

Automation with LOGO!

Hands-on training with example "Bank door"

Exercises with solutions

1st Edition – November 2013

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1 Preface

The Siemens LOGO! provides a lot of possibilities with this you can control a variety of automation applications. Compact design, possibility of extensions, low cost, and a powerful instruction set make the LOGO! a perfect solution for controlling a wide variety of applications within the lower price scale. The various programming features within LOGO!Soft Comfort give you the flexibility you need to solve your automation problems

This manual with exercises and solutions is designed for trainees, skilled workers, proficient, technicians, engineers, programmers and maintenance personnel who have a general knowledge of programmable logic controllers.

Required basic knowledge

To understand this Teachware, it is necessary to own a general knowledge of automation and programmable logic controllers.

Scope of the Teachware

This Teachware is valid for

- the LOGO! 0BA6 control in association with LOGO!Soft Comfort V6.0 software
or
- the LOGO! 0BA7 control in association with LOGO!Soft Comfort V7.0 software.

46 Pages

2 Notes on Safety

Warning notice system

This Teachware contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.



DANGER

indicates that death or severe personal injury will result if proper precautions are not taken.



WARNING

indicates that death or severe personal injury may result if proper precautions are not taken.



CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

means that damage to property can occur if the appropriate safety measures are not taken.



NOTE

is important information about the project, handling the product, or the part of the documentation in question, to which special attention must be paid.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Program examples provided by IKH Didactic Systems are only adapted for training purposes.

All program examples are proposals without engagement.



WARNING

Controls may become inoperative within instable operating status and therefore can cause uncontrolled operation of the controlled devices. Such dangerous events may result in death or severe personal injuries and/or result in material damage. Therefore take care for an emergency-off function, electrical or other redundant safety devices which are dependent on your automation system.

Disclaimer

Each user is responsible for the appropriate operation of the automation system (PLC Trainer S7-1200, S7-300 and LOGO!Learn). The program examples do not discharge from obligation for secure handling, usage, installation, operation or service. By using the program examples created by IKH Didactic Systems you admit that IKHDS (IKH Didactic Systems) is hold responsible under no circumstances for material or personal damage because of incorrect usage.

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

3 Introduction

This is a workshop intended to get participants interested in LOGO!. It's objective is not to teach participants extensive LOGO! knowledge or the basics of control engineering. These topics are covered by trainings. We are offering many exercises in this workshop. We are aware that not all participants will work on all exercises. The exercises are more of an offer to program as long as it is fun.

We start with simple exercises that can either be tried and tested by simulation or transferred to the training device and tested on it.

We will introduce all functions that are used in the "Bank door" example from Fischer-Technik in the exercises.

The workshop can be conducted with older LOGO! devices. It was originally created with 0BA6 but can be conducted with older ones as long as you don't focus on the external LOGO! Text Display. Our current training devices are equipped with 0BA7.

It is not important because we are dealing with basic functionalities and not the latest enhancements. An important difference is the ability to connect to LOGO!.

For older devices up to LOGO! 0BA6, you have to use the LOGO! programming cable (RS232 or USB). For 0BA7 you have to use the Ethernet interface. To give more guidance therefore we start with some advice how to get your Ethernet interface configured.

The entire documentation should not to be mistaken for a training course, but instead regarded as a reminder for when you work with the software later.

We welcome any suggestions you may have for improving the workshop and its description.

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4 Setting the programming interface

You should set up the workstations before you start the exercises:

- Install **LOGO! Soft Comfort** at least in the version required for the used hardware.
We generally recommend that you upgrade to the latest version.
Available for free on the Internet (**Help > Download center**)
- Enable the interface according to the used hardware.



NOTE

Administrator rights are required for the installation of the USB cable drivers.

- Install the drivers for the USB cable.

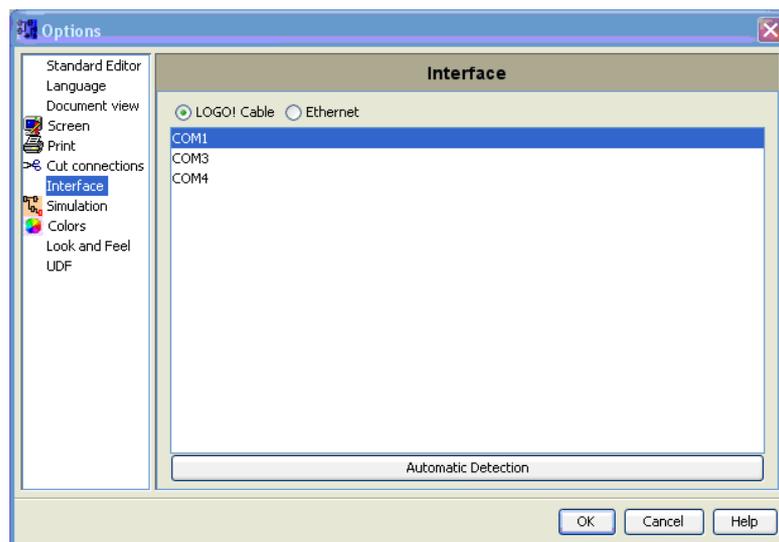


Figure 1: LOGO! 0BA6: USB cable with COM interface

If you are using a COM port, the correctly installed software can automatically detect at which COM port LOGO! is connected.

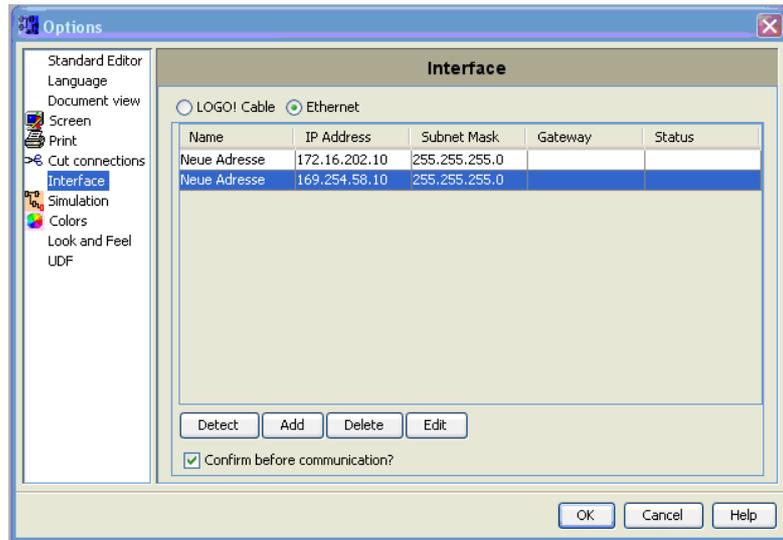


Figure 2: LOGO! 0BA7: RJ45 cable with Ethernet interface

In case of an Ethernet interface, you have to make a few settings as shown in the slides. We use the following values in most examples:

