

Application Guide

VLT® Integrated Motion Controller

Software version: 48.XX



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1 Before you begin

1.1 Introduction to the Application Guide

This chapter describes the purpose of the application guide, manual version, intended audience, disclaimer, safety conventions, and additional resources.

1.2 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 scope of the application guide.

1.3 Intended Audience

The intended audience of the application guide is trained personnel, automation engineers, and programmers with experience in operating with parameters and with basic knowledge of DanfossAC drives.

1.4 Manual Version

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

The original language of this manual is in English.

| Manual Version | Remarks | Software Version |
|----------------|-----------------|------------------|
| MG37S | First version | 48.XX |
| M00196 | Updated version | 48.XX |

1.5 Additional Resources

Additional resources are available with related information.

The programming guide provides information on all the parameters in Danfoss.

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 of FC 302 Automation Drive.

Technical documentation for various product options is available via the [Danfoss home page](#) in the Service and Support/ Documentation section.

Safety Symbols

The following symbols are used in this manual:

⚠ DANGER ⚠

Indicates a hazardous situation when not avoided, results in death or serious injury.

⚠ WARNING ⚠

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

⚠ CAUTION ⚠

Indicates a hazardous situation when 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).

1.6 Disclaimer

This publication contains information proprietary to Danfoss. By accepting and using this manual, the user agrees that the information contained in this guide is used solely for operating equipment from Danfoss, or equipment from other vendors if such equipment is intended for communication with Danfoss equipment over a serial communication link. This publication is protected under the Copyright laws of Denmark and most other countries.

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2 Introduction to IMC

2.1 An Overview to IMC

The Integrated Motion Controller (IMC) enables position control with all control principles and motor types with and without feedback for the VLT.

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. The controller can scale positions to any relevant physical unit such as mm or °.

To activate IMC, 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 position 24-27 of the type code. For more information on ordering the software, see Design Guide.

2.3 Reference Handling

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 (with feedback) control principle, 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 the illustration.

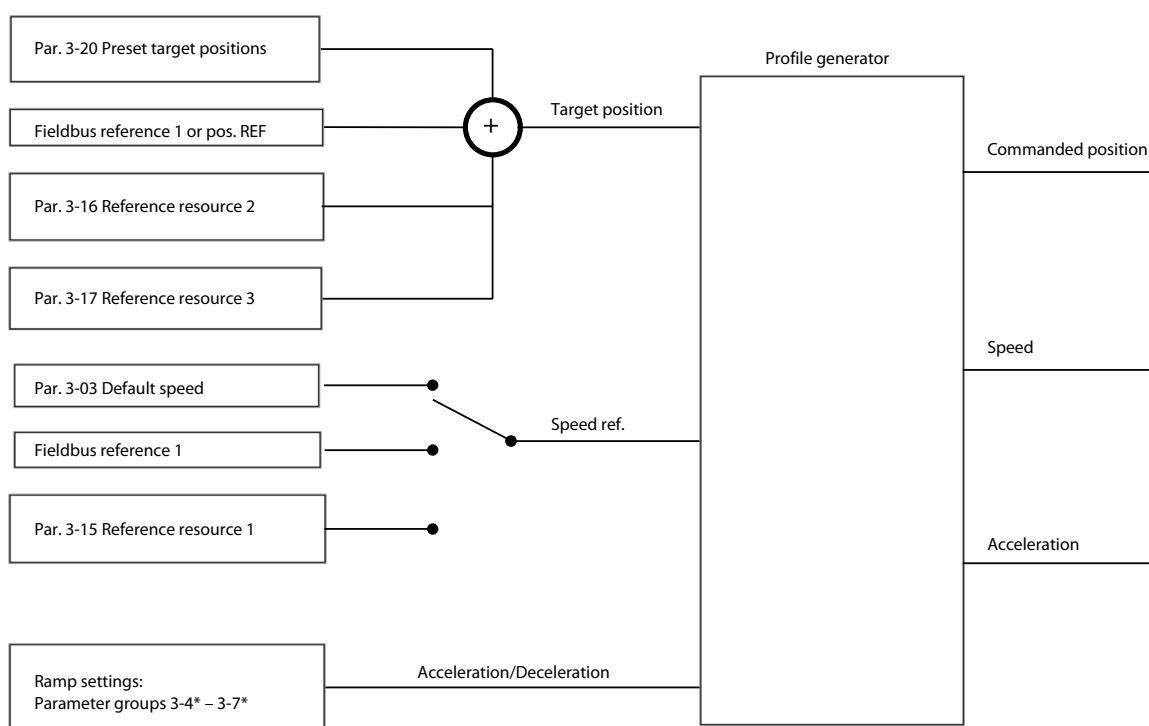


Illustration 1: Positioning References

Synchronization

During synchronization, a master encoder signal is sent to the drive which is followed by the motor based on scaling. The following synchronization features are available:

- Synchronize multiple shafts to the same encoder signal.
- Option to use different scaling on each shaft, as required.
- Synchronize to a real master.
- Synchronize to a virtual master.

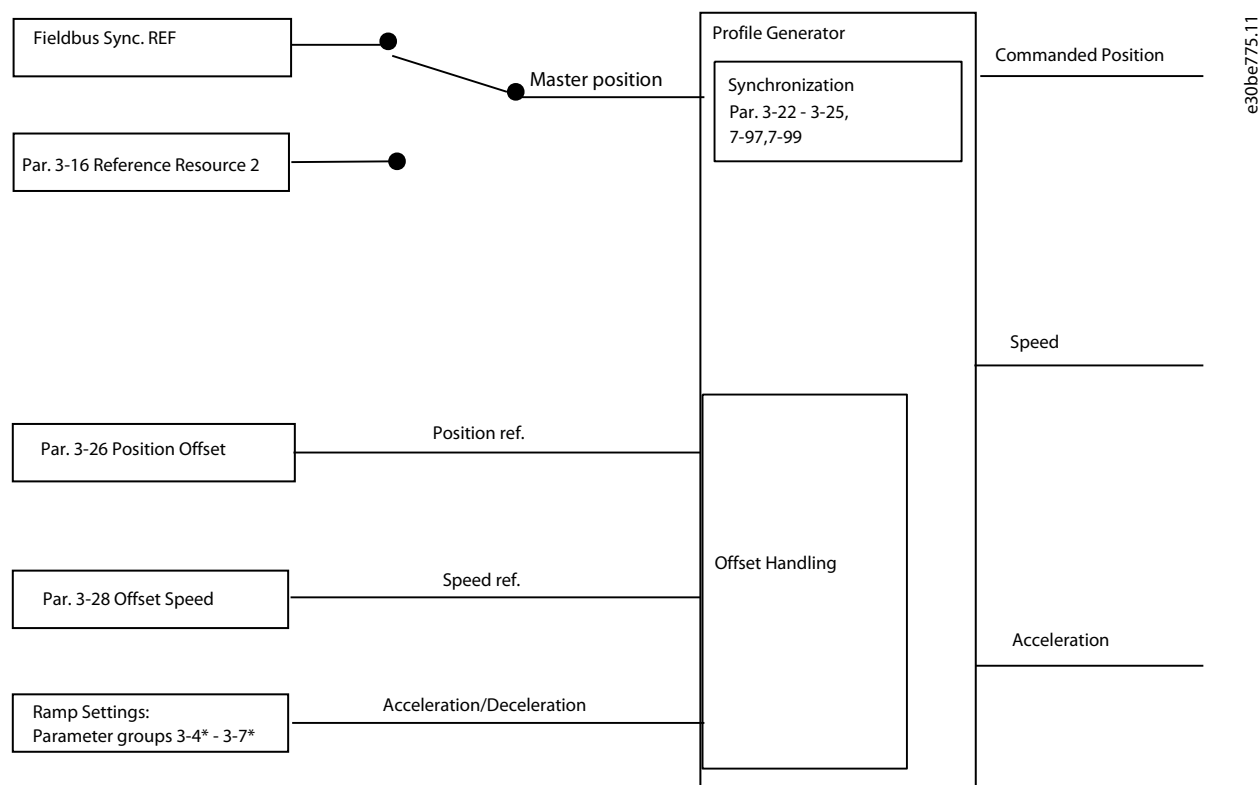


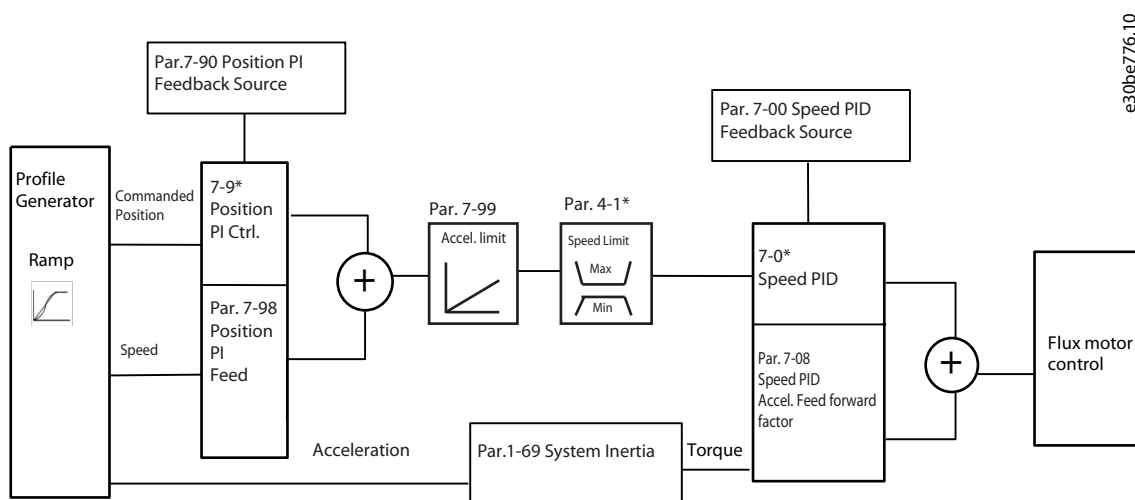
Illustration 2: Synchronization References

For positioning and synchronizing, 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 [2.4 Control Loops and Control Configurations](#).

2.4 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.

The illustration below shows the control structure and parameters affecting the control behavior with flux motor control.



