SIMOTION D

# SIMOTION

# Frequently asked Questions

Configuration of drive-related I/Os
(Onboard I/Os, TMs and TB30)
with SIMOTION V4.1 SP4

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- Trained or instructed according to the latest safety standards in the care and use of the appropriate safety equipment.
- Trained in rendering first aid.

There is no explicit warning information in this documentation. However, reference is made to warning information and instructions in the Operating Instructions for the particular product.



### Information regarding export codes

AL: N

ECCN: N

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# Configuration of Onboard I/Os, TMs and TB30

**Note**
SINAMICS is used as a general term for the following versions:
- for **SINAMICS Integrated** with SIMOTION D410 and D4x5
- for the **CX32 SIMOTION Controller Extension**
  (scaling of the processing power on the drive end of a SIMOTION D4x5)
- for **SINAMICS S110/S120 Control Units** (CU305, CU310 and CU320)

This is particularly important for references to the project tree in the SCOUT engineering system, as the names of the entries in the project tree vary accordingly.

In this document, Control Unit (CU) is used as a general term for SIMOTON D, CX32 and CU305/CU310/CU320.



## 1 Basic Principles

### Assignment of the I/Os

The following principle distinctions have to be made for the configuration of I/Os:
- **I/Os assigned to SIMOTION (in the following also referred to as "SIMOTION I/Os")**
  ➔ i.e. the I/Os are functionally assigned to SIMOTION and controlled from the SIMOTION user program
- **I/Os assigned to SINAMICS (in the following also referred to as "SINAMICS I/Os")**
  ➔ i.e. the I/Os are functionally assigned to SINAMICS
  ➔ The user can configure that SINAMICS I/Os can also be used by SIMOTION.

The approach to be pursued for configuration and possible fields of application depend on whether I/Os assigned to SIMOTION or SINAMICS are used.

**Table 1-1: Assignment of I/Os to SIMOTION or SINAMICS**

| | SIMOTION I/Os | SINAMICS I/Os |
|---|---|---|
| Available I/O terminals | ▪ I/Os connected via PROFIBUS or PROFINET (e.g. SIMATIC ET 200)<br>▪ Onboard I/Os with SIMOTION C2xx | ▪ Onboard I/Os SIMOTION D4xx<br>▪ Onboard I/Os SIMOTION CX32<br>▪ Onboard I/Os SINAMICS S120 CU310 / CU320<br>▪ Onboard I/Os SINAMICS S110 CU305<br>▪ TM15 DI/DO<br>▪ TM15 (SIMOTION)<br>▪ TM17 (SIMOTION)<br>▪ TM31<br>▪ TM41<br>▪ TB30<br><br>Depending on the configuration, all or some I/Os can also be used by SIMOTION. TM15 and TM17 High Feature are always assigned automatically and individually to SIMOTION. |
| Configuration | Access to the I/Os via SIMOTION I/O-variable (process image, direct accesses to the peripherals) or SIMOTION technology objects (TO Output Cam, TO Cam Track, ...) | Access to the I/Os via the interconnection of drive parameters (BICO interconnection) or via SINAMICS DCC (Drive Control Chart) |
| Example for use | Controlling of I/Os by means of a gating logic, e.g. programmed in LAD/FBD | Use of a DI on the Control Unit for the control of Safe Stop 1;<br>Use of a DO for the output of the "Infeed ready signal" |



**Note**

The module hardware of TM15 (SIMOTION) and TM15 DI/DO is identical, and a difference is only made when inserting the component. In the project navigator under the corresponding SINAMICS CU, double click on "Insert input/output component". In the dialog which pops up, select the "TM15 (SIMOTION)" or "TM15 DI/DO" terminal module in the "Drive objects type" field.

➔ For more detailed information, refer to the "*TM15/TM17 High Feature Terminal Modules" Commissioning Manual.*

The designation "(SIMOTION)" with TM15 and TM17 High Feature in the dialog "insert input/output components" is only made from V4.1 SP2 on.

## Overview of the use of I/Os

**PROFIBUS / PROFINET I/Os** (e.g. SIMATIC ET 200) are exclusively assigned to SIMOTION. The access to the I/O area is performed via technology objects (e.g. TO Cam Track) or from the SIMOTION user program via I/O variables.

**Onboard I/Os of a Control Unit (D4xx, CU3xx, CX32), and also TB30, TM15, TM15 DI/DO, TM17 High Feature, TM31 and TM41,** are SINAMICS I/Os, and the related inputs and outputs are available to SINAMICS functions (example: DO for the output of the Ready signal of the infeed).
In order to use SINAMICS I/Os with SIMOTION, these I/Os must be connected to frames via a BICO interconnection on the SINAMICS end in order to ensure that the inputs and outputs can be accessed from this end. For more detailed information on the various connection options, refer to *Chapter 2, Use of SINAMICS I/Os by SIMOTION*.

The **TM15 and TM17 High Feature terminal modules** are an exception, as an interconnection to a “free frame” is performed automatically already upon the creation of the modules. This ensures that the data of the frame is mapped to the I/O area of SIMOTION.
TM15 and TM17 High Feature are therefore exclusively available for SIMOTION.



### Drive objects type

Concerning the modules TM15 and TM17 High Feature, from V4.1 SP2 on, the following names are used for the drive objects types in the dialog "insert input/output components":

- Module TM15
  - → Drive objects type TM15 DI/DO → BICO-interconnectable (utilization by SIMOTION and/or SINAMICS)
  - → Drive objects type TM15 (SIMOTION) → exclusive utilization by SIMOTION
- Module TM17 High Feature
  - → Drive objects type TM17 (SIMOTION) → exclusive utilization by SIMOTION

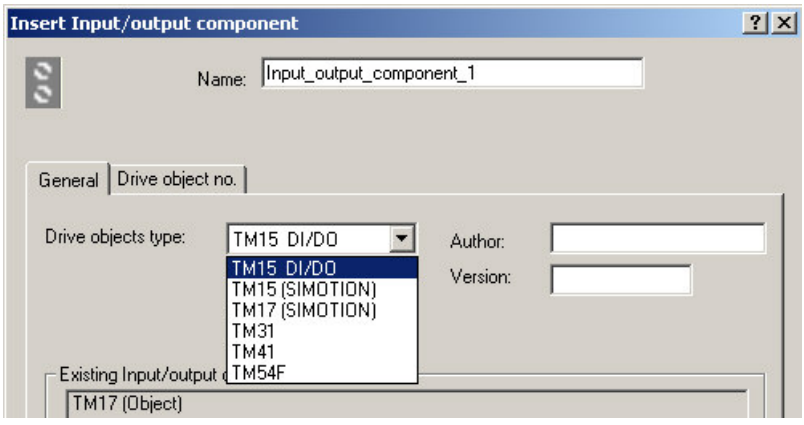



**Figure 1-1: Insert input/output components**

### The drive in the Topology view of SIMOTION

In the Topology view, drives are stations on the SIMOTION I/O bus.

The SINAMICS S110/S120 CU305, CU310 and CU320 drives are connected as stations to a real bus segment of the PROFIBUS or PROFINET type.
The SINAMICS Integrated of a D4xx and the CX32 Controller Extension are represented as a station on the "virtual" PROFIBUS Integrated. The "virtual" bus is extended by SINAMICS Integrated to the CX32 Controller Extension via the "real" DRIVE-CLiQ.

Due to the consistent representation of SINAMICS Integrated, the CX32 Controller Extension and the CU305/CU310/320 SINAMICS Control Units, the configuration is to a large degree independent of the topology.

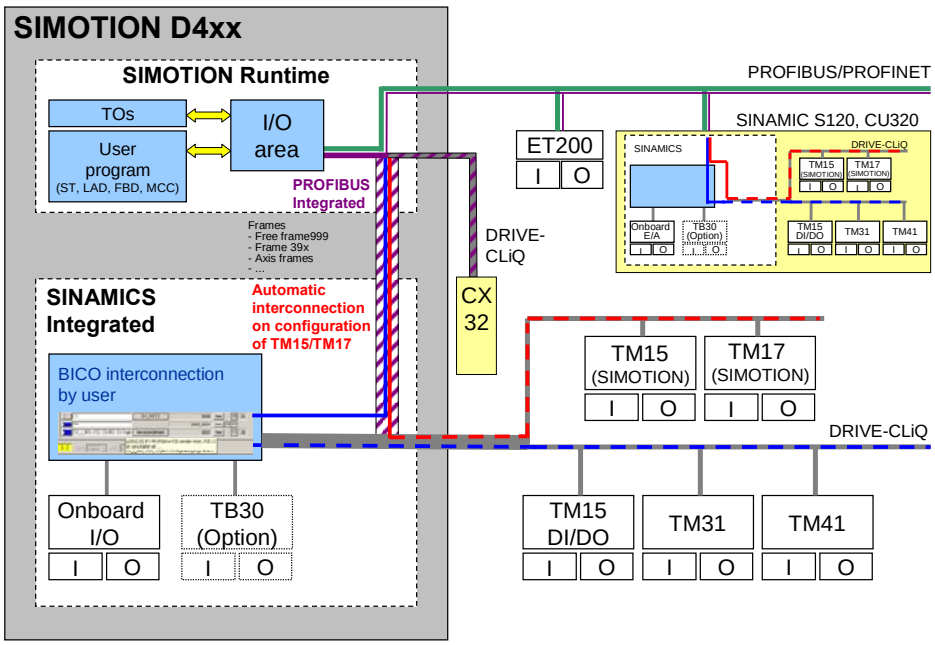



**Figure 1-2: Integration of I/Os**

## 1.1 Configuration of SIMOTION I/Os

### I/Os on PROFIBUS / PROFINET

Via the PROFIBUS or PROFINET interface, standard I/O systems can be connected to SIMOTION D, e.g. the distributed SIMATIC ET 200 I/O systems.

These I/Os can be accessed from SIMOTION D:
- via direct access with I/O variables
- via the process image of the cyclic tasks with I/O variables
- with the fixed process image of the BackgroundTask
- via TO Output Cam or TO Cam Track

**Note**
Access via the process image is more performant than direct access.

For more detailed information
- on I/O access options, refer to the *SIMOTION ST Structured Text Programming and Operation Manual.*
- on I/O processing on field bus systems (timing, classification within the task system), refer to the *Basic Functions Function Manual*.



