SIEMENS

Ingenuity for life

Rapid Traverse / Creep Speed Positioning (2SpeedPositioning)

TIA Portal V14 / S7-1500(C) / TM Count / TM PosInput

https://support.industry.siemens.com/cs/ww/en/view/109745386

Siemens Industry Online Support

Legal information

Use of application examples

Application examples illustrate the solution of automation tasks through an interaction of several components in the form of text, graphics and/or software modules. The application examples are a free service by Siemens AG and/or a subsidiary of Siemens AG ("Siemens"). They are non-binding and make no claim to completeness or functionality regarding configuration and equipment. The application examples merely offer help with typical tasks; they do not constitute customer-specific solutions. You yourself are responsible for the proper and safe operation of the products in accordance with applicable regulations and must also check the function of the respective application example and customize it for your system.

Siemens grants you the non-exclusive, non-sublicensable and non-transferable right to have the application examples used by technically trained personnel. Any change to the application examples is your responsibility. Sharing the application examples with third parties or copying the application examples or excerpts thereof is permitted only in combination with your own products. The application examples are not required to undergo the customary tests and quality inspections of a chargeable product; they may have functional and performance defects as well as errors. It is your responsibility to use them in such a manner that any malfunctions that may occur do not result in property damage or injury to persons.

Disclaimer of liability

Siemens shall not assume any liability, for any legal reason whatsoever, including, without limitation, liability for the usability, availability, completeness and freedom from defects of the application examples as well as for related information, configuration and performance data and any damage caused thereby. This shall not apply in cases of mandatory liability, for example under the German Product Liability Act, or in cases of intent, gross negligence, or culpable loss of life, bodily injury or damage to health, non-compliance with a guarantee, fraudulent non-disclosure of a defect, or culpable breach of material contractual obligations. Claims for damages arising from a breach of material contractual obligations shall however be limited to the foreseeable damage typical of the type of agreement, unless liability arises from intent or gross negligence or is based on loss of life, bodily injury or damage to health. The foregoing provisions do not imply any change in the burden of proof to your detriment. You shall indemnify Siemens against existing or future claims of third parties in this connection except where Siemens is mandatorily liable.

By using the application examples you acknowledge that Siemens cannot be held liable for any damage beyond the liability provisions described.

Other information

Siemens reserves the right to make changes to the application examples at any time without notice. In case of discrepancies between the suggestions in the application examples and other Siemens publications such as catalogs, the content of the other documentation shall have precedence.

The Siemens terms of use (https://support.industry.siemens.com) shall also apply.

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the Internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit https://www.siemens.com/industrialsecurity.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at: https://www.siemens.com/industrialsecurity.

Table of Contents

1 Introduction

1.1 Overview

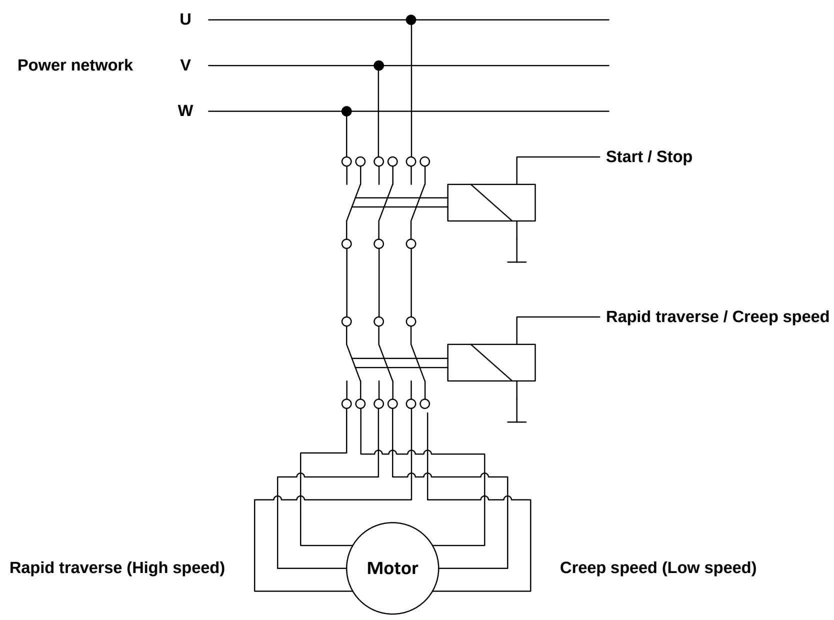
An axis can be positioned in many different ways. In this context, especially TIA Portal with the S7-1200 and S7-1500 controller families provides support in the form of technology objects. Very high positioning accuracy of the axis can be achieved. However, this is also reflected in the hardware used to control these axes.

If an axis is to be positioned with relatively little hardware or with lower, controlled accuracy, this can be achieved with the aid of position monitoring and a simple contactor circuit. To this end, the positioning axis can be moved at two different speeds and simply switched off at the desired target position at the appropriate time using a contactor. With this method, called rapid traverse/creep speed positioning, relatively high positioning accuracy of the axis can be achieved.

Controlled positioning in rapid traverse/creep speed mode first moves the positioning axis towards the target position at a high speed (rapid traverse). At a defined position, the speed is switched to a lower speed (creep speed) at which the axis can then be moved to the target position.

To implement the two speed levels of rapid traverse/creep speed positioning, for example, pole-changing motors with a simple contactor circuit or simple frequency converters that allow speed selection through digital inputs can be used. The axis position can be detected with incremental or absolute encoders.

Figure 1-1 Basic control of a pole-changing motor

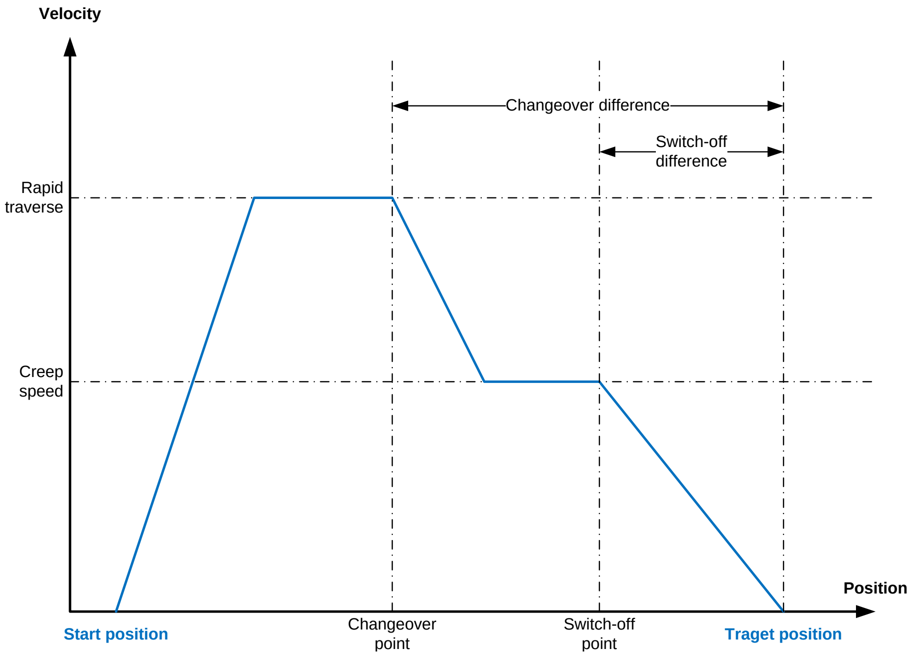


1.2 Mode of operation

1.2.1 Traversing motion principle

Rapid traverse/creep speed positioning moves an axis to a specified target position in a relatively simple way. The following figure shows the traversing motion principle:

Figure 1-2 Rapid traverse/creep speed positioning velocity profile



- From the start position, the axis is accelerated to rapid traverse speed and moved towards the target position. The rapid traverse speed is used to keep the time the axis moves to the target position to a minimum.
- When the axis reaches the switchover point defined relative to the target position via the switchover difference, the axis is switched to creep speed. Now the axis continues moving towards the target position at a lower speed.
- When the axis reaches the switch-off point defined relative to the target position via the switch-off difference, the axis is switched off and moves into the target position with the remaining kinetic energy.

To achieve the highest possible positioning accuracy of the axis, the parameters for the switchover and switch-off difference must be determined and set according to the axis inertia and the speeds selected for rapid traverse and creep speed positioning.

1.2.2 Functionality included

The following functionalities can be used when using rapid traverse/creep speed positioning via the "2SpeedPositioning" function block:

- Absolute and relative positioning
- Jog mode of the axis
- Use of linear and modulo axes

- Use of incremental and absolute encoders
- Support of hardware and software limit switches

1.3 Components used

Hardware components

This application example was created with the following hardware and software components:

Table 1-1 Hardware components used for the sample project

Component	No.	Article no.	Note
CPU 1511-1 PN Firmware: V1.8	1	6ES7511-1AK00-0AB0	S7 CPU for executing the user program with the function block for the rapid traverse/creep speed positioning functionality.
ET 200SP head module (IM 155-6 PN ST) Firmware: V3.3	1	6ES7155-6AA00-0BN0	SIMATIC ET 200SP, Bundle PROFINET: interface module, server module and bus adapter BA 2xRJ45
HTL incremental encoder (24V)			
TM Count 1x24V Firmware: V1.1	1	6ES7138-6AA00-0BA0	Counting module for connecting a 24V incremental encoder
Incremental encoder with HTL	1	6FX2001-4SA50	Incremental encoder for direct connection to TM Count.
TTL incremental encoder (5V) / SSI absolute encoder			
TM PosInput 1 Firmware: V1.2	1	6ES7138-6BA00-0BA0	Counting and position detection module for connecting an SSI absolute encoder.
Absolute encoder with SSI	1	6FX2001-5FS12	Absolute encoder for direct connection to TM PosInput.

The sample project has a flexible design and, with minor adjustments, can be used with a large number of hardware components. The following table provides an overview of further possible applications.

Table 1-2 Alternative hardware components for the sample project

Component	No.	Article no.	Note
Connection of HTL incremental encoders (24V)			
TM Count 1x24V (for ET 200SP) Firmware: V1.1 or higher	1	6ES7138-6AA00-0BA0	Counting module, 1 channel for 24V incremental encoder or 24V pulses, 3 DI, 2 DQ

Component	No.	Article no.	Note
TM Count 2x24V (for S7-1500 central or ET 200MP) Firmware V1.1 or higher	1	6ES7550-1AA00-0AB0	Counting module, 2 channels for 24V incremental encoder or 24V pulses, 3 DI, 2 DQ per channel
Compact CPU CPU 151xC-1 PN Firmware: V2.0 or higher	1	6ES7511-1CK00-0AB0 6ES7512-1CK00-0AB0	Central processing unit with 6 high-speed counters for detecting incremental encoders; with integrated outputs.
Connection of TTL incremental encoder (5V) / SSI absolute encoder			
TM PosInput 1 (for ET 200SP) Firmware: V1.2 or higher	1	6ES7138-6BA00-0BA0	Counting and position detection module for RS-422 incremental encoder or SSI absolute encoder, 2DI, 2DQ
TM PosInput 2 (for S7-1500 central or ET 200MP) Firmware V1.1 or higher	1	6ES7551-1AB00-0AB0	Counting and position detection module for RS-422 incremental encoder or SSI absolute encoder, 2 channels, 2DI, 2DQ per channel

Regarding the controller, you can choose from a wide range of CPUs of the S7-1500 controller family, for example:

- Standard CPUs: SIMATIC CPU 151x
- Compact CPUs: SIMATIC CPU 151xC
- Fail-safe CPUs: SIMATIC CPU 151xF
- Technology CPUs: SIMATIC CPU S7-151xT(F)
- Distributed controllers: SIMATIC CPU 151xSP (F), SIMATIC CPU 1516pro (F)
- Open controllers: SIMATIC CPU 1515SP PC (F)
- Software controllers: SIMATIC CPU 1507S (F)

Software components

The following software components were used to create this application example:

Table 1-3 Software components

Component	No.	Article no.	Note
TIA Portal V14 Update 1	1		Always included in the individual components as an engineering framework.
SIMATIC STEP7 Professional V14.0 Upd1	1	6ES7822-1AA04-0YA5	SIMATIC STEP 7 Prof. V14, floating license; engineering software in TIA Portal.

Components of the application example

This application example consists of the components listed in the following table:

Table 1-4 Components of this application example

Component	Note
109745386_2SpeedPositioning_DOC_v10_en.pdf	This document.
109745386_2SpeedPositioning_LIB_v10.zip	This .zip file contains a global library with all the program blocks and data types that are necessary for rapid traverse/creep speed positioning. This library can be used to implement rapid traverse/creep speed positioning in a self-created user program.
109745386_2SpeedPositioning_PROJ_v10.zip	Program example that shows the use of the blocks from the above global library.

1.4 Migration

For the SIMATIC S7-300 and SIMATIC S7-400 product families, special function modules are available for rapid traverse/creep speed positioning.

The following modules are examples of such modules:

- 1PosU for the ET 200S distributed I/O system
- FM351 for the SIMATIC S7-300
- FM451 for the SIMATIC S7-400

For the SIMATIC S7-1500 or the associated ET 200SP and ET 200MP I/O system, these modules are no longer available. To implement rapid traverse/creep speed positioning in this case, the library presented in this application example can be used in conjunction with the technology modules TM Count / TM PosInput for the encoder interface.

However, the following functions of the above function modules are no longer available in the function block presented in this application example:

- Relative positioning of the axis by more than one modulo length
- Loop traverse for short distances to the target position
- Active homing of the axis using the function block
- Monitoring the direction of rotation of the axis drive
- Latch function for length or edge measurement during the axis motion

However, related to the listed technology modules, it may be possible to implement the missing functions specific to an application.

NOTICE	**It may not be possible to fully migrate the previous function modules of the SIMATIC S7-300 / S7-400 with the function block introduced here without application-specific additions in the user program. Check the range of functions before the migration.**

1.5 Units

All positions and reference data of the axis are specified in increments of the encoder. They are not converted to physical units in the function block of this application example. If necessary, this can be implemented by application-specific additions in the user program.

This must be considered when setting parameters in the following places:

- Parameterizing the hardware.
- Parameterizing the software using the parameter data block.
- Setting positions in the user program such as target positions, homing positions and speeds.

2 Hardware

2.1 Selection aid for the required components

2.1.1 Basic selection

To determine the hardware required for your application in the easiest way possible, use the following table as a selection aid for the encoder type used and the desired configuration variant.

Selection aid

Select the required module based on the encoder type used and the desired configuration variant.

Table 2-1 Hardware selection aid

Module	HTL incremental encoder (voltage: 24V)	TTL incremental encoder (voltage: 5V)	SSI absolute encoder
Central configuration with compact CPU			
S7-1500C	Yes	No	No
Central or distributed configuration with ET 200MP			
TM Count 2x24V	Yes	No	No
TM PosInput 2	No	Yes	Yes
Distributed configuration with ET 200SP			
TM Count 1x24V	Yes	No	No
TM PosInput 1	No	Yes	Yes

Available interfaces of the modules

The following table lists the interfaces available on the specific module.

Table 2-2 Available interfaces of the modules

	DI	DQ	Encoder
Central configuration with compact CPU			
S7-1511C-1 PN	16	16	4 with signal A/B/N 2 with signal A/B
S7-1512C-1 PN	32	32	6 with signal A/B/N
Central or distributed configuration with ET 200MP			
TM Count 2x24V	3 per channel	2 per channel	1 per channel
TM PosInput 2	2 per channel	2 per channel	1 per channel
Distributed configuration with ET 200SP			
TM Count 1x24V	3	2	1
TM PosInput 1	2	2	1

In connection with this application example, the interfaces available on the modules can be used to control the contactors to switch between rapid traverse/creep speed, for the homing signal, the hardware limit switches and the encoder interface.

When using a SIMATIC S7-1500C compact CPU, up to 6 encoders can be wired. However, each wired encoder signal reduces the number of available digital inputs for wiring homing signals and hardware limit switches.

2.1.2 Optional outputs – DQ

As the number of technology module outputs per channel is limited, it is generally required to configure an additional IO module or an additional DQ to obtain the full functionality of the application.

Depending on the assignment of the contactors and their functionality, the application can be configured very easily through mode selection as specified in the following table.

Table 2-3 Defining the functionality of the application through different modes

Output	Mode 0	Mode 1	Mode 2
DQ0 on TM	Direction	Rapid traverse	Traverse plus
DQ1 on TM	Movement enable	Movement enable	Traverse minus
External DQ	Rapid traverse	Direction	Rapid traverse

For a detailed explanation of the available modes and the associated wiring diagrams, see Chapter 2.2 of this documentation.

Note The available modes of the application have been selected such that the application can be used with functional restrictions even without an additional external DQ, for example with only one traversing speed or only one usable traversing direction.

2.1.3 Optional inputs – DI

If the technology module TM PosInput 1 / TM PosInput 2 is used with a TTL encoder and the two functions …

- External zero mark (e.g., via Bero)
- Hardware limit switches in both directions

... are to be additionally used, at least one additional DI is necessary for interfacing a hardware limit switch.
In this case, however, it is recommended to connect both hardware limit switches to the controller via additional DIs as this is easier to implement in the user program.

The assignment of the additional DIs is made in the user program via the block interface where the signals of the hardware limit switches are passed on.

