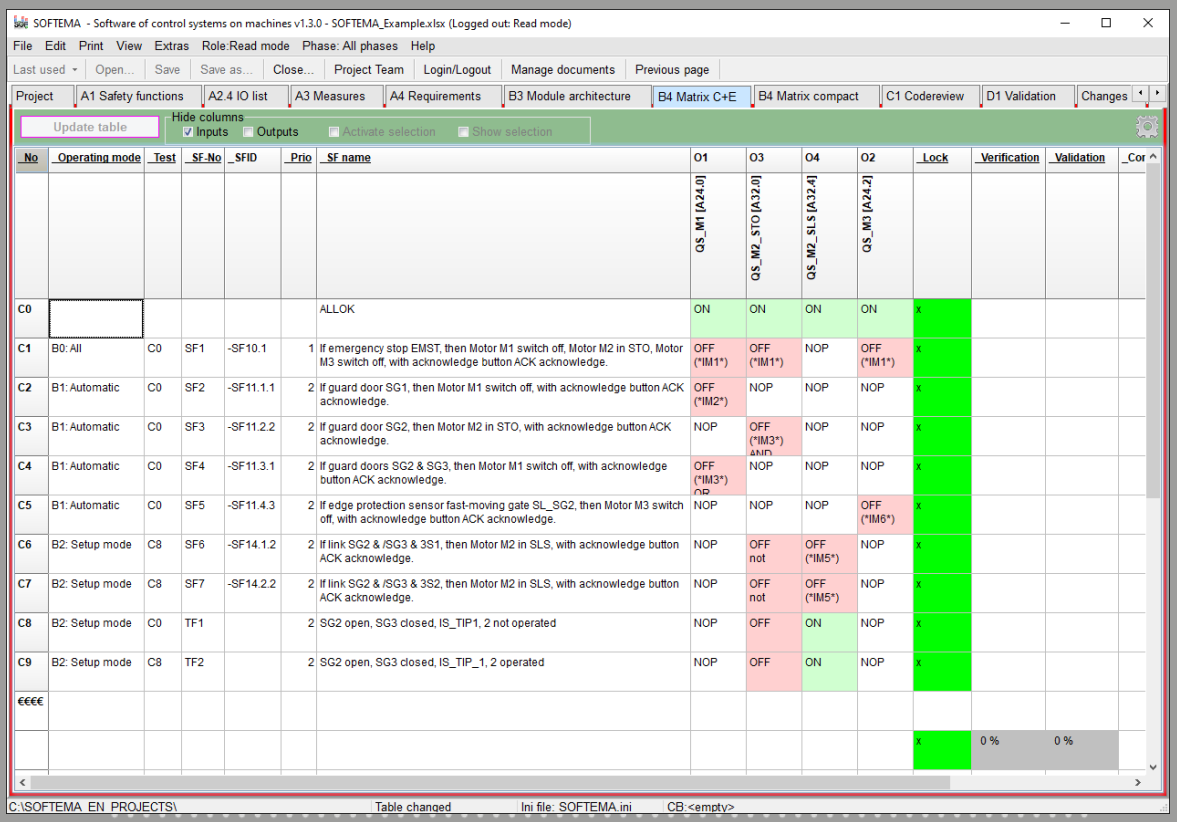
IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

SOFTEMA Cookbook 1

Application documentation for SOFTEMA



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1 Introduction

Machine manufacturers are increasingly implementing safety functions by programming safety-related programmable controllers. DIN EN 954-1 [2] used to define the requirements for the development of safety functions. However, at the end of the 2000s, this standard no longer reflected the state of the art and was replaced by DIN EN ISO 13849-1 [1] and DIN EN 62061 [3], which can be used as an alternative. Among other things, the new standards define requirements for the software development of safety functions. This is intended to prevent dangerous systematic errors in the application software for a machine. Software developers of safety functions are often unclear about how to implement these new requirements in detail. One of the reasons for this is that their presentation in a standard is naturally very general and that there are few published examples to date.

In the DGUV project FF-FP0319 " Norm compliant development and documentation of safety related application software in manufacturing system engineering" [13] (2011 - 2013), the project participant, Prof. *Norbert Becker* from the Bonn-Rhein-Sieg University of Applied Sciences, developed several concrete procedures for implementing the requirements for the software development of safety functions for machines contained in the new standards and evaluated and documented them using industrial examples. Project result was the description of the so-called matrix method and its application examples in a research report [12]. The IFA subsequently published this description as part of the IFA Report 2/2016 " Safety-related application software for machinery – The IFA matrix method (IFA Report 2/2016)" [8]. [8] was published.

Note: It is strongly recommended that you read the IFA Report 2/2016 before using SOFTEMA.

The SOFTEMA tool was then developed at the IFA for the practical implementation of this matrix method.

An important prerequisite for working with SOFTEMA and the project files is an understanding of the application of the IFA matrix method and the EN ISO 13849 series of standards in general. The IFA provides support with free publications:

- The IFA provides information on the EN ISO 13849 series of standards at https://www.dguv.de/ifa/praxishilfen/practical-solutions-machine-safety/sicherheit-von-maschinensteuerungen/index.jsp.
- and information about SOFTEMA on the page https://www.dguv.de/ifa/praxishilfen/practical-solutions-machine-safety/software-softema/index.jsp
- You can find more information, instructions and many examples of application programming using the IFA matrix method in the IFA Report 2/2016 and in the SOFTEMA examples for download: https://www.dguv.de/ifa/fachinfos/arbeiten-4-0/industrie-4-0/sicherheitsbezogene-maschinensoftware/index-2.jsp

- The definition of safety functions is described in SISTEMA Cookbook 6, see https://www.dguv.de/ifa/praxishilfen/practical-solutions-machine-safety/software-sistema/sistema-kochbuecher/index.jsp.

All IFA publications mentioned can be downloaded free of charge as PDF files in German and partly in English. The IFA Report 2/2016 is available for download and in print (right column on the page IFA – Technical information – Safety-related application software for machinery – The IFA matrix method).

2 About this guide

Safety-related application software for machines can be specified, validated and documented in accordance with standards using the IFA matrix method. The IFA software SOFTEMA can be used to edit Excel project files to implement this IFA matrix method. These instructions describe the configuration and editing of these project files with SOFTEMA.

Note: SOFTEMA - like any software tool for the development and verification of safe related control systems - must be qualified for use [6]. SOFTEMA falls into the category of "offline support tools". Therefore, when using SOFTEMA, the effects of potential tool errors and the required risk reduction of the developed safety functions must be evaluated in order to define appropriate measures for fault avoidance (e.g. review of the tool results; test of the software modules developed with the tool results, etc.).
It is therefore essential to note in Section 4.3 on tool qualification and the necessary measures for fault avoidance by SOFTEMA users.

These instructions provide support in two areas:

- Configuration of project files: Chapters 5 and 9 are primarily aimed at those who prepare SOFTEMA project files at the beginning and configure them (also during use). The structure of the project files and the various options are explained there.
- Editing project files: Chapters 6, 7 and 8 are for all users who use the prepared project files to implement the IFA matrix method for their application programs. These chapters provide detailed information on the SOFTEMA user interface and the table functions.

Introductory information for all users can be found in Chapters 1, **Fehler! Verweisquelle konnte nicht gefunden werden.** and 4. The final appendices provide references and useful information.

Note: Cookbook 2 "SOFTEMA Project Planning Guide" describes the steps for using SOFTEMA along the development process (menu command HELP → SOFTEMA COOKBOOK 2).

Changes

The version of this cookbook relates to the corresponding SOFTEMA version. Changes to the previous cookbook version are marked in yellow in the text.
For older changes please refer to "Appendix D: Change history".

Version 1.2.1:

- Reference to the current standard DIN EN ISO 13849-1:2023.
- Writing directly into cells no longer deletes the first character when opening the extended text field.
- Fixed an error when creating the PDF report (invalid and missing information).
- Formatting in the INFORMATION dialog (update CE matrix) adjusted.
- Labeling of the UPDATE TABLE button is now completely visible in CE-Matrix.
- Excess button at CHANGE PASSWORD / LOGOUT removed.
- Sequence of controls in dialog/form LOGIN improved (with tabulator).

Layout conventions

The following formats are used in this user manual:

Italics
: is used for file names and extensions, new terms and highlighting.

SMALL CAPS
: indicate GUI elements such as menu names and buttons.

Table font
: is used for column names and identifiers within the tables. ("Tables names" are enclosed in quotation marks).

Boxes
: highlight notes and warnings.

3 Overview of standards and reports

DGUV Project FF-FP0319 [13] and IFA Report 2/2016 [8] deal with the implementation of the requirements of the DIN EN ISO 13849-1:2016 series of standards, consisting of two parts [1, 5], which are primarily used in the machinery sector. Chapter 2 of IFA Report 2/2016 deals in detail with the types and language types of software and the normative requirements for safety-related application software (SRASW).

However, there are other applicable standards, of which the standard DIN EN 62061 [3] is also harmonized under the Machinery Directive. Although DIN EN 62061 is limited to electrical, electronic and programmable electronic systems and is therefore only suitable to a limited extent for many machines with hydraulic and pneumatic control parts, Section 6.11.3 of DIN EN 62061 formulates similar requirements and procedures to those in DIN EN ISO 13849-1 with regard to application software. For application software, both standards have a comparable application range for control systems up to the highest safety level for the machine sector (up to PL = e or SIL 3). The committees of both standards have now also examined the equivalence of the requirements and documented them in a joint report ISO/TR 23849:2010 [4]. The requirements differ in detail: DIN EN 62061, as the sector standard of the DIN EN 61508 series of standards [6], describes the aspect of "management of functional safety" in great detail, for example.

The IFA expressly recommends the procedure that can be implemented with SOFTEMA from only with regard to fulfilling the requirements of DIN EN ISO 13849 in the third edition published in 2016. Nevertheless, this approach may also be approximately suitable for DIN EN 62061.

4 The SOFTEMA software tool for developing and testing SRASW

For efficient and quality-assured application of the matrix method, the IFA has developed a software tool called SOFTEMA (Project information page for project IFA5137: https://www.dguv.de/ifa/forschung/projektverzeichnis/ifa5137-2.jsp), which, like the IFA tool SISTEMA [11], is available for free download. This chapter provides an overview of the basic features and functions of this tool. Further information and user aids are provided separately on the SOFTEMA [13] download page (see Section 4.5).

4.1 What can SOFTEMA do?

With SOFTEMA, you can create and edit your own new projects by adapting a template file (see Section 5.1). The template can be customised according to your own requirements for the desired project.

Note: The template for new projects is stored in the selected working directory when SOFTEMA is installed.

In addition, the Microsoft Excel examples [13] of the IFA Report 2/2016 [8] available for download can be viewed and reproduced. Besides using the IFA-Matrix method, SOFTEMA supports the following additional functions:

- Automatic updating of tables when input data is modified,
- formal verification of tables (for missing, contradictory or double entries),
- management of employees in the project,
- role-based user authorizations,
- support with verification, validation and testing,
- support with modifications,
- specific editors for the various cell contents,
- management of Documents and changes,
- search/replace functions,
- specific print functions and reports and
- automatic logging of changes to particularly security-critical cell contents.

SOFTEMA can only open and edit one project file at a time for the specification and documentation of an application program. However, you can run the software multiple times to view and edit different projects in parallel. This means that project data can be copied and pasted between several SOFTEMA instances (or Excel instances) via the clipboard.

SOFTEMA project files use the file type of a Microsoft Excel workbook (**.xlsx*). The project files can be edited either with SOFTEMA or directly with Microsoft Excel. With Excel, all tables in the worksheets can be freely edited. Under SOFTEMA, the content is protected by the user administration. Only under SOFTEMA are its specialized functions, as described below, available. The project files do not contain any macros and SOFTEMA cannot open Microsoft Excel workbooks with macros. All SOFTEMA functions are integrated and

protected in the software. However, additional worksheets can be inserted under Excel and used for development and documentation, e.g. for documentation of the control hardware. SOFTEMA can load and display these additional worksheets, but cannot edit them.

4.2 How is SOFTEMA used? - A brief tour of the program

SOFTEMA manages the tables required for the IFA matrix method [8] and also the information required for project management, such as project description, user administration, change logs, document management, and so on. Figure 1 shows, for example, the C&E matrix for the software specification of a project in SOFTEMA.

Note: Cookbook 2 "Project planning guide for SOFTEMA" describes in detail the steps for using SOFTEMA along the development process.

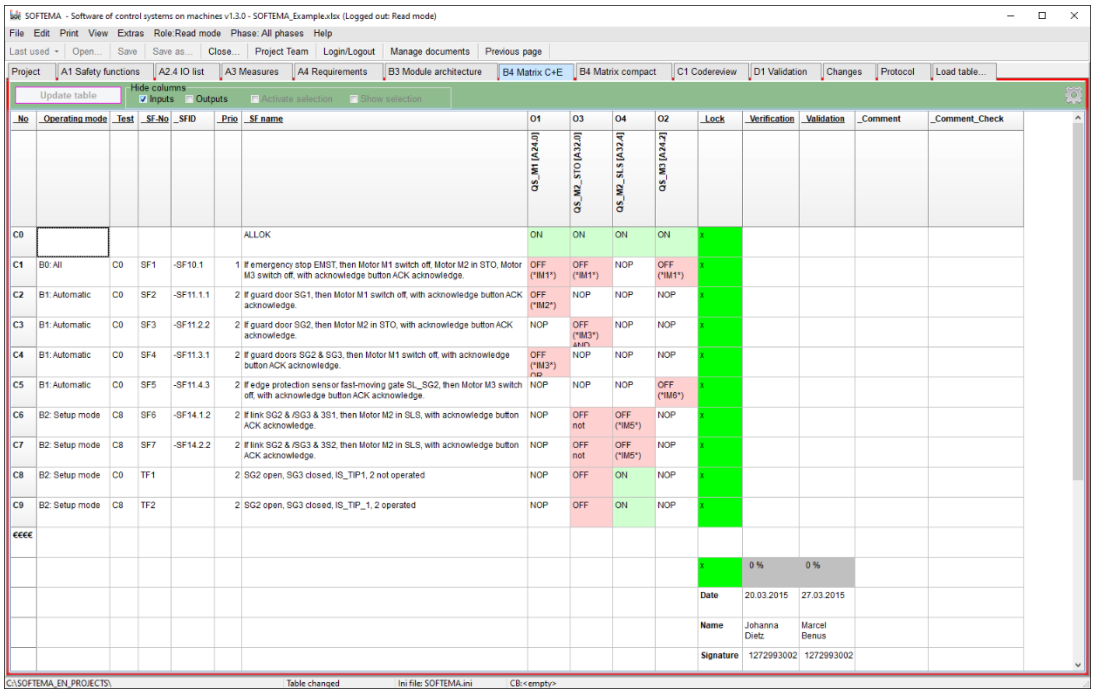

Figure 1: C&E matrix in SOFTEMA

For a new project, the user opens an empty but already pre-formatted project template. After filling in the project description ("Project" table), the safety functions with their properties such as PL_r, mode of operation, priority etc. are entered in table "A1 Safety functions" [10]. The input and output signals are entered in table "A2.4 IO list", each with variable names and hardware/network addresses. External content can also be copied and pasted into all tables via the clipboard.

The catalog of measures for fault avoidance and the programming rules can be selected and adapted in table "A3 Measures". The "A3 Measures" and "A4 Requirements" tables should already be pre-assigned in the project template. The list of required function blocks for the inputs and outputs stages is based on the safety functions, the peripheral hardware and the

I/O list. These should be managed in table "B3 Modular architecture". As soon as the function blocks have been defined in "B3 Modular architecture", they can be assigned to the respective input/output in the "A2.4 IO list" table using the instance name.

With these preparations, the "B4 Matrix C+E" table can be filled in. This is done using the automatic update button for I/O signals, modules and safety functions. The actual software specification is then carried out by

- Assigning input signals to the individual safety functions and
- entering the logical connective of the signals for the switching operations on the output signals.

The latter is required for coding the processing stage. A specialized editor helps with this connective. The compact representation in table "B4 Matrix compact" helps with extensive projects. This table is created using the update function, which automatically converts the "B4 Matrix C+E" table. At this point at the latest, all available functions for formal verification of the tables mentioned should have been used to detect and correct omissions, duplicates and contradictions.

After verification of all input documents and the specification described above, the program can be coded in the language selected for the control system. The code is also verified. This process is documented in detail in various tables and also summarized in "C1 Codereview". The program is then validated, which is also documented individually in various tables and summarized in table "D1 Validation". The questions in tables C1 and D1 can be adapted and supplemented as required. Persons who subsequently validate the project can also document and comment on their activities.

If the safety functions or I/O signals are modified, the changes from tables A1 and A2.4 are automatically updated in the specification tables and must revised manually. All modifications are initially marked in color (yellow). The markings must be deleted manually after completion of the renewed coding, verification and validation of these modifications.

4.3 Tool qualification for the use of SOFTEMA

Anyone using SOFTEMA must qualify it as an "offline support tool" (tool for short) for use with safety-related control systems. Currently, the standard DIN EN 61508-3:2011, paragraph 7.4.4 [6] would have to be applied, as the harmonized control standards for machines DIN EN ISO 13849 and DIN EN 62061 contain none of the more specific requirements. DIN EN ISO 13849-1 only states in general terms:

> *"for PL = e achieved with one component and its tool, the tool shall comply with the appropriate safety standard".*

However, DIN EN 61508-3 edition 2 is currently being revised and paragraph 7.4.4 is to be replaced. For this reason, the IFA at SOFTEMA is based on the new requirements for tool qualification, as already published in draft standards [9]. The following new parameters and abbreviations are used there (Table 1):

Table 1: Characteristics for tool qualification

Abbreviation	Explanation
TIL	Tool Integrity Level
TD	Tool error impact detection/prevention means
TI	Tool error impact
SIL	Safety Integrity Level (IEC 62061/61508)
PL	Performance Level (ISO 13849)

The area of application of SOFTEMA is limited to machine control systems. The underlying standard for the application of SOFTEMA is ISO 13849-1:2015 [1].

Note: The use of SOFTEMA is therefore limited to safety functions with a maximum of PL e or SIL 3.

In SOFTEMA, program code is generated by the user, but also by the tool itself, whereby any errors contained in the control system could lead to a failure of the safety function(s) at runtime. (Automatic code generation with the SOFTEMA code generator is in preparation and currently in the beta phase. If you are interested, please contact us at softema@dguv.de).

Note: The maximum Tool error Impact (TI) of 3 is therefore assumed for SOFTEMA.

The qualification of an "offline support tool" is generally the responsibility of the tool user. It is required [9] to establish an equal weighting in tool qualification between the risk of using the tool (PL/SIL and TI) and the measures for fault avoidance in relation to the tool. The latter are divided into measures for fault avoidance on the part of the tool developer (tool integrity level, "TIL" for short) and on the part of the user (tool error impact detection/prevention means, "TD" for short).

On the user side, different measures with a TD of 1 to 3 can be applied to detect tool errors. In relation to SOFTEMA and the generated code, these gradations mean:

- TD3: Use of a non-qualified tool. Detection of any type of tool errors through systematic measures external to the tool in accordance with IEC 61508-3, e.g. the generated code is subjected to a comprehensive review by SOFTEMA.
- TD2: Detection of any type of tool error by indirect measures external to the tool in accordance with IEC 61508-3, e.g. the generated code is not verified, but comprehensive module tests of the generated code are carried out.
- TD1: neither the generated code is verified nor are module tests carried out.

In all these cases, a functional test must also be carried out to verify the safety requirements. However, this is necessary anyway as part of the validation of the safety functions in accordance with ISO 13849-2.

4.4 The SOFTEMA user interface

SOFTEMA is an application for the Microsoft operating systems Windows 7, Windows 8, Windows 10 or Windows 11. It uses classic menu technology with a fixed toolbar for the most important commands. Further information is displayed in the title bar (above) and in the status bar (below). The SOFTEMA program interface (Figure 2) is characterized by intuitive usability because it is strongly oriented towards the concepts and operation of MS Excel.

The work area, a table, takes up the largest part of the program interface in the middle (Figure 2). SOFTEMA manages all entries in tables, which can be selected via the tabs at the top of the work area. Each table corresponds to a worksheet in the Excel file. Each tab contains an area above the actual table with table-related functions that can be operated via buttons, selection lists or radio buttons.

The structure and functions of the tabs and tables are described in Chapter 8 described in detail.

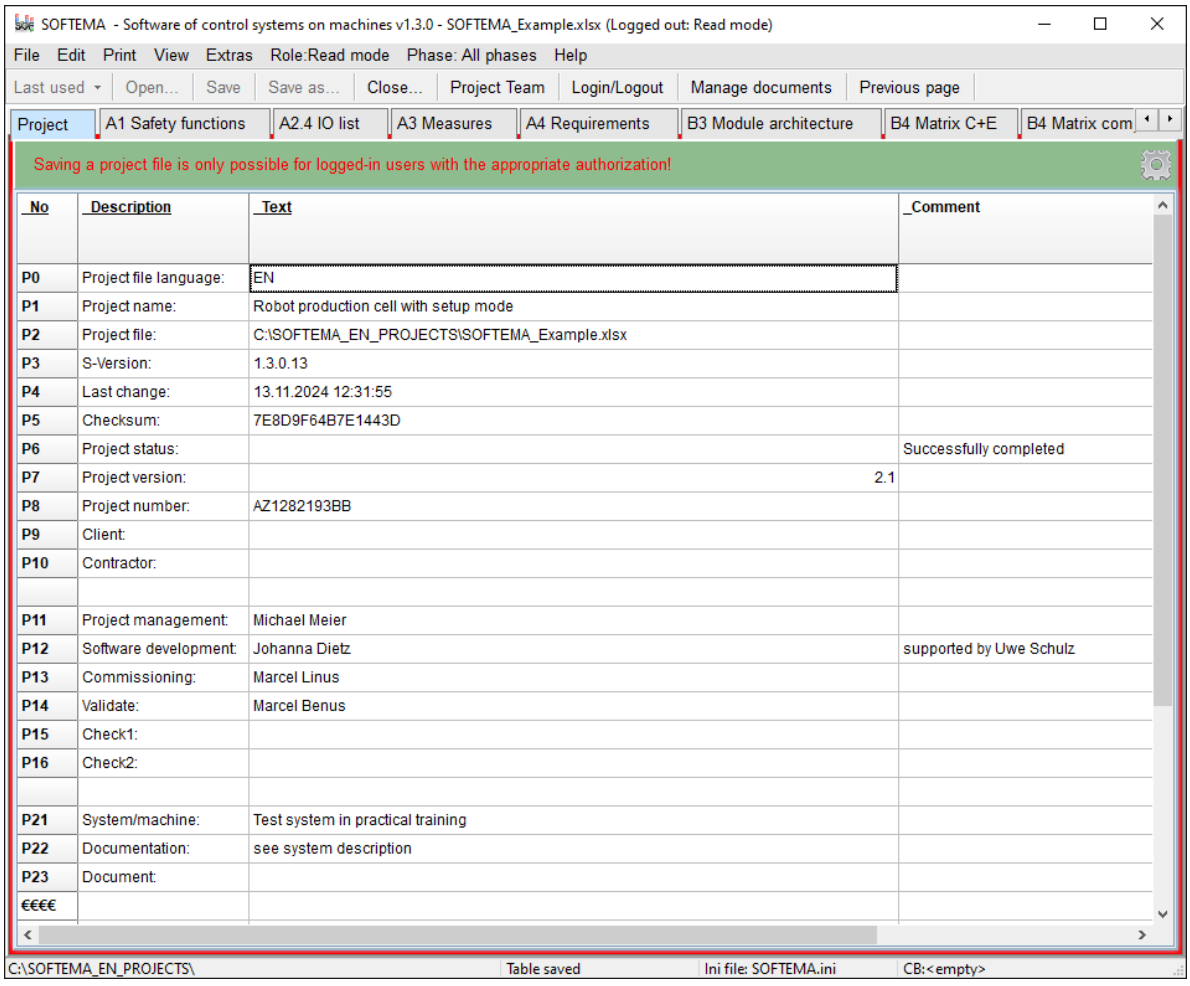

Figure 2: SOFTEMA program interface, representation of the project description

4.5 Where can I get SOFTEMA?

The SOFTEMA tool is available on the IFA website. It can be used free of charge. Current information on the development status, beta versions and the link to the download are available at the Internet address https://www.dguv.de/ifa/praxishilfen/practical-solutions-machine-safety/software-softema/index.jsp.

