

SIMOREG DC Master

Application
Master/Slave Switchover

6RA70 Series

Microprocessor-Based Converters from 6kW to 1900kW
for Variable-Speed DC Drives



NOTE

These application do 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.

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**WARNING**

These converters contain hazardous voltages, hazardous rotating machinery (fans) and control rotating mechanical components (drives). Death, serious bodily injury or substantial property damage may 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, installation, operating and maintenance instructions should be allowed to work on these devices.

The 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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We have checked that the contents of this publication agree with the hardware and software described herein. Nonetheless, differences might exist and therefore we cannot guarantee that they are completely identical. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. Suggestions for improvement are welcome at all times.

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1 Field of Application

This Guide describes the interaction between two or more SIMOREG DC Master converters for different technological applications.

1.1 Current control

- ◆ For two or more coupled machines operating in the armature range
- ◆ Including switchover between master and slave drives

1.2 Torque control

- ◆ For two or more coupled machines whose normal duty includes operation in the field-weakening range
- ◆ Including switchover between master and slave drives

1.3 Droop

- ◆ For two or more machines which are not coupled, but connected to the same load and master setpoint

CAUTION

- ◆ The information in this Guide always refers to the "Torque control" application since this also includes "Current control", and operation in torque control mode is possible without field weakening. The "Current control" application differs from "Torque control" in one respect only, i.e. that the field range of the motor (field weakening) is not utilized and the motor torque stays proportional to the armature current over the entire speed range. The requisite parameter modifications (P169, P170) can be found in the operating manual.
- ◆ Always adjust master and slaves to the same speeds!
- ◆ External interlocks must be implemented to ensure that the controllers on the slaves and relevant master drive are always enabled simultaneously, i.e. the series-connected auxiliary contacts of the main contactors must not activate terminal X171.38 on the master drive until all main contactors have picked up.
- ◆ The following applications are intended for installations operating on software version 1.9 and later. With software version 1.9 or earlier, option S00 would have to be activated to gain access to a free multiplier to match different motor-converter combinations. If all the motor-converter combinations are the same, option S00 need not be activated and the applications can be used in conjunction with earlier SW versions.

2 Master/Slave Drive with Rigidly Coupled Motors

2.1 Field of application

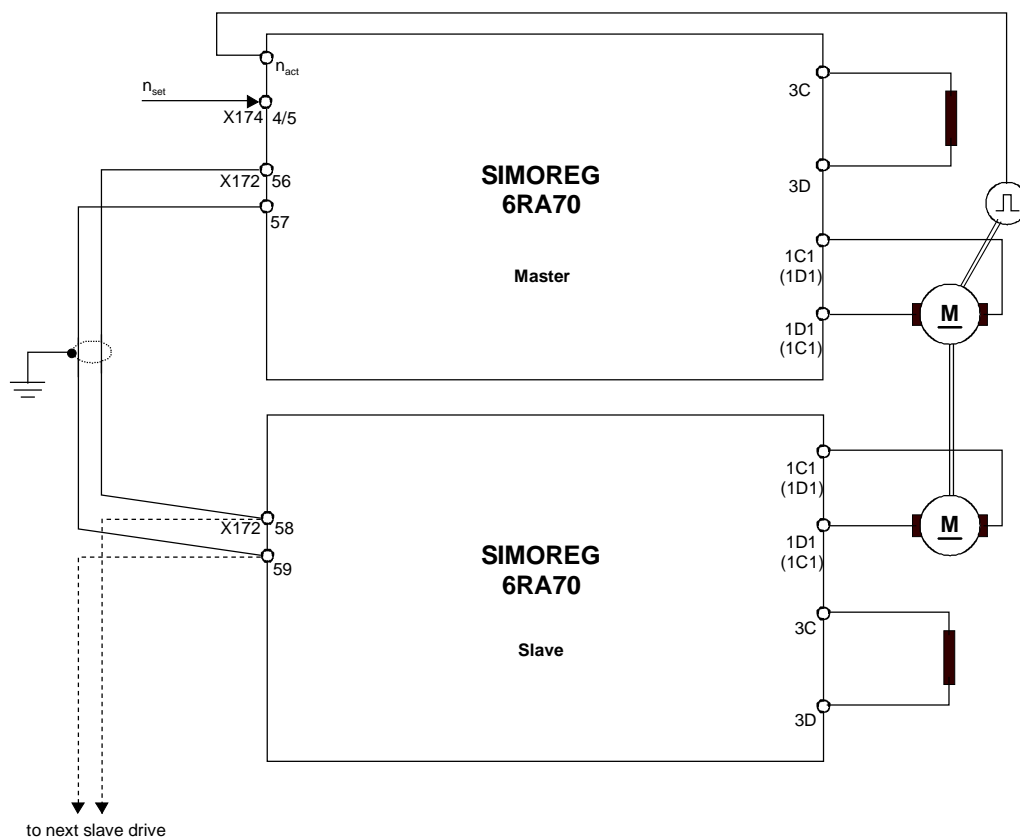
- ◆ In configurations with two or more coupled motors, the master drive operates in speed control mode
- ◆ The slaves operate under current (or torque) control and receive the current (or torque) setpoint, actual speed value and control word 1 from the master via the peer-to-peer link
- ◆ E.g. gears with two or more inputs

