ENGINEERING
TOMORROW

Application Guide

VLT® Integrated Motion Controller

Software Version 48.9X

Contents

1 Introduction

1.1 Purpose of this Application Guide

This application guide provides information about recommended parameter settings and descriptions to operate drives in applications which use Integrated Motion Controller (IMC) on the VLT® AutomationDrive FC 302 series.

Installation and operating instructions are not in the scope of this application guide.

1.2 Document and Software Version

This guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this guide is in English.

Table 1: Document and Software Version

Edition	Remarks	Software version
AB304441080478, version 02	Update to a new software version.	48.98

1.3 Additional Resources

Additional resources are available with related information.

- The programming guide provides detailed parameter descriptions of the VLT® AutomationDrive FC 302.
- The design guide provides information about the capability and functionality to design motor control systems.
- The operating guide provides detailed specification, requirements, and installation instructions for the VLT® AutomationDrive FC 302.
- Technical documentation for various product options is available via the https://www.danfoss.com/en/search/?filter=documentationArchived%3Afalse%2Ctype%3Adocumentation%2CdocumentationLanguage%3Aen_en&pageSize=10 in the Service and Support/Documentation section.

1.4 Safety Symbols

The following symbols are used in this guide:

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2 Introduction to IMC

2.1 An Overview of IMC

The Integrated Motion Controller (IMC) for use with VLT® AutomationDrive FC 302 enables position control with all control principles and motor types with and without feedback.

IMC enables the following functions:

- Positioning
- Synchronization
- Homing
- Virtual master

Position control in both positioning and synchronization modes can be either sensorless or with feedback.

In the sensorless control principle, the motor angle calculated by the motor controller is used as feedback. In the closed-loop control principle, VLT® AutomationDrive FC 302 supports 24 V encoders as standard. With extra options, the drive supports most standard incremental and absolute encoders and resolvers. The position controller can handle both linear and rotary systems. Position values can be scaled to any relevant physical unit such as mm or °.

VLT® AutomationDrive FC 302 with IMC offers 2 different control principles:

- Use the drive as a motion controller that takes advantage of the integrated positioning and synchronizing features based on references and control commands provided via I/Os or fieldbus.
- Use the drive as an actuator where all profiling is done by the external motion controller/PLC providing cyclic speed or position reference via synchronous fieldbus communication.

To set the motion control mode, select ***[9] Positioning*** or ***[10] Synchronization*** in parameter ***1-00 Configuration Mode***.

2.2 Software Version and Control Card

Software version 48.33 and higher can only be installed on control card MK II. The white USB port identifies a control card MK II.

To order VLT® AutomationDrive FC 302 drives with the IMC software, select S067 as Software Release in positions 24–27 of the type code. For more information on ordering the software, see *VLT® AutomationDrive FC 301/FC 302 Design Guide*.

2.3 Control Loops and Control Configurations

In positioning and synchronization mode, the position PI controller is added as an outer loop providing the speed reference for the speed PID.

Figure 1 shows the control structure and parameters affecting the control behavior with flux motor control.

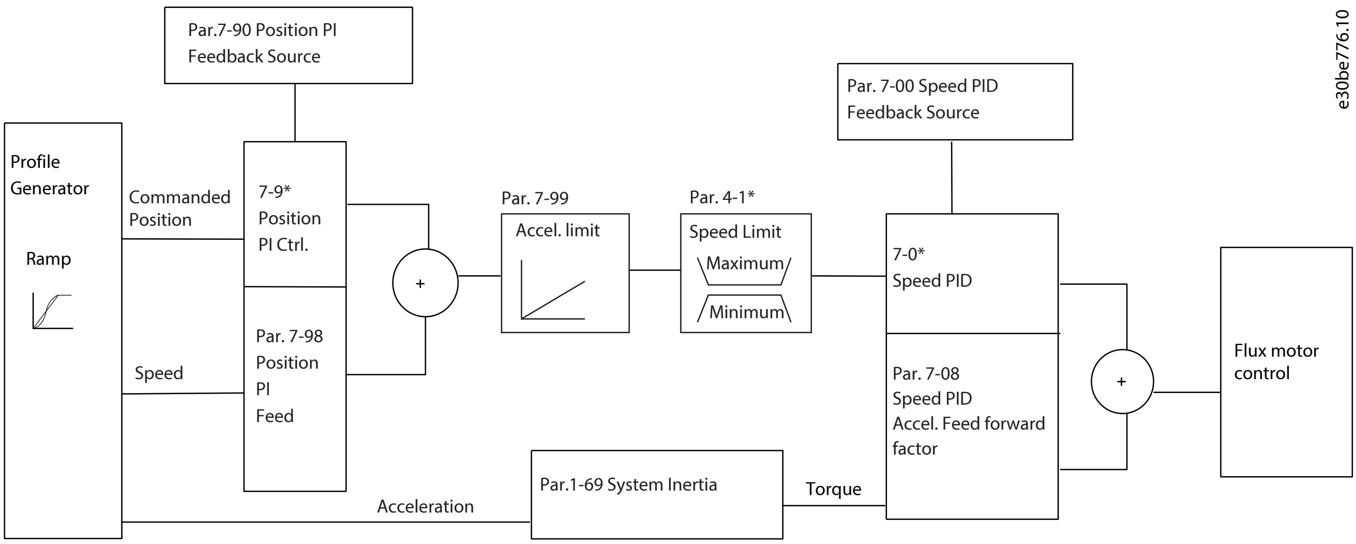


Figure 1: Positioning and Synchronization Mode

2.4 Control Configurations

IMC supports multiple types of configurations motor, speed, and position control with or without feedback and allows adaptation to most applications.

It is possible for 1 or more controllers to be active depending on the basic configuration in parameter ***1-01 Motor Control Principle***.

- U/F and VVC+: Position PI controller (parameter group *7-9* Position PI Ctrl*)
- Flux sensorless and flux with motor feedback: Speed PID controller (parameter group *7-0* Speed PID Ctrl*) and Position PI controller (parameter group *7-9* Position PI Ctrl*).

With sensorless control, the estimated rotor position is used as feedback for motor, speed, and position control.

Motor and speed control uses the same feedback whereas the position controller can use the same or a different feedback.

The following control configurations are possible:

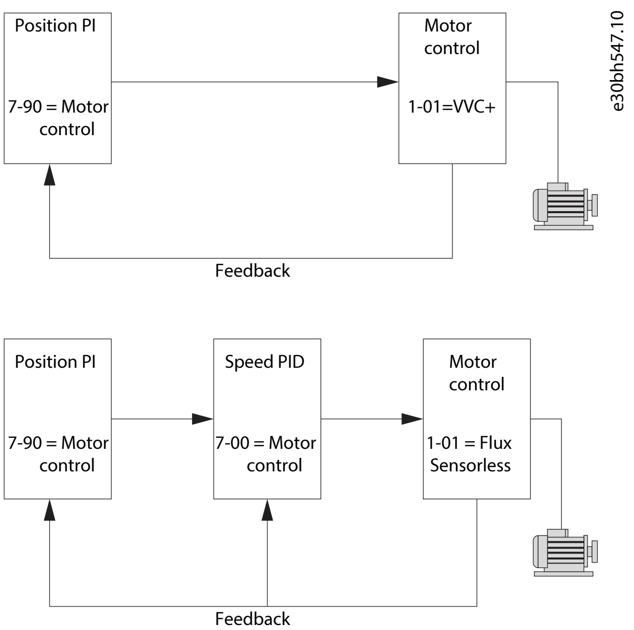


Figure 2: Sensorless Motor/Speed/Position Control, VVC+ or Flux Sensorless

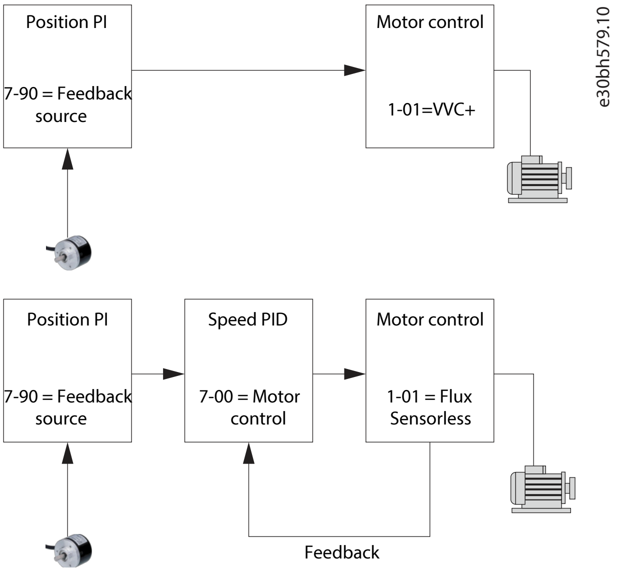


Figure 3: Sensorless Motor/Speed Control and Position Control with Feedback, VVC+ or Flux Sensorless

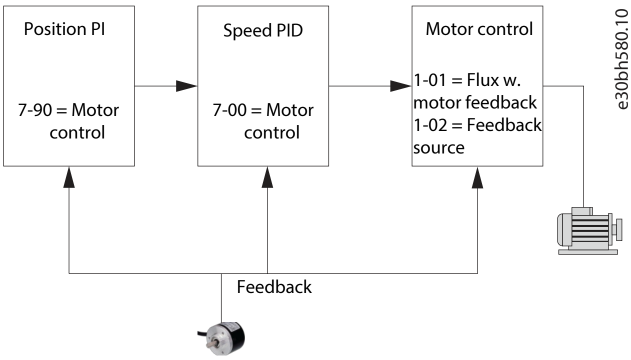


Figure 4: Motor/Speed/Position Control with Motor Feedback, Flux with Motor Feedback

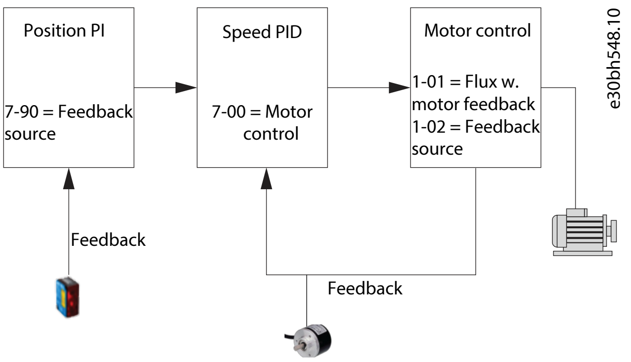


Figure 5: Motor/Speed/Position Control with Motor Feedback and Position Control with Application Feedback, Flux with Motor Feedback

2.5 Handling of Reference

IMC can be used in positioning and synchronization applications without more options.

Positioning

Reference for the target position depends on any of the following positioning types:

- Absolute: Target position relates to the defined zero point of the machine.
- Relative: Target position relates to the actual position of the machine.
- Touch probe: Target position relates to a signal on a digital input.

Position control can be sensorless or with feedback. For sensorless control, the motor angle calculated by the motor controller is used as feedback. In closed-loop control principle (with feedback), 24 V encoders are the standard option. With extra options, incremental encoders, absolute encoders, and resolvers are supported.

The position controller can handle both linear and rotary systems. Position values are scaled to relevant physical units. All positioning and synchronization are controlled either by digital I/O or fieldbus.

A positioning command requires 3 inputs:

- Target position
- Speed reference
- Ramp times

These 3 inputs can come from various sources as shown in Figure 6.

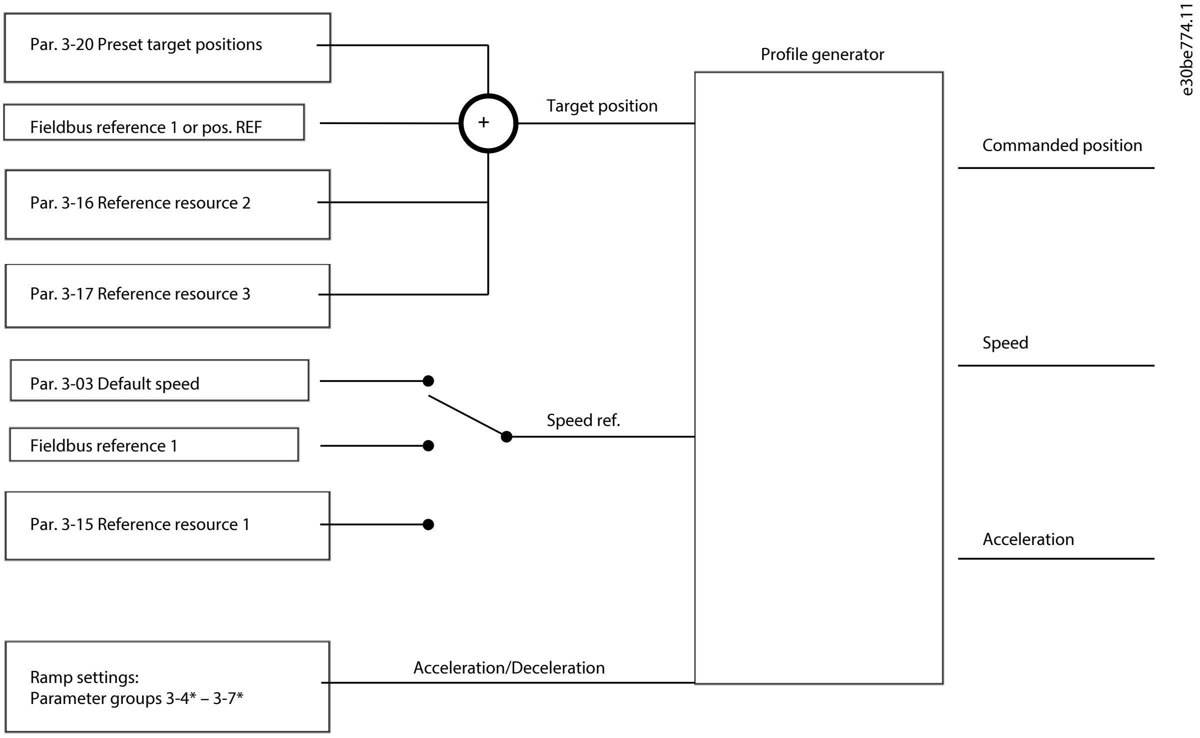


Figure 6: Positioning Reference

Synchronization

In synchronizing mode, the drive is position controlled and follows the provided master position scaled by the gear ratio. The source for the master signal can be 1 of the encoder interfaces of the drive, a fieldbus, or the virtual master. The drive offers several synchronizing types:

- Relative synchronizing
- Relative synchronizing with resync
- Absolute synchronizing
- Synchronizing with marker correction
- CAM control

For synchronizing, the gear ratio is set by the master scaling in parameter ***3-22 Master Scale Numerator*** and parameter ***3-23 Master Scale Denominator***. For CAM control, the relation between master and follower is set by the CAM table in parameter ***3-36 CAM Master Table*** and parameter ***3-37 CAM Follower Table***.

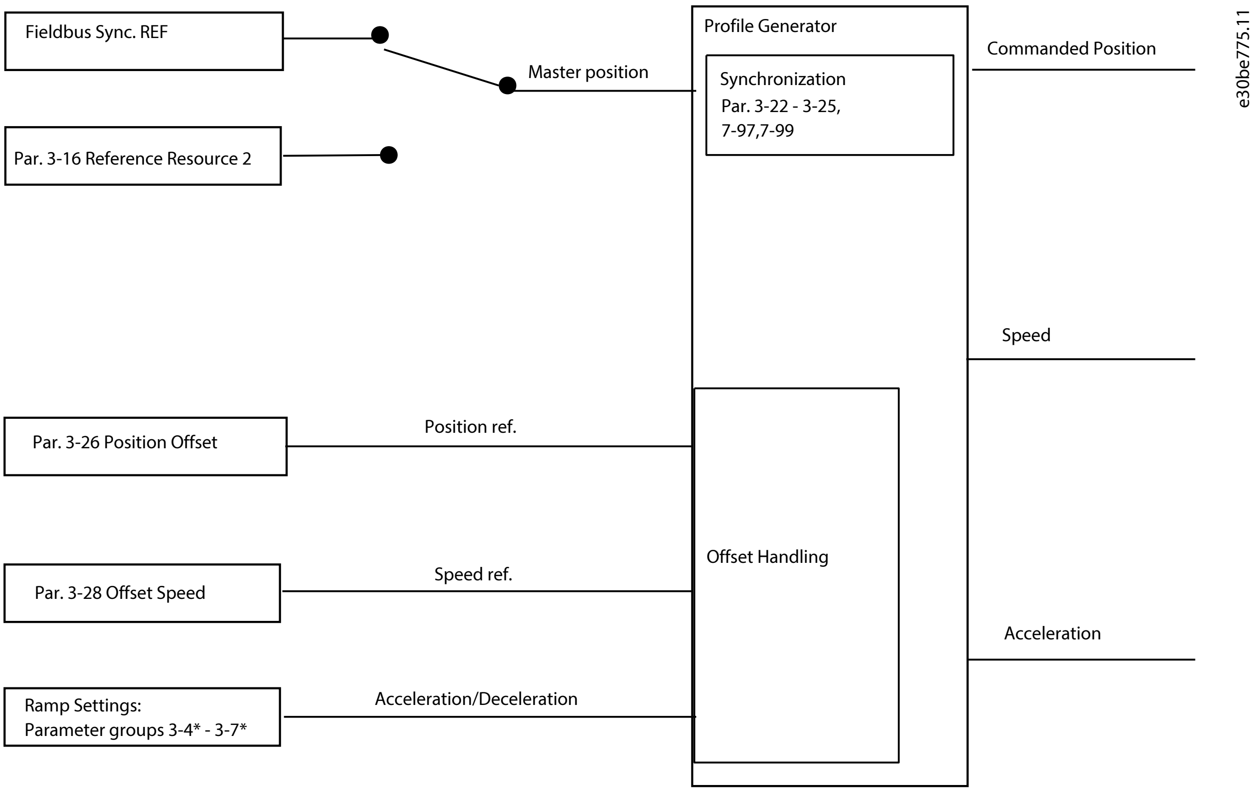


Figure 7: Synchronization References

For positioning and synchronization, in each control cycle (1 ms), the profile generator calculates position, speed, and acceleration required to do a specific movement. The outputs from the profile generator are used as inputs for the position and speed controller as described in 2.3 Control Loops and Control Configurations.

2.6 Control and Status Signals

2.6.1 Control Signals

IMC control signals are available as digital I/O bits and fieldbus bits. Table 2 details the available options.

Table 2: Control Signals

Name	Function	Digital input	Control word
Enable master offset	Activates the master offset when parameter ***17-93 Master Offset Selection*** is set to options ***[1]–[5]***.	✓	✓
Start homing	Starts selected homing function.	✓	✓
Enable virtual master	Starts the virtual master.	✓	✓
Activate touch	Selects touch probe positioning mode.	✓	✓
Relative position	Selects between absolute and relative positioning.	✓	✓

Table 2: Control Signals (continued)

Name	Function	Digital input	Control word
Enable reference	Starts selected motion.	✓	✓
Sync. to position mode	Selects positioning in synchronizing mode.	✓	✓
Home sensor	Selects input for home sensor.	✓	✓
Home sensor inverse	Selects input for home sensor.	✓	–
Touch sensor	Selects input for touch probe sensor.	✓	✓
Touch sensor inverse	Selects input for touch probe sensor.	✓	–
Speed mode	Selects speed mode when parameter ***1-00 Configuration Mode*** is set to ***[9] Positioning*** or ***[10] Synchronization***.	✓	✓
Target inverse	Changes the sign of the set target position. For example, if the set target is 1000, the activation of this option changes the value to -1000.	✓	✓
Position vir. master	Activates position-controlled virtual master.	✓	✓
Set master home	Sets the actual master position as defined in parameter ***17-88 Master Home Position***.	✓	✓
Master marker	Master marker signal (normally open).	✓	–
Master marker inv	Master marker signal (normally closed).	✓	–
Follower marker	Follower marker signal (normally open).	✓	–
Follower marker inv	Follower marker signal (normally closed).	✓	–
Activate CAM cycles	Activates the number of CAM cycles set in parameter ***17-97 Number of CAM Cycles***.	✓	✓
Activate CAM table	Activates a new CAM table with bumpless transfer.	✓	✓
Set vir. mas. pos. to actual	Sets the virtual master position = actual follower position.	✓	✓

When ***[3] FC Motion Profile*** is selected in parameter ***8-10 Control Word Profile***, the bits in the control word have meaning as described in Table 3.

Table 3: Control Word for [3] FC Motion Profile Selection in Parameter 8-10 Control Word Profile

Bit	0	1
0	Preset reference LSB	–
1	Preset reference MSB	–
2(1)	Preset reference EXB	–
3	Coast stop	No coast stop
4	Quick stop	No quick stop
5	No reference	Enable reference
6	Ramp stop	Start
7	No reset	Reset
8	No jog	Jog
9(1)	Absolute	Relative
10	Data not valid	Data valid
11(1)	No homing	Start homing
12(1)	No touch	Activate touch
13	Setup select LSB	–
14	Setup select MSB	–
15	No reversing	Reversing

1) Different from [0] FC Profile.

