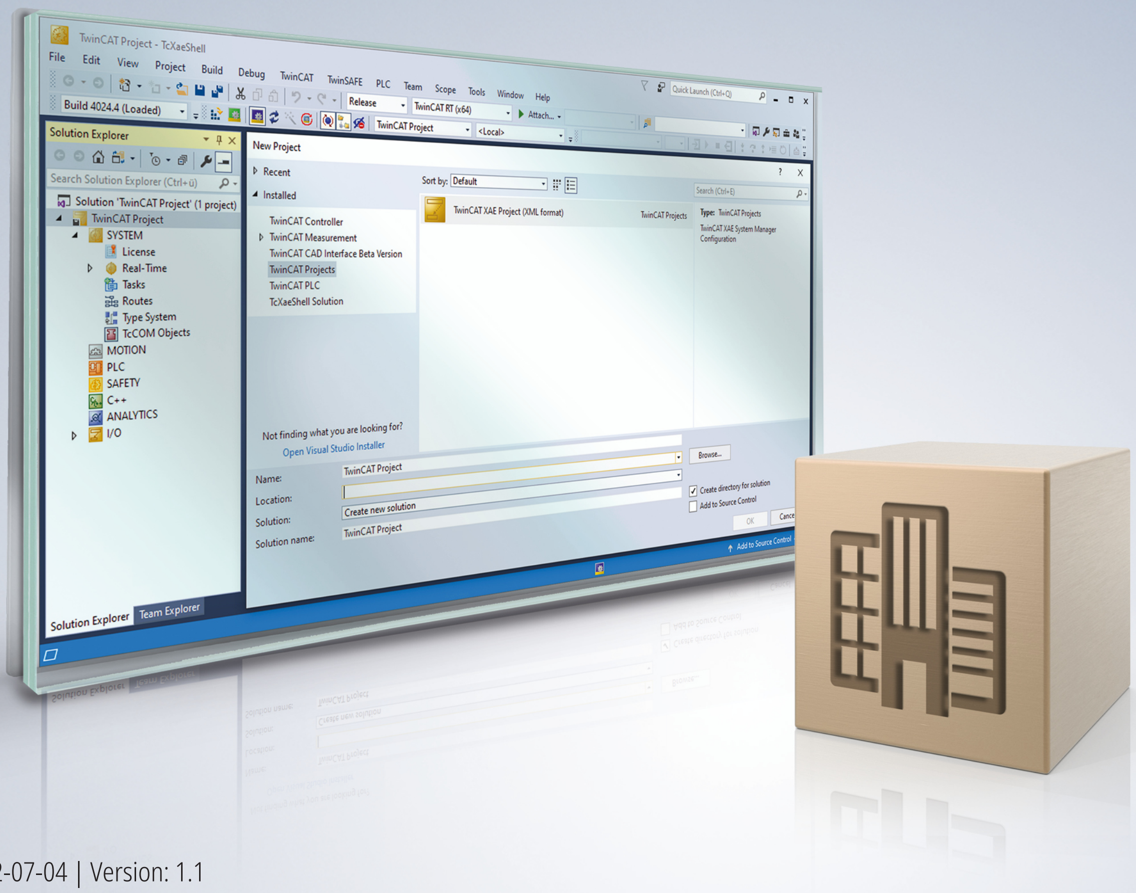
BECKHOFF New Automation Technology

Manual | EN

TF8010

TwinCAT 3 | Building Automation Basic



2022-07-04 | Version: 1.1

Table of contents

1 Foreword

1.1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

Beckhoff®, TwinCAT®, TwinCAT/BSD®, TC/BSD®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered trademarks of and licensed by Beckhoff Automation GmbH.
Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:
EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702
with corresponding applications or registrations in various other countries.

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

Copyright

1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

⚠ DANGER

Serious risk of injury!

Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.

NOTE

Damage to the environment or devices

Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our https://www.beckhoff.com/secguide.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at https://www.beckhoff.com/secinfo.

2 Introduction

The library offers users basic functions for room automation and building control.

The user of this library requires basic knowledge of the following:

- TwinCAT XAE
- Design and characteristics of Beckhoff IPCs and their Bus Terminal system
- Relevant safety regulations for building technical equipment

This software library is intended for building automation system partners of Beckhoff Automation GmbH & Co. KG. The system partners operate in the field of building automation and are concerned with the installation, commissioning, expansion, maintenance and service of measurement, control and regulating systems for the technical equipment of buildings.

The Tc3 Building Automation Basic library can be used on all hardware platforms that support TwinCAT 3.1 or higher.

3 Integration in TwinCAT

3.1 System requirements

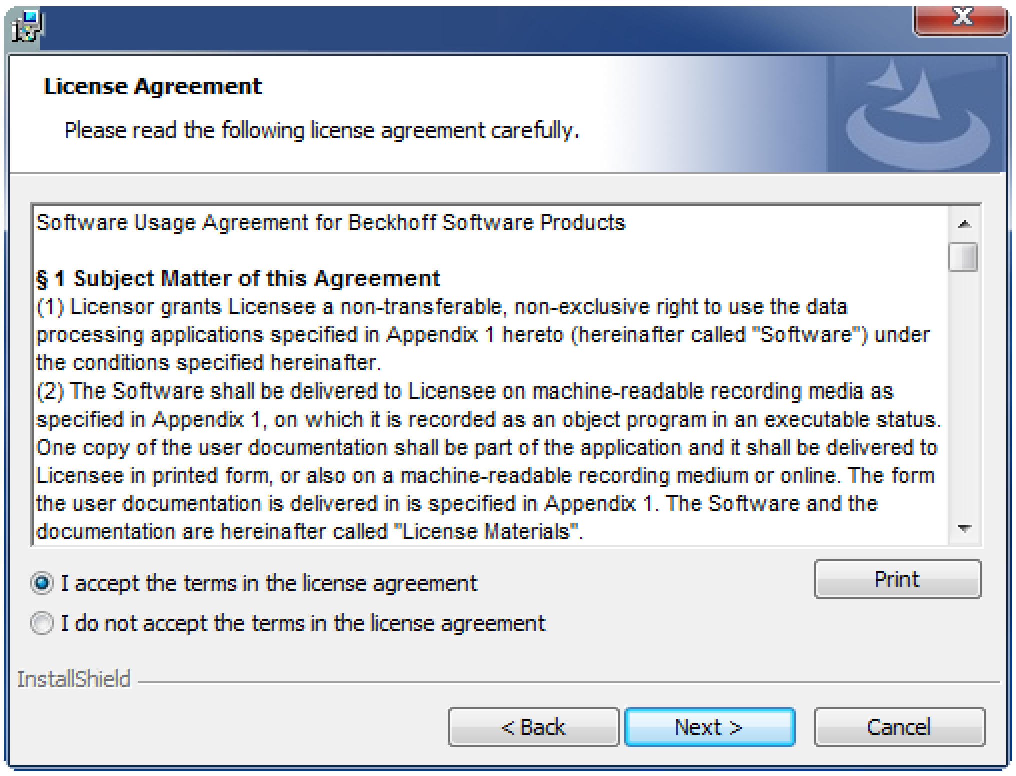
Technical data	Requirement
Operating system	Windows 7/10, Windows Embedded Standard 7, Windows CE 7
Target platform	PC architecture (x86, x64 or ARM)
TwinCAT version	TwinCAT 3.1 build 4020.32 or higher
Required TwinCAT setup level	TwinCAT 3 XAE, XAR
Required TwinCAT license	TF8010_TC3 Building Automation Basic

3.2 Installation

The following section describes how to install the TwinCAT 3 Function for Windows-based operating systems.

✓ The TwinCAT 3 Function setup file was downloaded from the Beckhoff website.

1. Run the setup file as administrator. To do this, select the command **Run as administrator** in the context menu of the file.
   ⇨ The installation dialog opens.
2. Accept the end user licensing agreement and click **Next**.


License Agreement

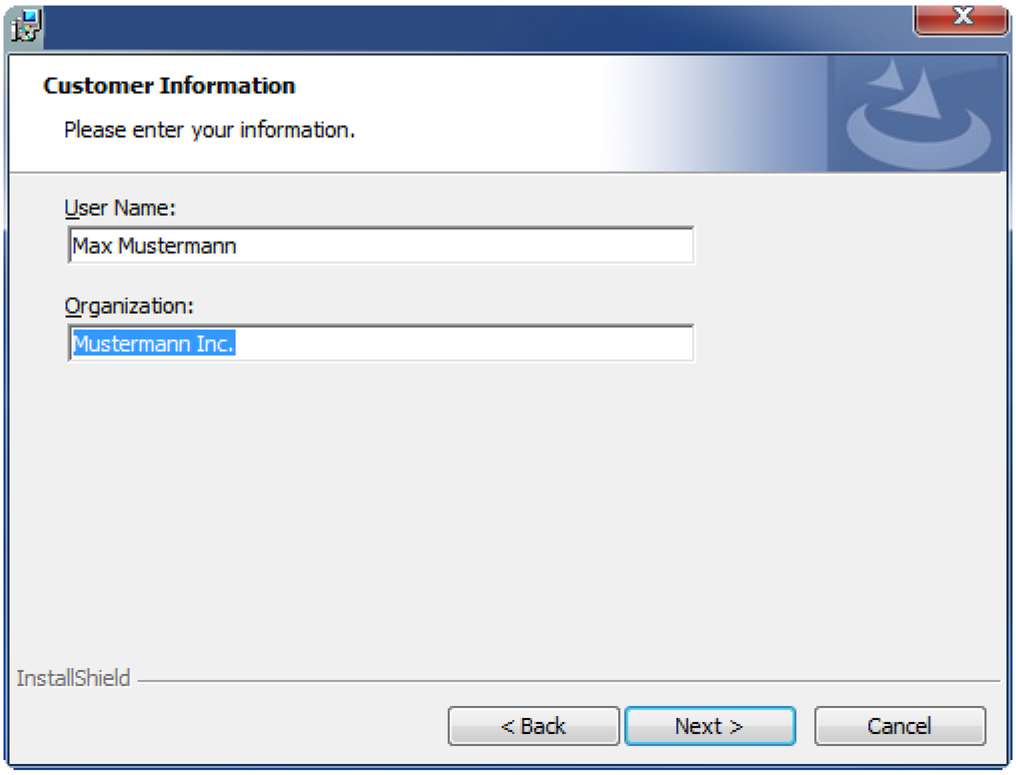
Please read the following license agreement carefully.

Software Usage Agreement for Beckhoff Software Products

§ 1 Subject Matter of this Agreement
(1) Licensor grants Licensee a non-transferable, non-exclusive right to use the data processing applications specified in Appendix 1 hereto (hereinafter called "Software") under the conditions specified hereinafter.
(2) The Software shall be delivered to Licensee on machine-readable recording media as specified in Appendix 1, on which it is recorded as an object program in an executable status. One copy of the user documentation shall be part of the application and it shall be delivered to Licensee in printed form, or also on a machine-readable recording medium or online. The form the user documentation is delivered in is specified in Appendix 1. The Software and the documentation are hereinafter called "License Materials".

[✓ I accept the terms in the license agreement]
I do not accept the terms in the license agreement

3. Enter your user data.



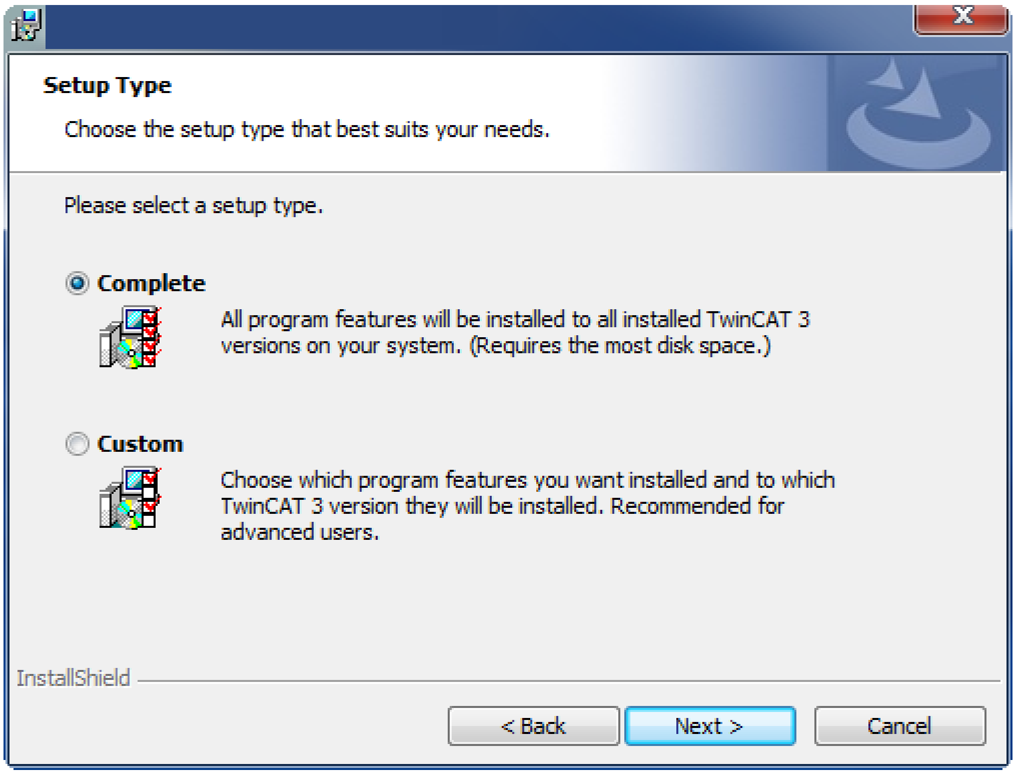
Customer Information

Please enter your information.

User Name:
Max Mustermann

Organization:
Mustermann Inc.

4. If you want to install the full version of the TwinCAT 3 Function, select **Complete** as installation type. If you want to install the TwinCAT 3 Function components separately, select **Custom**.



Setup Type

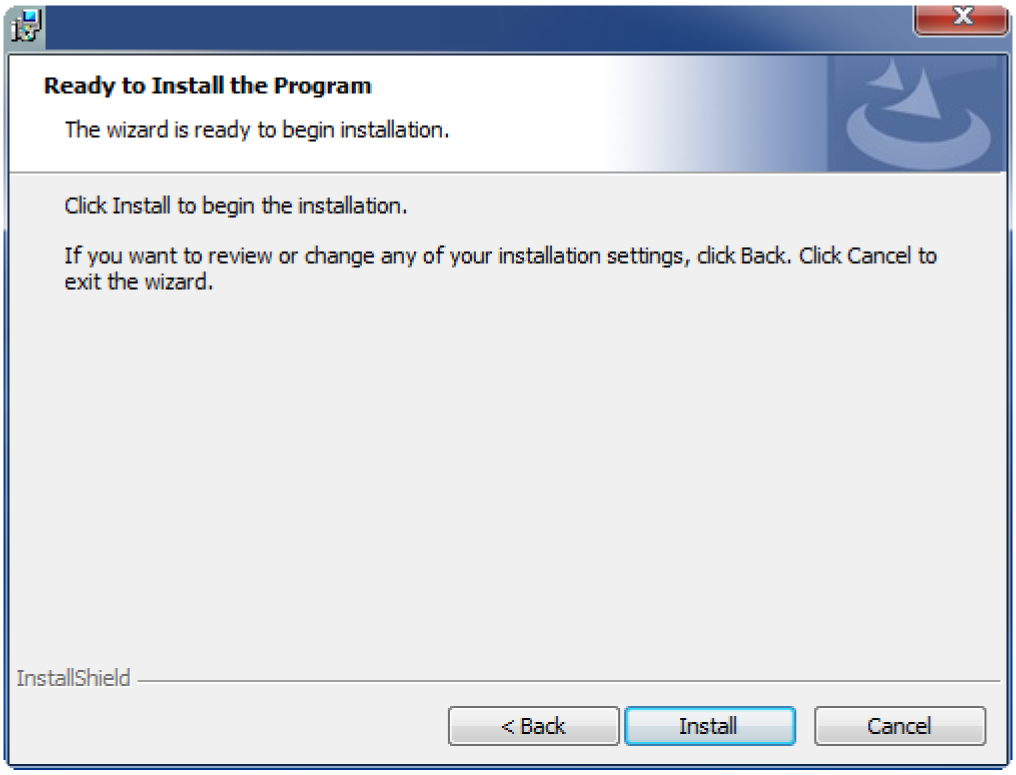
Choose the setup type that best suits your needs.

Please select a setup type.

[✓ Complete]
All program features will be installed to all installed TwinCAT 3 versions on your system. (Requires the most disk space.)

Custom
Choose which program features you want installed and to which TwinCAT 3 version they will be installed. Recommended for advanced users.

5. Select **Next**, then **Install** to start the installation.


Ready to Install the Program

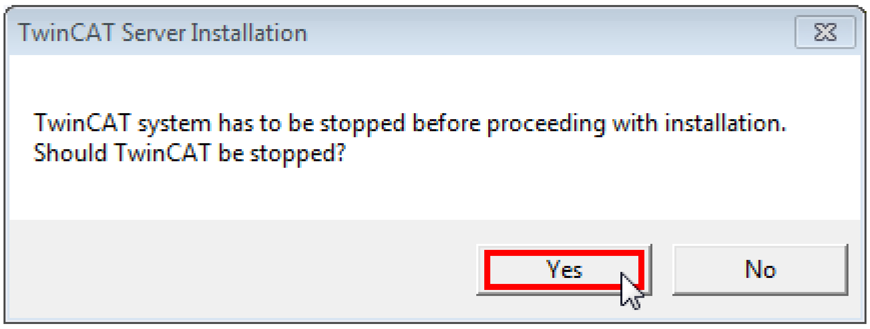
The wizard is ready to begin installation.

Click Install to begin the installation.

If you want to review or change any of your installation settings, click Back. Click Cancel to exit the wizard.

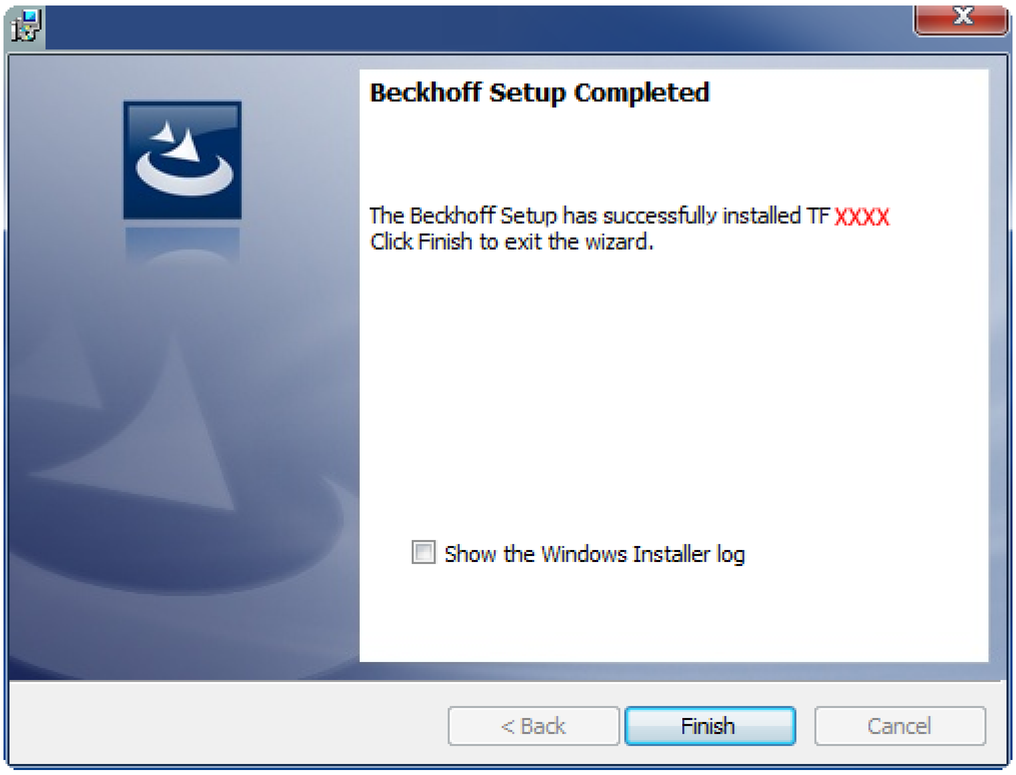
⇨ A dialog box informs you that the TwinCAT system must be stopped to proceed with the installation.

