

Consistent Data

PROFIBUS DP and PROFINET IO

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Question

What are the options for transferring data consistently in a PROFIBUS DP system or PROFINET IO system?

Answer

Follow the instructions and notes listed in this document for a detailed answer to the above question.

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1 Introduction

1.1 Definition

Consistent Data

Data that belongs together with regard to content and describes a process state at a specific time is called consistent data. For data to be consistent, it must not be changed or updated during processing or transfer.

Consistent data area

The size of the data area that is not changed simultaneously by concurrent processes is called a consistent data area. A data area that is larger than the consistent data area can be completely corrupted.

1.2 Example

You determine the mean value of a series of numbers. The following conditions hold for this example:

- The elements of the series of numbers are determined at the beginning of the calculation.
- The source data is made available in a buffer and has to be stored in a second buffer.
- Transfer of the source data between the buffers is serial.
- This takes different amounts of time.

If you do the calculation in a constant cycle, then not all of the elements include the latest value and you get a false mean value.

If you handle the series of numbers as one unit or structure, then the calculation is always made only when all the elements of the series of numbers include a valid value. Here it is irrelevant in which order the determination of the elements is made or how much time is required. This series of numbers is then consistent.

2 Reading data consistently from a DP standard slave/PROFINET IO device and writing it consistently to a DP standard slave/PROFINET IO device

2.1 Addressing

System function SFC14 "DPRD_DAT"

Using the system function SFC 14 "DPRD_DAT" (read consistent data of a DP standard slave), you read out the data of a DP standard slave/PROFINET IO device. If no errors occur during the data transfer, the data read is entered into the target area defined by RECORD. The target area must have the same length as you configured with STEP 7 for the selected module. With a DP standard slave with modular structure and with multiple DP identifications, with an SFC 14 call you can only ever access the data of one module / DP identification under the start address configured.

System function SFC15 "DPWR_DAT"

Using SFC 15 "DPWR_DAT" (write consistent data), you transfer the data in RECORD consistently to the DP standard slave/PROFINET IO device addressed. The source area must have the same length as you configured with STEP 7 for the selected module.

Maximum upper limits for transfer of consistent user data to DP slave

Upper limits for the transfer of consistent data to a DP slave are defined by the PROFIBUS DP standard. This is why only a maximum of 64 words = 128 bytes of user data can be transferred consistently in one block to a DP standard slave.

When configuring, you define the size of the consistent area. For this, in the special identification format (SKF) you can set a maximum length of 64 words = 128 bytes for the consistent data (128 bytes for inputs and 128 bytes for outputs); anything beyond that is not possible.

This upper limit applies only for pure user data. Diagnostics and parameter data is grouped into whole data records and is therefore always transferred consistently.

For this, in the general identification format (AKF) you can set a maximum length of 16 words = 32 bytes for the consistent data (32 bytes for inputs and 32 bytes for outputs); anything beyond that is not possible.

Note

The PROFIBUS DP standard defines upper limits for the transfer of consistent user data. Current DP standard slaves keep to these upper limits. Older CPUs (<1999) have CPU-specific restrictions for the transfer of consistent user data.

The maximum length of data that these CPUs can read consistently from a DP standard slave or write consistently to a DP standard slave is given in the technical data under "DP master – user data per DP slave". With the value, more recent CPUs exceed the length of the data that a DP standard slave provides or receives.

General identification format (AKF) and special identification format (SKF)

The special identification format (SKF) is an extension of the general identification format (AKF). It provides more flexibility for enabling manufacturer-specific functions.

Note

A CPU 41x / 31x as DP slave in the general context must be able to be configured on a third-party master (connection via GSD) via the general identification format (AKF). For this reason the transfer memory of a CPU 41x / 31x as DP slave to the PROFIBUS DP has a maximum size of 16 words = 32 bytes.

Maximum upper limits for transfer of consistent user data to an IO device

The upper limit for the transfer of consistent data to an IO device is 255 bytes (254 bytes user data + 1 byte associated value). Even if more than 255 bytes can be transferred to an IO device, the upper limit is 255 bytes of consistent user data.

For the communication processors, the following consistent area sizes apply for a submodule.

Table 2-1

CP	MLFB	Size of the consistency area for a submodule
CP343-1 ¹⁾	6GK343-1EX21-0XE0	128 bytes
CP343-1 ¹⁾	6GK343-1EX30-0XE0	240 bytes
CP343-1 Advanced ¹⁾	6GK343-1GX21-0XE0	128 bytes
CP343-1 Advanced ¹⁾	6GK343-1GX30-0XE0	240 bytes
CP443-1	6GK443-1EX20-0XE0	240 bytes
CP443-1 Advanced	6GK443-1EX40-0XE0	128 bytes
CP443-1 Advanced	6GK443-1EX41-0XE0	240 bytes
CP443-1 Advanced	6GK443-1GX20-0XE0	240 bytes

¹⁾Use communication blocks FC11 "PNIO_SEND" and FC12 "PNIO_RECV" for consistent data communication via the communication processors of the S7-300.

