Application for supporting the Safety Integrated function acceptance test

SINAMICS S110 and S120

Safety Integrated - acceptance test support

Application description • July 2012

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SINAMICS
Safety Integrated - acceptance test support

SINAMICS S110/S120

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1 Task

1.1 Overview

Introduction

The application supports you when documenting the safety parameters for the SINAMICS S120 according to Section 9.3 and the checksums according to Section 9.5 of the Safety Function Manual (SFM) Edition 01/2012 /3/.
As a further feature, screen forms guide you through the individual steps of the acceptance test according to Section 9.4 SFM /3/ (S120). For SINAMICS S110, you find this information in Section 8.9 of the Function Manual (FM) 01/2011 /6/.

Overview of the automation task

This application deals with the following key points:

- Creating understandable documentation.
- Documenting the safety parameters and checksums in accordance with Sections 9.3 and 9.5 SFM /3/ (S120) or Sections 8.9.4 and 8.9.6 FM /6/ (S110).
- Accompanying the acceptance test and logging the results of the acceptance test according to Section 9.4 of the SFM /3/ (S120), or Section 8.9.5 FM /6/ (S110).

Description of the automation task

This application is intended for commissioning engineers and service personnel. It is assumed that persons using this documentation are knowledgeable about configuring the SINAMICS S110 or S120 drives, especially the Safety Integrated functions.

This application is used for machines equipped with SINAMICS S110/S120 (also in conjunction with a SIMOTION) and in which the Safety Integrated functions (Basic and/or Extended) are used.

2 Automation solution

2.1 Overview of the overall solution

Schematic

The application consists of a script that is executed in STARTER/SCOUT. The script supports you when documenting and performing the acceptance test and saves the results in an Excel table that represents the acceptance report.

Configuration

This application cannot be independently executed. It must be integrated in an existing project (imported).

Demarcation

The following points must be observed in this application:

The application is not able to validate the compliance with the applicable regulations and standards. This remains the task of the machine manufacturer (OEM).

The operator must carefully observe and monitor the acceptance test; this application is not able to automatically identify every machine malfunction. The application, however, informs the operator as to which points need to be observed.

This documentation does not contain any information on how to commission the drive system. This documentation also does not address commissioning the Safety Integrated functions. In these cases, the manuals of the particular products must be referred to.

WARNING

The application provides support when performing the acceptance test for the Safety Integrated functions of SINAMICS. These are only part of the machine safety functions. All other safety-related functions or components (F-PLC, sensors, additional actuators) should be checked separately.

It is assumed that readers have basic knowledge of these topics.

Knowledge required

The user must be knowledgeable about using SINAMICS S110/S120 and the safety functions available in SINAMICS.

Further, the user must be knowledgeable about applying the relevant standards relating to machine safety.

2.2 Hardware and software components

The application was generated and tested with the following components.

Hardware components

- 2-axis demonstration case with SINAMICS S120 and motor module (6SL3120-2TE13-0AA3). For tests with FW 4.3, FW 4.4 and FW 4.5, the CU320 was replaced by the CU320-2 DP.
- The SBC function was tested with the 1FT6062-1AF71-3AH1 motor.
- The module with the order number 6SL3055-0AA00-3BA0 was used for the tests with the TM54F.
- An S7 F-CPU CU315F-2 PN/DP was used for control via PROFIsafe.
- A 1-axis demonstration case with a 1FK7 motor was used for the tests with the CU310.

Standard software components

- STARTER commissioning tool 4.3.1 or SCOUT 4.3.1
- SINAMICS FW versions: SINAMICS S120 v. 2.6.2; SINAMICS S120 v4.3.1, v 4.3.2, v4.4.2 and v 4.5
- Microsoft Excel 2003
- Internet Explorer 6

Sample files and projects

The list below contains all the files and projects used in this example.

Table 2-1: Sample files and projects

Component	Note
SI_AcceptanceTest_V21.zip	This zipped file contains the script in the form of an XML file. This can then be imported into an existing project. In addition, the following Excel file is included in the zip file.
SI_AcceptanceTest_V21.xls	The Excel table that documents the acceptance test.
52248627_APP_Safety_Acceptance_Test_en.pdf	This document.

3 Functional mechanisms of this application

An Excel table is provided with this application. In addition to the individual acceptance tests of the safety functions, this table also includes general information about the machine, the safety parameters and the checksums.

In some cases, the application queries the necessary data and automatically enters it into the Excel document. Other parts (e.g. the overview diagram of the machine, traces recorded during the tests, etc.) must be entered manually into the Excel table subsequently.

Note

The user cannot make these supplements as long as the application has the Excel table open and is processing it.

You must first close the application and then open the acceptance report (Excel file). You can now make the appropriate changes.

The Microsoft Excel and Internet Explorer software programs are required for the correct functioning of this application.

This table represents the acceptance report of the safety functions. All of the necessary information is contained in the spreadsheets. The following section provides an overview of the individual spreadsheets. These can be selected from a tab at the lower edge.

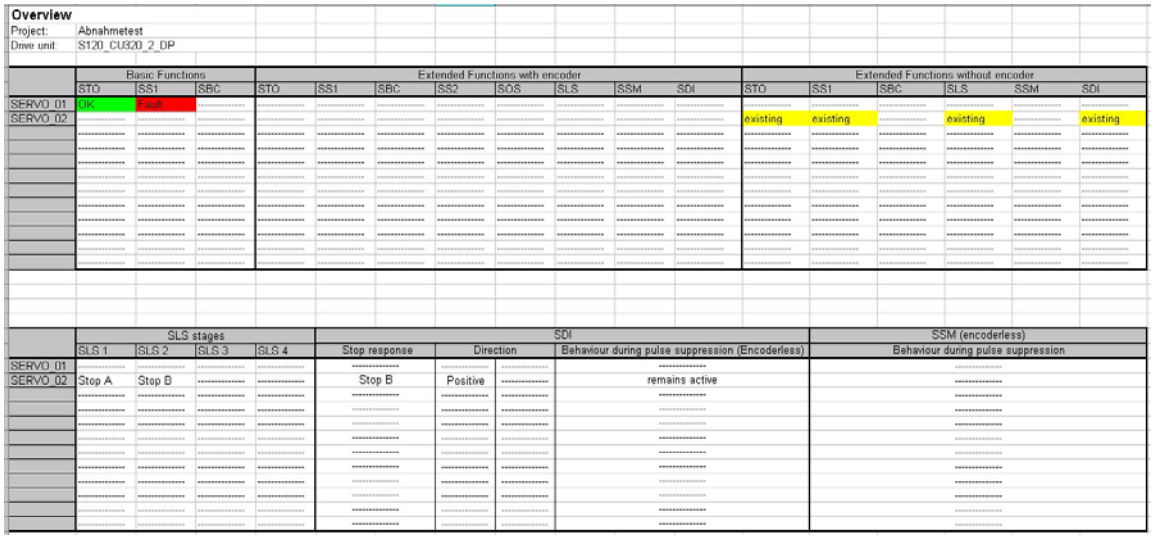
The structure is based on the report structure of the Safety Function Manual /3/ Chapter 9 (S120) and/or Function Manual /6/ Section 8.9 (S110).

After the acceptance test has been completed, this report must be printed and signed. It is recommended that the end customer should also sign this report when the machine is being accepted. The document must then be archived by the machine manufacturer (OEM). It is recommended that you also archive the Excel file. The report can be (but does not have to be) handed over to the end customer.

3.1 The Excel file - the acceptance report

3.1.1 "Overview" spreadsheet

This spreadsheet contains an overview of the safety functions used on the individual axes and their test status.



Overview

Project: Abnahmetest
Drive unit: S120_CU320_2_DP

	Basic Functions			Extended Functions with encoder								Extended Functions without encoder					
	STO	SS1	SBC	STO	SS1	SBC	SS2	SOS	SLS	SSM	SDI	STO	SS1	SBC	SLS	SSM	SDI
SERVO_01	OK	Fault															
SERVO_02												existing	existing		existing		existing

	SLS stages				SDI			SSM (encoderless)
	SLS 1	SLS 2	SLS 3	SLS 4	Stop response	Direction	Behaviour during pulse suppression (Encoderless)	Behaviour during pulse suppression
SERVO_01								
SERVO_02	Stop A	Stop B			Stop B	Positive	remains active	

Figure 3-1: "Overview" spreadsheet

Successfully tested functions are designated with OK and fields with a green background. Safety functions with yellow background are either not yet tested or, in the case of SLS and SDI, are not fully tested. Functions designated with "Fault" and a red background resulted in an error during the test. This means that you have a compact overview of the status of the acceptance test.

Two drives are used in this example. The STO and SS1 basic functions are used on SERVO_01. The following encoderless extended functions are used for SERVO_02: STO, SS1, SLS and SDI.

The table below shows the parameterized SLS levels with their stop responses. The same is the case for the SDI directions. The last two columns show the parameterized response for pulse inhibit for the SDI and SSM encoderless extended functions.

In the shown example, the first two SLS levels are parameterized with STOP A or STOP B for SERVO_02. For SDI, the positive direction and active monitoring are parameterized with STOP B and for pulse inhibit, respectively.

3.1.2 "Plant description" spreadsheet

This spreadsheet includes the information of Tables 9-2 and 9-3 from Section 9.3.1 of the SFM /3/ (S120) or the Tables 8-22 and 8-23 of the FM /6/ (S110). The general machine data is shown in the first section.

1. Acceptance report

1.1 Plant description - Documentation part 1

Table 1-1 Machine description and overview diagram

Designation	Sample Machine XF01
Type	T002X
Serial number	3A456-7AFR5-GB60A
Manufacturer	SIEMENS
End customer	CSTM
Electrical drives	2
Other drives	2

Overview diagram of machine

Figure 3-2: Plant description – Section 1

The fields with a yellow background are queried by the script and entered automatically into the report (Excel file). You must subsequently insert the overview diagram of the machine.

Information on the used firmware versions as well as on the safety clock cycles is stored in the second section. Here, the application reads the relevant data and enters it into the report.

Table 1-2 Values of relevant parameters

Versions of the firmware and of Safety Integrated					
Component	**DO number**	**Firmware version**		**SI version**	
Parameters		r0018 =	4402308	r9590 =	4.40.23
Control Unit				r9770 =	4.40.22
	DO number	**Firmware version**		**SI version**	
	SERVO_01	r0128 =	4402309	r9390 =	4.40.23
				r9870 =	4.40.23
	SERVO_02	r0128 =	4402309	r9390 =	4.40.23
				r9870 =	4.40.23
		r0128 =		r9390 =	
				r9870 =	
		r0128 =		r9390 =	
				r9870 =	
		r0128 =		r9390 =	
				r9870 =	

Figure 3-3: Plant description – Section 2

3.1.3 "Function description" spreadsheet

In addition, users must also complete the so-called description of functions (see Figure 3-4). The application cannot do this as the description of functions is dependent on the specific machine.

This spreadsheet corresponds to the Tables 9-4 and 9-5 from Section 9.3.2. of the SFM /3/ (S120) or Tables 8-24 and 8-25 from Section 8.9.4 of the FM /6/ (S110).