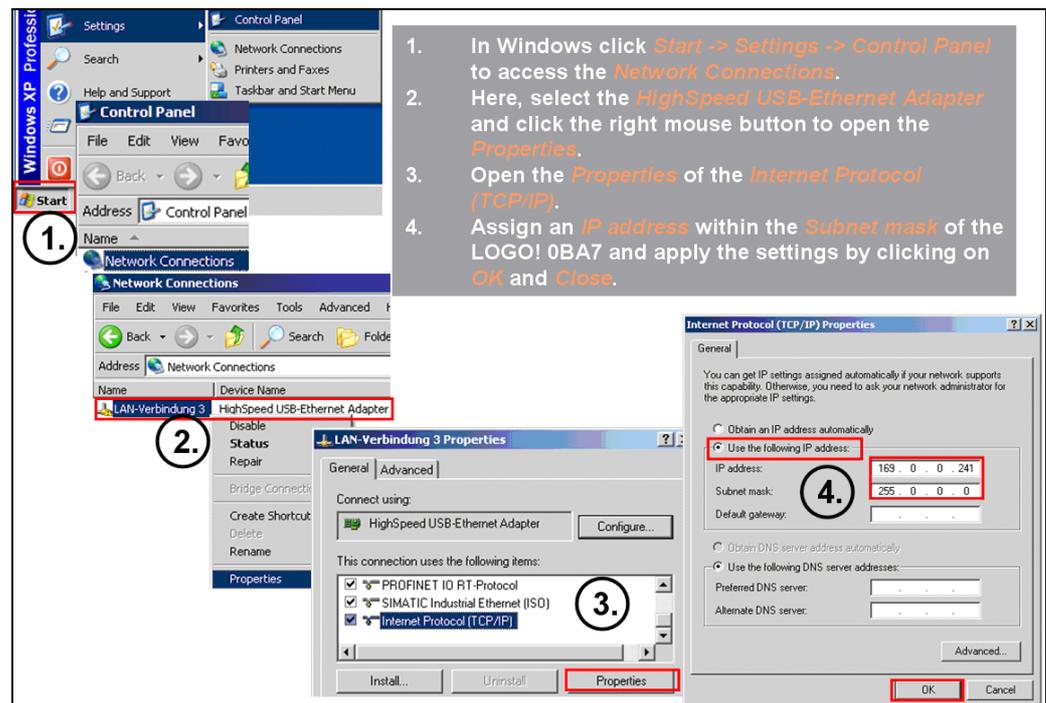


Figure 3: Settings on the PC with Ethernet communication

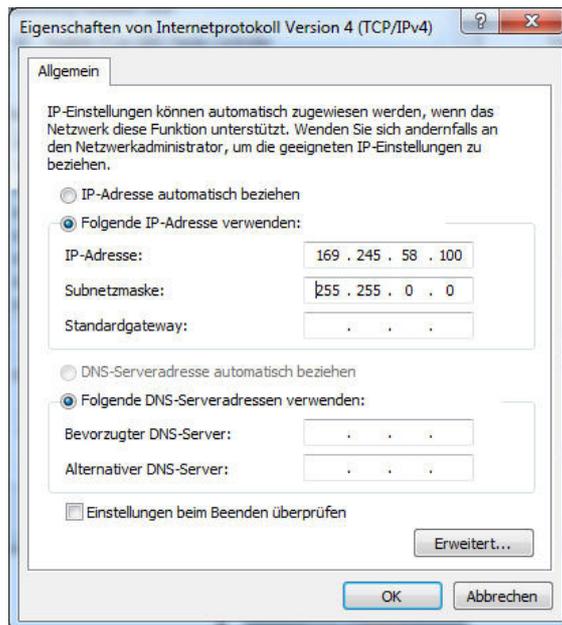


Figure 4: Setting of the IP address

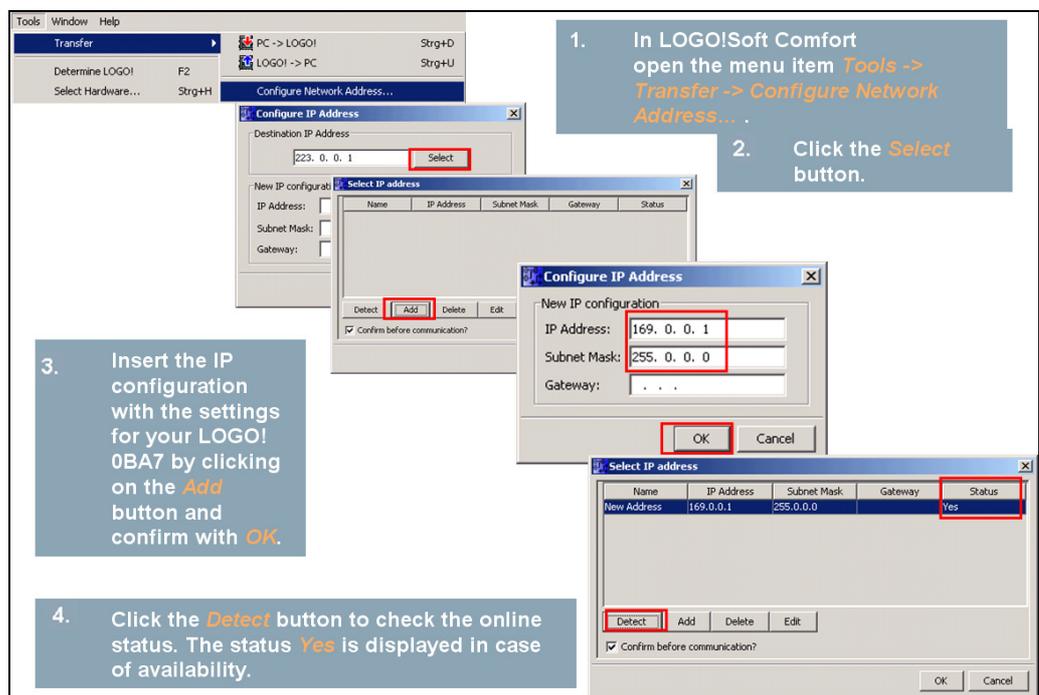


Figure 5: Settings on the PC with Ethernet communication

- ❑ Select the address of the connected LOGO! and start **Detect**, the status is **Yes** (checked with software in this case).

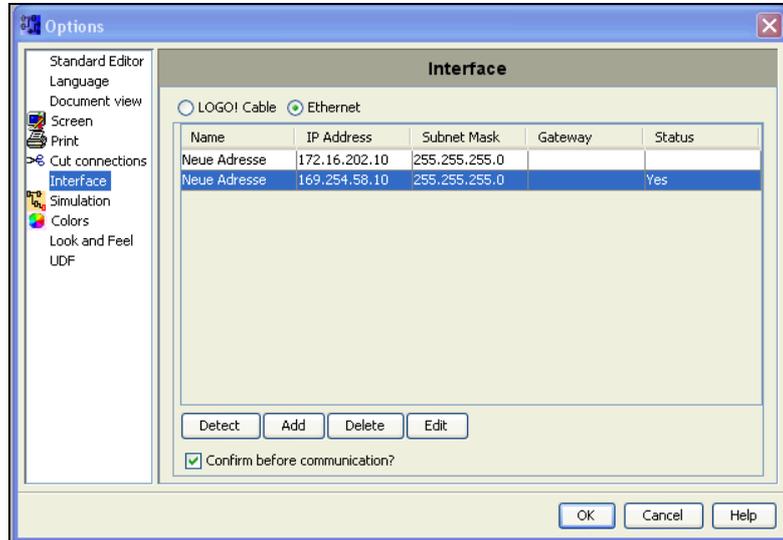


Figure 6: Detection of the Ethernet interface

- ❑ Check the communication with LOGO! by transferring a program to LOGO! or uploading an existing program from LOGO! to the PC.

5 Task 1: Logic functions "OR" and "NOR"

Program an OR and NOR circuit with inputs 1 – 3 and compare the operation.

- Develop a circuit diagram in the function block diagram view.
- Test the circuit in simulation mode.
- Transfer the program to LOGO!, activate online mode and test the behaviour.
- Save the result under the name: **Ue_1_or_01.lsc**.



NOTE

You should proceed this way in all exercises.

Suggested solution

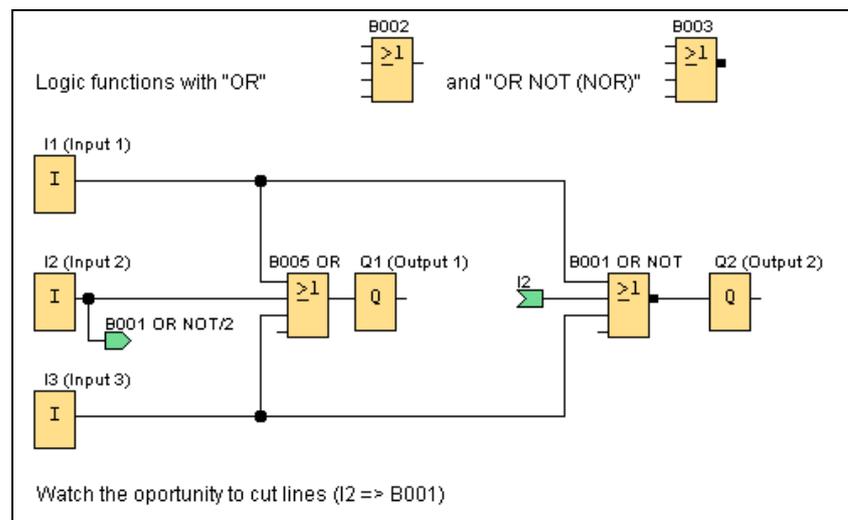


Figure 7: Logic functions „OR“ and „OR NOT (NOR)“

6 Task 2: Logic functions „AND“ and „NAND“

Program an "AND" and "NAND" circuit with inputs 1 – 3 and compare the operation.

- Proceed as described in task 1.
- Save the result under the name: ***Ue_2_and_01.lsc***

Suggested solution

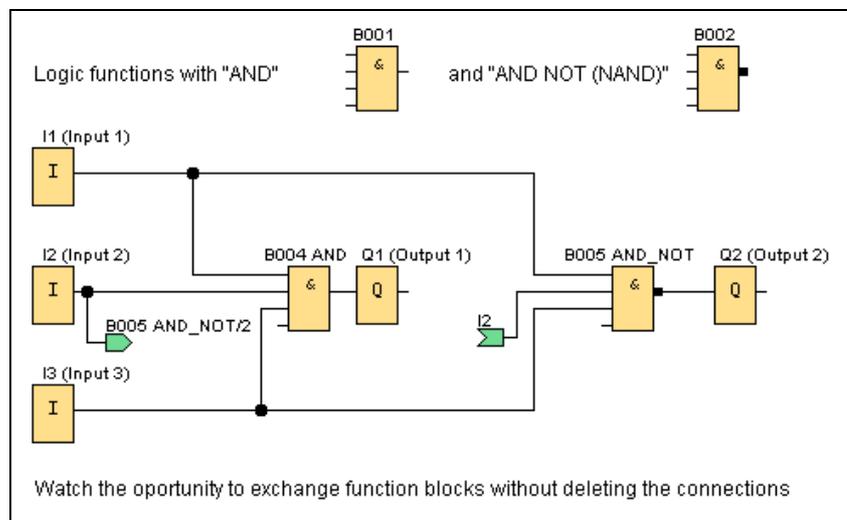


Figure 8: Logic functions „AND“ and „AND NOT (NAND)“

7 Task 3: Edge evaluations

Use inputs 4 - 6 to program an AND circuit with rising and falling edge. Compare the operation.

- Proceed as described in task 1.
- Save the example under the name: *Ue_3_and_edge_01.lsc*

Suggested solution

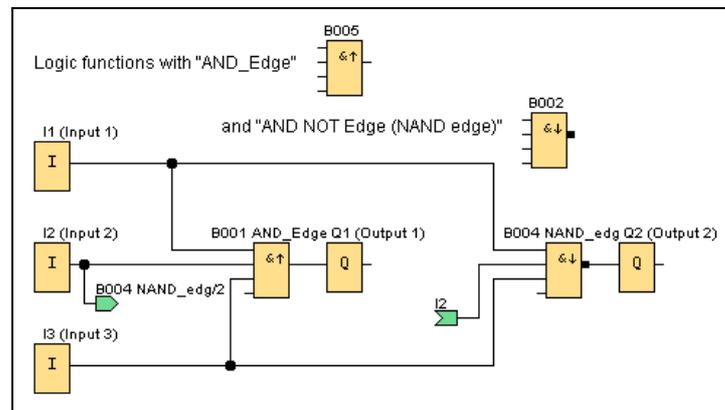


Figure 9: Logic functions with "AND rising edge" and "AND NOT (NAND) falling edge"

How can I make the signals visible?

Try different options.

What does the pulse relay do?

Here are some possible solutions. There are more.

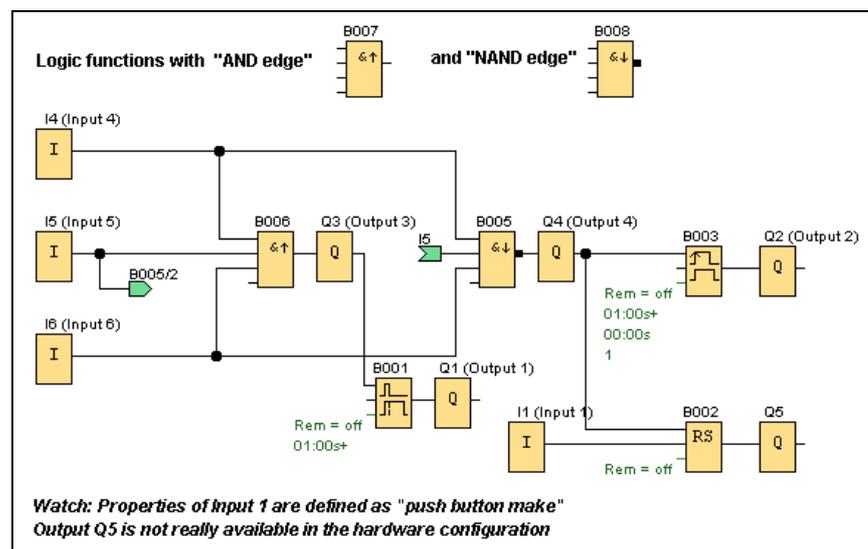


Figure 10: Logic functions with "AND rising edge" and "AND NOT (NAND) falling edge" with pulse relay

8 Task 4: Negation of signals

Open your example with the AND function and try different ways to negate a signal.

