ACS800

Master/Follower Application Guide
Supplement to Firmware Manual for
ACS800 Standard Application Program

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ACS800 Standard Application Program

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Overview

General

The Master/Follower function is designed for applications in which the system is run by several ACS800 drives and the motor shafts are coupled to each other via gearing, chain, belt etc. Thanks to the Master/Follower function, the load can be evenly distributed between the drives.

The external control signals are connected to the Master only. The Master controls the Follower(s) via a fibre optic serial communication link.

The Master station is typically speed-controlled and the other drives follow its torque or speed reference. In general,

- Torque control of the Follower should be used when the motor shafts of the Master and Follower drives are coupled solidly to each other by gearing, a chain etc., so that no speed difference between the drives is possible (see Master/Follower applications, schematic representation.)
- Speed control of the Follower should be used when the motor shafts of the Master and the Follower drives are coupled flexibly to each other, so that a slight speed difference between the drives is possible (see Master/Follower applications, schematic representation.). When both the Master and Followers are speed-controlled, drooping is also typically used (Parameter 60.06 DROOP RATE).

In some applications, both speed control and torque control of the Followers are required. In those cases an “on-the-fly” change between speed and torque control can be performed via a digital input of the Follower (see *M/F Communication and Parameter Set-up*).

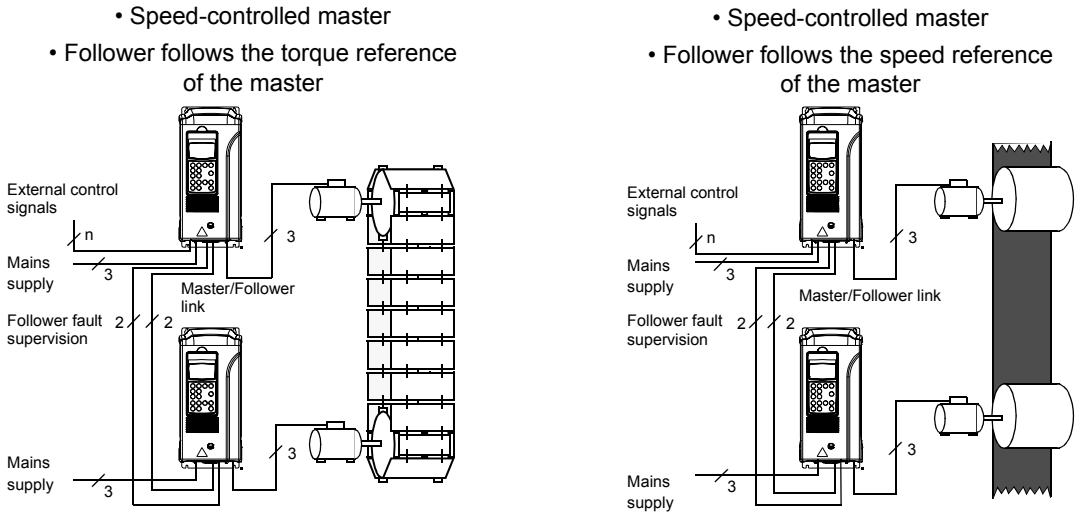


Figure 1. Master/Follower applications, schematic representation.

Checklist for a Quick Start-up

The installation and start-up procedure of the drive is explained in its manuals. A checklist for the Master/Follower function is given below.

- Switch off the power supplies of the drives. Wait for five minutes to ensure that the intermediate circuits are discharged.
- Install RDCO communication boards onto the RMIO boards of all drives to be used in Master/Follower communication (if not already installed). Follow the instructions included in the RDCO package.
- Build the Master/Follower Link. See *M/F Link Wiring and Specification*.
- Connect the external control signals to the Master. Wire the Run enable signal of the Master via the fault indicating relay output of the Followers. See *M/F Link Wiring and Specification*.
- Switch ON the power to the drives.
- On the Master drive, change Parameter 60.01 MASTER LINK MODE to MASTER.
- On the Follower drive(s), adjust the parameters according to your application. (The parameters are listed in *M/F Communication and Parameter Set-up.)* Switch all drives to external control with the LOC/REM key on the Control Panel (there should be no “L” on the first row of the display).
- Perform a test run with the motors still de-coupled from the driven machinery. Feed the control signals both through the Master analogue/digital inputs and from the Master Control Panel. Check the correct operation of the Master and Follower drives visually (by observing the motor & Control Panel display):
  - Start, Stop, Direction and Run enable signals given to the Master are received by all drives.
  - The Master follows the speed reference.
  - The Follower follows Master speed reference or torque reference. In torque control, Window control restricts the excessive speed rise of the motor. Thus the actual speed of an unloaded Follower is higher than that of the Master, but will not reach the maximum speed limit.
- Disconnect the Control Panels from the Follower drives to avoid accidental use. See WARNING! below.
- Switch the power to the drives OFF.
- Couple the motor shafts to the driven machinery and switch on the power supplies.



WARNING! To avoid conflicting control, drives coupled to the same machinery should receive the external control signals only via the Master. General rules:
– Connect all external control signals to the Master drive only.
– Never control the Follower(s) with the Control Panel or through a fieldbus system.

M/F Link Wiring and Specification

Installation

WARNING! Before installation, switch off the drive power supply. Wait for five minutes to ensure that the intermediate circuit is discharged. Switch off all dangerous voltages connected from external control circuits to the relay output terminals of the drive.

WARNING! Do not touch the printed circuits. They are extremely sensitive to electrostatic discharge.

Master/Follower Link

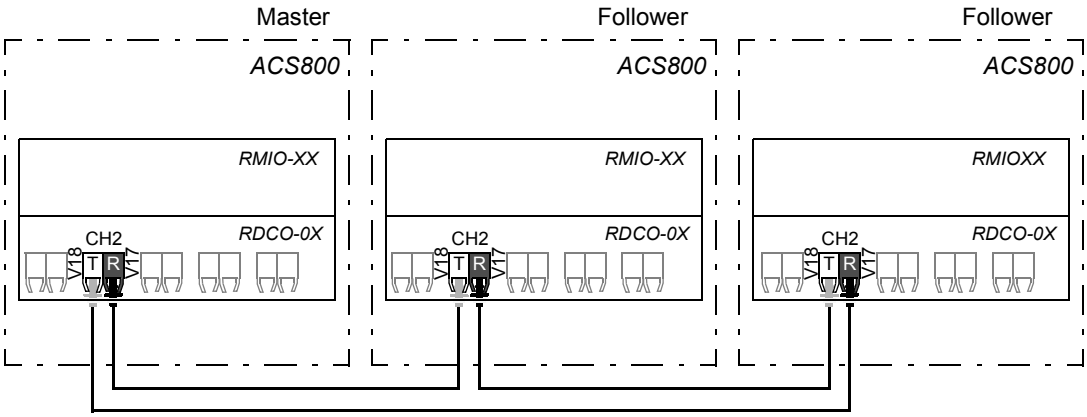


Figure 2. Connections. T = Transmitter; R = Receiver; RMIO = I/O and Control Board. (Please note that channels CH0/CH2/CH3 are located on the optional RDCO-0x board.)

The ring configuration can be used in most applications. A parallel connection can also be implemented by using a branching unit. (For more information, contact your local ABB representative.)

Handle the fibre optic cables with care. Do not touch the ends with bare hands, as fibre optic cables are extremely sensitive to dirt.

Note: For best results, all RDCO boards on the link should be of the same type.

Follower Supervision

There are two analogue outputs and three relay outputs in the drive for the external supervision purposes. By default, analogue output AO1 gives the motor speed and AO2 the motor current as 0 to 20 mA current signal. The relay outputs give the indications *Ready* (RO1), *Running* (RO2) and *No fault* (RO3).

It is possible to supervise the M/F Link with Parameters 30.18 COMM FAULT FUNC and 30.19 MAIN REF DS T-OUT. Parameter 30.18 defines the action (NO/FAULT/WARNING) when an error is detected on the M/F Link. Parameter 30.19 sets the time between the detection and the action defined by Parameter 30.18. For more information, see the *Firmware Manual*.

WARNING! The Follower does not send any feedback data to the Master via the serial Master/Follower Link. Therefore it is highly recommended to separately wire the fault information of the Follower to the Master.

