DCS800

DC Drives

**Master-Follower
Configuration
G568e Part 2**

eLearning

ABB

Welcome to the master-follower configuration training module for the DCS800, ABB DC Drives.

If you need help navigating this module, please click the Help button in the top right-hand corner. To view the presenter notes as text, please click the Notes button in the bottom right corner.

Objectives

After completing this module, you will be able to

- use master-follower via SDCS-COM-8

- use master-follower via SDCS-DSL-4

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After completing this module, you will be able to use

- master-follower via SDCS-COM-8, and
- master-follower via SDCS-DSL-4.
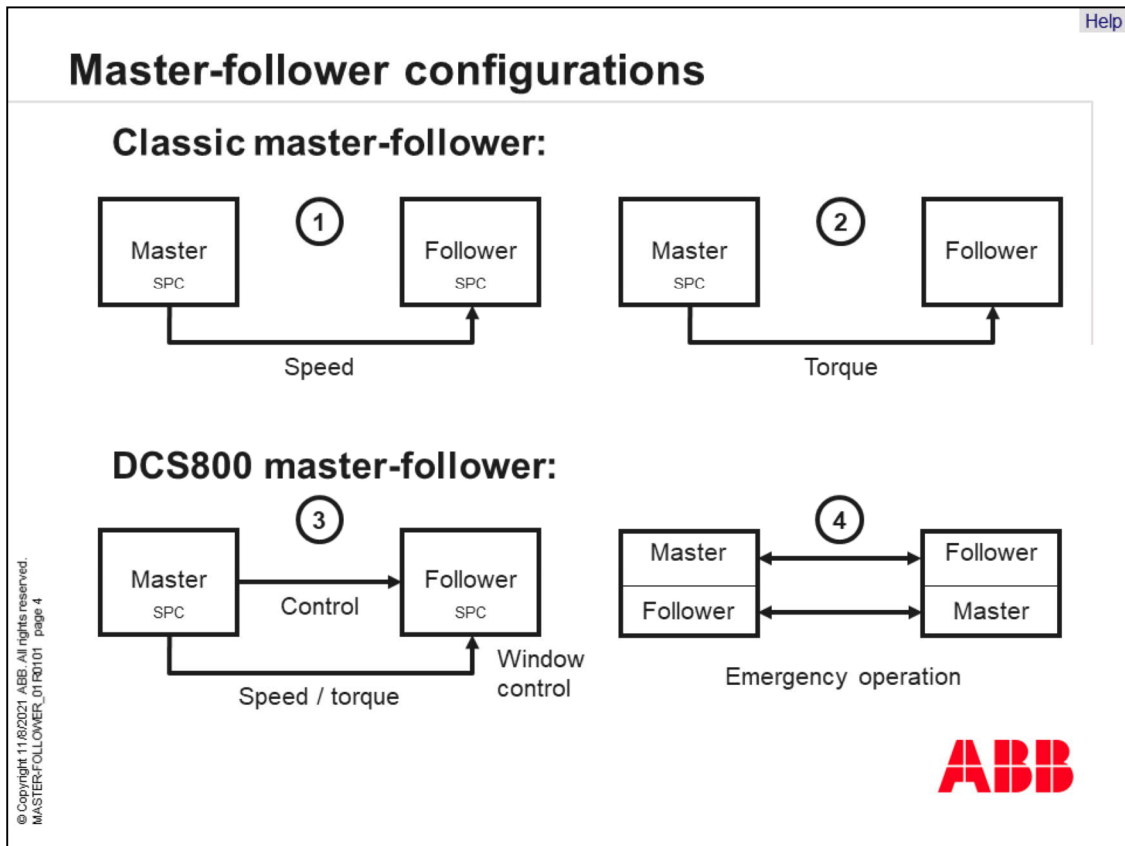
Master-follower

When to use:

- Master-follower is typically used when the motors are coupled (e.g. shafts, gears, chains belts) and no speed difference between the motors is possible

- in general the master is speed controlled

- the followers are torque or window controlled
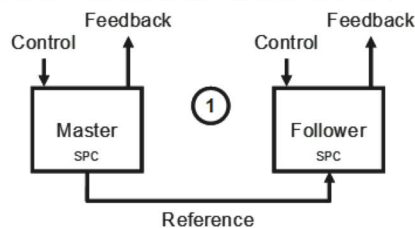
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- The master-follower link is designed for applications in which the system is operated by several drives and in which the shafts are coupled to each other via gearing, chains, belts etc. The master controls all followers via a serial communication link. Pulse encoders are recommended for the master and all followers.

