

Manual

multicon function blocks and projecting instructions for Siemens S7

Firmware version 1.00 and up

S7 Projecting instructions with explanations on
function blocks for integration of multicon spindle
position displays in PLC Siemens S7 via Profibus
interface of Baumer gateway GK473

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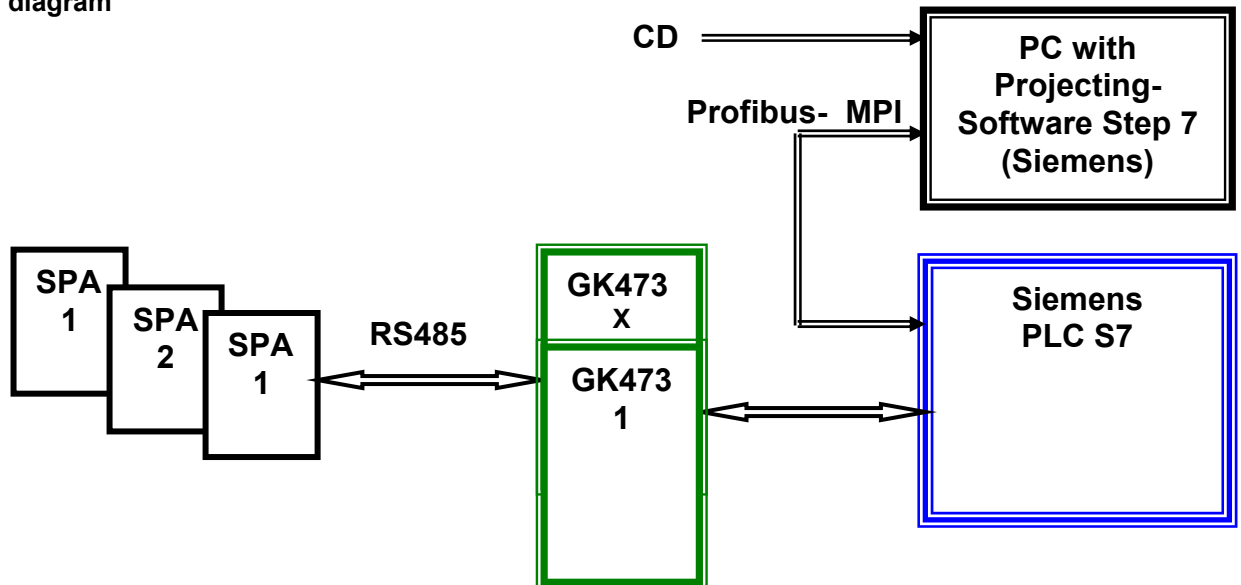
At any time we should be pleased receiving your comments and proposals for further improvement of the present document.

1. Overview

Part number Z 150.XXX

- CD** Including the function blocks as Step 7 – Project
 Including the function blocks as text blocks (AWL = STL statement list)
 Including manual „Projecting instructions“
 Including manual „GK473 - RS485 on Profibus“

System diagram



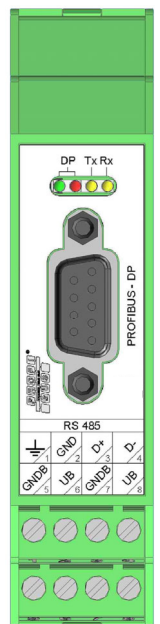
System description

The present manual is meant as support in creating a Profibus project under **SIEMENS Step7 Software**, in establishing communication with the spindle position displays (SPA) and in troubleshooting of Profibus errors.

Gateway GK473 (interface converter) is connecting the spindle position displays (= SPAs, for example N 140 / N 142 / N 150) of the **Baumer IVO multicon** system to a Profibus-DP-capable PLC. By aid of the gateway the data blocks of the SPA's RS485 interface are converted into Profibus DP protocol (and vice-versa).

Some individual gateway functions considerably improve and facilitate PLC programming. The gateway enables a network of max. 32 SPAs connected to Profibus-DP. The gateway can be applied with all spindle position displays of the **multicon** family. Furthermore, several gateways can be operated at a Profibus in order to connect more SPAs.

The Step7 project and function blocks described in this paper were created using a Step7 Software Version 5.0 + ServicePack2 under Windows 98, together with a S7-315-2DP with an input module DI16xDC24V and an output module DO32xDC24V/0,5A. However, with only slight modifications, the project should run in most other Windows / Step7 environments as well.



2. Gateway Settings

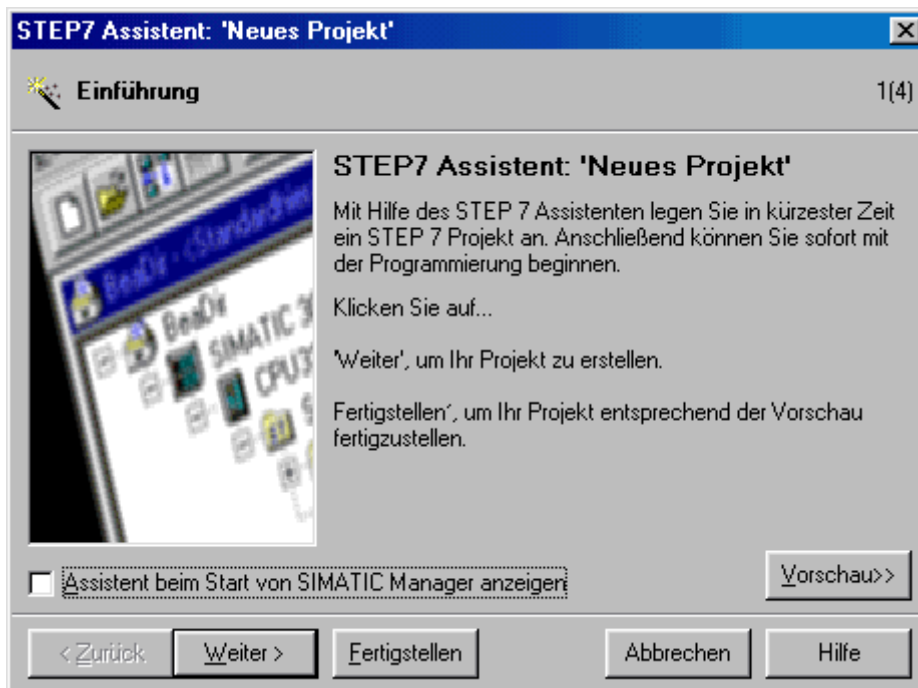
As described in the GK473 manual, set the Node ID in the gateway to an ID of your choice between 04 and 99. In the following example it is „42“.

If the gateway is either the only DP slave or the last DP slave in the Profibus line, the Bus terminator is activated by setting both DIP switches to ON. In any other case set both DIP switches to OFF.

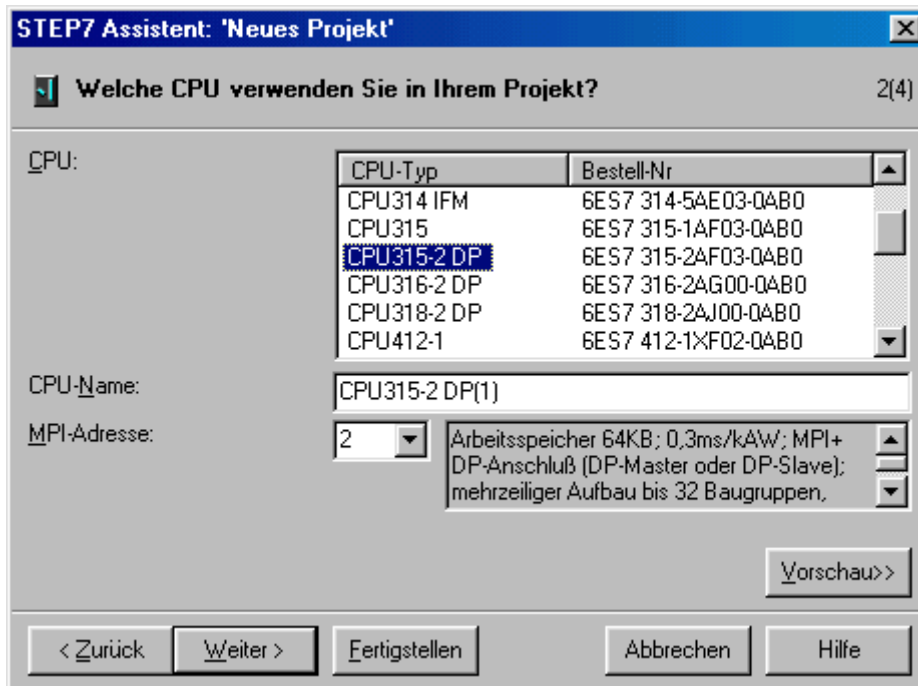
3. Simatic Manager (Step7 Software)

3.1 Creating a new project

Open Simatic-Manager (Step7 Software). For creating a new project call the assistant („File“ → Assistant „New Project“).



Click on „Next“.



STEP7 Assistent: 'Neues Projekt'

Welche CPU verwenden Sie in Ihrem Projekt? 2(4)

CPU:

CPU-Typ	Bestell-Nr
CPU314 IFM	6ES7 314-5AE03-0AB0
CPU315	6ES7 315-1AF03-0AB0
CPU315-2 DP	6ES7 315-2AF03-0AB0
CPU316-2 DP	6ES7 316-2AG00-0AB0
CPU318-2 DP	6ES7 318-2AJ00-0AB0
CPU412-1	6ES7 412-1XF02-0AB0

CPU-Name: CPU315-2 DP(1)

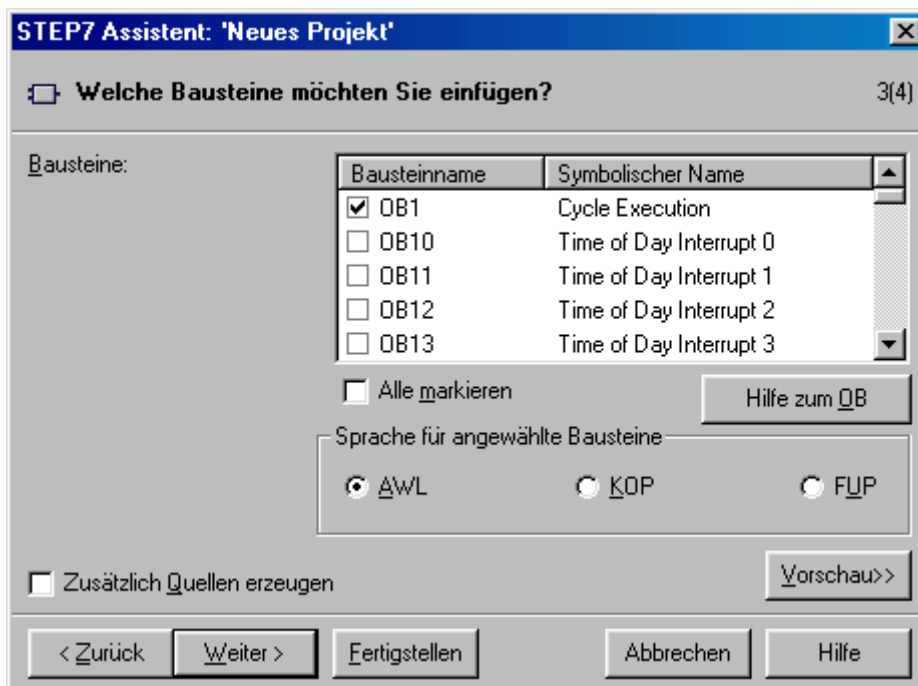
MPI-Adresse: 2

Arbeitsspeicher 64KB; 0,3ms/kAW; MPI+ DP-Anschluß (DP-Master oder DP-Slave); mehrzeiliger Aufbau bis 32 Baugruppen.

