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Operating Instructions
Positioning Controller MCO 351
VLT® AutomationDrive FC 301/302

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1 Introduction

1.1 Purpose of the Manual

These Operating Instructions provide information for safe installation and commissioning of the VLT® Positioning Controller MCO 351. The Operating Instructions are intended for use by qualified personnel. Read and follow the Operating Instructions to use the product safely and professionally, and pay particular attention to the safety instructions and general warnings. Keep these Operating Instructions available with the MCO 351 at all times.

Compliance with the information in these Operating Instructions is a prerequisite for:

- Trouble-free operation
- Recognition of product liability claims

Therefore, read the Operating Instructions before working with the MCO 351.

VLT® is a registered trademark.

1.2 Additional Resources

Resources available to understand advanced frequency converter and MCO functions and programming:

- VLT® AutomationDrive FC 301/FC 302 Operating Instructions
- VLT® AutomationDrive FC 301/FC 302 Design Guide
- VLT® AutomationDrive FC 301/FC 302 Programming Guide
- Motion Control Option MCO 305 Operating Instructions
- Motion Control Option MCO 305 Design Guide

Supplementary publications and manuals are available from Danfoss. See *www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm* for listings.

1.3 Overview

The VLT® Positioning Controller MCO 351 is for use with the FC 300 series frequency converters. The control card option expands the functional properties of the frequency converter in positioning applications. It is user-friendly, enabling the set-up of all parameters via the VLT® AutomationDrive Local Control Panel (LCP) or via the VLT® MCT 10 Set-up Software.

The module is available as an option card for field installation or as a built-in option in all VLT® AutomationDrives. It is available with and without conformal coating.

As the MCO 351 is a standard product with fixed functional properties, no additional application programming is required.

The positioning controller can handle most positioning applications with vertical as well as horizontal movements. The option is suited for applications with an overall control system, for example a PLC.

The main features are:

- Direct positioning via fieldbus
- Relative, absolute, and touch probe positioning
- 32 fixed positions (64 via fieldbus)
- End limit handling (software and hardware)
- Mechanical brake handling
- Error handling
- Jog speed/manual operation
- Home function
- Auto PID calculation

1.3.1 Software Version

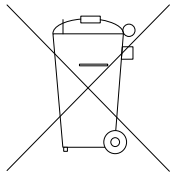
Refer to parameter *19-90 Type/Version* for the software version number.

1.4 Approvals

NOTICE

The T7 (525-690 V) frequency converters are not certified for UL.

1.5 Disposal



Equipment containing electrical components can not be disposed of together with domestic waste.
It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

2 Safety

2

2.1 Safety Symbols

The following symbols are used in this document:

⚠WARNING

Indicates a potentially hazardous situation which could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation which could result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that may result in damage to equipment or property.

2.2 Safety Warnings

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

- **Installation, start up, and maintenance must be performed by qualified personnel only.**

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC power supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 software, or after a cleared fault condition.

To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **Ensure that the frequency converter, motor, and any driven equipment is fully wired and assembled when the frequency converter is connected to AC mains, DC power supply, or load sharing.**

⚠WARNING

DISCHARGE TIME

Frequency converters contain DC link capacitors that can remain charged even when AC mains is disconnected. To avoid electrical hazards, remove AC mains from the frequency converter before doing any service or repair and wait the amount of time specified in *Table 2.1*. Failure to wait the specified time after power has been removed before doing service or repair on the unit could result in death or serious injury.

Voltage [V]	Minimum waiting time (minutes)	
	4	15
200–240	0.25–3.7 kW	5.5–37 kW
380–480	0.25–7.5 kW	11–75 kW
525–600	0.75–7.5 kW	11–75 kW
525–690	N/A	11–75 kW
High voltage may be present even when the warning indicator lights are off.		

Table 2.1 Discharge Time

NOTICE

Installation at high altitudes:

- **380–500 V: Enclosure A, B, and C: At altitudes above 2 km, contact Danfoss regarding PELV.**
- **380–500 V: Enclosure D, E, and F: At altitudes above 3 km, contact Danfoss regarding PELV.**
- **525–690 V: At altitudes above 2 km, contact Danfoss regarding PELV.**

2.3 Functional Safety

Safe Torque Off is an option. To run Safe Torque Off, additional wiring for the frequency converter is required. Refer to *VLT® Frequency Converters Safe Torque Off Operating Instructions* for further information.

3 Mechanical Installation

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This chapter is only relevant if the MCO 350/351 is delivered as an option for upgrading an existing VLT® AutomationDrive. When ordered with the frequency converter, MCO 350/351 is pre-installed. For retrofit, purchase a mounting kit.

There is a different mounting kit for different enclosures. Use MCO 350/351 in slot C0 or combine it with another option in slot C1.

Mounting kit depending on enclosure	Order no.
Bookstyle Enclosure	
A2 and A3 (40 mm for 1 C option)	130B7530
A2 and A3 (60 mm for C0 + C1 option)	130B7531
B3 (40 mm for 1 C option)	130B1413
B3 (60 mm for C0 + C1 option)	130B1414
Compact Enclosure	
A5	130B7532
B, C, D, E, and F (except B3)	130B7533

Table 3.1 Mounting Kits

Do not mount the small fan for B4, C3, C4, D, E, and F.

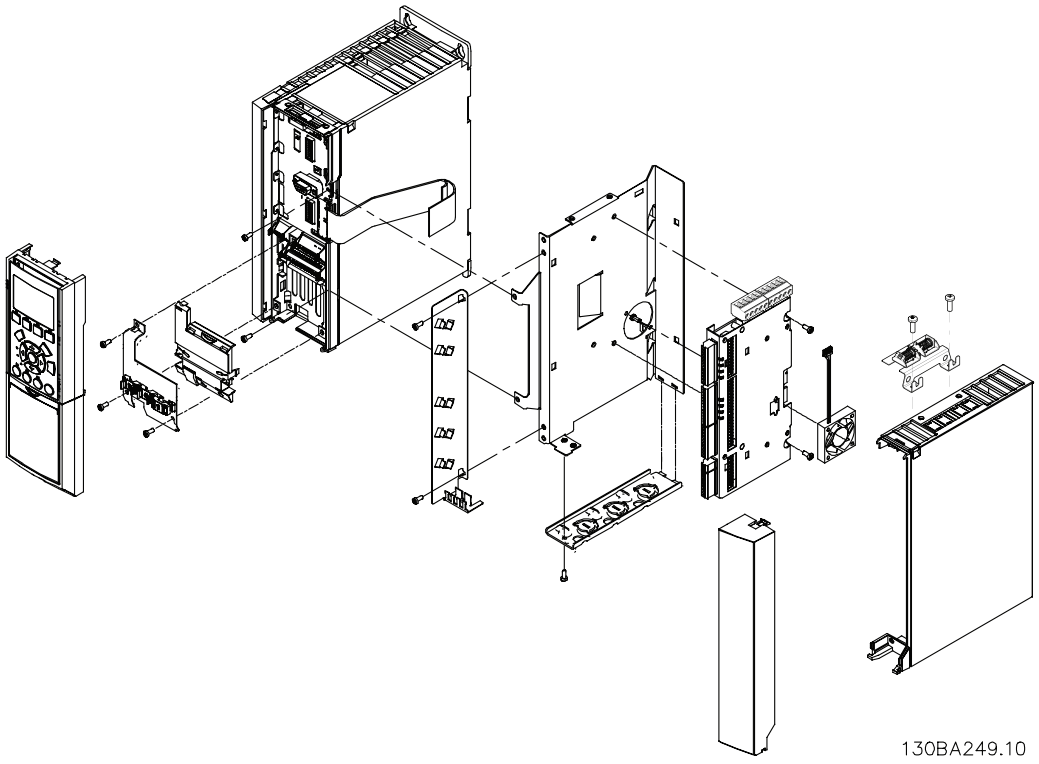

Illustration 3.1 Bookstyle Enclosure – A2, A3, B3

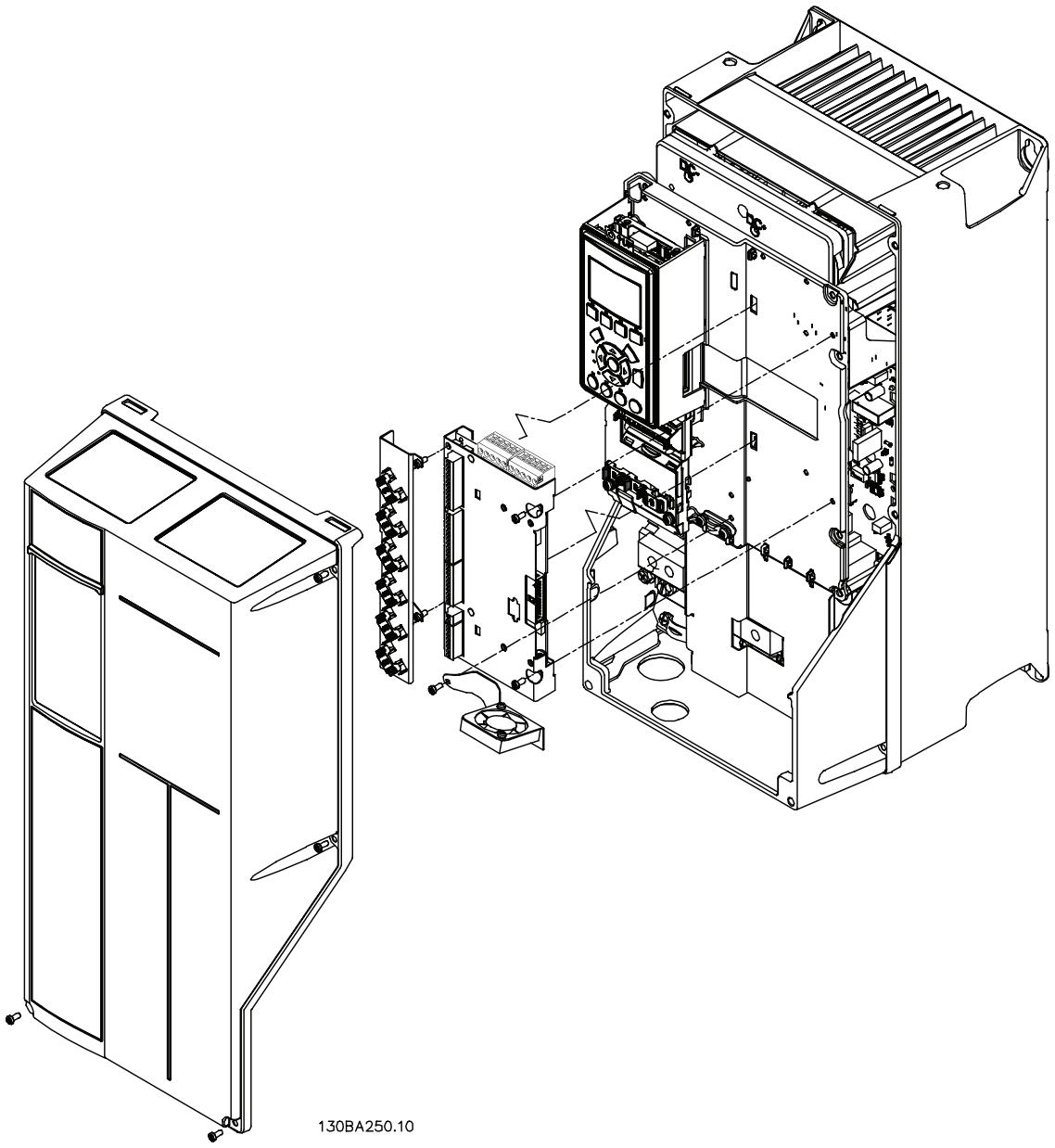

Illustration 3.2 Compact Enclosure – A5, B (except B3), C, D, E, F

4 Electrical Installation

Refer to the safety warnings in *chapter 2 Safety* before installing the MCO.

Screen all control cables and connect the cable screen to ground at both ends to avoid EMC problems. Always follow the instructions of the encoder supplier. See also *VLT® AutomationDrive FC 301/FC 302 0.25-75 kW Design Guide* for more information regarding cable installation.

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4.1 MCO 350/351 Control Terminals

4.1.1 Enclosure Types A2 and A3

Encoder and I/O terminal are located behind the C option terminal cover, see *Illustration 4.1*.

MCO CAN bus terminals and debug terminals (RS-485) are on the top of the C option cover. If these connections are used, cut out the plastic parts above the connectors and mount the cable relief.

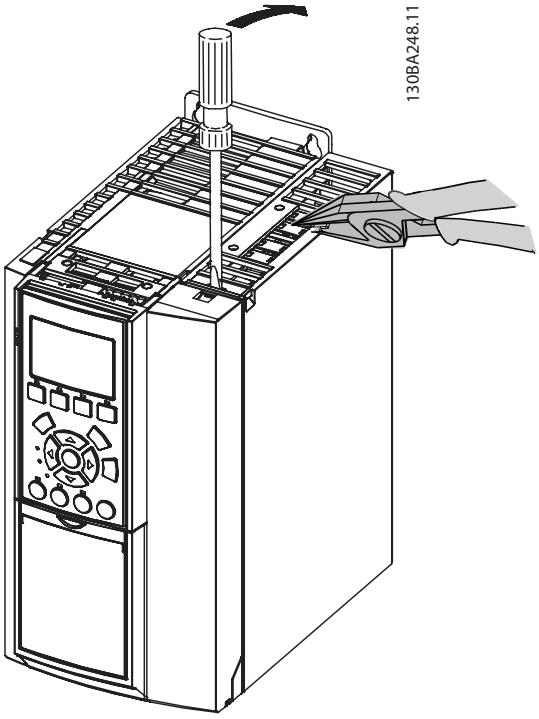


Illustration 4.1 Location of Encoder and I/O Terminals

4.1.2 Enclosure Types A5, B1, and B2

All MCO 350/351 terminals are located next to the VLT® AutomationDrive control card. Remove the front cover to get access. See *Illustration 4.2*.

MCO control terminals are plug connectors with screw terminals. Terminals X55, X56, X57, X58, and X59 are duplicated to be used for both bookstyle and compact enclosure type.
See *Illustration 4.3* to locate the terminal blocks.

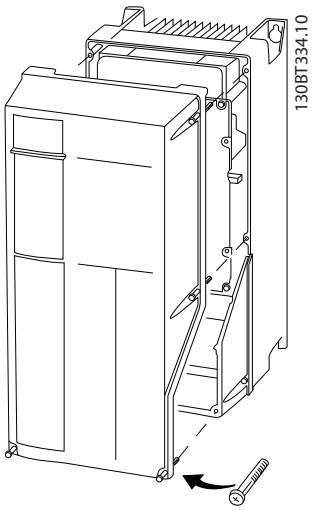
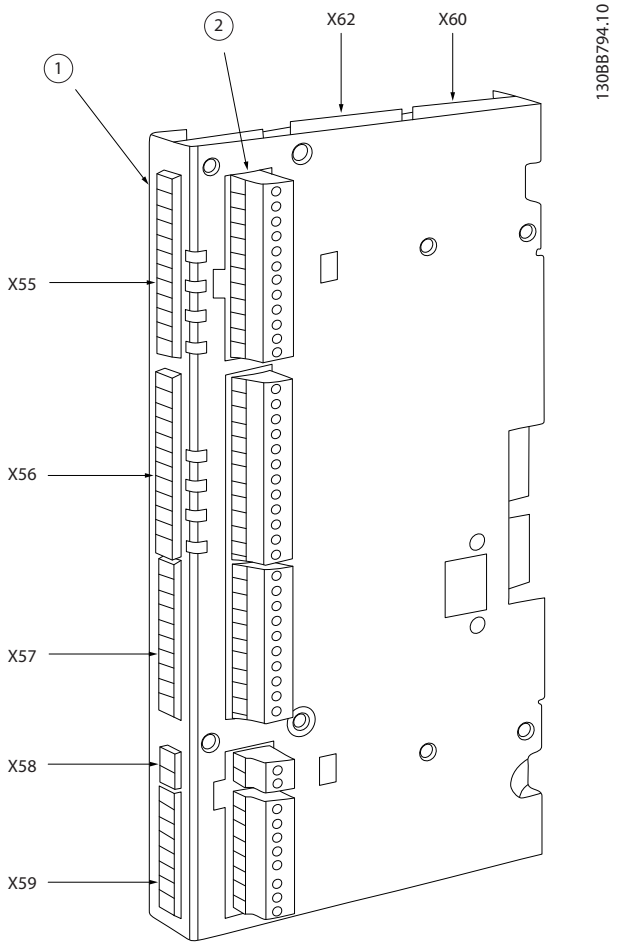


Illustration 4.2 Removing the Front Cover



1	Terminal block 1
2	Terminal block 2
X55	Encoder 2
X56	Encoder 1
X57	Digital inputs
X58	24 V DC supply
X59	Digital outputs
X60	MCO CAN Bus
X62	Debug connections (RS 485)

Illustration 4.3 Location of Terminal Blocks 1 and 2

Use terminal block 1 with bookstyle and terminal block 2 with compact.

