

# SIEMENS

## SIMATIC NET

### S7-CPs for PROFIBUS

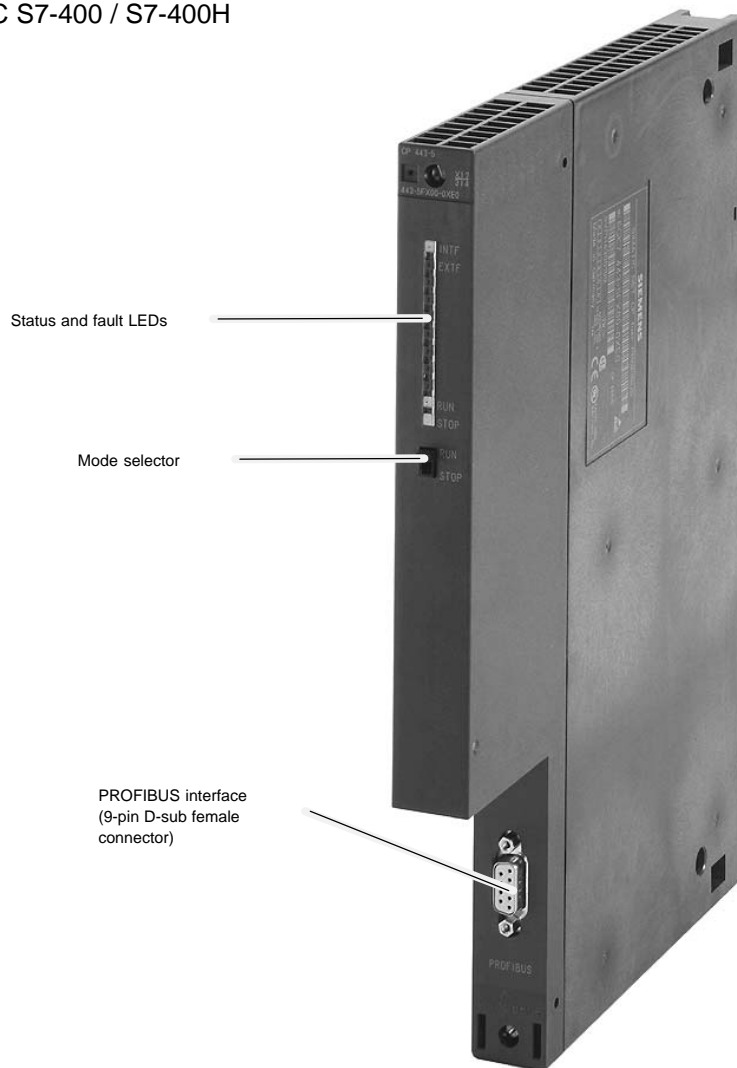
#### Manual Part B3

## CP 443-5 Basic

6GK7 443-5FX02-0XE0

Version 1 and higher (firmware version V4.0 and higher)

for SIMATIC S7-400 / S7-400H



## Notes on the Product

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### Note

All notes in the **product information bulletin**, which is supplied with this product, are valid and must be observed.

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## Compatibility with the Previous Version

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### Note

Make sure that you read the information regarding **extended functionality and restrictions** in Chapter 6 of this manual!

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# Contents

## Contents - Part A

|   |                         |
|---|-------------------------|
| <b>PROFIBUS CPs - General Information .....</b> | <b>See General Part</b> |
|---|-------------------------|

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### Note

Please remember that Part A of the manual also belongs to the description of the CP. Among other things, it contains explanations of the safety notices, references, and general information that applies to all S7 CPs for PROFIBUS.

You can also download this general part from the Internet:

<http://www4.ad.siemens.de/view/cs/de/8774037>

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## Contents - Part B3

|          |  |              |
|----------|--|--------------|
| <b>1</b> | <b>Properties / Services .....</b>   | <b>B3-4</b>  |
| <b>2</b> | <b>Requirements for Use .....</b>  | <b>B3-7</b>  |
| 2.1      | Use with the Current CPU Types .....   | B3-7         |
| 2.2      | Converting older Systems .....   | B3-8         |
| <b>3</b> | <b>Installation and Commissioning .....</b>  | <b>B3-9</b>  |
| <b>4</b> | <b>Displays and Mode Selector .....</b>  | <b>B3-10</b> |
| <b>5</b> | <b>Performance Data .....</b>  | <b>B3-12</b> |
| 5.1      | Supported Transmission Rates .....   | B3-12        |
| 5.2      | Data of S5-Compatible Communication (SEND/RECEIVE Interface)<br>on FDL Connections ..... | B3-12        |
| 5.3      | Data of FMS Connections .....  | B3-13        |
| 5.4      | Characteristics of S7 Communication .....  | B3-14        |
| 5.5      | Maximum Number of Connections in Total .....   | B3-16        |
| 5.6      | Time-of-day Synchronization .....  | B3-16        |
| 5.7      | Use in Fault-Tolerant Systems .....  | B3-17        |
| 5.8      | Other Characteristics .....  | B3-18        |
| <b>6</b> | <b>Compatibility with the Previous Product .....</b>                                     | <b>B3-19</b> |
| 6.1      | Extended Functionality Compared with Previous Product .....                              | B3-19        |
| 6.2      | Replacing Older Modules / Replacing Defective Modules .....                              | B3-20        |
| <b>7</b> | <b>Technical Specifications .....</b>  | <b>B3-22</b> |

# 1 Properties / Services

## Application

The CP 443-5 Basic communications processor is designed for use in a SIMATIC S7-400 (standard) and S7-400H (fault-tolerant system) programmable controller. It allows the S7-400 / S7-400H to be connected to a PROFIBUS fieldbus system.

## Services

The current version of the CP 443-5 Basic supports the following communication services in the standard and H systems:

- **PROFIBUS FMS** (complying with EN 50170, FMS client and server function)
  - as FMS master for the following types of connection:
    - MMAC: Master-master acyclic
    - MSAC: Master-slave acyclic
    - MSAC\_SI: Master-slave acyclic with slave initiative
    - MSCY: Master slave cyclic
    - BRCT (broadcast): Sending to all FMS stations
- **S7 communication and PG/OP communication**
  - PG functions with upload / download of FM modules, configuration / diagnostics and routing, user programs
 

Note on routing: Dynamic switchover to alternative paths (for example if there is a problem on one of the possible transmission paths) is not supported.
  - Operator control and monitoring functions (HMI)
  - Data exchange using communication function blocks on S7 connections (fault-tolerant S7 connections also possible) <sup>1)</sup>

1)

Blocks for S7 communication (see also STEP 7 online help or "System Software for S7-300/400 System and Standard Functions" manual):

|         |        |
|---------|--------|
| BSEND   | SFB 12 |
| BRCV    | SFB 13 |
| PUT     | SFB 14 |
| GET     | SFB 15 |
| USEND   | SFB 8  |
| URCV    | SFB 9  |
| START   | SFB 19 |
| STOP    | SFB 20 |
| RESUME  | SFB 21 |
| STATUS  | SFB 22 |
| USTATUS | SFB 23 |
| CONTROL | SFC 62 |

- **S5-compatible communication (SEND/RECEIVE Interface) over FDL connections of the following types:**
  - specified FDL connections
  - free layer 2 connections
  - broadcast
  - multicast
- **Time-of-day synchronization over PROFIBUS**
  - The CP forwards time-of-day synchronization frames from the LAN to the station (CPU = time slave) or from the station to the LAN (CPU= time master) or this station is synchronized via a different LAN and the time-of-day synchronization frame must be forwarded over PROFIBUS for the synchronization of further stations.
  - Time-of-day status value, standard/daylight saving time switchover, synchronization status

The services of the CP 443-5 Basic module listed above can be used at the same time.

## Configuration

When configuring, you must use STEP 7 version V5.2 SP1 or higher; for FDL connections and diagnostic functions, the NCM S7 for PROFIBUS optional package supplied with STEP 7 must be installed.

If the functionality of the predecessor module is adequate for your purposes, configuration and diagnostics are also possible with earlier STEP 7 versions.

It is possible to configure over the MPI or LAN/PROFIBUS.

System modifications are possible during operation (H system).

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### Note

For more detailed information on configuring PROFIBUS CP with STEP 7 / NCM S7, refer to the manual NCM S7 for PROFIBUS and the online help of STEP 7.

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## Programming - Using Blocks

For some communication services, there are “off-the-peg” blocks (FCs/FBs) available that implement the interface in your STEP 7 user program. You will find a detailed description of these blocks in the NCM S7 for PROFIBUS manuals.