Options for bits 0–2 and 12–15 in parameter ***8-14 Configurable Control Word CTW***:

- ***[11] Start homing***
- ***[12] Activate touch probe***
- ***[13] Sync. to pos. mode***
- ***[17] Speed mode***
- ***[18] Virtual master***
- ***[19] Enable master offset***
- ***[20] Target inverse***
- ***[26] Home sensor***
- ***[27] Touch sensor***
- ***[28] Position vir. master***
- ***[29] Set master home***
- ***[30] Set vir, mas. pos. to actual***
- ***[31] Activate CAM table***
- ***[34] Activate CAM cycles***

2.6.2 Status Signals

IMC status signals are available as digital I/O bits and fieldbus bits. Table 4 details the available options.

Table 4: Status Signals

Name	Function	Digital output	Status word
Reverse after ramp	Indicates the sign of speed reference after the ramp.	✓	✓
Virtual master dir.	Controls the direction of followers.	✓	–
Homing OK	Homing is completed with the selected homing function.	✓	✓
On target	Positioning: Target position reached. Synchronization: Follower position aligned with master position.	✓	✓
Position error	Maximum position error exceeded.	✓	✓
Position limit	A position limit is reached (parameter ***3-06 Minimum Position*** or parameter ***3-07 Maximum Position***).	✓	✓
Touch on target	Target position is reached in touch probe position mode.	✓	✓
Touch activated	Touch probe positioning active.	✓	✓
Touch sen. found	The touch sensor has been detected.	✓	✓
Vir. master on ref.	The virtual master is running on set reference.	✓	✓
Pos. set. acknowledge	Acknowledge that a new setpoint is received.	✓	✓
Execution distance extended	Indicates that the offset execution distance has been extended due to speed/ramp limitation.	–	✓

When ***[3] FC motion profile*** is selected in parameter ***8-10 Control Word Profile***, the bits in the status word have the meaning described in Table 5

Table 5: Status Word for [3] FC Motion Profile Selection in parameter *8-10 Control Word Profile*

Bit	0	1
0	Control not ready	Control ready
1	Frequency converter not ready	Frequency converter ready
2	Coasting	Enable
3	No error	Trip
4(1)	Not homed	Home done
5	Reserved	Reserved
6	No error	Trip lock

Table 5: Status Word for [3] FC Motion Profile Selection in parameter *8-10 Control Word Profile* (continued)

Bit	0	1
7	No warning	Warning
8[(1)]	Not on target position	Target position reached
9	Local operation	Bus control
10	Out of frequency limit	Frequency limit OK
11	No operation	In operation
12	Frequency converter OK	Stopped, auto start
13	Voltage OK	Voltage exceeded
14	Torque OK	Torque exceeded
15	Time OK	Timer exceeded

1) Different from [0] FC profile.

Options for bits 5 and 12–15 in parameter ***8-13 Configurable Status Word STW***:

- ***[4] Position error***
- ***[5] Position limit***
- ***[6] Touch on target***
- ***[7] Touch activated***
- ***[8] Touch sen. found***
- ***[9] Vir. master on ref.***
- ***[22] Execution distance extended***
- ***[96] Reverse after ramp***
- ***[210] Pos. set. acknowledge***

2.7 Cyclic Synchronous Control via EtherCAT

2.7.1 Introduction to Cyclic Synchronous Control via EtherCAT

With cyclic synchronous control, all profiling is done in the external controller, and the drive only works as a speed- or position-controlled axis.

Obtaining fast and low-jitter transmission of references requires a VLT® EtherCAT MCA 124 option, version 5.00 or newer. The MCA 124 supports synchronization of the internal drive clock to the EtherCAT cycle time.

The drive offers 3 different cyclic synchronous modes, which are selected in parameter ***1-00 Configuration Mode***:

- ***[11] Cyclic Sync. Position***: cyclic synchronous positioning according to DS402 (mode 8 CSP).
- ***[12] Cyclic Sync. Velocity***: cyclic synchronous velocity control according to DS402 (mode 9 CSP).
- ***[15] Mode of Operation DS402***: control mode according to DS402 selected in parameter ***1-09 Mode of Operation***.

Table 6: Available Modes in Parameter 1-09 Modes of Operation

Option	Name	Description
[0]	***No mode change***	No mode of operation is selected. The active mode of operation is ***[2] Velocity mode (vl)***.
[1]	***Profile position mode***	Basic positioning mode where the drive profile generator calculates the speed profile based on the set target position, speed, and ramps.
[2]	***Velocity mode (vl)***	Basic speed mode using the set speed and ramps.
[6]	***Homing mode***	Activates the homing function selected in parameter ***17-80 Homing Function***.
[8]	***Cyclic sync position mode***	The drive controls the position based on cyclic position reference from an external controller. The speed/ramp profile must be calculated/handled by the external controller.
[9]	***Cyclic sync velocity mode***	The drive controls the speed based on cyclic speed reference from an external controller. Acceleration/deceleration must be handled by the external controller.
[249]	***Gear mode***	The drive synchronizes to the provided master positions using the set gear ratio.
[250]	***CAM mode***	The drive synchronizes to the provided master positions according to the CAM table set.

2.7.2 Control Words

Control words are mapped according to the DSP402 profile depending on the selected mode.

Table 7: Control Words

Mode of operation	Velocity mode	Homing mode	Profile position mode	CSV and CSP
Bit	0/1	0/1	0/1	0/1
0	Switch off/on	Switch off/on	Switch off/on	Switch off/on
1	Disable/enable voltage	Disable/enable voltage	Disable/enable voltage	Disable/enable voltage
2	Quick stop/run	Quick stop/run	Quick stop/run	Quick stop/run
3	Disable/enable operation	Disable/enable operation	Disable/enable operation	Disable/enable operation
4	Disable/enable ramp	Stop/start homing	New setpoint	–
5	Freeze/enable ramp	0	Change set immediately	–
6	Ramp stop/start	0	Absolute/relative	–
7	No reset/reset	No reset/reset	No reset/reset	No reset/reset
8	Halt[(1)]	Halt[(1)]	Halt[(1)]	Halt[(1)]

Table 7: Control Words (continued)

Mode of operation	Velocity mode	Homing mode	Profile position mode	CSV and CSP
9	–	–	Buffered/standard	–
10	–	–	–	–
11	Jog 1 off/on	Jog 1 off/on	Jog 1 off/on	Jog 1 off/on
12	–	–	–	–
13	Setup select LSB	Setup select LSB	Setup select LSB	Setup select LSB
14	Setup select MSB	Setup select MSB	Setup select MSB	Setup select MSB
15	Forward/reverse	Forward/reverse	Forward/reverse	

1) Halt option code +1, ramp down to standstill and hold position.

2.7.3 Status Words

Status words are mapped according to the DS402 profile depending on the selected mode.

Table 8: Status Words

Mode of operation	Velocity mode	Homing mode	Profile position mode	CSV	CSP
Bit	0/1	0/1	0/1	0/1	
0	Ready to switch on	Ready to switch on	Ready to switch on	Ready to switch on	Ready to switch on
1	Switched on	Switched on	Switched on	Switched on	Switched on
2	Operation enabled	Operation enabled	Operation enabled	Operation enabled	Operation enabled
3	Fault	Fault	Fault	Fault	Fault
4	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled	Voltage enabled
5	Quick stop (0)	Quick stop (0)	Quick stop (0)	Quick stop (0)	Quick stop (0)
6	Switch on disabled	Switch on disabled	Switch on disabled	Switch on disabled	Switch on disabled
7	Warning	Warning	Warning	Warning	Warning
8	–	–	–	–	–
9	Remote	Remote	Remote	Remote	Remote
10	0	Target reached	Target reached	0	0
11	Internal limit active	Internal limit active	Internal limit active	Internal limit active	Internal limit active
12	0	Homing attained	Setpoint acknowl-edge	Drive follows the commanded value	Drive follows the commanded value
13	0	Homing error	Following error	0	Following error
14	Running	Running	Running	Running	Running
15	–	–	–	–	–

2.7.4 References for CSV

In cyclic synchronous velocity mode, the drive can be controlled in 2 ways:

- By providing a target velocity only.
- By providing a target velocity and acceleration.

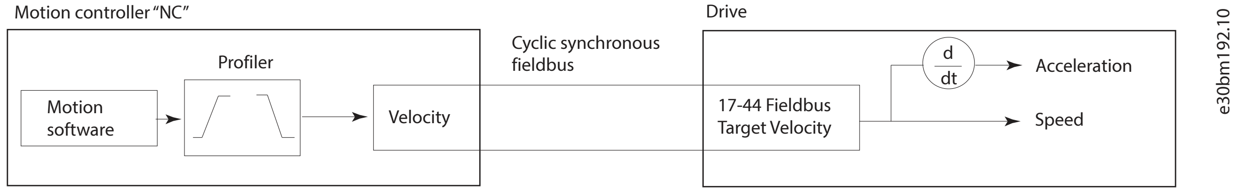


Figure 8: Target Velocity in CSV Mode

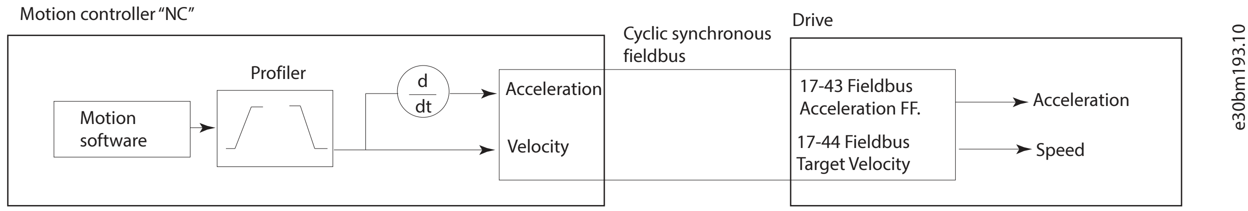


Figure 9: Target Velocity and Acceleration in CSV Mode

2.7.5 References for CSP

In cyclic synchronous position mode, the drive can be controlled in 2 ways:

- By providing a position reference only.
- By providing a position reference, target velocity, and acceleration.

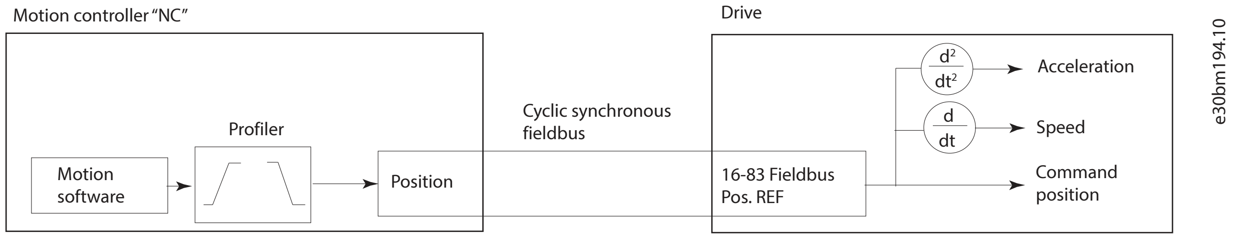


Figure 10: Position Reference in CSP Mode

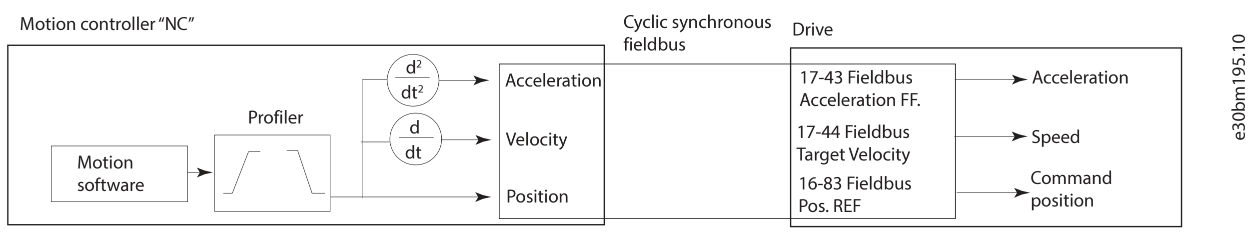


Figure 11: Position Reference, Target Velocity, and Acceleration in CSP Mode

2.8 Homing

2.8.1 Introduction to Homing

The homing function is typically used for the following purposes:

- To define the 0 point of the machine. Typically needed after every power-up when using sensorless position control or using incremental encoder for position feedback.

- Set the absolute encoder offset.
- Home synchronization to realign the home position right away.

Multiple homing functions in parameter ***17-80 Homing Function***, with and without sensor, are available for defining machine 0 or setting of absolute encoder offset.

Use the *Start Homing* signal to activate the selected homing function. The *Start Homing* signal can be activated from either

- Standby state: In this state, the drive is enabled with no start signal.
- Running state: In this state, the drive has a start signal, and the motor is magnetized.

The *Homing OK* signal is set when the selected homing function is completed. By default, the setting ***[0] Clear at Powerup***is used to clear the *Homing OK* signal at power-down or when restarting the homing function.

Apart from the default setting, it is possible to set the following homing behaviors in parameter ***17-86 Homing Flag Behavior***:

- ***[1] Clear at coast***: *Homing OK* signal is cleared at every motor coast and a new homing is needed. Typically relevant for sensorless control when position tracking is lost.
- ***[2] Clear at coast running***: *Homing OK* signal is cleared at motor coast only while the motor is running. A new homing is needed. Typically relevant for sensorless control when position tracking is lost even when the motor is moving, while the drive is coasted.
- ***[3] Clear at Homing Only***: The selected home function is used to set the absolute encoder offset in parameter ***17-74 Position Offset*** to get the actual position in parameter ***17-82 Home Position*** at the selected home position of the physical machine. The *Homing OK* signal is reset when restarting the homing function only, not at power-down.

Home synchronization is another homing function which requires a sensor and no *Start Homing* signal. When ***[2] Home sync function*** is selected in parameter ***17-80 Homing Function***, home synchronization is active in the background while the drive is running.

The behavior of the drive with the various homing functions is described in the following sections.

2.8.2 Home Position

The Home function does not start any movement. The current position of the physical machine is defined as Home Position. The actual position parameter ***16-06 Actual Position*** is set to the value of parameter ***17-82.0 Home Position***.

2.8.3 Analog Input

The Home function does not start any movement. The position value which corresponds to the actual value on the analog inputs is set as the actual position.

Example:

- Parameter ***3-06 Minimum Position*** = 0
- Parameter ***3-07 Maximum Position*** = 1000
- Analog input = 5 V

The actual position is set to 500.

2.8.4 Direction with Home Sensor

Search for home sensor is started in forward or reverse direction. The reversing signal controls the search using the speed set in parameter ***17-83 Homing Speed***.

The value in parameter ***16-06 Actual Position*** is set to the value of parameter ***17-82.0 Home Position*** index 0 when running forward or parameter ***17-82.1 Home Position*** index 1 when running reverse.

The drive stops at the set home position.

The following illustration shows scenarios with different starting points.

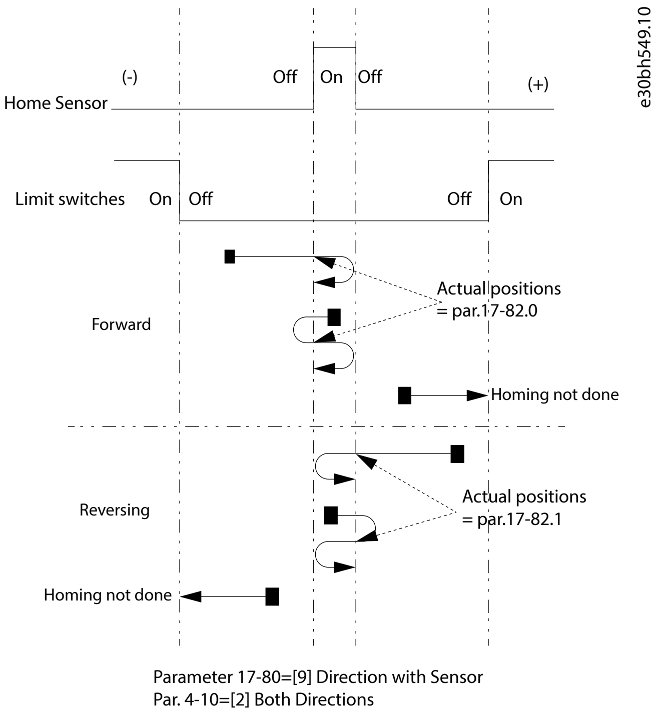


Figure 12: Direction with Sensor

2.8.5 Forward or Reverse with Home Sensor

Search for the home sensor is started in the selected direction using the speed set in parameter ***17-83 Homing Speed***.

When the home sensor is found, the position of the physical machine at the leading edge of the home sensor signal is defined as home position. The parameter ***16-06 Actual Position*** is set to the value of parameter ***17-82.0 Home Position*** index 0.

The drive then stops at the home position in parameter ***17-82.0 Home Position*** index 0 and the offset set position in parameter ***17-82.1 Home Position*** index 1.

The following illustration shows possible scenarios with different starting points.

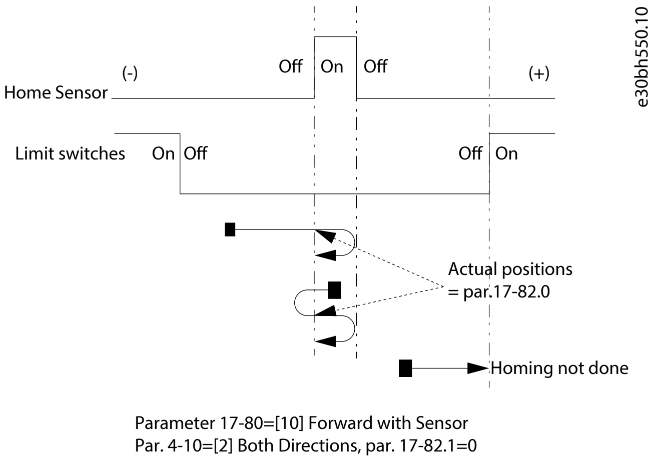


Figure 13: Forward with Home Sensor - Parameter 17-82.1 = 0

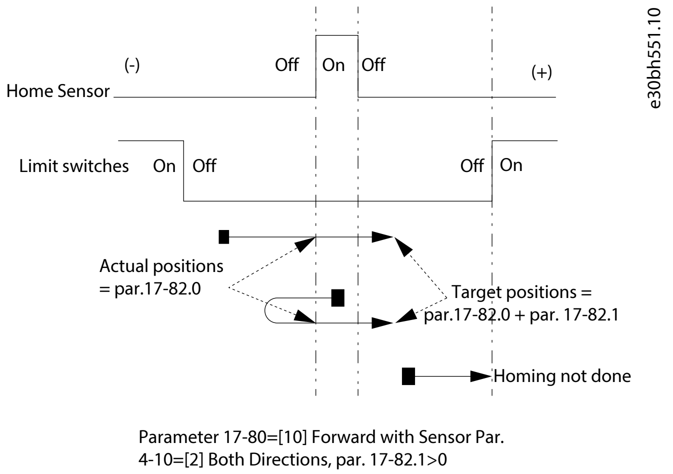


Figure 14: Forward with Home Sensor - Parameter 17-82.1 > 0

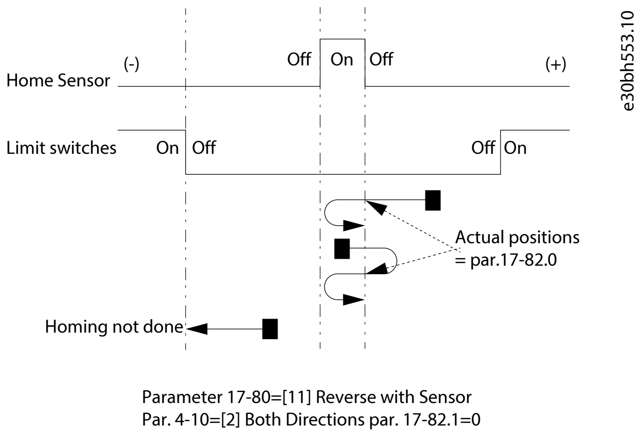


Figure 15: Reverse with Home Sensor - parameter 17-82=0

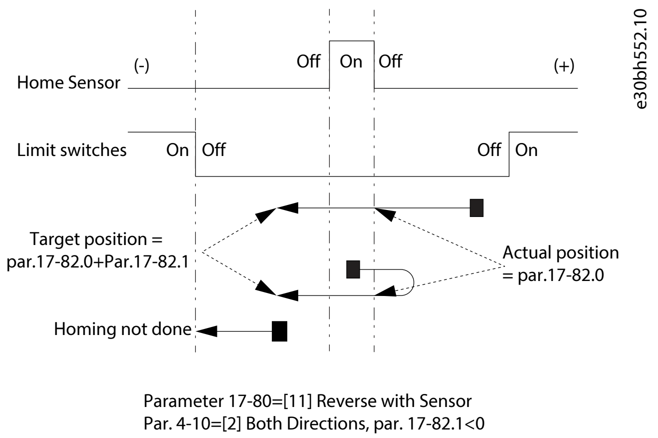


Figure 16: Reverse with Sensor - parameter 17-82.1<0

2.8.6 Forward or Reverse II with Home Sensor

The same functionality as forward or reverse with home sensor, with 2 more functions:

- Search for the home sensor with the speed set in parameter ***17-83 Homing Speed***. When the home sensor is detected, the actual homing is done with 10% of the homing speed. This technique enables searching for the home sensor at a high speed without reducing the homing accuracy.

- When an end limit switch is found before the home sensor is detected, the drive reverses and searches for the home sensor in the opposite direction. Based on the setting in parameter ***4-74 Start Fwd/Rev Function***, the drive shows a *warning/alarm 215 Start Fwd/ Rev*, when both the end limits are found without detecting the home sensor.

