SIEMENS

SIMATIC
S7 Distributed Safety

Getting Started Edition 10/2004

Safety Guidelines

This manual contains notices that you should observe to ensure your own personal safety, as well as to protect the product and connected equipment from damage. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

Danger
Indicates that death, severe physical injury, or substantial property damage **will** result if proper precautions are not taken.

Warning
Indicates that death, severe physical injury, or substantial property damage **can** result if proper precautions are not taken.

Caution
Indicates that minor physical injury or property damage can result if proper precautions are not taken.

Caution
Indicates that property damage can result if proper precautions are not taken.

Notice
Indicates important information relating to the product or draws special attention to part of the documentation.

Qualified Personnel

This device/system may only be set up and operated by **qualified personnel**. Qualified personnel are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Proper Use

Note the following:

Warning

This device and its components may only be used for the applications described in the catalog or the technical description, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.

This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

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Disclaimer of Liability

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the specifications in this manual are revised regularly, and any necessary corrections are included in subsequent editions. Suggestions for improvement are welcomed.

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Introduction

These instructions will guide you step-by-step through the configuration and programming with *S7 Distributed Safety* based on a concrete example.

You will learn about basic functions and the special properties of *S7 Distributed Safety*.

It should take one or two hours to work through this example depending on your experience.

Requirements for the Example

The following requirements must be met:

- In order to understand these Getting Started instructions, you need general knowledge about automation technology and also need to be familiar with the base software, STEP 7.
- You need an S7-300 station consisting of:

- Power supply (PS) with 2 A

- CPU 315F-2 DP with an inserted MMC

- Distributed I/O system ET 200S with:

  - Interface module IM 151-1 HIGH FEATURE

  - Power module PM-E 24-48 V DC

  - Terminal modules such as TM-E30S44-01 and TM-E30C44-01

  - Fail-safe digital input module ET 200S 4/8 F-DI DC24V

  - Fail-safe digital output module ET 200S 4 F-DO DC24V / 2A

  - Power module PM-E 24 V DC

  - Digital electronic module 2DI 24 V DC ST

- SIGUARD laser scanner LS4-4/P1 with PROFIBUS interface

- The following software packages must be correctly installed on your programming device featuring an MPI interface:

- STEP 7 as of version 5.3, service pack 1

- S7 Distributed Safety as of version V5.3

- GSD file of the laser scanner (this is included in the product package of the laser scanner; the file is also available in the Internet at http://www.siemens.com/automation/service&support).

- If the hardware components are not available, you can also use the add-on package S7-PLCSIM (hardware simulation program) as of version 5.3. This add-on package will enable you to simulate the hardware components as described in these Getting Started instructions.
- The programming device must be connected to the F-CPU via the MPI/DP interface (187.5 Kbps baud rate).
- The hardware must be fully installed and wired. Relevant information for this is provided in the manual, *ET 200S Distributed I/O System, Fail-Safe Modules*
- A description of the installation and wiring of the CPU 315F-2 DP is provided in the *Getting Started Collection, Automation System S7-300, CPU 31x: Commissioning*.

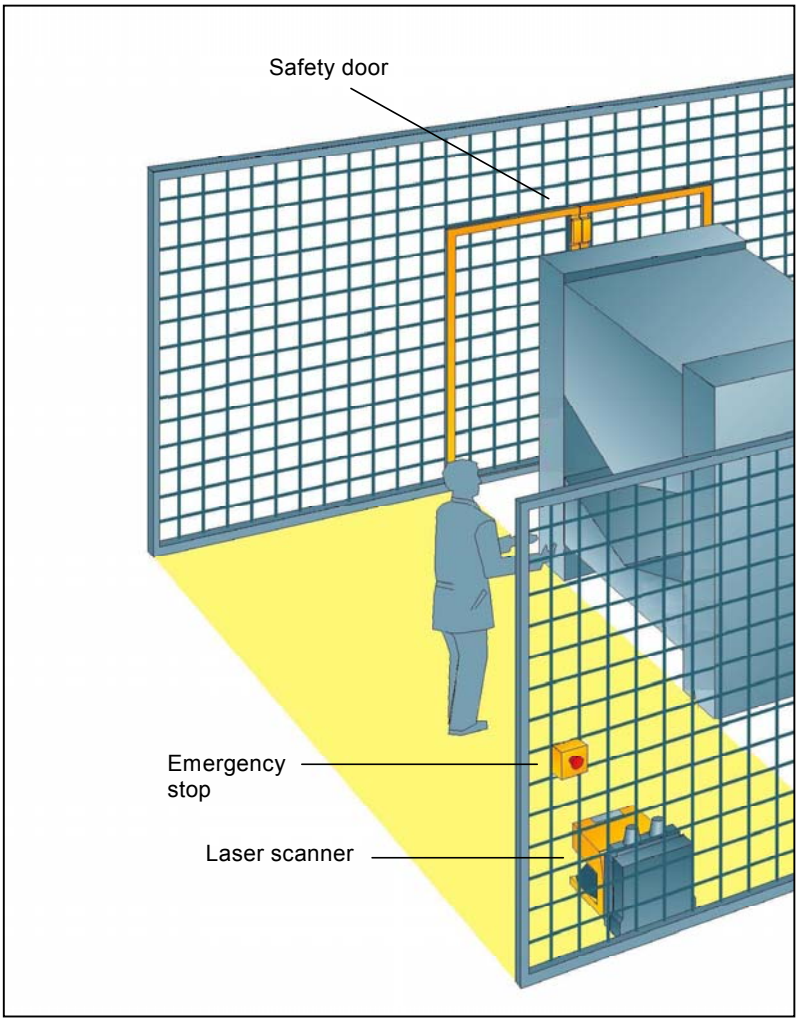
Warning

As a component in plants and systems, the S7-300 is subject to special standards and regulations depending on the area of application. Please observe current regulation on safety and accident prevention such as IEC 60204-1 (Emergency Stop Equipment), EN 954-1 (Safety Related Parts of Control Systems) and IEC 61508 (Functional Safety).

The example in these Getting Started instructions serves as an introduction to configuring and programming with *S7 Distributed Safety*. It does not lead to effective operation in every case. Before you do this, we highly recommend that you refer to the latest version of the manual, *S7 Distributed Safety, Configuring and Programming*. The warnings and additional notes this manual contains must be heeded at all times even if they are not repeated in this document!

Serious injury and damage to machines and equipment may result if these regulations are neglected.

Design and Tasks in the Example



Production cell with access protection

The walk-in production area is monitored with a laser scanner. The service area is secured by a safety door.

Entering the production area or opening the safety door results in a stop or shutdown of the production cell similar to an emergency stop.

The system can only be started when the emergency stop is interlock deactivated, the safety door is closed and the laser scanner detects no one in the protected area. User acknowledgment is required on site to restart production after the emergency stop has been activated or the safety door has been opened.

Procedure

Configuration

Using *HW Config* you configure an ET 200S fail-safe digital input module to connect an emergency stop switch and the position switches for monitoring a safety door, an ET 200S fail-safe digital output module to connect a motor, an ET 200S digital standard electronic module for user acknowledgment and feedback loop, and a laser scanner.

The configuration is described in steps 1 to 8.

Programming

Once the configuration is successfully completed, you can program your safety program.

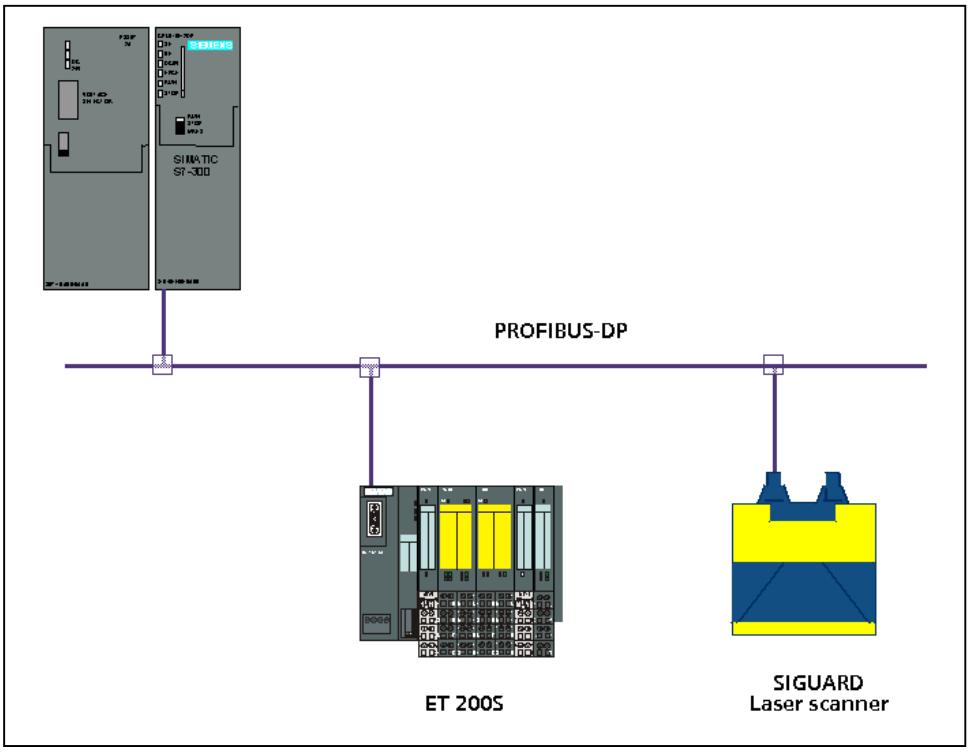
In our example, a fail-safe block is programmed with an emergency stop, a safety door function, a feedback loop (as restart protection when there is an incorrect load) and user acknowledgment for the reintegration. The block is then compiled to a safety program.

The programming is described in steps 9 to 19.

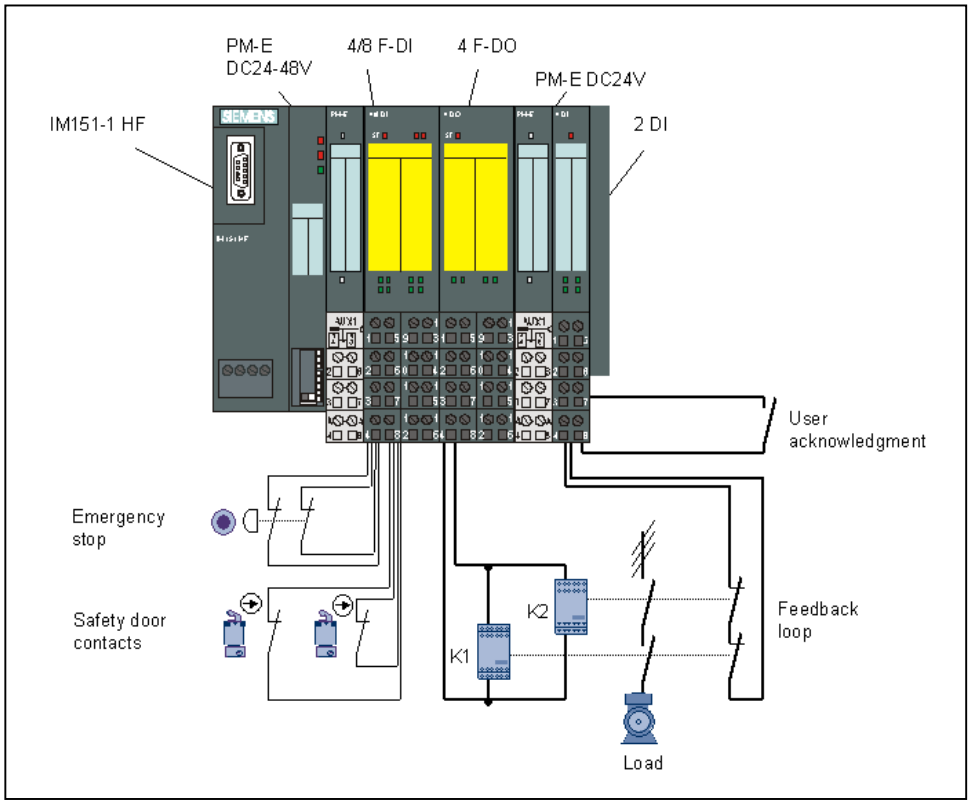
Acceptance test

Supporting measures for acceptance are described in the appendix.

Installation on the PROFIBUS DP



Wiring Overview for ET 200S



Step 1: Wiring

Warning

You may come into contact with live electrical wires connected to the power mains. Only wire the S7-300 and ET 200S when they are disconnected from the mains.

A description of the installation and wiring of the CPU 315F-2 DP is provided in the *Getting Started Collection, Automation System S7-300, CPU 31x: Commissioning*.

