Machine and Plant Diagnostics with ProDiag

TIA Portal, S7-1500 PLC

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1 Introduction

1 Introduction

Monitoring machines and plants plays an increasingly important role in automation technology. The ProDiag functionality integrated in TIA Portal allows you to configure custom monitoring for your machine or plant. This also allows you to diagnose faults in the process.

1.1 Overview

This application example shows a virtual conveyor system with two lifts. On the belt, cases are alternately transported to one of the lifts and then stacked upwards. The conveyor system is controlled using an operator panel (HMI) and monitored with ProDiag. The different supervisions can be simulated and displayed on the operator panel.

Figure 1-1: Plant overview
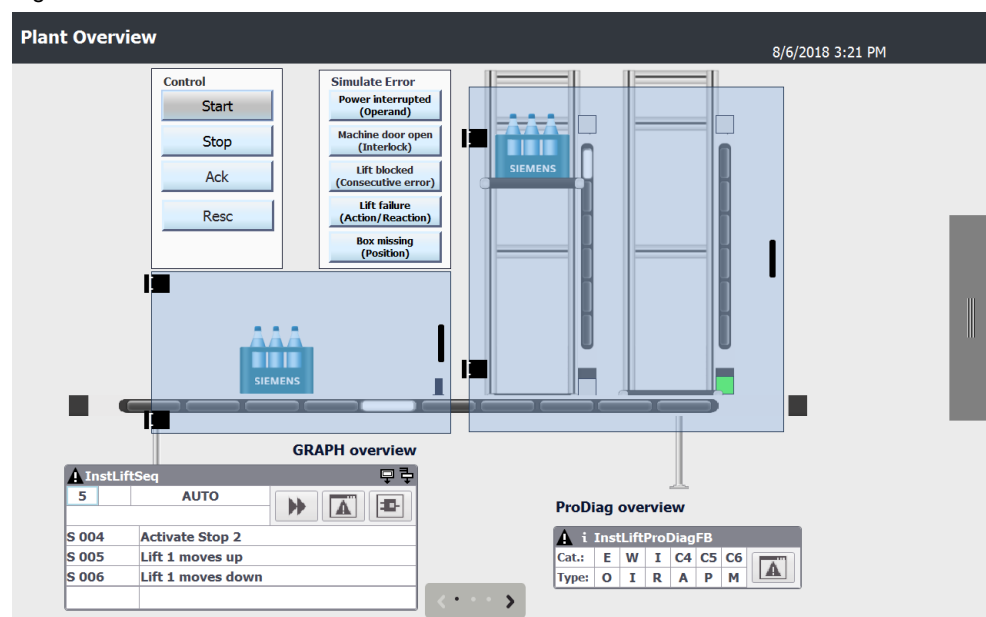
This application example describes the following aspects:

- Configuration of machine and plant monitoring with ProDiag.
- The different types of supervision.
- Diagnostics of supervision errors on the operator panel.

Advantage

With ProDiag, the supervisions are not programmed, but configured. This allows you to monitor your machine and plant without modifying the user program code.

Without a programmer, you diagnose the machine and plant directly on the operator panel.

Automatic synchronization ensures that all operator panel displays are always up to date.

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1.2 Principle of operation

User program

The sequence of the virtual conveyor system and its simulation are programmed in the user program. The program was created using the criteria that a maximum number of machine and plant diagnostics properties can be displayed. The user program is regarded as given in this example and therefore not described in greater detail.

Supervision with ProDiag

With ProDiag, you create global and local supervisions. You can configure global supervisions to Boolean tags within a tag table, a global data block or an ARRAY data block. Local supervisions are configured to Boolean parameters of a function block. In this way, the user program is not modified.

ProDiag provides different types of supervision. The following table lists these types with a use case.

Table 1-1: Types of supervision with ProDiag

Type of supervision	Use case in the example	Tag/parameter
Operand supervision	Monitors the compressed air and the power supply when the conveyor system is on.	SeqData [DB15] "SeqData".compressedAir "SeqData".powerVoltage
Interlock supervision	Monitors whether the interlock conditions (e.g., lift door closed) are met for the movements of the lift.	LiftCmd [FB190] #interlockAuto #interlockMan
Action supervision	Monitors whether the lift has left its start position within a specified time.	LiftCmd [FB190] #sensorLiftUp #sensorLiftDown
Reaction supervision	Monitors whether the lift has left its end position within a specified time.	LiftCmd [FB190] #sensorLiftUp #sensorLiftDown
Position supervision	Monitors whether a case is removed from a specific belt position when the conveyor system is off.	SeqData [DB15] "SeqData".newCase "SeqData".sensorStop1 "SeqData".sensorStop2 "SeqData".sensorStop3

To run or enable supervisions, you must assign them to ProDiag FBs. The "Add new block" dialog allows you to create ProDiag function blocks in the "PRODIAG (incl. IDB)" language. The ProDiag function block is automatically called in the ProDiag organization block.

Note

A maximum of 100 ProDiag FBs can be used in a project. You can assign a total of 1000 supervisions to one ProDiag FB (V2.0 or higher), which makes it even easier to design them based on technological aspects. For smaller plants without a plant hierarchy, you can combine all supervisions in a single ProDiag supervision block.

Supervision with GRAPH

For the GRAPH programming language, the supervisions have already been integrated into each single step. GRAPH provides two different types of supervision. The following table lists these types with a use case.

Table 1-2: Types of supervision with GRAPH

Type of supervision	Use case in the example
Interlock	Via an interlock, you program conditions on which the execution of the single actions depends. Actions of a step that are linked to the interlock are executed only when the interlock condition is met. If the interlock condition is not met, a fault has occurred. For this case, you can define alarms that will then be displayed. However, the fault has no influence on the transition to the next step. This example monitors whether the lift door is closed and the lift is free.
Supervision	Via a supervision, you program conditions that allow you to monitor an entire step. If the condition is met, a fault has occurred and the step remains active. This means that the sequencer does not transition to the next step. This example monitors only steps where lifts are moved. If the movement is not processed within a specified time (step duration exceeded), an alarm is output and the step remains active. Unlike the interlock, the supervision requires acknowledgment.

Display in Runtime

The occurring errors of the virtual conveyor system are displayed and diagnosed with the aid of Runtime. For this purpose, WinCC Professional provides different objects. The following table lists the objects:

Table 1-3: WinCC objects for displaying supervision errors

WinCC object	Use case in the example
ProDiag overview	The "ProDiag overview" object shows the current state of the configured supervisions. If an error occurs, the error type and category will be displayed. The integrated button allows you to open the "Alarm view".
GRAPH overview	The "GRAPH overview" object shows the following: • The current state. • The current step number. • The name of the step of the "LiftSeq" GRAPH sequencer. • Previous and next step. If an error occurs in the sequence, the respective step will be displayed. The buttons allow you to open the "Alarm view"/"PLC code view".
Alarm view	The ProDiag alarms are displayed in the "Alarm view". The button allows you to open the "PLC code view" of the selected alarm.

WinCC object	Use case in the example
PLC code view	The "PLC code view" object shows the current program status of the selected ProDiag alarm or "LiftSeq" GRAPH sequencer. The object supports the LAD, FBD and GRAPH programming languages. The PLC code view is possible for the following supervision alarms: • Global supervisions: interlocks only. • Local supervisions: all basic supervisions at input parameters. Program modifications are automatically detected and updated.
Criteria analysis view	The "Criteria analysis view" object displays the invalid operands of the user program that have triggered a selected ProDiag or GRAPH alarm.

1.3 Components used

This application example was created with the following hardware and software components:

Table 1-4

Component	No.	Article no.	Note
CPU 1516F-3 PN/DP	1	6ES7516-3FN01-0AB0	Alternatively, any other CPU of the S7-1500 product family can be used.
Memory card, 24 Mbytes	1	6ES7954-8LF02-0AA0	-
STEP 7 Professional V15	1	6ES7822-1..05-..	-
WinCC Professional /Advanced V15	1	6ES7822-1..05-..	-
WinCC Runtime Professional V15	1	6ES7822-1..05-..	-

This application example consists of the following components:
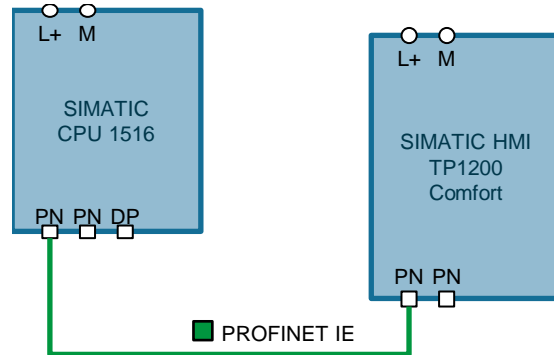
Table 1-5

Component	File name	Note
Documentation	109740151_ProDiag_DOC_V41_en.pdf	-
WinCC Advanced project	109740151_ProDiag_PROJ_Adv_V40.zip	-
WinCC Professional project	109740151_ProDiag_PROJ_Prof_V40.zip	-

2 Engineering

2.1 Hardware configuration

The following figure shows the hardware configuration of the application.

Figure 2-1: Hardware configuration

| Note	Follow the installation guidelines of the devices.

2.2 Configuration

2.2.1 Creating ProDiag function blocks

A ProDiag FB is created in the PRODIAG programming language, e.g., using the "Add new block" dialog.

To do this, proceed as follows:

1. In the "Program blocks" folder, double-click the "Add new block" command. The "Add new block" dialog opens.

2. Click the "Function block" button.

3. Enter the name "LiftProDiagFB" for the new ProDiag FB.

4. In "Language", select "PRODIAG (incl. IDB)".

5. To add more properties of the new ProDiag function block, click "Additional information".
   An area with more input fields is displayed.

6. Enter the desired properties.

7. Check the "Add new and open" check box if you want to open the ProDiag function block right away.

8. Click "OK" to confirm your entries.

Figure 2-2: "Add new block" dialog
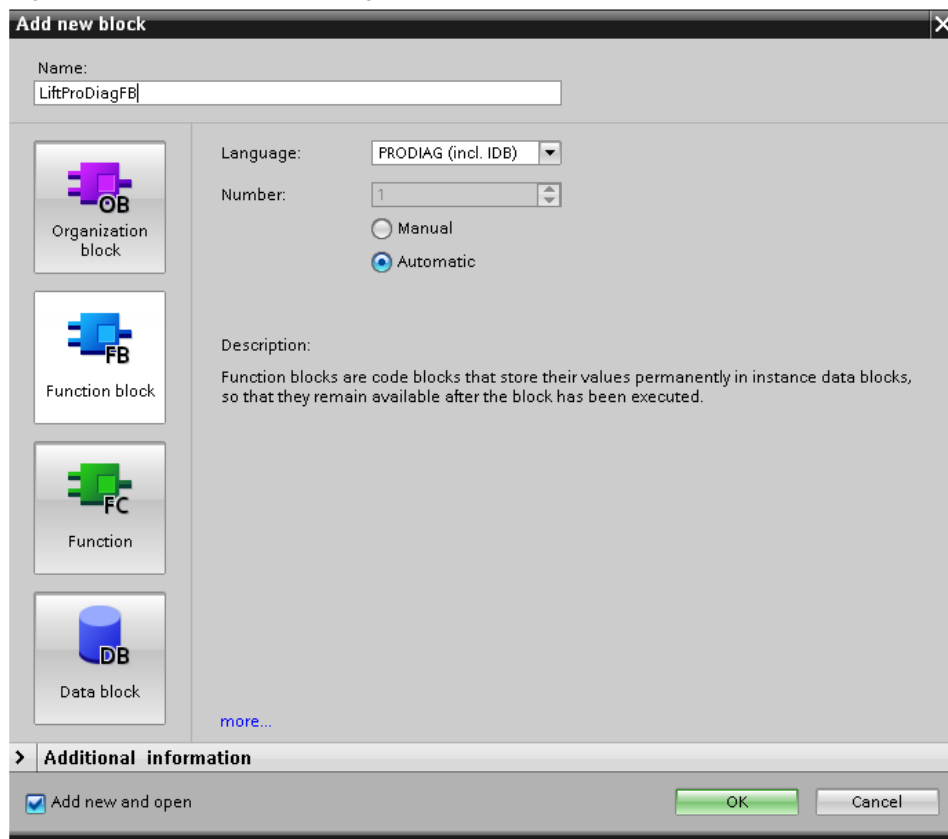
Alternatively, you can create ProDiag FBs as follows:

- Creating a global supervision automatically creates the ProDiag FB. The user is not required to perform an action.
- When calling an FB with local supervision.
- At the instance data block of an FB.
- In the ProDiag overview table.

Note	You can structure your supervision according to the machine and plant units by creating one ProDiag FB per unit.

2.2.2 Defining supervision settings at the ProDiag FB

Global enable criterion

The global enable criterion allows you to control the call of the ProDiag FB in the ProDiag OB. The global enable criterion must be a global Boolean tag. The ProDiag FB is called only when the signal state of this tag is "TRUE". This allows you to specifically disable, for example, all supervisions of the ProDiag FB.

To define a global enable criterion, proceed as follows:

1. Right-click the "LiftProDiagFB" ProDiag FB and from the context menu, select "Properties...".
   The ProDiag FB's properties dialog opens.

2. In the "General" tab, click "Supervision settings".

3. Select the global Boolean tag "SeqData".globalEnabler as the global enable criterion.

Figure 2-3: "Global enabler" dialog

LiftProDiagFB [FB1]	✕

General | Texts | FB supervision definitio...

General
Information
Time stamps
Compilation
Protection
Attributes
Supervision settings

Supervision settings

Global enabler

Global enabler   "SeqData".globalEnabler

Using the global enabler, you can define whether all supervisions of the ProDiag function block trigger supervision alarms. The prerequisite for this is that the global enable criterion has signal state "1" and the ProDiag function block is called in the ProDiag organization block OB250.

Categories

Select the category enable criterion and the display class for each category that is used in this ProDiag function block. Using the category enable criterion, you can define whether all supervisions of the ProDiag function block trigger supervision alarms. The prerequisite for this is that the category enable criterion has signal state "1". Using the display class, you can define the display of the supervision alarms on a HMI device.

OK | Cancel

Note	You can also use the global enable criterion to prevent, for example, a flood of alarms.

Category enable criterion

The category enable criterion allows you to enable and disable the supervisions for each single category of the ProDiag FB.

A category enable criterion is configured in the same way as the global enable criterion.

2.2.3 Creating global supervisions

In the application example, global supervisions are created at Boolean tags in the global data block "SeqData".

Operand supervisions

When the conveyor system is turned on, the compressed air supply must be ready. Otherwise, a supervision alarm of the "Error" category will be output. In the application example, the compressed air is monitored using the "SeqData".compressedAir tag.

To create the operand supervision, proceed as follows:

1. Open the global DB "SeqData".

2. Right-click the"SeqData".compressedAir tag and run "Add new supervision".

3. In "Type of supervision", select "Operand".

4. If an error has occurred, the state of the supervised tag is "False".

5. Set a "delay time", e.g. 0ms.

6. In "Condition 1", select the "SeqData".plantOn tag. Check the "True" check box for the condition trigger.
   If necessary, you can add a maximum of three more conditions.

7. In "Category", select "Error".

8. Select the ProDiag FB you have already created: "LiftProDiagFB".
   You can also create a new ProDiag FB.
   For the supervision, an "error flag" is automatically created in the instance data block of the ProDiag FB. The error flag indicates whether a fault has occurred. You can query this error flag in your program, for example, to shut off the machine in the event of certain faults.

9. In "Specific text field", enter the text "Compressed air not OK". For another example of entering text, refer to "Example of the Error message supervision type".

Figure 2-4: Operand supervision
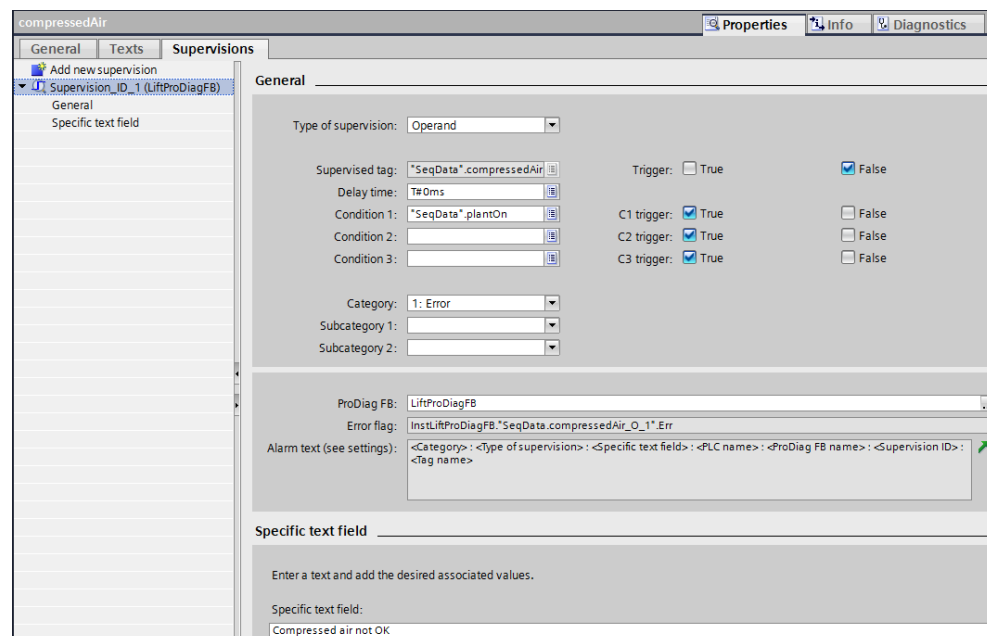
The supervision of the "SeqData".powerVoltage power supply is created in the same way as the compressed air supervision.

Position supervisions

When the conveyor system is at a standstill, the supervision monitors whether a case is removed from the first position. If a case is missing, a supervision alarm of the "Warning" category will be output. In the application example, the "SeqData".newCase tag (case exists sensor) is supervised for this purpose.

