S7 Diagnostics Block for the 3RK3 Modular Safety System (MSS)

SIMATIC S7 300/400 CPU

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Question

How can I read out diagnostics data from the SIRIUS 3RK3 modular safety system by using an S7 CPU?

Answer

The instructions and notes listed in this document provide a detailed answer to this question.

Table of Contents

1 Scope of Delivery

1.1 Area of application

The block described in this document is used to diagnose the SIRIUS 3RK3 modular safety system – in the following referred to as MSS.
The block can be used within an S7 program to read out diagnostic data from the relevant MSS station at runtime via the MSS DP interface.

The diagnostic data includes the following MSS status information:

1. Device status:
    - configuration mode
    - test mode
    - safety mode
    - device error
    - system error
    - bus error
    - wiring error
2. Number and status of all function elements configured in the MSS.
3. Number and status of all elements currently showing an error status (excerpt from list '2)').
4. Number and status of all emergency-stop elements (excerpt from list '2)').

1.2 CPUs

The diagnostics block as included in the delivery can be operated on all CPUs of the SIMATIC series S7-300, S7-400 and WinAC.

1.3 Principle of operation

Diagnosis is initiated with the help of a trigger signal from the MSS diagnostics block. This diagnostics block reads out the diagnostic data from the MSS central unit via the MSS DP interface and makes this data (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**) available at the relevant instance data block for further processing.

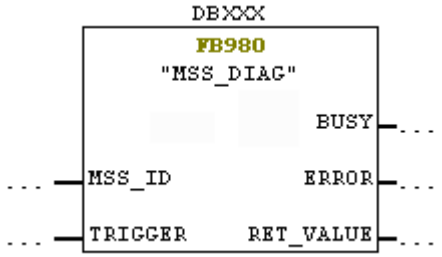
2 Integrating the MSS Diagnostics Block in the S7 Program

2.1 Calling the MSS diagnostics block

The MSS diagnostics block can be called in OB1 or in a time-controlled OB (OB30-OB38 [availability depends on the CPU-type used]).

ATTENTION	**The block may be called more than once. If so, make sure that only one block is active at a time. This means, that triggering of an MSS diagnostics block via the TRIGGER parameter must be possible only, if the BUSY parameter is not active on any other MSS diagnostics block.** **Furthermore, please note that the block must not be edited while the relevant MSS is accessed online via the MSS Engineering System.**

The MSS diagnostics block is provided with the following interfaces:



Note	If required, the block number of the MSS diagnostics block may be adapted (default: 'FB 980'). The number of the associated instance data block can be freely selected.

2.2 Description of parameters

Name	Data type	Type	Memory area*	Comment
MSS_ID	DWORD	I	I,Q,M,D,L,const.	I-address of the MSS DP-interfaces
TRIGGER	BOOL	I	I,Q,M,D,L,const.	Starts the diagnosis job
BUSY	BOOL	Q	I,Q,M,D,L	Diagnostics block is in operation
ERROR	BOOL	Q	I,Q,M,D,L	Error in block processing
RET_VALUE	WORD	Q	I,Q,M,D,L	Status value of the last process

* I – input, Q – output, M – bit memory, D – data, L – local data, const. - constant

