SIEMENS

SIMATIC NET

DP Base Programming Interface for CP 5613/CP 5614

Manual

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Safety Guidelines

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

Danger

indicates that death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

Warning

indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Caution

indicates that minor personal injury or property damage can result if proper precautions are not taken.

Note

draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel

Only qualified personnel should be allowed to install and work on this equipment . Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Correct Usage

Note the following:

Warning

This device and its components may only be used for the applications described in the catalog or the technical description, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.

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Preface

Purpose of the Manual

This manual supports you when creating user programs for the DP programming interface of the CP 5613/CP 5614.

It is assumed that you are familiar with writing user programs in the "C" programming language in Windows NT.

Validity of the Manual

This manual applies to the following software versions:

- CP 5613/CP 5614 (DP Base V1.0)
- CP 5613/CP 5614 (DP Base V1.1)

Guide to the Manual

To help you to find specific information quickly, the manual includes the following parts:

- At the front of the manual you will find a complete table of contents.
- At the back of the manual, you will find a comprehensive index with which you can find topics quickly.
- After the index, there is also a glossary in which important terminology used in the manual is defined.

Contents

Basic Steps in Creating a DP Application

1

This chapter recommends a step-by-step procedure for creating a DP user program based on the DP programming interface of the CP 5613 and CP 5614 known as "DP Base". The steps begin with the basics of PROFIBUS DP and are completed when you test your application.

The DP Base programming interface allows direct access to the DP process image in the dual-port RAM of the module. The DP Base programming interface is therefore not compatible with the DP programming interface of the CP 5412 (A2), the CP 5511, and the CP 5611.

Procedure

The steps outlined below represent the fastest and simplest way of achieving your aims:

Step	Description
1	Familiarize yourself with the basic principles of PROFIBUS DP. Read the following chapter 2 (“Overview of PROFIBUS DP").
2	Familiarize yourself with the basic characteristics of the DP Base programming interface of the CP 5613 and CP 5614. Read the following chapter 3 (“Overview of the DP Base Interface").
3	Check through the contents of the subfolder "prog" in your installation folder so that you know what it contains and the purpose of the components for the subsequent steps. The subfolder contains the following: ● The "readme.txt" file with the latest additional information and most recent modifications. ● The C header file "dp_5613.h" with the functions and data structures of the DP Base interface and "5613_ret.h" with the return codes. ● The import libraries "dp_base.lib" and "dps_base.lib" for linking to your user program. ● The sample programs and corresponding databases in the "examples" subfolder.
4	Now work through the source text of the sample program "ExamEasy" and read through the functions and data accesses in Chapter 4 Description of the DP Functions, Data, and Error Codes
5	Adapt the "ExamEasy" sample program to suit your system configuration by, for example, using additional or different slaves. Compile and link the sample program and try it out. You may need to extend the "ExamEasy" sample database (with COM PROFIBUS).
6	Now work through the source text of the sample program "ExamComp", modify the program and try it out with an extended sample database.
7	If you want to use the slave functions of the CP 5614, you should also work through the "transfer" sample, modify it to your requirements and try it out with an extended sample database.
8	Please read the FAQs in Chapter 5, particularly the check list for programmers and the information on structuring your user program.

Table continued on next page

Table continued from previous page

Step	Description
9	Now create your own DP user program. You can use the "ExamComp" sample as a basis.
10	Test your application. Refer to the information and tips in the FAQ list in Chapter 5 and the diagnostic tools described in the installation instructions.

Overview of PROFIBUS DP

2

This chapter will familiarize you with the basic principles of PROFIBUS DP.

2.1 Where Does PROFIBUS DP Fit In?

PROFIBUS - The Worldwide Fieldbus Strategy

The trend towards reducing costs in automation engineering has meant that programmable controllers (PLCs), PCs, drives, transducers and sensors are being networked more and more. This has resulted in greater distribution of these field devices using a fieldbus as the common communications medium for exchanging information.

The demand for an open, heterogeneous fieldbus system representing a safe and long-term investment for the user has been met by PROFIBUS. PROFIBUS is a bus system for communication between programmable controllers or PCs and field devices based on the European standard EN 50 170, Volume 2. This means that both users and manufacturers can be certain about long-term investments and guarantees "openness" for all applications conforming with the standard worldwide.

With more than 2 million network nodes in over 200,000 applications, PROFIBUS is the most successful open fieldbus having proved itself in applications in production automation, process automation, drive engineering, and building automation.

The PROFIBUS users organization represents a widespread information forum for PROFIBUS manufacturers and users. This is an organization involving more than 800 users, manufacturers and advisers from more than 20 countries worldwide. As a result of this cooperation, more than 1600 products are now available for use in PROFIBUS systems.

Siemens has supported PROFIBUS for many years as an optimized fieldbus solution and reliable investment for the user and supplies both products and complete systems. Apart from the programmable controllers (PLCs), devices such as network components, PC communications processors, and field devices for PROFIBUS are also included in the wide range of products.

The Role of the PC in PROFIBUS

Apart from the trend towards distribution, the standard PC is also becoming more important as an automation tool particularly in control tasks and for plant visualization thanks to its increased performance and widespread availability.

The Advantages of DP

PROFIBUS DP is intended for fast data exchange in the fieldbus area.

Distributed peripheral devices collect the input signals locally and transfer them via the fieldbus to the central controller in the PG/PC. In the opposite direction, the central controller sends the output data to the distributed peripheral devices.

The use of PROFIBUS DP means a considerable reduction in cabling compared to previous direct wiring of components.

2.2 The Master-Slave Concept of PROFIBUS DP

Distributed I/Os

The distributed peripheral I/Os (abbreviated to DP in the remainder of this manual) allow a large number of analog and digital input/output modules to be used in a distributed structure in the immediate vicinity of the process.

Node Classes

PROFIBUS DP defines two classes of bus nodes. Slaves as peripheral devices are passive nodes. Masters (class 1) are active nodes and control the slaves.

DP Master Class 1

Using the CP 5613 or CP 5614, the PC can adopt the role of DP master. Depending on the application, this role can also be adopted by, for example, a SIMATIC S7 programmable logic controller. In the remainder of the manual, the DP master class 1 is simply referred to as DP master.

DP Master Class 2

When installing and configuring the DP system or controlling the plant during operation, you can also use master class 2 devices.

DP Slave

A DP slave is a peripheral device from which the master reads in input information and to which it sends output information. There are also devices that provide only input or only output information.

Slaves are generally inexpensive since passive participation on the bus is simple to implement.

Figure 1 illustrates the basic structure and the components of a PROFIBUS DP system controlled by a computer with a PROFIBUS master installed (CP 5613/CP 5614).

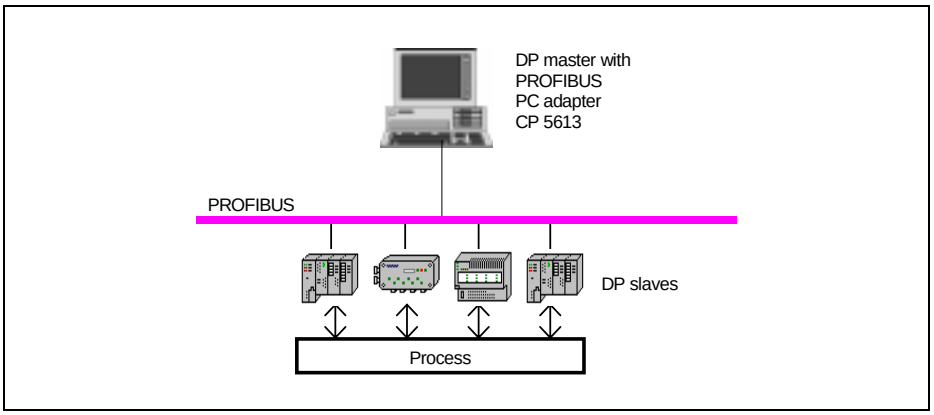


Figure 1 Basic Structure of a DP System.

2.3 Cyclic Polling by the Master

Polling

Communication between the DP master and the distributed nodes takes the form of polling. Polling means that the DP master sends cyclic calls to its slaves during the productive phase. A separate call frame is sent to each DP slave.

In one polling cycle, all the operational DP slaves are addressed. The next polling cycle starts as soon as the last slave has been addressed. This ensures that the data is up to date.

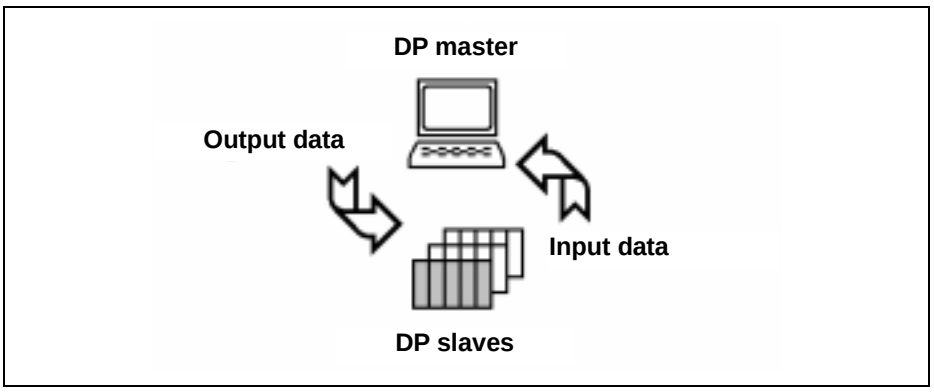


Figure 2 Schematic Representation of Polling

Output Data

The call frame contains the current output data that the DP slave will apply to its output ports. The data belonging to this area are specified by the DP application. If a DP slave does not have output ports, an "empty frame" is sent to it instead.

Input Data

The reception of a call frame must be confirmed by the DP slave by returning a confirmation frame. The confirmation frame contains the current input data that are applied to the input ports of the DP slave. If a DP slave does not have input ports, an "empty frame" is returned instead.

2.4 Process Image of the DP Master

Automatic Updating of the Data

The CP 5613 or 5614 as the PROFIBUS DP master polls the data of the slaves continuously and buffers this data on the PC. The DP application accesses this data directly. This means that the DP application is not involved in polling the slaves.

Figure 3 shows an overview of the data areas on the DP master.

Data Areas

There are three different data areas on the DP master for each configured DP slave, as follows:

- Input data from the DP slave
- Output data to the DP slave
- Diagnostic data from the DP slave

The data are buffered by the CP 5613 or CP 5614 in memory that can be accessed by the AP application directly without requiring function calls.

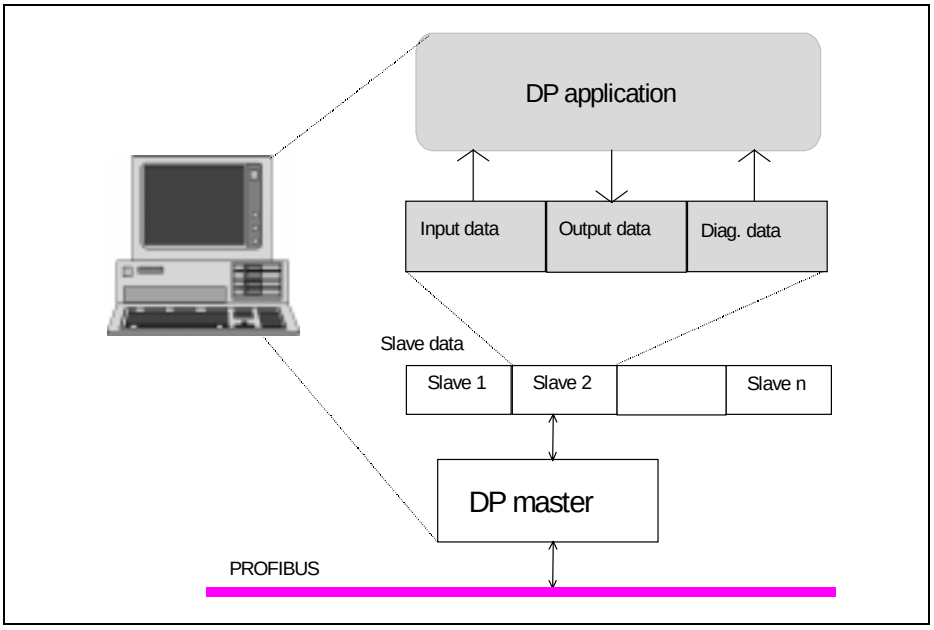


Figure 3 Data Areas of the DP Master

2.5 Startup and Operational Phase of a DP System

Functions of the DP Master during Startup and Operation

The DP master handles the following tasks:

- Initialization of the DP system
- Parameter assignment/configuration of the DP slaves
- Cyclic data transfer to the DP slaves
- Monitoring the DP slaves
- Storage of diagnostic information

Initialization

The DP master can only exchange productive data with the DP slaves when it has assigned parameters to the slaves and configured them. The parameter assignment/configuration takes place as follows:

- During the startup phase of the DP master
- Following any temporary failure of a DP slave during the productive phase

Parameter Assignment

The parameter assignment frame provides global operating parameters for the DP slave (for example ID).

Configuration

The configuration frame is sent after the DP slave has been assigned parameters. This frame contains the current configuration of the DP slave. The configuration includes the number and type of input/output ports. The DP slave compares the received configuration frame with the values that it determined itself during the startup phase. If the values match, the DP slave confirms the configuration and changes to the productive phase.

State of the Slave

During the operational phase, the DP master evaluates the confirmation frames received from the DP slaves. Based on this information, the DP master can find out the current state of the DP slaves.

Diagnostics

If a DP slave detects an error/fault during the initialization or productive phase, it can signal this to the DP master in the form of diagnostic data. The received diagnostic data are entered in the diagnostic area of the DP master. In this case, the DP application is then responsible for reacting to the error.

2.6 Modes of the DP Master

Overview

During communication with the DP slaves, the DP master can adopt the following four modes:

- OFFLINE
- STOP
- CLEAR (or AUTOCLEAR)
- OPERATE

Modes

Each of these modes is characterized by defined actions between the DP master and the DP slaves.

Master Mode	Meaning
OFFLINE	No communication between the DP master and DP slaves. This is the startup mode of the DP master.
STOP	In this mode, there is also no communication between the DP master and the DP slaves. In contrast to the OFFLINE mode, a DP diagnostic station (DP master class 2) can read out diagnostic information from the DP master.
CLEAR (or AUTOCLEAR)	All the DP slaves entered and activated in the database are assigned parameters and configured in this mode. This is followed by the cyclic data exchange between the DP master and DP slaves. In this CLEAR mode, the value 0 or empty frames are sent to all slaves with a process output; in other words, process output is deactivated. The input data of the slaves are known and can be read out.
OPERATE	The cyclic, productive data transfer to the DP slaves takes place in the OPERATE mode. This is the productive phase. In this mode, the DP slaves are addressed one after the other by the DP master. The call frame transfers the actual output data and the corresponding response frame transfers the actual input data.

Setting the Operating Mode

When the CP 5613 or CP 5614 is started up, the module runs through the modes OFFLINE -> STOP -> CLEAR -> OPERATE controlled by the user program.

2.7 Separation of the Slave Data from the User Program

The process image is separate from the user program and the slaves.

To increase efficiency, the DP standard does not include flow control. The timing of the cyclic updating of the process image of the DP master implementation is connected neither to the DP slaves nor to the user program. Examples of different situations are shown below:

Example: The slave writes too quickly

If, for example, an analog slave modifies its output data quickly (sequence 1.11, 1.2, 1.3, 1.42, 1.5, 1.6, 1.7, 1.8, ...), the DP master only receives a sequence of "snapshots" that it enters in the process image (sequence 1.11, 1.3, 1.5, 1.8, ...).

Example: The user program reads too quickly

If the user program polls the process image extremely quickly, it obtains the values more than once since it overtakes the polling cycle of the master. Based on the example above, the user program then reads a sequence 1.1, 1.1, 1.1, 1.1, 1.3, 1.3, 1.3, 1.5, 1.5, 1.5, ...

Example: The user program writes too quickly

If the user program modifies the process image extremely quickly (sequence 1, 2, 3, 4, 5, 6, ...), it overtakes the polling cycle of the DP master. This then only transfers "snapshots" to the slave (sequence 1, 4, 6, ...).

Example: The user program reads too slowly

If the user program only polls the process image occasionally, for example, because it has various tasks to execute in the meantime, it is possible that some values will be skipped. The sequence 1.1, 1.2, 1.3, 1.4 in the process image then becomes, for example 1.1, 1.3 etc. in the user program.

Remedy

If the user program requires a better link to the slave than described above, there are a number of options available:

- With the hardware events of the CP 5613 and CP 5614, the user program can be informed of changes on the slave.
- With the DP protocol expansion DP-V1 master class 1 (DPC1), the user program can read and write data with a confirmation and can confirm alarms (if this is supported by the slaves).
- With user-specific implementations in the user program and on the slaves, user-specific flow controls can be achieved (packed into the DP process image or DPC1 data) to link the master and slaves and to avoid loss of data.
- The hardware event at the start of the CP 5613/CP 5614 cycle can be used for synchronization.

2.8 Reliability of DP

Reliability Concept

The DP programming interface provides various mechanisms to limit the effects of the failure of a communication connection or the DP master.

- A watchdog function can be configured on the DP slave so that if a slave is not accessed for a longer period of time it can change automatically to a safe state.
- The AUTOCLEAR function can be activated to ensure that if DP slaves are not accessible, the master automatically changes to the CLEAR mode.
- A sign-of-life monitoring function can be activated on the DP master that recognizes inactivity of a DP user program so that the DP slaves controlled by the master can be changed to a safe state (for the software version in which this function is available, refer to the version table in Section of the installation instructions).

The AUTOCLEAR function

The AUTOCLEAR option can be set during configuration. If an error occurs on one or more DP slaves during the productive phase, the DP master then changes **automatically** to the AUTOCLEAR mode (the DP system is closed down). The AUTOCLEAR mode is the same as the CLEAR mode. The DP master then sends data with the value 0 or empty frames in the output direction to the DP slaves. The DP master can no longer exit this mode automatically; in other words, the change to the OPERATE mode must be triggered explicitly by the user.

2.9 Control Frames to One or More Slaves

Purpose of Control Frames

A control frame is a frame that the master sends to one slave, a group, several groups or to all slaves. These frames are not acknowledged by the slaves.

Control frames are used to transfer control commands (known as global control commands) to the selected slaves to allow synchronization. A control command contains three components:

- Identifier indicating whether one or more DP slaves are being addressed
- Identification of the slave group
- Control command

Creating Groups

During configuration, you can assign a group identifier to a slave; in other words, it is possible to include several slaves in one group.

Which slaves belong to a group is specified when you create the database. During this phase, each DP slave can be assigned a group number. The DP slave is informed of this group number during the parameter assignment phase. You can specify a maximum of eight groups.

Control Commands

The following control commands can be sent to DP slaves when necessary during operation:

Control Commands	Description
FREEZE	The states of the inputs are read in and frozen. With this function, your user program can achieve consistency over several slaves when reading the input data; in other words, it is certain that the values read were all set at the same time.
UNFREEZE	The freezing of the inputs is canceled.
SYNC	Output is frozen. With this function, your user program can achieve data consistency over several slaves when writing output data; in other words, all the slaves use the new values at the same time.
UNSYNC	The UNSYNC command cancels the SYNC command.

2.10 Typical Sequences in DP

Basic Sequence on the DP Master

A typical sequence run by a DP master when triggered by the user program is shown below:

Step	Meaning
1	Initial situation: The DP master is in the OFFLINE mode.
2	The DP master changes to the STOP mode.
3	The DP master changes to the CLEAR mode. At this point it automatically assigns parameters to the slaves and configures them and then starts to send cyclic zero frames or empty frames (depending on the configuration).
4	The DP master changes to the OPERATE mode.
5	The output data of the user program are now transferred cyclically to the slaves, the input data are transferred from the slaves to the user program.
6	The master changes to the intermediate modes CLEAR and STOP and then changes to the final mode OFFLINE and is turned off.

Failure of a Slave

While the DP master is in the CLEAR or OPERATE mode, a slave may fail; in other words, no longer respond). The master then automatically attempts to reassign parameters and reconfigure the slave so that it can be included in the cycle again.

Activating/Deactivating Slaves

When the DP master is in the CLEAR or OPERATE mode, slaves can be activated or deactivated. A deactivated slave is no longer accessed by the master.

AUTOCLEAR

In some circumstances, the DP master can change from the OPERATE to the AUTOCLEAR mode, see Section 2.8.

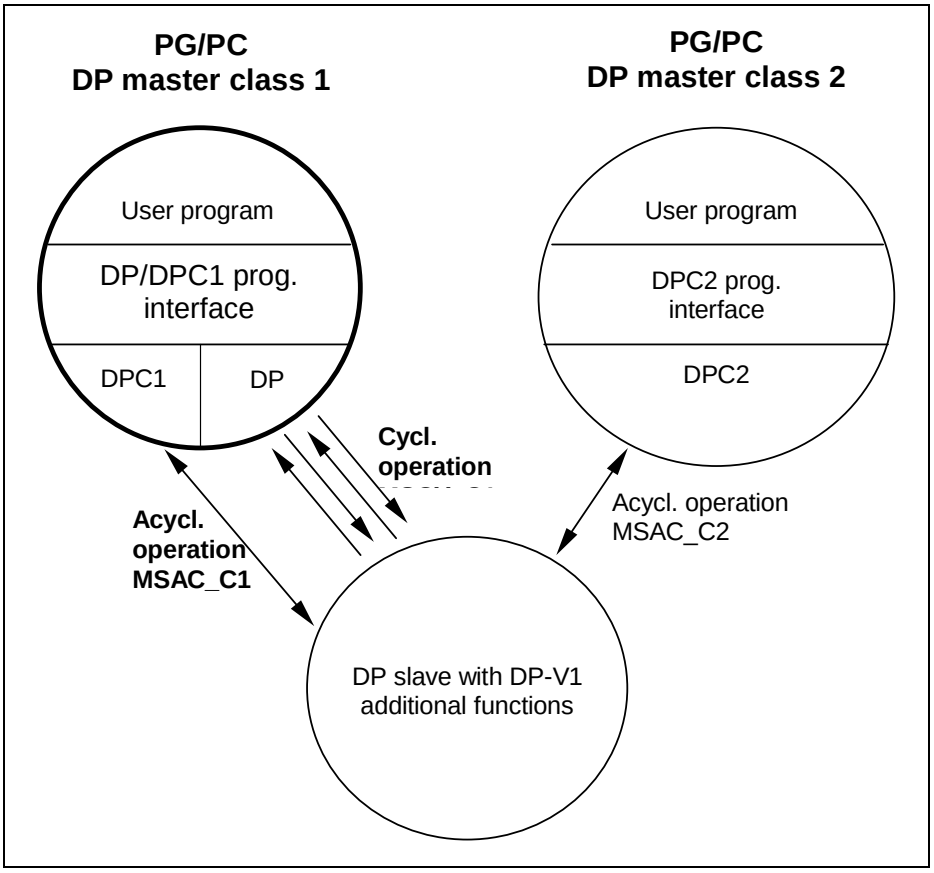
Receiving Diagnostic Data

When the slave returns high-priority input data to the master, it indicates that it has diagnostic data. The master then fetches the information and makes it available to the user program.

2.11 DP-V1 As an Extension of DP

Overview of the DP Protocol with DP-V1 Extensions

Apart from cyclic DP master operation (see Section 2.3), two further extensions are defined as DP-V1: DPC1 and DPC2. The paragraphs below contain an overview of these extensions:



DP-V1 Master Class 1 (DPC1)

With DPC1, a cyclic DP master can also send or read slave data and receive and acknowledge alarms. These data are not process data but slave-specific additional data (for example, new parameters). These data are not sent cyclically and must be acknowledged explicitly by the slave.

