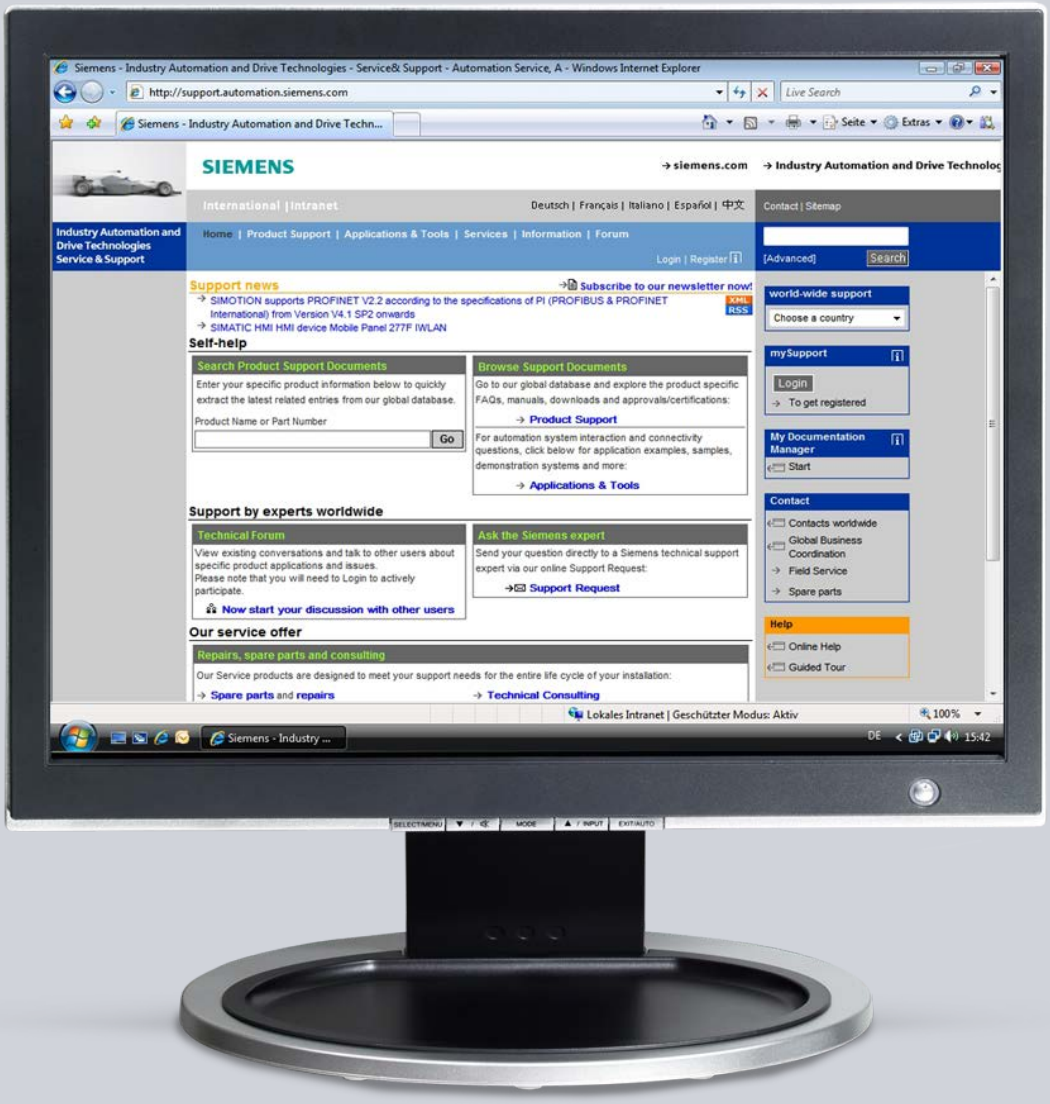
Which options exist for reading hardware limit switch signals into a technology CPU?

Technology CPU

FAQ • June 2013



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Question

Which options exist for reading hardware limit switch signals into a technology CPU?

Answer

The instructions and notes listed in this document provide a detailed answer to this question.

Table of Contents

1 Introduction

Monitoring the mechanical end-position of an axis occurs mainly via hardware limit switches which are operated by the axis as soon as the end position approaches.

For linear axes two hardware limit switches are required for complete monitoring of the end positions to enable monitoring the end position in positive and negative direction separately.

Generally, hardware limit switches are normally closed contacts which enable the CPU to also detect a wire-break as “end position” and to stop the axis.

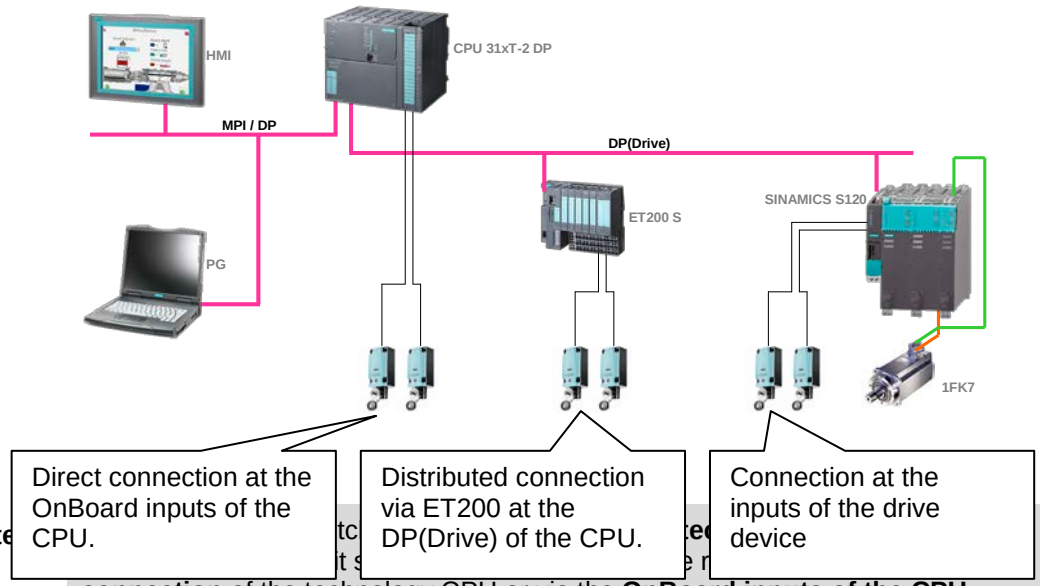
For the technology CPU the limit switch signals are processed for the respective axis in the integrated technology. For transferring the signals to the integrated technology several options are available which are explained in this FAQ in greater detail.

1.1 Reading in the hardware limit switches

To be able to use the limit switch signals in the integrated technology of the technology CPU, they must be read in there, or be transferred there. There are the following options:

- Direct connection of the hardware limit switch to the integrated technology via the digital OnBoard inputs of the technology CPU.
- Distributed connection of the hardware limit switches at the integrated technology via the digital inputs of a distributed I/O ET200 connected at the DP (Drive).
- Usage of the digital inputs of the drive device.

Figure 1-1 Example for the transfer options



Note tc te
t s e r
connection of the technology CPU or via the **OnBoard inputs of the CPU** which are also available in the integrated technology.

Using signals for technological functions which are read in via the distributed I/O at the MPI/DP connection of the technology CPU or via a signal module SMxxx in the PLC part is not possible!

1.2 Principle procedure for processing the signal

Principally, the following procedures are necessary for using the hardware limit switch signals in the integrated technology of the technology CPU:

- **Reading in** the hardware limit switches directly at the technology CPU or via input modules which are connected at the integrated technology.
- **Transferring** the signals into the integrated technology. This point does not apply for direct connection of the hardware limit switches at the technology CPU.
- **Assigning** the transferred signals as limit switch signals to the respective axis in the integrated technology.

The procedures required for the individual points are described for the respective connection type of the hardware limit switch in the following chapters.

