Training document for the company-wide automation solution

Totally Integrated Automation (T I A)

MODULE B4

Data blocks

We thank the company Michael Dziallas Engineering and the instructors of vocational schools as well as further persons for the support with the production of the document.

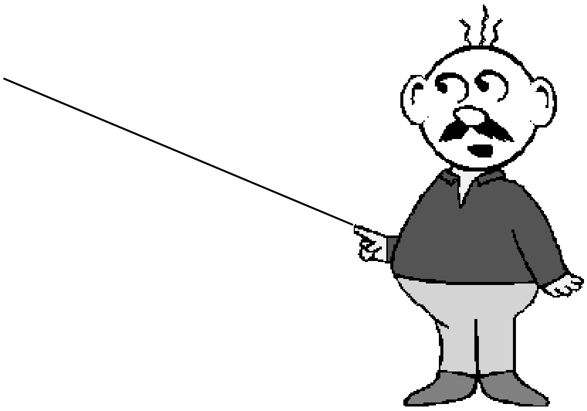
The following symbols stand for the specified modules:

ℹ Information

🖥 Programming

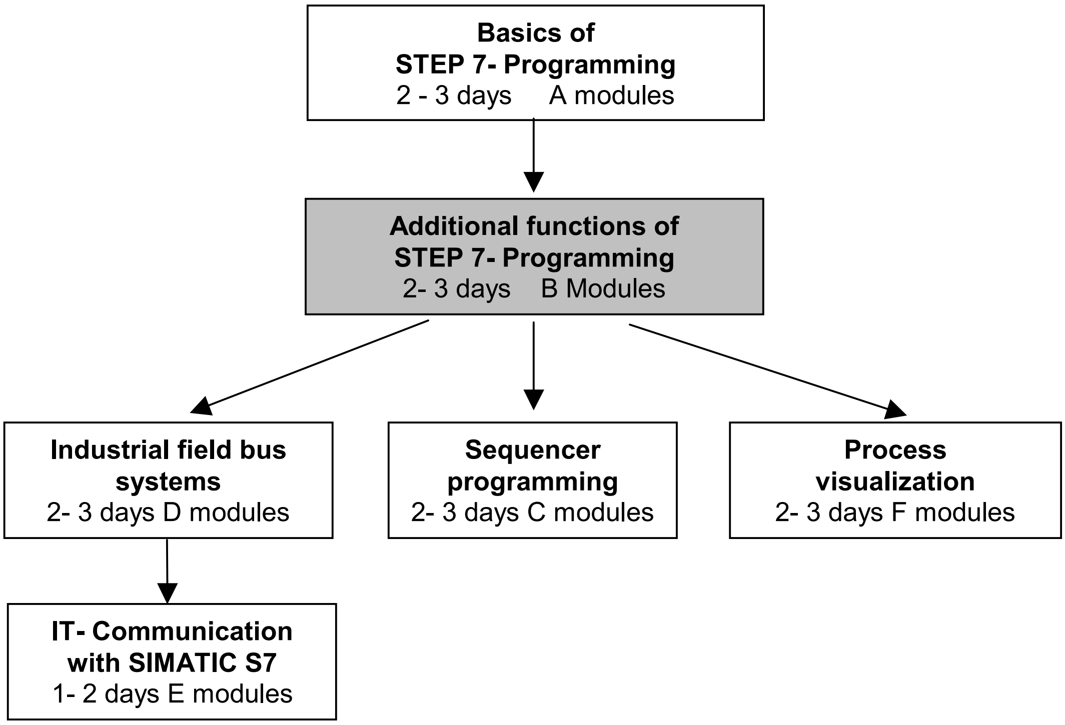
? Example exercise

⚠ Notes



1. FORWARD

The module B4 is assigned content wise to **Additional functions of STEP 7- Programming**.



Basics of STEP 7- Programming
2 - 3 days A modules

Additional functions of STEP 7- Programming
2- 3 days B Modules

Industrial field bus systems
2- 3 days D modules

Sequencer programming
2- 3 days C modules

Process visualization
2- 3 days F modules

IT- Communication with SIMATIC S7
1- 2 days E modules

Learning goal:

In this module, the reader should learn how a data block can be used to save data.

- Generating data blocks
- Specifying a structure of a data block
- Access to a data element in a STEP 7- Program

Requirements:

For the successful use of this module, the following knowledge is assumed:

- Knowledge in the use of Windows 95/98/2000/ME/NT4.0
- Basics of PLC- Programming with STEP 7 (e.g. Module A3 - 'Startup' PLC programming with STEP 7)
- Basics to structured programming (e.g. Appendix I - Basics to PLC –Programming with SIMATIC S7-300)

Forward Notes Generating data blocks

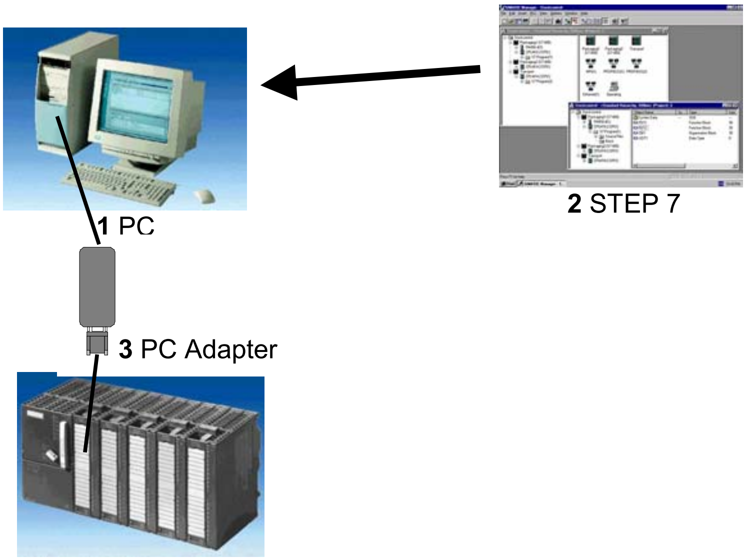
Required hardware and software

1 PC, Operating system Windows 95/98/2000/ME/NT4.0 with
- Minimal: 133MHz and 64MB RAM, approx. 65 MB free hard disk space
- Optimal: 500MHz and 128MB RAM, approx. 65 MB free hard disk space

2 Software STEP 7 V 5.x

3 MPI- Interface for the PC (e.g. PC- Adapter)

4 PLC SIMATIC S7-300 with at least one digital in- and output module. The inputs must be lead through a functional unit.
Example configuration:
- Power supply: PS 307 2A
- CPU: CPU 314
- Digital input: DI 16x DC24V
- Digital output: DO 16x DC24V / 0.5 A



