SIEMENS

SIMATIC

Loadable Driver for CP 341
Modbus ASCII Slave with 32-Bit Extensions

Manual

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Loadable Driver for CP341 Modbus Protocol ASCII Format S7 is Slave with 32-Bit Extensions

Manual

Edition 1.0

Safety Precautions and Warnings

This manual contains warnings, which you should note for your own safety as well as for the prevention of damage to property. These warnings are indicated by means of a triangle and displayed as follows in accordance with the level of danger:

Danger

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

Warning

indicates that death, severe personal injury or substantial 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.

Notice

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

Qualified Personnel

The equipment may be commissioned and put into operation by **qualified personnel** only. For the purpose of safety relevant warnings of this manual a qualified person is one who is authorized to commission, ground and tag devices, systems and circuits.

Correct Usage

Please note the following:

Warning

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

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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 welcome.

Subject to change without prior notice.

Preface

Purpose of this Manual

The information in this manual will enable you to establish and commission a data link between a CP 341 and a “Modbus capable” control system.

Required Basic Knowledge

You require a general knowledge in the field of automation engineering to be able to understand this manual.

In addition, you should know how to use computers or devices with similar functions (e.g. programming devices) under Windows 95/98/2000/NT or XP operating systems. Since loadable driver are based on the STEP 7 software, you should also know how to operate it. This is provided in the manual “Programming with STEP 7 V5.2”.

Contents of the Manual

This manual describes the loadable driver functions and how to create a link to the hardware and software of communication processor CP 341.

The manual contains the following subjects:

- Product Description / Installation
- Commissioning the Driver / Installation / Parameterization
- Interface CPU-CP
- Transmission Protocol
- Diagnostics Driver
- Application Example

Validity of the Manual

This manual Issue is valid for the following software package:

Product	Identification No.	from Version
Loadable Driver for CP 341 Modbus ASCII Slave	6ES7870-1CA00-0YA0	1.0

Note
This manual contains the driver description as is valid at the time of publication.

How to access the information in this manual

To enable you to access the information in this manual more easily, we would like to draw your attention to the following:

- The next few pages contain a complete list of contents.

Further sources of information

Any further information regarding CP 341 (installation, commissioning etc.) can be found in the following manual:

SIEMENS
SIMATIC
CP341 Point to Point Communication
Installation and Parameter Assignment
Manual
C79000-G7076-C341-..

Further information regarding STEP7 can be found in the following manuals:

SIEMENS
SIMATIC Software
Standard Software for S7 and M7
STEP7 User Manual
C79000-G7000-C502-..

SIEMENS
SIMATIC Software
System Software for S7-300/400
System- and Standard Functions
Reference Manual
C79000-G7000-C503-..

Queries

Should you have any queries regarding the use of the driver described in this manual, which are not answered in this documentation please contact the relevant person at Siemens who supplied you with this driver.

Terminology

This documentation uses the terms CP or CP341.

Scope of Application

The driver described in this manual serves as a loadable protocol for CP341, which may be used instead of Standard Protocols 3964R, RK512, and ASCII.

Note

With this driver, modifications or expansions to the sequences between CP and CPU are possible.

These modifications and expansions may apply in particular to event classes or event numbers available for diagnostic purposes.

Furthermore please note that this manual only describes the modifications and expansions as against the standard functions. Basic information may be found in the manuals mentioned in section “Further Sources of Information”.

In order to ensure safe use of the driver, detailed knowledge of the functionality of CP341 is a pre-requisite.

Contents

1 Product Description

1.1 Usage Possibilities

Position in the System

The Driver described here is a software product for communication processor CP341.

Environment

CP341 can be used in automation systems S7-300 and can establish serial communication links to partner systems.

Function of the Driver

This driver, together with the appropriate function block, enables you to establish a communication link between communication module CP341 and “Modbus capable” control systems.

The transmission protocol used is the **Modbus Protocol** in **ASCII Format**. In addition, de-facto standard 32-bit extensions are supported for accessing floating point and double-word registers in compatible slaves. Data transmission is carried out in accordance with the Master-Slave principle.

The Modbus master has the initiative during the transmission while the **the CP341 (installed in the the S7 CPU rack)** operates as the **slave**.

Function Codes 01, 02, 03, 04, 05, 06, 08, 15 and 16 can be used for communication between the CP and the host system.

The MODBUS “Starting Address” in the request message from the master is interpreted by the driver “in an S7 way.”

This means that it is possible to:

- read and write memory bits, outputs, data blocks,
- read inputs bits

in the S7 CPU.

The interpretation of the MODBUS “Starting Address” is explained in the following sections.

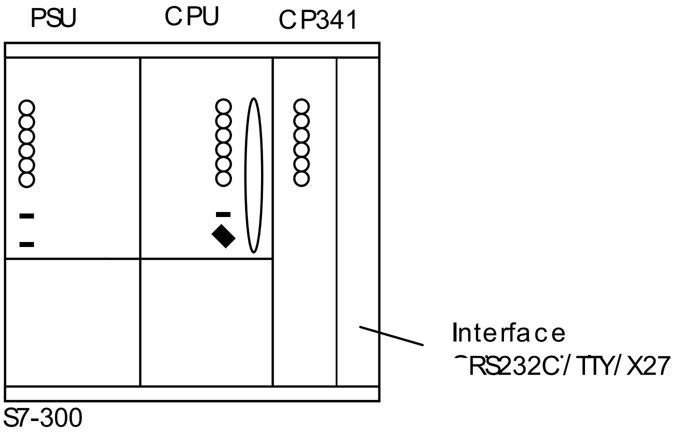
Usable Interfaces and Protocols

You can use CP341 with RS232, TTY, or RS422/485 (X27) interfaces.

With this driver, it is possible to use the RS422/485 (X27) interface submodule in both 2-wire operation and 4-wire operation. In 2-wire operation it is possible to connect up to 32 slaves to one master in half-duplex operation, thus creating a multipoint connection (network). However, this slave driver is not usable in a RS422 multipoint environment since the hardware “Send” line driver never Tri-States. See Appendix A.

Possible System Configuration

The following figure shows a schematic illustration of a possible system configuration.



1.2 Hardware and Software Prerequisites

Useable Module

The Driver runs on CP341 with part number 6ES7 341-1AH01-0AE0 as well as -1BH01 and -1CH01. Also the previous modules -1AH00, -1BH00 and -1CH00 can be used with this driver.

Dongle

In order to use the CP with loadable drivers, you require a dongle. The dongle with identification number 6ES7870-1CA00 is supplied with the driver.

Loading Memory of the CPU (Memory Card)

Every CP interface, for which this loadable driver has been assigned parameters, requires a CPU loading memory amount of about 25 Kbytes.

With CP 341 the loadable drivers are downloaded directly to the CP 341. Therefore you do not require a loading memory on the S7-300 CPU. You should note, however, that this means that you cannot swap out a failed CP 341 containg the driver with a good CP 341 that does not yet contain the driver without using the programming device to load the driver.

Software Issue Levels

Loading of drivers is possible with **STEP 7** from issue level 4.02.

An installed version of the **Parameter Assignment Tool** *CP: Point-to-Point Communication, Parameter Assignment* V4.1 or higher.

We recommend to use STEP 7 V5.1 or higher and Parameter Assignment Tool V5.1 or higher.

Data Structures

Prior to project configuration of your S7 data structures, you should ensure that they are compatible with the user programs of the Modbus Slave systems (clarify which function codes and which Modbus addresses will be used).

1.3 Summary of the Modbus Protocol

Function Codes

The type of data exchange between Modbus systems is controlled by Function Codes (FCs).

Data Exchange

The following FCs can be used to carry out data exchange **bit-by-bit**:
FC 01 Read Coils,
FC 02 Read Discrete Inputs,
FC 05 Write Single Coil,
FC 15 Write Multiple Coils.

The following FCs can be used to carry out data exchange **register-by-register**:
FC 03 Read Holding Registers,
FC 04 Read Input Registers,
FC 06 Write Single Register,
FC 16 Write Multiple Registers.

Data Areas

As a rule, the individual FCs operate in accordance with the table below:

Function Code	Data	Type of Data		Type of Access
01, 05, 15	Coils	Bit	Output	read/write
02	Discrete Inputs	Bit	Input	read only
03, 06, 16	Holding Registers	Register (16 bit or 32 bit)	Output Register	read/write
04	Input Registers	Register (16 bit)	Input Register	read only

Address Representation

Analogous to the partitioning into read/write and read-only areas, data at user level can be represented as shown in the table below:

Function Code	Type of Data	Address Representation at User Level (Decimal)
01, 05, 15	Output bit	0xxxx
02	Input bit	1xxxx
04	Input register	3xxxx
03, 06, 16	Holding register	4xxxx

In the **transmission messages** on the serial transmission line, the addresses used in the Modbus user system are referenced to **0**. In the **Modbus user system** itself, these addresses are typically counted beginning with **1**.

Example:
If the first holding register in the user system is represented as register **4**0001, in the transmission message the value 0000 Hex is transmitted as the register address when FC 03, 06, or 16 is used to access register **4**0001
If the 127th coil is represented as coil **0**0127 in the user system, it is assigned the coil address 007E Hex (126 decimal) in the transmission message.

Note:
The CP341 driver only deals with the transmitted or received zero-based PDU addresses. Any translation from the user level address must be handled in the application program in the S7 PLC or the associated HMI.

1.4 Notes

Data Consistency

The data exchange between the S7 CPU and the CP is carried out block-by block by integrated system functions.

You should also note the section “Data Consistency” in the section “CPU-CP Interface” in this manual.

2 Installation

2.1 Use of the Dongle

Introduction

In order to run the CP with loadable drivers, you require a dongle. When the dongle is plugged in, drivers can be loaded.

How to Plug In the Dongle

Before you can plug in the dongle, you must take the CP out of the rack. At the back of the CP, above the plugs for the backplane bus, there is a slot into which the dongle can be inserted.

2.2 Interface Connection

TTY

A point-to-point connection to one master can be realized.

Further notes to the interface connection please find in the manual “CP341 Point to Point Communication”.

RS232C

A point-to-point connection to one subsystem can be realized. It is possible to use RS232 auxiliary signals for e.g., modem control.

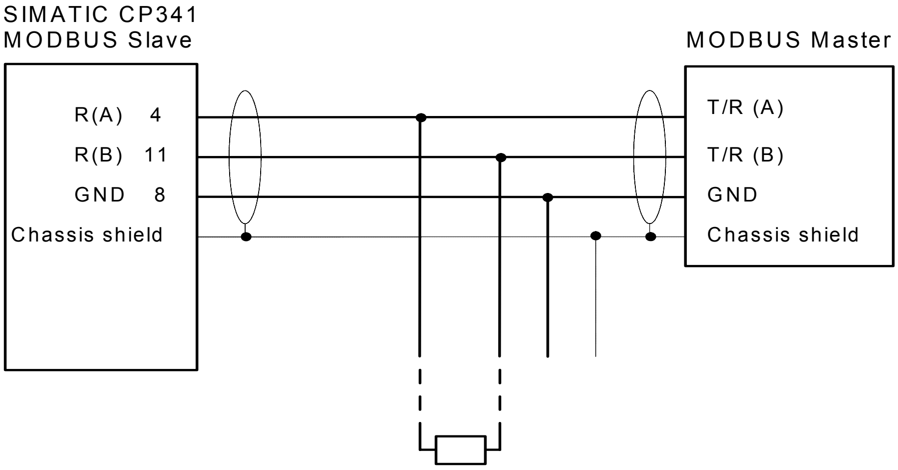
Further notes to the interface connection please find in the manual '“CP341 Point to Point Communication”.

X27 (2-wire, RS485)

A multipoint connection (network) connecting up to 32 slaves to one Master can be created directly.

The driver of the CP performs the switchover of the receive-2-wire line between transmit and receive.

Schematic connection: 1 Master system, 1 slave at the bus



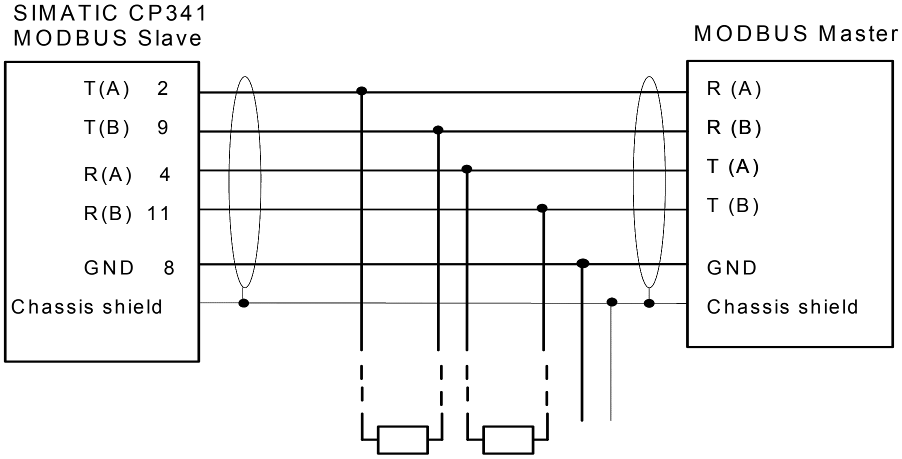
Further notes to the interface connection please find in the manual “CP341 Point to Point Communication”.

X27 (4-wire, RS422)

A Point-to-Point connection to one slave can be created.

The direct construction of a multipoint connection (network) connecting more than one slave is not possible when one or more of the slaves is a CP341 (See Appendix A).

Schematic connection: 1 Master system, 1 Slave



Further notes to interface connection please find in the manual “Point-to-Point Data Link CP341”.

3 Mode of Operation of the Data Link

General Information

The supplied data link converts data access of the Modbus protocol to the specific memory areas of the SIMATIC S7 CPU.

3.1 Components of the SIMATIC / Modbus Slave Data Link

Modbus Slave Data Link

The Modbus slave data link for the CP consists of **two parts**:

1) **Loadable Driver** for the CP

2) Modbus **Communications Function Block** for the SIMATIC S7 CPU

Modbus Slave Communications FB

In addition to the loadable Modbus slave driver, the SIMATIC Modbus slave data link requires a special **Communications FB** in the S7 CPU.

This can be found on the supplied CD for Modbus in the **STEP 7 library** *Modbus_ASCII*. It contains the Modbus communications function block **FB81**.

The call of the FBs is shown in the example OBs in the STEP 7 project file *Examples\MB_ASCII*.

The Modbus communications FB processes all functions necessary for the data link.

The supplied Modbus slave communications function block FB81 must be called in the cyclic program of the user program. The Modbus communications FB uses an instance data block as the work area.

Note
Any modifications carried out to the supplied function block will invalidate the warranty. Consequential damages cannot be claimed.

Modbus Slave Driver

The loadable driver realizes the Modbus protocol and maps the Modbus coil and register addresses to the SIMATIC memory areas.

The loadable driver is loaded into SIMATIC S7-300 using the parameter assignment tool *CP: Point-to-Point Communication, Parameter Assignment* where it is automatically transferred into the CP.

Parameters

The parameters and operating modes listed below must be set for the loadable driver using the parameter assignment tool.

- Transmission rate, parity
- Slave address (Modbus) of CP
- Operating mode (normal, interference suppression)
- Character delay time
- Address areas for FC01, 05, 15
- Address areas for FC02
- Base DB number for FC03, 06, 16
- Base DB number for FC04
- Ranges for write access

3.2 Task Distribution

Task Distribution

Modbus function codes 01, 02, 03, 04, 06, and 16 are processed by the CP directly.

For function codes 05 and 15 the communications FB81 carries out data input into the SIMATIC memory area bit-by-bit.

3.3 Used Modbus Function Codes

Used Function Codes

The following Modbus function codes are supported by the driver:

Function Codes	Function in accordance with Modbus Specification	General Description
01	Read Coils	Read bits
02	Read Discrete Inputs	Read bits
03	Read Holding Registers	Read registers (words/dwords)
04	Read Input Registers	Read registers (words)
05	Write Single Coil	Write 1 bit
06	Write Single Register	Write 1 register (word/dword)
08	Diagnostic	Subfunction 0 only, echo rcvd word
15	Write Multiple Coils	Write multiple contiguous bits
16	Write Multiple Registers	Write multiple contiguous registers (words/dwords)

3.4 Data Areas in the SIMATIC CPU

Data Areas

The individual FCs access the following SIMATIC data areas in the PLC:

Function Code	Modbus Data Type	SIMATIC Data Type	Type of Access
01	Read Coils	Memory bits	Read bit-by-bit
		Outputs	
		Data block bits	
02	Read Discrete Inputs	Memory bits	Read bit-by-bit
		Inputs	
		Data block bit	
03	Read Holding Registers	Data block	Read word-by-word Read dword-by-dword
04	Read Input Registers	Data block	Read word-by-word
05	Write Single Coil	Memory bits	Write bit
		Outputs	
		Data block bit	
06	Write Single Register	Data block	Write word Write dword
08	-	-	Echo received word
15	Write Multiple Coils	Memory bits	Write bit-by-bit
		Outputs	
		Data block bits	
16	Write Multiple Registers	Data block	Write word-by-word Write dword-by-dword

Address Transformation

The Modbus Starting Address in the messages is interpreted by the driver “in an S7 way” and is mapped to the SIMATIC memory area.

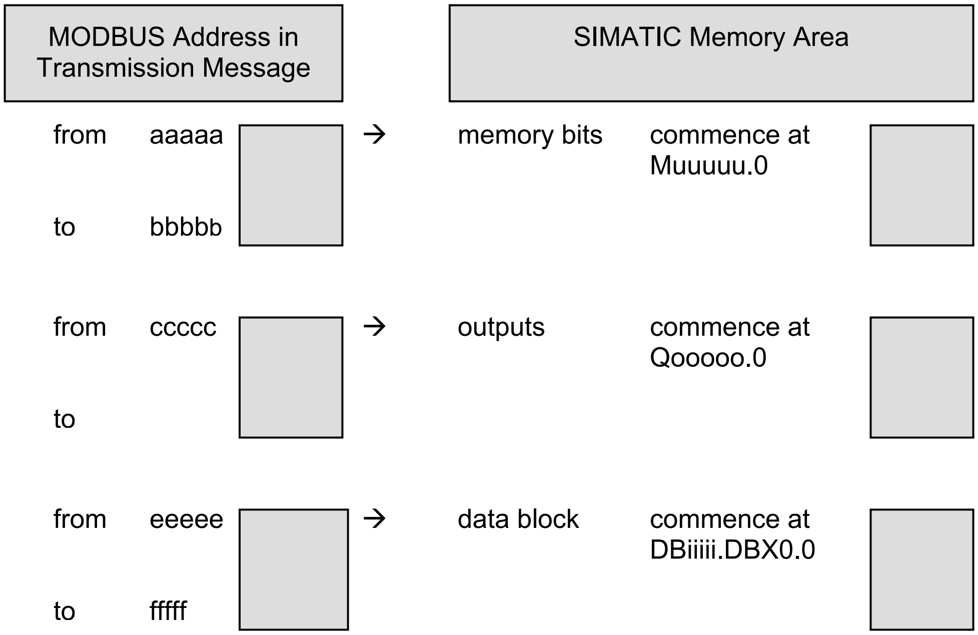
Access to the individual SIMATIC memory areas can be specified by the user by means of the parameter assignment tool *CP: Point-to-Point Communication, Parameter Assignment*.

3.5 Access with Bit-Orientated Function Codes

Function Codes 01, 05, 15

The coil access function codes **01, 05, and 15** allow both read and write access to the SIMATIC memory areas **memory bits, outputs, data block bits**.

You can use the parameter assignment tool to map three distinct ranges of Modbus coil addresss to SIMATIC memory bits, output bits and data block bits, as specified by a “commence at” address. This is illustrated in the following diagram.

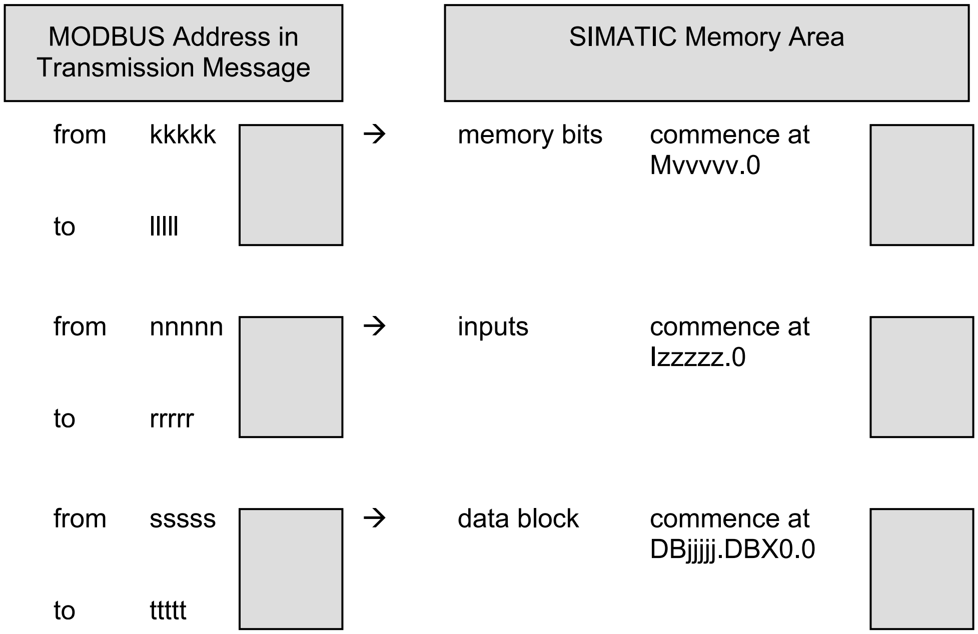


Function Code 02

The discrete output access function code **02** permits read-only access to the SIMATIC memory areas **memory bits**, **inputs, data block bits**

You can use the parameter assignment tool to map three distinct ranges of Modbus discrete input addresss to SIMATIC memory bits, input bits and data block bits, as specified by a “commence at” address. This is illustrated in the next diagram.