2 Direct Connection at the OnBoard Inputs

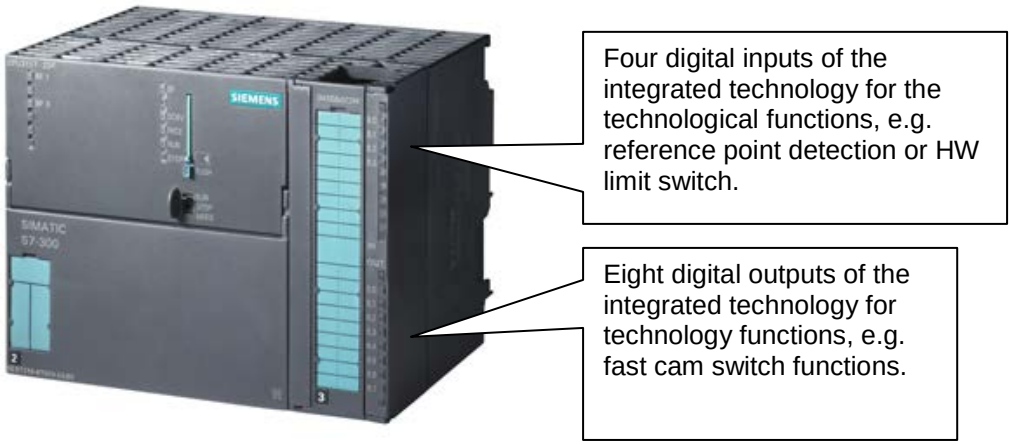
The easiest option of making limit switch signals available in the integrated technology of the technology CPU is connecting the hardware limit switches to the OnBoard inputs of the technology CPU.

2.1 Reading in the limit switch signals

The four digital inputs existing on the technology CPU can be evaluated directly in the integrated technology and be used for technological functions such as e.g. reference point detection.

The hardware limit switches of an axis can also be connected to these inputs.

Figure 2-1 OnBoard interfaces of the technology CPU



The evaluation of the limit switch signals of the OnBoard inputs in the integrated technology occurs via the I/O address of the OnBoard inputs.

Determining the I/O address

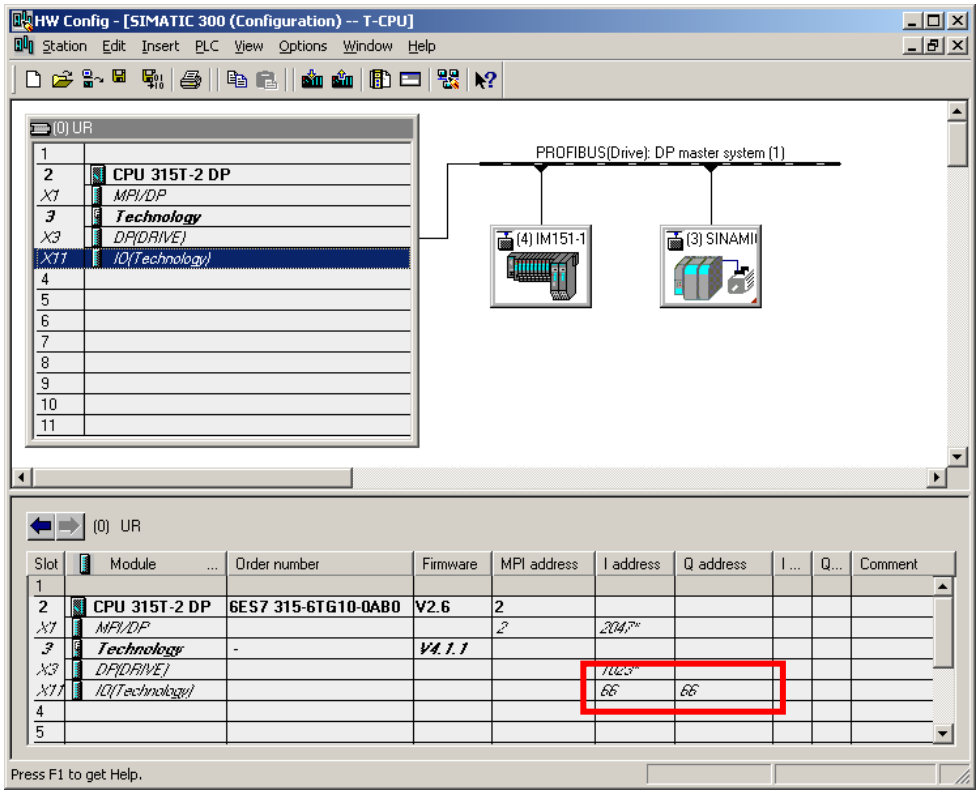
Open the HW Config and mark a slot of technology CPU in the SIMATIC rack.

In the Details section of HW Config the I/O addresses of the OnBoard inputs and outputs of the technology CPU are then displayed.

Double-clicking the slot of the OnBoard inputs and outputs of the technology CPU enables modifying the I/O address of the inputs and outputs. For using the OnBoard inputs and outputs in the integrated technology for technological functions select a **I/O address ≥64**.

Note **I/O addresses <64** can only be used in the PLC section of the technology CPU and are therefore available not available for technological functions in the integrated technology.

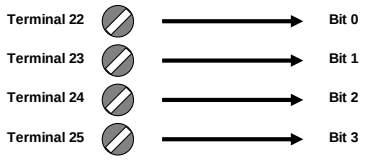
Figure 2-2 Determining the I/O addresses in HW Config



Determining the bit number

Between the bit numbers and the input terminals of the OnBoard inputs of the technology CPU there is a linear correlation so that the bit number can be determined very simply.

Figure 2-3 Determining the bit numbers



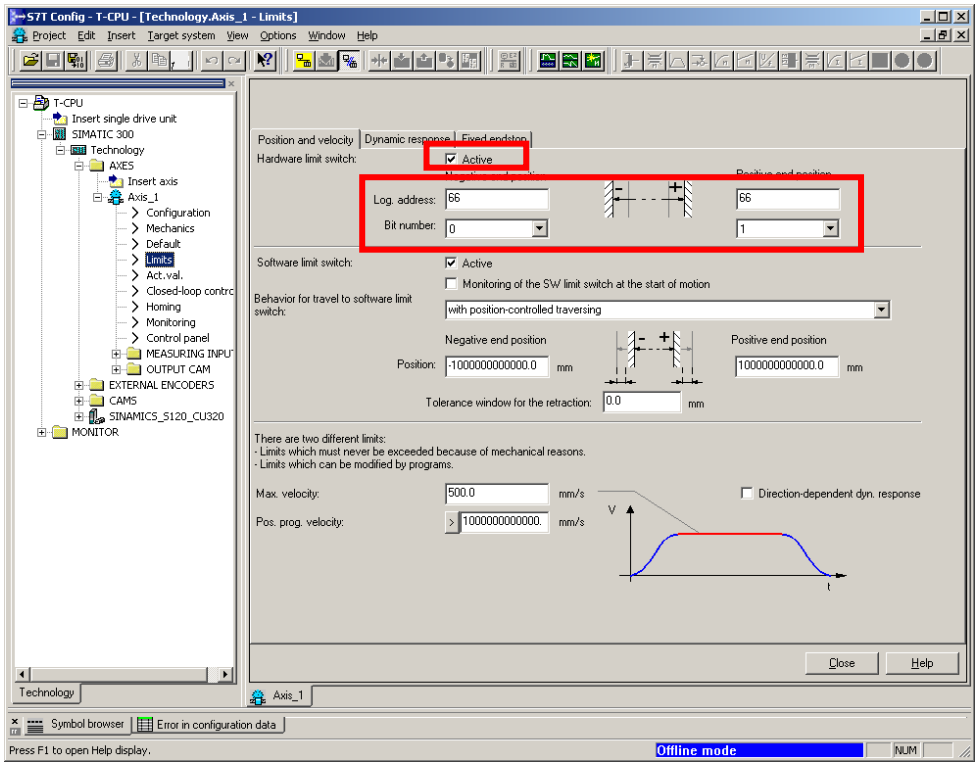
2.2 Assigning the limit switch signals in S7T Config

Now the determined I/O address must be entered in the mask for setting the hardware limit switch at the appropriate axis in S7T Config.

In S7T Config you open the configuration of the appropriate axis and select the configuration mask for the **limits**.

Activate the hardware limit switch and enter the determined I/O address in HW Config and the bit number of the input terminal.