Vorschau >>

< Zurück Weiter > Fertigstellen Abbrechen Hilfe

Select your CPU type. Another option is entering an individual CPU name. Click on “next”.



STEP7 Assistent: 'Neues Projekt'

Welche Bausteine möchten Sie einfügen? 3(4)

Bausteine:

Bausteinname	Symbolischer Name
<input checked="" type="checkbox"/> OB1	Cycle Execution
<input type="checkbox"/> OB10	Time of Day Interrupt 0
<input type="checkbox"/> OB11	Time of Day Interrupt 1
<input type="checkbox"/> OB12	Time of Day Interrupt 2
<input type="checkbox"/> OB13	Time of Day Interrupt 3

Alle markieren

Hilfe zum OB

Sprache für angewählte Bausteine

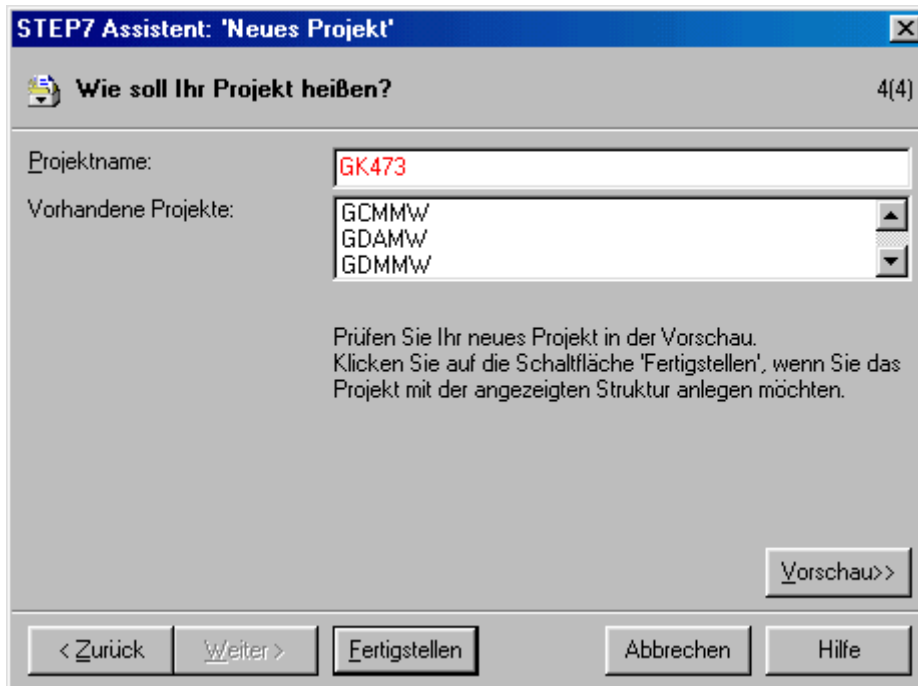
AWL KOP FUP

Zusätzlich Quellen erzeugen

Vorschau >>

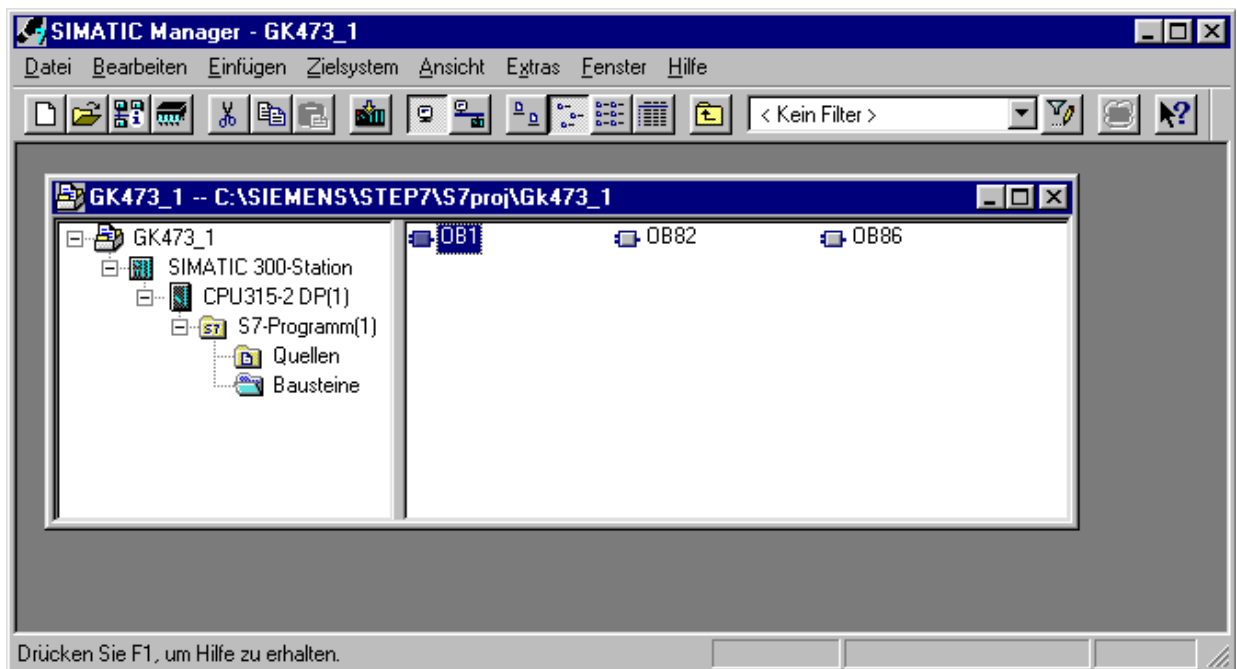
< Zurück Weiter > Fertigstellen Abbrechen Hilfe

When selecting the blocks to be implemented chose OB1, OB82 and OB86. Select “AWL” (STL, Statement List) as language for the chosen blocks.

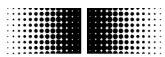


Enter a project name of your choice (for example GK473) and click to „Finish“.

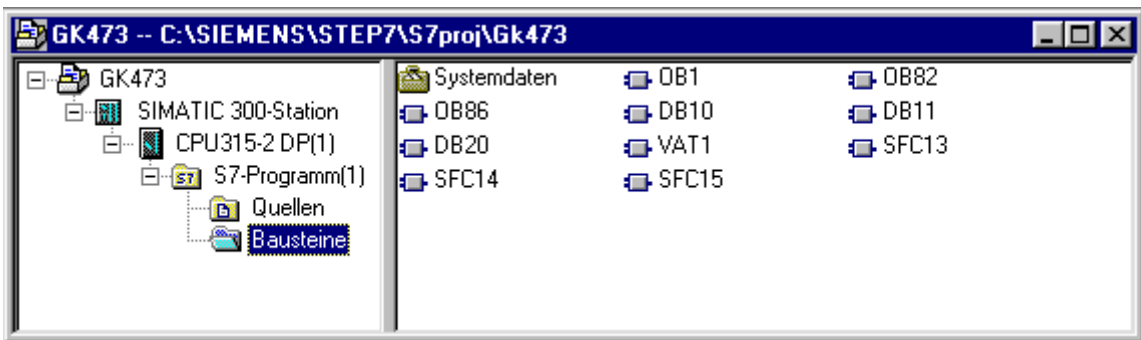
Now the project window showing the already implemented blocks will open.



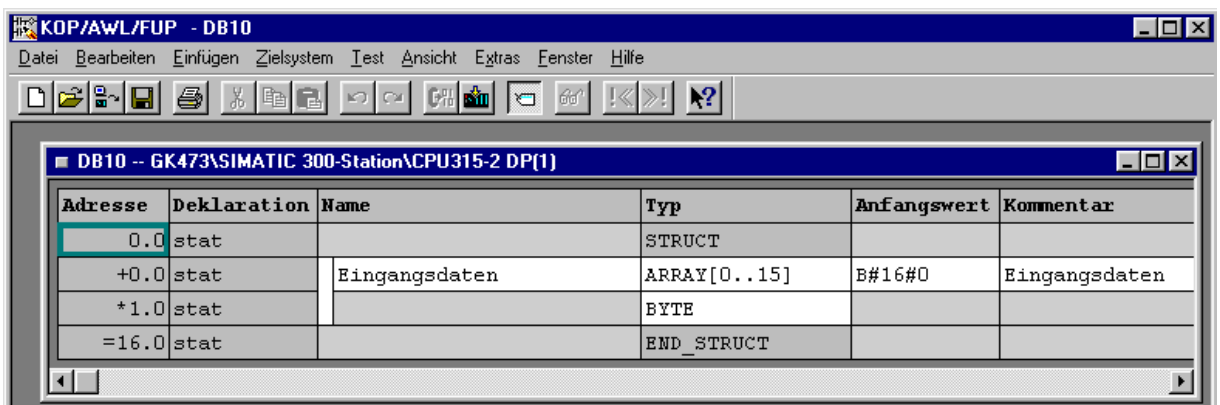
You have to implement further blocks for the project. Select “paste” -S7 block- and then the appropriate option.