4.6 Versioning and compatibility

SOFTEMA projects are given a four-digit version number. It originates from the SOFTEMA program with which it was created or edited.

The four numbers have the following meaning:

- The leading number (main version number) distinguishes fundamental changes in the program concept and possibly also in the data format of the project tables (Section 5). The main version number "0" indicates beta versions.
- The second number (minor version number) increases with changes in the data format date. The program functions may also have been extended.
- The third number (revision number) is incremented for bug fixes and minor functional enhancements. The data format does not change.
- The last number (build number) identifies the development status of the program, is incremented independently of the other numbers and is not reset.

Upward compatibility of projects is also ensured in the event of changes to the database format: Older project versions are loaded by a more recent SOFTEMA version and then the project tables and the SOFTEMA version stored there are updated (Section 5.7).

On the other hand, there is no downward compatibility: Newer project versions are not loaded by an older SOFTEMA version, as the data format of the project is unknown. Instead, a message is displayed stating that the project version is unknown and that SOFTEMA should be updated.

4.7 How is SOFTEMA installed and executed?

SOFTEMA is installed using the installation program supplied. Although the project files use the Microsoft Excel file type **.xlsx*, it is not necessary to install Microsoft Excel - but it is certainly useful for occasional direct editing of the project files.

The default installation path for SOFTEMA is:

- for admins: C:\Program Files (x86)\SOFTEMA
- for user name: C:\Users\%USERNAME%\SOFTEMA

4.8 Version check and error list

When SOFTEMA is started, the following information is requested and displayed in separate windows, provided there is an Internet connection:

- Version check: Information on the currently installed SOFTEMA version or any new versions that may be available.
- Error list: Information on known program errors and their remedy/workaround. Non-critical errors can be hidden and will not be displayed again the next time the program is started. Critical errors, on the other hand, cannot be hidden.

This information can also be called up in the HELP menu. This version check and testing for known errors can be deactivated via the SOFTEMA options.

4.9 Interfaces to SOFTEMA

None of the interfaces are implemented in the current version of SOFTEMA itself. It makes more sense to implement interfaces directly to the Excel file in order to be able to import (e.g. input signals) and export (e.g. safety functions) data.

4.10 The role concept

SOFTEMA defines various roles for the persons involved in the project. Each person involved in the project should be assigned a role corresponding to their task. Each role has authorizations defined in the tables. This prevents unauthorized and unintended changes. For example, a person in the Check1 role can only read and not modify the contents of the tables. Only the _Comment_Check column (Section 7.3) and its protocol fields (Check1, Date) (Section 5.6) can be described in this role. The following roles are currently defined (Table 2):

Table 2: Definition of roles

No.	role	Description/Authorizations
1	Project lead	Read all rows and write many columns, but not the _Validation and _Comment_Check columns.
2	SW developer	Read all rows and write many columns, but not the _Comment_Check column. The tables "Project", "A1 Safety functions", "A3 Measures", "A4 Requirements" can only be read.
3	Commissioning	Read all rows and write many columns, but not the _Comment_Check column. The tables "Project", "A1 Safety functions", "A3 Measures", "A4 Requirements" can only be read.
4	Validate	Read all cells. Write only in the columns _Comment, _Validation and the log fields below (name, date, signature).

No.	role	Description/Authorizations
5	Check1	Read all cells. Write only in the columns _Comment_Check and the log fields below (Check1, Date).
6	Check2	Read all cells. Write only in the _Comment_Check columns and the log fields below (Check2, Date).
7	Superuser	Has all authorizations.
8	Read mode	Has none authorizations, but all project content can be read.
9	Administrate	Role of an administrator to configure the user administration.

If cells or control elements are operated for which the current role is not authorized, the control elements are either deactivated or information is displayed, e.g. when double-clicking on a row lock (

Figure 3).

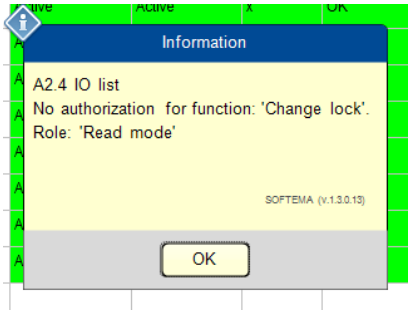

Figure 3: Information about unauthorized operation

4.11 User administration

The concept and functions for simply managing access and users for SOFTEMA are described here. User management always relates to a project and is stored exclusively in the project file, in the "Persons" table that has already been implemented. User administration can therefore differ from project to project. Only the user name and possibly the password are stored on the user's computer for a quick login process.

The advantage of this concept is that a project file together with the user administration stored in it can be exchanged between several users and always enables stable, access-protected and role-based editing.

4.11.1 General

In user administration, a distinction is made between:

- Administrators: They only have the exclusive role of "Administrator" and cannot edit a project. Administrators can create, manage and delete other administrators and normal users. However, none of the groups, group memberships of users or group authorizations can be defined.
- Normal users: They can edit the project in all other roles assigned to them by the administrator. The user can switch between these roles. Normal users can only change their own password.

Registration and deregistration process:

When a project is opened, the "read mode" role is initially active until a user logs in, i.e. a user can read all, but not edit.

The terms "Login" and "Logout" are also used in the SOFTEMA interface and here in the cookbook for the "Login" and "Logout" user management processes. These functions can be found via the menu bar under EXTRAS or directly via the toolbar.

When a user logs out, the project remains open with the "read mode" role.

Note: A project that is already open on another computer can only be opened read-only. Such a project can therefore only be viewed in "read mode" even after successful login.

If a project or even SOFTEMA is closed, users are automatically logged out.

Note: It is not possible to save a project in "read mode". SOFTEMA issues a message if changes have been made and the user attempts to close or save the project in "read mode".

User names:

Administrators and users do not need a separate user name to log in, but use their real name (e.g. "Peter Jones"). For administrators, the suffix "(Admin)" is added to the clear name, e.g. "Peter Jones (Admin)"

The names of users and administrators are only assigned once and must be different. However, "Peter Jones" and "Peter Jones (Admin)" at the same time in a "Persons" table is permitted. Each name in the _Name column of the "Persons" table may therefore only be assigned once if the company name is the same.

The SOFTEMA title bar displays the clear name of the user with role: "(Clear name: Role)". If none of the users are logged in, "(Logged out: read mode)" is displayed.

Roles:

For the logged-in user, only the assigned roles are displayed for selection in the ROLE menu. The other roles are invisible. In the ROLE MENU, the current role is displayed after the ROLE menu name (e.g. "Role: Project leads")

Each role has defined, fixed authorizations (see Section 4.10), which cannot be additionally varied from user to user. The assignment of authorizations to roles is not part of user administration.

Note: When working with SOFTEMA, only the clear name of the user currently logged in can be selected and entered in cells in which a name is to be entered (e.g. _Verification column).

Activate/deactivate password request for user login:

The password query for user logins can be deactivated by administrators via an option (Section 4.11.2) can be activated and deactivated by administrators. If the password prompt for user login is activated, a user must always log in with a password. If it is not activated, a user must still log in, but without a password, and can switch between the roles assigned to them.

Even if the password prompt is not enabled when users log in, only administrators can set up new users and make changes to clear names and assign roles.

An administrator can therefore disable or enable the password prompt for user logins on a project-by-project basis. This setting is also stored in the project file in encrypted form. For templates and project examples, the password prompt is deactivated when a user logs in so that these files can be viewed and edited quickly and easily.

4.11.2 Administration of user management

User administration is performed by persons who can log in with the "Administrate" role. The login takes place in the menu EXTRAS → USER ADMINISTRATION. A USER ADMINISTRATION dialog box opens (

Figure 4), in which the user name is selected and the login is performed after entering the password (LOGIN button).

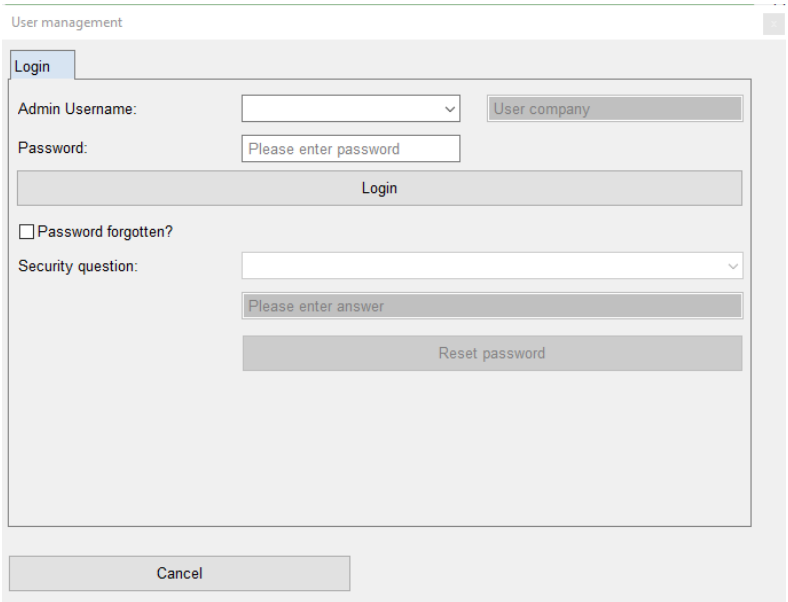

Figure 4 : User administration window

After successful login, several tabs are displayed (Figure 5).

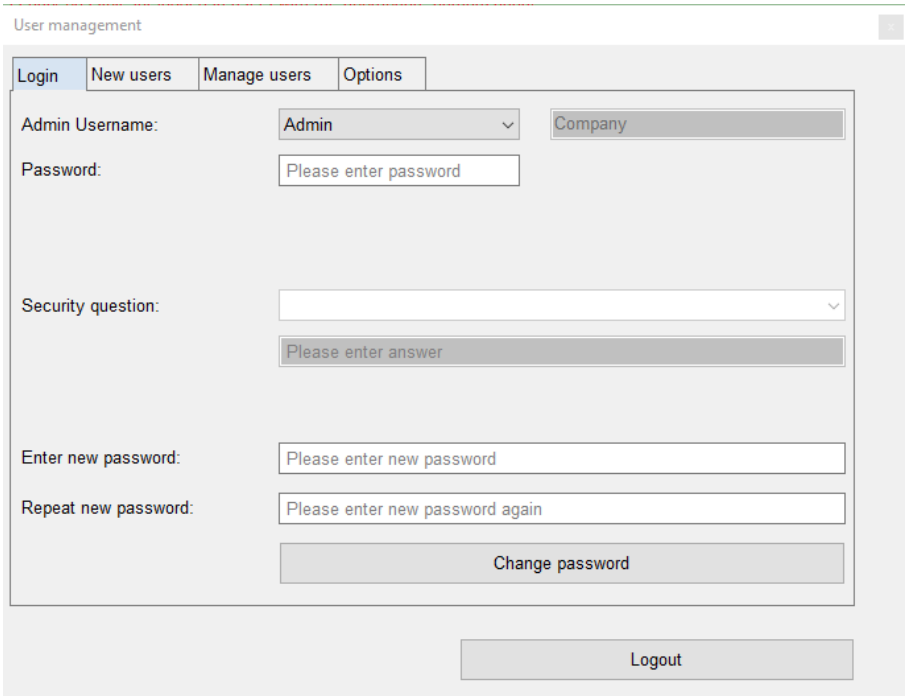

Figure 5: Tabs for user administration

Via the "LOGIN" tab (Figure 5), the administrator can change their own password. To do this, enter the current password and the new password twice. Click on the CHANGE button to accept the new password and enter it in encrypted form in the "Persons" table.

Note: For the default administrator name "Admin", the initial password in the installed template and sample projects is "admin".

When logging in with the password "admin", the password is forced to be changed. Individual security questions are set up in case that the default administrator "Admin" forgets the changed password. The answers to these security queries - in the example file "Sankt Augustin" - are also hidden in the project file and stored in encrypted form. If the "Forgot password" checkbox is ticked when "Admin" logs in, the password is reset to "admin" if the answers are correct. This allows "Admin" to log in again.

To log out of the user administration, click on the LOGOUT BUTTON. This button remains visible and active on every tab. When logging out, a confirmation prompt appears after "Saving the Project" because the administrator has probably made changes in the user administration and thus in the "Persons" table.

Via the NEW USERS tab (Figure 6), the administrator can create new users and generate an initial password for them. The clear name (first name and surname) is entered for this purpose.

By ticking the box to the right of "User is admin", this user can be created with the role of "Administrator". In this case, the suffix "(Admin)" is added to the clear name so that this role can be recognized by the clear name in the "Persons" table (e.g. "Heinz Jones (Admin)". This allows a person who is both an administrator and a normal user to be distinguished in the table.

Note: If the CREATE USER button is clicked, SOFTEMA generates an initial password that always begins with "IggfzA".

This password must then be sent to the new user. SOFTEMA recommends that the user change the initial password when logging in for the first time.

The COPY PASSWORD BUTTON copies the password to the Windows clipboard. The MANAGE USERS BUTTON DISPLAYS the next tab for this new user. Alternatively, the tab can be clicked.

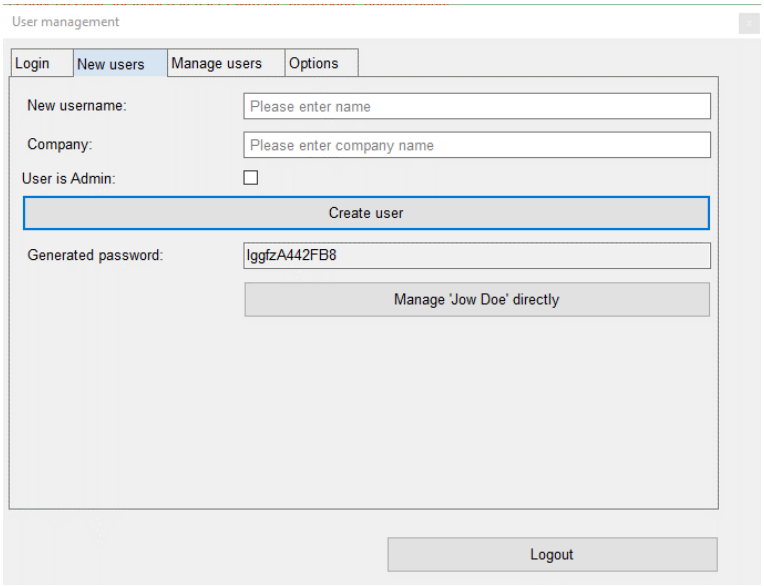

Figure 6: Creating new users

Via the MANAGE USERS tab (Figure 7), the administrator can manage users that have already been created, both administrators and normal users. The name is selected in the USER NAME selection field at the top. The currently assigned roles (only for normal users) are displayed below.

The selected user can be deleted from the user administration using the DELETE USER button. This also applies to users who are administrators. An administrator can even delete themselves, with one exception: the default administrator name "Admin" cannot be changed and cannot be deleted.

The user's company name can be changed in the COMPANY NAME input field.

A new or slightly changed name for the user selected above can be entered in the NEW NAME input field and accepted by clicking the CHANGE NAME button.

If users have forgotten their password, a new password can be generated for the selected user in this tab using the RESET PASSWORD button. It is displayed in the NEW PASSWORD field and copied to the Windows clipboard at the same time and can be sent to the user in this way.

Note: The new password cannot be entered or changed manually.

In the lower part of the tab, one or more roles (Section 4.10) are assigned to the normal user by ticking the checkbox. These are accepted with the CHANGE ROLES button. This assignment can always be changed later.

For administrators, the tab below is hidden. An administrator cannot assign themselves any authorizations other than administrate. An administrator who wants to work on the project at the same time will need to assign a second user name with the corresponding authorizations.

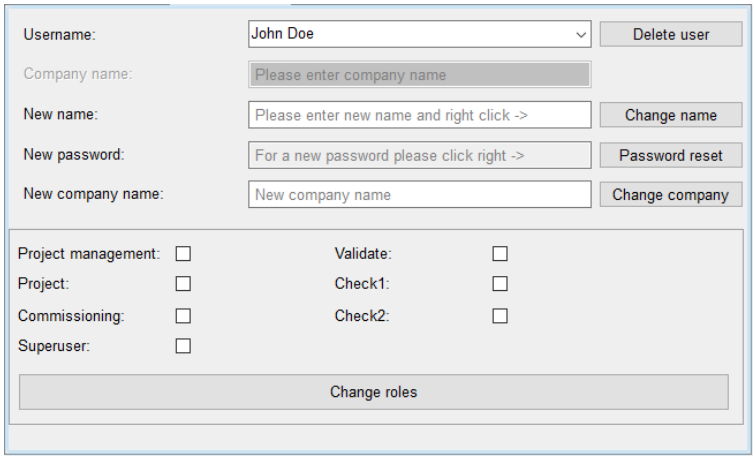

Figure 7: "Manage users" tab

In the OPTIONS tab (Figure 8), the administrator can change the option for the password prompt when users log in.

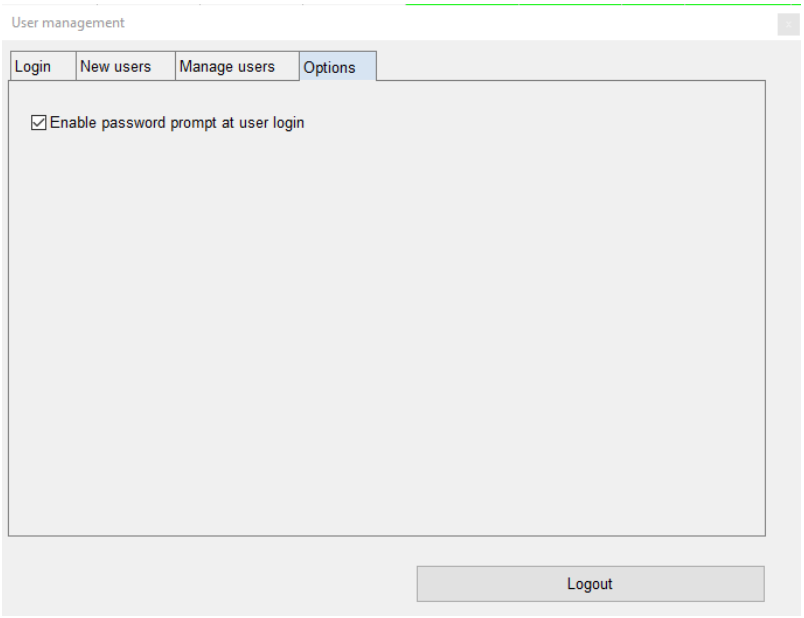

Figure 8: "Options" tab

In Table 3 the options are described.

Table 3: User administration options

Option (default setting)	Description
Activate password prompt for user login (Off)	If the password prompt for user login is deactivated, only the users stored in the user administration can log in, but now **without entering a password**. All stored user authorizations are still fully valid.

Note: The password prompt settings are included in the project checksum calculation.

4.11.3 User administration functions for normal users

For normal users who edit the SOFTEMA project with assigned roles, the functions and dialogs are limited to what is necessary. To log in, go to the menu bar EXTRAS → LOGIN/LOGOUT or use the button in the toolbar. To be able to log in, no one else must be logged in.

A LOGIN dialog box opens (Figure 9), in which the user name and the desired user role can be selected and, after entering the password, the login takes place (LOGIN button). If the password prompt is deactivated, there is no need to enter a password. The window can be closed with the CANCEL BUTTON. In this case, the user is not logged in.

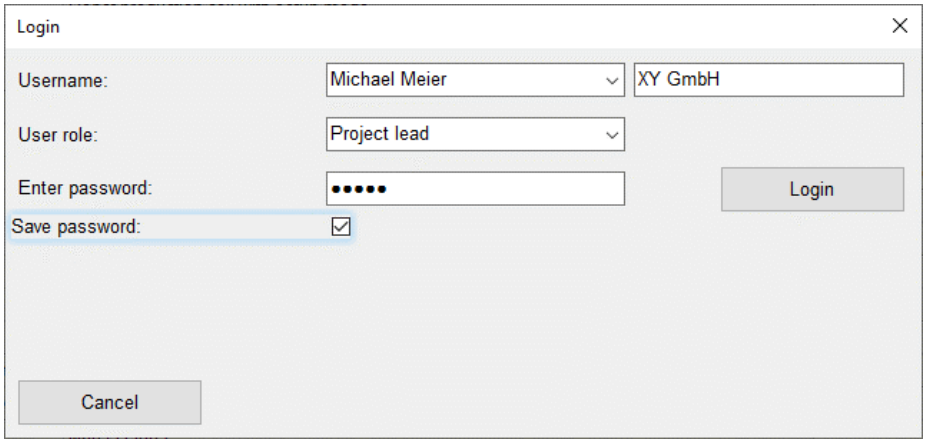

Figure 9: Window for logging in normal users

The selected user name is saved in the Windows registry database and is preset for the next login process. The login process can be further accelerated if the "Save password" checkbox is ticked during login. The password is then also saved in the registry database and preset for the next logon process. This should only be used if none of the other users have access to this Windows user account. If the check mark is no longer set during login, the password is deleted from the registration database.

To log out, use the LOGIN/LOGOUT command again. The CHANGE PASSWORD / LOGOUT dialog box opens (Figure 10), in which the current user name is already entered. After the user has entered their current password and the new password twice, they can accept this new password by clicking the "Change" button. If user management is deactivated, any password saved in the project cannot be changed.