2.2 Recommended circuit

When the configuration includes only rigidly coupled motors, we would recommend the circuit arrangement illustrated below.

Terminals that are not shown in the diagram, voltage supply, fuse protection, etc. are connected according to the individual device. Further details can be found in the relevant operating manual.

The master converter is operated in speed control mode, generating a torque setpoint which supplies its own current controller and those of the slaves. The slaves are switched on simultaneously by means of control word 1 of the master. The actual speed value is transferred to all devices via the peer-to-peer link to enable recording of a field characteristic for the slaves. The ramp-function generator and speed controller on the slaves are not active. When the drive is braked, all motors decelerate together along the deceleration ramp of the master and shut down simultaneously in response to $n < n_{min}$.



2.3 Parameter settings

Start up the converters as described in the relevant operating manual (rated data, current limits, etc.) excluding the optimization runs.

The following additional parameters must then be set:

Master drive	Slave drive 1....n
P081=1 Drive can operate in field weakening range	P081=1 Drive can operate in field weakening range
P083=2 Actual speed from pulse encoder	P083=4 Freely connected actual speed value
P169=0 Torque control	P169=0 Torque control
P170=1 Torque control	P170=1 Torque control
	P503=xx Adaptation of torque setpoint with different motor-converter combinations $xx = \frac{I_{MOTFA} * I_{GERLA}}{I_{MOTLA} * I_{GERFA}} [\%]$ I_{MOTFA}Motor current slave drive I_{MOTLA}Motor current master drive I_{GERFA}Converter current slave drive I_{GERLA}Converter current master drive
	P500=K6002 Torque setpoint from master
	P609=K6001 Actual speed value from master
	P648=K6003 Control word 1 from master
	P687=1 Switchover to slave drive
P790=5 Peer-to-peer	P790=5 Peer-to-peer
P791=3 Number of transmitted words	P791=3 Number of transmitted words
P793=8 Baud rate	P793=8 Baud rate
P794.01=K0179 Actual speed value	
P794.02=K0148 Torque setpoint	
P794.03=K0030 Control word 1	
	P795=1 Bus terminator G-SST2 ON (see also operating manual, Section 9.13.2)
P797=2s Telegram failure time	P797=2s Telegram failure time

2.4 Optimization runs

Execute the optimization runs one at a time.

2.4.1 Master drive

- ◆ Open coupling between gear unit and load.
- ◆ Set current limits in **P171**, **P172** to zero on slave drive. The master is now the only active drive.
- ◆ Execute optimization runs for precontrol and current controller on master drive.
- ◆ Execute optimization run for speed controller (without load!) on master drive. This serves to create stable speed conditions for recording field characteristics.
- ◆ Execute optimization run for field weakening on master drive.
- ◆ Reset **P171**, **P172** on the slave drive to their original values.

2.4.2 Slave drive

- ◆ Set current limits in **P171**, **P172** to zero on master drive. The slave is now the only active drive.
- ◆ Execute optimization runs for precontrol and current controller on slave drive.
- ◆ Execute optimization run for field weakening on slave drive. You can do this because the torque setpoint is being supplied by the optimized speed controller on the master drive!
- ◆ Reset **P171**, **P172** on the master drive to their original values.

2.4.3 Master drive + slave drive

- ◆ Couple the load and gear unit again.
- ◆ Execute the optimization run for the speed controller with the load connected.