## 1.2 Configuration of SINAMICS I/Os

I/Os assigned to SINAMICS are interconnected using the engineering tools of the drive. These include:
- BICO interconnection
  - via parameters in the expert list
  - via interconnection screen forms
- configuration via SINAMICS Drive Control Charts (DCC)

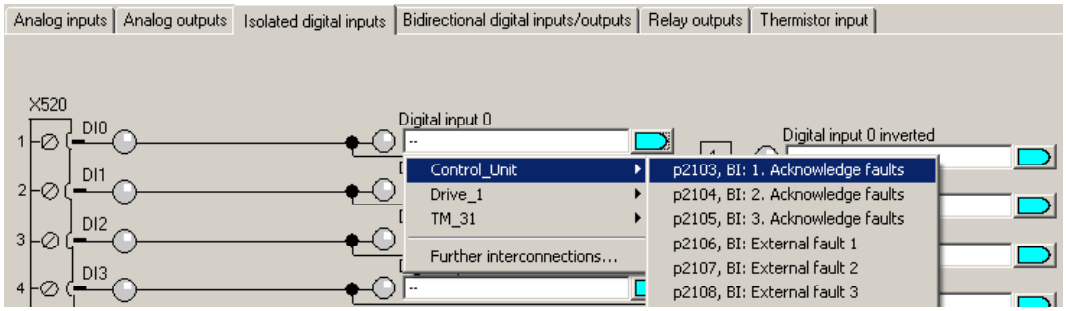



**Figure 1-3: Configuration in interconnection screen forms**

For more detailed information on the drive configuration, BICO interconnection and DCC, refer to the manuals of the SINAMICS S110/S120 drive system.

**Note**
The TM15 and TM17 High Feature terminal modules are an exception. When creating the modules, an automatic interconnection to a "free frame" is performed.
TM15 and TM17 High Feature therefore are exclusively available for SIMOTION.

## 1.3 Configuration of SINAMICS I/Os for use with SIMOTION

By means of the frame configuration, all or some I/Os assigned to SINAMICS can be used by SIMOTION.

Depending on the frame configuration, I/O data is exchanged with SIMOTION as follows:
- With SINAMICS Integrated D4xx and CX32: via PROFIBUS Integrated
- With SINAMICS (CU305, CU310 and CU320): via PROFIBUS / PROFINET

For more detailed information on configuration options, refer to *Chapter 2, Use of SINAMICS I/Os by SIMOTION*.

For more detailed information
- on I/O processing with drive I/Os (timing, classification within the task system), refer to the *Basic Functions Function Manual.*

# 2 Use of SINAMICS I/Os by SIMOTION

Depending on the frame configuration, some or all I/Os assigned to SINAMICS can be used by SIMOTION.

Examples:
- Use of the SINAMICS I/Os for the input and output of digital or analog signals from the SIMOTION user program (example: use of the onboard I/Os of a D4x5 assigned to SINAMICS by the SIMOTION user program)
- Use of SINAMICS I/Os in order to use drive-related functions (output cam output, measuring input, external zero mark, etc.)

In order to use SINAMICS I/Os with SIMOTION, input and output data must be exchanged by frames.
By means of the frame configuration, the SINAMICS I/Os are mapped in the logic address area of SIMOTION and can thus be used by a SIMOTION application.
By means of BICO interconnections on the drive end, it is determined which SINAMICS I/Os are mapped to the frame.

These BICO interconnections can:
- be freely definable (free frame configuration; frame extension)
- specifically defined (standard frames, e.g. Frame 39x; axis frames, etc.)
- depend on the configuration (TM15 / TM17 High Feature)

From the SIMOTION D, frame contents are accessed via I/O variables or input/output addresses.

Depending on how the I/Os are to be used, different configuration options can be defined.

**Table 2-1: Overview of the Use of SINAMICS I/Os by SIMOTION**

| Configuration option | Explanation | Applications | Supported I/Os (drive objects) |
|---|---|---|---|
| Free frame configuration with P915/P916 (exception: TM15 / TM17 High Feature)<br><br>➔ see Chapter 2.1 | With TM15 and TM17 High Feature terminal modules, an automatic connection to a “free frame with P915/P916" is performed upon the creation of modules.<br>TM15 and TM17 High Feature thus are exclusively available to SIMOTION. | Use of TM15 and TM17 High Feature for fast DI/DO, output cam outputs and measuring inputs | ▪ TM15 (SIMOTION)<br>▪ TM17 (SIMOTION) |
| Free frame configuration via BICO<br><br>➔ see Chapter 2.2 | The corresponding drive objects are assigned specific frames for data transmission.<br>The "free frame configuration via BICO", Frame 999, is used for data transmission. | Preferred solution if I/Os are to be distributed among SIMOTION and SINAMICS and a module view is preferred (e.g. frame created on a drive object, such as a TM or a CU) | ▪ Onboard I/Os on CU305, CU310, CU320, D410, D4x5, CX32<br>▪ TM15 DI/DO<br>▪ TM31<br>▪ TM41<br>▪ TB30 |
| Frame extension<br><br>➔ see Chapter 2.3 | For the transmission of I/O data, existing frames are extended by process status data (PZD), and the additional process status data is then connected via BICO. | Preferred solution if I/Os are to be distributed among SIMOTION and SINAMICS and e.g. an axis view is preferred (drive-related I/Os are attached to each axis frame) | |
| Use of Frame 39x<br><br>➔ see Chapter 2.4 | In order to access the onboard I/Os of a Control Unit (D4xx, CU305/CU310/CU320, CX32) from SIMOTION, 39x frames are alternatively available for free frame configuration or frame extension. | Only possible for onboard I/Os of CUs; preferred solution if all onboard I/Os are to be used by SIMOTION (inputs can be additionally connected on the SINAMICS end); use of fast output cam outputs or fast DO with D4xx; use of "global" measuring inputs | ▪ Onboard I/Os on D410, D4x5, CU305, CU310, CU320, CX32<br><br>Note:<br>CU305, CU310, CU320, CX32 do not provide<br>fast output cam outputs |

The configuration options are described in detail in the following subsections.

**Note**
With the "frame extension" and the "free frame configuration via BICO" options, the inputs and outputs can be used for selective channels via SIMOTION or SINAMICS.

With Frame 39x, however, all onboard inputs and outputs are automatically connected to the 39x frame via BICO interconnections and thus are available to all SIMOTION applications. The following rules apply:

- All onboard terminals configured as a digital output on the drive end are exclusively available for SIMOTION (i.e. they are no longer available for use by SINAMICS).
  Exception: CU3xx/CX32 from V4.1 SP4 on
- Digital inputs can be used by both SIMOTION and SINAMICS.

Details see *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x*

## 2.1 Free frame configuration with P915/P916

The TM15 and TM17 High Feature terminal modules are an exception (this, however, does not apply to TM15 DI/DO).
TM15 and TM17 High Feature are connected to the Control Unit via the DRIVE-CLiQ interface. Thus, they are assigned to SINAMICS.
When inserting a TM15 or TM17 High Feature, however, a connection to a "Free frame with P915/P916" is performed automatically.

The frame structure and length depend on the configured properties of the inputs and outputs. For example, the I/O channels can be specified as DIs, DOs, measuring inputs or output cam outputs.
The automatic connection of the frame ensures that the functions of the modules can be used exclusively by SIMOTION. The functions are controlled from the SIMOTION user program via input and output addresses or I/O variables.
**Configuration on the drive end via BICO / DCC SINAMICS is not possible.**

For more detailed information
- on the configuration of TM15 and TM17 High Feature, refer to the *SIMOTION TM15 and TM17 High Feature Commissioning Manual.*
- on the configuration of output cam outputs and measuring inputs, refer to the *SIMOTION Output Cams and Measuring Inputs Manual.*
- on I/O processing with TM15 and TM17 High Feature (timing, classification within a task system), refer to the *Basic Functions Function Manual*.

## 2.2 Free frame configuration via BICO

With the "Free frame configuration via BICO", the corresponding drive objects (e.g. terminal modules) are assigned specific frames for data transmission.

Frame type: Free frame configuration via BICO (Frame 999)

In order to ensure that the SINAMICS drive signals (e.g. I/Os) can be accessed from the SIMOTION, these signals must be connected to the frame on the SINAMICS end via BICO. For example, the "Free frame configuration via BICO" is the preferred solution for the distribution of I/Os between SIMOTION and SINAMICS for selective channels and if a module view is preferred (for example, the frame is applied to a drive object, such as a TM or a CU).

Possible drive objects:
CU305, CU310, CU320, D410, D4x5, CX32, TM15 DI/DO, TM31, TM41, TB30



**Table 2-2: Drive object: Maximum number of process status data (PZD)**

| Drive object | Maximum number of process status data for the configuration of PROFIdrive message frames | |
|---|---|---|
| | Input data (from the SIMOTION D end) | Output data (from the SIMOTION D end) |
| TM15 DI/DO | 5 | 5 |
| TM31 | 5 | 5 |
| TM41 | 19 | 16 |
| TB30 | 5 | 5 |
| CU | 15 | 5 |

### 2.2.1 Example: TM31 with SIMOTION D410

This subsection describes the interconnection of a signal of a TM31 connected to a SIMOTION D410 as an example.

The free frame configuration via BICO includes the following steps:
- Freely configure the frame
- Connect frame for TM31
- Create I/O variables in SIMOTION

#### Prerequisite

You have already created a project and configured a drive.

#### Freely configuring the frame (example: SIMOTION D410)

1. In the project navigator under "SINAMICS_Integrated", double click on "Insert input/output component". In the dialog which pops up, select the "TM31" terminal module in the "Drive objects type" field.
2. Enter the name of the module to be inserted and then click on OK to confirm.
3. In the project navigator under "SINAMICS_Integrated", double click on "Communication" > "Message frame configuration" in order to open the "PROFIdrive message frame" screen form.
   The "Free message frame configuration with BICO" (Frame 999) has been selected for the inserted TM31. Next, enter the number of process status data for the input and output data. Be aware of the maximum number of process status data for the drive objects in transmit and receive direction (see Table 2-2: Drive object: Maximum number of process status data, on page 16). For example, a TM31 can have max. 5 process status data.
4. Enter a 3 under "Input data" and "Output data" in the "Length" column.

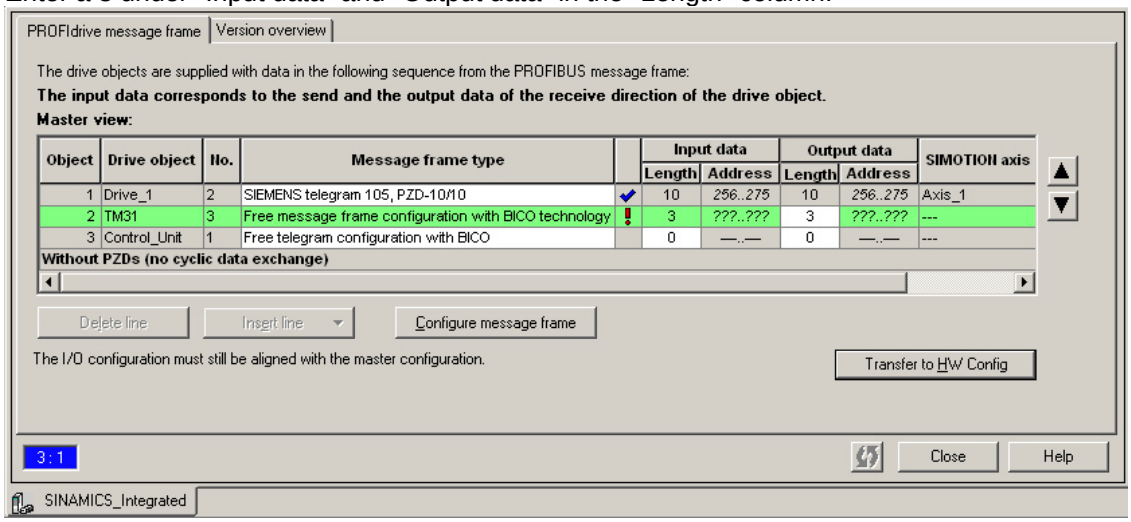



**Figure 2-1: Entering the number of process status data for input and output data**

5. Click the "Transfer to HW Config" button in order to transmit the data to HW Config and to read in the address area of the input and output data.