6. Confirm the dialog with **Yes**.


TwinCAT Server Installation

TwinCAT system has to be stopped before proceeding with installation.
Should TwinCAT be stopped?

7. Select **Finish** to exit the setup.



Beckhoff Setup Completed

The Beckhoff Setup has successfully installed TF XXXX
Click Finish to exit the wizard.

⇨ The TwinCAT 3 Function has been successfully installed and can be licensed (see Licensing [▶ 12]).

3.3 Licensing

The TwinCAT 3 function can be activated as a full version or as a 7-day test version. Both license types can be activated via the TwinCAT 3 development environment (XAE).

Licensing the full version of a TwinCAT 3 Function

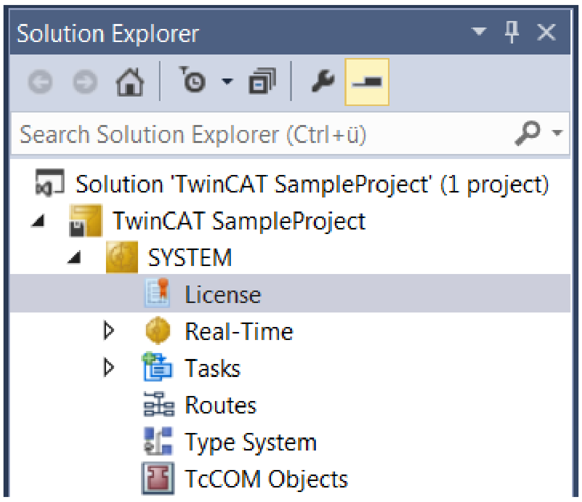
A description of the procedure to license a full version can be found in the Beckhoff Information System in the documentation "TwinCAT 3 Licensing".

Licensing the 7-day test version of a TwinCAT 3 Function

A 7-day test version cannot be enabled for a TwinCAT 3 license dongle.

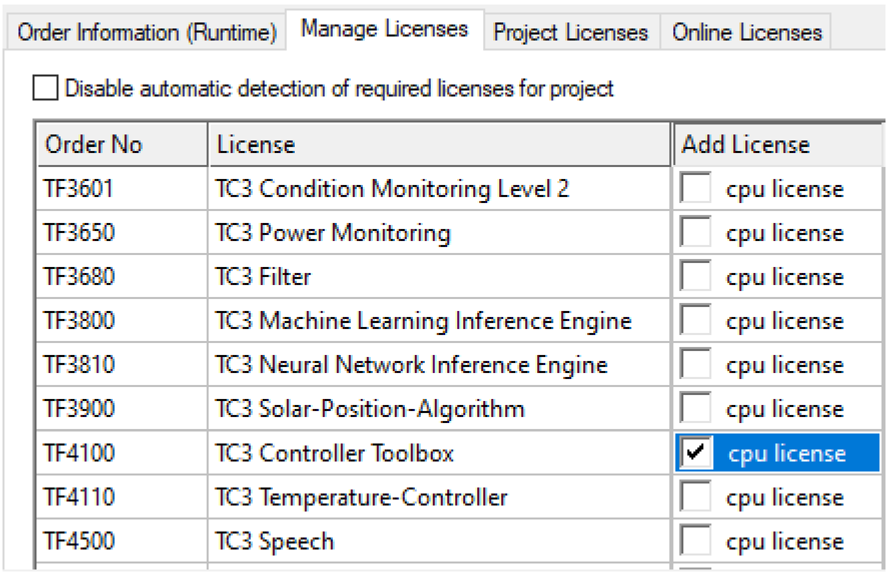
1. Start the TwinCAT 3 development environment (XAE).
2. Open an existing TwinCAT 3 project or create a new project.
3. If you want to activate the license for a remote device, set the desired target system. To do this, select the target system from the **Choose Target System** drop-down list in the toolbar.
   ⇨ The licensing settings always refer to the selected target system. When the project is activated on the target system, the corresponding TwinCAT 3 licenses are automatically copied to this system.

4. In the **Solution Explorer**, double-click **License** in the **SYSTEM** subtree.



⇨ The TwinCAT 3 license manager opens.

5. Open the **Manage Licenses** tab. In the **Add License** column, check the check box for the license you want to add to your project (e.g. "TF4100 TC3 Controller Toolbox").



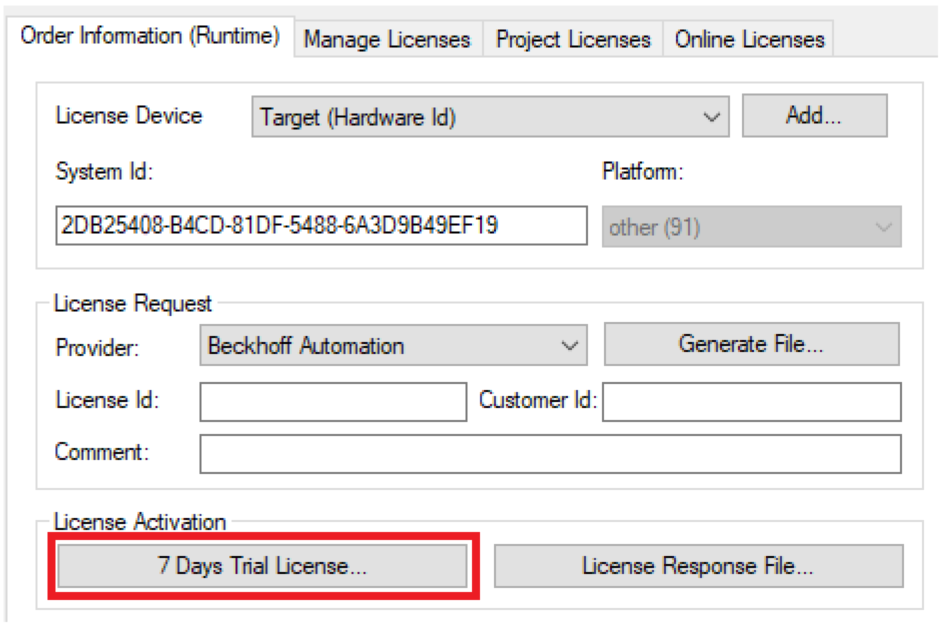
☐ Disable automatic detection of required licenses for project

Order No	License	Add License
TF3601	TC3 Condition Monitoring Level 2	☐ cpu license
TF3650	TC3 Power Monitoring	☐ cpu license
TF3680	TC3 Filter	☐ cpu license
TF3800	TC3 Machine Learning Inference Engine	☐ cpu license
TF3810	TC3 Neural Network Inference Engine	☐ cpu license
TF3900	TC3 Solar-Position-Algorithm	☐ cpu license
TF4100	TC3 Controller Toolbox	✓ cpu license
TF4110	TC3 Temperature-Controller	☐ cpu license
TF4500	TC3 Speech	☐ cpu license

6. Open the **Order Information (Runtime)** tab.

⇨ In the tabular overview of licenses, the previously selected license is displayed with the status “missing”**.**

7. Click **7-Day Trial License...** to activate the 7-day trial license.



License Device: Target (Hardware Id)

System Id: 2DB25408-B4CD-81DF-5488-6A3D9B49EF19

Platform: other (91)

License Request

Provider: Beckhoff Automation

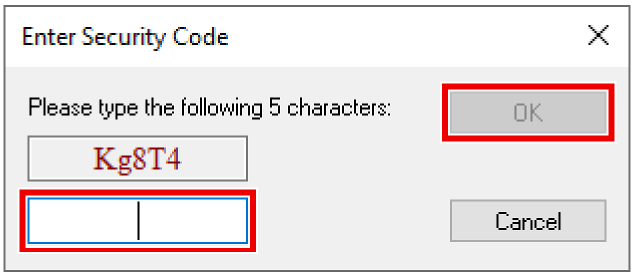
License Id:

Customer Id:

Comment:

License Activation

⇨ A dialog box opens, prompting you to enter the security code displayed in the dialog.



Please type the following 5 characters:

Kg8T4

8. Enter the code exactly as it is displayed and confirm the entry.
9. Confirm the subsequent dialog, which indicates the successful activation.
   ⇨ In the tabular overview of licenses, the license status now indicates the expiry date of the license.
10. Restart the TwinCAT system.

⇨ The 7-day trial version is enabled.

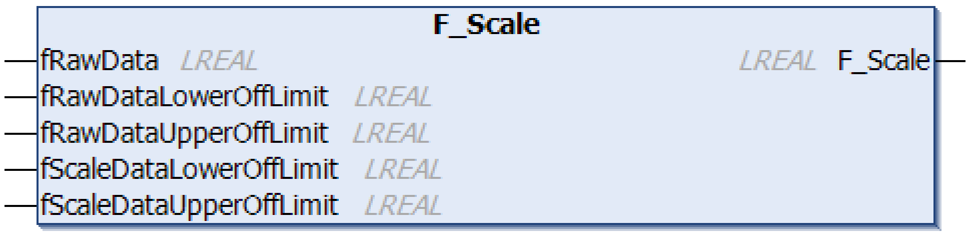
4 Programming

The TwinCAT PLC Building Automation library contains useful function blocks for building automation.

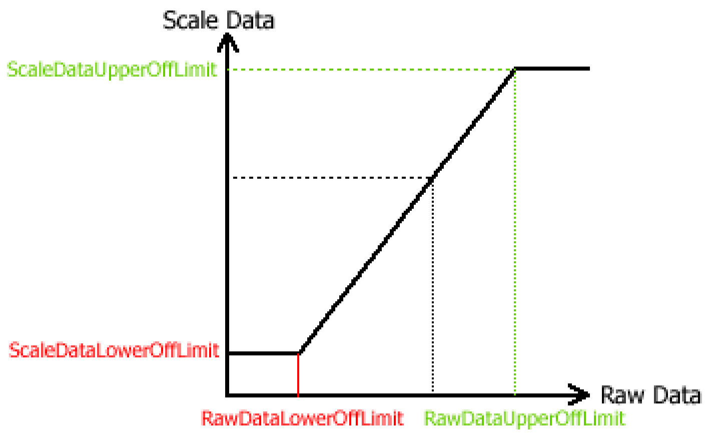
4.1 POUs

4.1.1 Conversion functions

4.1.1.1 F_Scale


F_Scale
fRawData LREAL
fRawDataLowerOffLimit LREAL
fRawDataUpperOffLimit LREAL
fScaleDataLowerOffLimit LREAL
fScaleDataUpperOffLimit LREAL
LREAL F_Scale

A raw analog value is scaled to the specified measuring range and returned as the function value. If the raw value extends beyond the upper or lower measuring range, the corresponding limit value is output. There must be a difference of at least 0.01 between the upper and lower limit values for the raw data. If this is not the case, the lower limit value is output.



FUNCTION F_Scale: LREAL

VAR_INPUT

```
fRawData                  : LREAL;
fRawDataLowerOffLimit     : LREAL;
fRawDataUpperOffLimit     : LREAL;
fScaleDataLowerOffLimit   : LREAL;
fScaleDataUpperOffLimit   : LREAL;
```

fRawData: raw value.

fRawDataLowerOffLimit: Lower limit for raw value.

fRawDataUpperOffLimit: Upper limit for raw value.

fScaleDataLowerOffLimit: Lower limit of scaled measured value.

fScaleDataUpperOffLimit: Upper limit of scaled measured value.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.1.2 Temperature conversion functions

between Kelvin, Celsius, Reaumur and Fahrenheit.

F_TO_C	**K_TO_F**	**C_TO_F**	**R_TO_K**
F_TO_K	**K_TO_C**	**C_TO_K**	**R_TO_C**
F_TO_R	**K_TO_R**	**C_TO_R**	**R_TO_F**

Overview

	Kelvin (K)	Degrees Celsius (°C)	Reaumur (°R)	Fahrenheit (°F)
Absolute zero	0	-273.15	-218.52	-459.67
Melting point	273.15	0	0	32
Boiling point	373.15	100	80	212

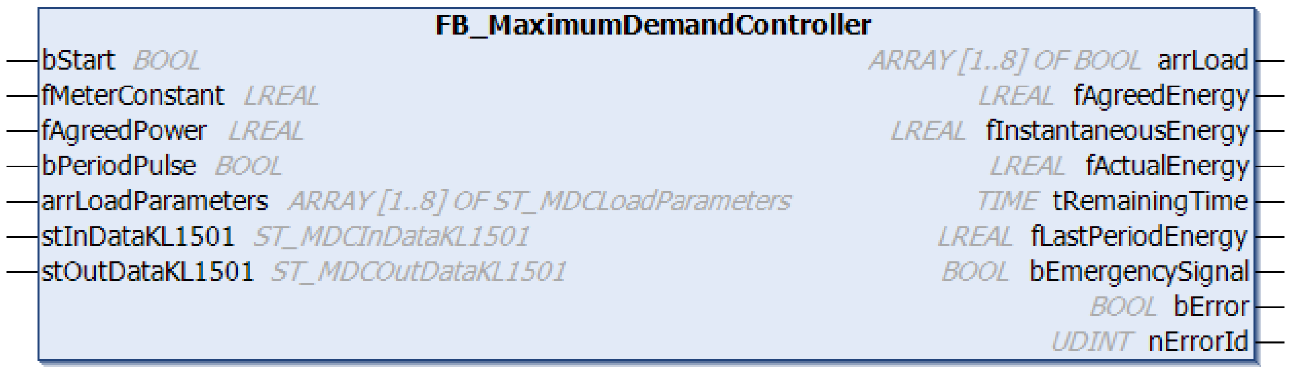
(The melting and boiling points refer to pure water.)

Conversion rules

	Kelvin (K)	Degrees Celsius (°C)	Reaumur (°R)	Fahrenheit (°F)
x = Kelvin (K)	-	$= x - 273{,}15\,°\mathrm{C}$	$= \frac{4}{5}(x - 273{,}15)\,°\mathrm{R}$	$= \frac{9}{5}(x - 273{,}15) + 32\,°\mathrm{F}$
x = degrees Celsius (°C)	$= x + 273{,}15\,\mathrm{K}$	-	$= \frac{4}{5}x\,°\mathrm{R}$	$= \frac{9}{5}x + 32\,°\mathrm{F}$
x = Reaumur (°R)	$= \frac{5}{4}x + 273{,}15\,\mathrm{K}$	$= \frac{5}{4}x\,°\mathrm{C}$	-	$= \frac{9}{4}x + 32\,°\mathrm{F}$
x = Fahrenheit (°F)	$= \frac{5}{9}(x - 32) + 273{,}15\,\mathrm{K}$	$= \frac{5}{9}(x - 32)\,°\mathrm{C}$	$= \frac{4}{9}(x - 32)\,°\mathrm{R}$	-

4.1.2 Energy management

4.1.2.1 FB_MaximumDemandController


FB_MaximumDemandController
bStart BOOL
fMeterConstant LREAL
fAgreedPower LREAL
bPeriodPulse BOOL
arrLoadParameters ARRAY [1..8] OF ST_MDCLoadParameters
stInDataKL1501 ST_MDCInDataKL1501
stOutDataKL1501 ST_MDCOutDataKL1501
ARRAY [1..8] OF BOOL arrLoad
LREAL fAgreedEnergy
LREAL fInstantaneousEnergy
LREAL fActualEnergy
TIME tRemainingTime
LREAL fLastPeriodEnergy
BOOL bEmergencySignal
BOOL bError
UDINT nErrorId

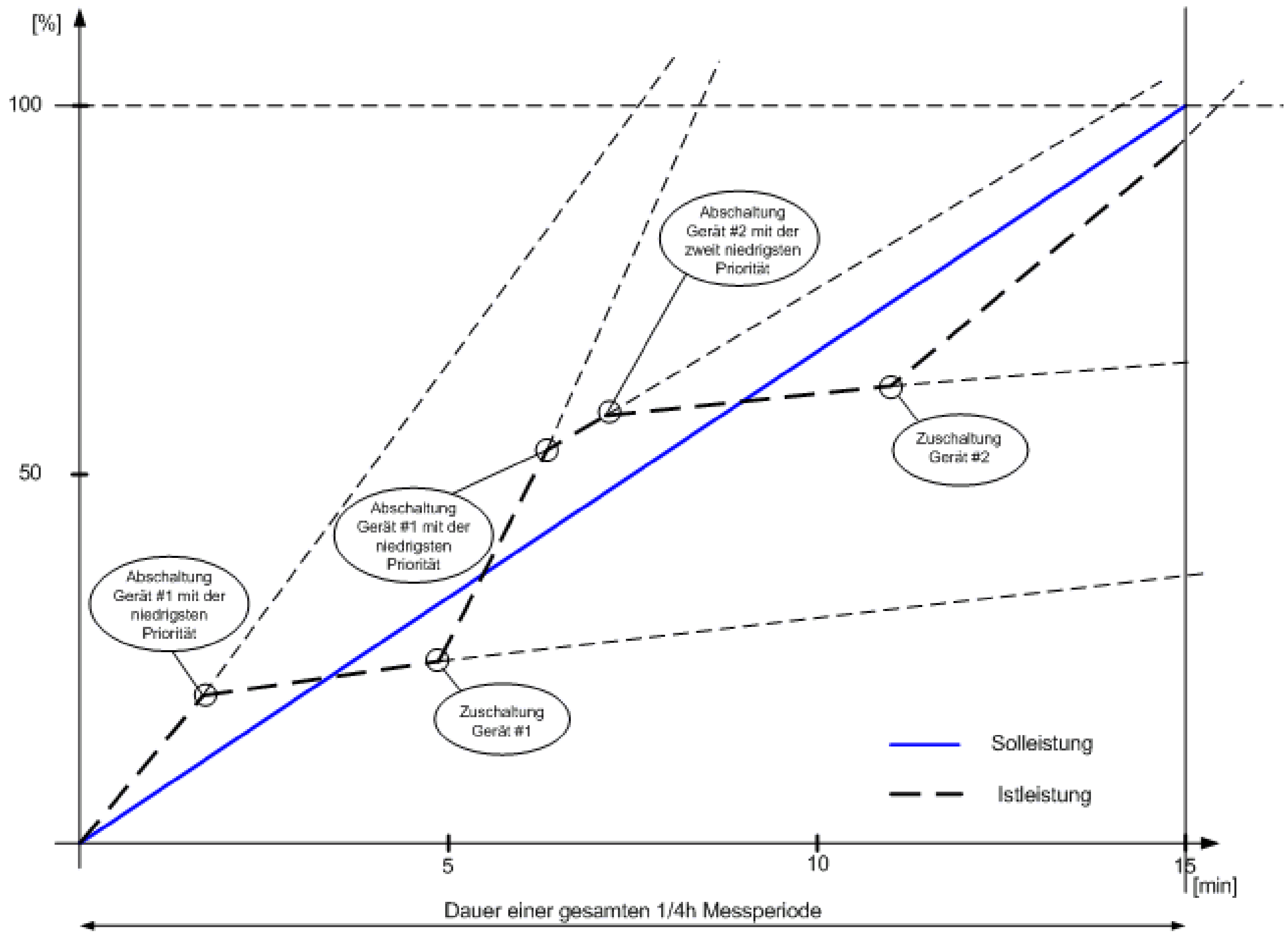
Function block for peak load optimization, which ensures that the set power limit is maintained by switching up to eight consumers on or off. The consumers can be switched off according to their power and priority in such a manner that the production process is not disturbed.

In order to distinguish the individual measurement cycles, a synchronization pulse is supplied by the electricity supply company. It indicates the start of a new measuring cycle and must be linked to the input *bPeriodPulse*. The actual power is recorded via the KL1501 counter terminal.

The function block works with a fixed measuring period of 15 minutes. If the synchronization pulse exceeds the 16 minute limit, the output *bEmergencySignal* is set.

All consumers are switched on at the start of each measuring period. In the event that the power limit (*fAgreedPower*) threatens to be exceeded within the measuring period, the consumers are switched off one after the other. If the danger of an excess load no longer exists, the consumers are switched on again.