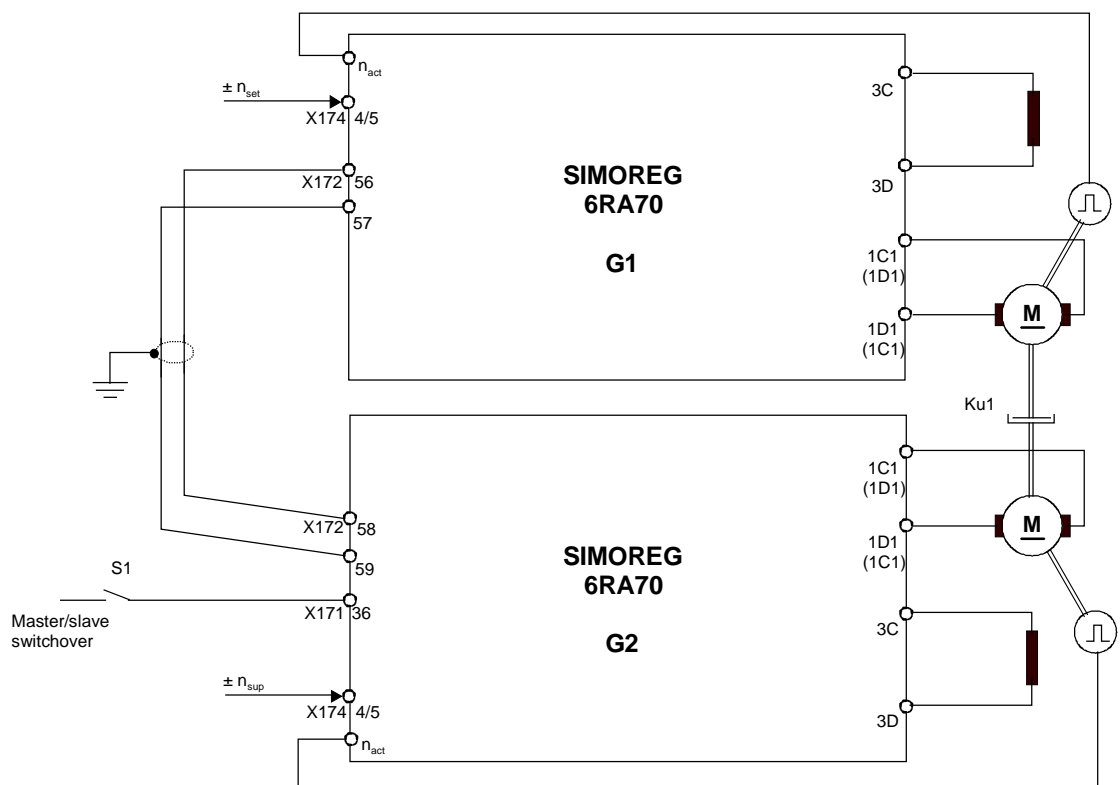
3 Master/Slave Switchover

3.1 Field of application

- ◆ For speed-controlled master drive with a slave drive that can also operate as a master drive.
- ◆ E.g. printing presses

3.2 Recommended circuit

The hardware circuit is identical for both variants. They differ only in terms of their parameter settings. Terminals that are not shown in the diagram, voltage supply, fuse protection, etc. are connected according to the individual device. Further details can be found in the relevant operating manual.



Ku1 Mechanical coupling
S1 Contact closed if Ku1 closed

$\pm n_{set}$...Speed setpoint
 $\pm n_{sup}$...Supplementary speed setpoint

3.3 Variant 1

3.3.1 "Master/slave drive" mode

Coupling Ku1 is closed.

G1 is the master and operating under speed control. The speed setpoint $\pm n_{\text{set}}$ is applied to term. X174:4-5 on G1. G2 is the slave operating under current control and receiving a current or torque setpoint from G1. It is absolutely essential to ensure that Ku1 remains closed in this mode. Drive G2 might otherwise "run away" due to the loss of the speed controller function and load torque < motor torque!

3.3.2 Decoupled operation

Coupling Ku1 is open.

G1 and G2 operate separately on their own speed controllers. They are switched on simultaneously and accelerate via the ramp-function generator of G1. The speed setpoint $\pm n_{\text{set}}$ is applied to term. X174:4-5 on G1 and transferred to G2 via the peer-to-peer link. The supplementary setpoint $\pm n_{\text{sup}}$ can be used to control the speed on G2 (via term. X174:4-5) if required.

3.3.3 Parameter settings

Start up the converters as described in the relevant operating manual (rated data, current limits, etc.) excluding the optimization runs.

