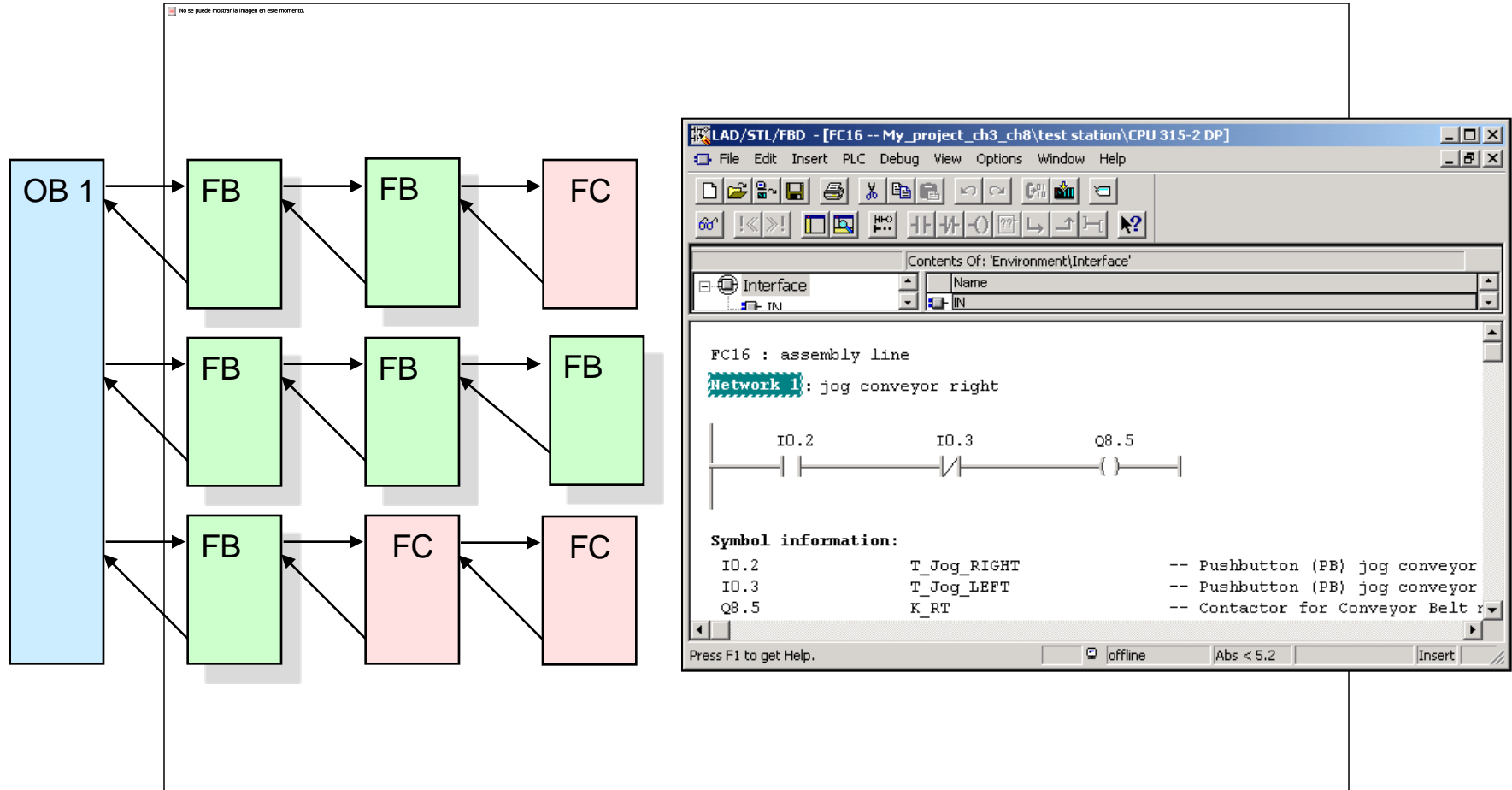


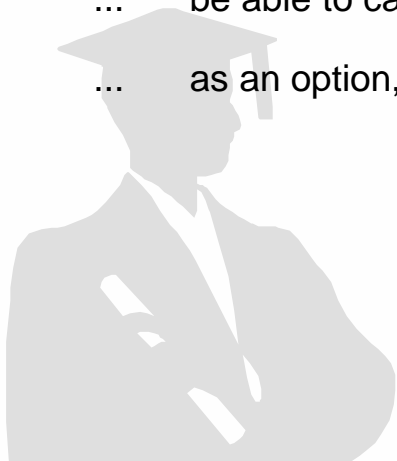
# Block Architecture and the LAD / STL / FBD Editor