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### **Notice**

We recommend that you always use the latest block versions for all module types.

You will find information on the latest block version and links to download the current blocks in our Customer Support on the Internet:

<http://www4.ad.siemens.de/view/cs/en/8797900>

If you are using older block types, this recommendation only applies if you also have the latest firmware version.

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You will find further information and Internet addresses in the Preface of the General Part of this manual.

### **Module Replacement without PG**

Depending on the setting in the project configuration, the configuration data can also be stored in the load memory of the CPU. This makes it possible to replace modules without having to download the configuration data from the PG.

The stored configuration data is protected from power outage by battery backup or by plugging an EPROM card into the CPU.

## 2 Requirements for Use

The CP 443-5 Basic described here is supported by all the CPU operating systems listed in the table below.

The chapter also contains the following information:

- The number of CPs that can be operated with one CPU.
- The number of AG-SEND or AG-RECV calls on the SEND/RECEIVE interface that can be active at the same time (data exchange on FDL connections over PROFIBUS and corresponding connections over Industrial Ethernet).

### 2.1 Use with the Current CPU Types

When operating the CP 443-5 Basic with the CPU types listed here in the table, the following functionality is supported without exception:

- Number of operable CPs: 14
- Multicomputing (except for H systems)

Table 2-1 Use with the Current CPU Types

| CPU              | Order number        | Firmware version |   |
|------------------|---------------------|------------------|---|
|                  |                     |                  | Number of AG-SEND or AG-RECV calls at same time |
| CPU 412          | 6ES7 412-1XF03-0AB0 | As of V3.0       | 24 / 24   |
| CPU 412-2        | 6ES7 412-2XG00-0AB0 | As of V3.0       |   |
| CPU414-2 128 KB  | 6ES7 414-2XG03-0AB0 | As of V3.0       |   |
| CPU414-3 384 KB  | 6ES7 414-3XJ00-0AB0 | As of V3.0       |   |
| CPU 414-4H       | 6ES7 414-4HJ00-0AB0 | As of V3.0       |   |
| CPU416-2 0.8 MB  | 6ES7 416-2XK02-0AB0 | As of V3.0       | 64 / 64   |
| CPU416-3 1.6 MB  | 6ES7 416-3XL00-0AB0 | As of V3.0       |   |
| CPU 417-4        | 6ES7 417-4XL00-0AB0 | As of V3.0       |   |
| CPU 417-4H       | 6ES7 417-4HL00-0AB0 | As of V2.1       |   |
|                  | 6ES7 417-4HL01-0AB0 | As of V3.0       |   |
| CPU416F-2 1.6 MB | 6ES7 416-2FK02-0AB0 | As of V3.1       | 64 / 64   |

## 2.2 Converting older Systems

The discontinued CPUs listed here in Table 2-2 support the following functionality in conjunction with the CP 443-5 Basic:

- Number of operable CPs: 8
- Multicomputing

Table 2-2 Use with Discontinued CPU Types

| CPU             | Order number        | Version     | Number of AG-SEND or AG-RECV calls at same time |         |
|-----------------|---------------------|-------------|---|---------|
|                 |                     |             |   |         |
| CPU 412         | 6ES7 412-1XF01-0AB0 | 2 or higher | 12 / 12   |         |
|                 | 6ES7 412-1XF02-0AB0 | 2 or higher |   |         |
| CPU 413         | 6ES7 413-1XG01-0AB0 | 2 or higher |   |         |
|                 | 6ES7 413-1XG02-0AB0 | 1 or higher |   |         |
| CPU 413-2       | 6ES7 413-2XG01-0AB0 | 2 or higher |   |         |
|                 | 6ES7 413-2XG02-0AB0 | 1 or higher |   |         |
| CPU414-1        | 6ES7 414-1XG01-0AB0 | 2 or higher |   |         |
|                 | 6ES7 414-1XG02-0AB0 | 2 or higher |   |         |
| CPU414-2 128 KB | 6ES7 414-2XG01-0AB0 | 2 or higher |   |         |
|                 | 6ES7 414-2XG02-0AB0 | 2 or higher |   |         |
| CPU414-2 384 KB | 6ES7 414-2XJ00-0AB0 | 4 or higher |   |         |
|                 | 6ES7 414-2XJ01-0AB0 | 2 or higher |   |         |
| CPU416-1        | 6ES7 416-1XJ01-0AB0 | 2 or higher |   | 32 / 32 |
|                 | 6ES7 416-1XJ02-0AB0 | 1 or higher |   |         |
| CPU416-2 0.8 MB | 6ES7 416-2XK00-0AB0 | 4 or higher |   |         |
|                 | 6ES7 416-1XK01-0AB0 | 1 or higher |   |         |
| CPU416-2 1.6 MB | 6ES7 416-2XL00-0AB0 | 4 or higher |   |         |
|                 | 6ES7 416-2XL01-0AB0 | 1 or higher |   |         |



