SIEMENS

SIMATIC

CP 541
Communications Processor

Manual

EWA 4NEB 812 6188-02

Edition 1

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

The device/system may only be set up and operated in conjunction with this manual.

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.

This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

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Disclaimer of Liability

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

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Industrial Automation Systems
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Preface

Purpose

The information in this Manual allows you

- to connect a programmable controller of the SIMATIC S5 family to the CP 541;
- to connect a programmable controller of the SIMATIC S5 family via the CP 541 to SINEC L2;
- to integrate a programmable controller of the SIMATIC S5 family via the CP 541 as a DP slave in SINEC L2-DP;
- to connect the CP 541 and start it.

Audience

This Manual is intended for readers wishing to integrate a programmable controller of the SIMATIC S5 family via the CP 541 in SINEC L2. It is assumed that you already have experience in or knowledge of working with programmable controllers of the SIMATIC S5 family and SINEC L2.

Scope of this Manual

This Manual applies to:

Device	Order No.	From Revision Level
CP 541	6ES5 541-8AA11	01
Connecting cable 1 m	6ES5 735-8BB00	–
Connecting cable 2.5 m	6ES5 735-8BC50	–

This Manual contains a description of all functions of the CP 541 at the time of publication of the Manual. We reserve the right to describe modifications to the functions in a product information.

Other Pertinent Manuals

This *CP 541* Manual describes the SINEC L2 interfacing of the CP 541.

The assigning of parameters to the programmable controller connected to the CP 541 as a SINEC L1 slave can be found in the relevant manual.

The description of SINEC L2-DP and a DP master, such as the IM 308-C master interface module, are not part of this Manual. Further information on this topic can be found in the manual: *ET 200 Distributed I/O System*.

Detailed information on SINEC L1 can be found in the manual: *SINEC L1 Local Area Network*.

Structure of this Manual

To facilitate rapid access to special information, the Manual contains the following aids:

- Given at the beginning of the Manual is a full, general table of contents, a list of figures and a list of tables contained in the entire Manual.
- In the chapters, the left column of each page provides a summary of the contents of the section.
- The appendices are followed by a glossary in which the important technical terms used in the Manual are defined.
- Given at the end of the Manual is a detailed index which allows rapid access to the desired information.

Standards

The CP 541 is based on PROFIBUS Standard DIN 19245 and PROFIBUS DP Standard DIN E 19245, Part 3.

Queries

In the event of queries on the CP 541, please consult:

Hotline SIMATIC
Nuremberg
Tel: 0911/895-7000
Fax: 0911/895-7001

In the event of queries or remarks relating to the Manual, please fill out the correction sheet and return it to us. You will find it at the end of the Manual.

Contents

Figures

Tables

Overview

1

Introduction

The CP 541 provides a link between programmable controllers of the SIMATIC S5 family via SINEC L2 and other programmable controllers.

Given in this chapter is a summary covering the application of the CP 541 and its characteristics.

Definitions

The following situation is covered by this Manual:

- The programmable controller connected to the PG/PLC port is referred to as a connected programmable controller.
- For working with the CP 541, it is not important to know which stations are connected to SINEC L2. We therefore do not refer to programmable controllers on SINEC L2, but generally to SINEC L2.

Summary of this Chapter

1.1 Performance Features of the CP 541

Introduction

The significant performance features of the CP 541 are described in the following.

Fields of Application

You can use the CP 541 for the following fields of application:

- Subsequent networking of installed programmable controllers of the SIMATIC S5 family
- Substitute for SINEC L1
- For connecting failsafe programmable controllers of the SIMATIC S5 family via SINEC L2

Communication Modes

You can establish the following communication links via the CP 541:

- PLC-PLC link
- Broadcast
- DP link for operating programmable controllers of the SIMATIC S5 family as a DP slave with any DP master in SIMATIC S5 and S7/M7 or with any DP master from another manufacturer.

  In contrast to other DP slaves, the CP 541 exhibits a minimum cycle time of 10 ms. It supports PROFIBUS profiles DP/FMS and User Defined at transmission rates of up to 1.5 Mbps and PROFIBUS-DP or DP for IM 308-B at up to 187.5 Kbps.
- Safety-related data traffic between failsafe programmable controllers of the SIMATIC S5 family

  The communication concept has been tested for freedom from reaction of the safety-related SINEC L1 communications between failsafe programmable controllers. The CP 541 is a non-safety-related module and can therefore be operated without a special test. However, the general conditions for special testing of the programmable controller must be observed.

Advantages for the User

The CP 541 offers you various advantages.

- It allows parallel operation of the various communication modes.
- It supports the safety-related connection of failsafe programmable controllers of the SIMATIC S5 family via SINEC L2.
- It can be used with most SIMATIC S5 systems.
- It allows simple retrofitting on existing systems.
- It is connected to the programmer interface of the programmable controller with a simple plug-in cable; no bus terminal is needed.
- Simple parameter assignment
- Freedom from maintenance
- It is secured directly on the standard rail; no slot in the connected programmable controller is needed.

1.2 The CP 541 in the SIMATIC Environment

Incorporation in SIMATIC

Figure 1-1 shows the incorporation of the CP 541 in the SIMATIC environment.

On account of the various communication modes, possible combinations of communication modes and number of connectable programmable controllers, Figure 1-1 is merely an example.

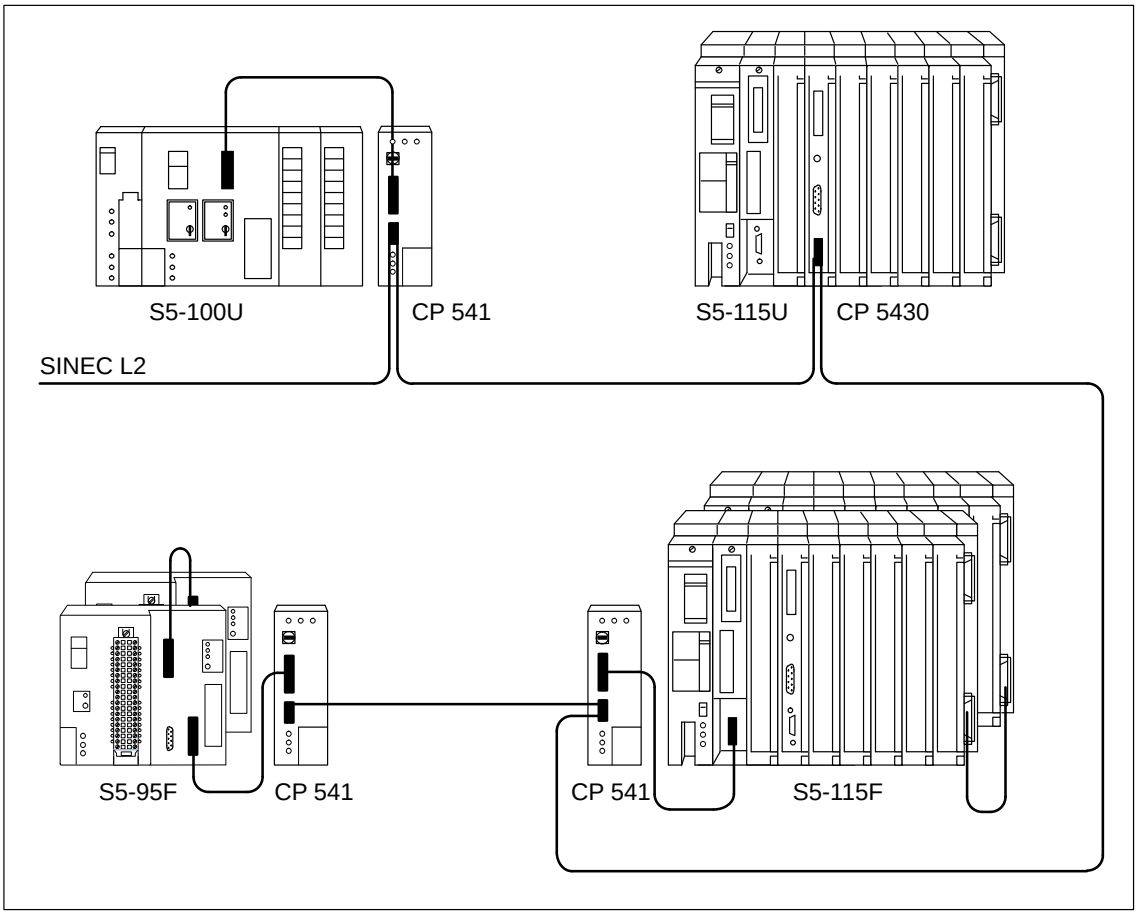


Figure 1-1 CP 541 in the SIMATIC Environment

CP 541 Emulates SINEC L1

For the connected programmable controller, the CP 541 emulates a fully configured SINEC L1 bus. The connected programmable controller is an L1 slave.

1.3 View of the CP 541

View

Figure 1-2 is a view of the CP 541

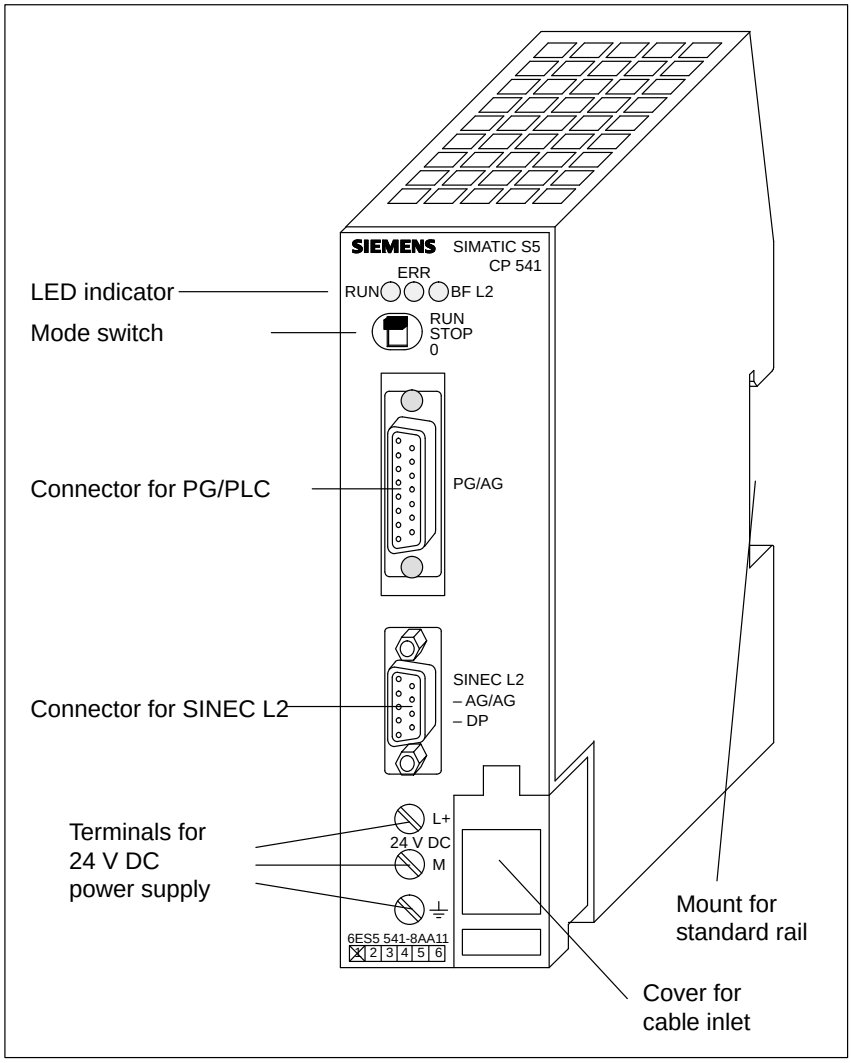


Figure 1-2 View of the CP 541

LED Indicators

The CP 541 has three LEDs to indicate the operational state of the CP 541 and any errors.

Table 1-1 LED Indicators of the CP 541

LED	Color	Position	Meaning
RUN	Green	Left	Operational state
ERR	Red	Middle	Error in CP 541 or at PG/PLC connection
BF L2	Red	Right	Error at L2 connection or SINEC L2 not yet activated

Mode Switch

The CP 541 has a mode switch with three settings. The meanings of the different settings are given in Table 1-2.

Table 1-2 Mode Switch of the CP 541

Switch Setting	Meaning
RUN	The CP 541 is in normal operation. Data will be exchanged between the PLC and SINEC L2.
STOP	You can assign parameters to the CP 541 with a PG and read out the diagnostics block.
0	The CP 541 is switched off.

Connectors and Terminals

The CP 541 has various connectors and terminals; these are listed in Table 1-3.

Table 1-3 Connectors and Terminals of the CP 541

Designation	Type	Meaning
PG/PLC	15-pin sub. D female with slide latch	For PG cable or connecting cable to PLC
SINEC L2 - PLC-PLC - DP	9-pin sub. D female with screw-type connection	For L2 bus connector
L+ M ⏚	Screw terminals	24 V DC power supply

1.4 Suitable Programmable Controllers for the CP 541

Introduction

The summaries in Tables 1-4 and 1-5 indicate the programmable controllers of the SIMATIC S5 family which you can connect to the CP 541.

Also given are the communication modes you can install by means of CP 541 via SINEC L2 and the appropriate programmable controllers.

Both Stations via CP 541

When both SINEC L2 stations are connected via CP 541, Table 1-4 shows the possible communication modes in relation to the appropriate programmable controllers of the SIMATIC S5 family.

Table 1-4 Connectable Programmable Controllers and Communication Modes; both Stations Connected to SINEC L2 via CP 541

<table>
<tr><th colspan="3" rowspan="2">SINEC L2 partner
Connected PLC</th><th colspan="5">CP 541 with</th></tr>
<tr><th>S5-95F</th><th>S5-115F</th><th>S5-90U
S5-95U
S5-100U
S5-115U</th><th>CP 530 in
S5-115H
S5-135U
S5-155U
S5-155H</th><th>S5-115H</th></tr>
<tr><td rowspan="5">To CP 541</td><td colspan="2">S5-95F</td><td colspan="2" rowspan="2">PLC-PLC and safety-related PLC-PLC
Broadcast and safety-related broadcast</td><td colspan="2" rowspan="4">PLC-PLC
Broadcast</td><td rowspan="5">PLC-PLC</td></tr>
<tr><td colspan="2">S5-115F</td></tr>
<tr><td colspan="2">S5-90U
S5-95U
S5-100U
S5-115U</td><td colspan="2" rowspan="2">PLC-PLC
Broadcast</td></tr>
<tr><td>CP 530 in</td><td>S5-115H
S5-135U
S5-155U
S5-155H</td></tr>
<tr><td colspan="2">S5-115H</td><td colspan="3">PLC-PLC</td></tr>
</table>

One Station via CP 541

When one SINEC L2 station is connected via CP 541, Table 1-5 shows the possible communication modes in relation to the appropriate programmable controllers of the SIMATIC S5 family.

Table 1-5 Connectable Programmable Controllers and Communication Modes; one Station Connected to SINEC L2 via CP 541

SINEC L2 partner / Connected PLC			S5-95U and SINEC L2 connection	S5-95U as DP master	IM 308B IM308C	CP 5430 CP 5431	CP 342-5 DP	CP 5412 A2
					S5-115U S5-115H S5-135U S5-155U S5-155H	S5-115U S5-115H S5-135U S5-155U S5-155H	S7-300	PG
To CP 541	S5-95F		PLC-PLC Broadcast	DP		PLC-PLC DP Broadcast	DP	DP Broadcast
	S5-115F							
	S5-90U S5-95U S5-100U S5-115U							
	CP 530 in	S5-115H S5-135U S5-155U S5-155H						
	S5-115H		PLC-PLC			PLC-PLC DP		DP

Meanings of Designations

The abbreviations in Tables 1-4 and 1-5 have the following meanings:

Designation	Meaning
PLC-PLC (see Section 2.1)	The PLC-PLC connection serves to transmit messages between two programmable controllers.
DP (see Section 2.2)	The DP connection serves to exchange messages with a higher-level DP master.
Broadcast (see Section 2.3)	You use a broadcast to transmit messages to all stations connected to SINEC L2.
Safety-related PLC-PLC (see Section 5.1.1)	The safety-related PLC-PLC connection serves to transmit safety-related messages between two failsafe programmable controllers.
Safety-related broadcast (see Section 5.1.2)	You use safety-related broadcast to transmit safety-related messages to all stations connected to SINEC L2.

Communication Modes

2

Introduction

This chapter provides an overview of the communication modes you can use via the CP 541.

Declarations

The following two declarations apply to the entire Manual. You require these declarations to facilitate understanding of the various communication modes.

- Node address

  The node address is the address with which the programmable controller connected to the CP 541 is accessed by it.

- Station number

  The station number is the number which distinguishes the various stations on the SINEC L2. Each station number is uniquely assigned to a station.

Acknowledgment

The CP 541 always provides a positive acknowledgment to all messages it receives from the programmable controller.

Summary of this Chapter

2.1 PLC-PLC Connection

Introduction

The PLC-PLC connection serves for message-oriented communication between two programmable controllers, without a detour via an additional station.

Message Length

Each message of the non-safety-related PLC-PLC connection can contain up to 64 bytes of data.

Parameter Assignment

If you install a PLC-PLC connection, you must parameterize the CP 541 as an active station.

Address Conversion

The node address specified in the programmable controller is converted by the CP 541 to the station number and vice versa. Node address 1 is converted to station number 1, node address 2 to station number 2, etc.

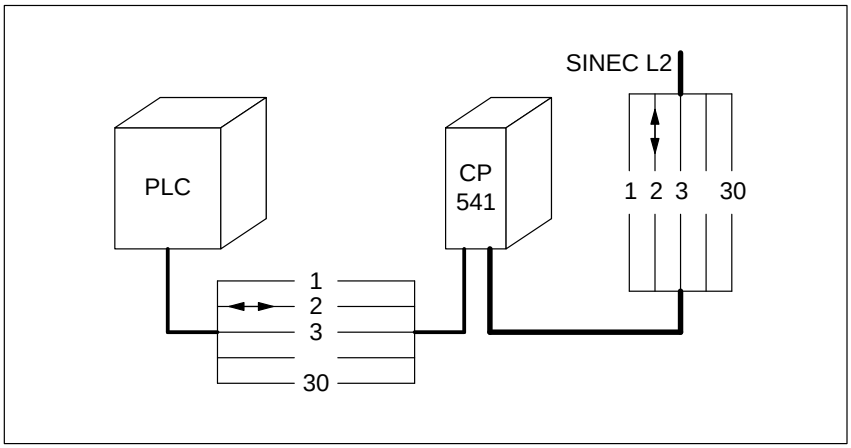


Figure 2-1 Address Conversion for PLC-PLC Connection

Address Range

Node addresses 1 to 30 are available in the connected programmable controller for the PLC-PLC connection.

2.2 DP Connection

Introduction

The DP connection is data-oriented non-safety-related communication between a DP master and a DP slave.

Message Length

The DP connection can contain up to 16 words of data in each direction.

Parameter Assignment

You install the DP connection in the connected programmable controller as a connection with node address 0 (see Section 4.3).

Address Conversion

Node address 0 sent by the connected programmable controller is converted to the DP master station number by the CP 541.

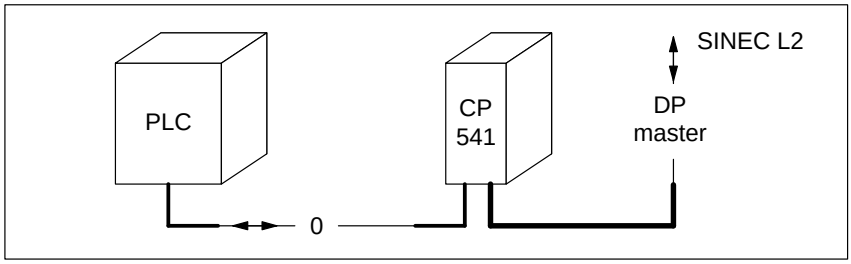


Figure 2-2 Address Conversion for DP Connection

Monitoring of the Connected PLC

The CP 541 monitors the DP connection to the programmable controller. Monitoring is active as soon as the CP 541 is accepted in the DP cycle and the programmable controller has sent the first DP message.

When writing the user program in the programmable controller, ensure that cyclic DP data are presented within the response monitoring time (DPWD, see Appendix C.5).

When the CP 541 no longer receives DP messages from the programmable controller, it emits a diagnosis to the DP master.

DP Master Monitoring

As soon as the CP 541 is accepted in the DP cycle and the DP watchdog is activated, the CP 541 monitors the connection to the DP master.

If the DP connection to the DP master fails, the CP 541 informs the programmable controller (see Section 6.4).

Note Relating to the S5-115F

With the S5-115F, you can install either the DP connection or a non-safety-related PLC-PLC connection. Both connections are not simultaneously possible because they both use node address 0.

2.3 Broadcast via FDL Connection

Introduction

The broadcast serves to transmit messages to all L2 stations which monitor the SINEC L2 via FDL and the set SAP (**s**ervice **a**ccess **p**oint), and use the SDN service.

Message Length

Each broadcast message can contain up to 64 bytes of data.

Implementation

The CP 541 converts a broadcast message from the connected programmable controller to a multicast message on SINEC L2. A service access point (SAP) is used for this conversion.

- SAP

  The CP 541 uses the default SAP 52 for broadcast. You can change the SAP with parameter BSAP in frame COM of DB1.

  The SAP number must be identical for all participating stations.

- SDN

  SDN (**s**end **d**ata with **n**o acknowledge) of the PROFIBUS protocol is used for the broadcast.

Address Conversion

You send the broadcast from the connected programmable controller to node address 31. This node address is converted to station number 127 by the CP 541.