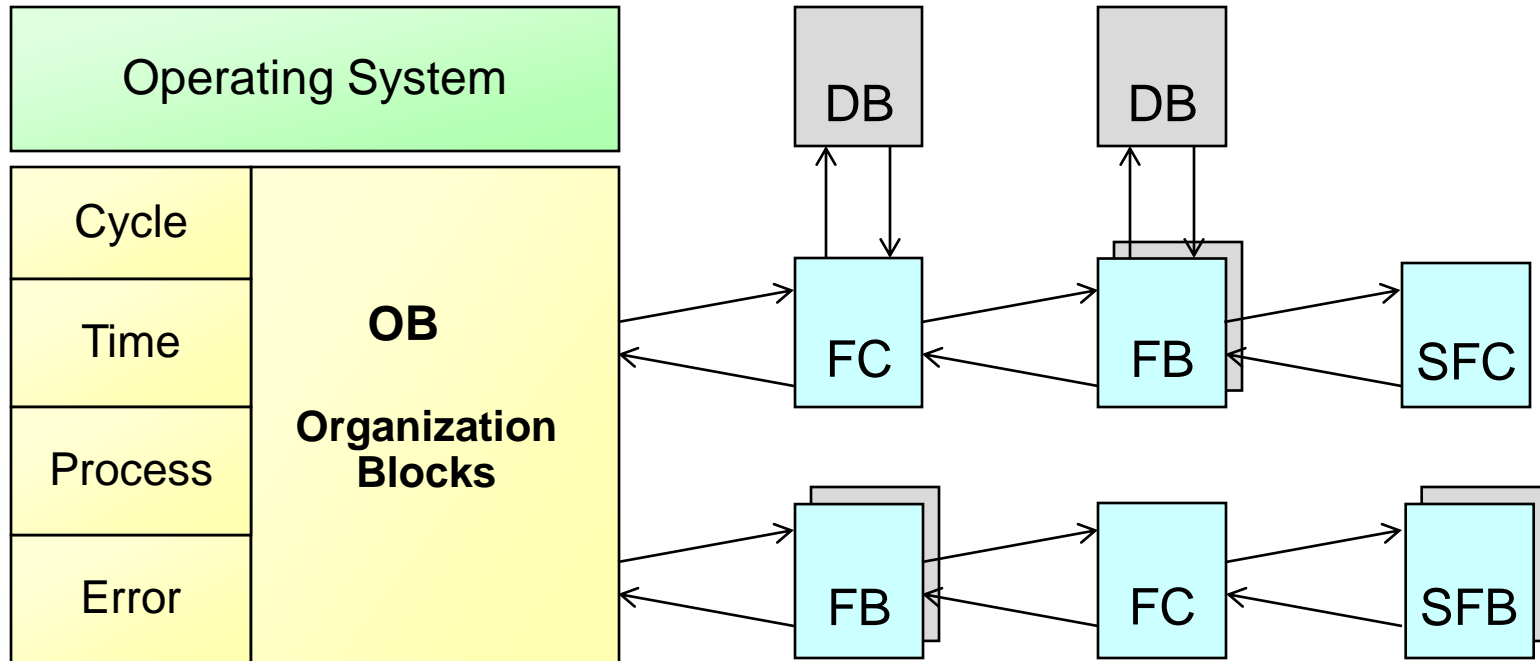
# Objectives

## Upon completion of this chapter the participant will ...

- ... know the different types of S7 blocks
- ... understand the principle of "structured programming"
- ... know the meaning of the process images (PII, PIQ)
- ... be able to explain the principle of cyclic program execution
- ... know and be able to select the LAD, FBD and STL programming languages
- ... be able to edit, save and download a block with the LAD/STL/FBD Editor
- ... be able to carry out a simple program debugging with the "Monitor Block" test function
- ... as an option, be able to make customizations to the LAD/FBD/STL Editor

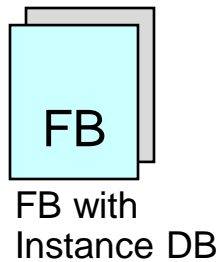


# Types of Program Blocks



Legend:

- OB = Organization Block
- FB = Function Block
- FC = Function
- SFB = System Function Block
- SFC = System Function
- DB = Data Block



Maximum nesting depth:

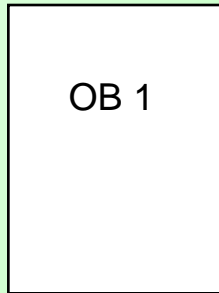
S7-300: 8 (16 for CPU 318)

S7-400: 24

(for each priority class,  
2 to 4 additional levels for Error OBs)

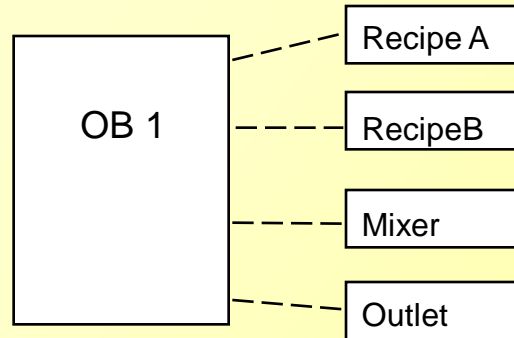
# Program Structuring Possibilities

## Linear Program



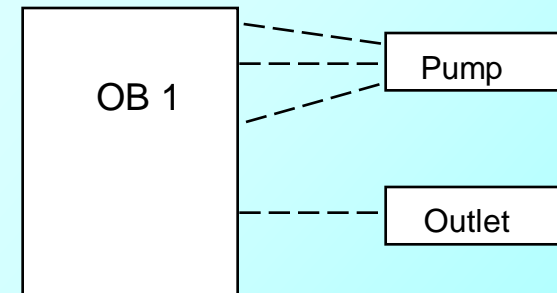
All instructions are found in one block (usually in Organization Block OB 1)