The Modbus discrete input address ranges and corresponding SIMATIC memory areas of FC 02 may be selected independently from those of FC 01, 05, and 15.



3.6 Access with Register-Orientated Function Codes

Function Codes 03, 06, 16

The holding register access function codes **03, 06, and 16** permit read and write access to the SIMATIC memory area **data blocks**.

Two **different access modes** are carried out, depending on how the parameter **“with 32-Bit Register” is set.**.

3.6.1 Access to Registers “with 32-Bit Register” Not Set

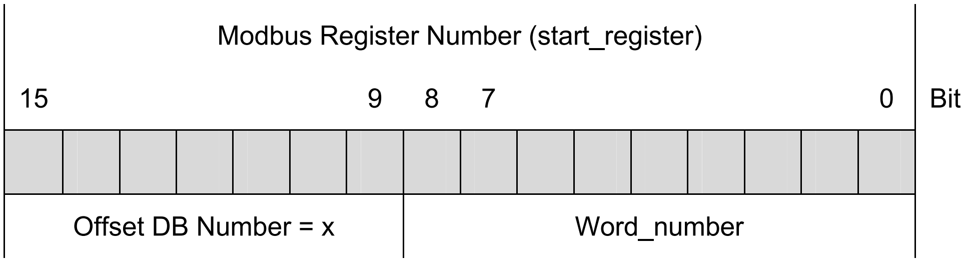
Calculation of Resulting DB Number

The holding register access function codes **03, 06, and 16** permit read and write access to the SIMATIC memory area **data blocks**. When parameter “with 32-Bit Register” is not set (standard Modbus mode) all holding registers are interpreted as 16-bit entities.

Calculation of the required data block number is carried out in **two steps**.

1) You must use the parameter assignment tool to specify a base DB number. This base DB is the first DB which can be accessed.

2) The Modbus **start_register address** (Register Number) transmitted in the received message is interpreted as follows:



<u>Resulting DB Number</u>

The resulting DB number which is then accessed, is calculated as follows: Base DB number + Offset DB number. (The Base DB number is set with the parameter assignment tool and Offset DB number comes from the “x” value in the Modbus start_register.)

This means that it is possible to access a memory area consisting of **128** consecutive DBs (data blocks) within the entire addressable data block area (65535 DBs).

<u>Word Number in DB</u>

Via the Word_number it is possible to address the area from **DBW 0 to DBW 1022** within each data block.

The DBs which are normally organized in bytes are in this instance interpreted by the driver as follows.

16-Bit Registers (“Word_number” and “x” comes from “start_register”)

Word_number	0	accesses	DBx DBW 0	(= DBB 0/1)	
	1		2	(2/3)	
	2		4	(4/5)	
	3		6	(6/7)	
	:		:	(: / :)	
	511		DBW 1022	(1022/1023)	

3.6.2 Access to Registers ”with 32-Bit Register” Set

Function Codes 03, 06, 16

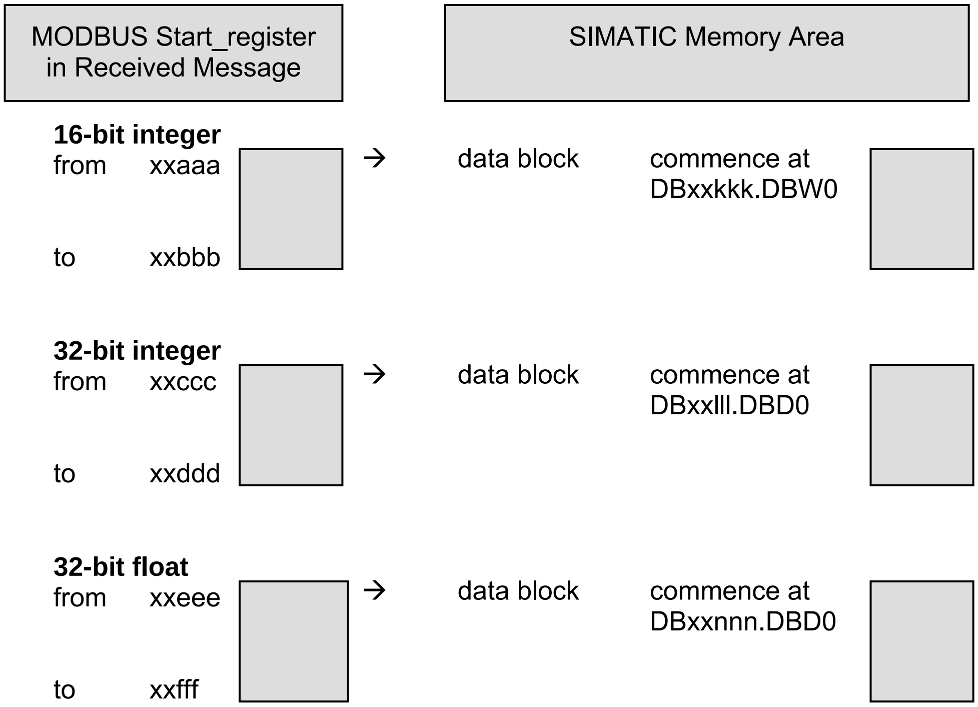
The holding register access function codes **03, 06, and 16** permit read and write access to the SIMATIC memory area **data blocks**. With parameter “with 32-Bit Register” set, holding registers are interpreted as 16-bit or 32-bit entities depending upon their Modbus address range.

When parameter “with 32-Bit Register” is set, **three SIMATIC data blocks (DB)** containing the following data types can be defined and accessed via Modbus:

- 16-bit integer
- 32-bit integer
- 32-bit float

When “with 32-Bit-Register” is set, each data block can be accessed up to DBW 65534 or DBD 65532, depending on the number of registers defined.

You use the parameter assignment tool to map three distinct ranges of Modbus holding register addresses to the three SIMATIC data blocks (DBs), as specified by a “commence at” address. This is illustrated in the next diagram.



The DBs which are normally organized in bytes are in this instance interpreted by the driver as follows.

16-Bit Integer

Start_register	xxaaa+0	accesses	DB xxkkk DBW 0	(= DBB 0/1)	
	xxaaa+1		2	(2/3)	
	xxaaa+2		4	(4/5)	
	xxaaa+3		6	(6/7)	
	:		:	(: / :)	
	:		:	(: / :)	

32-Bit Integer, 32-Bit Float

Start_register	xxeee+0	accesses	DB xxnnn DBD 0	(= DBB 0 to 3)	
	xxeee+1		4	(4 to 7)	
	xxeee+2		8	(8 to 11)	
	xxeee+3		12	(12 to 15)	
	:		:	(: / :)	
	:		:	(: / :)	

3.6.3 Access with Function Code 4

Function Code 04

The input register read function code **04** permits read-only access to SIMATIC memory area **data blocks**.

The mode and operation of this access is the same as the method described in section 3.6.1 but only reading is permitted

Function code **04** has its own base DB number that must be set with the parameter assignment tool. This will enable you to access a second **independent** read-only area consisting of 128 DBs.

These DBs have **read-only** access; it is not possible to write to them. Also, they are only accessible as 16-bits per addressed Modbus input register (setting “with 32-Bit Register” does not enabled 32-Bit access for Function Code 04).

3.7 Enable Write Access

General

You can use the parameter assignment tool to specify areas which enable **write** access from the Modbus master system. With a Modbus master, it is not possible to write outside these areas.

If the master tries to access any SIMATIC memory areas which are outside the enabled area, access is denied by means of the Modbus “Illegal Data Address” exception response, code 02.

Function Codes 05 and 15

For the **write coils** function codes **05 and 15** you must **enable** or allow access to the relevant SIMATIC memory areas (M and Q). You must set the enable ranges for the two data types M and Q as shown in the diagram below.

For the write function to data block bits you cannot set an enable range for writing. The entire accessible DB memory space remains writeable.

Function Codes 06 and 16 in standard mode

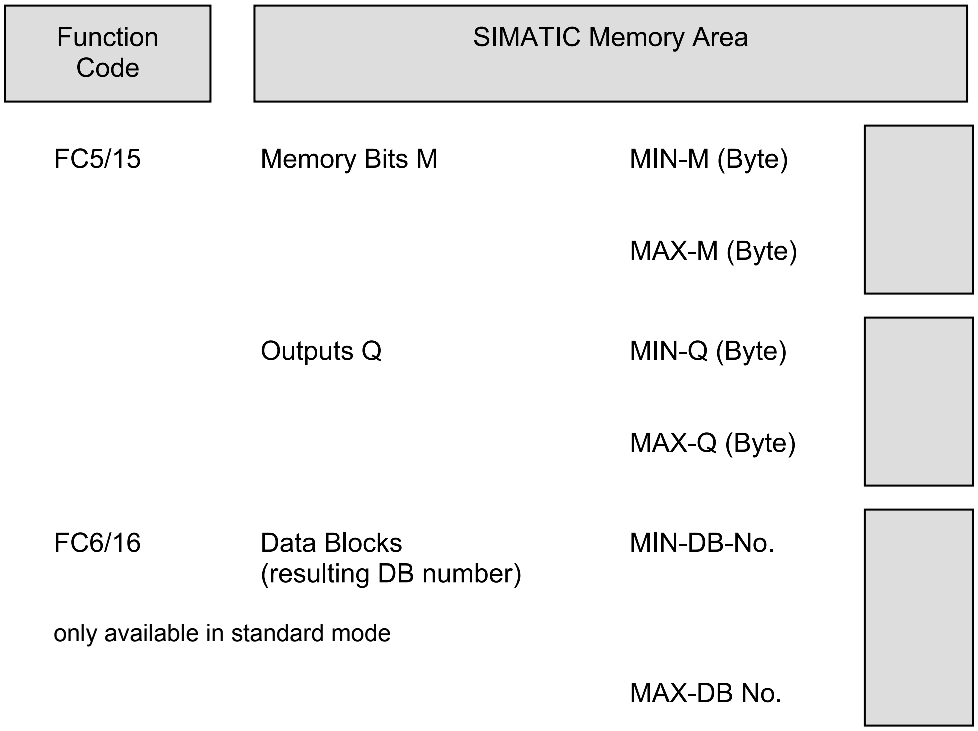
For the **write register** function codes **06 and 16** in **“standard mode”** (“with 32-Bit Register” **not** set) you must **enable** or allow access to the relevant SIMATIC memory area (a range of DBs as shown in the diagram below).

Function Codes 06 and 16 in mode “with 32-Bit Registers”

For the **write** function codes **06 and 16** in mode **“with 32-Bit Register”** you cannot set an enable range for writing to DB. The entire accessible DB memory space remains writable.

The following diagram shows approximately how the parameter entry screen looks for enabling the three contiguous writable ranges for M, Q and DB data types.

Enable Write Access



Function Code	SIMATIC Memory Area		
FC5/15	Memory Bits M	MIN-M (Byte)	
		MAX-M (Byte)	
	Outputs Q	MIN-Q (Byte)	
		MAX-Q (Byte)	
FC6/16	Data Blocks (resulting DB number)	MIN-DB-No.	
only available in standard mode			
		MAX-DB No.	

4 Commissioning the Driver

General Information

All statements in the following sections referring to STEP7 or configuring or setting parameters for CP-PtP, CP341 or the Driver are related to the STEP7-Version 5.3 SP3.

Operation flows, names and directory names might be different in other STEP7 versions.

4.1 Installing the Driver on the STEP 7 Programming Device / PC

Prerequisites

To make the driver installation possible, a **STEP7-Package** and the **Parameter Assignment Tool** *CP: Point-to-Point Communication, Parameter Assignment* must have been installed before.

Installation

Installation of the driver consisting of driver code and driver specific configuration screens for STEP7:
Insert your Modbus ASCII Driver CD into the CD-ROM drive and follow step-by-step the instructions that are automatically displayed by the installation program.
If the installation program fails to automatically run, perform these steps:

1. Using Windows Explore, navigate to the CD-ROM drive and go to the directory MODBUS_ASCII_SLAVE and double-click **Setup.EXE** file to start the installation procedure.

2. Follow step-by-step the instructions that are displayed by the installation program.

Result: The driver and the parameterization masks are installed in the following directory: **[**c:\Program Files**]SIEMENS\Step7\S7fptp\S7Driver** where the contents of **[ ]** are selectable during the installation procedures

The directory includes the following files:

- S7wfpnab.dll
- S7wfpnax.cod
- S7wfpnbx.cod

4.2 Uninstalling the Driver

The driver can be uninstalled from the STEP 7 package by selecting “Control Panel”, “Add / Remove Software” Find the driver in the list and follow the instruction for uninstalling it.

The user can check if all the files S7wfpna?.*, S7wfpnb?.*, S7wfpnc?.* have been deleted successfully in the **[**c:\Program Files\**]SIEMENS\**Step7\S7fptp\S7Driver directory.

Note:
Before uninstalling the package “**Parameter Assignment Tool** *CP: Point-to-Point Communication, Parameter Assignment“* all the loadable drivers must first be uninstalled.

4.3 Configuring the Data Link CP in Step7

Introduction

The configuration of a data link comprises the hardware allocation in the configuration table using HW config. The configuration can be carried out using the STEP 7 software.

S7 Project

Before you can carry out the configuration, you must have created a **S7 Project** with STEP 7.

Project Components

Insert the required project components into the opened project using the SIMATIC Manager. You must have a “SIMATIC 300 Station” in your project.

Before an insertion, you must select the target project name by clicking it. To insert the 300 Station, from the Insert menu of Simatic Manager do:

Insert ➢ Station ➢ SIMATIC 300 Station

Hardware Configuration

The configuration of the hardware comprises defining the hardware components themselves, and also their properties.

To start the hardware configuration, select the SIMATIC 300 station and double-click “Hardware” (or select the menu command **Edit ➢ Open Object**). Use the menu command **Insert ➢ Hardware Components** to insert a RACK- 300, a PS-300, a CPU-300 from SIMATIC 300, and the CP PtP from CP-300 with the appropriate part number.

A detailed description of how to configure S7-300 modules can be found in the User Manual for STEP 7.

4.4 Assigning Parameters to the CP

General

After you have arranged the modules in your rack using “Hardware Configuration,” you must assign parameters to them.

To start the parameter assignment tool, double-click the CP in “Hardware Configuration” or click the CP and select the menu command **Edit ➢ Object Properties.**

Properties CP

1) Properties - CP ➢ Basic Parameters Tab

   Clicking the “**Parameter…**” button along the bottom opens the protocol selection interface “**Assigning Parameters to Point-to-Point Connection**.” Here you can select the required driver protocol, **Modbus ASCII** Slave from the drop-down menu.

   After selecting the **“Protocol,”** you can carry out **Parameter Assignment of the Driver** (start by double-clicking the envelope symbol) labeled “Protocol.”

   A detailed description of how to select the protocol and assign parameters to the dialog boxes for the loadable driver can be found in the section “Assigning Parameters to the Loadable Driver.”

   After parameter assignment is complete, you return to the “**Assigning Parameters to Point-to-Point Connection**” screen and save any changes before closing it. This bring you back to the **“Properties - CP**” dialog box.

2) Properties - CP ➢ Addresses
   No settings are required in the “**Addresses**” tab (Properties - CP dialog box).

3) Properties - CP ➢ Basic Parameters
   No settings are required in the “**Basic Parameters**” tab (Properties - CP dialog box).

4) Properties - CP ➢ General
   No settings are required in the “**General**” tab (Properties - CP dialog box).

   You can complete the parameter assignment of the CP by clicking “OK” in the “Properties - CP” dialog box. You return to the “Hardware Configuration” dialog box.

   Save the parameter assignment and close the “Hardware Configuration” dialog box. You return to the basic menu of the STEP 7 project.

4.5 Assigning Parameters to the Loadable Driver

Opening the Parameter Assignment Tool CP-PtP

Select the SIMATIC station and double-click “Hardware” (or select the menu command **Edit ➢ Open Object**) to start the “Hardware Configuration.” Click the CP and select the menu command Edit ➢ Object Properties (or just Double-click the CP). Click the “**Parameter…**” button along the bottom to open the protocol selection dialog box.

Protocol Selection

In addition to the standard protocols, the selection box also displays all installed loadable drivers. Select “**Modbus ASCII Slave**” for this driver. Double-clicking the symbol for the transmission protocol (envelope icon) opens the dialog box where the protocol-specific parameters are set.

Driver-Specific Parameters

The parameters described in Section 5 can be set for this driver in the individual dialog boxes.

Selecting Parameters

Select the parameters required for your data link and exit the individual dialog boxes by clicking “OK”.

4.6 Loading the Driver to the CP

Loading the Driver

After selection of a loadable driver in the selection box “Protocol”, you must load the driver to the CP one time. Double clicking on to the icon **“Load Drivers”** gets you to the dialogue where the driver is loaded.

- You need an **online** connection to the CPU to load drivers.
- The tab “Load Drivers” shows you, which driver is already loaded on the CP and which driver was selected by you.
- Once again click “Load Drivers” and confirm with “yes”. The transfer of the driver to the CP is carried out.
- After the transfer the information “Driver version online on the module” is updated.
- If the driver in the current version already exists on the CP, the transfer in cancelled with the message “Driver already exists”.
- Click “Close” to return to the main tab.

The error “Module rejected driver download” may occur, when the driver files are missing or possibly corrupted. In that case a re-installation of the driver is necessary.

4.7 Loading the Configuration and Parameter Assignment Data

Data Management

On closing the “Hardware Configuration,” the data are automatically saved into your STEP 7 project.

Loading the Configuration and Parameters

The configuration and parameter assignment data can now be loaded online from the programming device to the CPU. Use the menu command **PLC ➢ Download** to transfer the data to the CPU.

During CPU startup and each time you switch between STOP mode and RUN mode, the module parameters of the CP are automatically transferred to the CP as soon as it can be reached via the S7-300 backplane bus.

The driver code is not saved in the CPU, but directly with the parameter assignment tool in the retentive memory of the CP 341. You should note, however, that for this reason you cannot swap out a failed CP 341 containg the driver with a good CP 341 that does not yet contain the driver without using the programming device to load the driver.

Further Information

Please refer to the User Manual for STEP 7 for a detailed description of:

- How to save the configuration and the parameters.
- How to load the configuration and the parameters into the CPU.
- How to read, change, copy, and print the configuration and the parameters.

5 Modbus ASCII Driver Specific Parameters

5.1 Modbus Slave Protocol Parameters

Overview of Transmission Parameters

Transmission Parameters			
Parameter	**Description**	**Value Range**	**Default value**
Baud Rate	Data transmission speed in bits / second	300 600 1200 2400 4800 9600 19200 38400 57600 76800	9600
Data Bits	Bit per character	7	7
Stop Bits	Amount of stop bits	1 2	1
Parity	amount of data bits is completed to an even number amount of data bits is completed to an odd number no parity bit transferred	even odd none	Even

Transmission Rate

The transmission rate is the speed of data transmission in bits per second (bps).

Data Bits

The amount of data bits describes how many bits represent a character to be transmitted. With Modbus ASCII 7 data bits are mandatory.

Stop Bits

The amount of stop bits defines the smallest possible distance between two characters to be transferred. With even or odd parity 1 stop bit is pre-defined. None parity effects two stop bits.

Parity

The parity bit is for data safety; depending on parameter assignment, it completes the amount of transmitted data bits to either an even or an odd number.
If “no” parity is selected, no parity bit is transmitted. This reduces the safety of data transmission.

Overview of Protocol Parameters

Protocol Parameter			
Parameter	**Description**	**Value range**	**Default value**
Slave Address	Own slave address of the CP	1 to 255	222
Character Delay Time	Time period used to monitor the incoming characters within a message	1 to 6500 milliseconds in 1ms intervals	1000ms
Operating Mode	"Normal Operation" "Interference Suppression"	Normal Interference Suppression	Normal
with 32-Bit Register	Registers can also imply 32-bit values	not selected selected	not selected

Slave Address

Here you can specify the Modbus Slave address assigned to the CP. The CP only processes and replies to messages where the received slave address is identical to its slave address. Messages to other slaves are not processed and not replied to.

However, the Modbus slave driver does also listen for messages directed to the special "broadcast address" zero. When a broadcast message is received, any data to be written to the CPU still occurs (e.g., FC 06, Write Single Register) but no response is sent. If a read request is contained in the broadcast message (e.g., FC 03, Read Holding Registers) it should be ignored by all slaves.

Character Delay Time

When receiving a message the quiet time between characters is measured. If the quiet time exceeds the character delay time, the message is ignored and an error is reported in the diagnostic buffer.

Normal Operation

In this operating mode, all recognized transmission errors and/or BREAK before and after receive messages from the master result in an appropriate error handling. The error is reported in the diagnostic buffer.

Interference Suppression

If "BREAK" is recognized on the receiving line at the start of the receive message, or if the CP interface block notices transmission errors before the message, no error is reported.

The start of the receive message from the master is recognized by means of the correctly-received start character. Transmission errors and/or BREAK are also ignored when they occur after the end of the receive message.

with 32-Bit Register

With standard Modbus, holding registers are always 16-bit values. When choosing "with 32-Bit Register" mode, holding registers can also imply 32-bit values (integer and floating point) or 16-bit values when accessed by a master with register addresses within preset ranges. (Section 5.3.2 explains how these address ranges are set.).