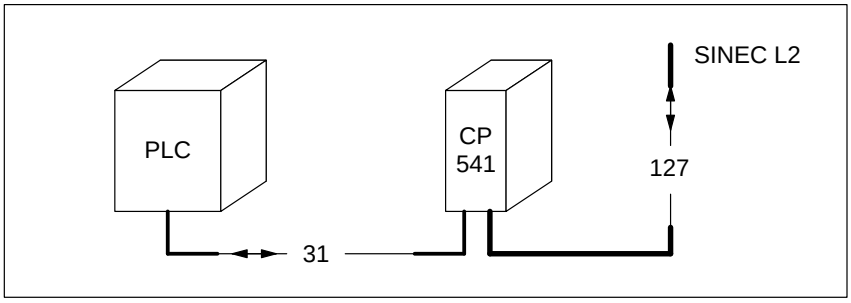


Figure 2-3 Address Conversion for Broadcast

FDL Connection

You can establish a point-to-point connection to any PROFIBUS station which can exchange data via FDL (free layer 2). You do this with a broadcast and use the SAP to specify only one other station in SINEC L2 which can receive the message.

If only the CP 541 and another station in SINEC L2 use this SAP, you can utilize this special form of broadcast to establish a connection to any other non-Siemens device.

Installing and Connecting the CP 541

3

Introduction

When you have studied this chapter, you will be able to install, connect and start up the CP 541.

Installation of Equipment

Programmable controllers of the SIMATIC S5-90U, S5-95U/F and S5-100U series must be installed in electrical apparatus rooms or in enclosed housings, such as metal or plastic cabinets.

Programmable controllers of the SIMATIC S5-115U/H/F, S5-135U and S5-155U/H series must be installed in grounded, enclosed metal housings such as cabinets.

Working on Cabinets

To protect the modules from the discharge of static electricity, operating personnel must discharge themselves electrostatically before opening cabinets and control boxes.

Summary of this Chapter

3.1 Installing the CP 541

Introduction

The CP 541 is mounted like a programmable controller of the SIMATIC S5 family, for example the S5-95U or S5-100U, on a standard rail to EN 50022-35 × 15.

Mounting

Mount the CP 541 on a standard rail. You need a free space of 46 mm.

Mount the CP 541 in the following order:

1. Hook the CP 541 onto the rail.
2. Swing the CP 541 down until the slide is heard to engage.

Removal

Remove the CP 541 in the following order:

1. Switch off the 24 VDC supply for the CP 541.
2. Remove the connecting cables.
3. Use a screwdriver to push the slide down.
4. Swing the CP 541 out of the rail.

3.2 Connecting the CP 541

Introduction

Connect the CP 541 as follows.

Supply of Power

We recommend the use of a SITOP power supply unit. If you do not use a SITOP power supply unit, you must use a safety-separated power supply meeting the requirements given in Appendix A.

Connect the supply of power (24 VDC) to the three screw terminals on the CP 541. Ensure correct polarity.

Connecting the PLC to the CP 541

Connect the CP 541 and the programmable controller with the preassembled connecting cable (see Table 3-1).

Observe correct connector assignments.

Table 3-1 Cable for Connecting the PLC and the CP 541

Length	Order No.
1 m	6ES5 735-8BB00
2.5 m	6ES5 735-8BC50

Connecting the Programmer

You connect a programmer (PG) for parameter assignment or to evaluate the diagnostics block, instead of the programmable controller, to the PG/PLC connector of the CP 541.

Connecting SINEC L2

Connect SINEC L2 to the 9-pin subminiature D female connector of the CP 541. Use standard components of SINEC L2 (see the manual: *SINEC L2/L2FO Network Components*, 6GK1 970-5CA00-0AA).

Components for SINEC L2

The components for SINEC L2 are given in Table 3-2.

Table 3-2 Components for SINEC L2

Name	Order No.
Bus cable	
• Indoor	6XV1 830-0AH10
• For burying in ground	6XV1 830-3AH10
Bus connector IP20	6ES5 762-2AA12

Connecting the Bus Cable

Connect the bus cable to the bus connector, as explained in the instructions with the bus connector.

Electrical Separation (Isolation)

The PG/PLC interface and the SINEC L2 interface are safety-separated (isolated) via optocouplers.

The reference potential and protective conductor terminal are internally connected.

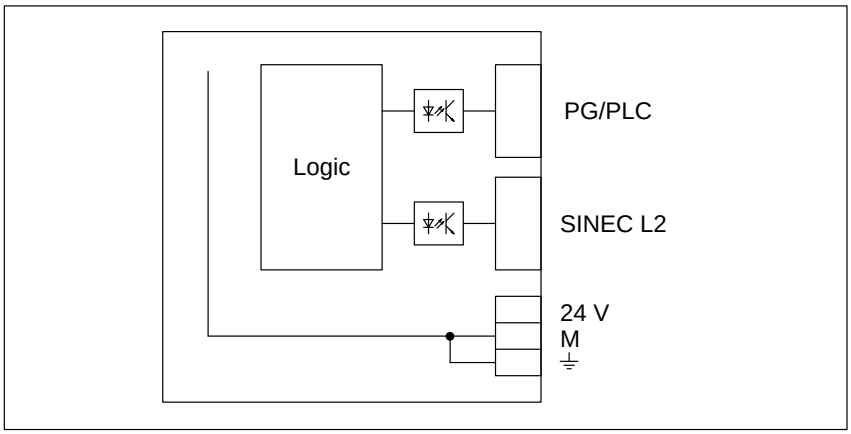


Figure 3-1 Isolation of Terminals

Grounded Configuration

As a rule, you should use a grounded arrangement. This offers very high rejection of interference. Any interference currents are discharged from the rail to the protective conductor.

You configure the CP 541 with a grounded reference potential by connecting the protective conductor terminal of the CP 541 to the protective conductor. Use a copper conductor with a cross-section of 2.5 mm.

Ungrounded Configuration

To use the CP 541 in an ungrounded arrangement, you must fit the rail on which the CP 541 is mounted, in an insulated arrangement. In the installed state, the reference potential of the CP 541 is electrically connected to the rail.

To discharge interference, you must connect the rail via an RC network to the protective conductor.

Values for the network:
Parallel connection of R=100 kΩ und C=1 µF.

Shielding

Connect the cable shields of the SINEC L2, and of the connecting cable between CP 541 and the programmable controller, to a shield bar at each end.

EMC Guidelines

Further instructions for EMC-oriented configuration can be found in the manual for the connected programmable controller.

3.3 Starting up the CP 541

Startup

Proceed in the following order for the first startup.

Step	Action	Meaning
1	Mount the CP 541 on the rail.	See Section 3.1.
2	Make connections for a programmer, the SINEC L2 and the power supply.	See Section 3.2 If you are restarting the CP 541 after an interval, connect the PLC via the connecting cable instead of the programmer. Skip Steps 4 to 7.
3	Switch the CP 541 to the STOP state.	The CP 541 will be initialized (See Section 3.4.1). Programmer operation is only possible in the STOP state.
4	Read DB1 into the programmer.	DB1 is always present in the CP 541. After a reset, there is a default DB1 in the CP 541.
5	Make the necessary changes to DB1.	You have defined the parameters to be changed in Chapter 4.
6	Transfer the modified DB1 to the CP 541.	
7	Remove the programmer from the CP 541.	
8	Assign parameters to the connected PLC.	
9	Connect the CP 541 to the PLC with the connecting cable.	For normal operation, you must provide the connection to the PLC.
10	Set the mode switch of the CP 541 to RUN. Switch the connected PLC to RUN.	DB1 will be stored after a STOP-RUN transition. The exchange of data between the connected PLC and SINEC L2 will begin. After a successful start and initialization of the interfaces, the green RUN LED lights up. The CP 541 is in the RUN state.

Operation

After startup, the CP 541 executes the exchanging of data.

Detailed information on the operating states of the CP 541 can be found in Section 3.4.

3.4 Operating States of the CP 541

Introduction

You can subdivide the operational behavior of the CP 541 into individual operating states and their transitions, as explained in following.

Operating States

We subdivide the operational behavior into the following operating states and state transitions:

- POWER ON

  POWER ON is understood to mean the behavior when the CP 541 has been switched on (from 0 to STOP), or when operating voltage has been restored.

- STOP state

  In the STOP state, you can use your PG to access both DBs in the CP 541.

- START

  The START serves to evaluate and store DB1 and activate the SINEC L2 interface.

- RUN state

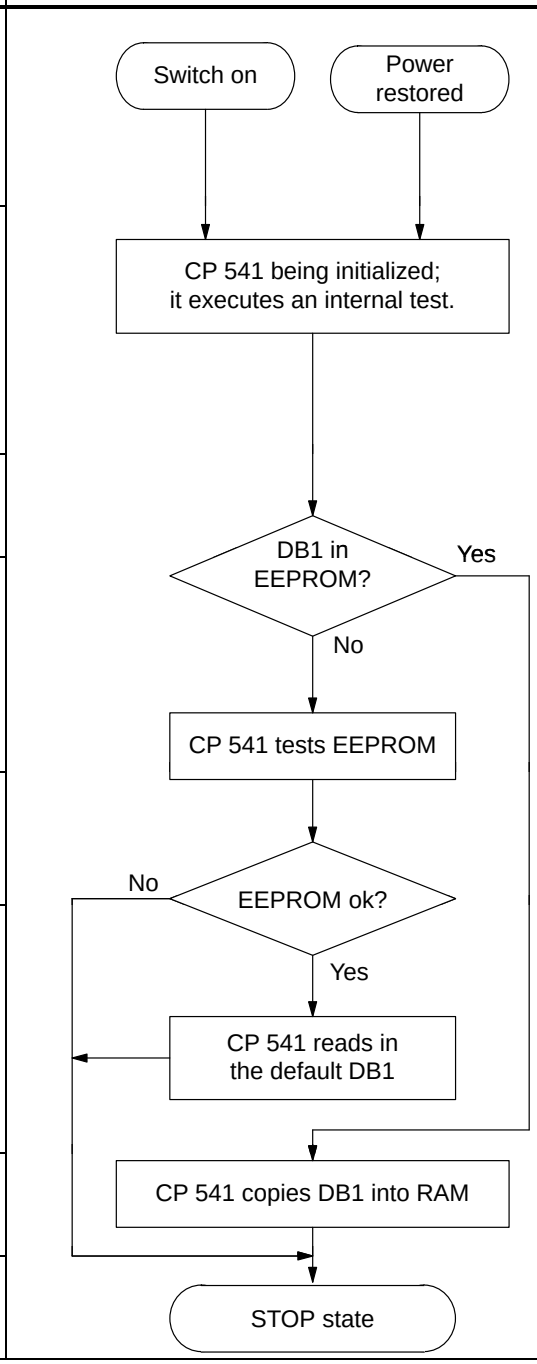
  In the RUN state, the CP 541 executes the exchanging of data between the connected programmable controller and SINEC L2.

Summary of this Section

3.4.1 POWER ON

Power On

In POWER ON, the CP 541 reacts as shown in the following flowchart.

Step	Flowchart	Explanation
1		Whether or not you set the mode switch from 0 to STOP, or whether power is restored after a power failure, the CP 541 reacts in the same way.
2		In the initialization phase, all internally stored interface data are reset to reach a defined initial state. An internal test is simultaneously executed. During the test, the green RUN LED flashes at 8 Hz.
3		The CP 541 checks whether a DB1 is present.
4		If no DB1 is stored in the EEPROM, it is subjected to a test of approx. 6 s. During the test, the green RUN LED flashes at 8 Hz.
5		With the EEPROM test, the CP 541 tests the EEPROM for proper functioning.
6		If the EEPROM is OK, the CP 541 loads the default DB1 from the operating system. If an error occurs, DB2 can be read out but the CP 541 cannot be switched to the RUN state.
7		The CP 541 copies DB1 from the EEPROM into the main memory.
8		The CP 541 is in the STOP state. The RUN LED flashes at 2 Hz.

3.4.2 STOP State

Meaning

In the STOP state, the CP 541 is initialized and the interface for the connected programmable controller is not activated.

RUN LED

In the STOP state, the RUN LED flashes at 2 Hz.

Programmer Operation

In the STOP state, you can connect a programmer to the CP 541. The programmer allows you to access the two data blocks DB1 and DB2.

The PG interface is activated in the STOP state.

DB1

DB1 is the initialization block. You store the parameters for the CP 541 there.

With the entries in DB1, you affect the operational behavior and interchange of data between the connected programmable controller and SINEC L2.

A full description of DB1 can be found in Appendix C.

DB2

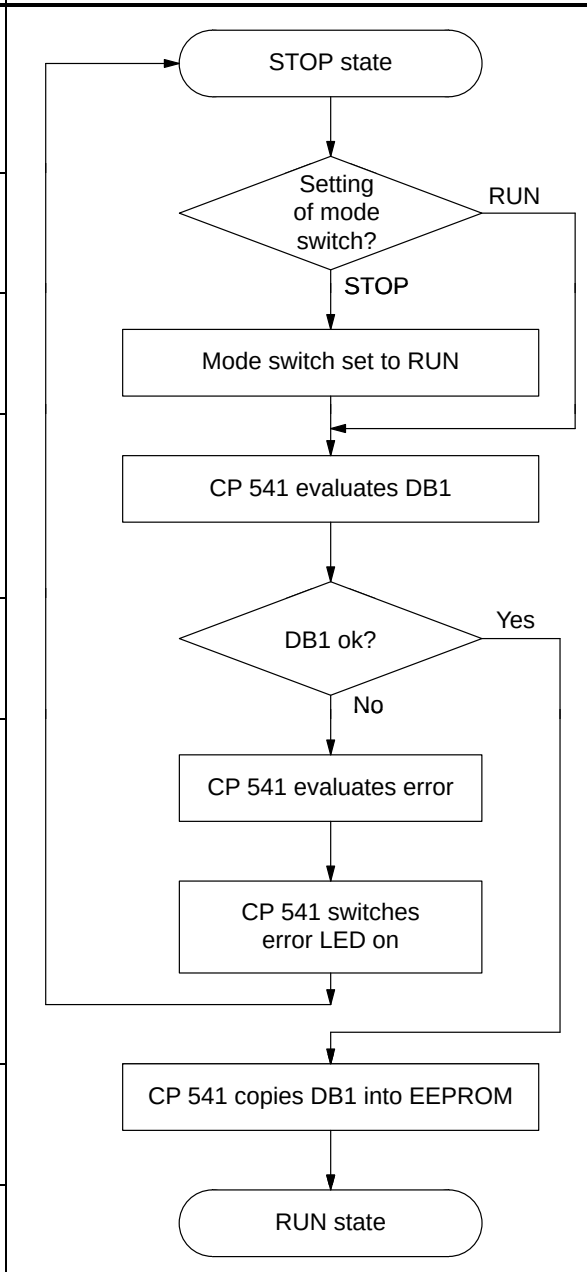
DB2 is the diagnostics block. The CP 541 stores the determined diagnostic data there. You can only read out DB2.

By means of the diagnostic data, you can establish whether there are errors in the CP 541 or in the two communication interfaces.

A full description of DB2 can be found in Section 6.2.

3.4.3 START

START The START is explained in the following flowchart.

Step	Flowchart	Explanation
1		The CP 541 is in the STOP state. RUN LED flashes at 2 Hz.
2		The CP 541 evaluates the setting of the mode switch.
3		Set the mode switch from STOP to RUN.
4		The CP 541 evaluates the parameters in DB1 and checks them for completeness and plausibility.
5		Is DB1 complete and are all parameters in order?
6		If an error is detected, the CP 541 evaluates the error and generates an appropriate diagnostics message in DB2. The ERR error LED is additionally activated. In the event of an error, the CP 541 remains in the STOP state.
7		The CP 541 writes DB1 into the EEPROM.
8		The CP 541 is in the RUN state. The RUN LED lights up.

3.4.4 RUN State

Meaning

In the RUN state, both the PLC interface and the SINEC L2 interface are ready to exchange data.

Operator inputs via the programmer are not possible in the RUN state.

Exchange of Data

The CP 541 transfers the data from the connected programmable controller to SINEC L2 and vice versa.

Communication

A description of communication modes supported by the CP 541 can be found in Chapter 2 and Section 5.1.

Assigning Parameters to the CP 541 for the Connections

4

Introduction

This chapter contains instructions for assigning parameters to the CP 541 with minimum complexity, for the individual connections between the connected programmable controller and SINEC L2.

We will explain which parameters you must change in DB1 in the reset state. A reset is only possible from the programmer.

Appendix B explains how to optimize the parameters in DB1.

Connections

Brief instructions are given here for the following connections:

- PLC-PLC connection
- Broadcast
- DP connection

Summary of this Chapter

4.1 Configuring a PLC-PLC Connection

Introduction

The PLC-PLC connection is comparable to a point-to-point link between two programmable controllers.

You can easily install the PLC-PLC connection with the parameters stored in the default DB1.

Assigning Parameters to CP 541

You assign parameters for the PLC-PLC connection via the CP 541 as shown in the following table.

Step	Action	Remark
1	Load DB1 into the programmer.	–
2	Enter the station number of the CP 541 with parameter TLN in frame SL2.	The station number of the CP 541 must be identical to the node address of the connected PLC.
3	Write the modified DB1 into the CP 541.	–
4	Switch the CP 541 to RUN.	Only upon transition from STOP to RUN will the modified DB1 be stored in the EEPROM of the CP 541.

In the Programmable Controller

In the connected programmable controller, you must observe the following points when assigning parameters:

- The station number set in the CP 541 must be identical to the node address of the connected programmable controller.
- With the connected programmable controller, you can access node addresses 1 to 30.
- Each PLC-PLC connection can contain up to 64 bytes of data.

4.2 Configuring the Broadcast Mode

Introduction

You can easily establish the broadcast mode with the parameters stored in the default DB1.

Assigning Parameters to CP 541

You assign parameters for the broadcast mode via the CP 541 as shown in the following table.

Step	Action	Remark
1	Load DB1 into the programmer.	–
2	Enter the station number of the CP 541 with parameter TLN in frame SL2.	The station number of the CP 541 must be identical to the node address of the connected PLC.
3	Write the modified DB1 into the CP 541.	–
4	Switch the CP 541 to RUN.	Only upon transition from STOP to RUN will the modified DB1 be stored in the EEPROM of the CP 541.

In the Programmable Controller

In the connected programmable controller, you must observe the following points when assigning parameters:

- The station number set in the CP 541 must be identical to the node address of the connected programmable controller.
- Install the broadcast mode in the connected programmable controller using node address 31.
- Each broadcast message can contain up to 64 bytes of data.

No Broadcast Possible

If you cannot receive a broadcast or the transmitted broadcast cannot be received by other stations, you must modify parameter BSAP (broadcast service access point) in the COM block of DB1.

Follow the instructions in Appendix C and Appendix G.

BSAP

Parameter BSAP in the COM block has the internal default value 52. If you do not change parameter BSAP, you must not remove the comment characters for the COM block.

4.3 Configuring a DP Connection

Introduction

You have a choice of two configurations for the DP connection. You can optionally operate the CP 541 purely as a DP slave or in mixed mode with a PLC-PLC connection and broadcast.

Assigning Parameters to the CP 541

You assign parameters for the DP connection via the CP 541 as shown in the following table.

Step	Action	Remark
1	Load DB1 into the programmer.	–
2	Enter the station number of the CP 541 with parameter TLN in frame SL2.	The station number of the CP 541 must be identical to the node address of the connected PLC.
3	Pure DP connection: Assign the value PAS to parameter STA. Mixed mode: Assign the value AKT (default value) to parameter STA.	With STA = PAS, the CP 541 becomes purely a DP slave. SINEC L2-DP is thus speeded up. With STA = AKT, the CP 541 allows PLC-PLC connection, broadcast and DP connection.
4	Remove the comment parentheses from frame DPS.	For the change in frame DPS to become effective, you must remove the comment parentheses.
5	Enter in parameter NWI the number of data words from the DP master to the CP 541 (see Appendix C).	With the DP connection, you must always keep to the entered value. NWI and NWO must not simultaneously be 0.
6	Enter in parameter NWO the number of data words from the CP 541 to the DP master (see Appendix C).	
7	Write the modified DB1 into the CP 541.	–
8	Switch the CP 541 to RUN.	Only upon a transition from STOP to RUN will the changed DB1 be stored in EEPROM of the CP 541.

In the Programmable Controller

In the connected programmable controller, you must observe the following points when assigning parameters:

- The station number set in the CP 541 must be identical to the node address of the connected programmable controller.
- Establish the DP connection in the connected programmable controller for node address 0.
- The DP connection always has a constant length. The number of data words for sending must agree with parameter NWO in the CP 541.
- Up to 16 data words per direction can be transferred via the DP connection.

Special Notes on the DP Master

You must observe the following points in the DP master:

- The CP 541 cannot be assigned parameters by the DP master with reference to SINEC L2 parameters.
- The parameter for minimum slave interval (minimum response interval) must be at least 10 ms.

IM 308-B

If you use the IM 308-B, you must assign the value PAS to parameter STA.

CP 541 with S5-95F/S5-115F

5

Introduction

This chapter is intended for customers wishing to use the failsafe programmable controllers S5-95F and S5-115F. If you do not use either of these two programmable controllers, you can skip this chapter.

Supported Failsafe PLCs

The CP 541 supports safety-related data transmission with the following Siemens failsafe programmable controllers:

Table 5-1 Supported Failsafe Programmable Controllers

PLC	Order No.	From Revision Level
S5-95F	6ES5 095-8FA01	03
S5-95F	6ES5 095-8FA02	01
S5-115F	6ES5 942-7UF15	01

Message Mode 115F-15

For the transmission of safety-related data, the programmable controllers must use message mode 115F-15.

Acknowledgement

The CP 541 always issues a positive acknowledgment of a send message from the connected programmable controller.

If there is a need in the sending programmable controller to ensure that the message was received in the receiving PLC, you must implement this in the user program with an acknowledgment message.

Summary of this Chapter

5.1 Communication Modes

Introduction

Section 5.1 provides a summary of the safety-related communication modes you can use via the CP 541.

Safety-Related Communication

Safety-related communication is possible via:

- PLC-PLC connection
- Broadcast via FDL

Other Communication Modes

Other communication modes are possible apart from the safety-related communication modes.

- Non-safety-related PLC-PLC connection (see Section 2.1)
- Non-safety-related DP connection (see Section 2.2)

Summary of this Section

5.1.1 Safety-Related PLC-PLC Connection

Introduction

The safety-related PLC-PLC connection serves for message-oriented communication between two failsafe programmable controllers, without a detour via an additional station.