The following entries show:

- How to program communication blocks FC11 "PNIO_SEND" and FC12 "PNIO_RECV" for the CP343-1 as PROFINET IO controller.

<http://support.automation.siemens.com/WW/view/en/26558253>

- How to program communication blocks FC11 "PNIO_SEND" and FC12 "PNIO_RECV" for the CP343-1 as PROFINET IO device.

<http://support.automation.siemens.com/WW/view/en/31764615>

2.2 Access to consistent data

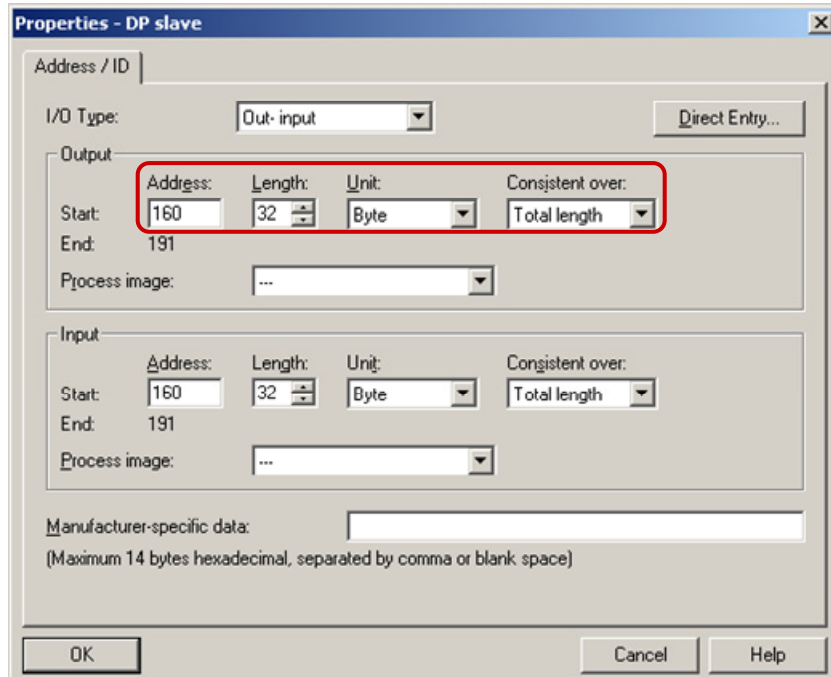
Configuration if consistent data areas >4 bytes

In the STEP 7 hardware configuration, you can define the following parameters for the consistent area in the "Properties - DP slave" dialog → "Address / ID" tab:

- Length
- Unit
- Consistent over

2 Reading data consistently from a DP standard slave/PROFINET IO device and writing it consistently to a DP standard slave/PROFINET IO device

Figure 2-1



Data areas and access forms in the program, which all CPUs support uniformly

Table 2-2

Length/data area	Read/write access	Consistency of data
1 byte	Load / Transfer	Consistency over unit
2 bytes	Word Load / Word Transfer	Consistency over total length
3 bytes	SFC14 / SFC15	Consistency over total length
4 bytes	Double-word Load / Double-word Transfer	Consistency over total length
5 bytes	SFC14 / SFC15	Consistency over total length

Example

```
CALL SCF 14 ("DPRD_DAT")           //Call
  LADDR:= W#16#80                   //Configured start address
                                     equivalent to decimal 128
  RECORD:= P#DB1.DBX0.0 BYTE 32    //Stores the I/O data in the
                                     data block for further
                                     processing

CALL SCF 15 ("DPWR_DAT")           //Call
  LADDR:= W#16#80                   //Configured start address
                                     equivalent to decimal 128
  RECORD:= P#DB1.DBX0.0 BYTE 32    //Writes the I/O data from the
                                     data block into the output address
                                     of the I/O
```

Possible sources of error

- ANY pointer on the RECORD parameter:
In the case of an ANY pointer on the RECORD parameter, a length of 1, 2 or 4 is specified. Here, we recommend the data lengths 3 or 4, because all CPUs support these data lengths.
- Different data types on the ANY pointer and in hardware configuration:
Only the BYTE data type is permissible on the ANY pointer for both SFC14 "DPRD_DAT" and SFC15 "DPWR_DAT".
- Incorrect consistency set in the hardware configuration:
The consistency must always be set over the entire area!