5.2 Conversion of Modbus Addresses for Bit Functions

Overview of FC 01, 05, 15

Conversion of Modbus Addressing for FC 01, 05, 15			
Parameter		**Input**	**Meaning**
SIMATIC Area Memory Bits			
Range of Modbus coil address in transmission message (Coil number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area memory bits (Memory byte number)	commence at	0 .. 65535 (decimal)	Commence at this memory byte
SIMATIC Area Outputs			
Range of Modbus coil address in transmission message (Coil number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Outputs (Output byte number)	commence at	0 .. 65535 (decimal)	Commence at this output byte
SIMATIC Area Data Block			
Range of Modbus coil address in transmission message (Coil number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Data block (Data block number)	commence at	0 .. 65535 (decimal)	Commence at this data block DBX0.0

“from” / “to” - Modbus Address

You can use the “from” address to set the Modbus address which is the start of the appropriate area; for example, memory bits, outputs, data block bit (= first bit number of area).

You can use the “to” address to set the Modbus address which is the end of the appropriate area; for example, memory bits, data block bit (= last bit number of area).

The “from” / “to” addresses refer to the Modbus coil address in the transmitted message received by the slave (coil numbers beginning at 0) for function codes FC 01, 05, and 15.

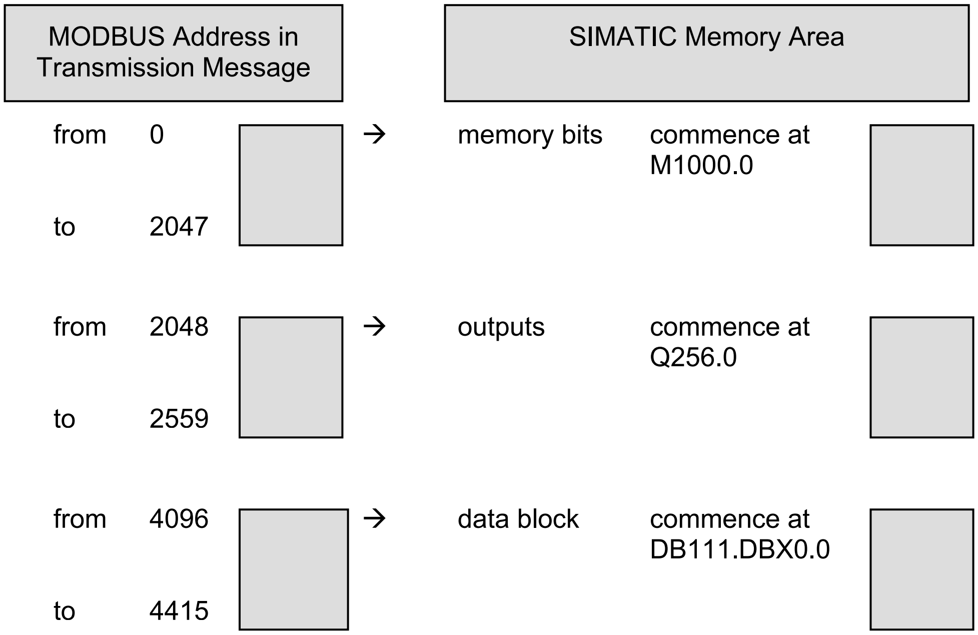
The individual “from / to” areas must not overlap.

Gaps between the individual “from / to” areas are permitted.

"Commence at" SIMATIC Memory Area

You can use the "commence at" input to specify the start of the SIMATIC area where the "from" / "to" Modbus area is displayed (= first memory byte-, output byte-/ data block number of SIMATIC area).

Example



MODBUS Address in Transmission Message			SIMATIC Memory Area	
from	0	→	memory bits	commence at M1000.0
to	2047			
from	2048	→	outputs	commence at Q256.0
to	2559			
from	4096	→	data block	commence at DB111.DBX0.0
to	4415			

The Modbus coil addresses from 0 to 2047 access the SIMATIC memory bits commencing at memory bit M 1000.0; i.e. length of area = 2048 bits = 256 bytes, which means last memory bit = M 1255.7.

The Modbus coil addresses from 2048 to 2559 access the SIMATIC outputs commencing at output Q 256.0; i.e. length of area = 512 bits = 64 bytes, which means last output bit = Q 319.7.

The Modbus coil addresses from 4096 to 4415 access the SIMATIC data block bit commencing at DB111.DBX0.0; i.e. length of area = 320 bits = 40 bytes, this means the last accessed bit in the data block is DB111.DBX39.7.

Note: The commence at Data Block (e.g., DB111) should be large enough to contain the entire from/to coil address range in the Modbus message. It is not possible to "roll" to the next higher DB number if the Data Block is smaller.

Overview of FC 02

Conversion of Modbus Addressing for FC 02			
Parameter		**Input**	**Meaning**
SIMATIC Area Memory Bits			
Range of Modbus Discrete Input addresses in transmission message (Discrete Input number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area memory bits (Memory byte number)	commence at	0 .. 65535 (decimal)	Commence at this memory byte
SIMATIC Area Outputs			
Range of Modbus Discrete Input address in transmission message (Discrete Input number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Outputs (Output byte number)	commence at	0 .. 65535 (decimal)	Commence at this output byte
SIMATIC Area Data Block			
Range of Modbus Discrete Input address in transmission message (Discrete Input number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Data block (Data block number)	commence at	0 .. 65535 (decimal)	Commence at this data block DBX0.0

“from” / “to” - Modbus Address

You can use the “from” address to set the Modbus address which is the start of the appropriate area; for example, memory bits, inputs, data block (= first bit number of area).

You can use the “to” address to set the Modbus address which is the end of the appropriate area; for example, memory bits, inputs, data block (= last bit number of area).

The “from” / “to” addresses refer to the Modbus Discrete Input address in the transmitted message received by the slave (discrete input numbers beginning at 0) for function codes FC 02.

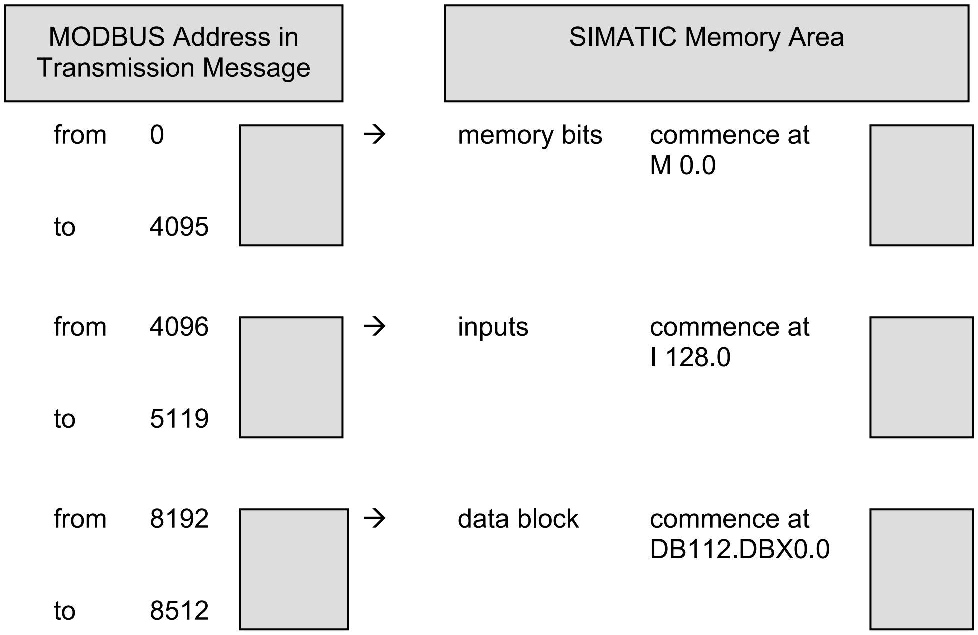
The individual “from / to” areas must not overlap.

Gaps between the individual “from / to” areas are permitted.

“Commence at” SIMATIC Memory Area

You can use the “commence at” input to specify the start of the SIMATIC area where the “from” / “to” Modbus area is displayed (= first memory byte-, input byte-/ data block number of SIMATIC area).

Example



MODBUS Address in Transmission Message			SIMATIC Memory Area	
from 0 to 4095		→	memory bits	commence at M 0.0
from 4096 to 5119		→	inputs	commence at I 128.0
from 8192 to 8512		→	data block	commence at DB112.DBX0.0

The Modbus addresses from 0 to 4095 access the SIMATIC memory bits commencing at memory bit M 0.0; i.e. length of area = 4096 bits = 512 bytes, which means last memory bit = M 511.7.

The Modbus addresses from 4096 to 5119 access the SIMATIC inputs commencing at input I 128.0; i.e. length of area = 1024 bits = 128 bytes, which means last input bit = I 255.7.

The Modbus addresses from 8192 to 8512 access the SIMATIC data block bit commencing at DB111.DBX0.0; i.e. length of area = 320 bits = 40 bytes, this means the last accessed bit in the data block is DB112.DBX39.7.

Note: The commencing Data Block (e.g., DB112) should be large enough to contain the entire from/to Discrete Input address range in the Modbus message. It is not possible to “roll” to the next higher DB number the Data Block is smaller.

Note

The input of values “commence at memory bit” and “commence at data block” are completely independent of input “commence at memory bit / data block” for function codes 01, 05, and 15.

This means that with FC 02 it is possible to use a second SIMATIC memory bits area as well as a second data block (read-only), which are completely independent from the first.

There is no point in defining memory bytes for simultaneous access with both FC01 and FC02 but it is still possible to do this.

5.3 Conversion of Modbus Addresses for Register Functions

5.3.1 Conversion for Register Functions in Standard Mode

Overview of FC 03, 06,16

Conversion of Modbus Addressing for FC 03, 06, 16			
Parameter		**Input**	**Meaning**
SIMATIC Area Memory Blocks			
Modbus address = 0 in transmission message (register number) means access to:			
SIMATIC memory area Data Blocks	commence at DB	1 .. 65535 (decimal)	Commence at this data block Commence at DBW 0 (= base DB number)

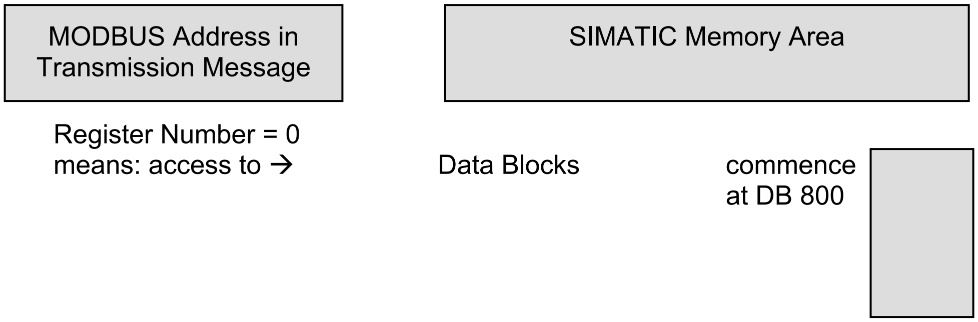
"Commence at DB"

You can use the "commence at DB" input to specify the **first** data block of the SIMATIC area which is to be accessed (= **base DB Number**). This DB is accessed when the register number of the Modbus message has value from 0 to 511, which accesses data word DBW 0 to DBW 1022 (512 words in the base DB Number). Modbus register addresses between 512 and 1023 access the same DBW range within DB **base DB Number+1.** Likewise, the next 512 Modbus register addresses, between 1024 and 1535, access the first 512 words in DB **base DB Number+2**.

Up to 128 successive DBs can be accessed (**base DB Number** to **base DB Number+127)**.

The driver interprets the upper (most significant) 7 bits, 15 - 9 of the Modbus register number for the access to the individual successive DBs It also interpretes the lower (least significant) 9 bits, 8 – 0 of the Modbus register number as the word index offset into the addressed DB.

Example



You can use Modbus register address 0 to access data block 800 commencing at DBW 0 in the SIMATIC system. Higher Modbus register addresses (≥ 512, etc.) access the following DBs DB 801, 802, etc.

Overview of FC 04

Conversion of Modbus Addressing for FC 04			
Parameter		**Input**	**Meaning**
SIMATIC Area Memory Blocks			
Modbus address = 0 in transmission message (register number) means access to:			
SIMATIC memory area Data Blocks	commence at DB	1 .. 65535 (decimal)	Commence at this data block Commence at DBW 0 (= base DB number)

“Commence at DB”

You can use the “commence at DB” input to specify the **first** data block of the SIMATIC area which is to be accessed (= **base DB Number**). This DB is accessed when the register number of the Modbus message has value from 0 to 511, which accesses data word DBW 0 to DBW 1022 (512 words in the base DB Number). Modbus register addresses between 512 and 1023 access the same DBW range within DB **base DB Number+1.** Likewise, the next 512 Modbus register addresses between 1024 and 1535 access the first 512 words in DB **base DB Number+2**.

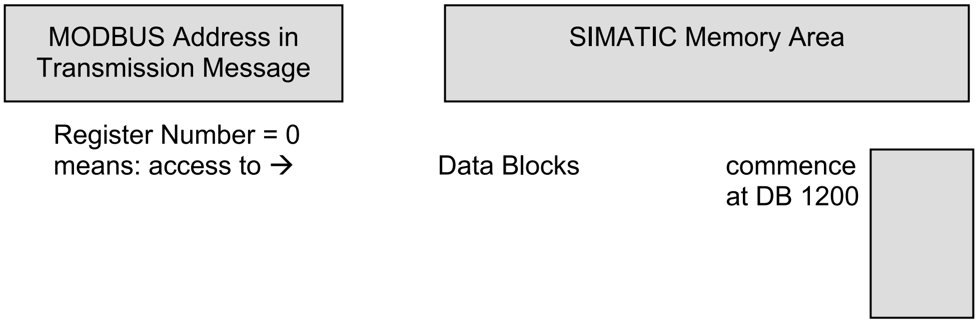
Up to 128 successive DBs can be accessed (**base DB Number** to **base DB Number+127)**.

The driver interprets the upper (most significant) 7 bits, 15 - 9 of the Modbus register number for the access to the individual successive DBs It also interpretes the lower (least significant) 9 bits, 8 – 0 of the Modbus register number as the word index offset into the addressed DB.

Note

The input of value “commence at DB” is completely independent of input “commence at DB” for function codes 03, 06, and 16. This means that with FC 04 it is possible to use a second SIMATIC data block area (read-only), which is completely independent from the first.

Example



You can use Modbus register address 0 to access data block 1200 commencing at DBW 0 in the SIMATIC system. Higher Modbus register addresses ≥ 512, 1024, etc.) access the following DBs DB 1201, 1202, etc.

5.3.2 Conversion for Register Functions in Mode “with 32-Bit Register”

Overview of FC 03, 06,16

Conversion of Modbus Addressing for FC 03, 06, 16			
Parameter		**Input**	**Meaning**
SIMATIC Area Memory Blocks			
16-bit integer Modbus address range in transmission message (register number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Data Block	commence at	1 .. 65535 (decimal)	Refer to this data block Commence at DBW 0
SIMATIC Area Memory Blocks			
32-bit integer Modbus address range in transmission message (register number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Data Block	commence at	1 .. 65535 (decimal)	Refer to this data block Commence at DBD 0)
SIMATIC Area Memory Blocks			
32-bit float Modbus address range in transmission message (register number)	from	0 .. 65535 (decimal)	Starting with this Modbus address
	to	0 .. 65535 (decimal)	Including this Modbus address
SIMATIC memory area Data Block	commence at	1 .. 65535 (decimal)	Refer to this data block Commence at DBD 0

“from” / “to” - Modbus Address

You can use the “from” address to set the Modbus address which is the start of the appropriate area: 16-bit integer, 32-bit integer, 32-bit float. You can use the “to” address to set the Modbus address which is the end of the appropriate area.

The “from” / “to” addresses refer to the Modbus address in the transmission message (register numbers starting at 0) for function codes FC 03, 06,16.

The individual “from / to” areas must not overlap.

Gaps between the individual “from / to” areas are permitted.

A data block can include up to 16383 32-bit registers or 32676 16-bit registers.

“Commence at DB”

You can use the “commence at DB” input to specify the data block of the SIMATIC area which is to be accessed. This DB is accessed when the register number of the Modbus message has the “from” value, starting at data word DBW or DBD 0. Higher Modbus register numbers access the sucessive words or double words.

Example

MODBUS Address in Transmission Message		SIMATIC Memory Area	
16-bit integer			
from 3000	→	Data Block	commence at
to 4999			DB2.DBW0
32-bit integer			
from 5000	→	Data Block	commence at
to 5099			DB3.DBD0
32-bit float			
from 7000	→	Data Block	commence at
to 9999			DB4.DBD0

You can use Modbus register address 3000 to access data block 2 commencing at DBW 0 in the SIMATIC system.; i.e. length of area = 2000 words, which means last data word = DB2.DBW3998 (last accessed byte is DB2.DBB3999).

You can use Modbus register address 5000 to access data block 3 commencing at DBD 0 in the SIMATIC system.; i.e. length of area = 100 double words, which means last DB address = DB3.DBD396 (last accessed byte is DB3.DBB 399).

You can use Modbus register address 7000 to access data block 4 commencing at DBD 0 in the SIMATIC system.; i.e. length of area = 3000 double words, which means last DB address = DB4.DBD11996 (last accessed byte is DB3.DBB11999).

5.4 Limits for Write Functions

Overview of FC 05, 06, 15, 16

SIMATIC Limits for Write Access (FC 05, 06, 15, 16)

Parameter		**Input**	**Meaning**
Memory bits M (Memory byte number)	MIN	0 .. 65535	First enabled memory byte
	MAX	1 .. 65535	Last enabled memory byte MAX = 0 all memory bits disabled
Outputs Q (Output byte number)	MIN	0 .. 65535	First enabled output byte
	MAX	1 .. 65535	Last enabled output byte MAX = 0 all outputs disabled
Data blocks DB: Resulting DB number only available in standard mode	MIN	1 .. 65535	First enabled DB
	MAX	1 .. 65535	Last enabled DB Max = 0 all DBs disabled

"MIN" / "MAX" SIMATIC Memory Area

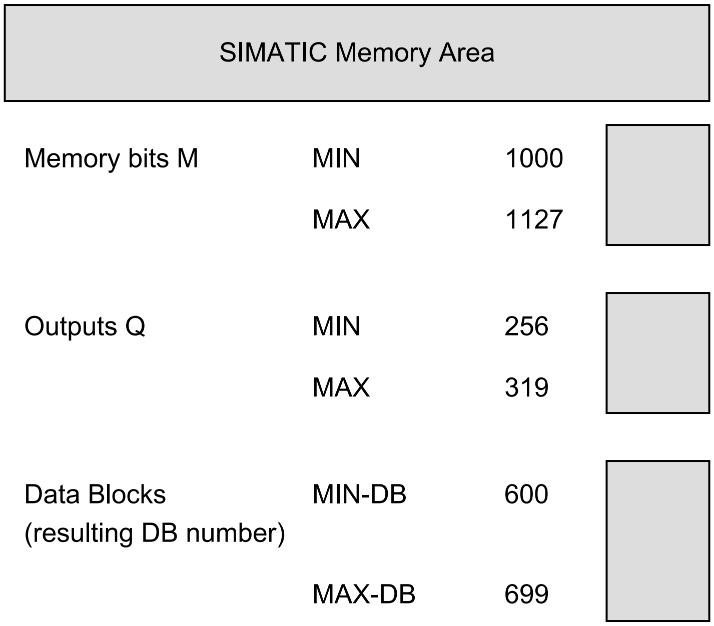
For the write function codes, it is possible to specify lower and upper access limits (MIN / MAX). Write access is permitted within this **enabled area** only. If the value for the upper limit (MAX) is 0, it means that the entire memory area, e.g., Q, can't be written via Modbus. When selecting the address and size of the enabled areas, ensure that the memory types and ranges are available in your S7-300 CPU model.

Note:
It is not possible to enable only address 0 (M0 or Q0) for write access.

If the master attempts a write access to an area which is outside the upper / lower limit, this is rejected by the CP with a Modbus exception response.

The MIN / MAX area for data blocks is only available in standard mode. The MIN / MAX values for the data block area must be specified as resulting DB numbers which makes the contents of each DB in the range potentially writable via Modbus.

Example



SIMATIC Memory Area

Memory bits M	MIN	1000
	MAX	1127
Outputs Q	MIN	256
	MAX	319
Data Blocks (resulting DB number)	MIN-DB	600
	MAX-DB	699

SIMATIC memory bytes MB 1000 to MB 1127 (FC 05, 15) can be changed with Modbus write function codes.

SIMATIC outputs output bytes QB 256 to QB 319 (FC 05, 15) can be changed with Modbus write function codes.

SIMATIC data blocks DB 600 to DB 699 can be changed with Modbus write function codes (FC 06, 16) in Standard mode. The DB range parameters have no effect when a DB is written as coils (bits) using FC 05 or 15. The mapping of a range of coil addresses to a DB (Section 5.2) independently allows that DB to be writable when its coils are written.

The Data Blocks range parameters are not available when “with 32-Bit Register” is set. Only selected DBs, as enabled Section 5.3.2, can be written with Modbus when “with 32-Bit Register” is set.

5.5 RS422/485 (X27) Interface

Overview

X27 (RS 422/485) - Interface Sub-module			
Parameter	**Description**	**Value range**	**Default value**
Presetting of the receiving line	No presets Preset “Break” Preset “High”	none R(A)5V,R(B)0V R(A)0V,R(B)5V	R(A)5V, R(B)0V
X27-Operation mode	Via the transmission line T(A), T(B) data are sent, via the receiving line R(A), R(B) data are received. The receiving line R(A),R(B) is changed-over from send to receive operation.	Full-duplex / four-wire-operation Half-duplex / two-wire-operation	Full-duplex / four-wire-operation

“Full-duplex / four-wire-operation”

In this operating mode, data are sent via the transmission line T(A),T(B) and received via the receiving line R(A),R(B). Error handling is carried out in accordance with the function set at the “Driver Operating Mode” parameter (Normal or Interference Suppression).

