

# **ACS 160 Engineering Guide**

## **Positioning Macro**

(sw –version: V1.4.0.3.)

ABB Oy, Drives  
3AFE 64693263 REV A EN 27.03.2003  
Written by David Verbruggen  
Approved by Esa Saunamäki

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION TO POSITIONING MACRO</b>	<b>4</b>
1.1	BASIC POSITIONING MODES	5
1.1.1	RELATIVE POSITIONING	5
1.1.2	ABSOLUTE POSITIONING	5
<b>2</b>	<b>HOMING</b>	<b>6</b>
2.1	MANUAL HOMING (JOGGING)	8
2.2	AUTOMATIC HOMING	9
<b>3</b>	<b>START UP PROCEDURES</b>	<b>10</b>
3.1	ENCODER INSTALLATION	10
3.2	ENCODER CONNECTION	10
3.2.1	ENCODER	10
3.2.2	CHOOSING ENCODER CONNECTION MODE	11
<b>4</b>	<b>POSITIONING MODES</b>	<b>14</b>
4.1	RELATIVE MOVE WITH POSITION CORRECTION	14
4.2	ABSOLUTE MOVE	15
4.3	ABSOLUTE MOVE WITH CYCLIC CORRECTION 1	16
4.4	ABSOLUTE MOVE WITH CYCLIC CORRECTION 2	17
4.5	RELATIVE MOVE WITHOUT POSITION CORRECTION	17
4.6	CONTINUOUS MOVE	18
<b>5</b>	<b>POSITIONING RELATED PARAMETERS</b>	<b>19</b>
5.1	GROUP 99: START UP DATA	19
5.2	GROUP 10: COMMAND INPUTS	19
5.3	GROUP 11: REFERENCE SELECT	19
5.4	GROUP 12: CONSTANT SPEEDS	20
5.5	GROUP 14: RELAY OUTPUT	20
5.6	GROUP 20: LIMITS	21
5.7	GROUP 21: START/STOP	21
5.8	GROUP 22: ACCEL/DECCEL	21
5.9	GROUP 54: BRAKING	22
5.10	GROUP 82: POSITIONING	23

<b>6</b>	<b>POSITIONING APPLICATION EXAMPLES</b>	<b>32</b>
<b>6.1</b>	<b>DIFFERENCES OF ACS 160 SW 1.0.0.E. COMPARED TO LATER VERSIONS</b>	<b>32</b>
<b>6.2</b>	<b>EXAMPLE 1: HOMING MODE = 4 AND POSITIONING MODE = 8</b>	<b>33</b>
<b>6.3</b>	<b>EXAMPLE 2: HOMING MODE = 4 AND POSITIONING MODE = 5</b>	<b>34</b>
<b>6.4</b>	<b>EXAMPLE 3: DETAILED DESCRIPTION OF LOAD MOVEMENT BETWEEN TWO TARGETS</b>	<b>35</b>
6.4.1	DESCRIPTION	35
6.4.2	PARAMETER SETTING	35
6.4.3	HOMING	36
6.4.4	POSITIONING MOVE FROM TARGET 1 (HOME POSITION) TO TARGET 2	37
6.4.5	POSITIONING MOVE FROM TARGET 2 TO TARGET 1 (HOME POSITION)	38
6.4.6	EXCEPTIONAL OCCASIONS	38
<b>6.5</b>	<b>EXAMPLE 4: RELATIVE CONTINUOUS MOVE OF LOAD</b>	<b>39</b>
6.5.1	DESCRIPTION	39
6.5.2	PARAMETER SETTING	40
6.5.3	FEATURES	41
<b>6.6</b>	<b>EXAMPLE 5: JOGGING WITH DIRECTION SETTING VIA DIGITAL INPUT</b>	<b>42</b>
6.6.1	DESCRIPTION	42
6.6.2	PARAMETER SETTINGS	42
6.6.3	NEW FUNCTIONS	42
<b>6.7</b>	<b>EXAMPLE 6: CONTINUOUS MOVE OF THE LOAD BETWEEN TWO TARGETS</b>	<b>43</b>
6.7.1	DESCRIPTION	43
6.7.2	PARAMETER SETTINGS	43
<b>6.8</b>	<b>EXAMPLE 7: OPERATION WHEN GEAR IS USED</b>	<b>44</b>
6.8.1	ENCODER IS ON THE SIDE OF THE LOAD	44
6.8.2	ENCODER ON THE MOTOR SHAFT	45
<b>7</b>	<b>APPENDIX A: COMPLETE PARAMETER SETTINGS TABLE</b>	<b>46</b>

# 1 INTRODUCTION TO POSITIONING MACRO

The advantage of the Positioning Macro is the possibility to achieve very fast and accurate movement from one certain point to the other without any external logic devices. Typical applications are for example conveyors with fixed interval feeding, and packaging machines etc.

An encoder is required to give feedback to the drive, so that the exact location (rotational angle) of the shaft is known. Hereby it is possible to adjust the amount of rotations (and also the angle of the shaft). Positioning can be done for maximum two different positions at a constant or variable speed. Constant speeds are mostly used. An external reference point can be inserted (Home position), but it can NOT be used as a third selectable target. When the distance, which needs to be moved, and the momentary location is known, fast movement can be achieved. A motion profile in Figure 1 represents the velocity of the motor during a period of time in which the motor moves an object to certain positions.

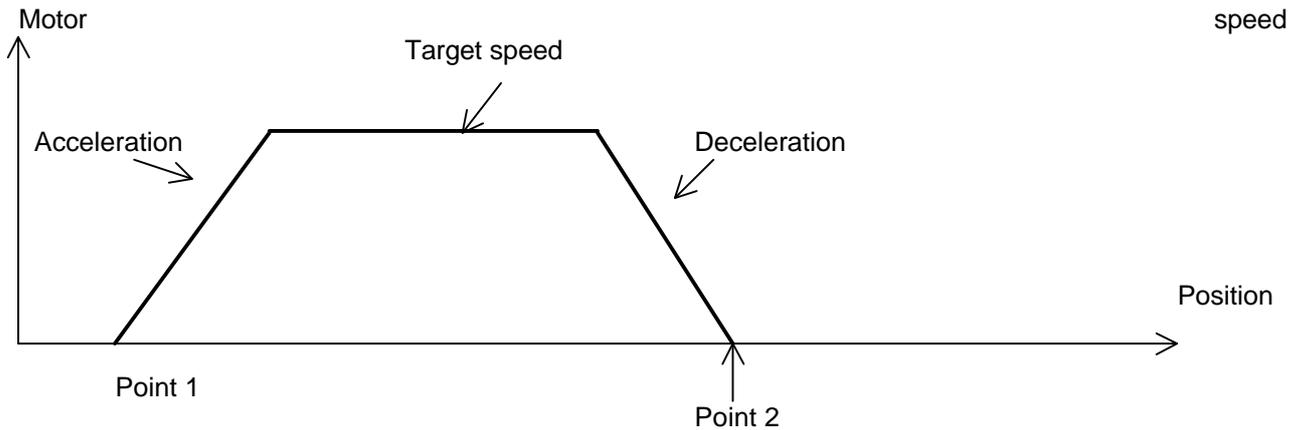


Figure 1. Motion profile

With the ACS 160, two target positions and two motion profiles can be selected. *Target speed* is selected with parameter group 12 (Constant Speeds) parameters. *Acceleration* and *deceleration times* are selected with parameter group 22 (Accel/Decel) parameters. *Target* is selected with group 82 (Positioning) parameters. The acceleration/deceleration rate must be limited to account for the inertia of the load plus friction, to allow operation within the torque limits of the motor and ACS160.

When positioning is started, the target speed is used as frequency reference. The motor accelerates with the selected acceleration time to the target speed. ACS 160 counts the position where deceleration starts, from the target speed and deceleration time parameter values. Linear ramp is assumed during deceleration. If S-curve is used, SLOPE GAIN 1 (parameter 8218) needs to be adjusted to compensate the longer actual deceleration time.

Position is given as *motor shaft revolutions*. Normally the encoder should be mounted on the motor shaft. If not so, then the target reference and the encoder pulse number scaling must be changed as explained later in this engineering guide. Figure 2 shows the load and ACS160 related directions.

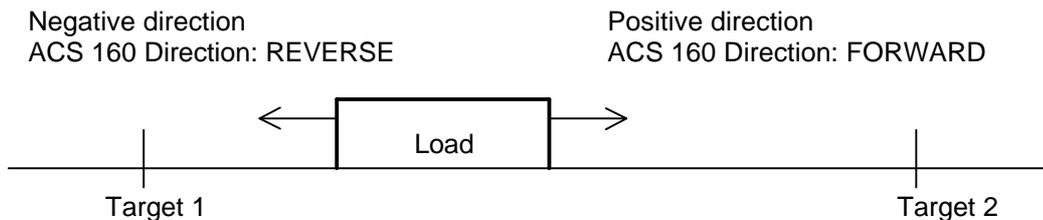


Figure 2. Load and ACS 160 directions

## 1.1 Basic positioning modes

The ACS 160 has two basic positioning modes, relative and absolute positioning. Relative moves allow to position the motor in relation to the motor's previous stopped position. With absolute positioning, moves are referenced to a predefined zero (Home) position, established by homing operation. Homing means that a load is driven at a moderate speed to a known position (Home position or "zero position"). The Positioning mode is selected with parameter 8215 (POS MODE).

### 1.1.1 Relative positioning

Relative move is used in systems, where items are repetitively moved over a certain distance. The principle of the operation is shown in Figure 3. When start command is given, the load moves from the current position to the next position. The distance between the positions is defined with a target parameter. The position counter starts counting from a defined initial value (usually zero). When the target distance is counted, ACS 160 output frequency is set to zero. The position counter is reset, when the next start command is given.

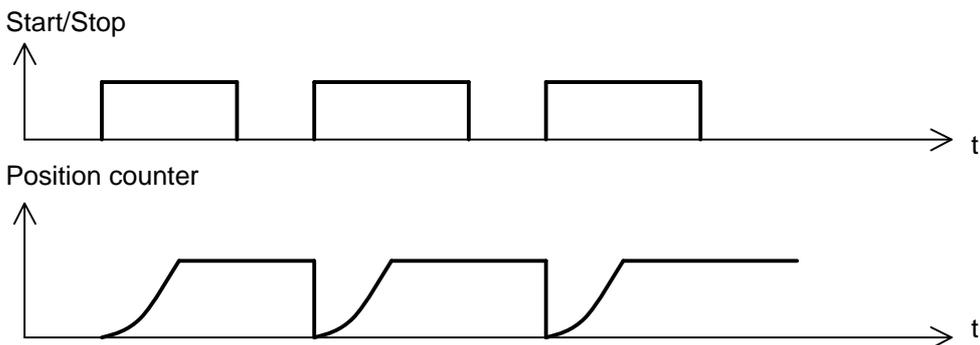


Figure 3. Relative positioning

### 1.1.2 Absolute positioning

Absolute move is used typically in systems, where a load is moved between two positions, which are defined in relation to zero (Home) position. The principle of the operation is shown in Figure 4. The position counter is not reset with start/stop-commands. Resetting is done only if a new target is selected.

As start command is given, the load moves to the selected position. The position counter starts counting from the value of the current position. When the selected target position is reached, ACS 160 output frequency is set to zero. The new move is possible only when the other target is selected.

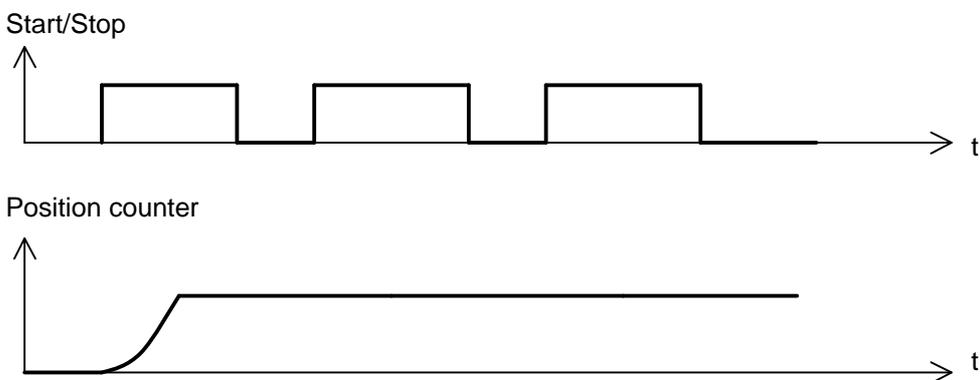


Figure 4. Absolute positioning

## 2 HOMING

Homing means that a load is driven at a slow speed to a known position (Home position). There are two homing possibilities available, *Jogging* and *Automatic homing*. A manually made homing is called Jogging. Automatic homing mode is selected with parameter 8216 (HOMING MODE).

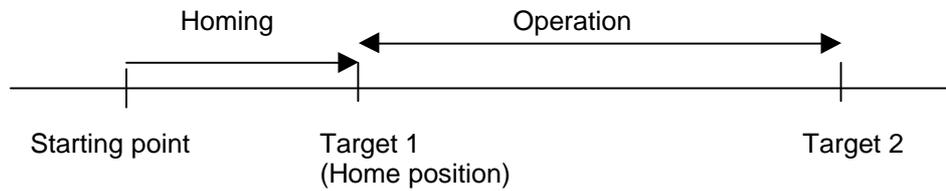


Figure 5a. Homing operation

Homing happens only once, and that is when the drive's power is switched on. The load is driven to Home position, which can be Target 1, Target 2 or a third position. The use of just one target position selection is also possible. When the load reaches Home position, the position counter is reset to zero, and the drive is ready for operation (positioning). The homing operation is illustrated in Figure 5a.

The direction for the homing is set with parameter 1003 DIRECTION. In general this parameter should be set to 3 (REQUEST). If jogging is used, the load is driven to only one direction, but with a joystick or fieldbus it is possible to change the direction.

An example of homing with parameter 8216 = 5 (HOMING 2) is given in Figure 5b.

The load is moved between two targets. Proximity switch is used for homing and it is connected to digital input DI3. The homing switch is placed in Target 1 position. When ACS 160 is powered up, and start command is given, the homing direction is always the same.

**Parameter settings:**

P8215 (POS MODE) = 5 (ABS MOVE 1)  
P8216 (HOMING MODE) = 5 (HOMING 2)

The homing direction is always reverse (DI3 input is inactive). When Home position is reached, the proximity switch is activated (DI3 activates) and the ACS 160 output frequency changes to 0 Hz.

### Example of homing

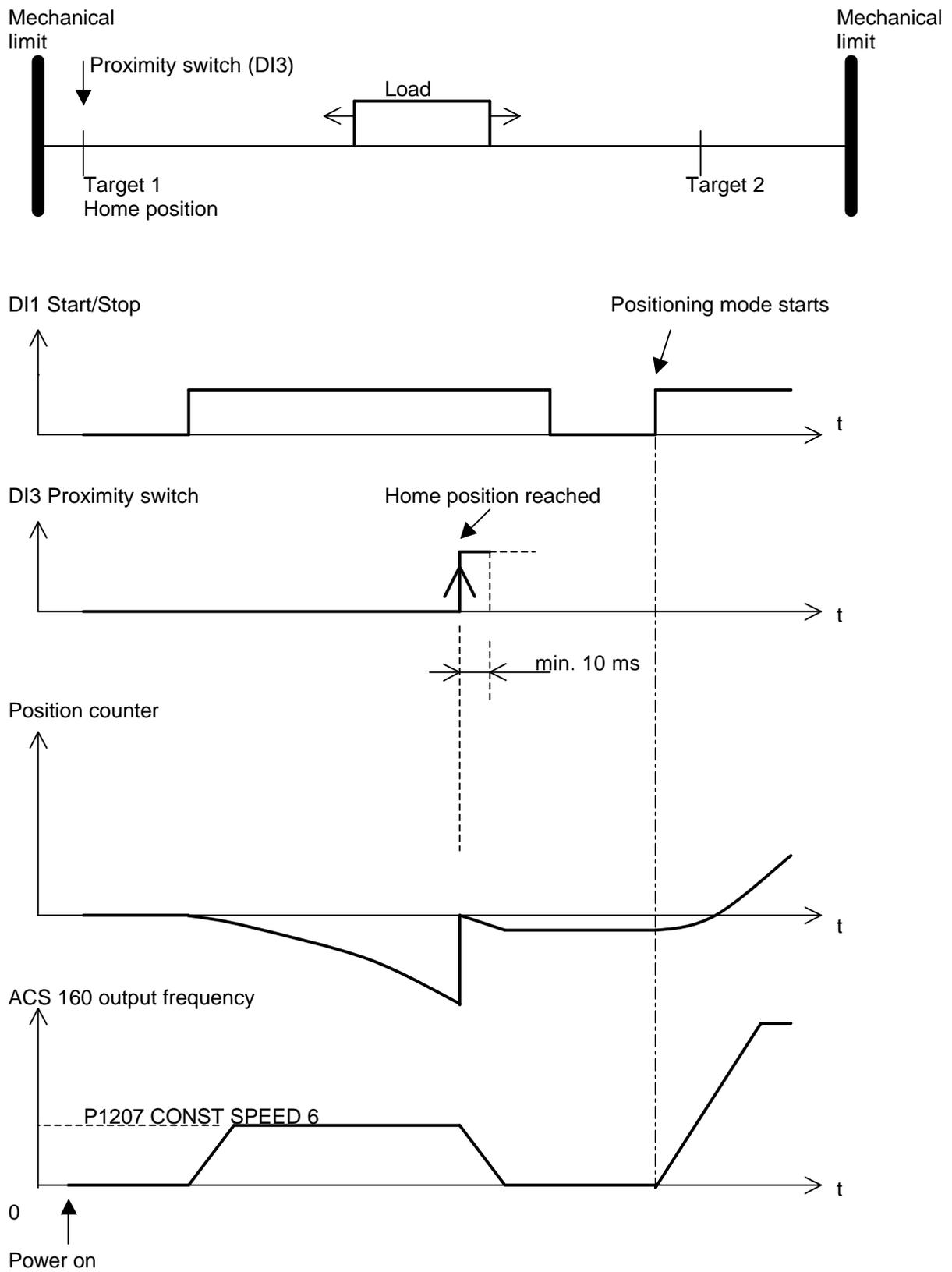


Figure 5b. Example of homing operation when homing mode = 5 (HOMING 2)

## 2.1 Manual homing (jogging)

Jogging is possible when the external control place EXT1 has been selected. Control place selection is made with parameter 1102 (EXT1/EXT2 SEL). As default EXT1/EXT2 selection is made with digital input DI2. Jogging speed is set with analogue input AI1. Jogging direction is defined with the direction lock parameter 1003 (DIRECTION).

### Special cases

If the frequency reference and commands are given with a *keypad*, through a *serial communication*, or with a *joystick* to AI1 or AI2, the motor rotation can be set to both directions. In this case parameter 1003 must be set to 3 (=REQUEST).

