Case 3.2
“SFC with SIMATIC S7-Graph“

In Case 3.1 you worked with SIEMENS SIMATIC Industrial software and learned to create Sequential Function Charts (SFC) with the Step7-GRAPH. This exercise is to deepen your skills in developing Sequential Function Charts with S7-GRAPH by the basis of a different example.

1 Problem definition

1.1 Learning goals

- After this exercise you will be able to use the basic functions of the SIMATIC Manager,
- develop common SFC projects with SIMATIC S7-GRAPH and
- run a simulation of your project with S7-PLCSIM.

1.2 Organization and procedure

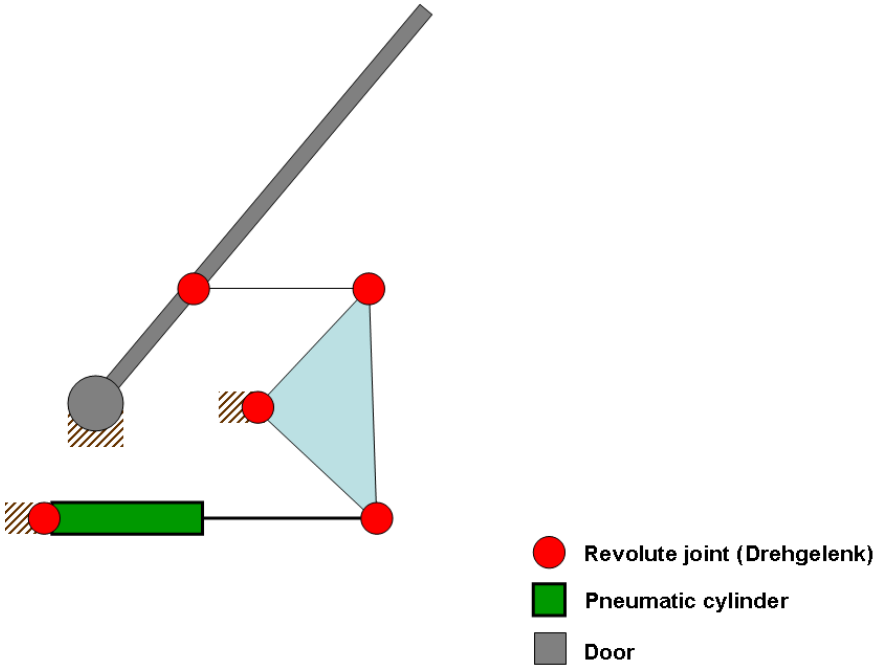
You have 90 min to solve the case. Proceed according to the following pattern:

0. Read the entire set of task ..... 5’
1. Solve the task “Drawing a flowchart” ..... 10’
2. Solve the task “Path-step diagram” ..... 10’
3. Solve the task “SIMATIC Manager” ..... 10’
4. Solve the task “Creating a SFC with S7-GRAPH” ..... 40’
5. Solve the task “Simulating with S7-PLCSIM” ..... 15’

2 Tasks

2.1 Drawing a flowchart

Consider the following sketch of an automatic door and try to set up a SFC of it (for help see example in case 3.1, page 6).



Automatic door

An adequate I/O-list exists:

Symbol	Address	Data type	Comment
do_door_close	A 0.0	BOOL	Set pneumatic cylinder to basic position
do_door_open	A 0.1	BOOL	Set pneumatic cylinder to work position
di_pers_left	E 0.0	BOOL	Detect person left
di_pers_right	E 0.1	BOOL	Detect person right
di_door_closed	E 0.2	BOOL	Limit switch for closed door
di_door_open	E 0.3	BOOL	Limit switch for opened door

I/O-list

Your sketch of the SFC should include the following:

2.1.1 Steps

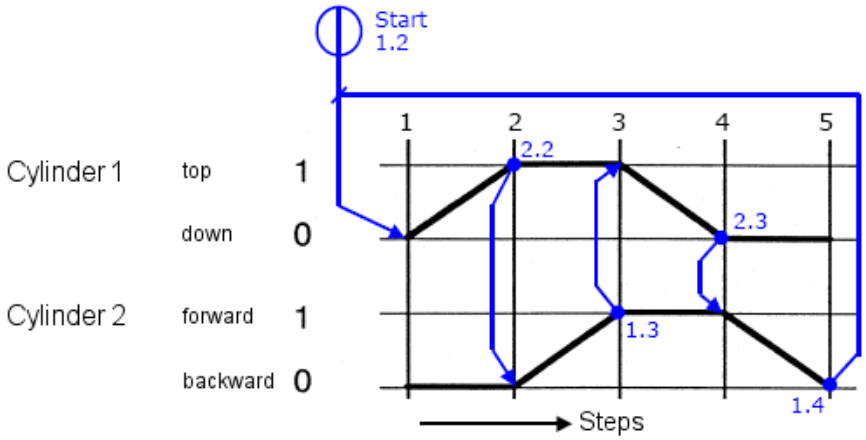
Remember that each step stands for a function and is represented by a rectangle. Name each step with a noun and a verb (e.g. “mix substances”). Connect the steps among each other.

2.1.2 Transitions

The transition from one step to another depends on conditions. Write these conditions besides the corresponding arrows down. The I/O-list helps you to find conditions!

2.2 Path-step diagram

Complete the path-step diagram given on the last page of this document.
Remember: The signal lines are carrying the *sensor* information!



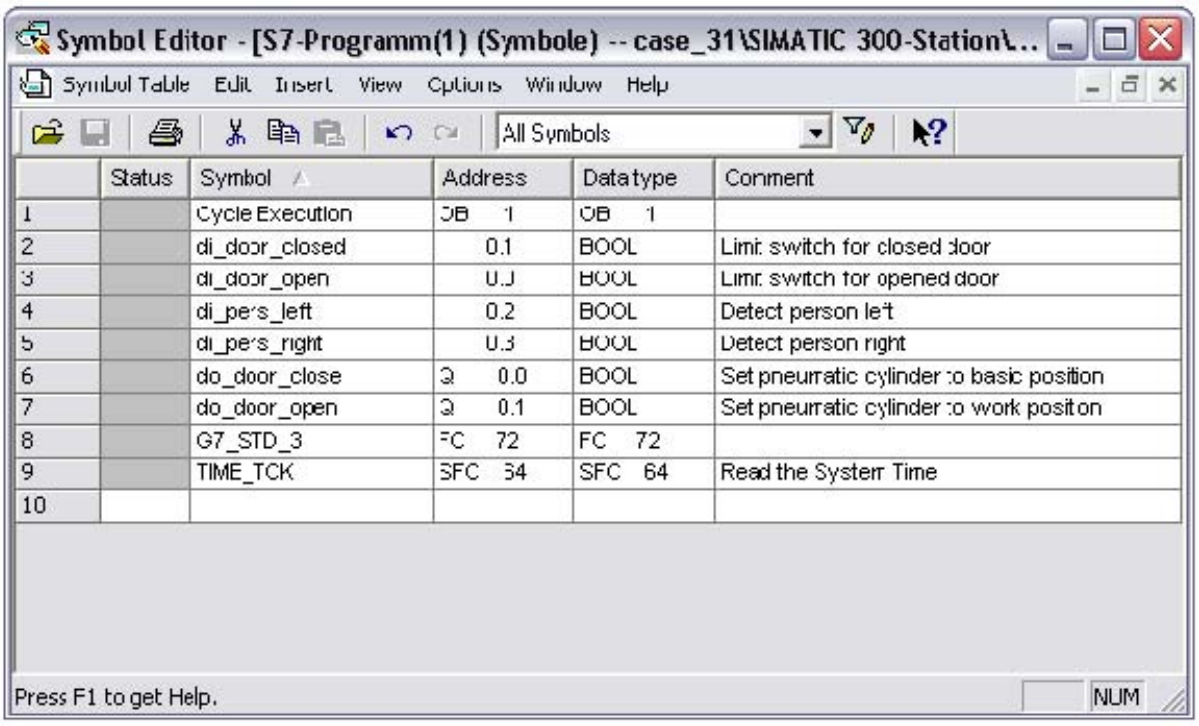
Example of a path-step diagram

2.3 SIMATIC Manager

Start the SIMATIC Manager like you learned it in the last exercise (*Programs -> SIMATIC -> SIMATIC Manager* in the windows start menu. If you are asked which CPU you want to use, choose CPU312. For the MPI address choose 2. In the next step you can choose the blocks. We only need OB1 (OB=Organization Block), so don’t change anything here and go on. The last step is to name your project.