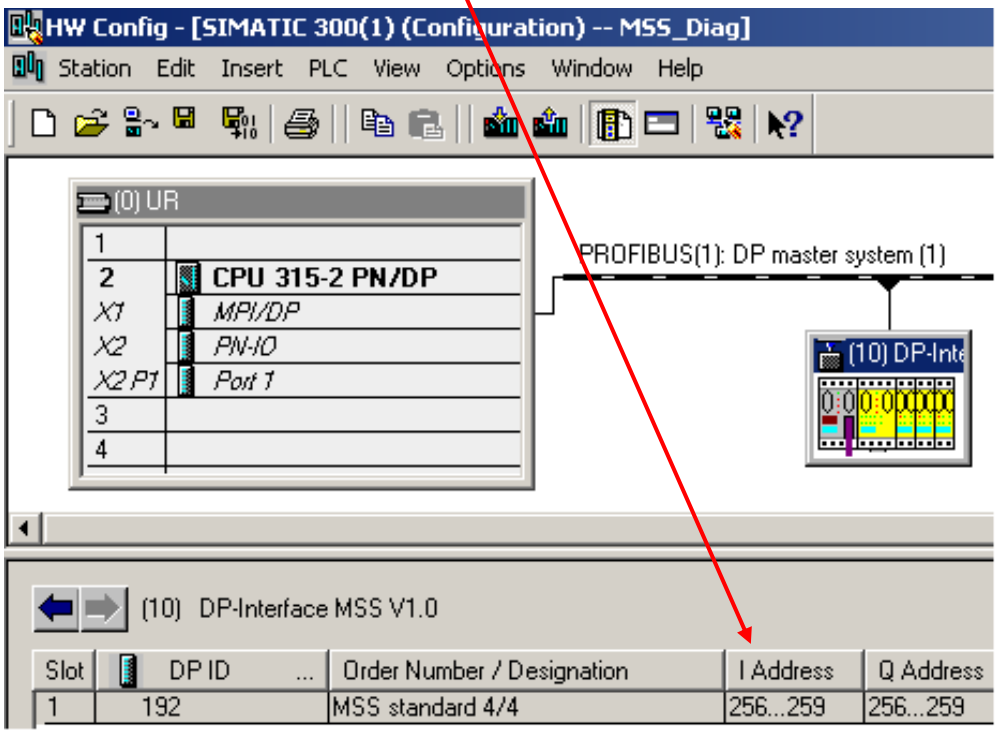
2.2.1 IN parameter: 'MSS_ID'

The IN parameter MSS_ID is used to address the DP interface of the relevant MSS station. The address is the number of the first byte of the input address of the MSS DP interface (in the figure below: byte 256). The system assigns this address automatically as default when creating the MSS DP interface in HW-Config, however, it may be edited by the user if required.

Example

The input address 256dec has been selected in the hardware configuration → block parameter MSS_ID: 100hex

```
CALL “MSS_DIAG” , “MSS_DIAG_I-DB”          FB980 / DB980
MSS_ID          :=DW#16#100
TRIGGER         :=M1.0
BUSY            :=M1.1
ERROR           :=M1.2
RET_VALUE       :=MW4
```



Note

Within HW-Config, the I-address is represented as a decimal value. The parameter of the MSS diagnostics block, however, requires a hexadecimal value. For this reason, the address must be converted from a decimal into a hexadecimal value.

2.2.2 IN parameter: 'TRIGGER'

The IN parameter TRIGGER is used to start the diagnosis job: it starts when TRIGGER = 1.

As soon as the diagnostics block starts processing of the job (status change of the parameter BUSY from '0' to '1'), the trigger parameter must be cleared within the user program.

Note

The trigger interval should be selected so that the diagnostics block can be triggered again only after the block has completed its last diagnosis job (analysis of the BUSY parameter).

It is at the discretion of the user to decide whether a fixed trigger interval (e.g. every 60 seconds) or a dynamic trigger interval (e.g. start job no. n as soon as job no. n-1 has been completed) shall be used.

2.2.3 OUT parameter: 'BUSY'

The OUT parameter BUSY indicates the processing status of the diagnostics block:

- BUSY = '0' → no diagnosis in process
- BUSY = '1' → diagnosis in process

Note

If the FB is called via more than one instance, simultaneous processing of the blocks must be prevented by an interlock based on an analysis of the BUSY parameters at the relevant diagnostics block instances. This task must be performed by the user and realized within the S7 program.

2.2.4 OUT parameter: 'ERROR'

The OUT parameter ERROR shows whether or not an error occurred in the course of the last diagnosis job:

- ERROR = '0' → No error during the last diagnosis
- ERROR = '1' → An error occurred during the last diagnosis

If an error occurred, the parameter RET_VALUE will show the corresponding error code.

2.2.5 OUT parameter: 'RET_VALUE'

If an error occurred (see parameter ERROR), the OUT parameter RET_VALUE outputs the relevant error code:

- 0000Hex → No error
- E101Hex → Data record could not be read; there was possibly no MSS available
- E201Hex → Internal error
- E202Hex → Max. number of supported function elements has been exceeded (max. 300)
- E203Hex → Max. number of supported and simultaneously faulty elements has been exceeded (max. 50)
- E204Hex → Max. number of supported emergency-stop elements has been exceeded (max. 50)

Note

The MSS diagnostics block supports up to 300 function elements configured in the MSS. 50 of these function elements may show an error status at the same time. Furthermore, up to 50 emergency-stop elements configured in the MSS are supported.