“Halfduplex / two-wire-operation”

In this operating mode, the driver **switches** the 2-wire receiving line R(A),R(B) of the interface from send to receive operation. In this operating mode, all recognized transmission errors and/or BREAK before and after receive messages are ignored. BREAK level during message pauses is also ignored. The beginning of the receive message from the slave is recognized by means of the correctly-received colon character.

The setting R(A) 0V, R(B) 5V (High) is recommended as the preset for the receiving line.

Presetting of the Receiving Line

“None” (Float)

The two-wire-line R(A),R(B) is **not** preset.
In this instance the link partner should carry out assignment.

Presetting “R(A) 5V, R(B) 0V” (BREAK)

The two-wire-line R(A),R(B) is preset by the CP as follows:
R(A) --> +5V, R(B) --> 0V (V$_A$ - V$_B$ $\geq$ +0,3V).
This means that BREAK level occurs on the CP in the event of a line break.

Presetting “R(A) 0V, R(B) 5V” (High)

The two-wire-line R(A),R(B) is preset by the CP as follows:
R(A) --> 0V, R(B) --> +5V (V$_A$ - V$_B$ $\leq$ -0,3V).
This means that HIGH level occurs on the CP in the event of a line break (and / or when it is running idle, i.e. no slave is transmitting).
Line status BREAK cannot be recognized.

5.6 RS232 Secondary Signals

Overview

Data Transmission			
Parameter	**Description**	**Value range**	**Default value**
Automatic use of RS232 signals	RS232 secondary signals are enabled	checked not checked	Not checked (disabled)
Time to RTS OFF	Time to elapse after the transmission before the CP sets the RTS line to OFF	0 to 655350 ms in 10 ms steps	1s
Data output waiting time	Delay before the CP starts sending of a telegram	0 to 655350 ms in 10 ms steps	1s

Automatic Use of RS232 Signals

With this parameter you can choose whether RS 232 C secondary (modem control) signals are used or not. If this remains unset (box not checked) the CP neither sets nor checks the secondary signals. When this is set (box checked) the following two parameters become available..

The description of the used secondary signal please find in Section 8-3 of this manual.

Time to RTS OFF

After a Modbus frame is transmitted the CP waits the defined time to set the RTS line to OFF.

Data Output Waiting Time

The data output waiting time is the time that the CP 341 waits for the communication partner to set CTS to ON after setting the RTS line to ON and before starting the transmission.

6 Commissioning the Communications FB

6.1 Installing the FB

Supplied CD

The Modbus slave communications FB is part of a STEP 7 project which is stored to the directory EXAMPLES of the STEP 7 software under the name “MB_ASCII” for CP 341 when the driver is installed. It is also stored in the library *Modbus_ASCII*.

You should ensure that there is not already a project with the same name.

Transfer

1) The project file *MB_ASCII* contains a complete STEP 7 project in the form of a loadable example.

2) Transfer the Modbus communications **FB81** to your user project if you wish to continue working in your own user project.

3) If required, transfer the startup OBs **OB100** and **OB101**, the cyclic **OB1,** and **DB81** to your user project. This will enable you to access the **call example** for the communications FB, as well as a completed instance DB for the FB.

Note:
OB1 and OB100/OB101 can also be generated themselves. If the instance DB is not included in the transfer, it must be generated when calling FB81 in OB1/OB100/OB101.

6.2 STEP7 Project

STEP 7 Project

The STEP 7 project file *Modsl* contains a complete project in the form of a loadable example consisting of:

- Hardware project configuration with UR1, PS, CPU and CP
- CP parameter assignment
- STEP 7 program with OBs and Modbus communications FB

The blocks in the program file are to be understood as examples only and may be changed by the user according to his requirements. If necessary, the Modbus communications FB may be renamed as required.

Contents of Modsl

The project file example contains the following:

Block	Symbol	Comment
FB 81		Modbus slave communications FB
DB 81		Instance DB and work area for
OB 1		Cyclic program
OB 100		Cold restart (complete restart)
FB 7	P_RCV_RK	Receive data
FB 8	P_SND_RK	Send data
SFC 24	TEST_DB	Testing a data block
SFC 36	MSK_FLT	Mask synchronous error events
SFC 37	DMSK_FLT	Unmask synchronous error events
SFC 38	READ_ERR	Read event status register
SFC 41	DIS_AIRT	Delay alarms
SFC 42	EN_AIRT	Enable alarms
SFC 51	RDSYSST	Read system area (SZL) of CPU

The SFCs are integrated in the CPU, the variable tables have been added for diagnostic purposes only.

6.3 FB 81 Parameters

Name	Type	Data Type	Meaning	Permitted Assignment
LADDR	I	Int	Base address of the CP	Use HW Config assignment
START_TIMER	I	Timer	Timer for “Timeout initialization”	
START_TIME	I	S5Time	Time value “Timeout initialization	
OB_MASK	I	BOOL	Mask I/O access errors, delay alarms	FALSE: I/O access errors are not masked. TRUE: Errors in access to nonexistent I/Os are masked and alarms are delayed.
CP_START	I	BOOL	Start FB initialization	
CP_START_FM	I	BOOL	The initialization is activated with the rising edge of CP_START	
CP_START_NDR	O	BOOL	Info: write job from CP	
CP_START_OK	O	BOOL	Initialization completed without error	TRUE: The initialization job could be completed without error before the monitoring time elapsed.
CP_START_ERROR	O	BOOL	Initialization completed with error	TRUE: The initialization job could not be completed without error even after the monitoring time had elapsed.
ERROR_NR	O	Word	Error number	Assignment, see diagnostics.
ERROR_INFO	O	Word	Error additional info	Assignment, see diagnostics.

6.4 Program Call

General Information

The Modbus communications **FB** for the loadable Modbus slave driver must be called in SIMATIC S7 CPU in the cyclic part.

The communications FB initializes the CP and carries out those Modbus functions which the driver cannot carry out itself. The Modbus slave communications FB must be called in the user program, even if these function codes are not used by the Modbus master system.

Communication between the CP and the FB is carried out via the CPU operating system functions and the function block P_SND_RK and P_RCV_RK which is called from the FB.

Startup, Initialization

After each complete restart or restart of the CPU, you must carry out an initialization of the Modbus communications FB. Initialization is activated with a rising edge at input CP_START.

First of all the FB deletes the instance DB, reads operand areas I, Q and M from the CPU with SFC51 SZL_READ, and files them in the instance DB. This enables you to check the write requirements of the Modbus master system for area overflow.

The number of the instance DB and the completed initialization sequence is communicated to the CP by means of a SEND job. As soon as the SEND job has been completed without error, output CP_START_OK is set and the FB initialization is complete.

If the SEND job is completed with error, CP_START is reset and CP_START_ERROR is set. If the initialization was completed with error, Modbus communication is not possible.

All requests from the Modbus Master system are answered with an Exception Code message.

Instance DB

All data relevant to the Modbus FB are located in an instance data block. This DB is also the instance DB (multi instances) for the used FBs / SFBs and work area for the Modbus communications FB. No further data area is required.

The Modbus FB only uses the instance DB and local data.

Access to the instance DB is permitted only as read-only.

Timeout Initialization (START_TIME)

After mains-on, the CP needs several seconds for hardware and memory checks until it is ready for run. Initialization attempts of the Modbus FB during this time are completed with error. Because of this, the Modbus FB repeats its initialization job several times during this timeout.

CP_START_OK is set if the initialization could be completed without error within the parameterized time START-TIME of the timer START-TIMER. If initialization could not be completed without error after the monitoring time has elapsed, CP_START_ERROR is set.

I/O Access Errors, Delay Alarms

Input parameter OB_MASK can be used to instruct the Modbus FB to mask I/O access errors. In the event of a write access to non-existent I/Os, the CPU does not go to STOP and neither does it call the error OB.

The access error is, however, recognized by the FB and the function is ended with an error message to the CP. I/O access errors in the event of a write command are masked only if parameter OB_MASK is = TRUE.

Prior to masking the access errors, all higher priority alarms are delayed (SFC14), and they are re-enabled after write access of the FBs and after unmasking the access errors (SFC42).

This ensures that access errors are recognized by higher priority programs (time or process alarms) in case the FB is interrupted between masking and unmasking.

Example OB100/101

Segment 1

```
UN      M       180.0                       // set CP_START
S       M       180.0                       // !
U       M       180.1                       // re-set CP_START_FM
R       M       180.1                       // !
```

Example OB1

Segment 1

```
CALL    FB              81 , DB81           // Modbus SLAVE
LADDR                   :=256               // Base address of the CP
START_TIMER             :=T120              // Timer “Timeout initi.”
START_TIME              :=S5T#5S            // Time value “Timeout”
OB_MASK                 :=TRUE              // Mask access errors
CP_START                :=M180.0            // Initialization start
CP_START_FM             :=M180.1            // Edge trigger memory bit
CP_NDR                  :=M180.2            // New write job from CP
CP_START_OK             :=M180.3            // Initial. without error
CP_START_ERROR          :=M180.4            // Initial. with error
CP_ERROR_NR             :=MW182             // Error number
CP_ERROR_INFO           :=MW184             // Error additional info
```

6.5 Cyclic Operation

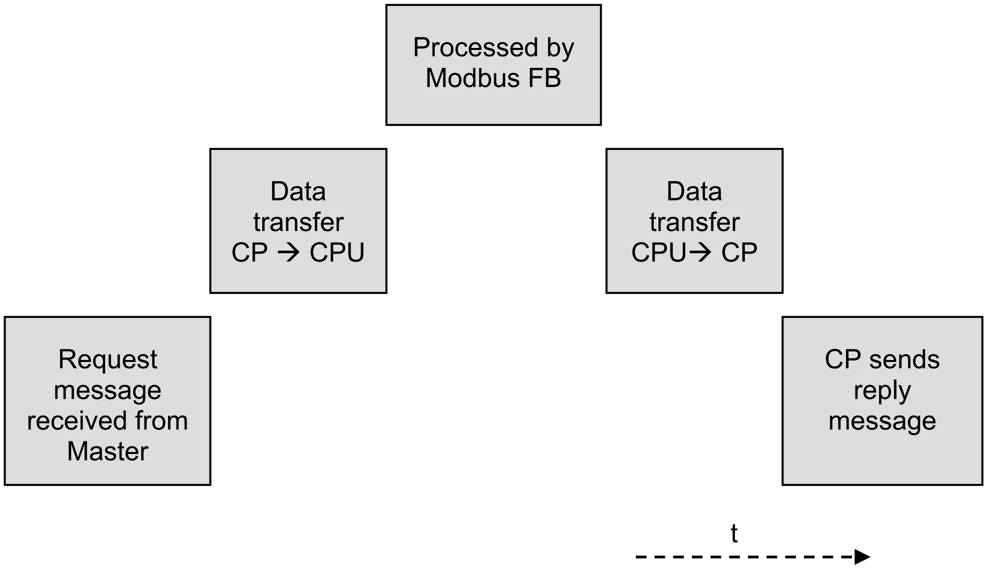
Communications FB

The Modbus communications FB carries out all necessary SFB calls and processes those function codes which the CP cannot run itself (write bit-by bit with FC05 or FC15 to the SIMATIC areas memory bits, outputs and data block bits).

Reaction Times

One FB sequence (one PLC cycle) plus data transfer times CP--->CPU and CPU--->CP are required to process the write function codes FC05, FC15. The other functions which are processed by the CP directly only require data transfer times CP--->CPU or CPU--->CP.

The CP does not send the reply message to the master system until after the data transfer CPU--->CP. In this instance the standard reply monitoring time of 2 sec. can be met.



The reaction times depend on the cycle time of the CPU program (Modbus FB) and the CPU type (data transfer CPU<-->CP).

7 CPU – CP Interface

Modbus Communications FB

Data transfer between CP and CPU is carried out by the function blocks **P_SND_RK** and **P_RCV_RK**.

The supplied Modbus communications FB calls the FBs. It is not necessary to program any further FB calls in the SIMATIC user program.

Module Address

The only remaining task is to specify the module address (LADDR) at the Modbus communications FB.

Data Transfer Length

Transfer of data CP <-> CPU is carried out by the function blocks P_SND_RK and P_RCV_RK.

The **length** of data transfer for the interface CPU - CP is a maximum of 1024 bytes. As Modbus PDU restricts the data length to a smaller amount, this limit is not applicable.

Block Size

Data transfer between CPU and CP with function blocks P_SND_RK and P_RCV_RK is carried out with a **block size** of 32 bytes to ensure a stable reaction handling to system alarms of the S7 automation system.

Data Consistency

Data consistency during data transmission is given only for the above-listed block size of 32 bytes or less.

For larger amounts of data, the data is transferred in the listed block size with a time delay between each block.

Data consistency between the individual blocks cannot be guaranteed because the data may be processed by the user program at the same time. Access to the CPU memory is carried out while the user program is running whenever the P_RCV_PK is passed.

Modbus Slave

This means the following for the driver Modbus slave:

If **data consistency** is required when reading / writing registers or bits, the amount of data transferred by a single message must be **limited** to the above listed block size: for example, a maximum of 16 of 16-bitregisters or 8 of 32-bit registers with FC 03,04,16 or a maximum of 256 bits with FC 01,02,15. If required, it is possible to ensure consistent processing of related data areas by appropriate coordination mechanisms at user level.

8 Transmission Protocol

General Information

The procedure used is a code-transparent, asynchronous half-duplex procedure. Data transfer is carried out without handshake.

Master-Slave Relationship

The Modbus master system initiates transmission, and after outputting a request message it waits for a reply message from the addressed slave. Message exchange from slave to slave is not possible.

ASCII Mode

When devices are setup to communicate on a Modbus serial line using ASCII mode, each 8–bit byte in a message is sent as two ASCII characters.

The allowable characters transmitted for all fields except the start character and end characters are hexadecimal 0–9, A–F (ASCII coded).

Example: The byte 0X5B is encoded as two characters: 0x35 and 0x42 (0x35 =“5”, and 0x42 =“B” in ASCII).

8.1 Message Structure

Message Structure

The data exchange “Master-Slave” and/or “Slave-Master” begins with the **Start Character**, followed by **Slave Address** and **Function Code**. Then the data are transferred. The structure of the data field depends on the function code used. The LRC check is transmitted at the end of the message, followed by the **End Characters**.

START	ADDRESS	FUNCTION	DATA	LRC	END
1 char colon	2 chars	2 chars	0 up to 2x252 char(s)	2 chars	2 chars CR, LF

START	Start Character :
ADDRESS	Modbus Slave Address
FUNCTION	Modbus Function Code
DATA Message	Data: Byte_Count, Coil_Number, Data
LRC	Message Checksum
END	End Characters CR, LF

Start Character

The start character is a colon (0x3A). The devices monitor the bus continuously for the ‘colon’ character. When this character is received, each device decodes the next character until it detects the End Characters (CR,LF).

Slave Address

The slave address can be within the range 1 to 255. The address is used to address a defined slave on the bus.

Broadcast Message

The master uses slave address zero to address all slaves on the bus. **Broadcast Messages** are only permitted in conjunction with writing **Function Codes 05, 06, 15, and 16**. A Broadcast Message is not followed by a reply message from the slave.

Function Code

The function code defines the meaning as well as the structure of a message. The following function codes are supported by the driver:

Function Code	Function in accordance with Modbus Specification
01	Read Coils
02	Read Discrete Inputs
03	Read Holding Registers
04	Read Input Registers
05	Write Single Coil
06	Write Single Register
08	Diagnostic (only sub-func 0, echo)
15	Write Multiple Coils
16	Write Multiple Registers

Data Field DATA

The data field DATA is used to transfer the function code-specific data such as: Bytecount, Coil_Start Address, Register_Start Address; Number_of_Coils, Number_of_Registers, ... See also Section “Function Codes”.

The data field contains up to 2 * 252 ASCII characters.

LRC

The Longitudinal Redundancy Checking (LRC) field is one byte, containing an 8-bit binary value. The LRC value is calculated by the transmitting device, which appends the LRC to the message. The device that receives recalculates an LRC during receipt of the message, and compares the calculated value to the actual value it received in the LRC field. If the two values are not equal, an error results.

The LRC is calculated by adding together successive 8–bit bytes in the message, discarding any carries, and then two’s complementing the result. The LRC is an 8–bit field, therefore each new addition of a character that would result in a value higher than 255 decimal simply ‘rolls over’ the fields value through zero. Because there is no ninth bit, the carry is discarded automatically.

A procedure for generating an LRC is:

1. Add all bytes in the message, excluding the starting ‘colon’ and ending CRLF. Add them into an 8–bit field, so that carries will be discarded.

2. Build the twos–complement.

3. Convert the LRC to ASCII.

Placing the LRC into the Message

When the 8–bit LRC (2 ASCII characters) is transmitted in the message, the high–order character will be transmitted first, followed by the low–order character. For example, if the LRC value is 61 Hex (0110 0001):

LRC high	0x36
LRC low	0x31

Message End

The end of the message is defined by the characters CR and LF.

Telegram Example

The Modbus serial line PDU is describes as follows:

05H	Slave Address
08H	Function Code (Diagnostics)
00H	Return Query Data (echo) sub-func code “High”
00H	Return Query Data (echo) sub-func code “Low”
A5H	Test Value “High”
C3H	Test Value “Low”
XxH	LRC

In ASCII transmission mode the following data is transferred on the line:

3AH	Start Character
30H	Slave Address
35H	
30H	Function Code
38H	
30H	Sub Function Code “High”
30H	
30H	Sub Function Code “Low”
30H	
41H	Test Value “High”
35H	
43H	Test Value “Low”
33H	
XxH	LRC Code High
xxH	LRC Code Low
0DH	CR
0AH	LF

Error Handling

If any of the errors listed below is recognized by the CP during reception of the reply message, the received data string is rejected and an error is reported

- wrong start character
- received character is no ASCII character
- overrun of the receive buffer
- received LRC incorrect
- transmission error in a character (parity, framing or overrun error)
- character delay time elapsed
- BREAK (line break or DSR or CTS not asserted)

If BREAK is recognized on the receiving line by the CP during output of a message, an error is reported too.

8.2 Exception Responses

Exception Responses

On recognition of an error in the request message from the master (for example, register address illegal), the slave sets the highest value bit in the function code of the reply message. This is followed by transmission of one byte of error code (Exception Code), which describes the reason for the error.

Exception Code Message

The error code reply message from the slave has the following structure:
for example, slave address 5, function code 5, exception code 02

Reply Message from Slave EXCEPTION_CODE_xx:

05H	Slave Address
85H	Function Code
02H	Exception Code (1..4)
XxH	LRC

The following error codes are sent by the driver:

Exception Code	Meaning in accordance with Modbus Specification	Cause
01	Illegal Function	Illegal function code received
02	Illegal Data Address	Access to a SIMATIC area which is not enabled (see parameter assignment - areas, limitation)
03	Illegal Data Value	Amount of bits/registers too large, data field not FF00 or 0000 for FC05, diagnostics subcode <> 0000 for FC08.
04	Failure in Associated Device	Initialization by Modbus communications FB not yet carried out or FB reports error, Error during data transfer CP<->CPU (for example, DB does not exist).

8.3 RS 232C Secondary Signals

Available Signals

The following RS 232C secondary signals exist on the CP when the RS232C interface submodule is used:

•	DCD	(input)	Data carrier detect; Data carrier detected
•	DTR	(output)	Data terminal ready; CP ready for operation
•	DSR	(input)	Data set ready; Communication partner ready for operation
•	RTS	(output)	Request to send; CP ready to send
•	CTS	(input)	Clear to send; Communication partner can receive data from the CP (response to RTS = ON of the CP)
•	RI	(input)	Ring indicator; Indication of an incoming call

When the CP is switched on, the output signals are in the OFF state (inactive).

You can parameterize the way in which the DTR/DSR and RTS/CTS control signals are used with the **CP 341: Point-to-Point Communication, Parameter Assignment** parameterization interface or control them by means of function calls (FBs) in the user program.

Using the RS 232C Secondary Signals

The RS 232C secondary signals can be used as follows:

- When the automatic use of all RS 232C secondary signals is parameterized
- By means of the V24_STAT and V24_SET functions (FBs)

Note
When automatic use of the RS 232C secondary signals is parameterized, neither RTS/CTS data flow control nor RTS and DTR control by means of the V24_SET FB are possible. On the other hand, it is always possible to read all RS 232C secondary signals by means of the V24_STAT FB.

The sections that follow describe how the control and evaluation of the RS 232C secondary signals is handled.

Automatic Use of the Secondary Signals

The automatic use of the RS 232C secondary signals on the CP is implemented as follows:

- As soon as the CP is switched by means of parameterization to an operating mode with automatic use of the RS 232C secondary signals, it switches the RTS line to OFF and the DTR line to ON (CP ready for use).
- Message frames cannot be sent and received until the DTR line is set to ON. As long as DTR remains set to OFF, no data is received via the RS 232C interface. If a send request is made, it is aborted with an error message.
- When a send request is made, RTS is set to ON and the parameterized data output waiting time starts. When the data output time elapses and CTS = ON, the data is sent via the RS 232C interface.
- If the CTS line is not set to ON within the data output time so that data can be sent, or if CTS changes to OFF during transmission, the send request is aborted and an error message generated.
- After the data is sent, the RTS line is set to OFF after the parameterized time to RTS OFF has elapsed. The CP does not wait for CTS to change to OFF.
- Data can be received via the RS 232C interface as soon as the DSR line is set to ON. If the receive buffer of the CP threatens to overflow, the CP does not respond.
- A send request or data receipt is aborted with an error message if DSR changes from ON to OFF. The message “DSR = OFF (automatic use of V24 signals)” is entered in the diagnostics buffer of the CP.

Note
When automatic use of the RS 232C secondary signals is parameterized, neither RTS/CTS data flow control nor RTS and DTR control by means of the V24_SET FB are not possible.

Note
The “time to RTS OFF” must be set in the parameterization interface so that the communication partner can receive the last characters of the message frame in their entirety before RTS, and thus the send request, is taken away. The “data out put waiting time” must be set so that the communication partner can be ready to receive before the time elapses.