**Note**
Prior to the adjustment, all drive objects without I/O addresses ("---..---") must be moved behind the objects with I/O addresses which still have to be adjusted ("???..???") or valid I/O addresses.

The icons in the status column show the following information:

- : The message frame is configured differently in HW Config. You must match with HW Config
- : You use a predefined standard message frame or free BICO interconnection.
- : You use a changed standard message frame that you have extended with additional data.
- : You use a message frame for which one of the two message frame lengths (I or O) is too long. The drive object cannot process this entry.

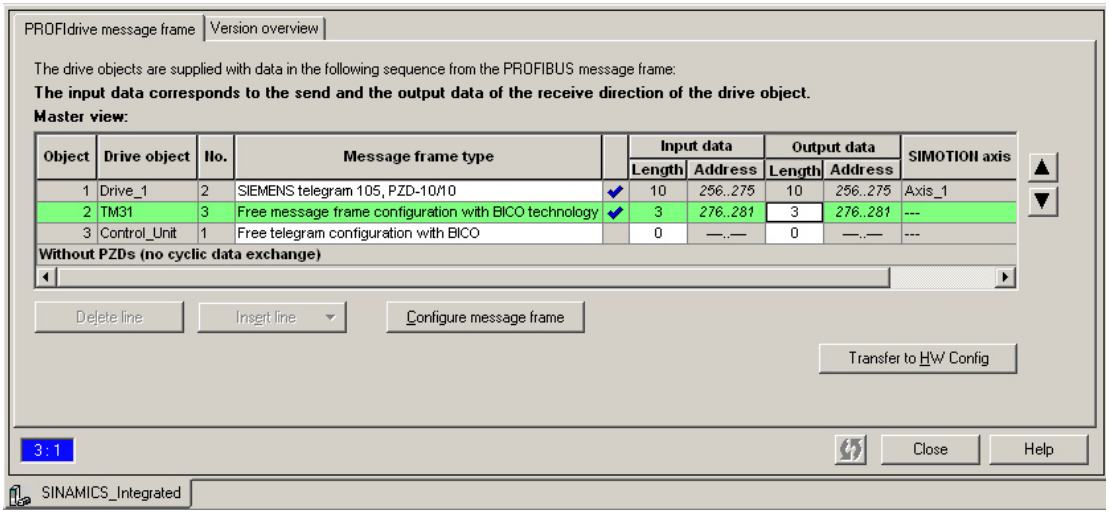



**Figure 2-2: Reading in the address range of the input and output data**

You can now transmit data from TM31 to SIMOTION (transmit direction) or receive data from SIMOTION (receive direction).

## Connecting a frame for TM31

The following paragraphs describe how to transmit a signal from TM31 to SIMOTION (transmit direction).

1. In the created TM31 double-click on "Communication". The related screen form pops up.
2. Change to the tab "transmit direction"
3. Select the source (blue symbol) for the process state data word 1 (PZD1). Select "further interconnections" under TM31 and choose "r4022 – CO/BO: TM31 digital inputs, status".

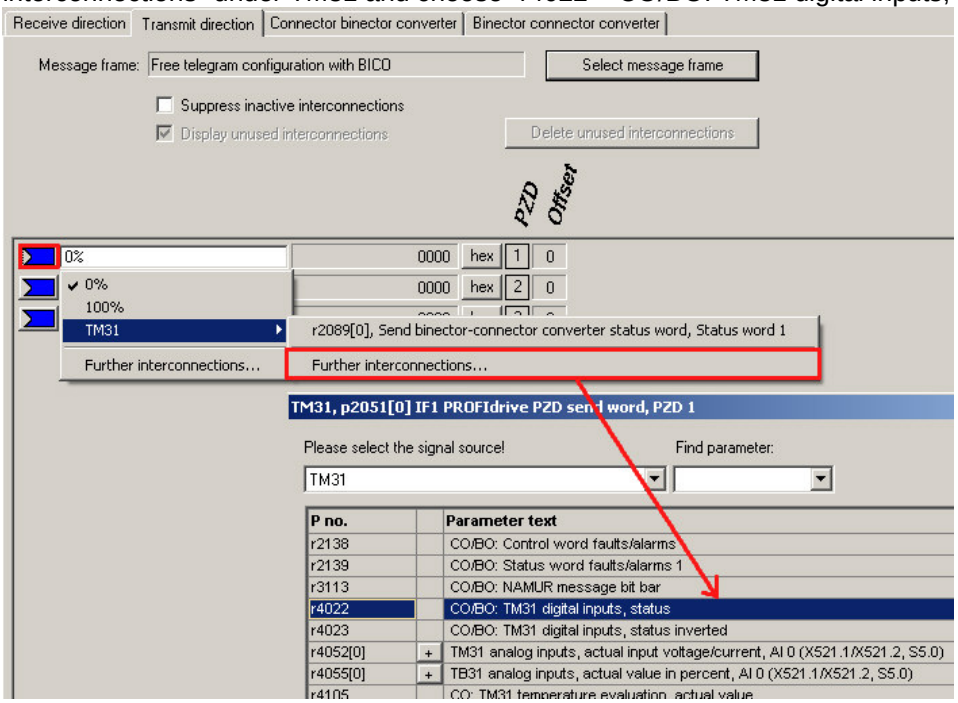



**Figure 2-3: Selecting process status data**

4. Now interconnect the analog inputs AI 0 and AI 1 in the same way (r4055[0] and r4055[1], current value in percent; 100% = 4000 Hex).

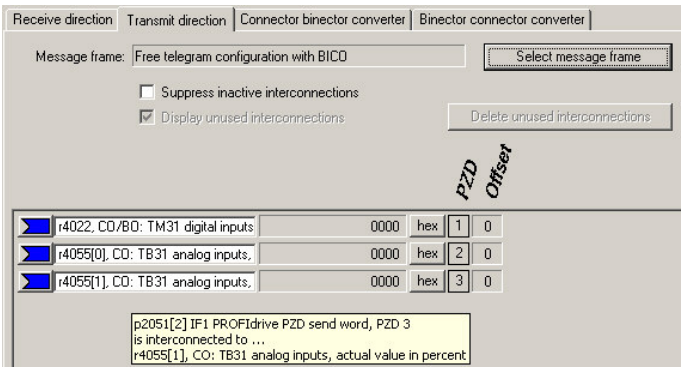



**Figure 2-4: Interconnection of the TM31 digital inputs and analog inputs**

Proceed as follows to transmit a signal from SIMOTION to TM31 (receive direction):

1. In the created TM31 double-click on "Communication". The related screen form pops up.
2. Change to the tab "Receive directions"
3. For PZD1, please click on the symbol for the bitwise representation and interconnect the single bits to p4038 (DO 8) up to p4041 (DO 11) as well as p4030 (DO 0) and p4031 (DO 1). On PZD2 and PZD3 you connect the analog outputs AO 0 and AO 1 (p4071[0] and p4071[1])


**Figure 2-5: Interconnection of the TM31 digital outputs and analog outputs**



**Note**

If you perform the above-mentioned interconnections "online", you must:

- prior to the interconnection: load the frame configuration into the Control Unit.
- after the interconnection: upload your settings into the PG. To do this, select "SINAMICS_Integrated" using the context button in the project navigator and then select **Destination device > Load into PG**.

### Creating I/O variables in SIMOTION

To access the signals of TM31, you have to create I/O variables in SIMOTION. The input or output addresses for the TM31 frame in the "PROFIdrive message frame" screen form are required for this purpose. In this way, you can assign the variable either a complete word, a byte or an individual bit.

1. In the project navigator under the created SIMOTION D4xx, double click on "I/O". The symbol browser pops up.
2. Enter a name for the I/O variable.
3. Enter an I/O address, e.g.:
   - o "PI277.0" ➔ for accessing PZD1 Bit 0 of the configured frame
   - o "PI276.0" ➔ for accessing PZD1 Bit 8 of the configured frame

   You can now access the signal from SIMOTION.

Process status data (PZD) are defined as 16-bit values based on the PROFIdrive profile. When determining the I/O address, it must be considered that the less significant byte of the SIMOTION I/O variable is assigned to (and inverts) the more significant PZD bits of frame:



**Table 2-3: Assignment of the byte representation versus the process status data (PZD) representation**

| I/O address | Byte 276 | | | | | | | | Byte 277 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Byte in bit representation | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PZD in bit representation | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

In the example, the addresses of the I/Os are as follows:

| | |
|---|---|
| DI 0...7 | the address PI 277.0 to PI 277.7 |
| DI/DO 8...11 | the address PI 276.0 to PI 276.3 (if DI/DO is parameterized as DI) |
| AI 0 | the address PIW 278 |
| AI 1 | the address PIW 280 |
| | |
| DI/DO 8...11 | the address PQ 276.0 to PQ 276.3 (if DI/DO is parameterized as DO) |
| AO 0 | the address PQW 278 |
| AO 1 | the address PQW 280 |

## 2.3 Frame extension

With the "frame extension", existing standard frames (e.g. axis frames) are extended by additional process status data (PZD) and the additional process status data is then interconnected via BICO (e.g. to an actual speed value or the status of a digital input).

The "frame extension" is the preferred solution if I/Os are to be distributed among SIMOTION and SINAMICS and e.g. an axis view is preferred (drive-related I/Os should be attached to each axis frame).

Possible drive objects:
CU305, CU310, CU320, D410, D4x5, CX32, TM15 DI/DO, TM31, TM41, TB30

To do this, proceed as follows:

1. Insert a drive using the drive wizard and select e.g. "Standard frame 103" for the process data exchange.
2. In the project navigator under "SINAMICS_Integrated", double click on "Communication" > "Message frame configuration" in order to open the "PROFIdrive message frame" tab card.
   In this tab card, the lengths of the input and output data are pre-assigned for the inserted drive. The addresses of the input and output data have not yet been transmitted to HW Config and are therefore pre-assigned with "???".
3. Highlight the line of the object the frame of which you want to extend.