### 3 Installation and Commissioning

#### Procedure / Steps

Table 3-1

| Step   | Explanation / Meaning  |
|--|--|
| <p>1. Insert the CP 443-5 Basic</p> <p><b>Note</b></p> <p>When using the universal rack as an extension rack, you require an IM with a communication bus link!</p>               | <p>The CP 443-5 Basic can be inserted in all racks with slots for P and K bus attachment:</p> <ul style="list-style-type: none"> <li>• Central rack CR2</li> <li>• Universal rack UR1, UR2 or UR2H as central rack as expansion rack with rack no. 1-6</li> </ul> <p>The CP 443-5 Basic <b>cannot</b> be operated in an ER1 or ER2 expansion rack (no K bus link possible).<br/>Suitable slots in the rack:<br/>With the exception of the slots reserved for the power supply and IM-R, the CP 443-5 Basic can be inserted in all slots with a P and K bus interface (in the central or in an expansion rack no. 1-6).</p> |
| <p>2. Attachment to PROFIBUS</p> <p><b>Note</b></p> <p>When using the CR2 rack, the CPU and CP must be plugged into the same segment if you want to use FDL/FMS connections.</p> | <p>Note the information in the General section of this manual.</p>   |
| <p>3. Configuration</p>  | <p>Depending on the communication services being used, configuration involves the following steps:</p> <ul style="list-style-type: none"> <li>• Node initialization<br/>This is necessary in all situations. This assigns a PROFIBUS address and bus parameters to the PROFIBUS CP. For details, refer to /4/</li> <li>• Configuring connections:<br/>This is necessary when using the communication services, S7 functions and FDL connections (SEND/RECEIVE interface). For details, refer to /5/ or /4/.</li> </ul>   |
| <p>4. PG/PC Attachment for Configuration</p>   | <p>You can connect the PG when configuring the CP as follows:</p> <ul style="list-style-type: none"> <li>• via MPI</li> <li>• via LAN / PROFIBUS</li> </ul> <p>The CP 443-5 Basic must already have a PROFIBUS address (for details of node initialization, refer to /4/).</p>   |

## 4 Displays and Mode Selector

### LEDs Displaying the Status of the CP

The 5 LED indicators on the front panel provide information on the status of the CP as shown in the table below:

Table 4-1

| INTF<br>(red) | EXTF<br>(red) | BUSF<br>(red) | RUN<br>(green) | STOP<br>(yellow) | CP-Betriebszustand  |
|---------------|---------------|---------------|----------------|------------------|---|
| ○             | ○             | ○             | ◐              | ●                | Starting up (STOP->RUN)   |
| ○             | ○             | ○             | ●              | ○                | Running (RUN)   |
| ○             | ○             | ○             | ●              | ◐                | Stopping (RUN->STOP)  |
| ○             | ○             | ○             | ○              | ●                | Stopped (STOP)  |
| ●             | ○             | ○             | ○              | ●                | STOP due to internal error (for example CP not configured)  |
| ●             | ○             | ○             | ●              | ○                | <ul style="list-style-type: none"> <li>Loading active in RUN.</li> <li>RUN with internal error (e.g. bad configuration data)</li> </ul> |
| ○             | ○             | ○             | ○              | ◐                | Waiting for firmware update (duration 10 seconds after power on)  |
| ●             | ●             | ○             | ○              | ◐                | Waiting for firmware update (CP currently has an incomplete firmware version).  |
| ○             | ○             | ●             | ●              | ○                | RUN and PROFIBUS bus errors   |
| ◐             | ◐             | ◐             | ◐              | ◐                | Module fault / system error   |

Key      ● on      ○ off      ◐ flashing

## Controlling the Operating Status

There are different ways of controlling the mode of the CP 443-5 Basic, as follows:

- Mode Selector
- NCM S7 for PROFIBUS configuration software
- SIMATIC Manager in STEP 7

To control the mode from STEP 7 / NCM S7 for PROFIBUS, the mode selector must be set to RUN.