- The master is typically speed controlled and the other drives follow the master's torque or speed reference. In general, torque control or window control of the followers should be used when the motor shafts of the master and the follower drives are fixed coupled to each other via gearing, chains, belts etc. and no speed differences between the drives are possible.

Master-follower configurations

Classic master-follower:
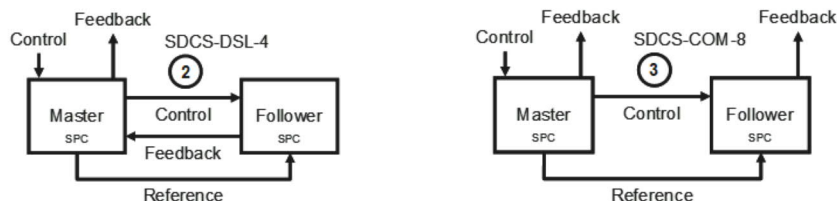
DCS800 master-follower:

- Master-follower comes in a vast variety of variations. The most common are the speed-controlled follower and the torque-controlled follower.
- For example, classic master-follower configurations send either a speed or a torque reference from the master to the follower. If a speed reference is sent, then the speed controller has to be active in both drives. The other option is sending a torque reference from the master to the follower. In that case the master is speed controlled and the follower is torque controlled.
- In a DCS800 master-follower configuration all followers from the master can be controlled. Additionally, it is possible to send a speed reference and a torque reference at the same time. The follower can be speed controlled, torque-controlled or window controlled. The idea of the window control is to block the speed controller as long as the speed error remains within a set window. This allows the external torque reference to have a direct effect on the process. If the speed error exceeds the programmed window, the speed controller is activated. This function could also be called over/underspeed protection in torque control mode.
- Master and follower functions can be easily swapped in an emergency operation.

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- In classic configurations the master and all followers have to be controlled directly by the overriding control. The feedback from for the overriding control has to be collected separately from each drive.
- In a DCS800 master-follower configuration only the master can be controlled directly by the overriding control. All followers can be controlled via the master. This is possible using an SDCS-COM-8 or an SDCS-DSL-4 configuration.
- In a DCS800 master-follower configuration using SDCS-DSL-4 it is possible to collect the feedback from all followers via the master, because the followers can send feedback to the master.
- In a DCS800 master-follower configuration using SDCS-COM-8, the feedback from all drives has to be collected from each individual drive, because the followers cannot send feedback to the master.
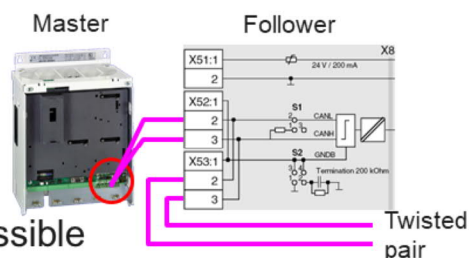
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Master-follower options for DCS800

Using SDCS-COM-8:

- one mailbox with 3 words
- only broadcast messages
- transmission speed 2 ms fixed
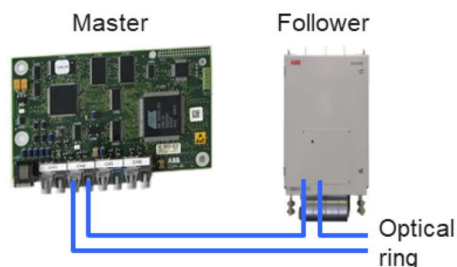
Using SDCS-DSL-4:

- 4 mailboxes with 4 words each
- bidirectional messages possible
- transmission speed depends on cable length and parameter setting (min. 5 ms)

