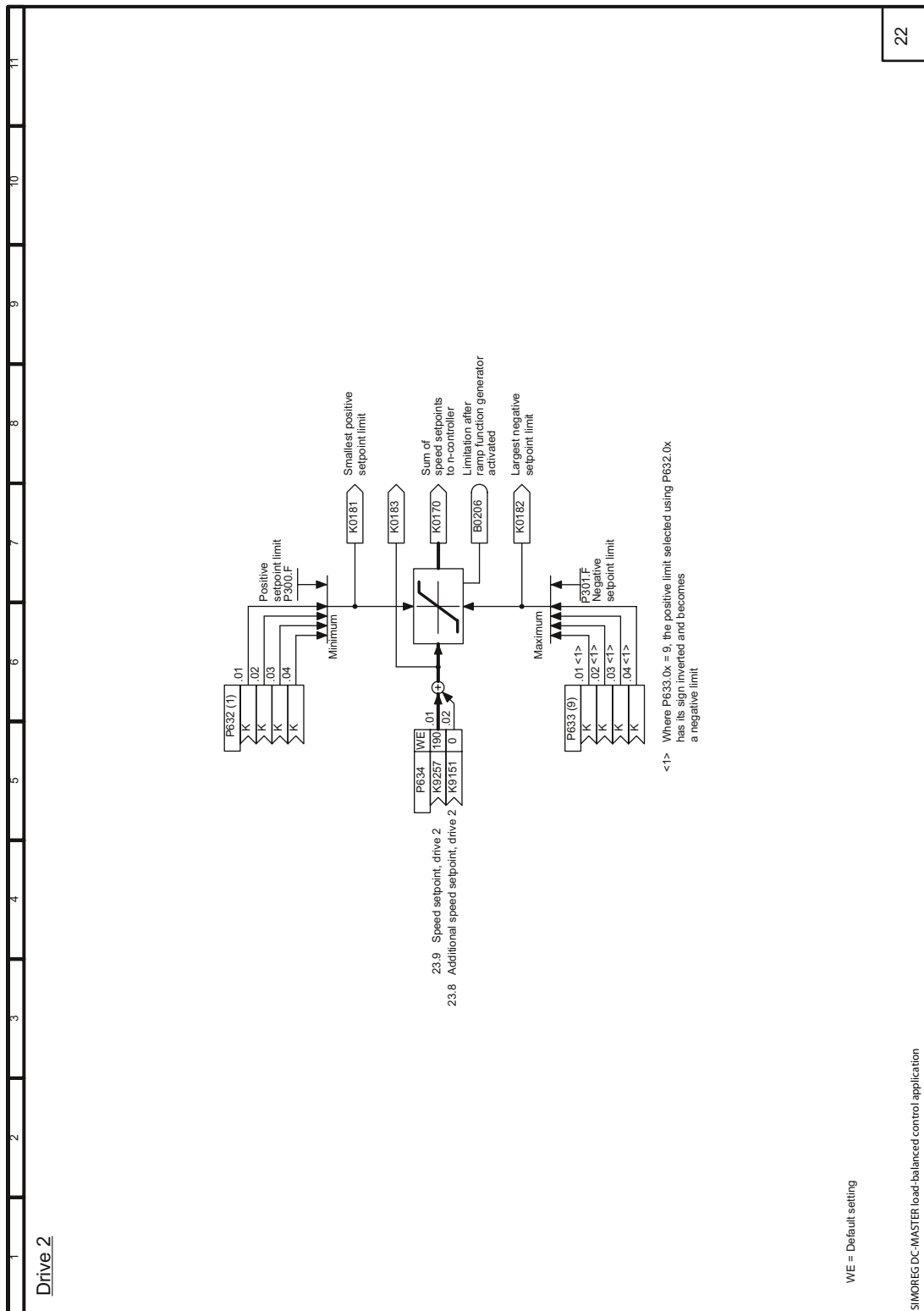


Figure A-7 Drive 2 - Sheet 2 (22)