## Mode Selector

With the mode selector, you can set the following operating statuses:

- Switch from STOP to RUN:  
The CP reads the configuration data into the work memory and then changes to the RUN mode.
- Switch from RUN to STOP:  
The CP changes to STOP with the following results:
  - Established connections (FDL, FMS connections, configured, and unconfigured S7 connections) are terminatedIn the STOP mode
  - Configuration and diagnostics are possible
  - The time of day is distributed

## 5 Performance Data

### 5.1 Supported Transmission Rates

The transmission rate is set with the SIMATIC STEP 7 configuration software. For the permitted rates, refer to Table 7-1 in Chapter 7

### 5.2 Characteristics of S5-compatible Communication (SEND/RECEIVE Interface) on FDL Connections

The following characteristics are important when operating FDL connections (specified, free layer 2 (SDA and SDN), broadcast, multicast):

Table 5-1

| Characteristic   | Explanation / Values  |
|--|---|
| <b>Total</b> number of FDL connections that can be operated. | 32 maximum  |
| Size of the transferable data area on FDL connections        | 240 bytes maximum per specified FDL connection (for sending and receiving)<br>Free layer 2, broadcast and multicast:<br>Per job up to 236 bytes of user data can be transferred. The job header requires an additional 4 bytes. |

### Cycle Load Caused by FDL Connections

The cycle load time for FDL connections is largely dependent on the time required to execute the function blocks (AG-SEND, AG-RECV) on the S7-400 CPU.

The following table lists the cycle load times of the available FCs in milliseconds. A distinction is made between the statuses "job completed" and "job active". The entries relate to the run time in the CPU 417-4 (see Table 5-2).

Table 5-2

| Status  | Job Completed |         | Job Active |         |
|---------|---------------|---------|------------|---------|
|         | min.          | max.    | min.       | max.    |
| AG-SEND | 0.12 ms       | 0.27 ms | 0.11 ms    | 0.29 ms |
| AG-RECV | 0.15 ms       | 0.37 ms | 0.10 ms    | 0.26 ms |

### 5.3 Data of FMS Connections

The following information is important for operating FMS connections:

Table 5-3

| Component                                  | Explanation / Values  |
|--|---|
| Maximum number of operable FMS connections | 48  |
| User data length                           | 237 bytes for READ<br>233 bytes for WRITE and REPORT  |
| Configurable variables                     | 512 server variables and 2640 variable descriptions that can be loaded from the partner (maximum values). These can be distributed as required on the maximum number of configurable FMS connections. The value applies to elementary data types or arrays of elementary data types.<br><br>This value does not apply to complex data types (STRUCT)! Note the information in the manual /2/ about using complex data types (STRUCT). |

## Cycle Load Caused by FMS Connections

When calculating the reaction times with FMS connections, the run time of the function blocks (FBs) in the S7-400 CPU (416-1 see Table 5-4) is the decisive factor.

The table below shows the cycle load resulting from the available FCs in ms. A distinction is made between the statuses "job completed" and "job active".

Table 5-4

| Status<br>Component / FB | Job Completed |        | Job Active |        |
|--------------------------|---------------|--------|------------|--------|
|                          | min           | max    | min        | max    |
| READ                     | 1.2 ms        | 1.6 ms | 1.0 ms     | 2.3 ms |
| WRITE                    | 1.2 ms        | 1.6 ms | 1.0 ms     | 2.7 ms |
| STATUS                   | 1.0 ms        | 1.5 ms | 1.0 ms     | 2.8 ms |
| REPORT                   | 1.7 ms        | 3.1 ms | 1.3 ms     | 4.8 ms |
| IDENTIFY                 | 1.7 ms        | 3.1 ms | 1.3 ms     | 4.8 ms |

### Note

To allow module replacement without a PG, settings on the CPU must be modified. Open the Properties dialog of the CPU in HW Config; in the "Monitoring time for" box in the "Startup" tab, check and, if necessary, modify the following values:

- "Transfer of parameters to modules" (recommended value = 600 \* 100 ms)

Depending on your system (station configuration), you may need to increase the following parameter:

- "Ready message from modules"

For more detailed information about supported services and parameters, refer to the PICS tables (PICS: Protocol Implementation Conformance Statements) in the manual /4/.