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Illustration 3: Positioning and Synchronization Mode

2.5 Control Configurations

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

It is possible for one 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:

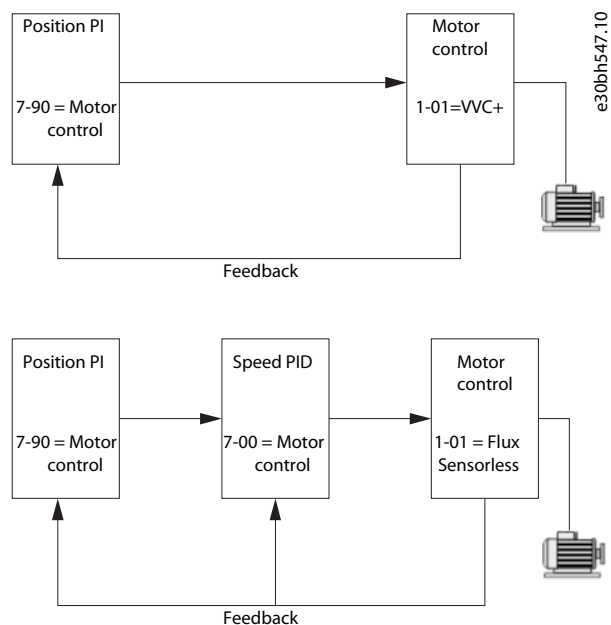


Illustration 4: Sensorless Motor/Speed/Position Control, VVC⁺ or Flux Sensorless

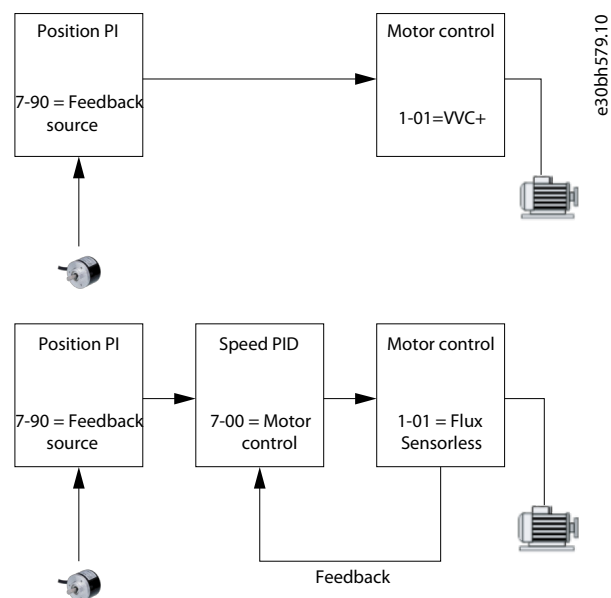


Illustration 5: Sensorless Motor/Speed Control and Position Control with Feedback, VVC⁺ or Flux Sensorless

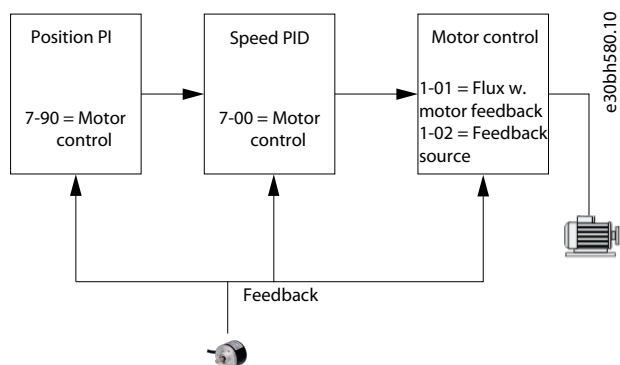


Illustration 6: Motor/Speed/Position Control with Motor Feedback, Flux with Motor Feedback

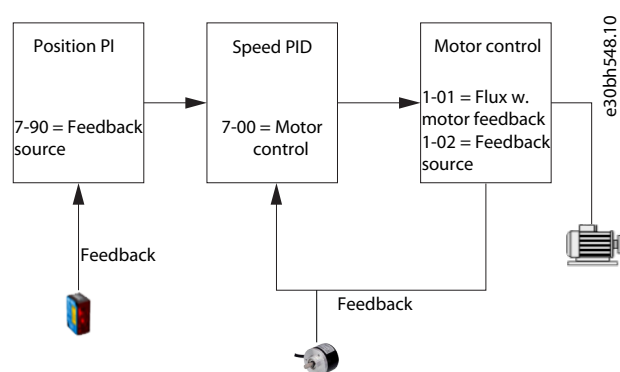


Illustration 7: Motor/Speed/Position control with Motor Feedback and position control with Application Feedback, Flux with Motor Feedback

2.6 Control and Status Signals

IMC control and status signals are available as digital I/O bits and fieldbus bits. The following table details the available options.

Table 1: Control Signals

| Name | Function | Digital Input | Control Word |
|------------------------|--|---------------|--------------|
| Enable master offset | Activates the master offset when <i>parameter 17-93 Master Offset Selection</i> 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. | ✓ | ✓ |
| 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 <i>parameter 1-00 Configuration Mode</i> is set to [9] <i>Positioning</i> or [10] <i>Synchronization</i> . | ✓ | ✓ |
| 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 actual master position as defined in <i>parameter 17-88 Master Home Position</i> | ✓ | ✓ |
| 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) | ✓ | - |

When [3] *FC Motion Profile* is selected in *parameter 8-10 Control Word Profile*, the bits in the control word have the following meaning, as in [table 2](#):

Table 2: Control word for *option [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 |

| Bit | 0 | 1 |
|------------------|------------------|------------------|
| 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 bit 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
- [14] Ramp 2
- [15] Relay 1
- [16] Relay 2
- [17] Speed Mode
- [18] Enable Virtual Master
- [19] Activate Master Offset
- [20] Target Inverse
- [26] Home Sensor
- [27] Touch Sensor
- [28] Position Vir. Master
- [29] Set Master Home

Table 3: 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 (<i>parameter 3-06 Minimum Position</i> or <i>parameter 3-07 Maximum Position</i>). | ✓ | ✓ |
| Touch on target | Target position is reached in touch probe position mode. | ✓ | ✓ |
| Touch activated | Touch probe positioning active. | ✓ | ✓ |

When [3] *FC Motion Profile* is selected in *parameter 8-10 Control Word Profile*, the bits in the status word have the following meaning. Status words are described in [table 4](#):

Table 4: Status word for *option [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 |
| 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 | Timer 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

2.7 Homing

The homing functions is typically used for the following 3 different purposes:

- To define the 0 point of the machine. Typically needed after every power up when using sensor less position control or using incremental encoder for position feedback
- Set absolute encoder offset
- Home synchronization to realign the home position on the fly

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

The selected homing function is activated by **Start Homing** signal. 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 start signal and the motor is magnetized.

The **Start Homing** signal must be kept high until homing is completed. When **Start Homing** signal goes low during or after homing, the drive returns to the previous state (Standby or Running).

The **Homing Ok** signal is set when the selected homing function is completed. By default, the setting *Option [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 behaviours in *parameter 17-86 Homing Flag Behavior* :

- *Option [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.
- *Option [2] Clear at Coast Running:* **Homing Ok** signal is cleared at motor coast only while 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.
- *Option [3] Clear at Homing Only:* The selected home function is used to set absolute encoder offset *parameter 17-74 Position Offset* to get actual position *parameter 17-82 Home Position* at the chosen 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 *option [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:

2.7.1 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*

2.7.2 Analog Input

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

Example:

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

Actual position is set to 500.

2.7.3 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*.

When the home sensor is detected, the position of the physical machine at the leading edge of the home sensor signal is defined as home position. 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 point.

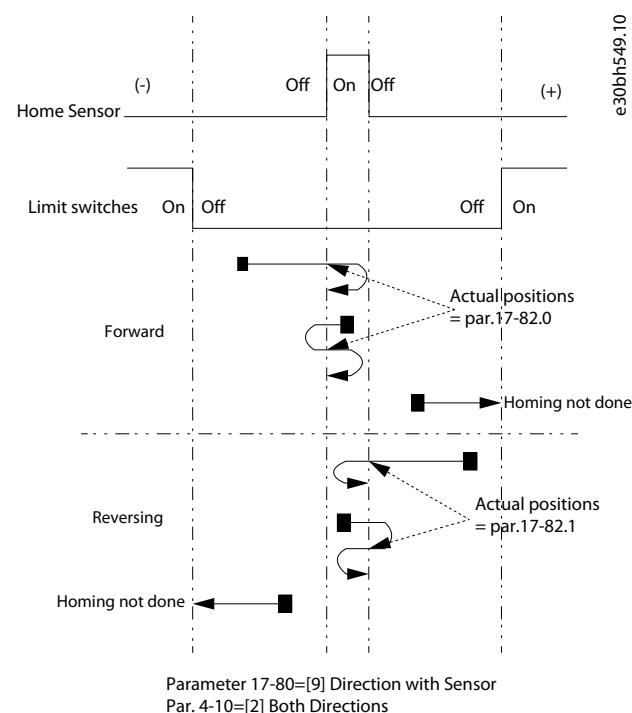


Illustration 8: Direction with Sensor

2.7.4 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.

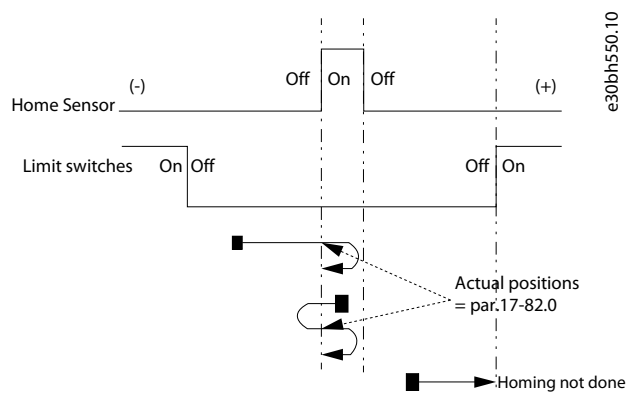


Illustration 9: Forward with Home Sensor - *Parameter 17-82.1 = 0*

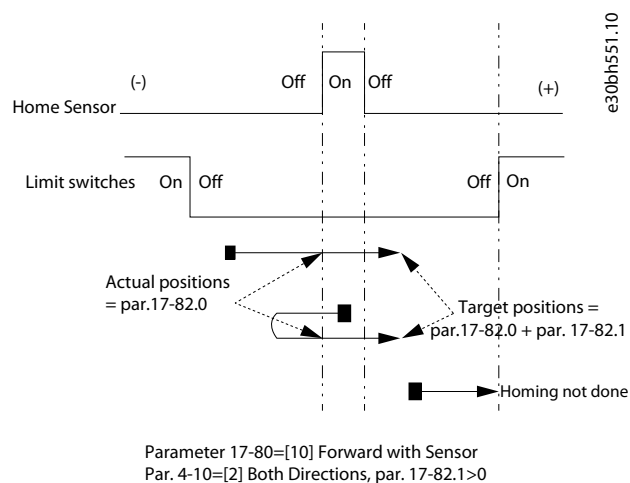


Illustration 10: Forward with Home Sensor - *Parameter 17-82.1 > 0*

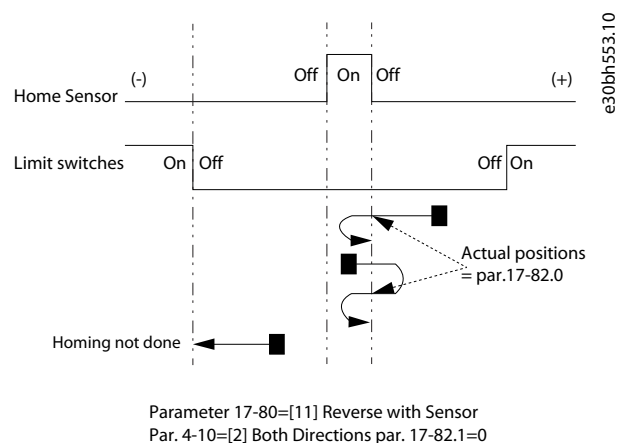


Illustration 11: Reverse with Home Sensor - parameter 17-82=0

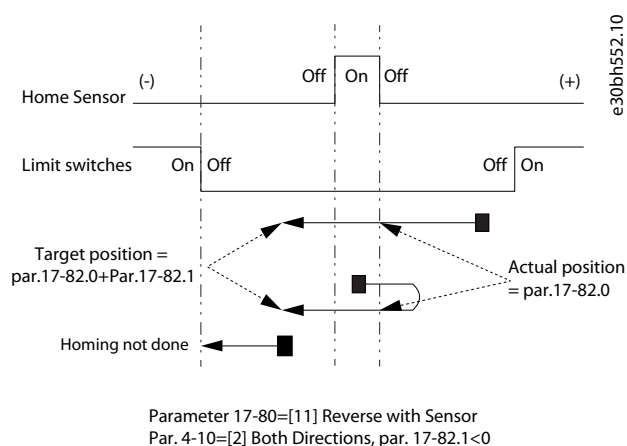


Illustration 12: Reverse with Sensor - parameter 17-82.1<0

2.7.5 Forward or Reverse II with Home Sensor

The same functionality as forward or reverse with home sensor, with two 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 show running at homing speed and the red line show running at 10% of the homing speed.