DP-V1 Master Class 2 (DPC2)

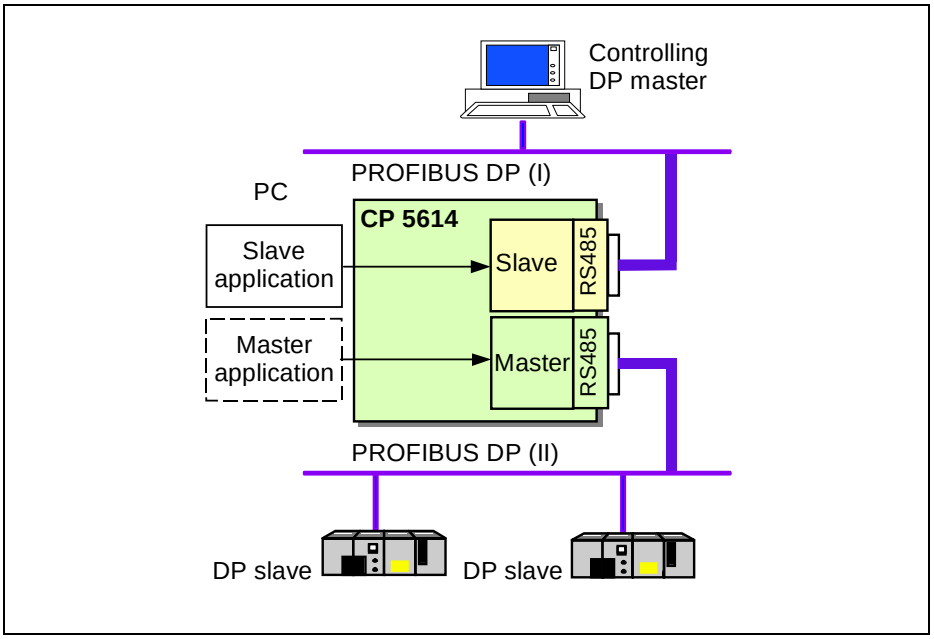
An additional DP master that is not operating cyclically can establish connections to slaves and send or read slave data using DPC2, for example, to reassign parameters or for diagnostic purposes.

For the software version in which the DPC2 functions are available for the CP 5613/CP 5614, refer to the version table in Section of the Installation Instructions.

2.12 Slave Functionality of the CP 5614

The Slave Functionality (Only CP 5614)

The piggy-back module on the CP 5614 provides slave functionality with its second PROFIBUS port. The slave is controlled by another DP master.

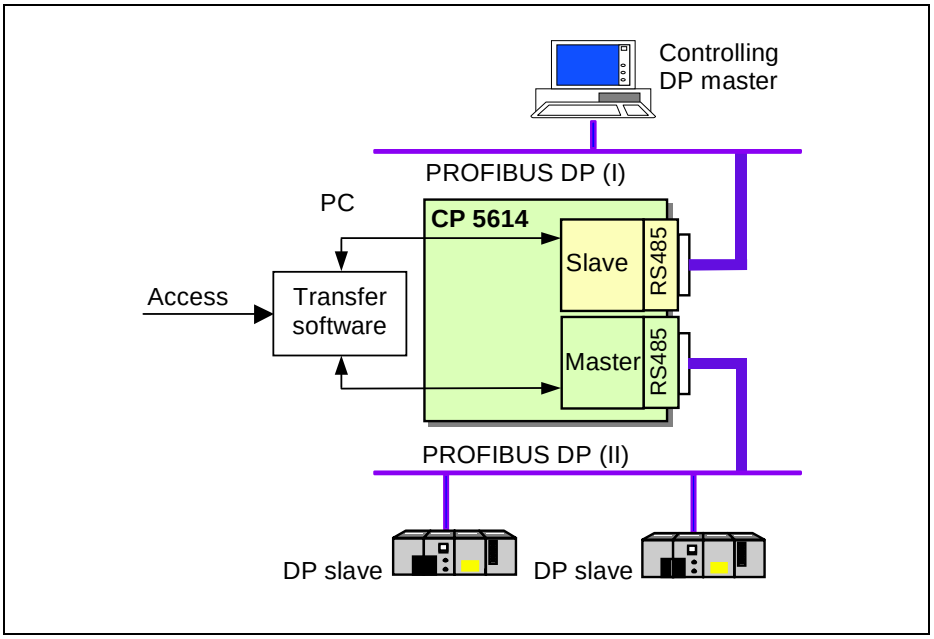


The Transfer Software (Only CP 5614)

To operate the CP 5614 with master and slave functionality, you can use the sample transfer software. The transfer software transfers data between the master and slave section of the CP 5614.

The transfer software includes an access with which additional input, output or diagnostic jobs can be executed. Your user program can use this access to add additional functions to the transfer program. (In the sample program, a counter on the CP 5614 slave module is incremented.)

The example illustrates how a separate transfer function can access the process image of the CP 5614 or CP 5613 with a local application.



The Configuration for the Transfer Software (Only CP 5614)

To allow you to specify the separate transfer function, a configuration tool and a configured transfer file are also shipped as an example.

Using the configuration tool, you can specify how data are copied from master to slave and vice-versa.

Overview of the DP Base Interface

3

The programming interface of the CP 5613/CP 5614 is known as the DP Base interface. This chapter explains the basic characteristics of the DP Base interface including typical call and access sequences to prepare you for creating your own DP applications.

For a detailed description of the function calls and data access, please refer to Section 3.10.

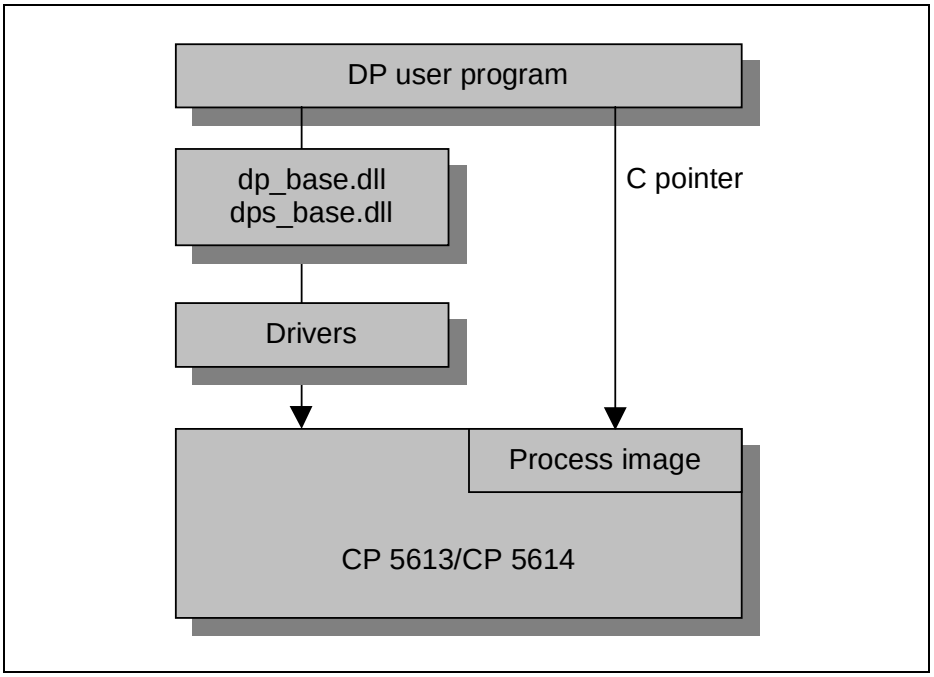
3.1 Functions and Data

Basic Structure of the DP Base Interface

The interface to the user program is implemented with two mechanisms, as follows:

- Interface calls of the dp_base.dll or dps_base.dll
- Direct access to the process image on the CP 5613/CP 5614

The schematic below shows you an overview.



Functions of the dp_base.dll and dps_base.dll

Your user program can execute administrative tasks and make use of less commonly required communication properties of the CP 5613 and CP 5614 by calling functions in the DP DLLs dp_base.dll and dps_base.dll.

Functions that begin with "DP_" have general and master module functionality. Functions that are only relevant for the slave module begin with "dps_" (the s stands for slave module).

Direct Access to the Process Image

While your user program is running, regularly required data from the CP 5613 and CP 5614 are available directly in a memory area of the CP. These include mainly the input, output, and diagnostic data of the DP slaves but also include mode and configuration data. Your user program can access the process image directly using a C pointer.

3.2 The Importance of Configuration

Using the DP Database

The DP database contains information about the bus parameters of PROFIBUS and about the slaves on the network. This information is evaluated when the CP 5613/CP 5614 starts up. This means that your user program does not need to contain these details and does not need to be modified (for example, if the data transmission rate is changed).

Configuring Slave Data Areas

During configuration, you specify the number and type (input, output, analog, digital) of the data areas of all the slaves. This configuration data is sent to the slave during startup and is then checked by the slave. If the configuration data does not match the actual properties of the slave, the slave enters this in the diagnostic data and it is not included in cyclic operation.

Activating the Watchdog

If the watchdog of a DP slave is activated in the configuration, the DP master must communicate with the DP slave within a selected time.

If there is no communication within this time, the slave switches its outputs to a safe state and no longer takes part in data transfer with the master section since the slave assumes that a serious problem has occurred, for example wire break or failure of the DP master.

The master must then assign parameters to the slave and configure it again. Following this, the exchange of productive data can be resumed.

The values adopted by the outputs can be found in the descriptions of the DP slaves.

Configuring the AUTOCLEAR Property

If one of the activated slaves does not take part in the data transfer and if the AUTOCLEAR function is set, the DP master automatically changes to the CLEAR mode (with the coding AUTOCLEAR).

Configuring the "Min_Slave_Interval"

The "Min_Slave_Interval" time is the minimum time that must elapse after the master accesses a slave before it can access it again. This is calculated automatically based on the GSD data of the slaves.

3.3 Consistent Access to the process image

Conflicts Accessing the Process Image

If, for example, your user program is currently reading the data of the DP slave from the process image and at exactly the same time the DP master overwrites this data with new data, your program could read the first few bytes from the previous DP cycle and the remaining bytes from the current cycle. The data would then be corrupted and inconsistent.

The Read Consistency Option

On the CP 5613 and CP 5614, you can decide whether or not you want to read the data of the process image of the input data or diagnostic data consistently. In some situations, for example, when the data is only 2 bytes long, you do not need to select consistency since inconsistency can only occur when the data is longer.

Consistency can be guaranteed up to a maximum data length of 244 bytes.

Writing Data is always Consistent

On the CP 5613 and CP 5614, output data are always written consistently due to the transfer mechanism on the CP 5613/CP 5614 up to the maximum data length of 244 bytes.

3.4 Working with Hardware Events

Reducing Load on the PC CPU

To relieve the PC of the computing time required for permanent polling on the DP interface, you can use hardware events. Your user program then decides which events will be reported by the CP 5613/CP 5614.

Possible Hardware Events

Hardware events can be triggered by the following criteria:

- The input data of a DP slave have changed. The hardware event can be activated separately for each slave.
- A DP slave sends diagnostic data (regardless of whether it has changed or not). The hardware event can be activated separately for each slave.
- Fast logic (see Section 3.5)
- A new DP cycle begins.

How Hardware Events are Activated

The process image memory area of the CP 5613 and CP 5614 contains a control area for activating hardware events (activating fast logic is described in Section 3.5). Your user program can set and delete hardware events by simply writing to this memory.

How Hardware Events are Transferred

A hardware event is transferred by incrementing a semaphore. This means that your user program or one of its threads can wait for individual events; see also Section 3.6.

Note

The use of hardware events for a lot of active slaves at the same time may result in greater load on the PC than polling; refer to the suggestions in the FAQ list.

3.5 Fast Logic

Purpose

With the fast logic property of the CP 5613/CP 5614, you can assign parameters to the CP so that it automatically monitors data from slaves and triggers reactions on other slaves.

This has the following advantages:

- The user program has less to do.
- The data transfer is faster due to separating the functions from the PC software.
- By being independent of the PC software, the reaction to the input signal is guaranteed.

For the software version in which this property is available, refer to the version table in Section in the Installation Instructions.

Procedure

Your program can activate functions that assign parameters for fast logic (DP_fast_logic_on) or clear parameters again (DP_fast_logic_off).

3.6 Overview of Triggering and Receiving Events

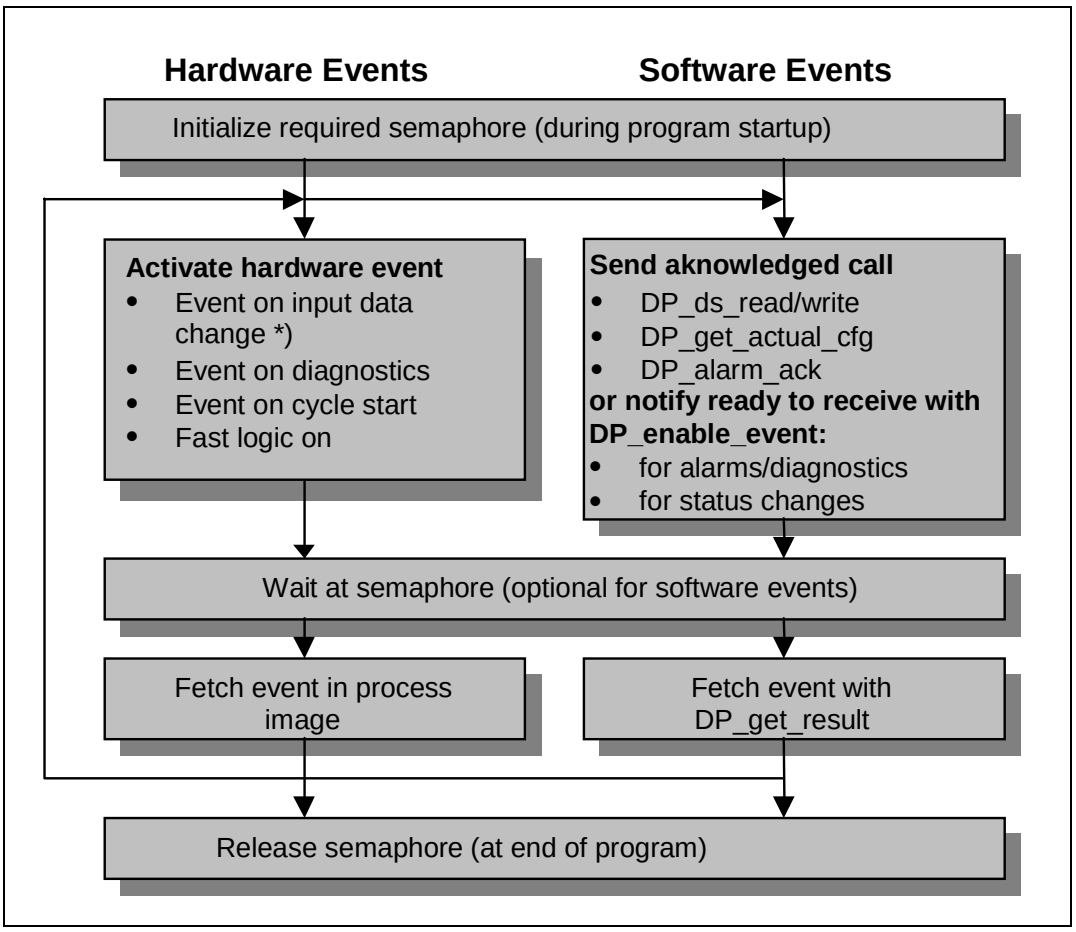
Properties of Hardware Events

The CP 5613/CP 5614 supports hardware events (see Section 3.4) with hardware mechanisms of the CP so that these can be processed extremely quickly. Hardware events (with the exception of fast logic) are activated in the process image of the CP, signaled by semaphores and the details of the event are located in the process image.

Properties of Software Events

Software events, on the other hand, are triggered by function calls, can be signaled by semaphores and are fetched again by function calls.

Overview of the Sequence of Events



*) Also possible if data changes in the slave module of the CP 5614.

3.7 Typical Sequences

3.7.1 Initializing and Exiting the Master Mode

Initialization

The typical initialization of a CP 5613 or CP 5614 activates the CP and brings the DP master to the OPERATE mode. The following steps are necessary:

Step	Action	Meaning
1	DP_start_cp	CP is initialized.
2	DP_open	Logon at the CP.
3	DP_get_pointer	Exclusive access to the process image.
4	DP_set_mode(Stop)	Change the master to the STOP mode.
5	DP_set_mode(Clear)	Change the master to the CLEAR mode, slaves are included in cyclic operation according to the information in the database.
6	DP_set_mode(Operate)	Bring the master to the OPERATE mode.

Productive Operation

The user program can access the data in the process image, trigger DP-V1 jobs and fetch their confirmations as well as trigger other DP functions. The sequences are described in greater detail on the following pages.

Shutdown Sequence

Shutting down the CP brings the DP master to the OFFLINE mode and is completed by stopping the CP:

Step	Action	Meaning
1	DP_set_mode(Clear)	Bring the master to the CLEAR mode, the slaves are reset.
2	DP_set_mode(Stop)	Bring the master to the STOP mode, cyclic operation is terminated.
3	DP_set_mode(Offline)	Bring the master to the OFFLINE mode.
4	DP_release_pointer	Enable access to the process image.
5	DP_close	Log off.
6	DP_reset_cp	Stop the CP.

3.7.2 Typical Sequences in Polling Master Operation

Definition

After the CP has been initialized as described above, the user program can use the CP for polling; in other words, for permanent direct access without waiting mechanisms.
A cycle for reading and writing the process data can be implemented with the tools described below.

Elements of a Polling Cycle

All the steps described below are achieved by direct access to the process image using the C pointer as the result of the "DP_get_pointer" call.

Taken together, they represent an example of a polling cycle.

Step	Action	Meaning
1	Check the mode of the master in the process image (USIF_state, Section 4.3.6)	Input data are only valid in the OPERATE and CLEAR modes. Output data can only be sent in the OPERATE mode.
2	Check the state of the slaves in the process image (slave_state, Section 4.3.5)	Communication functions only when the slaves are in the READY mode.
3	Optional: Check whether a slave has changed data (req_mask, Section 4.3.4), If yes: reset req_mask	Your user program can recognize whether or not input data from a slave has changed.
4	Read input data of the slaves (slave_in[ ].data, Section 4.3.1), consistency by accessing D_lock_in_slave_adr	For further processing in the user program
5	Check new diagnostic data of the slaves (diag_count, Section 4.3.2)	If the diagnostic counter has changed since the last cycle, there is new diagnostic data.
6	If applicable, read diagnostic data of the slaves (slave_diag[ ].data, Section 4.3.2), consistency by accessing D_lock_diag_slave_adr	For further processing in the user program
7	Write output data of the slaves (slave_out[ ].data)	As the result of processing the input and diagnostic data

3.7.3 Typical Sequences for Polling DPC1 master operation

Definition

After initializing the CP as described above, the user program can use DPC1 functions during cyclic operation to exchange data with slaves and to respond to alarms.

This section describes how these services are used in the polling mode; in other words, when continuously querying slaves without waiting mechanisms.

Individual pairs of jobs and confirmations can be used parallel to each other.

Polling to Write to a Slave with DPC1

Step	Action	Meaning
1	Send the write job (DP_ds_write)	On completion of the function, the job is active.
2	Poll the result (DP_get_result) until the job is completed	The result can be recognized by the order_id in the request field.

Polling to Read from a Slave with DPC1

Step	Action	Meaning
1	Send read job (DP_ds_read)	On completion of the function, the job is active.
2	Poll result with data (DP_get_result) until the job is completed.	The result can be recognized by the order_id in the request field.

Receiving and Responding to a DPC1 Alarm

Step	Action	Meaning
1	Attempt to receive alarm (DP_read_alarm)	If there is no alarm, this is indicated by the function result.
2	If received: Send alarm acknowledgment (DP_alarm_ack)	On completion of the function, the job is active.
3	Poll final result (DP_get_result) until the job is completed	The result can be recognized by the order_id in the request field.

3.7.4 Typical Sequences in Master Operation with Hardware Events

Definition

After initializing the CP as described above, the user program can activate hardware events and wait until they arrive with semaphores.

This means that polling for new data or diagnostic information can be omitted and it is possible to synchronize with the start of the cycle.
This mode can replace or supplement the polling described in Section 3.7.2.

The initialization of this mode, the elements of continuous operation and the canceling of the mode are explained below.

Initializing the Semaphores

Before you can use hardware events, semaphores must be created as follows:

Step	Action	Meaning
1	Initialize a semaphore for hardware events (function DP_init_sema_object)	The DP Base DLL provides semaphores for changes in the input data, reception of diagnostic information, cycle start and fast logic. The selector for a data change is, for example, DP_OBJECT_TYPE_INPUT_CHANGE.

Using Hardware Events

After initializing the required semaphores, the following sequence can be run through to activate and fetch events:

Step	Action	Meaning
1	Optional: Activate hardware event for input data changes (req_mask, Section 4.3.11)	With this, the user program indicates that it requires a semaphore to increment if input data change.
2	Optional: Activate hardware event for diagnostic data (req_mask, Section 4.3.11)	With this, the user program indicates that it requires a semaphore to switch if diagnostic data arrive.
3	Optional: Activate hardware event for start of cycle (D_cycle_start_mask, Section 4.3.11)	With this, the user program indicates that it requires a semaphore to increment at the start of a cycle.
4	Optional: DP_fast_logic_on	Send fast logic job
5	Wait for semaphore (for example WaitForMultipleObjects)	The user program or the thread waits until one of the events occurs. "WaitForMultipleObjects" is a Windows 32-bit API function.
6	Detect the type of event	The semaphore identifies the type of event, for example, data change.
7	Detect the source of the event (which slave)	Check the flags in the process image: • req_mask = DPR_DATA_CHANGE if data changes (Section 4.3.4) • diag_count changed during diagnostics (Section 4.3.2)
8	Read and process the event	• Read by accessing the process image: — slave_in[n].data for input data — slave_diag[n].data for diagnostic data — see Section 4.3.10 for fast logic • Pass on to other parts of the user program.

Clearing the Semaphores

After the last use of the hardware events, clear your semaphores as follows:

Step	Action	Meaning
1	Clear semaphores for events (function DP_delete_sema_object)	Releases the previously initialized semaphore.

3.7.5 Typical Sequences in DPC1 Operation with Semaphores

Definition

The polling mode for DPC1 described in Section 3.7.3 can also be replaced by operation with semaphores.
The initialization of this mode, the elements of continuous operation and canceling the mode are described below.

Initializing the Semaphores

Before it is used, the semaphore must be created as follows:

Step	Action	Meaning
1	Initialize a semaphore for asynchronous jobs (function DP_init_sema_object)	The DP Base DLL provides a semaphore for all asynchronous jobs (type DP_OBJECT_TYPE_ASYNC).

Using Semaphores for DPC1

Step	Action	Meaning
1	Send the write job (DP_ds_write)	On completion of the function, the job is active.
2	Wait for the semaphore (for example, WaitForMultipleObjects)	The user program or the thread waits until the event occurs. "WaitForMultipleObjects" is a Windows 32-bit API function.
3	Fetch result (DP_get_result)	The result can be recognized by the order_id in the request field.

The other DPC1 services function analogously.

