ABB MOTION CONTROL DRIVES

# ACSM1 speed and torque control program

## Firmware manual

# List of related manuals

| **Drive hardware manuals and guides** | **Code (English)** |
|---|---|
| ACSM1-04 (0.75 to 45 kW) Hardware manual | 3AFE68797543 |
| ACSM1-04 (55 to 110 kW) Hardware manual | 3AFE68912130 |
| ACSM1-04 drive modules (200 to 355 kW, 250 to 450 hp) Hardware manual | 3AUA0000117209 |
| **Drive firmware manuals and guides** | |
| ACSM1 speed and torque control program Firmware Manual | 3AFE68848261 |
| ACSM1 motion control program Firmware manual | 3AFE68848270 |
| **Drive PC tools manuals** | |
| DriveStudio User Manual | 3AFE68749026 |
| DriveSPC User Manual | 3AFE68836590 |
| **Application guides** | |
| Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives | 3AFE68929814 |
| Functional Safety Solutions with ACSM1 Drives Application Guide | 3AUA0000031517 |
| ACSM1 System Engineering Manual | 3AFE68978297 |
| **Option manuals** | |
| FIO-01 Digital I/O Extension User’s Manual | 3AFE68784921 |
| FIO-11 Analog I/O Extension User’s Manual | 3AFE68784930 |
| FEN-01 TTL Encoder Interface User’s Manual | 3AFE68784603 |
| FEN-11 Absolute Encoder Interface User’s Manual | 3AFE68784841 |
| FEN-21 Resolver Interface User’s Manual | 3AFE68784859 |
| ACSM1 Control Panel User’s Guide | 3AUA0000020131 |

You can find manuals and other product documents in PDF format on the Internet. See section Document library on the Internet on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.

The code below opens an online listing of the manuals applicable to the product:

ACSM1 manuals

# Firmware manual

## ACSM1 speed and torque control program

3AFE68848261 Rev J
EN
EFFECTIVE: 2019-08-30

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# Introduction to the manual

## What this chapter contains

The chapter includes a description of the contents of the manual. In addition it contains information about the compatibility, safety and intended audience.

## Compatibility

The manual is compatible with ACSM1 speed and torque control program version UMFI2040 and later. See parameter 9.04 FIRMWARE VER or PC tool (View - Properties).

## Safety instructions

Follow all safety instructions delivered with the drive.

- Read the **complete safety instructions** before you install, commission, or use the drive. The complete safety instructions are given at the beginning of the *Hardware Manual*.
- Read the **software function specific warnings and notes** before changing the default settings of the function. For each function, the warnings and notes are given in this manual in the section describing the related user-adjustable parameters.

## Reader

The reader of the manual is expected to know the standard electrical wiring practices, electronic components, and electrical schematic symbols.

## Contents

The manual consists of the following chapters:

- *Start-up* instructs in setting up the control program and how to control the drive through the I/O interface.
- *Drive programming using PC tools* introduces programming via PC tool (DriveStudio and/or DriveSPC).
- *Drive control and features* describes the control locations and operation modes of the drive, and the features of the application program.
- *Default connections of the control unit* presents the default connections of the JCU Control Unit.
- *Parameters and firmware blocks* describes the drive parameters and firmware function blocks.
- *Parameter data* contains more information on the parameters of the drive.
- *Fault tracing* lists the warning and fault messages with the possible causes and remedies.
- *Standard function blocks*
- *Application program template*
- *Appendix A – Fieldbus control* describes the communication between the drive and a fieldbus.
- *Appendix B – Drive-to-drive link* describes the communication between drives connected together by the drive-to-drive link.
- *Appendix C – Control chain and drive logic diagrams.*

## Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type code and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

## Product training

For information on ABB product training, go to new.abb.com/service/training.

## Providing feedback on ABB Drives manuals

Your comments on our manuals are welcome. Go to new.abb.com/drives/manuals-feedback-form.

## Cybersecurity disclaimer

This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

# Start-up

## What this chapter contains

This chapter describes the basic start-up procedure of the drive and instructs in how to control the drive through the I/O interface.

## How to start up the drive

The drive can be operated:

- locally from PC tool or control panel
- externally via I/O connections or fieldbus interface.

The start-up procedure presented uses the DriveStudio PC tool program. Drive references and signals can be monitored with DriveStudio (Data Logger or Monitor Window). For instructions on how to use DriveStudio, see *DriveStudio User Manual* [3AFE68749026 (English)].

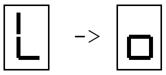
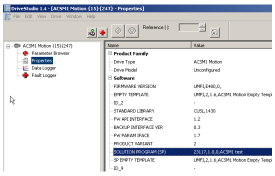
The start-up procedure includes actions which need to be performed only when the drive is powered up for the first time (eg, entering the motor data). After the first start-up, the drive can be powered up without using these start-up functions. The start-up procedure can be repeated later if start-up data needs to be changed.

In addition to the PC tool commissioning and drive power-up, the start-up procedure includes the following steps:

- entering the motor data and performing the motor identification run
- setting up the encoder/resolver communication
- checking the emergency stop and Safe Torque Off circuits
- setting up the voltage control
- setting the drive limits
- setting up the motor overtemperature protection
- tuning the speed controller
- setting up the fieldbus control.

If an alarm or a fault is generated during the start-up, see chapter *Fault tracing* for the possible causes and remedies. If problems continue, disconnect the main power and wait 5 minutes for the intermediate circuit capacitors to discharge and check the drive and motor connections.

Before you start, ensure you have the motor nameplate and encoder data (if needed) at your hand.

| | | |
|---|---|---|
| **Safety** | | |
| ⚠ | The start-up may only be carried out by a qualified electrician.<br>The safety instructions must be followed during the start-up procedure. See the safety instructions on the first pages of the appropriate hardware manual. | |
| □ | Check the installation. See the installation checklist in the appropriate hardware manual. | |
| □ | Check that the starting of the motor does not cause any danger.<br>**De-couple the driven machine** if<br>- there is a risk of damage in case of an incorrect direction of rotation, or<br>- a normal motor ID run (99.13 IDRUN MODE = (1) Normal) is required during the drive start-up, when the load torque is higher than 20% or the machinery is not able to withstand the nominal torque transient during the motor ID run. | |
| **PC tool** | | |
| □ | Install the DriveStudio PC tool onto the PC. Install also DriveSPC if block programming is needed. For instructions, see *DriveStudio User Manual* [3AFE68749026 (English)] and *DriveSPC User Manual* [3AFE68836590 (English)]. | |
| □ | Connect the drive to the PC:<br>Connect the other end of the communication cable (OPCA-02, code: 68239745) to the panel link of the drive. Connect the other end of the communication cable via USB adapter or directly to the PC serial port. | |
| **Power up** | | |
| □ | Switch the power on. | 7-segment display:<br> |
| **Note:** The drive will indicate an alarm (2021 NO MOTOR DATA) until the motor data is entered later in this procedure. This is completely normal. | | |
| □ | Start the DriveStudio program by clicking the DriveStudio icon on the PC desktop. | DriveStudio.<br>exe |
| □ | Check whether an application program exists using the DriveStudio tool. If it does, the rows SOLUTION PROGRAM (SP) and SP EMPTY TEMPLATE are displayed in drive properties (View - Properties, Software category).<br>If an application program already exists, NOTE that some of the drive functions may have been disabled. ENSURE that the application program is suitable for your drive application. | <br>DriveStudio 1.4 - [ACSM1 Motion {15}{247} - Properties]<br>ACSM1 Motion {15}{247}: Parameter Browser, Properties, Data Logger, Fault Logger<br>Name / Value<br>Product Family<br>Drive Type: ACSM1 Motion<br>Drive Model: Unconfigured<br>Software<br>FIRMWARE VERSION: UMFI,E480,0,<br>EMPTY TEMPLATE: UMFI,2,1.6,ACSM1 Motion Empty Templ<br>ID_2: -<br>STANDARD LIBRARY: CUSL,1430<br>FW API INTERFACE: 1.2<br>BACKUP INTERFACE VER: 0.3<br>FW PARAM IFACE: 1.7<br>PRODUCT VARIANT: 2<br>SOLUTION PROGRAM (SP): 23117,1.0,0,ACSM1 test<br>SP EMPTY TEMPLATE: UMFI,2,1.6,ACSM1 Motion Empty Templ<br>ID_9: - |
| □ | Switch to local control to ensure that external control is disabled by clicking the Take/Release button of the DriveStudio tool control panel. | |

<table>
<tr><th colspan="3">Motor data entering</th></tr>
<tr><td>☐</td><td>Open the parameter and signal list by selecting the Parameter Browser of the appropriate drive.</td><td>
Parameter Browser</td></tr>
<tr><td>☐</td><td>Select the language.<br>Parameters are set as follows:<br>Select the parameter group (in this case 99 START-UP DATA) by double-clicking it. Select the appropriate parameter by double-clicking it and set the new value.</td><td>99.01 LANGUAGE</td></tr>
<tr><td>☐</td><td>Select the motor type: asynchronous or permanent magnet motor.</td><td>99.04 MOTOR TYPE</td></tr>
<tr><td>☐</td><td>Select the motor control mode. DTC is suitable for most cases. For information on scalar control, see parameter 99.05 MOTOR CTRL MODE.</td><td>99.05 MOTOR CTRL MODE</td></tr>
<tr><td>☐</td><td>Enter the motor data from the motor nameplate.<br>Asynchronous motor nameplate example:

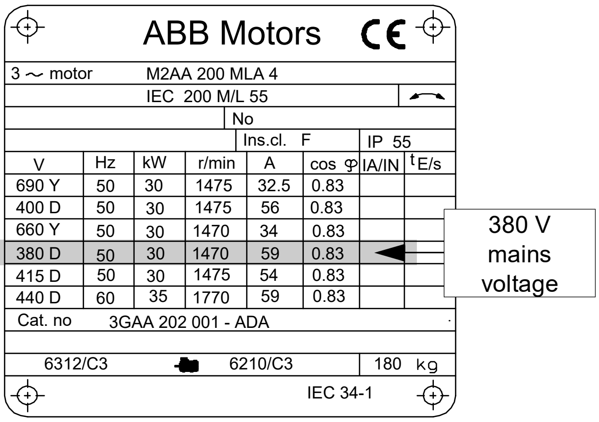



ABB Motors
<table>
<tr><td colspan="3">3 ~ motor</td><td colspan="5">M2AA 200 MLA 4</td></tr>
<tr><td colspan="8">IEC 200 M/L 55</td></tr>
<tr><td colspan="8">No</td></tr>
<tr><td colspan="5">Ins.cl. F</td><td colspan="3">IP 55</td></tr>
<tr><th>V</th><th>Hz</th><th>kW</th><th>r/min</th><th>A</th><th>cos φ</th><th>IA/IN</th><th>tE/s</th></tr>
<tr><td>690 Y</td><td>50</td><td>30</td><td>1475</td><td>32.5</td><td>0.83</td><td></td><td></td></tr>
<tr><td>400 D</td><td>50</td><td>30</td><td>1475</td><td>56</td><td>0.83</td><td></td><td></td></tr>
<tr><td>660 Y</td><td>50</td><td>30</td><td>1470</td><td>34</td><td>0.83</td><td></td><td></td></tr>
<tr><td>380 D</td><td>50</td><td>30</td><td>1470</td><td>59</td><td>0.83</td><td></td><td></td></tr>
<tr><td>415 D</td><td>50</td><td>30</td><td>1475</td><td>54</td><td>0.83</td><td></td><td></td></tr>
<tr><td>440 D</td><td>60</td><td>35</td><td>1770</td><td>59</td><td>0.83</td><td></td><td></td></tr>
<tr><td colspan="8">Cat. no 3GAA 202 001 - ADA</td></tr>
<tr><td colspan="3">6312/C3</td><td colspan="3">6210/C3</td><td colspan="2">180 kg</td></tr>
<tr><td colspan="8">IEC 34-1</td></tr>
</table>
380 V mains voltage<br>
Permanent magnet motor nameplate example:

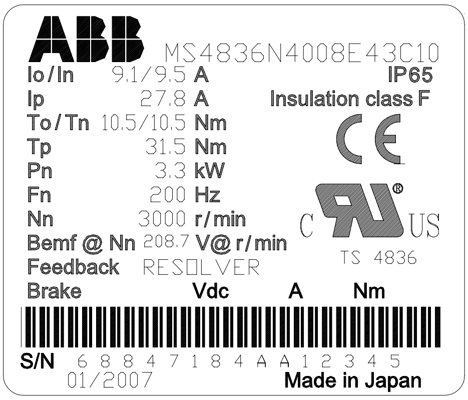
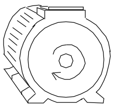
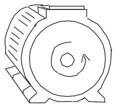



ABB MS4836N4008E43C10
<table>
<tr><td>Io/In</td><td>9.1/9.5 A</td><td>IP65</td></tr>
<tr><td>Ip</td><td>27.8 A</td><td>Insulation class F</td></tr>
<tr><td>To/Tn</td><td>10.5/10.5 Nm</td><td></td></tr>
<tr><td>Tp</td><td>31.5 Nm</td><td></td></tr>
<tr><td>Pn</td><td>3.3 kW</td><td></td></tr>
<tr><td>Fn</td><td>200 Hz</td><td></td></tr>
<tr><td>Nn</td><td>3000 r/min</td><td>C US</td></tr>
<tr><td>Bemf @ Nn</td><td>208.7 V@ r/min</td><td>TS 4836</td></tr>
<tr><td>Feedback</td><td>RESOLVER</td><td></td></tr>
<tr><td>Brake</td><td>Vdc</td><td>A Nm</td></tr>
<tr><td>S/N</td><td>6884718 4AA12345</td><td></td></tr>
<tr><td></td><td>01/2007</td><td>Made in Japan</td></tr>
</table>
With DTC control (99.05 MOTOR CTRL MODE = (0) DTC) at least parameters 99.06…99.10 must be set. Better control accuracy can be achieved by setting also parameters 99.11…99.12.</td><td><b>Note:</b> Set the motor data to exactly the same value as on the motor nameplate. For example, if the motor nominal speed is 1470 rpm on the nameplate, setting the value of parameter 99.09 MOT NOM SPEED to 1500 rpm results in wrong operation of the drive.</td></tr>
</table>

| | | |
|---|---|---|
| | - motor nominal current<br>Allowed range: approximately 1/6 · $I_{2n}$ … 2 · $I_{2n}$ of the drive (0…2 · $I_{2nd}$ if parameter 99.05 MOTOR CTRL MODE = (1) Scalar). With multimotor drives, see section *Multimotor drives* on page 21. | 99.06 MOT NOM CURRENT |
| | - motor nominal voltage<br>Allowed range: 1/6 · $U_N$ … 2 · $U_N$ of the drive. ($U_N$ refers to the highest voltage in each of the nominal voltage range, ie, 480 V AC for ACSM1-04).<br>With permanent magnet motors: The nominal voltage is the BackEMF voltage (at motor nominal speed). If the voltage is given as voltage per rpm, eg, 60 V per 1000 rpm, the voltage for 3000 rpm nominal speed is 3 × 60 V = 180 V.<br>Note that the nominal voltage is not equal to the equivalent DC motor voltage (E.D.C.M.) value given by some motor manufactures. The nominal voltage can be calculated by dividing the E.D.C.M. voltage by 1.7 (= square root of 3). | 99.07 MOT NOM VOLTAGE |
| | - motor nominal frequency<br>Range: 5…500 Hz. With multimotor drives, see section *Multimotor drives* on page 21.<br><br>With permanent magnet motor: If the frequency is not given on the motor nameplate, it has to be calculated with the following formula:<br>$f = n \times p / 60$<br>where p = number of pole pairs, n = motor nominal speed. | 99.08 MOT NOM FREQ |
| | - motor nominal speed<br>Range: 0…10000 rpm. With multimotor drives, see section *Multimotor drives* on page 21. | 99.09 MOT NOM SPEED |
| | - motor nominal power<br>Range: 0…10000 kW. With multimotor drives, see section *Multimotor drives* on page 21. | 99.10 MOT NOM POWER |
| | - motor nominal cos$\varphi$ (not applicable for permanent magnet motors). This value can be set for better DTC control accuracy. If value is not given by the motor manufacturer, use value 0 (i.e. default value).<br>Range: 0…1. | 99.11 MOT NOM COSFII |
| | - motor nominal shaft torque. This value can be set for better DTC control accuracy. If value is not given by the motor manufacturer, use value 0 (i.e. default value).<br>Range: 0…2147483.647 Nm. | 99.12 MOT NOM TORQUE |
| □ | After the motor parameters have been set, alarm ID-RUN is generated to inform that the motor ID run needs to be performed. | Alarm:<br>ID-RUN |

| | | |
|---|---|---|
| | **Multimotor drives**<br>**Ie, more than one motor is connected to one drive.** | |
| □ | Check that the motors have the same relative slip (only for asynchronous motors), nominal voltage and number of poles. If the manufacturer motor data is insufficient, use the following formulas to calculate the slip and the number of poles:<br>$p = \mathrm{Int}\left(\frac{f_N \cdot 60}{n_N}\right)$<br>$n_s = \frac{f_N \cdot 60}{p}$<br>$s = \frac{n_S - n_N}{n_S} \cdot 100\%$<br>where<br>$p$ = number of pole pairs (= motor pole number / 2)<br>$f_N$ = motor nominal frequency [Hz]<br>$n_N$ = motor nominal speed [rpm]<br>$s$ = motor slip [%]<br>$n_S$ = motor synchronous speed [rpm]. | |
| □ | Set the sum of the motor nominal currents. | 99.06 MOT NOM CURRENT |
| □ | Set the nominal motor frequencies. Frequencies must be the same. | 99.08 MOT NOM FREQ |
| □ | Set the sum of the motor nominal powers.<br>If the motor powers are close to each other or the same but the nominal speeds vary slightly, parameter 99.09 MOT NOM SPEED can be set to an average value of the motor speeds. | 99.10 MOT NOM POWER<br>99.09 MOT NOM SPEED |
| | **External control unit power supply** | |
| □ | If the control unit of the drive is powered from an external power supply (as specified in *Hardware Manual)*, set parameter 95.01 CTRL UNIT SUPPLY to EXTERNAL 24V. | 95.01 CTRL UNIT SUPPLY |
| | **External mains choke** | |
| □ | If the drive is equipped with an external choke (specified in *Hardware Manual)*, set parameter 95.02 EXTERNAL CHOKE to YES. | 95.02 EXTERNAL CHOKE |
| | **Motor overtemperature protection (1)** | |
| □ | Select how the drive reacts when motor overtemperature is detected. | 45.01 MOT TEMP PROT |
| □ | Select the motor temperature protection: motor thermal model or motor temperature measurement. For motor temperature measurement connections, see section *Temperature sensors* on page 44. | 45.02 MOT TEMP SOURCE |

| ID RUN (motor identification run) | | |
|---|---|---|
| ⚠ | **WARNING!** With Normal or Reduced ID run the motor will run at up to approximately 50…100% of the nominal speed during the motor ID run. ENSURE THAT IT IS SAFE TO RUN THE MOTOR BEFORE PERFORMING THE MOTOR ID RUN! | |
| **Note:** Ensure that possible Safe Torque Off and emergency stop circuits are closed during the motor ID run. | | |
| □ | Check the direction of rotation of the motor before starting the motor ID run. During the run (Normal or Reduced), the motor will rotate in the forward direction. | When drive output phases U2, V2 and W2 are connected to the corresponding motor terminals:<br> forward direction<br> reverse direction |

| | | |
|---|---|---|
| □ | Select the motor identification method by parameter 99.13 IDRUN MODE. During the motor ID run, the drive will identify the characteristics of the motor for optimum motor control. The motor ID run is performed at the next start of the drive.<br>**Note:** The motor shaft must NOT be locked and the load torque must be < 20% during Normal ID run. With permanent magnet motor this restriction applies also when Standstill ID run is selected.<br>**Note:** Mechanical brake (if present) is not opened during the motor ID run.<br>**Note:** The motor ID run cannot be performed if par. 99.05 MOTOR CTRL MODE = (1) Scalar.<br>NORMAL ID run should be selected whenever possible.<br>**Note:** The driven machinery must be de-coupled from the motor with Normal ID run if<br>• the load torque is higher than 20%, or<br>• the machinery is not able to withstand the nominal torque transient during the motor ID run.<br>The REDUCED ID run should be selected instead of the Normal ID run if the mechanical losses are higher than 20%, ie, the motor cannot be de-coupled from the driven equipment, or full flux is required to keep the motor brake open (conical motor).<br>The STANDSTILL ID run should be selected only if the Normal or Reduced ID run is not possible due to the restrictions caused by the connected mechanics (eg, with lift or crane applications).<br>AUTOPHASING can only be selected after the Normal/Reduced/ Standstill ID run has been performed once. Autophasing is used when an absolute encoder or a resolver (or encoder with commutation signals) has been added/changed to a permanent magnet motor, but there is no need to perform the Normal/Reduced/Standstill ID run again. See parameter 11.07 AUTOPHASING MODE on page 98 for information on autophasing modes, and section *Autophasing* on page 41. | 99.13 IDRUN MODE<br>11.07 AUTOPHASING MODE |
| □ | Check the drive limits. The following must apply to all drive ID run methods:<br>• 20.05 MAXIMUM CURRENT > 99.06 MOT NOM CURRENT<br>In addition, the following must apply for Reduced and Normal ID run:<br>• 20.01 MAXIMUM SPEED > 50% of synchronous speed of the motor<br>• 20.02 MINIMUM SPEED ≤ 0<br>• supply voltage ≥ 66% of 99.07 MOT NOM VOLTAGE<br>• 20.06 MAXIMUM TORQUE > 100% (asynchronous machines with Normal ID run only)<br>• 20.06 MAXIMUM TORQUE ≥ 30% (asynchronous machines with Reduced ID run, and permanent magnet motors).<br>When the motor ID run has been successfully completed, set the limit values as required by the application. | |

| | | |
|---|---|---|
| □ | Start the motor to activate the motor ID run.<br>**Note:** RUN ENABLE must be active.<br>Motor ID run is indicated by alarm ID-RUN and by a rotating display on the 7-segment display. | 10.09 RUN ENABLE<br>Alarm: ID-RUN<br>7-segment display:<br>rotating display |
| □ | If the motor ID run is not successfully completed, fault ID-RUN FAULT is generated. | Fault<br>ID-RUN FAULT |
| **Speed measurement with encoder/resolver** | | |
| An encoder/resolver feedback can be used for more accurate motor control.<br>Follow these instructions when encoder/resolver interface module FEN-xx is installed in drive option Slot 1 or 2. **Note:** Two encoder interface modules of the same type are not allowed. | | |
| □ | Select the used encoder/resolver. For more information, see parameter group 90 on page 188. | 90.01 ENCODER 1 SEL /<br>90.02 ENCODER 2 SEL |
| □ | Set other necessary encoder/resolver parameters:<br>- Absolute encoder parameters (group 91, page 192)<br>- Resolver parameters (group 92, page 198).<br>- Pulse encoder parameters (group 93, page 199). | 91.01…91.31 /<br>92.01…92.03 /<br>93.01…93.22 |
| □ | Set parameter 90.10 ENC PAR REFRESH to (1) Configure so that the new parameter settings take effect. | 90.10 ENC PAR REFRESH |
| **Checking the encoder/resolver connection** | | |
| Follow these instructions when encoder/resolver interface module FEN-xx is installed in drive option Slot 1 or 2. **Note:** Two encoder interface modules of the same type are not allowed. | | |
| □ | Set parameter 22.01 SPEED FB SEL to (0) Estimated. | 22.01 SPEED FB SEL |
| □ | Enter a small speed reference value (for example 3% of the nominal motor speed). | 45<br>45 rpm |
| □ | Start the motor. | |
| □ | Check that the estimated (1.14 SPEED ESTIMATED) and actual speed (1.08 ENCODER 1 SPEED / 1.10 ENCODER 2 SPEED) are equal. If the values differ, check the encoder/resolver parameter settings.<br>**Hint:** If the actual speed (with absolute or pulse encoder) differs form the reference value by a factor of 2, check the pulse number setting (91.01 SINE COSINE NR / 93.01 ENC1 PULSE NR / 93.11 ENC2 PULSE NR). | 1.14 SPEED ESTIMATED<br>1.08 ENCODER 1 SPEED /<br>1.10 ENCODER 2 SPEED |

| | | |
|---|---|---|
| □ | If the direction of rotation is selected as forward, check that the actual speed (1.08 ENCODER 1 SPEED / 1.10 ENCODER 2 SPEED) is positive:<br>• If the actual direction of rotation is forward and the actual speed negative, the phasing of the pulse encoder wires is reversed.<br>• If the actual direction of rotation is reverse and the actual speed negative, the motor cables are incorrectly connected.<br>Changing the connection:<br>Disconnect the main power, and wait for 5 minutes for the intermediate circuit capacitors to discharge. Do the necessary changes. Switch the power on and start the motor again. Check that the estimated and actual speed values are correct.<br>• If the direction of rotation is selected as reverse, the actual speed must be negative.<br>**Note:** Resolver autotuning routines should always be performed after resolver cable connection has been modified. Autotuning routines can be activated by setting parameter 92.02 EXC SIGNAL AMPL or 92.03 EXC SIGNAL FREQ, and then setting parameter 90.10 ENC PAR REFRESH to (1) Configure. If the resolver is used with a permanent magnet motor, an Autophasing ID run should be performed as well. | 1.08 ENCODER 1 SPEED /<br>1.10 ENCODER 2 SPEED |
| □ | Stop the motor. | ⛔ |
| □ | Set parameter 22.01 SPEED FB SEL to (1) Enc1 speed or (2) Enc2 speed.<br>If the speed feedback cannot be used in motor control: In special applications parameter 40.06 FORCE OPEN LOOP must be set to TRUE. | 22.01 SPEED FB SEL |
| □ | **Note:** Speed filtering needs to be adjusted especially when the encoder pulse number is small. See section *Speed filtering* on page 27. | |
| **Emergency stop circuit** | | |
| □ | If there is an emergency stop circuit in use, check that the circuit functions (emergency stop signal is connected to the digital input which is selected as the source for the emergency stop activation). | 10.10 EM STOP OFF3 or 10.11 EM STOP OFF1<br>(emergency stop control through fieldbus 2.12 FBA MAIN CW bits 2…4) |

<table>
<tr><th colspan="3">Safe Torque Off</th></tr>
<tr><td colspan="3">The Safe Torque Off function disables the control voltage of the power semiconductors of the drive output stage, thus preventing the inverter from generating the voltage required to rotate the motor. For Safe Torque Off wiring, see the appropriate hardware manual and <i>Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives</i> (3AFE68929814 [English]).</td></tr>
<tr><td>□</td><td>If there is a Safe Torque Off circuit in use, check that the circuit functions.</td><td></td></tr>
<tr><td>□</td><td>Selects how the drive reacts when the Safe Torque Off function is active (i.e. when the control voltage of the power semiconductors of the drive output stage is disabled).</td><td>46.07 STO DIAGNOSTIC</td></tr>
<tr><th colspan="3">Voltage control</th></tr>
<tr><td colspan="3">If the DC voltage drops due to input power cut off, the undervoltage controller will automatically decrease the motor torque in order to keep the voltage above the lower limit.<br>To prevent the DC voltage from exceeding the overvoltage control limit, the overvoltage controller automatically decreases the generating torque when the limit is reached.<br>When the overvoltage controller is limiting the generating torque, quick deceleration of the motor is not possible. Thus electrical braking (braking chopper and braking resistor) is needed in some applications to allow the drive to dissipate regenerative energy. The chopper connects the braking resistor to the intermediate circuit of the drive whenever the DC voltage exceeds the maximum limit.</td></tr>
<tr><td>□</td><td>Check that the overvoltage and undervoltage controllers are active.</td><td>47.01 OVERVOLTAGE CTRL<br>47.02 UNDERVOLT CTRL</td></tr>
<tr><td>□</td><td>If the application requires a braking resistor (the drive has a built-in braking chopper):<br>• Set the braking chopper and resistor settings.<br>• Check that the connection functions.<br>For more information on the braking resistor connection, see the appropriate hardware manual.</td><td>48.01…48.07<br>47.01 OVERVOLTAGE CTRL</td></tr>
<tr><th colspan="3">Start function</th></tr>
<tr><td>□</td><td>Select the start function.<br>Setting 11.01 START MODE to (2) Automatic selects a general-purpose start function. This setting also makes flying start (starting to a rotating motor) possible.<br>The highest possible starting torque is achieved when 11.01 START MODE is set to (0) Fast (automatic optimised DC magnetising) or (1) Const time (constant DC magnetising with user-defined magnetising time).<br><b>Note:</b> When 11.01 START MODE setting is (0) Fast or (1) Const time, flying start (start to a rotating motor) is not possible.</td><td>11.01 START MODE</td></tr>
</table>

| | | |
|---|---|---|
| **Limits** | | |
| □ | Set the operation limits according to the process requirements.<br>**Note:** If load torque is suddenly lost when the drive is operating in torque control mode, the drive will rush to the defined negative or positive maximum speed. For safe operation, ensure the set limits are suitable for your application. | 20.01…20.07 |
| **Motor overtemperature protection (2)** | | |
| □ | Set the alarm and fault limits for the motor overtemperature protection. | 45.03 MOT TEMP ALM LIM<br>45.04 MOT TEMP FLT LIM |
| □ | Set the typical ambient temperature of the motor. | 45.05 AMBIENT TEMP |
| □ | When 45.02 MOT TEMP SOURCE is set to (0) ESTIMATED, the motor thermal protection model must be configured as follows:<br>- Set the maximum allowed operating load of the motor.<br>- Set the zero speed load. A higher value can be used if the motor has an external motor fan to boost the cooling.<br>- Set the break point frequency of the motor load curve.<br>- Set the motor nominal temperature rise.<br>- Set the time inside which the temperature has reached 63% of the nominal temperature. | 45.06 MOT LOAD CURVE<br>45.07 ZERO SPEED LOAD<br>45.08 BREAK POINT<br>45.09 MOTNOM TEMP RISE<br>45.10 MOT THERM TIME |
| □ | If possible, perform the motor ID run again at this point (see page 22). | 99.13 IDRUN MODE |
| **Speed filtering** | | |
| The measured speed always has a small ripple because of electrical and mechanical interferences, couplings and encoder resolution (i.e. small pulse number). A small ripple is acceptable as long as it does not affect the speed control chain. The interferences in the speed measurement can be filtered with a speed error filter or with an actual speed filter.<br>Reducing the ripple with filters may cause speed controller tuning problems. A long filter time constant and fast acceleration time contradict one another. A very long filter time results in unstable control. | | |
| □ | If the used speed reference changes rapidly (servo application), use the speed error filter to filter the possible interferences in the speed measurement. In this case the speed error filter is more suitable than the actual speed filter:<br>- Set the filter time constant. | 26.06 SPD ERR FTIME |

<table>
<tr><td>□</td><td>If the used speed reference remains constant, use the actual speed filter to filter the possible interferences in the speed measurement. In this case the actual speed filter is more suitable than the speed error filter:<br>- Set the filter time constant.<br>If there are substantial interferences in the speed measurement, the filter time constant should be proportional to the total inertia of the load and motor, i.e. approximately 10…30% of the mechanical time constant<br>$t_{mech} = (n_{nom} / T_{nom}) \times J_{tot} \times 2\pi / 60$, where<br>$J_{tot}$ = total inertia of the load and motor (the gear ratio between the load and the motor must be taken into account)<br>$n_{nom}$ = motor nominal speed<br>$T_{nom}$ = motor nominal torque<br>To get a fast dynamic torque or speed response with a speed feedback value other than (0) Estimated (see parameter 22.01 SPEED FB SEL), the actual speed filter time must be set to zero.</td><td>22.02 SPEED ACT FTIME</td></tr>
<tr><th colspan="3">Speed controller tuning</th></tr>
<tr><td colspan="3">For the most demanding applications, the P- and I-parts of the speed controller of the drive can be tuned either manually or automatically. See parameter 28.16 PI TUNE MODE.<br>If it is necessary to adjust acceleration (deceleration) compensation, it must be done manually.</td></tr>
<tr><td>□</td><td>Acceleration (deceleration) compensation can be used to improve the speed control dynamic reference change (when the speed ramp times > 0). In order to compensate inertia during acceleration, a derivative of the speed reference is added to the output of the speed controller.<br>Set the derivation time for acceleration (deceleration) compensation. The value should be proportional to the total inertia of the load and motor, i.e. approximately 50…100% of the mechanical time constant ($t_{mech}$). See the mechanical time constant equation in section *Speed filtering* on page 27.</td><td>26.08 ACC COMP DERTIME</td></tr>
<tr><th colspan="3">Fieldbus control</th></tr>
<tr><td colspan="3">Follow these instructions when the drive is controlled from a fieldbus control system via fieldbus adapter Fxxx. The adapter is installed in drive Slot 3.</td></tr>
<tr><td>□</td><td>Enable the communication between the drive and fieldbus adapter.</td><td>50.01 FBA ENABLE</td></tr>
<tr><td>□</td><td>Connect the fieldbus control system to the fieldbus adapter module.</td><td></td></tr>
<tr><td>□</td><td>Set the communication and adapter module parameters: See section *Setting up communication through a fieldbus adapter module* on page 348.</td><td></td></tr>
<tr><td>□</td><td>Test that the communication functions.</td><td></td></tr>
</table>

## How to control the drive through the I/O interface

The table below instructs how to operate the drive through the digital and analogue inputs, when the default parameter settings are valid.

| | |
|---|---|
| **PRELIMINARY SETTINGS** | |
| Ensure the control connections are wired according to the connection diagram given in chapter *Default connections of the control unit*. | |
| Switch to external control by clicking the Take/Release button of the PC tool control panel. | |
| **STARTING AND CONTROLLING THE SPEED OF THE MOTOR** | |
| Start the drive by switching digital input DI1 on. Digital input status can be monitored with signal 2.01 DI STATUS. | 2.01 DI STATUS |
| Check that analogue input AI1 is used as a voltage input (selected by jumper J1). | Voltage:<br>J1 ○ ○ ⊡ |
| Regulate the speed by adjusting the voltage of analogue input AI1. | |
| Check analogue input AI1 signal scaling. AI1 values can be monitored with signals 2.04 AI1 and 2.05 AI1 SCALED.<br>When AI1 is used as a voltage input, the input is differential and the negative value corresponds to the negative speed and the positive value to the positive speed. | 13.02...13.04<br>2.04 AI1<br>2.05 AI1 SCALED |
| **STOPPING THE MOTOR** | |
| Stop the drive by switching digital input DI1 off. | 2.01 DI STATUS |

# Drive programming using PC tools

## What this chapter contains

This chapter introduces the drive programming using the DriveStudio and DriveSPC applications. For more information, see *DriveStudio User Manual* [3AFE68749026 (English)] and *DriveSPC User Manual* [3AFE68836590 (English)].

## General

The drive control program is divided into two parts:

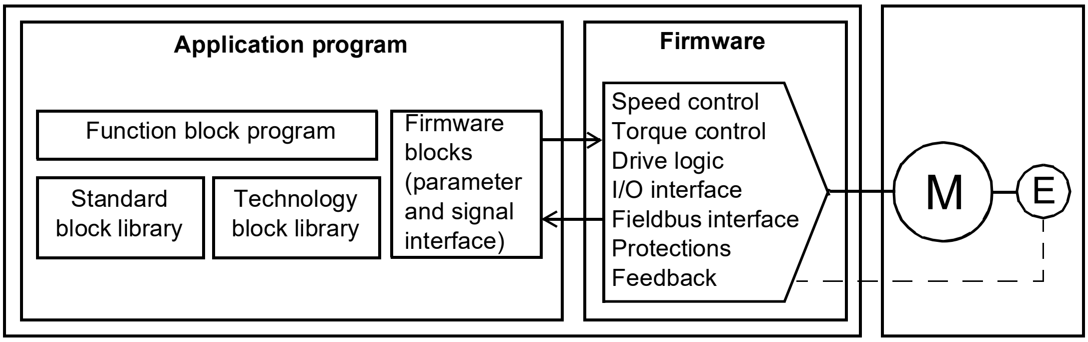
- firmware program
- application program.

The firmware program performs the main control functions, including speed and torque control, drive logic (start/stop), I/O, feedback, communication and protection functions. Firmware functions are configured and programmed with parameters. The functions of the firmware program can be extended with application programming. Application programs are built out of function blocks.

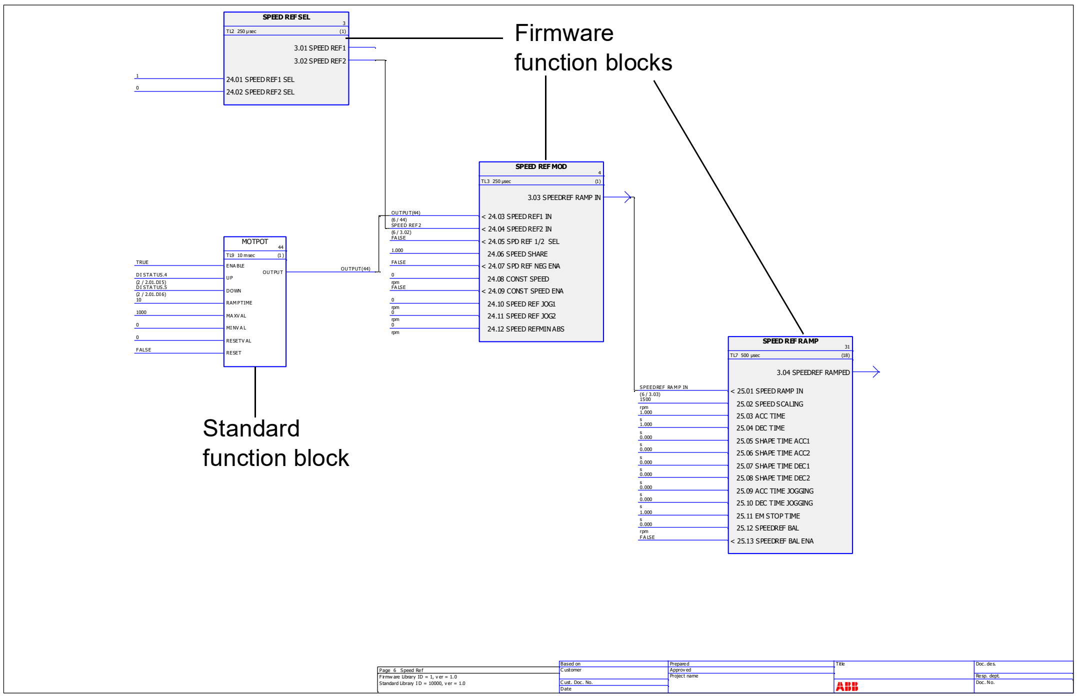
The drive supports two different programming methods:

- parameter programming
- application programming with function blocks (the blocks are based on the IEC-61131 standard).

Drive control program



The following picture presents a view from DriveSPC.



The application program template visible through DriveSPC is presented in chapter *Application program template* (page 335).

## Programming via parameters

Parameters can be set via DriveStudio, drive control panel (keypad) or the fieldbus interface. All parameter settings are stored automatically to the permanent memory of the drive. However, it is highly recommended to force a save by using parameter 16.07 PARAM SAVE before powering down the drive immediately after any parameter changes. Values are restored after the power switch-off. If necessary, the default values can be restored by parameter 16.04 PARAM RESTORE.

Because most parameters are used as firmware function block inputs, parameter values can also be modified via the application program. Note that parameter changes made via the application program override changes made via the DriveStudio PC tool.

# Application programming

Application programs are created with the DriveSPC PC tool.

The normal delivery of the drive does not include an application program. The user can create an application program with the standard and firmware function blocks. ABB also offers customised application programs and technology function blocks for specific applications. For more information, contact your local ABB representative.

## Function blocks

The application program uses three types of function blocks: firmware function blocks, standard function blocks and technology function blocks.

### *Firmware function blocks*

Most of the firmware functions are represented as function blocks in the DriveSPC tool. Firmware function blocks are part of the drive control firmware, and used as an interface between the application and firmware programs. Drive parameters in groups 10…99 are used as function block inputs and parameters in groups 1…9 as function block outputs. Firmware function blocks are presented in chapter *Parameters and firmware blocks*.

### *Standard function blocks (library)*

Standard function blocks (eg, ADD, AND) are used to create an executable application program. The standard function blocks available are presented in chapter *Standard function blocks*.

Standard function block library is always included in the drive delivery.

### *Technology function blocks*

Several technology function block libraries (eg, CAM) are available for different types of applications. One technology library can be used at a time. Technology blocks are used in a similar way as the standard blocks.

## User parameters

User parameters can be created with the DriveSPC tool. They are inserted into the application program as blocks that can be connected to existing application blocks.

User parameters can be added to any existing parameter group; the first available index is 70. Parameter groups 5 and 75…89 are available for user parameters starting from index 1. Using attributes, the parameters can be defined as write-protected, hidden, etc.

For more information, see the *DriveSPC User Manual.*

## Application events

The application programmer can create his/her own application events (alarms and faults) by adding alarm and fault blocks; these blocks are managed through the Alarm and Fault Managers of the DriveSPC tool.

The operation of alarm and fault blocks is the same: when the block is enabled (by setting the Enable input to 1), an alarm or fault is generated by the drive.

### Program execution

The application program is loaded to the permanent (non-volatile) memory of the memory unit (JMU). When the loading finishes, the drive control board is automatically reset, and the downloaded program started. The program is executed in real time on the same Central Processing Unit (CPU of the drive control board) as the drive firmware. The program can be executed at the two dedicated time levels of 1 and 10 milliseconds, as well as other time levels between certain firmware tasks.

**Note:** Because the firmware and application programs use the same CPU, the programmer must ensure that the drive CPU is not overloaded. See parameter 1.21 CPU USAGE.

### Application program licensing and protection

**Note:** This functionality is only available with DriveSPC version 1.5 and later.

The drive can be assigned an application licence consisting of an ID and password using the DriveSPC tool. Likewise, the application program created in DriveSPC can be protected by an ID and password. For instructions, refer to the DriveSPC user manual.

If a protected application program is downloaded to a licensed drive, the IDs and passwords of the application and drive must match. A protected application cannot be downloaded to an unlicensed drive. On the other hand, an unprotected application can be downloaded to a licensed drive.

The ID of the application licence is displayed by DriveStudio in the drive software properties as APPL LICENCE. If the value is 0, no licence has been assigned to the drive.

The parameters that are created using the DriveSPC parameter manager with hide flags can be viewed or hidden by parameter 16.03 PASS CODE. The password code must be the same as the drive APPL LICENCE. A wrong password code will hide the visible application parameters again.

**Notes:**

- The application licence can only be assigned to a complete drive, not a stand-alone control unit.
- A protected application can only be downloaded to a complete drive, not a stand-alone control unit.

### Operation modes

The DriveSPC tool offers the following operation modes:

*Off-line*

When the off-line mode is used without a drive connection, the user can

- open a application program file (if exists).
- modify and save the application program.
- print the program pages.

When the off-line mode is used with a drive(s) connection, the user can

- connect the selected drive to DriveSPC.
- upload an application program from the connected drive (an empty template which includes only the firmware blocks is available by default.)
- download the configured application program to the drive and start the program execution. The downloaded program contains the function block program and the parameter values set in DriveSPC.
- remove the program from the connected drive.

*On-line*

In the on-line mode, the user can

- modify firmware parameters (changes are stored directly to the drive memory)
- modify application program parameters (ie, parameters created in DriveSPC)
- monitor the actual values of all function blocks in real time.

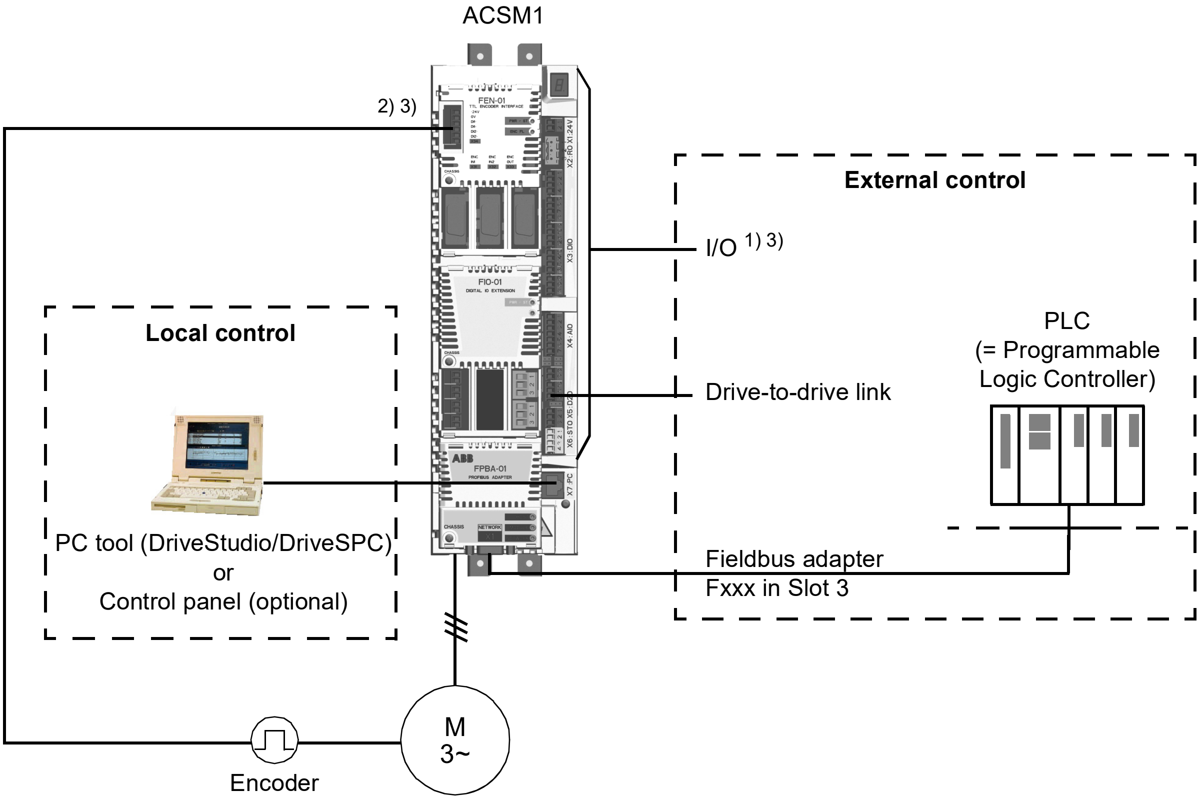
# Drive control and features

## What this chapter contains

This chapter describes the control locations and operation modes of the drive, and the features of the application program.

## Local control vs. external control

The drive has two main control locations: external and local. The control location is selected with the PC tool (Take/Release button) or with the LOC/REM key on the control panel.



1) Extra inputs/outputs can be added by installing optional I/O extension modules (FIO-xx) in drive Slot 1/2.
2) Incremental or absolute encoder, or resolver interface module (FEN-xx) installed in drive Slot 1/2
3) Two encoder/resolver interface modules of the same type are not allowed.

### *Local control*

The control commands are given from a PC equipped with DriveStudio and/or DriveSPC, or from the control panel keypad when the drive is in local control. Speed, torque and position control modes are available for local control.

Local control is mainly used during commissioning and maintenance. The control panel always overrides the external control signal sources when used in local control. Changing the control location to local can be disabled by parameter 16.01 LOCAL LOCK.

The user can select by a parameter (46.03 LOCAL CTRL LOSS) how the drive reacts to a control panel or PC tool communication break.

*External control*

When the drive is in external control, control commands (start/stop, reset etc.) are given through the fieldbus interface (via an optional fieldbus adapter module), the I/O terminals (digital inputs), optional I/O extension modules or the drive-to-drive link.

Two external control locations, EXT1 and EXT2, are available. The user can select control signals (eg, Group 10 START/STOP, Group 24 SPEED REF MOD and Group 32 TORQUE REFERENCE) and control modes (Group 34 REFERENCE CTRL) for both external control locations. Depending on the user selection, either EXT1 or EXT2 is active at a time. Selection between EXT1/EXT2 is done via a freely selectable bit pointer parameter 34.01 EXT1/EXT2 SEL. In addition, the EXT1 control location is divided into two parts, EXT1 CTRL MODE1 and EXT1 CTRL MODE2. Both use the EXT1 control signals for start/stop, but the control mode can be different; for example, EXT1 CTRL MODE2 can be used in homing.

## Operating modes of the drive

The drive can operate in speed and torque control modes. A block diagram of the drive control chain for these modes is presented on page 39; more detailed diagrams are presented in *Appendix EC – Control chain and drive logic diagrams* (page 513).

### Speed control mode

Motor rotates at a speed proportional to the speed reference given to the drive. This mode can be used either with estimated speed used as feedback, or with an encoder or resolver for better speed accuracy.

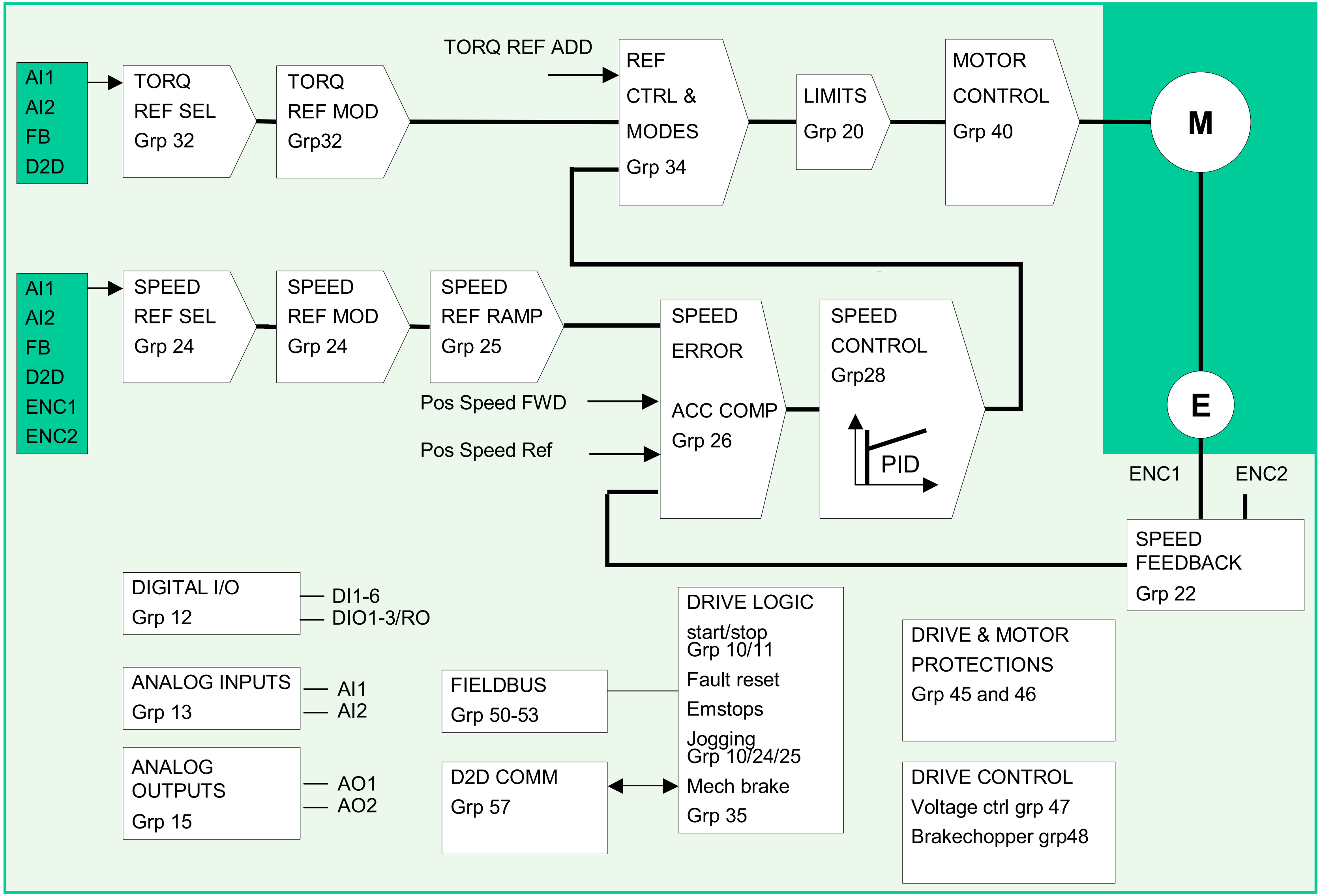
Speed control mode is available in both local and external control.

### Torque control mode

Motor torque is proportional to the torque reference given to the drive. This mode can be used either with estimated speed used as feedback, or with an encoder or resolver for more accurate and dynamic motor control.

Torque control mode is available in both local and external control.

## Drive control chain for speed and torque control



# Motor control features

## Scalar motor control

It is possible to select scalar control as the motor control method instead of Direct Torque Control (DTC). In scalar control mode, the drive is controlled with a frequency reference. However, the performance of DTC is not achieved in scalar control.

It is recommended to activate the scalar motor control mode in the following situations:

- In multimotor drives: 1) if the load is not equally shared between the motors, 2) if the motors are of different sizes, or 3) if the motors are going to be changed after motor identification (motor ID run)
- If the nominal current of the motor is less than 1/6 of the nominal output current of the drive
- If the drive is used without a motor connected (for example, for test purposes)
- If the drive runs a medium-voltage motor through a step-up transformer.

In scalar control, some standard features are not available.

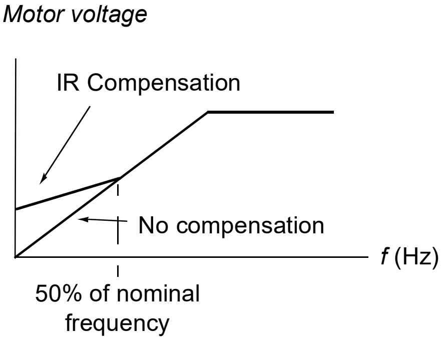
*IR compensation for a scalar controlled drive*

IR stands for voltage.

*I* (current) × *R* (resistance) = *U* (voltage).

IR compensation is active only when the motor control mode is scalar. When IR compensation is activated, the drive gives an extra voltage boost to the motor at low speeds. IR compensation is useful in applications that require a high break-away torque.

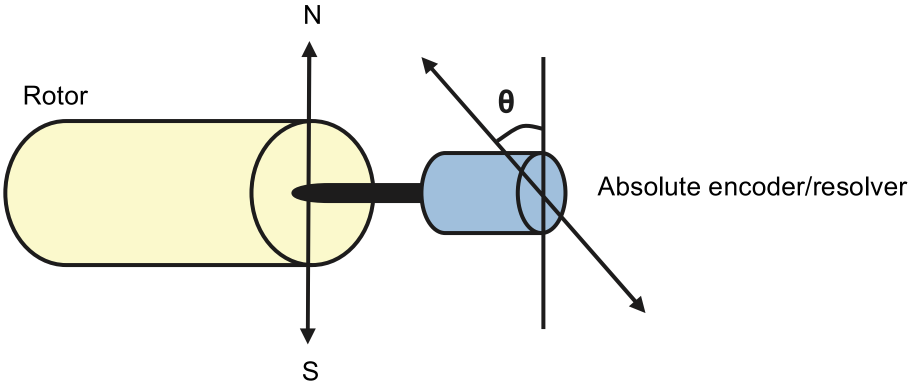
In direct torque control (DTC) mode, IR compensation is automatic and manual adjustment is not needed.



## Autophasing

Autophasing is an automatic measurement routine to determine the angular position of the magnetic flux of a permanent magnet synchronous motor or the magnetic axis of a synchronous reluctance motor. The motor control requires the absolute position of the rotor flux to control the motor torque accurately.

Sensors like absolute encoders and resolvers indicate the rotor position at all times after the offset between the zero angle of rotor and that of the sensor has been established. On the other hand, a standard pulse encoder determines the rotor position when it rotates but the initial position is not known. However, a pulse encoder can be used as an absolute encoder if it is equipped with Hall sensors, albeit with coarse initial position accuracy. The Hall sensors generate so-called commutation pulses that change their state six times during one revolution, so it is only known within which 60° sector of a complete revolution the initial position is.



The autophasing routine is performed with permanent magnet synchronous motors in the following cases:

1. One-time measurement of the rotor and encoder position difference when an absolute encoder, a resolver, or an encoder with commutation signals is used
2. At every power-up when an incremental encoder is used
3. With the open-loop motor control, repetitive measurement of the rotor position at every start.

In the open-loop mode, the zero angle of the rotor is determined before the start. In the closed loop mode, the actual angle of the rotor is determined with autophasing when the sensor indicates the zero angle. The offset of the angle must be determined because the actual zero angles of the sensor and the rotor do no usually match. The autophasing mode determines how this operation is done both in the open loop and closed loop modes.

**Note:** In the open loop mode, the motor always turns when it is started as the shaft is turned towards the remanence flux.

A rotor position offset used in motor control can also be given by the user. See parameter 97.20 POS OFFSET USER.

**Note:** The same parameter is used by the autophasing routine which always writes its result to parameter 97.20 POS OFFSET USER. Autophasing ID run results are updated even if the user mode is not enabled (see parameter 97.01 USE GIVEN PARAMS).

Several autophasing modes are available (see parameter 11.07 AUTOPHASING MODE).

The turning mode is recommended especially with case 1 (see the list above) as it is the most robust and accurate method. In the turning mode, the motor shaft is turned back and forward (±360/polepairs)° to determine the rotor position. In case 3 (open-loop control), the shaft is turned only in one direction and the angle is smaller.

The standstill modes can be used if the motor cannot be turned (for example, when the load is connected). As the characteristics of motors and loads differ, testing must be done to find out the most suitable standstill mode.

The drive is capable of determining the rotor position when started to a running motor in the open-loop or closed loop modes. In this situation, the setting of parameter 11.07 AUTOPHASING MODE has no effect.

The autophasing routine can fail and therefore it is recommended to perform the autophasing routine several times and check the value of parameter 97.20 POS OFFSET USER.

The autophasing fault can occur in a running motor if the estimated angle of the rotor differs too much from the measured angle of the rotor. One reason for different values in the estimated and measured angles is that there is a slip in the encoder connection to the motor axle.

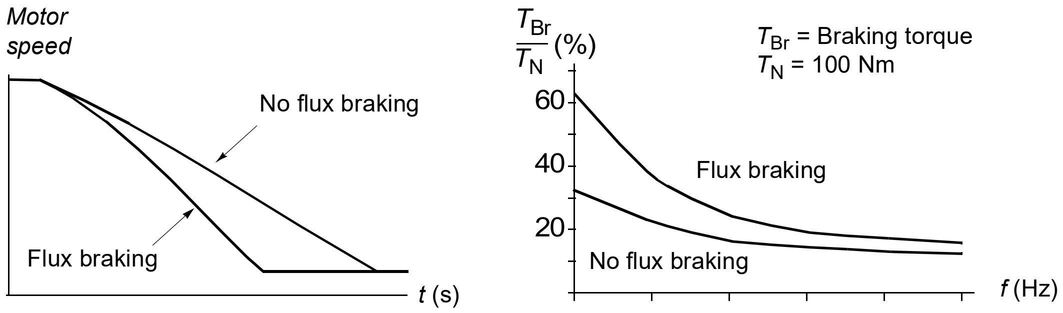
Another cause for the autophasing fault is a failed autophasing routine. In other words, there has been a wrong value in parameter 97.20 POS OFFSET USER from the beginning.

The third reason for the autophasing fault in a running motor is that there is a wrong motor type in the control program or that the motor ID run has failed.

In addition, fault 0026 AUTOPHASING can occur during the autophasing routine if parameter 11.07 AUTOPHASING MODE is set to Turning. The Turning mode requires that the rotor can be turned during the autophasing routine. If the rotor is locked or cannot be easily turned or if the rotor turns by force of external power, the autophasing fault is triggered. Regardless of the chosen mode, the autophasing fault occurs if the rotor is turning before the autophasing routine is started.

## Flux braking

The drive can provide greater deceleration by raising the level of magnetization in the motor. By increasing the motor flux with 40.10 FLUX BRAKING, the energy generated by the motor during braking can be converted to motor thermal energy.



The drive monitors the motor status continuously, also during flux braking. Therefore, flux braking can be used both for stopping the motor and for changing the speed. The other benefits of flux braking are:

- The braking starts immediately after a stop command is given. The function does not need to wait for the flux reduction before it can start the braking.
- The cooling of the induction motor is efficient. The stator current of the motor increases during flux braking, not the rotor current. The stator cools much more efficiently than the rotor.
- Flux braking can be used with induction motors and permanent magnet synchronous motors.

Two braking power levels are available:

- Moderate braking provides faster deceleration compared to a situation where flux braking is disabled. The flux level of the motor is limited to prevent excessive heating of the motor.
- Full braking exploits almost all available current to convert the mechanical braking energy to motor thermal energy. Braking time is shorter compared to moderate braking. In cyclic use, motor heating may be significant.

## Thermal motor protection

With the parameters in group 45, the user can set up the motor overtemperature protection and configure motor temperature measurement (if present). This block also shows the estimated and measured motor temperature.

The motor can be protected against overheating by

- the motor thermal protection model
- measuring the motor temperature with PTC or KTY84 sensors. This will result in a more accurate motor model.

### *Thermal motor protection model*

The drive calculates the temperature of the motor on the basis of the following assumptions:

1) When power is applied to the drive for the first time, the motor is at ambient temperature (defined by parameter 45.05 AMBIENT TEMP). After this, when power is applied to the drive, the motor is assumed to be at the estimated temperature (value of 1.18 MOTOR TEMP EST, saved at power switch-off).

2) Motor temperature is calculated using the user-adjustable motor thermal time and motor load curve. The load curve should be adjusted in case the ambient temperature exceeds 30 °C.

It is possible to adjust the motor temperature supervision limits and select how the drive reacts when overtemperature is detected.

**Note:** The motor thermal model can be used when only one motor is connected to the inverter.

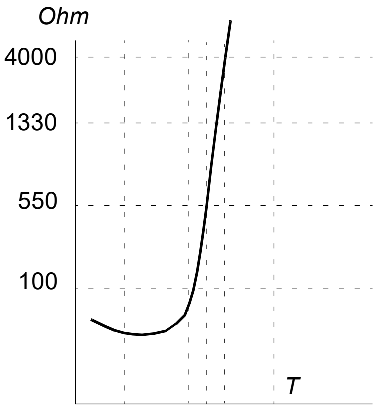
### *Temperature sensors*

It is possible to detect motor overtemperature by connecting a motor temperature sensor to thermistor input TH of the drive or to optional encoder interface module FEN-xx.

The resistance of the sensor increases as the motor temperature rises over the sensor reference temperature $T_{ref}$, as does the voltage over the resistor.

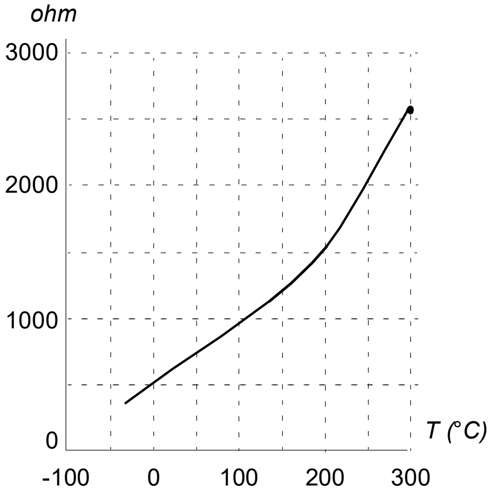
The figure below shows typical PTC sensor resistance values as a function of the motor operating temperature.

| Temperature | PTC resistance |
|---|---|
| Normal | 0…1 kohm |
| Excessive | ≥ 4 kohm* |
| *The limit for overtemperature protection is 2.5 kohm. | |



The figure below shows typical KTY84 sensor resistance values as a function of the motor operating temperature.

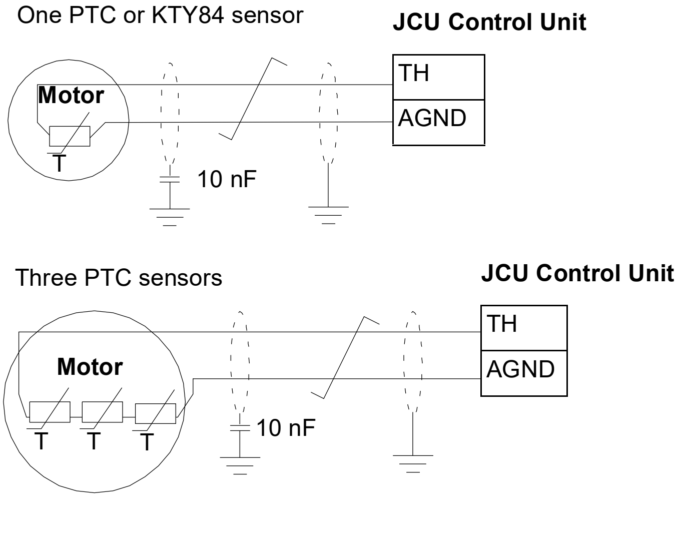
| KTY84 scaling |
|---|
| 90 °C = 936 ohm |
| 110 °C = 1063 ohm |
| 130 °C = 1197 ohm |
| 150 °C = 1340 ohm |



It is possible to adjust the motor temperature supervision limits and select how the drive reacts when overtemperature is detected.

**WARNING!** As the thermistor input on the JCU Control Unit is not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. If the assembly does not fulfil the requirement,
- the I/O board terminals must be protected against contact and must not be connected to other equipment
or
- the temperature sensor must be isolated from the I/O terminals.

The figure below shows a motor temperature measurement when thermistor input TH is used.



For encoder interface module FEN-xx connection, see the *User's Manual* of the appropriate encoder interface module.

# DC voltage control features

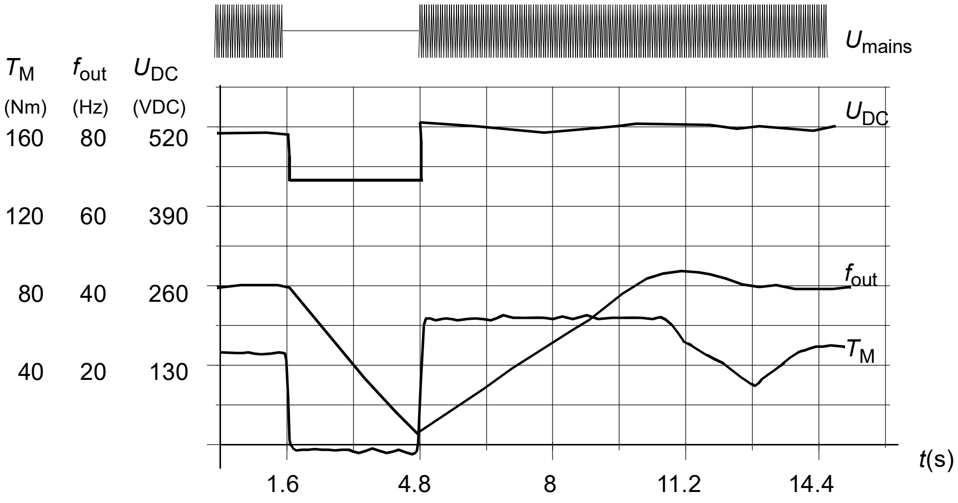
## Overvoltage control

Overvoltage control of the intermediate DC link is needed with two-quadrant line-side converters when the motor operates within the generating quadrant. To prevent the DC voltage from exceeding the overvoltage control limit, the overvoltage controller automatically decreases the generating torque when the limit is reached.

## Undervoltage control

If the incoming supply voltage is cut off, the drive will continue to operate by utilising the kinetic energy of the rotating motor. The drive will be fully operational as long as the motor rotates and generates energy to the drive. The drive can continue the operation after the break if the main contactor remained closed.

**Note:** Units equipped with main contactor option must be equipped with a hold circuit (eg, UPS) which keeps the contactor control circuit closed during a short supply break.



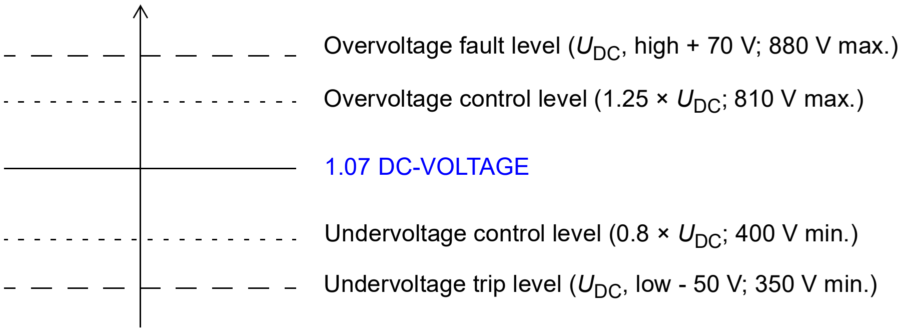
$U_{DC}$= intermediate circuit voltage of the drive, $f_{out}$ = output frequency of the drive, $T_M$ = motor torque

*Loss of supply voltage at nominal load ($f_{out}$ = 40 Hz). The intermediate circuit DC voltage drops to the minimum limit. The controller keeps the voltage steady as long as the supply is switched off. The drive runs the motor in generator mode. The motor speed falls but the drive is operational as long as the motor has enough kinetic energy.*

## Voltage control and trip limits

The control and trip limits of the intermediate DC voltage regulator are relative either to a supply voltage value provided by the user or to an automatically-determined supply voltage. The actual voltage used is shown by parameter 1.19 USED SUPPLY VOLT. The DC voltage ($U_{DC}$) equals 1.35 times this value.

Automatic identification of the supply voltage is performed every time the drive is powered. Automatic identification can be disabled by parameter 47.03 SUPPLVOLTAUTO-ID; the user can define the voltage manually at parameter 47.04 SUPPLY VOLTAGE.


Overvoltage fault level ($U_{DC}$, high + 70 V; 880 V max.)
Overvoltage control level (1.25 × $U_{DC}$; 810 V max.)
1.07 DC-VOLTAGE
Undervoltage control level (0.8 × $U_{DC}$; 400 V min.)
Undervoltage trip level ($U_{DC}$, low - 50 V; 350 V min.)

$U_{DC}$ = 1.35 × 1.19 USED SUPPLY VOLT

$U_{DC}$, high = 1.25 × $U_{DC}$

$U_{DC}$, low = 0.8 × $U_{DC}$

The intermediate DC circuit is charged over an internal resistor which is bypassed when the capacitors are considered charged and the voltage has stabilized.

## Braking chopper

The built-in braking chopper of the drive can be used to handle the energy generated by a decelerating motor.

When the braking chopper is enabled and a resistor connected, the chopper will start conducting when the DC link voltage of the drive reaches $U_{DC\_BR}$ - 30 V. The maximum braking power is achieved at $U_{DC\_BR}$ + 30 V.

$U_{DC\_BR}$ = 1.35 × 1.25 × 1.19 USED SUPPLY VOLT.

## Low voltage mode

A Low voltage mode is available to extend the supply voltage range. When the mode is enabled, the drive can operate below the nominal range, for example when it needs to be powered from an emergency supply.

Low voltage mode can be activated by parameter 47.05 LOW VOLT MOD ENA. Low voltage mode introduces parameters 47.06 LOW VOLT DC MIN and 47.07 LOW VOLT DC MAX for adjustment of minimum and maximum DC voltage control levels respectively. The following rules apply:

- 47.06 LOW VOLT DC MIN = 250 to 450 V
- 47.07 LOW VOLT DC MAX = 350 to 810 V
- 47.07 LOW VOLT DC MAX > 47.06 LOW VOLT DC MIN + 50 V.

The value of parameter 47.08 EXT PU SUPPLY or its source should be set to 1 (true) when a supply below 270 V DC – such as a battery – is used. In such a configuration, an additional DC power supply (JPO-01) is needed to power the main circuit electronics. With an AC supply, the value of parameter 47.08 EXT PU SUPPLY or its source should be set to 0 (false).

Parameters 47.06…47.08 are effective only when the Low voltage mode is active, ie, value of parameter 47.05 LOW VOLT MOD ENA (or its source) is 1 (true).

In the Low voltage mode, the default voltage control and trip levels as well as the braking chopper operation levels (see sections *Voltage control and trip limits* and *Braking chopper* elsewhere in this chapter) are changed as follows:

| **Level** | **Value of parameter 47.08 EXT PU SUPPLY** | |
|---|---|---|
| | **FALSE** | **TRUE** |
| Supply voltage range | 200…240 V AC ±10%<br>270…324 V DC ±10% | *48…270 V DC ±10% |
| Overvoltage trip level | Unaffected | Unaffected |
| Overvoltage control level | 47.07 LOW VOLT DC MAX | 47.07 LOW VOLT DC MAX |
| Undervoltage control level | 47.06 LOW VOLT DC MIN | Disabled |
| Undervoltage trip level | 47.06 LOW VOLT DC MIN - 50 V | Disabled |
| Braking chopper activation level | 47.07 LOW VOLT DC MAX - 30 V | 47.07 LOW VOLT DC MAX - 30 V |
| Braking chopper maximum power level | 47.07 LOW VOLT DC MAX + 30 V | 47.07 LOW VOLT DC MAX + 30 V |
| *Requires additional DC power supply JPO-01 | | |

Different system configurations are detailed in *ACSM1 System Engineering Manual* (3AFE68978297 [English]).

**Note:** The Low voltage mode is not available for frames E to G.

# Speed control features

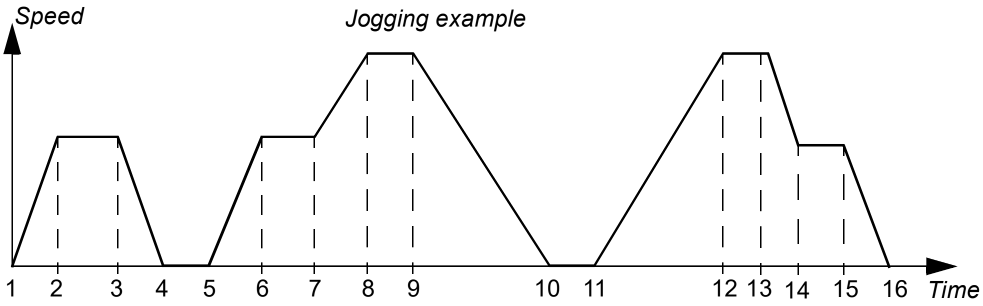
## Jogging

Jogging is typically used during servicing or commissioning to control the machinery locally. It involves rotating the motor in small increments until the desired load position is achieved.

Two jogging functions (1 or 2) are available. When a jogging function is activated, the drive starts and accelerates to the defined jogging speed (parameters 24.10 SPEED REF JOG1 and 24.11 SPEED REF JOG2) along the defined jogging acceleration ramp. When the function is deactivated, the drive decelerates to a stop along the defined jogging deceleration ramp. One push button can be used to start and stop the drive during jogging.

Jogging functions 1 and 2 are activated by a parameter or through fieldbus. The source of the jogging command is selected by bit pointer parameters 10.07 JOG1 START and 10.14 JOG2 START. For activation through fieldbus, see 2.12 FBA MAIN CW.

The figure and table below describe the operation of the drive during jogging. (Note that they cannot be directly applied to jogging commands through fieldbus as those require no enable signal; see parameter 10.15 JOG ENABLE.) They also represent how the drive shifts to normal operation (= jogging inactive) when the drive start command is switched on. Jog cmd = State of the jogging input; Jog enable = Jogging enabled by the source set by parameter 10.15 JOG ENABLE; Start cmd = State of the drive start command.



| Phase | Jog cmd | Jog enable | Start cmd | Description |
|---|---|---|---|---|
| 1-2 | 1 | 1 | 0 | Drive accelerates to the jogging speed along the acceleration ramp of the jogging function. |
| 2-3 | 1 | 1 | 0 | Drive runs at the jogging speed. |
| 3-4 | 0 | 1 | 0 | Drive decelerates to zero speed along the deceleration ramp of the jogging function. |
| 4-5 | 0 | 1 | 0 | Drive is stopped. |
| 5-6 | 1 | 1 | 0 | Drive accelerates to the jogging speed along the acceleration ramp of the jogging function. |
| 6-7 | 1 | 1 | 0 | Drive runs at the jogging speed. |
| 7-8 | x | 0 | 1 | Jog enable is not active; normal operation continues. |
| 8-9 | x | 0 | 1 | Normal operation overrides the jogging. Drive follows the speed reference. |
| 9-10 | x | 0 | 0 | Drive decelerates to zero speed along the active deceleration ramp. |
| 10-11 | x | 0 | 0 | Drive is stopped. |

| Phase | Jog cmd | Jog enable | Start cmd | Description |
|---|---|---|---|---|
| 11-12 | x | 0 | 1 | Normal operation overrides the jogging. Drive accelerates to the speed reference along the active acceleration ramp. |
| 12-13 | 1 | 1 | 1 | Start command overrides the jog enable signal. |
| 13-14 | 1 | 1 | 0 | Drive decelerates to the jogging speed along the deceleration ramp of the jogging function. |
| 14-15 | 1 | 1 | 0 | Drive runs at the jogging speed. |
| 15-16 | x | 0 | 0 | Drive decelerates to zero speed along the deceleration ramp of the jogging function. |

**Notes:**

- Jogging is not operational when the drive start command is on, or when the drive is in local control.
- Normal start is inhibited when jog enable is active.
- The ramp shape time is set to zero during jogging.

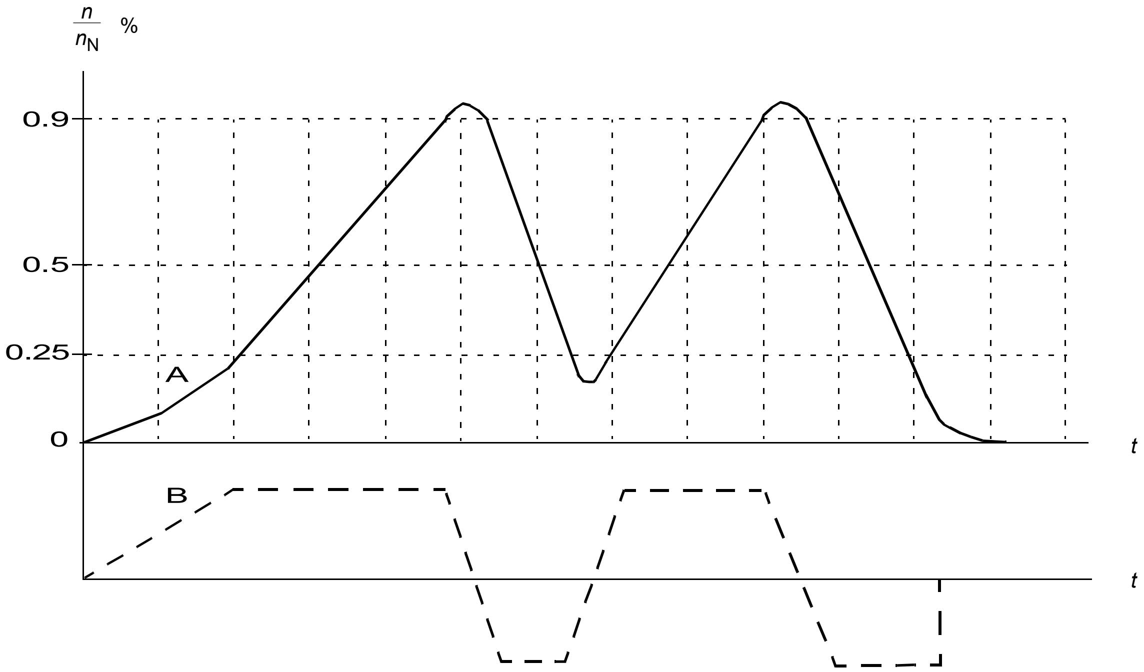
## Speed controller tuning

The speed controller of the drive can be automatically adjusted using the autotune function (parameter 28.16 PI TUNE MODE). Autotuning is based on the load and inertia of the motor and the machine. It is, however, also possible to manually adjust the controller gain, integration time and derivation time. Autotuning can also be performed from an external control location.

Autotuning can be performed in four different ways depending on the setting of parameter 28.16 PI TUNE MODE. The selections (1) Smooth, (2) Middle and (3) Tight define how the drive torque reference should react to a speed reference step after tuning. The selection (1) Smooth will produce a slow response; (3) Tight will produce a fast response. The selection (4) User allows customised control sensitivity adjustment through parameters 28.17 TUNE BANDWIDTH and 28.18 TUNE DAMPING. Detailed tuning status information is provided by parameter 6.03 SPEED CTRL STAT.

Once parameter 28.16 PI TUNE MODE has been set, an autotuning routine will be started when the drive modulation is started the next time. If the autotuning routine fails, the SPEED CTRL TUNE FAIL alarm will occur for approximately 15 seconds. If a stop command is given to the drive during the autotuning routine, the routine will be aborted.

The figure below illustrates the motor speed and torque behaviour during an autotuning routine.



A: Speed actual
B: Torque reference

The prerequisites for performing the autotune routine are:

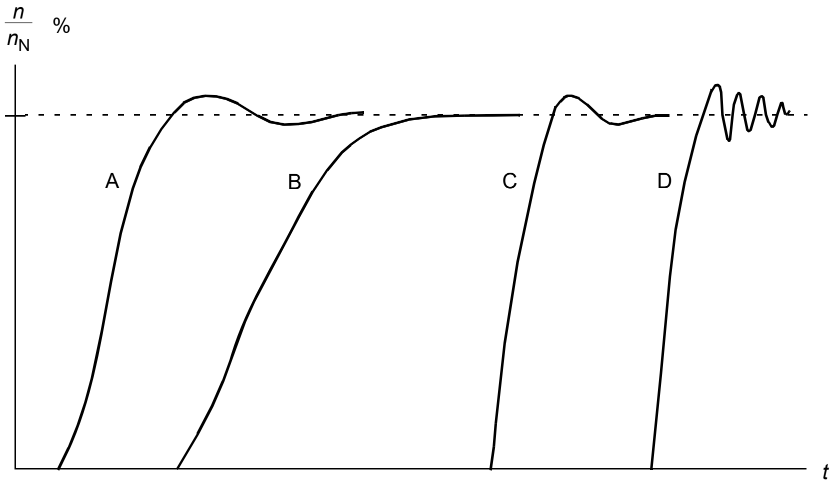
- The motor ID run has been successfully completed
- Speed, torque, current and acceleration limits (parameter groups 20 and 25) are set
- Speed feedback filtering, speed error filtering and zero speed are set (parameter groups 22 and 26)
- The drive is stopped.

The results of the autotune routine are automatically transferred into parameters

- 28.02 PROPORT GAIN (proportional gain of the speed controller)
- 28.03 INTEGRATION TIME (integration time of the speed controller)
- 1.31 MECH TIME CONST (mechanical time constant of the machinery).

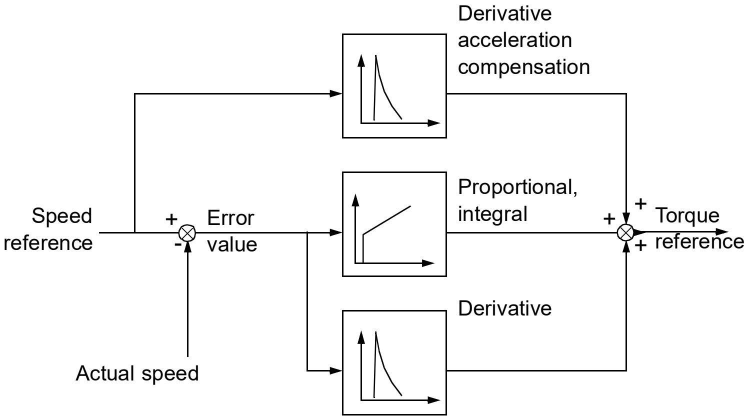
**Note:** The autotuning routine accelerates and decelerates the motor according to the ramp times set in group 25, and these values have an effect on the autotuning results.

The figure below shows speed responses at a speed reference step (typically 1…20%).



A: Undercompensated
B: Normally tuned (autotuning)
C: Normally tuned (manually). Better dynamic performance than with B
D: Overcompensated speed controller

The figure below is a simplified block diagram of the speed controller. The controller output is the reference for the torque controller.



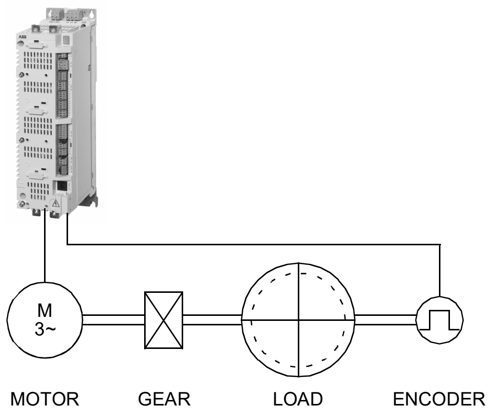
For more information on the use of the autotune function, see the description of parameter 28.16 PI TUNE MODE.

# Motor feedback features

## Motor encoder gear function

The drive provides motor encoder gear function for compensating of mechanical gears between the motor shaft, the encoder and the load.

Motor encoder gear application example:



Speed control uses the motor speed. If no encoder is mounted on the motor shaft, the motor encoder gear function must be applied in order to calculate the actual motor speed on the basis of the measured load speed.

The motor encoder gear parameters 22.03 MOTOR GEAR MUL and 22.04 MOTOR GEAR DIV are set as follows:

$$\frac{\text{22.03 MOTOR GEAR MUL}}{\text{22.04 MOTOR GEAR DIV}} = \frac{\text{Actual speed}}{\text{Encoder 1/2 speed}}$$

**Note:** If the motor gear ratio differs from 1, the motor model uses an estimated speed instead of the speed feedback value.

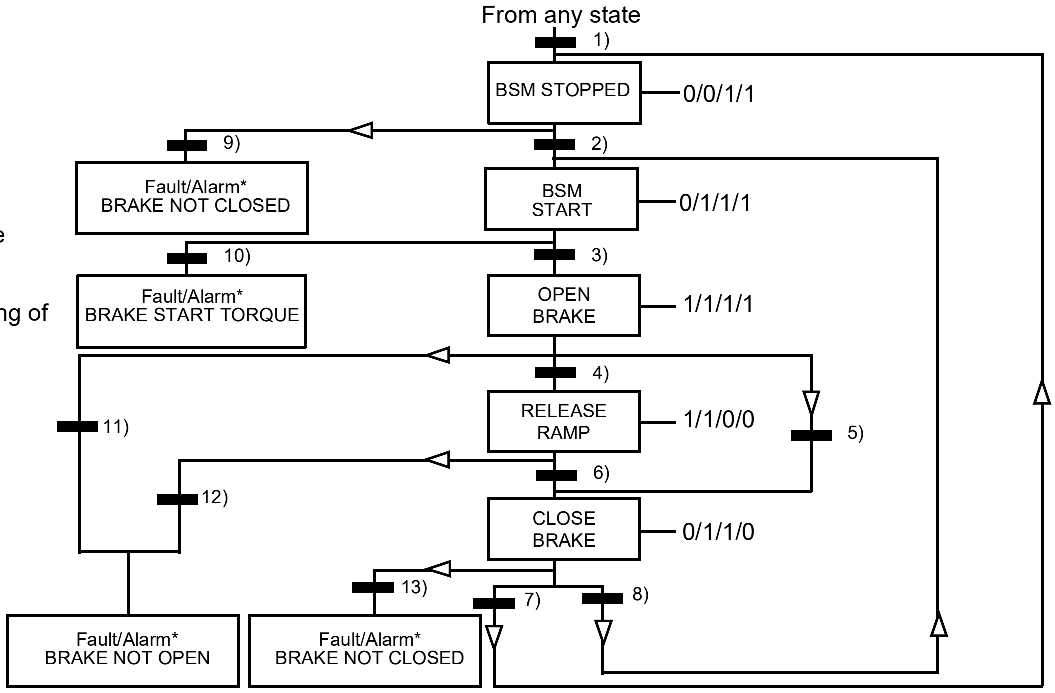
## Mechanical brake control

The program supports the use of a mechanical brake to hold the motor and load at zero speed when the drive is stopped or not powered.

Mechanical brake control (with or without acknowledgement) is activated by parameter 35.01 BRAKE CONTROL. The acknowledgement (supervision) signal can be connected to, for example, a digital input. The brake on/off value is reflected by 3.15 BRAKE COMMAND, which should be connected to a relay (or digital) output. The brake will open upon drive start after the delay 35.03 BRAKE OPEN DELAY has elapsed and requested motor start torque 35.06 BRAKE OPEN TORQ is available. The brake will close after motor speed decreases below 35.05 BRAKE CLOSE SPD and the delay 35.04 BRAKE CLOSE DLY has elapsed. When the brake close command is issued, the motor torque is stored into 3.14 BRAKE TORQ MEM.

**Note:** The mechanical brake must be opened manually before the motor ID run.

### *Mechanical brake state diagram*



BSM = Brake State Machine

* Depends on setting of par. 35.09 BRAKE FAULT FUNC.

State (Symbol NN W/X/Y/Z )

- NN: State name
- W/X/Y/Z: State outputs/operations

W: 1 = Brake open command is active. 0 = Brake close command is active. (Controlled through selected digital/relay output with signal 3.15 BRAKE COMMAND.)

X: 1 = Forced start (inverter is modulating). The function keeps the internal Start command on until the brake is closed regardless of the status of the external Stop. Effective only when ramp stop has been selected as the stop mode (11.03 STOP MODE). Run enable and faults override the forced start. 0 = No forced start (normal operation).

Y: 1 = Drive control mode is forced to speed/scalar.

Z: 1 = Ramp generator output is forced to zero. 0 = Ramp generator output is enabled (normal operation).

State change conditions (Symbol ▬)

1) Brake control is active (35.01 BRAKE CONTROL = (1) WITH ACK or (2) NO ACK) OR modulation of the drive is requested to stop. The drive control mode is forced to speed/scalar.

2) External start command is on AND brake open request is on (source selected by 35.07 BRAKE CLOSE REQ = 0).

3) Starting torque required at brake release is reached (35.06 BRAKE OPEN TORQ) AND brake hold is not active (35.08 BRAKE OPEN HOLD). **Note:** With scalar control, the defined starting torque has no effect.

4) Brake is open (acknowledgement = 1, selected by par. 35.02 BRAKE ACKNOWL) AND the brake open delay has passed (35.03 BRAKE OPEN DELAY). Start = 1.

5) 6) Start = 0 OR brake close command is active AND actual motor speed < brake close speed (35.05 BRAKE CLOSE SPD).

7) Brake is closed (acknowledgement = 0) AND brake close delay has passed (35.04 BRAKE CLOSE DLY). Start = 0.

8) Start = 1.

9) Brake is open (acknowledgement = 1) AND brake close delay has passed.

10) Defined starting torque at brake release is not reached.

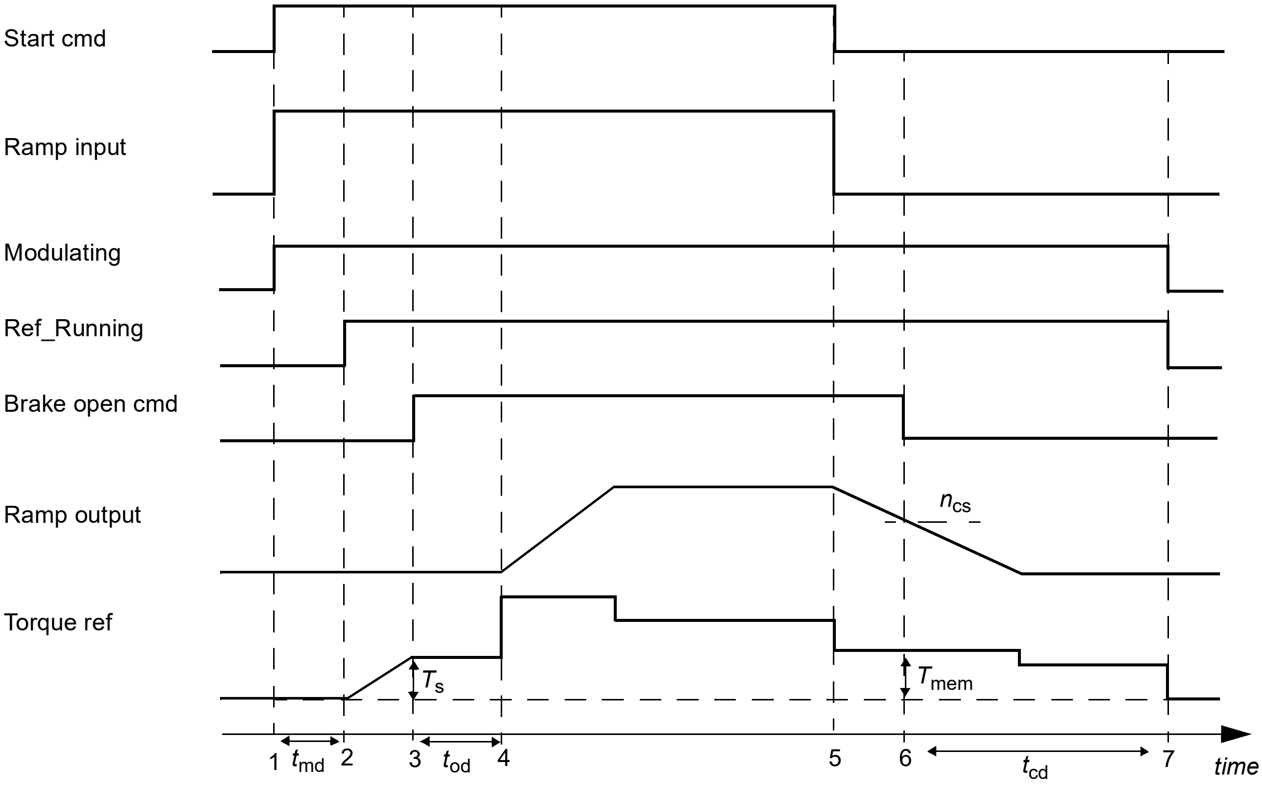
11) Brake is closed (acknowledgement = 0) AND brake open delay has passed.

12) Brake is closed (acknowledgement = 0).

13) Brake is open (acknowledgement = 1) AND brake close delay has passed.

### *Operation time scheme*

The simplified time scheme below illustrates the operation of the brake control function.



| | |
|---|---|
| $T_s$ | Start torque at brake release (parameter 35.06 BRAKE OPEN TORQ) |
| $T_{mem}$ | Stored torque value at brake close (signal 3.14 BRAKE TORQ MEM) |
| $t_{md}$ | Motor magnetising delay |
| $t_{od}$ | Brake open delay (parameter 35.03 BRAKE OPEN DELAY) |
| $n_{cs}$ | Brake close speed (parameter 35.05 BRAKE CLOSE SPD) |
| $t_{cd}$ | Brake close delay (parameter 35.04 BRAKE CLOSE DLY) |

### *Example*

The figure below shows a brake control application example.

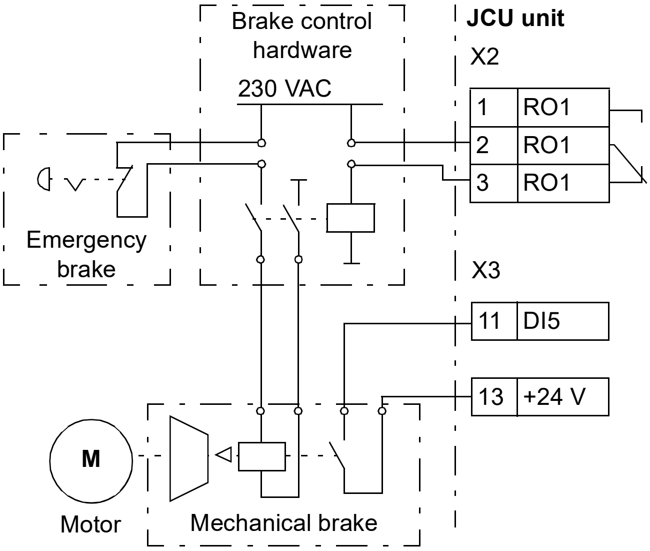
**WARNING!** Make sure that the machinery into which the drive with brake control function is integrated fulfils the personnel safety regulations. Note that the frequency converter (a Complete Drive Module or a Basic Drive Module, as defined in IEC 61800-2), is not considered as a safety device mentioned in the European Machinery Directive and related harmonised standards. Thus, the personnel safety of the complete machinery must not be based on a specific frequency converter feature (such as the brake control function), but it has to be implemented as defined in the application specific regulations.

The brake on/off is controlled via signal 3.15 BRAKE COMMAND. The source for the brake supervision is selected by parameter 35.02 BRAKE ACKNOWL.

The brake control hardware and wirings need to be done by the user.

- Brake on/off control through selected relay/digital output.
- Brake supervision through selected digital input.
- Emergency brake switch in the brake control circuit.

- Brake on/off control through relay output (ie, parameter 12.12 RO1 OUT PTR is set to P.03.15 = 3.15 BRAKE COMMAND).
- Brake supervision through digital input DI5 (ie, parameter 35.02 BRAKE ACKNOWL is set to P.02.01.04 = 2.01 DI STATUS bit 4)



## Emergency stop

**Note:** The user is responsible for installing the emergency stop devices and all the additional devices needed for the emergency stop to fulfil the required emergency stop category classes.

The emergency stop signal is connected to the digital input which is selected as the source for the emergency stop activation (parameter 10.10 EM STOP OFF3 or 10.11 EM STOP OFF1). Emergency stop can also be activated through fieldbus (2.12 FBA MAIN CW).

**Note:** When an emergency stop signal is detected, the emergency stop function cannot be cancelled even though the signal is cancelled.

For more information, refer to *Application Guide: Functional Safety Solutions with ACSM1 Drives* (3AUA0000031517 [English]).

# Miscellaneous features

## Backup and restore of drive contents

*General*

The drive offers a possibility of backing up numerous settings and configurations to external storage such as a PC file (using the DriveStudio tool) and the internal memory of the control panel. These settings and configurations can then be restored to the drive, or a number of drives.

Backup using DriveStudio includes

- Parameter settings
- User parameter sets
- Application program..

Backup using the drive control panel includes

- Parameter settings
- User parameter sets.

For detailed instructions for performing the backup/restore, refer to the DriveStudio and control panel documentation.

*Limitations*

A backup can be done without interfering with drive operation, but restoring a backup always resets and reboots the control unit, so restore is not possible with the drive running.

Backup/restore between different program variants (such as the motion control program and the speed and torque control program) is not possible.

Restoring backup files from one firmware version to another is considered risky, so the results should be carefully observed and verified when done for the first time. The parameters and application support are bound to change between firmware versions and backups are not always compatible with other firmware versions even if restore is allowed by the backup/restore tool. Before using the backup/restore functions between different firmware versions, refer to the release notes of each version.

Applications should not be transferred between different firmware versions. Contact the supplier of the application when it needs to be updated for a new firmware version.

*Parameter restore*

Parameters are divided into three different groups that can be restored together or individually:

- Motor configuration parameters and identification (ID) run results
- Fieldbus adapter and encoder settings
- Other parameters.

For example, retaining the existing motor ID run results in the drive will make a new motor ID run unnecessary.

Restore of individual parameters can fail for the following reasons:

- The restored value does not fall within the minimum and maximum limits of the drive parameter
- The type of the restored parameter is different from that in the drive
- The restored parameter does not exist in the drive (often the case when restoring the parameters of a new firmware version to a drive with an older version)
- The backup does not contain a value for the drive parameter (often the case when restoring the parameters of an old firmware version to a drive with a newer version).

In these cases, the parameter is not restored; the backup/restore tool will warn the user and offer a possibility to set the parameter manually.

#### *User parameter sets*

The drive has four user parameter sets that can be saved to the permanent memory and recalled using drive parameters. It is also possible to use digital inputs to switch between different user parameter sets. See the descriptions of parameters 16.09…16.12.

A user parameter set contains all values of parameter groups 10 to 99 (except the fieldbus communication configuration settings).

As the motor settings are included in the user parameter sets, make sure the settings correspond to the motor used in the application before recalling a user set. In an application where different motors are used with one drive, the motor ID run needs to be performed with each motor and saved to different user sets. The appropriate set can then be recalled when the motor is switched.

### Drive-to-drive link

The drive-to-drive link is a daisy-chained RS-485 transmission line that allows basic master/follower communication with one master drive and multiple followers. For more information, see *Appendix B – Drive-to-drive link*.

### Fan control logic

The fan operation can be controlled via parameter 46.13 FAN CTRL MODE. The parameter provides the following four operation modes: Normal, Force OFF, Force ON and Advanced. The control logic (Normal or Advanced) can be overridden by forcing the fan ON or OFF in which case the fan is running always or never.