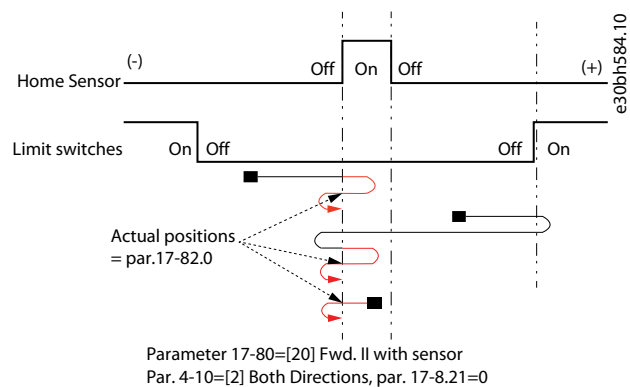


Illustration 13: Forward II with Sensor, *Parameter 17-82.1=0*

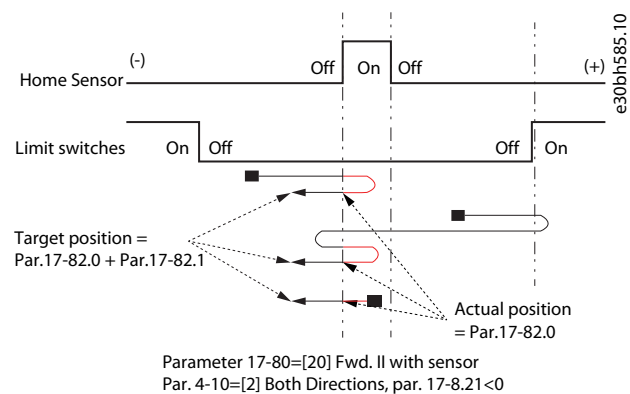


Illustration 14: Forward II with Sensor, *Parameter 17-82.1 < 0*

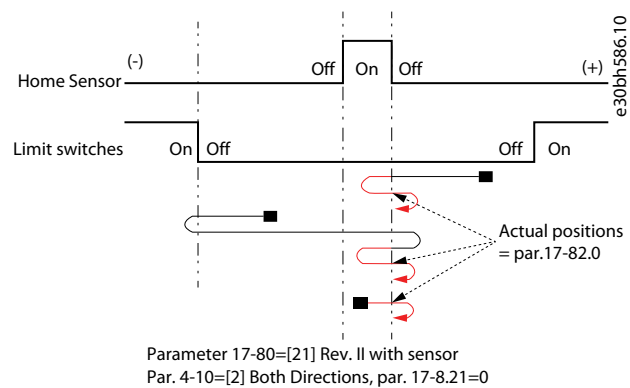


Illustration 15: Reverse II with Sensor, *Parameter 17-82.1=0*

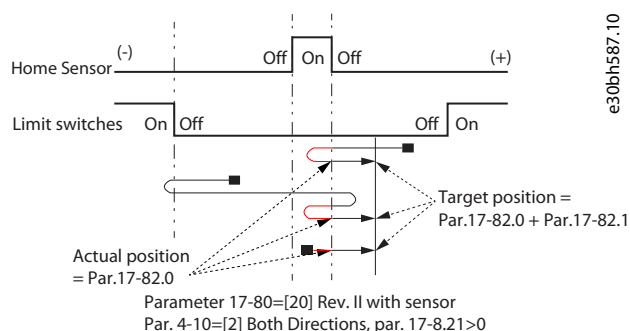


Illustration 16: Reverse II with Sensor, Parameter 17-82.1 > 0

2.7.6 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.

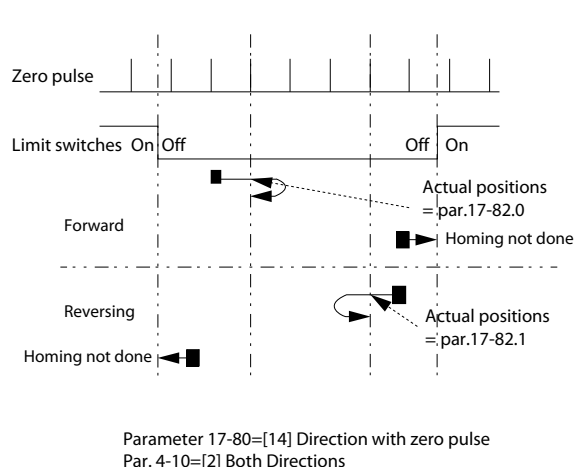


Illustration 17: Direction with Encoder Zero Pulse

2.7.7 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.

Home position is the value in *parameter 17-82.0* + the offset value in *parameter 17-82.1*.

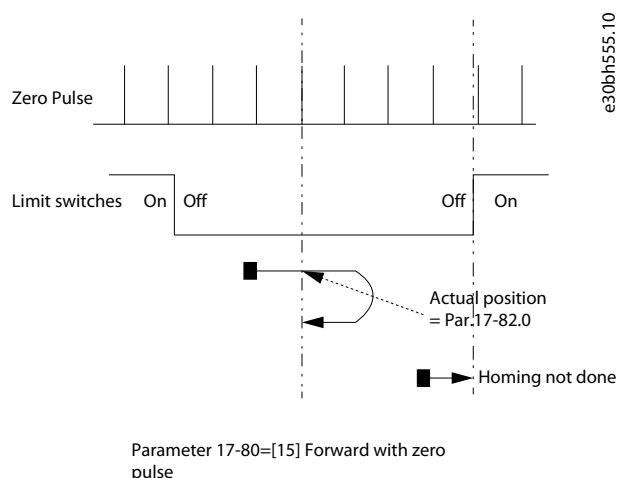


Illustration 18: Forward with Encoder Zero Pulse - *Parameter 17-82.1 = 0*

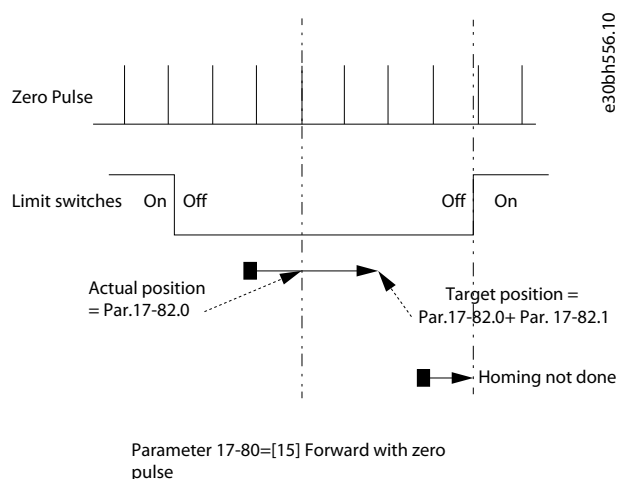


Illustration 19: Forward with Encoder Zero Pulse - *Parameter 17-82.1 > 0*

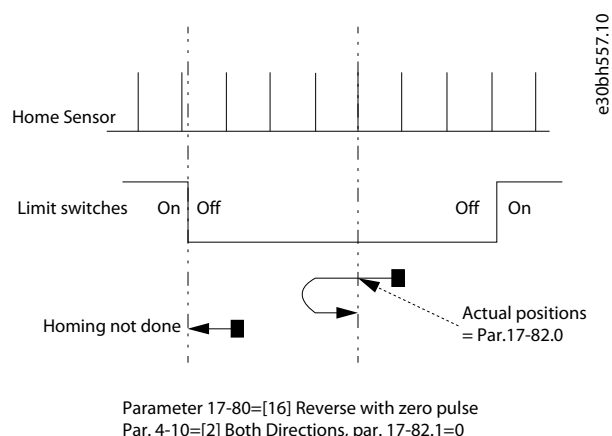


Illustration 20: Reverse with Zero Pulse - *Parameter 17-82.1 = 0*

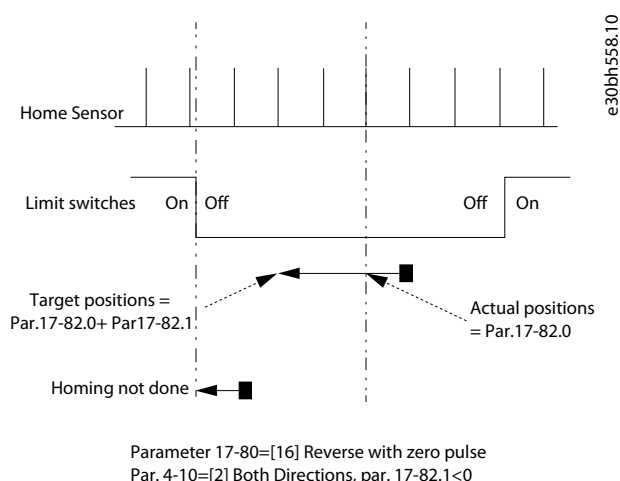


Illustration 21: Reverse with Zero Pulse - *Parameter 17-82.1 < 0*

2.7.8 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.