1.2 Description of safety functions - Documentation Part 2

1.2.1 Introduction

This description of a system is for illustration purposes only. In each case, the actual settings for the system concerned will need to be modified as required.

1.2.2 Function table

Table 1-3: Example table: Active monitoring functions depending on the operating mode, the protective doors or other sensors

Mode of operation	Protective door	Drive	Status of monitoring functions
Production	closed and locked	1	deactivated
		2	SLS enabled
	unlocked	1	SOS
		2	STO deactivated
Setup	closed and locked	1	deactivated
		2	SLS 1 enabled
	unlocked	1	SLS1 deselected /
		2	enabled

Table 1-4: Example: functional overview of the safety functions

Drive	SI function	Limit	Active if
1	SOS	100 mm	refer to the function table
	SLS 1	200000 mm/min	refer to the function table
	SLS 2	50000 mm/min	refer to the function table
2	SOS	100 mm	refer to the function table
	SLS 1	50 U/min	refer to the function table
...	...	...	...

Comments:

All drives use the SI function SS1 for the EMERGENCY STOP functionality.

Drive 2 is equipped with a holding brake which is controlled by two channels via the corresponding Motor Module output.

Figure 3-4: Description of functions

3.1.4 "Drive data" spreadsheet

All safety parameters of the drives and of the TM54F (if available) are entered into this spreadsheet. The application reads the values from the project and inserts them into the report. For the drives, all of the safety parameters are exported. It is not considered which safety functions are used. Also when using Basic Functions, the parameters of the Extended Functions are also read out. If a parameter does not exist (e.g. when using an older FW Version), the corresponding field is left empty.

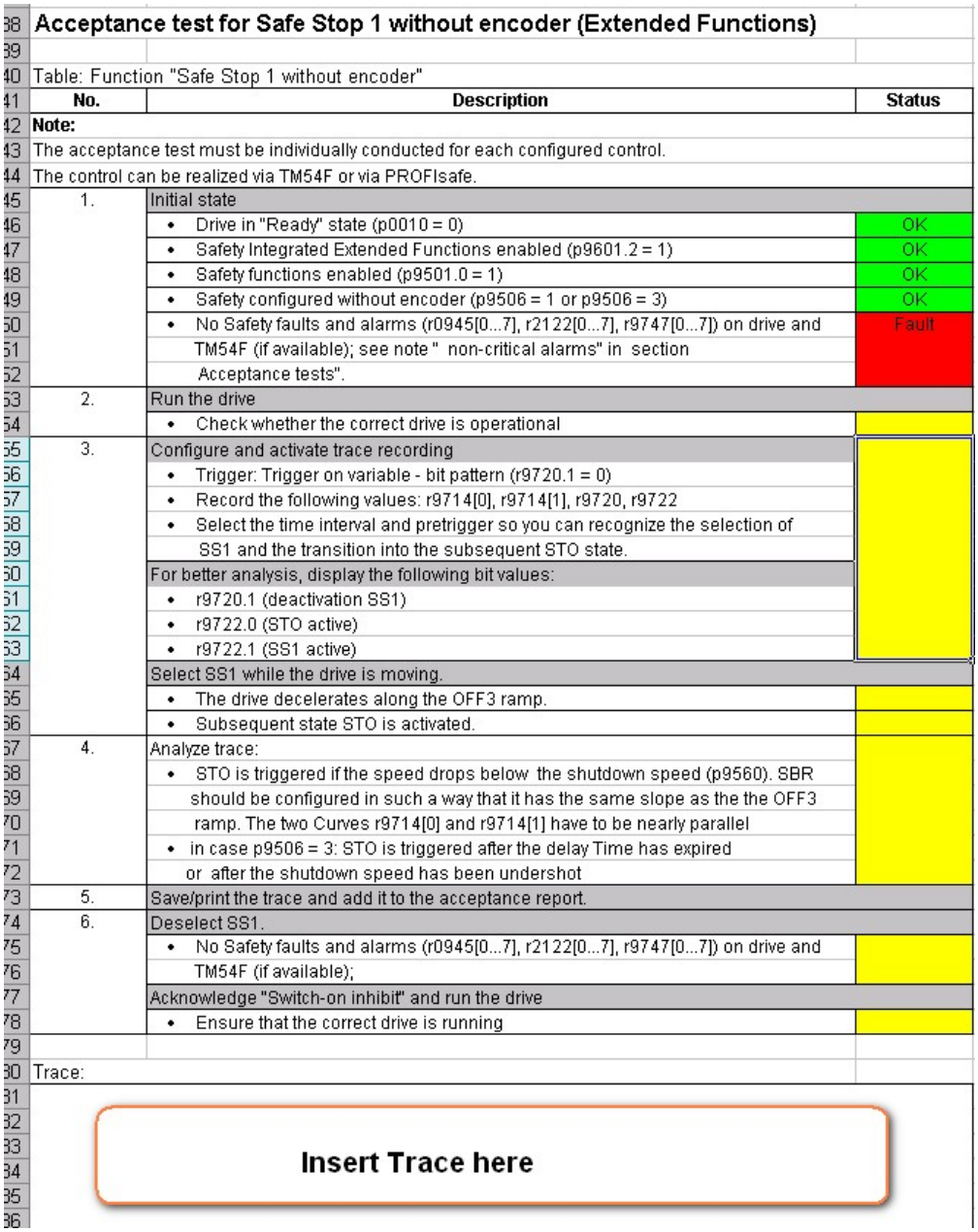
	A	B	C	D
12	**SERVO_02:**			
13	**SI function**	**Parameter Motor Modules / CU**	**Motor Module value**	**CU value**
14	Enable safety functions	p9301 / p9501	20001 Hex	20001 Hex
15	Axis type	p9302 / p9502	Linear axis	Linear axis
16	Function specification	p9306 / p9506	Safety without encoder with accel_monitoring/delay time	Safety without encoder with accel_monitoring/delay time
17	Function configuration	p9307 / p9507	4 Hex	4 Hex
18	Behavior during pulse suppression	p9309 / p9509	FF Hex	FF Hex
19	Act. value acq. clock cycle	p9311 / p9511	125 µs	0.125 ms
20	Coarse position value configuration	p9315 / p9515	0 Hex	0 Hex
21	Encoder configuration, safety functions	p9316 / p9516	0 Hex	0 Hex
22	Linear scale graduations	p9317 / p9517	0 nm	0 nm
23	Encoder pulses per revolution	p9318 / p9518	2048	2048
24	Fine resolution G1_XIST1	p9319 / p9519	11	11
25	Leadscrew pitch	p9320 / p9520	10 mm	10 mm
26	Gearbox encoder (motor) / load denominator	p9321[0] / p9521[0]	1	1
27		p9321[1] / p9521[1]	1	1

Figure 3-5: Drive data

Data is logged for each drive for which the safety functions have been configured (p9601>0). The figure above shows a section of the logged data for a drive.

3.1.5 "Drive1" to "Drive12" spreadsheets

The structure of these spreadsheets depends on which safety functions are being used. The tables from Section 9.4 of the SFM /3/ (S120) or from Section 8.9.5 of the FM /6/ (S110) are inserted. The application guides you through the individual test steps and logs them. For Extended Safety functions that require a trace, you must subsequently insert the graphic representation of this trace.



Acceptance test for Safe Stop 1 without encoder (Extended Functions)

Table: Function "Safe Stop 1 without encoder"

No.	Description	Status
Note:		
The acceptance test must be individually conducted for each configured control.		
The control can be realized via TM54F or via PROFIsafe.		
1.	Initial state	
	• Drive in "Ready" state (p0010 = 0)	OK
	• Safety Integrated Extended Functions enabled (p9601.2 = 1)	OK
	• Safety functions enabled (p9501.0 = 1)	OK
	• Safety configured without encoder (p9506 = 1 or p9506 = 3)	OK
	• No Safety faults and alarms (r0945[0...7], r2122[0...7], r9747[0...7]) on drive and TM54F (if available); see note " non-critical alarms" in section Acceptance tests".	Fault
2.	Run the drive	
	• Check whether the correct drive is operational	
3.	Configure and activate trace recording	
	• Trigger: Trigger on variable - bit pattern (r9720.1 = 0)	
	• Record the following values: r9714[0], r9714[1], r9720, r9722	
	• Select the time interval and pretrigger so you can recognize the selection of SS1 and the transition into the subsequent STO state.	
	For better analysis, display the following bit values:	
	• r9720.1 (deactivation SS1)	
	• r9722.0 (STO active)	
	• r9722.1 (SS1 active)	
	Select SS1 while the drive is moving.	
	• The drive decelerates along the OFF3 ramp.	
	• Subsequent state STO is activated.	
4.	Analyze trace:	
	• STO is triggered if the speed drops below the shutdown speed (p9560). SBR should be configured in such a way that it has the same slope as the the OFF3 ramp. The two Curves r9714[0] and r9714[1] have to be nearly parallel	
	• in case p9506 = 3: STO is triggered after the delay Time has expired or after the shutdown speed has been undershot	
5.	Save/print the trace and add it to the acceptance report.	
6.	Deselect SS1.	
	• No Safety faults and alarms (r0945[0...7], r2122[0...7], r9747[0...7]) on drive and TM54F (if available);	
	Acknowledge "Switch-on inhibit" and run the drive	
	• Ensure that the correct drive is running	

Trace:

Insert Trace here

Figure 3-6: DriveX

There are always 12 spreadsheets (Drive1 to Drive12). If no safety functions are used on a drive, or if there are less than 12 drives on a CU, then nothing is entered into these spreadsheets.

The figure above shows an excerpt from the "Drive2" spreadsheet. This shows the acceptance test of the encoderless Safety Extended function SS1. If the fields have a green background and marked with OK, then the relevant test steps have been processed successfully. If the test has still not been executed, then the fields in the right column have a yellow background. If an error occurs, the field for the corresponding test step has a red background and is marked with "Fault". This means that the report also includes information that indicates the exact fault for the acceptance test.

3.1.6 "Completion" spreadsheet

The checksums of the safety functions are saved here. As the name suggests, this is also the final page of the acceptance report. At this point (after the printout), signatures must be added. You must then subsequently enter data for these persons in the Excel file. The application does not support this data entry.

The structure of this spreadsheet is based on Section 9.5 of the SFM /3/ (S120) and/or Section 8.9.6 of the FM /6/ (S110).