In the Normal mode the fan operation is based on the ON/OFF status of the modulator. In addition, the fan runs a predetermined period after the modulator has been switched OFF, which prevents the fan from starting and stopping unnecessarily when the modulator is inactive only for a short period.

In the Advanced fan control mode, the fan operation is based on the measured temperature of power stage, braking chopper (BC), interface board (INT board) and DC link voltage. The fan is started if the temperature of the power stage or INT board or BC rises over the predetermined level. Also an exceptionally high long-term DC link voltage generates the running command for the fan. The fan is stopped if the power stage, braking chopper and INT board are cool and the DC link voltage is below the limit.

With the Normal or Advanced mode the DC voltage activation level for the fan ON command is 640 VDC.

The fan runs a short period after a power-up regardless of parameter 46.13 FAN CTRL MODE to remove moisture and dust from the machinery.

# Default connections of the control unit

## What this chapter contains

This chapter shows the default control connections of the JCU Control Unit.

More information on the connectivity of the JCU is given in the *Hardware Manual* of the drive.

**Notes:**

*Total maximum current: 200 mA

1) Selected by par. 12.01 DIO1 CONF.

2) Selected by par. 12.02 DIO2 CONF.

3) Selected by par. 12.03 DIO3 CONF.

4) Selected by jumper J1.

5) Selected by jumper J2.

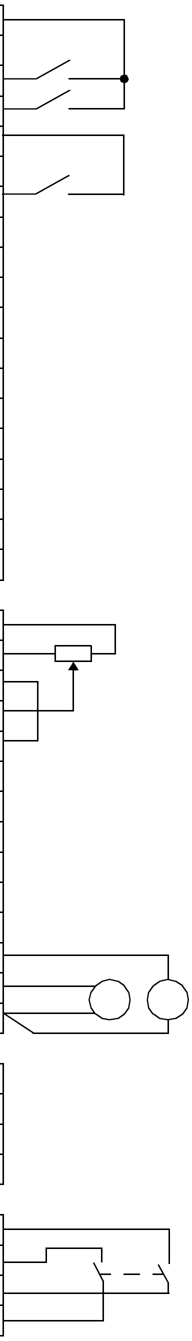
Current:

J1/2 ▣ ○ ○ |AIx|

Voltage:

J1/2 ○ ○ ▣ |AIx|

| | | |
|---|---|---|
| | | **X1** |
| External power input<br>24 V DC, 1.6 A | +24VI | 1 |
| | GND | 2 |
| | | **X2** |
| Relay output: Brake close/open<br>250 V AC / 30 V DC<br>2 A | NO | 1 |
| | COM | 2 |
| | NC | 3 |
| | | **X3** |
| +24 V DC* | +24VD | 1 |
| Digital I/O ground | DGND | 2 |
| Digital input 1: Stop/start (par. 10.02 and 10.05) | DI1 | 3 |
| Digital input 2: EXT1/EXT2 (par. 34.01) | DI2 | 4 |
| +24 V DC* | +24VD | 5 |
| Digital I/O ground | DGND | 6 |
| Digital input 3: Fault reset (par. 10.08) | DI3 | 7 |
| Digital input 4: Not connected | DI4 | 8 |
| +24 V DC* | +24VD | 9 |
| Digital I/O ground | DGND | 10 |
| Digital input 5: Not connected | DI5 | 11 |
| Digital input 6: Not connected | DI6 | 12 |
| +24 V DC* | +24VD | 13 |
| Digital I/O ground | DGND | 14 |
| Digital input/output 1 1): Ready | DIO1 | 15 |
| Digital input/output 2 2): Running | DIO2 | 16 |
| +24 V DC* | +24VD | 17 |
| Digital I/O ground | DGND | 18 |
| Digital input/output 3 3): Fault | DIO3 | 19 |
| | | **X4** |
| Reference voltage (+) | +VREF | 1 |
| Reference voltage (–) | –VREF | 2 |
| Ground | AGND | 3 |
| Analogue input 1 (mA or V) 4): Speed reference (par. 24.01) | AI1+ | 4 |
| | AI1– | 5 |
| Analogue input 2 (mA or V) 5): Torque reference (par. 32.01) | AI2+ | 6 |
| | AI2– | 7 |
| AI1 current/voltage selection | | J1 |
| AI2 current/voltage selection | | J2 |
| Thermistor input | TH | 8 |
| Ground | AGND | 9 |
| Analogue output 1 (mA): Output current | AO1 (I) | 10 |
| Analogue output 2 (V): Actual speed | AO2 (U) | 11 |
| Ground | AGND | 12 |
| | | **X5** |
| Drive-to-drive link termination | | J3 |
| Drive-to-drive link | B | 1 |
| | A | 2 |
| | BGND | 3 |
| | | **X6** |
| Safe Torque Off. Both circuits must be closed for the drive to start. See the appropriate drive hardware manual. | OUT1 | 1 |
| | OUT2 | 2 |
| | IN1 | 3 |
| | IN2 | 4 |
| Control panel connection | | |
| Memory unit connection | | |



# Parameters and firmware blocks

## What this chapter contains

This chapter lists and describes the parameters provided by the firmware.

## Types of parameters

Parameters are user-adjustable operation instructions of the drive (groups 10…99). There are four basic types of parameters: Actual signals, value parameters, value pointer parameters and bit pointer parameters.

### *Actual signal*

Type of parameter that is the result of a measurement or calculation by the drive. Actual signals can be monitored, but not adjusted, by the user. Actual signals are typically contained within parameter groups 1…9.

For additional actual signal data, eg, update cycles and fieldbus equivalents, see chapter *Parameter data*.

### *Value parameter*

A value parameter has a fixed set of choices or a setting range.

Example 1: Motor phase loss supervision is activated by selecting (1) Fault from the selection list of parameter 46.04 MOT PHASE LOSS.

Example 2: The motor nominal power (kW) is set by writing the appropriate value to parameter 99.10 MOT NOM POWER, eg, 10.

### *Value pointer parameter*

A value pointer parameter points to the value of another parameter. The source parameter is given in format **P.xx.yy**, where xx = Parameter group; yy = Parameter index. In addition, value pointer parameters may have a set of pre-selected choices.

Example: Motor current signal, 1.05 CURRENT PERC, is connected to analogue output AO1 by setting parameter 15.01 AO1 PTR to value P.01.05.

### *Bit pointer parameter*

A bit pointer parameter points to the value of a bit in another parameter, or can be fixed to 0 (FALSE) or 1 (TRUE). In addition, bit pointer parameters may have a set of pre-selected choices.

When adjusting a bit pointer parameter on the optional control panel, CONST is selected in order to fix the value to 0 (displayed as “C.FALSE”) or 1 (“C.TRUE”). POINTER is selected to define a source from another parameter.

A pointer value is given in format **P.xx.yy.zz**, where xx = Parameter group,
yy = Parameter index, zz = Bit number.

Example: Digital input DI5 status, 2.01 DI STATUS bit 4, is used for brake supervision by setting parameter 35.02 BRAKE ACKNOWL to value P.02.01.04.

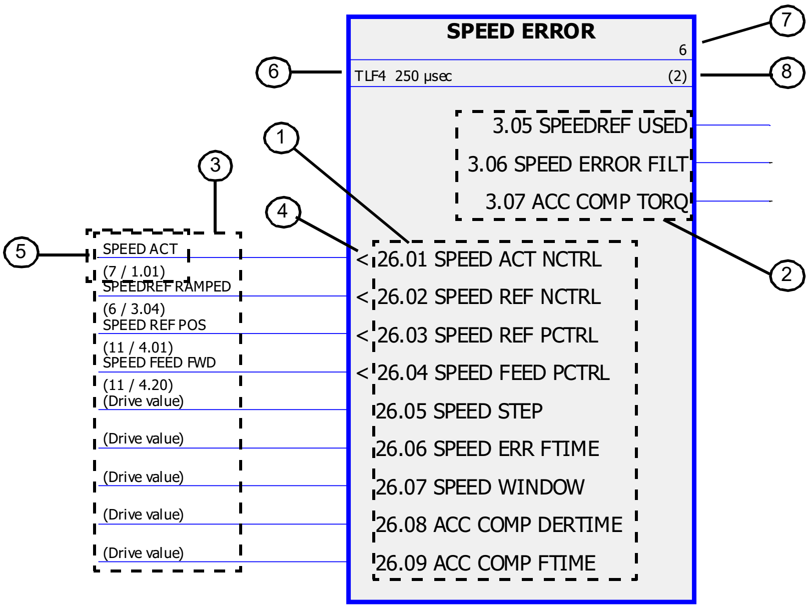
**Note:** Pointing to a non-existing bit will be interpreted as 0 (FALSE).

For additional parameter data, eg, update cycles and fieldbus equivalents, see chapter *Parameter data*.

## Firmware blocks

Firmware blocks accessible from the DriveSPC PC tool are described in the parameter group that contains the most of the block inputs/outputs. Whenever a block has inputs or outputs outside the current parameter group, a reference is given. Likewise, parameters have a reference to the firmware block they are included in (if any).

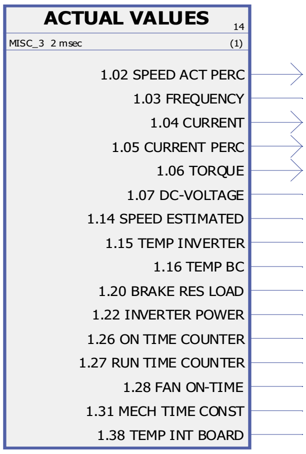
**Note:** Not all parameters are available through firmware blocks.



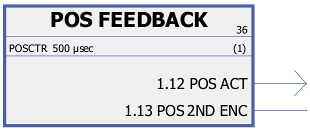
| | |
|---|---|
| 1 | Inputs |
| 2 | Outputs |
| 3 | Input parameter values |
| 4 | Pointer parameter indicator “<“ |
| 5 | Parameter 26.01 is set to value P.1.1, ie, parameter 1.01 SPEED ACT. The “7” means the parameter can be found on page 7 of DriveSPC. |
| 6 | Information of the block internal execution order (“TLF4”) and time level (“250 µsec”). Time level, ie, update cycle, is application-specific. See the time level of the block in DriveSPC. |
| 7 | Firmware block ID number in the application program |
| 8 | Firmware block execution order for the selected update cycle ID |

## Group 01 ACTUAL VALUES

This group contains basic actual signals for monitoring the drive.

| | | |
|---|---|---|
| Firmware block:<br>**ACTUAL VALUES**<br>(1) | |   ACTUAL VALUES<br>14<br>MISC_3 2 msec<br>(1)<br>1.02 SPEED ACT PERC<br>1.03 FREQUENCY<br>1.04 CURRENT<br>1.05 CURRENT PERC<br>1.06 TORQUE<br>1.07 DC-VOLTAGE<br>1.14 SPEED ESTIMATED<br>1.15 TEMP INVERTER<br>1.16 TEMP BC<br>1.20 BRAKE RES LOAD<br>1.22 INVERTER POWER<br>1.26 ON TIME COUNTER<br>1.27 RUN TIME COUNTER<br>1.28 FAN ON-TIME<br>1.31 MECH TIME CONST<br>1.38 TEMP INT BOARD |
| **1.01** | SPEED ACT | FW block: SPEED FEEDBACK (page 145) |
| | Filtered actual speed in rpm. Used speed feedback is defined by parameter 22.01 SPEED FB SEL. Filter time constant can be adjusted by parameter 22.02 SPEED ACT FTIME. | |
| **1.02** | SPEED ACT PERC | FW block: ACTUAL VALUES (see above) |
| | Actual speed in percent of the motor synchronous speed. | |
| **1.03** | FREQUENCY | FW block: ACTUAL VALUES (see above) |
| | Estimated drive output frequency in Hz. | |
| **1.04** | CURRENT | FW block: ACTUAL VALUES (see above) |
| | Measured motor current in A. | |
| **1.05** | CURRENT PERC | FW block: ACTUAL VALUES (see above) |
| | Motor current in percent of the nominal motor current. | |
| **1.06** | TORQUE | FW block: ACTUAL VALUES (see above) |
| | Motor torque in percent of the motor nominal torque. | |
| **1.07** | DC-VOLTAGE | FW block: ACTUAL VALUES (see above) |
| | Measured intermediate circuit voltage in V. | |
| **1.08** | ENCODER 1 SPEED | FW block: ENCODER (page 214) |
| | Encoder 1 speed in rpm. | |
| **1.09** | ENCODER 1 POS | FW block: ENCODER (page 214) |
| | Actual position of encoder 1 within one revolution. | |

| | | |
|---|---|---|
| **1.10** | ENCODER 2 SPEED | FW block: ENCODER (page 214) |
| | Encoder 2 speed in rpm. | |
| **1.11** | ENCODER 2 POS | FW block: ENCODER (page 214) |
| | Actual position of encoder 2 within one revolution. | |

| | | |
|---|---|---|
| Firmware block:<br>**POS FEEDBACK**<br>(60) | |  POS FEEDBACK<br>36<br>POSCTR 500 µsec<br>(1)<br>1.12 POS ACT<br>1.13 POS 2ND ENC |
| **1.12** | POS ACT | FW block: POS FEEDBACK (see above) |
| | Actual position of the encoder. | |
| **1.13** | POS 2ND ENC | FW block: POS FEEDBACK (see above) |
| | Scaled actual position of encoder 2 in revolutions. | |

| | | |
|---|---|---|
| **1.14** | SPEED ESTIMATED | FW block: ACTUAL VALUES (see above) |
| | Estimated motor speed in rpm. | |
| **1.15** | TEMP INVERTER | FW block: ACTUAL VALUES (see above) |
| | Measured temperature of the heatsink in Celsius. | |
| **1.16** | TEMP BC | FW block: ACTUAL VALUES (see above) |
| | Braking chopper IGBT temperature in Celsius. | |
| **1.17** | MOTOR TEMP | FW block: MOT THERM PROT (page 187) |
| | Measured motor temperature in Celsius when a KTY sensor is used. (With a PTC sensor, the value is always 0.) | |
| **1.18** | MOTOR TEMP EST | FW block: MOT THERM PROT (page 187) |
| | Estimated motor temperature in Celsius. | |
| **1.19** | USED SUPPLY VOLT | FW block: VOLTAGE CTRL (page 196) |
| | Either the user-given supply voltage (parameter 47.04 SUPPLY VOLTAGE), or, if auto-identification is enabled by parameter 47.03 SUPPLVOLTAUTO-ID, the automatically determined supply voltage. | |
| **1.20** | BRAKE RES LOAD | FW block: ACTUAL VALUES (see above) |
| | Estimated temperature of the braking resistor. The value is given in percent of the temperature the resistor reaches when loaded with the power defined by parameter 48.04 BR POWER MAX CNT. | |
| **1.21** | CPU USAGE | FW block: None |
| | Microprocessor load in percent. | |

| | | |
|---|---|---|
| **1.22** | INVERTER POWER | FW block: ACTUAL VALUES (see above) |
| | Drive output power in kilowatts. | |
| **1.26** | ON TIME COUNTER | FW block: ACTUAL VALUES (see above) |
| | This counter runs when the drive is powered. The counter can be reset using the DriveStudio tool. | |
| **1.27** | RUN TIME COUNTER | FW block: ACTUAL VALUES (see above) |
| | Motor run time counter. The counter run when the drive modulates. The counter can be reset using the DriveStudio tool. | |
| **1.28** | FAN ON-TIME | FW block: ACTUAL VALUES (see above) |
| | Running time of the drive cooling fan. Can be reset by entering 0. | |
| **1.31** | MECH TIME CONST | FW block: ACTUAL VALUES (see above) |
| | Mechanical time constant of the drive and the machinery as determined by the speed controller autotune function. See parameter 28.16 PI TUNE MODE on page 168. | |
| **1.38** | TEMP INT BOARD | FW block: ACTUAL VALUES (see above) |
| | Measured temperature of the interface board in degrees Celsius. | |
| **1.39** | OUTPUT VOLTAGE | FW block: None |
| | Calculated motor voltage. | |
| **1.42** | FAN START COUNT | FW block: None |
| | Number of times the drive cooling fan has been started. | |

## Group 02 I/O VALUES

This group contains information on the I/Os of the drive.

| | | |
|---|---|---|
| **2.01** | DI STATUS | FW block: DI (page 127) |
| | Status word of the digital inputs. Example: 000001 = DI1 is on, DI2 to DI6 are off. | |
| **2.02** | RO STATUS | FW block: RO (page 127) |
| | Status of relay output. 1 = RO is energized. | |
| **2.03** | DIO STATUS | FW blocks: DIO1 (page 125), DIO2 (page 125), DIO3 (page 125) |
| | Status word of digital inputs/outputs DIO1…3. Example: 001 = DIO1 is on, DIO2 and DIO3 are off. | |
| **2.04** | AI1 | FW block: AI1 (page 129) |
| | Analogue input AI1 value in V or mA. The type is selected with jumper J1 on the JCU Control Unit. | |
| **2.05** | AI1 SCALED | FW block: AI1 (page 129) |
| | Scaled value of analogue input AI1. See parameters 13.04 AI1 MAX SCALE and 13.05 AI1 MIN SCALE. | |
| **2.06** | AI2 | FW block: AI2 (page 130) |
| | Analogue input AI2 value in V or mA. The type is selected with jumper J2 on the JCU Control Unit. | |
| **2.07** | AI2 SCALED | FW block: AI2 (page 130) |
| | Scaled value of analogue input AI2. See parameters 13.09 AI2 MAX SCALE and 13.10 AI2 MIN SCALE. | |
| **2.08** | AO1 | FW block: AO1 (page 133) |
| | Analogue output AO1 value in mA | |
| **2.09** | AO2 | FW block: AO2 (page 134) |
| | Analogue output AO2 value in V | |
| **2.10** | DIO2 FREQ IN | FW block: DIO2 (page 125) |
| | Scaled value of DIO2 when it is used as a frequency input. See parameters 12.02 DIO2 CONF and 12.14 DIO2 F MAX…12.17 DIO2 F MIN SCALE. | |
| **2.11** | DIO3 FREQ OUT | FW block: DIO3 (page 125) |
| | Frequency output value of DIO3 when it is used as a frequency output. See parameters 12.03 DIO3 CONF and 12.08 DIO3 F MAX…12.11 DIO3 F MIN SCALE. | |

| 2.12 | FBA MAIN CW | FW block: FIELDBUS (page 200) |
|---|---|---|

Control Word for fieldbus communication.

Log. = Logical combination (ie, Bit AND/OR Selection parameter). Par. = Selection parameter. See *State diagram* on page *353.*

| Bit | Name | Val. | Information | Log. | Par. |
|---|---|---|---|---|---|
| 0 | STOP* | 1 | Stop according to the stop mode selected by 11.03 STOP MODE or according to the requested stop mode (bits 2…6). **Note:** Simultaneous STOP and START commands result in a stop command. | OR | 10.02,<br>10.03,<br>10.05,<br>10.06 |
| | | 0 | No operation | | |
| 1 | START | 1 | Start. **Note:** Simultaneous STOP and START commands result in a stop command. | OR | 10.02,<br>10.03,<br>10.05,<br>10.06 |
| | | 0 | No operation | | |
| 2 | STPMODE EM OFF* | 1 | Emergency OFF2 (bit 0 must be 1): Drive is stopped by cutting off the motor power supply (the inverter IGBTs are blocked). The motor coasts to stop. The drive will restart only with the next rising edge of the start signal when the run enable signal is on. | AND | - |
| | | 0 | No operation | | |
| 3 | STPMODE EM STOP* | 1 | Emergency stop OFF3 (bit 0 must be 1): Stop within the time defined by 25.11 EM STOP TIME. | AND | 10.10 |
| | | 0 | No operation | | |
| 4 | STPMODE OFF1* | 1 | Emergency stop OFF1 (bit 0 must be 1): Stop along the currently active deceleration ramp. | AND | 10.11 |
| | | 0 | No operation | | |
| 5 | STPMODE RAMP* | 1 | Stop along the currently active deceleration ramp. | - | 11.03 |
| | | 0 | No operation | | |
| 6 | STPMODE COAST* | 1 | Coast to stop. | - | 11.03 |
| | | 0 | No operation | | |
| 7 | RUN ENABLE | 1 | Activate run enable. | AND | 10.09 |
| | | 0 | Activate run disable. | | |
| 8 | RESET | 0->1 | Fault reset if an active fault exists. | OR | 10.08 |
| | | other | No operation | | |
| 9 | JOGGING 1 | 1 | Activate jogging function 1. See section *Jogging* on page *49*. | OR | 10.07 |
| | | 0 | Jogging function 1 disabled | | |

* If all stop mode bits 2…6 are 0, stop mode is selected by 11.03 STOP MODE. Coast stop (bit 6) overrides the emergency stop (bit 2/3/4). Emergency stop overrides the normal ramp stop (bit 5).

| 2.12 | FBA MAIN CW (continued from previous page) |
|---|---|

| Bit | Name | Val. | Information | Log. | Par. |
|---|---|---|---|---|---|
| 10 | JOGGING 2 | 1 | Activate jogging function 2. See section *Jogging* on page *49*. | OR | 10.14 |
| | | 0 | Jogging function 2 disabled | | |
| 11 | REMOTE CMD | 1 | Fieldbus control enabled | - | - |
| | | 0 | Fieldbus control disabled | | |
| 12 | RAMP OUT 0 | 1 | Force Ramp Function Generator output to zero. Drive ramps to a stop (current and DC voltage limits in force). | - | - |
| | | 0 | No operation | | |
| 13 | RAMP HOLD | 1 | Halt ramping (Ramp Function Generator output held). | - | - |
| | | 0 | No operation | | |
| 14 | RAMP IN 0 | 1 | Force Ramp Function Generator input to zero. | - | - |
| | | 0 | No operation | | |
| 15 | EXT1 / EXT2 | 1 | Switch to external control location EXT2. | OR | 34.01 |
| | | 0 | Switch to external control location EXT1. | | |
| 16 | REQ STARTINH | 1 | Activate start inhibit. | - | - |
| | | 0 | No start inhibit | | |
| 17 | LOCAL CTL | 1 | Request local control for Control Word. Used when the drive is controlled via PC tool or panel or through local fieldbus.<br>- Local fieldbus: Transfer to fieldbus local control (control via fieldbus control word or reference). Fieldbus steals the control.<br>- Panel or PC tool: Transfer to local control. | - | - |
| | | 0 | Request external control. | | |
| 18 | FBLOCAL REF | 1 | Request fieldbus local control. | - | - |
| | | 0 | No fieldbus local control | | |
| 19…27 | Not in use | | | | |
| 28 | CW B28 | | Freely programmable control bits. | - | - |
| 29 | CW B29 | | | | |
| 30 | CW B30 | | | | |
| 31 | CW B31 | | | | |

| 2.13 | FBA MAIN SW | FW block: FIELDBUS (page 200) |
|---|---|---|

Status Word for fieldbus communication. See *State diagram* on page *353.*

| Bit | Name | Value | Information |
|---|---|---|---|
| 0 | READY | 1 | Drive is ready to receive start command. |
| | | 0 | Drive is not ready. |
| 1 | ENABLED | 1 | External run enable signal is received. |
| | | 0 | No external run enable signal is received. |
| 2 | RUNNING | 1 | Drive is modulating. |
| | | 0 | Drive is not modulating. |
| 3 | REF RUNNING | 1 | Normal operation is enabled. Drive is running and following given reference. |
| | | 0 | Normal operation is disabled. Drive is not following given reference (for example, modulating during magnetization). |
| 4 | EM OFF (OFF2) | 1 | Emergency OFF2 is active. |
| | | 0 | Emergency OFF2 is inactive. |
| 5 | EM STOP (OFF3) | 1 | Emergency stop OFF3 (ramp stop) is active. |
| | | 0 | Emergency OFF3 is inactive. |
| 6 | ACK STARTINH | 1 | Start inhibit is active. |
| | | 0 | Start inhibit is inactive. |
| 7 | ALARM | 1 | An alarm is active. See chapter *Fault tracing*. |
| | | 0 | No alarm is active. |
| 8 | AT SETPOINT | 1 | Drive is at setpoint. Actual value equals reference value (ie, the difference between the actual speed and the speed reference is within the speed window defined by 26.07 SPEED WINDOW). |
| | | 0 | Drive has not reached setpoint. |
| 9 | LIMIT | 1 | Operation is limited by any torque or current limit. |
| | | 0 | Operation is within torque/current limits. |
| 10 | ABOVE LIMIT | 1 | Actual speed exceeds the defined limit, 22.07 ABOVE SPEED LIM. |
| | | 0 | Actual speed is within the defined limits. |
| 11 | EXT2 ACT | 1 | External control location EXT2 is active. |
| | | 0 | External control location EXT1 is active. |
| 12 | LOCAL FB | 1 | Fieldbus local control is active. |
| | | 0 | Fieldbus local control is inactive. |
| 13 | ZERO SPEED | 1 | Drive speed is below limit set by par. 22.05 ZERO SPEED LIMIT. |
| | | 0 | Drive has not reached zero speed limit. |
| 14 | REV ACT | 1 | Drive is running in reverse direction. |
| | | 0 | Drive is running in forward direction. |
| 15 | Not in use | | |
| 16 | FAULT | 1 | Fault is active. See chapter *Fault tracing*. |
| | | 0 | No fault is active. |
| 17 | LOCAL PANEL | 1 | Local control is active, ie, drive is controlled from PC tool or control panel. |
| | | 0 | Local control is inactive. |

| | | |
|---|---|---|
| 2.13 | FBA MAIN SW (continued from previous page) | |

| Bit | Name | Value | Information |
|---|---|---|---|
| 18…26 | Not in use with ACSM1 speed and torque control program | | |
| 27 | REQUEST CTL | 1 | Control word is requested from fieldbus. |
| | | 0 | Control word is not requested from fieldbus. |
| 28 | SW B28 | | Programmable status bits (unless fixed by the used profile). See parameters 50.08…50.11 and the user manual of the fieldbus adapter. |
| 29 | SW B29 | | |
| 30 | SW B30 | | |
| 31 | SW B31 | | |

| | | |
|---|---|---|
| **2.14** | FBA MAIN REF1 | FW block: FIELDBUS (page 200) |
| | Scaled fieldbus reference 1. See parameter 50.04 FBA REF1 MODESEL. | |
| **2.15** | FBA MAIN REF2 | FW block: FIELDBUS (page 200) |
| | Scaled fieldbus reference 2. See parameter 50.05 FBA REF2 MODESEL. | |
| **2.16** | FEN DI STATUS | FW block: ENCODER (page 214) |
| | Status of digital inputs of FEN-xx encoder interfaces in drive option Slots 1 and 2. Examples:<br>000001 (01h) = DI1 of FEN-xx in Slot 1 is ON, all others are OFF.<br>000010 (02h) = DI2 of FEN-xx in Slot 1 is ON, all others are OFF.<br>010000 (10h) = DI1 of FEN-xx in Slot 2 is ON, all others are OFF.<br>100000 (20h) = DI2 of FEN-xx in Slot 2 is ON, all others are OFF. | |
| **2.17** | D2D MAIN CW | FW block: D2D COMMUNICATION (page 209) |
| | Drive-to-drive control word received through the drive-to-drive link. See also actual signal 2.18 below. | |

| Bit | Information |
|---|---|
| 0 | Stop. |
| 1 | Start. |
| 2…6 | Reserved. |
| 7 | Run enable. By default, not connected in a follower drive. |
| 8 | Reset. By default, not connected in a follower drive. |
| 9…14 | Freely assignable through bit pointer parameters. |
| 15 | EXT1/EXT2 selection. 0 = EXT1 active, 1 = EXT2 active. By default, not connected in a follower drive. |

<table>
<tr><td>**2.18**</td><td>D2D FOLLOWER CW</td><td>FW block: DRIVE LOGIC (page 116)</td></tr>
<tr><td></td><td colspan="2">Drive-to-drive control word sent to the followers by default. See also firmware block D2D COMMUNICATION on page 209.
<table>
<tr><th>Bit</th><th>Information</th></tr>
<tr><td>0</td><td>Stop.</td></tr>
<tr><td>1</td><td>Start.</td></tr>
<tr><td>2…6</td><td>Reserved.</td></tr>
<tr><td>7</td><td>Run enable.</td></tr>
<tr><td>8</td><td>Reset.</td></tr>
<tr><td>9…14</td><td>Reserved.</td></tr>
<tr><td>15</td><td>EXT1/EXT2 selection. 0 = EXT1 active, 1 = EXT2 active.</td></tr>
</table>
</td></tr>
<tr><td>**2.19**</td><td>D2D REF1</td><td>FW block: D2D COMMUNICATION (page 209)</td></tr>
<tr><td></td><td colspan="2">Drive-to-drive reference 1 received through the drive-to-drive link.</td></tr>
<tr><td>**2.20**</td><td>D2D REF2</td><td>FW block: D2D COMMUNICATION (page 209)</td></tr>
<tr><td></td><td colspan="2">Drive-to-drive reference 2 received through the drive-to-drive link.</td></tr>
</table>

## Group 03 CONTROL VALUES

| | | |
|---|---|---|
| **3.01** | SPEED REF1 | FW block: SPEED REF SEL (page 151) |
| | Speed reference 1 in rpm. | |
| **3.02** | SPEED REF2 | FW block: SPEED REF SEL (page 151) |
| | Speed reference 2 in rpm. | |
| **3.03** | SPEEDREF RAMP IN | FW block: SPEED REF MOD (page 152) |
| | Used speed reference ramp input in rpm. | |
| **3.04** | SPEEDREF RAMPED | FW block: SPEED REF RAMP (page 155) |
| | Ramped and shaped speed reference in rpm. | |
| **3.05** | SPEEDREF USED | FW block: SPEED ERROR (page 159) |
| | Used speed reference in rpm (reference before the speed error calculation). | |
| **3.06** | SPEED ERROR FILT | FW block: SPEED ERROR (page 159) |
| | Filtered speed error value in rpm. | |
| **3.07** | ACC COMP TORQ | FW block: SPEED ERROR (page 159) |
| | Output of the acceleration compensation (torque in %). | |
| **3.08** | TORQ REF SP CTRL | FW block: SPEED CONTROL (page 163) |
| | Limited speed controller output torque in %. | |
| **3.09** | TORQ REF1 | FW block: TORQ REF SEL (page 170) |
| | Torque reference 1 in %. | |
| **3.10** | TORQ REF RAMPED | FW block: TORQ REF MOD (page 171) |
| | Ramped torque reference in %. | |
| **3.11** | TORQ REF RUSHLIM | FW block: TORQ REF MOD (page 171) |
| | Torque reference limited by the rush control (value in %). Torque is limited to ensure that the speed is between the defined minimum and maximum speed limits (parameters 20.01 MAXIMUM SPEED and 20.02 MINIMUM SPEED). | |
| **3.12** | TORQUE REF ADD | FW block: TORQ REF SEL (page 170) |
| | Torque reference additive in %. | |
| **3.13** | TORQ REF TO TC | FW block: REFERENCE CTRL (page 178) |
| | Torque reference in % for the torque control. When 99.05 MOTOR CTRL MODE is set to (1) Scalar, this value is forced to 0. | |
| **3.14** | BRAKE TORQ MEM | FW block: MECH BRAKE CTRL (page 181) |
| | Torque value (in %) stored when the mechanical brake close command is issued. | |

| | | |
|---|---|---|
| **3.15** | BRAKE COMMAND | FW block: MECH BRAKE CTRL (page 181) |
| | Brake on/off command. 0 = Close. 1 = Open. For brake on/off control, connect this signal to a relay output (or a digital output). See section *Mechanical brake control* on page *54*. | |
| **3.16** | FLUX REF USED | FW block: MOTOR CONTROL (page 184) |
| | Used flux reference in percent. | |
| **3.17** | TORQUE REF USED | FW block: MOTOR CONTROL (page 184) |
| | Used/limited torque reference in percent. | |
| **3.20** | MAX SPEED REF | FW block: LIMITS (page 141) |
| | Maximum speed reference. | |
| **3.21** | MIN SPEED REF | FW block: LIMITS (page 141) |
| | Minimum speed reference. | |

# Group 06 DRIVE STATUS

| 6.01 | STATUS WORD 1 | FW block: DRIVE LOGIC (page 116) |
|---|---|---|

Status word 1.

| Bit | Name | Val. | Information |
|---|---|---|---|
| 0 | READY | 1 | Drive is ready to receive start command. |
| | | 0 | Drive is not ready. |
| 1 | ENABLED | 1 | External run enable signal is received. |
| | | 0 | No external run enable signal is received. |
| 2 | STARTED | 1 | Drive has received start command. |
| | | 0 | Drive has not received start command. |
| 3 | RUNNING | 1 | Drive is modulating. |
| | | 0 | Drive is not modulating. |
| 4 | EM OFF (OFF2) | 1 | Emergency OFF2 is active. |
| | | 0 | Emergency OFF2 is inactive. |
| 5 | EM STOP (OFF3) | 1 | Emergency stop OFF3 (ramp stop) is active. |
| | | 0 | Emergency OFF3 is inactive. |
| 6 | ACK STARTINH | 1 | Start inhibit is active. |
| | | 0 | Start inhibit is inactive. |
| 7 | ALARM | 1 | An alarm is active. See chapter *Fault tracing*. |
| | | 0 | No alarm |
| 8 | EXT2 ACT | 1 | External control EXT2 is active. |
| | | 0 | External control EXT1 is active. |
| 9 | LOCAL FB | 1 | Fieldbus local control is active. |
| | | 0 | Fieldbus local control is inactive. |
| 10 | FAULT | 1 | A fault is active. See chapter *Fault tracing*. |
| | | 0 | No fault |
| 11 | LOCAL PANEL | 1 | Local control is active, ie, drive is controlled from PC tool or control panel. |
| | | 0 | Local control is inactive. |
| 12 | NOT FAULTED | 1 | No fault |
| | | 0 | A fault is active. See chapter *Fault tracing*. |
| 13 | Reserved | | |
| 14 | TORQ START ACT | 1 | Controlled starting torque functionality is active. |
| | | 0 | Controlled starting torque functionality is inactive. |
| 15 | Reserved | | |

| 6.02 | STATUS WORD 2 | FW block: DRIVE LOGIC (page 116) |
|---|---|---|

Status word 2.

| Bit | Name | Val. | Information |
|---|---|---|---|
| 0 | START ACT | 1 | Drive start command is active. |
| | | 0 | Drive start command is inactive. |
| 1 | STOP ACT | 1 | Drive stop command is active. |
| | | 0 | Drive stop command is inactive. |
| 2 | READY RELAY | 1 | Ready to function: run enable signal on, no fault, emergency stop signal off, no motor ID run inhibition. Connected by default to DIO1 by par. 12.04 DIO1 OUT PTR. (Can be freely connected anywhere.) |
| | | 0 | Not ready to function |
| 3 | MODULATING | 1 | Modulating: IGBTs are controlled, ie, the drive is RUNNING. |
| | | 0 | No modulation: IGBTs are not controlled. |
| 4 | REF RUNNING | 1 | Normal operation is enabled. Running. Drive follows the given reference. |
| | | 0 | Normal operation is disabled, Drive is not following the given reference (eg, in magnetisation phase drive is modulating). |
| 5 | JOGGING | 1 | Jogging function 1 or 2 is active. |
| | | 0 | Jogging function is inactive. |
| 6 | OFF1 | 1 | Emergency stop OFF1 is active. |
| | | 0 | Emergency stop OFF1 is inactive. |
| 7 | START INH MASK | 1 | Maskable (by par. 10.12 START INHIBIT) start inhibit is active. |
| | | 0 | No start inhibit (maskable) |
| 8 | START INH NOMASK | 1 | Non-maskable start inhibit is active. |
| | | 0 | No start inhibit (non-maskable) |
| 9 | CHRG REL CLOSED | 1 | Charging relay is closed. |
| | | 0 | Charging relay is open. |
| 10 | STO ACT | 1 | Safe Torque Off function is active. See parameter 46.07 STO DIAGNOSTIC. |
| | | 0 | Safe Torque Off function is inactive. |
| 11 | Reserved | | |
| 12 | RAMP IN 0 | 1 | Ramp Function Generator input is forced to zero. |
| | | 0 | Normal operation |
| 13 | RAMP HOLD | 1 | Ramp Function Generator output is held. |
| | | 0 | Normal operation |
| 14 | RAMP OUT 0 | 1 | Ramp Function Generator output is forced to zero. |
| | | 0 | Normal operation |
| 15 | DATA LOGGER ON | 1 | The drive data logger is on and has not been triggered. |
| | | 0 | The drive data logger is off, or its post-trigger time has not yet elapsed. See the DriveStudio user manual. |

| 6.03 | SPEED CTRL STAT | FW block: DRIVE LOGIC (page 116) |
|---|---|---|

Speed control status word.

| Bit | Name | Val. | Information |
|---|---|---|---|
| 0 | SPEED ACT NEG | 1 | Actual speed is negative. |
| 1 | ZERO SPEED | 1 | Actual speed has reached the zero speed limit (22.05 ZERO SPEED LIMIT). |
| 2 | ABOVE LIMIT | 1 | Actual speed has exceeded the supervision limit (22.07 ABOVE SPEED LIM). |
| 3 | AT SETPOINT | 1 | Difference between 1.01 SPEED ACT and 3.03 SPEEDREF RAMP IN (in speed control) or 3.05 SPEEDREF USED (in position control) is within speed window (26.07 SPEED WINDOW). |
| 4 | BAL ACTIVE | 1 | Speed controller output balancing is active (28.09 SPEEDCTRL BAL EN). |
| 5 | PI TUNE ACTIVE | 1 | Speed controller autotune is active. |
| 6 | PI TUNE REQ | 1 | Speed controller autotune has been requested by parameter 28.16 PI TUNE MODE. |
| 7 | PI TUNE DONE | 1 | Speed controller autotune has been completed successfully. |
| 8…15 | Reserved | | |

| 6.05 | LIMIT WORD 1 | FW block: DRIVE LOGIC (page 116) |
|---|---|---|

Limit word 1.

| Bit | Name | Val. | Information |
|---|---|---|---|
| 0 | TORQ LIM | 1 | Drive torque is being limited by the motor control (undervoltage control, overvoltage control, current limitation, load angle limitation, or pull-out limitation), or by parameter 20.06 MAXIMUM TORQUE or 20.07 MINIMUM TORQUE. The source of the limitation is identified by 6.07 TORQ LIM STATUS. |
| 1 | SPD CTL TLIM MIN | 1 | Speed controller output minimum torque limit is active. The limit is defined by parameter 28.10 MIN TORQ SP CTRL. |
| 2 | SPD CTL TLIM MAX | 1 | Speed controller output maximum torque limit is active. The limit is defined by parameter 28.11 MAX TORQ SP CTRL. |
| 3 | TORQ REF MAX | 1 | Torque reference (3.09 TORQ REF1) maximum limit is active. The limit is defined by parameter 32.04 MAXIMUM TORQ REF. |
| 4 | TORQ REF MIN | 1 | Torque reference (3.09 TORQ REF1) minimum limit is active. The limit is defined by parameter 32.05 MINIMUM TORQ REF. |
| 5 | TLIM MAX SPEED | 1 | Torque reference maximum value is limited by the rush control, because of maximum speed limit 20.01 MAXIMUM SPEED. |
| 6 | TLIM MIN SPEED | 1 | Torque reference minimum value is limited by the rush control, because of minimum speed limit 20.02 MINIMUM SPEED. |
| 7…15 | Reserved | | |

| 6.07 | TORQ LIM STATUS | FW block: DRIVE LOGIC (page 116) |
|---|---|---|

Torque controller limitation status word.

| Bit | Name | Val. | Information |
|---|---|---|---|
| 0 | UNDERVOLTAGE | 1 | Intermediate circuit DC undervoltage * |
| 1 | OVERVOLTAGE | 1 | Intermediate circuit DC overvoltage * |
| 2 | MINIMUM TORQUE | 1 | Torque reference minimum limit is active. The limit is defined by parameter 20.07 MINIMUM TORQUE. * |
| 3 | MAXIMUM TORQUE | 1 | Torque reference maximum limit is active. The limit is defined by parameter 20.06 MAXIMUM TORQUE. * |
| 4 | INTERNAL CURRENT | 1 | An inverter current limit is active. The limit is identified by bits 8…11. |
| 5 | LOAD ANGLE | 1 | For permanent magnet motor only: Load angle limit is active, ie, the motor cannot produce more torque. |
| 6 | MOTOR PULLOUT | 1 | For asynchronous motor only: Motor pull-out limit is active, ie, the motor cannot produce more torque. |
| 7 | Reserved | | |
| 8 | THERMAL | 1 | Bit 4 = 0: Input current is limited by main circuit thermal limit. Bit 4 = 1: Output current is limited by main circuit thermal limit. |
| 9 | I2MAX CURRENT | 1 | Inverter output current limit is active. ** |
| 10 | USER CURRENT | 1 | Maximum inverter output current limit is active. The limit is defined by parameter 20.05 MAXIMUM CURRENT. ** |
| 11…15 | Reserved | | |

* Only one of bits 0…3 can be on simultaneously. The bit typically indicates the limit that is exceeded first.

** Only either 9 or 10 can be on simultaneously. The bit typically indicates the limit that is exceeded first.

| 6.12 | OP MODE ACK | FW block: REFERENCE CTRL (page 178) |
|---|---|---|

Operation mode acknowledge: 0 = Stopped, 1 = Speed, 2 = Torque, 3 = Min, 4 = Max, 5 = Add, 10 = Scalar, 11 = Forced magn (ie, DC Hold).

| 6.14 | SUPERV STATUS | FW block: SUPERVISION (page 173) |
|---|---|---|

Supervision status word. See also parameter group 33 (page 173).

| Bit | Name | Val. | Information |
|---|---|---|---|
| 0 | SUPERV FUNC1 STATUS | 1 | Supervision function 1 is active (below low limit or over high limit) |
| 1 | SUPERV FUNC2 STATUS | 1 | Supervision function 2 is active (below low limit or over high limit) |
| 2 | SUPERV FUNC3 STATUS | 1 | Supervision function 3 is active (below low limit or over high limit) |
| 3…15 | Reserved | | |

| **6.17** | BIT INVERTED SW | FW block: None |
|---|---|---|
| | Shows the inverted values of the bits selected by parameters 33.17...33.22. | |

| **Bit** | **Name** | **Information** |
|---|---|---|
| 0 | INVERTED BIT0 | See parameter 33.17 BIT0 INVERT SRC. |
| 1 | INVERTED BIT1 | See parameter 33.18 BIT1 INVERT SRC. |
| 2 | INVERTED BIT2 | See parameter 33.19 BIT2 INVERT SRC. |
| 3 | INVERTED BIT3 | See parameter 33.20 BIT3 INVERT SRC. |
| 4 | INVERTED BIT4 | See parameter 33.21 BIT4 INVERT SRC. |
| 5 | INVERTED BIT5 | See parameter 33.22 BIT5 INVERT SRC. |

# Group 08 ALARMS & FAULTS

| | | |
|---|---|---|
| **8.01** | ACTIVE FAULT | FW block: FAULT FUNCTIONS (page 191) |
| | Fault code of the latest (active) fault. | |
| **8.02** | LAST FAULT | FW block: FAULT FUNCTIONS (page 191) |
| | Fault code of the 2nd latest fault. | |
| **8.03** | FAULT TIME HI | FW block: FAULT FUNCTIONS (page 191) |
| | Time (real time or power-on time) at which the active fault occurred in format dd.mm.yy (=day.month.year). | |
| **8.04** | FAULT TIME LO | FW block: FAULT FUNCTIONS (page 191) |
| | Time (real time or power-on time) at which the active fault occurred in format hh.mm.ss (hours.minutes.seconds). | |
| **8.05** | ALARM LOGGER 1 | FW block: FAULT FUNCTIONS (page 191) |
| | Alarm logger 1. For possible causes and remedies, see chapter *Fault tracing*. Can be reset by entering a 0. | |

| **Bit** | **Alarm** |
|---|---|
| 0 | BRAKE START TORQUE |
| 1 | BRAKE NOT CLOSED |
| 2 | BRAKE NOT OPEN |
| 3 | SAFE TORQUE OFF |
| 4 | STO MODE CHANGE |
| 5 | MOTOR TEMP |
| 6 | EMERGENCY OFF |
| 7 | RUN ENABLE |
| 8 | ID-RUN |
| 9 | EMERGENCY STOP |
| 10 | POSITION SCALING |
| 11 | BR OVERHEAT |
| 12 | BC OVERHEAT |
| 13 | DEVICE OVERTEMP |
| 14 | INTBOARD OVERTEMP |
| 15 | BC MOD OVERTEMP |

| 8.06 | ALARM LOGGER 2 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm logger 2. For possible causes and remedies, see chapter *Fault tracing*. Can be reset by entering a 0.

| Bit | Alarm |
|---|---|
| 0 | IGBT OVERTEMP |
| 1 | FIELDBUS COMM |
| 2 | LOCAL CTRL LOSS |
| 3 | AI SUPERVISION |
| 4 | Reserved |
| 5 | NO MOTOR DATA |
| 6 | ENCODER 1 FAIL |
| 7 | ENCODER 2 FAIL |
| 8 | LATCH POS 1 FAIL |
| 9 | LATCH POS 2 FAIL |
| 10 | ENC EMUL FAILURE |
| 11 | FEN TEMP FAILURE |
| 12 | ENC MAX FREQ |
| 13 | ENC REF ERROR |
| 14 | RESOLVER ERR |
| 15 | ENCODER 1 CABLE |

| 8.07 | ALARM LOGGER 3 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm logger 3. For possible causes and remedies, see chapter *Fault tracing*. Can be reset by entering a 0.

| Bit | Alarm |
|---|---|
| 0 | ENCODER 2 CABLE |
| 1 | D2D COMM |
| 2 | D2D BUF OVLOAD |
| 3 | PS COMM |
| 4 | RESTORE |
| 5 | CUR MEAS CALIB |
| 6 | AUTOPHASING |
| 7 | EARTH FAULT |
| 8 | Reserved |
| 9 | MOTOR NOM VALUE |
| 10 | D2D CONFIG |
| 11 | STALL |
| 12…14 | Reserved |
| 15 | SPEED FEEDBACK |

| **8.08** | ALARM LOGGER 4 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm logger 4. For possible causes and remedies, see chapter *Fault tracing*. Can be reset by entering a 0.

| **Bit** | **Alarm** |
|---|---|
| 0 | OPTION COMM LOSS |
| 1 | SOLUTION ALARM |
| 2…5 | Reserved |
| 6 | PROT. SET PASS |
| 7…8 | Reserved |
| 9 | DC NOT CHARGED |
| 10 | SPEED TUNE FAIL |
| 11…15 | Reserved |

| **8.09** | ALARM LOGGER 5 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm logger 5. For possible causes and remedies, see chapter *Fault tracing*. Can be reset by entering a 0.

| **Bit** | **Alarm** |
|---|---|
| 0…15 | Reserved |

| **8.10** | ALARM LOGGER 6 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm logger 6. For possible causes and remedies, see chapter *Fault tracing*. Can be reset by entering a 0.

| **Bit** | **Alarm** |
|---|---|
| 0…1 | Reserved |
| 2 | LOW VOLT MOD CON |
| 3…15 | Reserved |

| 8.15 | ALARM WORD 1 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm word 1. For possible causes and remedies, see chapter *Fault tracing*. This alarm word is refreshed, ie, when the alarm goes off, the corresponding alarm bit is cleared from the signal.

| Bit | Alarm |
|---|---|
| 0 | BRAKE START TORQUE |
| 1 | BRAKE NOT CLOSED |
| 2 | BRAKE NOT OPEN |
| 3 | SAFE TORQUE OFF |
| 4 | STO MODE CHANGE |
| 5 | MOTOR TEMP |
| 6 | EMERGENCY OFF |
| 7 | RUN ENABLE |
| 8 | ID-RUN |
| 9 | EMERGENCY STOP |
| 10 | POSITION SCALING |
| 11 | BR OVERHEAT |
| 12 | BC OVERHEAT |
| 13 | DEVICE OVERTEMP |
| 14 | INTBOARD OVERTEMP |
| 15 | BC MOD OVERTEMP |

| 8.16 | ALARM WORD 2 | FW block: FAULT FUNCTIONS (page 191) |
|---|---|---|

Alarm word 2. For possible causes and remedies, see chapter *Fault tracing*. This alarm word is refreshed, ie, when the alarm goes off, the corresponding alarm bit is cleared from the signal.

| Bit | Alarm |
|---|---|
| 0 | IGBT OVERTEMP |
| 1 | FIELDBUS COMM |
| 2 | LOCAL CTRL LOSS |
| 3 | AI SUPERVISION |
| 4 | Reserved |
| 5 | NO MOTOR DATA |
| 6 | ENCODER 1 FAIL |
| 7 | ENCODER 2 FAIL |
| 8 | LATCH POS 1 FAIL |
| 9 | LATCH POS 2 FAIL |
| 10 | ENC EMUL FAILURE |
| 11 | FEN TEMP FAILURE |
| 12 | ENC MAX FREQ |
| 13 | ENC REF ERROR |
| 14 | RESOLVER ERR |
| 15 | ENCODER 1 CABLE |

| | | |
|---|---|---|
| **8.17** | ALARM WORD 3 | FW block: FAULT FUNCTIONS (page 191) |
| | Alarm word 3. For possible causes and remedies, see chapter *Fault tracing*. This alarm word is refreshed, ie, when the alarm goes off, the corresponding alarm bit is cleared from the signal. | |

| **Bit** | **Alarm** |
|---|---|
| 0 | ENCODER 2 CABLE |
| 1 | D2D COMM |
| 2 | D2D BUF OVLOAD |
| 3 | PS COMM |
| 4 | RESTORE |
| 5 | CUR MEAS CALIB |
| 6 | AUTOPHASING |
| 7 | EARTH FAULT |
| 8 | Reserved |
| 9 | MOTOR NOM VALUE |
| 10 | D2D CONFIG |
| 11 | STALL |
| 12…14 | Reserved |
| 15 | SPEED FEEDBACK |

| | | |
|---|---|---|
| **8.18** | ALARM WORD 4 | FW block: FAULT FUNCTIONS (page 191) |
| | Alarm word 4. For possible causes and remedies, see chapter *Fault tracing*. This alarm word is refreshed, ie, when the alarm goes off, the corresponding alarm bit is cleared from the signal. | |

| **Bit** | **Alarm** |
|---|---|
| 0 | OPTION COMM LOSS |
| 1 | SOLUTION ALARM |
| 2…5 | Reserved |
| 6 | PROT. SET PASS |
| 7…8 | Reserved |
| 9 | DC NOT CHARGED |
| 10 | SPEED TUNE FAIL |
| 11…15 | Reserved |

## Group 09 SYSTEM INFO

| | | |
|---|---|---|
| **9.01** | DRIVE TYPE | FW block: None |
| | Displays the drive application type.<br>**(1)** ACSM1 Speed: Speed and torque control application | |
| **9.02** | DRIVE RATING ID | FW block: None |
| | Displays the inverter type of the drive.<br>**(0)** Unconfigured, **(1)** ACSM1-xxAx-02A5-4, **(2)** ACSM1-xxAx-03A0-4, **(3)** ACSM1-xxAx-04A0-4, **(4)** ACSM1-xxAx-05A0-4, **(5)** ACSM1-xxAx-07A0-4, **(6)** ACSM1-xxAx-09A5-4, **(7)** ACSM1-xxAx-012A-4, **(8)** ACSM1-xxAx-016A-4, **(9)** ACSM1-xxAx-024A-4, **(10)** ACSM1-xxAx-031A-4, **(11)** ACSM1-xxAx-040A-4, **(12)** ACSM1-xxAx-046A-4, **(13)** ACSM1-xxAx-060A-4, **(14)** ACSM1-xxAx-073A-4, **(15)** ACSM1-xxAx-090A-4, **(20)** ACSM1-xxAx-110A-4, **(21)** ACSM1-xxAx-135A-4, **(22)** ACSM1-xxAx-175A-4, **(23)** ACSM1-xxAx-210A-4, **(24)** ACSM1-xxCx-024A-4, **(25)** ACSM1-xxCx-031A-4, **(26)** ACSM1-xxCx-040A-4, **(27)** ACSM1-xxCx-046A-4, **(28)** ACSM1-xxCx-060A-4, **(29)** ACSM1-xxCx-073A-4, **(30)** ACSM1-xxCx-090A-4, **(31)** ACSM1-xxLx-110A-4, **(32)** ACSM1-xxLx-135A-4, **(33)** ACSM1-xxLx-175A-4, **(34)** ACSM1-xxLx-210A-4, **(35)** ACSM1-xxLx-260A-4, **(63)** ACSM1-390A-4, **(64)** ACSM1-500A-4, **(65)** ACSM1-580A-4, **(67)** ACSM1-635A-4 | |
| **9.03** | FIRMWARE ID | FW block: None |
| | Displays the firmware name, eg, UMFI. | |
| **9.04** | FIRMWARE VER | FW block: None |
| | Displays the version of the firmware package in the drive, eg, NNNN hex. | |
| **9.05** | FIRMWARE PATCH | FW block: None |
| | Displays the version of the firmware patch in the drive. | |
| **9.10** | INT LOGIC VER | FW block: None |
| | Displays the version of the logic in the power unit interface. | |
| **9.11** | SLOT 1 VIE NAME | FW block: None |
| | Displays the type of VIE logic used in the optional module in option slot 1. | |
| **9.12** | SLOT 1 VIE VER | FW block: None |
| | Displays the version of VIE logic used in the optional module in option slot 1. | |
| **9.13** | SLOT 2 VIE NAME | FW block: None |
| | Displays the type of VIE logic used in the optional module in option slot 2. | |
| **9.14** | SLOT 2 VIE VER | FW block: None |
| | Displays the version of VIE logic used in the optional module in option slot 2. | |

| | | |
|---|---|---|
| **9.20** | OPTION SLOT 1 | FW block: None |
| | Displays the type of the optional module in option Slot 1.<br>**(0)** NO OPTION, **(1)** NO COMM, **(2)** UNKNOWN, **(3)** FEN-01, **(4)** FEN-11, **(5)** FEN-21, **(6)** FIO-01, **(7)** FIO-11, **(8)** FPBA-01, **(9)** FPBA-02, **(10)** FCAN-01, **(11)** FDNA-01, **(12)** FENA-01, **(13)** FENA-11, **(14)** FLON-01, **(15)** FRSA-00, **(16)** FMBA-01, **(17)** FFOA-01, **(18)** FFOA-02, **(19)** FSEN-01, **(20)** FEN-31, **(21)** FIO-21, **(22)** FSCA-01, **(23)** FSEA-21, **(24)** FIO-31, **(25)** FECA-01, **(26)** FENA-21, **(27)** FB COMMON, **(28)** FMAC-01, **(29)** FEPL-01, **(30)** FCNA-01 | |
| **9.21** | OPTION SLOT 2 | FW block: None |
| | Displays the type of the optional module in option Slot 2. See 9.20 OPTION SLOT 1. | |
| **9.22** | OPTION SLOT 3 | FW block: None |
| | Displays the type of the optional module in option Slot 3. See 9.20 OPTION SLOT 1. | |

## Group 10 START/STOP

Settings for

- selecting start/stop/direction signal sources for external control locations EXT1 and EXT2
- selecting sources for external fault reset, run enable and start enable signals
- selecting sources for emergency stop (OFF1 and OFF3)
- selecting source for jogging function activation signal
- enabling the start inhibit function.

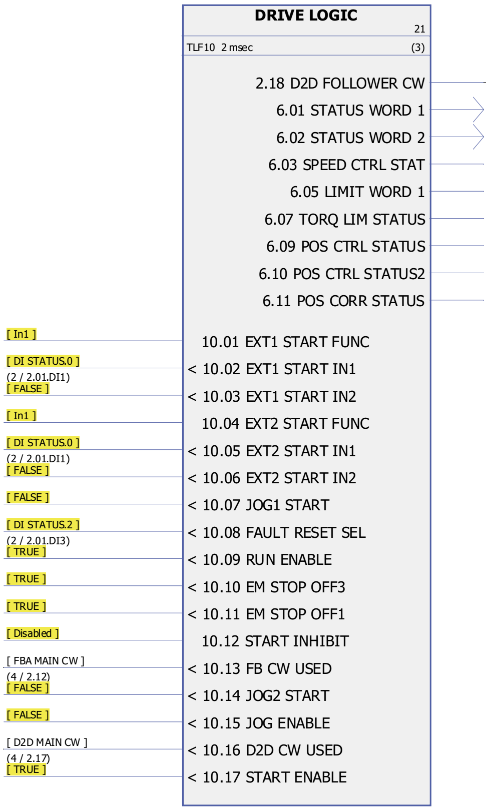
See also section *Jogging* on page 49.

Firmware block:

**DRIVE LOGIC**
(10)

This block

- selects the sources for the start/stop/direction signals for external control locations EXT1 and EXT2
- selects the sources for external fault reset, run enable and start enable signals
- selects the sources for emergency stop (OFF1 and OFF3)
- selects the source for jogging activation signal
- enables the start inhibit function.



<table>
<tr><td colspan="2">Block outputs located in other parameter groups</td><td>2.18 D2D FOLLOWER CW (page 101)<br>6.01 STATUS WORD 1 (page 104)<br>6.02 STATUS WORD 2 (page 105)<br>6.03 SPEED CTRL STAT (page 106)<br>6.05 LIMIT WORD 1 (page 106)<br>6.07 TORQ LIM STATUS (page 107)<br>Outputs 6.09…6.11 are not used with ACSM1 speed and torque control program.</td></tr>
<tr><td><b>10.01</b></td><td>EXT1 START FUNC</td><td>FW block: DRIVE LOGIC (see above)</td></tr>
<tr><td></td><td colspan="2">Selects the source for the start and stop control in external control location EXT1.<br><b>Note:</b> This parameter cannot be changed while the drive is running.</td></tr>
<tr><td></td><td><b>(0)</b> Not sel</td><td>No source selected.</td></tr>
<tr><td></td><td><b>(1)</b> In1</td><td>Source of the start and stop commands are selected by parameter 10.02 EXT1 START IN1. The start/stop is controlled as follows:
<table>
<tr><th>Par. 10.02</th><th>Command</th></tr>
<tr><td>0 -> 1</td><td>Start</td></tr>
<tr><td>1 -> 0</td><td>Stop</td></tr>
</table></td></tr>
<tr><td></td><td><b>(2)</b> 3-wire</td><td>Source of the start and stop commands are selected by parameters 10.02 EXT1 START IN1 and 10.03 EXT1 START IN2. The start/stop is controlled as follows:
<table>
<tr><th>Par. 10.02</th><th>Par. 10.03</th><th>Command</th></tr>
<tr><td>0 -> 1</td><td>1</td><td>Start</td></tr>
<tr><td>Any</td><td>1 -> 0</td><td>Stop</td></tr>
<tr><td>Any</td><td>0</td><td>Stop</td></tr>
</table></td></tr>
<tr><td></td><td><b>(3)</b> FBA</td><td>Start and stop control from the source selected by parameter 10.13 FB CW USED.</td></tr>
<tr><td></td><td><b>(4)</b> D2D</td><td>Start and stop control from another drive via D2D Control Word.</td></tr>
<tr><td></td><td><b>(5)</b> IN1 F IN2R</td><td>The source selected by 10.02 EXT1 START IN1 is the forward start signal, the source selected by 10.03 EXT1 START IN2 is the reverse start signal.
<table>
<tr><th>Par. 10.02</th><th>Par. 10.03</th><th>Command</th></tr>
<tr><td>0</td><td>0</td><td>Stop</td></tr>
<tr><td>1</td><td>0</td><td>Start forward</td></tr>
<tr><td>0</td><td>1</td><td>Start reverse</td></tr>
<tr><td>1</td><td>1</td><td>Stop</td></tr>
</table></td></tr>
<tr><td></td><td><b>(6)</b> IN1S IN2DIR</td><td>The source selected by 10.02 EXT1 START IN1 is the start signal (0 = stop, 1 = start), the source selected by 10.03 EXT1 START IN2 is the direction signal (0 = forward, 1 = reverse).</td></tr>
<tr><td><b>10.02</b></td><td>EXT1 START IN1</td><td>FW block: DRIVE LOGIC (see above)</td></tr>
<tr><td></td><td colspan="2">Selects the source 1 for the start and stop commands in external control location EXT1. See parameter 10.01 EXT1 START FUNC selections (1) In1 and (2) 3-wire.<br><b>Note:</b> This parameter cannot be changed while the drive is running.</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">Bit pointer: Group, index and bit</td></tr>
<tr><td><b>10.03</b></td><td>EXT1 START IN2</td><td>FW block: DRIVE LOGIC (see above)</td></tr>
<tr><td></td><td colspan="2">Selects the source 2 for the start and stop commands in external control location EXT1. See parameter 10.01 EXT1 START FUNC selection (2) 3-wire.<br><b>Note:</b> This parameter cannot be changed while the drive is running.</td></tr>
<tr><td></td><td colspan="2">Bit pointer: Group, index and bit</td></tr>
<tr><td><b>10.04</b></td><td>EXT2 START FUNC</td><td>FW block: DRIVE LOGIC (see above)</td></tr>
<tr><td></td><td colspan="2">Selects the source for the start and stop control in external control location EXT2.<br><b>Note:</b> This parameter cannot be changed while the drive is running.</td></tr>
<tr><td></td><td><b>(0)</b> Not sel</td><td>No source selected.</td></tr>
<tr><td></td><td><b>(1)</b> In1</td><td>Source of the start and stop commands are selected by parameter 10.05 EXT2 START IN1. The start/stop is controlled as follows:
<table>
<tr><th>Par. 10.05</th><th>Command</th></tr>
<tr><td>0 -> 1</td><td>Start</td></tr>
<tr><td>1 -> 0</td><td>Stop</td></tr>
</table></td></tr>
<tr><td></td><td><b>(2)</b> 3-wire</td><td>Source of the start and stop commands are selected by parameters 10.05 EXT2 START IN1 and 10.06 EXT2 START IN2. The start/stop is controlled as follows:
<table>
<tr><th>Par. 10.05</th><th>Par. 10.06</th><th>Command</th></tr>
<tr><td>0 -> 1</td><td>1</td><td>Start</td></tr>
<tr><td>Any</td><td>1 -> 0</td><td>Stop</td></tr>
<tr><td>Any</td><td>0</td><td>Stop</td></tr>
</table></td></tr>
<tr><td></td><td><b>(3)</b> FBA</td><td>Start and stop control from the source selected by parameter 10.13 FB CW USED.</td></tr>
<tr><td></td><td><b>(4)</b> D2D</td><td>Start and stop control from another drive via D2D Control Word.</td></tr>
<tr><td></td><td><b>(5)</b> IN1 F IN2R</td><td>The source selected by 10.05 EXT2 START IN1 is the forward start signal, the source selected by 10.06 EXT2 START IN2 is the reverse start signal.
<table>
<tr><th>Par. 10.05</th><th>Par. 10.06</th><th>Command</th></tr>
<tr><td>0</td><td>0</td><td>Stop</td></tr>
<tr><td>1</td><td>0</td><td>Start forward</td></tr>
<tr><td>0</td><td>1</td><td>Start reverse</td></tr>
<tr><td>1</td><td>1</td><td>Stop</td></tr>
</table></td></tr>
<tr><td></td><td><b>(6)</b> IN1S IN2DIR</td><td>The source selected by 10.05 EXT2 START IN1 is the start signal (0 = stop, 1 = start), the source selected by 10.06 EXT2 START IN2 is the direction signal (0 = forward, 1 = reverse).</td></tr>
</table>

| | | |
|---|---|---|
| **10.05** | EXT2 START IN1 | FW block: DRIVE LOGIC (see above) |
| | Selects the source 1 for the start and stop commands in external control location EXT2. See parameter 10.04 EXT2 START FUNC selections (1) In1 and (2) 3-wire.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **10.06** | EXT2 START IN2 | FW block: DRIVE LOGIC (see above) |
| | Selects the source 2 for the start and stop commands in external control location EXT2. See parameter 10.04 EXT2 START FUNC selection (2) 3-wire.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **10.07** | JOG1 START | FW block: DRIVE LOGIC (see above) |
| | If enabled by parameter 10.15 JOG ENABLE, selects the source for the activation of jogging function 1. 1 = Active. (Jogging function 1 can also be activated through fieldbus regardless of parameter 10.15.)<br>See section *Jogging* on page *49*. See also other jogging function parameters: 10.14 JOG2 START, 10.15 JOG ENABLE, 24.03 SPEED REF1 IN / 24.04 SPEED REF2 IN, 24.10 SPEED REF JOG1, 24.11 SPEED REF JOG2, 25.09 ACC TIME JOGGING, 25.10 DEC TIME JOGGING and 22.06 ZERO SPEED DELAY.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **10.08** | FAULT RESET SEL | FW block: DRIVE LOGIC (see above) |
| | Selects the source for the external fault reset signal. The signal resets the drive after a fault trip if the cause of the fault no longer exists. 1 = Fault reset. | |
| | Bit pointer: Group, index and bit | |
| **10.09** | RUN ENABLE | FW block: DRIVE LOGIC (see above) |
| | Selects the source for the run enable signal. If the run enable signal is switched off, the drive will not start or stops if the drive is running. 1 = Run enable.<br>See also parameter 10.17 START ENABLE.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **10.10** | EM STOP OFF3 | FW block: DRIVE LOGIC (see above) |
| | Selects the source for the emergency stop OFF3. 0 = OFF3 active: The drive is stopped along the emergency stop ramp time, 25.11 EM STOP TIME.<br>Emergency stop can also be activated through fieldbus (2.12 FBA MAIN CW).<br>See section *Emergency stop* on page 57.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |

| | | |
|---|---|---|
| **10.11** | EM STOP OFF1 | FW block: DRIVE LOGIC (see above) |
| | Selects the source for the emergency stop OFF1. 0 = OFF1 active: The drive is stopped with the active deceleration time.<br>Emergency stop can also be activated through fieldbus (2.12 FBA MAIN CW).<br>See section *Emergency stop* on page 57.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **10.12** | START INHIBIT | FW block: DRIVE LOGIC (see above) |
| | Enables the start inhibit function. The start inhibit function prevents drive restart (ie, protects against unexpected start) if<br>• drive trips on a fault and fault is reset.<br>• run enable signal activates while the start command is active. See parameter 10.09 RUN ENABLE.<br>• control changes from local to remote.<br>• external control switches from EXT1 to EXT2 or from EXT2 to EXT1.<br>An active start inhibit can be reset with a stop command.<br>Note that in certain applications it is necessary to allow the drive to restart. | |
| | **(0)** Disabled | Start inhibit function disabled. |
| | **(1)** Enabled | Start inhibit function enabled. |
| **10.13** | FB CW USED | FW block: DRIVE LOGIC (see above) |
| | Selects the source for the control word when fieldbus (FBA) is selected as the external start and stop control location (see parameters 10.01 EXT1 START FUNC and 10.04 EXT2 START FUNC). By default, the source is parameter 2.12 FBA MAIN CW.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Value pointer: Group and index | |
| **10.14** | JOG2 START | FW block: DRIVE LOGIC (see above) |
| | If enabled by parameter 10.15 JOG ENABLE, selects the source for the activation of jogging function 2. 1 = Active. (Jogging function 2 can also be activated through fieldbus regardless of parameter 10.15.)<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **10.15** | JOG ENABLE | FW block: DRIVE LOGIC (see above) |
| | Selects the source for enabling parameters 10.07 JOG1 START and 10.14 JOG2 START.<br>**Note:** Jogging can be enabled using this parameter only when no start command from an external control location is active. On the other hand, if jogging is already enabled, the drive cannot be started from an external control location apart from jog commands through fieldbus. | |
| | Bit pointer: Group, index and bit | |
| **10.16** | D2D CW USED | FW block: DRIVE LOGIC (see above) |
| | Selects the source for the control word for drive-to-drive communication. By default, the source is parameter 2.17 D2D MAIN CW. | |

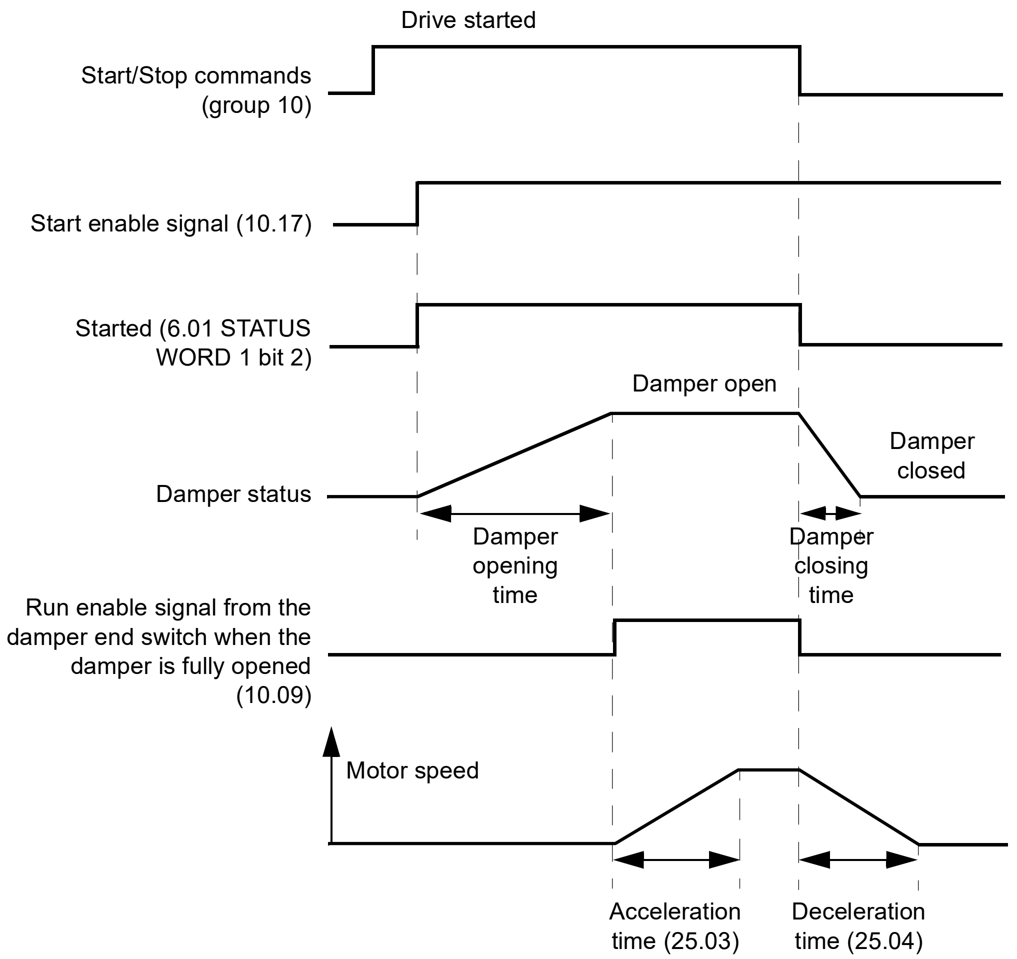
<table>
<tr><td></td><td colspan="2">Value pointer: Group and index</td></tr>
<tr><td><b>10.17</b></td><td>START ENABLE</td><td>FW block: DRIVE LOGIC (see above)</td></tr>
<tr><td></td><td colspan="2">

Selects the source for the start enable signal. If the start enable signal is switched off, the drive will not start or stops if the drive is running. 1 = Start enable.

**Note:** This parameter cannot be changed while the drive is running.

**Note**: Functionality of the Start enable signal is different from the Run enable signal.

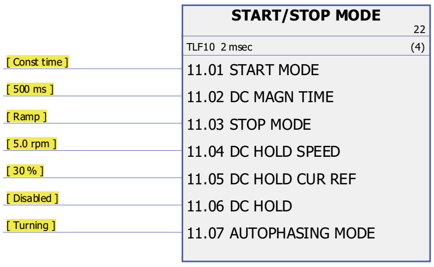
**Example:** External damper control application using Start enable and Run enable. Motor can start only after the damper is fully open.


Drive started
Start/Stop commands (group 10)
Start enable signal (10.17)
Started (6.01 STATUS WORD 1 bit 2)
Damper open
Damper closed
Damper status
Damper opening time
Damper closing time
Run enable signal from the damper end switch when the damper is fully opened (10.09)
Motor speed
Acceleration time (25.03)
Deceleration time (25.04)

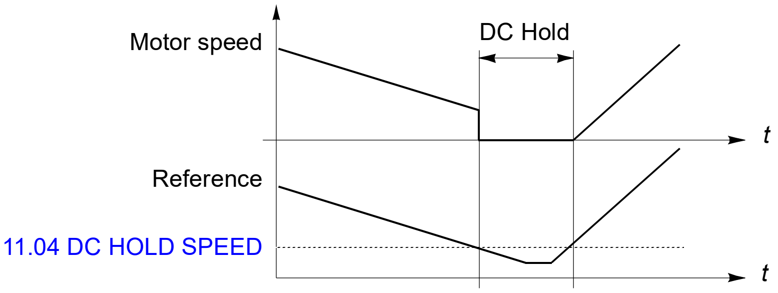
</td></tr>
<tr><td></td><td colspan="2">Bit pointer: Group, index and bit</td></tr>
</table>

# Group 11 START/STOP MODE

These parameters select the start and stop functions as well as the autophasing mode, define the DC magnetising time of the motor, and configure the DC hold function.

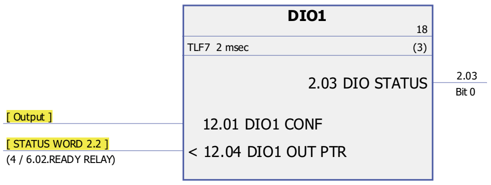
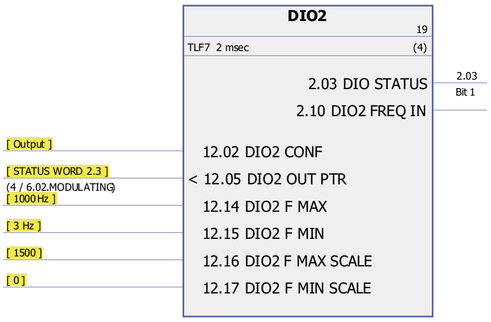
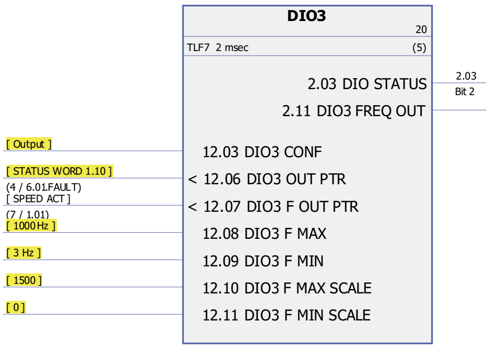
| | | |
|---|---|---|
| Firmware block:<br>**START/STOP MODE**<br>(11) | |  START/STOP MODE<br>22<br>TLF10 2 msec<br>(4)<br>[ Const time ]<br>[ 500 ms ]<br>[ Ramp ]<br>[ 5.0 rpm ]<br>[ 30 % ]<br>[ Disabled ]<br>[ Turning ]<br>11.01 START MODE<br>11.02 DC MAGN TIME<br>11.03 STOP MODE<br>11.04 DC HOLD SPEED<br>11.05 DC HOLD CUR REF<br>11.06 DC HOLD<br>11.07 AUTOPHASING MODE |
| **11.01** | START MODE | FW block: START/STOP MODE (see above) |
| | Selects the motor start function.<br>**Notes:**<br>• This parameter has no effect if parameter 99.05 MOTOR CTRL MODE is set to (1) Scalar.<br>• Starting to a rotating machine is not possible when DC magnetising is selected ((0) Fast or (1) Const time).<br>• With permanent magnet motors, automatic start must be used.<br>• This parameter cannot be changed while the drive is running. | |
| | **(0)** Fast | DC magnetising should be selected if a high break-away torque is required. The drive pre-magnetises the motor before the start. The pre-magnetising time is determined automatically, being typically 200 ms to 2 s depending on the motor size. |
| | **(1)** Const time | Constant DC magnetising should be selected instead of FAST DC magnetising if a constant pre-magnetising time is required (eg, if the motor start must be simultaneous with a mechanical brake release). This selection also guarantees the highest possible break-away torque when the pre-magnetising time is set long enough. The pre-magnetising time is defined by parameter 11.02 DC MAGN TIME.<br>**WARNING!** The drive will start after the set magnetising time has passed even if motor magnetisation is not completed. In applications where a full break-away torque is essential, ensure that the constant magnetising time is long enough to allow generation of full magnetisation and torque. |
| | **(2)** Automatic | Automatic start guarantees optimal motor start in most cases. It includes the flying start function (starting to a rotating machine) and the automatic restart function (stopped motor can be restarted immediately without waiting the motor flux to die away). The drive motor control program identifies the flux as well as the mechanical state of the motor and starts the motor instantly under all conditions. |

<table>
<tr><td><b>11.02</b></td><td>DC MAGN TIME</td><td>FW block: START/STOP MODE (see above)</td></tr>
<tr><td></td><td colspan="2">Defines the constant DC magnetising time. See parameter 11.01 START MODE. After the start command, the drive automatically premagnetises the motor the set time.<br>To ensure full magnetising, set this value to the same value as or higher than the rotor time constant. If not known, use the rule-of-thumb value given in the table below:<br><table>
<tr><th>Motor rated power</th><th>Constant magnetising time</th></tr>
<tr><td>&lt; 1 kW</td><td>≥ 50 to 100 ms</td></tr>
<tr><td>1 to 10 kW</td><td>≥ 100 to 200 ms</td></tr>
<tr><td>10 to 200 kW</td><td>≥ 200 to 1000 ms</td></tr>
<tr><td>200 to 1000 kW</td><td>≥ 1000 to 2000 ms</td></tr>
</table><br><b>Note:</b> This parameter cannot be changed while the drive is running.</td></tr>
<tr><td></td><td>0…10000 ms</td><td>DC magnetising time.</td></tr>
<tr><td><b>11.03</b></td><td>STOP MODE</td><td>FW block: START/STOP MODE (see above)</td></tr>
<tr><td></td><td colspan="2">Selects the motor stop function.</td></tr>
<tr><td></td><td><b>(1)</b> Coast</td><td>Stop by cutting of the motor power supply. The motor coasts to a stop.<br>⚠ <b>WARNING!</b> If the mechanical brake is used, ensure it is safe to stop the drive by coasting. For more information on mechanical brake function, see parameter group 35.</td></tr>
<tr><td></td><td><b>(2)</b> Ramp</td><td>Stop along ramp. See parameter group 25.</td></tr>
<tr><td><b>11.04</b></td><td>DC HOLD SPEED</td><td>FW block: START/STOP MODE (see above)</td></tr>
<tr><td></td><td colspan="2">Defines the DC hold speed. See parameter 11.06 DC HOLD.</td></tr>
<tr><td></td><td>0…1000 rpm</td><td>DC hold speed.</td></tr>
<tr><td><b>11.05</b></td><td>DC HOLD CUR REF</td><td>FW block: START/STOP MODE (see above)</td></tr>
<tr><td></td><td colspan="2">Defines the DC hold current in percent of the motor nominal current. See parameter 11.06 DC HOLD.</td></tr>
<tr><td></td><td>0…100%</td><td>DC hold current.</td></tr>
</table>

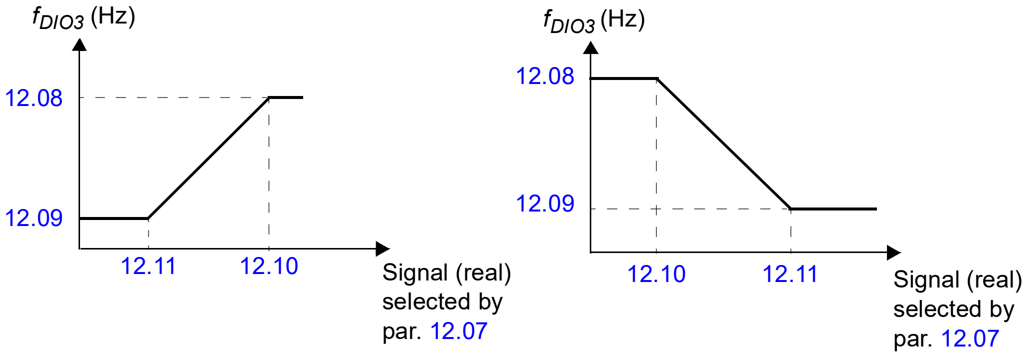
| | | |
|---|---|---|
| **11.06** | DC HOLD | FW block: START/STOP MODE (see above) |
| | Enables the DC hold function. The function makes it possible to lock the rotor at zero speed.<br>When both the reference and the speed drop below the value of parameter 11.04 DC HOLD SPEED, the drive will stop generating sinusoidal current and start to inject DC into the motor. The current is set by parameter 11.05 DC HOLD CUR REF. When the reference speed exceeds parameter 11.04 DC HOLD SPEED, normal drive operation continues.<br><br> <br>**Notes:**<br>• The DC hold function has no effect if the start signal is switched off.<br>• The DC hold function can only be activated in speed control mode.<br>• The DC hold function cannot be activated if par. 99.05 MOTOR CTRL MODE is set to (1) Scalar.<br>• Injecting DC current into the motor causes the motor to heat up. In applications where long DC hold times are required, externally ventilated motors should be used. If the DC hold period is long, the DC hold cannot prevent the motor shaft from rotating if a constant load is applied to the motor. | |
| | Bit pointer: Group and index and bit | |
| | **(0)** Disabled | DC hold function disabled. |
| | **(1)** Enabled | DC hold function enabled. |
| **11.07** | AUTOPHASING MODE | FW block: START/STOP MODE (see above) |
| | Selects the way the autophasing routine is performed. See also section *Autophasing* on page 41. | |
| | **(0)** Turning | This mode gives the most accurate autophasing result. This mode can be used, and is recommended if it is allowed for the motor to rotate and the start-up is not time-critical. **Note:** This mode will cause the motor to rotate during the motor ID run. |
| | **(1)** Standstill 1 | Faster than the (0) Turning mode, but not as accurate. The motor will not rotate. |
| | **(2)** Standstill 2 | An alternative standstill autophasing mode that can be used if the TURNING mode cannot be used, and the (1) Standstill 1 mode gives erratic results. However, this mode is considerably slower than (1) Standstill 1. |

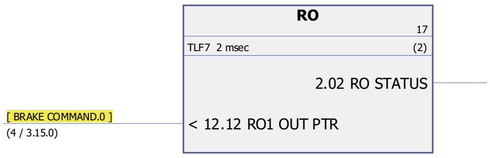
# Group 12 DIGITAL IO

Settings for the digital inputs and outputs, and the relay output.

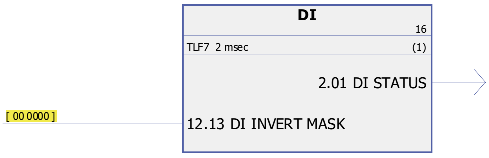
| | | |
|---|---|---|
| Firmware block:<br>**DIO1**<br>(6)<br>Selects whether DIO1 is used as a digital input or as a digital output and connects an actual signal to the digital output. The block also shows the DIO status. | |   DIO1<br>18<br>TLF7 2 msec<br>(3)<br>2.03 DIO STATUS<br>2.03<br>Bit 0<br>[ Output ]<br>12.01 DIO1 CONF<br>[ STATUS WORD 2.2 ]<br>(4 / 6.02.READY RELAY)<br>< 12.04 DIO1 OUT PTR |
| Block outputs located in other parameter groups | | 2.03 DIO STATUS (page 96) |
| Firmware block:<br>**DIO2**<br>(7)<br>Selects whether DIO2 is used as a digital or frequency input or as a digital output and connects an actual signal to the digital output. The block also shows the DIO status.<br>Frequency input can be scaled with standard function blocks. See chapter *Standard function blocks*. | |   DIO2<br>19<br>TLF7 2 msec<br>(4)<br>2.03 DIO STATUS<br>2.03<br>Bit 1<br>2.10 DIO2 FREQ IN<br>[ Output ]<br>12.02 DIO2 CONF<br>[ STATUS WORD 2.3 ]<br>(4 / 6.02.MODULATING)<br>< 12.05 DIO2 OUT PTR<br>[ 1000 Hz ]<br>12.14 DIO2 F MAX<br>[ 3 Hz ]<br>12.15 DIO2 F MIN<br>[ 1500 ]<br>12.16 DIO2 F MAX SCALE<br>[ 0 ]<br>12.17 DIO2 F MIN SCALE |
| Block outputs located in other parameter groups | | 2.03 DIO STATUS (page 96)<br>2.10 DIO2 FREQ IN (page 96) |
| Firmware block:<br>**DIO3**<br>(8)<br>Selects whether DIO3 is used as a digital input or as a digital/frequency output, connects an actual signal to the digital/frequency output and scales the frequency output. The block also shows the DIO status. | |   DIO3<br>20<br>TLF7 2 msec<br>(5)<br>2.03 DIO STATUS<br>2.03<br>Bit 2<br>2.11 DIO3 FREQ OUT<br>[ Output ]<br>12.03 DIO3 CONF<br>[ STATUS WORD 1.10 ]<br>(4 / 6.01.FAULT)<br>< 12.06 DIO3 OUT PTR<br>[ SPEED ACT ]<br>(7 / 1.01)<br>< 12.07 DIO3 F OUT PTR<br>[ 1000 Hz ]<br>12.08 DIO3 F MAX<br>[ 3 Hz ]<br>12.09 DIO3 F MIN<br>[ 1500 ]<br>12.10 DIO3 F MAX SCALE<br>[ 0 ]<br>12.11 DIO3 F MIN SCALE |
| Block outputs located in other parameter groups | | 2.03 DIO STATUS (page 96)<br>2.11 DIO3 FREQ OUT (page 96) |
| **12.01** | DIO1 CONF | FW block: DIO1 (see above) |
| | Selects whether DIO1 is used as a digital input or as a digital output. | |
| | **(0)** Output | DIO1 is used as a digital output. |
| | **(1)** Input | DIO1 is used as a digital input. |

| | | |
|---|---|---|
| **12.02** | DIO2 CONF | FW block: DIO2 (see above) |
| | Selects whether DIO2 is used as a digital input, as a digital output or as a frequency input. | |
| | **(0)** Output | DIO2 is used as a digital output. |
| | **(1)** Input | DIO2 is used as a digital input. |
| | **(2)** Freq input | DIO2 is used as a frequency input. |
| **12.03** | DIO3 CONF | FW block: DIO3 (see above) |
| | Selects whether DIO3 is used as a digital input, as a digital output or as a frequency output. | |
| | **(0)** Output | DIO2 is used as a digital output. |
| | **(1)** Input | DIO2 is used as a digital input. |
| | **(2)** Freq output | DIO2 is used as a frequency output. |
| **12.04** | DIO1 OUT PTR | FW block: DIO1 (see above) |
| | Selects a drive signal to be connected to digital output DIO1 (when 12.01 DIO1 CONF is set to (0) Output). | |
| | Bit pointer: Group, index and bit | |
| **12.05** | DIO2 OUT PTR | FW block: DIO2 (see above) |
| | Selects a drive signal to be connected to digital output DIO2 (when 12.02 DIO2 CONF is set to (0) Output). | |
| | Bit pointer: Group, index and bit | |
| **12.06** | DIO3 OUT PTR | FW block: DIO3 (see above) |
| | Selects a drive signal to be connected to digital output DIO3 (when 12.03 DIO3 CONF is set to (0) Output). | |
| | Bit pointer: Group, index and bit | |
| **12.07** | DIO3 F OUT PTR | FW block: DIO3 (see above) |
| | Selects a drive signal to be connected to frequency output (when 12.03 DIO3 CONF is set to (2) Freq output). | |
| | Value pointer: Group and index | |
| **12.08** | DIO3 F MAX | FW block: DIO3 (see above) |
| | When 12.03 DIO3 CONF is set to (2) Freq output, defines the maximum DIO3 output frequency. | |
| | 3…32768 Hz | Maximum DIO3 output frequency. |
| **12.09** | DIO3 F MIN | FW block: DIO3 (see above) |
| | When 12.03 DIO3 CONF is set to (2) Freq output, defines the minimum DIO3 output frequency. | |
| | 3…32768 Hz | Minimum DIO3 output frequency. |

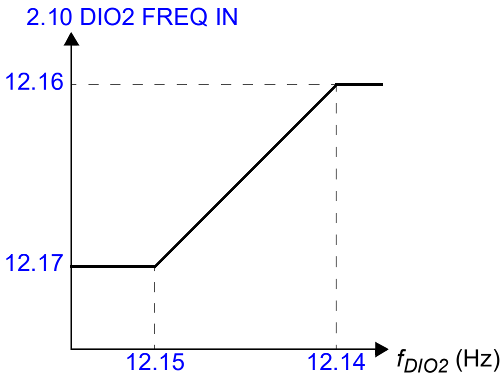
| **12.10** | DIO3 F MAX SCALE | FW block: DIO3 (see above) |
|---|---|---|
| | When 12.03 DIO3 CONF is set to (2) Freq output, defines the real value of the signal (selected by parameter 12.07 DIO3 F OUT PTR) that corresponds to the maximum DIO3 frequency output value (defined by parameter 12.08 DIO3 F MAX).<br><br> | |
| | 0…32768 | Real signal value corresponding to maximum DIO3 output frequency. |
| **12.11** | DIO3 F MIN SCALE | FW block: DIO3 (see above) |
| | When 12.03 DIO3 CONF is set to (2) Freq output, defines the real value of the signal (selected by parameter 12.07 DIO3 F OUT PTR) that corresponds to the minimum DIO3 frequency output value (defined by parameter 12.09 DIO3 F MIN). | |
| | 0…32768 | Real signal value corresponding to minimum DIO3 output frequency. |

| | |
|---|---|
| Firmware block:<br>**RO**<br>(5)<br>Connects an actual signal to the relay output. The block also shows the relay output status. | <br> RO<br>17<br>TLF7 2 msec<br>(2)<br>2.02 RO STATUS<br>[ BRAKE COMMAND.0 ]<br>(4 / 3.15.0)<br>< 12.12 RO1 OUT PTR |
| Block outputs located in other parameter groups | 2.02 RO STATUS (page 96) |

| **12.12** | RO1 OUT PTR | FW block: RO (see above) |
|---|---|---|
| | Selects a drive signal to be connected to relay output RO1. | |
| | Bit pointer: Group, index and bit | |

| | |
|---|---|
| Firmware block:<br>**DI**<br>(4)<br>Shows the status of the digital inputs. Inverts the status of any DI if desired. | <br> DI<br>16<br>TLF7 2 msec<br>(1)<br>2.01 DI STATUS<br>[ 00 0000 ]<br>12.13 DI INVERT MASK |
| Block outputs located in other parameter groups | 2.01 DI STATUS (page 96) |

| | | |
|---|---|---|
| **12.13** | DI INVERT MASK | FW block: DI (see above) |
| | Inverts status of digital inputs as reported by 2.01 DI STATUS. For example, a value of 0b000100 inverts the status of DI3 in the signal. | |
| | 0b000000…0b111111 | DI status inversion mask. |

| | | |
|---|---|---|
| **12.14** | DIO2 F MAX | FW block: DIO2 (see above) |
| | Defines the maximum input frequency for DIO2 when 12.02 DIO2 CONF is set to (2) Freq input.<br>The frequency signal connected to DIO2 is scaled into an internal signal (2.10 DIO2 FREQ IN) by parameters 12.14…12.17 as follows:<br> | |
| | 3…32768 Hz | DIO2 maximum frequency. |
| **12.15** | DIO2 F MIN | FW block: DIO2 (see above) |
| | Defines the minimum input frequency for DIO2 when 12.02 DIO2 CONF is set to (2) Freq input. See parameter 12.14 DIO2 F MAX | |
| | 3…32768 Hz | DIO2 minimum frequency. |
| **12.16** | DIO2 F MAX SCALE | FW block: DIO2 (see above) |
| | Defines the value that corresponds to the maximum input frequency defined by parameter 12.14 DIO2 F MAX. See parameter 12.14 DIO2 F MAX. | |
| | -32768…32768 | Scaled value corresponding to DIO2 maximum frequency. |
| **12.17** | DIO2 F MIN SCALE | FW block: DIO2 (see above) |
| | Defines the value that corresponds to the minimum input frequency defined by parameter 12.15 DIO2 F MIN. See parameter 12.14 DIO2 F MAX. | |
| | -32768…32768 | Scaled value corresponding to DIO2 minimum frequency. |

## Group 13 ANALOGUE INPUTS

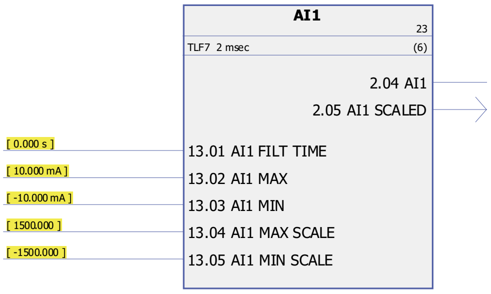
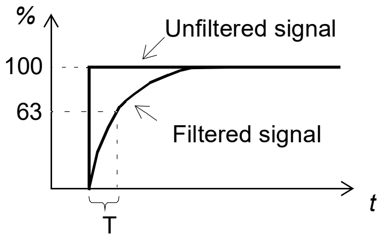
Settings for the analogue inputs.

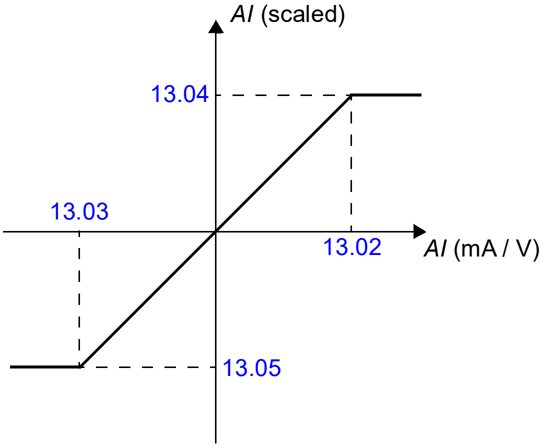
The drive offers two programmable analogue inputs, AI1 and AI2. Both inputs can be used either as a voltage or a current input (-11…11 V or -22…22 mA). The input type is selected with jumpers J1 and J2 respectively on the JCU Control Unit.

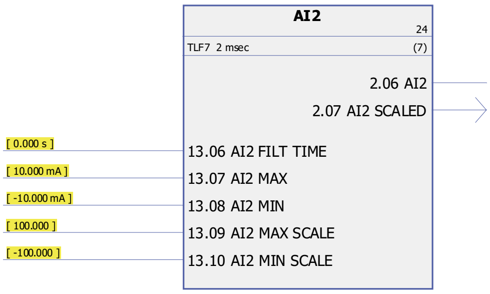
The inaccuracy of the analogue inputs is 1% of the full scale range and the resolution is 11 bits (+ sign). The hardware filter time constant is approximately 0.25 ms.

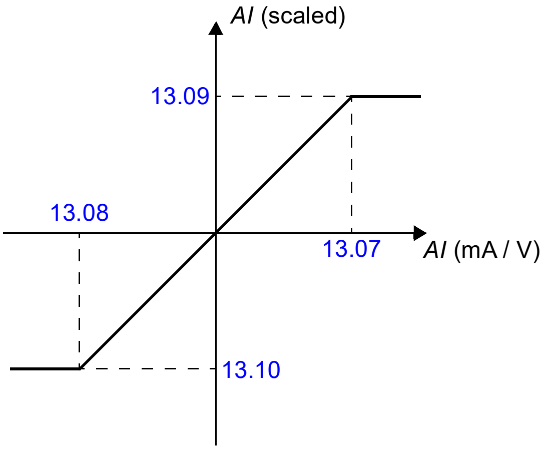
Analogue inputs can be used as the source for speed and torque reference.

Analogue input supervision can be added with standard function blocks. See chapter *Standard function blocks*.

| | | |
|---|---|---|
| Firmware block:<br>**AI1**<br>(12)<br>Filters and scales the analogue input AI1 signal and selects the AI1 supervision. Also shows the value of the input. | |  AI1<br>23<br>TLF7 2 msec<br>(6)<br>2.04 AI1<br>2.05 AI1 SCALED<br>[ 0.000 s ]<br>[ 10.000 mA ]<br>[ -10.000 mA ]<br>[ 1500.000 ]<br>[ -1500.000 ]<br>13.01 AI1 FILT TIME<br>13.02 AI1 MAX<br>13.03 AI1 MIN<br>13.04 AI1 MAX SCALE<br>13.05 AI1 MIN SCALE |
| Block outputs located in other parameter groups | | 2.04 AI1 (page 96)<br>2.05 AI1 SCALED (page 96) |
| **13.01** | AI1 FILT TIME | FW block: AI1 (see above) |
| | Defines the filter time constant for analogue input AI1.<br> <br>$O = I \cdot (1 - e^{-t/T})$<br>I = filter input (step)<br>O = filter output<br>t = time<br>T = filter time constant<br>**Note:** The signal is also filtered due to the signal interface hardware (approximately 0.25 ms time constant). This cannot be changed by any parameter. | |
| | 0…30 s | Filter time constant for AI1. |
| **13.02** | AI1 MAX | FW block: AI1 (see above) |
| | Defines the maximum value for analogue input AI1. The type is selected with jumper J1 on the JCU Control Unit. | |
| | -11…11 V / -22…22 mA | Maximum AI1 input value. |

| | | |
|---|---|---|
| **13.03** | AI1 MIN | FW block: AI1 (see above) |
| | Defines the minimum value for analogue input AI1. The type is selected with jumper J1 on the JCU Control Unit. | |
| | -11…11 V / -22…22 mA | Minimum AI1 input value. |
| **13.04** | AI1 MAX SCALE | FW block: AI1 (see above) |
| | Defines the real value that corresponds to the maximum analogue input value defined by parameter 13.02 AI1 MAX.<br><br> | |
| | -32768…32768 | Real value corresponding to value of parameter 13.02. |
| **13.05** | AI1 MIN SCALE | FW block: AI1 (see above) |
| | Defines the real value that corresponds to the minimum analogue input value defined by parameter 13.03 AI1 MIN. See parameter 13.04 AI1 MAX SCALE. | |
| | -32768…32768 | Real value corresponding to value of parameter 13.03. |

| | | |
|---|---|---|
| Firmware block:<br>**AI2**<br>(13)<br>Filters and scales the analogue input AI2 signal and selects the AI2 supervision. Also shows the value of the input. | | <br> AI2<br>24<br>TLF7 2 msec<br>(7)<br>2.06 AI2<br>2.07 AI2 SCALED<br>[ 0.000 s ]<br>[ 10.000 mA ]<br>[ -10.000 mA ]<br>[ 100.000 ]<br>[ -100.000 ]<br>13.06 AI2 FILT TIME<br>13.07 AI2 MAX<br>13.08 AI2 MIN<br>13.09 AI2 MAX SCALE<br>13.10 AI2 MIN SCALE |
| Block outputs located in other parameter groups | | 2.06 AI2 (page 96)<br>2.07 AI2 SCALED (page 96) |
| **13.06** | AI2 FILT TIME | FW block: AI2 (see above) |
| | Defines the filter time constant for analogue input AI2. See parameter 13.01 AI1 FILT TIME. | |
| | 0…30 s | Filter time constant for AI2. |

| | | |
|---|---|---|
| **13.07** | AI2 MAX | FW block: AI2 (see above) |
| | Defines the maximum value for analogue input AI2. The type is selected with jumper J2 on the JCU Control Unit. | |
| | -11…11 V / -22…22 mA | Maximum AI2 input value. |
| **13.08** | AI2 MIN | FW block: AI2 (see above) |
| | Defines the minimum value for analogue input AI2. The type is selected with jumper J2 on the JCU Control Unit. | |
| | -11…11 V / -22…22 mA | Minimum AI2 input value. |
| **13.09** | AI2 MAX SCALE | FW block: AI2 (see above) |
| | Defines the real value that corresponds to the maximum analogue input value defined by parameter 13.07 AI2 MAX.<br><br> | |
| | -32768…32768 | Real value corresponding to value of parameter 13.07. |
| **13.10** | AI2 MIN SCALE | FW block: AI2 (see above) |
| | Defines the real value that corresponds to the minimum analogue input value defined by parameter 13.08 AI2 MIN. See parameter 13.09 AI2 MAX SCALE. | |
| | -32768…32768 | Real value corresponding to value of parameter 13.08. |
| **13.11** | AITUNE | FW block: None |
| | Triggers the AI tuning function.<br>Connect the signal to the input and select the appropriate tuning function. | |
| | **(0)** No action | AI tune is not activated. |
| | **(1)** AI1 min tune | Current analogue input AI1 signal value is set as minimum value for AI1, parameter 13.03 AI1 MIN. The value reverts back to (0) No action automatically. |
| | **(2)** AI1 max tune | Current analogue input AI1 signal value is set as maximum value for AI1, parameter 13.02 AI1 MAX. The value reverts back to (0) No action automatically. |

<table>
<tr><td></td><td><b>(3)</b> AI2 min tune</td><td>Current analogue input AI2 signal value is set as minimum value for AI2, parameter 13.08 AI2 MIN. The value reverts back to (0) No action automatically.</td></tr>
<tr><td></td><td><b>(4)</b> AI2 max tune</td><td>Current analogue input AI2 signal value is set as maximum value for AI2, parameter 13.07 AI2 MAX. The value reverts back to (0) No action automatically.</td></tr>
<tr><td><b>13.12</b></td><td>AI SUPERVISION</td><td>FW block: None</td></tr>
<tr><td></td><td colspan="2">Selects how the drive reacts when analogue input signal limit is reached. The limit is selected by parameter 13.13 AI SUPERVIS ACT.</td></tr>
<tr><td></td><td><b>(0)</b> No</td><td>No action taken.</td></tr>
<tr><td></td><td><b>(1)</b> Fault</td><td>The drive trips on fault AI SUPERVISION.</td></tr>
<tr><td></td><td><b>(2)</b> Spd ref Safe</td><td>The drive generates alarm AI SUPERVISION and sets the speed to the speed defined by parameter 46.02 SPEED REF SAFE.<br>⚠ <b>WARNING!</b> Make sure that it is safe to continue operation in case of a communication break.</td></tr>
<tr><td></td><td><b>(3)</b> Last speed</td><td>The drive generates alarm AI SUPERVISION and freezes the speed to the level the drive was operating at. The speed is determined by the average speed over the previous 10 seconds.<br>⚠ <b>WARNING!</b> Make sure that it is safe to continue operation in case of a communication break.</td></tr>
<tr><td><b>13.13</b></td><td>AI SUPERVIS ACT</td><td>FW block: None</td></tr>
<tr><td></td><td colspan="2">Selects the analogue input signal supervision limit.
<table>
<tr><th>Bit</th><th></th><th>Supervision selected by parameter 13.12 AI SUPERVISION is activated if</th></tr>
<tr><td>0</td><td>AI1&lt;min</td><td>AI1 signal value falls below the value defined by equation:<br>par. 13.03 AI1 MIN - 0.5 mA or V</td></tr>
<tr><td>1</td><td>AI1&gt;max</td><td>AI1 signal value exceeds the value defined by equation:<br>par. 13.02 AI1 MAX + 0.5 mA or V</td></tr>
<tr><td>2</td><td>AI2&lt;min</td><td>AI2 signal value falls below the value defined by equation:<br>par. 13.08 AI2 MIN - 0.5 mA or V</td></tr>
<tr><td>3</td><td>AI2&gt;max</td><td>AI2 signal value exceeds the value defined by equation:<br>par. 13.07 AI2 MAX + 0.5 mA or V</td></tr>
</table>
Example: If parameter value is set to 0010 (bin), bit 1 AI1&gt;max is selected.</td></tr>
<tr><td></td><td>0b0000…0b1111</td><td>AI1/AI2 signal supervision selection.</td></tr>
</table>

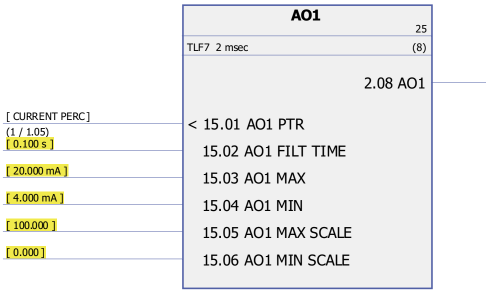
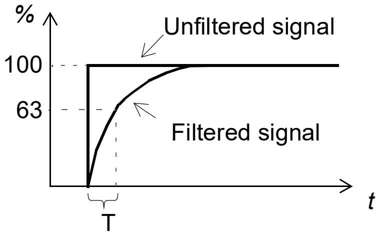
## Group 15 ANALOGUE OUTPUTS

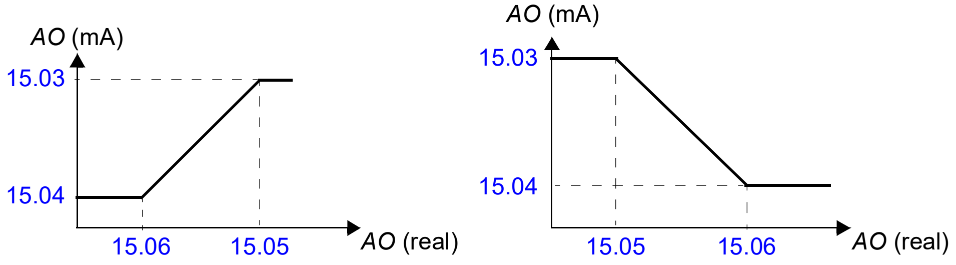
Settings for the analogue outputs.