- In the DCS800, the master-follower is implemented by using SDCS-COM-8 or SDCS-DSL-4 boards.
- Master-follower via SDCS-COM-8 board features one mailbox containing 3 words.
- Broadcast messages can only be transmitted from the master to the followers.
- The transmission speed is fixed to 2 ms.
- The connection is made with plastic fiber optic cables building an optical ring.
- Master-follower via SDCS-DSL-4 board features four mailboxes containing 4 words each.
- Thus 16 words for bidirectional communication are available.
- The transmission speed depends on total cable length and the parameter settings. The fastest possible communication speed is 5 ms.
- The connection is made with twisted pair cables, building a bus system.

Master-follower via SDCS-COM-8

Characteristics:

- plastic fiber optic cables

- channel 2 is used for connection between SDCS-COM-8 boards

- ring connection (one master can control up to 10 followers)

- max. length per ring segment is 20 m
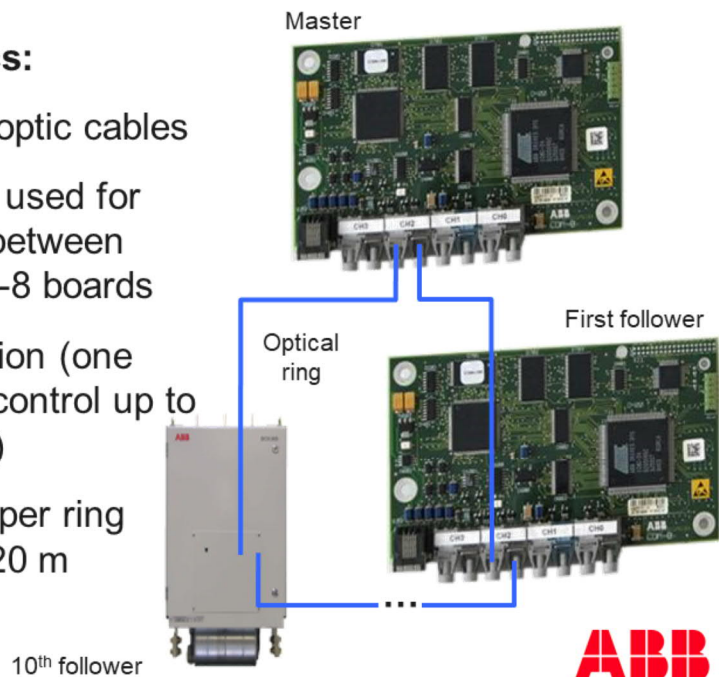
Master

First follower

Optical ring

10th follower

- The master-follower link is made up of plastic fiber optic cables and SDCS-COM-8 boards.
- Channel 2 on the SDCS-COM-8 board is used for the master-follower link between the drives.
- Thus, an optical ring configuration with one master and up to 10 followers can be created.
- The maximum length per fiber optic ring segment is 20 meters.

Master-follower via SDCS-COM-8

Characteristics and performance:

- the communication is a broadcast message from the master to all followers

- the transmission speed is 2 ms

- a direct feedback from the followers to the master is not possible

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- The communication between the drives is a broadcast message from the master to all followers.
- The master sends its values every 2 ms to the followers. Direct feedback from the followers cannot be transmitted to the master. Feedback from the followers is either sent via hardware using digital I/O or via the overriding control.

Example using SDCS-COM-8

Master parameters (source):

Ch2 MaFoMode (70.09):	**Master**
Ch2 MasSig1 (70.10):	*MainCtrlWord (7.01)* or *UsedMCW (7.04)*
Ch2 MasSig2 (70.11):	*SpeedRefUsed (2.17)*
Ch2 MasSig3 (70.12):	*TorqRef3 (2.10)*

Follower parameters (sinks):

Ch2 MaFoMode (70.09):	**Follower**
Ch2 FolSig1 (70.18):	*MainCtrlWord (7.01)*
Ch2 FolSig2 (70.19):	*SpeedRef (23.01)*
Ch2 FolSig3 (70.20):	*TorqRefA (25.01)*
CommandSel (10.01):	**MainCtrlWord**