Special items, such as minimum power-on time, minimum power-off time or maximum power-off time can be specified via an input variable. The priority of the individual consumers can similarly be determined. Consumers with a low priority will be switched off before consumers with a high priority.



VAR_INPUT

```
bStart                : BOOL;
fMeterConstant        : LREAL;
fAgreedPower          : LREAL;
bPeriodPulse          : BOOL;
arrLoadParameter      : ARRAY[1..8] OF ST_MDCLoadParameters;
```

bStart: The function block is activated by a positive edge at this input.

fMeterConstant: Meter constant [pulses / kWh].

fAgreedPower: This is the agreed power limit which, as far as possible, should not be exceeded in the operational case [kW].

bPeriodPulse: Synchronization pulse sent by the electricity supply company (ESC). This pulse starts the measurement interval.

arrLoadParameter: Parameter structure of the respective consumer (see ST_MDCLoadParameters [▸ 94]).

VAR_OUTPUT

```
arrLoad                : ARRAY[1..8] OF BOOL;
fAgreedEnergy          : LREAL;
fInstantaneousEnergy   : LREAL;
fActualEnergy          : LREAL;
tRemainingTime         : TIME;
fLastPeriodEnergy      : LREAL;
bEmergencySignal       : BOOL;
bError                 : BOOL;
nErrorId               : UDINT;
```

arrLoad: This is an array of data type BOOL; consumers that are switched on are TRUE.

fAgreedEnergy: Agreed energy consumption [kWh].

fInstantaneousEnergy: Current energy consumption [kWh] over an integration period of 15s (internal measuring interval).

fActualEnergy: Energy consumed at the "presently" observed point in time of the measuring period.

tRemainingTime: Time remaining until the next measurement interval.

fLastPeriodEnergy: Rated power from the preceding measuring period [kWh].

bEmergencySignal: This output is set as soon as the specified energy is exceeded.

bError: This output is switched to TRUE as soon as an error occurs during the execution of a command.

nErrorId: Contains the error code [▸ 93].

VAR_IN_OUT

```
stInDataKL1501       : ST_MDCInDataKL1501;
stOutDataKL1501      : ST_MDCOutDataKL1501;
```

stInDataKL1501: Linked to KL1501 (see ST_MDCInDataKL1501 [▸ 94]).

stOutDataKL1501: Linked to KL1501 (see ST_MDCOutDataKL1502 [▸ 95]).

Example

```
VAR_GLOBAL
  arrLoadParameters      AT %MB100 : ARRAY[1..8] OF ST_MDCLoadParameters;

  (* KL1002 *)
  bPeriodPulse       AT %IX6.0 : BOOL;

  (* KL1501*)
  stInDataKL1501     AT %IB0  : ST_MDCInDataKL1501;
  stOutDataKL1501    AT %QB0  : ST_MDCOutDataKL1501;

  (* KL2404 *)
  bLoadOut1          AT %QX6.0 : BOOL;
  bLoadOut2          AT %QX6.1 : BOOL;
  bLoadOut3          AT %QX6.2 : BOOL;
  bLoadOut4          AT %QX6.3 : BOOL;

  (* KL2404 *)
  bLoadOut5          AT %QX6.4 : BOOL;
  bLoadOut6          AT %QX6.5 : BOOL;
  bLoadOut7          AT %QX6.6 : BOOL;
  bEmergencySignal       AT %QX6.7 : BOOL;
END_VAR

PROGRAM MAIN
VAR
  fbMaximumDemandController : FB_MaximumDemandController;
END_VAR
```

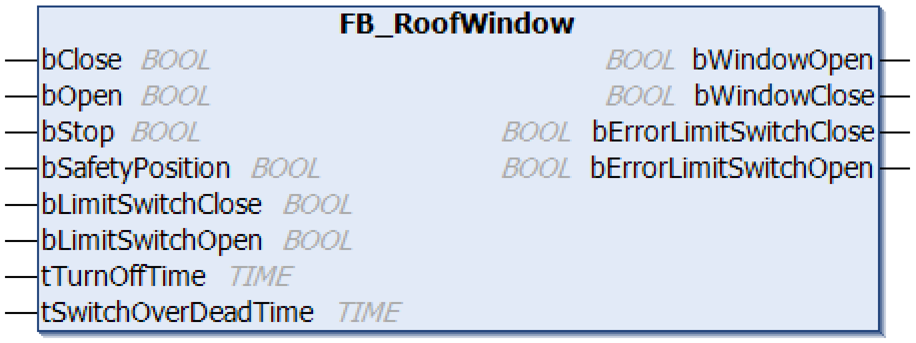
```
arrLoadParameters[1].bConnected := TRUE;
arrLoadParameters[1].nDegreeOfPriority := 1;
arrLoadParameters[1].tMINPowerOnTime := t#60s;
arrLoadParameters[1].tMINPowerOffTime := t#120s;
arrLoadParameters[1].tMAXPowerOffTime := t#600s;

arrLoadParameters[2].bConnected := TRUE;
arrLoadParameters[2].nDegreeOfPriority := 2;
arrLoadParameters[2].tMINPowerOnTime := t#60s;
arrLoadParameters[2].tMINPowerOffTime := t#120s;
arrLoadParameters[2].tMAXPowerOffTime := t#600s;

arrLoadParameters[3].bConnected := TRUE;
arrLoadParameters[3].nDegreeOfPriority := 3;
arrLoadParameters[3].tMINPowerOnTime := t#60s;
arrLoadParameters[3].tMINPowerOffTime := t#120s;
arrLoadParameters[3].tMAXPowerOffTime := t#300s;

arrLoadParameters[4].bConnected := TRUE;
arrLoadParameters[4].nDegreeOfPriority := 4;
arrLoadParameters[4].tMINPowerOnTime := t#20s;
arrLoadParameters[4].tMINPowerOffTime := t#30s;
arrLoadParameters[4].tMAXPowerOffTime := t#8m;

arrLoadParameters[5].bConnected := TRUE;
arrLoadParameters[5].nDegreeOfPriority := 5;
arrLoadParameters[5].tMINPowerOnTime := t#20s;
arrLoadParameters[5].tMINPowerOffTime := t#50s;
arrLoadParameters[5].tMAXPowerOffTime := t#20m;

arrLoadParameters[6].bConnected := TRUE;
arrLoadParameters[6].nDegreeOfPriority := 6;
arrLoadParameters[6].tMINPowerOnTime := t#30s;
arrLoadParameters[6].tMINPowerOffTime := t#1m;
arrLoadParameters[6].tMAXPowerOffTime := t#1m;

arrLoadParameters[7].bConnected := TRUE;
arrLoadParameters[7].nDegreeOfPriority := 7;
arrLoadParameters[7].tMINPowerOnTime := t#0s;
arrLoadParameters[7].tMINPowerOffTime := t#0s;
arrLoadParameters[7].tMAXPowerOffTime := t#1m;

arrLoadParameters[8].bConnected := FALSE;

fbMaximumDemandController(bStart := TRUE,
              fMeterConstant := 20000,
              fAgreedPower := 600,
              bPeriodPulse := bPeriodPulse,
              arrLoadParameters := arrLoadParameters,
              stInDataKL1501 := stInDataKL1501,
              stOutDataKL1501 := stOutDataKL1501);

bLoadOut1 := fbMaximumDemandController.arrLoad[1];
bLoadOut2 := fbMaximumDemandController.arrLoad[2];
bLoadOut3 := fbMaximumDemandController.arrLoad[3];
bLoadOut4 := fbMaximumDemandController.arrLoad[4];
bLoadOut5 := fbMaximumDemandController.arrLoad[5];
bLoadOut6 := fbMaximumDemandController.arrLoad[6];
bLoadOut7 := fbMaximumDemandController.arrLoad[7];
bEmergencySignal := fbMaximumDemandController.bEmergencySignal;
```

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.3 Facade

4.1.3.1 FB_RoofWindow



The outputs *bWindowOpen* or *bWindowClose* are set through a positive edge at the inputs *bOpen* or *bClose*. These remain asserted until the time *tTurnOffTime* has elapsed, or until the function block receives some other command. Both outputs are immediately reset by a positive edge at the *bStop* input.

The *tSwitchOverDeadTime* can be used to prevent damage to the drive motor caused by immediate changes in direction. In most cases, this value is between 0.5 s and 1.0 s. The drive manufacturer can give you a precise value.

Safety position

Moving to the safety position (e.g. in strong wind) can be achieved by setting the input *bSafetyPosition*. The output *bWindowClose* is set for the time *tTurnOffTime*, and the output *bWindowOpen* is reset. Window operation is disabled as long as the *bSafetyPosition* input is active.

VAR_INPUT

```
bClose                  : BOOL;
bOpen                   : BOOL;
bStop                   : BOOL;
bSafetyPosition         : BOOL;
bLimitSwitchClose       : BOOL;
bLimitSwitchOpen        : BOOL;
tTurnOffTime            : TIME := t#60s;
tSwitchOverDeadTime     : TIME := t#400ms;
```

bClose: Set output *bWindowClose* and reset output *bWindowOpen.* The output *bWindowClose* remains latched.

bOpen: Set output *bWindowOpen* and reset output *bWindowClose.* The output *bWindowOpen* remains latched.

bStop: Reset outputs *bWindowClose* and *bWindowOpen*

bSafetyPosition: The safety position is approached. The window is closed for the time *tTurnOffTime*. Window operation is blocked as long as the input is active.

bLimitSwitchClose: Optional limit switch. If *bClose* is set and is not set within *tTurnOffTimebLimitSwitchClose*, *bErrorLimitSwitchClose* is set.

bLimitSwitchOpen: Optional limit switch. If *bOpen* is set and is not set within *tTurnOffTimebLimitSwitchOpen*, *bErrorLimitSwitchOpen* is set.

tTurnOffTime: If no input is activated, then the outputs are reset after this period of time. The outputs are not automatically reset if the specified duration is 0. The value given here should be about 10% larger than the travel time that is actually measured.

tSwitchOverDeadTime: Dwell time at a change of direction. Both outputs are reset during this period.

VAR_OUTPUT

```
bWindowOpen              : BOOL;
bWindowClose             : BOOL;
bErrorLimitSwitchClose   : BOOL;
bErrorLimitSwitchOpen    : BOOL;
```

bWindowOpen: The window opens.

bWindowClose: The window closes.

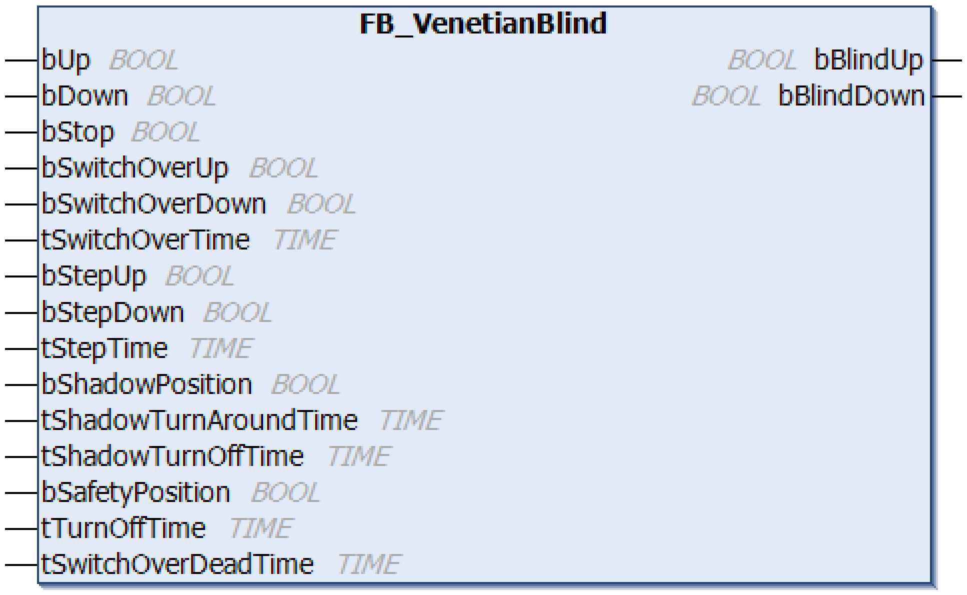
bErrorLimitSwitchClose: Error relating to the optional limit switch during closing.

bErrorLimitSwitchOpen: Error relating to the optional limit switch during opening.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.3.2 FB_VenetianBlind



There are three different ways in which the blinds may be controlled:

- A positive edge at the *bUp* or *bDown* inputs set the *bBlindUp* or *bBlindDown* outputs respectively. These remain asserted until the time *tTurnOffTime* has elapsed, or until the function block receives some other command. Both outputs are immediately reset by a positive edge at the *bStop* input.
- Static signals are provided to the *bSwitchOverUp* or *bSwitchOverDown* inputs (e.g. by buttons). These set the *bBlindUp* and *bBlindDown* outputs. If this signal is asserted for longer than *tSwitchOverTime*, the outputs are latched. This means that the outputs will continue to be asserted, even if the signals at the inputs are removed again. In most cases, a value of 500 ms is sufficient for the *tSwitchOverTime* parameter. However, the output only remains asserted for the time *tTurnOffTime*, or until a new command is given to the function block.
- This last variation can be useful if the user wants to alter the setting of the blind step by step. Each positive edge at the *bStepUp* or *bStepDown* inputs sets the corresponding output for the time *tStepTime*. A value of 200 ms has been found effective for *tStepTime*.

The *tSwitchOverDeadTime* can be used to prevent damage to the drive motor caused by immediate changes in direction. In most cases, this value is between 0.5 s and 1.0 s. The drive manufacturer can give you a precise value.

Safety position

Travel to the safety position (e.g. because there is a strong wind or because maintenance is being carried out at the window) can be achieved by setting the *bSafetyPosition* input. The output *bBlindUp* is set and the output *bBlindDown* reset for the period specified by *tTurnOffTime*. Operation of the blinds is prevented for as long as the *bSafetyPosition* input is active.

Shading position

Under conditions of above-average sunshine, the blinds can be moved to the shading position. After presenting a positive edge to the *bShadowPosition* input, the blinds are lowered for the period of time specified by *tShadowTurnOffTime*. The blind is then moved upwards again for the period of time specified by *tShadowTurnAroundTime*. A time of about 2 seconds is usually set for this. This prevents the room from being completely darkened. During a change of direction, a pause of duration *tSwitchOverDeadTime* is maintained. Travel to the shading position can be interrupted at any time by a new command.

VAR_INPUT

```
bUp                     : BOOL;
bDown                   : BOOL;
bStop                   : BOOL;
bSwitchOverUp           : BOOL;
bSwitchOverDown         : BOOL;
tSwitchOverTime         : TIME := t#500ms;
bStepUp                 : BOOL;
bStepDown               : BOOL;
tStepTime               : TIME := t#200ms;
bShadowPosition         : BOOL;
tShadowTurnAroundTime   : TIME := t#0s;
tShadowTurnOffTime      : TIME := t#20s;
bSafetyPosition         : BOOL;
tTurnOffTime            : TIME := t#60s;
tSwitchOverDeadTime     : TIME := t#400ms;
```

bUp: Set the *bBlindUp* output and reset the *bBlindDown* output. The *bBlindUp* output remains latched.

bDown: Set the *bBlindDown* output and reset the *bBlindUp* output. The *bBlindDown* output remains latched.

bStop: Reset the *bBlindUp* and *bBlindDown* outputs.

bSwitchOverUp: Set the *bBlindUp* output and reset the *bBlindDown* output. If the signal remains present for longer than *tSwitchOverTime*, the output *bBlindUp* remains latched.

bSwitchOverDown: Set the *bBlindDown* output and reset the *bBlindUp* output. If the signal remains present for longer than *tSwitchOverTime*, the output *bBlindDown* remains latched.

tSwitchOverTime: Gives the time for which the *bSwitchUp* and *bSwitchDown* inputs must remain asserted before the outputs are latched. If the value is 0, the outputs are latched immediately.

bStepUp: Reset the *bBlindDown* output and set the *bBlindUp* output for the time *tStepTime*.

bStepDown: Reset the *bBlindUp* output and set the *bBlindDown* output for the time *tStepTime*.

tStepTime: If the blind is controlled through the *bStepUp* or *bStepDown* inputs, the outputs remain asserted for this period of time. The outputs are not set if the specified duration is 0.

bShadowPosition: The shading position is approached.

tShadowTurnAroundTime: The blind travels in the opposite direction for the period of time specified by *tShadowTurnAroundTime* after the shading position has been reached.

tShadowTurnOffTime: The time for which the *bBlindDown* output is set in order to reach the shading position. A time of greater than 0 is necessary for the shading position to be approached.

bSafetyPosition: The safety position is approached. To do this, the blind is raised for the period of time specified by *tTurnOffTime*. It is not possible to operate the blinds while this input is set.

tTurnOffTime: If no input is activated, then the outputs are reset after this period of time. The outputs are not automatically reset if the specified duration is 0. The value given here should be about 10% larger than the travel time that is actually measured.

tSwitchOverDeadTime: Dwell time at a change of direction. Both outputs are reset during this period.

VAR_OUTPUT

```
bBlindUp          : BOOL;
bBlindDown        : BOOL;
```

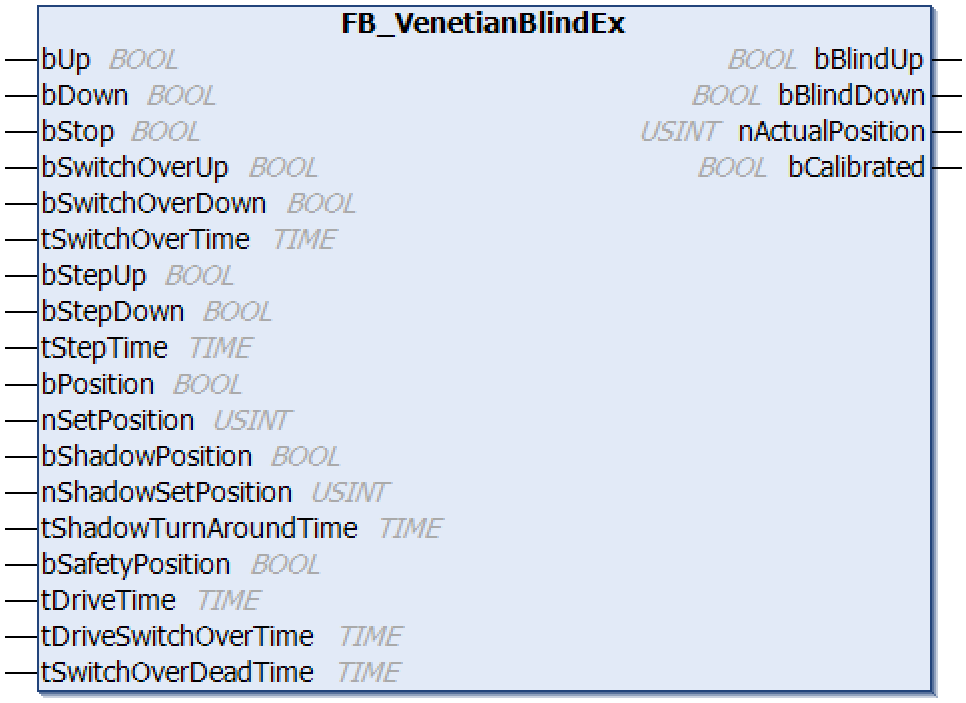
bBlindUp: The blind opens.

bBlindDown: The blind closes.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.3.3 FB_VenetianBlindEx



Four different methods are available for controlling the blind:

- A positive edge at the *bUp* or *bDown* inputs set the *bBlindUp* or *bBlindDown* outputs respectively. These remain asserted until the time *tDriveTime* + 10% has elapsed, or until the function block receives some other command. Both outputs are immediately reset by a positive edge at the *bStop* input.
- Static signals are provided to the *bSwitchOverUp* or *bSwitchOverDown* inputs (e.g. by buttons). These set the *bBlindUp* and *bBlindDown* outputs. If this signal is asserted for longer than *tSwitchOverTime*, the outputs are latched. This means that the outputs will continue to be asserted, even if the signals at the inputs are removed again. In most cases, a value of 500 ms is sufficient for the *tSwitchOverTime* parameter. However, the output only remains asserted for the time *tDriveTime* + 10%, or until a new command is given to the function block.
- In certain applications it may be useful for the operator to alter the blind position step by step. Each positive edge at the *bStepUp* or *bStepDown* inputs sets the corresponding output for the time *tStepTime*. A value of 200 ms has been found effective for *tStepTime*.
- Unlike the FB_VenetianBlind() [▶ 21] function block, this function block also enables movement to an absolute position. A percentage value is applied to input *nSetPosition*, and subsequently a positive edge is applied to input *bPosition*.