When a load has moved to Home position, stop command must be given. After that the control place is changed from EXT1 to EXT2 with DI2. This change from EXT1 to EXT2 sets the P8225 and P8226 (HOME POS LO, HI) values to the position counter. The relay (AT TARGET) is activated. The operation is illustrated in Figure 5c.

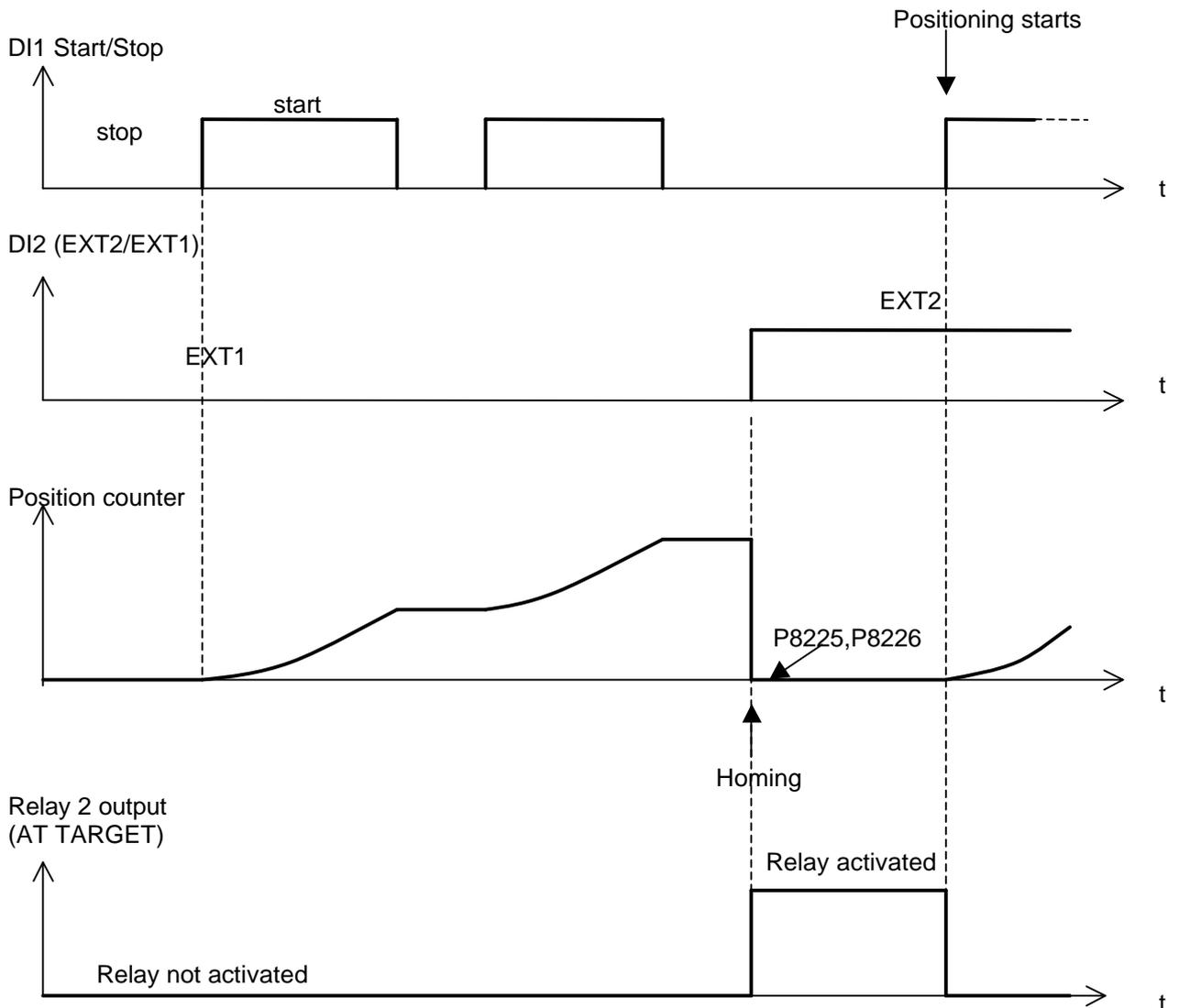


Figure 5c. Manual homing / jogging

## 2.2 Automatic homing

This homing (with a limit switch) is possible only when the external control place EXT2 has been selected. In this mode a load is moved at moderate speed into a limit switch. The limit switch must be connected to digital input DI3. Homing can be made only once after the supply voltage has been switched on to ACS 160.

Homing starts when start command is given. The homing speed is defined with constant speed parameter 1207 (CONST SPEED 6). The homing direction is defined with parameter 8216 (HOMING MODE) and the input value of digital input DI3. Home position is reached when the limit switch is activated and DI3 input changes state.

In Home position, the ACS 160 frequency reference is internally set to zero and the relay (AT TARGET) is activated. Output frequency goes to zero with the selected ramp time. Homing is finished when stop command is given. The next start command activates the positioning mode. An example of operation is given in Figure 6.

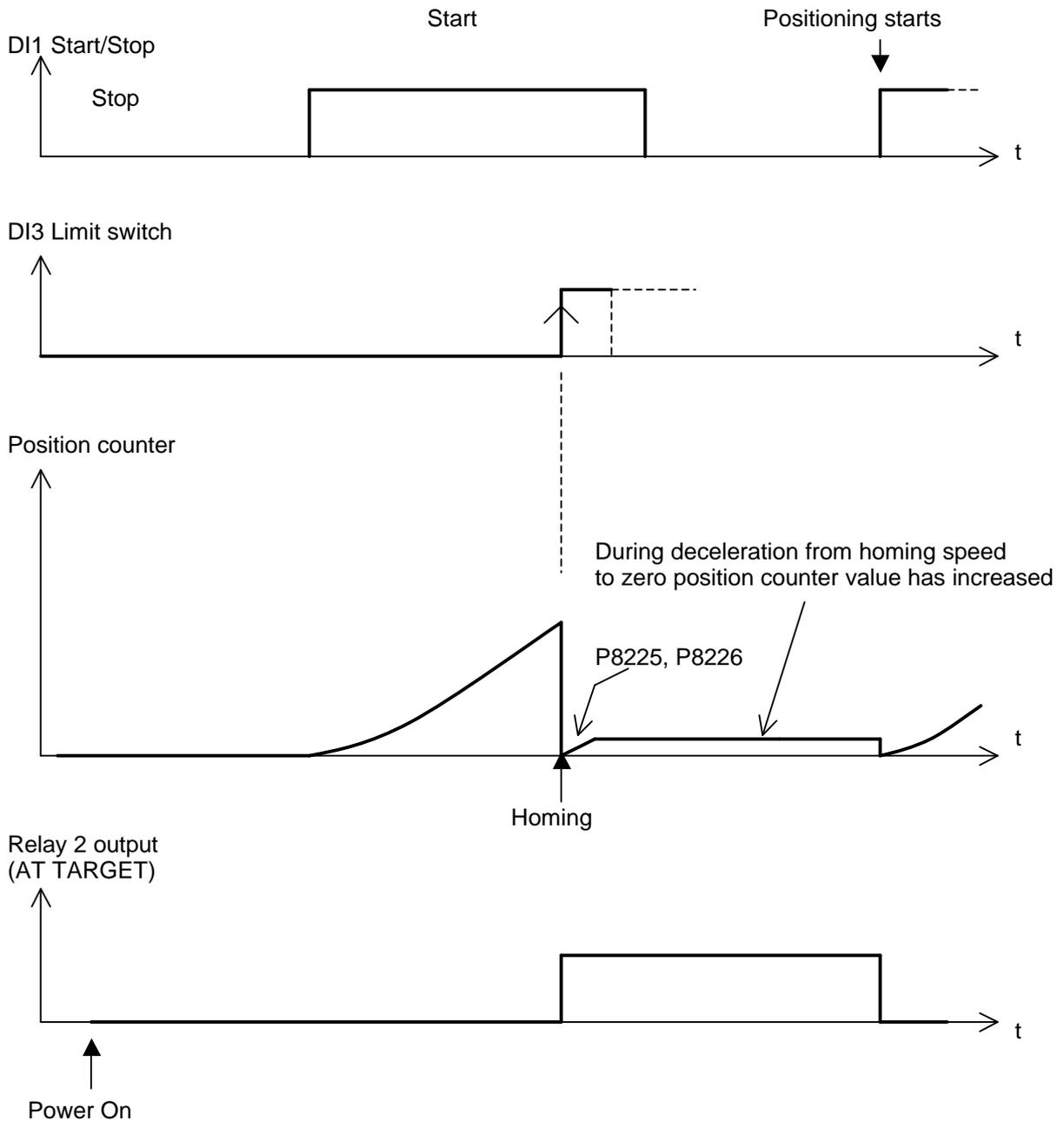


Figure 6. Automatic homing

## 3 START UP PROCEDURES

An ACS 160 drive with an incremental encoder connection can be used for simple positioning applications. The encoder connection is enabled by choosing Application macro 14, Positioning. The analogue output *does not function after this selection*. It is assumed by positioning logic that the encoder is installed to the motor shaft.

### 3.1 Encoder installation

#### Connect encoder to ACS 160

- Connect encoder output pulses (phase shift between pulse channels: 90 electrical degrees) to digital inputs DI4 and DI5.
- Connect 24 V supply voltage to encoder. Supply voltage can be taken from ACS 160 or from an external power supply.

#### Activate encoder pulse counting

- Set parameter 9902 value to 14 (POSITIONING), turn ACS 160 power off and then on again. (Necessary for activating the pulse counting.) Set all other group 99 (APPLIC MACRO) parameters.

#### Check that the encoder pulses are connected to digital inputs DI4 and DI5

- Rotate the motor shaft slowly and observe that DI4 and DI5 status is changing between 1 and 0 in parameters 0117 (DI1-DI4 STATUS) and 0121 (DI5 & RELAYS)

#### Check that encoder direction matches to ACS 160 direction

- Rotate the motor and encoder at slow speed and observe that the position counter is counting up (to more positive direction) when ACS 160 direction is forward, and down when ACS 160 direction is reverse. If the directions do not match, switch over the DI4/DI5 connections. The pulse counter value can be read from parameters 8227 and 8228 (POS ACT LO, HI). ACS 160 direction can be read from the control panel display. If the pulse counter is not counting up or down, check that the encoder pulses have a 90-degree phase shift.

#### Set positioning related parameters

- Positioning mode parameters are in parameter group 82.
- Positioning and homing frequency references are set with group 12, the Constant Speeds parameters. It is recommended to use low frequency references at the beginning of commissioning, and set them to optimal values later, when proper operation of positioning has been ensured.

#### Use a brake chopper if short deceleration times and/or high inertia load is used

- Usage without a brake chopper overvoltage controller can effect to actual deceleration times and cause momentary overshoot when reaching the target. Brake chopper operation is enabled with parameter 2005 (OVERVOLT CTRL).

### 3.2 Encoder connection

#### 3.2.1 Encoder

A two-channel single ended incremental encoder must be used. Encoder outputs are connected to digital inputs DI4 and DI5. Phase shift between encoder channel A and channel B signals must be 90 degrees.

Encoder pulses/rev: 1 – 8192 (1024 recommended).

Max. pulse frequency: 200 kHz.

Encoder supply voltage: 24Vdc

Encoder cable length: 3 m max. is recommended. See the encoder's datasheet.

Minimum input voltage to digital inputs DI4 and DI5: 12 V.

The pulse counter is programmed to up/down –counter, calculating both rising and falling edges of channel A and B encoder pulses. The pulse count is read from this 16 bit counter at *4 ms time level*.

### Example

If the encoder pulse count is 1024 pulses/rev => the pulse counter counts  $4 \cdot 1024 = 4096$  pulses/rev.  
See Figure 7.

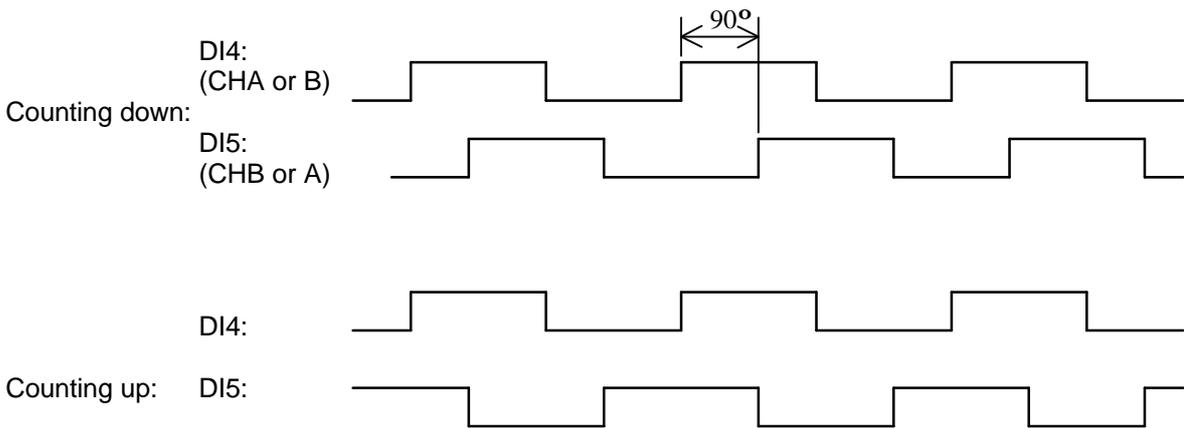


Figure 7. Encoder pulses

### 3.2.2 Choosing encoder connection mode

(Application macro Positioning)

- Set parameter 9902 (APPLIC MACRO) value to 14 (POSITIONING)
- Turn the ACS 160 supply voltage off and then on again. (Necessary for activating the pulse counting.)
- Set the other group 99 parameters.

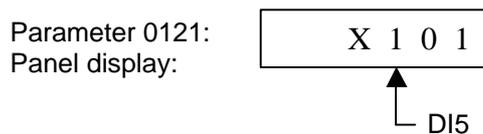
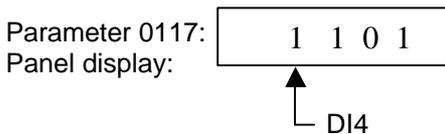
#### Checking encoder connection to ACS 160 I/O –terminal

The wiring between encoder and ACS 160 can be checked from parameters 0117 (DI1-DI4 STATUS) and 0121 (DI5 & RELAYS):

Rotate encoder shaft slowly and check that DI4 and DI5 status change between 0 and 1.

DI4 status: fourth digit from right in parameter 0117.

DI5 status: third digit from right in parameter 0121.



#### Matching the encoder direction of rotation and the ACS 160 direction

The pulse counter must count up (to more positive direction), when the ACS 160 direction of rotation is forward, and down, when the ACS 160 direction is reverse. If the directions do not match, the encoder output channels must be changed. The pulse counter value can be read from parameters 8227 and 8228 (POS ACT LO, HI).

The safest way to check this is in the Jogging mode. External control place EXT1 is used. If the application macro 14 default settings are used, the digital input DI2 must be inactive and the frequency reference is given with analogue input AI1. The direction is given with parameter 1003 (DIRECTION). External control place EXT1 can also be selected when setting the parameter 1102 (EXT1/EXT2 SEL) value to 6 (EXT1). The frequency reference can also be given with the control panel, setting the parameter 1103 value to 0 (KEYPAD). Start/stop and direction commands can be given with the panel, setting the parameter 1001 (EXT1 COMMANDS) value to 8 (KEYPAD). Local control mode can be used with panel also to give start/stop and direction commands.

## Encoder connection example 1

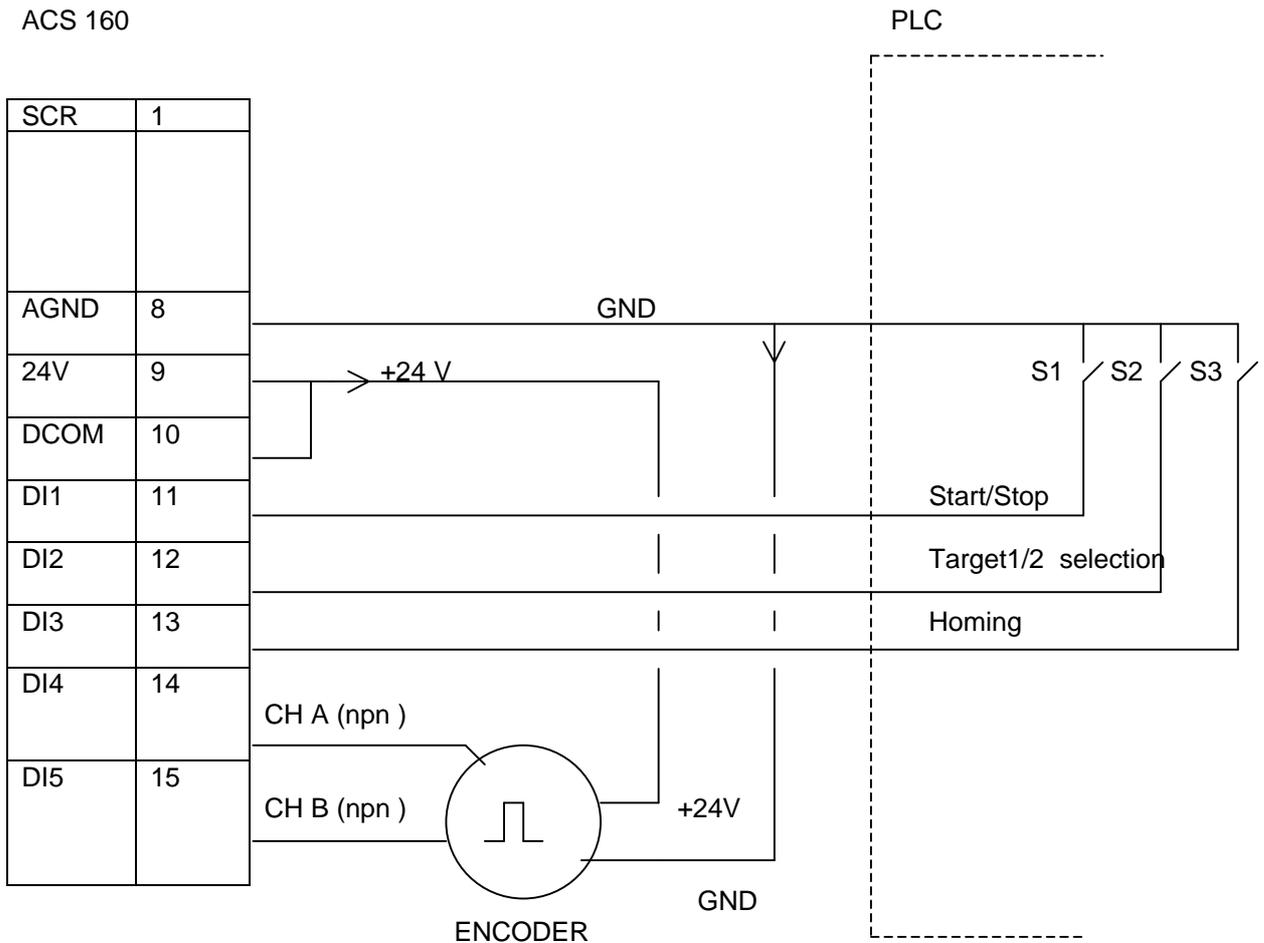


Figure 8. Encoder connection example 1

In Figure 8, the ACS 160 digital inputs are configured as NPN-connected. The encoder supply voltage is taken from the ACS 160 24 V auxiliary voltage output. A shielded cable is recommended.