Configuration of the Hardware

Using *HW Config*, you configure:

- CPU 315F-2 DP
- Distributed I/O system ET 200S with:

  - Interface module IM 151-1 HIGH FEATURE

  - Fail-safe digital input module ET 200S for connecting an emergency stop switch and the position switches for monitoring a safety door

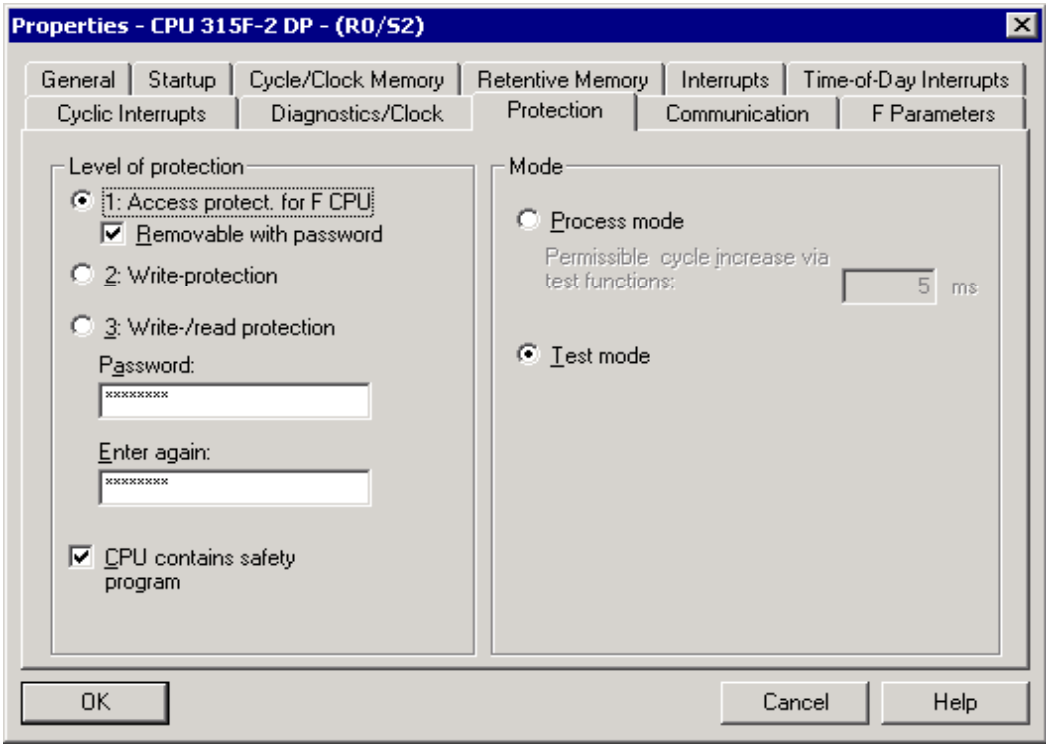
  - Fail-safe digital output module ET 200S for connecting a motor

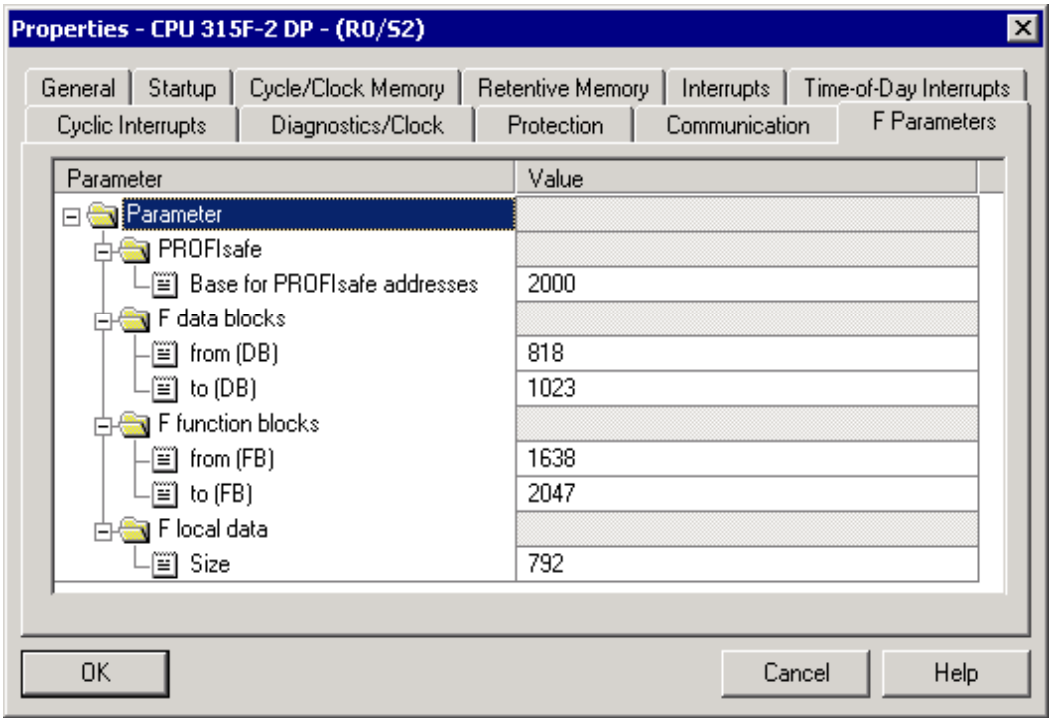
  - Digital standard electronic module ET 200S for user acknowledgment and feedback loop
- Laser scanner for area monitoring (fail-safe DP standard slave).

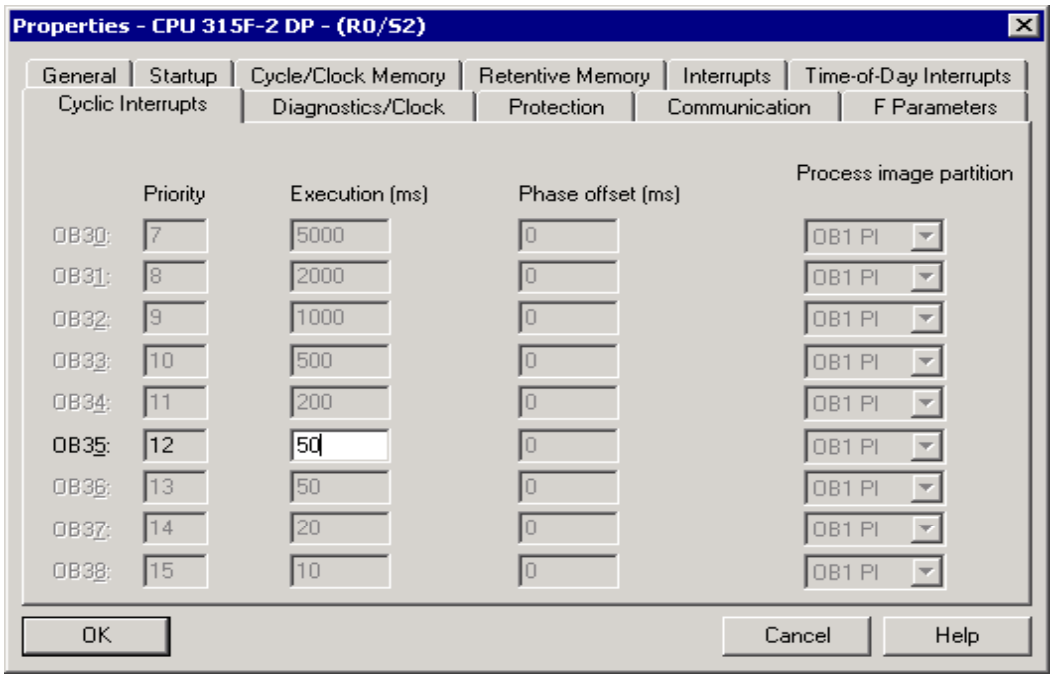
Step 2: Configuration of the CPU 315F-2 DP using *HW Config*

Sequence	Action	Result
1	Create a new project in the SIMATIC Manager (for example, "DS_Getting Started") and insert a SIMATIC 300 station.	The SIMATIC 300 station appears in the SIMATIC Manager.
2	Open *HW Config* by selecting the SIMATIC 300 station and open the object (for example, with Ctrl+Alt+O).	*HW Config* opens.
3	In the "Hardware Catalog" window, select the "Standard" hardware profile from the "Profile" pull-down list .	
4	Drag and drop a rail from the hardware catalog into the *HW Config* window, the power supply module (for example, PS307 2A) and the desired F-CPU (for example, CPU 315F-2 DP). Required path: 1.) Rail: \SIMATIC 300\RACK-300 2.) Power supply: \SIMATIC 300\PS-300 3.) CPU 315F: \SIMATIC 300\CPU-300\CPU 315F-2 DP (6ES7 315-6FF01-0AB0).	A dialog box opens for setting the PROFIBUS properties of the new subnet.
5	Click on "New". The dialog box for setting the PROFIBUS properties of the new subnet shows the newly created PROFIBUS subnet. Close the dialog box with "OK."	The fail-safe module will be later connected to the F-CPU over the new PROFIBUS subnet.
6	Double-click on the CPU 315F-2 DP in the configuration window to set the properties of the F-CPU.	The dialog box "Properties - CPU 315F-2 DP" opens.

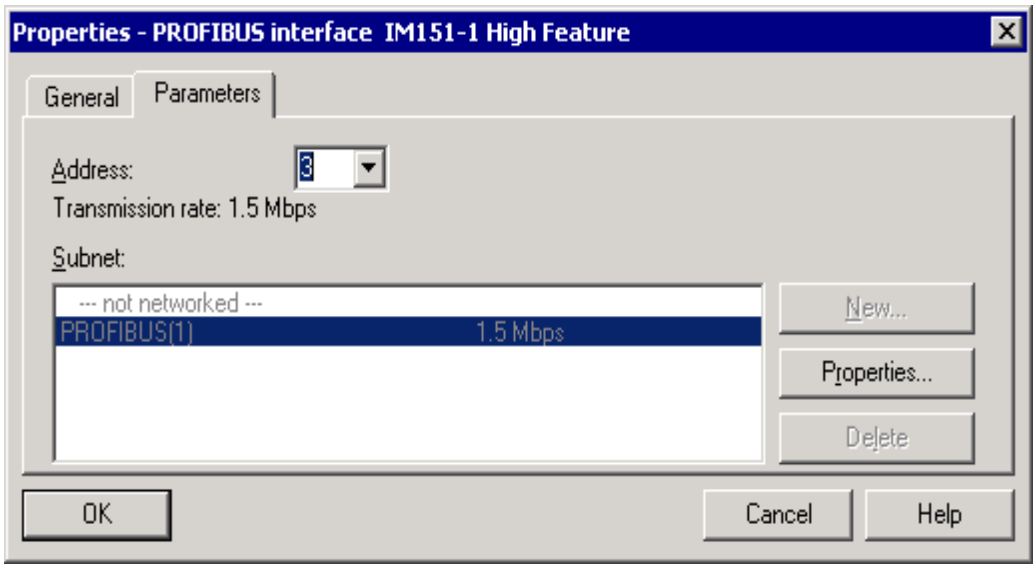
Sequence	Action	Result
7	Select the "Protection" tab. Make the following settings in the "Level of protection" field: 1.) Press the option button "1: Access protection for F-CPU" and select the option "Removable with password". 2.) Press the option button "3: Write/read protection" and enter a max. 8-digit password for the F-CPU, for example, "pw_fcpu". Type your password again in the field "Enter again". 3.) Mark the check box "CPU contains safety program". The dialog box should now appear as follows:	



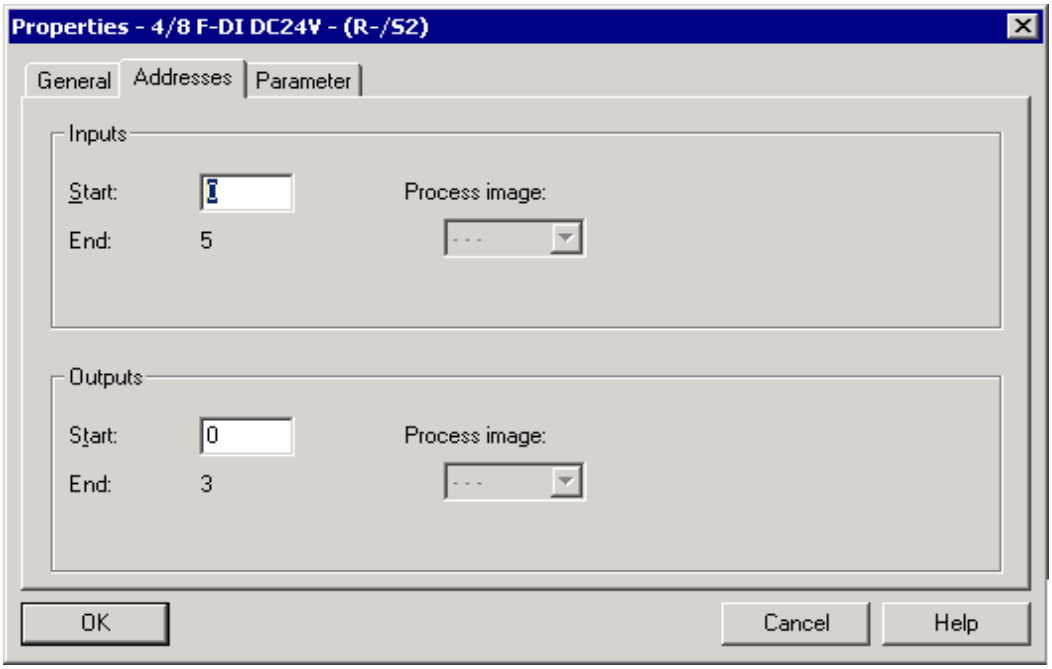
Sequence	Action	Result
8	Change to the "F-Parameters" tab. Here, you can change the following parameters or accept the default settings: - Basis for the PROFIsafe addresses - Number range for F-data blocks - Number range for F-function blocks - Amount of local data used by the F-system. Leave the default values for our example. The dialog box appears as follows:  **Note**: F-blocks are automatically added during the compilation of the safety program to ensure that it is runtime capable. You must reserve a range of numbers for the automatically added F-blocks. Use the default settings for our example. If the configured band of numbers is insufficient, *S7 Distributed Safety* signals this with an error message. You must then increase the size of the number band accordingly.	
9	Click "OK" to confirm.	The message window closes.

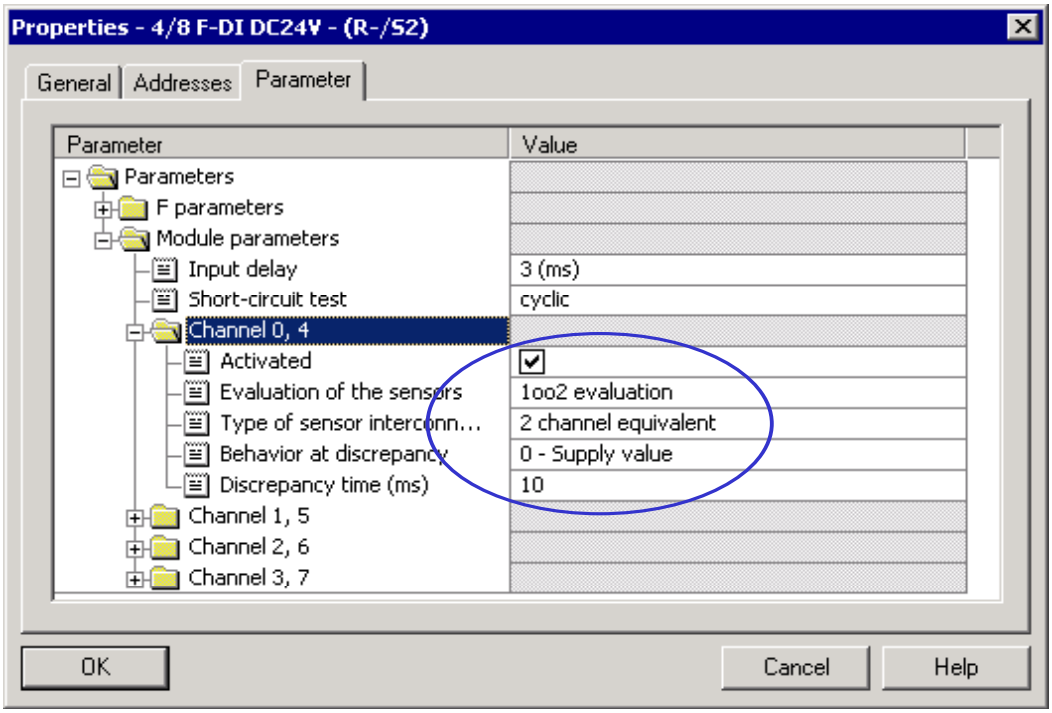
Sequence	Action	Result
10	Change to the "Cyclic Interrupts" tab and set the call time for the cyclic interrupt OB 35 to 50 ms. (The safety program is called and run at fixed time intervals in the cyclic interrupt OB.) The dialog box should now appear as follows: 	
11	Click "OK" to confirm.	The dialog box "Properties - CPU 315F-2 DP" closes. The configuration of the F-CPU is now completed.