To create the position supervisions, proceed as follows:

1. Right-click the "SeqData".newCase tag and run "Add new supervision".

2. In "Type of supervision", select "Position".

3. If an error has occurred, the state of the supervised tag is "False".

4. Set a "delay time", e.g. 0ms.

5. The conveyor system must be in stop. In "Condition", select the "SeqData".autoStarted tag (automatic started) and the "SeqData".autoStopped tag (automatic stopped). For both tags, check the "False" check box for the condition trigger.
   In addition, the "SeqData".stateCase[0] tag (case exists state) must be set. Check the "True" check box for the condition trigger.

6. In "Category", select "Warning".

7. Select the ProDiag FB you have already created: "LiftProDiagFB".
   You can also create a new ProDiag FB.
   For the supervision, an "error flag" is automatically created in the instance data block of the ProDiag FB. The error flag indicates whether a fault has occurred. You can query this error flag in your program, for example, to shut off the machine in the event of certain faults.

8. In "Specific text field", enter the text "Case at entrance missing".

Figure 2-5: Position supervision

According to the position supervision at "SeqData".newCase, the position supervision is implemented at the following stops:

- "SeqData".sensorStop1
- "SeqData".sensorStop2
- "SeqData".sensorStop3

2.2.4 Creating local supervisions

The local supervisions are created at the Boolean input parameters of the "LiftCmd" function block. The FB controls the outputs of a lift and is called twice in the program. Therefore, you have to configure the supervisions only once and can use them for both lifts.

Interlock supervisions

The lift outputs may be set only when the lift door is closed. The interlock supervision monitors whether the enables necessary for the "lift up" movement exist or whether the door is closed. The enables are transferred to the #interLockAuto FB parameter (automatic interlock) when the "LiftCmd" FB is called. If the enables are not provided, a supervision alarm of the "Error" category will be output. In the application example, the #interLockAuto FB parameter is supervised for this purpose.

To create the interlock supervision, proceed as follows:

1. Open the "LiftCmd" FB.
2. Right-click the #interLockAuto parameter and run "Add new supervision".
3. In "Type of supervision", select "Interlock".
4. If an error has occurred, the state of the supervised parameter is "False".
5. Set a "delay time", e.g. 0ms.
6. The #startLiftUp "actuator" and the #autoStarted "condition" (automatic started) must be set. For both, check the "True" check box for the condition trigger.
7. In "Category", select "Error".
8. In "Specific text field", enter the text "Door at lift not closed".

Figure 2-6: Interlock supervision

The interlock supervision for the "lift down" movement and using the #interLockMan parameter are created in the same way as this interlock supervision.

| Note	For local supervisions, the "LiftProDiagFB" ProDiag FB is not assigned to the individual parameters but to the "InstMainFB" instance data block of the calling "MainFB". See Chapter 2.2.5.

Action supervisions

The action supervision monitors whether the "lift up" movement has left the start position within a specified time. If the lift stops, a supervision alarm of the "Error" category will be output. In the application example, the #sensorLiftDown FB parameter is supervised for this purpose.

To create the action supervision, proceed as follows:

1. Right-click the #sensorLiftDown parameter and run "Add new supervision".

2. In "Type of supervision", select "Action".

3. If an error has occurred, the state of the supervised parameter is "True".

4. Set a "delay time", e.g. 200ms.

5. The #outLiftUp "action" (lift up output) must be set. Check the "True" check box for the condition trigger.

6. In "Category", select "Error".

7. In "Specific text field", enter the text "Lift has not left lower start position".

Figure 2-7: Action monitoring
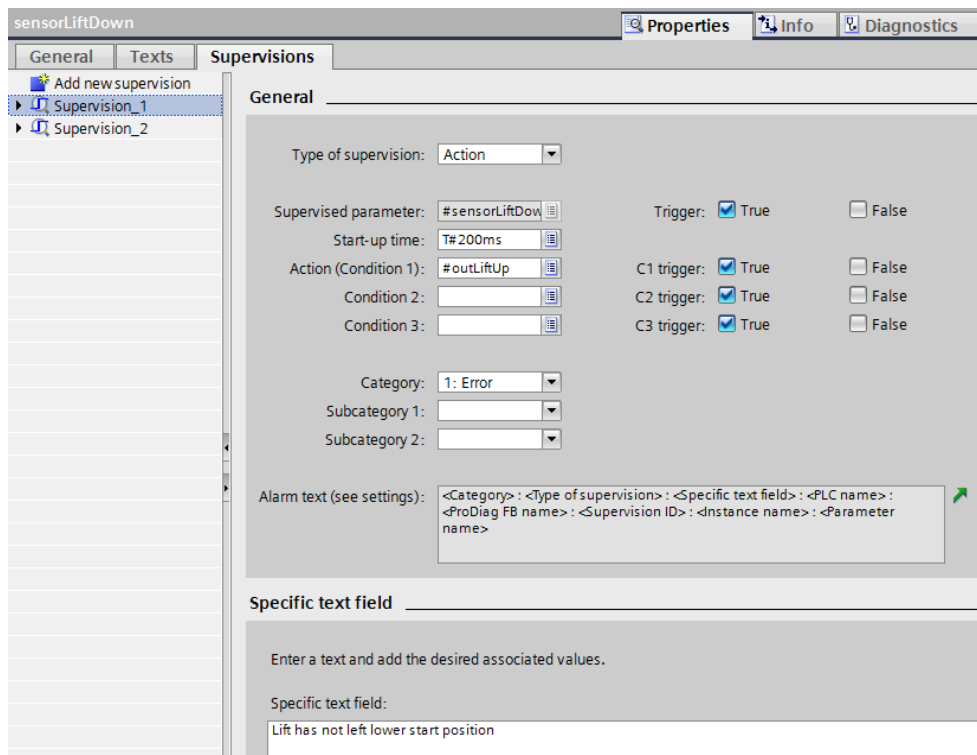
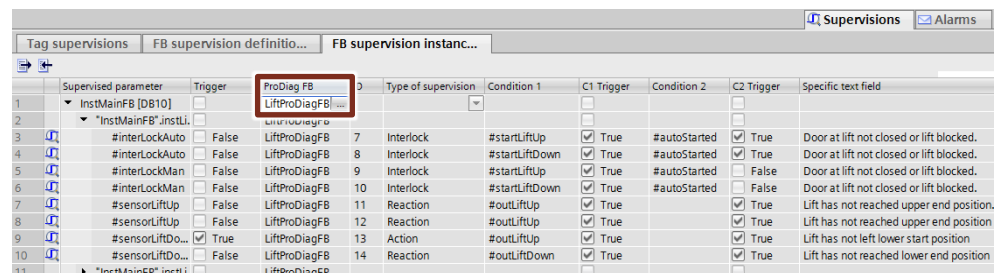The action supervision for the "lift down" movement is created in the same way as this action supervision.

Reaction supervisions

The reaction supervision monitors whether the "lift up" movement has reached the end position within a specified time. If the lift stops before reaching this position, a supervision alarm of the "Error" category will be output. In the application example, the #sensorLiftUp FB parameter is supervised for this purpose.

To create the reaction supervision, proceed as follows:

1. Right-click the #sensorLiftUp parameter and run "Add new supervision".
2. In "Type of supervision", select "Reaction".
3. If an error has occurred, the state of the supervised parameter is "False".
4. Set a "delay time", e.g. 5000ms.
5. The #outLiftUp "action" (lift up output) must be set. Check the "True" check box for the condition trigger.
6. In "Category", select "Error".
7. In "Specific text field", enter the text "Lift has not reached upper end position".

Figure 2-8: Reaction supervision

The reaction supervision for the "lift down" movement is created in the same way as this reaction supervision.

2.2.5 Assigning the ProDiag FB to the instance data block of an FB

The parameters to be supervised in the interface of a block must be assigned to a ProDiag FB via the instance of the FB.

To do this, proceed as follows:

1. In the project tree, double-click the "PLC supervisions & alarms" folder.
   The supervisions and alarms editor opens.

2. Click the "Supervisions > FB supervision instances" tab.
   It displays the instance data blocks with all local supervisions.

3. In the "ProDiag FB" column, click the selection field.

4. In the selection dialog, select the ProDiag FB you have already created: "LiftProDiagFB".
   You can also create a new ProDiag FB.

Figure 2-9: Assigning the ProDiag FB

You can also assign the ProDiag FB in the instance data block properties.

To do this, proceed as follows:

1. Right-click the "InstMainFB" instance data block.

2. In the context menu, click Properties.

3. In the Properties dialog, click "Attributes".

4. In "Assign ProDiag FB", select the "LiftProDiagFB" ProDiag FB.
   You can also create a new ProDiag FB here.

Figure 2-10: Assigning the ProDiag FB
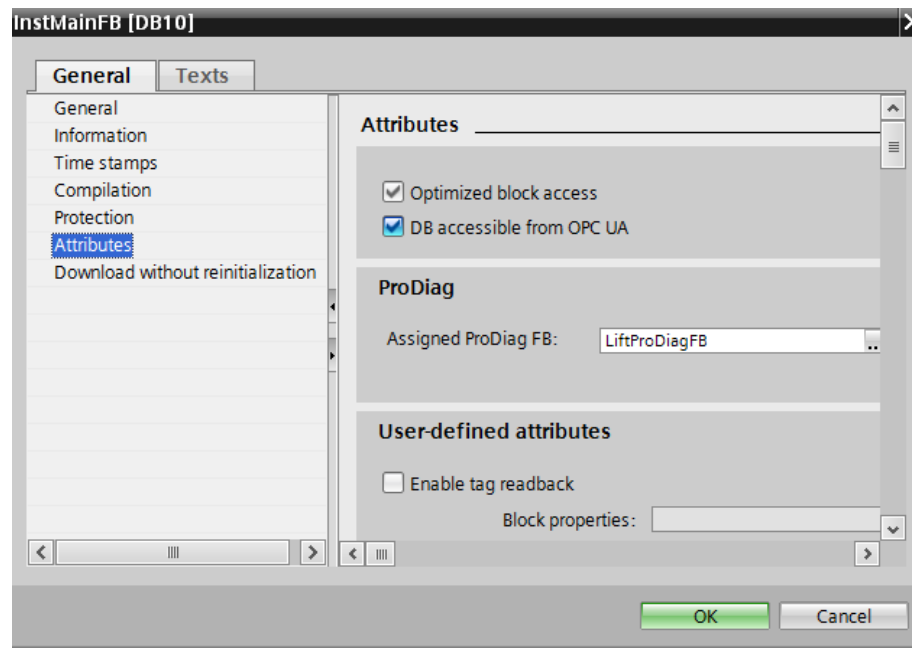
2.2.6 Querying error bits in the program
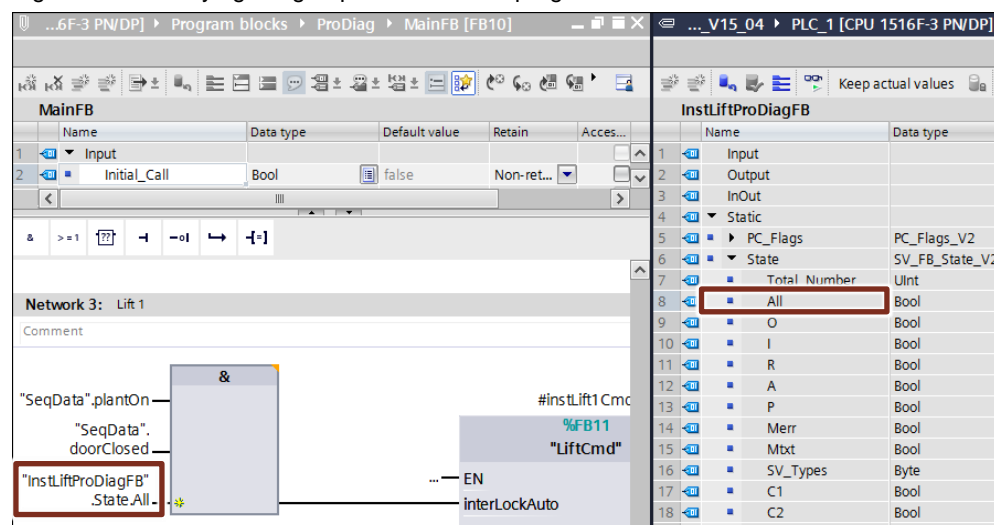
Querying the group error bit of a ProDiag FB

For each ProDiag FB, different types of group error bits can be queried in the user program, for example, to stop the machine in the event of certain faults. The group error bits can also be accessed via the "InstLiftProDiagFB" instance data block of the ProDiag FB.

There are two different types of group error bits:

- Group error bit for types of supervision (All, O, I, R, A, P, Merr and Mtxt)

- Group error bit for categories (C1, C2, C3, C4, C5, C6, C7 and C8)

The following figure shows the "All" group error bit in the data structure of the status tags in the ProDiag IDB and its use in the user program.

Figure 2-11: Querying the group error bit in the program

Querying the error bit of a supervision

For each supervision, an error bit can be queried in the user program, for example, to stop the machine in the event of certain faults. The error bits can also be accessed via the "InstLiftProDiagFB" instance data block of the ProDiag FB.

The following figure shows the "Err" error bit in the data structure of the operand supervision and its use in the user program.

Figure 2-12: Querying the operand supervision error bit in the program
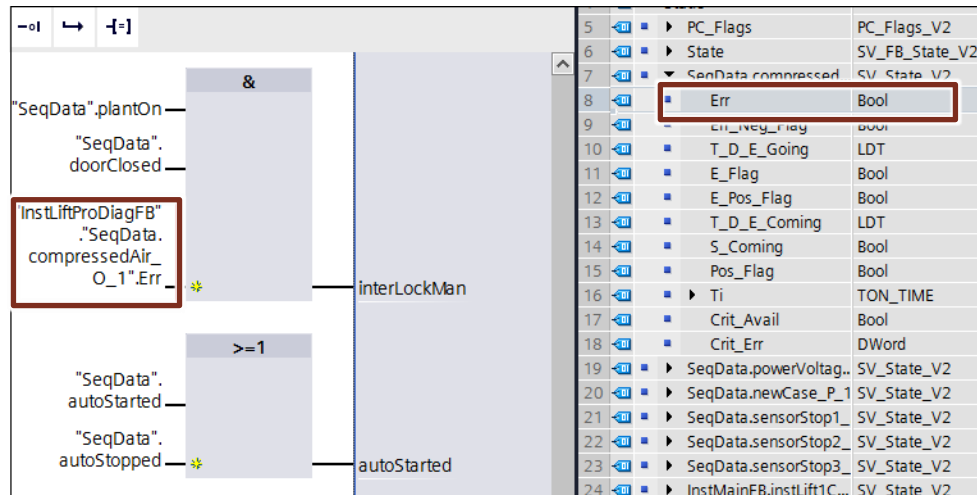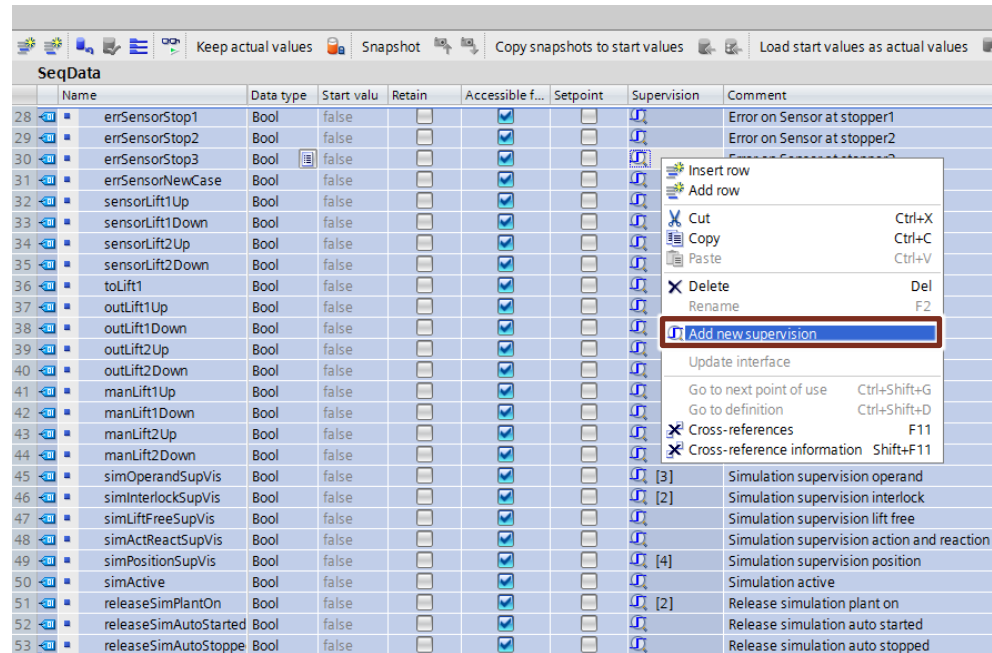
2.2.7 Multi-selection for defining supervisions

You can create a large number of supervisions in the PLC tag table, in the interfaces of function blocks and in global data blocks with a single operator action. Only Boolean tags will be considered.

Select the tags in the global data block and select "Add new supervision" from the context menu.

Figure 2-13: Multi-selection of supervisions

One supervision is created for each selected tag. In the "Properties" Inspector window, the "Supervisions" tab opens for the first tag. In this tab, you define the settings for every single supervision separately.

2.2.8 Creating supervisions in the GRAPH sequencer

For the GRAPH programming language, the supervisions have already been integrated into each single step. Alarms are generated automatically.

Interlock

With an interlock, you monitor whether an action can be executed. This example monitors whether the door at the lift entrance is closed and the lift is not blocked. If the interlock condition is not met, an alarm will be output.

To enter a specific alarm text, proceed as follows:

1. Open the step in the single step view.
2. Select "Interlock -(C)-".
3. Open the Inspector window and select the "Properties" tab.
4. In the "Alarm text" text field, enter the desired alarm text. This text is inserted into the interlock alarm with the "<step-specific text field>" alarm text field.