Figure 2-4 Assigning the I/O address in S7T Config



Save and compile the settings and download them into the technology CPU.

3 Distributed Connection at the DP(Drive) via ET200

The hardware limit switches can also be read in decentralized via an input module of an ET200 S or ET200 M which are connected at the DP(Drive) of the technology CPU.

Note Only use ET200 modules at **DP(Drive)** of the technology CPU, which are listed in the profile **SIMATIC technology CPU** of the hardware catalog of HW Config.

Example configuration

The connection of the hardware limit switch to an ET200 S is displayed in this FAQ as an example.

3.1 Reading in the limit switch signals

Connect the hardware limit switches to an input module of the ET200 S.

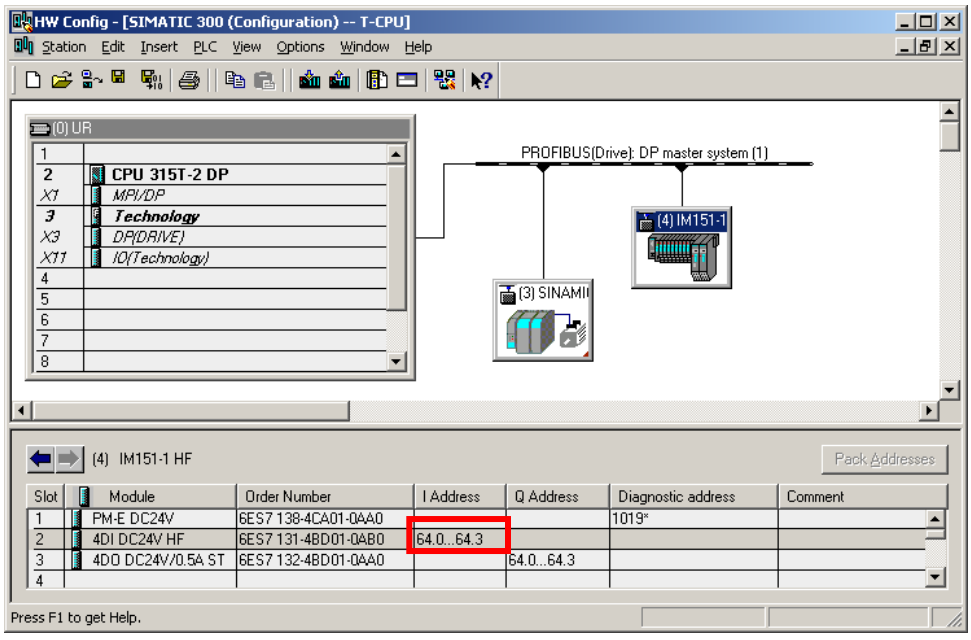
Determining the I/O address

Open the HW Config and mark the respective ET200 S module at the DP(Drive) of the technology CPU.

In the Details section of HW Config the I/O address of the respective ET200 S module (electronics module) can now be read off.

Double-clicking the electronics module in the Details section of the HW Config also enables modifying the I/O address. To be able to use the inputs in the integrated technology of the technology CPU, the **I/O address ≥64** must be selected.

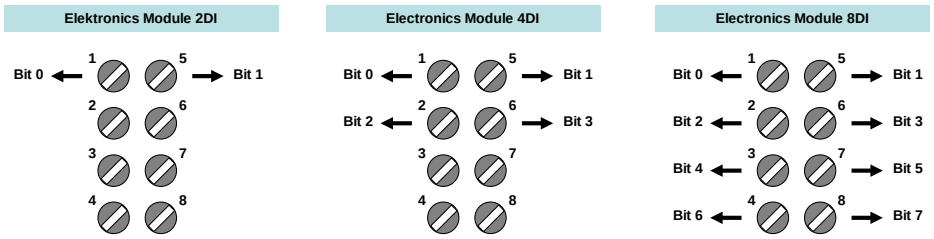
Figure 3-1 Determining the I/O addresses in HW Config



Determining the bit number

Between the bit numbers and the input terminals of the ET200 S there is the following correlation:

Figure 3-2 Determining the bit numbers



3.2 Transferring the limit switch signals

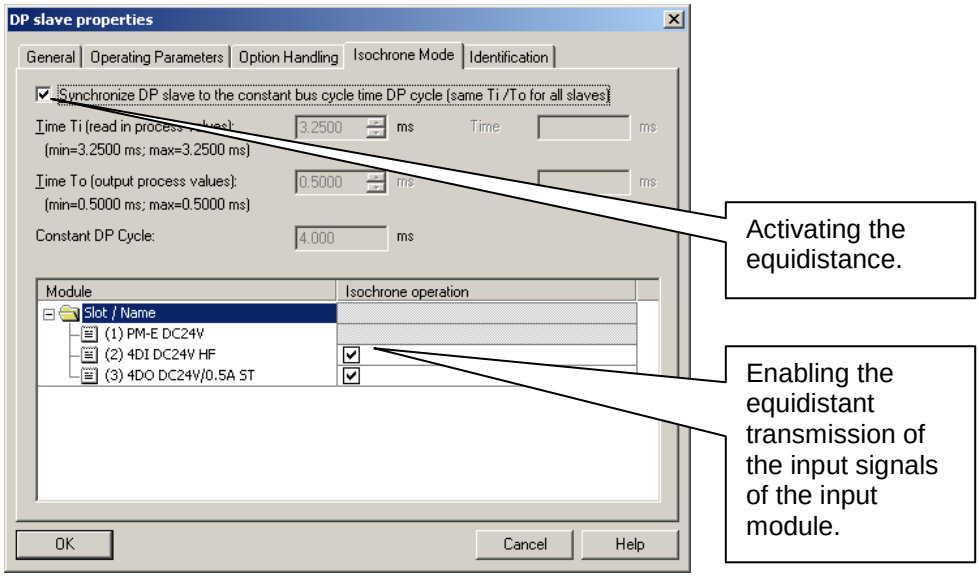
The signals of the hardware limit switches are transferred to the technology CPU by the ET200 S via the equidistant PROFIBUS DP(Drive).

Setting the equidistance at the ET200 S

Double-click the ET200 S in HW Config.

Select the **Isochrone Mode** tab for making the settings.

Figure 3-3 Activating the equidistant PROFIBUS for ET200 S



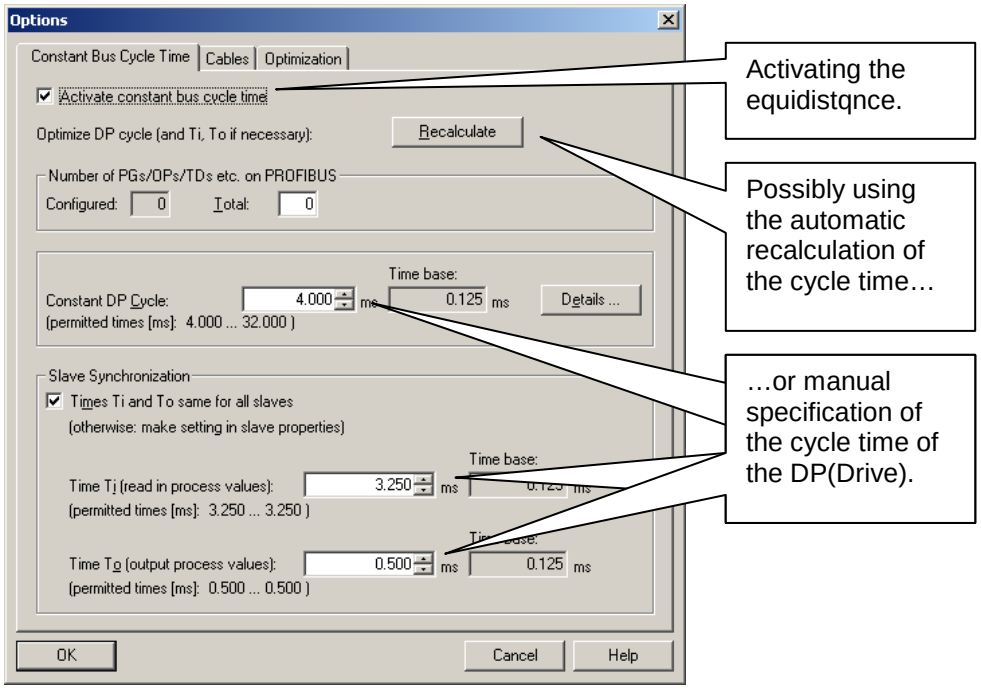
Adjusting the DP(Drive)

After adding the ET200 S the cycle time of the DP(Drive) and the setting of the T_i and T_o times may need to be adjusted.