## Program Partitioned into Areas



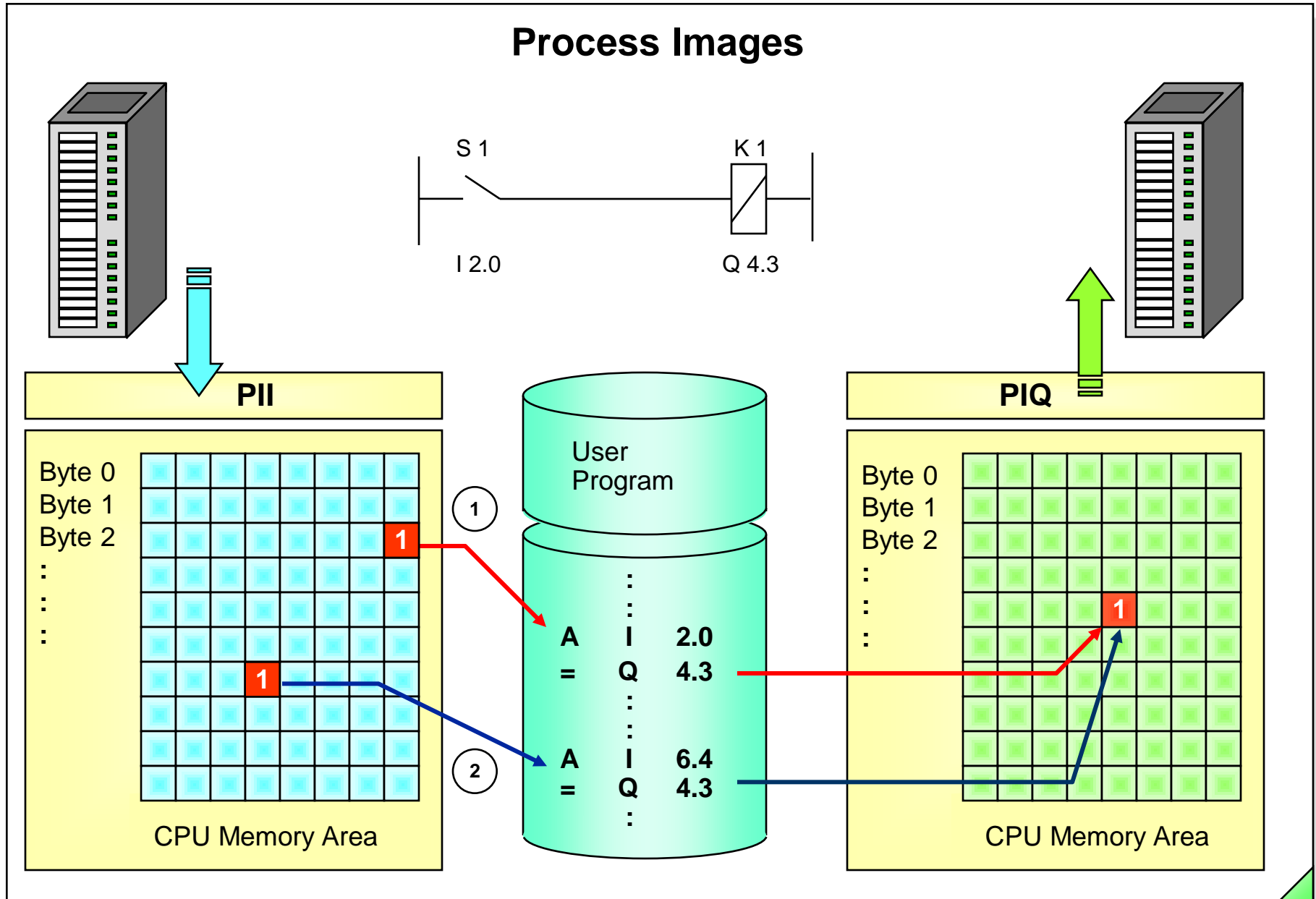
The instructions for the individual functions are found in individual blocks. OB 1 calls the individual blocks one after the other.

## Structured Program



Reusable functions are loaded into individual blocks. OB 1 (or other blocks) call these blocks and pass on the pertinent data.

# Process Images



# Cyclic Program Execution

Before October 1998

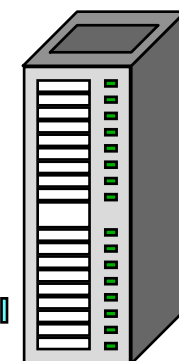
- Startup program: Call and execution of OB 100 (once, after Power ON, for example)
- Transfer PIQ to the digital output modules

Start of the cycle monitoring time

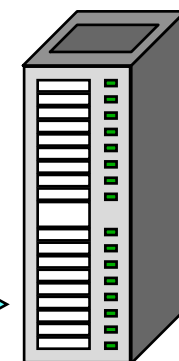
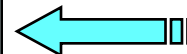
Reading the input states from the digital input modules and saving the states in the process image (PII)

Call and execution of OB1  
(possible interruption by call of other OBs for events such as time-of-day interrupt, hardware interrupts etc. )

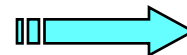
Writing the process-image output table (PIQ) in the digital output modules