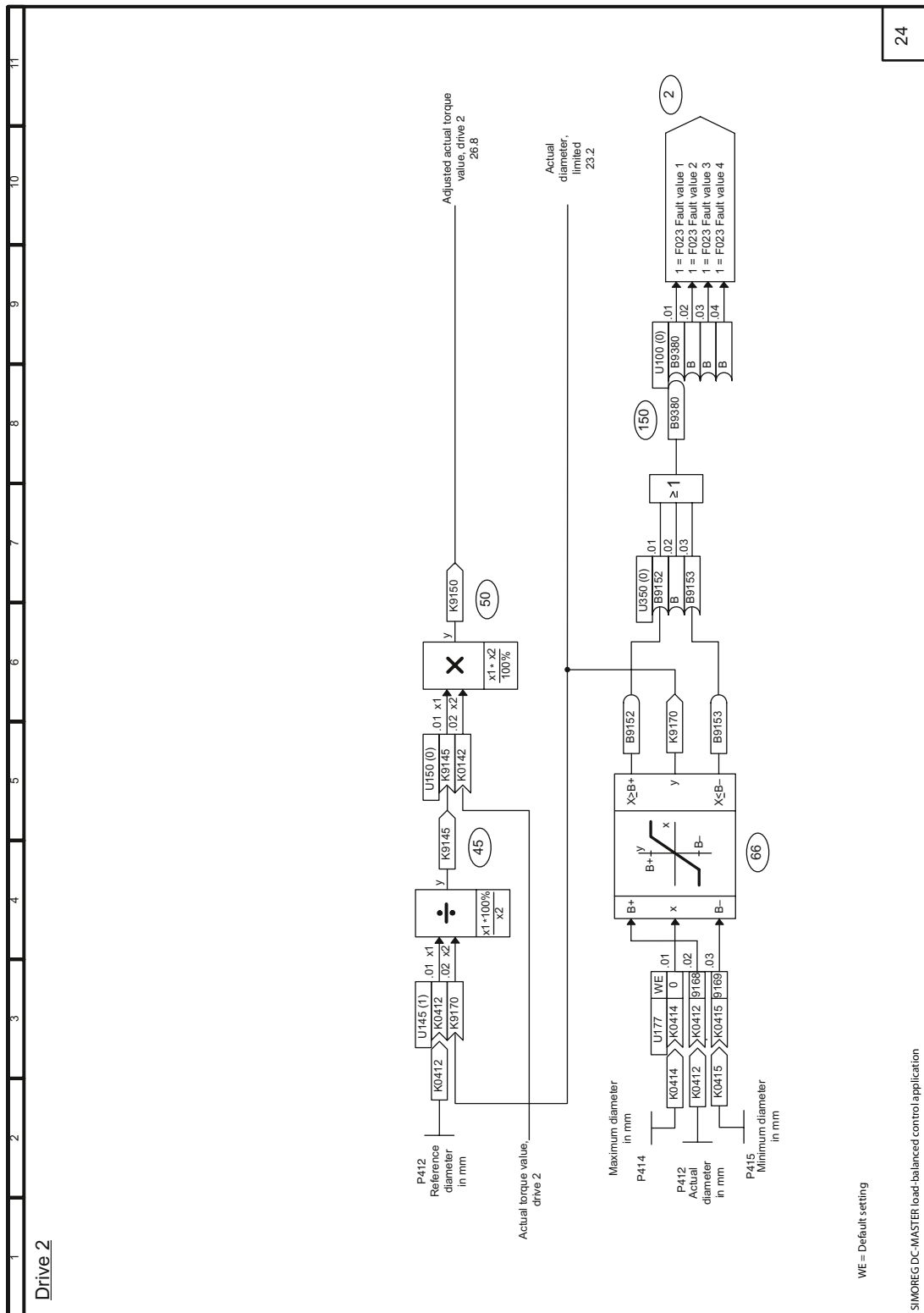


Figure A-9 Drive 2 - Sheet 4 (24)