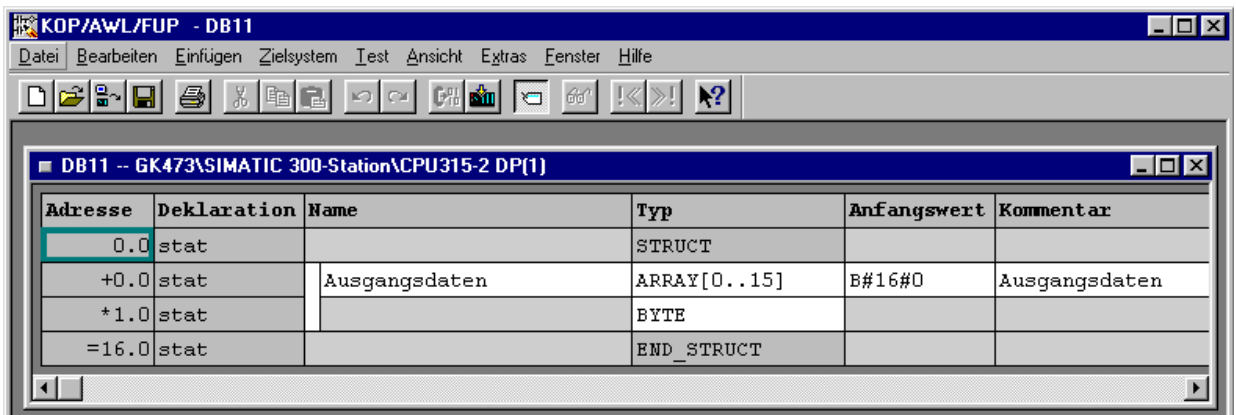
Install all the blocks shown above in successive order. In the following you will find further screenshots for both data blocks and a chart of variables (optional but recommended for testing purposes).



DB10



DB11

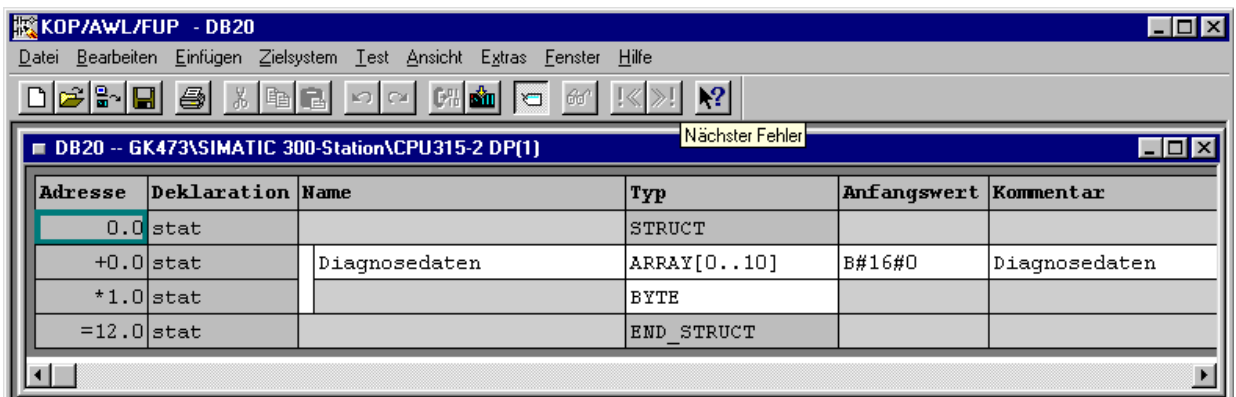


KOP/AWL/FUP - DB11

DB11 -- GK473\SIMATIC 300-Station\CPU315-2 DP(1)

Adresse	Deklaration	Name	Typ	Anfangswert	Kommentar
0.0	stat		STRUCT		
+0.0	stat	Ausgangsdaten	ARRAY[0..15]	B#16#0	Ausgangsdaten
*1.0	stat		BYTE		
=16.0	stat		END_STRUCT		

DB20



KOP/AWL/FUP - DB20

DB20 -- GK473\SIMATIC 300-Station\CPU315-2 DP(1) Nächster Fehler

Adresse	Deklaration	Name	Typ	Anfangswert	Kommentar
0.0	stat		STRUCT		
+0.0	stat	Diagnosedaten	ARRAY[0..10]	B#16#0	Diagnosedaten
*1.0	stat		BYTE		
=12.0	stat		END_STRUCT		

VAT1

VAT1 -- GK473\SIMATIC 300-Station\CPU315-2 DP(1)					
Operand	Symbol	Statusformat	Statuswert	Steuerwert	
//DB10: Eingangsdaten von den SPA					
//DB11: Ausgangsdaten zu den SPA					
MD	1	---	HEX		
MW	5	---	HEX		
DB10.DBB	0	---	HEX		
DB10.DBB	1	---	HEX		
DB10.DBB	2	---	HEX		
DB10.DBB	3	---	HEX		
DB10.DBB	4	---	HEX		
DB10.DBB	5	---	HEX		
DB10.DBB	6	---	HEX		
DB10.DBB	7	---	HEX		
DB10.DBB	8	---	HEX		
DB11.DBB	0	---	HEX		B#16#22
DB11.DBB	1	---	HEX		B#16#22
DB11.DBB	2	---	HEX		B#16#43
DB11.DBB	3	---	HEX		B#16#00
DB11.DBB	4	---	HEX		B#16#00
DB11.DBB	5	---	HEX		B#16#00
DB11.DBB	6	---	HEX		B#16#00
DB11.DBB	7	---	HEX		B#16#00
DB11.DBB	8	---	HEX		B#16#00
DB20.DBB	0	---	HEX		
DB20.DBB	1	---	HEX		
DB20.DBB	2	---	HEX		
DB20.DBB	3	---	HEX		
DB20.DBB	4	---	HEX		
DB20.DBB	5	---	HEX		
DB20.DBB	6	---	HEX		
DB20.DBB	10	---	HEX		

After being defined in the SIMATIC Manager, loading of all data blocks into the S7 is imperative (select blocks, then system of destination →load)! Otherwise it will not work (neither there will be an error message).

3.2 Import GSD file

Consider the left project window. Branch down to all project elements by clicking on the “+” sign. Click on SIMATIC 300 station.

Among others, the right window will indicate „Hardware“. Double click on „Hardware“.



The hardware window of the Simatic Manager as independent program element „HW config“ will open.

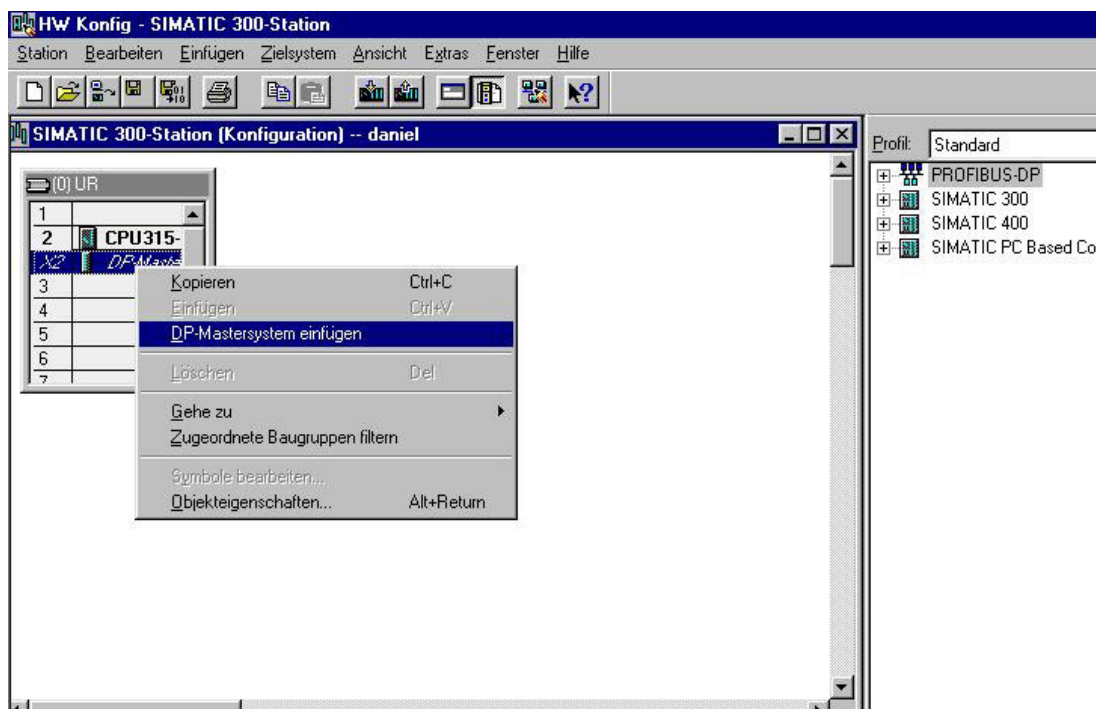
When importing a GSD file no station in the hardware window must be left open. Make sure they are closed by clicking on „Station“ → „Close“.

Importing a GSD file is realized by „Extras“ → import GSD file“. Then select the directory with the GSD file (for example A:\).

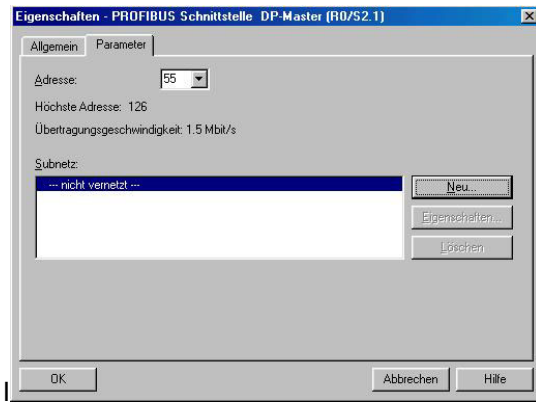
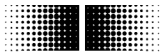
After having finalized the import operation re-open the present (File → At the bottom will appear a list of the recently opened stations).

3.3 Hardware-Configuration

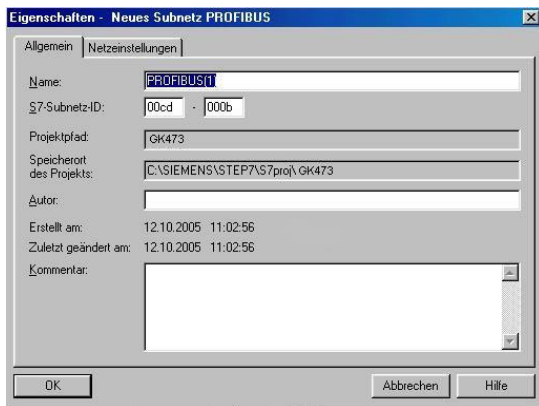
For hardware configuration the Profibus must be connected to CPU first – if not already done. Use right mouse key and click on X2-DP Master bus for insertion of a DP master system.