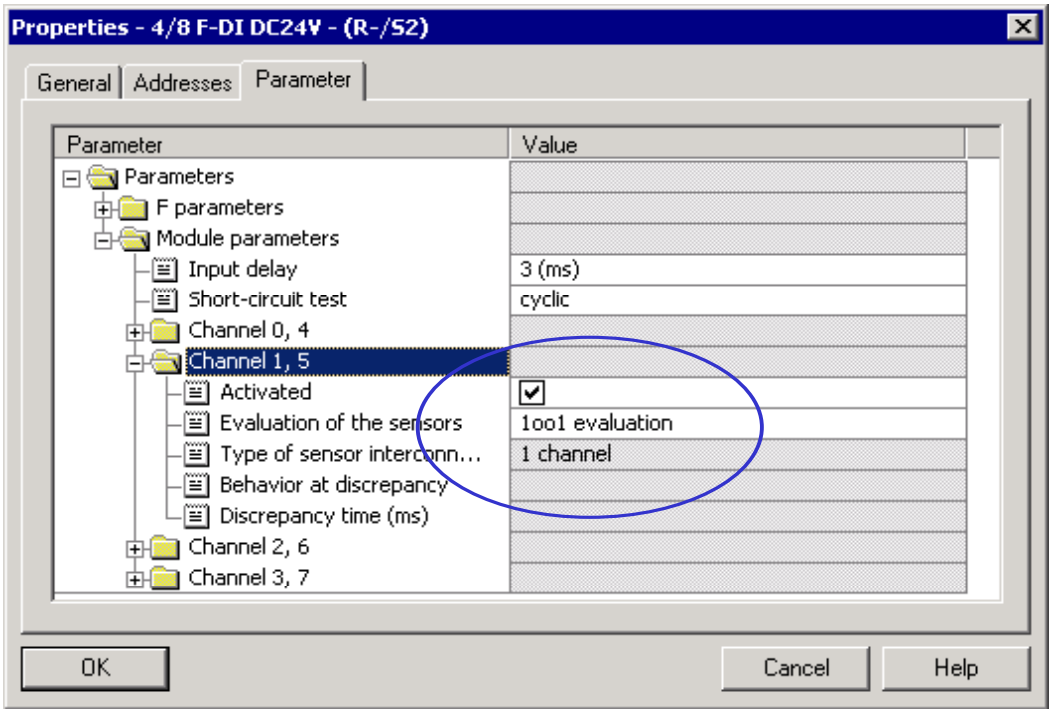
Step 3: Configuration of an ET 200S Distributed I/O System Using *HW Config*

Sequence	Action	Result
1	In the "Hardware Catalog" window, select the "Standard" hardware profile from the "Profile" pull-down list.	
2	Drag and drop the IM 151-1 HIGH FEATURE interface module from the hardware catalog (PROFIBUS DP\ET 200S) onto the PROFIBUS subnet in the *HW Config* window.	A dialog box opens for setting the PROFIBUS interface properties.
3	Enter "3" as the address. The dialog box should now appear as follows:  Close the dialog box with "OK". You have now set up a DP station with the address 3 on PROFIBUS subnet "(1)".	
4	Double-click on the IM 151-1 HIGH FEATURE in the configuration window to set the properties of the interface module.	The dialog box "Properties - DP slave" opens.
5	Confirm your settings with "OK".	The dialog box "Properties - DP slave" closes.
6	Drag and drop a PM-E 24-48 V DC power module from the hardware catalog to slot 1 of the IM 151-1 HIGH FEATURE interface module. Required path: 1.) \PROFIBUS DP\ET200S\IM151-1 HIGH FEATURE\PM	The configuration of the IM151-1 HIGH FEATURE is now completed.

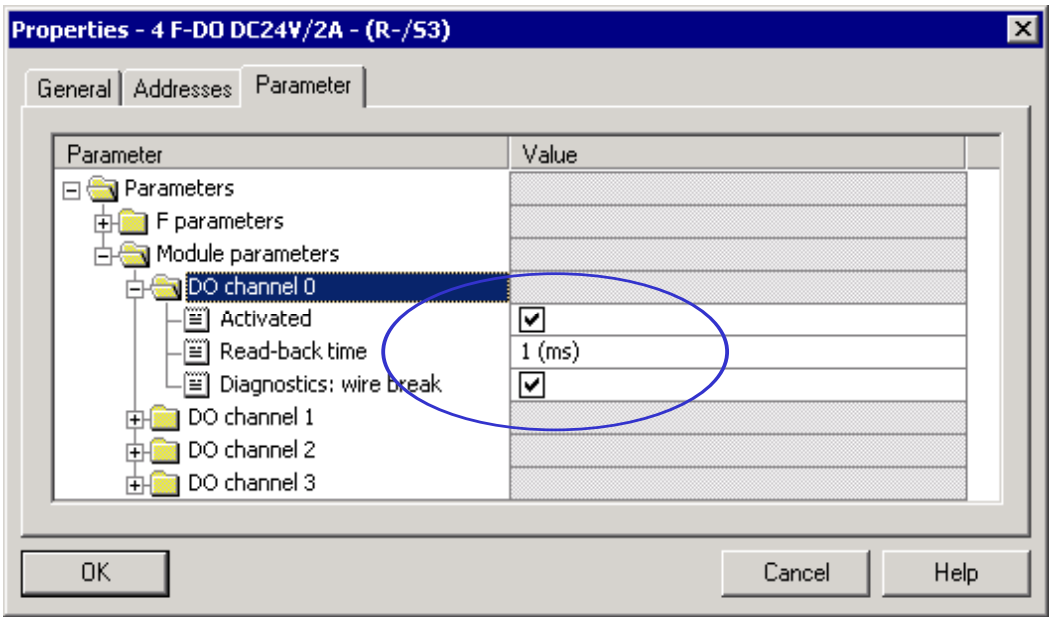
Step 4: Configuration of an F-DI Module for Connecting an Emergency Stop Switch and the Position Switches for Monitoring a Safety Door

Sequence	Action	Result
1	Drag and drop a 4/8 F-DI DC24V fail-safe digital input module from the hardware catalog to slot 2 of the ET 200S. Required path: 1.) \PROFIBUS DP\ET200S\IM151-1 HIGH FEATURE\DI (6ES7 138-4FA01-0AB0)	
2	Double-click on the 4/8 F-DI DC24V in the configuration window to set the properties of the input module.	The dialog box "Properties - 4/8 F-DI DC24V" opens.
3	Select the "Addresses" tab. Leave the default address "0" for our example. The dialog box appears as follows:  **Note**: If you wish to change the values, you need to ensure that the start addresses of the input and output data range are assigned identical values.	

Sequence	Action	Result
4	Change to the "Parameter" tab. Here, you can change the following parameters or accept the default settings: - F-parameters (PROFIsafe parameters) - Module parameters (global module parameters) - Channel-specific parameters. In our example, channels 0 and 4 should be connected to a two-channel emergency stop switch (emergency stop). Make the following settings (as highlighted in the figure):  **Note about "F-Parameters"**: The PROFIsafe addresses must be unique throughout the network and for all stations. The addresses are assigned automatically to prevent incorrect assignment of parameters. The PROFIsafe destination address must be set per DIL switch on the F-module. The PROFIsafe source address is assigned by the F-CPU ("Base for PROFIsafe addresses" F-parameter). A valid current safety message frame must be received by the F-CPU within the fail-safe monitoring time. Otherwise, the fail-safe module goes to the safe state. The fail-safe monitoring time must be set high enough for the message frame delay to be tolerated on the one hand, and low enough for the process to react as fast as possible and without impairment when an error occurs on the other. The calculation table 'S7cotia.xls' can aid you in determining the optimal time. This file is available on the Internet: http://www4.ad.siemens.de/ww/view/de/ under the contribution ID 19138505. Leave the default settings for the F-parameters unchanged for our example. **Note about "Module parameters"**: For a cyclic short-circuit test, you have to use the internal sensor supplies for all sensors connected to the F-module and deactivate any unused channels. Otherwise, errors will be detected on these channels. Leave the default settings for the module parameters unchanged for our example. **Note about "Channel x, y" parameters**: The "evaluation of the sensors" and "type of sensor interconnection" should be configured according to the sensor wiring. The sensor wiring and the safety quality of the sensor are decisive for the safety class that can be achieved. Deactivate the channels that are not used. **Note about "1oo2 evaluation", "Behavior at discrepancy" and "Discrepancy time" (see highlight in figure)**: The "Discrepancy time" configure here starts when different levels (or same levels with nonequivalence testing) are detected for two associated input signals ("1oo2 evaluation" of the sensor). When discrepancy time expires within the module and depending on the configuration of the discrepancy response, the "last, valid value" or "0" from the affected input channel is made available to the F-CPU.	

Sequence	Action	Result
5	In our example, channels 1 and 5 should be connected to the position switches for monitoring a two-channel safety door. Make the following settings (as highlighted in the figure): 	
6	Deactivate the unused channels 2, 6 and 3, 7 by unmarking the "Activated" check boxes and confirm your changes with "OK".	A message window opens informing you that the safety program must be compiled again due to your change.
7	Click "Close" to confirm.	The message window closes.
8	Confirm your settings with "OK".	The dialog box "Properties - 4/8 F-DI DC24V" closes. The configuration of the F-input module is now completed.

Step 5: Configuration of an F-DO Module for Connecting a Motor

Sequence	Action	Result
1	Drag and drop a 4 F-DO DC24V / 2A fail-safe digital input module from the hardware catalog to slot 3 of the ET 200S. Required path: 1.) \PROFIBUS DP\ET200S\IM151-1 HIGH FEATURE\DO (6ES7 138-4FB01-0AB0)	
2	Double-click on the 4 F-DO DC24V / 2A in the configuration window to set the properties of the output module.	The dialog box "Properties - 4 F-DO DC24V / 2A" opens.
3	Select the "Addresses" tab (See F-DI Configuration above). Leave the default address "6" for our example. **Note**: If you wish to change the values, you need to ensure that the start addresses of the input and output data range are assigned identical values.	
4	Change to the "Parameter" tab. Here, you can change the following parameters or accept the default settings: - F-parameters (PROFIsafe parameters) - Channel-specific parameters. In our example, a motor should be indirectly switched on channel 0 through two contactors. Make the following settings (as highlighted in the figure):  **Note about "F-Parameters"**: See Step 4. Leave the default settings for the F-parameters unchanged for our example. **Note about "DO channel x" parameters**: Each output channel has its own configurable readback time. This time specifies the maximum duration of the shutdown test for the corresponding channel and it therefore also specifies the readback time for the shutdown cycle of the channel. You use a wire break test for monitoring the connection of the output to the load.	

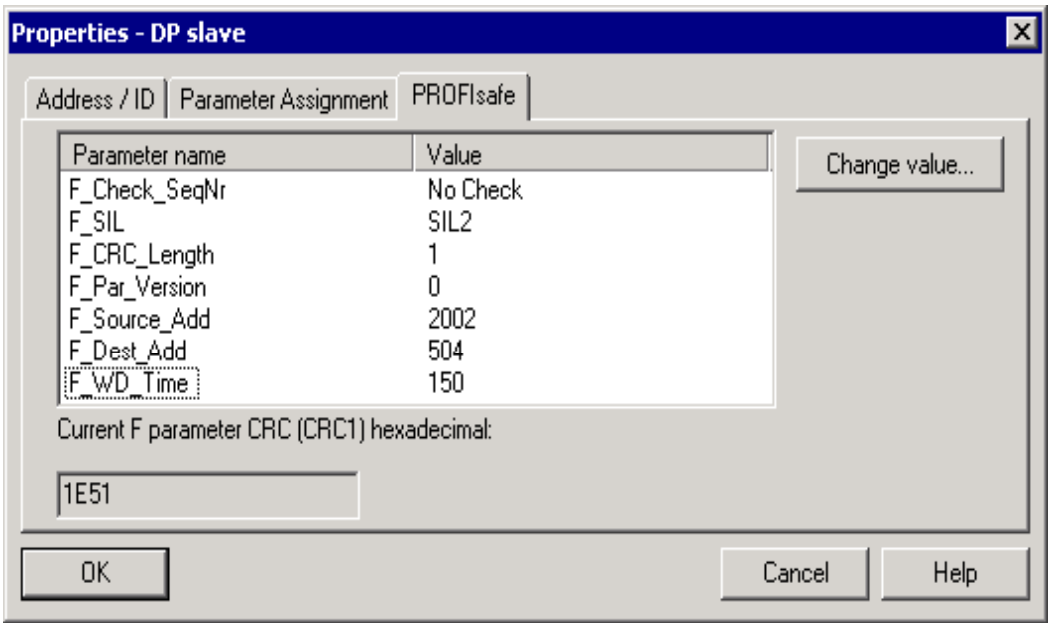
Sequence	Action	Result
5	Deactivate the unused DO channels 1, 2 and 3 and confirm your changes with "OK".	A message window opens informing you that the safety program must be compiled again due to your change.
6	Click "Close" to confirm.	The message window closes.
7	Confirm your settings with "OK".	The dialog box "Properties - 4 F-DO DC24V / 2A" closes. The configuration of the F-output module is now completed.

Step 6: Configuration of a Standard DI Module for User Acknowledgment and the Feedback Loop

Sequence	Action	Result
1	Drag and drop a PM-E 24 V DC power module from the hardware catalog to slot 4 of the standard DI module. **Note**: The power module has to be configured because a combination of F-DI / F-DO modules and standard DI / DO / FM modules **is not allowed within a voltage group** for AK6/SIL3/Cat.4 applications. A new voltage group must always begin with a power module.	
2	Drag and drop a 2DI 24 V DC ST digital electronic module from the hardware catalog to slot 5 of the ET 200S for non-safe signals (user acknowledgment and feedback loop) and set the start address to "11" for our example (same procedure as for the standard program). Required path: 1.) \PROFIBUS DP\ET200S\IM151-1 HIGH FEATURE\DI	The configuration of the electronic module 2DI 24 V DC ST is now completed.