- Proceed as described in task 1.
- Save the example under the name: ***Ue_4_Negations_01.lsc***

Suggested solution

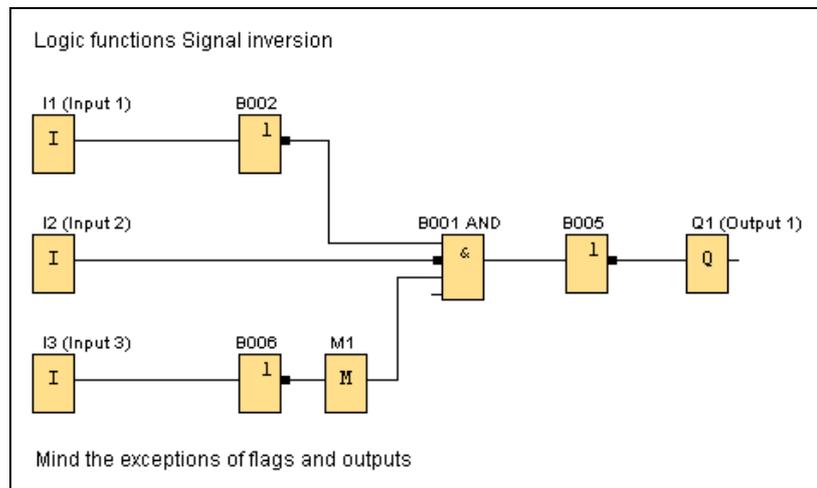


Figure 11: *Logic functions signal inversion*

9 Task 5: Two-way circuit and four-way circuit

Create a two-way circuit with inputs I1 and I2. Extend this circuit and build a four-way circuit with inputs I1 to I4.

- Proceed as described in task 1.
- Save the example under the name: *Ue_5_cross_connection_01.lsc*

Suggested solution

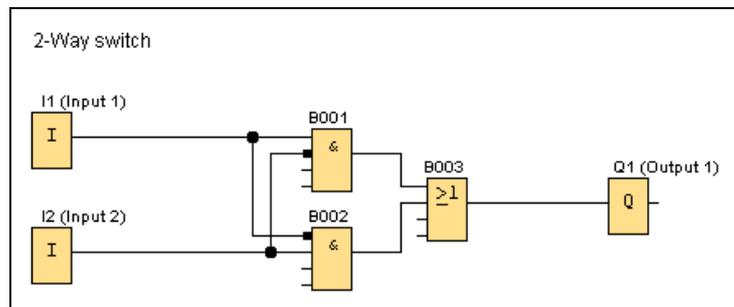


Figure 12: Two-way circuit

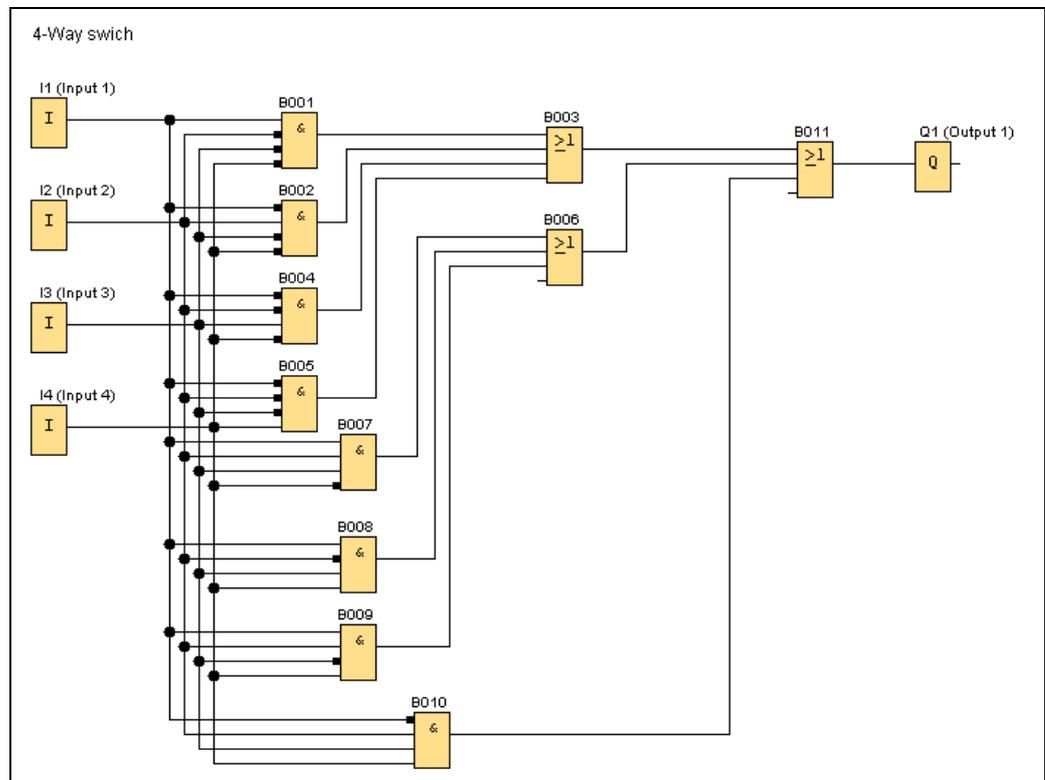


Figure 13: Four-way circuit with four switches

Alternative solution

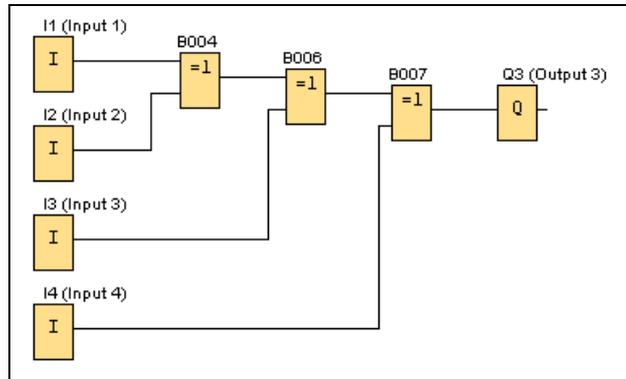


Figure 14: Four-way circuit with four switches

10 Task 6: The up/down counter

Program a counter with:

- I1 = Reset
- I2 = Pulse input
- I3 = Counting direction
- Switch-on value = 5
- Switch-off value = 10
- Start value = 2

- Proceed as described in task 1.
- Save the example under the name: **Ue_6_counter_01.lsc**
- Try the operating mode **Programming on device** and change the reset input to input I8

How do you get the latest counter value at LOGO! or on the text display?

- Change the switch-on value to 7 on the text display.
- Assign the password "A" for the program using the software.
- Now try to relocate the reset input at LOGO! back to I1.

Which blocks do you see in "Parameter setting mode"?

- Protect the counter from unwanted parameter changes.

Suggested solution

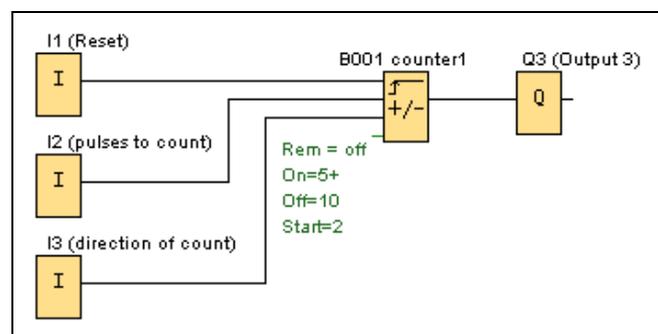


Figure 15: The up/down counter

11 Task 7: Message text

Program a message text with the following display:

1. Name of the block "Counter",
2. the current counter value, Act:
3. the switch-on threshold: ON:
4. The current time and date are to be displayed alternately in the fourth line.

The message text is to be displayed as permanent text in both displays.

Suggested solution

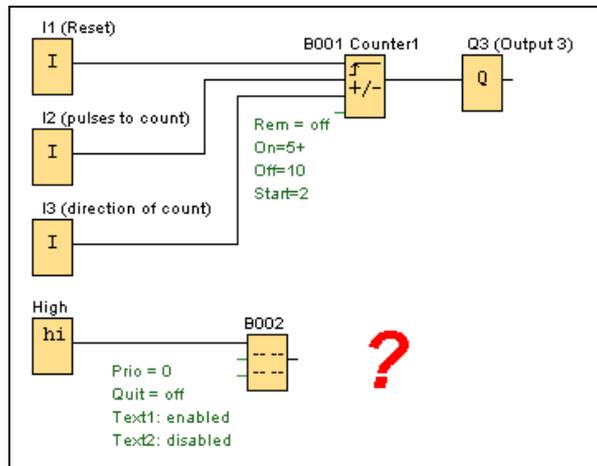


Figure 16: Message text for counter

- Also visualize the number as bar graph in the display.

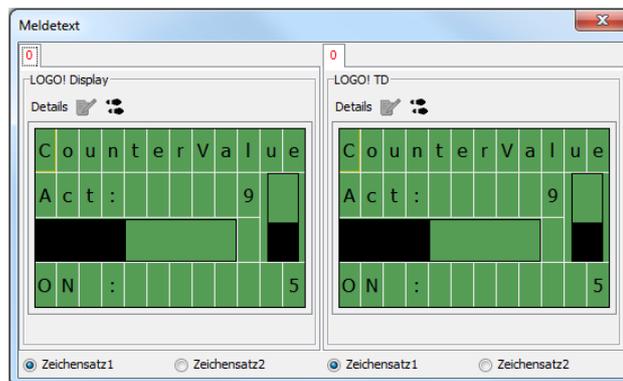
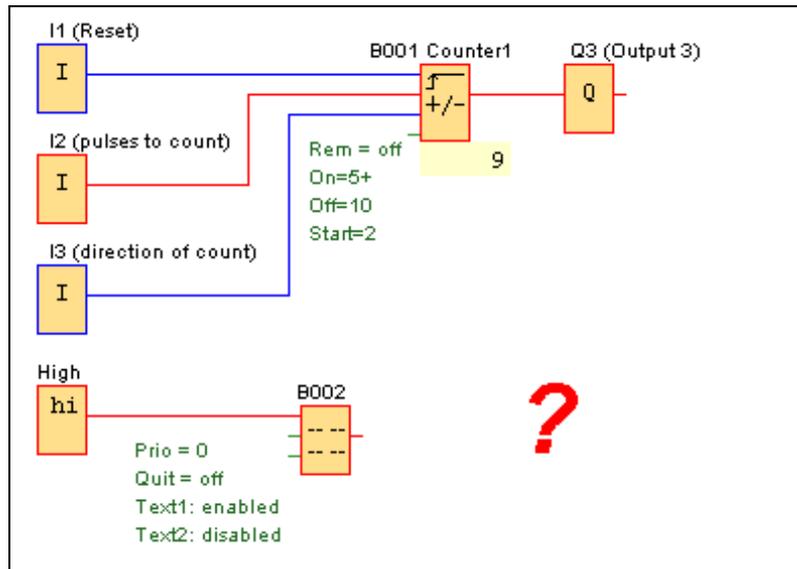


Figure 17: Simulation of the counter with message texts

?