2.1.4 Wiring the input and output signals

The following input and output signals must be wired to the selected module:

- Encoder signals (DI)
- External homing mark (DI)
- Hardware limit switches (DI)
- Contactors (DQ)

However, the explicit wiring of the signals depends on the selected module. For more detailed information, see the following chapters on the selected module:

- Chapter 2.3 for the technology module TM Count
- Chapter 2.4 for the technology module TM PosInput
- Chapter 2.5 for the SIMATIC S7-1500C compact CPU

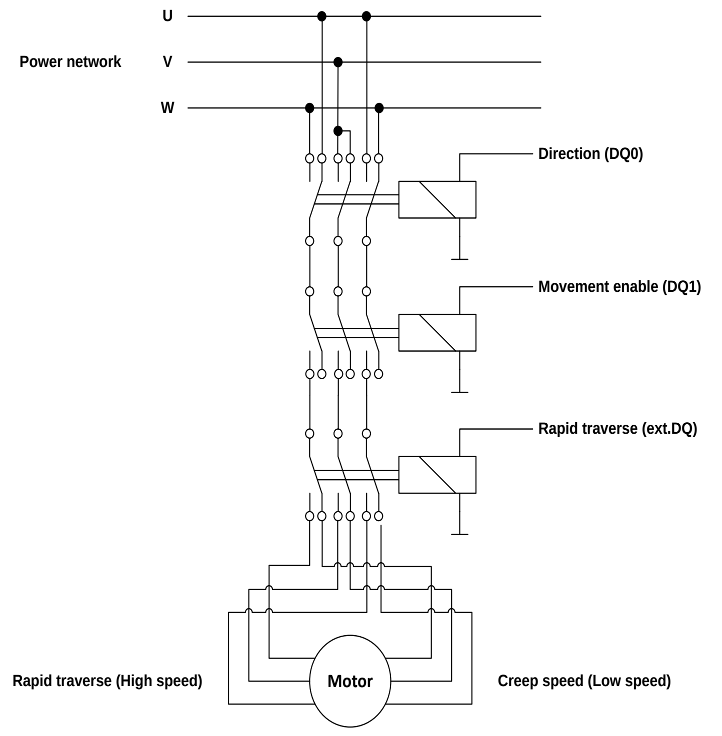
2.2 Wiring the motor and the contactors

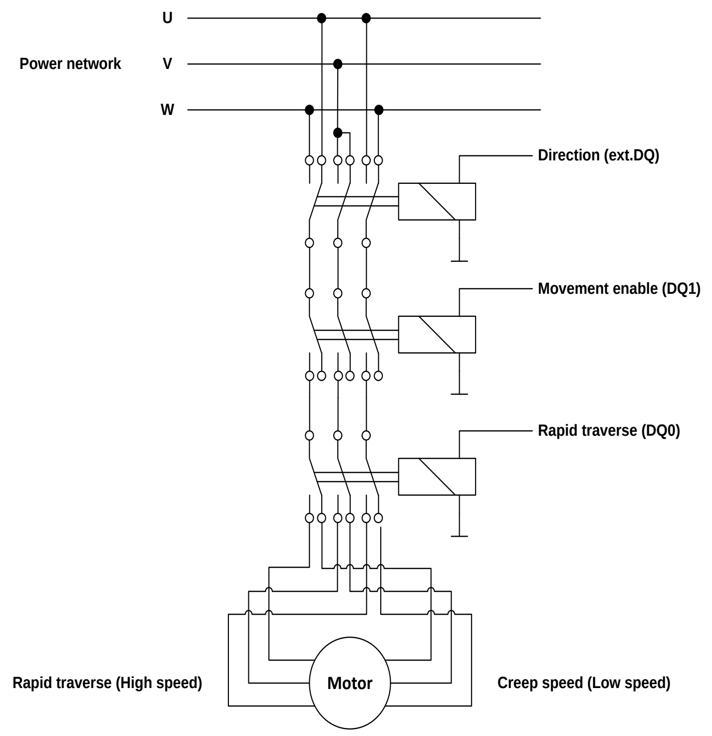
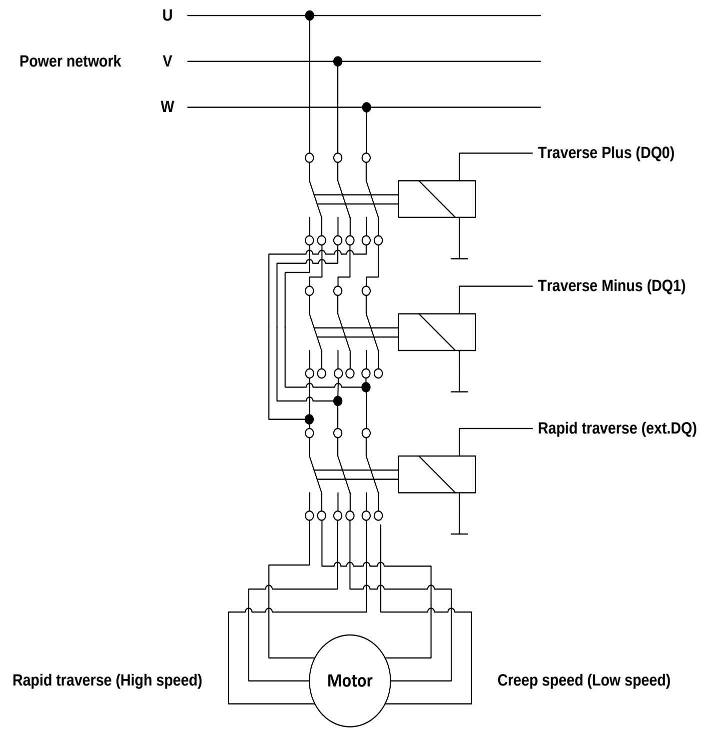
The contactors for motion control must be wired depending on the selected mode in which the function block for rapid traverse/creep speed positioning is to be run.

The following table shows the basic wiring of the motor and the contactors.

The wiring of the control signals such as movement enable, direction, rapid traverse, etc. to the selected technology module is shown in the following chapters on the specific technology module.

Table 2-4 Basic wiring of motor and contactors

Mode	Basic wiring
0	

Mode	Basic wiring
1	
2	

NOTICE	**The above wiring is a block diagram. Considering safety aspects, the actual wiring of your components may differ from the figures.**

2.3 Technology module TM Count

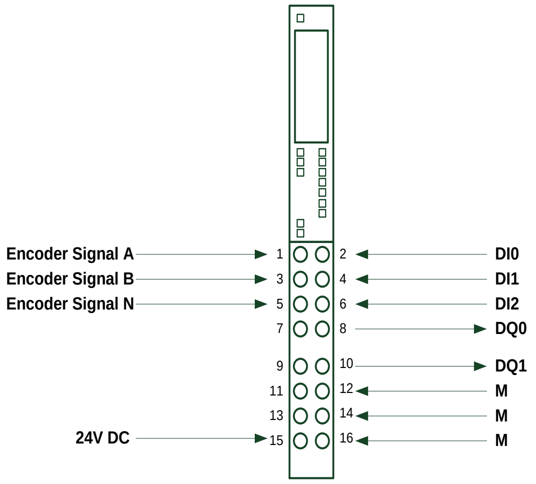
2.3.1 Hardware configuration and wiring

The technology module TM Count is available as TM Count 1x24V (single-channel) in ET 200SP design or as TM Count 2x24V (two-channel) in ET 200MP design.

Wire your TM Count using the following figures. In the application example, the function of the respective input/output is defined using the mode selection on the function block, as has already been shown in Chapter 2.2.

Technology module TM Count 1x24V for ET 200SP

Figure 2-1 Wiring of the technology module TM Count 1x24V for ET 200SP



Technology module TM Count 2x24V for ET 200MP

Figure 2-2 Wiring of the technology module TM Count 2x24V for ET 200MP

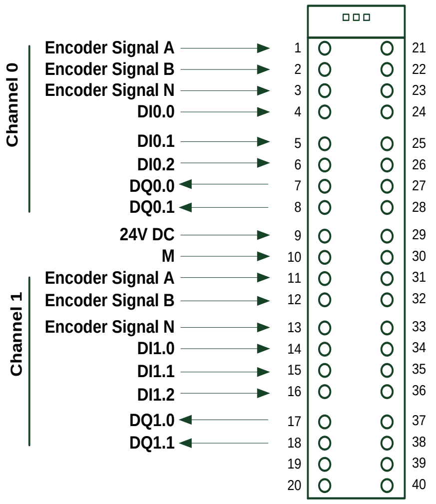


Table 2-5 Wiring of the technology module

Mode	Basic wiring
0	• DQ0: Direction • DQ1: Movement enable • Ext.DQ: Rapid traverse • DI0: External zero mark for encoder (external homing signal) • DI1: Hardware limit switch minus • DI2: Hardware limit switch minus
1	• DQ0: Rapid traverse • DQ1: Movement enable • Ext.DQ: Direction • DI0: External zero mark for encoder (external homing signal) • DI1: Hardware limit switch minus • DI2: Hardware limit switch minus
2	• DQ0: Traverse plus • DQ1: Traverse minus • Ext.DQ: Rapid traverse • DI0: External zero mark for encoder (external homing signal) • DI1: Hardware limit switch minus • DI2: Hardware limit switch minus

2.3.2 Configuration and device configuration

Set up and configure the hardware as follows:

Hardware configuration

Insert a SIMATIC S7-1500 into your project.

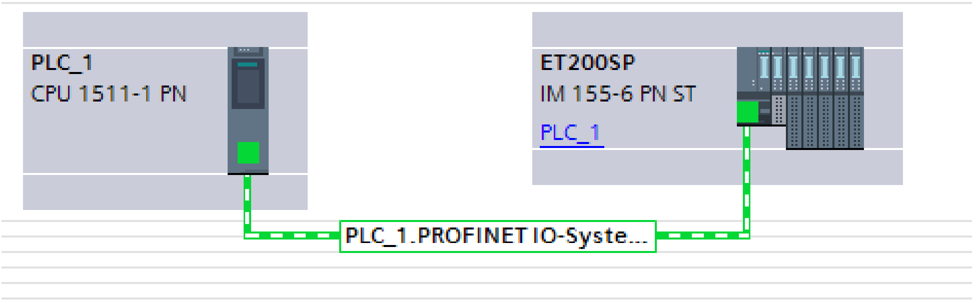
- ET 200SP design
  If you want to use the distributed I/O system, you must connect the technology module to the CPU using an IM155-6 interface module.
- ET 200MP design
  This design provides the following two variants:
  - Central configuration
    The technology module can be connected to the CPU directly via the backplane bus.
  - Distributed configuration
    As is the case with the ET 200SP, the technology module must be connected to the CPU using an IM155-5 interface module.

Note If you want to operate the technology modules isochronously, only the distributed design is available. The central configuration does not provide the ‘Isochronous mode’ function.

However, the ‘Isochronous mode’ function is not mandatory for the rapid traverse/creep speed positioning shown here.

Note The sample project and the following figure use an ET 200SP with an IM155-6 PN ST.

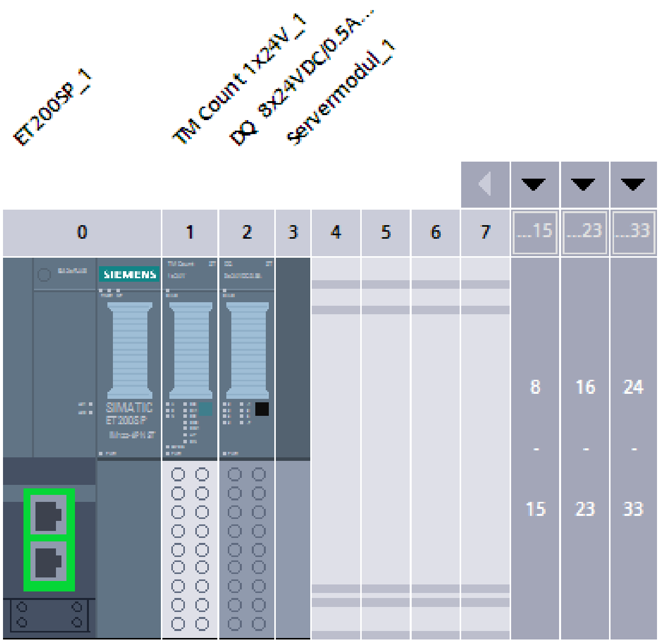
Figure 2-3 PROFINET connection between SIMATIC S7-1500 and IM155-6 PN ST



Adding the technology module TM Count

Insert the technology module TM Count into the correct slot. Depending on the selected mode and the required functionality, you need an additional DQ module that should also be configured on the ET 200.

Figure 2-4 Technology module TM Count 1x24V and additional DQ module



Device configuration

Depending on the selected encoder type, the parameterization is the same for all technology modules. Therefore, it is not shown explicitly until Chapter 2.6.

2.4 Technology module TM PosInput

2.4.1 Hardware configuration and wiring

The technology module TM PosInput is available as TM PosInput 1 (single-channel) in ET 200SP design or as TM PosInput 2x24V (two-channel) in ET 200MP design.

Wire your TM PosInput using the following figures. In the application example, the function of the respective input/output is defined using the mode selection on the function block, as has already been shown in Chapter 2.2.

Technology module TM PosInput 1 for ET 200SP

Figure 2-5 Wiring of an incremental encoder on the TM PosInput 1 for ET 200SP

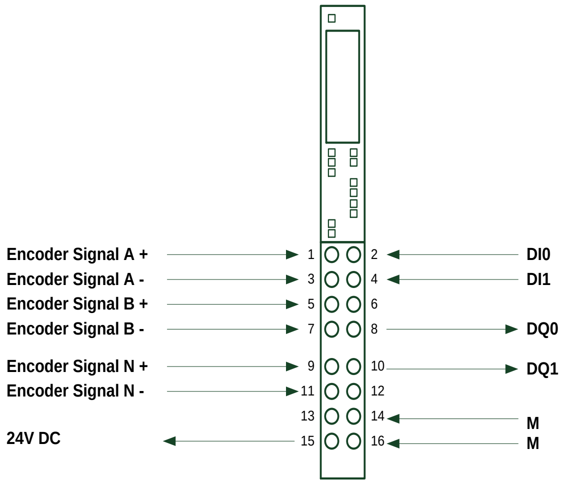
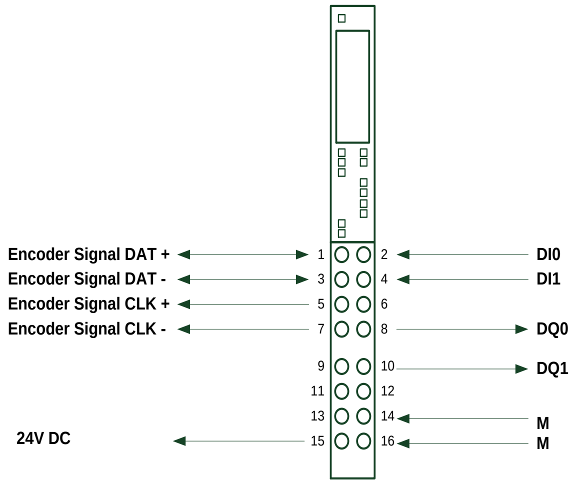


Figure 2-6 Wiring of an absolute encoder on the TM PosInput 1 for ET 200SP



Technology module TM PosInput 2 for ET 200MP

Figure 2-7 Wiring of incremental encoders on the TM PosInput 2 for ET 200MP

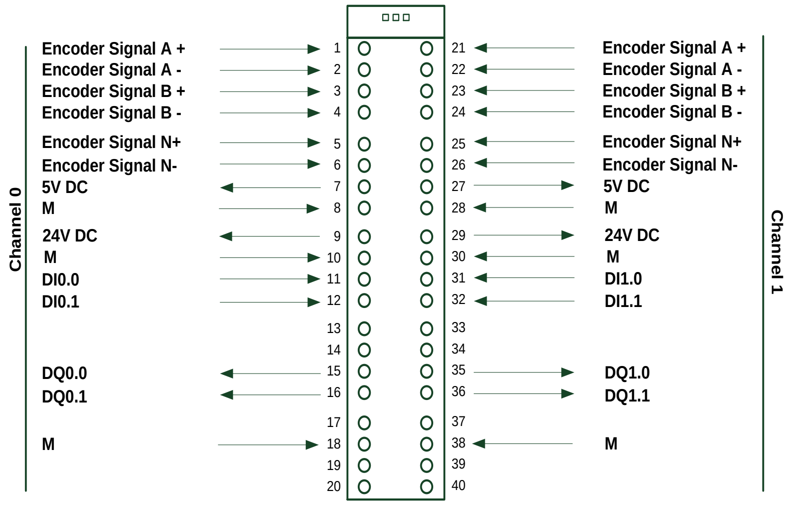


Figure 2-8 Wiring of absolute encoders on the TM PosInput 2 for ET 200MP

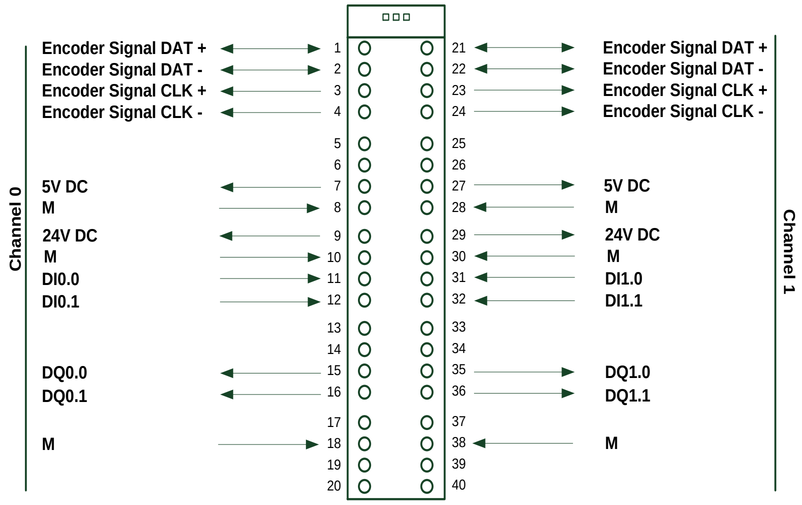


Table 2-6 Wiring of the technology module

Mode	Basic wiring
0	• DQ0: Direction • DQ1: Movement enable • Ext.DQ: Rapid traverse • DI0: External zero mark for encoder (external homing signal) • Ext.DI1: Hardware limit switch minus • Ext.DI2: Hardware limit switch minus
1	• DQ0: Rapid traverse • DQ1: Movement enable • Ext.DQ: Direction • DI0: External zero mark for encoder (external homing signal) • Ext.DI1: Hardware limit switch minus • Ext.DI2: Hardware limit switch minus

Mode	Basic wiring
2	• DQ0: Traverse plus • DQ1: Traverse minus • Ext.DQ: Rapid traverse • DI0: External zero mark for encoder (external homing signal) • Ext.DI1: Hardware limit switch minus • Ext.DI2: Hardware limit switch minus

2.4.2 Configuration and device configuration

Set up and configure the hardware as follows:

Hardware configuration

Insert a SIMATIC S7-1500 into your project.

