3.3.2 DP protocol

Basic properties

On field level, protocols for PROFIBUS with a large number of services or extensive data editing are unsuitable since these factors would make it impossible to reach the required bus cycle time and reaction time.

The **PROFIBUS DP (distributed I/O)** protocol was developed to be able to cover the field level within the automation hierarchy. The basic feature of PROFIBUS-DP is the fact that the user data are displayed in form of a **cyclic data image**. The object-oriented interfaces as used in the FMS or S7 protocol are completely bypassed. The principle of PROFIBUS-DP communication is a **master-slave system**. A master cyclically polls one or several slaves.

Instead of the user interface, the user interface is located on level 7 (ISO-OSI reference model) of the DP protocol which, as standardized application along with **DDLM (Direkt Data Link Mapper)**, is directly based on level 2 (ISO-OSI reference model), thus on FDL.

The following two different types of DP masters exist:

- Master Class 1: This DP master cyclically controls the process.
- Master Class 2: This DP master is used for device parameterization and diagnostics.

Since there are no differences for all PROFIBUS protocols on level 2, all protocols can be operated in parallel in one PROFIBUS network.

Services of the protocol

The DP protocol distinguishes different services which also result from the different master classes.

- Data services

Data services are used to write or read data of the parameterized distributed I/O. If a station is parameterized as slave, this also enables to make user data available to a master.

- Diagnostic services

Depending on the parameterized job, diagnostic services enable diagnostics of a DP slave or a DP master.

- Control services

The control service enables the sending of control jobs to a PROFIBUS-DP station in the following form:

  - Status changes
  - Read jobs for inputs / outputs of other stations
  - Sending of global control commands

  to the local master or other bus stations.

Note

Only the data services are dealt with in detail in this document since the e-infoshop focuses on data communication.

Advantages and disadvantages of the DP protocol

The advantages and disadvantages of using this protocol are listed in the following:

Table 3-74

Advantages	
1	Very quick communication protocol since it is **very hardware-intimate**.
2	The protocol can also be used **with third-party systems**.
3	The data transfer is **acknowledged**.
4	In case of **minor or inconsistent data access**, access is performed **without function call**.

Disadvantages	
1	The service is only suitable for **small data amounts** (<= 244 bytes).
2	The protocol can only transfer **static data amounts**.
3	The **effort required for configuring is considerable**.

Configuration steps when using the protocol in SIMATIC S7

The following list contains the configuration steps necessary for DP protocol.

Table 3-75

Configuration step	Engineering tool	What has to be done
1. Hardware configuration of the station	HW Config	The bus to be used and the module used are selected in the hardware configuration.
2. Hardware configuration of the slave	HW Config	In the next step, the used slave modules are selected and assigned to the bus.
3. Hardware configuration of the modules	HW Config	Depending on the slave, also functional modules can be configured depending on the requirement in the system. It also has to be considered how the data are transferred to the master. Consistent data require function calls in the program.
3. User programming	LADDER/FBD/Statement List Editor	The data are polled by the master by direct I/O accesses or using the function calls.

Note

For a detailed step-by-step description of the configuration of a CPU or a CP DP master-slave system, please refer to chapter 5.3 of the documentation: “Direct Data Exchange between separate DP Systems via DP Communication”

The user interface

The user interface of PROFIBUS DP can be divided into two groups in SIMATIC S7:

- S7-300 CP 342-5
- Internal DP interfaces (also CP 443-5 Extended or IM 467)

Correspondingly, different user interfaces are available for both types which will be briefly explained in the following.

S7-300 CP 342-5 user interface DP_SEND / DP_RECV

Depending on the operating mode of the PROFIBUS CP 342-5, the DP_SEND / DP_RECV functions have the following functions within the S7-300:

Table 3-76

Operating mode / Block	DP master	DP slave
DP_SEND	The block transfers the data of a specified DP output area to the PROFIUB CP for output to the distributed I/O.	The block transfers the input data of the DP slave to the PROFIBUS CP for transfer to the DP master.
DP_RECV	The block transfers the process data of the distributed I/O as well as status information into a specified DP input area.	The block transfers the output data transmitted from the DP master into the DP data area specified on the block.