Message Length

Each message of the safety-related PLC-PLC connection can contain up to 60 bytes of net data, plus 4 bytes for data detection and correction.

Active Station

When you install a PLC-PLC connection, the CP 541 must be programmed as the active station.

Address Conversion

The node address specified in the programmable controller is converted by the CP 541 to the station number and vice versa. Node address 1 is converted to station number 1, node address 2 to station number 2, etc.

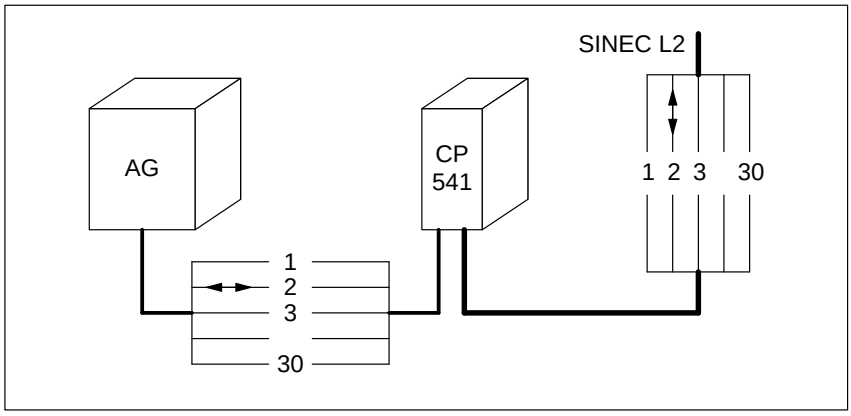


Figure 5-1 Address Conversion for the Safety-Related PLC-PLC Connection

Address Range

Node addresses 1 to 30 are available for the PLC-PLC connection in the connected programmable controller.

Parameter Assignment

You assign parameters for the safety-related PLC-PLC connection in the connected failsafe programmable controller as for a SINEC L1 slave with COM 95F or COM 115F.

Data Paths

With the S5-95F, you can install two safety-related data paths in message mode 115F-15. The S5-115F allows 29 safety-related data paths. Message mode 95F is not permissible.

5.1.2 Safety-Related Broadcast via FDL

Introduction

With the safety-related broadcast, you transwith messages to all failsafe L2 stations listening on the SINEC L2 via FDL and the set SAP, and using service SDN.

Message Length

Each safety-related broadcast message can contain up to 60 bytes of net data plus 4 bytes for data detection and correction.

Implementation

The CP 541 converts a broadcast message from the connected programmable controller to a multicast message on SINEC L2. A service access point (SAP) is used for this conversion.

- SAP (**s**ervice **a**ccess **p**oint); the CP 541 uses default SAP 52 for the broadcast. You can change the SAP with parameter BSAP in the COM block of DB1.
- SDN (**s**end **d**ata with **n**o Acknowledge) ; SDN of the PROFIBUS protocol is used for the broadcast.

Address Conversion

You install the broadcast with COM 95F/COM 115F. COM 95F/COM 115F uses node address 31. This node address is converted by the CP 541 to station number 127.

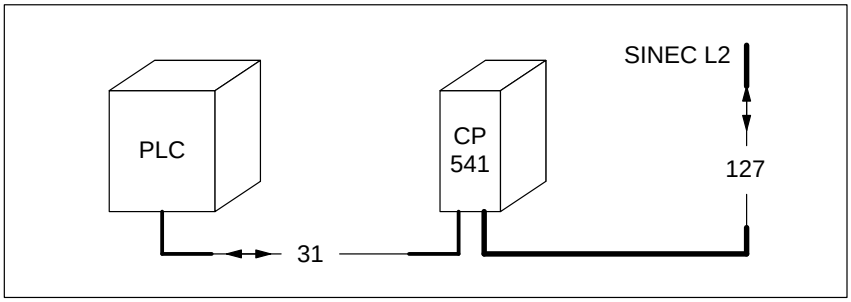


Figure 5-2 Address Conversion for Broadcast

Non-Failsafe Station

If you receive a safety-related broadcast with a non-failsafe SINEC L2 station, you must not evaluate the first four bytes of the safety-related broadcast message.

The first four bytes are used by the failsafe programmable controllers of the SIMATIC S5 family for data security information.

Configuring the Broadcast

As before, you can configure the broadcast in the connected programmable controller with COM 95F or COM 115F. In the connected programmable controller, you must not take into account any changes caused by the CP 541.

5.2 Configuring Connections

Introduction

This chapter contains instructions on assigning parameters to the CP 541 for operation with S5-95F or S5-115F.

DP Connection

Instructions on installing a DP connection can be found in Section 4.3. The DP connection is always non-safety-related.

SINEC L2 in Redundant Configuration

Operation of a SINEC L2 in redundant configurations is possible without restrictions (see Section 5.4).

Summary of this Section

5.2.1 Configuring a Safety-Related PLC-PLC Connection

Introduction

The safety-related PLC-PLC connection is comparable to a point-to-point connection between two failsafe programmable controllers.

You can easily install the safety-related PLC-PLC connection with the parameters stored in the default DB1.

Assigning Parameters to the CP 541

You assign parameters for the safety-related PLC-PLC connection via the CP 541 as shown in the following table.

Step	Action	Remark
1	Load DB1 into the programmer.	–
2	Enter the station number of the CP 541 with parameter TLN in frame SL2.	The station number of the CP 541 must be identical to the node address of the connected PLC.
3	Write the modified DB1 into the CP 541.	–
4	Switch the CP 541 to RUN.	Only upon transition from STOP to RUN will the modified DB1 be stored in the EEPROM of the CP 541.

In the Programmable Controller

In the connected programmable controller, you must observe the following points when assigning parameters with COM 95F or COM 115F:

- The station number set in the CP 541 must be identical to the node address of the connected programmable controller.
- You must use message mode 115F-15 to set up the connection.
- You can access node addresses 1 to 30 with the connected programmable controller.
- Each message of the safety-related PLC-PLC connection can contain up to 60 bytes of net data.

5.2.2 Configuring a Non-Safety-Related PLC-PLC Connection

Introduction

You need this chapter to set up a non-safety-related PLC-PLC connection from an S5-115F.

You install the non-safety-related PLC-PLC connection with the S5-95F as shown in Section 4.1.

Assigning Parameters to the CP 541

You assign parameters for the non-safety-related PLC-PLC connection via the CP 541 as shown in the following table.

Step	Action	Remark
1	Load DB1 into the programmer.	–
2	Enter the station number of the CP 541 with parameter TLN in frame SL2.	The station number of the CP 541 must be identical to the node address of the connected PLC.
3	Remove the comment parentheses from the COM block.	For the change in the COM block to be effective, you must remove the comment parentheses.
4	Use parameter L1M to enter the station number of the L2 station for which the non-safety-related connection is to be installed.	The S5-115F can only set up a non-safety-related connection for node address 0 (SINEC L1 master). This address is reserved in SINEC L2. The CP 541 will convert the address to the station number specified with parameter L1M.
5	Clear parameter PRI and dummy characters "..." or enter the priority list.	The CP 541 cannot start with the dummy characters for the priority list in DB1.
6	Write the modified DB1 into the CP 541.	–
7	Switch the CP 541 to RUN.	Only upon transition from STOP to RUN will the modified DB1 be stored in the EEPROM of the CP 541.

In the Programmable Controller

You must observe the following points in the connected PLC:

- The station number set in the CP 541 must be identical to the node address of the connected programmable controller.
- The non-safety-related PLC-PLC connection can contain up to 64 bytes of data.

5.2.3 Configuring the Safety-Related Broadcast Mode

Introduction

You can easily install the safety-related broadcast mode with the parameters stored in the default DB1.

Assigning Parameters to the CP 541

You assign parameters for the safety-related broadcast mode via the CP 541 as shown in the following table.

Step	Action	Remark
1	Load DB1 into the programmer.	–
2	Enter the station number of the CP 541 with parameter TLN in the SL2 block.	The station number of the CP 541 must be identical to the node address of the connected PLC.
3	Write the modified DB1 into the CP 541.	–
4	Switch the CP 541 to RUN.	Only upon transition from STOP to RUN will the modified DB1 be stored in the EEPROM of the CP 541.

In the Programmable Controller

In the connected programmable controller, you must observe the following points when assigning parameters:

- The station number set in the CP 541 must be identical to the node address of the connected programmable controller.
- Install the safety-related broadcast in the connected programmable controller.
- Each safety-related broadcast message can contain up to 60 bytes of net data.

No Broadcast Possible

If you cannot receive a broadcast or the transwithted broadcast cannot be received by other stations, you must modify parameter BSAP (broadcast service access point) in the COM block of DB1.

Follow the instructions in Appendices C and G.

BSAP

Parameter BSAP in the COM block has the internal default value 52. If you do not change parameter BSAP, you must not remove the comment characters for the COM block.

5.3 Safety Times

Introduction

When using the safety-related PLC-PLC connection or the safety-related broadcast, you must observe the process-dependent safety times. You must agree the safety times with the inspector.

Fundamental Rule

When using the CP 541 with S5-95F or S5-115F, you must comply with all the safety conditions specified in the manual for the programmable controller.

Interval for Received Messages

Please note: The S5-95F and S5-115F can only receive a new message when the old message has been processed by the operating system.

You must set a monitoring time of 100 ms for the S5-95F or S5-115F with parameter UPDL in DB1 of the CP 541. This ensures that message traffic is organized so that there is an interval of at least 100 ms between two received messages.

Safety Note

There is no useful message monitoring with message mode 115F-15. To prevent an undetected loss of message from occurring, you may only change the send mailbox once during the receive safety time.

Receive Safety Time

The CP 541 can receive messages simultaneously from two or more SINEC L2 stations; it executes intermediate storage of these messages.

Safety Note

On account of the intermediate storage of messages, you must deduct the local cycle time for CP 541 reception (t_{LUE}) from the SINEC L1 safety time for receiving, specified by the inspector (see Section 5.3.3). You must enter this time in COM.

Summary of this Section

5.3.1 Local Cycle Time for CP 541

Introduction

Based on the cycle time in SINEC L1, we use the local cycle time for operation of the CP 541.

You need the local cycle time to verify the receive safety time.

Definition

The local cycle time is the time elapsing until all the maximum possible messages between the CP 541 and the connected programmable controller have been exchanged once. We distinguish between the local cycle times for sending and receiving.

In the worst case, a message received by the CP 541 from SINEC L2 must wait until it is received by the connected programmable controller. This also applies to the opposite direction.

Variables Affecting the LCT

The local cycle time (LCT) is affected by the following variables:

- Number of messages

  For the number of messages, you must list all the messages sent and received from the viewpoint of the connected programmable controller.

- Length of individual messages

  The length of individual messages directly contributes to the transit time of the individual message.

- Receive delay time (UPDL, see Appendix C.4)

  You use parameter UPDL to set the receive delay time for the connected programmable controller; with failsafe programmable controllers S5-95F and S5-115F, the time must not drop below this value for safety-related communication.

- Send delay time (POL, see Appendix C.4)

  When this time has elapsed, the connected programmable controller will be interrogated for a new send message.

- Priority list (PRI, see Appendix C.4)

  The CP 541 passes on the received messages from all stations specified in the priority list to the connected programmable controller.

  If no particular priority list is defined, all possible stations are entered as standard.

5.3.2 Calculating the Local Cycle Time

Introduction

The following is an explanation for calculating the local receive and send cycle times for a connection between a CP 541 and a connected programmable controller.

Preconditions

The following preconditions apply to the calculation:

- The send delay time (POL) must not be longer than the transit time of the shortest send message, plus the transit time of the shortest receive message.
- The specially defined priority list must not contain duplications.

Note

The CP 541 receives broadcast messages from all the stations with the basic settings in DB1. These broadcast messages contribute to the local cycle time.

Proceed as follows to ensure that broadcast messages which are not needed will not be received:

- If no broadcast is to be received, you must assign the value 0 to parameter BSAP.
- If broadcast messages are only to be received from certain L2 stations, define your own priority list.

Definitions

The following definitions apply to this section:

- Receiving: Receiving is understood to mean the message direction from the CP 541 to the connected programmable controller.
- Sending: Sending is understood to mean the message direction from the connected programmable controller to the CP 541.

Preparing the Calculation

Before being able to calculate the cycle times for receiving and sending, you must carry out the following actions:

Step	Action	Meaning
1	Sort the messages according to message direction.	To calculate the local cycle time, you need to separate the send and receive messages.
2	Establish the number of data to be transmitted for each message.	With safety-related messages, take into account the 4 bytes for data security.
3	Determine the transit time for each message.	The message transit time is given by the basic load of 44 ms plus 2 ms per byte.
4	Sort the messages according to size.	–

Message Transit Time

Calculate the message transit times as follows:

Message transit time = basic load + (number of net data plus 4 bytes for data security over safety-related data paths) x 2 ms

where: basic load = 44 ms

Local Cycle Time for Receiving

Calculate the local cycle time for receiving as follows:

Step	Action
1	Draw up a simple table with two rows and the number of columns corresponding to the receive messages. Mark the first row “Receive” and the second row “Send”.
2	Enter in the “Receive” row the transit times of all possible receive messages in descending order.
3	Then enter in the “Send” row the transit times of all possible send messages. • If you have fewer send than receive messages, you must complete the “Send” row, starting with the longest send message, until the same number of send and receive messages has been entered. • If you have no send messages, do not make an entry. For receive messages whose transit times are shorter than UPDL, you must use the configured value for UPDL. • If you have more send than receive messages, delete all excessive send messages starting with the last, shortest send message.
4	You obtain the local cycle time for receiving by adding up all the message transit times in the completed table.

Local Cycle Time for Sending

Calculate the local cycle time for sending as follows:

Step	Action
1	Draw up a simple table with two rows and the number of columns corresponding to the send messages. Mark the first row “Send” and the second row “Receive”.
2	Enter in the “Send” row the transit times of all possible send messages in descending order.
3	Then enter in the “Receive” row the transit times of all possible receive messages. • If you have fewer receive than send messages, you must complete the “Receive” row, starting with the longest receive message, until the same number of send and receive messages has been entered. • If you have no receive messages, do not make an entry. • If you have more receive than send messages, delete all excessive receive messages starting with the last, shortest receive message.
4	You obtain the local cycle time for sending by adding up all the message transit times in the completed table.

5.3.3 Condition for the SINEC L1 Safety Time for Receiving

Introduction

When planning a safety-related system, you and the inspector agree a process-dependent SINEC L1 safety time for receiving.

Different Formula

When using the CP 541, you must verify the condition for the SINEC L1 safety time for receiving, according to a formula. Please note that you must not use the standard formula for verification from the manuals of the S5-95F and S5-115F programmable controllers.

Verify the SINEC L1 safety time for receiving on the basis of the formula given below. All other conditions from the manuals of our S5-95F and S5-115F programmable controllers still apply unchanged.

Formulae

The formula for verifying the SINEC L1 safety time for receiving is:

SINEC L1 safety time for receiving $\geq (2 \times t_{LUS}) + t_{L2} + (2 \times t_{LUE})$

Max. adjustable CP 541 safety time for receiving=(SINEC L1 safety time for receiving)–t_{LUE}

with:
t_{LUS} = local cycle time for sending by the sender
t_{LUE} = local cycle time for receiving by the recipient
t_{L2} = transmit time in SINEC L2

The following are valid for t_{L2}:
L2 no. of stations < 25: t_{L2} = 100 ms
L2 no. of stations ≥ 25: t_{L2} = L2 no. of stations × 4 ms

Graphic Representation of Cycle Times

Shown in the following figure are the local cycle times for sending and receiving and the transit times for message transmission.

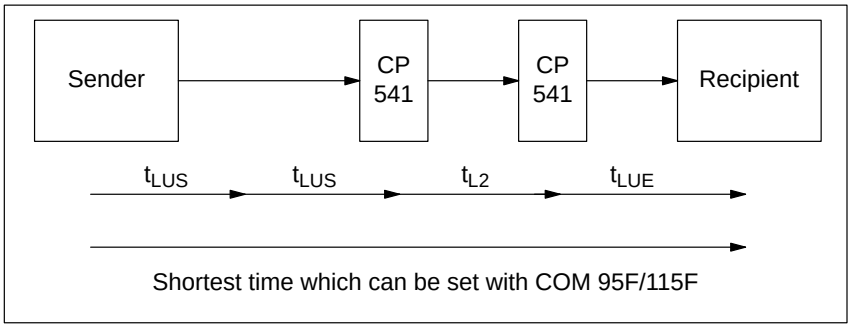


Figure 5-3 Graphic Representation of Cycle Times

Verifying the Receive Safety Time

Use the following table to verify the receive safety time:

Step	Action	Meaning
1	Calculate the local cycle times for sending and receiving.	See Section 5.3.2
2	Verify the condition for the SINEC L1 safety time for receiving using the formula on Page 5-14.	If the condition is fulfilled, you can use the CP 541 for communication.

5.3.4 Setting the Safety Times

Introduction

Explained in the following are the actions for setting the safety times in the failsafe programmable controller.

Safety Time for Receiving in the S5-95F

Proceed as follows to determine the SINEC L1 safety time for receiving for an S5-95F.

Step	Action	Meaning
1	Verify the condition for the SINEC L1 safety time for receiving, using the formula on Page 5-14.	The calculated value must be less than the SINEC L1 safety time for receiving.
2	Subtract the local cycle time for receiving of the S5-95F from the specified SINEC L1 safety time for receiving.	The local cycle time for receiving must be subtracted from the SINEC L1 safety time, because the received messages will be intermediately stored in the CP 541.
3	Round this time down to the next multiple of 100 ms.	You can only specify the receive safety time in COM 95F in multiples of 100 ms.
4	Enter this value as SINEC L1 safety time for receiving in COM 95F.	–

Safety Time for Sending in the S5-95F

Proceed as follows to determine the SINEC L1 safety time for sending for an S5-95F.

Step	Action	Meaning
1	Calculate the local cycle time for sending.	See Section 5.3.2.
2	Double this time.	This replaces condition 1 in the manual: *S5-95F Programmable Controller*, SINEC L1 safety time for sending.
3	Verify the conditions for S5-95F.	
4	Round up the resultant time to the next multiple of 100 ms.	See the manual: *S5-95F Programmable Controller*, SINEC L1 safety time for sending (conditions 2-4).
5	Enter this value in COM 95F.	–

Safety Time in the S5-115F

Proceed as follows to determine the SINEC L1 safety time for an S5-115F.

Step	Action	Meaning
1	Verify the conditions for the SINEC L1 safety time for receiving, using the formula on Page 5-14.	The calculated value must be less than the SINEC L1 safety time for receiving.
2	Subtract the local cycle time for receiving of the S5-115F from the specified SINEC L1 safety time for receiving.	The local cycle time for receiving must be subtracted from the SINEC L1 safety time, because the received messages will be intermediately stored in the CP 541.
3	Round this time down to the next multiple of 10 ms.	You can only specify the safety time in COM 115F in multiples of 10 ms.
4	Enter this value as SINEC L1 safety time for receiving in COM 115F.	For reception over two or more data paths, you must set the highest value.

5.3.5 Example for Calculating the Local Cycle Times

Introduction

An example for calculating the local cycle times is given here for clarification.

Configuration Example

There are three programmable controllers, each with a CP 541 and interconnected via SINEC L2.

The message traffic between the two failsafe programmable controllers is safety-related. Four bytes for data security are present per safety-related message.

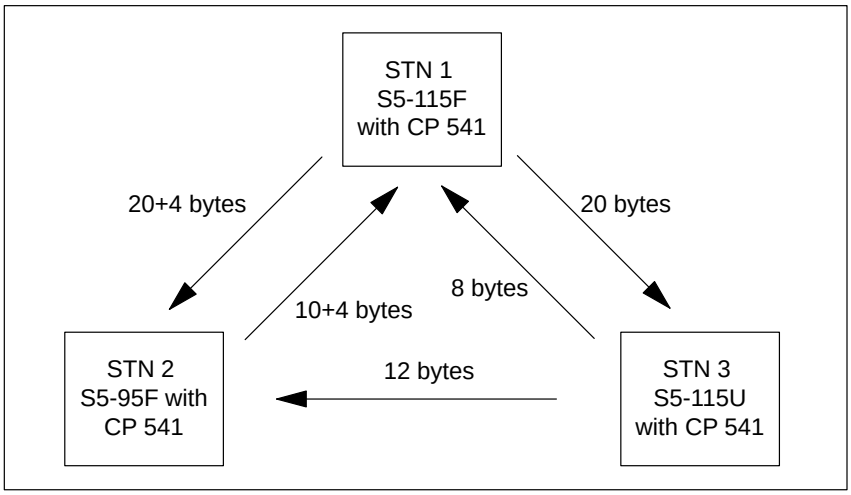


Figure 5-4 Configuration Example for Calculating the Local Cycle Times

Node 1

Calculation of the local cycle times:

- Two receive messages and two send messages are present. The message transit times are given by:
  - Sending of 20+4 bytes to Station 2: 24 × 2 ms + 44 ms = 92 ms
  - Sending of 20 bytes to Station 3: 20 × 2 ms + 44 ms = 84 ms
  - Receiving of 10+4 bytes from Station 2:
    14 × 2 ms + 44 ms = 72 ms
  - Receiving of 8 bytes from Station 3: 8 × 2 ms + 44 ms = 60 ms
- Messages sorted according to size:
  - Sending: 92 ms, 84 ms
  - Receiving: 72 ms, 60 ms
- Verification of conditions for the send delay time:

  POL ≤ shortest send message + shortest receive message

  POL = 100 ms (defaultsetting in DB1) ≤ 84 ms + 60 ms = 144 ms

Local Cycle Time for Sending STN 1

You obtain the local cycle time for sending by adding the individual values.

Sending	92 ms	84 ms	(92 + 84 + 72 + 60) ms
Receiving	72 ms	60 ms	= 308 ms

Local Cycle Time for Receiving STN 1

You obtain the local cycle time for receiving by adding the individual values.