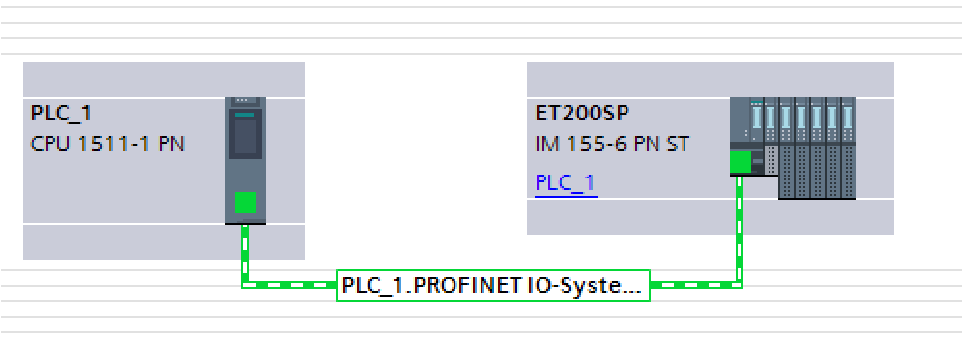
- ET 200SP design
  If you want to use the distributed I/O system, you must connect the technology module to the CPU using an IM155-6 interface module.
- ET 200MP design
  This design provides the following two variants:
  - Central configuration
    The technology module can be connected to the CPU directly via the backplane bus.
  - Distributed configuration
    As is the case with the ET 200SP, the technology module must be connected to the CPU using an IM155-5 interface module.

Note If you want to operate the technology modules isochronously, only the distributed design is available. The central configuration does not provide the 'Isochronous mode' function.

The 'Isochronous mode' function is not mandatory for the rapid traverse/creep speed positioning shown here.

Note The sample project and the following figure use an ET 200SP with an IM155-6 PN ST.

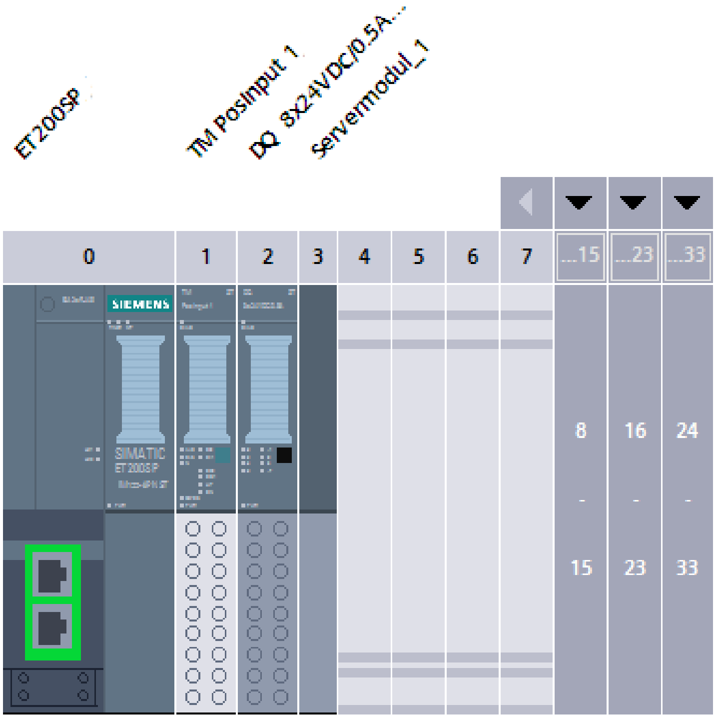
Figure 2-9 PROFINET connection between SIMATIC S7-1500 and IM155-6 PN ST



Adding the technology module TM PosInput

Insert the technology module TM PosInput into the correct slot. Depending on the selected mode and the required functionality, you need an additional DQ module that should also be configured on the ET 200.

Figure 2-10 Technology module TM PosInput 1 and additional DQ module



Device configuration

Depending on the selected encoder type, the parameterization is the same for all technology modules. Therefore, it is not shown explicitly until Chapter 2.6.

2.5 SIMATIC S7-1500C compact CPU

2.5.1 Hardware configuration and wiring

Directly on the central processing unit, the SIMATIC S7-1500C compact CPU provides ports for high-speed counters (HSC) that can be directly used for rapid traverse/creep speed positioning. Each of these counters can be assigned to an axis in the CPU.

Note

The ports on the SIMATIC S7-1511C-1 PN and on the SIMATIC CPU 1512C-1 PN differ. For the wiring diagrams of the specific CPU type, please refer to the associated CPU manual listed in Chapter 4.2 in \9\ or \10\.

This chapter shows the wiring of the SIMATIC S7-1511C-1 PN. Twice the number of digital inputs and outputs is available for the SIMATIC S7-1512C-1 PN.

The following section uses an example to show the wiring of two high-speed counters (HSC) with the assignment on two axes on the SIMATIC S7-1511C-1 PN.

The aim of this example is to illustrate the following special characteristics of the SIMATIC S7-1500C compact CPU:

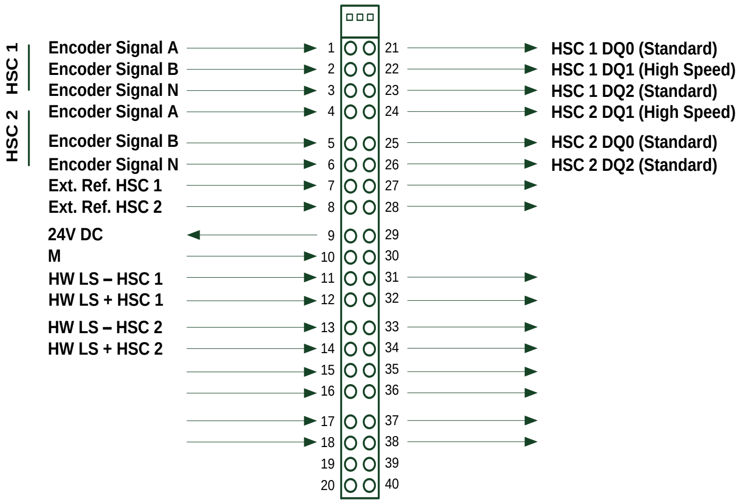
- Between the inputs of the high-speed counters (HSC) for reading the encoder signals and the high-speed outputs of the CPU, there is a logic operation for particularly fast reactions.
- On the compact CPU, multiple axes can be operated via rapid traverse/creep speed mode.
- It is possible that the number of axes that can be controlled by the high-speed outputs of the CPU is less than the maximum number of connectable encoders. You can expand the number of axes by additional I/O modules.
- Hardware limit switches (HW LS) can be wired to all available digital standard inputs. Standard inputs must not be assigned to a high-speed counter (HSC). Optionally, additional DI modules can be used for wiring the hardware limit switches.
- The DQ1 high-speed output is permanently assigned to the respective high-speed counter (HSC) for increment-precise switching and cannot be modified.
- The wiring of the encoder signals on each high-speed counter (HSC) is predefined.
- Fixed terminals – that are assigned to the respective high-speed counter (HSC) – are provided for wiring external homing signals.

Note

If external homing signals or hardware limit switches are wired to the S7-1500C compact CPU, not all high-speed counters (HSC) of the module can be used.

The following figure shows the wiring of two high-speed counters (HSC) with the associated external homing marks and hardware limit switches.

Figure 2-11 Wiring of 2 axes to the X11 front connector of the S7-1511C-1 PN



Note

> For rapid traverse/creep speed positioning, the DQ1 high-speed output assigned to each high-speed counter (HSC) for increment-precise switching-off must be explicitly used for the movement enable of the motor.

Due to the special characteristics of the SIMATIC S7-1500C compact CPU, this results in the mode-dependent interconnection of the signals shown in the following table:

Table 2-7 Wiring of the S7-1500C using the example of HSC 1

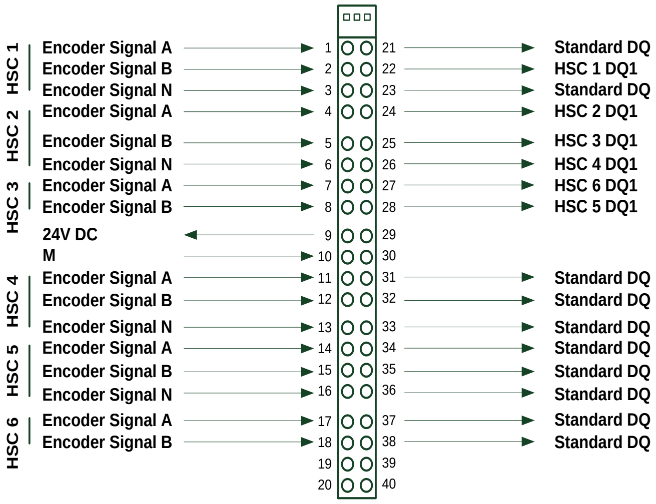
Mode	Basic wiring
0	• HSC 1 DQ0 (standard): Direction • HSC 1 DQ1 (high-speed): Movement enable • HSC 1 DQ2 (standard): Rapid traverse • DI6 (terminal 7): External zero mark for encoder (external homing signal) • DI10 (terminal 11): Hardware limit switch minus (example) • DI11 (terminal 12): Hardware limit switch minus (example)
1	• HSC 1 DQ0 (standard): Rapid traverse • HSC 1 DQ1 (high-speed): Movement enable • HSC 1 DQ2 (standard): Direction • DI6 (terminal 7): External zero mark for encoder (external homing signal) • DI10 (terminal 11): Hardware limit switch minus (example) • DI11 (terminal 12): Hardware limit switch minus (example)
2	Mode 2 is not available on the S7-1500C compact CPU as only one DQ1 high-speed output is available for each high-speed counter (HSC) for increment-precise switching off of the movement enable.

The standard outputs named "HSC x DQy" in the table are used for non-time-critical switching signals. The name was chosen to illustrate that they belong to the respective counter.

Using multiple rapid traverse/creep speed axes on a SIMATIC S7-1500C

If you want to use multiple rapid traverse/creep speed axes on a SIMATIC S7-1500C, the following figure helps you assign and wire the necessary signals.

Figure 2-12 X11 front connector of the S7-1511C-1 PN – wiring overview



Note

When using all high-speed counters (HSC) of the module, it may not be possible to interconnect all required signals on the module.

Example:
When wiring encoder signals A and B on high-speed counter HSC 3 via terminals 7 and 8, no external homing mark for high-speed counters HSC 1 and HSC 2 can be connected to these terminals!

2.5.2 Configuration and device configuration

Set up and configure the hardware as follows:

Hardware configuration

Insert a SIMATIC S7-1511C-1 PN into your project.

Device configuration

Depending on the selected encoder type, the parameterization is the same for all technology modules. Therefore, it is not shown explicitly until Chapter 2.6.

Note

Only 24V encoders, i.e. HTL incremental encoders, can be used for direct connection of an encoder to the S7-1500C compact CPU.

2.6 Parameterizing the technology modules

The parameterization of the technology modules is the same for all modules listed in this documentation; however, it depends on the selected encoder type.

For the respective encoder type, the following chapters list the settings to be made that apply to the following technology modules:

- Technology module TM Count
- Technology module TM PosInput
- SIMATIC S7-1500C compact CPU

Note When using multi-channel modules in ET 200MP design, the settings shown must be made for the module's specific channel used.

Note When using a SIMATIC S7-1500C compact CPU, the settings shown must be made for the module's specific high-speed counter (HSC) used.

In addition, Chapter 2.6.3 provides another parameterization example for this module.

2.6.1 Using the "incremental encoder" encoder type

In the hardware configuration of the technology module, make the following settings.

Table 2-8 Parameterizing a technology module with an incremental encoder

Parameter	Setting
Operating mode	Manual operation
Selection of the operating mode	Counting/Position input
Signal type	Depends on the encoder used (E.g.: Incremental encoder (A/B/N))
Signal evaluation	Depends on the encoder used (E.g.: Quadruple)
Filter frequency	Depends on the encoder used and the maximum frequency that occurs (E.g.: 200kHz)
Sensor type	Depends on the encoder used (E.g.: Sourcing output)
Reaction to signal N	• No reaction to signal N: If the encoder zero mark should not be used for homing. • Synchronization at signal N: If the encoder zero mark should be used for homing.

Parameter	Setting
High counting limit	For linear axis: 2147483647 For modulo axis: last increment before reaching the end of the modulo range, which generally corresponds to the value (modulo length -1).
Start value	0 (default) Start value for position and homing position.
Low counting limit	For linear axis: -2147483648 For modulo axis: 0
Reaction to violation of a counting limit	Continue counting
Reset when counting limit is violated	To opposite counting limit
Reaction to gate start	Continue with current value
Setting function of DI0	• With external zero mark and synchronization at signal N: Enable synchronization via input DI and synchronize when signal N of encoder arrives. • With external zero mark and no reaction to signal N: Direct synchronization via input DI. • Without external zero mark: No function of input DI
Edge selection	Depends on the application: • At rising edge • At falling edge
Frequency	Once
Setting function of DI1	Digital input without function
Setting function of DI2	Digital input without function
Setting function of DQ0	• For mode 0 or 1: Use by user program • For mode 2: After set command from CPU until comparison value 0
Comparison value 0	0
Comparison value 1	10
Count direction of DQ0	In both directions
Substitute value for DQ0	0
Setting function of DQ1	After set command from CPU until comparison value 1
Count direction of DQ1	In both directions
Substitute value for DQ1	0
Measured variable	Frequency
Update time	10ms This parameter allows you to vary the module-internal calculation of the speed. (Range from 0ms to 100ms.)

2.6.2 Using the "SSI absolute encoder" encoder type

In the hardware configuration of the technology module, make the following settings.

Table 2-9 Parameterizing a technology module with an SSI absolute encoder

Parameter	Setting
Operating mode	Manual operation
Selection of the operating mode	Counting/Position input
Signal type	SSI absolute encoder
Frame length	Depends on the encoder used (E.g.: 12 bits)
Code type	Depends on the encoder used (E.g.: Gray)
Transmission rate	Depends on the encoder used (E.g.: 125kHz)
Monoflop time	Depends on the encoder used (E.g.: Automatically)
Parity	Depends on the encoder used (E.g.: None)
Bit number LSB (position)	Depends on the encoder used (E.g.: 0
Bit number MSB (position)	Depends on the encoder used (E.g.: 11)
Setting function of DI0	Digital input without function
Setting function of DI1	Digital input without function
Setting function of DQ0	• For mode 0 or 1: Use by user program • For mode 2: After set command from CPU until comparison value 0
Comparison value 0	0
Comparison value 1	10
Count direction of DQ0	In both directions
Substitute value for DQ0	0
Setting function of DQ1	After set command from CPU until comparison value 1
Count direction of DQ1	In both directions
Substitute value for DQ1	0
Measured variable	Frequency
Update time	10ms This parameter allows you to vary the module-internal calculation of the speed. (Range from 0ms to 100ms.)

2.6.3 Parameterization example when using an S7-1500C

If, instead of a technology module, a SIMATIC S7-1500C compact CPU is used for rapid traverse/creep speed positioning, the internal high-speed counters (HSC) must be activated and parameterized in the compact CPU.

The high-speed counters (HSC) are parameterized in the same way as the technology module whose parameterization is shown in Chapter 2.6.1.

Note Only 24V encoders, i.e. HTL incremental encoders, can be used for direct connection of an encoder to the S7-1500C compact CPU.