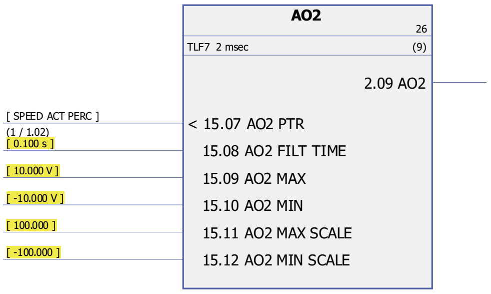
The drive offers two programmable analogue outputs: one current output AO1 (0…20 mA) and one voltage output AO2 (-10…10 V).

The resolution of the analogue outputs is 11 bits (+ sign) and the inaccuracy is 2% of the full scale range.

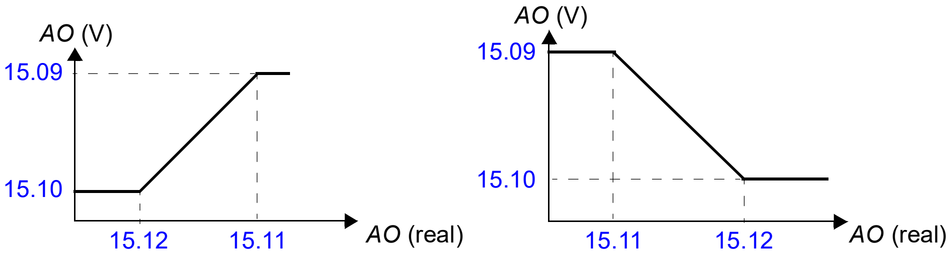
The analogue output signals can be proportional to motor speed, process speed (scaled motor speed), output frequency, output current, motor torque, motor power, etc. It is possible to write a value to an analogue output through a serial communication link (eg, fieldbus link).

| | | |
|---|---|---|
| Firmware block:<br>**AO1**<br>(14)<br><br>Connects an actual signal to analogue output AO1, and filters and scales the output signal. Also shows the value of the output. | |  AO1<br>25<br>TLF7 2 msec<br>(8)<br>2.08 AO1<br>[ CURRENT PERC ]<br>< 15.01 AO1 PTR<br>(1 / 1.05)<br>[ 0.100 s ]<br>15.02 AO1 FILT TIME<br>[ 20.000 mA ]<br>15.03 AO1 MAX<br>[ 4.000 mA ]<br>15.04 AO1 MIN<br>[ 100.000 ]<br>15.05 AO1 MAX SCALE<br>[ 0.000 ]<br>15.06 AO1 MIN SCALE |
| Block outputs located in other parameter groups | | 2.08 AO1 (page 96) |
| **15.01** | AO1 PTR | FW block: AO1 (see above) |
| | Selects a drive signal to be connected to analogue output AO1. | |
| | Value pointer: Group and index | |
| **15.02** | AO1 FILT TIME | FW block: AO1 (see above) |
| | Defines the filtering time constant for analogue output AO1.<br> <br>$O = I \cdot (1 - e^{-t/T})$<br>I = filter input (step)<br>O = filter output<br>t = time<br>T = filter time constant<br><br>**Note:** The signal is also filtered due to the signal interface hardware (approximately 0.5 ms time constant). This cannot be changed by any parameter. | |
| | 0…30 s | Filter time constant for AO1. |
| **15.03** | AO1 MAX | FW block: AO1 (see above) |
| | Defines the maximum value for analogue output AO1. | |
| | 0…22.7 mA | Maximum AO1 output value. |

| | | |
|---|---|---|
| **15.04** | AO1 MIN | FW block: AO1 (see above) |
| | Defines the minimum value for analogue output AO1. | |
| | 0…22.7 mA | Minimum AO1 output value. |
| **15.05** | AO1 MAX SCALE | FW block: AO1 (see above) |
| | Defines the real value that corresponds to the maximum analogue output value defined by parameter 15.03 AO1 MAX.<br><br> | |
| | -32768…32767 | Real value corresponding to value of parameter 15.03. |
| **15.06** | AO1 MIN SCALE | FW block: AO1 (see above) |
| | Defines the real value that corresponds to the minimum analogue output value defined by parameter 15.04 AO1 MIN. See parameter 15.05 AO1 MAX SCALE. | |
| | -32768…32767 | Real value corresponding to value of parameter 15.04. |

| | |
|---|---|
| Firmware block:<br>**AO2**<br>(15)<br>Connects an actual signal to analogue output AO2, and filters and scales the output signal. Also shows the value of the output. | <br> AO2<br>26<br>TLF7 2 msec<br>(9)<br>2.09 AO2<br>[ SPEED ACT PERC ]<br>(1 / 1.02)<br>[ 0.100 s ]<br>[ 10.000 V ]<br>[ -10.000 V ]<br>[ 100.000 ]<br>[ -100.000 ]<br>< 15.07 AO2 PTR<br>15.08 AO2 FILT TIME<br>15.09 AO2 MAX<br>15.10 AO2 MIN<br>15.11 AO2 MAX SCALE<br>15.12 AO2 MIN SCALE |
| Block outputs located in other parameter groups | 2.09 AO2 (page 96) |

| | | |
|---|---|---|
| **15.07** | AO2 PTR | FW block: AO2 (see above) |
| | Selects a drive signal to be connected to analogue output AO2. | |
| | Value pointer: Group and index | |
| **15.08** | AO2 FILT TIME | FW block: AO2 (see above) |
| | Defines the filtering time constant for analogue output AO2. See parameter 15.02 AO1 FILT TIME. | |
| | 0…30 s | Filter time constant for AO2. |

| | | |
|---|---|---|
| **15.09** | AO2 MAX | FW block: AO2 (see above) |
| | Defines the maximum value for analogue output AO2. | |
| | -10…10 V | Maximum AO2 output value. |
| **15.10** | AO2 MIN | FW block: AO2 (see above) |
| | Defines the minimum value for analogue output AO2. | |
| | -10…10 V | Minimum AO2 output value. |
| **15.11** | AO2 MAX SCALE | FW block: AO2 (see above) |
| | Defines the real value that corresponds to the maximum analogue output value defined by parameter 15.09 AO2 MAX.<br><br> | |
| | -32768…32767 | Real value corresponding to value of parameter 15.09. |
| **15.12** | AO2 MIN SCALE | FW block: AO2 (see above) |
| | Defines the real value that corresponds to the minimum analogue output value defined by parameter 15.10 AO2 MIN. See parameter 15.11 AO2 MAX SCALE. | |
| | -32768…32767 | Real value corresponding to value of parameter 15.10. |

## Group 16 SYSTEM

Local control and parameter access settings, restoration of default parameter values, save of parameters into permanent memory.

| | | |
|---|---|---|
| **16.01** | LOCAL LOCK | FW block: None |
| | Selects the source for disabling local control (Take/Release button on the PC tool, LOC/REM key of the panel). 1 = Local control disabled. 0 = Local control enabled.<br>⚠ **WARNING!** Before activating, ensure that the control panel is not needed for stopping the drive! | |
| | Bit pointer: Group, index and bit | |
| **16.02** | PARAMETER LOCK | FW block: None |
| | Selects the state of the parameter lock. The lock prevents parameter changing.<br>**Note:** This parameter can only be adjusted after the correct pass code has been entered at parameter 16.03 PASS CODE. | |
| | **(0)** Locked | Locked. Parameter values cannot be changed from the control panel. |
| | **(1)** Open | The lock is open. Parameter values can be changed. |
| | **(2)** Not saved | The lock is open. Parameter values can be changed, but the changes will not be stored at power switch off. |
| **16.03** | PASS CODE | FW block: None |
| | After entering 358 at this parameter, parameter 16.02 PARAMETER LOCK can be adjusted.<br>The value reverts back to 0 automatically. | |
| **16.04** | PARAM RESTORE | FW block: None |
| | Restores the original settings of the application, ie, parameter factory default values.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | **(0)** Done | Restoration is completed. |
| | **(1)** Restore defs | All parameter values are restored to default values, except motor data, motor ID run results, and fieldbus, drive-to-drive link and encoder configuration data. |
| | **(2)** Clear all | All parameter values are restored to default values, including motor data, motor ID run results and fieldbus and encoder configuration data. PC tool communication is interrupted during the restoration. Drive CPU is re-booted after the restoration is completed. |
| **16.07** | PARAM SAVE | FW block: None |
| | Saves the valid parameter values to permanent memory.<br>See also section *Programming via parameters* on page 32. | |
| | **(0)** Done | Save completed. |
| | **(1)** Save | Save in progress. |

| **16.09** | USER SET SEL | FW block: None |
|---|---|---|
| | Enables the save and restoration of up to four custom sets of parameter settings.<br>The set that was in use before powering down the drive is in use after the next power-up.<br>**Note:** Any parameter changes made after loading a user set are not automatically stored into the loaded set – they must be saved using this parameter. | |
| | **(1)** No request | Load or save operation complete; normal operation. |
| | **(2)** Load set 1 | Load user parameter set 1. |
| | **(3)** Load set 2 | Load user parameter set 2. |
| | **(4)** Load set 3 | Load user parameter set 3. |
| | **(5)** Load set 4 | Load user parameter set 4. |
| | **(6)** Save set 1 | Save user parameter set 1. |
| | **(7)** Save set 2 | Save user parameter set 2. |
| | **(8)** Save set 3 | Save user parameter set 3. |
| | **(9)** Save set 4 | Save user parameter set 4. |
| | **(10)** IO mode | Load user parameter set using parameters 16.11 and 16.12. |
| **16.10** | USER SET LOG | FW block: None |
| | Shows the status of the user parameter sets (see parameter 16.09 USER SET SEL). Read-only. | |
| | N/A | No user sets have been saved. |
| | **(1)** Loading | A user set is being loaded. |
| | **(2)** Saving | A user set is being saved. |
| | **(4)** Faulted | Invalid or empty parameter set. |
| | **(8)** Set1 IO act | User parameter set 1 has been selected by parameters 16.11 and 16.12. |
| | **(16)** Set2 IO act | User parameter set 2 has been selected by parameters 16.11 and 16.12. |
| | **(32)** Set3 IO act | User parameter set 3 has been selected by parameters 16.11 and 16.12. |
| | **(64)** Set4 IO act | User parameter set 4 has been selected by parameters 16.11 and 16.12. |
| | **(128)** Set1 par act | User parameter set 1 has been loaded using parameter 16.09. |
| | **(256)** Set2 par act | User parameter set 2 has been loaded using parameter 16.09. |
| | **(512)** Set3 par act | User parameter set 3 has been loaded using parameter 16.09. |
| | **(1024)** Set4 par act | User parameter set 4 has been loaded using parameter 16.09. |

<table>
<tr><th>16.11</th><th>USER IO SET LO</th><th>FW block: None</th></tr>
<tr><td></td><td colspan="2">Together with parameter 16.12 USER IO SET HI, selects the user parameter set when parameter 16.09 USER SET SEL is set to (10) IO mode. The status of the source defined by this parameter and parameter 16.12 select the user parameter set as follows:
<table>
<tr><th>Status of source defined by par. 16.11</th><th>Status of source defined by par. 16.12</th><th>User parameter set selected</th></tr>
<tr><td>FALSE</td><td>FALSE</td><td>Set 1</td></tr>
<tr><td>TRUE</td><td>FALSE</td><td>Set 2</td></tr>
<tr><td>FALSE</td><td>TRUE</td><td>Set 3</td></tr>
<tr><td>TRUE</td><td>TRUE</td><td>Set 4</td></tr>
</table></td></tr>
<tr><td></td><td colspan="2">Bit pointer: Group, index and bit</td></tr>
<tr><th>16.12</th><th>USER IO SET HI</th><th>FW block: None</th></tr>
<tr><td></td><td colspan="2">See parameter 16.11 USER IO SET LO.</td></tr>
<tr><td></td><td colspan="2">Bit pointer: Group, index and bit</td></tr>
<tr><th>16.13</th><th>TIME SOURCE PRIO</th><th>FW block: None</th></tr>
<tr><td></td><td colspan="2">Selects which real-time clock source is adopted by the drive as the master real-time clock. Some selections specify multiple sources that are in order of priority.</td></tr>
<tr><td></td><td><b>(0)</b> FB_D2D_MMI</td><td>Fieldbus (highest priority); drive-to-drive link; man-machine interface (control panel or PC).</td></tr>
<tr><td></td><td><b>(1)</b> D2D_FB_MMI</td><td>Drive-to-drive link (highest priority); fieldbus; man-machine interface (control panel or PC).</td></tr>
<tr><td></td><td><b>(2)</b> FB_D2D</td><td>Fieldbus (highest priority); drive-to-drive link.</td></tr>
<tr><td></td><td><b>(3)</b> D2D_FB</td><td>Drive-to-drive link (highest priority); fieldbus.</td></tr>
<tr><td></td><td><b>(4)</b> FB Only</td><td>Fieldbus only.</td></tr>
<tr><td></td><td><b>(5)</b> D2D Only</td><td>Drive-to-drive link only.</td></tr>
<tr><td></td><td><b>(6)</b> MMI_FB_D2D</td><td>Man-machine interface (control panel or PC) (highest priority); fieldbus; drive-to-drive link.</td></tr>
<tr><td></td><td><b>(7)</b> MMI Only</td><td>Man-machine interface (control panel or PC) only.</td></tr>
<tr><td></td><td><b>(8)</b> Internal</td><td>No external sources are used as master real-time clock.</td></tr>
<tr><th>16.20</th><th>DRIVE BOOT</th><th>FW block: None</th></tr>
<tr><td></td><td><b>(0)</b> No action</td><td>Reboot not requested.</td></tr>
<tr><td></td><td><b>(1)</b> Reboot drive</td><td>Reboot the drive control unit.</td></tr>
</table>

## Group 17 PANEL DISPLAY

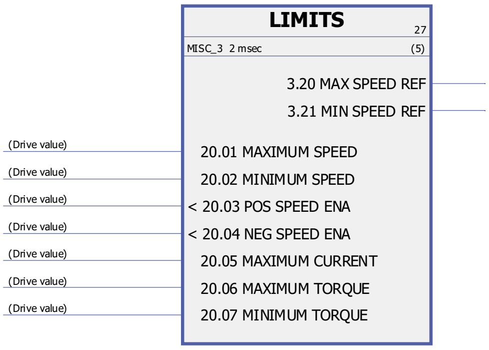
Selection of signals for panel display.

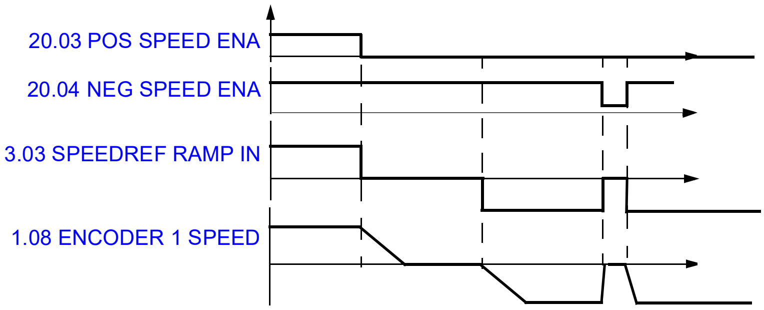
| | | |
|---|---|---|
| **17.01** | SIGNAL1 PARAM | FW block: None |
| | Selects the first signal to be displayed on the control panel. The default signal is 1.03 FREQUENCY. | |
| | Value pointer: Group and index | |
| **17.02** | SIGNAL2 PARAM | FW block: None |
| | Selects the second signal to be displayed on the control panel. The default signal is 1.04 CURRENT. | |
| | Value pointer: Group and index | |
| **17.03** | SIGNAL3 PARAM | FW block: None |
| | Selects the third signal to be displayed on the control panel. The default signal is 1.06 TORQUE. | |
| | Value pointer: Group and index | |
| **17.04** | SIGNAL1 MODE | FW block: None |
| | Defines the way the signal selected by parameter 17.01 SIGNAL1 PARAM is displayed on the optional control panel. | |
| | **(-1)** Disabled | Signal not displayed. Any other signals that are not disabled are shown together with their respective signal name. |
| | **(0)** Normal | Shows the signal as a numerical value followed by unit. |
| | **(1)** Bar | Shows the signal as a horizontal bar. |
| | **(2)** Drive name | Shows the drive name. (The drive name can be set using the DriveStudio PC tool.) |
| | **(3)** Drive type | Shows the drive type. |
| **17.05** | SIGNAL2 MODE | FW block: None |
| | Defines the way the signal selected by parameter 17.01 SIGNAL1 PARAM is displayed on the optional control panel. | |
| | **(-1)** Disabled | Signal not displayed. Any other signals that are not disabled are shown together with their respective signal name. |
| | **(0)** Normal | Shows the signal as a numerical value followed by unit. |
| | **(1)** Bar | Shows the signal as a horizontal bar. |
| | **(2)** Drive name | Shows the drive name. (The drive name can be set using the DriveStudio PC tool.) |
| | **(3)** Drive type | Shows the drive type. |

| **17.06** | SIGNAL3 MODE | FW block: None |
|---|---|---|
| | Defines the way the signal selected by parameter 17.01 SIGNAL1 PARAM is displayed on the optional control panel. | |
| | **(-1)** Disabled | Signal not displayed. Any other signals that are not disabled are shown together with their respective signal name. |
| | **(0)** Normal | Shows the signal as a numerical value followed by unit. |
| | **(1)** Bar | Shows the signal as a horizontal bar. |
| | **(2)** Drive name | Shows the drive name. (The drive name can be set using the DriveStudio PC tool.) |
| | **(3)** Drive type | Shows the drive type. |

## Group 20 LIMITS

Definition of drive operation limits.

| | | |
|---|---|---|
| Firmware block:<br>**LIMITS**<br>(20)<br>Adjusts the drive speed, current and torque limits, selects the source for the positive/negative speed reference enable command and enables the thermal current limitation. | |  LIMITS<br>27<br>MISC_3 2 msec<br>(5)<br>3.20 MAX SPEED REF<br>3.21 MIN SPEED REF<br>(Drive value)<br>20.01 MAXIMUM SPEED<br>(Drive value)<br>20.02 MINIMUM SPEED<br>(Drive value)<br>< 20.03 POS SPEED ENA<br>(Drive value)<br>< 20.04 NEG SPEED ENA<br>(Drive value)<br>20.05 MAXIMUM CURRENT<br>(Drive value)<br>20.06 MAXIMUM TORQUE<br>(Drive value)<br>20.07 MINIMUM TORQUE |
| Block outputs located in other parameter groups | | 3.20 MAX SPEED REF (page 103)<br>3.21 MIN SPEED REF (page 103) |
| **20.01** | MAXIMUM SPEED | FW block: LIMITS (see above) |
| | Defines the allowed maximum speed. See also parameter 22.08 SPEED TRIPMARGIN. | |
| | 0…30000 rpm | Allowed maximum speed. |
| **20.02** | MINIMUM SPEED | FW block: LIMITS (see above) |
| | Defines the allowed minimum speed. See also parameter 22.08 SPEED TRIPMARGIN. | |
| | -30000…0 rpm | Allowed minimum speed. |

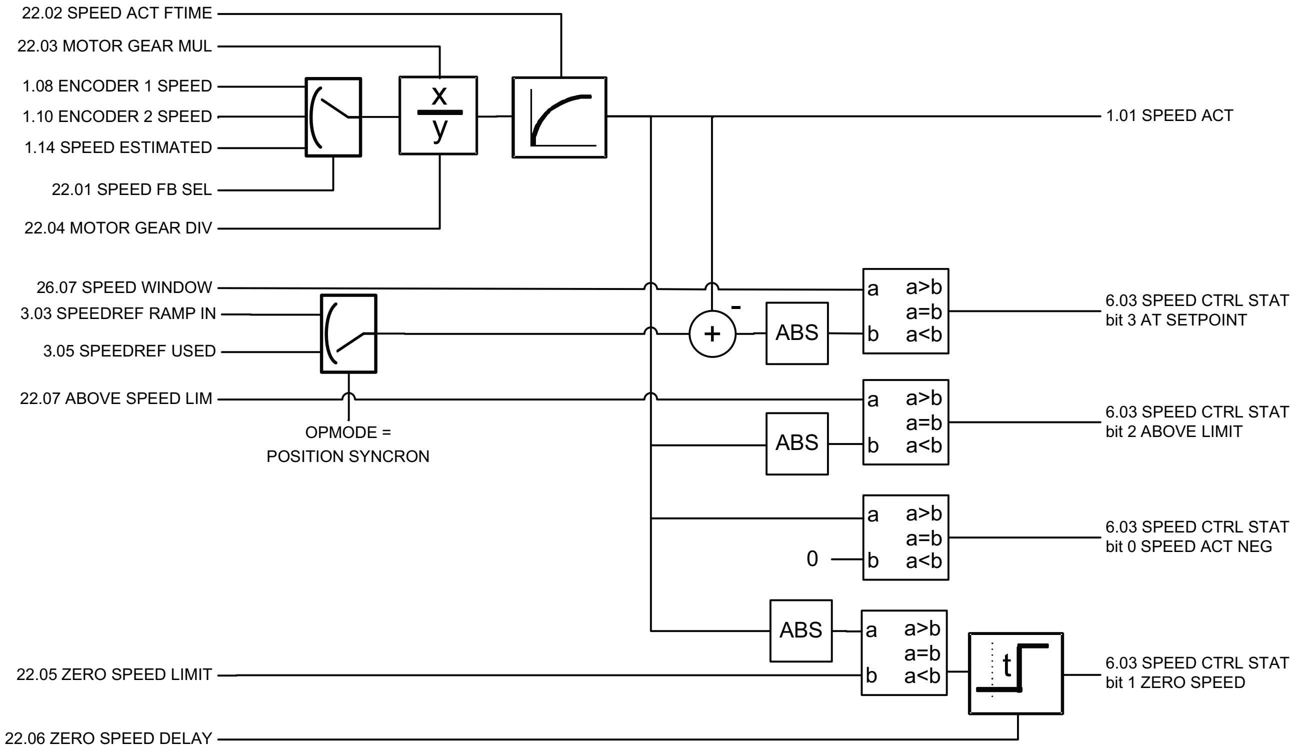
| | | |
|---|---|---|
| **20.03** | POS SPEED ENA | FW block: LIMITS (see above) |
| | Selects the source of the positive speed reference enable command.<br>1 = Positive speed reference is enabled.<br>0 = Positive speed reference is interpreted as zero speed reference (In the figure below 3.03 SPEEDREF RAMP IN is set to zero after the positive speed enable signal has cleared). Actions in different control modes:<br>Speed control: Speed reference is set to zero and the motor is stopped along the currently active deceleration ramp.<br>Torque control: Torque limit is set to zero and the rush controller stops the motor.<br> 20.03 POS SPEED ENA<br>20.04 NEG SPEED ENA<br>3.03 SPEEDREF RAMP IN<br>1.08 ENCODER 1 SPEED<br>**Example:** The motor is rotating in the forward direction. To stop the motor, the positive speed enable signal is deactivated by a hardware limit switch (eg, via digital input). If the positive speed enable signal remains deactivated and the negative speed enable signal is active, only reverse rotation of the motor is allowed. | |
| | Bit pointer: Group, index and bit | |
| **20.04** | NEG SPEED ENA | FW block: LIMITS (see above) |
| | Selects the source of the negative speed reference enable command. See parameter 20.03 POS SPEED ENA. | |
| | Bit pointer: Group, index and bit | |
| **20.05** | MAXIMUM CURRENT | FW block: LIMITS (see above) |
| | Defines the allowed maximum motor current. | |
| | 0…30000 A | Maximum allowed motor current. |
| **20.06** | MAXIMUM TORQUE | FW block: LIMITS (see above) |
| | Defines the maximum torque limit for the drive (in percent of the motor nominal torque). | |
| | 0…1600% | Maximum torque limit. |
| **20.07** | MINIMUM TORQUE | FW block: LIMITS (see above) |
| | Defines the minimum torque limit for the drive (in percent of the motor nominal torque). | |
| | -1600…0% | Minimum torque limit. |
| **20.08** | THERM CURR LIM | FW block: None |
| | Enables the thermal current limitation. Thermal current limit is calculated by the inverter thermal protection function. | |

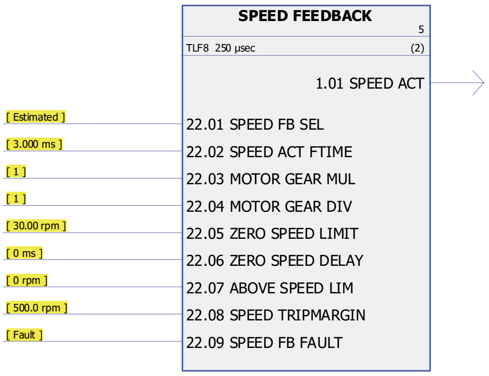
| | | |
|---|---|---|
| | **(0)** Disable | The calculated thermal limit is not used. If the inverter output current is excessive, alarm IGBT OVERTEMP is generated and eventually the drive trips on fault IGBT OVERTEMP. |
| | **(1)** Enable | The calculated thermal current value limits the inverter output current (ie, motor current). |

## Group 22 SPEED FEEDBACK

Settings for

- selection of speed feedback used in drive control
- filtering disturbances in measured speed signal
- motor encoder gear function
- zero speed limit for stop function
- delay for Zero Speed Delay function
- definition of limits for actual speed supervision
- loss of speed feedback signal protection.



| | | |
|---|---|---|
| Firmware block:<br>**SPEED FEEDBACK**<br>(22) | |  |
| Block outputs located in other parameter groups | | 1.01 SPEED ACT (page 93) |
| **22.01** | SPEED FB SEL | FW block: SPEED FEEDBACK (see above) |
| | Selects the speed feedback value used in control. | |
| | **(0)** Estimated | Calculated speed estimate. |
| | **(1)** Enc1 speed | Actual speed measured with encoder 1. The encoder is selected by parameter 90.01 ENCODER 1 SEL. |
| | **(2)** Enc2 speed | Actual speed measured with encoder 2. The encoder is selected by parameter 90.02 ENCODER 2 SEL. |
| **22.02** | SPEED ACT FTIME | FW block: SPEED FEEDBACK (see above) |
| | Defines the time constant of the actual speed filter, ie, time within the actual speed has reached 63% of the nominal speed (filtered speed = 1.01 SPEED ACT).<br>If the used speed reference remains constant, the possible interferences in the speed measurement can be filtered with the actual speed filter. Reducing the ripple with filter may cause speed controller tuning problems. A long filter time constant and fast acceleration time contradict one another. A very long filter time results in unstable control.<br>If there are substantial interferences in the speed measurement, the filter time constant should be proportional to the total inertia of the load and motor, in this case 10…30% of the mechanical time constant<br>$t_{\mathrm{mech}} = (n_{\mathrm{nom}} / T_{\mathrm{nom}}) \times J_{\mathrm{tot}} \times 2\pi / 60$, where<br>$J_{\mathrm{tot}}$ = total inertia of the load and motor (the gear ratio between the load and motor must be taken into account)<br>$n_{\mathrm{nom}}$ = motor nominal speed<br>$T_{\mathrm{nom}}$ = motor nominal torque<br>To get a fast dynamic torque or speed response with a speed feedback value other than (0) Estimated (see parameter 22.01 SPEED FB SEL), the actual speed filter time must be set to zero.<br>See also parameter 26.06 SPD ERR FTIME. | |
| | 0…10000 ms | Time constant for actual speed filter. |

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|---|---|---|
| **22.03** | MOTOR GEAR MUL | FW block: SPEED FEEDBACK (see above) |
| | Defines the motor gear numerator for the motor encoder gear function.<br>$\frac{\text{22.03 MOTOR GEAR MUL}}{\text{22.04 MOTOR GEAR DIV}} = \frac{\text{Actual speed}}{\text{Input speed}}$<br>where input speed is encoder 1/2 speed (1.08 ENCODER 1 SPEED / 1.10 ENCODER 2 SPEED) or speed estimate (1.14 SPEED ESTIMATED).<br>**Note:** If the motor gear ratio differs from 1, the motor model uses an estimated speed instead of the speed feedback value.<br>See also section *Motor encoder gear function* on page 53. | |
| | $-2^{31} \ldots 2^{31} - 1$ | Numerator for motor encoder gear. **Note:** A setting of 0 is changed internally to 1. |
| **22.04** | MOTOR GEAR DIV | FW block: SPEED FEEDBACK (see above) |
| | Defines the motor gear denominator for the motor encoder gear function. See parameter 22.03 MOTOR GEAR MUL. | |
| | $1 \ldots 2^{31} - 1$ | Denominator for motor encoder gear. |
| **22.05** | ZERO SPEED LIMIT | FW block: SPEED FEEDBACK (see above) |
| | Defines the zero speed limit. The motor is stopped along a speed ramp until the defined zero speed limit is reached. After the limit, the motor coasts to stop.<br>**Note:** Too low a setting may result in the drive not stopping at all. | |
| | 0…30000 rpm | Zero speed limit. |

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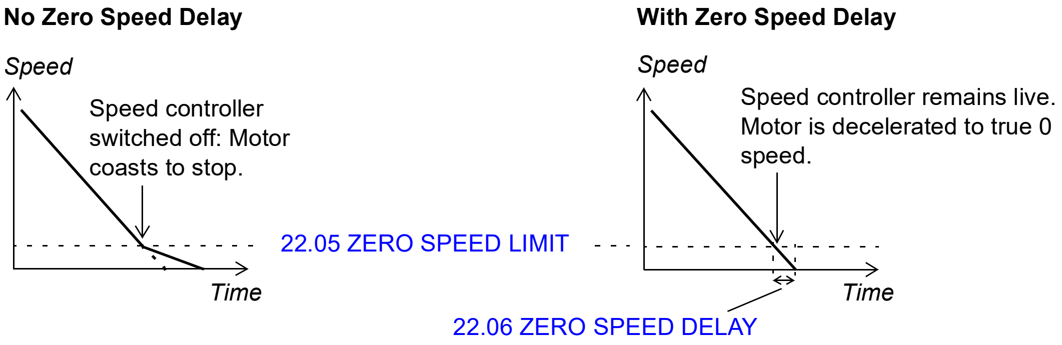
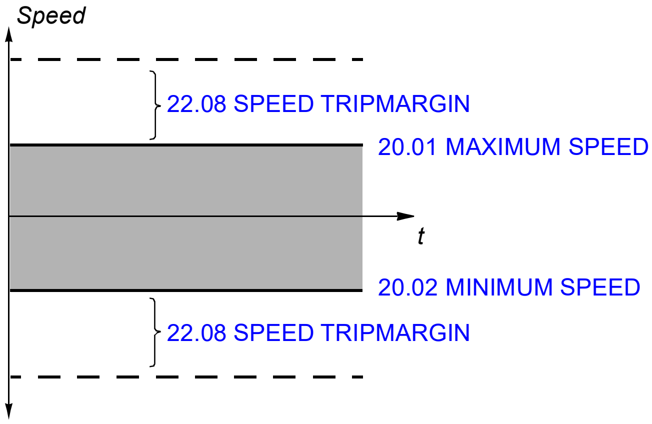
| **22.06** | ZERO SPEED DELAY | FW block: SPEED FEEDBACK (see above) |
| | Defines the delay for the zero speed delay function. The function is useful in applications where a smooth and quick restarting is essential. During the delay the drive knows accurately the rotor position.<br><br>**No Zero Speed Delay** **With Zero Speed Delay**<br> <br>**No Zero Speed Delay**<br>The drive receives a stop command and decelerates along a ramp. When the motor actual speed falls below the value of parameter 22.05 ZERO SPEED LIMIT, the speed controller is switched off. The inverter modulation is stopped and the motor coasts to standstill.<br>**With Zero Speed Delay**<br>The drive receives a stop command and decelerates along a ramp. When the actual motor speed falls below the value of parameter 22.05 ZERO SPEED LIMIT, the zero speed delay function activates. During the delay the function keeps the speed controller live: the inverter modulates, motor is magnetised and the drive is ready for a quick restart. Zero speed delay can be used, eg, with the jogging function. | |
| | 0…30000 ms | Zero speed delay. |
| **22.07** | ABOVE SPEED LIM | FW block: SPEED FEEDBACK (see above) |
| | Defines the supervision limit for the actual speed. See also parameter 2.13 FBA MAIN SW, bit 10. | |
| | 0…30000 rpm | Supervision limit for actual speed. |

| 22.08 | SPEED TRIPMARGIN | FW block: SPEED FEEDBACK (see above) |
|---|---|---|
| | Defines, together with 20.01 MAXIMUM SPEED and 20.02 MINIMUM SPEED, the maximum allowed speed of the motor (overspeed protection). If the actual speed (1.01 SPEED ACT) exceeds the speed limit defined by parameter 20.01 or 20.02 by more than 22.08 SPEED TRIPMARGIN, the drive trips on fault OVERSPEED.<br>Example: If the maximum speed is 1420 rpm and speed trip margin is 300 rpm, the drive trips at 1720 rpm.<br> Speed<br>22.08 SPEED TRIPMARGIN<br>20.01 MAXIMUM SPEED<br>t<br>20.02 MINIMUM SPEED<br>22.08 SPEED TRIPMARGIN | |
| | 0…10000 rpm | Speed trip margin. |
| **22.09** | SPEED FB FAULT | FW block: SPEED FEEDBACK (see above) |
| | Selects the action in case of speed feedback data loss.<br>**Note:** If this parameter is set to (1) Warning or (2) No, a loss of feedback will cause an internal faulted state. To clear the internal fault and to reactivate speed feedback, use parameter 90.10 ENC PAR REFRESH. | |
| | **(0)** Fault | Drive trips on a fault (OPTION COMM LOSS, ENCODER 1/2, ENCODER 1/2 CABLE or SPEED FEEDBACK depending on the type of problem). |
| | **(1)** Warning | Drive continues operation with open loop control and generates an alarm (OPTION COMM LOSS, ENCODER 1/2 FAILURE, ENCODER 1/2 CABLE or SPEED FEEDBACK depending on the type of problem). |
| | **(2)** No | Drive continues operation with open loop control. No faults or alarms are generated. The encoder speed is zero until encoder operation is reactivated with parameter 90.10 ENC PAR REFRESH. |

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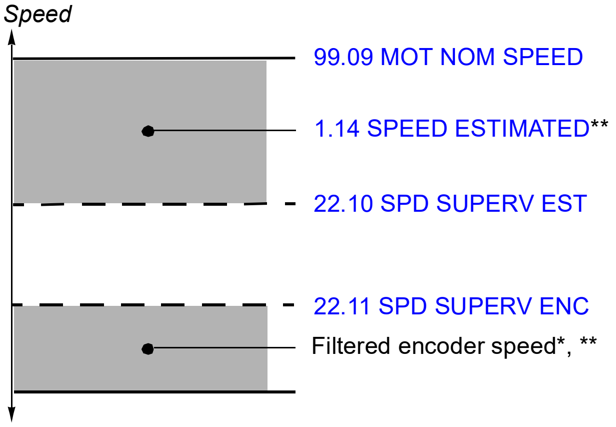
|---|---|---|
| **22.10** | SPD SUPERV EST | FW block: FAULT FUNCTIONS (see page 191) |
| | Defines the activation level for encoder supervision. The drive reacts according to 22.09 SPEED FB FAULT when:<br>• the estimated speed (1.14 SPEED ESTIMATED) is greater than 22.10 SPD SUPERV EST AND<br>• the filtered encoder speed* is lower than 22.11 SPD SUPERV ENC.<br><br> Speed<br>99.09 MOT NOM SPEED<br>1.14 SPEED ESTIMATED**<br>22.10 SPD SUPERV EST<br>22.11 SPD SUPERV ENC<br>Filtered encoder speed*, **<br>*Filtered outcome of encoder 1/2 speed. Parameter 22.12 SPD SUPERV FILT defines the filtration coefficient for this speed.<br>**In normal operation, the filtered encoder speed is equal to signal 1.14 SPEED ESTIMATED.<br>Encoder supervision can be disabled by setting this parameter to the maximum speed. | |
| | 0…30000 rpm | Activation level for encoder supervision. |
| **22.11** | SPD SUPERV ENC | FW block: FAULT FUNCTIONS (see page 191) |
| | Defines the activation level for the encoder speed used in encoder supervision. See parameter 22.10 SPD SUPERV EST. | |
| | 0…30000 rpm | Activation level for the encoder speed. |
| **22.12** | SPD SUPERV FILT | FW block: FAULT FUNCTIONS (see page 191) |
| | Defines the time constant for the encoder speed filtration used in encoder supervision. See parameter 22.10 SPD SUPERV EST. | |
| | 0…10000 ms | Time constant for the encoder speed filtration. |

## Group 24 SPEED REF MOD

Settings for

- speed reference selection
- speed reference modification (scaling and inversion)
- constant speed and jogging references
- definition of absolute minimum speed reference.

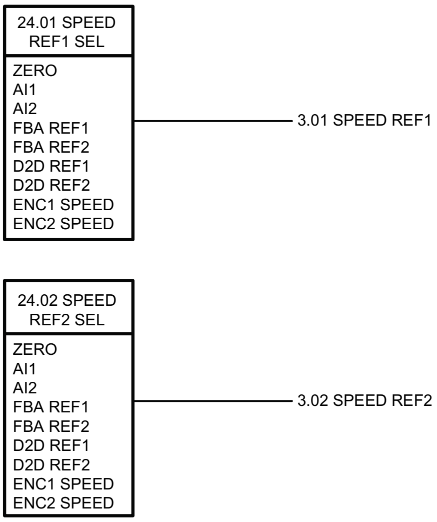
Depending on user selection, either speed reference 1 or speed reference 2 is active at a time.

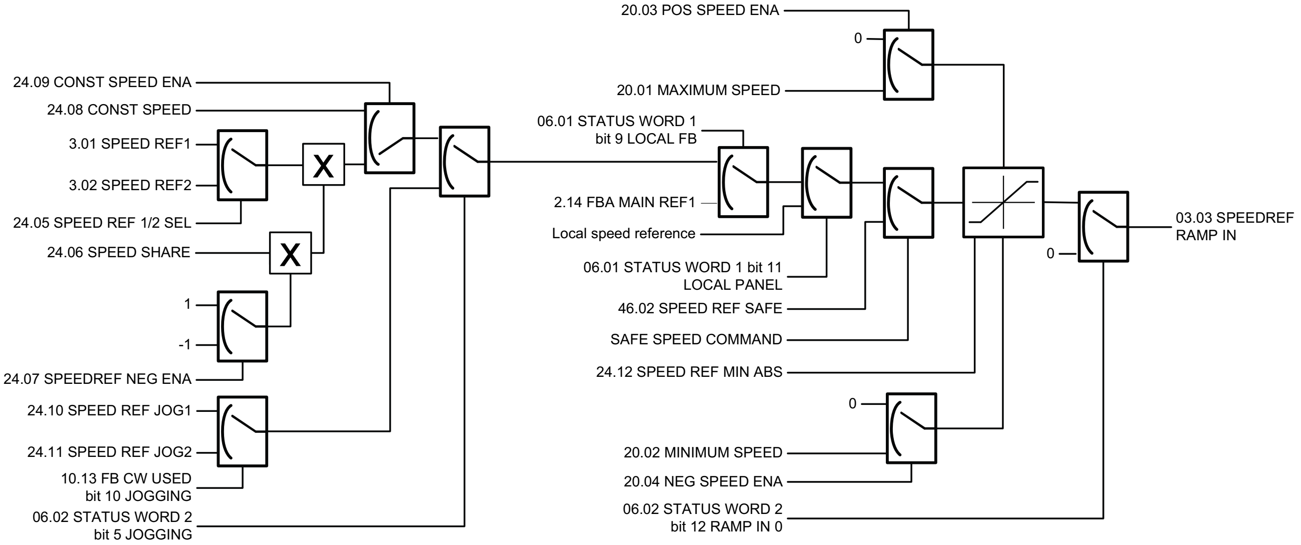
Speed reference can be any of the following (in priority order):

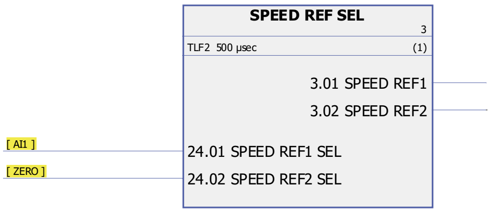
- fault speed reference (in a control panel or PC tool communication break)
- local speed reference (from panel)
- fieldbus local reference
- jogging reference 1/2
- constant speed reference 1/2
- external speed reference.

**Note:** Constant speed overrides external speed reference.

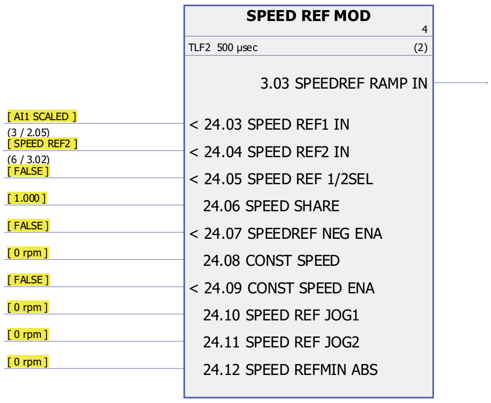
Speed reference is limited according to the set minimum and maximum speed values and ramped and shaped according to the defined acceleration and deceleration values. See parameter group 25 (page 155).

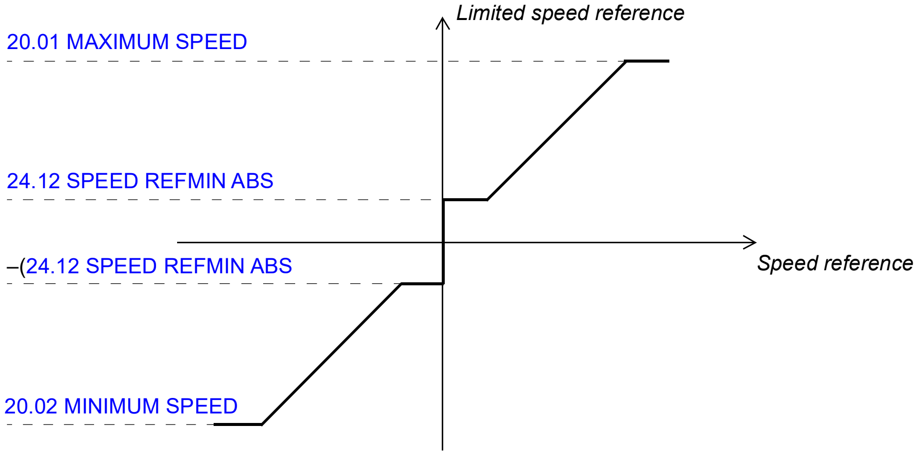




| | | |
|---|---|---|
| Firmware block:<br>**SPEED REF SEL**<br>(23)<br>Selects the sources for two speed references, REF1 or REF2, from a selection list. Also shows the values of both speed references.<br>The sources can alternatively be selected with value pointer parameters. See firmware block SPEED REF MOD on page 152. | |  SPEED REF SEL<br>3<br>TLF2 500 μsec<br>(1)<br>3.01 SPEED REF1<br>3.02 SPEED REF2<br>[ AI1 ]<br>24.01 SPEED REF1 SEL<br>[ ZERO ]<br>24.02 SPEED REF2 SEL |
| Block outputs located in other parameter groups | | 3.01 SPEED REF1 (page 102)<br>3.02 SPEED REF2 (page 102) |
| **24.01** | SPEED REF1 SEL | FW block: SPEED REF SEL (see above) |
| | Selects the source for speed reference 1 (3.01 SPEED REF1).<br>Source for speed reference 1/2 can also be selected by value pointer parameter 24.03 SPEED REF1 IN / 24.04 SPEED REF2 IN. | |
| | **(0)** ZERO | Zero reference. |
| | **(1)** AI1 | Analogue input AI1. |
| | **(2)** AI2 | Analogue input AI2. |
| | **(3)** FBA REF1 | Fieldbus reference 1. |
| | **(4)** FBA REF2 | Fieldbus reference 2. |
| | **(5)** D2D REF1 | Drive to drive reference 1. |

| | | |
|---|---|---|
| | **(6)** D2D REF2 | Drive to drive reference 2. |
| | **(7)** ENC1 SPEED | Encoder 1 (1.08 ENCODER 1 SPEED). |
| | **(8)** ENC2 SPEED | Encoder 2 (1.10 ENCODER 2 SPEED). |
| **24.02** | SPEED REF2 SEL | FW block: SPEED REF SEL (see above) |
| | Selects the source for speed reference 2 (3.02 SPEED REF2).<br>See parameter 24.01 SPEED REF1 SEL. | |

| | | |
|---|---|---|
| Firmware block:<br>**SPEED REF MOD**<br>(24)<br>This block<br>• selects the sources for two speed references, REF1 or REF2<br>• scales and inverts the speed reference<br>• defines the constant speed reference<br>• defines the speed reference for jogging functions 1 and 2<br>• defines the speed reference absolute minimum limit. | |  SPEED REF MOD<br>4<br>TLF2 500 µsec<br>(2)<br>3.03 SPEEDREF RAMP IN<br>[ AI1 SCALED ]<br>(3 / 2.05)<br>< 24.03 SPEED REF1 IN<br>[ SPEED REF2 ]<br>(6 / 3.02)<br>< 24.04 SPEED REF2 IN<br>[ FALSE ]<br>< 24.05 SPEED REF 1/2SEL<br>[ 1.000 ]<br>24.06 SPEED SHARE<br>[ FALSE ]<br>< 24.07 SPEEDREF NEG ENA<br>[ 0 rpm ]<br>24.08 CONST SPEED<br>[ FALSE ]<br>< 24.09 CONST SPEED ENA<br>[ 0 rpm ]<br>24.10 SPEED REF JOG1<br>[ 0 rpm ]<br>24.11 SPEED REF JOG2<br>[ 0 rpm ]<br>24.12 SPEED REFMIN ABS |
| Block outputs located in other parameter groups | | 3.03 SPEEDREF RAMP IN (page 102) |
| **24.03** | SPEED REF1 IN | FW block: SPEED REF MOD (see above) |
| | Selects the source for speed reference 1 (overrides the setting of parameter 24.01 SPEED REF1 SEL). The default value is P.3.1, ie, 3.01 SPEED REF1, which is the output of the SPEED REF RAMP block. | |
| | Value pointer: Group and index | |
| **24.04** | SPEED REF2 IN | FW block: SPEED REF MOD (see above) |
| | Selects the source for speed reference 2 (overrides the setting of parameter 24.02 SPEED REF2 SEL). The default value is P.3.2, ie, 3.02 SPEED REF2, which is the output of the SPEED REF RAMP block. | |
| | Value pointer: Group and index | |
| **24.05** | SPEED REF 1/2SEL | FW block: SPEED REF MOD (see above) |
| | Selects between speed reference 1 or 2. Reference 1/2 source is defined by parameter 24.03 SPEED REF1 IN / 24.04 SPEED REF2 IN. 0 = Speed reference 1. | |
| | Bit pointer: Group, index and bit | |
| **24.06** | SPEED SHARE | FW block: SPEED REF MOD (see above) |
| | Defines the scaling factor for speed reference 1/2 (speed reference 1 or 2 is multiplied by the defined value). Speed reference 1 or 2 is selected by parameter 24.05 SPEED REF 1/2SEL. | |

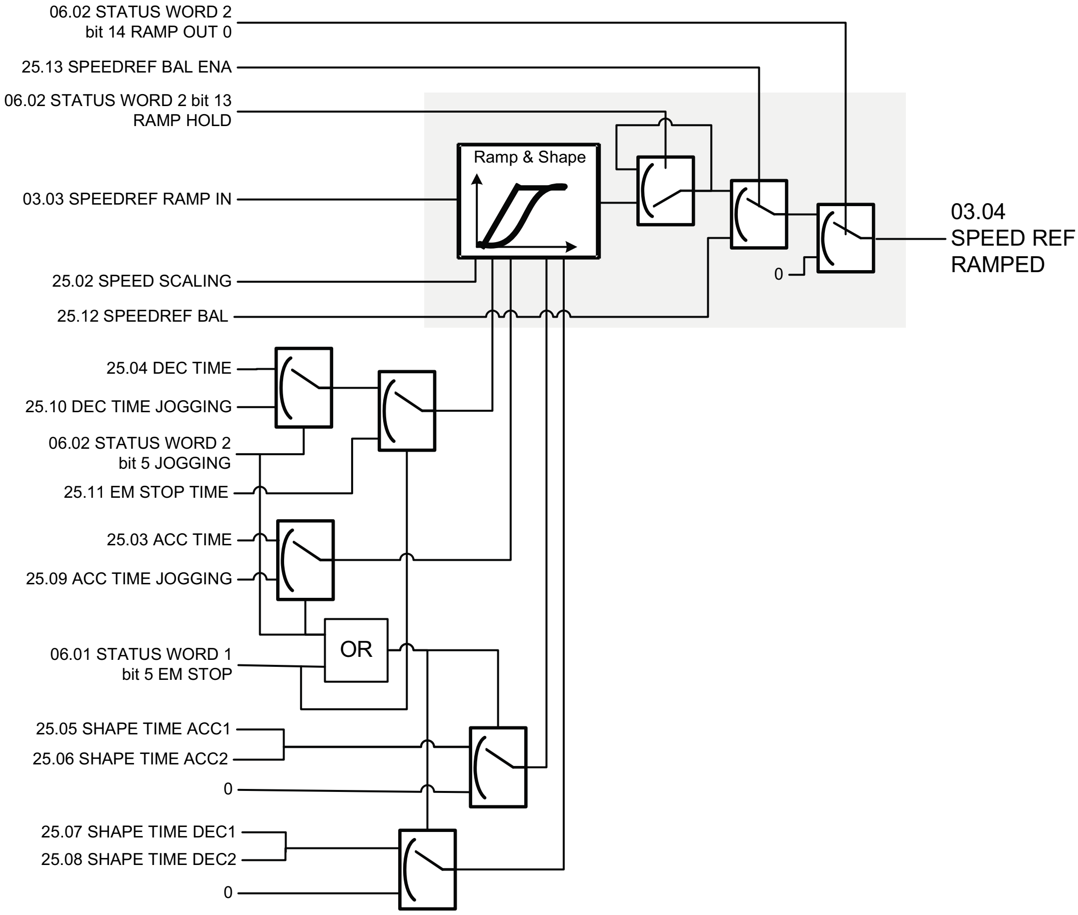
| | | |
|---|---|---|
| | -8…8 | Scaling factor for speed reference 1/2. |
| **24.07** | SPEEDREF NEG ENA | FW block: SPEED REF MOD (see above) |
| | Selects the source for the speed reference inversion. 1 = Sign of the speed reference is changed (inversion active). | |
| | Bit pointer: Group, index and bit | |
| **24.08** | CONST SPEED | FW block: SPEED REF MOD (see above) |
| | Defines the constant speed. | |
| | -30000…30000 rpm | Constant speed. |
| **24.09** | CONST SPEED ENA | FW block: SPEED REF MOD (see above) |
| | Selects the source for enabling the use of the constant speed reference define by parameter 24.08 CONST SPEED. 1 = Enable. | |
| | Bit pointer: Group, index and bit | |
| **24.10** | SPEED REF JOG1 | FW block: SPEED REF MOD (see above) |
| | Defines the speed reference for jogging function 1. See section *Jogging* on page 49. | |
| | -30000…30000 rpm | Speed reference for jogging 1. |
| **24.11** | SPEED REF JOG2 | FW block: SPEED REF MOD (see above) |
| | Defines the speed reference for jogging function 2. See section *Jogging* on page 49. | |
| | -30000…30000 rpm | Speed reference for jogging 2. |
| **24.12** | SPEED REFMIN ABS | FW block: SPEED REF MOD (see above) |
| | Defines the absolute minimum limit for the speed reference.<br><br> | |
| | 0…30000 rpm | Absolute minimum limit for speed reference. |

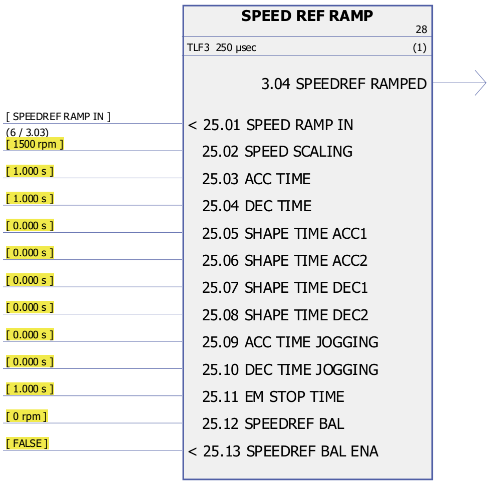
## Group 25 SPEED REF RAMP

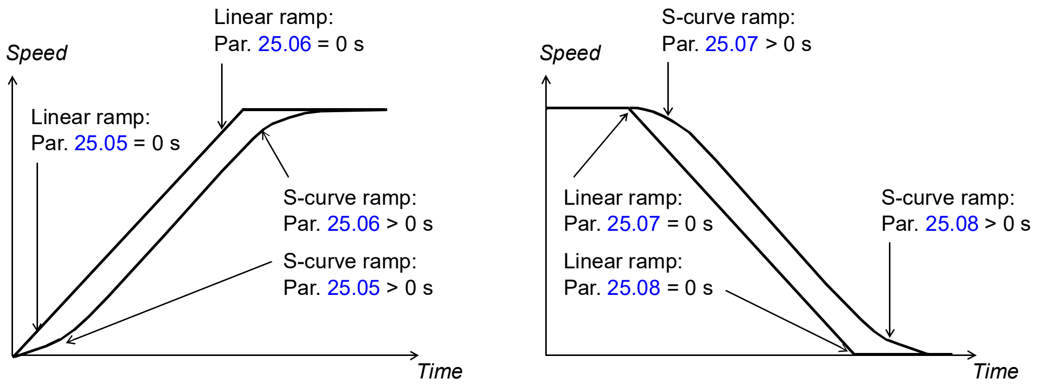
Speed reference ramp settings such as

- selection of source for speed ramp input
- acceleration and deceleration times (also for jogging)
- acceleration and deceleration ramp shapes
- emergency stop OFF3 ramp time
- the speed reference balancing function (forcing the output of the ramp generator to a predefined value).

**Note:** Emergency stop OFF1 uses the currently active ramp time.



<table>
<tr><td colspan="2">Firmware block:<br>**SPEED REF RAMP**<br>(25)<br>This block<br>• selects the source for the speed ramp input<br>• adjusts acceleration and deceleration times (also for jogging)<br>• adjusts acceleration/deceleration ramp shapes<br>• adjusts ramp time for emergency stop OFF3<br>• forces the output of the ramp generator to a defined value<br>• shows the ramped and shaped speed reference value.</td><td>
</td></tr>
<tr><td colspan="2">Block outputs located in other parameter groups</td><td>3.04 SPEEDREF RAMPED (page 102)</td></tr>
<tr><td>**25.01**</td><td>SPEED RAMP IN</td><td>FW block: SPEED REF RAMP (see above)</td></tr>
<tr><td></td><td colspan="2">Shows the source of the speed ramp input. The default value is P.3.3, ie, signal 3.03 SPEEDREF RAMP IN, which is the output of the SPEED REF MOD firmware block.</td></tr>
<tr><td></td><td colspan="2">Value pointer: Group and index</td></tr>
<tr><td>**25.02**</td><td>SPEED SCALING</td><td>FW block: SPEED REF RAMP (see above)</td></tr>
<tr><td></td><td colspan="2">Defines the speed value used in acceleration and deceleration (parameters 25.03/25.09 and 25.04/ 25.10/25.11). Also affects fieldbus reference scaling (see *Appendix A – Fieldbus control*, section *Fieldbus references* on page 352).</td></tr>
<tr><td></td><td>0…30000 rpm</td><td>Speed value for acceleration/deceleration.</td></tr>
<tr><td>**25.03**</td><td>ACC TIME</td><td>FW block: SPEED REF RAMP (see above)</td></tr>
<tr><td></td><td colspan="2">Defines the acceleration time, ie, the time required for the speed to change from zero to the speed value defined by parameter 25.02 SPEED SCALING.<br>If the speed reference increases faster than the set acceleration rate, the motor speed will follow the acceleration rate.<br>If the speed reference increases slower than the set acceleration rate, the motor speed will follow the reference signal.<br>If the acceleration time is set too short, the drive will automatically prolong the acceleration in order not to exceed the drive torque limits.</td></tr>
<tr><td></td><td>0…1800 s</td><td>Acceleration time.</td></tr>
</table>

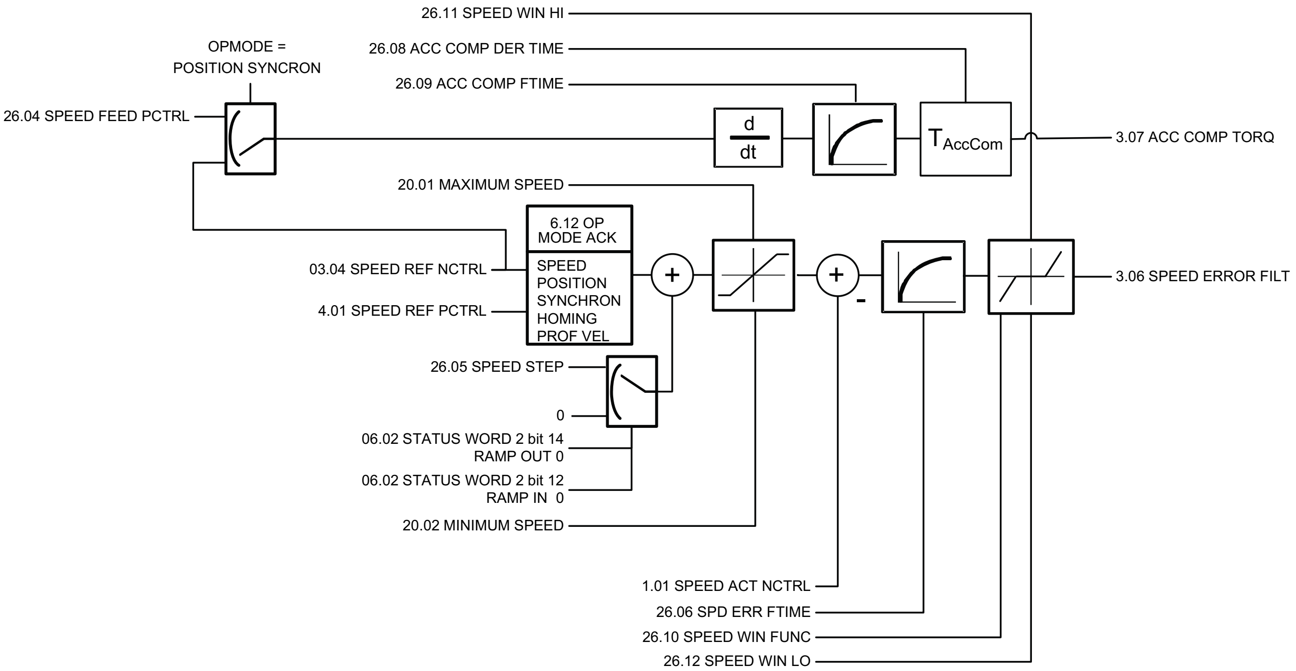
| | | |
|---|---|---|
| **25.04** | DEC TIME | FW block: SPEED REF RAMP (see above) |
| | Defines the deceleration time, ie, the time required for the speed to change from the speed value defined by parameter 25.02 SPEED SCALING to zero.<br>If the speed reference decreases slower than the set deceleration rate, the motor speed will follow the reference signal.<br>If the reference changes faster than the set deceleration rate, the motor speed will follow the deceleration rate.<br>If the deceleration time is set too short, the drive will automatically prolong the deceleration in order not to exceed drive torque limits. If there is any doubt about the deceleration time being too short, ensure that the DC overvoltage control is on (parameter 47.01 OVERVOLTAGE CTRL).<br>**Note:** If a short deceleration time is needed for a high inertia application, the drive should be equipped with an electric braking option, eg, with a braking chopper (built-in) and a braking resistor. | |
| | 0…1800 s | Deceleration time. |
| **25.05** | SHAPE TIME ACC1 | FW block: SPEED REF RAMP (see above) |
| | Selects the shape of the acceleration ramp at the beginning of the acceleration.<br>0.00 s: Linear ramp. Suitable for steady acceleration or deceleration and for slow ramps.<br>0.01…1000.00 s: S-curve ramp. S-curve ramps are ideal for conveyor and lifting applications. The S-curve consists of symmetrical curves at both ends of the ramp and a linear part in between.<br>**Note:** When jogging or emergency ramp stop is active, acceleration and deceleration shape times are forced to zero.<br><br> Speed<br>Linear ramp: Par. 25.06 = 0 s<br>Linear ramp: Par. 25.05 = 0 s<br>S-curve ramp: Par. 25.06 > 0 s<br>S-curve ramp: Par. 25.05 > 0 s<br>Time<br>Speed<br>S-curve ramp: Par. 25.07 > 0 s<br>Linear ramp: Par. 25.07 = 0 s<br>S-curve ramp: Par. 25.08 > 0 s<br>Linear ramp: Par. 25.08 = 0 s<br>Time | |
| | 0…1000 s | Ramp shape at beginning of acceleration. |
| **25.06** | SHAPE TIME ACC2 | FW block: SPEED REF RAMP (see above) |
| | Selects the shape of the acceleration ramp at the end of the acceleration. See parameter 25.05 SHAPE TIME ACC1. | |
| | 0…1000 s | Ramp shape at end of acceleration. |
| **25.07** | SHAPE TIME DEC1 | FW block: SPEED REF RAMP (see above) |
| | Selects the shape of the deceleration ramp at the beginning of the deceleration. See parameter 25.05 SHAPE TIME ACC1. | |
| | 0…1000 s | Ramp shape at beginning of deceleration. |

| | | |
|---|---|---|
| **25.08** | SHAPE TIME DEC2 | FW block: SPEED REF RAMP (see above) |
| | Selects the shape of the deceleration ramp at the end of the deceleration. See parameter 25.05 SHAPE TIME ACC1. | |
| | 0…1000 s | Ramp shape at end of deceleration. |
| **25.09** | ACC TIME JOGGING | FW block: SPEED REF RAMP (see above) |
| | Defines the acceleration time for the jogging function, ie, the time required for the speed to change from zero to the speed value defined by parameter 25.02 SPEED SCALING. | |
| | 0…1800 s | Acceleration time for jogging. |
| **25.10** | DEC TIME JOGGING | FW block: SPEED REF RAMP (see above) |
| | Defines the deceleration time for the jogging function, ie, the time required for the speed to change from the speed value defined by parameter 25.02 SPEED SCALING to zero. | |
| | 0…1800 s | Deceleration time for jogging. |
| **25.11** | EM STOP TIME | FW block: SPEED REF RAMP (see above) |
| | Defines the time inside which the drive is stopped if an emergency stop OFF3 is activated (ie, the time required for the speed to change from the speed value defined by parameter 25.02 SPEED SCALING to zero). Emergency stop activation source is selected by parameter 10.10 EM STOP OFF3. Emergency stop can also be activated through fieldbus (2.12 FBA MAIN CW).<br>Emergency stop OFF1 uses the active ramp time. | |
| | 0…1800 s | Emergency stop OFF3 deceleration time. |
| **25.12** | SPEEDREF BAL | FW block: SPEED REF RAMP (see above) |
| | Defines the reference for the speed ramp balancing, ie, the output of the speed reference ramp firmware block is forced to a defined value.<br>The source for the balancing enable signal is selected by parameter 25.13 SPEEDREF BAL. | |
| | -30000…30000 rpm | Speed ramp balancing reference. |
| **25.13** | SPEEDREF BAL ENA | FW block: SPEED REF RAMP (see above) |
| | Selects the source for enabling the speed ramp balancing. See parameter 25.12 SPEEDREF BAL.<br>1 = Speed ramp balancing enabled. | |
| | Bit pointer: Group, index and bit | |

## Group 26 SPEED ERROR

Speed error is determined by comparing the speed reference and speed feedback. The error can be filtered using a first-order low-pass filter if the feedback and reference have disturbances. In addition, a torque boost can be applied to compensate acceleration; the torque is relative to the rate of change (derivative) in the speed reference and inertia of the load. The speed error value can be supervised using the window function.

- The signal used as speed reference is 3.04 SPEEDREF RAMPED.



<table>
<tr>
<td colspan="2">

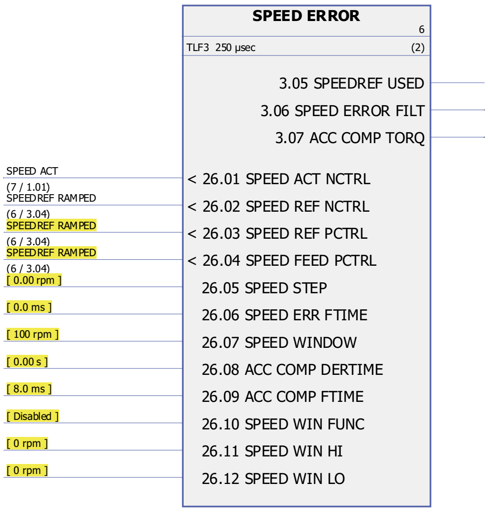
Firmware block:

**SPEED ERROR**
(26)

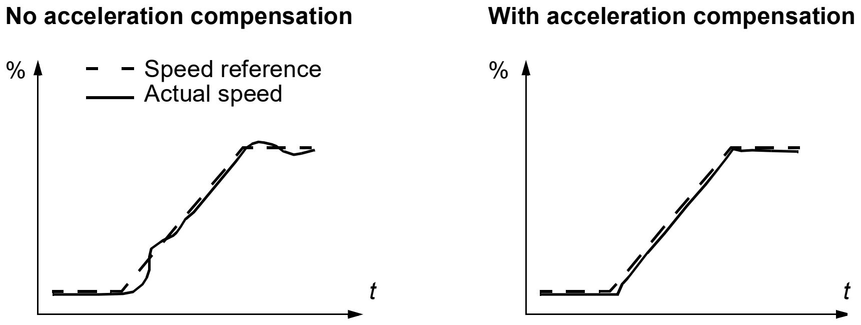
This block

- selects the source for speed error calculation (speed reference - actual speed) in different control modes
- selects the source for speed reference
- defines the speed error filtering time
- defines an additional speed step to the speed error
- defines the supervision of speed error with the speed error window function
- defines inertia compensation during acceleration
- shows the used speed reference, filtered speed error and the output of the acceleration compensation.

</td>
<td>



</td>
</tr>
<tr>
<td colspan="2">Block outputs located in other parameter groups</td>
<td>3.05 SPEEDREF USED (page 102)<br>3.06 SPEED ERROR FILT (page 102)<br>3.07 ACC COMP TORQ (page 102)</td>
</tr>
<tr>
<td>**26.01**</td>
<td>SPEED ACT NCTRL</td>
<td>FW block: SPEED ERROR (see above)</td>
</tr>
<tr>
<td></td>
<td colspan="2">Selects the source for the actual speed in the speed control mode.<br>**Note:** This parameter has been locked, ie, no user setting is possible.</td>
</tr>
<tr>
<td></td>
<td colspan="2">Value pointer: Group and index</td>
</tr>
<tr>
<td>**26.02**</td>
<td>SPEED REF NCTRL</td>
<td>FW block: SPEED ERROR (see above)</td>
</tr>
<tr>
<td></td>
<td colspan="2">Selects the source for the speed reference in the speed control mode.<br>**Note:** This parameter has been locked, ie, no user setting is possible.</td>
</tr>
<tr>
<td></td>
<td colspan="2">Value pointer: Group and index</td>
</tr>
<tr>
<td>**26.03**</td>
<td>SPEED REF PCTRL</td>
<td>FW block: SPEED ERROR (see above)</td>
</tr>
<tr>
<td></td>
<td colspan="2">Selects the source for the speed reference in position and synchron control modes.<br>**Note:** This parameter is only for positioning applications.</td>
</tr>
<tr>
<td></td>
<td colspan="2">Value pointer: Group and index</td>
</tr>
<tr>
<td>**26.04**</td>
<td>SPEED FEED PCTRL</td>
<td>FW block: SPEED ERROR (see above)</td>
</tr>
<tr>
<td></td>
<td colspan="2">This parameter is only for positioning applications.</td>
</tr>
<tr>
<td></td>
<td colspan="2">Value pointer: Group and index</td>
</tr>
</table>

| | | |
|---|---|---|
| **26.05** | SPEED STEP | FW block: SPEED ERROR (see above) |
| | Defines an additional speed step given to the input of the speed controller (added to the speed error value). | |
| | -30000…30000 rpm | Speed step. |
| **26.06** | SPD ERR FTIME | FW block: SPEED ERROR (see above) |
| | Defines the time constant of the speed error low pass filter.<br>If the used speed reference changes rapidly (servo application), the possible interferences in the speed measurement can be filtered with the speed error filter. Reducing the ripple with filter may cause speed controller tuning problems. A long filter time constant and fast acceleration time contradict one another. A very long filter time results in unstable control.<br>See also parameter 22.02 SPEED ACT FTIME. | |
| | 0…1000 ms | Time constant for speed error low pass filter. 0 ms = filtering disabled. |
| **26.07** | SPEED WINDOW | FW block: SPEED ERROR (see above) |
| | Defines the absolute value for the motor speed window supervision, ie, the absolute value for the difference between the actual speed and the unramped speed reference (1.01 SPEED ACT - 3.03 SPEEDREF RAMP IN). When the motor speed is within the limits defined by this parameter, signal 2.13 bit 8 (AT_SETPOINT) value is 1. If the motor speed is not within the defined limits, bit 8 value is 0. | |
| | 0…30000 rpm | Absolute value for motor speed window supervision. |
| **26.08** | ACC COMP DERTIME | FW block: SPEED ERROR (see above) |
| | Defines the derivation time for acceleration (deceleration) compensation. Used to improve the speed control dynamic reference change.<br>In order to compensate inertia during acceleration, a derivative of the speed reference is added to the output of the speed controller. The principle of a derivative action is described for parameter 28.04 DERIVATION TIME.<br>**Note:** The parameter value should be proportional to the total inertia of the load and motor, ie, approximately 50…100% of the mechanical time constant ($t_{mech}$). See the mechanical time constant equation in parameter 22.02 SPEED ACT FTIME.<br>If parameter value is set to zero, the function is deactivated.<br>The figure below shows the speed responses when a high inertia load is accelerated along a ramp.<br><br>**No acceleration compensation** **With acceleration compensation**<br> <br>See also parameter 26.09 ACC COMP FTIME.<br>The source for the acceleration compensation torque can also be selected by parameter 28.06 ACC COMPENSATION. See parameter group 28. | |

| | | |
|---|---|---|
| | 0…600 s | Derivation time for acceleration/deceleration compensation. |
| **26.09** | ACC COMP FTIME | FW block: SPEED ERROR (see above) |
| | Defines the filter time for the acceleration compensation. | |
| | 0…1000 ms | Filter time for acceleration compensation. 0 ms = filtering disabled. |
| **26.10** | SPEED WIN FUNC | FW block: SPEED ERROR (see above) |
| | Enables or disables speed error window control.<br>Speed error window control forms a speed supervision function for a speed and torque-controlled drive (Add operating mode). It supervises the speed error value (speed reference – actual speed). In the normal operating range, window control keeps the speed controller input at zero. The speed controller is evoked only if<br>• the speed error exceeds the upper boundary of the window (parameter 26.11 SPEED WIN HI), or<br>• the absolute value of the negative speed error exceeds the lower boundary of the window (parameter 26.12 SPEED WIN LO).<br>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 28.02 PROPORT GAIN) which the torque selector adds to the torque reference. The result is used as the internal torque reference for the drive.<br>Example: In a load loss condition, the internal torque reference of the drive is decreased to prevent an excessive rise of the motor speed. If window control were inactive, the motor speed would rise until a speed limit of the drive were reached. | |
| | **(0)** Disabled | Speed error window control inactive. |
| | **(1)** Absolute | Speed error window control active. The boundaries defined by parameters 26.11 and 26.12 are absolute. |
| | **(2)** Relative | Speed error window control active. The boundaries defined by parameters 26.11 and 26.12 are relative to speed reference. |
| **26.11** | SPEED WIN HI | FW block: SPEED ERROR (see above) |
| | Defines the upper boundary of the speed error window. Depending on the setting of parameter 26.10 SPEED WIN FUNC, this is either an absolute value or relative to speed reference. | |
| | 0…3000 rpm | Upper boundary of speed error window. |
| **26.12** | SPEED WIN LO | FW block: SPEED ERROR (see above) |
| | Defines the lower boundary of the speed error window. Depending on the setting of parameter 26.10 SPEED WIN FUNC, this is either an absolute value or relative to speed reference. | |
| | 0…3000 rpm | Lower boundary of speed error window. |

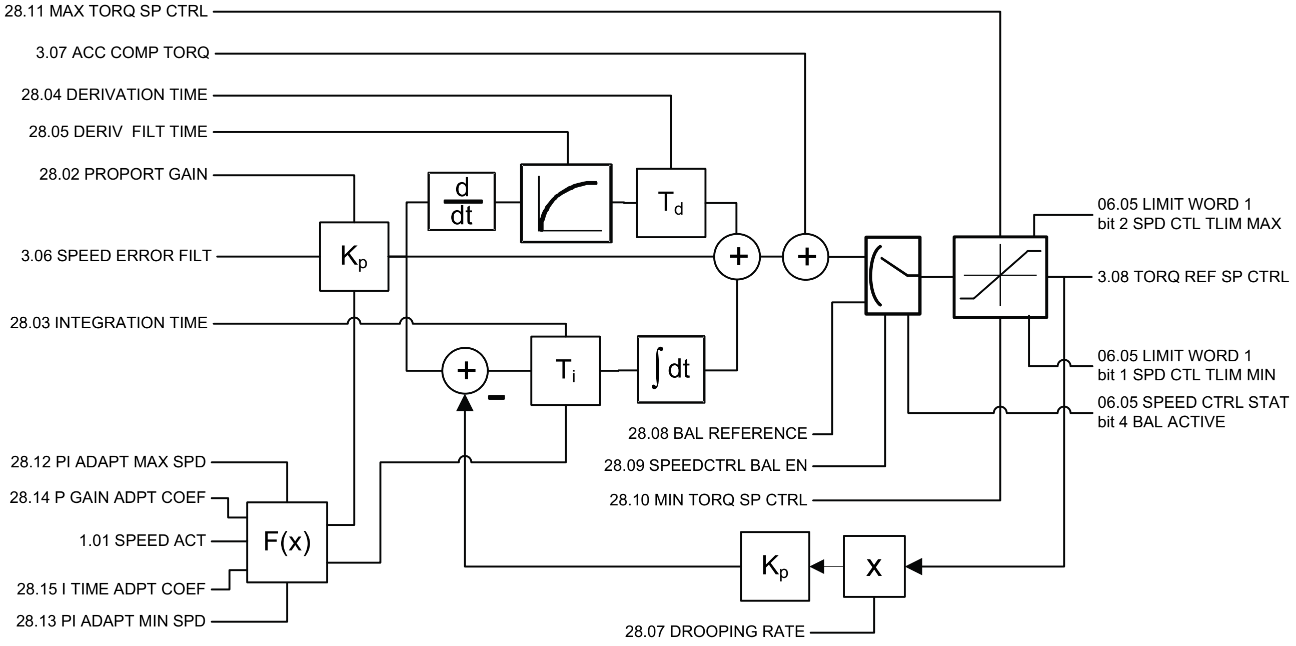
## Group 28 SPEED CONTROL

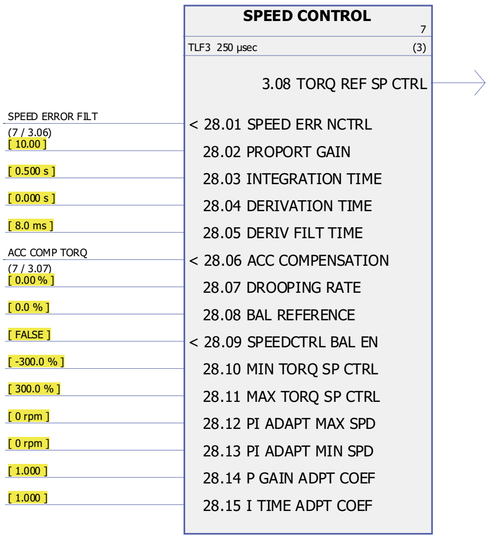
Speed controller settings such as

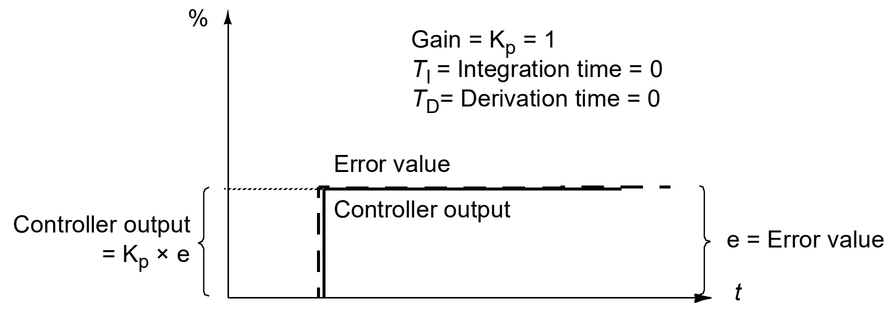
- selection of source for speed error
- adjustment of PID-type speed controller variables
- limitation of speed controller output torque
- selection of source for acceleration compensation torque
- forcing an external value to the output of the speed controller (with the balancing function).
- adjustment of the load sharing in a Master/Follower application run by several drives (the drooping function).

The speed controller includes an anti-windup function (ie, I-term is frozen during torque reference limitation).

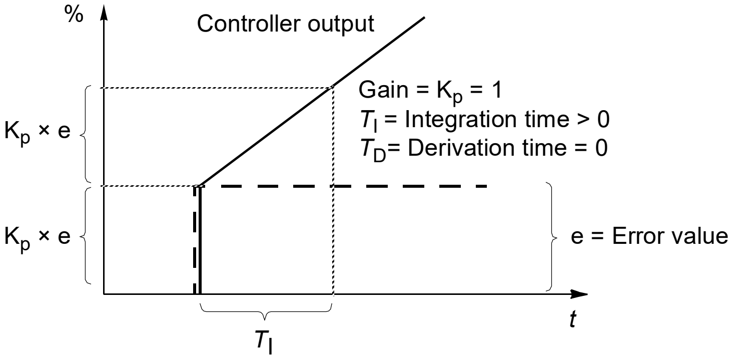
In torque control mode, the speed controller output is frozen.

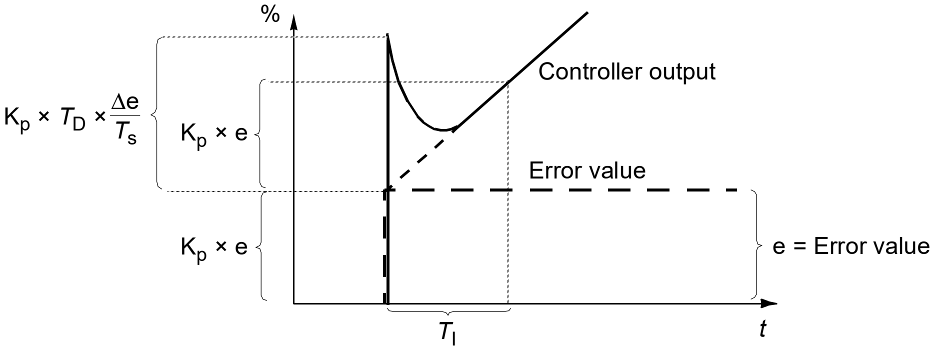


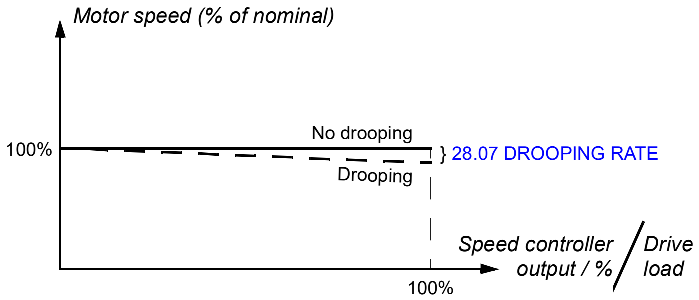
<table>
<tr><td colspan="2">Firmware block:<br>**SPEED CONTROL**<br>(28)<br><br>This block<br>• selects the source for speed error<br>• adjusts PID-type speed controller variables<br>• defines limits for speed controller output torque<br>• selects the source for acceleration compensation torque<br>• configures the balancing function which forces the output of the speed controller to an external value<br>• configures the drooping function (adjustment of load sharing in a Master/Follower application)<br>• shows the limited speed controller output torque value.</td><td>


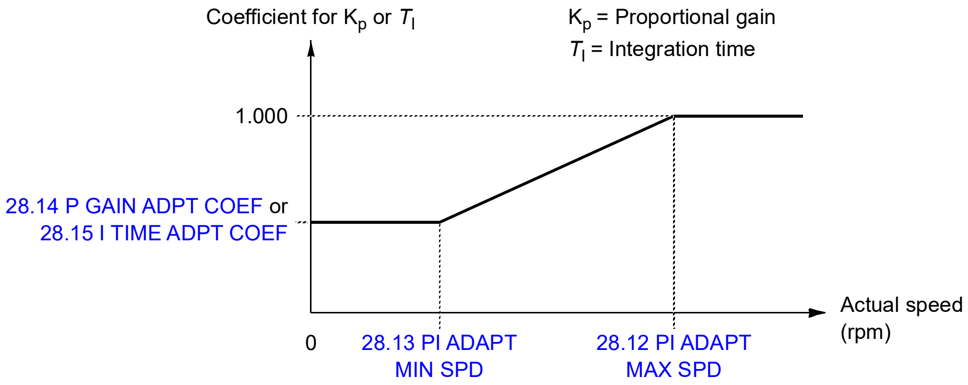
</td></tr>
<tr><td colspan="2">Block outputs located in other parameter groups</td><td>3.08 TORQ REF SP CTRL (page 102)</td></tr>
<tr><td>**28.01**</td><td>SPEED ERR NCTRL</td><td>FW block: SPEED CONTROL (see above)</td></tr>
<tr><td></td><td colspan="2">Selects the source for the speed error (reference - actual). The default value is P.3.6, ie, parameter 3.06 SPEED ERROR FILT, which is the output of the SPEED ERROR firmware block.<br>**Note:** This parameter has been locked, ie, no user setting is possible.</td></tr>
<tr><td></td><td colspan="2">Value pointer: Group and index</td></tr>
<tr><td>**28.02**</td><td>PROPORT GAIN</td><td>FW block: SPEED CONTROL (see above)</td></tr>
<tr><td></td><td colspan="2">Defines the proportional gain ($K_p$) of the speed controller. Too large a gain may cause speed oscillation. The figure below shows the speed controller output after an error step when the error remains constant.


If gain is set to 1, a 10% change in error value (reference - actual value) causes the speed controller output to change by 10%.<br>**Note:** This parameter is automatically set by the speed controller autotune function. See parameter 28.16 PI TUNE MODE.</td></tr>
<tr><td></td><td>0…200</td><td>Proportional gain for speed controller.</td></tr>
</table>

| **28.03** | INTEGRATION TIME | FW block: SPEED CONTROL (see above) |
|---|---|---|
| | Defines the integration time of the speed controller. The integration time defines the rate at which the controller output changes when the error value is constant and the proportional gain of the speed controller is 1. The shorter the integration time, the faster the continuous error value is corrected. Too short integration time makes the control unstable.<br>If parameter value is set to zero, the I-part of the controller is disabled.<br>Anti-windup stops the integrator if the controller output is limited. See 6.05 LIMIT WORD 1.<br>The figure below shows the speed controller output after an error step when the error remains constant.<br> <br>**Note:** This parameter is automatically set by the speed controller autotune function. See parameter 28.16 PI TUNE MODE. | |
| | 0…600 s | Integration time for speed controller. |

| | | |
|---|---|---|
| **28.04** | DERIVATION TIME | FW block: SPEED CONTROL (see above) |
| | Defines the derivation time of the speed controller. Derivative action boosts the controller output if the error value changes. The longer the derivation time, the more the speed controller output is boosted during the change. If the derivation time is set to zero, the controller works as a PI controller, otherwise as a PID controller. The derivation makes the control more responsive for disturbances.<br>The speed error derivative must be filtered with a low pass filter to eliminate disturbances.<br>The figure below shows the speed controller output after an error step when the error remains constant.<br>Gain = $K_p$ = 1<br>$T_I$ = Integration time > 0<br>$T_D$= Derivation time > 0<br>$T_s$= Sample time period = 250 µs<br>e = Error value<br>Δe = Error value change between two samples<br> <br>**Note:** Changing this parameter value is recommended only if a pulse encoder is used. | |
| | 0…10 s | Derivation time for speed controller. |
| **28.05** | DERIV FILT TIME | FW block: SPEED CONTROL (see above) |
| | Defines the derivation filter time constant. | |
| | 0…1000 ms | Derivation filter time constant. |
| **28.06** | ACC COMPENSATION | FW block: SPEED CONTROL (see above) |
| | Selects the source for the acceleration compensation torque.<br>The default value is P.3.7, ie, signal 3.07 ACC COMP TORQ, which is the output of the SPEED ERROR firmware block.<br>**Note:** This parameter has been locked, ie, no user setting is possible. | |
| | Value pointer: Group and index | |

| | | |
|---|---|---|
| **28.07** | DROOPING RATE | FW block: SPEED CONTROL (see above) |
| | Defines the droop rate (in percent of the motor nominal speed). The drooping slightly decreases the drive speed as the drive load increases. The actual speed decrease at a certain operating point depends on the droop rate setting and the drive load (= torque reference / speed controller output). At 100% speed controller output, drooping is at its nominal level, ie, equal to the value of this parameter. The drooping effect decreases linearly to zero along with the decreasing load.<br>Drooping rate can be used, eg, to adjust the load sharing in a Master/Follower application run by several drives. In a Master/Follower application the motor shafts are coupled to each other.<br>The correct droop rate for a process must be found out case by case in practice.<br>**Speed decrease =** Speed controller output × Drooping × Max. speed<br>**Example:** Speed controller output is 50%, drooping rate is 1%, maximum speed of the drive is 1500 rpm.<br>Speed decrease = 0.50 × 0.01 × 1500 rpm = 7.5 rpm.<br> | |
| | 0…100% | Droop rate. |
| **28.08** | BAL REFERENCE | FW block: SPEED CONTROL (see above) |
| | Defines the reference used in the speed control output balancing, ie, an external value to be forced to the output of the speed controller. In order to guarantee smooth operation during output balancing, the speed controller D-part is disabled and the acceleration compensation term is set to zero.<br>The source for the balancing enable signal is selected by parameter 28.09 SPEEDCTRL BAL EN. | |
| | -1600…1600% | Speed control output balancing reference. |
| **28.09** | SPEEDCTRL BAL EN | FW block: SPEED CONTROL (see above) |
| | Selects the source for the speed control output balancing enable signal. See parameter 28.08 BAL REFERENCE. 1 = Enabled. 0 = Disabled. | |
| | Bit pointer: Group, index and bit | |
| **28.10** | MIN TORQ SP CTRL | FW block: SPEED CONTROL (see above) |
| | Defines the minimum speed controller output torque. | |
| | -1600…1600% | Minimum speed controller output torque. |
| **28.11** | MAX TORQ SP CTRL | FW block: SPEED CONTROL (see above) |
| | Defines the maximum speed controller output torque. | |
| | -1600…1600% | Maximum speed controller output torque. |

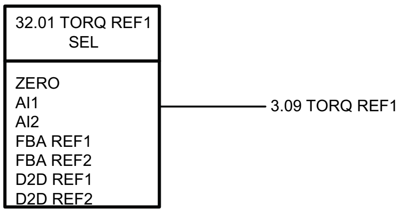
| | | |
|---|---|---|
| **28.12** | PI ADAPT MAX SPD | FW block: SPEED CONTROL (see above) |
| | Maximum actual speed for speed controller adaptation.<br>Speed controller gain and integration time can be adapted according to actual speed. This is done by multiplying the gain (28.02 PROPORT GAIN) and integration time (28.03 INTEGRATION TIME) by coefficients at certain speeds. The coefficients are defined individually for both gain and integration time.<br>When the actual speed is below or equal to 28.13 PI ADAPT MIN SPD, 28.02 PROPORT GAIN and 28.03 INTEGRATION TIME are multiplied by 28.14 P GAIN ADPT COEF and 28.15 I TIME ADPT COEF respectively.<br>When the actual speed is equal to or exceeds 28.12 PI ADAPT MAX SPD, no adaptation takes place; in other words, 28.02 PROPORT GAIN and 28.03 INTEGRATION TIME are used as such.<br>Between 28.13 PI ADAPT MIN SPD and 28.12 PI ADAPT MAX SPD, the coefficients are calculated linearly on the basis of the breakpoints.<br><br> | |
| | 0…30000 rpm | Maximum actual speed for speed controller adaptation. |
| **28.13** | PI ADAPT MIN SPD | FW block: SPEED CONTROL (see above) |
| | Minimum actual speed for speed controller adaptation. See parameter 28.12 PI ADAPT MAX SPD. | |
| | 0…30000 rpm | Minimum actual speed for speed controller adaptation. |
| **28.14** | P GAIN ADPT COEF | FW block: SPEED CONTROL (see above) |
| | Proportional gain coefficient. See parameter 28.12 PI ADAPT MAX SPD. | |
| | 0.000 … 10.000 | Proportional gain coefficient. |
| **28.15** | I TIME ADPT COEF | FW block: SPEED CONTROL (see above) |
| | Integration time coefficient. See parameter 28.12 PI ADAPT MAX SPD. | |
| | 0.000 … 10.000 | Integration time coefficient. |

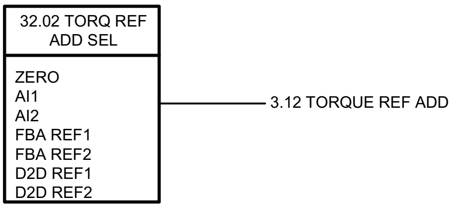
| | | |
|---|---|---|
| **28.16** | PI TUNE MODE | FW block: None |
| | Activates the speed controller autotune function.<br>The autotune will automatically set parameters 28.02 PROPORT GAIN and 28.03 INTEGRATION TIME, as well as 1.31 MECH TIME CONST. If the User autotune mode is chosen, also 26.06 SPD ERR FTIME is automatically set.<br>The status of the autotune routine is shown by parameter 6.03 SPEED CTRL STAT.<br>⚠ **WARNING!** The motor will reach the torque and current limits during the autotune routine. ENSURE THAT IT IS SAFE TO RUN THE MOTOR BEFORE PERFORMING THE AUTOTUNE ROUTINE!<br>**Notes:**<br>• Before using the autotune function, the following parameters should be set:<br>  • All parameters adjusted during the start-up as described in chapter *Start-up* (page 17)<br>  • 22.05 ZERO SPEED LIMIT<br>  • Speed scaling and reference ramp settings in parameter group 25<br>  • 26.06 SPD ERR FTIME<br>  • If the User autotune mode is desired: 28.17 TUNE BANDWIDTH and 28.18 TUNE DAMPING.<br>• The drive must be in local control mode and stopped before an autotune is requested.<br>• After requesting an autotune with this parameter, start the drive within 20 seconds.<br>• Wait until the autotune routine is completed (this parameter has reverted to the value (0) Done). The routine can be aborted by stopping the drive.<br>• Check the values of the parameters set by the autotune function.<br>See also section *Speed controller tuning* on page 50. | |
| | **(0)** Done | No tuning has been requested (normal operation). The parameter also reverts to this value after an autotune is completed. |
| | **(1)** Smooth | Request speed controller autotune with preset settings for smooth operation. |
| | **(2)** Middle | Request speed controller autotune with preset settings for medium-tight operation. |
| | **(3)** Tight | Request speed controller autotune with preset settings for tight operation. |
| | **(4)** User | Request speed controller autotune with the settings defined by parameters 28.17 TUNE BANDWIDTH and 28.18 TUNE DAMPING. |
| **28.17** | TUNE BANDWIDTH | FW block: None |
| | Speed controller bandwidth for autotune procedure, User mode (see parameter 28.16 PI TUNE MODE).<br>A larger bandwidth results in more restricted speed controller settings. | |
| | 0.00 … 2000.00 Hz | Tune bandwidth for User autotune mode. |
| **28.18** | TUNE DAMPING | FW block: None |
| | Speed controller damping for autotune procedure, User mode (see parameter 28.16 PI TUNE MODE).<br>Higher damping results in safer and smoother operation. | |
| | 0.0 … 200.0 | Speed controller damping for User autotune mode. |

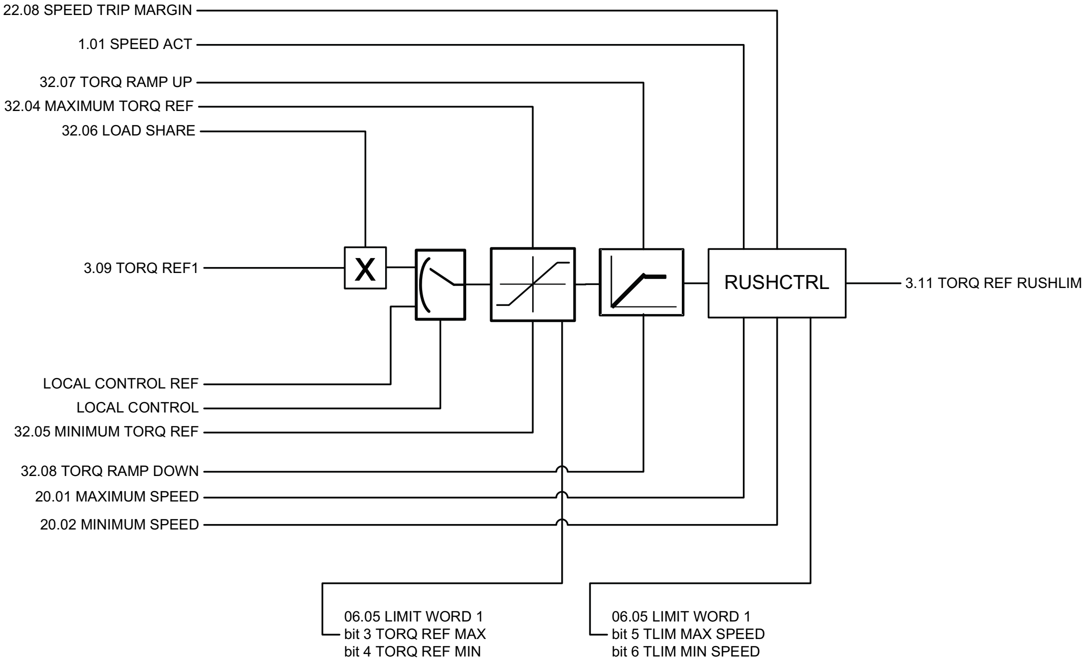
## Group 32 TORQUE REFERENCE

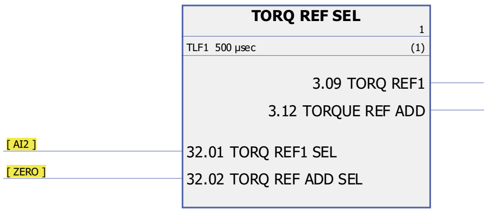
Reference settings for torque control.

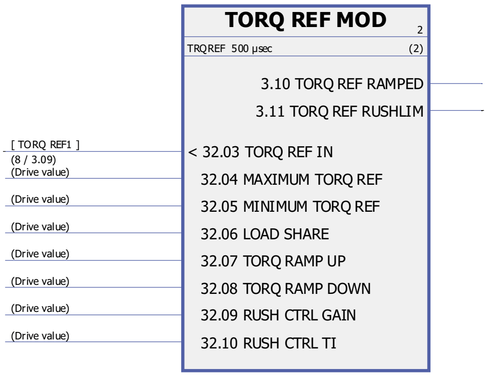
In torque control, the drive speed is limited between the defined minimum and maximum limits. Speed-related torque limits are calculated and the input torque reference is limited according to these limits. An OVERSPEED fault is generated if the maximum allowed speed is exceeded.