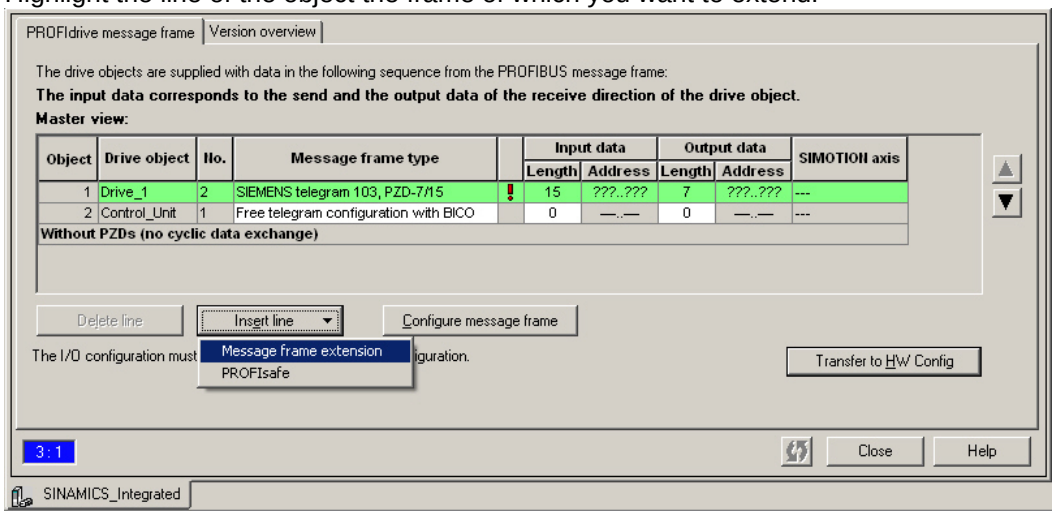



**Figure 2-6: PROFIdrive message frame**

4. Click the "Insert line" button and select the "Message frame extension" option from the menu which pops up.
   The new line with the frame extension is inserted below the highlighted line.
5. In the "Length" field of the input and output data, specify by how many process status data the frame has to be extended.
6. Click the "Transfer to HW Config" button in order to transmit the changes to HW Config.

The red check mark in the line shows that a changed standard protocol is used. Following the transmission to HW Config, the input and output addresses are entered.

**Note**
Prior to the adjustment, all drive objects without I/O addresses ("---..---") must be moved behind the objects with I/O addresses which still have to be adjusted ("???..???") or valid I/O addresses.

The icons in the status column show the following information:

- : The message frame is configured differently in HW Config. You must match with HW Config
- : You use a predefined standard message frame or free BICO interconnection.
- : You use a changed standard message frame that you have extended with additional data.
- : You use a message frame for which one of the two message frame lengths (I or O) is too long. The drive object cannot process this entry.

7. Now switch over to the configured drive. Double click on "Communication".
8. De-select the "Suppress inactive interconnections" option in order to show all process status data of the frame.
   The transmit and receive data (at least 16) is displayed. The first process status data is already pre-assigned with the standard frame and cannot be changed.
9. Via BICO, interconnect the added process status data (at the end of the PZD list) with the desired signals.

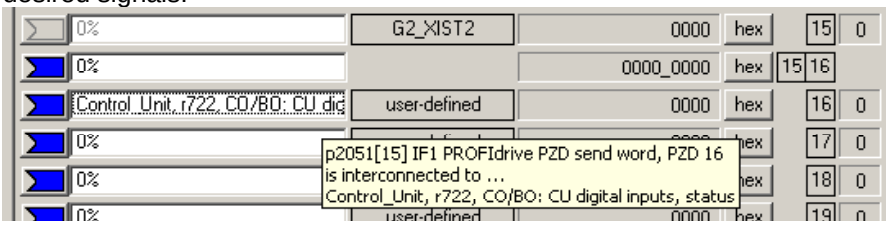



**Figure 2-7: Example: Interconnection of the onboard DIs in PROFIBUS transmit direction**

**Note**
The program does not show a warning message if you interconnect more process status data than indicated in the additional process status data. Be aware that a SERVO drive object supports up to 16 process status setpoint values and 19 process status actual values. The VEKTOR drive object supports up to 32 process status setpoint and actual values.

**Note**
If you perform the above-mentioned interconnections "online", you must:
- prior to the interconnection: load the frame connection into the Control Unit.
- after the interconnection: upload your settings into the PG. To do this, select "SINAMICS_Integrated" using the context button in the project navigator and then select **Targes device > Load to PG**.

## 2.4 Frame 39x

### 2.4.1 Functionality of Frames 390, 391 and 392

#### Basic Principles

By means of Frame 39x, SIMOTION can use the onboard I/Os of a Control Unit assigned to SINAMICS in a particularly convenient manner. The functionality is supported by SIMOTION V4.1, SP1 (or higher).

Possible drive objects: D410, D4x5, CU305, CU310, CU320, CX32

When setting a 39x frame, the SINAMICS I/Os are automatically connected to the 39x frame via BICO interconnections and thus are available for SIMOTION. All onboard I/Os of a Control Unit specified as digital outputs are exclusively available to SIMOTION; digital inputs can be used by both SIMOTION and SINAMICS.

Besides the use of the onboard I/Os, the 39x frame allows for the use of
- fast output cam outputs and fast digital outputs (DO) with SIMOTION D4xx
- "global" measuring inputs
- the control and status word of the Control Unit (CU_CW; CU_SW)



#### Frames 390, 391 and 392

Depending on the selected 39x frame type, different functionalities can be used with SIMOTION D.

**Table 2-4: Overview of the functionalities of frames 390, 391 and 392**

| Frame | Functionality available on the DI/DO | | |
|---|---|---|---|
| | D410 | D4x5 | CX32, CU310, CU320, CU305[2] |
| 390 | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 4 fast output cam outputs / DOs | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 8 fast output cam outputs / DOs | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs |
| 391 | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 4 fast output cam outputs / DOs<br>o up to 2 measuring inputs (global measuring inputs) | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 8 fast output cam outputs / DOs<br>o up to 2 measuring inputs (global measuring inputs) | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 2 measuring inputs (global measuring inputs) [1] |
| 392 | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 4 fast output cam outputs / DOs<br>o up to 3 measuring inputs (global measuring inputs) | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o up to 8 fast output cam outputs / DOs<br>o up to 6 measuring inputs (global measuring inputs) | o CU_CW; CU_SW<br>o I/O access to the DIs and DOs<br>o CU320: max. of 6 measuring inputs (global measuring inputs) [1]<br>o CU310/CX32: max. of 3 measuring inputs (global measuring inputs) [1] |

[1] in connection with CX32, CU310 and CU320, released from V4.1 SP2 on
[2] Utilizing CU305 with global measuring inputs: please ask hotline for current status

For the configuration of **local** measuring inputs, the 39x frame does not need to be configured. The maximum quantity framework of "Fast output cam outputs / DOs" is reduced by the number of measuring inputs used, as the same terminals are used.

### 2.4.2 Configuration of Frame 39x

#### Prerequisites

The following prerequisites are met:
- A project has been created.
- The Control Unit (e.g. SIMOTION D410 DP) has been inserted.
- A drive has been configured.

1. In the project navigator under "SINAMICS_Integrated", double click on "Communication" > "Message frame configuration".
   The "SINAMICS_Integrated – Message frame configuration" dialog pops up.
2. In the "PROFIdrive message frame" tab card, select the frame type (frames 390, 391 or 392) for the Control Unit.
3. Click the "Transfer to HW Config" button in order to transmit the frame data to HW Config.

A frame has been configured for the Control Unit. The address range of the frame is shown in the "SINAMICS - Configuration" dialog.

With the frame configuration of Frame 39x, BICO interconnections are performed automatically for the DI and DI/DO and thus are available for SIMOTION.

After the message frame configuration with automatic BICO interconnection, digital outputs can be connected to SINAMICS sources via manual BICO reconnections (as from SIMOTION V4.1 SP4, only for CU3xx/CX32; see *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x*)

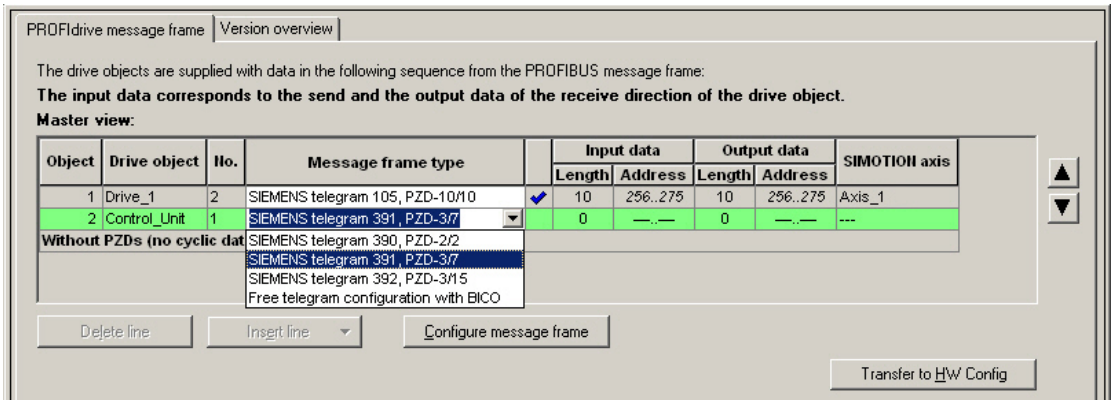



**Figure 2-8: Configuration of Frame 39x**

**Note to version V4.1 SP1**
In V4.1, SP1, the wirings for DI4 to 7 and DI/DO12 to 15 are not shown "offline" although they exist. This, however, does not affect the functionality. All data is displayed correctly when uploading the drive unit to the programming device (PG) after the project download.

### 2.4.3 Use of onboard I/Os by SIMOTION (as DI/DO)

When defining a 39x frame, the onboard I/Os are automatically connected to the 39x frame via BICO interconnections and thus are available to all SIMOTION applications. The following rules apply:

- All onboard terminals configured as digital outputs on the drive end are exclusively available for SIMOTION (i.e. they are no longer available for use by SINAMICS).
  Exception: CU3xx/CX32 from V4.1 SP4 on
- Digital inputs can be used by both SIMOTION and SINAMICS.

Details see *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x*

#### Address assignment

Frame 390 transmits the control and status word of the Control Unit in PZD 1 and the status of the onboard inputs and outputs in PZD2.

With frames 391 and 392, control and status information is additionally transmitted for the global measuring inputs. The contents of PZD3 to PZD15 are exclusively used by the Measuring Input technology object and are not relevant for the user.