Follower Fault Information Wiring

The connection will stop both the Master drive and the Follower drives upon a Follower fault.

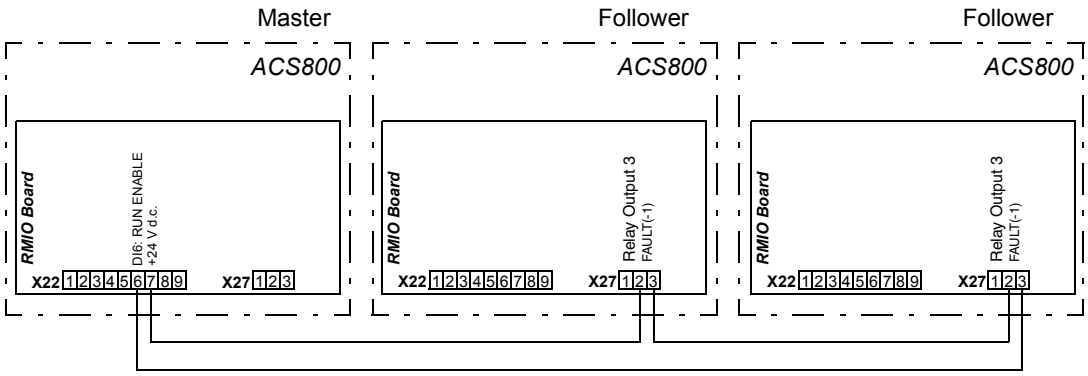


Figure 3. Follower fault information wiring.

Master/Follower Link Specification

Size of the Link: One Master and max. 10 Follower stations. If more than 10 followers are required, an ABB representative should be consulted.

Transmission medium: Fibre Optic Cable.

- Construction: Plastic core, diameter 1 mm, sheathed with plastic jacket
- Attenuation: 0.23 dB/m
- Maximum Length between Stations: 10 m
- Other:

Parameter	Minimum	Maximum	Unit
Storage Temperature	-55	+85	°C
Installation Temperature	-20	+70	°C
Short Term Tensile Force		50	N
Short Term Bend Radius	25		mm
Long Term Bend Radius	35		mm
Long Term Tensile Load		1	N
Flexing		1000	cycles

Various lengths of fibre optic cables are available as optional add-on kits.

Connectors: Blue – receiver (HP 9534, T-1521); grey – transmitter (HP 9534, R-2521)

Serial Communication Type: Synchronous, full Duplex

Transmission Rate: 4 Mbit/s

Transmission Interval: 4 ms

Maximum Transmission Delay: 16 ms

Protocol: ABB Distributed Drives Communication System (DDCS)

M/F Communication and Parameter Set-up

Overview

This chapter describes the communication between the Master station and the Follower stations, and presents the Master/Follower communication set-up parameters.

For other parameters, see the *Firmware Manual* delivered with the drive.



WARNING! The Follower must always be controlled by the Master while the motors are running and coupled to each other. **Do not change the control location of the Follower to Local, i.e. do not press the LOC/REM key on the Control Panel!**

Follower Control

The Master broadcasts a *Follower Control Word* and two references *(Reference 1* and *Reference 2)* to all Follower stations.

The Follower Control Word

The Follower Control Word (Actual signal 3.11 FOLLOWER MCW) is a packed 16-bit word. The commands in the Control Word are effective when the Follower Parameter 10.01 EXT1 STRT/STP/DIR or 10.02 EXT2 STRT/STP/DIR (whichever control location is selected) is set to COMM.CW.

Table 1. The Follower Control Word (Actual Signal 3.11 FOLLOWER MCW).

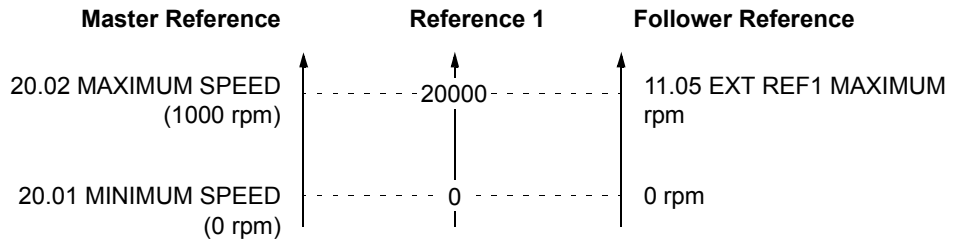
Bit	Name	Description
0	OFF1	Not in use
1	OFF2	
2	OFF3	
3	RUN	0 = Stop (Master not running), 1 = Run (Master running)
4	RAMP_OUT_ZERO	Not in use
5	RAMP_HOLD	
6	RAMP_IN_ZERO	
7	RESET	0 -> 1 Fault Reset (if an active fault exists)
8	INCHING_1	Not in use
9	INCHING_2	Not in use
10	REMOTE_CMD	Fieldbus control enabled
11	EXT_CTRL_LOC	Not in use
12 … 15	Reserved	

Reference 1

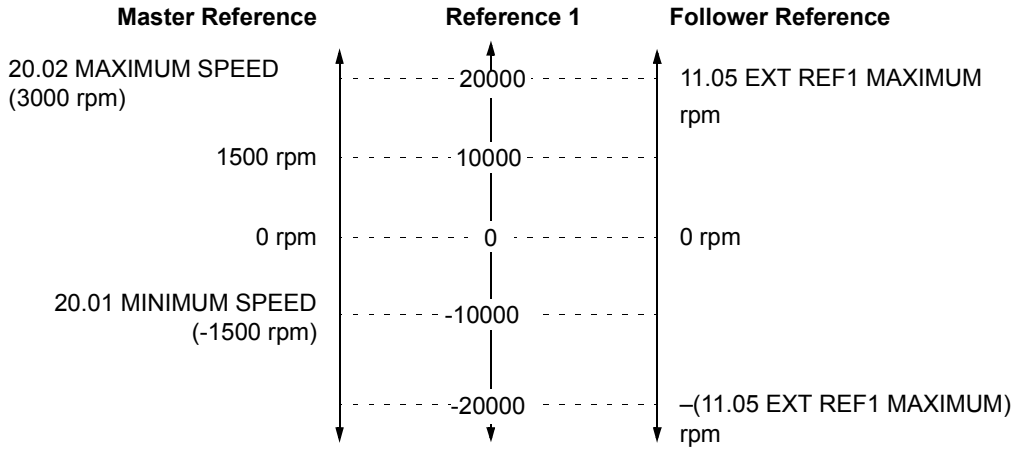
Reference 1 is a 16-bit word containing a sign bit and a 15-bit integer. It is formed from the speed reference of the Master using the values of Parameters 20.01 MINIMUM SPEED or 20.02 MAXIMUM SPEED: whichever has the greater absolute value determines both the positive and negative limits that correspond to Reference levels +20000 and –20000. See the examples in Figure 4. below.

In the Follower, *Reference 1* is decoded as follows: 20000 corresponds to the value of Follower Parameter 11.05 EXT REF1 MAXIMUM.

Example 1:
20.01 MINIMUM SPEED = 0 rpm
20.02 MAXIMUM SPEED = 1000 rpm



Example 2:
20.01 MINIMUM SPEED = –1500 rpm
20.02 MAXIMUM SPEED = 3000 rpm



Example 3:
20.01 MINIMUM SPEED = –5000 rpm
20.02 MAXIMUM SPEED = 2500 rpm

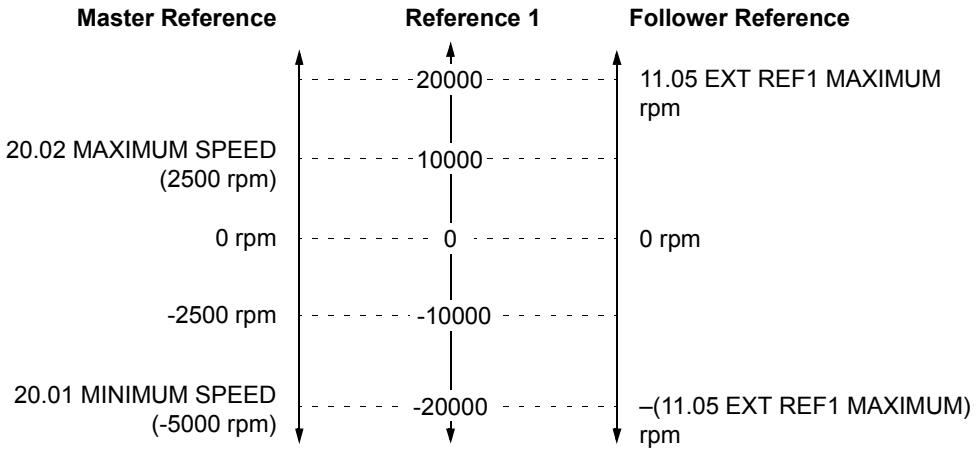


Figure 4. Relation between the speed references of the Master and the Follower.