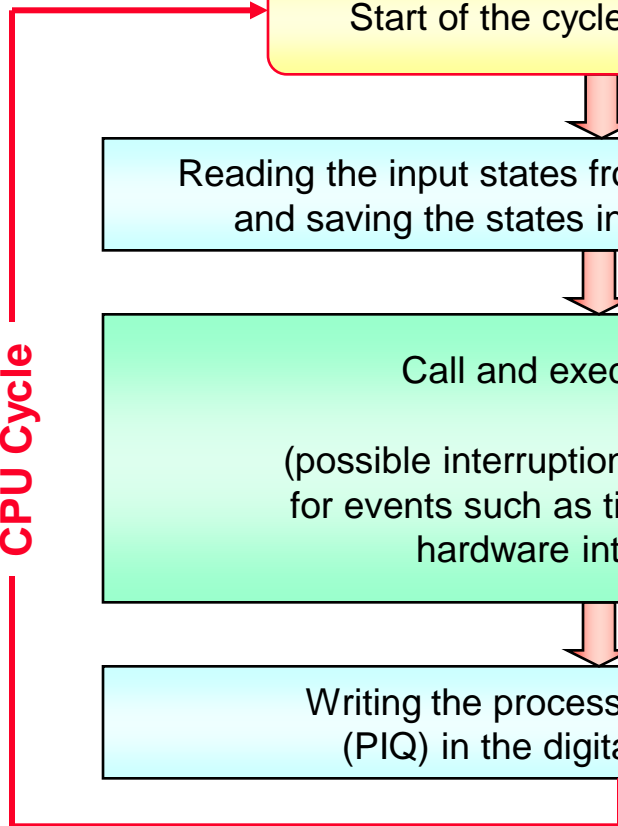
digital input module



digital output module

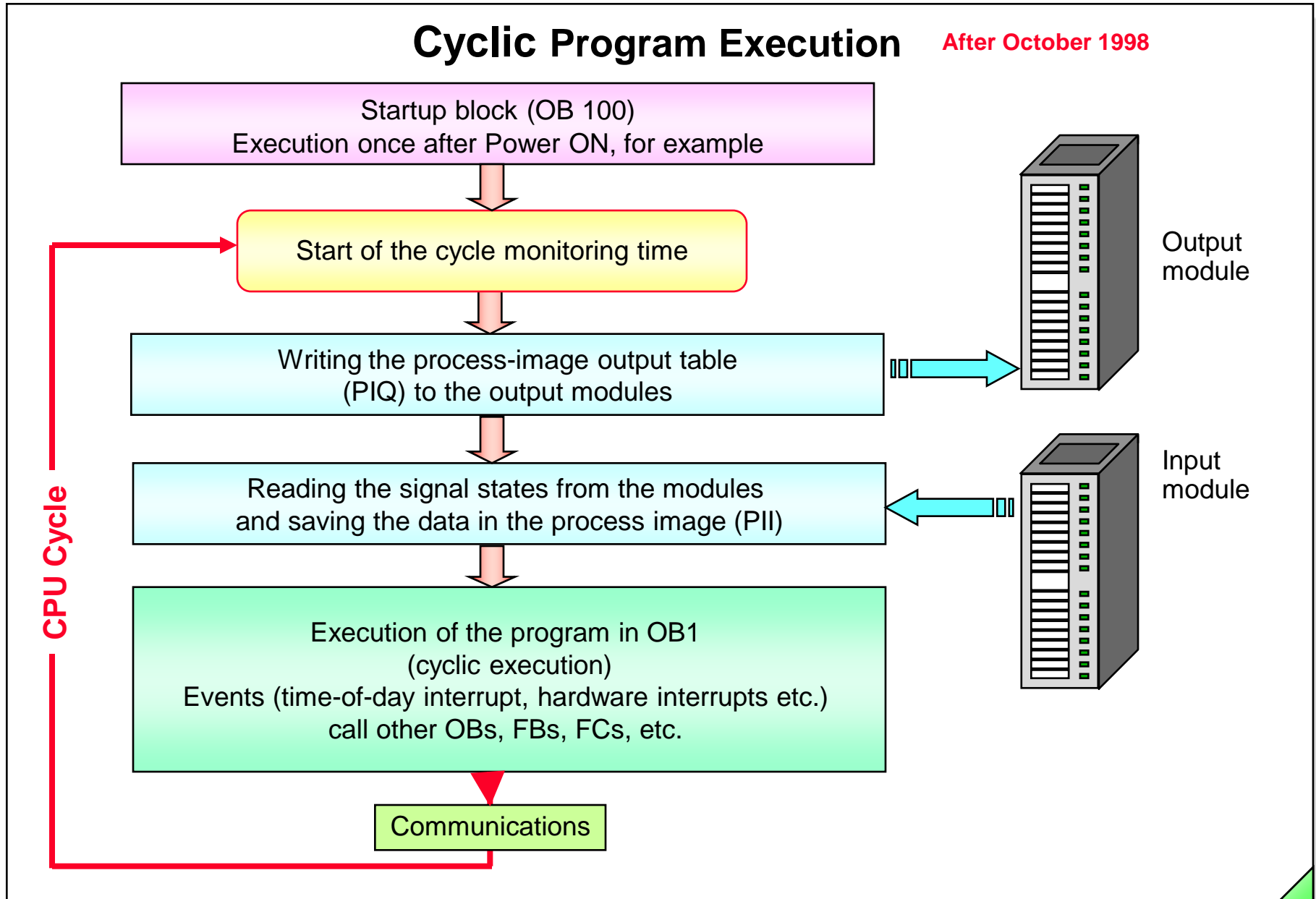


CPU Cycle



# Cyclic Program Execution

After October 1998



# Inserting an S7 Block

The screenshot shows the SIMATIC Manager interface with the 'Properties - Function' dialog box open. The 'Name' field is set to 'FC1'. The 'Created in Language' is set to 'STL'. The 'Storage location of project' is 'D:\S7\_Courses\My\_Proje'. The 'Date created' and 'Last modified' are both '10/12/2006 02:25:42 PM'. The 'Comment' field is empty. The 'OK', 'Cancel', and 'Help' buttons are visible at the bottom of the dialog box.

Inserts Function at the cursor position.

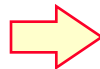


# The LAD / STL / FBD Editor

Declaration Table



Code Section



Detail Window



The screenshot shows the LAD/STL/FBD Editor interface for a program named 'FC1 -- test\S7 Program(1)'. The interface includes a menu bar (File, Edit, Insert, PLC, Debug, View, Options, Window, Help), a toolbar, and a main workspace. The workspace is divided into three main sections:

- Declaration Table:** Located at the top, it shows the contents of the 'Environment\Interface'. It lists variables: IN, OUT, IN\_OUT, TEMP, and RETURN.
- Code Section:** The main workspace displays ladder logic. It shows 'Network 1' with a normally open contact for I0.0, a normally closed contact for I0.1, and a coil for Q4.1. Below it, 'Network 2' is labeled 'Always OFF bit' and shows a normally open contact for M0.0 and a coil for M0.0.
- Detail Window:** Located at the bottom, it displays a table of variable declarations.

Address	Block	Type	Location	Location	Location
I 0.0	FC1	R	NW 1	/O	
I 0.1	FC1	R	NW 1	/A	
Q 4.1	FC1	W	NW 1	/=	

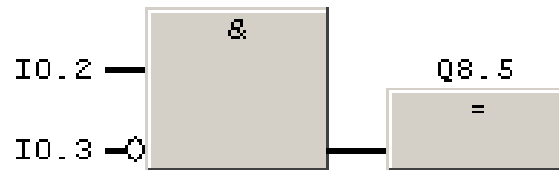
At the bottom of the interface, there is a status bar with navigation buttons (1: Error, 2: Info, 3: Cross-references, 4: Address info., 5: Modify, 6: Diagnostics, 7: Com) and a footer that says 'Press F1 to get Help.' and 'offline Abs < 5.2 Insert'.