	A	B	C	D	E	F
1	**Completion of certificate**					
2						
3	**SI parameters**					
4						
5		**Specified values checked?**				
6		**Yes**		**No**		
7	Control Unit					
8	Motor Module					
9						
10	**Checksums**					
11						
12	**Basic Functions + Extended Functions**					
13	**Drive name**	**Drive number**	**SI reference checksum SI**		**SI reference checksum SI**	
14	SERVO_01	2	r9799 =	2CAA99A2	r9899 =	22D8A32E
15	SERVO_02	3	r9799 =	D814100D	r9899 =	637F10C9
16			r9799 =		r9899 =	
17			r9799 =		r9899 =	
18			r9799 =		r9899 =	
19			r9799 =		r9899 =	
20			r9799 =		r9899 =	
21			r9799 =		r9899 =	
22			r9799 =		r9899 =	
23			r9799 =		r9899 =	
24			r9799 =		r9899 =	
25			r9799 =		r9899 =	
26	**only Extended Functions**					
27	**Drive name**	**Drive number**	**SI reference checksum SI**		**SI reference checksum SI**	
28	SERVO_01	2	p9399[0]=	0	p9729[0]=	0
29			p9399[1]=	0	p9729[1]=	0
30					p9729[2]=	0
31	SERVO_02	3	p9399[0]=	C5094CD6	p9729[0]=	81733484
32			p9399[1]=	2BCD926F	p9729[1]=	FCDC982
33					p9729[2]=	0
34			p9399[0]=		p9729[0]=	
35			p9399[1]=		p9729[1]=	
36					p9729[2]=	
37			p9399[0]=		p9729[0]=	
38			p9399[1]=		p9729[1]=	
39					p9729[2]=	

Figure 3-7: Completion

An excerpt of the spreadsheet is shown above. In this example, two drives with safety functions are being used.

Note

If drives are deactivated, the safety-relevant parameters which are provided with values will be readout and stored in the excel-file.

3.2 The script

3.2.1 Function

In addition to the Excel file, which represents the report, the application also includes a script. This guides the user through all of the necessary steps of the acceptance test. When the Basic Functions STO, SS1 and SBC, as well as the Extended Functions STO and SBC, are used, the script completely and automatically fills out the acceptance report. For all other Extended Functions, traces must be recorded. These must then be subsequently inserted into the Excel file. A trace may also be necessary for SS1 of the Basic Functions. This is the case for very short SS1 times. If the time for automatic evaluation of all feedback signals is too short, the application prompts the user to prove the correct signal states by performing a trace.

If you test one of the following Extended Functions: SS1, SS2, SOS, SLS, SSM or SDI, trace recordings are absolutely necessary. Because the active acceptance-test application does not permit access to other functions (e.g. trace) of the STARTER/SCOUT, the engineering system must be opened a second time. The trace recordings must be produced there. The application provides the user with information as to which variables should be recorded and how the trigger condition should be configured. The application orientates itself to the tables in Section 9.4 of the SFM /3/ (S120) or Section 8.9.5 of the FM /6/ (S110). Information is provided there as to how the traces should be evaluated. Here, the application also provides support.

The acceptance test does not have to be performed in one go. It can be interrupted and continued at a later time. If safety-relevant parameter changes must be made after a first test, then the data must be logged again and the modified safety function retested.

3.2.2 Delivery format

The script is provided as zip archive (SI_AcceptanceTest_V20.zip). It is just a zipped version of the exported script, the report file in the form of an Excel table and a documentation file. The zip file is not an executable project.

All of the necessary steps required to insert the script in an existing project are described in the following chapter.

Before you can work with the script, the machine or the test configuration must have been commissioned; this also applies to the safety functions. Further, the processes signals must have been connected in order to be able to operate the drives.

For individual tests, it can be necessary to make special settings on the control side in order to provoke a limit violation (e.g. when testing SLS).

4 Commissioning the application

4.1 Preparation

Commissioning the machine or the test configuration must have been completed sufficiently far so that the drives can be traversed. Further, it is assumed that the used safety functions can be controlled.

The script supports all safety functions up to V4.4 and their associated control versions. Other versions of the safety functions can also be tested.

4.2 Importing the script

The zip file must first be extracted. A program such as WinZip can be used to do this.

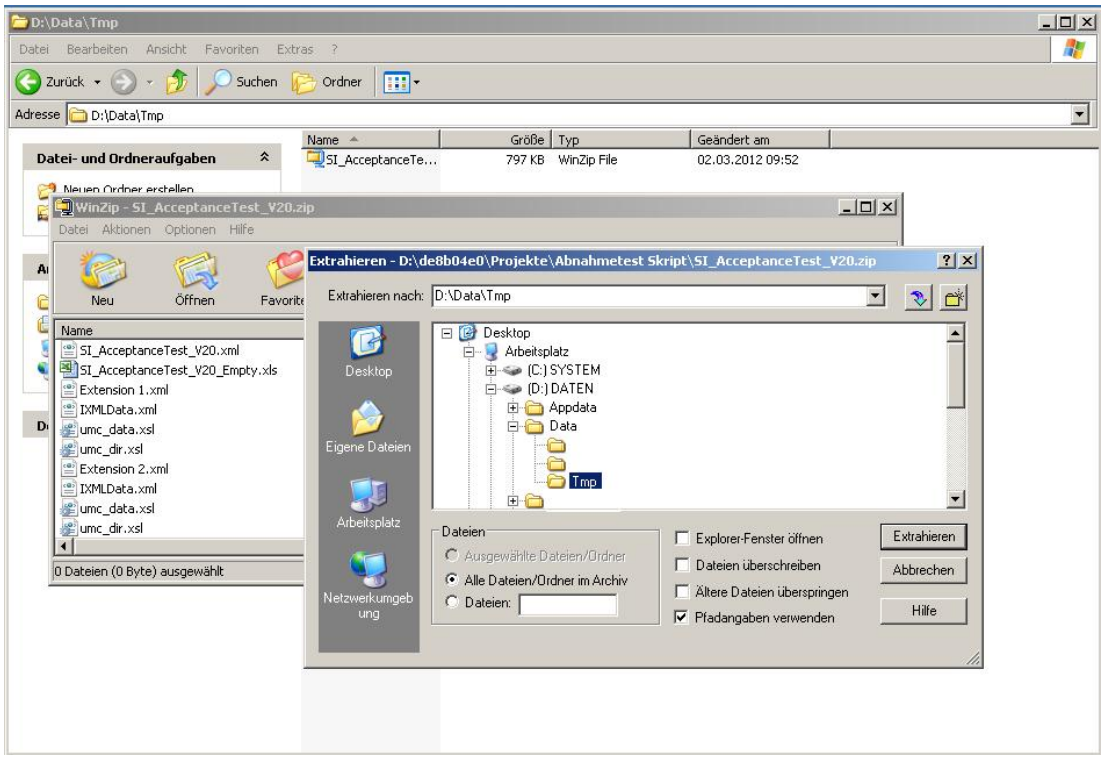


Figure 4-1: Extracting the "SI_AcceptanceTest_V20.zip" zip file

Extract the files to a directory of your choice. The "D:\Data\Tmp" folder was used in this example.

In the next step, a script folder must be created in your existing project. To do this, please open STARTER or SCOUT and the project that you have created. Please remain in the offline mode. The folder must be inserted directly below the drive unit. If the script is inserted at the incorrect position (e.g. under a drive or the Control Unit), then the application will not be able to be executed.

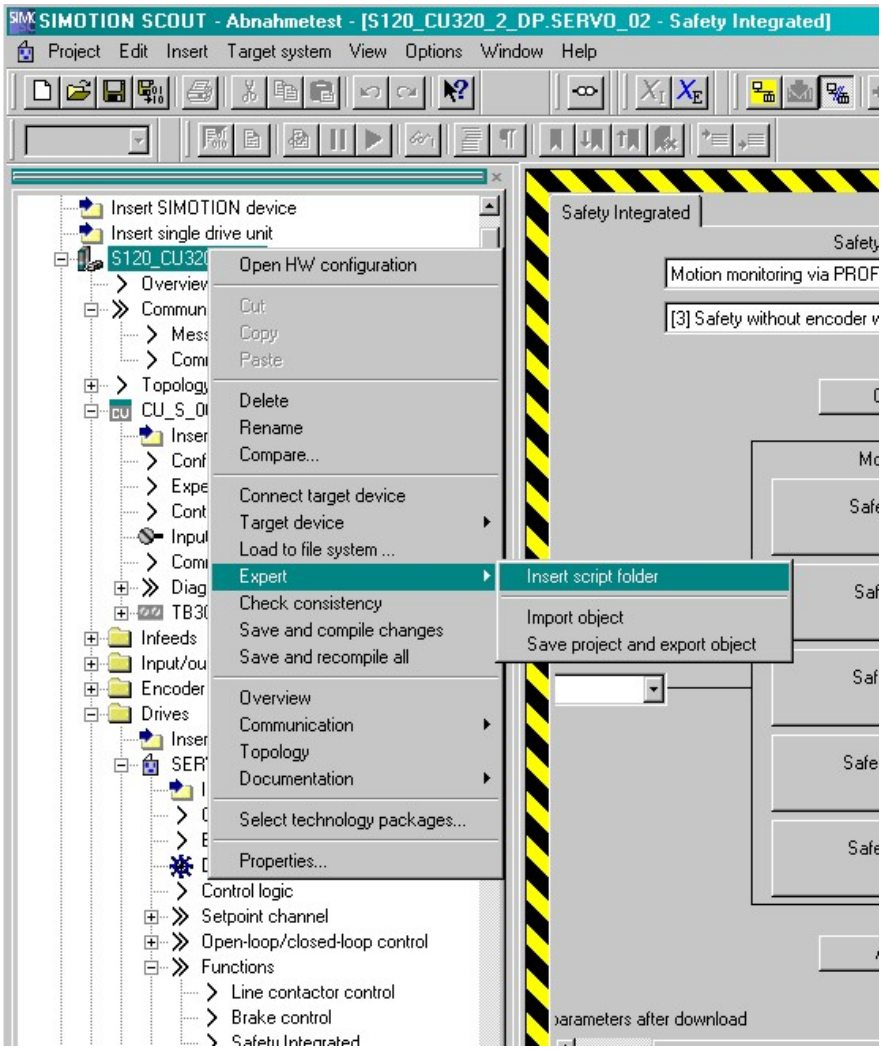


Figure 4-2: Creating the script folder

To create the folder, right-click the drive unit. Under "Experts", select the "Insert script folder" entry.

The folder is now created. Then right-click the folder and select the "Import object" entry.

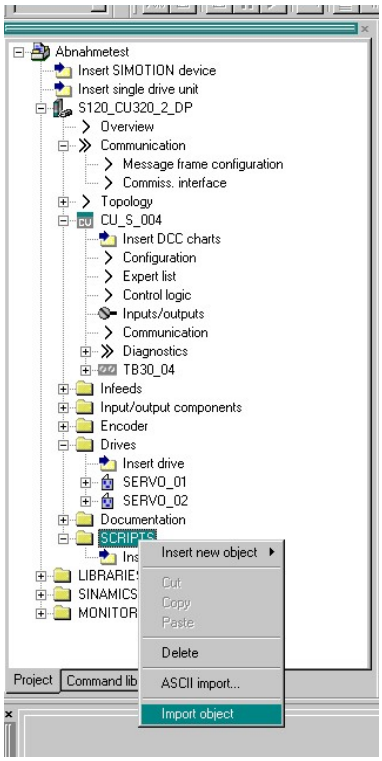


Figure 4-3: Importing a script

A window opens in which the "SI_AcceptanceTest_V20.xml" file to be imported can be selected. Use "Browse" to select the directory in which the "SI_AcceptanceTest_V20.zip" was extracted previously.