The DP(Drive) can be adjusted via a double-click on the PROFIBUS line of the DP(Drive).

You reach the mask displayed below via the **Properties** button and in the **Network Settings** tab via the **Options** button.

Figure 3-4 Setting the equidistance at DP(Drive)



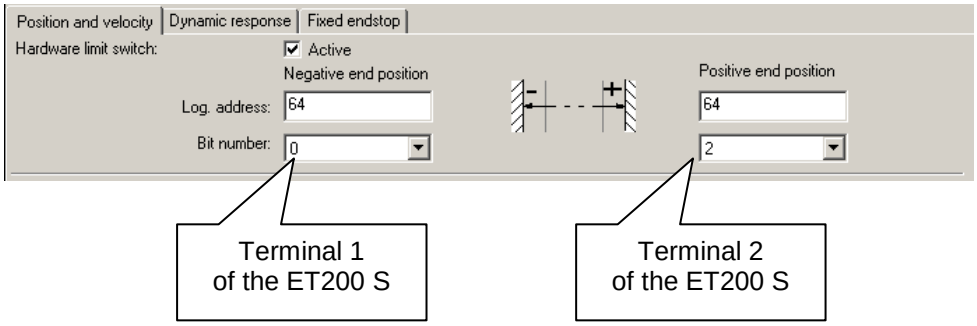
3.3 Assigning the limit switch signals in S7T Config

Finally the determined I/O address must be entered in the mask for setting the hardware limit switch at the appropriate axis in S7T Config.

In S7T Config you open the configuration of the appropriate axis and select the configuration mask for the **limits**.

Activate the hardware limit switch and enter the determined I/O address in HW Config and the bit number of the input terminal.

Figure 3-5 Assigning the I/O address in S7T Config



4 Connection at the Inputs of SINAMICS S120

The hardware limit switches can also be connected to the digital inputs of the drive device and via the drive message frames to the technology CPU.

There are two basic options:

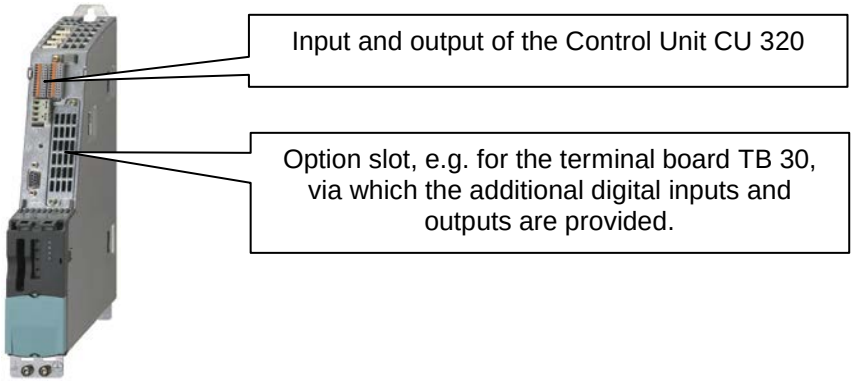
- **Using a special message frame of the drive**
  By providing a special message frame (telegram 390) the SINAMICS S120 enables transferring the signals of the digital inputs and outputs of the control unit in a very comfortable way to the integrated technology of the technology CPU.
- **Expanding the drive message frame**
  Should the digital inputs and outputs of an optionally pluggable terminal board TB 30 be used, an expansion of the drive message frame must be performed and the signals be switched to the message frame via BiCo technology.

4.1 Reading in the limit switch signals

The hardware limit switches can be connected to the SINAMICS S120 on the Control Unit CU 320 at the locations below:

- **Digital inputs of the Control Unit CU 320**
  For transferring the signals of the digital inputs of the control unit CU 320 the message frames 390 to 392 are available.
- **Digital inputs on the optional terminal board TB 30**
  If the optional terminal board TB 30 is plugged on the control unit CU 320 of the SINAMICS S120, the hardware limit switches can also be connected on the existing additional digital inputs there.
  However, no special telegrams are available in this case for the transmission of the signals. The transmission must be performed by a message frame expansion and manual assignment of signals via BiCo technology.

Figure 4-1 Reading in the hardware limit switches at the SINAMICS CU 320



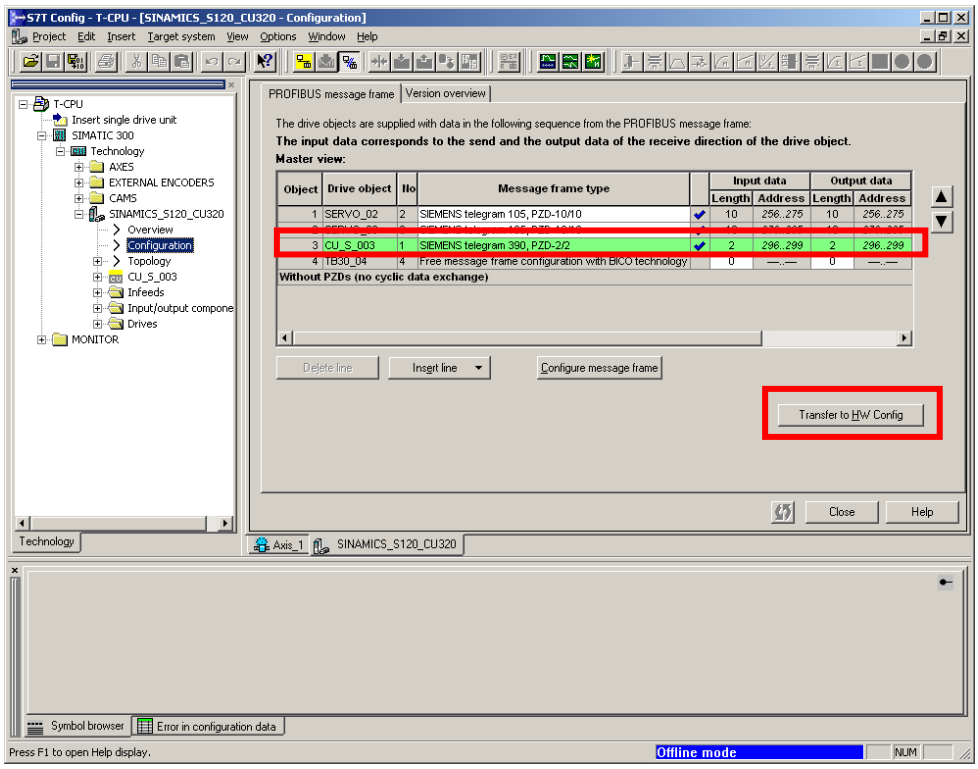
4.1.1 Selecting the communication message frame

Digital inputs of the CU 320

If the hardware limit switches are connected at the digital inputs of the CU 320, message frame 390 to 392 can be selected for the CU 320. In this message frame the signals for the digital inputs and outputs of the control unit can be automatically transferred.

After changing the message frame settings an alignment with HW Config must be performed, the configuration be saved and compiled and be loaded to the drive, and there be transferred from RAM to ROM.

Figure 4-2 Selecting the message frame 390 at the Control Unit CU 320



Optional Terminal Board TB 30

If on the other hand the hardware limit switches are connected at the optional terminal board TB 30, a telegram expansion in the configuration of the SINAMICS S120 must be performed and the limit switch signals must be transferred to the message frame expansion via BiCo technology.