Figure 2-14: GRAPH interlock
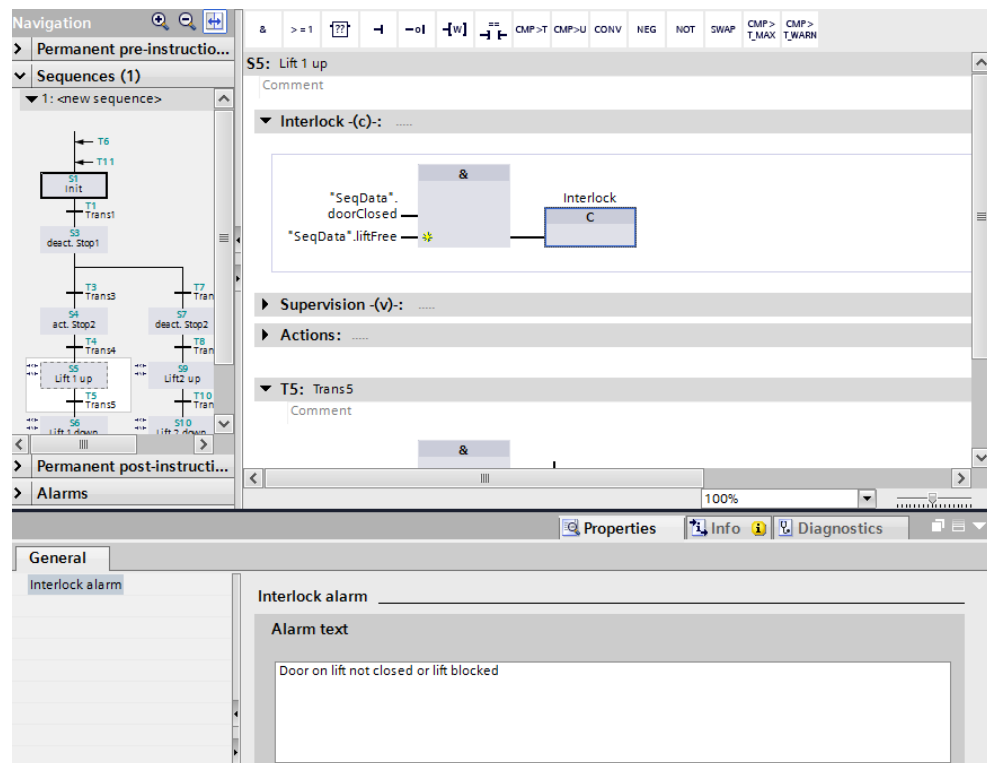
Supervision

With a supervision, you monitor an entire step. This example monitors the step duration. If the specified step duration is exceeded, an alarm will be output and the sequencer will not be transitioned to the next step.

To enter a specific alarm text, proceed as follows:

1. Open the step in the single step view.

2. Select "Supervision -(v)-".

3. Open the Inspector window and select the "Properties" tab.

4. In the "Alarm text" text field, enter the desired alarm text. This text is inserted into the supervision alarm with the "<step-specific text field>" alarm text field.

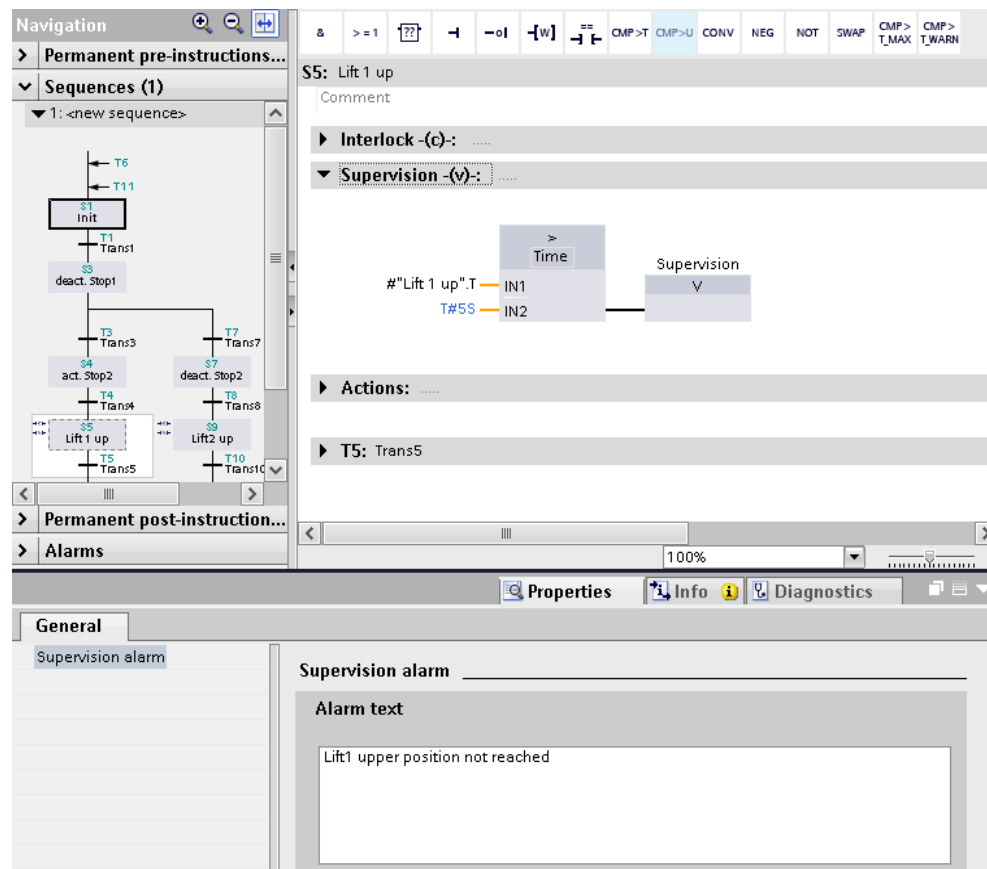Figure 2-15: GRAPH supervision

2.2.9 Configuring multilingual names in S7-GRAPH

You can configure the step and transition names in multiple languages and therefore output the names in the alarms, in the PLC code view and in the GRAPH overview in multiple languages.

1. In the "LiftSeq" S7-GRAPH FB [FB12], select the step to be edited and in the Inspector window, open the "Properties".

2. The "Texts" tab allows you to assign the names in multiple languages (enabled in the project).

Figure 2-16: Multilingual names in S7-GRAPH
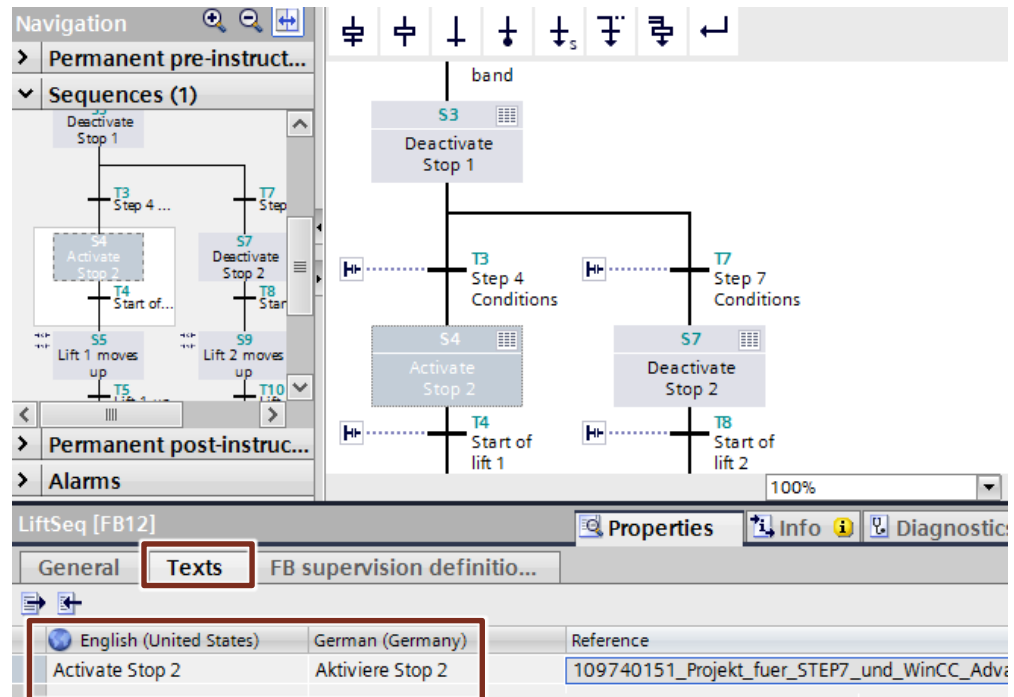
2.2.10 Activating initial value acquisition of the GRAPH sequencer

To activate initial value acquisition, proceed as follows:

1. Open the properties of the "LiftSeq" GRAPH sequencer.
2. In "General > Block", update the version. (In this example: block version V5.0)
3. Go to the "Attributes" tab.
4. Check "Initial value acquisition".

Figure 2-17: Attributes of the GRAPH sequencer

2.2.11 Resetting initial values on the GRAPH FB

With initial value acquisition, you analyze what triggered a supervision alarm. To this end, the initial values of those operands are recorded that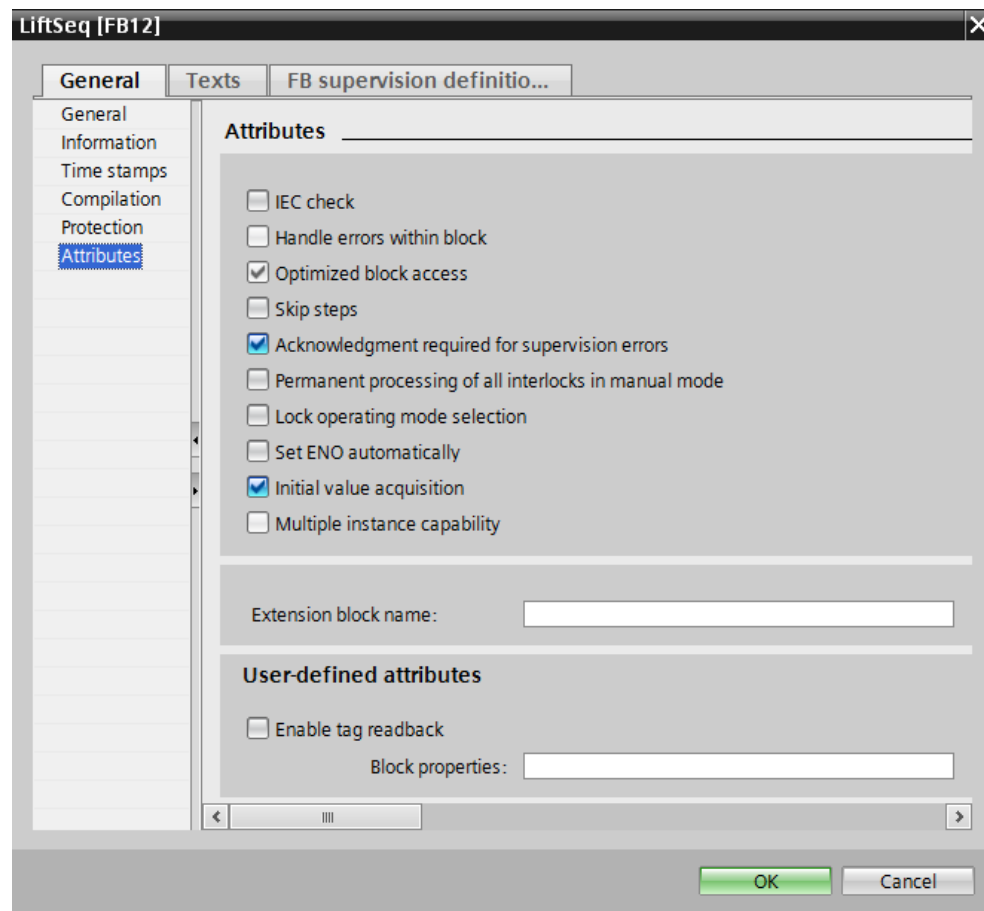 are programmed before the supervised operand in your program. GRAPH FB V5.0 allows you, with the aid of the "RESET_CRIT" input parameter, to reset the signal state of the two static parameters, "H_IL_ERR" (Interlock) and "H_SV_FLT" (Transition), to FALSE after the criteria analysis. As a result, the HMI PLC code viewer no longer displays old values. This is useful when you change the programming of interlocks and transitions and no longer need the then obsolete initial values. Reprogramming does not automatically reset the signal states to FALSE.

To reset the signal states of the two system-internal static parameters and therefore the initial values, proceed as follows:

1. Make sure that the version of the GRAPH function block is 5.0.
2. Open the "LiftSeq" GRAPH FB, click the block interface and in the menu bar, select "Edit > Interface parameters > Maximum interface parameters".
3. Open the "MainFB" FB and right-click the GRAPH FB.
4. From the context menu, select "Update block call". After updating, the "LiftSeq" GRAPH FB is displayed with its maximum parameters.
5. When calling the GRAPH function block, interconnect the "RESET_CRIT" input parameter in your user program with a Boolean tag, e.g. "SeqData.resetCrit".

Figure 2-18: Resetting initial values at the "RESET_CRIT" parameter
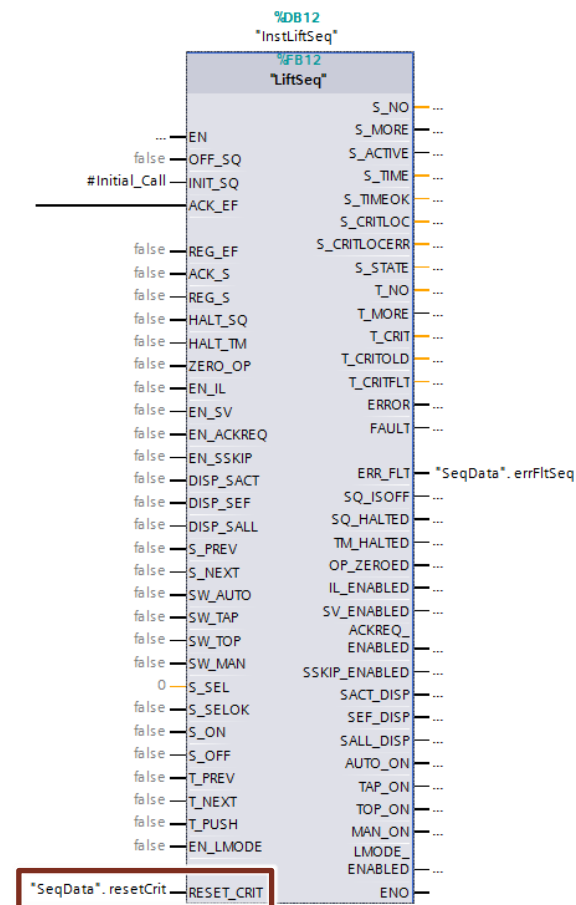
2.2.12 Setting the parameters of the GRAPH sequencer

For the program status of the GRAPH sequencer to be displayed on the "GRAPH overview" HMI object, the parameters of the GRAPH sequencer must be visible in the HMI and accessible from the HMI.

To set this, proceed as follows:

1. Open the "LiftSeq" GRAPH sequencer.

2. Open the "Edit" menu.

3. Check "Internal parameters visible/accessible from HMI".
   This selection can only be made if the GRAPH sequencer is open in the editor and the focus is on it.

Figure 2-19: Parameter settings of the GRAPH sequencer
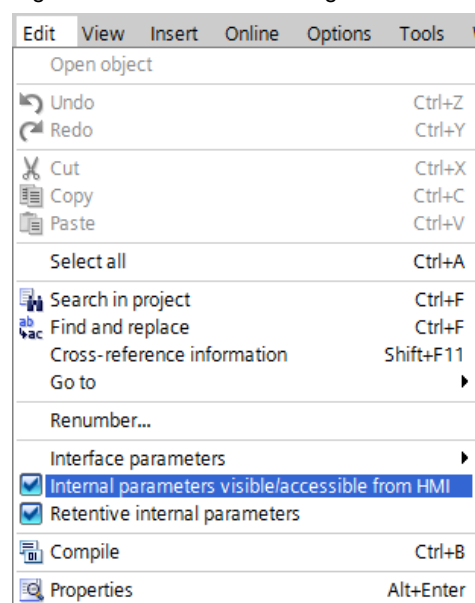
2.2.13 Defining the ProDiag supervision settings

In the ProDiag supervision settings, you define the settings that apply to all supervisions in the entire TIA Portal project. You can find the ProDiag supervision settings in the project tree in "Common data".

Defining categories

The "categories" allow you to divide occurring faults into different priorities. The categories can

- either be output as part of a supervision alarm or displayed as a group error bit in the "ProDiag overview" object on an HMI device.

- You can customize them to your requirements. For example, you can assign a separate alarm class to each category.

To go to the dialog, select "Common data > Supervision settings > General > Categories".

By default, there are three categories: "Error", "Warning" and "Info". You can create and enable/disable five more categories.

The "Error" category cannot be disabled.

Figure 2-20 Category settings

Defining subcategories

The subcategories allow you to specify the information in a supervision alarm in greater detail.

Defining the default settings for the types of supervision

In the "Types of supervision" section, you can change the default settings of the different types of supervision. This is where you define the delay time and for which signal state an operand or condition supervision should be performed.

Figure 2-21: Default settings for the types of supervision

Defining the ProDiag alarm texts

In the "Alarm texts" section, you can define the structure of the supervision alarms.

To create an alarm text, proceed as follows:

1. In the "Alarm texts" tab, select the desired area for which you want to create an alarm text, for example Basic supervisions > Tags.

2. Use drag and drop to move the desired alarm text fields from the "Supported alarm text fields" field to the "Alarm text" text frame.
   You can change the order of the individual text fields at any time.

3. If you want to delete a text field, right-click the appropriate text field and from the context menu, select "Delete".

4. Select a desired delimiter for the text fields.

Figure 2-22: Alarm text structure
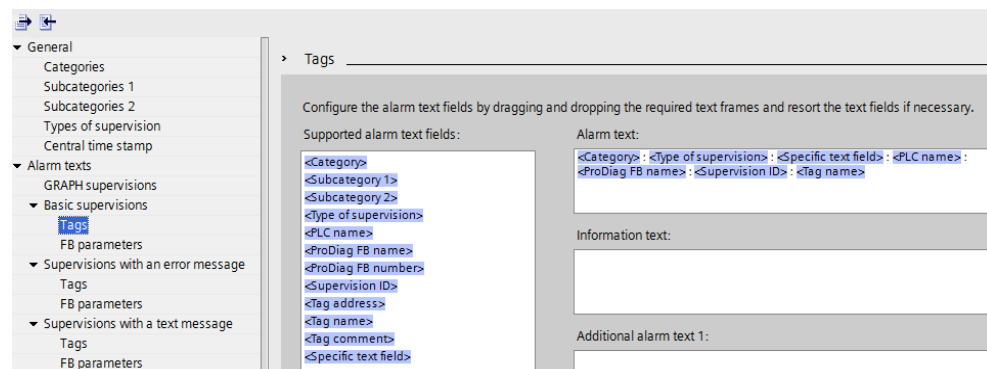
Define the alarm text structures of the different supervisions based on the basic supervisions. For local supervisions, insert the "<Instance name>" and "<Parameter name>" alarm text fields instead of "<Tag name>".