Time Diagram

The following Figure illustrates the chronological sequence of a send request.

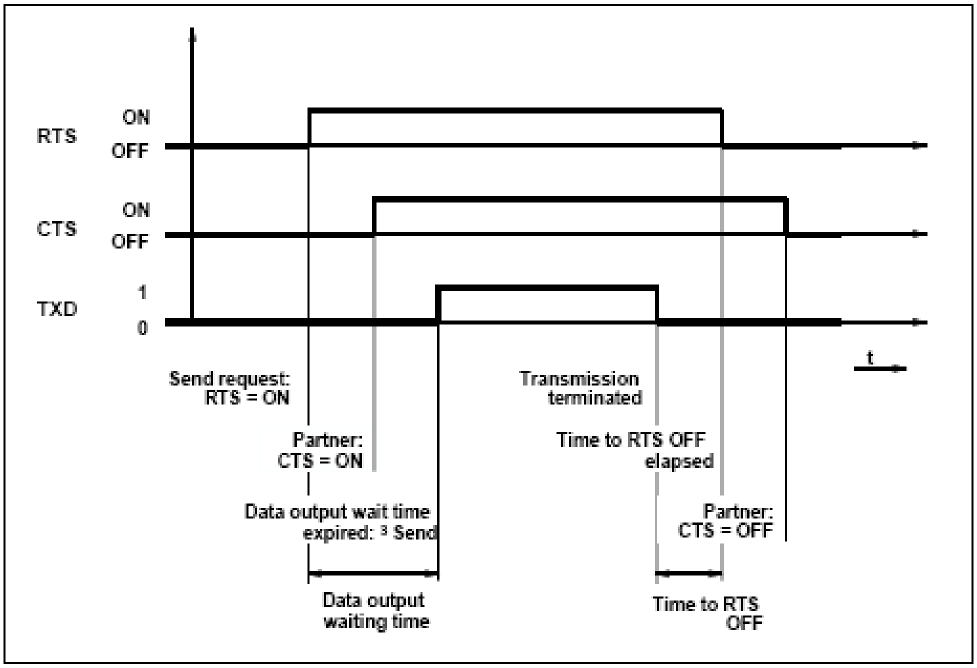


Figure 7-1 Time Diagram for Automatic Use of the RS 232C Secondary Signals

9 Function Codes

Used Function Codes

The following Modbus function codes are supported by the driver:

Function Code	Function in accordance with Modbus Specification	Function in SIMATIC S7	
01	Read coils	Read bit-by-bit (1…2008 bits)	Memory bits M
			Outputs Q
			Data block bits
02	Read discrete inputs	Read bit-by-bit (1…2008 bits)	Memory bits M
			Inputs I
03	Read holding registers	Read word-by-word (1…125 registers) Read dword by dword (1…62 registers)	Data block DB
04	Read input registers	Read word-by-word	Data block DB
05	Write single coil	Write bit	Memory bits M
			Outputs Q
06	Write single register	Write word/dword	Data block bit DB
08	Diagnostic (echo data)	-	-
15	Write multiple coils	Write bit-by-bit (1...1976 bits)	Memory bits M
			Outputs Q
			Data block bits
16	Write multiple (holding) registers	Write word-by-word (1...123 registers) Write dword by dword (1…61 registers)	Data block DB

Note
All Modbus addresses listed below refer to the transmission message level and not to the user level in the Modbus master system.

This means that the Modbus addresses in the transmission messages begin with 0000 Hex.

Note
When accessing SIMATIC DB addresses with Modbus register addresses, a direct transition or “roll-over” from one DB number to the subsequent DB number within a single **Modbus Master Request Message** is not possible. The Modbus slave responds to this with a Modbus exception message with error code 02. The slave CP also posts error code “0E 39” (error while accessing the SIMATIC range “Data block”) into its diagnostic buffer.

This potential error only applies for standard mode when the parameter “with 32-Bit Register” is **not** set since when this parameter is set each Modbus access can map only to a single SIMATIC Data Block. Please review Sections 3.6.1 and 5.3.1 to fully understand this issue.

Example:
Suppose the base DB number is set to 1 in the slave and the received Modbus register is 510 with a length (number of registers) of 3, Since 511 is the maximum register number (maps to DB word offset) before rolling into DB2, the length of 3 would cause access to DB1,DBW1020, DB1,DBW1022 and DB2,DBW0. This transition from DB 1 to 2 is not allowed. Therefore only a length of 1 or 2 registers is acceptable when the starting Modbus register value is 510.

9.1 Function Code 01 – Read Coils

Function

This function enables the Modbus master system to read individual bits from the SIMATIC memory areas listed below.

Request Message

ADDR	FUNC	start_address	number of coils	LRC

Reply Message

ADDR	FUNC	Byte_count n	n Byte DATA	LRC

start_address

The Modbus bit address “**start_address**” is interpreted by the driver as follows:

The driver checks that “start_address” is located within one of the areas which were specified during parameter assignment in the dialog box “**Conversion of Modbus Addressing for FC 01, 05, 15**” (from / to : memory bits, outputs, data block bits).

If Modbus bit address **start address** is located in area	Access is made to the following **SIMATIC memory area**	
from aaaaa to bbbbb	commence at memory bit	M uuuuu.0
from ccccc to ddddd	commence at output	Q ooooo.0
from eeeee to fffff	commence at data block bit	DBiiiiii.DBX0.0

The address calculation for access (address conversion) is carried out as follows:

Access beginning with SIMATIC	Conversion formula (ignore remainder)
Memory byte	= ((start_address - aaaaa) / 8) + uuuuu
Output byte	= ((start_address - ccccc) / 8) + ooooo
Data block byte	= ((start_address - eeeee) / 8)

Access to “Memory Bits”, “Outputs” and “Data Block Bits”

The above table determines the byte index into the addressed SIMATIC data area. The bit offset is also needed. It is simply the remainder from the above division operations.

number of coils

Values between **1** and **2008** are permitted as the **number of coils**. This is the amount of bits read.

Note
Please note the CPU-specific limitations as described in the section “CPU-CP Interface.”

Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 01, 05, 15					
Modbus address in transmission message				SIMATIC memory area	
from	0	To	2047	commence at memory bit	M 1000.0
from	2048	To	2559	commence at output	Q 256.0
from	4096	To	4607	commence at data block bit	DB111.DBX0.0

Request Message FUNCTION 01:

05H	Slave Address ADDR
01H	Function Code FUNC
00H	start_address “High”
40H	start_address “Low”
00H	number of coils “High”
20H	number of coils “Low”
xxH	LRC

Reply Message FUNCTION 01:

05H	Slave Address ADDR
01H	Function Code FUNC
04H	Byte_count
01H	<DATA 1> M 1008.0 – M 1008.7
17H	<DATA 2> M 1009.0 – M 1009.7
02H	<DATA 3> M 1010.0 – M 1010.7
18H	<DATA 4> M 1011.0 – M 1011.7
xxH	LRC

Address Calculation:

The Modbus address “start_address” 0040 Hex (64 decimal) is located in the “memory bit” area:

Memory byte	= ((start_address	- aaaaa)	/ 8)	+ uuuuu
	= ((64 - 0)		/ 8)	+ 1000
	= 1008			

The remainder from the above division determines the Bit_Number:

Bit_Number.	= ((start_address	- aaaaa)	% 8)	(Modulo 8)
	= ((64	- 0)	% 8)	
	= 0			

Access is made starting from bit M 1008.0 up to and including M 1011.7.

Amount of Bits:

In the request message, the **number of coils** 0020 Hex (32 decimal) means that 32 Bits = 4 Bytes will be read.

Further Examples

Some other access examples are listed in the table below. All examples below are based on the area specification from the previous example.

Start address		Access in SIMATIC beginning					→ with
HEX	dec.	(decimal)					
0000	0	Mem.bit	((0	- 0)	/ 8)	+ 1000	→ M 1000.0
0021	33	Mem.bit	((33	- 0)	/ 8)	+ 1000	→ M 1004.1
0400	1024	Mem.bit	((1024	- 0)	/ 8)	+ 1000	→ M 1128.0
0606	1542	Mem.bit	((1542	- 0)	/ 8)	+ 1000	→ M 1192.6
0840	2112	Output	((2112	- 2048)	/ 8)	+ 256	→ Q 264.0
09E4	2532	Output	((2532	- 2048)	/ 8)	+ 256	→ Q 316.4
1010	4112	DB bits	((4112	- 4096)	/ 8)	+ 0	→ DBX 2.0
10C2	4290	DB bits	((4290	- 4096)	/ 8)	+ 0	→ DBX 24.2

9.2 Function Code 02 – Read Discrete Inputs

Function

This function enables the Modbus master system to read individual bits from the SIMATIC memory areas listed below.

Request Message

ADDR	FUNC	start_address	number of inputs	LRC

Reply Message

ADDR	FUNC	Byte_count n	n Byte DATA	LRC

start_address

The Modbus bit address “**start_address**” is interpreted by the driver as follows: The driver checks whether “start_address” is located within one of these areas, which was entered during parameter assignment in the dialog box “**Conversion of Modbus Addressing for FC 02**” (from / to : memory bits, inputs, and data block bits).

If Modbus bit address **start address** is located in area	Access is made to the following **SIMATIC memory area**	
from kkkkk to lllll	commence at memory bit	M vvvvv.0
from nnnnn to rrrrr	commence at input	I zzzzz.0
from sssss to ttttt	commence at data block bit	DBjjjjj.DBX0.0

The address calculation for access (address conversion) is carried out as follows:

Access beginning with SIMATIC	Conversion formula
Memory byte	= ((start_address - kkkkk) / 8) + vvvvv
Output byte	= ((start_address - nnnnn) / 8) + zzzzz
Data block byte	= ((start_address - sssss) / 8)

Access to “Memory bits”, “Inputs” and “Data block bits”

The above table determines the byte index into the addressed SIMATIC data area. For this, ignore the remainder from the division operations. The bit offset is also needed. It is simply the remainder from the above division operations.

number of inputs

Any value from **1** to **2008** is allowed as the **number of inputs**. This is the amount of bits read.

Note:
Please note the CPU-specific limitations as described in the section “CPU-CP Interface.”

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 02		
Modbus address in transmission message	SIMATIC memory area	
From 0 to 4095	commence at memory bit	M 2000.0
From 4096 to 5119	commence at input	I 128.0
From 8192 to 8351	commence at data block bit	DB112.DBX0.0

Request Message FUNCTION 02:

05H	Slave Address ADDR
02H	Function Code FUNC
10H	start_address “High”
30H	start_address “Low”
00H	number of inputs “High”
18H	number of inputs “Low”
xxH	LRC

Reply Message FUNCTION 02:

05H	Slave Address ADDR
02H	Function Code FUNC
03H	Byte_count
12H	<DATA 1> I 134.0 – I 134.7
34H	<DATA 2> I 135.0 – I 135.7
56H	<DATA 3> I 136.0 – I 136.7
xxH	LRC

Address Calculation:

The Modbus address “start_address” 1030 Hex (4144 decimal) is located in the area “Inputs”:

Input byte	= ((start_address	- nnnnn)	/ 8)	+ zzzzz
	= ((4144	- 4096)	/ 8)	+ 128
	= 134			

The remainder from the above division determines the Bit_Number:

Bit_Number.	= ((start_address	- nnnnn)	% 8)
	= ((4144	- 4096)	% 8)
	= 0		

(Modulo 8)

Access is made starting from input **I** 134.0 up to and including **I** 136.7.

Amount of Bits:

In the request message, the **number of inputs** 0018 Hex (24 decimal) means that 24 Bits = 3 Bytes will be read.

Further Examples

Some other access examples are listed in the table below.

All examples are based on the above area specification.

Start address		Access in SIMATIC beginning					→ with
HEX	dec.	(decimal)					
0000	0	Mem.bit	((0	- 0)	/ 8)	+ 2000	→ M 2000.0
0071	113	Mem.bit	((113	- 0)	/ 8)	+ 2000	→ M 2014.1
0800	2048	Mem.bit	((2048	- 0)	/ 8)	+ 2000	→ M 2256.0
0D05	3333	Mem.bit	((3333	- 0)	/ 8)	+ 2000	→ M 2416.5
1000	4096	Input	((4096	- 4096)	/ 8)	+ 128	→ I 128.0
10A4	4260	Input	((4260	- 4096)	/ 8)	+ 128	→ I 148.4
2000	8192	DB bits	((8192	- 8192)	/ 8)	+ 0	→ DBX 0.0
2011	8386	DB bits	((8386	- 8192)	/ 8)	+ 0	→ DBX 24.2

9.3 Function Code 03 – Read Holding Registers in Standard Mode

Function

This function enables the Modbus master system to read data words from a data block.

Request Message

ADDR	FUNC	start_register	number of registers	LRC

Reply Message

ADDR	FUNC	byte_count n	n/2-register DATA (high, low)	LRC

start_register

The Modbus register address “**start_register**” is interpreted by the driver as follows:

Modbus Register Number (start_register)

15						9	8	7							0	Bit
start-register offset_DB_No.							start_register word No.									

For further address generation, the driver uses the “Base DB number” (commence at DB xxxxx) entered in the dialog box “**Conversion of Modbus Addressing for FC 03, 06, 16**” during parameter assignment.

The address calculation for access (address conversion) is carried out in two steps as follows:

Access to SIMATIC	Conversion Formula
Data block DB (resulting DB)	= (Base DB number xxxxx + start_register offset_DB_No.)
Data word DBW	= (start_register word_No. * 2)

Calculation Formula for start_register

If you want to access SIMATIC memory beginning at a particular DBx,DBWy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= ((x – Base DB number) * 512) + (y / 2)

This assumes that y is even and is <= 1022. It also assumes that (x – Base DB number) is not negative and from 0 to 127.

number of registers

A value from **1** to **125** is possible as the **number of registers to be read.** However, you must follow this rule to avoid errors due to rolling to the next DB:

(number of registers)$_{max}$ = 512 – (start_register word No.)

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 03, 06,16		
Modbus address in transmission message	SIMATIC memory area	
0	Commencing at data block (base DB number)	DB 800

Request Message FUNCTION 03:

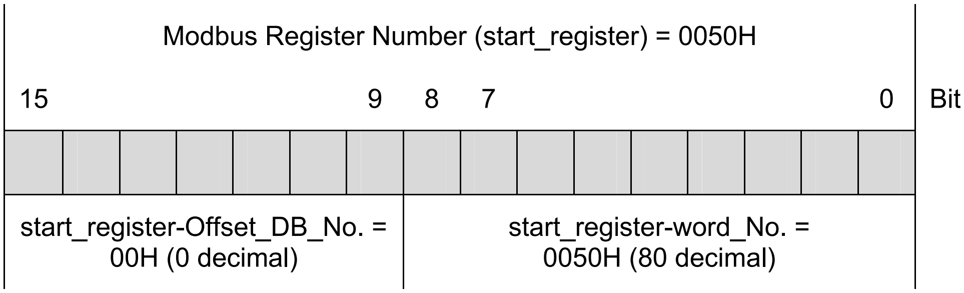
05H	Slave Address ADDR
03H	Function Code FUNC
00H	start_register “High”
50H	start_register “Low”
00H	number of registers “High”
02H	number of registers “Low”
xxH	LRC

Reply Message FUNCTION 03:

05H	Slave Address ADDR
03H	Function Code FUNC
04H	Byte_count
87H	<DATA 1> DBW 160 “High”
65H	<DATA 2> DBW 160 “Low”
43H	<DATA 3> DBW 161 “High”
21H	<DATA 4> DBW 161 “Low”
xxH	LRC

Address Calculation:

The Modbus address “start_register” 0050 Hex (80 decimal) is interpreted as follows:


Modbus Register Number (start_register) = 0050H
15
9
8
7
0
Bit
start_register-Offset_DB_No. = 00H (0 decimal)
start_register-word_No. = 0050H (80 decimal)

Data block DB (resulting DB)	= (base DB Number xxxxx + Start_register-Offset_DB_No.) = (800 + 0 = 800

Data word DBW	= (start_register word_No. * 2) = (80 * 2) = 160

Access is made to DB 800, data word DBW 160.

Amount of Registers:

The amount of Modbus registers “**number of registers**” 0002 Hex (2 decimal) means 2 registers = 2 data words are read.

Further Examples

Some other access examples are listed in the table below.

			Start_register				
Start register		Base DB No	Offset DB_No	Word Number		Resulting DB	DBW
HEX	dec.	dec.	dec.	HEX	dec.	decimal	dec.
0000	0	800	0	000	0	800	0
01F4	500	800	0	1F4	500	800	1000
0200	512	800	1	000	0	801	0
02FF	767	800	1	0FF	255	801	510
0300	768	800	1	100	256	801	512
03FF	1023	800	1	1FF	511	801	1022
0400	1024	800	2	000	0	802	0

9.4 Function Code 03 – Read Holding Registers in Mode “with 32-Bit Register”

General

In mode “with 32-Bit Register” 16-bit registers as well as 32-bit registers can be read. The address calculation in this mode is different than standard mode.

Function

This function enables the Modbus master system to read registers mapped to a data block of the SIMATIC CPU. The registers can contain a 16-bit value as well as a 32-bit value.

Request Message

ADDR	FUNC	start_register	number of registers	LRC

Reply Message

Depending on the requested address start_register, whether it belongs to 16-bit or 32-bit memory area, the reply message has a different form.

Reply message when requesting 16-bit registers:

ADDR	FUNC	byte_count n	n/2-register DATA (high, low)	LRC

Reply message when requesting 32-bit register:

ADDR	FUNC	byte_count n	n/4-register DATA (byte 1…4)	LRC

start_register

The Modbus register address “**start_register**” is interpreted by the driver as follows:

The driver checks that “start_register” is located within one of the areas which were specified during parameter assignment in the dialog box “**Conversion of Modbus Addressing for FC 03, 06, 16**” (from / to : 16-bit integer, 32-bit integer, 32-bit float).

If Modbus register address **start address** is located in area		Access is made to the following **SIMATIC memory area**	
16-bit integer	from xxaaa to xxbbb	commence at data block	DBxxkkk.DBW0
32-bit integer	from xxccc to xxddd	commence at data block	DBxxlll.DBD0
32-bit float	from xxeee to xxfff	commence at data block	DBxxnnn.DBD0

The address calculation for access (address conversion) is carried out as follows:

Register type	Access to SIMATIC	Conversion Formula
16-bit integer	Data block DB	fixed number DBxxkkk
	Data word DBW	= (start_register – xxaaa) * 2
32-bit integer	Data block DB	fixed number DBxxlll
	Data word DBW	= (start_register – xxccc) * 4
32-bit float	Data block DB	fixed number DBxxnnn
	Data word DBW	= (start_register – xxeee) * 4

register_number

The maximum register number depends on the accessed data area. If the **16-bit area** is accessed, values from **1** to **125** are permitted as the **number of registers**.

When accessing the **32-bit area**, the **number of registers** is limited from **1 to 62**.

The amount of registers contained in **number of registers**_is read.

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 03, 06,16	
Modbus address in transmission message	SIMATIC memory area
16-bit integer	
from 3000 to 4999	commence at data block DB2.DBW0
32-bit integer	
from 5000 to 5099	commence at data block DB3.DBW0
32-bit float	
from 7000 to 9999	commence at data block DB4.DBW0

16-Bit Area Accessed

Request Message FUNCTION 03:

05H	Slave Address ADDR
03H	Function Code FUNC
0BH	start_register "High"
EAH	start_register "Low"
00H	number of registers "High"
02H	number of registers "Low"
xxH	LRC

Reply Message FUNCTION 03:

05H	Slave Address ADDR
03H	Function Code FUNC
04H	Byte_count
87H	<DATA 1> DBW 100 "High"
65H	<DATA 2> DBW 100 "Low"
43H	<DATA 3> DBW 101 "High"
21H	<DATA 4> DBW 101 "Low"
xxH	LRC

32-Bit Area Accessed

Request Message FUNCTION 03:

05H	Slave Address ADDR
03H	Function Code FUNC
1BH	start_register "High"
59H	start_register "Low"
00H	number of registers "High"
02H	number of registers "Low"
xxH	LRC

Reply Message FUNCTION 03:

05H	Slave Address ADDR
03H	Function Code FUNC
08H	Byte_count
CDH	<DATA 5> DBD 4 "byte 1"
DCH	<DATA 6> DBD 4 "byte 2"
ABH	<DATA 7> DBD 4 "byte 3"
BAH	<DATA 8> DBD 4 "byte 4"
11H	<DATA 1> DBD 8 "byte 1"
22H	<DATA 2> DBD 8 "byte 2"
33H	<DATA 3> DBD 8 "byte 3"
44H	<DATA 4> DBD 8 "byte 4"
xxH	LRC

Address Calculation when 16-bit area is accessed:

The Modbus address "start_register" 0BEA Hex (3050 decimal) is located in the area "16-bit integer" and interpreted as follows:

Data block DB	= fixed number xxkkk = 2

Data word DBW	= (start_register	- xxaaa)	* 2
	= (3050	- 3000)	* 2
	= 100		

Read access is made to DB2.DBW100.

The amount of Modbus registers "**number of registers**" 0002 Hex (2 decimal) means 2 registers = 2 data words (4 bytes) are read.

Calculation Formula for start_register (16-bit)

If you want to read SIMATIC memory at a particular DBxxkkk,DBDy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= (y/2) + xxaaa, where xxkkk is the DB for 16-bit registers and start_register <= xxbbb

The value xxaaa to xxbbb are the parameters defining the Modbus registers for the 16-bit integer range.

Address Calculation: when 32-bit area is accessed:

The Modbus address “start_register” 1B59 Hex (7001 decimal) is located in the area “32-bit float” and interpreted as follows:

Data block DB	= fixed number xxnnn = 4

Data word DBW	= (start_register	- xxeee)	* 4
	= (7001	- 7000)	* 4
	= 4		

Read access is made to DB4.DBD4.