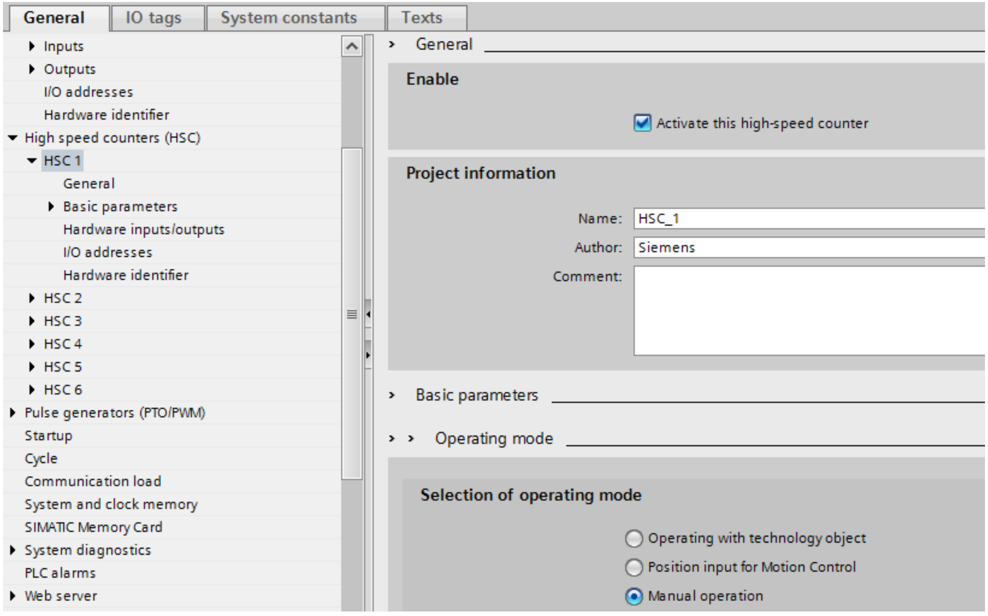
The aim of the below example is to provide specific in-depth information about the parameterization of the high-speed counters of the SIMATIC S7-1500C compact CPU. The compact CPU's high-speed counter HSC 1 is used as an example.

Activating the high-speed counters (HSC)

Enable the "High Speed Counter" function by checking the check box in the "Enable" section of HSC 1.

Then parameterize the high-speed counter in "Manual operation" and select the "Counting/Position input" operating mode for the counter.

Figure 2-13 Activating HSC 1 and parameterizing manual operation

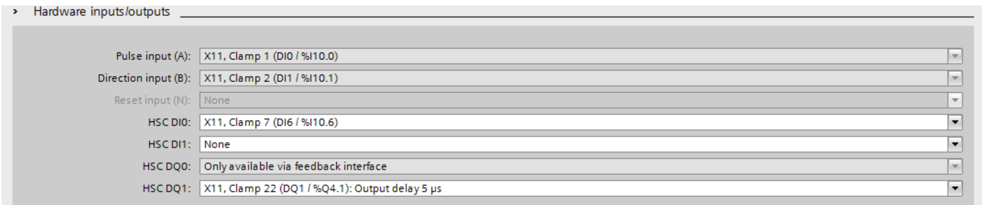


Assigning inputs and outputs

Set "HSC DI0" to clamp 7 of the X11 front connector of the compact CPU in order to read the external homing signal there.

Set the "HSC DQ1" high-speed output for increment-precise control of the movement enable to clamp 22 of the X11 front connector of the compact CPU with a 5 µs output delay.

Figure 2-14 Setting homing signal and high-speed DQ 1



Creating PLC tags

At the output addresses of the DQ0 and DQ2 standard outputs of the high-speed counter (HSC), create two PLC tags of the "Bool" data type.

Figure 2-15 PLC tags of the high-speed counters

tag_table

	Name	Data type	Address	Retain	Acces...	Writa...	Visibl...	Supervision	Comment
1	hsc1DQ0	Bool	%Q4.0	☐	☑	☑	☑		digital standard output DQ 0 for HSC 1
2	hsc1DQ2	Bool	%Q4.2	☐	☑	☑	☑		digital standard output DQ 2 for HSC 1
3	<Add new>			☐	☑	☑	☑		

In the software configuration that follows, these two PLC tags, as shown in Chapter 3.2.2, are used for speed and direction depending on the selected mode for controlling the contactors. Mode 2 cannot be used on the compact CPU.

Note

Mode 2 is not available on the S7-1500C compact CPU as only one DQ1 high-speed output is available for each high-speed counter (HSC) for increment-precise switching off of the movement enable.

3 Engineering Software

3.1 Interface description

3.1.1 "2SpeedPositioning” function block

The "2SpeedPositioning” function block contains the entire functionality for positioning an axis with the aid of a rapid traverse/creep speed movement.

Figure 3-1: Parameters of the "2SpeedPositioning” block

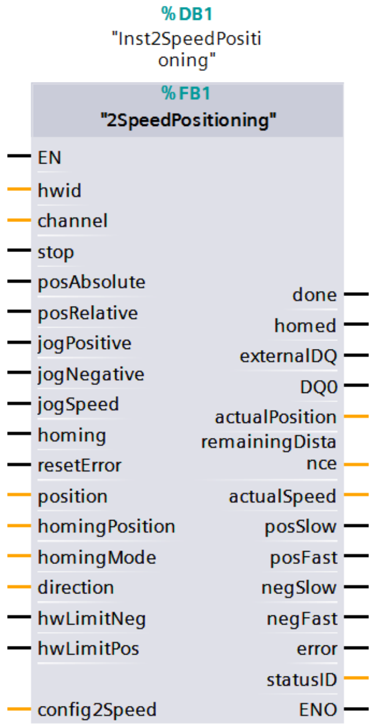


Table 3-1: Parameters of the block interface

Parameter	Data type	Start value	Description
Input parameters (IN)			
hwid	HW_IO	0	Hardware ID of the technology module to be addressed by the block.
channel	Int	0	Channel selection for multi-channel modules in ET 200MP design: • 0: Channel 0 • 1: Channel 1
stop	Bool	False	Movement enable of axis: • True: Stop axis • False: Enable axis The axis can only be moved when the input is "false”.

Parameter	Data type	Start value	Description
posAbsolute	Bool	False	Starts an absolute positioning job to the specified target position by a rising edge at the input. A currently active positioning job is overridden by starting another job.
posRelative	Bool	False	Starts a relative positioning job by the distance specified at the "position" parameter by a rising edge at the input. Positioning takes place from the current axis position. A currently active positioning job is overridden by starting another job.
jogPositive	Bool	False	Jog mode of axis: • True: Move axis in positive direction • False: Stop axis
jogNegative	Bool	False	Jog mode of axis: • True: Move axis in negative direction • False: Stop axis
jogSpeed	Bool	False	Selection of jog speed: • True: Rapid traverse • False: Creep speed
homing	Bool	False	Homes the axis by a starting edge at the input. Homing mode is set by the "homingMode" parameter.
resetError	Bool	False	Acknowledges error messages pending on the block by a rising edge at the input. For correct traversing, the signal has no effect.
position	DInt	0	Target position of the positioning job: • For an absolute positioning job, the parameter defines the absolute target position. • For a relative positioning job, the parameter defines the distance from the current axis position to the target position. The sign of the parameter defines the direction of motion.
homingPosition	DInt	0	Homing position for homing the axis. The way this parameter is interpreted by the block differs depending on the "homingMode" parameter.

Parameter	Data type	Start value	Description
homingMode	Int	0	Homing mode: • 0: Direct homing The current axis position is set to the value (absolute) specified at the "homingPosition" parameter. • 1: Passive homing in positive direction of motion • 2: Passive homing in negative direction of motion • 3: Absolute encoder adjustment The current axis position is set to the value (absolute) specified at the "homingPosition" parameter. The encoder offset is stored retentively in the CPU. **Note:** No automatic traversing motion takes place during passive homing. Chapter 3.3.4 provides a more detailed explanation of homing. Passive homing requires an external homing signal.
direction	Int	0	Traversing direction (for modulo axes) • 0: Shortest path • 1: Positive direction of motion • 2: Negative direction of motion This parameter is only effective for modulo axes. For all other axes, the direction of motion is defined by the absolute position or the sign of the distance to the target position.
hwLimitNeg	Bool	False	Signal of the negative hardware limit switch. Specify the PLC tag of the DI input of the negative hardware limit switch.
hwLimitPos	Bool	False	Signal of the positive hardware limit switch. Specify the PLC tag of the DI input of the positive hardware limit switch.
Output parameters (OUT)			
done	Bool	False	The currently active motion job is complete. The axis is at a standstill and all checks completed without error.
homed	Bool	False	The axis is homed. The output actual position of the axis is valid and matches the actual position of the axis.

Parameter	Data type	Start value	Description
externalDQ	Bool	False	Mode-dependent switching signal for controlling the "externalDQ" during a motion job: • Mode 0: Rapid traverse • Mode 1: Direction • Mode 2: Rapid traverse Specify the PLC tag of the "externalDQ" output that was additionally set up. The respective contactor is controlled via this output.
DQ0	Bool	False	Additional output for controlling DQ0 of the high-speed counter (HSC) of an S7-1500C compact CPU. When using a compact CPU, create the PLC tag, as created in Chapter 2.6.3, for DQ0 of the high-speed counter.
actualPosition	DInt	0	Current position of the axis (actual position) in increments.
remainingDistance	DInt	0	Distance of the axis to the target position in increments.
actualSpeed	Real	0	Current speed of the axis in increments per second.
posSlow	Bool	False	Direction-dependent specification of the currently active motion: • Pos: Positive direction • Neg: Negative direction • Slow: Creep speed • Fast: Rapid traverse These four outputs represent the functionality of the block. They can also be used if you do not want to output the signals for controlling the contactors via the technology modules and want to use your own control logic. However, the outputs are cycle-dependent and not increment-precise.
posFast	Bool	False	
negSlow	Bool	False	
negFast	Bool	False	
error	Bool	False	Error in the block. For the exact cause of the error, see the "statusID" output parameter.
statusID	Word	16#0000	Output for detailed specification of the error cause that is signaled by the "error" output. A list of output status IDs can be found in Chapter 3.1.5.
Input/output parameters (IN/OUT)			
config2Speed	"typeConfig2Speed"		Variable with the configuration data of the axis for the function block as explained in Chapter 3.1.2.

3.1.2 "typeConfig2Speed" data type

The "config2Speed" input variable of the "typeConfig2Speed" data type is used to parameterize your application in the "2SpeedPositioning" function block.

Chapter 3.4 provides instructions for determining and setting the parameters.

Before using the block for the first time, the parameters must be set so that the traversing motion can be performed as required.

Table 3-2 "typeConfig2Speed" data type

Identifier	Data type	Start value	Meaning
axisType	Int	0	Axis type setting: • 0: Linear axis • 1: Modulo axis
switchOverDistPos	DInt	0	Switchover distance between rapid traverse and creep speed in the positive direction of motion. The value must be positive and greater than 0.
switchOffDistPos	DInt	0	Switch-off distance for moving into the target position in the positive direction of motion. The value must be positive and greater than 0.
switchOverDistNeg	DInt	0	Switchover distance between rapid traverse and creep speed in the negative direction of motion. The value must be positive and greater than 0.
switchOffDistNeg	DInt	0	Switch-off distance for moving into the target position in the negative direction of motion. The value must be positive and greater than 0.
limitSwitchMin	DInt	0	Software limit switch minimum position **Note:** The software limit switches are only effective if a value not equal to 0 was parameterized for at least one of the two parameters.
limitSwitchMax	DInt	0	Software limit switchmaximum position **Note:** The software limit switches are only effective if a value not equal to 0 was parameterized for at least one of the two parameters.
targetRange	DInt	0	Position monitoring target range located symmetrically around the target position.
standStillVelocity	Real	0.0	Limit velocity below which the block considers the axis to be at a standstill. [Increments/s]

Identifier	Data type	Start value	Meaning
tMonitoring	Time	T#100ms	Delay time between the switch-off point of the positioning motion and the start of position monitoring and velocity monitoring.
tReverse	Time	T#100ms	Delay time for changes of direction during a motion command to avoid short circuits in the contactors.
controlMode	Int	0	Mode for controlling the contactors: • 0: Mode0: DQ0: Direction DQ1: Movement enable Ext. DQ: Rapid traverse • 1: Mode1: DQ0: Rapid traverse DQ1: Movement enable Ext. DQ : Direction • 2: Mode2: DQ0: Traverse plus DQ1: Traverse minus Ext. DQ: Rapid traverse After initialization, this parameter can no longer be changed.

3.1.3 "CalcSwitchPoints" function

In the "2SpeedPositioning" FB, the "CalcSwitchPoints" function is used internally to calculate the following data:

- Switchover point positive/negative
- Switch-off point positive/negative
- Remaining distance to target

3.1.4 Data types for TM Count and TM PosInput

The PLC data types prefixed by "LPD_typeCount" from the "TMCount_TMPosInput" group are used for data exchange between the SIMATIC S7-1500 CPU and the technology modules.

With the aid of these data types, a simple, readable image of the technology modules' control and feedback interface was created in the "2SpeedPositioning" FB.

For a detailed description of the data types and information about where you can download these data types for your own projects, see document \3\ in Chapter 4.2

3.1.5 Status IDs (errors and warnings)

Via the "statusID" output, the "2SpeedPositioning" function block outputs warning and error messages to specify an error or warning in greater detail.

The following table provides the exact meaning of the status IDs.

Table 3-3 Status IDs

Status ID	Meaning
16#0000	No warnings or errors are present.
Warnings	
16#0001	Switch-off distance positive (switchOffDistPos) greater than or equal to

Status ID	Meaning
	switchover distance positive (switchOverDistPos). Remedy: The following applies: Switch-off distance < Switchover distance. Both values must be positive and greater than 0.
16#0002	Switch-off distance negative (switchOffDistNeg) greater than or equal to switchover distance negative (switchOverDistNeg). Remedy: The following applies: Switch-off distance < Switchover distance. Both values must be positive and greater than 0.
16#0003	The axis is currently reversing and does not move in the opposite direction until the delay time "tReverse" has expired.
16#0004	Target position outside defined traversing range. Target position greater than maximum count or less than minimum count of module. Remedy: Define a different target position.
16#0005	Actual axis position already within switch-off difference. No positioning is performed. Remedy: First, move the axis to a position from which the distance to the original target position is greater than the switch-off difference.
16#0006	Absolute positioning is not possible until the axis has been successfully homed. Remedy: Home the axis.
16#0007	It is not possible to execute multiple positioning or homing commands at a time. Remedy: Set only one input for starting commands to "true".
16#0008	Jog mode is not started as the software limit switch is within the switch-off distance.
16#0009	Distance ("position") during relative positioning greater than modulo length. Remedy: Select a smaller distance for relative positioning.
16#0010	Target position outside working range. Remedy: Check the software limit switches and the target position of the positioning.
Errors	
16#8001	Error during communication between CPU and technology module. Remedy: Check your communication setting, the specified hardware ID and the channel number.
16#8002	Technology module with encoder error Remedy: Check your communication setting, the specified hardware ID and the channel number. Additionally, check the connection of the encoder to the technology module.
16#8003	Technology module with undervoltage Remedy: Check the supply voltage of the technology module.
16#8004	Error while downloading the parameterization to the technology module. Remedy: Check your communication setting, the specified hardware ID and the channel number.

Status ID	Meaning
16#8005	Incorrect parameterization of technology module. Problems while reading data record. Remedy: Check the parameterization of the technology module.
16#8006	Cannot open software gate of technology module. Remedy: Check the parameterization of the technology module.
16#8007	Hardware limit switch positive overrun.
16#8008	Hardware limit switch negative overrun.
16#8009	Software limit switch positive approached while jogging. Distance to software limit switch less than switch-off distance. Remedy: Retract the axis in the negative direction.
16#8010	Software limit switch negative approached. Distance to software limit switch less than switch-off distance. Remedy: Retract the axis in the positive direction.
16#8011	Software limit switch positive overrun. Moving in the positive direction is no longer possible. Remedy: Retract the axis in the negative direction.
16#8012	Software limit switch negative overrun. Moving in the positive negative is no longer possible. Remedy: Retract the axis in the positive direction.
16#8013	Jog positive and negative activated simultaneously. Remedy: Do not set "jogPos" and "jogNeg" to "true" at the same time.
16#8014	Standstill velocity exceeded. Remedy: Check the "standStillVelocity" setting in "config2Speed" and the frequency update time in the technology module's parameterization.
16#8015	Target range not reached during positioning. Remedy: Check the target range monitoring setting, "targetRange", in "config2Speed". If necessary, change the switch-off and switchover distances to reach the target range.
16#8016	No increment-precise switching by technology module at switch-off point. The switch-off was performed in the function block. (Internal error message)

If an error occurs, the "error" output bit of the "2SpeedPositioning" function block is set to "true". The associated error message is output via the "Status ID" output.

If warnings occur, the "error" output bit is not set. However, the associated messages are also output via the "Status ID" output.

Errors must be acknowledged with the "resetEror" block input. It is not necessary to acknowledge warnings.