# The STEP 7 Programming Languages

## Function Block Diagram

FC16 : Conveyor Control

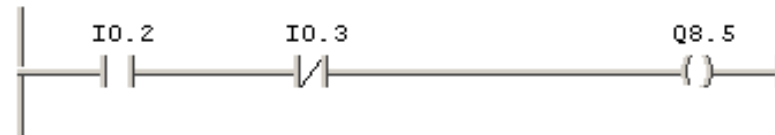
**Network 1** : Jog Conveyor RIGHT



## Ladder Diagram

FC16 : Conveyor Control

**Network 1** : Jog Conveyor RIGHT



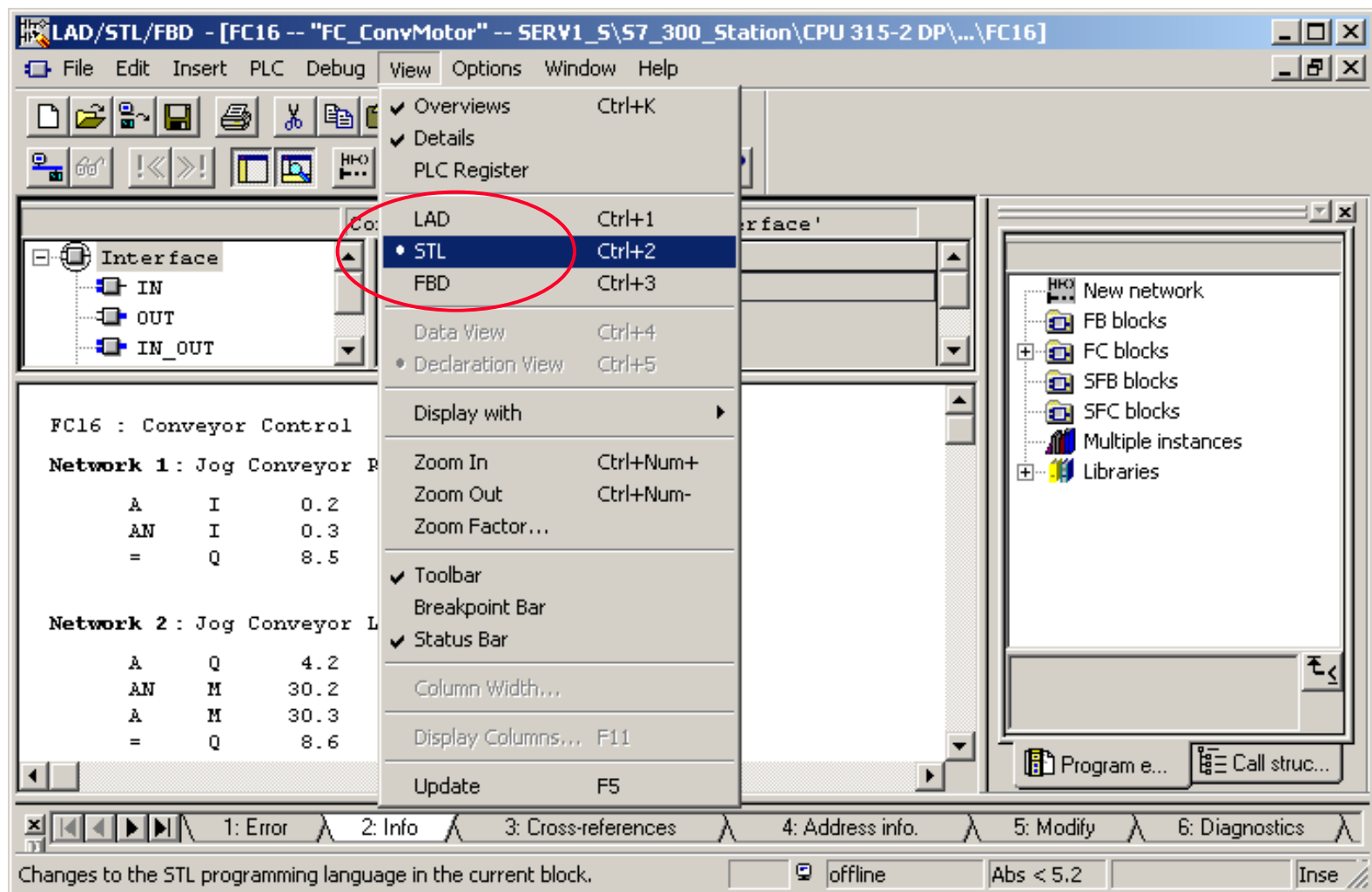
## Statement List

FC16 : Conveyor Control

**Network 1** : Jog Conveyor RIGHT

A	I	0.2
AN	I	0.3
=	Q	8.5

## Selecting the Programming Language



# Programming in LAD and FBD

The screenshot shows the SIMATIC Manager software interface for LAD programming. The main window displays a ladder logic network with the following components:

```

Network 1: System ON/OFF

|M_System_ON_HMI| |M_Aux_System_ON| S |L_SYSTEM_SR| Q
|-----| |-----| (P)-----|-----|-----|
|M_System_OFF_HMI|-----R-----|
    
```

**Symbol information:**

M_System_ON_HMI	M30.0
M_Aux_System_ON	M15.1
L_SYSTEM	Q4.1
M_System_OFF_HMI	M30.1

The **Overviews** dialog box is open, showing a list of logic elements for insertion. A red arrow points from the 'Insert / Cp' button in the bottom right corner to the 'Bit logic' section of the dialog. The 'Bit logic' section includes:

- Bit logic
- | |--
- |/|--
- |NOT|--
- ()
- (#)--
- (R)
- (S)
- R5
- SR
- (N)--
- (P)--
- (SAVE)
- NEG
- POS

The 'Comparator' section is also visible below the 'Bit logic' section.