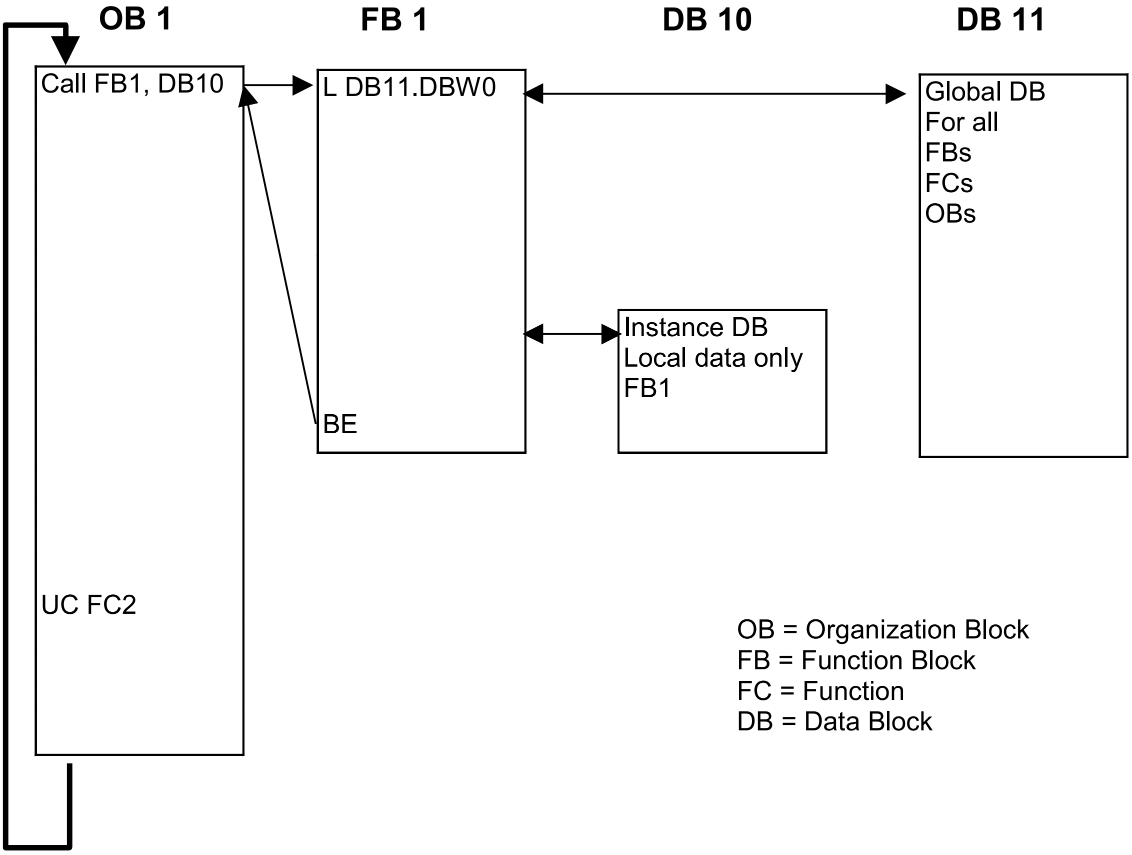
4 SIMATIC S7-300

Forward | Notes | Generating data blocks

2. NOTES FOR DATA BLOCKS

Data Blocks (DBs) can be used by your program to save data in the CPU. Your hard disk contains up to 8 KBytes (8192 Bytes) space.
There are two types of data blocks. **Global** DBs, where all OBs, FBs and FCs read all saved data or can even write in the DB and **local instance** DBs, which are assigned a particular FB.
In the DBs, different data types (e.g. BOOL or WORD) can be saved in arbitrary order.
This structuring of a DB follows through input in a table with the tool
LAD, STL,FBD - S7 Block Programming .

In the program structure from STEP 7, data blocks are found as follows:



OB = Organization Block
FB = Function Block
FC = Function
DB = Data Block

3. GENERATING DATA BLOCKS

Data blocks are generated and opened like program blocks in the tool **LAD,STL,FBD: Program blocks**. They serve e.g. for the saving of data and system states.

In the following text, the generation of a simple example is described by the use of a global data block:

Thereby values should be chosen with the switches 'S0' to 'S7' and displayed on an output module ‘Display‘. Thereby one has more switches by activation, where the representation of the value to switch S7 has the highest priority and the representation of the value to switch S1 has the lowest.

The example relates to the displayed addresses below:

Inputs:

- Switch S0 = I 0.0
- Switch S1 = I 0.1
- Switch S2 = I 0.2
- Switch S3 = I 0.3
- Switch S4 = I 0.4
- Switch S5 = I 0.5
- Switch S6 = I 0.6
- Switch S7 = I 0.7

Outputs:

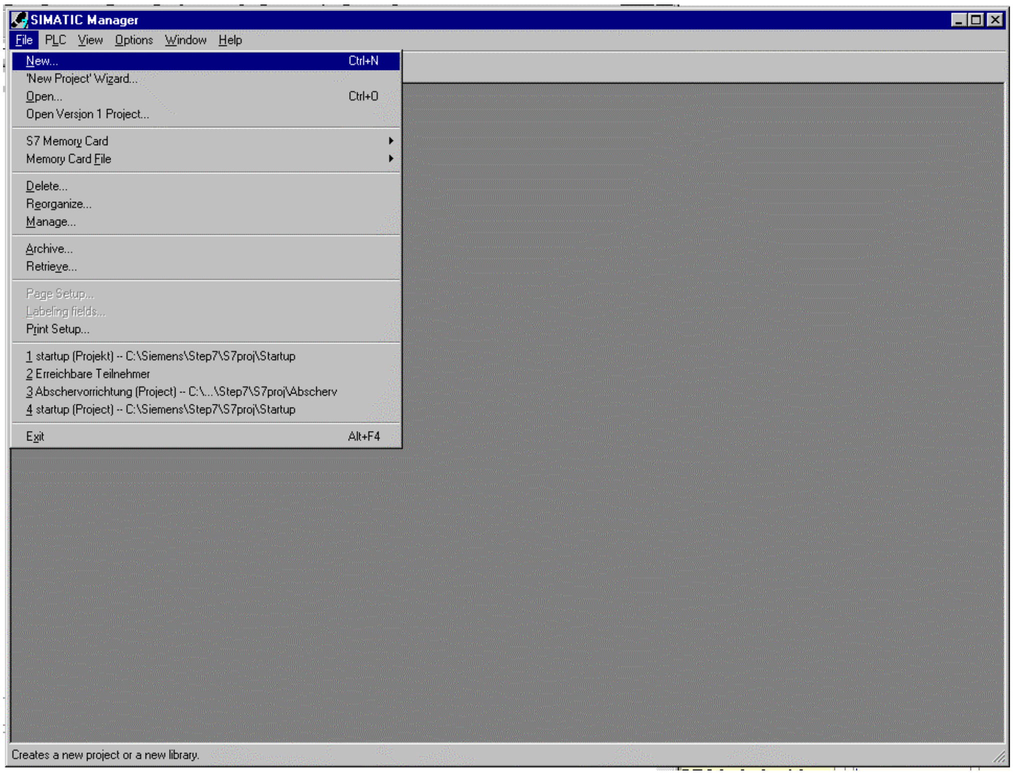
- Display = QW4

In order to generate this program example, the following steps must be followed (Thereby the program is dispensed with the creation of the hardware configuration):