Master signal *TorqRef3 (2.10)* is send via master parameter *Ch2 MasSig3 (70.12)* to follower signal *TorqRefA (25.01)* via follower parameter *Ch2 FolSig3 (70.20)*.
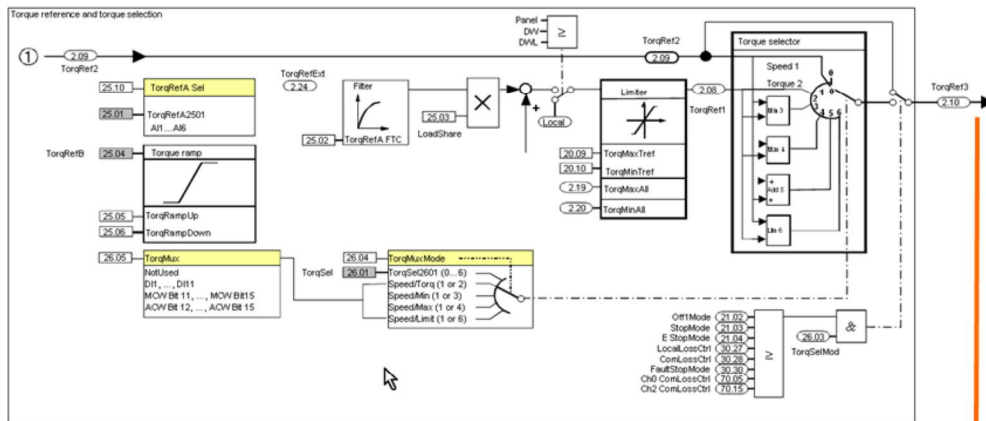
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- The master mode is selected by setting *Ch2 MaFoMode (70.09)* to Master. The torque reference source address is defined in the master by setting *Ch2 MasSig3 (70.12)* to 210. Two other signals can also be sent through the link if required. Their addresses are defined by *Ch2 MasSig1 (70.10)* and *Ch2 MasSig2 (70.11)*. Typical addresses are *MainCtrlWord (7.01)* or *UsedMCW (7.04)* and *SpeedRefUsed (2.17)*.
- The follower mode is selected by setting *Ch2 MaFoMode (70.09)* to Follower. To control start and stop from the master set *CommandSel (10.01)* to **MainCtrlWord**. The connections are selected by *Ch2 FolSig1 (70.18)*, *Ch2 FolSig2 (70.19)* and *Ch2 FolSig3 (70.20)* according to the table displayed.

Example:

- Send torque reference 3 from the master to torque reference A of the followers. In the master set *Ch2 MasSig3 (70.12)* to 210 to get the value of torque reference 3. In the follower set *Ch2 MasSig3 (70.12)* to 2501 to write the value to torque reference A.

Firmware structure master

Ch2 MaFoMode (70.09) = **Master**, activates read pointer Ch2 MasSig1 (70.10), Ch2 MasSig2 (70.11) and Ch2 MasSig3 (70.12).

Master parameter Ch2 MasSig3 (70.12) = 210 sends the torque value to the follower

The example from the previous page is provided in the firmware structure of the master.

- The master mode is selected by setting *Ch2 MaFoMode (70.09)* to Master. The torque reference source address is defined in the master by setting *Ch2 MasSig3 (70.12)* to 210. This torque reference value is sent to all followers.

Firmware structure followers

Ch2 MaFoMode (70.09) = **Follower**, activates write pointer Ch2 FolSig1 (70.18), Ch2 FolSig2 (70.19) and Ch2 FolSig3 (70.20).

Follower parameter Ch2 FolSig3 (70.20) = 2501 gets the torque value from the master.

The example from the previous page is provided in the firmware structure of the followers.