Why is it not possible to download the example to the LOGO! ?

Have a look at the message in the "Info Window" of LOGO!Soft Comfort!

>>> An „Open connector“ block must be added to the output of the message block B002.

12 Task 8: Monitoring the boiler temperature

Create a program that switches on the fan at output Q1 when the boiler temperature reaches 25 °C [analog value at the analog input AI1 (I7) of approx. 3 Volt] and turns it off when the temperature drops below 18 °C.

If the temperature reaches a value of 40 °C, an alarm is to be issued at output Q4 and turned off when the temperature drops below 30 °C.

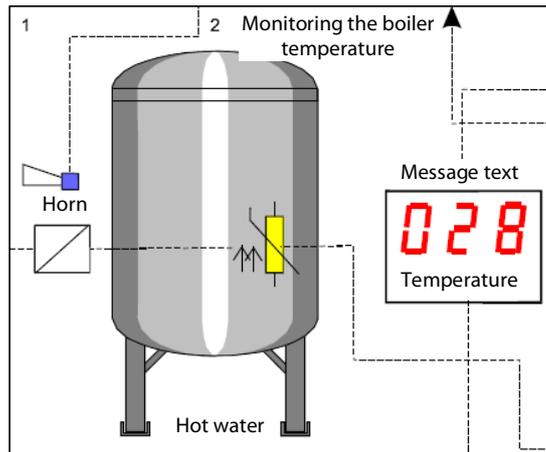


Figure 18: Monitoring the boiler temperature

Suggested solution

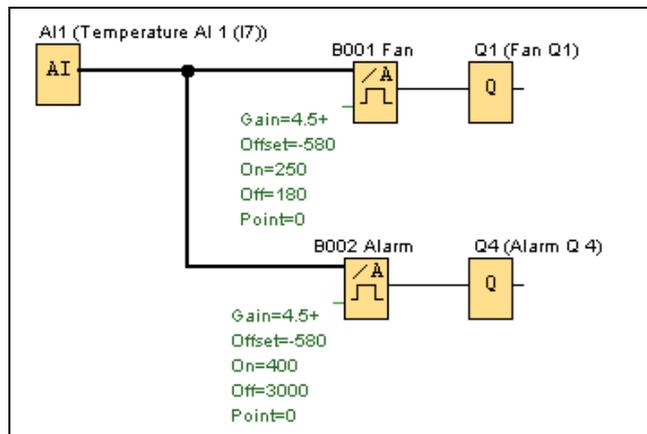


Figure 19: Monitoring the boiler temperature with alarm

13 Task 9: Analog value with message text, alarm with acknowledgment

Amend the program from task 8 by the following functions:

A message text is generally displayed with the current time and latest temperature.

An alarm window should display the following in case of an alarm:

- "Temperature alarm"
- Act: Temperature value
- Number of alarms
- Date and time of the first alarm

The backlighting of the message window should flash. The error must be acknowledged in LOGO! or on the display.

Suggested solution with message text

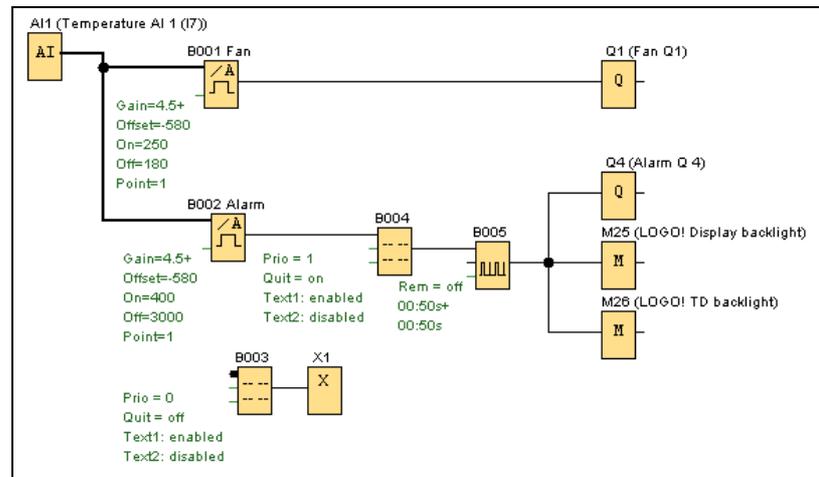


Figure 20: Analog value with message text, alarm with acknowledgment

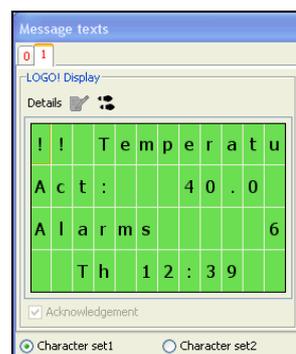


Figure 21: Display of the message texts

14 Task 10: Light / fan control

The fan in a bathroom should be controlled depending on the light with an on delay and an off delay. Additionally a timer should activate the fan at predefined times.

- Use the function "Input/Output names" with input I1 and outputs Q1 & Q2.
- Try out the yearly timer.

Suggested solution

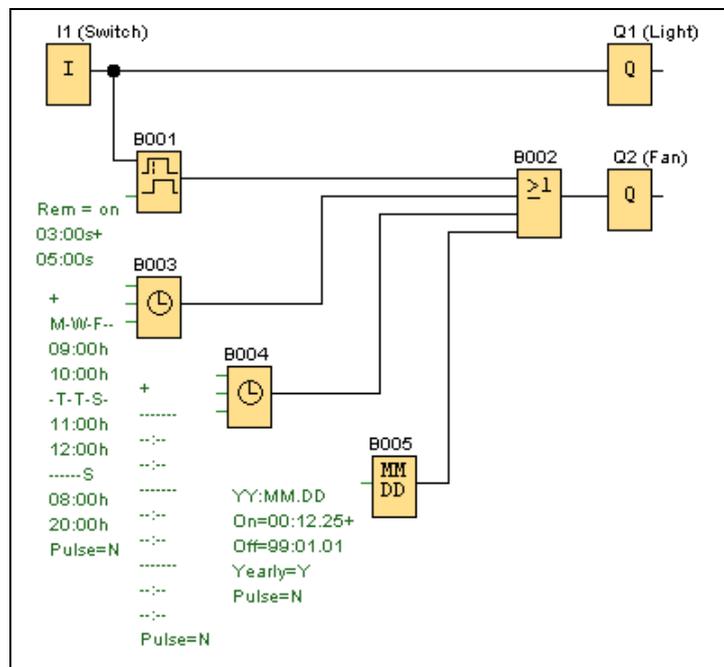


Figure 22: Light / fan control

15 Task 11: Solar collector

Solar collectors were installed on the roof to save energy when heating the water. If the water in the collector is 10 degrees warmer than the water in the hot water boiler, a pump is to pump the water from the collector into the heat exchanger. If the temperature difference drops below 0.5 degrees, the pump is to switch off.

- ❑ Use the analog inputs AI 1 and AI 2 and output Q4.
- ❑ Display the temperature values and the difference in the display.

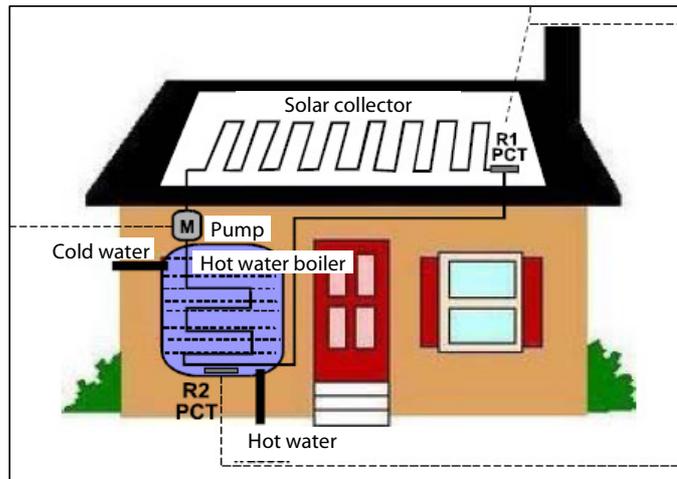


Figure 23: Temperature control of a heat exchanger with solar collector

Suggested solution

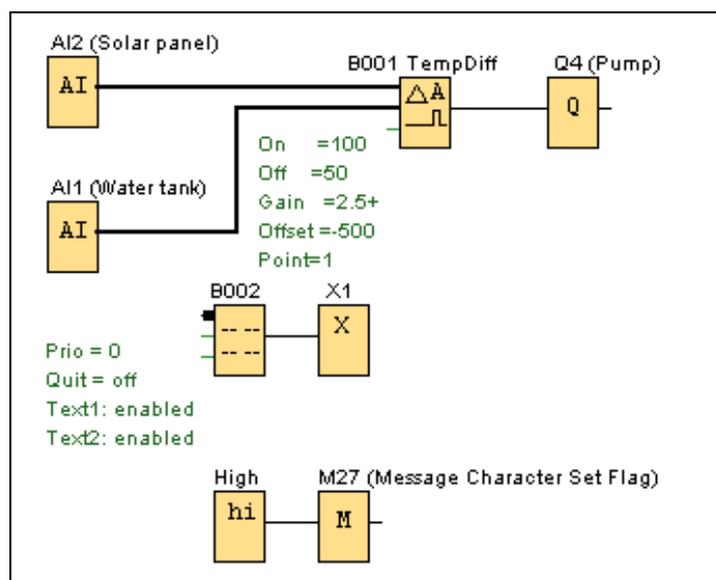


Figure 24: Temperature control with message text

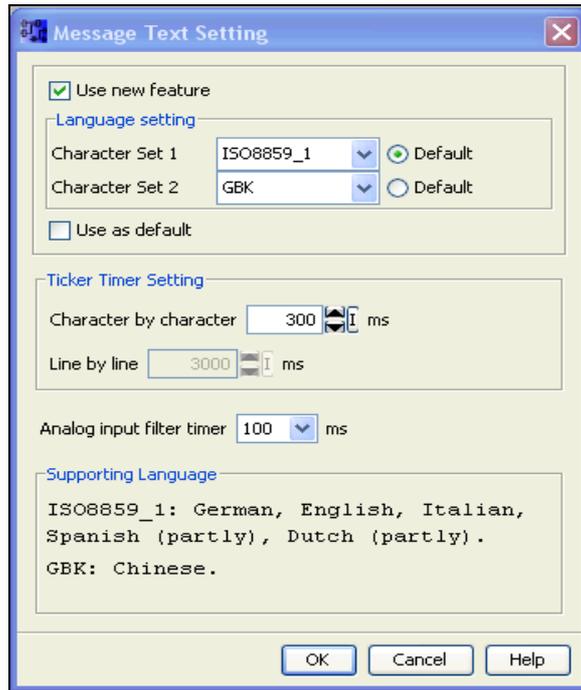


Figure 25: Message text setting

16 Task 12: Light settings in the conference room

The light in a conference room is to be dimmed in three permanently set steps. It will be turned on with a switch at input I3. Step selection takes place through switches at inputs I1 and I2. In manual operation, the operating personnel would like to set any brightness level with a potentiometer. The set point should be assigned to analog input AQ1. As we have no analog output in our demo lit, we want to see the set point as a bar graph in the display. It should also show if manual mode is activated.