2.2.14   Example of the Error message supervision type

For blocks that report errors and output a status, you can output error texts in a supervision alarm if an error has occurred.

In the following example, the "Frequency" FB checks the input frequency and outputs an error and the following status (error number):

- 16#8001 (32769 decimal): Input frequency less than 5.
- 16#8002 (32770 decimal): Input frequency greater than 10.

In a text list, the texts are assigned to the values of a tag. For the error texts to be output according to the status in a supervision alarm in the event of an error, proceed as follows:

1. In the "SeqData" DB, define the "freqError" tag (data type: Bool) and the "freqStatus" tag (data type: UInt).
2. Interconnect the "error" and "status" parameters of the "Frequency" FB with the defined DB tags.

Figure 2-23: Call and parameter assignment of the "Frequency" FB
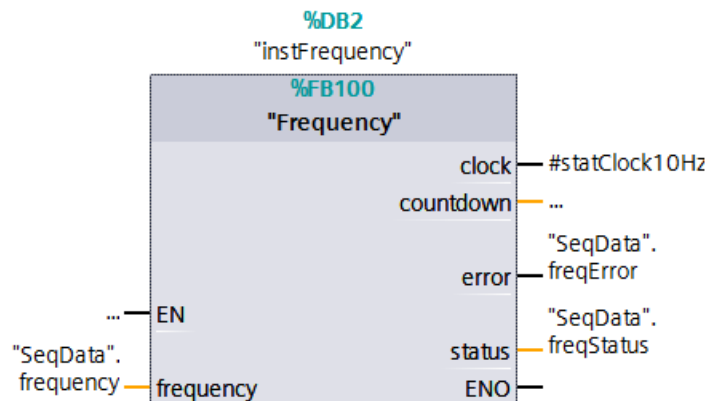
3. For the "freqError" DB tag, configure a supervision with the following properties:
   - Type of supervision: Error message
   - Supervised tag: "SeqData".freqError
   - Delay time: T#0ms
   - Category: 1 : Error
   - ProDiag FB: e.g., LiftProDiagFB
4. In "Specific text field", enter the following associated values:
5. Error message @4%5X@: @4%t#TextListStatus@

   In the event of an error, the error message is taken from the "TextListStatus" error text list.
6. In the "Tag 1 (SD_4)" input field, enter the "SeqData".freqStatus DB tag.

Figure 2-24: Definition of the specific text field
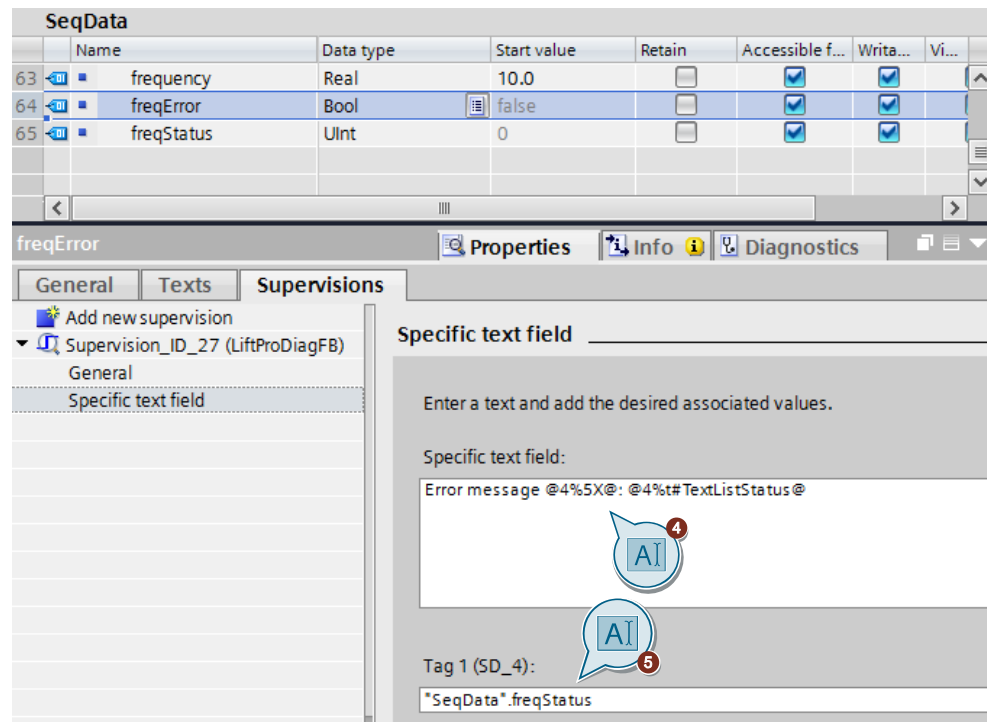
7. In the project tree, select the "PLC1" folder and double-click "PLC alarm text lists" to open the text list editor.

8. Add a new text list and name it, for example, "TextListStatus". This name must match the name in the specific text field.

9. In the "Selection" column, select the "Decimal" setting for the text list.

10. In "Text list entries", "Range from / Range to" columns, enter the status (error numbers) used in the "Frequency" FB.
    In "Entry", define the alarm texts.

Figure 2-25: Inserting the text list
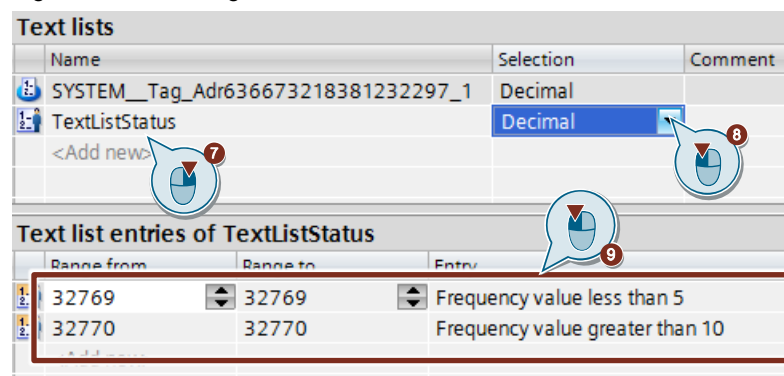
As soon as the signal state of the "freqError" DB tag is TRUE, the supervision alarm is output with the text from the specific text field. The error number is displayed as a decimal number and the error text from the text list is output.

2.2.15 Configuring identical time stamp

With the ProDiag function block version 2.0 or higher, you can specify a central time stamp tag in the ProDiag supervision settings and then use it in the entire project in each CPU.

To this end, the central time stamp tag is defined as a global tag or as a global data block element in the respective CPU.

The same system time is assigned to all ProDiag supervision alarms within a program cycle that are sent by ProDiag function blocks with the "Use central time stamp" check box checked. Configuring the identical time stamp is only necessary if you are using multiple ProDiag function blocks.

To use a central time stamp, proceed as follows:

1. In the global data block "SeqData", define the two tags:
   - "identTimeStamp" (data type: LDT)
   - "retVal" (data type: Int)
2. In the project tree, open the "Common data" folder.
3. Open the "Supervision settings" dialog.
4. In the area navigation, go to "General > Central time stamp".
5. In the "Time stamp tag" field, enter the "SeqData.identTimeStamp" DB tag defined above.

Figure 2-26: Configuring identical time stamp
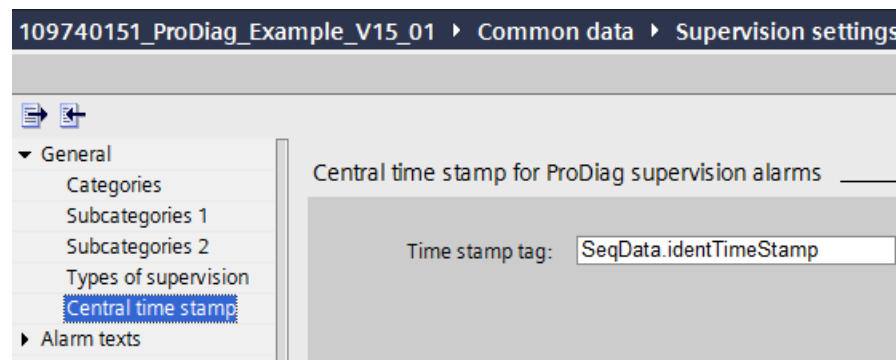
6. Right-click the "LiftProDiagFB" ProDiag FB and from the context menu, select "Properties".
7. Go to the "Attributes" tab and check the "Use central time stamp" check box.
8. Select "OK" to close the dialog.

Figure 2-27: Activating central time stamp
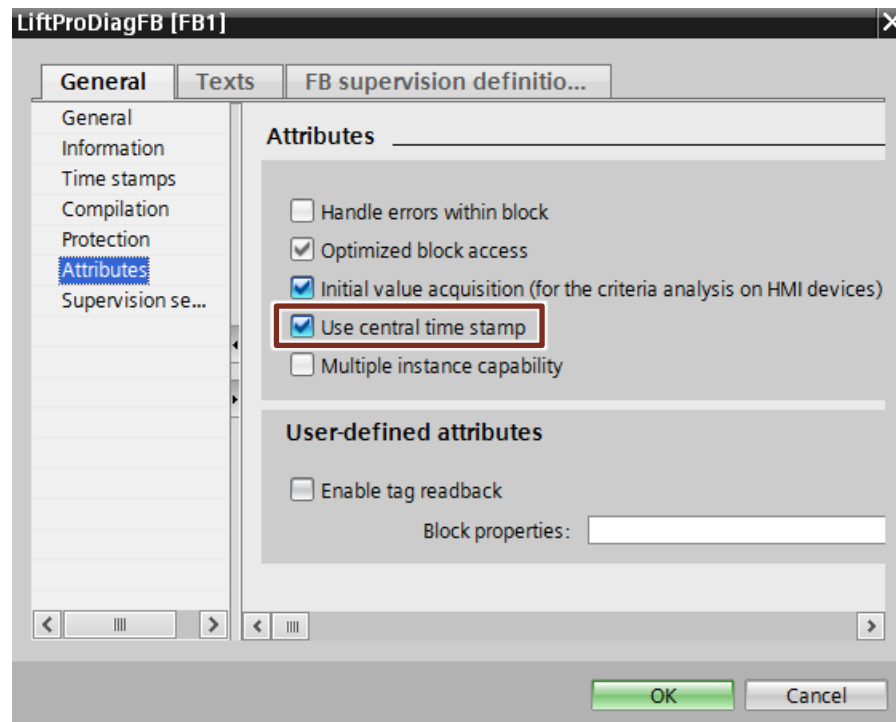
9. Insert the "RD_SYS_T" instruction into the Main organization block and parameterize the "OUT" output with the "SeqData.identTimeStamp" DB tag.

10. Interconnect the "RET_VAL" parameter with the "SeqData".retVal DB tag.

Figure 2-28: Read instruction for time
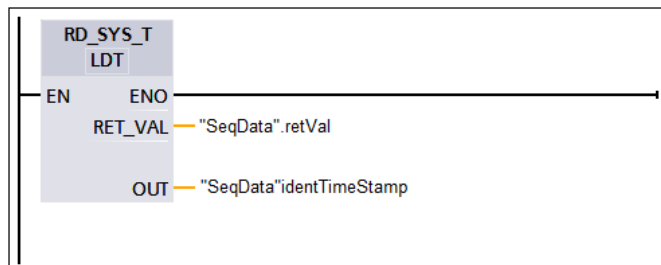
2.2.16 Exporting/importing supervision settings for ProDiag and S7-GRAPH

You can export the supervision settings for ProDiag and S7-GRAPH to a ".dat" file to import them into a new project.

To export/import the supervision settings, proceed as follows:

1. In the project tree, go to the "Common data" folder and open the "Supervision settings".

2. Click the

   a. "Export supervision settings" icon to export the settings. Select a storage location.

   b. "Import supervision settings" icon to import the settings. Select the file that you want to import.

Figure 2-29: Exporting and importing global settings
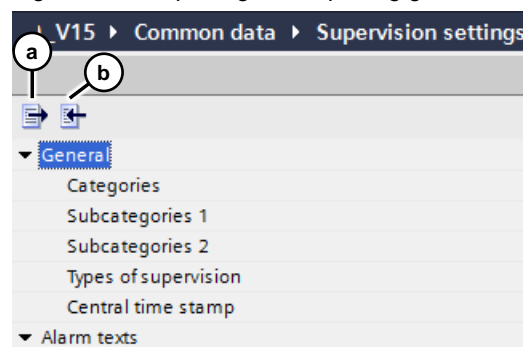
Note	The ProDiag supervision settings are based on alarm classes. You may have to export also the alarm classes as a ".dat" file.

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2.2.17 Exporting and importing ProDiag supervisions and properties of a ProDiag FB

Aside from the created supervisions, you can also export/import the properties of one or more ProDiag FBs from the "Tag supervisions" and "FB supervision definitions" ProDiag overview tables.

To export the supervisions and properties of one or more ProDiag FBs, proceed as follows:

1. In the project tree, open the "PLC supervisions & alarms" editor.
2. Go to the "Supervisions" tab.
3. Click the
   a. "Exports tag supervisions" icon to export the tag supervisions. Select a storage location.
   b. "Imports tag supervisions" icon to import the settings. Select the file that you want to import.

Figure 2-30: PLC supervisions & alarms

When importing, you can choose what and how you want to import. In addition to the supervisions, the "Supervision settings" can be included in the import.

Figure 2-31: PLC supervisions & alarms
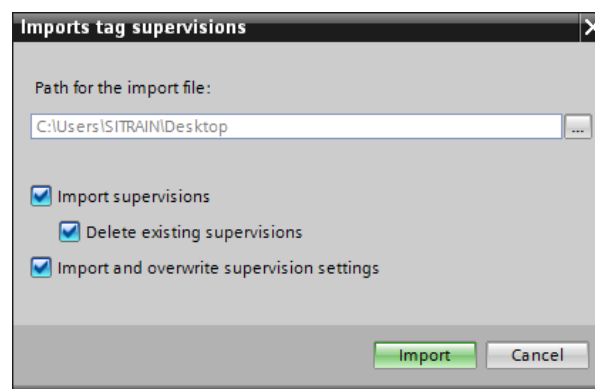
| Note | For more information about the export/import functions, refer to the online help or the STEP 7 and WinCC Engineering V15 system manual in chapter:

Exporting supervisions and properties of a ProDiag FB of a ProDiag FB |

2.2.18 Visualizing supervisions on the HMI

To display the current supervision state, TIA Portal provides different objects that you can integrate into an HMI screen.

ProDiag overview

The ProDiag overview provides an overview of the current state of the configured supervision. The object shows the error category and type of supervision of a supervision. The object is assigned the status tag of a ProDiag IDB.

To configure a ProDiag overview, proceed as follows:

1. Drag the "ProDiag overview" object from "Taskcard > Toolbox > Controls" to the HMI screen.

2. In the Inspector window, click "Properties > Properties > General".

3. In "Tag", open the selection dialog.

4. Select the "State" status tag from the "InstLiftProDiagFB" ProDiag instance data block.

5. In "Output > Categories", you can define the names and colors of the supervision categories.

6. In "Output > Supervision types", you can define the names and colors of the supervision types.

Figure 2-32: ProDiag overview

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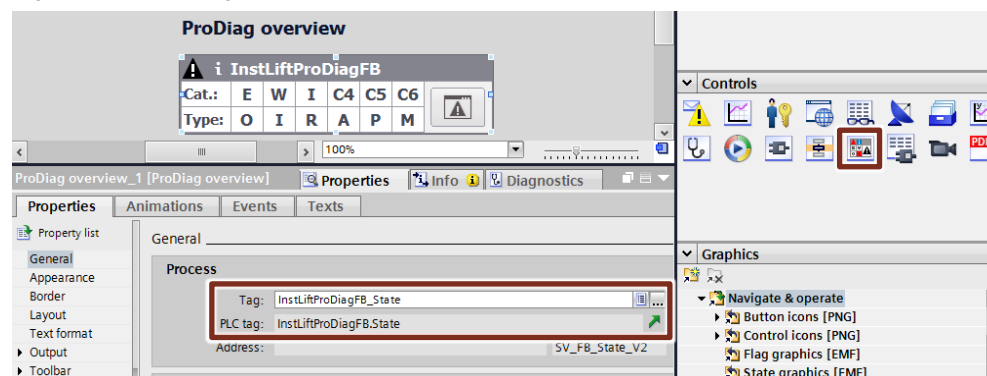
GRAPH overview

The GRAPH overview provides an overview of the current state of a GRAPH sequencer. Assign the first PLC tag of the GRAPH instance data block to the object.

Block version V5.0 or higher allows you to view three-line mode with the additional lines for the previous and next step and the first invalid operand of the criteria analysis.