3.2 Integrating the block into a user project

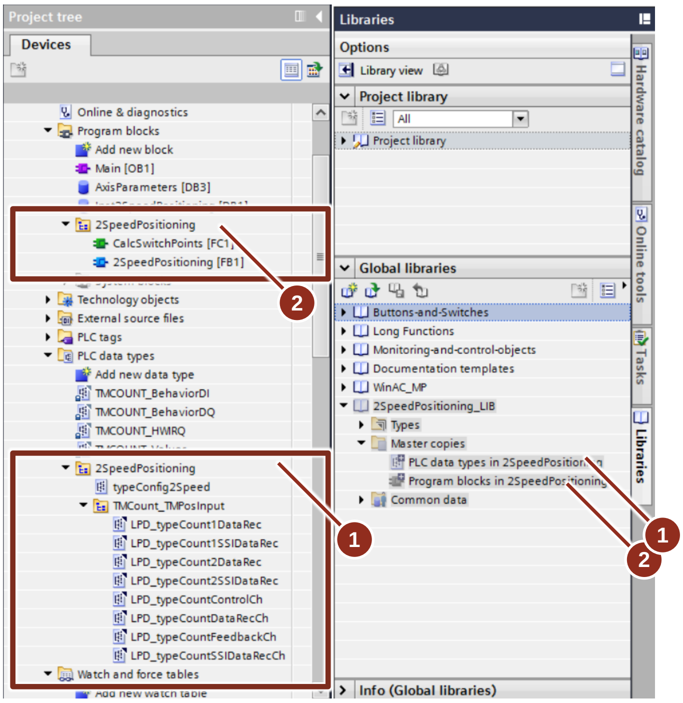
3.2.1 Integrating the function blocks and data types

To integrate the function blocks and data types for rapid traverse/creep speed positioning into a self-created user project, proceed as follows:

1. First, unzip the .zip file of the global library (LIB) to the hard drive of your TIA Portal PC.
2. Then open the unzipped global library (ap14 file) as a library in TIA Portal.

3. Use drag and drop to copy the following master copies from the library to your self-created user project:
   - The "PLC data types in 2SpeedPositioning” object to the "PLC data types” folder.
   - The "Program blocks in 2SpeedPositioning” object to the "Program blocks” folder.

Figure 3-2 Integrating the blocks into a user-defined user project



4. Now call the "2SpeedPositioning” function block in OB 1 of your user project and create the associated instance data block (e.g., "Inst2SpeedPositioning”).
5. In addition, create a global data block (DB) of the "typeConfig2Speed” data type in the project.
   In OB 1, this data block is interconnected with the "typeConfig2Speed” InOut tag of the "2SpeedPositioning” function block; it contains the configuration parameters for rapid traverse/creep speed positioning.
   In the following chapters, this data block is referred to as the "parameter DB”.

3.2.2 Interconnecting the signals on the function block

Now interconnect the signals on the function block in OB 1 to connect the function block to the I/O system. The following sections provide a more detailed explanation of the required interconnections.

HWID

At the "hwid" input of the block, create the hardware ID of the technology module (for TM Count / TM PosInput) or the HSCx high-speed counter (when using the S7-1500C compact CPU).

The required hardware ID is automatically generated by TIA Portal when setting up the hardware configuration in "PLC tags > Show all tags > System constants" ("Hw_..." data type). It can be copied from there or connected to the function block using drag and drop.

Channel

At the "channel" input, specify the technology module's channel used for rapid traverse/creep speed positioning.

For single-channel technology modules in ET 200SP design or when using the S7-1500C compact CPU, always specify channel 0.

Hardware limit switches

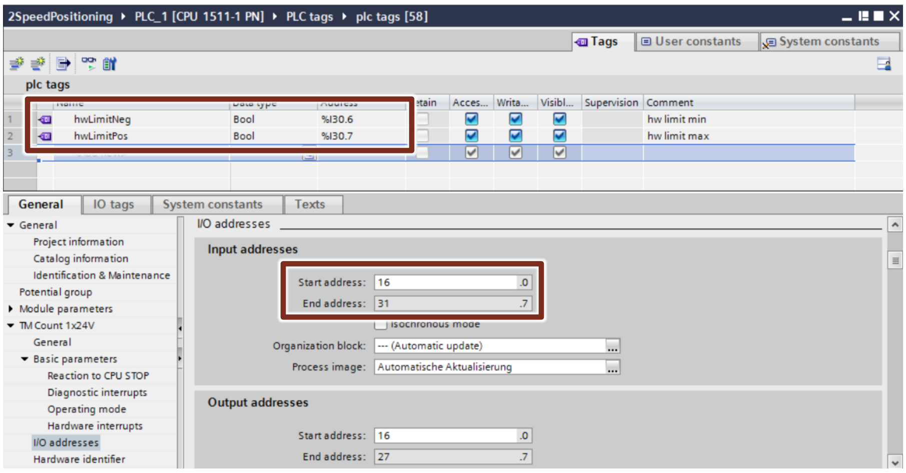
Create two PLC tags with the input addresses of the wired hardware limit switches and interconnect these tags with the "hwLimitNeg" and "hwLimitPos" inputs of the function block.

For the hardware limit switches, you can use external DIs or the DIs of the technology module used that are interconnected with the following addresses – related to the module's start address.

Table 3-4 Addresses of the internal DIs of the technology modules

DI of technology module	Offset to start of input address
DI0	Byte 14, bit 5
DI1	Byte 14, bit 6
DI2 (TM Count only)	Byte 14, bit 7

Figure 3-3 Creating PLC tags using the example of a TM Count 1x24V



NOTICE	**The hardware limit switches must be designed such that the axis stops at the limit switch and cannot overtravel the actuating cam.**

NOTICE	**The hardware limit switch must be a normally closed contact. When actuated, the "False" signal is output.** **In the event of a wire break, the hardware limit switches are permanently activated and the axis cannot be moved.**

External output (DQ)

As the technology modules have only two internal outputs (DQ), an additional output, for example on an additional DQ module, is necessary to use the full rapid traverse/creep speed positioning functionality.

Create a PLC tag with the address of the additional output (DQ) that is used to control the respective contactor for rapid traverse/creep speed positioning.

Then interconnect the created PLC tag with the "externalDQ" output of the function block.

Note	If an S7-1500C compact CPU is used for rapid traverse/creep speed positioning, you must specify the "externalDQ" output of the function block with the existing PLC tag of DQ2 (standard) of the high-speed counter (HSC) used. In this case, it is not necessary to create an additional PLC tag. For more information, see Chapter 2.5.1.

DQ0 output when using the S7-1500C compact CPU

As, when using an S7-1500C compact CPU, the DQ0 output cannot be switched by the "2SpeedPositioning" function block via the module interface, this output must be interconnected manually in OB 1 via the "DQ0" block output.

As shown in Chapter 2.5.1, connect the DQ0 PLC tag automatically created for the high-speed counter (HSC) used to this block output.

3.3 Commands

The following chapters describe the specific commands that can be used for rapid traverse/creep speed positioning in greater detail.

3.3.1 Positioning absolute

The "Positioning absolute" command allows you to move the connected axis to a target position specified as an absolute value.

Requirement

Absolute positioning requires that the axis was homed before starting the positioning operation. The "homed" output bit of the function block must be "true".

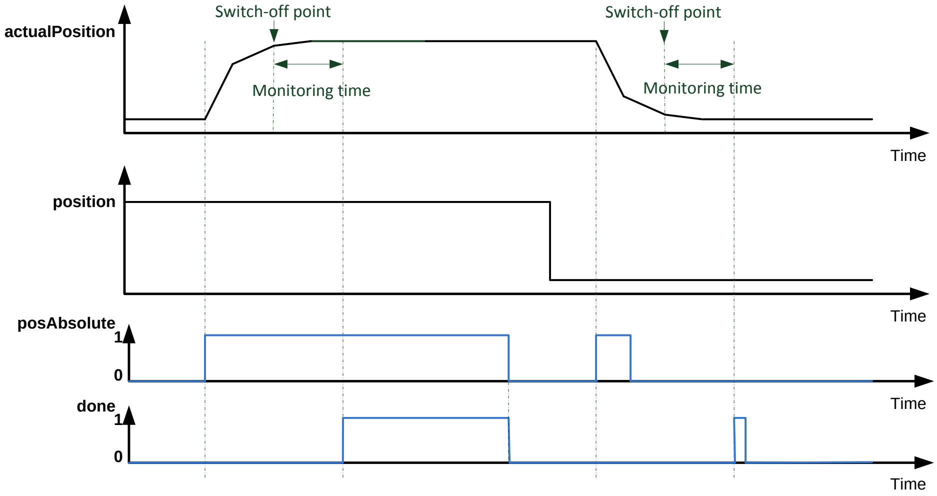
Mode of operation

Through absolute positioning, a target position specified as an absolute value can be approached with the axis. Based on the current axis position (actual position) when the command is called, the "2SpeedPositioning" FB autonomously determines the direction and distance of the motion. Via the "position" parameter, the target position is specified as an absolute value. A rising edge at the "posAbsolute" input of the function block starts the positioning operation.

Now the axis moves to the specified target position. When it reaches the switch-off point, the electrical power supply of the axis is interrupted and a monitoring time starts. Within this period, the axis motion must have dropped below the defined standstill velocity. In this case, the "done" output of the block is set to "true" for at least one OB cycle or the signal is output as long as the "posAbsolute" output is set to "true".

If a modulo axis is used as the axis, the direction for approaching the target position can be additionally specified via the "direction" input of the function block.

Figure 3-4 Function chart for absolute positioning



Restrictions

The positioning of the axis to the specified target position is only started when the distance between the current position of the axis (actual position) and the target position is greater than the one between the switch-off difference and the target position.

If the axis is closer to the specified target position than the switchover difference, the axis is only positioned at creep speed.

Table 3-5 Restrictions – Positioning absolute

Distance to target position (absolute value)	Axis behavior
Distance < Switch-off difference	No positioning. The axis remains at the current position (actual position) and status ID 16#0005 is output.
Switch-off difference < Distance < Switchover difference	Positioning at creep speed only.
Distance < Switchover difference	Positioning at rapid traverse and creep speed.

3.3.2 Positioning relative

The "Positioning relative" command allows you to move the connected axis from the current position by a user-definable distance.

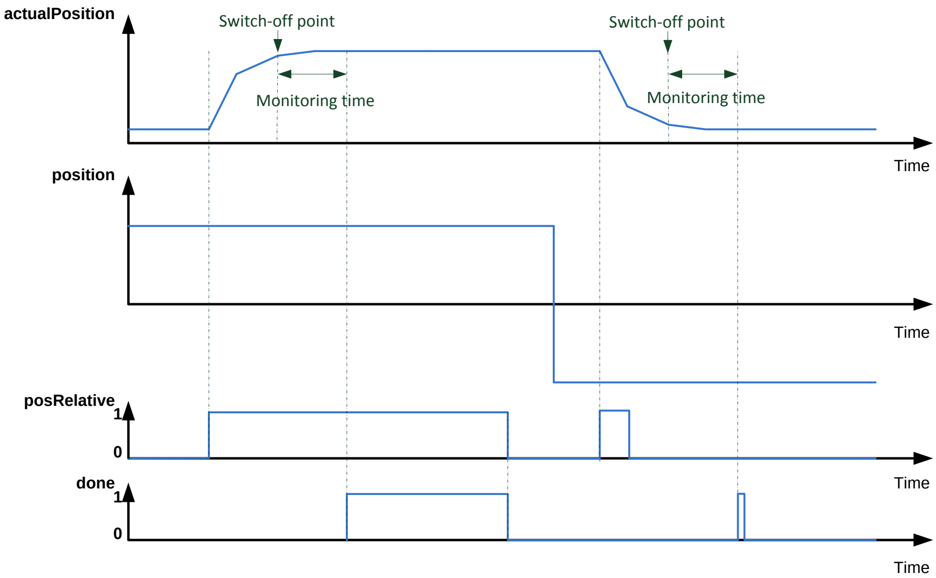
Requirement

Relative positioning of an axis is possible in the 'Homed' and 'Not homed' status of the axis.

Mode of operation

Relative positioning allows you to move the axis from the current position by the distance specified at the "position" input of the function block. The sign of the "position" parameter specifies the traversing direction of the axis. A rising edge at the "posRelative" input of the function block starts the positioning operation.

Figure 3-5 Function chart for relative positioning



Restrictions

The positioning of the axis by the specified distance is only started when the specified distance is greater than the switch-off difference.

If the specified distance is less than the switchover difference, the axis is only positioned at creep speed.

Table 3-6 Restrictions – Positioning relative

Distance to target position (absolute value)	Axis behavior
Distance < Switch-off distance	No positioning, axis remains at current position
Switch-off distance < Distance < Switchover distance	Positioning at creep speed only
Distance < Switchover distance	Positioning at rapid traverse and creep speed

Note Relative positioning of a modulo axis by more than one modulo length is not possible due to the way the technology modules work and will be rejected by the "2SpeedPositioning" function block.

3.3.3 Stop

The "Stop" command allows you to stop the connected axis immediately and prevent it from restarting. This completely stops the current traversing motion.

Set the "stop" input of the function block to "true" to stop the axis immediately.

This prevents other traversing motions as long as the "stop" input of the function block is set to "true".

Note The "stop" input of the function block has the highest priority so that the axis can be stopped at any time and the axis can be effectively prevented from restarting.

3.3.4 Homing

The "Homing" command allows you to influence the displayed current position of the connected axis.

Basic function

Through homing, the current position of the axis (actual position) displayed on the function block is synchronized with the actual physical position of the axis.

Block-internally, the displayed current position of the axis (actual position) is provided by the technology module to which the associated encoder is connected. The following characteristics must be considered:

- After turning on, incremental encoders provide a fixed start value, in most cases 0, that is independent of the actual encoder position. This means that the actual axis position does generally not correspond to the displayed axis position.
  To synchronize the displayed axis position with the actual axis position, the axis / encoder must be homed.
- After turning on, absolute encoders always provide a specific position value for each encoder position. However, it is not mandatory for the encoder position to correspond to the actual position of the axis.
  To synchronize the displayed axis position with the actual axis position, absolute encoder adjustment must be performed once. It determines an offset for the current encoder position, which is then stored retentively in the controller. From this time on, the absolute encoder should always indicate the actual axis position.

Note An axis with an incremental or pulse encoder must be homed after each CPU start or encoder error.

Note If position display errors occur on an axis with an adjusted absolute encoder after it has been turned on, check whether the absolute encoder used is a single-turn or multi-turn absolute encoder or whether the encoder's range of values is sufficient for the planned application.

A rising edge at the "homing" input of the function block starts homing. The "homingMode" input allows you to select the desired homing mode for the homing operation. In addition, the "homingPosition" input allows you to specify the homing position as follows:

- Direct homing: The displayed current axis position is directly set to the value of the specified homing position.
- Passive homing: When the external home position signal arrives, the displayed current axis position is set to the value of the specified homing position.
- Absolute encoder adjustment: The required encoder offset is calculated block-internally from the displayed current axis position and the specified homing position and stored retentively in the controller.

Table 3-7 "homingMode" homing modes

homingMode	Homing mode
0	Direct homing. Only valid for incremental encoders and pulse encoders.
1	Passive homing direction of motion positive Only valid for incremental encoders and pulse encoders.
2	Passive homing direction of motion negative Only valid for incremental encoders and pulse encoders.
3	Absolute encoder adjustment Only valid for absolute encoders.

The following sections explain the selectable homing modes in greater detail.

Direct homing (incremental encoder)

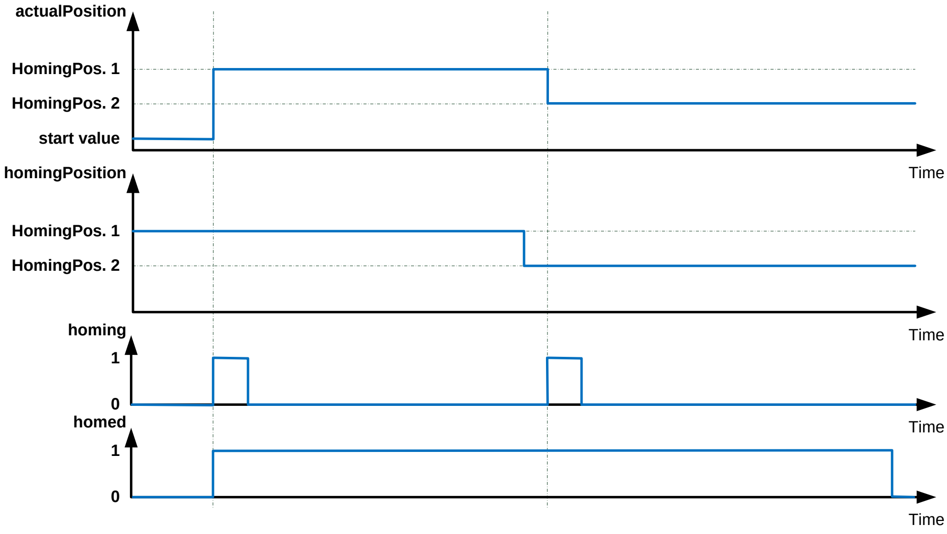
Direct homing requires that no traversing motion be active in the function block.

In direct homing mode, the actual axis position currently displayed on the block is set to the specified homing position. This does not involve a traversing motion. An external homing signal is not required for this function. The actual position is set directly with the rising edge at the "homing" input of the function block.

After successful homing, "true" is displayed at the "homed" block output.

In the following figure, the axis is homed twice with two different homing positions. This illustrates the behavior of the "homed" signal after the first homing operation.

Figure 3-6 Direct homing



Passive homing (incremental encoder)

Passive homing can be started when the axis is moving and when it is stopped.

A rising edge at the "homing" input of the function block starts the function. However, the actual axis position currently displayed on the block is not set to the specified homing position until the following cases occur:

- Mode 1:
  The axis overtravels the external homing signal in the positive direction.
- Mode 2:
  The axis overtravels the external homing signal in the negative direction.