Step 7: Configuration of a SIGUARD LS4-4/P1 Laser Scanner (fail-safe DP standard slave)

Sequence	Action	Result
1	In the "Hardware Catalog" window, select the "Standard" hardware profile from the "Profile" pull-down list .	
2	Drag and drop a laser scanner (for example, "SIGUARD Laser Scanner LS4-4/P1") from the hardware catalog (PROFIBUS DP\Additional Field Devices\General) into the window of *HW Config*. **Note**: The GSD file for the laser scanner must be already installed on the PG/PC.	A dialog box opens for setting the PROFIBUS interface properties.
3	Enter "4" as the address and confirm with "OK". You have now configured a DP station with address 4 on the PROFIBUS subnet "(1)" (See Step 3, IM 151-1 Configuration).	The dialog box "Properties - PROFIBUS Interface" closes.
4	Select the laser scanner in the configuration window and double-click in the line of the laser scanner below in the detail view to set its properties.	The dialog box "Properties - DP slave" opens.

Sequence	Action	Result
5	Select the "Address/ID" tab. Leave the default address "12" for our example. **Note**: If you wish to change the values, you need to ensure that the start addresses of the input and output data range are assigned identical values.	
6	Change to the "PROFIsafe" tab and make the following settings: 1.) Select the "F_Dest_Add" parameter, click on the "Change value" button and enter (500 + DP address =) "504". Close the dialog box with "OK". 2.) Select the "F_WD_Time" parameter, click on the "Change value" button and enter a value in ms for the F-monitoring time in the fail-safe DP standard slaves, for example, "150". The dialog box should now appear as follows:  **Note about F_WD_Time**: A valid current safety message frame must be received by the F-CPU within the fail-safe monitoring time. The fail-safe monitoring time must be set high enough for the message frame delay to be tolerated on the one hand, and low enough for the process to react as fast as possible and without impairment when an error occurs on the other. The "F_WD_Time" parameter can be set in 1 ms increments. The range of the "F_WD_Time" parameter is specified by the device database file (*.GSD file).	
7	Confirm your change with "OK".	A message window opens informing you that the safety program must be compiled again due to your change.
8	Click "Close" to confirm.	The message window closes.
9	Confirm your settings with "OK".	The dialog box "Properties - DP slave" closes. The configuration of the SIGUARD LS4-4/P1 laser scanner is now completed.

Step 8: Save, Compile and Download the Hardware Configuration

Sequence	Action	Result
1	Close the hardware configuration by calling the menu command **Station > Save and Compile**.	Your project is compiled.
2	Transfer the configuration when the F-CPU is in STOP with the menu command **PLC > Download to Module**.	The "Select Station Address" dialog box opens.
3	Select the F-CPU and confirm with "OK".	The data are transferred from the PG to the F-CPU. You have now finished configuration of the hardware for the tasks involved in the example.

Summary: Configuration of the Hardware

Up until now, you have used *HW Config* to configure:

- CPU 315F-2 DP
- Distributed I/O system ET 200S with:

  - Interface module IM 151-1 HIGH FEATURE

  - Fail-safe digital input module ET 200S for connecting an emergency stop switch and the position switches for monitoring a safety door

    - Start addresses of the output and input data ranges: both 0
    - Channels 0 and 4 for emergency stop
    - Channels 1 and 5 for safety door position switches

  - Fail-safe digital output module ET 200S for connecting a motor

    - Start address of the output and input data ranges: both 6
    - Channel 0 for indirect switching of a motor through two contactors

  - Digital standard electronic module ET 200S for user acknowledgment and feedback loop

    - Start address: 11

- Laser scanner for area monitoring (fail-safe DP standard slave)

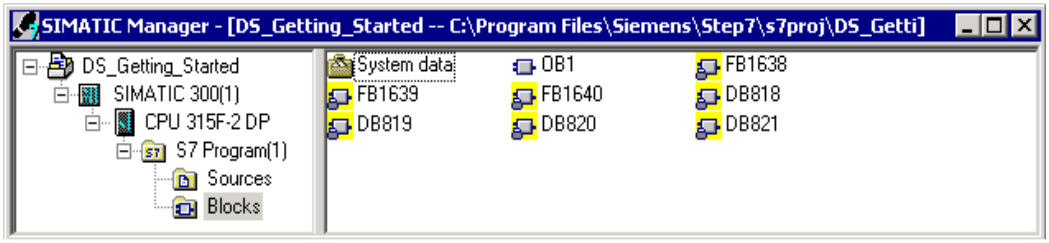
  - Start address of the output and input data ranges: both 12.

Now you are ready to program the safety program.

Programming the Safety Program

F-I/O Data Blocks

For each compilation in *HW Config,* an "F-I/O DB" is automatically created for each F-I/O and a symbolic name is entered for it in the symbol table. You can view the F-I/O DBs generated for the example I/O in the block container. These are the F-data blocks DB 819, DB 820 and DB 821.



The symbolic name of the F-I/O DB is made up of the fixed prefix "F," the start address of the F-I/O, and the names (maximum 17 characters) entered in the F-I/O object properties in *HW Config*.

Symbolic name in our example:

- "F00000_4_8_F_DI_DC24V": fail-safe digital input module 4/8 F-DI DC24V (= DB 819)
- "F00006_4_F_DO_DC24V_2A": fail-safe digital output module 4 F-DO DC24V / 2A (= DB 820)
- "F00012_196": SIGUARD LS4-4/P1 laser scanner (= DB 821).

You can access the variables of the F-I/O DB with "fully qualified DB access" (that is, by specifying the symbolic name of the F-I/O DB and by specifying the name of the variable).

F-Shared DB

The "DB 818" in the block container of our example is "F-Shared-DB". The F-shared data block is a fail-safe block that is automatically inserted and contains all of the shared data of the safety program and additional information needed by the F-system.

Procedure

In our example, a fail-safe block should be programmed with a safety door function, an emergency stop function (safety circuit for shutdown when an emergency stop occurs, when the safety door is open or when someone enters the protected area monitored by the laser scanner), a feedback loop (as restart protection when there is an incorrect load) and user acknowledgment for the reintegration. The block should then compiled to a safety program.

Inputs and outputs in the safety program

Following the configuration of the hard as described in steps 1 to 8, the following fail-safe I/O DBs are available for programming the example safety program:

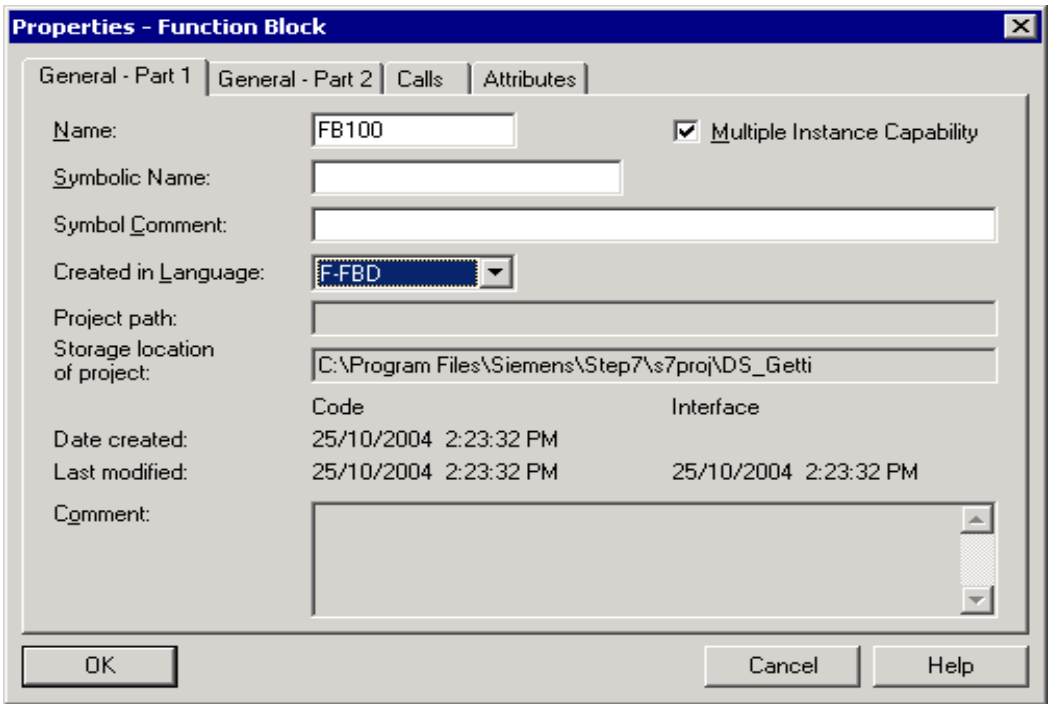
Configured Hardware	Start add.	Symbolic name	F-I/O DB
Fail-safe digital input module 4/8 F-DI DC24V (6ES7 138-4FA01-0AB0)	0	F00000_4_8_F_DI_DC24V	DB 819
Fail-safe digital output module 4 F-DO DC24V / 2A (6ES7 138-4FB01-0AB0)	6	F00006_4_F_DO_DC24V_2A	DB 820
Digital electronic module 2DI 24 V DC ST	11	-	-
SIGUARD LS4-4/P1 laser scanner	12	F00012_196	DB 821

Specify symbolic names for the fail-safe input and outputs (as you do in the standard program). In our example, these are:

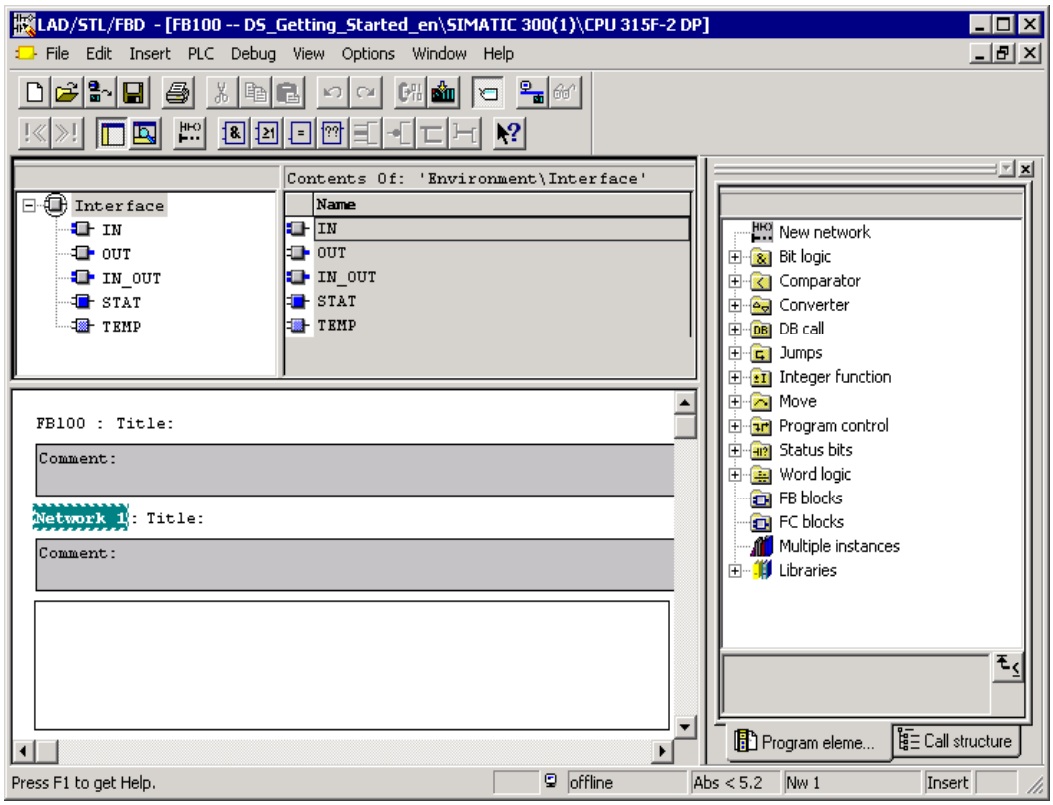
Inputs and outputs in the safety program	Symbolic name
I0.0 for emergency stop	Emergency stop
I0.1 for safety door position switch	Safety door contact 1
I0.5 for safety door position switch	Safety door contact 2
Q6.0 for motor starter	Load
I11.0 for acknowledgment	Ack. button
I11.1 for feedback loop	Feedback loop
Q12.0 for protected area control	LS4_Protected_field_bit_0
Q12.1 for protected area control	LS4_Protected_field_bit_1
Q12.2 for protected area control	LS4_Protected_field_bit_2
I12.7 for safe shutdown	LS4_OSSD

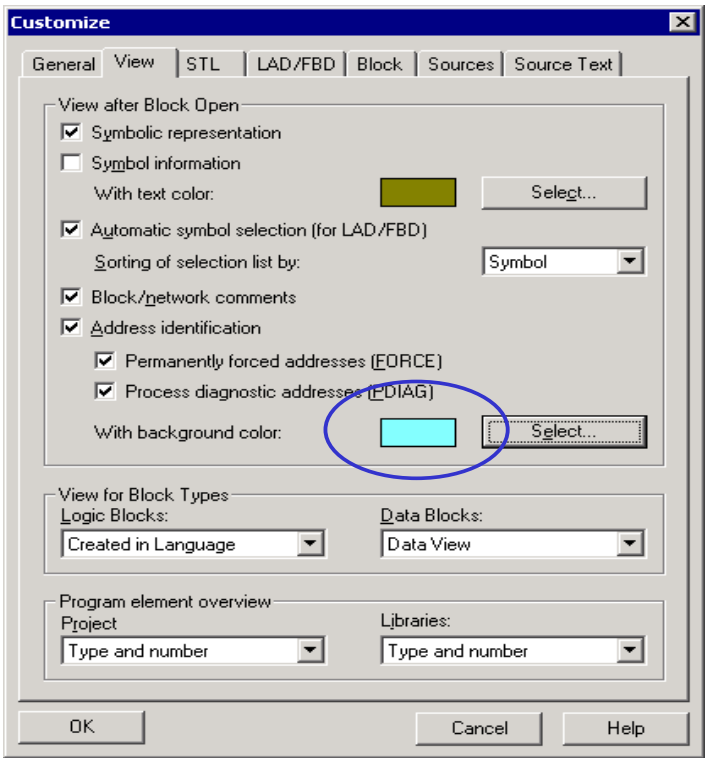
Note: Adhere to the rules for creating the program structure as described in the chapter "Defining the Program Structure" of the *S7 Distributed Safety, Configuring and Programming* manual.

Step 9: Creating an F-FB with the F-FBD Programming Language

Sequence	Action	Result
1	Insert a F-FB. Open the block container of the *SIMATIC Manager* and select the menu command **Insert > S7 Block > Function Block**. You can also use the "Insert New Object" shortcut menu.	The dialog box "Properties - Function Block" opens.
2	In the "General - Part 1" tab, enter a name for the F-FB (for example, "FB100"). Select "F-FBD" as the programming language. The dialog box should now appear as follows: 	
3	Close the dialog box with "OK".	The F-FB is generated in the block container and highlighted with a yellow background.