The following additional parameters must then be set:

G1	G2
P081=1 Drive can operate in field weakening range	P081=1 Drive can operate in field weakening range
P083=2 Actual speed from pulse encoder	P083=2 Actual speed from pulse encoder
P169=0 Torque control	P169=0 Torque control
P170=1 Torque control	P170=1 Torque control
	P503=xx Adaptation of torque setpoint with different motor-converter combinations $xx = \frac{I_{\text{MOTFA}} * I_{\text{GERLA}}}{I_{\text{MOTLA}} * I_{\text{GERFA}}} [\%]$ I_{MOTFA} Motor current slave drive I_{MOTLA} Motor current master drive I_{GERFA} Converter current slave drive I_{GERLA} Converter current master drive
	P500=K6002 Torque setpoint from G1
	P634.01=K6001 Speed setpoint from G1
	P634.02=K0011 Supplementary speed setpoint
	P648=K6003 Control word 1 from master
	P687=B0010 Switchover to slave drive
P790=5 Peer-to-peer	P790=5 Peer-to-peer
P791=3 Number of transmitted words	P791=3 Number of transmitted words
P793=8 Baud rate	P793=8 Baud rate
P794.01=K0170 Speed setpoint	
P794.02=K0148 Torque setpoint	
P794.03=K0030 Control word 1	
	P795=1 Bus terminator G-SST2 ON (see also operating manual, Section 9.13.2)
P797=2s Telegram failure time	P797=2s Telegram failure time

3.3.4 Optimization runs

When decoupled, the two drives can be optimized individually in accordance with the operating manual.

3.4 Variant 2

NOTICE

Since P712 is used as an overdrive setpoint for the speed controller of the slave drive, analog selectable input 1 (terminal X174:6-7) is no longer available for other purposes.
Please also note that the closed-loop control configuration selected for this variant allows operation in only one direction of rotation (with a positive setpoint). If you want to operate the machine in both directions, you must select variant 1 (para. 3.3).

3.4.1 Master/slave drive mode

Coupling Ku1 is closed.

The speed setpoint $\pm n_{\text{set}}$ is applied to term. X174:4-5 on G1 and transferred to G2 via the peer-to-peer connection. G1 and G2 operate under speed control. However, the speed controller on G2 is overdriven by a fixed value (e.g. 5%) and thus tends in the direction of the positive torque limit. By additionally applying the torque setpoint from G1 as a torque limit for the slave drive, it is possible to shift this limit freely between $+M_{\text{max}}$ and $-M_{\text{max}}$ and thus adjust it to equal the torque of G1.

If Ku1 is left open by mistake in this operating mode, then the speed of G2 increases only by the overdrive value since its speed controller then cuts in.

The action of $\pm n_{\text{sup}}$ is inhibited.

3.4.2 Decoupled operation

Coupling Ku1 is open.

The speed setpoint $\pm n_{\text{set}}$ is applied to term. X174:4-5 on G1 and transferred to G2 via the peer-to-peer link. G1 and G2 operate separately on their own speed controllers. They are switched on simultaneously and accelerate via the ramp-function generator of G1. The supplementary setpoint $\pm n_{\text{sup}}$ can be used to control the speed on G2 (via term. X174:4-5) if required.

3.4.3 Parameter settings

Start up the converters as described in the relevant operating manual (rated data, current limits, etc.) excluding the optimization runs.

The following additional parameters must then be set:

G1	G2
P081=1 Drive can operate in field weakening range	P081=1 Drive can operate in field weakening range
P083=2 Actual speed from pulse encoder	P083=2 Actual speed from pulse encoder
P169=0 Torque control	P169=0 Torque control
P170=1 Torque control	P170=1 Torque control
	P171=xx Adaptation of torque setpoint with different motor-converter combinations $xx = \frac{I_{\text{GERLA}}}{I_{\text{MOTLA}}} [\%]$ I _{GERLA}Converter current master drive I _{MOTLA}Motor current master drive
	P430.01=B0010 Inject torque setpoint from G1
	P430.02=B0011 Inject fixed setpoint in n control mode
	P431.01=K6002 Torque setpoint from G1
	P431.02=K0002 Torque enable in n control mode

G1	G2
	P605.01=K0204 Torque limit
	P606.01=K0004 Enable neg. torque limit
	P621=K0015 Overdrive setpoint for n controller
	P634.01=K6001 Speed setpoint from G1
	P634.02=K0011 Supplementary speed setpoint
	P648=K6003 Control word 1 from master
	P706=B0011 Enable supplementary speed setpoint
	P712=+5% Overdrive setpoint for n controller
	P716=B0011 Inject overdrive setpoint
P790=5 Peer-to-peer	P790=5 Peer-to-peer
P791=3 Number of transmitted words	P791=3 Number of transmitted words
P793=8 Baud rate	P793=8 Baud rate
P794.01=K0170 Speed setpoint	
P794.02=K0148 Torque setpoint	
P794.03=K0030 Control word 1	
	P795=1 Bus terminator G-SST2 ON (see also operating manual, Section 9.13.2)
P797=2s Telegram failure time	P797=2s Telegram failure time

3.4.4 Optimization runs

When decoupled, the two drives can be optimized individually in accordance with the operating manual.