The following graphical representations show scenarios with different starting positions.

The black line shows running at homing speed and the red line show running at 10% of the homing speed.

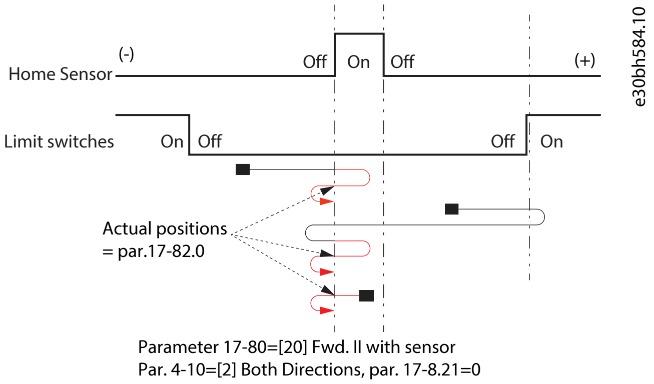


Figure 17: Forward II with Sensor, Parameter 17-82.1=0

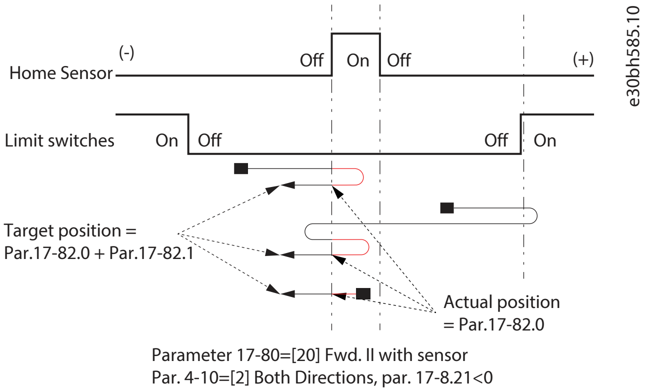


Figure 18: Forward II with Sensor, Parameter 17-82.1 < 0

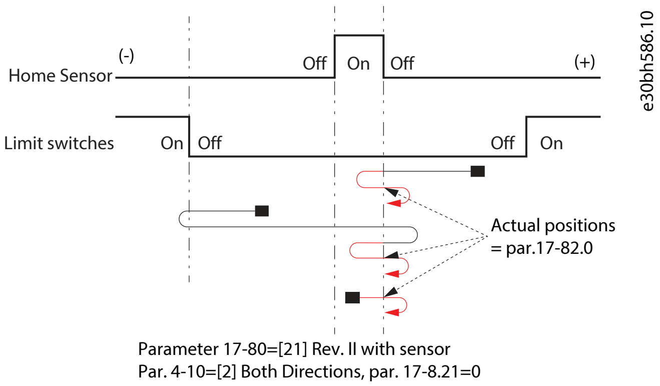


Figure 19: Reverse II with Sensor, Parameter 17-82.1=0

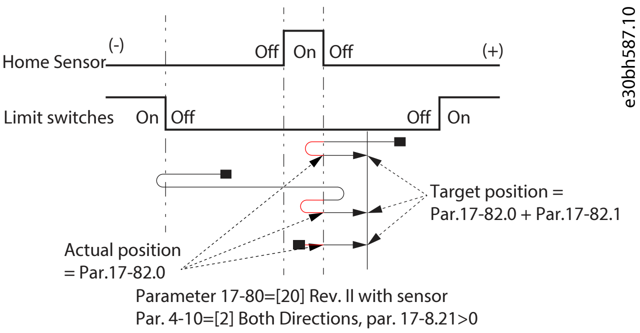


Figure 20: Reverse II with Sensor, Parameter 17-82.1 > 0

2.8.7 Direction with Encoder Zero Pulse

Search for zero pulse is started in forward or reverse direction. The reversing signal controls the search using the speed set in parameter ***17-83 Homing Speed***.

When the zero pulse is detected, the physical position of the machine at the zero pulse signal is defined as Home position.

The actual position parameter ***16-06 Actual Position*** is set to parameter ***17-82.0 Home Position*** index 0 when running forward or parameter ***17-82.1 Home Position*** index 1 when running reverse.

The drive stops at the set home position.

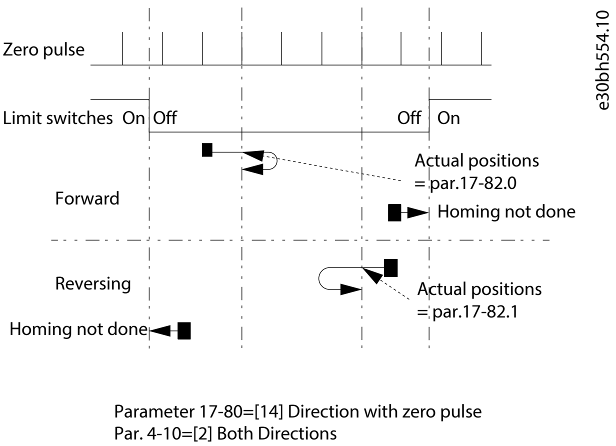


Figure 21: Direction with Encoder Zero Pulse

2.8.8 Forward or Reverse with Encoder Zero Pulse

The search for zero pulse begins in the selected direction using the speed set in parameter ***17-83 Homing Speed***.

When the zero pulse is detected, the physical position of the machine at the zero pulse signal is defined as home position. Parameter ***16-06 Actual Position*** is set to the value in parameter ***17-82.0 Home Position*** index 0.

The drive stops at the home position. The home position is the value in parameter ***17-82.0*** + the offset value in parameter ***17-82.1***.

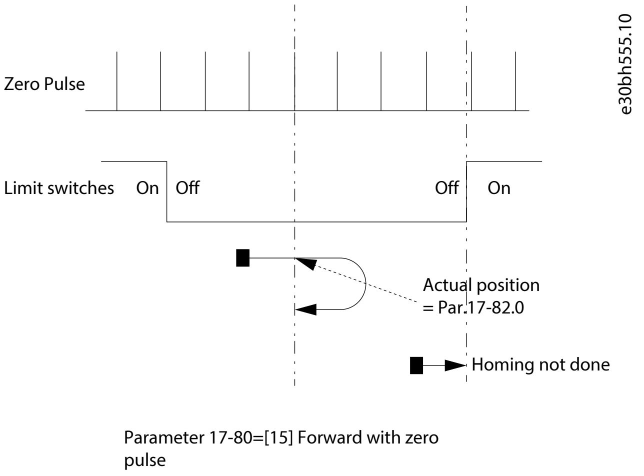


Figure 22: Forward with Encoder Zero Pulse - Parameter 17-82.1 = 0

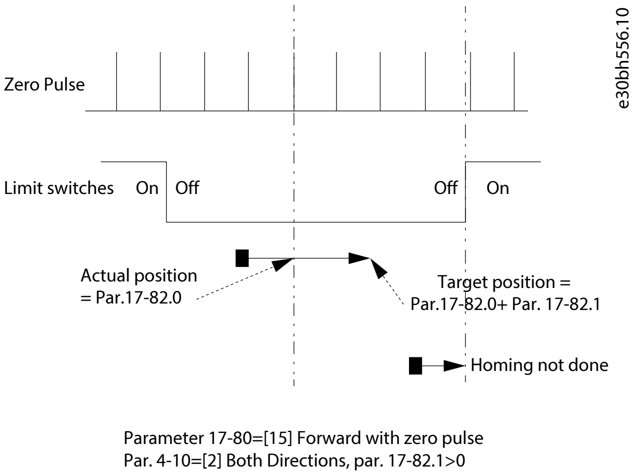


Figure 23: Forward with Encoder Zero Pulse - Parameter 17-82.1 > 0

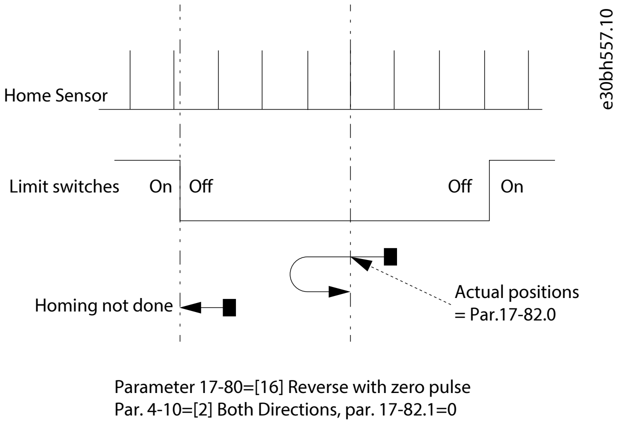


Figure 24: Reverse with Zero Pulse - Parameter 17-82.1 = 0

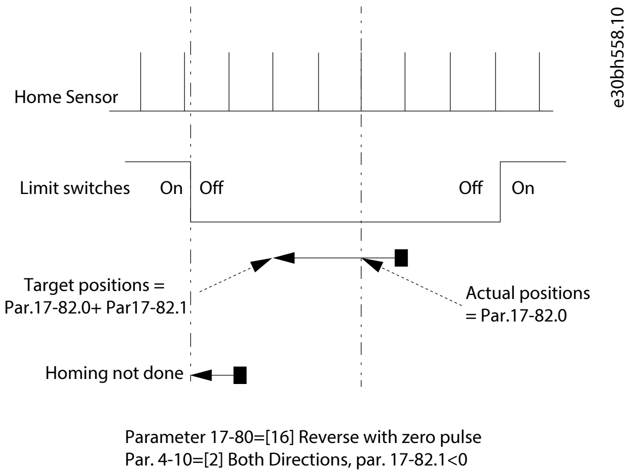


Figure 25: Reverse with Zero Pulse - Parameter 17-82.1 < 0

2.8.9 Direction with Home Sensor and Encoder Zero Pulse

The search for home sensor starts by using the speed set in parameter ***17-83 Homing Speed***. After finding the home sensor, the drive continues in the same direction.

The position of the physical machine at the next zero pulse signal is defined as home position. When in forward direction, parameter ***16-06 Actual Position*** is set to the value of parameter ***17-82.0 Home Position*** index 0 and when in reverse, parameter ***16-06 Actual Position*** is set to the value in parameter ***17-82.1 Home Position*** index 1.

The drive then stops at the set home position.

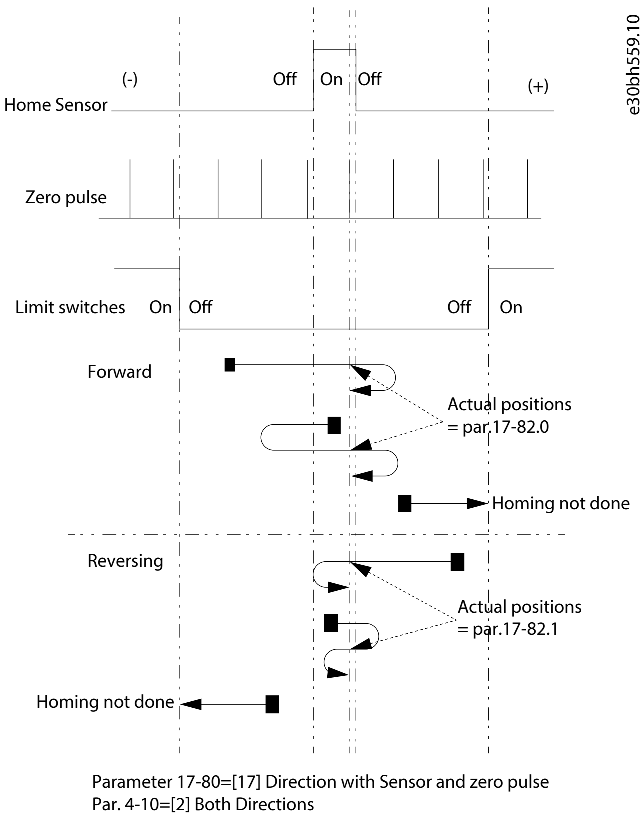
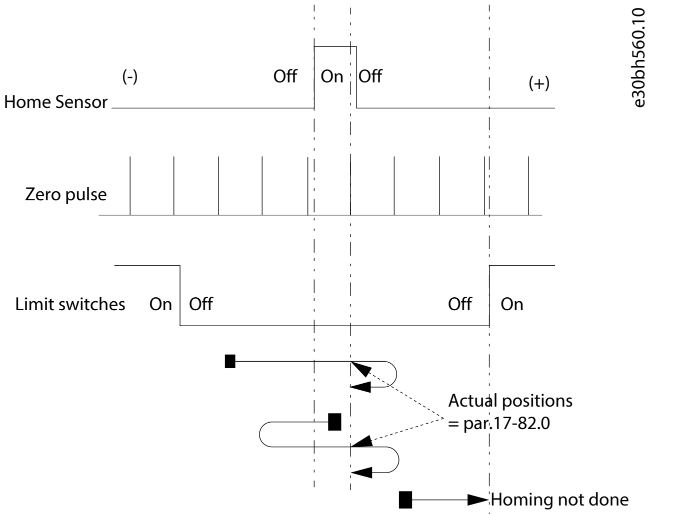


Figure 26: Direction with Home Sensor and Encoder Zero Pulse

2.8.10 Forward or Reverse with Home Sensor and Encoder Zero Pulse

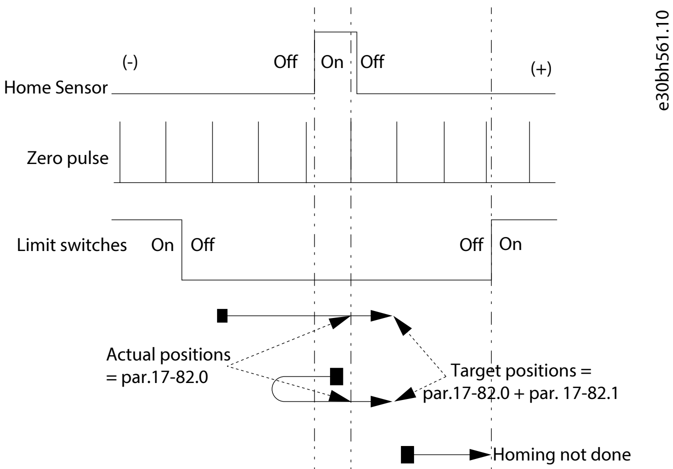
Home sensor search is started in the selected direction with the speed set in parameter ***17-83 Homing Speed***. On detecting the home sensor, the drive continues in the same direction and the physical position of the machine at the next zero pulse signal is defined as Home Position. The actual position parameter ***16-06 Actual Position*** is set to the value of parameter ***17-82.0 Home Position*** index 0.

The drive stops at the home position (parameter ***17-82.0 Home Position*** index 0) + the offset set in parameter ***17-82.1 Home Position*** index 1.



Parameter 17-80=[18] Forward with Sensor and zero pulse
Par. 4-10=[2] Both Directions, par. 17-82.1=0

Figure 27: Forward with Home Sensor - Parameter 17–82.1 = 0



Parameter 17-80=[18] Forward with Sensor and zero pulse
Par. 4-10=[2] Both Directions, par. 17-82.1>0

Figure 28: Forward with Home Sensor - Parameter 17–82.1 > 0

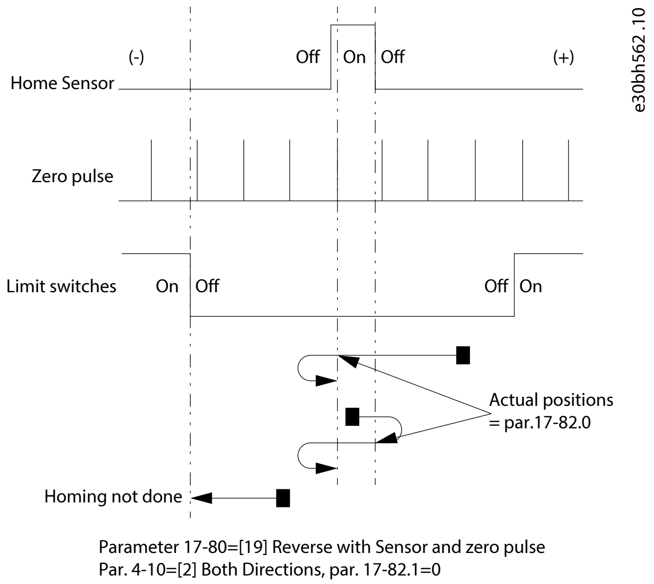


Figure 29: Reverse with Home Sensor - Parameter 17–82.1 = 0

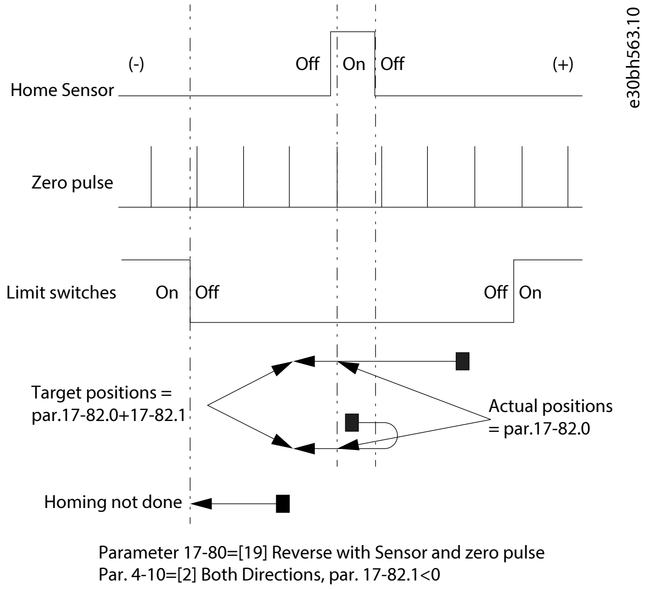


Figure 30: Reverse with Home Sensor - Parameter 17–82.1 < 0

2.8.11 Forward or Reverse only with Home Sensor for Rotary Mode

Homing on the sensor for rotary mode where movement is only allowed in 1 direction.

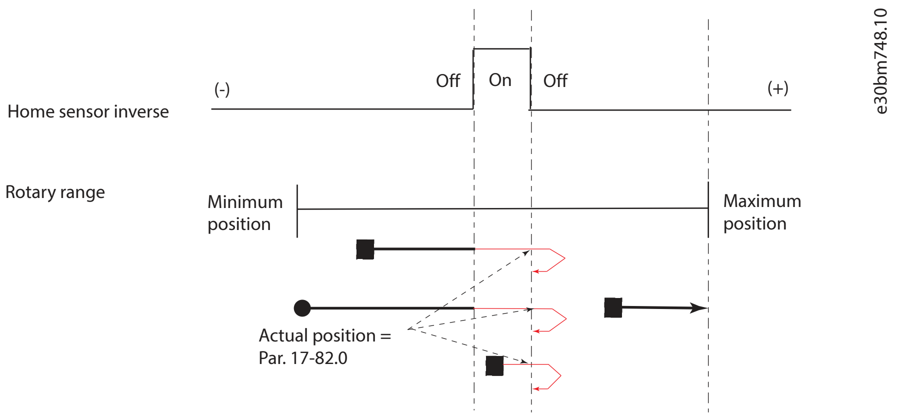
Search for the home sensor with the speed set in parameter ***17-83 Homing Speed*** in the selected direction. When the 1st edge of the home sensor is detected, movement continues in the same direction with 10% of the homing speed. The actual homing is done at the 2nd edge of the home sensor.

NOTE: Without Home Offset there will be a short movement opposite to the selected direction to stop at the Home Position.

The black lines in the following examples show running at homing speed while the red lines show running at 10% of the homing speed.

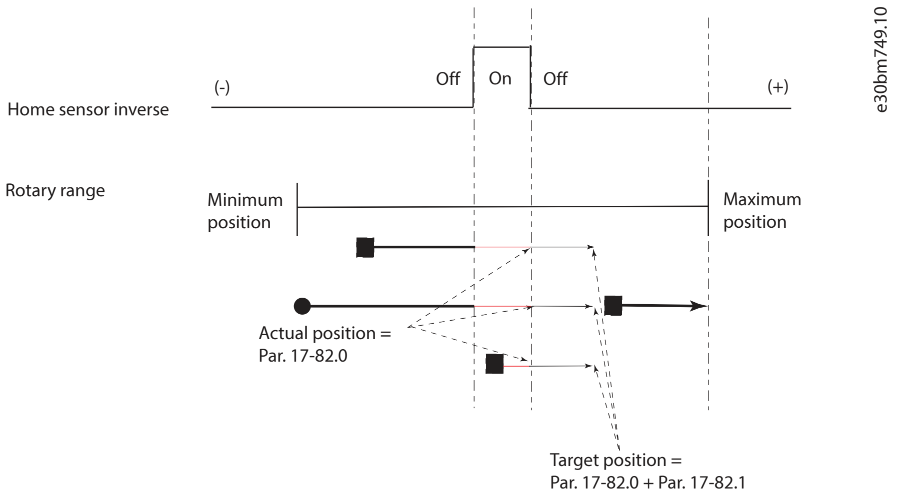
Example 1

Parameter ***17-80 Homing Function*** = ***[23] Fwd. only with sensor***, parameter ***4-10 Motor Speed Direction*** = ***[2] Both directions***, parameter ***17-82.1 Home Position*** = 0.