The window can be closed with the CANCEL button. The user remains logged in.

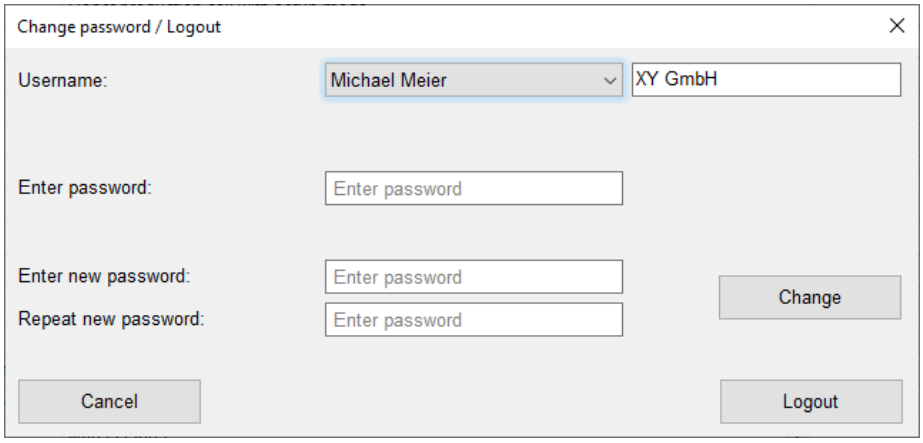

Figure 10: Window for logging out normal users

To log out, the user must click the LOGOUT button. There is then a security query after "Saving the project" because the user has probably edited the project and someone else could log in afterwards.

Note: A normal user cannot delete themselves from the user administration. Only an administrator can do this.

4.11.4 Functions and columns in the "Persons" table

In the hidden or encrypted _Role column, SOFTEMA enters all the roles assigned to the respective user in just one cell. If the mouse cursor is positioned on a row, the assigned roles are displayed in plain text in a pop-up message.

A person who is logged in can change the _Phone, _Email etc. columns in their own row in the "Persons" table (accessible via the PROJECT TEAM button). The clear name set up by the administrator cannot be changed. Properties of other users cannot be changed. All users can view all properties of other users and copy them with the key combination Ctrl+V.

The context menu is deactivated. Exception: A user can only set and delete markers in their own row. Deleting markers by clicking on a row identifier is deactivated.

Template and examples:

There is always the following entry in the "Persons" table in the installed template:

- Administrator "Admin" with a default password "admin"

The following applies to example projects: The password for normal users is the respective surname, e.g. for "Heinz Müller" the password is "Müller" (case-sensitive).

Attention: The password query is deactivated in examples and templates.

Note: SOFTEMA recognizes if the "Persons" table (e.g. in Excel) has been manipulated or replaced: SOFTEMA creates its own checksum for this table and saves it in the "Project" table. A checksum error in the "Persons" table is then reported when a project is opened.

4.12 Change protection: Locking and finalize

In addition to the role assignments described above, persons involved in the project are also protected from inadvertently changing project content by the following mechanisms:

- **Locking:** In many tables, the contents of a table row can be locked using a SOFTEMA function (Section 7.2) and thus be protected against accidental changes. To be able to edit the contents of a row, this lock must first be removed. This requires a role with the appropriate authorization. If the contents of a row are no longer changed, the lock should be set again. The "Set lock" and "Remove lock" functions can be repeated as required (also by double-clicking on the corresponding cell).
- **Finalize:** With this function (Section 6.4.11), a cell that is no longer to be changed can be irrevocably locked. This type of lock can no longer be removed in SOFTEMA. In the current version, this function is only used in the "Changes" table.

4.13 Backup of projects

The file name extension of the backup files for SOFTEMA is *$xlsx.backup*. SOFTEMA creates the backup file under the name *<project name>.$xlsx.backup at the* same time as the open project file is saved. The previous backup file is deleted and the project file is renamed to the backup file. The project file is then saved. The backup file always contains the previous version of the current project file *<project name>.xlsx*. The file name extension of the backup file can be renamed to *xlsx* if necessary in order to be able to open the backup file with SOFTEMA or Excel.

4.14 Open projects read-only

SOFTEMA uses the existence of a temporary file *~$<project name>.xlsx to* check whether a project file is already being processed by Excel, for example. A warning then appears (Figure 11) and the file is opened read-only (displayed in the title bar).

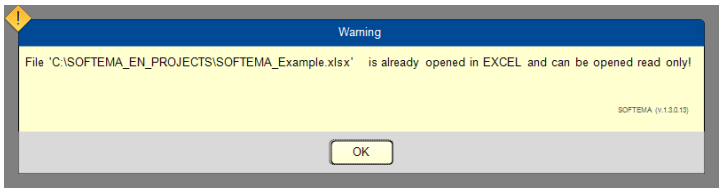

Figure 11: Warning if project file is already open in Excel

If a project file is not opened by Excel, for example, SOFTEMA itself creates a temporary file *~$<project name>.xlsx* and deletes it again after closing. When this project file is opened with Excel, for example, this application is also able to recognize that this file has already been opened by another application.

In addition, SOFTEMA creates a temporary file <project name>*.$xlsx.open* each time a project file is opened (even if it is read-only) and deletes it again after it is closed. This also makes it possible to recognize if this file <project *name>.xlsx* is already being edited by another SOFTEMA instance (Figure 12).

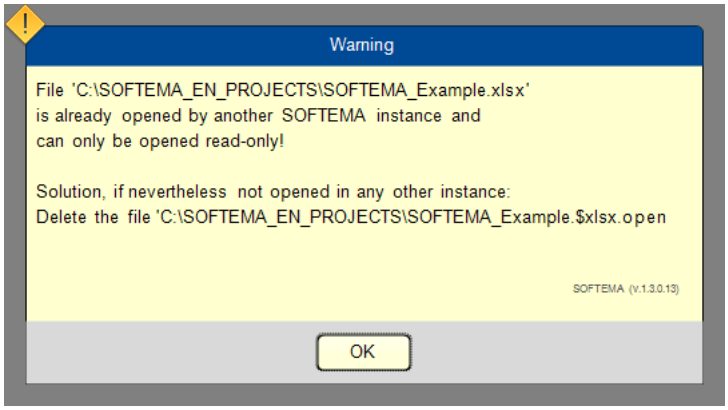

Figure 12: Warning for project file already open in another SOFTEMA instance

If it turns out that the file in question is not opened by SOFTEMA after all, this temporary file *<project name>.$xlsx.open* should be deleted so that the project can be edited again.

4.15 Data integrity of the project content

Each time a project file is opened, SOFTEMA generates a CRC32 checksum across all tables and compares it with the checksum stored in the project table. A warning appears (Figure 13).

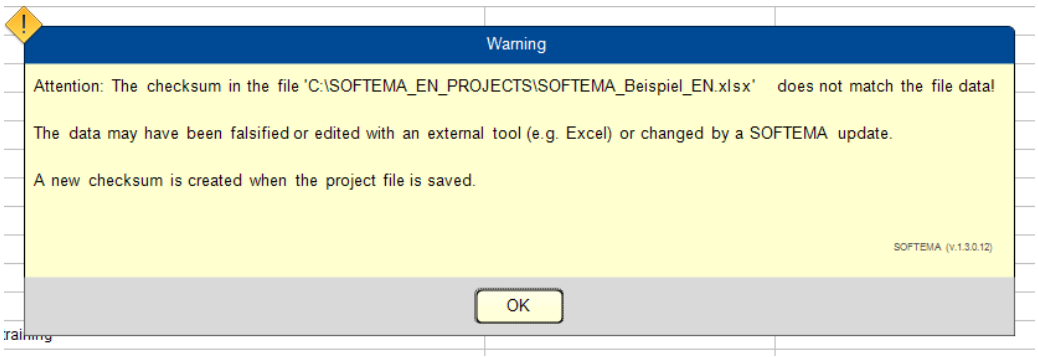

Figure 13: Warning for deviating checksum

The deviation could result from an automatic update of the project file after a SOFTEMA update. The project file could also have been previously edited with Microsoft Excel or another program, in which case the checksum could not be updated.

If these causes are out of the question, the unlikely case could be that the dates have been falsified by system errors.

5 Description of the data format for SOFTEMA

SOFTEMA project files use the file type "Microsoft Excel workbook (*.xlsx)". It is not possible to open the earlier Excel file type **.xls,* as this file type only supports 256 columns, among other things. The project files can be edited either with SOFTEMA or directly with Microsoft Excel. Each SOFTEMA table corresponds to a work sheet in the Excel file. All tables can be freely edited with Excel.

Note: This description is based on the SOFTEMA version named on the title page.

5.1 Template file for SOFTEMA

New projects cannot be created with SOFTEMA. For a new project, an empty but already pre-formatted project template *__SOFTEMA_Template__.xlsx* is opened and then saved under a different file name. This project template is already created in the SOFTEMA working directory. However, it can be customized according to your own requirements. In this way, different project templates can be created for different purposes.

5.2 Structure of a SOFTEMA project file

A project file is an Excel workbook and contains a large number of worksheets (see Table 4). The worksheets required for SOFTEMA (highlighted in gray) must be created as shown in the left-hand column of Table 4 otherwise they cannot be loaded into SOFTEMA. Under Excel, however, additional, freely named worksheets can be inserted and used for development and documentation, e.g. for documentation of the control hardware or for project management. In SOFTEMA, these additional worksheets can be loaded and viewed individually (Section 8.1.16).

Note: SOFTEMA does not require any Excel macros in the project files for its functions. SOFTEMA also cannot open Microsoft Excel workbooks with macros.

Table 4: Overview of the worksheets of the Excel documents (gray: required worksheets)

Worksheets used	Description
Project	Contains all project-related information of the application program.
V-model	Overview of the two V-models for software and module development with the associated documents
A1 Safety functions	Specification of safety functions: tabular list of safety functions with important properties

Worksheets used	Description
A2.1 System sketch	Rough overview of the system, can also contain the design data.
A2.2 Circuit diagram	Electrical wiring, especially of safety-related components
A2.3 System structure	Overview of the security components and their connection (topology with network)
A2.4 IO list	List of all safety-relevant and possibly other relevant inputs and outputs with addresses and variable names
A3 Measures	Catalog of measures for fault avoidance, tools and programming rules for avoiding errors
A4 Requirements	Listing and project-specific comments on the normative requirements in accordance with DIN EN ISO 13849-1, Section 4.6.3
B1 Safety program architecture	Overview of the structure of the safety program (call hierarchy of function blocks)
B2 Standard program architecture	Overview of the structure of the standard program (function block call hierarchy)
B3 Modular architecture	Overview of the modules (function blocks) used with the connected inputs and outputs and the logic signals for the processing stage
B4 Matrix C+E	Matrix-based specification of the software and test plan for the verification and validation of the software
B4 Matrix compact	Compact, transposed matrix representation of the Matrix C+E
B5 Program sketch	Representation of the software, e.g. in the function block diagram
C1 Codereview	The verification steps are listed in the code review protocol.

Worksheets used	Description
D1 Validation	Protocol for the validation of the software
Changes	Used to track changes to the application program.
Persons	The persons involved in development, validation and testing can be documented here.
Documents	Project-related documents and files can be managed here.
Protocol	Changes relevant to safety (e.g. to safety functions) are documented here.

The template provided (see Section 5.1) contains all the worksheets listed in Table 4. The examples generally only contain the required worksheets (highlighted in gray in Table 6).

5.3 Structure of a worksheet

When a project file is opened, SOFTEMA loads each required worksheet into a program-internal working memory and analyzes the structure of the worksheet. The worksheet must correspond to the structure and content described below, otherwise the loading process is canceled with error messages (see below).

5.3.1 Connected cells not allowed

SOFTEMA can be used to re-sort the rows and columns in the tables. This only works if the Excel file has been saved in the format shown in Table 4 mentioned worksheets or tables have none connected cells. This applies to all Excel worksheets used by SOFTEMA.

Additional loaded tables, on the other hand, can contain connected cells, as the functionality for these tables is severely limited.

5.3.2 Control character for the start of the table

Which part of the worksheet is displayed and edited in the corresponding SOFTEMA table can be controlled by two control characters in the designated cells of the worksheet. When reading in a worksheet, these two control characters are identified. Either the character string **€€€€** or **$$$$** are used as control characters in a cell. SOFTEMA first searches for the first occurrence of a control character (row 4 in Figure 14). All rows above and including the row with the first control character are ignored by SOFTEMA and are also not displayed in the corresponding table (rows 1 to 4 in Figure 14). Project planners can enter their own content here (only texts, none images or graphics), which can then only be displayed in Excel. The

specific column identifiers are then searched for in the row below the first control character (here for the "Project" table the identifiers _No, _Description, _Text, etc.).

_No	_Description	_Text
P1	Project name:	Robot production cell with setup mode
P2	Project file:	C:\SOFTEMA_EN_PROJECTS\SOFTEMA_Example.xlsx
P3	S-Version:	1.3.0.13
P4	Last change:	15.11.2024 11:46:35
P5	Checksum:	7E8D9F643AE1F42A
P6	Project status:	planned
P7	Project version:	2.1

Figure 14: Table header with first control character and column headers

The column in which the first control character is located (here A) also defines the column for the row identifiers (below _No: P1, P2, etc.).

Note: In the current version of SOFTEMA, the control character must be in the first column A.

5.3.3 Control character for the end of the table

SOFTEMA then searches for the second occurrence of a control character (row 28 in Figure 15). All rows below and including the row with the second control character are ignored by SOFTEMA and cannot be edited, but can still be displayed in the corresponding table (rows 28, 29 etc. in Figure 15). Project planners can also enter their own content here (only text, none images or graphics).

24			
25	**P21**	System/machine:	Test system in practical training
26	**P22**	Documentation:	see system description
27	**P23**	Document:	
28	**€€€€**		
29			

Figure 15: End of table with last control character

However, there are special cells below the table (below the second control character) that can be edited. These are the totals fields below the tables (see Section 5.6).

5.3.4 Missing control characters

If both control characters are not present, an error message is displayed (Figure 16) indicating the incorrect worksheet (or table) and SOFTEMA is terminated.

Figure 16: Error message for missing control character

Testers should then check the table and add the control characters in Excel if necessary.

5.4 Column identifiers

SOFTEMA expects the row with the column identifiers below the control character for the start of the table. Each table must have a quantity of predefined column identifiers defined by the program version. The order of the columns should not be changed from the project template. The authorizations of the respective roles apply to editing the columns and executing commands in these columns (see Section 4.10). There are three categories of column identifiers, which are characterized by the leading special character:

- Predefined column identifiers: Identifiers defined by SOFTEMA for a program version with a defined function, see Section 5.4.1. These identifiers begin with an underscore, e.g. "_Comment". These identifiers must all be present with the specified spelling.
- Project-specific column identifiers: Identifiers defined by the project planners for cells that can only be edited. These identifiers begin with a hash, e.g. #Comment. Of course, the spelling of these identifiers cannot be tested by SOFTEMA. These identifiers can be used to add content to the tables depending on the project. These columns can be inserted as required between the predefined columns, but only after the first, fixed columns (usually column _No).
- Project-specific column identifiers with special functions: Identifiers for cells in a column, also defined by the project planners, but whose function is defined by the prefix. These identifiers also begin with a hash, e.g. #CO_Comment. The identifier can be freely selected after the underscore of the prefix. The currently defined prefixes are listed in Table 5.
- Other column identifiers: All columns with descriptions that do not begin with an underscore or hash, or columns without identifiers, are displayed by SOFTEMA but ignored. The cells in these columns cannot be edited by SOFTEMA (but can be edited in Excel). Content could therefore be entered here that should only be readable in SOFTEMA.

Table 5: Prefixes for project-specific column identifiers

Prefix	Description
#DO_	Document column. The commands for Documents are available, see Section 7.15
#CO_	Comment column. Comments can be entered, see Section 7.3
#NA_	Name column. Names can be selected, see Section 7.9
#RO_	Column for roles. Roles can be selected, see Section 7.10
#NR_	Column for name with role. Names can be selected, see Section 7.9. The role is placed in brackets after the name.
#DA_	Date column. A date can be selected, see Section 7.14
#DT_	Column for date and time. A date with time can be selected

Not every column has to be filled in for project planning. Some functions require cells to be filled in; other cells are only used for additional documentation. In order to visualize these differences, the column identifiers of the necessary predefined "mandatory columns" are automatically highlighted by underlining. The additional project-specific column identifiers can also be marked as "mandatory columns" by the project planners by underlining them. All column identifiers that are not underlined are hidden using the menu command VIEW → ONLY MANDATORY COLUMNS.

Rows can be locked in almost all tables (see Section 7.2). Locking rows affects all columns with specific identifiers defined by the project engineer. However, locking only affects columns that have been inserted to the left of the _Lock column. The lock does not affect columns to the right of the _Lock column.

5.4.1 Predefined column identifiers

The predefined column identifiers are defined for each table in Section 8 and described together with the table functions. Many of these column identifiers are used in multiple tables. These so-called *system columns are described* in Section 7.

5.4.2 Missing column identifiers

If column identifiers do not exist, an error message is displayed (Figure 17) indicating the incorrect worksheet (or table) and SOFTEMA is terminated. The project engineer should then check the table and add the column identifiers in Excel if necessary.

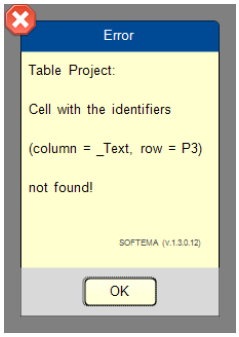

Figure 17: Error message for missing column identifier

5.5 Row identifiers

SOFTEMA expects the column with the row identifiers below the control character for the start of the table. This column always has the column identifier _No. The rows identifiers are entered by SOFTEMA and used to uniquely identify the rows in the entire project. Once deleted, row identifiers are not reused. The row identifiers are automatically incremented for new rows inserted.

When editing tables with Excel, the row identifiers must be defined carefully and in accordance with the conventions of the table. There must be no duplicate row identifiers. One or more fixed letters in combination with a consecutive number are defined for each table (Table 6).

Table 6: Letters for row identifiers of the tables

Table	Letter(s) x: consecutive number	Meaning (initials underlined)
Project	Px	Project description
A1 Safety functions	SFx	Safety Function
A2.4 IO list	Ix Ox	Row for input signal (Input) Row for output signal (Output)
A3 Measures	Rx	Measure (Rules)
A4 Requirements	Ax	Normative requirement
B3 Modular architecture	IMx OMx	Input Module Output Module

Table	Letter(s) x: consecutive number	Meaning (initials underlined)
B4 Matrix C+E	Cx	Cause
B4 Matrix compact	Bx	Effect
C1 Codereview	Rx	Review questions
D1 Validation	Vx	Validation points
Changes	Ax	Changes
persons	Ux	Persons (Users)
Documents	Dx	Documents
protocol	Lx	Log entry

Note: The current version of SOFTEMA does not yet define any project-specific row identifiers that could be defined by the project planners.

All rows without identifiers in this column are interpreted as comment rows (Figure 18). The cells can be edited and formatted, with the exception of the row identifier cell. In this way, the tables can be structured and commented on a project-specific basis. Comment rows can be inserted in SOFTEMA using context menu commands.

I9	Pushbutton 1 SLS, dual-channel (NO) (3S1)	IS_TIP_1	E9.0	BOOL
I10	Pushbutton 2 SLS, dual-channel (NO) (3S2)	IS_TIP_2	E9.1	BOOL
	Outputs			
O1	Contactor motor M1 (1K1, 1K2)	QS_M1	A24.0	BOOL
O2	Contactor motor M3 (3K1, 3K2)	QS_M3	A24.2	BOOL

Figure 18: Comment row without row identifier (between I10 and O1)

When loading a table, the cells of the row identifiers (column _No) are tested for permissible content. If errors are detected, a message is displayed with a reference to the affected table and Excel row (example Figure 19 Project table, Excel row 17). The program is then closed.

To remedy this, the project file should be loaded into Excel and the displayed cells should be corrected.

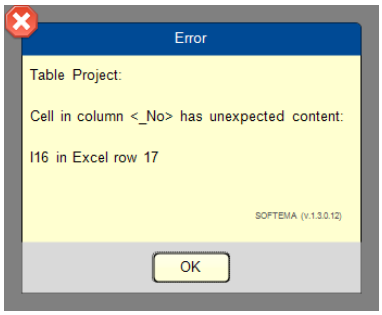

Figure 19: Error message when testing the row identifiers

5.6 Totals and log fields

SOFTEMA expects the totals fields (Figure 20, third row). These summary fields are located below the system columns _Verification, _Validation, _SW-Verif., _IO_Test etc. (see Chapter 7). The green OK or gray not-OK fields summarize the evaluations of the content rows above them:

- OK stands for "All content rows are rated **OK**" (OK = positively rated)
- not OK stands for "at least one row of content is rated **not OK**" (not OK = failed)
- Percentage describes how many content rows are already rated **OK**
- The cross in the green summary field in the _Lock column stands for "All content rows are locked"
- The circle in the yellow summary field in the _Lock column stands for "At least one content row is not locked"

Several log fields are arranged directly below the totals fields. The persons who have edited the system columns can enter their name, date and signature of the relevant application program here. Below this, there are corresponding date and name fields for the "Check1" and "Check2" roles for checking activities for these system columns. The date and name can be selected from the calendar and list, but can also be edited directly.

Lock	SW-Verif.	IO test	_DIAG test
x	OK	OK	OK
Date	04.03.2014	11.02.2014	11.02.2014
Name	Johanna D...	Marcel Benus	Johanna Dietz
Signature	1272993002	1272993002	1272993002
Date			
Check1			
Date			
Check2			

Figure 20: Totals and log fields of the "A2.4 IO list" table (content rows are hidden)

In the summary fields for verification and validation columns (V&V columns), the degree of compliance is displayed as a percentage in addition to the color (green for 100% compliance). The information is calculated dynamically from the ratio of cells rated "OK" to all cells in the V&V column. These percentages are also transferred to the "C1 Codereview" and "D1 Validation" tables (Figure 21).

R3	Has the interconnection of the I/O signals been implemented correctly?	A2.4 IO list	OK
R4	Has the architecture of the safety programme been adhered to?	B1 Safety program architecture	OK
R5	Has the modular architecture been adhered to?	B3 Modular architecture	OK
R6	Has the software specification from the matrix been implemented?	B4 Matrix C+E	0 %
€€€			
		Sum	83 %

Figure 21: Percentage of fulfillment of verification and validation

5.7 Automatic project update

The data format for SOFTEMA projects described in this chapter may change and be extended in future SOFTEMA versions, e.g:

- Changed names for predefined rows and column identifiers
- Additional columns with predefined column identifiers, etc.

The format description valid for the SOFTEMA version must therefore be used.

The version and data format of a project can be recognized by the SOFTEMA version in the "Project" table. An older version cannot be read by a new SOFTEMA version without further updating and without an error message. This older project version would then have to be manually adapted to the current data format in Excel using the format description. This would be time-consuming and error-prone.