4 Master/Slave Switchover for Several Drives

4.1 Field of application

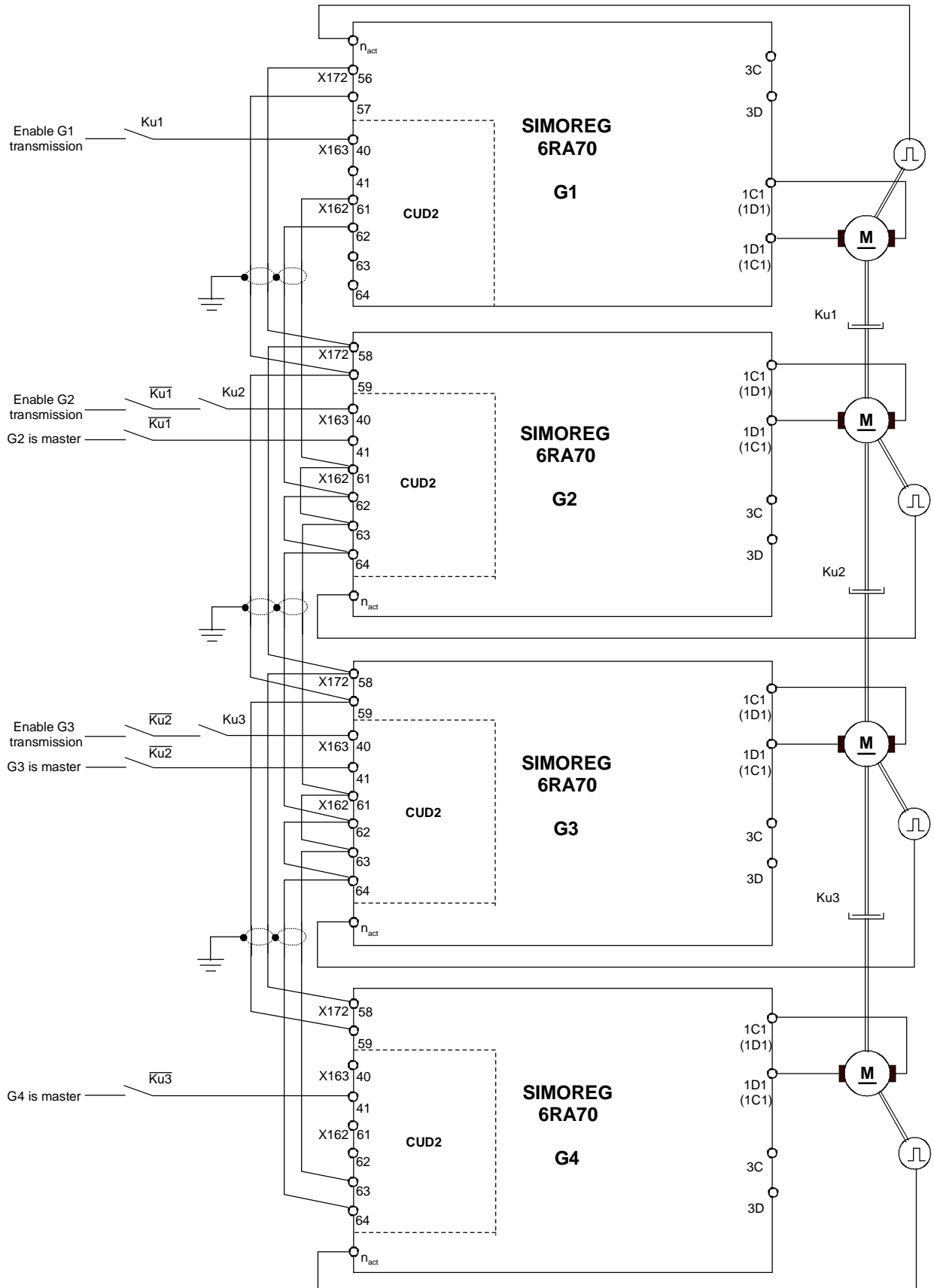
- ◆ For several motors on one shaft
- ◆ Each drive can act as the master for the following drives

4.2 Recommended circuit

This variant is explained below on the basis of an example configuration with four SIMOREG 6RA70 units. Terminals that are not shown in the diagram, voltage supply, fuse protection, etc. are connected according to the individual device. Further details can be found in the relevant operating manual.