The two blocks are structured as follows:

DP_SEND

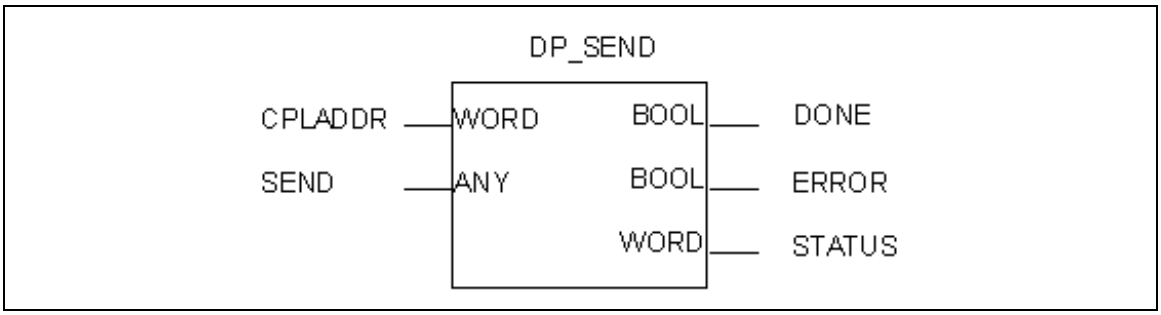

Fig. 3-31

Table 3-77

Parameter	Comment
CPLADDR	Module start address of the CP in HW Config.
SEND	Indication of the DP data area to be transferred in the I/O, bit memory address or data area.
DONE	Execution display for the completed send job.
ERROR	Error display if an error occurs during the function.
STATUS	Status display for detailed information on the status of the block.

DP_RECV

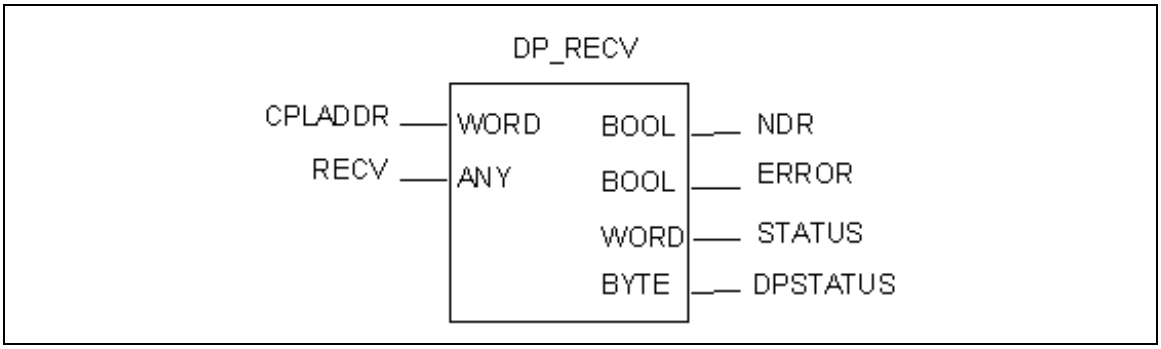

Fig. 3-32

Table 3-78

Parameter	Comment
CPLADDR	Module start address of the CP in HW Config.
RECV	Indication of the DP receive data area in the I/O, bit memory address or data area.
NDR	Execution display for the completed reception of a data area.
ERROR	Error display if an error occurs during the function.
STATUS	Status display for detailed information on the status of the block.
DPSTATUS	Status display for detailed information on the status of the bus system.

Note

Detailed information on the parameters and the user interface and their use is available in the SIMATIC NET NCM S7 for PROFIBUS – Volume 1 manual or in the STEP7 online help.

The DPWR_DAT / DPRD_DAT user interface

The DPWR_DAT / DPRD_DAT interface is suitable for all internal interfaces of the SIMATIC S7 DP master. This includes all DP communications processors of the S7-400.

.Note

The DPWR_DAT / DPRD_DAT interface is only to be used if the size of the consistent data is **3 bytes** or **more than 4 bytes**! For byte, word or double-word access, direct I/O access can be used.

The task of the blocks is described in the table below:

Table 3-79

Block	Task
DPWR_DAT	With SFC 15 “DPWR_DAT” (write consistent data to a DP-norm-slave) you consistently transfer the data from a data source area to the addressed DP standard slave and into the process image.
DPRD_DAT	With SFC 14 “DPRD_DAT” (read consistent data of a DP-norm slave) you consistently read out data of a DP standard slave or one of its modules.