SOFTEMA therefore contains an automatic version check and format update for loaded projects. A version difference (file version not equal to SOFTEMA version) is first reported (Figure 22) and triggers the update.

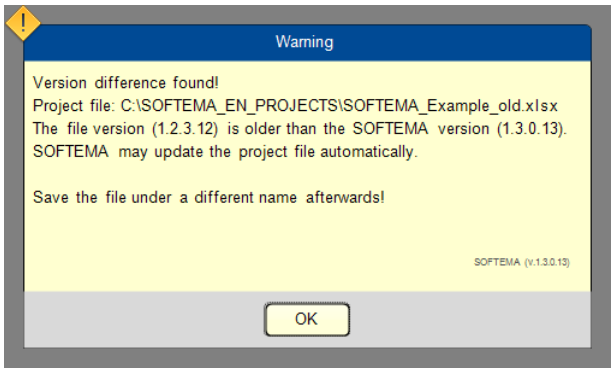

Figure 22: Messages of a version difference

SOFTEMA then performs all necessary updates step by step, even across several versions. The project is then loaded and is in a modified state. The SOFTEMA version in the "Project" table is also updated.

The project must then be saved, otherwise the updates will be lost. The project can be saved under the original or a new file name. Columns or rows added by the update are filled with meaningful content (usually empty fields).

6 The SOFTEMA user interface

6.1 Structure of the user interface

The SOFTEMA user interface essentially contains the tabs for the project tables and the command menus above the tabs. Further information is displayed dynamically in the title bar and status bar. Control elements and context menus are used to edit the tables.

6.2 The menu bar

The menu bar contains the seven menus FILE, EDIT, PRINT, VIEW, EXTRAS, ROLES, PHASES and HELP. These commands are described below.

6.2.1 Menu commands: File

There is no FILE → NEW command, as SOFTEMA cannot generate a new project file. Instead, templates for project files are opened (see Section 5.1).

- FILE → LAST USED the most recently opened project files from which a file can be selected and opened.
- FILE → OPEN displays the file manager in which a project file can be selected. (Reminder: Only one project file can be opened per SOFTEMA instance).
- FILE → SAVE saves the currently opened project file under its current file name.
- FILE → SAVE AS... displays the file manager and the currently open project file can be saved under a different file name/path. The new file name and path are displayed in the title and status bar.
- FILE → CLOSE closes the currently open project file.
- FILE → PRINT SETUP… opens a dialog in which the printer active for SOFTEMA can be selected and configured.
- FILE → EXIT terminates SOFTEMA.

6.2.2 Menu commands: Edit

The following commands are available in the EDIT menu:

- EDIT → CUT OUT: Windows clipboard function: Cut a marked text from to the clipboard. A marked *cells* can currently only be cut with the key combination Ctrl+X.
- EDIT → COPY: Windows clipboard function: Copying a marked text to the clipboard. A marked cells can currently only be copied with the key combination Ctrl+C.
- EDIT → INSERT: Windows clipboard function: Paste a text from the clipboard at the position in an edited cell. A marked cell can currently only be pasted with the key combination "Ctrl+V".
- EDIT → SEARCH opens a dialog to search for text in the currently displayed table.
- EDIT → REPLACE opens a dialog for replacing text in the currently displayed table.

6.2.3 Menu commands: Print

The following commands can be found in the PRINT menu:

- PRINT → PRINT TABLE opens a dialog for printing the currently displayed table.
- PRINT → SUMMARY opens a dialog for creating a complete project summary. A print preview opens by default. The summary can be printed from this or saved as a PDF. The project must be saved beforehand, whereby the checksum is recalculated. This checksum is displayed in the header on every page of the summary. This checksum and the date of the last change can be used to verify that an existing summary and a loaded project match.

6.2.4 Menu commands: View

The following commands are available in the VIEW menu:

- VIEW → ROW EDITOR opens the row editor (see Section 6.10).
- VIEW → COLUMN EDITOR opens the column editor (see Section 6.10).
- VIEW → TOOLBAR shows (checkmark set) or hides the toolbar.
- VIEW → SEARCH BAR displays a search function below the table. In the example in Figure 23 the search term "SG" was entered. All search locations are marked in the table. You can navigate between the search results using the FORWARD and BACKWARD buttons.
- VIEW → STATUS BAR shows (ticked) or hides the status bar.
- VIEW → ONLY MANDATORY COLUMNS hides all columns that are not mandatory (see Section 5.4).

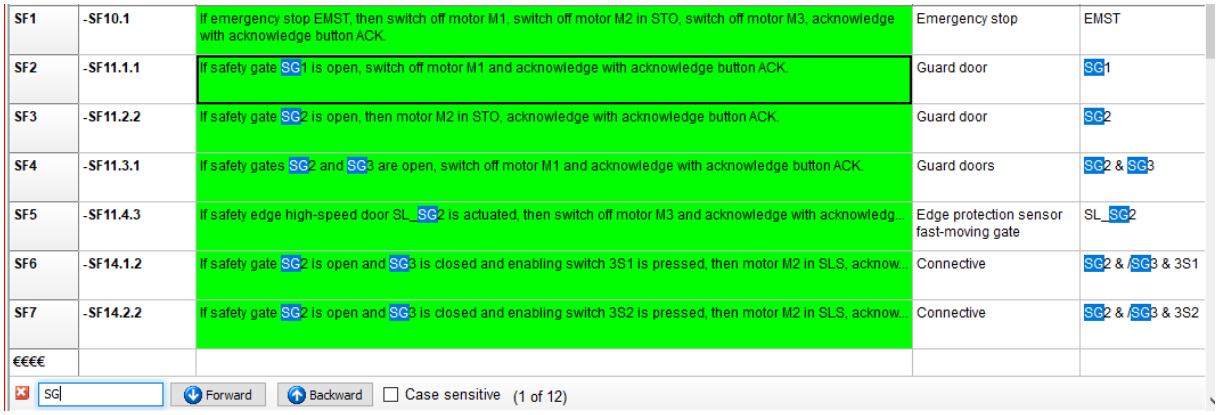

Figure 23 : Displayed search bar with highlighted search term

6.2.5 Menu commands: Extras

The following commands are available in the EXTRAS menu:

- EXTRAS → LOGIN/LOGOUT opens the separate window for logging a user in and out
- EXTRAS → PROJECT TEAM opens the separate window with the "Persons" table.
- EXTRAS → MANAGE DOCUMENTS opens the separate window with the "Documents" table.

- EXTRAS → USER MANAGEMENT opens the separate window for managing all users (Section 4.11)
- EXTRAS → OPTIONS opens the dialog for the SOFTEMA options (Section 9.4).
- EXTRAS → SOFTEMA CONFIGURATOR (CHANGE LANGUAGE) opens a dialog in which the language used in SOFTEMA and the working directory can be changed.

6.2.6 Menu commands: Role: Role name

The relevant role of the user (Section 4.10) can be selected here. If none is selected, the current role is retained. The default setting when starting SOFTEMA is the "read mode" role.

6.2.7 Menu commands: Phase: Phase name

A SOFTEMA project is processed in several phases. Different tables can be assigned to each project phase. Some tables are relevant in every phase. The phases can be selected in this menu so that the user can concentrate on the tables that are currently relevant. After selection, only the relevant tables are displayed. Once a phase has been completed, the next phase and its tables can be selected in this menu.

The following commands can be found in the PHASE menu:

- PHASE → REQUIREMENTS displays the tables in which the project's Requirements are managed.
- PHASE → SPECIFICATIONS displays the tables in which the software is specified.
- PHASE → VERIFICATION/VALIDATION displays the tables for these activities.
- PHASE → TESTING displays the tables for a testing.
- PHASE → ALL PHASES displays all tables (default setting).

The current selection is displayed in the menu under PHASE:.

6.2.8 Menu commands: Help

The following commands can be found in the HELP menu:

- HELP → SOFTEMA HOMEPAGE opens the default browser of the computer and, if there is an Internet connection, the SOFTEMA homepage on the IFA website.
- HELP → README opens the readme file saved in the installation directory.
- HELP → FIRST STEPS opens the IFA information "First steps" on the SOFTEMA homepage.
- HELP → HELP WIZARD opens a wizard for getting started with SOFTEMA (Section 6.11).
- HELP → VERSION CHECK connects to an IFA database, checks whether the installed version is still up-to-date and displays information about the installed version and, if necessary, a more up-to-date version in a separate window.
- HELP → NEWSLETTER allows you to register for the SOFTEMA newsletter.
- HELP → SOFTEMA COOKBOOK 1 opens this SOFTEMA Cookbook 1.

- HELP → SOFTEMA COOKBOOK 2 opens the SOFTEMA Cookbook 2 "Project planning guide for SOFTEMA".
- HELP → SOFTEMA FAQ (PDF) opens the information on frequently asked questions on the SOFTEMA homepage.
- HELP → SOFTEMA ERROR LIST connects to an IFA database and opens information on known program errors and their remedies in a separate window.
- HELP → IFA "EN ISO 13849" PORTAL opens the IFA page with the portal for the safety of machine control systems. Further IFA tools and publications can be loaded here.
- HELP → INFO opens an information window (notes, version etc.) for SOFTEMA.

6.3 The toolbar

You will find the toolbar (Figure 24) directly below the menu bar.

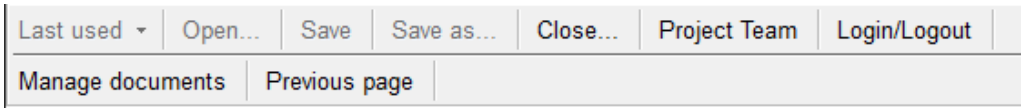

Figure 24 : SOFTEMA toolbar

The toolbar provides quick access to the most important commands. Most of the menu commands have already been explained in the previous sections.

After restarting SOFTEMA, the last used project file is opened by clicking on the LAST USED command. Clicking on the arrow to the right opens a selection list with other recently used project files.

The PREVIOUS PAGE command switches the view back to the previously displayed table. This is useful, for example, if you have selected a table from the "C1 Codereview" and "D1 Validation" tables - via the _Reference sheet column - and then want to switch back to C1 or D1.

6.4 The context menu (pop-up)

Within the tables, right-clicking a cell displays a pop-up near the mouse pointer (Figure 25). The context menu also contains nested submenus. The commands refer to the selected cell and, if applicable, to the column or row of this cell. Only those commands are available that are permitted according to the cell context and role. The commands are described in the following sections.

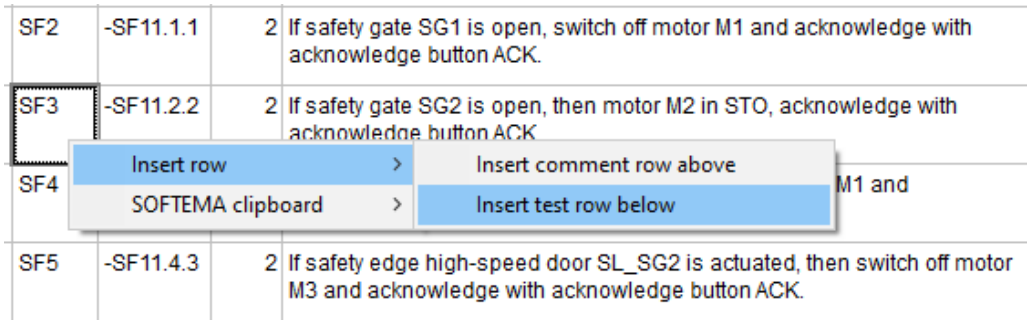

Figure 25 : Example of a context menu

6.4.1 Context menu: Set marker

Table 7 lists the commands in the SET MARKER context menu.

Note: Markings (yellow background color) are only set on content cells as well as column and cell identifiers, but not on system cells (lock, validation, etc.).

Table 7: Commands of the "Set marker" context menu

Command	Description
SET MARKER	The selected cell is highlighted in color (yellow background color).
SET MARKER IN SELECTION	The selected cells are highlighted in color (yellow background color).

Selections cannot be set in locked cells (default setting). However, an option can be set so that selections can also be changed in locked cells.

6.4.2 Context menu: Delete selection

Table 8 lists the commands in the DELETE MARKER context menu.

In addition to the context menu, there is another, faster option for deleting selections in columns and rows: Left-clicking and simultaneously pressing the CTRL key on a row identifier (1st column) deletes all selections in the row; similarly, left-clicking and pressing the CTRL key on a column identifier (1st row) deletes all selections in the column.

Selections cannot be deleted in locked cells (default setting). An option can be set so that selections can also be changed in locked cells.

Table 8: Commands of the "Delete marking" context menu

Command	Description
DELETE MARKER	If the selected cell is marked, the selection is deleted.
DELETE MARK IN COLUMN	Any existing selections in the column are deleted.
DELETE MARK IN ROW	Any existing markings in the row are deleted.
DELETE MARK IN SELECTION	Any existing selections of several cells are deleted.

6.4.3 Context menu: Cell(s) ...

Table 9 lists the commands of the CELL(S)... context menu.

The commands are only applied to the selected, visible cells between the row header (1st column) and the system columns (column _Lock, _Active etc.), i.e. the cells that are edited in terms of content. Comment cells and hidden rows are not considered. If there are locked cells in the selection, these are also not considered. All commands can be canceled in the dialog.

Table 9: The context menu "Cell(s)..."

Command	Description
FORMAT CELL(S)	Selected cells are displayed via a dialog (Figure 26).
DELETE CELL(S)	The contents of the selected cells are deleted (empty text entered).
SET CELL(S) TO ...	The selected cells are set to a text that can be entered in the subsequent dialog.
REPLACE CELL(S) TEXT ...	A search text is replaced by a replacement text in the selected cells. Both texts can be entered in subsequent dialogs. All text passages found are replaced, regardless of the case of the search text.

Note on formatting: In SOFTEMA, the cell contents are displayed according to the formatting of the Excel file. Using the above menu command, cells can be formatted in a dialog (Figure 26). This formatting is then saved in the Excel file and is therefore also visible when loading the project file in Excel.

Figure 26: Dialog for formatting a cell

6.4.4 Context menu: Set row

Table 10: The "Set row" context menu

Command	Description
SET O ROW TO ON (Only possible for test cases.)	All cells in the selected row that affect an output are set to the value "ON".
SET O ROW TO OFF	All cells in the selected row that affect an output are set to the value "OFF".
SET O ROW TO NOP	All cells in the selected row that affect an output are set to the value "NOP".

6.4.5 Context menu: Insert row

Table 11 lists the commands in the INSERT ROW context menu.

Table 11: The "Insert row" context menu

Command	Description
INSERT COMMENT ROW ABOVE	Inserts an empty comment row (without a row identifier) above the selected row. It can then be edited/formatted.
DUPLICATE AND APPEND ROW	The selected row is copied and inserted at the end of the table with the row identifier incremented.
INSERT TEST ROW BELOW	A new empty row with an incremented row identifier is inserted below the current row.

Command	Description
INSERT MULTIPLE ROWS BELOW	One or more new empty rows with incremented row identifiers are inserted below the current row. The desired number of rows is entered in a dialog box.

6.4.6 Context menu: Delete row

This context menu contains only one command (Table 12).

Table 12: The "Delete row" context menu

Command	Description
DELETE ROW(S)	The currently selected row(s) will be deleted. Each row deletion must be confirmed via a dialog. Locked and hidden rows are not deleted.

6.4.7 Context menu: Insert column

In the "A1 Safety functions" tab, it is necessary to be able to add separate columns for acknowledgement devices (Q) and operating equipment (BM). The Table 13 lists the commands in the INSERT COLUMN context menu that are available for this purpose. However, it is also possible to simply insert the Q and B columns using the "Insert Q column" and "Insert E column" buttons in the tab control (see Figure 27). When inserting Q and EL columns, the two header cells are prefilled with the texts "[Name]" and "[BMK]" (equipment identification). These texts must then be replaced by your own texts. To do this, activate the EDIT control in the "Columns" box on the tab.

Table 13: The "Insert column" context menu

Command	Description
INSERT COMMENT COLUMN ON THE LEFT	Inserts an empty comment column (without column identifier) to the left of the selected cell. It can then be edited/formatted.
INSERT Q COLUMN RIGHT	Inserts an empty column for an acknowledgement (with incremented column identifier) to the right of the selected cell. This column type is described in Table 24.

Command	Description
INSERT E COLUMN RIGHT	Inserts an empty column for a resource (with incremented column identifier) to the right of the selected cell. This column type described in Table 24.

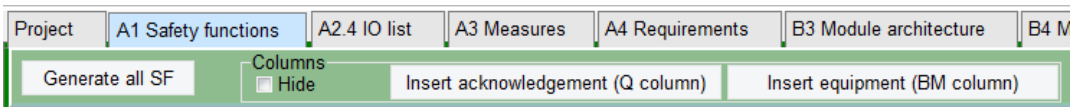

Figure 27: Insert Q and BM columns via button

6.4.8 Context menu: Delete column

This context menu contains only one command (Table 14).

Table 14: The "Delete column" context menu

Command	Description
DELETE COLUMN	The column of the selected cell is deleted.

6.4.9 Context menu: Set column

Table 15: The "Set column" context menu

Command	Description
SET I COLUMN TO ONE	The column of the selected cell of an input is set to the value "One".
SET I COLUMN TO ZERO	The column of the selected cell of an input is set to the value "zero".
SET O COLUMN TO ON (Only possible for test cases.)	The column of the selected cell of an output is set to the value "ON".
SET O COLUMN TO OFF	The column of the selected cell of an output is set to the value "OFF".
SET O COLUMN TO NOP	The column of the selected cell of an output is set to the value "NOP".

Command	Description
SET V-COLUMN TO OK	The validation or verification column is completely set to "OK". Only available in the "Administrate" role.
SET V-COLUMN TO NOT OK	The validation or verification column is completely set to "not OK". Only available in the "Administrate" role.
SET V-COLUMN TO EMPTY	The validation or verification column is completely emptied. Only available in the "Administrate" role.
SET A-COLUMN TO ACTIVE	The _Active column is completely set to "Active". Only available in the "Administrate" role.
SET A-COLUMN TO NOT ACTIVE	The _Active column is completely emptied (set to not active). Only available in the "Administrate" role.
SET L-COLUMN TO LOCKED	The _Lock column is completely set to "Locked". Only available in the "Administrate" role.
SET L-COLUMN TO NOT LOCKED	The _Lock column is completely set to "not locked". Only available in the "Administrate" role.

6.4.10 Context menu: Safety functions

This context menu contains only one command (Table 16).

Table 16: The "Safety functions" context menu

Command	Description
GENERATE SF NAMES	The name of the safety function is generated in the _Description cell from the configuration of the equipment, contactors and acknowledgement devices. If the cells required for this are empty, they are marked, a warning is issued and the generation is canceled.

6.4.11 Context menu: Changes

This context menu with a command (see Table 17) is only available in the "Changes" table.

Table 17: The "Changes" context menu

Command	Description
COMPLETE CHANGE IRREVOCABLY	The _Change cell of the selected row is highlighted in green. The row/change is now complete and can no longer be edited in SOFTEMA. For this command to be available, the selected row must already be locked but not yet completed (Section 4.11).

6.4.12 Context menu: Documents

This context menu is only available in the "Project" table in the _Text column in the Document: row and below the "SOFTEMA - Manage Documents" dialog box in the _Document column.

Table 18: The "Documents" context menu

Command	Description
REGISTER DOCUMENT	A file manager opens in which a document can be selected. The path and file name of the document are entered in the selected cell
OPEN DOCUMENT	The entered document is opened with the corresponding application.
REMOVE DOCUMENT	The path and file name of the document are deleted in the selected cell.

6.4.13 Context menu: SOFTEMA clipboard

The Microsoft Windows clipboard is used here by defining a separate clipboard format ('SOFTEMA_' + SOFTEMA version).

Note: It is possible to copy within a program instance or between several simultaneously running program instances of SOFTEMA. However, they must all have the same SOFTEMA version.

Table 19: The "SOFTEMA clipboard" context menu

Command	Description
COPY ROW(S) TO CLIPBOARD	The cell contents of the selected rows are copied to the clipboard. See below for details.
CUT ROW(S) IN CLIPBOARD	The cell contents of the selected rows are copied to the clipboard. The selected cells are then deleted. See below for details.
PASTE CELL(S) FROM CLIPBOARD	The rows in the clipboard are inserted below the selected row.

In the current SOFTEMA version, one or more selected rows of tables A1, A2.4, B3 and B4 can be copied. Other tables are currently not supported. Only test cases TFx can be copied to table B4 "Matrix C+E", as the other rows SFx are generated automatically. In tables A2.4 and B3, a distinction is made between input and output rows. Input and output rows cannot be mixed.

The rows do not have to be selected completely. It is sufficient to select individual cells of a row for the rows to be selected.

Only the cell contents of the columns with predefined column identifiers are copied (see Chapter 8), but without the columns described in Chapter 7 such as _Lock, _Validation or _Comment. Project-specific columns or comment columns are not copied. Each cell content is displayed in the clipboard in the form "Columns identifier = cellcontent". This allows the cell content to be correctly assigned again in the target table regardless of the column position of the column identifier.

When copying, the selected rows are always copied to the clipboard, regardless of authorizations or the row lock.

When cutting, the selected rows are first copied in full to the intermediate clipboard and then these rows are deleted. This command is not available without valid authorization. When deleting, the row lock is also tested. Therefore, it is possible that not all rows can be deleted.

Inserting these rows only works in a table of the same type. This command is not available without valid authorization. When inserting, new row identifiers are automatically created below the selected row. The cell contents in the intermediate file are assigned to the respective columns of the target table. This means that the source and target tables can have different column configurations.

In the status row, the type of content of the SOFTEMA clipboard is displayed in the form CB:. A clipboard that contains none or none usable content for SOFTEMA is displayed as CB: <empty>.

6.4.14 Context menu: Lock...

This context menu is only available in the _Lock column. Before executing the commands (Table 20), a confirmation prompt is displayed.

Table 20: The "Lock" context menu

Command	Description
UNLOCK ALL ROWS	All rows are unlocked
LOCK ALL ROWS	All rows are locked
UNLOCK SELECTION	Selected rows are unlocked
LOCK SELECTION	Selected rows are locked

6.5 Title bar and status bar

The program name SOFTEMA and the currently open project file are displayed in the title bar. The currently selected role is shown in brackets (Section 4.10). If the file can only be opened read-only, this is also shown in brackets after the role (Figure 28).

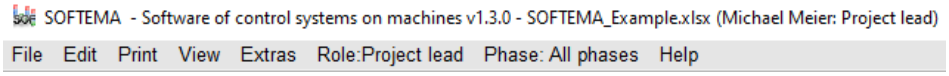

Figure 28: Title bar

The status bar at the bottom left of the window shows the working directory of the project file. The center of the status bar shows whether the currently selected table has been saved or changed. To the right of this, it shows whether and which INI-file (Section 9.1) is open. Further to the right, the type of content of the SOFTEMA clipboard is displayed in the form "CB: ".