The *tSwitchOverDeadTime* can be used to prevent damage to the drive motor caused by immediate changes in direction. In most cases, this value is between 0.5 s and 1.0 s. The drive manufacturer can give you a precise value.

Safety position

Travel to the safety position (e.g. because there is a strong wind or because maintenance is being carried out at the window) can be achieved by setting the *bSafetyPosition* input. The output *bBlindUp* is set and the output *bBlindDown* reset for the period specified by *tDriveTime* + 10%. Operation of the blinds is prevented for as long as the *bSafetyPosition* input is active.

Shading position

Under conditions of above-average sunshine, the blinds can be moved to the shading position. After applying a positive edge to the input bShadowPosition, the blind is moved to the position nShadowSetPosition. The blind is then moved upwards again for the period of time specified by tShadowTurnAroundTime. This prevents the room from being completely darkened. If the blind had moved upwards during the approach of the shading position, it is moved downwards for the time period tDriveSwitchOverTime - tShadowTurnAroundTime. The same angle will therefore be set as if the blind had been moved downwards for darkening purposes.
During a change of direction, a pause of duration tSwitchOverDeadTime is maintained. Travel to the shading position can be interrupted at any time by a new command.

The set shading time *tShadowTurnAroundTime* must never be longer than the time for the change of direction *tDriveSwitchOverTime*.

Moving to an absolute position

Comments

In most cases a blind will not provide feedback about its current position. Therefore, this can only be calculated via the travel time. The precision depends on the uniformity of the blind speed. Furthermore, the speed differences between opening and closing should be as small as possible.
The positions are always specified in percent. 0% corresponds to fully up, 100% to fully down. If a value greater than 100 is specified, it will be limited to 100 within the function block.

Determining the parameters

First of all, certain blind parameters have to be determined. One parameter is the travel time. This is the time it takes for the blind to open or close fully. The second parameter is the time required for a change of direction. During a change of direction, the angle between the individual blades will change. The travel time is transferred to the parameter *tDriveTime*. The duration for a direction change is transferred to *tDriveSwitchOverTime*.

Referencing a function block

Since the current position of the blind has to be calculated, inaccuracies during operation will accumulate. In order to limit deviations, the function block will automatically reference itself as often as possible. This happens when the blind is moved fully up or down and the corresponding output is reset automatically. The corresponding time is *tDriveTime* + 10%.

VAR_INPUT

```
bUp                     : BOOL;
bDown                   : BOOL;
bStop                   : BOOL;
bSwitchOverUp           : BOOL;
bSwitchOverDown         : BOOL;
tSwitchOverTime         : TIME  := t#500ms;
bStepUp                 : BOOL;
bStepDown               : BOOL;
tStepTime               : TIME  := t#200ms;
bPosition               : BOOL;
```

```
nSetPosition             : USINT;
bShadowPosition          : BOOL;
nShadowSetPosition       : USINT := 80;
tShadowTurnAroundTime    : TIME:= t#0s;
bSafetyPosition          : BOOL;
tDriveTime               : TIME := t#60s;
tDriveSwitchOverTime     : TIME := t#200ms;
tSwitchOverDeadTime      : TIME := t#400ms;
```

bUp: Set the *bBlindUp* output and reset the *bBlindDown* output. The *bBlindUp* output remains latched.

bDown: Set the *bBlindDown* output and reset the *bBlindUp* output. The *bBlindDown* output remains latched.

bStop: Reset the *bBlindUp* and *bBlindDown* outputs.

bSwitchOverUp: Set the *bBlindUp* output and reset the *bBlindDown* output. If the signal remains present for longer than *tSwitchOverTime*, the output *bBlindUp* remains latched.

bSwitchOverDown: Set the *bBlindDown* output and reset the *bBlindUp* output. If the signal remains present for longer than *tSwitchOverTime*, the output *bBlindDown* remains latched.

tSwitchOverTime: Gives the time for which the *bSwitchUp* and *bSwitchDown* inputs must remain asserted before the outputs are latched. If the value is 0, the outputs are latched immediately.

bStepUp: Reset the *bBlindDown* output and set the *bBlindUp* output for the time *tStepTime*.

bStepDown: Reset the *bBlindUp* output and set the *bBlindDown* output for the time *tStepTime*.

tStepTime: If the blind is controlled through the *bStepUp* or *bStepDown* inputs, the outputs remain asserted for this period of time. The outputs are not set if the specified duration is 0.

bPosition: Move blind to specified position.

nSetPosition: Position (0%-100%) to which the blind is to be moved, after a positive edge has been applied to input *bPosition*. 0% corresponds to fully up, 100% corresponds to fully down.

bShadowPosition: The shading position is approached.

nShadowSetPosition: Shading position (0%-100%) to which the blind is to be moved, after a positive edge has been applied to input *bShadowPosition*.

tShadowTurnAroundTime: Once the shading position has been reached, the blind is moved upwards for the period *tShadowTurnAroundTime*.

bSafetyPosition: The safety position is approached. To do this, the blind is raised for the period *tDriveTime* + 10%. It is not possible to operate the blinds while this input is set.

tDriveTime: Travel time of the blind from fully up to fully down. If no input is activated, the outputs are reset after the period *tDriveTime* + 10%. The outputs are not automatically reset if the specified duration is 0. In this case, the blind cannot be moved to absolute positions.

tDriveSwitchOverTime: Period of time required for a change of direction of the blind.

tSwitchOverDeadTime: Dwell time at a change of direction. Both outputs are reset during this period.

VAR_OUTPUT

```
bBlindUp             : BOOL;
bBlindDown           : BOOL;
nActualPosition      : USINT;
bCalibrated          : BOOL;
```

bBlindUp: The blind opens.

bBlindDown: The blind closes.

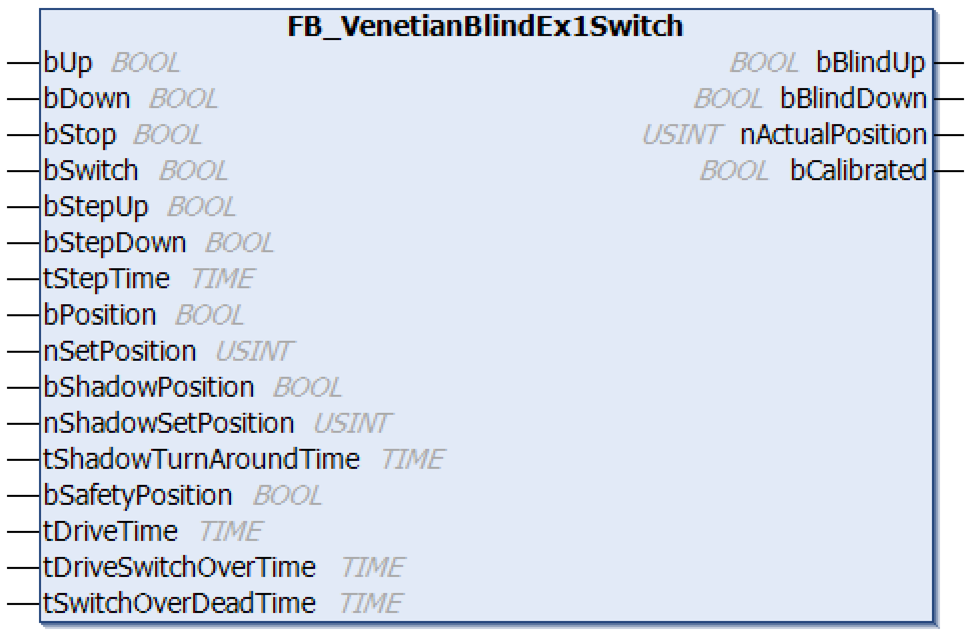
nActualPosition: Current position in percent.

bCalibrated: Indicates whether the blind is calibrated.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.3.4 FB_VenetianBlindEx1Switch



Blind function block with the same functionality as FB_VenetianBlindEx() [▶ 23] but with an input *bSwitch* for jogging up and down.
Four different methods are available for controlling the blind:

- A positive edge at the *bUp* or *bDown* inputs set the *bBlindUp* or *bBlindDown* outputs respectively. These remain asserted until the time *tDriveTime* + 10% has elapsed, or until the function block receives some other command. Both outputs are immediately reset by a positive edge at the *bStop* input.
- The input *bSwitch*, which is usually linked to a push button, can be used to switch the blind movement between up or down. In contrast to FB_VenetianBlindEx() [▶ 23], the outputs **immediately** switch to latching. Pressing the button switches between moving, stopping, moving in the opposite direction, stopping and moving again. The outputs remain active for a maximum period of *tDriveTime* + 10% or until a new command is issued for the function block. Switching is locked for the time tSwitchOverDeadTime.
- In certain applications it may be useful for the operator to be able to alter the blind position step by step. Each positive edge at the *bStepUp* or *bStepDown* inputs sets the corresponding output for the time *tStepTime*. A value of 200 ms has been found effective for *tStepTime*.
- Unlike the FB_VenetianBlind() [▶ 21] function block, this function block also enables movement to an absolute position. A percentage value is applied to input *nSetPosition*, and subsequently a positive edge is applied to input *bPosition*.

The *tSwitchOverDeadTime* can be used to prevent damage to the drive motor caused by immediate changes in direction. In most cases, this value is between 0.5 s and 1.0 s. The drive manufacturer can give you a precise value.

Safety position

Travel to the safety position (e.g. because there is a strong wind or because maintenance is being carried out at the window) can be achieved by setting the *bSafetyPosition* input. The output *bBlindUp* is set and the output *bBlindDown* reset for the period specified by *tDriveTime* + 10%. Operation of the blinds is prevented for as long as the *bSafetyPosition* input is active.

Shading position

Under conditions of above-average sunshine, the blinds can be moved to the shading position. After applying a positive edge to the input *bShadowPosition*, the blind is moved to the position *nShadowSetPosition*. The blind is then moved upwards again for the period of time specified by *tShadowTurnAroundTime*. This prevents the room from being completely darkened. If the blind had moved upwards during the approach of the shading position, it is moved downwards for the time period *tDriveSwitchOverTime* - *tShadowTurnAroundTime*. The same angle will therefore be set as if the blind had been moved downwards for darkening purposes.
During a change of direction, a pause of duration *tSwitchOverDeadTime* is maintained. Travel to the shading position can be interrupted at any time by a new command.

Moving to an absolute position

Comments

In most cases a blind will not provide feedback about its current position. Therefore, this can only be calculated via the travel time. The precision depends on the uniformity of the blind speed. Furthermore, the speed differences between opening and closing should be as small as possible.
The positions are always specified in percent. 0% corresponds to fully up, 100% to fully down. If a value greater than 100 is specified, it will be limited to 100 within the function block.

Determining the parameters

First of all, certain blind parameters have to be determined. One parameter is the travel time. This is the time it takes for the blind to open or close fully. The second parameter is the time required for a change of direction. During a change of direction, the angle between the individual blades will change. The travel time is transferred to the parameter *tDriveTime*. The duration for a direction change is transferred to *tDriveSwitchOverTime*.

Referencing a function block

Since the current position of the blind has to be calculated, inaccuracies during operation will accumulate. In order to limit deviations, the function block will automatically reference itself as often as possible. This happens when the blind is moved fully up or down and the corresponding output is reset automatically. The corresponding time is *tDriveTime* + 10%.

VAR_INPUT

```
bUp                       : BOOL;
bDown                     : BOOL;
bStop                     : BOOL;
bSwitch                   : BOOL;
bStepUp                   : BOOL;
bStepDown                 : BOOL;
tStepTime                 : TIME := t#200ms;
bPosition                 : BOOL;
nSetPosition              : USINT;
bShadowPosition           : BOOL;
nShadowSetPosition        : USINT := 80;
tShadowTurnAroundTime     : TIME := t#0s;
bSafetyPosition           : BOOL;
tDriveTime             : TIME := t#60s;
tDriveSwitchOverTime      : TIME := t#200ms;
tSwitchOverDeadTime       : TIME := t#400ms;
```

bUp: Set the *bBlindUp* output and reset the *bBlindDown* output. The *bBlindUp* output remains latched.

bDown: Set the *bBlindDown* output and reset the *bBlindUp* output. The *bBlindDown* output remains latched.

bStop: Reset the *bBlindUp* and *bBlindDown* outputs.

bSwitch: Switching input for jogging the blind, see description above. Switches between moving, stopping, moving in the opposite direction, stopping and moving again. In each case the activated output **immediately** switches to latching.

bStepUp: Reset the *bBlindDown* output and set the *bBlindUp* output for the time *tStepTime*.

bStepDown: Reset the *bBlindUp* output and set the *bBlindDown* output for the time *tStepTime*.

tStepTime: If the blind is controlled through the *bStepUp* or *bStepDown* inputs, the outputs remain asserted for this period of time. The outputs are not set if the specified duration is 0.

bPosition: Move blind to specified position.

nSetPosition: Position (0%-100%) to which the blind is to be moved after a positive edge has been applied to input *bPosition*. 0% corresponds to fully up, 100% corresponds to fully down.

bShadowPosition: The shading position is approached.

nShadowSetPosition: Shading position (0%-100%) to which the blind is to be moved, after a positive edge has been applied to input *bShadowPosition*.

tShadowTurnAroundTime: Once the shading position has been reached, the blind is moved upwards for the period *tShadowTurnAroundTime*.

bSafetyPosition: The safety position is approached. To do this, the blind is moved upwards for the period *tDriveTime* + 10%. It is not possible to operate the blinds while this input is set.

tDriveTime: Travel time of the blind from fully up to fully down. If no input is activated, the outputs are reset after the period *tDriveTime* + 10%. The outputs are not automatically reset if the specified duration is 0. In this case, the blind cannot be moved to absolute positions.

tDriveSwitchOverTime: Period of time required for a change of direction of the blind.

tSwitchOverDeadTime: Dwell time at a change of direction. Both outputs are reset during this period.

VAR_OUTPUT

```
bBlindUp            : BOOL;
bBlindDown          : BOOL;
nActualPosition     : USINT;
bCalibrated         : BOOL;
```

bBlindUp: The blind opens.

bBlindDown: The blind closes.

nActualPosition: Current position in percent.

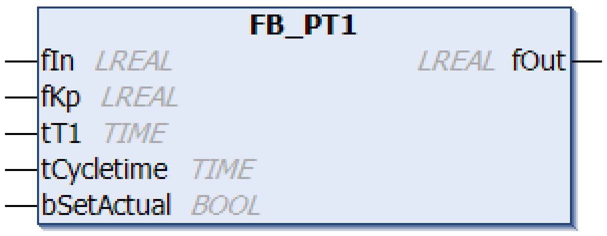
bCalibrated: Indicates whether the blind is calibrated.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

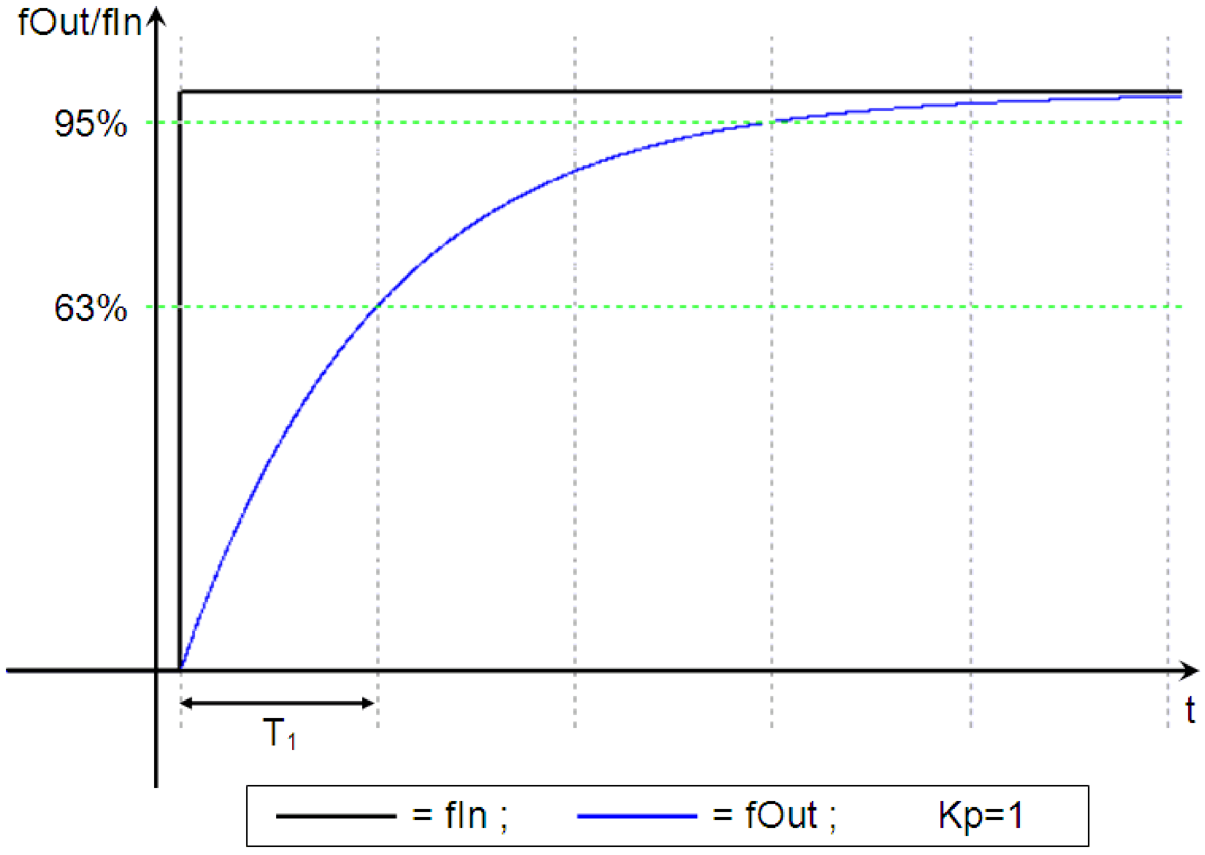
4.1.4 Filter functions

4.1.4.1 FB_PT1



PT$_1$ element for smoothing of input variables.

This function block is active continuously. The output *fOut* always follows the input value *fIn* multiplied by *Kp* with an exponential curve:



If *Kp* is 1 the output value directly follows the input value. *fOut has* reached 63% of the input value after the time *tT1* has elapsed, after 3 x *tT1* the value is 95%.