Please name your project “automatic_door”.
On the left side of the window you see the tree structure of your current project. There is an icon for sources and one for blocks.

If you select *S7 Program* in the tree structure three icons show up on the right side (blocks, sources and symbols). Open *symbols* and complete the table according to the given screenshot below.



Screenshot of the symbol list

2.4 Creating a SFC with S7-GRAPH

First of all you have to create a new *Function Block* (check that GRAPH is the creating language). If you did this right, you should now see an icon named FB1 (FB=Function Block) at the right side of the icon named OB1. Double-click the icon FB1 for editing it. A new window opens in which the first step of a SFC already exists. Add as many steps as needed. For each one, specify the actions which must be performed in the step. To program the step actions: Right-click on the action box (the one you labeled before) and choose *Insert New Ele-*

ment -> Action. An action consists of an instruction and an address. The addresses can be found in the given symbol list.
Instructions can be:

- S Set output (→1)
- R Reset output (→0)
- N Non holding: as long as the step is active, the signal state of the address is 1.
- D Delay: The address is set to 1 after the defined time has elapsed. It is reset when the following step is deactivated.

Save the project.

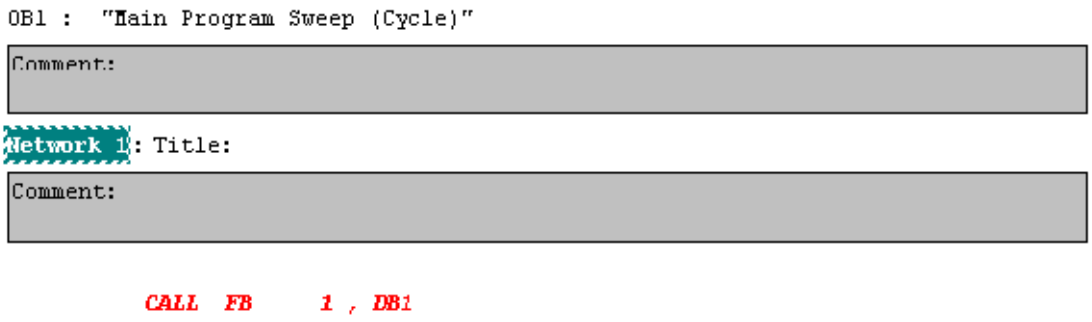
Go back to the SFC-window and program the transitions. Right-click on the transition field and choose *FDB Language Element*. Choose the needed condition (AND Box, OR Box or Comparator) and insert it. Now you can insert the conditions from your symbol editor (Mark the question marks and right click on it, then choose *Insert Symbol*). Afterwards you can insert more conditions if you need to (*FDB Language Element -> Bin. Input* or *Negate Bin. Input*). Complete all the transitions, name them and save your project.

In the frame at the bottom of the window you can see all errors and warnings. In case of errors the source will not be compiled.

Simulating with S7-PLCSIM

SIMATIC S7-PLCSIM is fully integrated in STEP 7 and provides a simulation of a Programmable Logic Controller (PLC). It lets you test user blocks and programs on a programming device or PC – even without existing target hardware, i.e. without CPU, signal modules etc. You can simulate online access operations and use the test functions of the programming tools just as a real PLC would be present.

Before a loaded S7-GRAPH FB can be executed on the CPU, it must be called in the block OB1 that is executed cyclically. Open OB1 and add the line “CALL FB1, DB1“. Save and close the program block OB1.