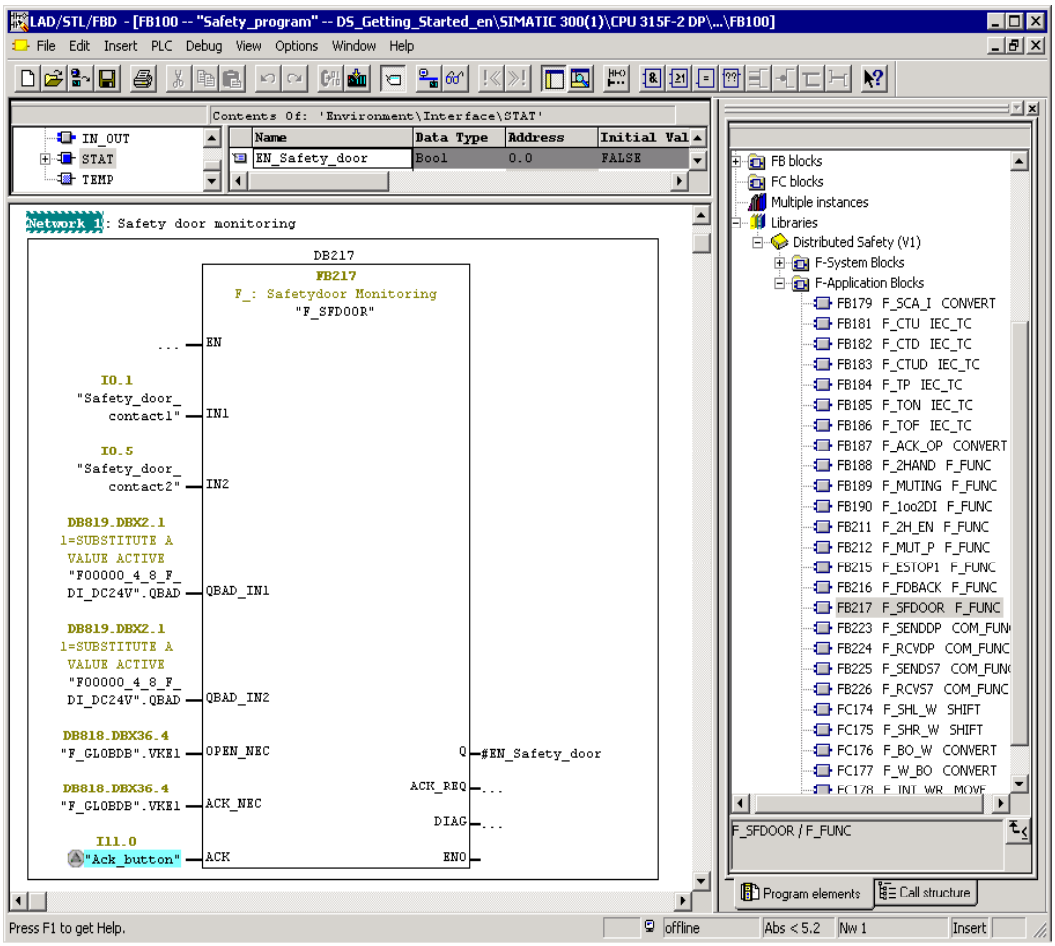
Step 10: Edit and Save the F-FB in the *FBD Editor*

Sequence	Action	Result
1	Double-click on the F-FB in *SIMATIC Manager*.	The dialog box for assigning a password for the safety program opens.
2	Enter (2x) a max. 8-digit password for the safety program, for example, "pw_fprog".	The *FBD/LAD Editor* opens, see figure below.
3	 **Note**: The F-FBD and F-LAD programming languages correspond in principle to the standard FBD/LAD languages. The standard *FBD/LAD editor* in *STEP 7* is used for programming. The primary differences between the F-FBD and F-LAD programming languages and their standard counterparts are limitations in the operation set and the data types and the address areas that can be used (see *S7 Distributed Safety, Configuring and Programming* manual). The following are displayed in the F-Program Elements Catalog: • Supported operations • F-FBs and F-FCs from the block container of your S7 program • F-blocks from F-libraries, e.g., F-application blocks of *Distributed Safety* F-library (V1), for safety door monitoring etc. • Multiple instances.	

Sequence	Action	Result
4	Assign special colors for non-safe data in the F-block. To do this, select the menu command **Options > Customize**, open the "View" tab, press the "Select" button and select a "Background Color"; In our example, this is 'light blue' (as highlighted in the figure below). 	
5	Confirm your change with "OK".	The "Customize" dialog box closes. Now non-safe data will be highlighted in light blue in the safety program.

Step 11: Programming the Safety Door Function

Sequence	Action	Result
1	Insert the following statical variable for the F-FB: - "EN_Safety_door" (enable safety door).	
2	Insert an FB 217 "F_SFDOOR" (safety door monitoring) into the fail-safe application block from the F-application blocks container and supply the inputs and outputs as shown in the figure below.	



The non-safe "Acknowledgment button" signal in the standard program has a light blue background.

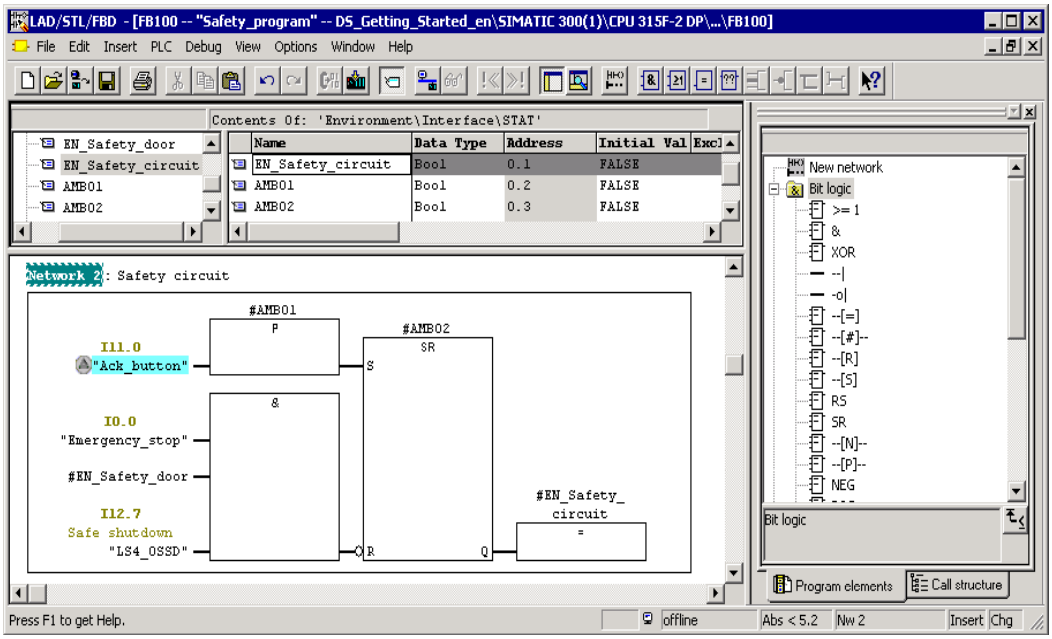
Connect the FB 217

Inputs/outputs	Parameters	Data type	Description	Default
I0.1	IN1	BOOL	Input 1	0
I0.5	IN2	BOOL	Input 2	0
DB819.DBX2.1	QBAD_ IN1	BOOL	QBAD signal from the F-I/O DB of the input IN1*	0
DB819.DBX2.1	QBAD_ IN2	BOOL	QBAD signal from the F-I/O DB of the input IN2*	0
DB818.DBX36.4	OPEN_NEC	BOOL	Fully qualified access to Variable RLO1 from F-shared DB**	1
DB818.DBX36.4	ACK_NEC	BOOL	Fully qualified access to Variable RLO1 from F-shared DB**	1
I11.0	ACK	BOOL	User acknowledgment (per button)	0
#EN_ Safety_door	Q	BOOL	Output (enable safety door)	0
	ACK_REQ	BOOL	Acknowledgment request	0
	DIAG	BYTE	Service information	B#16#0

* = Both the inputs QBAD_IN1 and QBAD_IN2 must be interconnected. In our example, they are interconnected to the QBAD signal from the F-I/O DB of the 4/8 F-DI to which the safety door position switches are connected. You can see the block number of the F-I/O DB from the symbolic name in the symbol table or in the *SIMATIC Manager*.
** = OPEN_NEC: 1 = Opening required at startup / ACK_NEC: 1 = Acknowledgment necessary.

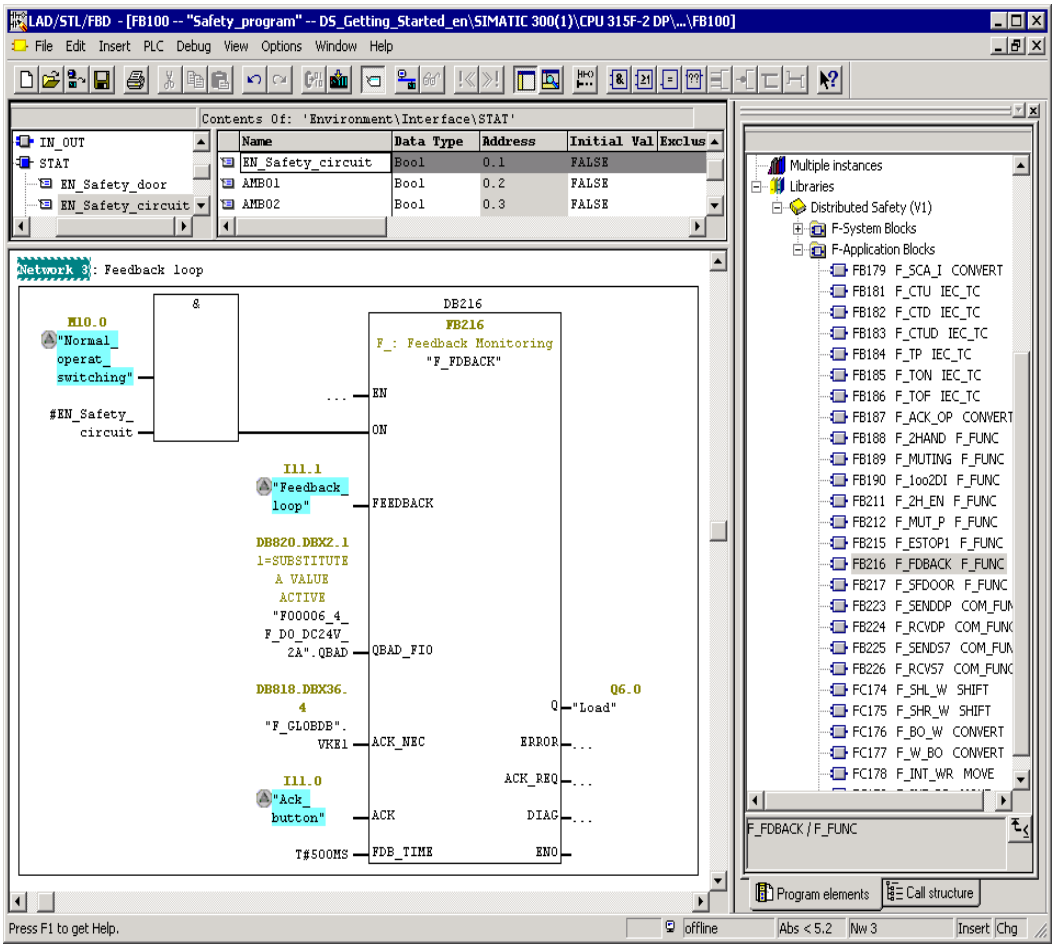
Sequence	Action	Result
	Note: If you require Boolean constants "0" and "1" in your safety program to assign parameters during block calls, you can access the "RLO0" and "RLO1" variables in the F-shared DB using fully qualified DB access. In our example, the F-shared DB in the block container has the number "DB 818" ("F_GLOBDB".VKE1). **Note**: In fail-safe programming, you cannot interconnect, supply with "0" or evaluate the enable input EN or the enable output ENO.	
3	Save the F-FB and confirm the message with "Yes".	The F-block is subjected to a consistency test and saved once it completes the test successfully. The programming of the safety door function is now completed.

Step 12: Programming the Emergency Stop Function

Sequence	Action	Result
1	Insert the following statical variables for the F-FB: - "EN_Safety_circuit" (enable safety circuit) and - the **a**uxiliary **m**emory **b**its "AMB01" and "AMB02".	
2	Insert a new network.	
3	Insert the required operations from the program element catalog ("Bit Logic") and supply the inputs and outputs as illustrated in the figure.  The non-safe "Acknowledgment button" signal in the standard program has a light blue background.	
4	Save the F-FB.	The F-block is subjected to a consistency test and saved once it completes the test successfully. The programming of the emergency stop function (shutdown at emergency stop, open safety door, violation of the laser scanner's protected area) is now completed.

Step 13: Programming the Feedback Loop Monitoring

Sequence	Action	Result
1	Open the F-Library *Distributed Safety* (V1) and copy the F-application block F_TOF (FB 186) from the F-Application Blocks\Blocks block container into the block container of your S7 program.	The block container of your S7 program contains the F-application block F_TOF (FB 186).
2	Insert a new network.	
3	Insert an FB 216 "F_FDBBACK" (feedback loop monitoring) into the fail-safe application block from the F-application blocks container and supply the inputs and outputs as shown in the figure below.	



The non-safe signals in the standard program have a light blue background.