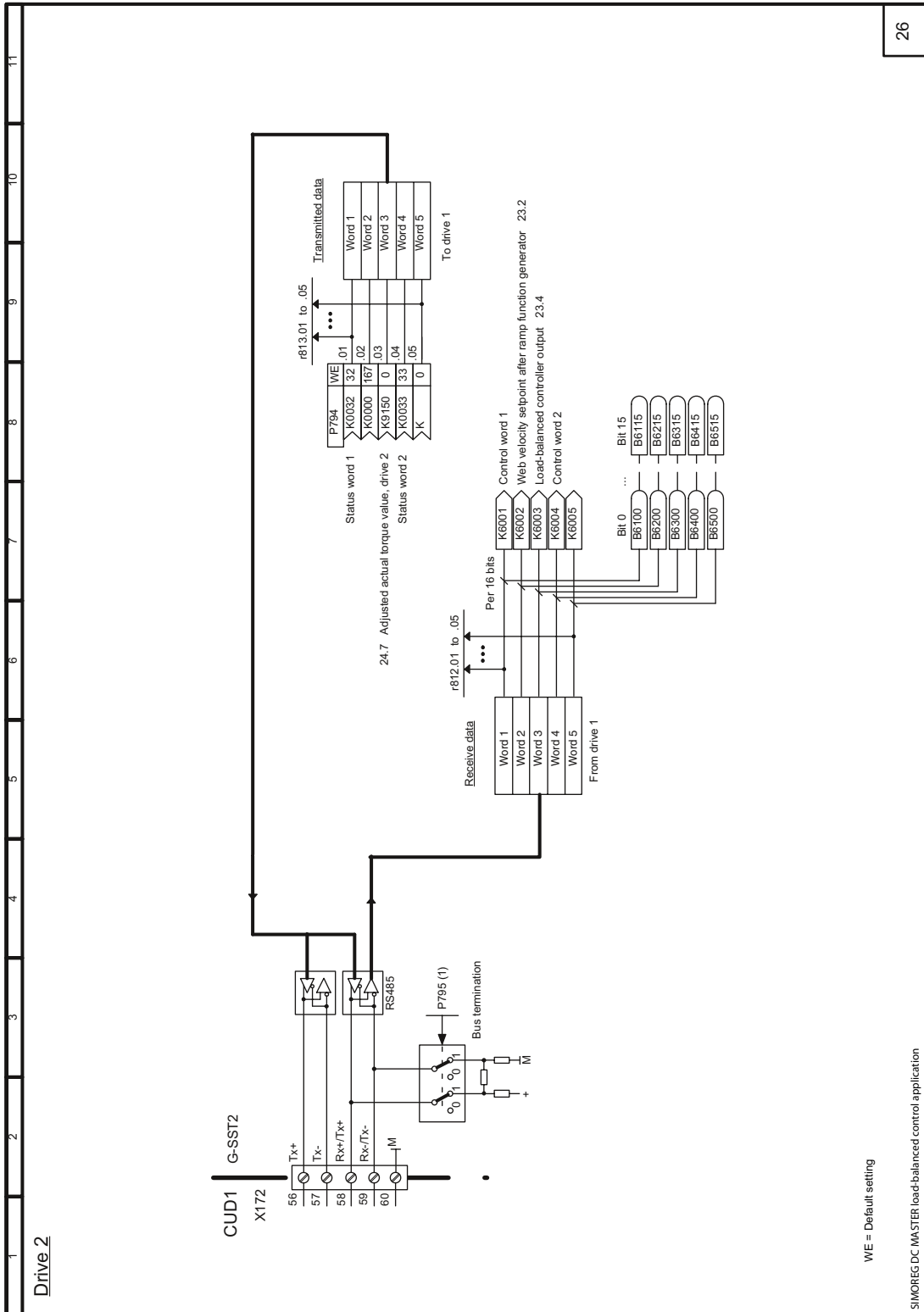


Figure A-10 Drive 2 - Sheet 6 (26)

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