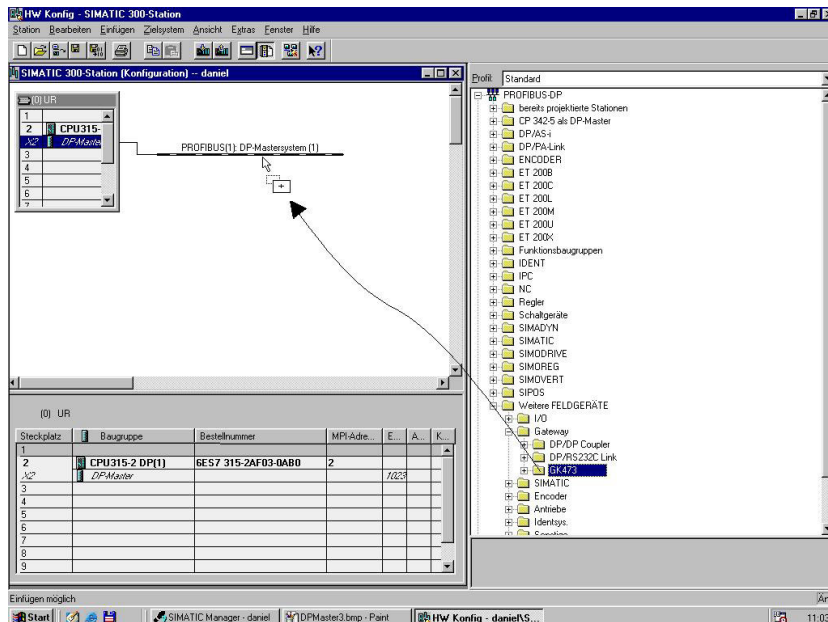
A new subnet is created by clicking on button „New“



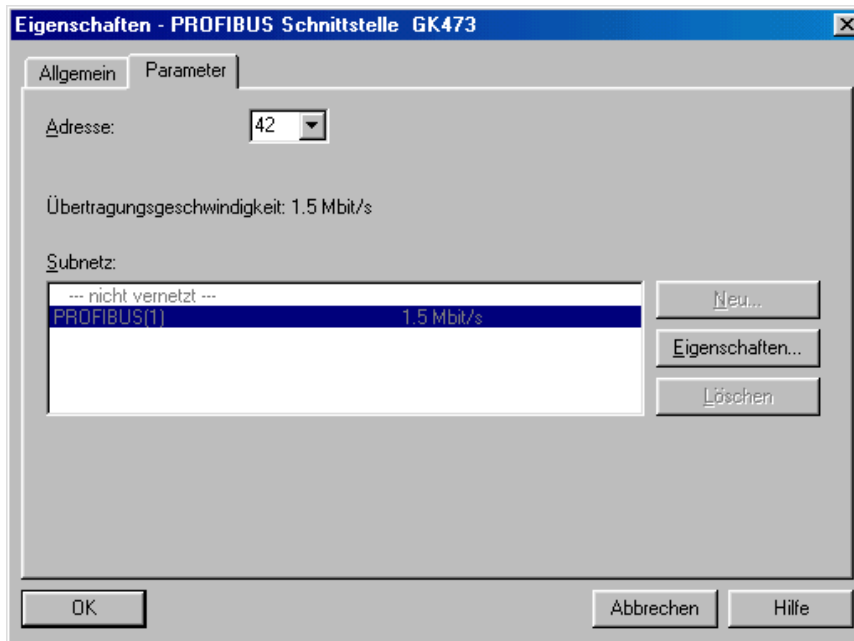
To enter default settings click on „OK“



Next step is connecting the gateway to Profibus.
 HW Config → Catalogue → other fieldbus devices → Gateway → GK473.
 Drag name „GK473“ to the dotted Bus rail using the left mouse key.



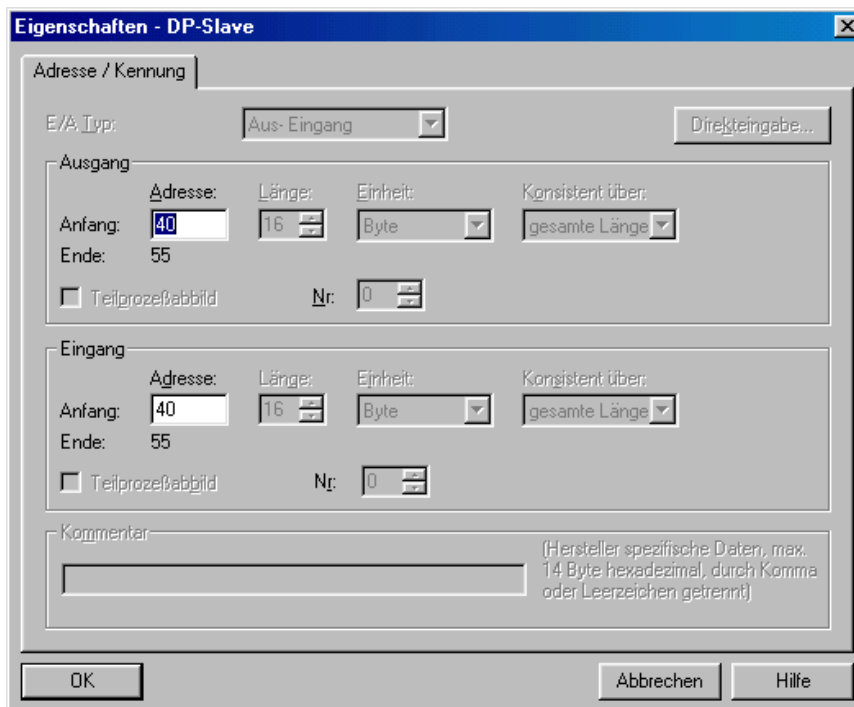
The window „Properties DP-Slave“ will open.



In this window enter only the Node ID which has to be identical to that previously set at the gateway's two rotary switches (Example: 42).

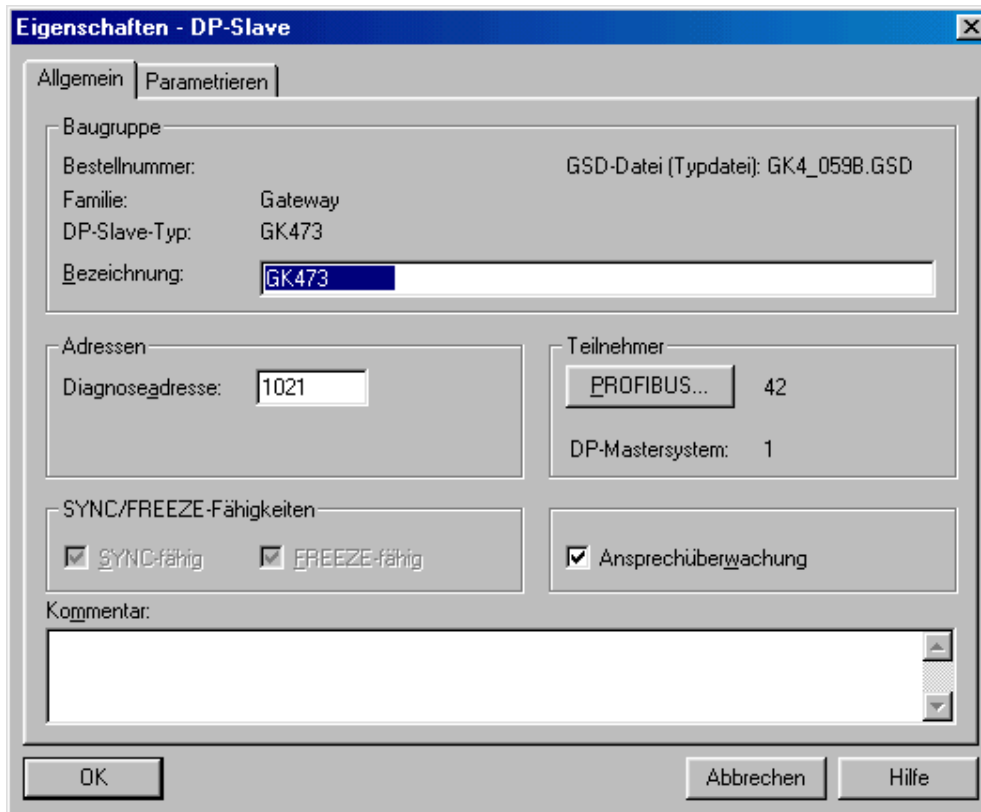
Close window by click on OK .

Drag module "16bit I/O" of GK473 from the hardware catalogue to the window „location /module“ in the left corner. Upon double click on the newly created line the window of module "16bit I/O" will reopen. Enter port addresses for input and output data. Different from the screenshot the example is using identifiers (addresses) 20 to 35.

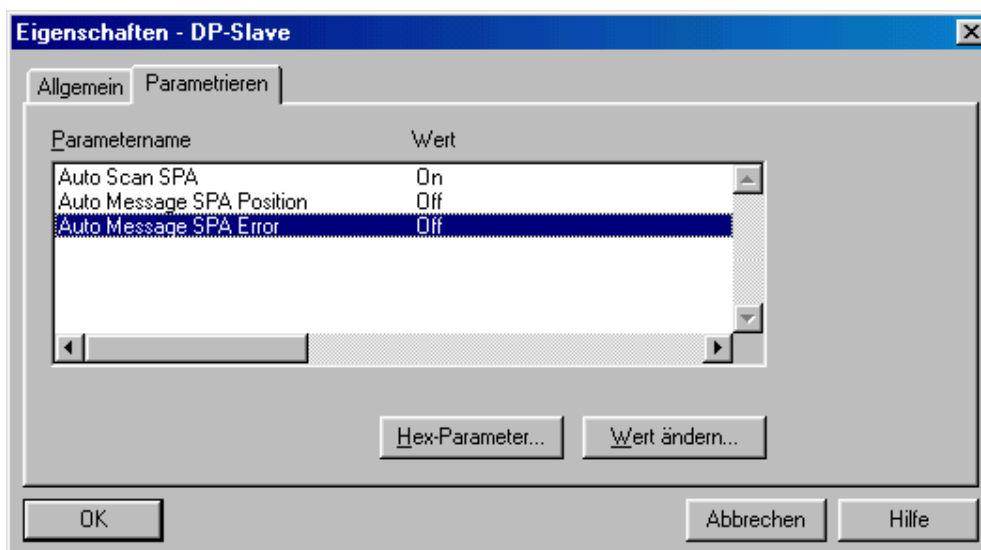


3.4 Parameterization

Upon double click on the gateway icon of the bus rail in window HW-config the window „Properties DP-Slave“ will open. You may proceed alterations of slave number and diagnostic address. The Profibus node ID has yet been entered above and therefore should already be the correct one.