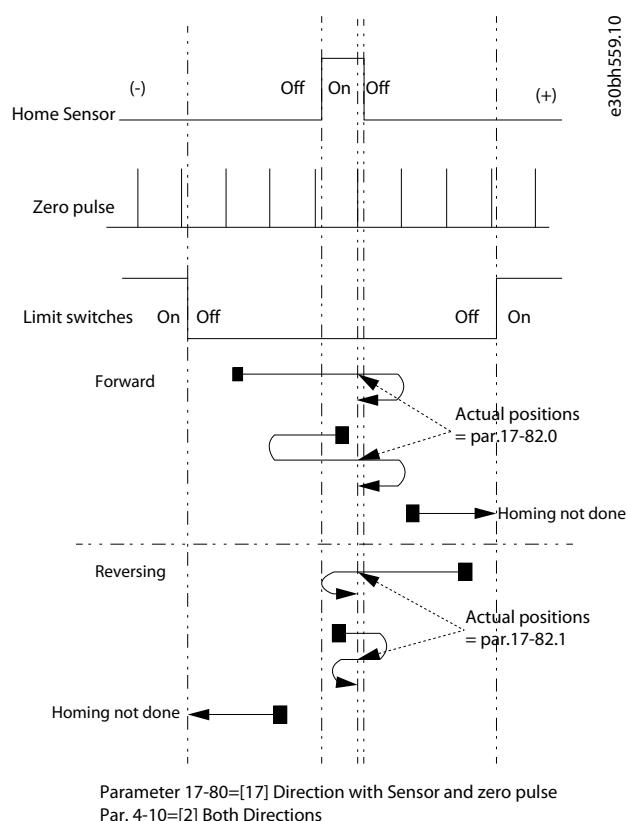
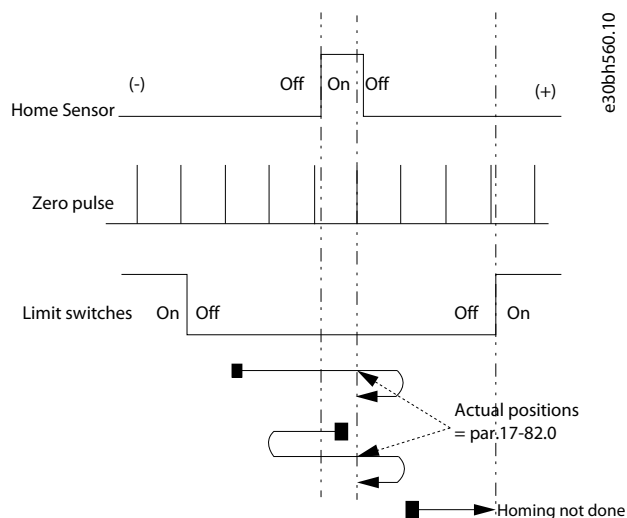


Illustration 22: Direction with Home Sensor and Encoder Zero Pulse

2.7.9 Forward or Reverse with Home Sensor and Encoder Zero Pulse

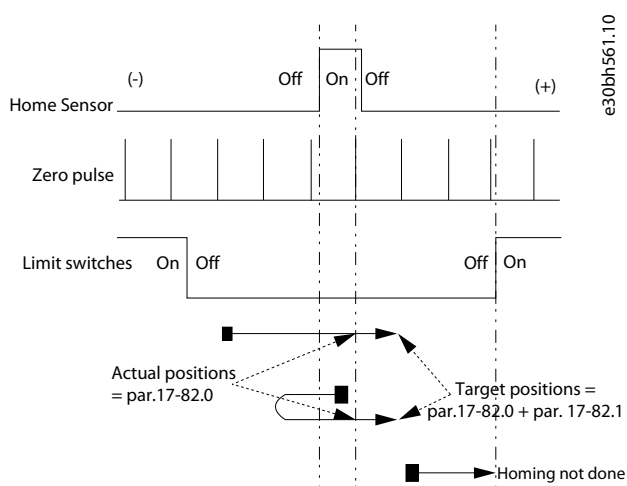
Home sensor search is started in the selected direction with the speed set in *parameter 17-83 Homing Speed*. On detecting the home sensor, the drive continues in the same direction and the physical position of the machine at the next zero pulse signal is defined as Home Position. The actual position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

Illustration 23: 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

Illustration 24: Forward with Home Sensor - Parameter 17-82.1 > 0

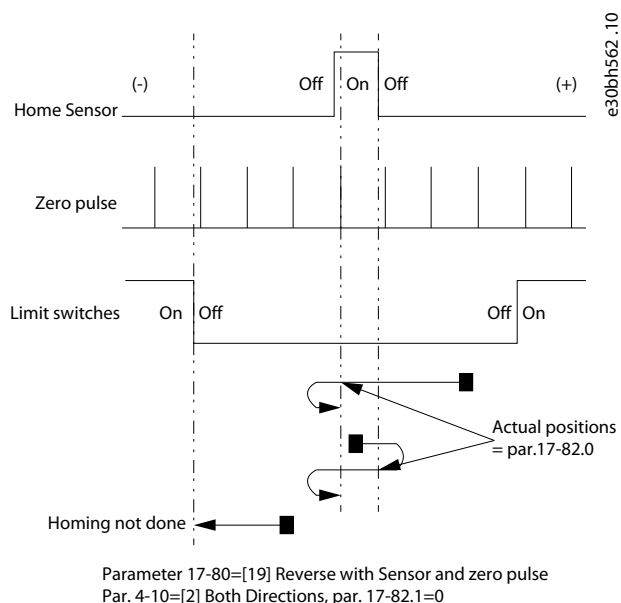


Illustration 25: Reverse with Home Sensor - Parameter 17-82.1 = 0

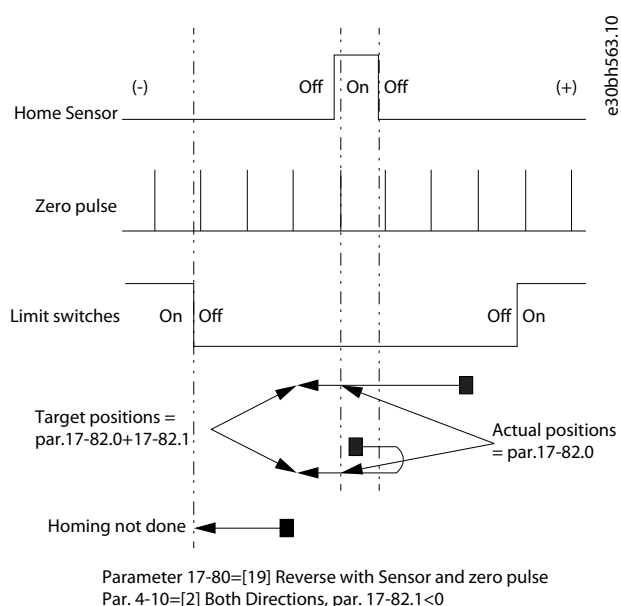


Illustration 26: Reverse with Home Sensor - Parameter 17-82.1 < 0

2.7.10 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* + the offset set in *parameter 17-82.1 Home Position* index 1. See [2.7.1 Home Position](#).

2.7.11 Home Synchronization

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

In 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 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.

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

2.8 Scaling of 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 right scaling, set values in *parameter 7-94 Position PI Feedback Scale Numerator* and *parameter 7-95 Position PI Feedback Scale Denominator*.

2.8.1 Example 1

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

Linear movement per motor revolution is $32 \times 10 = 320$ mm.

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

2.8.2 Example 2

Consider the linear belt drive (from [2.8.1 Example 1](#)). In this example, a VLT® OneGearDrive (OGD) with 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 resulting ratio is $43 \times 23 : 7 \times 10 = 989 : 70$

For position values in mm, set *parameter 17-72 Position Unit Numerator* = $320 \times 70 = 22400$ 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.

2.8.3 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 resulting ratio.
- 989 is the numerator of the resulting ratio.

See [2.8.2 Example 2](#) for ratio calculation.

2.9 Gear Ratio for Synchronization

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

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

The following examples 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.

2.9.1 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.

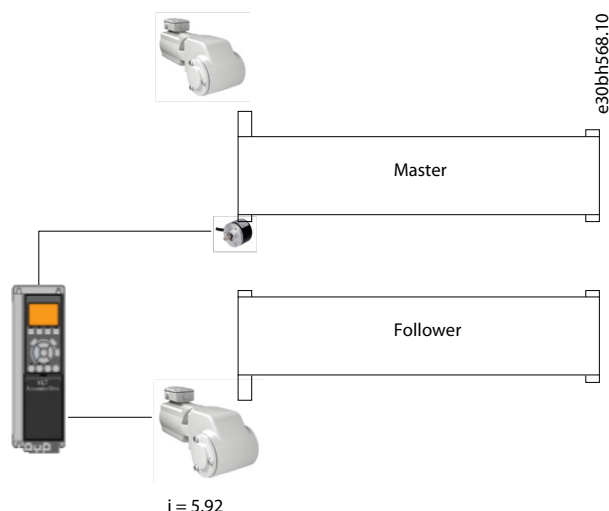


Illustration 27: Master encoder after the gearbox

Stage 1: 43/7

Stage 2: 27/28

Resulting Ratio: $43 \times 27 : 7 \times 28 = 1161:196$

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

Set the following parameters for the follower conveyor belt.

- parameter 3-22 Master Scale Numerator to 196
- 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.

2.9.2 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.

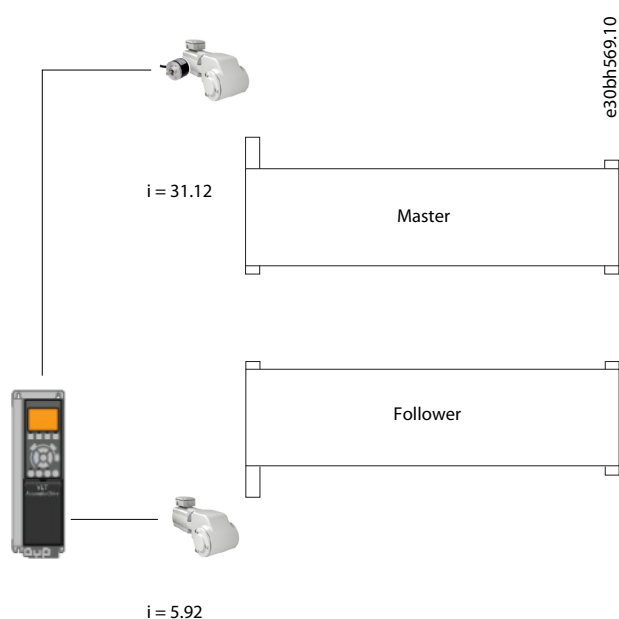


Illustration 28: Master Encoder before the Gear Box

Stage 1: 43/7

Stage 2: 76/15

Resulting ratio: $43 \times 76 : 7 \times 15 = 3268 : 105$

When multiplied by existing ratio: $196 \times 3268 : 1161 \times 105 = 640528 : 121905$

Reduced ratio: 2128 : 405

Set the parameter as follows:

- parameter 3-22 Master Scale Numerator to 2128.
- 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.

2.9.3 Scenario 3

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

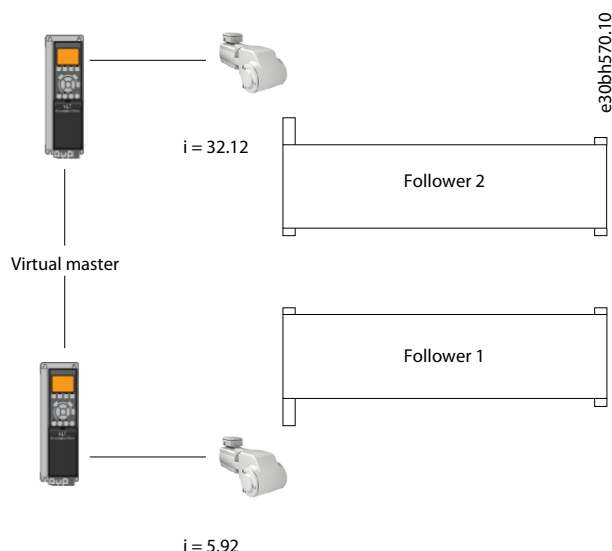


Illustration 29: Drives Synchronizing to Virtual Master Signal

- Follower 1 OGD has $i=5.92$
- Follower 2 OGD has $i=31.12$

Ratio for followers is calculated using the OGD.