To configure a GRAPH overview, proceed as follows:

1. In the project tree, right-click the "LiftSeq" GRAPH FB and from the context menu, open "Properties...".

2. In the "General" tab, the block version must be at least V5.0.

3. Drag the "GRAPH overview" object from "Taskcard > Toolbox > Controls" to the HMI screen.

4. In the Inspector window, click "Properties > Properties > General".

5. In "Tag", open the selection dialog.

6. Select the first PLC tag, "OFF_SQ", from the "InstLiftSeq" GRAPH instance data block.

Figure 2-33: GRAPH overview

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Entry-ID: 109740151,   V4.1,   03/2019

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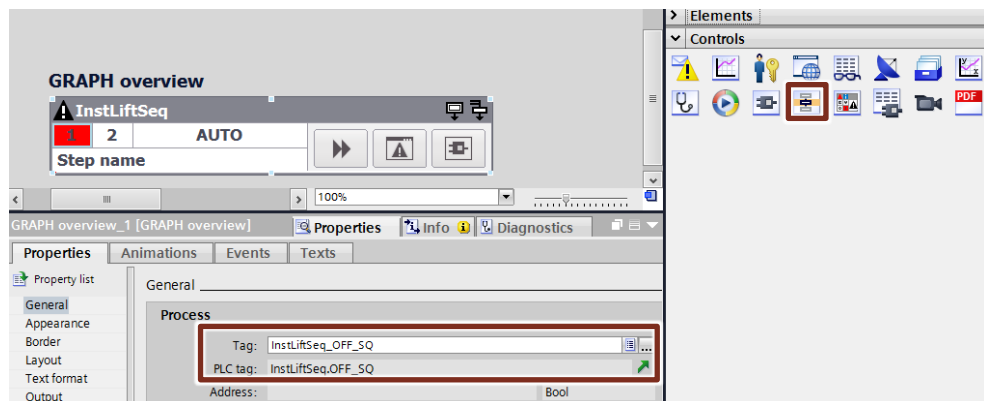
7. In "Properties" of the Inspector window, you can change the layout of the object.
8. Select the GRAPH overview, go to "Properties", "Layout" and check the following two check boxes:
   - "Show previous and next step" and
   - "Show first invalid operand".

Figure 2-34: GRAPH overview and extension
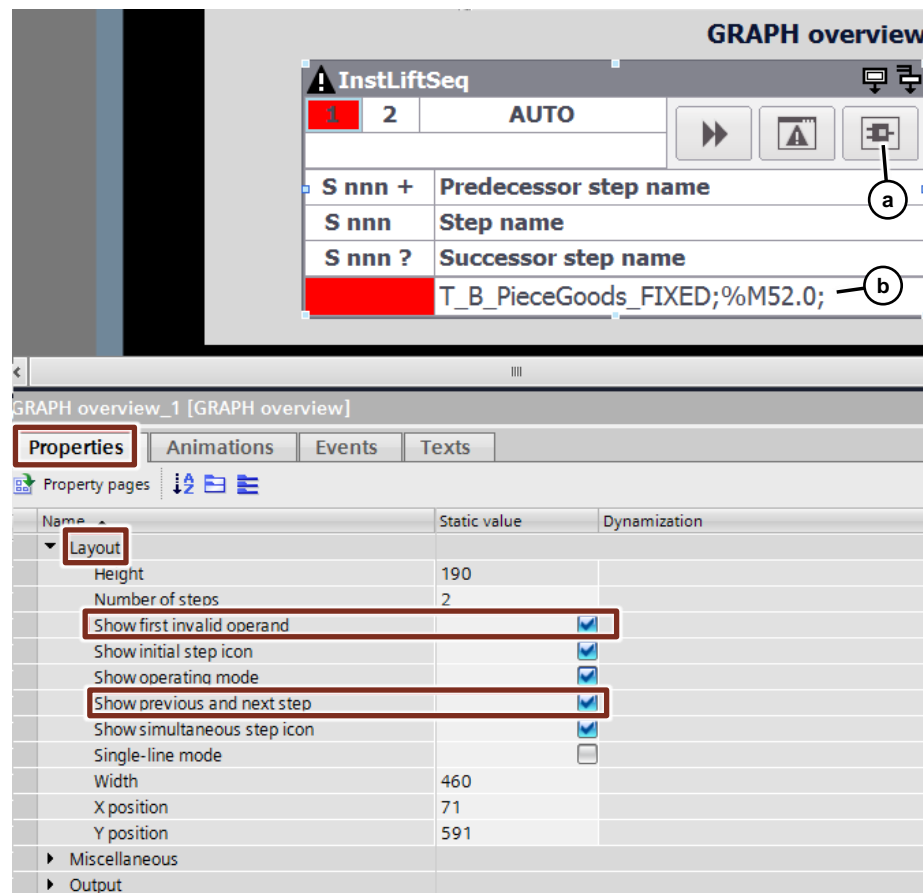
a. The "PLC code view" button takes you to the GRAPH program display. For more information, see the 'PLC code view' section on the next page.
b. The criteria analysis can also be activated in the GRAPH overview. The last row in the GRAPH overview is the criteria analysis.

PLC code view

The PLC code view is used to display PLC program parts of your LAD, FBD and GRAPH programs. The PLC code view is activated using a button. The PLC code view does not need a connection to a PLC tag.

To configure a PLC code view, proceed as follows:

1. Drag the "PLC code view" object from "Taskcard > Toolbox > Controls" to the HMI screen.

2. In "Properties" of the Inspector window, you can change the layout of the object.

Figure 2-35: PLC code view
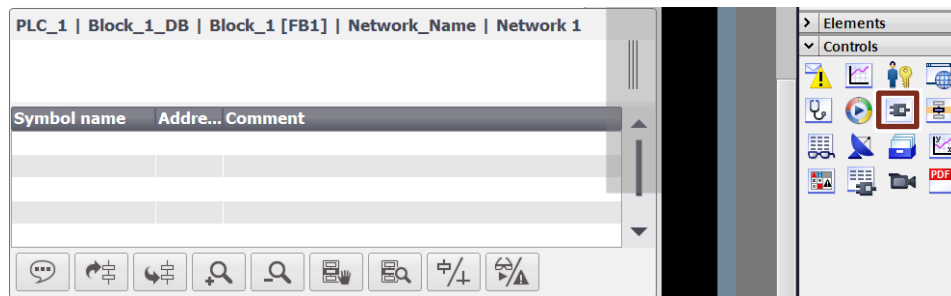
Note	You can open the PLC code view using the "PLC code" button or the "PLC code" button of the Graph overview.

Note	In the PLC code view, you can also display the program status of F-blocks. It is displayed in the same way as for standard blocks. A yellow header directly indicates that an F-block is being analyzed. F-operands are not marked.

Two-line display of step and transition names

Like TIA Portal, the PLC code view allows you to display the step and transition names in two lines.

1. Select the "PLC code view" and in the Inspector window, open the "Properties".
2. Select the "Properties" tab and in the area navigation, click "Layout".
3. In "GRAPH display", check the "Two-line display" check box.

Figure 2-36: Two-line display of step and transition names
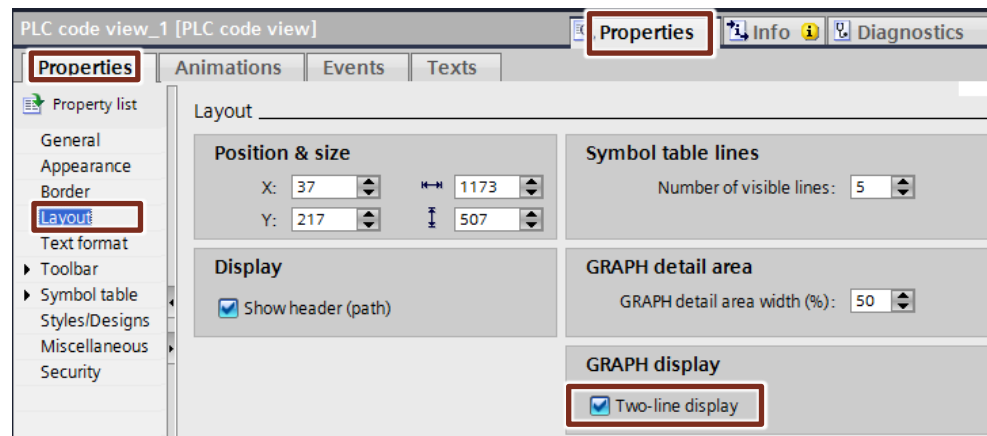
4. In TIA Portal, open the "Options > Settings" dialog.
5. In the area navigation, navigate to "PLC programming > GRAPH".
6. In "View", check the "Show two lines" check box.

Alarm view

The alarm view displays the supervision alarms. The alarm view is assigned a control tag for the PLC code view. The control tag enables the "PLC code" button for the PLC code view.

To configure an alarm view, proceed as follows:

1. Drag the "Alarm view" object from "Taskcard > Toolbox > Controls" to the HMI screen.
2. In the Inspector window, click "Properties > Properties > General".
3. Select "Current alarm states".
4. Check the "Acknowledgement" and "No Acknowledgement" alarm classes.

Figure 2-37: Alarm view
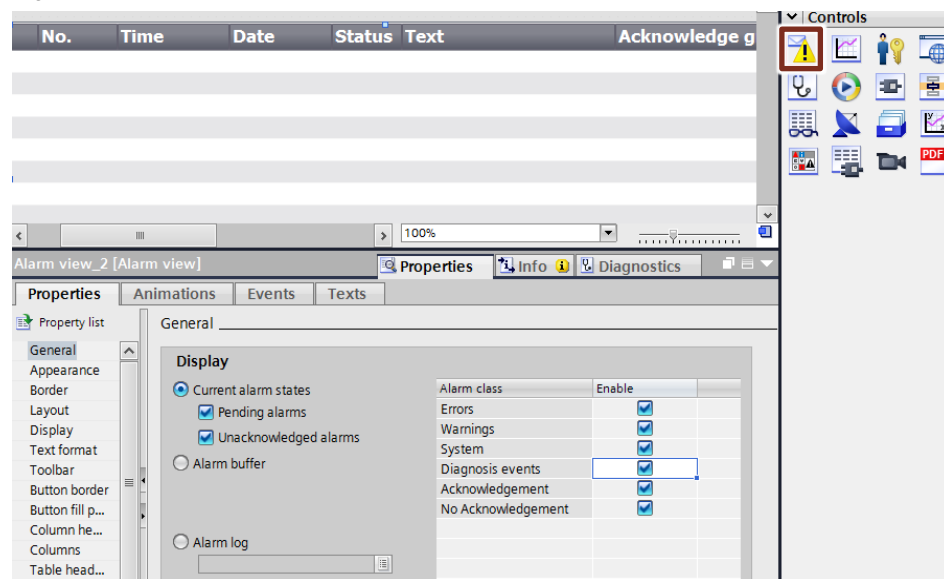
5. In the Inspector window, click "Properties > Properties > Display".

6. In "Tag" of the "Control tag for PLC code view" section, open the selection dialog.

7. Select the internal tag "enablePLCCode".

8. In "Properties", you can change the layout of the object.

Figure 2-38: Control tag for ProDiag
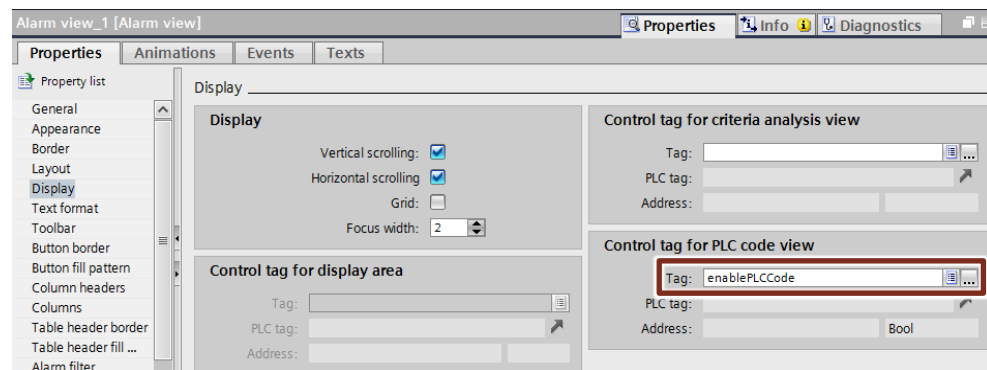
Note	Steps 6 through 8 are not required for WinCC Professional.

"PLC code" button for RT Advanced/Professional

The button activates the PLC code view.

To configure a PLC code view, proceed as follows:

1. Drag the "Button" object from "Taskcard > Toolbox > Elements" to the HMI screen.
2. In "Properties" of the Inspector window, you can change the layout of the object, for example the label.
3. In the Inspector window, select "Properties > Animations" and open the "Display" section.
4. Use "Add new animation" to add the "Control enable" animation.
5. In "Tag" of the "Process" section, open the selection dialog.
6. Select the internal tag "enablePLCCode".

Figure 2-39: Control enable of the "PLC code" button for RT Advanced
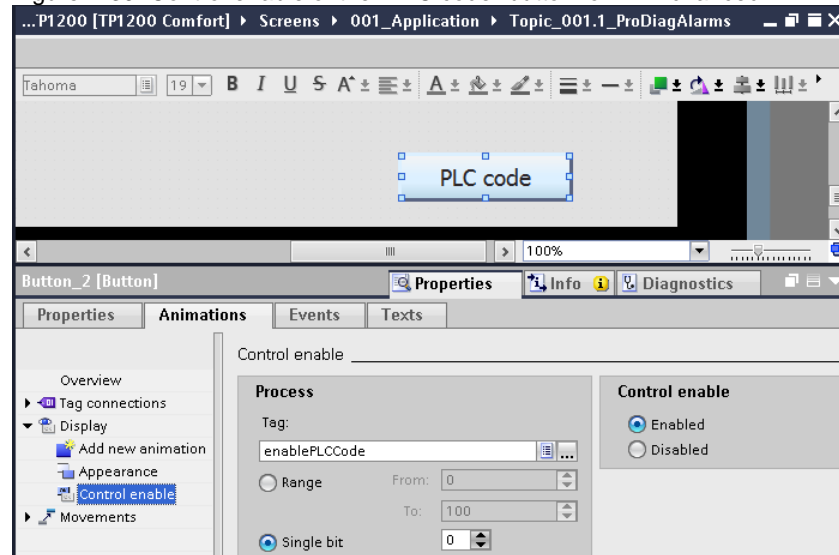
7. Use "Add new animation" to add the "Appearance" animation.
8. In "Name" of the "Tag" section, open the selection dialog.
9. Select the internal tag "enablePLCCode".
10. In the "Range" column, enter the ranges "0" and "1".
11. Select the "foreground" and "background color" for the ranges "0" and "1".

Figure 2-40: Appearance of the "PLC code" button for RT Advanced
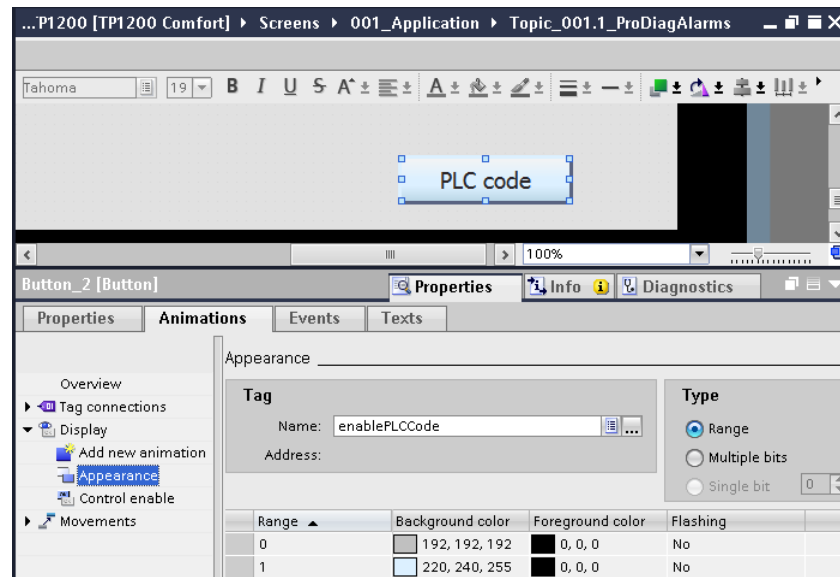
12. In the Inspector window, click "Properties > Events".

13. Select the "Click" event.

14. Insert the appropriate system function.

- c. RT Advanced:
  "ActivatePLCCodeView" with the following parameters:
  - Screen name: "Topic_001.2_ProDiagPLCCodeView"
  - Screen object: "PLC code view_1"

- d. RT Professional:
  "ShowPLCCodeViewFromAlarm" with the following parameters:
  - Alarm screen name: "ProDiag"
  - Alarm view name: "PLC code view_1"
  - Basic screen name: ProDiag
  - Screen Window Name: Bildfenster_1
  - Screen name of the PLC code view: "ProDiag_001_Graph"
  - Name of the PLC code view: "PLC code view_1"

Criteria analysis view

This function displays the invalid operands of the user program that have triggered a selected ProDiag or GRAPH alarm.

The following prerequisites must be met for the Criteria analysis view:

- The operator panel is connected to the controller.

- The ProDiag FBs were created with V2.0.

- The GRAPH FBs were created with V4.0.

- Initial value acquisition is activated for function blocks and an alarm view has been configured.

In Runtime, you can see incoming alarms and invalid operands at a glance, provided that you configure the 'Criteria analysis view' and the connected 'Alarm view' in the same screen.

1. In "HMI tags", insert a new internal tag (e.g., "criteriaAnalysisViewer") with the "WString" data type. The string must be at least 50 characters long.

2. Drag the "Criteria analysis view" object from "Taskcard > Toolbox > Controls" to the "Alarms" HMI screen.

Figure 2-41: Inserting object for Criteria analysis view
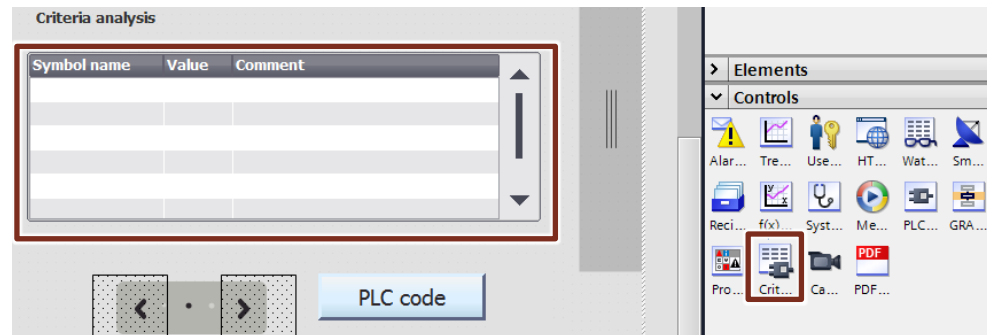
3. In the "Alarms" HMI screen, select the "Criteria analysis view" object and in the Inspector window, click "Properties > General".