6.6 The tabs

SOFTEMA uses control elements with tabs to access the different tables. Tabs are used to arrange information and input fields on several consecutive forms and tables. Only one table is always in the foreground. Clicking on the corresponding tab brings another tab to the foreground, whereby the information and any settings made on the previously used tabs are retained. In SOFTEMA, the tabs are arranged above the tables, while in Excel the tabs are arranged below the tables. However, the operating principle is the same.

The individual tabs are named after the required worksheets (see also Table 4).

6.7 Selection lists

Some cells can be edited using selection lists. Some cells only allow the selection of list texts, others can also be freely edited with individual text (Figure 29). The first two elements have a special function:

- <empty>: The cell is emptied (deleted) when this list element is selected
- <do not change>: When this list element is selected, the selection list closes and the cell content is not changed.

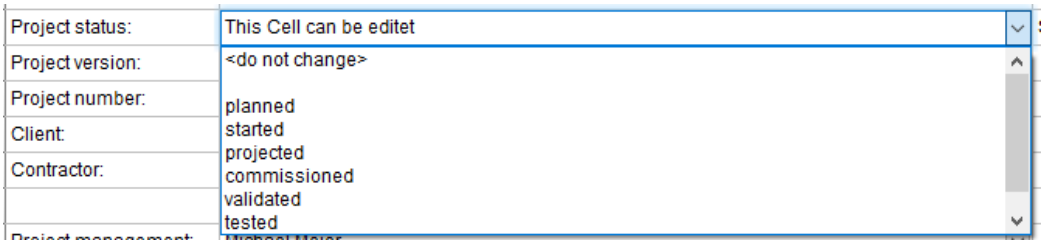

Figure 29: Selection list

6.8 Display of URLs

Every hyperlink of the type http://, https://, *ftp://, nntp://, mailto:* and *file://* that occurs in a cell text is automatically underlined in blue font color and reacts as a hyperlink when clicked (for examples, see Figure 30). The hyperlink can stand alone in the cell or be surrounded by other text. The corresponding standard application, e.g. the web browser or email client, opens as a reaction.

To link files, the schema identifier *file:///* (three slashes!) can be prefixed so that the absolute file name - for local or networked drives - can be displayed as a hyperlink and clicked on. The corresponding standard application opens, e.g. the PDF reader.

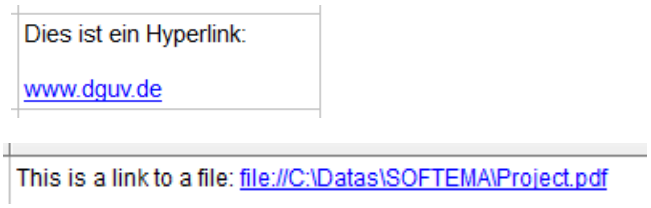

Figure 30: Representation of URLs in cells

6.9 Move rows/columns

In some configuration tables, it is useful and possible to swap the order of rows and columns. Changing the order has none influence on the results of the table (logics, validation, verification, etc.). Moving rows/columns using drag & drop is started by pressing the left mouse button on a row header (column <_No>) or column header. A symbolized sheet appears in addition to the mouse pointer and this can be dragged to the target position (another row/column) by holding down the left mouse button. Depending on the direction of

movement (up/down; left/right), the row/column is inserted above/below or to the left/right of the target row/column.

The columns can only be moved in the "B4 Matrix C+E" table for the I/O columns. However, it is possible to move the rows in the tables "A1 Safety functions", "A2.4 IO list", "A3 Measures", "B3 Modular architecture", "B4 Matrix CE", "B4 Matrix compact" and "Changes".

6.10 Row and column editor

The row height and column width can be set in a dialog for rows and columns of a table, and rows and columns can be hidden and shown. The width and height of the dialog boxes can be adjusted and moved.

The following applies to both editors: Clicking on the APPLY BUTTON applies the settings and the editor remains open for further settings. Clicking the OK BUTTON APPLIES the settings definitively and closes the editor. Clicking on the CANCEL BUTTON or the red window cross in the right above discards the settings.

The row editor (Figure 31) can be opened via the VIEW menu. On the left-hand page, a row can be shown (checkmark set) or hidden (not set) by setting a checkmark. The top check mark can be used to show or hide all rows at the same time. On the right page, the row height can be set individually for the row identifier shown in front of it. In addition, a value for the row height can be entered in the top input field, which is transferred to ALL rows when the ALL ROW HEIGHTS: button is clicked.

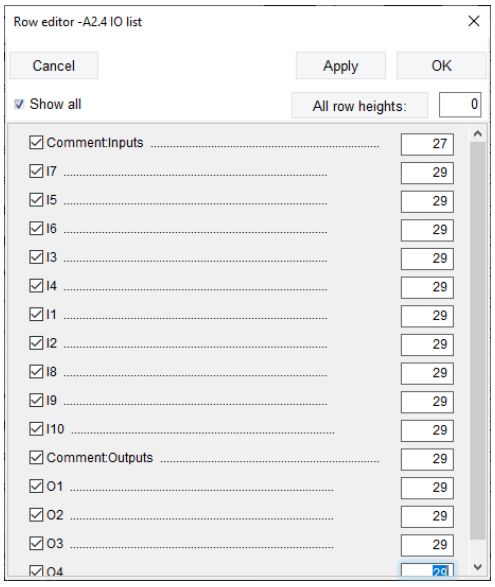

Figure 31: Row editor

The column editor (Figure 32) also opens via the command in the VIEW menu. On the left-hand page, a column can be shown (checkbox set) or hidden (not set) by setting a check mark. The top checkbox can be used to show or hide all columns at the same time. On the right side, the column width can be set individually for the column identifier shown on the left.

In addition, a value for the column width can be entered in the top input field, which is transferred to all columns when the ALL COLUMN WIDTHS: button is clicked.

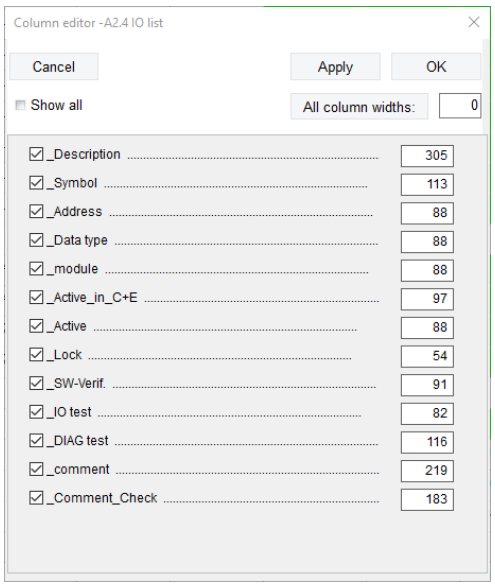

Figure 32: Column editor

6.11 Help Wizard

The "Help Wizard" is an assistance function (Figure 33) designed to support the initial use of SOFTEMA. The support consists of describing the various phases of a SOFTEMA project and the associated tables. At the same time, the wizard buttons are used to control the display of the tables (and thus the tabs).

The wizard is started with the HELP WIZARD command in the HELP menu (Section 6.2.8) and can be closed at any time by clicking on the X symbol in the window title. The wizard window is not modal. This means that SOFTEMA and the tables can still be used. However, the window will then always remain visible in SOFTEMA and may have to be moved to unused screen areas.

The interface of the window is divided into two parts: In the upper half, the phases are displayed and briefly explained. The tables (associated with the selected phase) are displayed and described in the lower half of the dialog.

The phases correspond to those that can be selected in the PHASE menu (Section 6.2.7). The phases can be set using the NEXT PHASE or LAST PHASE buttons. This is also displayed in the PHASE MENU.

THE NEXT TABLE and LAST TABLE buttons are used to switch between the corresponding tables within the selected phase.

By ticking the SHOW TABS checkbox, the tabs are shown in the order selected in the wizard when the NEXT TABLE button is clicked or hidden again when the LAST TABLE button is clicked. If the check mark is removed, all tables/tabs of the selected phase are displayed again.

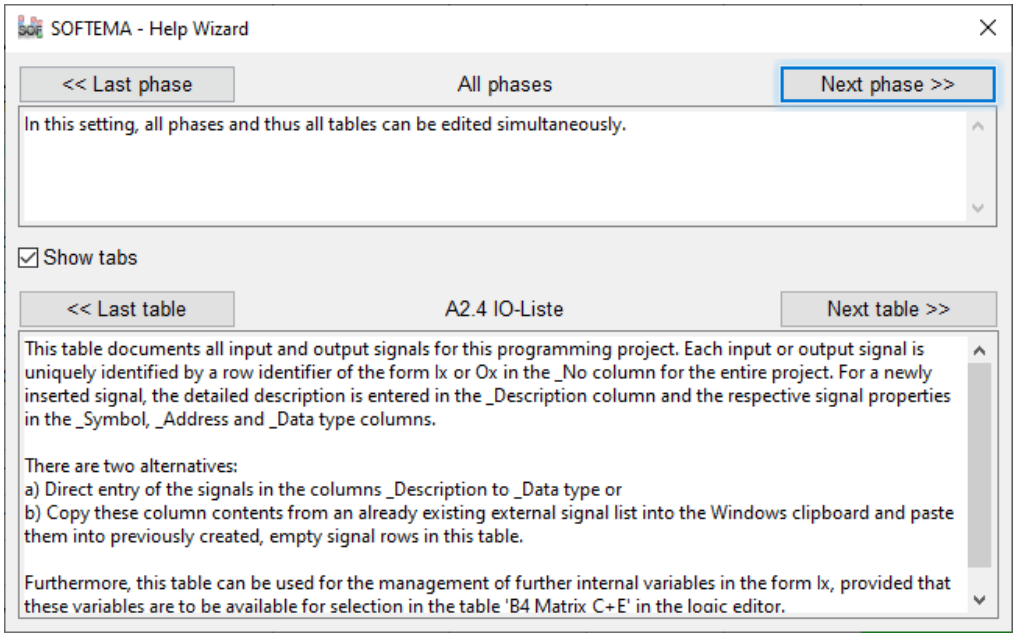

Figure 33: Help Wizard

7 Description of the system columns

In addition to the table-specific content and columns, the SOFTEMA tables also contain a row of system *columns* that are used in several tables. These system columns are described in this chapter.

7.1 Column _No

This column is always the first column of a table. The column cells contain the cells identifiers to uniquely identify the rows (see Section 5.5). The identifier cells are generated automatically under SOFTEMA, e.g. when defining new rows.

7.2 Column _Lock

Editing table rows is usually blocked by a lock to prevent accidental changes. This lock can be set or deactivated in the _Lock column for each relevant row - but only if the role authorizes the user to do so. This requires a double-click with the left mouse button on the cell.

The lock usually affects the row cells to the left of it. The row cells to the right of the lock are usually also system cells (validation, verification, comments, etc.) that can also be operated when the lock is active. Figure 34 shows three rows of a table:

- The first row with address E8.4 is locked (X and green background in the _Lock column) and cannot be edited in the cells to the left of the lock cell.
- The second row with address E8.2 is not locked (O and yellow background in the _Lock column) and can be edited in the cells to the left of the lock cell.
- The third row with the address E9.6 is locked again (X and green background in the _Lock column) and cannot be edited in the cells to the left of the lock cell. However, the verification and validation cells to the right of the lock cell can still be edited.

_Address	Data type	_Lock	SW-Verif.	IO test
E8.4	BOOL	x	OK	OK
E8.2	BOOL	o		
E9.6	BOOL	x	OK	OK

Figure 34: Table rows with lock

When the lock is deactivated, the system cells for validation and verification are automatically deleted, as the cell contents are no longer locked and can therefore be changed. New validation and verification can only be carried out once the lock has been reactivated.

7.3 Columns _Comment and _Comment_Check

All persons involved in the project can enter comments in these columns. The roles Check1 and Check2 enter their comments in the _Comment_Check column and all other roles in the _Comment column. Clicking with the left mouse button in these cells opens a multi-row editor (Figure 35), in which text can be entered or copied. If several persons use the comment, they should indicate this by their name, for example.

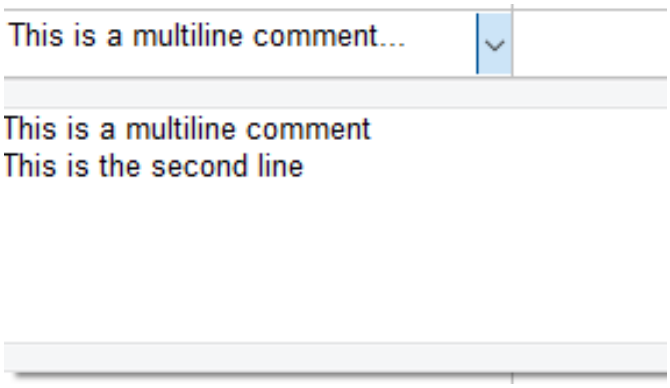

Figure 35: Comment cell with open editor

As soon as the editor is closed, e.g. with the ESC key, only the first row(s) are visible, depending on the row height. If the cursor is positioned on this cell without clicking, a tooltip ("Quick info") appears after a short time, displaying the complete cell content.

7.4 Column _Verification

As part of the IFA matrix method, the verification activity must be performed in several tables (IFA Report 2/2016 [8], Sections 5.2 to 5.4 and 6.8). The _Verification system column described here is used for documentation purposes.

In the cell of this column, an authorized role (project lead, SW developer or superuser) can mark the content of the relevant row as "verified". A drop-down list is available for this purpose. There are only two list entries: "not OK" (gray background) for an unsuccessful verification and "OK" (green background) for a successful verification. An empty list entry (without background color) is not provided. An empty verification cell indicates that either no verification was performed, or the row was unlocked after verification and the verification cell was cleared.

If a role is not authorized, this button is not displayed. If a row is not locked, it is generally not possible to operate the _Verification cell in this row. Figure 36 shows three table rows:

- The first row is not locked (O and yellow background in the _Lock column). The verification cell has been deleted and cannot be operated.
- The second row is locked (X and green background in the _Lock column) and can be operated in the verification cell (button with arrow visible). The cell is still empty, so it has not yet been operated.

- The third row is locked and the verification cell has already been operated. However, the verification has not yet been completed (not OK). There may be a comment about this in the comment cell. The button is still visible, which means that the current role can operate the drop-down list.
- The fourth row is locked and the verification cell has already been operated. The verification is completed here (OK). The button is still visible, which means that the current role can operate the drop-down list. The cell may have to be reset to "not OK" later.

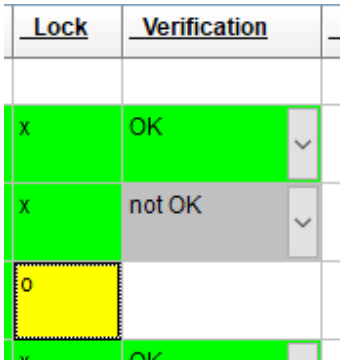

Figure 36: Verification cells in various states

7.5 Columns _SW-Verif., _IO-Test, _DIAG-Test

These columns are only used in the "A2.4 IO list" table:

- SW-Verif. is used for verification of the wiring of the inputs and outputs and their description in the software.
- _DIAG test is used for verification of the diagnostics/tests of the input and output signals.
- The _IO test is used for validation of the hardware wiring of the inputs and outputs.

Section 7.4 applies to these columns as well.

7.6 Column _Validation

As specified in the IFA matrix method, validation must be performed in several tables (IFA Report 2/2016 [8], Sections 5.2 to 5.4 and 6.8). The _Validation system column described here is used for documentation purposes.

In the cell of this column, an authorized role can mark the content of the relevant row as "validated". Section 7.4 applies analogously to the operation of the _Validation column.

7.7 Column _Active

In some tables - currently "A3 Measures" and "A4 Requirements" - individual rows can be activated or deactivated. When activated, the rows are relevant for the project and when deactivated, the rows are still visible but are not taken into account during verification and

validation. This means that measures and requirements can be listed across all projects in a project template, but can also be deactivated in individual projects.

Note: This should also be justified in the corresponding comment cells!

This activation can be set and reset in the _Active column for each relevant row, but only if the role is authorized (currently this is only the "Project lead" role). To do this, double-click on the cell with the left mouse button. If a row is deactivated, a confirmation prompt appears (Figure 37). However, none is requested when a row is activated.

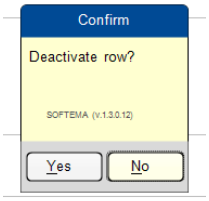

Figure 37: Confirmation to deactivate a row

Deactivation deletes the contents of the validation and verification system cells, as these are no longer relevant. When reactivated, these system cells must be filled in again. Figure 38 shows the two possible states:

- The first row R1 is deactivated (hyphen and gray background in the _Active column). The _Verification cell is empty or has been deleted. It is not relevant for the evaluation of the _Verification column.
- The second row R2 is activated ("Active" and green background in the _Active column). The _Verification cell is relevant and in this case is assigned "OK".

_No	_Measures	_Active	_Verification
R1	- Not safety-relevant: I_...	-	
R2	- Security relevant: IS_...	Active	OK

Figure 38: Possible states of the cells in column "_Active"

7.8 Column _Reference sheet

In some tables - currently "C1 Codereview" and "D1 Validation" - the _Reference sheet column is used. The worksheet or table to which the verification or validation of the respective row relates is entered in these cells (Figure 39). Another feature is that double-clicking with the left mouse button on this cell switches to the table named there. In this way, the "Validate" or "Tester" roles, for example, can get an overview of the named table, but also quickly switch back again (toolbar: PREVIOUS PAGE button).

No	Description	_Reference sheet	Verification
R1	Have the agreed error-prevention measures, tools and programming rules been adhered to?	A3 Measures	OK
R2	Has the system structure of the hardware been implemented?	A2.3 System structure	OK
R3	Has the wiring of the I/O signals been implemented correctly?	A2.4 IO list	OK

Figure 39: "_Reference sheet" column filled with table names

The cells in the _Reference sheet column cannot currently be edited in SOFTEMA. In the project template, tables C1 and D1 are assigned default contents and the corresponding table names. However, these contents can be changed and added to in Excel. For example, additional rows can be inserted there, in which the cell for _Reference sheet should also be assigned a valid worksheet name.

7.9 Column _Name

For tables with the _Name column, an associated name can be selected for each row via a drop-down list (Figure 40). These names are read from the "Persons" table and must therefore first be entered there ("Manage persons" command). However, only the names of persons with the currently set role are offered in the drop-down list.

The first item in the drop-down list is always empty. This selection allows you to delete the cell. The second element of the drop-down list contains the <DO NOT CHANGE> command: With this selection, the cell remains unchanged and the drop-down list closes again.

In some tables with this drop-down list, the cell can also be edited to enter multiple names. If rows are locked, the drop-down list cannot be used at all.

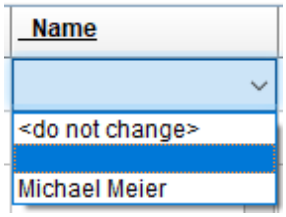

Figure 40: "_Name" column with drop-down list

7.10 Column _Roll

This column cannot be edited. The roles of the users are controlled via the user administration and automatically entered (encrypted) by SOFTEMA (Section 4.11). Several roles can be defined for a single person.

7.11 Column _Password

A user's password is defined via the user administration and entered by SOFTEMA in the "Persons" table (encrypted) (Section 4.11).

7.12 Column _Security query

The security query of a user is defined via the user administration and entered by SOFTEMA in the "Persons" table (encrypted) (Section 4.11).

7.13 Column _Security response

The security response to a user's security query is defined via the user administration and entered by SOFTEMA in the "Persons" table (encrypted) (Section 4.11).

7.14 Column _Date

For tables with the _Date column, a date can be entered for each row using a date picker (Figure 41).

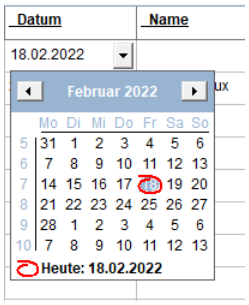

Figure 41: "_Date" column with date picker

7.15 Column _Document

For tables with the column _Document (currently only in table "Documents") or the project-specific column #D_<description> (see Section 5.4), the DOCUMENTS command group appears for a selected cell in the context menu (Figure 42). The commands are described in Section 6.4.12. Double-clicking with the left mouse button also opens an entered document.

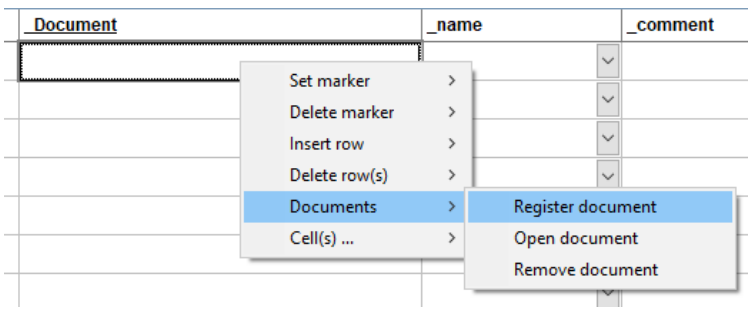

Figure 42: "_Document" column with the "Documents" context menu

8 Structure and functions of the tabs and tables

The following sections describe the tabs and tables with all their functions and details. Each tab contains a panel with control elements arranged in the upper part and the table below (Figure 43). The controls enable specific functions for the respective table.

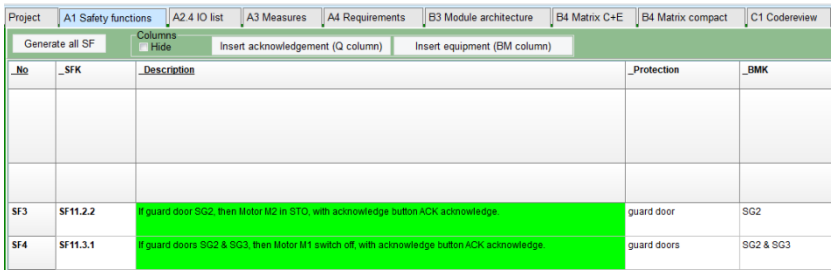

Figure 43: Multiple tabs and selected tab with controls and table

8.1 The tables

8.1.1 Operating of the tables

The view of the tables can be zoomed to a desired size by holding down the Ctrl key and moving the mouse scroll wheel.

As with Excel tables, the column width and row height can be set using the mouse. However, the row height can only be set manually if the option "Automatically adjust the row height of tables" (Section 9.4) is deactivated. If this option is active, the row height is automatically adjusted after the column width has been set.

If the mouse cursor is placed on the dividing row between two cells in the fixed rows/columns, the mouse cursor changes to the icons shown in Figure 44. There are several options:

- The respective column width and row height can be adjusted manually by holding down the left mouse button.
- By holding down the left mouse button and pressing the Ctrl key at the same time, all column widths and row heights of the table can be adjusted manually at the same time.