4.2 Frequency Converter Control Card Terminals

The terminals on the VLT® AutomationDrive control card are allocated for the MCO 351.

Do not change the following parameters for I/O settings:

- Parameters *5-10* to *5-15* set to *[0] No operation* (default setting)
- Parameters *3-15*, *3-16* and *3-17* set to *[0] No function* (default setting)
- Parameter *6-50* set to *[52] MCO 0–20 mA*

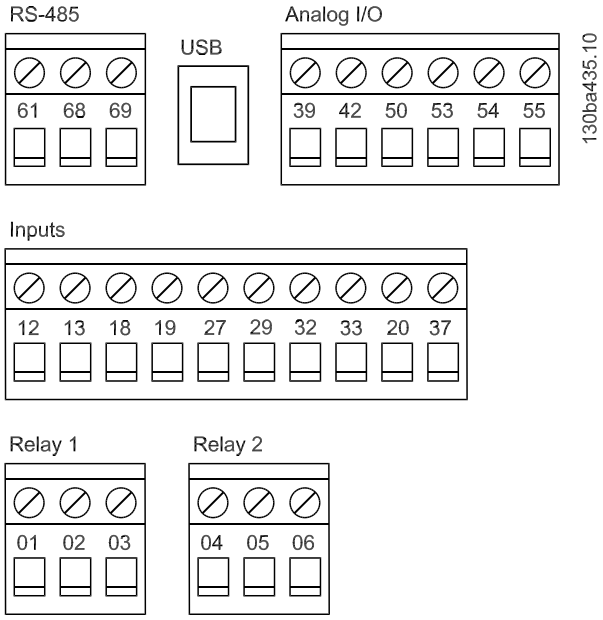


Illustration 4.4 FC 300 Terminals

Technical data on these terminals can be found in the *VLT® AutomationDrive FC 301/FC 302 Design Guide*.

4

Digital inputs

12	+24 V OUT
13	+24 V OUT
18	Reference index bit 0
19	Reference index bit 1
27	Enable (error clear in digital control mode)
29	Reference index bit 4
32	Reference index bit 3
33	Reference index bit 2
20	COM D in
37	Safe Torque Off (STO)

Table 4.1 Digital Inputs

Relay 1:
Mechanical brake (normally open)

Relay 2:
Mechanical brake monitoring (normally closed)

Analog input:
53 ±10 V-In Manual jog positive
54 ±10 V-In Manual jog negative
55 Common for analogue inputs

Supply voltage:
12, 13 +24 V Out
20 Common for digital inputs (common with X55/4-X56/4-X58/2)

4.3 Wiring Diagram

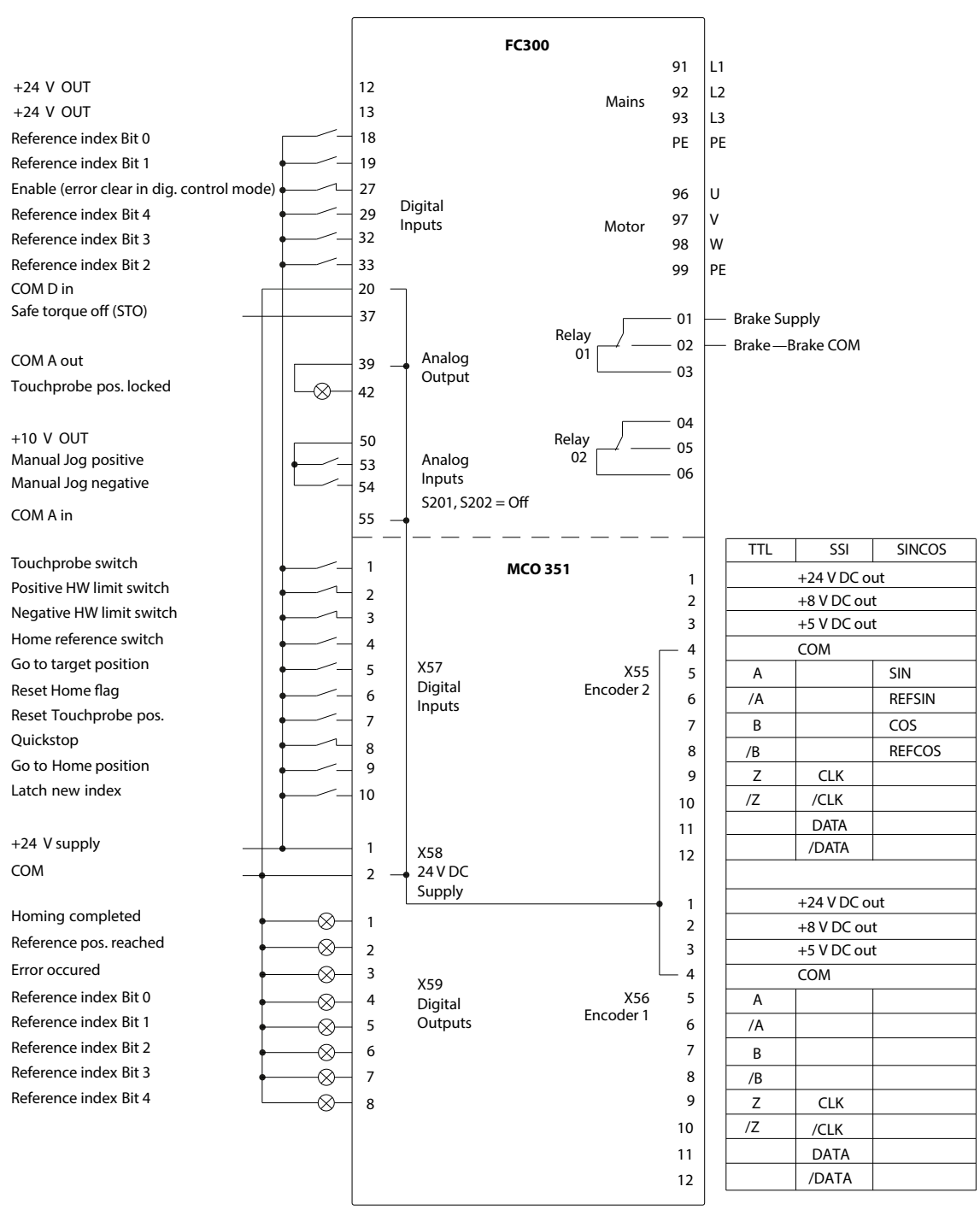


Illustration 4.5 Wiring Diagram

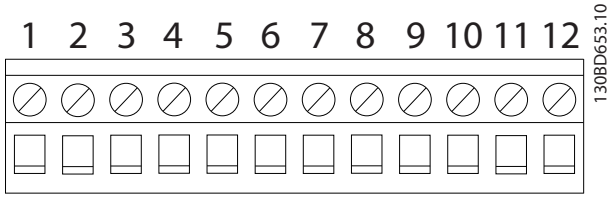
NOTICE

Input 29 is not available in FC 301. Therefore only 16 positions can be selected via digital inputs in FC 301.

4.4 MCO Option Card Terminals

Technical data on these terminals can be found in the *Motion Control Option MCO 305 Operating Instructions*.

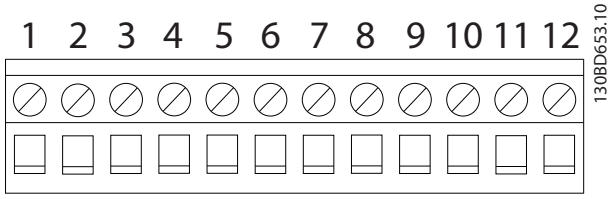
4.4.1 X55 Feedback Encoder Input



Pin number	TTL encoder	SSI encoder	SinCos encoder
1	+24 V DC Supply	+24 V DC Supply	+24 V DC Supply
2	+8 V DC Supply	+8 V DC Supply	+8 V DC Supply
3	+5 V DC Supply	+5 V DC Supply	+5 V DC Supply
4	GND	GND	GND
5	A	-	+SIN
6	A not	-	REFSIN
7	B	-	+COS
8	B not	-	REFCOS
9	Z	CLK	-
10	Z not	CLK not	-
11	-	DATA	-
12	-	DATA not	-

Illustration 4.6 X55 Feedback Encoder Input

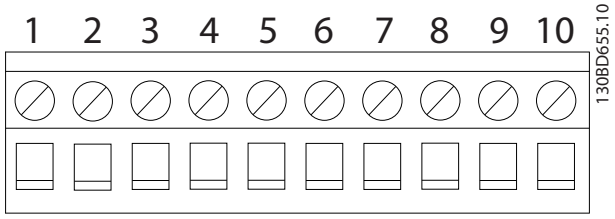
4.4.2 X56 Master Encoder Input/Virtual Master Output



Pin number	TTL encoder	SSI encoder
1	+24 V DC Supply	+24 V DC Supply
2	+8 V DC Supply	+8 V DC Supply
3	+5 V DC Supply	+5 V DC Supply
4	GND	GND
5	A	-
6	A not	-
7	B	-
8	B not	-
9	Z	CLK
10	Z not	CLK not
11	-	DATA
12	-	DATA not

Illustration 4.7 X56 Master Encoder Input/Virtual Master Output

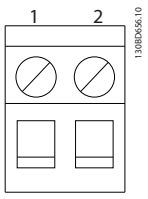
4.4.3 X57 Digital Input



Pin number	Description
1	Touch probe switch
2	Positive hardware limit switch
3	Negative hardware limit switch
4	Home switch
5	Go to target position
6	Reset home flag
7	Reset touch probe position
8	Quick stop
9	Go to home position
10	Latch new reference position index number

Illustration 4.8 X57 Digital Inputs

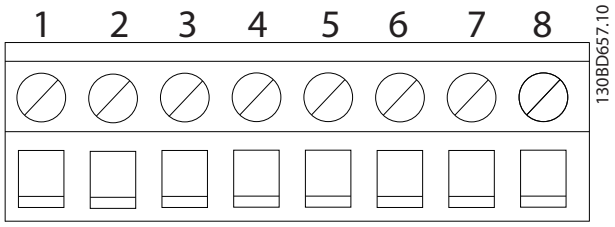
4.4.4 X58 24 V DC Supply



Pin number	Description
1	+24 V
2	COM

Illustration 4.9 X58 24 V DC Supply

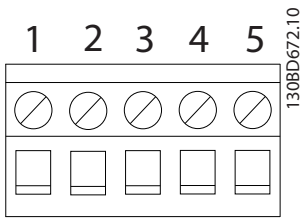
4.4.5 X59 Digital Outputs



Pin number	Description
1	Homing completed
2	Reference position reached
3	Error
4	Reference index bit 0
5	Reference index bit 1
6	Reference index bit 2
7	Reference index bit 3
8	Reference index bit 4

Illustration 4.10 X59 Digital Outputs

4.4.6 X62 MCO-CAN



Pin number	Description
1	–
2	CAN_L (CAN low)
3	Drain
4	CAN_H (CAN high)
5	–

Illustration 4.11 X62 MCO CAN

4

4.5 Description of Terminals

4.5.1 Frequency Converter Control Card Terminals

Connector	Terminal	Designation	Description
Inputs	12, 13	+24 V OUT	24 V (+1, –3 V) power supply Max. load: VLT® AutomationDrive FC 301: 130 mA VLT® AutomationDrive FC 302: 200 mA
	18	Reference index bit 0 (LSB)	Reference position index number bit 0 (least significant bit). Not used in fieldbus mode.
	19	Reference index bit 1	Reference position index number bit 1. Not used in fieldbus mode.
	20	COM D IN	Ground for 24 V – common with 39, 55, X55/4, X56/4, and X58/2
	27	Enable (error clear in digital control mode)	To enable operation, this input must be maintained at high in both digital control mode and fieldbus control mode. Digital control mode: Errors are cleared on the rising edge. Must be 0 V for at least 1 ms to guarantee edge detection.
	29	Reference index bit 4 (msb)	Reference position index number bit 4 (most significant bit). Not used in fieldbus mode. Not available in VLT® AutomationDrive FC 301.
	32	Reference index bit 3	Reference position index number bit 3. Not used in fieldbus mode.
	33	Reference index bit 2	Reference position index number bit 2. Not used in fieldbus mode.
	37	Safe Torque Off (STO)	Safe input. Used for STO.
Relay 01	01	COM Relay 01	Common terminal for Relay 01.
	02	Connect to electro-mechanical brake NO	Normal Open Relay 01 is open (brake activated) during power off and start-up of the FC 300. It is always open after a *Quick Stop* procedure or with an error situation. Relay 01 only closes with motion procedures or if specified in parameter *19-09 Automatic Brake Control*.
	03	NC	Normal Closed
Relay 02	04	COM Relay 02	Common terminal for Relay 02.
	05	Brake activated NC	Normal Closed Relay 02 is closed to indicate an activated electrome-chanical brake. It is open to indicate a deactivated electromechanical brake. Not used in fieldbus control mode.
	06	NO	Normal Open
Analogue I/O	39	COM A OUT	Ground for analog output. Common with 20 and 55.
	42	Touch probe position locked in	This analog output delivers either 0 mA (not locked in) or 20 mA (locked in) at a maximum of 500 Ω.
	50	+10 V OUT	Power supply for manual JOG inputs (terminal 53 and 54). Maximum 15 mA.
	53	±10 V-In Manual jog positive	When high (above 5 V), the drive travels with jogging speed (parameter *19-16*) and ramp (parameter *19-17*) in the positive direction. When low (below 5 V), the drive ramps down and stops if no other motion procedure is activated. Jog positive has higher priority than jog negative. Not used in fieldbus mode by default. Can be enabled via parameter *19-31 Digital Jog in field Bus mode*.
	54	±10 V-In Manual jog negative	When high (above 5 V), the drive travels with jogging speed (parameter *19-16*) and ramp (parameter *19-17*) in the negative direction. When low (below 5 V), the drive ramps down and stops if no other motion procedure is activated. Not used in fieldbus mode by default. Can be enabled via parameter *19-31 Digital Jog in field Bus mode*.
	55	COM A IN	Ground for analogue inputs. Common with 20 and 39.
RS-485	61	Shield	Integrated RC-filter for cable screen. **Only** for connecting the screen when experiencing EMC problems.
	68	RxTx+	A control card switch is provided for termination resistance.
	69	RxTx–	

Table 4.2 Control Card Terminals

4.5.2 MCO Digital Inputs Terminal (X57)

Terminal	Designation	Description
1	Touch probe switch input	Input triggered on the rising edge. If this signal goes high when no touch probe target position is locked, a new touch probe target position is calculated and locked in memory.
2	Positive hardware limit switch input	Input triggered on the falling edge. Triggers a hardware limit error and the motor is stopped according to parameter *19-06 Error Behaviour*.
3	Negative hardware limit switch input	Input triggered on the falling edge. Triggers a hardware limit error and the motor is stopped according to parameter *19-06 Error Behaviour*.
4	Home reference switch input	Active high. Marks the home position in the application.
5	Go to the target position	Active high. Upon activation the motor goes to the specified target position. A low signal interrupts any positioning sequence. Not used in fieldbus mode.
6	Reset home flag	Active high. This input clears the home flag. This allows the performance of a 2nd homing sequence.
7	Reset touch probe position	Active high. This input clears the touch probe position flag. The reset is necessary to carry out a touch probe positioning command to a new target position. Not used in fieldbus mode.
8	Quick stop	Active low. This input activates the *Quick Stop* function. The motor is stopped according to the setting of parameter *19-06 Error Behaviour*. After that, the electromechanical brake is always activated when the *Quick stop* input is activated, regardless of the parameter *19-06 Error Behaviour* setting.
9	Go to home position	While this input is high the motor executes the homing sequence and no position or jog operations are carried out. Any homing sequence is interrupted by a low state on this input. Not used in fieldbus mode.
10	Latch new reference position index number	Active on the rising edge (must be 0 V for at least 1 ms to guarantee edge detection): Latches reference position index number specified on terminal 18, 19, 29, 32, 33 into memory. Digital output 4-8 is changed to mirror the new reference index specified when using digital input control. Not used in fieldbus mode.