## Encoder connection example 2

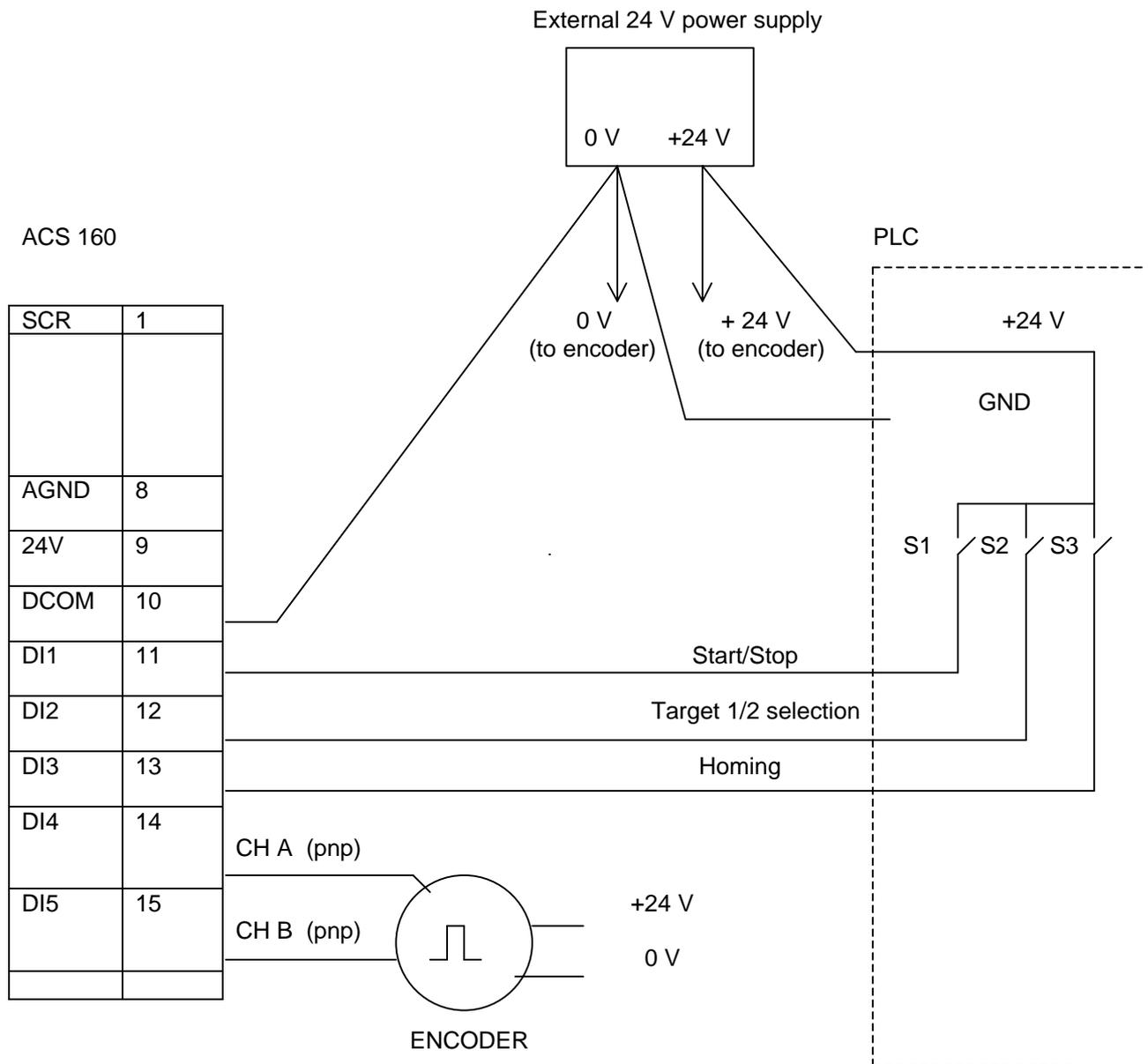


Figure 9. Encoder connection example 2

In Figure 9, the ACS 160 digital inputs are configured as PNP-connected. An external power supply is used for the digital inputs and encoder.

## 4 POSITIONING MODES

With the parameter 8215 (POS MODE), it is possible to select the positioning mode. The Positioning mode defines the way in which the positioning is done. Depending on the application the selection between relative and absolute positioning is done with this parameter.

Six different positioning modes can be selected: Relative move with position correction, Absolute move, Absolute move with cyclic correction, Absolute move with cyclic correction 2, Relative move without position correction and Continuous move 1.

A detailed description of each of the different positioning modes is given on the following pages.

The table below presents the positioning modes used for certain type of application characteristics.

Mode	Application characteristic
Relative move with position correction	Repetitive move in one direction. Conveyor moves to one direction, with position correction properties.
Absolute move	Load needs to be moved between two positions.
Absolute move with cyclic correction 1	Load needs to be moved between two positions, but taking drift error in account.
Absolute move with cyclic correction 2	Load is moved between two positions, but considering drift error. (Other configuration as Absolute move cc1)
Relative move without position correction	Repetitive move in one direction. Conveyor moves in one direction, without position correction properties.
Continuous move	Continuous movement between two positions, with possibility for delay time at turning points.

### 4.1 Relative move with position correction

(4 = RELAT MOVE 1)

Selected target position is relative to previous target position. When start command is given, the position counter is first reset to zero and then corrected with the distance between the actual and desired stopping position. The purpose of this is to prevent the axis to “creep” from its original zero position. Correction is made only in cases, when the previous move has reached the target window area.

Without this corrective action, in applications where the same incremental move should be done time after time, the position counter would be zeroed at the actual (stopping) positions, not at the desired (stopping) positions. Because of this, the actual stopping position becomes the new zero position. Without a corrective action the zero position would “creep” either forward or reverse the direction from the desired position. See Figure 10.

If there is a need to do a positioning application, where a load must be moved to the opposite direction, a negative value can be set as the target position. By doing so the rotation of the shaft will be reversed when this particular target is selected.

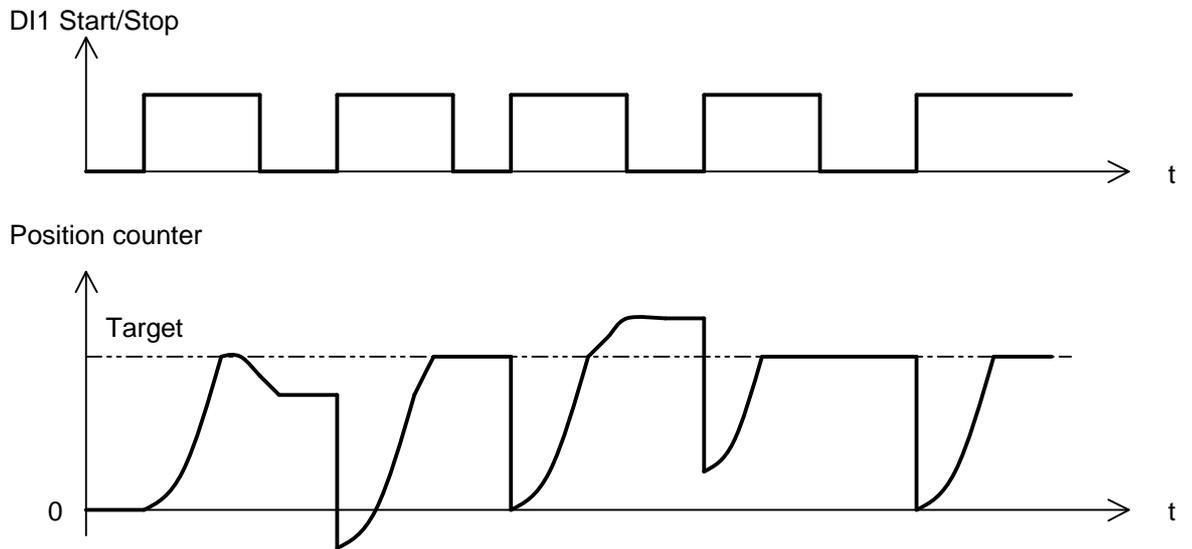


Figure 10. Relative move 1 mode with corrective action.

## 4.2 Absolute move

(5 = ABS MOVE 1)

The selected target position is absolute. The position counter is not reset, when start command is given. This mode is used especially, when the load is moved between two positions as shown in Figure 11.

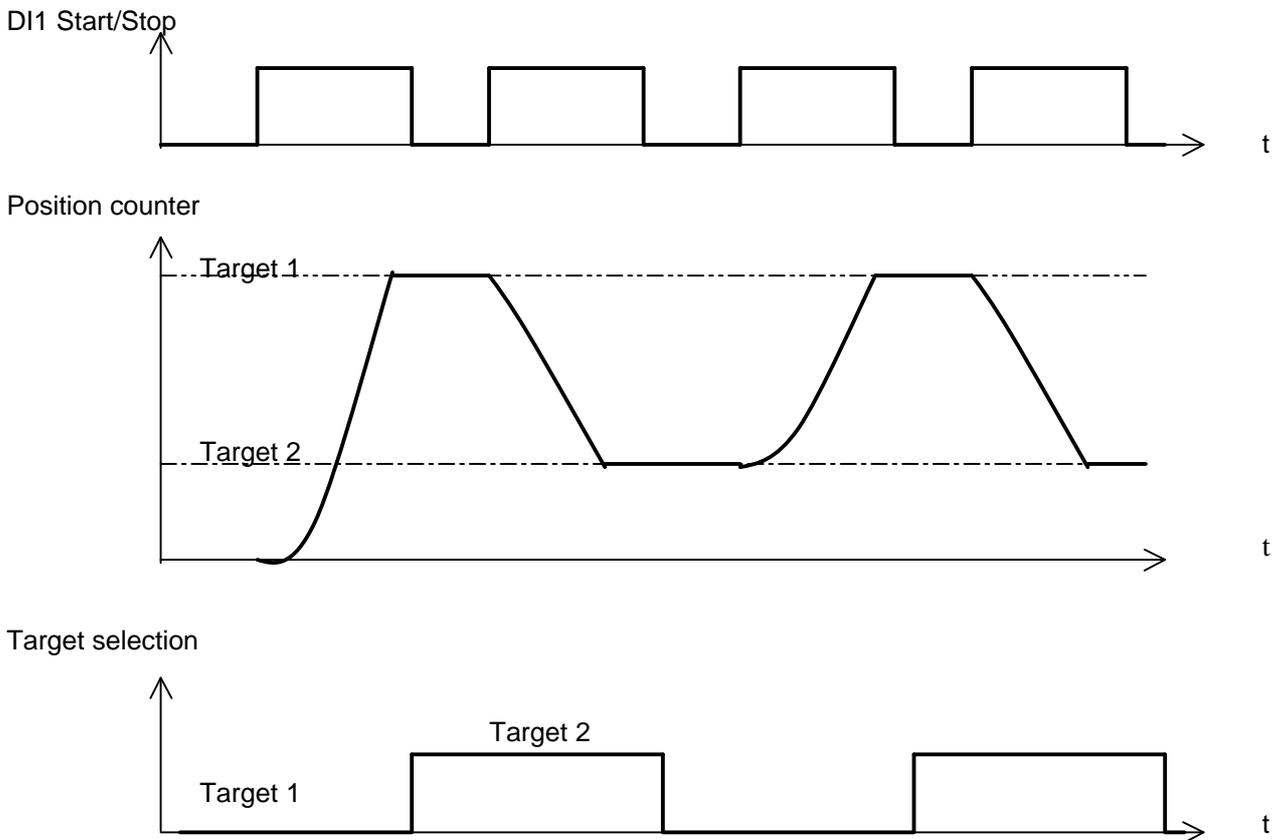


Figure 11. Absolute move 1 mode with two targets

### 4.3 Absolute move with cyclic correction 1

(6 = ABS MOVE CC 1)

Basic operation as in mode 5, but cyclic correction added. The positioning counter is set to the value of Home position parameters 8225 and 8226 (HOME POS LO, HI), when digital input 3 (DI3) state changes from inactive to active. This mode should be used, where there is a possibility that some drift errors may appear due to mechanical parts of the machinery.

#### Example:

Figure 12 presents an application where a load is moved between two targets. A proximity switch is installed to the same position as Target 1, which is chosen also as Home position. This means that parameters 8207 and 8208 (TARGET 1 LO, HI) and 8225 and 8226 (HOME POS LO, HI) must have the same values. The proximity switch is connected to digital input DI3. This example assumes that homing has been done earlier.

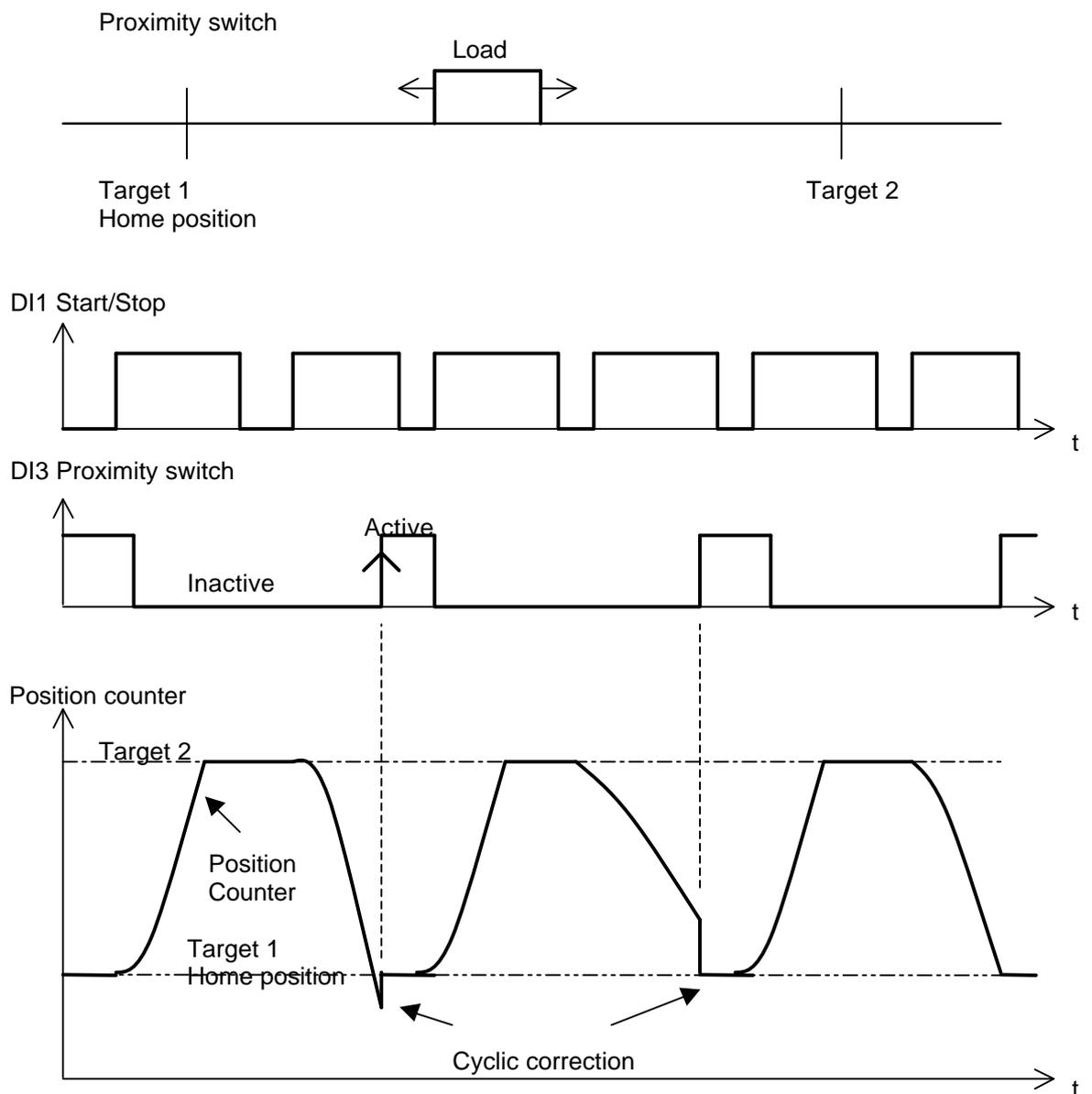


Figure 12. Absolute position mode and cyclic correction

#### 4.4 Absolute move with cyclic correction 2

(7 = ABS MOVE CC 2)

Basic operation as in mode 5 but, cyclic correction added. Positioning counter is set to the value of Home position parameters 8225 and 8226 (HOME POS LO, HI), when digital input 3 (DI3) state changes from active to inactive. Operation same as in mode 6, except for the effect of digital input DI3.

#### 4.5 Relative move without position correction

(8 = RELAT MOVE 2)

The selected target position is relative to previous target position. When start command is given, the position counter is set to the value of Home position parameters 8225 and 8226 (HOME POS LO, HI). There are no position correction properties in this mode. Figure 13 presents the operation.