1. Call **SIMATIC Manager** with a double click (→ SIMATIC Manager)

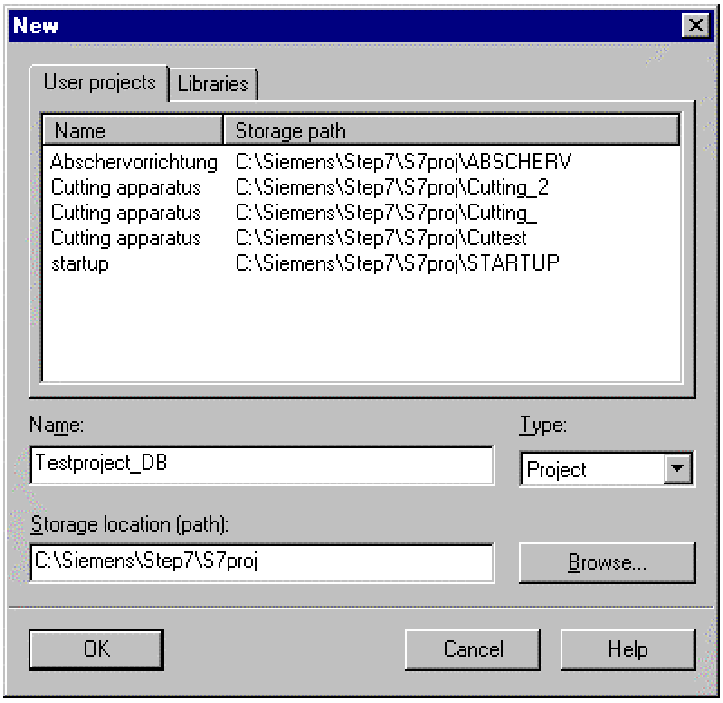
SIMATIC Manager

2. Create a new project (→ File → New)


SIMATIC Manager
File PLC View Options Window Help
New... Ctrl+N
'New Project' Wizard...
Open... Ctrl+O
Open Version 1 Project...
S7 Memory Card
Memory Card File
Delete...
Reorganize...
Manage...
Archive...
Retrieve...
Page Setup...
Labeling fields...
Print Setup...
1 startup (Projekt) -- C:\Siemens\Step7\S7proj\Startup
2 Erreichbare Teilnehmer
3 Abschervorrichtung (Project) -- C:\...\Step7\S7proj\Abscherv
4 startup (Project) -- C:\Siemens\Step7\S7proj\Startup
Exit Alt+F4

Creates a new project or a new library.

3. In the name path, create the project with the name **Testproject_DB**.
(→ 'Testproject_DB' → OK)



New

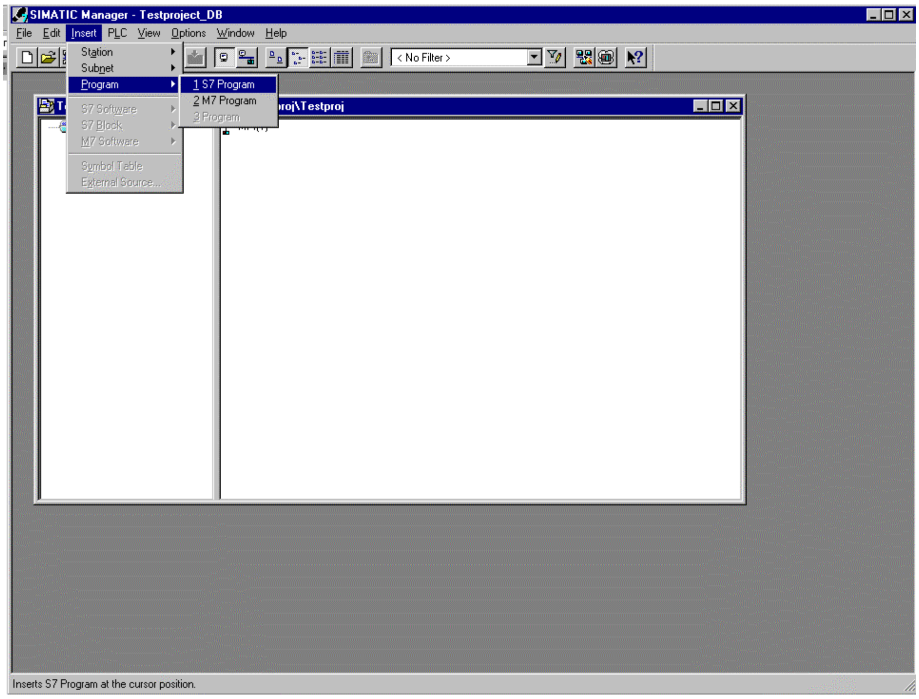
Name	Storage path
Abschervorrichtung	C:\Siemens\Step7\S7proj\ABSCHERV
Cutting apparatus	C:\Siemens\Step7\S7proj\Cutting_2
Cutting apparatus	C:\Siemens\Step7\S7proj\Cutting_
Cutting apparatus	C:\Siemens\Step7\S7proj\Cuttest
startup	C:\Siemens\Step7\S7proj\STARTUP

Name: Testproject_DB

Type: Project

Storage location (path): C:\Siemens\Step7\S7proj

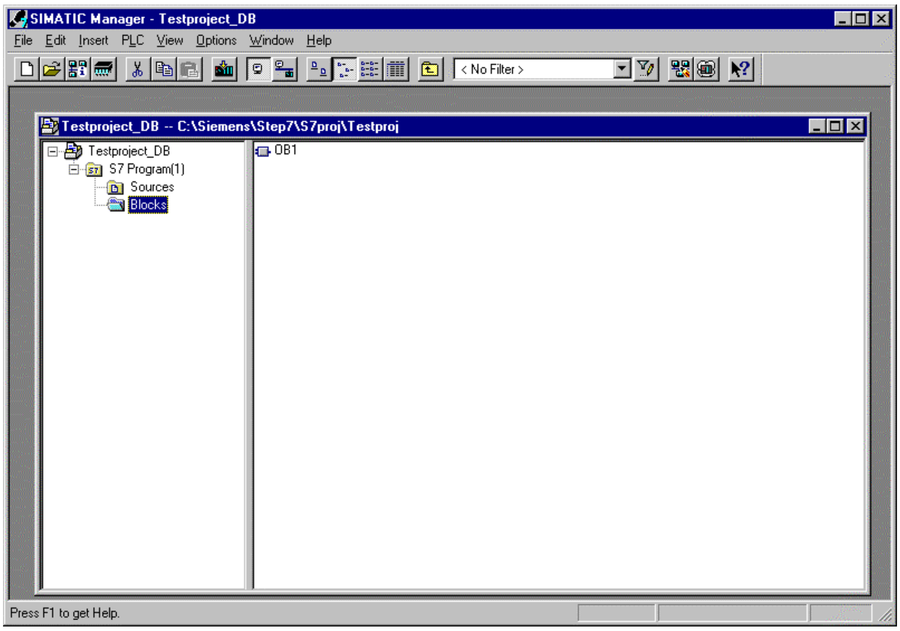
4. Insert a new **S7-Program** (→ Insert → Program → S7-Program).