Figure 4-3 Message frame expansion at terminal board TB 30

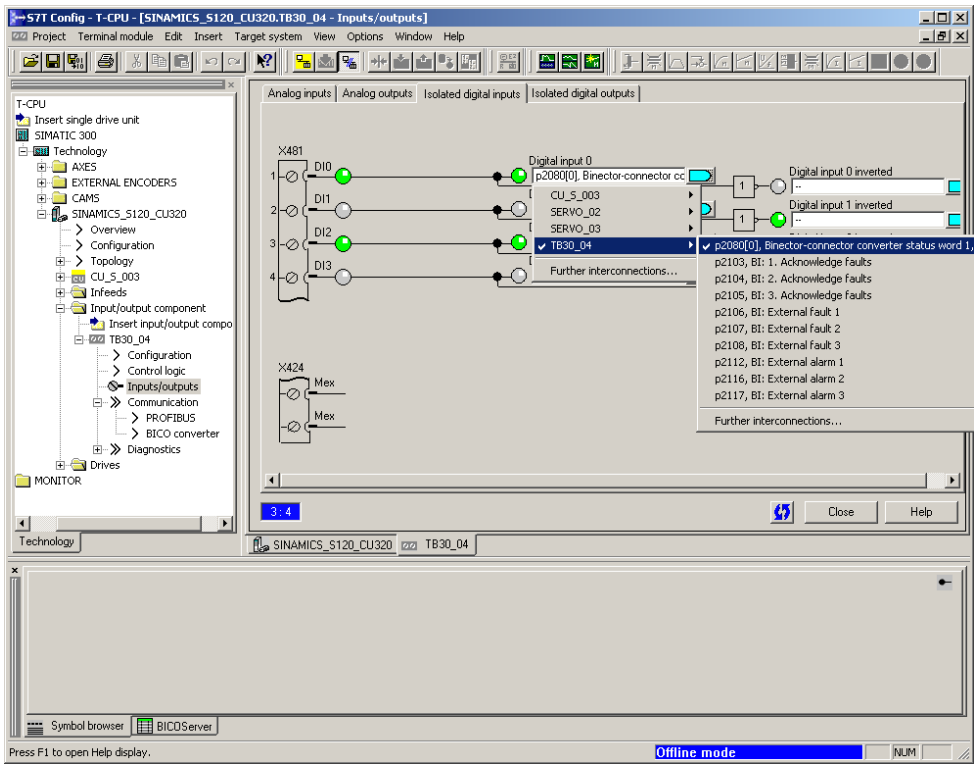
Object	Drive object	No	Message frame type		Input data		Output data	
					Length	Address	Length	Address
1	SERVO_02	2	SIEMENS telegram 105, PZD-10/10	✔	10	256..275	10	256..275
2	SERVO_03	3	SIEMENS telegram 105, PZD-10/10	✔	10	276..295	10	276..295
3	CU_S_003	1	SIEMENS telegram 390, PZD-2/2	✔	2	296..299	2	296..299
4	TB30_04	4	Free message frame configuration with BICO technology	✔	2	300..303	2	300..303
Without PZDs (no cyclic data exchange)								

Prolonging the input data by 2 words

Prolonging the output data by 2 words

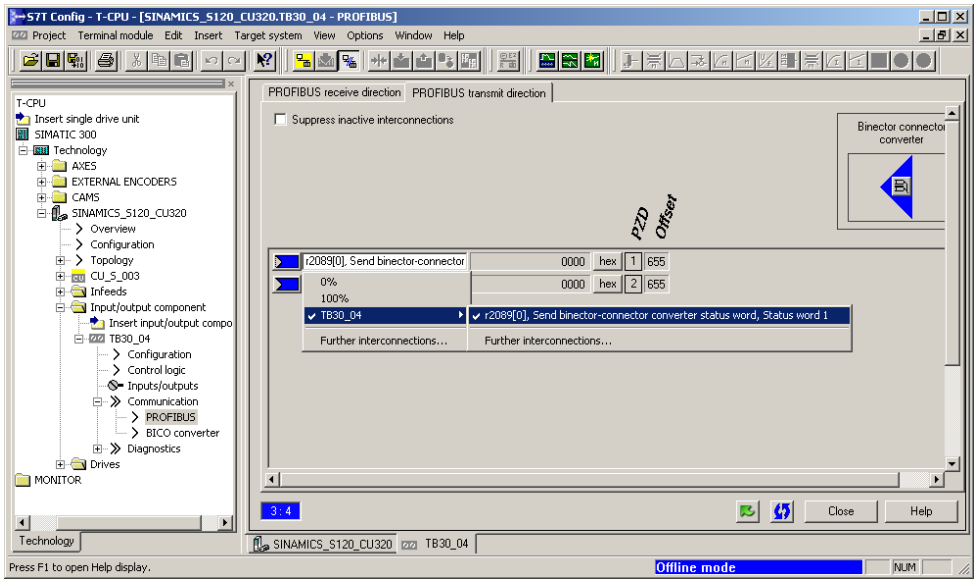
Inter nal board e
fram n additiona tor
converter. The individual bits of the inputs are thereby entered into the converter…

Figure 4-4 Connecting the inputs with the BiCo converter



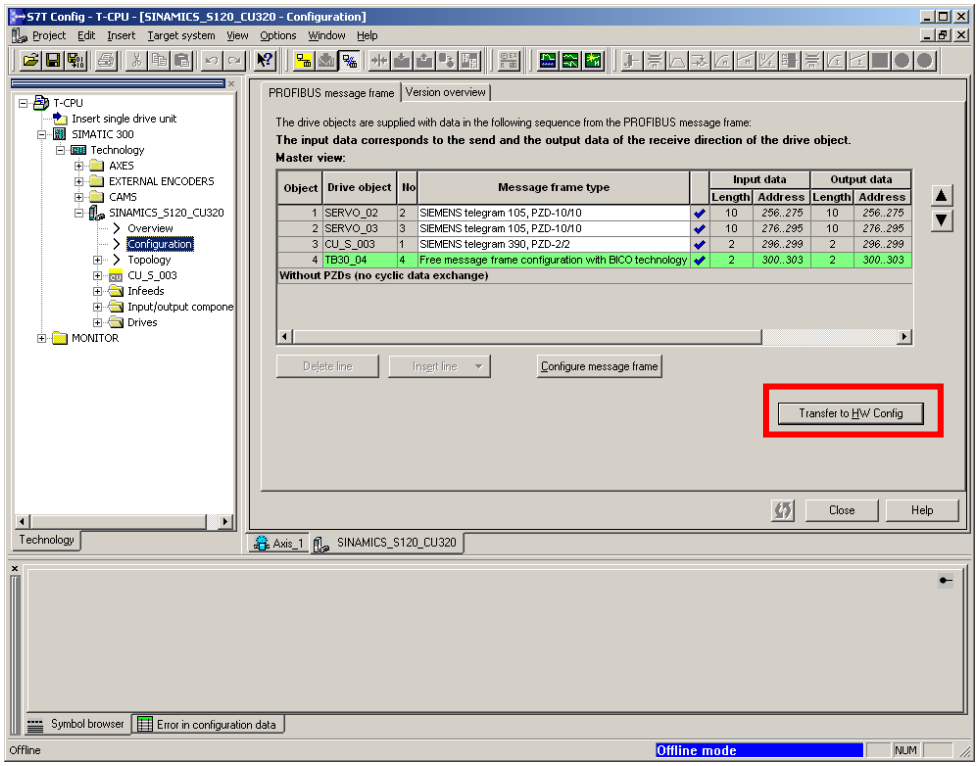
…and the complete converter word is then transferred to the message frame which is sent to the technology CPU.

Figure 4-5 Transferring the BiCo connector WORD to the message frame



After modifying the message frame settings an alignment with HW Config must also be performed here.

Figure 4-6 Alignment with HW Config after message frame expansion of the TB 30



4.1.2 Determining the I/O address

After the alignment with HW Config the respective addresses are assigned to the individual message frames in the configuration of the SINAMICS S120.