Table 4.3 MCO Digital Inputs Terminal (X57)

4.5.3 MCO Digital Outputs Terminal (X59)

Terminal	Designation	Description
1	Homing completed	Active high. This output is always high if an absolute encoder is used.
2	Referenced position reached	Active high. This output is set when the target position is reached according to the setting of parameter *33-47 Size of Target Window*.
3	Error occurred	Active high. This output is set every time an error occurs. It is cleared every time a successful error clear is carried out. This output remains high as long as the power recovery function is selected (parameter *19-08 Power-Recovery*) and active.
4	Reference index bit 0	Mirror of the currently locked-in reference index bit 0. Not used in fieldbus mode.
5	Reference index bit 1	Mirror of the currently locked-in reference index bit 1. Not used in fieldbus mode.
6	Reference index bit 2	Mirror of the currently locked-in reference index bit 2. Not used in fieldbus mode.
7	Reference index bit 3	Mirror of the currently locked-in reference index bit 3. Not used in fieldbus mode.
8	Reference index bit 4	Mirror of the currently locked-in reference index bit 4. Not used in fieldbus mode.

Table 4.4 MCO Digital Outputs Terminal (X59)

4

4.5.4 MCO Encoder Connection

MCO 351 provides 2 encoder interfaces, X55 and X56. Terminal block X55 is configured as the default feedback encoder input.

Encoder supported

- TTL/RS422 incremental encoder (X55, X56)
- SSI absolute encoder - Grey code (X55, X56)
- Sin/Cos Encoder 1 Vpp (only X55)
- Resolver (needs extra option MCB103) - only in speed closed loop.
- CANopen encoder (X62)

NOTICE

Use parameter *32-50 Source Slave* for setting encoder feedback to *[1] Encoder 1 X56* or *[3] Motor Control*.

4.5.4.1 Encoder Connection Examples

Example 1
Encoder connected to X55 for positioning loop. Since the encoder is mounted directly on the motor shaft, the same feedback can be used for the MCO positioning loop and the FC speed control loop.

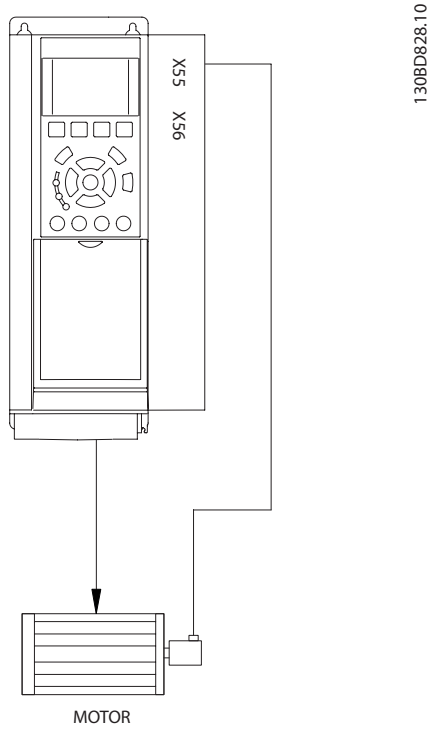


Illustration 4.12 Encoder Mounted on the Motor

Example 2
Encoder connected to X55 for positioning loop. Since the encoder is **not** mounted directly on the motor shaft, this configuration can be used for the MCO positioning loop and the FC speed control loop.

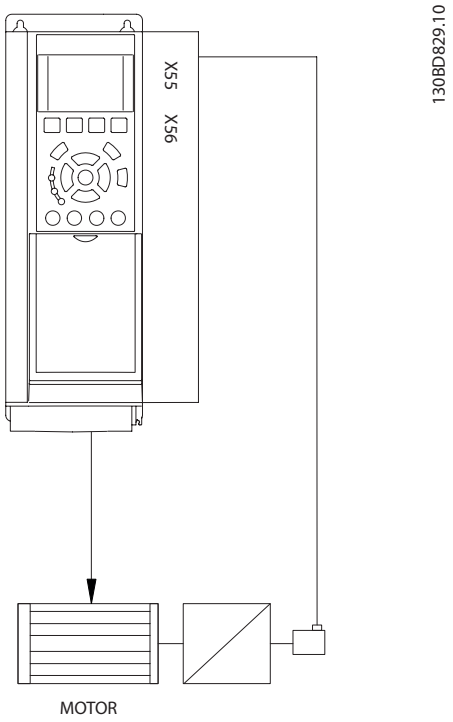
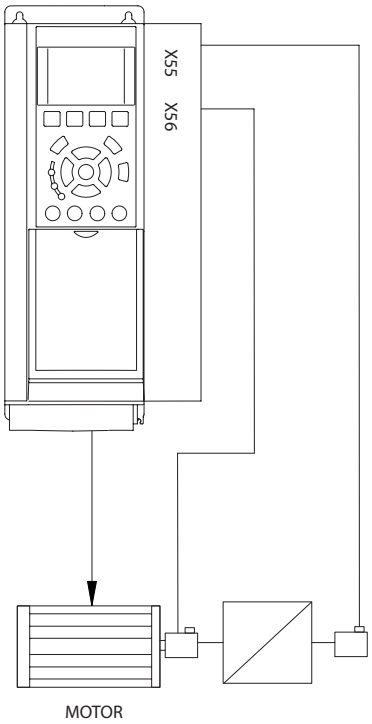


Illustration 4.13 Encoder Mounted on the Gear Box

Example 3

Encoder connected to X55 for positioning loop. Since the encoder is not mounted directly on the motor shaft, a 2nd encoder connection (X56) is needed for running closed FC speed control loop.

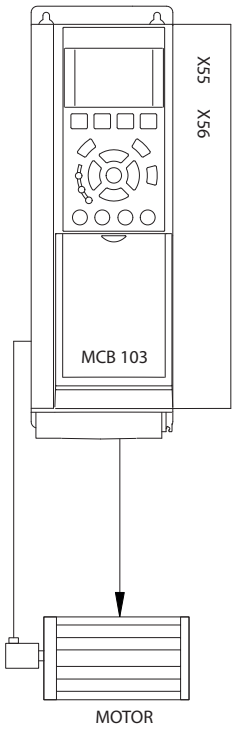


130BD830.10

Illustration 4.14 Encoders Mounted on the Motor and the Gear Box

Example 4

Resolver feedback used. MCB 103 option is needed. FC speed control loop must be closed.



130BD831.10

Illustration 4.15 Resolver Mounted on the Motor

4

4.6 Fieldbus Interface

4.6.1 Introduction

This section is only relevant if the frequency converter is equipped with a fieldbus interface (option) as well as the positioning controller.

The positioning controller is controlled via the digital/analog inputs or via fieldbus. Select the control source in parameter *19-04 Control Source*. There can only be 1 control source at a time, meaning that the digital/analog inputs are inactive when fieldbus is selected as control source and vice-versa. The only exceptions are listed in *Table 4.5*. In fieldbus mode, it is possible to specify the target position and velocity. If the acceleration and deceleration PCDs are left blank, the values for acceleration and deceleration from index 1 are used.

4.6.2 Data Layout

Control and status signals are transferred via the so-called process data channel (PCD) of the various fieldbus interfaces. The telegram structure and the available number of data words depends on the fieldbus used. Refer to the manual of the fieldbus option in use for further details. The example in *Illustration 4.16* is based on the layout of a Profibus telegram, the so-called PPO:

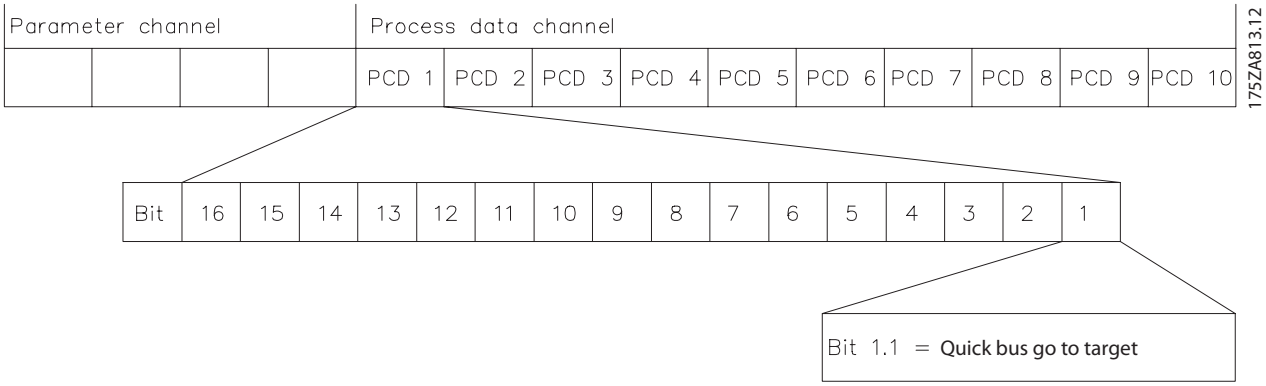


Illustration 4.16 Example using PROFIBUS PPO Type 5

Fieldbus control signals (inputs)

Fieldbus [word.bit]	Fieldbus mode	Corresponding input
1.1	Quick bus go to target (high)	N/A
1.2	Reset error (high)	27
1.3	Go to home position (high)	9
1.4	Read new trajectory index (high)	10
1.5	Start index positioning (high)/Stop index positioning (manual mode activated) (low)	5
1.6	Reset home status (high)	6
1.7	Reset touch probe position (high)	7
1.8	Quick stop (low)	8
1.9	Positive jog (high)	53
1.10	Negative jog (high)	54
1.11	Quick bus type absolute (high)	N/A
1.12	Quick bus type relative (high)	N/A
1.13	Quick bus type touch probe positive (high)	N/A
1.14	Quick bus type touch probe negative (high)	N/A
1.15	Teach in (via LCP or fieldbus) (high)	[Back] and [Cancel] on the LCP
1.16	Change sign on quick bus target position (high)	N/A
2	Quick bus target position (MSB)	N/A
3	Quick bus target position (LSB)	N/A
4	Quick bus target velocity	N/A
5	Quick bus target acceleration	N/A
6	Quick Bus target deceleration	N/A
7.1	Reference index bit 0	18
7.2	Reference index bit 1	19
7.3	Reference index bit 2	33
7.4	Reference index bit 3	32
7.5	Reference index bit 4	29
7.6	Reference index bit 5	N/A

Table 4.5 Fieldbus Control Signals (Inputs)

4

Fieldbus control signals (outputs)

Fieldbus [word.bit]	Fieldbus mode	Corresponding output/parameter
1.1	Homing done (high)	1
1.2	Referenced position reached (high)	2
1.3	Error occurred (high)	3
1.4	Electro-mechanical brake closed (high)	04
1.5	Touch probe position locked (high)	N/A
1.6	Watchdog output (toggling)	N/A
1.7	Positive hardware limit (high)	N/A
1.8	Negative hardware limit (high)	N/A
2.1	Current index bit 0	4
2.2	Current index bit 1	5
2.3	Current index bit 2	6
2.4	Current index bit 3	7
2.5	Current index bit 4	8
2.6	Current index bit 5	N/A
3	Actual position (high word)	Parameter *34-50 Actual Position* (high word)
4	Actual position (low word)	Parameter *34-50 Actual Position* (low word)
5	Error status	*19-93 Error Status*

Table 4.6 Fieldbus Control Signals (Outputs)

5 Commissioning

5.1 Safety Instructions

Refer to the safety warnings in *chapter 2 Safety* before commissioning.

5.2 Basic Parameters Set-up

VLT Parameter Groups

- Parameter 1-** Motor data, open or closed loop, AMA
- Parameter 2-** Dynamic brake
- Parameter 3-** Reference range and limits, Ramps
- Parameter 4-** Speed limits, Torque limits
- Parameter 7-** If using the Drive speed closed loop, tune it before MCO PID

MCO Basic Parameters

- Parameter 32-0* Encoder2 (feedback) set-up type and resolution
- Parameter 32-3* Encoder1 (if used) set-up type and resolution
- Parameter 32-6* Set PID values
- Parameter 32-8* Maximum velocity, Ramps

5.3 Basic Set-up

Refer to the safety warnings in *chapter 2 Safety* before commissioning.

For information on applying power and operation of the LCP, refer to the *VLT® AutomationDrive FC 301/FC 302 Operating Instructions*.

1. Check the motor connection. Control the brake externally from the option until set-up is finished, because the mechanical brake control cannot be guaranteed during this basic set-up. Also ensure that the motor can rotate freely without causing damage or injury.
2. Remove all signals to inputs. Only Input 27 (coast), I8 (Qstop), I3 (Negative HW limit) and I2 (Positive HW limit) must be connected and high.
3. Select *Off* Mode
4. Run the Quick Set-up with the correct motor data.
5. Go to *Hand on* mode and set the frequency for a low positive value, for example +3 Hz in the reference value. The motor should now rotate.
6. If the motor rotates in the wrong (negative) direction, exchange the motor phases.
7. Set the parameters for feedback encoder in parameter group *32-0* Encoder 2 parameters* and, if needed, parameters for encoder in parameter group *32-3* Encoder 1 parameters*.

   7a **For incremental encoder:**
   Set parameter *32-00 Incremental Signal Type* to the type needed. Set the resolution of the encoder in parameter *32-01 Incremental Resolution*. Set parameter *32-00 Incremental Signal Type*.

   7b **For absolute encoder:**
   Set parameter *32-00 Incremental Signal Type* to [0]. Set parameter *32-02 Absolute Protocol* to the encoder type used and *32-03 Absolute Resolution* to the encoder resolution. Set the data bit and clock settings for the absolute encoder from parameter *32-05 Absolute Encoder Data Length* to *32-08 Absolute Encoder Cable Length*.
8. Press the [Status] button on the LCP. Now the *RPM* and *Actual Position* values appear in the upper line of the display.
9. Optimise the PID controller(s).