If these limits are exceeded, a corresponding error code will be issued at the parameter RET_VALUE (E202, E203 & E204).

3 Analysis of Diagnostic Data in the Instance Data Block

3.1 Data structure in the instance data block

This chapter explains the data structure of the determined diagnostic data in the instance data block.

Note Since the whole diagnostic program only requires one data block, this data block (instance data block) not only includes the diagnostic data relevant to the user, but also data required for system-internal diagnostic purposes.

The diagnostic data relevant to the user is available in the instance data block in the address range from bytes 100 to 3627. The previous and subsequent data areas are irrelevant to the user.

The table below shows the position and structure of diagnostic data in the instance data block:

	Function	Data type	Address
	Irrelevant data area (start)	ARRAY [0..99] of BYTE	0.0 to 99.0
a)	Device status		
	device error	BOOL	100.0
	group error	BOOL	100.1
	bus error	BOOL	100.2
	wiring error	BOOL	100.3
	configuration mode	BOOL	100.4
	test mode	BOOL	100.5
	safety mode	BOOL	100.6
b)	Configured function elements		
	Number of all configured elements	INT	102.0
	Status of all elements	ARRAY [0..3019] of BYTE	104.0
c)	Function elements showing an error status		
	Number of all faulty elements	INT	3124.0
	Diagnostic data of all faulty elements	ARRAY [0..149] of WORD	3126.0
d)	Configured 'emergency-stop' elements		
	Number of all emergency-stops configured	INT	3426.0
	Diagnostic data of all emergency-stops	ARRAY [0..99] of WORD	3428.0
	Irrelevant data area (end)		3628.0 to END

3.1.1 Device status

The device status shows the status of all relevant operational parameters. If the MSS has detected a short circuit between two terminals, for example, it will signal a system fault (SF), as well as a wiring error (WE).

The table below describes the meaning of the individual device states:

Identifier	Status	Meaning
DEV_DeviceErr	Device error	• Input or output defective • Module defective
DEV_GroupErr	Group error	At least one error is present
DEV_BusErr	Bus error	Fault in communication to the fieldbus master
DEV_WiringErr	Wiring error	Fault in the sensor wiring or directly in the sensor
DEV_ConfigMode	Configuration mode	The MSS is in configuration mode
DEV_TestMode	Test mode	The MSS is in test mode
DEV_SafetyMode	Safety mode	The MSS is in safety mode

3.1.2 Configured function elements

The complete status of all configured elements is stored in this data area.

Note As regards the MSS, a maximum of 300 configured function elements is supported in the MSS.

The total number of all configured function elements is indicated directly in the first section of this data area, followed by the data blocks of all function elements. Each block is 10 bytes in size. The individual function elements are sorted in an ascending order – i.e. function elements with low element numbers will be found at the beginning of the data area, those with high numbers are located at the end.

Note The element number of the relevant function elements is allocated by the MSS Engineering System (MSS ES).

The illustration below shows the data structure of this data area.

ELEM_Count	INT	0	45
ELEM_Status[0]	BYTE	B#16#0	B#16#00
ELEM_Status[1]	BYTE	B#16#0	B#16#00
ELEM_Status[2]	BYTE	B#16#0	B#16#00
ELEM_Status[3]	BYTE	B#16#0	B#16#00
ELEM_Status[4]	BYTE	B#16#0	B#16#00
ELEM_Status[5]	BYTE	B#16#0	B#16#00
ELEM_Status[6]	BYTE	B#16#0	B#16#00
ELEM_Status[7]	BYTE	B#16#0	B#16#00
ELEM_Status[8]	BYTE	B#16#0	B#16#00
ELEM_Status[9]	BYTE	B#16#0	B#16#00
ELEM_Status[10]	BYTE	B#16#0	B#16#00
ELEM_Status[11]	BYTE	B#16#0	B#16#0A
ELEM_Status[12]	BYTE	B#16#0	B#16#00
ELEM_Status[13]	BYTE	B#16#0	B#16#01
ELEM_Status[14]	BYTE	B#16#0	B#16#00
ELEM_Status[15]	BYTE	B#16#0	B#16#01
ELEM_Status[16]	BYTE	B#16#0	B#16#81
ELEM_Status[17]	BYTE	B#16#0	B#16#00
ELEM_Status[18]	BYTE	B#16#0	B#16#01
ELEM_Status[19]	BYTE	B#16#0	B#16#01
ELEM_Status[20]	BYTE	B#16#0	B#16#00
ELEM_Status[21]	BYTE	B#16#0	B#16#0A
ELEM_Status[22]	BYTE	B#16#0	B#16#00
ELEM_Status[23]	BYTE	B#16#0	B#16#03
ELEM_Status[24]	BYTE	B#16#0	B#16#0F
ELEM_Status[25]	BYTE	B#16#0	B#16#BE

Total number of the configured function elements [dec]

The **first 10** bytes are always set to 0 by the system and can be ignored.