Reference 2

Reference 2 is a 16-bit word containing a sign bit and a 15-bit integer. It is formed from the relative torque reference of the Master: the motor nominal torque (calculated by the drive) of the Master corresponds to the Reference value of 10000. In the Follower *Reference 2* is decoded as follows: 10000 corresponds to the maximum reference setting of the Follower (Parameter 11.08 EXT REF2 MAXIMUM, given as a percentage of Follower motor nominal torque).

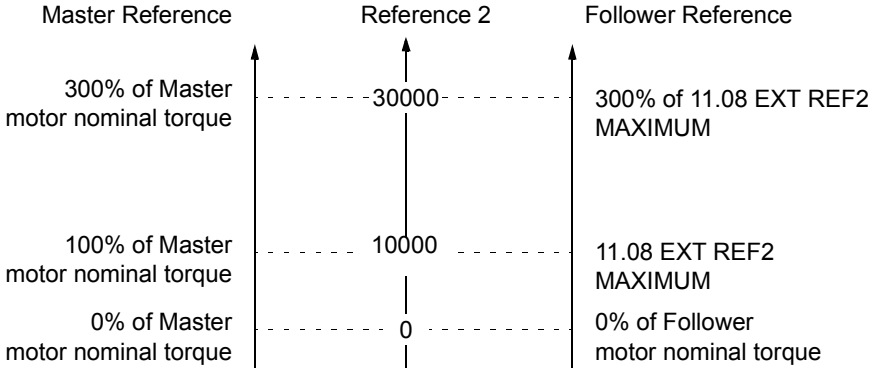


Figure 5. Relation between the torque references of the Master and the Follower.

Parameter Settings – Master Station

The Master station can be set up and controlled quite like an independent drive. (Follow the instructions in the *Firmware Manual.*) In addition, the table below lists the parameters that need to be adjusted for a Master/Follower application. The parameters are detailed further in the text.

Parameter	Typical Setting for Master
60.01 MASTER LINK MODE	MASTER
60.02 TORQUE SELECTOR	TORQUE
60.03 WINDOW SEL ON	NO
60.04 WINDOW WIDTH POS	0.0 rpm
60.05 WINDOW WIDTH NEG	0.0 rpm
60.06 DROOP RATE	see text
60.07 MASTER SIGNAL 2	202
60.08 MASTER SIGNAL 3	213

60.01 MASTER LINK MODE

This parameter determines the role of the drive on the Master/Follower link. On the Master station, set this parameter to **MASTER**. The drive will now start transmitting the Follower Control Word and the two selected References (see Parameters 60.07 MASTER SIGNAL 2 and 60.08 MASTER SIGNAL 3) through fibre optic channel CH2.

60.02 TORQUE SELECTOR

The default value of this parameter is **TORQUE**. Typically, the value needs to be changed for Follower stations only. For more information, see section *Parameter Settings – Follower Station* below.

60.03 WINDOW SEL ON

This parameter selects Window control. Typically, Window control is used in Follower stations only.

The default value of this parameter is **NO** (i.e. Window control is OFF). For more information, see the section *Parameter Settings – Follower Station* below.

60.04 WINDOW WIDTH POS

See the section *Parameter Settings – Follower Station* below.

60.05 WINDOW WIDTH NEG

See the section Parameter Settings – Follower Station below.

60.06 DROOP RATE

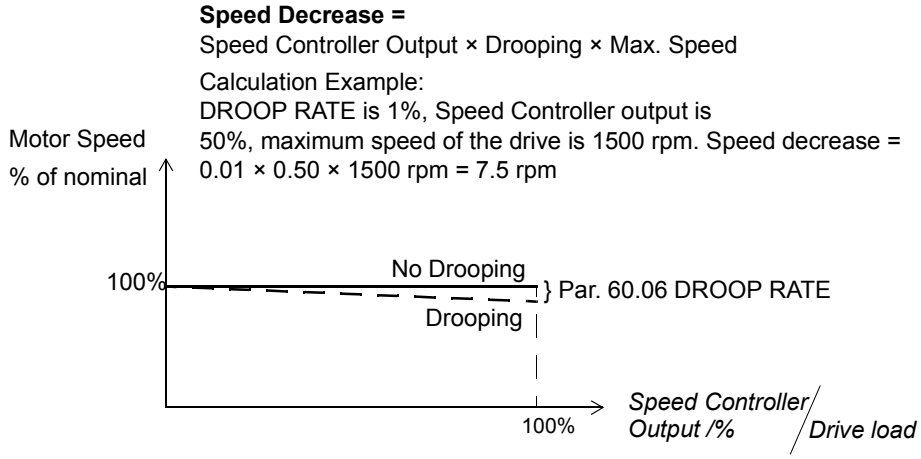
Drooping prevents conflict between the Master and Follower stations by allowing a slight speed difference between them. The default value is **0%**.

The droop rate needs to be adjusted only if both the Master and the Follower are speed-controlled, i.e.

- external control location 1 (EXT1) is selected (see Parameter 11.02 EXT1/EXT2 SELECT), or
- external control location 2 (EXT2) is selected (see Parameter 11.02 EXT1/EXT2 SELECT) and Parameter 60.02 TORQUE SELECTOR is set to SPEED.

The correct droop rate for a process must be found out case by case in practice. The droop rate must be set for both the Master and the Follower.

The droop rate is set as a percentage of the nominal speed of the motor. The actual speed decrease at a certain operating point depends on the droop rate setting and the drive load (i.e. torque reference / speed controller output). Drooping decreases the drive speed slightly as the load increases. When the speed controller output is 100%, drooping is at the level specified by Parameter 60.06 DROOP RATE. The drooping effect decreases linearly to zero along with the decreasing load.



60.07 MASTER SIGNAL 2

Selects the signal that is sent by the Master to the Followers as Reference 1 (speed reference).

The format is as follows: **(x)xyy**, where **(x)x** denotes Parameter Group and **yy** denotes Index. For example, the default value of **202** corresponds to Group 2, Index 02, i.e. 2.02 SPEED REF 3.

60.08 MASTER SIGNAL 3

Selects the signal that is sent by the Master to the Followers as Reference 2 (torque reference).

The format is as follows: **(x)xyy**, where **(x)x** denotes Parameter Group and **yy** denotes Index. For example, the default value of **213** corresponds to Group 2, Index 13, i.e. 2.13 TORQ REF USED.

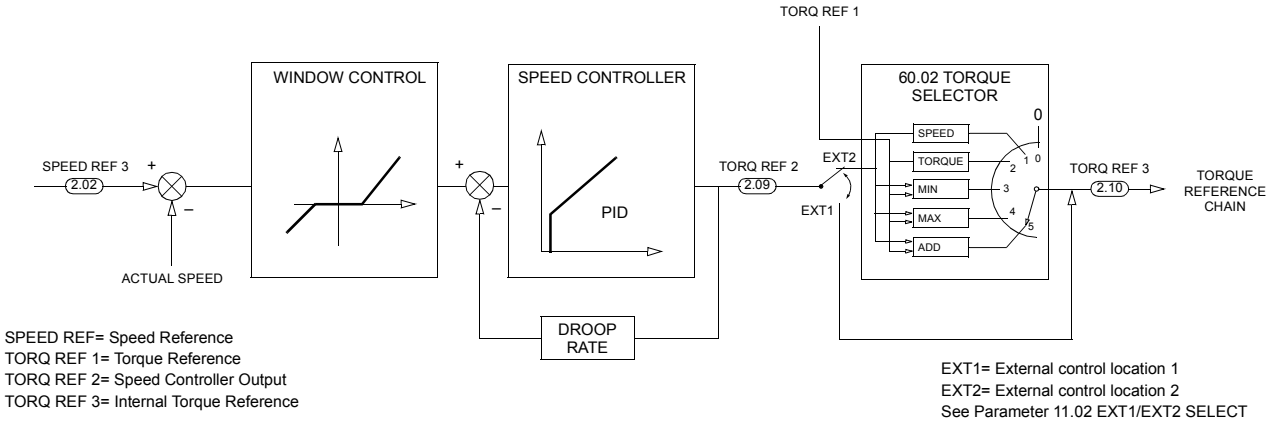


Figure 6. Window control, Torque selector and Droop rate settings. For information on tuning the speed controller, see the Firmware Manual*, Parameter Group 23 Speed Control.*

Parameter Settings – Follower Station

The table below lists the parameters that need to be adjusted for a Master/Follower application. The parameters are detailed further in the text.