The mathematical formula is:

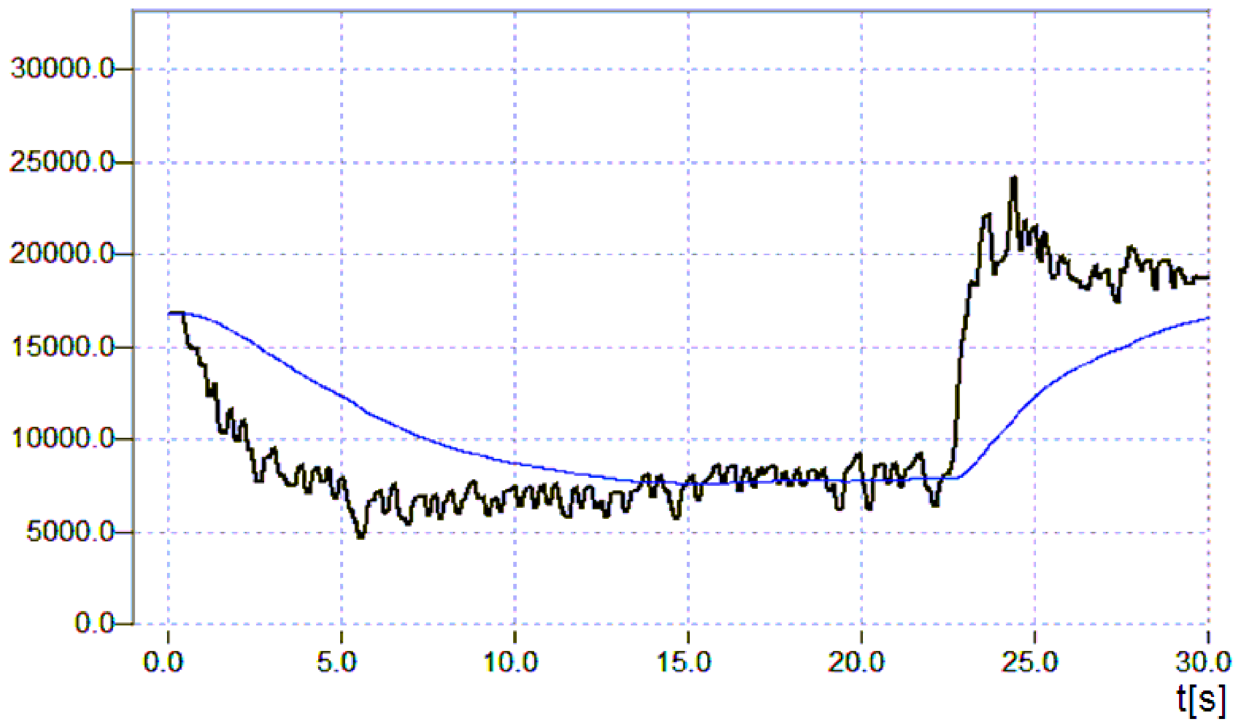
$$f(t) = K_p(1 - e^{-\frac{t}{T_1}})$$

The following time-discrete formula is used for the calculation in the PLC:

$$y_{n+1} = (Kp \cdot x \cdot \frac{t_{cycle}}{T_1}) + \left((1 - \frac{t_{cycle}}{T_1}) \cdot y_n \right)$$

$$\underline{T_1 = 0:} \qquad y_{n+1} = Kp \cdot x$$

With a continuously changing input *fIn*, *fOut* behaves as follows (*fIn*= 0..33000, *Kp*= 1, *T1*= 5s):



—— = fIn ;	—— = fOut ;	Kp=1

Note on damping times: Since this function block is a time-discrete model of a PT_1 element, it only works correctly if the damping time is significantly longer than the set cycle time. To be on the safe side, if a damping time is entered that is less than twice the set cycle time it is internally set to zero. A damping time of 0s means that the output variable directly follows the input variable multiplied by Kp.

VAR_INPUT

```
fIn          : LREAL;
fKp          : LREAL := 1;
tT1          : TIME := t#10s;
tCycletime   : TIME := t#10ms;
bSetActual   : BOOL;
```

fIn: Input value.

fkP: Gain factor, preset value: 1.

tT1: Damping time, preset value: 10 s.

tCycleTime: PLC cycle time, preset value: 10 ms.

bSetActual: Sets the output *fOut* directly to the input value *fIn*.

VAR_OUTPUT

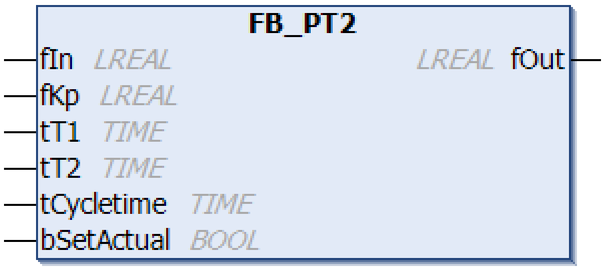
```
fOut        : LREAL;
```

fOut: Output value.

Requirements

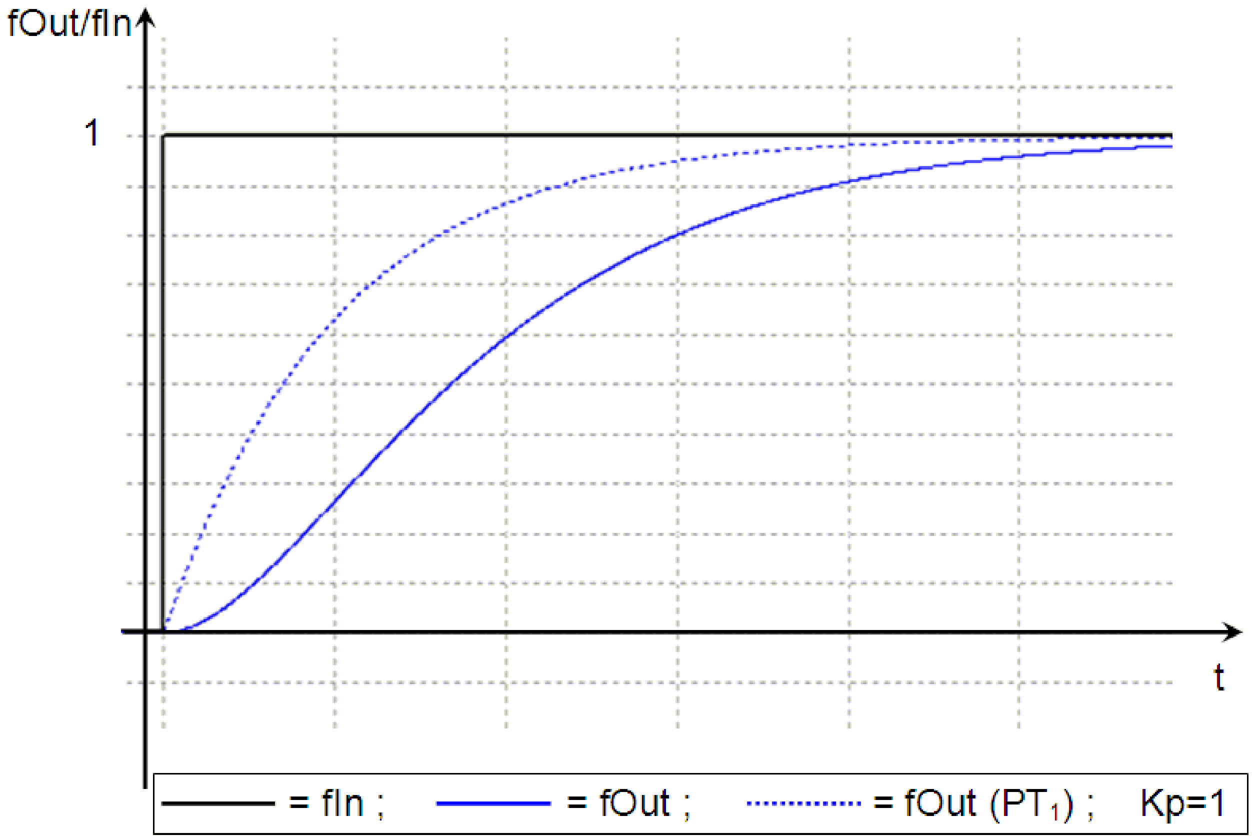
Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.4.2 FB_PT2



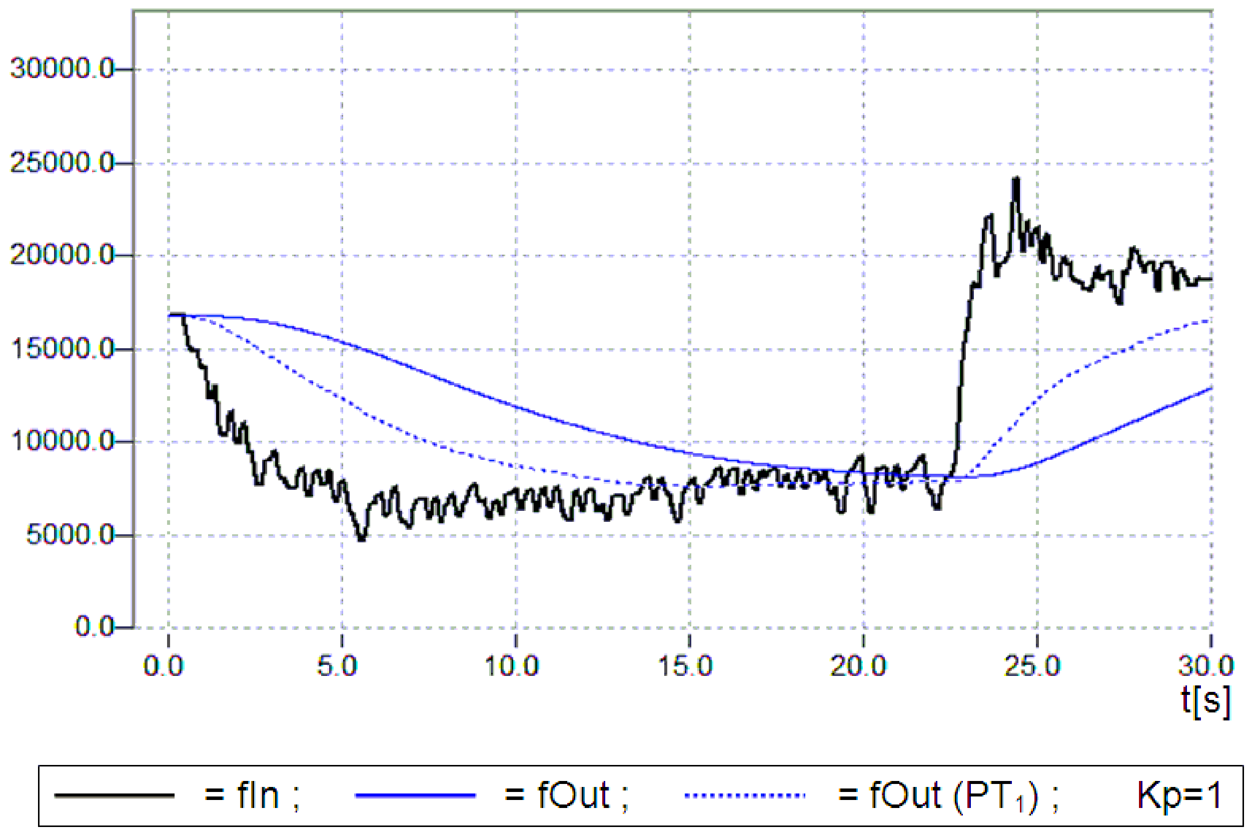
PT_2 element for smoothing of input variables.

This function block is active continuously. The output *fOut* always follows the input value *fIn* multiplied by *Kp*.



This PT_2 element consists of a series of two PT_1 elements; the time constants T1 and T2 can have different values. The step response (see above) shows a significantly more attenuated subsequent behavior compared to the PT_1 element (dashed) right from the start.

With a continuously changing input *fIn*, *fOut* behaves as follows (*fIn*= 0..33000, *Kp*= 1, *T1,T2*= 5s):



In comparison, the dotted line shows the behavior of a PT1 element [▸ 28] with *fIn*= 0..33000, *Kp*= 1, *T1*= 5s.

Note on damping times: Since this function block is a time-discrete model of a PT_2 element, it only works correctly if the damping time is significantly longer than the set cycle time. To be on the safe side, if damping times are entered that are less than twice the set cycle time they are internally set to zero. As already mentioned, the PT_2 element consists of two PT_1 elements connected in series. If one of the two damping times is set to zero, the PT_2 element is reduced to a PT_1 element. If both damping times are set to zero, the output variable directly follows the input variable multiplied by Kp.

VAR_INPUT

```
fIn           : LREAL;
fKp           : LREAL := 1;
tT1           : TIME := t#10s;
tT2           : TIME := t#10s;
tCycletime        : TIME := t#10ms;
bSetActual        : BOOL;
```

fIn: Input value.

fkP: Gain factor, preset value: 1.

tT1: Damping time 1, preset value: 10 s.

tT2: Damping time 2, preset value: 10 s.

tCycleTime: PLC cycle time, preset value: 10 ms.

bSetActual: Sets the output *fOut* directly to the input value *fIn*.

VAR_OUTPUT

```
fOut          : LREAL;
```

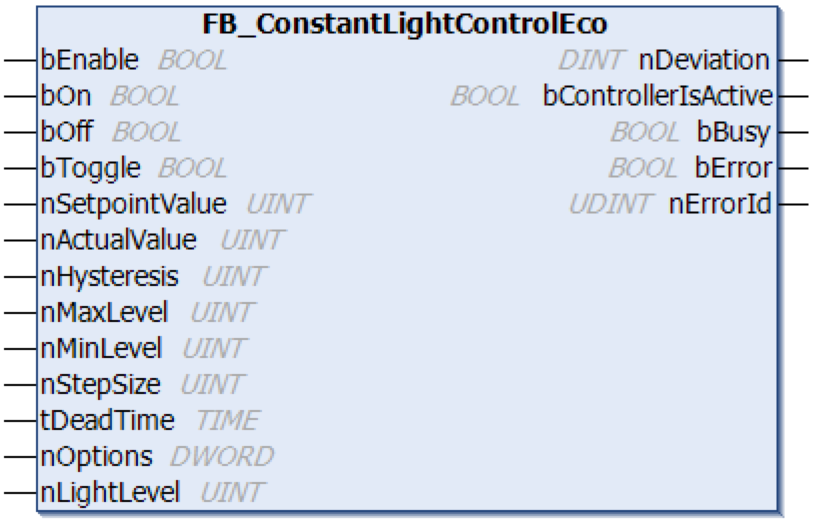
fOut: Output value.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5 Lighting

4.1.5.1 FB_ConstantLightControlEco



The function block is used for constant light control.

The system tries to match a specified setpoint through cyclic dimming. The control dynamics are determined by a dead time (*tDeadTime*) and the step size (*nStepSize*). The dead time specifies the waiting time between the individual steps or increments of the control value, which are determined by the set step size. The smaller the dead time, the faster the control. A freely definable hysteresis (*nHysteresis*) prevents continuous oscillation around the setpoint. If the actual value is within the hysteresis range around the setpoint, the lamps brightness remains unchanged.

NOTE

If the set step size *nStepSize* is too large or the hysteresis *nHysteresis* is too small, the hysteresis range may be "missed". This cannot be prevented by the function block, because the light output *nLightLevel* is only physically linked to the recorded actual light value, *nActualLevel*.

VAR_INPUT

```
bEnable            : BOOL;
bOn                : BOOL;
bOff               : BOOL;
bToggle            : BOOL;
nSetpointValue     : UINT := 16000;
nActualValue       : UINT;
nHysteresis        : UINT := 100;
nMaxLevel          : UINT := 32767;
nMinLevel          : UINT := 3276;
nStepSize          : UINT := 10;
tDeadTime          : TIME := t#50ms;
nOptions           : DWORD;
```

bEnable: Enables the function block. If this input is FALSE, the inputs *bOn*, *bOff* and *bToogle* are disabled. The control value remains unchanged.

bOn: Switches the controlled devices to *nMaxLevel* and activates constant light control.

bOff: Switches the addressed devices off and disables constant light control.

bToggle: The lighting is switched on or off, depending on the state of the reference device.

nSetpointValue: This input is used for specifying the setpoint.

nActualValue: The actual value is applied at this input.

nHysteresis: Control hysteresis around the setpoint. If the actual value is within this range, the control values for the lamps remain unchanged.

nMaxLevel: Maximum value of the control value at *nLightLevel*.

nMinLevel: Minimum value of the control value at *nLightLevel*. If this value is to be undercut by a dimming process, *nLightLevel* is set directly to "0". On the other hand, if *nLightLevel* is set to "0" when control is active, the dimming process starts directly at this value.

nStepSize: Step size with which the control value *nLightLevel* is changed.

tDeadTime: Dead time between the individual steps (up or down) of the control value.

nOptions: Currently not used. Reserved for future extensions.

VAR_OUTPUT

```
nDeviation             : INT;
bControllerIsActive    : BOOL;
bBusy                  : BOOL;
bError                 : BOOL;
nErrorId               : UDINT;
```

nDeviation: Current control deviation (setpoint/actual value).

bControllerIsActive: This output is set once the control is activated.

bBusy: When the function block is activated, this output is always active when changes are made to the control value.

bError: This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in *nErrorId*. Is reset to FALSE by the execution of a command at the inputs.

nErrorId: Contains the command-specific error code of the most recently executed command. Is reset to "0" by the execution of a command at the inputs.
See Error codes [▸ 93].

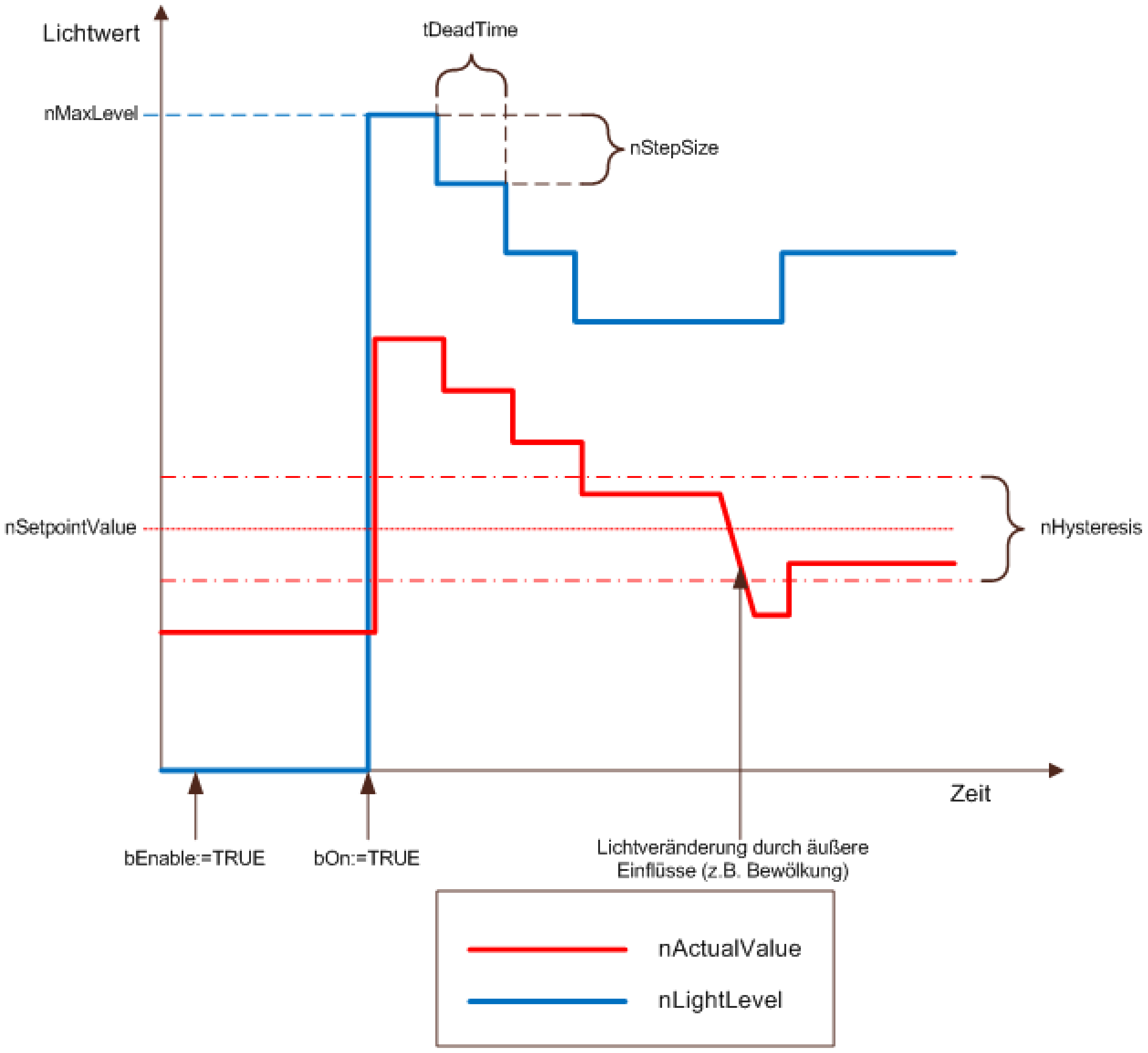
VAR_IN_OUT

```
nLightLevel       : UINT;
```

nLightLevel: Output control value of the function block and reference to the light output value. This value is defined as In-Out variable because the function block reads and writes the light value.