NOTICE

When more than two converters are configured in the master/slave circuit, a CUD2 must be installed in each converter (to provide the extra peer-to-peer interface required).



Ku1.....Mechanical coupling 1
 Ku2.....Mechanical coupling 2
 Ku3.....Mechanical coupling 3

Contact designations:
 e.g. Ku1 Contact closes if coupling 1 is closed
 $\overline{\text{Ku1}}$ Contact closes if coupling 1 is open

Based on the feedback information about coupling states, the correct connections for the peer-to-peer links are made in the converters. This process is explained in more detail by the following table.

Ku1	Ku2	Ku3	G1	G2	G3	G4
Closed	Closed	Closed	Master Send M_{set} to G-SST3	Slave of G1	Slave of G1	Slave of G1
Open	Closed	Closed	Master	Master Send M_{set} to G-SST3	Slave of G2	Slave of G2
Open	Open	Closed	Master	Master	Master Send M_{set} to G-SST3	Slave of G3
Open	Open	Open	Master	Master	Master	Master

4.3 Variant 1

4.3.1 Functional description

A master always operates under speed control. A slave is always torque-controlled and receives its torque setpoint from the master positioned immediately upstream.

The external speed setpoint is connected to G1 (at X174:4-5) and transferred to all the other drives via the peer-to-peer link. The ramp-function generator is active on every drive acting as a master.

The speed of drives G2...G4 can be controlled separately via $\pm n_{sup}$ (at X174:4-5) if required.

If the drives are to be powered up separately, an external control must be provided for each individual drive, e.g. at terminals X171:37, 38 (see operating manual).

In this mode, it is again important to ensure that a rigid mechanical connection to the "master" actually exists before "slave" is selected or else the slave drive may "run away".

4.3.2 Parameter settings

Start up the converters as described in the relevant operating manual including the optimization runs (separately in decoupled state).

The parameter settings are basically identical for all drives, any deviations between drive settings are indicated explicitly in the tables.

G1.....G4	
P081=1	Drive can operate in field weakening range
P083=2	Actual speed from pulse encoder
P169=0	Torque control
P170=1	Torque control
P500=K0204	Torque setpoint
P644=K6001	Speed setpoint from G1
IMPORTANT! Set this parameter on all drives except the first (G1).	

G1.....G4
P645=K0011 Supplementary speed setpoint IMPORTANT! Apply supplementary setpoint only to drives that are not G1. K0011 is the main setpoint on G1.
U655=K0148 Torque setpoint from own n controller
P687=B0021 Switchover to slave drive
P706=B0020 Enable supplementary setpoint IMPORTANT! Set parameter only on drives that are not G1, otherwise leave factory setting.
P790=5 Peer-to-peer
P791=1 Number of transmitted words
P793=8 Baud rate
P794.01=K0011 External speed setpoint IMPORTANT! Set this parameter only on the first drive (G1). K0011 is the supplementary setpoint on all drives except G1.
P795=1 Bus terminator G-SST2 ON IMPORTANT! Set only on the last drive! (see also operating manual, Section 9.13.2)
P797=2s Telegram failure time
P800=5 Peer-to-peer
P801=1 Number of transmitted words
P803=8 Baud rate
P804.01=K0452 Torque setpoint to slave
P805=1 Bus terminator G-SST3 ON IMPORTANT! Set only on the first and last drive! (see also operating manual, Section 9.13.2)
P818=B0021 Enable reception
P819=B0018 Enable transmission
U652=xx Adaptation of torque setpoint with different motor-converter combinations $xx = \frac{I_{Ger}}{I_{MOT}} [\%]$ I_{GER} Converter current I_{MOT} Motor current

4.4 Variant 2

NOTICE

Since P712 is used as an overdrive setpoint for the speed controller of the slave drives, analog selectable input 1 (terminal X174:6-7) is no longer available for other purposes.
Please also note that the closed-loop control configuration selected for this variant allows operation in only one direction of rotation (with a positive setpoint). If you want to operate the machine in both directions, you must select variant 1 (para. 4.3).

4.4.1 Functional description

Master and slaves are operated under speed control. However, the speed controller of each slave is overdriven by a fixed value (e.g. 5%) and thus tends in the direction of the positive torque limit. By additionally applying the torque setpoint of the master as a torque limit for the slaves, it is possible to shift this limit freely between $+M_{\max}$ and $-M_{\max}$ and thus adjust it to equal the torque of the master.