Clearing a Semaphore

After the last use, clear your semaphore as follows:

Step	Action	Meaning
1	Clear semaphores for events (function DP_delete_sema_object)	Releases the previously initialized semaphore.

3.8 Properties of the CP 5614 (Slave Functions, Transfer Software)

Interaction Between the Master and Slave Functions

The DP master and slave on the CP 5614 can be operated together or singly.

"Simple Slave" Mode

In this mode, all the data necessary to include the slave module in the data exchange are transferred to the CP when the DPS_open (... slave_mode=DPS_SM_SIMPLE ...) function is called. The advantage of this is that the user program can read outputs and write inputs simply without checking the state of the slave module and without checking the parameters and configuration data.

"Dynamic Slave" Mode

In this mode, the slave can set itself dynamically to the configuration of its master. With the DPS_open() call, "DPS_SM_SIMPLE" is not selected. The user is informed when parameter and configuration data are received. It then checks whether it accepts the settings. This allows greater flexibility, particularly when the slave has a modular structure. In this case, the view of the master can be compared with the actual configuration of the slave.

Transfer Software

You are supplied with sample software with which the data can be routed between various slaves of the master section and the slave module. This is particularly advantageous in applications in which the master section is used to control a separate bus and the PC is connected, for example, to a control computer via the slave module.

3.9 Typical Sequences for the CP 5614 Slave Module

3.9.1 Initialization and Shutdown of the Slave Module in the "Simple" Mode

Initialization

The initialization of the CP 5614 in the "Simple" mode activates the CP and initializes the slave module so that it can be brought to the productive state by the master. The following steps are necessary:

Step	Action	Meaning
1	DP_start_cp	CP is initialized.
2	DPS_open	Initialization of the slave module: The "DPS_SM_SIMPLE" bit is set in the "slave_mode" parameter, the expected parameter and configuration data are in the "init_data" parameter.
3	DPS_start	Start the slave module
4	DP_get_pointer	Exclusive access to the process image.

Productive Operation

The user program can read and write the data in the process image.

Shutdown Sequence

To shut down the CP, the slave module changes to the OFFLINE mode and finishes by stopping the CP:

Step	Action	Meaning
1	DPS_stop	Bring the slave to the OFFLINE state
2	DP_release_pointer	Enable access to the process image.
3	DPS_close	Log off on the slave module
4	DP_reset_cp	Stop the CP.

3.9.2 Initialization and Shutdown of the Slave Module in the Dynamic" Mode

Initialization

Initializing the CP 5614 in the "Dynamic" mode activates the CP and initializes the slave module so that it responds on the bus. The parameter and configuration frames sent by the master must be checked and acknowledged by the user. The following steps are necessary:

Step	Action	Meaning
1	DP_start_cp	The CP is initialized
2	DPS_open	Initialization of the slave module: The "DPS_SM_SIMPLE" bit is **not** set in the "slave_mode" parameter, the "init_data" parameter contains the default configuration.
3	DPS_start	Start the slave module
4	DP_get_pointer	Exclusive access to the process image.

Polling Productive Operation

The user program can access data in the process image but must be prepared to process parameter and configuration frames. This is the case when the master wants to include the slave module in data exchange (for example, when the master starts up or after the bus connector has been removed and reinserted, ...). The following sequence must be executed cyclically in a main program loop.

Step	Action	Meaning
1	DPS_get_ind	Query whether indications have arrived.
2a	If DPS_CHK_PRM: DPS_set_resp	If a new parameter assignment has arrived: • Check user parameter data and • Acknowledge positively or negatively
2b	If DPS_CHK_CFG: DPS_set_resp	If a new configuration has arrived: • Check configuration data and • Acknowledge positively or negatively.
3	Access to PI (PI - **P**rocess **I**mage)	Read and write data in the process image (access as necessary)
4	Go to Step 1.	DPS_get_ind must be called cyclically.

Note

After positive confirmation of configuration data, the input data in the process image table of the slave module must be written at least once (initialization), before the slave module can change to data exchange.

Shutdown Sequence

To shut down the CP, the slave module changes to the OFFLINE mode and the CP is stopped:

Step	Action	Meaning
1	DPS_stop	Bring the slave to the OFFLINE state
2	DP_release_pointer	Enable access to the process image.
3	DPS_close	Log off on the slave module
4	DP_reset_cp	Stop the CP.

3.9.3 Typical Sequences with Semaphores on the slave Module

Definition

The polling mode described in Section 3.7.3 can also be replaced by operation with semaphores. The initialization of this mode, the elements of continuous operation and canceling the mode are described below.

Initializing the Semaphore

Before it is used, the semaphore must be created as follows:

Step	Action	Meaning
1	Initialize a semaphore for asynchronous jobs (function DP_init_sema_object)	The DP Base Lib provides a semaphore for all asynchronous jobs (type DP_OBJECT_TYPE_ASYNC).

Using Semaphores for the Slave Module

Step	Action	Meaning
1	Wait for the semaphore (for example, WaitForMultipleObjects)	The user program or the thread waits until an event occurs. "WaitForMultipleObjects" is a Windows 32-bit API function.
2	DPS_get_ind	Fetch arrived indications
3a	If DPS_CHK_PRM: DPS_set_resp	If a new parameter assignment has arrived: Check user parameter data and acknowledge positively or negatively
3b	If DPS_CHK_CFG: DPS_set_resp	If a new configuration has arrived: Check configuration data and acknowledge positively or negatively
4	Go to Step 1.	

Note

After positive confirmation of configuration data, the input data in the process image table of the slave module must be written at least once (initialization), before the slave module can change to data exchange.

Clearing the Semaphore

After the last use, clear your semaphore as follows:

Step	Action	Meaning
1	Clear semaphores for events (function DP_delete_sema_object)	Releases the previously initialized semaphore.

3.10 Multiple Protocols, User Programs, CPUs

Multiple CP Operation

For the software version in which the simultaneous operation of multiple CP 5613/CP 5614 modules is supported, refer to the version table in Section of the Installation Instructions.

Multiple Application Programs

For the software version in which the simultaneous operation of multiple application programs is supported, refer to the version table in Section of the Installation Instructions.

Multiple CPUs in one PC

Operation in PCs with multiple CPUs is supported

Description of the DP Functions, Data, and Error Codes

4

This chapter describes the individual functions and options for accessing data in the process image of the CP 5613 and CP 5614.

The chapter also explains the significance of the possible error codes.

The data formats for I/O data and for diagnostics are also described.

The chapter is primarily intended as a source of reference when you are writing your user programs.

4.1 List of Functions of the CP 5613 and CP 5614

Conventions in the Text

In the descriptions in this chapter, the following conventions are used in the function declaration:

Notation	Meaning
// in	The value is provided by the user program as input for the function.
// out	The value is returned to the user program by the function.
// inout	The value must be initialized and is updated on completion of the function.

Uniform Call Structure of the Functions of dp_base.dll

The functions have a uniform structure, as follows:

```
Error class = DP_... (      Job-defining parameter 1,
                                ...
                            Job-defining parameter n,
                            DP_ERROR_T *error);
```

Each function returns one of the error classes described below. If an error occurs, then depending on the error class, the DP_ERROR_T structure contains detailed error information (see Section 4.4). How the error is evaluated and the function DP_get_err_txt are explained in the sample programs supplied.

In the descriptions of the functions, the return values are described in tables as shown below based on the example of the DP_start_cp function call:

- If the return value is DP_OK, the function was executed successfully.
- If the return value is not DP_OK and the error_code component in the DP_ERROR_T error structure has the value CI_RET_START_ALREADY_DONE, the CP has already been started using a different database. Your user program should be able to react to such explicit error codes.
- In other situations, the error only occurs in exceptional cases.

Header Files

The C header files dp_5613.h and dps_5614.h with the detailed C description of the functions and data structures is in the "prog" subfolder of your software installation.

Synchronous and Asynchronous Functions

Unless explicitly indicated, the execution of a task is completed at the end of the function (in other words, the function is synchronous).
Some functions (for example, DP_ds_read) only trigger execution and are then completed. The actual result of the function must then be fetched with the DP_get_result function (in other words, the functions are asynchronous).

4.1.1 Overview of the Functions

Administrative Functions

Name	Purpose
DP_start_cp	Downloads the firmware and the database to the CP 5613/CP 5614.
DP_open	Logs on a DP user program, assigns a user handle.
DP_get_pointer	Requests a pointer to the process image.
DP_init_sema_object	This function initializes a semaphore at which your user program can wait for the arrival of events.
DP_delete_sema_object	This function clears a semaphore again.
DP_release_pointer	Releases the pointer to the process image.
DP_close	The DP user logs off.
DP_reset_cp	Stops the CP firmware.

Standard DP Functions

Name	Purpose
DP_set_mode	This function sets the required DP mode (OFFLINE, STOP, CLEAR, OPERATE).
DP_slv_state	This function activates or deactivates a slave explicitly and can be used to change the AUTOCLEAR property.
DP_read_slv_par	This function reads out the parameters of a DP slave from the database.
DP_global_ctrl	This function sends a global control command to one or more slaves.

Functions for the DP-V1 Master Class 1 (DPC1)

Name	Purpose
DP_ds_read	This function sends a "Read Data Record" call to a DP-V1 slave.
DP_ds_write	This function sends a "Write Data Record" call to a DP-V1 slave.
DP_read_alarm	This function fetches a DPC1 alarm or a DPC1 status message.
DP_alarm_ack	This function sends an "Alarm Acknowledge" call to a DP-V1 slave.
DP_get_cref	This function obtains the communication reference (c_ref) from the slave address and the user ID for DP-V1 jobs.
DP_get_actual_cfg	This function reads out the current configuration data of a slave.

Auxiliary Functions

Name	Purpose
DP_get_err_txt	This function outputs error information in plain language.
DP_enable_event	This function activates the waiting for status changes or diagnostic information on slaves.
DP_get_result	This function fetches the confirmation of an asynchronous call and other software events.
DP_disable_event	Cancels DP_enable_event

Fast Logic

Name	Purpose
DP_fast_logic_on	Assigns parameters to the CP 5613/CP 5614 for automatic monitoring of a slave and data transfer to another slave.
DP_fast_logic_off	Cancels the parameter assignment made with DP_fast_logic_on.

4.1.2 DP_start_cp

Purpose

This function initializes the CP 5613/CP 5614. The CP firmware and the database are downloaded.

Syntax

```
DPR_DWORD DP_start_cp  ( DPR_STRING     *cp_name,    // in
                         DPR_STRING     *database,   // in
                         DP_ERROR_T     *error );    // out
```

Parameters

Name	Description
cp_name	Name of the CP 5613/CP 5614 (for example, "CP5613_5614_1" for the first inserted CP).
database	Path and name of the database - if there is a zero pointer, the database name set in the start menu is used.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function - The green LED is lit.
otherwise if error->error_code == CI_RET_START_ALREADY_ DONE	Error: The CP has already been started with a different database.
other	Unsuccessful completion of the function.

4.1.3 DP_reset_cp

Purpose

This function resets the CP 5613/CP 5614. Following this, the CP is no longer active on the bus (Token LED is off).
If other applications are still using the CP, this function does not reset it, in this case use the "Installation" diagnostic tool in the start menu.

Note

To use the CP again, your user program must use the DP_start_cp call.

Syntax

```
DPR_DWORD DP_reset_cp  (DPR_STRING       *cp_name,   // in
                        DP_ERROR_T       *error );   // out
```

Parameters

Name	Description
cp_name	Configured name of the CP 5613/CP 5614, for example, "CP5613_5614_1" for the first inserted CP.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
otherwise if error->error_code == CI_RET_RESET_CP_USED	Unsuccessful because other applications are still using the CP.
other	Unsuccessful completion of the function

4.1.4 DP_open

Purpose

This function logs on a DP user program for communication. If successful, the function returns a user handle. The user handle must be included in all further function calls.

Syntax

```
DPR_DWORD  DP_open (
           DPR_STRING  *cp_name,         // in
           DPR_DWORD   *user_handle,     // out
           DP_ERROR_T  *error );         // out
```

Parameters

Name	Description
cp_name	Configured name of the CP 5613/CP 5614, (for example, "CP5613_5614_1" for the first inserted CP).
user_handle	Pointer to the user handle variable - if successful, the user handle assigned to the user program is entered here.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function.
otherwise if error->error_code == CI_RET_OPEN_CP_NOT_ STARTED	CP not started.
otherwise if error->error_code == DP_RET_TOO_MANY_USR	No further instances can log on at the dp_base.dll.
other	Unsuccessful completion of the function.

4.1.5 DP_get_pointer

Purpose

With this function, a DP user program obtains the exclusive pointer to the process data of the CP 5613/CP 5614. Using this pointer, the DP user program can then access the data image of the CP 5613/CP 5614.

General Notes

Note 1

Only one program can be in possession of a pointer to the process image at any one time. This prevents conflicts accessing the registers for controlling consistency in the process image (for example, refer toD_lock_in_slave_adr in Section 4.3.1).

Note 2

Note that access to the dual-port RAM without a valid pointer leads to an access violation in Windows NT. The reason for this is as follows: The DP_get_pointer was not called, the DP_get_pointer is terminated with an error message or the pointer was released again with DP_release_pointer.

Note 3

This function requires a relatively long run-time and if it is called often, can be detrimental to the real-time properties of your user program.

Note 4

The CP must already have been started with DP_start_cp.

Syntax

```
DPR_DWORD DP_get_pointer (
          DPR_DWORD              user_handle,      // in
          DPR_DWORD              timeout,          // in
          DPR_CP5613_DP_T   volatile **dpr,        // out
          DP_ERROR_T                 *error); // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
timeout	Duration of the maximum wait time (in milliseconds) until the function returns. **Limit values:** 0: No wait time (Function returns immediately) 0x7FFFFFFE: Maximum wait time DP_TIMEOUT_FOREVER: "Endless" wait time
dpr	Address of a pointer provided by the user program. If successful, the address for access to the process image of the CP 5613/CP 5614 is entered here - using this pointer, the DP user program can then access the data image of the CP 5613/CP 5614 directly.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
otherwise if error->error_code == DP_RET_TIMEOUT	Timeout – Pointer being used by another program.
other	Unsuccessful completion of the function

4.1.6 DP_release_pointer

Purpose

With this function, a DP user program releases the pointer to the process data. Following this, the DP user program can no longer access the data image of the CP 5613/CP 5614 directly.

Note

This function requires a relatively long run-time and if it is called often, can be detrimental to the real-time properties of your user program.

Syntax

```
DPR_DWORD  DP_release_pointer(
                DPR_DWORD   user_handle,          // in
                DP_ERROR_T  *error );             // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.1.7 DP_close

Purpose

With this function, a DP user program logs off for communication at the CP.

Note 1

If the logoff was successful, the user handle is no longer valid and must not continue to be used. The pointer to the dual-port RAM obtained with the DP_get_pointer function is also no longer valid.

Note 2

To shut down the DP master, your user program should first change the master to the OFFLINE mode with the DP_set_mode function.

Note 3

To disconnect the CP completely from the bus, your application can then use the DP_reset_cp function.

Syntax

```
DPR_DWORD  DP_close    (DPR_DWORD   user_handle,     // in
                        DP_ERROR_T  *error );       // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.1.8 DP_get_err_txt

Purpose

This function obtains detailed error information from the return values of the DP_ERROR_T error structure in plain language.

Syntax

```
DPR_DWORD  DP_get_err_txt (
           DP_ERROR_T        *error,                 // in
           DPR_STRING        *language,              // in
           DPR_STRING        text[DP_ERR_TXT_SIZE] ); // out
```

Parameters

Name	Description
error	Address of a structure provided by the user program of the type DP_ERROR_T. The structure contains the error values of a previously called DP function (see Section 4.4).
language	Language of the error text to be displayed: • "German" • "English"
text	Pointer to the data area in which the error text including the terminating zero byte is stored.

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

Note

If a string other than "German" or "English" is entered in the "language" parameter, the error text is displayed in English.

4.1.9 DP_set_mode

Purpose

This function sets the required DP mode (OFFLINE, STOP, CLEAR, OPERATE).

Warning

If you want the master to change from DP_CLEAR to DP_OPERATE, but AUTOCLEAR (see 2.8) is configured and one or more slaves have failed, it cannot change to the DP_OPERATE mode. Instead of this, it changes to DP_AUTOCLEAR which has the identical significance to DP_CLEAR. Your user program must therefore not query whether or not the DP_OPERATE mode has been reached endlessly but must also check whether the master has changed to the DP_AUTOCLEAR mode as a result of a slave problem (USIF_state, see Section 4.3.6).

Note 1

Since it can take some time to reach a new mode (depending on the data transmission rate, number of slaves etc.), the function does not wait until the new mode has been reached. This prevents the user program being delayed unnecessarily long.

Note 2

When a new mode is set, no other modes can be skipped. Starting from the current mode, the modes must be run through in the specified (ascending or descending) order OFFLINE - STOP - CLEAR - OPERATE. Following a DP_set_mode call, the "Master Info" area of the process image (USIF_state, see Section 4.3.6) must be queried to check whether or not the new mode was reached. Only then can a new mode be set.

Note 3

If your DP master changed to the AUTOCLEAR mode instead of the OPERATE mode, because a slave with the AUTOCLEAR property could not change to productive operation, you can nevertheless change the DP master to OPERATE. To do this, first deactivate the slave or its AUTOCLEAR property (in each case using the DP_set_slv_state call).

Syntax

```
DPR_DWORD DP_set_mode (DPR_DWORD   user_handle,      // in
                       DPR_WORD    mst_mode,         // in
                       DP_ERROR_T  *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
mst_mode	New mode to be set. The following constants can be used: DP_OFFLINE: OFFLINE mode DP_STOP: STOP mode DP_CLEAR: CLEAR mode DP_OPERATE: OPERATE mode
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	The change in the DP mode was activated.
otherwise if error->error_code == DP_RET_CP_REQ_ACTIV	There is still a DP_set_mode request being processed.
otherwise if error->error_code == DP_RET_CP_WRONG_MODE	The selected master mode is not permitted (a master mode has been skipped).
other	Unsuccessful completion of the function

4.1.10 DP_slv_state

Purpose

With this function, you can change the state of a DP slave while the DP user program is running. The slave can either be taken out of processing or can be activated again. You can also change the AUTOCLEAR property of a slave.

Using the slave address 0xFF and slv_mode == DP_SLV_ACTIVATE/ DP_SLV_DEACTIVATE you can activate or deactivate the AUTOCLEAR property.

As an option, selected single slaves (slv_add != 0xFF) can be included or removed from the AUTOCLEAR processing.

Note 1

If the AUTOCLEAR property is configured in the database, the AUTOCLEAR property of all slaves is already activated.

Note 2

If the AUTOCLEAR property was not configured in the database and you want to activate it you must first activate the AUTOCLEAR property generally (slave address 0xFF) and then activate the AUTOCLEAR property of the individual slaves.

Syntax

```
DPR_DWORD  DP_slv_state(DPR_DWORD  user_handle,      // in
                        DPR_WORD   slv_add;          // in
                        DPR_WORD   slv_mode,         // in
                        DP_ERROR_T *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
slv_add	Address of the slave or 0xFF with the meaning: Activate or deactivate AUTOCLEAR for all.
slv_mode	Required slave state: • DP_SLV_ACTIVATE Activate the slave • DP_SLV_DEACTIVATE Deactivate the slave • AUTOCLEAR setting: • DP_AUTOCLEAR_ON Activate • DP_AUTOCLEAR_OFF Deactivate The values can also be ORed.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.1.11 DP_read_slv_par

Purpose

This function queries the parameters of a currently active DP slave of the CP 5613/CP 5614.

Syntax

```
DPR_DWORD  DP_read_slv_par  (DPR_DWORD   user_handle,// in
                             DPR_WORD    slv_add,    // in
                             DPR_WORD    type,       // in
                             DPR_WORD    *data_len;  // out
                             DPR_BYTE    *data;      // out
                             DP_ERROR_T  *error );   // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
slv_add	Address of the slave
type	Required data type (see Section 4.7): DP_SLV_TYP: General slave parameters DP_SLV_PRM: Parameter assignment data DP_SLV_CFG: Configuration DP_SLV_ADD_TAB: Add tab data DP_SLV_USR: User-specific data With the last two, no data are supplied.
data_len	Address of a length variable - the number of valid bytes in the data buffer is entered here.
data	Pointer to a data area - the data area must be at least DP_PAR_SIZE long (see Section 4.7).
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
otherwise if error->error_code == DP_RET_CP_ADR_NOT_IN_DB	Error: The specified slave does not exist.
other	Unsuccessful completion of the function

4.1.12 DP_global_ctrl

Purpose

With this function, a global control command can be sent to one or more slaves.

Note

Slaves are assigned to a slave group when the DP database is configured.

Syntax

```
DPR_DWORD  DP_global_ctrl(
                        DPR_DWORD   user_handle,       // in
                        DPR_WORD    slv_add,           // in
                        DPR_BYTE    command,           // in
                        DPR_BYTE    group,             // in
                        DP_ERROR_T  *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
slv_add	Address of the slave or group address (DP_BROADCAST_ADR)
command	Here, the following global control commands can be specified (they can also be ORed): • DP_SYNC: freeze the output bytes • DP_UNSYNC: cancel the DP_SYNC command • DP_FREEZE: the states of the inputs are read in and frozen • DP_UNFREEZE: cancel the DP_FREEZE command
group	Slave group to be addressed, where bit 0 means group 1, bit 1 group 2 etc. The bits can also be ORed.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.1.13 DP_ds_read

Purpose

This function sends a "Read Data Record" call to a DP-V1 slave. The DP-V1 data are read parallel to cyclic operation. This is, however, not slave input but an additional data packet addressed using the slot and index of a slave. The structure and meaning of the data can vary depending on the slave type.

Note

Reading is executed **asynchronously** (DP_OK_ASYNC). The result must be fetched with DP_get_result.

Syntax

```
DPR_DWORD  DP_ds_read (DPR_DWORD   user_handle,      // in
                       DPC1_REQ_T        *request,   // in
                       DP_ERROR_T        *error );   // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.

Request	Pointer to DP-V1 structure DPC1_REQ_S with entries for the read data record job.
	`typedef struct DPC1_REQ_S`
	`{`
	`DPR_WORD order_id; // in`
	`DPR_DWORD c_ref; // in`
	`union`
	`{`
	`DP_DS_READ_T dp_ds_read;`
	`DP_DS_WRITE_T dp_ds_write;`
	`DP_ALARM_ACK_T dp_alarm_ack;`
	`DP_ENABLE_EVT_T dp_enable_evt;`
	`DP_GET_CFG_T dp_get_cfg;`
	`}req;`
	`} DPC1_REQ_T;`
	where
	`typedef struct DP_DS_READ_S`
	`{`
	`DPR_BYTE slot_number; // in`
	`DPR_BYTE index; // in`
	`DPR_BYTE length_s; //inout`
	`DPR_BYTE data_s[DPR_DPC1_MAX_LENGTH];`
	`// out`
	`} DP_DS_READ_T;`

Table continued on next page

Table continued from previous page

Name	Description
"Request" continued	The order_id is a job identifier assigned by the user program. The identifier is returned unchanged in the asynchronous confirmation and can be used to identify the job to which the confirmation belongs. The c_ref element specifies the slave. The value of c_ref can be obtained using the function DP_get_cref(user_id, slv_add). For information on the elements slot_number and index, refer to the description of the particular slave. The length_s element specifies the length of the data to be read. After receiving the DP_ds_read confirmation, length_s contains the actual number of data received from the slave. The received data are entered in data_s.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK_ASYNC	Execution of the function was activated successfully.
other	Unsuccessful completion of the function

4.1.14 DP_ds_write

Purpose

With this function, the master can send data to a slave. The data is sent parallel to cyclic operation.