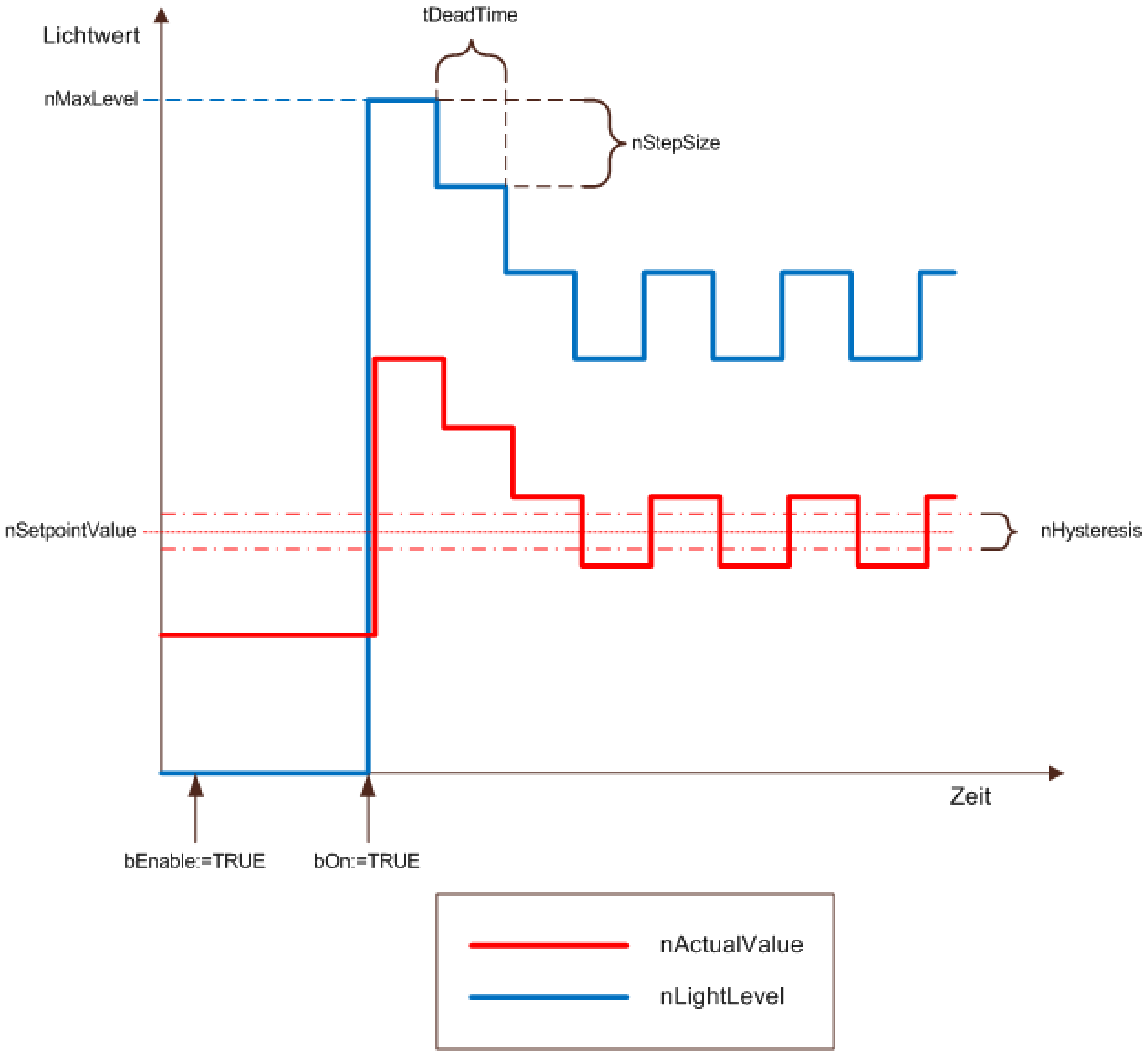
Flow diagram

The following diagram illustrates the regular control behavior:



The control is enabled by a TRUE signal at input *bEnable*. When a positive edge is encountered at *bOn*, *nLightLevel* is set to the maximum value. This also influences the measured light value *nActualValue*, which increases, so that dimming becomes necessary. *nLightLevel* is now reduced step-by-step until the measured light value *nActualValue* is in the hysteresis range around the setpoint (*nSetpointValue* - 0.5**nHysteresis* < x < *nSetpointValue* + 0.5**nHysteresis*).
If, for example, the measured light value then falls, e.g. due to cloudiness, the control system counteracts this by gradually increasing the lighting level until the light value is back in the hysteresis band.

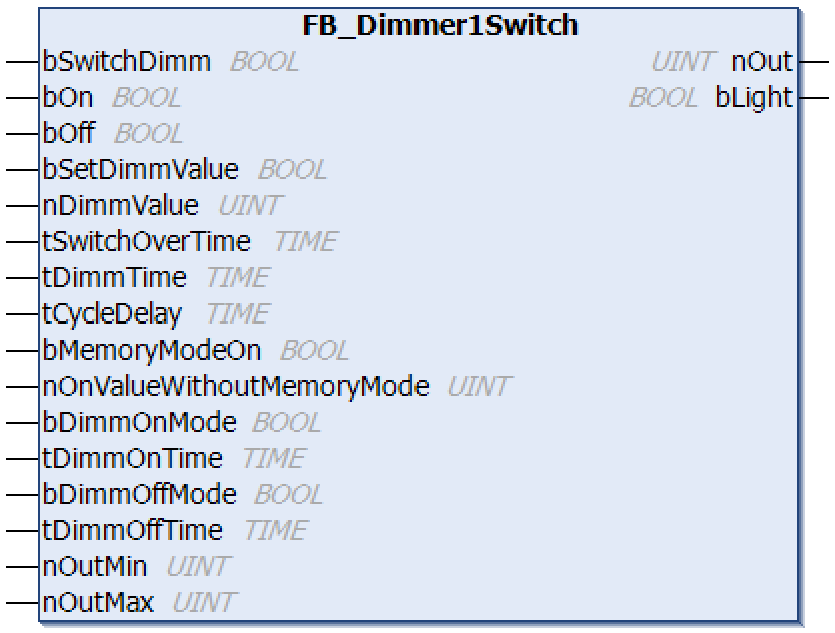
If the step size *nStepSize* is too large or the hysteresis is too small, an oscillation around the setpoint can occur. Because the hysteresis is small compared to the step changes, the hysteresis range is constantly missed:



Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.2 FB_Dimmer1Switch



The function block is used to dim lights with a switch.

Operating by means of the *bSwitchDimm* input

The light is switched on or off by a short signal at the *bSwitchDimm* input. Dimmer mode will be activated if the signal remains for longer than *tSwitchOverTime* (typical recommended value: 200 ms). The output signal then cycles between *nOutMin* and *nOutMax*. In order to be able to set the maximum or minimum value more easily, the output signal pauses at the level of the maximum and minimum values for the time given by *tCycleDelay*. When the signal is once more removed, the output signal being generated at that time is retained. Another pulse at the input will set the output to 0.

Operation by means of the *bOn* and *bOff* inputs

The light is immediately switched on or off if a positive edge is applied to the *bOn* or *bOff* inputs. For example, for global on/off functions. The output value is set to 0 when switching off. The switch-on behavior can be affected by the memory function (see below).

Operation by means of the *bSetDimmValue* and *nDimmValue* inputs

If the value of *nDimmValue* changes, the signal will be passed through directly to the output. The significant point here is that the value changes. The lighting is switched off by changing the value to 0. If there is a positive edge at the *bSetDimmValue* input, the value of *nDimmValue* immediately appears at the output. Immediate modification of the output can be suppressed by a static 1- signal at the *bSetDimmValue* input. This makes it possible to apply a value to the *nDimmValue* input, but for this value only to be passed to the output at the next positive edge of *bSetDimmValue*.
The *bSetDimmValue* and *nDimmValue* inputs can be used to implement a variety of lighting scenarios. Direct setting of the output, by means of *nDimmValue*, can be used to achieve particular brightness levels. Either directly or by continuously changing the value. *nDimmValue* must have a value between *nOutMin* and *nOutMax*. The value 0 is an exception. If the value is outside this range, the output value is limited to the upper or lower limit, as appropriate.

The memory function

It is necessary to determine whether the memory function (*bMemoryModeOn* input) is active or not at switch-on. If the memory function is active, then the last set value is placed at the output as soon as the lamp is switched on. If the memory function is not active, then the value specified by the *nOnValueWithoutMemoryMode* parameter is output. It is irrelevant, in this case, whether the light it has been switched on by means of the *bOn* input or the *bSwitchDimm* input. It should be noted that the *nOnValueWithoutMemoryMode* parameter must lie between *nOutMin* and *nOutMax*. If this is not the case, the output value is adjusted to the upper or lower limit, as appropriate.

Fast dimming up/down when switching on and off

Lighting is particularly pleasant if sudden changes are replaced by a slow change to the desired value. This mode can be activated both for switching on and for switching off by means of the two inputs, *bDimmOnMode* and *bDimmOffMode*. The *tDimmOnTime* and *tDimmOffTime* parameters specify the time that will be taken by the switching processes. This value is always related to the minimum and maximum possible output values (*nOutMin* and *nOutMax*). The *bOn* and *bOff* inputs are one way in which the switch on/off commands may be given. Alternatively, a short pulse can be provided to the *bSwitchDimm* input. If the *nDimmValue* input is set to 0, the output is modified without delay. The same is true if the output is set by a positive edge at the *bSetDimmValue* input.

Comments on the *tSwitchOverTime* and *tDimmTime* parameters

If a duration of 0 is specified for the *tSwitchOverTime* parameter, while a value of greater than 0 is specified for *tDimmTime*, then the *tSwitchDimm* input can only be used to dim the light. Switching on and off is only possible with the *bOn* and *bOff* inputs.

If the *tDimmTime* parameter is 0, the *bSwitchDimm* input can only be used to switch the light on or off. In this case, the value of *tSwitchOverTime* is irrelevant.

VAR_INPUT

```
bSwitchDimm                  : BOOL;
bOn                          : BOOL;
bOff                         : BOOL;
bSetDimmValue                : BOOL;
nDimmValue                   : UINT;
tSwitchOverTime              : TIME := t#500ms;
tDimmTime                    : TIME := t#5s;
tCycleDelay                  : TIME := t#10ms;
bMemoryModeOn                : BOOL := FALSE;
nOnValueWithoutMemoryMode    : UINT := 20000;
bDimmOnMode                  : BOOL := FALSE;
tDimmOnTime                  : TIME := t#0s;
bDimmOffMode                 : BOOL := FALSE;
tDimmOffTime                 : TIME := t#0s;
nOutMin                      : UINT := 5000;
nOutMax                      : UINT := 32767;
```

bSwitchDimm: Switches or dims the output.

bOn: Switches the output to the last output value, or to the value specified by *nOnValueWithoutMemoryMode*.

bOff: Switches the output to 0.

bSetDimmValue: Switches the output to the value *nDimmValue*.

nDimmValue: The value is immediately applied to the output when there is a change.

tSwitchOverTime: Time for switching between the light on/off and dimming functions for the *bSwitchDimm* input.

tDimmTime: Time required for dimming to go from its minimum value to its maximum value.

tCycleDelay: Delay time, if either the minimum or maximum value is reached.

bMemoryModeOn: Switches over to use the memory function, so that the previous value is written to the output as soon as it is switched on.

nOnValueWithoutMemoryMode: Switch-on value if the memory function is not active.

bDimmOnMode: The output value is increased in steps when switching on.

tDimmOnTime: Time period during which the light level is increased when the light is switched on. *bDimmOnMode* must be active.

bDimmOffMode: The output value is reduced in steps when switching off

tDimmOffTime: Time period during which the light is reduced when the light is switched off. *bDimmOffMode* must be active.

nOutMin: Minimum output value.

nOutMax: Maximum output value. If the parameter *nOutMin* is not smaller than *nOutMax*, the output will remain at 0.

VAR_OUTPUT

```
nOut                : UINT;
bLight              : BOOL;
```

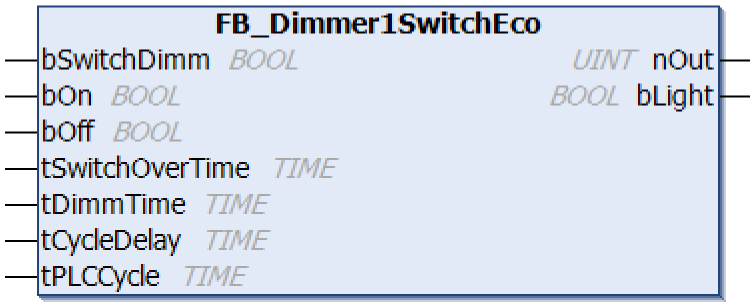
nOut: analog output value.

bLight: digital output value. This is set if *nOut* is greater than 0.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.3 FB_Dimmer1SwitchEco



This function block is a memory-saving variant of FB_Dimmer1Switch() [▸ 37]. It does not have the special functions "Set brightness value" and "Switch off memory function", which may not be required for many applications. Moreover, the values *nOutMin* and *nOutMax* of the FB_Dimmer1Switch() [▸ 37] are set internally here to 0 and 32767 respectively. This output span corresponds to the display range of an analog output terminal. The *tPLCCycle* input is important. This time is used to calculate internally the amount by which the *nOut* output must be increased per cycle - that saves additional time calculations.

Operating by means of the *bSwitchDimm* input

The light is switched on or off by a short signal at the *bSwitchDimm* input. Dimmer mode will be activated if the signal remains for longer than *tSwitchOverTime* (typical recommended value: 200ms). The output signal moves cyclically between 0 and 32767. In order to be able to set the maximum or minimum value more easily, the output signal pauses at the level of the maximum and minimum values for the time given by *tCycleDelay*. When the signal is once more removed, the output signal being generated at that time is retained. Another pulse at the input will set the output to 0.

Operation by means of the *bOn* and *bOff* inputs

The light is immediately switched on or off if a positive edge is applied to the *bOn* or *bOff* inputs. For example, for global on/off functions. The output value is set to 0 when switching off.

The memory function

In contrast to FB_Dimmer1Switch() [▶ 37], where the memory function can be activated or deactivated via the input *bMemoryModeOn* , the memory function is always active in this memory-saving version. This means that the last-set value is adopted as the brightness value when switching on. It is irrelevant, in this case, whether the light it has been switched on by means of the *bOn* input or the *bSwitchDimm* input.

Comment on the *tSwitchOverTime* parameter

If a duration of 0 is specified for the parameter *tSwitchOverTime*, the *bSwitchDimm* input can only be used to dim the light. Switching on and off is only possible with the *bOn* and *bOff* inputs.

VAR_INPUT

```
bSwitchDimm         : BOOL;
bOn                 : BOOL;
bOff                : BOOL;
tSwitchOverTime     : TIME := t#500ms;
tDimmTime           : TIME := t#5s;
tCycleDelay         : TIME := t#500ms;
tPLCCycle           : TIME := t#10ms;
```

bSwitchDimm: Switches or dims the output.

bOn: Switches the output to the last output value, or to the value specified by *nOnValueWithoutMemoryMode*.

bOff: Switches the output to 0.

tSwitchOverTime: Time for switching between the light on/off and dimming functions for the *bSwitchDimm* input.

tDimmTime: Time required for dimming to go from its minimum value to its maximum value.

tCycleDelay: Delay time, if either the minimum or maximum value is reached.

tPLCCycle: the set PLC cycle time.

VAR_OUTPUT

```
nOut                : UINT;
bLight              : BOOL;
```

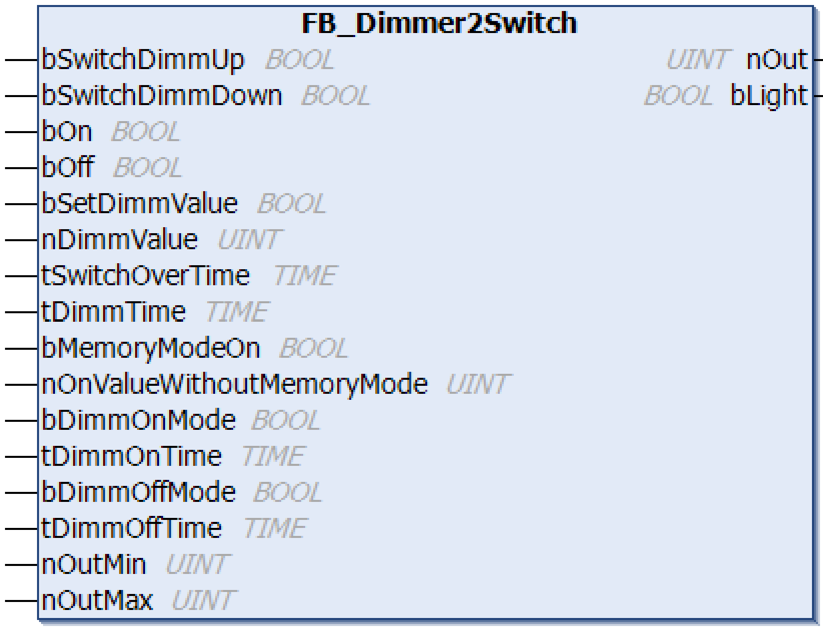
nOut: analog output value.

bLight: digital output value. This is set if *nOut* is greater than 0.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.4 FB_Dimmer2Switch



The function range of the function block corresponds to that of the function block FB_Dimmer1Switch() [▶ 37]. The difference is that in the function block FB_Dimmer2Switch two switches are connected. This allows the user to choose specifically between dimming up or dimming down.

Operation by means of the *bSwitchDimmUp* and *bSwitchDimmDown* inputs

The light is switched on or off by a short signal at the *bSwitchDimmUp* or *bSwitchDimmDown* inputs. Dimmer mode will be activated if the signal remains for longer than *tSwitchOverTime* (typical recommended value: 200ms). The output signal goes to *nOutMin* or *nOutMax*. When the signal is once more removed, the output signal being generated at that time is retained. Another pulse at one of the inputs will set the output to 0.

Operation by means of the *bOn* and *bOff* inputs

The light is immediately switched on or off if a positive edge is applied to the *bOn* or *bOff* inputs. For example, for global on/off functions. The output value is set to 0 when switching off. The switch-on behavior can be affected by the memory function (see below).

Operation by means of the *bSetDimmValue* and *nDimmValue* inputs

If the value of *nDimmValue* changes, the signal will be passed through directly to the output. The significant point here is that the value changes. The lighting is switched off by changing the value to 0. If there is a positive edge at the *bSetDimmValue* input, the value of *nDimmValue* immediately appears at the output. Immediate modification of the output can be suppressed by a static 1- signal at the *bSetDimmValue* input. This makes it possible to apply a value to the *nDimmValue* input, but for this value only to be passed to the output at the next positive edge of *bSetDimmValue*.
The *bSetDimmValue* and *nDimmValue* inputs can be used to implement a variety of lighting scenarios. Direct setting of the output, by means of *nDimmValue*, can be used to achieve particular brightness levels. Either directly or by continuously changing the value. *nDimmValue* must have a value between *nOutMin* and *nOutMax*. The value 0 is an exception. If the value is outside this range, the output value is limited to the upper or lower limit, as appropriate.

The memory function

It is necessary to determine whether the memory function (*bMemoryModeOn* input) is active or not at switch-on. If the memory function is active, then the last set value is placed at the output as soon as the lamp is switched on. If the memory function is not active, then the value specified by the *nOnValueWithoutMemoryMode* parameter is output. It is irrelevant, in this case, whether the light it has been switched on by means of the *bOn* input or one of the *bSwitchDimmUp* or *bSwitchDimmDown* inputs. It should be noted that the *nOnValueWithoutMemoryMode* parameter must lie between *nOutMin* and *nOutMax*. If this is not the case, the output value is adjusted to the upper or lower limit, as appropriate.