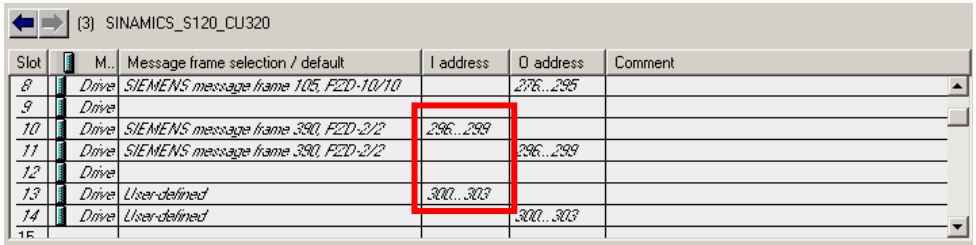
The I/O address of the hardware limit switch can either be determined via the configuration of the SINAMICS S120 in S7T Config…

Figure 4-7 Determining the I/O address in S7T Config

Object	Drive object	No	Message frame type		Input data		Output data	
					Length	Address	Length	Address
1	SERVO_02	2	SIEMENS telegram 105, PZD-10/10	✔	10	256..275	10	256..275
2	SERVO_03	3	SIEMENS telegram 105, PZD-10/10	✔	10	276..295	10	276..295
3	CU_S_003	1	SIEMENS telegram 390, PZD-2/2	✔	2	296..299	2	296..299
4	TB30_04	4	Free message frame configuration with BICO technology	✔	2	300..303	2	300..303
Without PZDs (no cyclic data exchange)								

... or via the drive device in HW Config.

Figure 4-8 Determining the I/O address in HW Config

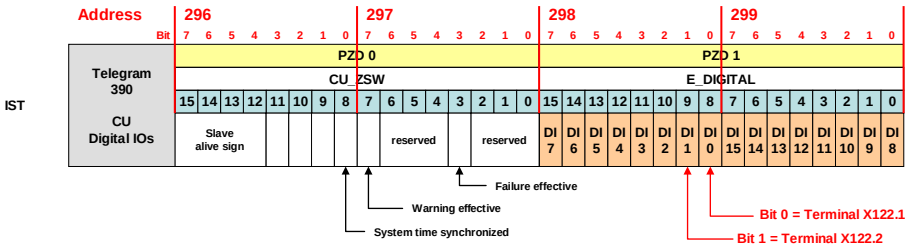


4.1.3 Determining the bit number

Digital inputs of the CU 320

For determining the bit number within the message frame the **Big Endian format** must be observed which is applied when transferring data between drive and CPU.

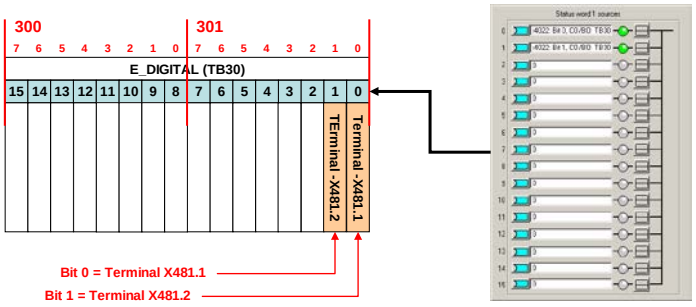
Figure 4-9 Bit numbers of the hardware limit switches in message frame 390



Optional Terminal Board TB 30

When using the terminal board TB 30 while using the message frame expansion the **Big Endian Format** is also used for transferring data to the technology CPU. Additionally, however, the assignment of the inputs via the BiCo technology must be observed.

Figure 4-10 Bit numbers of the hardware limit switches at the terminal board TB 30



4.2 Transferring the limit switch signals

After adding the message frame 390 or the message frame expansion the cycle time of the DP(Drive) and the setting of the T_i and T_o times may need to be adjusted.

The settings occur analog to the displayed procedure for using the ET200 S at the DP(Drive).

4.3 Assigning the limit switch signals in S7T Config

Finally the determined I/O address must be entered in the mask for setting the hardware limit switch at the appropriate axis in S7T Config.

In S7T Config you open the configuration of the appropriate axis and select the configuration mask for the **limits**.

Activate the hardware limit switch and enter the determined I/O address in HW Config and the bit number of the input terminal.

Figure 4-11 Assigning the limit switch signals of Control Unit CU 320

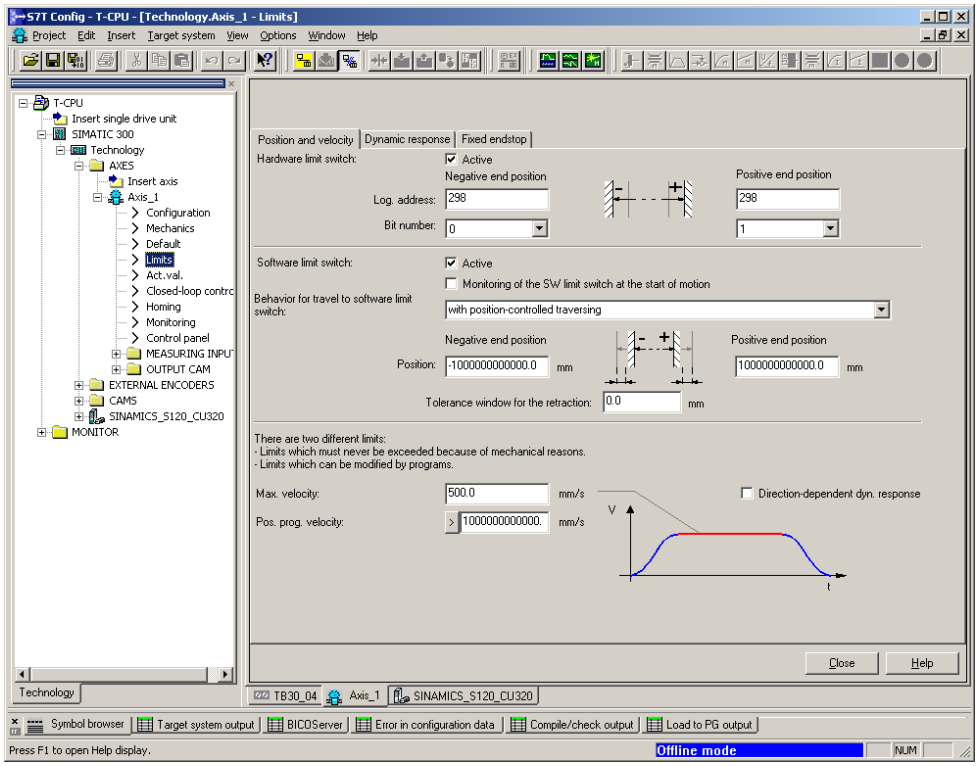
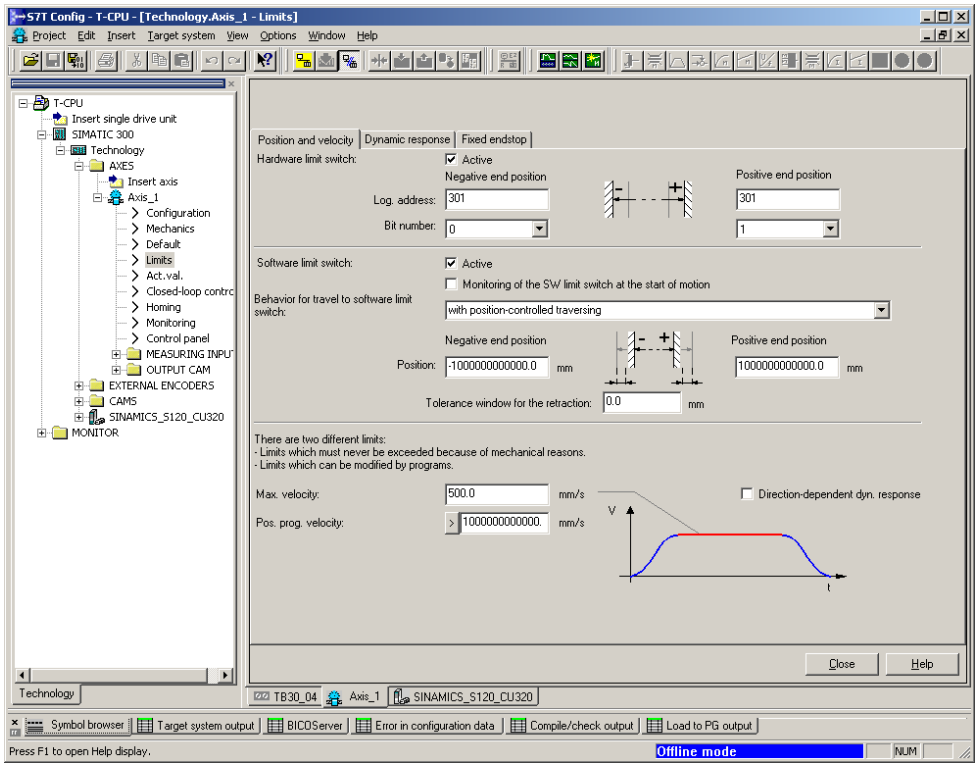