This does not involve the slave output but rather an additional data packet with addressing using the slot and index of a slave. The structure and meaning of the data can vary depending on the slave type.

Note

Writing is executed **asynchronously**. The result must be fetched with DP_get_result.

Syntax

```
DPR_DWORD DP_ds_write  ( DPR_DWORD user_handle,      // in
                        DPC1_REQ_T        *request    // in
                         DP_ERROR_T       *error );   // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.

request	Pointer to DP-V1 structure DPC1_REQ_S with entries for the write data record job.
	`typedef struct DPC1_REQ_S`
	`{`
	`DPR_WORD order_id; // in`
	`DPR_DWORD c_ref; // in`
	`union`
	`{`
	`DP_DS_READ_T dp_ds_read;`
	`DP_DS_WRITE_T dp_ds_write;`
	`DP_ALARM_ACK_T dp_alarm_ack;`
	`DP_ENABLE_EVT_T dp_enable_evt;`
	`DP_GET_CFG_T dp_get_cfg;`
	`}req;`
	`} DPC1_REQ_T;`
	where
	`typedef struct DP_DS_WRITE_S`
	`{`
	`DPR_BYTE slot_number; // in`
	`DPR_BYTE index; // in`
	`DPR_BYTE length_m; // in`
	`DPR_BYTE data_m[DPR_DPC1_MAX_LENGTH];`
	`// in`
	`} DP_DS_WRITE_T;`
	The order_id is a job identifier assigned by the user program. The identifier is returned unchanged in the asynchronous confirmation and can be used to identify the job to which the confirmation belongs.
	The c_ref element specifies the slave. The value of c_ref can be obtained using the function DP_get_cref(user_id, slv_add).
	For information on the elements slot_number and index, please refer to the slave description.
	The length_m element specifies the length of the data to be sent to the slave in data_m.

error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK_ASYNC	Execution of the function was activated successfully.
other	Unsuccessful completion of the function

4.1.15 DP_read_alarm

Purpose

DPC1-compliant slaves can send alarms and status messages. This function reads the current alarm data or the current status message of a DP slave.
Depending on the slave type and the configuration, a DP slave can send up to 32 alarms to the CP 5613/CP 5614.

The structure and the meaning of the alarms or status message can vary depending on the slave type.

Note 1

All alarms are buffered by the CP 5613/CP 5614 and are therefore not lost. Only the last status message of a slave is, however, retained.

Note 2

The user program must acknowledge every alarm with a DP_alarm_ack call (this does not apply to status messages). For more information, refer to the documentation of the relevant slave.

Note 3

If the slave drops out of the processing phase, buffered alarms or status data are discarded. In this case, no alarm acknowledgment is necessary.

Syntax

```
DPR_DWORD  DP_read_alarm(
                DPR_DWORD        user_handle,      // in
                DPR_WORD         slv_add,          // in
                DP_ALARM_T       *alarm,           // out
                DP_ERROR_T       *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
slv_add	Address of the slave (0-126 or DP_NEXT_ALARM for the next message of any slave (seen chronologically))

alarm	Pointer to the DP_ALARM_S structure with the alarm or status data.
	`typedef struct DP_ALARM_S`
	`{`
	`DPR_WORD msg; // out`
	`DPR_WORD slv_add; // out`
	`DPR_BYTE slot_number; // out`
	`DPR_BYTE alarm_type; // out`
	`DPR_BYTE specifier; // out`
	`DPR_BYTE length_s; // out`
	`DPR_BYTE data_s[DP_ALARM_SIZE]; //out`
	`} DP_ALARM_T;`
	The "msg" parameter contains the type of data read:
	• DP_MSG_NONE no alarm/status message
	• DP_MSG_ALARM alarm data
	• DP_MSG_STATUS status message
	Slv_add indicates the slave from which the alarm or status data originate.
	For information on the slot_number, alarm_type, and specifier elements, see Section 4.6.4.
	The "length_s" structure element contains the number of alarm or status data stored in the "data_s" array.

error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function; the entry in DP_ALARM_T is valid.
other	Unsuccessful completion of the function; the entry in DP_ALARM_T is invalid.

4.1.16 DP_alarm_ack

Purpose

In certain situations, slaves with DPC1 functionality can signal alarms. These alarms are received by the DP master as part of the diagnostic data and buffered. Each alarm must be acknowledged by the master DP user program explicitly using the DP_alarm_ack function.

Note

Sending is executed **asynchronously**. The result must be fetched with DP_get_result.

Syntax

```
DPR_DWORD  DP_alarm_ack(DPR_DWORD  user_handle,      // in
                        DPC1_REQ_T  *request,        // in
                         DP_ERROR_T *error );        // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.

request	Pointer to DP-V1 structure DPC1_REQ_S with entries for the acknowledge alarm job.
	
	`typedef struct DPC1_REQ_S`
	`{`
	`  DPR_WORD  order_id;  // in`
	`  DPR_DWORD  c_ref;  // in`
	`  union`
	`  {`
	`  DP_DS_READ_T  dp_ds_read;`
	`  DP_DS_WRITE_T  dp_ds_write;`
	`  DP_ALARM_ACK_T  dp_alarm_ack;`
	`  DP_ENABLE_EVT_T  dp_enable_evt;`
	`  DP_GET_CFG_T  dp_get_cfg;`
	`  }req;`
	`} DPC1_REQ_T;`
	
	where
	
	`typedef struct DP_ALARM_ACK_S`
	`{`
	`  DPR_BYTE slot_number;  // in`
	`  DPR_BYTE alarm_type;  // in`
	`  DPR_BYTE  specifier;  // in`
	`} DP_ALARM_ACK_T;`
	
	The order_id is a job identifier assigned by the user program. The identifier is returned unchanged in the asynchronous confirmation and can be used to identify the job to which the confirmation belongs.
	
	The c_ref element specifies the slave. The value of c_ref can be obtained using the function DP_get_cref(user_id, slv_add).
	
	The slot_number, alarm_type, and specifier elements are taken from the received slave alarm.

error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK_ASYNC	Execution of the function was activated successfully.
other	Unsuccessful completion of the function

4.1.17 DP_get_actual_cfg

Purpose

This function can be used to read out the current configuration data from a slave. The data is requested from the slave using a special DP frame. With this function, you can check whether the expected configuration (database) matches the actual configuration.

The function can be used with modular slaves to detect the actual module configuration.

Note

Reading is executed **asynchronously**. The result must be fetched with DP_get_result.

Syntax

```
DPR_DWORD  DP_get_actual_cfg (DPR_DWORD  user_handle, // in
                              DPC1_REQ_T  *request,    // in
                              DP_ERROR_T  *error );   // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.

request	Pointer to DP-V1 structure DPC1_REQ_S with entries for the DP_get_actual_cfg job.
	
	`typedef struct DPC1_REQ_S`
	`{`
	`  DPR_WORD  order_id;  // in`
	`  DPR_DWORD  c_ref;  // in`
	`  union`
	`  {`
	`  DP_DS_READ_T  dp_ds_read;`
	`  DP_DS_WRITE_T  dp_ds_write;`
	`  DP_ALARM_ACK_T  dp_alarm_ack;`
	`  DP_ENABLE_EVT_T  dp_enable_evt;`
	`  DP_GET_CFG_T  dp_get_cfg;`
	`  }req;`
	`} DPC1_REQ_T;`
	
	where
	
	`typedef struct DP_GET_CFG_S`
	`{`
	`  DPR_BYTE length_s;  // out`
	`  DPR_BYTE data_s[DPR_SLAVE_DATA_SIZE];`
	`  // out`
	`} DP_GET_CFG_T;`
	
	The order_id is a job identifier assigned by the user program. The identifier is returned unchanged in the asynchronous confirmation and can be used to identify the job to which the confirmation belongs.
	
	The c_ref element specifies the slave. The value of c_ref can be obtained using the function DP_get_cref(user_id, slv_add).
	
	The length_s element specifies the length of the data received from the slave. The received data are entered in data_s (see Section 4.7).

error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK_ASYNC	Execution of the function was activated successfully.
other	Unsuccessful completion of the function

4.1.18 DP_enable_event

Purpose

Calling this function means that the following important events (software events) on the DP master can be signaled explicitly to the DP application:

- Diagnostic data, alarms and status messages can be fetched
- Slaves are included in the cyclic DP processing (operational) or have dropped out
- The mode of the master has changed

The function does not wait for the events but simply registers its program for notification. To fetch the events, use DP_get_result.

Note 1

By calling this function, your user program simply indicates that it is ready to receive the specified event type. The actual event message must be fetched with DP_get_result.

Note 2

When a DP_enable_event confirmation is received (see DP_get_result), the DP_enable_event function must be called again, if the user program wants to be informed of new events. The events DP_DIAG_ALARM and DP_SLV_STATE are buffered in the time between receiving the confirmation and calling DP_enable_event again so that they are not lost.

Note 3

When you first call DP_enable_event with the DP_SLV_STATE selector activated, note the following points:

- If slaves are operable at the time of the call (READY state), the event message DP_SLAVE_ENTER is triggered immediately for these slaves.
- If no slaves are operable at the time of the call (NOT READY state), no DP_SLAVE_EXIT event message is triggered.

Note 4

If the event DP_SLAVE_ENTER or DP_SLAVE_EXIT is signaled in consecutive DP_enable_event confirmations (with no DP_SLAVE_EXIT or DP_SLAVE_ENTER in the meantime), this means the following:

- Multiple DP_SLAVE_ENTER: The slave changed to the NOT READY state and back to the READY state.
- Multiple DP_SLAVE_EXIT: The slave changed to the READY state and then back to the NOT READY state.

Note 5

If the slave is in the NOT_READY state and the DP_DIAG_ALARM selector is activated, the event is signaled only when the slave signals Diag.Prm_Fault, Diag.Cfg_Fault or Diag.Ext_Diag in its diagnostic frame (for more information on the formats, see Section 4.6).

Note 6

If the DP master is not in the state to be monitored (mst_state) at the point when DP_enable_event is called with the DP_MST_STATE selector, the event is triggered immediately.

Syntax

```
DPR_DWORD  DP_enable_event   (DPR_DWORD  user_handle,// in
                             DPC1_REQ_T  *request,   // in
                             DP_ERROR_T  *error );   // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.

Request	Pointer to DP-V1 structure DPC1_REQ_S with entries for the event mechanism.
	
	`typedef struct DPC1_REQ_S`
	`{`
	`  DPR_WORD  order_id;  // in`
	`  DPR_DWORD  c_ref;  // reserved`
	`  union`
	`  {`
	`  DP_DS_READ_T  dp_ds_read;`
	`  DP_DS_WRITE_T  dp_ds_write;`
	`  DP_ALARM_ACK_T  dp_alarm_ack;`
	`  DP_ENABLE_EVT_T  dp_enable_evt;`
	`  DP_GET_CFG_T  dp_get_cfg;`
	`  }req;`
	`} DPC1_REQ_T;`
	
	The order_id is a job identifier assigned by the user program. The identifier is returned unchanged in the asynchronous confirmation and can be used to identify the job to which the confirmation belongs.
	Here, the c_ref element is reserved.
	In the "req" union, only the "dp_enable_event" variant is relevant and is described below.

error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Structure of the request->req.dp_enable_evt Structure Element

```
typedef struct   DP_ENABLE_EVT_S
{
     DPR_DWORD   selector;                    // in
     DPR_BYTE    mst_state;                   // in
     DPR_BYTE    event [DPR_MAX_SLAVE_ADDR];  // out
     DPR_BYTE    mst_event;                   // out
     DPR_BYTE    new_mst_state;               // out
} DP_ENABLE_EVT_T;
```

Description of the Elements of request->req.dp_enable_evt

Element	Description
selector	The selector element selects the type of events to be signaled. The values can be specified singly or “ORed". ● DP_DIAG_ALARM notify if diagnostic information or alarms occur ● DP_SLAVE_STATE notify when the slave enters or exits processing ● DP_MST_STATE notify when the master has or changes to a status other than that in the parameter mst_state.
mst_state	The mst_state element is relevant only when the identifier DP_MST_STATE is entered in selector. This contains a master state. If the master has or changes to a different state from that entered here, the DP_enable_event signals the DP_MST_STATE_CHG event. You can select one of the following values: ● DP_OFFLINE ● DP_STOP ● DP_CLEAR ● DP_AUTOCLEAR ● DP_OPERATE

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Element	Description
event	On completion of the job, the event array contains an element for every slave address with the events involving the specific slave. `event[5]`, for example, contains information about slave 5. The following event IDs can be returned per slave address, and if required, several can be “ORed". ● 0 — no event ● DP_DIAG — diagnostic information arrived. ● DP_ALARM_STATUS — alarm or status data was buffered and must be read out with DP_read_alarm. ● DP_SLAVE_ENTER — the slave was included in processing. ● DP_SLAVE_EXIT — the slave has dropped out of processing.
mst_event	The mst_event element contains the DP_MST_STATE_CHG identifier, if the value DP_MST_STATE is entered in selector and the master state has changed compared with the value in mst_state; otherwise the value 0.
new_mst_state	new_mst_state contains the current master state.

Return Value

Name	Description
DP_OK_ASYNC	Execution of the function was activated successfully.
otherwise if error-> error_code == DP_RET_REQ_ACTIV	There is still a DP_enable_event request active (delete with DP_disable_event).
other	Unsuccessful completion of the function

4.1.19 DP_disable_event

Purpose

With this function, an earlier DP_enable_event call can be canceled. This ends the previous ready to receive state without the relevant event having occurred.
The result of the terminating call must be fetched with DP_get_result. Following this, DP_enable_event, for example, can be called again with changed conditions.

Syntax

```
DPR_DWORD  DP_disable_event  (DPR_DWORD  user_handle,// in
                              DP_ERROR_T *error );   // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Execution of the function was executed successfully.
other	Unsuccessful completion of the function

4.1.20 DP_get_result

Purpose

This function fetches the confirmation (result) of an asynchronous job. The result of every asynchronous job must be fetched with this function.

Depending on the transferred timeout time, the function returns **immediately** or after the monitoring time has elapsed. If the timeout time "forever" is entered, DP_get_result waits until the confirmation has arrived.

Note 1

If a function is still waiting for asynchronous confirmations when DP_close is sent, DP_get_result is terminated with the error class DP_ERROR_USR_ABORT.

Note 2

The confirmations can arrive in any order. Below, there is an example of a sequence:

- The user program sends a DP_enable_event call so that it will be notified of alarms.
- The user program sends a DP_ds_write call, for example, to reassign parameters to slave 10.
- The user program then calls the DP_get_result function in a second thread and obtains a confirmation for the DP_ds_write job.
- Only after DP_get_result has been called again, does the DP_enable_event confirmation signal that there is an alarm for slave 10.

Syntax

```
DPR_DWORD  DP_get_result(DPR_DWORD user_handle,      // in
                         DPR_DWORD   timeout,        // in
                         DPR_WORD    *req_type,      // out
                         DPC1_REQ_T  *result,        // out
                         DP_ERROR_T  *error          // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
timeout	Duration of the maximum wait time (in milliseconds) until the function returns. Limit values: 0: no wait time - the function returns immediately 0x7FFFFFFE: maximum wait time DP_TIMEOUT_FOREVER: "Endless" wait time
req_type	Address of a variable for the job type. After receiving a confirmation, the job type is entered here: ● DP_NO_CNF: No confirmation received ● DP_DS_READ: Confirmation for DP_ds_read ● DP_DS_WRITE: Confirmation for DP_ds_write ● DP_ALARM_ACK: Confirmation for DP_alarm_ack ● DP_ENABLE_EVENT Confirmation for DP_enable_event ● DP_GET_CFG_EVENT Confirmation for DP_get_actual_cfg
result	The result parameter points to a structure of the type DPC1_REQ_T. When a confirmation is received, the confirmation parameters are entered in the relevant substructures of this structure (according to the entry in req_type).
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	A confirmation was received. The values in req_type and result are valid and identify the job. The corresponding job was completed without errors.
DP_ ERROR_EVENT_NET and error->error_code == DP_RET_TIMEOUT	No confirmation available.
DP_ERROR_EVENT, other DP_ERROR_EVENT_NET or DP_ERROR_RES	A confirmation was received. The values in req_type and result are valid and identify the job. The corresponding job was terminated with an error. The return structure contains details of the cause of the error.
DP_ERROR_CI, DP_ERROR_USR_ABORT	The function call was terminated with an error. No confirmation was received. The result parameter is not valid. The return structure contains details of the cause of the error.

4.1.21 DP_get_cref

Purpose

This function obtains the c_ref from the slave address and the user_handle for DPC1 functions. c_ref must be entered in these functions in the DPC1_REQ_S structure as a job-defining parameter.

Note

The c_ref for a slave only needs to be obtained once. It is not necessary to call DP_get_cref again before each DPC1 function.

Syntax

```
DPR_DWORD  DP_get_cref (DPR_DWORD  user_handle,      // in
                        DPR_WORD   slv_add,          // in
                        DPR_DWORD  *c_ref,           // out
                        DP_ERROR_T *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
c_ref	After successful completion of the function *c_ref contains the required reference.
slv_add	Slave address
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	c_ref was obtained.
other	Unsuccessful completion of the function, no result available

4.1.22 DP_init_sema_object

Purpose

This function initializes a semaphore for an event from the CP 5613/CP 5614 . With Win32 API functions (WaitForMultipleObjects, WaitForSingleObject, MsgWaitForMultipleObjects), a user program can wait at these semphores until an event arrives.

Semaphores are synchronization objects that Win32 API interface also supports. Using semaphores, it is possible to wait for the arrival of events in threads or processes.

Note 1

If you want to use semaphores for CP 5614 master and slave modes at the same time, initialize a master semaphore of the type DP_OBJECT_TYPE_ASYNC with the user handle of the DP_open call and then initialize a further semaphore of the type DP_OBJECT_TYPE_ASYNC but with the user handle of the DPS_open call.

Note 2

A semaphore initialized with DP_init_sema_object must only be deleted with the DP_delete_sema_objet function. Never use Win32 API functions to delete such semaphores.

Syntax

```
DPR_DWORD  DP_init_sema_object(
                        DPR_DWORD   user_handle,      // in
                        DPR_DWORD   sema_type,        // in
                        DPR_DWORD   *sema_handle,     // out
                        DP_ERROR_T  *error);          // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
sema_type	Type of semaphore: • DP_OBJECT_TYPE_INPUT_CHANGE - Hardware event when slave input data changes. • DP_OBJECT_TYPE_DIAG_CHANGE - Hardware event when diagnostic data changes. • DP_OBJECT_TYPE_CYCLE_INT - Hardware event at the start of a new DP cycle (reserved for later expansions) • DP_OBJECT_TYPE_ASYNC - Software event on completion of an asynchronous call, can be fetched with DP_get_result. • DP_OBJECT_TYPE_FAST_LOGIC - Hardware event for fast logic. Apart from DP_OBJECT_TYPE_ASYNC, the semaphores can be initialized only once per CP.
sema_handle	Address of a variable for the semaphore object. The returned semaphore object must be used with the Win32 API functions.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	The semaphore could be initialized.
other	Unsuccessful completion of the function

4.1.23 DP_delete_sema_object

Purpose

This function deletes a previously initialized semaphore.

Syntax

```
DPR_DWORD DP_delete_sema_object (
                        DPR_DWORD   user_handle,      // in
                        DPR_DWORD sema_handle,        // in
                        DP_ERROR_T  *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DP_open call.
sema_handle	Semaphore handle
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	The semaphore could be removed.
other	Unsuccessful completion of the function.

4.1.24 DP_fast_logic_on

Purpose

This function activates the "fast logic" functionality of the CP 5613/CP 5614. With this function, an input value of a slave X can be linked with an output value of a slave Y. When the specified trigger condition occurs, the CP 5613/14 firmware automatically writes a specified output value to the output buffer of a slave.

For the software version in which this function is available, refer to the version table in Section in the Installation Instructions.

4.1.25 DP_fast_logic_off

Purpose

This function deactivates the "fast logic" functionality of the CP 5613/CP 5614 again.

For the software version in which this function is available, refer to the version table in Section in the Installation Instructions.

4.2 Additional Functions of the CP 5614

This section describes the additional functions required for the slave module.

The functions of the slave module are located in "dps_base.dll", the prototypes and data structures are in the file "dps_base.h" in the "prog" subfolder of your software installation.

Functions that begin with "DP_" have general and master module functionality. Functions that are only relevant for the slave module begin with "dps_" (the s stands for slave module).

4.2.1 Overview of the Slave Module Functions

Administrative Functions

The following table lists the functions common to the master and slave modules. These begin with DP_ .

Name	Purpose
DP_start_cp (Section 4.1.2)	Downloads the firmware and the database to the CP 5614 - Use the function of the master.
DPS_open	Logs on a DPS user program, assigns a user handle.
DP_get_pointer (Section 4.1.5)	Requests pointer to the process image - Use the function of the master.
DP_release_pointer (Section 4.1.6)	Releases pointer to the process image - Use the function of the master.
DPS_close	A DPS user logs off again with this function.
DP_reset_cp (Section 4.1.3)	Stops the CP firmware - Use the function of the master.
DP_get_err_txt (Section 4.1.8)	This function outputs error information in plain language. Use the function of the master.
DP_init_sema_object (Section 4.1.22)	This function initializes a semaphore at which your user program can wait for the arrival of events.
DP_del_sema_object (Section 4.1.23)	This function clears a semaphore again.

Initialization Functions

Name	Purpose
DPS_start	This function activates the slave module.
DPS_stop	This function deactivates the slave module. It then no longer reacts on the bus.

Standard DP Functions

Name	Purpose
DPS_get_baud_rate	This function queries the current data transmission rate.
DPS_get_gc_ command	This function queries the last received global control command.
DPS_get_state	This function queries the current slave state.
DPS_set_diag	This function sets new diagnostic data.
DPS_get_ind	Receive asynchronous events.
DPS_set_resp	Confirm asynchronous events.
DPS_calc_io_data_len	Calculate I/O data length based on the configuration data.

4.2.2 DPS_open

Purpose

With this function, a DPS user program logs on at the driver and sets the slave parameters. If successful, the function returns a user handle. The user handle must be included in all further function calls.

Note 1

In the slave mode DPS_SM_SIMPLE, the input data are taken automatically from the default data of the slave module. If the slave is not operated in the DPS_SM_SIMPLE mode, the input data of the slave module must be initialized after receiving the positive confirmation of a configuration frame (in other words they must be written).

Syntax

```
DPR_DWORD  DPS_open (
           DPR_STRING        *cp_name,         // in
           DPR_DWORD         *user_handle,     // out
           DPR_DWORD         slave_mode,       // in
           DPR_WORD          station_addr,     // in
           DPR_WORD          addr_change,      // in
           DPR_WORD          pno_ident_nr,     // in
           DPR_WORD          user_wd,          // in
           DPS_INIT_DATA_T   *init_data,       // in
           DPS_MAX_DATA_T    *max_data,        // in
           DPR_WORD          baud_rate,        // in
           DP_ERROR_T        *error);          // out
```

Parameters

Name	Description
cp_name	Configured name of the CP 5614, for example, "CP5613_5614_1" for the first inserted CP.
user_handle	Pointer to the user handle variable - if successful, the user handle assigned to the user program is entered here.
slave_mode	Setting for the slave mode (the individual flags are logically linked in bits): • DPS_SM_SIMPLE — simple slave with automatic checking of the parameter assignment and configuration data • DPS_SM_V1_ENABLE — activate DP-V1 services • DPS_SM_FREEZE_SUPP — support freeze • DPS_SM_SYNC_SUPP — support sync
station_addr	Station address of the slave
addr_change	1 means: allow address change on the bus 0 means: do not allow address change on the bus
pno_ident_nr	Number assigned to this slave by the PROFIBUS users organization during certification, for example, 0x0008 for the sample user program. This number is represented in Intel format.
user_wd	Formula: User_wd*10ms = monitoring time of the user program. If the watchdog is not restarted in this time, the slave drops out of productive operation (Data_Ex). The value 0 deactivates the watchdog. Up to version 1.1, the watchdog is not implemented and the value 0 must be entered.