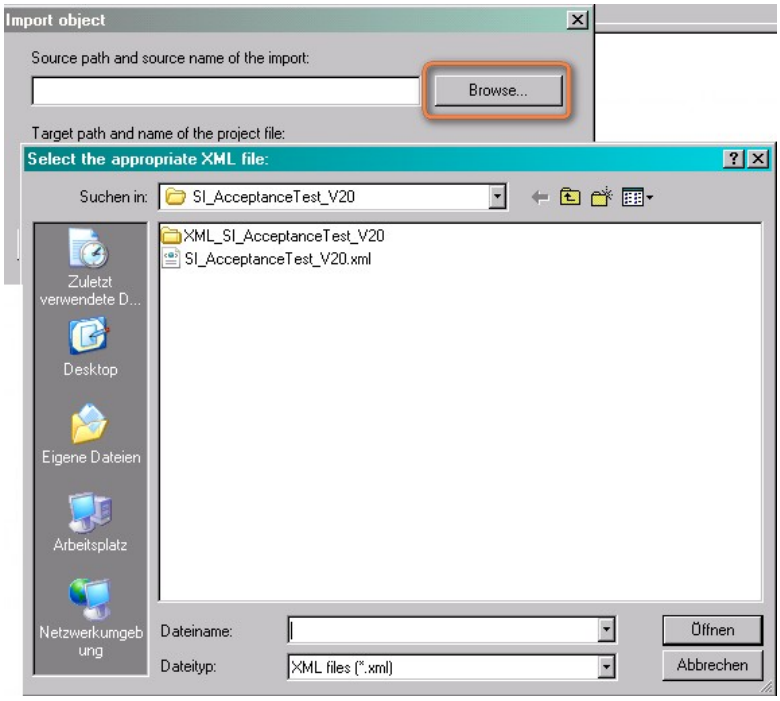


Figure 4-4: Selecting the file to be imported

Now select the "SI_AcceptanceTest_V20.xml" xml file and click the "Open" button.

The file is now selected and "OK" clicked to import.

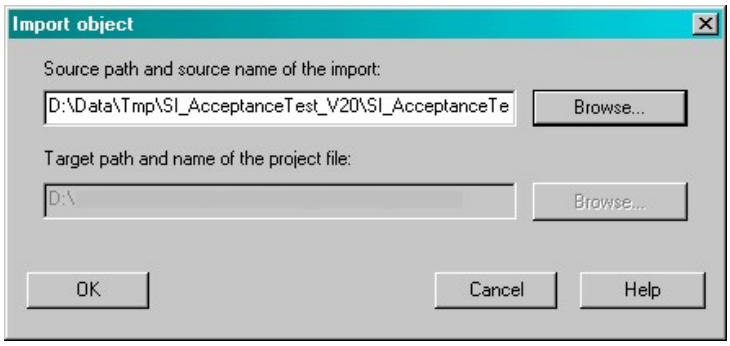


Figure 4-5: Importing the file

If the procedure was completed successfully, the acceptance-test script is now available in the previously inserted script folder (see the figure below). The script is know-how protected and cannot be changed by the user.

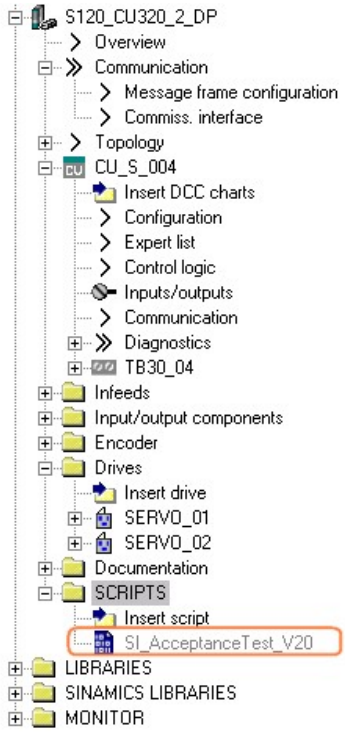


Figure 4-6: Project with imported script

The "SI_AcceptanceTest_V20.zip" file also contains the "SI_AcceptanceTest_V20.xls" Excel file. This can be used, unchanged as report file. You can, however, give this file a different name and move it to any directory. In order to always have the original file available for multiple use, it is recommended to use a copy of the file for logging rather than the original file.

The following chapter describes not only the operation of the application but also specifies how to integrate the Excel file.

5 Using the application

5.1 Starting the application

Before the script is started, ensure that a functioning connection has been established between STARTER or SCOUT and SINAMICS. It is not assumed that an online connection has already been established when the script is started.

The script is started with a right-click and selecting the "Accept and execute" menu item.

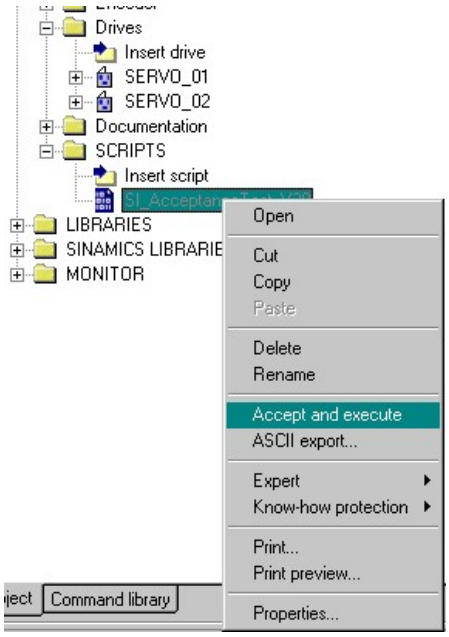


Figure 5-1: Starting the script

Immediately after the start, an HTML page opens in which the language can be selected. The script currently supports the German and English languages.

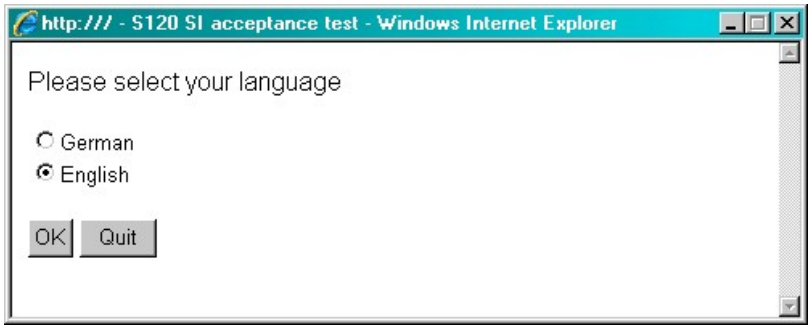


Figure 5-2: Selecting the language

A window then opens to inform the user that this script is only a support for performing the acceptance test. The operator remains responsible.

Figure 5-3: Note regarding the acceptance test using a script

The Excel file used as the report must then be selected. The script opens a window in which the user selects the Excel file.

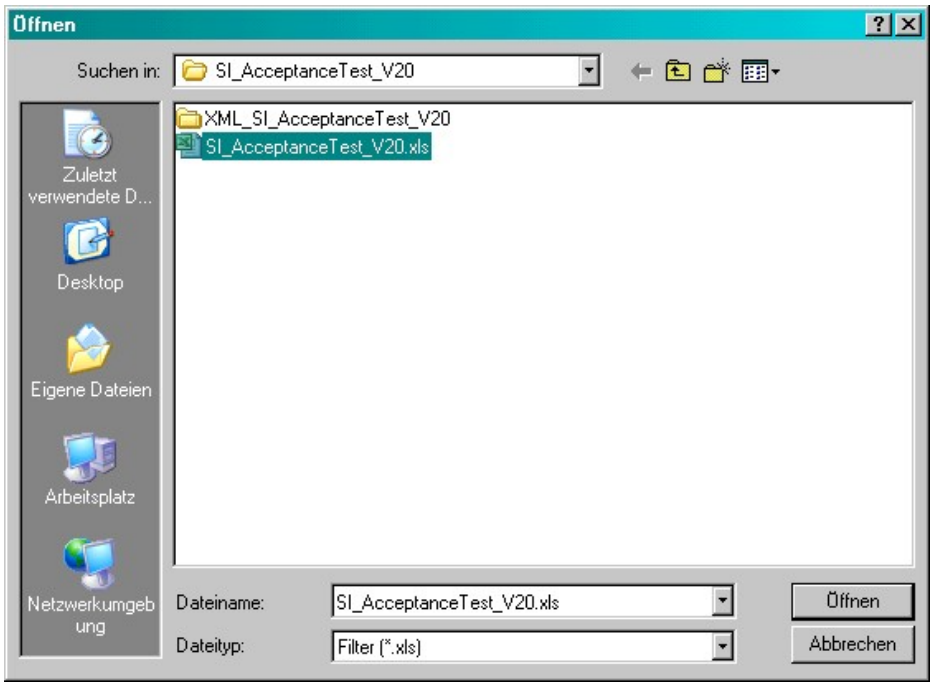


Figure 5-4: Selecting the report file

This must either be the file supplied or a copy of it. An Excel table created by the user cannot be used. However, the provided file – or a copy of it – can have any name.

An internal check is made as to whether the script version matches the Excel file version. The application can only be executed if this is the case. Otherwise a window opens with an appropriate error message.

If an online connection has not been established, the script establishes it. A message window is opened to give users time to physically establish the connection. The connection can be established only after clicking "OK".

5.2 Operator inputs

5.2.1 Starting a new acceptance test

After the steps described in Section 5.1 have been performed, the operator is now prompted to enter some machine data. To do this, several windows are opened one after the other.

You must first enter some general machine data.

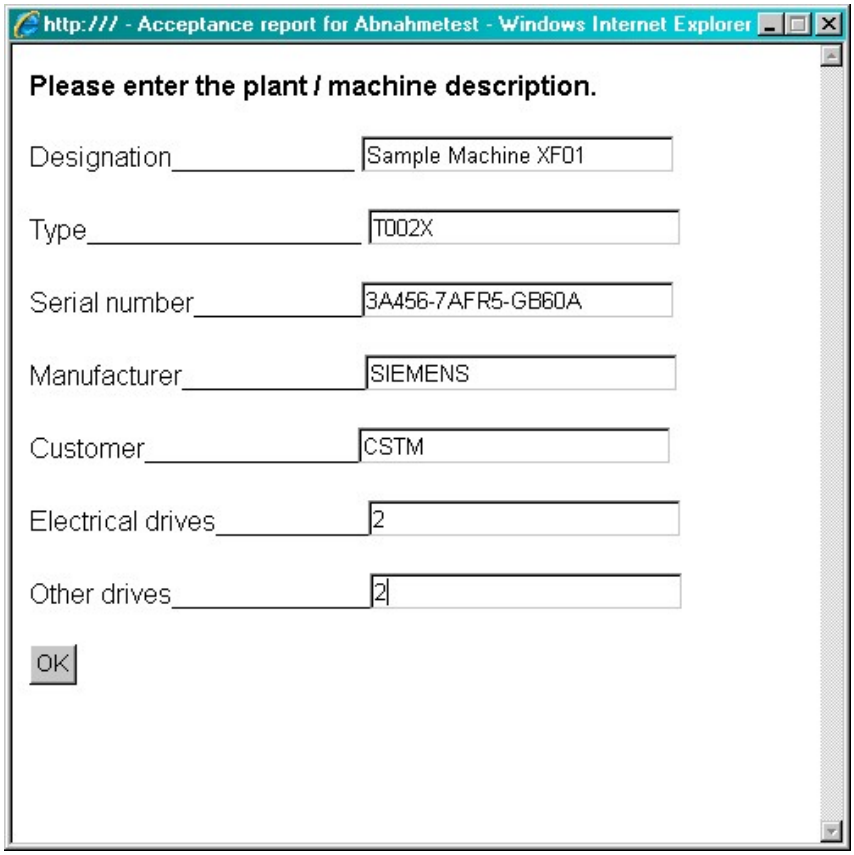


Figure 5-5: General machine data

The input regarding the number of drives is only used for documentation purposes, and has no influence on the subsequent test. "Other drives" mean non-electrical drives (e.g. hydraulic axes); they cannot, however, be tested by the application.