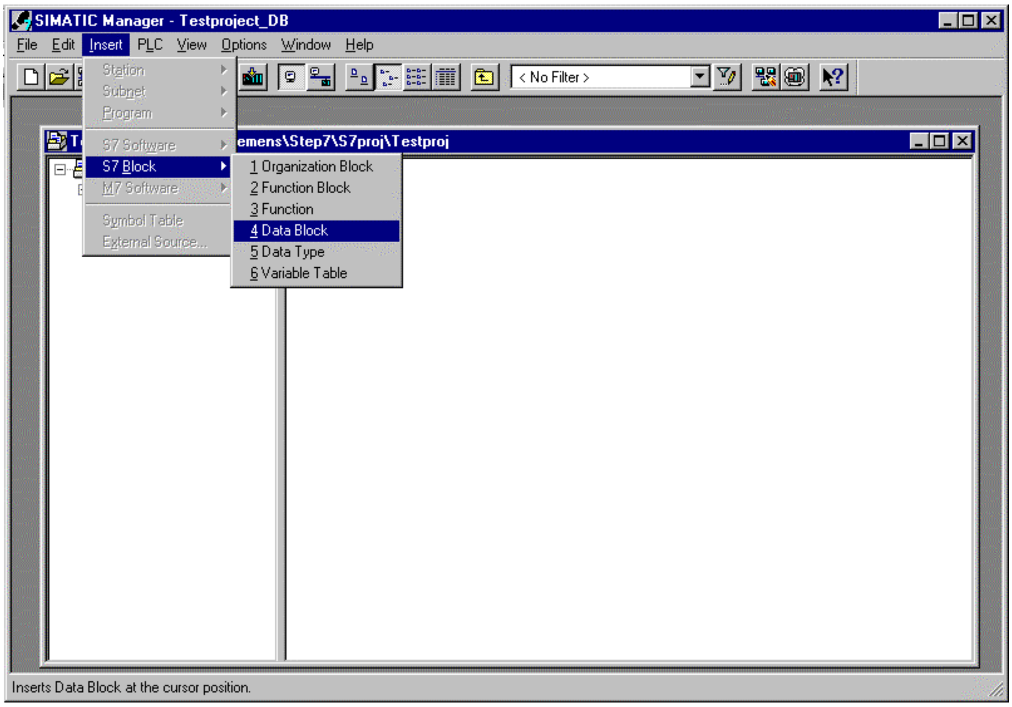
SIMATIC Manager - Testproject_DB

Inserts S7 Program at the cursor position.

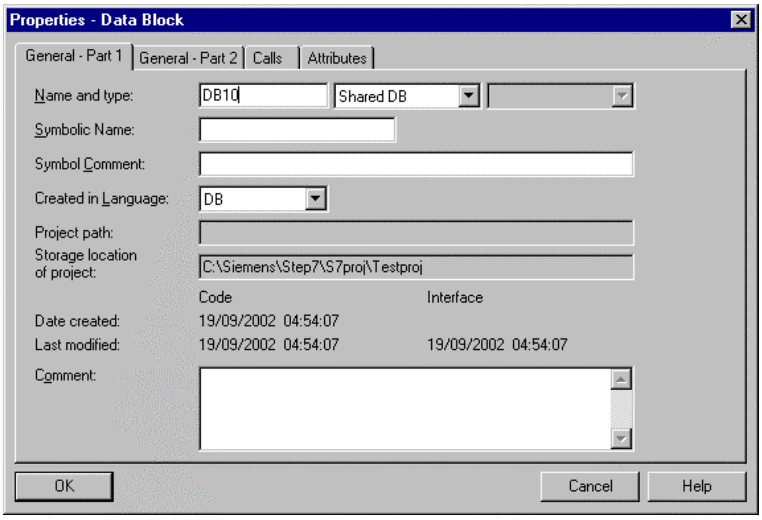
5. Highlight the folder **Blocks**. (→ Blocks)


SIMATIC Manager - Testproject_DB
File Edit Insert PLC View Options Window Help
< No Filter >
Testproject_DB -- C:\Siemens\Step7\S7proj\Testproj
Testproject_DB
S7 Program(1)
Sources
Blocks
OB1
Press F1 to get Help.

6. Insert **Data Block** (→ Insert → S7 Block → Data Block).



7. Enter the number **DB10** for the data block and accept with **OK** (→ DB10 → OK).



Properties - Data Block

General - Part 1 | General - Part 2 | Calls | Attributes

Name and type: DB10 | Shared DB

Symbolic Name:

Symbol Comment:

Created in Language: DB

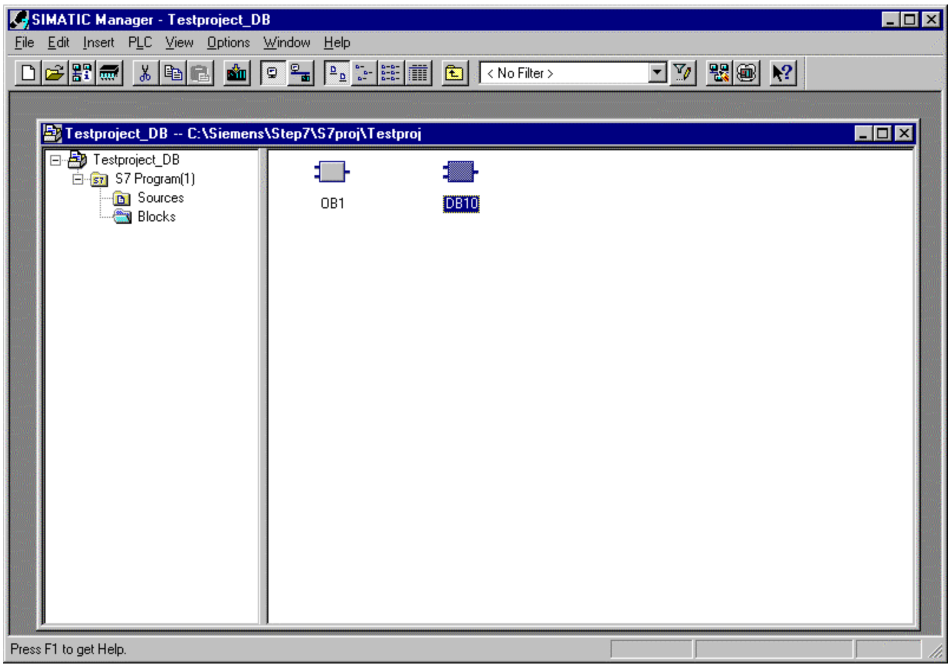
Project path:

Storage location of project: C:\Siemens\Step7\S7proj\Testproj

	Code	Interface
Date created:	19/09/2002 04:54:07	
Last modified:	19/09/2002 04:54:07	19/09/2002 04:54:07

Comment:

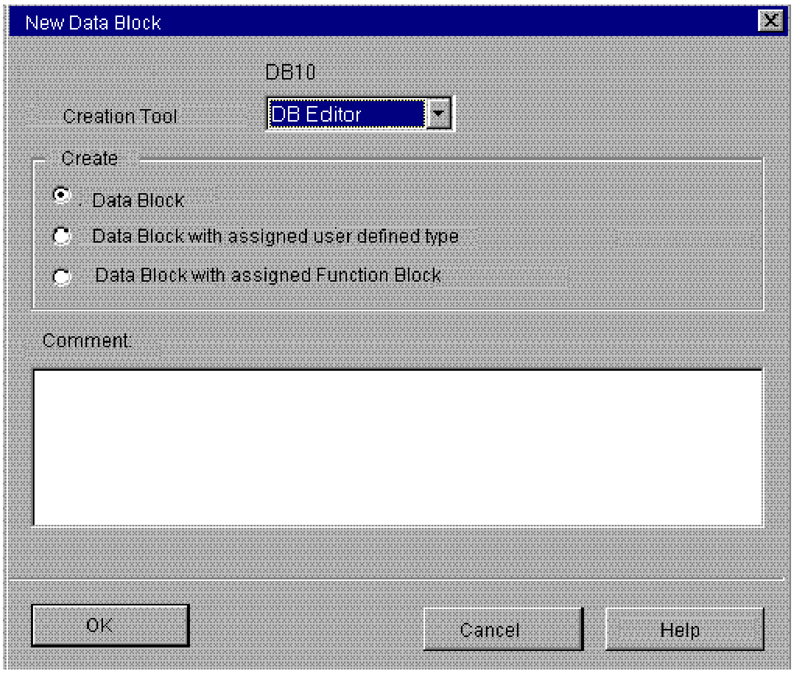
8. Open the data block **DB10** with a double click(→ DB10).



SIMATIC Manager - Testproject_DB

Testproject_DB -- C:\Siemens\Step7\S7proj\Testproj

9. Acknowledge the type of data block. (→ Data Block → OK)



New Data Block

DB10

Creation Tool: DB Editor

Create

● Data Block

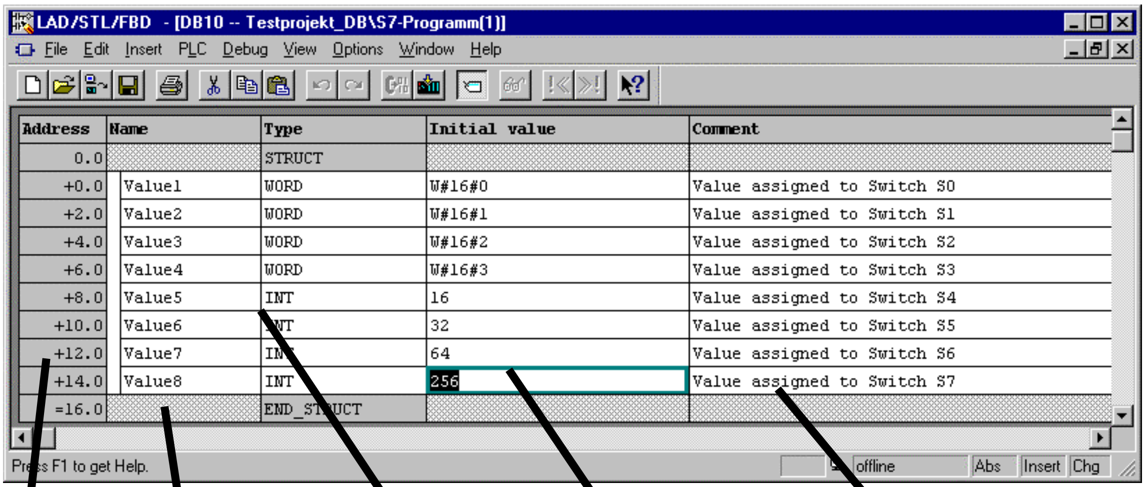
○ Data Block with assigned user defined type

○ Data Block with assigned Function Block

Comment:

Note: Data blocks with an assigned FB are automatically displayed by the call of your associated FB. It makes no sense to create this alone. Data blocks with assigned user defined data types (UDT) are data blocks, whose structure was already assigned in this UDT.

10. The Data Block is generated with a symbol **Name**. The **Type**, an **Initial value** as well as a **Comment** (optional) are entered.
The address is automatically generated and cannot be altered.
The data block can be saved 💾 and downloaded into the PLC 📥. The mode switch on the PLC must be on STOP! (→ Name→ Type → Initial value → Comment → 💾 → 📥)


LAD/STL/FBD - [DB10 -- Testprojekt_DB\S7-Programm(1)]
File Edit Insert PLC Debug View Options Window Help

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Value1	WORD	W#16#0	Value assigned to Switch S0
+2.0	Value2	WORD	W#16#1	Value assigned to Switch S1
+4.0	Value3	WORD	W#16#2	Value assigned to Switch S2
+6.0	Value4	WORD	W#16#3	Value assigned to Switch S3
+8.0	Value5	INT	16	Value assigned to Switch S4
+10.0	Value6	INT	32	Value assigned to Switch S5
+12.0	Value7	INT	64	Value assigned to Switch S6
+14.0	Value8	INT	256	Value assigned to Switch S7
=16.0		END_STRUCT		

Symbolic name which is referenced to the absolute address.

Desired data type (see below) for your data element.

Initial value , to which the data type must be compatible (optional).

Comment for documentation (optional).