Table continued on next page

Table continued from previous page

Name	Description

init_data	Pointer to a structure with information on the extended slave data.
	
	`Typedef union DPS_INIT_DATA_S`
	`{`
	`struct DPS_SIMPLE_S`
	`{`
	`DPR_WORD user_prm_data_len; // in`
	`DPR_BYTE user_prm_dat`
	`[DPS_MAX_PDU_LEN]; // in`
	`DPR_WORD cfg_data_len; // in`
	`DPR_BYTE cfg_data[DPS_MAX_PDU_LEN]; // in`
	`}simple;`
	`struct DPS_DYNAMIC_S`
	`{`
	`DPR_WORD def_cfg_data_len; // in`
	`DPR_BYTE def_cfg_data`
	`[DPS_MAX_PDU_LEN]; // in`
	`}dynamic;`
	`}DPS_INIT_DATA_T`
	
	user_prm_data_len: length of the specified user parameter assignment data <= 237 bytes
	user_prm_data: specified user parameter assignment data
	cfg_data_len: length of the specified configuration data <= 244 bytes
	cfg_data: specified configuration data (format see Section 4.7.3)
	def_cfg_data_len: length of the default configuration data <= 244 bytes
	def_cfg_data: default configuration data
	
	Note:
	The first parameter assignment data byte is reserved for the slave controller and is ignored in the check!
	In the DP-V1 mode, the first 3 user parameter assignment data bytes are reserved and are ignored in the check!

Table continued on next page

Table continued from previous page

Name	Description

max_data	Pointer to a structure with the maximum buffer lengths for input and output data, for user diagnostics, for user parameter assignment data and configuration data and also for the user set slave address data.
	
	`Typedef DPS_MAX_DATA_S`
	`{`
	`DPR_BYTE max_input_data_len; // in`
	`DPR_BYTE max_output_data_len; // in`
	`DPR_BYTE max_user_diag_len; // in`
	`DPR_BYTE max_user_prm_data_len; // in`
	`DPR_BYTE max_cfg_data_len; // in`
	`DPR_BYTE max_user_ssa_data_len; // in`
	`}DPS_MAX_DATA_T`
	
	Note:
	max_user_ssa_data_len needs no entry, if addr_change has the value 0.

baud_rate	Data transmission rate to be set. For the CP 5614, DPS_BD_AUTO_DETECT must be specified since the CP 5614 automatically detects the data transmission rate.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function.
otherwise if error -> error_code == DPS_RET_NO_SLAVE_MODULE	DP slave functions are not available since this is a CP 5613 (without a slave module).
other	Unsuccessful completion of the function.

4.2.3 DPS_close

Purpose

With this function, a DP user program logs off for communication at the slave module.

Note 1

If the logoff was successful, the user handle is no longer valid and must not continue to be used.

Note 2

To shut down the DP slave, your user program should first change the slave module to the OFFLINE mode with the DPS_stop function.

Syntax

```
DPR_DWORD  DPS_close   (DPR_DWORD  user_handle,      // in
                       DP_ERROR_T  *error );        // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.4 DPS_start

Purpose

This function can be used to switch the slave ONLINE. This is necessary after initialization.

After switching the slave OFFLINE with DPS_stop, the slave module can be switched online again with DPS_start.

Syntax

```
DPR_DWORD  DPS_start(
                      DPR_DWORD    user_handle,      // in
                      DP_ERROR_T   *error);          // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.5 DPS_stop

Purpose

This function is used to deactivate the slave module. The slave module then no longer reacts on the bus.

Syntax

```
DPR_DWORD  DPS_stop    (DPR_DWORD  user_handle,      // in
                        DP_ERROR_T *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.6 DPS_get_baud_rate

Purpose

Using this function, your user program can query the current data transmission rate of the slave module.

Syntax

```
DPR_DWORD  DPS_get_baud_rate(
                        DPR_DWORD   user_handle       // in
                        DPR_WORD    *state,           // out
                        DPR_WORD    *baud_rate,       // out
                        DP_ERROR_T  *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
state	• DPS_BAUD_SEARCH: no data transmission rate found. • DPS_BAUD_FOUND: data transmission rate found, bus watchdog not activated. • DPS_BAUD_FOUND_WD: data transmission rate found, bus watchdog activated.
baud_rate	• DPS_BD_9K6 9600 Kbps • DPS_BD_19K2 19.2 Kbps • DPS_BD_45K45 45.45 Kbps • DPS_BD_93K75 93.75 Kbps • DPS_BD_187K5 187.5 Kbps • DPS_BD_500K 500 Kbps • DPS_BD_1M5 1.5 Mbps • DPS_BD_3M 3 Mbps • DPS_BD_6M 6 Mbps • DPS_BD_12M 12 Mbps
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.7 DPS_get_gc_command

Purpose

This function queries the last received global control command sent by the master controlling this slave. This function simply provides information for the user program and no reaction is required by the user program to process the global control frame.

Syntax

```
DPR_DWORD  DPS_get_gc_command(
                        DPR_DWORD   user_handle,      // in
                        DPR_WORD    *gc_cmd,          // out
                        DP_ERROR_T  *error);          // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
gc_cmd	Last received global control command The global control information is represented in bits. It is possible that more than one bit is set at the same time. The structure corresponds to the "global control byte" of EN 50170: • DPS_CLEAR — master is in the CLEAR mode. • DPS_FREEZE — inputs are adopted and frozen. • DPS_UNFREEZE — inputs are updated cyclically again. • DPS_SYNC — outputs are updated once. • DPS_UNSYNC — outputs are updated cyclically again.
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.8 DPS_get_state

Purpose

This function queries the current DP slave state. The function simply provides information for the user program.

Note 1

During operation, the slave runs through the states: OFFLINE, waiting for parameter assignment data, waiting for configuration data and finally data exchange.

In its default state it is OFFLINE. After DPS_start, it first expects a parameter assignment frame (DPS_WAIT_PRM). This must be followed by a configuration frame (DPS_WAIT_CFG). If these two frames are confirmed as being correct, the slave changes to productive operation (DPS_DATA_EX).

Note 2

If the slave is not operated in the DPS_SM_SIMPLE mode, the input data of the slave module must be written after receiving the positive confirmation of a configuration frame. The slave can only change to productive operation after the input data have been initialized.

Syntax

```
DPR_DWORD  DPS_get_state(
                        DPR_DWORD   user_handle,      // in
                        DPR_WORD    *dps_state,       // out
                        DP_ERROR_T  *error);          // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
dps_state	• DPS_OFFLINE the slave module has not started up. • DPS_WAIT_PRM the slave module is waiting for a parameter assignment frame from the remote master. • DPS_WAIT_CFG the slave module is waiting for a configuration frame from the remote master. • DPS_DATA_EX the slave module is taking part in data exchange (productive phase).
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.9 DPS_set_diag

Purpose

This function transfers diagnostic data to the DP slave module. The CP 5614 slave module passes on the data to the master that controls it.

Note

The length of the diagnostic data can vary during operation!
The 6 standard diagnostic bytes are managed by the CP 5614 slave module itself.

For more information on the structure and formats of diagnostic information see Section 4.6.

Syntax

```
DPR_DWORD  DPS_set_diag(DPR_DWORD  user_handle,      // in
                        DPR_BYTE   *user_diag_data,  // in
                        DPR_WORD   user_diag_len,    // in
                        DPR_WORD   diag_state,       // in
                        DP_ERROR_T *error );         // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
user_diag_data	Pointer to the user diagnostic data from the 7th byte onwards. The first 6 bytes contain the standard information added by the slave module hardware. (Format see Section 4.6).
user_diag_len	Length of the user diagnostic data.
diag_state	This bit field can be logically combined bitwise from the following values: • DPS_EXT_DIAG: if set, this is error information, otherwise a status message. • DPS_EXT_DIAG_OV: there is more diagnostic data than can be represented in the diagnostic buffer. • DPS_STAT_DIAG: a serious error has occurred and no more useful data can be supplied.
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.10 DPS_get_ind

Purpose

This function is used to fetch an indication (message from the controlling master).

Note 1

In the call, name the indications you want to receive. You will then receive exactly one indication as the result.

DPS_CHK_PRM is also signaled if user parameter assignment data length of the remote master is 0. This allows the slave module to reject a set of parameters without user data.

Note 2

If there is no indication at the time of the function call and the monitoring time has elapsed, the DPS_get_ind does not wait but returns the value DPS_NO_IND in the indication field.

Note 3

If a function is still waiting for asynchronous indications when DPS_close is sent, DPS_get_ind is terminated with error class DPS_ERROR_USR_ABORT.

Note 4

This call can only be sent a total of once at any one time by one or more programs.

Syntax

```
DPR_DWORD   DPS_get_ind(
            DPR_DWORD       user_handle,            // in
            DPR_DWORD       *ind_ref,               // out
            DPR_DWORD       timeout,                // in
            DPR_DWORD       *indication,            // inout
            DPR_WORD        *data_len               // inout
            DPR_BYTE        *data_blk               // out
            DP_ERROR_T      *error );               // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
timeout	Duration of the maximum wait time (in milliseconds) until the function returns. Limit values: 0: no wait time - the function returns immediately 0x7FFFFFFE: maximum wait time DP_TIMEOUT_FOREVER: "Endless" wait time
ind_ref	Address of the reference number of the indication. Must be included again with DPS_set_resp.

Table continued on next page

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Name	Description
indication	In this address, the user enters the indications it wants to be informed of. These are bits that can be ORed bit by bit. When the function returns, it contains the current indication type (always one indication only). • DPS_NO_IND: No indication occurred. • DPS_CHK_PRM: New parameter assignment frame was received and must be checked by the host software (only for the dynamic mode, i.e. when DPS_simple was not selected with DPS_open). • DPS_CHK_CFG: New configuration frame was received and must be checked by the host software (only for the dynamic mode, i.e. when DPS_simple was not selected with DPS_open). • DPS_NEW_SSA: Set slave address. Frame was received and must be checked by the host software (only when address changes via the bus are permitted). • DPS_BAUD_CHANGED: The data transmission rate information has changed (see DPS_get_baud_rate). • DPS_GO_LEAVE_DATA_EX: The slave has entered the DPS_DATA_EX state or has left it (see DPS_get_state). • DPS_NEW_GC: A new (modified) global control frame was received (see DPS_get_gc_ command).
data_len	Maximum length of the data_blk array when the function is called, number of bytes entered when the function returns - The constant DPS_MAX_PDU_LEN should be used for the call.

Table continued on next page

Table continued from previous page

Name	Description
data_blk	The indication data for the particular indication are entered in this array (see next section: Data Structure).
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Data Structure (for data_blk parameter)

The content of the data_blk data structure depends of the type of indication.

Indication	Content of the data_blk Data Structure
DPS_CHK_PRM	`DPR_BYTE user_prm_data[ ];` User parameter assignment data of the master, without the standard section.
DPS_CHK_CFG	`DPR_BYTE cfg_data[ ];` Configuration data of the master

DPS_NEW_SSA	`DPR_WORD new_address;`
	`DPR_WORD ident_number;`
	`DPR_WORD no_addr_chg;`
	`DPR_BYTE user_data[ ];`
	Data structure containing the new station address, the identification number, the enabling of address changes, and the user data.
	All information is represented in the Intel format.

DPS_BAUD_ CHANGED	`DPR_WORD state;`
	`DPR_WORD transmission rate;`
	Data structure , see DPS_get_baud_rate (see Section 4.2.6).

DPS_GO_ LEAVE_DATA_ EX	`DPR_WORD dps_state;` see DPS_get_state parameter (see Section 4.2.8).
DPS_NEW_GC	`DPR_WORD gc_command;` see DPS_get_gc_command parameter (see Section 4.2.7).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.11 DPS_set_resp

Purpose

With this function, the user program provides the response data of an indication obtained previously with DPS_get_ind. This is necessary for the indications that require information from the user to control internal processing (DPS_CHK_PRM, DPS_CHK_CFG and DPS_NEW_SSA).

Note

The DPS_BAUD_CHANGED, DPS_GO_LEAVE_DATA_EX, DPS_NEW_GC and DPS_NO_IND must not be confirmed!

Syntax

```
DPR_DWORD  DPS_set_resp(
                        DPR_DWORD   user_handle,      // in
                        DPR_DWORD   ind_ref,          // in
                        DPR_WORD    data_len,         // in
                        DPR_BYTE    *data_blk,        // in
                        DP_ERROR_T  *error);          // out
```

Parameters

Name	Description
user_handle	User handle assigned with the DPS_open call.
ind_ref	Reference number returned by DPS_get_ind.
data_len	Length of the data in data_blk
data_blk	Address of the response data
error	Address of a structure provided by the user program of the type DP_ERROR_T - If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Data Structure (for data_blk parameter)

<table>
<tr><th>Indication</th><th>Content of the data_blk Data Structure</th></tr>
<tr><td>DPS_CHK_PRM</td><td>DPR_WORD status
<table><tr><th>Value</th><th>Meaning</th></tr><tr><td>DPS_PRM_OK</td><td>Parameter assignment data accepted.</td></tr><tr><td>DPS_PRM_FAULT</td><td>Parameter assignment not accepted, the slave does not enter data exchange.</td></tr></table></td></tr>
<tr><td>DPS_CHK_CFG</td><td>DPR_WORD status formatting
<table><tr><th>Value</th><th>Meaning</th></tr><tr><td>DPS_CFG_OK</td><td>Configuration data accepted.</td></tr><tr><td>DPS_CFG_FAULT</td><td>Configuration not accepted, slave does not enter data exchange.</td></tr></table></td></tr>
<tr><td>DPS_NEW_SSA</td><td>DPR_WORD status formatting
<table><tr><th>Value</th><th>Meaning</th></tr><tr><td>DPS_SSA_OK</td><td>Set slave address completed.</td></tr></table></td></tr>
</table>

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.2.12 DPS_calc_io_data_len

Purpose

This function calculates the input/output data length from any configuration frame. This function is intended to provide information for the user program, so that it does not need to evaluate the ID bytes of the configuration frame itself. Any configuration frame can be evaluated.

Syntax

```
DPR_DWORD        DPS_calc_io_data_len (
                 DPR_WORD    cfg_len,              // in
                 DPR_BYTE    *cfg_data,            // in
                 DPR_WORD    *in_data_len,         // out
                 DPR_WORD    *out_data_len,        // out
                 DP_ERROR_T  *error );             // out
```

Parameters

Name	Description
cfg_len	Length of the configuration data
cfg_data	Pointer to the configuration data
in_data_len	Pointer to the calculated input data length
out_data_len	Pointer to the calculated output data length
error	Address of a structure provided by the user program of the type DP_ERROR_T. If an error occurred, the structure contains details for troubleshooting (see Section 4.4).

Return Value

Name	Description
DP_OK	Successful completion of the function
other	Unsuccessful completion of the function

4.3 Access to the Process Image of the CP 5613/CP 5614

Overview of the Existing Data

The following table provides you with an overview of the data available to your user program in the process image of the CP 5613/CP 5614.

Category	Data
DP process data	• Input data of the slaves • Output data of the slaves • Diagnostic data of the slaves, including diagnostic counter • Slave data change indicator • Input data of the slave module of the CP 5614 • Output data of the slave module of the CP 5614
Other information	• Information on the DP master • Information on a slave • Slave states • Current bus parameters • Bus statistics
Hardware events	• Control of event generation at start of cycle • Control of event generation if input data of slaves changes • Control of event generation if data of the slave module on the CP 5614 changes • Control of event generation when diagnostic data is received from slaves • Query of the fast logic status (for more information on controlling fast logic hardware events, see Sections 4.1.24 and 4.1.25)

The formats of the I/O data and the diagnostic data are described in Sections 4.5 and 4.6.

4.3.1 Reading the Input Data of a DP Slave

Consistent Reading

There is a fixed data area in the process image of the CP 5613/CP 5614 for the input data of each individual slave.

To allow the input data of a slave to be read consistently, your user program first locks this data area to prevent it being updated by the DP master, then accesses the area, and releases it again.

The program locks the area by writing the slave number to a control register in the process image. The program releases the area by writing the value DPR_DP_UNLOCK or a different slave number to the same register.

Example of Consistent Reading

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. Then 200 bytes of slave no. 5 are copied to a local buffer "buf":

```
/* Lock the data area against updating */
p->ctr.D_lock_in_slave_adr = 5;
/* Copy data */
memcpy(buf, &p->pi.slave_in[5].data[0], 200);
/* Cancel lock again  */
p->ctr.D_lock_in_slave_adr = DPR_DP_UNLOCK;
```

Reading without Consistency

To read without consistency, the locking and release of the data area are simply omitted.

Warning

The lock is canceled by the following:

- Locking a different slave to read its data,
- Locking a different slave to read its diagnostic information (Section 4.3.2)
- Or by triggering a write job using the corresponding control register (Section 4.3.3).

Note 1

The data is only valid when the master is in the OPERATE or CLEAR/ AUTOCLEAR mode and the slave is in the READY state.

Note 2

The memory area with index 127 contains the data of the slave module of the CP 5614.

Note 3

The input data are not updated as long as the slave reports static diagnostic data (Section 4.6.2, byte 2 - stationstatus_2, bit 1).

4.3.2 Reading the Diagnostic Data of a DP Slave

Consistent Reading of the Diagnostic Data

Each individual slave has a fixed data area in the process image of the CP 5613/CP 5614 (for more information on the data format see Section 4.6).

To allow the diagnostic data of a slave to be read consistently, your user program first locks this data area to prevent it being updated by the DP master, then accesses the area, and releases it again. The program locks the area by writing the slave number to a control register in the process image. The data area is released again by writing the value DPR_DP_UNLOCK to the same register.

There is also a counter that counts the diagnostic data of the relevant slave.

Example of Consistent Reading of the Diagnostic Data

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. Then 200 bytes of the diagnostic data of slave no. 5 are copied to a local buffer "buf":

```
/* Lock the diagnostic data area against updating */
p->ctr.D_lock_diag_slave_adr = 5;
/* Evaluate the counter */
count = p->pi.slave_diag[5].diag_count;
/* Copy current data */
memcpy(buf, &p->pi.slave_diag[5].data[0],
                              p->pi.slave_diag[5].diag_len);
/* Cancel lock again  */
p->ctr.D_lock_diag_slave_adr = DPR_DP_UNLOCK;
```

Reading without Consistency

To read without consistency, the locking and release of the data area are simply omitted.

General Notes

Warning

The lock is canceled by the following:

- Locking a different slave to read its input data (Section 4.3.1)
- Locking a different slave to read its diagnostic information
- Triggering a job to write the output data of a slave using the corresponding control register (Section 4.3.3)

Note 1

The data is only valid when the master is in the STOP, OPERATE, or CLEAR/ AUTOCLEAR mode and the slave is configured in the current database.

Note 2

The memory area with index 127 contains the data of the slave module of the CP 5614.

Note 3

Based on the diagnostic counter, you can recognize whether or not new diagnostic data have been received. The diagnostic counter is incremented each time a diagnostic message is received.

4.3.3 Writing the Output Data of a DP Slave

Writing is always consistent

There is a fixed data area in the process image of the CP 5613/CP 5614 for the output data of each individual slave.

To write the output data of a slave consistently, your user program writes the data to the data area and then triggers the acceptance of the data in the next DP cycle by writing the slave number to a control register in the process image of the CP.

Since the data transfer is triggered explicitly, the written output data are always consistent.

Example of Consistent Writing

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. Then 200 bytes from a local buffer "buf" are written to slave 5 as follows:

```
/* Copy data */
memcpy(&p->pi.slave_out[5].data[0], buf, 200);
/* Trigger transfer */
p->ctr. D_out_slave_adr = 5;
```

Warning

The lock is canceled by the following:

- Locking a different slave to read its input data (Section 4.3.1)
- Locking a different slave to read its diagnostic information

Note 1

The data is only transferred to the slave when the master is in the OPERATE mode and the slave is in the READY state.

Note 2

The memory area with index 127 contains the data of the slave module of the CP 5614.

Note 3

The output data are not sent as long as the slave reports static diagnostic data (Section 4.6.2, byte 2 - stationstatus_2, bit 1).

4.3.4 Checking the Slaves for Changed Data

Uses of the Data Changed Information

The process image of the CP 5613/CP 5614 contains a memory area where you can see which slave data have changed.
You can use this property to quickly check where data have changed without having to use semaphores.

Example

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To count, for example, how many slave have changed data, you would write a program like that shown below, where "sum" contains the result:

```
unsigned short sum = 0;
unsigned short i;
for (i=0; i < DPR_MAX_SLAVE_ADDR;i++)
{
   if ( p->ef.input[i].req_mask == DPR_DATA_CHANGE )
   {  /* Changed data found on slave i */
      /* Mask released again */
      p->ef.input[i].req_mask =
                              DPR_DATA_INT_CLEAR_AND_UNMASK;
      sum++;
  }
}
```

General Notes

Warning

Your user program must first lock the input data of a slave (D_lock_in_slave_addr, Section 4.3.1), then reset "req_mask" if data changes (DPR_DATA_INT_CLEAR_AND_UNMASK), and then read the data itself. Otherwise if events overlap, this may mean that the next data change goes unnoticed.

Note 1

Your user program must reset the mask itself (DPR_DATA_INT_CLEAR_AND_UNMASK).

Note 2

The memory area with index 127 contains the data of the slave module of the CP 5614.

4.3.5 Querying the State of a DP Slave

Uses of the Slave State

Before accessing data, your user program should check the state of a slave, to find out whether or not the data to be read are valid.

Example

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To count, for example, how many slaves are in the READY state, you would write a program like that shown below, where "sum" contains the result:

```
unsigned short sum = 0;
unsigned short i;
for (i = 0; i< DPR_MAX_SLAVE_ADDR; i++)
{
   if (p->info_watch.slave_info[i].slave_state ==
                                          DPR_SLV_READY)
   {
      sum++;  /* found */
   }
}
```

There is also the DPR_SLV_NOT_READY state that also includes non-configured slaves.

Note 1

The DP master automatically attempts to reinitialize slaves in the NOT READY state and to include them in cyclic processing.

Note 2

The user program must not overwrite the slave_state variable.

Note 3

The memory area with index 127 contains the state of the slave module of the CP 5614.

Note 4

If the slave is in the READY state, this does not necessarily mean that its data are valid. Diagnostic data may mean that the validity of the data is restricted.

4.3.6 Querying Information about the DP Master

Uses of the DP Master Information

The process image of the CP 5613/CP 5614 contains a memory area where you can read out the following information about the DP master:

- Mode (OFFLINE, STOP, CLEAR, AUTOCLEAR, OPERATE)
- Identification number of the certification
- Hardware version
- Firmware version

Example

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To display this information in a simple application, you would write a program similar to that below:

```
printf("master state -> %ld",
                    p->info_watch.master_info.USIF_state);
     /* 0 means OFFLINE */
     /* 1 means STOP */
     /* 2 means CLEAR */
     /* 3 means AUTOCLEAR */
     /* 4 means OPERATE */
printf("master ident number -> %lx",
                  p->info_watch.master_info.ident_number);
     /* in Motorola format */
printf("master HW version -> %lx",
                    p->info_watch.master_info.hw_version);
     /* e.g. 0x00000102 for version 1.2 */
printf("master FW version -> %lx",
                    p->info_watch.master_info.fw_version);
```

Note

Writing these values is not permitted and does not change the master data.