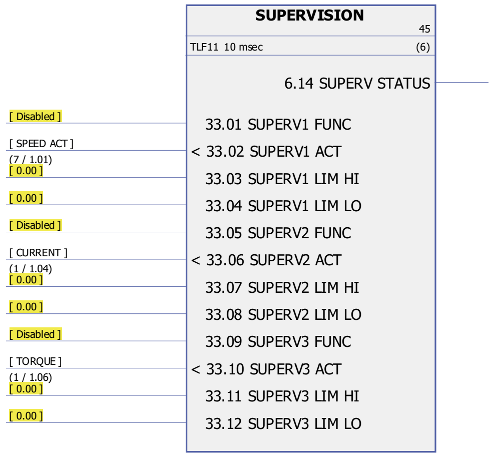
| | | |
|---|---|---|
| Firmware block:<br>**TORQ REF SEL**<br>(32)<br>Selects the source for torque reference 1 (from a parameter selection list) and the source for torque reference addition (used, eg, for compensating mechanical interferences). Also shows the torque reference and reference addition values. | |  TORQ REF SEL<br>1<br>TLF1 500 μsec<br>(1)<br>3.09 TORQ REF1<br>3.12 TORQUE REF ADD<br>[ AI2 ]<br>[ ZERO ]<br>32.01 TORQ REF1 SEL<br>32.02 TORQ REF ADD SEL |
| Block outputs located in other parameter groups | | 3.09 TORQ REF1 (page 102)<br>3.12 TORQUE REF ADD (page 102) |
| **32.01** | TORQ REF1 SEL | FW block: TORQ REF SEL (see above) |
| | Selects the source for torque reference 1. See also parameter 32.03 TORQ REF IN. | |
| | **(0)** ZERO | Zero reference. |
| | **(1)** AI1 | Analogue input AI1. |
| | **(2)** AI2 | Analogue input AI2. |
| | **(3)** FBA REF1 | Fieldbus reference 1. |
| | **(4)** FBA REF2 | Fieldbus reference 2. |
| | **(5)** D2D REF1 | Drive to drive reference 1. |
| | **(6)** D2D REF2 | Drive to drive reference 2. |
| **32.02** | TORQ REF ADD SEL | FW block: TORQ REF SEL (see above) |
| | Selects the source for the torque reference addition, 3.12 TORQUE REF ADD. Parameter 34.10 TORQ REF ADD SRC is connected to signal 3.12 TORQUE REF ADD by default.<br>Because the reference is added after the torque reference selection, this parameter can be used in speed and torque control modes. See the block diagram in parameter group 34 (page 178). | |
| | **(0)** ZERO | Zero reference addition. |
| | **(1)** AI1 | Analogue input AI1. |
| | **(2)** AI2 | Analogue input AI2. |
| | **(3)** FBA REF1 | Fieldbus reference 1. |
| | **(4)** FBA REF2 | Fieldbus reference 2. |
| | **(5)** D2D REF1 | Drive to drive reference 1. |
| | **(6)** D2D REF2 | Drive to drive reference 2. |

| | | |
|---|---|---|
| Firmware block:<br>**TORQ REF MOD**<br>(33)<br>This block<br>• selects the source for the torque reference<br>• scales the input torque reference according to the defined load share factor<br>• defines limits for the torque reference<br>• defines ramp-up and ramp-down times for the torque reference<br>• shows the ramped torque reference value and the torque reference value limited by the rush control. | |  |
| Block outputs located in other parameter groups | | 3.10 TORQ REF RAMPED (page 102)<br>3.11 TORQ REF RUSHLIM (page 102) |
| **32.03** | TORQ REF IN | FW block: TORQ REF MOD (see above) |
| | Selects the source for the torque reference input for the torque ramp function. The default value is P.3.9, ie, signal 3.09 TORQ REF1, which is the output of the TORQ REF SEL firmware block. | |
| | Value pointer: Group and index | |
| **32.04** | MAXIMUM TORQ REF | FW block: TORQ REF MOD (see above) |
| | Defines the maximum torque reference. | |
| | 0…1000% | Maximum torque reference. |
| **32.05** | MINIMUM TORQ REF | FW block: TORQ REF MOD (see above) |
| | Defines the minimum torque reference. | |
| | -1000…0% | Minimum torque reference. |
| **32.06** | LOAD SHARE | FW block: TORQ REF MOD (see above) |
| | Scales the external torque reference to a required level (external torque reference is multiplied by the selected value).<br>**Note:** If local torque reference is used, no load share scaling is applied. | |
| | -8…8 | External torque reference multiplier. |
| **32.07** | TORQ RAMP UP | FW block: TORQ REF MOD (see above) |
| | Defines the torque reference ramp-up time, ie, the time for the reference to increase from zero to the nominal motor torque. | |
| | 0…60 s | Torque reference ramp-up time. |

| | | |
|---|---|---|
| **32.08** | TORQ RAMP DOWN | FW block: TORQ REF MOD (see above) |
| | Defines the torque reference ramp-down time, ie, the time for the reference to decrease from the nominal motor torque to zero. | |
| | 0…60 s | Torque reference ramp-down time. |
| **32.09** | RUSH CTRL GAIN | FW block: TORQ REF MOD (see above) |
| | Defines the proportional gain of the rush controller. | |
| | 1…10000 | Proportional gain of the rush controller. |
| **32.10** | RUSH CTRL TI | FW block: TORQ REF MOD (see above) |
| | Defines the integration time of the rush controller. | |
| | 0.1…10 s | Integration time of the rush controller. |
| **32.11** | TORQ START ABS | FW block: TORQ REF MOD (see above) |
| | Defines the absolute value of torque to use when the drive is started. If external or local torque reference is negative at start, then the used starting torque is also negative.<br>The controlled starting torque feature activates at start when 32.12 TORQ START TIME1 or 32.13 TORQ START TIME2 is set to a non-zero value, and the absolute value of the torque reference used is lower than defined in parameter 32.11 TORQ START ABS. It automatically deactivates if the sign of the torque reference used is changed.<br>**Note:** Rush control is active also with starting torque. Consequently, the actual torque used during start might be decreased to a very low value to prevent excessive motor speed, if the requested starting torque (32.11 TORQ START ABS) is too high compared to the actual load on the motor. | |
| | 15…300% | Absolute value of starting torque. |
| **32.12** | TORQ START TIME1 | FW block: TORQ REF MOD (see above) |
| | Defines the time that the starting torque specified in 32.11 TORQ START ABS is used after start. | |
| | 0…60 s | Duration of starting torque. |
| **32.13** | TORQ START TIME2 | FW block: TORQ REF MOD (see above) |
| | Defines the starting torque ramp time. The torque defined in 32.11 TORQ START ABS is ramped down (or up if negative) to zero within the time defined by this parameter. | |
| | 0…60 s | Starting torque ramp time. |

# Group 33 SUPERVISION

Configuration of signal supervision.

| | | |
|---|---|---|
| Firmware block:<br>**SUPERVISION**<br>(17) | |  SUPERVISION<br>45<br>TLF11 10 msec<br>(6)<br>6.14 SUPERV STATUS<br>[ Disabled ]<br>33.01 SUPERV1 FUNC<br>[ SPEED ACT ]<br>(7 / 1.01)<br>< 33.02 SUPERV1 ACT<br>[ 0.00 ]<br>33.03 SUPERV1 LIM HI<br>[ 0.00 ]<br>33.04 SUPERV1 LIM LO<br>[ Disabled ]<br>33.05 SUPERV2 FUNC<br>[ CURRENT ]<br>(1 / 1.04)<br>< 33.06 SUPERV2 ACT<br>[ 0.00 ]<br>33.07 SUPERV2 LIM HI<br>[ 0.00 ]<br>33.08 SUPERV2 LIM LO<br>[ Disabled ]<br>33.09 SUPERV3 FUNC<br>[ TORQUE ]<br>(1 / 1.06)<br>< 33.10 SUPERV3 ACT<br>[ 0.00 ]<br>33.11 SUPERV3 LIM HI<br>[ 0.00 ]<br>33.12 SUPERV3 LIM LO |
| Block outputs located in other parameter groups | | 6.14 SUPERV STATUS (page 107) |
| **33.01** | SUPERV1 FUNC | FW block: SUPERVISION (see above) |
| | Selects the mode of supervision 1. | |
| | **(0)** Disabled | Supervision 1 not in use. |
| | **(1)** Low | When the signal selected by parameter 33.02 SUPERV1 ACT falls below the value of parameter 33.04 SUPERV1 LIM LO, bit 0 of 6.14 SUPERV STATUS is activated. To clear the bit, the signal must exceed the value of parameter 33.03 SUPERV1 LIM HI. |
| | **(2)** High | When the signal selected by parameter 33.02 SUPERV1 ACT exceeds the value of parameter 33.03 SUPERV1 LIM HI, bit 0 of 6.14 SUPERV STATUS is activated. To clear the bit, the signal must fall below the value of parameter 33.04 SUPERV1 LIM LO. |
| | **(3)** Abs Low | When the absolute value of the signal selected by parameter 33.02 SUPERV1 ACT falls below the value of parameter 33.04 SUPERV1 LIM LO, bit 0 of 6.14 SUPERV STATUS is activated. To clear the bit, the absolute value of the signal must exceed the value of parameter 33.03 SUPERV1 LIM HI. |
| | **(4)** Abs High | When the absolute value of the signal selected by parameter 33.02 SUPERV1 ACT exceeds the value of parameter 33.03 SUPERV1 LIM HI, bit 0 of 6.14 SUPERV STATUS is activated. To clear the bit, the absolute value of the signal must fall below the value of parameter 33.04 SUPERV1 LIM LO. |
| **33.02** | SUPERV1 ACT | FW block: SUPERVISION (see above) |
| | Selects the signal to be monitored by supervision 1. See parameter 33.01 SUPERV1 FUNC. | |
| | Value pointer: Group and index | |

| | | |
|---|---|---|
| **33.03** | SUPERV1 LIM HI | FW block: SUPERVISION (see above) |
| | Sets the upper limit for supervision 1. See parameter 33.01 SUPERV1 FUNC. | |
| | -32768…32768 | Upper limit for supervision 1. |
| **33.04** | SUPERV1 LIM LO | FW block: SUPERVISION (see above) |
| | Sets the lower limit for supervision 1. See parameter 33.01 SUPERV1 FUNC. | |
| | -32768…32768 | Lower limit for supervision 1. |
| **33.05** | SUPERV2 FUNC | FW block: SUPERVISION (see above) |
| | Selects the mode of supervision 2. | |
| | **(0)** Disabled | Supervision 2 not in use. |
| | **(1)** Low | When the signal selected by parameter 33.06 SUPERV2 ACT falls below the value of parameter 33.08 SUPERV2 LIM LO, bit 1 of 6.14 SUPERV STATUS is activated. To clear the bit, the signal must exceed the value of parameter 33.07 SUPERV2 LIM HI. |
| | **(2)** High | When the signal selected by parameter 33.06 SUPERV2 ACT exceeds the value of parameter 33.07 SUPERV2 LIM HI, bit 1 of 6.14 SUPERV STATUS is activated. To clear the bit, the signal must fall below the value of parameter 33.08 SUPERV2 LIM LO. |
| | **(3)** Abs Low | When the absolute value of the signal selected by parameter 33.06 SUPERV2 ACT falls below the value of parameter 33.08 SUPERV2 LIM LO, bit 1 of 6.14 SUPERV STATUS is activated. To clear the bit, the absolute value of the signal must exceed the value of parameter 33.07 SUPERV2 LIM HI. |
| | **(4)** Abs High | When the absolute value of the signal selected by parameter 33.06 SUPERV2 ACT exceeds the value of parameter 33.07 SUPERV2 LIM HI, bit 1 of 6.14 SUPERV STATUS is activated. To clear the bit, the absolute value of the signal must fall below the value of parameter 33.08 SUPERV2 LIM LO. |
| **33.06** | SUPERV2 ACT | FW block: SUPERVISION (see above) |
| | Selects the signal to be monitored by supervision 2. See parameter 33.05 SUPERV2 FUNC. | |
| | Value pointer: Group and index | |
| **33.07** | SUPERV2 LIM HI | FW block: SUPERVISION (see above) |
| | Sets the upper limit for supervision 2. See parameter 33.05 SUPERV2 FUNC. | |
| | -32768…32768 | Upper limit for supervision 2. |
| **33.08** | SUPERV2 LIM LO | FW block: SUPERVISION (see above) |
| | Sets the lower limit for supervision 2. See parameter 33.05 SUPERV2 FUNC. | |
| | -32768…32768 | Lower limit for supervision 2. |

| **33.09** | SUPERV3 FUNC | FW block: SUPERVISION (see above) |
|---|---|---|
| | Selects the mode of supervision 3. | |
| | **(0)** Disabled | Supervision 3 not in use. |
| | **(1)** Low | When the signal selected by parameter 33.10 SUPERV3 ACT falls below the value of parameter 33.12 SUPERV3 LIM LO, bit 2 of 6.14 SUPERV STATUS is activated. To clear the bit, the signal must exceed the value of parameter 33.11 SUPERV3 LIM HI. |
| | **(2)** High | When the signal selected by parameter 33.10 SUPERV3 ACT exceeds the value of parameter 33.11 SUPERV3 LIM HI, bit 2 of 6.14 SUPERV STATUS is activated. To clear the bit, the signal must fall below the value of parameter 33.12 SUPERV3 LIM LO. |
| | **(3)** Abs Low | When the absolute value of the signal selected by parameter 33.10 SUPERV3 ACT falls below the value of parameter 33.12 SUPERV3 LIM LO, bit 2 of 6.14 SUPERV STATUS is activated. To clear the bit, the absolute value of the signal must exceed the value of parameter 33.11 SUPERV3 LIM HI. |
| | **(4)** Abs High | When the absolute value of the signal selected by parameter 33.10 SUPERV3 ACT exceeds the value of parameter 33.11 SUPERV3 LIM HI, bit 2 of 6.14 SUPERV STATUS is activated. To clear the bit, the absolute value of the signal must fall below the value of parameter 33.12 SUPERV3 LIM LO. |
| **33.10** | SUPERV3 ACT | FW block: SUPERVISION (see above) |
| | Selects the signal to be monitored by supervision 3. See parameter 33.09 SUPERV3 FUNC. | |
| | Value pointer: Group and index | |
| **33.11** | SUPERV3 LIM HI | FW block: SUPERVISION (see above) |
| | Sets the upper limit for supervision 3. See parameter 33.09 SUPERV3 FUNC. | |
| | -32768…32768 | Upper limit for supervision 3. |
| **33.12** | SUPERV3 LIM LO | FW block: SUPERVISION (see above) |
| | Sets the lower limit for supervision 3. See parameter 33.09 SUPERV3 FUNC. | |
| | -32768…32768 | Lower limit for supervision 3. |
| **33.17** | BIT0 INVERT SRC | FW block: None |
| | Parameters 33.17...33.22 enable the inversion of freely selectable source bits. The inverted bits are shown by parameter 6.17 BIT INVERTED SW.<br>This parameter selects the source bit whose inverted value is shown by parameter 6.17 BIT INVERTED SW, bit 0. | |
| | DI1 | Digital input DI1 (as indicated by 2.01 DI STATUS, bit 0). |
| | DI2 | Digital input DI2 (as indicated by 2.01 DI STATUS, bit 1). |
| | DI3 | Digital input DI3 (as indicated by 2.01 DI STATUS, bit 2). |

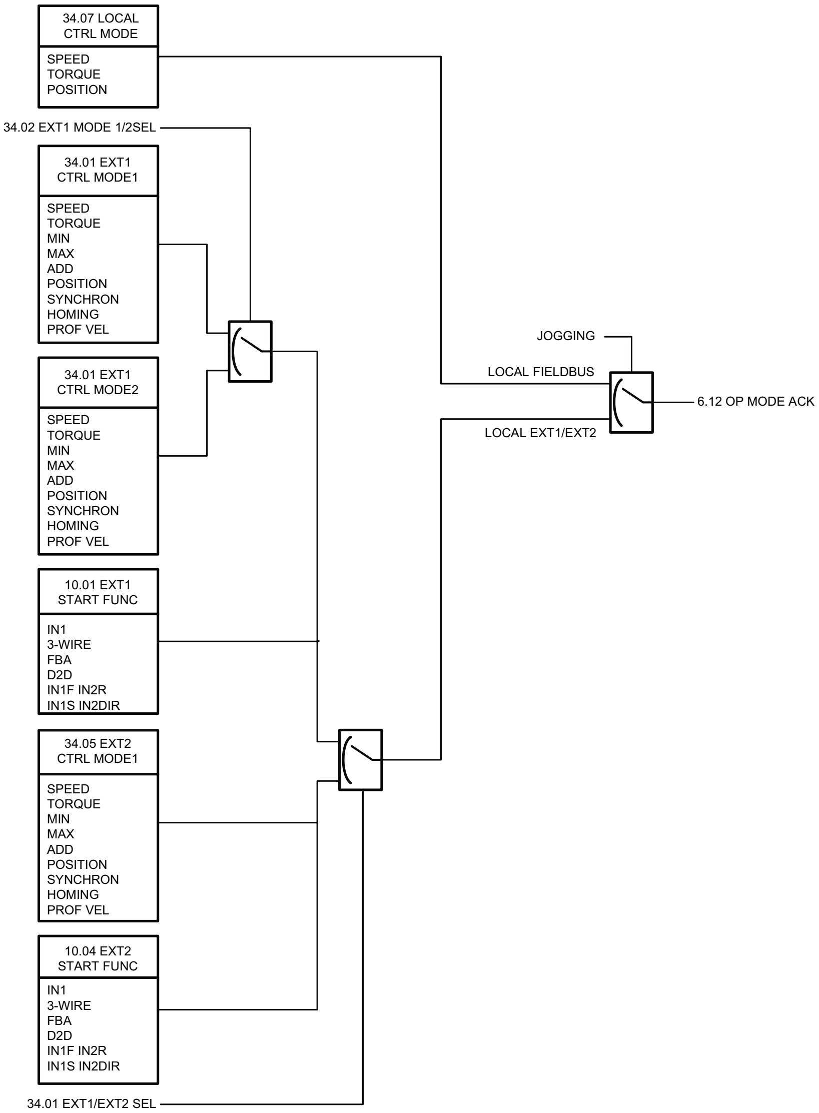
| | | |
|---|---|---|
| | DI4 | Digital input DI4 (as indicated by 2.01 DI STATUS, bit 3). |
| | DI5 | Digital input DI5 (as indicated by 2.01 DI STATUS, bit 4). |
| | DI6 | Digital input DI6 (as indicated by 2.01 DI STATUS, bit 5). |
| | RO1 | Relay output RO1 (as indicated by 2.02 RO STATUS, bit 0). |
| | RO2 | Relay output RO2 (as indicated by 2.02 RO STATUS, bit 1). |
| | RO3 | Relay output RO3 (as indicated by 2.02 RO STATUS, bit 2). |
| | RO4 | Relay output RO4 (as indicated by 2.02 RO STATUS, bit 3). |
| | RO5 | Relay output RO5 (as indicated by 2.02 RO STATUS, bit 4). |
| | Running | Bit 3 of 6.01 STATUS WORD 1 (see page 120). |
| | Const | Constant and bit pointer settings (see Bit pointer parameter on page 91). |
| | Pointer | |
| **33.18** | BIT1 INVERT SRC | FW block: None |
| | Selects the source bit whose inverted value is shown by 6.17 BIT INVERTED SW, bit 1. For the selections, see parameter 33.17 BIT0 INVERT SRC. | |
| **33.19** | BIT2 INVERT SRC | FW block: None |
| | Selects the source bit whose inverted value is shown by 6.17 BIT INVERTED SW, bit 2. For the selections, see parameter 33.17 BIT0 INVERT SRC. | |
| **33.20** | BIT3 INVERT SRC | FW block: None |
| | Selects the source bit whose inverted value is shown by 6.17 BIT INVERTED SW, bit 3. For the selections, see parameter 33.17 BIT0 INVERT SRC. | |
| **33.21** | BIT4 INVERT SRC | FW block: None |
| | Selects the source bit whose inverted value is shown by 6.17 BIT INVERTED SW, bit 4. For the selections, see parameter 33.17 BIT0 INVERT SRC. | |
| **33.22** | BIT5 INVERT SRC | FW block: None |
| | Selects the source bit whose inverted value is shown by 6.17 BIT INVERTED SW, bit 5. For the selections, see parameter 33.17 BIT0 INVERT SRC. | |

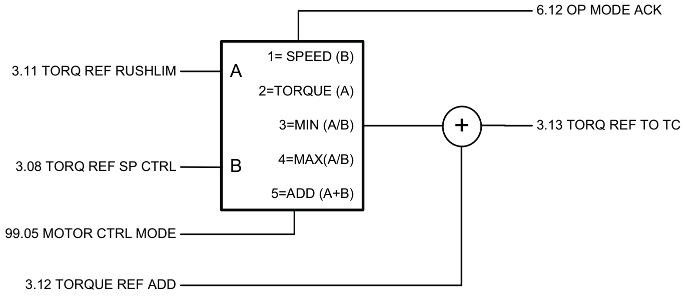
## Group 34 REFERENCE CTRL

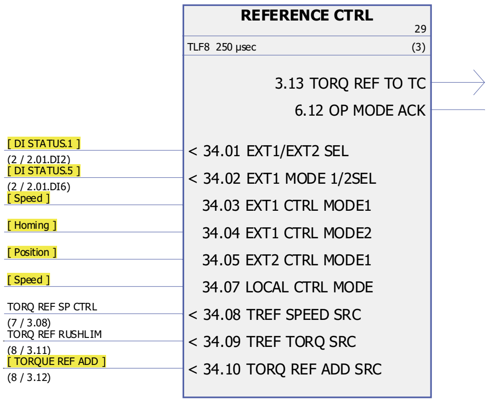
Reference source and type selection.

Using the parameters in this group, it is possible to select whether external control location EXT1 or EXT2 is used (either one is active at a time). These parameters also select the control mode (SPEED/TORQUE/MIN/MAX/ADD) and the used torque reference in local and external control. It is possible to select two different control modes for the EXT1 location by using parameters 34.03 EXT1 CTRL MODE1 and 34.04 EXT1 CTRL MODE2; the same start/stop commands are used in both modes.

For more information on control locations and control modes, see chapter *Drive control and features*. For start/stop control in different control locations, see parameter group 10 (page 116).





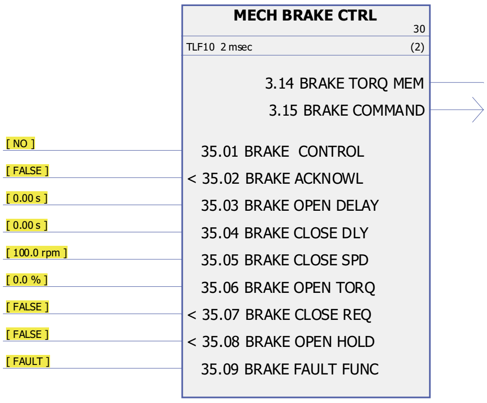
| | | |
|---|---|---|
| Firmware block:<br>**REFERENCE CTRL**<br>(34)<br>This block<br>• defines the selection method between external control locations EXT1 and EXT2<br>• configures control mode (SPEED/ TORQUE/MIN/MAX/ADD) selection<br>• selects the torque reference used in local and external control<br>• shows the torque reference (for torque control) and operating mode. | |  REFERENCE CTRL<br>29<br>TLF8 250 µsec<br>(3)<br>3.13 TORQ REF TO TC<br>6.12 OP MODE ACK<br>[ DI STATUS.1 ]<br>(2 / 2.01.DI2)<br>< 34.01 EXT1/EXT2 SEL<br>[ DI STATUS.5 ]<br>(2 / 2.01.DI6)<br>< 34.02 EXT1 MODE 1/2SEL<br>[ Speed ]<br>34.03 EXT1 CTRL MODE1<br>[ Homing ]<br>34.04 EXT1 CTRL MODE2<br>[ Position ]<br>34.05 EXT2 CTRL MODE1<br>[ Speed ]<br>34.07 LOCAL CTRL MODE<br>TORQ REF SP CTRL<br>(7 / 3.08)<br>< 34.08 TREF SPEED SRC<br>TORQ REF RUSHLIM<br>(8 / 3.11)<br>< 34.09 TREF TORQ SRC<br>[ TORQUE REF ADD ]<br>(8 / 3.12)<br>< 34.10 TORQ REF ADD SRC |
| Block outputs located in other parameter groups | | 3.13 TORQ REF TO TC (page 102)<br>6.12 OP MODE ACK (page 107) |
| **34.01** | EXT1/EXT2 SEL | FW block: REFERENCE CTRL (see above) |
| | Selects the source for external control location EXT1/EXT2 selection. 0 = EXT1. 1 = EXT2. | |
| | Bit pointer: Group, index and bit | |
| **34.02** | EXT1 MODE 1/2SEL | FW block: REFERENCE CTRL (see above) |
| | Selects the source for EXT1 control mode 1/2 selection. 1 = mode 2. 0 = mode 1.<br>Control mode 1/2 is selected by parameter 34.03 EXT1 CTRL MODE1 / 34.04 EXT1 CTRL MODE2. | |
| | Bit pointer: Group, index and bit | |
| **34.03** | EXT1 CTRL MODE1 | FW block: REFERENCE CTRL (see above) |
| | Selects control mode 1 for external control location EXT1. | |
| | **(1)** Speed | Speed control. Torque reference is 3.08 TORQ REF SP CTRL, which is the output of the SPEED CONTROL firmware block. Torque reference source can be changed by parameter 34.08 TREF SPEED SRC. |

| | | |
|---|---|---|
| | **(2)** Torque | Torque control. Torque reference is 3.11 TORQ REF RUSHLIM, which is the output of the TORQ REF MOD firmware block. Torque reference source can be changed by parameter 34.09 TREF TORQ SRC. |
| | **(3)** Min | Combination of selections (1) Speed and (2) Torque: Torque selector compares the torque reference and the speed controller output and the smaller of them is used. |
| | **(4)** Max | Combination of selections (1) Speed and (2) Torque: Torque selector compares the torque reference and the speed controller output and the greater of them is used. |
| | **(5)** Add | Combination of selections (1) Speed and (2) Torque: Torque selector adds the speed controller output to the torque reference. |
| **34.04** | EXT1 CTRL MODE2 | FW block: REFERENCE CTRL (see above) |
| | Selects control mode 2 for external control location EXT1.<br>For selections, see parameter 34.03 EXT1 CTRL MODE1. | |
| **34.05** | EXT2 CTRL MODE1 | FW block: REFERENCE CTRL (see above) |
| | Selects control mode for external control location EXT2.<br>For selections, see parameter 34.03 EXT1 CTRL MODE1. | |

| | | |
|---|---|---|
| **34.07** | LOCAL CTRL MODE | FW block: REFERENCE CTRL (see above) |
| | Selects the control mode for local control.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | **(1)** Speed | Speed control. Torque reference is 3.08 TORQ REF SP CTRL, which is the output of the SPEED CONTROL firmware block. Torque reference source can be changed by parameter 34.08 TREF SPEED SRC. |
| | **(2)** Torque | Torque control. Torque reference is 3.11 TORQ REF RUSHLIM, which is an output of the TORQ REF MOD firmware block. Torque reference source can be changed by parameter 34.09 TREF TORQ SRC. |
| **34.08** | TREF SPEED SRC | FW block: REFERENCE CTRL (see above) |
| | Selects the source for the torque reference (from the speed controller). Default value is P.3.8, ie, 3.08 TORQ REF SP CTRL, which is the output of the SPEED CONTROL firmware block.<br>**Note:** This parameter has been locked, ie, no user setting is possible. | |
| | Value pointer: Group and index | |
| **34.09** | TREF TORQ SRC | FW block: REFERENCE CTRL (see above) |
| | Selects the source for the torque reference (from the torque reference chain). Default value is P.3.11, ie, 3.11 TORQ REF RUSHLIM, which is an output of the TORQ REF MOD firmware block.<br>**Note:** This parameter has been locked, ie, no user setting is possible. | |
| | Value pointer: Group and index | |
| **34.10** | TORQ REF ADD SRC | FW block: REFERENCE CTRL (see above) |
| | Selects the source for the torque reference added to the torque value after the torque selection. Default value is P.3.12, ie, 3.12 TORQUE REF ADD, which is an output of the TORQ REF SEL firmware block.<br>**Note:** This parameter has been locked, ie, no user setting is possible. | |
| | Value pointer: Group and index | |

## Group 35 MECH BRAKE CTRL

Settings for the control of a mechanical brake. See also section *Mechanical brake control* on page 54.

| | | |
|---|---|---|
| Firmware block:<br>**MECH BRAKE CTRL**<br>(35) | |   MECH BRAKE CTRL<br>30<br>TLF10 2 msec<br>(2)<br>3.14 BRAKE TORQ MEM<br>3.15 BRAKE COMMAND<br>[ NO ]<br>[ FALSE ]<br>[ 0.00 s ]<br>[ 0.00 s ]<br>[ 100.0 rpm ]<br>[ 0.0 % ]<br>[ FALSE ]<br>[ FALSE ]<br>[ FAULT ]<br>35.01 BRAKE CONTROL<br>< 35.02 BRAKE ACKNOWL<br>35.03 BRAKE OPEN DELAY<br>35.04 BRAKE CLOSE DLY<br>35.05 BRAKE CLOSE SPD<br>35.06 BRAKE OPEN TORQ<br>< 35.07 BRAKE CLOSE REQ<br>< 35.08 BRAKE OPEN HOLD<br>35.09 BRAKE FAULT FUNC |
| Block outputs located in other parameter groups | | 3.14 BRAKE TORQ MEM (page 102)<br>3.15 BRAKE COMMAND (page 103) |
| **35.01** | BRAKE CONTROL | FW block: MECH BRAKE CTRL (see above) |
| | Activates the brake control function with or without supervision.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | **(0)** NO | Inactive. |
| | **(1)** WITH ACK | Brake control with supervision (supervision is activated by parameter 35.02 BRAKE ACKNOWL). |
| | **(2)** NO ACK | Brake control without supervision. |
| **35.02** | BRAKE ACKNOWL | FW block: MECH BRAKE CTRL (see above) |
| | Selects the source for the external brake on/off supervision activation (when par. 35.01 BRAKE CONTROL = (1) WITH ACK). The use of the external on/off supervision signal is optional. 1 = The brake is open. 0 = The brake is closed.<br>Brake supervision is usually controlled with a digital input. It can also be controlled with an external control system, eg, fieldbus.<br>When brake control error is detected the drive reacts as defined by parameter 35.09 BRAKE FAULT FUNC.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |

| | | |
|---|---|---|
| **35.03** | BRAKE OPEN DELAY | FW block: MECH BRAKE CTRL (see above) |
| | Defines the brake open delay (= the delay between the internal open brake command and the release of the motor speed control). The delay counter starts when the drive has magnetised the motor and risen the motor torque to the level required at the brake release (parameter 35.06 BRAKE OPEN TORQ). Simultaneously with the counter start, the brake function energises the relay output controlling the brake and the brake starts opening.<br>Set the delay the same as the mechanical opening delay of the brake specified by the brake manufacturer. | |
| | 0…5 s | Brake open delay. |
| **35.04** | BRAKE CLOSE DLY | FW block: MECH BRAKE CTRL (see above) |
| | Defines the brake close delay. The delay counter starts when the motor actual speed has fallen below the set level (parameter 35.05 BRAKE CLOSE SPD) after the drive has received the stop command. Simultaneously with the counter start, the brake control function de-energises the relay output controlling the brake and the brake starts closing. During the delay, the brake function keeps the motor live preventing the motor speed from falling below zero.<br>Set the delay time to the same value as the mechanical make-up time of the brake (= operating delay when closing) specified by the brake manufacturer. | |
| | 0…60 s | Brake close delay. |
| **35.05** | BRAKE CLOSE SPD | FW block: MECH BRAKE CTRL (see above) |
| | Defines the brake close speed (an absolute value). See parameter 35.04 BRAKE CLOSE DLY. | |
| | 0…1000 rpm | Brake close speed. |
| **35.06** | BRAKE OPEN TORQ | FW block: MECH BRAKE CTRL (see above) |
| | Defines the motor starting torque at brake release (in percent of the motor nominal torque). | |
| | 0…1000% | Motor starting torque at brake release. |
| **35.07** | BRAKE CLOSE REQ | FW block: MECH BRAKE CTRL (see above) |
| | Selects the source for the brake close (open) request. 1 = Brake close request. 0 = Brake open request.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |
| **35.08** | BRAKE OPEN HOLD | FW block: MECH BRAKE CTRL (see above) |
| | Selects the source for the activation of the brake open command hold. 1 = Hold active. 0 = Normal operation.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | Bit pointer: Group, index and bit | |

| **35.09** | BRAKE FAULT FUNC | FW block: MECH BRAKE CTRL (see above) |
|---|---|---|
| | Defines how the drive reacts in case of mechanical brake control error. If brake control supervision has not been activated by parameter 35.01 BRAKE CONTROL, this parameter is disabled. | |
| | **(0)** FAULT | The drive trips on fault BRAKE NOT CLOSED / BRAKE NOT OPEN if the status of the optional external brake acknowledgement signal does not meet the status presumed by the brake control function. The drive trips on fault BRAKE START TORQUE if the required motor starting torque at brake release is not achieved. |
| | **(1)** ALARM | The drive generates alarm BRAKE NOT CLOSED / BRAKE NOT OPEN if the status of the optional external brake acknowledgement signal does not meet the status presumed by the brake control function. The drive generates alarm BRAKE START TORQUE if the required motor starting torque at brake release is not achieved. |
| | **(2)** OPEN FLT | The drive generates alarm BRAKE NOT CLOSED (when closing the brake) and trips on fault BRAKE NOT OPEN (when opening the brake) if the status of the optional external brake acknowledgement signal does not match the status presumed by the brake control function. The drive trips on BRAKE START TORQUE if the required motor start torque at brake release is not achieved. |

## Group 40 MOTOR CONTROL

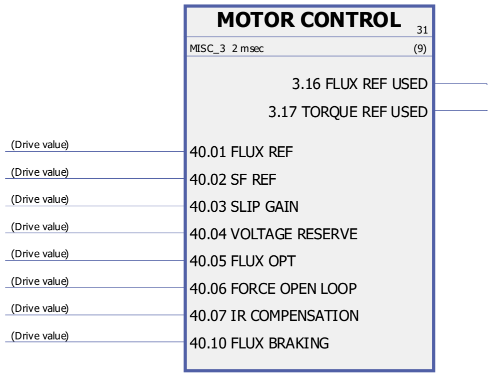
Motor control settings, such as

- flux reference
- drive switching frequency
- motor slip compensation
- voltage reserve
- flux optimisation
- IR compensation for scalar control mode.

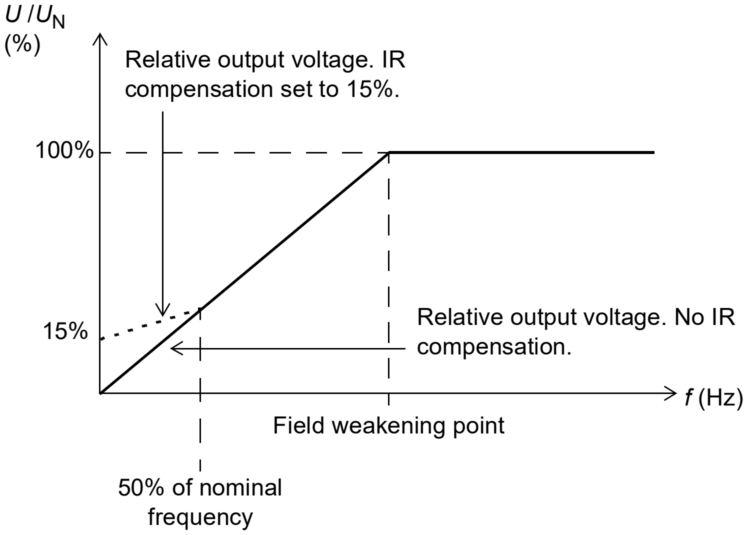
*Flux optimisation*

Flux optimisation reduces the total energy consumption and motor noise level when the drive operates below the nominal load. The total efficiency (motor and drive) can be improved by 1% to 10%, depending on the load torque and speed.

**Note:** Flux optimisation limits the dynamic control performance of the drive because with a small flux reference the drive torque cannot be increased fast.

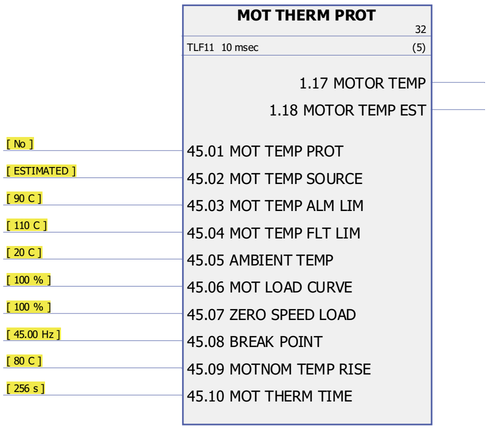
| | | |
|---|---|---|
| Firmware block:<br>**MOTOR CONTROL**<br>(40)<br>This block defines motor control settings such as<br>• flux reference<br>• drive switching frequency<br>• motor slip compensation<br>• voltage reserve<br>• flux optimisation<br>• IR compensation for scalar control mode<br>• flux braking.<br>The block also shows the flux and torque reference used. | |  MOTOR CONTROL<br>31<br>MISC_3 2 msec<br>(9)<br>3.16 FLUX REF USED<br>3.17 TORQUE REF USED<br>(Drive value)<br>40.01 FLUX REF<br>(Drive value)<br>40.02 SF REF<br>(Drive value)<br>40.03 SLIP GAIN<br>(Drive value)<br>40.04 VOLTAGE RESERVE<br>(Drive value)<br>40.05 FLUX OPT<br>(Drive value)<br>40.06 FORCE OPEN LOOP<br>(Drive value)<br>40.07 IR COMPENSATION<br>(Drive value)<br>40.10 FLUX BRAKING |
| Block outputs located in other parameter groups | | 3.16 FLUX REF USED (page 103)<br>3.17 TORQUE REF USED (page 103) |
| **40.01** | FLUX REF | FW block: MOTOR CONTROL (see above) |
| | Defines the flux reference. | |
| | 0…200% | Flux reference. |
| **40.02** | SF REF | FW block: MOTOR CONTROL (see above) |
| | Defines the switching frequency of the drive.<br>When switching frequency exceeds 4 kHz, the allowed drive output current is limited. See switching frequency derating in the appropriate *Hardware Manual*. | |
| | 1/2/3/4/5/8/16 kHz | Switching frequency. |

| | | |
|---|---|---|
| **40.03** | SLIP GAIN | FW block: MOTOR CONTROL (see above) |
| | Defines the slip gain which is used to improve the estimated motor slip. 100% means full slip gain; 0% means no slip gain. The default value is 100%. Other values can be used if a static speed error is detected despite of the full slip gain.<br>Example (with nominal load and nominal slip of 40 rpm): A 1000 rpm constant speed reference is given to the drive. Despite of the full slip gain (= 100%), a manual tachometer measurement from the motor axis gives a speed value of 998 rpm. The static speed error is 1000 rpm - 998 rpm = 2 rpm. To compensate the error, the slip gain should be increased. At the 105% gain value, no static speed error exists (2 rpm / 40 rpm = 5%). | |
| | 0…200% | Slip gain. |
| **40.04** | VOLTAGE RESERVE | FW block: MOTOR CONTROL (see above) |
| | Defines the minimum allowed voltage reserve. When the voltage reserve has decreased to the set value, the drive enters the field weakening area.<br>If the intermediate circuit DC voltage $U_{dc}$ = 550 V and the voltage reserve is 5%, the RMS value of the maximum output voltage in steady-state operation is<br>0.95 × 550 V / sqrt(2) = 369 V<br>The dynamic performance of the motor control in the field weakening area can be improved by increasing the voltage reserve value, but the drive enters the field weakening area earlier. | |
| | -4…50% | Minimum allowed voltage reserve. |
| **40.05** | FLUX OPT | FW block: MOTOR CONTROL (see above) |
| | Enables the flux optimisation function. Flux optimisation improves motor efficiency and reduces noise. Flux optimisation is used in drives that usually operate below nominal load.<br>**Note:** With a permanent magnet motor, flux optimisation is always enabled regardless of this parameter. | |
| | **(0)** Disable | Flux optimisation disabled. |
| | **(1)** Enable | Flux optimisation enabled. |
| **40.06** | FORCE OPEN LOOP | FW block: MOTOR CONTROL (see above) |
| | Defines the speed/position information used by the motor model. | |
| | **(0)** FALSE | Motor model uses the speed feedback selected by parameter 22.01 SPEED FB SEL. |
| | **(1)** TRUE | Motor model uses the internal speed estimate (even when parameter 22.01 SPEED FB SEL setting is (1) Enc1 speed / (2) Enc2 speed). |

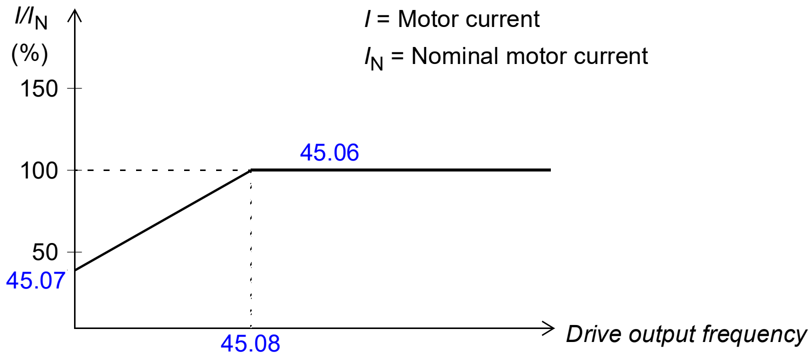
| | | |
|---|---|---|
| **40.07** | IR COMPENSATION | FW block: MOTOR CONTROL (see above) |
| | Defines the relative output voltage boost at zero speed (IR compensation). The function is useful in applications with high break-away torque when no DTC motor can be applied.<br>This parameter is only effective when parameter 99.05 MOTOR CTRL MODE is set to (1) Scalar.<br><br> | |
| | 0…50% | IR compensation. |
| **40.10** | FLUX BRAKING | FW block: MOTOR CONTROL (see above) |
| | Defines the level of braking power. | |
| | **(0)** Disabled | Flux braking is disabled. |
| | **(1)** Moderate | Flux level is limited during the braking. Deceleration time is longer compared to full braking. |
| | **(2)** Full | Maximum braking power. Almost all available current is used to convert the mechanical braking energy to thermal energy in the motor. |

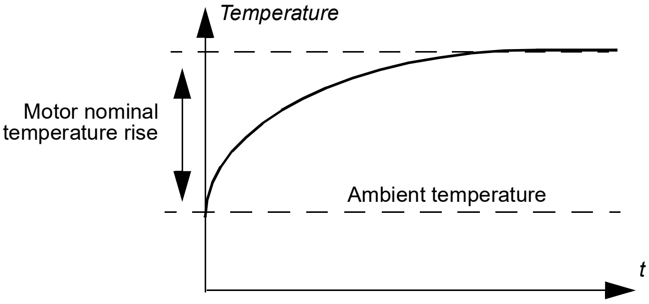
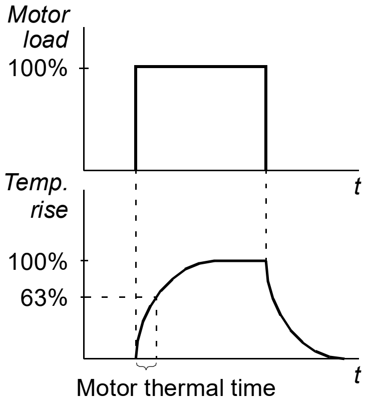
## Group 45 MOT THERM PROT

Settings for thermal protection of the motor. See also section *Thermal motor protection* on page 43.

| | | |
|---|---|---|
| Firmware block:<br>**MOT THERM PROT**<br>(45)<br>Configures motor overtemperature protection and temperature measurement. Also shows the estimated and measured motor temperatures. | |  MOT THERM PROT<br>32<br>TLF11 10 msec<br>(5)<br>1.17 MOTOR TEMP<br>1.18 MOTOR TEMP EST<br>[ No ]<br>45.01 MOT TEMP PROT<br>[ ESTIMATED ]<br>45.02 MOT TEMP SOURCE<br>[ 90 C ]<br>45.03 MOT TEMP ALM LIM<br>[ 110 C ]<br>45.04 MOT TEMP FLT LIM<br>[ 20 C ]<br>45.05 AMBIENT TEMP<br>[ 100 % ]<br>45.06 MOT LOAD CURVE<br>[ 100 % ]<br>45.07 ZERO SPEED LOAD<br>[ 45.00 Hz ]<br>45.08 BREAK POINT<br>[ 80 C ]<br>45.09 MOTNOM TEMP RISE<br>[ 256 s ]<br>45.10 MOT THERM TIME |
| Block outputs located in other parameter groups | | 1.17 MOTOR TEMP (page 94)<br>1.18 MOTOR TEMP EST (page 94) |
| **45.01** | MOT TEMP PROT | FW block: MOT THERM PROT (see above) |
| | Selects how the drive reacts when motor overtemperature is detected. | |
| | **(0)** No | Inactive. |
| | **(1)** Alarm | The drive generates alarm MOTOR TEMPERATURE when the temperature exceeds the alarm level defined by parameter 45.03 MOT TEMP ALM LIM. |
| | **(2)** Fault | The drive generates alarm MOTOR TEMPERATURE or trips on fault MOTOR OVERTEMP when the temperature exceeds the alarm/fault level defined by parameter 45.03 MOT TEMP ALM LIM / 45.04 MOT TEMP FLT LIM. |
| **45.02** | MOT TEMP SOURCE | FW block: MOT THERM PROT (see above) |
| | Selects the motor temperature protection. When overtemperature is detected the drive reacts as defined by parameter 45.01 MOT TEMP PROT. | |
| | **(0)** ESTIMATED | The temperature is supervised based on the motor thermal protection model, which uses the motor thermal time constant (parameter 45.10 MOT THERM TIME) and the motor load curve (parameters 45.06…45.08). User tuning is typically needed only if the ambient temperature differs from the normal operating temperature specified for the motor.<br>The motor temperature increases if it operates in the region above the motor load curve. The motor temperature decreases if it operates in the region below the motor load curve (if the motor is overheated).<br>⚠ **WARNING!** The model does not protect the motor if it does not cool properly due to dust and dirt. |

| | | |
|---|---|---|
| | **(1)** KTY JCU | The temperature is supervised using a KTY84 sensor connected to drive thermistor input TH. |
| | **(2)** KTY 1st FEN | The temperature is supervised using a KTY84 sensor connected to encoder interface module FEN-xx installed in drive Slot 1/2. If two encoder interface modules are used, encoder module connected to Slot 1 is used for the temperature supervision.<br>**Note:** This selection does not apply for FEN-01. * |
| | **(3)** KTY 2nd FEN | The temperature is supervised using a KTY84 sensor connected to encoder interface module FEN-xx installed in drive Slot 1/2. If two encoder interface modules are used, encoder module connected to Slot 2 is used for the temperature supervision.<br>**Note:** This selection does not apply for FEN-01. * |
| | **(4)** PTC JCU | The temperature is supervised using 1…3 PTC sensors connected to drive thermistor input TH. |
| | **(5)** PTC 1st FEN | The temperature is supervised using 1…3 PTC sensors connected to encoder interface module FEN-xx installed in drive Slot 1/2. If two encoder interface modules are used, encoder module connected to Slot 1 is used for the temperature supervision. * |
| | **(6)** PTC 2nd FEN | The temperature is supervised using 1…3 PTC sensors connected to encoder interface module FEN-xx installed in drive Slot 1/2. If two encoder interface modules are used, encoder module connected to Slot 2 is used for the temperature supervision. * |
| | **(13)** PT1000 FEN1 | The temperature is supervised using a PT1000 sensor connected to encoder interface module FEN-xx installed in drive Slot 1/2. If two encoder interface modules are used, encoder module connected to Slot 1 is used for the temperature supervision.<br>**Note:** This selection does not apply for FEN-01. |
| | **(14)** PT1000 FEN2 | The temperature is supervised using a PT1000 sensor connected to encoder interface module FEN-xx installed in drive Slot 1/2. If two encoder interface modules are used, encoder module connected to Slot 1 is used for the temperature supervision.<br>**Note:** This selection does not apply for FEN-01. |
| | *__Note:__ If one FEN-xx module is used, parameter setting must be either (2) KTY 1st FEN or (5) PTC 1st FEN. The FEN-xx module can be in either Slot 1 or Slot 2. | |
| **45.03** | MOT TEMP ALM LIM | FW block: MOT THERM PROT (see above) |
| | Defines the alarm limit for the motor overtemperature protection (when par. 45.01 MOT TEMP PROT = (1) Alarm or (2) Fault). | |
| | 0…200 °C | Motor overtemperature alarm limit. |
| **45.04** | MOT TEMP FLT LIM | FW block: MOT THERM PROT (see above) |
| | Defines the fault limit for the motor overtemperature protection (when par. 45.01 MOT TEMP PROT = (2) Fault). | |
| | 0…200 °C | Motor overtemperature fault limit. |

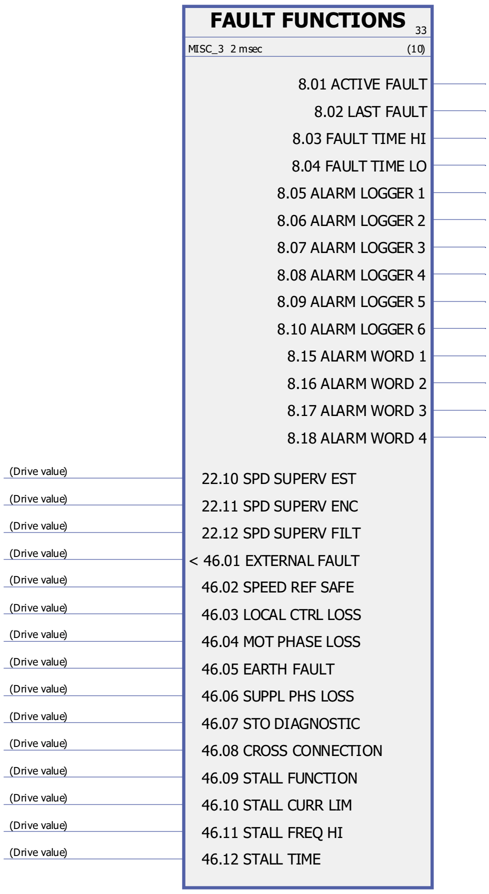
| | | |
|---|---|---|
| **45.05** | AMBIENT TEMP | FW block: MOT THERM PROT (see above) |
| | Defines the ambient temperature for the thermal protection mode. | |
| | -60…100 °C | Ambient temperature. |
| **45.06** | MOT LOAD CURVE | FW block: MOT THERM PROT (see above) |
| | Defines the load curve together with parameters 45.07 ZERO SPEED LOAD and 45.08 BREAK POINT.<br>The value is given in percent of nominal motor current. When the parameter is set to 100%, the maximum load is equal to the value of the parameter 99.06 MOT NOM CURRENT (higher loads heat up the motor). The load curve level should be adjusted if the ambient temperature differs from the nominal value.<br> <br>The load curve is used by the motor thermal protection model when parameter 45.02 MOT TEMP SOURCE is set to (0) ESTIMATED. | |
| | 50…150% | Motor current above breakpoint. |
| **45.07** | ZERO SPEED LOAD | FW block: MOT THERM PROT (see above) |
| | Defines the load curve together with parameters 45.06 MOT LOAD CURVE and 45.08 BREAK POINT. Defines the maximum motor load at zero speed of the load curve. A higher value can be used if the motor has an external motor fan to boost the cooling. See the motor manufacturer's recommendations.<br>The value is given in percent of nominal motor current.<br>The load curve is used by the motor thermal protection model when parameter 45.02 MOT TEMP SOURCE is set to (0) ESTIMATED. | |
| | 50…150% | Motor current at zero speed. |
| **45.08** | BREAK POINT | FW block: MOT THERM PROT (see above) |
| | Defines the load curve together with parameters 45.06 MOT LOAD CURVE and 45.07 ZERO SPEED LOAD. Defines the break point frequency of the load curve, ie, the point at which the motor load curve begins to decrease from the value of parameter 45.06 MOT LOAD CURVE to the value of parameter 45.07 ZERO SPEED LOAD.<br>The load curve is used by the motor thermal protection model when parameter 45.02 MOT TEMP SOURCE is set to (0) ESTIMATED. | |
| | 0.01…500 Hz | Load curve breakpoint. |

| | | |
|---|---|---|
| **45.09** | MOTNOM TEMP RISE | FW block: MOT THERM PROT (see above) |
| | Defines the temperature rise of the motor when the motor is loaded with nominal current. See the motor manufacturer's recommendations.<br>The temperature rise value is used by the motor thermal protection model when parameter 45.02 MOT TEMP SOURCE is set to (0) ESTIMATED.<br> *Temperature*<br>Motor nominal temperature rise<br>Ambient temperature<br>*t* | |
| | 0…300 °C | Motor temperature rise. |
| **45.10** | MOT THERM TIME | FW block: MOT THERM PROT (see above) |
| | Defines the thermal time constant for the motor thermal protection model (ie, time inside which the temperature has reached 63% of the nominal temperature). See the motor manufacturer's recommendations.<br>The motor thermal protection model is used when parameter 45.02 MOT TEMP SOURCE is set to (0) ESTIMATED.<br> *Motor load*<br>100%<br>*t*<br>*Temp. rise*<br>100%<br>63%<br>*t*<br>Motor thermal time | |
| | 100…10000 s | Motor thermal time. |

## Group 46 FAULT FUNCTIONS

Definition of drive behaviour upon a fault situation.

An alarm or a fault message indicates abnormal drive status. For the possible causes and remedies, see chapter *Fault tracing*.

| | |
|---|---|
| Firmware block:<br>**FAULT FUNCTIONS**<br>(46)<br>This block<br>• configures supervision of external faults by defining the source (for example, a digital input) for external fault indication signal<br>• selects the reaction of the drive (alarm; fault; continuation at safe speed in some cases) upon situations like local control communication break, motor/supply phase loss, earth fault, or Safe Torque Off function activation<br>• shows the codes of the latest faults, the time at which the active fault occurred, and the alarm words. |   FAULT FUNCTIONS<br>33<br>MISC_3 2 msec<br>(10)<br>8.01 ACTIVE FAULT<br>8.02 LAST FAULT<br>8.03 FAULT TIME HI<br>8.04 FAULT TIME LO<br>8.05 ALARM LOGGER 1<br>8.06 ALARM LOGGER 2<br>8.07 ALARM LOGGER 3<br>8.08 ALARM LOGGER 4<br>8.09 ALARM LOGGER 5<br>8.10 ALARM LOGGER 6<br>8.15 ALARM WORD 1<br>8.16 ALARM WORD 2<br>8.17 ALARM WORD 3<br>8.18 ALARM WORD 4<br>(Drive value)<br>22.10 SPD SUPERV EST<br>(Drive value)<br>22.11 SPD SUPERV ENC<br>(Drive value)<br>22.12 SPD SUPERV FILT<br>(Drive value)<br>< 46.01 EXTERNAL FAULT<br>(Drive value)<br>46.02 SPEED REF SAFE<br>(Drive value)<br>46.03 LOCAL CTRL LOSS<br>(Drive value)<br>46.04 MOT PHASE LOSS<br>(Drive value)<br>46.05 EARTH FAULT<br>(Drive value)<br>46.06 SUPPL PHS LOSS<br>(Drive value)<br>46.07 STO DIAGNOSTIC<br>(Drive value)<br>46.08 CROSS CONNECTION<br>(Drive value)<br>46.09 STALL FUNCTION<br>(Drive value)<br>46.10 STALL CURR LIM<br>(Drive value)<br>46.11 STALL FREQ HI<br>(Drive value)<br>46.12 STALL TIME |
| Block inputs located in other parameter groups | 22.10 SPD SUPERV EST (page 149)<br>22.11 SPD SUPERV ENC (page 149)<br>22.12 SPD SUPERV FILT (page 149) |
| Block outputs located in other parameter groups | 8.01 ACTIVE FAULT (page 109)<br>8.02 LAST FAULT (page 109)<br>8.03 FAULT TIME HI (page 109)<br>8.04 FAULT TIME LO (page 109)<br>8.05 ALARM LOGGER 1 (page 109)<br>8.06 ALARM LOGGER 2 (page 110)<br>8.07 ALARM LOGGER 3 (page 110)<br>8.08 ALARM LOGGER 4 (page 111)<br>8.09 ALARM LOGGER 5 (page 111)<br>8.10 ALARM LOGGER 6 (page 111)<br>8.15 ALARM WORD 1 (page 112)<br>8.16 ALARM WORD 2 (page 112)<br>8.17 ALARM WORD 3 (page 113)<br>8.18 ALARM WORD 4 (page 113) |

| | | |
|---|---|---|
| **46.01** | EXTERNAL FAULT | FW block: FAULT FUNCTIONS (see above) |
| | Selects an interface for an external fault signal. 0 = External fault trip. 1 = No external fault. | |
| | Bit pointer: Group, index and bit | |
| **46.02** | SPEED REF SAFE | FW block: FAULT FUNCTIONS (see above) |
| | Defines the fault speed. Used as a speed reference when an alarm occurs when parameter 13.12 AI SUPERVISION / 46.03 LOCAL CTRL LOSS / 50.02 COMM LOSS FUNC setting is (2) Spd ref Safe. | |
| | -30000…30000 rpm | Fault speed. |
| **46.03** | LOCAL CTRL LOSS | FW block: FAULT FUNCTIONS (see above) |
| | Selects how the drive reacts to a control panel or PC tool communication break. | |
| | **(0)** No | No action. |
| | **(1)** Fault | Drive trips on LOCAL CTRL LOSS fault. |
| | **(2)** Spd ref Safe | The drive generates alarm LOCAL CTRL LOSS and sets the speed to the speed defined by parameter 46.02 SPEED REF SAFE.<br>⚠ **WARNING!** Make sure that it is safe to continue operation in case of a communication break. |
| | **(3)** Last speed | The drive generates alarm LOCAL CTRL LOSS and freezes the speed to the level the drive was operating at. The speed is determined by the average speed over the previous 10 seconds.<br>⚠ **WARNING!** Make sure that it is safe to continue operation in case of a communication break. |
| **46.04** | MOT PHASE LOSS | FW block: FAULT FUNCTIONS (see above) |
| | Selects how the drive reacts when a motor phase loss is detected. | |
| | **(0)** No | No action. |
| | **(1)** Fault | Drive trips on MOTOR PHASE fault. |
| **46.05** | EARTH FAULT | FW block: FAULT FUNCTIONS (see above) |
| | Selects how the drive reacts when an earth fault or current unbalance is detected in the motor or the motor cable. | |
| | **(0)** No | No action. |
| | **(1)** Warning | Drive generates alarm EARTH FAULT. |
| | **(2)** Fault | Drive trips on EARTH FAULT. |

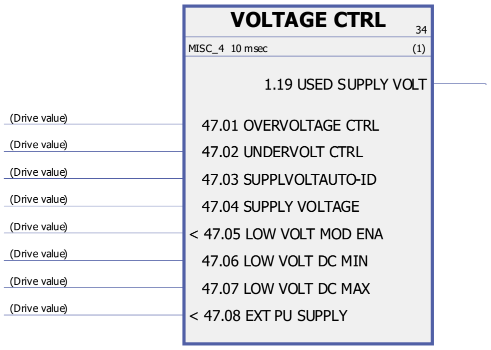
| | | |
|---|---|---|
| **46.06** | SUPPL PHS LOSS | FW block: FAULT FUNCTIONS (see above) |
| | Selects how the drive reacts when a supply phase loss is detected. This parameter is only used with an AC supply. | |
| | **(0)** No | No reaction. |
| | **(1)** Fault | Drive trips on SUPPLY PHASE fault. |
| **46.07** | STO DIAGNOSTIC | FW block: FAULT FUNCTIONS (see above) |
| | Selects how the drive reacts when it detects the absence of one or both Safe Torque Off (STO) signals.<br>**Note:** This parameter is for supervision only. The Safe Torque Off function can activate even when this parameter is set to (3) No.<br>For general information on the Safe Torque Off function, see the *Hardware Manual* of the drive and *Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives* (3AFE68929814 [English]). | |
| | **(1)** Fault | The drive trips on SAFE TORQUE OFF when one or both of the STO signals are lost. |
| | **(2)** Alarm | Drive running:<br>The drive trips on SAFE TORQUE OFF when one or both of the STO signals is lost.<br>Drive stopped:<br>The drive generates a SAFE TORQUE OFF alarm if both STO signals are absent. If only one of the signals is lost, the drive trips on STO1 LOST or STO2 LOST. |
| | **(3)** No | Drive running:<br>The drive trips on SAFE TORQUE OFF when one or both of the STO signals is lost.<br>Drive stopped:<br>No action if both STO signals are absent. If only one of the signals is lost, the drive trips on STO1 LOST or STO2 LOST. |
| | **(4)** Only Alarm | The drive generates a SAFE TORQUE OFF alarm if both STO signals are absent. If only one of the signals is lost, the drive trips on STO1 LOST or STO2 LOST. |
| **46.08** | CROSS CONNECTION | FW block: FAULT FUNCTIONS (see above) |
| | Selects how the drive reacts to incorrect input power and motor cable connection (ie, input power cable is connected to drive motor connection). This parameter is only used with an AC supply. | |
| | **(0)** No | No reaction. |
| | **(1)** Fault | Drive trips on CABLE CROSS CON fault. |

<table>
<tr><td><b>46.09</b></td><td>STALL FUNCTION</td><td>FW block: FAULT FUNCTIONS (see above)</td></tr>
<tr><td></td><td colspan="2">Selects how the drive reacts to a motor stall condition.<br>A stall condition is defined as follows:<br>• The drive is at stall current limit (46.10 STALL CURR LIM), and<br>• the output frequency is below the level set by parameter 46.11 STALL FREQ HI, and<br>• the conditions above have been valid longer than the time set by parameter 46.12 STALL TIME.<br>A fast stall condition is defined as follows:<br>• The drive is at stall current limit (46.10 STALL CURR LIM), and<br>• the output frequency is below the level set by parameter 46.11 STALL FREQ HI, and<br>• the conditions above have been valid longer than the time set by parameter 46.15 FAST STALL TIME
<table>
<tr><th>Bit</th><th>Function</th></tr>
<tr><td>0</td><td>Ena sup (Enable supervision)<br>0 = Disabled: Supervision disabled.<br>1 = Enabled: Supervision enabled.</td></tr>
<tr><td>1</td><td>Ena warn (Enable warning)<br>0 = Disabled<br>1 = Enabled: Drive generates an alarm upon a stall condition.</td></tr>
<tr><td>2</td><td>Ena fault (Enable fault)<br>0 = Disabled<br>1 = Enabled: Drive trips on a fault upon a stall condition.</td></tr>
</table>
</td></tr>
<tr><td><b>46.10</b></td><td>STALL CURR LIM</td><td>FW block: FAULT FUNCTIONS (see above)</td></tr>
<tr><td></td><td colspan="2">Stall current limit in percent of the nominal current of the motor. See parameter 46.09 STALL FUNCTION.</td></tr>
<tr><td></td><td>0 …1600%</td><td>Stall current limit.</td></tr>
<tr><td><b>46.11</b></td><td>STALL FREQ HI</td><td>FW block: FAULT FUNCTIONS (see above)</td></tr>
<tr><td></td><td colspan="2">Stall frequency limit. See parameter 46.09 STALL FUNCTION.<br><b>Note:</b> Setting the limit below 10 Hz is not recommended.</td></tr>
<tr><td></td><td>0.5…1000 Hz</td><td>Stall frequency limit.</td></tr>
<tr><td><b>46.12</b></td><td>STALL TIME</td><td>FW block: FAULT FUNCTIONS (see above)</td></tr>
<tr><td></td><td colspan="2">Stall time. See parameter 46.09 STALL FUNCTION.</td></tr>
<tr><td></td><td>0…3600 s</td><td>Stall time.</td></tr>
<tr><td><b>46.13</b></td><td>FAN CTRL MODE</td><td>FW block: None</td></tr>
<tr><td></td><td colspan="2">Selects the fan control mode. Available in frame sizes A to D. See section Fan control logic.</td></tr>
<tr><td></td><td><b>(0)</b> Normal</td><td>Control mode based on the modulator ON/OFF status.</td></tr>
<tr><td></td><td><b>(1)</b> Force OFF</td><td>Fan is always OFF.</td></tr>
<tr><td></td><td><b>(2)</b> Force ON</td><td>Fan is always ON.</td></tr>
<tr><td></td><td><b>(3)</b> Advanced</td><td>Control mode based on measured temperatures of the power stage, braking chopper and interface board.</td></tr>
</table>

| **46.14** | FAULT STOP MODE | FW block: None |
|---|---|---|
| | Fault class selection for non-critical HW faults.<br>Use this parameter for configuring the following faults to the stop mode:<br>0003, 0005, 0007, 0008, 0011, 0012, 0015, 0024, 0025, 0029, 0030, 0036, 0038…0045, 0047…0051, 0053, 0054, 0057, 0059…0062, 0073, 0074, 0317. | |
| | **(0)** Coast | Stop by cutting off the motor power supply. The motor coasts to stop. |
| | **(1)** Emergency ramp stop | The drive is stopped along the emergency stop ramp time, 25.11 EM STOP TIME. |
| **46.15** | FAST STALL TIME | FW block: None |
| | Defines the fast stall time. If a fast stall condition is detected, fast stall detection stops drive modulation and automatically forces a new start (up to a maximum of 5 times). See parameter 46.09 STALL FUNCTION. Fast stall detection is disabled when this parameter is set to 0 ms (default).<br>This function is active only for permanent magnet (PM) motors in open loop (estimated speed feedback) control. | |
| | 0…3600 ms | Fast stall time. |

## Group 47 VOLTAGE CTRL

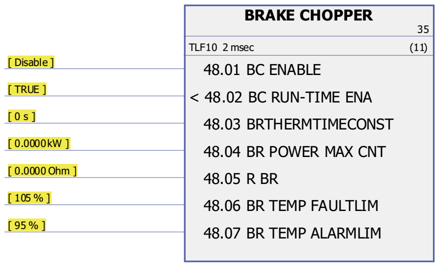
Settings for overvoltage and undervoltage control, and supply voltage.

| | | |
|---|---|---|
| Firmware block:<br>**VOLTAGE CTRL**<br>(47)<br>This block<br>• enables/disables overvoltage and undervoltage control<br>• enables/disables automatic identification of supply voltage<br>• provides a parameter for manual definition of supply voltage<br>• shows the supply voltage value used by the control program. | |  VOLTAGE CTRL<br>34<br>MISC_4 10 msec<br>(1)<br>1.19 USED SUPPLY VOLT<br>(Drive value)<br>(Drive value)<br>(Drive value)<br>(Drive value)<br>(Drive value)<br>(Drive value)<br>(Drive value)<br>(Drive value)<br>47.01 OVERVOLTAGE CTRL<br>47.02 UNDERVOLT CTRL<br>47.03 SUPPLVOLTAUTO-ID<br>47.04 SUPPLY VOLTAGE<br>< 47.05 LOW VOLT MOD ENA<br>47.06 LOW VOLT DC MIN<br>47.07 LOW VOLT DC MAX<br>< 47.08 EXT PU SUPPLY |
| Block outputs located in other parameter groups | | 1.19 USED SUPPLY VOLT (page 94) |
| **47.01** | OVERVOLTAGE CTRL | FW block: VOLTAGE CTRL (see above) |
| | Enables the overvoltage control of the intermediate DC link. Fast braking of a high inertia load causes the voltage to rise to the overvoltage control limit. To prevent the DC voltage from exceeding the limit, the overvoltage controller automatically decreases the braking torque.<br>It is possible to enable the braking chopper and overvoltage controller at the same time. If both are enabled, the overvoltage controller limits are increased above the braking chopper limits. In this configuration, the controller works as a backup for the braking chopper.<br>**Note:** If a regenerative supply section is included in the drive, the controller must be disabled. | |
| | **(0)** Disable | Overvoltage control disabled. |
| | **(1)** Enable | Overvoltage control enabled. |
| **47.02** | UNDERVOLT CTRL | FW block: VOLTAGE CTRL (see above) |
| | Enables the undervoltage control of the intermediate DC link. If the DC voltage drops due to input power cut off, the undervoltage controller will automatically decrease the motor torque in order to keep the voltage above the lower limit. By decreasing the motor torque, the inertia of the load will cause regeneration back to the drive, keeping the DC link charged and preventing an undervoltage trip until the motor coasts to stop. This will act as a power-loss ride-through functionality in systems with high inertia, such as a centrifuge or a fan. | |
| | **(0)** Disable | Undervoltage control disabled. |
| | **(1)** Enable | Undervoltage control enabled. |

| | | |
|---|---|---|
| **47.03** | SUPPLVOLTAUTO-ID | FW block: VOLTAGE CTRL (see above) |
| | Enables the auto-identification of the supply voltage. See also section *Voltage control and trip limits* on page 46. | |
| | **(0)** Disable | Auto-identification of supply voltage disabled. The drive sets the voltage control and trip limits using the value of parameter 47.04 SUPPLY VOLTAGE. |
| | **(1)** Enable | Auto-identification of supply voltage enabled. The drive detects the supply voltage level during intermediate circuit charging and sets the voltage control and trip limits accordingly. |
| **47.04** | SUPPLY VOLTAGE | FW block: VOLTAGE CTRL (see above) |
| | Defines the nominal supply voltage. Used if auto-identification of the supply voltage is not enabled by parameter 47.03 SUPPLVOLTAUTO-ID. | |
| | 0…1000 V | Nominal supply voltage. |
| **47.05** | LOW VOLT MOD ENA | FW block: None |
| | Enables/disables (or selects a signal source that enables/disables) Low voltage mode. 0 = Low voltage mode disabled, 1 = Low voltage mode enabled. See section *Low voltage mode* on page 47. | |
| | Bit pointer: Group, index and bit | |
| **47.06** | LOW VOLT DC MIN | FW block: None |
| | Minimum DC voltage for Low voltage mode. See section *Low voltage mode* on page 47. | |
| | 250…450 V | Minimum DC voltage for Low voltage mode. |
| **47.07** | LOW VOLT DC MAX | FW block: None |
| | Maximum DC voltage for Low voltage mode. See section *Low voltage mode* on page 47.<br>**Note:** The value of this parameter must be higher than (47.06 LOW VOLT DC MIN + 50 V). | |
| | 350…810 V | Maximum DC voltage for Low voltage mode. |
| **47.08** | EXT PU SUPPLY | FW block: None |
| | Enables/disables (or selects a signal source that enables/disables) external power unit supply, used with low DC supply voltages such as a battery. 0 = External power unit supply disabled, 1 = External power unit supply enabled. See section *Low voltage mode* on page 47. | |
| | Bit pointer: Group, index and bit | |

## Group 48 BRAKE CHOPPER

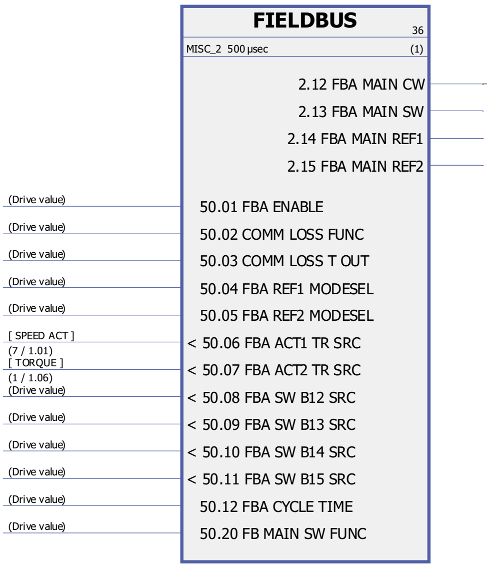
Configuration of an internal braking chopper.

| | | |
|---|---|---|
| Firmware block:<br>**BRAKE CHOPPER**<br>(48)<br>This block configures the braking chopper control and supervision. | |  BRAKE CHOPPER<br>35<br>TLF10 2 msec<br>(11)<br>[ Disable ]<br>[ TRUE ]<br>[ 0 s ]<br>[ 0.0000 kW ]<br>[ 0.0000 Ohm ]<br>[ 105 % ]<br>[ 95 % ]<br>48.01 BC ENABLE<br>< 48.02 BC RUN-TIME ENA<br>48.03 BRTHERMTIMECONST<br>48.04 BR POWER MAX CNT<br>48.05 R BR<br>48.06 BR TEMP FAULTLIM<br>48.07 BR TEMP ALARMLIM |
| **48.01** | BC ENABLE | FW block: BRAKE CHOPPER (see above) |
| | Enables the braking chopper control.<br>**Note:** Before enabling the braking chopper control, make sure that the braking resistor is installed. The drive has a built-in braking chopper. | |
| | **(0)** Disable | Braking chopper control disabled. |
| | **(1)** EnableTherm | Enable the braking chopper control with resistor overload protection. |
| | **(2)** Enable | Enable the braking chopper control without resistor overload protection. This setting can be used, for example, if the resistor is equipped with a thermal circuit breaker that is wired to stop the drive if the resistor overheats. |
| **48.02** | BC RUN-TIME ENA | FW block: BRAKE CHOPPER (see above) |
| | Selects the source for the quick run-time braking chopper control.<br>0 = Braking chopper operation is prevented. In other words, although the braking chopper has been enabled with parameter 48.01 and DC voltage rises over the activation level, the braking chopper remains inactive.<br>1 = Braking chopper is always active, ie, the braking chopper starts switching, if the DC voltage reaches the activation level (even if the drive is not running).<br>This parameter can be used for programming the chopper control to function only when the drive is operating in the generating mode. By default this parameter is connected to parameter 06.01 STATUS WORD 1 bit3 (RUNNING). | |
| | Bit pointer: Group, index and bit | |
| **48.03** | BRTHERMTIMECONST | FW block: BRAKE CHOPPER (see above) |
| | Defines the thermal time constant of the braking resistor for overload protection. | |
| | 0…10000 s | Braking resistor thermal time constant. |
| **48.04** | BR POWER MAX CNT | FW block: BRAKE CHOPPER (see above) |
| | Defines the maximum continuous braking power which will raise the resistor temperature to the maximum allowed value. The value is used in the overload protection. | |
| | 0…10000 kW | Maximum continuous braking power. |

| | | |
|---|---|---|
| **48.05** | R BR | FW block: BRAKE CHOPPER (see above) |
| | Defines the resistance value of the braking resistor. The value is used for braking chopper protection. | |
| | 0.1…1000 ohm | Resistance. |
| **48.06** | BR TEMP FAULTLIM | FW block: BRAKE CHOPPER (see above) |
| | Selects the fault limit for the braking resistor temperature supervision. The value is given in percent of the temperature the resistor reaches when loaded with the power defined by parameter 48.04 BR POWER MAX CNT.<br>When the limit is exceeded the drive trips on fault BR OVERHEAT. | |
| | 0…150% | Resistor temperature fault limit. |
| **48.07** | BR TEMP ALARMLIM | FW block: BRAKE CHOPPER (see above) |
| | Selects the alarm limit for the braking resistor temperature supervision. The value is given in percent of the temperature the resistor reaches when loaded with the power defined by parameter 48.04 BR POWER MAX CNT.<br>When limit is exceeded the drive generates alarm BR OVERHEAT. | |
| | 0…150% | Resistor temperature alarm limit. |

## Group 50 FIELDBUS

Basic settings for fieldbus communication. See also *Appendix A – Fieldbus control* on page 347.

| | | |
|---|---|---|
| Firmware block:<br>**FIELDBUS**<br>(50)<br>This block<br>• initialises the fieldbus communication<br>• selects communication supervision method<br>• defines scaling of the fieldbus references and actual values<br>• selects sources for programmable status word bits<br>• shows the fieldbus control and status words, and references. | |  FIELDBUS<br>36<br>MISC_2 500 μsec<br>(1)<br>2.12 FBA MAIN CW<br>2.13 FBA MAIN SW<br>2.14 FBA MAIN REF1<br>2.15 FBA MAIN REF2<br>(Drive value)<br>50.01 FBA ENABLE<br>(Drive value)<br>50.02 COMM LOSS FUNC<br>(Drive value)<br>50.03 COMM LOSS T OUT<br>(Drive value)<br>50.04 FBA REF1 MODESEL<br>(Drive value)<br>50.05 FBA REF2 MODESEL<br>[ SPEED ACT ]<br>(7 / 1.01)<br>< 50.06 FBA ACT1 TR SRC<br>[ TORQUE ]<br>(1 / 1.06)<br>< 50.07 FBA ACT2 TR SRC<br>(Drive value)<br>< 50.08 FBA SW B12 SRC<br>(Drive value)<br>< 50.09 FBA SW B13 SRC<br>(Drive value)<br>< 50.10 FBA SW B14 SRC<br>(Drive value)<br>< 50.11 FBA SW B15 SRC<br>(Drive value)<br>50.12 FBA CYCLE TIME<br>(Drive value)<br>50.20 FB MAIN SW FUNC |
| Block outputs located in other parameter groups | | 2.12 FBA MAIN CW (page 97)<br>2.13 FBA MAIN SW (page 99)<br>2.14 FBA MAIN REF1 (page 100)<br>2.15 FBA MAIN REF2 (page 100) |
| **50.01** | FBA ENABLE | FW block: FIELDBUS (see above) |
| | Enables communication between the drive and fieldbus adapter. | |
| | **(0)** Disable | No communication. |
| | **(1)** Enable | Communication between drive and fieldbus adapter enabled. |
| **50.02** | COMM LOSS FUNC | FW block: FIELDBUS (see above) |
| | Selects how the drive reacts upon a fieldbus communication break. The time delay is defined by parameter 50.03 COMM LOSS T OUT. | |
| | **(0)** No | Communication break detection disabled. |
| | **(1)** Fault | Communication break detection active. Upon a communication break, the drive trips on fault FIELDBUS COMM and coasts to stop. |
| | **(2)** Spd ref Safe | Communication break detection active. Upon a communication break, the drive generates alarm FIELDBUS COMM and sets the speed to the value defined by parameter 46.02 SPEED REF SAFE.<br>⚠ **WARNING**! Make sure that it is safe to continue operation in case of a communication break. |

| | | |
|---|---|---|
| | **(3)** Last speed | Communication break detection active. Upon a communication break, the drive generates alarm FIELDBUS COMM and freezes the speed to the level the drive was operating at. The speed is determined by the average speed over the previous 10 seconds.<br>⚠ **WARNING**! Make sure that it is safe to continue operation in case of a communication break. |
| **50.03** | COMM LOSS T OUT | FW block: FIELDBUS (see above) |
| | Defines the time delay before the action defined by parameter 50.02 COMM LOSS FUNC is taken. Time count starts when the link fails to update the message. | |
| | 0.3…6553.5 s | Delay for fieldbus communication loss function. |
| **50.04** | FBA REF1 MODESEL | FW block: FIELDBUS (see above) |
| | Selects the fieldbus reference FBA REF1 scaling and the actual value, which is sent to the fieldbus (FBA ACT1). | |
| | **(0)** Raw data | No scaling (ie, data is transmitted without scaling). Source for the actual value, which is sent to the fieldbus, is selected by parameter 50.06 FBA ACT1 TR SRC. |
| | **(1)** Torque | Fieldbus adapter module uses torque reference scaling. Torque reference scaling is defined by the used fieldbus profile (eg, with ABB Drives Profile integer value 10000 corresponds to 100% torque value). Signal 1.06 TORQUE is sent to the fieldbus as an actual value. See the *User's Manual* of the appropriate fieldbus adapter module. |
| | **(2)** Speed | Fieldbus adapter module uses speed reference scaling. Speed reference scaling is defined by the used fieldbus profile (eg, with ABB Drives Profile integer value 20000 corresponds to the value of parameter 25.02 SPEED SCALING). Signal 1.01 SPEED ACT is sent to the fieldbus as an actual value. See the *User's Manual* of the appropriate fieldbus adapter module. |
| | **(5)** Auto | One of the above selections is chosen automatically according to the currently active control mode. See parameter group 34. |
| **50.05** | FBA REF2 MODESEL | FW block: FIELDBUS (see above) |
| | Selects the fieldbus reference FBA REF2 scaling.<br>See parameter 50.04 FBA REF1 MODESEL. | |

| | | |
|---|---|---|
| **50.06** | FBA ACT1 TR SRC | FW block: FIELDBUS (see above) |
| | Selects the source for fieldbus actual value 1 when parameter 50.04 FBA REF1 MODESEL / 50.05 FBA REF2 MODESEL is set to (0) Raw data. | |
| | Value pointer: Group and index | |
| **50.07** | FBA ACT2 TR SRC | FW block: FIELDBUS (see above) |
| | Selects the source for fieldbus actual value 2 when parameter 50.04 FBA REF1 MODESEL / 50.05 FBA REF2 MODESEL is set to (0) Raw data. | |
| | Value pointer: Group and index | |
| **50.08** | FBA SW B12 SRC | FW block: FIELDBUS (see above) |
| | Selects the source for freely programmable fieldbus status word bit 28 (2.13 FBA MAIN SW bit 28). Note that this functionality may not be supported by the fieldbus communication profile. | |
| | Bit pointer: Group, index and bit | |
| **50.09** | FBA SW B13 SRC | FW block: FIELDBUS (see above) |
| | Selects the source for freely programmable fieldbus status word bit 29 (2.13 FBA MAIN SW bit 29). Note that this functionality may not be supported by the fieldbus communication profile. | |
| | Bit pointer: Group, index and bit | |
| **50.10** | FBA SW B14 SRC | FW block: FIELDBUS (see above) |
| | Selects the source for freely programmable fieldbus status word bit 30 (2.13 FBA MAIN SW bit 30). Note that this functionality may not be supported by the fieldbus communication profile. | |
| | Bit pointer: Group, index and bit | |
| **50.11** | FBA SW B15 SRC | FW block: FIELDBUS (see above) |
| | Selects the source for freely programmable fieldbus status word bit 31 (2.13 FBA MAIN SW bit 31). Note that this functionality may not be supported by the fieldbus communication profile. | |
| | Bit pointer: Group, index and bit | |

| | | |
|---|---|---|
| **50.12** | FBA CYCLE TIME | FW block: FIELDBUS (see above) |

Selects the fieldbus communication speed. The default selection is (2) Fast. Lowering the speed reduces the CPU load.

The table below shows the read/write intervals for cyclic and cyclic low data with each parameter setting.

| **Selection** | **Cyclic*** | **Cyclic low*** |
|---|---|---|
| Slow | 10 ms | 10 ms |
| Normal | 2 ms | 10 ms |
| Fast | 500 us | 2 ms |

*Cyclic data consists of fieldbus CW and SW, Ref1 and Ref2, and Act1 and Act2.

**Cyclic low data consists of the parameter data mapped to parameter groups 52 and 53.

| | | |
|---|---|---|
| | **(0)** Slow | Slow speed selected. |
| | **(1)** Normal | Normal speed selected. |
| | **(2)** Fast | Fast speed selected. |
| **50.20** | FB MAIN SW FUNC | FW block: FIELDBUS (see above) |

Contains various compatibility settings especially for drive retrofits.

| **Bit** | **Name** | **Information** |
|---|---|---|
| 0 | Run enable func | 1 = Parameter only:<br>Bit 1 of 2.13 FBA MAIN SW is set to 1 whenever the external run enable signal (par. 10.09 RUN ENABLE) is 1. |
| | | 0 = Param AND Fb cw:<br>Bit 1 of 2.13 FBA MAIN SW is set to 1 whenever both the external run enable signal (par. 10.09 RUN ENABLE) is 1 AND 2.12 FBA MAIN CW bit 7 (RUN ENABLE) are 1. |
| 1 | Mech brake func | 1 = Force ramp stop:<br>Drive always uses ramp stop when a mechanical brake is used. |
| | | 0 = Allow coast stop:<br>Coast stop is allowed when a mechanical brake is used. |

## Group 51 FBA SETTINGS

Further fieldbus communication configuration. These parameters need to be set only if a fieldbus adapter module is installed. See also *Appendix A – Fieldbus control* on page 347.

**Notes:**

- This parameter group is presented in the *User's Manual* of the fieldbus adapter as parameter group 1 or A.
- The new settings will take effect when the drive is powered up the next time (before powering off the drive, wait at least 1 minute), or when parameter 51.27 FBA PAR REFRESH is activated.

| | | |
|---|---|---|
| **51.01** | FBA TYPE | FW block: None |
| | Displays the fieldbus protocol on the basis of the adapter module installed. | |
| | Not defined | Fieldbus adapter module not found (not properly connected, or disabled by parameter 50.01 FBA ENABLE). |
| | (Fieldbus protocol) | Fieldbus adapter for the stated protocol installed. |
| **51.02** | FBA PAR2 | FW block: None |
| … | …. | …. |
| **51.26** | FBA PAR26 | FW block: None |
| | Parameters 51.02…51.26 are adapter module-specific. For more information, see the *User's Manual* of the fieldbus adapter module. Note that not all of these parameters are necessarily used. | |
| **51.27** | FBA PAR REFRESH | FW block: None |
| | Validates any changed adapter module configuration parameter settings. After refreshing, the value reverts automatically to (0) DONE.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | **(0)** DONE | Refreshing done. |
| | **(1)** REFRESH | Refreshing. |
| **51.28** | PAR TABLE VER | FW block: None |
| | Displays the parameter table revision of the fieldbus adapter module mapping file stored in the memory of the drive.<br>In format xyz, where x = major revision number; y = minor revision number; z = correction number. | |
| **51.29** | DRIVE TYPE CODE | FW block: None |
| | Displays the drive type code of the fieldbus adapter module mapping file stored in the memory of the drive.<br>Example: 520 = ACSM1 speed and torque control program. | |

| | | |
|---|---|---|
| **51.30** | MAPPING FILE VER | FW block: None |
| | Displays the fieldbus adapter module mapping file revision stored in the memory of the drive.<br>In hexadecimal format. Example: 0x107 = revision 1.07. | |
| **51.31** | D2FBA COMM STA | FW block: None |
| | Displays the status of the fieldbus adapter module communication. | |
| | **(0)** IDLE | Adapter not configured. |
| | **(1)** EXEC. INIT | Adapter initializing. |
| | **(2)** TIME OUT | A timeout has occurred in the communication between the adapter and the drive. |
| | **(3)** CONFIG ERROR | Adapter configuration error – the major or minor revision code of the common program revision in the fieldbus adapter module is not the revision required by the module (see par. 51.32 FBA COMM SW VER), or mapping file upload has failed more than three times. |
| | **(4)** OFF-LINE | Adapter is off-line. |
| | **(5)** ON-LINE | Adapter is on-line. |
| | **(6)** RESET | Adapter is performing a hardware reset. |
| **51.32** | FBA COMM SW VER | FW block: None |
| | Displays the common program revision of the adapter module.<br>In format axyz, where a = major revision number, xy = minor revision numbers. z = correction letter.<br>Example: 190A = revision 1.90A. | |
| **51.33** | FBA APPL SW VER | FW block: None |
| | Displays the application program revision of the adapter module.<br>In format axyz, where: a = major revision number, xy = minor revision numbers, z = correction letter.<br>Example: 190A = revision 1.90A. | |

## Group 52 FBA DATA IN

These parameters select the data to be sent by the drive to the fieldbus controller, and need to be set only if a fieldbus adapter module is installed. See also *Appendix A – Fieldbus control* on page 347.

**Notes:**

- This parameter group is presented in the *User's Manual* of the fieldbus adapter as parameter group 3 or C.
- The new settings will take effect when the drive is powered up the next time (before powering off the drive, wait at least 1 minute), or when parameter 51.27 FBA PAR REFRESH is activated.
- The maximum number of data words is protocol-dependent.

| **52.01** | FBA DATA IN1 | FW block: None |
|---|---|---|
| | Selects data to be transferred from the drive to the fieldbus controller. | |
| | 0 | Not in use. |
| | 4 | Status Word (16 bits). |
| | 5 | Actual value 1 (16 bits). |
| | 6 | Actual value 2 (16 bits). |
| | 14 | Status Word (32 bits). |
| | 15 | Actual value 1 (32 bits). |
| | 16 | Actual value 2 (32 bits). |
| | 101…9999 | Parameter index. |
| **52.02** | FBA DATA IN2 | FW block: None |
| … | … | |
| **52.12** | FBA DATA IN12 | FW block: None |
| | See 52.01 FBA DATA IN1. | |

## Group 53 FBA DATA OUT

These parameters select the data to be sent by the fieldbus controller to the drive, and need to be set only if a fieldbus adapter module is installed. See also *Appendix A – Fieldbus control* on page 347.

**Notes:**

- This parameter group is presented in the *User's Manual* of the fieldbus adapter as parameter group 2 or B.
- The new settings will take effect when the drive is powered up the next time (before powering off the drive, wait at least 1 minute), or when parameter 51.27 FBA PAR REFRESH is activated.
- The maximum number of data words is protocol-dependent.

| **53.01** | FBA DATA OUT1 | FW block: None |
|---|---|---|
| | Selects data to be transferred from the fieldbus controller to the drive. | |
| | 0 | Not in use. |
| | 1 | Control Word (16 bits). |
| | 2 | Reference REF1 (16 bits). |
| | 3 | Reference REF2 (16 bits). |
| | 11 | Control Word (32 bits). |
| | 12 | Reference REF1 (32 bits). |
| | 13 | Reference REF2 (32 bits). |
| | 1001…9999 | Parameter index. |
| **53.02** | FBA DATA OUT2 | FW block: None |
| … | | |
| **53.12** | FBA DATA OUT12 | FW block: None |
| | See 53.01 FBA DATA OUT1. | |

## Group 55 COMMUNICATION TOOL

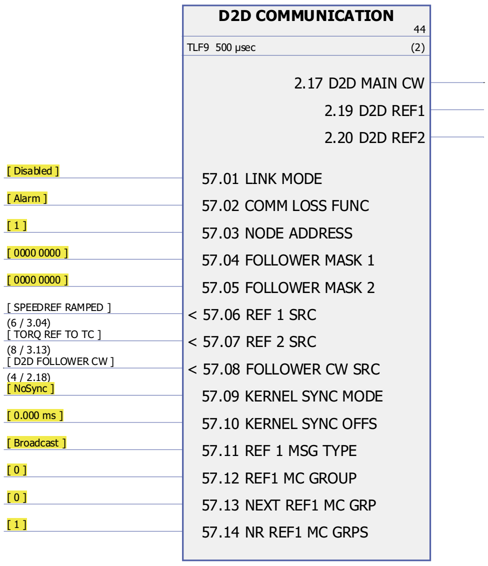
Settings for an RS-485 network implemented using optional JPC-01 Network communication adapters. The network enables the use of a single PC or control panel to control multiple drives.

For more information, see the *JPC-01 Network communication adapter User's manual* (3AUA0000072233).

| **55.01** | MDB STATION ID | FW block: None |
|---|---|---|
| | Defines the ID of the drive on the RS-485 network. Each drive must have a dedicated ID number. | |
| | 1…247 | ID number. For drives, use a number between 1 and 31. (DriveStudio uses ID number 247.) |
| **55.02** | MDB BAUD RATE | FW block: None |
| | Sets the baud rate on the network.<br>**Note:** This parameter must be set to (0) Auto if a control panel is used as the controlling device. | |
| | **(0)** Auto | Baud rate is determined automatically. At start-up, and after a communication break, the initial rate is 9600 baud. |
| | **(1)** 9600 | 9600 baud. |
| | **(2)** 19200 | 19200 baud. |
| | **(3)** 38400 | 38400 baud. |
| | **(4)** 57600 | 57600 baud. |
| **55.03** | MDB PARITY | FW block: None |
| | Defines the use of parity bits. The same setting must be used in all on-line stations. | |
| | 0…3 | Number of parity bits.<br>• 0 = 8 none 1<br>• 1 = 8 none 2<br>• 2 = 8 even 1<br>• 3 = 8 odd 1 |

## Group 57 D2D COMMUNICATION

Drive-to-drive communication settings. See *Appendix B – Drive-to-drive link* on page 355.

<table>
<tr><td colspan="2">Firmware block:<br><b>D2D COMMUNICATION</b><br>(57)<br><br>This block sets up the drive-to-drive communication. It also shows the main drive-to-drive control word and the two references.</td><td>
</td></tr>
<tr><td colspan="2">Block outputs located in other parameter groups</td><td>2.17 D2D MAIN CW (page 100)<br>2.19 D2D REF1 (page 101)<br>2.20 D2D REF2 (page 101)</td></tr>
<tr><td><b>57.01</b></td><td>LINK MODE</td><td>FW block: D2D COMMUNICATION (see above)</td></tr>
<tr><td></td><td colspan="2">Activates the drive-to-drive connection.</td></tr>
<tr><td></td><td><b>(0)</b> Disabled</td><td>Drive-to-drive connection disabled.</td></tr>
<tr><td></td><td><b>(1)</b> Follower</td><td>The drive is a follower on the drive-to-drive link.</td></tr>
<tr><td></td><td><b>(2)</b> Master</td><td>The drive is the master on the drive-to-drive link. Only one drive can be the master at a time.</td></tr>
<tr><td><b>57.02</b></td><td>COMM LOSS FUNC</td><td>FW block: D2D COMMUNICATION (see above)</td></tr>
<tr><td></td><td colspan="2">Selects how the drive acts when an erroneous drive-to-drive configuration or a communication break is detected.</td></tr>
<tr><td></td><td><b>(0)</b> No</td><td>Protection inactive.</td></tr>
<tr><td></td><td><b>(1)</b> Alarm</td><td>The drive generates an alarm.</td></tr>
<tr><td></td><td><b>(2)</b> Fault</td><td>The drive trips on a fault.</td></tr>
</table>

| | | |
|---|---|---|
| **57.03** | NODE ADDRESS | FW block: D2D COMMUNICATION (see above) |
| | Sets the node address for a follower drive. Each follower must have a dedicated node address.<br>**Note:** If the drive is set to be the master on the drive-to-drive link, this parameter has no effect (the master is automatically assigned node address 0). | |
| | 1…62 | Node address. |
| **57.04** | FOLLOWER MASK 1 | FW block: D2D COMMUNICATION (see above) |
| | On the master drive, selects the followers to be polled. If no response is received from a polled follower, the action selected by parameter 57.02 COMM LOSS FUNC is taken.<br>The least significant bit represents follower with node address 1, while the most significant bit represents follower 31. When a bit is set to 1, the corresponding node address is polled. For example, followers 1 and 2 are polled when this parameter is set to the value of 0x3. | |
| | 0x00000000…0x7FFFFFFF | Follower mask 1. |
| **57.05** | FOLLOWER MASK 2 | FW block: D2D COMMUNICATION (see above) |
| | On the master drive, selects the followers to be polled. If no response is received from a polled follower, the action selected by parameter 57.02 COMM LOSS FUNC is taken.<br>The least significant bit represents follower with node address 32, while the most significant bit represents follower 62. When a bit is set to 1, the corresponding node address is polled. For example, followers 32 and 33 are polled when this parameter is set to the value of 0x3. | |
| | 0x00000000…0x7FFFFFFF | Follower mask 2. |
| **57.06** | REF 1 SRC | FW block: D2D COMMUNICATION (see above) |
| | Selects the source of D2D reference 1 sent to the followers. The parameter is effective on the master drive, as well as submasters (57.03 NODE ADDRESS = 57.12 REF1 MC GROUP) in a multicast message chain (see parameter 57.11 REF 1 MSG TYPE).<br>The default value is P.03.04, ie, 3.04 SPEEDREF RAMPED. | |
| | Value pointer: Group and index. | |
| **57.07** | REF 2 SRC | FW block: D2D COMMUNICATION (see above) |
| | On the master drive, selects the source of D2D reference 2 broadcast to all followers.<br>The default value is P.03.13, ie, 3.13 TORQ REF TO TC. | |
| | Value pointer: Group and index. | |
| **57.08** | FOLLOWER CW SRC | FW block: D2D COMMUNICATION (see above) |
| | Selects the source of the D2D control word sent to the followers. The parameter is effective on the master drive, as well as submasters in a multicast message chain (see parameter 57.11 REF 1 MSG TYPE).<br>The default value is P.02.18, ie, 2.18 D2D FOLLOWER CW. | |
| | Value pointer: Group and index. | |

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|---|---|---|
| **57.09** | KERNEL SYNC MODE | FW block: D2D COMMUNICATION (see above) |
| | Determines which signal the time levels of the drive are synchronised with. An offset can be defined by parameter 57.10 KERNEL SYNC OFFS if desired. | |
| | **(0)** NoSync | No synchronisation. |
| | **(1)** D2DSync | If the drive is the master on a drive-to-drive link, it broadcasts a synchronisation signal to the follower(s). If the drive is a follower, it synchronises its firmware time levels to the signal received from the master. |
| | **(2)** FBSync | The drive synchronises its firmware time levels to a synchronisation signal received through a fieldbus adapter. |
| | **(3)** FBToD2DSync | If the drive is the master on a drive-to-drive link, it synchronises its firmware time levels to a synchronisation signal received from a fieldbus adapter, and broadcasts the signal on the drive-to-drive link. If the drive is a follower, this setting has no effect. |
| **57.10** | KERNEL SYNC OFFS | FW block: D2D COMMUNICATION (see above) |
| | Defines an offset in microseconds between the synchronisation signal received and the time levels of the drive. With a positive value, the drive time levels will lag behind the synchronisation signal; with a negative value, the drive time levels will lead. | |
| | -4999…5000 us | Synchronisation offset. |
| **57.11** | REF 1 MSG TYPE | FW block: D2D COMMUNICATION (see above) |
| | By default, in drive-to-drive communication, the master broadcasts the drive-to-drive control word and references 1 and 2 to all followers. This parameter enables multicasting, ie, sending the drive-to-drive control word and reference 1 to a certain drive or group of drives. The message can then be further relayed to another group of drives to form a multicast chain.<br>In the master, as well as any submaster (ie, follower relaying the message to other followers), the sources for the control word and reference 1 are selected by parameters 57.08 FOLLOWER CW SRC and 57.06 REF 1 SRC respectively.<br>**Note:** Reference 2 is broadcast by the master to all followers.<br>For more information, see *Appendix B – Drive-to-drive link* on page 355. | |
| | **(0)** Broadcast | The control word and reference 1 are sent by the master to all followers. If the master has this setting, the parameter has no effect in the followers. |
| | **(1)** Ref1 MC Grps | The drive-to-drive control word and reference 1 are only sent to the drives in the multicast group specified by parameter 57.13 NEXT REF1 MC GRP. This setting can also be used in submasters (followers in which parameters 57.03 NODE ADDRESS and 57.12 REF1 MC GROUP are set to the same value) to form a multicast chain. |

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| **57.12** | REF1 MC GROUP | FW block: D2D COMMUNICATION (see above) |
| | Selects the multicast group the drive belongs to. See parameter 57.11 REF 1 MSG TYPE. | |
| | 0…62 | Multicast group (0 = none). |
| **57.13** | NEXT REF1 MC GRP | FW block: D2D COMMUNICATION (see above) |
| | Specifies the next multicast group of drives the multicast message is relayed to. See parameter 57.11 REF 1 MSG TYPE. This parameter is effective only in the master or in submasters (followers in which parameters 57.03 NODE ADDRESS and 57.12 REF1 MC GROUP are set to the same value). | |
| | 0…62 | Next multicast group in message chain. |
| **57.14** | NR REF1 MC GRPS | FW block: D2D COMMUNICATION (see above) |
| | Sets the number of drives sending messages in the message chain. The value is typically equal to the number of multicast groups in the chain assuming that the last drive is NOT sending an acknowledgement to the master. See parameter 57.11 REF 1 MSG TYPE.<br>**Notes:**<br>• This parameter is only effective in the master. | |
| | 1…62 | Total number of links in multicast message chain. |
| **57.15** | D2D COMM PORT | FW block: None |
| | Defines the hardware to which the drive-to-drive link is connected. In special cases (such as harsh operating conditions), the galvanic isolation provided by the RS-485 interface of the FMBA module may make for more robust communication than the standard drive-to-drive connection. | |
| | **(0)** on-board | Connector XD2D on the JCU Control Unit is used. |
| | **(1)** Slot 1 | An FMBA module installed in JCU option slot 1 is used. |
| | **(2)** Slot 2 | An FMBA module installed in JCU option slot 2 is used. |
| | **(3)** Slot 3 | An FMBA module installed in JCU option slot 3 is used. |

## Group 90 ENC MODULE SEL

Settings for encoder activation, emulation, TTL echo, and encoder cable fault detection.