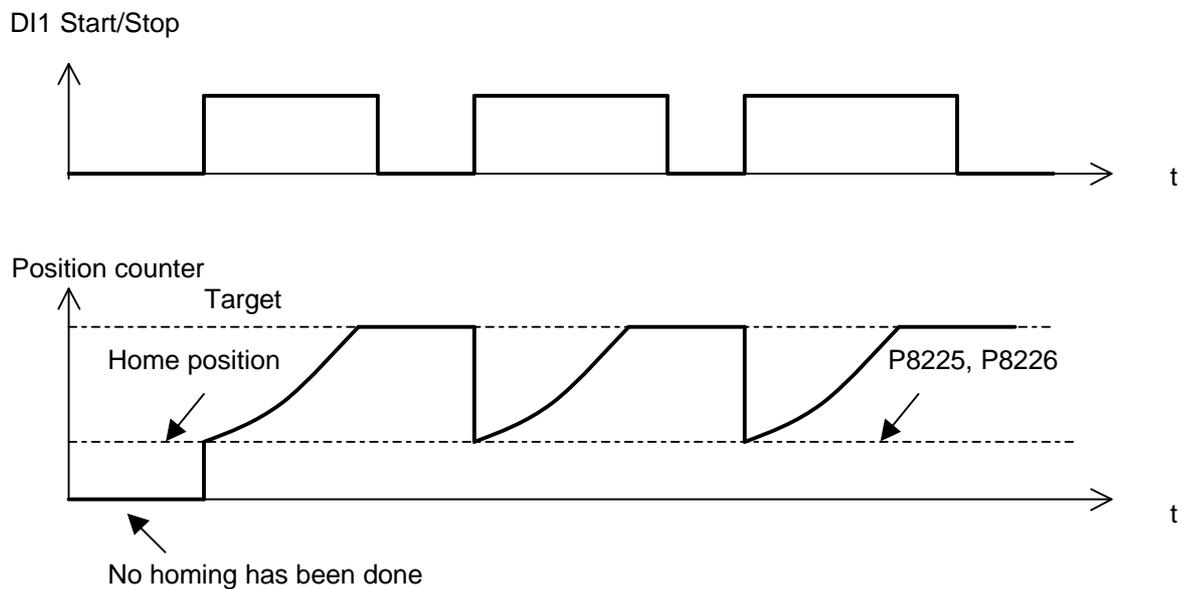


Figure 13. Relative move 2 mode

## 4.6 Continuous move

(9 = CONT MOVE 1)

(CONTINUOUS MOVE, for software V1402 and later. Changes in functionality are possible in later software versions.)

Selected target is absolute. Continuous move is made between positions Home and Target 1, and for example used with wobbling wires. Target 1 is defined by parameters 8207 and 8208 (TARGET 1 LO, HI). A position time delay parameter 8213 (POS DEALY) and external frequency reference parameter 8217 (AUX POS CMD) can be defined.

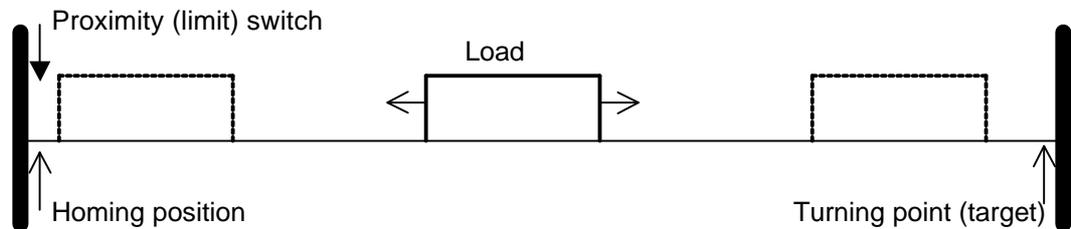


Figure 14. Wobble function of the load

Figure 14 presents the wobble function. Homing is done only once when the ACS 160 is switched on. The direction is defined with the output signal level of the limit switch, which is connected to DI3. When Home position is reached, the position counter is reset to zero and the drive is ready for normal positioning operation.

The object moves straight from home position towards the target position (only Target 1 can be used). When the position counter's actual value equals the target position value, the direction of movement is changed (the object returns to Home position). When the limit switch signal changes (Home position reached), the position counter is reset to zero and the direction is changed again causing the load to move towards the target position.

### Dual feature of DI3

#### Feature 1

DI3 is continuously low when going to Target 1. The load moves relatively from the previous turning point. Movement between Home and Target 1 is done by the parameter value in Target 1 position.

#### Feature 2

DI3 changes from low to high when going to Target 1. The load moves back to home position after turning in Target 1 position until DI3 changes state from high to low. Cyclic correction is made.

A position time delay at the turning points (target and home position) can be integrated by inserting a value into the parameter 8213 (POS DEALY). By default this value is zero. The formula for calculating the actual delay is in ms:

$$\text{Delay [ms]} = \text{POS DELAY} * 40 / \text{Positioning frequency reference [Hz]}.$$

## 5 POSITIONING RELATED PARAMETERS

Reference: User's Manual for type ACS 160 frequency converters.

### 5.1 Group 99: Start up data

#### P9902 APPLIC MACRO

Value 14 selected for Positioning application macro. Turn the ACS 160 power off and then on again to activate the encoder pulse counter. The analogue output does not function after this selection.

### 5.2 Group 10: Command inputs

#### P1001 EXT1 COMMANDS

Defines the connections and the source of Start/Stop/Direction commands for External control location 1 (EXT1). This control place is used as default when ACS 160 is operating at Jogging (manual homing) mode. All selections are possible except those where digital inputs DI4, DI5 are used. DI4 and DI5 are used for encoder connections only.

#### P1002 EXT2 COMMANDS

Defines the connections and the source of Start/Stop/Direction commands for External control location 2 (EXT2). This control place is used when ACS 160 is operating at Positioning mode. These selections are possible, where digital inputs DI1, DI2 and DI3 are not used for other purposes (DI4 and DI5 are reserved for encoder connections). Selections for direction commands are not relevant, because positioning logic uses internal direction commands.

#### P1003 DIRECTION

Rotation direction lock. In Jogging mode the motor rotation direction is given with this parameter, if the frequency reference does not define the direction. In Positioning mode this is not relevant. If Jogging mode is not used, selection 3 (REQUEST) is recommended.

### 5.3 Group 11: Reference select

#### P1101 KEYPAD REF SEL

Selection of active control panel reference in local control mode. Relevant only in Jogging mode if local control has been selected.

#### P1102 EXT1/EXT2 SEL

External control place selection. Used for Jogging/Positioning mode selection. Default value = 2 (DI2): EXT1/EXT2 selection with digital input DI2. Set this parameter value to 7 (EXT2) if Jogging mode (manual homing) is not used.

#### P1103 EXT REF1 SELECT

Selects the signal source for External reference 1, when Jogging mode (EXT1 control place) is active. Default value: 1 (AI1). All alternatives are possible except those, which use digital inputs DI4 and DI5 (reserved for encoder pulses).

#### P1106 EXT REF2 SELECT

Selects the signal source for External reference 2. This parameter is relevant where speed is given by analogue input. In other cases positioning speeds are given with parameter group 12: constant speed parameters.

## 5.4 Group 12: Constant speeds

### P1201 CONST SPEED SEL

Selects which digital inputs are used to select Constant speeds. This parameter can be used with Jogging mode, but not with Positioning mode. Default value: 0 (NOT SEL). In Positioning mode Constant speeds are selected internally and not with digital inputs.

### P1202 CONST SPEED 1

Defines positioning frequency reference for Target 1 (= target speed in Figure 1). The target is selected with parameter 8206 (POS TABLE SEL).

### P1203 CONST SPEED 2

Defines positioning frequency reference for Target 2.

### P1204 CONST SPEED 3

Defines the maximum internal frequency reference near and inside the target window. The purpose of this frequency reference is to ensure that the target is reached with different loads. This value should be as low as possible in order to avoid oscillation around the target with a light load. On the other hand the frequency reference should be high enough to ensure that the motor torque is sufficient for the load to reach the target. See Figure 15 and related parameters: 8220 (SPEED GAIN 1) and 8229 (DELTA DISTANCE).

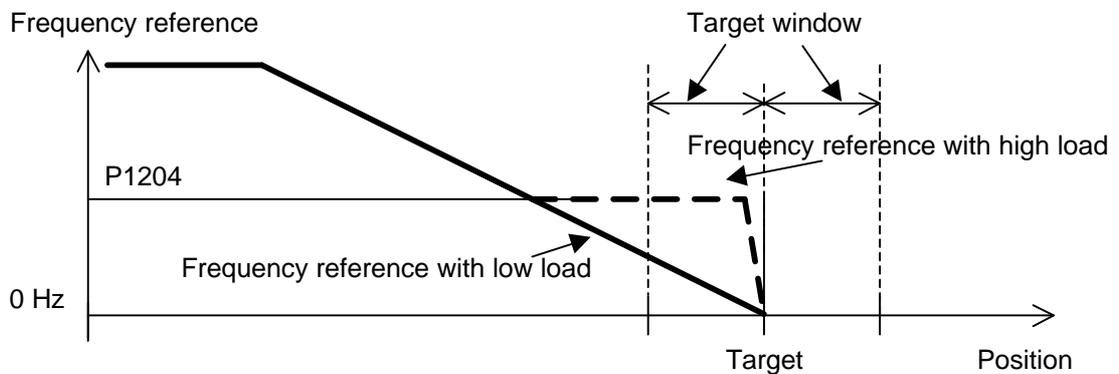


Figure 15. Effect of parameters 1204, 8220 and 8229

### P1207 CONST SPEED 6

This parameter defines the frequency reference during homing when external control place EXT2 has been selected.

Parameters 1205, 1206 and 1208 are not used with the Positioning mode. For proper operation of positioning, constant speeds must be equal or lower than the maximum frequency parameter 2008 (MAXIMUM FREQ).

## 5.5 Group 14: Relay output

### P1401 RELAY OUTPUT 1

### P1402 RELAY OUTPUT 2

Relay output content, value 34 = AT TARGET. Relay is activated when the position counter has reached the target window area. See related parameters 8221 and 8222 (T WINDOW LO, HI).

## 5.6 Group 20: Limits

### P2005 OVERVOLT CTRL

DC overvoltage enable.

Default value = 1 (ENABLE).

During decelerations the overvoltage controller is activated, if short deceleration times and/or high inertia loads are used. The active overvoltage controller increases deceleration time and positioning will not be optimal. In these cases it is recommended to use a brake chopper and a brake resistor. The brake chopper is enabled and the overvoltage controller is disabled when setting this parameter to value 0 (DISABLE).

### P2008 MAXIMUM OUTPUT FREQUENCY

Operating range maximum frequency. The value of this parameter must always be higher or equal to the positioning speeds.

## 5.7 Group 21: Start/Stop

### P2101 START FUNCTION

With positioning only ramp-start or torque boost-start can be used.

1 = RAMP

3 = TORQUE BOOST

### P2102 STOP FUNCTION

Both stop functions can be used with positioning. It is recommended to use ramp stop.

## 5.8 Group 22: Accel/Decel

### P2220 ACC/DEC 1/2 SEL

Set this value to 0 (NOT SEL) with positioning. (Default value=0.)

### P2202 ACCELER TIME 1

Defines the acceleration time of Target 1 speed profile.

### P2203 DECELER TIME 1

Defines the deceleration time of Target 1 speed profile.

### P2204 ACCELER TIME 2

Defines the acceleration time of Target 2 speed profile.

### P2205 DECELER TIME 2

Defines the deceleration time of Target 2 speed profile.

### P2206 RAMP SHAPE

Defines acceleration/deceleration ramp shape. Default value = 0 (LINEAR). Linear deceleration ramps are assumed, where deceleration starting position is calculated. The S-Curve increases the acceleration and deceleration times. This can cause that the actual position overshoots momentarily the target position. This overshooting can be compensated with deceleration slope gain parameter 8218 (SLOPE GAIN 1). If there is overshooting, lower parameter 8218 from default value 980 to 950 or even lower if necessary. The S-Curve velocity profiles are often used for gentle acceleration of liquid or fragile loads.

## 5.9 Group 54: Braking

ACS 160 can also be used in positioning applications, where an electromechanical brake is used. Relay output 1 or 2 is used to control the brake coil. Electromechanical brake control is enabled setting parameter 1401 (RELAY OUTPUT 1) or 1402 (RELAY OUTPUT 2) to value 32 (MEC BR CNTRL). When approaching the target, the brake is switched on when the output frequency is below the frequency limit set 6 with parameter 5403 (MBRK FREQ LVL) and the actual position is inside the target window area.

### P5401 MBRK OPEN DLY

Releases delay for external electromechanical brake.

### P5402 MBRK FREQ LVL

The level of output frequency below which the external brake operation is applied. When co-operating with positioning, the brake locking control is given after ACS 160 output frequency is below this limit and the actual position is within the target window. After this the frequency reference is forced to 0 Hz. See Figure 16.

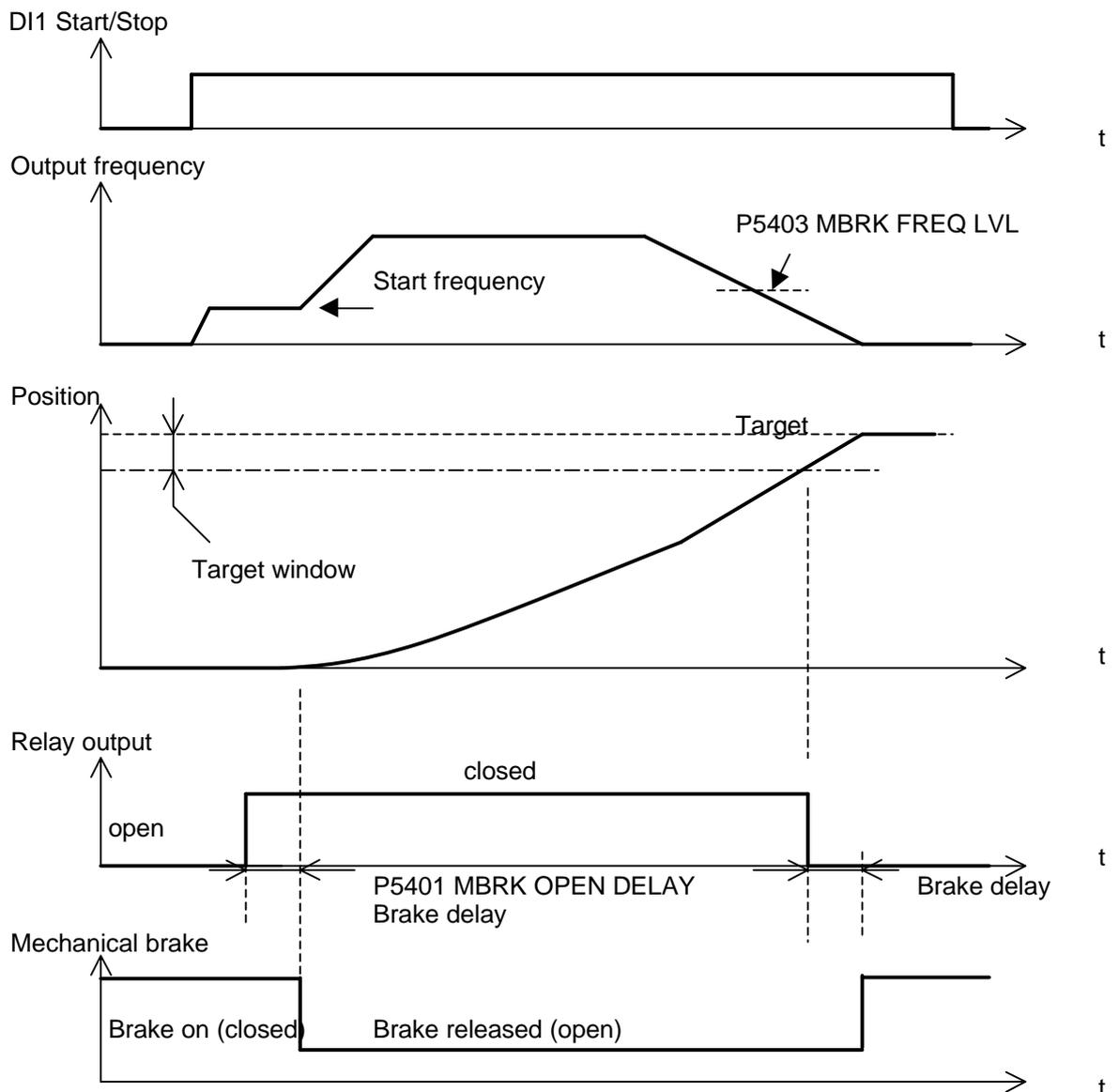


Figure 16. Operation of electromechanical brake control with positioning.

## 5.10 Group 82: Positioning

Position related parameters are given as motor shaft revolutions. Each position parameter needs two parameter locations. The most significant part of the position (referred as HI) is given as full revolutions of the shaft and the least significant part (referred as LO) is given as multiples of 1/65536 of one shaft revolution.

Example:

Target 1 is at the distance of 170 full shaft revolutions plus 1/10 of a revolution. In this case Target 1 is stored as:

Parameter 8207 TARGET 1 LO =  $1/10 * 65536 = 6553$  (least significant part)  
Parameter 8208 TARGET 1 HI = 170 (most significant part)

The significant part of the target parameters 8208 (TARGET 1 HI) and 8210 (TARGET 2 HI) and home position parameter 8226 (HOME POS HI) are given as signed values. Allowed target and home position are presented in Figure 17.

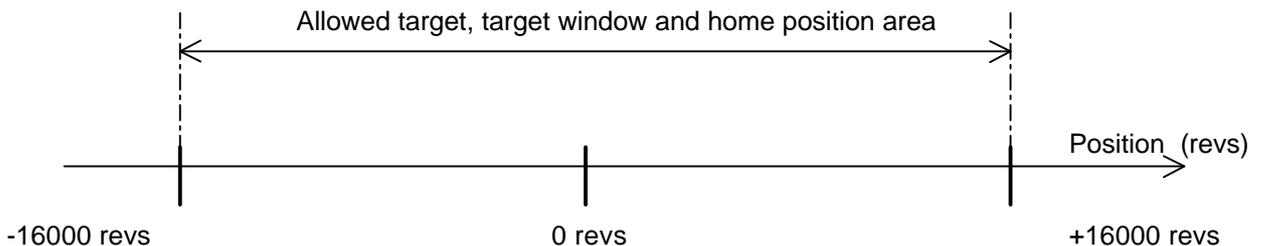


Figure 17. Target, target window and home position setting area

### P8201 ENC PULSE NUM

Encoder pulse number/revolution (line count/revolution) is entered into this parameter.  
Default value is 1024.

### P8202 ENC ERROR

Defines the action of ACS 160 in encoder error situations: 0 = NO ACTION

Encoder error supervision disabled: 1 = FAULT

The drive is stopped with coast stop and fault indication 31 is given, when the following conditions are fulfilled:

- the drive is running and output frequency is over 4.5 Hz,
- no encoder pulses are detected for the time defined with parameter 8203 (ENC DELAY).

### P8203 ENC DELAY

Delay before the encoder fault is given. See parameter 8202 (ENC ERROR).

### P8204 ENC SCALING

0 and positive values = DIRECTION 1 (default value).

Negative values = DIRECTION 2.

The purpose of this parameter is to set the position counter's counting direction to match the direction of rotation of the motor. When ACS 160 direction is forward, the position counter must count to a positive direction.

#### Example:

If the motor is rotating forward and the position counter value is counting to a positive direction (see parameters 8227 and 8228, POS ACT LO, HI) DIRECTION 1 is selected. Otherwise DIRECTION 2 must be selected. It is recommended that direction matching is made with encoder pulse wiring, and not with this parameter, as explained in paragraph 3.1.

**P8206 POS TABLE SEL**

Position reference set selection. This parameter sets the input used for selecting the reference set or fixes it to REF SET 1 or REF SET 2.