4.3.7 Querying Current Bus Parameters of the Master

Uses of the Bus Parameter Query

In the process image of the CP 5613/CP 5614, there is a memory area from which you can read out the current bus parameters, for example, to display them in your user program.

Example

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To display this information in a simple application, you would write a program similar to that below:

```
printf("Baudrate -> %d",
                    p->info_watch. aspc2_buspara.baud_rate);
```

The parameters are bytes, words or double words. Refer to the header file for the formats, structure DPR_ASPC2_BUSPARA_T.

Description of the Bus Parameters

<table>
<tr><th>Name</th><th>Meaning</th></tr>
<tr><td>ts</td><td>Local station address</td></tr>
<tr><td>baud_rate</td><td>Data transmission rate
<table>
<tr><th>Value</th><th colspan="2">Meaning</th></tr>
<tr><td>DP_M_BAUDRATE_9K6</td><td>9.6</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_19K2</td><td>19.2</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_93K75</td><td>93.75</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_187K5</td><td>187.5</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_500K</td><td>500</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_750K</td><td>750</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_1M5</td><td>1.5</td><td>Mbps</td></tr>
<tr><td>DP_M_BAUDRATE_3M</td><td>3</td><td>Mbps</td></tr>
<tr><td>DP_M_BAUDRATE_6M</td><td>6</td><td>Mbps</td></tr>
<tr><td>DP_M_BAUDRATE_12M</td><td>12</td><td>Mbps</td></tr>
<tr><td>DP_M_BAUDRATE_31K25</td><td>31.25</td><td>Kbps</td></tr>
<tr><td>DP_M_BAUDRATE_45K45</td><td>45.45</td><td>Kbps</td></tr>
</table></td></tr>
<tr><td>tsl</td><td>Slot time (in bit times)</td></tr>
<tr><td>min_tsdr</td><td>Minimum station delay (in bit times)</td></tr>
<tr><td>max_tsdr</td><td>Maximum station delay (in bit times)</td></tr>
<tr><td>tqui</td><td>Modulator quiet time (in bit times)</td></tr>
<tr><td>tset</td><td>Setup time (in bit times)</td></tr>
<tr><td>ttr</td><td>Target rotation time (in bit times)</td></tr>
<tr><td>g</td><td>GAP update factor</td></tr>
<tr><td>hsa</td><td>Highest (station) PROFIBUS address</td></tr>
<tr><td>max_retry_limit</td><td>Maximum number of call retries</td></tr>
<tr><td>station_type</td><td>0 (master)</td></tr>
<tr><td>trdy</td><td>READY time (in bit times)</td></tr>
<tr><td>BpFlag</td><td>• Bit 7=0 means: no mode change if an error occurs
• Bit 7=1 means: mode change if error occurs (AUTOCLEAR)
• Bit 6 to 0: reserved</td></tr>
<tr><td>MinSlaveInterval</td><td>see Section 3.2 (unit: 1 ms)</td></tr>
<tr><td>PollTimeout</td><td>Monitoring time for communication with a master class 2 (unit: 10 ms)</td></tr>
<tr><td>DataControlTime</td><td>see Section 3.2 (unit: 10 ms)</td></tr>
</table>

Note

Writing these values is not permitted and does not change the bus parameters actually used.

4.3.8 Querying Information about DP Slaves

Uses of the DP Slave Information

In the process image of the CP 5613/CP 5614, there is a memory area from which you can read out the configuration data for DP slaves, for example, to display it in your user program.

Example

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To display this information in a simple application, you would write a program similar to that below:

```
printf("Slave type -> %d",
                    p->info_watch.slave_info[5].slave_type);
     /* 0 means slave is not configured */
     /* 1 means slave is configured */
     /* 2 means DP-V1-compliant slave is configured */
printf("number of output bytes -> %d",
               p->info_watch.slave_info[5]. slave_out_byte);
printf("number of input bytes -> %d",
                p->info_watch.slave_info[5]. slave_in_byte);
printf("In database -> %d",
            p->info_watch.slave_info[5]. slave_in_database);
```

4.3.9 Reading PROFIBUS Statistical Data

Overview

In the process image of the CP 5613/CP 5614 there is a memory area in which the CP stores statistical data of the connected PROFIBUS network allowing, for example, diagnostic programs to read them.

Example of Access

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To count, for example, the counter for the bus short-circuits detected up to now, you would write a program like the following:

```
/* Output counter for bus short-circuits */
printf("bus ctrl err =%u\n",
              p->info_watch.aspc2_event.bus_control_error);
```

Description of the Available Statistics Counters

All elements are unsigned 16-bit counters that count the occurrences of a specific event. The first four events are particularly important.

Counter Name	Meaning
off_ts_adr_error	Another station with the same name was detected.
in_ring	Indicates how often the CP entered the ring of the active PROFIBUS master.
out_of_ring	Indicates how often the CP dropped out of the ring of the active PROFIBUS master (the CP is currently in the ring when in_ring > out_ring).
bus_control_error	Number of bus-short circuits - These adversely affect the functioning of the PROFIBUS and must be eliminated.
on_double_token	Indicates how often duplicate tokens or token loss was detected.
on_timeout	Indicates how often the token was lost and was generated again by this CP.
on_syni_error	Indicates how often sporadic problems occurred on the PROFIBUS cable.
on_hsa_error	Indicates how often a station address higher than the HSA configured on this CP was detected on the bus.
off_hsa_error	reserved
on_response_error	Indicates how often errors occurred receiving a response.
on_las_useless	reserved
on_rec_frame_ overflow	reserved
on_fifo_error	reserved
on_req_length_error	reserved
off_pass_token_error	Indicates how often the token was corrupted when it was passed on.

4.3.10 Querying the Fast Logic Status

Overview

In the process image of the CP 5613/CP 5614, there is a memory area in which you can check whether data exchange with fast logic has taken place.

For the software version in which this property is available, refer to the version table in Section in the Installation Instructions.

4.3.11 Activating/Deactivating the Generation of Hardware Events

Overview

In the process image of the CP 5613/CP 5614, there is a memory area in which you can activate the triggering of hardware events for a new DP cycle, data changes, or the arrival of diagnostic data.

Hardware events for changes in slave input data and diagnostic data can be set separately for each individual slave.

The events are indicated by incrementing semaphores.

Example of Activation

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. To activate events at the start of the cycle, when data changes and when diagnostic data arrive, you would write a program like the one below:

```
/* Activate event at the start of the cycle */
p->ctr.D_cycle_start_mask = 0;
/* Activate event if slave 5 data changes 5 */
p->ef.input[5].req_mask = DPR_DATA_INT_CLEAR_AND_UNMASK;
/* Activate event if diagnostic data arrive
                                        from slave 5 */
p->ef.diag[5].req_mask = DPR_DATA_INT_CLEAR_AND_UNMASK;
```

Afterwards, when events arrive, the semaphores initialized by your user program with DP_init_sema_object are incremented.
The other possible values for "req_mask" are:

- **DPR_DATA_INT_CLEAR_AND_MASK** – Waiting for an event, but then no setting of the semaphore, and
- **DPR_DATA_CHANGE** – an event has arrived.

Example of Deactivation

The following activation sequence would be canceled by your user program as follows:

```
/* Deactivate event for cycle start */
p->ctr.D_cycle_start_mask = 1;
/* Deactivate event for slave 5 data change */
p->ef.input[5].req_mask = DPR_DATA_INT_CLEAR_AND_MASK;
/* Deactivate event if diagnostic data arrive
                                        from slave 5  */
p->ef.diag[5].req_mask = DPR_DATA_INT_CLEAR_AND_MASK;
```

Note 1

If your user program has not yet passed through a semaphore, it will not be incremented again. When the program passes through a semaphore, you should therefore always check whether multiple events have already occurred.

Note 2

When a hardware event is received, the corresponding control condition is reset so that your user program must set it again. This avoids overload on your PC when your user program does not process hardware events quickly enough.

Note 3

The use of hardware events for a lot of active slaves at the same time puts greater load on the PC than polling; refer to the suggestions in the FAQ list.

4.3.12 Sending Data with the CP 5614 as DP Slave

Integration in the Process Image of the CP 5613/CP 5614

The send data of the slave module are in the output image with slave index 127. Writing the output data area with slave index 127 supplies the slave module with new data that the controlling master reads as inputs.

Example of Consistent Writing

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. Then 200 bytes from a local buffer "buf" are written to the slave module as send data as follows:

```
/* Copy data */
memcpy(&p->pi.slave_out[127].data[0], buf, 200);
/* Trigger transfer */
p->ctr. D_out_slave_adr = 127;
```

The data is now transferred to the slave module. Here, the controlling master can read the data as inputs.

Note

The send data are only accepted by the master when the slave module of the CP 5614 is in the READY state and the master is in the CLEAR, AUTOCLEAR or OPERATE mode.

4.3.13 Receiving Data with the CP 5614 as DP Slave

Integration in the Process Image of the CP 5613/CP 5614

The received data of the slave module are stored in the input image with slave index 127. This allows the user program to read the data sent by the controlling master as outputs to the slave module by reading the input data area with slave index 127.

Example of Consistent Reading

"p" is a pointer to the process image that your user program obtained with the "DP_get_pointer" call. Then 200 bytes of the received data of the slave module are copied to a local buffer "buf":

```
/* Lock the data area against updating */
p->ctr.D_lock_in_slave_adr = 127;
/* Copy data */
memcpy(buf, &p->pi.slave_in[127].data[0], 200);
/* Cancel lock again  */
p->ctr.D_lock_in_slave_adr = DPR_DP_UNLOCK;
```

The copied data is the received data of the slave module that the controlling master sent as outputs.

Reading without Consistency

To read without consistency, the locking and release of the data area are simply omitted.

General Notes

Note

The data are only valid when the slave module of the CP 5614 is in the READY state and the master controlling the slave is in the OPERATE mode.

4.3.14 Sending Diagnostic Data with the CP 5614 as DP Slave

Integration in the CP 5613/CP 5614

The slave module of the CP 5614 can transfer its diagnostic data to the controlling master. The diagnostic data area with slave index 127 is not used (since this functions only in the receive direction), but rather a C function.

For information on the format of the diagnostic data, see Section 4.6.

Example of Sending Diagnostic Data

"h" is the user handle obtained by your user program with the DPS_open call. Then 10 bytes of the user diagnostic data of the slave module are sent as follows from a local buffer "buf":

```
/* Transfer diagnostic data to the slave module */
DPS_set_diag(h, diag_buf, 10, 0, &err);
```

Note

The diagnostic data are only accepted by the master when the slave module of the CP 5614 is in the READY state and the master controlling the slave is in the CLEAR, AUTOCLEAR or OPERATE mode.

4.4 Error Codes

Uniform Error Structure DP_ERROR_T

The error identifiers for the individual jobs have a uniform structure DP_ERROR_T. If an error occurs, the various elements return the exact description of the error.

```
typedef struct DP_ERROR
{
     DPR_DWORD error_class;
     DPR_DWORD error_code;
     DPR_BYTE     error_decode;
     DPR_BYTE     error_code_1;
     DPR_BYTE     error_code_2;
} DP_ERROR_T;
```

error_class Structure Element

The error_class structure element specifies the general error class. The entry in error_class is **identical** to the return value of the function call.

A DP application can therefore evaluate either the error_class structure element or the return value of the function call.

The table describes the possible error classes and shows which of the other structure elements of DP_ERROR_T are valid for the individual error classes.

Error Class	Description
DP_OK	No error, the job was executed and the results are available.
DP_OK_ASYNC	Job was execution was triggered successfully, the confirmation is not yet available. The result must be fetched later by a DP_get_result call. This result is only possible with asynchronous jobs.
DP_ERROR_EVENT	The slave returns an error coding in the response frame for a DPC1 request (ds_write/read, alarm_acknowledge).
DP_ERROR_EVENT_NET	Error in PROFIBUS communication, for example, connection abort
DP_ERROR_REQ_PAR	Incorrect transferred parameter for a call or call illegal.
DP_ERROR_CI	Error accessing the CP
DP_ERROR_RES	Not enough resources available
DP_ERROR_USR_ABORT	Active jobs aborted because the user program has logged off (only possible with DP_get_result).

error_code Structure Element

The error_code structure element is relevant in the error classes:

- DP_ERROR_EVENT_NET
- DP_ERROR_REQ_PAR
- DP_ERROR_CI
- DP_ERROR_RES
- DP_ERROR_USR_ABORT

error_decode, error_code_1, error_code_2

The error_decode, error_code_1 and error_code_2 structure elements are only relevant in the DP_ERROR_EVENT error class. In this case, all three elements must be evaluated. They contain an error coding that a DP-V1 slave can return in the response frame after a DP-V1 request.

Description of the Error Classes

The following Figure 4 shows how a DP user program evaluates errors when a DP function is called.

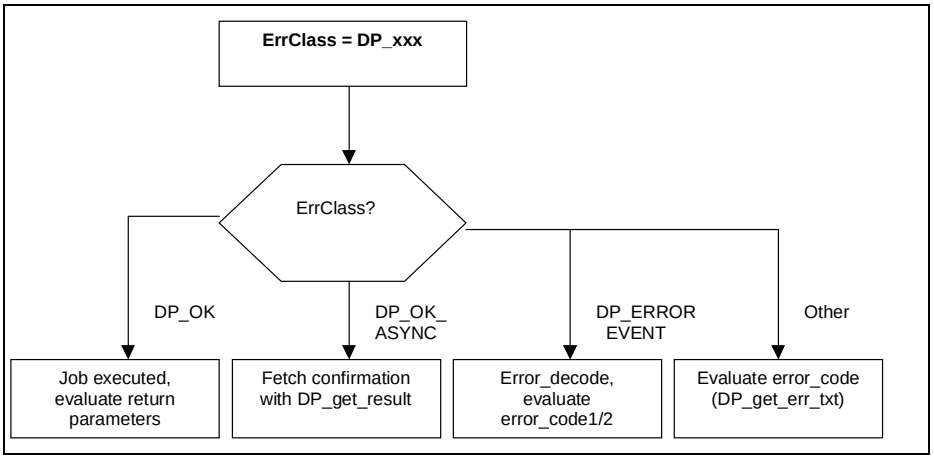


Figure 4 Evaluation of the Return Values

Meaning of the Errors

The "5613_ret.h" file contains an overview of the error messages. A detailed description is displayed when the function DP_get_err_txt is called.

4.4.1 Entries in the error_decode, error_code_1 and error_code_2 Structure Elements

Description

This section describes the entries in the following structure elements:

- error_decode
- error_code_1
- error_code_2

Entries are only relevant in the error class DP_ERROR_EVENT. All three parameters must be evaluated together.

They contain error information sent by the DP-V1 slave.

error_decode

The error_decode parameter specifies the meaning of the parameters error_code_1 and error_code_2. The following table shows the range of values:

Values	Meaning
0 to 127	reserved
128	DP V1
129 to 253	reserved
254	PROFIBUS FMS
255	HART®

Error_Decode = PROFIBUS_FMS, HART®

The Error_Decode values PROFIBUS FMS and HART® indicate that the parameters Error_Code_1 and Error_Code_2 must be interpreted as defined in the relevant protocols.

With PROFIBUS FMS:

Error_Code Parameter	Meaning
Error_Code_1	Error_**Class**_FMS
Error_Code_2	Error_**Code**_FMS

With HART®:

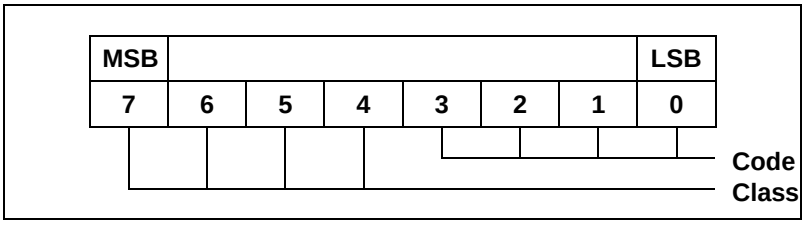
Error_Code Parameter	Meaning
Error_Code_1	see HART specification
Error_Code_2	see HART specification

Error_Decode = DP V1

The parameters Error_Code_1 and Error_Code_2 contain the error information specific to DP-V1.

Structure of Error_Code_1 with DP-V1

The error coding strategy of DP V1 uses Error_Code_1 to classify the error (class) and to specify an additional error code.



Error_Code_1

The possible values of code and class are shown in the following table:

Byte Structure		Meaning	
Class	**Code**	**Class**	**Code**
0 to 9	any	reserved	reserved
10	0	application	read error
	1		write error
	2		module failure
	3 to 7		reserved
	8		version conflict
	9		feature not supported
	10 to 15		user specific
11	0	access	invalid access
	1		write length error
	2		invalid slot
	3		type conflict
	4		invalid area
	5		state conflict
	6		access denied
	7		invalid range
	8		invalid parameter
	9		invalid type
	10 to 15		user specific
12	0	resource	read constrain conflict
	1		write constrain conflict
	2		resource busy
	3		resource unavailable
	4 to 7		reserved
	8 to 15		user specific
13 to 15	any	user specific	user specific

Structure of Error_Code_2 with DP-V1

The Error_Code_2 parameter is user-specific.

4.5 Formats of the Slave Data

Order of the Slave Data

The order of the data corresponds to the configured input/output ports of the DP slaves.

For example, the input ports of an ET 200B 16DI station are stored as follows: port 0 in the first byte, port 1 in the 2nd byte etc.

Format of Data Words

The following order is necessary for storing values in the word format (2-byte numbers):

First, the high byte (lower order address) of the word is entered followed by the low byte (higher order address), in other words in Motorola format.

Note 1

This order does not correspond to the format of processors belonging to the 80x86/Pentium family!

Note 2

Take into account any additional information from the vendor of the slaves your user program should support.

4.6 Formats of the Slave Diagnostic Data

Explanation

In some cases, in the following data structures single bits in the bytes are significant. The bits are numbered as follows: the least significant bit has the number 0 and the most significant bit has the number 7.

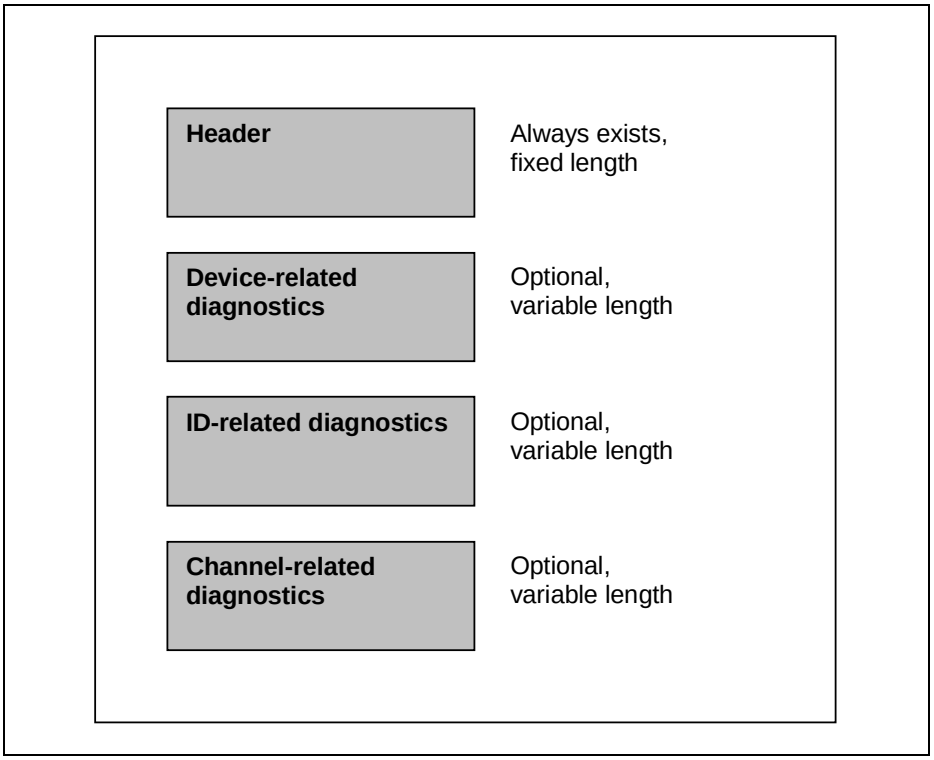
4.6.1 Overview of the Entire Structure

Possible Length

The typical length of diagnostic data is between 6 and 32 bytes. The maximum possible length is 244 bytes.

Header and up to Three Following Fields

Diagnostic data have a fixed header and up to three further fields:



Identification of the Optional Parts

At the beginning of the optional parts there is a unique coding to distinguish one part from another.

4.6.2 Format of the Diagnostic Data Header

Overall Structure of the Header

Byte	Meaning
Byte 1	Stationstatus_1
Byte 2	Stationstatus_2
Byte 3	Stationstatus_3
Byte 4	Diag.Master_Add
Byte 5 and 6	Ident_Number

Byte 1 (Stationstatus_1)

Each bit in byte 1, the "stationstatus_1“ byte has a special meaning.

Bit	Name and Meaning
7	**Diag. Master_Lock** - The DP slave has already had parameters assigned by a different master, in other words, the local master cannot currently access this slave.
6	**Diag. Prm_Fault** - This bit is set by the slave if the last parameter assignment frame was incorrect (for example wrong length, wrong ident number, invalid parameters).
5	**Diag. Invalid_Slave_Response** - This bit is set as soon as an implausible response is received from an addressed DP slave.
4	**Diag. Not_Supported** - This bit is set as soon as a function is requested that is not supported by the slave (for example operation in the SYNC mode although the slave does not support this).
3	**Diag. Ext_Diag** - This bit is set by the DP slave. If the bit is set, there must be a diagnostic entry in the slave-specific diagnostic area (Ext_Diag_Data). If the bit is not set, there may be a status message in the slave-specific diagnostic area (Ext_Diag_Data). The meaning of the status message must be negotiated with each specific user program.
2	**Diag. Cfg_Fault** - This bit is set when the configuration data last sent by the master do not match those determined by the DP slave, in other words, when there is a configuration error.
1	**Diag. Station_Not_Ready** - This bit is set when the DP slave is not yet ready for the productive phase.
0	**Diag. Station_Non_Existent** - The DP master sets this bit, if the DP slave is not obtainable on the bus. If this bit is set, the diagnostic bits contain the status of the last diagnostic message or the initial value. The DP slave always sets this bit to zero.

Byte 2 (Stationstatus_2)

Each bit in byte 2, the "station_status_2“ byte has a special meaning.

Bit	Meaning
7	**Diag. Deactivated** - This bit is set as soon as the DP slave is indicated as inactive in the local parameter record and was taken out of cyclic processing.
6	reserved
5	**Diag. Sync_Mode** - This bit is set by the DP slave as soon as it receives the Sync control command.
4	**Diag. Freeze_Mode** - This bit is set by the DP slave as soon as it receives the Freeze control command.
3	**Diag. WD_On (Watchdog on)** - This bit is set by the DP slave. If this bit is set to 1, the watchdog monitoring is activated on the DP slave.
2	The DP slave always sets this bit to 1.
1	**Diag.Stat_Diag (Static Diagnostics)** - If the DP slave sets this bit, the DP master must fetch diagnostic information until the bit is cleared. The DP slave, for example, sets this bit when it is not capable of providing valid user data.
0	**Diag. Prm_Req** - If the DP slave sets this bit, it must be reassigned parameters and be reconfigured. This bit remains set until parameters have been assigned (if bit 1 and bit 0 are set, bit 0 has the higher priority).