$S1 = 0 + S2 = 0 \Rightarrow 200 \%$

$S1 = 1 + S2 = 0 \Rightarrow 600 \%$

$S1 = 1 + S2 = 1 \Rightarrow 900 \%$

$S1 = 0 + S2 = 1 \Rightarrow$ manual operation

Suggested solution

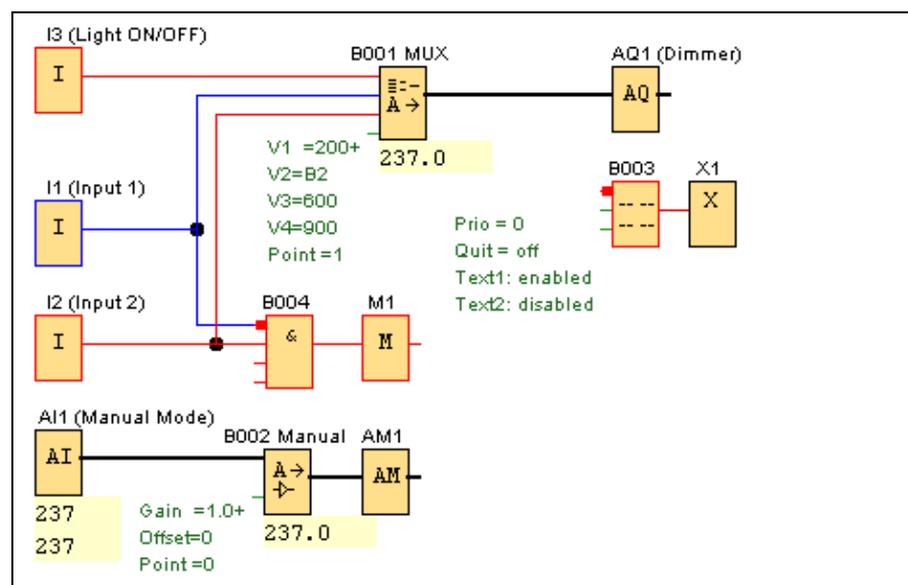


Figure 26: Light settings in the conference room with manual operation

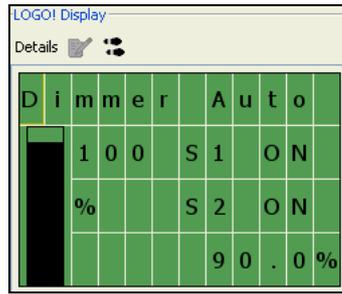


Figure 27: Display with automatic operation

17 Task 13: Arithmetic example

LOGO! did not offer a function block for calculation before 0BA6, because it mostly only scales signals. But this customers can do this more easily in the block properties.

Design a circuit for adding and subtracting counter values without using the Math Function block.

Suggested solution

It may look complicated, but you usually only need one of the two arithmetic operations.

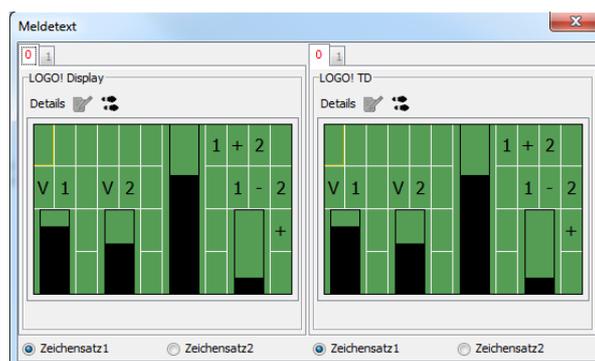
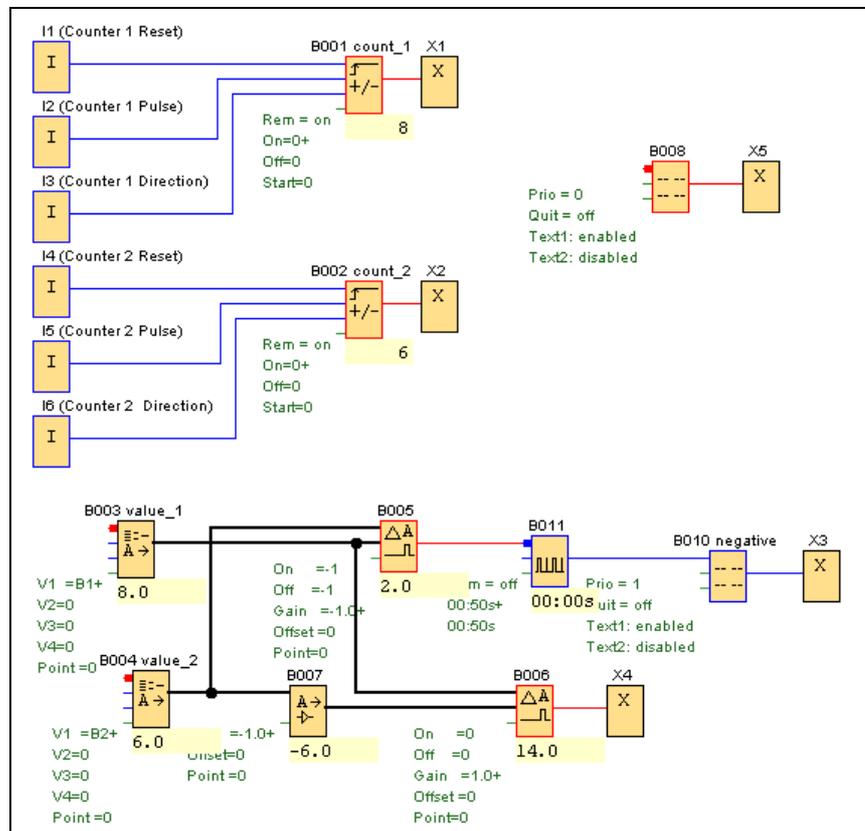


Figure 28: Arithmetic operation for adding and subtracting

By the way, the solution also includes the basic approach to multiplication and division.

Do you see the solution?

18 Functional model: Bank door

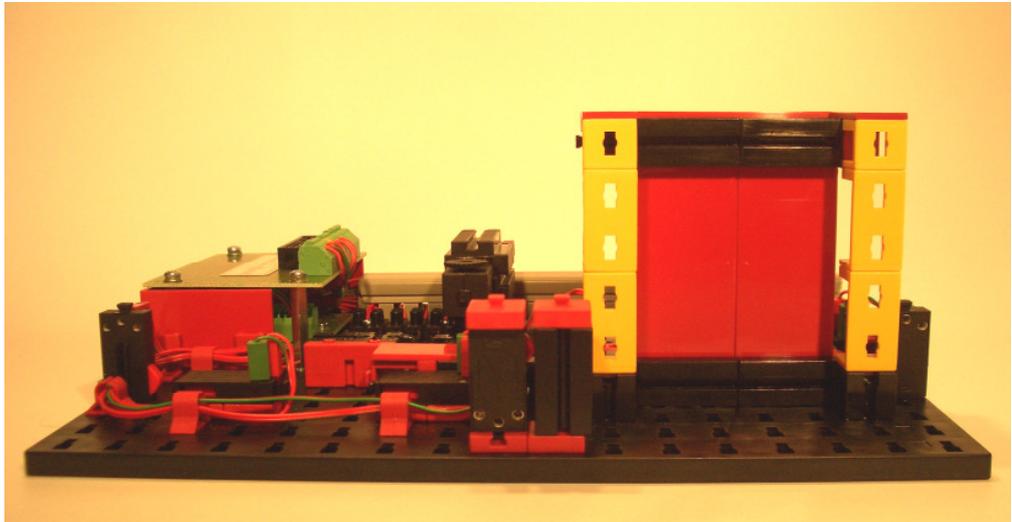


Figure 29: Functional model "Bank door" (Fischer-Technik)

18.1 Introduction

Our model simulates the function of a modern automatic sliding door that is typically used in businesses or banks.

We are looking at a bank door in our example. The customer opens the door from the outside with a "bank card". The door is to close automatically afterwards. When leaving the bank, the door opens automatically triggered by a sensor when the customer approaches the door. We are using a light barrier in our case. With a LOGO! text display, the door can be opened and closed manually.

The "card reader" only admits customers during regular banking hours. Customers who are still inside the bank at the end of regular business hours should be able to leave the building without any problems. For security reasons, the number of customers inside the bank is not to exceed a maximum value. Once this value is reached, the card reader is blocked until a few customers have left the bank and the card reader is activated once again.

We are going to develop a program in several steps. Please keep in mind that we do not have to use all safety devices in our exercises (as is the case in actual applications). We are only working on understanding the operating principle.

18.2 Check the wiring of the system

We start by checking the wiring of the system.

LOGO! offers an excellent tool for this purpose, the status display. The LOGO! display must be in the basic state "Display of time and date" for this purpose.

If this is the case, push the ">" button and the display shows the status of the INputs.

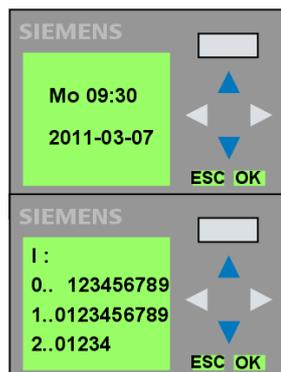


Figure 30: Display of the LOGO!

Every time you press the ">" button, you are switching to the next display.

1. Pressing ">" once shows the status of the INputs
2. Pressing ">" twice shows the status of the OUTputs
3. Pressing ">" three times shows the status of the analog INputs 1 to 3
4. Pressing ">" four times shows the status of the analog INputs 4 to 6
5. Pressing ">" five times shows the status of the analog INputs 7 to 8
6. Pressing ">" six times shows the status of the analog OUTputs 1 to 2
7. Pressing ">" seven times shows the status of the bit memories
8. Pressing ">" eight times shows the status of the four cursor keys
9. Pressing ">" nine times takes you back to date and time

Check to make sure that the switches are connected to the correct LOGO! inputs.