Ratio for follower 1 is calculated as in [2.9.1 Scenario 1](#). Set parameters as follows:

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

Ratio for follower 2 using OGD with $i=31.12$. See resulting ratio calculation in [2.9.2 Scenario 2](#).

Set parameters as follows:

- *parameter 3-22 Master Scale Numerator* to 105
- *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.

2.10 Recommendations for Commissioning Steps

Procedure

1. Configure the LCP status screen.
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

The following setup shows an application which utilizes sensorless control of a PM 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.

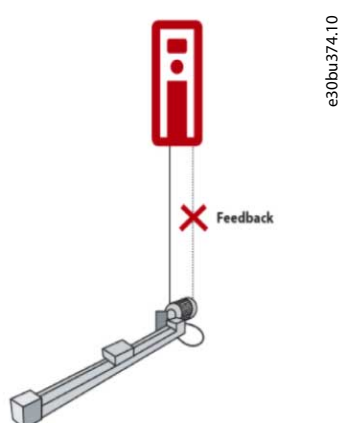


Illustration 30: Linear Sensorless Positioning

3.1.1 Control by Digital I/O

Following are the recommended parameter settings when absolute positioning with 2 fixed targets is controlled by digital I/O.

Table 5: 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. |
| 4-10 Motor speed direction | [2] Both directions | Enables motor rotation in both directions. |

| Parameter number and name | Setting for the application | Description of the setting |
|----------------------------------|-----------------------------|---|
| 4-74 Start Fwd/Rev function | [8] Coast & Trip | Set the function when hardware end limits are activated to coast and trip (alarm). The alarm must be reset before movement can be resumed. 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 low signal with active sensor. |
| 5-11 Terminal 19 Digital input | [8] Start | Use input 19 as start. The option magnetizes the motor and starts movement towards 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 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 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 Connections

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

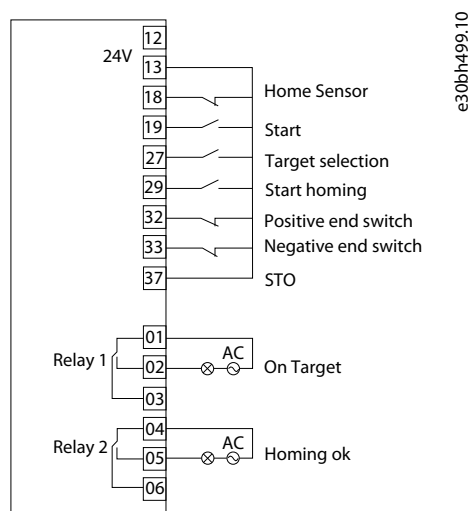


Illustration 31: Linear Positioning - Control by Digital I/O

3.1.2 Control by Fieldbus

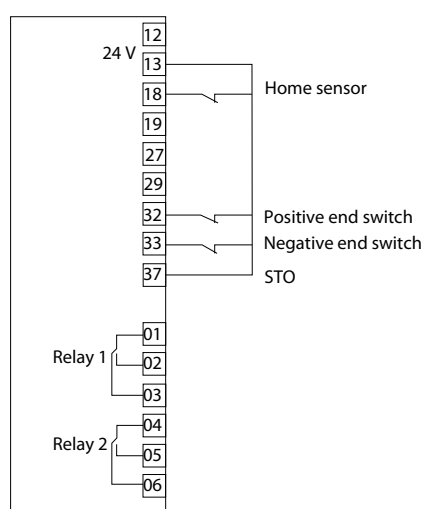
Following are the recommended parameter settings when absolute positioning with 2 fixed targets is selected by PROFIBUS.

Table 6: 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 low signal with 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. |

| Parameter number and name | Setting for the application | Description of the setting |
|---------------------------------|-----------------------------|--|
| 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 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. |

3.1.2.1 Connections



e30bh500.10

Illustration 32: Linear Positioning - Fieldbus

3.1.2.2 Control Word Examples

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

Table 7: Control Word

| Function | Binary | Hexadecimal | Comment |
|--------------------------|---------------------|-------------|--|
| Start homing (bit 11) | 0000 1100 0001 1000 | 0C18 | Homing is also possible with 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 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. |

3.1.2.3 Status Word Examples

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

Table 8: Status Word

| Function | Binary | Hexadecimal | Comment |
|------------------------|---------------------|-------------|---|
| Coasting (bit 2) | 0000 0110 0000 0011 | 0603 | Drive is coasting, motor is not controlled. |
| Tripped (bit 3) | 0000 0111 0001 1000 | 0718 | Drives 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 <i>parameter 3-08 On Target Window</i> . |

3.1.2.4 Fieldbus Data Layout

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

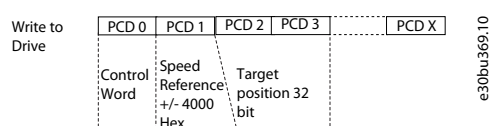


Illustration 33: Data Layout - Write to Drive

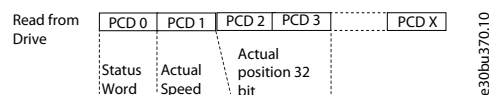


Illustration 34: Data Layout - Read from Drive

3.2 Rotary Positioning

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

- Relative positioning of 45 degrees.
- 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.

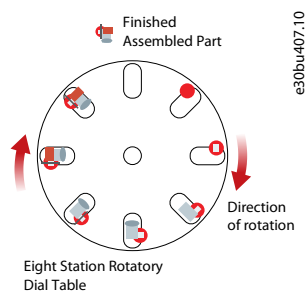


Illustration 35: Rotary Positioning

3.2.1 Control by Digital I/O

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

Table 9: Parameter Settings and Descriptions

| Parameter number and name | Setting for the applicaton | 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 required positioning speed. | The setting is used to calculate speed profile for positioning. The setting can also be set by external signal or preset reference <i>parameter 3-10 Preset Reference</i> . |
| 3-06 Minimum Position | 0° | The minimum and maximum positions defines 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 low signal with active sensor. |
| 5-11 Terminal 19 Digital Input | [8] Start | Use input 19 as start. The option magnetizes the motor and starts movement towards selected target. |

| Parameter number and name | Setting for the applicaton | Description of the setting |
|----------------------------------|----------------------------|---|
| 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 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 (6.14 is a rounded value. Using 6.14 means the position drifts over time). Numerator is 360 x 7 considering 360° per revolution. 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 <i>parameter 3-07 Maximum Position..</i> |
| 17-80 Homing function | [2] Home Sync Function | The actual position is set to the value defined by <i>parameter 17-82</i> when home sensor is activated. |
| 17-81 Home Sync function | [6] Every time | Defines that 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 forward direction. Use <i>parameter 17-82.1 Home Position</i> 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 digital input, when necessary. |

3.2.1.1 Connections

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

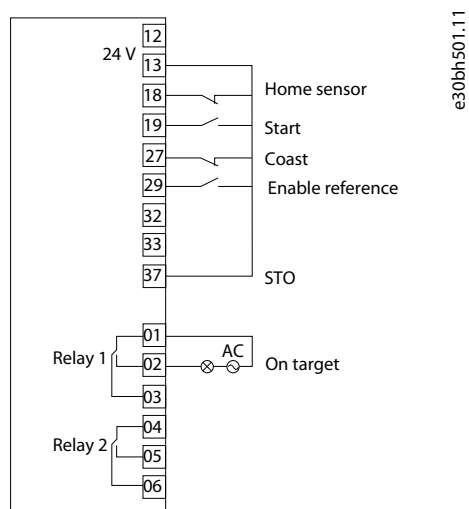


Illustration 36: Rotary Positioning - Digital I/O Control

3.2.2 Control by Fieldbus

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

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 | 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. |
| 5-10 Terminal 18 Digital input | [116] Home sensor inverse | Use input 18 as home sensor input. the option sets low signal with 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 | |

| 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 | [1606] Actual position | |
| 17-70 Position unit | [4]° | Use degrees as position unit in LCP. |
| 17-72 Position unit numerator | 2520 | Defines 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 numerator is 360 x 7 and 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 <i>parameter 3-07 Maximum Position</i> . |
| 17-80 Homing function | [2] Home Sync Function | Actual position is set to the value defined by <i>parameter 17-82 Home Position</i> when home sensor is activated. |
| 17-81 Home Sync Function | [6] Every time | Defines that 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 forward direction. Use <i>parameter 17-82.1 Home Position</i> to define position of 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. |

3.2.2.1 Connections

The illustration shows rotary positioning when controlled by fieldbus.

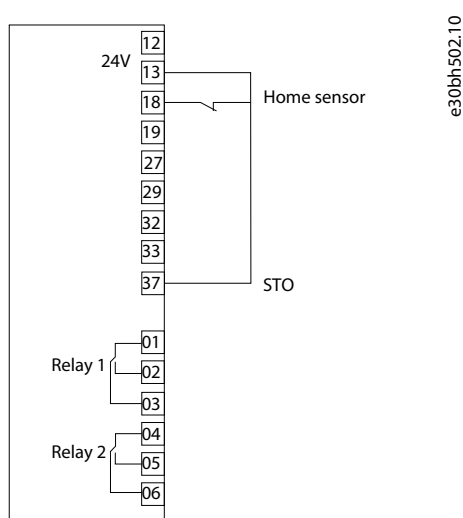


Illustration 37: Rotary Positioning - Fieldbus Control

3.2.2.2 Control Word Examples

| Function | Binary | Hexadecimal | Description |
|--------------------------|---------------------|-------------|--|
| Start (bit 6) | 0000 0100 0101 1000 | 0458 | Magnetizes the motor while maintaining 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. |

3.2.2.3 Status Word Examples

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

3.2.2.4 Fieldbus Data Layout

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

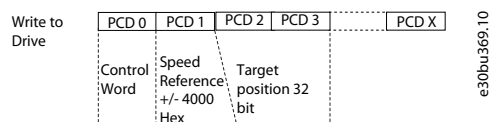


Illustration 38: Data Layout - Write to Drive

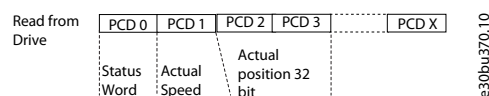


Illustration 39: Data Layout - Read from Drive

3.3 Touch Probe Positioning

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

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

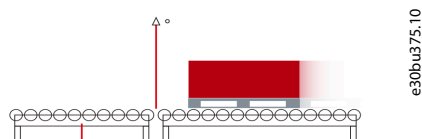


Illustration 40: Touch Probe Positioning

3.3.1 Control by Digital I/O

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

Table 11: 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 touch probe sensor is found. |
| 1-01 Motor Control Principle | [2] Flux sensorless | Motor and position control without feedback. |
| 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 distance between touch sensor and 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 option sets low signal with active sensor. |
| 5-11 Terminal 19 Digital input | [8] Start | Use input 19 as start. The option magnetizes motor and starts movement towards selected target. |
| 5-13 Terminal 29 Digital input | [111] Activate touch | Input 29 activates monitoring of touch sensor while running in speed mode. When touch sensor is detected the drive changes to position control and sets target as the sum of position of the touch sensor and the value of <i>parameter 3-21 Touch Target</i> . After reaching the target input 29 must be set low to re-start 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 distance of movement per motor revolution. |
| 17-73 Position unit denominator | 10 | |