However, enabling the function does not result in an active traversing motion of the axis. To execute the function, one of the following conditions must therefore be met:

- The axis is moved in jog mode in the appropriate direction until the external homing signal is triggered.
- Relative positioning of the axis in the appropriate direction until the external homing signal is triggered.
- Due to a positioning job that is already active, the axis moves in the appropriate direction until the external homing signal is triggered.

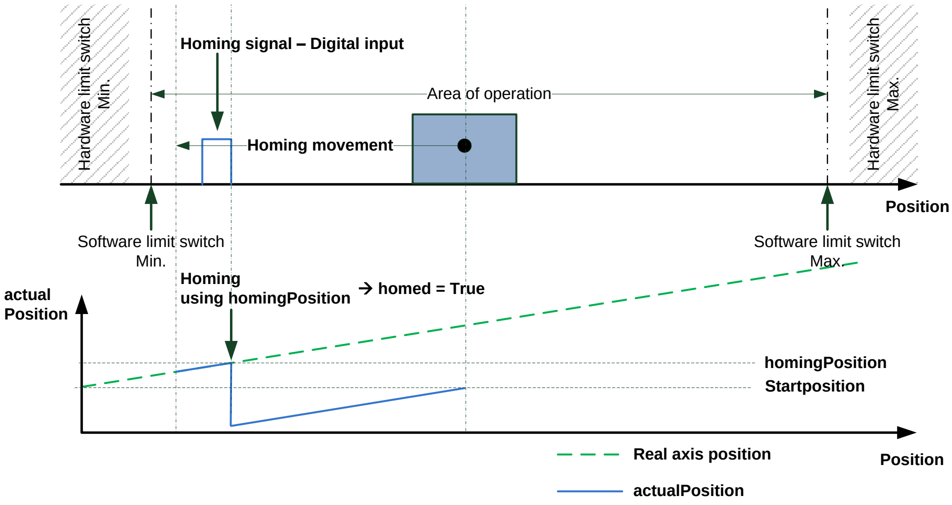
The following signals can be used as an external homing signal:

- Rising edge of signal N at the encoder input
  The zero mark signal (signal N) of the encoder must occur only once in the traversing range of the axis. However, as the signal is output for each encoder revolution, this homing signal can generally only be used for modulo axes for this rapid traverse/creep speed positioning.
  When parameterizing the technology module, this homing signal is selected in the "Counter inputs" section.
- Rising or falling edge of a digital input
  The digital input is assigned to a fixed homing mark within the traversing range of the axis and is therefore only approached once within the traversing range. This means that this homing signal can be used for modulo axes that cannot use a zero mark signal of the encoder or for linear axes with a traversing range that is greater than one encoder revolution.

When parameterizing the technology module, this homing signal is selected in the "Behavior of DI0" section using the "Synchronization" function.

- Rising edge of signal N at encoder input depending on level of assigned digital input
  This function is a combination of the two above functions. The zero mark of the encoder (signal N) is only evaluated if the assigned digital input is controlled by a fixed homing mark. This function should generally only be used in conjunction with linear axes.
  When parameterizing the technology module, this homing signal is selected in the "Behavior of DI0" section using the "Enable synchronization at signal N" function and additionally in the "Counter inputs" section using the "Synchronization at signal N" function.

Figure 3-7 Passive homing – example: rising edge of a digital input



Absolute encoder adjustment (absolute encoder)

Absolute encoder adjustment requires that no traversing motion be active in the function block.

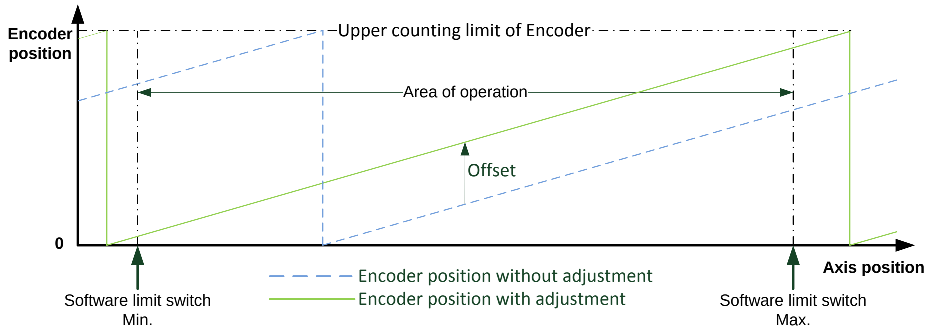
To synchronize the displayed axis position with the actual axis position, absolute encoder adjustment must be performed once. It determines an offset for the current encoder position, which is then stored retentively in the controller. From this time on, the absolute encoder always indicates the actual axis position.

No traversing motion takes place during active homing and this function does not require an external homing signal.

A rising edge at the "homing" input of the function block starts the function.

After successful homing, "true" is displayed at the "homed" block output.

Figure 3-8 Absolute encoder adjustment



In the function block, the offset is calculated as follows:

- Offset = actual position of axis – actual position of encoder

Within the function block, this offset is then used to calculate the current axis position (actual position). The following formula is used for the calculation:

- Current position (actual position) of axis = offset + actual position of encoder

3.3.5 Jog mode

The "Jog” command allows you to manually move the connected axis by a key press.

Requirement

Jog mode is possible in the ‘Homed’ and ‘Not homed’ status of the axis.

Mode of operation

The axis motion starts with a positive level at the appropriate input:

- The "jogPositive” input moves the axis in the positive direction
- The "jogNegative” input moves the axis in the negative direction
- If both inputs are activated simultaneously, the axis is stopped.

Resetting the level at the appropriate input stops the axis.

In addition, the "jogSpeed” input allows you to influence the speed of the axis in jog mode.

- True: Rapid traverse
- False: Creep speed

Switching between rapid traverse and creep speed can also be performed while the axis is moving in jog mode.

If the axis has already been homed and software limit switches have been parameterized within the traversing range of the axis, the axis stops automatically when the distance to the approached software limit switch is less than the switch-off distance.

3.3.6 Override response of the commands

If necessary, active commands can be overridden by specifying a new command. The following table shows the specific commands that can be overridden. This allows you to change the target position, for example, during an active positioning operation.

Table 3-8 Override response of the specific commands

Active command → / New command↓	jog Positive	jog Negative	pos Relative	pos Absolute	homing Mode: 0, 3
jogPositive	x	S	-	-	-
jogNegative	S	x	-	-	-
posRelative	-	-	A	A	-
posAbsolute	-	-	A	A	-
homing Mode: 0, 3	-	-	-	-	A

A = The active command is canceled. The new command is executed.
S = The axis is stopped.
X = Not possible; level-controlled
- = No effect, the active command continues

NOTICE **A command can only be started if all other command inputs are "false”. Before you start a new command, set all command inputs to "false”.**

Note Within the function block, only one command is active at a time. The block has no command buffer.

The following table shows how an axis responds when a positioning command is overridden by a new positioning command, as an example, in the positive direction.

Table 3-9 Axis behavior when a positioning command is overridden

Current traversing motion of positioning command	Direction of motion to target position	Distance between new target position and current axis position	Effect on traversing motion
Rapid traverse positive	Positive	> Switchover difference	Rapid traverse positive is output until switchover point. Creep speed until switch-off point is reached
Rapid traverse positive	Positive	< Switchover difference > Switch-off difference	Creep speed is output and switched off at switch-off point.

Current traversing motion of positioning command	Direction of motion to target position	Distance between new target position and current axis position	Effect on traversing motion
Creep speed positive	Positive	> Switchover difference	Creep speed is output. Switching to creep speed is performed at the switchover point. Switch-off is performed at the switch-off point.
Creep speed or rapid traverse positive	Negative (reversal)	> Switchover difference	Traversing signals are switched off. The system waits until the reversing time expires. Then rapid traverse in the negative direction is output until the switchover point is reached. Switching to creep speed is performed at the switchover point. Switch-off is performed at the switch-off point.
Creep speed or rapid traverse positive	Negative (reversal)	< Switchover difference > Switch-off difference	Traversing signals are switched off. The system waits until the reversing time expires. Then creep speed in the negative direction is output until the switch-off point is reached. Switch-off is performed at the switch-off point.
Creep speed or rapid traverse positive	Positive or negative	< Switch-off difference	Traversing signals are switched off.

3.4 Parameterizing rapid traverse/creep speed positioning

The behavior of rapid traverse/creep speed positioning is defined by the following parameters:

- Parameterization of the technology modules as shown in Chapter 2.6.
- Parameterization by setting the tags of the parameter data block.

It is recommended to set the values of the parameter data block once during CPU startup or store the parameter values directly in the parameter data block during the engineering phase.
Operating parameters in the parameter data block can then also be changed at runtime directly from the user program.

The following chapters provide information for setting the values for the specific tags of the parameter data block.

3.4.1 Axis type

The "axisType” tag defines the axis type used for rapid traverse/creep speed positioning.

Table 3-10 Possible axis types

Axis type	axisType
Linear axis	0
Modulo axis	1

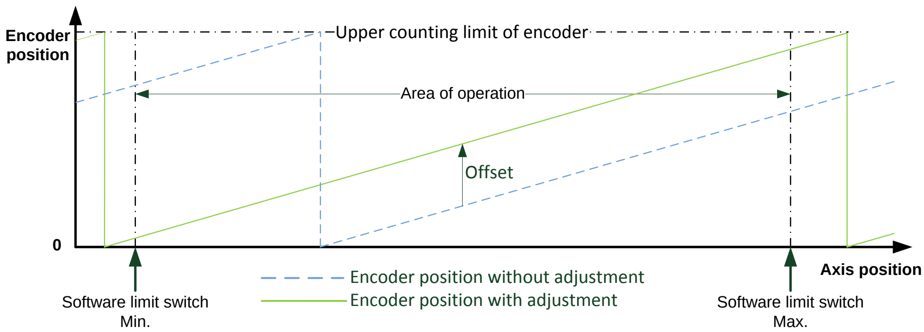
Linear axis

Select the "Linear axis" axis type if the working range of the axis is between the low and high counting limit of the encoder. The axis must not fall below the low counting limit of the encoder and not exceed the high counting limit of the encoder.

If the axis uses an incremental encoder, set the low and high counting limit of the encoder, when parameterizing the technology module, such that the working range of the axis is within these limits.

If the axis uses an absolute encoder, use absolute encoder adjustment to adjust the absolute encoder such that no overflow or jump of the encoder value occurs within the working range of the axis.

Figure 3-9 Absolute encoder adjustment for linear axis



CAUTION	**Limit the working range of the axis to avoid damage to the mechanical system!** Parameterize the software limit switches to limit the axis working range and, if necessary, use hardware limit switches to switch off the contactors.

Note If you want to use an absolute encoder in conjunction with a linear axis, the working range of the encoder must cover the complete traversing range of the linear axis.

Modulo axis

Select the "Modulo axis" axis type if the low and high counting limit of the encoder is violated within the working range of the axis.

For this axis type, the working range of the axis can be limited by using software limit switches or the axis can, for example as a rotary axis, be moved within the complete counting range of the encoder.

If the axis uses an incremental encoder, proceed as follows to define the modulo length of the axis by setting the low and high counting limit of the encoder when parameterizing the technology module:

- Set the low counting limit of the encoder to the value 0.
- Set the high counting limit of the encoder to the value (modulo length -1).

Example:
If one encoder revolution corresponds to the modulo length of the axis and the encoder has a resolution of 1500 increments per revolution, set the low counting limit of the encoder to 0 and the high counting limit of the encoder to 1499.

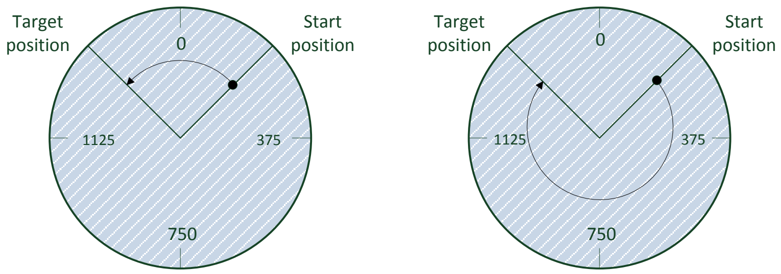
If the axis uses an absolute encoder, the modulo length of the axis is automatically defined by the encoder resolution.

Example:
If the absolute encoder outputs counts from 0 (low counting limit) to 8191 (high counting limit), the axis is automatically set to the modulo range of 8192 (0 to 8191 increments).

For a modulo axis, you can additionally specify the direction of a positioning job on the function block:

- Shortest path positioning
- Positioning in the negative direction
- Positioning in the positive direction

Figure 3-10 Negative and positive traversing direction for modulo axis



3.4.2 Software limit switches

The working range of the axis can be limited both by hardware switches, so-called hardware limit switches, and, on a position-related basis, by so-called software limit switches.

In the parameter data block, the software limit switches are defined by the "limitSwitchMin" and "limitSwitchMax" tags. The software limit switches are deactivated when both variable values are set to 0.

CAUTION	**The set software limit switches are not activated until the axis is homed and therefore the actual axis position corresponds to the position displayed on the block.** Home the axis before using it for the first time to activate the software limit switches and avoid the risk of damage to the mechanical system of the axis.

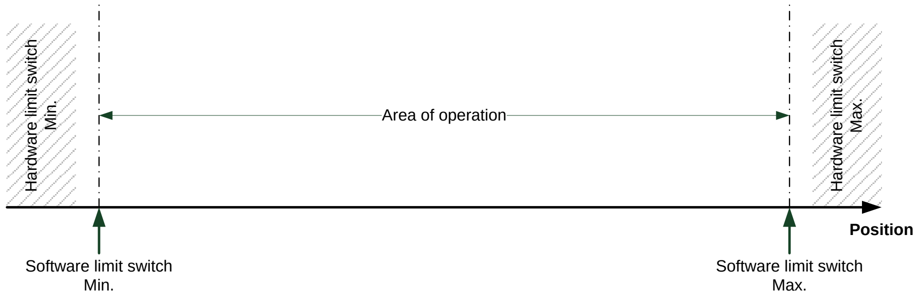
Software limit switches for a linear axis

If you are using a linear axis, you need to parameterize the positions of the software limit switches within the counting limits of the encoder.

Table 3-11 Software limit switch parameterization for linear axis

Axis type	Software limit switch parameterization
Linear axis	Low counting limit <= limitSwitchMin < limitSwitchMax <= High counting limit

Figure 3-11 Configuration of the working range of a linear axis



Software limit switches for a modulo axis

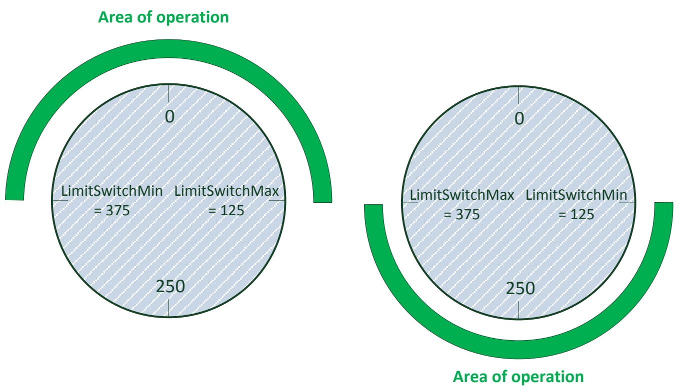
If you are using a modulo axis, the working range of the modulo axis is defined by the positions of the software limit switches.

Table 3-12 Software limit switch parameterization for modulo axis

Axis type	Software limit switch parameterization
Modulo axis	Low counting limit <= limitSwitchMin < limitSwitchMax <= High counting limit Low counting limit <= limitSwitchMax < limitSwitchMin <= High counting limit

The following example shows a modulo axis with an encoder with a high counting limit of 499.

Figure 3-12 Configuration of the working range of a modulo axis



3.4.3 Switchover/switch-off difference

When determining the switchover and switch-off difference, consider the following information and enter the determined differences in the parameter data block:

- In the parameter data block, two tags are available for both the switchover and switch-off difference; one for the positive and one for the negative direction of motion of the axis.
- Determine particularly the switch-off difference as accurately as possible to achieve high accuracy for positioning the axis.
- If the axis is moved with loads that differ significantly, measure, where possible, the switchover and switch-off difference of each axis for each load of the axis and write these values to the parameter data block on a load-dependent basis before the start of the respective motion.

By the direction-dependent setting of the switchover and switch-off difference of the axis, different mechanical properties or loads of the axis can be balanced in the individual traversing directions.

Table 3-13 Switchover and switch-off difference in the parameter DB

Range	Variable in config2Speed	Meaning
Switchover difference	switchOverDistPos switchOverDistNeg	Distance to the target position where the speed is switched from rapid traverse to creep speed. The switchover difference must always be greater than the switch-off difference.
Switch-off difference	switchOffDistPos switchOffDistNeg	Distance to the target position where the drive motor of the axis is switched off and the axis moves into the target position with the remaining kinetic energy (coasts down). The selected switch-off difference must always be less than the switchover difference.