The inputs mentioned above can be subsequently found in the report (Excel file) in the "Plant description" spreadsheet. After the acceptance test has been completed, these should be supplemented by a sketch/diagram of the machine. A detailed description of the specified spreadsheet can be found in Section 3.1.2 of this document.

The inputs are confirmed by clicking the "OK" button to close the window.

The application now investigates all of the drives connected to the Control Unit. It is evaluated as to whether safety functions have been configured – and if they have, whether the Safety Integrated Basic Functions or the Extended Functions are being used. When Basic Functions are being used, then the application is in a position to automatically identify the configured functions. These are then displayed in a window. The case when the Basic Functions are controlled via PROFIsafe and SS1 has been parameterized is an exception. Because SS1 and STO can be

controlled, the checkbox that appears in the window must be activated if both functions should be used.

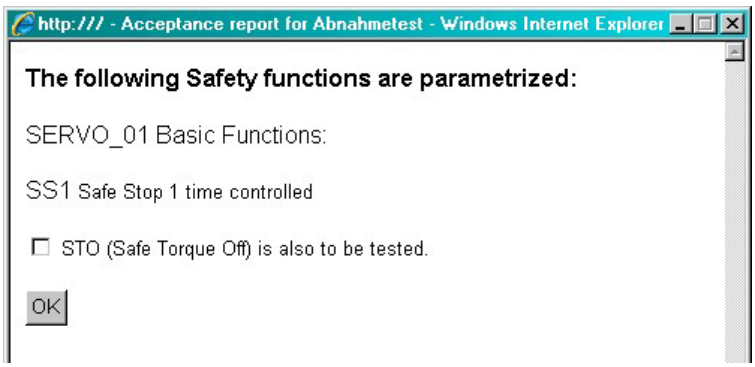


Figure 5-6: Display of the configured Safety Integrated Basic Functions

The display must be confirmed with OK.

In the case that Safety Integrated Extended Functions (with or without encoder) are used, the application cannot decide which functions are being used on the machine. The operator must make the appropriate selection. Only these functions can be tested later using the application.

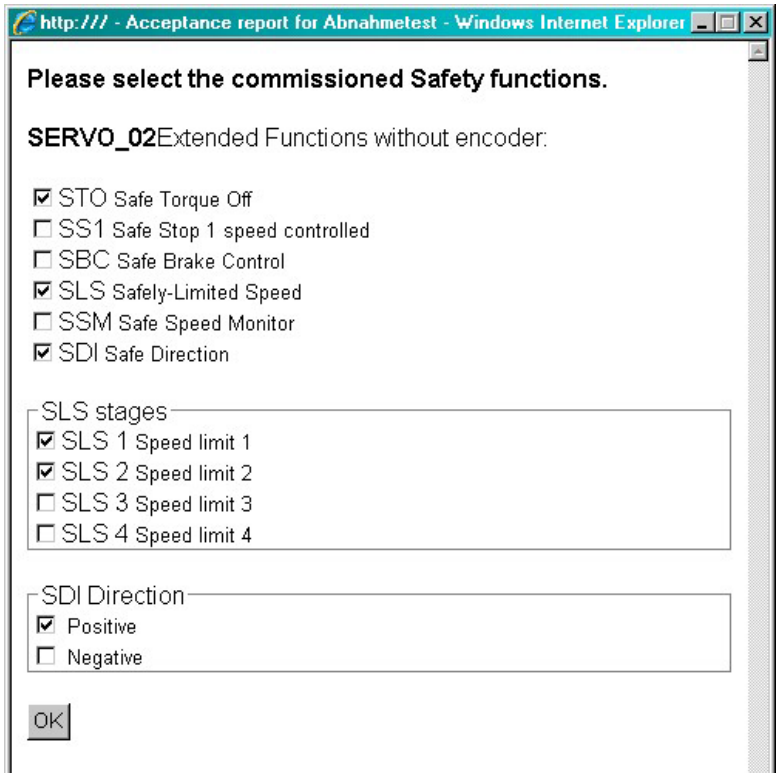


Figure 5-7: Selecting the used Safety Integrated Extended Functions

You must select all used safety functions that should be tested. If you are not sure about the selection, then you can find additional information on this in Section 9.1.1 of the SFM /3/ (S120) or Section 8.9.2.1 of the FM /5/ (S110).

For the selection of SLS and SDI, the parameterized stages or directions must be selected below. The input is completed with "OK" and the window closes.

Once the functions to be tested have been selected, the application opens two windows. One window provides an overview of the safety functions selected for testing and their associated test progress.

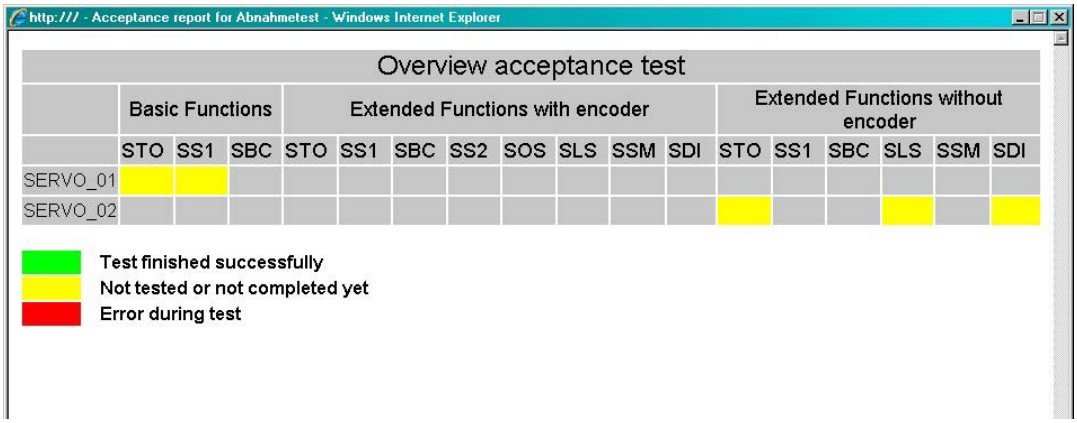


Figure 5-8: Overview of the acceptance test when starting the application

Selected functions that have not yet been tested (completely) are shown with a yellow background. The field changes to green once the test has been successfully completed. If an error has occurred while testing, then this is flagged in red. This screen form corresponds to the spreadsheet "Overview" (see Section 3.1.1).

The second screen form is for actually performing the acceptance test. For example, the drive and the function to be tested are selected here. Furthermore, at this point you can initiate that the safety parameters of the drives are logged.

Note

This version of the acceptance test does not permit the concurrent test of several drives.

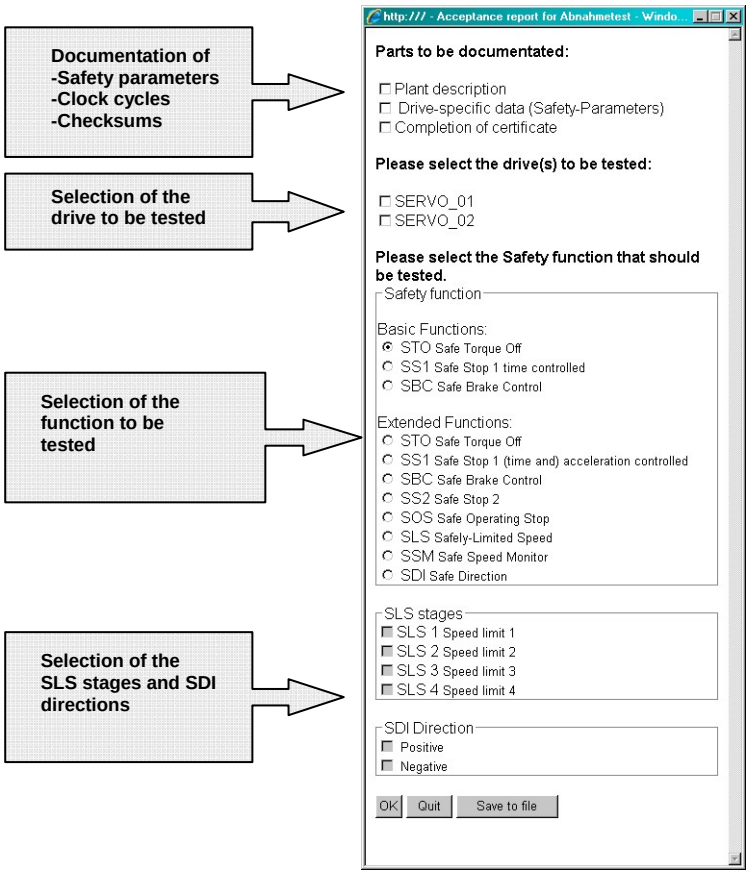


Figure 5-9: Using the application

The documentation also includes the safety parameters, the safety clock cycles, the firmware versions and the checksums. This data is subsequently included in the report in the spreadsheets "Plant description", "Drive-specific data" and "Completion" (see Section 3.1). The documentation must be selected once otherwise the report is not complete. It is recommended that this is done at the end of the test. This means any parameters that change during the test are not lost. A check mark must be set in the fields in order to document the appropriate sections.

In order to test a safety function, the associated drive must first be selected. The safety function must then be selected. It is not possible to select more than one function for the test. The test is started with "OK". If a function is selected that is not parameterized (for Basic Functions) or was not selected previously, a window appears with an error message specifying that the relevant drive does not support this function. The test starts once a correct selection has been made. In Sections 5.3.1 and 5.3.2, an example is provided for one Basic and one Extended Function in order to explain the test procedure and the necessary interactions. Click the "Save to file" button to save the current test version. This should be done after each tested function.

Note

The acceptance test must be performed for each configured control of a Safety Integrated function. The Safety Integrated functions can be controlled via the onboard terminals, the fail-safe TM54F module or the PROFIsafe telegram.

For the case of the Basic Functions control via PROFIsafe and terminals, please note Section 5.3.4 of this document.

The display (Figure 5-8) changes depending on progression of the test. The following figure shows the display after test of STO on drive SERVO_01 was successful and the test of SS1 was completed with error.