# Programming in STL

Contents Of: 'Environment\Interface'

Name
IN
OUT
IN_OUT
TEMP
RETURN

```

FC1 : System
Network 1: System ON/OFF
  A   I   0.0
  S   Q   8.0
  AN  I   0.1
  R   Q   8.0
  NOP 0
  
```

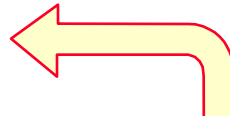
Program elements | Call structure

1: Error | 2: Info | 3: Cross-references | 4: Address info. | 5: Modify | 6: Diagnostics | 7: Comparison

Press F1 to get Help. | offline | Abs < 5.2 | Nw 1 Ln 6 | Insert Chg

# Saving a Block

Current project directory with block name



The screenshot shows the SIMATIC Manager interface. The title bar indicates the project path: [FC1 -- My\_Project\SIMATIC 300(1)\CPU 315-2 DP]. The 'File' menu is open, and a red arrow points to it from the text above. The main workspace displays a ladder logic network for 'Network 1: System ON/OFF'. The network contains a set coil (S) for output Q8.0, triggered by input I0.0 (normally open contact) and input I0.1 (normally closed contact). The coil is labeled 'SR' (Set Reset) and 'Q'. The status bar at the bottom shows 'offline', 'Abs < 5.2', 'Nw 1 Ln 6', and 'Insert Chg'.

# Calling a Block in OB1

LAD/STL/FBD - [OB1 -- My\_Project\SIMATIC 300(1)\CPU 315-2 DP]

File Edit Insert PLC Debug View Options Window Help

OB1 : Cyclic Program Operation

Network 1: Call FC1 in LAD

Network 2: Call FC1 in STL

```
CALL FC 1
```

FC1

- Move
- Program control
- Shift/Rotate
- Status bits
- Timers
- Word logic
- FB blocks
- FC blocks
  - FC1
  - FC14
  - FC15
  - FC16
  - FC17
  - FC18
  - FC19
  - FC42
- SFB blocks

Program elements Call structure

BLOCK\_FC

1: Error 2: Info 3: Cross-references 4: Address info. 5: Modify 6: Diagnostics 7: Comparison

Press F1 to get Help. offline Abs < 5.2 Nw 1 Insert Chg

# Downloading Blocks into the PLC

The screenshot shows the SIMATIC Manager interface. On the left, a project tree displays the hierarchy: My\_Project > SIMATIC 300(1) > CPU 315-2 DP > S7 Program(5) > Blocks. The main window displays a table of objects:

Object name	Symbolic name	Created in language	Size in the work me...
System data	---	---	---
OB1	OB_Cycle	LAD	68
FC1		LAD	48
FC14	FC_Signal	FBD	124
FC15	FC_Mode	FBD	104
FC16	FC_ConvMotor	FBD	100
FC17	FC_Fault	FBD	64
FC18	FC_Count	FBD	64
FC19	FC_Count_Add	FBD	112
FC42	FC_MM420	FBD	102
I/O Conveyor	VAT_I/O_conveyor		---

A red arrow points from the 'Blocks' folder in the project tree to a download icon (a square with a downward arrow and a PLC symbol) located to the right of the table. The status bar at the bottom of the window shows 'CP5611(MPI)'.





# Simple Program Debugging

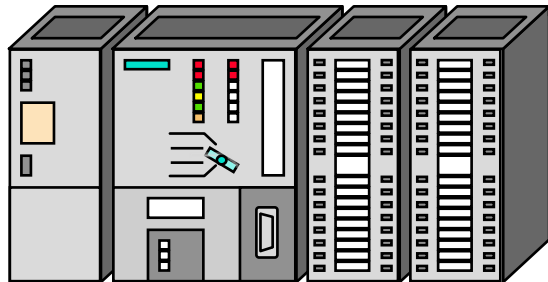
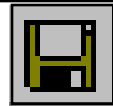
The screenshot displays the SIMATIC Manager interface for a SIMATIC 300(1) CPU 315-2 DP. The main window shows the LAD/STL/FBD editor in 'ONLINE' mode. The title bar reads 'LAD/STL/FBD - [FC1 -- My\_Project\SIMATIC 300(1)\CPU 315-2 DP ONLINE]'. The toolbar includes a red arrow pointing to the 'ONLINE' button. The main workspace shows a ladder logic network for 'System ON/OFF' with inputs I0.0 and I0.1, and an SR coil Q8.0. The status bar at the bottom indicates 'RUN' mode and 'Abs < 5.2 Nw 1 Rd'.

# Downloading and Saving Modified Blocks



Open offline

Save



Open online

Download



The screenshot shows the SIMATIC Manager software interface. The title bar reads "LAD/STL/FBD - [FC1 -- My\_Project\SIMATIC 300(1)\CPU 315-...". The menu bar includes File, Edit, Insert, PLC, Debug, View, Options, Window, and Help. The toolbar contains various icons for file operations and navigation. The main workspace displays a ladder logic diagram for "FC1 : System" with "Network 1" selected. The network contains a Set-Reset (SR) coil for output Q8.0. The coil is set by input I0.0 (normally closed) and reset by input I0.1 (normally open). The status bar at the bottom shows "Press F1 to get Help." and a tabbed interface with "1: Error", "2: Info", "3: Cross-references", and "4: A".

# Exercise 1: Jogging the Conveyor Motor (FC 16)

The screenshot displays the SIMATIC Manager software interface for editing a Ladder Logic (LAD) program. The title bar indicates the program is "FC16 -- testS7 Program(1)". The menu bar includes File, Edit, Insert, PLC, Debug, View, Options, Window, and Help. The toolbar contains various icons for editing and execution.

The project tree on the left shows a "New network" folder containing "Bit logic". The main workspace displays the Ladder Logic for "FC16 : Conveyor Movement".

**Network 1 : Jog Conveyor RIGHT**

The logic for Network 1 consists of a normally closed contact labeled I0.2 in series with a normally open contact labeled I0.3, leading to a coil (output) labeled Q8.5.