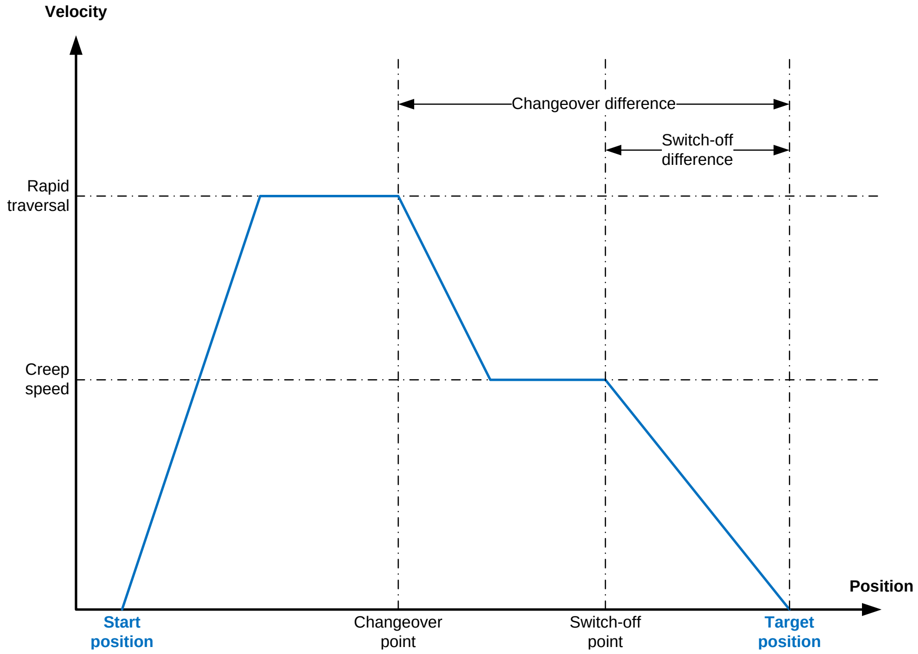
Velocity profile

The positioning operation of rapid traverse/creep speed positioning is performed based on the following velocity profile that depends on the specified switchover and switch-off difference of the axis in the respective direction of motion:

- From the start position, the axis is first accelerated to the high axis velocity (rapid traverse) and then moved to the target position at this velocity.
- At the distance to the target position that corresponds to the switchover difference, the axis is decelerated to the low axis velocity (creep speed) and then moved to the target position at this velocity.
- The axis is then switched off at the distance to the target position that corresponds to the switch-off difference. As a result, the axis coasts down and thus reaches the desired target position.

If the entire travel path is shorter than the switchover difference, the axis covers the entire distance at creep speed.

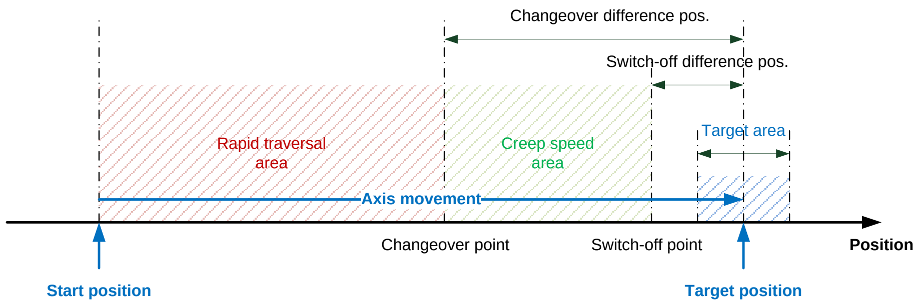
Figure 3-13 Rapid traverse/creep speed positioning velocity profile



The values of the switchover/switch-off difference depend on the following factors that need to be considered when determining the two differences:

- Use of a motor brake and/or operating brake on the axis.
- Set axis velocities for rapid traverse and creep speed.
- Used mechanical system of the axis and moments of inertia of the mechanical system.
- Loads moved by the axis.
- Delay and switch-off times of the contactors used.

Figure 3-14 Positioning in the positive direction within the working range



Determining the switchover/switch-off difference

To ensure that the target position is reached in the most precise way possible, use the following method to determine, where appropriate even for multiple axis loads, the switchover and switch-off difference settings in the respective direction of motion:

6. First, parameterize the axis type, the hardware limit switches and the software limit switches for the appropriate axis. If necessary, home the axis.

7. In TIA Portal, set up a trace recording with the following signals of the "2SpeedPositioning" function block:
   a. Jog mode in positive direction "jogPos"
   b. Jog mode in negative direction "jogNeg"
   c. Selection of "jogSpeed"
   d. Current axis position "actualPosition"
   e. Current axis speed "actualSpeed"
8. As a trigger condition for the trace recording, select a rising a rising edge at the "jogPos" input of the function block and, if necessary, a pre-trigger of 10..20.
9. Use TIA Portal to start the trace recording in the CPU.
10. Now execute the following traversing motions of the axis; keep in mind that the trace recording starts only with jog mode in the positive direction and that the axis should reach the speed levels for rapid traverse and creep speed during the measurement:
    a. Move the axis with jogPos = True and jogSpeed = True
    b. Move the axis with jogPos = True and jogSpeed = False
    c. Stop the axis with jogPos = False
11. When the recording is complete, save the recorded measurement in TIA Portal.
12. Repeat the measurement in the negative direction of motion. However, before you start the measurement, change the trigger tag of the measurement to the "jogNeg" input of the function block. Save this measurement as well.

To determine the switchover and switch-off difference of the axis in the respective direction of motion, evaluate the saved measurements as follows:

- For the switch-off difference, calculate the position difference between the falling edge at the input for jog mode ("jogPos" or "jogNeg") and the measured value recording range where the position of the axis no longer changes and the actual speed of the axis is almost zero.
- Now calculate the position difference between the falling edge at the "jogSpeed" input and the position where the speed switches to low speed (creep speed).
  When adding the switch-off difference, this value results in the switchover difference.

Transfer the values for the switchover and switch-off differences of the axis calculated as shown above to the parameter data block. Then use the "2SpeedPositioning" function block to perform defined positioning operations to check the positioning accuracy.

If necessary, correct the settings for the switchover and switch-off differences of the axis in the parameter data block.

Trace recording and evaluation example

The following figures show a sample trace recording of the axis motion in jog mode.

Figure 3-15 Complete trace

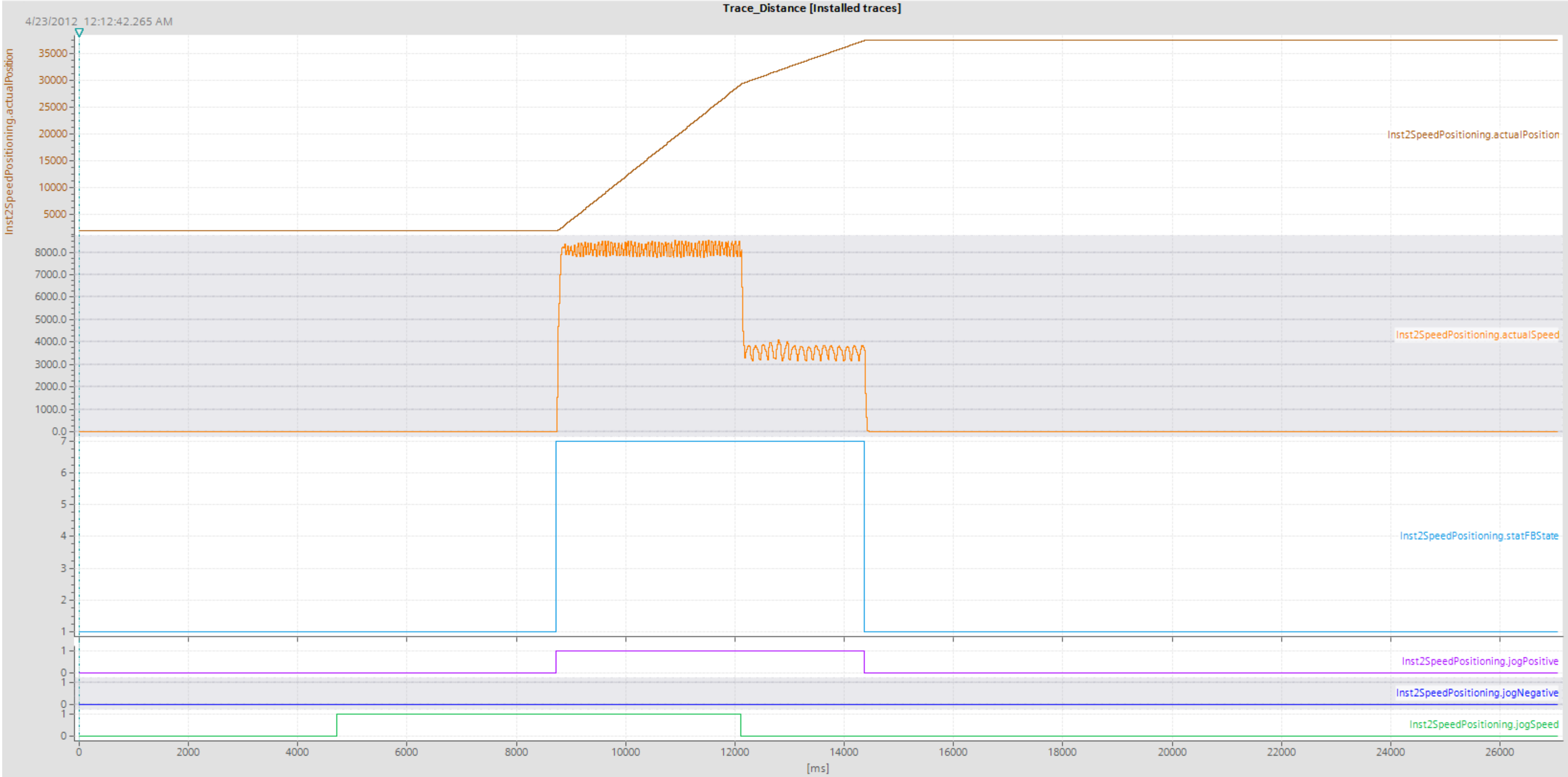


Figure 3-16 Determining the switch-off difference

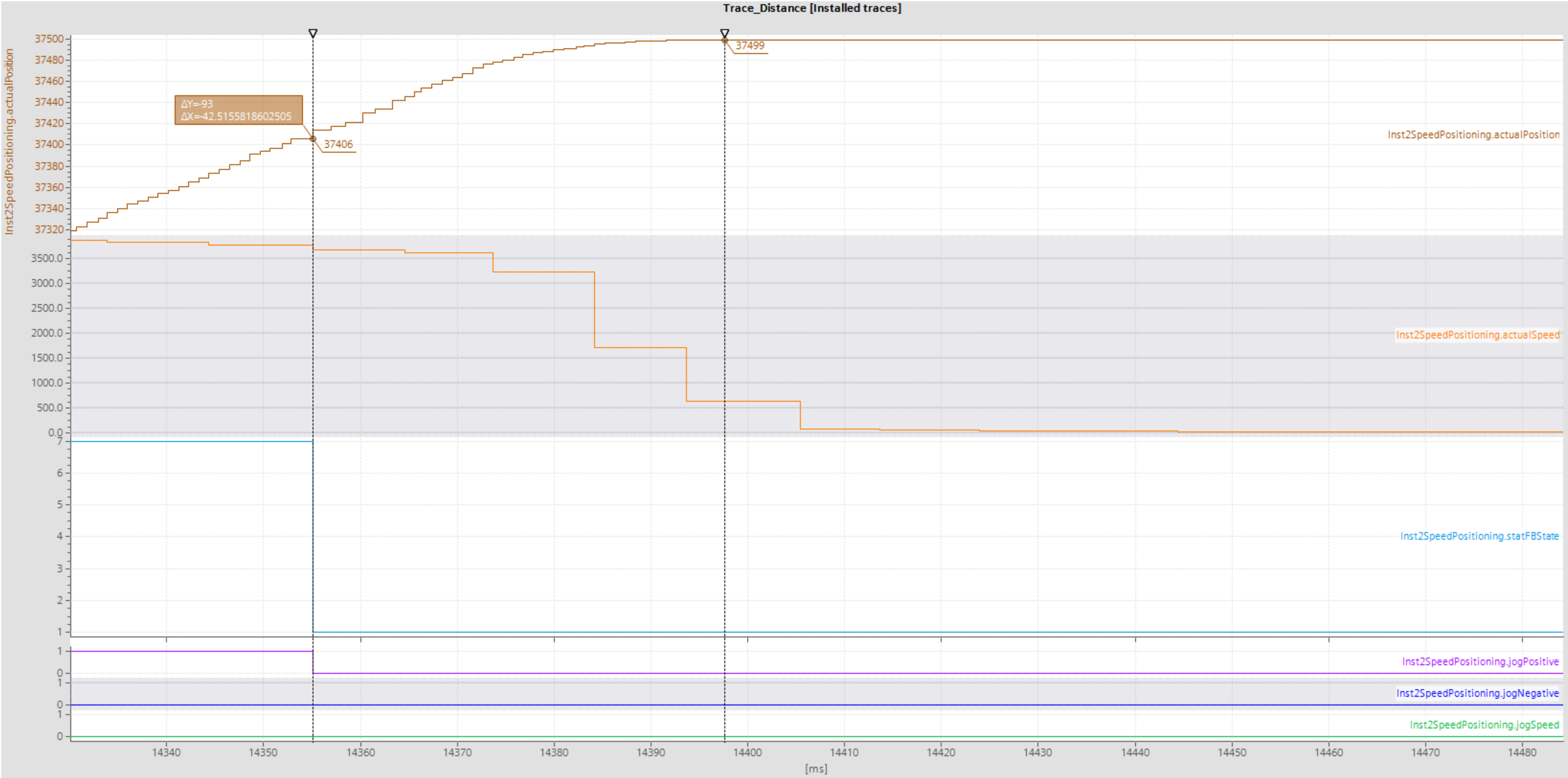
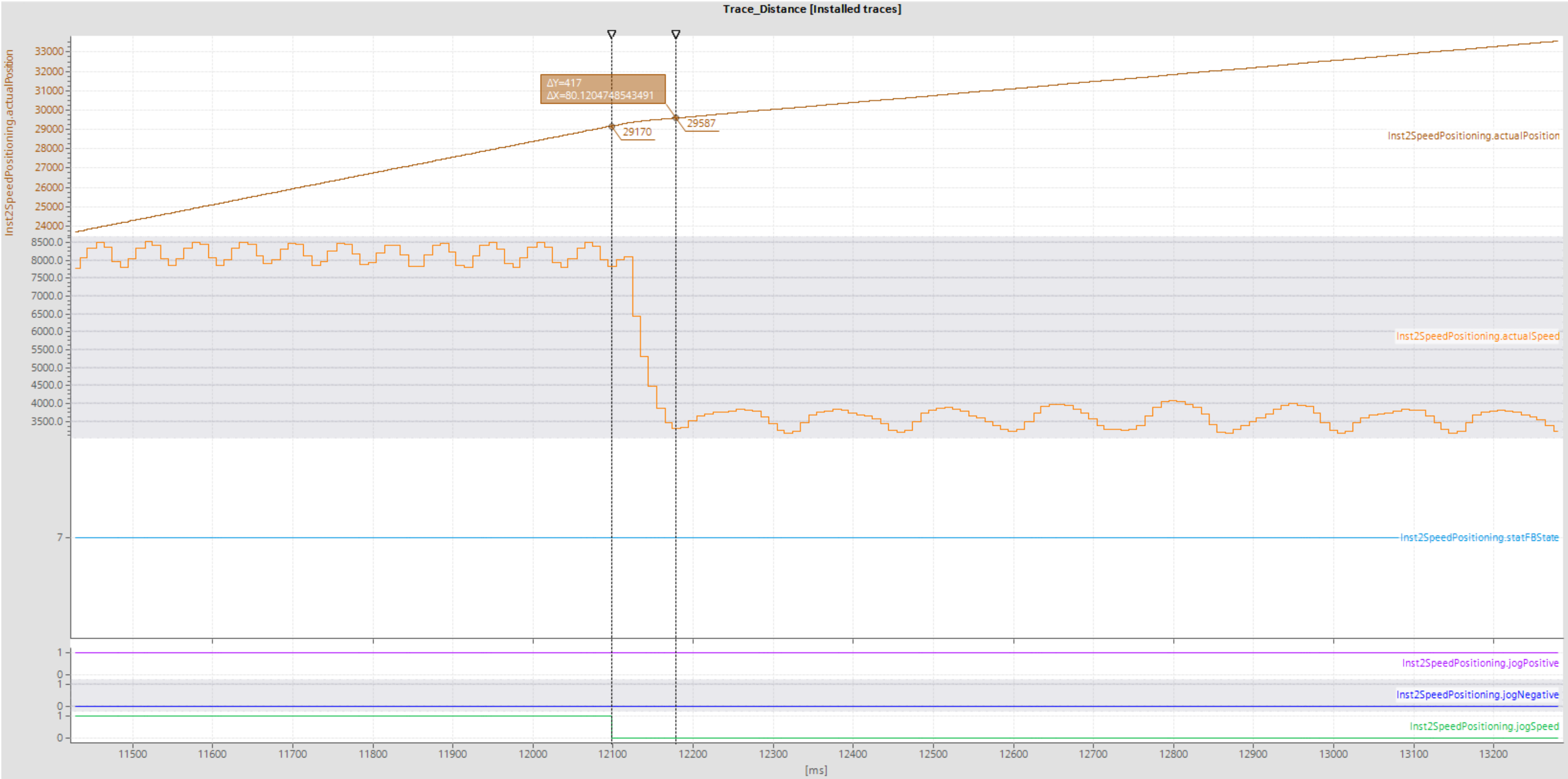


Figure 3-17 Determining the switchover difference



Based on the evaluation of the trace recordings and using the vertical measurement cursors of the trace display, this results in the following switchover and switch-off difference settings:

- The switch-off difference from Figure 3-16 is 37499 – 34706 = 93 (increments).
- The position difference calculated in Figure 3-17 is 29587 – 29170 = 417 (increments); adding the switch-off difference, this results in a switchover difference of 417 + 93 = 510 (increments).
  If necessary, add a tolerance to ensure that creep speed is reached.