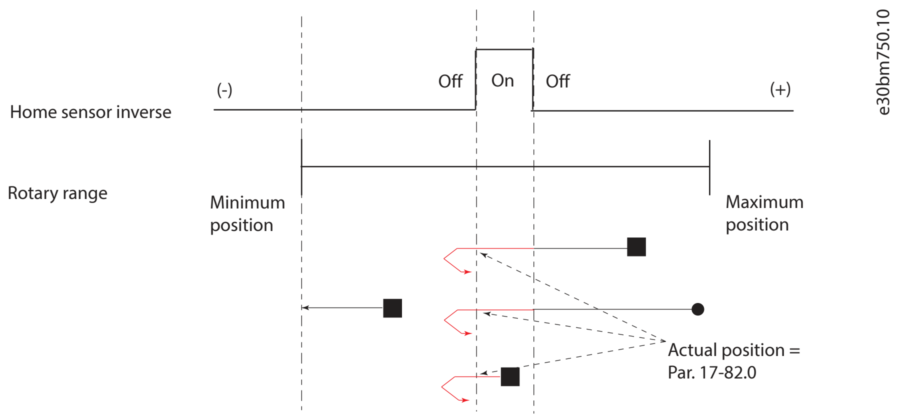
Example 2

Parameter ***17-80 Homing Function***= ***[23] Fwd. only with sensor***, parameter ***17-82.1 Home Position*** > 0.



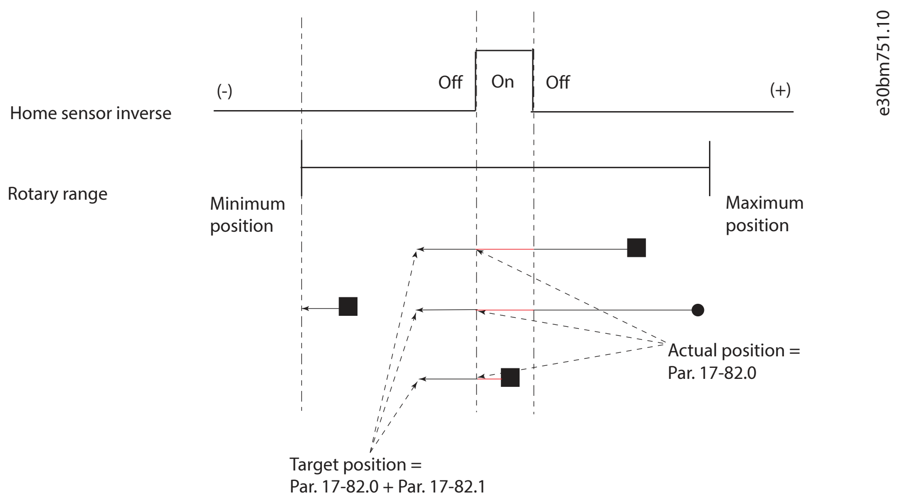
Example 3

Parameter ***17-80 Homing Function***= ***[24] Rev. only with sensor***, parameter ***4-10 Motor Speed Direction*** = ***[2] Both directions***, parameter ***17-82.1 Home Position*** = 0.



Example 4

Parameter ***17-80 Homing Function*= *[24] Rev. only with sensor***, parameter ***17-82.1 Home Position*** < 0.



2.8.12 Torque Limit

Using the speed set in parameter ***17-83 Homing Speed***, the search for home sensor begins in the selected direction. The position of the physical machine where the motor is forced to stop on reaching the homing Torque Limit is defined as Home Position. The homing torque limit is set in parameter ***17-84 Homing Torque Limit***.

Actual Position is set to the value specified in parameter ***17-82.0 Home Position*** index 0. The drive then goes to the home position.

Home position is the value in parameter ***17-82.0 Home Position*** + the offset set in parameter ***17-82.1 Home Position*** index 1. See 2.8.2 Home Position.

2.8.13 Home Synchronization

When Home Synchronization is active, the actual position is reset when passing the home sensor in a forward or reverse direction.

In the forward direction, the actual position is set to parameter ***17-82.0 Home Position*** index 0, at the leading edge of the home sensor signal.

In the reverse direction, the actual position is set to parameter ***17-82.1 Home Position*** index 1 at the leading edge of the home sensor signal.

The condition for resetting the actual position when Home Synchronization is active can be selected in parameter ***17-81 Home Sync Function***

2.9 Scaling of Position Units

2.9.1 Overview of Scaling of the Position Units

IMC supports scaling of position units. 3 examples of linear belt drive are considered to provide recommended parameter settings for position values. Set position values in parameter ***17-72 Position Unit Numerator*** and parameter ***17-73 Position Unit Denominator***. To obtain the right scaling, set values in parameter ***7-94 Position PI Feedback Scale Numerator*** and parameter ***7-95 Position PI Feedback Scale Denominator***.

2.9.2 Example 1

Linear belt drive with pulley wheel direct on motor. The pulley wheel has 32 teeth and the timing belt pitch is 10 mm.

Linear movement per motor revolution is 32 x 10 = 320 mm.

For position values in mm, set parameter ***17-72 Position Unit Numerator*** = 320 and parameter ***17-73 Position Unit Denominator*** = 1.

2.9.3 Example 2

Consider the linear belt drive (from 2.9.2 Example 1). In this example, a VLT® OneGearDrive (OGD) with a gear ratio of 14.13 is also considered.

14.13 is a rounded value. The actual gear ratio of this 2 stage gear is stage one 43/7 and stage two 46/20. Without making rounding errors, the calculated ratio is 43*23: 7*10 = 989:70

For position values in mm, set parameter ***17-72 Position Unit Numerator*** = 320 * 70 = 22400 and parameter ***17-73 Position Unit Denominator*** = 989.

Where

- 320 is the linear movement per motor revolution.
- 70 is the denominator of the gear ratio.
- 989 is the numerator of the gear ratio.

2.9.4 Example 3

Consider the linear belt drive which uses a VLT® OneGearDrive (OGD) with closed loop control using an encoder mounted on the pulley wheel shaft. The gear ratio is 14.13 which is a rounded value.

To obtain the right scaling between motor and encoder, set parameter ***7-94 Position PI Feedback Scale Numerator*** to 70 and parameter ***7-95 Position PI Feedback Scale Denominator*** to 989.

Where

- 70 is the denominator of the calculated ratio.
- 989 is the numerator of the calculated ratio.

See 2.9.3 Example 2 for ratio calculation.

2.10 Gear Ratio for Synchronization

2.10.1 Synchronization of Gear Ratio

The gear ratio between master and follower is set by determining the number of revolutions the follower has to move per master revolution.

When an encoder is master, 1 master revolution is defined as 1 encoder revolution. For a virtual master, 1 master revolution is defined by the encoder output resolution.

The following example shows how to determine accurate master scaling. Using the following example, 3 scenarios are described.

Example: Consider 2 identical conveyor belts driven by 2 different VLT® One Gear Drive. The master OGD has a gear ratio of 31.12 and the follower OGD has a gear ratio (i) of 5.92. The gear ratio is the same independent of whether the follower control configuration is with or without encoder feedback.

2.10.2 Scenario 1

The master encoder is placed on the conveyor shaft, which indicates that the master encoder is placed after the gearbox. Hence, the gear ratio of the master OGD is not considered.

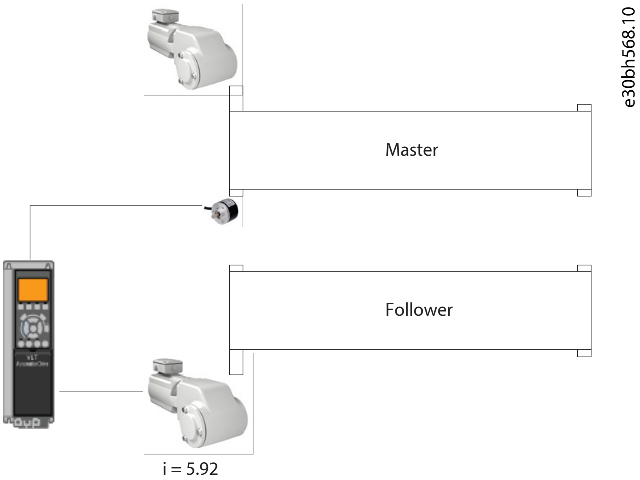


Figure 31: Master Encoder After the Gearbox

Stage 1: 43/7

Stage 2: 27/28

Calculated Ratio: 43 x 27 : 7 x 28 = 1161:196

The calculated ratio indicates that 196 master encoder revolutions correspond to 1161 follower motor revolutions.

Set the following parameters for the follower conveyor belt.

- Set parameter ***3-22 Master Scale Numerator*** to 196.
- Set parameter ***3-23 Master Scale Denominator*** to 1161.

This setting allows the follower conveyor belt to move the same distance as the master conveyor belt.

2.10.3 Scenario 2

Master encoder is placed on the master motor which indicates that the master encoder is placed before the gearbox. Therefore, the master signal must be scaled with both the master OGD gear ratio and the follower OGD gear ratio.

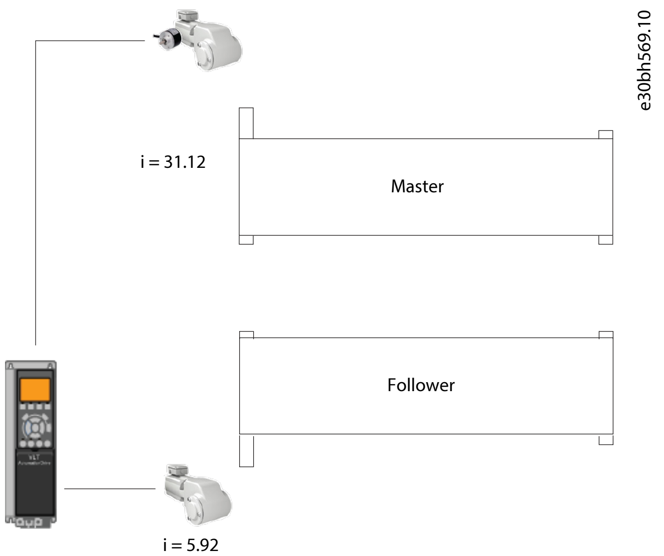


Figure 32: Master Encoder Before the Gearbox

Stage 1: 43/7

Stage 2: 76/15

Calculated ratio: 43 x 76 : 7 x 15 = 3268 : 105

When multiplied by the existing ratio: 196 x 3268 : 1161 x 105 = 640528 : 121905

Reduced ratio: 2128 : 405

Set the parameter as follows:

- Set parameter **3-22 Master Scale Numerator** to 2128.
- Set parameter **3-23 Master Scale Denominator** to 405.

In this scenario, for every 2128 revolutions of the master motor/encoder the follower motor must make 405 revolutions for the 2 conveyor belts to move the exact same distance.

2.10.4 Scenario 3

In this scenario, both drives are followers synchronizing to a virtual master signal, as shown.

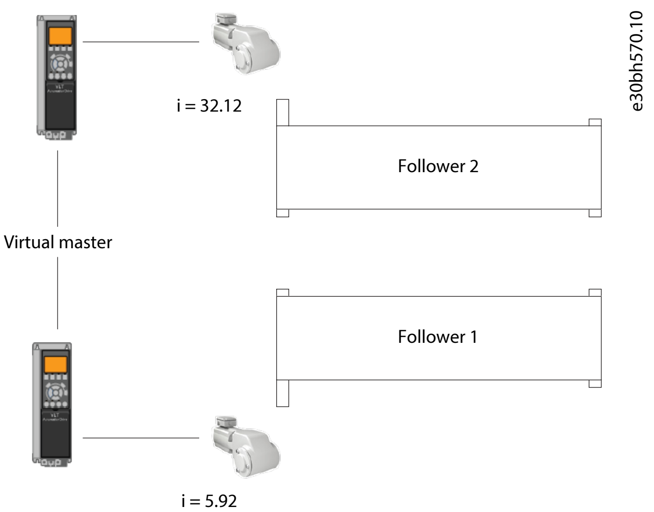


Figure 33: Drives Synchronizing to Virtual Master Signal

- Follower 1 OGD has i=5.92

- Follower 2 OGD has i=31.12

The ratio for followers is calculated using the OGD. The ratio for follower 1 is calculated as in 2.10.2 Scenario 1. Set parameters as follows:

- Set parameter ***3-22 Master Scale Numerator*** to 196.
- Set parameter ***3-23 Master Scale Denominator*** to 3268.

Ratio for follower 2 using OGD with i=31.12. See the calculated ratio calculation in 2.10.3 Scenario 2.

Set parameters as follows:

- Set parameter ***3-22 Master Scale Numerator*** to 105.
- Set parameter ***3-23 Master Scale Denominator*** to 3268.

For each master revolution (defined by virtual master encoder output resolution), follower 1 must make 1161/196 (approximately 5.92) motor revolutions, and follower 2 must make 3268/105 (approximately 31.12) motor revolutions for the 2 conveyor belts to move the same distance.

2.11 Recommendations for Commissioning Steps

2.11.1 Commissioning Steps

Procedure

1. Configure the LCP status view.
2. Perform motor configuration.
3. Configure feedback for closed loops.
4. Configure speed PID and position PI.

   Default settings available in the AC drives are suitable for most applications.
5. Scale position units and scale master for synchronizing the gear ratio.
6. Configure homing.

   This configuration is only relevant for absolute positioning in sensorless or closed loop with incremental encoder.
7. Configure control signals and references.

3 Setups and Connection Examples for Positioning and Synchronizing

3.1 Linear Sensorless Positioning

3.1.1 Linear Sensorless Positioning Application

The following setup shows an application which uses sensorless control of a permanent magnet motor without encoder feedback.

- Absolute positioning with 2 fixed targets selected by PROFIBUS or Digital I/O.
- Position reference after power-up is created by homing on a physical sensor.
- Hardware end limits.
- Position values are scaled to mm units.
- Application is moving at 37 mm per motor revolution.

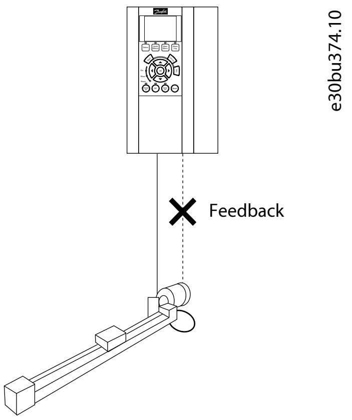


Figure 34: Linear Sensorless Positioning

3.1.1.1 Control by Digital I/O

Following are the recommended parameter settings when a digital I/O controls the absolute positioning with 2 fixed targets.

Table 9: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[9] Positioning***	Enables position control.
1-01 Motor Control Principle	***[2] Flux sensorless***	Motor and position control without feedback.
3-06 Minimum Position	-100 mm	Defines the safe area of movement. The setting of this parameter depends on physical machine layout.
3-07 Maximum Position	500 mm	Defines the safe area of movement. The values depend on the layout of the physical machine.
3-20.0 Preset Target	-50 mm	First fixed target.
3-20.1 Preset Target	450 mm	Second fixed target.
3-41 Ramp 1 Ramp Up Time	2 s	Used to calculate the speed profile for positioning.
3-42 Ramp 1 Ramp Down Time	2 s	Used to calculate the speed profile for positioning.

Table 9: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
4-10 Motor Speed Direction	*[2] Both directions*	Enables motor rotation in both directions.
4-74 Start Fwd/Rev Function	*[8] Coast & Trip*	Set the function when hardware end limits are activated to coast and trip (alarm). To resume movement, reset the alarm. Reset is only possible via LCP as all inputs are used.
5-10 Terminal 18 Digital Input	*[116] Home sensor inverse*	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
5-11 Terminal 19 Digital Input	*[8] Start*	Use input 19 as start. The option magnetizes the motor and starts movement towards the selected target.
5-12 Terminal 27 Digital Input	*[16] Preset ref bit 0*	Use input 27 to select between the 2 preset targets.
5-13 Terminal 29 Digital Input	*[110] Start homing*	Use input 29 to start the home function.
5-14 Terminal 32 Digital Input	*[12] Enable start forward*	Use inputs 32 and 33 as hardware end limits.
5-15 Terminal 33 Digital Input	*[13] Enable start reverse*	
5-40.0 Function Relay	*[223] On target*	Use relay 1 to signal that the target position is reached.
5-40.1 Function Relay	*[222] Homing ok*	Use relay 2 to signal that home function is completed.
17-70 Position Unit	[2] mm	Select mm as position unit in LCP.
17-72 Position Unit Numerator	37	Defines the distance of movement per motor revolution.
17-73 Position Unit Denominator	1	
17-80 Homing Function	*[11] Reverse with sensor*	Performs a search for the homing sensor in reverse direction.
17-83 Homing Speed	100 RPM	The speed required for homing.
17-92 Position Control Selection	*[2] Enable reference*	The enable reference mode is selected permanently. Extra signal is not required to enable new target position. Drive moves to a new target when it is selected while in run mode (start).

3.1.1.1.1 Connections

The following connection shows linear sensorless positioning when sensor homing and end limits are controlled by digital I/O.

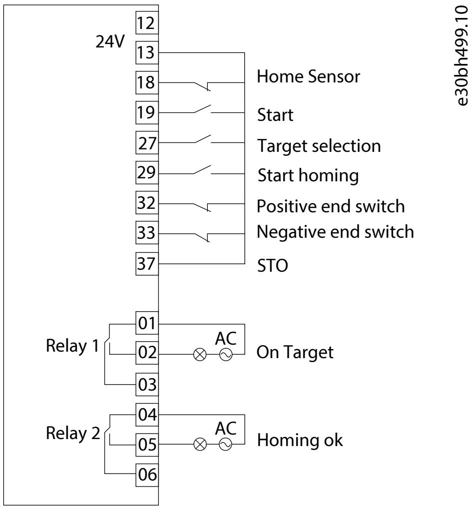


Figure 35: Linear Positioning - Control by Digital I/O

3.1.1.2 Control by Fieldbus

Following are the recommended parameter settings when absolute positioning with 2 fixed targets is selected by PROFIBUS.

Table 10: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[9] Positioning***	Enables position control.
1-01 Motor Control Principle	***[2] Flux Sensorless***	Motor and position control without feedback.
3-06 Minimum Position	-100 mm	Defines the safe area of movement. The setting of this parameter depends on the physical machine layout.
3-07 Maximum Position	500 mm	
3-41 Ramp 1 Ramp Up Time	2 s	Used to calculate the speed profile for positioning.
3-42 Ramp 1 Ramp Down Time	2 s	
4-10 Motor Speed Direction	***[2] Both directions***	Enables motor rotation in both directions.
5-10 Terminal 18 Digital Input	***[116] Home sensor inverse***	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
5-14 Terminal 32 Digital Input	***[12] Enable start forward***	Use inputs 32 and 33 as hardware end limits.
5-15 Terminal 33 Digital Input	***[13] Enable start reverse***	
4-74 Start Fwd/Rev function	***[8] Coast & Trip***	Set the function when hardware end limits are activated to coast and trip (alarm). Make sure to reset before movement can be resumed. Reset is possible only via LCP as all inputs are used.
8-01 Control Site	***[2] Control Word only***	Select option for control is via fieldbus.
9-15.2 PCD Write Configuration	***[1683] Fieldbus Pos. REF***	Use PCD 2 and 3 as 32-bit target position, PCD 1 is speed reference.
9-15.3 PCD Write Configuration	***[1683] Fieldbus Pos. REF***	
9-16.2 PCD Read Configuration	***[1606] Actual position***	Use PCD 2 and 3 to read the actual position as a 32-bit value.
9-16.3 PCD Read Configuration	***[1606] Actual position***	
17-70 Position unit	***[2] mm***	Select mm as the position unit in LCP.

Table 10: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
17-72 Position unit numerator	37	Defines the distance of movement per motor revolution.
17-73 Position unit denominator	1	
17-80 Homing function	***[11] Reverse with sensor***	Performs a search for the homing sensor in reverse direction.
17-83 Homing speed	100 RPM	The speed required for homing.

3.1.1.2.1 Connections

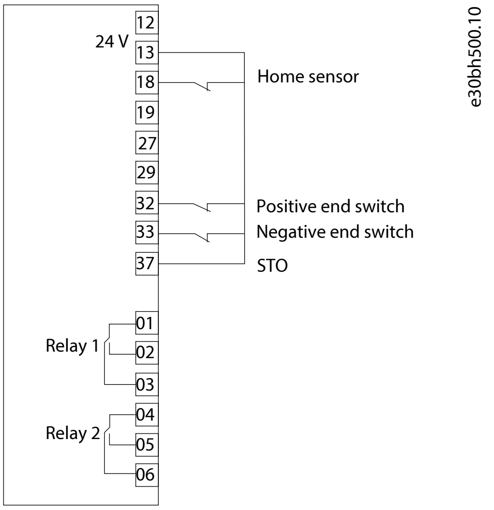


Figure 36: Linear Positioning - Fieldbus

3.1.1.2.2 Control Word Examples

Following are the control word and status word examples applicable for linear sensorless positioning when controlled by fieldbus.

Table 11: Control Word

Function	Binary	Hexadecimal	Comment
Start homing (bit 11)	0000 1100 0001 1000	0C18	Homing is also possible with an active start signal (0C58).
Start (bit 6)	0000 0100 0101 1000	0458	Magnetizes motor maintaining current position.
Enable reference (bit 5)	0000 0100 0111 1000	0478	Activates the set target position and starts movement.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset is also possible with active start and/or enable reference signals such as 04F8.

3.1.1.2.3 Status Word Examples

Following are the status word and status word examples applicable for linear sensorless positioning when controlled by fieldbus.