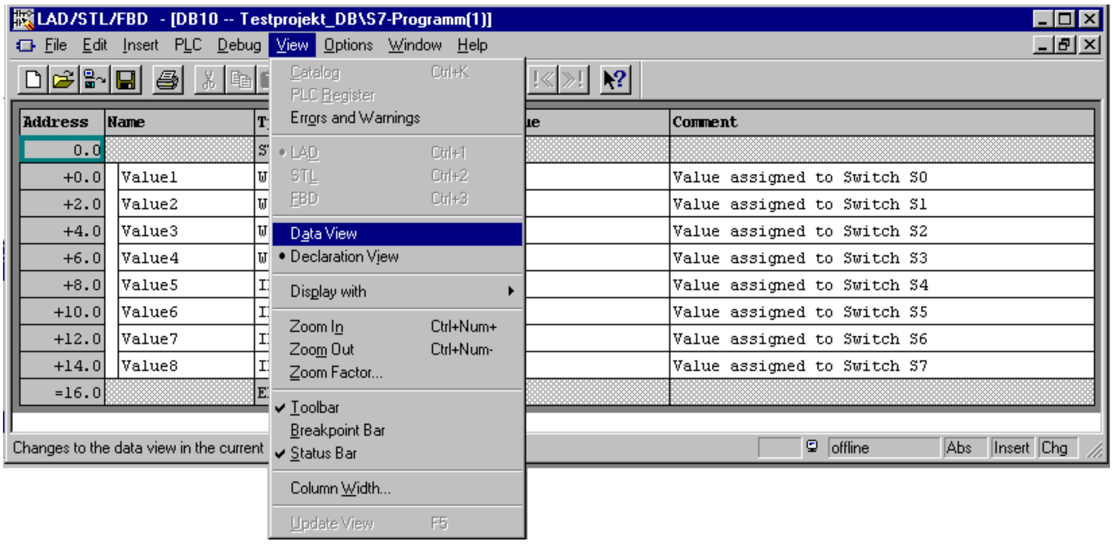
The absolute address is created from STEP 7, when the DB is compiled or saved.
The address format is **BYTE, BIT.**
Over this address, the data elements can also be accessed. (e.g. over download- and compile operations or in logical operations.).

⚠ **Note:** If the data block is assigned as a local instance DB to a FB, the declarations table of the FB declares the structure of the DB.

Data in a data block must be determined through data types.
The following standard- data types are defined in the S7 below :

Type and description	Size in Bits	Format-Options	Range and number notation (lowest to highest values)	Example
BOOL (Bit)	1	Boolean text	TRUE/FALSE	TRUE
BYTE (Byte)	8	Hexadecimal number	B#16#0 to B#16#FF	B#16#10
WORD (Word)	16	Binary number	2#0 to 2#1111_1111_1111_1111	2#0001_0000_0000_0000
		Hexadecimal number	W#16#0 to W#16#FFFF	W#16#1000
		BCD	C#0 to C#999	C#998
		Decimal number unsigned	B#(0,0) to B#(255,255)	B#(10,20)
DWORD (Double word)	32	Binary number	2#0 to 2#1111_1111_1111_1111_1111_1111_1111_1111	2#1000_0001_0001_1000_1011_1011_0111_1111
		Hexadecimal number	DW#16#0000_0000 to DW#16#FFFF_FFFF	DW#16#00A2_1234
		Decimal number unsigned	B#(0,0,0,0) to B#(255,255,255,255)	B#(1,14,100,120)
INT (Integer)	16	Decimal number signed	-32768 to 32767	1
DINT (Int,32 bit)	32	Decimal number signed	L#-2147483648 to L#2147483647	L#1
REAL (Floating-point number)	32	IEEE floating-point number	Upper limit: +/-3.402823e+38 Lower limit: +/-1.175495e-38	1.234567e+13
S5TIME (Simatic-Time)	16	S7-Time in steps of 10 ms	S5T#0H_0M_0S_10MS to S5T#2H_46M_30S_0MS and S5T#0H_0M_0S_0MS	S5T#0H_1M_0S_0MS S5TIME#1H_1M_0S_0MS
TIME (IEC-Date)	32	IEC-Time in steps from 1ms, integer signed	-T#24D_20H_31M_23S_648MS to T#24D_20H_31M_23S_647MS	T#0D_1H_1M_0S_0MS TIME#0D_1H_1M_0S_0MS
DATE (IEC-Date)	16	IEC-Date in steps of 1 day	D#1990-1-1 to D#2168-12-31	DATE#1994-3-15
TIME_OF_DAY (Time)	32	Time in steps of 1ms	TOD#0:0:0.0 to TOD#23:59:59.999	TIME_OF_DAY#1:10:3.3
CHAR (Character)	8	ASCII-Characters	´A´, ´B´ etc.	´B´

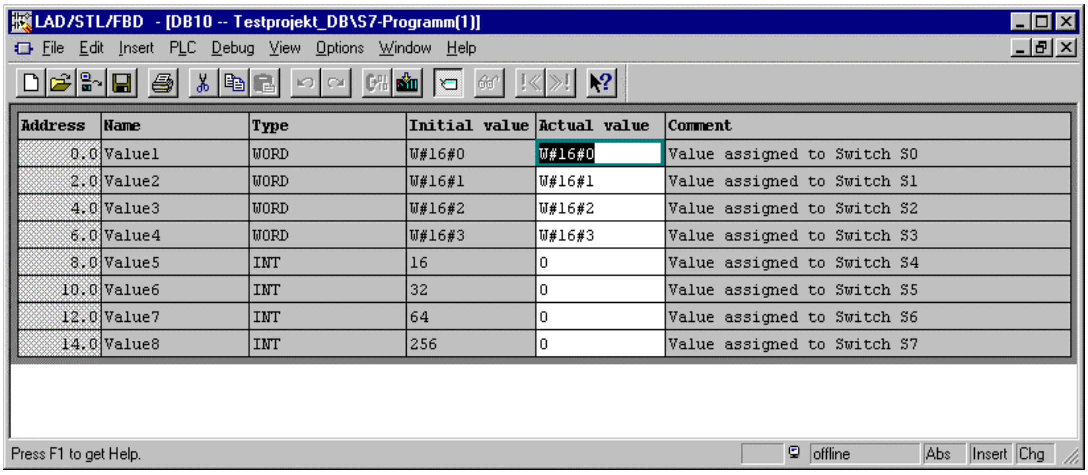
11. Values should be modified in a data block. It is not adequate to modify them in the field **Initial value** . This is only possible, when one switches to the **Data View** under **View** (→ View → Data View).