The amount of Modbus registers “**number of registers**” 0002 Hex (2 decimal) means 2 registers = 2 double words (8 byte) are read.

Formula for start_register (32-bit)

If you want to read SIMATIC memory beginning at a particular DBxxlll,DBDy or DBxxnnn,DBDy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= (y/4) + xxccc, where xxlll is the DB for 32-bit integer range and start_register <= xxddd
start_register	= (y/4) + xxeee, where xxnnn is the DB for 32-bit float range and start_register <=xxfff

The values xxccc to xxddd and xxeee to xxfff are the parameters defining the Modbus registers for the 32-bit integer and float ranges respectively.

Further Examples

Some other access examples are listed in the table below

Start register		Access in SIMATIC beginning				→ with
HEX	dec.	(decimal)				
0C37	3127	DBW	(3127	- 3000)	* 2	→ DB2.DBW254
1324	4900	DBW	(4900	- 3000)	* 2	→ DB2.DBW3800
1388	5000	DBW	(5000	- 5000)	* 4	→ DB3.DBD0
13E2	5090	DBW	(5090	- 5000)	* 4	→ DB3.DBD360
1BBC	7100	DBW	(7100	- 7000)	* 4	→ DB4.DBD400
26AC	9900	DBW	(9900	- 7000)	* 4	→ DB4.DBD7600

9.5 Function Code 04 – Read Input Registers

Function

This function enables the Modbus master system to read data words from a data block.

Request Message

ADDR	FUNC	start_register	number of registers	LRC

Reply Message

ADDR	FUNC	byte_count n	n/2-register DATA (high, low)	LRC

Start_Register

The Modbus Register Address “**start_register**” is interpreted by the driver as follows:

Modbus Register Number (start_register)

15						9	8	7							0	Bit
start-register offset_DB_No.							start_register word No.									

For further address generation, the driver uses the “Base DB number” (commence at DB yyyyy) entered in the dialog box “**Conversion of Modbus Addressing for FC 04**.”

The address calculation for access (address conversion) is carried out in two steps as follows:

Access to SIMATIC	Conversion Formula
Data block DB (resulting DB)	= (Base DB number yyyyy + start_register offset_DB_No.)
Data word DBW	= (start_register word_No. * 2)

Calculation Formula for start_register

If you want to access SIMATIC memory beginning at a particular DBx,DBWy , the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= ((x – Base DB number) * 512) + (y / 2)

This assumes that y is even and is <= 1022. It also assumes that (x – Base DB number) is not negative and from 0 to 127.

Number of registers

Any value from **1** to **125** is possible as the **number of registers**. to be read. However, you must follow this rule to avoid errors due to rolling to the next DB:

$(\text{register\_number})_{max}$ = 512 – (start_register word No.)

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 04		
Modbus address in transmission message	SIMATIC memory area	
0	Commencing at data block (base DB number)	DB 800

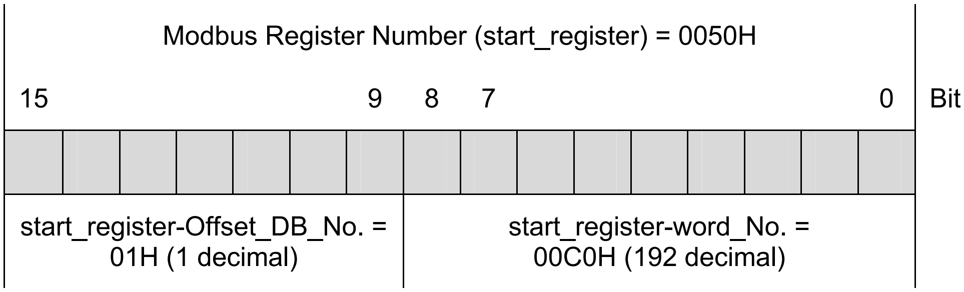
Request Message FUNCTION 04:

05H	Slave Address ADDR
04H	Function Code FUNC
02H	start_register “High”
C0H	start_register “Low”
00H	number of registers “High”
03H	number of registers “Low”
xxH	LRC

Reply Message FUNCTION 04:

05H	Slave Address
04H	Function Code
06H	Byte Counter
A1H	<DATA 1> DBW 384 “High”
A2H	<DATA 2> DBW 384 “Low”
A3H	<DATA 3> DBW 385 “High”
A4H	<DATA 4> DBW 385 “Low”
A5H	<DATA 5> DBW 386 “High”
A6H	<DATA 6> DBW 386 “Low”
xxH	LRC

Address Calculation:
The Modbus address “start_register” 02C0 Hex (704 decimal) is interpreted as follows:


Modbus Register Number (start_register) = 0050H
15
9
8
7
0
Bit
start_register-Offset_DB_No. = 01H (1 decimal)
start_register-word_No. = 00C0H (192 decimal)

Data block DB (resulting DB) = (base DB Number yyyyy +
Start_register-Offset_DB_No.)
= (900 + 1
= 901

Data word DBW = (start_register word_No. * 2)
= (192 * 2)
= 384

Access is made to DB 901, data word DBW 384.

Amount of Registers:

The amount of Modbus registers “number of registers” 0003 Hex (3 decimal) means 3 registers = 3 data words are read.

Further Examples

Some other access example is listed in the table below.

			Start_register				
Start register		Base DB No	Offset DB_No	Word Number		Resulting DB	DBW
HEX	dec.	dec.	dec.	HEX	dec.	decimal	dec.
0000	0	900	0	000	0	900	0
0064	100	900	0	064	100	900	200
00C8	200	900	0	0C8	200	900	400
0190	400	900	0	190	400	900	800
1400	5120	900	10	000	0	900	0
1464	5220	900	10	064	100	910	200
14C8	5320	900	10	0C8	200	910	400

9.6 Function Code 05 – Write Single Coil

Function

This function enables the Modbus master system to write a bit into the SIMATIC memory areas of the CPU as listed below.

Request Message

ADDR	FUNC	coil_address	DATA on/off	LRC

Reply Message

ADDR	FUNC	coil_address	DATA on/off	LRC

coil_address

The Modbus bit address “**coil_address**” is interpreted by the driver as follows: The driver checks whether “coil_address” is located within one of these areas, which was entered during parameter assignment in the dialog box “**Conversion of Modbus Addressing for FC 01, 05, 15**” (from / to : memory bits, outputs, data block bits).

If Modbus bit address **coil address** is located in area	Access is made to the following **SIMATIC memory area**
from aaaaa to bbbbb	commence at memory bit M uuuuu.0
from ccccc to ddddd	commence at output Q ooooo.0
from eeeee to fffff	commence at data block bit DBiiiiii.DBX0.0

The address calculation for access (address conversion) is carried out as follows:

Access beginning with SIMATIC	Conversion formula
Memory byte	= ((coil_address - aaaaa) / 8) + uuuuu
Output byte	= ((coil_address - ccccc) / 8) + ooooo
Data block byte	= ((coil_address - eeeee) / 8)

Access to “Memory bits”, “Outputs” and “Data Block Bits”

The above table determines the byte index into the addressed SIMATIC data area. For this, ignore the remainder from the division operations. The bit offset is also needed. It is simply the remainder from the above division operations.

DATA on/off

The following two values are permitted as **DATA on/off**:

FF00H → set bit to logical 1.

0000H → reset bit to logical 0.

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 01, 05, 15						
Modbus address in transmission message				SIMATIC memory area	
from	0	to	2047	commence at memory bit	M 1000.0
from	2048	to	2559	commence at output	Q 256.0
from	4096	to	4607	commence at data block bit	DB111.DBX0.0

Request Message FUNCTION 05:

05H	Slave Address ADDR
05H	Function Code FUNC
08H	coil_address "High"
09H	coil_address "Low" Q257.1
FFH	DATA on/off "High"
00H	DATA on/off "Low"
xxH	LRC

Reply Message FUNCTION 05:

05H	Slave Address ADDR
05H	Function Code FUNC
08H	coil_address "High"
09H	coil_address "Low" Q257.1
FFH	DATA on/off "High"
00H	DATA on/off "Low"
xxH	LRC

Address Calculation:
The Modbus address "coil_address" 0809 Hex (2057 decimal) is located in the area "outputs":

Output byte	= ((coil_address	- ccccc)	/ 8)	+ ooooo
	= ((2057 - 2048)		/ 8)	+ 256
	= 257			

The remainder from the above division determines the Bit_Number:

Bit_Number.	= ((coil_address	- ccccc)	% 8)
	= ((2057	- 2048)	% 8)
	= 1		

(Modulo 8)

Access is made to output Q 257.1.

Further Examples

For further access examples to memory bits and outputs, please refer to section 9.1.

9.7 Function Code 06 – Write Single Register in Standard Mode

Function

This function enables the Modbus master system to write a data word in a data block of the CPU.

Request Message

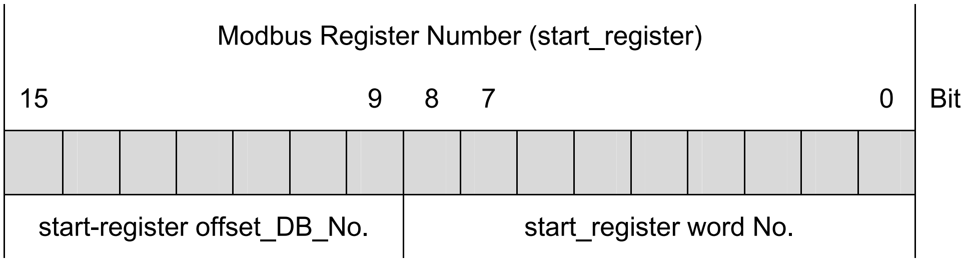
ADDR	FUNC	start_register	DATA-value (High, Low)	LRC

Reply Message

ADDR	FUNC	start_register	DATA-value (High, Low)	LRC

start_register

The Modbus register address “**start_register**” is interpreted by the driver as follows:


Modbus Register Number (start_register)
15
9
8
7
0
Bit
start-register offset_DB_No.
start_register word No.

For further address generation, the driver uses the “Base DB number” (from DB xxxxx) entered in the dialog box “**Conversion of Modbus Addressing for FC 03, 06, 16**” during parameter assignment.

The address calculation for access (address conversion) is carried out in two steps as follows:

Access to SIMATIC	**Conversion Formula**
Data block DB (resulting DB)	= (Base DB number xxxxx + start_register offset_DB_No.)
Data word DBW	= (start_register word_No. * 2)

Calculation Formula for start_register

If you want to write SIMATIC memory at a particular DBx,DBWy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= ((x – base DB number) * 512) + (y/ 2)

This assumes that y is even and is <= 1022. It also assumes that (x – Base DB number) is not negative and from 0 to 127

DATA Value

Any value can be used as the DATA-**value** (register value).

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 03, 06,16		
Modbus address in transmission message	SIMATIC memory area	
0	Commencing at data block (base DB number)	DB 800

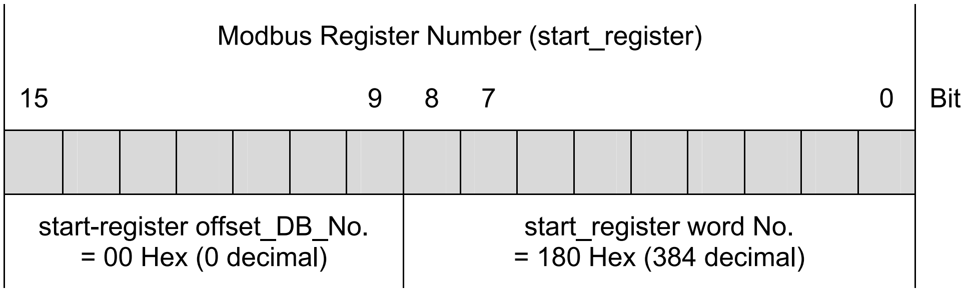
Request Message FUNCTION 06:

05H	Slave Address ADDR
06H	Function Code FUNC
01H	start_register “High”
80H	start_register “Low” DBW 768
2BH	DATA Value “High”
1AH	DATA Value “Low”
xxH	LRC

Reply Message FUNCTION 06:

05H	Slave Address ADDR
06H	Function Code FUNC
01H	start_register “High”
80H	start_register “Low” DBW 768
2BH	DATA Value “High”
1AH	DATA Value “Low”
xxH	LRC

Address Calculation:
The Modbus address “start_register” 0180 Hex (384 decimal) is interpreted:



Data block DB (resulting DB)	= (base DB Number xxxxx + Start_register-Offset_DB_No.) = (800 + 0 = 800

Data word DBW	= (start_register word_No. * 2) = (384 * 2) = 768

Access is made to DB 800, data word DBW 768.

Further Examples

For further access examples please, refer to FC 03.

9.8 Function Code 06 – Write Single Register in Mode “with 32-Bit Register”

General

In mode “with 32-Bit Register” a 16-bit register as well as a 32-bit register can be read. The address calculation in this mode is different than standard mode.

Function

This function enables the Modbus master system to write a register mapped to a data block of the CPU. The register can contain a 16-bit value as well as a 32-bit value.

Message Structure for 16-Bit Values

When writing a 16-Bit register the structure for Request and Reply message is as follows:

Request Message:

ADDR	FUNC	start_register	DATA-value (High, Low)	LRC

Reply Message:

ADDR	FUNC	start_register	DATA-value (High, Low)	LRC

Message Structure for 32-Bit Values

When writing a 32-Bit register the structure for Request and Reply message is as follows:

Request Message:

ADDR	FUNC	start_register	DATA-value (byte 1…4)	LRC

Reply Message:

ADDR	FUNC	start_register	DATA-value (byte 1…4)	LRC

start_register

The Modbus register address “**start_register**” is interpreted by the driver as follows:

The driver checks that “start_register” is located within one of the areas which were specified during parameter assignment in the dialog box “**Conversion of Modbus Addressing for FC 03, 06, 16**” (from / to : 16-bit integer, 32-bit integer, 32-bit float).

If Modbus register address **start address** is located in area		Access is made to the following **SIMATIC memory area**	
16-bit integer	from xxaaa to xxbbb	commence at data block	DBxxkkk.DBW0
32-bit integer	from xxccc to xxddd	commence at data block	DBxxlll.DBD0
32-bit float	from xxeee to xxfff	commence at data block	DBxxnnn.DBD0

The address calculation for access (address conversion) is carried out as follows:

Register type	**Access to SIMATIC**	**Conversion Formula**
16-bit integer	Data block DB	fixed number DBxxkkk
	Data word DBW	= (start_register – xxaaa) * 2
32-bit integer	Data block DB	fixed number DBxxlll
	Data word DBW	= (start_register – xxccc) * 4
32-bit float	Data block DB	fixed number DBxxnnn
	Data word DBW	= (start_register – xxeee) * 4

DATA Value

Any value can be used as the DATA-**value** (register value).

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 03, 06,16	
Modbus address in transmission message	SIMATIC memory area
16-bit integer	
from 3000 to 4999	commence at data block DB2.DBW0
32-bit integer	
from 5000 to 5099	commence at data block DB3.DBW0
32-bit float	
from 7000 to 9999	commence at data block DB4.DBW0

16-Bit Area Accessed

Request Message FUNCTION 06:

05H	Slave Address ADDR
06H	Function Code FUNC
0DH	start_register “High”
37H	start_register “Low” DBW 768
2BH	DATA Value “High”
1AH	DATA Value “Low”
xxH	LRC

Reply Message FUNCTION 06:

05H	Slave Address ADDR
06H	Function Code FUNC
0DH	start_register “High”
37H	start_register “Low” DBW 768
2BH	DATA Value “High”
1AH	DATA Value “Low”
xxH	LRC

32-Bit Area Accessed

Request Message FUNCTION 06:

05H	Slave Address ADDR
06H	Function Code FUNC
1BH	start_register “High”
5AH	start_register “Low” DBW 8
12H	DATA Value “Byte 1”
23H	DATA Value “Byte 2”
34H	DATA Value “Byte 3”
45H	DATA Value “Byte 4”
xxH	LRC

Reply Message FUNCTION 06:

05H	Slave Address ADDR
06H	Function Code FUNC
1BH	start_register “High”
5AH	start_register “Low” DBW 8
12H	DATA Value “Byte 1”
23H	DATA Value “Byte 2”
34H	DATA Value “Byte 3”
45H	DATA Value “Byte 4”
xxH	LRC

Address Calculation when 16-bit area is accessed:

The Modbus master system wants to write value 2B1A Hex. The Modbus address “start_register” 0D37 Hex (3383 decimal) is located in the area “16-bit integer” and is interpreted as follows:

Data block DB	= fixed number xxkkk = 2

Data word DBW	= (start_register	- xxaaa)	* 2
	= (3383	- 3000)	* 2
	= 766		

Write access is made to DB2.DBW766.

Calculation Formula for start_register (16-bit)

If you want to write SIMATIC memory at a particular DBxxkkk,DBDy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= (y/2) + xxaaa, where xxkkk is the DB for 16-bit integer range and start_register <= xxbbb

The value xxaaa to xxbbb are the parameters defining the Modbus registers for the 16-bit integer range.

Address Calculation: when 32-bit area is accessed:

The Modbus master system wants to write value 12233445 Hex.The Modbus address “start_register” 1B5A Hex (7002 decimal) is located in the area “32-bit float” and is interpreted as follows:

Data block DB	= fixed number xxnnn = 4

Data word DBW	= (start_register	- xxaaa)	* 4
	= (7002	- 7000)	* 4
	= 8		

Write access is made to DB4.DBD8.

Formula for start_register (32-bit)

If you want to write SIMATIC memory at a particular DBxxlll,DBDy or DBxxnnn,DBDy the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= (y/4) + xxccc, where xxlll is the DB for 32-bit integer range and start_register <= xxddd
start_register	= (y/4) + cceee, where xxnnn is the DB for 32-bit float range and start_register <=xxfff

The values xxccc to xxddd and xxeee to xxfff are the parameters defining the Modbus registers for the 32-bit integer and float ranges respectively.

Further Examples

For further access examples please, refer to section 9.4.

9.9 Function Code 08 - Diagnostics

Function

This function serves to check the communications connection.

It does not affect the S7 CPU, nor the user programs, nor user data. The received message is just echoed back to the master system by the driver.

Request Message

ADDR	FUNC	Sub-function Code (High, Low)	Test Data	LRC

Reply Message

ADDR	FUNC	Sub-function Code (High, Low)	Test Data	LRC

Diagnostic Code

Only Diagnostic Code 0000, “Return Query Data”, is supported.

Test Data

Any value (16 bit).

Application Example

Request Message FUNCTION 08:

05H	Slave Address ADDR
08H	Function Code FUNC
00H	Sub-function Code “High”
00H	Sub-function Code “Low”
A5H	Test Value “High”
C3H	Test Value “Low”
xxH	LRC

Reply Message FUNCTION 08:

05H	Slave Address ADDR
08H	Function Code FUNC
00H	Sub-function Code “High”
00H	Sub-function Code “Low”
A5H	Test Value “High”
C3H	Test Value “Low”
xxH	LRC

9.10 Function Code 15 – Write Multiple Coils

Function

This function enables the Modbus master system to write several contiguously addressed bits in the SIMATIC memory areas listed below.

Request Message

ADDR	FUNC	start_address	quantity	byte_count	n DATA	LRC

Reply Message

ADDR	FUNC	start_address	quantity	LRC

start_address

The starting Modbus coil address “**start_address**” is interpreted by the driver as follows:

The driver checks if “start_address” is located within one of the areas which were entered in the dialog box “**Conversion of Modbus Addressing for FC 01, 05, 15**” during parameter assignment (from / to : memory bits, outputs, data block bits).

If Modbus bit address **start_address** is located in area	Access is made to the following **SIMATIC memory area**	
from aaaaa to bbbbb	commence at memory bit	M uuuuu.0
from ccccc to ddddd	commence at output	Q ooooo.0
from eeeee to fffff	commence at data block bit	DBiiiiii.DBX0.0

The address calculation for access (address conversion) is carried out as follows:

Access beginning with SIMATIC	Conversion formula
Memory byte	= ((start_address - aaaaa) / 8) + uuuuu
Output byte	= ((start_address - ccccc) / 8) + ooooo
Data block byte	= ((start_address - eeeee) / 8)

Access to “Memory bits”, “Outputs” and “Data Block Bits”

The above table determines the byte index into the addressed SIMATIC data area. For this, ignore the remainder from the division operations. The bit offset is also needed. It is simply the remainder from the above division operations.

Quantity

Any value between **1** and **1976** is permitted as the **quantity** (amount of bits).

Note:
Please note the CPU-specific limitations as described in the section “CPU-CP Interface.”

DATA

Bit status (any values) is contained in the **DATA field**.

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 01, 05, 15					
Modbus address in transmission message				SIMATIC memory area	
From	0	to	2047	commence at memory bit	M 1000.0
From	2048	to	2559	commence at output	Q 256.0
From	4096	to	4607	commence at data block bit	DB111.DBX0.0

Action:

The Modbus master system wants to write 12 coil values to SIMATIC memory bits M 1144.1 ... M 1144.7 and M 1145.0 ... M 1145.4:

Memory bit	7	6	5	4	3	2	1	0	Bit
M 1144	ON	OFF	OFF	ON	ON	OFF	ON	-	

Memory bit	7	6	5	4	3	2	1	0	Bit
M 1145	-	-	-	ON	OFF	OFF	ON	ON	

Request Message FUNCTION 15:

05H	Slave Address ADDR
0FH	Function Code FUNC
04H	start_address “High”
81H	start_address “Low”
00H	Quantity “High”
0CH	Quantity “Low”
02H	byte_count
CDH	Status coil (M1145.0, M 1144.7 … M 1144.1)
09H	Status coil (M 1145.4 … M 1145.0)
xxH	LRC

Reply Message FUNCTION 15:

05H	Slave Address ADDR
0FH	Function Code FUNC
04H	start_address “High”
81H	start_address “Low”
00H	Quantity “High”
0CH	Quantity “Low”
xxH	LRC

Address Calculation:

The Modbus coil “start_address” 0481 Hex (1153 decimal) is located in the “memory bit” area:

Memory byte	= ((start_address	- aaaaa)	/ 8)	+ uuuuu
	= ((1153 - 0)		/ 8)	+ 1000
	= 1144			

The remainder from the above division determines the Bit_Number:

Bit_Number	= ((start_address	- aaaaa)	% 8)	(Modulo 8)
	= ((1153	- 0)	% 8)	
	= 1			

Write access is made to memory bits starting at M 1144.1 and extending to M 1145.4. Only these bits are affected.