Table 12: Status Word

Function	Binary	Hexadecimal	Comment
Coasting (bit 2)	0000 0110 0000 0011	0603	The drive is coasting, the motor is not controlled.
Tripped (bit 3)	0000 0111 0001 1000	0718	The drive has stopped with an Alarm, alarm type and status can be read in parameters ***16-9x***.
Homing done (bit 4)	0000 1111 0001 0111	0F17	The selected homing function has been completed.
Target reached (bit 8)	0000 1111 0001 0111	0F17	The active target position has been reached within parameter ***3-08 On Target Window***.

3.1.1.2.4 Fieldbus Data Layout

The following illustrations describe the fieldbus data layout when writing to the drive and reading from the drive.

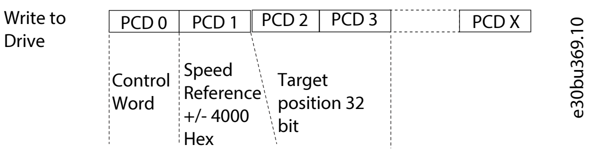


Figure 37: Data Layout - Write to Drive

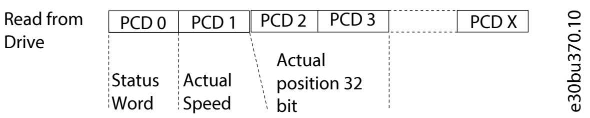


Figure 38: Data Layout - Read from Drive

3.2 Rotary Positioning

3.2.1 Rotary Positioning Application

Consider an indexing table with 8 stations, used by an application with rotary positioning:

- Relative positioning of 45°.
- Sensorless control of induction motor with gearbox 6.14:1.
- Homing is performed on the fly.
- Position values scaled to degrees.
- Control, status, and target position communicated via PROFIBUS or digital I/O.

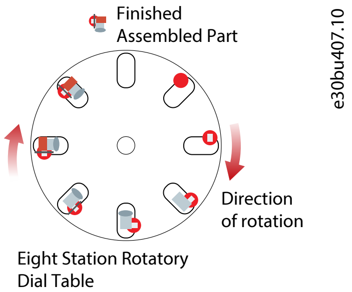


Figure 39: Rotary Positioning

3.2.1.1 Control by Digital I/O

Following are the recommended parameter settings for the application when controlled by digital I/O.

Table 13: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[9] Positioning***	Enables position control.
1-01 Motor Control Principle	***[2] Flux sensorless***	Motor and position control without feedback.
3-03 Maximum Reference	Set the required positioning speed.	The setting is used to calculate the speed profile for positioning. The setting can also be set by external signal or preset reference parameter ***3-10 Preset Reference***.
3-06 Minimum Position	0°	The minimum and maximum positions define 1 revolution in rotary mode.
3-07 Maximum Position	360°	
3-20.0 Preset Target	45°	Target position
3-41 Ramp 1 Ramp Up Time	2 s	Used to calculate the speed profile for positioning.
3-42 Ramp 1 Ramp Down Time	2 s	
4-10 Motor Speed Direction	***[2] Both directions***	Enables motor rotation in both directions.
5-10 Terminal 18 Digital Input	***[116] Home sensor inverse***	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
5-11 Terminal 19 Digital Input	***[8] Start***	Use input 19 as start. The option magnetizes the motor and starts movement towards the selected target.
5-13 Terminal 29 Digital Input	***[110] Start Homing***	Use input 29 to start the home function.
5-40.0 Function Relay	***[223] On target***	Use relay 1 to signal that the target position is reached.
5-40.1 Function Relay	***[222] Homing ok***	Use relay 2 to signal that home function is completed.
17-70 Position Unit	***[4°]***	Use degrees as position unit in LCP.
17-72 Position Unit Numerator	2520	Defines the distance of movement per motor revolution. The gearbox is 43/7 to 1 (Using 6.14 is a rounded value which means that the position drifts over time). The numerator is 360 x 7 considering 360° per revolution. The denominator is 43.
17-73 Position Unit Denominator	43	
17-76 Position Axis Mode	***[1] Rotary 0 - Max***	Rotary axis, actual position counting between 0 and value of parameter ***3-07 Maximum Position***.
17-80 Homing Function	***[2] Home Sync Function***	The actual position is set to the value defined by parameter ***17-82 Home Position*** when the home sensor is activated.
17-81 Home Sync Function	***[6] Every time***	Defines that the home position is aligned every time the home sensor is passed.

Table 13: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
17-82.0 Home Position	***[Sensor Position]***	Set the position of the home sensor when approached in a forward direction. Use parameter ***17-82.1 Home Position*** to define the position of the home sensor when approached in reverse direction, if relevant.
17-92 Position Control Selection	***[1] Relative Position***	Select relative positioning. When set to ***[0] No Operation*** by default, absolute positioning is enabled. Switch between absolute and relative positioning using a digital input, when necessary.

3.2.1.1.1 Connections

The illustration shows connection for rotary positioning when controlled by digital I/O.

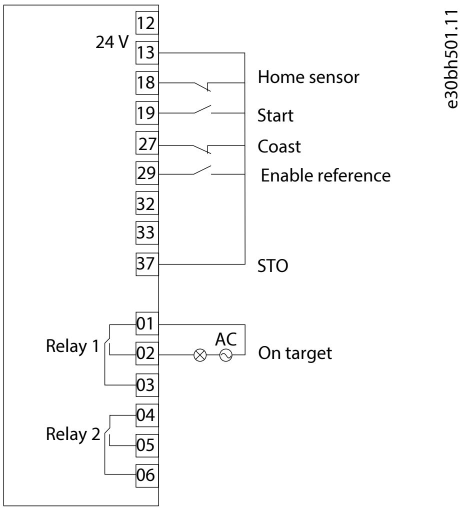


Figure 40: Rotary Positioning - Digital I/O Control

3.2.1.2 Control by Fieldbus

Following is the recommended parameter settings for the application when control is led via fieldbus.

Table 14: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[9] Positioning***	Enables position control.
1-01 Motor Control Principle	***[2] Flux sensorless***	Motor and position control without feedback.
3-06 Minimum Position	0°	Defines 1 revolution in rotary mode.
3-07 Maximum Position	360°	
3-41 Ramp 1 Ramp Up Time	2 s	Used to calculate the speed profile for positioning.
3-42 Ramp 1 Ramp Down Time	2 s	
4-10 Motor Speed Direction	***[2] Both directions***	Enables motor rotation in both directions.

Table 14: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
5-10 Terminal 18 Digital Input	***[116] Home sensor inverse***	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
8-01 Control Site	***[2] Control word only***	Control via fieldbus control word only, no need for digital inputs.
9-15.2 PCD Write Configuration	***[1683] Fieldbus Pos. REF***	Use PCD 2 and 3 as 32-bit target position, PCD 1 is speed reference.
9-15.3 PCD Write Configuration	***[1683] Fieldbus Pos. REF***	
9-16.2 PCD Read Configuration	***[1606] Actual position***	Use PCD 2 and 3 to read the actual position as a 32-bit value.
9-16.3 PCD Read Configuration	***[1606] Actual position***	
17-70 Position Unit	[4]°	Use degrees as position unit in LCP.
17-72 Position Unit Numerator	2520	Defines the distance of movement per motor revolution. The gearbox is 43/7 to 1 (Using 6.14 is a rounded value which means that the position drifts over time) and there is 360° per revolution so the numerator is 360 x 7 and the denominator is 43.
17-73 Position Unit Denominator	43	
17-76 Position Axis Mode	***[1] Rotary 0 - Max***	Rotary axis, actual position counting between 0 and value of parameter ***3-07 Maximum Position***.
17-80 Homing Function	***[2] Home Sync Function***	The actual position is set to the value defined by parameter ***17-82 Home Position*** when the home sensor is activated.
17-81 Home Sync Function	***[6] Every time***	Defines that the home position is aligned every time the home sensor is passed.
17-82.0 Home Position	***[Sensor position]***	Set the position of the home sensor when approached in a forward direction. Use parameter ***17-82.1 Home Position*** to define the position of the home sensor when approached in reverse direction if relevant.
17-92 Position Control Selection	***[1] Relative Position***	Selects relative positioning. If set to ***[0] No Operation***, absolute positioning is default and it is possible to switch between absolute and relative positioning by digital input.

3.2.1.2.1 Connections

The illustration shows rotary positioning when controlled by fieldbus.

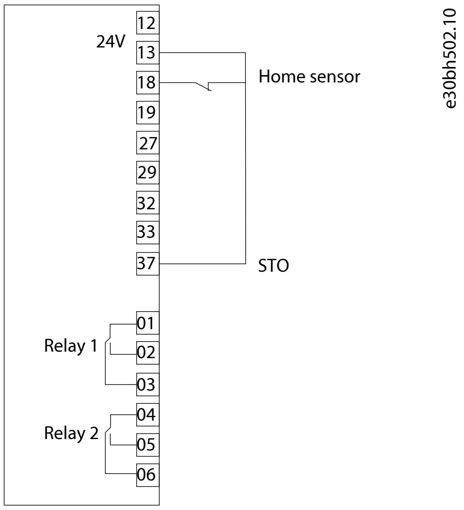


Figure 41: Rotary Positioning - Fieldbus Control

3.2.1.2.2 Control Word Examples

Table 15: Control Word Examples

Function	Binary	Hexadecimal	Description
Start (bit 6)	0000 0100 0101 1000	0458	Magnetizes the motor while maintaining the current position.
Enable reference (bit 5)	0000 0100 0111 1000	0478	The drive moves the distance set by target position (PCD 2 and 3) at each change of bit 5 from 0 to 1.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset is also possible with active start and/or enabling reference signals such as 04F8.

3.2.1.2.3 Status Word Examples

Function	Binary	Hexadecimal	Description
Coasting (bit 2)	0000 0110 0000 0011	0603	Drive is coasting, the motor is not controlled.
Tripped (bit 3)	0000 0110 0000 1000	0608	The drive has stopped with an Alarm, alarm type and status can be read in parameter group ***16-9* Diagnosis Readouts***.
Target reached (bit 8)	0000 1111 0001 0111	0F17	The active target position has been reached within parameter ***3-08 On Target Window***.

3.2.1.2.4 Fieldbus Data Layout

The following illustrations describe the fieldbus data layout when writing to the drive and reading from the drive.

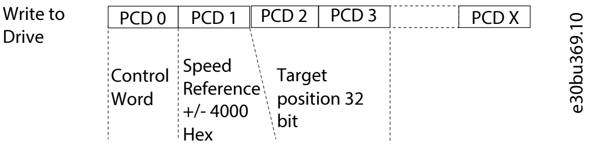


Figure 42: Data Layout - Write to Drive

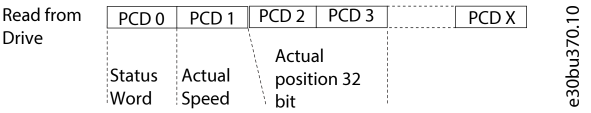


Figure 43: Data Layout - Read from Drive

3.3 Touch Probe Positioning

3.3.1 Touch Probe Positioning Application

This application uses a roller conveyer for positioning of pallets using touch probe positioning, based on the following:

- Sensor signal.
- Sensorless control of a permanent magnet motor.
- Movement of pallet by 29.3 mm per motor revolution, which is determined from power drive system and roller diameter.
- Control, status, and touch target position by digital I/O or PROFIBUS (fieldbus).

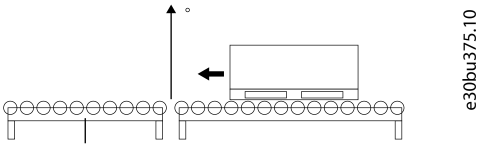


Figure 44: Touch Probe Positioning

3.3.1.1 Control by Digital I/O

Following are the recommended parameter settings for Touch Probe Positioning when the control is via Digital I/O.

Table 16: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[0] Speed open loop***	Speed control until a touch probe sensor is found.
1-01 Motor Control Principle	***[2] Flux sensorless***	Motor and position control without feed-back.
3-10.0 Preset Reference	50%	Preset reference for speed and positioning mode. Reference can also be an external signal such as analog input 53.
3-21 Touch Target	500 mm	Set the distance between the touch sensor and the required stop position.
3-41 Ramp 1 Ramp Up Time	2 s	Ramps used to calculate speed profile for positioning.
3-42 Ramp 1 Ramp Down Time	2 s	
4-10 Motor Speed Direction	***[2] Both directions***	Enables motor rotation in both directions.
5-10 Terminal 18 Digital Input	***[118] Touch sensor inverse***	Use input 18 as touch sensor input. The op-tion sets a low signal with an active sensor.

Table 16: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
5-11 Terminal 19 Digital Input	***[8] Start***	Use input 19 as start. The option magnetizes the motor and starts movement towards the selected target.
5-13 Terminal 29 Digital Input	***[111] Activate touch***	Input 29 activates monitoring of the touch sensor while running in speed mode. When the touch sensor is detected the drive changes to position control and sets the target as the sum of the position of the touch sensor and the value of parameter ***3-21 Touch Target***. After reaching the target, input 29 must be set low to restart running in speed mode.
5-40.0 Function Relay	***[226] Touch on target***	Use relay 1 to signal touch probe target position reached.
17-70 Position Unit	***[2] mm***	Use mm as position unit in LCP.
17-72 Position Unit Numerator	293	Defines the distance of movement per motor revolution.
17-73 Position Unit Denominator	10	

3.3.1.1.1 Connections

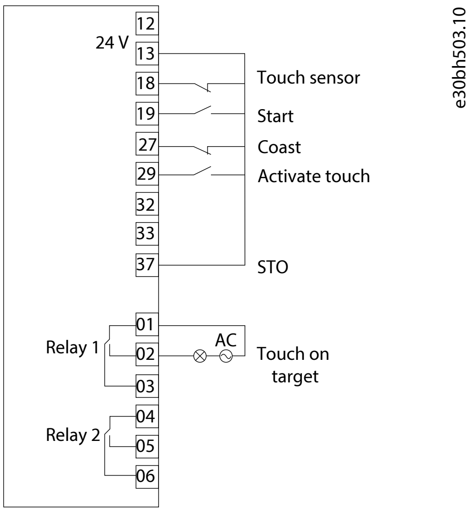


Figure 45: Touch Probe Positioning - Digital I/O Control

3.3.1.2 Control by Fieldbus

Following are the recommended parameter settings for touch probe positioning when control is via fieldbus (PROFIBUS).

Table 17: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[9] Positioning***	Enables position control.
1-01 Motor Control Principle	***[2] Flux sensorless***	Motor and position control without feedback.
3-41 Ramp 1 Ramp Up Time	2 s	Ramps used to calculate the speed profile for positioning.
3-42 Ramp 1 Ramp Down Time	2 s	

Table 17: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
8-01 Control Site	***[2] Control word only***	Control signals via fieldbus control word.
8-13.15 Configurable Status Word CTW	***[226] Touch on target***	Use bit 15 to signal when the stop position is reached.
8-14.12 Configurable Control Word CTW	***[12] Activate touch***	Bit 12 activates touch sensor search.
8-14.13 Configurable Control Word CTW	***[17] Speed Mode***	Bit 13 activates speed mode. Speed reference is set by PCD1 Fieldbus REF 1.
9-15.2 PCD Write Configuration	***[321] Touch Target***	Use PCD 2 and 3 to set parameter ***3-21 Touch Target***. PCD 1 is speed reference.
9-15.3 PCD Write Configuration	***[321] Touch Target***	
9-16.2 PCD Read Configuration	***[1606] Actual position***	Use PCD 2 and PCD 3 to read the actual position as a 32-bit value.
9-16.3 PCD Read Configuration		
17-70 Position Unit	***[2] mm***	Use mm as the position unit in LCP.
17-72 Position Unit Numerator	293	Defines the distance of movement per motor revolution.
17-73 Position Unit Denominator	10	

3.3.1.2.1 Connections

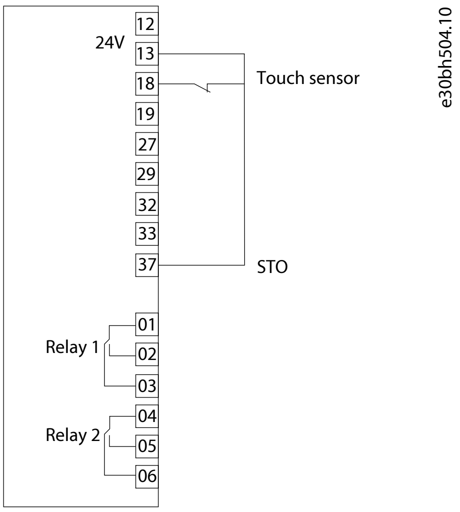


Figure 46: Touch Probe Positioning - Control by Fieldbus

3.3.1.2.2 Control Word Examples

Function	Binary	Hexadecimal	Description
Start (bit 6)	0000 0100 0101 1000	0458	Magnetizes the motor maintaining the current position.
Speed Mode (bit 13)	0010 0100 0101 1000	2478	The drive runs in speed control with reference set by PCD 1.
Activate touch (bit 12)	0011 0100 0101 1000	3478	Activates touch mode monitoring touch sensor input, when touch sensor is detected, the drive will move the distance defined by PCD 2 and 3.

3.3.1.2.3 Status Word Examples

Function	Binary	Hexadecimal	Description
Coasting (bit 2)	0000 0110 0000 0011	0603	Drive is coasting, the motor is not controlled.
Tripped (bit 3)	0000 0110 0000 1000	0608	The drive has stopped with an Alarm, alarm type and status can be read in parameter group ***16-9* Diagnosis Readouts***.
Target reached (bit 8)	0000 1111 0001 0111	0F17	The active target position has been reached within parameter ***3-08 On Target Window***.

3.3.1.2.4 Fieldbus Data Layout

The following illustrations describe the fieldbus position data layout for touch probe positioning when writing to the drive and reading from the drive.

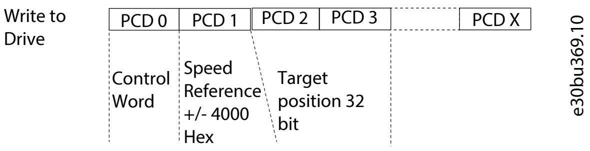


Figure 47: Data Layout - Write to Drive

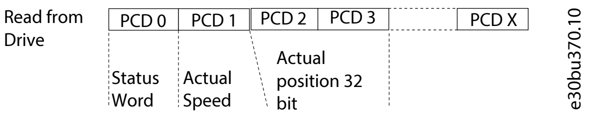


Figure 48: Data Layout - Read from Drive

3.4 Position Stop

3.4.1 Application with Position Stop

Consider a rotating machine in an application which uses position stop, with the following specifications:

- Speed-controlled permanent magnet motor without feedback.
- Machine stop at 90°.
- Position scaled for 0–360°.
- 10 motor revolutions per machine cycle.
- Homing on sensor.
- Control by digital I/O input (analog) or fieldbus (PROFIBUS).

3.4.1.1 Control by Digital I/O

Following are the recommended parameter settings when the control is via digital I/O.

Table 18: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1–00 Configuration Mode	***[0] Speed Open Loop***	Open-loop speed control.
1–01 Motor Control Principle	***[2] Flux Sensorless***	Motor and position control without feed-back.

Table 18: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
3–06 Minimum Position	0°	Defines 1 revolution in rotary mode.
3–07 Maximum Position	360°	
3–21 Touch Target	90°	Stop position.
3–41 Ramp 1 Ramp Up Time	2 s	Used for start or stop in speed mode and to calculate speed profile for positioning.
3–42 Ramp 1 Ramp Down Time	2 s	
5–10 Terminal 18 Digital Input	***[116] Home sensor inverse***	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
5–11 Terminal 19 Digital Input	***[8] Start***	Use input 19 as start. The option magnetizes motor and runs with the reference set by analog input 53.
5–13 Terminal 29 Digital Input	***[111] Activate Touch***	A high signal activates positioning to the target set by parameter *3-21 Touch Target*. Low signal speed control with the set reference is resumed.
5–14 Terminal 32 Digital Input	***[110] Start Homing***	Use input 32 to start the home function.
5–40.0 Function Relay	***[223] On target***	Use relay 1 to signal the target position reached.
17–70 Position Unit	***[4] °***	Use ° as the position unit in LCP.
17–72 Position Unit Numerator	36	Defines the distance of movement per motor revolution. 1 motor revolution is 1/10th of machine revolution, hence 36° per motor revolution.
17–73 Position Unit Denominator	1	
17–76 Position Axis Mode	***[1] Rotary 0 - Max***	Rotary axis, actual position counting between 0 and value of parameter ***3-07 Maximum Position***.
17–80 Homing Function	***[10] Forward with sensor***	The drive moves forward at homing speed set in parameter ***17-83 Homing Speed*** until the home sensor is activated. The actual position is set to value to parameter ***17-82.0 Home Position***.
17–82.0 Home Position	Sensor position	The actual position of the home sensor is set.

3.4.1.1.1 Connections

The illustration depicts the connection for position stop when controlled by digital I/O.