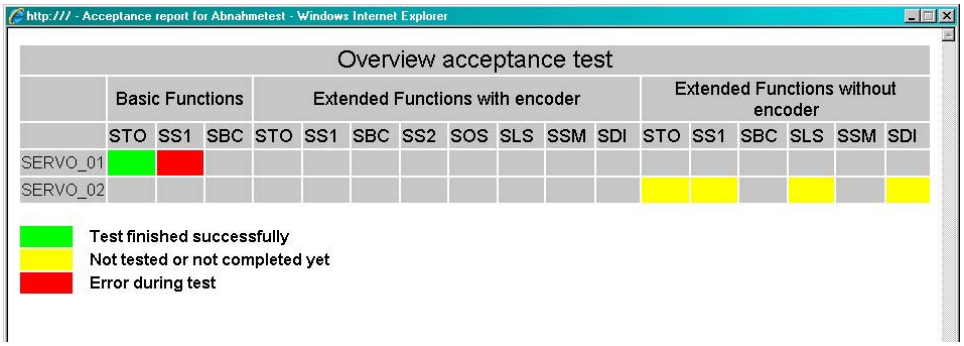


Figure 5-10: Overview of the acceptance test during the progression of the test

After one or several functions have been tested, the acceptance test can be exited with "Quit" (see Figure 5-9). If not all of the functions were (successfully) tested, the test can be continued later. This is required, for example, if an error results or it was determined that a safety parameter needs to be changed.

Note

Always exit the script with the the "Quit" button and never with the STARTER/SCOUT "Cancel" button.

5.2.2 Continuing an existing acceptance test

The first steps do not differ from those when starting a new test. The report file is opened as shown in Figure 5-3. The application detects that this file has already been used once. The window shown in Figure 5-4 opens and the previous entries are displayed. After confirming with "OK", the following message window opens.

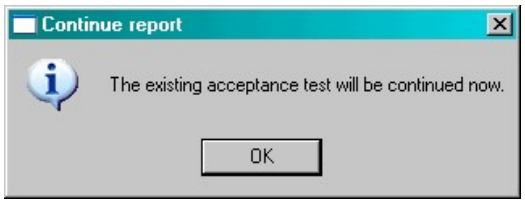


Figure 5-11: Message when continuing the acceptance test

After confirming with "OK", the windows shown in Figs. 5-9 and 5-10 open and the test can be continued.

Note If the test is saved in a certain language, it can only be continued in this language.

5.2.3 Response in the case of an error

If an error occurs during a test, then the application opens a corresponding alarm window and cancels the test.

Figure 5-12: Message window in the event of an error in testing SS1

For better diagnostics, the current status should be saved and the application terminated ("Quit" key in Figure 5-9). The report file can now be opened. The test point that resulted in an error can be identified in the spreadsheet of the drive involved.

38	**Acceptance test for Safe Stop 1 without encoder (Extended Functions)**		
39			
40	Table: Function "Safe Stop 1 without encoder"		
41	**No.**	**Description**	**Status**
42	**Note:**		
43	The acceptance test must be individually conducted for each configured control.		
44	The control can be realized via TM54F or via PROFIsafe.		
45	1.	Initial state	
46		• Drive in "Ready" state (p0010 = 0)	OK
47		• Safety Integrated Extended Functions enabled (p9601.2 = 1)	OK
48		• Safety functions enabled (p9501.0 = 1)	OK
49		• Safety configured without encoder (p9506 = 1 or p9506 = 3)	OK
50		• No Safety faults and alarms (r0945[0...7], r2122[0...7], r9747[0...7]) on drive and	Fault
51		TM54F (if available); see note " non-critical alarms" in section	
52		Acceptance tests".	
53	2.	Run the drive	

Figure 5-13: Excerpt from the report file

As can be seen, the error buffer query resulted in an error. It can be assumed that when starting the test, a Safety error was already active. This must now be checked using the STARTER/SCOUT alarm window.

Once the cause has been corrected and the messages acknowledged, the test can be continued as described in Section 5.2.2.

Note It must be ensured that the report file not is open in Excel, otherwise the script execution cannot be continued.

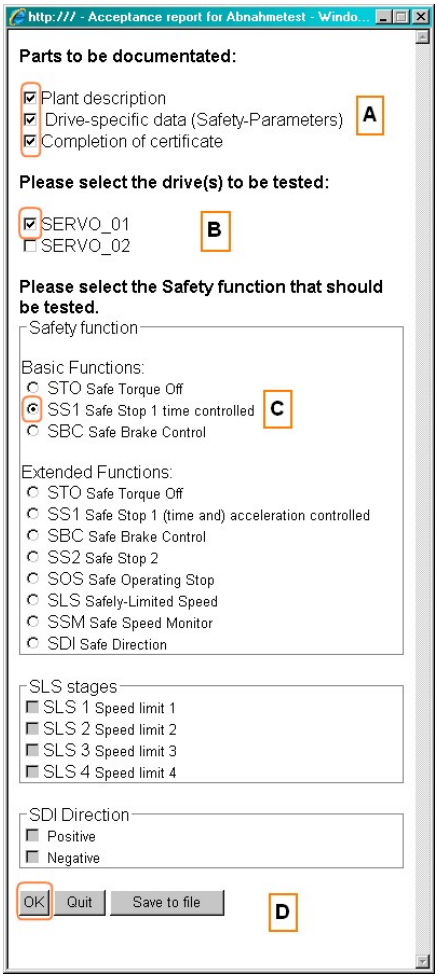
5.3 Performing the tests

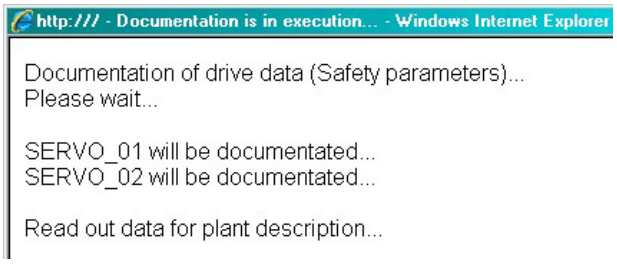
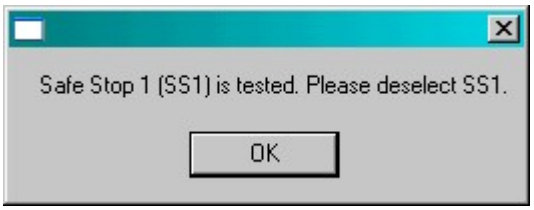
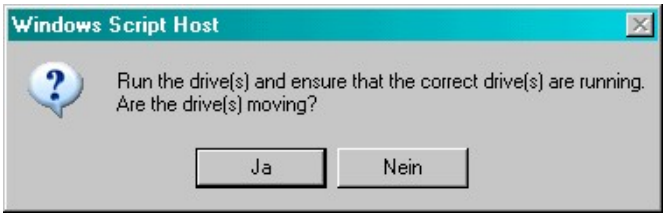
5.3.1 Testing Safety Integrated Basic Function SS1

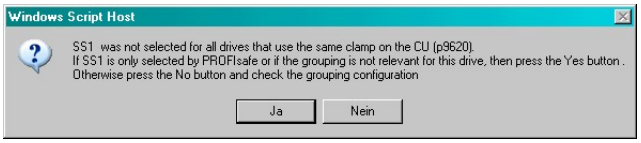
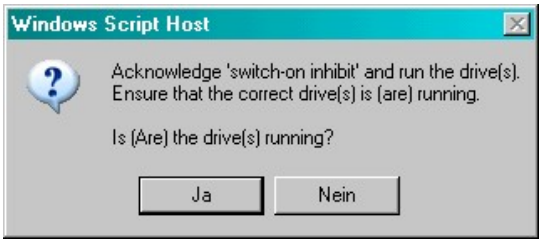
The following tabular overview shows the test of the Safety Integrated Basic Function "Safe Stop 1" (SS1). Here, the function is controlled via PROFIsafe. All operator interactions are described. The procedure when testing the other Basic Functions (STO and SBC) is very similar. This also applies when testing the Safety Integrated Extended Functions STO and SBC. This is the reason why there is no detailed description of the tests for the other Safety functions mentioned above.

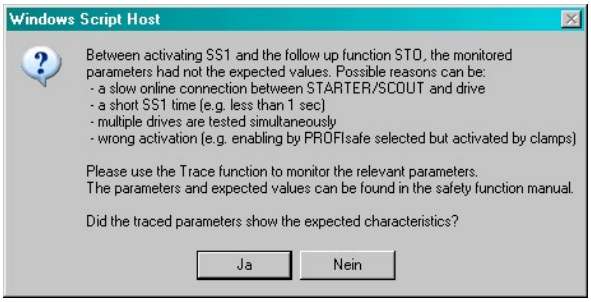
The following table describes the steps that are required after starting the test according to Section 5.2.

Table 5-1: Testing SS1 (Basic Function)

No.	Action	Remark
1	A) Select the safety data to be logged B) Select the "SERVO_01" drive C) Select safety function SS1 D) Start the test	

No.	Action	Remark
2	When logging the data you will be informed of the progress.	
3	At the beginning of the test, SS1 (and if necessary all other Safety functions) must be deselected. "OK" may only be selected if this has been done. If STO or SS1 is still active, then this results in an error in the test.	
4	You are now prompted to traverse the drive to be tested. It is also queried as to whether the drive is rotating. Here, the application does not perform a check. You are responsible for making the correct entry. When selecting "Yes", the test point is evaluated as OK; if "No", then the test is canceled with an error message.	
6	You are now prompted to select the SS1 function. The "OK" button must be clicked before the function is selected. SS1 must now be selected within 2 minutes. If this is not done, the test will be canceled with an error message.	
7	The SS1 time is long enough to automatically evaluate the signal states between selecting SS1 and the resulting state STO -> continue with point 8. The SS1 time is too short for an automatic evaluation of the signal states -> continue with point 13. This can be the case for SS1 times less than 1 sec.	

No.	Action	Remark
8	You must observe and monitor the braking action of the axis and decide whether the axis was correctly braked. The application cannot evaluate this. When selecting "Yes", the test point is evaluated as OK; if "No", then the test is canceled with an error message. **Note:** For very long SS1 times, ensure that "Yes" is only clicked after this time has elapsed. The test will be exited with an error message if this is done too early.	
9	When controlling (several drives) via PROFIsafe, this message appears and must be confirmed with "Yes". Please carefully observe the information immediately provided after this table.	
10	You will now be prompted to deselect SS1 again. Confirmation with "OK" is permissible only after this has been done.	
11	You are now prompted to again traverse the drive to be tested. It is also queried as to whether the drive is rotating. Here, the application does not perform a check. The user is responsible for the correct entry. When selecting "Yes", the test point is evaluated as OK; if "No", then the test is canceled with an error message.	
12	A successfully performed test is displayed with this message. It must be confirmed with "OK".	
The following lines are only relevant, if an automatic evaluation of the signals was not possible due to an excessively short SS1 time.		

No.	Action	Remark
13	If the SS1 time is too short for an automatic evaluation, then this message appears. You will now be prompted to record a trace to verify the correct signal characteristic. "No" must be selected because this is generally not available when the message is displayed for the first time.	
14	The test is now exited with an error. The message must be confirmed with "OK".	
15	You should now end the acceptance test and record the required trace. You must trace all of the signals that are listed in Table 9-9, Section 9.4.1.2 of the SFM /3/ (S120) or in Table 8-29, Section 8.9.5.1 of the FM /6/ (S110). These are as follows: r9772, r9872, r9773; r9774 (only if you are using grouped drives) Selecting SS1 (e.g. r9773.5) is recommended as trigger. Configure the recording interval greater than the SS1 time in order to be able to identify all of the signal transitions. You also require a pre-trigger in order to be able to evaluate the signals before selection. Please refer to the tables above regarding which bits must be considered. To verify correct braking along the OFF3 ramp, you can optionally record the speed setpoint and the actual value. If you are working with version **V2.6 SP1**, then please orientate yourself to Table 9-9 from the SFM with revision level **10/2008.** The acceptance test of the function is repeated after the trace has been positively evaluated with OK. "Yes" can now be selected in the window from point 13. The test is now continued with point 8.	