5.4 PID Settings

Calculate Feed forward velocity (FFVEL – *32-65 Velocity Feed Forward*)

$$FFVEL = \frac{62914560000}{MaxVelEnc \times EncRes \times Tsample}$$

- FFVEL = *32-65 Velocity Feed Forward*
- MaxVelEnc = parameter *32-80 Maximum Velocity (Encoder)*
- EncRes = Encoder resolution
  - For incremental and sinusoidal encoders: EncRes = 4 x (*32-01 Incremental Resolution*)
  - For CAN encoders: EncRes = 1 x (parameter *32-01 Incremental Resolution*)
  - For absolute encoders: EncRes = *32-03 Absolute Resolution*
- Tsample = PID sampling time (*32-69 Sampling Time for PID Control*)

Use parameter *19-19 FFVEL Auto-calculation* to specify if the calculation should be made automatically. This is only possible when encoder and speed parameters have been set.

Setting of PID:

32-60 Proportional factor ≈ FFVEL/50

32-61 Derivative factor ≈ FFVEL/10

32-62 Integral factor = 5

5.5 Description of Application Parameters

5.5.1 19-** Application Parameters

The 19-** parameters configure the MCO 351 Positioning Controller specific application software. The other parameters configure the underlying MCO firmware.

19-00 Control Mode

Option:		Function:
[0] *	MCO control	The motor is controlled by MCO.
[1]	VLT control	The motor is controlled by VLT and not by MCO. Manual running is possible. Note that the standard controller functions, for example, limit switches and other safety-related functions, are not active.

19-01 Endless Positioning

Option:		Function:
[0] *	Limited	The positioning is performed in a limited position range without position overflow.
[1]	Endless	The positioning is performed continuously in 1 direction. Also remember to set parameters *19-08 Power Recovery*, *33-43 Negative Software End Limit Active*, and *33-44 Positive Software End Limit Active* to [0].

19-02 Block Direction

Option:		Function:
[0] *	No blocking	The motor is enabled to move in both directions.
[1]	Block reverse	Defined as an error situation ("Reverse operation prohibited" – ERROR STATUS = 12) if the motor is moving in reverse direction.
[2]	Block forward	Defined as an error situation ("Forward operation prohibited" – ERROR STATUS = 13) if the motor is moving in forward direction.

19-03 Touch Probe Delay

Range:		Function:
0	[1–100000 ms]	This parameter enables compensation for any fixed delay in the touch probe.

19-04 Control Source

Option:		Function:
[0] *	Digital I/O	The positioning is controlled via digital inputs.
[1]	Fieldbus	The positioning is controlled via fieldbus.

19-05 User Actual Position Setting

Range:		Function:
0	[–1073741824 to 1073741824]	At power-up, if parameter *33-00 Force Home* is set to *[0] Home not forced*, the actual position is equal to the value set here.

19-06 Error Behaviour

Option:		Function:
[0] *	Electronic brake	This parameter determines the behaviour of the motor after an error is detected. The motor ramps down to standstill with the shortest possible ramp (parameter *32-81*). After achieving standstill it activates the electronic brake according to the setting of parameter *19-10 Coast Delay*. If the motor is coasted at any point during ramp down (for example, due to an overcurrent trip), the motor immediately activates the brake and coasts the motor.
[1]	Mechanical brake	The motor immediately activates the brake and coasts the motor.

NOTICE

The brake is always activated after an error situation (or quick stop), regardless of the setting in parameter *19-09 Automatic Brake Control*.

19-07 Error Reset

Option:		Function:
[0] *	No reset	No error reset.
[1]	Reset error	By selecting this option, it is possible to clear the error flag (if the reason for the error is not still present). The parameter automatically resets to *[0] No reset* when the error is successfully cleared.

19-08 Power-Recovery

Option:		Function:
[0]	Disabled	When the power recovery function is disabled (set to [0]), it is not possible to drive the application by any means (neither jogging nor positioning) as long as the application is outside the HW or SW limits. The only way to recover from this situation is to move the application by hand.
[1] *	Enabled	When the power recovery function is enabled (set to [1]), it is possible to make a partial reset of the limit error (ERROR STATUS = 2/3/4/5), whereby it is possible to use the jogging function to drive the application out of the HW or SW limit area. It is not possible to drive the application with homing, positioning, or jogging (in the wrong direction), as long as the application is still within the HW or SW limit area. The *error occurred* output remains high to indicate that these restrictions are in effect. As soon as the application is moved

19-08 Power-Recovery

Option:		Function:
		outside the HW or SW limit area, the error is automatically cleared and the *error occurred* signal goes low to indicate that normal operation is restored.

19-09 Automatic Brake Control

Option:		Function:
[0]	Disabled	When the automatic brake control function is disabled (set to [0]), the frequency converter control loop is active, even at standstill.
[1] *	Enabled	When the automatic brake control function is enabled (set to [1]), the electromechanical brake is automatically activated every time the application has been at standstill for a time period specified in parameter *19-12 Hold Delay*. This is especially useful in hoist applications where the motor could overheat if it has to deliver full torque at standstill for a prolonged period.

19-10 Coast Delay

Range:		Function:
200 ms	[0–1000 ms]	Used with the automatic brake control function. The coast delay is the delay after activating the electro-mechanical brake before disabling the controller and coasting the motor. Useful in hoisting applications where the load would otherwise drop a little after each stop. This is because the activation of the brake is slower than the deactivation of the motor.

19-11 Brake Delay

Range:		Function:
200 ms	[0–1000 ms]	Used with the automatic brake control function. The brake delay is the delay after activating the control and magnetising the motor, before the brake is deactivated. Useful in applications with (typically large) motors that take a longer time to be fully magnetised than the time it takes for the electro-mechanical brake to deactivate.

19-12 Hold Delay

Range:		Function:
0 s	[0–10000 s]	Used with the automatic brake control function. The hold delay is a waiting period in which the brake is not activated, even though the application is at standstill. Useful in applications where a sequence of fast positioning commands is followed by longer standstill periods.

19-13 Brake Wear Limit

Range:		Function:
0	[0–1073741824 UU]	If a value higher than [0] (disabled) is set, the motor defines an error situation (*Brake wear limit exceeded* – ERROR STATUS = 7) if the drive moves more than the number of user units (UU) specified in this parameter while the electronic brake is activated.

19-14 Motor/Encoder Gear Numerator

Range:		Function:
1	[1–100000]	If the encoder is mounted on a gear where 5 revolutions of the motor correspond to 2 revolutions of the encoder, this parameter should be set to [5] (the number of motor revolutions) and parameter *19-15 Motor/Encoder Gear Denominator* should be set to [2] (the number of encoder revolutions). If the encoder is mounted directly on the motor shaft, this parameter setting should remain at [1].

19-15 Motor/Encoder Gear Denominator

Range:		Function:
1	[1–100000]	See the description of parameter *19-14 Motor/Encoder Gear Numerator*. If the encoder is mounted directly on the motor shaft, this parameter setting should remain at [1].

19-16 Maximum Jog Velocity

Range:		Function:
100 ERPM	[1–20000 ERPM]	The maximum speed allowed while jogging the application is specified in terms of Encoder Revolutions Per Minute (ERPM).

NOTICE

This setting must never exceed a value that is approximately 5% lower than the value in parameter *32-80 Maximum Velocity (Encoder)*.

19-17 Jog Ramp Time

Range:		Function:
5000 ms	[10–100000 ms]	This parameter specifies the ramp-up time and the ramp-down time used during jogging. The ramp time is defined as the time in milliseconds it would take to ramp from standstill to the maximum allowed velocity in parameter *32-80 Maximum Velocity (Encoder)*.

19-18 Jog Velocity Scaling

Option:		Function:
[0] *	No scaling	The jog velocity is defined in encoder revolutions per minute (ERPM).
[1]	Scaling	The jog velocity is scaled by Motor/Encoder Gear Numerator/Gear Denominator.

5

5

19-19 FFVEL Auto-calculation

Option:		Function:
[0] *	Disabled	Automatic calculation is disabled for both velocity feed forward (FFVEL) and velocity control loop (PID).
[1]	FFVEL enabled	The optimal setting of parameter velocity feed forward is calculated automatically. This parameter automatically resets to *[0] Disabled* when the calculation is complete.
[2]	FFVEL + PID enabled	The optimal setting of parameter velocity feed forward, proportional, derivative, and integral factor is calculated automatically. This parameter automatically resets to *[0] Disabled* when the calculation is complete. Parameter *32-80 Maximum Velocity* Parameter *32-00* OR *32-02 Encoder type* Parameter *32-01* OR *32-03 Encoder resolution* Parameter *19-14 motor/encoder gear ratio numerator* Parameter *19-15 motor/encoder gear ratio denominator*

NOTICE

A change to any one of these parameters prompts a recalculation, since the optimum value of the regulation parameters has changed.

19-20 Factory Reset

Option:		Function:
[0] *	Disabled	No parameters reset.
[1]	Enabled	Resets all parameter values to default and also resets all trajectory data. The parameter automatically resets to *[0] Disabled* when the reset is successfully carried out.

19-21 Link LCP Input to Index

Option:		Function:
[0] *	Disabled	Disables the automatic update of parameter *19-23 Index Number*. This is necessary when programming a position number different from the one loaded into the PLC memory.
[1]	Enabled	Parameter *19-23 Index Number* is automatically updated with the last position reference number that has been loaded into memory. This enables the operator to see what position reference is given by the PLC system.

19-23 Index Number

Range:		Function:
0	[0–31 (0–63 in fieldbus mode)]	Specifies which position data should be displayed in parameters *19-24 Index Target Position* to *19-28 Index Trajectory Type*. Whenever this number is changed, the current values of the index parameters are stored in the memory under the previously specified index number. After that, the values of the index parameters are updated with the data stored in the memory relevant to the newly specified index number.

19-24 Index Target Position

Range:		Function:
0	[–1073741824 to 1073741824 UU]	The meaning of this parameter depends on the position type specified in parameter *19-28 Trajectory Type*. If parameter *19-28 Index Trajectory Type = [0] Absolute*, the value of this parameter refers to an absolute position (relative to the fixed *Home* position). If parameter *19-28 Index Trajectory Type = [1] Relative*, and the last position was obtained through jogging, the value of this parameter is a position relative to that position. If the last position was reached as a result of a positioning command, then the value of this parameter specifies a position relative to the last target position (whether it was reached or not). If parameter *19-28 Index Trajectory Type = [2] Touch probe positive*, the application moves in the positive direction until a touch probe position is defined. If a touch probe position is already defined, the application moves directly to that position. A touch probe position is defined as the position at which the *touch probe switch* input goes high plus the value of parameter *19-24 Index Target Position*. A touch probe position is cleared by a high signal on the *reset touch probe position* input. The output *Touch probe position locked* is high if a touch probe position is defined. If parameter *19-28 Trajectory Type = [3] Touch probe negative*, the application moves in a negative direction until a touch probe position is defined. If a touch probe position is already defined, the application moves directly to that position.

NOTICE

This parameter is automatically updated depending on parameter *19-23 Index Number*.

19-25 Index Ramp Up Time

Range:		Function:
5000	[10–100000 ms]	The index ramp-up time is defined as the time in milliseconds it would take to ramp from standstill to the maximum allowed velocity set in parameter *32-80 Maximum Velocity (Encoder)*. This setting is relevant during positioning with the current trajectory index.

NOTICE

This parameter is automatically updated depending on parameter *19-23 Index Number*.

19-26 Index Ramp Down Time

Range:		Function:
5000	[10–100000 ms]	The index ramp-down time is defined as the time in milliseconds it would take to ramp from the maximum allowed velocity set in parameter *32-80 Maximum Velocity (Encoder)* to standstill. This setting is relevant during positioning with the current trajectory index.

NOTICE

This parameter is automatically updated depending on parameter *19-23 Index Number*.

19-27 Index Maximum Velocity

Range:		Function:
100 ERPM	[1–20000 ERPM]	The index maximum velocity is defined as the velocity in encoder revolutions per minute (ERPM). This setting is relevant during positioning with the current trajectory index.

NOTICE

This parameter is automatically updated depending on parameter *19-23 Index Number*. The setting should never exceed a value that is approximately 5% lower than the value calculated in parameter *32-80 Maximum Velocity (Encoder)*.

19-28 Index Trajectory Type

Option:		Function:
[0] *	Absolute	Positioning is absolute, related to the *Home* position.
[1]	Relative	Positioning is relative to the last target position, whether it was reached or not. When jogging was executed previously, positioning is relative to the position reached via jogging.
[2]	Touch probe positive	Positioning is relative to a touch probe position expected in positive direction.
[3]	Touch probe negative	Positioning is relative to a touch probe position expected in negative direction.

Also see parameter *19-24 Index Target Position*.

NOTICE

This parameter is automatically updated depending on parameter *19-23 Index Number*.

19-29 Parameter Save

Option:		Function:
[0] *	No action	No trajectory data saved. Trajectory data are not automatically saved and are therefore not automatically available after power-cycle.
[1]	Save persistent	Saves trajectory data persistent and parameters too. This parameter automatically resets to [0] when the data is saved successfully.

19-30 Main Screen Setup Save

Option:		Function:
[0] *	No action	Main screen set-up is not saved persistent. The main screen set-up is not automatically saved and is therefore not automatically available after a power-cycle.
[1]	Save persistent	Saves main screen set-up persistent. This parameter automatically resets to *[0] No action* when the main screen set-up is saved successfully.

19-31 Digital Jog in Field Bus mode

Option:		Function:
[0] *		Off
[1]		Activates jog with digital inputs (53, 54), also in field bus mode.

19-90 Type/Version

Range:	Function:
[351xxyy]	The text in this parameter shows the MCO product type/software version.

19-91 Software Version

Range:	Function:
[xxyy]	The text in this parameter shows the software version number (xx = major version code, yy = minor version code).

19-92 New Index

Range:		Function:
0	[0–31 (0–63 in fieldbus mode)]	Currently latched index number.

19-93 Error Status

Option:		Function:
[0] *	0 = OK 1 = Homing needed 2 = Positive HW limit 3 = Negative HW limit 4 = Positive SW limit 5 = Negative SW limit 6 = VLT not running 7 = Brake wear limit 8 = Quick stop 9 = PID error too big 12 = Reverse operation 13 = Forward operation 92 = Encoder hardware error	This is a read-only parameter. It displays the current fault code.

5.6 MCO Basic Settings

5.6.1 32-0* and 32-1*, Encoder 2 Parameters

The 32-0* and 32-1* parameters configure the interface for encoder 2.

32-00 Incremental Signal Type (0x1234) Slave Denominator (Subindex 02)

This parameter specifies the type of incremental encoder connection to *Encoder 2 interface* (X55 and X62 if a CAN encoder is used).

Option:		Function:
[0]	None	No incremental encoder is used.
[1] *	RS422 (5 V TTL)	Digital incremental encoder with an interface according to RS422 is connected.
[2]	Sinusoidal 1 Vpp	Analog incremental encoder with 1 V peak-peak signal is connected.
[3]	CAN encoder	CAN encoder is used.

32-01 Incremental Resolution

Range:		Function:
1024*	[1073741823]	The encoder resolution is used to calculate velocity in RPM (revolutions per minute) as well as time-out for detection of the zero pulse with homing. Set the resolution of the incremental encoder connected to *Encoder 2 interface* (X55 and X62 if a CAN encoder is used). The encoder resolution can be found on the encoder nameplate or datasheet. If parameter *32-00 Incremental Signal Type* is set to: • *[0] Digital incremental encoder*, the resolution must be set in pulses per revolution. • *[1] Analog incremental encoder*, the resolution must be set in sinusoidal signal periods per revolution. • *[2] CAN encoder* and the CAN encoder is an incremental encoder, the resolution must be set in pulses per revolution. If the CAN encoder is an absolute encoder, the resolution must be set in (pulses per revolution)/4.

NOTICE

The parameters for the incremental resolution (*32-01* or *32-31*) are always used, even if the CAN encoder is an absolute encoder. But a quarter of the encoder resolution must be set for a CAN absolute encoder. The reason is the internal calculation, which uses 4 times the number of counts, because an incremental encoder returns 4 times more quad counts than its counts. An absolute encoder only returns this real resolution as a maximum value.