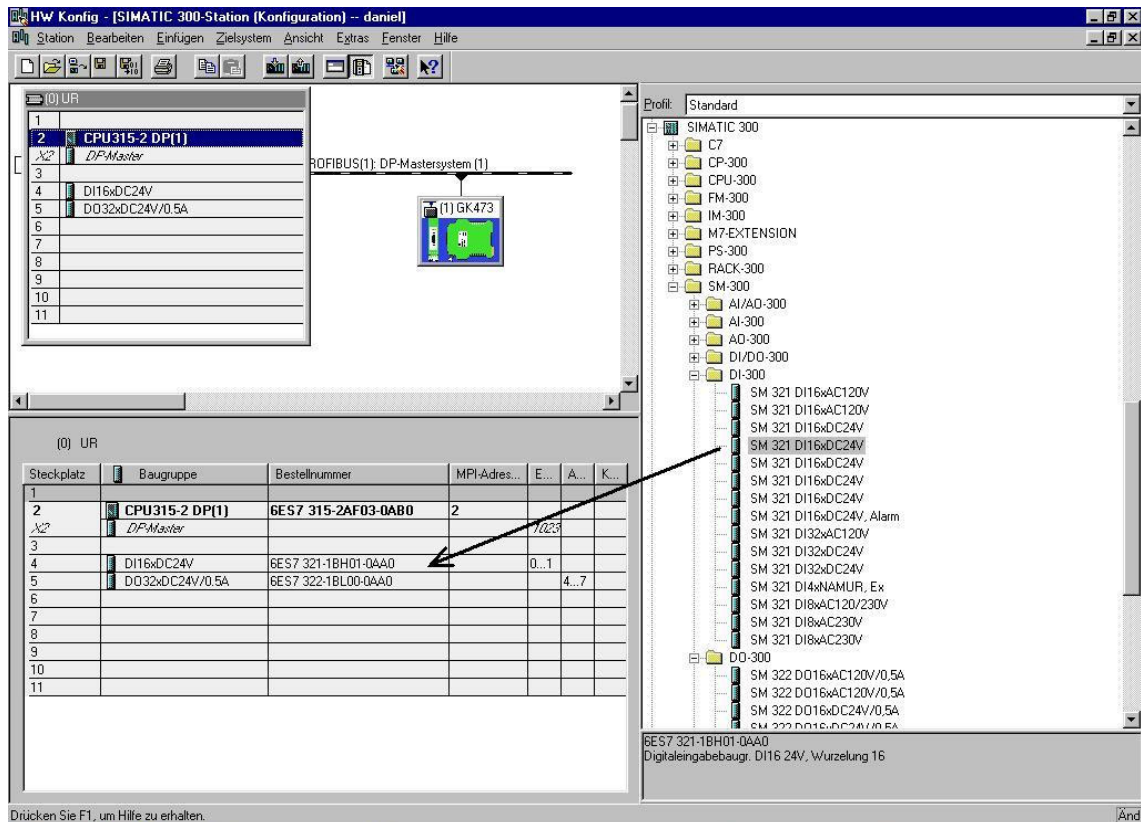
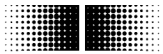


Click on index card „Parameterize“.



Now define the gateway properties as required (see manual) by either double click on the respective line or by click on „change value“.

Finally the connected peripheral devices have to be configured. Use left mouse key and click on the corresponding block in the catalog window, dragging it to the place desired. The following screenshot is showing the status after configuration.



3.5 Store, compile and load

Select „Store and compile“ in HW config to load the hardware configuration into the PLC. This has to be done after ANY modification in the hardware configuration.

3.6 Organization block OB1

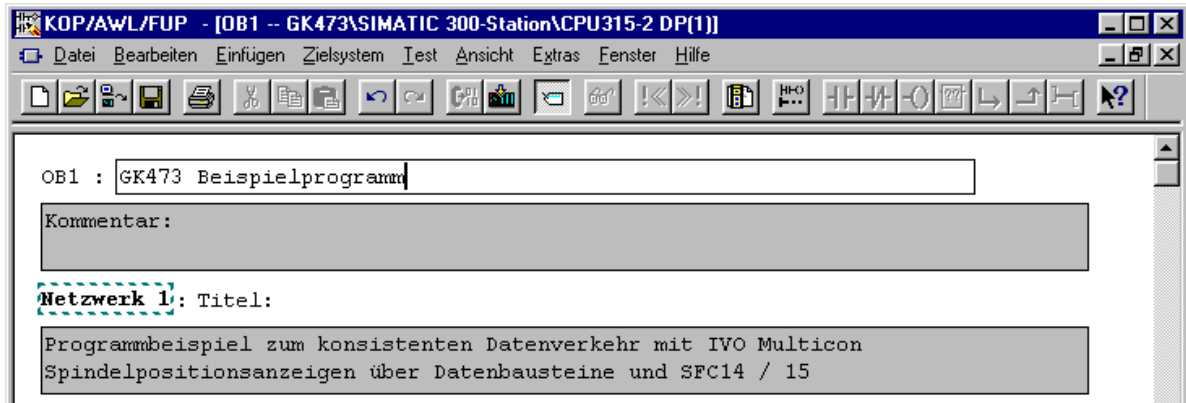
Create a master program as described in the following.

After polling operation of the key for clearing the status-LEDs of OB82 and OB86 the program will consistently read according to label NOCL the 16 bytes input data into data block DB10 by help of function SFC14. These are messages of the gateway respectively of the spindle position displays (SPAs).

Next step is output of the 16 Bit output data by help of function SFC15 of data block DB11 for consistent transfer to the gateway. The output data imply the commands to the gateway respectively SPA.

The end of OB1 operates a 16 bit binary counter serving as trigger of the 16 LEDs of the output module at identifiers 6 and 7. This way a cyclic processing of OB1 is verified.

The organization block OB1 is continuously operated in a cyclic way, reason why data are always transferred in the same way. The gateway will only consider a transfer as relevant (new) if the count byte (first byte of a data block) has been altered (refer to manual GK473). Filling respectively evaluation of the data blocks is not considered in this example.



```

U      E      0.3      // Reset key operated? (at input module group ID 0)
SPBN  NOCL      // clear outputs ID 4 and 5 of OB82
L      W#16#0
T      AW      4
NOCL  NOP      0

CALL  SFC      14      // Read input data to DB10
      LADDR :=W#16#14  // E/A range of the gateways starts with 20d=14h
      RET_VAL:=MW10    // Status and error messages after memory word 10
      RECORD :=P#DB10.DBX 0.0 BYTE 16 // Target is data block DB10, start byte 0,
      // Length 16 bytes

CALL  SFC      15      // Output of output data of DB11
      LADDR :=W#16#14  // E/A range of the gateways starts with 20d=14h
      RECORD :=P#DB11.DBX 0.0 BYTE 16 // Source is data block DB11,
      // Start byte 0, length 16 bytes
      RET_VAL:=MW11    // Status- and error messages after memory word 11

L      MD      1      // Visualized by LEDs of
      // output module group ID 6 and 7
+      L#1      // add Long 1 to AKKU1 (increment)
T      MD      1      // Double memory word 1
T      AW      6      // Output module group here on IDs 6...7

NOP  0

```

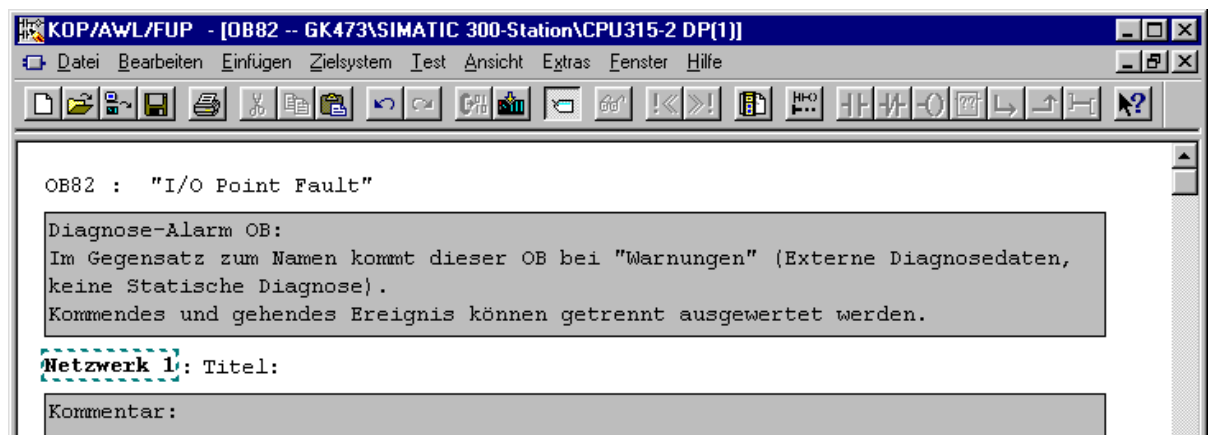

3.7 Organization block OB82

Contrary to the name „Diagnostic alarm“ OB82 "I/O Point Fault" is not effected upon DP-Slave alarm but upon „warnings“ (existing external diagnostic data, no static diagnosis). Incoming and outgoing events can be evaluated separately.

Organization block OB82 not inserted in the project will make the PLC stop upon occurrence of such event. To prevent a PLC stop it is sufficient inserting OB82 without program code.

The program in OB82 described in the following first is tracing the logic basic identifier of the DP slave the warning comes from. After having stored the identifier in memory word 5 it is checked whether it is an incoming or outgoing event with branching down into several subprograms. In the following example however the same applies to both cases. The diagnostic data (10 byte) are consistently being copied into data block DB20. There is a repetition loop since this procedure may take several cycles and SFC13 is repeated until the procedure has been finalized (BUSY).