The firmware supports two encoders, encoder 1 and 2 (but only one FEN-21 Resolver Interface Module). Revolution counting is only supported for encoder 1. The following optional interface modules are available:

- TTL Encoder Interface Module FEN-01: two TTL inputs, TTL output (for encoder emulation and echo), two digital inputs for position latching, PTC temperature sensor connection
- Absolute Encoder Interface FEN-11: absolute encoder input, TTL input, TTL output (for encoder emulation and echo), two digital inputs for position latching, PTC/KTY temperature sensor connection
- Resolver Interface Module FEN-21: resolver input, TTL input, TTL output (for encoder emulation echo), two digital inputs for position latching, PTC/KTY temperature sensor connection
- HTL Encoder Interface Module FEN-31: HTL encoder input, TTL output (for encoder emulation and echo), two digital inputs for position latching, PTC/KTY temperature sensor connection.

The interface module is connected to drive option Slot 1 or 2. **Note:** Two encoder interface modules of the same type are not allowed.

For encoder/resolver configuration, see parameter groups 91 (page 218), 92 (page 224) and 93 (page 225).

**Note:** Configuration data is written into the logic registers of the interface module once after the power-up. If parameter values are changed, save values into the permanent memory using parameter 16.07 PARAM SAVE. The new settings will take effect when the drive is powered up again, or after re-configuration is forced using parameter 90.10 ENC PAR REFRESH.

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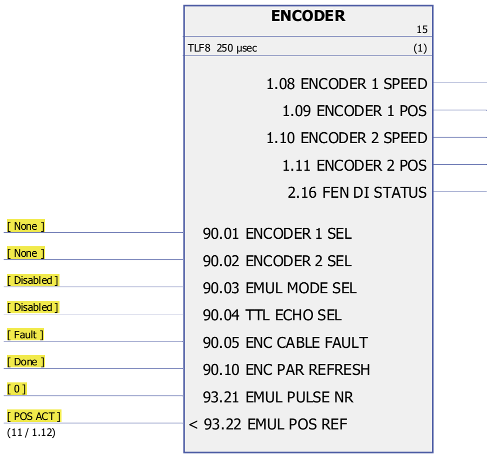
|---|---|---|
| Firmware block:<br>**ENCODER**<br>(3)<br>This block<br>• activates the communication to encoder interface 1/2<br>• enables encoder emulation/echo<br>• shows encoder 1/2 speed and actual position. | |  ENCODER<br>15<br>TLF8 250 µsec<br>(1)<br>1.08 ENCODER 1 SPEED<br>1.09 ENCODER 1 POS<br>1.10 ENCODER 2 SPEED<br>1.11 ENCODER 2 POS<br>2.16 FEN DI STATUS<br>[ None ]<br>90.01 ENCODER 1 SEL<br>[ None ]<br>90.02 ENCODER 2 SEL<br>[ Disabled ]<br>90.03 EMUL MODE SEL<br>[ Disabled ]<br>90.04 TTL ECHO SEL<br>[ Fault ]<br>90.05 ENC CABLE FAULT<br>[ Done ]<br>90.10 ENC PAR REFRESH<br>[ 0 ]<br>93.21 EMUL PULSE NR<br>[ POS ACT ]<br>(11 / 1.12)<br>< 93.22 EMUL POS REF |
| Block inputs located in other parameter groups | | 93.21 EMUL PULSE NR (page 228)<br>93.22 EMUL POS REF (page 228) |
| Block outputs located in other parameter groups | | 1.08 ENCODER 1 SPEED (page 93)<br>1.09 ENCODER 1 POS (page 93)<br>1.10 ENCODER 2 SPEED (page 94)<br>1.11 ENCODER 2 POS (page 94)<br>2.16 FEN DI STATUS (page 100) |
| **90.01** | ENCODER 1 SEL | FW block: ENCODER (see above) |
| | Activates the communication to optional encoder/resolver interface 1.<br>**Note:** It is recommended that encoder interface 1 is used whenever possible since the data received through that interface is fresher than the data received through interface 2. On the other hand, when position values used in emulation are determined by the drive software, the use of encoder interface 2 is recommended as the values are transmitted earlier through interface 2 than through interface 1. | |
| | **(0)** None | Inactive. |
| | **(1)** FEN-01 TTL+ | Communication active. Module type: FEN-01 TTL Encoder interface Module. Input: TTL encoder input with commutation support (X32). See parameter group 93. |
| | **(2)** FEN-01 TTL | Communication active. Module type: FEN-01 TTL Encoder interface Module. Input: TTL encoder input (X31). See parameter group 93. |
| | **(3)** FEN-11 ABS | Communication active. Module type: FEN-11 Absolute Encoder Interface. Input: Absolute encoder input (X42). See parameter group 91. Emulation is not possible with SSI or EnDat in the Continuous mode (parameters 91.25 and 91.30). |
| | **(4)** FEN-11 TTL | Communication active. Module type: FEN-11 Absolute Encoder Interface. Input: TTL encoder input (X41). See parameter group 93. |
| | **(5)** FEN-21 RES | Communication active. Module type: FEN-21 Resolver Interface. Input: Resolver input (X52). See parameter group 92. |
| | **(6)** FEN-21 TTL | Communication active. Module type: FEN-21 Resolver Interface. Input: TTL encoder input (X51). See parameter group 93. |

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|---|---|---|
| | **(7)** FEN-31 HTL | Communication active. Module type: FEN-31 HTL Encoder Interface. Input: HTL encoder input (X82). See parameter group 93. |
| **90.02** | ENCODER 2 SEL | FW block: ENCODER (see above) |
| | Activates the communication to the optional encoder/resolver interface 2.<br>For selections, see parameter 90.01 ENCODER 1 SEL.<br>**Note:** The counting of full shaft revolutions is not supported for encoder 2. | |
| **90.03** | EMUL MODE SEL | FW block: ENCODER (see above) |
| | Enables the encoder emulation and selects the position value and the TTL output used in the emulation process.<br>In encoder emulation, a calculated position difference is transformed to a corresponding number of TTL pulses to be transmitted via the TTL output. The position difference is the difference between the latest and the previous position values.<br>The position value used in emulation can be either a position determined by the drive software or a position measured by an encoder. If drive software position is used, the source for the used position is selected by parameter 93.22 EMUL POS REF. Because the software causes a delay, it is recommended that actual position is always taken from an encoder. Drive software is recommended to be used only with position reference emulation.<br>Encoder emulation can be used to increase or decrease the pulse number when TTL encoder data is transmitted via the TTL output, eg, to another drive. If the pulse number requires no alternation, use encoder echo for data transformation. See parameter 90.04 TTL ECHO SEL. **Note:** If encoder emulation and echo are enabled for the same FEN-xx TTL output, the emulation overrides the echo.<br>If an encoder input is selected as emulation source, the corresponding selection must be activated either with parameter 90.01 ENCODER 1 SEL or 90.02 ENCODER 2 SEL.<br>The TTL encoder pulse number used in emulation must be defined by parameter 93.21 EMUL PULSE NR. See parameter group 93. | |
| | **(0)** Disabled | Emulation disabled. |
| | **(1)** FEN-01 SWref | Module type: FEN-01 TTL Encoder interface Module. Emulation: Drive software position (source selected by par. 93.22 EMUL POS REF) is emulated to FEN-01 TTL output. |
| | **(2)** FEN-01 TTL+ | Module type: FEN-01 TTL Encoder interface Module. Emulation: FEN-01 TTL encoder input (X32) position is emulated to FEN-01 TTL output. |
| | **(3)** FEN-01 TTL | Module type: FEN-01 TTL Encoder interface Module. Emulation: FEN-01 TTL encoder input (X31) position is emulated to FEN-01 TTL output. |
| | **(4)** FEN-11 SWref | Module type: FEN-11 Absolute Encoder Interface. Emulation: Drive software position (source selected by par. 93.22 EMUL POS REF) is emulated to FEN-11 TTL output. |
| | **(5)** FEN-11 ABS | Module type: FEN-11 Absolute Encoder Interface. Emulation: FEN-11 absolute encoder input (X42) position is emulated to FEN-11 TTL output. Emulation is not possible with SSI or EnDat in the Continuous mode (parameters 91.25 and 91.30). |
| | **(6)** FEN-11 TTL | Module type: FEN-11 Absolute Encoder Interface. Emulation: FEN-11 TTL encoder input (X41) position is emulated to FEN-11 TTL output. |

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| | **(7)** FEN-21 SWref | Module type: FEN-21 Resolver Interface. Emulation: Drive software position (source selected by par. 93.22 EMUL POS REF) is emulated to FEN-21 TTL output. |
| | **(8)** FEN-21 RES | Module type: FEN-21 Resolver Interface. Emulation: FEN-21 resolver input (X52) position is emulated to FEN-21 TTL output. |
| | **(9)** FEN-21 TTL | Module type: FEN-21 Resolver Interface. Emulation: FEN-21 TTL encoder input (X51) position is emulated to FEN-21 TTL output. |
| | **(10)** FEN-31 SWref | Module type: FEN-31 HTL Encoder Interface. Emulation: Drive software position (source selected by par. 93.22 EMUL POS REF) is emulated to FEN-31 TTL output. |
| | **(11)** FEN-31 HTL | Module type: FEN-31 HTL Encoder Interface. Emulation: FEN-31 HTL encoder input (X82) position is emulated to FEN-31 TTL output. |
| **90.04** | TTL ECHO SEL | FW block: ENCODER (see above) |
| | Enables and selects the interface for the TTL encoder signal echo.<br>**Note:** If encoder emulation and echo are enabled for the same FEN-xx TTL output, the emulation overrides the echo. | |
| | **(0)** Disabled | TTL echo disabled. |
| | **(1)** FEN-01 TTL+ | Module type: FEN-01 TTL Encoder Interface. Echo: TTL encoder input (X32) pulses are echoed to the TTL output. |
| | **(2)** FEN-01 TTL | Module type: FEN-01 TTL Encoder Interface. Echo: TTL encoder input (X31) pulses are echoed to the TTL output. |
| | **(3)** FEN-11 TTL | Module type: FEN-11 Absolute Encoder Interface. Echo: TTL encoder input (X41) pulses are echoed to the TTL output. |
| | **(4)** FEN-21 TTL | Module type: FEN-21 Resolver Interface. Echo: TTL encoder input (X51) pulses are echoed to the TTL output. |
| | **(5)** FEN-31 HTL | Module type: FEN-31 HTL Encoder Interface. Echo: HTL encoder input (X82) pulses are echoed to the TTL output. |

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| **90.05** | ENC CABLE FAULT | FW block: ENCODER (see above) |
| | Selects the action in case an encoder cable fault is detected by the FEN-xx encoder interface.<br>**Notes:**<br>• This functionality is only available with the absolute encoder input of the FEN-11 based on sine/cosine incremental signals, and with the HTL input of the FEN-31.<br>• When the encoder input is used for speed feedback (see 22.01 SPEED FB SEL), this parameter may be overridden by parameter 22.09 SPEED FB FAULT. | |
| | **(0)** No | Cable fault detection inactive. |
| | **(1)** Fault | The drive trips on an ENCODER 1/2 CABLE fault. |
| | **(2)** Warning | The drive generates an ENCODER 1/2 CABLE warning. This is the recommended setting if the maximum pulse frequency of sine/cosine incremental signals exceeds 100 kHz; at high frequencies, the signals may attenuate enough to invoke the function. The maximum pulse frequency can be calculated as follows:<br>$\frac{\text{Pulses per revolution (par. 91.01)} \times \text{Maximum speed in rpm}}{60}$ |
| **90.06** | INVERT ENC SIG | FW block: None |
| | Rotation direction of encoder signals can be inverted separately without cabling changes. | |
| | **(0)** No | Encoder rotation directions are not inverted. |
| | **(1)** Enc1 | Encoder 1 rotation direction is inverted. |
| | **(2)** Enc2 | Encoder 2 rotation direction is inverted. |
| | **(3)** Both | Both encoder 1 and 2 rotation directions are inverted. |
| **90.10** | ENC PAR REFRESH | FW block: ENCODER (see above) |
| | Setting this parameter to 1 forces a reconfiguration of the FEN-xx interfaces, which is needed for any parameter changes in groups 90…93 to take effect.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | **(0)** Done | Refreshing done. |
| | **(1)** Configure | Reconfigure. The value will automatically revert to DONE. |

## Group 91 ABSOL ENC CONF

Absolute encoder configuration; used when parameter 90.01 ENCODER 1 SEL / 90.02 ENCODER 2 SEL is set to (3) FEN-11 ABS.

The optional FEN-11 Absolute Encoder Interface module supports the following encoders:

- Incremental sin/cos encoders with or without zero pulse and with or without sin/cos commutation signals
- Endat 2.1/2.2 with incremental sin/cos signals (partially without sin/cos incremental signals*)
- Hiperface encoders with incremental sin/cos signals
- SSI (Synchronous Serial Interface) with incremental sin/cos signals (partially without sin/cos incremental signals*)
- Tamagawa 17/33-bit digital encoders (the resolution of position data within one revolution is 17 bits; multiturn data includes a 16-bit revolution count).

* EnDat and SSI encoders without incremental sin/cos signals are partially supported only as encoder 1: Speed is not available and the time instant of the position data (delay) depends on the encoder.

See also parameter group 90 on page 214, and *FEN-11 Absolute Encoder Interface User's Manual* (3AFE68784841 [English]).

**Note:** Configuration data is written into the logic registers of the interface module once after the power-up. If parameter values are changed, save values into the permanent memory using parameter 16.07 PARAM SAVE. The new settings will take effect when the drive is powered up again, or after re-configuration is forced using parameter 90.10 ENC PAR REFRESH.

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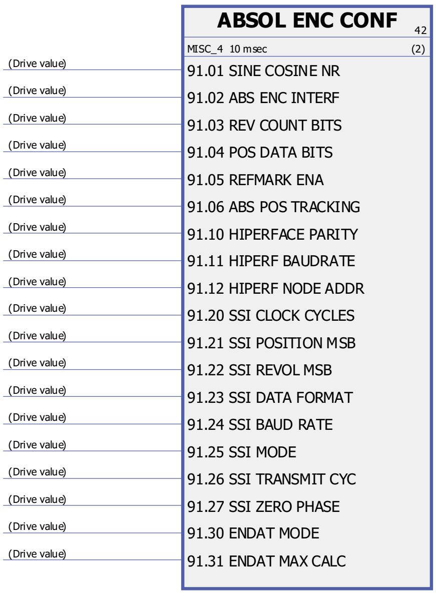
| Firmware block:<br>**ABSOL ENC CONF**<br>(91)<br>This block configures the absolute encoder connection. |  |

ABSOL ENC CONF
42
MISC_4 10 msec
(2)
(Drive value) 91.01 SINE COSINE NR
(Drive value) 91.02 ABS ENC INTERF
(Drive value) 91.03 REV COUNT BITS
(Drive value) 91.04 POS DATA BITS
(Drive value) 91.05 REFMARK ENA
(Drive value) 91.06 ABS POS TRACKING
(Drive value) 91.10 HIPERFACE PARITY
(Drive value) 91.11 HIPERF BAUDRATE
(Drive value) 91.12 HIPERF NODE ADDR
(Drive value) 91.20 SSI CLOCK CYCLES
(Drive value) 91.21 SSI POSITION MSB
(Drive value) 91.22 SSI REVOL MSB
(Drive value) 91.23 SSI DATA FORMAT
(Drive value) 91.24 SSI BAUD RATE
(Drive value) 91.25 SSI MODE
(Drive value) 91.26 SSI TRANSMIT CYC
(Drive value) 91.27 SSI ZERO PHASE
(Drive value) 91.30 ENDAT MODE
(Drive value) 91.31 ENDAT MAX CALC

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| **91.01** | SINE COSINE NR | FW block: ABSOL ENC CONF (see above) |
| | Defines the number of sine/cosine wave cycles within one revolution.<br>**Note:** This parameter does not need to be set when EnDat or SSI encoders are used in continuous mode. See parameter 91.25 SSI MODE / 91.30 ENDAT MODE. | |
| | 0…65535 | Number of sine/cosine wave cycles within one revolution. |
| **91.02** | ABS ENC INTERF | FW block: ABSOL ENC CONF (see above) |
| | Selects the source for the encoder absolute position.<br>With (2) EnDat or (3) Hiperface encoder selected and configuration parameters at zero, encoder configuration is automatically initialized when encoder refresh is done. Configured parameters are 91.01 SINE COSINE NR, 91.03 REV COUNT BITS and 91.04 POS DATA BITS.<br>**Note:** Automatic configuration requires FEN-11 FPGA logic version VIE1 2200. | |
| | **(0)** None | Not selected. |
| | **(1)** Commut sig | Commutation signals. |
| | **(2)** EnDat | Serial interface: EnDat encoder. |
| | **(3)** Hiperface | Serial interface: HIPERFACE encoder. |
| | **(4)** SSI | Serial interface: SSI encoder. |
| | **(5)** Tamag.17/33 bits | Serial interface: Tamagawa 17/33-bit encoder. |
| **91.03** | REV COUNT BITS | FW block: ABSOL ENC CONF (see above) |
| | Defines the number of bits used in revolution counting with multiturn encoders. Used when parameter 91.02 ABS ENC INTERF is set to (2) EnDat, (3) Hiperface or (4) SSI. When 91.02 ABS ENC INTERF is set to (5) Tamag.17/33 bits), setting this parameter to a non-zero value activates multiturn data requesting. | |
| | 0…32 | Number of bits used in revolution count. Eg, 4096 revolutions => 12 bits. |
| **91.04** | POS DATA BITS | FW block: ABSOL ENC CONF (see above) |
| | Defines the number of bits used within one revolution when parameter 91.02 ABS ENC INTERF is set to (2) EnDat, (3) Hiperface or (4) SSI. When 91.02 ABS ENC INTERF is set to (5) Tamag.17/33 bits, this parameter is internally set to 17. | |
| | 0…32 | Number of bits used within one revolution. Eg, 32768 positions per revolution => 15 bits. |
| **91.05** | REFMARK ENA | FW block: ABSOL ENC CONF (see above) |
| | Enables the encoder zero pulse for the absolute encoder input (X42) of an FEN-11 module (if present). Zero pulse can be used for position latching.<br>**Note:** With serial interfaces (ie, when parameter 91.02 ABS ENC INTERF is set to (2) EnDat, (3) Hiperface, (4) SSI or (5) Tamag.17/33 bits), the zero pulse does not exist. | |
| | **(0)** FALSE | Zero pulse disabled. |
| | **(1)** TRUE | Zero pulse enabled. |

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| **91.06** | ABS POS TRACKING | FW block: ABSOL ENC CONF (see above) |
| | Enables position tracking, which counts the number of absolute encoder overflows (single and multiturn encoder and resolver) in order to determine the actual position uniquely and clearly after a power-up (or encoder refresh), especially with an odd load gear ratio.<br>Each time the position tracking is enabled or disabled, it must also be activated by setting parameter 90.10 ENC PAR REFRESH to (1) Configure.<br>**Note:** If the encoder was turned by more than half the encoder range while the drive was switched off, the overflow counter has to be cleared. To clear the counter, set 91.06 ABS POS TRACKING to (0) Disable and 90.10 ENC PAR REFRESH to (1) Configure. | |
| | **(0)** Disable | Position tracking disabled. |
| | **(1)** Enable | Position tracking enabled. |
| **91.10** | HIPERFACE PARITY | FW block: ABSOL ENC CONF (see above) |
| | Defines the use of parity and stop bit(s) for HIPERFACE encoder (ie, when parameter 91.02 ABS ENC INTERF is set to (3) Hiperface).<br>Typically this parameter does not need to be set. | |
| | **(0)** Odd | Odd parity indication bit, one stop bit. |
| | **(1)** Even | Even parity indication bit, one stop bit. |
| **91.11** | HIPERF BAUDRATE | FW block: ABSOL ENC CONF (see above) |
| | Defines the transfer rate of the link for HIPERFACE encoder (ie, when parameter 91.02 ABS ENC INTERF is set to (3) Hiperface).<br>Typically this parameter does not need to be set. | |
| | **(0)** 4800 | 4800 bits/s. |
| | **(1)** 9600 | 9600 bits/s. |
| | **(2)** 19200 | 19200 bits/s. |
| | **(3)** 38400 | 38400 bits/s. |
| **91.12** | HIPERF NODE ADDR | FW block: ABSOL ENC CONF (see above) |
| | Defines the node address for HIPERFACE encoder (ie, when parameter 91.02 ABS ENC INTERF is set to (3) Hiperface).<br>Typically this parameter does not need to be set. | |
| | 0…255 | HIPERFACE encoder node address. |
| **91.20** | SSI CLOCK CYCLES | FW block: ABSOL ENC CONF (see above) |
| | Defines the length of the SSI message. The length is defined as the number of clock cycles. The number of cycles can be calculated by adding 1 to the number of the bits in a SSI message frame.<br>Used with SSI encoders, ie, when parameter 91.02 ABS ENC INTERF is set to (4) SSI. | |
| | 2…127 | SSI message length. |

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| **91.21** | SSI POSITION MSB | FW block: ABSOL ENC CONF (see above) |
| | Defines the location of the MSB (main significant bit) of the position data within a SSI message. Used with SSI encoders, ie, when parameter 91.02 ABS ENC INTERF is set to (4) SSI. | |
| | 1…126 | Position data MSB location (bit number). |
| **91.22** | SSI REVOL MSB | FW block: ABSOL ENC CONF (see above) |
| | Defines the location of the MSB (main significant bit) of the revolution count within a SSI message. Used with SSI encoders, ie, when parameter 91.02 ABS ENC INTERF is set to (4) SSI. | |
| | 1…126 | Revolution count MSB location (bit number). |
| **91.23** | SSI DATA FORMAT | FW block: ABSOL ENC CONF (see above) |
| | Selects the data format for SSI encoder (ie, when parameter 91.02 ABS ENC INTERF is set to (4) SSI). | |
| | **(0)** binary | Binary code. |
| | **(1)** gray | Gray code. |
| **91.24** | SSI BAUD RATE | FW block: ABSOL ENC CONF (see above) |
| | Selects the baud rate for SSI encoder (ie, when parameter 91.02 ABS ENC INTERF is set to (4) SSI). | |
| | **(0)** 10 kbit/s | 10 kbit/s. |
| | **(1)** 50 kbit/s | 50 kbit/s. |
| | **(2)** 100 kbit/s | 100 kbit/s. |
| | **(3)** 200 kbit/s | 200 kbit/s. |
| | **(4)** 500 kbit/s | 500 kbit/s. |
| | **(5)** 1000 kbit/s | 1000 kbit/s. |
| | **(6)** 1500 kbit/s. | 1500 kbit/s. |
| | **(7)** 2000 kbit/s. | 2000 kbit/s. |
| **91.25** | SSI MODE | FW block: ABSOL ENC CONF (see above) |
| | Selects the SSI encoder mode.<br>**Note:** Parameter needs to be set only when an SSI encoder is used in continuous mode, ie, SSI encoder without incremental sin/cos signals (supported only as encoder 1). SSI encoder is selected by setting parameter 91.02 ABS ENC INTERF to (4) SSI. | |
| | **(0)** Initial pos. | Single position transfer mode (initial position). |
| | **(1)** Continuous | Continuous position transfer mode. Measured encoder speed is not calculated and is always 0. |
| | **(3)** Cont.spd+pos. | Both speed and absolute position are transferred continuously. Measured speed quality depends on the baudrate and may be weak. |

| | | |
|---|---|---|
| **91.26** | SSI TRANSMIT CYC | FW block: ABSOL ENC CONF (see above) |
| | Selects the transmission cycle for SSI encoder.<br>**Note:** This parameter needs to be set only when an SSI encoder is used in continuous mode, ie, SSI encoder without incremental sin/cos signals (supported only as encoder 1). SSI encoder is selected by setting parameter 91.02 ABS ENC INTERF to (4) SSI. | |
| | **(0)** 50 us | 50 µs. |
| | **(1)** 100 us | 100 µs. |
| | **(2)** 200 us | 200 µs. |
| | **(3)** 500 us | 500 µs. |
| | **(4)** 1 ms | 1 ms. |
| | **(5)** 2 ms | 2 ms. |
| **91.27** | SSI ZERO PHASE | FW block: ABSOL ENC CONF (see above) |
| | Defines the phase angle within one sine/cosine signal period that corresponds to the value of zero on the SSI serial link data. The parameter is used to adjust the synchronization of the SSI position data and the position based on sine/cosine incremental signals. Incorrect synchronization may cause an error of ±1 incremental period.<br>**Note:** This parameter needs to be set only when an SSI encoder with sine/cosine incremental signals is used in initial position mode. | |
| | **(0)** 315–45 deg | 315–45 degrees. |
| | **(1)** 45–135 deg | 45–135 degrees. |
| | **(2)** 135–225 deg | 135–225 degrees. |
| | **(3)** 225–315 deg | 225–315 degrees. |
| **91.30** | ENDAT MODE | FW block: ABSOL ENC CONF (see above) |
| | Selects the EnDat encoder mode.<br>**Note:** This parameter needs to be set only when an EnDat encoder is used in continuous mode, ie, EnDat encoder without incremental sin/cos signals (supported only as encoder 1). EnDat encoder is selected by setting parameter 91.02 ABS ENC INTERF to (2) EnDat. | |
| | **(0)** Initial pos. | Single position transfer mode (initial position). |
| | **(1)** Continuous | Continuous position data transfer mode. Measured encoder speed is not calculated and is always 0. |
| | **(3)** Cont.spd+pos. | Both speed and absolute position are transferred continuously. |
| **91.31** | ENDAT MAX CALC | FW block: ABSOL ENC CONF (see above) |
| | Selects the maximum encoder calculation time for EnDat encoder.<br>**Note:** This parameter needs to be set only when an EnDat encoder is used in continuous mode, ie, EnDat encoder without incremental sin/cos signals (supported only as encoder 1). EnDat encoder is selected by setting parameter 91.02 ABS ENC INTERF to (2) EnDat. | |
| | **(0)** 10 us | 10 µs. |

| | | |
|---|---|---|
| | **(1)** 100 us | 100 µs. |
| | **(2)** 1 ms | 1 ms. |
| | **(3)** 50 ms | 50 ms. |
| **91.32** | ENDAT CLOCK FREQ | FW block: ABSOL ENC CONF (see above) |
| | Selects the EnDat bitrate.<br>**Note:** Requires FEN-11 FPGA logic version VIE1 2200. | |
| | **(0)** 1 MHz | 1 MHz. |
| | **(1)** 2 MHz | 2 MHz. |
| | **(2)** 4 MHz | 4 MHz. |
| | **(3)** 8 MHz | 8 MHz. |

## Group 92 RESOLVER CONF

Resolver configuration; used when parameter 90.01 ENCODER 1 SEL / 90.02 ENCODER 2 SEL is set to (5) FEN-21 RES.

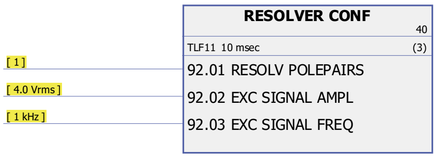
The optional FEN-21 Resolver Interface module is compatible with resolvers which are excited by sinusoidal voltage (to the rotor winding) and which generate sine and cosine signals proportional to the rotor angle (to stator windings).

**Note:** Configuration data is written into the logic registers of the adapter once after the power-up. If parameter values are changed, save values into the permanent memory by parameter 16.07 PARAM SAVE. The new settings will take effect when the drive is powered up again, or after re-configuration is forced by parameter 90.10 ENC PAR REFRESH.

Resolver autotuning is performed automatically whenever the resolver input is activated after changes to parameters 92.02 EXC SIGNAL AMPL or 92.03 EXC SIGNAL FREQ. Autotuning must be forced after any changes in the resolver cable connection. This can be done by setting either 92.02 EXC SIGNAL AMPL or 92.03 EXC SIGNAL FREQ to its already existing value, and then setting parameter 90.10 ENC PAR REFRESH to 1.

If the resolver (or absolute encoder) is used for feedback from a permanent magnet motor, an Autophasing ID run should be performed after replacement or any parameter changes. See parameter 99.13 IDRUN MODE and section *Autophasing* on page 41.

See also parameter group 90 on page 214, and *FEN-21 Resolver Interface User's Manual* (3AFE68784859 [English]).

| | | |
|---|---|---|
| Firmware block:<br>**RESOLVER CONF**<br>(92)<br>This block configures the resolver connection. | |  RESOLVER CONF<br>40<br>TLF11 10 msec<br>(3)<br>[ 1 ]<br>[ 4.0 Vrms ]<br>[ 1 kHz ]<br>92.01 RESOLV POLEPAIRS<br>92.02 EXC SIGNAL AMPL<br>92.03 EXC SIGNAL FREQ |
| **92.01** | RESOLV POLEPAIRS | FW block: RESOLVER CONF (see above) |
| | Selects the number of pole pairs. | |
| | 1…32 | Number of pole pairs. |
| **92.02** | EXC SIGNAL AMPL | FW block: RESOLVER CONF (see above) |
| | Defines the amplitude of the excitation signal. | |
| | 4.0…12.0 Vrms | Excitation signal amplitude. |
| **92.03** | EXC SIGNAL FREQ | FW block: RESOLVER CONF (see above) |
| | Defines the frequency of the excitation signal. | |
| | 1…20 kHz | Excitation signal frequency. |

## Group 93 PULSE ENC CONF

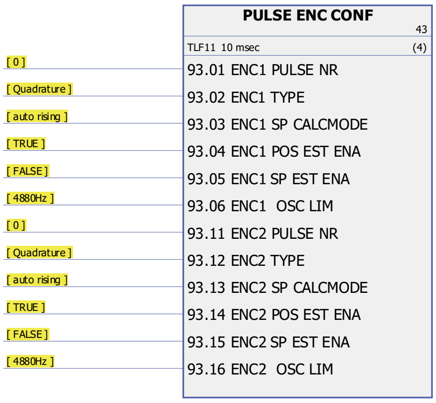
TTL/HTL input and TTL output configuration. See also parameter group 90 on page 214, and the appropriate encoder extension module manual.

Parameters 93.01…93.06 are used when a TTL/HTL encoder is used as encoder 1 (see parameter 90.01 ENCODER 1 SEL).

Parameters 93.11…93.16 are used when a TTL/HTL encoder is used as encoder 2 (see parameter 90.02 ENCODER 2 SEL).

Typically, only parameter 93.01/93.11 needs to be set for TTL/HTL encoders.

**Note:** Configuration data is written into the logic registers of the adapter once after the power-up. If parameter values are changed, save values into the permanent memory by parameter 16.07 PARAM SAVE. The new settings will take effect when the drive is powered up again, or after re-configuration is forced by parameter 90.10 ENC PAR REFRESH.

| | | |
|---|---|---|
| Firmware block:<br>**PULSE ENC CONF**<br>(93)<br>This block configures the TTL/HTL input and TTL output. | |  PULSE ENC CONF<br>43<br>TLF11 10 msec<br>(4)<br>[ 0 ]<br>93.01 ENC1 PULSE NR<br>[ Quadrature ]<br>93.02 ENC1 TYPE<br>[ auto rising ]<br>93.03 ENC1 SP CALCMODE<br>[ TRUE ]<br>93.04 ENC1 POS EST ENA<br>[ FALSE ]<br>93.05 ENC1 SP EST ENA<br>[ 4880Hz ]<br>93.06 ENC1 OSC LIM<br>[ 0 ]<br>93.11 ENC2 PULSE NR<br>[ Quadrature ]<br>93.12 ENC2 TYPE<br>[ auto rising ]<br>93.13 ENC2 SP CALCMODE<br>[ TRUE ]<br>93.14 ENC2 POS EST ENA<br>[ FALSE ]<br>93.15 ENC2 SP EST ENA<br>[ 4880Hz ]<br>93.16 ENC2 OSC LIM |
| **93.01** | ENC1 PULSE NR | FW block: PULSE ENC CONF (see above) |
| | Defines the pulse number per revolution for encoder 1. | |
| | 0…65535 | Pulses per revolution for encoder 1. |
| **93.02** | ENC1 TYPE | FW block: PULSE ENC CONF (see above) |
| | Selects the type of encoder 1. | |
| | **(0)** Quadrature | Quadrature encoder (two channels, channels A and B). |
| | **(1)** single track | Single track encoder (one channel, channel A). |
| **93.03** | ENC1 SP CALCMODE | FW block: PULSE ENC CONF (see above) |
| | Selects the speed calculation mode for encoder 1.<br>*When single track mode has been selected by parameter 93.02 ENC1 TYPE, the speed is always positive. | |

<table>
<tr><td></td><td><b>(0)</b> A&B all</td><td>Channels A and B: Rising and falling edges are used for speed calculation. Channel B: Defines the direction of rotation. *<br><b>Note:</b> When single track mode has been selected by parameter 93.02 ENC1 TYPE, setting 0 acts like setting 1.</td></tr>
<tr><td></td><td><b>(1)</b> A all</td><td>Channel A: Rising and falling edges are used for speed calculation. Channel B: Defines the direction of rotation. *</td></tr>
<tr><td></td><td><b>(2)</b> A rising</td><td>Channel A: Rising edges are used for speed calculation. Channel B: Defines the direction of rotation. *</td></tr>
<tr><td></td><td><b>(3)</b> A falling</td><td>Channel A: Falling edges are used for speed calculation. Channel B: Defines the direction of rotation. *</td></tr>
<tr><td></td><td><b>(4)</b> auto rising<br><b>(5)</b> auto falling</td><td>Used mode (0, 1, 2 or 3) is changed automatically depending on the pulse frequency according to the following table:
<table>
<tr><th>93.03 = 4</th><th>93.03 = 5</th><th rowspan="2">Pulse frequency of the channel(s)</th></tr>
<tr><th colspan="2">Used mode</th></tr>
<tr><td>0</td><td>0</td><td>&lt; 2442 Hz</td></tr>
<tr><td>1</td><td>1</td><td>2442…4884 Hz</td></tr>
<tr><td>2</td><td>3</td><td>&gt; 4884 Hz</td></tr>
</table></td></tr>
<tr><td><b>93.04</b></td><td>ENC1 POS EST ENA</td><td>FW block: PULSE ENC CONF (see above)</td></tr>
<tr><td></td><td colspan="2">Selects whether position estimation is used with encoder 1 to increase position data resolution or not.</td></tr>
<tr><td></td><td><b>(0)</b> FALSE</td><td>Measured position (Resolution: 4 x pulses per revolution for quadrature encoders, 2 x pulses per revolution for single track encoders.)</td></tr>
<tr><td></td><td><b>(1)</b> TRUE</td><td>Estimated position. (Uses position extrapolation. Extrapolated at the time of data request.)</td></tr>
<tr><td><b>93.05</b></td><td>ENC1 SP EST ENA</td><td>FW block: PULSE ENC CONF (see above)</td></tr>
<tr><td></td><td colspan="2">Selects whether calculated or estimated speed is used with encoder 1.</td></tr>
<tr><td></td><td><b>(0)</b> FALSE</td><td>Last calculated speed (calculation interval is 62.5 µs…4 ms).</td></tr>
<tr><td></td><td><b>(1)</b> TRUE</td><td>Estimated speed (estimated at the time of data request) Estimation increases the speed ripple in steady state operation, but improves the dynamics.</td></tr>
<tr><td><b>93.06</b></td><td>ENC1 OSC LIM</td><td>FW block: PULSE ENC CONF (see above)</td></tr>
<tr><td></td><td colspan="2">Activates transient filter for encoder 1. Changes of direction of rotation are ignored above the selected pulse frequency.</td></tr>
<tr><td></td><td><b>(0)</b> 4880Hz</td><td>Change in rotation of direction allowed below 4880 Hz.</td></tr>
<tr><td></td><td><b>(1)</b> 2440Hz</td><td>Change in rotation of direction allowed below 2440 Hz.</td></tr>
<tr><td></td><td><b>(2)</b> 1220Hz</td><td>Change in rotation of direction allowed below 1220 Hz.</td></tr>
<tr><td></td><td><b>(3)</b> Disabled</td><td>Change in rotation of direction allowed at any pulse frequency.</td></tr>
</table>

| | | |
|---|---|---|
| **93.07** | ENC1 PULSE FILT | FW block: PULSE ENC CONF (see above) |
| | Selects pulse edge filtering settings for encoder 1. Pulse edge filtering can improve the reliability of measurements, especially from encoders with a single-ended connection.<br>**Note:** Requires FEN-31 FPGA logic version VIE3 2200 or later.<br>**Note:** Pulse edge filtering decreases the maximum pulse frequency. With 2 µs filtering time, the maximum pulse frequency is 200 kHz. | |
| | **(0)** No filtering | Filtering disabled. |
| | **(1)** 1 µs | Filtering time: 1 microsecond. |
| | **(2)** 2 µs | Filtering time: 2 microseconds. |
| **93.11** | ENC2 PULSE NR | FW block: PULSE ENC CONF (see above) |
| | Defines the pulse number per revolution for encoder 2. | |
| | 0…65535 | Pulses per revolution for encoder 2. |
| **93.12** | ENC2 TYPE | FW block: PULSE ENC CONF (see above) |
| | Selects the type of encoder 2. For selections, see parameter 93.02 ENC1 TYPE. | |
| **93.13** | ENC2 SP CALCMODE | FW block: PULSE ENC CONF (see above) |
| | Selects the speed calculation mode for encoder 2.<br>For selections, see parameter 93.03 ENC1 SP CALCMODE. | |
| **93.14** | ENC2 POS EST ENA | FW block: PULSE ENC CONF (see above) |
| | Selects whether measured or estimated position is used with encoder 2.<br>For selections, see parameter 93.04 ENC1 POS EST ENA. | |
| **93.15** | ENC2 SP EST ENA | FW block: PULSE ENC CONF (see above) |
| | Selects whether calculated or estimated speed is used with encoder 2.<br>For selections, see parameter 93.05 ENC1 SP EST ENA. | |
| **93.16** | ENC2 OSC LIM | FW block: PULSE ENC CONF (see above) |
| | Activates transient filter for encoder 2. Changes of direction of rotation are ignored above the selected pulse frequency.<br>For selections, see parameter 93.06 ENC1 OSC LIM. | |

| | | |
|---|---|---|
| **93.17** | ENC2 PULSE FILT | FW block: PULSE ENC CONF (see above) |
| | Selects pulse edge filtering settings for encoder 2. Pulse edge filtering can improve the reliability of measurements, especially from encoders with a single-ended connection.<br>**Note:** Requires FEN-31 FPGA logic version VIE3 2200 or later.<br>**Note:** Pulse edge filtering decreases the maximum pulse frequency. With 2 µs filtering time, the maximum pulse frequency is 200 kHz. | |
| | **(0)** No filtering | Filtering disabled. |
| | **(1)** 1 µs | Filtering time: 1 microsecond. |
| | **(2)** 2 µs | Filtering time: 2 microseconds. |
| **93.21** | EMUL PULSE NR | FW block: ENCODER (page 214) |
| | Defines the number of TTL pulses per revolution used in encoder emulation.<br>Encoder emulation is enabled by parameter 90.03 EMUL MODE SEL. | |
| | 0…65535 | TTL pulses used in encoder emulation. |
| **93.22** | EMUL POS REF | FW block: ENCODER (page 214) |
| | Selects the source for the position value used in encoder emulation when parameter 90.03 EMUL MODE SEL is set to (1) FEN-01 SWref, (4) FEN-11 SWref, (7) FEN-21 SWref or (10) FEN-31 SWref. See parameter group 90.<br>The source can be any actual or reference position value (except 1.09 ENCODER 1 POS and 1.11 ENCODER 2 POS). | |
| | Value pointer: Group and index | |
| **93.23** | EMUL POS OFFSET | FW block: None |
| | Defines the zero point for emulated position in relation of the zero point of the input position (within one revolution). The input position is selected by parameter 90.03 EMUL MODE SEL.<br>For example, if the offset is 0, an emulated zero pulse is generated each time the input position moves across 0. With an offset of 0.5, an emulated zero pulse is generated each time the input position (within one revolution) moves across 0.5. | |
| | 0 … 0.99998 rev | Emulated zero pulse position offset. |

## Group 95 HW CONFIGURATION

Miscellaneous hardware-related settings.

| | | |
|---|---|---|
| **95.01** | CTRL UNIT SUPPLY | FW block: None |
| | Defines the manner in which the drive control unit is powered. | |
| | **(0)** Internal 24V | The drive control unit is powered from the drive power unit it is mounted on. |
| | **(1)** External 24V | The drive control unit is powered from an external power supply. |
| **95.02** | EXTERNAL CHOKE | FW block: None |
| | Defines if the drive is equipped with an AC choke or not. | |
| | **(0)** NO | The drive is not equipped with an AC choke. |
| | **(1)** YES | The drive is equipped with an AC choke. |

## Group 97 USER MOTOR PAR

User adjustment of motor model values estimated during motor ID run. The values can be entered in either “per unit” or SI.

| | | |
|---|---|---|
| **97.01** | USE GIVEN PARAMS | FW block: None |
| | Activates the motor model parameters 97.02…97.14 and the rotor angle offset parameter 97.20.<br>**Notes:**<br>• Parameter value is automatically set to zero when motor ID run is selected by parameter 99.13 IDRUN MODE. The values of parameters 97.02…97.20 are updated according to the motor characteristics identified during the motor ID run.<br>• This parameter cannot be changed while the drive is running. | |
| | **(0)** NoUserPars | Parameters 97.02…97.20 inactive. |
| | **(1)** UserMotPars | The values of parameters 97.02…97.14 are used in the motor model. |
| | **(2)** UserPosOffs | The value of parameter 97.20 is used as the rotor angle offset. Parameters 97.02…97.14 are inactive. |
| | **(3)** AllUserPars | The values of parameters 97.02…97.14 are used in the motor model, and the value of parameter 97.20 is used as the rotor angle offset. |
| **97.02** | RS USER | FW block: None |
| | Defines the stator resistance $R_S$ of the motor model. | |
| | 0…0.5 p.u. (per unit) | Stator resistance. |
| **97.03** | RR USER | FW block: None |
| | Defines the rotor resistance $R_R$ of the motor model.<br>**Note:** This parameter is valid only for asynchronous motors. | |
| | 0…0.5 p.u. (per unit) | Rotor resistance. |
| **97.04** | LM USER | FW block: None |
| | Defines the main inductance $L_M$ of the motor model.<br>**Note:** This parameter is valid only for asynchronous motors. | |
| | 0…10 p.u. (per unit) | Main inductance. |
| **97.05** | SIGMAL USER | FW block: None |
| | Defines the leakage inductance $\sigma L_S$.<br>**Note:** This parameter is valid only for asynchronous motors. | |
| | 0…1 p.u. (per unit) | Leakage inductance. |
| **97.06** | LD USER | FW block: None |
| | Defines the direct axis (synchronous) inductance.<br>**Note:** This parameter is valid only for permanent magnet motors. | |
| | 0…10 p.u. (per unit) | Direct axis (synchronous) inductance. |

| | | |
|---|---|---|
| **97.07** | LQ USER | FW block: None |
| | Defines the quadrature axis (synchronous) inductance.<br>**Note:** This parameter is valid only for permanent magnet motors. | |
| | 0…10 p.u. (per unit) | Quadrature axis (synchronous) inductance. |
| **97.08** | PM FLUX USER | FW block: None |
| | Defines the permanent magnet flux.<br>**Note:** This parameter is valid only for permanent magnet motors. | |
| | 0…2 p.u. (per unit) | Permanent magnet flux. |
| **97.09** | RS USER SI | FW block: None |
| | Defines the stator resistance $R_S$ of the motor model. | |
| | 0.00000…100.00000 ohm | Stator resistance. |
| **97.10** | RR USER SI | FW block: None |
| | Defines the rotor resistance $R_R$ of the motor model.<br>**Note:** This parameter is valid only for asynchronous motors. | |
| | 0.00000…100.00000 ohm | Rotor resistance. |
| **97.11** | LM USER SI | FW block: None |
| | Defines the main inductance $L_M$ of the motor model.<br>**Note:** This parameter is valid only for asynchronous motors. | |
| | 0.00…100000.00 mH | Main inductance. |
| **97.12** | SIGL USER SI | FW block: None |
| | Defines the leakage inductance $\sigma L_S$.<br>**Note:** This parameter is valid only for asynchronous motors. | |
| | 0.00…100000.00 mH | Leakage inductance. |
| **97.13** | LD USER SI | FW block: None |
| | Defines the direct axis (synchronous) inductance.<br>**Note:** This parameter is valid only for permanent magnet motors. | |
| | 0.00…100000.00 mH | Direct axis (synchronous) inductance. |
| **97.14** | LQ USER SI | FW block: None |
| | Defines the quadrature axis (synchronous) inductance.<br>**Note:** This parameter is valid only for permanent magnet motors. | |
| | 0.00…100000.00 mH | Quadrature axis (synchronous) inductance. |

| 97.18 | SIGNAL INJECTION | FW block: None |
|---|---|---|
| | Enables signal injection. A high frequency alternating signal is injected to the motor at the low speed region to improve the stability of torque control. Signal injection can be enabled with different amplitude levels.<br>**Note:** Use as low a level as possible that gives satisfactory performance. Signal injection cannot be applied to asynchronous motors. | |
| | **(0)** Disabled | Signal injection is disabled. |
| | **(1)** Enabled5% | Signal injection is enabled with an amplitude level of 5%. |
| | **(2)** Enabled10% | Signal injection is enabled with an amplitude level of 10%. |
| | **(3)** Enabled15% | Signal injection is enabled with an amplitude level of 15%. |
| | **(4)** Enabled20% | Signal injection is enabled with an amplitude level of 20%. |
| **97.20** | POS OFFSET USER | FW block: None |
| | Defines an angle offset between the zero position of the synchronous motor and the zero position of the position sensor.<br>**Notes:**<br>• The value is in electrical degrees. The electrical angle equals the mechanical angle multiplied by the number of motor pole pairs.<br>• This parameter is valid only for permanent magnet motors. | |
| | 0…360° | Angle offset. |

## Group 98 MOTOR CALC VALUES

Calculated motor values.

| | | |
|---|---|---|
| **98.01** | TORQ NOM SCALE | FW block: None |
| | Nominal torque in N•m which corresponds to 100%.<br>**Note:** This parameter is copied from parameter 99.12 MOT NOM TORQUE if given. Otherwise the value is calculated. | |
| | 0…2147483 Nm | Nominal torque. |
| **98.02** | POLEPAIRS | FW block: None |
| | Calculated number of motor pole pairs.<br>**Note:** This parameter cannot be set by the user. | |
| | 0…1000 | Calculated number of motor pole pairs. |

## Group 99 START-UP DATA

Start-up settings such as language, motor data and motor control mode.

The nominal motor values must be set before the drive is started; for detailed instructions, see chapter *Start-up* on page 17.

With DTC motor control mode, parameters 99.06…99.10 must be set; better control accuracy is achieved by also setting parameters 99.11 and 99.12.

With scalar control, parameters 99.06…99.09 must be set.

| **99.01** | LANGUAGE | FW block: None |
|---|---|---|
| | Selects the language.<br>**Note:** Not all languages listed below are necessarily supported. | |
| | **(0809h)** ENGLISH | English. |
| | **(0407h)** DEUTSCH | German. |
| | **(0410h)** ITALIANO | Italian. |
| | **(040Ah)** ESPAÑOL | Spanish. |
| | **(041Dh)** SVENSKA | Swedish. |
| | **(041Fh)** TÜRKÇE | Turkish. |
| **99.04** | MOTOR TYPE | FW block: None |
| | Selects the motor type.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | **(0)** AM | Asynchronous motor. Three phase AC voltage supplied induction motor with squirrel cage rotor. |
| | **(1)** PMSM | Permanent magnet motor. Three phase AC voltage supplied synchronous motor with permanent magnet rotor and sinusoidal BackEMF voltage. |

| **99.05** | MOTOR CTRL MODE | FW block: None |
|---|---|---|
| | Selects the motor control mode.<br>DTC (Direct torque control) mode is suitable for most applications.<br>Scalar control is suitable for special cases where DTC cannot be applied. In Scalar Control, the drive is controlled with a frequency reference. The outstanding motor control accuracy of DTC cannot be achieved in scalar control. There are some standard features that are disabled in the scalar control mode, for example motor identification run (99.13), torque limits in parameter group 20, DC hold and DC magnetising (11.04…11.06, 11.01).<br>**Note:** Correct motor run requires that the magnetising current of the motor does not exceed 90 percent of the nominal current of the inverter.<br>**Note:** Scalar control mode must be used<br>• with multimotor applications 1) if the load is not equally shared between the motors, 2) if the motors are of different sizes, or 3) if the motors are going to be changed after the motor identification,<br>• if the nominal current of the motor is less than 1/6 of the nominal output current of the drive, or<br>• if the drive is used with no motor connected (eg, for test purposes). | |
| | **(0)** DTC | Direct torque control mode. |
| | **(1)** Scalar | Scalar control mode. |
| **99.06** | MOT NOM CURRENT | FW block: None |
| | Defines the nominal motor current. Must be equal to the value on the motor rating plate. If several motors are connected to the inverter, enter the total current of the motors.<br>**Note:** Correct motor run requires that the magnetising current of the motor does not exceed 90 percent of the nominal current of the inverter.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | 0…32767 A | Nominal motor current.<br>**Note:** The allowed range is 1/6…2 × $I_{2N}$ of drive for direct control mode (parameter 99.05 MOTOR CTRL MODE = (0) DTC). For scalar control mode (parameter 99.05 MOTOR CTRL MODE = (1) Scalar), the allowed range is 0…2 × $I_{2N}$ of drive. |
| **99.07** | MOT NOM VOLTAGE | FW block: None |
| | Defines the nominal motor voltage. Nominal voltage is a fundamental phase to phase rms voltage, which is supplied to the motor at the nominal operating point. This parameter value must be equal to the value on the asynchronous motor name plate.<br>**Note:** Make sure the motor is connected correctly (star or delta) in accordance to the rating plate.<br>**Note:** With permanent magnet motors, the nominal voltage is the BackEMF voltage (at motor nominal speed). If the voltage is given as voltage per rpm, eg, 60 V per 1000 rpm, the voltage for 3000 rpm nominal speed is 3 × 60 V = 180 V. Note that the nominal voltage is not equal to the equivalent DC motor voltage (E.D.C.M.) value given by some motor manufactures. The nominal voltage can be calculated by dividing the E.D.C.M. voltage by 1.7 (= square root of 3).<br>**Note:** The stress on the motor insulations is always dependent on the drive supply voltage. This also applies to the case where the motor voltage rating is lower than the rating of the drive and the supply of the drive.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | 0…32767 V | Nominal motor voltage.<br>**Note:** The allowed range is 1/6…2 × $U_N$ of drive. |

| | | |
|---|---|---|
| **99.08** | MOT NOM FREQ | FW block: None |
| | Defines the nominal motor frequency.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | 5…500 Hz | Nominal motor frequency. |
| **99.09** | MOT NOM SPEED | FW block: None |
| | Defines the nominal motor speed. Must be equal to the value on the motor rating plate. When parameter value is changed, check the speed limits in parameter group 20.<br>**Note:** This parameter cannot be changed while the drive is running.<br>**Note:** For safety reasons, after motor ID run, the maximum and minimum speed limits (parameters 20.01 and 20.02) are automatically set to a 1.2 times bigger value than the nominal motor speed. | |
| | 0…30000 rpm | Nominal motor speed. |
| **99.10** | MOT NOM POWER | FW block: None |
| | Defines the nominal motor power. Must be equal to the value on the motor rating plate. If several motors are connected to the inverter, enter the total power of the motors. Set also parameter 99.11 MOT NOM COSFII.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | 0…10000 kW | Nominal motor power. |
| **99.11** | MOT NOM COSFII | FW block: None |
| | Defines the cosphi (not applicable to permanent magnet motors) for a more accurate motor model. Not obligatory; if set, should be equal to the value on the motor rating plate.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | 0…1 | Cosphi (0 = parameter disabled). |
| **99.12** | MOT NOM TORQUE | FW block: None |
| | Defines the nominal motor shaft torque for a more accurate motor model. Not obligatory.<br>**Note:** This parameter cannot be changed while the drive is running. | |
| | 0…2147483 Nm | Nominal motor shaft torque. |

| **99.13** | IDRUN MODE | FW block: None |
|---|---|---|
| | Selects the type of the motor identification performed at the next start of the drive in DTC mode. During the identification, the drive will identify the characteristics of the motor for optimum motor control. After the motor ID run, the drive is stopped. **Note:** This parameter cannot be changed while the drive is running.<br>Once the motor ID run is activated, it can be cancelled by stopping the drive: If motor ID run has already been performed once, parameter is automatically set to (0) No. If no motor ID run has been performed yet, parameter is automatically set to (3) Standstill. In this case, the motor ID run must be performed.<br>**Notes:**<br>• Motor ID run can only be performed in local control (ie, when drive is controlled via PC tool or control panel).<br>• Motor ID run cannot be performed if parameter 99.05 MOTOR CTRL MODE is set to (1) Scalar.<br>• Motor ID run must be performed every time any of the motor parameters (99.04, 99.06…99.12) have been changed. Parameter is automatically set to STANDSTILL after the motor parameters have been set.<br>• With permanent magnet motor, the motor shaft must NOT be locked and the load torque must be < 10% during the motor ID run (Normal/Reduced/Standstill).<br>• Mechanical brake (if present) is not opened during the motor ID run.<br>• Ensure that possible Safe Torque Off and emergency stop circuits are closed during motor ID run. | |
| | **(0)** No | No motor ID run is requested. This mode can be selected only if the motor ID run (Normal/Reduced/Standstill) has already been performed once. |
| | **(1)** Normal | Guarantees the best possible control accuracy. The motor ID run takes about 90 seconds. This mode should be selected whenever it is possible.<br>**Note:** The driven machinery must be de-coupled from the motor with Normal ID run:<br>• if the load torque is higher than 20%.<br>• if the machinery is not able to withstand the nominal torque transient during the motor ID run.<br>**Note:** Check the direction of rotation of the motor before starting the motor ID run. During the run, the motor will rotate in the forward direction.<br>⚠ **WARNING!** The motor will run at up to approximately 50…100% of the nominal speed during the motor ID run. ENSURE THAT IT IS SAFE TO RUN THE MOTOR BEFORE PERFORMING THE MOTOR ID RUN! |

| | | |
|---|---|---|
| | **(2)** Reduced | Reduced ID run. This mode should be selected instead of the Normal ID run<br>• if mechanical losses are higher than 20% (ie, the motor cannot be de-coupled from the driven equipment), or<br>• if flux reduction is not allowed while the motor is running (ie, in case of a motor with an integrated brake supplied from the motor terminals), or<br>• if large speed vibrations are detected during the Normal ID run.<br>With Reduced ID run, the control in the field weakening area or at high torques is not necessarily as accurate as with the Normal ID run. Reduced ID run is completed faster than the Normal ID run (< 90 seconds).<br>**Note:** Check the direction of rotation of the motor before starting the motor ID run. During the run, the motor will rotate in the forward direction.<br>⚠ **WARNING!** The motor will run at up to approximately 50…100% of the nominal speed during the motor ID run. ENSURE THAT IT IS SAFE TO RUN THE MOTOR BEFORE PERFORMING THE MOTOR ID RUN! |
| | **(3)** Standstill | Standstill ID run. The motor is injected with DC current. With asynchronous motor, the motor shaft is not rotating (with permanent magnet motor the shaft can rotate < 0.5 revolution).<br>**Note:** This mode should be selected only if the Normal or Reduced ID run is not possible due to the restrictions caused by the connected mechanics (eg, with lift or crane applications). |
| | **(4)** Autophasing | During autophasing, the start angle of the motor is determined. Note that other motor model values are not updated. See also parameter 11.07 AUTOPHASING MODE, and section *Autophasing* on page 41.<br>**Notes:**<br>• Autophasing can only be selected after the Normal/Reduced/ Standstill ID run has been performed once. Autophasing is used when an absolute encoder, a resolver or an encoder with commutation signals has been added/changed to a permanent magnet motor and there is no need to perform the Normal/Reduced/ Standstill ID run again.<br>• During Autophasing the motor shaft must NOT be locked and the load torque must be < 5%. |
| | **(5)** Cur meas cal | Current offset and gain measurement calibration. The calibration will be performed at next start. |

| | | |
|---|---|---|
| | **(6)** Advanced | Advanced ID run. Guarantees the best possible control accuracy. The motor ID run can take a couple of minutes. This mode should be selected when top performance is needed in the whole operating area.<br>**Notes:**<br>• The driven machinery must be de-coupled from the motor because of high torque and speed transients that are applied.<br>• During the run, the motor may rotate both in the forward and reverse direction.<br>⚠ **WARNING!** The motor may run at up to the maximum (positive) and minimum (negative) allowed speed during the motor ID run. Several accelerations and decelerations are done. The maximum torque, current and speed allowed by the limit parameters may be utilized. ENSURE THAT IT IS SAFE TO RUN THE MOTOR BEFORE PERFORMING THE MOTOR ID RUN! |
| | **(7)** Adv standstill | Advanced standstill ID run. This mode is recommended with asynchronous motors up to 75 kW instead of the Standstill ID run if:<br>• the actual nominal ratings of the motor is not known<br>• the control performance of the motor is not satisfactory after a Standstill ID run.<br>**Note:** The performance of this mode depends on the motor size. With small motors, the ID run completes in 5 minutes. With bigger motors, the ID run takes up to 60 minutes. |
| **99.16** | PHASE INVERSION | FW block: None |
| | Switches the rotation direction of the motor. This parameter can be used if the motor turns in the wrong direction (for example, because of the wrong phase order in the motor cable), and correcting the cabling is considered impractical.<br>**Note:** After changing this parameter, the sign of encoder feedback (if any) must be checked. This can be done by comparing the sign of parameter 1.14 SPEED ESTIMATED to that of 1.08 ENCODER 1 SPEED (or 1.10 ENCODER 2 SPEED). If the signs are in conflict, the encoder wiring must be corrected. | |
| | **(0)** No | Normal. |
| | **(1)** Yes | Reversed rotation direction. |

# Parameter data

## What this chapter contains

This chapter lists the parameters of the drive with some additional data. For the parameter descriptions, see chapter Parameters and firmware blocks.

## Terms

| Term | Definition |
|---|---|
| Actual signal | Signal measured or calculated by the drive. Can be monitored by the user. No user setting is possible. |
| Def | Default value |
| enum | Enumerated list, ie, selection list |
| FbEq | Fieldbus equivalent: The scaling between the value shown on the panel and the integer used in serial communication. |
| Page no. | Page number for more information |
| INT32 | 32-bit integer value (31 bits + sign) |
| Bit pointer | Bit pointer. A bit pointer points to a single bit in the value of another parameter. |
| Val pointer | Value pointer. A value pointer points to the value of another parameter. |
| Parameter | An operation instruction of the drive that is often user-adjustable. Parameters that are signals measured or calculated by the drive are called actual signals. |
| Pb | Packed boolean |
| PT | Parameter protection type. See WP, WPD and WP0. |
| REAL | $\underbrace{\text{16-bit value}}_{\text{= integer value}}\ \underbrace{\text{16-bit value}}_{\text{= fractional value}}$ (31 bits + sign) |
| REAL24 | $\underbrace{\text{8-bit value}}_{\text{= integer value}}\ \underbrace{\text{24-bit value}}_{\text{= fractional value}}$ (31 bits + sign) |
| Save PF | Parameter setting is protected against power failure. |
| Type | Data type. See enum, INT32, Bit pointer, Val pointer, Pb, REAL, REAL24, UINT32. |
| UINT32 | 32-bit unsigned integer value |
| WP | Write protected parameter (ie, read only) |
| WPD | Write protected parameter while drive is running |
| WP0 | Parameter can only be set to zero. |

## Fieldbus equivalent

Serial communication data between fieldbus adapter and drive is transferred in integer format. Thus the drive actual and reference signal values must be scaled to 16/32-bit integer values. Fieldbus equivalent defines the scaling between the signal value and the integer used in serial communication.

All the read and sent values are limited to 16/32 bits.

Example: If 32.04 MAXIMUM TORQ REF is set from external control system, an integer value of 10 corresponds to 1%.

## Pointer parameter format in fieldbus communication

Value and bit pointer parameters are transferred between the fieldbus adapter and drive as 32-bit integer values.

### 32-bit integer value pointers

When a value pointer parameter is connected to the value of another parameter, the format is as follows:

| | **Bit** | | | |
|---|---|---|---|---|
| | **30…31** | **16…29** | **8…15** | **0…7** |
| **Name** | Source type | Not in use | Group | Index |
| **Value** | 1 | - | 1…255 | 1…255 |
| **Description** | Value pointer is connected to parameter/signal. | - | Group of source parameter | Index of source parameter |

For example, the value that should be written into parameter 33.02 SUPERV1 ACT to change its value to 1.07 DC-VOLTAGE is
0100 0000 0000 0000 0000 0001 0000 0111 = 1073742087 (32-bit integer).

When a value pointer parameter is connected to an application program, the format is as follows:

| | **Bit** | | |
|---|---|---|---|
| | **30…31** | **24…29** | **0…23** |
| **Name** | Source type | Not in use | Address |
| **Value** | 2 | - | 0 … $2^{24}$-1 |
| **Description** | Value pointer is connected to application program. | - | Relative address of application program variable |

**Note:** Value pointer parameters which are connected to an application program cannot be set via fieldbus (ie, read access only).

### 32-bit integer bit pointers

When a bit pointer parameter is connected to value 0 or 1, the format is as follows:

| | Bit | | | |
|---|---|---|---|---|
| | **30…31** | **16…29** | **1…15** | **0** |
| **Name** | Source type | Not in use | Not in use | Value |
| **Value** | 0 | - | - | 0…1 |
| **Description** | Bit pointer is connected to 0/1. | - | - | 0 = False, 1 = True |

When a bit pointer is connected to a bit value of another parameter, the format is as follows:

| | Bit | | | | |
|---|---|---|---|---|---|
| | **30…31** | **24…29** | **16…23** | **8…15** | **0…7** |
| **Name** | Source type | Not in use | Bit sel | Group | Index |
| **Value** | 1 | - | 0…31 | 2…255 | 1…255 |
| **Description** | Bit pointer is connected to signal bit value. | - | Bit selection | Group of source parameter | Index of source parameter |

When a bit pointer parameter is connected to an application program, the format is as follows:

| | Bit | | |
|---|---|---|---|
| | **30…31** | **24…29** | **0…23** |
| **Name** | Source type | Bit sel | Address |
| **Value** | 2 | 0…31 | 0 … $2^{24}$-1 |
| **Description** | Bit pointer is connected to application program. | Bit selection | Relative address of application program variable |

**Note:** Bit pointer parameters which are connected to an application program cannot be set via fieldbus (ie, read access only).

## Actual signals (Parameter groups 1…9)

| Index | Name | Type | Range | Unit | FbEq | Update time | Data length | PT | Save PF | Page no. |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | ACTUAL VALUES | | | | | | | | | |
| 1.01 | SPEED ACT | REAL | -30000…30000 | rpm | 1 = 100 | 250 µs | 32 | WP | | 93 |
| 1.02 | SPEED ACT PERC | REAL | -1000…1000 | % | 1 = 100 | 2 ms | 32 | WP | | 93 |
| 1.03 | FREQUENCY | REAL | -30000…30000 | Hz | 1 = 100 | 2 ms | 32 | WP | | 93 |
| 1.04 | CURRENT | REAL | 0…30000 | A | 1 = 100 | 10 ms | 32 | WP | | 93 |
| 1.05 | CURRENT PERC | REAL | 0…1000 | % | 1 = 10 | 2 ms | 16 | WP | | 93 |
| 1.06 | TORQUE | REAL | -1600…1600 | % | 1 = 10 | 2 ms | 16 | WP | | 93 |
| 1.07 | DC-VOLTAGE | REAL | - | V | 1 = 100 | 2 ms | 32 | WP | | 93 |
| 1.08 | ENCODER 1 SPEED | REAL | - | rpm | 1 = 100 | 250 µs | 32 | WP | | 93 |
| 1.09 | ENCODER 1 POS | REAL24 | - | rev | 1=100000000 | 250 µs | 32 | WP | | 93 |
| 1.10 | ENCODER 2 SPEED | REAL | - | rpm | 1 = 100 | 250 µs | 32 | WP | | 94 |
| 1.11 | ENCODER 2 POS | REAL24 | - | rev | 1=100000000 | 250 µs | 32 | WP | | 94 |
| 1.12 | POS ACT | REAL | -32768…32767 | rev | 1 = 1000 | 250 µs | 32 | WP | | 94 |
| 1.13 | POS 2ND ENC | REAL | -32768…32767 | revs | 1 = 1 | 250 µs | 32 | WP | | 94 |
| 1.14 | SPEED ESTIMATED | REAL | -30000…30000 | rpm | 1 = 100 | 2 ms | 32 | WP | | 94 |
| 1.15 | TEMP INVERTER | REAL24 | -40…160 | °C | 1 = 10 | 2 ms | 16 | WP | | 94 |
| 1.16 | TEMP BC | REAL24 | -40…160 | °C | 1 = 10 | 2 ms | 16 | WP | | 94 |
| 1.17 | MOTOR TEMP | REAL | -10…250 | °C | 1 = 10 | 10 ms | 16 | WP | | 94 |
| 1.18 | MOTOR TEMP EST | INT32 | -60…1000 | °C | 1 = 1 | 10 ms | 16 | WP | x | 94 |
| 1.19 | USED SUPPLY VOLT | REAL | 0…1000 | V | 1 = 10 | 10 ms | 16 | WP | | 94 |
| 1.20 | BRAKE RES LOAD | REAL24 | 0…1000 | % | 1 = 1 | 50 ms | 16 | WP | | 94 |
| 1.21 | CPU USAGE | UINT32 | 0…100 | % | 1 = 1 | 100 ms | 16 | WP | | 94 |
| 1.22 | INVERTER POWER | REAL | $-2^{31}…2^{31} - 1$ | kW | 1 = 100 | 10 ms | 32 | WP | | 95 |
| 1.26 | ON TIME COUNTER | INT32 | 0…35791394.1 | h | 1 = 100 | 10 ms | 32 | WP0 | x | 95 |
| 1.27 | RUN TIME COUNTER | INT32 | 0…35791394.1 | h | 1 = 100 | 10 ms | 32 | WP0 | x | 95 |
| 1.28 | FAN ON-TIME | INT32 | 0…35791394.1 | h | 1 = 100 | 10 ms | 32 | WP0 | x | 95 |
| 1.31 | MECH TIME CONST | REAL | 0…32767 | s | 1 = 1000 | 10 ms | 32 | WP | x | 95 |
| 1.38 | TEMP INT BOARD | REAL24 | -40…160 | °C | 1 = 10 | 2 ms | 16 | WP | | 95 |
| 1.39 | OUTPUT VOLTAGE | REAL | 0…1000 | V | 1 = 1 | 10 ms | 16 | WP | | 95 |
| 1.42 | FAN START COUNT | INT32 | 0...2147483647 | - | 1 = 1 | 10 ms | 32 | WP | x | 95 |
| 02 | I/O VALUES | | | | | | | | | |
| 2.01 | DI STATUS | Pb | 0…0x3F | - | 1 = 1 | 2 ms | 16 | WP | | 96 |
| 2.02 | RO STATUS | Pb | - | - | 1 = 1 | 2 ms | 16 | WP | | 96 |
| 2.03 | DIO STATUS | Pb | - | - | 1 = 1 | 2 ms | 16 | WP | | 96 |
| 2.04 | AI1 | REAL | - | V or mA | 1 = 1000 | 2 ms | 16 | WP | | 96 |
| 2.05 | AI1 SCALED | REAL | - | - | 1 = 1000 | 250 µs | 32 | WP | | 96 |
| 2.06 | AI2 | REAL | - | V or mA | 1 = 1000 | 2 ms | 16 | WP | | 96 |
| 2.07 | AI2 SCALED | REAL | - | - | 1 = 1000 | 250 µs | 32 | WP | | 96 |
| 2.08 | AO1 | REAL | - | mA | 1 = 1000 | 2 ms | 16 | WP | | 96 |
| 2.09 | AO2 | REAL | - | V | 1 = 1000 | 2 ms | 16 | WP | | 96 |
| 2.10 | DIO2 FREQ IN | REAL | -32768…32768 | - | 1 = 1000 | 2 ms | 32 | WP | | 96 |
| 2.11 | DIO3 FREQ OUT | REAL | -32768…32768 | Hz | 1 = 1000 | 2 ms | 32 | WP | | 96 |

| Index | Name | Type | Range | Unit | FbEq | Update time | Data length | PT | Save PF | Page no. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.12 | FBA MAIN CW | Pb | 0 … 0xFFFFFFFF | - | 1 = 1 | 500 µs | 32 | WP | | 97 |
| 2.13 | FBA MAIN SW | Pb | 0 … 0xFFFFFFFF | - | 1 = 1 | 500 µs | 32 | WP | | 99 |
| 2.14 | FBA MAIN REF1 | INT32 | $-2^{31}…2^{31} - 1$ | - | 1 = 1 | 500 µs | 32 | WP | | 100 |
| 2.15 | FBA MAIN REF2 | INT32 | $-2^{31}…2^{31} - 1$ | - | 1 = 1 | 500 µs | 32 | WP | | 100 |
| 2.16 | FEN DI STATUS | Pb | 0…0x33 | - | 1 = 1 | 500 µs | 16 | WP | | 100 |
| 2.17 | D2D MAIN CW | Pb | 0…0xFFFF | - | 1 = 1 | 500 µs | 16 | WP | | 100 |
| 2.18 | D2D FOLLOWER CW | Pb | 0…0xFFFF | - | 1 = 1 | 2 ms | 16 | WP | | 101 |
| 2.19 | D2D REF1 | REAL | $-2^{31}…2^{31} - 1$ | - | 1 = 1 | 500 µs | 32 | WP | | 101 |
| 2.20 | D2D REF2 | REAL | $-2^{31}…2^{31} - 1$ | - | 1 = 1 | 2 ms | 32 | WP | | 101 |
| 03 | CONTROL VALUES | | | | | | | | | |
| 3.01 | SPEED REF1 | REAL | -30000…30000 | rpm | 1 = 100 | 500 µs | 32 | WP | | 102 |
| 3.02 | SPEED REF2 | REAL | -30000…30000 | rpm | 1 = 100 | 500 µs | 32 | WP | | 102 |
| 3.03 | SPEEDREF RAMP IN | REAL | -30000…30000 | rpm | 1 = 100 | 500 µs | 32 | WP | | 102 |
| 3.04 | SPEEDREF RAMPED | REAL | -30000…30000 | rpm | 1 = 100 | 500 µs | 32 | WP | | 102 |
| 3.05 | SPEEDREF USED | REAL | -30000…30000 | rpm | 1 = 100 | 250 µs | 32 | WP | | 102 |
| 3.06 | SPEED ERROR FILT | REAL | -30000…30000 | rpm | 1 = 100 | 250 µs | 32 | WP | | 102 |
| 3.07 | ACC COMP TORQ | REAL | -1600…1600 | % | 1 = 10 | 250 µs | 16 | WP | | 102 |
| 3.08 | TORQ REF SP CTRL | REAL | -1600…1600 | % | 1 = 10 | 250 µs | 16 | WP | | 102 |
| 3.09 | TORQ REF1 | REAL | -1000…1000 | % | 1 = 10 | 500 µs | 16 | WP | | 102 |
| 3.10 | TORQ REF RAMPED | REAL | -1000…1000 | % | 1 = 10 | 500 µs | 16 | WP | | 102 |
| 3.11 | TORQ REF RUSHLIM | REAL | -1000…1000 | % | 1 = 10 | 250 µs | 16 | WP | | 102 |
| 3.12 | TORQUE REF ADD | REAL | -1000…1000 | % | 1 = 10 | 250 µs | 16 | WP | | 102 |
| 3.13 | TORQ REF TO TC | REAL | -1600…1600 | % | 1 = 10 | 250 µs | 16 | WP | | 102 |
| 3.14 | BRAKE TORQ MEM | REAL | -1000…1000 | % | 1 = 10 | 2 ms | 16 | WP | x | 102 |
| 3.15 | BRAKE COMMAND | enum | 0…1 | - | 1 = 1 | 2 ms | 16 | WP | | 103 |
| 3.16 | FLUX REF USED | REAL24 | 0…200 | % | 1 = 1 | 2 ms | 16 | WP | | 103 |
| 3.17 | TORQUE REF USED | REAL | -1600…1600 | % | 1 = 10 | 250 µs | 32 | WP | | 103 |
| 3.20 | MAX SPEED REF | REAL | 0…30000 | rpm | 1 = 100 | 2 ms | 16 | WP | | 103 |
| 3.21 | MIN SPEED REF | REAL | -30000…0 | rpm | 1 = 100 | 2 ms | 16 | WP | | 103 |
| 06 | DRIVE STATUS | | | | | | | | | |
| 6.01 | STATUS WORD 1 | Pb | 0…65535 | - | 1 = 1 | 2 ms | 16 | WP | | 104 |
| 6.02 | STATUS WORD 2 | Pb | 0…65535 | - | 1 = 1 | 2 ms | 16 | WP | | 105 |
| 6.03 | SPEED CTRL STAT | Pb | 0…31 | - | 1 = 1 | 250 µs | 16 | WP | | 106 |
| 6.05 | LIMIT WORD 1 | Pb | 0…255 | - | 1 = 1 | 250 µs | 16 | WP | | 106 |
| 6.07 | TORQ LIM STATUS | Pb | 0…65535 | - | 1 = 1 | 250 µs | 16 | WP | | 107 |
| 6.12 | OP MODE ACK | enum | 0…11 | - | 1 = 1 | 2 ms | 16 | WP | | 107 |
| 6.14 | SUPERV STATUS | Pb | 0…65535 | - | 1 = 1 | 2 ms | 16 | WP | | 107 |
| 6.17 | BIT INVERTER SW | Pb | 0b000000… 0b111111 | - | 1 = 1 | 2 ms | 16 | WP | | 108 |
| 08 | ALARMS & FAULTS | | | | | | | | | |
| 8.01 | ACTIVE FAULT | enum | 0…65535 | - | 1 = 1 | - | 16 | WP | | 109 |
| 8.02 | LAST FAULT | enum | 0…65535 | - | 1 = 1 | - | 16 | WP | | 109 |
| 8.03 | FAULT TIME HI | INT32 | $-2^{31}…2^{31} - 1$ | days | 1 = 1 | - | 32 | WP | | 109 |

| Index | Name | Type | Range | Unit | FbEq | Update time | Data length | PT | Save PF | Page no. |
|---|---|---|---|---|---|---|---|---|---|---|
| 8.04 | FAULT TIME LO | INT32 | $-2^{31}...2^{31}-1$ | time | 1 = 1 | - | 32 | WP | | 109 |
| 8.05 | ALARM LOGGER 1 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 109 |
| 8.06 | ALARM LOGGER 2 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 110 |
| 8.07 | ALARM LOGGER 3 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 110 |
| 8.08 | ALARM LOGGER 4 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 111 |
| 8.09 | ALARM LOGGER 5 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 111 |
| 8.10 | ALARM LOGGER 6 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 111 |
| 8.15 | ALARM WORD 1 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 112 |
| 8.16 | ALARM WORD 2 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 112 |
| 8.17 | ALARM WORD 3 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 113 |
| 8.18 | ALARM WORD 4 | UINT32 | - | - | 1 = 1 | 2 ms | 16 | WP0 | | 113 |
| 09 | SYSTEM INFO | | | | | | | | | |
| 9.01 | DRIVE TYPE | INT32 | 0…65535 | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.02 | DRIVE RATING ID | INT32 | 0…65535 | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.03 | FIRMWARE ID | Pb | - | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.04 | FIRMWARE VER | Pb | - | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.05 | FIRMWARE PATCH | Pb | - | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.10 | INT LOGIC VER | Pb | - | - | 1 = 1 | - | 32 | WP | | 114 |
| 9.11 | SLOT 1 VIE NAME | INT32 | 0x0000…0xFFFF | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.12 | SLOT 1 VIE VER | INT32 | 0x0000…0xFFFF | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.13 | SLOT 2 VIE NAME | INT32 | 0x0000…0xFFFF | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.14 | SLOT 2 VIE VER | INT32 | 0x0000…0xFFFF | - | 1 = 1 | - | 16 | WP | | 114 |
| 9.20 | OPTION SLOT 1 | INT32 | 0…18 | - | 1 = 1 | - | 16 | WP | | 115 |
| 9.21 | OPTION SLOT 2 | INT32 | 0…18 | - | 1 = 1 | - | 16 | WP | | 115 |
| 9.22 | OPTION SLOT 3 | INT32 | 0…18 | - | 1 = 1 | - | 16 | WP | | 115 |

## Parameter groups 10…99

| Index | Parameter | Type | Range | Unit | FbEq | Update time | Data length | Def | PT | Save PF | Page no. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | START/STOP | | | | | | | | | | |
| 10.01 | EXT1 START FUNC | enum | 0…6 | - | - | 2 ms | 16 | 1 | WPD | | 117 |
| 10.02 | EXT1 START IN1 | Bit pointer | | - | | 2 ms | 32 | P.02.01.00 | WPD | | 117 |
| 10.03 | EXT1 START IN2 | Bit pointer | | - | | 2 ms | 32 | C.False | WPD | | 118 |
| 10.04 | EXT2 START FUNC | enum | 0…6 | - | - | 2 ms | 16 | 1 | WPD | | 118 |
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| 25.05 | SHAPE TIME ACC1 | REAL | 0…1000 | s | 1 = 1000 | 10 ms | 32 | 0 | | | 156 |
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| 26.06 | SPD ERR FTIME | REAL | 0…1000 | ms | 1 = 10 | 2 ms | 16 | 0 | | | 160 |
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| 26.08 | ACC COMP DERTIME | REAL | 0…600 | s | 1 = 100 | 2 ms | 32 | 0 | | | 160 |
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| 33.06 | SUPERV2 ACT | Val pointer | | - | | 2 ms | 32 | P.01.04 | | | 174 |
| 33.07 | SUPERV2 LIM HI | REAL | -32768… 32768 | - | 1 = 100 | 2 ms | 32 | 0 | | | 174 |
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| 35.04 | BRAKE CLOSE DLY | UINT32 | 0…60 | s | 1 = 100 | 2 ms | 16 | 0 | | | 182 |
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| 35.06 | BRAKE OPEN TORQ | REAL | 0…1000 | % | 1 = 10 | 2 ms | 16 | 0 | | | 182 |
| 35.07 | BRAKE CLOSE REQ | Bit pointer | | - | | 2 ms | 32 | C.False | WPD | | 182 |
| 35.08 | BRAKE OPEN HOLD | Bit pointer | | - | | 2 ms | 32 | C.False | WPD | | 182 |
| 35.09 | BRAKE FAULT FUNC | enum | 0…2 | - | 1 = 1 | 2 ms | 16 | 0 | | | 183 |
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| 40.01 | FLUX REF | REAL | 0…200 | % | 1 = 1 | 10 ms | 16 | 100 | | | 184 |
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| 40.03 | SLIP GAIN | REAL | 0…200 | % | 1 = 1 | - | | 100 | | | 185 |
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| 40.05 | FLUX OPT | enum | 0…1 | - | 1 = 1 | - | | - | | | 185 |
| 40.06 | FORCE OPEN LOOP | enum | 0…1 | - | 1 = 1 | 250 µs | 16 | 0 | | | 185 |
| 40.07 | IR COMPENSATION | REAL24 | 0…50 | % | 1 = 100 | 2 ms | 32 | 0 | | | 186 |
| 40.10 | FLUX BRAKING | enum | 0…2 | - | 1 = 1 | - | 16 | 0 | | | 186 |
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| 46.01 | EXTERNAL FAULT | Bit pointer | | - | | 2 ms | 32 | C.True | | | 192 |
| 46.02 | SPEED REF SAFE | REAL | -30000… 30000 | rpm | 1 = 1 | 2 ms | 16 | 0 | | | 192 |
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| … | … | … | … | … | … | | …. | … | | | |
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| 51.33 | FBA APPL SW VER | UINT32 | 0…65536 | - | 1 = 1 | | 16 | 0 | | x | 205 |
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| 52.01 | FBA DATA IN1 | UINT32 | 0…9999 | - | 1 = 1 | | 16 | 0 | | x | 206 |
| … | … | … | … | … | … | | … | … | | | - |
| 52.12 | FBA DATA IN12 | UINT32 | 0…9999 | - | 1 = 1 | | 16 | 0 | | x | 206 |
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| 53.01 | FBA DATA OUT1 | UINT32 | 0…9999 | - | 1 = 1 | | 16 | 0 | | x | 207 |
| … | … | … | … | … | … | | … | … | | | |
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| 57.03 | NODE ADDRESS | UINT32 | 1…62 | - | 1 = 1 | 10 ms | 16 | 1 | WPD | | 210 |
| 57.04 | FOLLOWER MASK 1 | UINT32 | $0…2^{31}$ | - | 1 = 1 | 10 ms | 32 | 0 | WPD | | 210 |
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| 57.06 | REF 1 SRC | Val pointer | | - | | 10 ms | 32 | P.03.04 | | | 210 |
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| 90.05 | ENC CABLE FAULT | UINT32 | 0…2 | - | 1 = 1 | | 16 | 1 | | | 217 |
| 90.06 | INVERT ENC SIG | enum | 0…3 | - | 1 = 1 | - | 16 | 0 | | | 217 |
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| 91.05 | REFMARK ENA | UINT32 | 0…1 | - | 1 = 1 | | 16 | 0 | | | 219 |
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| 91.10 | HIPERFACE PARITY | UINT32 | 0…1 | - | 1 = 1 | | 16 | 0 | | | 220 |
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| 91.25 | SSI MODE | UINT32 | 0…3 | - | 1 = 1 |  | 16 | 0 |  |  | 221 |
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| 91.27 | SSI ZERO PHASE | UINT32 | 0…3 | - | 1 = 1 |  | 16 | 0 |  |  | 222 |
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| 93 | PULSE ENC CONF |  |  |  |  |  |  |  |  |  |  |
| 93.01 | ENC1 PULSE NR | UINT32 | 0…65535 | - | 1 = 1 |  | 16 | 0 |  |  | 225 |
| 93.02 | ENC1 TYPE | enum | 0…1 | - | 1 = 1 |  | 16 | 0 |  |  | 225 |
| 93.03 | ENC1 SP CALCMODE | enum | 0….5 | - | 1 = 1 |  | 16 | 4 |  |  | 225 |
| 93.04 | ENC1 POS EST ENA | enum | 0…1 | - | 1 = 1 |  | 16 | 1 |  |  | 226 |
| 93.05 | ENC1 SP EST ENA | enum | 0…1 | - | 1 = 1 |  | 16 | 0 |  |  | 226 |
| 93.06 | ENC1 OSC LIM | enum | 0…3 | - | 1 = 1 |  | 16 | 0 |  |  | 226 |
| 93.07 | ENC1 PULSE FILT | UINT32 | 0…2 | - | 1 = 1 |  | 16 | 0 |  |  | 227 |
| 93.11 | ENC2 PULSE NR | UINT32 | 0…65535 | - | 1 = 1 |  | 16 | 0 |  |  | 227 |
| 93.12 | ENC2 TYPE | enum | 0…1 | - | 1 = 1 |  | 16 | 0 |  |  | 227 |
| 93.13 | ENC2 SP CALCMODE | enum | 0….5 | - | 1 = 1 |  | 16 | 4 |  |  | 227 |
| 93.14 | ENC2 POS EST ENA | enum | 0…1 | - | 1 = 1 |  | 16 | 1 |  |  | 227 |
| 93.15 | ENC2 SP EST ENA | enum | 0…1 | - | 1 = 1 |  | 16 | 0 |  |  | 227 |
| 93.16 | ENC2 OSC LIM | enum | 0…3 | - | 1 = 1 |  | 16 | 0 |  |  | 227 |
| 93.17 | ENC2 PULSE FILT | UINT32 | 0…2 | - | 1 = 1 |  | 16 | 0 |  |  | 228 |
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| 97.03 | RR USER | REAL24 | 0…0.5 | p.u. | 1 = 100000 |  | 32 | 0 |  |  | 230 |
| 97.04 | LM USER | REAL24 | 0…10 | p.u. | 1 = 100000 |  | 32 | 0 |  |  | 230 |
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| 97.07 | LQ USER | REAL24 | 0…10 | p.u. | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.08 | PM FLUX USER | REAL24 | 0…2 | p.u. | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.09 | RS USER SI | REAL24 | 0…100 | ohm | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.10 | RR USER SI | REAL24 | 0…100 | ohm | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.11 | LM USER SI | REAL24 | 0…100000 | mH | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.12 | SIGL USER SI | REAL24 | 0…100000 | mH | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.13 | LD USER SI | REAL24 | 0…100000 | mH | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.14 | LQ USER SI | REAL24 | 0…100000 | mH | 1 = 100000 | | 32 | 0 | | | 231 |
| 97.18 | SIGNAL INJECTION | UINT32 | 0…4 | - | 1 = 1 | | 16 | 0 | | | 232 |
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| 98 | MOTOR CALC VALUES | | | | | | | | | | |
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| 99.01 | LANGUAGE | enum | | - | 1 = 1 | | 16 | | | | 234 |
| 99.04 | MOTOR TYPE | enum | 0…1 | - | 1 = 1 | | 16 | 0 | WPD | | 234 |
| 99.05 | MOTOR CTRL MODE | enum | 0…1 | - | 1 = 1 | | 16 | 0 | | | 235 |
| 99.06 | MOT NOM CURRENT | REAL | 0…6400 | A | 1 = 10 | | 32 | 0 | WPD | | 235 |
| 99.07 | MOT NOM VOLTAGE | REAL | 80…960 | V | 1 = 10 | | 32 | 0 | WPD | | 235 |
| 99.08 | MOT NOM FREQ | REAL | 0…500 | Hz | 1 = 10 | | 32 | 0 | WPD | | 236 |
| 99.09 | MOT NOM SPEED | REAL | 0…30000 | rpm | 1 = 1 | | 32 | 0 | WPD | | 236 |
| 99.10 | MOT NOM POWER | REAL | 0…10000 | kW | 1 = 100 | | 32 | 0 | WPD | | 236 |
| 99.11 | MOT NOM COSFII | REAL24 | 0…1 | - | 1 = 100 | | 32 | 0 | WPD | | 236 |
| 99.12 | MOT NOM TORQUE | INT32 | 0…2147483 | Nm | 1 = 1000 | | 32 | 0 | WPD | | 236 |
| 99.13 | IDRUN MODE | enum | 0…7 | - | 1 = 1 | | 16 | 0 | WPD | | 237 |
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# Fault tracing

## What this chapter contains

The chapter lists all alarm and fault messages including the possible cause and corrective actions.

## Safety

**WARNING!** Only qualified electricians are allowed to maintain the drive. The *Safety Instructions* on the first pages of the appropriate hardware manual must be read before you start working with the drive.

## Alarm and fault indications

The alarm/fault code is displayed on the control panel of the drive, as well as the DriveStudio PC tool. An alarm or a fault message indicates abnormal drive status. Most alarm and fault causes can be identified and corrected using this information. If not, an ABB representative should be contacted.

The four-digit code number in brackets after the message is for the fieldbus communication.

The alarm/fault code is displayed on the 7-segment display of the drive. The following table describes the indications given by the 7-segment display.

| Display | Meaning |
|---|---|
| "E-" followed by error code | System error.<br>9001…9002 = Control unit hardware failure.<br>9003 = No memory unit connected.<br>9004 = Memory unit failure.<br>9007…9008 = Loading of firmware from memory unit failed.<br>9009…9018 = Internal error. Contact an ABB representative.<br>9019 = Contents of memory unit corrupted.<br>9020 = Internal error. Contact an ABB representative.<br>9021 = Program versions of memory unit and drive incompatible.<br>9022…9026 = Internal error. Contact an ABB representative.<br>9027 = Memory unit of out memory.<br>9102…9106 = Internal error. Contact an ABB representative.<br>9107…9108 = Application initialization fault.<br>9109…9111 = Internal error. Contact an ABB representative.<br>9112 = Problem with ACSM1 variant data (Speed / Motion). |
| "A-" followed by error code | Alarm. See section *Alarm messages generated by the drive* on page 235. |
| "F-" followed by error code | Fault. See section *Fault messages generated by the drive* on page 243. |

## How to reset

The drive can be reset either by pressing the reset key on the PC tool (✚) or control panel (***RESET***) or switching the supply voltage off for a while. When the fault has been removed, the motor can be restarted.

A fault can also be reset from an external source by parameter 10.08 FAULT RESET SEL.

## Fault history

When a fault is detected, it is stored in the fault logger with a time stamp. The fault history stores information on the 16 latest faults of the drive. Three of the latest faults are stored at the beginning of a power switch off.

Signals 8.01 ACTIVE FAULT and 8.02 LAST FAULT store the fault codes of the most recent faults.

Alarms can be monitored via bit words 8.05 ALARM LOGGER 1…8.10 ALARM LOGGER 6 and 8.15 ALARM WORD 1…8.18 ALARM WORD 4. Alarm information is lost at power switch off or fault reset.