If the mechanical coupling between the master and slaves is left open by mistake in this operating mode, then the speed of the slaves increases only by the overdrive value since their own speed controller then cuts in.

The external speed setpoint is connected to G1 (e.g. at X174:4-5) and transferred to all the other drives via the peer-to-peer link. The ramp-function generator is active on every drive acting as a master.

The speed of drives G2...G4 can be controlled separately via $\pm n_{\text{sup}}$ (at X174:4-5) if required.

If the drives are to be powered up separately, an external control must be provided for each individual drive, e.g. at terminals X171:37, 38 (see operating manual).

4.4.2 Parameter settings

G1.....G4	
P081=1	Drive can operate in field weakening range
P083=2	Actual speed from pulse encoder
P169=0	Torque control
P170=1	Torque control
P430.01=B0021	Inject torque setpoint
P430.02=B0020	Inject fixed setpoint in n control mode
P431.01=K9001	Torque setpoint from upstream master
P431.02=K0002	Torque enable in n control mode
P605.01=K0204	Torque setpoint
P606.01=K0004	Enable neg. torque limit
P621=K0015	Overdrive setpoint for n controller
IMPORTANT! Set this parameter on all drives except the first (G1). Leave the factory setting on G1.	
P644=K6001	Speed setpoint from G1
IMPORTANT! Set this parameter on all but the first drive (G1).	
P645=K0011	Supplementary speed setpoint
IMPORTANT! Apply supplementary setpoint only to drives that are not G1. K0011 is the main setpoint on G1.	

G1.....G4
U655=K0148 Torque setpoint from own n controller
P706=B0020 Enable supplementary speed setpoint IMPORTANT! Set parameter only on drives that are not G1, otherwise leave factory setting.
P712=+5% Overdrive setpoint for n controller
P716=B0021 Inject overdrive setpoint
P790=5 Peer-to-peer
P791=1 Number of transmitted words
P793=8 Baud rate
P794.01=K0011 External speed setpoint IMPORTANT! Set this parameter only on the first drive (G1). K0011 is the supplementary setpoint on all drives except G1.
P795=1 Bus terminator G-SST2 ON IMPORTANT! Set only on the last drive! (see also operating manual, Section 9.13.2)
P797=2s Telegram failure time
P800=5 Peer-to-peer
P801=1 Number of transmitted words
P803=8 Baud rate
P804.01=K0452 Torque setpoint to slave
P805=1 Bus terminator G-SST3 ON IMPORTANT! Set only on the first and last drive! (see also operating manual, Section 9.13.2)
P818=B0021 Enable reception
P819=B0018 Enable transmission
U652=xx Adaptation of torque setpoint with different motor-converter combinations $xx = \frac{I_{GER}}{I_{MOT}} [\%]$ I_{GER} Converter current I_{MOT} Motor current