4. In "Tag", select the "criteriaAnalysisViewer" control tag.

Figure 2-42: Configuring control tag for Criteria analysis view
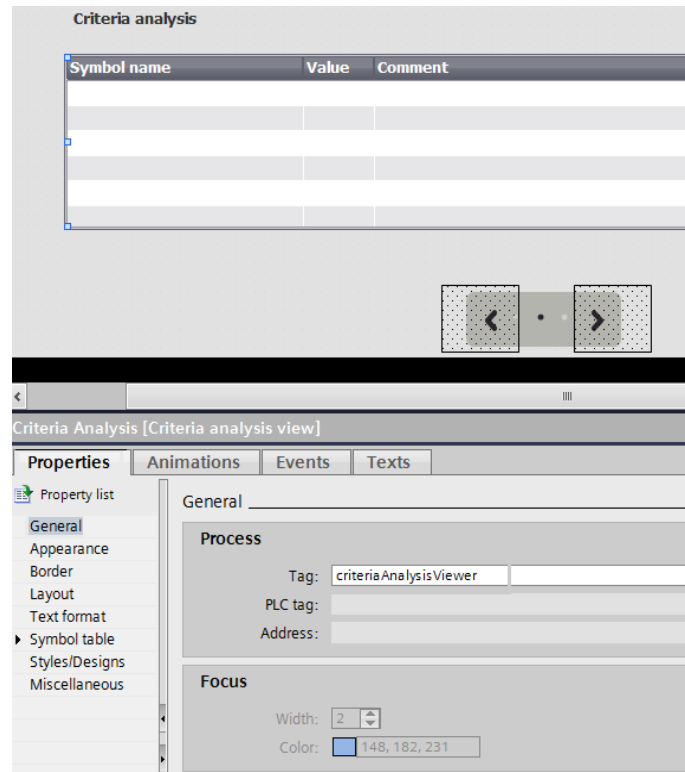
5. To connect to the alarm, you must also configure the control tag on the "Alarm view" object.
Select the "Alarm view" object and in the Inspector window, click "Properties > Display".

6. In the "Control tag for criteria analysis view" window, click the selection button in "Tag".

7. Select the "criteriaAnalysisViewer" control tag.

Figure 2-43: Configuring control tag for alarm view
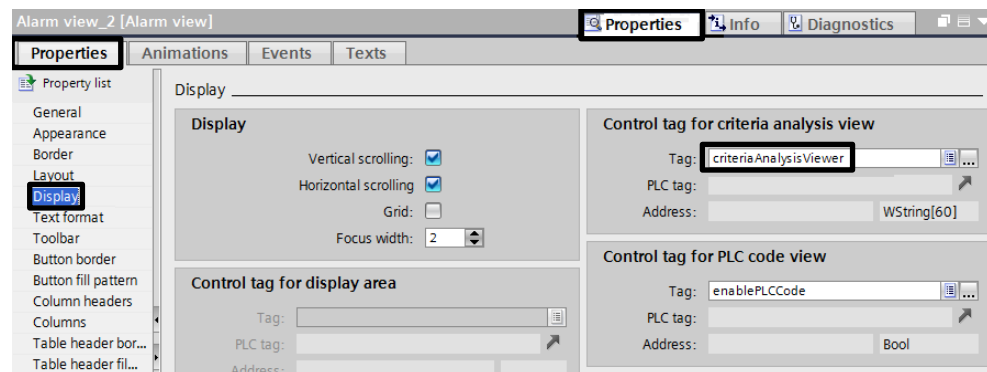
2.2.19 Downloading the project

Now the configuration must be compiled and downloaded to the PLC or HMI.

Downloading to the PLC

To download the configuration to the PLC, proceed as follows:

1. In the project tree, select the "PLC_1" folder of the controller.
2. In the toolbar, click the "Download to device" button.

Figure 2-44: Download to PLC
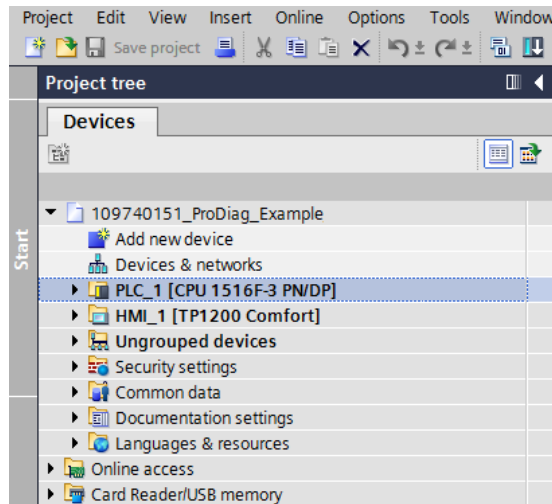
Downloading to the HMI

To download the configuration to the HMI, proceed as follows:

1. In the project tree, select the "TP1200" folder of the operator panel.
2. In the toolbar, click the "Download to device" button.

Figure 2-45: Download to HMI
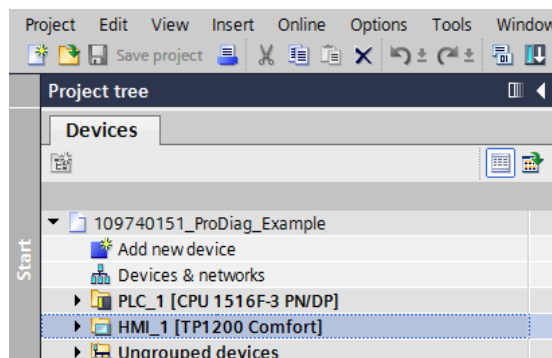
2.3 Control and diagnostics with WinCC Runtime Advanced

You control the virtual conveyor system directly on the operator panel. A programmer for diagnostics is not required. The following three figures show the user interface of the operator panel.

2.3.1 Overview

The "Plant Overview" screen shows the conveyor belt with the two lifts and the buttons for controlling the plant and simulating errors. The ProDiag overview displays the current state of the configured supervisions and the GRAPH overview shows the current state of the GRAPH sequencer.

Figure 2-46: User interface overview
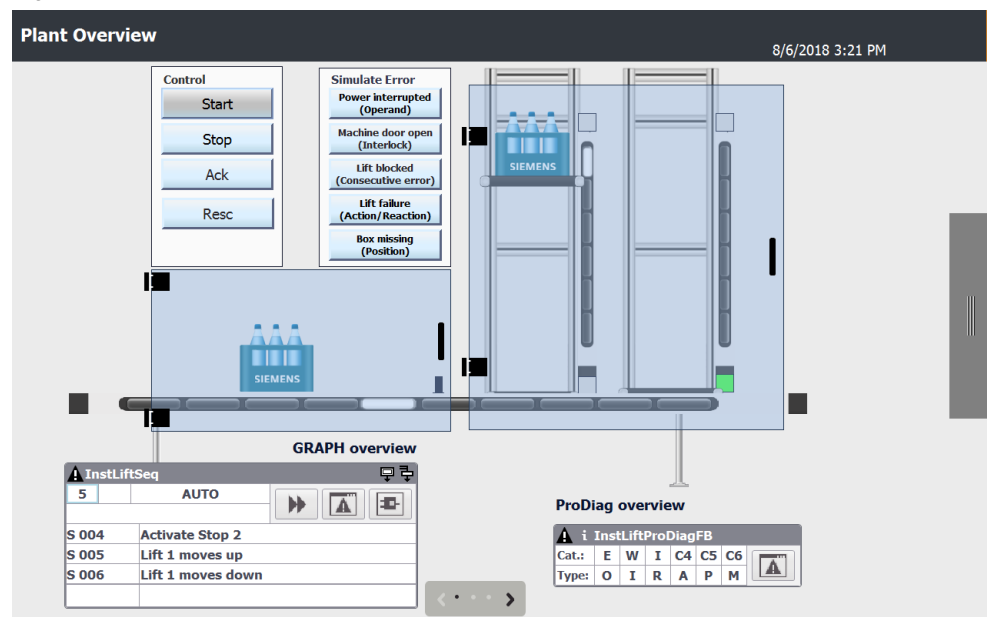
The "Alarms" screen shows the alarm view with the supervision alarms and the "PLC code" button takes you to the PLC code view.

Figure 2-47: Alarms

The HMI diagnostics, PLC overview, GRAPH overview and PLC code view objects allow you to diagnose supervision alarms.

Figure 2-48: "HMI PLC code view"
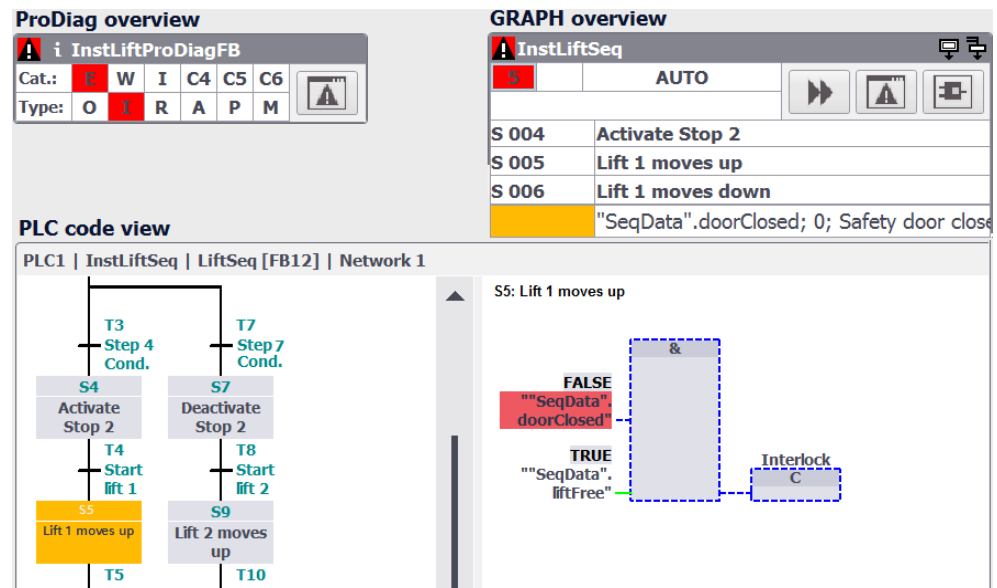
2.3.2 Controlling the conveyor system

Use the "Control" section to control the conveyor system. The buttons have the following functions.

- "Start" starts the conveyor system.
- "Stop" stops the conveyor system. The conveyor system does not stop immediately. It is not stopped until the lifts reach the lower position. In the meantime, the button flashes.
- "Ack" acknowledges errors.
- "Resc" allows you to manually delete the last recorded initial values.

2.3.3 Simulation and diagnostics of ProDiag supervisions

Simulation and diagnostics of a global operand supervision

You can trigger operand supervisions when the conveyor system is stopped or running. Proceed as follows:

1. Go to the "Plant Overview" screen.
2. Click the "Operand" button to trigger the operand supervision of the compressed air and power supply. The button color changes to red and the two red symbols in the ProDiag overview, "E" and "O", indicate an error of the "Operand" type.

Figure 2-49: ProDiag overview
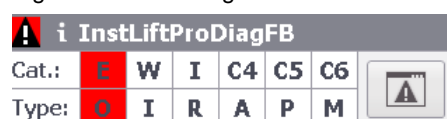
3. In the ProDiag overview, click the "Alarm view" button.
The "Alarms" screen opens. The alarm view displays the supervision alarms of the operand errors.

Figure 2-50: Alarm view

Time	Text
9:24:44 PM	Error : Operand : Voltage power supply not OK : PLC_1 : LiftProDiagFB : 14 : SeqData.powerVoltage
9:24:42 PM	Error : Operand : Compressed air not OK : PLC_1 : LiftProDiagFB : 13 : SeqData.compressedAir

4. Select an alarm.
The "PLC code" button remains gray. A PLC code cannot be displayed for this operand error.

5. Click the "Operand" button again to disable the operand supervision.

Simulation and diagnostics of a global position supervision

To simulate a position supervision, the conveyor system must be stopped. The position is supervised where the case is on the belt.

To simulate and diagnose the position supervision, proceed as follows:

1. Go to the "Plant Overview" screen.

2. If the conveyor system is running, click the "Stop" button and wait until the conveyor system has stopped.

3. To trigger a position supervision, click the "Position" button.

- The button color changes to red.

- The sensor display behind the case changes its color from green to red.

- The orange symbol, "W", and the red symbol, "P", in the ProDiag overview indicate a warning of the "Position" type.

Figure 2-51: ProDiag overview

Cat.:	E	W	I	C4	C5	C6
Type:	O	I	R	A	P	M

InstLiftProDiagFB

4. In the ProDiag overview, click the "Alarm view" button.
The "Alarms" screen opens. The alarm view displays the supervision alarms of the position error.

Figure 2-52: Alarm view

Time	Text
9:42:53 PM	Warning : Position : Case at stopper 1 missing : PLC_1 : LiftProDiagFB : 16 : SeqData.sensorStop1

5. Select the alarm.
The "PLC code" button remains gray. A PLC code cannot be displayed for this position error.

6. Click the "Position" button again to disable the position supervision.

7. Restart the conveyor system.

Simulation and diagnostics of local interlock supervisions

To simulate the interlock supervisions, the conveyor system must be running. The supervision is not activated until a lift is started upwards or downwards. To simulate and diagnose an interlock supervision, proceed as follows:

1. Go to the "Plant Overview" screen.

2. If the conveyor system is not running, click the "Start" button.

3. To trigger an interlock supervision on the lifts, click the "Interlock" button.

   - The button color changes to red.

   - The door on the lift opens and the lift stops.

   - The two red symbols in the ProDiag overview, "E" and "I", indicate an error of the "Interlock" type.

Figure 2-53: ProDiag overview

4. In the ProDiag overview, click the "Alarm view" button.
   The "Alarms" screen opens. The alarm view displays the supervision alarm of the interlock error.

Figure 2-54: Alarm view

5. Select this alarm.
   The "PLC code" button turns light blue. This means that the associated PLC code can be displayed for this interlock error.

6. Click the "PLC code" button.
   The "PLC code view" screen opens. The PLC code view displays the program part at the supervised "interLockAuto" input parameter of the "LiftCmd" function block.
   The link indicates that the "SeqData".doorClosed signal (lift door closed) is not "TRUE".

Figure 2-55: PLC code view

7. Click the "Interlock" button again to disable the interlock supervision.

2 Engineering

Simulation and diagnostics of local action supervisions

To simulate the action supervisions, the conveyor system must be running and both lifts must not yet be controlled. The supervision is not activated until a lift is controlled upwards or downwards by the program.

To simulate and diagnose the action supervision, proceed as follows:

1. Go to the "Plant Overview" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until both lifts have stopped and a case is provided for lift 2.

4. Click the "Action / Reaction" button to trigger an action supervision on a lift.

   • The button color changes to red.

   • If a lift is now controlled by the program, it will stop.

   • An action error will be triggered when a delay time has expired.

   • The two red symbols in the ProDiag overview, "E" and "A", indicate an error of the "Action" type.
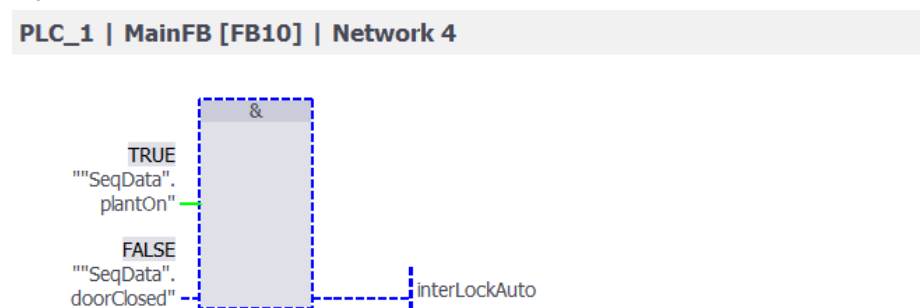
Figure 2-56: ProDiag overview

5. In the ProDiag overview, click the "Alarm view" button.
   The "Alarms" screen opens. The alarm view displays the supervision alarm of the action error.

Figure 2-57: Alarm view

6. Select this alarm.
   The "PLC code" button turns light blue. This means that the associated PLC code can be displayed for this action error.

7. Click the "PLC code" button.

   • The "HMI PLC code view" screen opens.

   • The PLC code view displays the program part at the supervised "sensorLiftDown" input parameter of the "LiftCmd" function block.

   • The link indicates that the state of the "SeqData".sensorLift2Down signal remains "TRUE", i.e. that the unit has not left the lower end position.

Figure 2-58: PLC code view

8. Click the "Action / Reaction" button again to disable the action supervision.

Note	In this application example, an action error, once a delay time has expired, always results in a reaction error.

Simulation and diagnostics of local reaction supervisions

To simulate the reaction supervisions, the conveyor system must be running. The supervision is not activated until a lift is controlled upwards or downwards by the program. If you activate the simulation before a lift is controlled, an action error will be triggered first, later followed by a reaction error. If you activate the simulation during the movement, only a reaction error will be triggered.

To simulate and diagnose the reaction supervision, proceed as follows:

1. Go to the "Plant Overview" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until a case is lifted by lift 2.

4. Click the "Action / Reaction" button to trigger a reaction supervision on the lifts.

   - The button color changes to red.

   - If a lift is now controlled, it will stop.

   - A lift that has already been controlled will be stopped.

   - A reaction error will not be triggered until a delay time has expired.

   - The two red symbols in the ProDiag overview, "E" and "R", indicate an error of the "Reaction" type.
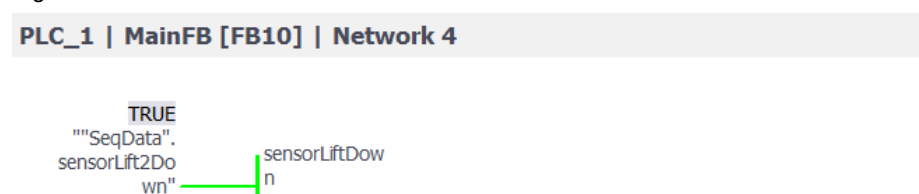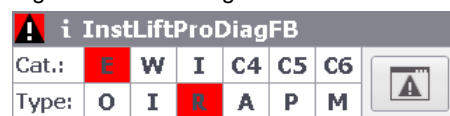
Figure 2-59: ProDiag overview

5. In the ProDiag overview, click the "Alarm view" button.
   The "Alarms" screen opens. The alarm view displays the supervision alarm of the reaction error.