Figure 4-12 Assigning the limit switch signals of the TB 30

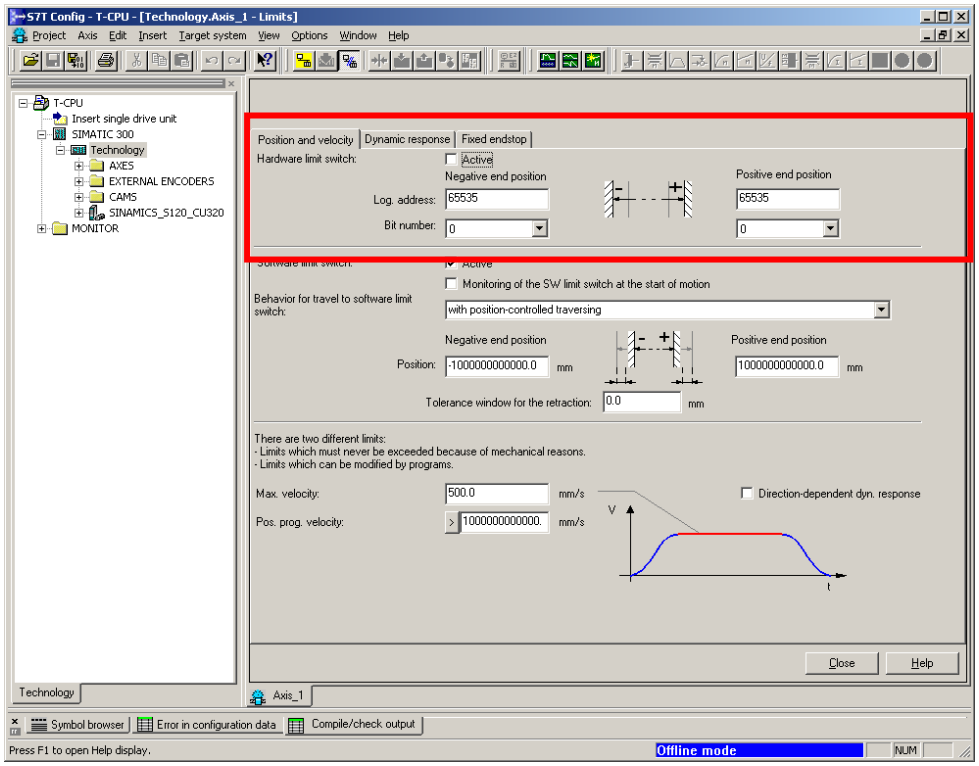


5 Additional Notes

5.1 Deactivating the hardware limit switches in S7T Config

Deactivating the hardware limit switches in S7T Config requires entering the value **65535** for the I/O address or **log. address**. Otherwise an error-free compilation of the technology in S7T Config is no longer possible.

Figure 5-1 Deactivation of the hardware limit switches in S7T Config



5.2 Observe the states of the hardware limit switches

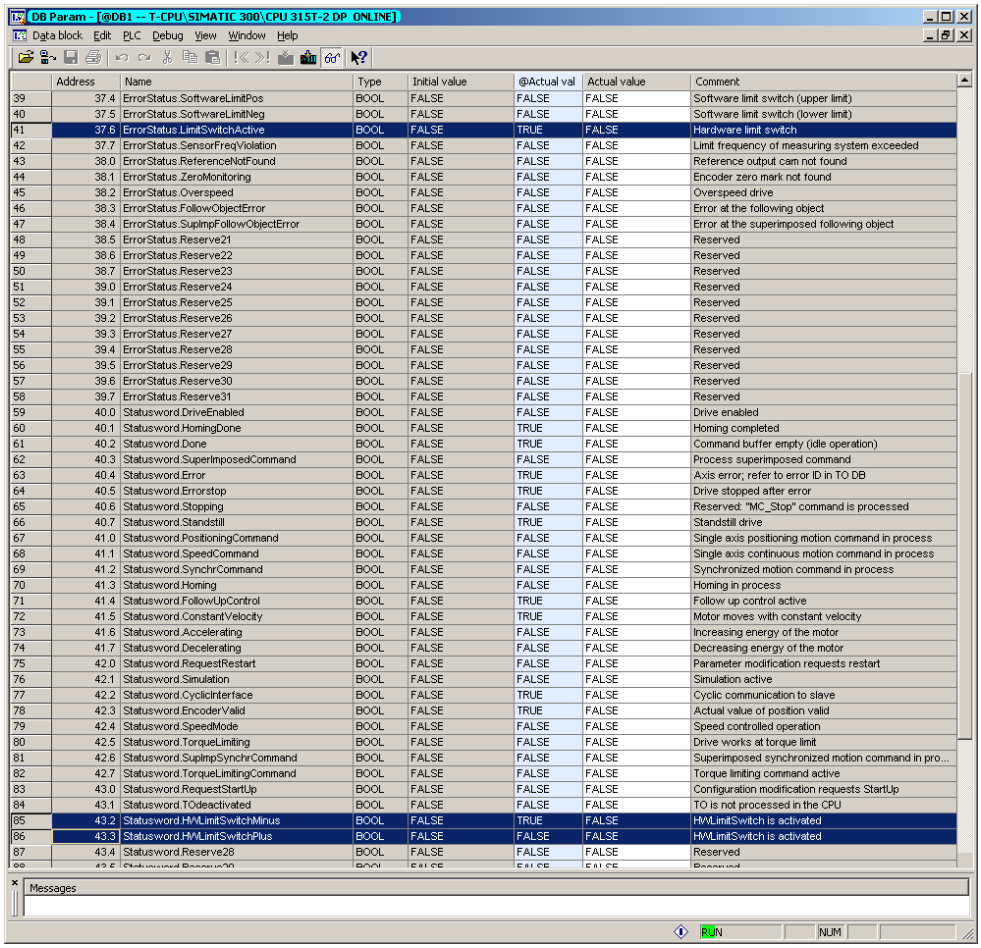
The states of the hardware limit switches can be monitored via the technology data block of the respective axes or via the expert list of the axis in S7T Config.

Monitoring the hardware limit switches in the technology data block

Two different displays for the states of the hardware limit switches are available in the technology data block:

- **ErrorStatus.LimiSwitchActive**
  Display of the error status of the integrated technology. This bit indicates that a limit switch has picked up. The bit is only deleted if the occurred error has been acknowledged in the integrated technology.
- **Statusword.HWLimitSwitchMinus** / **Statusword.HWLimitSwitchPlus**
  Display of the current status of the input terminals and hence the hardware limit switches.