## Alarm messages generated by the drive

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2000 | BRAKE START TORQUE<br>(0x7185)<br>Programmable fault: 35.09 BRAKE FAULT FUNC | Mechanical brake alarm. Alarm is activated if required motor starting torque, 35.06 BRAKE OPEN TORQ, is not achieved. | Check brake open torque setting, parameter 35.06.<br>Check drive torque and current limits. See firmware block LIMITS on page 141. |
| 2001 | BRAKE NOT CLOSED<br>(0x7186)<br>Programmable fault: 35.09 BRAKE FAULT FUNC | Mechanical brake control alarm. Alarm is activated, eg, if brake acknowledgement is not as expected during brake closing. | Check mechanical brake connection.<br>Check mechanical brake settings, parameters 35.01…35.09.<br>To determine whether problem is with acknowledgement signal or brake: Check if brake is closed or open. |
| 2002 | BRAKE NOT OPEN<br>(0x7187)<br>Programmable fault: 35.09 BRAKE FAULT FUNC | Mechanical brake control alarm. Alarm is activated, eg, if brake acknowledgement is not as expected during brake opening. | Check mechanical brake connection.<br>Check mechanical brake settings, parameters 35.01…35.08.<br>To determine whether problem is with acknowledgement signal or brake: Check if brake is closed or open. |
| 2003 | SAFE TORQUE OFF<br>(0xFF7A)<br>Programmable fault: 46.07 STO DIAGNOSTIC | Safe Torque Off function is active, ie, safety circuit signal(s) connected to connector X6 is lost while drive is stopped and parameter 46.07 STO DIAGNOSTIC is set to (2) Alarm. | Check safety circuit connections. For more information, see appropriate drive hardware manual and *Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives* (3AFE68929814 [English]). |
| 2005 | MOTOR TEMPERATURE<br>(0x4310)<br>Programmable fault: 45.01 MOT TEMP PROT | Estimated motor temperature (based on motor thermal model) has exceeded alarm limit defined by parameter 45.03 MOT TEMP ALM LIM. | Check motor ratings and load.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc.<br>Check value of alarm limit.<br>Check motor thermal model settings, parameters 45.06…45.08 and 45.10 MOT THERM TIME. |
| | | Measured motor temperature has exceeded alarm limit defined by parameter 45.03 MOT TEMP ALM LIM. | Check that actual number of sensors corresponds to value set by parameter 45.02 MOT TEMP SOURCE.<br>Check motor ratings and load.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc.<br>Check value of alarm limit. |
| 2006 | EMERGENCY OFF<br>(0xF083) | Drive has received emergency OFF2 command. | To restart drive, activate RUN ENABLE signal (source selected by parameter 10.09 RUN ENABLE) and start drive. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2007 | RUN ENABLE<br>(0xFF54) | No Run enable signal is received. | Check setting of parameter 10.09 RUN ENABLE. Switch signal on (eg, in the fieldbus Control Word) or check wiring of selected source. |
| 2008 | ID-RUN<br>(0xFF84) | Motor identification run is on. | This alarm belongs to normal start-up procedure. Wait until drive indicates that motor identification is completed. |
| | | Motor identification is required. | This alarm belongs to normal start-up procedure.<br>Select how motor identification should be performed, parameter 99.13 IDRUN MODE.<br>Start identification routines by pressing Start key. |
| 2009 | EMERGENCY STOP<br>(0xF081) | Drive has received emergency stop command (OFF1/OFF3). | Check that it is safe to continue operation.<br>Return emergency stop push button to normal position (or adjust the fieldbus Control Word accordingly).<br>Restart drive. |
| 2011 | BR OVERHEAT<br>(0x7112) | Braking resistor temperature has exceeded alarm limit defined by parameter 48.07 BR TEMP ALARMLIM. | Stop drive. Let resistor cool down.<br>Check resistor overload protection function settings, parameters 48.01…48.05.<br>Check alarm limit setting, parameter 48.07.<br>Check that braking cycle meets allowed limits. |
| 2012 | BC OVERHEAT<br>(0x7181) | Braking chopper IGBT temperature has exceeded internal alarm limit. | Let chopper cool down.<br>Check for excessive ambient temperature.<br>Check for cooling fan failure.<br>Check for obstructions in the air flow.<br>Check the dimensioning and cooling of the cabinet.<br>Check resistor overload protection function settings, parameters 48.01…48.05.<br>Check that braking cycle meets allowed limits.<br>Check that drive supply AC voltage is not excessive. |
| 2013 | DEVICE OVERTEMP<br>(0x4210) | Measured drive temperature has exceeded internal alarm limit. | Check ambient conditions.<br>Check air flow and fan operation.<br>Check heatsink fins for dust pick-up.<br>Check motor power against unit power. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2014 | INTBOARD OVERTEMP<br>(0x7182) | Interface board (between power unit and control unit) temperature has exceeded internal alarm limit. | Let drive cool down.<br>Check for excessive ambient temperature.<br>Check for cooling fan failure.<br>Check for obstructions in the air flow.<br>Check the dimensioning and cooling of the cabinet. |
| 2015 | BC MOD OVERTEMP<br>(0x7183) | Input bridge or braking chopper temperature has exceeded internal alarm limit. | Let drive cool down.<br>Check for excessive ambient temperature.<br>Check for cooling fan failure.<br>Check for obstructions in the air flow.<br>Check the dimensioning and cooling of the cabinet. |
| 2016 | IGBT OVERTEMP<br>(0x7184) | Drive temperature based on thermal model has exceeded internal alarm limit. | Check ambient conditions.<br>Check air flow and fan operation.<br>Check heatsink fins for dust pick-up.<br>Check motor power against unit power. |
| 2017 | FIELDBUS COMM<br>(0x7510)<br>Programmable fault: 50.02 COMM LOSS FUNC | Cyclical communication between drive and fieldbus adapter module or between PLC and fieldbus adapter module is lost. | Check status of fieldbus communication. See appropriate User's Manual of fieldbus adapter module.<br>Check fieldbus parameter settings. See parameter group 50 on page 200.<br>Check cable connections.<br>Check if communication master can communicate. |
| 2018 | LOCAL CTRL LOSS<br>(0x5300)<br>Programmable fault: 46.03 LOCAL CTRL LOSS | Control panel or PC tool selected as active control location for drive has ceased communicating. | Check PC tool or control panel connection.<br>Check control panel connector.<br>Replace control panel in mounting platform. |
| 2019 | AI SUPERVISION<br>(0x8110)<br>Programmable fault: 13.12 AI SUPERVISION | Analogue input AI1 or AI2 signal has reached limit defined by parameter 13.13 AI SUPERVIS ACT. | Check analogue input AI1/2 source and connections.<br>Check analogue input AI1/2 minimum and maximum limit settings, parameters 13.02 and 13.03 / 13.07 and 13.08. |
| 2020 | FB PAR CONF<br>(0x6320) | The drive does not have a functionality requested by PLC, or requested functionality has not been activated. | Check PLC programming.<br>Check fieldbus parameter settings. See parameter group 50 on page 200. |
| 2021 | NO MOTOR DATA<br>(0x6381) | Parameters in group 99 have not been set. | Check that all the required parameters in group 99 have been set.<br>**Note:** It is normal for this alarm to appear during the start-up until the motor data is entered. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2022 | ENCODER 1 FAILURE<br>(0x7301) | Encoder 1 has been activated by parameter but the encoder interface (FEN-xx) cannot be found. | Check parameter 90.01 ENCODER 1 SEL setting corresponds to encoder interface 1 (FEN-xx) installed in drive Slot 1/2 (signal 9.20 OPTION SLOT 1 / 9.21 OPTION SLOT 2).<br>**Note:** The new setting will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time. |
| 2023 | ENCODER 2 FAILURE<br>(0x7381) | Encoder 2 has been activated by parameter but the encoder interface (FEN-xx) cannot be found. | Check parameter 90.02 ENCODER 2 SEL setting corresponds to encoder interface 2 (FEN-xx) installed in drive Slot 1/2 (signal 9.20 OPTION SLOT 1 / 9.21 OPTION SLOT 2).<br>**Note:** The new setting will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time. |
| | | EnDat or SSI encoder is used in continuous mode as encoder 2.<br>[I.e. 90.02 ENCODER 2 SEL = (3) FEN-11 ABS<br>and<br>91.02 ABS ENC INTERF = (2) EnDat or (4) SSI)<br>and<br>91.30 ENDAT MODE = (1) Continuous (or 91.25 SSI MODE = (1) Continuous).] | If possible, use single position transfer instead of continuous position transfer (i.e. if encoder has incremental sin/cos signals):<br>- Change parameter 91.25 SSI MODE / 91.30 ENDAT MODE to value (0) Initial pos..<br>Otherwise use EnDat/SSI encoder as encoder 1:<br>- Change parameter 90.01 ENCODER 1 SEL to value (3) FEN-11 ABS and parameter 90.02 ENCODER 2 SEL to value (0) None.<br>**Note:** The new setting will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2026 | ENC EMULATION FAILURE<br>(0x7384) | Encoder emulation error | If position value used in emulation is measured by encoder:<br>- Check that FEN-xx encoder used in emulation (90.03 EMUL MODE SEL) corresponds to FEN-xx encoder interface 1 or (and) 2 activated by parameter 90.01 ENCODER 1 SEL / 90.02 ENCODER 2 SEL. (Parameter 90.01/90.02 activates the position calculation of the used FEN-xx input).<br>If position value used in emulation is determined by drive software:<br>- Check that FEN-xx encoder used in emulation (90.03 EMUL MODE SEL) corresponds to FEN-xx encoder interface 1 or (and) 2 activated by parameter 90.01 ENCODER 1 SEL / 90.02 ENCODER 2 SEL (because position data used in emulation is written to FEN-xx during encoder data request). Encoder interface 2 is recommended.<br>**Note:** The new setting will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time. |
| 2027 | FEN TEMP MEAS FAILURE<br>(0x7385) | Error in temperature measurement when temperature sensor (KTY or PTC) connected to encoder interface FEN-xx is used. | Check that parameter 45.02 MOT TEMP SOURCE setting corresponds to encoder interface installation (9.20 OPTION SLOT 1 / 9.21 OPTION SLOT 2):<br>If one FEN-xx module is used:<br>- Parameter 45.02 MOT TEMP SOURCE setting must be either (2) KTY 1st FEN or (5) PTC 1st FEN. FEN-xx module can be in either Slot 1 or Slot 2.<br>If two FEN-xx modules are used:<br>- When parameter 45.02 MOT TEMP SOURCE setting is (2) KTY 1st FEN or (5) PTC 1st FEN, the encoder installed in drive Slot 1 is used.<br>- When parameter 45.02 MOT TEMP SOURCE setting is (3) KTY 2nd FEN or (6) PTC 2nd FEN, the encoder installed in drive Slot 2 is used. |
| | | Error in temperature measurement when KTY sensor connected to encoder interface FEN-01 is used. | FEN-01 does not support temperature measurement with KTY sensor. Use PTC sensor or other encoder interface module. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2028 | ENC EMUL MAX FREQ<br>(0x7386) | TTL pulse frequency used in encoder emulation.exceeds maximum allowed limit (500 kHz). | Decrease parameter 93.21 EMUL PULSE NR value.<br>**Note:** The new setting will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time. |
| 2029 | ENC EMUL REF ERROR<br>(0x7387) | Encoder emulation has failed due to failure in writing new (position) reference for emulation. | Contact your local ABB representative. |
| 2030 | RESOLVER AUTOTUNE ERR<br>(0x7388) | Resolver autotuning routines, which are automatically started when resolver input is activated for the first time, have failed. | Check cable between resolver and resolver interface module (FEN-21) and order of connector signal wires at both ends of cable.<br>Check resolver parameter settings.<br>For resolver parameters and information, see parameter group 92 on page 224.<br>**Note:** Resolver autotuning routines should always be performed after resolver cable connection has been modified. Autotuning routines can be activated by setting parameter 92.02 EXC SIGNAL AMPL or 92.03 EXC SIGNAL FREQ, and then setting parameter 90.10 ENC PAR REFRESH to (1) Configure. |
| 2031 | ENCODER 1 CABLE<br>(0x7389) | Encoder 1 cable fault detected. | Check cable between FEN-xx interface and encoder 1. After any modifications in cabling, re-configure interface by switching drive power off and on, or by activating parameter 90.10 ENC PAR REFRESH. |
| 2032 | ENCODER 2 CABLE<br>(0x738A) | Encoder 2 cable fault detected. | Check cable between FEN-xx interface and encoder 2. After any modifications in cabling, re-configure interface by switching drive power off and on, or by activating parameter 90.10 ENC PAR REFRESH. |
| 2033 | D2D COMMUNICATION<br>(0x7520)<br>Programmable fault: 57.02 COMM LOSS FUNC | On the master drive: The drive has not been replied to by an activated follower for five consecutive polling cycles. | Check that all drives that are polled (parameters 57.04 and 57.05) on the drive-to-drive link are powered, properly connected to the link, and have the correct node address.<br>Check the drive-to-drive link wiring. |
| | | On a follower drive: The drive has not received new reference 1 and/or 2 for five consecutive reference handling cycles. | Check the settings of parameters 57.06 and 57.07 on the master drive.<br>Check the drive-to-drive link wiring. |
| 2034 | D2D BUFFER OVERLOAD<br>(0x7520)<br>Programmable fault: 57.02 COMM LOSS FUNC | Transmission of drive-to-drive references failed because of message buffer overflow. | Contact your local ABB representative. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2035 | PS COMM<br>(0x5480) | Communication errors detected between the JCU Control Unit and the power unit of the drive. | Check the connections between the JCU Control Unit and the power unit.<br>If the JCU is powered from an external supply, ensure that parameter 95.01 CTRL UNIT SUPPLY is set to (1) External 24V. |
| 2036 | RESTORE<br>(0x630D) | Restoration of backed-up parameters failed. | Contact your local ABB representative. |
| 2037 | CUR MEAS CALIBRATION<br>(0x2280) | Current measurement calibration will occur at next start. | Informative alarm. |
| 2038 | AUTOPHASING<br>(0x3187) | Autophasing will occur at next start. | Informative alarm. |
| 2039 | EARTH FAULT<br>(0x2330)<br>Programmable fault: 46.05 EARTH FAULT | Drive has detected load unbalance typically due to earth fault in motor or motor cable. | Check that there are no power factor correction capacitors or surge absorbers in motor cable.<br>Check that there is no earth fault in motor or motor cables:<br>- measure insulation resistances of motor and motor cable.<br>If no earth fault can be detected, contact your local ABB representative. |
| 2041 | MOTOR NOM VALUE<br>(0x6383) | The motor configuration parameters are set incorrectly. | Check the settings of the motor configuration parameters in group 99. |
| | | The drive is not dimensioned correctly. | Check that the drive is sized correctly for the motor. |
| 2042 | D2D CONFIG<br>(0x7583) | The settings of drive-to-drive link configuration parameters (group 57) are incompatible. | Check the settings of the parameters in group 57. |
| 2043 | STALL<br>(0x7121)<br>Programmable fault:<br>46.09 STALL FUNCTION | Motor is operating in stall region because of, eg, excessive load or insufficient motor power. | Check motor load and drive ratings.<br>Check fault function parameters. |
| 2047 | SPEED FEEDBACK<br>(0x8480) | No speed feedback is received. | Check the settings of the parameters in group 22.<br>Check encoder installation. See the description of fault 0039 (ENCODER1) for more information.<br>Check encoder cabling. See the descriptions of alarms 2031 (ENCODER 1 CABLE) and 2032 (ENCODER 2 CABLE) for more information. |

| Code | Alarm<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 2048 | OPTION COMM LOSS<br>(0x7000) | Communication between drive and option module (FEN-xx and/or FIO-xx) is lost. | Check that option modules are properly connected to Slot 1 and (or) Slot 2.<br>Check that option modules or Slot 1/2 connectors are not damaged. To determine whether module or connector is damaged: Test each module individually in Slot 1 and Slot 2. |
| 2072 | DC NOT CHARGED<br>(0x3250) | The voltage of the intermediate DC circuit has not yet risen to operating level. | Wait for the DC voltage to rise. |
| 2073 | SPEED CTRL TUNE FAIL<br>(0x8481) | Speed controller autotune routine did not finish successfully. | See parameter 28.16 PI TUNE MODE. |
| 2075 | LOW VOLT MODE CONFIG<br>(0xC015) | Low voltage mode has been activated but the parameter settings are outside allowable limits. | Check the Low voltage mode parameters in group 47. See also section *Low voltage mode* on page 47. |
| 2079 | ENC 1 PULSE FREQUENCY<br>(0x738B) | Encoder 1 is receiving too high data flow (pulse frequency). | Check encoder settings.<br>Change parameters 93.03 ENC1 SP CALCMODE and 93.13 ENC2 SP CALCMODE to use only one channel pulses/ edges. |
| 2080 | ENC 2 PULSE FREQUENCY<br>(0x738C) | Encoder 2 is receiving too high data flow (pulse frequency). | Check encoder settings.<br>Change parameters 93.03 ENC1 SP CALCMODE and 93.13 ENC2 SP CALCMODE to use only one channel pulses/ edges. |
| 2082 | BR DATA<br>(0x7113) | Brake chopper is configured wrong. | Check the brake chopper configuration in parameter group 48. |

## Fault messages generated by the drive

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0001 | OVERCURRENT<br>(0x2310) | Output current has exceeded internal fault limit. | Check motor load.<br>Check acceleration time. See parameter group 25 on page 155.<br>Check motor and motor cable (including phasing and delta/star connection).<br>Check that the start-up data in parameter group 99 corresponds to the motor rating plate.<br>Check that there are no power factor correction capacitors or surge absorbers in motor cable.<br>Check encoder cable (including phasing). |
| 0002 | DC OVERVOLTAGE<br>(0x3210) | Excessive intermediate circuit DC voltage. | Check that overvoltage controller is on, parameter 47.01 OVERVOLTAGE CTRL.<br>Check mains for static or transient overvoltage.<br>Check braking chopper and resistor (if used).<br>Check deceleration time.<br>Use coast-to-stop function (if applicable).<br>Retrofit frequency converter with braking chopper and braking resistor. |
| 0003 | DEVICE OVERTEMP<br>(0x4210) | Measured drive temperature has exceeded internal fault limit. | Check ambient conditions.<br>Check air flow and fan operation.<br>Check heatsink fins for dust pick-up.<br>Check motor power against unit power. |
| 0004 | SHORT CIRCUIT<br>(0x2340) | Short-circuit in motor cable(s) or motor. | Check motor and motor cable.<br>Check that there are no power factor correction capacitors or surge absorbers in motor cable.<br>Check the braking chopper cabling. |
|  | Extension: 1 | Short-circuit in the upper transistor of the U-phase. | Contact your local ABB representative. |
|  | Extension: 2 | Short-circuit in the lower transistor of the U-phase. | Contact your local ABB representative. |
|  | Extension: 4 | Short-circuit in the upper transistor of the V-phase. | Contact your local ABB representative. |
|  | Extension: 8 | Short-circuit in the lower transistor of the V-phase. | Contact your local ABB representative. |
|  | Extension: 16 | Short-circuit in the upper transistor of the W-phase. | Contact your local ABB representative. |
|  | Extension: 32 | Short-circuit in the lower transistor of the W-phase. | Contact your local ABB representative. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0005 | DC UNDERVOLTAGE<br>(0x3220) | Intermediate circuit DC voltage is not sufficient due to missing mains phase, blown fuse or rectifier bridge internal fault. | Check mains supply and fuses. |
| 0006 | EARTH FAULT<br>(0x2330)<br>Programmable fault: 46.05 EARTH FAULT | Drive has detected load unbalance typically due to earth fault in motor or motor cable. | Check that there are no power factor correction capacitors or surge absorbers in motor cable.<br>Check that there is no earth fault in motor or motor cables:<br>- measure insulation resistances of motor and motor cable.<br>If no earth fault can be detected, contact your local ABB representative. |
| 0007 | FAN FAULT<br>(0xFF83) | Fan is not able to rotate freely or fan is disconnected. Fan operation is monitored by measuring fan current. | Check fan operation and connection. |
| 0008 | IGBT OVERTEMP<br>(0x7184) | Drive temperature based on thermal model has exceeded internal fault limit. | Check ambient conditions.<br>Check air flow and fan operation.<br>Check heatsink fins for dust pick-up.<br>Check motor power against unit power. |
| 0009 | BC WIRING<br>(0x7111) | Braking resistor is missing, damaged or there is a problem in the resistor cabling.<br>Short circuit in the braking chopper IGBT. | Ensure that the braking resistor is connected and not damaged.<br>Replace the braking chopper. |
| 0010 | BC SHORT CIRCUIT<br>(0x7113) | Short circuit in the braking chopper IGBT. | Ensure that the braking resistor is connected and not damaged.<br>Replace the braking chopper. |
| 0011 | BC OVERHEAT<br>(0x7181) | Braking chopper IGBT temperature has exceeded internal fault limit. | Let chopper cool down.<br>Check for excessive ambient temperature.<br>Check for cooling fan failure.<br>Check for obstructions in the air flow.<br>Check the dimensioning and cooling of the cabinet.<br>Check resistor overload protection function settings, parameters 48.03…48.05.<br>Check that braking cycle meets allowed limits.<br>Check that drive supply AC voltage is not excessive. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0012 | BR OVERHEAT<br>(0x7112) | Braking resistor temperature has exceeded fault limit defined by parameter 48.06 BR TEMP FAULTLIM. | Stop drive. Let resistor cool down.<br>Check resistor overload protection function settings, parameters 48.01…48.05.<br>Check fault limit setting, parameter 48.06.<br>Check that braking cycle meets allowed limits. |
| 0013 | CURR MEAS GAIN<br>(0x3183) | Difference between output phase U2 and W2 current measurement gain is too great. | Contact your local ABB representative. |
| 0014 | CABLE CROSS CON<br>(0x3181)<br>Programmable fault: 46.08 CROSS CONNECTION | Incorrect input power and motor cable connection (ie, input power cable is connected to drive motor connection). | Check input power connections. This fault can be disabled after the drive has been commissioned until the input power cable or motor cable are disconnected again. |
| 0015 | SUPPLY PHASE<br>(0x3130)<br>Programmable fault: 46.06 SUPPL PHS LOSS | Intermediate circuit DC voltage is oscillating due to missing input power line phase or blown fuse. | Check input power line fuses.<br>Check for input power supply imbalance. |
| 0016 | MOTOR PHASE<br>(0x3182)<br>Programmable fault: 46.04 MOT PHASE LOSS | Motor circuit fault due to missing motor connection (all three phases are not connected). | Connect motor cable. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0017 | ID-RUN FAULT<br>(0xFF84) | Motor ID run is not completed successfully. | Check the fault logger for a fault code extension. See appropriate actions for each extension below. |
| | Extension: 1 | The motor ID run cannot be completed because the maximum current setting and/or the internal current limit of the drive is too low. | Check setting of parameters 99.06 MOT NOM CURRENT and 20.05 MAXIMUM CURRENT. Make sure that 20.05 MAXIMUM CURRENT > 99.06 MOT NOM CURRENT.<br>Check that the drive is dimensioned correctly according to the motor. |
| | Extension: 2 | The motor ID run cannot be completed because the maximum speed setting and/or calculated field weakening point is too low. | Check setting of parameters 99.07 MOT NOM VOLTAGE, 99.08 MOT NOM FREQ, 99.09 MOT NOM SPEED, 20.01 MAXIMUM SPEED and 20.02 MINIMUM SPEED. Make sure that<br>• 20.01 MAXIMUM SPEED > (0.55 × 99.09 MOT NOM SPEED) > (0.50 × synchronous speed),<br>• 20.02 MINIMUM SPEED ≤ 0, and<br>• supply voltage ≥ (0.66 × 99.07 MOT NOM VOLTAGE). |
| | Extension: 3 | The motor ID run cannot be completed because the maximum torque setting is too low. | Check setting of parameters 99.12 MOT NOM TORQUE and 20.06 MAXIMUM TORQUE. Make sure that 20.06 MAXIMUM TORQUE > 100%. |
| | Extension: 5…8 | Internal error. | Contact your local ABB representative. |
| | Extension: 9 | Asynchronous motors only: Acceleration did not finish within reasonable time. | Contact your local ABB representative. |
| | Extension: 10 | Asynchronous motors only: Deceleration did not finish within reasonable time. | Contact your local ABB representative. |
| | Extension: 11 | Asynchronous motors only: Speed dropped to zero during motor ID run. | Contact your local ABB representative. |
| | Extension: 12 | Permanent magnet motors only: First acceleration did not finish within reasonable time. | Contact your local ABB representative. |
| | Extension: 13 | Permanent magnet motors only: Second acceleration did not finish within reasonable time. | Contact your local ABB representative. |
| | Extension: 14…16 | Internal error. | Contact your local ABB representative. |
| 0018 | CURR U2 MEAS<br>(0x3184) | Measured offset error of U2 output phase current measurement is too great. (Offset value is updated during current calibration.) | Contact your local ABB representative. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0019 | CURR V2 MEAS<br>(0x3185) | Measured offset error of V2 output phase current measurement is too great. (Offset value is updated during current calibration.) | Contact your local ABB representative. |
| 0020 | CURR W2 MEAS<br>(0x3186) | Measured offset error of W2 output phase current measurement is too great. (Offset value is updated during current calibration.) | Contact your local ABB representative. |
| 0021 | STO1 LOST<br>(0x8182) | Safe Torque Off function is active, i.e. safety circuit signal 1 connected between X6:1 and X6:3 is lost while drive is at stopped state and parameter 46.07 STO DIAGNOSTIC setting is (2) Alarm or (3) No. | Check safety circuit connections. For more information, see the appropriate drive hardware manual and *Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives* (3AFE68929814 [English]). |
| 0022 | STO2 LOST<br>(0x8183) | Safe Torque Off function is active, i.e. safety circuit signal 2 connected between X6:2 and X6:4 is lost while drive is at stopped state and parameter 46.07 STO DIAGNOSTIC setting is (2) Alarm or (3) No. | Check safety circuit connections. For more information, see the appropriate drive hardware manual and *Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives* (3AFE68929814 [English]). |
| 0024 | INTBOARD OVERTEMP<br>(0x7182) | Interface board (between power unit and control unit) temperature has exceeded internal fault limit. | Let drive cool down.<br>Check for excessive ambient temperature.<br>Check for cooling fan failure.<br>Check for obstructions in the air flow.<br>Check the dimensioning and cooling of the cabinet. |
| 0025 | BC MOD OVERTEMP<br>(0x7183) | Input bridge or braking chopper temperature has exceeded internal fault limit. | Let drive cool down.<br>Check for excessive ambient temperature.<br>Check for cooling fan failure.<br>Check for obstructions in the air flow.<br>Check the dimensioning and cooling of the cabinet. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0026 | AUTOPHASING<br>(0x3187) | Autophasing routine failed because the estimated angle of the rotor differs too much from the measured angle of the rotor.<br>All other reasons for the autophasing fault are explained in section *Autophasing* on page 41. | Try other autophasing modes (see parameter 11.07 AUTOPHASING MODE) if possible.<br>In addition, repeat autophasing multiple times and check the value in parameter 97.20 POS OFFSET USER between separate runs (see section Autophasing). The value should not change between consecutive autophasing runs.<br>Check that there is no slip in the encoder connection to the motor axle. Because of the slip the estimated and measured drive speed may differ during fast accelerations/ decelerations. |
| 0027 | PU LOST<br>(0x5400) | Connection between the JCU Control Unit and the power unit of the drive is lost. | Check the connections between the JCU Control Unit and the power unit.<br>If the JCU is powered from an external supply, ensure that parameter 95.01 CTRL UNIT SUPPLY is set to (1) External 24V. |
| 0028 | PS COMM<br>(0x5480) | Communication errors detected between the JCU Control Unit and the power unit of the drive. | Check the connections between the JCU Control Unit and the power unit.<br>If the JCU is powered from an external supply, ensure that parameter 95.01 CTRL UNIT SUPPLY is set to (1) External 24V. |
| 0029 | IN CHOKE TEMP<br>(0xFF81) | Temperature of internal AC choke excessive. | Check cooling fan. |
| 0030 | EXTERNAL<br>(0x9000) | Fault in external device. (This information is configured through one of programmable digital inputs.) | Check external devices for faults.<br>Check setting of parameter 46.01 EXTERNAL FAULT. |
| 0031 | SAFE TORQUE OFF<br>(0xFF7A)<br>Programmable fault: 46.07 STO DIAGNOSTIC | Safe Torque Off function is active, i.e. safety circuit signal(s) connected to connector X6 is lost<br>- during drive start or drive run<br>or<br>- while drive is stopped and parameter 46.07 STO DIAGNOSTIC setting is (1) Fault. | Check safety circuit connections. For more information, see the appropriate drive hardware manual and *Application guide - Safe torque off function for ACSM1, ACS850 and ACQ810 drives* (3AFE68929814 [English]). |
| 0032 | OVERSPEED<br>(0x7310) | Motor is turning faster than highest allowed speed due to incorrectly set minimum/ maximum speed, insufficient braking torque or changes in load when using torque reference. | Check minimum/maximum speed settings, parameters 20.01 MAXIMUM SPEED and 20.02 MINIMUM SPEED.<br>Check adequacy of motor braking torque.<br>Check applicability of torque control.<br>Check need for braking chopper and resistor(s). |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0033 | BRAKE START TORQUE<br>(0x7185)<br>Programmable fault: 35.09 BRAKE FAULT FUNC | Mechanical brake fault. Fault is activated if required motor starting torque, 35.06 BRAKE OPEN TORQ, is not achieved. | Check brake open torque setting, parameter 35.06.<br>Check drive torque and current limits. See parameter group 20 on page 141. |
| 0034 | BRAKE NOT CLOSED<br>(0x7186)<br>Programmable fault: 35.09 BRAKE FAULT FUNC | Mechanical brake control fault. Fault is activated if brake acknowledgement is not as expected during brake closing. | Check mechanical brake connection.<br>Check mechanical brake settings, parameters 35.01…35.09.<br>To determine whether problem is with acknowledgement signal or brake: Check if brake is closed or open. |
| 0035 | BRAKE NOT OPEN<br>(0x7187)<br>Programmable fault: 35.09 BRAKE FAULT FUNC | Mechanical brake control fault. Fault is activated if brake acknowledgement is not as expected during brake opening. | Check mechanical brake connection.<br>Check mechanical brake settings, parameters 35.01…35.08.<br>To determine whether problem is with acknowledgement signal or brake: Check if brake is closed or open. |
| 0036 | LOCAL CTRL LOSS<br>(0x5300)<br>Programmable fault: 46.03 LOCAL CTRL LOSS | Control panel or PC tool selected as active control location for drive has ceased communicating. | Check PC tool or control panel connection.<br>Check control panel connector.<br>Replace control panel in mounting platform. |
| 0037 | NVMEMCORRUPTED<br>(0x6320) | Drive internal fault<br>**Note:** This fault cannot be reset. | Check the fault logger for a fault code extension. See appropriate actions for each extension below. |
|  | Fault code extension: 2051 | Total number of parameters (including unused space between parameters) exceeds firmware maximum. | Move parameters from the firmware groups to the application groups.<br>Reduce the number of parameters. |
|  | Fault code extension: Other | Drive internal fault. | Contact your local ABB representative. |
| 0038 | OPTION COMM LOSS<br>(0x7000) | Communication between drive and option module (FEN-xx and/or FIO-xx) is lost. | Check that option modules are properly connected to Slot 1 and (or) Slot 2.<br>Check that option modules or Slot 1/2 connectors are not damaged. To determine whether module or connector is damaged: Test each module individually in Slot 1 and Slot 2. |
|  |  | Speed feedback (22.01 SPEED FB SEL) has been selected from an encoder which does not supply a speed feedback. SSI and EnDat type absolute encoders do not supply speed feedback when in the 'Continuous' mode (91.25 SSI MODE, 91.30 ENDAT MODE). | In this case, either the estimated speed value must be used, or another encoder mode must be selected. Check parameters 22.01 SPEED FB SEL and 91.25 SSI MODE/91.30 ENDAT MODE. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0039 | ENCODER1<br>(0x7301) | Encoder 1 feedback fault | If fault appears during first start-up before encoder feedback is used:<br>- Check cable between encoder and encoder interface module (FEN-xx) and order of connector signal wires at both ends of cable.<br>If absolute encoder, EnDat/Hiperface/SSI, with incremental sin/cos pulses is used, incorrect wiring can be located as follows: Disable serial link (zero position) by setting parameter 91.02 ABS ENC INTERF to (0) None and test encoder operation:<br>- If encoder fault is not activated, check serial link data wiring. Note that zero position is not taken into account when serial link is disabled.<br>- If encoder fault is activated, check serial link and sin/cos signal wiring.<br>**Note:** Because only zero position is requested through serial link and during run, position is updated according to sin/cos pulses.<br>- Check encoder parameter settings.<br>If fault appears after encoder feedback has already been used or during drive run:<br>- Check that encoder connection wiring or encoder is not damaged.<br>- Check that encoder interface module (FEN-xx) connection or module is not damaged.<br>- Check earthings (when disturbances are detected in communication between encoder interface module and encoder).<br>**Note:** The new settings (or fixed wiring) will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time.<br>For more information on encoders, see parameter groups 90 (page 214), 91 (page 218), 92 (page 224) and 93 (page 225). |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0040 | ENCODER2<br>(0x7381) | Encoder 2 feedback fault | See fault ENCODER1. |
| | | EnDat or SSI encoder is used in continuous mode as encoder 2.<br>[I.e. 90.02 ENCODER 2 SEL = (3) FEN-11 ABS<br>and<br>91.02 ABS ENC INTERF = (2) EnDat or (4) SSI<br>and<br>91.30 ENDAT MODE = (1) Continuous (or 91.25 SSI MODE = (1) Continuous).] | If possible, use single position transfer instead of continuous position transfer (i.e. if encoder has incremental sin/cos signals):<br>- Change parameter 91.25 SSI MODE / 91.30 ENDAT MODE to value (0) Initial pos..<br>Otherwise use Endat/SSI encoder as encoder 1:<br>- Change parameter 90.01 ENCODER 1 SEL to value (3) FEN-11 ABS and parameter 90.02 ENCODER 2 SEL to value (0) None.<br>**Note:** The new setting will only take effect after parameter 90.10 ENC PAR REFRESH is used or after the JCU control unit is powered up the next time. |
| 0045 | FIELDBUS COMM<br>(0x7510)<br>Programmable fault: 50.02 COMM LOSS FUNC | Cyclical communication between drive and fieldbus adapter module or between PLC and fieldbus adapter module is lost. | Check status of fieldbus communication. See appropriate User's Manual of fieldbus adapter module.<br>Check fieldbus parameter settings. See parameter group 50 on page 200.<br>Check cable connections.<br>Check if communication master can communicate. |
| 0046 | FB MAPPING FILE<br>(0x6306) | Drive internal fault | Contact your local ABB representative. |
| 0047 | MOTOR OVERTEMP<br>(0x4310)<br>Programmable fault: 45.01 MOT TEMP PROT | Estimated motor temperature (based on motor thermal model) has exceeded fault limit defined by parameter 45.04 MOT TEMP FLT LIM. | Check motor ratings and load.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc.<br>Check value of fault limit.<br>Check motor thermal model settings, parameters 45.06…45.08 and 45.10 MOT THERM TIME. |
| | | Measured motor temperature has exceeded fault limit defined by parameter 45.04 MOT TEMP FLT LIM. | Check that actual number of sensors corresponds to value set by parameter 45.02 MOT TEMP SOURCE.<br>Check motor ratings and load.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc.<br>Check value of fault limit. |
| | | Broken wire in the temperature sensor. | Check the temperature sensor connection. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0049 | AI SUPERVISION<br>(0x8110)<br>Programmable fault: 13.12 AI SUPERVISION | Analogue input AI1 or AI2 signal has reached limit defined by parameter 13.13 AI SUPERVIS ACT. | Check analogue input AI1/2 source and connections.<br>Check analogue input AI1/2 minimum and maximum limit settings, parameters 13.02 and 13.03 / 13.07 and 13.08. |
| 0050 | ENCODER 1 CABLE<br>(0x7389)<br>Programmable fault: 90.05 ENC CABLE FAULT | Encoder 1 cable fault detected. | Check cable between FEN-xx interface and encoder 1. After any modifications in cabling, re-configure interface by switching drive power off and on, or by activating parameter 90.10 ENC PAR REFRESH. |
| 0051 | ENCODER 2 CABLE<br>(0x738A)<br>Programmable fault: 90.05 ENC CABLE FAULT | Encoder 2 cable fault detected. | Check cable between FEN-xx interface and encoder 2. After any modifications in cabling, re-configure interface by switching drive power off and on, or by activating parameter 90.10 ENC PAR REFRESH. |
| 0052 | D2D CONFIG<br>(0x7583) | Configuration of the drive-to-drive link has failed for a reason other than those indicated by alarm 2042, for example start inhibition is requested but not granted. | Contact your local ABB representative. |
| 0053 | D2D COMM<br>(0x7520)<br>Programmable fault: 57.02 COMM LOSS FUNC | On the master drive: The drive has not been replied to by an activated follower for five consecutive polling cycles. | Check that all drives that are polled (parameters 57.04 FOLLOWER MASK 1 and 57.05 FOLLOWER MASK 2) on the drive-to-drive link are powered, properly connected to the link, and have the correct node address.<br>Check the drive-to-drive link wiring. |
| | | On a follower drive: The drive has not received new reference 1 and/or 2 for five consecutive reference handling cycles. | Check the settings of parameters 57.06 REF 1 SRC and 57.07 REF 2 SRC on the master drive.<br>Check the drive-to-drive link wiring. |
| 0054 | D2D BUF OVLOAD<br>(0x7520)<br>Programmable fault: 57.02 COMM LOSS FUNC | Transmission of drive-to-drive references failed because of message buffer overflow. | Contact your local ABB representative. |
| 0055 | TECH LIB<br>(0x6382) | Resettable fault generated by a technology library. | Refer to the documentation of the technology library. |
| 0056 | TECH LIB CRITICAL<br>(0x6382) | Permanent fault generated by a technology library. | Refer to the documentation of the technology library. |
| 0057 | FORCED TRIP<br>(0xFF90) | Generic Drive Communication Profile trip command. | Check PLC status. |
| 0058 | FIELDBUS PAR ERROR<br>(0x6320) | The drive does not have a functionality requested by PLC, or requested functionality has not been activated. | Check PLC programming.<br>Check fieldbus parameter settings. See parameter group 50 on page 200. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0059 | STALL<br>(0x7121)<br>Programmable fault:<br>46.09 STALL FUNCTION | Motor is operating in stall region because of, eg, excessive load or insufficient motor power. | Check motor load and drive ratings.<br>Check fault function parameters. |
| 0061 | SPEED FEEDBACK<br>(0x8480) | No speed feedback is received. | Check the settings of the parameters in group 22.<br>Check encoder installation. See the description of fault 0039 (ENCODER1) for more information.<br>Check encoder cabling. See the descriptions of faults 0050 (ENCODER1) and 0051 (ENCODER2) for more information. |
| 0062 | D2D SLOT COMM<br>(0x7584) | Drive-to-drive link is set to use an FMBA module for communication, but no module is detected in specified slot. | Check the settings of parameters 57.01 LINK MODE and 57.15 D2D COMM PORT. Ensure that the FMBA module has been detected by checking parameters 9.20…9.22.<br>Check that the FMBA module is correctly wired.<br>Try installing the FMBA module into another slot. If the problem persists, contact your local ABB representative. |
| 0067 | FPGA ERROR1<br>(0x5401) | Drive internal fault | Contact your local ABB representative. |
| 0068 | FPGA ERROR2<br>(0x5402) | Drive internal fault | Contact your local ABB representative. |
| 0069 | ADC ERROR<br>(0x5403) | Drive internal fault | Contact your local ABB representative. |
| 0073 | ENC 1 PULSE FREQUENCY<br>(0x738B) | Encoder 1 is receiving too high data flow (pulse frequency). | Check encoder settings.<br>Change parameters 93.03 ENC1 SP CALCMODE and 93.13 ENC2 SP CALCMODE to use only one channel pulses/ edges. |
| 0074 | ENC 2 PULSE FREQUENCY<br>(0x738C) | Encoder 2 is receiving too high data flow (pulse frequency). | Check encoder settings.<br>Change parameters 93.03 ENC1 SP CALCMODE and 93.13 ENC2 SP CALCMODE to use only one channel pulses/ edges. |
| 0075 | MOT OVERFREQUENCY<br>(0x7390) | Inverter output (motor) frequency has exceeded the frequency limit 599 Hz. | Reduce the motor rotation speed. |
| 0201 | T2 OVERLOAD<br>(0x0201) | Firmware time level 2 overload<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0202 | T3 OVERLOAD<br>(0x6100) | Firmware time level 3 overload<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0203 | T4 OVERLOAD<br>(0x6100) | Firmware time level 4 overload<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0204 | T5 OVERLOAD<br>(0x6100) | Firmware time level 5 overload<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0205 | A1 OVERLOAD<br>(0x6100) | Application time level 1 fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0206 | A2 OVERLOAD<br>(0x6100) | Application time level 2 fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0207 | A1 INIT FAULT<br>(0x6100) | Application task creation fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0208 | A2 INIT FAULT<br>(0x6100) | Application task creation fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0209 | STACK ERROR<br>(0x6100) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0210 | JMU MISSING<br>(0xFF61) | JMU Memory Unit is missing or broken. | Check that the JMU is properly installed. If the problem persists, replace the JMU. |
| 0301 | UFF FILE READ<br>(0x6300) | File read error<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0302 | APPL DIR CREATION<br>(0x6100) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0303 | FPGA CONFIG DIR<br>(0x6100) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0304 | PU RATING ID<br>(0x5483) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0305 | RATING DATABASE<br>(0x6100) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0306 | LICENSING<br>(0x6100) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0307 | DEFAULT FILE<br>(0x6100) | Drive internal fault<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0308 | APPL FILE PAR CONF<br>(0x6300) | Corrupted application file<br>**Note:** This fault cannot be reset. | Reload application.<br>If fault is still active, contact your local ABB representative. |
| 0309 | APPL LOADING<br>(0x6300) | Application file incompatible or corrupted.<br>**Note:** This fault cannot be reset. | Check the fault logger for a fault code extension. See appropriate actions for each extension below. |
| | Fault code extension: 8 | Template used in the application incompatible with drive firmware. | Change the template of the application in DriveSPC. |
| | Fault code extension: 10 | Parameters defined in the application conflict with existing drive parameters. | Check the application for conflicting parameters. |
| | Fault code extension: 35 | Application memory full. | Reduce the application size and reload the application. |
| | Fault code extension: 38 | Too many powerfail parameters | Reduce the powerfail parameters from the application. |
| | Fault code extension: 39 | Memory unit full | Reduce the application size and reload the application. |
| | Fault code extension: Other | Corrupted application file | Reload application.<br>If fault is still active, contact your local ABB representative. |
| 0310 | USERSET LOAD<br>(0xFF69) | Loading of user set is not successfully completed because:<br>- requested user set does not exist<br>- user set is not compatible with drive program<br>- drive has been switched off during loading. | Reload. |
| 0311 | USERSET SAVE<br>(0xFF69) | User set is not saved because of memory corruption. | Check the setting of parameter 95.01 CTRL UNIT SUPPLY.<br>If the fault still occurs, contact your local ABB representative. |
| 0312 | UFF OVERSIZE<br>(0x6300) | UFF file is too big. | Contact your local ABB representative. |

| Code | Fault<br>(fieldbus code) | Cause | What to do |
|---|---|---|---|
| 0313 | UFF EOF<br>(0x6300) | UFF file structure failure | Contact your local ABB representative. |
| 0314 | TECH LIB INTERFACE<br>(0x6100) | Incompatible firmware interface<br>**Note:** This fault cannot be reset. | Contact your local ABB representative. |
| 0315 | RESTORE FILE<br>(0x630D) | Restoration of backed-up parameters failed. | Contact your local ABB representative.<br>The fault is reset after a successful restoration via the control panel or DriveStudio. |
| 0316 | DAPS MISMATCH<br>(0x5484) | Mismatch between firmware version (in JMU) and power unit logic versions. | Contact your local ABB representative. |
| 0317 | SOLUTION FAULT<br>(0x6200) | Fault generated by function block SOLUTION_FAULT in the application program. | Check the usage of the SOLUTION_FAULT block in the application program. |
| 0319 | APPL LICENCE<br>(0x6300) | Drive power unit (JPU) lacks the correct application licence required to use the downloaded application program. | Assign the correct application licence to the drive power unit using the DriveSPC PC tool or remove the protection from the application used.<br>For more information, see section *Application program licensing and protection* on page 34. |

# Standard function blocks

## What this chapter contains

This chapter describes the standard function blocks. The blocks are grouped according to the grouping in the DriveSPC tool.

The number in brackets in the standard block heading is the block number.

**Note:** The given execution times may vary depending on the drive application used. The block execution time describes how much CPU load (1.21 CPU USAGE) the block reserves. For example, if a block with the execution time of 2.33 µs is set to a 1 ms time level, the increase in the CPU load will be 0.23%.

## Terms

| **Data type** | **Description** | **Range** |
|---|---|---|
| Boolean | Boolean | 0 or 1 |
| DINT | 32-bit integer value (31 bits + sign) | -2147483648…2147483647 |
| INT | 16-bit integer value (15 bits + sign) | -32768…32767 |
| PB | Packed Boolean | 0 or 1 for each individual bit |
| REAL | $\underbrace{\text{16-bit value}}_{\text{= integer value}}\ \underbrace{\text{16-bit value}}_{\text{= fractional value}}$ (31 bits + sign) | -32768,99998…32767,9998 |
| REAL24 | $\underbrace{\text{8-bit value}}_{\text{= integer value}}\ \underbrace{\text{24-bit value}}_{\text{= fractional value}}$ (31 bits + sign) | -128,0…127,999 |

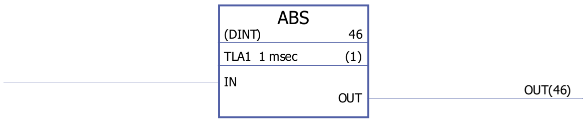
## Alphabetical index

# Arithmetic

## ABS

## (10001)

**Illustration**



**Execution time** 0.53 µs

**Operation** The output (OUT) is the absolute value of the input (IN).

OUT = | IN |

**Inputs** The input data type is selected by the user.

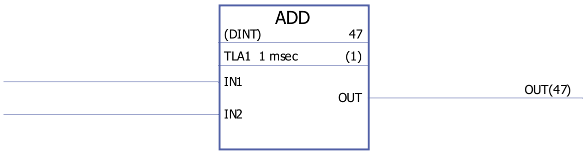
Input (IN): DINT, INT, REAL or REAL24

**Outputs** Output (OUT): DINT, INT, REAL or REAL24

## ADD

## (10000)

**Illustration**



**Execution time** 3.36 µs (when two inputs are used) + 0.52 µs (for every additional input). When all inputs are used, the execution time is 18.87 µs.

**Operation** The output (OUT) is the sum of the inputs (IN1…IN32).

OUT = IN1 + IN2 + … + IN32

The output value is limited to the maximum and minimum values defined by the selected data type range.

**Inputs** The input data type and the number of the inputs (2…32) are selected by the user.

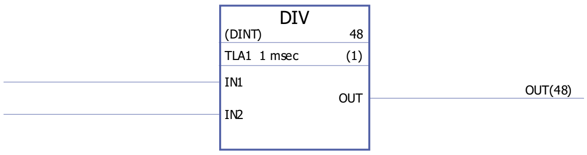
Input (IN1…IN32): DINT, INT, REAL or REAL24

**Outputs** Output (OUT): DINT, INT, REAL or REAL24

## DIV

## (10002)

**Illustration**



**Execution time** 2.55 µs

**Operation** The output (OUT) is input IN1 divided by input IN2.

OUT = IN1/IN2

The output value is limited to the maximum and minimum values defined by the selected data type range.

If the divider (IN2) is 0, the output is 0.

**Inputs** The input data type is selected by the user.

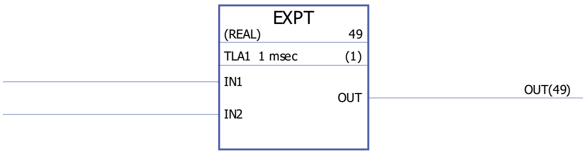
Input (IN1, IN2): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

# EXPT

## (10003)

**Illustration**



**Execution time** 81.90 µs

**Operation** The output (OUT) is input IN1 raised to the power of the input IN2:

OUT = IN1$^{IN2}$

If input IN1 is 0, the output is 0.

The output value is limited to the maximum value defined by the selected data type range.

**Note:** The execution of the EXPT function is slow.

**Inputs** The input data type is selected by the user.

Input (IN1): REAL, REAL24

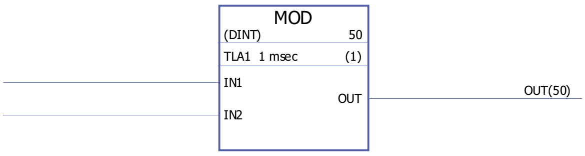
Input (IN2): REAL

**Outputs** Output (OUT): REAL, REAL24

# MOD

## (10004)

**Illustration**



**Execution time** 1.67 µs

**Operation** The output (OUT) is the remainder of the division of the inputs IN1 and IN2.

OUT = remainder of IN1/IN2

If input IN2 is zero, the output is zero.

**Inputs** The input data type is selected by the user.

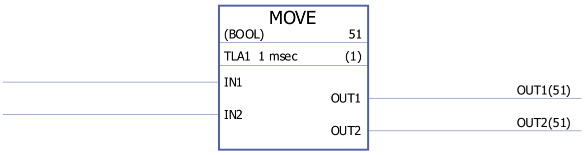
Input (IN1, IN2): INT, DINT

**Outputs** Output (OUT): INT, DINT

# MOVE

## (10005)

**Illustration**



**Execution time** 2.10 µs (when two inputs are used) + 0.42 µs (for every additional input). When all inputs are used, the execution time is 14.55 µs.

**Operation** Copies the input values (IN1…32) to the corresponding outputs (OUT1…32).

**Inputs** The input data type and number of inputs (2…32) are selected by the user.

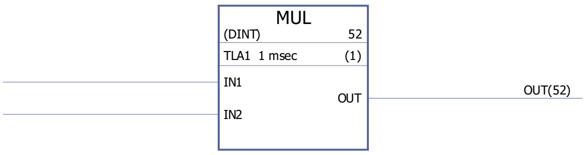
Input (IN1…IN32): INT, DINT, REAL, REAL24, Boolean

**Outputs** Output (OUT1…OUT32): INT, DINT, REAL, REAL24, Boolean

# MUL

## (10006)

**Illustration**



**Execution time** 3.47 µs (when two inputs are used) + 2.28 µs (for every additional input). When all inputs are used, the execution time is 71.73 µs.

**Operation** The output (OUT) is the product of the inputs (IN).

O = IN1 × IN2 × … × IN32

The output value is limited to the maximum and minimum values defined by the selected data type range.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

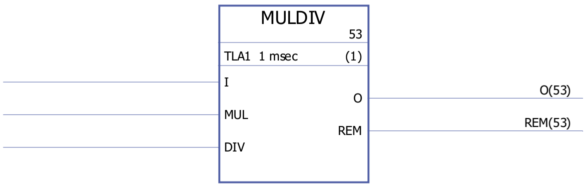
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

# MULDIV

## (10007)

**Illustration**



**Execution time** 7.10 µs

**Operation**

The output (O) is the product of input IN and input MUL divided by input DIV.

Output = (I × MUL) / DIV

O = whole value. REM = remainder value.

Example: I = 2, MUL = 16 and DIV = 10:

(2 × 16) / 10 = 3.2, i.e. O = 3 and REM = 2

The output value is limited to the maximum and minimum values defined by the data type range.

**Inputs**

Input (I): DINT

Multiplier input (MUL): DINT

Divider input (DIV): DINT

**Outputs**

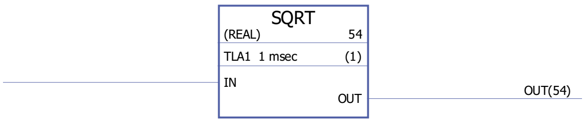
Output (O): DINT

Remainder output (REM): DINT

# SQRT

## (10008)

**Illustration**



**Execution time**

2.09 µs

**Operation**

Output (OUT) is the square root of the input (IN).

OUT = sqrt(IN)

Output is 0 if the input value is negative.

**Inputs**

The input data type is selected by the user.

Input (IN): REAL, REAL24

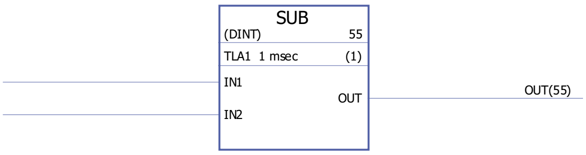
**Outputs**

Output (OUT): REAL, REAL24

# SUB -

## (10009)

**Illustration**



**Execution time**

2.33 µs

**Operation**

Output (OUT) is the difference between the input signals (IN):

OUT = IN1 - IN2

The output value is limited to the maximum and minimum values defined by the selected data type range.

**Inputs**

The input data type is selected by the user.

Input (IN1, IN2): INT, DINT, REAL, REAL24

**Outputs**

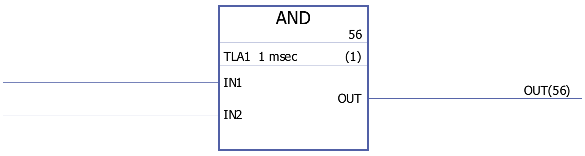
Output (OUT): INT, DINT, REAL, REAL24

# Bitstring

## AND

## (10010)

**Illustration**



**Execution time** 1.55 µs (when two inputs are used) + 0.60 µs (for every additional input). When all inputs are used, the execution time is 19.55 µs.

**Operation** The output (OUT) is 1 if all the connected inputs (IN1…IN32) are 1. Otherwise the output is 0.

Truth table:

| IN1 | IN2 | OUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

The inputs can be inverted.

**Inputs** The number of inputs is selected by the user.

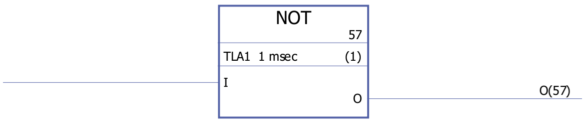
Input (IN1…IN32): Boolean

**Outputs** Output (OUT): Boolean

## NOT

## (10011)

**Illustration**



**Execution time** 0.32 µs

**Operation** The output (O) is 1 if the input (I) is 0. The output is 0 if the input is 1.

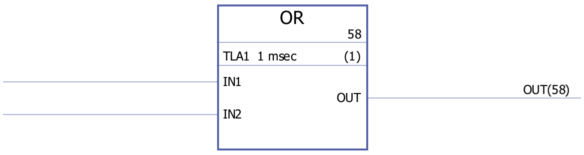
**Inputs** Input (I): Boolean

**Outputs** Output (O): Boolean

# OR

## (10012)

**Illustration**



**Execution time** 1.55 µs (when two inputs are used) + 0.60 µs (for every additional input). When all inputs are used, the execution time is 19.55 µs.

**Operation** The output (OUT) is 0, if all connected inputs (IN) are 0. Otherwise the output is 1.

Truth table:

| IN1 | IN2 | OUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

The inputs can be inverted.

**Inputs** The number of inputs (2…32) is selected by the user.

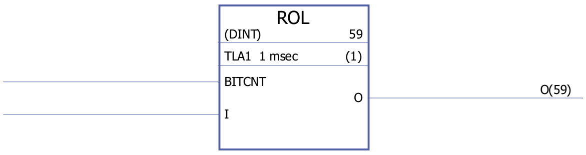
Input (IN1…IN32): Boolean

**Outputs** Output (OUT): Boolean

# ROL

## (10013)

**Illustration**



**Execution time** 1.28 µs

**Operation** Input bits (I) are rotated to the left by the number (N) of bits defined by BITCNT. The N most significant bits (MSB) of the input are stored as the N least significant bits (LSB) of the output.

Example: If BITCNT = 3

3 MSB

| | | |
|---|---|---|
| **I** | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 | |
| **O** | 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 | 1 1 1 |

3 LSB

**Inputs** The input data type is selected by the user.

Number of bits input (BITCNT): INT, DINT

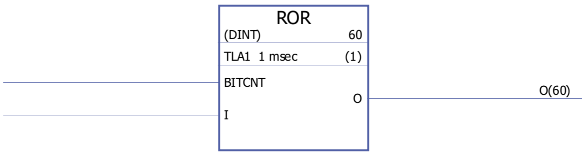
Input (I): INT, DINT

**Outputs** Output (O): INT, DINT

# ROR

## (10014)

**Illustration**



**Execution time** 1.28 µs

**Operation** Input bits (I) are rotated to the right by the number (N) of bits defined by BITCNT. The N least significant bits (LSB) of the input are stored as the N most significant bits (MSB) of the output.

Example: If BITCNT = 3

3 LSB

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| **O** | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |

3 MSB

**Inputs** The input data type is selected by the user.

Number of bits input (BITCNT): INT, DINT

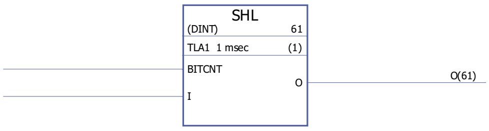
Input (I): INT, DINT

**Outputs** Output (O): INT, DINT

# SHL

## (10015)

**Illustration**



**Execution time** 0.80 µs

**Operation** Input bits (I) are rotated to the left by the number (N) of bits defined by BITCNT. The N most significant bits (MSB) of the input are lost and the N least significant bits (LSB) of the output are set to 0.

Example: If BITCNT = 3

3 MSB

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| **O** | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

3 LSB

**Inputs** The input data type is selected by the user.

Number of bits (BITCNT): INT; DINT

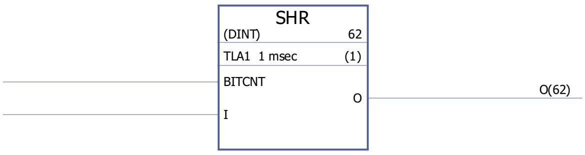
Input (I): INT, DINT

**Outputs** Output (O): INT; DINT

## SHR

### (10016)

**Illustration**



**Execution time** 0.80 µs

**Operation** Input bits (I) are rotated to the right by the number (N) of bits defined by BITCNT. The N least significant bits (LSB) of the input are lost and the N most significant bits (MSB) of the output are set to 0.

Example: If BITCNT = 3

3 LSB

| | |
|---|---|
| **I** | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 |
| **O** | 0 0 0 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 |

3 MSB

**Inputs** The input data type is selected by the user.

Number of bits (BITCNT): INT; DINT

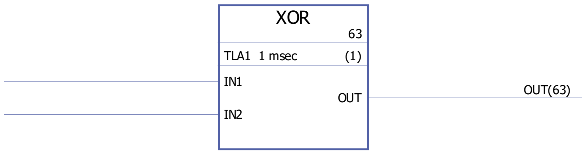
Input (I): INT, DINT

**Outputs** Output (O): INT; DINT

# XOR

## (10017)

**Illustration**



**Execution time** 1.24 µs (when two inputs are used) + 0.72 µs (for every additional input). When all inputs are used, the execution time is 22.85 µs.

**Operation** The output (OUT) is 1 if one of the connected inputs (IN1…IN32) is 1. Output is zero if all the inputs have the same value.

Example:

| IN1 | IN2 | OUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

The inputs can be inverted.

**Inputs** The number of inputs (2…32) is selected by the user.

Input (IN1…IN32): Boolean

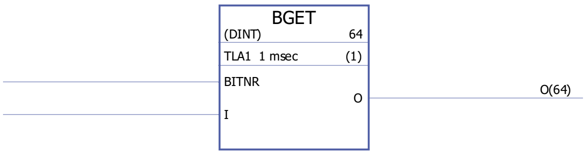
**Outputs** Output (OUT): Boolean

# Bitwise

## BGET

### (10034)

**Illustration**



**Execution time** 0.88 µs

**Operation** The output (O) is the value of the selected bit (BITNR) of the input (I).

BITNR: Bit number (0 = bit number 0, 31 = bit number 31)

If bit number is not in the range of 0…31 (for DINT) or 0…15 (for INT), the output is 0.

**Inputs** The input data type is selected by the user.

Number of the bit (BITNR): DINT

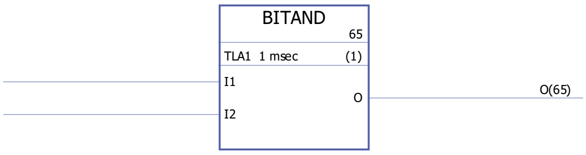
Input (I): DINT, INT

**Outputs** Output (O): Boolean

## BITAND

### (10035)

**Illustration**



**Execution time** 0.32 µs

**Operation** The output (O) bit value is 1 if the corresponding bit values of the inputs (I1 and I2) are 1. Otherwise the output bit value is 0.

Example:

| | |
|---|---|
| **I1** | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 |
| **I2** | 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 1 1 1 |
| **O** | 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 1 0 1 |

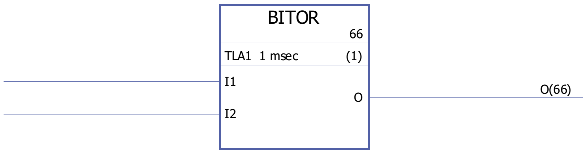
**Inputs** Input (I1, I2): DINT

**Outputs** Output (O): DINT

# BITOR

## (10036)

**Illustration**



**Execution time** 0.32 µs

**Operation** The output (O) bit value is 1 if the corresponding bit value of any of the inputs (I1 or I2) is 1. Otherwise the output bit value is 0.

Example:

| | |
|---|---|
| **I1** | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 |
| **I2** | 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 1 1 1 |
| **O** | 1 1 1 0 0 1 1 1 1 1 1 0 1 1 1 1 1 1 0 1 1 0 1 1 1 0 1 1 1 1 1 1 |

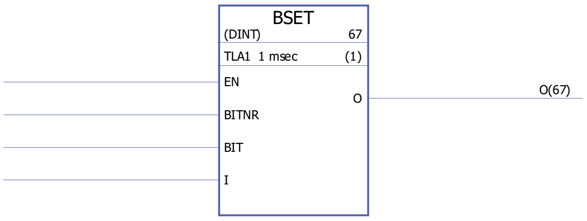
**Input** Input (I1, I2): DINT

**Output** Output (O): DINT

# BSET

## (10037)

**Illustration**



**Execution time** 1.36 µs

**Operation** The value of a selected bit (BITNR) of the input (I) is set as defined by the bit value input (BIT). The function must be enabled by the enable input (EN).

BITNR: Bit number (0 = bit number 0, 31 = bit number 31)

If BITNR is not in the range of 0…31 (for DINT) or 0…15 (for INT) or if EN is reset to zero, the input value is stored to the output as it is (i.e. no bit setting occurs).

Example:

EN = 1, BITNR = 3, BIT = 0

IN = 0000 0000 1111 1111

O = 0000 0000 1111 0111

**Inputs** The input data type is selected by the user.

Enable input (EN): Boolean

Number of the bit (BITNR): DINT

Bit value input (BIT): Boolean

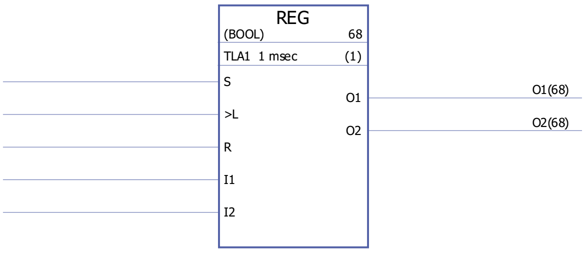
Input (I): INT, DINT

**Outputs** Output (O): INT, DINT

# REG

## (10038)

**Illustration**



**Execution time** 2.27 µs (when two inputs are used) + 1.02 µs (for every additional input). When all inputs are used, the execution time is 32.87 µs.

**Operation** The input (I1…I32) value is stored to the corresponding output (O1…O32) if the load input (L) is set to 1 or the set input (S) is 1. When the load input is set to 1, the input value is stored to the output only once. When the set input is 1, the input value is stored to the output every time the block is executed. The set input overrides the load input.

If the reset input (R) is 1, all connected outputs are 0.

Example:

| S | R | L | I | $O1_{previous}$ | O1 |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 10 | 15 | 15 |
| 0 | 0 | 0->1 | 20 | 15 | 20 |
| 0 | 1 | 0 | 30 | 20 | 0 |
| 0 | 1 | 0->1 | 40 | 0 | 0 |
| 1 | 0 | 0 | 50 | 0 | 50 |
| 1 | 0 | 0->1 | 60 | 50 | 60 |
| 1 | 1 | 0 | 70 | 60 | 0 |
| 1 | 1 | 0->1 | 80 | 0 | 0 |
| $O1_{previous}$ is the previous cycle output value. | | | | | |

**Inputs** The input data type and number of inputs (1…32) are selected by the user.

Set input (S): Boolean

Load input (L): Boolean

Reset input (R): Boolean

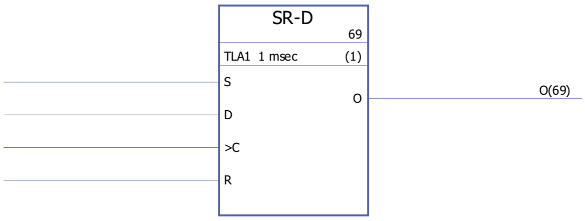
Input (I1…I32): Boolean, INT, DINT, REAL, REAL24

**Outputs** Output (O1…O32): Boolean, INT, DINT, REAL, REAL24

# SR-D

## (10039)

**Illustration**



**Execution time** 1.04 µs

**Operation**

When clock input (C) is set to 1, the data input (D) value is stored to the output (O). When reset input (R) is set to 1, the output is set to 0.

If only set (S) and reset (R) inputs are used, SR-D block acts as an SR block:
The output is 1 if the set input (S) is 1. The output will retain the previous output state if the set input (S) and reset input (R) are 0. The output is 0 if the set input is 0 and the reset input is 1.

Truth table:

| S | R | D | C | $O_{previous}$ | O |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 (= Previous output value) |
| 0 | 0 | 0 | 0 -> 1 | 0 | 0 (= Data input value) |
| 0 | 0 | 1 | 0 | 0 | 0 (= Previous output value) |
| 0 | 0 | 1 | 0 -> 1 | 0 | 1 (= Data input value) |
| 0 | 1 | 0 | 0 | 1 | 0 (Reset) |
| 0 | 1 | 0 | 0 -> 1 | 0 | 0 (Reset) |
| 0 | 1 | 1 | 0 | 0 | 0 (Reset) |
| 0 | 1 | 1 | 0 -> 1 | 0 | 0 (Reset) |
| 1 | 0 | 0 | 0 | 0 | 1 (= Set value) |
| 1 | 0 | 0 | 0 -> 1 | 1 | 0 (= Data input value) for one execution cycle, then changes to 1 according to the set input (S = 1). |
| 1 | 0 | 1 | 0 | 1 | 1 (= Set value) |
| 1 | 0 | 1 | 0 -> 1 | 1 | 1 (= Data input value) |
| 1 | 1 | 0 | 0 | 1 | 0 (Reset) |
| 1 | 1 | 0 | 0 -> 1 | 0 | 0 (Reset) |
| 1 | 1 | 1 | 0 | 0 | 0 (Reset) |
| 1 | 1 | 1 | 0 -> 1 | 0 | 0 (Reset) |
| $O_{previous}$ is the previous cycle output value. | | | | | |

**Inputs**

Set input (S): Boolean
Data input (D): Boolean
Clock input (C): Boolean
Reset input (R): Boolean

**Outputs**

Output (O): Boolean

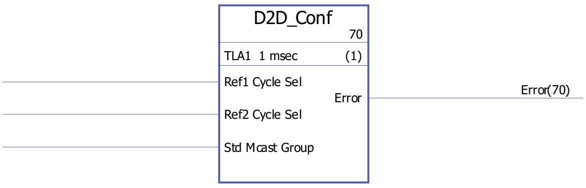
# Communication

See also *Appendix B – Drive-to-drive link* (page 355).

## D2D_Conf

## (10092)

**Illustration**



**Execution time** -

**Operation**

Defines handling interval for drive-to-drive references 1 and 2, and the address (group number) for standard (non-chained) multicast messages.

The values of the Ref1/2 Cycle Sel inputs correspond to the following intervals:

| Value | Handling interval |
|---|---|
| 0 | Default (500 µs for reference 1; 2 ms for reference 2) |
| 1 | 250 µs |
| 2 | 500 µs |
| 3 | 2 ms |

**Note:** Negative value of Ref2 Cycle Sel disables the handling of Ref2 (if disabled in the master, it must be disabled in all follower drives as well).

Allowable values for the Std Mcast Group input are 0 (= multicasting not used) and 1…62 (multicast group).

An unconnected input, or an input in an error state, is interpreted as having the value 0.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 0 | REF1_CYCLE_ERR: Value of input Ref1 Cycle Sel out of range |
| 1 | REF2_CYCLE_ERR: Value of input Ref2 Cycle Sel out of range |
| 2 | STD_MCAST_ERR: Value of input Std Mcast Group out of range |

See also section *Examples of using standard function blocks in drive-to-drive communication* starting on page 363.

**Inputs**

Drive-to-drive reference 1 handling interval (Ref1 Cycle Sel): INT

Drive-to-drive reference 2 handling interval (Ref2 Cycle Sel): INT

Standard multicast address (Std Mcast Group): INT

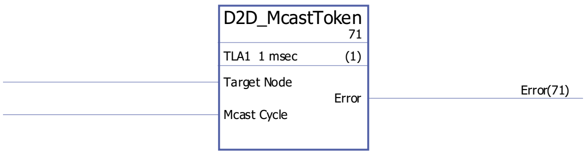
**Outputs**

Error output (Error): PB

# D2D_McastToken

## (10096)

**Illustration**



**Execution time** -

**Operation**

Configures the transmission of token messages sent to a follower. Each token authorizes the follower to send one message to another follower or group of followers. For the message types, see the block D2D_SendMessage.

**Note:** This block is only supported in the master.

The Target Node input defines the node address the master sends the tokens to; the range is 1…62.

The Mcast Cycle specifies the interval between token messages in the range of 2…1000 milliseconds. Setting this input to 0 disables the sending of tokens.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 0 | D2D_MODE_ERR: Drive is not master |
| 5 | TOO_SHORT_CYCLE: Token interval is too short, causing overloading |
| 6 | INVALID_INPUT_VAL: An input value is out of range |
| 7 | GENERAL_D2D_ERR: Drive-to-drive communication driver failed to initialize message |

See also section *Examples of using standard function blocks in drive-to-drive communication* starting on page 363.

**Inputs**

Token recipient (Target Node): INT

Token interval (Mcast Cycle): INT

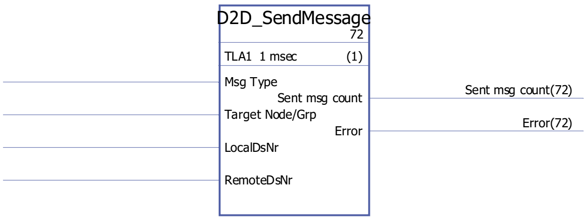
**Outputs**

Error output (Error): DINT

# D2D_SendMessage

## (10095)

**Illustration**



**Execution time** -

**Operation**

Configures the transmission between the dataset tables of drives.

The Msg Type input defines the message type as follows:

| Value | Message type |
|---|---|
| 0 | Disabled |
| 1 | Master P2P:<br>The master sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of a follower (specified by Target Node/Grp input).<br>The follower replies by sending the next dataset (RemoteDsNr + 1) to the master (LocalDsNr + 1).<br>The node number of a drive is defined by parameter 57.03.<br>**Note:** Only supported in the master drive. |
| 2 | Read Remote:<br>The master reads a dataset (specified by RemoteDsNr input) from a follower (specified by Target Node/Grp input) and stores it into local dataset table (dataset number specified by LocalDsNr input).<br>The node number of a drive is defined by parameter 57.03.<br>**Note:** Only supported in the master drive. |
| 3 | Follower P2P:<br>The follower sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of another follower (specified by Target Node/Grp input).<br>The node number of a drive is defined by parameter 57.03.<br>**Note:** Only supported in a follower drive. A token from the master drive is required for the follower to be able to send the message. See the block D2D_McastToken. |
| 4 | Standard Multicast:<br>The drive sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of a group of followers (specified by Target Node/Grp input).<br>Which multicast group a drive belongs to is defined by the Std Mcast Group input of the D2D_Conf block.<br>A token from the master drive is required for a follower to be able to send the message. See the block D2D_McastToken. |
| 5 | Broadcast:<br>The drive sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of all followers.<br>A token from the master drive is required for a follower to be able to send the message. See the block D2D_McastToken.<br>**Note:** With this message type, the Target Node/Grp input must be connected in DriveSPC even if not used. |

See also section *Examples of using standard function blocks in drive-to-drive communication* starting on page 363.

The Target Node/Grp input specifies the target drive or multicast group of drives depending on message type. See the message type explanations above.

**Note:** The input must be connected in DriveSPC even if not used.

The LocalDsNr input specifies the number of the local dataset used as the source or the target of the message.

The RemoteDsNr input specifies the number of the remote dataset used as the target or the source of the message.

The Sent msg count output is a wrap-around counter of successfully sent messages.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 0 | D2D_MODE_ERR: Drive-to-drive communication not activated, or message type not supported in current drive-to-drive mode (master/follower) |
| 1 | LOCAL_DS_ERR: LocalDsNr input out of range (16…199) |
| 2 | TARGET_NODE_ERR: Target Node/Grp input out of range (1…62) |
| 3 | REMOTE_DS_ERR: Remote dataset number out of range (16…199) |
| 4 | MSG_TYPE_ERR: Msg Type input out of range (0…5) |
| 5…6 | Reserved |
| 7 | GENERAL_D2D_ERR: Unspecified error in D2D driver |
| 8 | RESPONSE_ERR: Syntax error in received response |
| 9 | TRA_PENDING: Message has not yet been sent |
| 10 | REC_PENDING: Response has not yet been received |
| 11 | REC_TIMEOUT: No response received |
| 12 | REC_ERROR: Frame error in received message |
| 13 | REJECTED: Message has been removed from transmit buffer |
| 14 | BUFFER_FULL: Transmit buffer full |

**Inputs**

Message type (Msg Type): INT

Target node or multicast group (Target Node/Grp): INT

Local dataset number (LocalDsNr): INT

Remote dataset number (RemoteDsNr): INT

**Outputs**

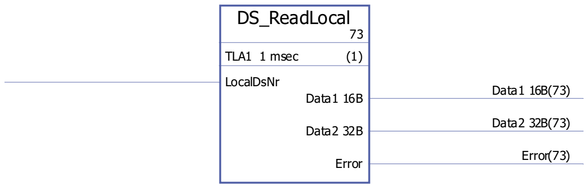
Successfully sent messages counter (Sent msg count): DINT

Error output (Error): PB

# DS_ReadLocal

## (10094)

**Illustration**



**Execution time** -

**Operation**

Reads the dataset defined by the LocalDsNr input from the local dataset table. One dataset contains one 16-bit and one 32-bit word which are directed to the Data1 16B and Data2 32B outputs respectively.

The LocalDsNr input defines the number of the dataset to be read.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 1 | LOCAL_DS_ERR: LocalDsNr out of range (16…199) |

See also section *Examples of using standard function blocks in drive-to-drive communication* starting on page 363.

**Inputs**

Local dataset number (LocalDsNr): INT

**Outputs**

Contents of dataset (Data1 16B): INT

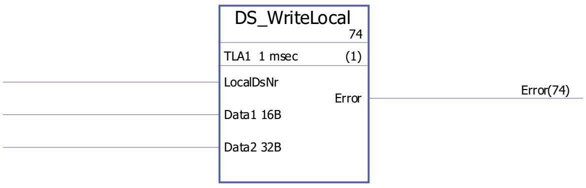
Contents of dataset (Data2 32B): DINT

Error output (Error): DINT

# DS_WriteLocal

## (10093)

**Illustration**



**Execution time**

-

**Operation**

Writes data into the local dataset table. Each dataset contains 48 bits; the data is input through the Data1 16B (16 bits) and Data2 32B (32 bits) inputs. The dataset number is defined by the LocalDsNr input.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 1 | LOCAL_DS_ERR: LocalDsNr out of range (16…199) |

See also section *Examples of using standard function blocks in drive-to-drive communication* starting on page 363.

**Inputs**

Local dataset number (LocalDsNr): INT

Contents of dataset (Data1 16B): INT

Contents of dataset (Data2 32B): DINT

**Outputs**

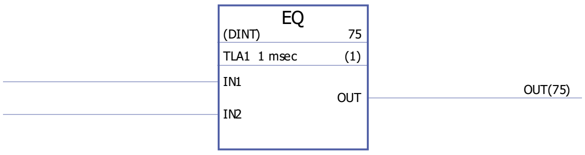
Error output (Error): DINT

# Comparison

## EQ

## (10040)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** The output (OUT) is 1 if all the connected input values are equal (IN1 = IN2 = … = IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

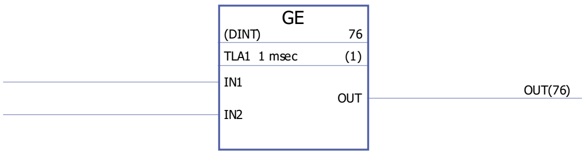
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

## GE **>=**

## (10041)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** The output (OUT) is 1 if (IN1 ≥ IN2) & (IN2 ≥ IN3) & … & (IN31 ≥ IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

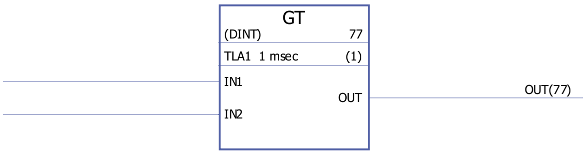
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

## GT >

## (10042)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** The output (OUT) is 1 if (IN1 > IN2) & (IN2 > IN3) & … & (IN31 > IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

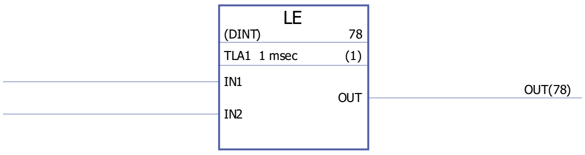
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

## LE <=

## (10043)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** Output (OUT) is 1 if (IN1 ≤ IN2) & (IN2 ≤ IN3) & … & (IN31 ≤ IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

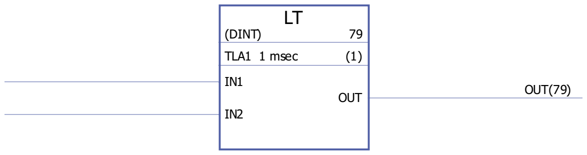
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

# LT <

# (10044)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** Output (OUT) is 1 if (IN1 < IN2) & (IN2 < IN3) & … & (IN31 < IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

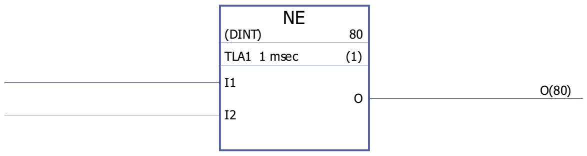
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

# NE <>

# (10045)

**Illustration**



**Execution time** 0.44 µs

**Operation** The output (O) is 1 if I1 <> I2. Otherwise the output is 0.

**Inputs** The input data type is selected by the user.

Input (I1, I2): INT, DINT, REAL, REAL24

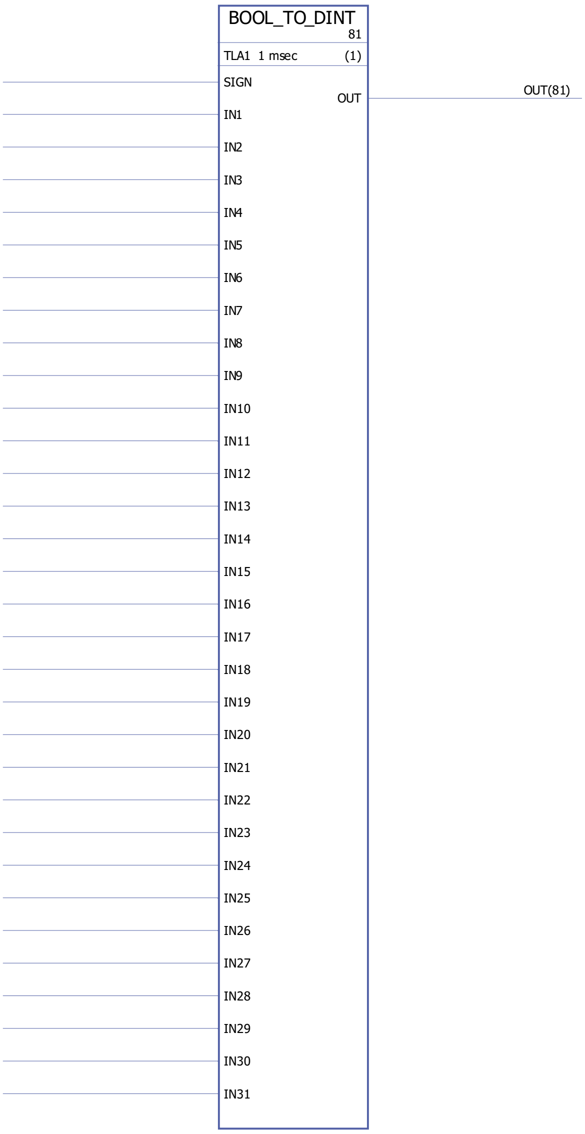
**Outputs** Output (O): Boolean

# Conversion

## BOOL_TO_DINT

### (10018)

**Illustration**



**Execution time** 13.47 µs

**Operation** The output (OUT) value is a 32-bit integer value formed from the boolean input (IN1…IN31 and SIGN) values. IN1 = bit 0 and IN31 = bit 30.

Example:

IN1 = 1, IN2 = 0, IN3…IN31 = 1, SIGN = 1

$\text{OUT} = \underbrace{1}_{\text{SIGN}}\underbrace{111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1101}_{\text{IN31…IN1}}$

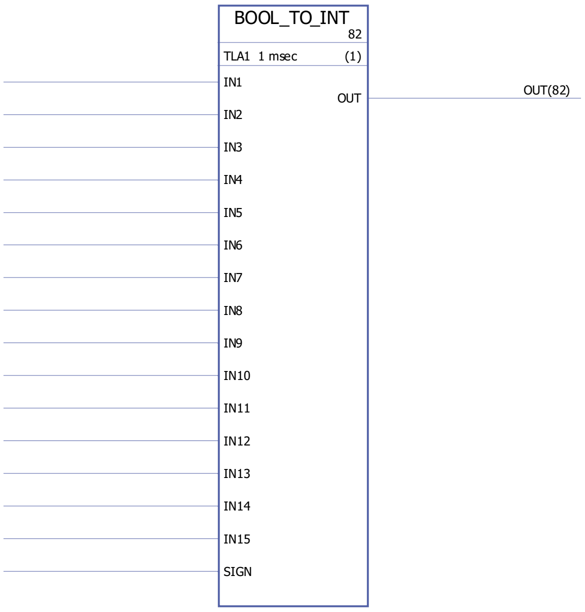
**Input** Sign input (SIGN): Boolean
Input (IN1…IN31): Boolean

**Output** Output (OUT): DINT (31 bits + sign)

## BOOL_TO_INT

### (10019)

**Illustration**



**Execution time** 5.00 µs

**Operation** The output (OUT) value is a 16-bit integer value formed from the boolean input (IN1…IN15 and SIGN) values. IN1 = bit 0 and IN15 = bit 14.

Example:

IN1…IN15 = 1, SIGN = 0

$$\text{OUT} = \underbrace{0}_{\text{SIGN}}\underbrace{111\ 1111\ 1111\ 1111}_{\text{IN15…IN1}}$$

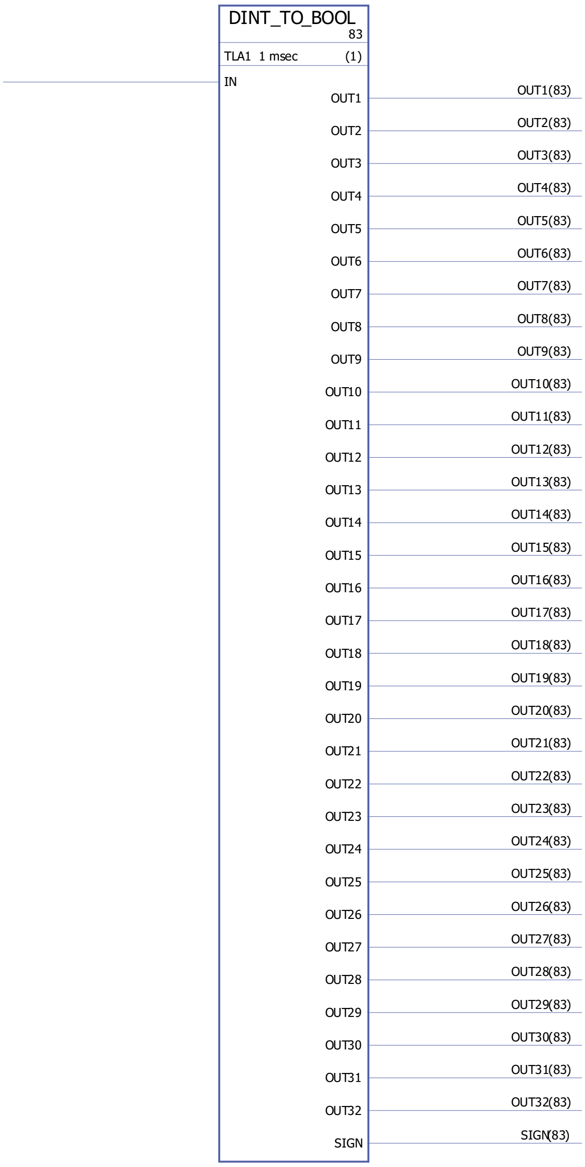
**Inputs** Input (IN1…IN15): Boolean
Sign input (SIGN): Boolean

**Outputs** Output (OUT): DINT (15 bits + sign)

# DINT_TO_BOOL

## (10020)

**Illustration**



**Execution time** 11.98 µs

**Operation** The boolean output (OUT1…OUT32) values are formed from the 32-bit integer input (IN) value.

Example:

$$\text{IN} = \underbrace{0}_{\text{SIGN}}\ \underbrace{111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1100}_{\text{OUT32…OUT1}}$$

**Inputs** Input (IN): DINT

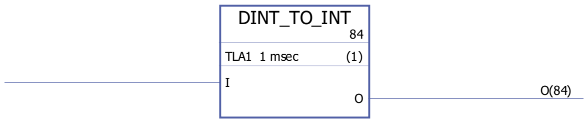
**Outputs** Output (OUT1…OUT32): Boolean

Sign output (SIGN): Boolean

# DINT_TO_INT

## (10021)

**Illustration**



**Execution time** 0.53 µs

**Operation** The output (O) value is a 16-bit integer value of the 32-bit integer input (I) value.

Examples:

| **I** (31 bits + sign) | **O** (15 bits + sign) |
|---|---|
| 2147483647 | 32767 |
| -2147483648 | -32767 |
| 0 | 0 |

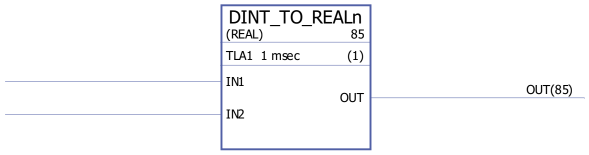
**Inputs** Input (I): DINT

**Outputs** Output (O): INT

# DINT_TO_REALn

## (10023)

**Illustration**



**Execution time** 7.25 µs

**Operation** The output (OUT) is the REAL/REAL24 equivalent of the input (IN). Input IN1 is the integer value and input IN2 is the fractional value.

If one (or both) of the input values is negative, the output value is negative.

Example (from DINT to REAL):

When IN1 = 2 and IN2 = 3276, OUT = 2.04999.

The output value is limited to the maximum value of the selected data type range.

**Inputs** Input (IN1, IN2): DINT

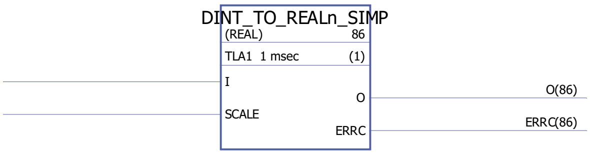
**Outputs** The output data type is selected by the user.

Output (OUT): REAL, REAL24

# DINT_TO_REALn_SIMP

## (10022)

**Illustration**



**Execution time** 6.53 µs

**Operation** The output (O) is the REAL/REAL24 equivalent of the input (I) divided by the scale input (SCALE).

Error codes indicated at the error output (ERRC) are as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| 1001 | The calculated REAL/REAL24 value exceeds the minimum value of the selected data type range. The output is set to the minimum value. |
| 1002 | The calculated REAL/REAL24 value exceeds the maximum value of the selected data type range. The output is set to the maximum value. |
| 1003 | The SCALE input is 0. The output is set to 0. |
| 1004 | Incorrect SCALE input, i.e. the scale input is < 0 or is not a factor of 10. |

Example (from DINT to REAL24):

When I = 205 and SCALE = 100, I/SCALE = 205 /100 = 2.05 and O = 2.04999.

**Inputs** Input (I): DINT

Scale input (SCALE): DINT

**Outputs** The output data type is selected by the user.

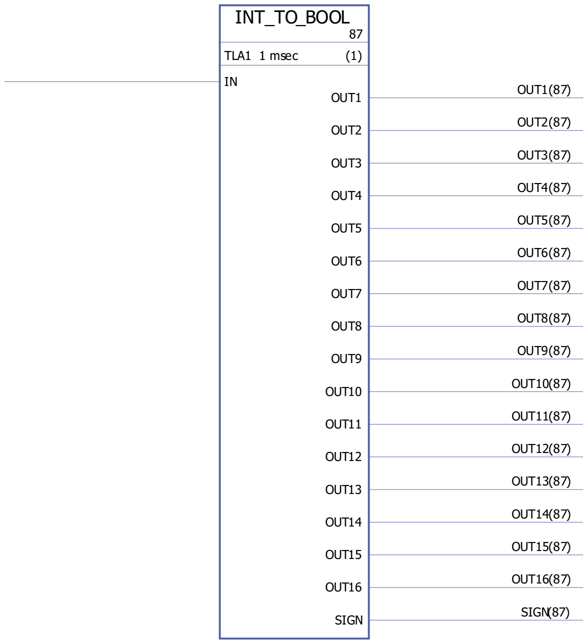
Output (O): REAL, REAL24

Error output (ERRC): DINT

# INT_TO_BOOL

## (10024)

**Illustration**



**Execution time** 4.31 µs

**Operation** The boolean output (OUT1…OUT16) values are formed from the 16-bit integer input (IN) value.

Example:

$$\text{IN} = \underbrace{\underbrace{0}_{\text{SIGN}}111\ 1111\ 1111\ 1111}_{\text{OUT16…OUT1}}$$

**Inputs** Input (IN): INT

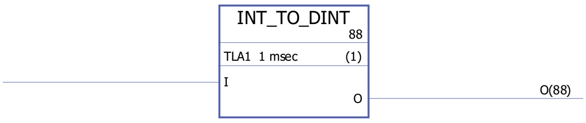
**Outputs** Output (OUT1…OUT16): Boolean

Sign output (SIGN): Boolean

# INT_TO_DINT

## (10025)

**Illustration**



**Execution time** 0.33 µs

**Operation** The output (O) value is a 32-bit integer value of the 16-bit integer input (I) value.

| I | O |
|---|---|
| 32767 | 32767 |
| -32767 | -32767 |
| 0 | 0 |

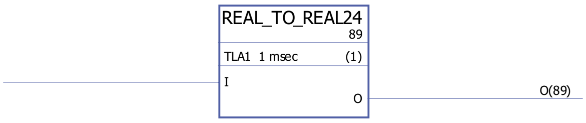
**Inputs** Input (I): INT

**Outputs** Output (O): DINT

# REAL_TO_REAL24

## (10026)

**Illustration**



**Execution time** 1.35 µs

**Operation** Output (O) is the REAL24 equivalent of the REAL input (I).

The output value is limited to the maximum value of the data type.

Example:

$$I = \underbrace{0000\ 0000\ 0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111}_{\text{Fractional value}}$$

$$O = \underbrace{0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111\ 0000\ 0000}_{\text{Fractional value}}$$

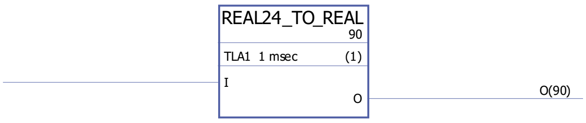
**Inputs** Input (I): REAL

**Outputs** Output (O): REAL24

# REAL24_TO_REAL

## (10027)

**Illustration**



**Execution time** 1.20 µs

**Operation** Output (O) is the REAL equivalent of the REAL24 input (I).

The output value is limited to the maximum value of the data type range.

Example:

$$I = \underbrace{0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111\ 0000\ 0000}_{\text{Fractional value}}$$

$$O = \underbrace{0000\ 0000\ 0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111}_{\text{Fractional value}}$$

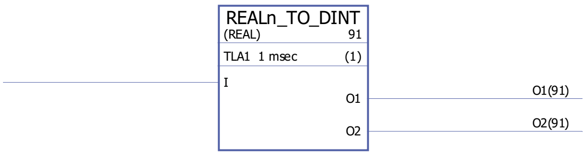
**Inputs** Input (I): REAL24

**Outputs** Output (O): REAL

# REALn_TO_DINT

## (10029)

**Illustration**



**Execution time** 6.45 µs

**Operation** Output (O) is the 32-bit integer equivalent of the REAL/REAL24 input (I). Output O1 is the integer value and output O2 is the fractional value.

The output value is limited to the maximum value of the data type range.

Example (from REAL to DINT):

When I = 2.04998779297, O1 = 2 and O2 = 3276.

**Inputs** The input data type is selected by the user.

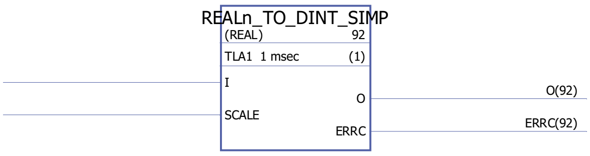
Input (I): REAL, REAL24

**Outputs** Output (O1, O2): DINT

# REALn_TO_DINT_SIMP

## (10028)

**Illustration**



**Execution time** 5.54 µs

**Operation** Output (O) is the 32-bit integer equivalent of the REAL/REAL24 input (I) multiplied by the scale input (SCALE).

Error codes are indicated by the error output (ERRC) as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| 1001 | The calculated integer value exceeds the minimum value. The output is set to the minimum value. |
| 1002 | The calculated integer value exceeds the maximum value. The output is set to the maximum value. |
| 1003 | Scale input is 0. The output is set to 0. |
| 1004 | Incorrect scale input, i.e. scale input is < 0 or is not a factor of 10. |

Example (from REAL to DINT):

When I = 2.04998779297and SCALE = 100, O = 204.

**Inputs** The input data type is selected by the user.

Input (I): REAL, REAL24

Scale input (SCALE): DINT

**Outputs** Output (O): DINT

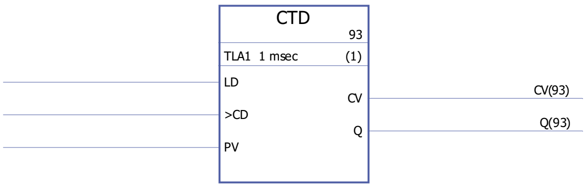
Error output (ERRC): DINT

# Counters

## CTD

## (10047)

**Illustration**



**Execution time** 0.92 µs

**Operation**

The counter output (CV) value is decreased by 1 if the counter input (CD) value changes from 0 -> 1 and the load input (LD) value is 0. If the load input value is 1, the preset input (PV) value is stored as the counter output (CV) value. If the counter output has reached its minimum value -32768, the counter output remains unchanged.

The status output (Q) is 1 if the counter output (CV) value ≤ 0.

Example:

| **LD** | **CD** | **PV** | **Q** | **CV$_{prev}$** | **CV** |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 10 | 0 | 5 | 5 |
| 0 | 0 -> 1 | 10 | 0 | 5 | 5 - 1 = 4 |
| 1 | 1 -> 0 | -2 | 1 | 4 | -2 |
| 1 | 0 -> 1 | 1 | 0 | -2 | 1 |
| 0 | 0 -> 1 | 5 | 1 | 1 | 1 -1 = 0 |
| 1 | 1 -> 0 | -32768 | 1 | 0 | -32768 |
| 0 | 0 -> 1 | 10 | 1 | -32768 | -32768 |
| CV$_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs**

Load input (LD): Boolean

Counter input (CD): Boolean

Preset input (PV): INT

**Outputs**

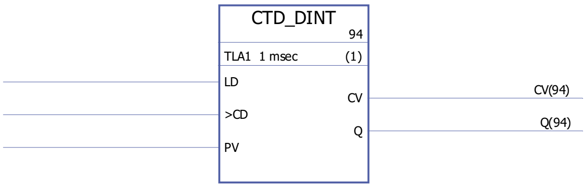
Counter output (CV): INT

Status output (Q): Boolean

# CTD_DINT

## (10046)

**Illustration**



**Execution time** 0.92 µs

**Operation** The counter output (CV) value is decreased by 1 if the counter input (CD) value changes from 0 -> 1 and the load input (LD) value is 0. If the load input (LD) value is 1, the preset input (PV) value is stored as the counter output (CV) value. If the counter output has reached its minimum value -2147483648, the counter output remains unchanged.

The status output (Q) is 1 if the counter output (CV) value < 0.

Example:

| **LD** | **CD** | **PV** | **Q** | **$CV_{prev}$** | **CV** |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 10 | 0 | 5 | 5 |
| 0 | 0 -> 1 | 10 | 0 | 5 | 5 - 1 = 4 |
| 1 | 1 -> 0 | -2 | 1 | 4 | -2 |
| 1 | 0 -> 1 | 1 | 0 | -2 | 1 |
| 0 | 0 -> 1 | 5 | 1 | 1 | 1 -1 = 0 |
| 1 | 1 -> 0 | -2147483648 | 1 | 0 | -2147483648 |
| 0 | 0 -> 1 | 10 | 1 | -2147483648 | -2147483648 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs** Load input (LD): Boolean

Counter input (CD): Boolean

Preset input (PV): DINT

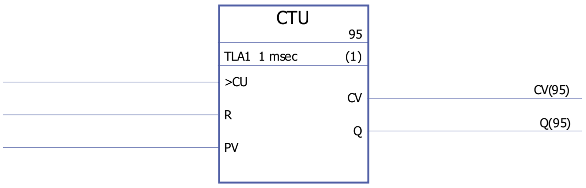
**Outputs** Counter output (CV): DINT

Status output (Q): Boolean

# CTU

## (10049)

**Illustration**



**Execution time** 0.92 µs

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) value changes from 0 -> 1 and the reset input (R) value is 0. If the counter output has reached its maximum value 32767, the counter output remains unchanged.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

The status output (Q) is 1 if the counter output (CV) value ≥ preset input (PV) value.

Example:

| R | CU | PV | Q | $CV_{prev}$ | CV |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 20 | 0 | 10 | 10 |
| 0 | 0 -> 1 | 11 | 1 | 10 | 10 + 1 = 11 |
| 1 | 1 -> 0 | 20 | 0 | 11 | 0 |
| 1 | 0 -> 1 | 5 | 0 | 0 | 0 |
| 0 | 0 -> 1 | 20 | 0 | 0 | 0 + 1 = 1 |
| 0 | 0 -> 1 | 30 | 1 | 32767 | 32767 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs**

Counter input (CU): Boolean

Reset input (R): Boolean

Preset input (PV): INT

**Outputs**

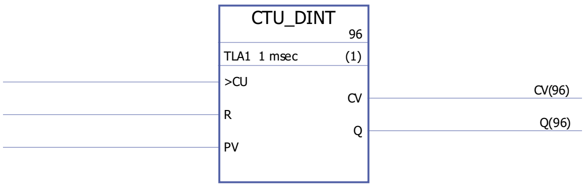
Counter output (CV): INT

Status output (Q): Boolean

# CTU_DINT

## (10048)

**Illustration**



**Execution time** 0.92 µs

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) value changes from 0 -> 1 and the reset input (R) value is 0. If the counter output has reached its maximum value 2147483647, the counter output remains unchanged.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

The status output (Q) is 1 if the counter output (CV) value ≥ preset input (PV) value.

Example:

| R | CU | PV | Q | $CV_{prev}$ | CV |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 20 | 0 | 10 | 10 |
| 0 | 0 -> 1 | 11 | 1 | 10 | 10 + 1 = 11 |
| 1 | 1 -> 0 | 20 | 0 | 11 | 0 |
| 1 | 0 -> 1 | 5 | 0 | 0 | 0 |
| 0 | 0 -> 1 | 20 | 0 | 0 | 0 + 1 = 1 |
| 0 | 0 -> 1 | 30 | 1 | 2147483647 | 2147483647 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

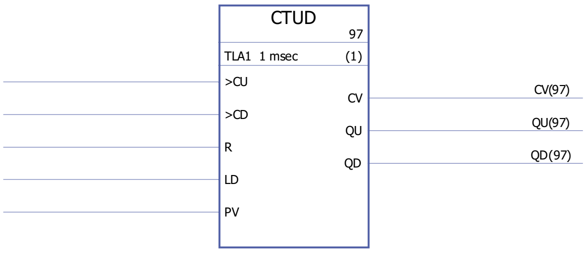
**Inputs** Counter input (CU): Boolean
Reset input (R): Boolean
Preset input (PV): DINT

**Outputs** Counter output (CV): DINT
Status output (Q): Boolean

# CTUD

## (10051)

**Illustration**



**Execution time** 1.40 µs

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) value changes from 0 -> 1 and the reset input (R) is 0 and the load input (LD) is 0.

The counter output (CV) value is decreased by 1 if the counter input (CD) changes from 0 -> 1 and the load input (LD) is 0 and the reset input (R) is 0.

If the load input (LD) is 1, the preset input (PV) value is stored as the counter output (CV) value.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

If the counter output has reached its minimum or maximum value, -32768 or +32767, the counter output remains unchanged until it is reset (R) or until the load input (LD) is set to 1.

The up counter status output (QU) is 1 if the counter output (CV) value ≥ preset input (PV) value.

The down counter status output (QD) is 1 if the counter output (CV) value ≤ 0.

Example:

| **CU** | **CD** | **R** | **LD** | **PV** | **QU** | **QD** | **$CV_{prev}$** | **CV** |
|---|---|---|---|---|---|---|---|---|
| 0 -> 0 | 0 -> 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 0 | 2 |
| 0 -> 0 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 0 -> 0 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 0 -> 0 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 1 | 1 -> 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 + 1 = 1 |
| 1 -> 1 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 1 -> 1 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 1 -> 1 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 1 -> 1 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 1 -> 1 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | | | | |

**Inputs**

Up counter input (CU): Boolean

Down counter input (CD): Boolean

Reset input (R): Boolean

Load input (LD): Boolean

Preset input (PV): INT

**Outputs**

Counter output (CV): INT

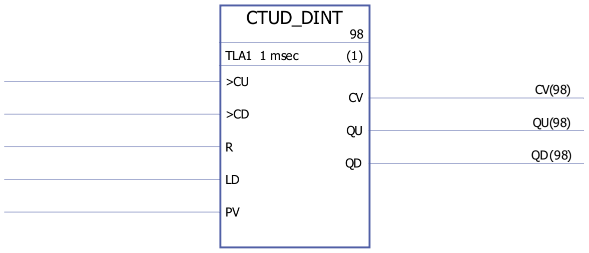
Up counter status output (QU): Boolean

Down counter status output (QD): Boolean

# CTUD_DINT

## (10050)

**Illustration**



**Execution time** 1.40 µs

**Operation** The counter output (CV) value is increased by 1 if the counter input (CU) changes from 0 -> 1 and the reset input (R) is 0 and the load input (LD) is 0.

The counter output (CV) value is decreased by 1 if the counter input (CD) changes from 0 -> 1 and the load input (LD) is 0 and the reset input (R) is 0.

If the counter output has reached its minimum or maximum value, -2147483648 or +2147483647, the counter output remains unchanged until it is reset (R) or until the load input (LD) is set to 1.

If the load input (LD) value is 1, the preset input (PV) value is stored as the counter output (CV) value.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

The up counter status output (QU) is 1 if the counter output (CV) value ≥ preset input (PV) value.

The down counter status output (QD) is 1 if the counter output (CV) value ≤ 0.

Example:

| CU | CD | R | LD | PV | QU | QD | $CV_{prev}$ | CV |
|---|---|---|---|---|---|---|---|---|
| 0 -> 0 | 0 -> 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 0 | 2 |
| 0 -> 0 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 0 -> 0 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 0 -> 0 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 1 | 1 -> 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 + 1 = 1 |
| 1 -> 1 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 1 -> 1 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 1 -> 1 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 1 -> 1 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 1 -> 1 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | | | | |

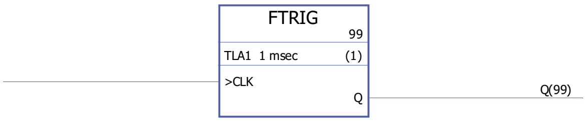
| | |
|---|---|
| **Inputs** | Up counter input (CU): Boolean<br>Down counter input (CD): Boolean<br>Reset input (R): Boolean<br>Load input (LD): Boolean<br>Preset input (PV): DINT |
| **Outputs** | Counter output (CV): DINT<br>Up counter status output (QU): Boolean<br>Down counter status output (QD): Boolean |

# Edge & bistable

## FTRIG

### (10030)

**Illustration**



**Execution time** 0.38 µs

**Operation** The output (Q) is set to 1 when the clock input (CLK) changes from 1 to 0. The output is set back to 0 with the next execution of the block. Otherwise the output is 0.

| **$CLK_{previous}$** | **CLK** | **Q** |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 (for one execution cycle time, returns to 0 at the next execution) |
| 1 | 1 | 0 |
| $CLK_{previous}$ is the previous cycle output value. | | |

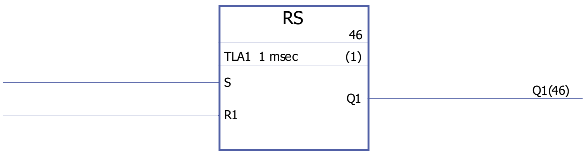
**Inputs** Clock input (CLK): Boolean

**Outputs** Output (Q): Boolean

## RS

### (10032)

**Illustration**



**Execution time** 0.38 µs

**Operation**

The output (Q1) is 1 if the set input (S) is 1 and the reset input (R1) is 0. The output will retain the previous output state if the set input (S) and the reset input (R1) are 0. The output is 0 if the reset input is 1.

Truth table:

| **S** | **R1** | **$Q1_{previous}$** | **Q1** |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 |
| $Q_{previous}$ is the previous cycle output value. | | | |

**Inputs**

Set input (S): Boolean

Reset input (R1): Boolean

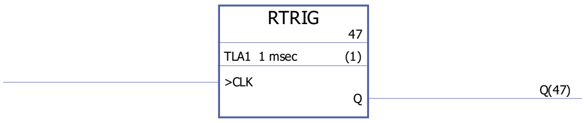
**Outputs**

Output (Q1): Boolean

# RTRIG

## (10031)

**Illustration**



**Execution time**

0.38 µs

**Operation**

The output (Q) is set to 1 when the clock input (CLK) changes from 0 to 1. The output is set back to 0 with the next execution of the block. Otherwise the output is 0.

| **$CLK_{previous}$** | **CLK** | **Q** |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |
| $CLK_{previous}$ is the previous cycle output value. | | |

**Note:** The output (Q) is 1 after the first execution of the block after cold restart when the clock input (CLK) is 1. Otherwise the output is always 0 when the clock input is 1.

**Inputs**

Clock input (CLK): Boolean

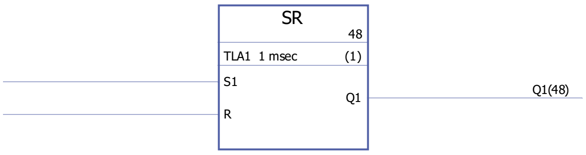
**Outputs**

Output (Q): Boolean

# SR

## (10033)

**Illustration**



**Execution time** 0.38 µs

**Operation** The output (Q1) is 1 if the set input (S1) is 1. The output will retain the previous output state if the set input (S1) and the reset input (R) are 0. The output is 0 if the set input is 0 and the reset input is 1.

Truth table:

| S1 | R | $Q1_{previous}$ | Q1 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |
| $Q1_{previous}$ is the previous cycle output value. | | | |

**Inputs** Set input (S1): Boolean

Reset input (R): Boolean

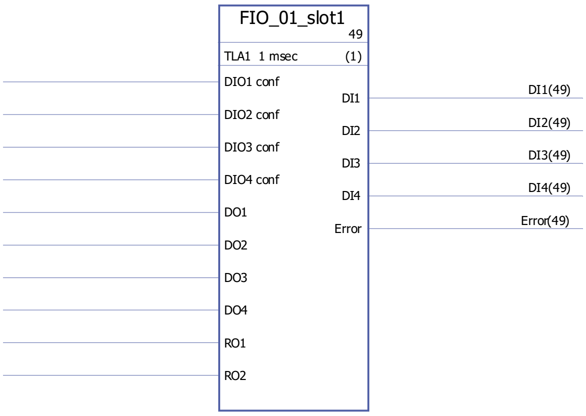
**Outputs** Output (Q1): Boolean

# Extensions

## FIO_01_slot1

### (10084)

**Illustration**



**Execution time** 8.6 µs

**Operation** The block controls the four digital inputs/outputs (DIO1…DIO4) and two relay outputs (RO1, RO2) of a FIO-01 Digital I/O Extension mounted on slot 1 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO-01 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The RO1 and RO2 inputs define the state of the relay outputs of the FIO-01 (0 = not energised, 1 = energised).

The DIx outputs show the state of the DIOs.

**Inputs** Digital input/output mode selection (DIO1 conf … DIO4 conf): Boolean

Digital output state selection (DO1…DO4): Boolean

Relay output state selection (RO1, RO2): Boolean

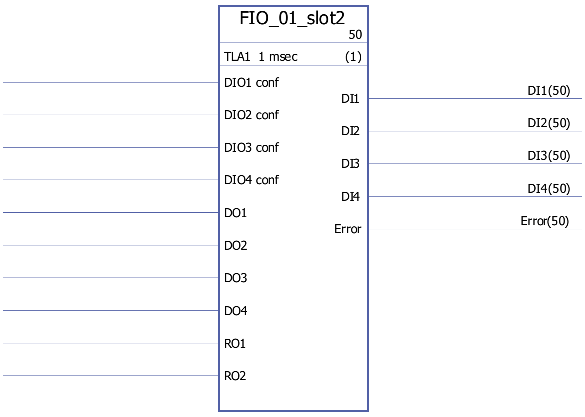
**Outputs** Digital input/output state (DI1…DI4): Boolean

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_01_slot2

## (10085)

**Illustration**



**Execution time** 8.6 µs

**Operation** The block controls the four digital inputs/outputs (DIO1…DIO4) and two relay outputs (RO1, RO2) of a FIO-01 Digital I/O Extension mounted on slot 2 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO-01 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The RO1 and RO2 inputs define the state of the relay outputs of the FIO-01 (0 = not energised, 1 = energised).

The DIx outputs show the state of the DIOs.