Receiving	72 ms	60 ms	(72 + 60 + 92 + 84) ms
Sending	92 ms	84 ms	= 308 ms

Node 2

Calculation of local cycle times:

- Two receive messages and one send message are present. The message transit times are given by:
  - Sending of 10+4 bytes to Station 1: 14 × 2 ms + 44 ms = 72 ms
  - Receiving of 20+4 bytes from Station 1: 24 × 2 ms + 44 ms = 92 ms
  - Receiving of 12 bytes from Station 3: 12 × 2 ms + 44 ms = 68 ms
- Messages sorted according to size:
  - Sending: 72 ms
  - Receiving: 92 ms, 68 ms
- Verification of conditions for the send delay time:

  POL ≤ shortest send message + shortest receive message

  POL = 100 ms (default setting in DB1) ≤ 72 ms + 68 ms = 140 ms

Local Cycle Time for Sending STN 2

You obtain the local cycle time for sending by adding the individual values.

Sending	72 ms		(72 + 92) ms
Receiving	92 ms	~~68 ms~~*	= 164 ms

* Receive message is deleted.

Local Cycle Time for Receiving STN 2

You obtain the local cycle time for receiving by adding the individual values.

Receiving	92 ms	68 ms	(92 + 68 + 72 + 72) ms
Sending	72 ms	72 ms*	= 304 ms

* Send message is filled in.

Node 3

Calculation of local cycle times:

- Two receive messages and one send message are present. The message transit times are given by:
  - Sending of 8 bytes to Station 1: 8 × 2 ms + 44 ms = 60 ms
  - Sending of 12 bytes to Station 2: 12 × 2 ms + 44 ms = 68 ms
  - Receiving of 20 bytes from Station 1:
    20 × 2 ms + 44 ms = 84 ms
- Messages sorted according to size:
  - Sending: 68 ms, 60 ms
  - Receiving: 84 ms
- Verification of conditions for the send delay time:

  POL ≤ shortest send message + shortest receive message

  POL = 100 ms (default setting in DB1) ≤ 60 ms + 84 ms = 144 ms

Local Cycle Time for Sending STN 3

You obtain the local cycle time for sending by adding the individual values.

Sending	68 ms	60 ms	(68 + 60 + 84 + 84) ms
Receiving	84 ms	84 ms*	= 296 ms

* Receive message is filled in.

Local Cycle Time for Receiving STN 3

You obtain the local cycle time for receiving by adding the individual values.

Receiving	84 ms		(84 + 68) ms
Sending	68 ms	~~60 ms~~*	= 152 ms

* Send message is deleted.

5.3.6 Example of Verification of Safety Times

Example

The example previously described (see Section 5.3.5) serves for verifying the safety times.

We will now determine the safety time for a connection between the two programmable controllers, Stations 1 and 2.

By agreement with the inspector, a SINEC L1 safety time for receiving of 2 s is specified.

Local Cycle Time

You have determined the local cycle times from the example. They are as follows:

Local Cycle Time for	STN 1	STN 2	STN 3
Sending (t_{LUS})	308 ms	164 ms	296 ms
2 × sending ($2 \times t_{LUS}$)	616 ms	328 ms	592 ms
Receiving (t_{LUE})	308 ms	304 ms	152 ms
2 × receiving ($2 \times t_{LUE}$)	616 ms	608 ms	304 ms

Safety Time

From these data and taking into account the formula in Section 5.3.3 and the data in 5.3.4, we obtain the safety times as follows:

STN	Calculation	Value to be Set
1 (S5-115F)	First formula from Page 5-14: SINEC L1 safety time for receiving >= $2 \times t_{LUS,STN2} + 2 \times t_{LUE,STN1} + t_{L2}$ = 2 × 164 ms + 2 × 308 ms + 100 ms = 1044 ms 2000 ms >= 1044 ms Condition is fulfilled.	Second formula from Page 5-14: 2000 ms – $t_{LUE,STN1}$ = 2000 ms – 308 ms = 1692 ms Safety time to be set with COM 115 F = 1690 ms
2 (S5-95F)	First formula from Page 5-14: SINEC L1 safety time for receiving >= $2 \times t_{LUS,STN1} + 2 \times t_{LUE,STN2} + t_{L2}$ = 2 × 308 ms + 2 × 304 ms + 100 ms = 1324 ms 2000 ms >= 1324 ms Condition is fulfilled.	Second formula from Page 5-14: 2000 ms – $t_{LUE,STN2}$ = 2000 ms – 304 ms = 1696 ms Safety time for receiving to be set with COM 95F = 1600 ms
	Safety time for sending = $2 \times t_{LUS,STN2}$ = 2 × 164 ms = 328 ms	Safety time for sending to be set with COM 95F = 400 ms

Result

With the data in this example, a safety-related connection can be established between the two programmable controllers via SINEC L2, using the CP 541, because both the safety time of Station 1 and safety time for receiving of Station 2 are less than the specified value.

5.4 Redundant SINEC L2 Configuration

Introduction

You can configure SINEC L2 with redundancy for a safety-related connection between two or more failsafe programmable controllers. Redundant operation is not subject to any restrictions.

Configuration

Shown in Figure 5-5 is the configuration for SINEC L2 in a redundant configuration for communication using two failsafe programmable controllers.

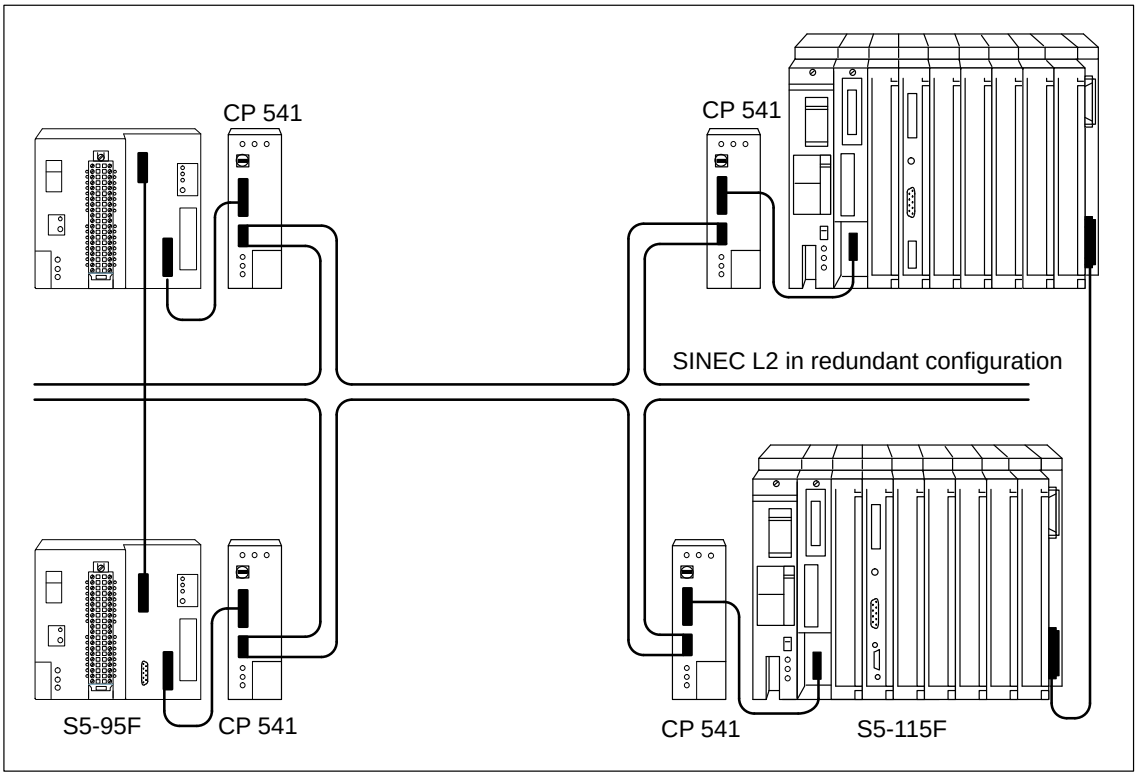


Figure 5-5 Schematic Configuration of SINEC L2 in Redundant Configuration

Special Note

For SINEC L2 with redundancy, you use two separate SINEC L2 LANs. On each SINEC L2, you use the same station numbers for the same failsafe programmable controllers.

Diagnostics and Error Handling

6

Introduction

Diagnostics offers you the facility for monitoring the proper functioning of the CP 541 and evaluating any errors.

Information on incorrect operational states are stored by the CP 541 in diagnostics block DB2. If necessary, the CP 541 generates the DP diagnostics.

Diagnostic Facilities

The CP 541 issues a diagnosis at different locations:

- Locally with the LED indicators
- In diagnostics block DB2
- In a diagnostics message with a DP connection to the DP master
- DP diagnostic report to the connected programmable controller

If an error occurs, the CP 541 always activates the LED indicator according to the error, and enters the error code in DB2.

Summary of this Chapter

6.1 Local Diagnostics with LEDs

Indication

The CP 541 has three LEDs to indicate the current operational state and any errors.

Operational State

The current operational state of the CP 541 is indicated with three LEDs.

- RUN LED

  The current state is indicated with the green RUN LED. Table 6-1 contains a summary of the indications.

Table 6-1 Indications of the RUN LED

RUN LED ...	CP 541 ...
is off	is switched off.
flashes at 2 Hz	is in the STOP state.
flashes at 8 Hz	is executing an internal test.
is lit	is in the RUN state.

- ERR LED

  The red ERR LED indicates a general error in the CP 541 or at the PG/PLC connection.

- BF L2 LED

  The red BF L2 LED indicates a SINEC L2 bus error or that the CP 541 has not yet been integrated in SINEC L2.

Diagnosis

The diagnosis is given by the combination of the three LEDs. To clear the error, you must evaluate DB2.

DB1 Error

If you set the mode switch on the CP 541 from STOP to RUN, and the RUN LED continues to flash, there is a DB1 error.

Evaluating the Diagnosis

Proceed as follows to evaluate the diagnosis and clear any error:

Step	Action	Explanation
1	Set the mode switch to STOP.	DB2 can only be read out with the switch set to STOP.
2	Connect the programmer to the CP 541.	You cannot access DB2 via a programmable controller.
3	Read out DB2.	–
4	Evaluate the errors in DB2 and take the appropriate actions.	Section 6.2 contains a detailed description of DB2.
5	Reconnect the programmable controller.	–
6	Set the mode switch to RUN.	The CP 541 evaluates DB1 again.

6.2 Diagnostics Block

Introduction

The CP 541 stores in the diagnostics block (DB2) all data on events occurring during the start and in operation.

Reading out DB2

You can read out the diagnostics block in the STOP mode with a PG. You connect the PG to the PG/PLC connector.

You cannot access the diagnostics block in the RUN mode. In the RUN mode, the CP 541 carries out the exchange of data between the connected programmable controller and SINEC L2. A PG access via the programmable controller is not possible.

DB2 can only be read out.

Resetting DB2

DB2 is reset by the CP 541 in the initialization phase and upon each change of status from STOP to RUN.

When you switch the CP 541 from STOP to RUN, all information in DB2 is cleared.

Defaults

The diagnostics block has the default 0.

Summary of this Section

6.2.1 Structure of the Diagnostics Block

Introduction

The following is a summary of the structure of the diagnostics block (DB2). This is where the CP 541 stores information on all detected error states.

Detailed information on DB2 can be found in the following sections.

Structure

The diagnostics block contains the ranges given in Table 6-2.

Table 6-2 Assignments of the Data Words in DB2

DW	Range	See Section
DW0	Status word	Below
DW1 ... DW11	DB1 error	6.2.2
DW12	SINEC L2 bus error	6.2.3
DW13 ... DW17	SINEC L1 message error	6.2.4
DW18 ... DW26	Reserved	–
DW27 ... DW30	Internal error	6.2.5

Significance of DW0

DW0 specifies the block in DB2 of the CP 541 in which an error has been entered.

Table 6-3 shows the significance of the individual bits in DW0. The positions not mentioned are not assigned.

Table 6-3 Significance of DW0 in DB2

Bit	Significance	Stored in
0	DB1 error	DW1 ... DW11
1	SINEC L2 bus error	DW12
2	SINEC L1 message error	DW13 ... DW17
4	Internal error	DW27 ... DW30

6.2.2 DB1 Errors

DW1

Given in DW1, in the event of an error, is the number of the byte at which the error in DB1 has occurred. For some errors, the address of the errored block is indicated.

Display on the Programmer

For the display of a DB on the PG, the data are not numbered in bytes but in words.

Multiple Errors

If the CP 541 detects more than ten error messages, it ceases evaluation of DB1.

Multiple Messages

For some errors, you receive multiple error messages. You should therefore not consider each error message on its own but compare it to the other error messages.

Example

You have inadvertently entered station number 289 instead of 28, but you have entered all other parameters correctly. You receive the following error messages:

- 1704H: L2 interface not operational
- 2104H: TLN beyond permissible value range (1 to 30)
- 2204H: TLN of an active station is greater than HSA.

Error Code

Up to 10 DB1 errors may be entered. The meanings of the error code and the remedies can be found in Table 6-4.

Table 6-4 DB1 Error Codes

Error Code		Meaning	Remedy
In DL	**In DR**		
00_H	FF_H	DB1 identifier missing	Specify DB1 as the first entry in DB1.
01_H	FF_H	END identifier missing	Specify END as the last entry in DB1.
02_H	FF_H	DB1 PTR overrange	Specify ";" before END. Or check the DB1 format.
03_H	$F0_H$	Block designator syntax error	Verify the structure of the block designator and fully specify all parameters.

[1] DR specifies the error location for most error messages. The following error locations are possible:

- 04_H: error in SL2 block
- 14_H: error in COM block
- 15_H: error in DPS block

Table 6-4 DB1 Error Codes, continued

Error Code		Meaning	Remedy
In DL	In DR		
04_H	XX_H[1]	Parameter syntax error	Verify the structure of parameters in the specified block and fully specify all parameters.
05_H	XX_H[1]	Argument syntax error or overrange/underrange	Observe the structure of individual parameters and enter the right value.
06_H	XX_H[1]	Overrange/underrange in an argument	Observe the value range of individual parameters and enter the right value.
07_H	XX_H[1]	Parameter combination not allowed, the values in various parameters are mutually exclusive.	Check the values in parameters TLN, STA, HSA, SET, SDT 1, L1M, PRI, NWI and NWO. Enter the right values.
17_H	XX_H[1]	L2 interface not operational	Check the parameters for SINEC L2.
21_H	XX_H[1]	TLN beyond permissible value range (1 to 30)	Specify the right station number of the CP 541.
22_H	XX_H[1]	TLN of an active station is greater than highest station number HSA.	Check SINEC L2. HSA must be the same for all stations.
23_H	XX_H[1]	A connection to the own station number has been established.	Modify the user program of the connected PLC.
26_H	XX_H[1]	The value of SET must be greater than the value of SDT 1.	The specification is: SET>(SDT 1 – 35)/2. Check the values of SET and SDT 1 and enter the right values.
29_H	XX_H[1]	An L2 basic parameter is missing.	Check whether all L2 basic parameters have been correctly entered. You must specify the following basic parameters: • STA = AKT: TLN, STA, BDR, HSA, TRT, SET, ST, SDT 1 and SDT 2 • STA = PAS: TLN, STA, BDR, ST and SDT 1 Enter the missing parameters.
30_H	XX_H[1]	Frame designator SL2 is present more than once.	Delete the excessive SL2 frame.
31_H	XX_H[1]	The value of SDT 2 is too low in relation to SET.	The specification is: SDT $2 \geq (35+2xSET)$. Enter the right values for SDT 2 and SET.
32_H	XX_H[1]	The value of SDT 2 is too great in relation to ST.	The specification is: $(ST - 15) \geq$ SDT 2. Enter the right values for SDT 2 and ST.

[1] DR specifies the error location for most error messages. The following error locations are possible:

- 04_H: error in SL2 block
- 14_H: error in COM block
- 15_H: error in DPS block

Table 6-4 DB1 Error Codes, continued

Error Code		Meaning	Remedy
In DL	**In DR**		
41_H	XX_H[1]	The transmission rate (BDR) chosen is too low.	Lowest permissible transmission rate is 93.75 Kbps. Enter the right value.
42_H	XX_H[1]	The own station number is entered in PRI.	Delete the own station number (value of TLN) from the priority list (PRI).
43_H	XX_H[1]	The station number is duplicated.	Delete the excessive TLN parameter.
44_H	XX_H[1]	The priority list has more than 60 entries.	You may make up to 60 entries in the priority list. Delete the excessive entries.
45_H	XX_H[1]	PRI is duplicated.	Delete the excessive parameter.
46_H	XX_H[1]	UPDL is duplicated.	
47_H	XX_H[1]	BSAP is duplicated.	
48_H	XX_H[1]	L1M is duplicated.	
49_H	XX_H[1]	POL is duplicated.	
50_H	XX_H[1]	NWI is duplicated.	
51_H	XX_H[1]	NWO is duplicated.	
52_H	XX_H[1]	DPWD is duplicated.	
53_H	XX_H[1]	DPS is present and L1M $\neq 0$.	Assign the value 0 to parameter L1M.
54_H	XX_H[1]	NWI and NWO are 0.	For a DP connection, you must assign a value $\neq 0$ to at least one of parameters NWI and NWO.
55_H	XX_H[1]	DP connection configured but 0 is not entered in the user-defined PRI list.	Enter the value 0 in the user-defined PRI list.
56_H	XX_H[1]	STBS and STBR not allowed.	Delete parameters STBS and STBR.
57_H	XX_H[1]	L1M is identical to TLN.	Specify the right station number.
58_H	XX_H	SL2 block designator missing.	Specify the SL2 block. Or carry out a reset.
60_H	FF_H	DB1 is too long.	DB1 may have only 1 Kbyte. Delete all unnecessary entries.

[1] DR specifies the error location for most error messages. The following error locations are possible:

- 04_H: error in SL2 block
- 14_H: error in COM block
- 15_H: error in DPS block

6.2.3 SINEC L2 Bus Errors

Error Code

The diagnostics block contains the error code in DR12 for SINEC L2 bus errors. The meanings of the error codes and the remedies can be found in Table 6-5.

Table 6-5 SINEC L2 Bus Errors

Error Code	Meaning	Remedy
21_H	Interference to send message by hardware fault in module or bus interference	• Check the EMC measures described in Section 3.2. • Replace the module.
24_H	Station is not yet in the ring, parameter HSA is too low.	• Check SINEC L2. HSA must be the same for all stations.
27_H ... 30_H	Protocol error or protocol monitoring error	• Verify the basic parameters in DB1 and enter the right values. The basic parameters must be the same for all stations.
41_H	Station is not in the ring; another station with the same station number is present.	• Change the station number in DB1.
$B2_H$	Only for active stations: station was not accepted in the ring within the monitoring time.	• Verify the hardware configuration of SINEC L2 and correct the values in DB1.
42_H ... $B1_H$, $C0_H$ ... FF_H	An internal fatal error has occurred.	• Replace the module. • Consult your Siemens office with the error code.

Clearing Errors

If the BF L2 LED lights up during operation, the CP 541 requires a POWER OFF/POWER ON transition to restart.

Note

If you have changed the parameters in DB1 of the CP 541, you must store them in the EEPROM. Do this by switching the CP 541 to RUN.

Then switch the CP 541 to 0 and back to RUN again.

6.2.4 SINEC L1 Message Errors

Error Codes

The error codes for SINEC L1 message errors are stored in bytes in the diagnostics block (DB2) or the CP 541, in DW13 to DW17.

Meanings of the error codes and the remedies are given in Table 6-6.

Table 6-6 SINEC L1 Message Errors

Error Code	Meaning	Remedy
01_H	The mode switch is at RUN and a programmer is connected to the L1 interface or there is interference on SINEC L1. The CP 541 remains at RUN.	• If you connect the programmer to the CP 541, you must set the mode switch to STOP or • Remove the programmer.
02_H	The L1 slave sends a message with destination address 0. However, you have not configured a DP connection or a non-safety-related connection (S5-115F only). The CP 541 goes to STOP.	• You must not send an L1 master message. • You must configure a DP connection. • For S5-115F: You must configure a non-safety-related connection.
03_H	L1 slave is sending to a node address $\neq 0$. However, the CP 541 is configured as a passive station. The CP 541 goes to STOP.	• You may only establish a DP connection. • You must assign a parameter to the CP 541 as an active station (STA = AKT).
04_H	The number of outgoing data from the connected programmable controller to the CP 541 is not the same as the parameter value of NWO. The CP 541 goes to STOP.	• Ensure that the data volume to the CP 541 agrees with the value of NWO. • You must always send a constant data volume with the DP connection. • Ensure that the parameter values in the connected PLC, in the CP 541 and in the DP master agree.

Table 6-6 SINEC L1 Message Errors, continued

Error Code	Meaning	Remedy
05_H	• Connected PLC does not have the same TLN as CP 541. The CP 541 remains at RUN.	• Specify the same TLN (node address/station number) in both devices.
	• The CP 541 is at RUN and a programmer is connected. The CP 541 remains at RUN.	• If you connect the programmer to the CP 541, you must set the mode switch to STOP.
	• Interference between CP 541 and connected PLC which is cleared without intervention. The CP 541 remains at RUN.	–
06_H ... $0A_H$	Interference on SINEC L1 which is cleared without intervention. The CP 541 remains at RUN.	–
$0B_H$	The CP 541 has not received a DP message from the connected PLC within the monitoring time parameterized in DPWD. The CP 541 remains at RUN.	• Increase the monitoring time specified in DPWD. • Modify the user program in the PLC to allow more frequent sending to the DP master.
$0C_H$	The connected PLC has sent a broadcast, but BSAP is 0. The CP 541 goes to STOP.	• You must not send a broadcast. • Or assign a value between 33 and 52 to BSAP in frame COM.
$0D_H$	A PLC-PLC message with more than 64 bytes has been received from SINEC L2. The CP 541 goes to STOP.	• The CP 541 can only transmit messages of up to 64 bytes. Change the maximum PLC-PLC message length in the sending PLC.

Circulating Buffer

The DB2 area for SINEC L1 message errors is established as a circulating buffer. After the last and, therefore, also latest entry, FF_H is always present.

If the CP 541 detects a new error, it shifts the end marker (FF_H) by one byte and enters the new error message in the released field.

When the byte in DR17 has been written, the next byte is the one in DL13 again.