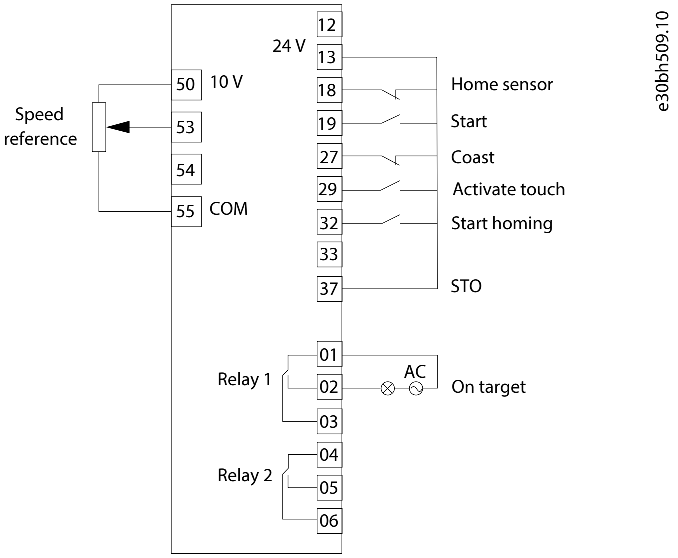


Figure 49: Position Stop - Digital I/O Control

3.4.1.2 Control by Fieldbus

Following are the parameter recommendations for the application when controlled by PROFIBUS.

Table 19: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration mode	***[9] Positioning***	Enables position control.
1-01 Motor Control Principle	***[2] Flux Sensorless***	Motor and position control without feedback.
3-06 Minimum Position	0°	Defines 1 revolution in rotary mode.
3-07 Maximum Position	360°	
3–41 Ramp 1 Ramp Up Time	2 s	Used for start/stop in speed mode and to calculate speed profile for positioning.
3–42 Ramp 1 Ramp Down Time	2 s	
4–10 Motor Speed Direction	***[2] Both directions***	Enables movement in both directions.
5–10 Terminal 18 Digital Input	***[116] Home Sensor Inverse***	Use input 18 as Home sensor input. The option sets a low signal with an active sensor.
8-01 Control Site	***[2] Control word only***	Control via fieldbus control word only, no need for digital inputs.
8–13.15 Configurable Status Word STW	***[6] Touch on target***	Use bit 15 to signal that the stop position is reached.
8–14.0 Configurable Control Word CTW	***[17] Speed Mode***	Bit 0 activates speed control with speed reference set by PCD 1 Fieldbus REF 1.
8–14.12 Configurable Control Word CTW	***[12] Activate touch***	Bit 12 activates positioning to target set by parameter ***3–21 Touch Target***. 0 reactivates speed control with the set reference.
9–15.2 PCD Write Configuration	***[321] Touch target***	Use PCD 2 to set stop position, max position value is 360 so 1 PCD (16 bit) is sufficient.

Table 19: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
9–16.2 PCD Read Configuration	***[1606] Actual Position***	Use PCD 2 and 3 to read the actual position as a 32-bit value.
9–16.3 PCD Read Configuration		
17–70 Position Unit	*[4] °*	Select ° (degree) as the position unit using the LCP.
17–72 Position Unit Numerator	36	Defines the distance of movement per motor revolution. 1 motor revolution is 1/10th of machine revolution hence 36° per motor revolution.
17–76 Position Axis Mode	1	
17–80 Home Function	***[10] Forward with Sensor***	The drive moves forward at Homing speed parameter ***17-83 Homing Speed*** until the home sensor is activated. The actual position is set to value to parameter ***17-82.0 Home Position***.
17–82.0 Home Position	Sensor position	The actual position of the home sensor is set.

3.4.1.2.1 Connections

The illustration shows position stop when controlled by fieldbus.

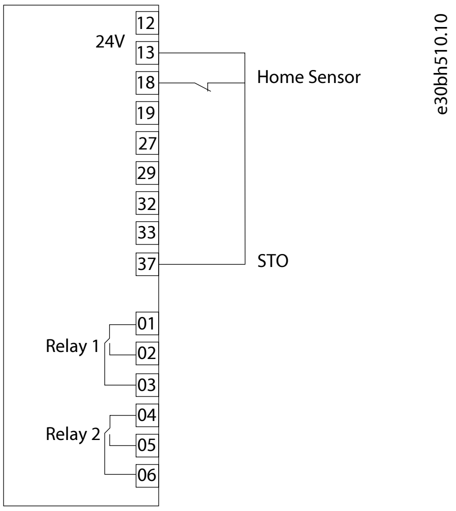


Figure 50: Position stop - Fieldbus Control

3.4.1.2.2 Control Word Examples

Function	Binary	Hexadecimal	Description
Start homing (bit 11)	0000 1100 0001 1000	0C18	Homing is also possible with an active start signal (0C58).
Speed mode (bit 0)	0010 0100 0001 1001	0419	Change from position to speed mode.
Start (bit 6)	0000 0100 0101 1001	0459	Starts running at speed reference.

Function	Binary	Hexadecimal	Description
Activate touch (bit 12)	0001 0100 0101 1001	1459	Activates position stop to set stop position.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset is also possible with active start, speed mode, and touch signals (14D9).

3.4.1.2.3 Status Word Examples

Function	Binary	Hexadecimal	Description
Coasting (bit 2)	0000 0110 0000 0011	0603	Drive is coasting, the motor is not controlled.
Tripped (bit 3)	0000 0110 0000 1000	060B	The drive has stopped with an Alarm, alarm type and status can be read in parameter group ***16-9* Diagnosis Readouts***.
Homing done (bit 4)	0000 1110 0001 0111	0E17	The selected homing function has been completed.
Touch on target (bit 5)	0000 1111 0001 0111	0EA7	The active target position has been reached within parameter ***3-08 On Target Window***.

3.4.1.2.4 Fieldbus Data Layout

The following illustrations describe the fieldbus position data layout for position stop when writing to the drive and reading from the drive.

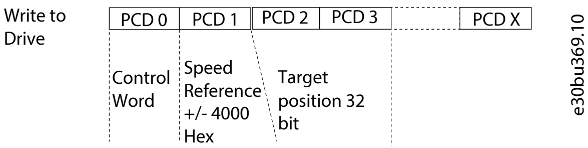


Figure 51: Data Layout - Write to Drive

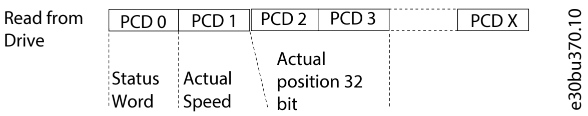


Figure 52: Data Layout - Read from Drive

3.5 Synchronizing with External Master

3.5.1 Synchronizing with External Master Application

The following image shows an application which uses a vertical conveyor belt. The vertical conveyor belt is synchronized with the horizontal conveyor for transfer of boxes.

- Master signal from HTL encoder on horizontal conveyor.
- Vertical conveyor is driven by a permanent magnet motor in sensorless control.
- Homing on the sensor to get correct alignment before starting synchronization.
- Determination of gear ratio from the physical setup as the slot length is

different. The follower must make 1 rotation when the master makes 1.5 rotations.

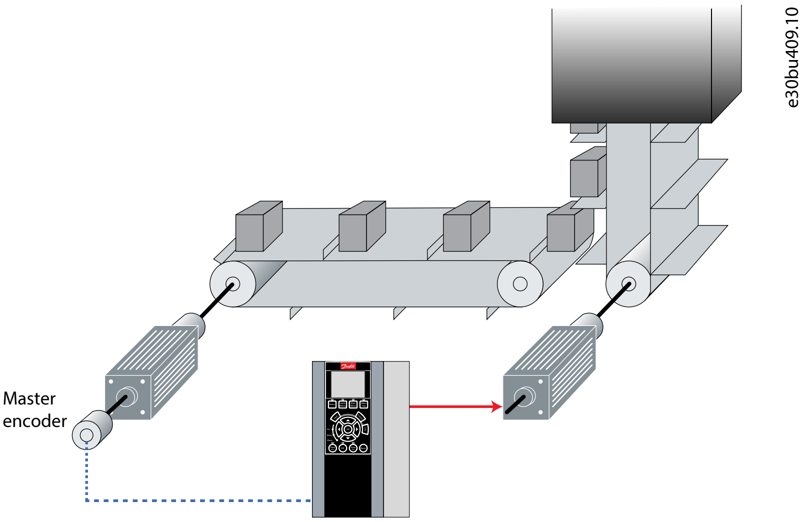


Figure 53: Synchronizing with External Master and Homing

3.5.1.1 Control by Digital I/O

Following are the recommended parameter settings for the application when controlled by I/O.

Table 20: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	*[10] Synchronizing*	Sets synchronizing control.
1-01 Motor Control Principle	*[2] Flux Sensorless*	Motor and position control without feedback.
3-16 Reference Resource 2	*[3] 24V Encoder 32/33*	Use an encoder connected to input 32/33 as a synchronizing master.
3–22 Master Scale Numerator	15	The gear ratio is set as a fraction to avoid rounding errors. Set the factors as integers, so 1.5 and 1 are both multiplied by 10.
3–23 Master Scale Denominator	10	
4–10 Motor Speed Direction	*[2] Both directions*	Enables motor rotation in both directions.
5–10 Terminal 18 Digital Input	*[116] Home sensor inverse*	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
5–11 Terminal 19 Digital Input	*[8] Start*	Use input 19 as start. The option magnetizes the motor while maintaining its current position.
5–12 Terminal 27 Digital Input	*[110] Start Homing*	Use input 27 as start homing to activate the selected home function parameter ***17-80 Homing Function***.
5–13 Terminal 29 Digital Input	*[113] Enable Reference*	Input 29 activates synchronizing. The actual follower position is locked to the actual master position.
5–14 Terminal 32 Digital Input	*[0] No operation*	Used for 24 V encoder.
5–15 Terminal 33 Digital Input	*[0] No operation*	Used for 24 V encoder.

Table 20: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
5–40.0 Function Relay	***[226] On target***	Use relay 1 to signal that synchronizing accuracy is within the window set in parameter ***3-08 Target Window***.
5–70 Term 32/33 Pulses Per Revolution		Configuration of encoder interface.
5–71 Term 32/33 Encoder Direction		
5–72 Term 32/33 Encoder Type		
17–80 Homing Function	***[11] Reverse with sensor***	Performs a search in reverse direction for homing on sensor.
17–83 Homing Speed	100 RPM	Speed required for homing.

3.5.1.1.1 Connections

The illustration depicts a connection for synchronization with an external master when controlled by digital I/O.

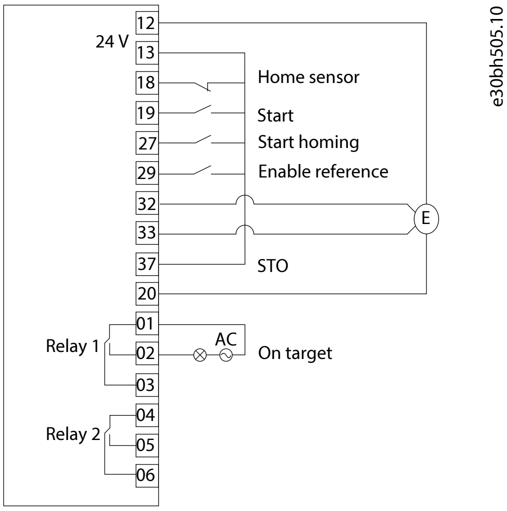


Figure 54: Synchronization - Control by Digital I/O

3.5.1.2 Control by Fieldbus

Following are the recommended parameter settings for the application when offset adjustment is controlled via fieldbus.

Table 21: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	***[10] Synchronizing***	Set synchronizing control.
1-01 Motor Control Principle	***[2] Flux sensorless***	Motor and position control without feedback.
3-16 Reference Resource 2	***[3] 24V Encoder 32/33***	Use an encoder connected to input 32/33 as a synchronizing master.
3-22 Master Scale Numerator	15	The gear ratio is set as a fraction to avoid rounding errors. Set the factors as integers, so 1.5 to 1 are both multiplied by 10.
3-23 Master Scale Denominator	10	
4-10 Motor Speed Direction	***[2] Both directions***	Enables motor rotation in both directions.

Table 21: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
5-10 Terminal 18 Digital Input	***[116] Home sensor inverse***	Use input 18 as home sensor input. The option sets a low signal with an active sensor.
5-14 Terminal 32 Digital Input	***[0] No operation***	Used for 24 V encoder.
5-15 Terminal 33 Digital Input	***[0] No operation***	Used for 24 V encoder.
5-70 Term 32/33 Pulses Per Revolution		Configuration of encoder interface.
5-71 Term 32/33 Encoder Direction		
5-72 Term 32/33 Encoder Type		
8-01 Control Site	***[2] Control Word only***	Control via fieldbus control word.
9-15.2 PCD Write Configuration	***[326] Master Offset***	Sets the position offset between master and follower. 2 PCDs are needed for a 32 bit value.
9-15.3 PCD Write Configuration		
9-15.4 PCD Write Configuration	***[328] Master Offset Speed Ref***	Sets the speed with which the offset is executed/adjusted.
9-16.2 PCD Read Configuration	***[1608] Position Error***	PCD 2 and PCD 3 are used to read position error as a 32-bit value.
9-16.3 PCD Read Configuration	***[1608] Position Error***	
17-80 Homing function	***[11] Reverse with sensor***	Performs a search for the homing sensor in reverse direction.
17-83 Homing speed	100 RPM	Sets the speed required for homing.

3.5.1.2.1 Connections

The illustration depicts the connection for synchronization with external master when controlled by fieldbus.

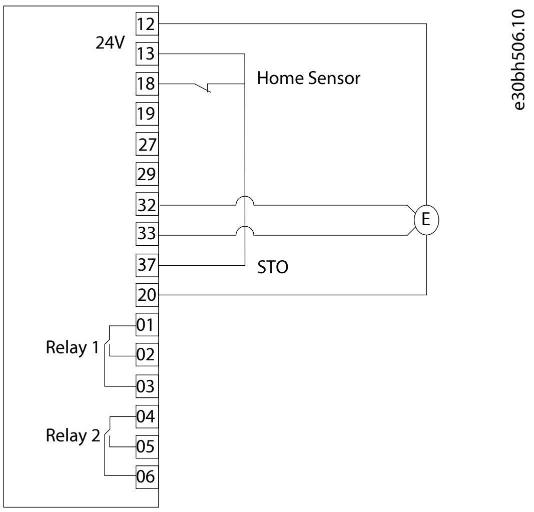


Figure 55: Synchronization - Controlled by Fieldbus

3.5.1.2.2 Control Word Examples

Function	Binary	Hexadecimal	Description
Start Homing (bit 11)	0000 1100 0001 1000	0C18	Homing is also possible with an active start signal (0C58).
Start (bit 6)	0010 0100 0101 1000	0458	Magnetizes the motor maintaining the current position.
Enable reference (bit 5)	0000 0100 0111 1000	0478	Activates synchronizing. The actual follower position is locked to the actual master position.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset is also possible with active start, speed mode, and touch signals (34D8).

3.5.1.2.3 Status Word Examples

Function	Binary	Hexadecimal	Description
Coasting (bit 2)	0000 0110 0000 0011	0603	Drive is coasting, the motor is not controlled.
Tripped (bit 3)	0000 0110 0000 1000	060B	The drive has stopped with an alarm. Status can be read in parameter group ***16-9* Diagnosis Readout***.
Homing done (bit 4)	0000 1110 0001 0111	0E17	The selected homing function has been completed.
Target reached (bit 8)	0000 1111 0001 0111	0F17	Synchronizing accuracy within parameter ***3-08 On Target Window***.

3.5.1.2.4 Fieldbus Data Layout

Following are the fieldbus data layouts to read from or write to a drive, when synchronizing with an external master.

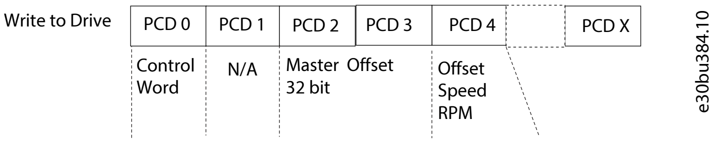


Figure 56: Read from Drive

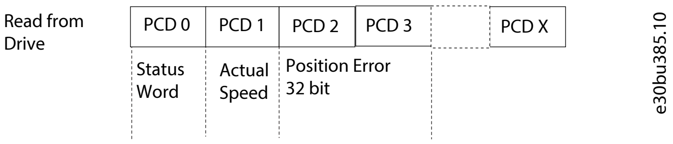


Figure 57: Write to Drive

3.6 Synchronizing with Virtual Master

3.6.1 Introduction to Synchronizing with Virtual Master

In this concept, 2 different applications are considered when control is via digital inputs and fieldbus. See 3.6.1.1 Control by Digital I/O and 3.6.1.2 Control by Fieldbus

3.6.1.1 Control by Digital I/O

This application illustration shows 2 conveyors synchronized in position to a common master signal. Each conveyor runs on a permanent magnet motor with sensorless control by VLT® AutomationDrive FC 302. Speed control of the virtual master by analog input 0–10 V corresponding to 0–1500 RPM on the followers. Homing on sensor of both drives is performed to align before starting the synchronization.

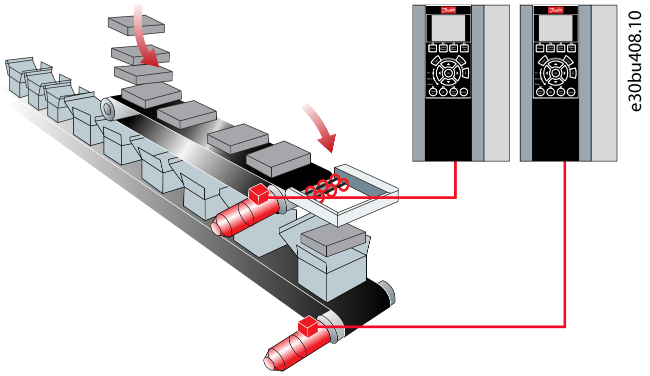


Figure 58: Synchronizing with Virtual Master - Digital I/O Control

Table 22: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration Mode	*[10] Synchronizing*	Synchronizing control.
1-01 Motor Control Principle	*[2] Flux Sensorless*	Motor and position control without feedback.
3–22 Master Scale Numerator	1	The gear ratio is set as a fraction to avoid rounding errors. Set the factors according to the physical layout of each follower. In this example, both followers are identical, and therefore, a ratio of 1:1.
3–23 Master Scale Denominator	1	
5–10 Terminal 18 Digital Input	*[116] Home sensor inverse*	Use input 18 as Home sensor input. The option sets a low signal with an active sensor.
5–11 Terminal 19 Digital Input	*[8] Start*	Use input 19 as start. The option magnetizes the motor and maintains its current position.
5–15 Terminal 33 Digital Input	*[110] Start Homing*	Use input 33 as start homing. Activate the home function selected in parameter ***17-80 Homing Function***.
5–40.0 Function Relay	*[223] On target*	Use relay 1 to signal that synchronizing accuracy is within the window set by parameter ***3-08 Target Window***.
5–75 Term 27/29 Pulses Per Revolution	1024	Set the number of pulses per master revolution. The number should be the same for master (output) and follower (input).
17–80 Homing Function	*[10] Forward with sensor*	Performs a search for the homing sensor in forward direction.
17–92 Position Control Selection	*[2] Enable reference*	Synchronization starts with the activation of the start signal.

Configuration of virtual master function, only in the drive which hosts the virtual master (follower 1):

Table 23: Parameter Settings and Description

Parameter number and name	Setting for the application	Description of the setting
3–15 Reference Resource 1	***[1] Analog input 53***	Virtual master reference.
3–16 Reference Resource 2	***[6] Virtual master***	Select virtual master as synchronization master signal, no external connection needed.
3–27 Virtual Master Max Ref	25 Hz	Enter the maximum reference for the virtual master. The actual reference is set relative to this value using the source selected in parameter ***3-15 Reference Resource 1*** or fieldbus reference 1. Virtual master ramps are set in parameter group ***3-6* Ramp 3***.
5-01 Terminal 27 Mode	***[1] Output***	Terminal 27 is used as output.
5-02 Terminal 29 Mode	***[1] Output***	Terminal 29 is used as output.
5–14 Terminal 32 Digital Input	***[109] Enable Virtual Master***	Digital input for start/stop of virtual master.
5–30 Terminal 27 Digital Output	***[54] 24 V Encoder Sim***	Terminal 27 is used for encoder simulation.
5–31 Terminal 29 Digital Output	***[54] 24 V Encoder Sim***	Terminal 29 is used for encoder simulation.
5–75 Term 27/29 Pulses Per Revolution	1024	Set the number of pulses per revolution for the encoder simulation.
5–78 Term 27/29 Encoder Sim	***[3] Vir. Master Position***	Select virtual master as source for the encoder simulation.

Configuration of synchronization master signal in follower without virtual master (follower 2):

Table 24: Parameter Settings and Description

Parameter number and name	Setting for the application	Description of the setting
3–16 Reference Resource 2	***[13] 24 V Encoder 27/29***	Select 24 V encoder signal from virtual master as synchronization master signal.
5–12 Terminal 27 Digital Input	***[0] No operation***	Digital inputs 27 and 29 are used as 24 V encoder input.
5–13 Terminal 29 Digital Input	***[0] No operation***	

3.6.1.1.1 Connections

The illustration shows connection for synchronization with virtual master when controlled by digital I/O.