2.3 Access to consistent data without SFC14 "DPRD_DAT" and SFC15 "DPWR_DAT"

Description

Consistent data access > 4 bytes is now possible without the system functions SFC14 "DPRD_DAT" and SFC15 "DPWR_DAT". The option of being able to consistently access data > 4 bytes using download/transfer commands provides a particularly convenient and high-performance method of access (low runtime load).

In this case, the data area of a DP slave or IO device that is to be transferred consistently is transferred to a process image or process image partition. The data in this area is then always consistent. You can use download/transfer commands (e.g. L IW 1) to access the process image or process image partition. There is no limitation of the area with respect to addressing.

Properties

- The operating system automatically controls updating of the process image.
- Updating of the process image partition is done either on the user side using SFCs or automatically on the system side through a link to an OB.
- If you access the process image or process image partition directly (e.g. L PEW or T PAW), then there is no I/O access error.

Overview

You can use the following CPUs for configuring without SFC14 "DPRD_DAT" and SFC15 "DPWR_DAT":

Table 2-3

MLFB	CPU	As from firmware version
6ES7 31..	CPU 31x	2.5
6ES7 41	CPU 41x	3.0

Note

Do **not** use the system functions SFC14 / SFC15 and access via the process image at the same time.

The consistency between process image values and the values of system function SFC14 "DPRD_DAT" is not guaranteed, because the process image is not tracked when reading with system function SFC14 "DPRD_DAT". The process image is tracked only when writing with system function SFC15 "DPWR_DAT". This means that the consistency between process image values and the values of system function SFC14 "DPRD_DAT" is not guaranteed.

If you are using a CP443-5 Extended, then simultaneous use of the system functions SFC14 / SFC15 and access via the process image produces the following messages:

"Read/write in the process image is not possible and/or it is no longer possible to read/write with SFC 14 "DPRD_DAT" and SFC 15 "DPWR_DAT"."

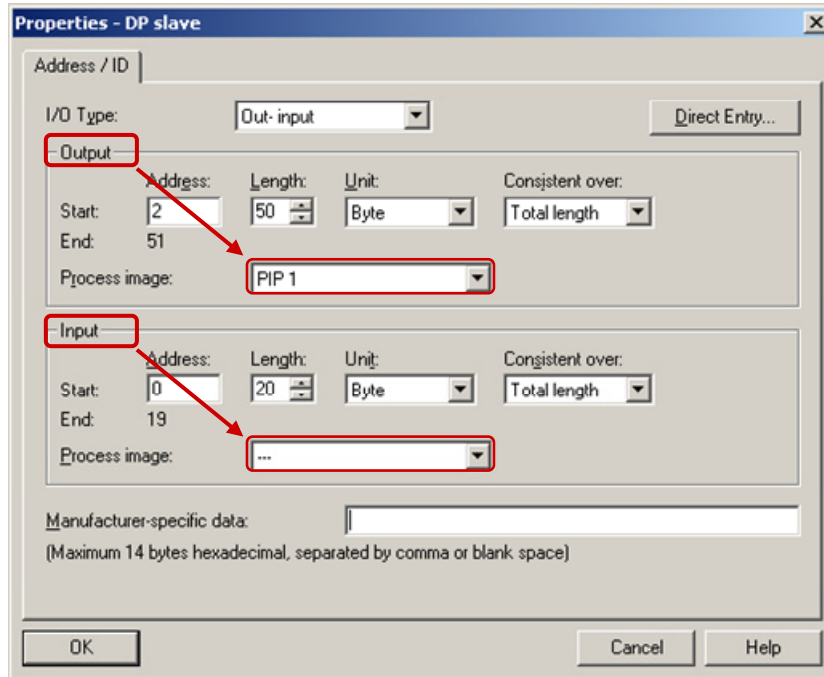
Example

This example shows configuration of consistent output in the process image partition TPA 1 of a CPU319-3PN/DP. In this way, you can write the 50 bytes using download/transfer commands.

The input is **not** configured in the process image partition. The 20 bytes can only be read with the system functions SFC 14 "DPRD_DAT" and SFC 15 "RDWR_DAT".

Fig. Figure 2-2 shows how to configure an output in the process image partition TPA1 in the hardware configuration of the CPU319-3PN/DP.

Figure 2-2



Updating the process image:

The process image is automatically updated during cyclic program processing of the CPU. You can deselect updating of the process image with S7-400 CPUs and CPU 318 if:

- you access the I/O directly instead or
- update one or more process images of the inputs and outputs at another time using the system functions SFC26 "UPDAT_PI" and SFC27 "UPDAT_PO".