6.2.5 Internal Errors

Meaning

The CP 541 executes a self-test during the start. If an error is detected within the test, an appropriate error message is written into the range for internal errors (DW 27 to DW 30).

If the CP 541 detects an error in the RUN state, it interrupts the exchange of data and goes to STOP.

Remedy

Proceed in the following order to clear the error:

Step	Remedy	Explanation
1	Switch the CP 541 to the 0 setting.	You reset the CP 541 in a defined basic state.
2	Switch the CP 541 to the STOP mode and then to RUN.	The CP 541 executes a self-test, including initialization.
3	If you again receive an internal error message, continue with the next step. If you no longer receive an error message, the CP 541 is ready again.	There is a fatal error.
4	Make a note of the error code.	The error code is stored from DL27 onward.
5	Replace the CP 541.	Follow the instructions in Chapter 3.
6	Consult your Siemens office with the error message.	–

6.3 DP Diagnostic Message Using the Example of an IM 308-C with FB IM308C

Introduction

The DB diagnostic message is structured to Standard DIN E 19245, Part 3, and provides information on the DP slave or CP 541.

Choice of Diagnosis

Two diagnostic facilities are available:

- Master diagnosis as an overview diagnosis
- Slave diagnosis as a secondary diagnosis

Master Diagnosis

In the master diagnosis, an overview diagnosis is contained in the first 16 bytes. From the overview diagnosis, you can take the DP slaves which have reported a diagnosis or which cannot be addressed from this DP master.

The overview diagnosis is particularly recommended when you have two or more DP slaves. Since you are using the master diagnosis, you need not request the slave diagnosis from each DP slave.

Slave Diagnosis

Contained in the slave diagnosis is all diagnostic information for a particular DP slave.

The structure of the slave diagnosis is explained in Section 6.3.1

FB IM308C

You can read the CP 541 diagnosis into your programmable controller, such as SIMATIC S5, as a so-called slave diagnosis, with function block IM308C (FB192) for example, with IM 308-C.

A detailed description of FB IM308C is given in the manual: *ET 200 Distributed I/O System*.

Exchanging Diagnostic Data

The CP 541 informs the DP master of a diagnosis via high-priority sending of the useful data. The DP master then automatically requests the diagnostic message from the CP 541.

Procedure

The procedure for reading the diagnosis into your programmable controller with FB IM308C is described in detail in the manual: *ET 200 Distributed I/O System*.

An example of a diagnostic call for the slave diagnosis is given in Section 6.3.4.

Output of the Diagnosis

The CP 541 indicates to the DP master that there is a diagnosis. If a new error occurs, the diagnosis is automatically fetched by the DP master. This procedure is repeated with each change of diagnosis.

Summary of this Section

6.3.1 Structure of the Diagnosis

Size

The diagnostic message contains 8 bytes of data.

Structure

The structure of the diagnostic message complies with the specifications of the PROFIBUS DP standard. The structure of the entire diagnosis is represented in Table 6-7.

Table 6-7 Structure of the Diagnostic Message

Byte	Content
0	Station status 1
1	Station status 2
2	Station status 3
3	Station number DP master
4	Manufacturer ID (for CP 541: 001FH)
5	
6	Length of the device-related diagnosis in bytes inc. header (always 02H for CP 541)
7	Device-related diagnosis

Diagnostic Data

The diagnostic message of the CP 541 contains exactly one byte of device-related diagnostic data.

6.3.2 Contents of the DP Standard Section

DP Standard Section

The first 6 bytes of the diagnostic message (byte 0 to byte 5) are also known as the DP standard section.

This information is exchanged between the CP 541 and the DP master. You do not normally require this information.

Station Status 1

Table 6-8 Structure of Station Status 1 (Byte 0)

Bit	Value	Content
0	1	The CP 541 cannot be addressed.
1	1	The CP 541 is not yet ready to exchange data.
2	1	The configuration data sent by the DP master do not agree with the specifications in DB1.
3	1	There is a slave diagnosis.
4	1	Requested function is not supported by the CP 541.
5	1	An implausible reply has been received from the CP 541.
6	1	There is an incorrect parameter assignment message.
7	1	The CP 541 has been assigned parameters by a different DP master from the one now attempting access to the CP 541.

Station Status 2

Table 6-9 Structure of Station Status 2 (Byte 1)

Bit	Value	Content
0	1	The CP 541 must be assigned new parameters.
1	1	There is a static diagnosis.
2	1	Set to 1
3	1	Response monitoring has been activated.
4	0	Always with CP 541 The FREEZE mode cannot be switched on.
5	0	Always with CP 541 The SYNC mode cannot be switched on.
6	0	Set to 0
7	0	The CP 541 has been deactivated.

Station Status 3

Station status 3 (byte 2) is reserved for later applications. With the CP 541 it always has the value 00_H.

Station Number of DP Master

Byte 3 contains the station number of the DP master which assigned parameters to the DP slave. Only this DP master has read and write access to this DP slave.

The station number is given the default FF_H during the start. This means that the CP 541 has not been assigned parameters by a DP master so far.

Manufacturer Identifier

The manufacturer identifier (bytes 4 and 5) allows you to make a unique identification of the DP slave. The manufacturer identifier is product-specific.

The manufacturer identifier for the CP 541 has the value 31_D ($001F_H$).

6.3.3 Device-Related Diagnosis

Range

The device-related diagnosis is contained in bytes 6 and 7.

Contents

Table 6-10 Structure of Bytes 6 and 7 of the Diagnostic Message

Byte	Value	Content
6	02_H	Length of device-related diagnosis in bytes inc. header
7	$0X_H$	Device-related diagnosis The significance of the individual bits can be found in Table 6-11.

Device-Related Diagnosis

The device-related diagnosis (byte 7) is arranged as shown in Table 6-11. A report is signaled with a 1.

Table 6-11 Structure of the Device-Related Diagnosis, Byte 7 of the Diagnostic Message

Bit[1]	Meaning	Cause/Reaction	Remedy
0	Response monitoring in CP 541 elapsed	The PLC at the CP 541 has not reported with a DP message, within the time specified with parameter DPWD in DB1.	Inspect the connection between CP 541 and PLC for an open-circuit. Check the PLC connected to the CP 541 for faults. Increase the monitoring time specified in DPWD. Change the user program in the PLC for more frequent sending to the DP master.
1	PLC is sending again.	Detected failure of the DP connection between CP 541 and PLC no longer exists.	–

1 Bits not mentioned are not significant.

6.3.4 Example of a Diagnostic Call with IM308-C and FB IM308C

Example

Given here is a short example of the S5-115U with IM 308-C as the DP master. It shows how you read the slave diagnosis for the CP 541 into your programmable controller with FB IM308C.

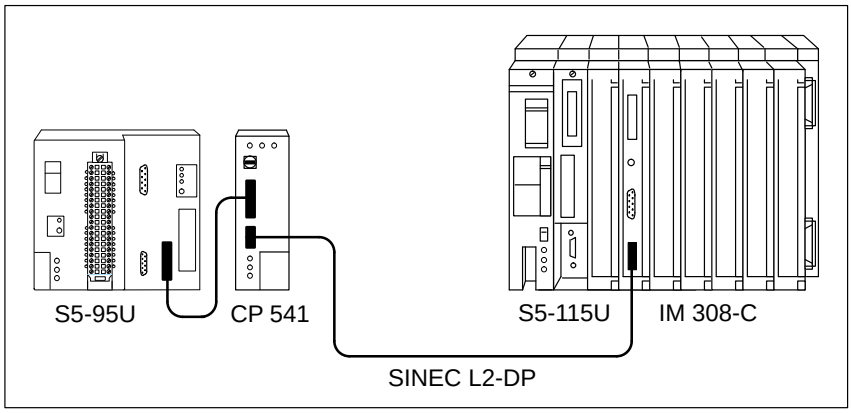


Figure 6-1 Example of Configuration

Assumed Situation

The following situation is assumed for this user program:

- The IM 308-C reserves pages 0 to 15 as the SINEC L2-DP master.
- The CP 541 has station number 3.
- The slave diagnosis is to be stored in DB 20.
- The slave diagnosis consists of 8 bytes.

Diagnostic Call

The following user program shows how to request the slave diagnosis for the CP 541 with FB IM308C.

```
STL                                          Explanation
        :Q      DB 30
        :JU     FB 192
Name    :IM308C
DPAD    :       KH F800                      Default address area of the IM 308-C
IMST    :       KY 0, 3                      IM no. = 0, CP 541 station no. = 3
FCT     :       KS SD                        Function: read slave diagnosis
GCGR    :       KM 0                         Will not be evaluated
TYP     :       KY 0, 20                     S5 data area: DB 20
STAD    :       KF +1                        Diagnostic data from data word 1
LENG    :       KF 8                         Diagnostic length = 8 bytes
ERR     :       DW 0                         Error code stored in DW 0 of DB 30
```

6.4 DP Diagnosis in the Programmable Controller

Introduction

The CP 541 informs the connected programmable controller of a failure of the DP connection to the DP master.

This chapter describes how this is achieved and what you must take into account.

DP Master Monitoring

The connection to the DP master is monitored as soon as the CP 541 is accepted in the DP cycle as a DP slave, and the DP watchdog in CP 541 has been activated.

Reaction of the CP 541

If the CP 541 detects a failure of the DP master or of the connection to the DP master, it reacts as follows:

- The CP 541 sends a “zero” message to the programmable controller.
- The CP 541 sets bit 1 in the CBR (see below).

Zero Message

In the “zero” message, all data contain the value 0 (closed-circuit principle).

The message has the length you specified with parameter NWI in frame DPS.

CBR

When the CP 541 is used with the DP connection, the receive coordination byte (CBR) must be interpreted as follows:

- Bit 1 is always reset by the CP 541 in normal operation.
- The CP 541 sets bit 1 in the CBR in the event of failure of the DP master.

Remedy

Take the following actions:

- Inspect the connection of the DP master to SINEC L2.
- Check SINEC L2.
- Verify proper functioning of the DP master.
- Check the watchdog specified in the DP master for the connection between DP master and CP 541.

Technical Data

A

What are General Technical Data?

The general technical data contain the standards and test values met and satisfied by the CP 541; that is, the criteria to which the CP 541 has been tested.

CE Mark

Our products meet the requirements of EU Guideline 89/336/EEC for electromagnetic compatibility and the harmonized European Norms (ENs) listed there.

CE

The EU conformity declarations are kept available for the appropriate authorities at the following address, in compliance with the above EU Guideline, Article 10:

Siemens Aktiengesellschaft
Bereich Automatisierungstechnik
AUT E 148
Postfach 1963
D-92209 Amberg

Field of Application

SIMATIC products are designed for operation in industry.

With an individual approval, SIMATIC products can also be used in domestic applications (homes, shops, trades and small businesses). You must obtain the individual approval from an authority or test center. In Germany, the individual approval is issued by the Federal Department for Post and Telecommunications and its regional centers.

Field of application	Requirement for	
	Spurious emission	Noise immunity
Industry	EN 50081-2 : 1993	EN 50082-2 : 1995
Domestic	Individual approval	EN 50082-1 : 1992

Installation Guidelines

SIMATIC products meet the requirements if you comply with the installation guidelines described in the manuals for installation and operation.

This Chapter

This chapter contains the technical data of the CP 541.

Climatic environmental conditions to IEC 1131-2	
Temperature	
Operation	
• Horizontal installation	0 ... + 60 °C
• Vertical installation	0 ... + 40 °C
Storage/transportation	– 40 ... + 70 °C
Temperature change	
• Operating	3 K/h max.
• Non-operating	1 K/min max.
Relative humidity	
to DIN 40040	15 ... 95 % No condensation
Atmospheric pressure	
• Operating	795 ... 1080 hPa
• Non-operating	660 ... 1080 hPa
Pollutants	
SO_2	$\leq$ 0.5 ppm relative humidity $\leq$ 60% no condensation
H_2S	$\leq$ 0.5 ppm relative humidity $\leq$ 60% no condensation
Degree of protection to IEC 529	
• Construction	IP 20
• Class	I to IEC 536

Mechanical environmental conditions	
Vibrations to IEC 68-2-6	
• 10 Hz $\leq$ f < 58 Hz	const. amplitude 0.075 mm
• 58 Hz $\leq$ f < 150 Hz	const. acceleration 1 g
Repetitive shock tested to VDE 0116	
• Type of shock	semi-sinusoidal
• Shock intensity	15 g peak value 11 ms duration
• Number	18 shocks
Drop and topple to IEC 68-2-31	
• Tested with	drop height 100 mm

Electromagnetic compatibility (EMC)/interference immunity	
Discharge of static electricity to IEC 801-2 Severity 3	
• Discharge of static electricity	8 kV discharge in air Discharge on all parts accessible to the user in normal operation
• Test voltage	6 kV contact discharge
Electromagnetic fields to IEC 801-3, Severity 3	
• Field strength	10 V/m
Fast transient noise voltages (burst) to IEC 801-4, Severity 3	
• On power supply lines	2 kV
• At communication interfaces	2 kV
Spurious emission to EN 55011	
• Limit class	A
RF test to IEC 801-6, Severity 3	
• Test voltage	10 V
• Frequency range	150 kHz – 80 MHz

IEC/VDE safety specifications	
Insulation rating	
• Between electrically independent circuits and circuits connected to central ground point	to DIN VDE 0160 (05.1988) or UL 508 CSA 22.2 Nr. 142
• Between all circuits and central ground point	to DIN VDE 0160 (05.1988) or UL 508 CSA 22.2 Nr. 142
RFI suppression	to EN 50081-2 industrial application
Test voltage	
• Rated voltage	V_i = 0 ... 50 V DC
• Test voltage	500 VDC

Dimensions and weight	
Dimensions	
• Height	162 mm
• Width	46 mm
• Depth	120 mm
Weight	415 g

Supply of power	
Input voltage	
• Rated value	24 VDC
• Permissible range	20 ... 30 VDC including ripple
• Ripple	U_{ppmax} = 3 V
Current consumption	
• From 24 V	200 mA typical
• Power dissipation	4.8 W
Output voltage	
• V1 for PG	5 V
• Isolation	no
• V2 for SINEC L2	5 V
• Isolation	yes
Output current	
• From V1 for PG	≤ 55 mA
• Short-circuit protection	electronic
• From V2 for SINEC L2	≤ 100 mA
• Short-circuit protection	fuse
• Fuse rating	250 mA fast not replaceable
Chassis ground and protective ground conductor are internally bridged.	

Interface data	
Communication modes	
• PLC-PLC	29 connections
• Broadcast	125 connections
• DP connection	1 to DP master
Message length for	
• PLC-PLC	64 bytes max.
• Broadcast	64 bytes max.
• DP connection	16 words max. (word-consistent)
Permissible blocks	
• Data blocks	DB1 and DB2

SINEC L2 data	
Main processor	80C537
Communications processor	V 25+ with SPC
Bus cable	twisted, shielded pair
Interface	RS 485
Transmission method	bit serial
Transmission protocol	to DIN 19245, Part 1
Access method	
• Between active stations	token passing to DIN 19245, Part 1
• Between active and passive stations	master-slave to DIN 19245, Part 1
Transmission rates (adjustable in DB1)	93.75 Kbps 187.5 Kbps 500 Kbps 1500 Kbps
Min. slave interval	10 ms
Manufacturer identifier	$001F_H$

Dimension Drawing

The dimension drawing for the CP 541 is given in Figure A-1.

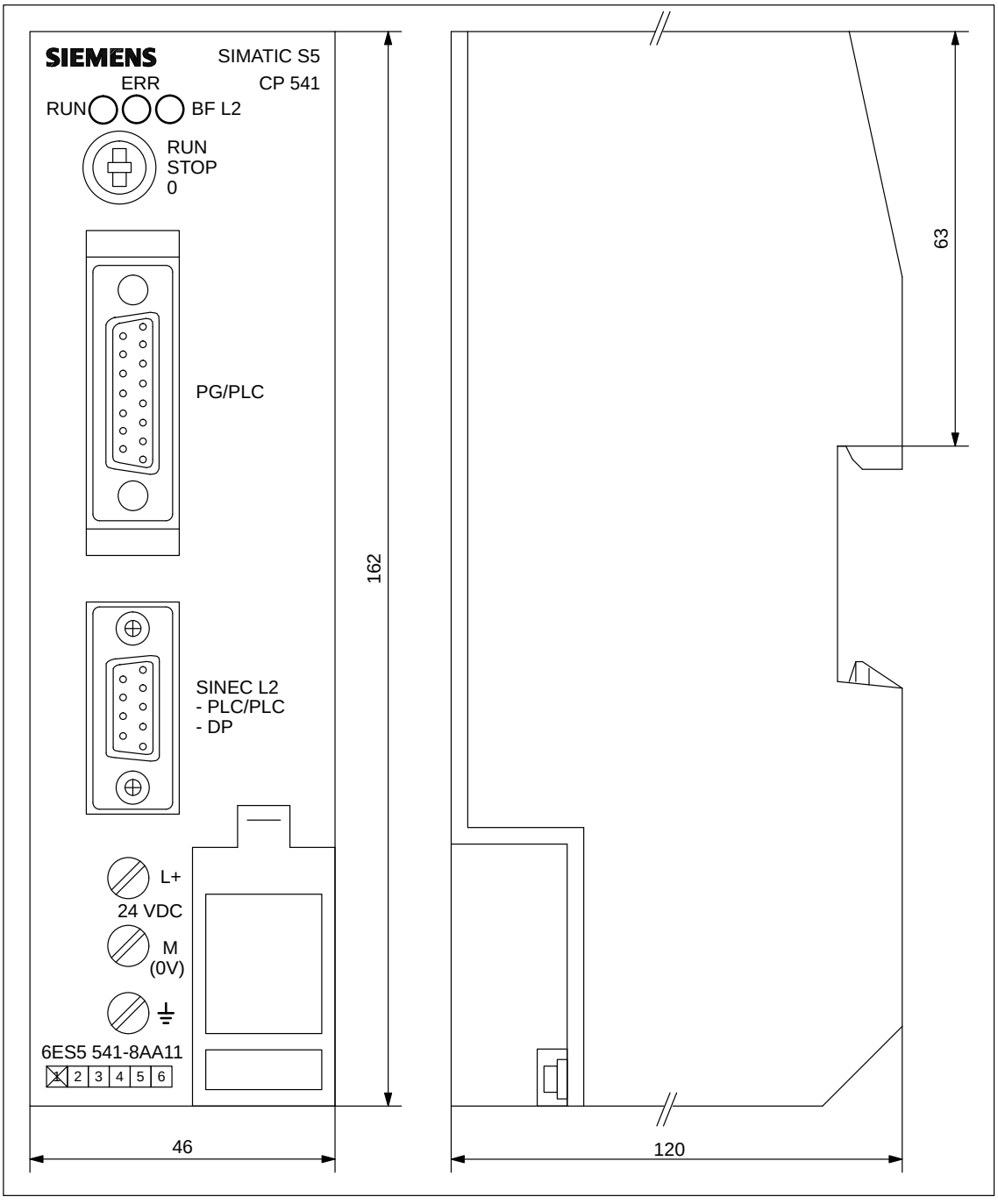


Figure A-1 CP 541 Dimension Drawing

Optimizing SINEC L2

B

Introduction

By optimizing the parameters in DB1, you can speed up message processing in the CP 541 and, therefore, also SINEC L2.

A full description of DB1 is given in Appendix C.

Parameter BSAP

You specify the SAP (service access point) for broadcast with parameter BSAP. Additionally, you can suppress the broadcast with BSAP.

The greater the number of broadcast messages sent from the CP 541 to the connected programmable controller, the longer is the duration of the entire data transmission to this programmable controller.

Optimization

You can optimize parameter BSAP as follows:

If you do not wish to send or receive a broadcast, you must assign the value 0 to parameter BSAP. The CP 541 will then not send any received broadcast messages to the connected programmable controller.

If you still generate a broadcast in your user program and send it to the CP 541, the CP 541 will generate an error message and go to the STOP state.

Parameter HSA

You affect the degree of management for SINEC L2 in the CP 541 with parameter HSA. You use parameter HSA to specify the active station with the highest station number.

Each active station must manage its own polling list with all L2 stations in SINEC L2. When the token is passed on, all stations not entered in the list which are located between the own station number and the station number of the next active station, are called cyclically.

Optimization

You can optimize parameter HSA as follows:

- Specify the station numbers of all active stations in a connected series.
- Begin the addressing of active stations with station number 1.
- Assign the station number of the highest active station to HSA.
- Specify no reserve or only slight reserves for any active stations to be inserted later.

Parameter POL

Parameter POL affects the data transmission from the connected programmable controller to the CP 541. The default for POL is 100 ms (POL = 10).

By varying this value, you can interrogate the connected programmable controller more or less frequently for messages to be sent, or fully suppress the interrogation.

Optimization

You can optimize parameter POL as follows. Observe the defaults of your connected programmable controller, especially with the S5-95F and S5-115F.

- If the connected programmable controller is to be interrogated more frequently, you can reduce the value of POL. The minimum delay is 10 ms (POL = 1).

  Note that the more frequent interrogation of the connected programmable controller results in its being subjected to a higher basic load for interface processing.
- If you do not wish to send messages from the connected programmable controller, you can assign the value 0 to POL. The connected programmable controller will no longer be interrogated for messages to be sent.

Parameter PRI

Without a user-defined priority list PRI, all possible receive mailboxes (station numbers 1 to 30, broadcast and DP connection) will be interrogated by the CP 541 for newly received messages.

You can define the priority list yourself.

Optimization

You can optimize parameter PRI as follows:

If you know which connection partners are present for the CP 541, you define your own priority list. You can thus specify the priorities for particular connection partners and from which partners a message will be transmitted.

With your self-defined priority list, you reduce the internal degree of management for the CP 541.

Example

Here are two examples of a priority list.

- PRI 1, 6, 2

  Stations 1, 6 and 2 will always be interrogated successively. Each station has the same priority. Messages from other stations will not be transmitted.

- PRI 1, 6, 1, 2

  With each cycle, Station 1 will be interrogated twice. Station 1 thus has a higher priority. Messages from other stations will not be transmitted.