**Inputs** Digital input/output mode selection (DIO1 conf … DIO4 conf): Boolean

Digital output state selection (DO1…DO4): Boolean

Relay output state selection (RO1, RO2): Boolean

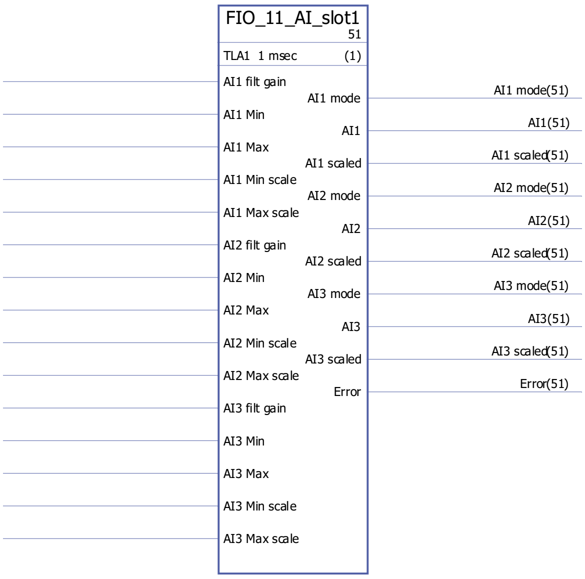
**Outputs** Digital input/output state (DI1…DI4): Boolean

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_11_AI_slot1

## (10088)

### Illustration



### Execution time

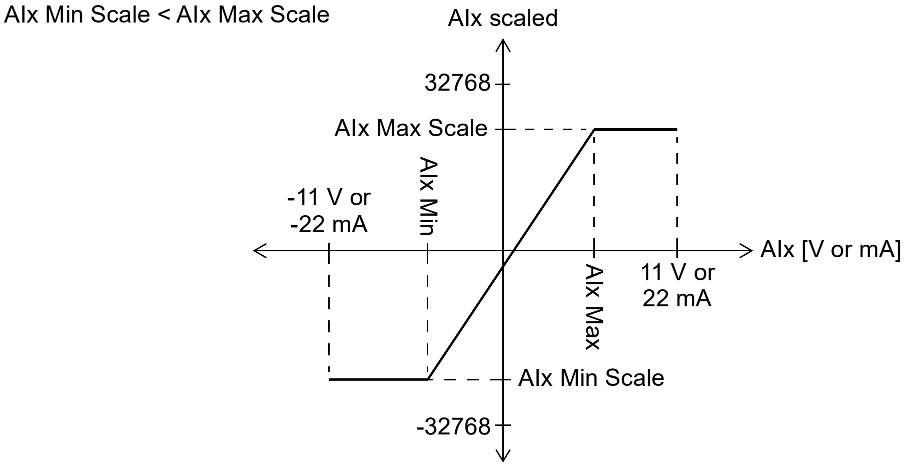
11.1 µs

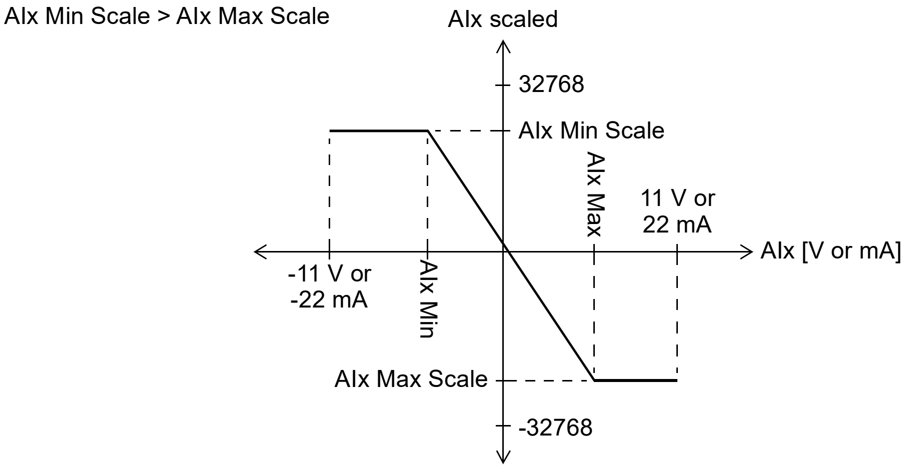
### Operation

The block controls the three analogue inputs (AI1…AI3) of a FIO-11 Analog I/O Extension mounted on slot 1 of the drive control unit.

The block outputs both the unscaled (AIx) and scaled (AIx scaled) actual values of each analogue input. The scaling is based on the relationship between the ranges AIx min … AIx max and AIx min scale … AIx max scale.

AIx Min must be smaller than AIx Max; AIx Max Scale can be greater or smaller than AIx Min Scale.





The AIx filt gain inputs determine a filtering time for each input as follows:

| AIx filt gain | Filtering time | Notes |
|---|---|---|
| 0 | No filtering | |
| 1 | 125 µs | Recommended setting |
| 2 | 250 µs | |
| 3 | 500 µs | |
| 4 | 1 ms | |
| 5 | 2 ms | |
| 6 | 4 ms | |
| 7 | 7.9375 ms | |

The AIx mode outputs show whether the corresponding input is voltage (0) or current (1). The voltage/current selection is made using the hardware switches on the FIO-11.

**Inputs**

Analogue input filter gain selection (AI1 filt gain … AI3 filt gain): INT
Minimum value of input signal (AI1 Min … AI3 Min): REAL (≥ -11 V or -22 mA)
Maximum value of input signal (AI1 Max … AI3 Max): REAL (≤ 11 V or 22 mA)
Minimum value of scaled output signal (AI1 Min scale … AI3 Min scale): REAL
Maximum value of scaled output signal (AI1 Max scale … AI3 Max scale): REAL

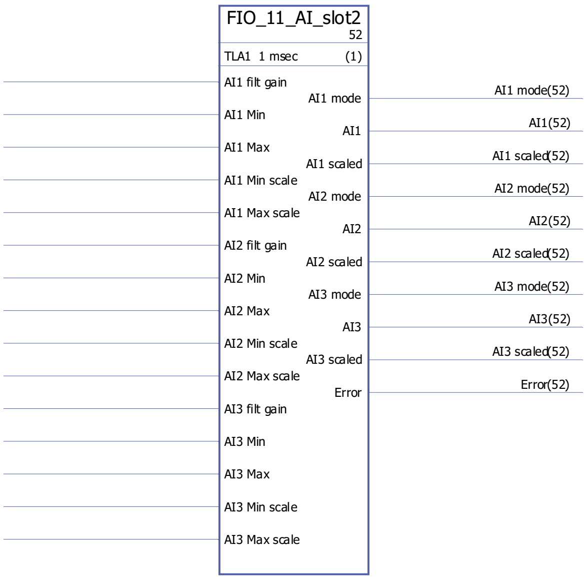
**Outputs**

Analogue input mode (voltage or current) (AI1 mode … AI3 mode): Boolean
Value of analogue input (AI1 … AI3): REAL
Scaled value of analogue input (AI1 scaled … AI3 scaled): REAL
Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_11_AI_slot2

## (10089)

**Illustration**

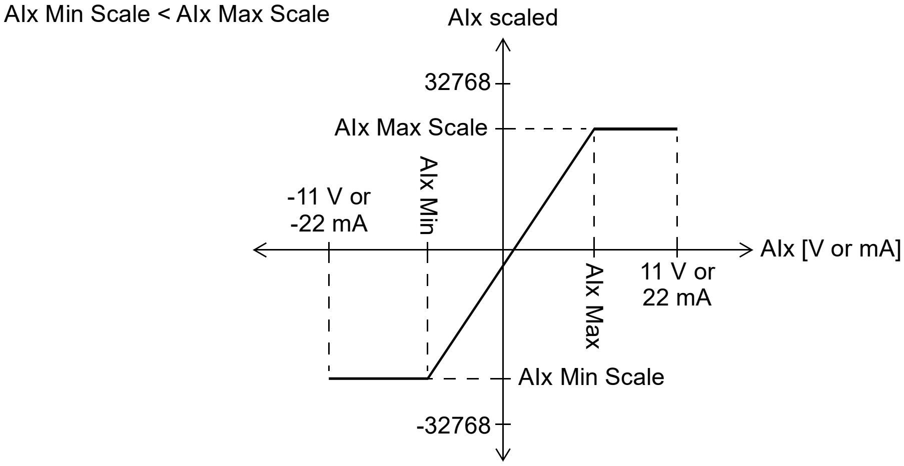


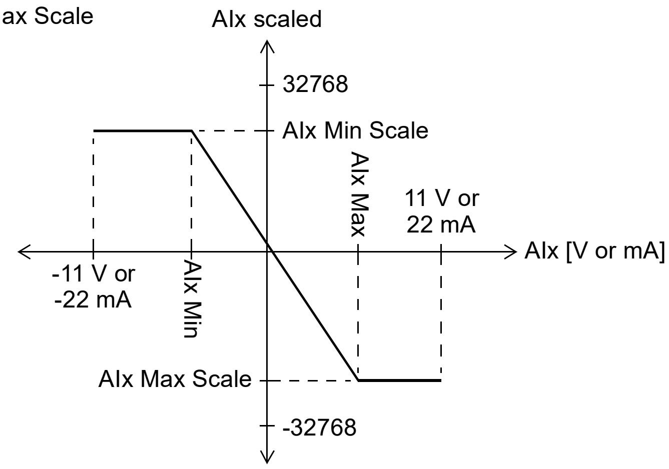
**Execution time** 11.1 µs

**Operation** The block controls the three analogue inputs (AI1…AI3) of a FIO-11 Analog I/O Extension mounted on slot 2 of the drive control unit.

The block outputs both the unscaled (AIx) and scaled (AIx scaled) actual values of each analogue input. The scaling is based on the relationship between the ranges AIx min … AIx max and AIx min scale … AIx max scale.

AIx Min must be smaller than AIx Max; AIx Max Scale can be greater or smaller than AIx Min Scale.





The AIx filt gain inputs determine a filtering time for each input as follows:

| AIx filt gain | Filtering time | Notes |
|---|---|---|
| 0 | No filtering | |
| 1 | 125 µs | Recommended setting |
| 2 | 250 µs | |
| 3 | 500 µs | |
| 4 | 1 ms | |
| 5 | 2 ms | |
| 6 | 4 ms | |
| 7 | 7.9375 ms | |

The AIx mode outputs show whether the corresponding input is voltage (0) or current (1). The voltage/current selection is made using the hardware switches on the FIO-11.

**Inputs**

Analogue input filter gain selection (AI1 filt gain … AI3 filt gain): INT

Minimum value of input signal (AI1 Min … AI3 Min): REAL (≥ -11 V or -22 mA)

Maximum value of input signal (AI1 Max … AI3 Max): REAL (≤ 11 V or 22 mA)

Minimum value of scaled output signal (AI1 Min scale … AI3 Min scale): REAL

Maximum value of scaled output signal (AI1 Max scale … AI3 Max scale): REAL

**Outputs**

Analogue input mode (voltage or current) (AI1 mode … AI3 mode): Boolean

Value of analogue input (AI1 … AI3): REAL

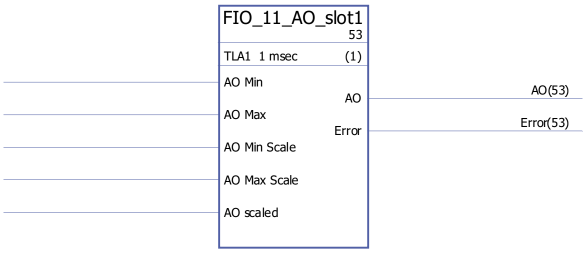
Scaled value of analogue input (AI1 scaled … AI3 scaled): REAL

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_11_AO_slot1

## (10090)

**Illustration**

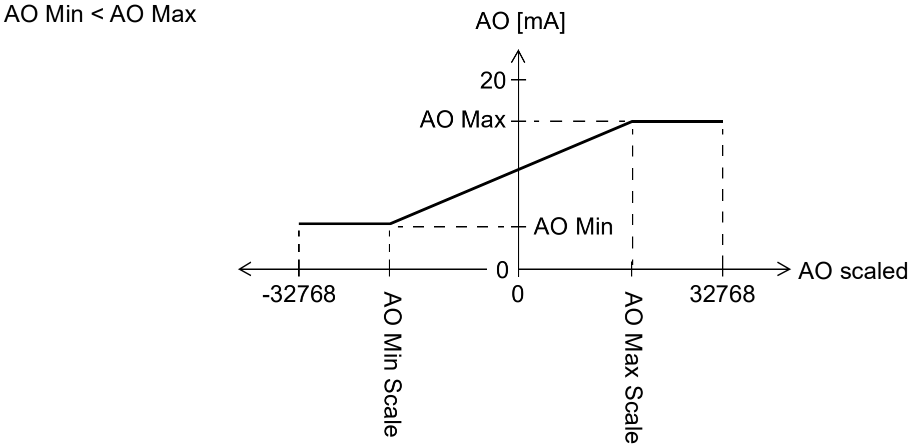


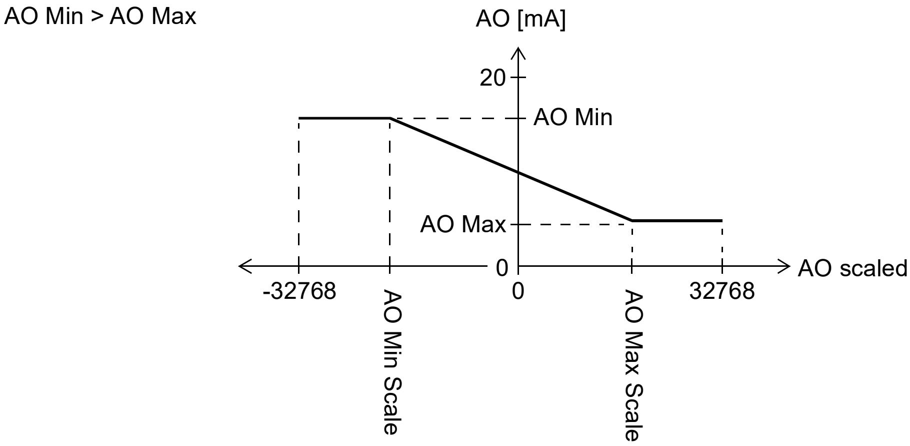
**Execution time** 4.9 µs

**Operation** The block controls the analogue output (AO1) of a FIO-11 Analog I/O Extension mounted on slot 1 of the drive control unit.

The block converts the input signal (AO scaled) to a 0…20 mA signal (AO) that drives the analogue output; the input range AO Min Scale … AO Max Scale corresponds to the current signal range of AO Min … AO Max.

AO Min Scale must be smaller than AO Max Scale; AO Max can be greater or smaller than AO Min.





**Inputs**

Minimum current signal (AO Min): REAL (0…20 mA)
Maximum current signal (AO Max): REAL (0…20 mA)
Minimum input signal (AO Min Scale): REAL
Maximum input signal (AO Max Scale): REAL
Input signal (AO scaled): REAL

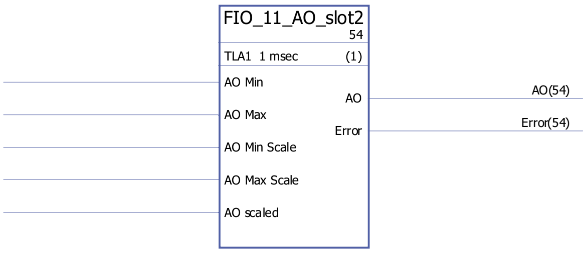
**Outputs**

Analogue output current value (AO): REAL
Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_11_AO_slot2

## (10091)

**Illustration**



**Execution time** 4.9 µs

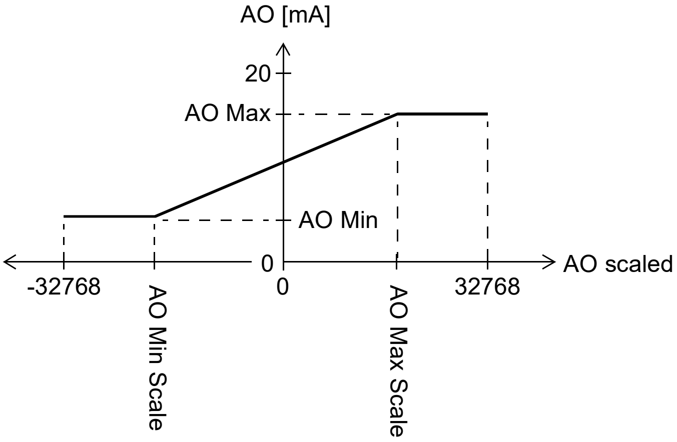
**Operation**

The block controls the analogue output (AO1) of a FIO-11 Analog I/O Extension mounted on slot 2 of the drive control unit.

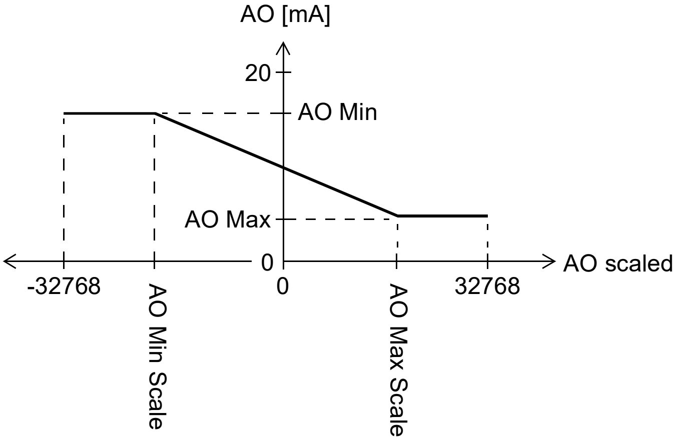
The block converts the input signal (AO scaled) to a 0…20 mA signal (AO) that drives the analogue output; the input range AO Min Scale … AO Max Scale corresponds to the current signal range of AO Min … AO Max.

AO Min Scale must be smaller than AO Max Scale; AO Max can be greater or smaller than AO Min.

AO Min < AO Max



AO Min > AO Max



**Inputs**

Minimum current signal (AO Min): REAL (0…20 mA)

Maximum current signal (AO Max): REAL (0…20 mA)

Minimum input signal (AO Min Scale): REAL

Maximum input signal (AO Max Scale): REAL

Input signal (AO scaled): REAL

**Outputs**

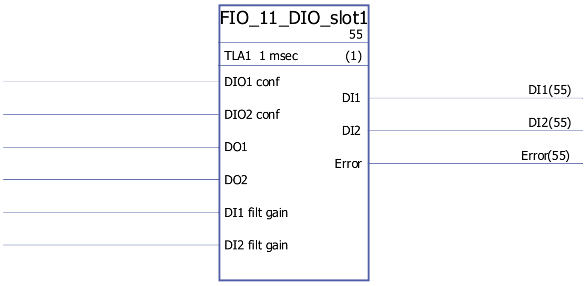
Analogue output current value (AO): REAL

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_11_DIO_slot1

## (10086)

**Illustration**



**Execution time** 6.0 µs

**Operation** The block controls the two digital inputs/outputs (DIO1, DIO2) of a FIO-11 Digital I/O Extension mounted on slot 1 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO-11 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The DIx outputs show the state of the DIOs.

The DIx filt gain inputs determine a filtering time for each input as follows:

| DIx filt gain | Filtering time |
|---|---|
| 0 | 7.5 µs |
| 1 | 195 µs |
| 2 | 780 µs |
| 3 | 4.680 ms |

**Inputs** Digital input/output mode selection (DIO1 conf, DIO2 conf): Boolean

Digital output state selection (DO1, DO2): Boolean

Digital input filter gain selection (DI1 filt gain, DI2 filt gain): INT

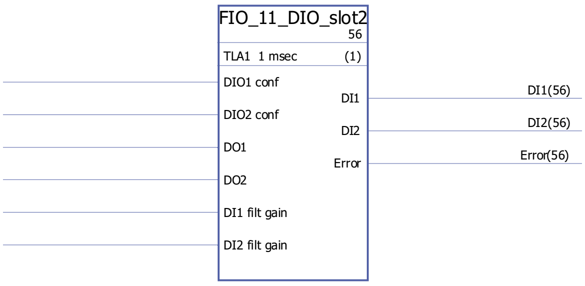
**Outputs** Digital input/output state (DI1, DI2): Boolean

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# FIO_11_DIO_slot2

## (10087)

**Illustration**



**Execution time** 6.0 µs

**Operation** The block controls the two digital inputs/outputs (DIO1, DIO2) of a FIO-11 Digital I/O Extension mounted on slot 2 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO-11 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The DIx outputs show the state of the DIOs.

The DIx filt gain inputs determine a filtering time for each input as follows:

| DIx filt gain | Filtering time |
|---|---|
| 0 | 7.5 µs |
| 1 | 195 µs |
| 2 | 780 µs |
| 3 | 4.680 ms |

**Inputs** Digital input/output mode selection (DIO1 conf, DIO2 conf): Boolean

Digital output state selection (DO1, DO2): Boolean

Digital input filter gain selection (DI1 filt gain, DI2 filt gain): INT

**Outputs** Digital input/output state (DI1, DI2): Boolean

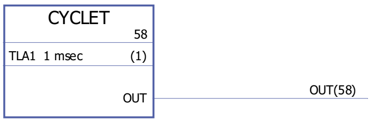
Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# Feedback & algorithms

## CYCLET

## (10074)

**Illustration**



**Execution time** 0.00 µs

**Operation** Output (OUT) is the time level of the CYCLET function block.

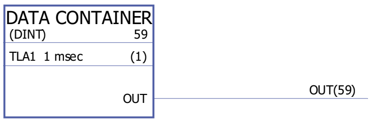
**Inputs** -

**Outputs** Output (OUT): DINT. 1 = 1 µs

## DATA CONTAINER

## (10073)

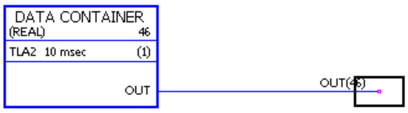
**Illustration**

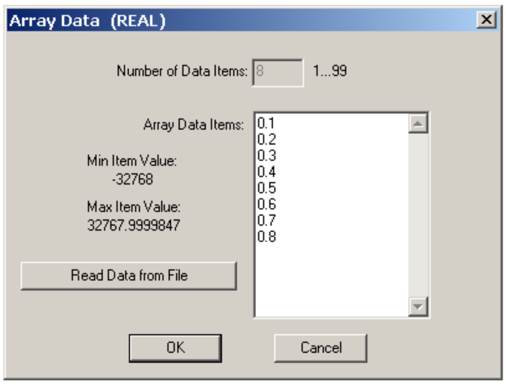


**Execution time** 0.00 µs

**Operation** Output (OUT) is an array of data with values 1…99. The array can be used by the XTAB and YTAB tables in the block FUNG-1V (page 311). The array is defined by selecting “Define Pin Array Data” on the output pin in DriveSPC. Each value in the array must be on a separate row. Data can also be read from an *.arr file.

Example:





Number of Data Items: 8 1...99

Array Data Items:
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

Min Item Value:
-32768

Max Item Value:
32767.9999847

**Inputs** -

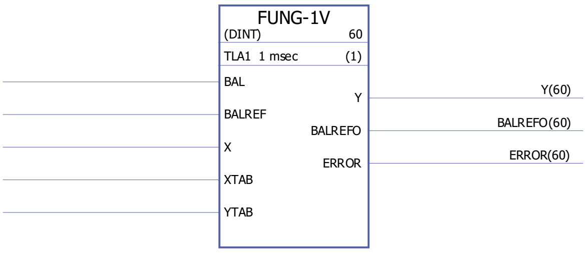
**Outputs** The output data type and the number of coordinate pairs are selected by the user.

Output (OUT): DINT, INT, REAL or REAL24

# FUNG-1V

## (10072)

**Illustration**



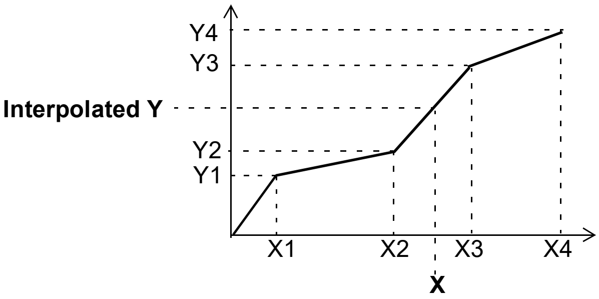
**Execution time** 9.29 µs

**Operation** The output (Y) at the value of the input (X) is calculated with linear interpolation from a piecewise linear function.

$Y = Y_k + (X - X_k)(Y_{k+1} - Y_k) / (X_{k+1} - X_k)$

The piecewise linear function is defined by the X and Y vector tables (XTAB and YTAB). For each X-value in the XTAB table, there is a corresponding Y-value in the YTAB table. The values in XTAB and YTAB must be in ascending order (i.e. from low to high).

XTAB and YTAB values are defined with the DriveSPC tool.



| **X table** | **Y table** |
|---|---|
| **(XTAB)** | **(YTAB)** |
| X1 | Y1 |
| X2 | Y2 |
| X3 | Y3 |
| … | … |
| X9 | Y9 |

The balancing function (BAL) permits the output signal to track an external reference and gives a smooth return to the normal operation. If BAL is set to 1, output Y is set to the value of the balance reference input (BALREF). The X value which corresponds to this Y value is calculated with linear interpolation and it is indicated by the balance reference output (BALREFO).

If the X input is outside the range defined by the XTAB table, the output Y is set to the highest or lowest value in the YTAB table.

If BALREF is outside the range defined by the YTAB table when balancing is activated (BAL: 0 -> 1), the output Y is set to the value of the BALREF input and the BALREFO output is set to the highest or lowest value in the XTAB table.

The ERROR output is set to 1 when the number of the XTAB and YTAB inputs are different. When ERROR is 1, the FUNG-1V block will not function. XTAB and YTAB tables can be defined in the DATA CONTAINER block (page 310) or the REG-G block (page 317).

**Inputs** The input data type is selected by the user.

Balance input (BAL): Boolean

Balance reference input (BALREF): DINT, INT, REAL, REAL24.

X value input (X): DINT, INT, REAL, REAL24

X table input (XTAB): DINT, INT, REAL, REAL24

Y table input (YTAB): DINT, INT, REAL, REAL24

**Outputs**

Y value output (Y): DINT, INT, REAL, REAL24

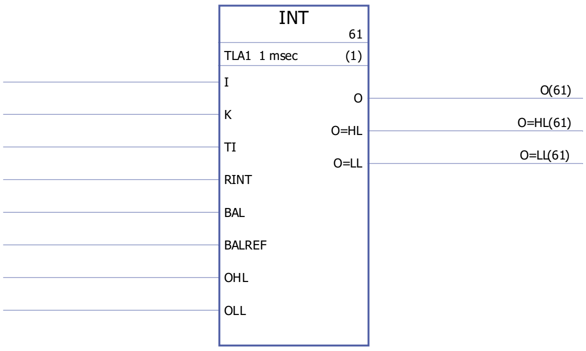
Balance reference output (BALREFO): DINT, INT, REAL, REAL24

Error output (ERROR): Boolean

# INT

## (10065)

**Illustration**



**Execution time**

4.73 µs

**Operation**

The output (O) is the integrated value of the input (I):

O(t) = K/TI (∫ I(t) dt)

Where TI is the integration time constant and K is the integration gain.

The step response for the integration is:

O(t) = K × I(t) × t/TI

The transfer function for the integration is:

G(s) = K 1/sTI

The output value is limited according to the defined minimum and maximum limits (OLL and OHL). If the value is below the minimum value, output O = LL is set to 1. If the value exceeds the maximum value, output O = HL is set to 1. The output (O) retains its value when the input signal I(t) = 0.

The integration time constant is limited to value 2147483 ms. If the time constant is negative, zero time constant is used.

If the ratio between the cycle time and the integration time constant Ts/TI < 1, Ts/TI is set to 1.

The integrator is cleared when the reset input (RINT) is set to 1.

If BAL is set to 1, output O is set to the value of the input BALREF. When BAL is set back to 0, normal integration operation continues.

**Inputs**

Input (I): REAL

Gain input (K): REAL

Integration time constant input (TI): DINT, 0…2147483 ms

Integrator reset input (RINT): Boolean

Balance input (BAL): Boolean

Balance reference input (BALREF): REAL

Output high limit input (OHL): REAL

Output low limit input (OLL): REAL

**Outputs** Output (O): REAL

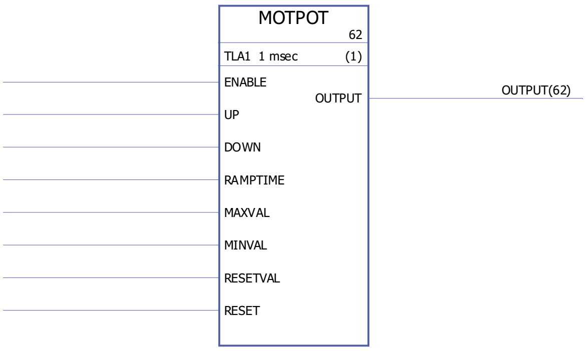
High limit output (O=HL): Boolean

Low limit output (O=LL): Boolean

# MOTPOT

## (10067)

**Illustration**



**Execution time** 2.92 μs

**Operation** The motor potentiometer function controls the rate of change of the output from the minimum to the maximum value and vice versa.

The function is enabled by setting the ENABLE input to 1. If the up input (UP) is 1, the output reference (OUTPUT) is increased to the maximum value (MAXVAL) with the defined ramp time (RAMPTIME). If the down input (DOWN) is 1, the output value is decreased to the minimum value (MINVAL) with the defined ramp time. If the up and down inputs are activated/deactivated simultaneously, the output value is not increased/ decreased.

If the RESET input is 1, the output will be reset to the value defined by the reset value input (RESETVAL) or to the value defined by the minimum input (MINVAL), whichever is higher.

If the ENABLE input is 0, the output is zero.

Digital inputs are normally used as up and down inputs.

**Inputs** Function enable input (ENABLE): Boolean

Up input (UP): Boolean

Down input (DOWN): Boolean

Ramp time input (RAMPTIME): REAL (seconds) (i.e. the time required for the output to change from the minimum to the maximum value or from the maximum to the minimum value)

Maximum reference input (MAXVAL): REAL

Minimum reference input (MINVAL): REAL

Reset value input (RESETVAL): REAL

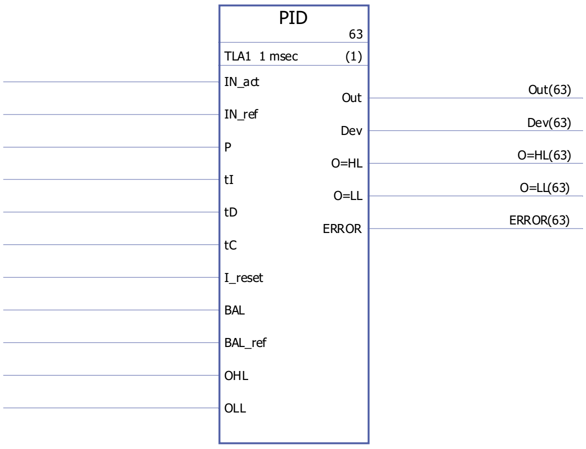
Reset input (RESET): Boolean

**Outputs** Output (OUTPUT) REAL

# PID

## (10075)

### Illustration



**Execution time** 15.75 µs

**Operation**

The PID controller can be used for closed-loop control systems. The controller includes anti-windup correction and output limitation.

The PID controller output (Out) before limitation is the sum of the proportional ($U_P$), integral ($U_I$) and derivative ($U_D$) terms:

$\text{Out}_{\text{unlimited}}(t) = U_P(t) + U_I(t) + U_D(t)$

$U_P(t) = P \times \text{Dev}(t)$

$U_I(t) = P/tI \times [\int \text{Dev}(\tau)d\tau + tC \times (\text{Out}(t) - \text{Out}_{\text{unlimited}}(t))]$

$U_D(t) = P \times tD \times d(\text{Dev}(t))/dt$

Integrator:

The integral term can be cleared by setting I_reset to 1. Note that the anti-windup correction is simultaneously disabled. When I_reset is 1, the controller acts as a PD controller.

If integration time constant tI is 0, the integral term will not be updated.

Smooth return to normal operation is guaranteed after errors or abrupt input value changes. This is achieved by adjusting the integral term so that the output will retain its previous value during these situations.

Limitation:

The output is limited by the defined minimum and maximum values, OLL and OHL:

If the actual value of the output reaches the specified minimum limit, output O=LL is set to 1.

If the actual value of the output reaches the specified maximum limit, output O=HL is set to 1.

Smooth return to normal operation after limitation is requested if and only if the anti-windup correction is not used, i.e. when tI = 0 or tC = 0.

Error codes:

Error codes are indicated by the error output (ERROR) as follows

| Error code | Description |
|---|---|
| 1 | The minimum limit (OLL) exceeds the maximum limit (OHL). |
| 2 | Overflow with Up, Ui, or Ud calculation |

Balancing:

The balancing function (BAL) permits the output signal to track an external reference and gives a smooth return to the normal operation. If BAL is set to 1, the output (Out) is set to the value of the balance reference input (BAL_ref). Balance reference is limited by the defined minimum and maximum limits (OLL and OHL).

Anti-windup:

Anti-windup correction time constant is defined by input tC, which defines the time after which the difference between the unlimited and limited outputs is subtracted from the I-term during limitation. If tC = 0 or tI = 0, anti-windup correction is disabled.

**Inputs**

Actual input (IN_act): REAL
Reference input (IN_ref): REAL
Proportional gain input (P): REAL
Integration time constant input (tI): REAL. 1 = 1 ms
Derivation time constant input (tD): REAL. 1 = 1 ms
Antiwind-up correction time constant input (tC): IQ6. 1 = 1 ms
Integrator reset input (I_reset): Boolean
Balance input (BAL): Boolean
Balance reference input (BAL_ref): REAL
Output high limit input (OHL): REAL
Output low limit input (OLL): REAL

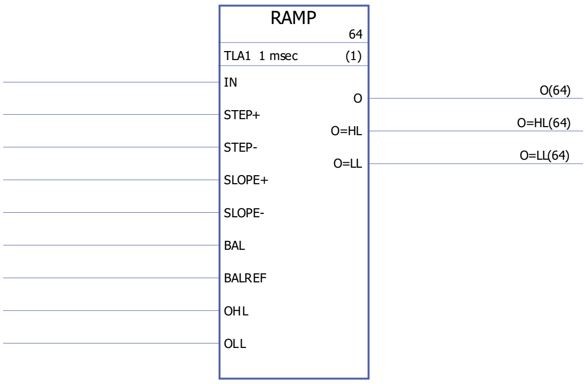
**Outputs**

Output (Out): REAL
Deviation output (Dev): REAL (= actual -reference = IN_act - IN_ref)
High limit output (O=HL): Boolean
Low limit output (O=LL): Boolean
Error code output (ERROR): INT32

# RAMP

## (10066)

**Illustration**



**Execution time** 4.23 µs

**Operation**

Limits the rate of the change of the signal.

The input signal (IN) is connected directly to the output (O) if the input signal does not exceed the defined step change limits (STEP+ and STEP-). If the input signal change exceeds these limits, the output signal change is limited by the maximum step change (STEP+/STEP- depending on the direction of rotation). After this, the output signal is accelerated/decelerated by the defined ramp value (SLOPE+/SLOPE-) per second until the input and output signal values are equal.

The output is limited by the defined minimum and maximum values (OLL and OHL). If the actual value of the output falls below the specified minimum limit (OLL), output O=LL is set to 1. If the actual value of the output exceeds the specified maximum limit (OHL), output O=HL is set to 1.

If the balancing input (BAL) is set to 1, the output (O) is set to the value of the balance reference input (BAL_ref). Balancing reference is also limited by the minimum and maximum values (OLL and OHL).

**Inputs**

Input (IN): REAL
Maximum positive step change input (STEP+): REAL
Maximum negative step change input (STEP-): REAL
Ramp-up value per second input (SLOPE+): REAL
Ramp-down value per second input (SLOPE-): REAL
Balance input (BAL): Boolean
Balance reference input (BALREF): REAL
Output high limit input (OHL): REAL
Output low limit input (OLL): REAL

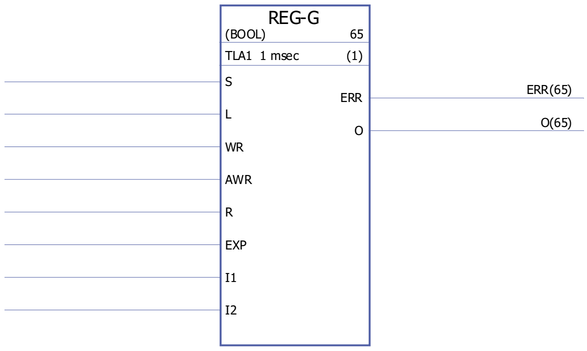
**Outputs**

Output (O): REAL
High limit output (O=HL): Boolean
Low limit output (O=LL): Boolean

# REG-G

## (10102)

**Illustration**



**Execution time** -

**Operation**

Combines the array (group of variables) (if any) on the EXP input with the values of the I1…I32 pins to produce an output array. The data type of the arrays can be INT, DINT, REAL16, REAL24 or Boolean. The output array consists of the data from the EXP input and the values of the I1…In (in this order).

When input S is 1, data is continuously assembled into the output array. The element acts as a latch when input S is 0; the latest data assembled then remains at the output.

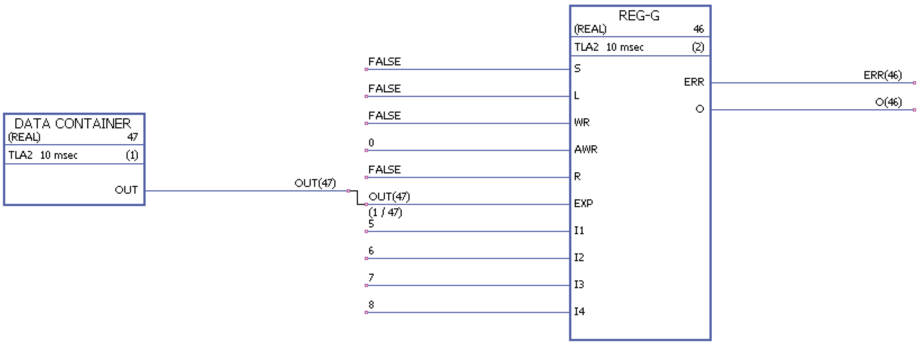
If S is 0 and L changes state from 0 to 1, the array from the EXP input and the values of the I1…In inputs are copied to output O during this program cycle. If S or R is 1, L has no effect.

WR and AWR are used to change individual cells of the output array. AWR indicates the input whose value is moved to the output array. If AWR is 0, only the array from input EXP is moved to the output. If AWR is not 0, the corresponding I input is moved to the output. This is performed when WR goes from 0 to 1.

When input R is 1, the output array is cleared and all further data entry is prevented. R overrides both S and L. If WR is 1, the address at AWR is checked and if it is illegal (negative or greater than the number of inputs), the error output (ERR) is set to 2. Otherwise ERR is 0.

Whenever an error is detected, ERR is set within one cycle. No place in the register is affected when an error occurs.

Example:



In the diagram, the DATA CONTAINER block includes an array with values [1,2,3,4]. At start, the output array is [0,0,0,0,0,0,0,0]. When WR changes to 1 and returns to 0, the AWR value of 0 means that only EXP is moved into the output array, which now reads [1,2,3,4,0,0,0,0]. After this, AWR is changed to 3, meaning that inputs EXP and I3 are moved to the output. After a WR switch, the output array is [1,2,3,4,0,0,7,0].

**Inputs**

Set (S): Boolean, INT, DINT, REAL, REAL24

Load (L): Boolean, INT, DINT, REAL, REAL24

Write (WR): Boolean, INT, DINT, REAL, REAL24

Write address (AWR): INT

Reset (R): Boolean

Expander (EXP): IArray

Data input (I1…I32): Boolean, INT, DINT, REAL, REAL24

**Outputs**

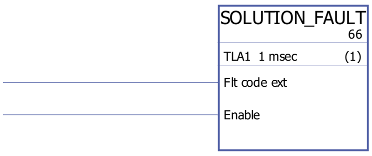
Error (ERR): INT

Array data output (O): OC1

# SOLUTION_FAULT

## (10097)

**Illustration**



**Execution time** -

**Operation** When the block is enabled (by setting the Enable input to 1), a fault (F-0317 SOLUTION FAULT) is generated by the drive. The value of the Flt code ext input is recorded by the fault logger.

**Inputs** Fault code extension (Flt code ext): DINT

Generate fault (Enable): Boolean

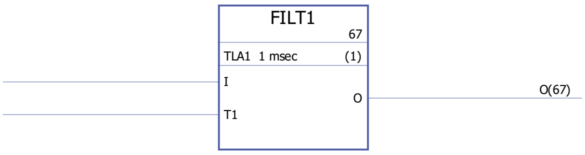
**Outputs** -

# Filters

## FILT1

### (10069)

**Illustration**



**Execution time** 7.59 µs

**Operation** The output (O) is the filtered value of the input (I) value and the previous output value ($O_{prev}$). The FILT1 block acts as 1st order low pass filter.

**Note:** Filter time constant (T1) must be selected so that T1/Ts < 32767. If the ratio exceeds 32767, it is considered as 32767. Ts is the cycle time of the program in ms.

If T1 < Ts, the output value is the input value.

The step response for a single pole low pass filter is:

$O (t) = I(t) \times (1 - e^{-t/T1})$

The transfer function for a single pole low pass filter is:

$G(s) = 1/ (1 + sT1)$

**Inputs** Input (I): REAL

Filter time constant input (T1): DINT, 1 = 1 ms

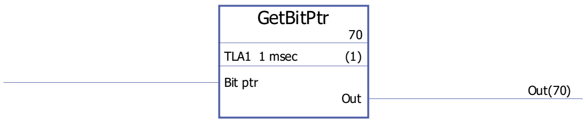
**Outputs** Output (O): REAL

# Parameters

## GetBitPtr

### (10099)

**Illustration**



**Execution time** -

**Operation** Reads the status of one bit within a parameter value cyclically.

The Bit ptr input specifies the parameter group, index and bit to be read.

The output (Out) provides the value of the bit.

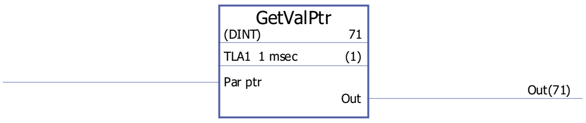
**Inputs** Parameter group, index and bit (Bit ptr): DINT

**Outputs** Bit status (Out): DINT

## GetValPtr

### (10098)

**Illustration**



**Execution time** -

**Operation** Reads the value of a parameter cyclically.

The Par ptr input specifies the parameter group and index to be read.

The output (Out) provides the value of the parameter.

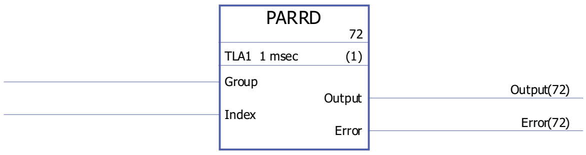
**Inputs** Parameter group and index (Par ptr): DINT

**Outputs** Parameter value (Out): DINT

## PARRD

### (10082)

**Illustration**



**Execution time** 6.00 µs

**Operation**

Reads the scaled value of a parameter (specified by the Group and Index inputs). If the parameter is a pointer parameter, the Output pin provides the number of the source parameter instead of its value.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| <> 0 | Error |

See also blocks PARRDINTR and PARRDPTR.

**Inputs**

Parameter group input (Group): DINT

Parameter index input (Index): DINT

**Outputs**

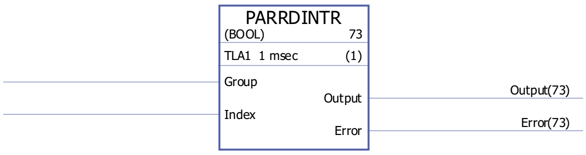
Output (Output): DINT

Error output (Error): DINT

# PARRDINTR

## (10101)

**Illustration**



**Execution time**

-

**Operation**

Reads the internal (non-scaled) value of a parameter (specified by the Group and Index inputs). The value is provided by the Output pin.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error or busy |
| <> 0 | Error |

**Note:** Using this block may cause incompatibility issues when upgrading the application to another firmware version.

**Inputs**

Parameter group (Group): DINT

Parameter index (Index): DINT

**Outputs**

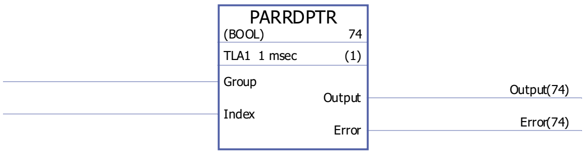
Output (Output): Boolean, INT, DINT, REAL, REAL24

Error output (Error): DINT

# PARRDPTR

## (10100)

**Illustration**



**Execution time**

-

**Operation**

Reads the internal (non-scaled) value of the source of a pointer parameter. The pointer parameter is specified using the Group and Index inputs.

The value of the source selected by the pointer parameter is provided by the Output pin.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error or busy |
| <> 0 | Error |

**Inputs**

Parameter group (Group): DINT

Parameter index (Index): DINT

**Outputs**

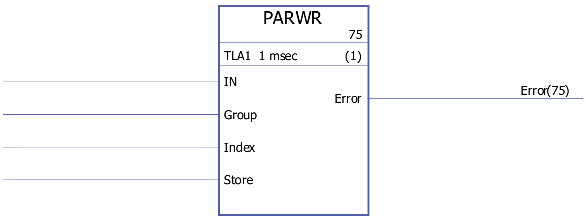
Output (Output): Boolean, INT, DINT, REAL, REAL24

Error output (Error): DINT

# PARWR

## (10080)

**Illustration**



**Execution time**

14.50 µs

**Operation**

The input value (IN) is written to the defined parameter (Group and Index).

The new parameter value is stored to the flash memory if the store input (Store) is 1. **Note:** Cyclic parameter value storing can damage the memory unit. Parameter values should be stored only when necessary.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| <> 0 | Error |

**Inputs**

Input (IN): DINT

Parameter group input (Group): DINT

Parameter index input (Index): DINT

Store input (Store): Boolean

**Outputs**

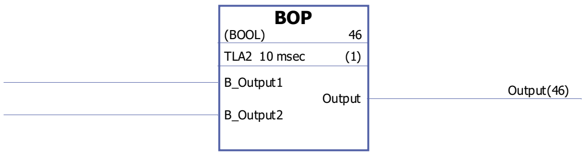
Error output (Error): DINT

# Program structure

## BOP

## (10105)

**Illustration**



**Execution time** -

**Operation** The BOP (Bundle OutPut) block collects the outputs of several different sources. The sources are connected to the B_Output pins. The B_Output pin that changed last is relayed to the Output pin.

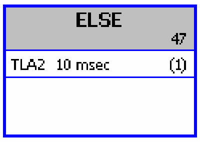
The block is intended for use with conditional IF-ENDIF structures. See the example under the IF block.

**Inputs** Values from different conditional branches (B_Output1…B_OutputN): INT, DINT, Boolean, REAL, REAL24

**Outputs** Output from currently active branch of a IF-ELSEIF structure or latest updated input value (Output): INT, DINT, Boolean, REAL, REAL24

## ELSE

**Illustration**



**Execution time** -

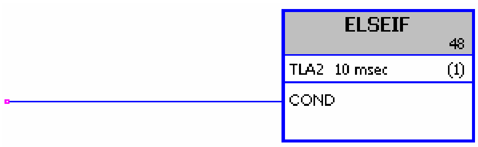
**Operation** See description of IF block.

**Inputs** -

**Outputs** -

# ELSEIF

**Illustration**



**Execution time** -

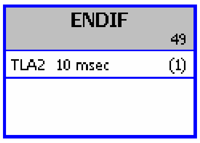
**Operation** See description of IF block.

**Inputs** Input (COND): Boolean

**Outputs** -

# ENDIF

**Illustration**



**Execution time** -

**Operation** See description of IF block.

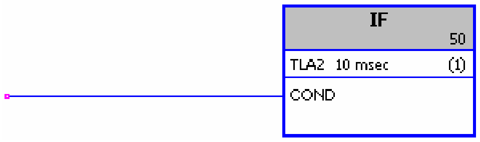
**Inputs** -

**Outputs** -

# IF

## (10103)

### Illustration



### Execution time

-

### Operation

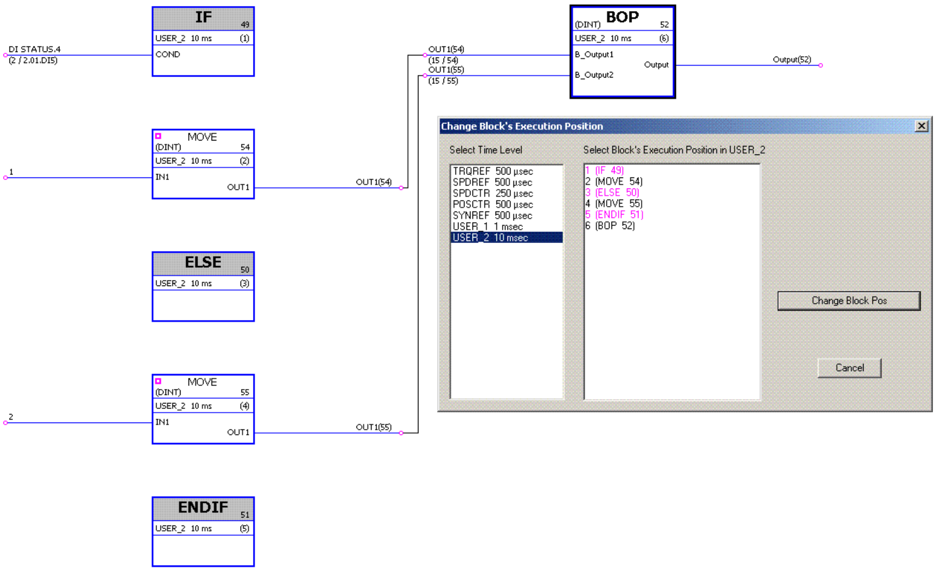
The IF, ELSE, ELSEIF and ENDIF blocks define, by Boolean logic, which parts of the application program are executed.

If the condition input (COND) is true, the blocks between the IF block and the next ELSEIF, ELSE or ENDIF block (in execution order) are run. If the condition input (COND) is false, the blocks between the IF block and the next ELSEIF, ELSE or ENDIF block are skipped.

The outputs of the “branches” are collected and selected by using the BOP block.

Example:

Bit 4 of 2.01 DI STATUS (digital input DI5) controls the branching of the application program. If the input is 0, the blocks between the IF and ELSE blocks are skipped but the blocks between ELSE and ENDIF are run. If the input is 1, the blocks between IF and ELSE are run. The program execution then jumps to the block that follows ENDIF, which is a BOP. The BOP block outputs the value from the branch that was executed. If the digital input is 0, the BOP block output is 2; if the digital input is 1, the BOP block output is 1.



TRQREF 500 µsec
SPDREF 500 µsec
SPDCTR 250 µsec
POSCTR 500 µsec
SYNREF 500 µsec
USER_1 1 msec
USER_2 10 msec

1 (IF 49)
2 (MOVE 54)
3 (ELSE 50)
4 (MOVE 55)
5 (ENDIF 51)
6 (BOP 52)

### Inputs

Input (COND): Boolean

### Outputs

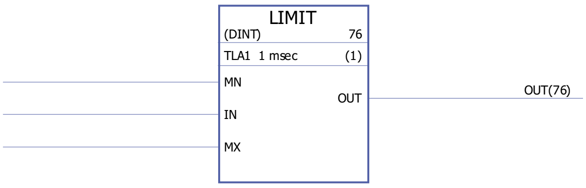
-

# Selection

## LIMIT

### (10052)

**Illustration**



**Execution time** 0.53 µs

**Operation** The output (OUT) is the limited input (IN) value. Input is limited according to the minimum (MN) and maximum (MX) values.

**Inputs** The input data type is selected by the user.

Minimum input limit (MN): INT, DINT, REAL, REAL24

Input (IN): INT, DINT, REAL, REAL24

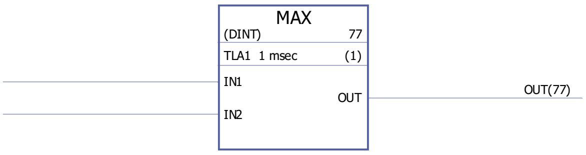
Maximum input limit (MX): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

## MAX

### (10053)

**Illustration**



**Execution time** 0.81 µs (when two inputs are used) + 0.53 µs (for every additional input). When all inputs are used, the execution time is 16.73 µs.

**Operation** The output (OUT) is the highest input value (IN).

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

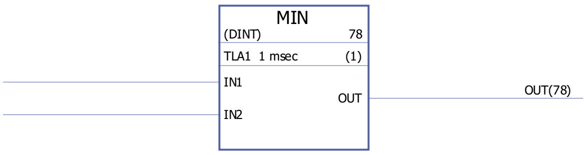
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

## MIN

### (10054)

**Illustration**



**Execution time** 0.81 µs (when two inputs are used) + 0.52 µs (for every additional input). When all inputs are used, the execution time is 16.50 µs.

**Operation** The output (OUT) is the lowest input value (IN).

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

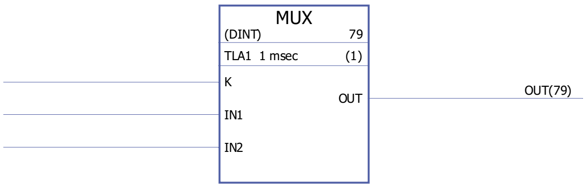
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

# MUX

## (10055)

**Illustration**



**Execution time** 0.70 µs

**Operation** The value of an input (IN) selected by the address input (K) is stored to the output (OUT).

If the address input is 0, negative or exceeds the number of the inputs, the output is 0.

**Inputs** The input data type and number of inputs (2…32) are selected by the user.

Address input (K): DINT

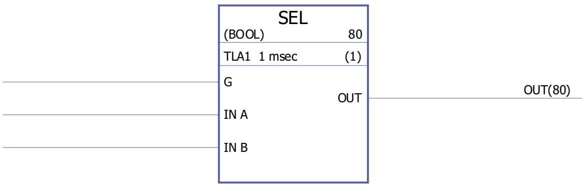
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

# SEL

## (10056)

**Illustration**



**Execution time** 1.53 µs

**Operation** The output (OUT) is the value of the input (IN) selected by the selection input (G).

If G = 0: OUT = IN A.

If G = 1: OUT = IN B.

**Inputs** The input data type is selected by the user.

Selection input (G): Boolean

Input (IN A, IN B): Boolean, INT, DINT, REAL, REAL24

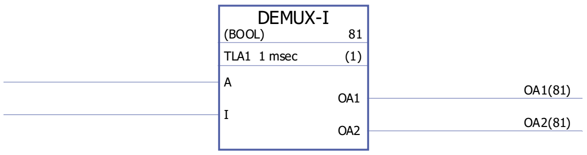
**Outputs** Output (OUT): Boolean, INT, DINT, REAL, REAL24

# Switch & Demux

## DEMUX-I

### (10061)

**Illustration**



**Execution time** 1.38 µs (when two outputs are used) + 0.30 µs (for every additional output). When all outputs are used, the execution time is 10.38 µs.

**Operation** Input (I) value is stored to the output (OA1…OA32) selected by the address input (A). All other outputs are 0.

If the address input is 0, negative or exceeds the number of the outputs, all outputs are 0.

**Inputs** The input data type is selected by the user.

Address input (A): DINT

Input (I): INT, DINT, Boolean, REAL, REAL24

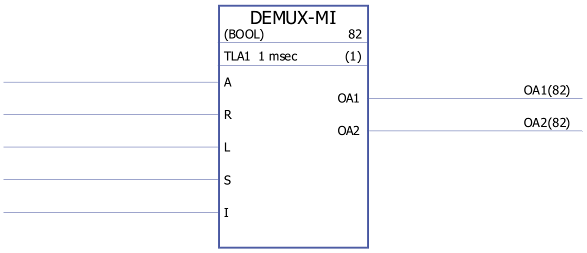
**Outputs** The number of the output channels (1…32) is selected by the user.

Output (OA1…OA32): INT, DINT, REAL, REAL24, Boolean

## DEMUX-MI

### (10062)

**Illustration**



**Execution time** 0.99 µs (when two outputs are used) + 0.25 µs (for every additional output). When all outputs are used, the execution time is 8.4 µs.

**Operation**

The input (I) value is stored to the output (OA1…OA32) selected by the address input (A) if the load input (L) or the set input (S) is 1. When the load input is set to 1, the input (I) value is stored to the output only once. When the set input is set to 1, the input (I) value is stored to the output every time the block is executed. The set input overrides the load input.

If the reset input (R) is 1, all connected outputs are 0.

If the address input is 0, negative or exceeds the number of the outputs, all outputs are 0.

Example:

| S | L | R | A | I | OA1 | OA2 | OA3 | OA4 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 2 | 150 | 0 | 150 | 0 | 0 |
| 0 | 0 | 0 | 2 | 120 | 0 | 150 | 0 | 0 |
| 0 | 1 | 0 | 3 | 100 | 0 | 150 | 100 | 0 |
| 1 | 0 | 0 | 1 | 200 | 200 | 150 | 100 | 0 |
| 1 | 1 | 0 | 4 | 250 | 200 | 150 | 100 | 250 |
| 1 | 1 | 1 | 2 | 300 | 0 | 0 | 0 | 0 |

**Inputs**

The input data type is selected by the user.

Address input (A): DINT

Reset input (R): Boolean

Load input (L): Boolean

Set input (S): Boolean

Input (I): DINT, INT, REAL, REAL24, Boolean

**Outputs**

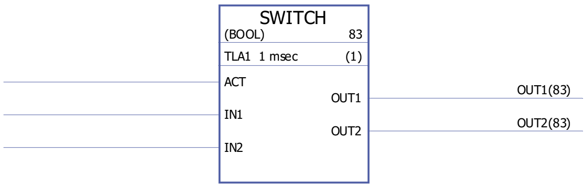
The number of the output channels (1…32) is selected by the user.

Output (OA1…OA32): DINT, INT, REAL, REAL24, Boolean

# SWITCH

## (10063)

**Illustration**



**Execution time**

0.68 µs (when two inputs are used) + 0.50 µs (for every additional input). When all inputs are used, the execution time is 15.80 µs.

**Operation**

The output (OUT) is equal to the corresponding input (IN) if the activate input (ACT) is 1. Otherwise the output is 0.

**Inputs**

The input data type and the number of inputs (1…32) are selected by the user.

Activate input (ACT): Boolean

Input (IN1…IN32): INT, DINT, REAL, REAL24, Boolean

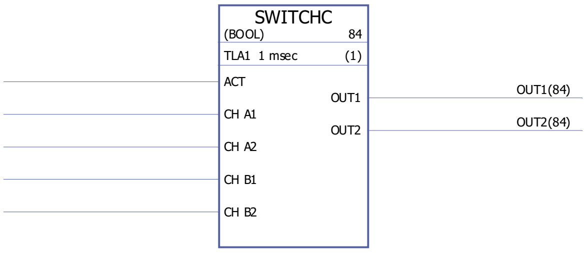
**Outputs**

Output (OUT1…OUT32): INT, DINT, REAL, REAL24, Boolean

# SWITCHC

## (10064)

**Illustration**



**Execution time** 1.53 µs (when two inputs are used) + 0.73 µs (for every additional input). When all inputs are used, the execution time is 23.31 µs.

**Operation** The output (OUT) is equal to the corresponding channel A input (CH A1…32) if the activate input (ACT) is 0. The output is equal to the corresponding channel B input (CH B1…32) if the activate input (ACT) is 1.

**Inputs** The input data type and the number of inputs (1…32) are selected by the user.

Activate input (ACT): Boolean

Input (CH A1…CH A32, CH B1…CH B32): INT, DINT, REAL, REAL24, Boolean

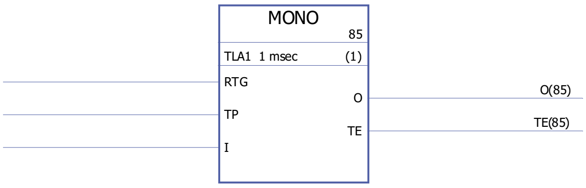
**Outputs** Output (OUT1…OUT32): INT, DINT, REAL, REAL24, Boolean

# Timers

## MONO

## (10057)

**Illustration**



**Execution time** 1.46 µs

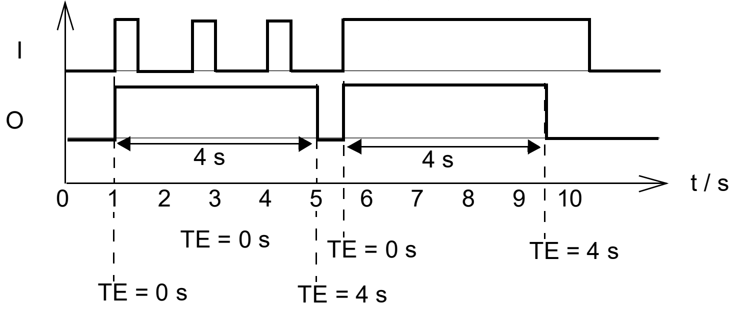
**Operation** The output (O) is set to 1 and the timer is started, if the input (I) is set to 1. The output is reset to 0 when the time defined by the time pulse input (TP) has elapsed. Elapsed time (TE) count starts when the output is set to 1 and stops when the output is set to 0.

If RTG is 0, a new input pulse during the time defined by TP has no effect on the function. The function can be restarted only after the time defined by TP has elapsed.

If RTG is 1, a new input pulse during the time defined by TP restarts the timer and sets the elapsed time (TE) to 0.

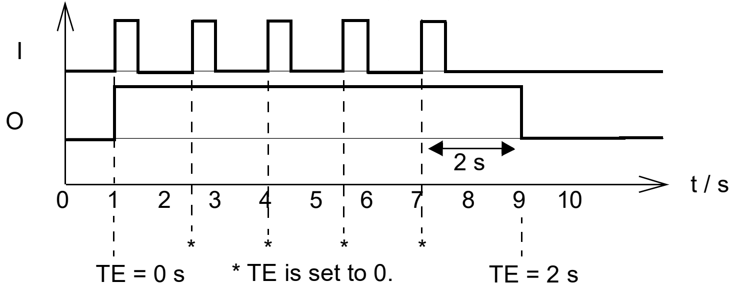
Example 1: MONO is not re-triggable, i.e. RTG = 0.

**RTG = 0, TP = 4 s**



Example 2: MONO is re-triggable, i.e. RTG = 1.

**RTG = 1, TP = 2 s**



**Inputs** Re-trigger input (RTG): Boolean

Time pulse input (TP): DINT (1 =  µs)

Input (I): Boolean

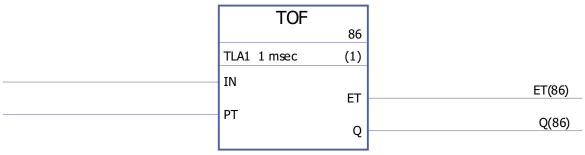
**Outputs** Output (O): Boolean

Time elapsed output (TE): DINT (1 = 1 µs)

# TOF

## (10058)

**Illustration**

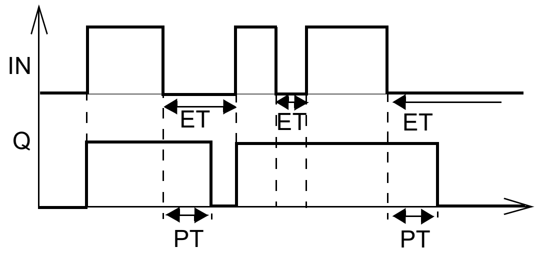


**Execution time** 1.10 µs

**Operation** The output (Q) is set to 1, when the input (IN) is set to 1. The output is reset to zero when the input has been 0 for a time defined by the pulse time input (PT).

Elapsed time count (ET) starts when the input is set to 0 and stops when the input is set to 1.

Example:



**Inputs** Input (IN): Boolean

Pulse time input (PT): DINT (1 = 1 µs)

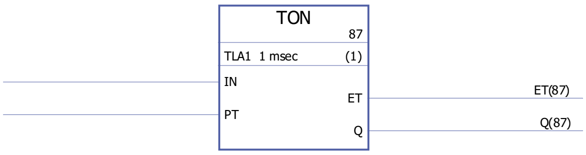
**Outputs** Elapsed time output (ET): DINT (1 = 1 µs)

Output (Q): Boolean

# TON

## (10059)

**Illustration**



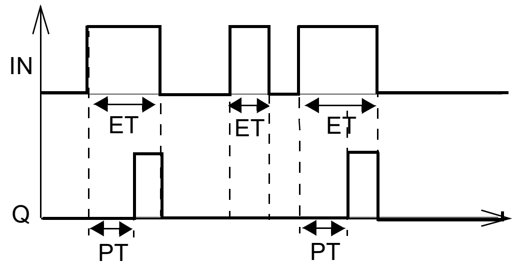
**Execution time** 1.22 µs

**Operation**

The output (Q) is set to 1 when the input (IN) has been 1 for a time defined by the pulse time input (PT). The output is set to 0, when the input is set to 0.

Elapsed time count (ET) starts when the input is set to 1 and stops when the input is set to 0.

Example:



**Inputs**

Input (IN): Boolean

Pulse time input (PT): DINT (1 = 1 µs)

**Outputs**

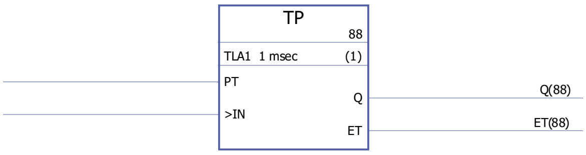
Elapsed time output (ET): DINT (1 = 1 µs)

Output (Q): Boolean

# TP

## (10060)

**Illustration**



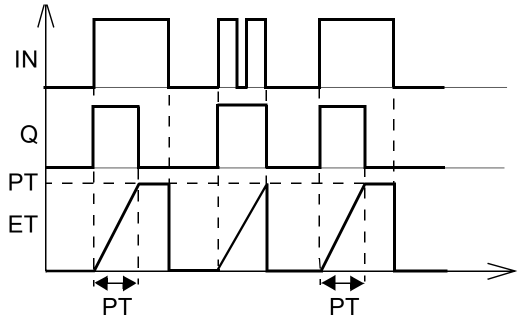
**Execution time**

1.46 µs

**Operation**

The output (Q) is set to 1 when the input (IN) is set to 1. The output is set to 0, when it has been 1 for a time defined by the pulse time input (PT).

Elapsed time count (ET) starts when the input is set to 1 and stops when the input is set to 0.



**Inputs**

Pulse time input (PT): DINT (1 = 1 µs)

Input (IN): Boolean

**Outputs**

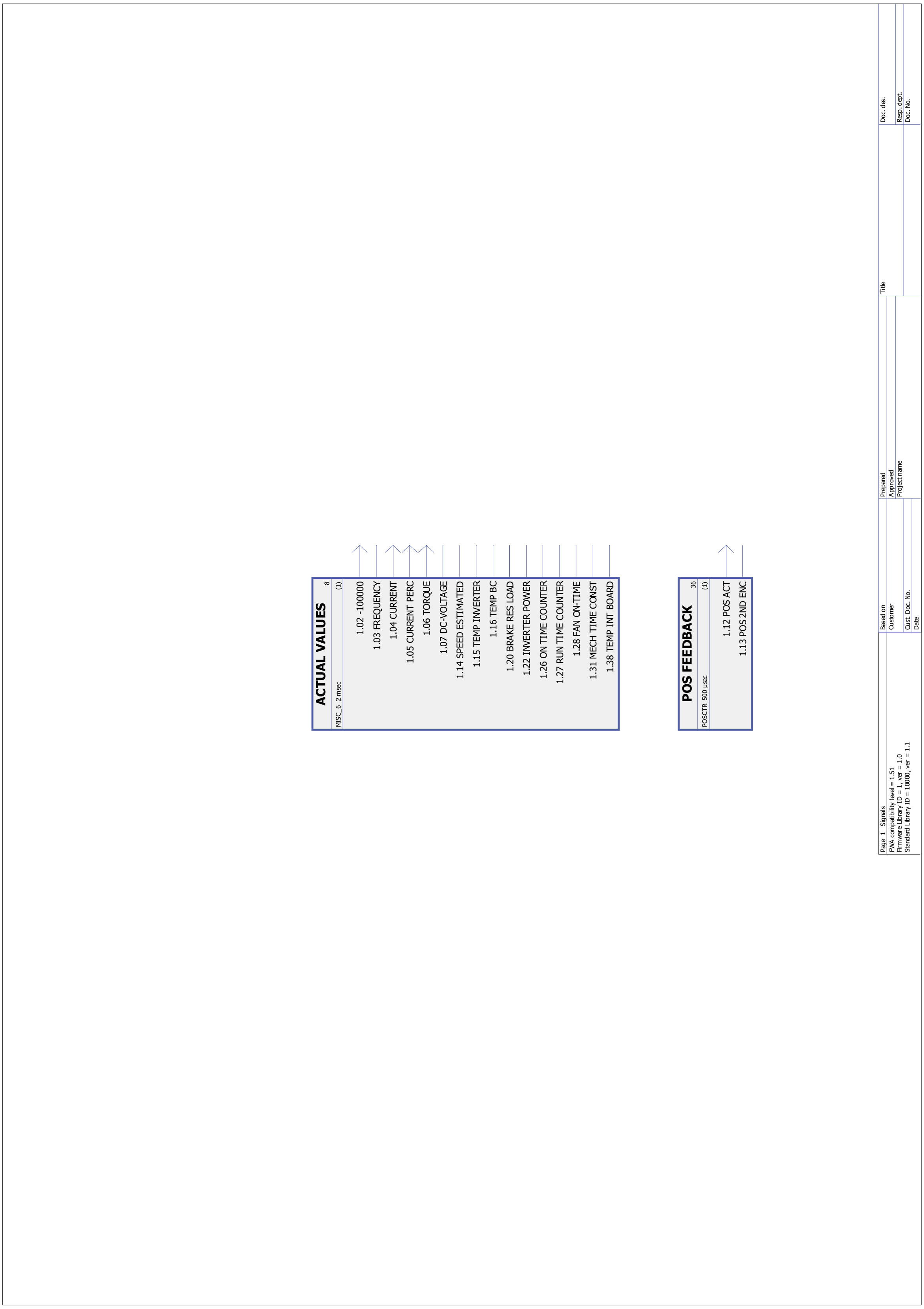
Output (Q): Boolean

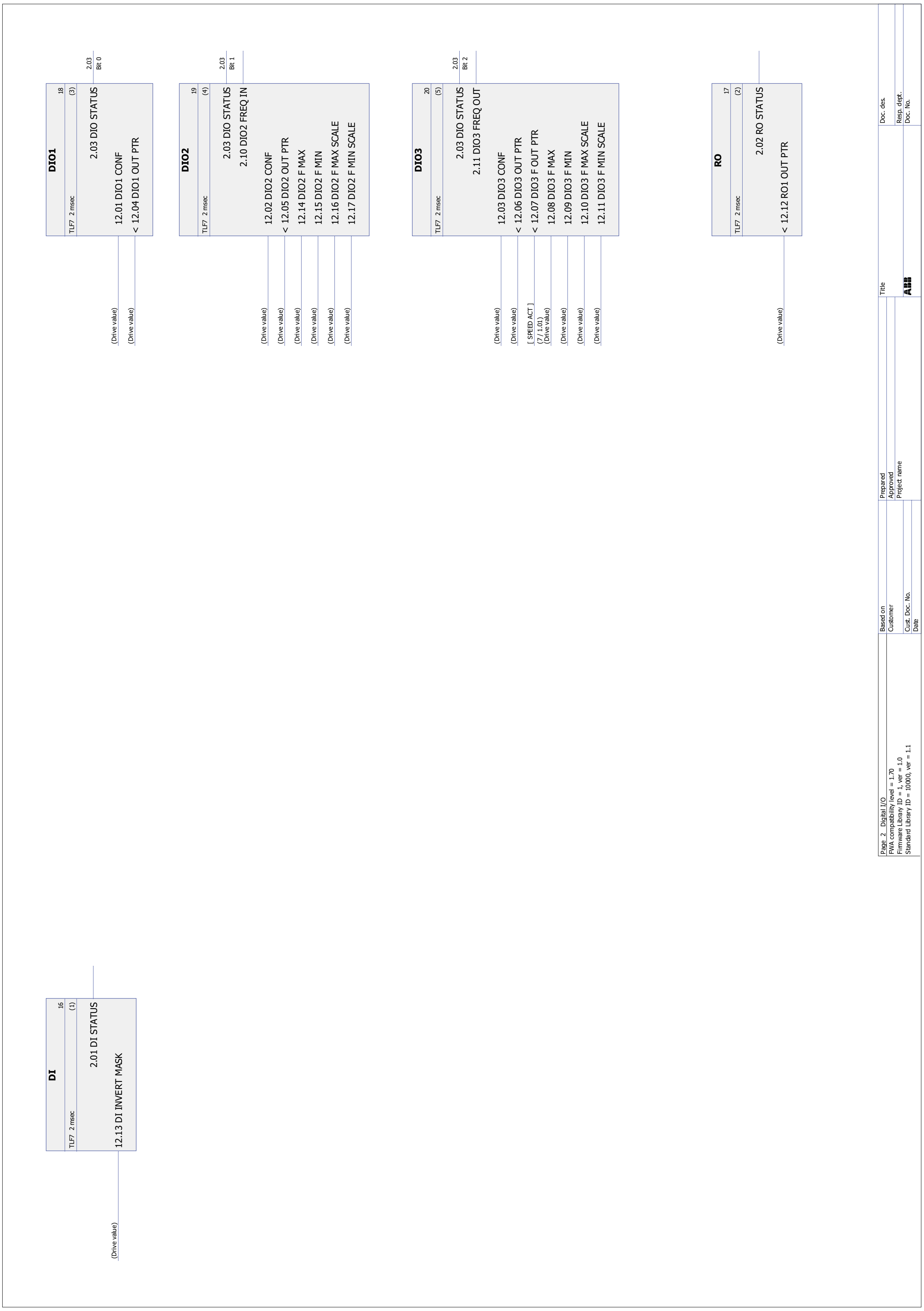
Elapsed time output (ET): DINT (1 = 1 µs)

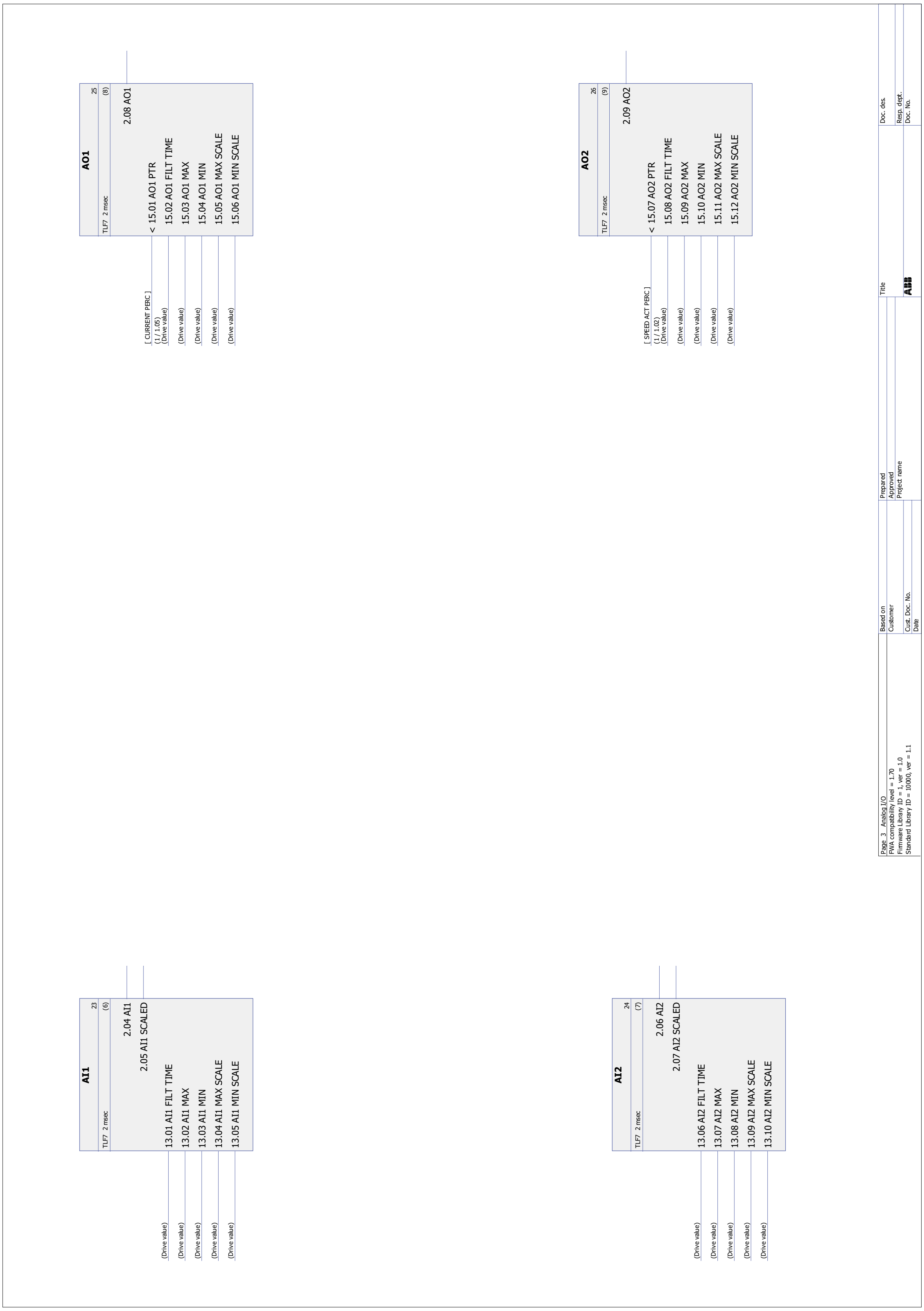
# Application program template

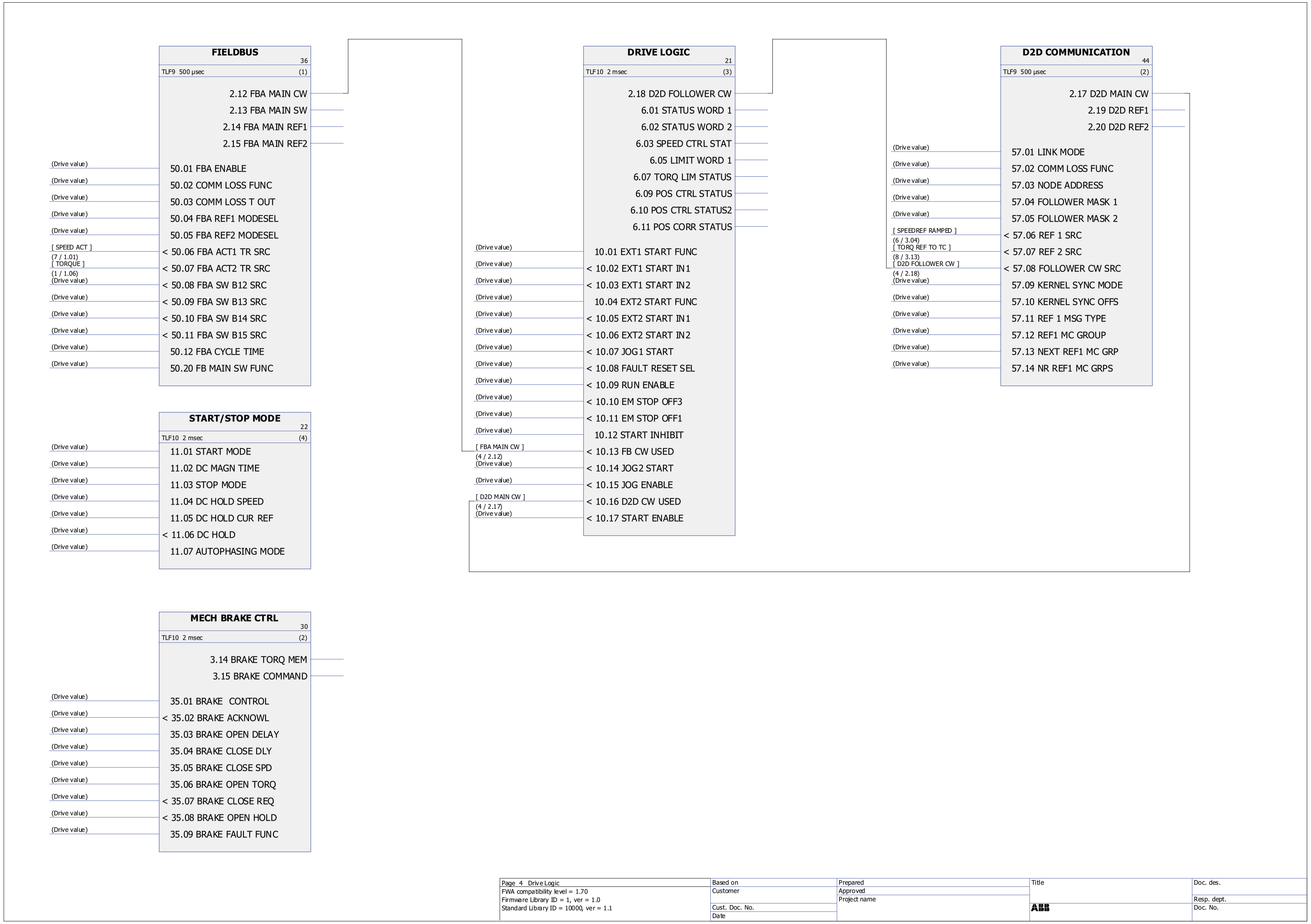
## What this chapter contains

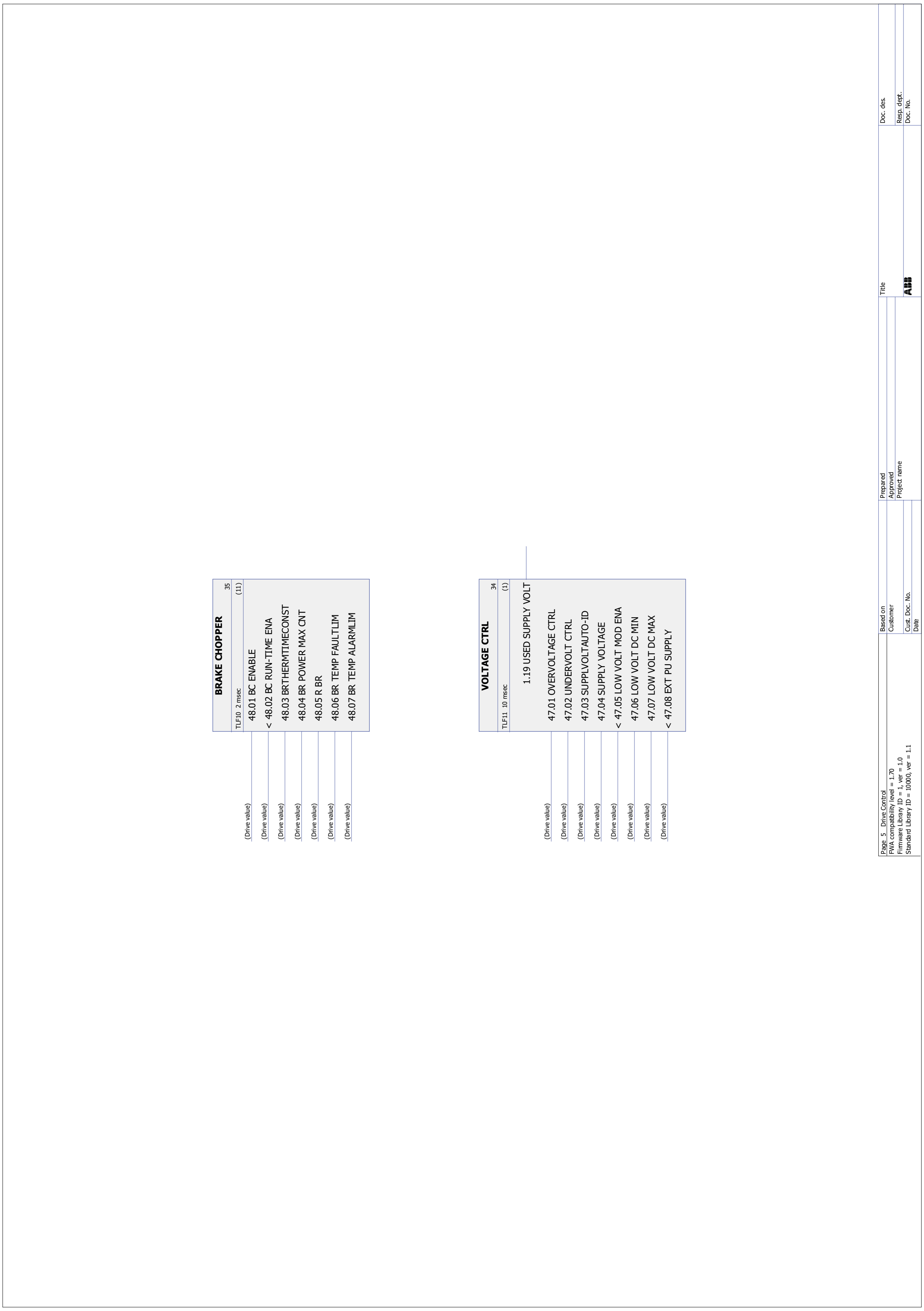
This chapter presents the application program template as displayed by the DriveSPC tool after empty template upload (Drive - Upload Template from Drive).

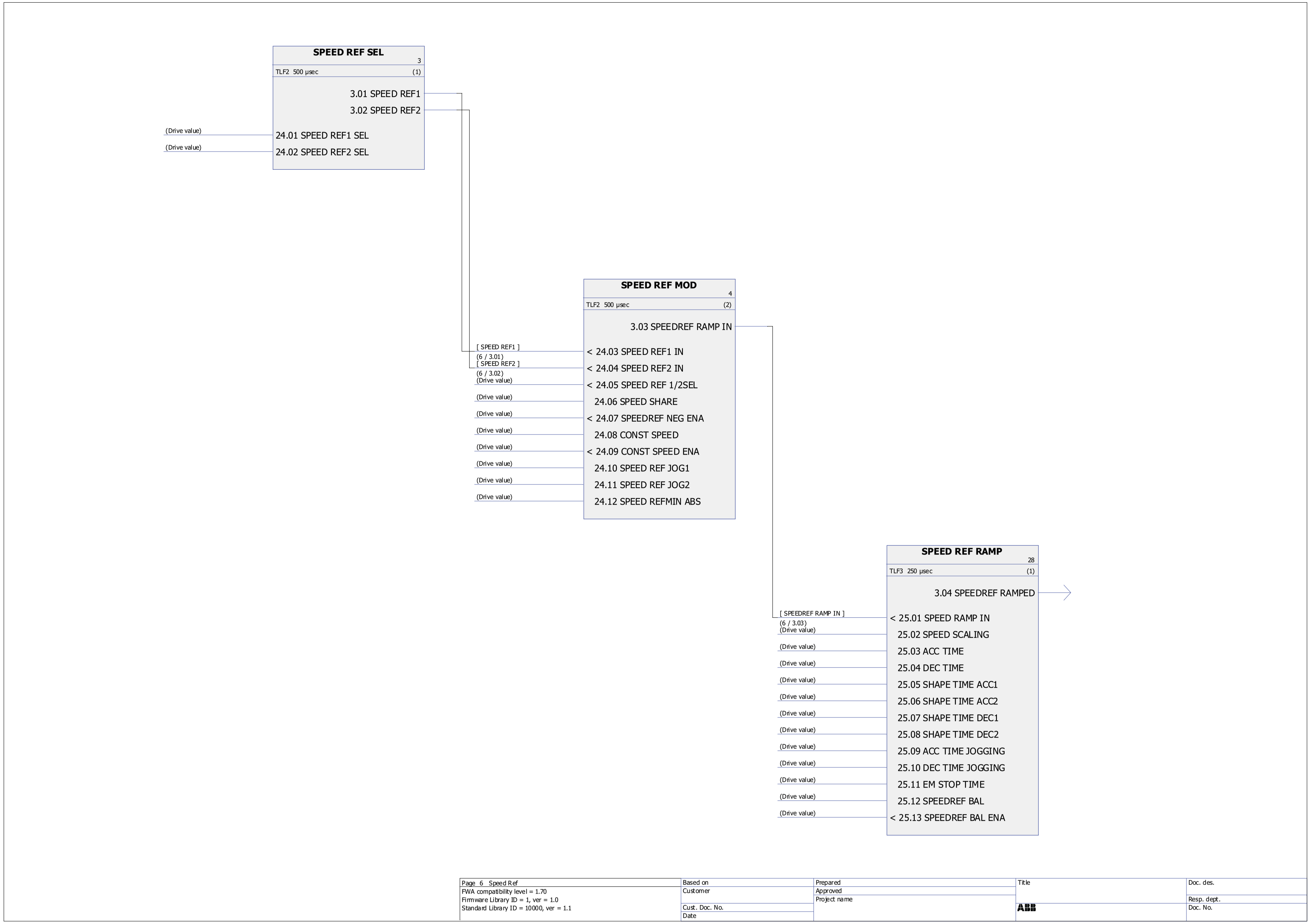

ACTUAL VALUES
8
MISC_6 2 msec
(1)
1.02 -100000
1.03 FREQUENCY
1.04 CURRENT
1.05 CURRENT PERC
1.06 TORQUE
1.07 DC-VOLTAGE
1.14 SPEED ESTIMATED
1.15 TEMP INVERTER
1.16 TEMP BC
1.20 BRAKE RES LOAD
1.22 INVERTER POWER
1.26 ON TIME COUNTER
1.27 RUN TIME COUNTER
1.28 FAN ON-TIME
1.31 MECH TIME CONST
1.38 TEMP INT BOARD
POS FEEDBACK
36
POSCTR 500 µsec
(1)
1.12 POS ACT
1.13 POS 2ND ENC
Page 1 Signals
FWA compatibility level = 1.51
Firmware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
Based on
Customer
Cust. Doc. No.
Date
Prepared
Approved
Project name
Title
Doc. des.
Resp. dept.
Doc. No.


DI
TLF7 2 msec
16
(1)
2.01 DI STATUS
12.13 DI INVERT MASK
(Drive value)
DIO1
TLF7 2 msec
18
(3)
2.03 DIO STATUS
2.03
Bit 0
12.01 DIO1 CONF
< 12.04 DIO1 OUT PTR
(Drive value)
(Drive value)
DIO2
TLF7 2 msec
19
(4)
2.03 DIO STATUS
2.10 DIO2 FREQ IN
2.03
Bit 1
12.02 DIO2 CONF
< 12.05 DIO2 OUT PTR
12.14 DIO2 F MAX
12.15 DIO2 F MIN
12.16 DIO2 F MAX SCALE
12.17 DIO2 F MIN SCALE
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
DIO3
TLF7 2 msec
20
(5)
2.03 DIO STATUS
2.11 DIO3 FREQ OUT
2.03
Bit 2
12.03 DIO3 CONF
< 12.06 DIO3 OUT PTR
< 12.07 DIO3 F OUT PTR
12.08 DIO3 F MAX
12.09 DIO3 F MIN
12.10 DIO3 F MAX SCALE
12.11 DIO3 F MIN SCALE
(Drive value)
(Drive value)
[ SPEED ACT ]
(7 / 1.01)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
RO
TLF7 2 msec
17
(2)
2.02 RO STATUS
< 12.12 RO1 OUT PTR
(Drive value)
Page 2 Digital I/O
FWA compatibility level = 1.70
Firmware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
Based on
Customer
Cust. Doc. No.
Date
Prepared
Approved
Project name
Title
ABB
Doc. des.
Resp. dept.
Doc. No.


AO1
TLF7 2 msec
25
(8)
2.08 AO1
< 15.01 AO1 PTR
15.02 AO1 FILT TIME
15.03 AO1 MAX
15.04 AO1 MIN
15.05 AO1 MAX SCALE
15.06 AO1 MIN SCALE
[ CURRENT PERC ]
(1 / 1.05)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
AO2
TLF7 2 msec
26
(9)
2.09 AO2
< 15.07 AO2 PTR
15.08 AO2 FILT TIME
15.09 AO2 MAX
15.10 AO2 MIN
15.11 AO2 MAX SCALE
15.12 AO2 MIN SCALE
[ SPEED ACT PERC ]
(1 / 1.02)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
AI1
TLF7 2 msec
23
(6)
2.04 AI1
2.05 AI1 SCALED
13.01 AI1 FILT TIME
13.02 AI1 MAX
13.03 AI1 MIN
13.04 AI1 MAX SCALE
13.05 AI1 MIN SCALE
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
AI2
TLF7 2 msec
24
(7)
2.06 AI2
2.07 AI2 SCALED
13.06 AI2 FILT TIME
13.07 AI2 MAX
13.08 AI2 MIN
13.09 AI2 MAX SCALE
13.10 AI2 MIN SCALE
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
Page 3 Analog I/O
FWA compatibility level = 1.70
Fimware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
Based on
Customer
Cust. Doc. No.
Date
Prepared
Approved
Project name
Title
ABB
Doc. des.
Resp. dept.
Doc. No.


FIELDBUS
36
TLF9 500 µsec
(1)
2.12 FBA MAIN CW
2.13 FBA MAIN SW
2.14 FBA MAIN REF1
2.15 FBA MAIN REF2
(Drive value)
50.01 FBA ENABLE
(Drive value)
50.02 COMM LOSS FUNC
(Drive value)
50.03 COMM LOSS T OUT
(Drive value)
50.04 FBA REF1 MODESEL
(Drive value)
50.05 FBA REF2 MODESEL
[ SPEED ACT ]
(7 / 1.01)
< 50.06 FBA ACT1 TR SRC
[ TORQUE ]
(1 / 1.06)
< 50.07 FBA ACT2 TR SRC
(Drive value)
< 50.08 FBA SW B12 SRC
(Drive value)
< 50.09 FBA SW B13 SRC
(Drive value)
< 50.10 FBA SW B14 SRC
(Drive value)
< 50.11 FBA SW B15 SRC
(Drive value)
50.12 FBA CYCLE TIME
(Drive value)
50.20 FB MAIN SW FUNC
START/STOP MODE
22
TLF10 2 msec
(4)
(Drive value)
11.01 START MODE
(Drive value)
11.02 DC MAGN TIME
(Drive value)
11.03 STOP MODE
(Drive value)
11.04 DC HOLD SPEED
(Drive value)
11.05 DC HOLD CUR REF
(Drive value)
< 11.06 DC HOLD
(Drive value)
11.07 AUTOPHASING MODE
MECH BRAKE CTRL
30
TLF10 2 msec
(2)
3.14 BRAKE TORQ MEM
3.15 BRAKE COMMAND
(Drive value)
35.01 BRAKE CONTROL
(Drive value)
< 35.02 BRAKE ACKNOWL
(Drive value)
35.03 BRAKE OPEN DELAY
(Drive value)
35.04 BRAKE CLOSE DLY
(Drive value)
35.05 BRAKE CLOSE SPD
(Drive value)
35.06 BRAKE OPEN TORQ
(Drive value)
< 35.07 BRAKE CLOSE REQ
(Drive value)
< 35.08 BRAKE OPEN HOLD
(Drive value)
35.09 BRAKE FAULT FUNC
DRIVE LOGIC
21
TLF10 2 msec
(3)
2.18 D2D FOLLOWER CW
6.01 STATUS WORD 1
6.02 STATUS WORD 2
6.03 SPEED CTRL STAT
6.05 LIMIT WORD 1
6.07 TORQ LIM STATUS
6.09 POS CTRL STATUS
6.10 POS CTRL STATUS2
6.11 POS CORR STATUS
(Drive value)
10.01 EXT1 START FUNC
(Drive value)
< 10.02 EXT1 START IN1
(Drive value)
< 10.03 EXT1 START IN2
(Drive value)
10.04 EXT2 START FUNC
(Drive value)
< 10.05 EXT2 START IN1
(Drive value)
< 10.06 EXT2 START IN2
(Drive value)
< 10.07 JOG1 START
(Drive value)
< 10.08 FAULT RESET SEL
(Drive value)
< 10.09 RUN ENABLE
(Drive value)
< 10.10 EM STOP OFF3
(Drive value)
< 10.11 EM STOP OFF1
(Drive value)
10.12 START INHIBIT
[ FBA MAIN CW ]
(4 / 2.12)
< 10.13 FB CW USED
(Drive value)
< 10.14 JOG2 START
(Drive value)
< 10.15 JOG ENABLE
[ D2D MAIN CW ]
(4 / 2.17)
< 10.16 D2D CW USED
(Drive value)
< 10.17 START ENABLE
D2D COMMUNICATION
44
TLF9 500 µsec
(2)
2.17 D2D MAIN CW
2.19 D2D REF1
2.20 D2D REF2
(Drive value)
57.01 LINK MODE
(Drive value)
57.02 COMM LOSS FUNC
(Drive value)
57.03 NODE ADDRESS
(Drive value)
57.04 FOLLOWER MASK 1
(Drive value)
57.05 FOLLOWER MASK 2
[ SPEEDREF RAMPED ]
(6 / 3.04)
< 57.06 REF 1 SRC
[ TORQ REF TO TC ]
(8 / 3.13)
< 57.07 REF 2 SRC
[ D2D FOLLOWER CW ]
(4 / 2.18)
< 57.08 FOLLOWER CW SRC
(Drive value)
57.09 KERNEL SYNC MODE
(Drive value)
57.10 KERNEL SYNC OFFS
(Drive value)
57.11 REF 1 MSG TYPE
(Drive value)
57.12 REF1 MC GROUP
(Drive value)
57.13 NEXT REF1 MC GRP
(Drive value)
57.14 NR REF1 MC GRPS
Page 4 Drive Logic
FWA compatibility level = 1.70
Firmware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
Based on
Customer
Cust. Doc. No.
Date
Prepared
Approved
Project name
Title
ABB
Doc. des.
Resp. dept.
Doc. No.


BRAKE CHOPPER
TLF10 2 msec
35
(11)
48.01 BC ENABLE
< 48.02 BC RUN-TIME ENA
48.03 BRTHERMTIMECONST
48.04 BR POWER MAX CNT
48.05 R BR
48.06 BR TEMP FAULTLIM
48.07 BR TEMP ALARMLIM
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
VOLTAGE CTRL
TLF11 10 msec
34
(1)
1.19 USED SUPPLY VOLT
47.01 OVERVOLTAGE CTRL
47.02 UNDERVOLT CTRL
47.03 SUPPLVOLTAUTO-ID
47.04 SUPPLY VOLTAGE
< 47.05 LOW VOLT MOD ENA
47.06 LOW VOLT DC MIN
47.07 LOW VOLT DC MAX
< 47.08 EXT PU SUPPLY
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
(Drive value)
Page 5 Drive Control
FWA compatibility level = 1.70
Firmware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
Based on
Customer
Cust. Doc. No.
Date
Prepared
Approved
Project name
Title
ABB
Doc. des.
Resp. dept.
Doc. No.