3.4.4 Target range

The target range of a positioning operation of rapid traverse/creep speed positioning is located symmetrically around the target position. The target range is used to monitor a positioning operation's positioning accuracy.

If the axis does not reach the target range after the monitoring time has expired, an error is output on the "2SpeedPositioning" function block.

In the parameter data block, the target range is defined by the "targetRange" tag. Proceed as follows to determine the correct setting of the tag:

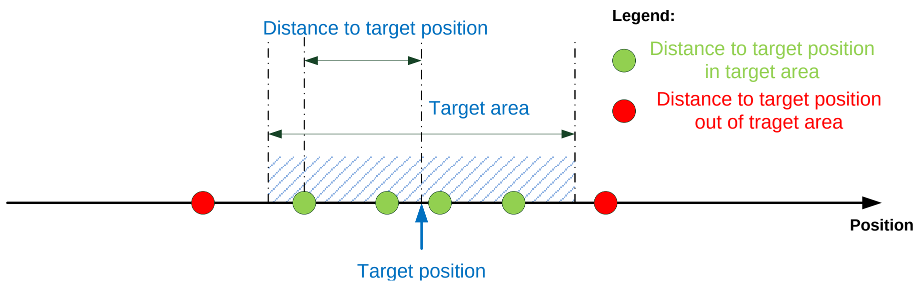
1. First, select a large value for the target range to avoid an error message when positioning the axis.
2. Then determine the switchover and switch-off difference of the axis very accurately to enable a very accurate positioning operation to the target position.
3. Now perform different positioning operations with the axis and check by how much the results deviate from the target position. The maximum of 'less than/greater than target position' defines the symmetrical target range.

Table 3-14 Effect of the target range setting during a positioning operation

Target range	Effect
Too small	The block often outputs errors although the positioning accuracy is sufficient for the application.
Correct	The block only outputs errors if the positioning accuracy required for the application is not complied with.
Too large	The system accepts positioning tolerances that are too large and prevent the application from being used satisfactorily.

The example in the following figure shows different end positions of the axis after a positioning operation. The red positions are outside the target range, the green ones are within the target range.

Figure 3-18 Definition of the target range



3.4.5 Standstill velocity

The current velocity (actual velocity) of the axis is determined directly by the technology module. To do this, the technology module counts the pulses per time

unit transmitted by the encoder.
The "Update time" parameter of the technology module allows you to set the time unit the technology module will use to newly determine the velocity.

In addition to position monitoring using the target range, the positioning operation of rapid traverse/creep speed positioning is monitored with the aid of the standstill velocity of the axis. When the set monitoring time has expired, the current velocity of the axis is checked. If the actual velocity of the axis is higher than the standstill velocity defined in the "standStillVelocity" tag in the parameter data block, an error is output on the "2SpeedPositioning" function block.

Set the "standStillVelocity" tag in the parameter data block to the lowest possible value and, if necessary, check the maximum standstill velocity of the axis using a trace recording in TIA Portal.

Note A standstill velocity that is set too high in the "standStillVelocity" tag of the parameter data block disables this monitoring function and can cause inaccuracies in positioning.

3.4.6 Monitoring time

The monitoring time is used for the following monitoring functions in the "2SpeedPositioning" function block:

- Monitor that the end position of the axis in the target range is around the target position of the positioning operation.
- Monitor that the velocity of the axis at the end position is lower than the set standstill velocity.

The monitoring time is set using the "tMonitoring" tag in the parameter data block and starts at the creep speed switch-off point.

NOTICE **For each positioning operation, the 'target position and standstill velocity reached' check is performed only once when the monitoring time has expired. Any subsequent axis motions are not detected by the "2SpeedPositioning" function block.**

3.4.7 Reversing time

In the event of a change of direction from a motion, the reversing time protects the axis against short circuits on the contactors/motor or against excessive jerk loads on the mechanical system of the axis.

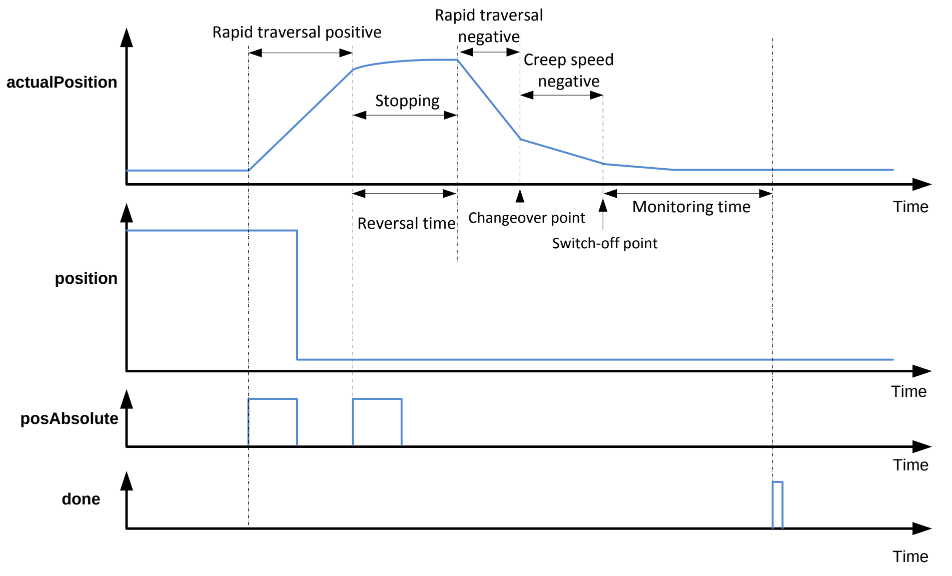
The reversing time is used for the following traversing motions of the axis:

- Issuing a positioning job in the opposite direction while the axis is moving.
- Jog mode of the axis in the opposite direction during an active motion.

The direction of the axis is not reversed until the set reversing time has expired. Within the reversing time, the axis is decelerated or coasts down. Therefore, set the reversing time to a value greater than required by the axis for decelerating from rapid traverse.

CAUTION	**When the direction is changed too quickly, short circuits can occur on the contactors/motor.** Set the reversing time to a value greater than the contactor dead times of the contactors used to avoid short circuits.

Figure 3-19 Reversing axis from positive to negative direction



3.4.8 Control of the contactors

The contactors for controlling the motor are controlled via three digital outputs (DQ). The DQs are assigned to the appropriate contactors by selecting the mode and the wiring shown in Chapter 2.2.

The desired mode is set using the "controlMode" tag in the parameter data block.

Mode 0 and mode 1

In mode 0 and mode 1, the movement enable of the axis via DQ0 is controlled directly by the technology module and switched off on an increment-precise basis when the target position is reached.

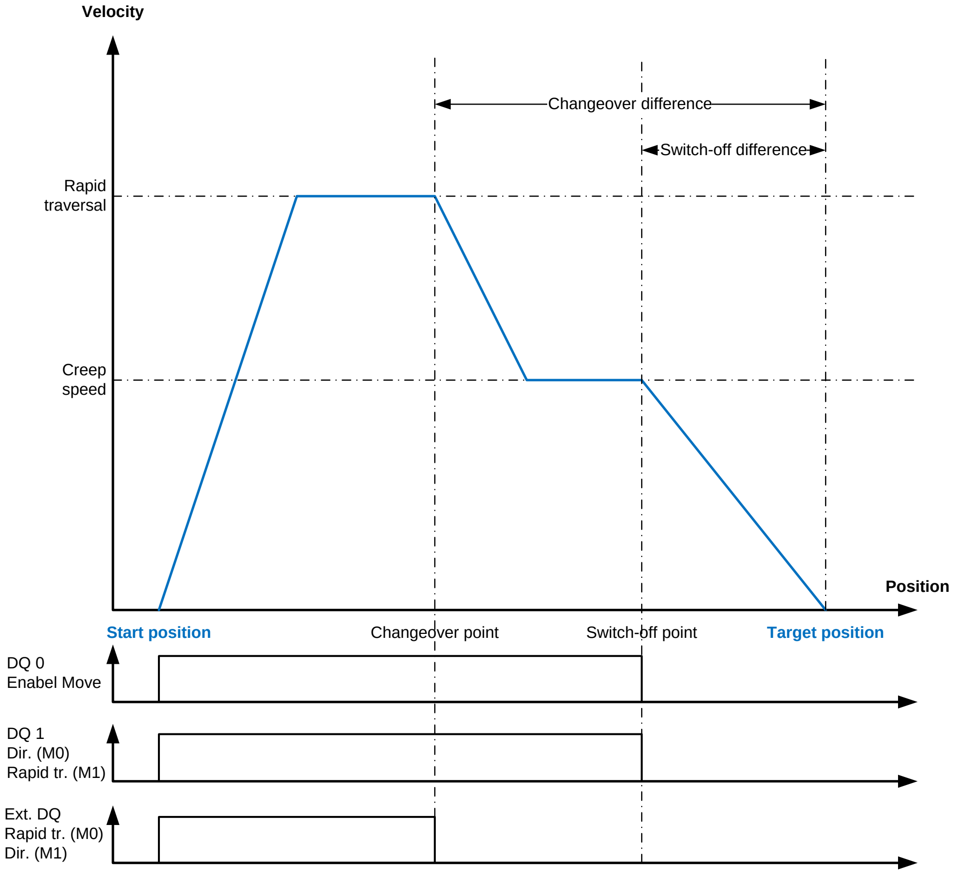
In mode 0, DQ1 of the technology module is used to switch the direction of the traversing motion. In mode 1, DQ1 is used to switch between rapid traverse and creep speed.

In mode 1, the external DQ is used to switch the direction of the traversing motion. In mode 0, DQ1 is used to switch between rapid traverse and creep speed.

Table 3-15 Output-dependent traversing motion in mode 0 and 1

Movement enable	Direction	Rapid traverse	Traversing motion
True	True	True	Rapid traverse positive
True	True	False	Creep speed positive
True	False	True	Rapid traverse negative
True	False	False	Creep speed negative
False	Don’t care	Don’t care	Axis stops

Figure 3-20 Control in mode 0 (M0) / mode 1 (M1)



Mode 2

In mode 2, DQ0 switches the traversing motion of the axis in the positive direction and DQ1 switches the traversing motion in the negative direction. In this process, the "2SpeedPositioning" function block prevents the two outputs from being simultaneously set.

The external DQ is used to switch between rapid traverse and creep speed.

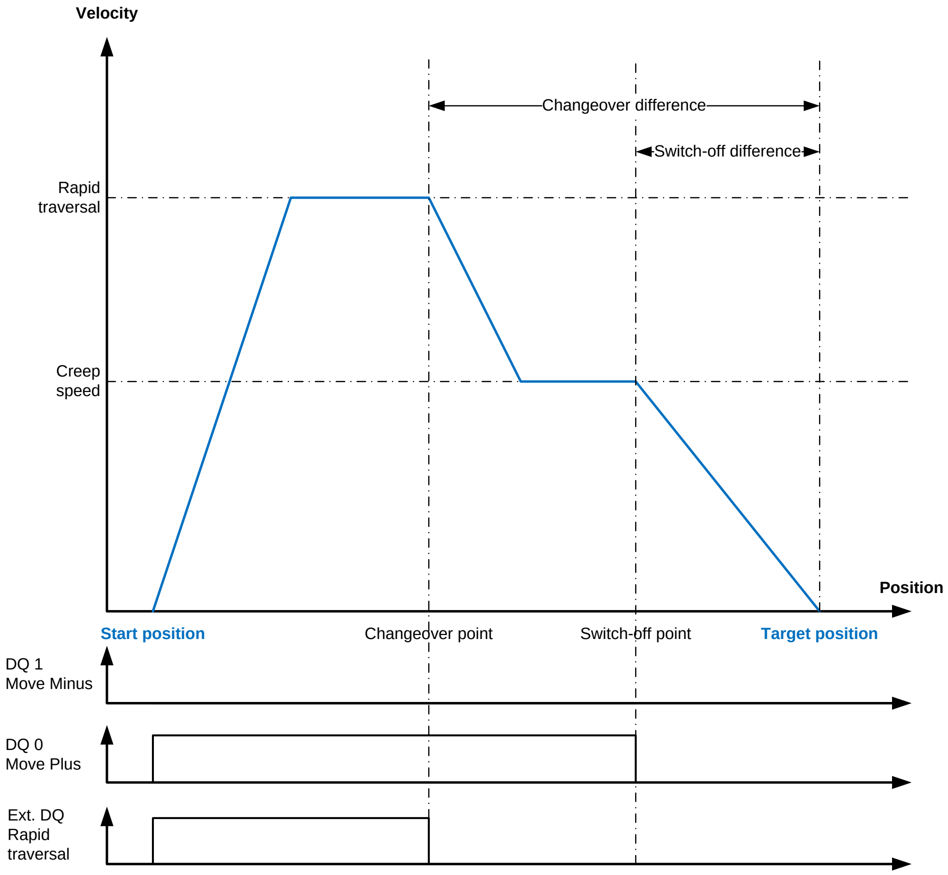
NOTICE	**Mode 2 cannot be used on a SIMATIC S7-1500C compact CPU.** For the compact CPU, increment-precise switching off is only possible via the DQ1 digital output that is assigned to a high-speed counter; it is not possible with the DQ0 output. If you want to use an S7-1500C compact CPU, choose mode 0 or mode 1 and wire the contactors of the axis as shown in Chapter 2.2 of this documentation.

Table 3-16 Output-dependent traversing motion in mode 2

Traverse plus	Traverse minus	Rapid traverse	Traversing motion
True	True	True	Prevented by block
True	True	False	Prevented by block
True	False	True	Rapid traverse positive
True	False	False	Creep speed positive
False	True	True	Rapid traverse negative

Traverse plus	Traverse minus	Rapid traverse	Traversing motion
False	True	False	Creep speed negative
False	False	True	Axis stops
False	False	False	Axis stops

Figure 3-21 Control in mode 2



CAUTION	**An incorrect setting of the "controlMode" tag in the parameter data block can result in unexpected traversing motions of the axis.** Set the "controlMode" tag accordingly and check the wiring of the contactors for controlling the axis.

4 Appendix

4.1 Service and Support

Industry Online Support

Do you have any questions or do you need support?

With Industry Online Support, our complete service and support know-how and services are available to you 24/7.

Industry Online Support is the place to go to for information about our products, solutions and services.

Product Information, Manuals, Downloads, FAQs and Application Examples – all the information can be accessed with just a few clicks:
https://support.industry.siemens.com/

Technical Support

Siemens Industry's Technical Support offers you fast and competent support for any technical queries you may have, including numerous tailor-made offerings ranging from basic support to custom support contracts.

You can use the web form below to send queries to Technical Support:
www.siemens.com/industry/supportrequest.

Service offer

Our service offer includes the following services:

- Product Training
- Plant Data Services
- Spare Part Services
- Repair Services
- Field & Maintenance Services
- Retrofit & Modernization Services
- Service Programs & Agreements

For detailed information about our service offer, please refer to the Service Catalog:
https://support.industry.siemens.com/cs/sc

Industry Online Support app

The "Siemens Industry Online Support" app provides you with optimum support while on the go. The app is available for Apple iOS, Android and Windows Phone.
https://support.industry.siemens.com/cs/ww/en/sc/2067

4.2 Links and literature

Table 4-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
https://support.industry.siemens.com/cs/ww/en/view/109745386	https://support.industry.siemens.com/cs/ww/en/view/109745386
\3\	Application example "Libraries with PLC data types (LPD) for STEP 7 (TIA Portal) and S7-1200 / S7-1500" https://support.industry.siemens.com/cs/ww/en/view/109482396
\4\	Manual SIMATIC S7-1500, ET 200MP, ET 200SP Counting, measurement and position detection Function Manual Document ID: A5E32009889-AF https://support.industry.siemens.com/cs/ww/en/view/59709820
\5\	Manual SIMATIC ET 200SP TM Count 1x24V Equipment Manual Document ID: A5E33002339-AA https://support.industry.siemens.com/cs/ww/en/view/83727715
\6\	Manual SIMATIC ET 200SP TM PosInput 1 Equipment Manual Document ID: A5E33015755-AC https://support.industry.siemens.com/cs/ww/en/view/109482269
\7\	Manual SIMATIC S7-1500 TM Count 2x24V Equipment Manual Document ID: A5E31870371-AA https://support.industry.siemens.com/cs/ww/en/view/59193105
\8\	Manual SIMATIC S7-1500 TM PosInput 2 Equipment Manual Document ID: A5E03982218-01 https://support.industry.siemens.com/cs/ww/en/view/61777657
\9\	Manual SIMATIC S7-1500 CPU 1511C-1 PN Equipment Manual

No.	Topic
	Document ID: A5E35306259-AB https://support.industry.siemens.com/cs/ww/en/view/109478675
\10\	Manual SIMATIC S7-1500 CPU 1512C-1 PN Equipment Manual Document ID: A5E35306440-AB https://support.industry.siemens.com/cs/ww/en/view/109478676

4.3 Change documentation

Table 4-2

Version	Date	Modifications
V1.0	04/2017	First version