Parameter STA

When the message-oriented communication modes PLC-PLC connection and broadcast are used, the CP 541 must be assigned a parameter as the active station (STA = AKT). In this case, the CP 541 must receive the send authorization within the token rotation time.

The greater the number of active stations in SINEC L2, the greater is the time required for token management of all active stations.

Optimization

You can optimize parameter STA as follows:

If you only wish to use the DP connection, you can assign a parameter to the CP 541 as the passive station (STA = PAS). The token rotation time will thus be reduced and SINEC L2 will only be loaded with data transmission.

Parameter UPDL

Parameter UPDL affects data transmission from the CP 541 to the connected programmable controller. With the default setting, it is intended for the S5-95F and S5-115F. UPDL is preset with 100 ms (UPDL = 10) for these two SIMATIC S5 controllers.

With a reduction in this value, successive messages can be sent more frequently from the CP 541 to the connected programmable controller.

Optimization

You can optimize parameter UPDL as follows. Observe the defaults of your connected programmable controller, especially with the S5-95F and S5-115F (see Sections 5.3.1 to 5.3.5).

- If your programmable controller can process a subsequent message after a receive message after a shorter time, you can reduce the value of UPDL.

  Note that more frequent sending to the connected programmable controller results in its being subjected to a higher basic load for interface processing.

- If incoming messages from SINEC L2 can be sent to the connected programmable controller without delay, you can assign the value 0 to UPDL.

Parameter TRT

You specify the token rotation time for SINEC L2 with parameter TRT. Given in Appendix C.7 is a detailed description for calculating parameter TRT and, therefore, optimizing it.

Parameters of DB1

C

Introduction

You assign parameters to the CP 541 with DB1 in the CP 541. You thus determine the operational behavior of the CP 541.

Modifying DB1

To be able to modify DB1 in CP 541, you must switch the CP 541 to STOP and connect a PG to the PG/PLC input. It is assumed that you already know how to modify DB1 with a PG.

Default DB1

The CP 541 operating system contains a default DB1 with which the CP 541 can be started.

COM DB1

You **cannot** use software package COM DB1.

Size of DB1

DB1 in CP 541 can contain up to one Kbyte of data. Ensure that DB1 does not contain too much unnecessary data such as blanks and remarks.

If you have modified DB1 repeatedly, you must compress the main memory in the CP 541 from a PG. After a change in DB1, the old DB1 is not overwritten but merely declared invalid and the modified DB1 is stored in a free memory area. Invalid data blocks are cleared by compression.

Interaction

For some parameters, you need information from all the stations in use in SINEC L2. You will be informed again with the relevant parameters.

Summary of this Section

C.1 Structure of DB1

Introduction

With your entries in DB1, you coordinate the exchange of data between the connected programmable controller and SINEC L2.

Structure

DB1 is subdivided into three areas, as shown in Figure C-1. You can define the following three areas in DB1:

- General SINEC L2 parameters, block identifier SL2 (**S**INEC **L2**)
- CP 541-specific parameters, block identifier COM (**com**munication)
- Parameters for the DP connection, block identifier DPS (**DP s**lave)

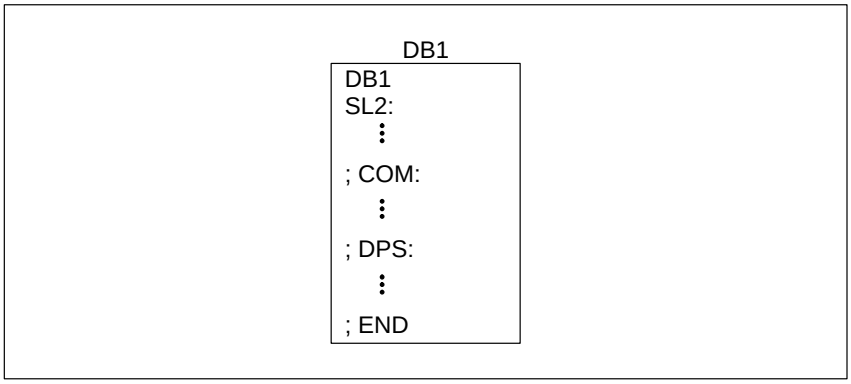


Figure C-1 Structure of DB1

General SINEC L2 Parameters

You mark the area for the general SINEC L2 parameters with the block identifier SL2. This contains the station number, transmission rate and various time-dependent parameters. This area is described in Appendix C.3.

CP 541-Specific Parameters

You mark the area with the CP 541-specific parameters with block identifier COM. It contains the conversion for node address 0, the SAP for the broadcast, the send delay time, receive delay time and the priority list. This area is described in Appendix C.4.

DP Parameters

You mark the area with parameters for the DP connection with block identifier DPS. It contains the number of data words for input and output data and the response monitoring time for DP messages from the connected programmable controller to the CP 541. This area is described in Appendix C.5.

C.2 Syntax of DB1

Introduction

The structure of DB1 and the syntax of the individual parameters comply with fixed rules. Given in Figure C-2 is the syntax for DB1.

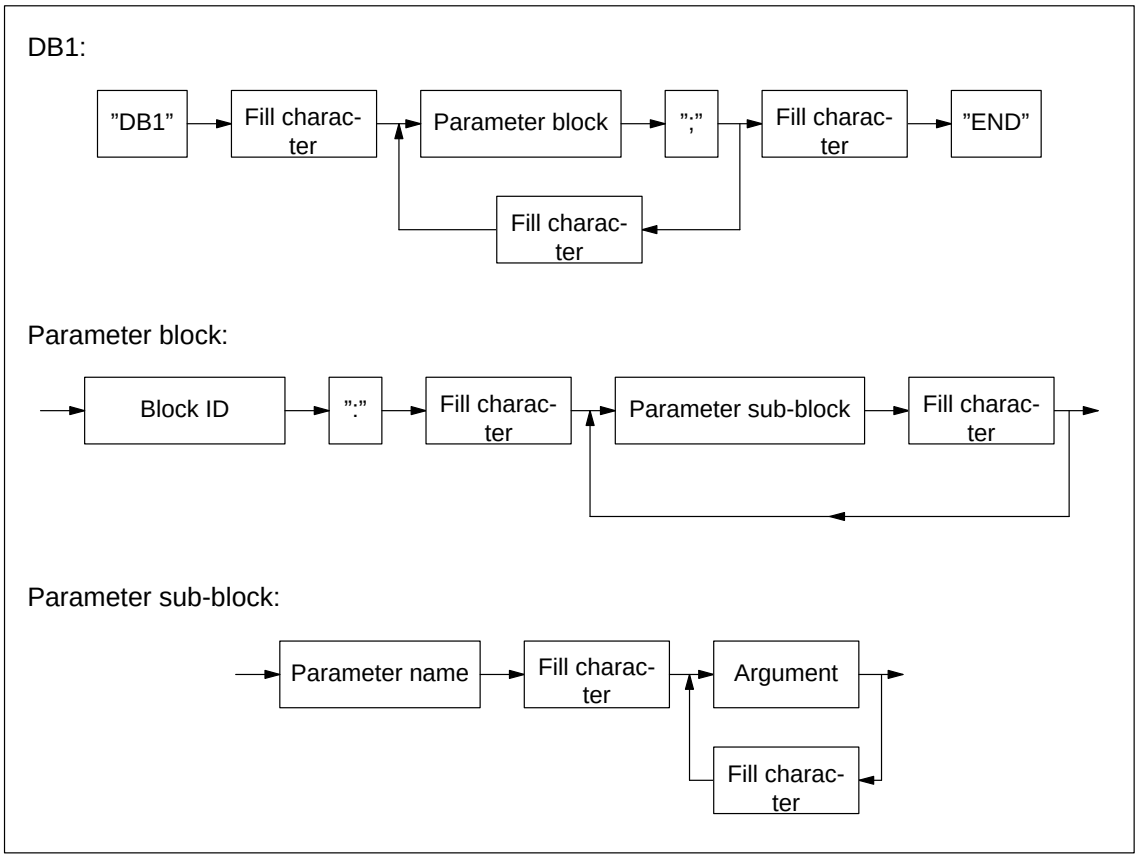


Figure C-2 Syntax of DB1

Fill character

You can use the following fill characters in DB1.

Character	<TAB>	<LF>	<FF>	<CR>	" "	","
Hex value	09_H	$0A_H$	$0C_H$	$0D_H$	20_H	$2C_H$

Block Identifier

You can use the following block identifiers in DB1:

- SL2 (see Appendix C.3)
- COM (see Appendix C.4)
- DPS (see Appendix C.5)

C.3 General SINEC L2 Parameters - block Identifier SL2

Meaning

With block identifier SL2, you enter the general parameters for the SINEC L2. An explanation of individual parameters can be found in Table C-1.

Observe the syntax of DB1 (see Appendix C.2).

Table C-1 SL2 Parameters

Parameter[1]	Values	Meaning
TLN (Address)	1 ... 30	Station number The station number which you enter with parameter TLN for the CP 541 must not be entered in the priority list (parameter PRI, COM block). The station number must be identical to the node address of the connected programmable controller.
STA	 AKT PAS	**Sta**tion status • Active You can install message-oriented communication (PLC-PLC connection), broadcast and data-oriented communication (DB connection) in parallel. • Passive You can only establish a data-oriented DP connection. Token management does not take place in the CP 541. The token rotation time is reduced; this corresponds to an acceleration of communication in the SINEC L2.
BDR (Baud_rate)	93.75 187.5 500 1500	**B**au**d r**ate Specify the transmission rate in Kbps. Ensure that you use a decimal point to separate the decimal places in DB1. This parameter must be set identically in all stations. Use the value of the station with the lowest maximum transmission rate. Observe the bus topology, such as cable lengths.
HSA	1 ... 126	With parameter HSA, you specify the **h**ighest **sta**tion number of all active stations present in SINEC L2. You take this value from the configuration of your SINEC L2. Note that with each PLC-PLC connection and each broadcast, the sending CP 541 is an active station.
TRT (T_{TR})	256 ... 1048320*	**T**arget **r**otation **t**ime (for token) The token rotation time is the calculated average time elapsing until all stations have had the token once. A calculation of the token rotation time is given in detail in Appendix C.7. This parameter must be set identically in all stations.

1 Designations given in parentheses comply with DIN 19245.

* Specify the value in bit times. A bit time is the time elapsing during transmission of one bit. It is the reciprocal of the baud rate.

Table C-1 SL2 Parameters, continued

Parameter[1]	Values	Meaning
SET (T_{SET})	0 ... 494*	**Set**up time The setup time is the time which may elapse between an event and the reaction to the event. The formula is: (SDT 2 − 35)/2 ≥ SET > (SDT 1 − 35)/2. This parameter must be set identically in all stations.
ST (T_{SL})	50 ... 4095*	**S**lot **t**ime The slot time specifies how long a sending station must wait until the addressed station reacts. The type of message concerned is not significant. The formula is: ST ≥ (SDT 2 + 15). This parameter must be set identically in all stations.
SDT 1 (min T_{SDR})	11 ... 255*	**S**tation **d**elay **t**ime 1 (shortest protocol processing time) Station delay time 1 is the minimum time elapsing between the sending or receiving of the last bit of a message and the sending or receiving of the first bit of a subsequent message. The formula is: SDT 1 < (35 + 2 × SET). The parameter must be set identically in all stations.
SDT 2 (max T_{SDR})	35 ... 1023*	**S**tation **d**elay **t**ime 2 (greatest protocol processing time) Station delay time 2 is the maximum time elapsing between the sending or receiving of the last bit of a message and the sending or receiving of the first bit of a subsequent message. The formula is: SDT 1 < (35 + 2 × SET) ≤ SDT 2 ≤ (ST − 15) This parameter must be set identically in all stations.

1 Designations given in parentheses comply with DIN 19245.

* Specify the value in bit times. A bit time is the time elapsing during transmission of one bit. It is the reciprocal of the baud rate.

Basic Parameters

Parameters TLN, STA, BDR, HSA, TRT, SET, ST, SDT 1 and SDT 2 are referred to as basic parameters. You must set these basic parameters identically in all stations in the entire SINEC L2, except for TLN and STA.

Necessary Basic Parameters

Depending on the station status (STA) you need not specify all basic parameters. The necessary basic parameters are given in Table C-2.

Table C-2 Necessary Basic Parameters According to Station Status (STA)

Station Status	TLN	STA	BDR	HSA	TRT	SET	ST	SDT 1	SDT 2
STA = AKT	X	X	X	X	X	X	X	X	X
STA = PAS	X	X	X				X	X	

Bus Profiles

Various bus profiles are defined for SINEC L2. The CP 541 supports the following profiles:

- DP/FMS
- PROFIBUS-DP
- DP with IM 308-B
- User defined

DP/FMS

Table C-3 DP/FMS Bus Profile (in Bit Times)

Parameter	Transmission rate in Kbps			
	93.75	**187.5**	**500**	**1500**
SET (T_{SET})	50	110	110	80
ST (T_{SL})	600	1500	3500	3000
SDT 1 (min T_{SDR})	125	250	250	150
SDT 2 (max T_{SDR})	250	500	1000	980

PROFIBUS-DP

Table C-4 PROFIBUS-DP Bus Profile (in Bit Times)

Parameter	Transmission rate in Kbps	
	93.75	**187.5**
SET (T_{SET})	1	
ST (T_{SL})	100	
SDT 1 (min T_{SDR})	11	
SDT 2 (max T_{SDR})	60	

DP for IM 308-B

Table C-5 DP Bus Profile for IM 308-B (in Bit Times)

Parameter	Transmission rate in Kbps	
	93.75	**187.5**
SET (T_{SET})	12	12
ST (T_{SL})	100	200
SDT 1 (min T_{SDR})	55	55
SDT 2 (max T_{SDR})	60	60

User Defined

Table C-6 User-Defined Bus Profile (in Bit Times)

Parameter	Transmission rate in Kbps			
	93.75	**187.5**	**500**[1]	**1500**
SET (T_{SET})	45	80	80	80
ST (T_{SL})	240	400	1000	3000
SDT 1 (min T_{SDR})	45	80	80	150
SDT 2 (max T_{SDR})	200	360	360	980

[1] These values are entered in default DB1.

Adjusting the Values

You must use the basic parameters of the slowest station in SINEC L2. The slowest station is the one with the highest value in parameter ST (slot time).

Optimization

If you find that these values do not meet the requirements of your SINEC L2 configuration, you can modify the values. Ensure that you change the values in all stations.

Example of SL2

The following example shows the contents of block SL2 in DB1 for an active CP 541 with station number (TLN) 1, a transmission rate of 500 Kbps and the user-defined bus profile.

The highest station number of an active station is 30. The token rotation time is set for the maximum possible communication size of 29 stations. The setup time has been set to 80 bit times, the slot time to 1000 bit times, the smallest station delay time to 80 bit times and the greatest station delay time to 360 bit times.

```
0:        KS ='SL2:                        ';
12:       KS ='TLN 1 STA AKT BDR 500       ';
24:       KS ='HSA 30 TRT 30000            ';
36:       KS ='SET 80 ST 1000 SDT 1 80     ';
48:       KS ='SDT 2 360                   ';
```

C.4 CP 541-Specific Parameters - Block ID COM

Meaning

You enter the specific parameters for the CP 541 with block identifier COM. An explanation of the individual parameters can be found in Table C-7.

Observe the syntax of DB1 (see Appendix C.2).

Table C-7 COM Parameters

Parameter	Values	Meaning
L1M	0, 1 ... 30	**L1 m**aster address
		Only for S5-115F with a non-safety-related PLC-PLC connection: You need the parameter for the S5-115F to be able to establish a non-safety-related PLC-PLC connection. The S5-115F can only send in non-safety-related mode to node address 0 (SINEC L1 master). Node address 0 is converted with parameter L1M to the station number for the L2 station to which the non-safety-related PLC-PLC connection is to established. The CP 541 executes address conversion; the message itself is not changed. No other PLC-PLC connection to the station specified with L1M is possible.
		Only for DP connection: Node address 0 is reserved for the DP master. In this case, together with the two parameters NWI and NWO in block DPS, it forms an indicator for a DP connection. No further address decoding with the S5-115F can then be entered.
BSAP	0, 33 ... 52	**B**roadcast **s**ervice **a**ccess **p**oint (SAP number for broadcast) The SAP number specifies the service access point to be used to route a broadcast message from the connected programmable controller to SINEC L2 and vice versa. If a broadcast is not to be supported, assign the value 0 to BSAP. The connected programmable controller will then not be unnecessarily loaded with the evaluation of messages which are not needed. BSAP has the internal default 52, even with no specification in DB1. If you have already assigned this service access point in SINEC L2, you must use another free service access point located within the permissible value range (see Appendix G).
POL	0, 1 ... 65535	Slave **POL** interval (send delay time) With the send delay time, you specify the time after which the CP 541 interrogates the connected programmable controller for a new message. If you assign the value 0 to POL, the connected programmable controller will no longer be interrogated. It can then no longer send messages to the CP 541. Enter the send delay time in multiples to 10 ms. POL has the internal default 10 (= 100 ms), even with no specification in DB1.

Table C-7 COM Parameters, continued

Parameter	Values	Meaning
UPDL	0 ... 10	**U**pdate **d**elay (receive delay time) With the receive delay time, you specify the time after which a new message can be sent from the CP 541 to the connected programmable controller. If you enter the value 0, there will be no delay and a message received from SINEC L2 will be immediately sent to the connected programmable controller. The receive delay time depends on the processing speed of the user program in the connected programmable controller. The receive delay time must be 100 ms for S5-95F and S5-115F. With all other PLCs, UPDL can assume all values. Enter the receive delay time in multiples of 10 ms. UPDL has the internal default 10 (= 100 ms), even with no specification in DB1.
PRI	0, 1 ... 30	**Pri**ority list With a maximum of 60 entries, separated by blanks or commas, you use the priority list to specify the priority of individual messages relayed from the CP 541 to the connected programmable controller. You can also designate individual station numbers more than once. On account of the lower transmission rate on the connecting cable between the CP 541 and the connected programmable controller, there may be more than one message in the CP 541 for the connected PLC. If the CP 541 receives a new message from a station, although the previous message of this station has not yet been passed on to the connected programmable controller, the old message is overwritten by the new one. If you do not specify a priority list, the CP 541 internally enters all station numbers (station number 1 to 30), even without a specification in DB1. The own station number will be deleted. If you use the DP connection, the CP 541 additionally enters 0. If you only install a DP connection and set STA = PAS, the internal priority list will only contain 0. With the self-defined priority list, the CP 541 will only transmit messages of the specified stations to the connected programmable controller. For sending via SINEC L2, the priority list is not significant.

Example of COM

The following example shows the contents of block COM. Node address 0 is converted to station number 8.

The connected programmable controller is interrogated every 100 ms; you used service access point 52 for the broadcast. The receive delay time for two successive messages is preset to 100 ms.

Messages are received from stations 1, 2 and 6. Messages from station 1 are passed on to the connected programmable controller with priority.

```
0:        KS ='COM:                        ';
12:       KS ='L1M 8 POL 10 PRI 1 6 1 2    ';
24:       KS ='BSAP 52 UPDL 10             ';
```

C.5 DP Parameters – Block ID ”DPS”

Meaning

You specify the parameters for the DP connection with block identifier DPS. An explanation of the individual parameters can be found in Table C-8.

With block identifier DPS, you inform the CP 541 that it is to store data for node address 0 in the DP transfer area. Data transmission is not safety-related.

Observe the syntax of DB1 (see Appendix C.2).

Data Transfer

The DP master fetches the data in the DP transfer area and simultaneously stores the input data for the CP 541. The CP 541 sends the new data with node source address 0 to the connected programmable controller.

Table C-8 DPS Parameters

Parameter	Values	Meaning
NWI	0 ... 16	**N**umber **w**ord **i**nput (length of receive data) With parameter NWI, you specify the volume in words of the receive data from the DP master (sent by the DP master). You enter the values for input and output data separately.
NWO	0 ... 16	**N**umber **w**ord **o**utput (length of send data) With parameter NWO you specify the volume in words of the send data to the DP master (made available for the DP master). You enter the values for the input and output data separately.
DPWD	50 ... 65535	**DP w**atch**d**og (DP response monitoring time) The DP watchdog serves to monitor the DP connection between the CP 541 and the connected programmable controller. The DP watchdog specifies the time within which a new DP message must be sent from the connected programmable controller to the CP 541. If the CP 541 does not receive a new DP message with node address 0 within the DP watchdog, an error message in the form of a diagnosis will be issued to the DP master. Specify the DP watchdog so that the connected programmable controller can reliably send a DP message within this time. Take into account all interrupt processing times within your user program. DP monitoring becomes active as soon as the CP 541 is accepted in the DP cycle and DP monitoring has been activated by the DP master. Enter the DP monitoring time in multiples of 10 ms. DPWD has the internal default 50 (= 500 ms), even with no specification in DB1.

Consistent Data

The input and output data to the DP master and from it are word-consistent.

DP Connection

If you configure a DP connection, at least one of the two parameters NWI or NWO must be ≠ 0.

Special Note for S5-115F

If you have configured a DP connection in an S5-115F, you cannot additionally install a non-safety-related PLC-PLC connection.

Reason: In both connections, the S5-115F uses node address 0 (SINEC L1 master).

Example of DPS

The following example shows the contents of block DPS.

For the exchange of data on the DP connection, 16 words of input data and 16 words of output data are allowed for. The DP watchdog has been set to 500 ms.

```
0:        KS ='DPS:            ';
12:       KS ='NWI 16 NWO 16   ';
24:       KS ='DPWD 50         ';
```

C.6 Default DB1

Introduction

When delivered and after a reset, the CP 541 contains a default DB1. The settings of the default DB1 in the CP 541 are such that you can use it immediately in most cases. You need only adjust the station number.