Fast dimming up/down when switching on and off

Lighting is particularly pleasant if sudden changes are replaced by a slow change to the desired value. This mode can be activated both for switching on and for switching off by means of the two inputs, *bDimmOnMode* and *bDimmOffMode*. The *tDimmOnTime* and *tDimmOffTime* parameters specify the time that will be taken by the switching processes. This value is always related to the minimum and maximum possible output values (*nOutMin* and *nOutMax*). The *bOn* and *bOff* inputs are one way in which the switch on/off commands may be given. Alternatively, a short pulse can be provided to either of the inputs *bSwitchDimmUp* or *bSwitchDimmDown*. If the *nDimmValue* input is set to 0, the output is modified without delay. The same is true if the output is set by a positive edge at the *bSetDimmValue* input.

Comments on the *tSwitchOverTime* and *tDimmTime* parameters

If a duration of 0 is specified for the *tSwitchOverTime* parameter, while a value of greater than 0 is specified for *tDimmTime*, then the *bSwitchDimmUp* or *bSwitchDimmDown* inputs can only be used to dim the light. Switching on and off is only possible with the *bOn* and *bOff* inputs.

If the *tDimmTime* parameter is 0, the *bSwitchDimmUp* or *bSwitchDimmDown* inputs can only be used to switch the light on or off. In this case, the value of *tSwitchOverTime* is irrelevant.

VAR_INPUT

```
bSwitchDimmUp                : BOOL;
bSwitchDimmDown              : BOOL;
bOn                          : BOOL;
bOff                         : BOOL;
bSetDimmValue                : BOOL;
nDimmValue                   : UINT;
tSwitchOverTime              : TIME := t#500ms;
tDimmTime                    : TIME := t#5s;
bMemoryModeOn                : BOOL := FALSE;
nOnValueWithoutMemoryMode    : UINT := 20000;
bDimmOnMode                  : BOOL := FALSE;
tDimmOnTime                  : TIME := t#0s;
bDimmOffMode                 : BOOL := FALSE;
tDimmOffTime                 : TIME := t#0s;
nOutMin                      : UINT := 5000;
nOutMax                      : UINT := 32767;
```

bSwitchDimmUp: Switches or dims the output Up.

bSwitchDimmDown: Switches or dims the output Down.

bOn: Switches the output to the last output value, or to the value specified by *nOnValueWithoutMemoryMode*.

bOff: Switches the output to 0.

bSetDimmValue: Switches the output to the value *nDimmValue*.

nDimmValue: The value is immediately applied to the output when there is a change.

tSwitchOverTime: Time for switching between the light on/off and dimming functions for the *bSwitchDimmUp* and *bSwitchDimmDown* inputs.

tDimmTime: Time required for dimming to go from its minimum value to its maximum value.

bMemoryModeOn: Switches over to use the memory function, so that the previous value is written to the output as soon as it is switched on.

nOnValueWithoutMemoryMode: Switch-on value if the memory function is not active.

bDimmOnMode: The output value is increased in steps when switching on.

tDimmOnTime: Time period during which the light level is increased when the light is switched on. *bDimmOnMode* must be active.

bDimmOffMode: The output value is reduced in steps when switching off

tDimmOffTime: Time period during which the light is reduced when the light is switched off. *bDimmOffMode* must be active.

nOutMin: Minimum output value.

nOutMax: Maximum output value. If the parameter *nOutMin* is not smaller than *nOutMax*, the output will remain at 0.

VAR_OUTPUT

```
nOut                : UINT;
bLight              : BOOL;
```

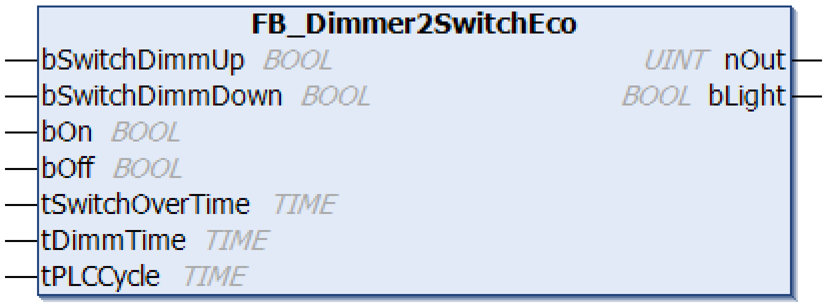
nOut: analog output value.

bLight: digital output value. This is set if *nOut* is greater than 0.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.5 FB_Dimmer2SwitchEco



This function block is a memory-saving variant of FB_Dimmer2Switch() [▸ 41]. It does not have the special functions "Set brightness value" and "Switch off memory function", which may not be required for many applications. Moreover, the values *nOutMin* and *nOutMax* of the FB_Dimmer2Switch() [▸ 41] are set internally here to 0 and 32767 respectively. This output span corresponds to the display range of an analog output terminal. The *tPLCCycle* input is important. This time is used to calculate internally the amount by which the *nOut* output must be increased per cycle - that saves additional time calculations.

Operation by means of the *bSwitchDimmUp* and *bSwitchDimmDown* inputs

The light is switched on or off by a short signal at the *bSwitchDimmUp* or *bSwitchDimmDown* inputs. Dimmer mode will be activated if the signal remains for longer than *tSwitchOverTime* (typical recommended value: 200ms). The output signal goes to *nOutMin* or *nOutMax*. When the signal is once more removed, the output signal being generated at that time is retained. Another pulse at one of the inputs will set the output to 0.

Operation by means of the *bOn* and *bOff* inputs

The light is immediately switched on or off if a positive edge is applied to the *bOn* or *bOff* inputs. For example, for global on/off functions. The output value is set to 0 when switching off.

The memory function

In contrast to FB_Dimmer2Switch() [▶ 41], where the memory function can be activated or deactivated via the input *bMemoryModeOn* , the memory function is always active in this memory-saving version. This means that the last-set value is adopted as the brightness value when switching on. It is irrelevant, in this case, whether the light it has been switched on by means of the *bOn* input or one of the *bSwitchDimmUp* or *bSwitchDimmDown* inputs.

Comment on the *tSwitchOverTime* parameter

If a duration of 0 is specified for the parameter *tSwitchOverTime*, the *bSwitchDimmUp* and *bSwitchDimmDown* inputs can only be used to dim the light. Switching on and off is only possible with the *bOn* and *bOff* inputs.

VAR_INPUT

```
bSwitchDimmUp       : BOOL;
bSwitchDimmDown     : BOOL;
bOn                 : BOOL;
bOff                : BOOL;
tSwitchOverTime     : TIME := t#500ms;
tDimmTime           : TIME := t#5s;
tPLCCycle           : TIME := t#10ms;
```

bSwitchDimmUp: Switches or dims the output Up.

bSwitchDimmDown: Switches or dims the output Down.

bOn: Switches the output to the last output value.

bOff: Switches the output to 0.

tSwitchOverTime: Time for switching between the light on/off and dimming functions for the *bSwitchDimmUp* and *bSwitchDimmDown* inputs.

tDimmTime: Time required for dimming to go from its minimum value to its maximum value.

tCycleDelay: Delay time, if either the minimum or maximum value is reached.

tPLCCycle: the set PLC cycle time.

VAR_OUTPUT

```
nOut                : UINT;
bLight              : BOOL;
```

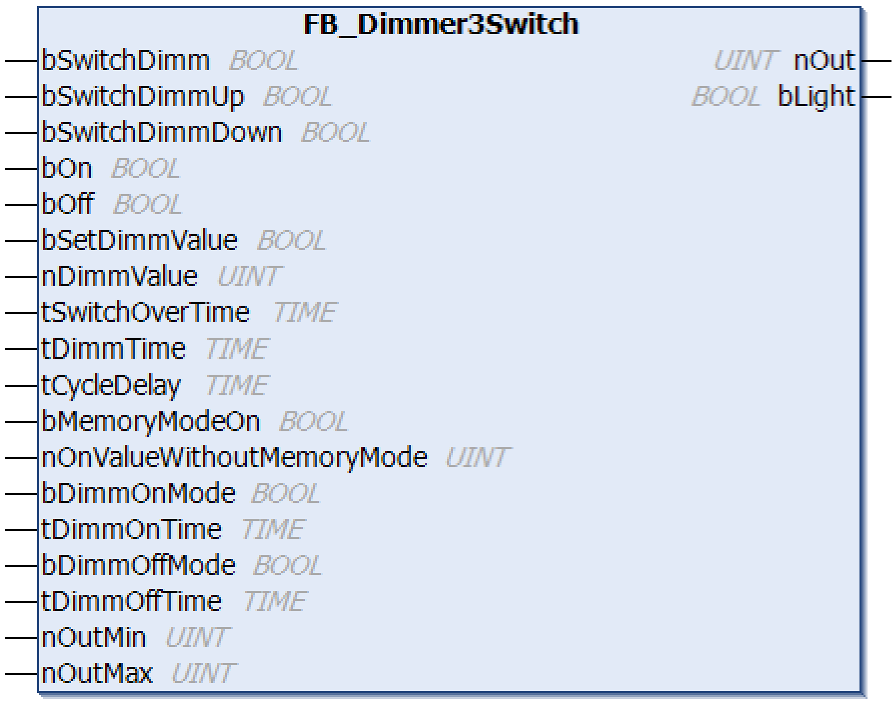
nOut: analog output value.

bLight: digital output value. This is set if *nOut* is greater than 0.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.6 FB_Dimmer3Switch



The functionality of the function block corresponds to the function blocks FB_Dimmer1Switch() [▶ 37] and FB_Dimmer2Switch() [▶ 41].

Operating by means of the *bSwitchDimm* input

The light is switched on or off by a short signal at the *bSwitchDimm* input. Dimmer mode will be activated if the signal remains for longer than *tSwitchOverTime* (typical recommended value: 200 ms). The output signal then cycles between *nOutMin* and *nOutMax*. In order to be able to set the maximum or minimum value more easily, the output signal pauses at the level of the maximum and minimum values for the time given by *tCycleDelay*. When the signal is once more removed, the output signal being generated at that time is retained. Another pulse at the input will set the output to 0.

Operation by means of the *bSwitchDimmUp* and *bSwitchDimmDown* inputs

The light is switched on or off by a short signal at the *bSwitchDimmUp* or *bSwitchDimmDown* inputs. Dimmer mode will be activated if the signal remains for longer than *tSwitchOverTime* (typical recommended value: 200ms). The output signal goes to *nOutMin* or *nOutMax*. When the signal is once more removed, the output signal being generated at that time is retained. Another pulse at one of the inputs will set the output to 0.

Operation by means of the *bOn* and *bOff* inputs

The light is immediately switched on or off if a positive edge is applied to the *bOn* or *bOff* inputs. For example, for global on/off functions. The output value is set to 0 when switching off. The switch-on behavior can be affected by the memory function (see below).

Operation by means of the *bSetDimmValue* and *nDimmValue* inputs

If the value of *nDimmValue* changes, the signal will be passed through directly to the output. The significant point here is that the value changes. The lighting is switched off by changing the value to 0. If there is a positive edge at the *bSetDimmValue* input, the value of *nDimmValue* immediately appears at the output. Immediate modification of the output can be suppressed by a static 1-signal at the *bSetDimmValue* input. This makes it possible to apply a value to the *nDimmValue* input, but for this value only to be passed to the output at the next positive edge of *bSetDimmValue*.
The *bSetDimmValue* and *nDimmValue* inputs can be used to implement a variety of lighting scenarios. Direct setting of the output, by means of *nDimmValue*, can be used to achieve particular brightness levels.

Either directly or by continuously changing the value. *nDimmValue* must have a value between *nOutMin* and *nOutMax*. The value 0 is an exception. If the value is outside this range, the output value is limited to the upper or lower limit, as appropriate.

The memory function

It is necessary to determine whether the memory function (*bMemoryModeOn* input) is active or not at switch-on. If the memory function is active, then the last set value is placed at the output as soon as the lamp is switched on. If the memory function is not active, then the value specified by the *nOnValueWithoutMemoryMode* parameter is output. It is irrelevant, in this case, whether the light it has been switched on by means of the *bOn* input or one of the *bSwitchDimmUp* or *bSwitchDimmDown* inputs. It should be noted that the *nOnValueWithoutMemoryMode* parameter must lie between *nOutMin* and *nOutMax*. If this is not the case, the output value is adjusted to the upper or lower limit, as appropriate.

Fast dimming up/down when switching on and off

Lighting is particularly pleasant if sudden changes are replaced by a slow change to the desired value. This mode can be activated both for switching on and for switching off by means of the two inputs, *bDimmOnMode* and *bDimmOffMode*. The *tDimmOnTime* and *tDimmOffTime* parameters specify the time that will be taken by the switching processes. This value is always related to the minimum and maximum possible output values (*nOutMin* and *nOutMax*). The *bOn* and *bOff* inputs are one way in which the switch on/off commands may be given. Alternatively, a short pulse can be provided to either of the inputs *bSwitchDimmUp* or *bSwitchDimmDown*. If the *nDimmValue* input is set to 0, the output is modified without delay. The same is true if the output is set by a positive edge at the *bSetDimmValue* input.

Comments on the *tSwitchOverTime* and *tDimmTime* parameters

If a duration of 0 is specified for the *tSwitchOverTime* parameter, while a value of greater than 0 is specified for *tDimmTime*, then the *bSwitchDimmUp* or *bSwitchDimmDown* inputs can only be used to dim the light. Switching on and off is only possible with the *bOn* and *bOff* inputs.

If the *tDimmTime* parameter is 0, the *bSwitchDimmUp* or *bSwitchDimmDown* inputs can only be used to switch the light on or off. In this case, the value of *tSwitchOverTime* is irrelevant.

VAR_INPUT

```
bSwitchDimm                 : BOOL;
bSwitchDimmUp               : BOOL;
bSwitchDimmDown             : BOOL;
bOn                         : BOOL;
bOff                        : BOOL;
bSetDimmValue               : BOOL;
nDimmValue                  : UINT;
tSwitchOverTime             : TIME := t#500ms;
tDimmTime                   : TIME := t#5s;
tCycleDelay                 : TIME := t#10ms;
bMemoryModeOn               : BOOL := FALSE;
nOnValueWithoutMemoryMode   : UINT := 20000;
bDimmOnMode                 : BOOL := FALSE;
tDimmOnTime                 : TIME := t#0s;
bDimmOffMode                : BOOL := FALSE;
tDimmOffTime                : TIME := t#0s;
nOutMin                     : UINT := 5000;
nOutMax                     : UINT := 32767;
```

bSwitchDimm: Switches or dims the output.

bSwitchDimmUp: Switches or dims the output Up.

bSwitchDimmDown: Switches or dims the output Down.

bOn: Switches the output to the last output value, or to the value specified by *nOnValueWithoutMemoryMode*.

bOff: Switches the output to 0.

bSetDimmValue: Switches the output to the value *nDimmValue*.

nDimmValue: The value is immediately applied to the output when there is a change.

tSwitchOverTime: Time for switching between the light on/off and dimming functions for the *bSwitchDimmUp* and *bSwitchDimmDown* inputs.

tDimmTime: Time required for dimming to go from its minimum value to its maximum value.

tCycleDelay: Delay time, if either the minimum or maximum value is reached.

bMemoryModeOn: Switches over to use the memory function, so that the previous value is written to the output as soon as it is switched on.

nOnValueWithoutMemoryMode: Switch-on value if the memory function is not active.

bDimmOnMode: The output value is increased in steps when switching on.

tDimmOnTime: Time period during which the light level is increased when the light is switched on. *bDimmOnMode* must be active.

bDimmOffMode: The output value is reduced in steps when switching off

tDimmOffTime: Time period during which the light is reduced when the light is switched off. *bDimmOffMode* must be active.

nOutMin: Minimum output value.

nOutMax: Maximum output value. If the parameter *nOutMin* is not smaller than *nOutMax*, the output will remain at 0.

VAR_OUTPUT

```
nOut                : UINT;
bLight              : BOOL;
```

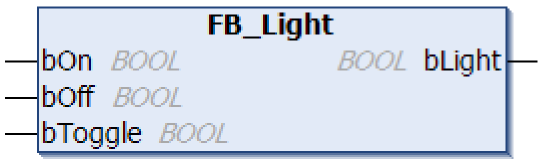
nOut: analog output value.

bLight: digital output value. This is set if *nOut* is greater than 0.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.7 FB_Light



A positive edge at the *bOn* input sets the *bLight* output. The output is reset by a positive edge at the *bOff* input. If a positive edge is presented to *bToggle*, the output is negated; i.e., if On it goes Off, and if Off it goes On.

VAR_INPUT

```
bOn            : BOOL;
bOff           : BOOL;
bToggle        : BOOL;
```

bOn: Switches the output on.

bOff: Switches the output off.

bToggle: Negates the state of the output.

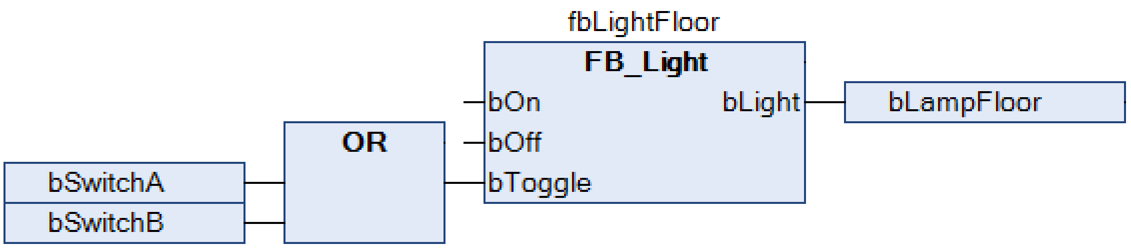
VAR_OUTPUT

```
bLight        : BOOL;
```

bLight: The output is set with a positive edge at *bOn* .

Example 1:

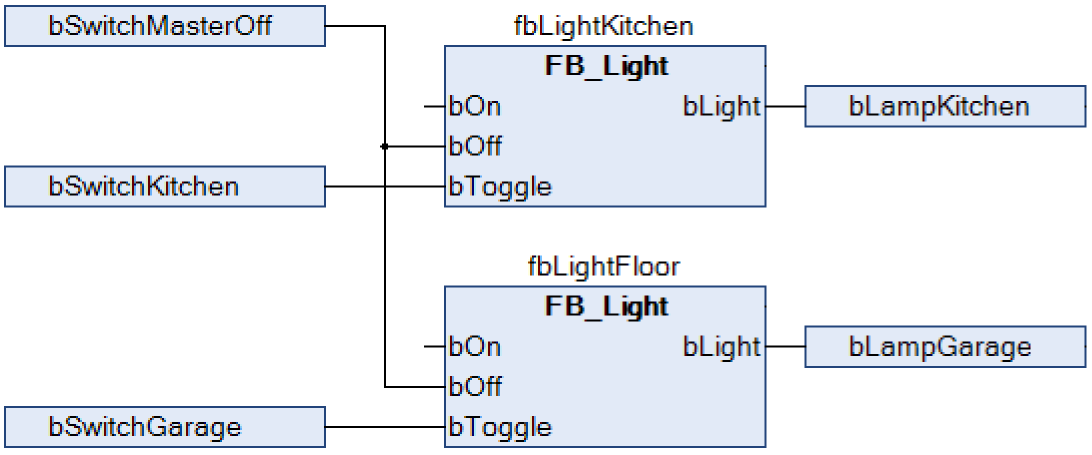
In the following example a light is operated by two switches.



If either the *bSwitchA* or the *bSwitchB* button is pressed, then the state of the light, as represented by the *bLight* output, is changed.