**Table 2-5: Address assignment: Control/status word and onboard I/Os**

| | Logic hardware address and bit number | D4x5, CU320 | | D410, CX32, CU310, CU305 | |
|---|---|---|---|---|---|
| | | Input | Output | Input | Output |
| PZD 1 | Start address Frame 39x + 0 | CU_SW | CU_CW | CU_SW | CU_CW |
| PZD 2 | Start address Frame 39x + 2, Bit 0 | DI 0 | --- | DI 0 | --- |
| | Start address Frame 39x + 2, Bit 1 | DI 1 | --- | DI 1 | --- |
| | Start address Frame 39x + 2, Bit 2 | DI 2 | --- | DI 2 | --- |
| | Start address Frame 39x + 2, Bit 3 | DI 3 | --- | DI 3 | --- |
| | Start address Frame 39x + 2, Bit 4 | DI 4 | --- | --- | --- |
| | Start address Frame 39x + 2, Bit 5 | DI 5 | --- | --- | --- |
| | Start address Frame 39x + 2, Bit 6 | DI 6 | --- | --- | --- |
| | Start address Frame 39x + 2, Bit 7 | DI 7 | --- | --- | --- |
| | Start address Frame 39x + 3, Bit 0 | DI 8 | DO 8 | DI 8 | DO 8 |
| | Start address Frame 39x + 3, Bit 1 | DI 9 | DO 9 | DI 9 | DO 9 |
| | Start address Frame 39x + 3, Bit 2 | DI 10 | DO 10 | DI 10 | DO 10 |
| | Start address Frame 39x + 3, Bit 3 | DI 11 | DO 11 | DI 11 | DO 11 |
| | Start address Frame 39x + 3, Bit 4 | DI 12 | DO 12 | --- | --- |
| | Start address Frame 39x + 3, Bit 5 | DI 13 | DO 13 | --- | --- |
| | Start address Frame 39x + 3, Bit 6 | DI 14 | DO 14 | --- | --- |
| | Start address Frame 39x + 3, Bit 7 | DI 15 | DO 15 | --- | --- |
| PZD 3 | Start address Frame 39x + 4 | Used internally for global measuring inputs (only for frames 391, 392) | --- | Used internally for global measuring inputs (only for frames 391, 392) | --- |
| PZD 4-7 | Start address Frame 39x + 6 | Used internally for global measuring inputs 1 to 2 (only for frames 391, 392) | --- | Used internally for global measuring inputs 1 to 2 (only for frames 391, 392) | --- |
| PZD 8-15 | Start address Frame 39x + 10 | Used internally for global measuring inputs 3 to 6 (only for frame 392) | --- | Used internally for global measuring inputs 3 to 6 (only for frame 392) | --- |

**Note**
Write access to the CU_CW can only be performed by means of the _setDriveObjectSTW system function.
Only a read access to the CU_CW is possible with I/O variables ("Read only" checkbox in the I/O symbol browser).

To access the individual process status data for accessing the I/Os, I/O variables have to be created in SIMOTION. To do this, the input or output address of Frame 39x in the "PROFIdrive message frame" screen form is required.

Example: Frame 390 (address of the input data = 276; address of the output data = 276)

D435:

| | Name | I/O address | Read only | Data type | Field length | Process image | Strategy | Substitute value | Display format | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | cu_sw | PW 276 | | WORD | 1 | | CPU stop | 0000 | HEX | |
| 2 | cu_cw | PQW 276 | ☑ | WORD | 1 | | CPU stop | 0000 | HEX | |
| 3 | cu_di_0 | PI278.0 | | BOOL | 1 | | | | BOOL | |
| 4 | cu_do_8 | PQ279.0 | ☐ | BOOL | 1 | | | | BOOL | |
| 5 | | | | | 1 | | | | | |

## Configuring DI/DO as an input or output

In the interconnection screen forms, the user can define whether a DI/DO is used as a digital input or digital output.

In the project navigator under "SINAMICS" > "Control_Unit", double-click on "Inputs/Outputs" and then modify the assignment as required in the "Bidirectional digital inputs/outputs" tab card.

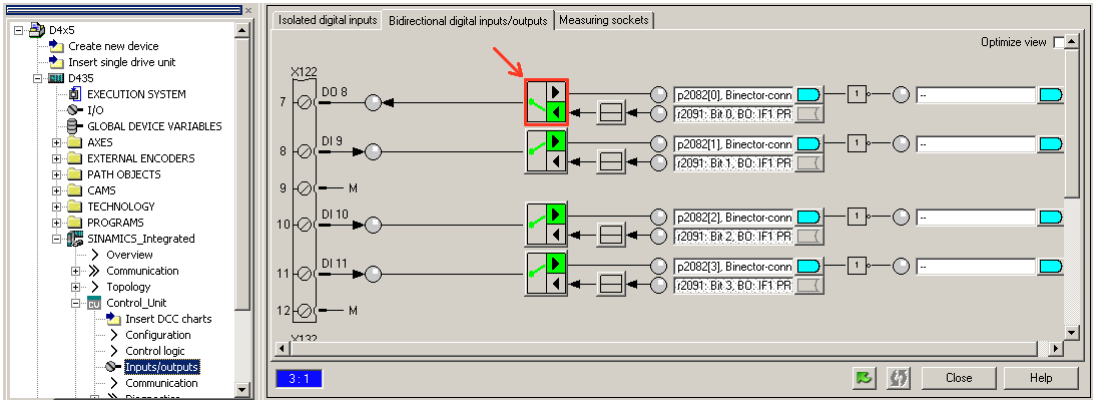



**Figure 2-9: Configuring DI/DO as an input or output**

Alternatively, the setting can be performed via the p728 parameter in the expert list of the Control Unit, for selective channels (context menu of the Control Unit: "Expert" > "Expert list").

**Note:**
When configuring telegram 39x and onboard I/Os, it is absolutely necessary to consider *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x.*

### 2.4.4 Use of fast output cam outputs / fast DOs

If a 390, 391 or 392 frame has been configured, the onboard outputs of the SIMOTION D can be used
- as an output cam output or
- as a fast output with write access from the user program

---

**Note:**
If I/O data is transmitted via bus frames, the update of the I/O data depends on the defined bus cycle.
Therefore, an I/O via Frame 39x can change its state only once in each bus cycle of PROFIBUS Integrated.
SIMOTION D onboard outputs are controlled via **direct write access** to the hardware (i.e. without considering the frame):
- Write access to digital outputs therefore becomes effective with a particularly short delay time (as the write access is independent of the bus cycle)
- Furthermore, a more precise output cam output is possible (see *Table 3-1: Comparison of components for fast output cam output on page 39*)

**Direct write access is not possible on CX32, CU305, CU310 and CU320.**

The delay time resulting from fast write accesses from the user program includes the following individual delays:
- Delay time of the user program ➔ Terminal register: up to 75 µs
- Load-dependent output delay time of the hardware
  with D410/D4x5: L ➔ H: up to 400 µs
  H ➔ L: up to 100 µs

---

For fast output cam outputs / digital outputs, the same addresses have to be used as for the "normal" use of the digital outputs.

For more detailed information
- on the addresses, refer to *Table 2-5: Address assignment: Control/Status Word and Onboard I/Os on page 27*
- on output cam outputs, see *Chapter 3, Configuration of output cam outputs*

### 2.4.5 Use of global measuring inputs

#### Global measuring inputs with 391 and 392 frames

The control and status data of the global measuring inputs are additionally transmitted with the 391 and 392 frames.

For more detailed information
- on global measuring inputs, see *Chapter 4.3, Configuration of global measuring inputs on a Control Unit)*

### 2.4.6 Use of the control and status word of the Control Unit



#### Configuration of the control and status word of the Control Unit

The tables on the following page show the structure of the control and status word of the Control Unit. Advanced drive expertise is required for the use of the control and status word.

**Note**
Write access to the CU_CW is only permissible via the _setDriveObjectCW system function.
Only read access to the CU_CW is possible with I/O variables ("Read only" checkbox in the I/O symbol browser).
A fault can only be acknowledged with the _resetDriveObjectFault system function.
Faults and warnings are notified with the PeripheralFaultTask of SIMOTION.

**Table 2-6: Description of CU_CW (control word for Control Unit)**

| Bit | Significance | Remarks | | BICO |
|---|---|---|---|---|
| 0 | Synchronization flag | - | This signal synchronizes the common system time of the controller and the drive unit. | BI: p0681[0] |
| 1 | RTC PING | - | This signal sets the UTC time via the PING event. | BI: p3104 |
| 2…6 | reserved | - | - | - |
| 7 | Acknowledge faults | 0/1 | Acknowledge faults | BI: p2103 |
| 8…11 | reserved | - | - | - |
| 12 | Controller life sign Bit 0 | - | Controller life sign | CI:p2045 |
| 13 | Controller life sign Bit 1 | - | | |
| 14 | Controller life sign Bit 2 | - | | |
| 15 | Controller life sign Bit 3 | - | | |

**Table 2-7: Description of CU_SW (status word of the Control Unit)**

| Bit | Significance | Remarks | | BICO |
|---|---|---|---|---|
| 0…2 | reserved | - | - | - |
| 3 | Fault effective | 1 | Fault effective | BO: r2139.3 |
| | | 0 | No fault effective | |
| 4…6 | reserved | - | - | - |
| 7 | Warning effective | 1 | Warning effective | BO: 2139.7 |
| | | 0 | No warning effective | |
| 8 | SYNC | - | - | BO: r0899.8 |
| 9…11 | reserved | - | - | - |
| 12 | Drive unit life sign Bit 0 | - | Slave life sign | Implicitly connected |
| 13 | Drive unit life sign Bit 1 | - | | |
| 14 | Drive unit life sign Bit 2 | - | | |
| 15 | Drive unit life sign Bit 3 | - | | |

For more detailed information on the control and status word, refer to the manuals of the SINAMICS S110/S120 drive system.

### 2.4.7 Particularities of the use of Frame 39x

The following particularities have to be considered when the inputs and outputs are used by SIMOTION based on the configuration of Frame 39x:

**Table 2-8: Overview: Particularities to be considered when using onboard DOs with Frame 39x**

| | **Frame 39x configured** | **No Frame 39x configured** |
|---|---|---|
| Access options to digital output (DO) | see *Chapter 4.3, Configuration of global measuring inputs on a Control Unit* | Depending on the BICO interconnection, the output can be used by SIMOTION or SINAMICS |
| DO is BICO-interconnectable | | Yes |
| Inversion settings (= cu.p748) | Not effective | effective |
| Behavior in STOP state of SIMOTION | LOW level | After the first transition of the controller to RUN state, the outputs are set according to the BICO connection **also in STOP state of the controller**. The outputs therefore function drive-independently in this case. |
| Status display in the interconnection screen forms of SIMOTION SCOUT | The status is displayed correctly if no inversion via p748 has been defined. | The status display only shows the current status of the output when the SINAMICS_Integrated has received the internal "NCReady" bus signal from the controller for the first time after the start-up. This is achieved during the first transition of the controller to RUN state. Afterwards, the outputs are set according to the status display also in the STOP state of the controller! |

**Table 2-9: Overview: Particularities to be considered when using onboard DIs with Frame 39x**

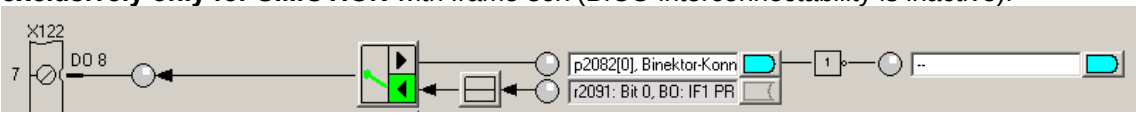
| | **DI assigned to SIMOTION via Frame 39x** | **DI assigned to SINAMICS** |
|---|---|---|
| DI is BICO-interconnectable (r721, r722, r723) | Yes The state of the DI can be further connected on the SINAMICS end | Yes |
| Settings for simulation (= cu.p795 / cu.p796) | effective | effective |
| Behavior in the STOP state of SIMOTION | The signal state of the DI is still available on the SIMOTION end | The inputs function independently of the drive, and the STOP state has no influence. |
| Status display in the interconnection screen forms of SIMOTION SCOUT | The status is displayed (even if the SIMOTION CPU is in STOP state) | The status is displayed (also in STOP mode of the SIMOTION CPU) |

### 2.4.8 Notes on the use/reparameterization of Frame 39x

#### Rules for Frame 39x

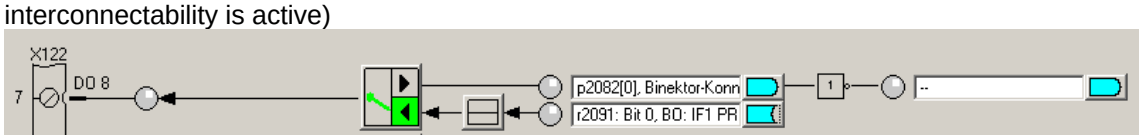
The onboard I/Os of a Control Unit assigned to SINAMICS can be used with message frames 39x by SIMOTION. If a frame 39x has been set for the Control Unit, the onboard I/Os are automatically connected via BICO interconnections with this frame 39x and are thus available to SIMOTION.