Figure 2-60: Alarm view

Time	Text
11:15:01 PM	Error : Reaction : Lift has not reached upper end position : PLC_1 : LiftProDiagFB : 32 : instLift2Cmd : sensorLiftUp

6. Select this alarm.
   The "PLC code" button turns light blue. This means that the associated PLC code can be displayed for this reaction error.

7. Click the "PLC code" button.
   The "HMI PLC code view" screen opens. The PLC code view displays the program part at the supervised "sensorLiftUp" input parameter of the "LiftCmd" function block.
   The link indicates that the state of the "SeqData".sensorLift2Up signal remains "FALSE", i.e. that the unit has not reached the upper end position.

Figure 2-61: PLC code view

PLC_1 | MainFB [FB10] | Network 4

FALSE
""SeqData".
sensorLift2Up" ------- sensorLiftUp
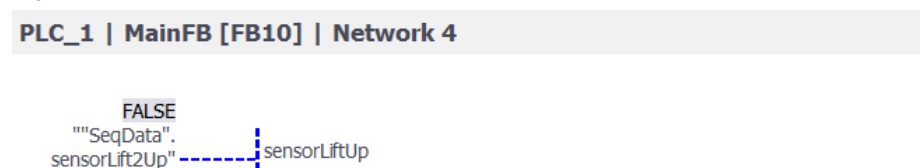
8. Click the "Action / Reaction" button again to disable the reaction supervision.

Simulation of the Error message supervision type with the text from the specific text field

1. In the project tree, navigate to "PLC1 > Watch and force tables" and open the "WatchTableFreq" watch table.

2. Click the glasses icon to change the watch table to the Online view.

3. In "Modify value", enter a value greater than 10.0, e.g. 11.0.

4. In the toolbar, click the "Modify now" function. This action simulates 'exceed upper limit'.

Figure 2-62: Watch table

5. Go to WinCC Runtime Advanced. In the ProDiag overview, the two symbols "E" and "M" are displayed in red.

Figure 2-63: ProDiag overview

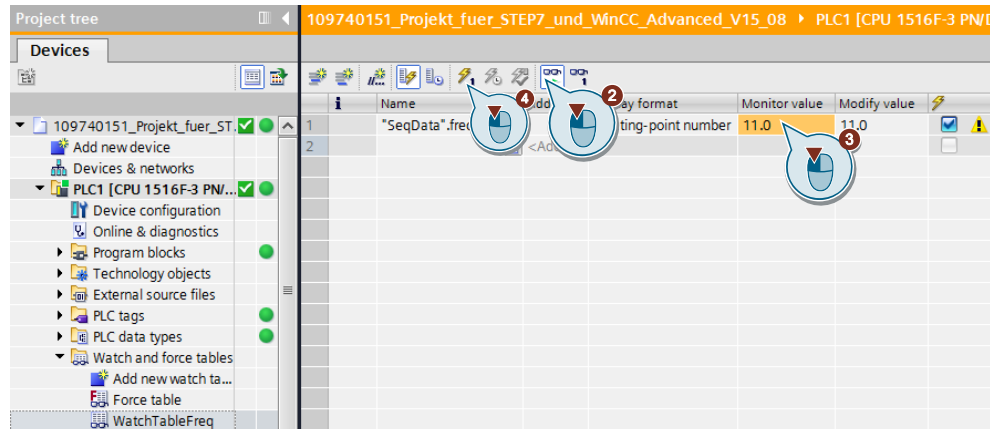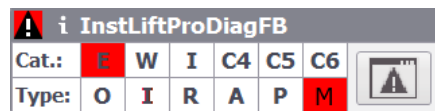6. In the ProDiag overview, click the "Alarm view" button. The "Alarms" screen opens. The error message is displayed as shown in the below figure.

Figure 2-64: "Frequency value greater than" error message

Time	Text
5:12:26 AM	Error : Error message : LiftProDiagFB : 27 : SeqData.freqError : Error message 08002: Frequency value greater than 10

7. Return to the watch table and in "Modify value", enter a value less than 5.0, e.g. 4.0.

8. In the toolbar, click the "Modify now" function. This action simulates 'fall below lower limit'.

9. Go to the "Alarms" screen. The error message is displayed as shown in the below figure.

Figure 2-65: "Frequency value less than" error message

Time	Text
6:37:08 AM	Error : Error message : LiftProDiagFB : 27 : SeqData.freqError : Error message 08001: Frequency value less than 5

10. To stop the simulation, change the "SeqData".frequency DB tag in the watch table back to the value 10.0.

2.3.4 Simulation and diagnostics of GRAPH supervisions

**Simulation and diagnostics of a supervision (step supervision)**

Technologically, the GRAPH supervision can be compared to a reaction supervision.

To simulate a supervision of the "LiftSeq" GRAPH sequencer, the conveyor system must be running. The supervision is only configured in those steps where a lift is controlled upwards or downwards. The respective end position of the movement is configured as a transition (step enabling condition for the next step). The specified step duration of a step is supervised in the supervision. If the movement within a step takes too long, the supervision will be activated and an alarm will be output. The supervision is triggered by simulating an interlock error or an action/reaction error.

To simulate and diagnose the supervision, proceed as follows:

1. Go to the "Plant Overview" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until a case is lifted on lift 2.

4. Click the "Interlock" or "Action / Reaction" button to trigger a supervision in a step.

   - The color of the respective button changes to red.

   - If a lift is now controlled, it will stop.

   - A lift that has already been controlled will be stopped.

   - When the specified step duration has expired, an alarm will be output.

   - The red step number in the GRAPH overview indicates an error in the GRAPH sequencer.

Figure 2-66: GRAPH overview
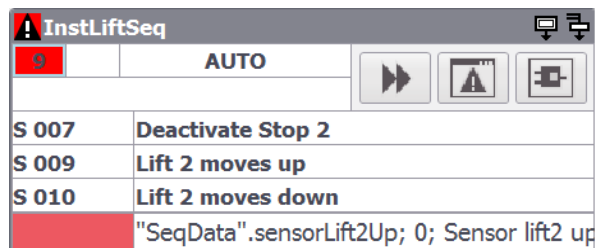
5. In the GRAPH overview, click the "Alarm view" button.
   The "Alarms" screen opens. The alarm view displays the error alarm of the supervision.

Figure 2-67: Alarm view

6. Click the right arrow at the bottom edge of the screen.
   The "HMI PLC code view" screen opens.

7. Click the "PLC code" button of the GRAPH overview.
   The PLC code view shows a part of the "LiftSeq" GRAPH sequencer. The interrupted step is displayed in red.
   The below transition network shows that the state of the "SeqData".sensorLift2Up signal remains "FALSE", i.e. that the unit has not reached the upper end position.

Figure 2-68: PLC code view

8. Click the "Interlock" or "Action / Reaction" button again to disable the supervision.
The error that the GRAPH sequencer displays is automatically acknowledged in the program.

Simulation and diagnostics of an interlock with initial value acquisition (criteria analysis)

To simulate an interlock of the "LiftSeq" GRAPH sequencer, the conveyor system must be running. The interlock is only configured in those steps where a lift is controlled upwards or downwards. The "SeqData".doorClosed signal (lift door closed) ANDed with the "SeqData".liftFree signal (lift not blocked) is programmed as a condition for the interlock. The action in the step will be executed only if the interlock condition is met. If the interlock condition is not met, an alarm will be output. The interlock is triggered by simulating an interlock error. You can additionally display the initial values and directly view the invalid operands (criteria analysis). You can also toggle between the Actual values view and the Initial values view.

To simulate and diagnose an interlock, proceed as follows:

1. Go to the "Plant Overview" screen.
2. If the conveyor system is not running, click the "Start" button.
3. Wait until a case is lifted by lift 1.
4. Click the "Interlock" button to trigger an interlock in a step.
   - The color of the respective button changes to red.
   - In a step with a configured interlock, the lift is no longer controlled and stops.
   - An interlock alarm is output.
   - The red step number in the GRAPH overview indicates an error in the GRAPH sequencer.

Figure 2-69: GRAPH overview

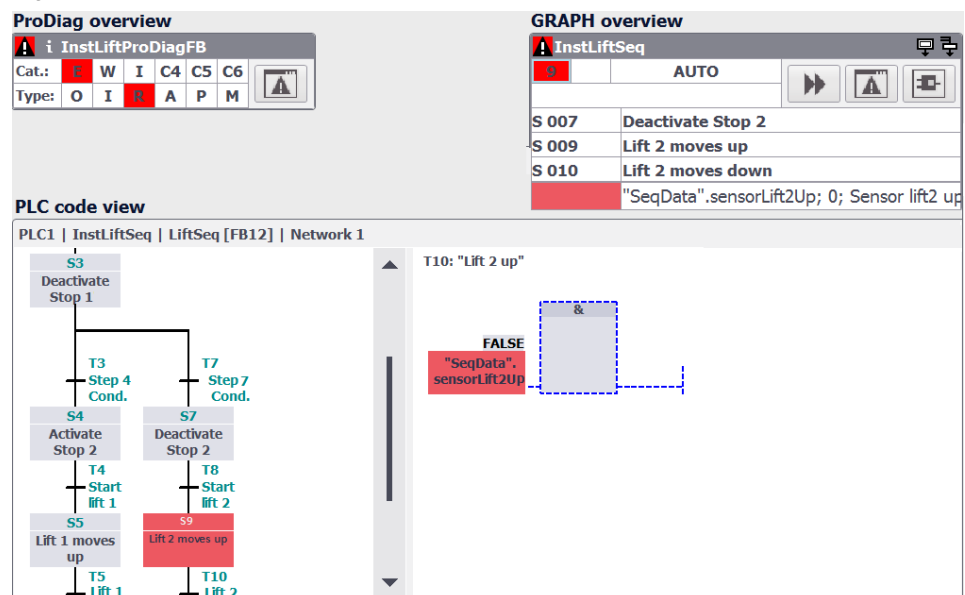5. Click the "Lift blocked" button to simulate the initial value analysis.

6. In the GRAPH overview, click the "Alarm view" button.
   The "Alarms" screen opens.

7. Select the following alarm: "Error: Interlock: Door at lift not closed or lift blocked."

   - The alarm view displays the interlock alarm indicating that the door is not closed or blocked.

   - The Criteria analysis view displays the "SeqData.doorClosed" tag with the value 0. The safety door is not closed.

Figure 2-70: Alarm and Criteria analysis view

8. Click the "PLC code" button and the "HMI PLC code view" screen opens. The PLC code view shows a part of the "LiftSeq" GRAPH sequencer. The step with the interlock alarm is displayed in red.

9. Click the "Transition/Interlock" button to go to the interlock network.

   The "Initial values view" of the interlock network shows that the "SeqData".doorClosed condition is not met, i.e. that the lift door is not closed. The first error is displayed in red.

Figure 2-71: PLC code Initial values view
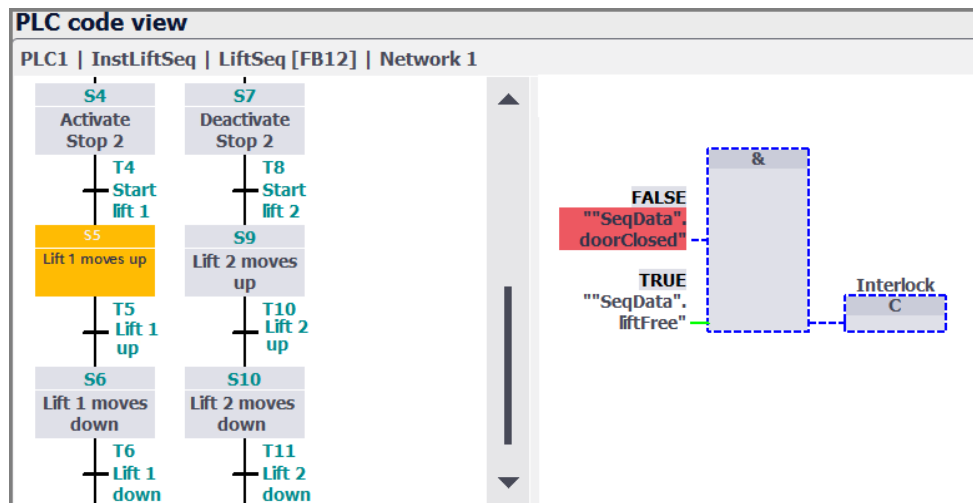
10. Click the "Actual values/Initial values" button to go to the Actual values view.

    The "Actual values view" of the interlock network shows that the two conditions "SeqData".doorClosed and "SeqData".liftFree are not met, i.e. that the lift door is not closed and the lift is not free.

11. Clicking the "Lift blocked" button and the "Interlock" button again disables the interlock.
    The error in the GRAPH sequencer is automatically acknowledged in the program.

## 2.4 Control and diagnostics with WinCC Runtime Professional

The application example was extended for WinCC Runtime Professional. The extension of this application example was implemented with the configuration from Chapter Configuration 2.2.

Note   For ProDiag with WinCC Runtime Professional, the GRAPH block must have been configured in V5.

2.4.1 Overview

The figure shows the Runtime user interface.

Figure 2-72: User interface overview
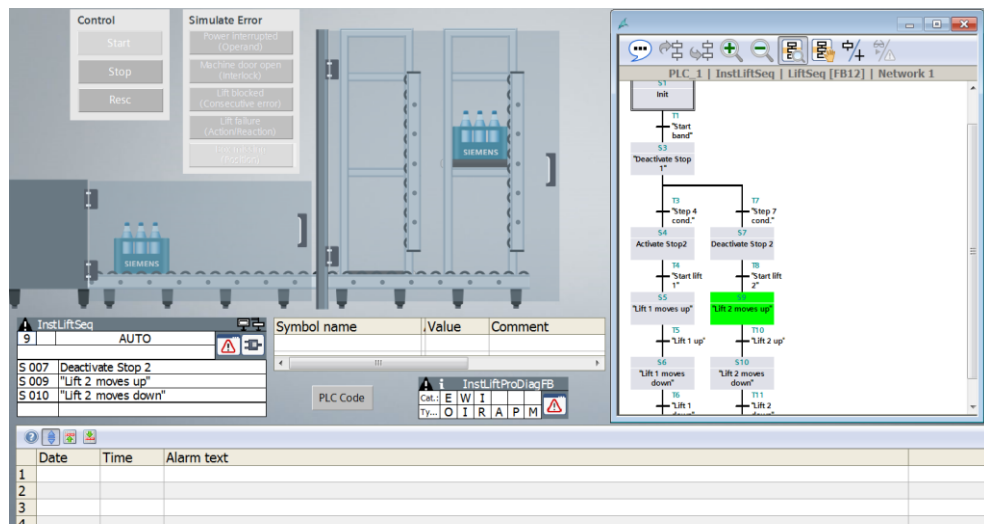
The "ProDiag" screen shows the conveyor belt with the two lifts and the buttons for controlling the plant and simulating errors. In addition, the screen shows

- the current state of the configured supervisions and the GRAPH overview with the current state of the GRAPH sequencer.

- the alarm view with the supervision alarms and the "PLC code" button with which the PLC code view is activated.

- the following HMI diagnostic objects: ProDiag overview, GRAPH overview and Criteria analysis view. The objects allow you to diagnose the supervision alarms.

2.4.2 Controlling the conveyor system

Use the "Control" section to control the conveyor system. The buttons have the following functions.

- "Start" starts the conveyor system.

- "Stop" stops the conveyor system. The conveyor system does not stop immediately. It is not stopped until the lifts reach the lower position. In the meantime, the button flashes.

- "Resc" allows you to manually delete the last recorded initial values.

2.4.3 Simulation and diagnostics of ProDiag supervisions

Simulation and diagnostics of a global operand supervision

You can trigger operand supervisions when the conveyor system is stopped or running.

To simulate and diagnose the operand supervision, proceed as follows:

1. Open the "ProDiag" screen.

2. Click the "Operand" button to trigger the operand supervision of the compressed air and power supply.

   - The color of the "Operand" button changes to red.

The two red symbols in the ProDiag overview, "E" and "O", indicate an error of the "Operand" type.

Figure 2-73: ProDiag overview
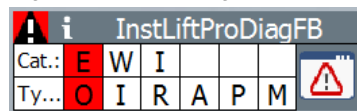
3. In the ProDiag overview, click the "Alarm view" button. The alarm view displays the supervision alarms of the operand errors and the 'exceed upper limit' simulation.

Figure 2-74: Alarm view

4. Click the "Operand" button again to disable the operand supervision.

Simulation and diagnostics of a global position supervision

To simulate a position supervision, the conveyor system must be stopped. The position is supervised where the case is on the belt.

To simulate and diagnose the position supervision, proceed as follows:

1. Open the "ProDiag" screen.
2. If the conveyor system is running, click the "Stop" button and wait until the conveyor system has stopped.
3. To trigger a position supervision, click the "Position" button.

   - The button color changes to red.
   - The sensor display behind the case changes its color from green to red.
   - The orange symbol, "W", and the red symbol, "P", in the ProDiag overview indicate a warning of the "Position" type.

Figure 2-75: ProDiag overview

4. In the ProDiag overview, click the "Alarm view" button. The alarm view displays the supervision alarms of the position error.

Figure 2-76: Alarm view

	Date	Time	Alarm text
1	06/08/18	10:26:24	Warning : Position : LiftProDiagFB : 4 : -- : SeqData.sensorStop1 : Sensor at stopper1

5. Click the "Position" button again to disable the position supervision.

**Simulation and diagnostics of local interlock supervisions**

To simulate the interlock supervisions, the conveyor system must be running. The supervision is not activated until a lift is started upwards or downwards.