Connect the FB 216

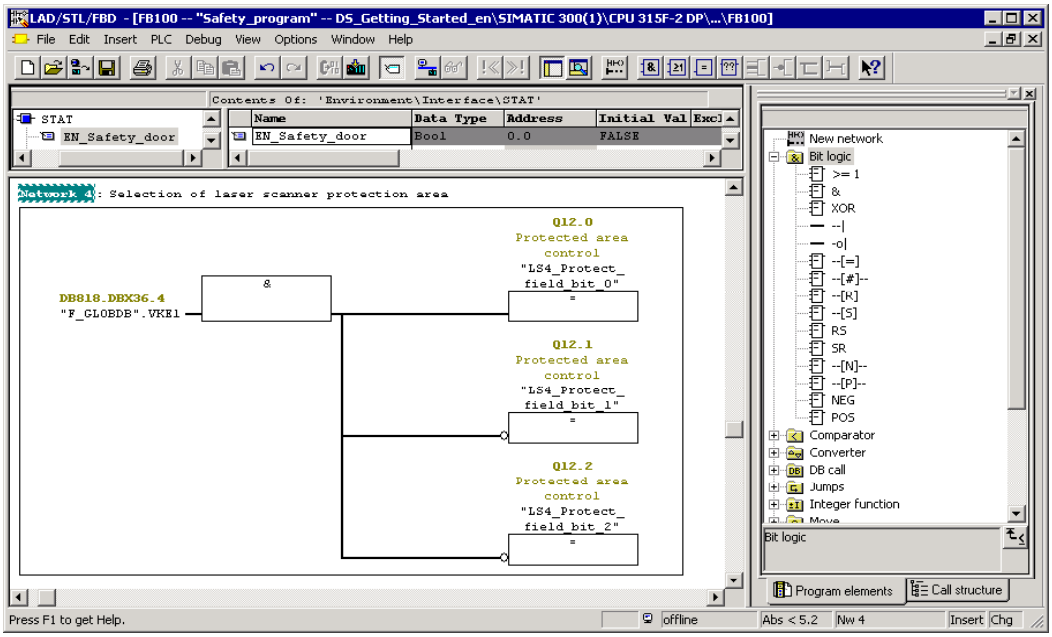
Inputs/outputs	Parameters	Data type	Description	Default
M10.0	ON	BOOL	1=activate output	0
I11.1	FEEDBACK	BOOL	Readback input	0
DB820.DBX2.1	QBAD_FIO	BOOL	QBAD signal from F-I/O DB of output Q*	0
DB818.DBX36.4	ACK_NEC	BOOL	Fully qualified access to variable RLO1 from F-shared DB**	1
I11.0	ACK	BOOL	User acknowledgment (per button)	0
T#500MS	FDB_TIME	TIME	Readback time	T#0 ms
Q6.0	Q	BOOL	Output	0
	ERROR	BOOL	Readback error	0
	ACK_REQ	BOOL	Acknowledgment request	0
	DIAG	BYTE	Service information	B#16#0

* = In our example, this is the QBAD signal from the F-I/O DB of the F-DO to which the load is connected (the contactors). You can see the block number of the F-I/O DB from the symbolic name in the symbol table or in the *SIMATIC Manager*.

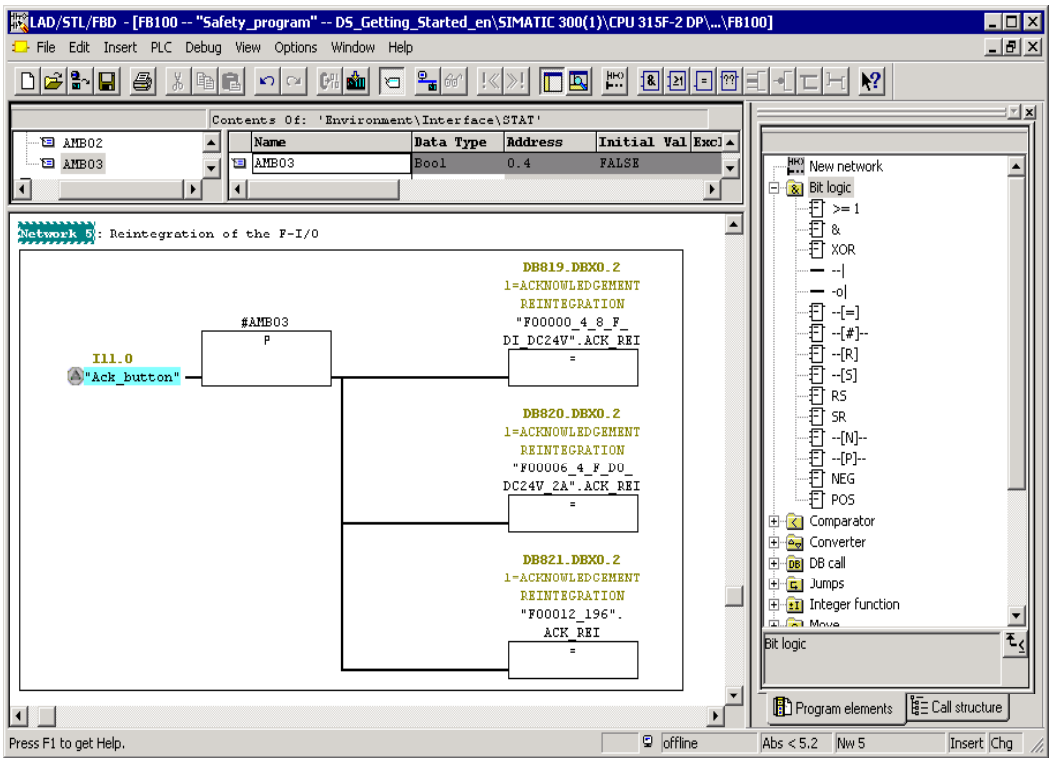
** = ACK_NEC: 1 = acknowledgment required.

Sequence	Action	Result
	Note: If you require Boolean constants "0" and "1" in your safety program to assign parameters during block calls, you can access the "RLO0" and "RLO1" variables in the F-shared DB using fully qualified DB access. In our example, the F-shared DB in the block container has the number "DB 818" ("F_GLOBDB".VKE1). **Note**: In fail-safe programming, you cannot interconnect, supply with "0" or evaluate the enable input EN or the enable output ENO.	
4	Save the F-FB.	The F-block is subjected to a consistency test and saved once it completes the test successfully. The programming of the feedback loop monitoring is now completed.

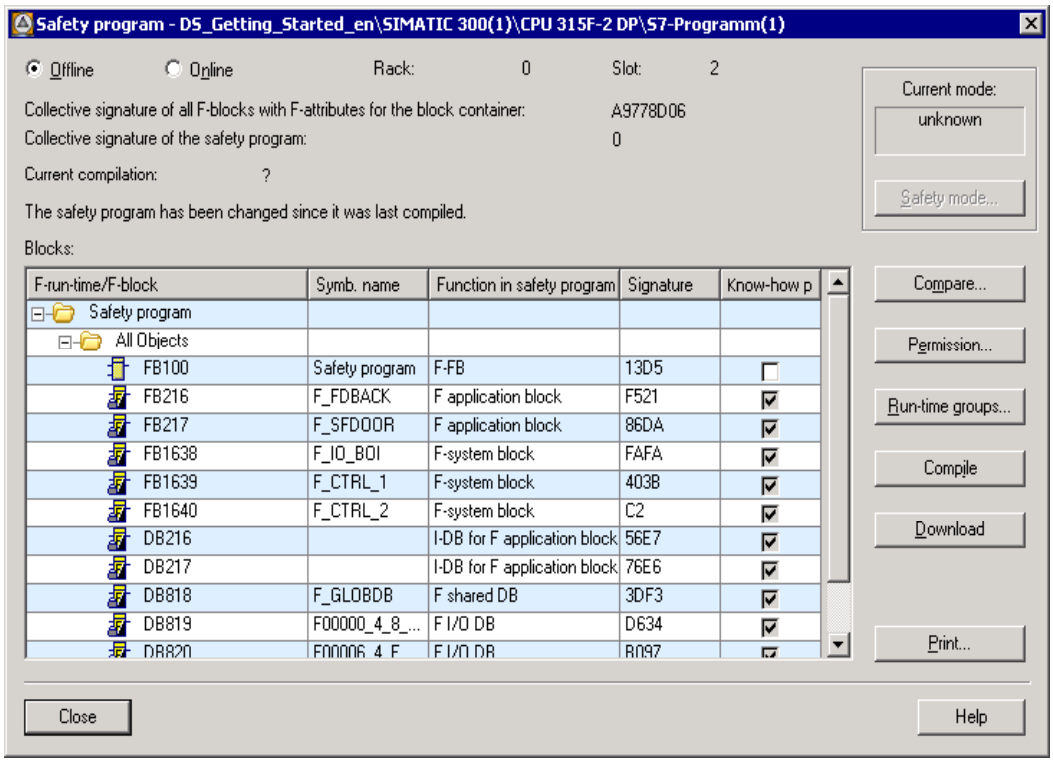
Step 14: Programming the Selection of the Laser Scanner Protection Area

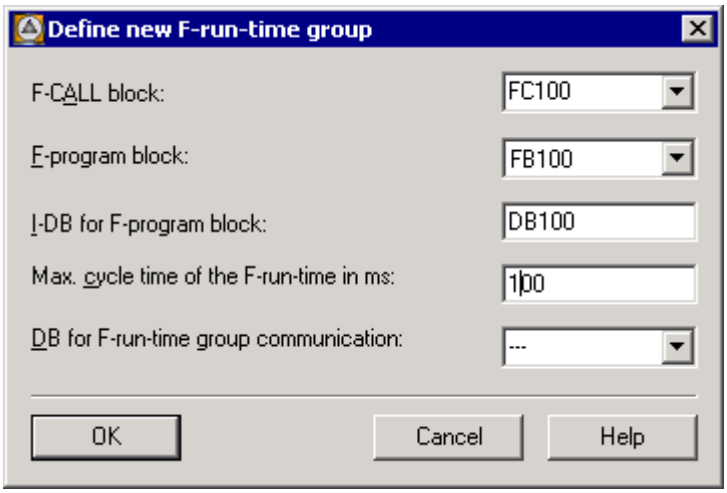
Sequence	Action	Result
1	Insert a new network.	
2	Insert the required operations from the program element catalog ("Bit logic") and supply the inputs and outputs as illustrated in the figure. 
3	Save the F-FB.	The F-block is subjected to a consistency test and saved once it completes the test successfully. The programming for the selection of the laser scanner protection area is now completed.

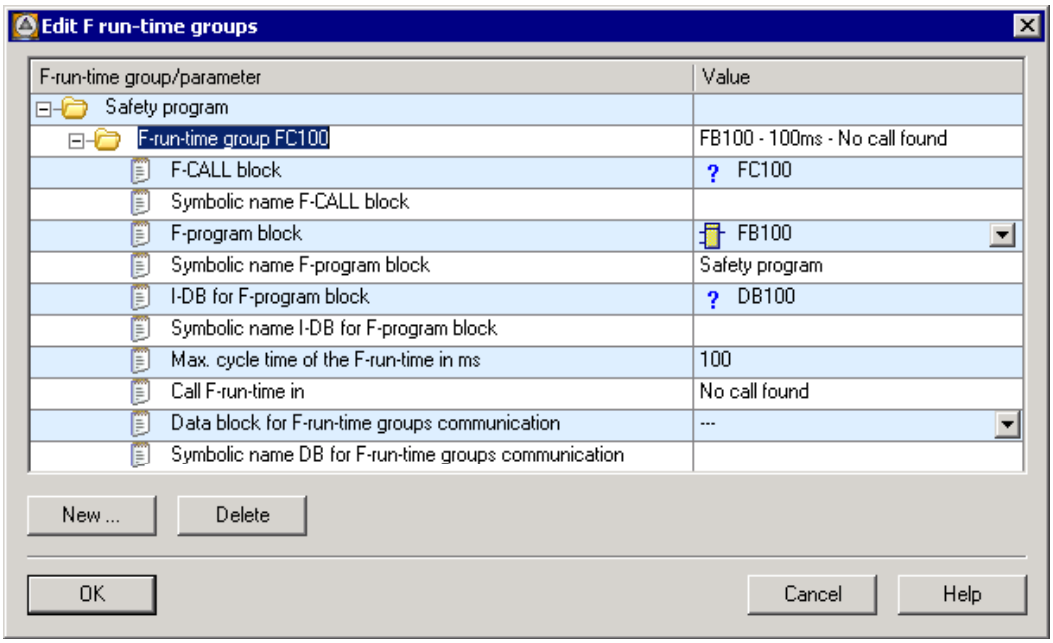
Step 15: Programming the User Acknowledgment for Reintegration of the F-I/O

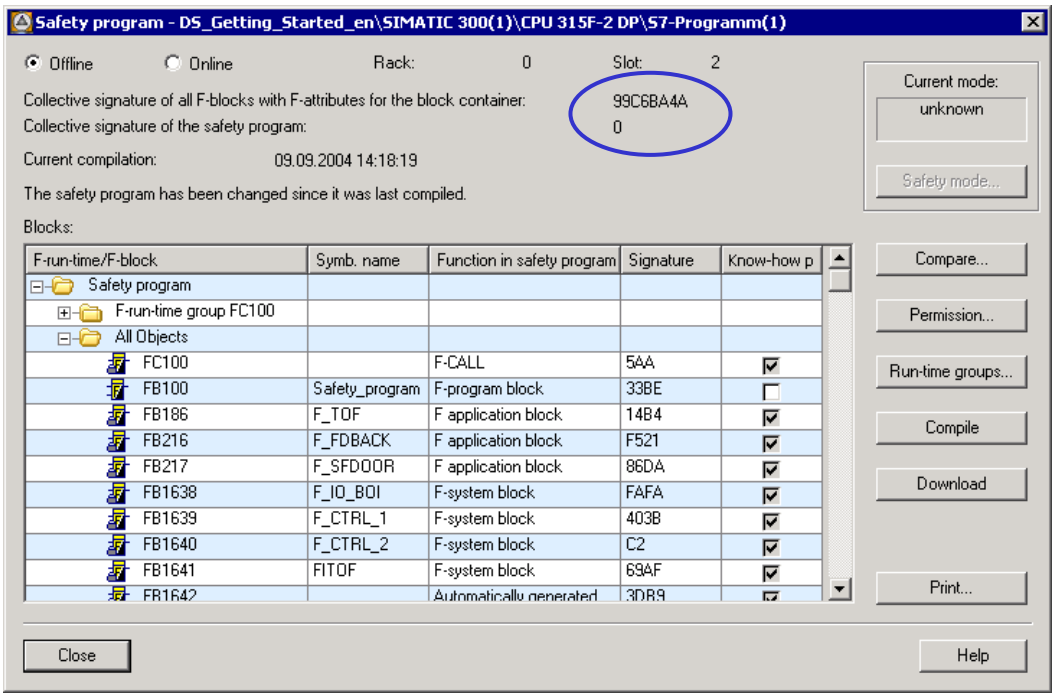
Sequence	Action	Result
1	Insert the following statical variable for the F-FB: - **a**uxiliary **m**emory **b**it "AMB03".	
2	Insert a new network.	
3	You need to provide a user acknowledgment for each F-I/O in your safety program for the reintegration through the ACK_REI variable of the respective F-I/O DB as shown in the figure below.  The non-safe "Acknowledgment button" signal in the standard program has a light blue background. **Symbolic name** in our example: - "F00000_4_8_F_DI_DC24V": fail-safe digital input module 4/8 F-DI DC24V (= DB 819) - "F00006_4_F_DO_DC24V_2A": fail-safe digital output module 4 F-DO 24 V DC / 2A (= DB 820) - "F00012_196": SIGUARD LS4-4/P1 laser scanner (= DB 821). **Note**: A user acknowledgment with a positive edge at the ACK_REI variable of the F-I/O DB is required for the reintegration of the F-I/O (i.e. for switching from fail-safe values (0) to process data) after an error is corrected: - After every communication error - After F-I/O errors or channel errors when the parameter ACK_NEC = 1.	
4	Save the F-FB and ensure that no errors have occurred by checking the "Error" output window of the *FBD/LAD Editor*.	The F-block is subjected to a consistency test and saved once it completes the test successfully. The programming of the user acknowledgment is now completed.
5	Close the F-FB and the *FBD/LAD Editor*.	You have programmed the functionality for the task involved in the example and can now specify the F-runtime group.