- 1 = REF SET 1            Reference set 1 used.
- 2 = REF SET 2            Reference set 2 used.
- 3 = AI2                    Reference set is selected with analogue input 2 (AI2):  
AI2 = 0 ...4V (0 ...8 mA): Reference set 1 is selected.  
AI2 = 6V ...10V (12 mA ... 20 mA): Reference set 2 is selected.
- 4 = DI2                    Reference set is selected with digital input 2 (DI2):  
DI2 is inactive: Reference set 1 is selected.  
DI2 is active: Reference set 2 is selected.
- 5 = DI3                    Reference set is selected with digital input 3 (DI3):  
DI3 is inactive: Reference set 1 is selected.  
DI3 is active: Reference set 2 is selected.

Table 1: Reference sets, when P8206 = 1-5

	Reference Set 1	Reference Set 2
Target position, low-part	8207 TARGET 1 LO	8209 TARGET 2 LO
Target position, high-part	8208 TARGET 1 HI	8210 TARGET 2 HI
Positioning frequency reference	1202 CONST SPEED 1	1203 CONST SPEED 2
Target window freq. reference	1204 CONST SPEED 3	1204 CONST SPEED 3
Homing frequency reference	1207 CONST SPEED 6	1207 CONST SPEED 6
Acceleration time	2202 ACCELER TIME 1	2204 ACCELER TIME 2
Deceleration time	2203 DECELER TIME 1	2205 DECELER TIME 2

- 6 = SET 1 + EXT F        Reference set 1 is used except when the positioning frequency reference is selected with parameter 1106 (EXT REF2 SELECT).
- 7 = SET 2 + EXT F        Reference set 2 is used except when the positioning frequency reference is selected with parameter 1106 (EXT REF2 SELECT).

Table 2: Reference sets, when P8206 = 6, 7

	Reference Set 1	Reference Set 2
Target position, low-part	8207 TARGET 1 LO	8209 TARGET 2 LO
Target position, high-part	8208 TARGET 1 HI	8210 TARGET 2 HI
Positioning frequency reference	1106 EXT REF2 SELECT	1106 EXT REF2 SELECT
Target window freq. reference	1204 CONST SPEED 3	1204 CONST SPEED 3
Homing frequency reference	1207 CONST SPEED 6	1207 CONST SPEED 6
Acceleration time	2202 ACCELER TIME 1	2204 ACCELER TIME 2
Deceleration time	2203 DECELER TIME 1	2205 DECELER TIME 2

### Timing requirements of reference sets

Reference set selection is recommended to be made when ACS 160 is at stop state. The target reference must be selected 200 ms before the next start command. The target reference is sampled at the time instant when start command is activated (stop -> start instant). See Figure 18.

#### Note

- Frequency reference, acceleration and deceleration times become effective 0 ... 200 ms after reference set selection instant. They are not synchronised with the start command.
- Only selection P1106 = 0, 1 and 2 are allowed.

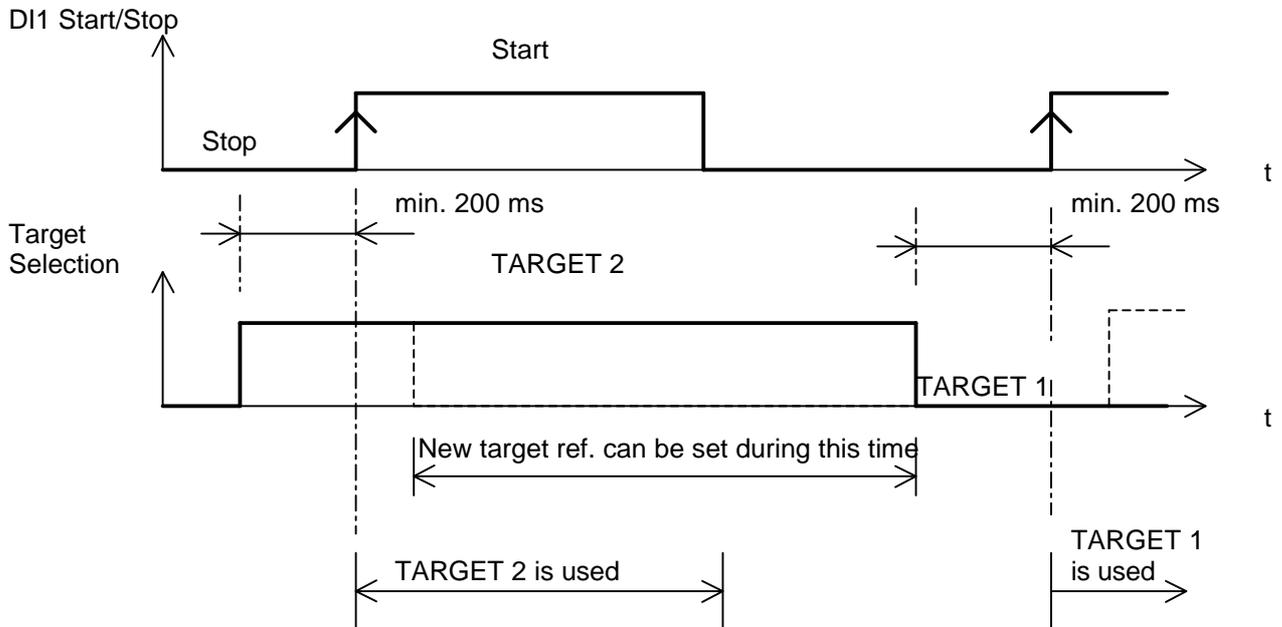


Figure 18. Timing of target reference selection.

#### P8207 TARGET 1 LO

#### P8208 TARGET 1 HI

Target 1 position reference values. TARGET 1 LO is the least significant part (partial revolution) and TARGET 1 HI is most significant part (full revolution) of the parameter.

#### P8209 TARGET 2 LO

#### P8210 TARGET 2 HI

Target 2 position reference values.

#### P8213 POS DELAY

Stop delay scaling factor at positioning mode 9 (CONT MOVE 1). Stopping time at turning points can be scaled with this parameter. If value is zero, the delay is always zero.

$$\text{Delay [ms]} = \text{POS DELAY} * 40 / \text{Positioning frequency reference [Hz]}.$$

#### P8215 POS MODE

Positioning mode selection. The principle of operation and modes are presented in chapter 4. In ACS 160 there are two Relative move modes, one Absolute move mode, and one Continuous move mode. With Absolute move mode it is also possible to select from two cyclic correction mode.

#### 4 = RELAT MOVE 1

Selected target position is relative to previous target position. When start command is given, the position counter is first reset to zero and then corrected with the distance between actual and desired stopping position. The purpose of this is to prevent the axis to “creep” from its original zero position. Correction is made only in cases, where the previous move has reached the target window area.

See Figure 10. Without this corrective action, in applications where the same incremental move is done time after time, the position counter will be zeroed at the actual (stopping) positions, not at the desired (stopping) positions.

The actual stopping position becomes the new zero position. Without corrective action the zero position would “creep” either forward or to the reverse direction from the desired position.

#### 5 = ABS MOVE 1

Selected target position is absolute. The position counter is not reset when start command is given. This mode is typically used, when the load is moved between two positions as shown in Figure 11.

#### 6 = ABS MOVE CC 1

Basic operation as in mode 5, but cyclic correction added. Positioning counter is set to the value of home position parameters 8225 and 8226 (HOME POS LO,HI), when digital input 3 (DI3) state changes from inactive to active.

This mode should be used, when there is a possibility that some drift errors may appear due to mechanical parts of the machinery.

#### 7 = ABS MOVE CC 2

Basic operation as in mode 5, but cyclic correction added. Positioning counter is set to the value of home position parameters 8225 and 8226 (HOME POS LO,HI), when digital input 3 (DI3) state changes from active to inactive. Operation same as in mode 6, except the effect of digital input DI3.

#### 8 = RELAT MOVE 2

Selected target position is relative to previous target position. When start command is given, the position counter is set to the value of home position parameters 8225 and 8226 (HOME POS LO,HI). There are no position correction properties in this mode.

#### 9 = CONT MOVE 1

Continuous move between positions Home and Target 1. (Changes in functionality are possible in later software versions.)

### **P8216 HOMING MODE**

Homing means that the load is driven at a slow speed to a known position (Home position). The principles of homing are presented in chapter 2.

#### 0 = NO HOMING

No homing is made, when ACS 160 supply voltage is switched on. Positioning mode is enabled.

1 = Reserved for future use. Do not use.

2 = Reserved for future use. Do not use.

3 = Reserved for future use. Do not use.

#### 4 = HOMING 1

Homing with limit switch. Homing frequency reference is set with parameter 1207 (CONST SPEED 6). Homing direction is defined with digital input 3 (DI3):

- direction is forward, when DI3 is inactive,
- direction is reverse, when DI3 is active.

The Home position is set to the position counter, when DI3 state changes. After this the homing speed reference is internally forced to zero. The load decelerates from homing frequency to zero. It

usually means that the load is *not stopped exactly* to home position!

Positioning mode is enabled, when stop command is given.

ACS 160 will perform homing operation when it is powered up and it receives the first start command.

External control place EXT2 must be selected. After the homing operation is completed, the drive will go to Position mode as set by parameter 8215 (POS MODE). See Figure 5a, 5b, and 5c.

#### 5 = HOMING 2

Same as mode 4, except digital input DI3 has a different effect:

- direction is reverse, when DI3 is inactive,
- direction is forward, when DI3 is active.

#### 6 = HOMING 3

Like HOMING 1 and HOMING 2 with the following differences.

Homing direction is defined with analogue input AI1:

- direction is forward, when AI1 = 0..4 V (0...8 mA),
- direction is reverse, when AI1 = 6..10 V (12...20 mA).

### **P8217 AUX POS CMD**

Auxiliary positioning mode commands selection

#### 0 = NOT SELECTED

#### 1 = DI2

Digital input 2 (DI2) is used to give auxiliary positioning start/stop commands. This command does not start or stop the ACS 160 modulation. During homing this command acts only as start enable. Positioning mode is enabled when the actual start/stop command goes to stop state and then to start state. See Figure 19.

NOTE! If DI2 is selected it is not allowed to select P1102 (EXT1/EXT2 SEL) = 2 (DI2).

NOTE! If DI2 is selected it is not allowed to select P8206 (POS TABLE SEL) = 4 (DI2).

#### 2 = STOP 0 Hz

Positioning frequency is set to 0 Hz, when positioning target window has been reached.

#### 3 = STOP MODUL

Modulation is stopped, when the target window has been reached.

#### 4 = EXT FREQ

Enables external frequency reference use at positioning mode 9:

Frequency reference is selected with parameter 1106 (EXT REF2 SELECT). Allowed selections are 0 (KEY PAD), 1(AI1) or 2 (AI2).

External frequency reference update can be controlled with digital input DI2:

- DI2 is inactive: frequency reference is sampled at turning point,
- DI2 is active: frequency reference is sampled continuously.

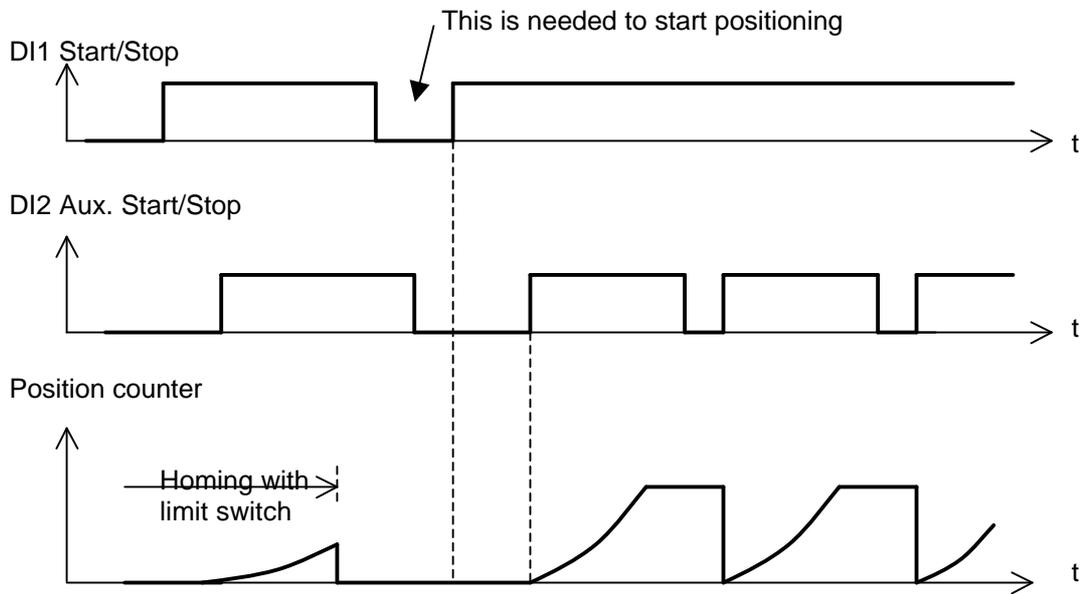


Figure 19. Auxiliary position start/stop

**P8218 SLOPE GAIN 1**

Frequency reference deceleration slope control. Values above 1000 delay the beginning of the deceleration ramp and make the target position approach faster. Values below 1000 increase the effective deceleration time and make the target position approach slower. See the effect of slope gain 1 parameter in Figure 20.

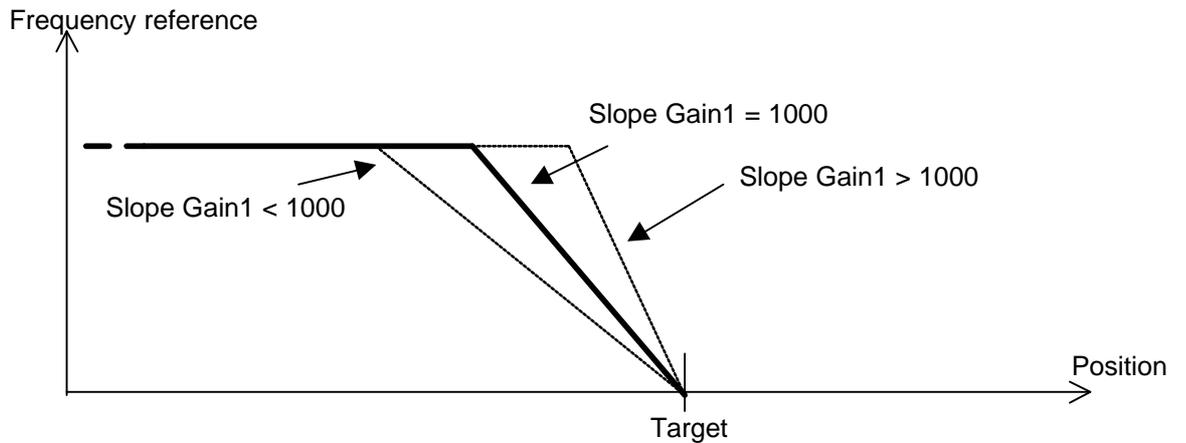


Figure 20. The effect of Slope gain 1 parameter

### P8220 SPEED GAIN 1

Gain factor of positioning speed control during deceleration. Higher value means higher speed change. Related parameter 8229 (DELTA DISTANCE). See also parameter 1204 (CONST SPEED 3) and Figure 15 where the effects of parameters 8220 and 8229 are shown. Figure 21 shows the effects of the parameters in more detail. Scaling: 1 = 0.01 Hz/4ms.

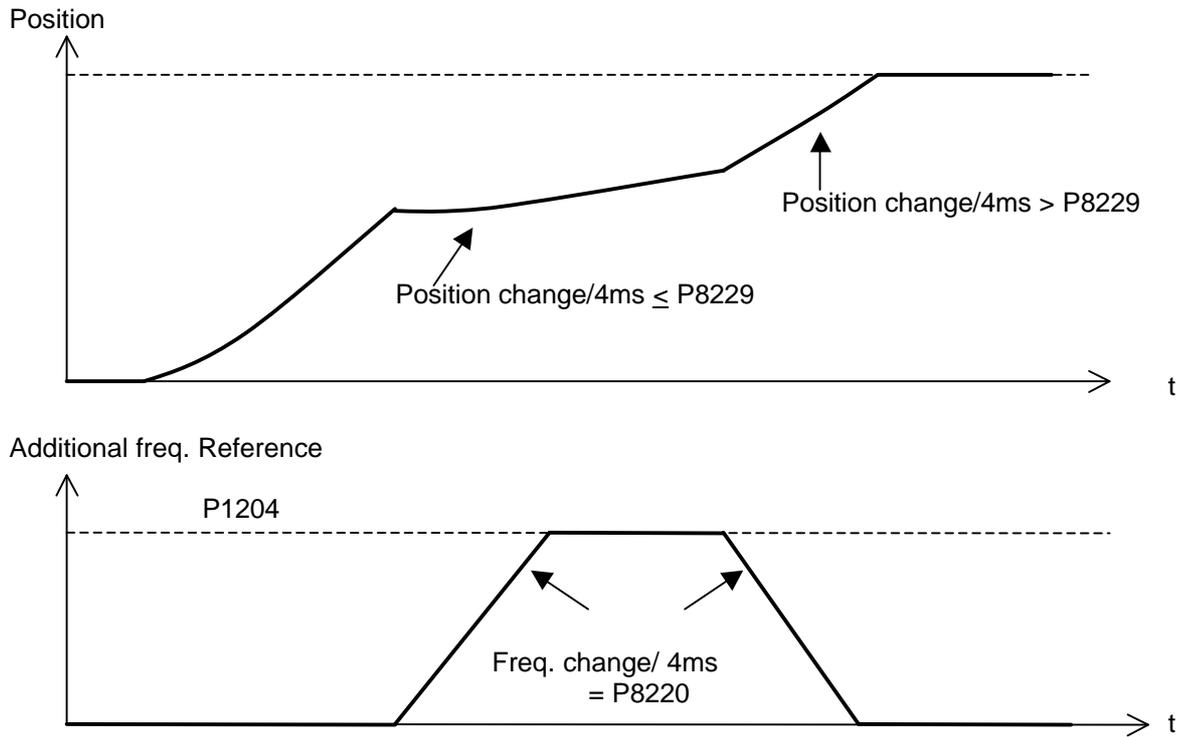


Figure 21. The effect of parameters 8220 and 8229.

### P8221 T WINDOW LO

### P8222 T WINDOW HI

Defines a target position window area. This parameter is common to Target 1 and Target 2.  
Scaling: See the example prior to Figure 17.

Operation: When position actual value (position counter) is inside the target area (target ref.  $\pm$  target window), the relay output is activated, if parameter 1401 or 1402 has value 34 (AT TARGET). The relay is deactivated when the next position start command is given. See Figure 22.