Limit switch "Door OPEN"	present at LOGO! input I___? Is it an NC / NO contact?
Limit switch "Door CLOSED"	present at LOGO! input I___? Is it an NC / NO contact?
Switch "Card reader"	present at LOGO! input I___? Is it an NC / NO contact?
The "Light barrier"	present at LOGO! input I___? Is it an NC / NO contact?

18.3 Input/Output names

Before we start the program, name your inputs/outputs.

- To do so, press **Edit > Input/Output names**
- Fill in the table as shown below:

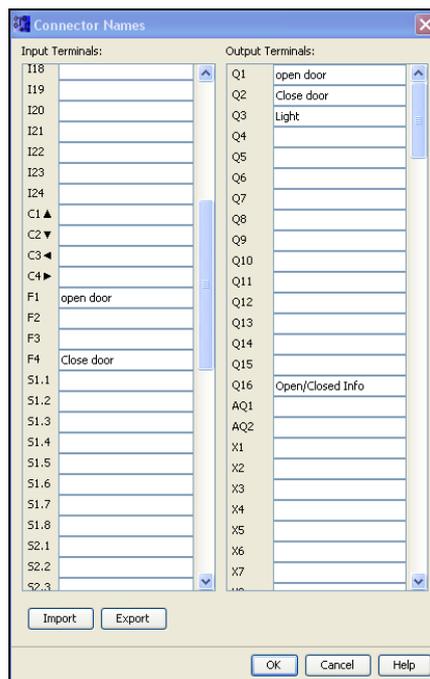
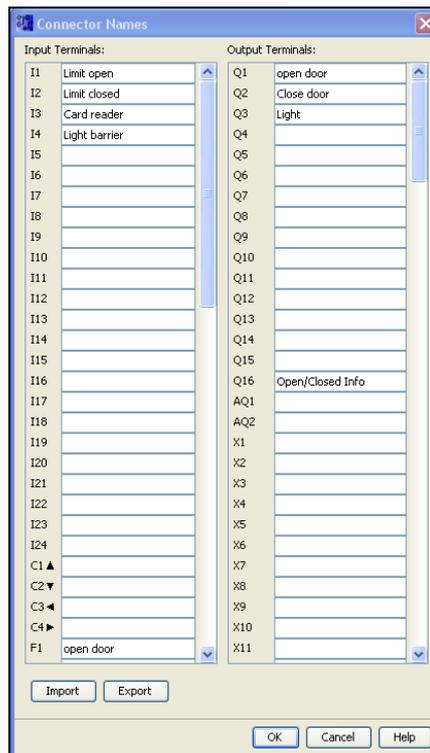


Figure 31: Table of the connector names

Function test of drive and limit switches

Apply the following program structure to receive a uniform program later:

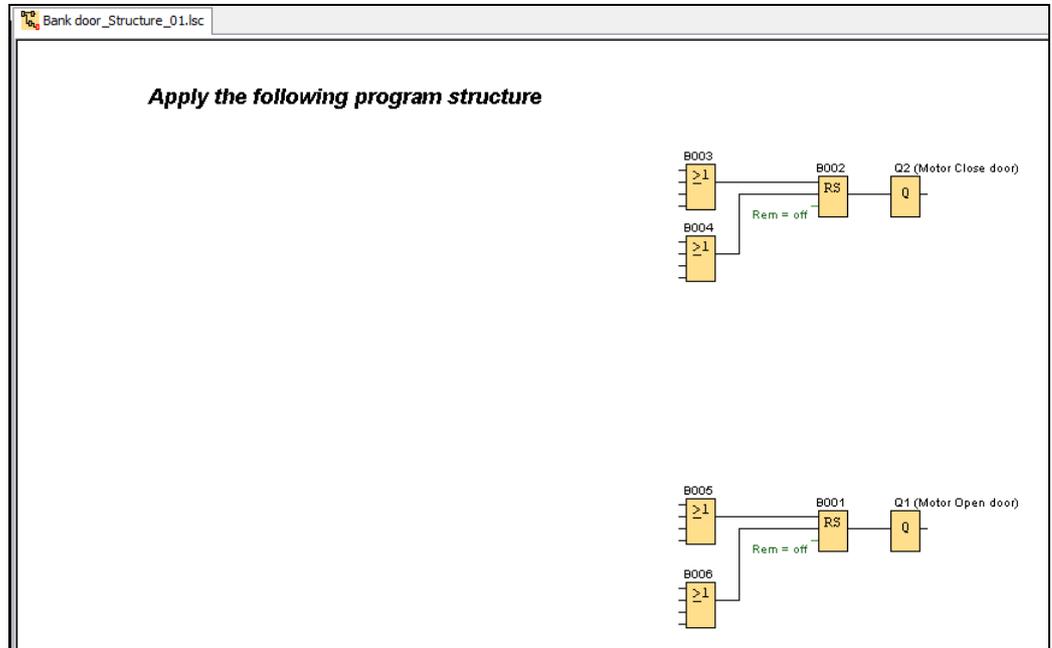


Figure 32: Program structure

Direction control

This means direction control takes place through pulses and the motor runs in this direction until it is stopped by a stop pulse.

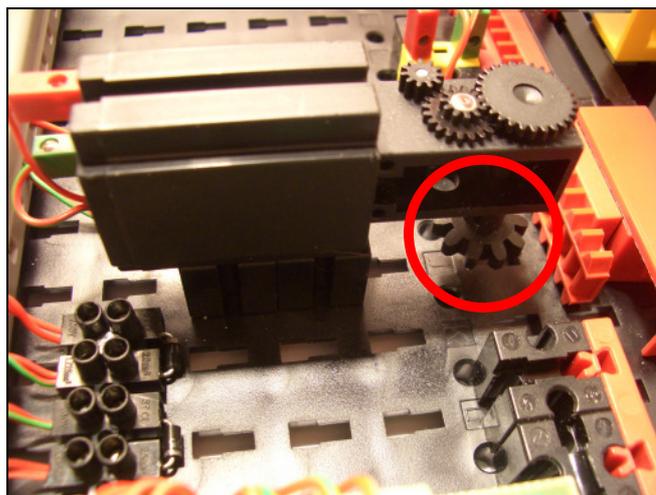


Figure 33: Direction control



NOTE

The geared motor is somewhat recessed during initial testing of the model so that the door is **NOT** moved at the same time.

Create a program that starts the movement of the door manually with the function keys of the text display and stops it with the respective limit switch.

- Create a program and upload it to LOGO!.
- Manually close the door and start the motor with the F1 key. Check the direction of rotation of the gearwheel. Move the door manually to the point where the limit switch stops the motor.
- Use the same approach to test the direction of rotation and the limit switch for closing the door.

If the system works properly in both directions, carefully move the motor block forward until the gear engages with the door opening mechanism. Do not press in too tight.

Suggested solution

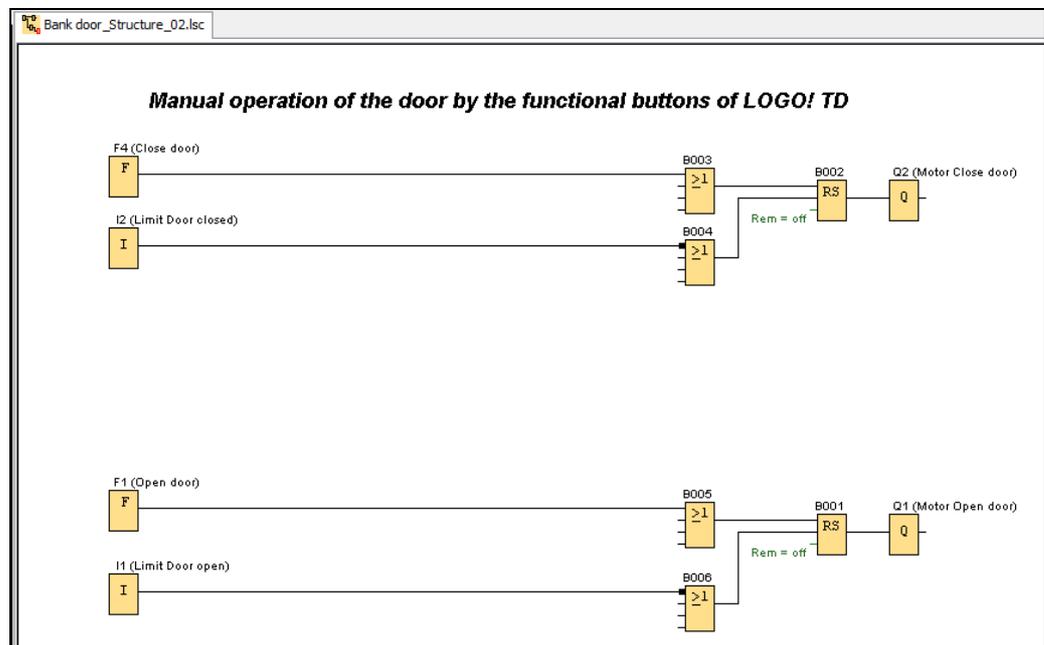


Figure 34: Manual operation of the door by the functional buttons of LOGO! TD

18.4 Customer gets access to the bank with his bank card

The customer is to open the door using the "card reader" in front of the door.

- Integrate the corresponding input for this step into the program.
This step should not affect the previous function.

Suggested solution

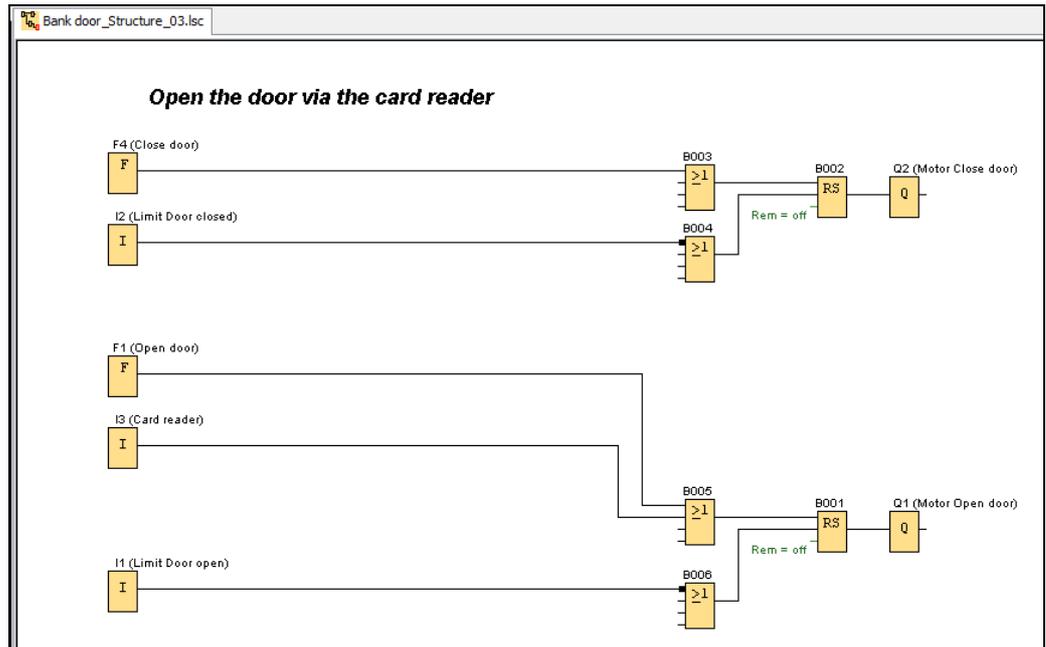


Figure 35: Open the door via the card reader

18.5 Automatic, time controlled closing of the door

The door is to close automatically. Because we have no sensors that detect if someone is still standing in the door, the door is to close automatically 5 seconds after it has opened completely.