- For SINAMICS V2.5 the following applies:
  All onboard I/Os of a Control Unit parameterized as digital outputs are available **exclusively only for SIMOTION** with frame 39x (BICO interconnectability is inactive).




  Digital inputs can be used by both SIMOTION and SINAMICS.

- For SINAMICS V2.6 the following applies:
  - Onboard I/Os of CX32 or CU3xx:
    The digital outputs are assigned to SIMOTION D by creating frame 39x --- can, however, be reconnected to SINAMICS via BICO interconnection (BICO interconnectability is active)




    Access rights for diagnostic purposes are displayed via CU parameter r0729.
    Bit = 1: SIMOTION has access rights to the digital output
    Bit = 0: SINAMICS has access rights to the digital output

  - Onboard I/Os of SIMOTION D:
    Even if the digital output can be connected (BICO interconnectability is active), interconnection is not possible!
    **All onboard I/Os parameterized as digital outputs are still exclusively assigned to SIMOTION D. (Direct access for fast DO / output cam outputs)**

In addition, the following has to be considered

- After selecting a frame 39x, the parameters on the CU have to be adjusted if required (p728 for the parameterization of a DI/DO as an input or output; p680 for global measuring inputs).
- You can use DI/DO for global measuring inputs or fast output cam outputs. A combination is also possible (e.g. 3 measuring inputs and 1 output cam output with D410)

To avoid consistence problems, please proceed as follows when using frame 39x.

### Recommended method of proceeding for the configuration of telegram 39x

When using telegram 39x, please proceed as follows in case of telegram changes or after changing I/O-related parameters.

**Note**

The described method of proceeding has to be applied

- When you have changed the telegram in connection with telegram 39x, e.g. reparameterization from:
  - telegram 39x → telegram 39y
  - "free telegram configuration with BICO (teleg. 999)" → telegram 39x
  - telegram 39x → "free telegram configuration with BICO (teleg. 999)"
- when you have changed parameters that are relevant to the onboard I/Os (e.g. settings of the CU parameters cu.p728/cu.p680)

**Proceeding:**

1. Go offline to change telegrams (e.g. settings/reparameterization of telegram 39x) or to make I/O-interconnections (e.g. parameterization of an onboard DI/DO as DO, parameterization of a global measuring inputs via cu.p728/cu.p680, ...).
2. Realize a HW Config adjustment after the changes have been made.
   The HW Config adjustment is always made only for the corresponding selected control unit in the configuration tree and not project-globally!
3. Execute "save project and compile all"
4. Go "online"
5. Load the configuration to the D4xx and the SINAMICS Integrated with "load project to target system". Activate the option "copy RAM to ROM after loading".
6. Please execute a power OFF/ON in the following cases. As an alternative, you can also make a RESET via the RESET key of the D4xx:
   - V4.1 SP1: Power OFF/ON is necessary after every reparameterization
   - V4.1 SP2/4: Power OFF/ON is only necessary if you reset the telegram 39x to "free telegram configuration with BICO (teleg. 999)"

**We generally recommend applying this method of proceeding even if this is not always necessary for some scenarios.**

In case of consistence problems, please proceed as described in *Chapter 2.4.9, Fault diagnosis*.

**Note**

In principle, the described method of proceeding is also valid for the configuration of TM15 / TM17 high feature with telegram P915/P916.

### Free BICO wiring using Frame 390

Frame 390 can also be used in order to define a pre-assignment for the wiring of the inputs and outputs to SIMOTION and to modify this pre-assignment via BICO interconnection (e.g. in order to assign individual outputs to SINAMICS).
Regarding CU3xx and CX32 as from V4.1 SP4, we recommend the procedure described in *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x*.

Proceed as follows:
1. Set Frame 390 for the Control Unit.
2. **Immediately afterwards** (without adjustment to HW Config), return to "Free frame configuration with BICO".
   This procedure automatically generates preassignments for the wiring of the inputs and outputs to SIMOTION.
3. Next, perform an adjustment to HW Config.
4. Modify the connections a desired.

This procedure does not generate any configuration information for fast output cam outputs/digital outputs, as you have not performed a HW Config adjustment with defined Frame 39x.



**Note:**
We urgently recommend NOT to proceed as follows: Set a Frame 39x, perform an adjustment to HW Config and then return to "Free frame configuration with BICO".
In this case, configuration information is generated for fast output cam outputs/digital outputs and global measuring inputs. By returning to "Free frame configuration with BICO", this configuration information is maintained and can now cause inconsistencies due to the BICO interconnections which now follow.

In order to return from 39x to the free BICO configuration, proceed as described under *Recommended method of proceeding for the configuration of telegram 39x on page 34.*

### 2.4.9 Fault diagnosis

## Error identification

In case of incorrect configurations (e.g. incorrect BICO wiring), inconsistencies can occur with the standard Frame 39x.

Consistence problems can show as follows:
- An onboard I/O does not function as desired (e.g. a DO is still controlled by SIMOTION instead of SINAMICS)
- Error messages during the consistence check
- Entry in the diagnosis buffer of SIMOTION. You can read the diagnosis buffer from SIMOTION SCOUT as follows: "target system" > "device diagnosis".

**Examples of entries in the diagnosis buffer**
Diagnosis buffers with base 3xx contains the onboard-I/O-configuration of the control unit with telegram 39x inconsistent entries.
Cause 310: P2079 - incompatible frame type
Cause 311: Pxxx - Double configuration of an onboard I/O channel of the CU for SINAMICS and SIMOTION, indicated by the bit number
Cause 312: P728 - The direction configuration of an onboard I/O channel of the CU is not clear, indicated by the bit number
Cause 320: P680 - onboard I/O channel of the CU not configured as measuring input or configured in the incorrect measuring input channel, indicated by the bit number
Cause 321: P680 - measuring input channel not configured, indicated by the channel number (index of the P680)

**Examples of error messages during the consistence check**
- Error --- technology: I/O telegram '(1F038FC4-F97F-4C68-9B3D-16AE24CDDEEF)': address area (PQB312[20]) is not configured in HWCFG
- Error --- technology: I/O address overlapping between the free telegrams: '(1F038FC.....)' (address PQB312[20]) and '(FA212.....)' (address PQB306[8])
- Error --- technology: I/O address overlapping between the I/O points: '(1F038FC.....)' (address PIW306) and '(FA212.....)' (address PIW306)
- Error --- There is no configuration of a free telegram for the I/O: 'measuring_input_1: LogAddress' (address: PI299.1).

### Error elimination

To eliminate inconsistencies, please proceed as follows:
1. Check the used addresses; please consider that it is not possible to access to a digital output of "a technology object" and "an I/O-variable" at the same time
2. Execute in the offline configuration the transmission of the concerned control unit to the HW-Config
3. Execute "save project and compile all"
4. Go "online"
5. Load the configuration to the D4xx and the SINAMICS Integrated with "load project to target system". Activate the option "copy RAM to ROM after loading".
6. Please execute a power OFF/ON in the following cases. As an alternative, you can also make a RESET via the RESET key of the D4xx

If this action is not successful, please proceed as follows:
1. Go "offline"
2. Generate new configuration information:

| **Procedure < V4.1 SP4** | **Procedure ≥ V4.1 SP4** |
|---|---|
| Several steps are necessary:<br>• Delete FastIO configuration (context menu of the CPU: "FastIO" > "Delete configuration")<br>• HW Config adjustment of the configured frames via the button "Transfer to HW Config" and thus new generation of the FastIO configuration<br>Note:<br>If the FastIO configuration has been deleted, the HW Config adjustment must be executed **for all** drive units of a SIMOTION CPU which contain a FastIO component (onboard I/O of a CU with frame 39x, TM15 or TM17 High Feature). | Context menu of the CPU: "FastIO" > "Generate new configuration"<br><br>This will delete the FastIO configuration of the CPU and generate a new one. |

3. Execute "save project and compile all"
4. Go "online"
5. Load the configuration to the D4xx and the SINAMICS Integrated with "load project to target system". Activate the option "copy RAM to ROM after loading ".
6. Please execute a power OFF/ON in the following cases. As an alternative, you can also make a RESET via the RESET key of the D4xx

**Note**

An output via I/O-variables to a digital output, which is simultaneously used by a TO Output Cam or TO Cam Track, is not possible.
When loading the configuration to the target system, an error message is indicated.

Please, also consider that SINAMICS or the terminal module must be ramped-up before any access to an I/O is possible.
One possibility to check if the ramp-up has been realized, is to use the system function _getSafeValue and _setSafeValue. These functions permit to eliminate errors when having access to the I/O-variables.
With the aid of the return value you can see if the access was successful.

**Note**

In principle, the described method of proceeding is also valid for the configuration of TM15 / TM17 High Feature with telegram P915/P916.

# 3 Configuration of output cam outputs

Output cams involve the position-dependent output of switching signals. For SIMOTION, the output cam output is controlled by the Output Cam and Cam Track technology objects (TO).

## 3.1 Output cam outputs (standard I/Os)

The switching signals for the output cam output can be output on each standard output (e.g. ET 200S distributed I/O system). In these cases, the switching accuracy is limited by the bus cycle and the processing cycle of the technology object. Furthermore, up to one edge can be output per bus cycle.
Besides the ET 200 I/O systems, digital outputs can also be used on the Control Units (D4xx, CU, CX32), terminal modules (TM) or the TB30 terminal board.
In these cases, the outputs must be assigned to SIMOTION.
➔ see *Chapter 2, Use of SINAMICS I/Os by SIMOTION*

To configure the output cam output via standard I/Os, the logic hardware address and the bit number of the output is indicated with TO Output Cam or TO Cam Track.

For more detailed information,
- refer to the *SIMOTION Output Cams and Measuring Inputs Manual*



## 3.2 Fast output cam outputs

Due to a special hardware support, fast output cam outputs provide for improved output precision of the output signals and more edges per time unit.