NOTICE

When *[3] Motor Control* is selected in parameter *32-50 Source Slave*, the resolution can be set with this parameter. The resolution value must be a second power, otherwise rounding errors lead to positioning drifts. The maximum frequency of the encoder signal must not exceed 410 kHz. The parameter is only visible when parameter *32-00 Incremental Signal Type* is not set to *[0] None*.

32-02 Absolute Protocol

This parameter specifies the type of absolute encoder connected to *Encoder 2 interface* (X55 and X62 if a CAN encoder is used).

Option:		Function:
[0] *	None	No absolute encoder is connected.
[1]	HIPERFACE	HIPERFACE absolute encoder is connected. The selection includes the default settings encoder ID *1* and encoder parity *even*.
[4]	SSI	An absolute encoder with SSI interface is connected
[5]	SSI with filter	An absolute encoder with SSI interface is connected and the communication/ signal is unstable.

A leap in the position data is detected if it is larger than the encoder resolution/2. The correction is made with an artificial position value, which is calculated from the last velocity. If the error continues for more than 100 readouts (>100 ms), there is no further correction, which then leads to a position error (error 108).

32-03 Absolute Resolution

Range:		Function:
8192*	[1 to 1073741823]	The encoder resolution is used to calculate the velocity in RPM (revolutions per minute). Set the resolution of the absolute encoder connected to *Encoder 2 interface* (X55/X62) in positions per revolution. The encoder resolution can be found on the encoder nameplate or datasheet.

5

NOTICE

The parameter is only visible when parameter *32-02 Absolute Protocol* is not set to *[0] None*.

32-04 Absolute Encoder Baudrate X55

Select the baud rate of the attached encoder.

Option:		Function:
[0]	600	Baud
[1]	1200	
[2]	2400	
[3]	4800	
[4] *	9600	
[5]	19200	
[6]	38400	

32-05 Absolute Encoder Data Length

Range:		Function:
25*	[8-37 Bit]	Specify the number of data bits for the connected absolute encoder, see encoder datasheet. This is required for the MCO to generate the correct number of clock bits.

NOTICE

The parameter is only visible when parameter *32-02 Absolute Protocol* is not set to *[0] None*.

32-06 Absolute Encoder Clock Frequency

Range:		Function:
262.000*	[78.124–2000.000 kHz]	Specifies the frequency of the absolute encoder clock signal generated by the MCO. Set a frequency appropriate for the connected encoder.

NOTICE

This parameter is only visible when parameter *32-02 Absolute Protocol* is not set to *[0] None*.

32-07 Absolute Encoder Clock Generation

Select whether the MCO should generate an absolute encoder clock signal or not.

Option:		Function:
[0]	Off	Select this option if more MCOs are connected to the same absolute encoder and another MCO generates the clock signal. Only 1 device is allowed to generate the clock signal and only 1 device (encoder or MCO) is allowed to generate the data signal when multiple MCOs are interconnected.
[1] *	On	Select this option if the MCO is the only clock generator for the connected absolute encoder.

NOTICE

This parameter is only visible when parameter *32-02 Absolute Protocol* is not set to [0].

32-08 Absolute Encoder Cable Length

Range:		Function:
0*	[0-300 m]	The absolute encoder (SSI) clock and data signals will be out of synchronisation if the signal delay caused by the encoder cable is too long. The MCO automatically compensates the cable delay when the cable length is known. The cable delay compensation is based on a cable delay of approximately 6 ns (6×10^{-9} seconds) per meter. Specify the total cable length (in meters) between the MCO and the absolute encoder.

NOTICE

This parameter is only visible when parameter *32-02 Absolute Protocol* is not set to *[0] None*.

32-09 Encoder Monitoring

Monitoring of open-circuit and short-circuit of the encoder inputs can be enabled or disabled.

An encoder error issues fault code 192.

Option:		Function:
[0] *	Off	Hardware monitoring is not required.
[1]	3 channels	All 3 channels (A, B, and Index) are monitored.
[2]	2 channels	Channels A and B are monitored.

32-10 Rotational Direction

Normally, a positive reference value initiates a positive change of the position. If not, the reference value can be reversed internally.

Option:		Function:
[1] *	No action	No change. Positive reference values produce positive encoder values.
[2]	Reference reversed	The sign of the reference value is reversed internally (plus becomes minus and vice-versa). This is equal to a reversal of the motor cables, or a transposition of the A and B tracks on the encoder.
[3]	User Units reversed (–1)	The sign of the user unit is reversed. Thus, positive reference values produce positive encoder values which are indicated as negative values, however. This applies to all outputs (parameters *34-50 Actual Position*, *34-51 Commanded Position*, …), all user inputs (parameter *19-24 Index Target Position*, …), and all synchronization factors, as well as the velocities (parameter *33-03 Velocity of Home Motion*).

32-10 Rotational Direction

Normally, a positive reference value initiates a positive change of the position. If not, the reference value can be reversed internally.

Option:		Function:
[4]	User Units and Reference reversed (–2)	The sign of the reference value is reversed internally; in addition, the sign of the user unit is negated as in option [3].

32-11 User Unit Denominator

Range:		Function:
1*	[1 to 1073741823]	All path information in motion commands is made in user units and are converted to quad-counts internally. By selecting these scaling units correspondingly, it is possible to work with any technical measurement unit (for example mm). This factor is a fraction, which consists of a numerator and denominator. $1\ UU = \frac{P32\text{–}12\ User\ Unit\ Numerator}{P32\text{–}11\ User\ Unit\ Denominator}$ Scaling determines how many quad-counts make up a user unit. For example, if it is 50375/1000, then 1 UU corresponds to exactly 50.375 qc.

32-12 User Unit Numerator

Range:		Function:
1*	[1 to 10737418237/ max. position (UU)]	All path information in motion commands is made in user units and is converted to quad-counts internally. By selecting these scaling units correspondingly, it is possible to work with any technical measurement unit (for example mm). This factor is a fraction, which consists of a numerator and denominator. $1\ UU = \frac{P32\text{–}12\ User\ Unit\ Numerator}{P32\text{–}11\ User\ Unit\ Denominator}$ Scaling determines how many quad-counts make up a user unit. **Example 1** *Shaft or spindle* 25 motor revolutions result in 1 spindle revolution; gearing factor = 25/1 Encoder resolution (incremental encoder) = 500 Spindle gradient = 1 revolution of the spindle = 5 mm Scaling factor when working with 1/10 mm resolution = 5 x 10 = 50 $\frac{25}{1} \times \frac{500 \times 4}{50}\ qc = \frac{25 \times 10 \times 4}{1}\ qc = \frac{1000}{1}\ qc = 1\ UU$ 130BD771.10 **Illustration 5.1 Example 1** Parameter *32-12 User Unit Numerator* = 1000

32-12 User Unit Numerator

Range:		Function:
		Parameter *32-11 User Unit Denominator* = 1 **Example 2** *Cylinder* Gear factor = 5/1 Encoder resolution (incremental encoder) = 500 One revolution of the cylinder is 360 degrees. Work with a resolution of 1/10 degrees, which means that 1 revolution of the cylinder is divided into 3600 units. Scaling factor = 3600 $\frac{5}{1} \times \frac{500 \times 4}{3600}\ qc = \frac{5 \times 500 \times 4}{3600}\ qc = 1\ UU$ 130BD772.10 $\frac{25}{9}\ qc = 1\ UU = \frac{Parameter\ 32\text{-}12\ User\ Unit\ Numerator}{Parameter\ 32\text{-}11\ User\ Unit\ Denominator}$ **Illustration 5.2 Example 2** Parameter *32-12 User Unit Numerator* = 25 Parameter *32-11 User Unit Denominator* = 9

32-14 Encoder 2 node ID

Range:		Function:
127*	[1-127]	Enter the feedback CAN encoder node ID.

32-15 Encoder 2 CAN Guard

Feedback CAN encoder guardians can be enabled or disabled.

Option:		Function:
[0] *	Off	Default setting. No monitoring.
[1]	On	Feedback CAN encoder is monitored.

5.6.2 32-3* and 32-4*, Encoder 1 Parameters

The 32-3* and 32-4* parameters configure the interface for encoder 1.

32-30 Incremental Signal Type

Specifies the type of incremental encoder connected to *Encoder 1 interface* (X56 and X62 if a CAN encoder is used).

Option:		Function:
[0]	None	No incremental encoder is connected.
[1] *	RS422 (5 V TTL)	A digital incremental encoder with an interface according to RS-422 is connected.
[3]	CAN encoder	An encoder with a CAN interface is connected.

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32-31 Incremental Resolution

Range:		Function:
1024*	[1 to 1073741823]	Set the resolution of the incremental encoder connected to *Encoder 1 interface* (X56). The encoder resolution can be found on the encoder nameplate or datasheet. • Digital incremental encoder (parameter *32-30* = [1]): The resolution must be set in pulses per revolution. • CAN encoder (parameter *32-30* = [3]): - Incremental encoder: Pulses per revolution - Absolute encoder: Pulses per revolution/4

NOTICE

The parameters for the incremental resolution (*32-01* or *32-31*) are always used, even if the CAN encoder is an absolute encoder. However, a quarter of the encoder resolution must be set for a CAN absolute encoder.
The maximum frequency of the encoder signal must not exceed 410 kHz.
This parameter is only visible when parameter *32-30* is not set to *[0] None*.

32-32 Absolute Protocol

Specifies the type of absolute encoder connected to *Encoder 1 interface* (X56/X62).

Option:		Function:
[0] *	None	No absolute encoder is connected.
[4]	SSI	An absolute encoder with SSI interface is connected.
[5]	SSI with filter	An absolute encoder with SSI interface is connected and the communication/signal is unstable.

32-33 Absolute Resolution

Range:		Function:
8192*	[1 to 1073741823]	This parameter is only visible when parameter *32-32 Absolute Protocol* is not set to *[0] None*.

32-34 Absolute Encoder Baudrate X56

Select the baud rate of the attached encoder.

Option:		Function:
[0]	600	Baud
[1]	1200	Baud
[2]	2400	Baud
[3]	4800	Baud
[4] *	9600	Baud
[5]	19200	Baud
[6]	38400	Baud

32-35 Absolute Encoder Data Length

Range:		Function:
25*	[8-37 Bit]	Specifies the number of data bits for the connected absolute encoder, see encoder datasheet. This is required for the MCO to generate the correct number of clock bits.

NOTICE

The parameter is only visible when parameter *32-32 Absolute Protocol* is not set to *[0] None*.

32-36 Absolute Encoder Clock Frequency

Range:		Function:
262.000*	[78.125–2000.000 kHz]	Specifies the frequency of the absolute encoder clock signal generated by the MCO. Set a frequency appropriate for the connected encoder.

NOTICE

The parameter is only visible when parameter *32-32 Absolute Protocol* is not set to *[0] None*.

32-37 Absolute Encoder Clock Generation

Select whether the MCO should generate an absolute encoder clock signal or not.

Option:		Function:
[0]	Off	Select this option if more MCOs are connected to the same absolute encoder and another MCO generates the clock signal. Only 1 device is allowed to generate the clock signal and only 1 device (encoder or MCO) is allowed to generate the data signal when multiple MCOs are interconnected.
[1] *	On	Select this option if the MCO is the only clock generator for the connected absolute encoder.

NOTICE

This parameter is only visible when parameter *32-32 Absolute Protocol* is not set to *[0] None*.

32-38 Absolute Encoder Cable Length

Range:		Function:
0*	[0–300 m]	The absolute encoder (SSI) clock and data signals will be out of synchronisation if the signal delay caused by the encoder cable is too long. The MCO automatically compensates the cable delay when the cable length is known. The cable delay compensation is based on a cable delay of approximately 6 ns (6 x 10^{-9} seconds) per meter. Specify the total cable length (in meters) between the MCO and the absolute encoder.

NOTICE

This parameter is only visible when parameter *32-32 Absolute Protocol* is not set to *[0] None*.

32-39 Encoder Monitoring

Monitoring of open-circuit and short-circuit of the encoder inputs can be enabled or disabled.
An encoder error issues fault code 192.

Option:		Function:
[0] *	Off	Hardware monitoring is not required.
[1]	3 channels	All 3 channels (A, B, and Index) are monitored.
[2]	2 channels	Channels A and B are monitored.

32-40 Encoder Termination

Termination resistors can be switched on or off for encoder 1.

Option:		Function:
[0]	Off	Select this option if high input impedance is required when 1 encoder is connected to multiple MCOs.
[1] *	On	Select this option when the encoder is only connected to this MCO.

32-43 Encoder 1 Control

The encoder control word configures the position evaluation after a change of encoder source. Soft encoder changing is useful if encoders should be switched while running. If this is done without using this parameter, then setting the new encoder typically causes a position error because the encoder values are not the same.

Option:		Function:
[0] *	No soft changing	Select this option to switch directly to the position data of the new encoder.
[1]	Encoder soft changing enable	Select this option to not switch entirely to the value of the new encoder. Instead, the old value is kept and the differences from the new encoder are added. This makes it possible to change encoders “on the run”.

32-43 Encoder 1 Control

The encoder control word configures the position evaluation after a change of encoder source. Soft encoder changing is useful if encoders should be switched while running. If this is done without using this parameter, then setting the new encoder typically causes a position error because the encoder values are not the same.

Option:		Function:
[2]	Soft zero setting enable	Select this option if it is not desired to really change the encoder value when homing is carried out. If the soft zero setting is on, then homing can be carried out and the new reported actual position is [0] afterwards.
[3]	Encoder soft changing and soft zero enable	This option enables the smooth changing of the feedback encoder in the software while running, and setting the position to [0] without losing the actual position.

32-44 Encoder 1 node ID

Range:		Function:
127*	[1–127]	Enter the CAN encoder node ID.

32-45 Encoder 1 CAN Guard

CAN encoder guardians can be enabled or disabled.

Option:		Function:
[0] *	Off	Default setting. No monitoring.
[1]	On	CAN encoder is monitored.

5.6.3 32-5* Feedback Source

The 32-5* parameters configure the feedback source.

32-50 Source Slave

Specifies the feedback source for MCO.

Option:		Function:
[1]	Encoder 1 X56	Select this option to use encoder 1 as the feedback source.
[2] *	Encoder 2 X55	Select this option to use encoder 2 as the feedback source.
[3]	Motor Control	Select this option for MCO feedback from the feedback source specified in parameter *1-02 Flux Motor Feedback Source*. This can be an internal 24 V encoder, encoder option, or resolver option. The resolution for *Motor Control* can be set in parameter *32-01 Incremental Resolution*.

32-52 Source Master

Option:		Function:
[1] *	Encoder 1 X56	Source master is encoder 1 on X56.
[2]	Encoder 2 X55	Source master is encoder 2 on X55.
[3]	Motor Control	This source master can be an internal 24 V encoder, encoder option, or resolver option.

5.6.4 32-6* and 32-7*, PID-Controller Parameters

The 32-6* and 32-7* parameters optimise the controller.

32-60 Proportional Factor

Range:		Function:
30*	[0–100000]	The proportional factor indicates the linear correction factor with which the deviation between the current set and actual position is evaluated and a corresponding correction of the motor speed is made. The greater the value, the stiffer the motor behaviour becomes. There is a tendency to overswing if the value is too high.

32-61 Derivative Value for PID Control

Range:		Function:
0*	[0–100000]	The derivative value is the correction factor with which the changing speed of a motor position error is evaluated. The derivative value works against the tendency to overswing due to a high P-share and dampens the system. However, if the derivative value selected is too large, this leads to unstable motor behaviour.

32-62 Integral Factor

Range:		Function:
0*	[0–100000]	The integral factor is the weighting factor with which, at time n, the sum of all motor position errors are evaluated. The integral factor of the PID filter causes a corresponding corrective motor torque, which increases over time. Through the integral share, a static position error is reduced to 0, even if a constant load is affecting the motor. However, an integral factor, which is too large leads to unstable motor behaviour.