3.3.1.1 Connections

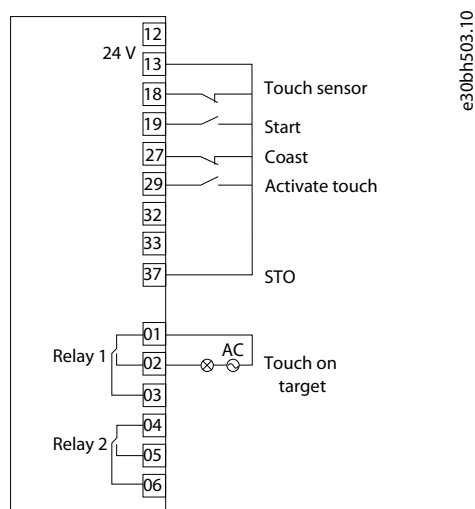


Illustration 41: Touch Probe Positioning - Digital I/O Control

3.3.2 Control by Fieldbus

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

Table 12: 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 | |
| 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 <i>parameter 3-21 Touch Target</i> . 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 position unit in LCP. |

| Parameter number and name | Setting for the application | Description of the setting |
|---------------------------------|-----------------------------|--|
| 17-72 Position unit numerator | 293 | Defines the distance of movement per motor revolution. |
| 17-73 Position unit denominator | 10 | |

3.3.2.1 Connections

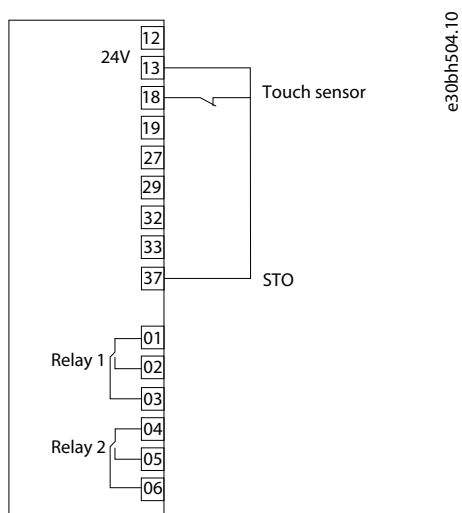


Illustration 42: Touch Probe Positioning - Control by Fieldbus

3.3.2.2 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 drive will move distance defined by PCD 2 and 3. |
| Reset (bit 7) | 0000 0100 1001 1000 | 0498 | Reset is also possible with active start, speed mode and touch signals, for example: 34D8 |

3.3.2.3 Status Word Examples

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

3.3.2.4 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.

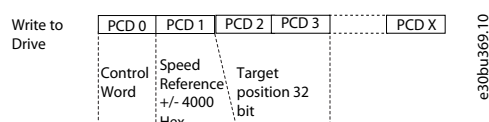


Illustration 43: Data Layout - Write to Drive

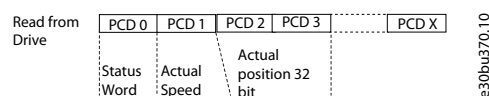


Illustration 44: Data Layout - Read from Drive

3.4 Position Stop

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

- Speed controlled PM 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 Control by Digital I/O

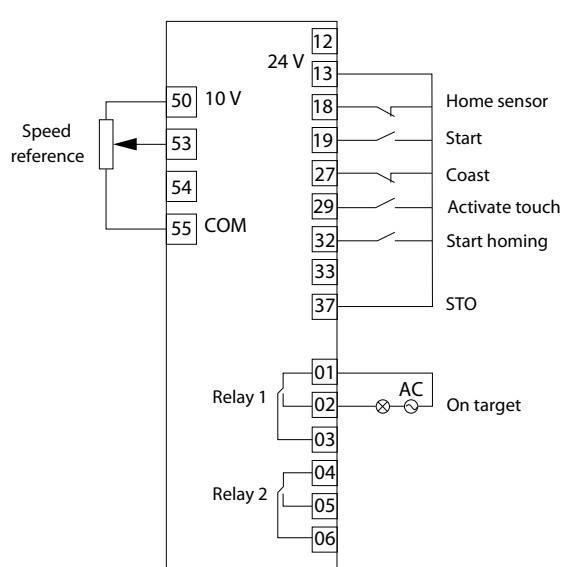
Following are the recommended parameter settings when the control is via digital I/O.

Table 13: Parameter Settings and Descriptions

| Parameter number and name | Setting for the application | Description of the setting |
|---------------------------------|-----------------------------|--|
| 1-00 Configuration Mode | [0] Speed Open Loop | Open-loop speed 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° | |
| 3-21 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 low signal with 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 | High signal activates positioning to target set by <i>parameter 3-21 Touch Target</i> . 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 target position reached. |
| 17-70 Position unit | [4]° | Use ° as 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 <i>parameter 3-07</i> . |
| 17-80 Homing function | [10] Forward with sensor | The drive moves forward at homing speed set in <i>parameter 17-83 Homing Speed</i> until home sensor is activated. The actual position is set to value to <i>parameter 17-82.0 Home Position</i> . |
| 17-82.0 Home Position | Sensor position | The actual position of the home sensor is set. |

3.4.1.1 Connections

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



e30bh509;10

Illustration 45: Position stop - Digital I/O Control

3.4.2 Control by Fieldbus

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

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 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 low signal with 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 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. |

| Parameter number and name | Setting for the application | Description of the setting |
|--------------------------------|-----------------------------|---|
| 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. |
| 9-16.2 PCD Read Configuration | [1606] Actual Position | Use PCD 2 and 3 to read actual position as a 32-bit value. |
| 9-16.3 PCD Read Configuration | | |
| 17-70 Position unit | [4]° | Select ° (degree) as position unit using the LCP. |
| 17-72 Position unit numerator | 36 | Defines 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 <i>parameter 17-83 Homing Speed</i> until home sensor is activated. The actual position is set to value to <i>parameter 17-82.0 Home Position</i> . |
| 17-82.0 Home Position | Sensor position | Actual position of the home sensor is set. |

3.4.2.1 Connections

The illustration shows position stop when controlled by fieldbus.

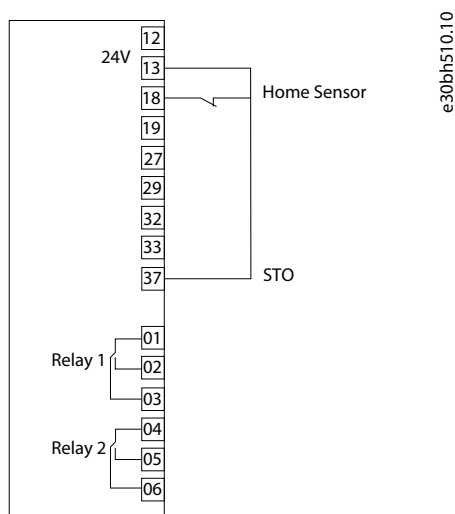


Illustration 46: Position stop - Fieldbus Control

3.4.2.2 Control Word Examples

| Function | Binary | Hexadecimal | Description |
|-------------------------|---------------------|-------------|---|
| Start homing (bit 11) | 0000 1100 0001 1000 | 0C18 | Homing is also possible with 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. |
| 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). |

3.4.2.3 Status Word Examples

| Function | Binary | Hexadecimal | Description |
|-------------------------|---------------------|-------------|---|
| Coasting (bit 2) | 0000 0110 0000 0011 | 0603 | Drive is coasting, motor is not controlled. |
| Tripped (bit 3) | 0000 0110 0000 1000 | 060B | Drives has stopped with an Alarm, alarm type and status can be read in parameters 16-9x. |
| 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 <i>parameter 3-08 On Target Window</i> . |

3.4.2.4 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.

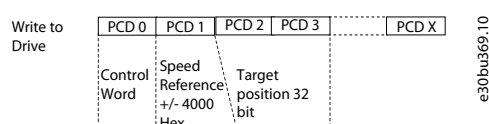


Illustration 47: Data Layout - Write to Drive

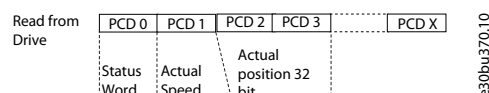


Illustration 48: Data Layout - Read from Drive

3.5 Synchronizing with External Master

The following image shows an application which utilizes 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 PM motor in sensor less control.
- Homing on 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 master makes 1.5 rotations.

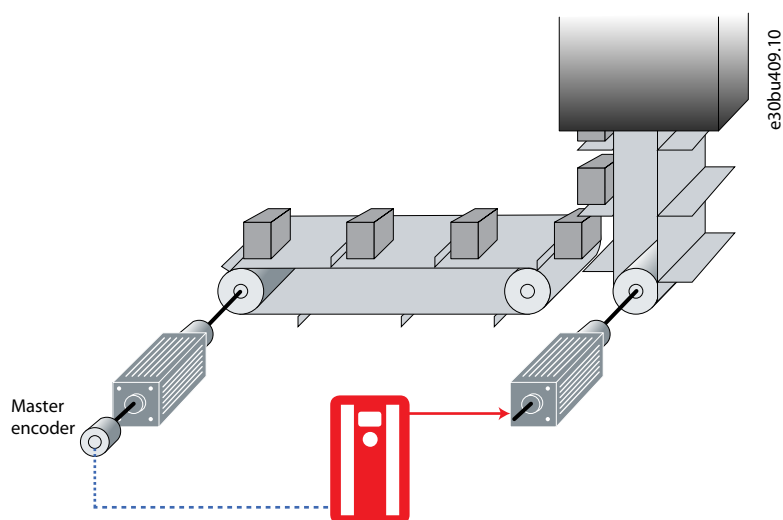


Illustration 49: Synchronizing with External Master and Homing

3.5.1 Control by Digital I/O

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

Table 15: 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 encoder connected to input 32/33 as synchronizing master. |
| 3-22 Master scale numerator | 15 | The gear ratio is set as a fraction to avoid rounding errors. The factors must be set 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 low signal with active sensor. |
| 5-11 Terminal 19 Digital input | [8] Start | Use input 19 as start. The option magnetizes motor while maintaining 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. |

| Parameter number and name | Setting for the application | Description of the setting |
|---------------------------------------|-----------------------------|---|
| 5-13 Terminal 29 Digital input | [113] Enable Reference | Input 29 activates synchronizing. The actual follower position is locked to 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. |
| 5-40.0 Function relay | [226] On target | Use relay 1 to signal that synchronizing accuracy is within the window set in <i>parameter 3-08 Target Window</i> . |
| 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 Connections