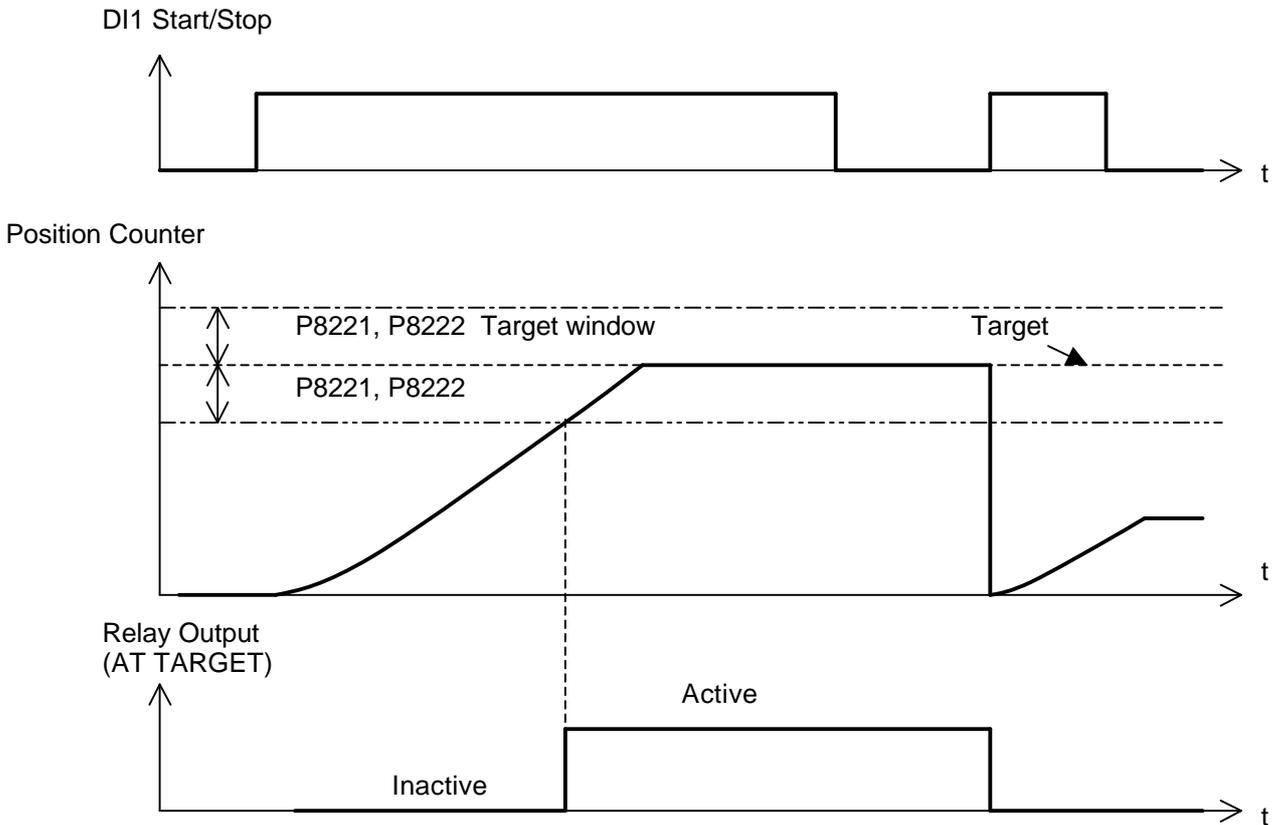


Figure 22. Target window

### P8223 MAX TARGET LO

### P8224 MAX TARGET HI

Target position maximum limit. ("SW limit").  
Scaling: See the example prior to Figure 17.  
This limit value gives the positive and negative limit of the maximum target.

Operation: When the absolute value of the position actual value (position counter) goes above this limit, the ACS 160 frequency reference is forced to 0 Hz. No alarm or fault indication is given.

### P8225 HOME POS LO

### P8226 HOME POS HI

Home position.  
Scaling: See the example prior to Figure 17.  
This value is set to the position counter in situations defined by parameters 8216 (HOMING MODE) and 8215 (POS MODE), and also when the external control position is changed from EXT1 to EXT2. See Figures 5, 6, 12 and 16.

**P8227 POS ACT LO**

**P8228 POS ACT HI**

Position actual value/position counter value. Read only parameter.  
Scaling: See the example prior to Figure 17.

**P8229 DELTA DISTANCE**

This positioning speed tuning parameter represents the position change during a 4ms time period.

Scaling: 1 = 1 position counter increment/4ms.

See related parameter 8220 (SPEED GAIN 1) and Figure 21.

If the position difference between two consecutive 4ms time instances is smaller than this parameter value, the positioning speed is increased with the amount of the parameter 8220 value. If the difference is greater, the positioning speed is decreased.

The purpose of parameters 8220 and 8229 is to make the actual positioning speed near the target depended on the load and to ensure that the target is reached.

## 6 POSITIONING APPLICATION EXAMPLES

The following examples are meant as illustrations of possibilities of the Positioning macro, and not as answers to specific problems.

### 6.1 Differences of ACS 160 SW 1.0.0.E. compared to later versions

- Some default settings have been changed.
- Version 1.0.0.E: Positioning and homing are active at both external control places EXT1 and EXT2.
- Later versions: Positioning and limit switch homing are active only at external control place EXT2.
- Version 1.0.0.E: No jogging (manual homing) possibility with control place EXT1.
- Version 1.0.0.E: Digital input DI3 cannot be used for reference set select. See parameter 8206.
- Version 1.0.0.E: Selected target reference becomes active during the next 200 ms after selection has been made => Target reference selection must be made at stop state and at the latest 200 ms before start command.
- Version 1.0.0.E: Relay output (AT TARGET) is updated only during Positioning mode and it is not updated during Homing mode.

## 6.2 Example 1: Homing mode = 4 and Positioning mode = 8

The following example in Figure 23 is applicable for situations where items are moved repeatedly over a certain distance. When the drive is powered up, homing is done. After homing the drive is ready for positioning control.

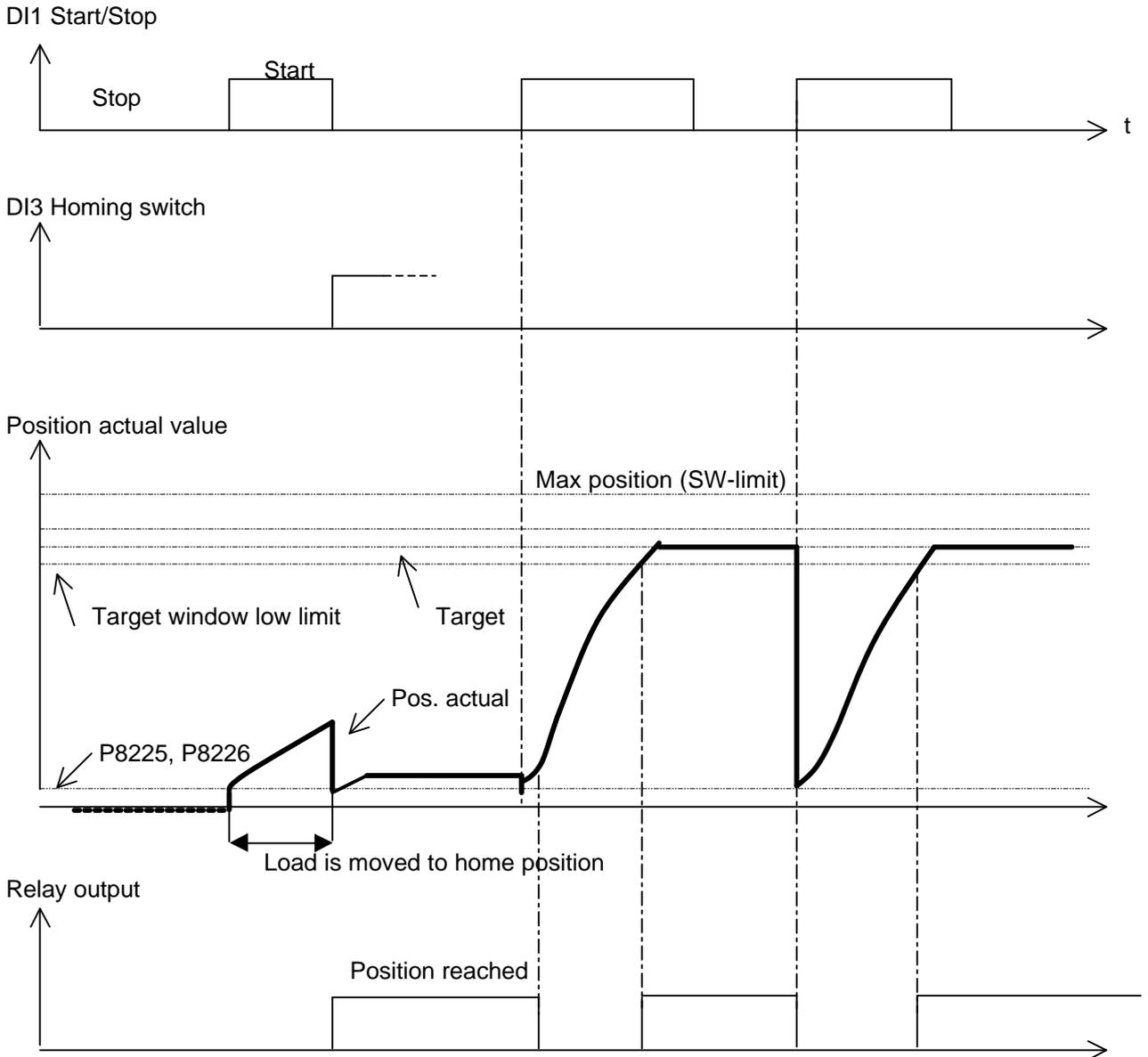


Figure 23. Homing and relative positioning

Homing is done only once after ACS 160 is powered up. With Homing mode 4, the homing direction is forward, because the homing switch input DI3 is inactive. When DI3 state changes from inactive to active, the position actual value is set to the value of parameter Home position. Frequency reference is set to zero. Relay output (when programmed to value 34) is activated. Positioning is enabled only after sop command is given.

The next start command after homing starts the positioning. Load is moved towards the target position with acceleration and deceleration times. The constant frequency reference is defined with parameter 8206 (POS TABLE SEL). When the target window is reached, relay output is activated. Relay output stays activated until a new start command is given.

### 6.3 Example 2: Homing mode = 4 and Positioning mode = 5

The following example in Figure 24 is applicable for situations where the load is moved between position points. When the drive is powered up, homing is done (in this case the Home position is located between the two target positions). After homing the drive is ready for positioning control. Two targets, acceleration, and deceleration times, and frequency reference sets are used. The actual value is not reset during start/stop sequence.

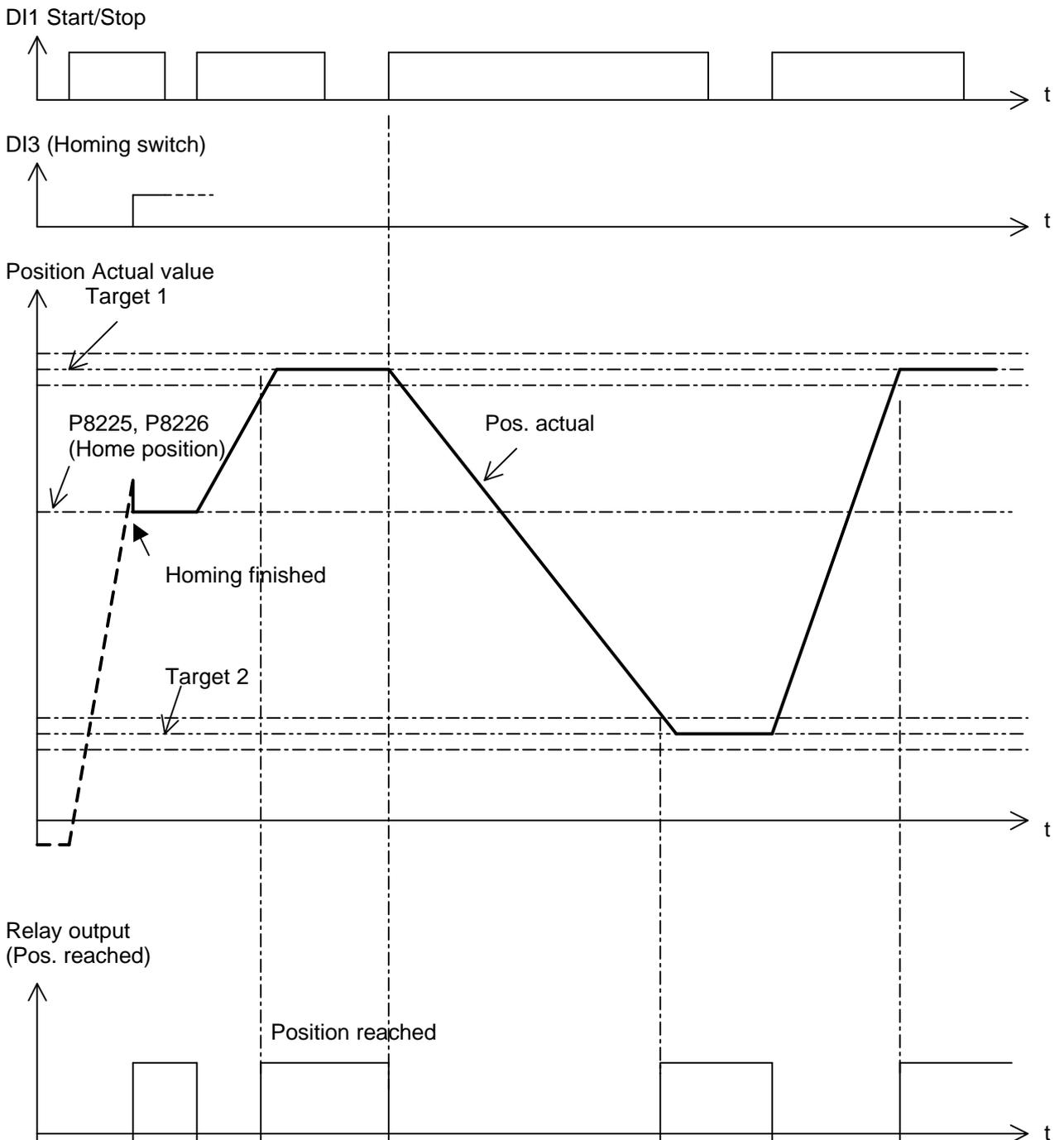


Figure 24. Homing and absolute positioning

## 6.4 Example 3: Detailed description of load movement between two targets

### 6.4.1 Description

One section of a pulp bale conveyor is moved between two places as shown in Figure 25. The conveyor is loaded with pulp bales at Target 1 and moved to Target 2 where the bales are unloaded. ACS 160 and the motor are installed to this conveyor section. The incremental encoder (1024 pulses/rev) is connected to the motor axis. ACS 160 is controlled by a PLC. Connections between ACS 160 and the PLC can be made as shown in Figure 8.

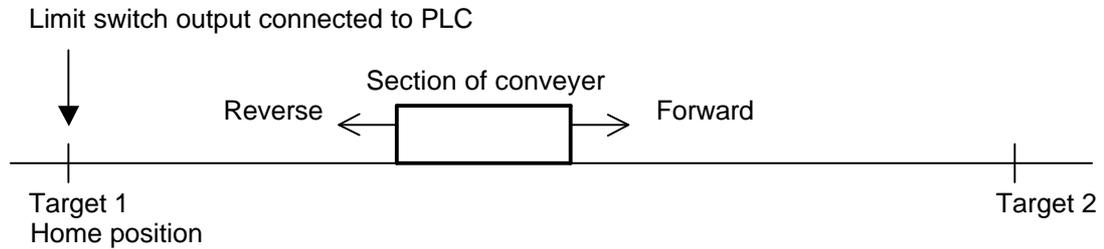


Figure 25. Targets, home position and directions

### 6.4.2 Parameter Setting

P1102	EXT1/EXT2 SEL	7	External control place EXT2 is selected. Enables positioning.
P1202	CONST SPEED 1	60 Hz	Target 1 frequency reference
P1203	CONST SPEED 2	60 Hz	Target 2 frequency reference
P1204	CONST SPEED 3	4.5 Hz	Target window frequency reference
P1207	CONST SPEED 6	5 Hz	Homing frequency reference
P2005	OVERVOLT CTRL	0	Overvoltage controller disabled and brake chopper enabled
P2008	MAXIMUM FREQ	60 Hz	Maximum allowed frequency
P2102	STOP FUNCTION	2	Ramp stop is used
P2202	ACCELER TIME 1	5 s	Acceleration time to Target 1
P2203	DECELER TIME 1	3 s	Deceleration time to Target 1
P2204	ACCELER TIME 2	5 s	Acceleration time to Target 2
P2205	DECELER TIME 2	3 s	Deceleration time to Target 2
P8206	POS TABLE SEL	4	Target 1/Target 2 selection with DI2
P8207	TARGET 1 LO	0	
P8208	TARGET 1 HI	0 revs	Target 1 is 0 revs position (same as Home)
P8209	TARGET 2 LO	0	
P8210	TARGET 2 HI	180 revs	Target 2 is 180 revs position
P8215	POS MODE	6	Absolute move and cyclic correction with DI3
P8216	HOMING MODE	4	Homing direction is forward when DI3 is inactive, and direction is reverse when DI3 is active
P8221	T WINDOW LO	0	
P8222	T WINDOW HI	1 rev	Relay output AT TARGET is activated one motor axis rev before Target 1/Target 2 is reached
P8223	MAX TARGET LO	0	
P8224	MAX TARGET HI	200 revs	Acts as software limit switch. Position counter should never reach this limit.
P8225	HOME POS LO	0	
P8226	HOME POS HI	0 revs	Home set at 0 revs position (same as Target 1)

Other parameters have their own default values.

Controls to digital inputs DI1...DI3 come from PLC:

- DI1: Start/Stop
- DI2: Target 1/2 selection
- DI3: Limit switch status. Defines homing direction.

### 6.4.3 Homing

Homing is made only once after ACS 160 is powered up.

Home position is set to same position as Target 1. This ensures that homing can always be done to the reverse direction (DI3 is active). The limit switch is used for homing and also for cyclic correction operation during positioning. Digital input DI2 chooses ramp times 1 or 2. If new homing is necessary, ACS 160 supply voltage is switched off and then on again.