## 5.4 Characteristics of S7 Communication

The following data is important for operating S7 connections:

Table 5-5

| <b>Characteristic</b>                                      | <b>Explanation / Values</b>                                     |
|--|---|
| Number of S7 connections that can be operated via PROFIBUS | Maximum 48<br>(The value depends on the S7-400 CPU being used.) |

## 5.5 Maximum Number of Connections in Total

In total (FDL , FMS , and S7 connections) a maximum of 59 connections can be operated

As an example, the following multiprotocol configuration was tested:

- 28 FMS client connections to S7-400/300 with SCC=RCC=1
- + 1 FMS server connection to S7-400 with SCC=RCC=4
- + 1 FMS server connection to S7-300 with SCC=RCC=1
- + 16 FDL connections to S7-400/300
- + 8 configured S7 connections to S7-400/300
- + 4 unconfigured HMI connections
- + Time-of-day forwarding
- + Diagnostics

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### Note

If PG or HMI functions are used, a suitable number of S7 connections must be reserved during configuration!

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## 5.6 Time-of-day Synchronization

The CP 443-5 forwards time-of-day synchronization frames in the following directions:

1. From the CPU via the CP to PROFIBUS if the local CPU is the time master or this station is synchronized via a different LAN and the time-of-day synchronization frame is forwarded via PROFIBUS for the synchronization of further stations.
2. From PROFIBUS over the CP to the CPU if a remote station is time master, for example:
  - a remote CPU 41x with PROFIBUS interface (for example, CP 443-5)
  - a remote PC with CP 5412 / 5613 / 5614

All stations on a PROFIBUS subnet are synchronized with an accuracy of 10 ms.

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### Note

With transmission rates of < 1.5 Mbps, we recommend that you configure a synchronization interval of at least 10 s.

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## 5.7 Use in Fault-tolerant Systems

With the CP 443-5 Basic, you can operate fault-tolerant S7 connections in an H system.

You will find more detailed information about the possible operating and structural options in the "SIMATIC S7-400H Programmable Controller Manual, Fault-tolerant Systems".

If the CP 443-5 Basic is used in a fault-tolerant S7-400H system, the following communications services can also be used on single (non-redundant) connections:

- S7 connection for PG functions and PG routing
- S5-compatible communication (SEND/RECEIVE interface) on FDL connections
- FMS connections
- Time-of-day distribution

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### Note

Please note the CPU types in Table 4-3

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## 5.8 Other Characteristics

### Memory Reset of the CP



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#### Warning

Please note that when you reset the CP memory using NCM Diagnostics or the SIMATIC Manager, the configuration data on the CPU must also be deleted otherwise the data will become inconsistent.

When using the S7-400H, do not use the memory reset function on the CP!

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### FMS Operation - Disabling and Enabling Interrupts and Asynchronous Events

Communication using the FMS blocks in the user program can break down if interrupts take too long to service (interrupt-driven programs such as hardware and diagnostic interrupts). You should check the codes in the CP diagnostic buffer.

It is advisable to disable interrupts before calling the FMS blocks and to enable them again after the FMS block call.

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#### Note

Please read the additional information and notes. These are available in our Customer Support on the Internet:

<http://www4.ad.siemens.de/view/cs/de/4557726>

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### FMS Mode- Triggering a CP STOP from the PG

If you trigger a CP STOP using a PG function on a CP when using large numbers of connections, it is possible that you may have to repeat the job.

### FMS Mode - Startup Behavior of the CPU after POWER ON

In the Properties dialog of the CPU, set "Startup after POWER UP" only to "Warm restart" or "Cold restart".

## 6 Compatibility with the Previous Product

### 6.1 Extended Functionality Compared with Previous Product:

The CP 443-5 Basic (6GK7 443-5FX02-0XE0) described here can be used as a replacement for the previous products CP 443-5 Basic (6GK7 443-5FX01-0XE0 and 6GK7 443-5FX00-0XE0).

Please note the following information on the **extended functionality**.