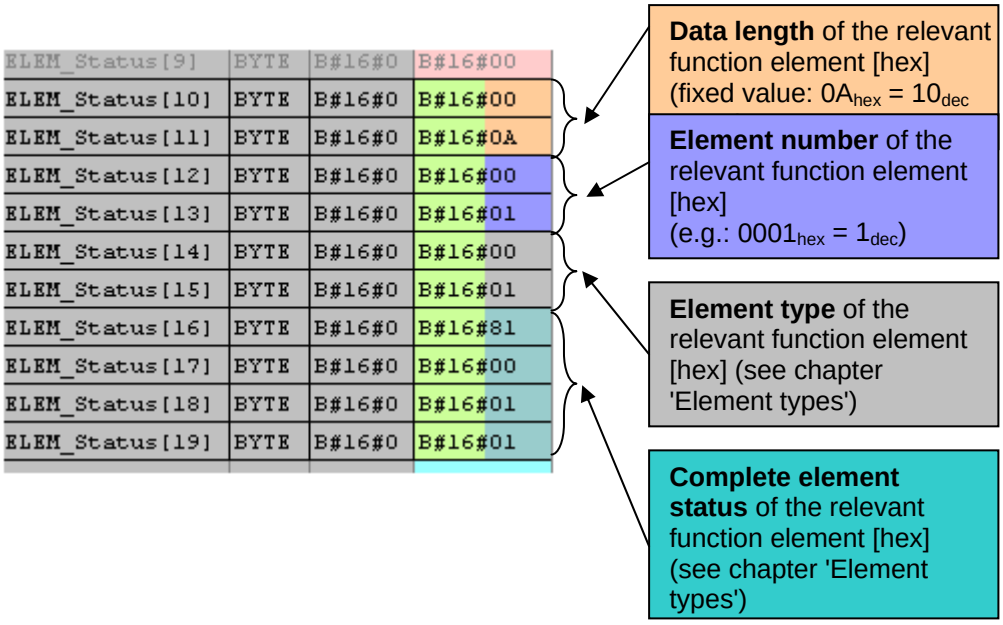
Bytes 10..19:
Status of the first function element

Bytes 20..29:
Status of the second function element

Note

The value 'Elem_Count – total number of configured function elements' defines the valid data of this data area. In the illustration above, all data after the 45th function element are invalid, because only a total of 45 elements has been configured.

The individual 10-byte data blocks, in turn, have the following data structure:



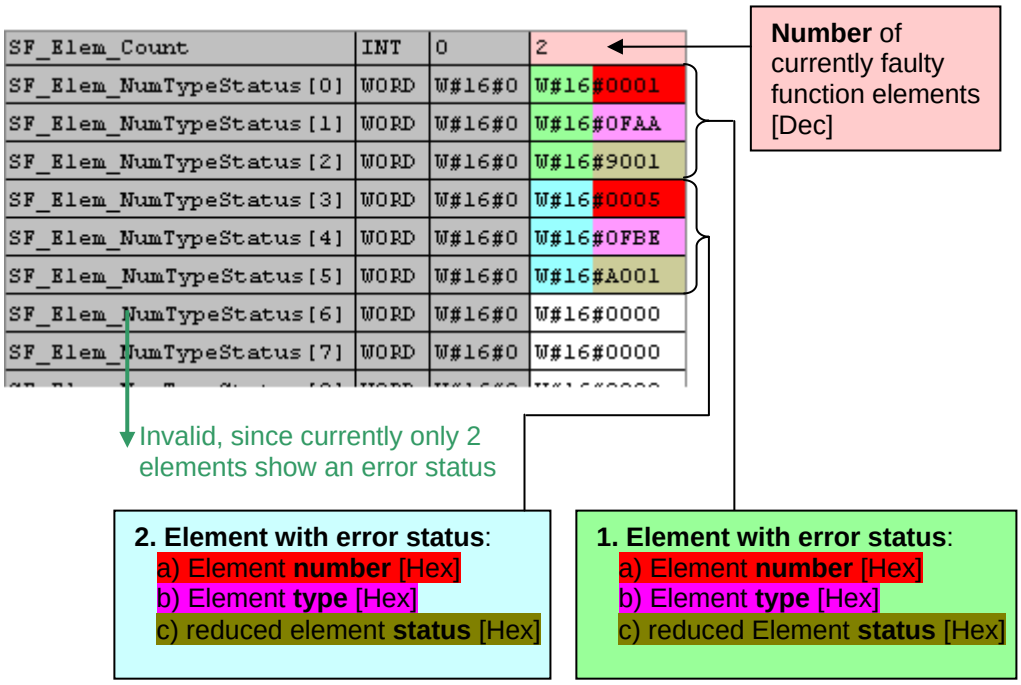
3.1.3 Function elements indicating an error status