At the beginning of the program a characteristic bit pattern is written on the S7 module groups (outputs ID 4 and 5) to visualize OB82 at the S7 LEDs. The LEDs are cleared by key (see OB1).



```

L      W#16#5555           // Visualize event at LEDs of
T      AW      4           // output module group ID 4

L      #OB82_MDL_ADDR     // Logic basic identifier of DP-Slaves
T      MW      5

L      #OB82_EV_CLASS     // Event class and token
L      B#16#39            // Mark incoming event
                                // (B#16#38: outgoing event)
==     I                  // Identical?
SPB    KOMM

GEHT:  NOP      0

CALL   "DPNRM_DG"         // Symbols SFC13
      REQ      :=TRUE
      LADDR   :=W#16#3FE   // Diagnostic address 1022=3FEh,
                                // see Hardware Config Slave
      RET_VAL :=MW20       // any free memory word available
      RECORD  :=P#DB20.DBX 0.0 BYTE 11 // Target is data block DB20,
                                // Beginning byte 0, length 6+5=11 byte
      BUSY    :=M1.0       // any memory bit used as Busy token;
                                // Repeat as long as Busy

U      M      1.0         // Call memory bit M1.0; set VKE correspondingly
SPB    GEHT              // Repeat SFC13,
                                // as long as VKE=1 (linked result)
    
```

```

        BEA                                // End current block

KOMM: NOP    0

        CALL "DPNRM_DG"                    // symbol SFC13
            REQ    :=TRUE
            LADDR :=W#16#3FE                // Diagnostic address 1022=3FEh,
                                           // see Hardware Config Slave
            RET_VAL:=MW20                    // any free memory word available
            RECORD :=P#DB20.DBX 0.0 BYTE 11 // Target is data block DB20,
                                           // Start byte 0, length 6+5=11 byte
            BUSY   :=M1.0                    // any memory bit used as Busy token;
                                           // Repeat as long as Busy

        U    M    1.0                        // Call memory bit M1.0 ; set VKE correspondingly
        SPB   KOMM                           // Repeat SFC13
                                           // As long as VKE=1 (linked result)
    
```

3.8 Organization block OB86

OB86 "Loss Of Rack Fault" is effected once (incoming and outgoing) upon DP slave alarm (with existing external and static diagnostic data). These events occur with station breakdown and rebooting after power loss of the DP-Slave, bus interruption or slave alarm messages. Incoming and outgoing events can be evaluated separately.

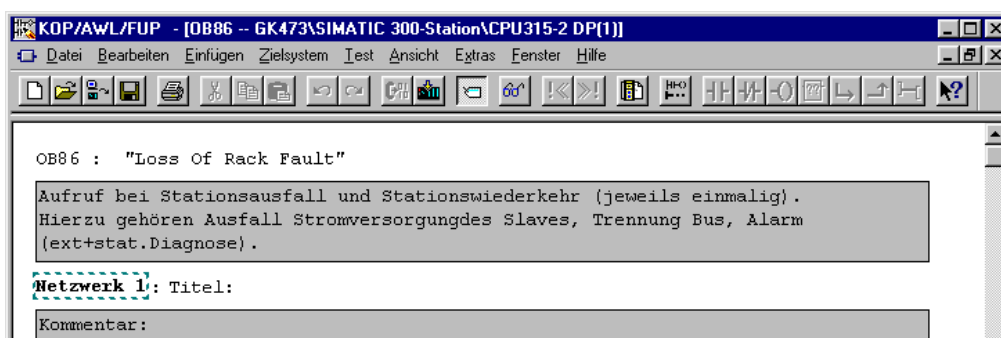
Organization block OB86 not inserted in the project will make the PLC stop upon occurrence of such event.

To prevent a PLC stop it is sufficient inserting OB86 without program code.

The program in OB86 described in the following is first tracing the logic basic address of the DP-slave the warning comes from and stores the information in memory word 5.

Further the fault ID (possible values hex. C1 to C7) is checked and stored in memory word 7.

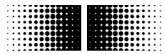
After having checked whether it is an incoming or outgoing event the program is branching down into several subprograms. In the following example however the same applies to both cases. The diagnostic data (10 byte) are being consistently copied into data block DB20. There is a repetition loop since this procedure may take several cycles and SFC13 is repeated until the operation has been finalized (BUSY).



```

        L    #OB86_MDL_ADDR                // Logic basic address of DP-Slaves
        T    MW    5

        L    #OB86_FLT_ID                  // Fault ID
        T    MB    7
    
```



```

L      #OB86_EV_CLASS      // Event class and marks
L      B#16#39              // Mark incoming event
                                // (B#16#38 is outgoing event)
==     I                    // Identical?
SPB    KOMM

GEHT:  NOP  0
L      W#16#FF              //Switch on LEDs of output component group
T      AW   4

CALL   "DPNRM_DG"          // SFC13
      REQ  :=TRUE
      LADDR :=W#16#3FE      // Diagnostic address 1022=3FEh,
                                // see Hardware Config Slave
      RET_VAL :=MW20        // any free memory word available
      RECORD :=P#DB20.DBX 0.0 BYTE 11 // Target is data block DB20,
                                // Start of byte 0, length 6+5=11bByte
      BUSY  := M1.0         // any memory bit as Busy mark
                                // Repeat as long as Busy

U      M      1.0          // Poll memory word bit M1.0 ab; set VKE
correspondingly
SPB    GEHT                // Repeat SFC13
                                // as long as VKE=1 (linked result)

BEA                                // end current block

KOMM:  NOP  0
L      W#16#FF00
T      AW   4

CALL   "DPNRM_DG"          // SFC13
      REQ  :=TRUE
      LADDR :=W#16#3FE      // Diagnostic address 1022=3FEh, s. HW Config
      Slave
      RET_VAL:=MW20        // any free memory word available
      RECORD :=P#DB20.DBX 0.0 BYTE 11 // Target is data block DB20,
                                // Start byte 0, length 6+5=11 byte
      BUSY  :=M1.0         // any memory bit for Busy mark;
                                // Repeat as long as Busy

U      M      1.0          // Poll memory word bit M1.0; set VKE
correspondingly
SPB    KOMM                // Repeat SFC13
                                // as long as VKE=1 (linked result)

```

3.9 Troubleshooting

3.10 Evaluating the diagnostic data

Chapter 3.7 „Organization block OB82“ describes diagnostic data readout. For evaluating the diagnostic data stored in DB20 byte 11 must be read off and compared to possible fault numbers. To do so, byte 11 is checked regarding coincidence with available fault numbers. Upon coincidence the program skips to the responsible troubleshooting mark.

```

L DB20.DBB 11 // Read byte 11
L 0 // compare with 0 (00h = no fault, see gateway manual)
==| // if VKE = 1
SPB ENDE // skip to END mark (no error)
L DB20.DBB 11
L 1 // (01h)
==|
SPB EFLA // Flash fault
L DB20.DBB 11
L 2 // (02h)
==|
SPB ERAM // RAM fault
L DB20.DBB 11
L 3 // (03h)
==|
SPB EROM // Eeprom fault
L DB20.DBB 11
L 17 // (11h)
==|
SPB EKON // Configuration fault
L DB20.DBB 11
L 18 // (12h)
==|
SPB EPAR // Parameter fault
L DB20.DBB 11
L 33 // (21h)
==|
SPB ESPA // lost connected SPA
SPA EINT // otherwise internal error
    
```

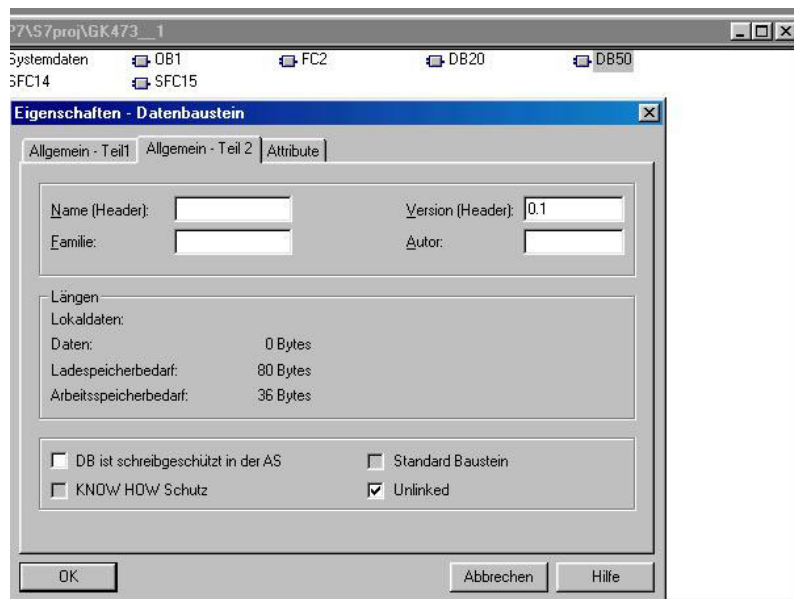
```

EFLA: NOP 0
//... Code for troubleshooting in case of Flash fault
SPA ENDE
ERAM: NOP 0
//... Code for troubleshooting in case of RAM fault
SPA ENDE
EROM: NOP 0
//...Code for troubleshooting in case of EEPROM fault
SPA ENDE
EKON: NOP 0
//... Code for troubleshooting in case of configuration fault
SPA ENDE
EPAR: NOP 0
//... Code for troubleshooting in case of parameter fault
SPA ENDE
ESPA: NOP 0
//... Code for troubleshooting in case of lost SPA
EINT: NOP 0
//... Code for troubleshooting in case of internal fault
SPA ENDE
ENDE: NOP 0
    
```

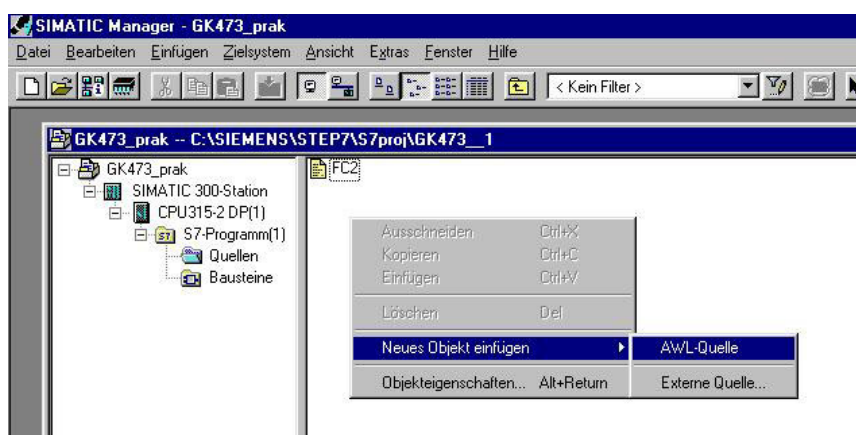
3.11 Remanent profile storing

Data blocks may be defined as „not process relevant“ (key word: UNLINKED) so that they are stored only in the remanent memory when being loaded into CPU. Thus they do not burden the CPU memory unnecessarily and the relevant data are only loaded if required. This procedure is especially recommended for profiles since they do not require frequent access due to the fact that a profile is not being altered very often. A data block is marked as “not process relevant” by using the right mouse key to click on block SIMATIC Manager →object properties” and by ticking „unlinked“ in index card „General – Part 2“ (see screenshot).