#### Extended Functions as of 6GK7 443-5FX02-0XE0

The CP 443-5 Basic (6GK7 443-5FX02-0XE0) is functionally identical to the predecessor CP 443-5 Basic (6GK7 443-5FX01-0XE0).

The new CP 443-5 Basic provides better performance compared with the predecessor by a factor of up to 3

#### Extended Functions as of 6GK7 443-5FX01-0XE0

- PG bus functions in multiple subnets

If you want to use the PG bus functions in multiple subnets, you must install the STEP 7 software version V5.0 or higher on the PG/PC.

Note: Dynamic switchover to alternative paths (for example if there is a problem on one of the possible transmission paths) is, however, not supported.

- Time-of-day synchronization
- Use in SIMATIC S7-400H (fault-tolerant PLC)

## 6.2 Replacing Older Modules / Replacing Defective Modules

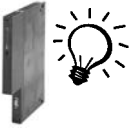
### Replacing Modules

Please follow the procedure outlined below when replacing an older module with one of those described here:

Table 6-1

| Module used until now | Configuration Procedure  |
|-----------------------|--|
| 6GK7 443-5FX00-0XE0   | <p><b>Configuration unchanged (replacing a defective module)</b></p> <p>If you have no extra requirements for the CP compared with the old one, no changes to the configuration are necessary.</p> <p>You then only need to remember the following difference when using the CP:</p> <ul style="list-style-type: none"> <li>• Download the configuration data from your PG/PC to the CP again.</li> </ul> <p>Note the following when forwarding the time of day:</p> <p>When you have replaced a CP as described, the new CP assumes the following fixed direction for forwarding the time of day:<br/>From LAN to S7 station (can be modified by configuration of the new module type, see below)</p> <p><b>Extending the Configuration (using new functions)</b></p> <p>If you want to use the extended functions of the new CP, follow the steps outlined below (see also Chapter 3):</p> <ol style="list-style-type: none"> <li>1. In STEP 7 / HW Config, replace the already configured CP 443-5 Basic with the new module; you will find this in the Hardware Catalog.</li> <li>2. Modify your configuration according to your requirements, for example in the Properties dialog for the PROFIBUS subnet.</li> <li>3. Save, compile, and download the configuration data to the CPU or the CP.</li> </ol> |
| 6GK7 443-5FX01-0XE0   | <p><b>Configuration unchanged (replacing a defective module)</b></p> <p>If you do not require any extra performance compared with the previously used CP, you do not need to make any changes in the configuration</p> <ul style="list-style-type: none"> <li>• Download the configuration data from the PG/PC again if the data is stored on the CP and not on the CPU.</li> </ul>  |

### Information in the NCM S7 for PROFIBUS Online Help and Documentation



The information “for new modules” contained in both the STEP 7 / NCM S7 online help and the NCM S7 for PROFIBUS manual is also relevant for the CP described here. Look out for this symbol.

## 7 Technical Specifications

### General Technical Data

Table 7-1

| Technical Specifications   | Value  |
|--|--|
| Supported Transmission Rates   | 9.6 Kbps, 19.2 Kbps, 45.45 Kbps<br>93.75 Kbps, 187.5 Kbps, 500 Kbps<br>1.5 Mbps, 3 Mbps, 6 Mbps, 12 Mbps |
| Interfaces   |  |
| Attachment to PROFIBUS   | 9-pin sub-D female connector   |
| Maximum current consumption on the PROFIBUS interface with network components attached (for example, optical network components) | 100 mA at 5V   |
| Power supply   | 5 V DC   |
| Current consumption<br>- from S7-400 backplane bus   | 1.0 A typical at 5V  |
| Power loss   | 5.5 W  |
| Permitted ambient conditions   |  |
| • Operating temperature  | 0 °C to +60 °C   |
| • Transportation/storage temperature   | -40 °C to +70 °C   |
| • Relative humidity max.   | 95% at +25 °C  |
| • Altitude   | up to 1500 m above sea level   |
| Design   |  |
| Dimensions W x H x D (mm)  | 25 x 292 x 200   |
| Weight   | approx. 800 g  |

All the information in /1/ in the Section “General Technical Specifications” regarding the following topics also applies to the CP 443-5 Basic

- Electromagnetic compatibility
- Transportation and storage conditions
- Mechanical and climatic ambient conditions
- Insulation tests, class of protection and degree of protection