- The follower mode is selected by setting *Ch2 MaFoMode (70.09)* to Follower. The torque reference sink address is defined in the followers by setting *Ch2 MasSig3 (70.12)* to 2501. Thus, the torque reference value from the master is received by all followers.
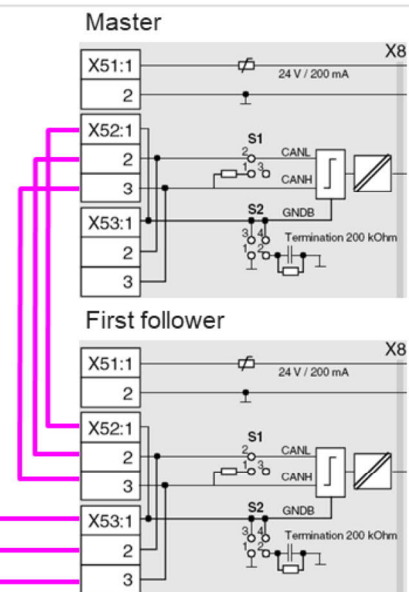
Master-follower via SDCS-DSL-4

Characteristics:

- communication via DCSLink
- one master can control up to 10 followers
- max. total length of the DCSLink cable is 100 m

- The master-follower link is established with the DCSLink using twisted pair cables and SDCS-DSL-4 boards. The wires must be connected as shown in the picture. X52 and X53 are internally connected and used to daisy chain the DCSLink cable.
- One master and up to 10 followers can be used.
- The maximum total length of the DCSLink cable is 100 meters.

Master-follower via SDCS-DSL-4

Characteristics and performance:

- communication via mailboxes between the master and all followers

- the fastest transmission speed is 5 ms

- a direct feedback from the followers to the master is possible

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- The drives communicate with each other via mailboxes between the master and all followers.
- The fastest transmission speed is 5 ms. Due to the use of mailboxes feedback from the followers can be transmitted to the master.

Master-follower via SDCS-DSL-4

Bus termination:

- the DCSLink is a bus system using twisted pair cables, therefore

- bus termination is mandatory at the two physical ends of the bus
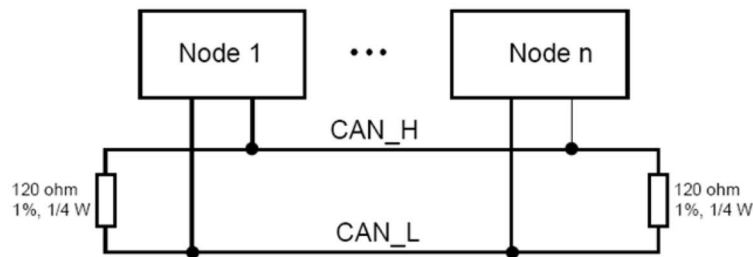
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- The DCSLink is a bus system based on CAN-bus hardware using twisted pair cables. Therefore, a bus termination with a 120 ohm resistor at the two physical ends of the bus is mandatory.
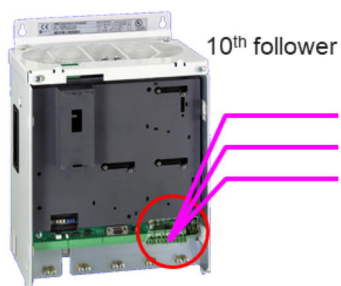
Master-follower via SDCS-DSL-4

Bus- and ground termination:

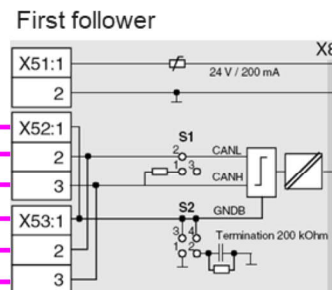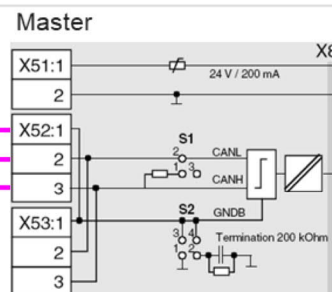- in this example termination is mandatory at the master and the 10th follower

SDCS-DSL-4
jumper **S1** = **1-2** sets the bus termination
jumper **S2** sets the ground termination

- In this example the bus termination has to be performed at the master and the 10th follower. Set jumper S1 to 1-2 on both SDCS-DSL-4 boards.
- The ground termination can be set with jumper S2 at the master and at the 10th follower. A hard ground termination can be achieved by setting S2 to 1-3. An R-C ground termination can be performed by setting S2 to 2-4.