Step 16: Specify the F-Runtime Group

Sequence	Action	Result
1	In the SIMATIC Manager, select the **Options > Edit Safety Program** menu command. The "Safety Program" dialog box appears. 	
2	Click on the "Runtime Groups..." button. **Note**: F-blocks must not be called directly in an OB; rather, they must be inserted into one (or two) F-runtime groups.	The dialog box "Edit F-Runtime Groups" opens.

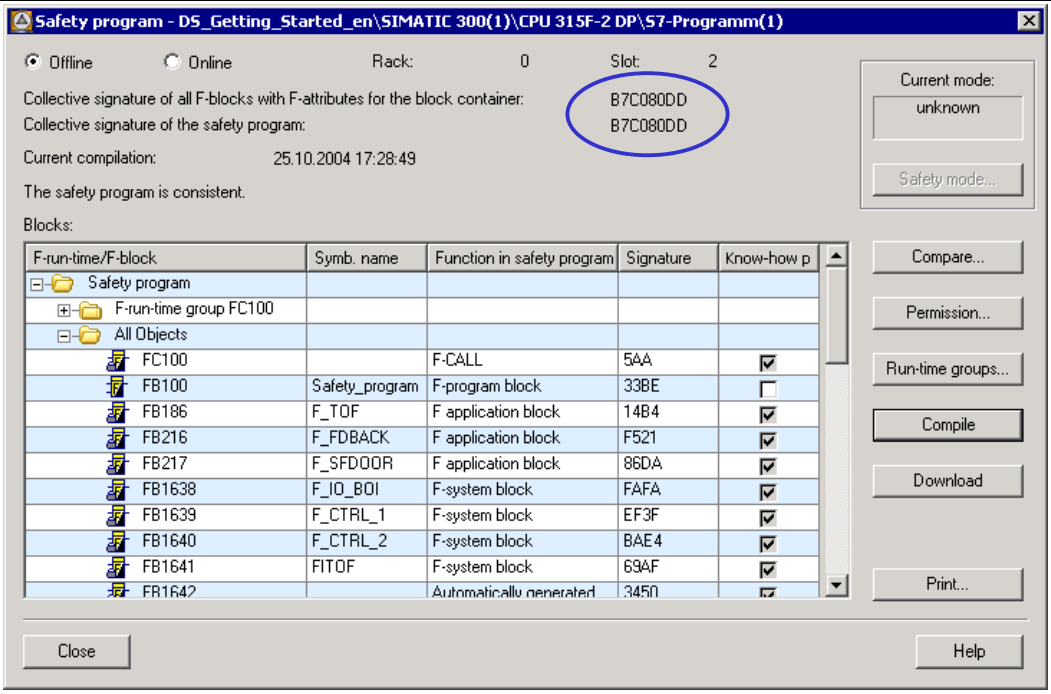
Sequence	Action	Result
3	Click on the "New..." button to open the "Define New F-Runtime Group" dialog box. Make the following settings for the F-runtime group: • Enter "FC100" as the F-CALL call block for the new F-runtime group. This FC is automatically created as soon as you exit the "Edit F-Runtime Groups" dialog with "OK." • Define the F-program block of the F-runtime group by selecting the previously programmed F-FB from the drop-down list that you want to define as the F-program block for the F-runtime group, "FB100" in our example. • Since the F-program block is a function block in our example, assign an instance DB to it (for example, "DB 100"). This I-DB is automatically created as soon as you exit the "Edit F-Runtime Groups" dialog with "OK." • Set the maximum cycle time of the F-runtime group to "100 ms". The dialog box should now appear as follows.  **Note**: The F-CALL is the F-block for calling the F-runtime group from the standard user program. The F-CALL includes the call for the F-program block and the calls for the automatically added F-blocks of the F-runtime group. You create the F-CALL, but you cannot edit it. **Note**: The F-program block is an F-FC or F-FB (with instance DB) that becomes the F-program block when assigned to the F-CALL. You can do the following in the F-program block: • Program the safety program with F-FBD or F-LAD • Call other created F-FBs/F-FCs for structuring the safety program • Insert F-blocks from the F-Application Blocks block container from the *Distributed Safety* F-library (V1) • Insert F-blocks from "custom F-libraries" The user defines the call sequence of the F-blocks within the F-program block. Close the dialog box with "OK".	

<table>
<tr><th>Sequence</th><th>Action</th><th>Result</th></tr>
<tr><td>4</td><td>You return to the "Edit F-Runtime Groups” dialog which now appears as follows:
 

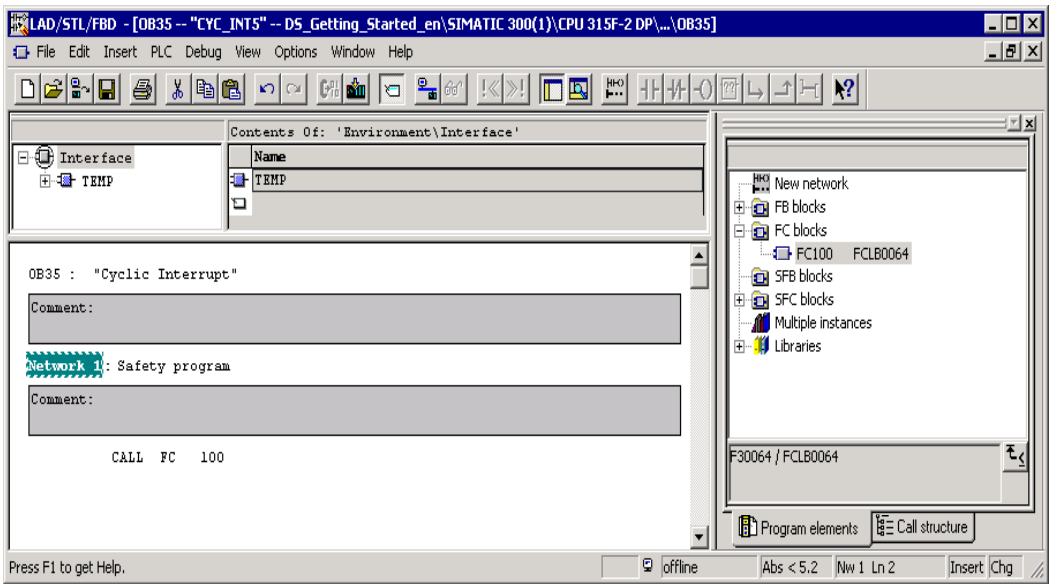
Close the dialog box with "OK".</td><td></td></tr>
<tr><td>5</td><td>A message window opens asking if you wish to create any other blocks that are still needed. In our example, these are the F-CALL ("FC100") and the I-DB for the F-program block ("DB 100").
Confirm by clicking on "Yes".</td><td>The remaining blocks are created and saved. The message window then closes.</td></tr>
<tr><td>6</td><td>You return to the "Safety Program” dialog which now appears as follows:
 

The safety program has now been created but has not yet been compiled. The collective signature of all F-blocks with the F-attribute in the block container and the collective signature of the safety program differ (as highlighted in the figure).</td><td></td></tr>
</table>

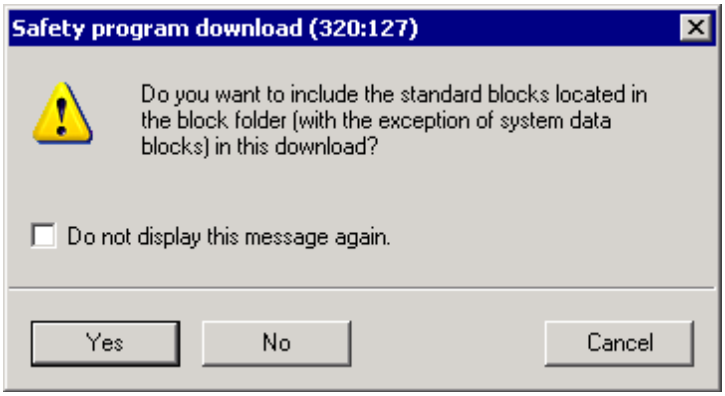
Step 17: Compile the Safety Program

Sequence	Action	Result
1	Click on the "Compile" button in the "Safety Program" dialog. A consistency test is performed on the F-blocks involved in the runtime when the safety program is compiled, in other words the safety program is checked for errors. Any error messages are output in an error window. Once the consistency test is successfully completed, the additionally required F-system blocks are generated automatically and inserted into the runtime group to create an executable safety program.	Following a successful compilation, the block container always contains a consistent safety program composed entirely of F-blocks with the F-attribute. See figure below.
2	 The collective signature of all F-blocks with the F-attribute of the block container and the collective signature of the safety program must match (as highlighted in the figure); in other words, a consistent and executable safety program has been generated. Click "Close" to confirm. The "Safety Program" dialog box closes.	

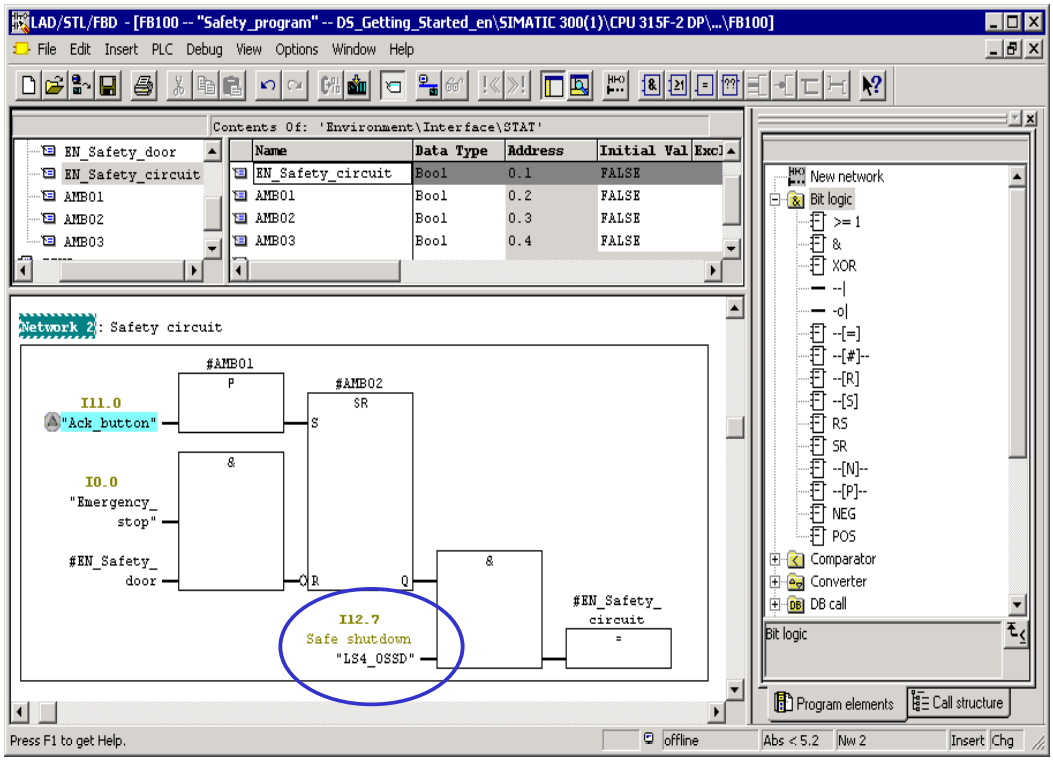
Step 18: Call the Safety Program in the Cyclic Program

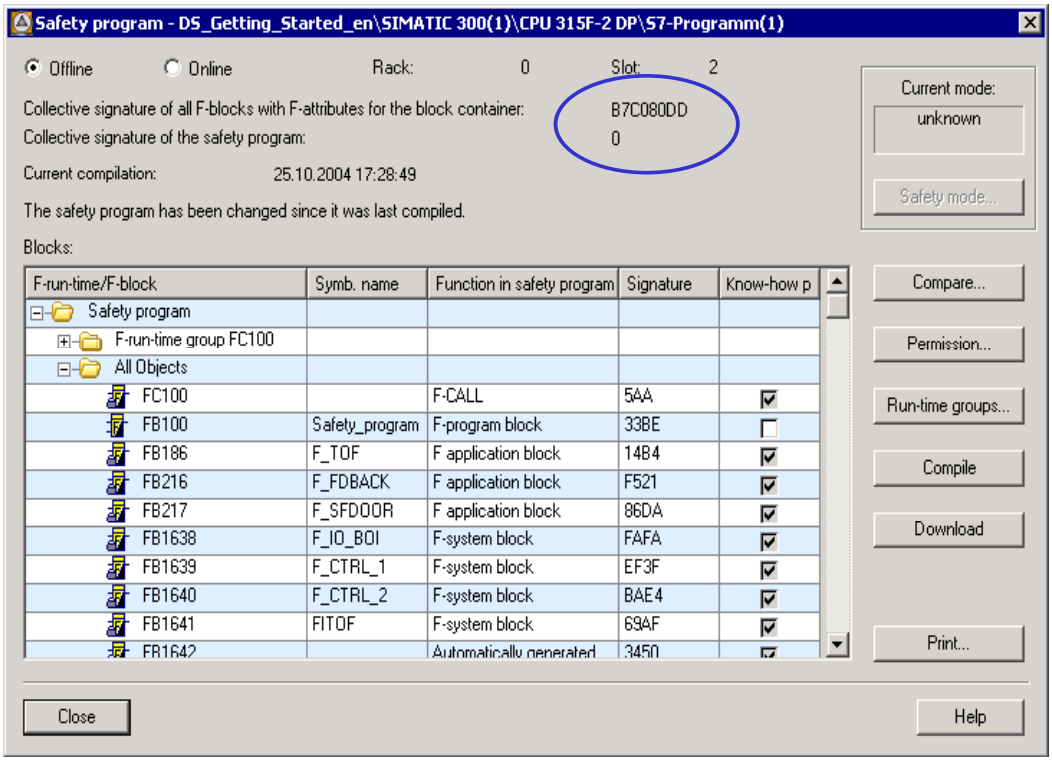
Sequence	Action	Result
1	The safety program is accessed by calling F-CALL from the standard user program. Call the F-CALL in the cyclic interrupt OB 35 as shown in the figure. **Note**: You need to insert the cyclic interrupt OB 35 beforehand in the *SIMATIC Manager*.  **Note**: Cyclic interrupt OBs have the advantage of interrupting the cyclic program execution in OB1 of the standard user program at fixed time intervals; that is, a safety program is called and executed at fixed time intervals in a cyclic interrupt OB. Once the safety program is executed, the standard user program resumes.	
2	Save and close OB 35.	The block is saved.