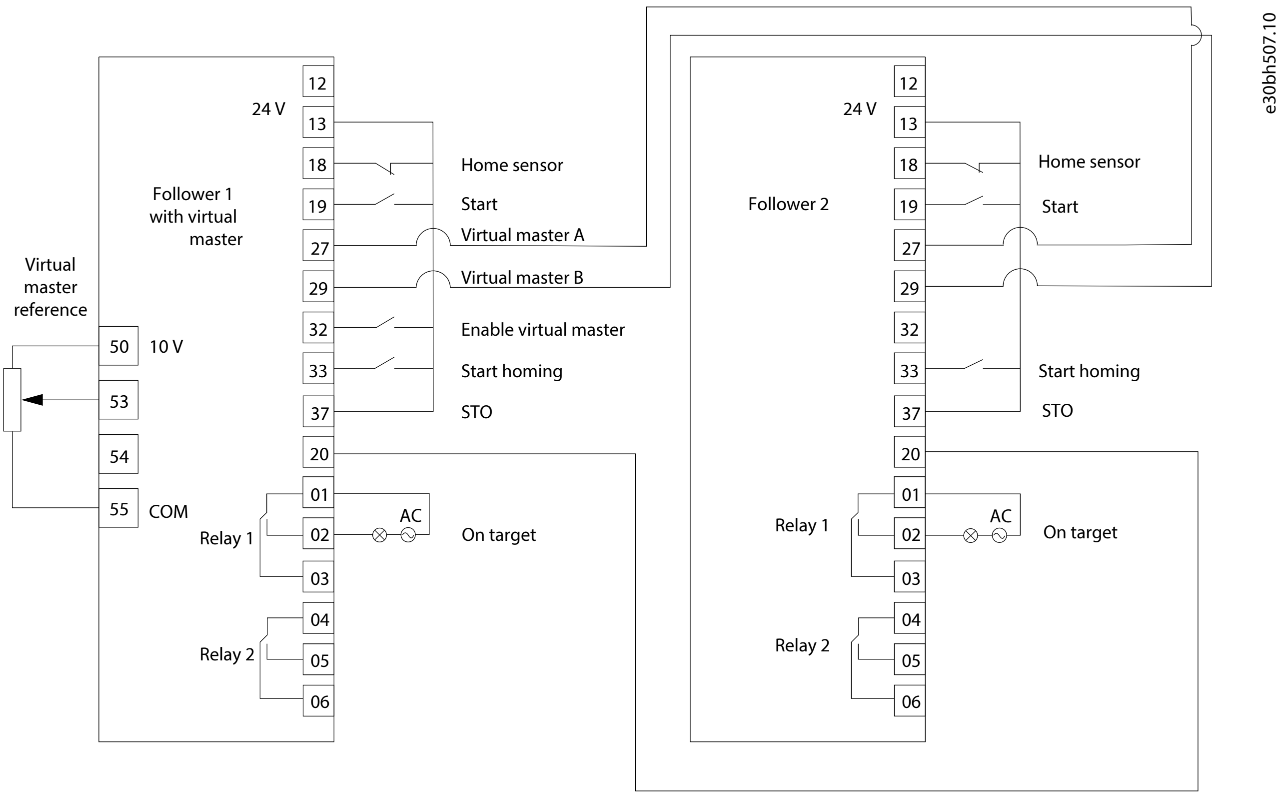


Figure 59: Virtual Master Synchronization - Digital I/O

3.6.1.2 Control by Fieldbus

Consider a platform lift application with the following:

- 4 screw actuators each with a permanent magnet motor and a mechanical brake. The 4 motors are synchronized in position to a virtual master hosted by 1 of the drives.
- Position control of the virtual master is set by fieldbus reference.
- Sensorless synchronizing control of the 4 permanent magnet motors.
- Homing on sensor of all 4 drives to align before synchronization start.

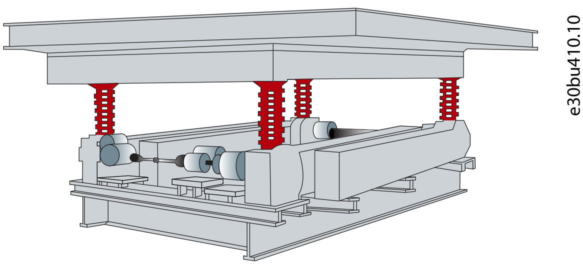


Figure 60: Synchronizing with Virtual Master - Fieldbus Control

Configuration of Synchronizing Control in All 4 Drives:

Table 25: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
1-00 Configuration mode	***[10] Synchronizing***	Synchronizing control.
1-01 Motor Control Principle	***[2] Flux Sensorless***	Motor and position control without feed-back.

Table 25: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
1–67 Load Type	***[1] Active Load***	Select ***Active Load*** when torque must be applied to hold the load in position.
1–72 Start Function	***[6] Hoist Mech Brake Rel***	For jerk-free transition between mechanical brake and holding torque. Tuning via parameters ***2-24*** to ***2-29***.
3–22 Master Scale Numerator	1	The gear ratio is set as a fraction to avoid rounding errors. All 4 power drive systems are identical, so the ratio is 1:1.
3–23 Master Scale Denominator	1	
4–10 Motor Speed Direction	***[2] Both directions***	Enables movement in both directions.
5–10 Terminal 18 Digital Input	***[116] Home Sensor Inverse***	Use input 18 as Home sensor input. The option sets a low signal with an active sensor.
5–40.0 Function Relay	***[32] Mech brake control***	Relay 1 is used to control the mechanical brake.
8-01 Control Site	***[2] Control word only***	Control signals only from fieldbus.
9–16.2 PCD Read Configuration	***[1608] Position Error***	Use PCD 2 and 3 to read the position error as a 32-bit value.
9–16.3 PCD Read Configuration	***[1608] Position Error***	
17–80 Home Function	***[10] Forward with Sensor***	Use homing on sensor with search for sensor in forward direction.

Configuration of virtual master function, only in the drive which hosts the virtual master (Follower 1):

Table 26: Parameter Settings and Descriptions

Parameter number and name	Setting for the application	Description of the setting
3-16 Reference Resource 2	***[6] Virtual master***	Select virtual master as synchronization master signal. An external connection is not needed.
3-27 Virtual Master Max Ref	50 Hz	Enter the maximum reference for the virtual master. The actual reference is set relative to this value using the source selected in parameter ***3-15 Reference Resource 1***or fieldbus reference 1.
5-01 Terminal 27 Mode	***[1] Output***	Terminal 27 used as output.
5-02 Terminal 29 Mode	***[1] Output***	Terminal 29 used as output.
5-30 Terminal 27 Digital Output	***[54] 24 V Encoder Sim***	Terminal 27 used for encoder simulation.
5-31 Terminal 29 Digital Output	***[54] 24 V Encoder Sim***	Terminal 29 used for encoder simulation.
5-75 Term 27/29 Pulses Per Revolution	1024	Set the number of pulses per revolution for the encoder simulation. Should be the same as parameter ***5-70 Term 32/33 Pulses Per Revolution*** in followers 2–4.
5-78 Term 27/29 Encoder Sim	***[3] Vir. Master Position***	Select virtual master as the source for the encoder simulation.

Table 26: Parameter Settings and Descriptions (continued)

Parameter number and name	Setting for the application	Description of the setting
8-14.0 Configurable Control Word CTW	***[18] Enable Vir. Master***	Bit 0 activates the virtual master. Ramps for starting and stopping the virtual master are set by parameter group ***3-6* Ramp 3***.
8-14.14 Configurable Control Word CTW	***[28] Position Vir. Master***	Select position-controlled virtual master, as the target position is set by fieldbus.
9-15.2 PCD Write Configuration	***[1683] Fieldbus Pos.REF***	PCD 2 and 3 as 32-bit target position for the virtual master. Fieldbus REF 1 is speed reference for the virtual master.
9-15.3 PCD Write Configuration	***[1683] Fieldbus Pos.REF***	

Configuration of synchronization master signal in followers without virtual master (follower 2–4)

Table 27: Parameter Settings and Descriptions

Parameter number and Name	Setting for the application	Description of the setting
3-16 Reference Resource 2	***[3] 24V Encoder 32/33***	Select 24 V encoder signal from virtual master as synchronization master signal.
5-14 Terminal 32 Digital Input	***[0] No operation***	Digital inputs 32 and 33 are used as 24 V encoder input.
5-15 Terminal 33 Digital Input	***[0] No operation***	
5-70 Term 32/33 Pulses Per Revolution	1024	Set the number of pulses per revolution for the master signal. The number should be the same as set in ***parameter 5-75 Term 27/29 Pulses Per Revolution*** for follower 1.

3.6.1.2.1 Connections

The illustration shows synchronization with virtual master when controlled by fieldbus.

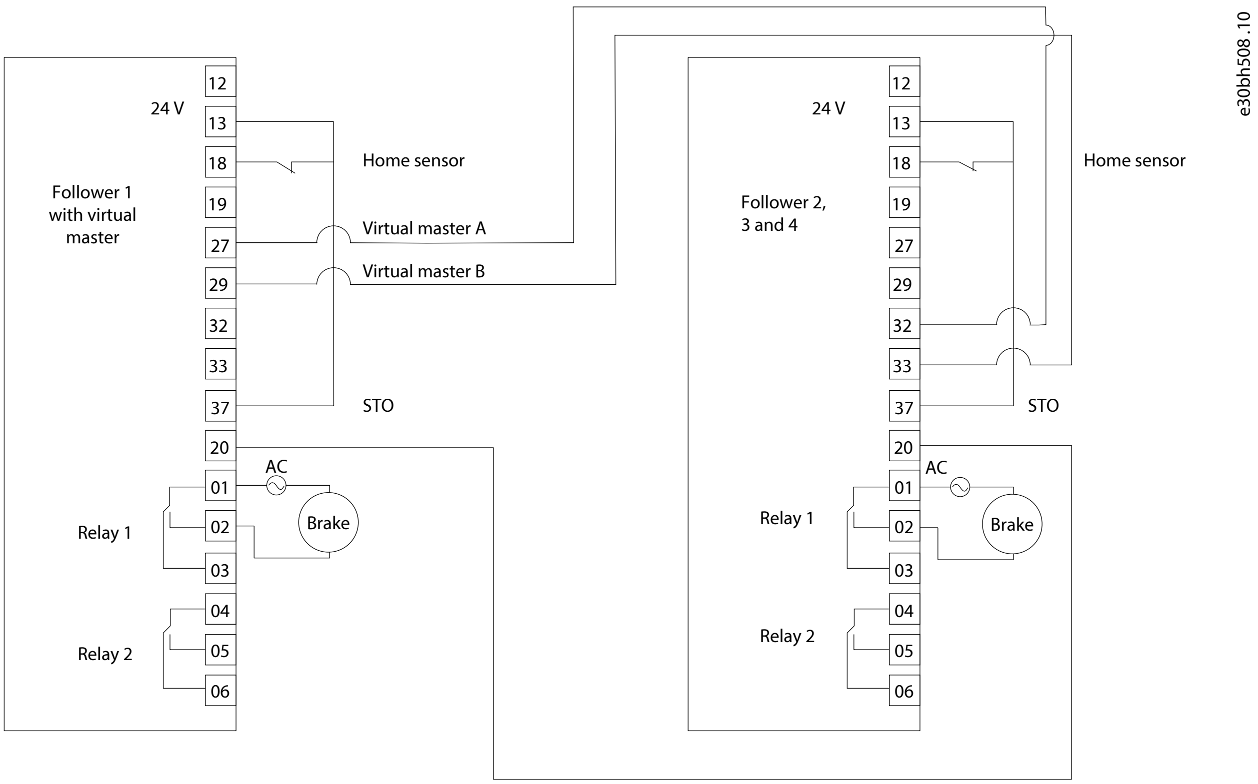


Figure 61: Synchronization with Virtual master - fieldbus

3.6.1.2.2 Control Word Examples

Function	Binary	Hexadecimal	Comment
Start homing (bit 11)	0000 1100 0001 1000	0C18	Homing is also possible with an active start signal (0C58)
Start (bit 6)	0000 0100 0101 1000	0458	Magnetizes the motor which maintains current position.
Enable reference (bit 5)	0000 0100 0111 1000	0478	Activates synchronizing. The actual follower position is locked to the actual master position.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset is also possible with active start and enable reference such as 04F8.
Enable virtual master (bit 0) and selection of virtual master positioning (bit 14). Only for drive which hosts the virtual master.	0100 0100 0111 1001	4479	Activates the virtual master positioning while the followers are synchronizing.

3.6.1.2.3 Status Word Examples

Function	Binary	Hexadecimal	
Coasting (bit 2)	0000 0110 0000 0011	0603	
Tripped (bit 3)	0000 0110 0000 1011	060B	
Homing done (bit 4)	0000 1110 0001 0111	0E17	

Function	Binary	Hexadecimal	
Target reached (bit 8)	0000 1111 0001 0111	0F07	Synchronizing, accuracy is within parameter ***3-08 On Target Window***.
Target not reached (bit 8)	0000 1110 0001 0111	0E07	Synchronizing, accuracy is not within parameter ***3-08 On Target Window***.

3.6.1.2.4 Fieldbus Data Layout

Following is the fieldbus data layout for reading from drive and writing to drive, when synchronizing with virtual master. The PCD 1, 2, and 3 are only for the drive which hosts the virtual master.

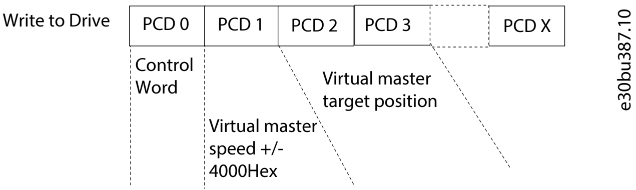


Figure 62: Write to drive

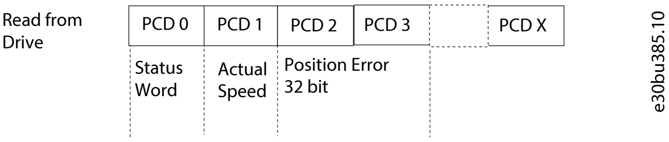


Figure 63: Read from drive

3.7 Synchronizing with Marker Correction

3.7.1 Application Synchronizing with Marker Correction

Each object on the upper conveyor has to be aligned with a box on the lower conveyor. As the objects and boxes are not fixed to the conveyors, synchronizing the position of the 2 conveyors is not sufficient. The position of the object and the box on the conveyors must be aligned.

In the illustration below, the lower conveyor is the master and the upper conveyor is controlled by the follower drive. Sensors detect the position of the object and the box by providing marker signals. To enable alignment of product and box, the position of each product and box is detected by a sensor providing marker signals. These marker signals are used to automatically adjust the offset of the follower drive. The follower drive controls the upper conveyor, synchronizes, and performs marker correction to align the product with the box on the lower conveyor. This is performed using the encoder signal from the lower (master) conveyor and the 2 marker signals.

The blue lines indicate power from the encoders and sensors to the drive. The red lines indicate power from the drive to the motor and the connection to the power supply.

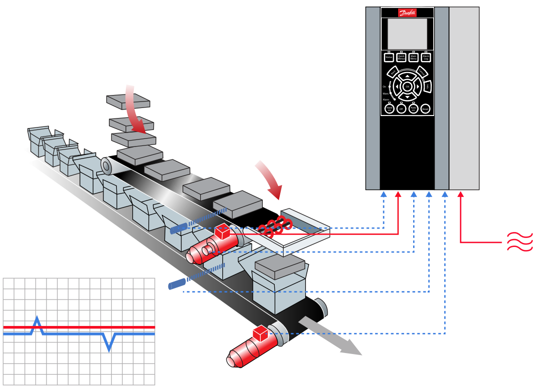


Figure 64: Synchronizing with Marker Correction

3.7.1.1 Control by Digital I/O

Following are the recommended parameter settings when controlled by digital I/O.

Parameter number and name	Setting	Description
1-00 Configuration Mode	***[10] Synchronizing***	Synchronizing control.
1-01 Motor Control Principle	***[2] Flux Sensorless***	Motor and position control without feedback.
3-16 Reference Resource 2	***[3] 24 V Encoder 32/33***	Select 24 V encoder on input 32/33 as master signal.
3-22 Master Scale Numerator	1	The gear ratio is set as a fraction to avoid rounding errors. In this example the 2 conveyors are identical, hence the gear ratio is 1–1.
3-23 Master Scale Denominator	1	The gear ratio is set as a fraction to avoid rounding errors. In this example the 2 conveyors are identical, hence the gear ratio is 1–1.
3-33 Sync Mode & Start Behavior	***[10] Marker shortest***	Activates marker correction while synchronizing. Start-up of the follower marker is aligned with the closest master marker when the marker distance is set in parameter ***3-34 Marker Distance***. If the marker distance is not set, the 1st follower marker aligns with the 1st master marker. The start behavior can be configured always to catch up or slow down for the 1st marker correction.

Parameter number and name	Setting	Description
3-34 Marker Distance		Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting parameter ***3–34 Marker Distance*** and parameter ***3–35 Marker Window***. After detecting the 1st marker pulse, the consequent marker pulse is only accepted if the position is within the marker distance +/- the marker window and only the 1st pulse within the window. Hence, any maker pulses outside the window or multiple pulses within the window are ignored.
3-35 Marker Window		Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting parameter ***3–34 Marker Distance*** and parameter ***3– 35 Marker Window***. After detecting the 1st marker pulse, the consequent marker pulse is only accepted if the position is within the marker distance +/- the marker window and only the 1st pulse within the window. Hence, any marker pulses outside the window or multiple pulses within the window are ignored.
4-10 Motor Speed Direction	*[2] Both directions*	Enables movement in both directions.
5-10 Terminal 18 Digital Input	*[113] Enable reference*	Input 29 activates synchronizing. The actual follower position is locked to the actual master position.
5-11 Terminal 19 Digital Input	*[8] Start*	Use input 19 as start. The option setting magnetizes the motor and maintains the current position.
5-12 Terminal 27 Digital Input	*[123] Master Marker*	Connect master marker sensor to input 27.
5-13 Terminal 29 Digital Input	*[125] Follower Marker*	Connect follower marker sensor to input 29.
5-14 Terminal 32 Digital Input	*[0] No operation*	Used for 24 V master encoder.
5-15 Terminal 33 Digital Input	*[0] No operation*	Used for 24 V master encoder.
5-40.0 Function Relay	*[226] On target*	Use relay 1 to signal that synchronizing accuracy is within the window set by parameter ***3-08 Target Window***.
5-70 Term 32/33 Pulses Per Revolution		Configuration of encoder interface according to the specifications of the encoder.

Parameter number and name	Setting	Description
5-71 Term 32/33 Encoder Direction		Configuration of encoder interface according to the specifications of the encoder.
5-72 Term 32/33 Encoder Type		Configuration of encoder interface according to the specifications of the encoder.

3.7.1.1.1 Connections

Following is the connection illustration for synchronizing marker corrections using digital I/O control.

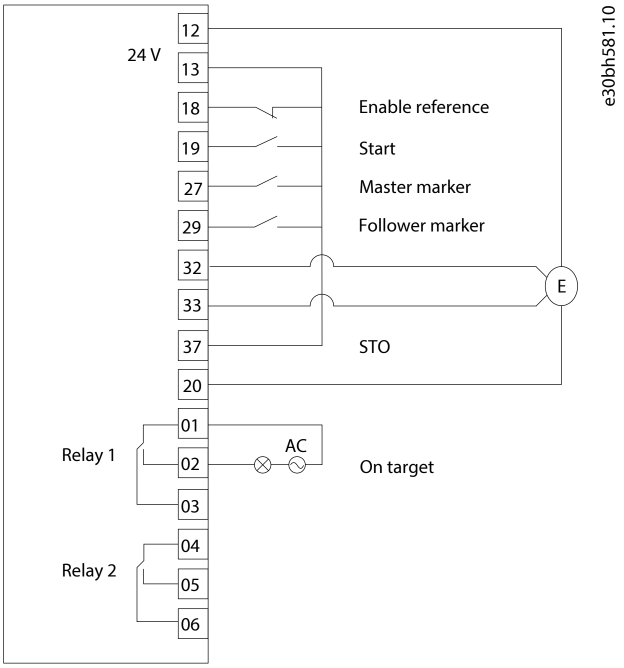


Figure 65: Marker Synchronization - Digital I/O

3.7.1.2 Control by Fieldbus

Following are the recommended parameter settings when controlled by PROFIBUS.

Parameter number and name	Setting	Description
1-00 Configuration Mode	***[10] Synchronizing***	Synchronizing control.
1-01 Motor Control Principle	***[2] Flux Sensorless***	Motor and position control without feedback.
3-16 Reference Resource 2	[3] 24 V Encoder 32/33	Select 24 V encoder on input 32/33 as master signal.
3-22 Master Scale Numerator	1	The gear ratio is set as a fraction to avoid rounding errors. In this example the 2 conveyors are identical, hence the gear ratio is 1–1.
3-23 Master Scale Denominator	1	The gear ratio is set as a fraction to avoid rounding errors. In this example the 2 conveyors are identical, hence the gear ratio is 1–1.