To configure the output cam output, the logic hardware address and the bit number of the output are indicated for the TO Output Cam or TO Cam Track technology object.

**Table 3-1: Comparison of components for fast output cam output**

| Component | Output accuracy | Max. number of output cam outputs per component | Minimum edge spacing |
|---|---|---|---|
| D4x5 onboard digital outputs | 125 µs | 8 | Up to two edges per processing cycle of TO Output Cam / TO Cam Track |
| D410 onboard digital outputs | 200 µs | 4 | |
| TM15 | 125 µs<br>(or DRIVE-CLiQ cycle) | 24 | Up to two edges per processing cycle of TO Output Cam / Cam Track |
| TM17 High Feature | 10 µs | 16 | |
| CX32, CU305, CU310, CU320, TM31, TM41, TM54, TB30 | Components **do not** support fast output cam outputs<br>➔ up to 1 edge per servo or interpolation cycle<br>(depending on the processing cycle of TO Output Cam / Cam Track) | | |

### 3.2.1 Fast output cam outputs with SIMOTION D4xx

The onboard digital outputs of the SIMOTION D can be used as output cam output or as fast output with write access from the user program.

In order to be able to use the fast outputs, a 390, 391 or 392 frame must be created.

**Note:**
If I/O data is transmitted via bus frames, the update of the I/O data depends on the defined bus cycle.
Therefore, an I/O via Frame 39x can change its state only once during each PROFIBUS Integrated bus cycle.
SIMOTION D onboard outputs are controlled via **direct write access** to the hardware (i.e. without considering the frame). Consequently:

- a write access to digital outputs becomes effective after a particularly short delay time (as the write access is independent of the bus cycle).
- the output cam output is more precise (see Table 3-1: Comparison of components for fast output cam output *on page 39).*

**CX32, CU305, CU310 and CU320 cannot be directly accessed.**

The delay time resulting from fast write access from the user program includes the following individual delays:

- Delay time of the user program ➔ Terminal register: up to 75 µs
- Load-dependent output delay time of the hardware
  with D410/D4x5: L ➔ H: up to 400 µs
  H ➔ L: up to 100 µs



Bei der Konfiguration des TO Nocken / TO Nockenspur müssen Sie den DO/DO als Ausgangs parametrieren and die logische HW-address and Bitnummer des verwendeten Ausgangs in die eintragen.

**Table 3-2: Necessary settings in the expert list**

| | | | |
|---|---|---|---|
| Parameterization of DI/DO as output | Via the parameters p728[8....15] of the control unit, you have to define as output all DI/DOs being used as output cam output. | parameterization as | |
| | | D4x5 | D410 |
| | Parameter p728[8] (DI/DO 8) | output | output |
| | Parameter p728[9] (DI/DO 9) | output | output |
| | Parameter p728[10] (DI/DO 10) | output | output |
| | Parameter p728[11] (DI/DO 11) | output | output |
| | Parameter p728[12] (DI/DO 12) | output | --- |
| | Parameter p728[13] (DI/DO 13) | output | --- |
| | Parameter p728[14] (DI/DO 14) | output | --- |
| | Parameter p728[15] (DI/DO 15) | output | --- |

**Table 3-3: Configuration of TO Output Cam / TO Cam Track**

| Logic hardware address and bit number | | D4x5 output | D410 output |
|---|---|---|---|
| | Start address Frame 39x + 3, Bit 0 | DO 8 | DO 8 |
| | Start address Frame 39x + 3, Bit 1 | DO 9 | DO 9 |
| | Start address Frame 39x + 3, Bit 2 | DO 10 | DO 10 |
| | Start address Frame 39x + 3, Bit 3 | DO 11 | DO 11 |
| | Start address Frame 39x + 3, Bit 4 | DO 12 | --- |
| | Start address Frame 39x + 3, Bit 5 | DO 13 | --- |
| | Start address Frame 39x + 3, Bit 6 | DO 14 | --- |
| | Start address Frame 39x + 3, Bit 7 | DO 15 | --- |

**Note**
When configuring telegram 39x and onboard I/Os, it is absolutely necessary to consider *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x*.



For more detailed information, refer to the following documents:

- *Chapter 2.4, Frame 39x*
- *SIMOTION Output Cams and Measuring Inputs Manual*

### 3.2.2 Fast output cam outputs with TM15 / TM17 High Feature

The quantity framework on the output cam outputs can be extended by means of the TM15 and TM17 High Feature terminal modules:

- TM15: up to 24 output cam outputs
- TM17 High Feature: up to 16 output cam outputs

For a detailed description of the configuration, refer to the following manuals:

- *SIMOTION Output Cams and Measuring Inputs Manual*
- *TM15/TM17 High Feature Terminal Modules Commissioning Manual*

# 4 Configuration of Measuring Inputs

Measuring inputs provide for fast and precise actual position detection by means of hardware support (e.g. measuring input on the corresponding drive unit).
Digital inputs of standard I/Os (e.g. SIMATIC ET 200 distributed I/O system) can principally not be used as measuring inputs.
For SIMOTION, the measuring input functionality is controlled by the Measuring Input technology object (TO).
Two different classes of measuring inputs are distinguished for SIMOTION. The measuring inputs of these classes have different properties and are configured differently.

## 4.1 Local and global measuring inputs

Depending on the hardware, local and global measuring inputs are available for measuring tasks.
**Local measuring inputs** are axis-related and realized in the SINAMICS drive. The actual position value is measured in this case.
**Global measuring inputs** can be freely assigned to the axes. The measuring result is assigned an internal time stamp for high-precision determination of the axis positions.
In the drive context, the term "central measuring input" is also used.



**Table 4-1: Comparison of local and global measuring inputs**

| | Local measuring input | Global measuring input |
|---|---|---|
| Supported hardware | D410, D4x5, CX32, CU305, CU310, CU320 | TM15, TM17 High Feature<br>V4.1, SP1 (or higher): D410, D4x5<br>V4.1, SP2 (or higher): CX32, CU310, CU320<br>CU305 [1)] |
| Measuring method | With a signal edge on the corresponding input, the current actual values of an encoder connected to the Control Unit are detected with the precise position in order to determine the lengths or distances. | With a signal edge on the corresponding input, the current actual values of one or several encoders are detected with the precise position by means of the time stamp functionality in order to determine the lengths or distances (possible with any encoders existing in the project). |
| Configuration of TO Measuring Input in the SCOUT engineering system | The inputs are specifically assigned to the hardware of the Control Unit, i.e. the assignment is performed via the **measuring input number** during the configuration of TO Measuring Input**.** | The inputs are not specifically assigned to the corresponding hardware, i.e. the assignment is performed during the configuration of TO Measuring Input **via the hardware address**. |
| Setting of TO Measuring Input:<br>One-time measurement<br>(Measuring tasks must be triggered individually for each measurement. Several interpolation cycles run between two measuring events.) | yes | yes |

| | | |
|---|---|---|
| Setting of TO Measuring Input:<br>Cyclic measurement<br>(The measurement is activated only once and then continues at cyclical intervals until it is deactivated.) | no | D410, D4x5<br>V4.1, SP2 (or higher): CX32, CU310, CU320<br>Minimum distance between two measurements:<br>3 servo cycles (up to 2 edges per measurement)<br>TM17 High Feature:<br>Minimum distance between two measurements:<br>1 servo cycle (up to 2 edges per measurement)<br>TM15:<br>No cyclic measuring |
| Use of several TO Measuring Input on one axis/encoder, which can be simultaneously active. | no | yes |
| Listening TO Measuring Input<br>This functionality ensures that a measuring input can include several Measuring Input technology objects and thus several axes/external encoders. | no | yes |
| Measuring on virtual axes | no | yes |
| Measuring on axes connected to another drive unit | no | yes |

[1] Utilizing CU305 with global measuring inputs: please ask hotline about current status



**Table 4-2: Overview of the quantity frameworks and functionality of measuring inputs**

| | Max. quantity framework available | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | D410 | CU305 | CU310 | D4x5 | CX32 | CU320 | TM15 | TM17 High Feature |
| Max. number of measuring inputs | 3 | 2 | 3 | 6 | 3 | 6 | 24 | 16 |
| Configurable as local measuring inputs [1] | x | x | x | x | x | x | --- | --- |
| Configurable as global measuring inputs | x | ---[2] | x (released from V4.1, SP2 on) | x | x (released from V4.1, SP2 on) | x (released from V4.1, SP2 on) | x | x |

[1] A maximum of two measuring inputs per axis
[2] Utilizing CU305 with global measuring inputs: please ask hotline about current status

## 4.2 Configuration of local measuring inputs on a Control Unit

Local measuring inputs are always assigned to an axis (drive). They are specifically configured for each individual drive. The drive and the measuring input must always be located on the same Control Unit. The measuring results are transmitted via the axis frame as specified by the PROFIdrive profile.
**The configuration of Frame 39x is not required for local measuring inputs.**

The following Control Units support local measuring inputs: D410, D4x5, CX32, CU305, CU310, CU320

**Table 4-3: Local measuring inputs, required settings in the expert list**

| | | | |
|---|---|---|---|
| Parameterization of DI/DO as an input | Via the p728[8....15] parameters of the Control Unit, all DI/DO used as measuring inputs must be defined as inputs. | Parameterization as | |
| | | D4x5, CU320 | D410, CX32, CU305, CU310 |
| | p728[8] parameter (DI/DO 8) | DI/DO 8 (apart from the CU305) cannot be used as measuring input | |
| | p728[9] parameter (DI/DO 9) | Input | Input |
| | p728[10] parameter (DI/DO 10) | Input | Input |
| | p728[11] parameter (DI/DO 11) | Input | Input |
| | p728[12] parameter (DI/DO 12) | DI/DO 12 cannot be used as measuring input | |
| | p728[13] parameter (DI/DO 13) | Input | --- |
| | p728[14] parameter (DI/DO 14) | Input | --- |
| | p728[15] parameter (DI/DO 15) | Input | --- |
| Definition of the measuring input terminal | The terminals for the local measuring inputs (probe inputs) must be assigned via the p488[0..2] and p489[0..2] parameters of the drive. | Parameterization (selection) | |
| | | D4x5, CU320 | D410, CX32, CU305, CU310 |
| | p488[0] parameter Probe 1 input terminal, Encoder 1 | DI/DO 9<br>DI/DO 10<br>DI/DO 11<br>DI/DO 13<br>DI/DO 14<br>DI/DO 15 | DI/DO 8 (*)<br>DI/DO 9<br>DI/DO 10<br>DI/DO 11<br><br>(*) only CU305 |
| | p488[1] parameter Probe 1 input terminal, Encoder 2 | | |
| | p488[2] parameter Probe 1 input terminal, Encoder 3 | | |
| | p489[0] parameter Probe 2 input terminal, Encoder 1 | | |
| | p489[1] parameter Probe 2 input terminal, Encoder 2 | | |
| | p489[2] parameter Probe 2 input terminal, Encoder 3 | | |

A maximum of 3 encoders can be assigned to a drive, and the index [0..2] specifies whether the measurement refers to Encoder 1, 2 or 3.