**Network 2 : Jog Conveyor LEFT**

The logic for Network 2 consists of a normally open contact labeled I0.3 in series with a normally closed contact labeled I0.2, leading to a coil (output) labeled Q8.6.

The status bar at the bottom shows "offline" and "Abs < 5.2".

## Exercise 2: Calling FC 16 in OB 1

The screenshot displays the SIMATIC Manager interface for editing a cyclic program operation (OB1). The title bar indicates the project path: "LAD/STL/FBD - [OB1 -- 'OB\_Cycle' -- My\_Project\SIMATIC 300(1)\CPU 315-2 DP\...\OB1]". The menu bar includes File, Edit, Insert, PLC, Debug, View, Options, Window, and Help. The toolbar contains various editing tools.

The left-hand pane shows a project tree with the following structure:

- Shift/Rotate
- Status bits
- Timers
- Word logic
- FB blocks
- FC blocks
  - FC1
  - FC14 FC\_Signal
  - FC15 FC\_Mode
  - FC16 FC\_ConvMotor** (highlighted with a red arrow)
  - FC17 FC\_Fault
  - FC18 FC\_Count
  - FC19 FC\_Count\_Add
  - FC42 FC\_MM420
- SFB blocks
- SFC blocks
- Multiple instances
- Libraries

The main editing area shows "OB1 : Cyclic Program Operation" with "Network 1: Control of conveyor" selected. The network diagram consists of a single call to the function block "FC\_ConvMotor", with "EN" on the left and "ENO" on the right.

Below the network diagram, the "Symbol information:" table is displayed:

Symbol	Address	Description
FC_ConvMotor	FC16	-- FC Control of conveyor motor

The bottom status bar includes navigation buttons (1: Error, 2: Info, 3: Cross-references, 4: Address info., 5: Modify, 6: Diagnostics, 7: Comparison), a "Press F1 to get Help." message, and system indicators for "offline" status and "Abs < 5.2".

## If You Want to Know More



## Editor Customization: "General" Tab

The screenshot displays the SIMATIC Manager editor interface. The main window shows a ladder logic network for a system ON/OFF control. The network is titled "Network 1: System ON/OFF". It features a set coil (S) for "T\_System\_ON" (IO.0) and a reset coil (R) for "T\_System\_OFF" (IO.1) connected to a set/reset coil (SR) for output Q8.0. The SR coil is connected to the output Q8.0. The network is part of a function block FC1: System.

The "Customize" dialog box is open, showing the "General" tab. The dialog has several sections:

- Font:** Font: Courier New, Font Size: 8, Select...
- Further options:**
  - Report cross-accesses as error
  - Save window arrangement on exit
  - Set network title automatically
- Program status:**
  - Control at Contact
  - Automatic Program Status Change on Blocks
  - Terminate ONLINE connection after program status
  - Time Lag: 5 (0 - 60) seconds
- Mnemonics (Change: SIMATIC Manager Options>Customize):** English

The dialog box has buttons for OK, Abbrechen, and Hilfe. The status bar at the bottom of the editor shows "Changes various individual settings of this application."

# Editor Customization: "View " Tab

The screenshot displays the SIMATIC Manager software interface. In the background, a ladder logic network is visible for 'Network 1: System ON/OFF'. It features a set/reset coil (SR) with address Q8.0. The coil is set by two normally open contacts labeled 'T\_System\_ON' and reset by one normally closed contact labeled 'T\_System\_OFF'. Below the network, a 'Symbol information' table is shown:

Symbol information:			
T_System_ON	I0.0	--	Momentary
T_System_OFF	I0.1	--	Momentary

The 'Customize' dialog box is open, with the 'View' tab selected. The 'View after Block Open' section contains the following settings:

- Symbolic representation
- Symbol information
  - With text color: [Green color swatch] [Select...]
- Automatic symbol selection (for LAD/FBD)
  - Sorting of selection list by: [Symbol]
- Block/network comments
- Address identification
  - Permanently forced addresses (FORCE)
  - Process diagnostic addresses (PDIAG)
- With background color: [Red color swatch] [Select...]

The 'View for Block Types' section contains the following settings:

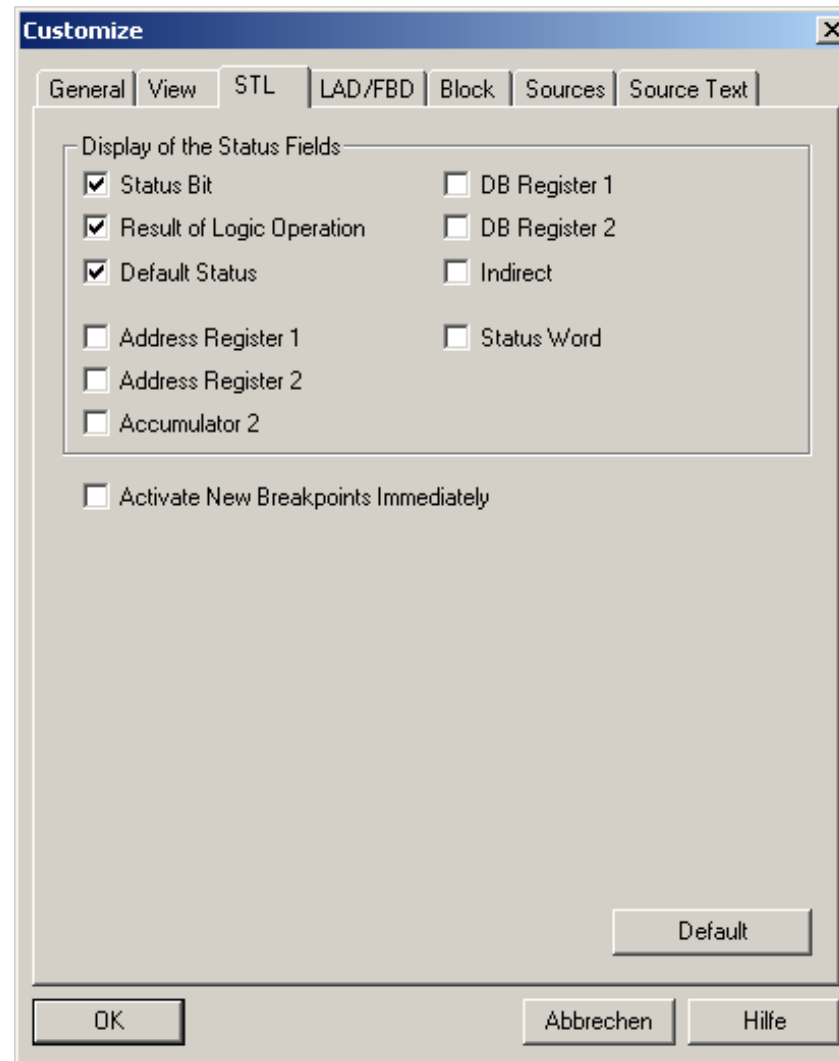
- Logic Blocks: [LAD]
- Data Blocks: [Declaration View]