Figure 5-2 Monitoring the hardware limit switches in the technology data block



	Address	Name	Type	Initial value	@Actual val	Actual value	Comment
39	37.4	ErrorStatus.SoftwareLimitPos	BOOL	FALSE	FALSE	FALSE	Software limit switch (upper limit)
40	37.5	ErrorStatus.SoftwareLimitNeg	BOOL	FALSE	FALSE	FALSE	Software limit switch (lower limit)
41	37.6	ErrorStatus.LimitSwitchActive	BOOL	FALSE	TRUE	FALSE	Hardware limit switch
42	37.7	ErrorStatus.SensorFreqViolation	BOOL	FALSE	FALSE	FALSE	Limit frequency of measuring system exceeded
43	38.0	ErrorStatus.ReferenceNotFound	BOOL	FALSE	FALSE	FALSE	Reference output cam not found
44	38.1	ErrorStatus.ZeroMonitoring	BOOL	FALSE	FALSE	FALSE	Encoder zero mark not found
45	38.2	ErrorStatus.Overspeed	BOOL	FALSE	FALSE	FALSE	Overspeed drive
46	38.3	ErrorStatus.FollowObjectError	BOOL	FALSE	FALSE	FALSE	Error at the following object
47	38.4	ErrorStatus.SuplmpFollowObjectError	BOOL	FALSE	FALSE	FALSE	Error at the superimposed following object
48	38.5	ErrorStatus.Reserve21	BOOL	FALSE	FALSE	FALSE	Reserved
49	38.6	ErrorStatus.Reserve22	BOOL	FALSE	FALSE	FALSE	Reserved
50	38.7	ErrorStatus.Reserve23	BOOL	FALSE	FALSE	FALSE	Reserved
51	39.0	ErrorStatus.Reserve24	BOOL	FALSE	FALSE	FALSE	Reserved
52	39.1	ErrorStatus.Reserve25	BOOL	FALSE	FALSE	FALSE	Reserved
53	39.2	ErrorStatus.Reserve26	BOOL	FALSE	FALSE	FALSE	Reserved
54	39.3	ErrorStatus.Reserve27	BOOL	FALSE	FALSE	FALSE	Reserved
55	39.4	ErrorStatus.Reserve28	BOOL	FALSE	FALSE	FALSE	Reserved
56	39.5	ErrorStatus.Reserve29	BOOL	FALSE	FALSE	FALSE	Reserved
57	39.6	ErrorStatus.Reserve30	BOOL	FALSE	FALSE	FALSE	Reserved
58	39.7	ErrorStatus.Reserve31	BOOL	FALSE	FALSE	FALSE	Reserved
59	40.0	Statusword.DriveEnabled	BOOL	FALSE	FALSE	FALSE	Drive enabled
60	40.1	Statusword.HomingDone	BOOL	FALSE	TRUE	FALSE	Homing completed
61	40.2	Statusword.Done	BOOL	FALSE	TRUE	FALSE	Command buffer empty (idle operation)
62	40.3	Statusword.SuperImposedCommand	BOOL	FALSE	FALSE	FALSE	Process superimposed command
63	40.4	Statusword.Error	BOOL	FALSE	TRUE	FALSE	Axis error; refer to error ID in TO DB
64	40.5	Statusword.Errorstop	BOOL	FALSE	TRUE	FALSE	Drive stopped after error
65	40.6	Statusword.Stopping	BOOL	FALSE	FALSE	FALSE	Reserved: "MC_Stop" command is processed
66	40.7	Statusword.Standstill	BOOL	FALSE	TRUE	FALSE	Standstill drive
67	41.0	Statusword.PositioningCommand	BOOL	FALSE	FALSE	FALSE	Single axis positioning motion command in process
68	41.1	Statusword.SpeedCommand	BOOL	FALSE	FALSE	FALSE	Single axis continuous motion command in process
69	41.2	Statusword.SynchrCommand	BOOL	FALSE	FALSE	FALSE	Synchronized motion command in process
70	41.3	Statusword.Homing	BOOL	FALSE	FALSE	FALSE	Homing in process
71	41.4	Statusword.FollowUpControl	BOOL	FALSE	TRUE	FALSE	Follow up control active
72	41.5	Statusword.ConstantVelocity	BOOL	FALSE	TRUE	FALSE	Motor moves with constant velocity
73	41.6	Statusword.Accelerating	BOOL	FALSE	FALSE	FALSE	Increasing energy of the motor
74	41.7	Statusword.Decelerating	BOOL	FALSE	FALSE	FALSE	Decreasing energy of the motor
75	42.0	Statusword.RequestRestart	BOOL	FALSE	FALSE	FALSE	Parameter modification requests restart
76	42.1	Statusword.Simulation	BOOL	FALSE	FALSE	FALSE	Simulation active
77	42.2	Statusword.CyclicInterface	BOOL	FALSE	TRUE	FALSE	Cyclic communication to slave
78	42.3	Statusword.EncoderValid	BOOL	FALSE	TRUE	FALSE	Actual value of position valid
79	42.4	Statusword.SpeedMode	BOOL	FALSE	FALSE	FALSE	Speed controlled operation
80	42.5	Statusword.TorqueLimiting	BOOL	FALSE	FALSE	FALSE	Drive works at torque limit
81	42.6	Statusword.SuplmpSynchrCommand	BOOL	FALSE	FALSE	FALSE	Superimposed synchronized motion command in pro...
82	42.7	Statusword.TorqueLimitingCommand	BOOL	FALSE	FALSE	FALSE	Torque limiting command active
83	43.0	Statusword.RequestStartUp	BOOL	FALSE	FALSE	FALSE	Configuration modification requests StartUp
84	43.1	Statusword.TOdeactivated	BOOL	FALSE	FALSE	FALSE	TO is not processed in the CPU
85	43.2	Statusword.HWLimitSwitchMinus	BOOL	FALSE	TRUE	FALSE	HWLimitSwitch is activated
86	43.3	Statusword.HWLimitSwitchPlus	BOOL	FALSE	FALSE	FALSE	HWLimitSwitch is activated
87	43.4	Statusword.Reserve28	BOOL	FALSE	FALSE	FALSE	Reserved

Monitoring the hardware limit switches via the expert list in S7T Config

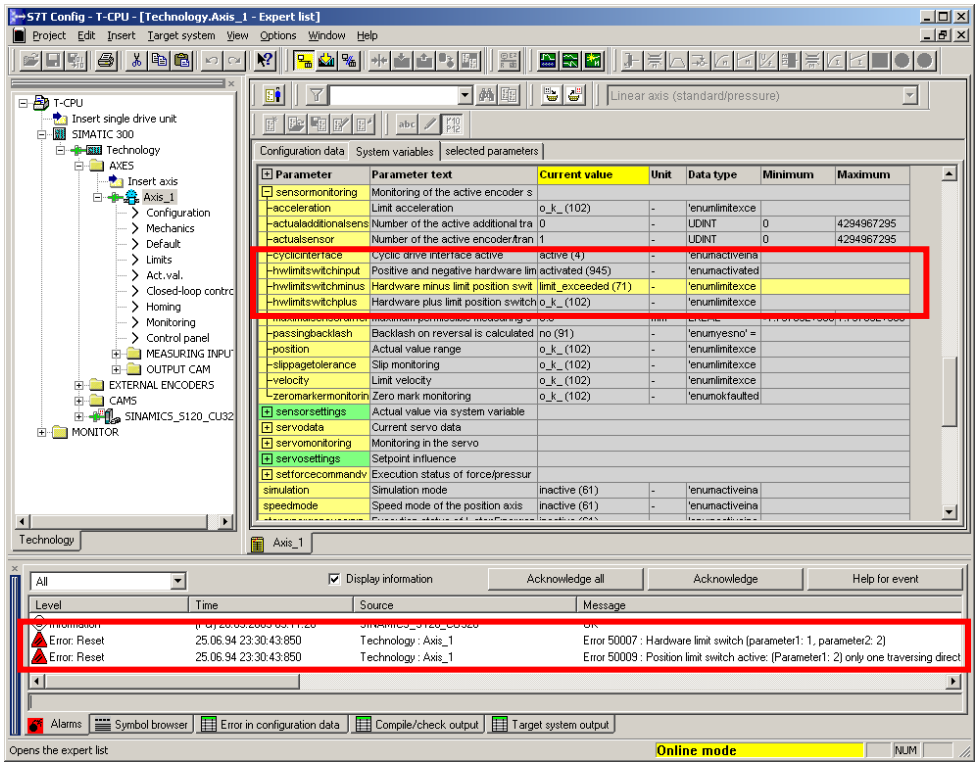
The signals of the hardware limit switches are available in the expert list of the respective axis in the **sensormonitoring** section.

There the following signals for monitoring the states of the hardware limit switches are output:

- **hwlimitswitchinput**
  Display whether the evaluation of the hardware limit switches in the configuration have been switched active or inactive.
- **hwlimitswitchminus**
  Switching state of the hardware limit switch in negative direction.
- **hwlimitswitchplus**
  Switching state of the hardware limit switch in positive direction.

Additionally after pickup of a hardware limit switch in the alarm window the respective technology error messages are output.

Figure 5-3 Monitoring the hardware limit switches in S7T Config



Note

Please note the **inverse logic** when evaluation the hardware limit switches which are required for wire-break detection by the CPU:

- Signal = 0 ⇨ hardware limit switch has picked up.
- Signal = 1 ⇨ hardware limit switch has **not** picked up.