What happens when you activate the card reader while the door is closing?

How can you prevent this from happening?
(see solution of the next exercise)

Suggested solution

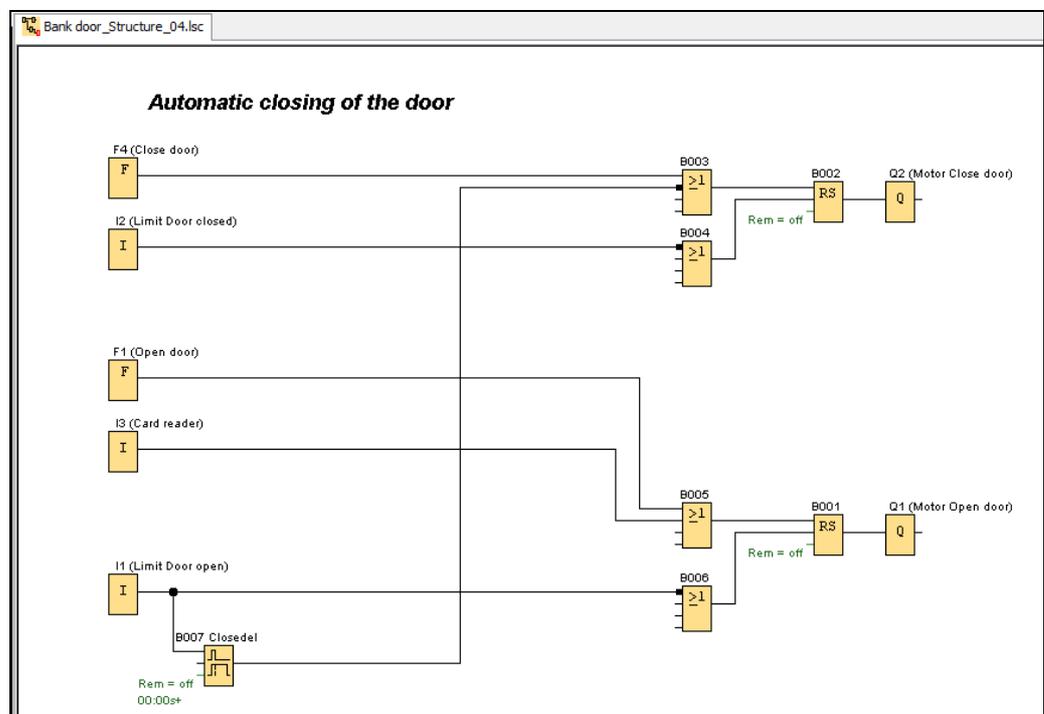


Figure 36: Automatic closing of the door

18.6 Door opens automatically to let the customer exit

If a customer wants to leave the bank, the door is to open automatically as soon as the customer enters the sensor range (light barrier). The door closes automatically again after 5 seconds.

The light barrier must be activated by turning on the bulb via Q3. If the light is on the sensor input I4 should give a "1" signal as long as the light beam reaches the sensor.

Suggested solution

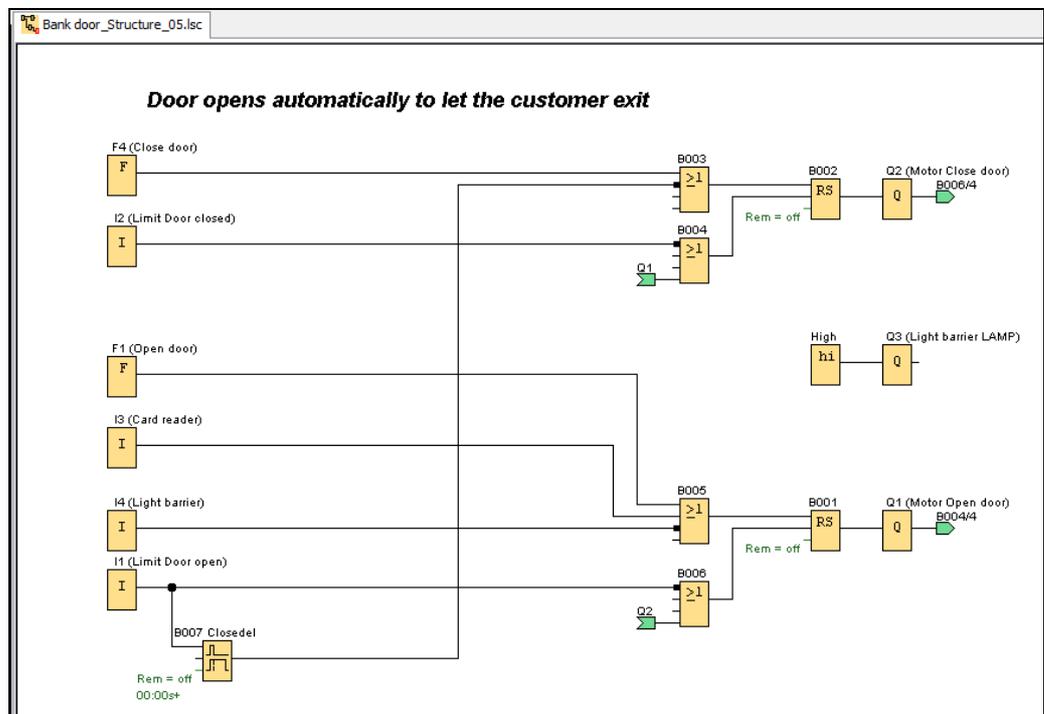


Figure 37: Door opens automatically to let the customer exit

Why does the door open when you start LOGO! ?

How can we avoid this ?

(see solution of the next exercise: flag M8 and message text B008)

18.7 Customer can only enter during banking hours

Now the customer can only open the door during regular banking hours.

It must still be possible to open the door manually from the inside and to leave the bank after hours.

Business hours:

Mo – Fr : 9:00 p.m. to 3:00 a.m.

Sa : 9:00 to 12:00 p.m.

Suggested solution

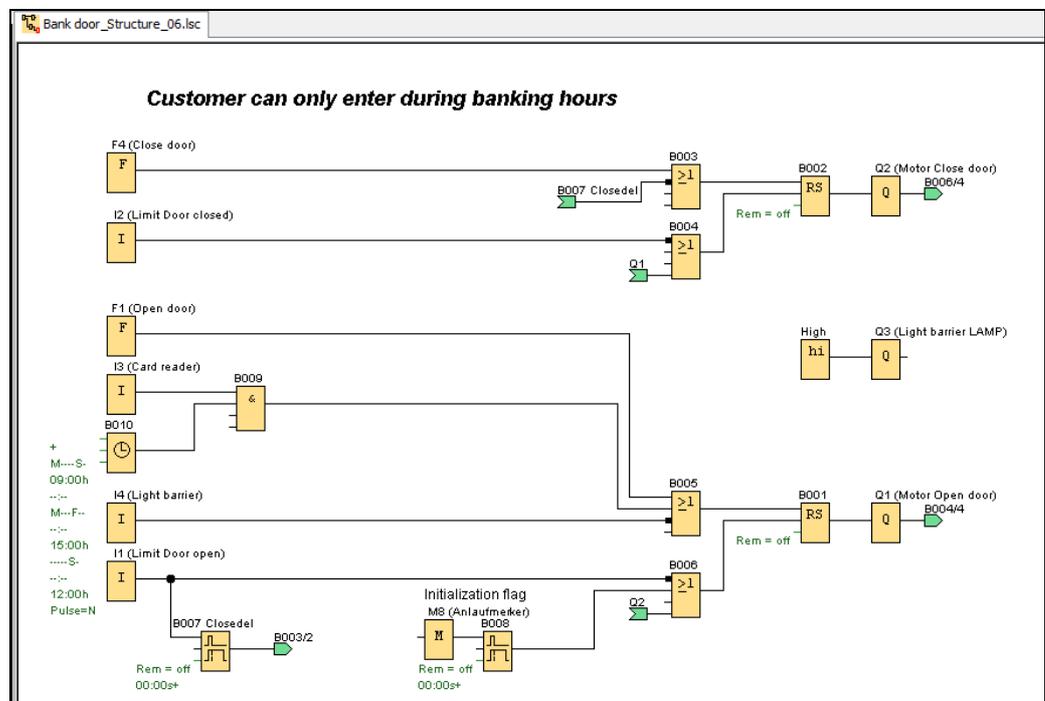


Figure 38: Customer can only enter during banking hours

18.8 Limitation of number of customers in the bank

For security reasons, the number of customers inside the bank is to be limited.

If there are 5 customers inside the bank, the card reader for opening the door is to be blocked. Only if there are less than 4 customers inside the bank, is the reader to be reactivated.

Assumption for our example:

Each time the card reader is operated, exactly one customer enters the bank; each time the light barrier is activated, exactly one customer exits the bank.