SPEED REF SEL
3
TLF2 500 µsec
(1)
3.01 SPEED REF1
3.02 SPEED REF2
(Drive value)
24.01 SPEED REF1 SEL
(Drive value)
24.02 SPEED REF2 SEL
SPEED REF MOD
4
TLF2 500 µsec
(2)
3.03 SPEEDREF RAMP IN
[ SPEED REF1 ]
(6 / 3.01)
< 24.03 SPEED REF1 IN
[ SPEED REF2 ]
(6 / 3.02)
< 24.04 SPEED REF2 IN
(Drive value)
< 24.05 SPEED REF 1/2SEL
(Drive value)
24.06 SPEED SHARE
(Drive value)
< 24.07 SPEEDREF NEG ENA
(Drive value)
24.08 CONST SPEED
(Drive value)
< 24.09 CONST SPEED ENA
(Drive value)
24.10 SPEED REF JOG1
(Drive value)
24.11 SPEED REF JOG2
(Drive value)
24.12 SPEED REFMIN ABS
SPEED REF RAMP
28
TLF3 250 µsec
(1)
3.04 SPEEDREF RAMPED
[ SPEEDREF RAMP IN ]
(6 / 3.03)
< 25.01 SPEED RAMP IN
(Drive value)
25.02 SPEED SCALING
(Drive value)
25.03 ACC TIME
(Drive value)
25.04 DEC TIME
(Drive value)
25.05 SHAPE TIME ACC1
(Drive value)
25.06 SHAPE TIME ACC2
(Drive value)
25.07 SHAPE TIME DEC1
(Drive value)
25.08 SHAPE TIME DEC2
(Drive value)
25.09 ACC TIME JOGGING
(Drive value)
25.10 DEC TIME JOGGING
(Drive value)
25.11 EM STOP TIME
(Drive value)
25.12 SPEEDREF BAL
(Drive value)
< 25.13 SPEEDREF BAL ENA
Page 6 Speed Ref
FWA compatibility level = 1.70
Firmware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
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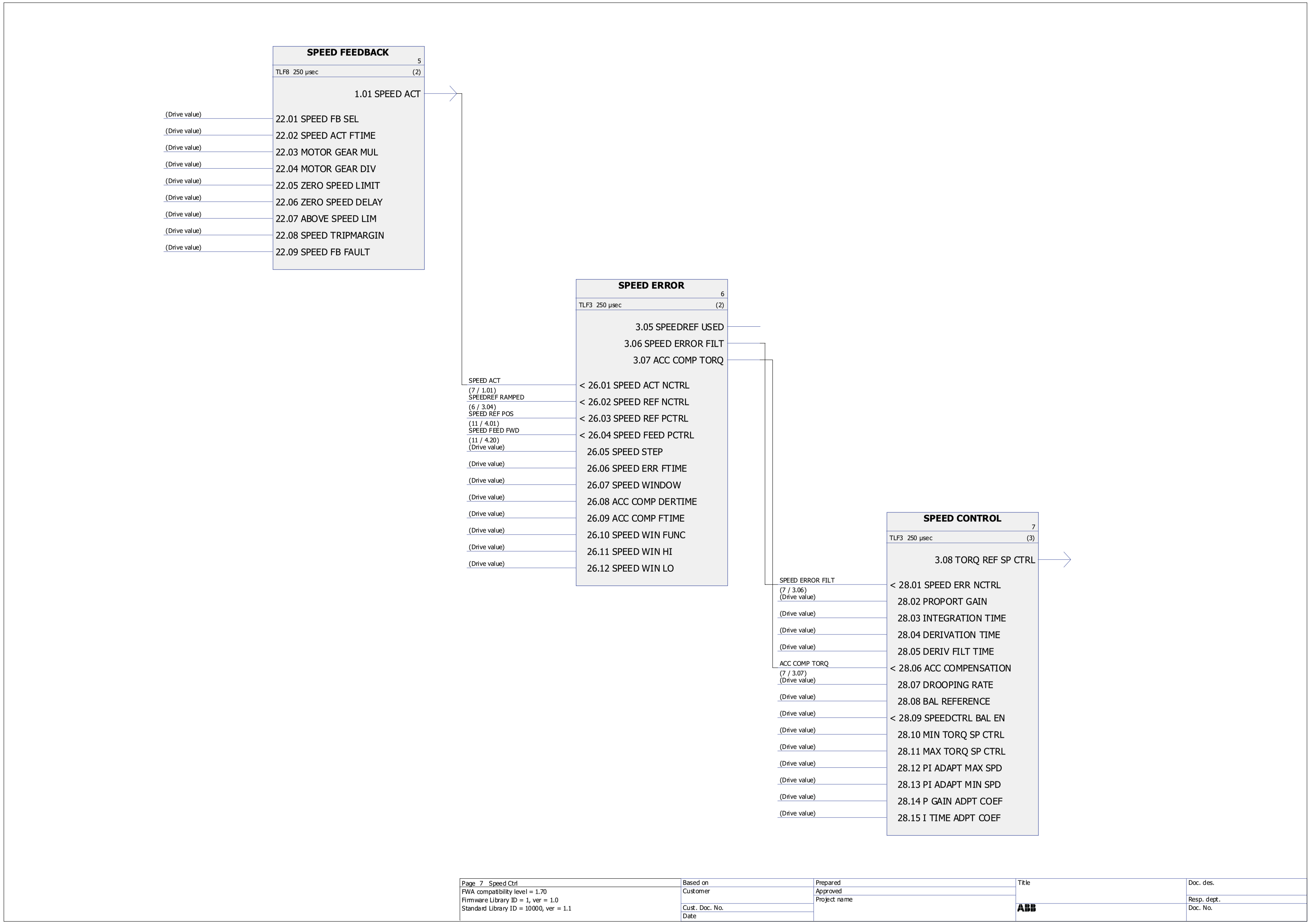
SPEED FEEDBACK
5
TLF8 250 µsec
(2)
1.01 SPEED ACT
(Drive value)
22.01 SPEED FB SEL
(Drive value)
22.02 SPEED ACT FTIME
(Drive value)
22.03 MOTOR GEAR MUL
(Drive value)
22.04 MOTOR GEAR DIV
(Drive value)
22.05 ZERO SPEED LIMIT
(Drive value)
22.06 ZERO SPEED DELAY
(Drive value)
22.07 ABOVE SPEED LIM
(Drive value)
22.08 SPEED TRIPMARGIN
(Drive value)
22.09 SPEED FB FAULT
SPEED ERROR
6
TLF3 250 µsec
(2)
3.05 SPEEDREF USED
3.06 SPEED ERROR FILT
3.07 ACC COMP TORQ
SPEED ACT
(7 / 1.01)
< 26.01 SPEED ACT NCTRL
SPEEDREF RAMPED
(6 / 3.04)
< 26.02 SPEED REF NCTRL
SPEED REF POS
(11 / 4.01)
< 26.03 SPEED REF PCTRL
SPEED FEED FWD
(11 / 4.20)
< 26.04 SPEED FEED PCTRL
(Drive value)
26.05 SPEED STEP
(Drive value)
26.06 SPEED ERR FTIME
(Drive value)
26.07 SPEED WINDOW
(Drive value)
26.08 ACC COMP DERTIME
(Drive value)
26.09 ACC COMP FTIME
(Drive value)
26.10 SPEED WIN FUNC
(Drive value)
26.11 SPEED WIN HI
(Drive value)
26.12 SPEED WIN LO
SPEED CONTROL
7
TLF3 250 µsec
(3)
3.08 TORQ REF SP CTRL
SPEED ERROR FILT
(7 / 3.06)
< 28.01 SPEED ERR NCTRL
(Drive value)
28.02 PROPORT GAIN
(Drive value)
28.03 INTEGRATION TIME
(Drive value)
28.04 DERIVATION TIME
(Drive value)
28.05 DERIV FILT TIME
ACC COMP TORQ
(7 / 3.07)
< 28.06 ACC COMPENSATION
(Drive value)
28.07 DROOPING RATE
(Drive value)
28.08 BAL REFERENCE
(Drive value)
< 28.09 SPEEDCTRL BAL EN
(Drive value)
28.10 MIN TORQ SP CTRL
(Drive value)
28.11 MAX TORQ SP CTRL
(Drive value)
28.12 PI ADAPT MAX SPD
(Drive value)
28.13 PI ADAPT MIN SPD
(Drive value)
28.14 P GAIN ADPT COEF
(Drive value)
28.15 I TIME ADPT COEF
Page 7 Speed Ctrl
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Standard Library ID = 10000, ver = 1.1
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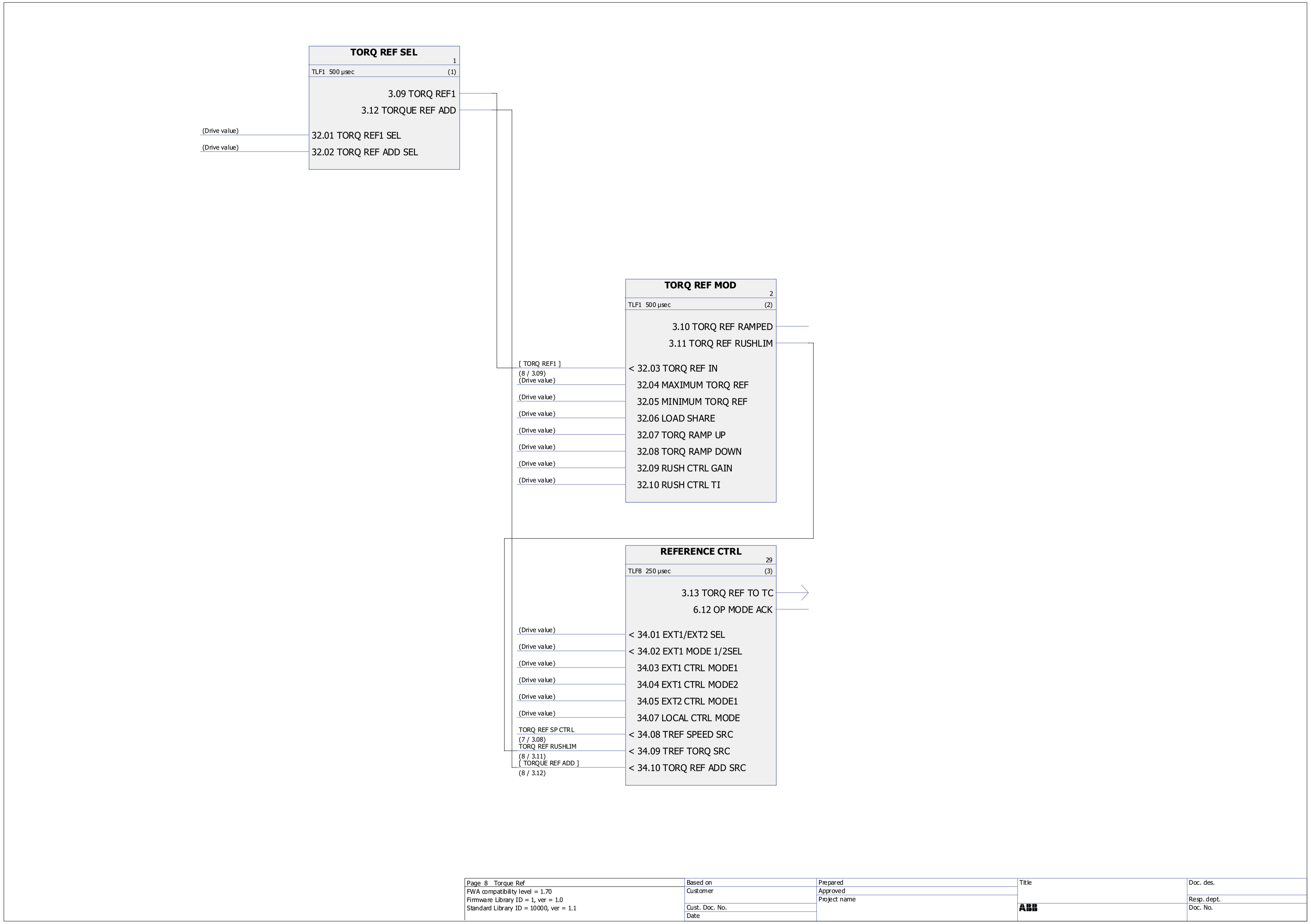
TORQ REF SEL
1
TLF1 500 µsec
(1)
3.09 TORQ REF1
3.12 TORQUE REF ADD
(Drive value)
32.01 TORQ REF1 SEL
(Drive value)
32.02 TORQ REF ADD SEL
TORQ REF MOD
2
TLF1 500 µsec
(2)
3.10 TORQ REF RAMPED
3.11 TORQ REF RUSHLIM
[ TORQ REF1 ]
(8 / 3.09)
< 32.03 TORQ REF IN
(Drive value)
32.04 MAXIMUM TORQ REF
(Drive value)
32.05 MINIMUM TORQ REF
(Drive value)
32.06 LOAD SHARE
(Drive value)
32.07 TORQ RAMP UP
(Drive value)
32.08 TORQ RAMP DOWN
(Drive value)
32.09 RUSH CTRL GAIN
(Drive value)
32.10 RUSH CTRL TI
REFERENCE CTRL
29
TLF8 250 µsec
(3)
3.13 TORQ REF TO TC
6.12 OP MODE ACK
(Drive value)
< 34.01 EXT1/EXT2 SEL
(Drive value)
< 34.02 EXT1 MODE 1/2SEL
(Drive value)
34.03 EXT1 CTRL MODE1
(Drive value)
34.04 EXT1 CTRL MODE2
(Drive value)
34.05 EXT2 CTRL MODE1
(Drive value)
34.07 LOCAL CTRL MODE
TORQ REF SP CTRL
(7 / 3.08)
< 34.08 TREF SPEED SRC
TORQ REF RUSHLIM
(8 / 3.11)
< 34.09 TREF TORQ SRC
[ TORQUE REF ADD ]
(8 / 3.12)
< 34.10 TORQ REF ADD SRC
Page 8 Torque Ref
FWA compatibility level = 1.70
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Standard Library ID = 10000, ver = 1.1
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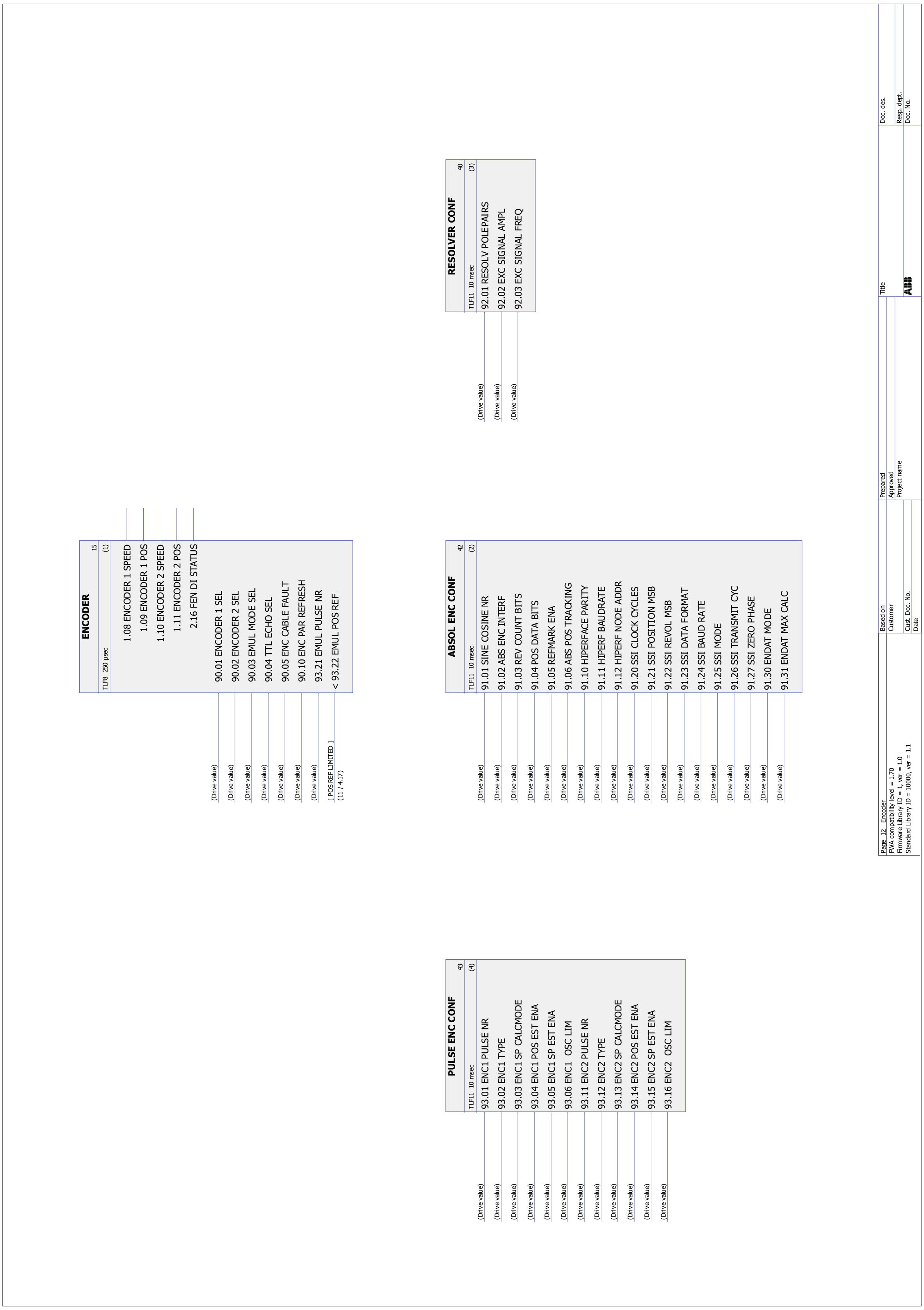

ENCODER
15
TLF8 250 µsec
(1)
1.08 ENCODER 1 SPEED
1.09 ENCODER 1 POS
1.10 ENCODER 2 SPEED
1.11 ENCODER 2 POS
2.16 FEN DI STATUS
(Drive value)
90.01 ENCODER 1 SEL
(Drive value)
90.02 ENCODER 2 SEL
(Drive value)
90.03 EMUL MODE SEL
(Drive value)
90.04 TTL ECHO SEL
(Drive value)
90.05 ENC CABLE FAULT
(Drive value)
90.10 ENC PAR REFRESH
(Drive value)
93.21 EMUL PULSE NR
[ POS REF LIMITED ]
(11 / 4.17)
< 93.22 EMUL POS REF
RESOLVER CONF
40
TLF11 10 msec
(3)
(Drive value)
92.01 RESOLV POLEPAIRS
(Drive value)
92.02 EXC SIGNAL AMPL
(Drive value)
92.03 EXC SIGNAL FREQ
ABSOL ENC CONF
42
TLF11 10 msec
(2)
(Drive value)
91.01 SINE COSINE NR
(Drive value)
91.02 ABS ENC INTERF
(Drive value)
91.03 REV COUNT BITS
(Drive value)
91.04 POS DATA BITS
(Drive value)
91.05 REFMARK ENA
(Drive value)
91.06 ABS POS TRACKING
(Drive value)
91.10 HIPERFACE PARITY
(Drive value)
91.11 HIPERF BAUDRATE
(Drive value)
91.12 HIPERF NODE ADDR
(Drive value)
91.20 SSI CLOCK CYCLES
(Drive value)
91.21 SSI POSITION MSB
(Drive value)
91.22 SSI REVOL MSB
(Drive value)
91.23 SSI DATA FORMAT
(Drive value)
91.24 SSI BAUD RATE
(Drive value)
91.25 SSI MODE
(Drive value)
91.26 SSI TRANSMIT CYC
(Drive value)
91.27 SSI ZERO PHASE
(Drive value)
91.30 ENDAT MODE
(Drive value)
91.31 ENDAT MAX CALC
PULSE ENC CONF
43
TLF11 10 msec
(4)
(Drive value)
93.01 ENC1 PULSE NR
(Drive value)
93.02 ENC1 TYPE
(Drive value)
93.03 ENC1 SP CALCMODE
(Drive value)
93.04 ENC1 POS EST ENA
(Drive value)
93.05 ENC1 SP EST ENA
(Drive value)
93.06 ENC1 OSC LIM
(Drive value)
93.11 ENC2 PULSE NR
(Drive value)
93.12 ENC2 TYPE
(Drive value)
93.13 ENC2 SP CALCMODE
(Drive value)
93.14 ENC2 POS EST ENA
(Drive value)
93.15 ENC2 SP EST ENA
(Drive value)
93.16 ENC2 OSC LIM
Page 12 Encoder
FWA compatibility level = 1.70
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Standard Library ID = 10000, ver = 1.1
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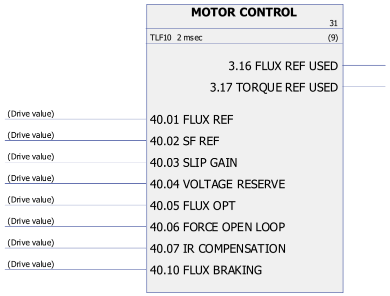
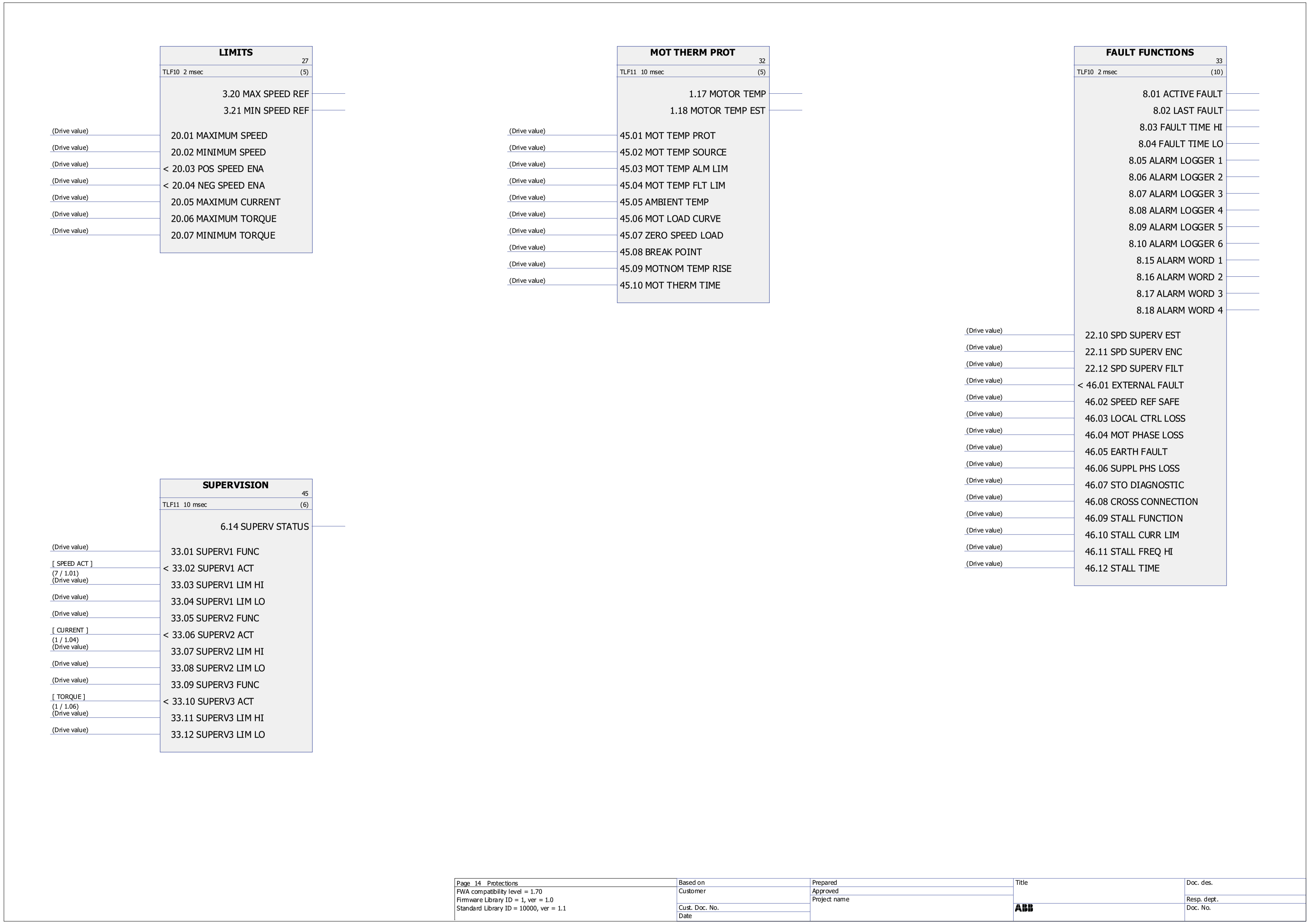


| | | | | |
|---|---|---|---|---|
| Page 13 Motor Ctrl | Based on | Prepared | Title | Doc. des. |
| FWA compatibility level = 1.70<br>Firmware Library ID = 1, ver = 1.0<br>Standard Library ID = 10000, ver = 1.1 | Customer | Approved | | |
| | Cust. Doc. No. | Project name | | Resp. dept. |
| | Date | | | Doc. No. |


LIMITS
27
TLF10 2 msec
(5)
3.20 MAX SPEED REF
3.21 MIN SPEED REF
(Drive value)
20.01 MAXIMUM SPEED
(Drive value)
20.02 MINIMUM SPEED
(Drive value)
< 20.03 POS SPEED ENA
(Drive value)
< 20.04 NEG SPEED ENA
(Drive value)
20.05 MAXIMUM CURRENT
(Drive value)
20.06 MAXIMUM TORQUE
(Drive value)
20.07 MINIMUM TORQUE
MOT THERM PROT
32
TLF11 10 msec
(5)
1.17 MOTOR TEMP
1.18 MOTOR TEMP EST
(Drive value)
45.01 MOT TEMP PROT
(Drive value)
45.02 MOT TEMP SOURCE
(Drive value)
45.03 MOT TEMP ALM LIM
(Drive value)
45.04 MOT TEMP FLT LIM
(Drive value)
45.05 AMBIENT TEMP
(Drive value)
45.06 MOT LOAD CURVE
(Drive value)
45.07 ZERO SPEED LOAD
(Drive value)
45.08 BREAK POINT
(Drive value)
45.09 MOTNOM TEMP RISE
(Drive value)
45.10 MOT THERM TIME
FAULT FUNCTIONS
33
TLF10 2 msec
(10)
8.01 ACTIVE FAULT
8.02 LAST FAULT
8.03 FAULT TIME HI
8.04 FAULT TIME LO
8.05 ALARM LOGGER 1
8.06 ALARM LOGGER 2
8.07 ALARM LOGGER 3
8.08 ALARM LOGGER 4
8.09 ALARM LOGGER 5
8.10 ALARM LOGGER 6
8.15 ALARM WORD 1
8.16 ALARM WORD 2
8.17 ALARM WORD 3
8.18 ALARM WORD 4
(Drive value)
22.10 SPD SUPERV EST
(Drive value)
22.11 SPD SUPERV ENC
(Drive value)
22.12 SPD SUPERV FILT
(Drive value)
< 46.01 EXTERNAL FAULT
(Drive value)
46.02 SPEED REF SAFE
(Drive value)
46.03 LOCAL CTRL LOSS
(Drive value)
46.04 MOT PHASE LOSS
(Drive value)
46.05 EARTH FAULT
(Drive value)
46.06 SUPPL PHS LOSS
(Drive value)
46.07 STO DIAGNOSTIC
(Drive value)
46.08 CROSS CONNECTION
(Drive value)
46.09 STALL FUNCTION
(Drive value)
46.10 STALL CURR LIM
(Drive value)
46.11 STALL FREQ HI
(Drive value)
46.12 STALL TIME
SUPERVISION
45
TLF11 10 msec
(6)
6.14 SUPERV STATUS
(Drive value)
33.01 SUPERV1 FUNC
[ SPEED ACT ]
(7 / 1.01)
< 33.02 SUPERV1 ACT
(Drive value)
33.03 SUPERV1 LIM HI
(Drive value)
33.04 SUPERV1 LIM LO
(Drive value)
33.05 SUPERV2 FUNC
[ CURRENT ]
(1 / 1.04)
< 33.06 SUPERV2 ACT
(Drive value)
33.07 SUPERV2 LIM HI
(Drive value)
33.08 SUPERV2 LIM LO
(Drive value)
33.09 SUPERV3 FUNC
[ TORQUE ]
(1 / 1.06)
< 33.10 SUPERV3 ACT
(Drive value)
33.11 SUPERV3 LIM HI
(Drive value)
33.12 SUPERV3 LIM LO
Page 14 Protections
FWA compatibility level = 1.70
Firmware Library ID = 1, ver = 1.0
Standard Library ID = 10000, ver = 1.1
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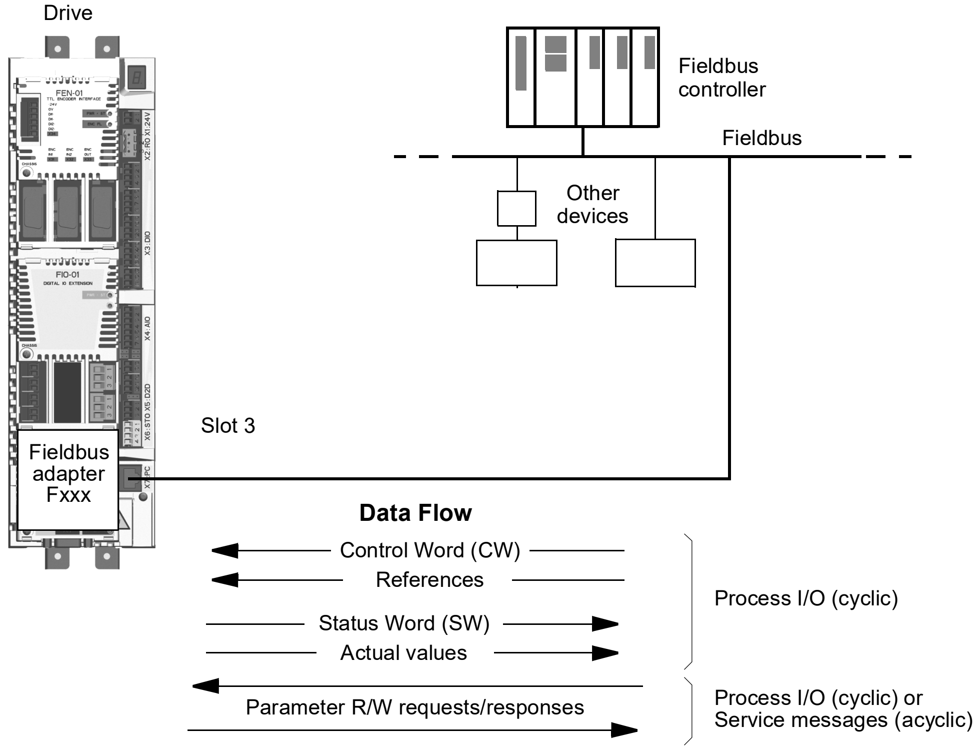
# Appendix A – Fieldbus control

## What this chapter contains

The chapter describes how the drive can be controlled by external devices over a communication network (fieldbus) through an optional fieldbus adapter module.

## System overview

The drive can be connected to an external control system via a fieldbus adapter module. The adapter module is installed into drive Slot 3.



The drive can be set to receive all of its control information through the fieldbus interface, or the control can be distributed between the fieldbus interface and other available sources, for example, digital and analogue inputs.

Fieldbus adapters are available for various serial communication protocols, for example:

- PROFIBUS DP (FPBA-xx adapter)
- CANopen (FCAN-xx adapter)
- DeviceNet™ (FDNA-xx adapter)
- Modbus/RTU (FSCA-xx adapter)
- Modbus/TCP, EtherNet/IP™, PROFINET IO (FENA-xx adapter)

- EtherCAT® (FECA-xx adapter)
- MACRO (FMAC-xx adapter)
- ControlNet™ (FCNA-xx adapter)
- EthernetPOWERLINK (FEPL-xx adapter)
- Sercos II (FSEA-xx adapter).

## Setting up communication through a fieldbus adapter module

Before configuring the drive for fieldbus control, the adapter module must be mechanically and electrically installed according to the instructions given in the *User's Manual* of the appropriate fieldbus adapter module.

The communication between the drive and the fieldbus adapter module is activated by setting parameter 50.01 FBA ENABLE to (1) Enable. The adapter-specific parameters must also be set. See the table below.

| Parameter | Setting for fieldbus control | Function/Information |
|---|---|---|
| | | |
| COMMUNICATION INITIALISATION AND SUPERVISION | | |
| | | |
| 50.01 FBA ENABLE | (1) Enable | Initialises communication between drive and fieldbus adapter module. |
| 50.02 COMM LOSS FUNC | (0) No<br>(1) Fault<br>(2) Spd ref Safe<br>(3) Last speed | Selects how the drive reacts upon a fieldbus communication break. |
| 50.03 COMM LOSS T OUT | 0.3…6553.5 s | Defines the time between communication break detection and the action selected with parameter 50.02 COMM LOSS FUNC. |
| 50.04 FBA REF1 MODESEL and 50.05 FBA REF2 MODESEL | (0) Raw data<br>(1) Torque<br>(2) Speed<br>(5) Auto | Defines the fieldbus reference scaling.<br>When (0) Raw data is selected, see also parameters 50.06…50.11.<br>When both parameters are set to (5) Auto, the scalings for fieldbus references are set automatically according to parameter 34.03 EXT1 CTRL MODE1 as follows:<br>FBA REF1 = Speed, FBA REF2 = Torque |
| | | |
| ADAPTER MODULE CONFIGURATION | | |
| | | |
| 51.01 FBA TYPE | – | Displays the type of the fieldbus adapter module. |
| 51.02 FBA PAR2 | These parameters are adapter module-specific. For more information, see the *User's Manual* of the fieldbus adapter module. Note that not all of these parameters are necessarily used. | |
| • • • | | |
| 51.26 FBA PAR26 | | |
| 51.27 FBA PAR REFRESH | (0) DONE<br>(1) REFRESH | Validates any changed adapter module configuration parameter settings. |
| 51.28 PAR TABLE VER | – | Displays the parameter table revision of the fieldbus adapter module mapping file stored in the memory of the drive. |
| 51.29 DRIVE TYPE CODE | – | Displays the drive type code of the fieldbus adapter module mapping file stored in the memory of the drive. |
| 51.30 MAPPING FILE VER | – | Displays the fieldbus adapter module mapping file revision stored in the memory of the drive. |
| 51.31 D2FBA COMM STA | – | Displays the status of the fieldbus adapter module communication. |

| Parameter | Setting for fieldbus control | Function/Information |
|---|---|---|
| 51.32 FBA COMM SW VER | – | Displays the common program revision of the adapter module. |
| 51.33 FBA APPL SW VER | – | Displays the application program revision of the adapter module. |
| **Note:** In the *User's Manual* of the fieldbus adapter module, the parameter group number is 1 or A for parameters 51.01…51.26. | | |
| | | |
| TRANSMITTED DATA SELECTION | | |
| | | |
| 52.01 FBA DATA IN1 … 52.12 FBA DATA IN12 | 0<br>4…6<br>14…16<br>101…9999 | Defines the data transmitted from drive to fieldbus controller.<br>**Note:** If the selected data is 32 bits long, two parameters are reserved for the transmission. |
| 53.01 FBA DATA OUT1 … 53.12 FBA DATA OUT12 | 0<br>1…3<br>11…13<br>1001…9999 | Defines the data transmitted from fieldbus controller to drive.<br>**Note:** If the selected data is 32 bits long, two parameters are reserved for the transmission. |
| **Note:** In the User's Manual of the fieldbus adapter module, the parameter group number is 2 or B for parameters 52.01…52.12 and 3 or C for parameters 53.01…53.12. | | |

After the module configuration parameters have been set, the drive control parameters (see section Setting the drive control parameters below) must be checked and adjusted when necessary.

The new settings will take effect when the drive is powered up the next time, or when parameter 51.27 FBA PAR REFRESH is activated.

## Setting the drive control parameters

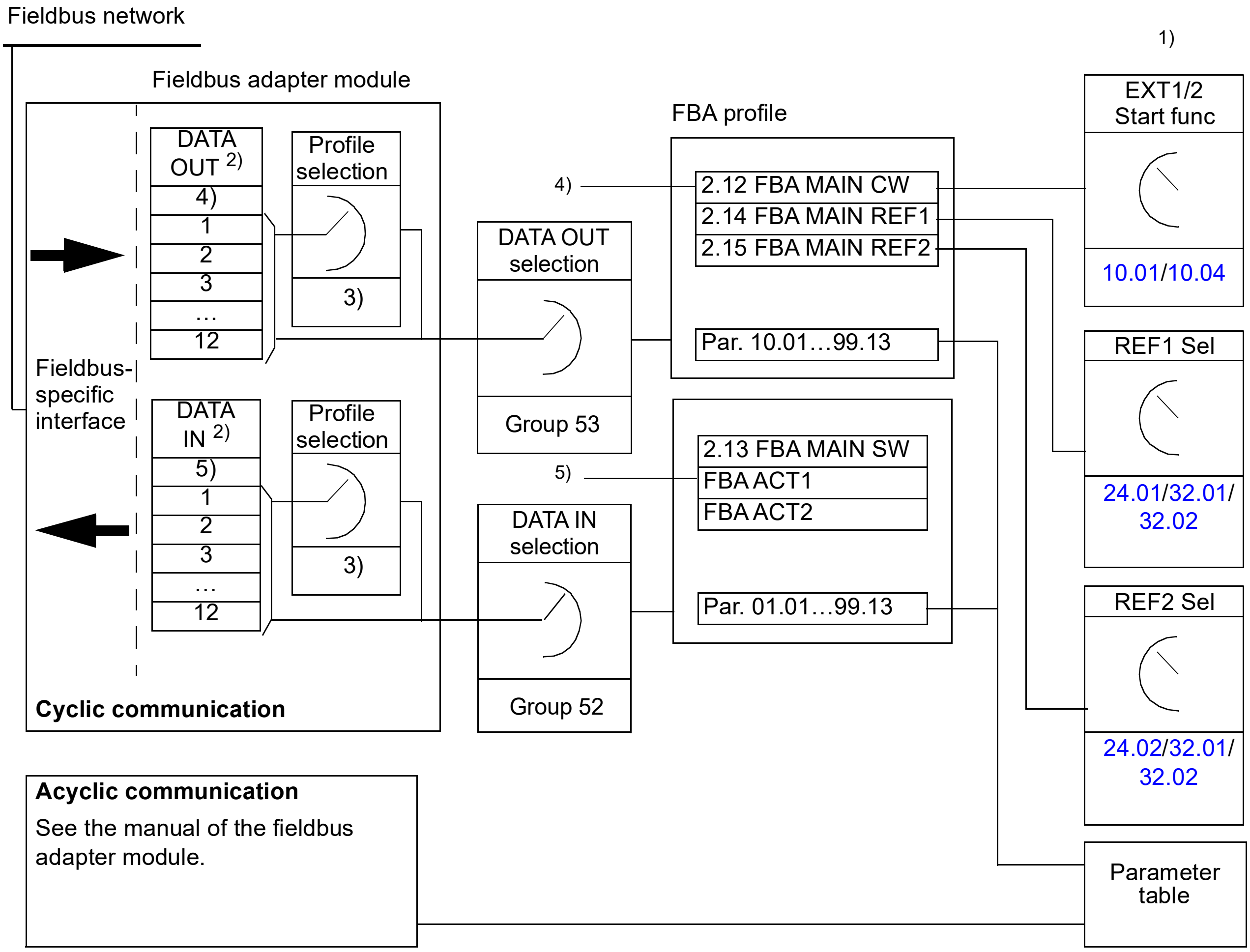
The **Setting for fieldbus control** column gives the value to use when the fieldbus interface is the desired source or destination for that particular signal. The **Function/ Information** column gives a description of the parameter.

| **Parameter** | **Setting for fieldbus control** | **Function/Information** |
|---|---|---|
| | | |
| CONTROL COMMAND SOURCE SELECTION | | |
| | | |
| 10.01 EXT1 START FUNC | (3) FBA | Selects fieldbus as the source for the start and stop commands when EXT1 is selected as the active control location. |
| 10.04 EXT2 START FUNC | (3) FBA | Selects fieldbus as the source for the start and stop commands when EXT2 is selected as the active control location. |
| 24.01 SPEED REF1 SEL | (3) FBA REF1<br>(4) FBA REF2 | Fieldbus reference REF1 or REF2 is used as speed reference 1. |
| 24.02 SPEED REF2 SEL | (3) FBA REF1<br>(4) FBA REF2 | Fieldbus reference REF1 or REF2 is used as speed reference 2. |
| 32.01 TORQ REF1 SEL | (3) FBA REF1<br>(4) FBA REF2 | Fieldbus reference REF1 or REF2 is used as torque reference 1. |
| 32.02 TORQ REF ADD SEL | (3) FBA REF1<br>(4) FBA REF2 | Fieldbus reference REF1 or REF2 is used for torque reference addition. |
| | | |
| SYSTEM CONTROL INPUTS | | |
| | | |
| 16.07 PARAM SAVE | (0) Done<br>(1) Save | Saves parameter value changes (including those made through fieldbus control) to permanent memory. |

## Basics of the fieldbus adapter interface

The cyclic communication between a fieldbus system and the drive consists of 16/32-bit input and output data words. The drive supports at the maximum the use of 12 data words (16 bits) in each direction.

Data transmitted from the drive to the fieldbus controller is defined by parameters 52.01 FBA DATA IN1…52.12 FBA DATA IN12 and data transmitted from the fieldbus controller to the drive is defined by parameters 53.01 FBA DATA OUT1…53.12 FBA DATA OUT12.



1) See also other parameters which can be controlled by the fieldbus.
2) The maximum number of used data words is protocol-dependent.
3) Profile/instance selection parameters. Fieldbus module specific parameters. For more information, see the *User's Manual* of the appropriate fieldbus adapter module.
4) With DeviceNet, the control part is transmitted directly.
5) With DeviceNet, the actual value part is transmitted directly.

### Control Word and Status Word

The Control Word (CW) is the principal means of controlling the drive from a fieldbus system. The Control Word is sent by the fieldbus controller to the drive. The drive switches between its states according to the bit-coded instructions of the Control Word.

The Status Word (SW) is a word containing status information, sent by the drive to the fieldbus controller.

### Actual values

Actual values (ACT) are 16/32-bit words containing information on selected operations of the drive.

## FBA communication profile

The FBA communication profile is a state machine model which describes the general states and state transitions of the drive. The State diagram on page 353 presents the most important states (including the FBA profile state names). The FBA Control Word (2.12 FBA MAIN CW, page 71) commands the transitions between these states and the FBA Status Word (2.13 FBA MAIN SW, page 73) indicates the status of the drive.

Fieldbus adapter module profile (selected by adapter module parameter) defines how the control word and status word are transmitted in a system which consists of fieldbus controller, fieldbus adapter module and drive. With transparent modes, control word and status word are transmitted without any conversion between the fieldbus controller and the drive. With other profiles (eg, PROFIdrive for FPBA-01, AC/DC drive for FDNA-01, DS-402 for FCAN-01 and ABB Drives profile for all fieldbus adapter modules) fieldbus adapter module converts the fieldbus-specific control word to the FBA communication profile and status word from FBA communication profile to the fieldbus-specific status word.

For descriptions of other profiles, see the *User’s Manual* of the appropriate fieldbus adapter module.

### Fieldbus references

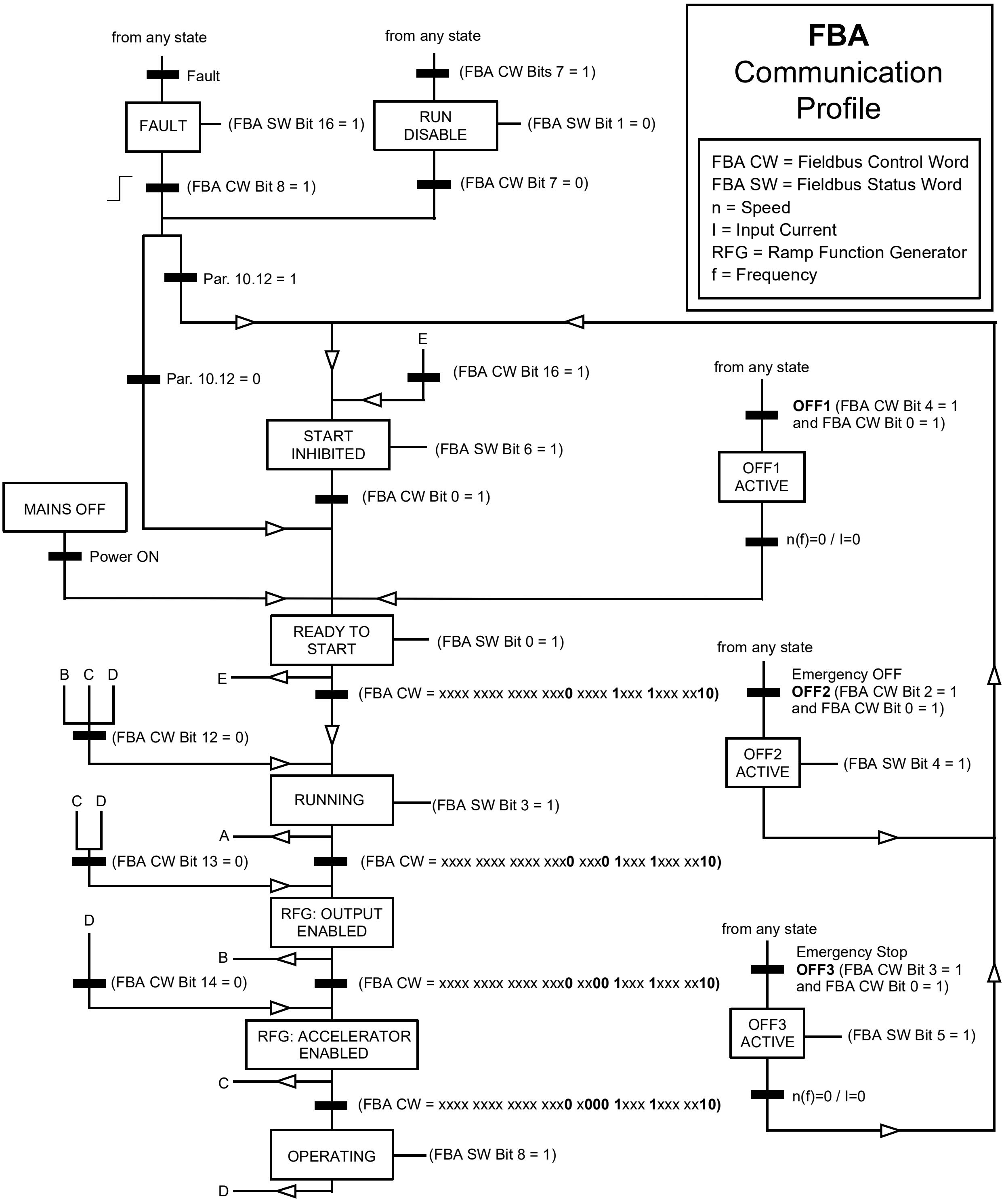
References (FBA REF) are 16/32-bit signed integers. A negative reference is formed by calculating the two’s complement from the corresponding positive reference value. The contents of each reference word can be used as speed or torque reference.

When torque or speed reference scaling is selected (by parameter 50.04 FBA REF1 MODESEL / 50.05 FBA REF2 MODESEL), the fieldbus references are 32-bit integers. The value consists of a 16-bit integer value and a 16-bit fractional value. The speed/torque reference scaling is as follows:

| Reference | Scaling | Notes |
|---|---|---|
| Torque reference | FBA REF / 65536 (value in %) | Final reference is limited by parameters 20.06 MAXIMUM TORQUE and 20.07 MINIMUM TORQUE. |
| Speed reference | FBA REF / 65536 (value in rpm) | Final reference is limited by parameters 20.01 MAXIMUM SPEED, 20.02 MINIMUM SPEED and 24.12 SPEED REFMIN ABS. |

### State diagram

The following presents the state diagram for the FBA communication profile. For other profiles, see the *User's Manual* of the appropriate fieldbus adapter module.



**FBA**
Communication
Profile

FBA CW = Fieldbus Control Word
FBA SW = Fieldbus Status Word
n = Speed
I = Input Current
RFG = Ramp Function Generator
f = Frequency

# Appendix B – Drive-to-drive link

## What this chapter contains

This chapter describes the wiring of, and available communication methods on the drive-to-drive link. Examples of using standard function blocks in the communication are also given starting on page 363.

## General

The drive-to-drive link is a daisy-chained RS-485 transmission line, constructed by connecting the X5 terminal blocks of the JCU Control Units of several drives. It is also possible to use an FMBA Modbus extension module installed into an option slot on the JCU. The firmware supports up to 63 nodes on the link.

The link has one master drive; the rest of the drives are followers. By default, the master broadcasts control commands as well as speed and torque references for all followers. The master can send 8 messages per millisecond at 100/150-microsecond intervals. Sending one message takes approximately 15 microseconds, which results in a theoretical link capacity of roughly 6 messages per 100 microseconds.

Multicasting the control data and reference 1 to a pre-defined group of drives is possible, as is chained multicast messaging. Reference 2 is always broadcast by the master to all followers. See parameters 57.11…57.14.

### Wiring

Shielded twisted-pair cable (~100 ohm, eg, PROFIBUS-compatible cable) must be used for the wiring. The maximum length of the link is 50 metres (164 ft).

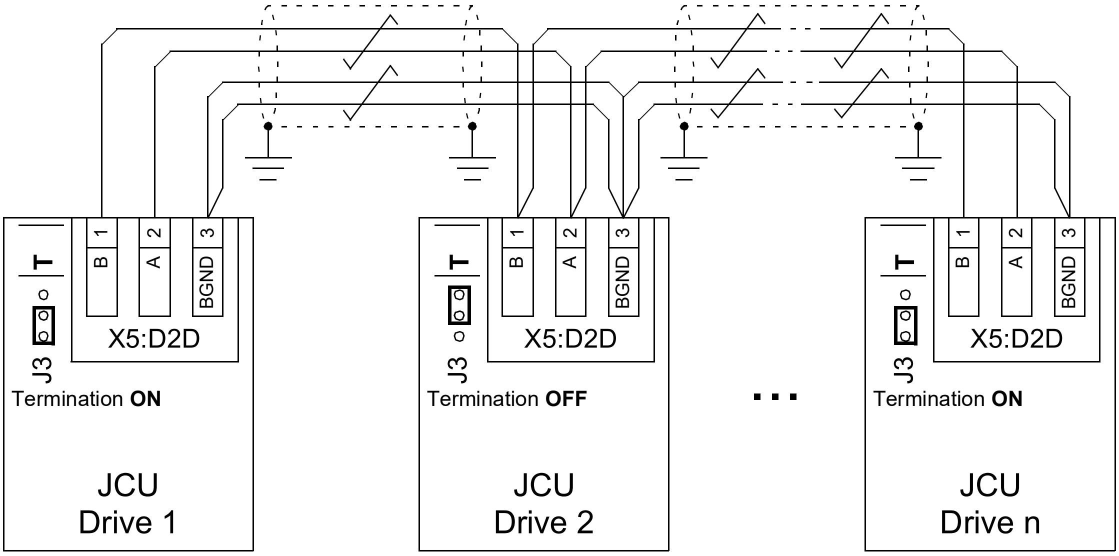
The JCU Control Unit has a jumper (J3, “T”) next to the X5 terminal block for bus termination. Termination must be ON on the drives at the ends of the drive-to-drive link; on intermediate drives, termination must be OFF.

Instead of the X5 connector, an FMBA Modbus extension module can be used.

For best immunity, high quality cable is recommended. The cable should be kept as short as possible. Unnecessary loops and running the cable near power cables (such as motor cables) must be avoided.

**Note:** The cable shields are to be grounded to the control cable clamp plate on the drive. Follow the instructions given in the *Hardware Manual* of the drive.

The following diagram shows the wiring of the drive-to-drive link.



## Datasets

Drive-to-drive communication uses DDCS (Distributed Drives Communication System) messages and dataset tables for data transfer. Each drive has a dataset table of 256 datasets, numbered 0…255. Each dataset contains 48 data bits.

By default, datasets 0…15 and 200…255 are reserved for the drive firmware; datasets 16…199 are available for the user application program.

The contents of the two firmware communication datasets can be configured freely with pointer parameters and/or application programming with the DriveSPC tool. The 16-bit control word and 32-bit drive-to-drive reference 1 are transmitted from one dataset on a 500-microsecond (by default) time level; drive-to-drive reference 2 (32 bits) is transmitted from the other dataset on a 2-millisecond (by default) time level. Depending on the drive control mode, the followers can be configured to use the drive-to-drive commands and references with the following parameters:

| **Control data** | **Parameter** | **Setting for drive-to-drive communication** |
|---|---|---|
| Start/Stop commands | 10.01 EXT1 START FUNC<br>10.04 EXT2 START FUNC | (4) D2D |
| Speed reference | 24.01 SPEED REF1 SEL<br>24.02 SPEED REF2 SEL | (5) D2D REF1 or<br>(6) D2D REF2 |
| Torque reference | 32.01 TORQ REF1 SEL<br>32.02 TORQ REF ADD SEL | (5) D2D REF1 or<br>(6) D2D REF2 |

The communication status of the followers can be supervised by a periodic supervision message from the master to the individual followers (see parameters 57.04 FOLLOWER MASK 1 and 57.05 FOLLOWER MASK 2).

Drive-to-drive function blocks can be used in the DriveSPC tool to enable additional communication methods (such as follower-to-follower messaging) and to modify the use of datasets between the drives. See the function blocks under *Communication* (page 272).

## Types of messaging

Each drive on the link has a unique node address allowing point-to-point communication between two drives. The node address 0 is automatically assigned to the master drive; on other drives, the node address is defined by parameter 57.03 NODE ADDRESS.

Multicast addressing is supported, allowing the composition of groups of drives. Data sent to a multicast address is received by all drives that have that address. A multicast group can consist of 1…62 drives.

In broadcast messaging, data can be sent to all drives (actually, all followers) on the link.

Both master-to-follower(s) and follower-to-follower(s) communication is supported. A follower can send one message to another follower (or a group of followers) after receiving a token message from the master.

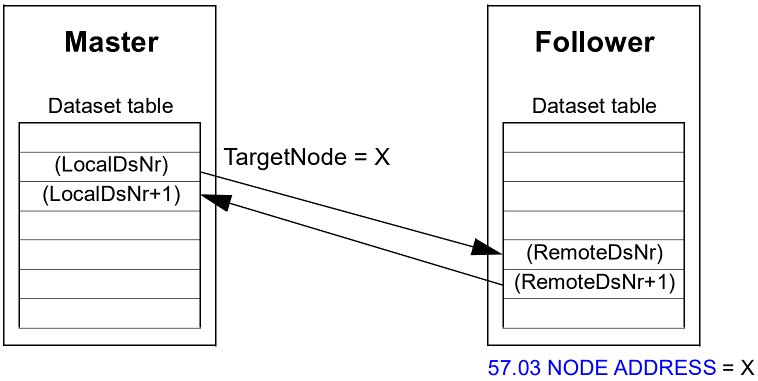
| **Type of messaging** | | **Note** |
|---|---|---|
| Point-to-point | Master point-to-point | Supported only at master |
| | Read remote | Supported only at master |
| | Follower point-to-point | Supported only at followers |
| Standard multicast | | For both master and followers |
| Broadcast | | For both master and followers |
| Token message for follower-to-follower communication | | – |
| Chained multicast | | Supported only for drive-to-drive reference 1 and control word |

### Master point-to-point messaging

In this type of messaging, the master sends one dataset (LocalDsNr) from its own dataset table to the follower's. TargetNode stands for the node address of the follower; RemoteDsNr specifies the target dataset number.

The follower responds by returning the contents of the next dataset. The response is stored into dataset LocalDsNr+1 in the master.

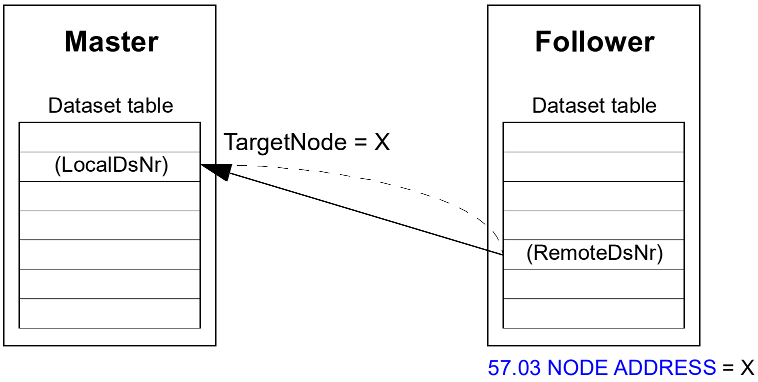
**Note:** Master point-to-point messaging is only supported at the master because the response is always sent to node address 0 (the master).



### Read remote messaging

The master can read a dataset (RemoteDsNr) from a follower specified by TargetNode. The follower returns the contents of the requested dataset to the master. The response is stored at dataset LocalDsNr in the master.

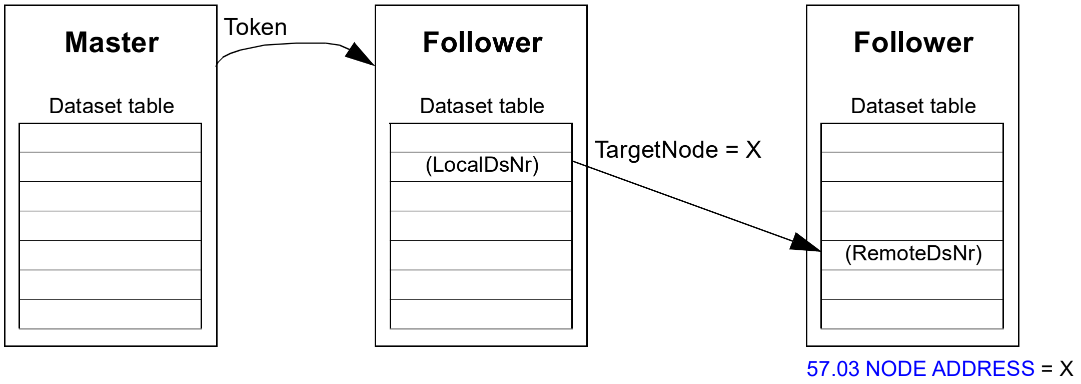
**Note:** Read remote messaging is only supported at the master because the response is always sent to node address 0 (the master).



### Follower point-to-point messaging

This type of messaging is for point-to-point communication between followers. After receiving a token from the master, a follower can send one dataset to another follower with a follower point-to-point message. The target drive is specified using the node address.

**Note:** The data is not sent to the master.



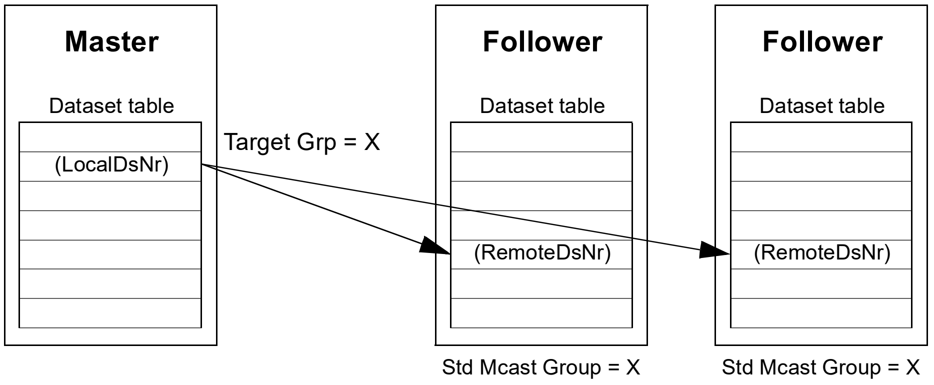
### Standard multicast messaging

In standard multicast messaging, one dataset can be sent to a group of drives having the same standard multicast group address. The target group is defined by the D2D_Conf standard function block (see page 272).

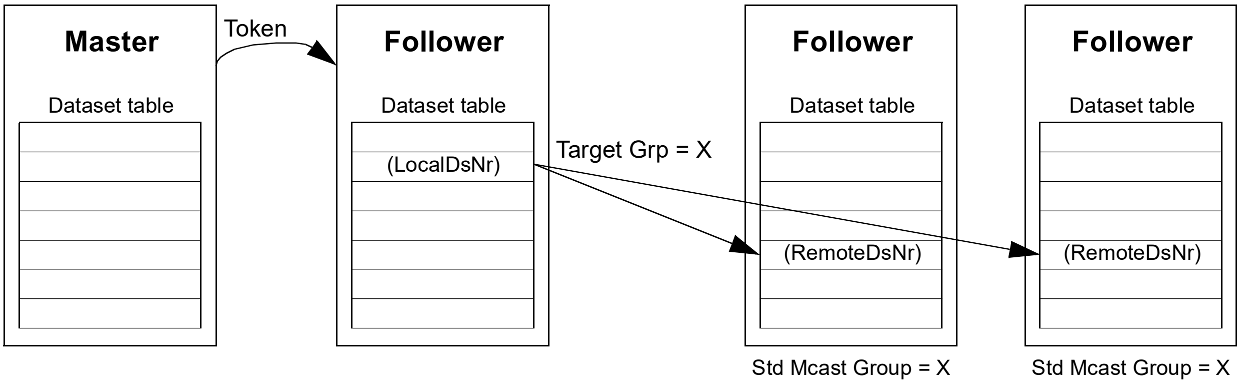
The sending drive can either be the master, or a follower after receiving a token from the master.

**Note:** The master does not receive the sent data even if it is a member of the target multicast group.

*Master-to-follower(s) multicasting*



*Follower-to-follower(s) multicasting*



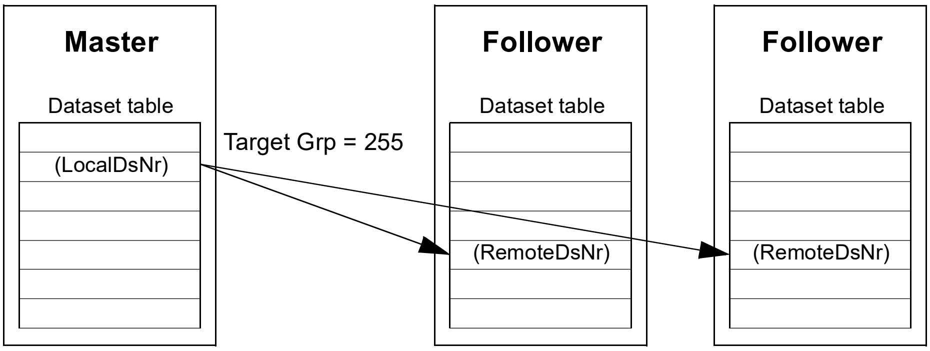
### Broadcast messaging

In broadcasting, the master sends one dataset to all followers, or a follower sends one dataset to all other followers (after receiving a token from the master).

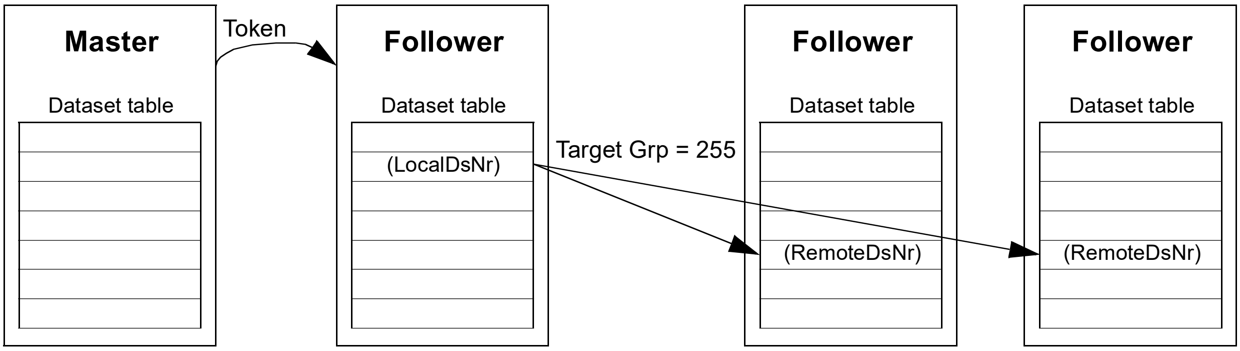
The target (Target Grp) is automatically set to 255 denoting all followers.

**Note:** The master does not receive any data broadcast by the followers.

*Master-to-follower(s) broadcasting*



*Follower-to-follower(s) broadcasting*



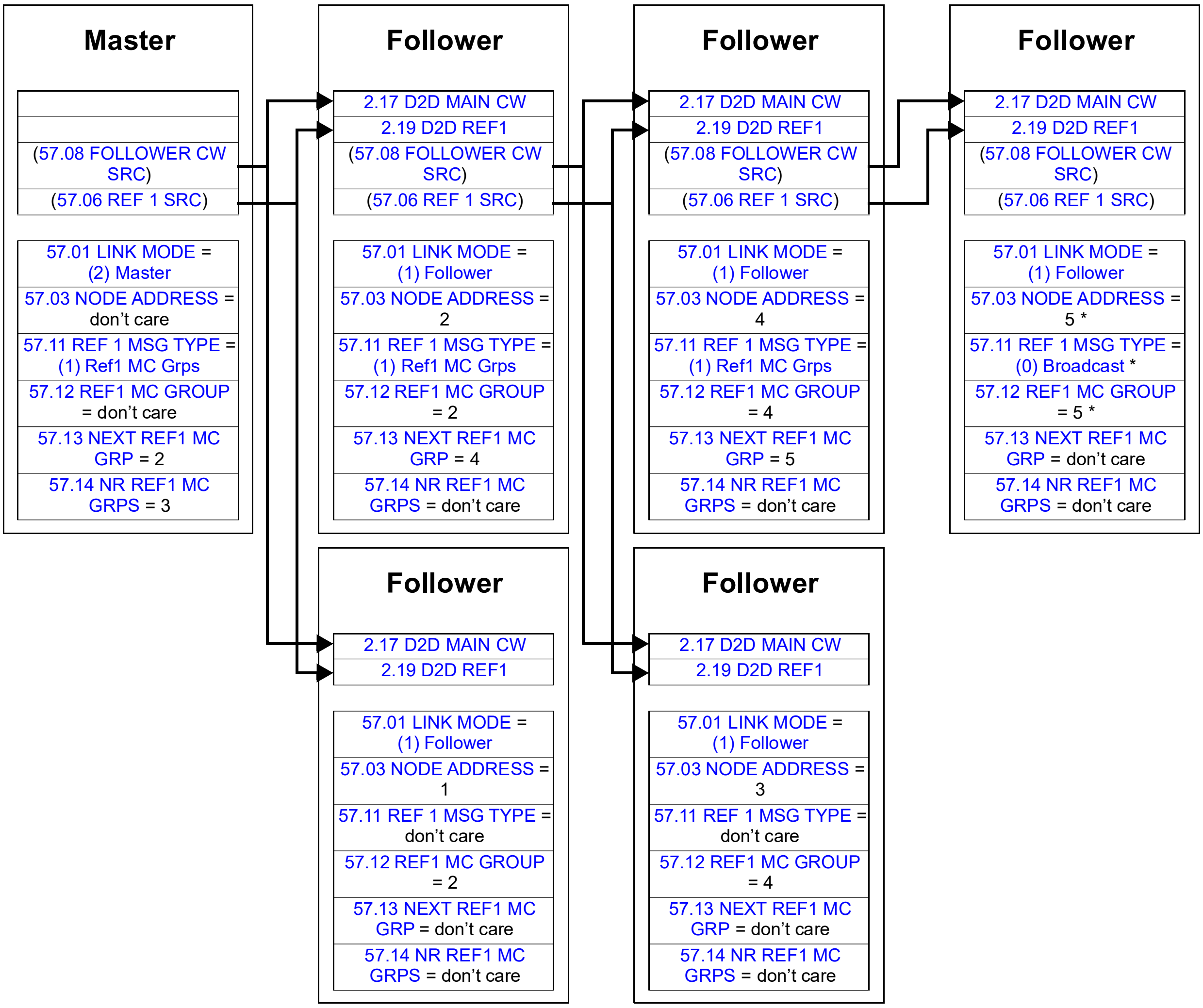
## Chained multicast messaging

Chained multicasting is supported only for drive-to-drive reference 1 by the firmware.

The message chain is always started by the master. The target group is defined by parameter 57.13 NEXT REF1 MC GRP. The message is received by all followers that have parameter 57.12 REF1 MC GROUP set to the same value as parameter 57.13 NEXT REF1 MC GRP in the master.

If a follower has parameters 57.03 NODE ADDRESS and 57.12 REF1 MC GROUP set to the same value, it becomes a submaster. Immediately after a submaster receives the multicast message, it sends its own message to the next multicast group defined by parameter 57.13 NEXT REF1 MC GRP.

The duration of the entire message chain is approximately 15 microseconds multiplied by the number of links in the chain (defined by parameter 57.14 NR REF1 MC GRPS in the master).


Master
(57.08 FOLLOWER CW SRC)
(57.06 REF 1 SRC)
57.01 LINK MODE = (2) Master
57.03 NODE ADDRESS = don’t care
57.11 REF 1 MSG TYPE = (1) Ref1 MC Grps
57.12 REF1 MC GROUP = don’t care
57.13 NEXT REF1 MC GRP = 2
57.14 NR REF1 MC GRPS = 3
Follower
2.17 D2D MAIN CW
2.19 D2D REF1
(57.08 FOLLOWER CW SRC)
(57.06 REF 1 SRC)
57.01 LINK MODE = (1) Follower
57.03 NODE ADDRESS = 2
57.11 REF 1 MSG TYPE = (1) Ref1 MC Grps
57.12 REF1 MC GROUP = 2
57.13 NEXT REF1 MC GRP = 4
57.14 NR REF1 MC GRPS = don’t care
Follower
2.17 D2D MAIN CW
2.19 D2D REF1
(57.08 FOLLOWER CW SRC)
(57.06 REF 1 SRC)
57.01 LINK MODE = (1) Follower
57.03 NODE ADDRESS = 4
57.11 REF 1 MSG TYPE = (1) Ref1 MC Grps
57.12 REF1 MC GROUP = 4
57.13 NEXT REF1 MC GRP = 5
57.14 NR REF1 MC GRPS = don’t care
Follower
2.17 D2D MAIN CW
2.19 D2D REF1
(57.08 FOLLOWER CW SRC)
(57.06 REF 1 SRC)
57.01 LINK MODE = (1) Follower
57.03 NODE ADDRESS = 5 *
57.11 REF 1 MSG TYPE = (0) Broadcast *
57.12 REF1 MC GROUP = 5 *
57.13 NEXT REF1 MC GRP = don’t care
57.14 NR REF1 MC GRPS = don’t care
Follower
2.17 D2D MAIN CW
2.19 D2D REF1
57.01 LINK MODE = (1) Follower
57.03 NODE ADDRESS = 1
57.11 REF 1 MSG TYPE = don’t care
57.12 REF1 MC GROUP = 2
57.13 NEXT REF1 MC GRP = don’t care
57.14 NR REF1 MC GRPS = don’t care
Follower
2.17 D2D MAIN CW
2.19 D2D REF1
57.01 LINK MODE = (1) Follower
57.03 NODE ADDRESS = 3
57.11 REF 1 MSG TYPE = don’t care
57.12 REF1 MC GROUP = 4
57.13 NEXT REF1 MC GRP = don’t care
57.14 NR REF1 MC GRPS = don’t care

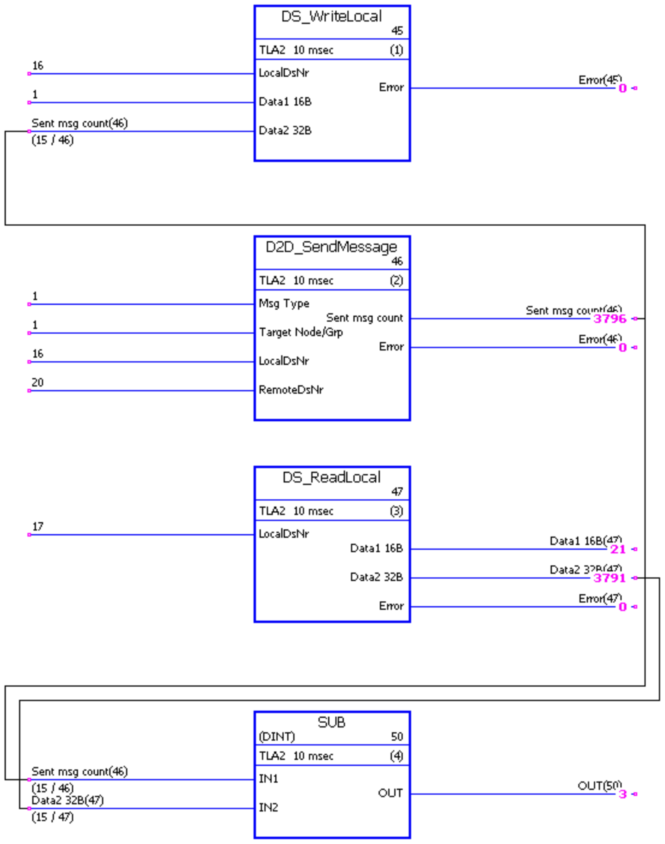
* Acknowledgement from last follower to master can be prevented by setting parameter 57.11 REF 1 MSG TYPE to (0) Broadcast (required because parameters 57.03 NODE ADDRESS and 57.12 REF1 MC GROUP are set to the same value). Alternatively, node/group addresses (parameters 57.03 NODE ADDRESS and 57.12 REF1 MC GROUP) could be set to non-equal values.

# Examples of using standard function blocks in drive-to-drive communication

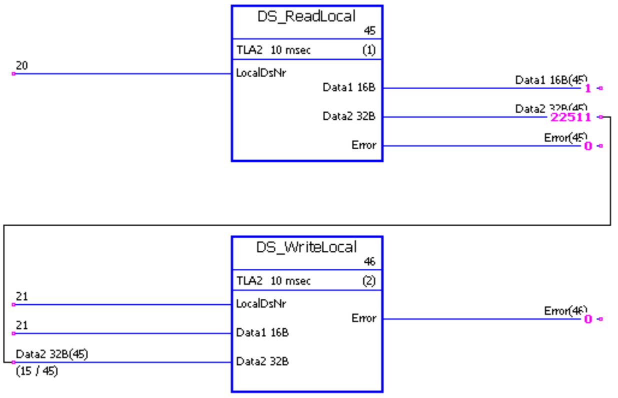
See also the descriptions of the drive-to-drive function blocks starting on page 272.

## Example of master point-to-point messaging

*Master*



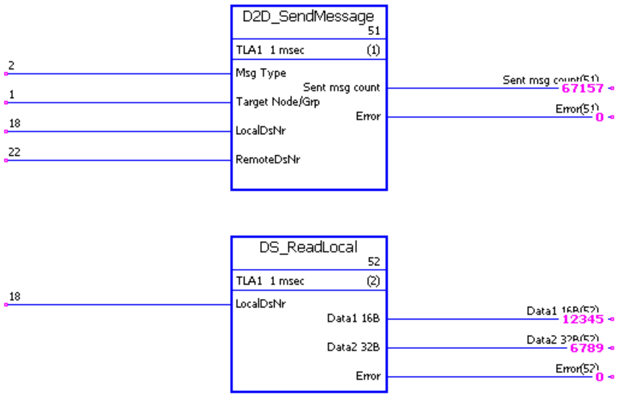
*Follower (node 1)*



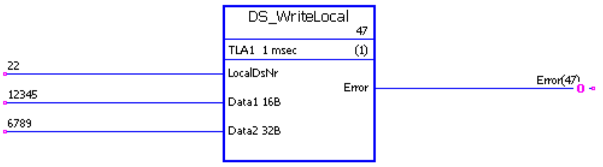
1. The master sends a constant (1) and the value of the message counter into follower dataset 20. Data is prepared to and sent from dataset 16.
2. The follower sends the received counter value and a constant (21) as a reply to the master.
3. The master calculates the difference of the latest message number and received data.

## Example of read remote messaging

*Master*



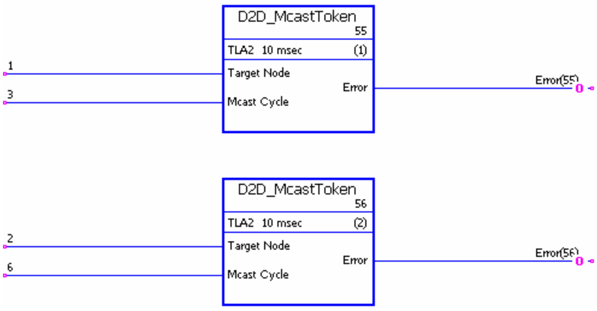
*Follower (node 1)*



1. The master reads the contents of the follower dataset 22 into its own dataset 18. Data is accessed using the DS_ReadLocal block.
2. In the follower, constant data is prepared into dataset 22.

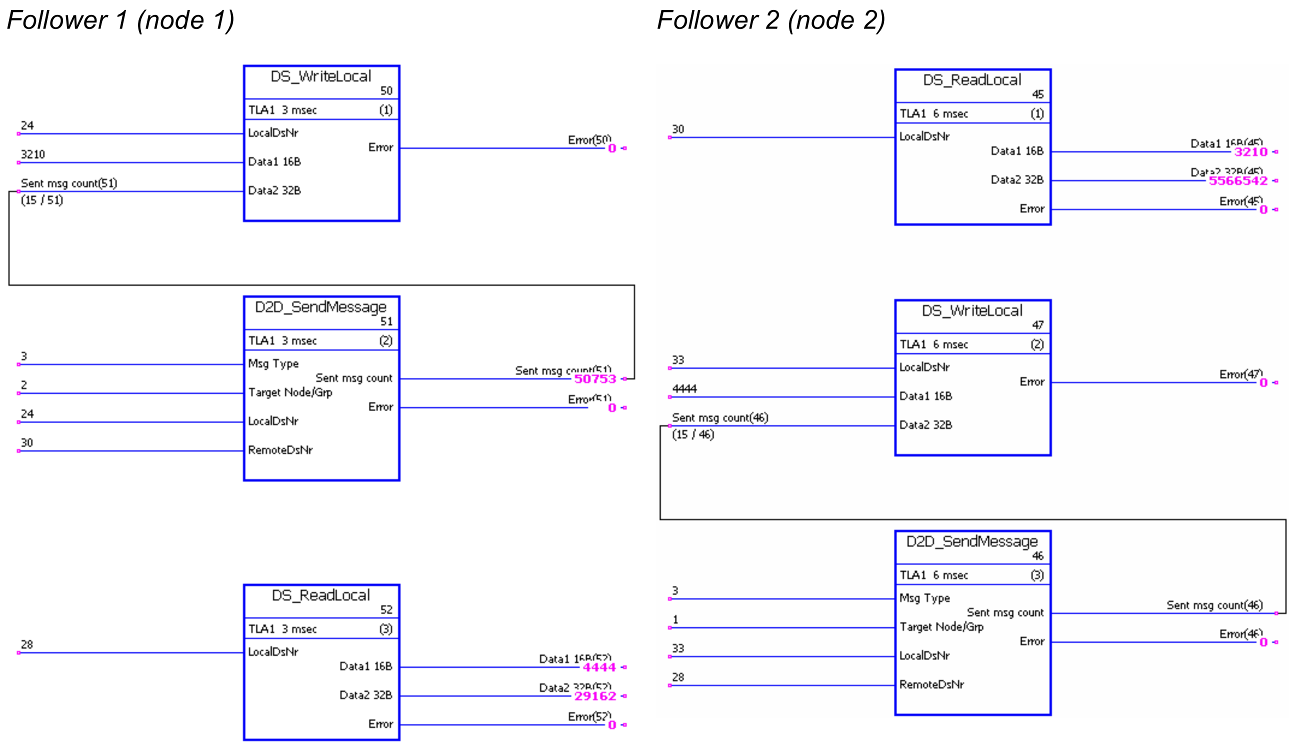
## Releasing tokens for follower-to-follower communication

*Master*



1. This drive-to-drive link consists of three drives (master and two followers).
2. The master operates as a “chairman”. Follower 1 (node 1) is allowed to send one message every 3 milliseconds. Follower 2 (node 2) is allowed to send one message every 6 milliseconds.

## Example of follower point-to-point messaging



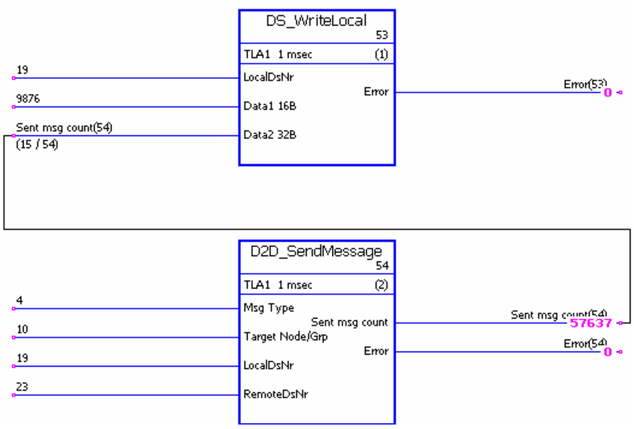
*Follower 1 (node 1)*

*Follower 2 (node 2)*

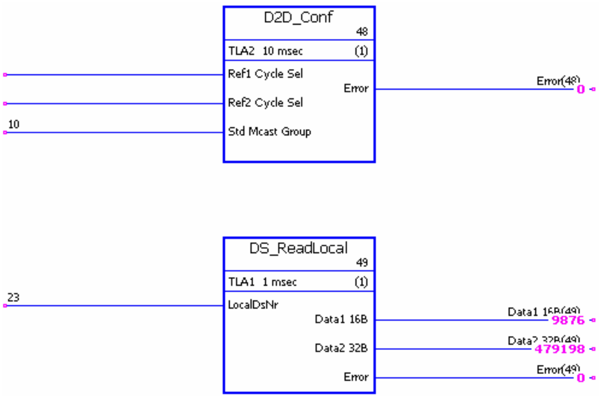
1. Follower 1 writes local dataset 24 to follower 2 dataset 30 (3 ms interval).
2. Follower 2 writes local dataset 33 to follower 1 dataset 28 (6 ms interval).
3. In addition, both followers read received data from local datasets.

## Example of standard master-to-follower(s) multicast messaging

*Master*



*Follower(s) in Std Mcast Group 10*

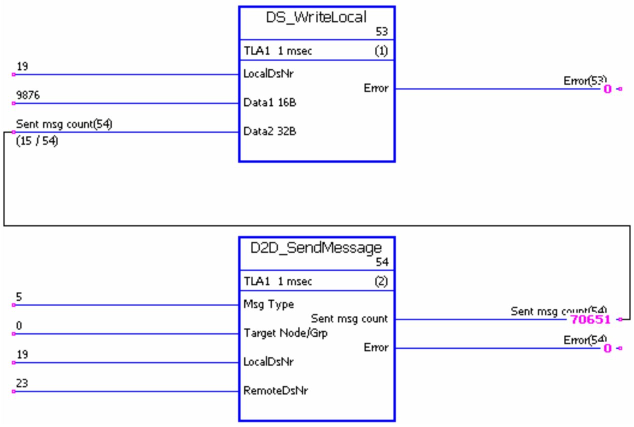


1. The master sends a constant (9876) and the value of the message counter to all followers in standard multicast group 10. The data is prepared into and sent from master dataset 19 to follower dataset 23.
2. Received data is read from dataset 23 of the receiving followers.

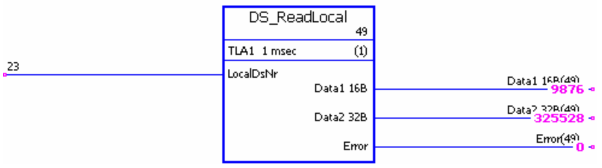
**Note:** The example application shown for Master above also applies to the sending follower in standard follower-to-follower multicasting.

## Example of broadcast messaging

*Master*



*Follower(s)*



1. The master sends a constant (9876) and the value of the message counter to all followers. The data is prepared into and sent from master dataset 19 to follower dataset 23.
2. Received data is read from dataset 23 of the followers.

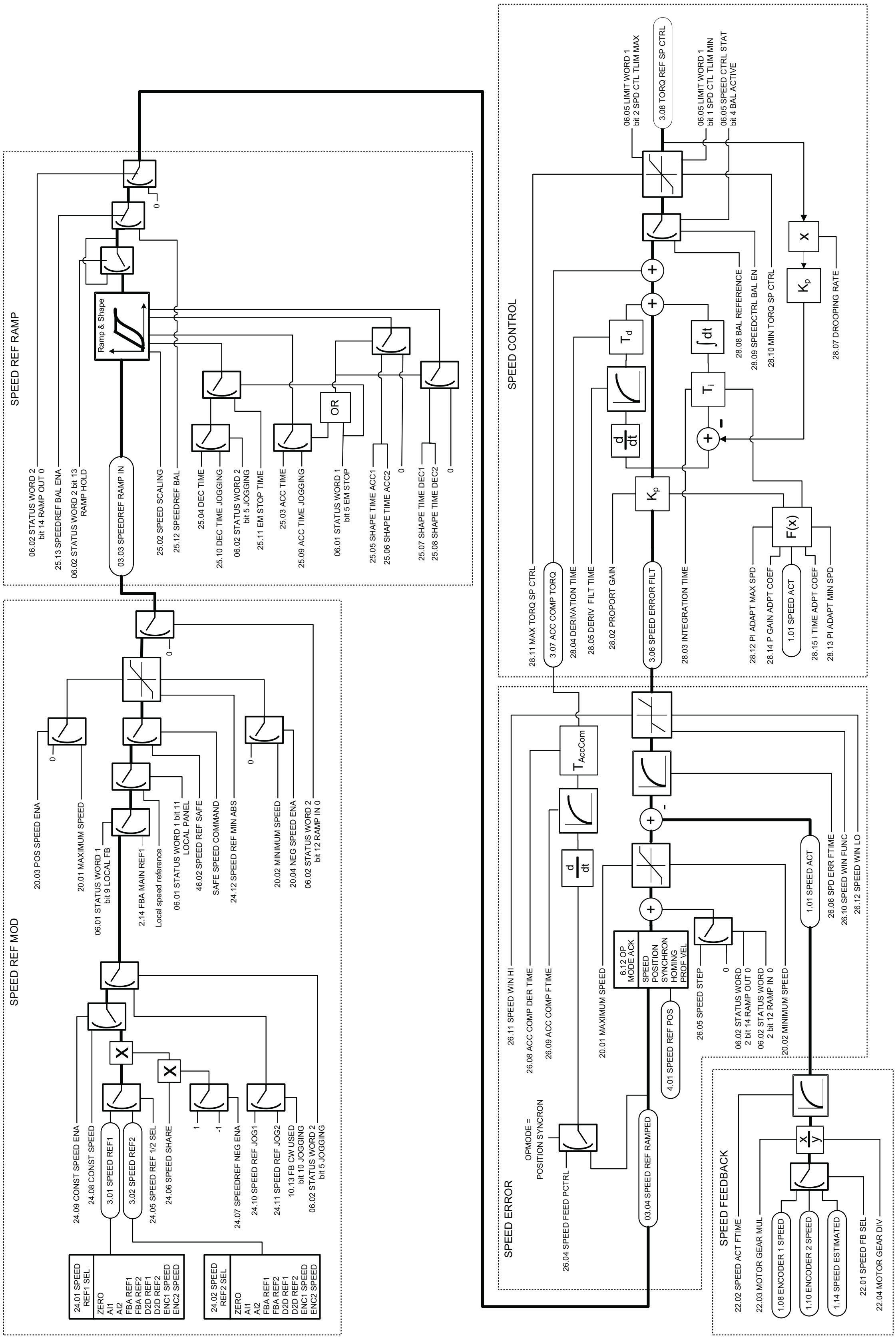
**Note:** The example application shown for Master above also applies to the sending follower in follower-to-follower broadcasting.

# Appendix C – Control chain and drive logic diagrams

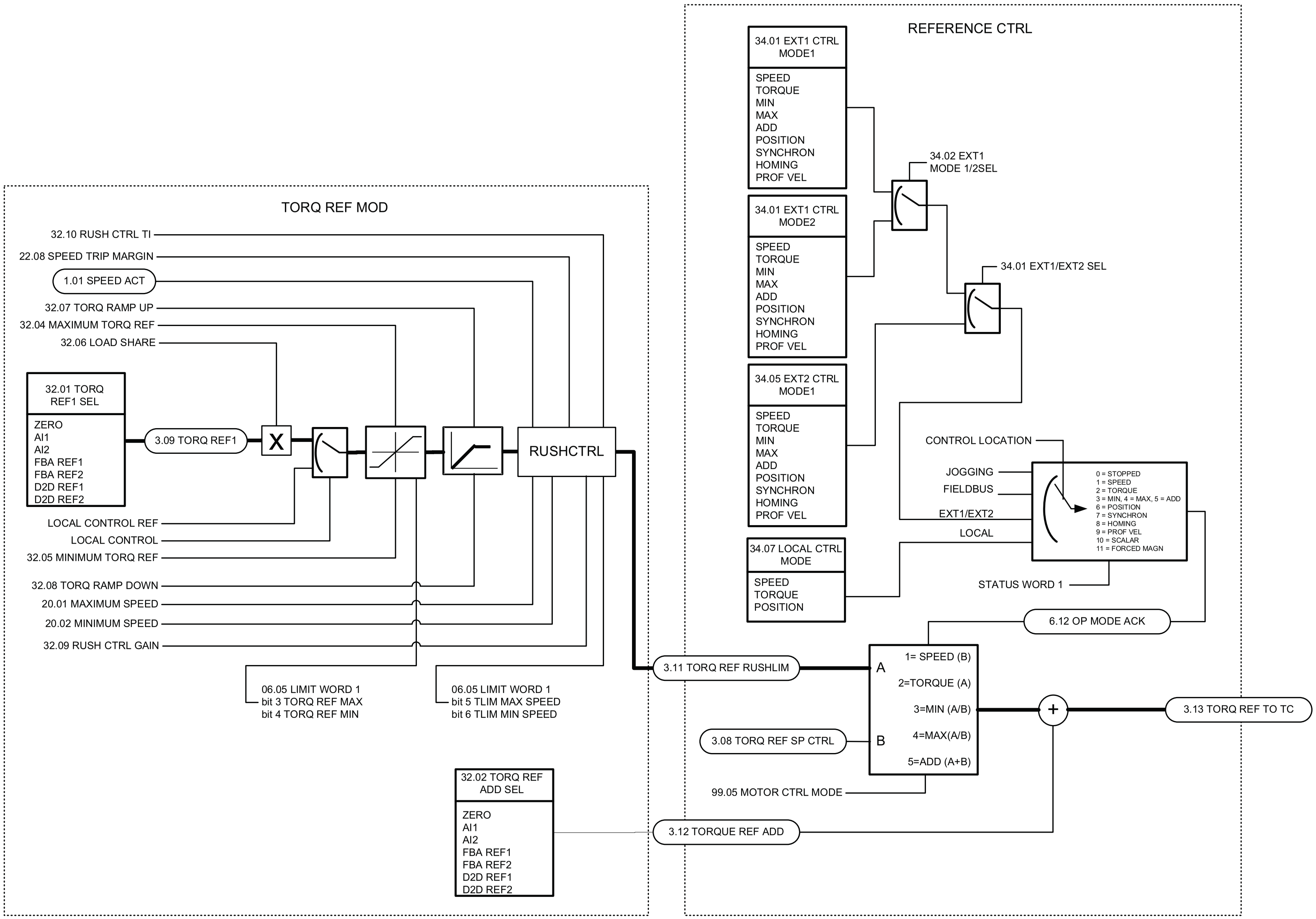
## What this chapter contains

This chapter presents the drive control chain and logic.

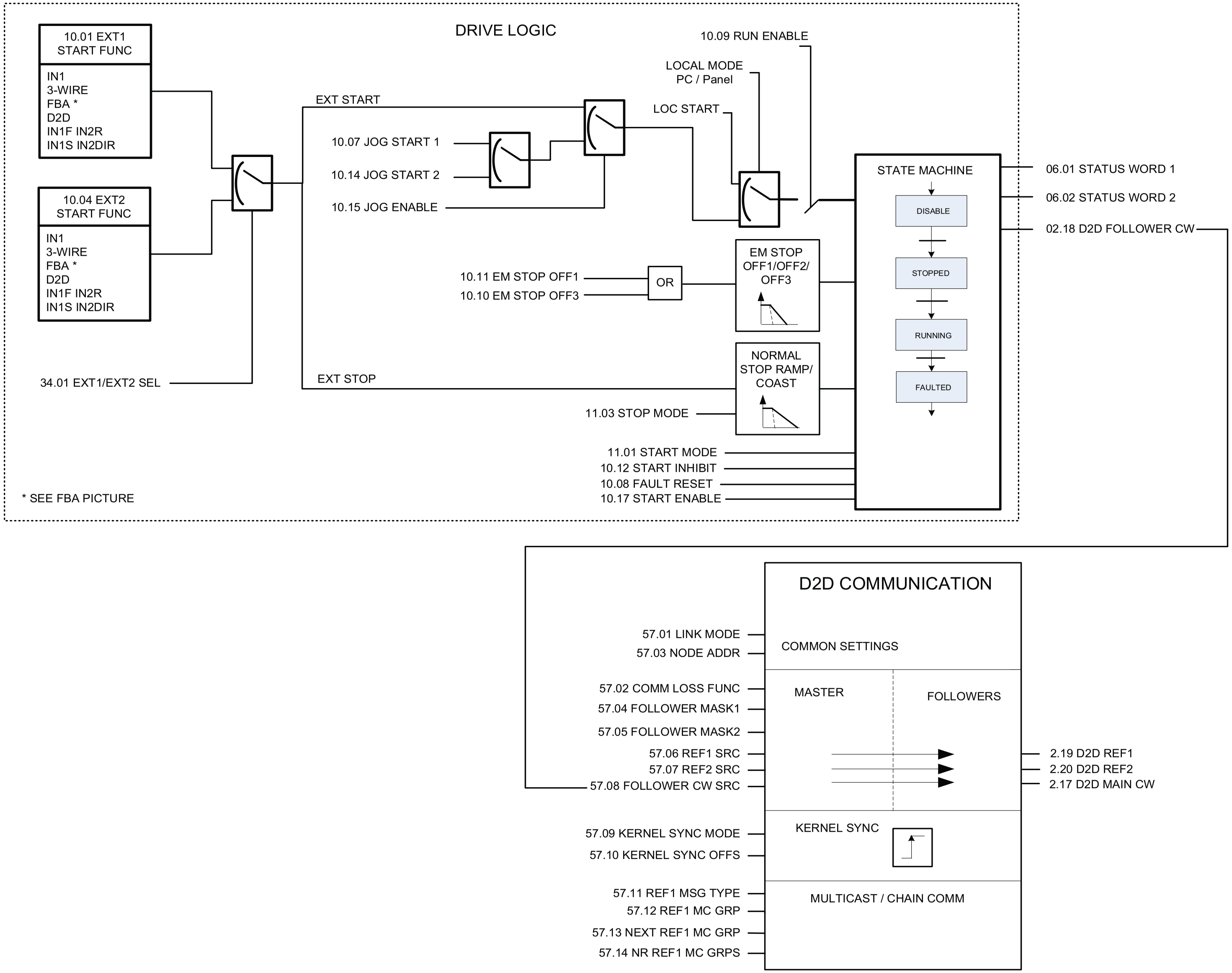
## Speed control chain



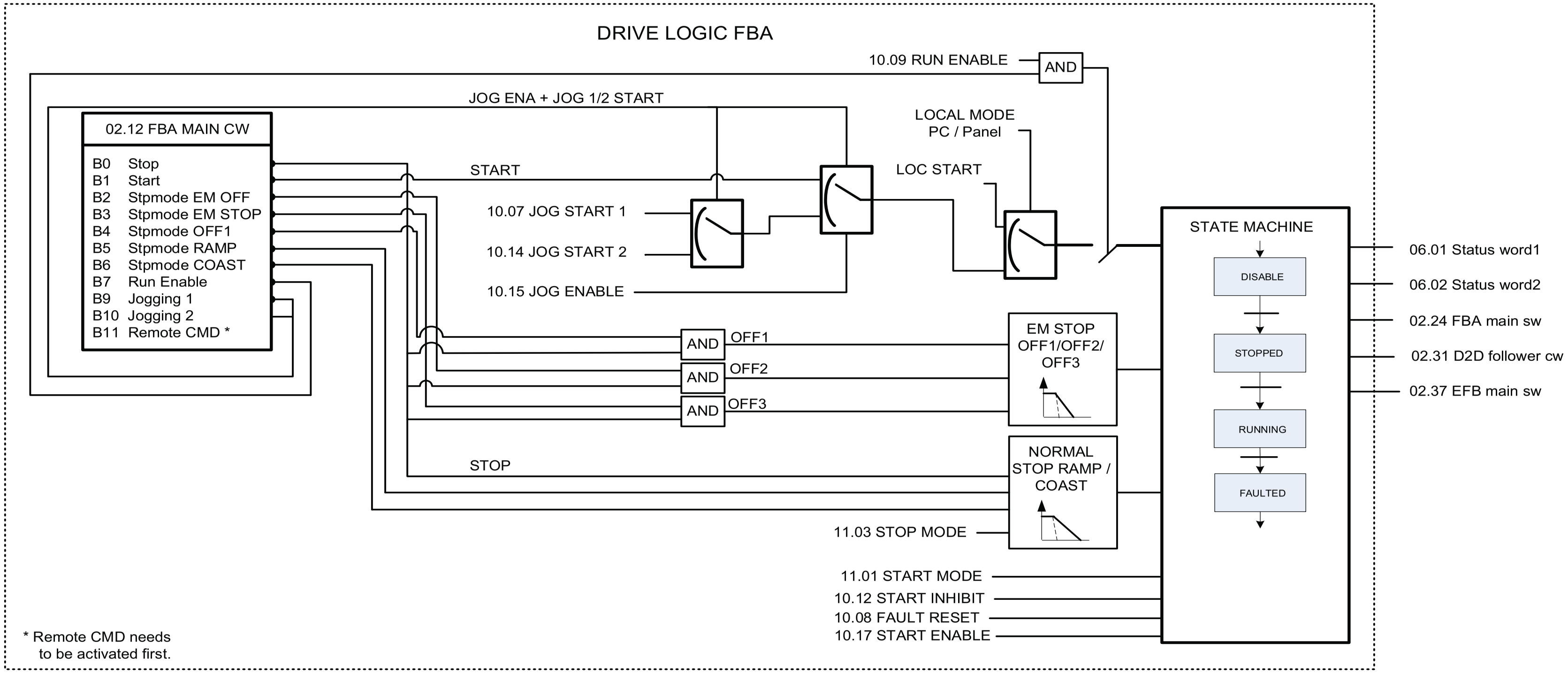
## Torque control chain



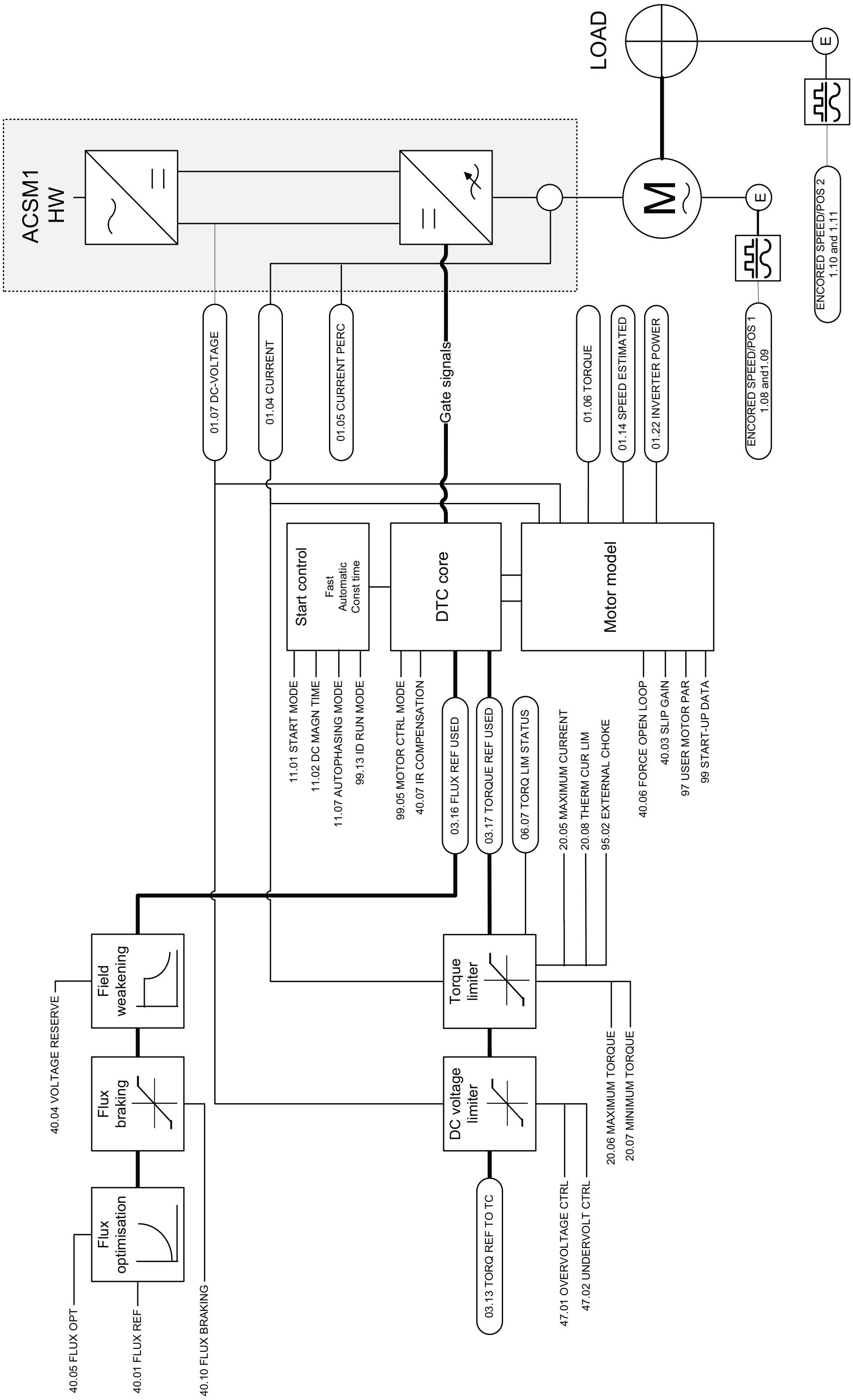
## Drive logic 1



## Drive logic 2 (Fieldbus interface)



## DTC motor control



# Further information

## Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to abb.com/searchchannels.

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## Providing feedback on ABB Drives manuals

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## Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet at abb.com/drives/documents.

**abb.com/drives**