Default DB1

The following list contains an explanation of the default DB1.

```
Indication                              Explanation
KS ='DB1                ';

KS ='SL2:               ';              Block ID SL2
KS ='TLN 1              ';              Station number 1
KS ='STA AKT            ';              Station status active
KS ='BDR 500    ';                      Transmission rate: 500 Kbps
KS ='HSA 30             ';              Highest station number of all L2 masters: 30
KS ='TRT 30000 ';                       Token rotation time: 30000 bit times = 60 ms
KS ='SET 80             ';              Setup time: 80 bit times = 0.16 ms
KS ='ST 1000            ';              Slot time: 1000 bit times = 2 ms
KS ='SDT 1 80           ';              Shortest station delay time:
                                        80 bit times = 0.16 ms
KS ='SDT 2 360 ;        ';              Greatest station delay time:
                                        360 bit times = 0.72 ms

KS ='#COM:              ';              Block identifier: COM (remarks)
KS ='L1M 0              ';              Address conversion to station number: 0
KS ='BSAP 52            ';              Broadcast service access point: 52
KS ='POL 10             ';              L1 send delay time: 100 ms
KS ='UPDL 10            ';              Priority: ...; a dummy character has been
KS ='PRI ........  ;# ';                entered.

KS ='#DPS:              ';              Block identifier: DPS (remarks)
KS ='NWI 16             ';              Length of input data: 16 words
KS ='NWO 16             ';              Length of output data: 16 words
KS ='DPWD 50 ;#         ';              DP watchdog: 500 ms

KS ='END                ';
```

Important

The two blocks COM and DPS are marked as remarks. If you wish to use these two blocks, you must overwrite the "#" remark marks with a blank.

Note

If you remove the comment characters from block COM, you must either clear parameter PRI or define you own priority list.

The CP 541 cannot run with the dummy character for the values of PRI in default DB1.

Defaults

All values are preset as defaults. If individual parameters are marked as remarks, the values stored internally will be used by the CP 541. The default values are listed in Table C-9.

Table C-9 Default Values in DB1

Parameter	L1M	BSAP	POL	UPDL	PRI	DPWD
Value	0	52	10	10	0*, 1..30	50

* For the DP connection, the 0 is also entered automatically in PRI.

Modifying DB1

Proceed as follows to modify DB1.

Step	Action	Explanation
1	Connect your PG to the PG/PLC interface.	You only have access to DB1 via the PG/PLC interface.
2	Switch the CP 541 to the STOP mode.	You can only modify DB1 in the STOP mode.
3	Read DB1 in the CP 541.	–
4	Make the desired changes.	For example, enter the station number in the default DB1 (see Chapter 4).
5	Store DB1 in the CP 541 again.	–
6	Remove your PG and reconnect the connecting cable.	–
7	Switch the CP 541 to the RUN mode.	The CP 541 is now ready and DB1 is stored in the EEPROM.

Overall Reset

You can only execute an overall reset of the CP 541 by means of a programmer.

Storage of DB1

After a STOP-RUN transition, DB1 is stored in the nonvolatile EEPROM of the CP 541. Even if you switch off the CP 541, the modified DB1 will be retained.

C.7 Calculating the Token Rotation Time

Meaning

The token rotation time (TRT, target rotation time) specifies the time required until all active stations have had possession of the token once.

The calculation for the token rotation time is given in the following.

Default

The token rotation time has the default 30000 bit times in DB1 of the CP 541. You can operate SINEC L2 with this setting.

Optimization

If you wish to optimize the timing of your SINEC L2, you must calculate the token rotation time yourself. You can thus minimize the token rotation time, which results in a speeding up of time-critical messages.

Calculation

Calculate the token rotation time according to the following instructions. Bit times are used.

The bit time is the time elapsing during sending of one bit (the reciprocal of the transmission rate, see DIN 19245).

Step	Action	Meaning
1	Determine the number of stations in SINEC L2.	You must take into account all active stations of SINEC L2. Passive stations cannot send messages independently.
2	Determine the maximum number of messages for each active station.	The number of messages is given by the number of configured connections per station. You must add the connections which the station can establish by itself.
3	Distinguish the messages according to their type, such as broadcast, PLC-PLC or DP connection [1]).	Sort the messages according to their type. You will have an overview of the frequency of individual types of connection.
4	Calculate the basic load for the individual messages without data.	Add up the values from Table C-10 according to the frequency of individual connections.
5	Determine the total data volume.	Add up the data (number of bytes) of each message.
6	Calculate the loading caused by data for each message.	For each transmitted data byte, you must add 11 bit times.
7	Add up the individual loads.	–

[1] If necessary, you can take the time requirement for the DB connections from the configuring tool, such as COM ET 200 Windows, which calculates the token rotation time for a pure DP system.

Basic Load

The values for the basic load as a function of message type and transmission rate can be found in Table C-10.

Table C-10 Basic Load on SINEC L2 (in Bit Times)

Message type	Transmission rate in Kbps			
	93.75	**187.5**	**500**	**1500**
Token	70	75	145	345
Broadcast	210	230	480	1120
PLC-PLC connection	190	230	425	1040
DP connection (SRD[1])	270	280	500	1160

1 SRD = **S**end and **r**equest **d**ata

C.8 Example of Calculation of the Token Rotation Time

Example The following example is intended to clarify the calculation of the token rotation time. It is based on a transmission rate of 500 Kbps.

Step	Action	Implementation
1	Determine the number of stations in SINEC L2.	The following stations are present: • DP master with station number 1 • CP 541 with station number 2 • CP 541 with station number 3 • 3 DP slaves Both CP 541s can be simultaneously addressed as additional DP slaves.
2	Determine the maximum possible number of messages for each station.	• One token message per active station • CP 541 (No. 2): one PLC-PLC connection to station 3 and broadcast • CP 541 (No. 3): one PLC-PLC connection to station 2 • DP master: five DP connections
3	Distinguish the messages according to type, such as broadcast, PLC-PLC or DP connection.	• 3 token messages • 1 broadcast • 2 PLC-PLC connections • 5 DP connections
4	Calculate the basic load for the individual messages without data.	• Token: $3 \times 145 = 435$ • Broadcast: $1 \times 480 = 480$ • PLC-PLC: $2 \times 425 = 850$ • DP (SRD) $5 \times 500 = 2500$ • Total load: 4265 bit times
5	Determine the total data volume.	• 3 DP slaves: 50 bytes (both directions taken together) • CP 541 (No. 2): – 20 bytes PLC-PLC connection – 10 bytes broadcast – 20 bytes DP connection • CP 541 (No. 2): – 20 bytes PLC-PLC connection – 30 bytes DP connection • Total load: 150 bytes of data

Step	Action	Implementation
6	Calculate the load caused by the data for each message.	You must add 11 bit times for each transmitted data byte. Load: $150 \times 11 = 1650$ bit times
7	Add up the individual loads.	• Basic load: 4265 bit times • Data: 1650 bit times Total load: 5915 bit times The total load in ms is given by: bit times $\times$ 1/transmission rate$_{(\text{in Kbps})}$ = time$_{(\text{in ms})}$ 5915 bit times / 500 Kbps $\doteq$ 11.8 ms

DP Parameter Assignment Message

D

Introduction

The CP 541 needs the parameter assignment message in the DP start; it is explained here. The DP master sends the DP parameter assignment message to the DP slave (CP 541).

Structure

The parameter assignment message contains 7 bytes of data, byte 0 to byte 6. It is structured according to DP Standard DIN E 19254, Part 3.

DP Standard Section

The structure of the 7 bytes according to the DP standard can be found in Table D-1.

Table D-1 Structure of the DP Standard Section of the Parameter Assignment Message

Byte	Value	Meaning
0		Station status[1]
1	0 ... FF_H	Watchdog factor These two bytes represent two factors for the response monitoring time. The response time is calculated with the following formula: $T_{WD} = 10\ ms \times factor\ 1_{(byte\ 1)} \times factor\ 2_{(byte\ 2)}$
2	0 ... FF_H	
3	0 ... FF_H	Response delay (min. T_{SDR}) This entry is not significant with the CP 541 because parameter min. TSDR must be permanently entered via DB1 as parameter SDT 1.
4, 5	$001F_H$	Manufacturer identifier The manufacturer identifier is a product-specific ID. The CP 541 only accepts in the parameter assignment message the manufacturer ID corresponding to the own ID. If the ID in the parameter assignment message does not agree with the own ID, an error message is issued.
6		Group identifier Two or more DP slaves can be grouped with group identifier.

[1] Meanings of the individual bits of the station status are given in Table D-2.

Station Status

The operational behavior of the CP 541 as a DP slave is defined with the station status. Its reactions to other L2 masters are defined, and whether the SYNC and FREEZE mode and the watchdog are used.

The SYNC and FREEZE mode are not supported by the CP 541.

Table D-2 Structure of the Station Status in the Parameter Assignment Message

Bit	Value	Meaning
7, 6	00	Not supported by the CP 541.
	01	
	11	
	10	The CP 541 is not accessible to other PROFIBUS masters. All parameters other than TSDR will be changed.
5	0	The SYNC mode will not be supported by the CP 541.
4	0	The FREEZE mode will not be supported by the CP 541.
3	0	The watchdog is deactivated.
	1	The watchdog for SINEC L2-DP is activated in the CP 541.
2 ... 0	000	Reserved

DP Configuring Message

E

Introduction

The CP 541 requires the configuring message in the start after the parameter assignment message, as described in the DP standard. The DP master sends the DP parameter assignment message to the DP slave (CP 541).

Meaning

The lengths of input and output data are specified in the configuring message. They are compared to the data contained in DB1 of the CP 541.

Structure

The configuring message contains one or two identifier bytes.

Identifier Byte

You define the structure of input and output data with the identifier byte. The structure of the identifier byte is represented in Table E-1.

Table E-1 Structure of Identifier Byte in Configuring Message

Bit	Value	Meaning
7, 6	01	The data of the CP 541 are always word-oriented and word consistent.
5, 4	00	Special ID format, not used
	01	Input data
	10	Output data
	11	Input and output data, not used
3 ... 0		Length of data
	0000 ...	1 word
	1111	16 words

Number (Quantity)

You can specify up to 2 identifier bytes.

You **must** specify the input and output data independently of each other.

Definitions for the DP Master

F

Introduction

For the DP connection between the CP 541 and the DP master, the protocol specified in Standard DIN E 19245, Part 3, is used.

Definitions

Given in the following list is a summary of definitions for the CP 541 which are established for the DP connection.

- The CP 541 and connected programmable controller do not require device-specific parameters.

  The structure of the parameter assignment message is given in Appendix D.

- The configuring message does not contain manufacturer-related data.

  The structure of the configuring message is given in Appendix E.

- You can specify up to 16 words of data per direction.
- The data have word format.
- Data consistency

  You must select word-oriented consistency for the data transmission in the DP master.

- Manufacturer identifier: 001FH
- DP watchdog

  When configuring the DP master, you ensure that the DP watchdog with the CP 541 is set in the DP master according to the transmission rate, as follows:

T'mission rate (in Kbps)	93.75	187.5	500	1500
Watchdog (in ms)	≥ 80	≥ 70	≥ 60	≥ 50

CP 5430/31

With the CP 5430/31, you must select cycle-synchronous exchange of data.

IM 308-B

If you use the IM 308-B as the DP master, you must always assign parameters to the CP 541 as the passive station.

DMD File

All slave-related characteristics are stored in a device master data (DMD) file. The structure of the DMD file is defined in Standard DIN 19245, Part 3.

If you need the DMD file, you can retrieve it via modem under telephone number 0911/737972.

You can also retrieve the DMD file under CompuServe in AUTFORUM (GO AUTFORUM) in the SINEC library area.

Type File

All data of the DP slave needed for configuring with COM ET 200 are contained in a type file.

If you need the type file, you can retrieve it via modem under telephone number 0911/737972.

You can also retrieve the type file under CompuServe in AUTFORUM (GO AUTFORUM) in the SINEC library area.

Additional Information

Additional information on the distributed I/O can be found in, for example, the manual: *ET 200 Distributed I/O System*.

Service Access Point (SAP) and PROFIBUS Services

G

Introduction

You do not necessarily require information on the service access points to work with the CP 541. You can specify a service access point for broadcast with parameter BSAP in frame COM of DB1.

The PROFIBUS services used by the CP 541 are given in Table G-2.

Audience

This chapter is intended for the bus specialist wanting more detail on the internal data transmission process on SINEC L2.

Definition

A message on SINEC L2 is identified and read in by the intended receiving station, by means of the station number carried with the message. To reach its destination, another parameter, the service access point (SAP) is specified in the message.

The CP 541 handles the entering of station number and SAP for you. You can adjust the SAP for broadcast to your bus in DB1.

Service Access Point

The intended SAPs in the CP 541 are shown in Table G-1.

Table G-1 Meanings of Service Access Points (SAPs)

SAP	Meaning
0	If you assign the value 0 to parameter BSAP, this indicates to the CP 541 that broadcast will not be used. No SAP will be assigned for broadcast.
2 ... 31*	PLC-PLC connection
33 ... 52	Broadcast, selectable with BSAP
55 ... 62	DP connection according to DIN E 19245, Part 3

* The following definitions apply to PLC-PLC connections:
SAP 2 means PLC-PLC connection to station 1
SAP 3 means PLC-PLC connection to station 2, etc. up to
SAP 31 means PLC-PLC connection to station 30

PROFIBUS Services

Messages from the connected programmable controller are converted by the CP 541 to the PROFIBUS services given in Table G-2.

Table G-2 PROFIBUS Services

Communication mode	PROFIBUS service	Priority
PLC-PLC connection	SDA[1]	Low priority
Broadcast	SDN[2]	Low priority
DP connection	SRD[3]	See DIN E 19245, Part 3

1 SDA: **S**end **D**ata with **A**cknowledge
2 SDN: **S**end **D**ata with **N**o Acknowledge
3 SRD: **S**end and **R**equest **D**ata

Program Examples

H

Introduction

In this chapter, we have assembled three examples to demonstrate the incorporation of the CP 541 and the effects on the user program of the connected programmable controller.

Summary of this Section

H.1 PLC-PLC Connection

Introduction

This example shows a PLC-PLC connection between two S5-95Q programmable controllers. It is a bidirectional PLC-PLC connection.

Program Sequence

From each programmable controller (station 11 and station 12), the value of IB 33 is sent with a positive-going edge at I 32.0 to the partner PLC and indicated there with QB 32.

Configuration

Shown in Figure H-1 is the configuration for a PLC-PLC connection.

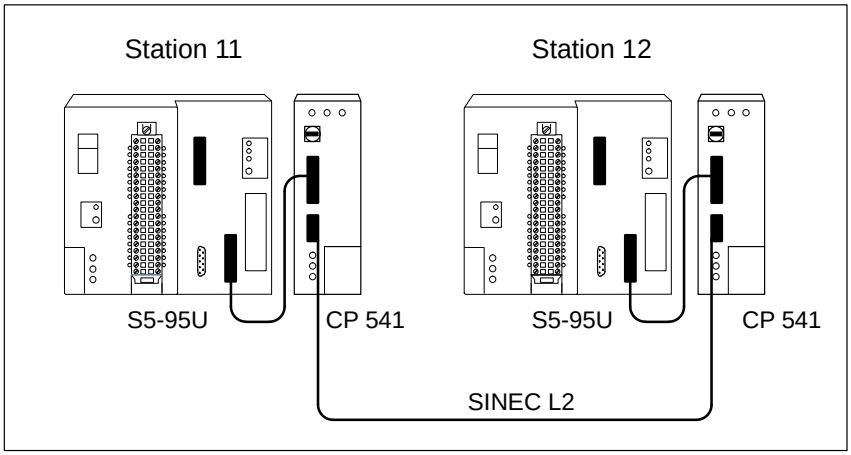


Figure H-1 Configuration for a PLC-PLC Connection

Station 11

Given in the following are the data blocks (DBs), function blocks (FBs) and organization blocks (OBs) for station 11.

DB1 in CP 541

```
DB1 in CP 541
DB1

  0:    KS ='DB1 SL2: TLN 11 STQ AKT ';
 12:    KS =' BDR 500     HSQ 30     ';
 24:    KS =' TRT 30000              ';
 36:    KS =' SET 80      ST  1000   ';
 48:    KS =' SDT 1 80    SDT 2 360 ;';
 60:    KS ='#DPS: NWO 16 NWI  16    ';
 72:    KS =' DPWD 50               ;#';
 84:    KS ='#COM: L1F 0  POL  10    ';
 96:    KS =' BSAP 52     UPDL 10    ';
108:    KS =' PRI  .........       ;#';
120:    KS =' END                    ';
132:
```

DB1 in S5-95U

DB1 in S5-95U PLC

```
DB1

 0:     KS =’DB1 SL1:                ’;
12:     KS =’SLN 11                  ’;
24:     KS =’EF DB11 DW0             ’;
36:     KS =’SF DB12 DW0             ’;
48:     KS =’CBR FY11                ’;
60:     KS =’CBS FY12                ’;
72:     KS =’; END                   ’;
75:
```

DB11 and DB12

DB11 and DB12 in S5-95U PLC

```
DB11

0:      KH = 0000H
1:      KH = 0000H
```

```
DB12

0:      KH = 0000H
1:      KH = 0000H
```

STL	Explanation
OB 21 Segment 1 :JU PB 1 :BE	Restart block
OB 22 Segment 1 :JU PB 1 :BE	Restart block
PB 1 Segment 1 :L KH 0000 :T FY 0 :T FY 12 : :L KH 0080 :T FY 11 :BE	 Reset auxiliary flag Reset CBS Set “ready” in CBR

STL	Explanation
OB 1	Cyclic program block
Segment 1	
:JU FB 12	
Name :S 11=>12	FB to send to station 12
ANST :I 32.0	
:	Initiate sending with I 32.0
:JU FB 11	
:R 11<=12	FB to receive from station 12
:	
:BE	
FB11	Receive block
Segment 1	
Name :R 11<=12	
:Q F 11.7	
:BEC	Test whether L1 message present
:	If not, block end
:Q DB 11	
:L DW 1	Open receive mailbox
:T QB 32	Output DR 1 to QB 32
:	
:AN F 11.7	
:S F 11.7	Indication for operating system,
:BE	ready to receive again
FB12	Send block
Segment 1	
Name :S 11=>12	
Des :ANST I/Q/D/B/T/C: I BI/BY/W/D: BI	
:Q F 12.7	
:BEC	If send mail box blocked by operating
:	system, then block end
:Q =ANST	
:AN F 0.0	Initiation bit
:= F 0.1	Auxiliary flag for signal edge
:Q =ANST	Signal edge flag
:= F 0.0	
:	Auxiliary flag for next cycle
:AN F 0.1	
:BEC	If positive-going edge
:	
:Q DB 12	
:L KY 2,12	Open send mailbox
:T DW 0	Send 2 bytes to station 12
:L IB 33	
:T DW 1	Store IB 33 in DR 1
:	
:AN F 12.7	
:S F 12.7	Release send mailbox for operating
:	system
:BE	

Station 12

Given in the following are the data blocks (DBs), function blocks (FBs) and organization blocks (OBs) for station 12.

DB1 in CP 541

DB1 in CP 541

```
DB1

  0:    KS ='DB1 SL2: TLN 12 STQ AKT ';
 12:    KS =' BDR 500     HSQ 30     ';
 24:    KS =' TRT 30000              ';
 36:    KS =' SET 80      ST  1000   ';
 48:    KS =' SDT 1 80    SDT 2 360 ;';
 60:    KS ='#DPS: NWO 16 NWI  16    ';
 72:    KS =' DPWD 50               ;#';
 84:    KS ='#COM: L1F 0  POL  10    ';
 96:    KS =' BSAP 52     UPDL 10    ';
108:    KS =' PRI  .........       ;#';
120:    KS =' END                    ';
132:
```

DB1 in S5-95U

DB1 in S5-95U PLC

```
DB1

 0:     KS ='DB1 SL1:                ';
12:     KS ='SLN 12                  ';
24:     KS ='EF DB11 DW0             ';
36:     KS ='SF DB12 DW0             ';
48:     KS ='CBR FY11                ';
60:     KS ='CBS FY12                ';
72:     KS ='; END                   ';
75:
```

DB11 and DB12

DB11 and DB12 in S5-95U PLC

```
DB11

0:      KH = 0000H
1:      KH = 0000H

DB12

0:      KH = 0000H
1:      KH = 0000H
```

STL	Explanation
OB 21	Restart block
Segment 1	
:JU PB 1	
:BE	

STL	Explanation
OB 22	Restart block
Segment 1	
:JU PB 1	
:BE	

STL	Explanation
PB 1	
Segment 1	
:L KH 0000	
:T FY 0	
:T FY 12	Reset auxiliary flag
:	Reset CBS
:L KH 0080	
:T FY 11	Set “ready” in CBR
:BE	

STL	Explanation
OB 1	Cyclic program block
Segment 1	
:JU FB 12	
Name :S 12=>11	FB for sending to station 11
ANST :I 32.0	
:	Initiate sending with I 32.0
:JU FB 11	
:R 12<=11	FB for receiving from station 12
:	
:BE	

STL	Explanation
FB11	Receive block
Segment 1	
Name :R 12<=11	
:Q F 11.7	
:BEC	Test whether L1 message present
:	If not, block end
:Q DB 11	
:L DW 1	Open receive mailbox
:T QB 32	Output DR 1 to QB 32
:	
:AN F 11.7	
:= F 11.7	Indication for operating system,
:BE	ready to receive again
FB12	Send block
Segment 1	
Name :S 12=>11	
Des :ANST I/Q/D/B/T/C: I BI/BY/W/D: BI	
:Q F 12.7	
:BEC	If send mail box blocked by operating
:	system, then block end
:Q =ANST	
:AN F 0.0	Initiation bit
:= F 0.1	Auxiliary flag for signal edge
:Q =ANST	Signal edge flag
:= F 0.0	
:	Auxiliary flag for next cycle
:AN F 0.1	
:BEC	If positive-going edge
:	
:Q DB 12	
:L KY 2,11	Open send mailbox
:T DW 0	Send 2 bytes to station 11
:L IB 33	
:T DW 1	Store IB 33 in DR 1
:	
:AN F 12.7	
:S F 12.7	Release send mailbox for operating
:	system
:BE	

H.2 DP Connection

Introduction

Shown in the following is the DP connection between a DP master (S5-115U with IM 308-C) and a DP slave (S5-90U with CP 541).

Program Sequence

The DP master sends five data words to the DP slave. The DP master receives two data words from the DP slave. The data are made available and processed in flag words in the S5-90U.

Configuration

The configuration for the DP connection is represented in Figure H-2.