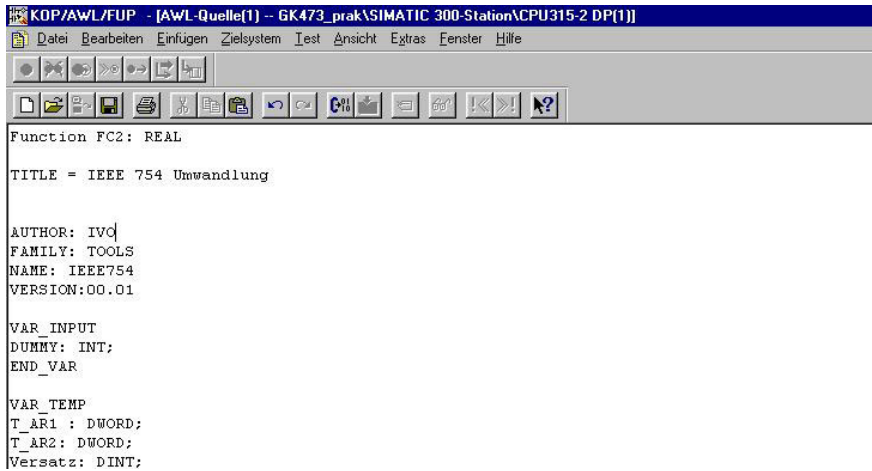
Besides an integrated RAM memory, the S7-300-CPU's load memory may also provide an integrated EPROM part. Otherwise the memory is supplied by battery buffer so that the data will remain even after PLC switch off. Therefore it is recommended to store SPA profiles in a data block marked “not process relevant” and to load the profiles only if necessary. This loading operation is realized by system function SFC 20 BLKMOV.



3.12 Creating an AWL-(STL Statement List) source file



By double click to the new AWL (STL) source file a window showing the function's source code will open. Afterwards the source file is stored and the program returns to the SIMATIC manager.



```

KOP/AWL/FUP - [AWL-Quelle(1)] -- GK473_prak\SIMATIC 300-Station\CPU315-2 DP(1)
Datei Bearbeiten Einfügen Zielsystem Test Ansicht Extras Fenster Hilfe

Function FC2: REAL

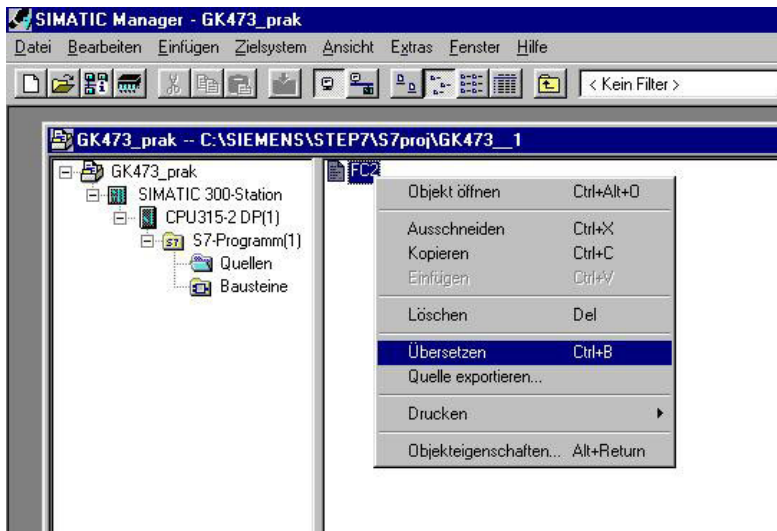
TITLE = IEEE 754 Umwandlung

AUTHOR: IVO
FAMILY: TOOLS
NAME: IEEE754
VERSION:00.01

VAR_INPUT
DUMMY: INT;
END_VAR

VAR_TEMP
T_AR1 : DWORD;
T_AR2: DWORD;
Versatz: DINT;
    
```

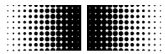
Now the project source file must be compiled. Use right mouse key and click to →Compile to AWL (STL)-source file (in the following FC2) of the SIMATIC-Manager.



3.13 Transferring PLC commands to SPA by gateway

As described in the GK473 manual, possible commands of gateway to SPA have basically the same structure. For example, a count byte marking the beginning of a new RS485 telegram is followed by the SPA identifier and then by the true command. Other data may also be attached, for example a target and/or profile number to write. This Profibus data block has a permanent length of 16 bytes and must always be transferred in a consistent way.

For consistent transfer Siemens provides the system functions SFC14 (read) and SFC15 (write), that in our example transfer (SFC15) respectively store (SFC14) 16 bytes each of a data block.



3.14 Structure of profile data block DB98

Profile data block DB98 implies all profiles of each single SPA connected .The individual targets are written into the data block in successive order and each SPA is capable of memorizing up to 100 targets. When adapting this data block it has to be made sure that it is in line with function FC14. For example, the DB is not only for storing targets but also other data, or maybe only 15 profiles are required instead of 100. Since the offset is explicitly calculated by permanent values it has to be considered in the calculation. If further values besides the targets have to be stored or read in, the additional output variables must be defined in the function.

Adresse	Name	Typ	Anfangswert	Aktualwert
0.0	SPA_NR[0]	REAL	0.000000e+000	9.234500e+002
4.0	SPA_NR[1]	REAL	0.000000e+000	8.332500e+002
8.0	SPA_NR[2]	REAL	0.000000e+000	7.430500e+002
12.0	SPA_NR[3]	REAL	0.000000e+000	6.434500e+002
16.0	SPA_NR[4]	REAL	0.000000e+000	7.141000e+001
20.0	SPA_NR[5]	REAL	0.000000e+000	8.234500e+002
24.0	SPA_NR[6]	REAL	0.000000e+000	9.634500e+002

```

:           :           :           :           :
:           :           :           :           :
:           :           :           :           :

```

400.0	SPA_NR2[0]	REAL	0.000000e+000	1.234500e+002
404.0	SPA_NR2[1]	REAL	0.000000e+000	2.332500e+002
408.0	SPA_NR2[2]	REAL	0.000000e+000	3.430500e+002
412.0	SPA_NR2[3]	REAL	0.000000e+000	5.434500e+002
416.0	SPA_NR2[4]	REAL	0.000000e+000	1.141000e+001
420.0	SPA_NR2[5]	REAL	0.000000e+000	6.234500e+002

```

:           :           :           :           :
:           :           :           :           :
:           :           :           :           :

```

3580.0	SPA_NR9[95]	REAL	0.000000e+000	0.000000e+000
3584.0	SPA_NR9[96]	REAL	0.000000e+000	0.000000e+000
3588.0	SPA_NR9[97]	REAL	0.000000e+000	0.000000e+000
3592.0	SPA_NR9[98]	REAL	0.000000e+000	0.000000e+000
3596.0	SPA_NR9[99]	REAL	0.000000e+000	0.000000e+000

4. Functions



Important!

Since it takes the SPA a little time to answer the calls some functions have to be called repeatedly.

This is indicated by a „Busy“ message (Busy bit). It is up to the operator to have the OB functions repeated until the Busy bit is no longer active in order to make sure that the data being read in are truly the current ones and do not rely to a previous data call.

!

4.1 Overview on function

Following functions are on CD, both as project files as well as simple text files where an AWL (STL-Statement List) source file can be copied

- FC 1 Converting ASCII number (6 Byte) into real number
- FC 5 - Converting real number into ASCII (6 Byte)
- FC 10 – Read current value
- FC 11 – Read target off current SPA profile
- FC 12 – Read target off defined SPA profile
- FC 13 – Write target into defined SPA profile
- FC 14 – Read target off profile data block
- FC 15 – Automatic placing of identifier/address
- FC 16 – Program bit parameter
- FC 17 – Change profile
- FC 18 – Collective information „SPA connected“
- FC 19 – Collective information „Check Position“
- FC 21 – Automatic SPA scanning operation on/off

Following data blocks and memory bytes, memory words and double memory words are applied by the previously described functions:

- DB95 16 byte data block to store data that are read in by gateway
- DB96 16 byte data block to store outgoing data to the gateway
- DB97 6 byte data block to convert from ASCII into Real
- DB98 DB to store all targets of a single SPA
- DB99 Applies to global variables, for example Busy, current value_real, Timeout as well as other variables required by the function blocks.
- MW 1 Memory word to store the respectively current status of the gateway's master counter.
- M50.0 – M54.7 Memory range applied by function FC16.

4.2 The global variables, data block DB99

Since many functions are called off repeatedly and the variables defined in the local function blocks are valid for calling operations only they are stored in data block 99. This way they can be accessed any time. The chart below gives an overview on the stored variables.

Adresse	Name	Typ	Anfangswert
0.0		STRUCT	
+0.0	SPA_Adr	INT	0
+2.0	Time_Out	BOOL	FALSE
+2.1	Fehler	BOOL	FALSE
+2.2	Busy	BOOL	FALSE
+2.3	Startadr_saved	BOOL	FALSE
+2.4	inkrementieren	BOOL	FALSE
+2.5	gesendet	BOOL	FALSE
+2.6	Zaehlbyteeingelesen	BOOL	FALSE
+4.0	Istwert_REAL	REAL	0.000000e+000
+8.0	altes_Zaehlbyte	INT	0
+10.0	Fehler_snd	BYTE	B#16#0
+11.0	Fehler_rcv	BYTE	B#16#0
+12.0	Fehler_cpy	BYTE	B#16#0
+13.0	akt_Adresse	BYTE	B#16#0
+14.0	old_one	BYTE	B#16#0
=16.0		END_STRUCT	

4.3 Busy bit, Timeout bit and Error bit

All functions awaiting an SPA reply will come with a Busy bit, Timeout bit and an Error bit.