The 'Program element overview' section contains the following settings:

- Project: [Type and number]
- Libraries: [Type and number]

At the bottom of the dialog, there are buttons for 'OK', 'Abbrechen', and 'Hilfe'. A red arrow points from the 'Customize...' menu item to the 'Customize' dialog box.

## Editor Customization: "STL" Tab





## Editor Customization: "LAD/FBD" Tab

**Customize** [X]

General | View | STL | **LAD/FBD** | Block | Sources | Source Text

Layout:  Address Field Width:  (10 - 26)

Element Representation:

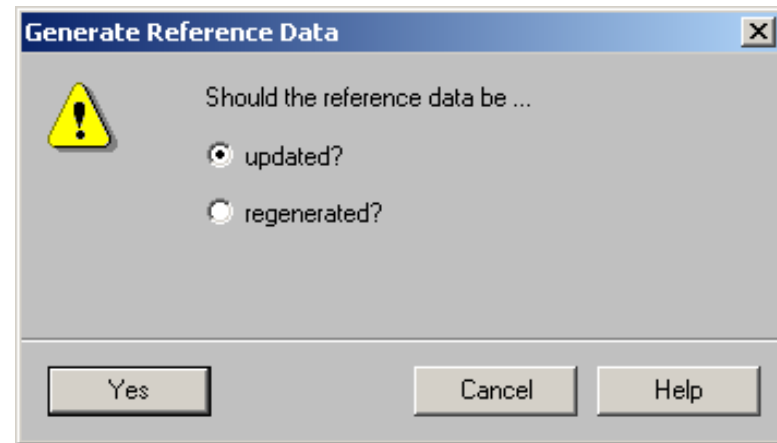
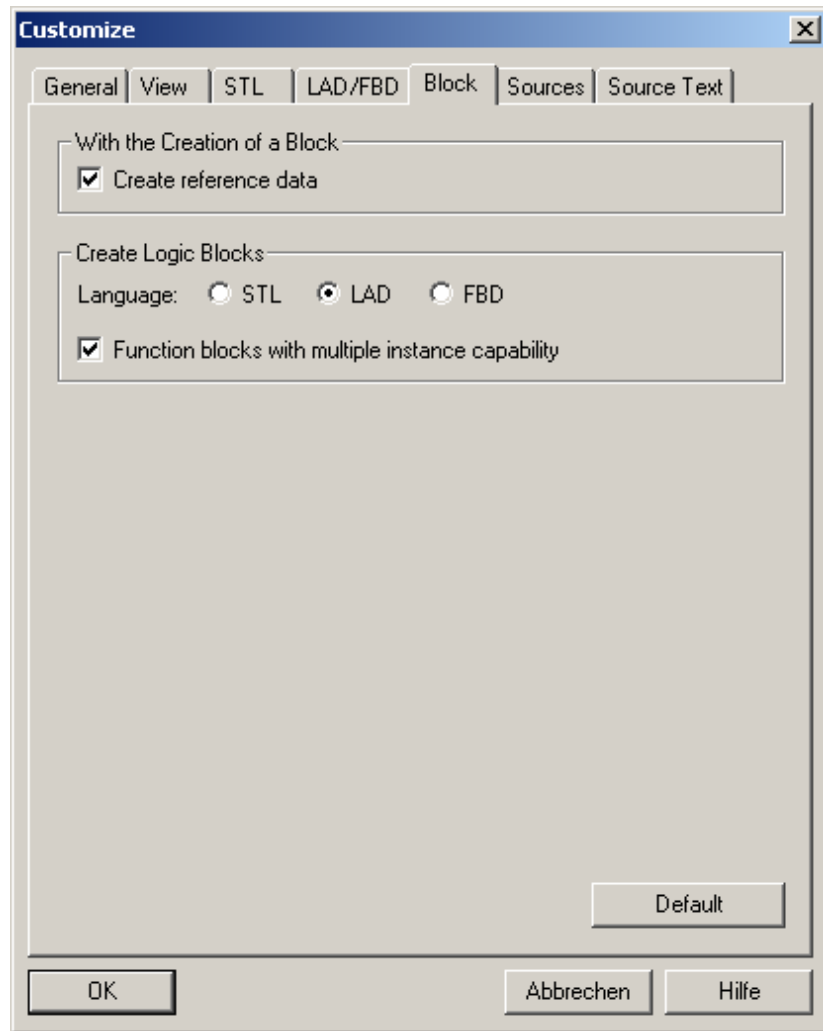
Line/Color Reference:

Line Weight:  Narrow  Medium  Wide

Color:

Type Check of Addresses  
 Display symbol information at address

## Editor Customization: "Block" Tab



## Editor Customization: "Sources/Source Text" Tab