The two blocks are structured as follows:

DPWR_DAT

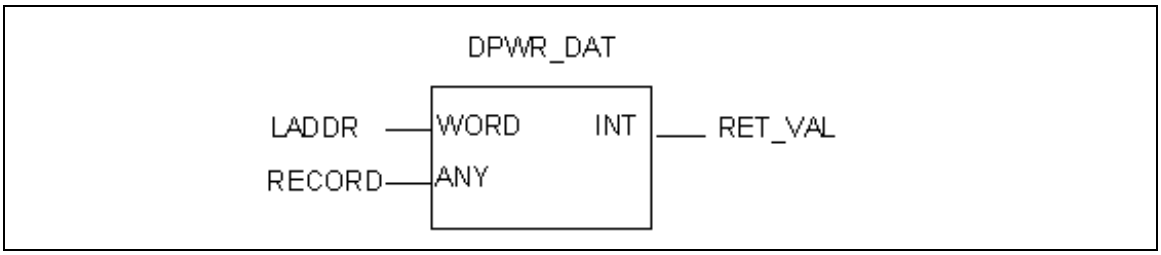

Fig. 3-33

Table 3-80

Parameter	Comment
LADDR	This is the configured start address from the output area of the module which is to be written to.
RECORD	This is the source area for the user data to be written. The length of the source area has to correspond to the configured data area of the respective module.
RET_VAL	If an error occurs during processing the function, the return value contains an error code.

DPRD_DAT

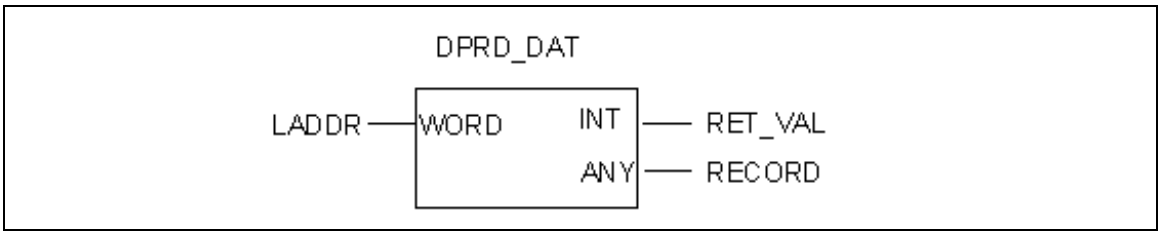

Fig. 3-34

Table 3-81

Parameter	Comment
LADDR	This is the configured start address from the input area of the module from which is to be read.
RET_VAL	If an error occurs during processing the function, the return value contains an error code.
RECORD	This is the destination area for the read user data. The length of the destination area has to correspond to the configured data area of the respective module.

Note

Detailed information on the parameters of the user interfaces and their use in the different modes of the DP modules is available in the STEP7 online help or in the manuals: “STEP 7 – System and Standard Functions for S7-300 and S7-400” or ”SIMATIC NET NCM S7 for PROFIBUS Volume 1 of 2”

Basic performance data/quantity frameworks

Within the framework of this e-infoshop, an application dealing with DP communication between internal DP interfaces and a CP 342-5 was created. In the scope of this application, a transfer time measurement serving as an example for the communication between internal and external interfaces was performed.

The measurement was performed under the following boundary conditions:

Table 3-82

Condition	Frame
Data amount	240 bytes, including 16 bytes acknowledgement
Baud rate	1.5 MBit/sec
Bus profile	DP
Master	**CPU 315 AG 10**
Slave	CPU 315 AG 10 with **CP 342-5 DA 02**

The following results were measured:

Table 3-83

Condition	Measured value
Transfer time master -> slave (224 bytes user data) for 100 measurements	
Average duration	79 ms
Maximum duration	438 ms
Minimum duration	7 ms
Transfer time slave -> master (224 bytes user data) for 100 measurements	
Average duration	33 ms
Maximum duration	51 ms
Minimum duration	19 ms

The measurement of a transfer process lasts from the initiation of the data transfer in the sending station until the acknowledgement of the data by the receiving station. The short average time shows the high data throughput of the used protocol.