Master-follower via SDCS-DSL-4

Set the node ID numbers and transmission speed:

- the master and all followers have to have unique node ID numbers

- two stations with the same node ID number are not allowed

- the transmission speed of all devices has to match

Firmware master	Firmware first follower	Firmware 10th follower
DCSLinkNodeID (94.01) = 1	*DCSLinkNodeID (94.01)* = 2	*DCSLinkNodeID (94.01)* = 11
BaudRate (94.02) = **500 kBit/s**	*BaudRate (94.02)* = **500 kBit/s**	*BaudRate (94.02)* = **500 kBit/s**

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- In all bus systems unique node ID numbers are required and have to be set in the master and all followers.
- Two stations cannot have the same node ID number. For example, set the masters node ID number to 1 and add one for each follower.
- The transmission speed of all devices has to match. The default baud rate is 500 kBit/s.

Master-follower via SDCS-DSL-4

Activate the mailboxes:

- the master-follower communication utilizes 4 mailboxes to transfer data

- data transfer to any device / node in the system is possible

- positive mailbox node ID numbers only transmit data, negative only receive data

- to get communication mailbox node ID pairs (e.g., 5 and -5) are needed

Firmware master	Firmware first follower	Firmware 10th follower
MailBox1 (94.12) = 5	MailBox1 (94.12) = -5	MailBox1 (94.12) = -5

transmitting data receiving data

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- After setting the node ID numbers and transmission speed, activate the mailboxes.
- The master-follower communication utilizes 4 mailboxes to transfer data.
- Thus, data can be transferred to any device in the system.
- Positive mailbox node ID numbers only transmit data, negative only receive data.

Attention:

- Positive mailbox node ID numbers must be unique. Negative mailbox node ID numbers can be used by several mailboxes.
- To receive communications, mailbox node ID pairs (e.g., 5 and -5) are needed. Master mailbox one, for example, is set to 5 and thus transmits data. Mailbox one of the followers is set to -5 and thus receives data.

Master-follower via SDCS-DSL-4

Activate the communication supervision:

■ the communication supervision is activated by means of *MailBoxCycle1 (94.13)*

Attention:

■ the communication timeout must be set at least twice if the corresponding mailbox cycle time

Firmware master	Firmware first follower	Firmware 10th follower
MailBoxCycle1 (94.13) = 100	*MailBoxCycle1 (94.13) = 200*	*MailBoxCycle1 (94.13) = 200*

set cycle time   set timeout

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- After activating mailbox one in the master and all followers, the communication supervision has to be activated via *MailBoxCycle1 (94.13)*.
- The function of *MailBoxCycle1 (94.13)* depends on the setting of *MailBox1 (94.12)*.
  - If *MailBox1 (94.12)* is positive:
    - data will be transmitted,
    - *MailBoxCycle1 (94.13)* sets the transmitting and receiving intervals,
    - values from 1 - 4 ms are too fast and will generate a fault and
    - the communication is inactive, if *MailBoxCycle1 (94.13)* is set to 0 ms.
  - If *MailBox1 (94.12)* is negative:
    - data will be received,
    - *MailBoxCycle1 (94.13)* sets the communication timeout,
    - this is the time delay before a master-follower communication break is declared,
    - depending on the setting of *ComLossCtrl (30.28)* either a fault or an alarm is set and
    - the communication fault and alarm are inactive, if *MailBoxCycle1 (94.13)* is set to 0 ms.
- To ensure proper supervision, set the communication timeout at least twice as long as the corresponding mailbox cycle time parameter.

Example using SDCS-DSL-4

Master parameters (source):
- TrmtRecVal1.1 (94.14):   MainCtrlWord (7.01) or UsedMCW (7.04)
- TrmtRecVal1.2 (94.15):   SpeedRefUsed (2.17)
- TrmtRecVal1.3 (94.16):   TorqRef3 (2.10)
- TrmtRecVal1.4 (94.17):   not used

Follower parameters (sinks):
- TrmtRecVal1.1 (94.14):   MainCtrlWord (7.01)
- TrmtRecVal1.2 (94.15):   SpeedRef (23.01)
- TrmtRecVal1.3 (94.16):   TorqRefA (25.01)
- TrmtRecVal1.4 (94.17):   not used
- CommandSel (10.01):   **MainCtrlWord**

Master signal TorqRef3 (2.10) is send via master parameter TrmtRecVal1.3 (94.16) to follower signal TorqRefA (25.01) via follower parameter TrmtRecVal1.3 (94.16).