Busy bit

The Busy bit indicates that the SPA has not yet replied and that the function has to be repeated. The true command of the function is not transferred twice but it is only checked whether recent data are yet available at the gateway. **Function polling goes together with setting of Busy bit to make sure that the function is really repeated until the Busy bit is not active anymore.**

Timeout bit

No new data provided within the time window defined will result in setting the Timeout bit what is done by a timer that is started upon command transfer.

Error bit

In case system functions SFC14 or SFC 15 signalize a polling error latter is stored and can be verified by the operator. The error bit indicates that an error has occurred.

0	4
000	010
0	0

To achieve number 5 the first 4 bits are masked out using an UND link. 1111 is loaded into the battery and linked to 0100 0101 UND.

	010	010
	0	1
UND- Linked to	000	111
	0	1
Result	000	010
	0	1

To both numbers the ASCII offset is added what equals 0x34 and 0x35 that is written into the DB.

4.6 FC 10 – Read current value

The function "read current value" is reading the current value off the SPA addressed. The function is given the SPA identifier as integer number (1,2,3 ...). The function then is converting the SPA identifier into the format required by the gateway. Returned is the current SPA value in real format. Furthermore the function outputs a Busy bit, a Timeout bit and an Error bit.

Call function:

CALL FC 10

```

SPA ID:          INT;
Time_Out:        BOOL;
Error:           BOOL;
Busy:            BOOL;
Current value_Real: REAL;
    
```

First the function calls SFC14 for reading in the current count byte to be stored in MW1. Second step is generating the command to be sent to the gateway. To do so, MW1 is incremented and the SPA identifier converted into ASCII. MW1, SPA identifier and command byte are then written into DB96. Remaining digits are filled by zeroes.

The command is sent to the gateway by SFC15 with subsequent start of a timer. Also the Busy bit is set to prevent the command from being resent to the gateway during repeated function call. Only the read in routine of the function will be proceeded again.

Prior to the read-in operation the timer is checked. When having expired, the program directly skips to label/mark Timeout. The Timeout bit is set whereas the Busy bit is reset.

If the timer has not yet expired the read-in operation will be proceeded by SFC14. The count bytes are compared to reckon whether new data are provided. The "ancient" count byte was stored in DB99 and compared with the recent count byte provided by DB95 prior to sending the command. In case the count bytes are not identical the gateway is in receipt of the SPA reply and the function will reset the Busy bit.

The new data are processed by aid of FC1 that is converting the current value provided in ASCII format by DB95 into a floating point number. Returned is FC10. The Busy memory word is reset and it is checked whether there has any error occurred in system functions SFC14 and SFC15 what is registered by the error bit.

4.7 FC 11 – Read target off current SPA profile

This function is for reading off the current profile of the addressed SPA. The SPA identifier is passed to the function as integer number and returned is the target.

The function runs identical to FC10, but instead of the current value being read in FC1 only the target being read in is converted.

Call function:

```
CALL FC 11
    SPA_ID      := INT
    Time_Out    := BOOL
    Error       := BOOL
    Busy        := BOOL
    Target_Real := REAL
    Active_profile := INT
```

4.8 FC 12 – Read target off defined SPA profile

This function is for reading a defined target from a profile presently not active. FC12 is given both SPA identifier and the selected profile number for read out. Returned is the target.

The function runs identical to FC10 and FC11 with the only difference that when generating the command also the required profile number is first converted into ASCII format and then also written into DB96.

Call function:

```
CALL FC 12
    SPA_ID      := INT
    Profile number := INT
    Time_Out    := BOOL
    Error       := BOOL
    Busy        := BOOL
    Target_Real := REAL
```

4.9 FC 13 – Write target into defined SPA profile

This function is for writing a target in real format into a certain SPA profile. The function is given the respective SPA identifier, the required profile number to write in as well as the target in REAL format.

Call function:

```
CALL FC 13
    SPA_ID      := INT
    Profile number := INT
    Target       := REAL
    Time_Out    := BOOL
    Error       := BOOL
    Busy        := BOOL
```

4.10 FC 14 – Read target off profile data block

Of course the profiles can also be stored by PLC. This function is meant as example for a possible profile arrangement. Access is on DB98 where the SPA profiles (1-99) are listed. The pointer allows immediate access to a defined target. The function is given both SPA identifier and profile number in order to calculate the offset and to reply the target.

Example: SPA-identifier = 4
Profile nr. = 8

The function will now read the target off DB98.DBB 1228.

The formula for calculating the offset is as follows:

$(SPA_ID - 1) \times 400 + (\text{profile number} - 1) \times 4$

In case DB98 is adapted to prevailing requirements, the calculation of the offset has to be adapted as well. If for example only 10 profiles are required, the memory capacity of the block is reduced and also the offset is calculated in a different way. With 10 profiles for example the formula is as under:

$(SPA_ID - 1) \times 40 + (\text{profile number} - 1) \times 4$

Call function:

```
CALL FC 14
    SPA_ID := 3
    Profile number := 1
    Target := MD130
```

4.11 FC 15 – Automatic identifier (address) designation

This function is giving a broadcast command to all SPAs connected what enables automatic placing of the SPA identifiers in successive order. To place the identifier, the shaft of the respective SPA must be turned by at least a half, the direction does not matter.

The function must be given the identifier to start with and the total of SPAs. Thus it is possible to place the identifier also with SPAs that are connected later by simply naming the next identifier and the number of additional SPAs to be addressed.

Call function:

```
CALL FC 15
    Start_Adr := INT
    Anzahl_SPA := INT
    Time_Out := BOOL
    Fehler := BOOL
    Busy := BOOL
```

4.12 FC 16 – Set bit parameter

This function is for writing the bit parameters into the SPA. The function applies the memory range from M50.0 to M54.7. Parameters are given as Bool in case of two options only respectively as an integer number in case of more than two options. 0 is representing a binary zero, 1 a binary 1, 2 for binary 10 and 3 for binary 11. Parameters to hide arrows, Offset and target are parameters with more than two options (example arrows: UP/DOWN /UNI/ OFF).

Data_4_5 makes the SPA identifier entered as integer number what the function will convert correspondingly.

Positioning direction	0/1	(UP/DOWN)
Counting direction	0/1	(UP/DOWN)
Arrows	0/1/2/3	(UP/DOWN/UNI/OFF)
Rounding the current value	0/1	(OFF/ON)
Turn display	0/1	(OFF/ON)
Offset	0/1/2/3	(NORM/MAST/SLAV/WKZR)
Hide target	0/1/2	(OFF/ON/EVER)
Data_4_5	1..99	(SPA-Identifier)

Call function

CALL FC 16

SPA_identifier	:= INT;
Positioning direction	:= BOOL;
Counting direction	:= BOOL;
Arrows	:= INT;
Rounding the current value	:= BOOL;
Turn display	:= BOOL;
Offset	:= INT;
Hide target	:= INT;
Data_4_5	:= INT;

4.13 FC 17 – Program profile

This function is for selecting a SPA profile. The function comprises SPA identifier and the requested profile number. Both information is converted into ASCII and written into the respective command to be sent.

Call function

CALL FC 17

SPA_identifier	:= INT
Profile number	:= INT
Time_Out	:= BOOL
Error	:= BOOL
Busy	:= BOOL

4.14 FC 18 – Collective information “connected SPA”

This function is for calling the gateway function „SPA connected“. The command generated comprises the imperative count byte, the gateway address (20h) and the command byte for internal processing (40h= '@') as well as the command byte for special functions, in the example 41h. Following is a block number (1..3 (21..23h)) comprising a group of 10 SPAs each.

Replied is again a 16 byte data block of the following structure: Count byte, gateway address, byte for internal processing and command byte followed by the addressed block. The next byte comprises the total of SPAs connected followed by their individual identifiers (please refer also to gateway manual GK473, chapter 3.5).

Presently the function calls and reads the first block only. The function replies the total of SPAs connected. If the function is intended for calling off other blocks due to requiring the identifiers of the connected SPAs the function has to be correspondingly extended and adapted.

Call function

```
CALL FC 18
  Total_SPA      := INT
  Time_Out       := BOOL
  Error          := BOOL
  Busy           := BOOL
```

4.15 FC 19 – Collective information “Check Position”

This function is for accomplishing the gateway function command „Check Position“. The command is processed in the same way as previously described. Same restrictions as for block processing do apply. Latter is not existing and has to be completed if required.

Call function

```
CALL FC 19
  Number_not_in_posi := INT
  Time_Out           := BOOL
  Error              := BOOL
  Busy               := BOOL
```

4.16 FC 21 – Automatic SPA scanning operation ON or OFF

This function is for switching ON or OFF the automatic SPA scanning operation. The desired option is entered by aid of a bool variable. For automatic scanning operation ON, enter 1 = TRUE respectively 0 = FALSE for OFF.

Although by this command the gateway default parameter is overwritten it does not mean a permanent alteration. Some commands require switching off the automatic scanning operation since they are only valid until another command is received – for example indicate SPA identifier in the lower display or with any automatic placing of identifiers.

Call function

```
CALL FC
  Auto_Scan_On := BOOL
  Time_Out     := BOOL
  Error        := BOOL
  Busy         := BOOL
```

5. Annex

5.1 Abbreviations applied

ASCII	A merican S tandard C ode for I nformation I nterchange
AWL	PLC programming language „ A nweisungs L iste“ (STL – Statement List)
BCD	B inary C oded D ecimal
BISS	B idirectional S ensor interface
CRC	C yclic R edundancy C heck
DB	D aten b austein
FC	F unction
FB	F unction b lock
GSD	D evice s tandard f ile
IC	I ntegrated C ircuit
LSB	L owest S ignificant B it or B yte
MSB	M ost S ignificant B it or B yte
MT	M ultiturn
OB1	O peration- B lock
PLC	P rogrammable L ogic C ontrol
PROFIBUS	P rocess F ield B us
RS485	R adio S ector 485, physical standard for differential data transfer
SPA	S pindle p osition display
SSI	S ynchron S erial I nterface
ST	S ingleturn
TÜV	T echnischer Ü berwachungs- V erein (German Technical Regulations Authority)