For other parameter settings, see the *Firmware Manual.*

Parameter	Typical Setting for Speed-controlled Follower	Typical Setting for Torque-controlled Follower
10.01 EXT1 STRT/STP/DIR	COMM.CW	COMM.CW
10.02 EXT2 STRT/STP/DIR	COMM.CW	COMM.CW
11.02 EXT1/EXT2 SELECT	EXT1	EXT2
11.03 EXT REF1 SELECT	COMM.REF	COMM.REF
11.06 EXT REF2 SELECT	COMM.REF	COMM.REF
16.01 RUN ENABLE	COMM.CW(3)	COMM.CW(3)
16.04 FAULT RESET SEL	COMM.CW(7)	COMM.CW(7)
30.18 COMM FAULT FUNC	FAULT	FAULT
30.19 MAIN REF DS T-OUT	1.00 s	1.00 s
60.01 MASTER LINK MODE	FOLLOWER	FOLLOWER
60.02 TORQUE SELECTOR	SPEED	ADD
60.03 WINDOW SEL ON	NO	YES
60.04 WINDOW WIDTH POS	0.0 rpm	30.0 rpm
60.05 WINDOW WIDTH NEG	0.0 rpm	30.0 rpm
60.06 DROOP RATE	see text	see text

10.01 EXT1 STRT/STP/DIR

This parameter defines the source of the Start, Stop and Direction commands for the Follower when it has EXT1 selected as the active control location.

The direction of rotation is determined as in fieldbus control; see the *Firmware Manual*.

COMM.CW
This is the typical setting for a Follower. The Follower Control Word, received from the Master station through channel CH2, is the signal source of the Start and Stop commands when EXT1 is the active control location for the Follower.

For information on the selection between speed and torque control, see the description of Parameter 11.02 EXT1/EXT2 SELECT.

(ALL OTHER SELECTIONS)
See the *Firmware Manual.*

10.02 EXT2 STRT/STP/DIR

Defines the source of Start, Stop and Direction commands for External control location 2 (EXT2). See Parameter 10.01 EXT1 STRT/STP/DIR above for the alternative settings.

11.02 EXT1/EXT2 SELECT

This parameter sets the input used for selecting the External control location, or fixes it to EXT1 or EXT2. The parameter determines the active External control location for both the Start/Stop/Direction commands and the reference.

EXT1; EXT2; DI1 … DI6; COMM.CW(11)
See the Firmware Manual.

Note: The Follower Control Word sent by the Master does not contain control location selection information. Thus, do not set this parameter to COMM.CW(11) on a Follower station.

The selection between EXT1 and EXT2 is illustrated in the control connection diagrams (see the chapter *Follower Control Signal Connections*):

When EXT1 is selected,

- the control commands are read from the source defined with Parameter 10.01 STRT/STP/DIR
- the external speed reference is read from the source defined with Parameter 11.03 EXT REF1 SELECT
- the drive is speed-controlled; Window control is not possible.

When EXT2 is selected,

- the control commands are read from the source defined with Parameter 10.02 STRT/STP/DIR
- the external speed reference is read from the source defined with Parameter 11.03 EXT REF1 SELECT (Note that the critical speeds (Parameter Group 25) are ignored in the speed control chain.)
- the external torque reference is read from the source defined with Parameter 11.06 EXT REF2 SELECT
- the drive is speed-controlled or torque-controlled depending on the value of Parameter 60.02 TORQUE SELECTOR which selects the internal torque reference. The parameter fixes it to the speed controller output (SPEED) or direct torque reference (TORQUE), or the MINIMUM, MAXIMUM or ADD function is used to automatically switch between speed and torque control. See description of Parameter 60.02 TORQUE SELECTOR below.

WARNING! The Follower should always be controlled by the Master while the motors are coupled to each other. Do not change the control location if this activates a control signal source other than Master:

- Do not change the External control location if Parameter 10.01, 10.02, 11.03 or 11.06 is set to a value other than COMM.CW or COMM.REF.
- Do not switch to local control (do not press the LOC/REM key on the Control Panel).

If the Master and Follower are controlled with different control signals, the drives will conflict with each other.

Hint: In some applications, both speed control and torque control of the Followers are required, e.g. if it is necessary to accelerate all drives along the same speed ramp up to a certain speed before torque control can be implemented. In those cases, “on-the-fly” switching between speed and torque controls is required. The switching can be done through a digital input on the Follower. One solution is to set Parameter 11.02 EXT1/EXT2 SELECT to DI3, 60.02 TORQUE SELECTOR to TORQUE and 60.03 WINDOW SEL ON to OFF. With these settings,

- 0 V d.c connected to DI3 ≙ External control location 1 is selected and the Follower follows the speed reference of the Master. Window control is disabled.
- +24 V d.c. connected to DI3 ≙ External control location 2 is selected and the Follower follows the torque reference of the Master. Window control is enabled.

11.03 EXT REF1 SELECT

This parameter selects the signal source of External reference 1 (speed reference). The selection is illustrated in the control connection diagrams (see the chapter *Follower Control Signal Connections*).

COMM.REF
Reference 1 received from the Master is External reference 1.

COMMREF1+AI1; COMMREF1*AI1; COMMREF1+AI5; COMMREF1*AI5
Reference 1 received from the Master is added to or multiplied by the rpm value converted from the signal connected to Analogue input AI1 or AI5. The effect of the correction on the reference is as with a fieldbus reference signal; see the *Firmware Manual*.

FAST COMM
Reference 1 received from the Master is External reference 1. With FAST COMM, the reference is transferred to the core motor control program every 2 milliseconds (as opposed to 6 ms with COMM.REF). However, the motor rotation direction cannot be controlled through the interfaces defined by Parameter 10.01 EXT1 STRT/STP/DIR or from the Control Panel. Furthermore, critical speeds (Group 25) are not effective.

Note: If any of the following selections is TRUE, the selection FAST COMM is not effective, and the operation is as with COMM. REF:

- 99.02 APPLICATION MACRO is PID
- 99.04 MOTOR CTRL MODE is SCALAR
- 40.14 TRIM MODE is PROPORTIONAL or DIRECT

(ALL OTHER SELECTIONS)
See the *Firmware Manual*.

11.06 EXT REF2 SELECT

This parameter selects the signal source of External reference 2 (torque reference). The selection is illustrated in the control connection diagrams (see the chapter *Follower Control Signal Connections*).

COMM.REF
Reference 2 received from the Master is External reference 2.

COMMREF2+AI1; COMMREF2*AI1; COMMREF2+AI5; COMMREF2*AI5
Reference 2 received from the Master is added to or multiplied by the % value converted from the signal connected to Analogue input AI1 or AI5. The effect of the correction on the reference is as with a fieldbus reference signal; see the *Firmware Manual*.

FAST COMM
Reference 2 received from the Master is External reference 2. With FAST COMM, the reference is transferred to the core motor control program every 2 milliseconds (as opposed to 6 ms with COMM. REF). However, the motor rotation direction cannot be controlled through the interface defined by Parameter 10.02 EXT2 STRT/STP/DIR or from the Control Panel. Furthermore, critical speeds (Group 25) are not effective.

Note*:* If any of the following selections is TRUE, the selection FAST COMM is not effective, and the operation is as with COMM. REF:

- 99.02 APPLICATION MACRO is PID
- 99.04 MOTOR CTRL MODE is SCALAR
- 40.14 TRIM MODE is PROPORTIONAL or DIRECT

(ALL OTHER SELECTIONS)
See the *Firmware Manual*.