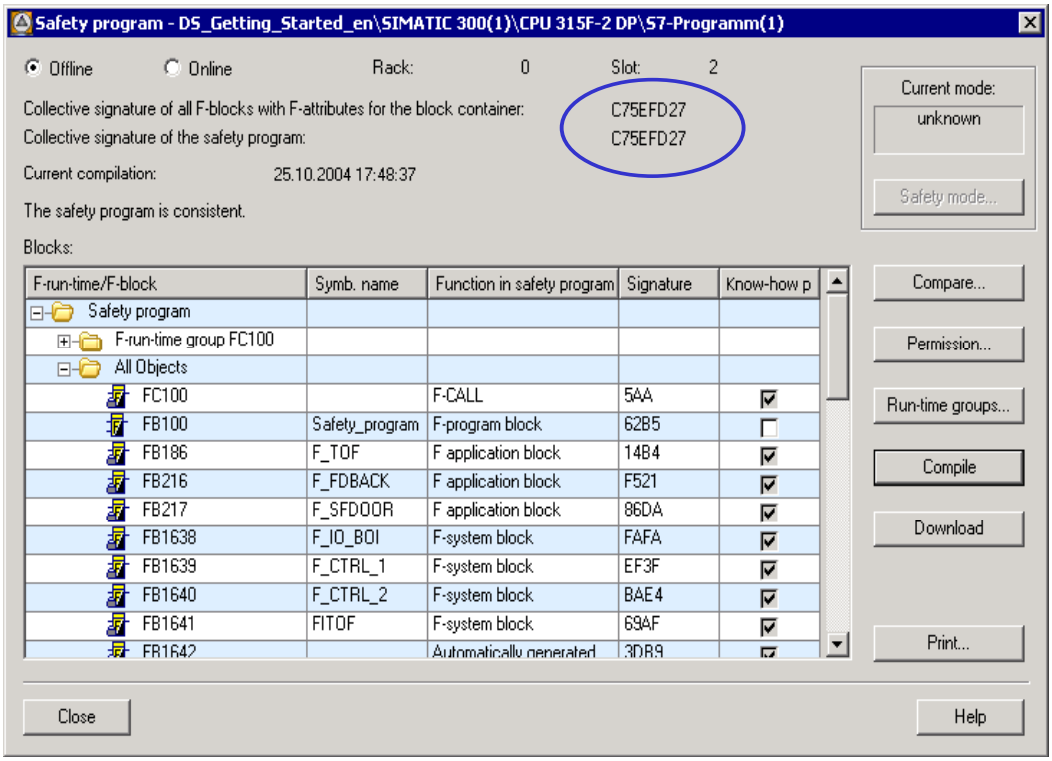
Step 19: Download the Complete Safety Program to the F-CPU and Activate the Safety Mode

Sequence	Action	Result
1	In the *SIMATIC Manager,* select the **Options > Edit Safety Program** menu command.	The "Safety Program" dialog box appears.
2	Activate the "Download" button.	All F-blocks with the F-attribute belonging to the safety program are identified and downloaded to the F-CPU.
3	A note is displayed offering you the option of downloading the standard user program in addition to the safety program.  Confirm by clicking on "Yes". **Note**: If you are downloading F-blocks only, the block in which the F-CALL block is called (cyclic interrupt OB35 in our example) is not downloaded. You then have to download this OB the same way as for a standard program. **Note**: To download the entire safety program, the F-CPU has to be in STOP mode.	
4	In the "Safety Program" dialog box, select the "Offline" and "Online" option buttons in turn to check whether the collective signatures of all F-blocks with F-attribute in the block container match offline and online.	If they match, downloading was successful. If not, repeat the download operation.
5	To activate safety mode, switch the F-CPU from STOP to RUN mode. **Note**: Once a safety program has been created, you need to perform a full function test for your automation tasks (see *S7 Distributed Safety, Configuring and Programming* manual).	You have now finished creating the safety program for the tasks involved in the example.

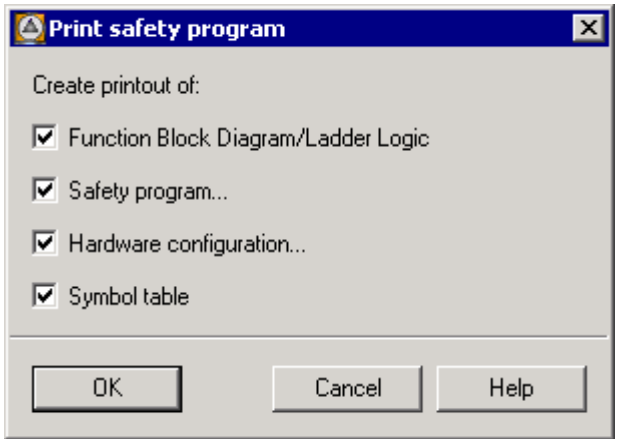
Appendix 1: Modifying the Safety Program

Sequence	Action	Result
1	Change the example safety program so that **no user acknowledgment** is required for an OSSD signal (Output Signal Switching Device) from the laser scanner. To do this, program the emergency stop function (Network 2) as shown in the figure.  **Note**: Changes to the safety program during operation (in RUN mode) can only be made in deactivated safety mode. You make changes to F-blocks offline in *FBD/LAD Editor* in the same way as for a standard program. F-blocks cannot be modified online. Refer to the corresponding chapter describing how to modify and test the safety program and deactivate the safety mode in the *S7 Distributed Safety, Configuring and Programming* manual.	
2	Save the F-FB.	The F-block is subjected to a consistency test and saved once it completes the test successfully.

Sequence	Action	Result
3	In the *SIMATIC Manager,* select the **Options > Edit Safety Program** menu command. The "Safety Program" dialog box appears.  **Note**: You have changed and saved an F-block of the safety program and therefore created an inconsistent safety program. In other words, the collective signature of all F-blocks with the F-attribute in the block container and the collective signature of the safety program differ (as highlighted in the figure).	
4	**Note**: You must deactivate safety mode of the safety program to download changes to the safety program in **RUN** mode. Safety mode remains deactivated until F-CPU is next switched from STOP to RUN mode. Check to see whether "Safety mode activated" is indicated as the "Current mode". If it is, activate the "Safety mode" button and enter the password for the safety program.	Another prompt will appear. This prompt contains the collective signature of the safety program in the F-CPU.
5	Confirm the prompt to deactivate safety mode with "OK." **Warning** Deactivation of safety mode is intended only for test purposes, commissioning, etc. Whenever safety mode is deactivated, the safety of the system must be ensured by other organizational measures, such as operation monitoring and manual safety shutdown.	Safety mode will be deactivated.
6	Download the modified F-FB from the *FDB/LAD Editor* to the F-CPU (same procedure as for the standard program).	The F-FB is loaded in the F-CPU.
7	Test the changes to the system or view the "Program status online".	Once the test is successfully completed, continue by compiling the safety program.

Sequence	Action	Result
8	To apply the changes to the safety program and get a consistent safety program again, press the "Compile" button. The dialog box should now appear as follows.  The collective signature of all F-blocks with the F-attribute of the block container and the collective signature of the safety program must match; in other words, a consistent and executable safety program has been generated (as highlighted in the figure).	
9	Click on the "Download" button to download the modified safety program to the F-CPU.	All F-blocks with the F-attribute belonging to the safety program are identified and downloaded to the F-CPU.
10	In the "Safety Program" dialog box, select the "Offline" and "Online" option buttons in turn to check whether the collective signatures of all F-blocks with F-attribute in the block container match offline and online.	If they match, downloading was successful. If not, repeat the download operation.
11	To activate safety mode, switch the F-CPU from STOP to RUN mode. **Note**: After creating a safety program, you must perform a full function test for your automation tasks. After modifying a safety program that has already be fully tested, it is sufficient to only test the modifications (see *S7 Distributed Safety, Configuring and Programming* manual).	You have now finished adapted the safety program for the modified task (see Sequence 1 above).

Appendix 2: Acceptance Support for the Safety Program

Sequence	Action	Result
1	**Note**: The documentation of the safety program is part of the acceptance documents in accordance with machine guidelines or IEC 61508 for the process industry and correspondingly applied standards. Print out the safety program for the acceptance. Proceed as follows: 1.) Activate the "Offline" button in the "Safety Program" dialog in order for the signature of the symbols to be included in the footer of the offline safety program printout. 2.) Click on the "Print" button in the "Safety Program" dialog. 3.) Activate all four check boxes in the "Print Safety Program" dialog.  4.) Click "OK" to confirm. 5.) Select "All" for the print range of the "Hardware Configuration" and mark the option "With parameter description." Confirm with "OK". **Note**: You need to archive all four printouts and logs of the function tests.	The "Print Safety Program" dialog box opens. The safety program is printed.
2	Check the printout. The collective signatures in the footer of the printout (each with the collective signature of all F-blocks with an F-attribute in the block container and signature of the symbols) must match **in all four printouts**.	
3	Activate the "Online" option to run a check in the "Safety Program" dialog (the safety program must be loaded): The **online** collective signature of all F-blocks with F-attribute in the block container must match those in the accepted **offline** printout and no unused F-CALL may be present in the online safety program. **Note**: Additional important notes and instructions about acceptance of the safety program are available in the *S7 Distributed Safety, Configuring and Programming* manual.	If these checks reveal any deviations or errors, recompile the safety program and perform the acceptance procedure again.

Appendix 3: Typical Configuration and Programming Mistakes and the Causes

Type	Error	Possible Cause / Remedy
Configuration error	F-blocks cannot be downloaded to the F-CPU.	F-CPU parameter "CPU contains safety program" in the "Protection" tab is not activated.
Configuration error	SF LED on the F-module lights when the safety program is not loaded.	ET 200M: System property ET 200S: The PROFIsafe address set on the DIL switch does not match the one set in *HW Config*.
Configuration error	- SF-LED on the F-module lights and - TIMEOUT error in the DIAG byte of the F-I/O DB	Monitoring time of the F-module ≤ cycle time of the F-CALL.
Configuration error	- SF-LED on the F-module lights and - CRC error in the DIAG byte of the F-I/O DB	- Loaded safety program does not match the one loaded in *HW Config*. - Safety program is inconsistent. - PIQ/PII of the F-module was overwritten by the standard user program.
Configuration error	- SF-LED on the F-DI module lights and - module reports short-circuit	Sensor connection does not match configuration, for example: - Only one switching contact is connected to a channel with 1oo2 evaluation - A sensor with non-equivalence contacts is connected to a channel configure for "two-channel equivalence". - Two switching contacts of a single-channel or two-channel non-equivalence sensor are supplied via VS1 **and** VS2
Programming error	After an F-block is edited and saved, the block cannot be closed and the message "The block was not saved" appears.	Check for any programming or syntax errors in the "Error" detail tab of the *FBD/LAD Editor*.
Programming error	F-PIQ/PII has not been updated.	F-CALL is not called in the cyclic OB3x. F-module has been passivated. Evaluate the QBAD and DIAG byte parameters in the respective F-I/O DB.
Programming error	F-CPU goes to STOP due to data corruption in the safety program.	- F-CALL is called more than once in the cyclic program. - The standard user program is writing to F-DB addresses. - Undeclared TEMP variables are being used in the safety program. - Memory bits are being read in the safety program that are changing during the processing of the F-CALL, for example, clock memory bits. - Overflow during INT operations has not been checked.

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Your Feedback as regards the S7 Distributed Safety (Version 10/2004)

Dear SIMATIC user,

Our goal is to provide you information with a high degree of quality and usability, and to continuously improve the SIMATIC documentation for you. To achieve this goal, we require your feedback and suggestions. Please take a few minutes to fill out this questionnaire and return it to me by Fax, e-mail or by post.

We are giving out three presents every month in a raffle among the senders. Which present would you like to have?

☐ **SIMATIC Manual Collection** ☐ **Automation Value Card** ☐ **Laser pointer**

Dr. Thomas Rubach,
Head of Information & Documentation

General Questions

1. Are you familiar with the SIMATIC Manual Collection?

☐ yes ☐ no

2. Have you ever downloaded manuals from the internet?

☐ yes ☐ no

3. Do you use Getting Starteds?

☐ yes ☐ no

if yes, which:

4. How much experience do you have with the S7 Distributed Safety?

☐ Expert
☐ Experienced user
☐ Advanced user
☐ Beginner

Please specify the documents, for which you want to answer the questions below:

- ☐ **A: Manual S7 Distributed Safety, Configuring and Programming**
- ☐ **B: Manual S7-300, Fail-Safe Signal Modules**
- ☐ **C: Manual ET 200S, Distributed I/O System Fail-Safe Modules**
- ☐ **D: Manual ET 200eco, Distributed I/O Fail-Safe I/O Module**
- ☐ **E: System Description Safety Engineering in SIMATIC S7**
- ☐ **F: Getting Started S7 Distributed Safety**

1. **In which project phase do you use this document frequently?**

☐ Information ☐ Assembly
☐ Planning ☐ Commissioning
☐ Configuration ☐ Maintenance & Service
☐ Programming ☐ others:

2. Finding the required information in the document:

- How quickly can you find the desired information in the document?

☐ immediately ☐ not at all
☐ after a brief search ☐ after a long search

- Which search method do you prefer?

☐ Table of contents ☐ Index
☐ Full-text search ☐ others:

- Which supplements/improvements would you like in order to help you find the required information quickly?

3. Your judgement of the document as regards content.

- How satisfied are you with this document

☐ Totally satisfied ☐ not very satisfied
☐ Very satisfied ☐ not satisfied
☐ Satisfied

- Were able to find the required information?

☐ yes ☐ no

which was not:

4. What is the scope of the information?

☐ Just right
☐ Not enough - which topic:
☐ Too detailed – which topic:

5. Is the information easy to understand (texts, figures, tables)?

☐ yes ☐ no

if no, which was not:

6. Are examples important to you?

☐ no, of less importance
☐ yes, important –were the examples enough?

☐ yes ☐ no

if no, on which topic:

7. What are your suggestions as regards the contents of the document?

Thank you for your cooperation