The following rules have to be considered:
- Two TO Measuring Inputs can be configured per TO Axis or TO External Encoder.
- Only one TO Measuring Input can be active on a TO Axis or TO External Encoder.

**Table 4-4: Local measuring inputs, configuration of TO Measuring Input**

| | |
|---|---|
| Axis measuring system No. | Under Axis Measuring System No., enter the number of the encoder system used (i.e. Encoders 1...3).<br>Encoder system 1 is used by default. |
| Local measuring | Tick this checkbox if a local measuring input is to be used. |
| Measuring input number | Define in this field which measuring input is to be used (i.e. 1 or 2).<br>Input 1 is used by default. |

For more detailed information, refer to the following document:
- *SIMOTION Output Cams and Measuring Inputs Manual*

## 4.3 Configuration of global measuring inputs on a Control Unit

Global measuring inputs can be freely assigned to the axes (drives). They assign the measuring result an internal time stamp for the highly accurate determination of the axis positions.
The drive and the measuring input do not need to be located on the same Control Unit. The measuring results are not transmitted via the axis frame, but via Frame 391 / 392.
The following Control Units support global measuring inputs:

- from V4.1, SP1 on: D410, D4x5
- from V4.1, SP2 on: CX32, CU310 and CU320
- CU305: please ask hotline about current status for CU305

**Table 4-5: Global measuring inputs, required settings in the expert list**

| | | | |
|---|---|---|---|
| Parameterization of DI/DO as an input | Via the p728[8....15] parameters of the Control Unit, all DI/DO used as measuring inputs must be defined as inputs. | Parameterization as | |
| | | D4x5, CU320 | D410, CX32, CU310 |
| | p728[8] parameter (DI/DO 8) | DI/DO 8 cannot be used as measuring input | |
| | p728[9] parameter (DI/DO 9) | Input | Input |
| | p728[10] parameter (DI/DO 10) | Input | Input |
| | p728[11] parameter (DI/DO 11) | Input | Input |
| | p728[12] parameter (DI/DO 12) | DI/DO 12 cannot be used as measuring input | |
| | p728[13] parameter (DI/DO 13) | Input | --- |
| | p728[14] parameter (DI/DO 14) | Input | --- |
| | p728[15] parameter (DI/DO 15) | Input | --- |
| Definition of the measuring input terminal | The terminals for the global measuring inputs (probe inputs) are defined via the p680[0....5] parameters of the Control Unit. Depending on the Control Unit and Frame 39x, up to 6 global measuring inputs can be defined. | Parameterization (selection) | |
| | | D4x5, CU320 | D410, CX32, CU310 |
| | p680[0] parameter probe input terminal | DI/DO 9<br>DI/DO 10<br>DI/DO 11<br>DI/DO 13<br>DI/DO 14<br>DI/DO 15 | DI/DO 9<br>DI/DO 10<br>DI/DO 11 |
| | p680[1] parameter probe input terminal | | |
| | p680[2] parameter probe input terminal | | |
| | p680[3] parameter probe input terminal | | |
| | p680[4] parameter probe input terminal | | |
| | p680[5] parameter probe input terminal | | |

Besides the parameter settings, Frame 391 (up to 2 measuring inputs) or 392 (up to 6 measuring inputs) must be defined for the Control Unit.
The p680 parameter is used to define a terminal as global measuring input.

- With frame 391, p680[0..1] can be assigned
- With frame 392, p680[0..5] can be assigned (D410/CX32/CU310 only p680 [0..2])

It is not relevant on which parameter the desired terminal is defined. The measuring inputs are assigned to an axis via the logic hardware address and the bit number of the digital input to be used as the measuring input.
--> see *Table 2-5: Address assignment: Control/status word and onboard I/Os*

Furthermore, the measuring input can be inverted via the p490 / p2088[2] parameter of the Control Unit. Please note that both parameters need changing.

Examples:
Inversion DI/DO9: p490.9 = INVERTED; p2088[2].1 = INVERTED
Inversion DI/DO10: p490.10 = INVERTED; p2088[2].2 = INVERTED
Inversion DI/DO11: p490.11 = INVERTED; p2088[2].3 = INVERTED
Inversion DI/DO13: p490.13 = INVERTED; p2088[2].5 = INVERTED
Inversion DI/DO14: p490.14 = INVERTED; p2088[2].6 = INVERTED
Inversion DI/DO15: p490.15 = INVERTED; p2088[2].7 = INVERTED

Note:
The p684 and r685 to r688 Control Unit parameters are not relevant for SIMOTION.
Don't change any parameters which have an influence of the interconnection of global measuring inputs to telegram 39x (e.g. cu.p2082)

**Note**
When configuring telegram 39x and onboard I/Os, it is absolutely necessary to consider *Chapter 2.4.8, Notes on the use/reparameterization of Frame 39x.*



**Table 4-6: Global measuring inputs, configuration of TO Measuring Input**

| | | | |
|---|---|---|---|
| Axis measuring system No. | In the “Axis measuring system No.” field, enter the number of the encoder system used (i.e. Encoders 1...3).<br>Encoder system 1 is used by default. | | |
| Global measuring | Tick this checkbox if a global measuring input is to be used. | | |
| Logic hardware address and bit number | Enter the logic hardware address and the bit number of the input used. | | |
| | Logic hardware address and bit number | Input D4x5, CU320 | Input D410, CX32, CU310 |
| | Start address Frame 39x + 3, Bit 0 | DI/DO 8 cannot be used as measuring input | |
| | Start address Frame 39x + 3, Bit 1 | DI/DO 9 | DI/DO 9 |
| | Start address Frame 39x + 3, Bit 2 | DI/DO 10 | DI/DO 10 |
| | Start address Frame 39x + 3, Bit 3 | DI/DO 11 | DI/DO 11 |
| | Start address Frame 39x + 3, Bit 4 | DI/DO 12 cannot be used as measuring input | |
| | Start address Frame 39x + 3, Bit 5 | DI/DO 13 | --- |
| | Start address Frame 39x + 3, Bit 6 | DI/DO 14 | --- |
| | Start address Frame 39x + 3, Bit 7 | DI/DO 15 | --- |

For more detailed information, refer to:
- *SIMOTION Output Cams and Measuring Inputs Manual*
- *Chapter 2.4, Frame 39x*

### 4.4 Configuration of global measuring inputs with TM15 / TM17

The quantity framework on global measuring inputs can be extended by means of the TM15 and TM17 High Feature terminal modules:
- TM15: up to 24 global measuring inputs
- TM17 High Feature: up to 16 global measuring inputs

The configuration is described in detail in the corresponding manuals.

For more detailed information, refer to the following documents:
- *SIMOTION Output Cams and Measuring Inputs Manual*
- *TM15/TM17 High Feature Terminal Modules Commissioning Manual*

## 5 Combination of Different Functionalities



Provided that the Control Unit supports the individual functionality, the following combinations are possible:
- Global and local measuring inputs can be combined on the same Control Unit.
- A local measuring input can also be used as an input for external zero marks.
- A **global** measuring input **cannot** be used as an input for external zero marks (download message: p495[0..2] parameter: inadmissible value)
- Global measuring inputs and fast output cam outputs can be combined on a SIMOTION D (e.g. for D4x5: 2 measuring inputs; 6 output cam outputs)
- For measuring inputs, the static state of the input can be read via the same digital input.

## 6 Integration in the SIMOTION Runtime System / Timing

For more detailed information on the integration in the runtime system, refer to the following document:
- *Basic Functions Function Manual, Chapter Runtime System/Tasks/System Cycles – Integration of Drive I/Os*

# 7 Tips & Tricks

## 7.1 Programming examples

The following FAQ programming examples are available for the integration of the onboard I/Os, TM15 DI/DI, TM31 and TB30.

The examples are written in Structured Text. The supported functionality includes the following functions:

- Reading out data words from the frame and writing the values in the individual global variables (for BOOL binary words, e.g. the status of the inputs)
- Reading out the individual variables and writing the data words in the frame

Depending on the required response times, the program can be executed in the background or also in an IPO task.
For analog inputs and outputs (TB30, etc.), respectively one additional FC is available for the conversion of the normalized percent value (-200% ... +200%) into a floating point number and vice versa.



**Download Sources**


D4x5_CU320_TB30.txt


D410_CU310.txt


TM15.txt


TM31.txt

More detailed information on these documents is available under the following FAQ:
http://support.automation.siemens.com/WW/view/en/29063656

Besides more detailed information, the link also provides access to the sources of the programming examples.

## 7.2 Performant Access to the I/O Area

For performance reasons, it is more advisable to access the I/O area word by word instead of creating individual BOOL variables for I/O access.

```
// Reading in inputs of TM15
//-----------------------------------------------------------------------
      boFault           := _getBit( wInData[0],  7 );

      boState_DI00      := _getBit( wInData[1],  0 );
      boState_DI01      := _getBit( wInData[1],  1 );
      boState_DI02      := _getBit( wInData[1],  2 );
      boState_DI03      := _getBit( wInData[1],  3 );

      boState_DI20      := _getBit( wInData[2],  4 );
      boState_DI21      := _getBit( wInData[2],  5 );
      boState_DI22      := _getBit( wInData[2],  6 );
      boState_DI23      := _getBit( wInData[2],  7 );

// Defining outputs of TM15
//-----------------------------------------------------------------------
      wOutData[1] := _setbit(wOutData[1], 0, boState_DO00);
      wOutData[1] := _setbit(wOutData[1], 1, boState_DO01);
      wOutData[1] := _setbit(wOutData[1], 2, boState_DO02);
      wOutData[1] := _setbit(wOutData[1], 3, boState_DO03);

      wOutData[3] := _setbit(wOutData[3], 4, boState_DO20);
      wOutData[3] := _setbit(wOutData[3], 5, boState_DO21);
      wOutData[3] := _setbit(wOutData[3], 6, boState_DO22);
      wOutData[3] := _setbit(wOutData[3], 7, boState_DO23);
```

# Annex

## 8 Modifications

Table 8-1: Modifications/Author

| Version | Date/Modification |
|---|---|
| V1.0 | April 18, 2008 / creation of the initial document |
| V1.1 | August 19, 2008 / supplements to V4.1, SP2 |
| V1.2 | August 29, 2009 / supplements to V4.1, SP4 |
| | |



## 9 Reference List

### References

This list is not complete. It only provides a selection of reference literature.

Table 9-1: List of documents

| | Subject | Title |
|---|---|---|
| /1/ | High Speed I/Os with terminal modules | TM15/TM17 High Feature Terminal Modules Commissioning Manual |
| /2/ | Configuration of the technology objects | SIMOTION Output Cams and Measuring Inputs Manual |
| /3/ | Runtime and task system | Basic Functions Function Manual |
| /4/ | Programming | SIMOTION ST Structured Text Programming and Operation Manual |
| /5/ | Drive technology | Manuals of the SINAMICS S120 drive system |

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# 10 Contact Persons

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