This data area includes only function elements indicating an error status. This provides the user with a list of all currently faulty elements, so that he does not need to evaluate the entire data area including all configured elements.

Note The MSS diagnostics block supports a maximum of 50 faulty function elements at a time. If this situation occurs, a corresponding error code will be output at the block parameter RET_VALUE (see chapter OUT parameter: 'RET_VALUE').

The relevant data of each faulty function element will be displayed. This data includes:

1. the **element number** of the faulty function element
2. the **element type** of the faulty function element
3. the **reduced element status** of the faulty function element (see chapter 'Element status')



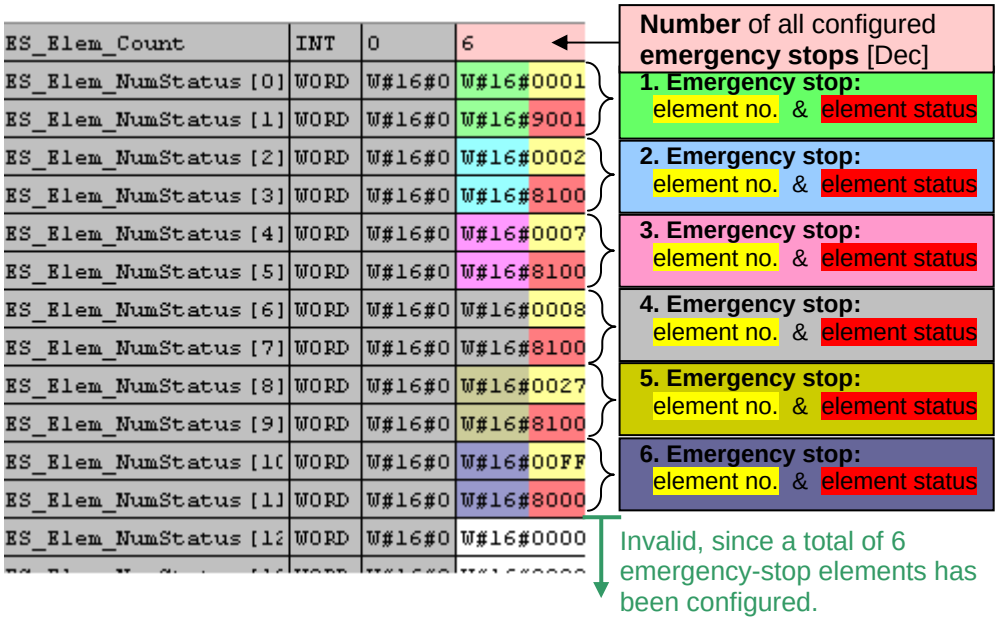
Sorting within this data area is based exclusively on the element number of the faulty element. The chronological order of occurrence cannot be deduced.
The prefix 'SF_' in the identifier stands for 'System Failure'.

Note The value 'Number of faulty function elements' defines the valid data of this data area. In the illustration above, all data after the second disturbed element is invalid, since only a total of two elements show an error at the moment.

3.1.4 Configured 'Emergency-stop' elements

This data area includes only function elements of the type 'emergency-stop'. This provides the user with an overview of all emergency-stop elements and their current status.

Each emergency-stop element is indicated with its element number and its current (reduced) status.
The prefix 'ES_' in the identifier stands for 'Emergency Stop'.



Sorting within this data area is based on the element number of the relevant emergency stop.