- The master mode - transmitting data - is selected by setting $MailBox1\ (94.12) = 5$. The torque reference source address is defined in the master by setting *TrmtRecVal1.3 (94.16) = 210*. Also, two other signals can be sent through the link if required. Their addresses are defined by *TrmtRecVal1.1 (94.14)* and *TrmtRecVal1.2 (94.15).* Typical addresses are *MainCtrlWord (7.01)* or *UsedMCW (7.04)* and *SpeedRefUsed (2.17).*

- The follower mode - receiving data - is selected by setting $MailBox1\ (94.12) = -5$. To control start and stop from the master set *CommandSel (10.01)* = **MainCtrlWord**. The connections are selected by *TrmtRecVal1.3 (94.16), TrmtRecVal1.1 (94.14)* and *TrmtRecVal1.2 (94.15)* according to the shown table.

Example:

- Send torque reference 3 from the master to torque reference A of the followers. In the master set *TrmtRecVal1.3 (94.16) = 210* to get the value of torque reference 3. In the follower set *TrmtRecVal1.3 (94.16)* = 2501 to write the value to torque reference A.

- The master mode - transmitting data - is selected by setting *MailBox1 (94.12)* to 5. The torque reference source address is defined in the master by setting *TrmtRecVal1.3 (94.16)* to 210. Two other signals can also be sent through the link if required. Their addresses are defined by *TrmtRecVal1.1 (94.14)* and *TrmtRecVal1.2 (94.15)*. Typical addresses are *MainCtrlWord (7.01)* or *UsedMCW (7.04)* and *SpeedRefUsed (2.17)*.

- The follower mode - receiving data - is selected by setting *MailBox1 (94.12)* to -5. To control start and stop from the master set *CommandSel (10.01)* to **MainCtrlWord**. The connections are selected by *TrmtRecVal1.3 (94.16)*, *TrmtRecVal1.1 (94.14)* and *TrmtRecVal1.2 (94.15)* according to the table shown.

Example:

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- Send torque reference 3 from the master to torque reference A of the followers. In the master set *TrmtRecVal1.3 (94.16)* to 210 to get the value of torque reference 3. In the follower, set *TrmtRecVal1.3 (94.16)* to 2501 to write the value to torque reference A.

Firmware structure master

MailBox1 (94.12) = 5, configures the master's first mailbox to transmit data.

Master parameter *TrmtRecVal1.3 (94.16)* = 210
sends the torque value to the follower.

The example from the previous page is provided in the firmware structure of the master.

- The master mode - transmitting data - is selected by setting *MailBox1 (94.12)* to 5. The torque reference source address is defined in the master by setting *TrmtRecVal1.3 (94.16)* to 210. This torque reference value is sent to all followers.

Firmware structure followers

MailBox1 (94.12) = -5, configures the follower's first mailbox to receive data.

Follower parameter TrmtRecVal1.3 (94.16) = 2510 gets the torque value from the master.

The example from the previous page is provided in the firmware structure of the followers.

- The follower mode - receiving data - is selected by setting *MailBox1 (94.12)* to -5. The torque reference sink address is defined in the followers by setting *TrmtRecVal1.3 (94.16)* to 2501. Thus, the torque reference value from the master is received by all followers.

Summary

Key points of this module

- use master-follower via SDCS-COM-8

- use master-follower via SDCS-DSL-4

ABB

Now you can use
- master-follower via SDCS-COM-8, and
- master-follower via SDCS-DSL-4.

Additional information

- Firmware Manual (3ADW000193, manual)

ABB

Here are some related documents for further training and additional references.

Thank you for your attention. You may now go ahead and move on to the next unit.