Note regarding grouping

According to Section 5.1 of SFM /3/, drives are considered to be grouped if they have the same value in p9620. This also applies to the value 0. If the Basic Functions are not used or if they are controlled via PROFIsafe, then p9620 has the value 0. However, in the strict sense, there is no grouping. In spite of this, for the test, the message specified under point 13 is displayed.

When controlling the Basic Functions via PROFIsafe – or when using Extended Functions without Basic Functions – this message should generally be confirmed with "Yes".

When controlling the Basic Functions via terminal for grouped drives, it is only permissible that the above window is displayed when an error occurs. "No" would be the answer in this case. This leads to the test being canceled with an error message. In this case, using the report you must determine the cause of the problem.

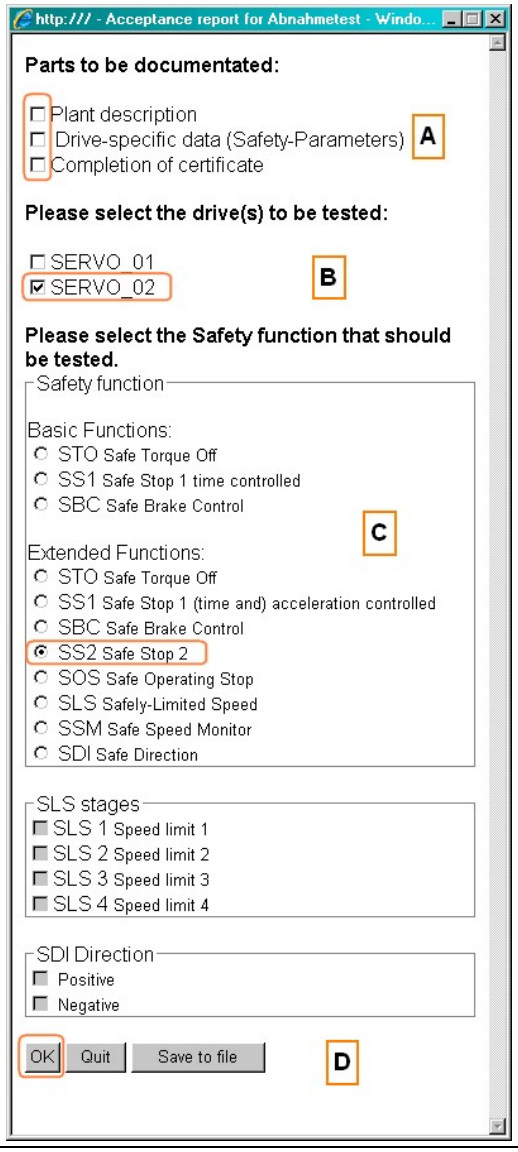
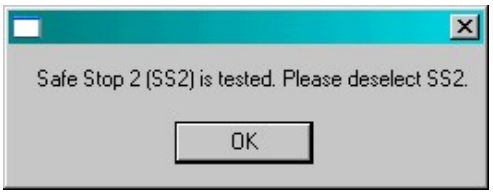
Because of deactivated drives, the correct function cannot always be guaranteed and so the test of currently grouped drives with the application is not released.

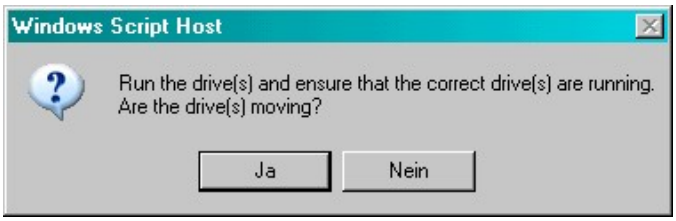
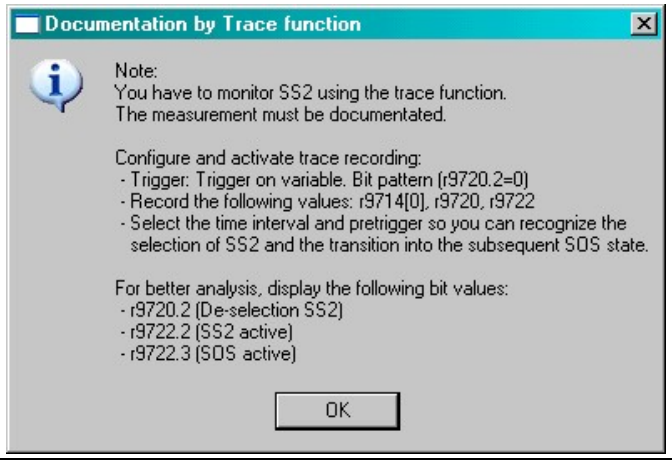
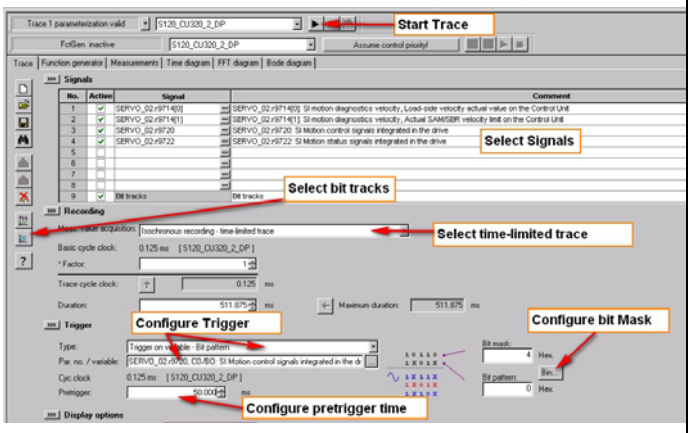
5.3.2 Testing Safety Integrated Extended function SS2

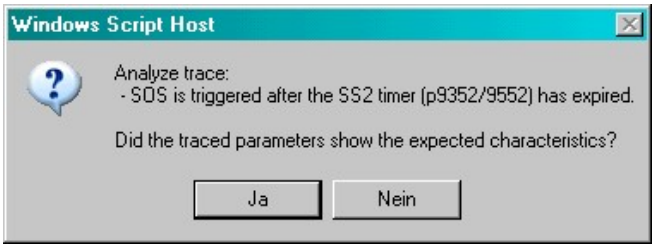
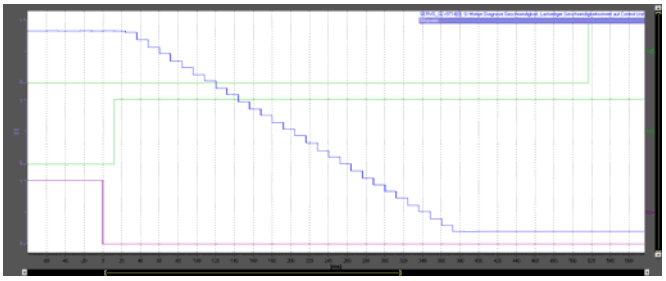
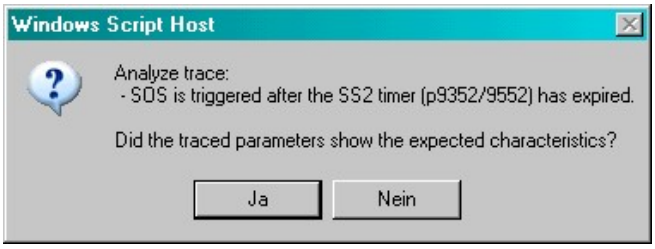
Performing the Safety Integrated Extended Function "Safe Stop 2" (SS2) test is shown in the following tabular overview. Here, the function is controlled via PROFIsafe. All operator interactions are described. The other Extended Functions are tested in a very similar way. This also applies when controlling the functions via the fail-safe TM54F Terminal Module. This is the reason why there is no detailed description of the tests for the other Safety Integrated Extended Functions.

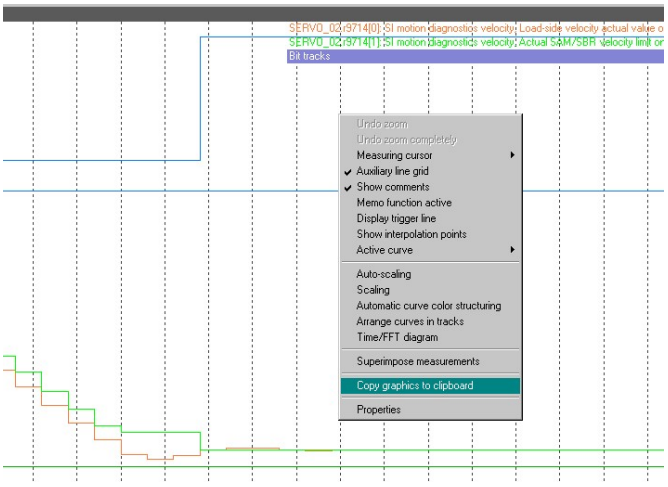
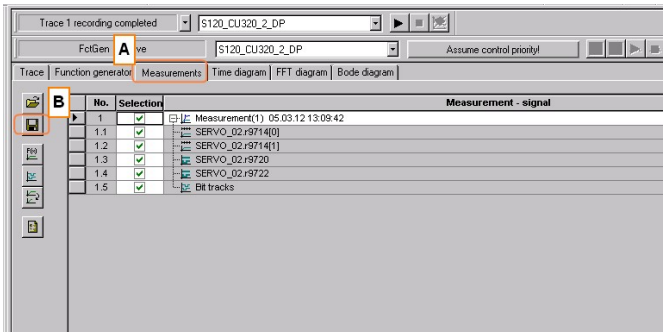
The following table describes the steps that are required after starting the test according to Section 5.2.