Suggested solution

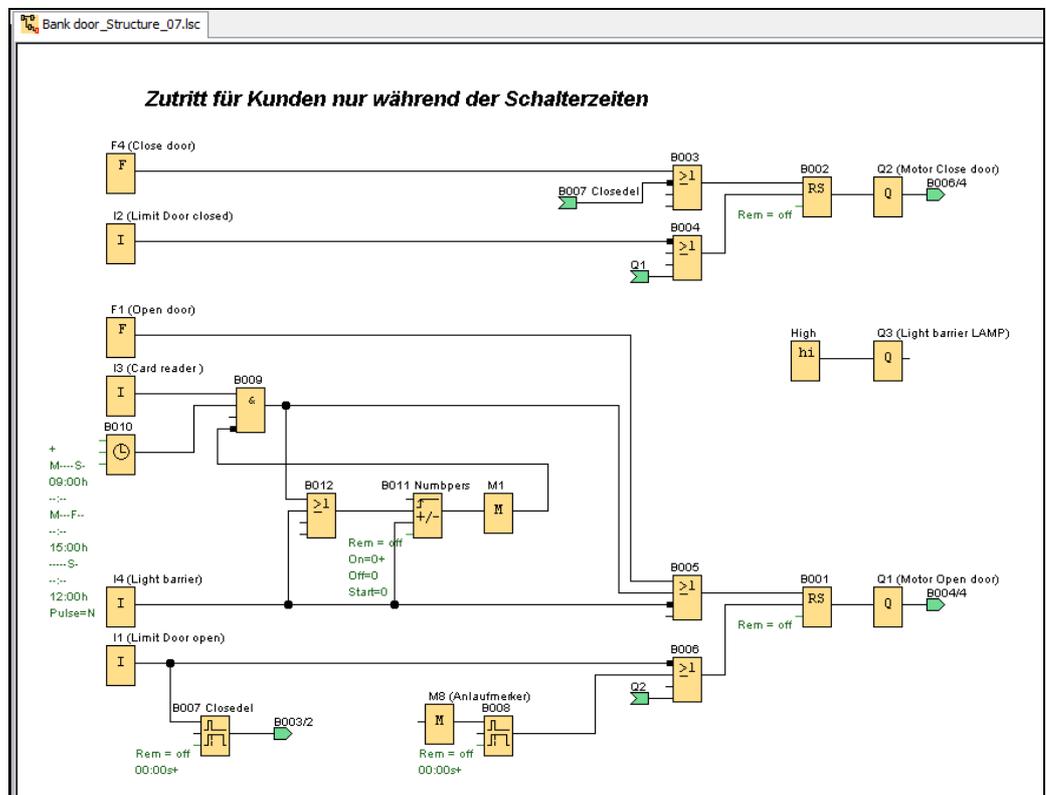


Figure 39: Limitation of number of customers in the bank

18.9 Implementation of the Text Display for customer information

We now want to show the current time and the number of customers on both displays as number and bar graph.

- Turn on the backlighting in both displays using the program and use a display with 16 (32) characters per line.

Suggested solution

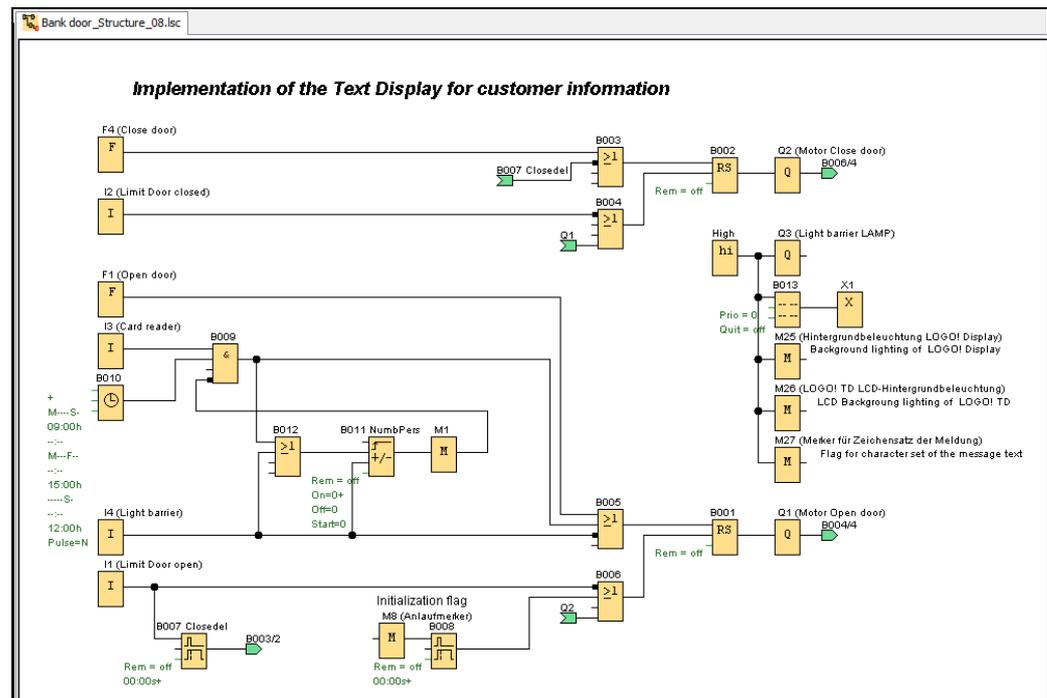


Figure 40: Implementation of the Text Display for customer information

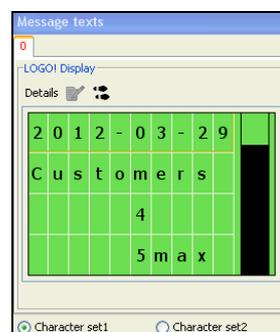


Figure 41: Display of the message texts

We have come to the end of our programming for the functional model "Bank door".

You can now try out many more LOGO! functions using this example.

- Password protection
- Changing parameters in parameter mode
- Protecting parameters
- Changing special parameters despite parameter protection
- Saving values in case of a power outage
- Setting the maximum number of customers with "potentiometer" (depending on daily available personnel)
- And so much more.

19 Appendix

19.1 Overview of the switching elements

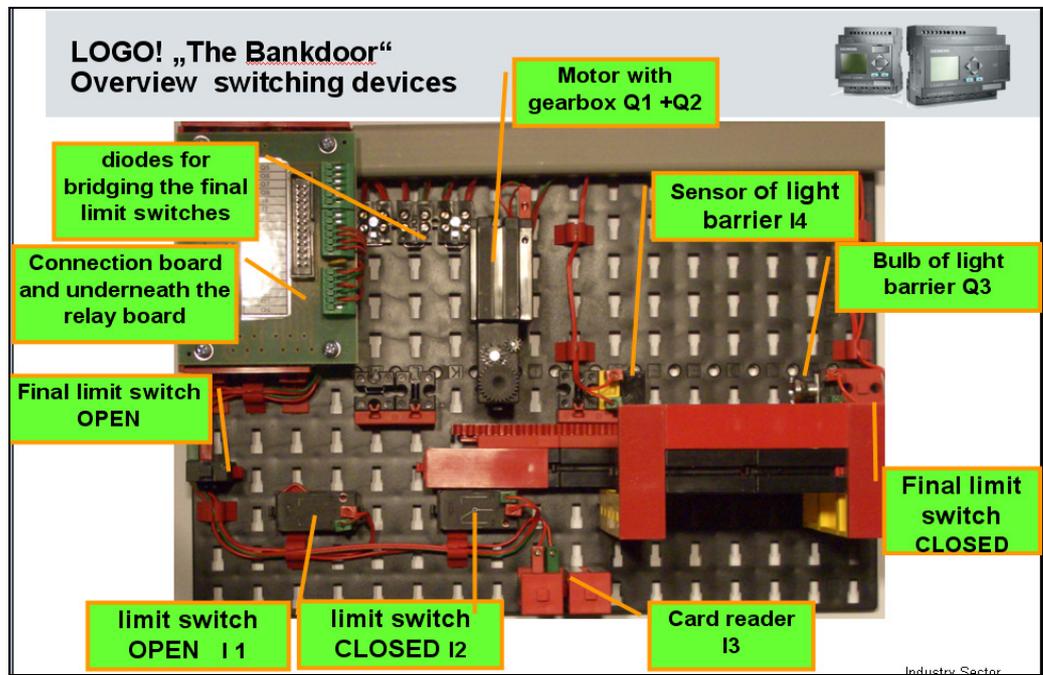


Figure 42: Overview of the switching elements

19.2 Usage of "normal open" or "normal closed" switches

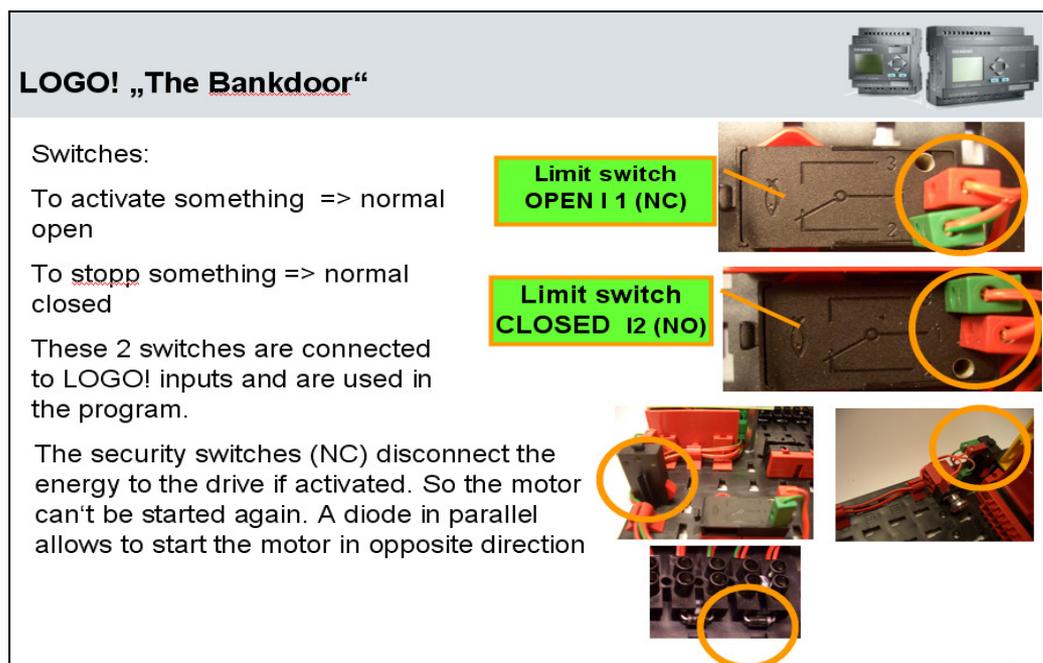


Figure 43: Usage of "normal open" or "normal closed" switches

19.3 Function of the relay board for motor control

The relay board allows to control the motor direction with two digital outputs of the LOGO!

Depending which output is activated the polarity of the motor power is reversed

Additionally the board prohibits to activate the motor in both directions at the same time which would build a short cut at the power supply.

Figure 44: Function of the relay board for motor control

19.4 Design of the training kit LOGO! Learn Advanced

Figure 45: Construction of the training device LOGO! Learn Advanced

20 References

- [1] Online help of the software Siemens LOGO!Soft Comfort V7.0
- [2] Kaftan, J.: LOGO! Course (German). Vogel Business Media, 2009