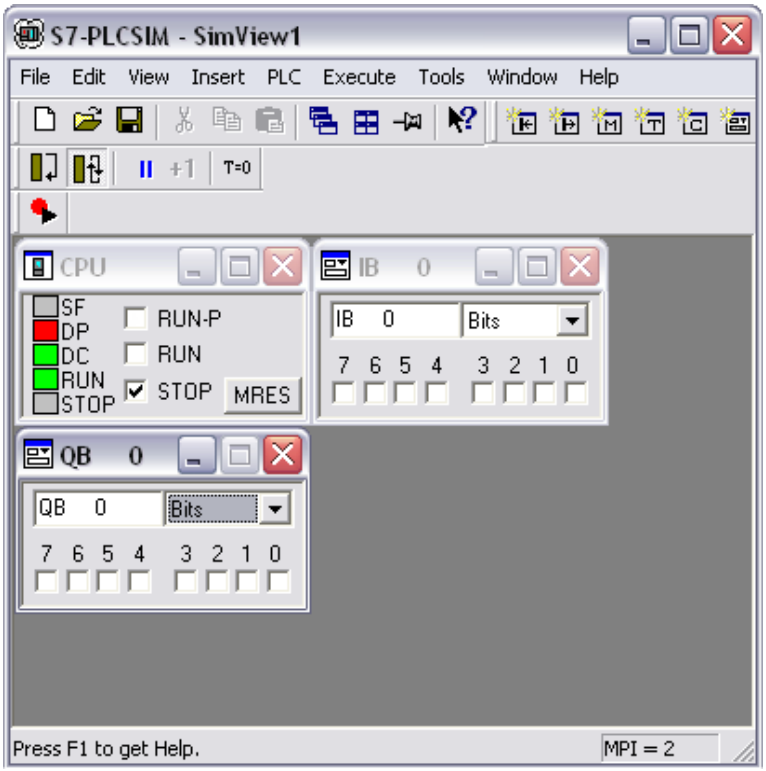


Screenshot Call FB1, DB1

To open PLCSIM, click on the Simulation On/Off button on the toolbar (menu command *Options -> Simulate Modules*) in the SIMATIC Manager. S7-PLCSIM starts and loads a CPU view object for your simulated PLC. You can display different types of view objects that allow you to monitor and modify the program running in the simulated PLC. Please activate the following view objects from the *Insert* menu:

- *Input Variable*: allows you to access the data stored in the process input (I) memory area. The default address is byte 0 (IB0). Sensors are providing the input data when using a real PLC. Otherwise inputs are set by user.
- *Output Variable*: allows you to access the data stored in the process output (Q) memory area. The default address is byte 0 (QB0). This output signals are transmitted to the actuators. Outputs can not be set by user.

Your PLCSIM window should look like the following screenshot.



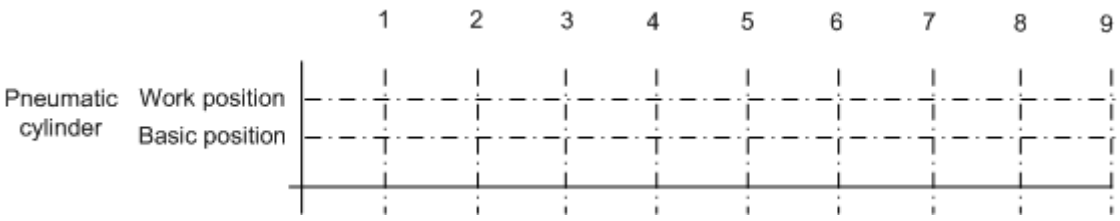
Screenshot of the PLCSIM window

Before using S7-PLCSIM you have to download the data. In the SIMATIC Manager window, navigate to your project and select *SIMATIC 300-Station*. Click on the Download button on the tool bar or select *PLC -> Download* from the menu for downloading the hardware configuration. Afterwards, select *blocks* and click the download button again for downloading the program data.

Return to the S7-GRAPH window and click on the Monitor button on the tool bar (menu command *Debug -> Monitor*). By clicking on the RUN-P button in the PLCSIM window you can start your simulation. The active step appears green. By giving the correct inputs (i.e. transition conditions) the next step will be activated. Click the small boxes (which stand for the addresses) in the IB windows for activating the transition conditions.

2.5 Benchmark

The exercise is fulfilled if the created SFC is error free and can be simulated in PLCSIM.



Path-Step diagram for the automatic door