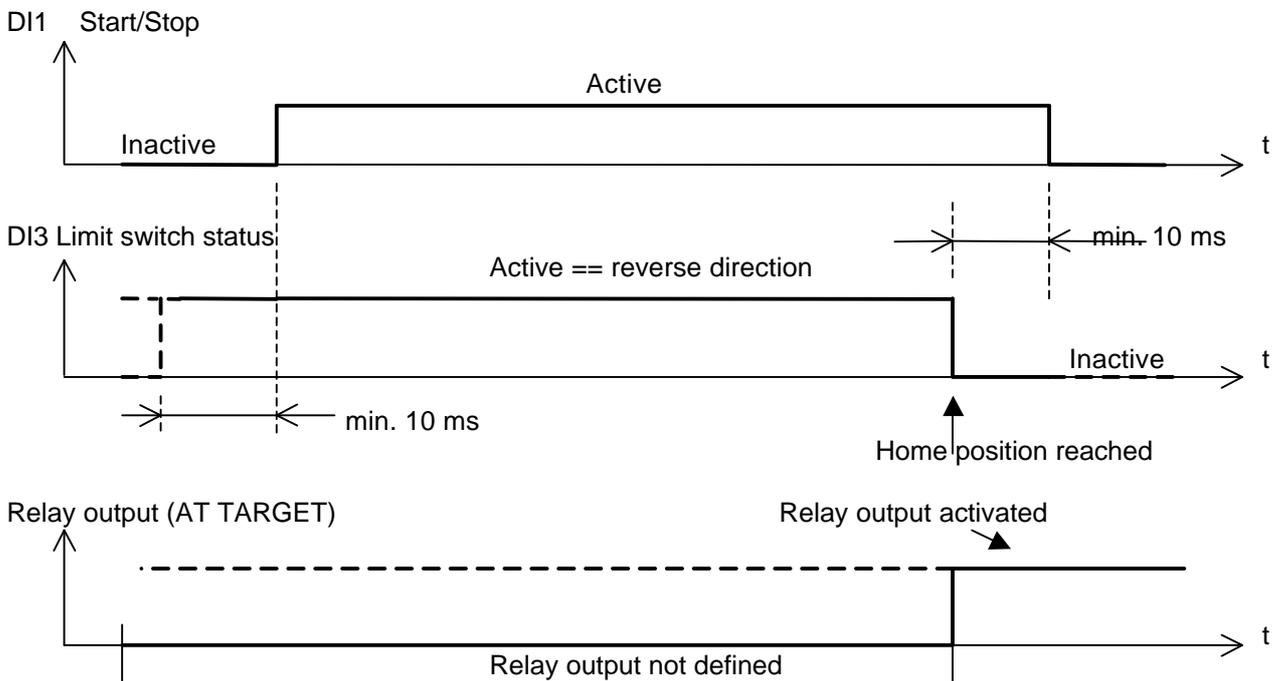


Figure 26. Homing timing diagram

Homing is finished when D13 state changes from active to inactive and start command is active, see Figure 26. Positioning is enabled, when stop command is given (D11 state becomes inactive).

#### 6.4.4 Positioning move from Target 1 (Home position) to Target 2

DI2 is activated to choose Target 2 at least 200 ms before the start command is given with DI1 as shown in Figure 27. During positioning DI3 is used for cyclic correction of the position counter.

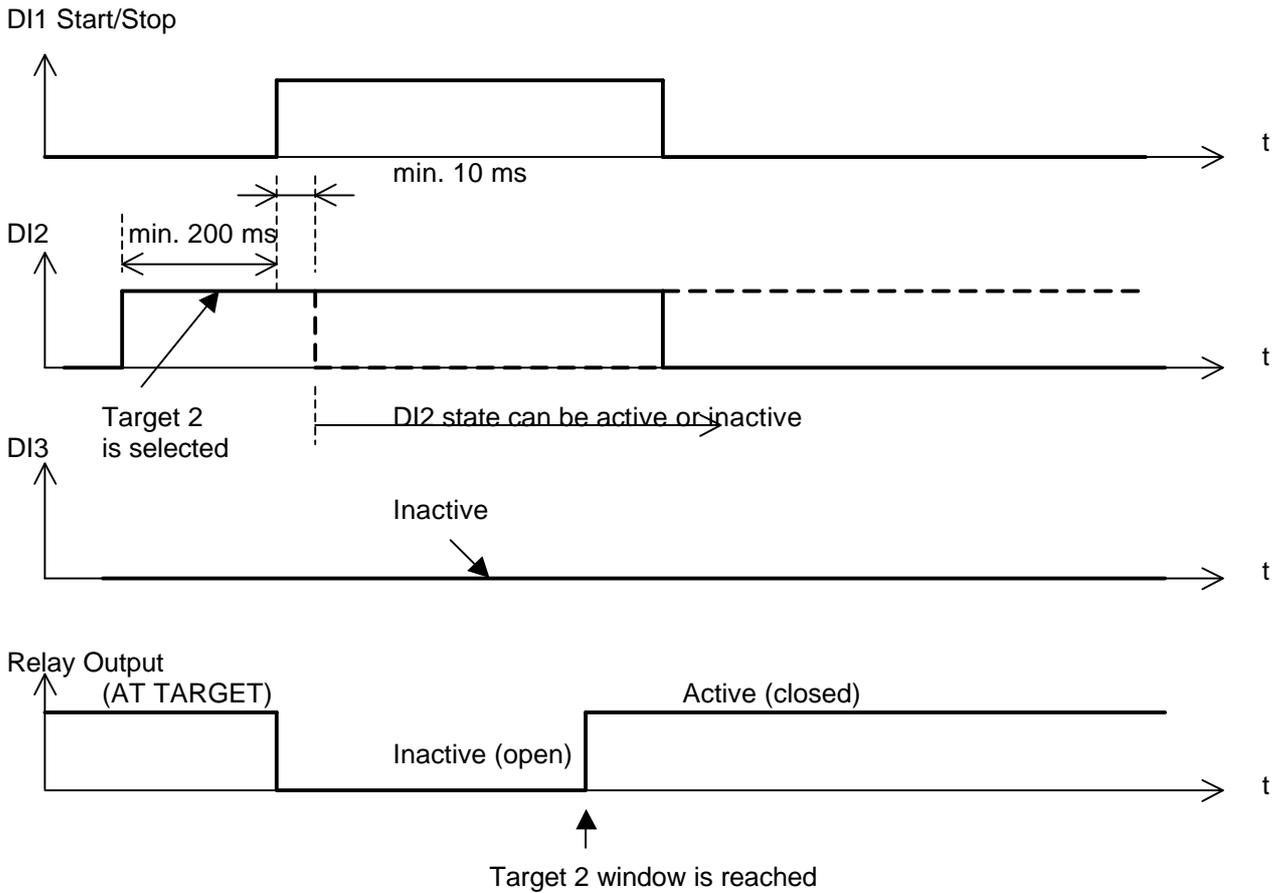


Figure 27. Positioning move from Target 1 to Target 2

### 6.4.5 Positioning move from Target 2 to Target 1 (Home position)

DI2 is checked to be inactive for choosing Target 1 at least 200 ms before the start command is given with DI1. During positioning DI3 is used for cyclic correction of the position counter when Target 1 is reached. See Figure 28.

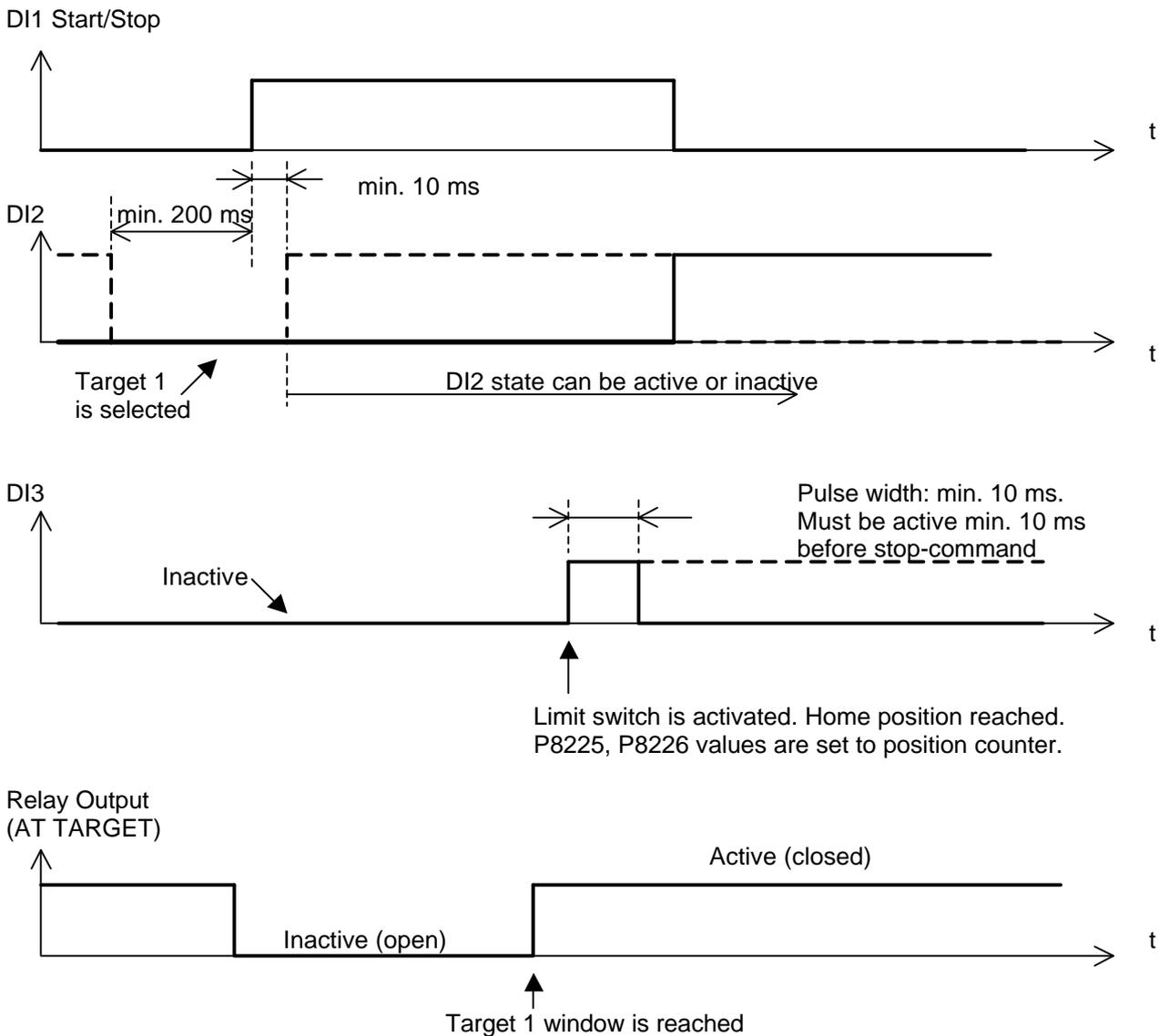


Figure 28. Positioning move from Target 2 to Target 1

### 6.4.6 Exceptional occasions

1. A conveyer section is stopped between Target 1 and Target 2 positions because of an ACS 160 fault:
  - If relay output (FAULT(-1)) indicates fault, the reason must be solved. Switching the ACS 160 supply voltage off and then on again does new homing.  
Note: If resetting is possible and it is not Fault 31 (ENCODER FAULT), the positioning move could be continued by giving stop and then start command.
2. A conveyer section is stopped between Target 1 and Target 2 positions because ACS 160 is overloaded and no fault indication is shown:
  - New homing is made after the ACS 160 supply voltage has been switched off, and the cause for overload has been removed.
3. There is a short ACS 160 supply voltage break:
  - Voltage break is indicated with voltage relay. New homing is made.

## 6.5 Example 4: Relative continuous move of load

### 6.5.1 Description

This application could be for example a conveyor system, where items are repeatedly moved a certain distance in the same direction. With digital input DI3 two distances can be selected (Target 1 or Target 2). Start/Stop command is connected to digital input DI1.

Initial item positioning (manual homing) can be made in jogging mode:

- digital input DI2 is inactive,
- jogging speed is controlled with the potentiometer voltage connected to analogue input AI1,
- jogging direction is controlled with parameter 1003 (DIRECTION).

Positioning mode is activated, when DI2 input is active. Positioning mode 4 (Relative move 1) has been selected. The position counter is reset every time when start command is given. After each counter reset, the actual stopping position is checked and the position counter value is corrected with the error value of the actual and desired stopping position. See Figure 29.

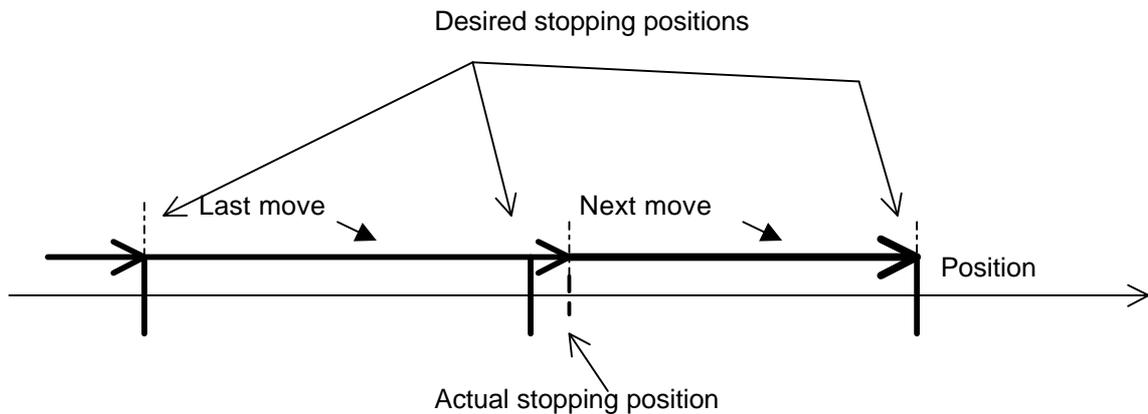


Figure 29. Application example 4, corrective action of position mode 4

## 6.5.2 Parameter Setting

Default values except:

P1002	DIRECTION		Set forward or reverse for jogging direction
P1202	CONST SPEED 1	acc. to process	Target 1 frequency reference
P1203	CONST SPEED 2	acc. to process	Target 2 frequency reference
P1204	CONST SPEED 3	acc. to process	Target window frequency reference
P1207	CONST SPEED 6		Homing frequency reference. Not used in this application
P1401	RELAY OUTPUT 1	34	At target
P1402	RELAY OUTPUT 2	34	At target
P1403	RO 1 ON DELAY	3.5 s	Switch-on delay for relay 1
P1404	RO 1 OFF DELAY	0 s	Switch-off delay for relay 1
P1405	RO 2 ON DELAY	5 s	Switch-on delay for relay 2
P1406	RO 2 OFF DELAY	0.3 s	Switch-off delay for relay 2
P2102	STOP FUNCTION	2	Ramp stop is used
P2202	ACCELER TIME 1	acc. to process	Acceleration time to Target 1
P2203	DECELER TIME 1	acc. to process	Deceleration time to Target 1
P2204	ACCELER TIME 2	acc. to process	Acceleration time to Target 2
P2205	DECELER TIME 2	acc. to process	Deceleration time to Target 2
P8207	TARGET 1 LO	acc. to process	
P8208	TARGET 1 HI	acc. to process	Target 1 full revs position
P8209	TARGET 2 LO	acc. to process	
P8210	TARGET 2 HI	acc. to process	Target 2 full revs position
P8215	POS MODE	4	Relative move with position correction
P8216	HOMING MODE	0	No homing

DI1 Start/Stop

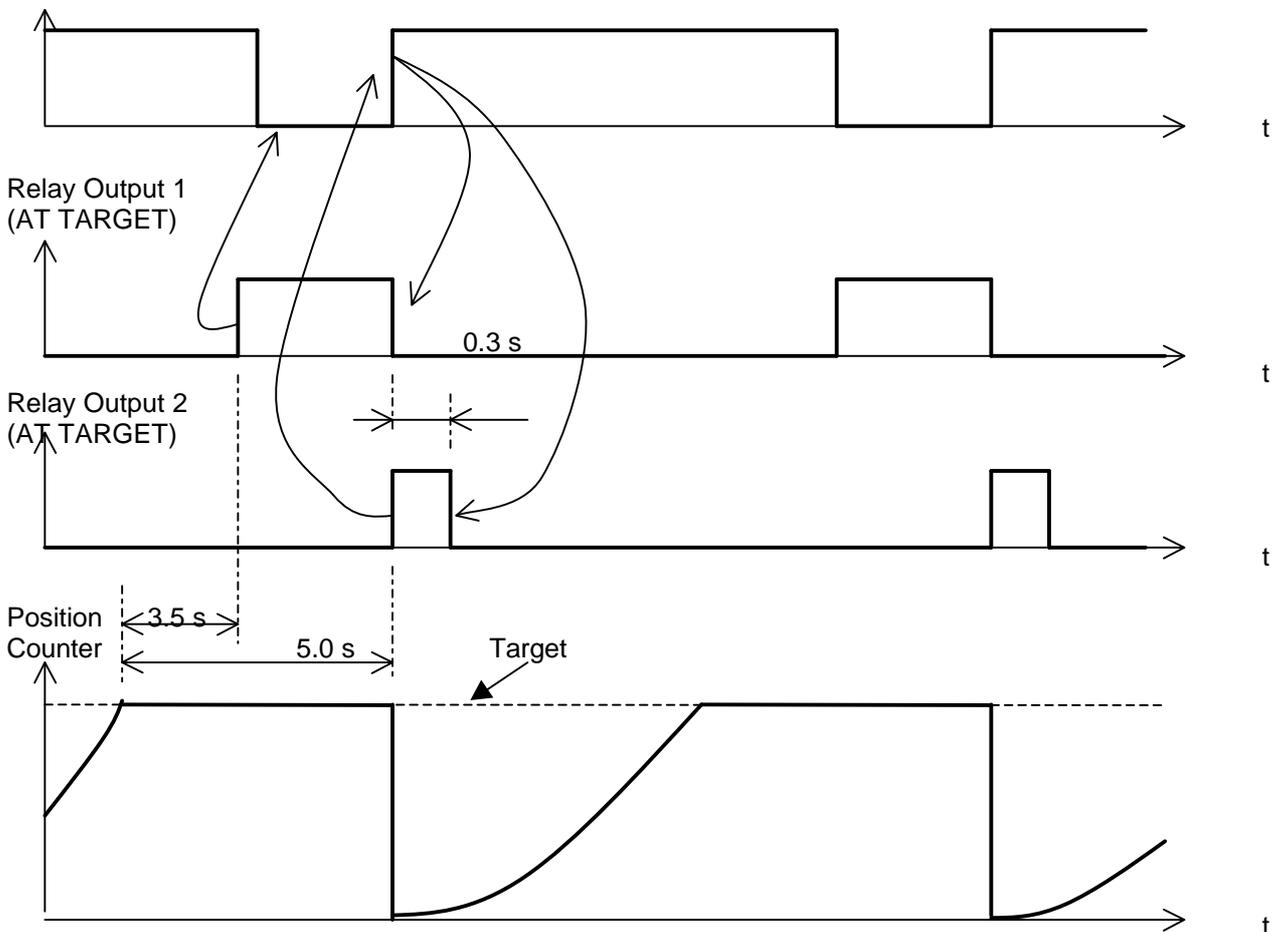


Figure 30. Application example 4, operation diagram

### 6.5.3 Features

The example is not fully tested and its purpose is only to inspire creating profitable and simple applications.