32-63 Limit Value for Integral Sum

Range:		Function:
1000*	[0–1000]	0 = integral off. Limits the integral sum to avoid instability and PID wind-up in case of feedback error.

32-64 PID Bandwidth

Range:		Function:
1000*	[0–1000 [1/10%]]	0 = PID off. The value 1000 means that the PID filter can output the full command value. For a Bandwidth of 500, only 50% of the set value is output. Thus, values less than 1000 limit the P-share accordingly. The bandwidth, in which the PID controller should function, can be limited. For example, to avoid the build-up of vibration for a system, which could be jeopardised by vibration. However, it is then necessary to enter considerably higher values for the parameters *32-65 Velocity Feed-Forward* and *32-66 Acceleration Feed-Forward* to achieve the corresponding control. A system adjusted in such a manner is not as dynamic as it could be, but is considerably more stable and experiences less uncontrolled vibration.

32-65 Velocity Feed-Forward

Range:		Function:
0*	[0–100000]	When a control has a limited bandwidth, a base velocity must be set. This rules out that the control entirely prevents the motor from running due to the limit set. This parameter indicates the value with which the velocity forward feed is completed. When working with a normal PID algorithm, the velocity feed-forward must always be the same as the derivative factor to achieve typical dampening derivative.

32-66 Acceleration Feed-Forward

Range:		Function:
0*	[0–100000]	Set the base acceleration whenever the bandwidth is limited. This prevents the control from not accelerating at all due to the limit set. This parameter indicates the value with which the acceleration forward feed is completed. For a normal PID algorithm, this value is equal to 0.

32-67 Maximum Tolerated Position Error

Range:		Function:
20000*	[1 to 1073741823 qc]	Defines the tolerance allowed between the current actual position and the calculated command position. If the defined value is exceeded, the position control is turned off and a position error is triggered. The position error does not affect the positioning accuracy. It determines how precisely the theoretically calculated path of motion must be followed, without an error being triggered. However, to avoid frequent errors, the value must be bigger than the capability of the axis, to follow the position generated by the trajectory generator. As a guideline, it is wise to set the quadruple of encoder counts per

32-67 Maximum Tolerated Position Error

Range:		Function:
		revolution. This corresponds to 1 encoder rotation.

WARNING

UNINTENDED START

The motor can restart unintentionally if the value of this parameter is higher than the acceptable position deviation.

- **Ensure that the value of this parameter is lower than the acceptable position deviation.**

32-68 Reverse Behaviour for Slave

This parameter determines the behaviour while moving in reverse (moving in a negative direction).

Option:		Function:
[0] *	Reversing allowed.	–
[1]	Reversing only allowed when the master is reversed.	–
[2]	Reversing blocked.	–

32-69 Sampling Time for PID Control

Range:		Function:
2*	[1–1000 ms]	Determines the sampling time of the position control algorithm. For example, increase the value of the factory settings as follows: • For very low pulse frequencies, such as 1–2 qc per sampling time: At least 10–20 qc per sampling time are required. • For very slow systems with a long dead time: If 1 ms is used here for control, large motors will vibrate. ***NOTICE*** **This value has a direct effect on the feed-forward calculation. For example, if the value in this parameter is doubled, then the effectiveness of parameter *32-65 Velocity Feed-Forward* is halved.**

32-70 Scan Time for Profile Generator

This parameter sets the sample time for the profile generator, which is independent of the sample time for the PID controller. For demanding background control tasks, the execution time of the application programme may rise drastically. In such cases, the profile generator scan time can be increased to 2. Values higher than 2 ms provide hardly any benefits.

Option:		Function:
[1]	1 ms	–
[2] *	2 ms	–
[3]	3 ms	–
[4]	4 ms	–
[5]	5 ms	–

32-71 Size of the Control Window (Activation)

Range:		Function:
0*	[0 to 1073741823 qc]	The parameters *32-71 Size of the Control Window (Activation)* and *32-72 Size of the Control Window (Deactivation)* are used to turn the position control within defined areas (control windows) on and off. Parameter *32-71 Size of the Control Window (Activation)* indicates the size of the window outside of which the control should restart.

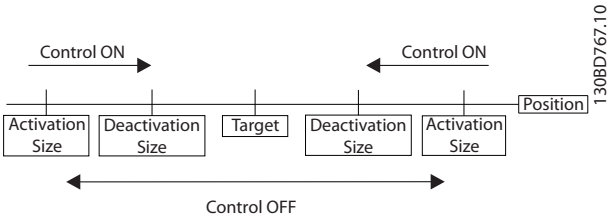

Illustration 5.3 Size of the Control Window

32-72 Size of the Control Window (Deactivation)

Range:		Function:
0*	[0 to 1073741823 qc]	Indicates the size of the window inside of which the control is to be deactivated until parameter *32-71 Size of the Control Window (Activation)* is reached again.

32-73 Integral Limit Filter Time

Range:		Function:
0*	[–10000 to 10000]	Time in ms, which is used to increase or decrease the integral limit of the position control loop up to parameter *32-63 Limit Value for Integral Sum*. The integral part of the PID position control loop can be active all the time, just during a movement, or just at standstill. The value of this parameter determines this behaviour. Using value 0 activates the integral part of the PID position control loop all the time according to parameter *32-62 Integral Factor* and the limitation parameter *32-63 Limit Value for Integral Sum*. Using a value >0 activates the integral part of the PID position control loop just during a motor movement. If the motor is at standstill, the integral part is reduced to 0. If the motor starts to move, the integration limit is increased from 0 to the defined value in *32-63 Limit Value for Integral Sum* within the period of time set in parameter *32-73 Integral Limit Filter Time*. If the motor stops again, the integral part is reduced again by decreasing the limit to 0 within the defined period. This handling of the integral part can be an advantage for synchronisation applications, where

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32-73 Integral Limit Filter Time

Range:		Function:
		low synchronisation errors are requested, but no hard regulation at standstill is desired. Using a value <0 only activates the integral part of the PID position control loop at standstill. If the motor starts to move, the integral part is reduced to 0 by decreasing the integration limit within the period of time given by the absolute value set in parameter *32-73 Integral Limit Filter Time*. If the motor stops again, the integration limit increased from 0 to the value defined in parameter *32-63 Limit Value for Integral Sum* within the defined period of time. This handling of the integral part can be helpful to prevent unstable motor behaviour during a movement, but still ensure an accurate positioning result at standstill. Also see parameters *32-60 Proportional Factor* and *32-61 Derivative Value for PID Control*.

32-74 Position Error Filter Time

Range:		Function:
0*	[0–10000]	Time frame in milliseconds for triggering position error state. Too large tracking errors (parameter *19-93 Error Status* = 9) only trigger an error state if they exist longer than the position error filter time set in this parameter. The default value is [0]. If the value is not [0], then a position error is only produced if the value in parameter *32-67 Maximum Tolerated Position Error* is exceeded for a time longer than the position error filter time.

5.6.5 32-8* Velocity & Acceleration

The 32-8* parameters specify velocity, acceleration, and ramp.

32-80 Maximum Velocity (Encoder)

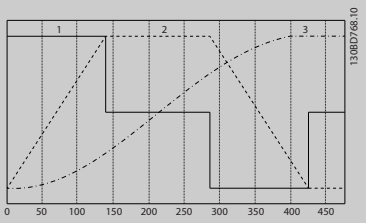
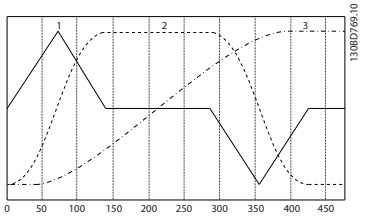
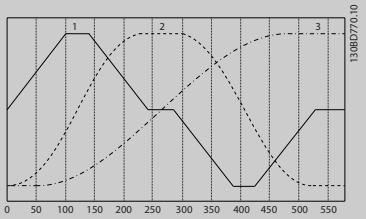
Range:		Function:
1500*	[1–100000 RPM]	This parameter defines the rated speed of the motor. This value is listed in RPM and is needed for the calculation of ramps and actual velocities. The nominal speed refers to the speed of the encoder. For linear encoders, this equals the number of increments per minute divided by the value in parameter *32-01 Incremental Resolution* or *32-03 Absolute Resolution*.

32-81 Shortest Ramp

Range:		Function:
1.000*	[0.001–3600.000 s]	This parameter determines the shortest ramp (maximum acceleration). It indicates the length of the minimum acceleration phase to achieve the rated velocity. Always set the ramps via the option card and not in the frequency converter. The frequency converter ramps (parameters *3-41* and *3-42*) must always be set to minimum.

32-82 Ramp Type

This parameter defines the ramp type: trapeze, sinusoidal, or limited jerk. These ramp types are relevant for all movements.

Option:		Function:
[0] *	Linear	 **Illustration 5.4 Linear Ramp** 1 = Acceleration 2 = Speed 3 = Position
[1]	S-ramp	 **Illustration 5.5 S-Ramp** 1 = Acceleration 2 = Speed 3 = Position
[2]	Movements with limited jerk	 **Illustration 5.6 Movements with Limited Jerk** 1 = Acceleration 2 = Speed 3 = Position

Movements with limited jerk start with acceleration 0 and increase acceleration by maximum jerk until the maximum acceleration (defined by parameter *32-81 Shortest Ramp*) is

reached. The movement then continues with maximum acceleration. At the end, the acceleration is decreased by maximum jerk until acceleration returns to 0. The maximum jerk is calculated by parameter *32-86 Acceleration Up for Limited Jerk*.

When using ramp type 2, also see parameters *32-86* to *32-89*.

32-83 Velocity Resolution

Range:		Function:
1000*	[Fixed to 1000]	Defines a relative size for the velocity values of the motion commands and parameters. The information concerning speed and acceleration can then be made in whole numbers in relation to this scaling. The value 1000 means that the information in the commands is related to 1000, thus in per mill.

32-84 Default Velocity

Range:		Function:
50*	[1 to value in parameter *32-83 Velocity Resolution*]	Indicates the default velocity, which is always used when no velocity is defined in the application. This value refers to parameter *32-83 Velocity Resolution*.

32-85 Default Acceleration

Range:		Function:
100*	[0 to 1073741823]	Indicates the default acceleration used when an acceleration value is not defined in the application. This value is in relation to parameter *32-81 Shortest Ramp* and refers to parameter *32-83 Velocity Resolution*.

32-86 Acceleration Up for Limited Jerk

Range:		Function:
100*	[0 to 1073741823 ms]	Acceleration ramp-up constant for limited jerk movements. This specifies the time in ms required to ramp the acceleration up from 0 to maximum acceleration. There are 4 different parameters for limited jerk: *32-86* to *32-89*. In this parameter, the maximum jerk used in parameter *32-82 Ramp Type* for ramp type 2 is calculated. The following formulae are used: $\text{Max. accel.} = \frac{\text{Max. velocity}}{\text{Parameter 32-81}}$ $\text{Max. jerk} = \frac{\text{Max. accel.}}{\text{Parameter 32-86}}$ **NOTICE** **Parameters *32-81 Shortest Ramp* and *32-86 Acceleration Up for Limited Jerk* are time values in milliseconds.** **Calculation sample:**

32-86 Acceleration Up for Limited Jerk

Range:		Function:
		32-80 Maximum Velocity (Encoder) = 3000 RPM *32-01, 32-31 Incremental Resolution* = 500 counts/rev PPR *32-81 Shortest Ramp* = 500 ms *32-86 Acceleration Up for Limited Jerk* = 200 ms This results in: *32-80 Maximum Velocity (Encoder)* = 3000 x 500 x (4/60) = 100000 qc/s = 100 qc/ms MaxAcc = 200000 qc/s^2 = 0.2 qc/ms^2 MaxJerk = 1000000 qc/s^3 = 0.001 qc/ms^3

32-87 Acceleration Down for Limited Jerk

Range:		Function:
0*	[0 to 1073741823 ms]	Acceleration ramp-down constant. This specifies the time in milliseconds required to ramp the acceleration down from maximum acceleration to 0 (that is, normally to constant maximum velocity). If set to [0], this defaults to the same value as in parameter *32-86 Acceleration Up for Limited Jerk*.

NOTICE

If set to [0], this defaults to the same value as parameter *32-86 Acceleration Up for Limited Jerk*.

32-88 Deceleration Up for Limited Jerk

Range:		Function:
0*	[0 to 1073741823 ms]	Deceleration ramp-up constant. This specifies the number of milliseconds required to ramp the deceleration up from 0 to maximum deceleration.

NOTICE

If set to [0], this defaults to the same value as parameter *32-86 Acceleration Up for Limited Jerk*.

32-89 Decleration Down for Limited Jerk

Range:		Function:
0*	[0 to 1073741823 ms]	Deceleration ramp-down constant. This specifies the number of milliseconds required to ramp the deceleration down from maximum deceleration to 0 (that is, normally to 0 velocity).

NOTICE

If set to [0], this defaults to the same value as *32-86 Acceleration Up for Limited Jerk*

5.7 MCO Advanced Settings

5.7.1 33-0* Home Motion

The 33-0* parameters specify the behaviour for homing run and home motion.

33-00 Force Home

Option:		Function:
[0] *	Homing run is not forced	After being turned on the current position is valid as the real zero point.
[1]	Home forced	After turning on the frequency converter and after changing axis parameters, a forced tracking of the home position must be made before a motion command is executed, either directly or by the programme. In this setting, movement to the home position must be completed before any other positioning movement can take place. For a motion command that is not executed with a terminated homing run, the error 1 is triggered in parameter *19-93 Error Status*.

NOTICE

For safety reasons, and to avoid false positioning, the parameter should always be set to [1], which forces tracking of the home position. However, to ensure correct function, a homing run must be completed before the first motion command.

33-01 Zero Point Offset from Home Position

Range:		Function:
0*	[–1073741823 to +1073741823 qc]	Used to introduce an offset compared to the reference switch or index pulse. After homing, the motor is positioned to the value in this parameter.

33-02 Ramp for Home Motion

Range:		Function:
10*	[1 to value in parameter *32-83 Velocity Resolution*]	Acceleration to be used during movement to home position. This statement refers to the minimum ramp, defined in parameter *32-81 Shortest Ramp*. This unit results from parameter *32-83 Velocity Resolution* usually in % of the minimal ramp; 50% means half as fast, that is, twice as long. The following formula for the ramp is calculated as follows: Home ramp time = $\frac{P32-83}{P33-02} \times P32-81$ in ms

NOTICE

***Ramp for Home Motion* can never have a higher value than parameter *32-85 Default Acceleration*.**

33-03 Velocity of Home Motion

Range:		Function:
10*	[– value to + value in parameter *32-83 Velocity Resolution*]	Determines the velocity of home motion, with which the movement to the reference switch is made. The velocity refers to the rated speed and depends on parameter *32-83 Velocity Resolution*. A negative sign means that the search is made in the other direction. The following cohesion for the ramp is calculated as follows: Home velocity in RPM = $\frac{P33-03}{P32-83}$

NOTICE

Since the program always searches for the reference switch in the same direction of rotation (depending on sign), this should be set at the limits of the motion area. This is the only way to guarantee that the motor actually moves towards, rather than away from, the reference switch when moving home.
To maintain a good repeatability of the reference motion, do not use more than 10% of the maximum speed.

33-04 Behaviour during Home Motion

Option:		Function:
[0] *	Reverse and index	Moves to reference switch with velocity of home motion and direction, then reverses and slowly leaves the switch. Then it moves to the next index impulse.
[1]	Reverse no index	As option [0], but does not search for index impulse.
[2]	Forward and index	As option [0] but without reversing. Instead it continues movement in the same direction out of the switch.
[3]	Forward no index	As option [1] but without reversing.