16.01 RUN ENABLE

This parameter selects the source of the Run enable signal. The selection is illustrated in the control connection diagrams in the chapter *Follower Control Signal Connections*.

YES; DI1; … ; DI12

See the *Firmware Manual*.

COMM.CW(3)

The Run enable signal is read from Bit 3 of the *Follower Control Word* received from the Master.

16.04 FAULT RESET SEL

NOT SEL; DI1; …; DI12; ON STOP

See the *Firmware Manual*.

COMM.CW(7)

The fault reset signal is read from Bit 7 of the *Follower Control Word* received from the Master.

30.18 COMM FAULT FUNC

Defines the action in case communication with the Master is lost. The supervision is based on monitoring of received Follower Control data sets. For the available selections, see the *Firmware Manual.*

30.19 MAIN REF DS T-OUT

See the Firmware Manual.

60.01 MASTER LINK MODE

This parameter determines the role of the drive on the Master/Follower link. On Follower stations, set this parameter to **FOLLOWER**. The drive will now start reading the Follower Control Word and the two References through fibre optic channel CH2.

Note*:* Selecting FOLLOWER does not mean that data received from the Master takes effect at once. The data only becomes available as one possible source of control, and is accessible by parameters as “COMM.CW” or “COMM.REF”.

60.02 TORQUE SELECTOR

This parameter is only visible when Parameter 99.02 APPLICATION MACRO is set to T CTRL (Torque Control). The parameter selects the reference used in motor torque control, and only affects External control location 2 (EXT2).

SPEED
The Follower speed controller output is used as the reference for motor torque control. The drive is speed-controlled. This setting can be used both in the Master and the Follower if the motor shafts of the Master and the Follower have a flexible connection, so that a slight speed difference is possible/allowable between them.

TORQUE
The drive is torque-controlled. This is the default value.

This selection should be used in the Follower(s) when the motor shafts of the Master and the Follower(s) are coupled solidly (e.g. by gearing or a chain), so that no speed difference is possible/allowable between them.

Note*:* If TORQUE is selected, the drive does not restrict the speed variation as long as the speed is within the limits defined by Parameters 20.01 MINIMUM SPEED and 20.02 MAXIMUM SPEED. More definite speed supervision is often needed. In these cases, the selection ADD should be used instead.

MINIMUM
The torque selector compares the torque reference and the speed controller output, the smaller of which is used as the motor torque reference. Used in special cases only.

MAXIMUM
The torque selector compares the torque reference and the speed controller output, the greater of which is used as the motor torque reference. This setting is used in special cases only.

ADD
The torque selector adds the speed controller output to the torque reference. The drive is torque-controlled within the normal operating range.

The selection ADD, together with Window control, forms a speed supervision function for a torque-controlled Follower station as follows:

- Within the normal operating range, the Follower follows the torque reference of the Master (TORQ REF 1)
- Window control keeps the speed controller input and output to zero as long as speed error (speed reference minus actual speed) remains within the parameterised window.
- If the speed error moves out of the window, Window control connects the error to the speed controller. The speed controller output increases or decreases the internal torque reference, stopping the change in actual speed.

ZERO
Forces the torque selector output to zero.

60.03 WINDOW SEL ON

Window control, together with selection ADD at Parameter 60.02 TORQUE SELECTOR, forms a speed supervision function for a torque-controlled drive.

The parameter is visible only when Parameter 99.02 APPLICATION MACRO is set to T CTRL. External control location 2 (EXT2) must be active to enable Window control.

NO
Window control is off. This is the default value.

YES
Window control is on. Use this setting only when Parameter 60.02 TORQUE SELECTOR is set to ADD.

Window control supervises the speed error value (speed reference minus actual speed). Within the normal operating range, Window control keeps the speed controller input to zero. The speed controller is active only when

- speed error exceeds the value of Parameter 60.04 WINDOW WIDTH POS or
- absolute value of the negative speed error exceeds the value of Parameter 60.05 WINDOW WIDTH NEG.

When the speed error moves outside the window, the exceeding part of the error value is connected to the speed controller. The speed controller produces a reference term relative to the input and gain of the speed controller (Parameter 23.01 GAIN) which the torque selector adds to the torque reference. The result is used as the internal torque reference for the drive.

For example in a load loss condition, the internal torque reference of the drive decreases, preventing the excessive rise of motor speed (see Window control.). If Window control were deactivated, the motor speed would rise until speed limit of the drive was reached. (Parameters 20.01 MINIMUM SPEED and 20.02 MAXIMUM SPEED define the speed limits.)

60.04 WINDOW WIDTH POS

See Parameter 60.03 WINDOW SEL ON. The parameter is only visible when Parameter 99.02 APPLICATION MACRO is set to T CTRL.

0 … 1500 rpm
Default: 0.

60.05 WINDOW WIDTH NEG

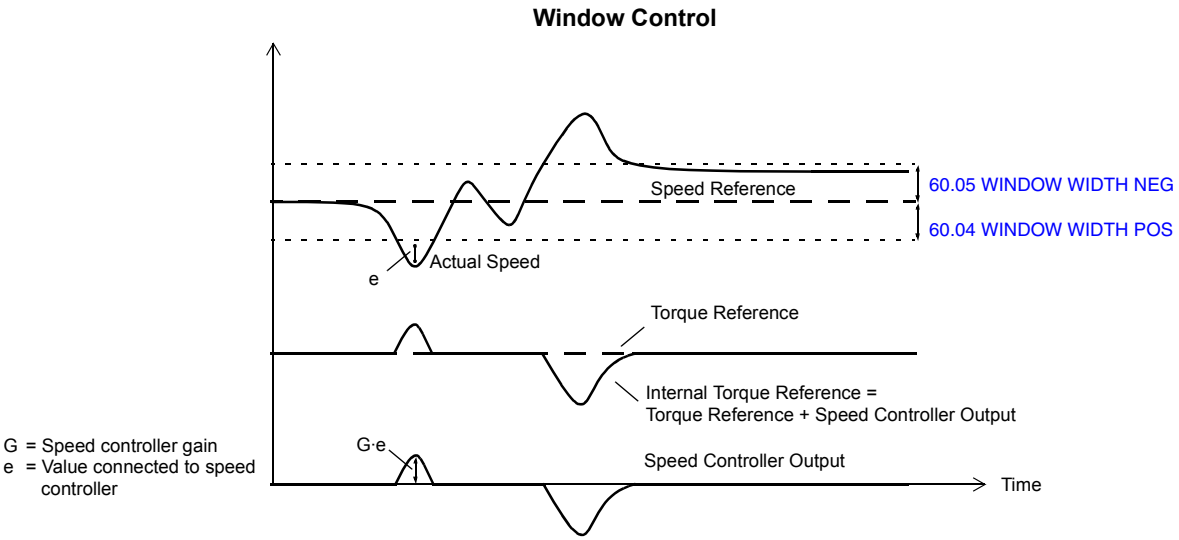
See Parameter 60.03 WINDOW SEL ON. The parameter is only visible when Parameter 99.02 APPLICATION MACRO is set to T CTRL.

0 … 1500 rpm
Default: 0.

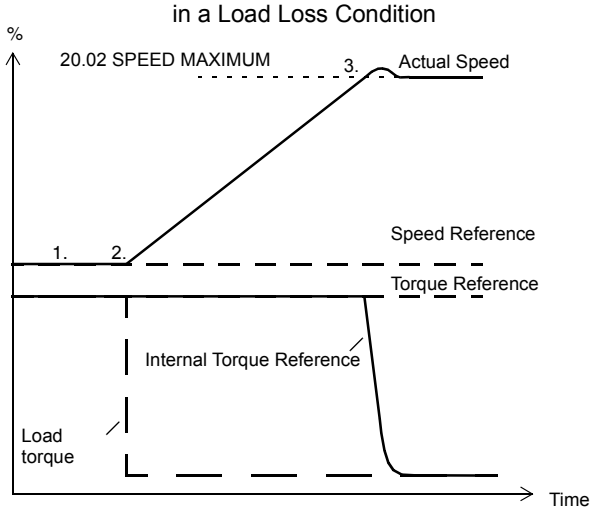
60.06 DROOP RATE

See section *Parameter Settings – Master Station* above.