Byte 3 (Stationstatus_3)

Bit	Meaning
7	**Diag. Ext_Diag_Overflow** - If this bit is set, there is more diagnostic data than can be indicated. The DP slave sets this bit, for example, when there is more channel diagnostic data than the DP slave can enter in its send buffer. The DP master also sets this bit when the DP slave sends more diagnostic data than the DP master can accommodate in its diagnostic buffer.
6 to 0	reserved

Byte 4 (Diag. Master_Add)

The address of the DP master that assigned parameters to the DP slave is entered here. If the DP slave has not been assigned parameters by a DP master, the DP slave sets the address 255 in this byte.

Bytes 5 and 6 (Ident_Number)

The vendor ID for a DP slave type is assigned in bytes 5 and 6, the "Ident_Number“ byte. This identifier can be used on the one hand for test purposes and on the other for precise identification of the slave.
The value is in Motorola format, in other words the higher order part is in byte 5.

4.6.3 Format of the Device-Related Diagnostic Data (Standard DP Slave)

Meaning

With standard DP slaves (without the DPC1 extensions), this field contains general diagnostic information such as overtemperature, undervoltage or overvoltage. The coding is specified by the slave vendor. For further evaluation, the Ident_Number of the slave is required.

Structure

Byte	Meaning
Byte 1	Header byte
Bytes 2 to 63	Diagnostic_User_Data

Byte 1 (Header Byte)

The two most significant bits in the first byte have the value 00. This identifies the entire field as "device-related diagnostics".

The remaining six bits specify the length of the data field including the first byte.

4.6.4 Format of the Device-Related Diagnostic Data (Slaves with DP-V1 Extensions)

Meaning

With these slaves, the device-related diagnostic data contains alarm data or status messages. The status messages also include the variant "module status".

Entire Structure with Two Variants

The device-related diagnostic data exists in two variants: alarms and status messages. Some components therefore have different codings.

The two variants can be distinguished by byte 2, bit 7.

Byte	"Alarms" Variant	"Status Messages" Variant
Byte 1	Header byte	
Byte 2	Alarm_Type	Status_Type
Byte 3	Slot number	
Byte 4	Alarm specifier	Status specifier
Byte 5 to 63	Diagnostic_User_Data	

Byte 1 (Header Byte)

The two most significant bits in the first byte have the value 00. This identifies the entire field as "device-related diagnostics".

The remaining six bits specify the length of the data field including the first byte.

Byte 2 (Alarm_Type Variant)

Bit	Meaning	
7	Value	Meaning
	0	**Alarm**
6 to 0	**Alarm_Type** 0 = reserved 1 = Diagnostic alarm 2 = Process alarm 3 = Pull alarm 4 = Plug alarm 5 = Status alarm 6 = Update alarm 7-31 = reserved 32-126 = Vendor-specific 127 = reserved	

Byte 2 (Status_Type Variant)

Bit	Meaning	
7	Value	Meaning
	1	**Status message**
6 to 0	**Status_Type** 0 = reserved 1 = Status message 2 = Module status 3-31 = reserved 32-126 = Vendor-specific 127 = reserved	

Byte 3 (Slot Number Variant)

Bit	Meaning
7 to 0	Slot number

Byte 4 (Alarm Specifier Variant)

Bit	Meaning	
7 to 3	Seq_Nr	Unique identifier of an alarm message
2	Add_Ack	If this bit is set, the DP-V1 master indicates that in addition to the DPC1 Alarm Acknowledge, a separate user confirmation(for example in the form of a Write service) is required.
1 to 0	Alarm specifier	**0 = no further information** 1 = **Alarm enters state, slot problem** The slot generates an alarm due to an error/fault. **2 = Alarm leaves state, slot OK** The slot generates an alarm and indicates that the slot no longer has an error/fault. **3 = Alarm leaves state, slot still has problem** The slot generates an alarm and indicates that the slot still has an error/fault.

Byte 4 (Status Specifier Variant)

Bit	Meaning
7 to 2	reserved
1 to 0	Status specifier 0 = no further information 1 = status enters state 2 = status leaves state 3 = reserved

Byte 5-63

User-Specific Information

These bytes contain data with additional user-specific information. The format is described in the slave documentation.

With the "status messages" variant **and** the "Module_Status" setting (see byte 2), two bits are assigned to each module/slot. The module status is byte-oriented, unused bits are set to 0.

	MSB							LSB
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Byte 5:	Module_ Status 4		Module_ Status 3		Module_ Status 2		Module_ Status 1	
...	...		...		...		...	
Byte m:	Module_ Status n		Module_ Status n-1		...		...	

The status bits are coded as follows:

Bit	Meaning
00	Data valid
01	Data invalid: the data of the corresponding module are invalid due to an error/fault (for example short-circuit)
10	Data invalid/wrong module: the data of the corresponding module are invalid because the module is wrong
11	Data invalid/ no module: the data of the corresponding module are invalid because no module is inserted

Example of Device-Related Diagnostic Data with Status Message

The following diagram shows status diagnostic data based on the scheme outlined above.

	MSB							LSB
	7	6	5	4	3	2	1	0
Device-related diagnostics:	**0**	**0**	0	0	0	1	1	1
Status type: status message	**1**	0	0	0	0	0	0	**1**
Slot number 2	0	0	0	0	0	0	**1**	0
Specifier: no further information	0	0	0	0	0	0	0	0
User diagnostic data: 5 average temperature	0	0	0	0	0	**1**	0	**1**
User diagnostic data: temperature value (unsigned 16)	x	x	x	x	x	x	x	x
	x	x	x	x	x	x	x	x

Example of Device-Related Diagnostic Data with Alarm Message

The following diagram shows alarm diagnostic data based on the scheme outlined above.

Device-related diagnostics:	**0**	**0**	0	0	1	0	0	1
Alarm type: process alarm	**0**	0	0	0	0	0	**1**	0
Slot number 3 (valve B)	0	0	0	0	0	0	**1**	**1**
Specifier: alarm enters state	0	0	0	0	0	0	0	**1**
User diagnostic data: 0x50 (upper pressure limit exceeded)	0	1	0	1	0	0	0	0
User diagnostic data (time of day, 4 bytes)	x	x	x	x	x	x	x	x
	x	x	x	x	x	x	x	x
	x	x	x	x	x	x	x	x
	x	x	x	x	x	x	x	x

4.6.5 Format of ID-Related Diagnostics

Meaning

Module-specific diagnostics is possible for modular slaves with an ID byte per module. The DP master sends ID bytes to the slave in a configuration frame during the startup phase. In the ID-related diagnostic data each module is assigned a bit in the data field. If a bit is set, this means that there is diagnostic information on the corresponding module.

Identification of the ID-Related Diagnose Data and Length in the First Byte

The two most significant bits in the first byte have the value 01.

The remaining six bits specify the length of the data field including the first byte.

Content of the Data Field

The remaining bytes of the data field contain a bit array. The least significant bit of the 2nd byte has the index 0 and so on in ascending order so that, for example, the most significant bit of the 3rd byte has index 15.

The bits indicate whether or not diagnostic data were signaled for the ID index.

Meaning of the Bits in the Diagnostic Byte

Each bit in the "diagnostic bytes“ has a special meaning.

Note

Refer to the example at the end of Section 4.6.6.

4.6.6 Format of Channel-Related Diagnostics

Meaning

A channel is identified by the slot of the module and the channel number. A slot (module) can consist of several channels (for example, analog module with two channels each with 4 bits).
Here, the data organization of the channel and messages such as "undervoltage" or "short-circuit" are supplied for the individual channels of a module.

Note

Refer to the example later in the section.

Sequence of Entries each with Three Bytes

Channel-related diagnostic data consists of a sequence of entries all with the same format and three bytes long (header byte, channel number, type of diagnostic information).

Header Byte (ID Number) with Identification

The two most significant bits in the first byte of each entry have the value 10.

The remaining six bits in the first byte indicate the ID number. In ID-related diagnostics, the appropriate bit is set for the ID number.

Channel Number

Bit	Meaning	
7 and 6	Value	Meaning
	00	reserved
	01	Input
	10	Output
	11	Input/output
5 to 0	Channel number 0 to 63	

Note

If ID bytes contain both input and output, the direction of the diagnostic channel is indicated in bit 7 and bit 6 of the channel number.

Type of Diagnostics

<table>
<tr><th>Bit</th><th>Meaning</th></tr>
<tr><td>7 and 6</td><td>Channel type
<table>
<tr><th>Channel type</th><th>Meaning</th></tr>
<tr><td>000</td><td>reserved</td></tr>
<tr><td>001</td><td>bit</td></tr>
<tr><td>010</td><td>2 bits</td></tr>
<tr><td>011</td><td>4 bits</td></tr>
<tr><td>100</td><td>byte</td></tr>
<tr><td>101</td><td>word</td></tr>
<tr><td>110</td><td>2 words</td></tr>
<tr><td>111</td><td>reserved</td></tr>
</table></td></tr>
<tr><td>5 to 0</td><td>Error type
<table>
<tr><th>Error type</th><th>Meaning</th></tr>
<tr><td>0</td><td>reserved</td></tr>
<tr><td>1</td><td>Short circuit</td></tr>
<tr><td>2</td><td>Undervoltage</td></tr>
<tr><td>3</td><td>Overvoltage</td></tr>
<tr><td>4</td><td>Overload</td></tr>
<tr><td>5</td><td>Overtemperature</td></tr>
<tr><td>6</td><td>Wire break</td></tr>
<tr><td>7</td><td>Upper limit value exceeded</td></tr>
<tr><td>8</td><td>Below lower limit value</td></tr>
<tr><td>9</td><td>Error</td></tr>
<tr><td>10 - 15</td><td>reserved</td></tr>
<tr><td>16 - 31</td><td>Specified by the vendor</td></tr>
</table></td></tr>
</table>

Example: Structure of Diagnostic Information According the Above Scheme

The following figure represents diagnostic information arranged according to the scheme listed above.

	MSB							LSB
	7	6	5	4	3	2	1	0
Header	6 bytes long							
Device-related diagnostics:	**0**	**0**	0	0	0	1	0	0
(Header byte)	device-specific							
The meaning of the bits is	diagnostics field,							
Specified by the vendor	here 3 bytes long							
ID-related diagnostics: (Header byte)	**0**	**1**	0	0	0	1	0	1
ID number **0** with diag info (diagnostic byte)	0 7.	0 6.	0 5.	0 4.	0 3.	0 2.	0 1.	**1** 0.
ID number **12** with diag info (diagnostic byte)	0 15.	0 14.	0 13.	**1** 12.	0 11.	0 10.	0 9.	0 8.
ID number 18 with diag info (diagnostic byte)	0 23.	0 22.	0 21.	0 20.	0 19.	**1** 18.	0 17.	0 16.
(diagnostic byte)	0 31.	0 30.	0 29.	0 28.	0 27.	0 26.	0 25.	0 24.
Channel-related diagnostics:								
ID number **0** (header byte)	**1**	**0**	0	0	0	0	0	0
Channel 2 (channel number)	0	0	0	0	0	0	1	0
Overload, channel organized in bits (type of diagnostics)	0	0	1	0	0	1	0	0
ID number **12** (header byte)	**1**	**0**	0	0	1	1	0	0
Channel 6 (channel number)	0	0	0	0	0	1	1	0
Upper limit value exceeded, channel organized in words (type of diagnostics)	1	0	1	0	0	1	1	1

4.7 Format of the Slave Parameter Data

Definition

This section describes the format of the slave parameter data as obtained by the DP_read_slv_par call described in Section 4.1.11. There are three variants possible that are selected by the value of the "type" parameter in the DP_read_slv_par call:

Variant	Value of the "type" Parameter
General slave parameters	DP_SLV_TYP
Parameter assignment data	DP_SLV_PRM
Configuration data	DP_SLV_CFG

The structure of the three variants is described below in greater detail.

4.7.1 Structure of the General Slave Parameters

Overview

The components are bytes. They are byte-aligned, in other words, they are located one immediately following the other. The parameters shown on a gray background are only relevant for DP slaves with DP-V1 additional functions. Where necessary the parameters are described in more detail later in the section.

Name	Meaning (see below)
Sl_Flag	Activates fail-safe mechanisms etc.
Slave_Typ	Specified by the vendor
Max_Diag_Data_Len	Max. length of the diagnostic data
Max_Alarm_Len	Max. length of alarm data
Max_Channel_Data_Len	Max. length of DPC1 frame
Diag_Upd_Delay	Diagnostic counter
Alarm_Mode	Max. number of simultaneous alarms
Add_Sl_Flag	Data for AUTOCLEAR etc.
Bytes 1 to 6	reserved

Byte Structure

In some cases, in the following data structures single bits in the bytes are significant. The bits are numbered as follows: the least significant bit has the number 0 and the most significant bit has the number 7.

SI_Flag

This parameter contains slave-related flags.

Each bit in the "SI_Flag“ byte has a special meaning.

Bit	Meaning
7	**Active** 0 means: DP slave is not activated 1 means: DP slave is activated
6	**New_Prm** 0 means: DP slave receives user data 1 means: DP slave receives new parameter assignment data
5	**Fail_Safe** 0 means: DP slave receives bytes with content 0 in the CLEAR mode 1 means: DP slave receives empty frames in the CLEAR mode
4	reserved
3	**DPV1_Supported** 0 means: DP slave functionality complying with EN 50170 1 means: DP slave functionality complying with DP-V1
2	**DP-V1 data types** 0 means: DP slave configuration data complying with EN 50170 1 means: DP slave configuration data complying with DP-V1
1	**Extra alarm SAP** 0 means: DP master acknowledges alarms via SAP 51 1 means: DP master acknowledges alarms via SAP 50
0	reserved

Slave Type

This parameter contains a vendor-specific type identifier for the slave unit.

Value	Meaning
0	Standard DP slave
1 to 15	reserved
16 to 255	Specified by the vendor

Alarm_Mode

This parameter specifies the maximum number of possible active alarms.

Value	Meaning
0	1 alarm of each alarm type
1	2 alarms in total
2	4 alarms in total
3	8 alarms in total
4	12 alarms in total
5	16 alarms in total
6	24 alarms in total
7	32 alarms in total

Add_Sl_Flag

Bit	Name and Meaning
7-2	reserved
1	**Ignore_AClr** 0 means: execute AUTOCLEAR 1 means: ignore AUTOCLEAR
0	**NA_To_Abort** 0 means: the slave is not initialized if it does not respond. 1 means: the slave is reinitialized if it does not respond.

4.7.2 Structure of the Parameter Assignment Data

Overview

The parameter assignment data consist of bus-specific data and DP slave-specific data.

Byte Number	Meaning
Byte 1	Station_status
Byte 2	WD_Fact_1
Byte 3	WD_Fact_2
Byte 4	Min. Station Delay Responder
Byte 5-6	Ident_Number
Byte 7	Group_Ident
Byte 8	DPV1_Status_1
Byte 9	DPV1_Status_2
Byte 10	DPV1_Status_3
Byte 11-n	User_Prm_Data

Byte 1 (Station_status)

Byte 1 "Station_status" has the following structure:

Each bit in the "station_status“ byte has a special meaning.

<table>
<tr><th>Bit</th><th>Meaning</th></tr>
<tr><td>7 and 6</td><td>Lock_Req and Unlock_Req
<table>
<tr><th>Bit 7</th><th>Bit 6</th><th>Meaning</th></tr>
<tr><td>0</td><td>0</td><td>The min T_{SDR} is overwritten when parameters are assigned. All other parameters remain unchanged.</td></tr>
<tr><td>0</td><td>1</td><td>The DP slave is released for other masters.</td></tr>
<tr><td>1</td><td>0</td><td>The DP slave is disabled for other masters, all parameters are adopted
(exception: min T_{SDR} = 0).</td></tr>
<tr><td>1</td><td>1</td><td>The DP slave is released for other masters.</td></tr>
</table></td></tr>
<tr><td>5</td><td>Sync_Req
This bit indicates to the slave that it must operate in the Sync mode as soon as the command is transferred with the dpn_global_crtl() function.</td></tr>
<tr><td>4</td><td>Freeze_Req
This bit indicates to a DP slave that it must operate in the freeze mode as soon as the command is transferred with the dpn_global_ctrl() function.</td></tr>
<tr><td>3</td><td>Watchdog
If this bit is set to zero, the watchdog monitoring is deactivated. If the bit is set, the watchdog monitoring is activated on the DP slave.</td></tr>
<tr><td>2 to 0</td><td>reserved</td></tr>
</table>

Bytes 2 and 3 (WD_Fact_1 and WD_Fact_2)

These two bytes contain factors for setting the watchdog time (T_{WD}).

The watchdog ensures that if this time expires after a DP master has failed, the outputs are set to a safe state.

T_{WD} [ms] = 10 * WD_Fact_1 * WD_Fact_2

Byte 4 (Min. Station Delay Responder)

This is the time that the DP slave must wait before it is allowed to send its response frames to the DP master, unit: bit times.

Bytes 5 and 6 (Ident_Number)

This number is assigned by the vendor. The DP slave only accepts parameter assignment frames when the Ident_Number transferred with the parameter assignment data matches its own Ident_Number. The value is transferred in Motorola format, in other words, the higher order half is in byte 5.

Byte 7 (Group_Ident)

With this parameter, a group can be formed for the DP_global_ctrl() function. Each bit represents a group. The Group_Ident is accepted only when the Lock_Req bit is set (see byte 1).

Byte 8 (DPV1_Status_1)

Bit	Meaning
7	**DPV1_Enable** This bit is set to activate the DP-V1 functionality of a DP-V1 slave. If the bit is not set, the slave operates in the compatibility mode whenever possible.
6	**Fail Safe** This bit is set to show that the slave operates in the fail-safe mode.
5-3	reserved
2	**WD_Base_1ms** If this bit is set, the watchdog time is calculated according to the following formula: T_{WD} [ms] = WD_Fact_1 * WD_Fact 2 If the bit is not set, the watchdog time is calculated as follows: T_{WD} [ms] = 10 * WD_Fact_1 * WD_Fact 2
1 to 0	reserved

Byte 9 (DPV1_Status_2)

Bit	Meaning
7	**Enable_Pull_Plug_Alarm** This bit is set to allow an alarm of the type "Pull_Plug_Alarm" to be signaled.
6	**Enable_Process_Alarm** This bit is set to allow an alarm of the type "Process_Alarm" to be signaled.
5	**Enable_Diagnostic_Alarm** This bit is set to allow an alarm of the type "Diagnostic_Alarm" to be signaled.
4	**Enable_Manufacturer_Specific_Alarm** This bit is set to allow all vendor-specific alarms to be signaled.
3	**Enable_Status_Alarm** This bit is set to allow an alarm of the type "Status_Alarm" to be signaled.
2	**Enable_Update_Alarm** This bit is set to allow an alarm of the type "Update_Alarm" to be signaled.
1	reserved
0	**Check_Cfg_Mode** This bit can be used to influence the reaction to the reception of configuration data. If the bit is set to 0, the check is as described in EN 50170. If this bit is set, the check is made according to a specific user definition.

Byte 10

DPV1_Status_3

Bit	Meaning
7-3	reserved
2-0	**Alarm Mode** **Bit 4** — **Meaning** 0 — 1 alarm of each type 1 — 2 alarms in total 2 — 4 alarms in total 3 — 8 alarms in total 4 — 12 alarms in total 5 — 16 alarms in total 6 — 24 alarms in total 7 — 32 alarms in total

Bytes 11 to n

User_Prm_Data

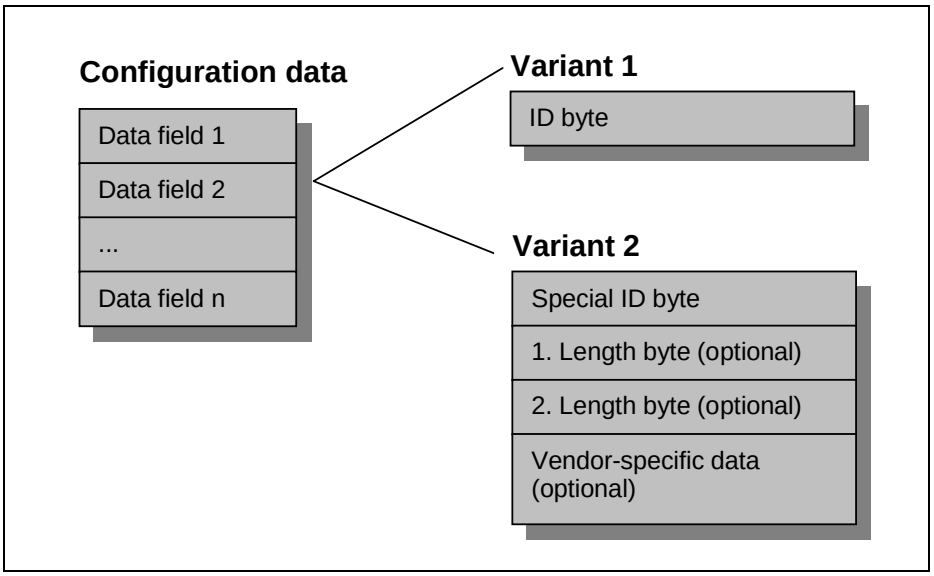
This byte can be used for parameters specific to a DP slave (for example, diagnostic filter, controller parameters). The meaning and the range of values are specified by the specific vendor.

4.7.3 Structure of the Configuration Data

Overview of the Structure

The configuration data contain the range of the input and output data areas and information on data consistency.

They consist of a sequence of data fields, each data field having one of two alternative formats:



The two data block variants can be distinguished by bits 4 and 5 of the first byte.

Length of the Configuration Data

The length of the configuration data is ideally 1 to 32. If necessary, however, up to 244 bytes are possible.

Structure of an ID Byte

Each bit has a special meaning.

<table>
<tr><th>Bit</th><th>Meaning</th></tr>
<tr><td>0 to 3</td><td>Number of data units - 1
3 means for example 4 data units of the length specified in bit 6</td></tr>
<tr><td>4 and 5</td><td>Input/output
<table>
<tr><th>Bit 5</th><th>Bit 4</th><th>Meaning</th></tr>
<tr><td>0</td><td>0</td><td>does not occur (see below)</td></tr>
<tr><td>0</td><td>1</td><td>Input</td></tr>
<tr><td>1</td><td>0</td><td>Output</td></tr>
<tr><td>1</td><td>1</td><td>input/output</td></tr>
</table></td></tr>
<tr><td>6</td><td>Length of the data units
0 means: the data unit is in bytes
1 means: the data unit is 2 bytes</td></tr>
<tr><td>7</td><td>Consistency
0 means: byte or word consistency
1 means: consistency over the entire length</td></tr>
</table>

Structure of a Special ID Byte

Special identifier formats allow the configuration to be extended by increasing the flexibility. Each bit in the ID byte has a special meaning.