Address	Name	T	e	Comment
0.0		S		
+0.0	Value1	W		Value assigned to Switch S0
+2.0	Value2	W		Value assigned to Switch S1
+4.0	Value3	W		Value assigned to Switch S2
+6.0	Value4	W		Value assigned to Switch S3
+8.0	Value5	I		Value assigned to Switch S4
+10.0	Value6	I		Value assigned to Switch S5
+12.0	Value7	I		Value assigned to Switch S6
+14.0	Value8	I		Value assigned to Switch S7
=16.0		E		

Changes to the data view in the current

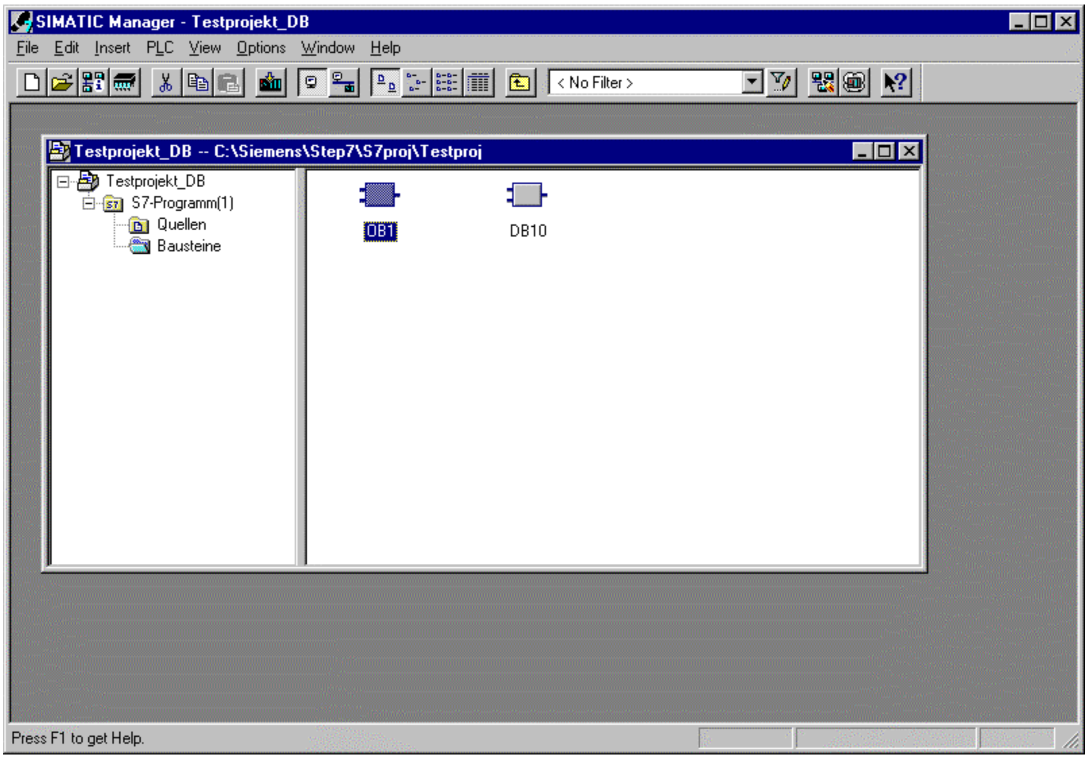
12. Now a new value can be entered in the field **Actual value** and saved onto the hard drive with 💾 as well as downloaded into the CPU with 📥 (→ Actual value → 💾 → 📥).


LAD/STL/FBD - [DB10 -- Testprojekt_DB\S7-Programm(1)]
File Edit Insert PLC Debug View Options Window Help
offline
Abs
Insert
Chg

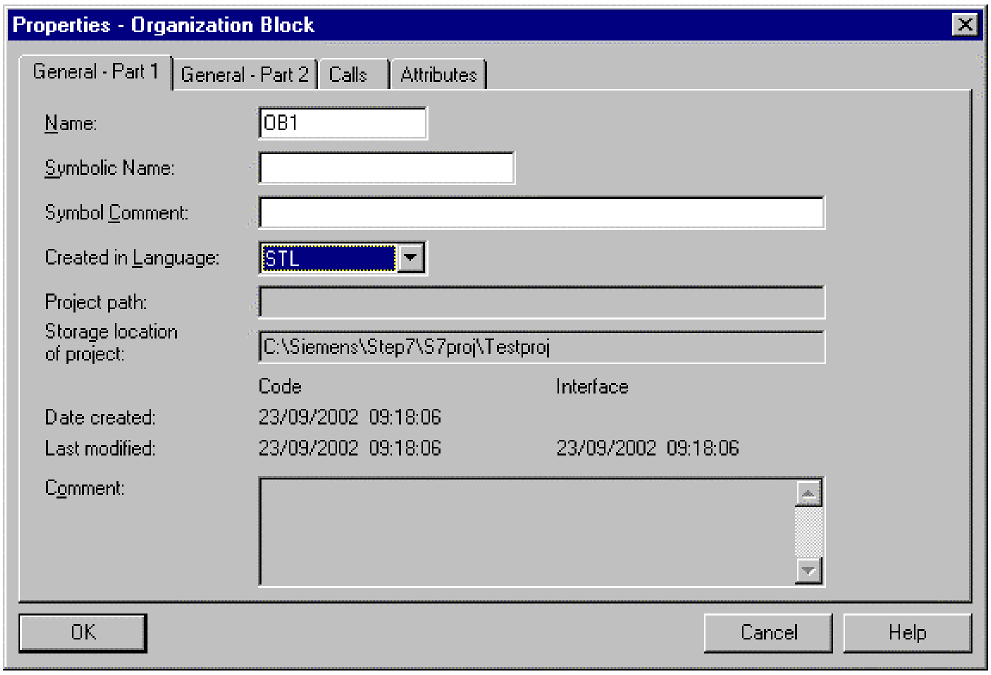
Address	Name	Type	Initial value	Actual value	Comment
0.0	Value1	WORD	W#16#0	W#16#0	Value assigned to Switch S0
2.0	Value2	WORD	W#16#1	W#16#1	Value assigned to Switch S1
4.0	Value3	WORD	W#16#2	W#16#2	Value assigned to Switch S2
6.0	Value4	WORD	W#16#3	W#16#3	Value assigned to Switch S3
8.0	Value5	INT	16	0	Value assigned to Switch S4
10.0	Value6	INT	32	0	Value assigned to Switch S5
12.0	Value7	INT	64	0	Value assigned to Switch S6
14.0	Value8	INT	256	0	Value assigned to Switch S7

Press F1 to get Help.

13. In order to generate the program with the accessible data elements, the **OB1** must be opened through a double click in **SIMATIC Manager** (→ SIMATIC Manager → OB1).


SIMATIC Manager - Testprojekt_DB
File Edit Insert PLC View Options Window Help
< No Filter >
Testprojekt_DB -- C:\Siemens\Step7\S7proj\Testproj
Testprojekt_DB
S7-Programm(1)
Quellen
Bausteine
OB1
DB10
Press F1 to get Help.