WARNING! Follower speed control or drooping should not be used if the motor shafts of the Master and the Follower are coupled solidly by a mechanical construction (gearing, chain etc.).



Example 1: Window Control Off in a Load Loss Condition



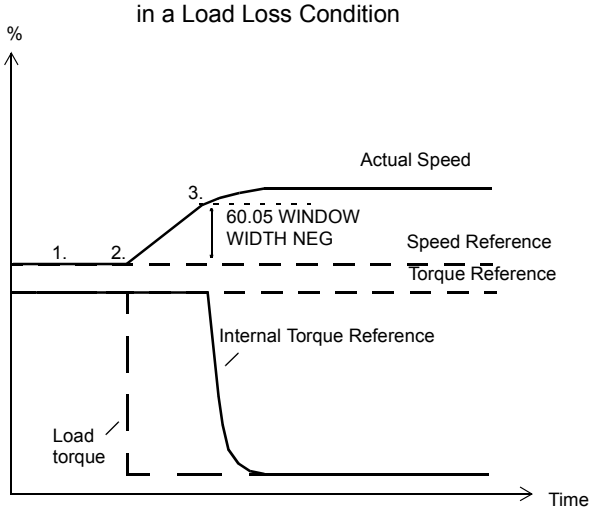
The Follower drive is torque-controlled. Parameter 11.02 EXT1/ EXT2 SELECT is set to EXT2 and 60.02 TORQUE SELECTOR to TORQUE.

1. Normal operating range. The Follower is controlled by torque reference of the Master.

2. Load loss occurs. Follower actual speed starts to rise.

3. The speed increases until the maximum speed limit of the drive is reached (Parameter 20.02 MAXIMUM SPEED). Internal torque reference is restricted to stop the speed increase.

Example 2: Window Control On in a Load Loss Condition



The Follower drive is torque-controlled. Parameter 11.02 EXT1/ EXT2 SELECT is set to EXT2 and 60.02 TORQUE SELECTOR to ADD.

1. Normal operating range. Window Control keeps the speed controller input zero. The Follower is controlled by torque reference of the Master.

2. Load loss occurs. Follower actual speed starts to rise.

3. The speed increases until the absolute value of the negative speed error exceeds WINDOW WIDTH NEG. Window Control connects the value outside the window to the speed controller. Negative speed controller output value is produced and added to torque reference received from the Master. Internal torque reference is restricted to stop the speed increase.

Figure 7. Window control.

Fieldbus Connection

A fieldbus adapter can be used for monitoring the Follower, but not for controlling it.

The Master can be controlled through a fieldbus system as described in the *Firmware Manual*.

Pulse Encoder Connection

If speed measurement is required with Master or Follower stations, a pulse encoder must be used. The encoder is connected to the drive through an optional pulse encoder module. For more information, see the appropriate module manual.

Follower Control Signal Connections

Follower Control

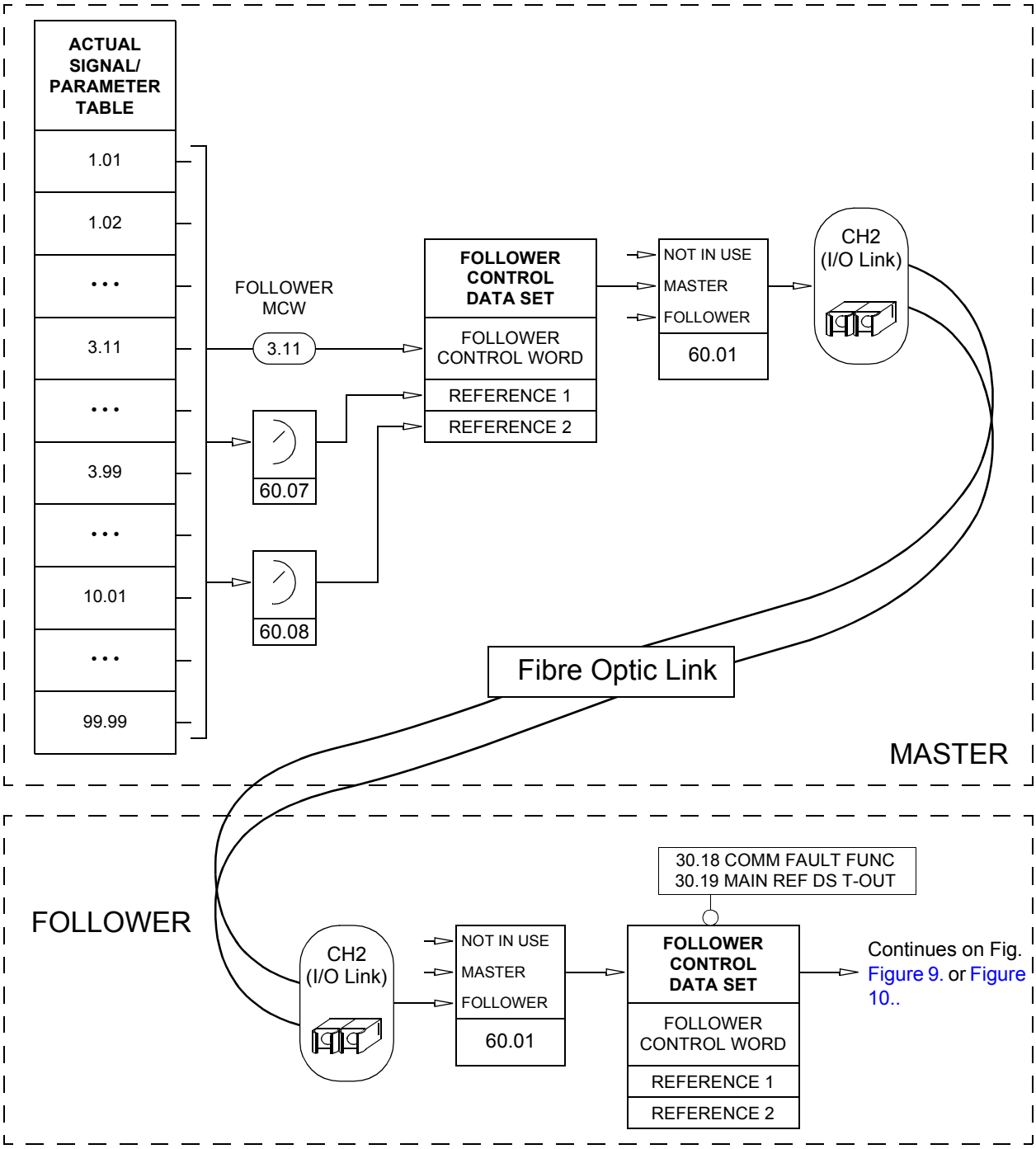


Figure 8. Follower control data transfer.