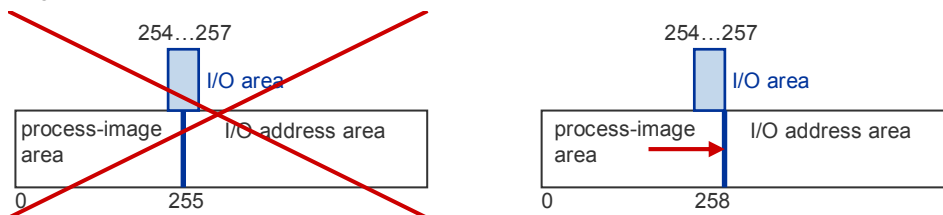
2.4 Conditions for assigning addresses

When assigning addresses in the hardware configuration you must note that a data area created (e.g. a double-word) must not be configured on the limit of the process image (i.e. a part of the area within and the rest of this area outside the double-word).

Example

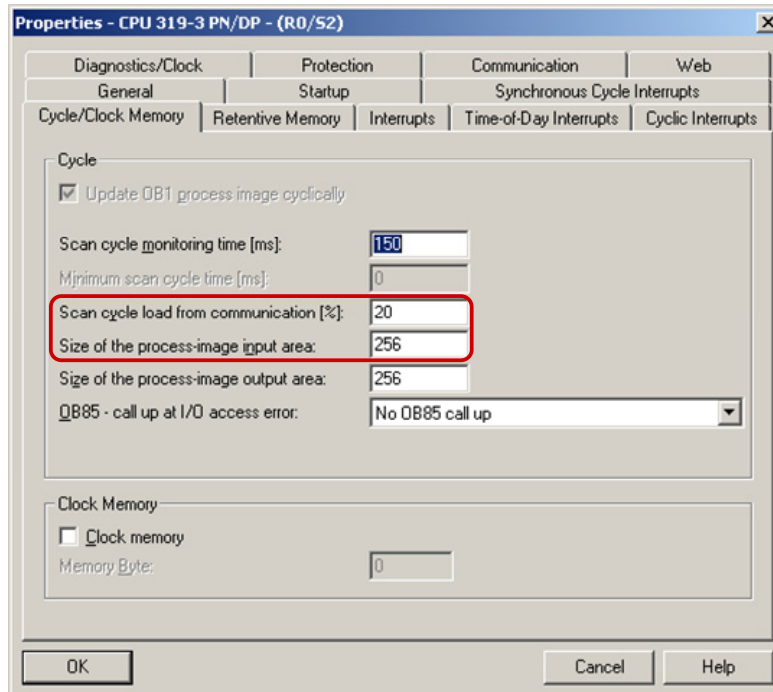
In the case of a process image of 256 bytes (address area 0 to 255), an input double-word is configured to the addresses 254 to 257. In this case, you must match the size of the process image accordingly (can be set in the Properties of the CPU).

Figure 2-3



In the hardware configuration, you set the size of the process image in the Properties dialog of the CPU → "Cycle/Clock Memory" tab.

Figure 2-4



Overview

The following table gives an overview of the CPUs for which you can variably set the size of the process image:

Table 2-4

S7-300 CPU	MLFB	Restriction
CPU315-2 PN/DP	6ES7 315-2EH13-0AB0	Firmware V2.5 plus
CPU317-2 DP	6ES7 315-2AJ10-0AB0	Firmware V2.5 plus
CPU317-2 PN/DP	6ES7 315-2EJ10-0AB0	Firmware V2.3 plus
CPU317-2 PN/DP	6ES7 315-2EK13-0AB0	Firmware V2.3 plus
CPU318-2 DP	6ES7 318-2AJ00-0AB0	-
CPU319-3 PN/DP	6ES7 318-3EL00-0AB0	-
IM154-8 CPU	6ES7 154-8AB00-0AB0	Firmware V2.5 plus
IM151-8 PN/DP	6ES7 151-8AB00-0AB0	-

Table 2-5

S7-400 CPU	MLFB	Restriction
CPU 4xx..	6ES7 41..	Firmware V1.1 plus
CPU 416-2	6ES7 416-2XK00-0AB0	Only selection between 512 and 1024 bytes possible
	6ES7 416-2XK01-0AB0	
	6ES7 416-2XL00-0AB0	
	6ES7 416-2XK01-0AB0	

Note

Correct configuration of the I/O addresses is checked in STEP 7 V5.4 plus.

2.5 Handling consistent data with the communications processor CP342-5

You need the communication blocks FC1 "DP_SEND" and FC2 "DP_RECV" for communicating distributed data with the CP342-5. These blocks always transfer the data consistently (taking into account the evaluation of the block parameters DONE/NDR).

The following entry contains more information on configuring communication blocks FC1 "DP_SEND" and FC2 "DP_RECV":

<http://support.automation.siemens.com/WW/view/en/23905010>

Note

You cannot use the system functions SFC14 "DPRD_DAT" and SFC15 "DPWR_DAT". These system functions are available only for integrated DP interfaces with the S7-300.