Further Examples

For further access examples to memory bits, outputs and data block bits, please refer to section 9.1.

9.11 Function Code 16 – Write Multiple Registers in Standard Mode

Function

This function code enables the Modbus master system to write several data words in a data block of the SIMATIC CPU.

Request Message

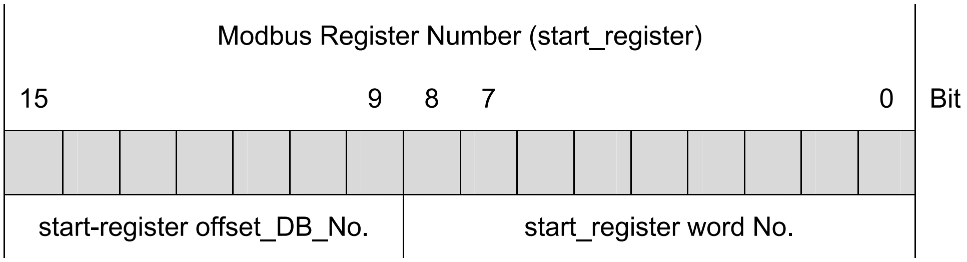
ADDR	FUNC	start_register	quantity	byte-count	n DATA (high, low)	LRC

Reply Message

ADDR	FUNC	start_register	quantity	LRC

start_register

The Modbus register address “**start_register**” is interpreted by the driver as follows:


Modbus Register Number (start_register)
15
9
8
7
0
Bit
start-register offset_DB_No.
start_register word No.

For further address generation, the driver uses the “Base DB number” (from DB xxxxx) entered in the dialog box “**Conversion of Modbus Addressing for FC 03, 06, 16**” during parameter assignment.

The address calculation for access (address conversion) is carried out in two steps as follows:

Access to SIMATIC	Conversion Formula
Data block DB (resulting DB)	= (Base DB number xxxxx + start_register offset_DB_No.)
Data word DBW	= (start_register word_No. * 2)

Calculation Formula for start_register

If you want to write SIMATIC memory beginning at a particular DBx,DBWy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= ((x – base DB number) * 512) + (y/ 2)

This assumes that y is even and is <= 1022. It also assumes that (x – Base DB number) is not negative and from 0 to 127.

Quantity

A value between **1** and **123** is possible as the **quantity** of registers to be written. However, you must follow this rule to avoid errors due to rolling to the next DB:

(**quantity** of registers)max = 512 – (start_register word No)

Note:
Please note the CPU-specific limitations as described in the section “CPU-CP Interface.”

DATA (High, Low)

Any value can be used in the **DATA (High, Low)** (register values).

Application Example

Example for Parameter Assignment:

Conversion of Modbus Addressing for Function Codes FC 03, 06,16		
Modbus address in transmission message	SIMATIC memory area	
0	Commencing at data block (base DB number)	DB 800

Action:

The Modbus master system wants to write values CD09 Hex, DE1A Hex, EF2B Hex to data words DBW 100, DBW 102, and DBW 104 of DB 805.

Request Message FUNCTION 16:

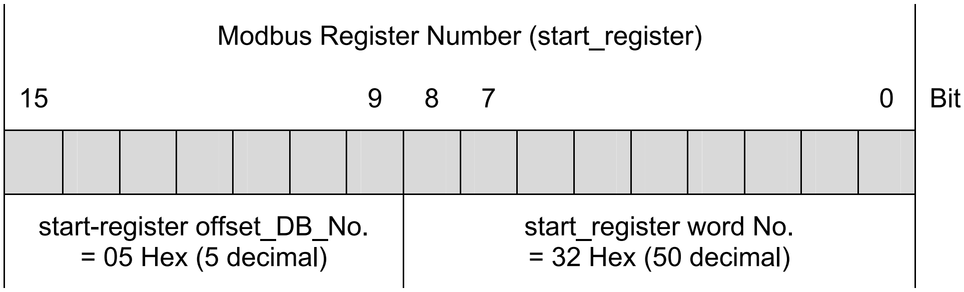
05H	Slave Address ADDR
10H	Function Code FUNC
0AH	start_register “High” offset DB No = 5 (DB 805)
32H	start_register “Low” word No = 50 (DBW 100)
00H	Quantity “High”
03H	Quantity “Low” (3 registers)
06H	bytecount
CDH	Register Value –High (DBW 100)
09H	Register Value –Low
DEH	Register Value –High (DBW 102)
1AH	Register Value –Low
EFH	Register Value –High (DBW 104)
2BH	Register Value –Low
xxH	LRC

Reply Message FUNCTION 16:

05H	Slave Address ADDR
10H	Function Code FUNC
0AH	start_register “High”
32H	start_register “Low”
00H	Quantity “High”
03H	Quantity “Low” (3 registers)
xxH	LRC

Address Calculation:

The Modbus Address “start_register” 0A32 Hex is interpreted as follows:



Data block DB (resulting DB)	= (Base DB Number xxxxx + Start_register-Offset_DB_No.) = (800 + 5) = 805

Data word DBW	= (start_register word_No. * 2) = (50 * 2) = 100

Write access is made to DB 805, data words DBW 100 to DBW 104.

Further Examples

For further access examples, please refer to section 9.3.

9.12 Function Code 16 – Write Multiple Registers in Mode “with 32-Bit Register”

General

In mode “with 32-Bit Register” 16-bit registers as well as 32-bit registers can be written. The address calculation in this mode is different than standard mode.

Function

This function code enables the Modbus master system to write registers mapped to a data block of the SIMATIC CPU. The registers can contain a 16-bit value as well as a 32-bit value.

Request Message

Depending on the requested address start_register, whether it belongs to 16-bit or 32-bit memory area, the request message has a different form.

Request message when 16-bit values are transferred:

ADDR	FUNC	start_register	quantity	byte-count n	n/2 DATA (high, low)	LRC

Request message when 32-bit values are transferred:

ADDR	FUNC	start_register	quantity	byte-count n	n/2 DATA (byte 1…4)	LRC

Reply Message

ADDR	FUNC	start_register	quantity	LRC

start_register

The Modbus register address “**start_register**” is interpreted by the driver as follows:

The driver checks that “start_register” is located within one of the areas which were specified during parameter assignment in the dialog box “**Conversion of Modbus Addressing for FC 03, 06, 16**” (from / to : 16-bit integer, 32-bit integer, 32-bit float).

If Modbus register address **start address** is located in area		Access is made to the following **SIMATIC memory area**	
16-bit integer	from xxaaa to xxbbb	commence at data block	DBxxkkk.DBW0
32-bit integer	from xxccc to xxddd	commence at data block	DBxxlll.DBD0
32-bit float	from xxeee to xxfff	commence at data block	DBxxnnn.DBD0

The address calculation for access (address conversion) is carried out as follows:

Register type	Access to SIMATIC	Conversion Formula
16-bit integer	Data block DB	fixed number DBxxkkk
	Data word DBW	= (start_register – xxaaa) * 2
32-bit integer	Data block DB	fixed number DBxxlll
	Data word DBW	= (start_register – xxccc) * 4
32-bit float	Data block DB	fixed number DBxxnnn
	Data word DBW	= (start_register – xxeee) * 4

Quantity

The maximum register number depends on the accessed data area. If the **16-bit area** is accessed, values from **1** to **123** are permitted as the **quantity** (number of registers to write).

When accessing a **32-bit area**, **quantity** (the number of registers to write) is limited from **1 to 61**.

The number of registers (16 or 32 bit) set in **quantity** is written.

DATA

Any value can be used as **DATA** (register value).

Application Example

Conversion of Modbus Addressing for Function Codes FC 03, 06,16	
Modbus address in transmission message	SIMATIC memory area
16-bit integer	
from 3000 to 4999	commence at data block DB2.DBW0
32-bit integer	
from 5000 to 5099	commence at data block DB3.DBW0
32-bit float	
from 7000 to 9999	commence at data block DB4.DBW0

16-Bit Area Accessed

Request Message FUNCTION 16:

05H	Slave Address ADDR
10H	Function Code FUNC
0CH	start_register “High”
1CH	start_register “Low” DBW 200
00H	Quantity “High”
03H	Quantity “Low” (3 registers)
06H	bytecount
CDH	Register Value –High (DBW 200)
09H	Register Value –Low
DEH	Register Value –High (DBW 202)
1AH	Register Value –Low
EFH	Register Value –High (DBW 204)
2BH	Register Value –Low
xxH	LRC

Reply Message FUNCTION 16:

05H	Slave Address ADDR
10H	Function Code FUNC
0CH	start_register “High”
1CH	start_register “Low”
00H	Quantity “High”
03H	Quantity “Low” (3 registers)
xxH	LRC

32-Bit Area Accessed

Request Message FUNCTION 16:

05H	Slave Address ADDR
10H	Function Code FUNC
13H	start_register “High”
8BH	start_register “Low” DBD 12
00H	Quantity “High”
03H	Quantity “Low” (2 registers)
08H	bytecount
3AH	Reg. Value – Byte 1 (DBD12)
09H	Reg. Value – Byte 2
DEH	Reg. Value – Byte 3
1AH	Reg. Value – Byte 4
01H	Reg. Value – Byte 1 (DBD16)
02H	Reg. Value – Byte 2
03H	Reg. Value – Byte 3
04H	Reg. Value – Byte 4
xxH	LRC

Reply Message FUNCTION 16:

05H	Slave Address ADDR
10H	Function Code FUNC
13H	start_register “High”
8BH	start_register “Low”
00H	Quantity “High”
02H	Quantity “Low” (2 registers)
xxH	LRC

Address Calculation when 16-bit area is accessed:

The Modbus master system wants to write values CD09 Hex, DE1A Hex, EF2B Hex. The Modbus address “start_register” 0C1C Hex (3100 decimal) is located in the area “16-bit integer” and is interpreted as follows:

Data block DB	= fixed number xxkkk = 2

Data word DBW	= (start_register	- xxaaa)	* 2
	= (3100	- 3000)	* 2
	= 200		

Write access is made to DB2.DBW200, DBW202 and DBW204.

Calculation Formula for start_register (16-bit)

If you want to write SIMATIC memory beginning at a particular DBxxkkk,DBDy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= (y/2) + xxaaa, where xxkkk is the DB for 16-bit integer range and start_register <= xxbbb

The value xxaaa to xxbbb is the parameter defining the Modbus registers for the 16-bit integer range.

Address Calculation: when 32-bit area is accessed:

The Modbus master system wants to write values 3A09DE1A Hex, 01020304 Hex.The Modbus address “start_register” 138B Hex (5003 decimal) is located in the area “32-bit integer” and is interpreted as follows:

Data block DB	= fixed number xxnnn = 3

Data word DBW	= (start_register	- xxaaa)	* 4
	= (5003	- 5000)	* 4
	= 12		

Write access is made to DB3.DBD12 and DBD 16.

Formula for start_register (32-bit)

If you want to write SIMATIC memory beginning at a particular DBxxlll,DBDy or DBxxnnn.DBDy, the Modbus address **start_register** required in the master system can be calculated in accordance with the following formula:

start_register	= (y/4) + xxccc, where xxlll is the DB for 32-bit integer range and start_register <= xxddd
start_register	= (y/4) + xxeee, where xxnnn is the DB for 32-bit float range and start_register <=xxfff

The values xxccc to xxddddd and xxeee to xxfff are the parameters defining the Modbus registers for the 32-bit integer and float ranges respectively.

Further Examples

For further access examples, please refer to section 9.4.

10 Diagnostics of the Driver

Diagnostics Functions

The diagnostics functions of the CP enable you to easily know when an error has occurred and quickly determine the cause of the problem. The following diagnostic facilities are available:

- Diagnostics via display elements of the CP
- Diagnostics via the STATUS output of the function blocks
- Diagnostic buffer of the CP

Display Elements (LED)

The display elements provide information on the operating status and/or a possible error status of the CP. The display elements give a first overview of internal or external errors, as well as interface-specific errors.

STATUS Output of FBs / SFBs

Each function block / system function block has a STATUS output for error diagnostics purposes. Reading this STATUS output enables the user to obtain information on errors which occurred during communication. The STATUS parameter can be evaluated in the user program.

Diagnostic Buffer of the CP

All errors / events described in Section 10.3 are also entered in the diagnostic buffer of the CP. The manual for the CP describes how you can read the diagnostic buffer.

10.1 Diagnostics via Display Elements (LEDs)

Introduction

The display LEDs of the CP 341 provide general operational information. The following different display functions are available:

- **Group Error Displays**

  - SF (red) Error occurred or new parameters assigned

- **Special Displays**

  - TXD (green) Send active; lights up when the CP 341 sends user data via the interface
  - RXD (green) Receive active; lights up when the CP 341 receives user data via the interface

Group Error Display SF

The group error display SF always lights up after power-on and goes out after initialization is complete. If parameter assignment data were created for the CP 341, the SF LED lights up again briefly when new parameters are loaded.

The group error display SF lights up, when the following errors have occurred:

- Hardware error
- Firmware error
- Parameter assignment error
- BREAK (Receiving line between CP 341 and communication partner is interrupted or CTS or DSR signals not asserted at the connector.)

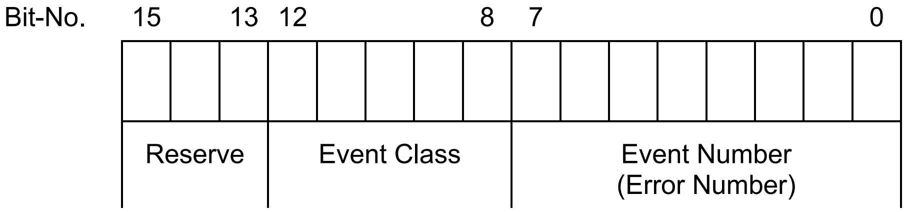
10.2 Diagnostic Messages of the Function Blocks of the CP 341

Introduction

Each function block has a STATUS parameter for error diagnostics purposes. Each STATUS message number has the same meaning, independent of the system function block used.

Event Class / Event Number Numbering Scheme

The following figure shows the structure of the STATUS parameter.



The individual errors / events are listed in Section 10.3

10.3 Table of Errors / Events

Event Classes

The following event classes are defined:

Event Class	Description	Described in
1	Hardware error on CP	CP Manual
2	Error during initialization	CP Manual
3	Error during parameter assignment of PBK	CP Manual
4	Errors in CP – CPU data traffic recognized by CP	CP Manual
5	Error during processing of a CPU job	CP Manual, Driver Manual
6	Error during processing of a partner job	CP Manual
7	Send error	CP Manual
8	Receive error	Driver Manual
9	Error code message received from link partner	Not used
10	Errors recognized by CP in reaction message from partner	Not used
14	General processing errors of the loadable driver	Driver Manual

10.3.1 Error Codes for “CPU Job Errors”

Event Class 5 (05_H) “CPU Job Errors”			
Event Class/ No. (Hex)	**Event Number (Decimal)**	**Event Text**	**Remedy**
05 18H	24	Transmission length during transmission is too large (> 4 Kbytes), or transmission length for SEND is too small. (Note: Modbus ASCII driver should limit transmission to 512 bytes.)	Check communications FB, possibly reload

10.3.2 Error Codes for “Receive Errors”

Event Class 8 (08_H) **“CPU Receive Errors”**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
08 06_H	6	Character delay time exceeded	Eliminate error in partner device or interference on the transmission line or increase the value of the “Character Delay Time” parameter.
08 $0C_H$	12	Transmission error (parity error, overflow error, stop bit error (frame)) recognized in a character	Check for interference which could influence the transmission line. If required, change system structure and/or cable routing. Check whether the protocol parameters transmission rate amount of stop bits have the same settings for the CP and the link partner.
08 $0D_H$	13	BREAK Receiving line to partner device is interrupted.	Establish connection between the devices or switch on partner device. Make sure CTS and DSR are asserted at the CP connector. For use with TTY operation check line current at idle state. For use with an RS422/485 (X27) connection check and, if required, change the connector pin assignment of the 2-wire receiving line R(A), R(B).
08 16_H	22	The length of a receive message was longer then the receive buffer of the CP. The PDU size can be up to 512 byte.	Check for interference which could influence the transmission line.
08 18_H		DSR = OFF or CTS = OFF	The partner has switched the DSR or CTS signal to ”OFF” before or during a transmission. Check the partner’s control of the RS 232C secondary signals.

Event Class 8 (08_H) **“Receive Errors”**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
08 30_H	48	Broadcast not allowed with this function code.	The Modbus master system is allowed to use Broadcast only for the function codes enabled for this purpose.
08 31_H	49	Received function code not allowed.	This function code cannot be used for this driver.
08 32_H	50	Maximum amount of bits or registers exceeded. Maximum values: bit read: 2008, bit write: 1976, 16-bit register read: 125, write: 123 32-bit registers read: 62, write: 61	Limit maximum amount with request of the master.
08 33_H	51	Amount of bits or registers for function codes FC 15/16 and message element byte_count do not match.	Correct amount of bits / registers or byte_count.
08 34_H	52	Illegal bit coding recognized for “set bit / reset bit.”	Only use codings 0000 Hex or FF00 Hex for FC05.
08 35_H	53	Illegal diagnostic subcode (!= 0000 Hex) recognized for function code FC 08 “Loop Back Test.”	Only use subcode 0000 Hex for FC08.
08 36_H	54	LRC incorrect: An error has occurred on checking the LRC of the request message from the master.	Check LRC generation at Modbus master system.
08 37_H	55	Message sequence error: The Modbus master system sent a new request message before the last reply message was transferred by the driver.	Increase the timeout to the slave reply message for the Modbus master system.
08 38_H	56	A wrong start character was received. The start character was not a colon ($3A_H$).	Check protocol settings for the slave.
08 39_H	57	A start character was received within a telegram. The first part of the telegram is discarded and reception starts again with the second start character.	Check if transmission line is interrupted (interface analyzer may be required).
08 $3A_H$	58	A received character within the reply message is not an ASCII character (0-9, A-F)	Check slave device. Make sure it is in ASCII mode and not RTU.

10.3.3 Error Codes in SYSTAT for “General Processing Errors”

Event Class 14 (0EH) **“Loadable Driver – General Processing Errors”**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
0E 01_H	1	Error during initialization of the driver-specific SCC process	Reassign parameters of driver and reload.
0E 02_H	2	Error during startup of driver: Wrong SCC process active (SCC driver). The driver cannot function with this SCC driver.	Reassign parameters of driver and reload.
0E 03_H	3	Error during startup of driver: Wrong data transfer process active (interface to SFBs). The driver cannot function with this data transfer process.	Reassign parameters of driver and reload.
0E 04_H	4	Error during startup of driver: Illegal interface submodule. The driver cannot run with the parameterized interface submodule.	Check and correct parameter assignment.
0E 05_H	5	Error with driver dongle: No dongle plugged in, or inserted dongle is faulty. The driver is not ready to run.	Check if a driver dongle is plugged into the CP. If the inserted dongle is faulty, replace it with a correct dongle.
0E 06_H	6	Error with driver dongle: The dongle has no valid contents. The driver is not ready to run.	Obtain a correct dongle from the Siemens office which supplied you with the driver.
…	…	…	…
0E 10_H	16	Internal error procedure: default branch in Send automatic device.	Restart CP (Mains_ON)
0E 11_H	17	Internal error procedure: default branch in Receive automatic device.	Restart CP (Mains_ON)
0E 12_H	18	Internal error active automatic device: default branch.	Restart CP (Mains_ON)
0E 13_H	19	Internal error passive automatic device: default branch.	Restart CP (Mains_ON)

Event Class 14 (0EH) **“Loadable Driver – General Processing Errors <Parameter Assignment>“**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
0E 20_H	32	For this data link the amount of data bits must be set to 7. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 21_H	33	The Character Delay Time parameter is not within the range of 1 to 6500 milliseconds. The driver is operating with a default value of 1000 milliseconds	Correct parameter assignment of the driver. Load driver parameters.
0E 22_H	34	The operating mode set for the driver is illegal. “Normal” or “Interference Suppression” must be specified. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 23_H	35	An illegal value has been set for the slave address. Slave address 0 is not allowed. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 24_H	36	Illegal limitations have been set for write access. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 25_H	37	An illegal “from/to” combination has been set for the input of areas “Conversion of Modbus Addressing for FC 01,05,15.” (Areas memory bits, outputs, data bits), or the selected DB number is 0. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 26_H	38	An illegal “from/to” combination has been set for the input of areas “Conversion of Modbus Addressing for FC 02.” (Areas memory bits, inputs, data bits), or the selected DB number is 0.. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 27_H	39	An overlap has been set for the “from/to” combination for the input of areas “Conversion of Modbus Addressing for FC 01,05,15.” (Areas memory bits, outputs, data bits). The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 28_H	40	An overlap has been set for the “from/to” combination for the input of areas “Conversion of Modbus Addressing for FC 02.” (Areas memory bits, inputs, data bits). The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.