Follower Station, Torque Control

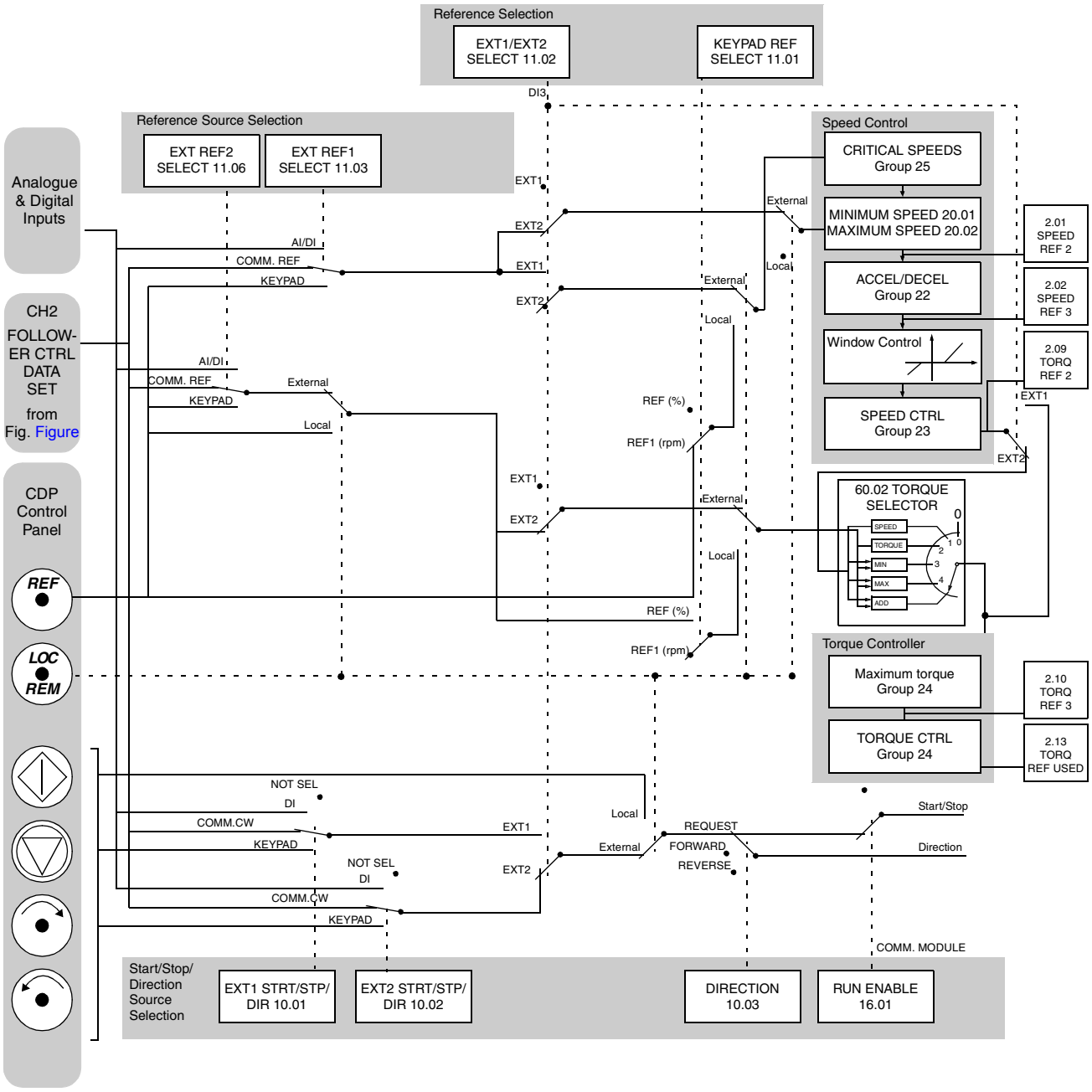


Figure 9. Control signal connections for the Follower station when the Follower Torque Control settings of the parameters are valid and local control (Control Panel) is not active.

Follower Station, Speed Control

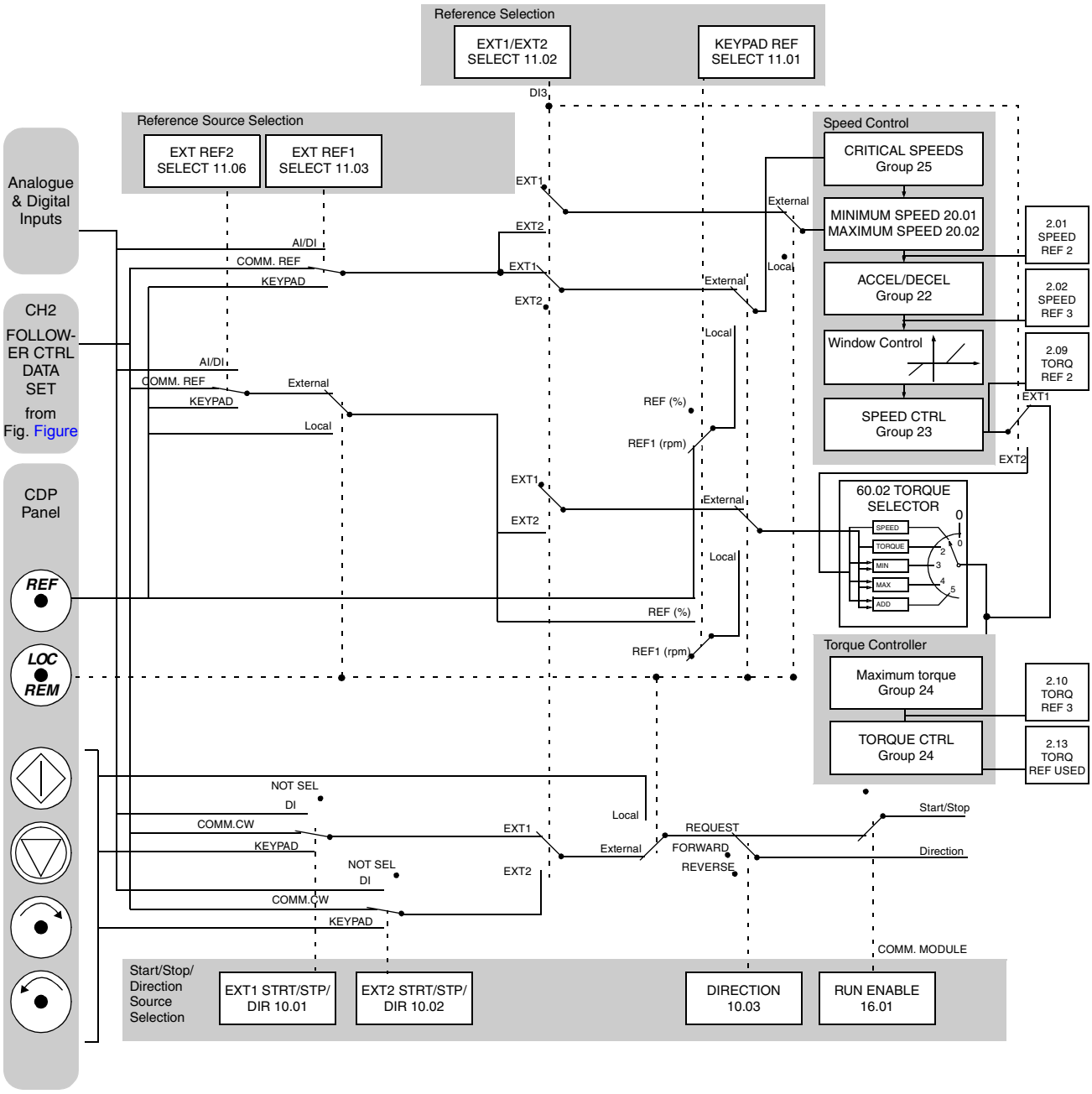
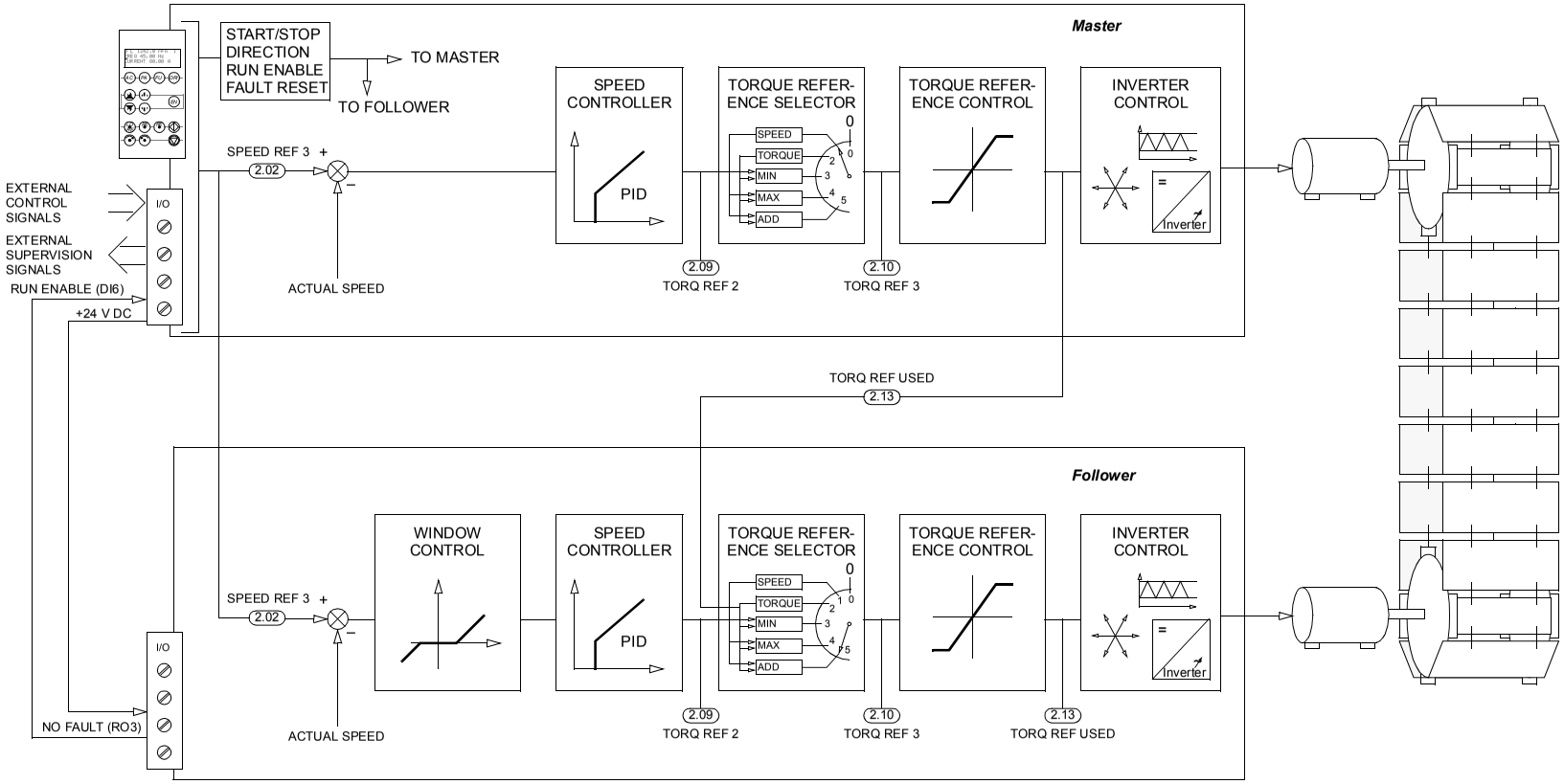