5.7.2 33-4* Limit Handling

The 33-4* parameters determine the limit switch behaviour.

When the positive or negative hardware limit switch has been activated, the movement is stopped. Parameter *19-93 Error Status* is set to either *[2] Positive HW limit* or *[3] Negative HW limit*. For behaviour after an error, see parameter *33-83 Behaviour after Error*.

33-41 Negative Software End Limit

Range:		Function:
–500000*	[–1073741823 to +1073741823 qc]	Indicates the negative position limit for all movements. If this value is exceeded, then error 5 is triggered. This parameter is only active if parameter *33-43 Negative Software End Limit Active* has been set. If a positioning command is entered, which exceeds the limits set, then it is not executed.

33-42 Positive Software End Limit

Range:		Function:
500000*	[–1073741823 to +1073741823 qc]	Indicates the positive position limit for all movements. If this value is exceeded, then error 4 is triggered. This parameter is only active if parameter *33-44 Positive Software End Limit Active* has been set. If a positioning command is entered, which exceeds the limits set, it is not executed.

33-43 Negative Software End Limit Active

Option:		Function:
[0] *	Inactive	Negative software end limit is not monitored.
[1]	Active	The negative software end limit is monitored. During every movement, checks ascertain whether the target position is located outside of the permissible movement range. In this case, error message 5 is issued in parameter *19-93 Error Status*, and the motor control is switched off.

33-44 Positive Software End Limit Active

Option:		Function:
[0] *	Inactive	Positive software end limit is not monitored.
[1]	Active	The positive software end limit is monitored. During every movement, checks ascertain whether the target position is located outside of the permissible movement range. In this case, error message 4 is issued in parameter *19-93 Error Status*, and the motor control is switched off.

33-45 Time in Target Window

Range:		Function:
0*	[0–10 ms]	Once the target window has been reached, the position is read twice and the difference is compared with parameter *33-46 Target Window Limit Value*. If the result is lower, then the position has been reached, otherwise a new reading is taken. This parameter indicates the time interval between the measurements.

NOTICE

The time is limited to 10 ms because during that time the application program is blocked, and the monitoring of the limit switch and the position error is not active.

33-46 Target Window Limit Value

Range:		Function:
1*	[1–10000 qc]	The target window is read with an interval of the time set in parameter *33-45 Time in Target Window*. The target window has been reached when 2 consecutive readings are within the target window set in parameter *33-46 Target Window Limit Value*.

NOTICE

Example: When the time set in parameter *33-45 Time in Target Window* is 1000 ms, then the target window is registered as reached 1000 ms after the position is within the target window.

33-47 Size of Target Window

Range:		Function:
0*	[0–10000 qc]	0 = Off Indicates the size of the target window. A position is only viewed as reached when the trajectory generator is finished, the actual position is within the window, and the velocity is less than parameter *33-46 Target Window Limit Value* (prerequisite is that both *parameters 33-47 Size of Target Window* and *33-45 Time in Target Window* are activated.) In this content the velocity is given as: $\frac{\text{P33–46 in qc}}{\text{P33–45}}$ The controller waits to execute the next command until the actual position is within the target window. If this parameter is not active, the target has been reached if the set position equals the target position. However, this does not necessarily correspond with the actual position of the motor.

NOTICE

If the target window surrounding the end position is selected to be too small, the motor could move in a small area around the end position, without reaching the target window. Thus the application programme would be stuck after the corresponding positioning command. A target window of 0 deactivates the monitoring of the actual position and only monitors the command position.

5

NOTICE

Different handling of the target window to adapt to the needs of CANopen: If parameter *33-45 Time in Target Window* is set but parameter *33-46 Target Window Limit Value* is not set, then it is assumed that a CANopen encoder is used. In that case, it is checked if the time within the target window is longer than the value set in parameter *33-45 Time in Target Window*. If so, the position has been reached. Otherwise, the position has not been reached.

5

5.7.3 33-8*, Global Parameters

33-81 Power-up State

Option:		Function:
[0]	Motor off	Select this option if the motor must remain uncontrolled (the frequency converter is coasted) after power-up. Frequency converter and position control must be enabled by pressing [Auto On] on the LCP before movement can be started.
[1] *	Motor on	Select this option if the motor must be controlled after power-up, the positioning controller is active and keeps the actual position until another control command is given.

33-82 Drive Status Monitoring

This parameter enables/disables monitoring of the FC 300 status while position control from the MCO is active.

Option:		Function:
[0]	Off	Select this option if monitoring must be disabled, meaning that the MCO tries to control the motor independent of the FC 300 status. Error message 6 in parameter *19-93 Error Status* is issued if it is attempted to start a movement while the FC 300 is not enabled.
[1] *	On	Select this option if monitoring must be enabled. Error 113 occurs if the FC 300 is not enabled while the MCO is in position control, for example if the motor trips.

33-83 Behaviour After Error

With hardware and software limit switches, it is possible to clear a software limit error and then drive in the opposite direction. If a movement in the wrong direction is attempted again, a new error is generated. Handling of hardware limit switches is the same as software limit switches. This means that the error can be cleared and then the motor is enabled to move in the opposite direction. Error 198 (Limit sw. violation) is issued if a movement in the wrong direction is attempted.

Option:		Function:
[0] *	Coast	Standard, that is, motor moves in coasting, control loop is interrupted.
[1]	Coast and brake	This option is the same as option [0] but brake output (if defined) is activated.

33-83 Behaviour After Error

With hardware and software limit switches, it is possible to clear a software limit error and then drive in the opposite direction. If a movement in the wrong direction is attempted again, a new error is generated. Handling of hardware limit switches is the same as software limit switches. This means that the error can be cleared and then the motor is enabled to move in the opposite direction. Error 198 (Limit sw. violation) is issued if a movement in the wrong direction is attempted.

Option:		Function:
[2]	Controlled stop	Motor stop with maximum deceleration (stop ramp), then standstill control.
[3]	Controlled stop and brake	This option is the same as option [2] and, in addition, brake output (if defined) is activated, but only after the motor is stopped.
[5]	Handled by the application programme	The behaviour is defined by the application programme.

NOTICE

Define brake output in parameters *33-63* to *33-70*, O_FUNCTION_n options 5 and 6 (see *Motion Control Option MCO 305 Design Guide*).

33-85 MCO Supplied by External 24 V DC

Option:		Function:
[0] *	No	External 24 V supply not connected.
[1]	Yes	External 24 V supply connected to terminal X58.

5.7.4 33-9*, MCO Port Settings

33-91 X62 MCO CAN Baud Rate

This parameter defines the baud rate of the MCO CAN interface.

Option:		Function:
[16]	10 Kbps	–
[17]	20 Kbps	–
[18]	50 Kbps	–
[19]	100 Kbps	–
[20] *	125 Kbps	–
[21]	250 Kbps	–
[22]	500 Kbps	–
[24]	1000 Kbps	–

5.8 MCO Data Readouts

The parameters in the *34-0** and *34-2** groups support the PCD array reading and writing, and are in accordance with the PROFIdrive profile.

5.8.1 34-0*, PCD Write Parameters

34-01 to 34-10 PDCn Write to MCO

PCDs 1-7 are used by MCO as default. The remaining PCDs can be configured to write user-defined parameters.

Option:		Function:
[34-01]	PCD 1 Write to MCO	
[34-02]	PCD 2 Write to MCO	
[34-03]	PCD 3 Write to MCO	
[34-04]	PCD 4 Write to MCO	
[34-05]	PCD 5 Write to MCO	
[34-06]	PCD 6 Write to MCO	
[34-07]	PCD 7 Write to MCO	
[34-08]	PCD 8 Write to MCO	
[34-09]	PCD 9 Write to MCO	
[34-10]	PCD 10 Write to MCO	

5.8.2 34-2*, PCD Read Parameters

34-21 to 34-31 PCDn Read from MCO

PCDs 1- 5 are used by MCO as default. The remaining PCDs can be configured to read user-defined parameters, for example to read the digital inputs.

Option:		Function:
[34-21]	PCD 1 Read from MCO	
[34-22]	PCD 2 Read from MCO	
[34-23]	PCD 3 Read from MCO	
[34-24]	PCD 4 Read from MCO	
[34-25]	PCD 5 Read from MCO	
[34-26]	PCD 6 Read from MCO	
[34-27]	PCD 7 Read from MCO	
[34-28]	PCD 8 Read from MCO	
[34-29]	PCD 9 Read from MCO	
[34-30]	PCD 10 Read from MCO	

5.8.3 34-4*, Inputs and Outputs

34-40 Digital Inputs

Readout status of the digital inputs.

34-41 Digital Outputs

Readout status of the digital outputs.

5.8.4 34-5*, Process Data

Some actual data from the application programme can be read via the following parameters.

34-50 Actual Position

Current slave position in user units (UU).

34-51 Commanded Position

Commanded position in user units (UU).

34-52 Actual Master Position

Current master position in qc.

34-56 Track Error

Queries the actual position error of the axis in user units (either a plus or minus value).

34-58 Actual Velocity

Actual velocity in UU/s.

34-59 Actual Master Velocity

Actual master velocity in qc/s.

5

6 Application Examples

6.1 Homing

Function	Digital control mode	Fieldbus mode	Quick bus (Fieldbus mode)
Homing	IN 9	PCD[1].3	PCD[1].3
Clear home status	IN 6	PCD[1].6	PCD[1].6

Table 6.1 Homing Signals

NOTICE

Connect the homing switch to IN 4 and select the sequence in parameter *33-04 Behaviour during Home Motion*.

6.2 Touch Probe Positioning

The target position is calculated relative to the actual position, after the touch probe input is activated.
Similar configuration like relative/absolute positioning, but:
Parameter *19-28 Index Trajectory Type* must be either positive (2) or negative (3)
By using quick bus: PCD[1].13 (positive) / PCD[1].14 (negative) *Parameter 19-03 Touch Probe Delay* in ms.

Operating mode

Function	Digital control mode	Fieldbus mode	Quick bus (Fieldbus mode)
Start positioning	IN 5	PCD[1].5	PCD[1].1
Position reached	OUT 2	PCD[1].2	PCD[1].2
Reset touch probe	IN 7	PCD[1].7	PCD[1].7

Table 6.2 Operating Mode

6.3 Brake Control

Important parameters:

- *19-09 Automatic Break Control*
- *19-10 Coast Delay*
- *19-11 Brake Delay*
- *19-12 Hold Delay*
- *19-13 Brake Wear Limit*

If the application is not equipped with an electromechanical brake, these parameters are not relevant. However, it is important to set parameter *19-09 Automatic Brake Control* to *[0] Disabled* to enable the motor also at standstill.

Start procedure:
After *start positioning* is activated, the mechanical brake is opened after the time selected in *19-11 Brake Delay*. This time delay is to ensure that the motor is fully magnetised when the brake is released, preventing the load from dropping after start.

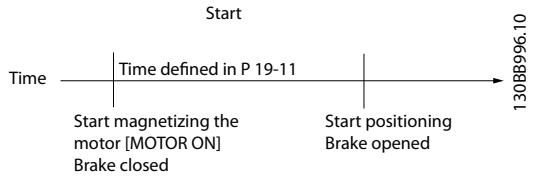


Illustration 6.1 Brake Delay

Stop procedure:
At *position reached* the delay selected in *19-10 Coast Delay* ensures that the brake is closed when the controller coasts the motor.

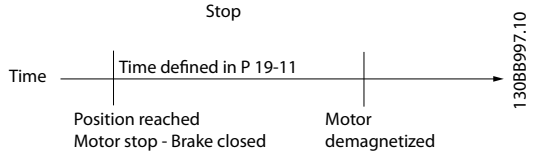


Illustration 6.2 Coast Delay

Parameter 19-12 Hold delay
Especially used for applications where a sequence of fast positioning is followed by a longer standstill time. It defines the time period in which the brake is not activated, even though the application is at standstill. This spares the brakes for wear for rapid positioning.

Parameter 19-13 Brake wear limit
Monitors the wear of the brake. It defines the numbers of user units the motor can move while the brake is closed.

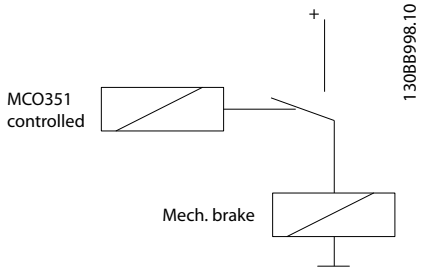


Illustration 6.3 MCO Controlled Brake

Using both FC 300 and MCO brake control
For extra safety both MCO and FC 300 can be used for mechanical brake control. The FC 300 only has influence during start-up. In normal conditions, after the time in parameter *19-11*, the current activating the FC brake control should be reached. If the MCO loses control over the motor and the controller cannot magnetise the motor, the brake cannot open. Without FC brake control, the brake opens shortly and closes again because of *position error*. It is important to optimise the time in parameter *19-11 Brake Delay* according to the maximum allowed position error.

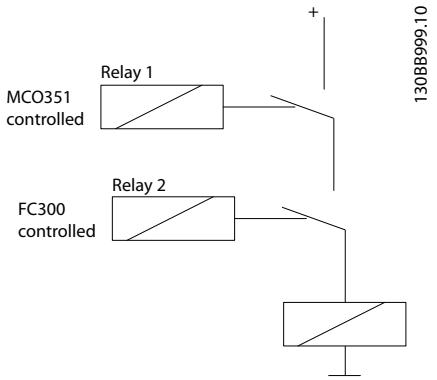


Illustration 6.4 MCO and FC 300 Controlled Brake

6.4 Hardware End Limit

The hardware end limit switch is an emergency switch for the application.

Inputs:

- X57/2: Positive hardware limit switch input
- X57/3: Negative hardware limit switch input

Must be kept high to start/run the application.

6.5 Software Limits

The software limits are placed just in front of the hardware limit switches with a distance to the hardware limit switches, which allows for the motor to be stopped with the shortest allowable ramp before the HW limit switch is activated.

Parameters:

- *33-41: Negative Software Limit*
- *33-42: Positive Software Limit*
- *33-43: Negative Software Limit Active*
- *33-44: Positive Software Limit Active*

Either both or no software limits must be active. Activating only one border is not valid. The motor must be repowered after activating or deactivating software limits.

6.6 Index Positioning

Positions with individual ramps, velocity, and positioning type can be predefined in the VLT® Positioning Controller MCO 351.

- 64 positions when using fieldbus option.
- 32 positions when using digital I/O and FC 302.
- 16 positions when using digital I/O and FC 301.

Parameters used for definition of index positioning:

- *19-23: Reference Index No.*
- *19-24: Index Target Position (UU)*
- *19-25: Index Ramp Up Time (ms)*
- *19-26: Index Ramp Down Time (ms)*
- *19-27: Index Maximum Velocity (RPM, on the encoder side)*
- *19-28: Index Trajectory Type (absolute, relative, or touch probe)*
- *19-29 Parameter Save*: Save parameter settings for *19-24* to *19-28*

Inputs:

- 18 Reference index bit 0
- 19 Reference index bit 1
- 33 Reference index bit 2
- 32 Reference index bit 3
- 29 Reference index bit 4

Outputs:

- X59/4 Reference index bit 0
- X59/5 Reference index bit 1
- X59/6 Reference index bit 2
- X59/7 Reference index bit 3
- X59/8 Reference index bit 4

Operating procedure:

1. Select index (DI 18, 19, 29, 32, 33/PCD[7].1, .2, .3, . 4, .5, .6)
2. Latch index (DI 10/PCD[1].4)
3. New index read? (DO 4, 5, 6, 7, 8/PCD[2].1, .2, .3, . 4, .5, .6)
4. Start positioning (DI 5/PCD[1].5)
5. Referenced position reached (DO 2/PCD[1].2)

Input	18 (LSB)	19	33	32	29 (MSB)	Index
state	0	0	0	0	0	0
state	0	1	1	0	0	6
state	1	0	1	1	0	13

Table 6.3 Index Numbering using Digital Inputs

PCD(7)	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Index
state	0	0	0	0	0	0	0
state	0	1	1	0	0	0	6
state	1	0	1	1	0	1	45

Table 6.4 Index Numbering using PCD

6.7 Quick Bus Positioning

The MCO 351 is controlled by an overall control system, e.g. a PLC system.