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

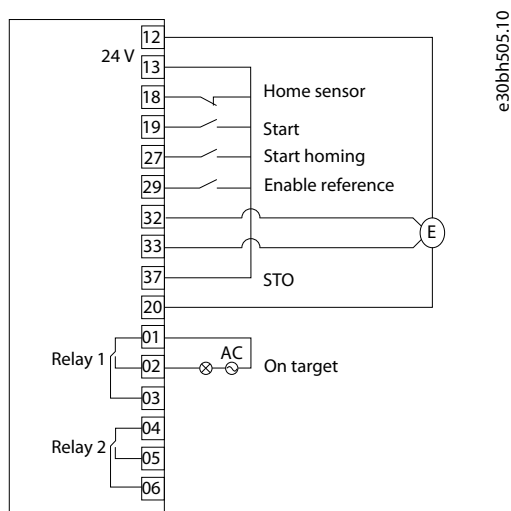


Illustration 50: Synchronization - control by digital I/O

3.5.2 Control by Fieldbus

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

Table 16: 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 encoder connected to input 32/33 as synchronizing master. |
| 3-22 Master scale numerator | 15 | The gear ratio is set as a fraction to avoid rounding errors. The factors must be set 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. |
| 5-10 Terminal 18 Digital input | [116] Home sensor inverse | Use input 18 as home sensor input. The option sets low signal with 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 PCD's 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 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. |

3.5.2.1 Connections

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

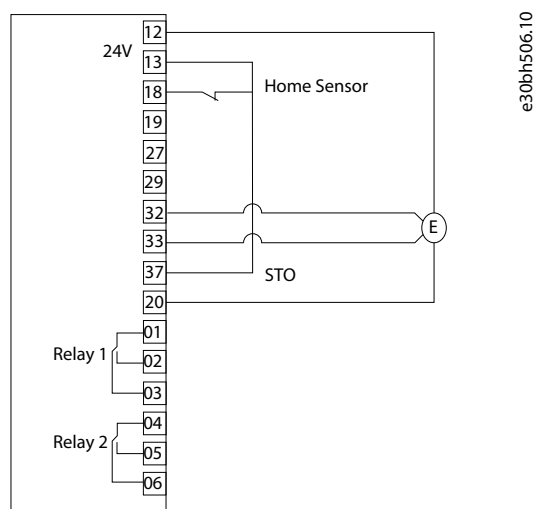


Illustration 51: Synchronization - controlled by fieldbus

3.5.2.2 Control Word Examples

| Function | Binary | Hexadecimal | Description |
|--------------------------|---------------------|-------------|--|
| Start Homing (bit 11) | 0000 1100 0001 1000 | 0C18 | Homing is also possible with 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 actual master position. |
| Reset (bit 7) | 0000 0100 1001 1000 | 0498 | Reset is also possible with active start, speed mode, and touch signals (34D8). |

3.5.2.3 Status Word Examples

| Function | Binary | Hexadecimal | Description |
|------------------------|---------------------|-------------|---|
| Coasting (bit 2) | 0000 0110 0000 0011 | 0603 | Drive is coasting, motor is not controlled. |
| Tripped (bit 3) | 0000 0110 0000 1000 | 060B | Drives has stopped with an alarm. Status can be read in parameters 16-9x. |
| 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 <i>parameter 3-08 On Target Window</i> . |

3.5.2.4 Fieldbus Data Layout

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

| | | | | | | | |
|----------------|--------------|-------|----------------------|--------|------------------|--|-------|
| Write to Drive | PCD 0 | PCD 1 | PCD 2 | PCD 3 | PCD 4 | | PCD X |
| | Control Word | N/A | Master Offset 32 bit | Offset | Offset Speed RPM | | |

e30bu384.10

Illustration 52: Read from Drive

| | | | | | | |
|-----------------|-------------|--------------|-----------------------|-------|--|-------|
| Read from Drive | PCD 0 | PCD 1 | PCD 2 | PCD 3 | | PCD X |
| | Status Word | Actual Speed | Position Error 32 bit | | | |

e30bu385.10

Illustration 53: Write to Drive

3.6 Synchronizing with Virtual Master

In this concept, 2 different applications are considered when control is via digital inputs and fieldbus. See [3.6.1 Control by Digital I/O](#) and [3.6.2 Control by Fieldbus](#)

3.6.1 Control by Digital I/O

This application illustration shows 2 conveyors synchronized in position to a common master signal. Each conveyor runs on a PM 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 start of synchronization.

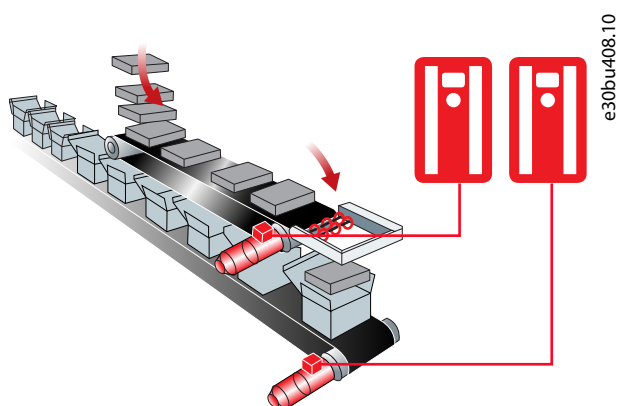


Illustration 54: Synchronizing with Virtual Master - Digital I/O Control

Table 17: 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. The factors must be set 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 low signal with active sensor. |
| 5-11 Terminal 19 Digital input | [8] Start | Use input 19 as start. The option magnetizes motor and maintains 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 start signal. |

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

Table 18: 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. |

| Parameter number and name | Setting for the application | Description of the setting |
|---------------------------------------|-----------------------------|---|
| 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 19: 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 Connections

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

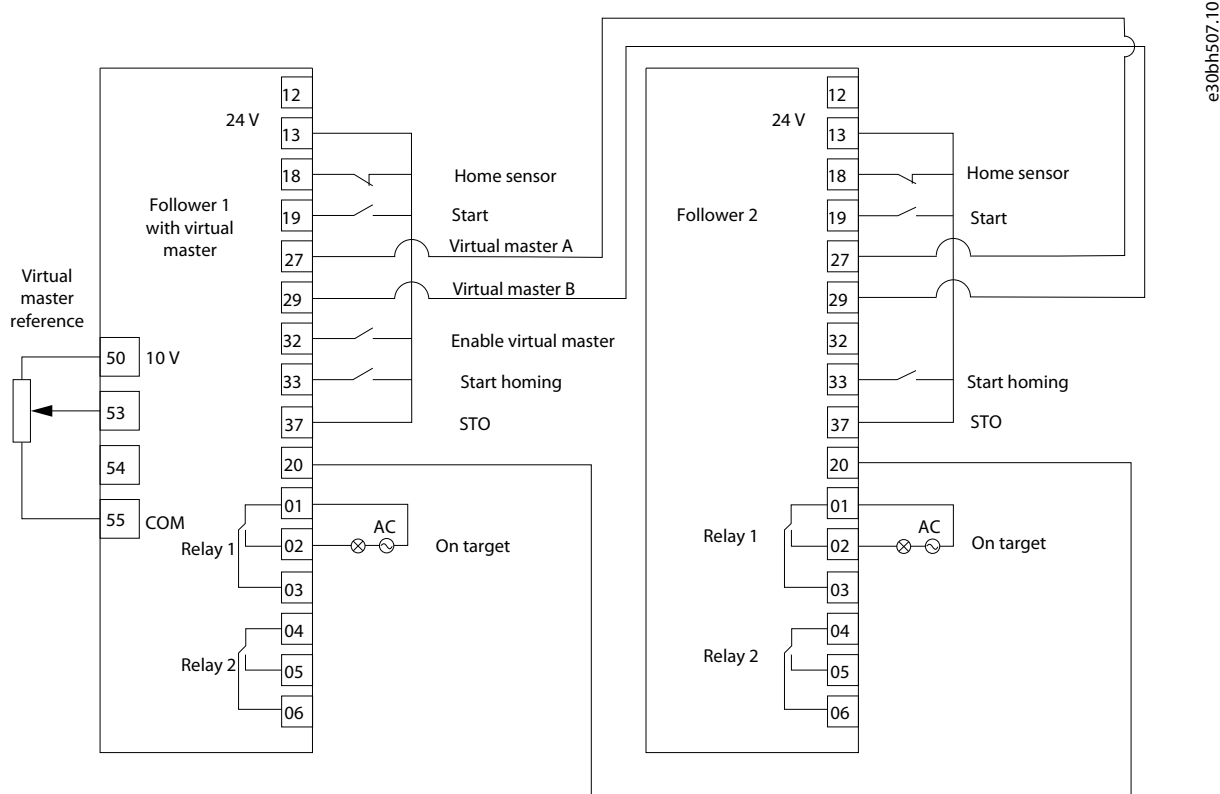


Illustration 55: Virtual Master Synchronization - Digital I/O

3.6.2 Control by Fieldbus

Consider a platform lift application with the following:

- 4 screw actuators each with a PM 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 PM motors.
- Homing on sensor of all 4 drives to align before synchronization start.

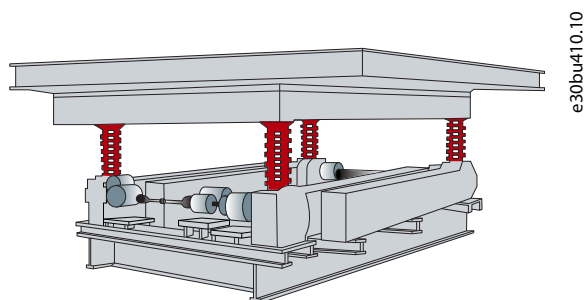


Illustration 56: Synchronizing with Virtual Master - Fieldbus Control

Configuration of Synchronizing Control in All 4 Drives:

Table 20: 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. |
| 1-67 Load Type | [1] Active Load | Select <i>Active Load</i> when torque must be applied to hold load in position. |
| 1-72 Start Function | [6] Hoist Mech Brake Rel | For jerk-free transition between mechanical brake and holding torque. Tuning via <i>parameters 2-24 to 2-29</i> . |
| 3-22 Master scale numerator | 1 | The gear ratio is set as a fraction to avoid rounding errors. All 4 drive trains 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 low signal with 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 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 21: 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 <i>parameter 3-15 Reference Resource 1</i> 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 <i>parameter 5-70 Term 32/33 Pulses Per Revolution</i> in followers 2-4. |
| 5-78 Term 27/29 Encoder Sim | [3] Vir. Master Position | Select virtual master as source for the encoder simulation. |
| 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 is set by <i>parameter group 3-6* Ramp 3</i> . |
| 8-14.14 Configurable Control Word CTW | [28] Position Vir. Master | Select position-controlled virtual master, as 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 | |