<table>
<tr><th>Bit</th><th>Meaning</th></tr>
<tr><td>0 to 3</td><td>Length of the vendor-specific data
These bits contain the length of the vendor-specific data.</td></tr>
<tr><td>4 and 5</td><td>These bits always have the value 00.</td></tr>
<tr><td>6 and 7</td><td>Input/output
<table>
<tr><td>Bit 7</td><td>Bit 6</td><td>Meaning</td></tr>
<tr><td>0</td><td>0</td><td>No optional bytes follow</td></tr>
<tr><td>0</td><td>1</td><td>1 length byte for inputs follows</td></tr>
<tr><td>1</td><td>0</td><td>1 length byte for outputs follows</td></tr>
<tr><td>1</td><td>1</td><td>This is followed by
● 1 length byte for outputs
● 1 length byte for inputs</td></tr>
</table></td></tr>
</table>

Length Bytes

Each bit in the length bytes has a special meaning.

Bit	Meaning
0 to 5	**Number of data units** 0 (decimal) means: 1 data unit 63 (decimal) means: 64 data units (for the length of the data units see bit 6)
6	**Length** 0 means: a data unit is one byte long 1 means: a data unit is two bytes long
7	**Consistency** 0 means: consistency over byte or word 1 means: consistency over the entire length

Example of a Special ID Format

The following table shows an example of a special ID format.

Octet	Bits in the byte								Meaning
1	1	1	0	0	0	0	1	1	Input/output, 3 bytes of vendor-specific data
2	1	1	0	0	1	1	1	1	Consistency, output, 16 words
3	1	1	0	0	0	1	1	1	Consistency, input, 8 words
4 to 6									Vendor-specific data

FAQ (Frequently Asked Questions)

5

This chapter contains answers to typical questions ("Frequently Asked Questions") on the programming interface of the CP 5613 and CP 5614 arranged in categories.

For information on creating your user program, refer to the sections on structuring user programs and the check list for programmers.

You should also read the FAQ list in the Installation Instructions of the product.

5.1 FAQs about the Range of Functions of the Product

Which software versions exist and how do they differ from each other?

Please refer to the version table in Section of the Installation Instructions.

Which operating systems are supported?

Please refer to the version table in Section of the Installation Instructions.

Which compilers and programming languages are supported?

Please refer to the version table in Section of the Installation Instructions.

For linking to Borland C++ and Delphi, please check with the AIXO company (Internet: http://www.aixo.com).
By designing the "dp_base.dll" with standard calling conventions, linking to other development environments is in principle possible.

What are the differences between the CP 5613 and CP 5614?

The CP 5614 has an additional DP port with which the PC can be operated as a DP slave on a second PROFIBUS network. There is also a transfer function for the automatic transfer of slave data to the controlling master.

Do the CP 5613 and CP 5614 also support the DP programming interface of the CP 5412(A2), the CP 5511 and CP 5611?

A further product "DP 5613/Windows NT" is intended for this purpose.

Are multiple CPUs, user programs and CPs supported?

Multiple CPUs in one PC: yes.

Please refer to the version table in Section of the Installation Instructions.

Is the user watchdog supported?

Please refer to the version table in Section of the Installation Instructions.

Are the CP 5613 and CP 5614 OPC-compliant?

OPC products that support the CP 5613/CP 5614 are planned.

What are the reaction times and data transfer rates available with the CP 5613/CP 5614?

Please refer to the numeric data in Section of the Installation Instructions.

5.2 FAQs about Structuring the User Program

Can DP and DPC1 be operated at the same time?

Yes. The DP master must, however, already by in the OPERATE mode before DPC1 functions can be used.

How many DPC1 jobs can be sent at the same time?

Per slave address, up to two DPC1 jobs can be sent at any one time, one for reading or writing and one for alarm acknowledge.

How can I structure my user program?

There are basically three wait mechanisms that you can combine together:

- You can poll with your user program, in other words, it queries the process image cyclically.
- You can use hardware events with semaphores as the wait mechanism.
- You can call the DP_get_event function with a timeout value to wait for software events.

You can also break down your user program into several threads (see also the "ExamComp" sample program.).

What are the advantages of simply polling in the user program?

The program structure is relatively simple (assuming that your program does not use any other interfaces that would require event handling such as DPC1). Polling is particularly suitable when you expect a lot of data traffic due to a fast data transmission rate and a lot of slaves with fast changing data.

What are the disadvantages of simply polling in the user program?

If your user program does not restrict itself, the entire available CPU performance of the of the PC will be used to query the process image unnecessarily often. If the program restricts itself too much, on the other hand, the data will no longer be up to date. We recommend that you restrict polling using a time control suitable for your system.

What are the advantages of hardware events ?

Your user program can react to changes quickly. Since it waits, it does not take up unnecessary CPU time on the PC.

What are the disadvantages of hardware events?

If your user program monitors a large number of active slaves using hardware events, the overheads for fetching events is high because semaphores must constantly be incremented and run through. This increases PC-CPU load. If you therefore have a lot of slaves or very active slaves, we recommend that you use hardware events for only a few slaves and poll the others periodically.

What are the advantages of programming with multiple threads?

With multiple threads, you achieve a clearer structure in your user program. This is particularly useful when you want to run different processes at the same time, for example, periodic polling combined with hardware events on the one hand and asynchronous DPC1 jobs on the other. These unrelated tasks with their different dynamic characteristics can be implemented in two threads.

What are the disadvantages of programming with multiple threads?

The threads of an application, for example, must not interfere with each other when accessing global variables. Overwriting data and deadlocks must be avoided. It is particularly important to avoid multiple threads accessing the process image of the CP 5613 or CP 5614 at the same time otherwise they will overwrite the each other's control register for consistent reading and writing of slave data. This could, for example, jeopardize the consistency of the slave data currently being read by a thread.

How do I access the process image with more than one thread?

This is not recommended. The control register for consistent reading and writing of slave data can then be overwritten, so that, for example, the consistency of the slave data currently being read by a thread would be jeopardized.
To avoid this, some form of interlock would be necessary so that only one thread can access the process image at any one time. You could do this using semaphores, mutexes etc. in Windows NT.

How can I access the process image with multiple programs?

This works fine as long all the programs involved release the pointer to the process image again with the DP_release_pointer call. In real-time operation, we would advise against this, since both calls take up time and you would need to implement extra mechanisms to coordinate the programs.

5.3 FAQ Check List for Programmers

What are the most important aspects of the program structure?

Make sure that you keep to the rules below when structuring your program:

- Begin your user program with a DP_start_cp, DP_open and DP_get_pointer and always complete these with DP_release_pointer, DP_close and DP_reset_cp.
- Evaluate all errors and check all the diagnostic data.
- Check that all the conditions necessary for validating the data are met (for example, when reading slave data, the master must be in the OPERATE or CLEAR mode and the slave in the READY state).
- Read out alarms with DP_read_alarm and acknowledge them with DP_alarm_ack.
- Events can be reported in any order; so make sure that your algorithms are suitably flexible.
- Do not send more than one asynchronous DPC1 job to a slave at the same time (DP_ds_read/DP_ds_write, DP_alarm_ack).
- If the result of a DP_enable_event call has been fetched, it must be sent again.

Should I retain the pointer while my program is running?

As long as your user program is in possession of the pointer to the process image (DP_get_pointer call), no other user program can access it. In this case, retain the pointer until the end of the program. If you only access the process image sporadically, for example, as a diagnostic program or when you do not have real-time requirements, you should release the pointer after every access or cycle.

What are the most important aspects of accessing data areas?

The process image is separate from the user program and the slaves. Note the information in Section 2.7.

Use the check list below for your data areas:

- Select data buffer lengths to match the longest possible data.
- Link job fields with valid data buffers in the startup phase of your program.
- If you use multiple threads, each thread should have its own job fields and data buffers.
- Interlock the threads if they can access the dual-port RAM at the same time, to avoid access conflicts.

What are the most important aspects of using hardware events and semaphores?

- Until your user program has run through a semaphore for hardware events, it will not be incremented again. After running through a semaphore, you should therefore check whether or not more than one event has occurred. (This is unnecessary with software events.)
- After a hardware event arrives, the triggering control condition is reset so that your user program must then set it again.
- Your user program must log off with DP_delete_sema_object and not with Windows API functions.

How can I wait for more than one event in a thread at the same time?

Initialize a semaphore for each event type (DP_create_sema_object), trigger your jobs and then wait at the semaphores by calling the Win32 API function "WaitForMultipleObjects" or “sgWaitForMultipleObjects".

Where can I find a list of all the error messages?

In the header files "5613_ret.h" and "5614_ret.h". To decode the error messages, use the DP_get_err_txt function.

What should a user programmer take into account?

- Use unique order_ids for parallel jobs.
- Remember that a hardware event entering the state deletes its activation condition. You must make sure it is reactivated.
- Do not use hardware events at the same time as periodic polling on the same slave.

5.4 FAQs about Debugging and Starting Up Your Program

What are the typical errors when a program is first run?

- Bus malfunctions caused by bad contacts/bad cabling/forgetting the terminator are often the cause of initial problems.
- Incorrectly configured slave types
- Using the wrong database
- Bad bus parameters
- Wrong station addresses set on the slaves

Are there tools for troubleshooting?

Use the diagnostic tools described in the Installation Instructions for the CP 5613/CP 5614. You can start these tools from the start menu of Windows NT. These tools also include a trace of the DP function calls.

5.5 FAQs Miscellaneous Programming Questions

Can groups of slaves be used for hardware events?

You can do this yourself with the software tools, for example: at the start of each cycle, activate the hardware events of all slaves in the group and, as soon as an event occurs, deactivate them all again until the end of the cycle.

What names are given to the modules when they are installed?

The modules are given the names "CP5613_5614_1", "CP5613_5614_2" etc. by the driver.

What differences are there in the user program for a CP 5614 and a CP 5613?

With a CP 5613, the "DPS_open" call returns the message that no slave exists; see Section 4.2.2.

How can I use the CP 5613 or CP 5614 with a real-time kernel in Windows NT without having to port all the drivers etc.?

Implement the CP startup and log off in Windows NT. In the meantime, operate the CP in the real-time kernel only by accessing the process image. The alarm used and also data are entered in the structure "info_watch.pci" in the process image each time the Windows NT driver is started (see header file "dp_5613.h"). A Windows NT user program can read this from here and pass it on to a real-time kernel.

Who can I contact if I have problems?

Read the chapter "Where to Get Help" in the Installation Instructions for the product.

Further information for programmers is also available from the following address: http://www.ad.siemens.de/net/html_00/index.shtml

Where to Get Help

6

This Chapter lists contacts for SIMATIC NET:

Contacts for technical questions

Contacts for training with SIMATIC NET products

6.1 Help with Technical Questions

Documentation

You will find information on the use of this software in the following sources:

- in the corresponding paper documentation
- in the online help (F1 key)
- in the text files on the product diskettes
- in text and PDF files on the SIMATIC NET CD

Who to Contact

If you cannot find answers to technical questions on the software in the sources listed above, please contact your local Siemens office.

You will find the addresses:

- in our catalog IK 10
- on the Internet (http://www.ad.siemens.de)
- in the "README.TXT" in the main folder of the SIMATIC NET CD

Common Questions

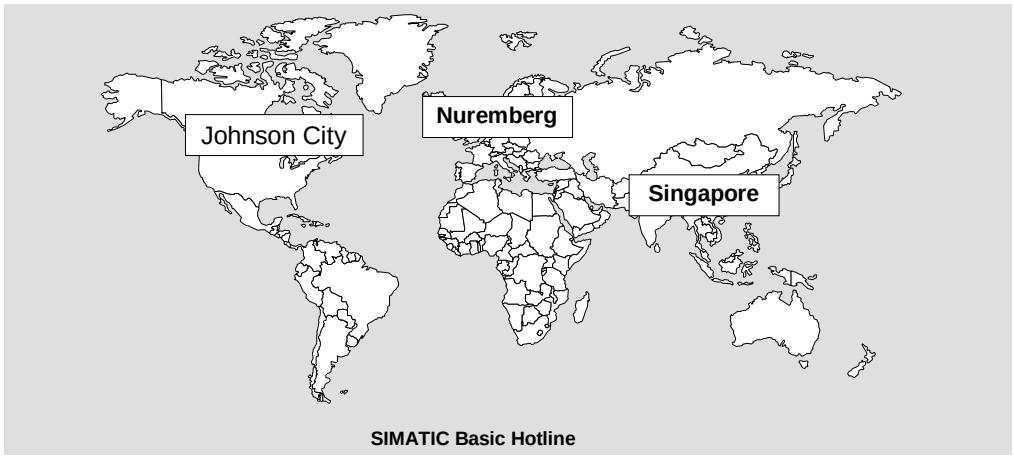
Our customer support on the Internet provides useful information and answers to frequently asked questions (FAQ). Under FAQ, you will find information about our entire range of products.

The address of the A&D home page in the World Wide Web of the Internet is as follows:

- http://www.ad.siemens.de/net

SIMATIC Customer Support Hotline

Available at all times worldwide:



Nuremberg **SIMATIC BASIC Hotline**	**SIMATIC Premium Hotline** (charged, only with SIMATIC card)
Local time: Mo to Fr 7:00 to 17:00 (CET) Phone: +49 (911) -895-7000 Fax: +49 (911) -895-7002 E-mail: simatic.support@nbgm.siemens.de	Local time: Mo to Fr 0:00 to 24:00 (CET) Phone: +49 (911) -895-7777 Fax: +49 (911) -895-7001

Johnson City **SIMATIC BASIC Hotline**	**Singapore** **SIMATIC BASIC Hotline**
Local time: Mo to Fr 8:00 to 17:00 Phone: +1 423 461-2522 Fax: +1 423 461-2231 E-mail: simatic.hotline@sea.siemens.com	Local time: Mo to Fr 8:30 to 17:30 Phone: +65 740-7000 Fax: +65 740-7001 E-mail: simatic@singnet.com.sg

SIMATIC Customer Support Online Services

In its online services, SIMATIC Customer Support provides you with wide-ranging additional information about SIMATIC products:

- You will find general, up-to-date information:
  - on the Internet (http://www.ad.siemens.de/simatic)
  - using fax polling
- You can obtain the latest product information and downloads:
  - on the Internet (http://www.ad.siemens.de/support/html-00).
  - via the Bulletin Board System (BBS) of the SIMATIC Customer Support mailbox in Nuremberg (Tel.: +49 (911) - 895-7100).

    To contact the mailbox, use a modem with up to 28.8 Kbps, V.34 (parameters: 8, N, 1, ANSI) or ISDN (parameters: x.75, 64 Kbps).

6.2 Contacts for training with SIMATIC NET

SIMATIC Training Center

Please contact your regional training center or the central training center in D-90327 Nuremberg, Tel. +49-911-895-3154.

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Glossary

8

AUTOCLEAR

1. Configuration property of a DP slave - the master changes to the AUTOCLEAR mode if this slave drops out.

2. This is the same as the DP_CLEAR mode of a DP master, when it changes to the mode due to the AUTOCLEAR property of a slave.

Bit time

Time required by a bit for transmission on the bus, this is the reciprocal of the data transmission rate.

Bus parameter

Bus parameters control the data transmission on the bus - Each PROFIBUS node must use bus parameters that match the bus parameters of other nodes.

c_ref

Reference to identify connections to slaves in DPC1 calls.

COM PROFIBUS

Configuration tool for defining communications nodes and the bus parameters.

CP

Communications **P**rocessor - communications module/network card for installation in computers or programmable controllers.

CPU

Central **P**rocessing **U**nit - here processor of the PC

CPU load

Load on the CPU of the PC - here: resulting from DP communication

Data_Ex

The slave is ready for productive operation

Data transmission rate

Transmission rate on the bus (unit: bps). A bus parameter for PROFIBUS. The data transmission rate used depends on various conditions such as distance.

DB

Here: **D**ata**b**ase - The local database describes the communications network from the view of the local system.

Deadlock

When more than one parallel process (here: threads) become blocked (A waits for B and B waits for A).

Distributed I/Os

An input/output module used in a distributed configuration. The connection between the programmable controller and the distributed I/Os is established via the PROFIBUS bus system. For the programmable controller, the distributed I/Os are no different from local process inputs/outputs.

DP

Distributed peripheral I/Os, communication protocol for PROFIBUS complying with EN 50 170 Volume 2.

DP Base

Name of the DP programming interface of the CP 5613/CP 5614, in contrast to the DP Lib interface of the CP 5412 (A2), CP 5611 and CP 5511.

DPC1

DP extended by acyclic read and write jobs and alarms between cyclic DP master and slave.

DPC2

DP extended by connection control and read and write jobs from a non-cyclic master.

DP-V1

DP extensions, this includes DPC1 and DPC2

DP master

A node with master class 1 functionality in PROFIBUS DP - The DP master handles the exchange of data with the DP slaves assigned to it.

DP master class 1

see DP master

DP master class 2

Optional diagnostic master – The diagnostic master is used to monitor the DP master class 1 and the DP slaves.

DP Slave

A node with slave functions in PROFIBUS DP.

DP subnet

PROFIBUS subnet in which only distributed peripheral I/Os are operated.

DP subsystem

A DP master and all DP slaves with which the master exchanges data.

Driver

Software that allows data exchange between application programs and the CP client.

Dual-port RAM

Dual **P**ort **R**andom **A**ccess **M**emory - allows simultaneous access to one memory area (RAM) by two computer units (CP and CPU).

Event

Here: an event that the CP 5613/CP 5614 can signal to the user program. There are hardware events and software events.

Fast Logic

Property of the CP 5613/CP 5614: an input value of a slave can be monitored. When it changes to a specified value, output data of another slave is set.

FDL

Fieldbus **D**ata **L**ink - Layer 2 for PROFIBUS

Frame

Message from one PROFIBUS node to another.

Frame header

A frame header consists of an identifier for the frame and the source and destination address.

Frame trailer

A frame trailer consists of a checksum and the end identifier of the frame.

FREEZE mode

The FREEZE mode is a DP mode in which the process data are acquired at the same time from all (or a group) of DP slaves. The time at which the data are required is indicated in the FREEZE command (a synchronization control frame).

Gap update factor

A free address area between two active nodes is checked cyclically by the node with the lower PROFIBUS address to find out whether or not another station is requesting to enter the logical ring. The cycle time for this check is as follows:

gap update factor x target rotation time [ms]

Group identifier

DP slaves can be assigned to one or more groups using a group identifier. The DP slaves can then be addressed by the group identifier when transferring control frames.

Highest PROFIBUS address

A bus parameter for PROFIBUS. This specifies the highest PROFIBUS address of an active node on the PROFIBUS. For passive nodes, PROFIBUS addresses higher than the HSA are permitted (possible values: HSA 1 to 126).

HSA

Highest **S**tation **A**ddress - one of the bus parameters. Specifies the highest node address used in the network.

Hardware event

Event whose arrival is monitored by the hardware of the CP (at the start of the cycle, when data changes, when diagnostic data arrive, and when a fast logic condition arrives).

Input data

Here: the data read cyclically by the DP master from the slaves.

Indication

Message from a remote node.

Intel format

Numbers are stored in the Intel format when lower order bytes are stored first (in other words, at lower addresses).

I/O module

DP slaves can have a modular structure. A DP slave has at least one DP I/O module.

I/O type

The DP I/O type identifies a DP I/O module. The following types exist:

- Input module
- Output module
- Input/output module

ISO

International **S**tandard **O**rganization - International organization based in Geneva responsible for formulating general standards particularly in the area of data transmission.

LAN

Local **A**rea **N**etwork - local network for direct connection of computers.

LSB

Least **S**ignificant **B**it

Master

An active node on PROFIBUS that can send frames on its own initiative when it is in possession of the token.

Maximum station delay

The maximum station delay (max. TSDR) specifies the longest interval required by a node in the subnet between receiving the last bit of an unacknowledged frame and sending the first bit of the next frame. After sending an unacknowledged frame, a sender must wait for the max. TSDR to elapse before sending a further frame.

Minimum station delay

The minimum station delay (min. TSDR) specifies the minimum time that the receiver of a frame must wait before sending the acknowledgment or sending a new frame. The min. TSDR takes into account the longest interval required by a station in the subnet for receiving an acknowledgment after sending a frame.

min T_{SDR}

see "Minimum station delay"

Motorola format

Numbers are stored in the Motorola format when higher order bytes are stored first (in other words, at lower addresses).

MSAC_C1

"Master Slave Acyclic Class 1" - Name for DPC1 in the DP-V1 standard description.

MSAC_C2

"Master Slave Acyclic Class 2" - Name for DPC2 in the DP-V1 standard description.

MSB

Most **S**ignificant **B**it

MSCY_C1

"Master Slave cyclic class 1" - name of the normal DP master operation in the DP-V1 standard description.

Network

A network consists of one or more interconnected subnets with any number of nodes. Several networks can exist one beside the other. For each subnet, there is a common node table.

Output data

Here: the data sent cyclically to the slaves by the DP master.

PC

Personal **C**omputer

PG

Programming device (industrial PC) belonging to the SIMATIC product family from Siemens AG used for programming, configuring and in maintenance and service.

PNO

PROFIBUS Users Organization

PROFIBUS

A fieldbus complying with EN 50 170 Vol. 2 (DIN 19245).

PROFIBUS address

The PROFIBUS address is a unique identifier of a node connected to a PROFIBUS network. To address a node, the PROFIBUS address is transferred in the frame.

PROFIBUS DP

PROFIBUS DP EN 50 170 Vol. 2 (DIN 19245 T1 + T3) is a guideline from the PROFIBUS users organization for data exchange with distributed peripheral devices.

Protocol

Rules governing the transmission of data - The rules specify not only the formats of the messages but also the data flow during data transmission.

Process image

Here: used for a dual-port RAM of the CP 5613/CP 5614 that can be accessed directly by user programs and where the current data of the slaves are located.

READY time

A PROFIBUS bus parameter- The READY time is the time within which an active node must be ready to receive an acknowledgment or response after sending a call.

Reorganization token ring

All the masters on PROFIBUS form a logical token ring. Within this token ring, the token is passed on from station to station. If the transmission of the token is incorrect or if a master is removed from the ring, this leads to an error when the token is passed on (the token is not accepted by this station) and the station is excluded from the ring. The number of exclusions is counted in the internal Token_error_counter. If this counter reaches an upper limit value, the logical token ring is then reorganized.

S7 PLC

Abbreviation for a programmable logic controller belonging to the SIMATIC product family from Siemens AG.

SAP

Service **A**ccess **P**oint - access point to PROFIBUS within a station

Semaphore

Wait mechanism for synchronizing several programs, for example in Windows NT.

Services

Services provided by a communication protocol.

Setup time

A PROFIBUS bus parameter - The setup time specifies the minimum time between receiving an acknowledgment and sending a new call.

Sign of life monitoring

A monitoring time that can be set on a DP slave to detect failure of the controlling DP master.

SIMATIC NET

Siemens Network and Communication - Product range for networks and network components from Siemens.

Slot Time

A PROFIBUS bus parameter - The slot time (TSL) is monitoring time between a sender sending a frame and receiving the acknowledgment of the receiver.

Software event

Here: an event that must be fetched with the DP_get_result function.

SYNC mode

The SYNC mode is a DP mode in which several or all DP slaves transfer data to their process outputs at a certain time. The time at which the data is transferred is indicated in the SYNC command (a control command for synchronization).

System

The entire electrical equipment belonging to a plant/system including programmable controllers, devices for operator monitoring and control, bus systems, field devices, drives, supply lines.

Target rotation time

A PROFIBUS bus parameter - The token is right to send for a node on PROFIBUS. A node compares the actual token rotation time it has measured with the target rotation time and depending on the result can then send high or low priority frames.

Thread

A subprocess running parallel.

User watchdog

Watchdog for monitoring the DP user program

Watchdog

A mechanism for monitoring operability of nodes.