Double-clicking with the left mouse button automatically adjusts the column width to the left of the separator row to the text in the column. The row height cannot be adjusted automatically.

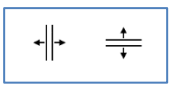

Figure 44: Mouse cursor to adjust column width (left) and row height (right)

8.1.2 Tab: Project

This tab does not yet contain any controls in the current version of SOFTEMA.

Table 21 lists the column identifiers predefined for "Project" (Section 5.4).

Table 21: Predefined column identifiers

Column identifier	Description
_No	Row identifier
Designation	Description of the data field in _Text
_Text	Project data fields (some set by SOFTEMA)
_Comment	Comment field for all roles other than "Tester" (Section 7.3)
_Comment_Check	Comment field only for "Tester" (Section 7.3)

The "Project" table contains general information about the programming project. The rows with the fixed row identifiers Px have the meanings described below (Table 22). In addition, individual rows can be defined with the non-predefined row identifiers (see also Table 22). These adjustments cannot currently be made with SOFTEMA. They can only be made with Excel.

Table 22: Row identifier

_No:_Name	Description
P1: Project name	Name of the Project (editable)
P2: Project file	Path and file name (entered by SOFTEMA, not editable)
P3: SOFTEMA version	Last used SOFTEMA version (entered by SOFTEMA, not editable)
P4: Last change	Date/time of last save (entered by SOFTEMA, not editable)
P5: Checksum	The checksum (CRC32) is recalculated and entered each time the SOFTEMA project file is saved. If tables have been changed (and not yet saved), the checksum is invalid. For a new file whose tables have not yet been changed, the checksum is valid and can be compared with the checksum of a summary.

_No:_Name	Description
P6: Project status	Project status (editable or selectable from drop-down list). The selection list can be customized via options in the INI file (Section 9.1).
P7: Project version	Version of the project (editable)
P8: Project number	Project number (editable)
P9: Customer	Customer or client of the project (editable)
P10: Contractor	Contractor or supplier of the project (editable)
P11: Project lead	Name(s) of the person(s) with the role "Project lead" (editable or selectable from drop-down list). The list evaluates the "Persons" table for this purpose.
P12: SW developer	Name(s) of the person(s) with the role of "SW developer" (editable or selectable from drop-down list).
P13: Commissioning	Name(s) of the person(s) with the role "Commissioning" (editable or selectable from drop-down list).
P14: Validate	Name(s) of the person(s) with the role "Validate" (editable or selectable from drop-down list).
P15: Check1	Name(s) of the person(s) with the role "Check1" (editable or selectable from drop-down list).
P16: Check2	Name(s) of the person(s) with the role "Check2" (editable or selectable from drop-down list).
P17 - P20	These rows can be inserted and are freely available, e.g. for additional roles and names. In the project template, the number Px must be entered in the _No field and the assigned description in _Identifier. The _Text field is freely editable (without a selection list).
P21: Plant/Machine	Description of plant/machine of the project (editable)
P22: Documentation	Text for the description of the project (editable)
P23: Documents	A document can be linked here (Section 7.15)

_No:_Name	Description
P24 - Pxy	These rows can be inserted and are freely available, e.g. for further project descriptions. In the project template, the number Px must be entered in the _No. field and the assigned description in _Identifier. The _Text field is editable. These rows must be marked with the control character for the end of the table (Section 5.3.3) in the _No column.

8.1.3 Tab: A1 Safety functions

This tab contains the functions described in Table 23.

Table 23: Control elements of the "A1 Safety functions" tab

Control element	Description
Button: GENERATE ALL SF	All texts in the _Description column are generated new based on the configuration of protection devices, acknowledgement and equipment.
Box “Columns": HIDE	Marked: The configuration columns (between _Description and _PLr) are hidden.
Box “Columns": INSERT Q COLUMN	A new Q column is added to the right of the last Q column.
Box “Columns": INSERT BM COLUMN	A new BM column is added to the right of the last BM column.
Button: FORMAL CHECKS	Formal testing of the table is started. For configuration, see Section 9.1.1.

The column identifiers listed in Table 24 (Section 5.4) are predefined for "A1 Safety functions":

Table 24: Predefined column identifiers in "A1 Safety functions"

Column identifier	Description
_No	Row identifier

Column identifier	Description
_SFK	Unique safety function identifier
_Description	Description of the safety function (SF) (editable or automatically generated)
_Protection	Type of protection device (can also be connective) (editable)
_BMK	Equipment lable identifier (or its connective) of the protection device(s) (editable)
_NQuit	X set: None acknowledgement required for triggered SF, e.g. for connective devices that are already acknowledged or for higher-level devices that are already acknowledged elsewhere. Empty or other content: Is ignored (the X can be set/reset by double-clicking).
_SQuit	X set: triggered SF is self-acknowledging. Empty or other content: Is ignored (the X can be set/reset by double-clicking)
Qx	Q set: Equipment assigned to acknowledge the triggered SF (the Q can be set/reset by double-clicking).
Bx	Equipment for switching off the SF hazard, corresponds to the outputs (effects) of the C&E matrix (editable or selectable from drop-down list).
_PLr	Required performance level of the SF (results from risk assessment, see SISTEMA Cookbook 6, Section 2.4) (selectable from drop-down list).
_Response time	Overrun of the entire system, i.e. the reaction time of the protection device plus the stopping time of the dangerous machine part (see SISTEMA Cookbook 6, Section 2.6) (editable)
_Priority	Prioritization of the SFs among each other (1 = higher priority, e.g. emergency stop; 2 = low priority), see SISTEMA Cookbook 6, Section 4.2 (selectable from drop-down list).

Column identifier	Description
_Mode of operation	Mode of operation of the SF (see SISTEMA Cookbook 6, Section 2.3); can be adapted via options in the INI-file (see 9.1). (selectable from drop-down list)
_Active	Activation field for this row (Section 7.7)
_Lock	Lock field for this row (Section 7.2)
_Validation	Validation field for this row (Section 7.6)
_Comment	Comment field for all roles outside “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table documents all safety functions for this programming project. Each safety function is uniquely identified by a row identifier of the form SFx in the _No column for the entire project. For a new safety function, a safety function identifier is entered in the _SFK column, the detailed description is entered in the _Description column and the respective properties are entered in the _PLr, _Reaction time, _Priority and _Mode of operation columns.

The safety function identifier is intended to enable unique identification throughout the project or system and can be freely assigned as any text. It is advisable to use system and location identifiers in front of the equipment identifier, e.g. "=B05.D04+A10-SF10.2.5". In this example, the safety function is specified with -SF10.2.5, whereby the individual numbers can mean:

- 1st number "10": Type of safety function, e.g. emergency stop
- 2nd number "2": second emergency stop device
- 3rd number "5": Effect on hazard no. 5

Alternatively, the equipment label identifiers of the relevant devices could be used directly, e.g. with the identifier "-SF/ESTOP/S2/M5". These identifiers are also important in order to achieve cross-tool and cross-trade traceability of all safety functions. They should then also be used in the risk assessment and in SISTEMA [11].

The columns _Protection to _SQuit and the column groups Qx and Bx (described below as configuration columns or cells) are optional. They can be used for configuration and more detailed documentation of the safety functions.
First, the protection device or the combination of several protection devices/sensors with description and BMK are entered in the _Protection and _BMK cells. For each safety function, the acknowledgement after triggering must be configured in one of the columns _NQuit, _SQUIT or Qx by double-clicking on these cells. An "X" or a "Q" with a green background indicates that this acknowledgement affects the safety function in that row. Several equipment resources for acknowledgement can be inserted through additional Qx columns.

This means that a safety function can also be assigned to several acknowledgement resources by double-clicking.
The basic effect of a safety function on the actuators Bx can be entered in the following columns Bx. To do this, these actuators must also be specified in advance using additional columns. A selection list with the typical basic control commands appears for each cell in the columns Bx:

- A, ZA: Switch off, time-delayed switch off
- E, ZE: Switch on, time-delayed switch on
- STO, SS1, SS2, etc.: Drive functions
- <do not change>: Cell content is not changed
- Empty element: cell (control command) is deleted

A more detailed specification of the control commands (time and control parameters) is not possible at this point. Nevertheless, the control commands in this selection list can be used via the options in the INI file (Section 9.1) and parameters can be added if necessary.

Automatic generation of the description:

If the configuration of the columns _Protection to _SQuit and the column groups Qx and Bx described above is complete and the content and form have been tested, the descriptions can be generated automatically in a formal language (via the GENERATE ALL SF button or for individual rows in the context menu SAFETY FUNCTIONS → GENERATE SF NAMES).

Note: These commands may first need to be activated in the TOOLS → OPTIONS menu on the TABLES tab.

These functions are used to generate the name of the safety function in the _Description cell from the configuration of the equipment, contactors and acknowledgement devices. If the cells required for this are empty, they are marked, a warning is issued and generation is canceled. Once the marked cells have been completed, generation can be started again.

After a successful generation, the _Description cell is **marked green** (OK state). If one of the configuration cells required for generation is changed or deleted, the _Description cell is **marked yellow**. There are two alternatives:

- If the changes were intended: restart the generation.
- After this change, the generation can be deliberately omitted. Adjust the description manually and then delete the yellow marker. The cell _Description **without marking** means: The description was created manually and is complete and correct from the user's point of view. This manually created description should be consistent with the configuration cells if they are filled in.

Note: Whether the description was edited manually or generated automatically: In both cases, only this description is copied to the "B4 Matrix C+E" table and used further. The configuration cells, on the other hand, are not used in other tables.

If the configuration columns described above are not used, they can be hidden using the COLUMNS → HIDE control element. The _Description column is then entered manually.

The FORMAL CHECKS button can be used to formally verify the table (options for formal verification, see Section 9.1.1).

8.1.4 Tab: A2.4 IO list

This tab contains the functions described in Table 25:

Table 25: Control elements in "A2.4 IO list"

Control element	Description
Button: SAVE IO LIST	An Excel list with IO signals can be exported via a file manager.
Button: FORMAL CHECKS	Formal testing of the table is started. For configuration, see Section 9.1.1.

In addition, the column identifiers described in Table 26 (Section 5.4) are predefined for "A2.4 IO list":

Table 26: Column identifiers in "A2.4 IO list"

Column identifier	Description
_No	Row identifier
_Description	Description of the IO signals. The content of the column is optional and can be omitted if the symbol is self-explanatory. However, the column *identifier* must be present.
_Symbol	Symbol of the IO variable in the program. The _Symbol column should normally be filled in completely. Duplicates or an empty cell can be detected using the "formal checks". If none of the symbols are to be assigned, use the "-" character. This character is excluded from formal testing.
_Address	Address of the IO variable in the program. The content of the column is optional and can be omitted if none is available. However, the column *identifier* must be present.

Column identifier	Description
_Data type	Data type of the signal (e.g. BOOL, SAFEBOOL, etc.). The content should be filled in to pass the testing by the "Formal Checks" control element.
_Module	If an input signal or the output signal is processed via a module (function block), this module can be specified here. Only modules (function blocks) that have already been created in the "B3 Modular architecture" table can be selected here. If a module is defined, the module name is displayed for this signal (e.g. [DOOR_SG1]) is displayed in square brackets in the table "B4 Matrix C+E" instead of the address (e.g. [E8.4]).
_Active in C+E	When the "B4 Matrix C+E" table is updated, all input and output signals are automatically added to the matrix. If there are signals that are not required for the matrix - e.g. because they are only processed by a function block itself - they can still be deactivated here. Deactivated signals are now not added to the C&E matrix (during an update).
_Active	Activation field for this row (Section 7.7)
_Lock	Lock field for this row (Section 7.2)
_SW-Verif.	Verification field for this row (Section 7.5)
_IO test	Validation field for this row (Section 7.6)
_DIAG test	Verification field for this row (Section 7.5)
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table documents all input and output signals for this programming project. Each input or output signal is uniquely identified by a row identifier of the form Ix or Ox in the _No column for the entire project. For a new signal, the detailed description is entered in the _Description column and the respective signal properties are entered in the _Symbol and _Address columns.

This table can also be used to manage other internal variables in the form Ix if these variables are to be available for selection in the "B4 Matrix C&E" table in the logic editor.

8.1.5 Tab: A3 Measures

This tab does not yet contain any controls in the current version of SOFTEMA.

The predefined column identifiers (Section 5.4) are listed in Table 27:

Table 27: Column identifiers for "A3 Measures"

Column identifier	Description
_No	Row identifier
_Measures	Description of the measure
_Active	Activation field for this row (Section 7.7)
_Verification	Verification field for this row (Section 7.4)
_Comment	Comment field for all roles except "Tester" (Section 7.3)
_Comment_Check	Comment field only for "Tester" (Section 7.3)

This table documents all measures taken (programming rules, tools, conventions, error detection and control, etc.) for this programming project. Each measure is uniquely identified by a row identifier of the form Rx in the column _No for the entire project. This worksheet should already be prepared with Excel in the project template file (*__SOFTEMA_Template__.xlsx*). In the "Project lead" or "Superuser" role, this table can be edited later in the actual project file. It is also possible to use the SOFTEMA GUI to deactivate certain measures depending on the project (_Active column).

8.1.6 Tab: A4 Requirements

This tab does not yet contain any controls in the current version of SOFTEMA.

Table 28 lists the column identifiers defined for this tab.

Table 28: Predefined column identifiers for "A4 Requirements"

Column identifier	Description
_No	Row identifier

Column identifier	Description
_Requirements	Description of the normative requirements
_PLr	Specification of the PLr for which the request is needed.
_Fulfillment	Explanation of how the requirements are fulfilled
_Active	Activation field for this row (Section 7.7)
_Validation	Validation field for this row (Section 7.6)
_Comment	Comment field for all roles except "Tester" (Section 7.3)
_Comment_Check	Comment field only for "Tester" (Section 7.3)

This table documents which normative requirements are relevant for this programming project. Each requirement is uniquely identified by a row identifier of the form Ax in the _No column for the entire project. The requirements cannot yet be edited in this version of SOFTEMA. This worksheet should therefore already be prepared with Excel in the project template file (*__SOFTEMA_Template__.xlsx*) and also edited later with Excel in the actual project file. However, it is possible to use the SOFTEMA GUI to deactivate certain requirements depending on the project (_Active column). The _Fulfillment column can be used to explain how the requirements are fulfilled.

8.1.7 Tab: B3 Modular architecture

In the current version of SOFTEMA, this tab contains the "Module Manager" control element. The Module Manager can help you to manage your module or function block templates. For details, please refer to Section 9.2.

Table 29 lists the column identifiers defined for this tab.

Table 29: Predefined column identifiers for "B3 Modular architecture"

Column identifier	Description
_No	Row identifier
_FB name	Name of the function block (function, module, etc.)
_Instance name	Name of the instance of the above function block (FB)
_Inputs	Variables that are connected to inputs of the FB

Column identifier	Description
_Output	Variables that are connected to the output of the FB
_Description	Description of the FB or the safety-related output
_Parameters	Possible input parameters of the FB
_Manufacturer	Manufacturer of the FB (third-party or in-house development)
_Version/Signature	Version/Signature of the FB
_Active	Activation field for this row (Section 7.7)
_Lock	Lock field for this row (Section 7.2)
_Verification	Verification field for this row (Section 7.4)
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table lists the instances of all function blocks/modules used for this programming project. Each input or output module is uniquely identified by a row identifier of the form IMx or OMx in the _No column for the entire project. For each module, the detailed description can be entered in the _Description column and the names, parameters, signals, etc. can be entered in the other columns.

The _FB name cell opens a drop-down list of modules that can be specified by an options file (Section 9.2). The options file can be created using the Module Manager (Section 9.2). With this selection, the cells _FB name, _Instance name, _Description, _Manufacturer and _Version/Signature can be set to predefined texts. The selection list first contains an empty element, which is used to delete the previously mentioned cells. If the second element <Do not change> is selected, none of the cells are changed. However, the cell can also be edited manually without setting any of the list elements. You must then confirm your manual editing with "Return".

8.1.8 Tab: B4 Matrix C+E

This tab contains the Control elements described in Table 30.

Table 30: Control elements in "B4 Matrix C+E"

Control element	Description
Button: UPDATE TABLE	The table contents are updated and marked according to the changes in table "A1 Safety functions", "A2.4 IO list" and "B3 Modular architecture". This button is only active if all columns are displayed (see corresponding control below). If updates are available, the border of the button flashes pink.
Box "Hide columns": Inputs	Marked: The input columns Ix are hidden, with the exception of the column that is selected.
Box "Hide columns": Outputs	Marked: The output columns Ox are hidden, except for the column that is selected.
Box “Hide columns": Activate selection	Marked: After selection, multiple columns (input and/or output) can be selected. Individual columns can be selected using the Ctrl key (multiple selection is currently not visible, but works). "Show selection" must then be selected (see below).
Box “Hide columns": Show selection	Marked: All columns are hidden, except those selected with the previous command. By deleting this selection, all columns are displayed again and the "Activate selection" selection is deleted at the same time.

The column identifiers predefined for "B4 Matrix C+E" (Section 5.4) are described in Table 31.

Table 31: Column identifiers for "B4 Matrix C+E"

Column identifier	Description
_No	Row identifier
_Mode of operation	Mode of operation of the row, either selection list or taken from table "A1 Safety functions"

Column identifier	Description
_Test	Selection list: State/Cause of the system from which this row is to be tested.
Ix	Input variables for the matrix (from table "A2.4 IO list")
_SF-No	Row identifier (SFx) of the safety function (automatically imported from table "A1 Safety functions") or test case ("TFx") (entered manually)
_SFK	Unique safety function identifier (see Section 8.1.3)
_Prio	Priority (for safety functions automatically imported from table “A1 Safety functions”, enter manually for test cases)
_SF name	Description of the safety function (automatically imported from the “A1 Safety functions” table) or the test case (entered manually)
Ox	Output variables for the matrix (from table “A2.4 IO list”). These columns contain the logic cells that define the control of the output variables.
_Lock	Lock field for this row (Section 7.2)
_Verification	Verification field for this row (Section 7.4)
_Validation	Validation field for this row (Section 7.6)
_Comment	Comment field for all roles except "Tester" (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table contains in each row Cx the specification for one safety function SFx or for one test case TFx, according to the representation in the column _SF-No. The safety functions can only be changed by updating table A1. The test cases, on the other hand, can only be entered and changed manually.

When table A1 is updated, the affected cells are marked as follows:

- For newly inserted rows (safety functions) or columns (I/O signals), all new cells are marked in **yellow.** These cells must be checked and edited if necessary. The marking can then be deleted.

- For rows or columns that are deleted or deactivated in their original tables, the row or column header is marked in **red.** These rows and columns must be deleted manually. The red marking cannot be deleted.

Basic functions:

The prepared tables "A1 Safety functions", "A2.4 IO list" and "B3 Module architecture" can be used to fill in the table "B4 Matrix C+E". This is done using the button UPDATE TABLE for automatic updating of I/O signals and safety functions. The actual software specification is then carried out by

- Assigning input signals to the individual safety functions and
- Enter the logical connective of the signals for the switching operations to the output signals in the logic cells of the columns Ox.

The latter is required for Coding the processing stage. A specialized logic editor (see Section 8.2) helps with this connective.

Functions in detail:

Column _Test: After updating a safety function or inserting a test case, the cell in the _Test column must be adjusted. This cell indicates the state/cause of the system from which this row is to be tested. This is usually the cause C0, in which all safety functions are either deactivated or not requested. A safety function or a test case is usually requested from this state C0.

Columns Ix: These columns each represent an input variable from table "A2.4 IO list". The state of the input variable (0 for active-low signals; 1 for active-high signals) is entered in the cells of these columns when the safety function or test case under consideration is activated. This information is optional and is intended to support subsequent verification/validation. If this information is omitted, the columns Ix can be hidden (see control above the table).

Columns Ox: These columns contain the logic cells for controlling each individual output variable from table "A2.4 IO list". Further information on this can be found in IFA Report 2/2016 [8], Section 6.7. The Ox columns can also be hidden completely or selectively to improve the clarity of the table.

In the first row of the logic cells in these columns, you enter how this output variable is to be controlled when the safety function/test case under consideration is activated.

There are three control alternatives that also color the cell background:

- OFF (red background) means: The output variable is controlled with 0/False (typical for wired contactors or valve controls).
- ON (green) means: The output variable is controlled with 1/True (typical for communication-based control of drive functions) and is only available for test functions.
- NOP (white) means: This output variable is not enabled.

The switching conditions according to which the output variable is to be controlled are entered in the rows of the logic cell below. By double-clicking on the cell, SOFTEMA makes the logic editor available for editing these conditions in a dialog window (see Section 8.2).

8.1.9 Tab: B4 Matrix compact

This tab contains the functions described in Table 32:

Table 32: Control elements in "B4 Matrix compact"

Control element	Description
Button: CREATE NEW TABLE	The table contents (columns of the modes of operation and all output rows) are deleted and new ones are created from the table "B4 Matrix C+E". All cells are marked. Finally, the table contents are verified against table “B4 Matrix C+E” table.
Button: EMPTY TABLE	The table contents (columns of the modes of operation and all output rows) are deleted.
Button: UPDATE TABLE	The table contents are not deleted, but compared to the contents of the "B4 Matrix C+E" table and updated. If updates are available, the margins of the control flash pink. Updated cells are marked. Previously marked cells remain marked. Finally, a verification of the table contents against table B4 Matrix C+E is performed.

For "B4 Matrix compact", the following column identifiers (Section 5.4) are predefined:

Table 33: Predefined column identifiers in "B4 Matrix compact"

Column identifier	Description
_No	Row identifier
_Output	Row identifier and syntax for the output of this row (from tables "B4 Matrix C&E" and "A2.4 IO list")
_Description	Description of the output (from table "A2.4 IO list")

Mx	For each existing mode of operation, the connective of a safety function (SF) to this output is shown per row (from table "B4 Matrix C+E"). Further information will follow.
_SF_(Prio)	Enumeration of the row identifiers (SFx) of the safety function linked to this output or test case (TFx) with priority in brackets (from table "B4 Matrix C+E"). Further information will follow.
_Verification	Verification field for this row (Section 7.4)
_Validation	Validation field for this row (Section 7.6)
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table also documents the logic module's connectives in a transposed, compact matrix. This matrix is generated by SOFTEMA.

The table is explained below. SOFTEMA creates a column in the table "B4 Matrix C+E" for each mode of operation (Mx) used. Each row represents an output that is controlled by safety functions (Figure 45). Example: Row E1 stands for the output "O1: QS_M1".