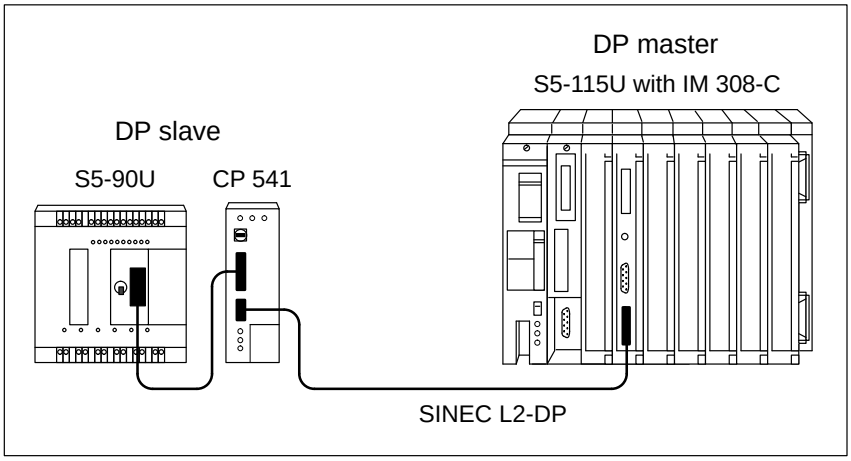


Figure H-2 Configuration of a DP Connection

DP Master

In this example, we assume that you configure the IM 308-C with COM ET 200 Windows and that the type file is available (see Appendix F).

The configuration of the DP connection is subject to the following conditions:

- The IM 308-C has station number 1 and reserves pages 0 to 15.
- The user-defined bus profile will be used.
- A transmission rate of 500 Kbps is set.
- The S5-115U with CP 944 serves as the host.
- The inputs and outputs will be addressed linearly.
- The CP 541 has station number 3.
- The IM 308-C receives two data words from the CP 541.
- The IM 308-C sends five data words to the CP 541.
- Address P000 is assigned in the DP master as the start address for the inputs and for the outputs.

DP Slave

Given in the following are the data blocks (DBs), functions blocks (FBs) and organization blocks (OBs) for the slave (CP 541 with S5-90U). In the S5-90U, you must define data block DB 10 with 50 data words in addition to the following data.

DB1 in CP 541

DB1 in CP 541

```
DB1

  0:    KS ='DB1 SL2: TLN 3 STQ AKT ';
 12:    KS =' BDR 500     HSQ 30     ';
 24:    KS =' TRT 30000              ';
 36:    KS =' SET 80      ST  1000   ';
 48:    KS =' SDT 1 80    SDT 2 360 ;';
 60:    KS =' DPS: NWO 2  NWI  5     ';
 72:    KS =' DPWD 50               ;';
 84:    KS ='#COM: L1F 0  POL  10    ';
 96:    KS =' BSAP 52     UPDL 10    ';
108:    KS =' PRI  .........       ;#';
120:    KS =' END                    ';
132:
```

DB1 in S5-90U

DB1 in S5-90U PLC

```
DB1

 0:     KS ='DB1    SL1:   SLN 3     ';
12:     KS =' EF DB10DW0    CBR FY6  ';
24:     KS =' SF DB10DW33   CBS FY8 ;';
36:     KS =' END                    ';
48:
```

```
STL                                          Explanation
OB 21                                        Restart processing
Segment 1
       :L   KH 0000
       :T   FW   6
       :T   FW   8                           Reset CBR
       :                                     Reset CBS
       :AN  F    6.7
       :S   F    6.7                         Set receive readiness in CBR
       :
       :BE
```

```
OB 22                                        Restart processing
Segment 1
       :L   KH 0000
       :T   FW   6
       :T   FW   8                           Reset CBR
       :                                     Reset CBS
       :AN  F    6.7
       :S   F    6.7                         Set receive readiness in CBR
       :
       :BE
```

```
STL                                          Explanation
OB 1                                         Cyclic program processing
Segment 1
       :
       :JU FB  11
Name   :R 3<=0                               FB for receiving from DP master
       :
       :JU FB  12
Name   :S 3=>0                               FB for sending to DP master
       :
       :BE
```

```
STL                                     Explanation
FB 11                                   Receive block
Segment 1
Name :R 3<=0

       :Q   F    6.7
       :BEC                             Test whether L1 message is present
       :                                If not, block end
       :Q   DB  10
       :                                Open receive mailbox
       :L   DW   1
       :T   FW  10                      Intermediate storage of receive data
       :L   DW   2                      for further processing
       :T   FW  12
       :    ⋮
       :    ⋮
       :L   DW   5
       :T   FW  18
       :
       :                                ======================================
       :                                Program section to evaluate
       :                                receive data
       :                                ======================================
       :AN  F    6.7
       :S   F    6.7                    Indicates to operating system that
       :BE                              ready to receive again

FB 12                                   Send block
Segment 1
Name :S 3=>0

       :Q   F    8.7
       :BEC                             If send mailbox blocked by operating
       :                                system, then block end
       :Q   DB  10
       :L   KY 4,0                      Open send mailbox
       :T   DW  33                      Send 4 bytes to station 0 DP master
       :
       :                                ======================================
       :                                Program section to reserve
       :                                send data
       :                                ======================================
       :L   FW  20
       :T   DW  34                      Write send data into transfer area
       :L   FW  22
       :T   DW  35
       :
       :AN  F    8.7
       :S   F    8.7                    Release send mailbox for operating
       :                                system
       :BE
```

H.3 Safety-Related PLC-PLC Connection: S5-95F - S5-115F

Introduction

The example here shows a safety-related PLC-PLC connection between two failsafe programmable controllers: the S5-95F and S5-115F.

Program Sequence

With a positive-going edge at I 32.0, the value of IB 33 is sent from each PLC (S5-95F and S5-115F) to the partner PLC, and indicated there at QB 32.

Configuration

Shown in Figure H-3 is the configuration for the safety-related PLC-PLC connection between an S5-95F and an S5-115F.

Note that the CP 541 is connected to part-PLC B at both programmable controllers.

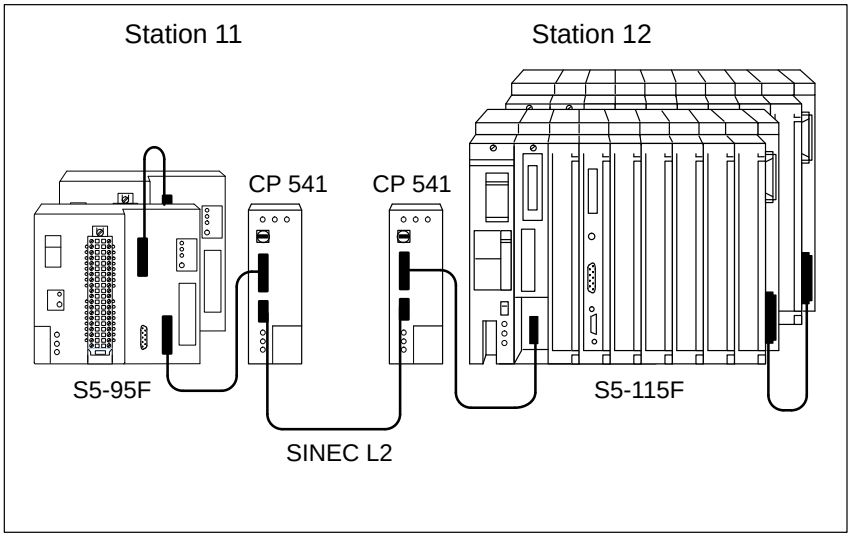


Figure H-3 Configuration for a Safety-Related PLC-PLC Connection

Station 11

Given in the following are the data blocks (DBs), function blocks (FBs) and organization blocks (OBs) for station 11 (S5-95F).

DB1 in CP 541

DB1 in CP 541

```
DB1

  0:    KS ='DB1 SL2: TLN 11 STQ AKT ';
 12:    KS =' BDR 500     HSQ 30     ';
 24:    KS =' TRT 30000              ';
 36:    KS =' SET 80      ST  1000   ';
 48:    KS =' SDT 1 80    SDT 2 360 ;';
 60:    KS ='#DPS: NWO 16 NWI  16    ';
 72:    KS =' DPWD 50               ;#';
 84:    KS ='#COM: L1F 0  POL  10    ';
 96:    KS =' BSAP 52     UPDL 10    ';
108:    KS =' PRI  .........       ;#';
120:    KS =' END                    ';
132:
```

COM 95F

Parameter assignment with COM 95F

```
Parameters for the operating system

User program signature (CRC checksum):              0

System identification number               (0..255): 0
Interval for OB 13    (0..65535):          80 * 10ms
DB area with constant contents          (Y 2..251/N): Yes 2..251
Maximum PLC cycle time                    (10..255): 25 * 10ms
PLC cycle time statistic                      (Y/N): No
DB no. for operator action in F operation(J 2..251/N):No
T'mission of error DB via SINEC L1 part-PLC B  (Y/N): No
T'mission of error DB via CP 521               (Y/N): No
```

```
Parameter assignment for SINEC L1 with 95F PLC

       PG bus number  (Y 1..30/N):                No

       SINEC L1 at part-PLC A                (Y/N) : No
       SINEC L1 at part-PLC B                (Y/N) : Yes

       Slave number   (1..30):                    11
```

```
Parameter assignment with COM 95F, continued
Safety-related data traffic to another 95F PLC or 115F PLC

       Control byte (UVB) (Y 0..255/N):  Yes   FY  10

Data path 1 (DB 252)

       Sending part-PLC (Y A,B,H/N):   Yes    B
       Broadcast message (Y/N):        No
       Sending to slave (0/1..30):     12
       Mode   (95F, 115F–14/15):       115F-15
       Safety time  (0/3..1638):       3*100ms

       Receiving part-PLC (Y A,B,H/N): Yes    B
       Receiving from slave (0/1..30): 12
       Mode   (95F, 115F–14/15):       115F-15
       Safety time  (0/3..1638):       7*100ms
       Reaction  (stop, user):         Stop

Data path 2 (DB 253)

       Sending part-PLC (Y A,B,H/N):   No
       Sending to slave (0/1..30):     0
       Mode   (95F, 115F–14/15):       95F
       Safety time  (0/3..1638):       0*100ms

       Receiving part-PLC (Y A,B,H/N): No
       Receiving from slave (0/1..30): 0
       Mode   (95F, 115F–14/15):       95F
       Safety time  (0/3..1638):       0*100ms
       Reaction  (stop, user):          Stop
```

```
STL                                          Explanation
OB 21                                        Restart processing
Segment 1
       :JU PB   1
       :BE

OB 22                                        Restart processing
Segment 1
       :JU PB   1
       :BE

PB 1
Segment 1
       :Q   DB 252
       :L   KH 0200                          Open send mailbox
       :T   DW  32                           Sending length 2 bytes in DL 32
       :BE
```

STL, continued	Explanation
OB 1	Cyclic program processing
Segment 1	
:JU FB 11	
Name :RECEIVE	FB for sending to station 11
:BE	
FB 11	Receive block
Segment 1	
Name :RECEIVE	
:Q F 10.1	Test whether L1 message present
:BEC	If not, block end
:	
:Q DB 252	Open receive mailbox
:L DW 1	Output DB1 at QB 32
:T QB 32	
:	
:AN F 10.1	Indication for operating system: ready
:S F 10.1	to receive again
:BE	
OB 13	
Segment 1	
:Q I 32.0	Send initiation with I 32.0
:SPB FB 12	
Name :SEND	
:BE	
FB 12	Send block
Segment 1	
Name :SEND	
:Q DB 252	
:L IB 33	Open send mailbox
:T DW 33	Store IB 33 in DR 33 for sending
:	
:AN F 10.0	
:S F 10.0	Release send mailbox for operating
:BE	system

Station 12

Given in the following are the data blocks (DBs), function blocks (FBs) and organization blocks (OBs) for station 12 (S5-115F).

DB1 in CP 541

```
DB1 in CP 541
DB1

  0:    KS ='DB1 SL2: TLN 12 STQ AKT ';
 12:    KS =' BDR 500     HSQ 30     ';
 24:    KS =' TRT 30000              ';
 36:    KS =' SET 80      ST  1000   ';
 48:    KS =' SDT 1 80    SDT 2 360 ;';
 60:    KS ='#DPS: NWO 16 NWI  16    ';
 72:    KS =' DPWD 50              ;#';
 84:    KS ='#COM: L1F 0  POL  10    ';
 96:    KS =' BSAP 52     UPDL 10    ';
108:    KS =' PRI  .........       ;#';
120:    KS =' END                    ';
132:
```

S5-115F with COM 115F

```
Parameter assignment with COM 115F
Parameters for operating system

       0 means not used

User EPROM capacity   (0/8/16/32):          16 KBytes
Max. PLC cycle duration^                (10..16383): 25 * 10ms
Time of occurrence of second error         (1..255): 9 * 10min
Calculated test frame time                         : 51 s
Test cycle time       (1..255):             9 * 10min
User time update :    max. interval (2..16383):10 * 10ms
Interrupt processing: max. interval  (2..255):5 * 10ms
Interval for OB 13    (0;10..16383):        80 * 10ms
Short discrepancy time, no interrupt DI      (1..63): 3 * 10ms
Short discrepancy time, interrupt DI      (0;1..255): 20 ms
Short discrepancy time, analog input       (0;2..63): 0 * 10ms
I/O per. error tolerance variant              (1..4): 1
DB no. for long discrepancy times         (0;4..255): 4
Min. absolute AI deviation               (0;16..255): 16
Global lower wire-break limit             (norm. KF): 0
Global upper wire-break limit             (norm. KF): 0
```

S5-115F with COM 115F, Continued

```
Parameter assignment with COM 115F

DB no. for PG operator control
in F operation                              (0;4..255) : 0

Number of SINEC L1 buses                  (0 , 1 , 2) : 1
Own slave number(1..30) :                             12

Number of elements in SINEC L1 polling list (1..60) : 4
Number of all data bytes transferred      (0..7680) : 24

Safety time SINEC L1  (0;1..16383)                    : 70 * 10ms
Calculated SINEC L1 setup time                        : 23 * 10ms

T'mission of error DB via SINEC L1          (S/R/N) : N
High-grade protection of destination slave no.(Y/N) : J
Detection of message change                   (Y/N) : J
```

Defining the Mailbox

You define the send and receive mailbox in the S5-115F as follows:

```
SINEC L1   SLAVE 12

    0: MASTER    1..30: SLAVE   31: BROADCAST       PARTNER:  11
================================================================================
 SEND      !   !   !   !   !   !   !   !   !   !   ! 11!***!   !   !   !
           !---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--
 TO PARTNER  !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !
================================================================================
 RECEIVE   !   !   !   !   !   !   !   !   !   !   !   !   !***!   !   !   !
           !---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--
 FROM PARTNER !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !XXX!
================================================================================
                            Send mailbox panel

MAILBOX ! DB  OR FLAG (D/M)         : D        DB_NR          (4..255) : 12
        ! MAILBOX LENGTH IN BYTES (1..62) :   4      FROM DATAWORD   (0..255) : 10
```

```
    0: MASTER    1..30: SLAVE   31: BROADCAST       PARTNER:  11
================================================================================
 SEND      !   !   !   !   !   !   !   !   !   !   ! 11!***!   !   !   !
           !---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--
 TO PARTNER  !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !
================================================================================
 RECEIVE   !   !   !   !   !   !   !   !   !   !   !   ! 11!***!   !   !   !
           !---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--
 FROM PARTNER !   !   !   !   !   !   !   !   !   !   !   !   !   !   !   !XXX!
================================================================================
                           RECEIVE mailbox panel

MAILBOX ! DB  OR FLAG (D/M)         : D        DB_NR          (4..255) : 12
        ! MAILBOX LENGTH IN BYTES (1..62) :   4      FROM DATAWORD   (0..255) :  0
```

STL	Explanation
OB 1	**Cyclic Program block**
Segment 1	
:	
:L FW 0	
:L KF +1	**LPLZ sequence**
:+F	
:T FW 0	
:	
:JU FB 11	
Name :RECEIVE	**FB for sending to station 11**
:BE	
FB 11	**Receive block**
Segment 1	
Name :RECEIVE	
:	
:L FW 0	**LPLZ sequence**
:L KF +1	
:+F	
:T FW 0	
:	
:Q DB 12	**Open receive mailbox**
:L DW 1	**Output DR1 to QB 32**
:T QB 32	
:BE	
OB 13	
Segment 1	
:	
:L FW 0	**LPLZ sequence**
:L KF +1	
:+F	
:T FW 0	
:	
:A I 32.0	**Send initiation with I 32.0**
:SPB FB 12	
Name :SEND	
:BE	
FB 12	**Send block**
Segment 1	
Name :SEND	
:	
:L FW 0	**LPLZ sequence**
:L KF +1	
:+F	
:T FW 0	
:	
:Q DB 12	**Open send mailbox**
:L IB 33	**Store IB 33 in DR 11 for sending**
:T DW 11	
:BE	

Glossary

A

Active Stations

When authorized to send, active stations may send data to other stations and request data from other stations.

B

Bit Time

The bit time is the time taken to transmit one bit. It is the reciprocal of the transmission rate: T_{bit} = 1/transmission rate.

Broadcast

A broadcast is a message sent to all stations connected to a bus system.

C

Consistent Data

Data, which are related with regard to contents and must not be separated, are known as consistent data.

The data must not be corrupted by reading out at different times.

CP 5430/31

The CP 5430/31 is an active station which supports the following communication modes: PLC-PLC, FDL, CP, GP and DP.

D

Data-Oriented Connection

With the data-oriented connection, individual messages are transmitted cyclically. The messages may contain identical information over a long time. Transmission takes place in background without initiation via the user program.

Device-Related Diagnosis

Highest level of the slave-specific DP diagnosis: the device-related diagnosis relates to the entire slave.

With CP 541, the device-related diagnosis merely contains the information on whether or not the connected programmable controller has failed.

Diagnostics

Diagnostics covers the detection, locating, classifying, indicating and further evaluation of errors, interference and messages.

Diagnostics offers monitoring functions which are executed automatically during system operation. The availability of the system is thus increased by reducing the startup and down-times.

Within the distributed periphery (I/Os), there are various diagnostic facilities: from the summary showing which DP slave has reported a diagnosis, to the monitoring of an individual input/output.

Distributed I/O Devices

Distributed peripherals are input/output units in a distributed configuration, and not used in the CPU. For example:

- ET 200 family
- S5-95U with SINEC L2-DP interface
- CP 541
- Other DP slaves from Siemens or non-Siemens devices

Distributed I/O devices are connected to the DP master via the SINEC L2-DP bus.

DMD File

All DP slave-specific characteristics are stored in a DMD file (device master data file). The format of the DMD file can be found in Standard DIN E 19245, Part 3.

DP

DP stands for distributed peripherals.

DP Connection

The CP connection is a connection between a DP master and a DP slave in compliance with the DP standard.

DP Master

→ An active station which communicates with the DP slave stations according to a defined algorithm, and makes data available to the user. It acts according to Standard DIN E 19245, Part 3.

DP Master Diagnosis

The master diagnosis indicates the diagnostic data for the DP master; for example, which DP slave has a diagnostic message.

DP Slave

→ DP standard slave

DP Standard Short designation for Standard DIN E 19245, Part 3

DP Standard Slave → Passive station which acts according to Standard DIN E 19245, Part 3.

F

FDL **F**ieldbus **D**ata **L**ink. Layer 2 of the 7-layer model complying with PROFIBUS Standard DIN 19245.

I

IM 308-C The IM 308-C is a DP master for the distributed periphery (I/O) system.

M

Master-Slave Method The master-slave method is a bus access method with which only one station is → active and all the others are → passive.

Message-Oriented Connection With a message-oriented connection, a message is only transmitted when required. Initiation takes place via the user program.

P

Parameter Assignment This is the transfer of slave parameters from the DP master to the DP slave.

Passive Stations Passive stations may only exchange data with an active station when requested to do so by the active station.

PLC-PLC Connection The PLC-PLC connection is a direct connection between two programmable controllers via SINEC L2, without a detour via a master.

PROFIBUS **Pro**cess **Fi**eld **Bus**: the German process and field bus standard specified in the PROFIBUS standard (DIN 19245).

It specifies the functional, electrical and mechanical characteristics for a bit-serial field bus system.

PROFIBUS DP

Draft standard PROFIBUS DP (DIN E 19245, Part 3) on which the distributed periphery (I/O) system is based.

The main task of PROFIBUS DP is fast cyclic exchange of data between the central DP master and the peripherals.

R

Response Delay Time

You specify the duration of the response delay time with the configuring software of the DP master.

If a DP slave is not addressed within the response monitoring time, it goes to the safe state and all outputs are set to 0.

The CP 541 sends a zero message to the connected programmable controller.

S

SDA

Send **D**ata with **A**cknowledge: SDA is a service used in PROFIBUS. The addressed station confirms reception of the message.

SDN

Send **D**ata with **N**o Acknowledge: the SDN service is used in SINEC L2 if a station wishes to send a message to two or more other stations. The addressed stations do not confirm reception of the message.

SINEC L2

SINEC L2 is a bus system for the networking of PROFIBUS-compatible automation systems and field devices in the cell and field level. SINEC L2 is available with the following protocols: PLC-PLC, DP (distributed periphery (I/O)), FDL (fieldbus data link), FMS (fieldbus message specification) and TF (technological functions).

SINEC L2-DP

The SINEC L2 bus system with the DP protocol

Slave

A slave may only exchange data with a master when requested to do so by the master.

SRD

Send and **R**equest **D**ata: SRD is a service used in PROFIBUS. The addressed station confirms reception of the message or sends the requested data.

Station

A station is a device which can send, receive or amplify data via the bus; for example, master, slave, repeater, transceiver.

Station Number Each SINEC L2 station must be assigned a station number. The CP 541 only allows station numbers 1 to 30.

T

Transmission Rate The speed of data transmission; this is the number of transmitted bits per second.

Type File A file requiring configuring software COM ET 200 to configure a DP slave. Defined in the type file are the slave-specific characteristics, such as the number of inputs/outputs, number of diagnostic bytes, SYNC-capable, etc.

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