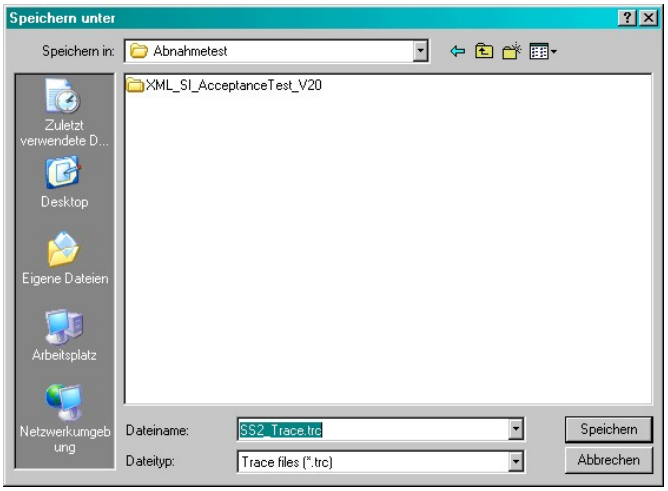
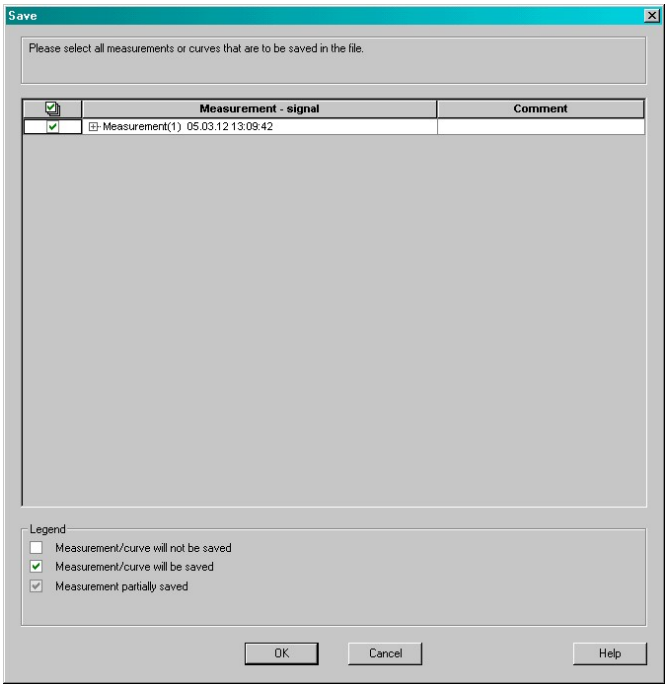
Table 5-2: Testing the safety function SS2 (Extended Function)

No.	Action	Remark
1	Before you start the application according to Section 5-2, STARTER or SCOUT should be opened a second time. Only then is it possible to configure, start and evaluate a trace while the application is running. Open the same project in both STARTER and SCOUT.	
2	A) Select the safety data to be logged B) Select the "SERVO_03" drive C) Select safety function SS2 D) Start the test **Note:** Step A is not necessary if the data has already been logged – and in addition, the safety parameterization has not been changed.	
3	At the beginning of the test, SS2 (and if necessary all other Safety functions) must be deselected. "OK" may only be selected if this has been done. If SS2 is still active, this will lead to an error in the test.	

No.	Action	Remark
4	You are now prompted to traverse the drive to be tested. It is also queried as to whether the drive is rotating. Here, the application does not perform a check. You are responsible for making the correct entry. When selecting "Yes", the test point is evaluated as OK; if "No", then the test is canceled with an error message.	
5	You are now requested to configure the trace recording.	
6	In this case, now change to the second opened STARTER/SCOUT and open the trace screen form.	
7	Signals to be traced: • r9714[0] • r9720 • r9722 Trigger: • Isochronous recording - time-limited trace • The duration should be selected in such a way that braking along the OFF3 ramp and the transition to the next state SOS can be identified. • Use pretrigger • Triggering on bit pattern • Signal r9720 bit 2 Load the trigger settings and start recording.	
8	After the trace has been started, you return to the STARTER/SCOUT on which the application is running.	

No.	Action	Remark
9	You are now prompted to select the SS2 function. You must observe and monitor the braking action of the axis and decide whether the axis was correctly braked. The application cannot evaluate this. When selecting "Yes", the test point is evaluated as OK; if "No", then the test is canceled with an error message. Note: Braking along the OFF3 ramp can be checked using the trace.	
10	You are now requested to analyze the trace recording. The application provides some notes in this case. Additional information can be found in Chapter 9 of SFM /3/ (S120) or Section 8.9 of FM /6/ (S110). Neither the "Yes" nor "No" button may be clicked at this time.	
11	Now switch back to the STARTER/SCOUT that is open in parallel on which the trace was recorded. According to the information above, display bits r9720.2 (SS2 deselection), r9722.2 (SS2 active) and r9722.3 (SOS active).	
12	Your trace should now have a similar characteristic as shown in the adjacent diagram. Note: Under no circumstances should you close the trace. The trace that was recorded still has to be saved. The required steps are described from row 18 and higher.	
13	Now return to STARTER/SCOUT on which the acceptance test application is running.	
14	If the trace has verified a correct behavior, confirm this with "Yes". If not, "No" must be selected. In this case the test is completed with error.	
15	You are now prompted and/or reminded that the trace still has to be saved and attached to the acceptance report. Confirm the message with "OK". Save the trace after the SS2 test has been completed. You can find the description from row 22 and higher in this table.	

No.	Action	Remark
16	Deselect SS2 again. If the drives are to be traversed again with the setpoint, confirm this with "Yes". If "No" is the answer, the test is canceled with error.	
17	The application displays a successfully performed test with this window. Confirm this with "OK".	
18	Now switch back to the STARTER/SCOUT that is open in parallel on which the trace was recorded. A graphic display of the trace is first saved.	
19	Right-click when the cursor is located in the graphic to receive the displayed menu. Select "Copy graphic to clipboard".	
20	Create an Office document (e.g. a Word document) that you can then use as buffer for the graphics until the acceptance test has been completed. As long as the application has not yet been completed, you cannot insert the graphic directly into the Excel acceptance report. After exiting the application, you can copy the buffered graphics from the document to the corresponding points in the acceptance report.	
21	This means that the steps specified by the report have been executed. Since the graphic in the report is relatively small it is recommended that the trace data is also backed up. The required steps are described in the following.	
22	A) Select the "Measurements" tab. B) Click the symbol to save the data.	

No.	Action	Remark
23	A) Select a suitable data storage location. B) Specify the file name. The trc extension signifies STARTER/SCOUT trace files. C) Click the "Save" button	
24	A) Select the measurement you want to save. In the example, only one measurement was made. B) Confirm your selection with OK	
25	You can now archive these recorded traces together with the report file.	

5.3.3 Notes regarding the application

Particularly in the case of errors during the acceptance test, entries in the report are not necessarily self-explanatory. The notes in this section allow you to interpret the entries that have been made.

- If an error occurs when querying a parameter, then the corresponding line in the report has a red background and is marked with Fault. The test of the corresponding safety function is exited with an error message. However, it is possible in the report that after the "incorrect" line additional lines have a green background and are marked with OK. This does not represent an error. The reason is that the application queries the parameter values block-by-block and completes the corresponding lines in the report.
- The application will prompt you at several positions to confirm whether a drive is rotating or is at a standstill (zero speed). Here you are responsible for monitoring the situation. The application does not evaluate as to whether your entry is correct or not.
- When testing the Basic Function SS1, you will be prompted whether the drive has braked along the OFF3 ramp down to standstill. This should be confirmed with "OK". If you can confirm this before the SS1 time expires, the tests are evaluated as faulty because the expected signal states are set only after the SS1 time has expired.
- When testing the SS1 Basic Function, for short SS1 times, the application cannot evaluate the signal state between selecting SS1 and initiating the subsequent STO function. In this case, a message makes the user aware of this (see Section 5.3.1). The correct signal states must be verified using a trace. In this case, trace the following variables: r9772, r9773 and r9774. As a trigger signal you can use the corresponding selection bit for SS1 from r9772. Select the recording interval so that you can see the selection of SS1 as well as the transition to the subsequent STO function. If you wish to verify braking along the OFF3 ramp, you can also record the speed setpoint and actual value. For further information on this test, see Section 9.4.1.2 of SFM /3/ (S120) or Section 8.9.5.1 of FM /6/ (S110).
- If the project is closed and reopened, the attempt to execute the script produces an error message. In this case, the script must be deleted and re-imported.
- The response for a pulse inhibit must also be tested for the test of SDI without encoder If this test is performed only in one direction, i.e. only one direction is parameterized, the test immediately follows the function test. If both directions are parameterized, the test follows the function test in the negative direction. Only when all parameterized directions and the response for pulse inhibit have been tested successfully is the SDI test marked as successful in the overview.
- If a different behavior for pulse inhibit is parameterized for the two SDI and SSM encoderless functions, an error occurs during the test of the function with inactive monitoring because the relevant parameters caused by the other function do not have the expected values. For example, if the monitoring for pulse inhibit is active for SSM but not for SDI, the test for SDI causes an error because the parameterization specifies that STO should not be active after pulse inhibit but is active because of the SSM parameterization. The feedback signals SSM active for pulse inhibit or SDI active for pulse inhibit must be set identical because otherwise the behavior of the two feedback signals does not exactly match the parameterization. The script recognizes this and tests the associated safety function as faulty.

5.3.4 Supplementary conditions when using the application

Some supplementary conditions and restrictions must be observed when using the application. They are described below.

- The application was created and tested with STARTER/SCOUT V4.3. Because no test with version V4.1 has yet been performed, the use of the application with the STARTER/SCOUT version V4.1 is not released.
- The application is basically capable of simultaneously testing one safety function for several drives. However, under certain circumstances, the test is canceled with error although there are no errors. As a consequence, testing one safety function at several drives simultaneously has still not been released.
- The above point also applies to grouped drives. Grouped drives must be tested manually in accordance with the documentation in Chapter 9 SFM /3/ (S120).

Safety Integrated Basic Functions can be controlled in parallel via terminal and PROFIsafe. Here, the application is not capable of documenting the control in separate test report files. In this very special case, the application can only test one type of control. The second control type must be "manually" tested.

6 References

6.1 Related documents

This list does not claim to be complete and only provides a selection of suitable references.

Table 6-1

	Topic	Title
/1/	SINAMICS S120 Commissioning	Commissioning Manual "SINAMICS S120 Commissioning" Edition 1/2012
/2/	SINAMICS S120 Drive Functions	Function Manual "SINAMICS S120 Drive Functions" Editions 1/2012
/3/	SINAMICS S120 Safety Functions	Function Manual "SINAMICS S120 Safety Integrated Function Manual" Edition 1/2012
/4/	SINAMICS S120 List Manual	List Manual "SINAMICS S120 List Manual" Edition 1/2012
/5/	SINAMICS S110 Equipment Manual	"SINAMICS S110 Equipment Manual" 1/2011 Edition
/6/	SINAMICS S110 Drive Functions	"SINAMICS S110 Function Manual" 1/2011 Edition
/7/	SINAMICS S110 List Manual	"SINAMICS S110 List Manual" 1/2011 Edition

6.2 Internet links

This list does not claim to be complete and only provides a selection of suitable information.

Table 6-2

	Topic	Title
\1\	Reference to the article	http://support.automation.siemens.com/WW/view/de/52248627
\2\	Siemens Industry Online Support	http://support.automation.siemens.com
\3\	SINAMICS Documentation DocOnWeb	http://www.automation.siemens.com/doconweb/

7 Contact

Siemens AG

Industry Sector
I DT MC PMA APC
Frauenauracher Strasse 80
D - 91056 Erlangen, Germany
E-mail: safety.team.motioncontrol.i-dt@siemens.com

8 History

Table 8-1

Version	Date	Change
V1.0	07/2010	First edition
V1.1	11/2010	First internal revision
V1.2	04/2011	First official edition
V2.0	05/2012	Extension with the safety functionality of SINAMICS Firmware V4.4
V2.1	07/2012	Readout of parameters also at deactivated drives