No	Output	Description	B0: All	B1: Automatic	B2: Setup mode	SF (Prio)
E1	O1: QS_M1 [A24.0]	Contactors Motor M1 (1K1, 1K2)	OFF: (*IM1*) S_ESTOP_S1_OK	OFF: (*IM2*) S_DOOR_SG1_OK OFF: (*IM3*) S_DOOR_SG2_OK OR (*IM4*) S_DOOR_SG3_OK		B0:SF1 (1), B1:SF2 (2),SF4 (2), B2:
E2	O3: QS_M2_STO [A32.0]	Activation of STO for M2	OFF: (*IM1*) S_ESTOP_S1_OK	OFF: (*IM3*) S_DOOR_SG2_OK AND (*IM5*) S_EN_SLS_OK	OFF: not (*IM5*) S_EN_SLS_OK OFF: not (*IM5*) S_EN_SLS_OK OFF:	B0:SF1 (1), B1:SF3 (2), B2:SF6 (2),SF7 (2),TF1 (2),TF2 (2),
E3	O4: QS_M2_SLS [A32.4]	Activation of SLS for M2			OFF: (*IM5*) S_EN_SLS_OK OFF: (*IM5*) S_EN_SLS_OK ON:	B0: B1: B2:SF6 (2),SF7 (2),TF1 (2),TF2 (2),

Figure 45: "B4 Matrix compact" table (excerpt with 3 outputs)

The cells in the _SF_(Prio) column list the safety functions that control an output for each mode of operation (Mx). In Figure 46 on the right, all three modes of operation used, M0, M1 and M2, are listed in one row each. Each mode of operation is followed by the safety function(s) SFx that act on the output of the row (here E1) in this mode of operation. The numbers in brackets indicate the priority of the safety functions.

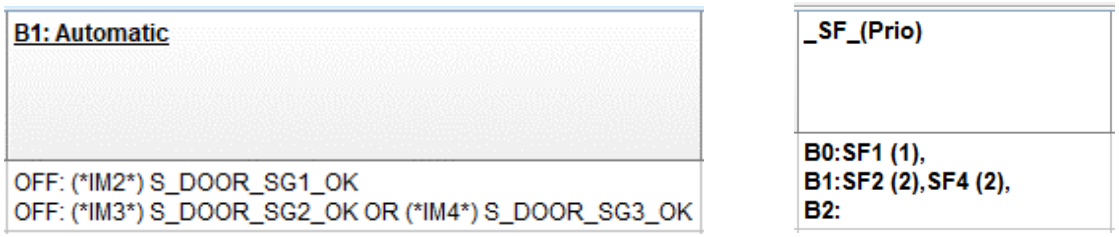

Figure 46: Excerpts from the "B4 Matrix compact" table

Explanation of Figure 46:

- In mode of operation B1, the functions SF2 and SF4 (right in the figure) act on the first output O1: QS_M1.
- The Bx column contains one control logic for one SF per row, starting with OFF or ON. The first control logic belongs to the first safety function in the list and so on. In this example in the figure on the left, the control logic OFF: IM2: SG1_OK belongs to SF2 in mode of operation B1 and the control logic OFF: IM3: SG2_OK or IM4: SG3_OK belongs to SF4.
- In mode of operation B0, only the SF1 function acts (column B0 and control logic not shown here) and in mode of operation B2, none of the functions act on the output of the row under consideration here (cell in column B2 remains empty).

8.1.10 Tab: C1 Codereview

This tab does not yet contain any controls in the current version of SOFTEMA.

The following column identifiers (Section 5.4) are predefined in this tab:

Table 34: Predefined column identifiers in "C1 Codereview"

Column identifier	Description
_No	Row identifier
_Description	Description of the review question
_Reference sheet	Name of the relevant table
_Verification	Either set by SOFTEMA according to the reference sheet or input as a verification field for this row (Section 7.4)
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table documents the code review for this programming project. Changes can only be made using Excel.

The positions of rows R1 to R6 are fixed and may not be changed. No comment rows are possible in between.

However, further review questions R7 to Rx and comment rows can be inserted and formulated below R6 up to the end character. A relevant table can be named in the _Reference sheet column. The usual selection list appears in the _Verification column.

8.1.11 Tab: D1 Validation

This tab does not yet contain any controls in the current version of SOFTEMA.

The following column identifiers (Section 5.4) are predefined for this tab:

Table 35: Predefined column identifiers in "D1 Validation"

Column identifier	Description
_No	Row identifier
_Description	Description of the validation question
_Reference sheet	Name of the table in question
_Validation	Either set by SOFTEMA according to the reference sheet or input as a validation field for this row (Section 7.6)
_Comment	Comment field for all roles except "Tester" (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

This table documents all validations for this programming project. Changes can only be made using Excel.

The positions of rows V1 to V7 are fixed and may not be changed. No comment rows are possible in between.

However, further validation questions V8 to Vx, questions on documentation D1 to Dx and comment rows can be inserted and formulated below V7 up to the end character. A relevant table can be named in the _Reference sheet column. The usual selection list appears in the _Validation column.

8.1.12 Tab: Changes

This tab does not yet contain any controls in the current version of SOFTEMA.

The following column identifiers (Section 5.4) are predefined for this tab:

Table 36: Predefined column identifiers in the "Changes" table

Column identifier	Description
_No	Row identifier
_Change	Description of the changes
_Date	Date of changes
_Name	Name of the person responsible for the changes
_Reference	Reference to the changes (e.g. table/row identifier etc.).
_New_Value	Value of the cell/contents after the changes
_Old_Value	Value of the cell/contents before the changes
_Lock	Lock field for this row (Section 7.2)
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

Changes in the project planning tables can be documented in this table.

8.1.13 Tab: Protocol

This tab does not yet contain any controls in the current version of SOFTEMA.

The following column identifiers (Section 5.4) are predefined in "Protocol":

Table 37: Predefined column identifiers in the "Protocol" table

Column identifier	Description
_No	Row identifier
_Date/Time	Date and time of the changes logged here
_Name	Name of the person who made the changes
_Table	Table in which the changes were made

Column identifier	Description
_Row	Row of the changed table cell
_Column	Column of the changed table cell
_New_Value	Value of the cell/contents after the changes
_Old_Value	Value of the cell/contents before the changes

In this table, SOFTEMA documents particularly safety-relevant changes in the project planning tables.

Note: In the current version, changes to the PLr are logged in the "A1 Safety functions" table. Further logging is planned.

8.1.14 Form: Project team

This form is not called up via a tab, but in the menu under TOOLS and then under PROJECT TEAM or the toolbar. It contains the following controls:

Table 38: Controls in "Project team"

Control element	Description
Button: CLOSE	The changes are applied and the form is closed.

The PROJECT TEAM form displays the contents of the "Persons" table.

The following column identifiers (Section 5.4) are predefined in the "Project team" form:

Table 39: Predefined column identifiers in "Manage people"

Column identifier	Description
_No	Row identifier
_Name	Title, first name and name of the person
_Phone	Telephone number(s) of the person
_E-mail	Address of the person
_Room	Room number of the person

Column identifier	Description
_Company	Organization of the person
_Roll	Role of the person (Section 7.10)
_Password	Password of the person (Section **Fehler! Verweisquelle konnte nicht gefunden werden.**)
_Security query	Security query of the person (Section 7.12)
_Security response	Security response of the person (Section 7.13)
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

All persons associated with the programming project are documented in this table.

8.1.15 Form: Manage Documents

This form is not called up via a tab, but in the menu under TOOLS and then under MANAGE DOCUMENTS or the toolbar. It contains the following controls:

Table 40: Controls in "Manage Documents"

Control element	Description
Button: CLOSE	Changes are applied and the form is closed.

The following column identifiers (Section 5.4) are predefined in the table:

Table 41: Predefined column identifiers in "Manage Documents"

column identifier	Description
_No	Row identifier
_Desription	Title of the document
_Document	Relative path and file name of the document in the format "File name > path"

column identifier	Description
_Name	Selection list: Name of the person who entered the document
_Comment	Comment field for all roles except “Tester” (Section 7.3)
_Comment_Check	Comment field for “Testers” only (Section 7.3)

Documents relevant to the programming project can be managed and edited in this table.

8.1.16 Tab: Loading table

This tab (Figure 47) contains the following control element.

The name of this tab is determined by the selection from the existing drop-down list. It is always the tab on the far right (the last tab displayed).

Table 42: Control element in "Load table"

Control element	Description
Drop-down list	The additional worksheets that are not automatically loaded by SOFTEMA are displayed in this list. Clicking on a list element loads the worksheet. Content from this worksheet can be copied, but cannot currently be edited.

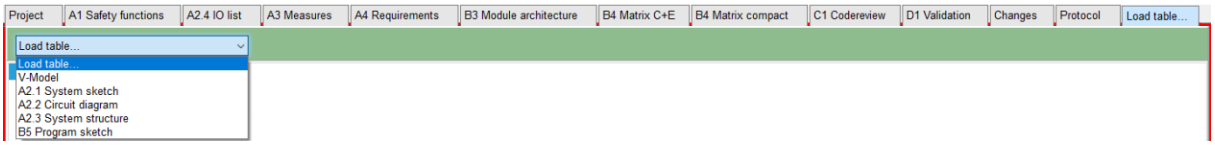

Figure 47: "Load table ..." form with drop-down list of additional worksheets

None of the column identifiers are defined, as this is an external table.

Additional worksheets that are not automatically loaded by SOFTEMA can be displayed in this table.

8.2 The logic editor

The logic editor (Figure 48) is called up by double-clicking with the left mouse button on a logic cell in the "B4 Matrix C+E" table. When you exit the editor, the switching conditions are entered in the logic cell that has just been edited. If the row of the safety function/test case under consideration is locked, none of the changes can be made in the editor.

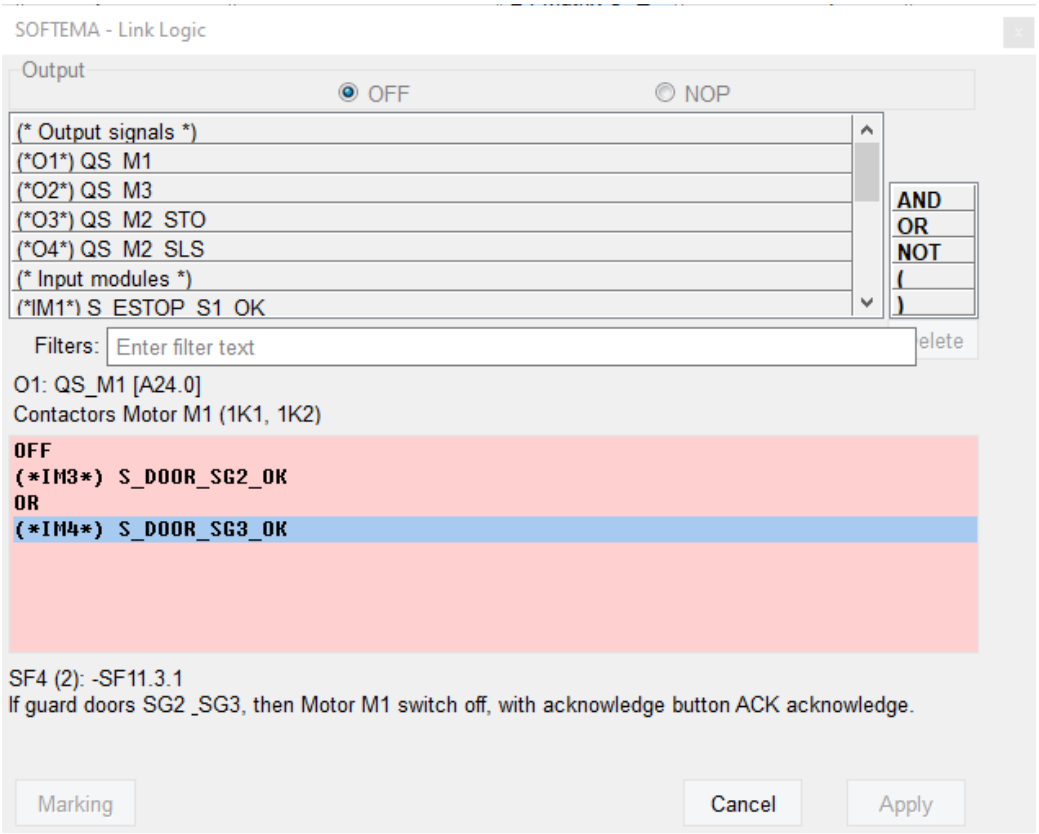

Figure 48: The logic editor

The controls are explained from above to below according to their arrangement in the form:

- The two basic switching commands OFF, NOP can be selected in the "Output" area. This then changes the background color of the central logic link.
- Below this is a list of the signals Ix, Ox from the "A2.4 IO list" table and the modules IMx, OMx from the "B3 Modular architecture" table. Double-click on a list element to add it to the logic link below the selected row (in Figure 48 shown in blue). List elements already used in the logic are marked with an asterisk in the list, but can be inserted again. The selection and design of the list elements can be changed via options (Section 9.1) can be customized.
- The available logical operators are shown to the right of these input elements. These can also be inserted by double-clicking below the selected cell. The "NOT" operator is applied directly to the selected row. The brackets can be used to create nested logic conditions. When exiting the logic editor, the system checks whether the same number of opening and closing brackets are used.
- The DELETE button is located below the operators. Simply click with the left mouse button to delete the selected logic row.
- Below the input elements and operators, the output variable under consideration is displayed with its description, symbol and address.
- Below this is the editing area of the logic link: The first row contains the switching command, below this the conditions that lead to switching according to the IFA matrix method. In the Figure 48 the condition means: If the fast-moving gate SG2 and the

vertical guard SG3 are open at the same time (SG2.SG_OK = False *and* SG3.SG_OK = False), then the contactor for motor M1 is switched off (OFF, which corresponds to QS_M1 = False).

- The safety functions/test cases under consideration are displayed below the logic link.
- In the logic editor of a test function, there is also the ON switching command.

There are buttons at the margins below the editor. The MARK button can be used to set or delete the marking color for the cell. CANCEL exits the editor, but does not apply the logic link and therefore does not change the original cell content. The cell is updated with APPLY.

9 Options

SOFTEMA manages program-specific options (for all project files) in the Windows registry. In addition, project-specific options can be written and read in various INI files. The options in the INI files can then be opened by different persons together with the project file(s). On the other hand, the registration database options are bound to a SOFTEMA installation (the computer). The project-specific INI files can be edited with an editor (e.g. Notepad) or controlled within SOFTEMA using the "SOFTEMA.ini Manager" and the "Module Manager".

The "SOFTEMA.ini Manager" for managing the SOFTEMA.INI (Section 9.1), can be found via the  button in the control bar of the "Projects", "A1 Safety functions", "A2.4 IO list", "B3 Modular architecture" and "B4 Matrix C+E" worksheets.

The function block templates (SOFTEMA_FB.ini Section 9.2) can be managed using the "Module Manager", which can be found in the control bar of the "B3 Modular architecture" worksheet.

9.1 Options of the SOFTEMA.INI file

An initialization file (INI file for short) is a normal text file with the file extension *.ini*. The file extension is registered for a text editor in Windows and can simply be edited (e.g. using the "SOFTEMA.ini Manager" integrated in SOFTEMA). The basic structure of the text is:

```
; comment

[Section1]

Key1=entry

; Key2=other entry (is considered a comment)

[Section2]

Key3=entry
```

Comments are introduced with a semicolon and may only appear on separate rows (not after sections or keys). In this version, SOFTEMA uses a fixed "SOFTEMA.ini" file for general options. This INI-file is searched for in the working directory of the open project file and is immediately evaluated in full when this file is opened. Changes to the INI file only take effect when the same or a different project file is opened again.

If none such INI file is found, a message is displayed in the status bar (Section 6.5) and as a message window. The

Table 43 shows all general sections and keys that are evaluated. If the INI file or individual sections or keys are not available, SOFTEMA uses the specified default values.

Table 43: Definitions of the INI file

[Section] Key	Meaning	Default (if entry does not exist)
`[General]` `IniFile_PrintSettings=`	Name of the INI file for print settings. This file can be saved and loaded by SOFTEMA to restore project-specific print settings (see Section 9.3).	`SOFTEMAPrintSettings.ini`
`[Project]` `States=`	Semicolon-separated character string containing various project statuses. Are displayed in the "Project" table in the selection list	`planned; started; projected; commissioned; validated; tested; modified`

`[SafetyFunctions]`
`OpModes=`
	Semicolon-separated character string containing various modes of operation. Are displayed in table "A1 Safety functions" in the selection list of the _Mode of operation column	`B0: All;`
		`B1: Automatic;`
		`B2: Setup mode;`
		`B3: Process monitoring`

[Section] Key	Meaning	Default (if entry does not exist)
`[SafetyFunctions]` `Actions=`	Semicolon-separated character string containing various control commands. Are displayed in table "A1 Safety functions" in the selection list of columns Bx	`A; ZA; E; ZE; STO; SS1; SS2; SOS; SLS; SDI; SLT; SLI; SLP; SLA; SBC; SCA; SSM`
`[IOList]` `MaxLengthOfIOSymbol=`	Maximum permitted character length for symbols in the "A2.4 IO list" table	`99999`
`[Modules]` `MaxLengthOfFBInstanceName=`	Maximum permitted character length for instance names in the "B3 Modular architecture" table	`99999`
`[LogicEditor]` `ShowInputSignals=`	`True`: The input signals from table "B4 Matrix C+E" are also displayed for selection in the logic editor.	`False`
`[LogicEditor]` `ShowOutputSignals=`	`True`: In the logic editor, the output signals (without instance name) from table "B4 Matrix C+E" are also displayed for selection	`False`
`[LogicEditor]` `AddInstanceNameToOutput=`	Only if previous option is active: `True`: "Instance name.output" from table "B3 Modular architecture" is displayed for selection in the logic editor; `False`: Only "Output" is displayed for selection in the logic editor.	`False`

[Section] Key	Meaning	Default (if entry does not exist)
`[LogicEditor]` `ShowOutputModules=`	`True`: In the logic editor, the output modules from table "B3 Modular architecture" are also displayed for selection	

.

9.1.1 Options for formal checks

Which individual formal checks are carried out in the relevant tables can be controlled by the INI-file options shown below (Table 44).

Example: `FCheck_SF_PropertiesComplete=True`.

If the INI file does not exist or the individual options in the file are missing, the checks are always executed (default = True). Individual checks can be set to False to disable them. When the checks are executed, the settings of the options are listed in the dialog (Figure 49).

Table 44: Options for formal checks

Option	Table: Description
FCheck_SF_PropertiesComplete	A1: Properties of the SF complete
FCheck_SF_ProperControlOfActuator	A1: Permitted control of the actuators
FCheck_SF_OnlyOneResetElementPerSF	A1: Exactly one acknowledgement element per SF
FCheck_SF_ProperResetElementsPerColumn	A1: Permitted acknowledgements per column
FCheck_SF_ProperResetElementsPerSF	A1: Permitted acknowledgements per SF
FCheck_IO_NoDuplicatesInVariables	A2.4: None duplicates in variables
FCheck_IO_VariablesWithNameAddress	A2.4: Variables have name / address
FCheck_IO_VariablesWithDataType	A2.4: Variables have data type

These options are initially only implemented for table "A1 Safety functions" and "A2.4 IO list".

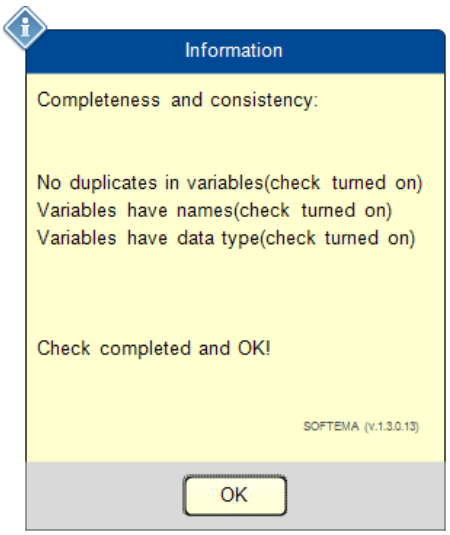

Figure 49: Formal check options dialog

9.2 Options of the SOFTEMA_FB.INI file

The initialization file *SOFTEMA_FB.ini* (example in Figure 50) contains the list of available function blocks with their properties, which can be entered in the table "B3 Module architecture" via a selection list. The basic structure of the text rows is based on the columns of table B3 (see Section 8.1.7):

```
...
; Comment row begins with semicolon as first character
FB name1; Version/Signature1; Manufacturer1; Description1; Instance name1; Output1; Parameter1
FB name2; Version/signature2; Manufacturer2; Description2; Instance name2; Output2; Parameter2
; further comment row
...
```

Blank rows or rows with spaces only are ignored. Comment rows begin with a semicolon. The six elements of a row are separated by a semicolon (;). Leading or trailing spaces are ignored. If not all six elements are entered, they are read in as empty elements and entered as empty text in the "B3 Modular architecture" table. Two semicolons in a row are interpreted as an empty element. In the last column "Parameter", individual parameters are separated by commas and transferred row by row to the _Parameter cell.

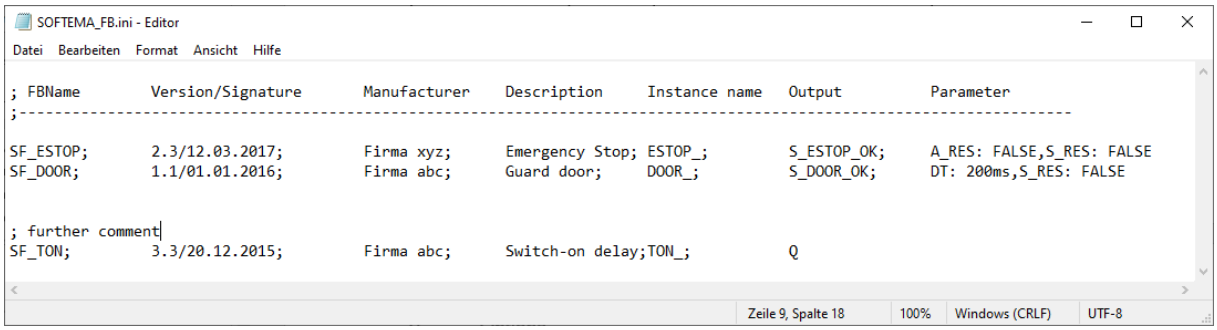

Figure 50: Example of a SOFTEMA_FB.INI file

The instance name shown here in the file is entered in the Instance name column during subsequent selection and should then be supplemented to an individual instance name, e.g. ESTOP_SG1. The description can also be added to the table.

The *SOFTEMA_FB.ini* file is also searched for in the working directory of the open project file and is immediately evaluated in full when this file is opened. Changes to this INI-file only take effect when the same or another project file is opened again. If the file is not found, messages are displayed in a message window.

To simplify the management of this file, a "Module-Manager" has been integrated into SOFTEMA. You can access the Module-Manager via the control bar of the "B3 Modular architecture" worksheet (see Figure 51).