Note

The value 'Number of all configured emergency stops' defines the valid data of this data area. In the above illustration, all data after the sixth emergency stop is invalid, since only six emergency stops have been configured.

3.2 Interpretation of data in the instance data block

This chapter describes how the data in the instance data block of the MSS diagnostics block is to be interpreted.

3.2.1 Overview: 'Element types'

The table below provides an overview of all relevant element types:

Element type	Value	
	hexadecimal	decimal
Input cell	0001	1
Output cell	0002	2
Standard output	4075	16501
F-output	4075	16501
Emergency stop	0FFA	4010
Electro-sensitive protective equipment (ESPE)	0FB4	4020
Protective door	0FBE	4030
Safety shut-down mat, NC principle	0FC8	4040
Safety shut-down mat, cross-circuit principle	0FC9	4041
Two-hand operation	0FD2	4050
Acknowledgement button	0FDC	4060
Mode selector switch	0FE6	4070

3.2.2 Overview: 'Element status'

In the MSS data management, the status of each individual function element is stored in a 4-byte status double word. This status double word is stored in the data area 'Configured function elements' in its **complete form**. Since the user requires only the first two bytes of this status double word, the data areas 'faulty function elements' and 'configured emergency-stop elements' include only these two bytes – also referred to as **reduced element status**.

The meaning of these reduced element states is described in the tables below.

Address ($byte^{bit}$)	Status description for bits with a 'HIGH' status
0^7	Element activated
0^6	Hardware fault
0^5	Wiring error
0^4	Logic error
0^3	Function is waiting for start-up testing
0^2	Timer active

Address (byte^{bit})	Status description for bits with a 'HIGH' status
0^1	Function ready for operation and waiting for start signal
0^0	At least one function output is active
1^7	reserved
1^6	reserved
1^5	reserved
1^4	reserved
1^3	(Element) group event
1^2	(Element) group pre-warning
1^1	(Element) group warning
1^0	(Element) group error

Some typical errors are listed in the following.

1. Emergency-stop not operated – hex value: **8100**

0^7	0^6	0^5	0^4	0^3	0^2	0^1	0^0	1^7	1^6	1^5	1^4	1^3	1^2	1^1	1^0
1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

2. Emergency-stop operated – hex value: **8000**

0^7	0^6	0^5	0^4	0^3	0^2	0^1	0^0	1^7	1^6	1^5	1^4	1^3	1^2	1^1	1^0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3. Emergency-stop: discrepancy monitoring active – hex value: **8400**

0^7	0^6	0^5	0^4	0^3	0^2	0^1	0^0	1^7	1^6	1^5	1^4	1^3	1^2	1^1	1^0
1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

4. Emergency-stop: discrepancy condition violated – hex value: **9001**

0^7	0^6	0^5	0^4	0^3	0^2	0^1	0^0	1^7	1^6	1^5	1^4	1^3	1^2	1^1	1^0
1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1

5. Cross-circuit at input – hex value: **A001**

0^7	0^6	0^5	0^4	0^3	0^2	0^1	0^0	1^7	1^6	1^5	1^4	1^3	1^2	1^1	1^0
1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1

6. feedback loop error on the F-output – hex value: **A001**

0^7	0^6	0^5	0^4	0^3	0^2	0^1	0^0	1^7	1^6	1^5	1^4	1^3	1^2	1^1	1^0
1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1

4 Literature

4.1 Bibliographic references

The following list is by no means complete and only provides a selection of appropriate sources.

	Topic	Title
/1/	STEP 7	Automating with STEP7 in STL and SCL Hans Berger Published by Publicis MCD Verlag - 4th edition, 2004 ISBN 3-89578-242-4
/2/	STEP 7	Decentralization with PROFIBUS-DP/DPV1 Josef Weigmann, Gerhard Kilian Published by Publicis MCD Verlag - 3rd edition, 2002 ISBN 3-89578-189-4

4.2 Internet Links

The following list is by no means complete and only provides a selection of appropriate sources.

	Topic	Title
\1\	Reference to this entry	http://support.automation.siemens.com/WW/view/en/40631654
\2\	Siemens I IA/DT Customer Support	http://support.automation.siemens.com
\3\	MSS Manual	MSS System Manual: http://support.automation.siemens.com/WW/view/en/26493228

5 History

Version	Date	Revisions
V1.0	01/2010	First version