Parameter number and name	Setting	Description
3-33 Sync Mode & Start Behavior	***[10] Marker shortest***	Activates marker correction while synchronizing. Start-up of the follower marker is aligned with the closest master marker when the marker distance is set in parameter ***3-34 Marker Distance***. If the marker distance is not set, the 1st follower marker aligns with the 1st master marker. The start behavior can be configured always to catch up or slow down for the 1st marker correction.
3-34 Marker Distance		Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting parameter ***3–34 Marker Distance*** and parameter ***3–35 Marker Window***. After detecting the 1st marker pulse, the consequent marker pulse is only accepted if the position is within the marker distance +/- the marker window and only the 1st pulse within the window. Hence, any maker pulses outside the window or multiple pulses within the window are ignored.
3-35 Marker Window		Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting parameter ***3–34 Marker Distance*** and parameter ***3– 35 Marker Window***. After detecting the 1st marker pulse, the consequent marker pulse is only accepted if the position is within the marker distance +/- the marker window and only the 1st pulse within the window. Hence, any marker pulses outside the window or multiple pulses within the window are ignored.
4-10 Motor Speed Direction	***[2] Both directions***	Enables movement in both directions.
5-12 Terminal 27 Digital Input	***[123] Master Marker***	Connect master marker sensor to input 27.
5-13 Terminal 29 Digital Input	***[125] Follower Marker***	Connect follower marker sensor to input 29.
5-14 Terminal 32 Digital Input	***[0] No operation***	Used for 24 V master encoder.
5-15 Terminal 33 Digital input	***[0] No operation***	Used for 24 V master encoder.
5-70 Term 32/33 Pulses Per Revolution		Configuration of encoder interface according to the specifications of the encoder.
5-71 Term 32/33 Encoder Direction		

Parameter number and name	Setting	Description
5-72 Term 32/33 Encoder Type		
8-01 Control Site	***[2] Control Word only***	Control via fieldbus only.
9-16.2 PCD Read Configuration	***[1608] Position Error***	Use PCD 2 and 3 to read the position error as a 32-bit value.
9-16.3 PCD Read Configuration	***[1608] Position Error***	Use PCD 2 and 3 to read the position error as a 32-bit value.
9-16.4 PCD Read Configuration	***[1821] Master Position***	Use PCD 2 and 3 to read the position error as a 32-bit value.
9-16.5 PCD Read Configuration	***[1821] Master Position***	Use PCD 2 and 3 to read the position error as a 32-bit value.

3.7.1.2.1 Connections

Following is the connection diagram for marker synchronization when controlled by fieldbus (PROFIBUS).

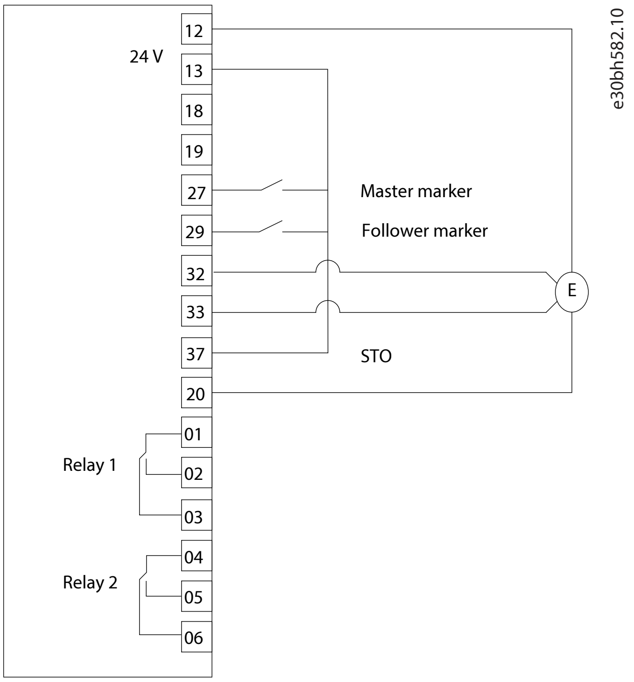


Figure 66: Marker Synchronization - PROFIBUS

3.7.1.2.2 Control Word Examples

Table 28: Control Word Examples

Function	Binary	Hexadecimal	Comment
Start (bit 6)	0000 0100 0101 1000	0458	Magnetizes the motor maintaining the current position.
Enable reference (bit 5)	0000 0100 0111 1000	0478	Activates synchronizing. Actual follower position is locked to the actual master position.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset is also possible with active start, speed mode, and touch signals, such as 34D8.

3.7.1.2.3 Status Word Examples

Table 29: Status Word Examples

Function	Binary	Hexadecimal	Comment
Coasting (bit 2)	0000 0110 0000 0011	0603	Drive is coasting, the motor is not controlled.
Tripped (bit 3)	0000 0110 0000 1011	060B	The drive has stopped with an Alarm, alarm type and status can be read in parameter group ***16-9x Diagnosis Readouts***.
Target reached (bit 8)	0000 1111 0001 0111	0F17	Synchronizing, accuracy within parameter ***3-08 On Target Window***.

3.7.1.2.4 Fieldbus Data Layout

The illustrations show fieldbus data layout for reading from the drive or writing to the drive, when synchronizing with marker correction.

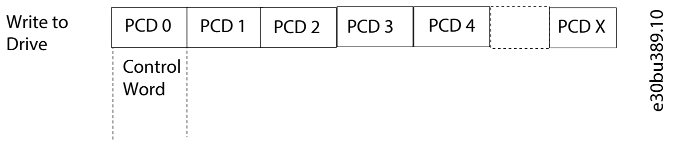


Figure 67: Write to Drive

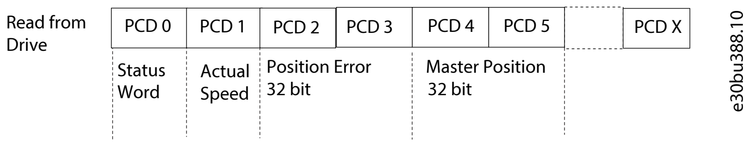


Figure 68: Read from Drive

3.8 CAM Synchronizing with External Master

3.8.1 Introduction to CAM Synchronizing with External Master

In this application example, a flying saw cuts a continuously moving tube to length. The flying saw acts as the follower, and its sequence is based on the master position.

- Accelerate to master speed.
- Follow the master position while cutting.
- Return to the original position to be ready for the next cut.

The flying saw is scaled to mm, and 1 motor revolution moves the saw 25 mm.

The saw runs in closed-loop control of an induction motor with 4096 PPR incremental encoder.

A 24 V incremental encoder with 1024 PPR registers the tube movement via a wheel with a circumference of 500 mm.

A digital CAM switch is used to move the saw up and down at specific master positions.

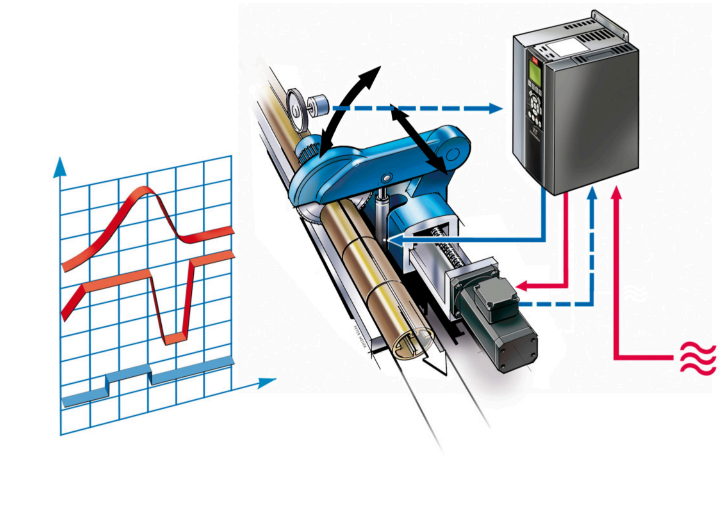


Figure 69: Example of Application using the CAM Function

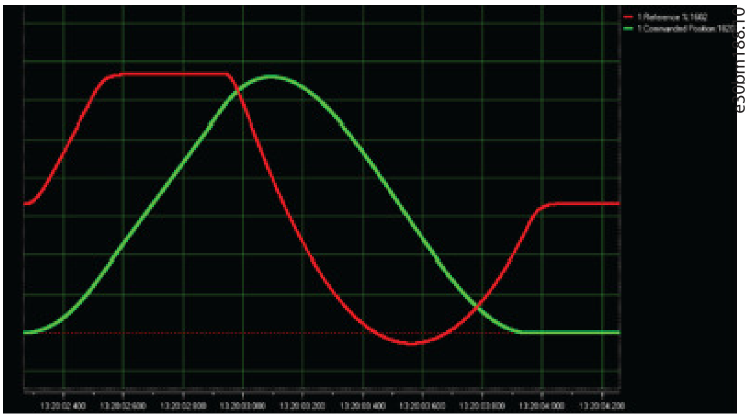


Figure 70: Follower Speed and Position

Red line	Follower speed	Green line	Follower position

3.8.2 Control by Digital I/O

Table 30: Parameter Settings for Control by Digital I/O

Parameter	Setting	Description
1-00 Configuration Mode	*[10] Synchronizing*	Synchronizing control.
1-01 Motor Control Principle	*[3] Flux w/motor feedb*	Motor and position control with feedback.
1-02 Motor Feedback Source	*[2] MCB 102*	A motor-mounted encoder connected to the VLT® Encoder Option MCB 102 is used as motor and position feedback.
3-16 Reference Resource 2	*[3] 24V encoder*	A 24 V encoder on input 32/33 is used as master signal.
3-22 Master Scale Numerator	1	Scaling of the master relative to follower scaling (25 mm/rev). 1 master revolution is 500 mm corresponding to 20 follower revolutions (500/25=20). Therefore, set the master scale to 1:20.
3-23 Master Scale Denominator	20	
3-33 Sync. Mode & Start Behavior	*[20] CAM*	

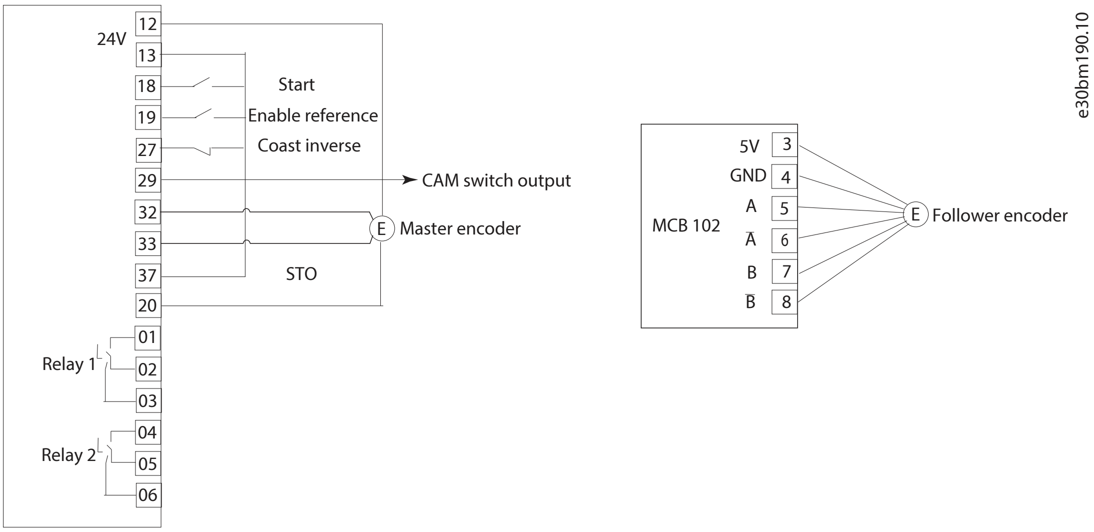
Table 30: Parameter Settings for Control by Digital I/O (continued)

Parameter	Setting	Description
3-36.0 CAM Master Table	0	Master positions forming position pairs with the corresponding follower positions.
3-36.1 CAM Master Table	400	
3-36.2 CAM Master Table	1200	
3-36.3 CAM Master Table	3000	
3-36.4 CAM Master Table	3600	
3-37.0 CAM Follower Table	0	Follower positions forming position pairs with the corresponding master positions.
3-37.1 CAM Follower Table	200	
3-37.2 CAM Follower Table	1000	
3-37.3 CAM Follower Table	0	
3-37.4 CAM Follower Table	0	
3-38.0 CAM Curve Table	***[3] Poly 2nd order***	Smooth start
3-38.1 CAM Curve Table	***[1] Linear***	Fixed gear ratio locking saw position to tube positioning while sawing.
3-38.2 CAM Curve Table	***[4] Poly 3rd order***	Smooth reversing.
3-38.3 CAM Curve Table	***[1] Linear***	Stand still until the next cutting sequence.
3-38.4 CAM Curve Table	***[10] End***	End of curve.
4-10 Motor Speed Direction	***[2] Both directions***	Enables movement in both directions.
5-02 Terminal 29 Mode	***[1] Output***	Use terminal 29 as digital output.
5-10 Terminal 18 Digital Input	***[8] Start***	Using input 18 as start magnetizes the motor and maintains current position.
5-11 Terminal 19 Digital Input	***[113] Enable reference***	Input 19 activates synchronizing. The actual follower position is locked to the actual master position.
5-14 Terminal 32 Digital Input	***[0] No operation***	Used for 24 V encoder.
5-15 Terminal 33 Digital Input	***[0] No operation***	Used for 24 V encoder.
5-31 Terminal 29 Digital Input	***[100] Digi. CAM Switch A***	Use the digital output 29 to activate up and down movement of the saw. The saw can only be down while the follower is keeping its position relative to the master.
5-70 Term 32/33 Pulses Per Revolution	1024	Configuration of interface for the master encoder connected to terminals 32 and 33.
5-72 Term 32/33 Encoder Type	***[0] Quadrature A/B format***	
17-10 Signal Type	***[1] RS422 (5 V TTL)***	Configuration of interface for the follower encoder connected to VLT® Encoder Option MCB 102.
17-11 Resolution (PPR)	4096	
17-70 Position Unit	***[2] mm***	Use [mm] as unit for the position values.
17-72 Position Unit Numerator	25	To avoid rounding errors, set the movement in mm per motor revolution as integer.
17-73 Position Unit Denominator	1	

Table 30: Parameter Settings for Control by Digital I/O (continued)

Parameter	Setting	Description
24-50 Switch Source A	***[2] Master position***	Activation of up and down movement of the saw based on master position.
24-52.0 First Position A	400	Saw down at master position 400 mm.
24-53.0 Last Position A	1200	Saw up at master position 1200 mm.

3.8.2.1 Connections



3.8.3 Control by Fieldbus

Table 31: Parameter Settings for Control via Fieldbus

Parameter	Setting	Description
1-00 Configuration Mode	***[10] Synchronizing***	Synchronizing control.
1-01 Motor Control Principle	***[3] Flux w/motor feedb***	Motor and position control with feedback.
1-02 Motor Feedback Source	***[2] MCB 102***	A motor-mounted encoder connected to the VLT® Encoder Option MCB 102 is used as motor and position feedback.
3-16 Reference Resource 2	***[3] 24V encoder***	A 24 V encoder on input 32/33 is used as master signal.
3-22 Master Scale Numerator	1	Scaling of the master relative to follower scaling (25 mm/rev). 1 master revolution is 500 mm corresponding to 20 follower revolutions (500/25=20). Therefore, set the master scale to 1:20.
3-23 Master Scale Denominator	20	
3-33 Sync. Mode & Start Behavior	***[20] CAM***	

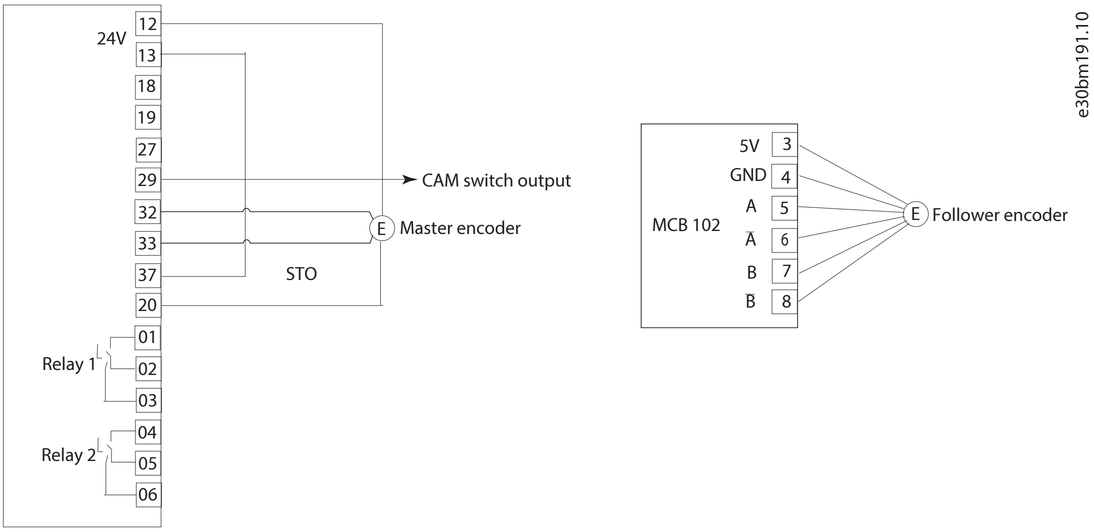
Table 31: Parameter Settings for Control via Fieldbus (continued)

Parameter	Setting	Description
3-36.0 CAM Master Table	0	Master positions forming position pairs with the corresponding follower positions.
3-36.1 CAM Master Table	400	
3-36.2 CAM Master Table	1200	
3-36.3 CAM Master Table	3000	
3-36.4 CAM Master Table	3600	
3-37.0 CAM Follower Table	0	Follower positions forming position pairs with the corresponding master positions.
3-37.1 CAM Follower Table	200	
3-37.2 CAM Follower Table	1000	
3-37.3 CAM Follower Table	0	
3-37.4 CAM Follower Table	0	
3-38.0 CAM Curve Table	***[3] Poly 2nd order***	Smooth start
3-38.1 CAM Curve Table	***[1] Linear***	Fixed gear ratio locking saw position to tube positioning while sawing.
3-38.2 CAM Curve Table	***[4] Poly 3rd order***	Smooth reversing.
3-38.3 CAM Curve Table	***[1] Linear***	Stand still until the next cutting sequence.
3-38.4 CAM Curve Table	***[10] End***	End of curve.
4-10 Motor Speed Direction	***[2] Both directions***	Enables movement in both directions.
5-02 Terminal 29 Mode	***[1] Output***	Use terminal 29 as digital output.
5-14 Terminal 32 Digital Input	***[0] No operation***	Used for 24 V encoder.
5-15 Terminal 33 Digital Input	***[0] No operation***	Used for 24 V encoder.
5-31 Terminal 29 Digital Input	***[100] Digi. CAM Switch A***	Use the digital output 29 to activate up and down movement of the saw. The saw can only be down while the follower is keeping its position relative to the master.
5-70 Term 32/33 Pulses Per Revolution	1024	Configuration of interface for the master encoder connected to terminals 32 and 33.
5-72 Term 32/33 Encoder Type	***[0] Quadrature A/B format***	
8-01 Control Site	***[2] Control word only***	Control signals via fieldbus control word only.
9-16.2 PCD Read Configuration	***[1608] Position error***	PCD 2 and 3 are used to read positions errors as 32-bit values.
9-16.3 PCD Read Configuration	***[1608] Position error***	
17-10 Signal Type	***[1] RS422 (5 V TTL)***	Configuration of interface for the follower encoder connected to VLT® Encoder Option MCB 102.
17-11 Resolution (PPR)	4096	
17-70 Position Unit	***[2] mm***	Use [mm] as unit for the position values.
17-72 Position Unit Numerator	25	To avoid rounding errors, set the movement in mm per motor revolution as integer.
17-73 Position Unit Denominator	1	
24-50 Switch Source A	***[2] Master position***	Activation of up and down movement of the saw based on master position.

Table 31: Parameter Settings for Control via Fieldbus (continued)

Parameter	Setting	Description
24-52.0 First Position A	400	Saw down at master position 400 mm.
24-53.0 Last Position A	1200	Saw up at master position 1200 mm.

3.8.3.1 Connections



3.8.4 Control Word Examples

Table 32: Control Word Examples

Function	Binary	Hexadecimal	Comment
Start (bit 6)	0000 0100 0101 1000	0458	Magnetizes the motor while maintaining the current position.
Enable reference (bit 5)	0000 0100 0111 1000	0478	Activates synchronizing. The actual follower position is locked to the actual master position.
Reset (bit 7)	0000 0100 1001 1000	0498	Reset of active alarms by toggling bit 7, but only if the condition causing the alarm has been rectified.

3.8.5 Status Word Examples

Table 33: Status Word Examples

Function	Binary	Hexadecimal	Comment
Coasting (bit 2)	0000 0110 0000 0011	0603	–
Tripped (bit 3)	0000 0110 0000 1011	060B	–
Target reached (bit 8)	0000 1111 0001 0111	0F17	Synchronizing. The accuracy is within parameter ***3-08 On Target Window***.

3.8.6 Fieldbus Data Layout

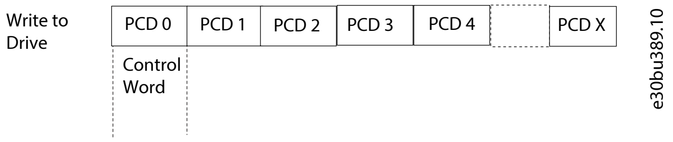


Figure 71: Write to Drive

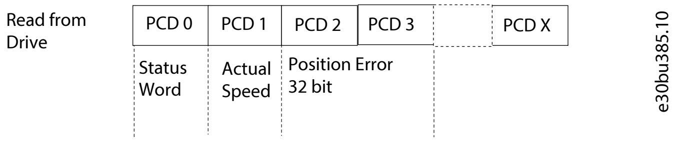


Figure 72: Read from Drive

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