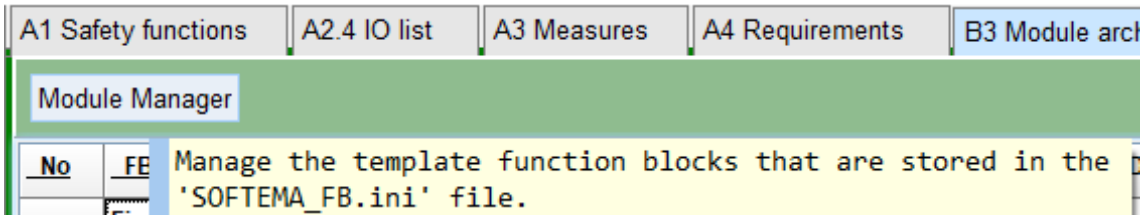

Figure 51: "Module Manager" button

You can use the Module Manager to add, change and remove your function module templates. Mandatory fields for each module / function block are the name itself and, if a parameter is added, the name of the parameter. You can see an overview of the input fields in Figure 52. You can still edit the initialization file *SOFTEMA_FB.ini* in other ways, the Module Manager is just an additional help.

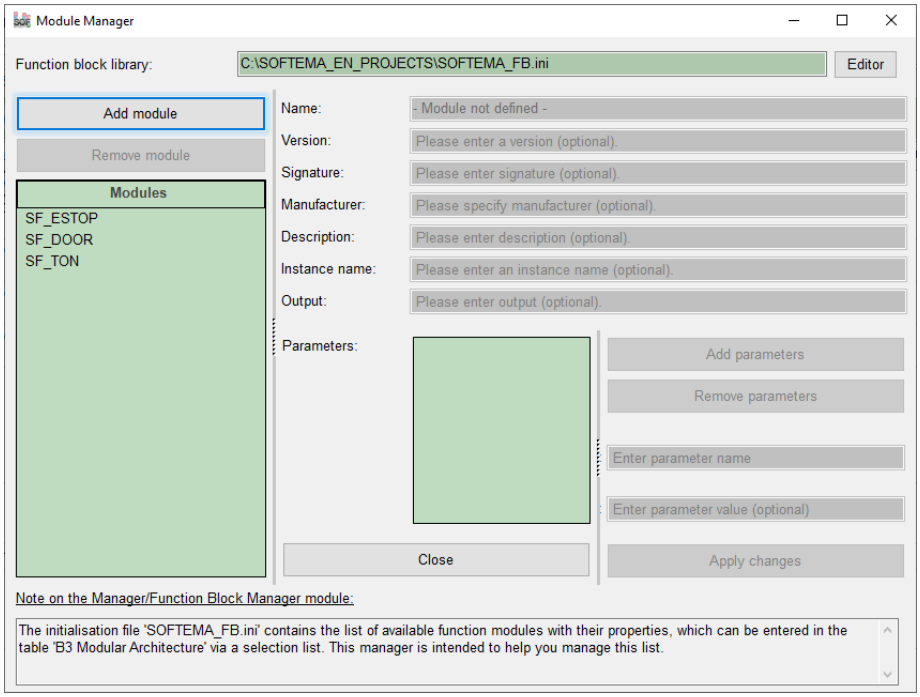

Figure 52: Module Manager

9.3 Options of the SOFTEMAPrintSettings.INI-file

The print settings can be changed in the "SOFTEMA - Print table" dialog (menu bar command PRINT → PRINT TABLE) and saved via the SETTINGS tab in the initialization file specified there, in the working directory of the open project file (Figure 53). They are then automatically loaded and used for the following print processes.

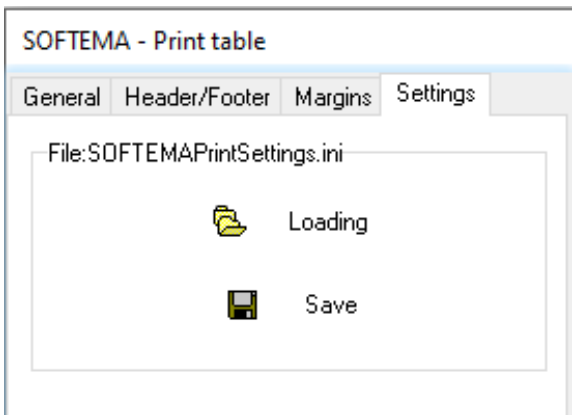

Figure 53: SOFTEMA Print table

The name of the initialization file can be adjusted in the SOFTEMA.ini file (default: SOFTEMAPrintSettings.ini). However, this file must be located in the working directory of the open project file.

9.4 SOFTEMA options

The SOFTEMA options (Table 45) are saved separately on the computer for each SOFTEMA version and for each user. They therefore apply to all projects that a user edits with this installation. If the project files are passed on to different persons, these options may be set differently. The SOFTEMA options are set in the menu bar with the command EXTRAS → OPTIONS. A dialog (Figure 54) opens, in which the option category can be selected on the left-hand page. For each category, the possible options and their descriptions are listed in individual subcategories on the right.

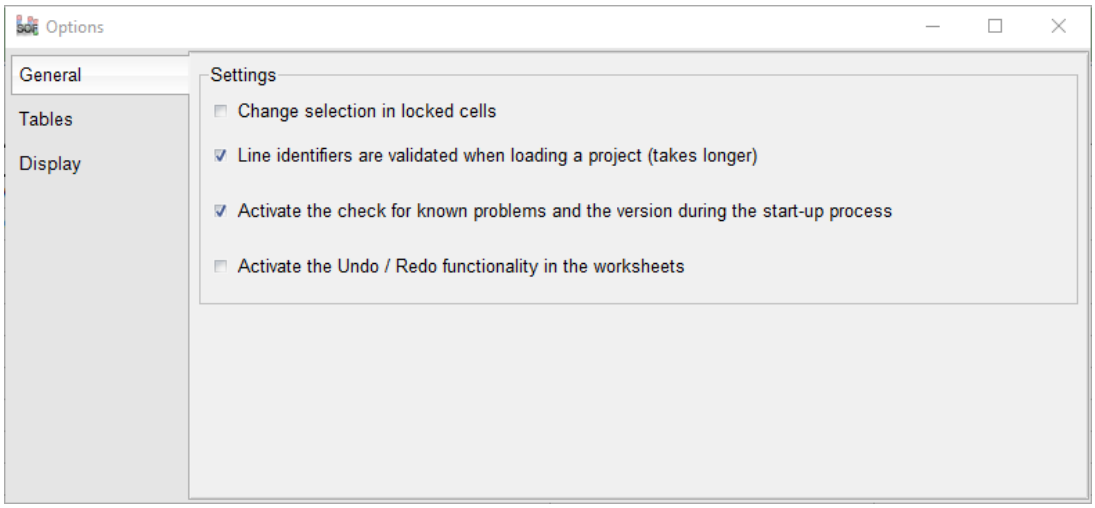

Figure 54 : Dialog for SOFTEMA options

Table 45: List of SOFTEMA options

Category: Subcategory	Option [default setting]
GENERAL: SETTINGS	Change selections in locked cells [Off]
GENERAL: SETTINGS	Row identifiers are validated when loading a project (takes longer) [On]
GENERAL: SETTINGS	Enable testing for known issues and the version at startup [On]
TABLES: GENERAL	Activate protection of headings against removal or deletion [On]
TABLES: GENERAL	Activate top parameter row fixing [On]
TABLES: SAFETY FUNCTIONS	Generation of safety functions [On]
DISPLAY: TABLES	Automatically adjust row height of tables [Off]

Appendix A: Role authorizations

Introduction

SOFTEMA defines various roles for the persons involved in the project. Each person involved should select the appropriate role for their task. Each role in turn has defined authorizations. This concept helps to avoid unintentional and unauthorized changes.

This appendix describes which authorizations are defined for the various roles. These authorizations are hard-coded and cannot be changed. Further information on the concept of roles can be found in Section 4.10 of this cookbook.

Table functions

A distinction is made between the following functions with regard to role authorizations (Table 46):

Table 46: Table editing functions

No.	Function	Explanation
1	Delete row	... via the context menu
2	Insert row	... via the context menu
3	Delete column	... via the context menu
4	Insert column	... via the context menu
5	Change lock	... Double-click in the _Lock column
6	Change activation	... Double-click in the _Active column
7	Mark table	... and remove markers via the context menu
8	Edit table	... directly in the content cells to the left of the system columns
9	Empty table	... via buttons
10	Update table	... via buttons
11	Verify table	... by selection list in the column _Verification etc.
12	Validate table	... by selection list in the _Validation column
13	Check1 table	Edit log fields for role "Check1" and explain in column _Comment_Check

No.	Function	Explanation
14	Check2 table	Edit log fields for role "Check2" and explain in column _Comment_Check
15	Formal checks	... via the buttons
16	Remove document	... via the context menu
17	Insert document	... via the context menu
18	Admin functions	Functions that act on several cells (of a column or row) at the same time

Role authorizations

The functions to which a role is authorized are defined for each project table. The following tables show these authorizations separately for each role: for the project lead (Table 47), for SW developer persons (Table 48), commissioning persons (Table 49), persons validating (Table 50), Check1 persons (Table 51), validating persons 2 (Table 52) and for administrative persons or superusers (Table 53).

All tables in SOFTEMA are listed in the columns from left to right. The functions as they appear in Table 46 are described in the rows from top to bottom. A cross ("X") in a cell means: This function is allowed in the table.

Table 47: Role authorizations for project lead persons

Functions \ Tables	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row	X	X	X	X		X	X	X	X	X	X	X	X	
Insert row	X	X	X	X		X	X	X	X	X	X	X	X	
Delete column	X	X	X	X		X	X	X	X	X	X	X	X	
Insert column	X	X	X	X		X	X	X	X	X	X	X	X	
Change lock	X	X	X	X		X	X	X	X	X	X	X	X	
Change activation	X	X	X	X	X	X	X	X	X	X	X	X	X	
Mark table	X	X	X	X	X	X	X	X	X	X	X	X	X	
Edit table	X	X	X	X		X	X				X	X	X	
Empty table	X	X	X	X		X	X	X	X	X	X	X	X	
Update table	X	X	X	X		X	X	X	X	X	X	X	X	
Verify table	X	X	X			X	X	X	X	X	X	X	X	
Validate table														
Check1 table														
Check2 table														
Formal checks	X	X	X	X	X	X	X	X	X	X	X	X	X	
Remove document	X	X	X	X	X	X	X	X	X	X	X	X	X	
Insert document	X	X	X	X	X	X	X	X	X	X	X	X	X	
Admin functions														

Table 48: Role authorizations for SW developer persons

Tables / Functions	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row			X			X	X	X						
Insert row			X			X	X	X			X		X	
Delete column			X			X	X	X						
Insert column			X			X	X	X			X		X	
Change lock			X			X	X	X			X			
Change activation			X			X	X	X						
Mark table			X			X	X	X	X	X	X		X	
Edit table			X			X	X				X	X	X	
Empty table			X			X	X	X						
Update table			X			X	X	X			X			
Verify table			X	X		X	X	X	X	X	X		X	
Validate table														
Check1 table														
Check2 table														
Formal checks			X	X		X	X	X	X	X	X		X	
Remove document			X			X	X	X						
Insert document			X			X	X	X			X		X	
Admin functions														

Table 49: Role authorizations for commissioning persons

Tables / Functions	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row			X					X						
Insert row			X					X			X		X	
Delete column			X					X						
Insert column			X					X			X		X	
Change lock			X			X		X			X			
Change activation			X											
Mark table			X			X	X	X	X	X	X		X	
Edit table			X			X					X	X	X	
Empty table								X						
Update table			X			X		X			X			
Verify table				X		X			X	X	X		X	
Validate table			X			X	X	X						
Check1 table														
Check2 table														
Formal checks			X	X		X	X	X	X	X	X		X	
Remove document			X											
Insert document			X								X		X	
Admin functions														

Table 50: Role authorizations for validating persons

Functions \ Tables	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row														
Insert row											X			
Delete column														
Insert column											X			
Change lock											X			
Change activation														
Mark table		X	X			X	X	X	X	X	X	X	X	
Edit table											X	X		
Empty table														
Update table											X			
Verify table														
Validate table	X	X	X	X	X	X	X	X	X	X	X	X	X	
Check1 table														
Check2 table														
Formal checks	X	X	X	X	X	X	X	X	X	X	X	X	X	
Remove document														
Insert document											X			
Admin functions														

Table 51: Role authorizations for Check1 persons

Tables / Functions	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row														
Insert row														
Delete column														
Insert column														
Change lock														
Change activation														
Mark table														
Edit table												X		
Empty table														
Update table														
Verify table														
Validate table														
Check1 table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check2 table														
Formal checks	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Remove document														
Insert document														
Admin functions														

Table 52: Role authorizations for Check2 persons

Tables / Functions	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row														
Insert row														
Delete column														
Insert column														
Change lock														
Change activation														
Mark table														
Edit table												X		
Empty table														
Update table														
Verify table														
Validate table														
Check1 table														
Check2 table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Formal checks	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Remove document														
Insert document														
Admin functions														

Table 53: Role authorizations for administrating persons (superuser)

Tables / Functions	Project	A1 Safety functions	A2.4 IO list	A3 Measures	A4 Requirements	B3 Modular architecture	B4 Matrix C+E	B4 Matrix compact	C1 Codereview	D1 Validation	Changes	Persons	Documents	Protocol
Delete row	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Insert row	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Delete column	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Insert column	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Change lock	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Change activation	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mark table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Edit table	X	X	X	X	X	X		X			X	X	X	
Empty table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Update table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Verify table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Validate table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check1 table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check2 table	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Formal checks	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Remove document	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Insert document	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Admin functions	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Appendix B: Literature

[1] EN ISO 13849-1: Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (2015)

[2] EN 954-1: Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (1996) (no longer valid)

[3] IEC 62061: Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems (2012)

[4] DIN ISO/TR 23849: Guidance on the application of EN ISO 13849-1 and IEC 62061 in the design of safety-related control systems for machinery (2014)

[5] EN ISO 13849-2: Safety of machinery - Safety-related parts of control systems - Part 2: Validation (2/2012)

[6] IEC 61508: Functional safety of electrical, electronic, programmable electronic safety-related systems - Part 1 to Part 7 (2010)

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[8] Huelke, M.; Becker, N.; Eggeling, M.: IFA Report 2/2016 Safety-related application software for machinery - The IFA matrix method -, Published by: German Social Accident Insurance (DGUV), Berlin 2024

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[10] SISTEMA Cookbook 6 Definition of safety functions: what is important? Version 1.0 (EN), Published by: German Social Accident Insurance (DGUV), Berlin 2015

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[13] Software-Assistant SOFTEMA, Published by: German Social Accident Insurance (DGUV), Berlin
https://www.dguv.de/ifa/praxishilfen/practical-solutions-machine-safety/software-softema/index.jsp

Appendix C: List of abbreviations

Table 54 contains the abbreviations used in this cookbook.

Table 54: Abbreviations used in this cookbook

Abbreviation	Description
ACT	Identifier of the ACTuation logic
BIA, BGIA	Institute for Occupational Safety and Health (today: IFA)
EL	Equipment Labeling
C&E matrix	Cause and Effect matrix; synonym: cause and effect table; cause-effect diagram
DC/DC_{avg}	Diagnostic Coverage / average Diagnostic Coverage
DKE	German Commission for Electrotechnical, Electronic, and Information Technologies of DIN and VDE
FB	Function Block
FBD	PLC language: Function Block Diagram (also abbreviated by FUP or FBS)
FMEA	Failure Mode and Effect Analysis
FI	Frequency Inverter
FVL	Full Variability Language; programming language with no Limited variability language range
IFA	Institute for Occupational Safety and Health of the German Social Accident Insurance
I/O	Input/Output; inputs/outputs of a PLC
LVL	Limited Variability Language; programming language with limited variability language range
$MTTF_D$	Mean Time To dangerous Failure
NOP	No OPeration: is a command in the C&E matrix that does nothing
PFH	Average frequency of a dangerous failure per hour
PL	Performance Level
PL_r	Required Performance Level
PLC(s)	Programmable Logic Controller(s)
SF	Safety Function
SFK	Safety Function IDentifier
SIL	Safety Integrity Level
SISTEMA	Software assistant of the IFA "Safety Integrity Software Tool for the Evaluation of Machine Applications"
SOFTEMA	Software assistant of the IFA "Safety of software on machines"
SRASW	Safety-Related Application SoftWare
SRESW	Safety-Related Embedded SoftWare
SRP/CS	Safety Related Parts of Control Systems

Appendix D : Change history

The version of this cookbook corresponds to the corresponding SOFTEMA version. Changes to the previous cookbook version are listed in Chapter 2 on page 8 and marked in yellow in the text.

Changes in previous versions of this cookbook:

Beta versions 0.7.X: Cookbook for SOFTEMA beta version 0.7.X

- first beta release

Beta versions 0.8.X: Cookbook for SOFTEMA beta version 0.8.X

- The row and column editor can be opened via the VIEW menu (see Section 6.2.4);
- Selections can be deleted column by column and row by row using buttons on the column and row identifiers (see Section 6.4.2);
- There is an additional command INSERT MULTIPLE ROWS BELOW in the context menu (see Section 6.4.5);
- Mandatory columns are specially marked in the column header (see Section 5.4);
- There is a new command for this in the VIEW menu → MANDATORY COLUMNS ONLY (see Section 6.2.4);
- There is also a new LOCK ... context menu for locking/unlocking multiple rows (see Section 6.4.14);
- Cells in a project-specific column can also be locked (see Section 5.4);
- Summary fields of verification and validation columns represent the degree of fulfillment as a percentage (see Section 5.6);
- The "Help Wizard", an assistance function for getting started with SOFTEMA, has been implemented (see Section 6.11). It is started with the HELP WIZARD command in the HELP menu (see Section 6.2.8);
- There is a new PHASE menu that can be used to control the display of the tabs depending on the project phase (see Section 6.2.7);
- A thin red or green frame is displayed around the tables. This visualizes the authorization to edit the table depending on the active role (red = none editing possible; green = editing possible) (see Section 6.6).
- If INI-files are not found, a message is displayed (see Sections 9.1 and 9.2);
- An additional parameter has been added to the SOFTEMA_FB.ini option file (see Section 9.2);
- A new option is available: the generation of safety functions (see Section 9.4);
- There are two new predefined rows in the "Project" table: P9: Customer and P10: Contractor (see Section 8.1.2);

- Empty cells are marked in the "A1 Safety functions" table when safety functions are generated (see Section 6.4.10);
- In the "A1 Safety functions" table, the header cells are preset when inserting Q and E columns (see Section 6.4.7);
- An _Active column has been added to the "A1 Safety functions" table (see Section 8.1.3);
- In the "A1 Safety functions" table, the selection of the priority is now limited to the values 1 or 2 (see Section 8.1.3);
- Table "A1 Safety functions": The marking functions in connection with the automatic generation of the _Description column have been adapted, expanded and described in more detail (see Section 8.1.3);
- In the "A2.4 IO list" table, there is a new predefined column _Data type (see Section 8.1.4);
- The "A3 Measures" table can be edited in the "Project leads" role (see Section 8.1.5);
- In the "A4 Requirements" table, there is a new predefined column _Compliance (see Section 8.1.6);
- An _Active column has been added to the "B3 Modular architecture" table (see Section 8.1.7);
- Table "B4 Matrix C+E": The update function is explained in more detail (see Section 8.1.8);
- Table "B4 Matrix C+E": There is a new predefined column _Prio and the previous column _SF_(Prio) has been renamed _SF-No. When updating from version 0.7.x, the contents of _SF_(Prio) will be distributed to the new columns accordingly (see Section 8.1.8);
- Table "B4 Matrix C+E": The UPDATE button becomes active and flashes as soon as one of the source tables A1, A2.4 or B3 has been changed. This indicates that a manual update is required (see Section 8.1.8).
- “B4 Matrix compact" table: The UPDATE button becomes active and flashes as soon as the source table "B4 Matrix C+E" has been changed in a relevant way. This indicates that a manual update is required (see Section 8.1.9).
- C1 Codereview" and "D1 Validation" tables: When double-clicking in the _Reference sheet column, worksheets named there and existing in the project file, but not managed by SOFTEMA, are loaded in the "Load table ..." tab (see Section 8.1.16);
- In the "Persons" and "Documents" tables, changes are indicated by the text "Table changed" at the bottom left of the window (see Sections 8.1.14 and 8.1.15);
- The columns _Alter_Value and _New_Value have been added to the "Changes" table (see Section 8.1.12);

- Protocol" table: The _Age_Value column has been added, the _Value column has been renamed _New_Value (see Section 8.1.13);

Beta versions 0.9.0:

- General troubleshooting.
- New user administration added.
- In the table "B4 Matrix C+E" switching condition "ON" for safety functions deactivated / hidden (only available for test functions)
- In the "A3 Measures" table, project leads can edit, add and delete rows.
- Keyboard shortcut "Ctrl+M" added to show and hide mandatory columns.
- The INI-files can be saved with "Save as".
- In the "B3 Modular architecture" table, column identifier _Outputs has been renamed _Output.
- In the "A2.4 IO list" table, the data type and Address are also checked when "Formal checks" are executed.

Version 1.0.0:

- General troubleshooting.
- Role-based saving has been revised. Saving is no longer possible in read mode.
- The admin password must be changed for full access to the user administration when logging in for the first time.
- In "B4 Matrix C+E", "ON" values can only be set for test functions.
- Several new setting options have been added (TOOLS → OPTIONS).
- New columns ("_Module" and "_Active in C+E") have been added in "A2.4 IO list" in order to specify the effect of the input and output signals more precisely.
- The first rows in the "A1 Safety functions" and "B4 Matrix C+E" tables are now fixed. The user can also remove this fixation (EXTRAS → OPTIONS → TABLE).
- Adding Acknowledgement button and equipment columns (in "A1 Safety functions") via a button, as a context menu cannot be displayed in fixed cells.
- A security prompt for resetting the admin password has been implemented.
- It is now possible to change the company name of a user.
- The "Undo/Redo" functionality is no longer available as it is currently not fully implemented (a complete implementation is in progress).

Version 1.1.0:

- General troubleshooting.
- The new "Module Manager" is used to manage the function blocks from worksheet "B4 Modular architecture", see Section 8.1.7.

- Using the new "SOFTEMA.ini Manager", the SOFTEMA.ini settings (Chapter 9) can be conveniently managed.
- Selective optical and structural revision of the user administration
- New: The placeholder "-" can be used if a cell is not to be defined in the "_Symbol" column of the "A2.4 IO list" table. This placeholder is ignored in the formal checks and generates none.
- In "Manage Documents", paths are displayed as relative paths to the documents.
- The default installation path for non-admin users is now "C:\Users\%USERNAME%"
- If a project file is closed and the user has only been working in "read mode", none of the save queries are made.
- Changes in the user administration no longer require SOFTEMA to save the project file in a new file.

Version 1.2.0:

- General troubleshooting.
- Options from the options menu are now saved correctly.
- Multiple selection in the link logic editor had caused a crash, this has now been fixed.
- Security question in the user administration can now not be edited when selected.
- Input modules in the area of logic operation and options can be selected.
- The selection of an entire row can now be removed with the key combination "Ctrl+left-click" on the row identifier.
-