To simulate and diagnose an interlock supervision, proceed as follows:

1. Open the "ProDiag" screen.
2. If the conveyor system is not running, click the "Start" button.

3. To trigger an interlock supervision on the lifts, click the "Interlock" button.
The button color changes to red.
The door on the lift opens and the lift stops.
The two red symbols in the ProDiag overview, "E" and "I", indicate an error of
the "Interlock" type.
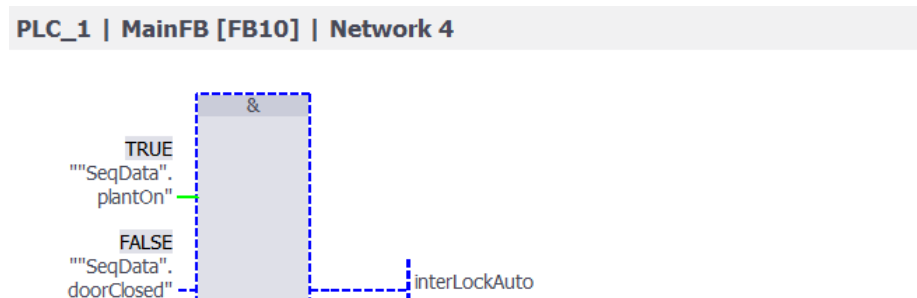
Figure 2-77: ProDiag overview
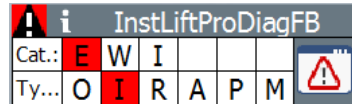
4. In the ProDiag overview, click the "Alarm view" button.
The alarm view displays the supervision alarm of the interlock error and the 'fall
below lower limit' simulation.

Figure 2-78: Alarm view

5. Disable "auto scroll" and select the Interlock alarm.
6. Click the "PLC code" button. The PLC code view displays the block error.

Figure 2-79: PLC code view

7. Click the "Interlock" button again to disable the interlock supervision.

Simulation and diagnostics of local action supervisions

To simulate the action supervisions, the conveyor system must be running and both lifts must not yet be controlled. The supervision is not activated until a lift is controlled upwards or downwards by the program.

To simulate and diagnose the action supervision, proceed as follows:

1. Open the "ProDiag" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until both lifts have stopped and a case is provided for lift 2.

4. Click the "Action / Reaction" button to trigger an action supervision on a lift.

   - The button color changes to red.

   - If a lift is now controlled by the program, it will stop.

   - An action error will be triggered when a delay time has expired.

   - The two red symbols in the ProDiag overview, "E" and "A", indicate an error of the "Action" type.

Figure 2-80: ProDiag overview
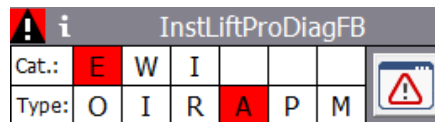
5. In the ProDiag overview, click the "Alarm view" button.
   The alarm view displays the supervision alarm of the action error.
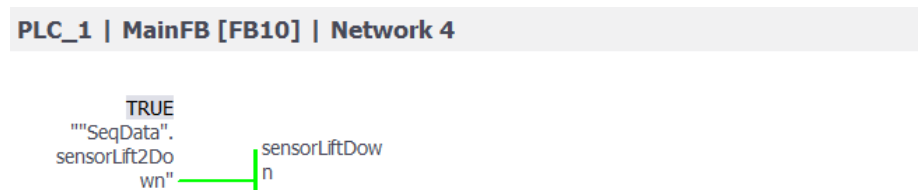
Figure 2-81: Alarm view

	Date	Time	Alarm text
1	06/08/18	10:56:52	Error : Reaction : LiftProDiagFB : 12 : instLift2Cmd : sensorLiftUp : Lift has not reached upper end position
2	06/08/18	10:56:51	Error : GRAPH-Supervision : PLC_1 : LiftSeq : Lift 2 moves up : S009 :
3	06/08/18	10:56:47	Error : Action : LiftProDiagFB : 13 : instLift2Cmd : sensorLiftDown : Lift has not left lower start position

Click the "PLC code" button.
The PLC code view displays the program part at the supervised "sensorLiftDown" input parameter of the "LiftCmd" function block. The link indicates that the state of the "SeqData".sensorLift2Down signal remains "TRUE", i.e. that the unit has not left the lower end position.

Figure 2-82: PLC code view

PLC_1 | MainFB [FB10] | Network 4

```
            TRUE
       ""SeqData".
       sensorLift2Do          sensorLiftDow
             wn"  ————————————  n
```

6. Click the "Action / Reaction" button again to disable the action supervision.

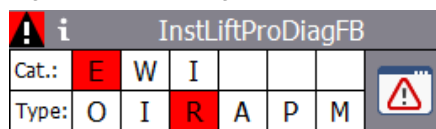| Note	In this application example, an action error, once a delay time has expired, always results in a reaction error.

Simulation and diagnostics of local reaction supervisions

To simulate the reaction supervisions, the conveyor system must be running. The supervision is not activated until a lift is controlled upwards or downwards by the program. If you activate the simulation before a lift is controlled, an action error will be triggered first, later followed by a reaction error. If you activate the simulation during the movement, only a reaction error will be triggered.

To simulate and diagnose the reaction supervision, proceed as follows:

1. Open the "ProDiag" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until a case is lifted by lift 2.

4. Click the "Action / Reaction" button to trigger a reaction supervision on the lifts.

   - The button color changes to red.

   - If a lift is now controlled, it will stop. A lift that has already been controlled will be stopped.

   - A reaction error will not be triggered until a delay time has expired.

   - The two red symbols in the ProDiag overview, "E" and "R", indicate an error of the "Reaction" type.

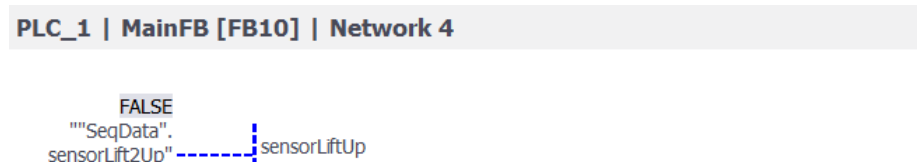Figure 2-83: ProDiag overview

5. In the ProDiag overview, click the "Alarm view" button.
   The alarm view displays the supervision alarm of the reaction error.

Figure 2-84: Alarm view

6. Disable "auto scroll" and select the alarm.

7. Click the "PLC code" button.

   - The PLC code view displays the program part at the supervised "sensorLiftUp" input parameter of the "LiftCmd" function block.

   - The link indicates that the state of the "SeqData".sensorLift2Up signal remains "FALSE", i.e. that the unit has not reached the upper end position.

Figure 2-85: PLC code view

8. Click the "Action / Reaction" button again to disable the reaction supervision.

2.4.4 Simulation and diagnostics of GRAPH supervisions

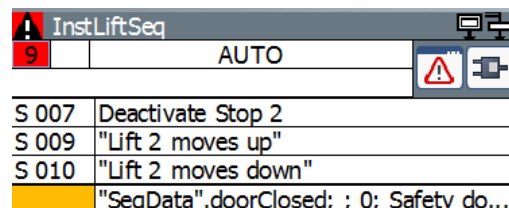**Simulation and diagnostics of a supervision (step supervision)**

Technologically, the GRAPH supervision can be compared to a reaction supervision.

To simulate a supervision of the "LiftSeq" GRAPH sequencer, the conveyor system must be running. The supervision is only configured in those steps where a lift is controlled upwards or downwards. The respective end position of the movement is configured as a transition (step enabling condition for the next step). The specified step duration of a step is supervised in the supervision. If the movement within a step takes too long, the supervision will be activated and an alarm will be output. The supervision is triggered by simulating an interlock error or an action/reaction error.

To simulate and diagnose the supervision, proceed as follows:

1. Open the "ProDiag" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until a case is lifted by lift 2.

4. Click the "Interlock" or "Action / Reaction" button to trigger a supervision in a step.

   - The color of the respective button changes to red.

   - If a lift is now controlled, it will stop.

   - A lift that has already been controlled will be stopped.

   - When the specified step duration has expired, an alarm will be output.

   - The red step number in the GRAPH overview indicates an error in the GRAPH sequencer.
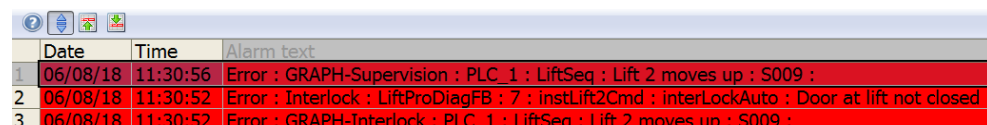
Figure 2-86: GRAPH overview

5. In the GRAPH overview, click the "Alarm view" button.
   The alarm view displays the error alarm of the supervision.

Figure 2-87: Alarm view

6. Select the following alarm: "Error: GRAPH-Supervision: PLC_1: LiftSeq: Lift 2 moves up: S009".

7. Click the "PLC code" button of the GRAPH overview.
The PLC code view shows a part of the "LiftSeq" GRAPH sequencer. The interrupted step is displayed in red. The below transition network shows that the state of the "SeqData".sensorLift2Up signal remains "FALSE", i.e. that the unit has not reached the upper end position.

Figure 2-88: PLC code view
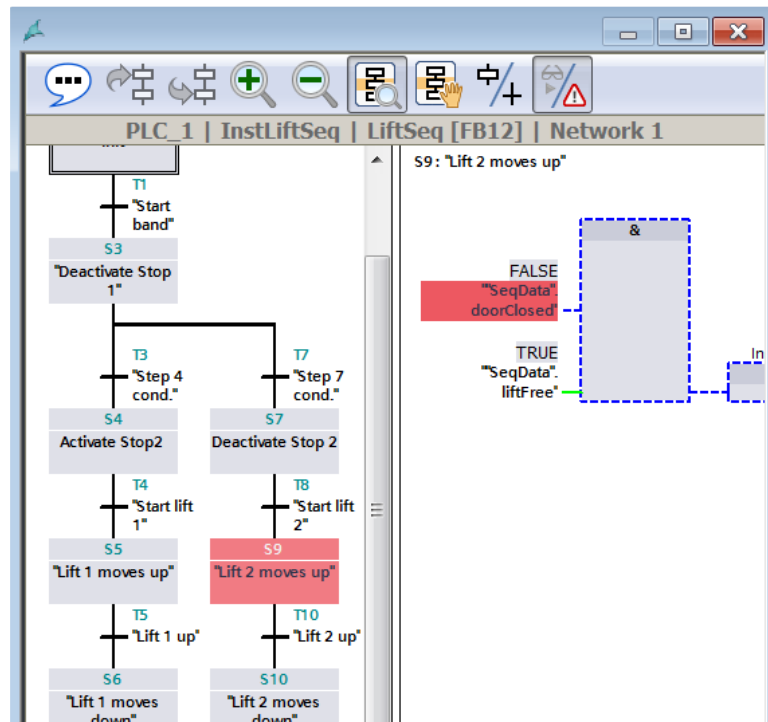
8. This information is also displayed in the Criteria analysis view.

Figure 2-89: Criteria analysis view

Symbol name	Value	Comment
"SeqData".sensorLift2Up	0	Sensor lift2 up

9. Click the "Interlock" or "Action / Reaction" button again to disable the supervision.
The error that the GRAPH sequencer displays is automatically acknowledged in the program.

Simulation and diagnostics of an interlock with initial value acquisition (criteria analysis)

To simulate an interlock of the "LiftSeq" GRAPH sequencer, the conveyor system must be running. The interlock is only configured in those steps where a lift is controlled upwards or downwards. The "SeqData".doorClosed signal (lift door closed) ANDed with the "SeqData".liftFree signal (lift not blocked) is programmed as a condition for the interlock. The action in the step will be executed only if the interlock condition is met. If the interlock condition is not met, an alarm will be output. The interlock is triggered by simulating an interlock error. You can additionally display the initial values and directly view the invalid operands (criteria analysis). You can toggle between the Actual values view and the Initial values view.

To simulate and diagnose an interlock, proceed as follows:

1. Open the "ProDiag" screen.

2. If the conveyor system is not running, click the "Start" button.

3. Wait until a case is lifted by lift 1.

4. Click the "Interlock" button to trigger an interlock in a step.

5. Click the "Lift blocked" button.

   - The color of the respective button changes to red.

   - In a step with a configured interlock, the lift is no longer controlled and stops.

   - An interlock alarm is output.

   - The red step number in the GRAPH overview indicates an error in the GRAPH sequencer.

Figure 2-90: GRAPH overview

6. In the GRAPH overview, click the "Alarm view" button.
   The alarm view displays the interlock alarm.

Figure 2-91: Alarm view

Select the following alarm: "Error: GRAPH-Supervision: PLC_1: LiftSeq: Lift 2 moves up: S009".

7. Click the "PLC code view" button of the GRAPH overview or the "PLC code" button. The PLC code view shows a part of the "LiftSeq" GRAPH sequencer. The step with the interlock alarm is displayed in red.

   The "Initial values view" of the interlock network shows that the "SeqData".doorClosed condition is not met, i.e. that the lift door is not closed. The first error is displayed in red.

Figure 2-92: PLC code Initial values view
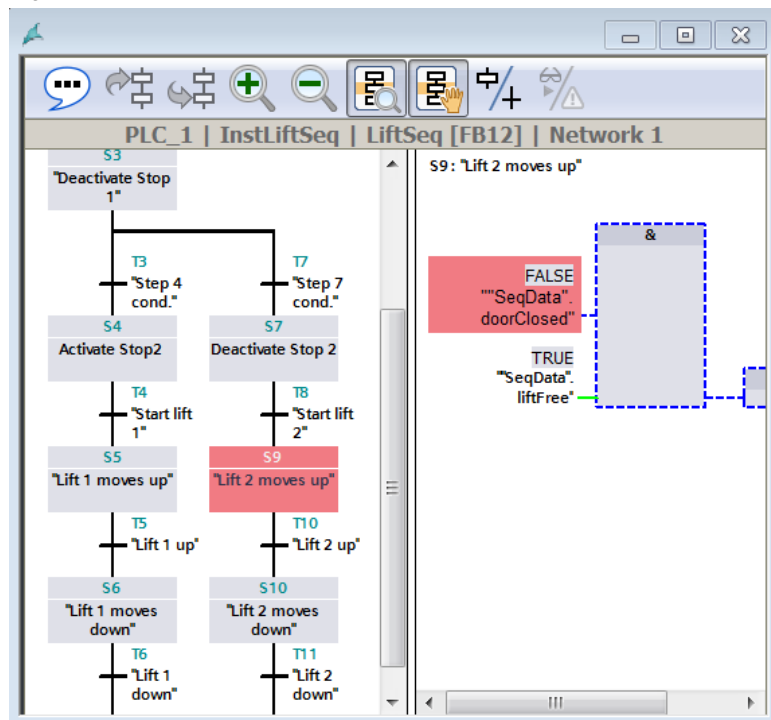
8. Clicking the "Actual values/Initial values" button allows you to go to the Actual values view.

9. The "Actual values view" of the interlock network shows that the two conditions "SeqData".doorClosed and "SeqData".liftFree are not met, i.e. that the lift door is not closed and the lift is not free.

Figure 2-93 PLC code Actual values view
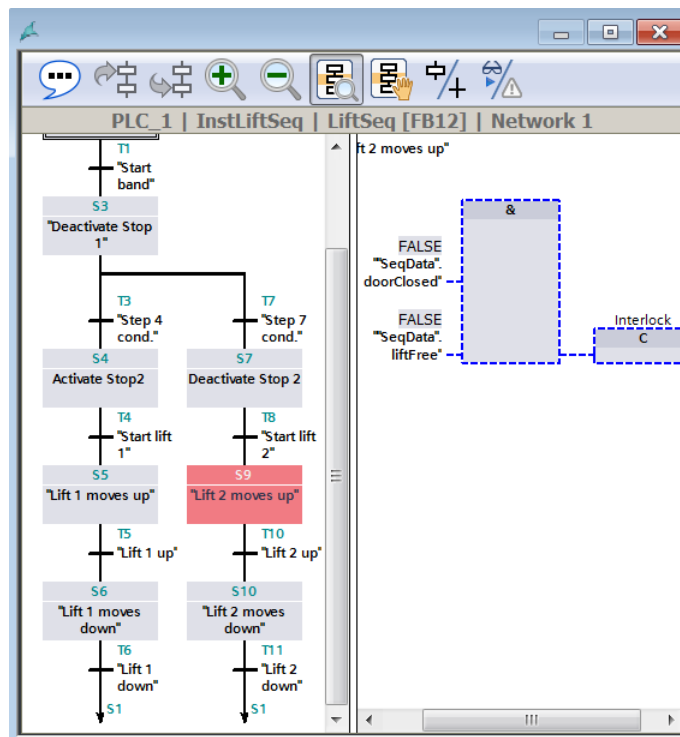
10. The "Lift blocked" button and the "Interlock" button disable the interlock. The error in the GRAPH sequencer is automatically acknowledged in the program.

Simulation of the Error message supervision type with the text from the specific text field

1. In the project tree, navigate to "PLC1 > Watch and force tables" and open the "WatchTableFreq" watch table.

2. Click the glasses icon to change the watch table to the Online view.

3. In "Modify value", enter a value greater than 10.0, e.g. 11.0.

4. In the toolbar, click the "Modify now" function. This action simulates 'exceed upper limit'.

Figure 2-94: Watch table

5. Go to WinCC Professional. In the ProDiag overview, the two symbols "E" and "M" are displayed in red.

Figure 2-95: ProDiag overview
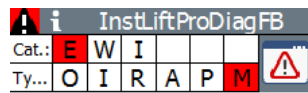
6. In the ProDiag overview, click the "Alarm view" button. The error message is displayed as shown in the below figure.

Figure 2-96: "Frequency value greater than" error message

7. Return to the watch table and in "Modify value", enter a value less than 5.0, e.g. 4.0.

8. In the toolbar, click the "Modify now" function. This action simulates 'fall below lower limit'.

9. Return to WinCC Professional. The error message is displayed as shown in the below figure.

Figure 2-97: "Frequency value less than" error message

10. To stop the simulation, change the "SeqData".frequency DB tag in the watch table to the value 10.0.

3 Appendix

3.1 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:
support.industry.siemens.com

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- Repair services
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- Service programs and contracts

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support.industry.siemens.com/cs/sc

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You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
support.industry.siemens.com/cs/ww/en/sc/2067

3.2 Links and literature

Table 3-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/109740151
\3\	STEP 7 and WinCC Engineering V15 system manual: https://support.industry.siemens.com/cs/ww/en/view/109755202

3.3 Change documentation

Table 3-2

Version	Date	Modifications
V1.0	10/2016	First version
V2.0	12/2016	WinCC Runtime Professional added
V3.0	09/2017	Initial value acquisition (criteria analysis) added
V4.0	07/2018	Updated and new functions added with TIA Portal V15
V4.1	03/2019	Text changed in chapter 2.2.7