Figure 10. Control signal connections for the Follower station when the Follower Speed Control settings of the parameters are valid and local control (Control Panel) is not active.

Example 1: Master and Follower Drives Coupled Solidly to Each Other



Example 1: Master and Follower are coupled solidly by a mechanical construction (gearing, chain etc.)

To equalise the load between the Master and the Follower, Master is speed controlled and Follower follows the torque reference of the Master.

For parameter settings, see *M/F Communication and Parameter Set-up*.

Operation:

When driven at normal operating conditions, the speed controller output (TORQ REF 2) of the Follower is zero due to Window Control. The Follower follows the torque reference of the Master (TORQ REF 1).

In a Follower load loss condition, Window Control activates the speed controller, thus preventing the Follower drive from rushing up to the maximum speed limit:

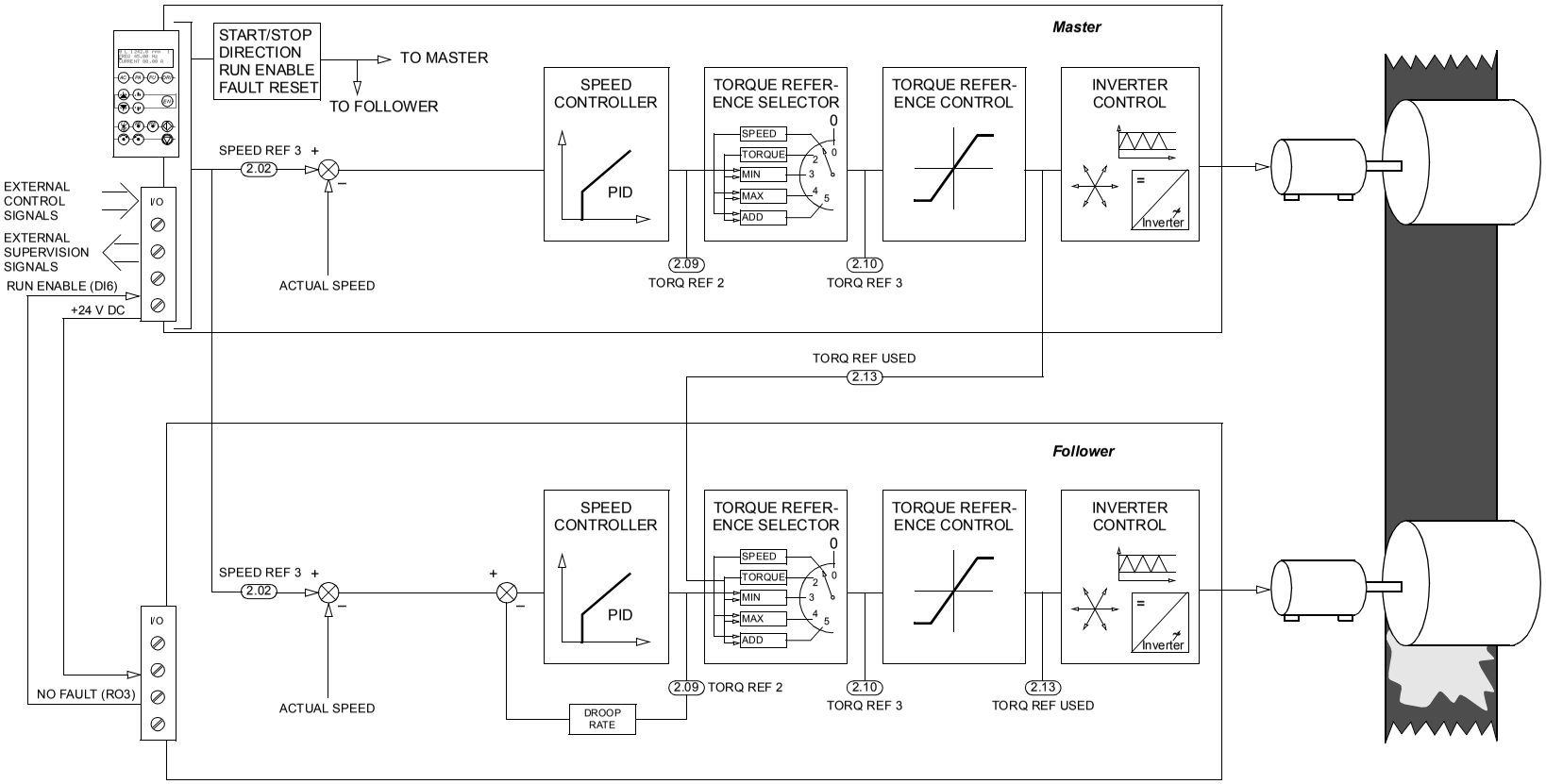
–Follower actual speed starts to rise rapidly.

–Absolute value of the speed error (SPEED REF 3 - ACTUAL SPEED) exceeds the value set by Parameter 60.05 WINDOW WIDTH NEG. As a consequence, the Window Control block connects the error to the speed controller.

–The speed controller starts adding a negative term to the torque reference (TORQ REF 1). The motor torque is limited and speed rise prevented.

The Run enable signal to the master is wired through Relay Output RO3 of the Follower. By default, RO3 switches off the Run enable signal upon a Follower fault or power loss.

Example 2: Master and Follower Drives Coupled Flexibly to Each Other



Example 2: Master and Follower are coupled flexibly.

To equalise the load between the Master and the Follower, they are controlled with the same speed reference. Torque control of the Follower cannot be used due to varying friction of the belt driven; a sudden fall in friction of the follower wheel would cause the motor to rush as the drive would be trying to retain a certain torque level. Drooping should be used to ensure smooth operation and even load distribution between the Master and the Follower.

For parameter settings, see *M/F Communication and Parameter Set-up*.

Operation:

The Follower follows the same speed reference as the Master (SPEED REF 3). Drooping ensures even load distribution in all operating conditions. An example:

–Friction under the follower wheel drops, causing slipping. The torque is decreased to prevent the speed rise.

–The load of the master increases -> Internal torque reference increases to keep the speed constant -> Drooping in the Master increases -> Speed decreases slightly.

–The Follower now runs a little faster than the Master. When the friction returns to normal, the Follower load increases, causing a rise in the internal torque reference. Drooping in the Follower increases -> Follower actual speed decreases. The Master load increases. This cycle is repeated until the balance is regained.

The Run enable signal to the master is wired through Relay Output RO3 of the Follower. By default, RO3 switches off the Run enable signal upon a Follower fault or power loss.

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