14. Then accept the setting with **OK** (→ OK).


Properties - Organization Block

General - Part 1 | General - Part 2 | Calls | Attributes

Name: OB1

Symbolic Name:

Symbol Comment:

Created in Language: STL

Project path:

Storage location of project: C:\Siemens\Step7\S7proj\Testproj

	Code	Interface
Date created:	23/09/2002 09:18:06	
Last modified:	23/09/2002 09:18:06	23/09/2002 09:18:06

Comment:

There are three possibilities to access the data:

1. **Direct address access:**

One can access one data element in a data block with the following instructions:

Example:

L	DB 20. DBB2	Load data byte 2 from DB20 into ACCU 1
L	DB 22. DBW4	Load data word 4 from DB22 into ACCU 1
A	DB 2. DBX5.6	Carry out an AND- logical operation with data bit 5.6 from DB2.

2. **Access to the data elements in the already opened data blocks:**

In order to be able to access a data element over several data elements, the DB must first be opened with the instructions OPN DB or OPN DI. Then several data bits (DBX/DIX),data bytes (DBB/DIB), data words (DBW/DIW) or data double words (DBD/DID) can be processed in digital or binary operations.
In doing so, one especially uses OPN DI for the opening of instance DBs. It can also be used for global DBs, when 2 DBs remain open at the same time.

Example:

OPN	DB 20	Opening of DB20
OPN	DI 22	Opening of DB22
L	DBW 0	Download data word 0 from DB20 into AKKU 1
T	MW 1	Transfer the contents from ACCU 1 to memory bit 1
A	DIX 0.0	AND- Operation from data bit 0.0 to DB22 with
A	I 1.0	input bit 1.0
=	Q 4.0	Assignment of the result to output bit 4.0

3. **Access to data out of local instance DBs by call with the function block:**

Data can be transferred by the call of the corresponding instance data block with the instruction CALL FB1, DB19. The assignment of the variables that would be defined in the declarations table of the FB and whose value stands in the DB, take place directly in the absolute address (e.g. IW0, M 10.0 or QW4) with the CALL instruction.

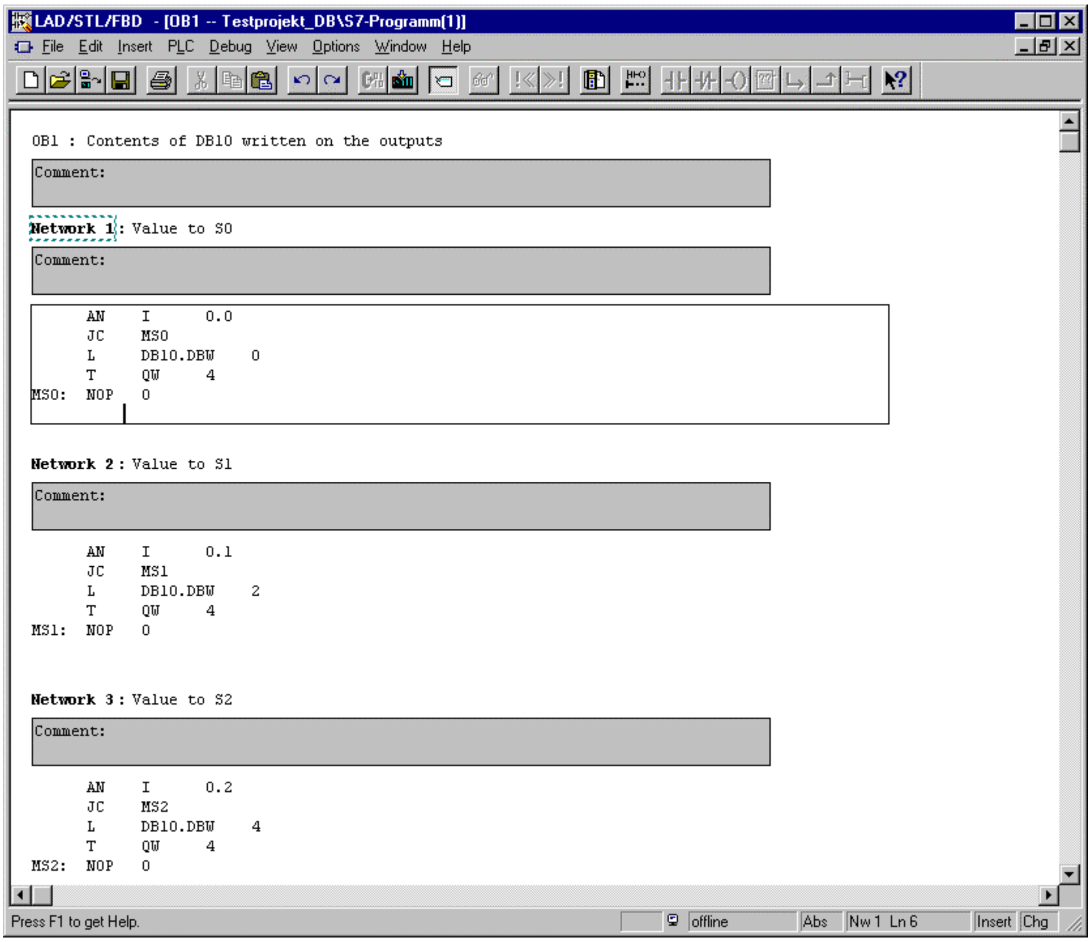
Example:

CALL	FB1, DB19	
COUNT:=	IW 0	The variable COUNT is assigned to IW 0 as an absolute address.
OUT:=	Q 4.0	The variable OUT is assigned to Q4.0 as an absolute address.

Note: The format of the variables and the assigned absolute address must be equal.

15. With **LAD, STL, FBD: Program blocks**, you now have an editor that give you the possibility to generate your STEP 7-Program.
    The schema for the selection of the data element through the button is shown for the first three inputs as specified below.

    If the organization block OB1 is not generated for all switches S0 to S7, it should be saved and downloaded into the PLC. The mode switch of the CPU must be on STOP! (→ →)


LAD/STL/FBD - [OB1 -- Testprojekt_DB\S7-Programm(1)]
File Edit Insert PLC Debug View Options Window Help
Press F1 to get Help.
offline
Abs
Nw 1 Ln 6
Insert
Chg

```
OB1 : Contents of DB10 written on the outputs
Comment:

Network 1: Value to S0
Comment:
      AN    I       0.0
      JC    MS0
      L     DB10.DBW    0
      T     QW      4
MS0:  NOP   0

Network 2 : Value to S1
Comment:
      AN    I       0.1
      JC    MS1
      L     DB10.DBW    2
      T     QW      4
MS1:  NOP   0

Network 3 : Value to S2
Comment:
      AN    I       0.2
      JC    MS2
      L     DB10.DBW    4
      T     QW      4
MS2:  NOP   0
```

16. Through the switching of the key switch to RUN, the program is started.
    If only one of buttons S0 to S7 is activated through inching, the display of the value in the data block that is assigned takes place on the output module with the address QW4.

Forward	Notes	**Generating data blocks**