Event Class 14 (0EH) **“Loadable Driver – General Processing Errors <Parameter Assignment>“**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
0E 29$_H$	37	An illegal “from/to” combination has been set for the input of areas “Conversion of Modbus Addressing for FC 03,06,16.” (Data types INT16, INT32, FLOAT32), or the selected DB number is 0.. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 2A$_H$	39	An overlap has been set for the “from/to” combination for the input of areas “Conversion of Modbus Addressing for FC 03,06,16.” (Areas memory bits, outputs, data bits). The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 2B$_H$	39	The same DB number was selected for FC1, FC2 and FC3 with 32-bit registers. Please use different numbers for each FC. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 2C$_H$	39	The number of registers defined for FC3 with 32-bit registers is larger than a DB can consist of. The maximum amount is 16383 32-bit-registers or 32676 16-bit registers. The driver is not ready to run.	Correct parameter assignment of the driver. Load driver parameters.
0E 2E$_H$	46	An error occurred when reading the interface parameter file. The driver is not ready to run.	Restart CP (Mains_ON).

Event Class 14 (0EH) **“Loadable Driver – General Processing Errors <CPU-CP>“**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
0E 30$_{H}$	48	Internal error during data transfer to CPU: Unexpected acknowledgment Passive.	Can be ignored if it happens intermittently.
0E 31$_{H}$	49	Timeout during data transfer to CPU.	Check CP-CPU interface.
0E 32$_{H}$	50	Error occurred during data transfer to CPU with RCV: Exact failure reason (detailed error) is in diagnostic buffer before this entry.	Check CP-CPU interface.
0E 33$_{H}$	51	Internal error during data transfer to CPU: Illegal status of automatic device.	Check CP-CPU interface.
…	…	…	…
0E 38$_{H}$	56	Error occurred when accessing one of the SIMATIC areas “memory bits, outputs, timers, counters, inputs” with function codes FC 01 or FC 02: For example, input does not exist, or read attempt in excess of range end.	Check if the addressed SIMATIC area exists and whether an attempt was made to access in excess of range end.
0E 39$_{H}$	57	Error occurred when accessing SIMATIC area “data block” with function codes FC 03, 04, 06, 16: Data block does not exist or is too short.	Check if the addressed data block exists and that it is sufficiently long.
0E 3A$_{H}$	58	Error occurred when executing a write job with function codes FC 05, 15: Instance data block of Modbus FB does not exist or is too short.	Check if instance DB parameterized on the Modbus communications FB exists and that it is sufficiently long.
0E 3B$_{H}$	59	Timeout during execution of a write job by Modbus communications FB.	Check project configuration of data link and CP-CPU interface (SFB SEND): possibly reload Modbus communications FB.

Event Class 14 (0EH) **“Loadable Driver – General Processing Errors <Receive Evaluation>“**			
Event Class / No.(Hex)	**Event Number (decimal)**	**Event Text**	**Remedy**
0E 51_H	81	The received Modbus address is outside the parameterized “from/to” areas. (See section “Assigning Parameters to the Loadable Driver”).	Only use addresses as the address specification in the request message, which have previously been defined during parameter assignment.
0E 52_H	82	SIMATIC range limitation exceeded during access attempt by Modbus master system: Resulting DB number < 1, or Write access to an area which has not been enabled (parameter assignment), or write access to instance DB of the communications FB.	Limit access range to valid SIMATIC memory areas.
0E 53_H	83	SIMATIC range limitation exceeded during access attempt by Modbus master system, for example, overflow when generating the resulting DB number (> 65535).	Limit access range to valid SIMATIC memory areas.
0E 54_H	84	Access in excess of parameterized range end, or access in excess of SIMATIC range end.	Limit access range to valid SIMATIC memory areas.
0E 55_H	85	Write access to this SIMATIC memory area is not allowed.	Carry out write access only to SIMATIC data areas memory bits, outputs.
0E 56_H	86	Data link operation not possible because communications FB not running.	Make cyclic call of Modbus communications FB in STEP 7 user program. If required, re-initialize communications FB.
0E 57_H	87	Error occurred in communications FB during processing of the Modbus function code.	Analyze exact reason as described in Section “Diagnostics of the Communications FB.”

11 Diagnostics of the Communications FB

Diagnostic Functions

The Modbus communications FB has the following two **output parameters**, which indicate occurred errors:

- Parameter “ERROR_NR”
- Parameter “ERROR_INFO”

ERROR_NR,

Occurred errors are indicated at the **ERROR_NR** output.

ERROR_INFO

Further details on the error in ERROR_NR are displayed at the output **ERROR_INFO**.

Deleting the Errors

The errors are deleted with a rising edge at CP_START.

The error displays may be deleted by the user at any time, if required.

11.1 Diagnostics via Parameters ERROR_NR, ERROR_INFO

ERROR_No 1...9

Error during Initialization FB and CP

Error numbers 1...9 indicate initialization with error. Parameter CP_START_ERROR is 1.

Modbus communication to the master system is not possible.

ERROR_No 10...19

Error during Processing of a Function Code

Error numbers 10...19 indicate an error during processing of a function code. The CP transmitted an illegal processing job to the communications FB.

The error is also reported to the driver.

Subsequent processing jobs continue to be processed.

ERROR_No 90...99

Other Errors

A processing error has occurred.

The error is not reported to the driver.

Subsequent processing jobs continue to be processed.

11.1.1 Errors during “Initialization”

“Error during Initialization”			
ERROR_No (decimal)	**ERROR_INFO**	**Error Text**	**Remedy**
0	0	no error	
1	SFC51 → RET_VAL	Error when reading SZL with SFC51.	Analyze RET_VAL in ERROR_INFO, eliminate cause.
2	FB8 → STATUS	Timeout when initializing CP or error when initializing CP (Error in SEND job).	Check if protocol “Modbus Slave” has had parameters assigned on this interface. Analyze ERROR_INFO.

11.1.2 Errors during “Processing of Function Codes”

“Error during Processing of Function Codes”			
ERROR_No(decimal)	**ERROR_INFO**	**Error Text**	**Remedy**
10	Processing Code	Illegal processing function transferred by the driver to the communications FB.	Restart CP (Mains_ON)
11	Start Address	Illegal start address transferred by the driver to communications FB.	Check Modbus address of Modbus master system.
12	Amount of Registers	Illegal amount of registers transferred by the driver to communications FB: Amount of registers = 0.	Check amount of registers of Modbus master system, if required restart CP (Mains_ON)
13	Amount of Registers	Illegal amount of registers transferred by the driver to communications FB.	Check amount of registers of Modbus master system, if required restart CP (Mains_ON)
14	Memory bits M - End Address	Attempted access to SIMATIC memory area “memory bits” in excess of range end. Attention: Range length in SIMATIC CPU is CPU type-dependent.	Reduce Modbus start address and/or access length in Modbus master system.

“Error during Processing of Function Codes”			
ERROR_No (decimal)	**ERROR_INFO**	**Error Text**	**Remedy**
15	Outputs Q – End Address	Attempted access to SIMATIC memory area “outputs” in excess of range end. Attention: Range length in SIMATIC CPU is CPU type-dependent.	Reduce Modbus start address and/or access length in Modbus master system.
16	SFC24 → STATUS	Accessed DB does not exist. Error message of SFB24.	Establish the accessed DB in the CPU.
17		The accessed DB is too short.	Reduce length in Modbus master system or enlarge DB.
18	0	Illegal SIMATIC memory area transferred by the driver to communications FB.	If required, restart CP (Mains_ON)
19		Error during access to SIMATIC I/Os.	Check if required I/Os exist and are error-free.

11.1.3 “Other” Errors

“Other Errors”			
ERROR_No (decimal)	**ERROR_INFO**	**Error Text**	**Remedy**
92	FB7 → STATUS	Error when executing a RECEIVE/FETCH call with FB7 (RCV_RK).	Analyze FB7-STATUS

A Technical Data

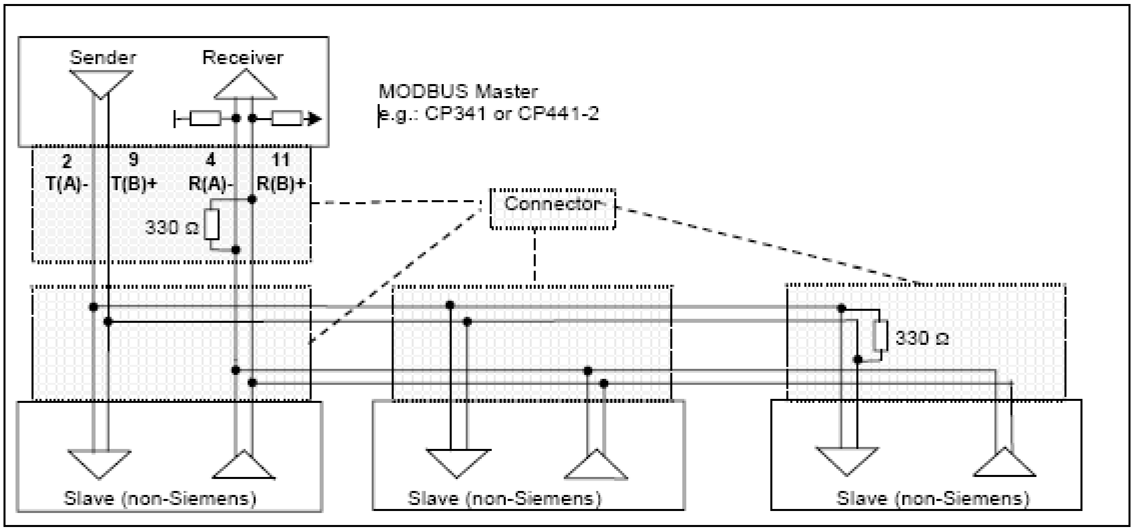
Memory Requirements

The following table displays the memory requirements of the function blocks FB81 of the CP 341 in bytes. The memory requirements of the FBs 7 and 8 can be found in the manual for the CP 341.

Block	Name	Version	Loading Memory	Work Memory	Local Data
FB 81	MODB_ASCII	1.0	3186	2432	44

B Wiring Diagrams Multipoint

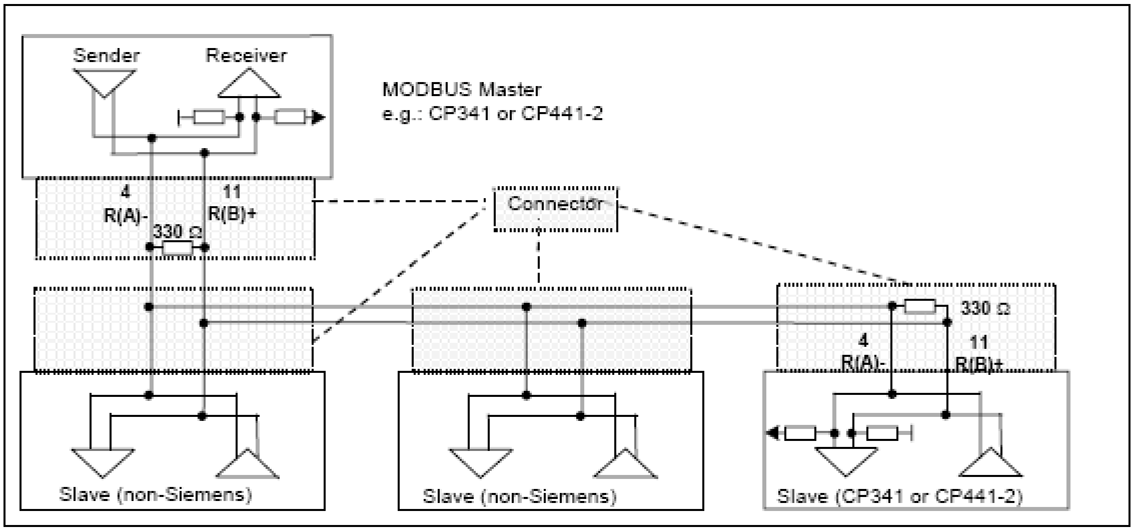
Wiring diagram RS422 multipoint (Modbus ASCII Multipoint)



Caution
The CP cannot switch its SEND line to "Tri State" in 4-wire operation. So in RS422 mode this ASCII Slave driver cannot be used in multipoint connections. You must use RS485 with the ASCII Slave driver.

In the **RS422** mode CP341 can **only be used as a Master**.

Wiring diagram RS485 multipoint (Modbus Multipoint)



The following applies:

- GND (PIN 8 must always be connected on both sides
- The casing shield must be installed everywhere
- A terminating resistor of approx. 330 Ω is to be soldered into the connector on the last receiver of a node sequence.
- Recommended cable type: LIYCY 3 x 2 x 0,14 R(A)/R(B) and T(A)/T(B) twisted pairs. For additional information see the “Cables” section of the “Modbus over Serial Line Specification and Implementation Guide” available at www.modbus.org.
- A wiring with “Stub“ is not allowed

Wiring diagram RS232 Point to Point (Modbus RS232)

Please refer to Section B.1 of the CP 341 Point – to – Point Communication Manual.

C Access Cheat Sheat

Summary of Access Spaces to DB by Function Code Group and Mode

<table>
<tr><th>Mode</th><th>Access</th><th>FC 03,06,16
Access Holding Registers</th><th>FC 01,05,15
Access Coils</th><th>FC 04
Read Input Registers</th><th>FC 02
Read Discrete Inputs</th></tr>
<tr><td>Standard</td><td>Read</td><td>Map a Start Reg # to a Base DBx.DBW0, decode Register# as follows:
Register#<table><tr><td>Offset to DBx</td><td>DBW index / 2</td></tr><tr><td>7-Bits (0-127)</td><td>9-Bits (0-511)</td></tr></table>Therefore can read first 512 words in128 contiguous DBs (Sec 3.6.1)</td><td>Map Coil Range to a DBx.DBX0.0
(Sec 3.5)</td><td>Map a Start Reg # to a Base DBx.DBW0, decode Register# as follows:
Register#<table><tr><td>Offset to DBx</td><td>DBW index / 2</td></tr><tr><td>7-Bits (0-127)</td><td>9-Bits (0-511)</td></tr></table>Therefore can read first 512 words in 128 contiguous DBs (Sec 3.6.3)</td><td>Map Discrete Input Range to a DBx.DBX0.0
(Sec 3.5)</td></tr>
<tr><td></td><td>Write</td><td>Sub-Range of contiguous DBs in Read Space. (Sec 3.7)</td><td>Same as Read Space</td><td>N/A</td><td>N/A</td></tr>
<tr><td>With 32-Bit Regs</td><td>Read</td><td>Map 3 Register Ranges to 3 DBs:
DBx.DBW0 16-bit Int
DBy.DBD0 32-bit Int
DBz.DBD0 32-bit Float (Sec 3.6.2)</td><td>Map Coil Range to a DBx.DBX0.0</td><td>Same as for Standard</td><td>Same as for Standard</td></tr>
<tr><td></td><td>Write</td><td>Same as Read Space</td><td>Same as Read Space</td><td>N/A</td><td>N/A</td></tr>
</table>

Summary of Access Spaces to M , Q and I by Function Code Group and Mode

Mode	**Access**	**FC 01,05,15** **Access Coils**	**FC 02** **Read Discrete Inputs**
Standard	Read	Map two Coil ranges to Mx.0 and Qy.0 (Sec 3.5)	Map two Discrete Input Ranges to Mx.0 and and Iy.0 (Sec 3.5)
	Write	Sub-range of contiguous M and Q in Read Space (Sec 3.7)	N/A
With 32-Bit Regs	Read	Same as for ***Standard***	Same as for ***Standard***
	Write	Same as for ***Standard***	N/A

Note: In all cases the write access space is a subset of the read space or is shown as N/A when the Function Code group is itself read-only.

D Literature List

Modbus Protocol

Modbus over Serial Line
Specification & Implementation Guide
V1.0
12/02/02

Modbus Application Protocol Specification
V1.1a
6/4/04

http://www.modbus.org

Glossary

A

Address

The address identifies a physical storage location and enables the user to directly access the operand store there.

B

Block

Blocks are elements of the user program which are defined by their function, structure, or purpose. With STEP 7 there are

- Code blocks (FB, FC, OB, SFB, SFC)
- Data blocks (DB, SDB)
- User-defined data types (UDT)

Block Call

A block call occurs when program processing branches to the called block

Block Parameter

Block parameters are wildcards within multiple-use blocks, which are replaced with current values when the relevant block is called.

C

Communications Processor

Communications processors are modules for point-to-point connections and bus connections.

Configuration

The configuration is the setup of individual modules of the PLC in the configuration table.

CPU

Central processing unit of the S7 programmable controller with control and arithmetic unit, memory, operating system, and interfaces to I/O modules.

Cycle Time

The cycle time is the time the CPU needs to scan the user program once.

Cyclic Program Processing

In cyclic program processing, the user program is executed in a constantly-repeating program loop, called a cycle.

D

Data Block (DB)

These are blocks containing data and parameters with which the user program works. Unlike all other blocks, data blocks do not contain instructions. They are subdivided into global data blocks and instance data blocks. The data held in the data blocks can be accessed absolutely or symbolically. Complex data can be stored in structured form.

Data Type

Data types allow users to define how the value of a variable or constant is to be used in the user program. They are subdivided into elementary and structured data types.

Default Setting

The default setting is a practical basic setting, which is always used if no other value is specified.

Diagnostic Buffer

Every CPU has a diagnostic buffer, in which detailed information on diagnostic events is stored in the order in which they occur.

Diagnostic Event

Diagnostic events are, for example, errors on a module or system errors in the CPU, which may be caused by a program error or by operating mode transitions.

Diagnostics Functions

The diagnostics functions cover the entire system diagnosis and include detection, analysis and reporting of errors within the PLC.

Download

Downloading means loading load objects (e.g. code blocks) from the programming device into the load memory of the CPU.

F

Function Block (FB)

Function blocks are components of the user program and, in accordance with the IEC standard, are “blocks with memory”. The memory for the function block is an assigned data block of the “instance data block”. Function blocks can be assigned parameters, or they can be used without parameters.

H

Hardware

Hardware is the term given to all the physical and technical equipment of a PLC.

I

Instance Data Block

An instance data block is a block assigned to a function block and contains data for this particular function block.

Interface Submodule

The CP 441-2 interface submodule is responsible for the physical conversion of signals. By changing the interface submodule, you can make the communications processor compatible with the communications partner.

Interrupt

An interrupt occurs when program processing in the processor of a PLC is interrupted by an external alarm.

L

LRC

Longitudinal Redundancy-Check = Checksum which guaranteed accuracy of error recognition.

M

Module

Modules are pluggable printed circuit boards for programmable controllers.

Module Parameter

Module parameters are used to set the module reactions. A distinction is made between static and dynamic module parameters.

O

Online/Offline

Online means that a data circuit exists between PLC and programming device. Offline means that no such data circuit exists.

Online Help

STEP 7 allows you to display contextual help texts on the screen while you are working with the programming software.

Operand

An operand is part of a STEP 7 instruction and states with what the processor is to do something. It can be both absolutely and symbolically addressed.

Operating Mode

The SIMATIC S7 programmable controllers have three different operating modes: STOP, RESTART and RUN. The functionality of the CPUs varies in the individual operating modes.

Operating System of the CPU

The operating system of the CPU organizes all functions and operations of the CPU which are not connected to a specific control task.

P

Parameter

Parameters are values that can be assigned. A distinction is made between block parameters and module parameters.

Parameter Assignment

Parameter assignment means setting the behavior of a module.

Parameter Assignment Tool CP: Point-to-Point Communication, Parameter Assignment

The CP Point-to-Point Communication, Parameter Assignment Tool is used to assign parameters to the interface submodule of the communications processor and to set the driver-specific parameters. The standard range is expanded for each loadable driver.

Point-to-Point Connection

In a point-to-point connection the communications processor forms the interface between a PLC and a communications partner.

Procedure

The execution of a data interchange operation according to a specific protocol is called a procedure.

Process Image

The process image is a special memory area in the PLC. At the beginning of the cyclic program, the signal states of the input modules are transferred to the process image input table. At the end of the cyclic program, the process image output table is transferred to the output modules as signal state.

Programmable Controller

Programmable controllers (PLCs) are electronic control devices consisting of at least one central processing unit, various input/output modules, and operator control and monitoring devices.

Project Configuration of Data Link

Project configuration of data link is the term given to the allocation of a Connection ID in the system function block. The Connection ID enables the system function blocks to communicate between two communication terminal points.

Protocol

The communications partners involved in a data interchange must abide by fixed rules for handling and implementing the data traffic. These rules are called protocols.

R

Rack

A rack is the rail containing slots for mounting modules.

RESTART

On transition from the STOP to the RUN mode, the PLC goes through the RESTART mode.

S

Software
Software is the term given to all programs used on a computer system. These include the operating system and the user programs.

Standard Mode
The standard mode of Modbus ASCII slave driver means, that the parameter “with 32-Bit registers” is not set. In this mode all registers imply 16-bit values.

STEP 7
This is the programming software for SIMATIC S7 programmable controllers.

System Block
System blocks differ from the other blocks in that they are already integrated into the S7-300/400 system and are available for already defined system functions. They are subdivided into system data blocks, system functions, and system function blocks.

System Function (SFC)
System functions are modules without memory which are already integrated into the operating system of the CPU and can be called up by the user as required.

System Function Block (SFB)
System function blocks are modules with memory which are already integrated into the operating system of the CPU and can be called up by the user as required.

U

Upload
Uploading means loading load objects (e.g. code blocks) from the load memory of the CPU into the programming device.

User Program
The user program contains all instructions and declarations for signal processing, by means of which a system or a process can be controlled. The user program for SIMATIC S7 is structured and is divided into smaller units called blocks.

V

Variable
A variable is an operand (e.g. E 1.0), which can have a symbolic name and can therefore also be addressed symbolically.

W

With 32-Bit Registers When choosing “with 32-Bit Register” mode, holding registers can imply 32-bit values (integer and floating point) as well as 16-bit values when accessed by a master.

Work Memory The work memory is a RAM on the CPU, which the processor accesses while processing the user program.