Application: Relative, continuously repeated moves. One external relay K1 is used. See circuit diagram in Figure 31.

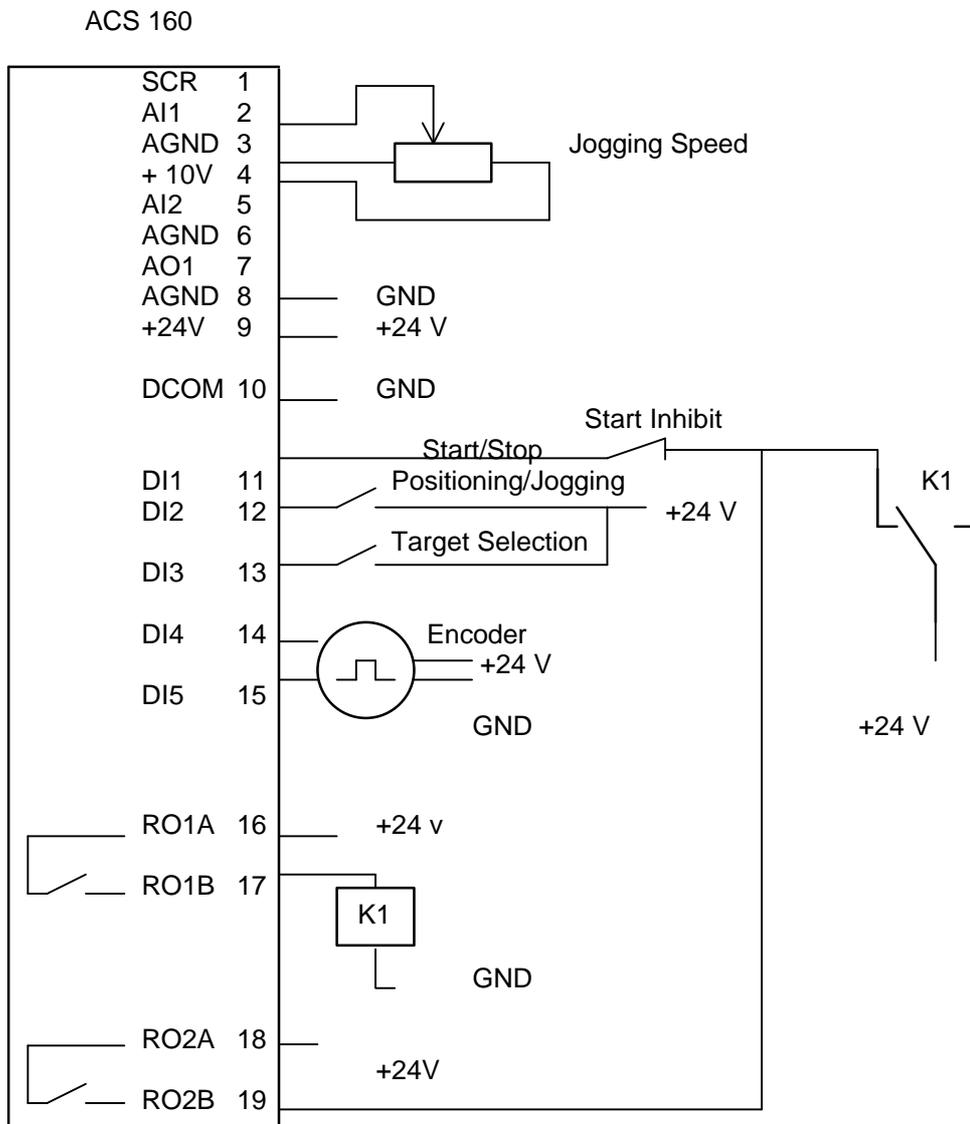


Figure 31. Application example 4, circuit diagram

## 6.6 Example 5: Jogging with direction setting via digital input

ACS 160 SW VERSION V1403.ROM

This version is based on ACS 160 SW versions V1400, V1401 and V1402.

### 6.6.1 Description

Manually made homing is called jogging. In jogging mode the frequency reference is given with AI1, and rotation direction is given with digital input DI2. Jogging/positioning mode is selected with digital input DI3. Positioning frequency reference is given with analogue input AI2.

### 6.6.2 Parameter settings

P1001	EXT 1 COMMANDS	2	Start/stop with DI1, direction with DI2 in Jogging mode
P1002	EXT 2 COMMANDS	1	Start/stop with DI1 Positioning mode
P1003	DIRECTION	3	Request
P1102	EXT1/EXT2 SEL	3	Jogging/Positioning mode selected with DI3
P1103	EXT REF1 SELECT	1	Jogging frequency reference set with AI1
P1106	EXT REF2 SELECT	2	Positioning frequency reference set with AI2
P1204	CONST SPEED	3 4.7	Target window frequency reference
P2202	ACCELER TIME	1 0.5	Acceleration time
P2203	DECELER TIME	1 0.5	Deceleration time
P8206	POS TABLE SEL	6	Reference set 1 is used, except the positioning frequency reference is selected with parameter 1106 EXT REF2 SELECT
P8207	TARGET 1 LO	0	
P8208	TARGET 1 HI	107	Target 1 is 107 revs position
P8215	POS MODE	4	Relative move with position correction
P8216	HOMING MODE	0	No homing. For defining Home position Jogging mode in EXT1 control location is used.
P8217	AUX POS CMD	0	Not selected

### 6.6.3 New functions

Now the positioning frequency reference can be set also with analogue input 1 or 2.

New selections for parameter 8206 (POS TABLE SEL):

6 = Reference set 1, except positioning frequency reference is selected with parameter 1106 (EXT REF2 SELECT).

7 = Reference set 2, except positioning frequency reference is selected with parameter 1106 (EXT REF2 SELECT).

## 6.7 Example 6: Continuous move of the load between two targets

### 6.7.1 Description

When the drive is powered up, the load moves left with a speed that is defined with constant speed parameter 1207 (CONST SPEED 6), until the limit switch output signal level changes. If the object is on the left side of the home place when homing starts, the object moves to the right and stops, when the limit switch signal level changes.

Requirement: The limit switch signal must have the same level all the time when the load is to the left from Home position. When Home position is reached, the limit switch resets the position counter to zero and normal positioning operation starts.

The continuous move is shown in Figure 32. The load moves right from the home position towards the target position. When the position counter actual value equals the target position value, the direction changes. The load then moves towards Home position. When the limit switch signal changes, the position counter is reset to zero, the direction changed and the load moves towards the target position again.

Continuous move can be used for example for spinning wires.

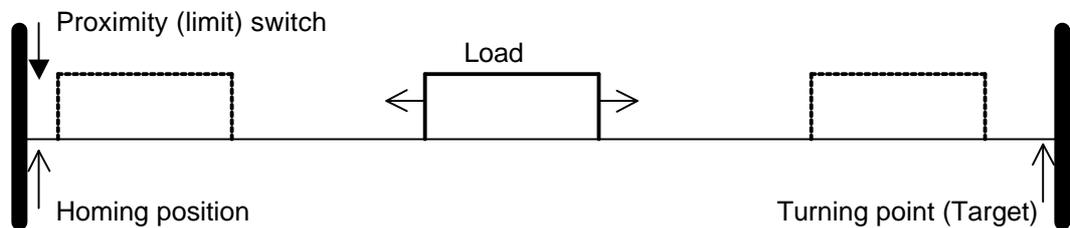


Figure 32. Wobble function of the load

### 6.7.2 Parameter settings

P1002	EXT 2 COMMANDS	1	Start/stop with DI1 Positioning mode
P1102	EXT1/EXT2 SEL	7	External control location EXT2 is selected
P1106	EXT REF2 SELECT	1	Positioning frequency reference set with AI1
P1207	CONST SPEED 6	10 Hz	Speed reference during homing
P2202	ACCELER TIME 1	acc. to process	Acceleration time
P2203	DECELER TIME 1	acc. to process	Deceleration time
P8201	ENC PULSE NUM	1024	Used encoder gives 1024 pulses / rev
P8206	POS TABLE SEL	1	Target 1 reference set is used only
P8207	TARGET 1 LO	acc. to process	
P8208	TARGET 1 HI	acc. to process	Target 1 distance from Home position
P8215	POS MODE	9	Continuous move is selected
P8216	HOMING MODE	4	Homing frequency reference is set with parameter 1207 CONST SPEED 6. Homing direction is defined with DI3 (forward when inactive, reverse when active). Home position is set to position counter when DI3 state changes.
P8217	AUX POS CMD	4	Selected EXT REF2 gives positioning speed reference (AI1 in this case). This parameter setting can be used only when P8215 (POS MODE) = 9 (CONT MOVE1).

- NOTE! When parameter 8215 (POS MODE) is other than 9 (CONT MOVE 1), the positioning speed reference can be set only with constant speed parameters 1202 (CONST SPEED 1) and 1203 (CONST SPEED 2).
- (Changes in functionality are possible in later software versions.)

## 6.8 Example 7: Operation when gear is used

### 6.8.1 Encoder is on the side of the load

ACS 160 positioning algorithm assumes that the encoder is installed to the motor shaft, thus the relationship between the motor shaft speed and the number of encoder pulses/motor shafts is known. However if an encoder is on the side of a load and there is gear between the motor and encoder, parameter 8201 (ENCODER PULSE NUM) value must be changed according to the gear ratio. See Figure 33.

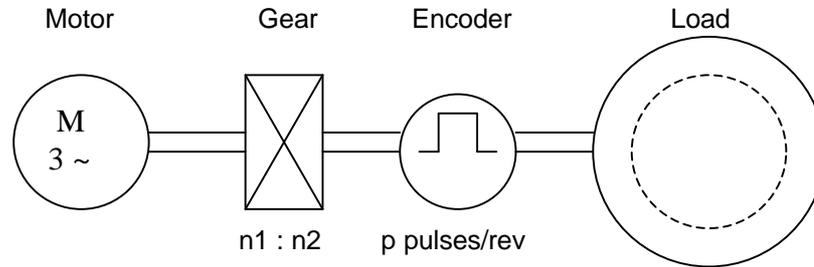


Figure 33. Encoder gear function when encoder is on the side of the load

$$\frac{\text{Motor speed}}{\text{Encoder speed}} = \frac{n_1}{n_2}$$

When the motor shaft rotates one revolution, the encoder rotates  $n_2/n_1$  revolutions  
 $\Rightarrow$  Pulses received from encoder =  $p * n_2/n_1$  pulses

$\Rightarrow$   
 Parameter 8201 value = encoder pulses/rev \*  $n_2/n_1$

Parameters 8207...8210 (Target 1, Target 2): given as  $n_1/n_2 * \text{encoder revolutions}$

Parameter 8221, 8222 (Target window): given as  $n_1/n_2 * \text{encoder revolutions}$

Parameter 8223, 8224 (Max. target): given as  $n_1/n_2 * \text{encoder revolutions}$

Parameter 8223, 8226 (Home position): given as  $n_1/n_2 * \text{encoder revolutions}$

Position counter actual value, parameters 8227, 8228 show the position as  $n_1/n_2 * \text{encoder revolutions}$

Example: (see Figure 33)

Gear ratio:  $n_1:n_2 = 10 : 1$   
 Encoder: 1000 pulses/rev  
 Target 1 reference = 180 encoder revolutions  
 $\Rightarrow$

P8201 (ENC PULSE NUM) =  $1000 * 1 / 10 = 100$  (pulses/rev)  
 P8207 (TARGET 1 LO) = 0  
 P8208 (TARGET 1 HI) =  $180 * 10 / 1 = 1800$  (revs)  
 In Target 1 position parameter 8228 (POS ACT HI) value = 1800 (revs).

## 6.8.2 Encoder on the motor shaft

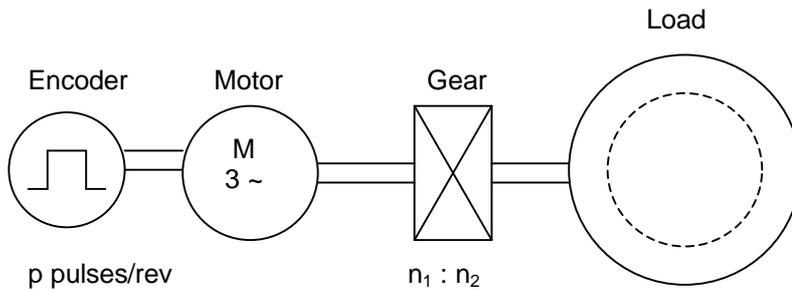


Figure 34. Encoder gear function when encoder is on the motor shaft

In case the encoder is on the motor shaft, as in Figure 34, the positioning parameters are set normally as encoder revolutions. If positions are given as load side positions, they must be transformed to the motor (or encoder) side.

$$\frac{\text{Motor speed}}{\text{Load speed}} = \frac{n_1}{n_2}$$

When the motor shaft rotates one revolution, the load rotates  $n_2/n_1$  revolutions

⇒ Pulses received from encoder = p pulses

⇒

Parameter 8201 value = encoder pulses/rev

Parameters 8207...8210 (Target 1, Target 2): given as encoder revolutions =  $n_1/n_2$  \* load revolutions

Parameter 8221, 8222 (Target window): given as encoder revolutions =  $n_1/n_2$  \* load revolutions

Parameter 8223, 8224 (Max. target): given as  $n_1/n_2$  \* encoder revolutions =  $n_1/n_2$  \* load revolutions

Parameter 8223, 8226 (Home position): given as  $n_1/n_2$  \* encoder revolutions =  $n_1/n_2$  \* load revolutions

Position counter actual value, parameters 8227, 8228 shows the position as encoder revolutions =  $n_1/n_2$  \* load revolutions

## 7 APPENDIX A: COMPLETE PARAMETER SETTINGS TABLE

Here is a complete table of parameters related to the corresponding positioning macro of software version V1.4.0.3. The value for each parameter related to the positioning mode is presented, as well as the alternatives for certain parameters.

Block	Description	Parameter	Default	Positioning		Jogging	Homing				
				Relative move 1	Absolute move 1		Absolute move 1	Absolute move cc1	Absolute move cc2	Relative move 2	Cont move 1
Start-up Data	APPLIC MACRO	9902	14	14	14	14	14	14	14	14	14
Command Inputs	EXT1 COMMANDS	1001	1	1	1	D	1	1	1	1	1
	EXT2 COMMANDS	1002	1	1	1	D	1	1	1	1	1
	DIRECTION	1003	3	3	3	1/2	3	3	3	3	3
Reference Select	KEYPAD REF SEL	1101	1	D	D	D	D	D	D	D	D
	EXT1/EXT2 SEL	1102	2	7	7	2	7	7	7	7	7
	EXT REF1 SELECT	1103	1	D	D	D	D	D	D	D	D
	EXT REF2 SELECT	1106	1	D	D	D	D	D	D	D	1
Constant Speeds	CONST SPEED SEL	1201	0	V	V	0	V	V	V	V	V
	CONST SPEED 1	1202	5 Hz	V	V	V	V	V	V	V	V
	CONST SPEED 2	1203	10 Hz	V	V	V	V	V	V	V	V
	CONST SPEED 3	1204	15 Hz	V	V	V	V	V	V	V	V
	CONST SPEED 6	1207	40 Hz	V	V	V	V	V	V	V	V
Relay Outputs	RELAY OUTPUT 1	1401	3	D	D	D	D	D	D	D	D
	RELAY OUTPUT 2	1402	34	D	D	D	D	D	D	D	D
Limits	OVERVOLT CTRL	2005	1	D	D	D	D	D	D	D	D
Start/Stop	START FUNCTION	2101	1	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/4
	STOP FUNCTION	2102	1	2	2	2	2	2	2	2	2
Accel/Decel	ACC/DEC ½ SEL	2201	0	0	0	D	0	0	0	0	0
	ACCELER TIME 1	2202	5 s	V	V	V	V	V	V	V	V
	DECELER TIME 1	2203	5 s	V	V	V	V	V	V	V	V
	ACCELER TIME 2	2204	60 s	V	V	V	V	V	V	V	V
	DECELER TIME 2	2205	60 s	V	V	V	V	V	V	V	V
	RAMP SHAPE	2206	0	D	D	D	D	D	D	D	D
Braking	MBRK OPEN DLY	5401	0.20 s	D	D	D	D	D	D	D	D
	MBRK FREQ LVL	5403	2 Hz	D	D	D	D	D	D	D	D
Positioning	ENC PULSE NUM	8201	1024	D/V	D/V	D/V	D/V	D/V	D/V	D/V	D/V
	ENC ERROR	8202	0	D/V	D/V	D/V	D/V	D/V	D/V	D/V	D/V
	ENC DELAY	8203	5 s	D/V	D/V	D/V	D/V	D/V	D/V	D/V	D/V
	ENC SCALING	8204	0	D/V	D/V	D/V	D/V	D/V	D/V	D/V	D/V
	POS TABLE SEL	8206	5	4	4	D/V	4-5	4-5	4-5	4-5	1, 6-7
	TARGET 1 LO	8207	0	V	V	V	V	V	V	V	V
	TARGET 1 HI	8208	0	V	V	V	V	V	V	V	V
	TARGET 2 LO	8209	0	V	V	V	V	V	V	V	-
	TARGET 2 HI	8210	0	V	V	V	V	V	V	V	-
	POS DELAY	8213	0	-	-	-	-	-	-	-	V
	POS MODE	8215	8	4	5	D	5	6	7	8	9
	HOMING MODE	8216	0	0	0	0	4-5	4-5	4-5	4-5	4-6

Positioning	AUX POS CMD	8217	0	D	D	D	D	D	D	D	4, 0
	SLOPE GAIN 1	8218	980	D	D	D	D	D	D	D	D
	SPEED GAIN 1	8220	2	D	D	D	D	D	D	D	D
	T WINDOW LO	8221	0	V	V	V	V	V	V	V	V
	T WINDOW HI	8222	1	V	V	V	V	V	V	V	V
	MAX TARGET LO	8223	0	V	V	V	V	V	V	V	V
	MAX TARGET HI	8224	1000	V	V	V	V	V	V	V	V
	HOME POS LO	8225	0	V	V	V	V	V	V	V	V
	HOME POSHI	8226	0	V	V	V	V	V	V	V	V
	POS ACT LO	8227	RO	RO	RO	RO	RO	RO	RO	RO	RO
	POS ACT HI	8228	RO	RO	RO	RO	RO	RO	RO	RO	RO
	DELTA DISTANCE	8229	2	V	V	V	V	V	V	V	V

D = Positioning macro default value (leave default if no special actions needed), value from column "Default"  
V = Input physical/wanted Value  
- = This parameter does not need configuring  
RO = Read Only