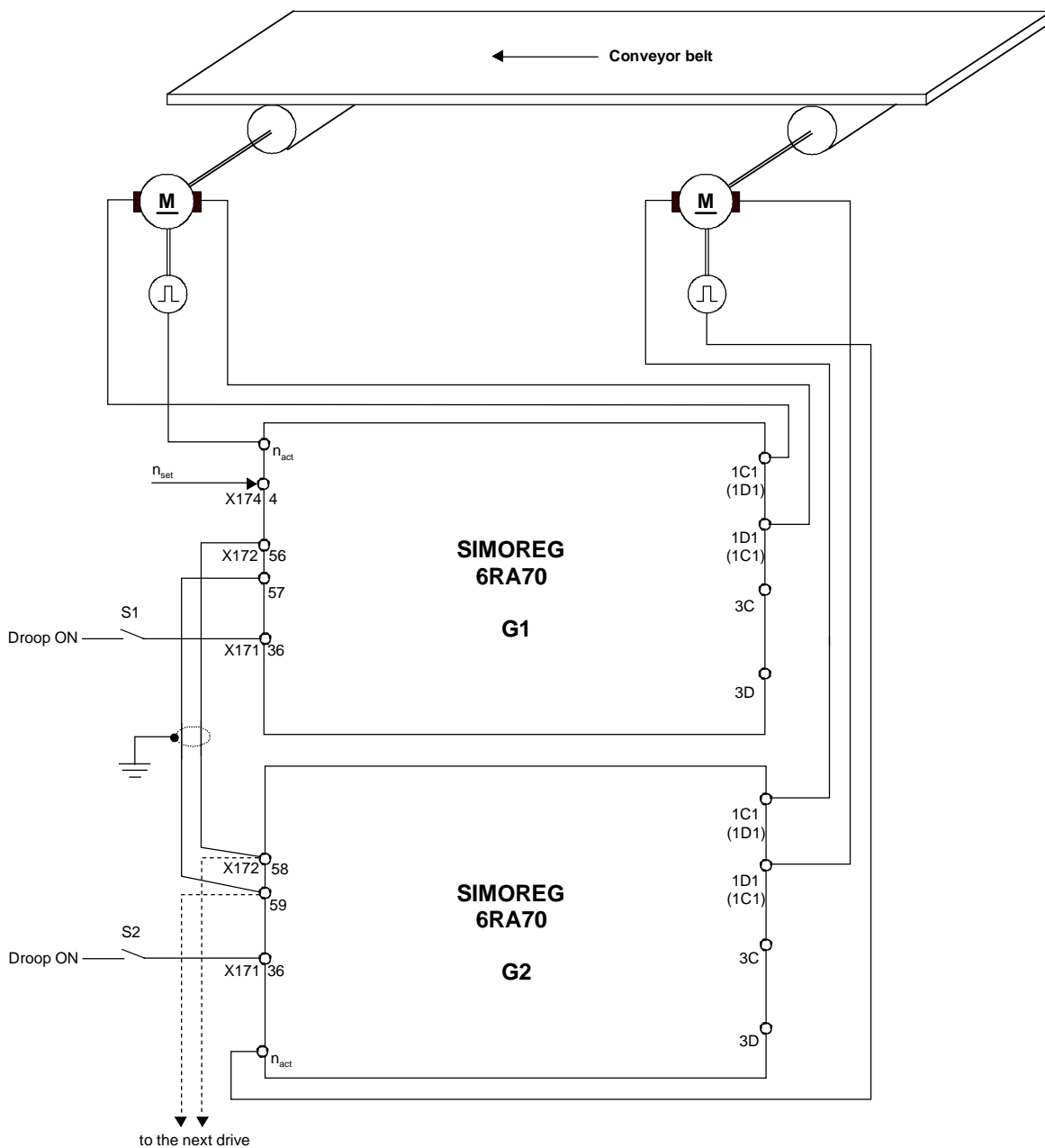
5 Current Distribution Using Droop Function

5.1 Field of application

- ◆ The "Droop" function can be used to distribute the load between the converters in configurations with two or more drives that are not rigidly coupled.
- ◆ E.g. guide rollers on a conveyor belt operating at an injected velocity

5.2 Recommended circuit

Terminals that are not shown in the diagram, voltage supply, fuse protection, etc. are connected according to the individual device. Further details can be found in the relevant operating manual.



5.3 Functional description

For the purpose of load distribution, the speed controller output (torque setpoint) is looped back to the input and used as an auxiliary quantity for current distribution. The speed controller output can be set in parameter P227 and activated via control word 2 / bit 24. With some drives it may be advantageous to delay activating the droop until a frictional connection with the conveyor belt exists. The droop can also be applied adaptively (see operating manual, Section "Function Diagrams", Sheet G151).

A 10% droop setting means that the actual speed deviates by 10% from the setpoint with a 100% controller output (control "softening").

5.4 Parameterization

Start up the converters separately as instructed in the operating manual (including optimization runs) with the droop function deactivated.

The parameter settings are basically identical for all drives, any deviations between drive settings are indicated explicitly in the tables.

Drive G1...Gn	
P081=1	Drive can operate in field weakening range
P083=2	Actual speed from pulse encoder
P169=0	Torque control
P170=1	Torque control
P227=e.g.5%	Droop Adaptation if desired, see operating manual, Sheet G151.
P634.01=K6001	Speed setpoint from G1 IMPORTANT! Set this parameter on all drives except the first (G1).
P648=K6003	Control word 1 from G1 Power up all drives together via G1
P684=B0010	Activate droop function
P790=5	Peer-to-peer
P791=1	Number of transmitted words
P793=8	Baud rate
P794.01=K0190	Speed setpoint after RFG IMPORTANT! Set this parameter on drive G1 only.
P795=1	Bus terminator G-SST2 ON IMPORTANT! Set only on the last drive! (see also operating manual, Section 9.13.2)
P797=2s	Telegram failure time

5.5 Final setting

- ◆ Activate the droop function on all drives.
- ◆ In operation and after frictional connection is made with conveyor, adjust P227 until the load distribution between the converters has reached the desired value.
- ◆ If the setting range of P227 (0....10%) is not wide enough, adjust the speed in P143 until the setting in P227 becomes operative.

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Master/Slave Switchover

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