Parameter *19-04 Control Source* must be set to *[1] Fieldbus* to enable fieldbus operation.

Operating procedure:

1. Referenced target position: PCD[2]msb + PCD[3]lsb (UU)
2. Type: PCD[1].11 (Absolute)/PCD[1].12 (Relative)
3. Sign: PCD[1].16 (negative)
4. Velocity: PCD[4] (RPM, on the encoder side)
5. Acceleration: PCD[5] (% of shortest ramp time in parameter *32-81*)
6. Deceleration: PCD[6] (% of shortest ramp time in parameter *32-81*)
7. Go to target position: PCD[1].1 (Start/Stop)
8. Position reached: PCD[1].2

Quick stop: PCD[1].8 (must always be enabled to allow operation)
Reset error: PCD[1].2

Fieldbus communication is supported only if PCD channels are available, such as Profibus, DeviceNet, Ethernet/IP, CANopen etc.

A table for noting the positioning settings can be found in *chapter 8.3.1 Positioning Table*.

7 Diagnostics

7.1 Troubleshooting

Problem	Solution
When a *PID tracking error too big* error (*19-93 Error Status*) occurs, the inverter also trips on ALARM 13 (overcurrent)	• Check the velocity setting. • Check encoder for correct rotation direction. • Check encoder wiring and parameter configuration. • Check for correct brake handling. • Check velocity limits. • The time set in parameter *3-81 Quick Stop Ramp Time* is too short. Increase the setting.
Parameter *32-80 Maximum Velocity (Encoder)* needs adjusting.	Increase the setting in parameter *3-03 Maximum Reference*. Doing this also affects the performance of the parameters *32-60 Proportional Factor* to *32-66 Acceleration Feed-Forward*. Smaller changes to *parameter 3-03 Maximum Reference* may not have any noticeable effect on most of these parameters but *32-65 Velocity Feed-Forward* should always be recalculated using the auto-calculation function *19-19 FFVEL Auto-calculation*.
The frequency converter frequently trips on ALARM 7 (DC Overvoltage) while ramping down.	• Use a higher ramp time setting in parameter *19-17 Jog Ramp Time* for jogging and parameter *19-26 Index Ramp Down Time* for positioning. • Check *PCD [6] Quickbus Target Deceleration*. • If a lower ramp time is required, install a brake resistor.
The frequency converter frequently trips on ALARM 13 (overcurrent) while ramping up.	• The ramp settings require too much torque. Determine which operation (manual move or positioning) caused the trip, and then set the corresponding ramp time (parameter *19-17 Jog Ramp Time* for jogging and parameter *19-25 Index Ramp Up Time* for positioning) with a higher ramp time setting. • Check *PCD [5] Quickbus Target Acceleration*. • The PID controller may be unstable – optimise the PID controller parameters.
The correct target position is reached, but the *PID tracking error* (parameter *34-56 Track Error*) is too big while the motor is turning.	• Harder settings of the PID controller may be required – optimise the PID controller parameters.
The option sometimes forgets changes to trajectory data after a power cycle.	Changes to trajectory data values are not saved after power-down unless parameter *19-29 Parameter Save* is activated before power-down.

Table 7.1 Troubleshooting

7.2 Error Messages

The LCP shows all error messages on the status screen (below the index number). They are also shown in parameter *19-93 Error Status*. Detailed information, additional notes on possible causes of errors, and tips for clearing errors can be found in *Table 7.2*.

Parameter 19-93, value	Status/error message	Meaning/cause
0	Status OK. No errors detected	No errors detected.
1	Homing needed	• A positioning command to a certain position has been issued while the home position is not defined. • Clear the error and complete a homing sequence successfully before issuing the next position command to the application.
2	Positive hardware limit exceeded	• The positive hardware switch input has been activated. • The application has hit the positive limit marker switch. Alternatively, the connection to the limit switch has been lost or the limit switch is defective.
3	Negative hardware limit exceeded	• The negative hardware switch input has been activated. • The application has hit the negative limit marker switch. Alternatively, the connection to the limit switch has been lost or the limit switch is defective.
4	Positive software limit exceeded	• A motor command has caused the software limit switch to be activated. The maximum limit is specified in parameter *33-42 Positive Software End Limit*. • Move the application back from the limit before clearing the error. If power recovery is enabled in parameter *19-08 Power-Recovery*, this can be done through an error reset and a negative jog (input 54).
5	Negative software limit exceeded	• A motor command has caused the software limit switch to be activated. The maximum limit is specified in parameter *33-41 Negative Software End Limit*. • Move the application back from the limit before clearing the error. If power recovery is enabled in parameter *19-08 Power-Recovery*, this can be done through an error reset and a positive jog (input 53).
6	VLT not running	• The motor was not magnetised in a situation where it should have been. The electromechanical brake is immediately activated in this case regardless of the settings in parameters *19-12 Hold Delay* and *19-06 Error Behaviour*. • While the motor was holding/driving the load, the frequency converter either tripped, connection to terminal X57/8 was lost, or the *Hand On* or *Off* key on the LCP was pressed.
7	Brake wear limit exceeded	• This error message is given if the motor has moved more than the allowed number of user units specified in parameter *19-13 Brake Wear Limit while* the electronic brake was activated. • The mechanical brake is worn and must be replaced in the near future or the limit specified in parameter *19-13 Brake Wear Limit* is too low.
8	Quick stop input activated	• The quick stop input has been activated. As a safety precaution, the electro-mechanical brake is activated according to the setting in parameter *19-06 Error Behaviour* and the motor is coasted regardless of the setting in parameter *19-09 Automatic Brake Control*. • Clear the error to resume normal operation.

9	Controller (PID) tracking error too big	• The difference between the desired setpoint position and the actual position read via the encoder feedback has exceeded the limit specified in parameter *32-67 Maximum Tolerated Position Error*. • Reasons: - The encoder is not properly connected. Check the encoder connection. - The encoder is counting positive in the wrong direction. Switch A and B channels if necessary. - The PID controller settings are not properly optimised. Follow the instructions for optimising. - The limit specified in parameter *32-67 Maximum Tolerated Position Error* may be too low.
12	Reverse operation prohibited	The motor has been operated in reverse direction while this was not allowed according to the setting in parameter *32-68 Reverse Behaviour for Slave*.
13	Forward operation prohibited	The motor has been operated in forward direction while this was not allowed according to the setting in parameter *32-68 Reverse Behaviour for Slave*.
92	Error from encoder monitoring	• Open or short circuit in accordance with the displayed indicator light. • An error is displayed even if no encoder is connected and the monitor is active (parameter *32-09 Encoder Monitoring = [1] 3 channels*.

Table 7.2 Error Messages

8 Appendix

8.1 Abbreviations and Conventions

Abbreviation	Explanation
AC	Alternating current
AEO	Automatic Energy Optimisation
AWG	American Wire Gauge
AMA	Automatic Motor Adaptation
°C	Degrees Celsius
DC	Direct current
EMC	Electromagnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
HO	High overload
IP	Ingress protection
I_{LIM}	Current limit
I_{INV}	Rated inverter output current
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
LCP	Local Control Panel
N.A.	Not applicable
NO	Normal overload
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PE	Protective earth
PELV	Protective Extra Low Voltage
PM motor	Permanent magnet motor
Regen	Regenerative terminals
RPM	Revolutions per minute
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 8.1 Abbreviations

Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information and description of illustrations.

Italicised text indicates:

- Cross-reference
- Link
- Footnote
- Parameter name, parameter group name, parameter option

8.2 Glossary of Key Terms

Absolute value encoder

This is a special form of encoder, as it indicates not only the speed and direction of rotation, but also the absolute physical position. This is communicated via transfer of the position in parallel form or in the form of a telegram in serial form. Absolute value encoders also come in 2 versions: Single-turn encoders supply an absolute position via a specific quantity, or via a freely definable number of rotations.

AMA

Automatic Motor Adaptation - function in parameter *1-29 Automatic Motor Adaptation (AMA)*.

ERPM

The speed is defined in relation to the RPM of the encoder. To underline this, the term *encoder revolutions per minute* is selected as the unit.

Motor/encoder gear ratio

Since the encoder is not necessarily mounted on the motor itself, the relationship between the nominal motor speed in RPM and the nominal encoder speed in ERPM must be specified.

Incremental encoder

This is an encoder system that picks up the speed and the direction of rotation and transmits on the appropriate configuration. The number of tracks, and thus the number of signals, indicate the properties of the encoder system. There are single-track systems that deliver a pulse signal dependent on the speed as well as a fixed direction signal. Dual-track systems deliver 2 pulse signals that are offset 90 degrees. By evaluating the 2 tracks, the direction signal is also obtained. As well as the 2 tracks of the dual-track encoder, 3-track encoders deliver an additional *zero-track*, which emits a signal when the zeros transit is passed through.

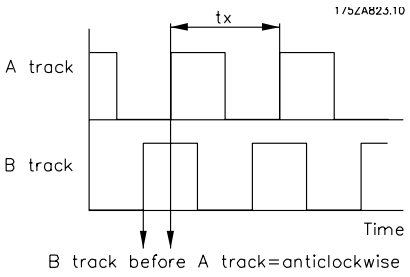


Illustration 8.1 Incremental Encoder Signals

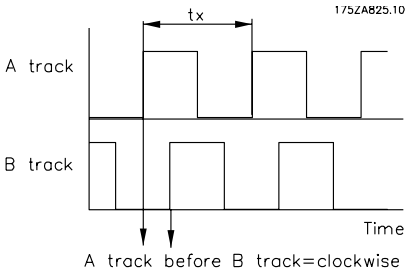


Illustration 8.2 Incremental Encoder Signals

Quad counts

Through edge detection, a quadrupling of the increments is produced by both tracks (A/B) of the incremental encoder. This improves the resolution.

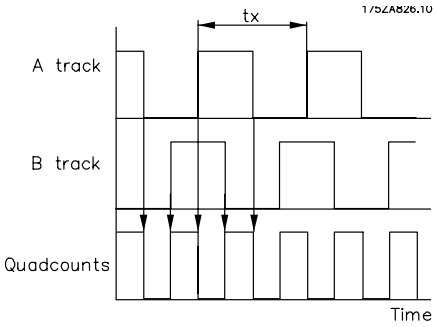


Illustration 8.3 Derivation of Quad Counts

SinCos encoder

Like the incremental encoder, the SinCos encoder delivers 2 tracks, one shifted 90° from the other. The signal form is not rectangular but sinusoidal. This allows a higher resolution of the encoder position since the 2 analog signals, SIN and COS, deliver each value between 0 and 1.

Touch probe positioning

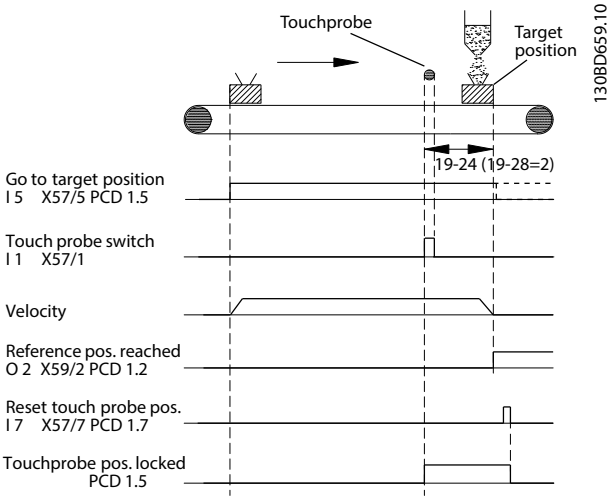


Illustration 8.4 Touch Probe Positioning

NOTICE

A delay in the touch probe sensor makes the target position drift. This means that the target position becomes larger than stated in parameter *19-24 Index Target Position*. To compensate for this, specify a delay value in parameter *19-03 Touch Probe Delay*. Only a constant delay can be compensated for, and not a variable delay.

Track error

The PID track error is defined as the difference between the internal controller setpoint and the actual position. The track error is specified in user units (UU) and is displayed in parameter *34-56 Track Error*. The maximum tolerated PID error is entered in parameter *32-67 Maximum Tolerated Position Error* in quad counts (qc).

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8.3 Positioning

8.3.1 Positioning Table

Position [INDEX] Parameter 19-23	FC 300 Terminal					Target Position Parameter 19-24	Ramp-up time Parameter 19-25	Ramp-down time Parameter 19-26	Velocity Parameter 19-27	Trajectory type Parameter 19-28	Fieldbus [HEX] PCD 7
	29*	32	33	19	18						
0	0	0	0	0	0						0000
1	0	0	0	0	1						0001
2	0	0	0	1	0						0002
3	0	0	0	1	1						0003
4	0	0	1	0	0						0004
5	0	0	1	0	1						0005
6	0	0	1	1	0						0006
7	0	0	1	1	1						0007
8	0	1	0	0	0						0008
9	0	1	0	0	1						0009
10	0	1	0	1	0						000A
11	0	1	0	1	1						000B
12	0	1	1	0	0						000C
13	0	1	1	0	1						000D
14	0	1	1	1	0						000E
15	0	1	1	1	1						000F
16	1	0	0	0	0						0010
17	1	0	0	0	1						0011
18	1	0	0	1	0						0012
19	1	0	0	1	1						0013
20	1	0	1	0	0						0014
21	1	0	1	0	1						0015
22	1	0	1	1	0						0016
23	1	0	1	1	1						0017
24	1	1	0	0	0						0018
25	1	1	0	0	1						0019
26	1	1	0	1	0						001A
27	1	1	0	1	1						001B
28	1	1	1	0	0						001C
29	1	1	1	0	1						001D
30	1	1	1	1	0						001E
31	1	1	1	1	1						001F
* = For FC 302 only. Not valid for FC 301.											

Table 8.2 Positioning Table

8.3.2 Positioning Templates

8.3.2.1 Example of Index Positioning via Fieldbus

PCD 1				–				–				–				–				PCD 7			
0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Error reset (toggle bit 2)																							
0	0	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real target position for index 1																							
0	0	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Move to index 1 target position																							
0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Real target position for index 0																							
0	0	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jog forward (move manually in positive direction)																							
0	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.3 Example of Index Positioning via Fieldbus

8.3.2.2 Example of Index Positioning via Quick Bus

PCD 1				PCD 2				PCD 3				PCD 4				PCD 5				PCD 6			
Read: Absolute position 65535 UU; Velocity 1000 RPM; Ramp-up/down time 500 ms																							
0	4	8	0	0	0	0	0	F	F	F	F	0	3	E	8	0	1	F	4	0	1	F	4
Move to absolute position 65535 UU with velocity 1000 RPM and ramp-up/down time 500 ms																							
0	4	8	1	0	0	0	0	F	F	F	F	0	3	E	8	0	1	F	4	0	1	F	4
Move to relative position 10000 UU with velocity 750 RPM, ramp-up time 1 s and ramp-down time 500 ms																							
0	8	8	1	0	0	0	0	2	7	1	0	0	2	E	E	0	3	E	8	0	1	F	4
Move to absolute position 131072 UU with velocity 500 RPM and ramp-up/down time 100 ms																							
0	4	8	1	0	0	0	1	F	F	F	F	0	1	F	4	0	0	6	4	0	0	6	4
Reset a pending error via Quick Bus																							
0	4	8	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 8.4 Example of Index Positioning via Quick Bus

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