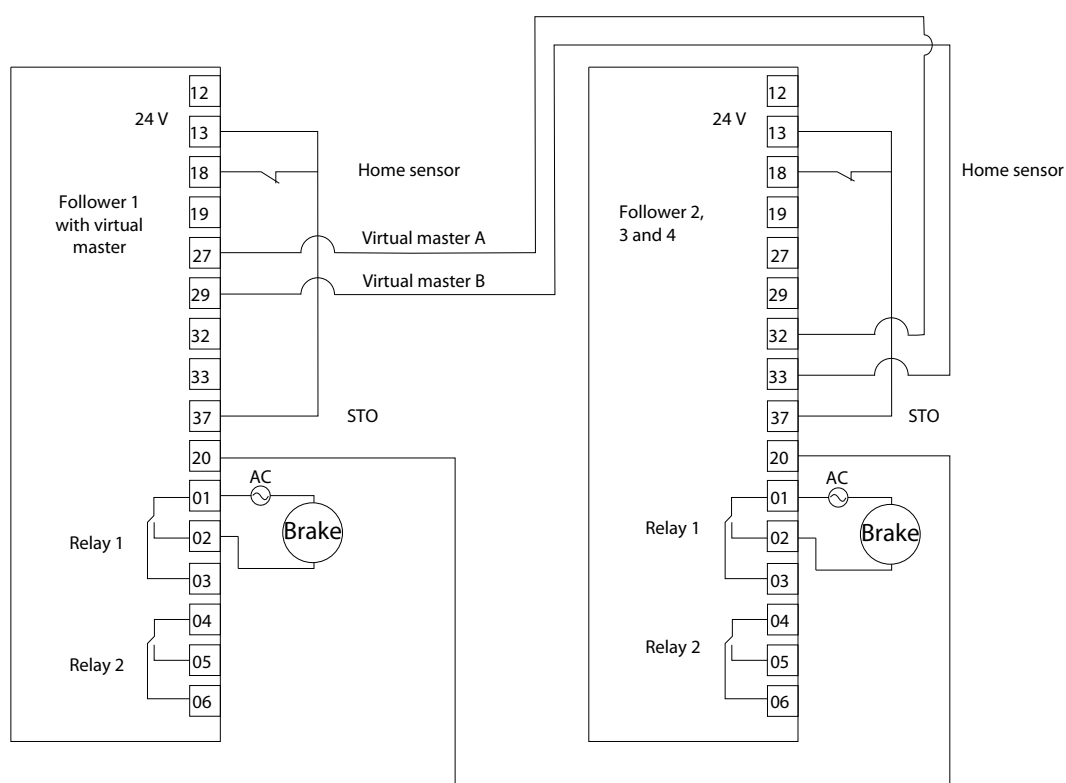
Configuration of synchronization master signal in followers without virtual master (follower 2-4)

Table 22: 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. Should be the same as set in <i>parameter 5-75</i> for follower 1. |

3.6.2.1 Connections

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



e30bh508 .10

Illustration 57: Synchronization with Virtual master - fieldbus

3.6.2.2 Control Word Examples

| Function | Binary | Hexadecimal | Comment |
|--|---------------------|-------------|--|
| Start homing (bit 11) | 0000 1100 0001 1000 | 0C18 | Homing is also possible with active start signal (0C58) |
| Start (bit 6) | 0000 0100 0101 1000 | 0458 | Magnetizes motor which maintains current position. |
| Enable reference (bit 5) | 0000 0100 0111 1000 | 0478 | Activates synchronizing. The actual follower position is locked to 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. |

3.6.2.3 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 | |
| Target reached (bit 8) | 0000 1111 0001 0111 | 0F07 | Synchronizing, accuracy within <i>parameter 3-08 On Target Window</i> . |
| Target not reached (bit 8) | 0000 1110 0001 0111 | 0E07 | Synchronizing, accuracy not within <i>parameter 3-08 On Target Window</i> . |

3.6.2.4 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.

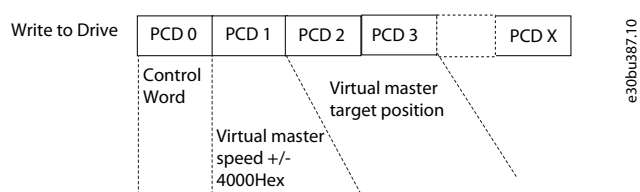


Illustration 58: Write to drive

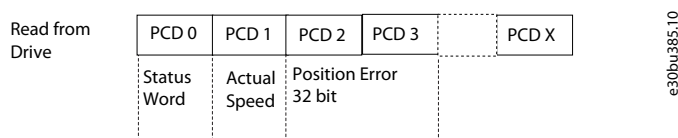


Illustration 59: Read from drive

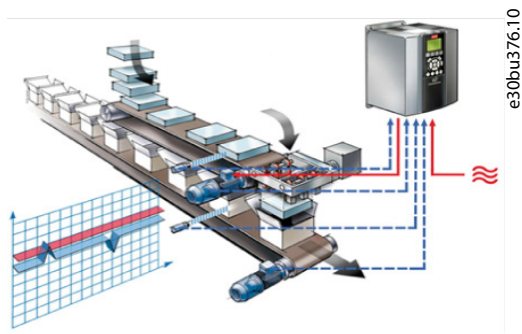
3.7 Synchronizing with Marker Correction

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. 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 which 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 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 power supply.

Illustration 60: Synchronizing with Marker Correction



3.7.1 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 | <p>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 <i>parameter 3-34 Marker Distance</i>.</p> <p>If the marker distance is not set, the 1st follower marker aligns with the 1st master marker.</p> <p>The start behavior can be configured to always catch up or slow down for the 1st marker correction.</p> |
| 3-34 Marker Distance | | <p>Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting <i>parameter 3-34 Marker Distance</i> and <i>parameter 3-35 Marker Window</i>.</p> <p>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.</p> <p>Hence, any maker pulses outside the window or multiple pulses within the window are ignored.</p> |
| 3-35 Marker Window | | <p>Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting <i>parameter 3-34 Marker Distance</i> and <i>parameter 3-35 Marker Window</i>.</p> <p>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.</p> <p>Hence, any marker pulses outside the window or multiple pulses within the window are ignored.</p> |
| 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 actual master position. |
| 5-11 Terminal 19 Digital input | [8] Start | Use input 19 as start. The option setting magnetizes motor and maintains current position. |
| 5-12 Terminal 27 Digital input | [123] Master Marker | Connect master marker sensor to input 27. |

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

3.7.1.1 Connections

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

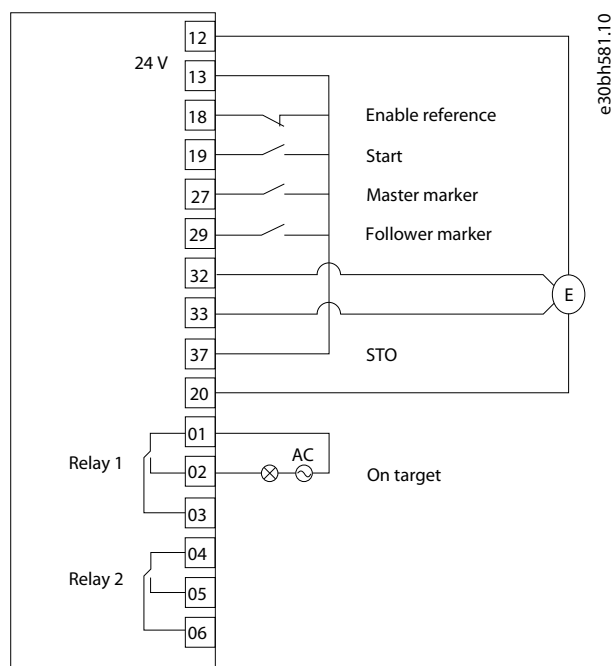


Illustration 61: Marker Synchronization - Digital I/O

3.7.2 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] 24V 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 | <p>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 <i>parameter 3-34 Marker Distance</i>.</p> <p>If the marker distance is not set, the 1st follower marker aligns with the first master marker.</p> <p>The start behavior can be configured to either always catch up or slow down for the 1st marker correction.</p> |
| 3-34 Marker Distance | | <p>Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting <i>parameter 3-34 Marker Distance</i> and <i>parameter 3-35 Marker Window</i>.</p> <p>After detecting the 1st marker pulse, the consequent marker pulse is only accepted if the position is within the marker distance +/- the marker window. Only the 1st pulse within the window is accepted. Hence, any marker pulses outside the window or multiple pulses within the window are ignored.</p> |
| 3-35 Marker Window | | <p>Specify the position units (pu). Monitoring or filtering of the marker signals can be activated by setting <i>parameter 3-34 Marker Distance</i> and <i>parameter 3-35 Marker Window</i>.</p> <p>After detecting the 1st marker pulse, the consequent marker pulse is only accepted if the position is within the marker distance +/- the marker window. Only the 1st pulse within the window is accepted.</p> <p>Hence, any marker pulses outside the window or multiple pulses within the window are ignored.</p> |
| 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 19 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. |

| Parameter number and name | Setting | Description |
|---------------------------------------|------------------------|--|
| 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 | | |
| 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 position error as a 32-bit value. |
| 9-16.3 PCD Read Configuration | [1608] Position Error | Use PCD 2 and 3 to read position error as a 32-bit value. |
| 9-16.4 PCD Read Configuration | [1821] Master Position | Use PCD 4 and 5 to read master position as a 32-bit value. |
| 9-16.5 PCD Read Configuration | [1821] Master Position | Use PCD 4 and 5 to read master position as a 32-bit value. |

3.7.2.1 Connections

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

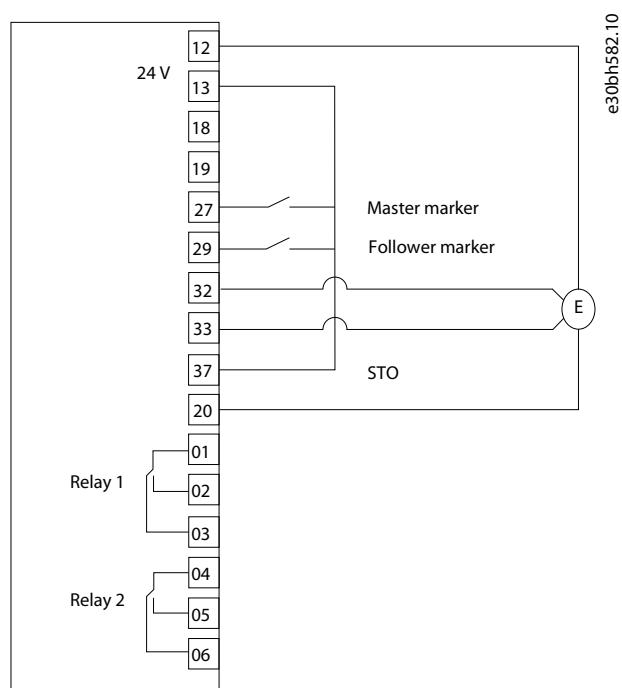


Illustration 62: Marker Synchronization - PROFIBUS

3.7.2.2 Control Word Examples

Table 23: 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 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. |

3.7.2.3 Status Word Examples

Table 24: Status word examples

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

3.7.2.4 Fieldbus Data Layout

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

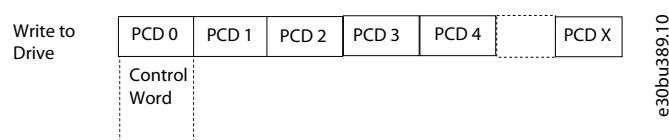


Illustration 63: Write to Drive

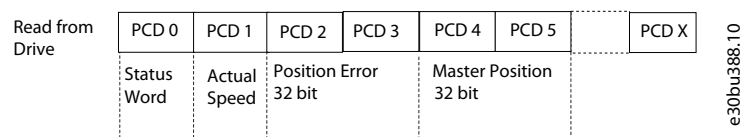


Illustration 64: Read from Drive

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