Example 2:

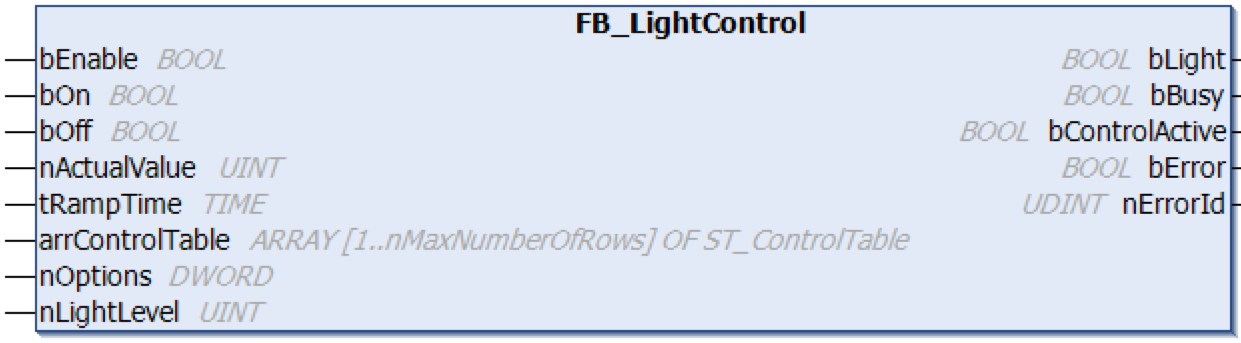
In the following example the *bSwitchMasterOff* switch is used to switch the *bLampKitchen* and *bLampGarage* lights off together. This function can be used, for instance, for central control of an area of a building.



Requirements

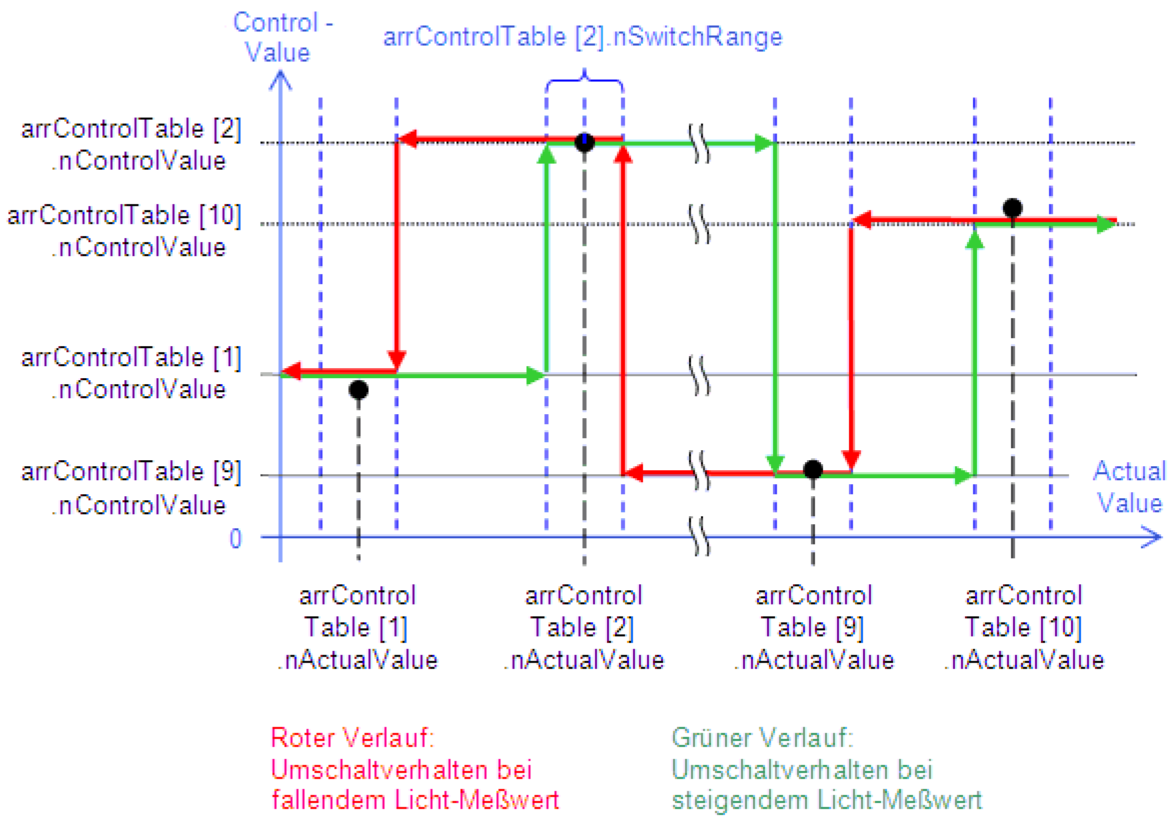
Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.8 FB_LightControl



Function block for daylight-dependent lighting control with up to 30 interpolation points.

At the core of this function block is an input/control value table consisting of 30 elements with threshold switching. If the input value reaches the range of an interpolation point (*arrControlTable[n].nActualValue-arrControlTable[n].nSwitchRange/2 ... arrControlTable[n].nActualValue+arrControlTable[n].nSwitchRange/2*), the control value jumps to the corresponding function value *arrControlTable[n].nSetpoint* (see diagram). Coupled to this is a ramp block that runs up the control value over the time *tRampTime*.
When switching on with a positive edge at *bOn*, however, the light is initially switched directly to the nearest control value. Only then is the controller activated. While the control is active, "post-starting" can take place at any time with a positive edge at *bOn*, thus directly controlling the light to the nearest control value. A positive edge at *bOff* switches the light off directly.


Control - Value
arrControlTable [2].nSwitchRange
arrControlTable [2] .nControlValue
arrControlTable [10] .nControlValue
arrControlTable [1] .nControlValue
arrControlTable [9] .nControlValue
0
Actual Value
arrControl Table [1] .nActualValue
arrControl Table [2] .nActualValue
arrControl Table [9] .nActualValue
arrControl Table [10] .nActualValue
Roter Verlauf: Umschaltverhalten bei fallendem Licht-Meßwert
Grüner Verlauf: Umschaltverhalten bei steigendem Licht-Meßwert

The whole range of the table does not have to be used. The first table element (*arrControlTable*, see below) for which the parameter *nSwitchrange* is 0 is considered the start of the unused area.

VAR_INPUT

```
bEnable             : BOOL;
bOn                 : BOOL;
bOff                : BOOL;
nActualValue        : UINT;
tRampTime           : TIME := t#30s;
arrControlTable     : ARRAY[1..30] OF ST_ControlTable;
nOptions            : DWORD;
```

bEnable: The *bOn* and *bOff* inputs are active as long as this input is *TRUE*. A negative state deactivates the inputs.

bOn: A rising edge directly switches *nLightLevel* to the nearest control value.

bOff: A rising edge directly switches *nLightLevel* to "*0*".

nActualValue: Current brightness.

tRampTime: Time period during which the brightness value is controlled to the next control value. (Preset value: 30 s).

arrControlTable: Input value/control value table. *arrControlTable[1]* to *arrControlTable[30]* of type ST_ControlTable [▸ 94].

nOptions: Reserved for future developments.

VAR_OUTPUT

```
bLight              : BOOL;
bBusy               : BOOL;
bControlActive      : BOOL;
bError              : BOOL;
nErrorId            : UDINT;
```

bLight: This output is set as long as *nLightLevel* is greater than "*0*".

bBusy: This output is always active as long as the processing of a command (*bOn*, *bOff*, *bToggle* or ramp) is active.

bControlActive: This output is active as long as the control is active.

bError: This output is switched to *TRUE* as soon as an error occurs during the execution of a command. The command-specific error code is contained in *nErrorId*. Is reset to *FALSE* by the execution of a command at the inputs.

nErrorId: Contains the specific error code of the most recently executed command. Is reset to "*0*" by the execution of a command at the inputs. See Error codes [▸ 93].

VAR_IN_OUT

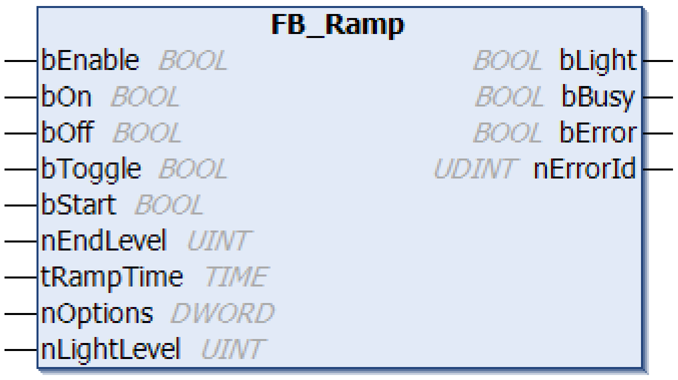
```
nLightLevel             : UINT;
```

nLightLevel: Output control value of the function block and reference to the light output value.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.9 FB_Ramp



Function block for realizing a light-ramp.

A rising edge at input *bOn* switches the light to the maximum value (*32767*). A rising edge at input *bOff* switches the light off again. Rising edges at the *bToggle* input invert the respective light state. A positive edge at the *bStart* input allows the function block to dim the light from the current level to *nEndLevel*. The time required for this is defined by *tRampTime*. All inputs are only active as long as *bEnable* is TRUE, otherwise the function block is reset internally.

VAR_INPUT

```
bEnable             : BOOL;
bOn                 : BOOL;
bOff                : BOOL;
bToggle             : BOOL;
bStart              : BOOL;
nEndLevel           : BYTE;
tRampTime           : TIME := t#10s;
nOptions            : DWORD;
```

bEnable: The *bOn*, *bOff*, *bToggle* and *bStart* inputs are active as long as this input is TRUE. A negative state deactivates the inputs and resets the function block.

bOn: A rising edge directly switches *nLightLevel* to the maximum value (*32767*).

bOff: A rising edge directly switches *nLightLevel* to "*0*".

bToggle: Switches the light state between On (*32767*) and Off (*0*).

bStart: If a rising edge is applied to this input, the light is dimmed up or down from the current value to *nEndLevel*. The time required for this is defined by *tRampTime*. The dimming procedure can be interrupted at any time by *bOn*, *bOff* or *bToggle*.

nEndLevel: Target value of the dimming procedure.

tRampTime: Ramp time, see *bStart*. (Preset value: 10 seconds).

nOptions: Reserved for future developments.

VAR_OUTPUT

```
bLight              : BOOL;
bBusy               : BOOL;
bError              : BOOL;
nErrorId            : UDINT;
```

bLight: This output is set as long as *nLightLevel* is greater than 0.

bBusy: This output is always active as long as the processing of a command (*bOn*, *bOff*, *bToggle* or ramp) is active.

bError: This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in *nErrorId*. Is reset to FALSE by the execution of a command at the inputs.

nErrorId: Contains the command-specific error code of the most recently executed command. Is reset to "0" by the execution of a command at the inputs. See Error codes [▶ 93].

VAR_IN_OUT

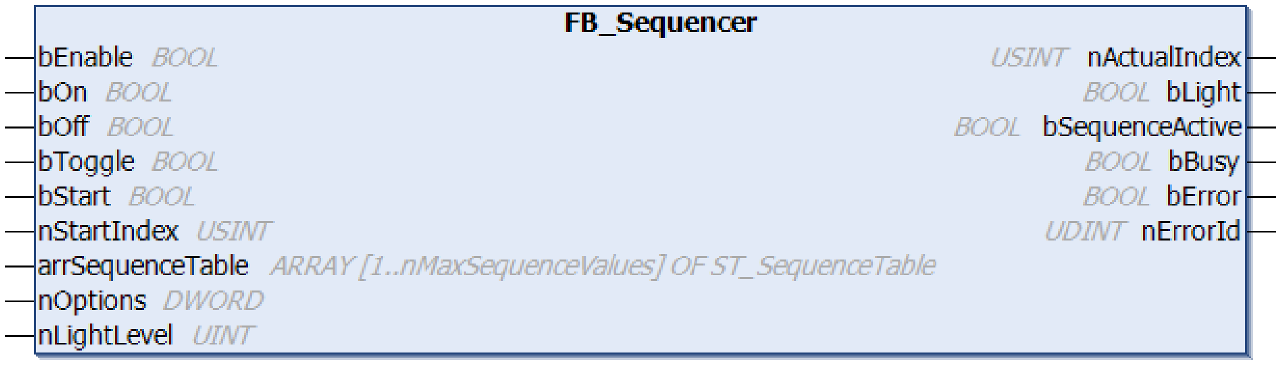
```
nLightLevel            : UINT;
```

nLightLevel: Output control value of the function block and reference to the light output value. This value is defined as In-Out variable because the function block reads and writes the light value.

Requirements

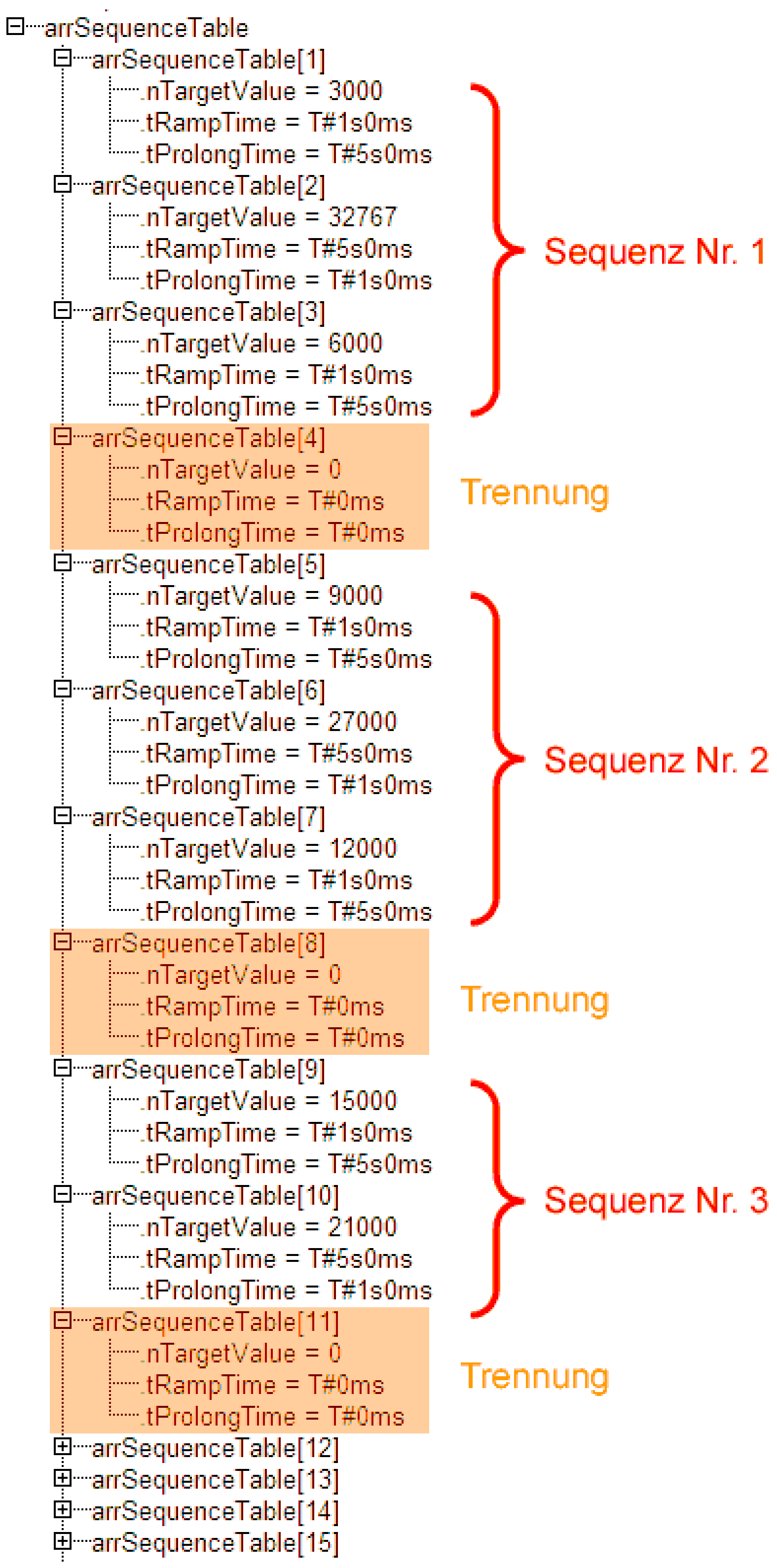
Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.10 FB_Sequencer



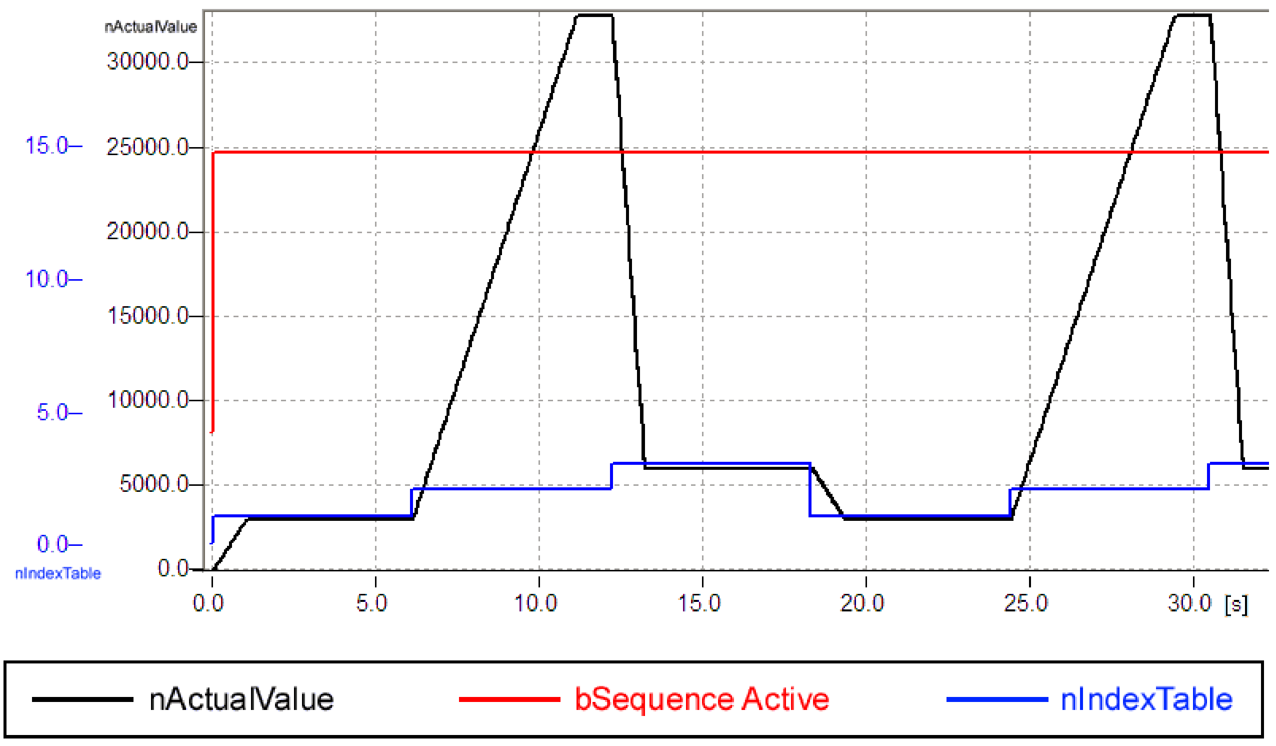
Function block for realizing light sequences with up to 50 interpolation points.

At the core of this function block is a ramp that approaches individual brightness values defined in a table within an adjustable time and then remains at this brightness value for a time that can also be defined. After the dwell time the next value is then driven to. As already mentioned, the table *arrSequenceTable* consists of 50 entries with the values for *nTargetValue* (target value), *tRampTime* (time taken to reach the target value) and *tProlongTime* (dwell time at the target value). It is not absolutely necessary to use all 50 values. A 0 entry of all 3 values marks the end of a sequence. Beyond that it is possible using the *nStartIndex* input to have a light sequence begin at any desired place in the table. This allows several different light sequences to be programmed even within the 50 entries, the sequences being separated from one another by 0 entry elements:



```
⊟arrSequenceTable
  ⊟arrSequenceTable[1]
      .nTargetValue = 3000
      .tRampTime = T#1s0ms
      .tProlongTime = T#5s0ms
  ⊟arrSequenceTable[2]
      .nTargetValue = 32767
      .tRampTime = T#5s0ms
      .tProlongTime = T#1s0ms
  ⊟arrSequenceTable[3]
      .nTargetValue = 6000
      .tRampTime = T#1s0ms
      .tProlongTime = T#5s0ms
  ⊟arrSequenceTable[4]
      .nTargetValue = 0
      .tRampTime = T#0ms
      .tProlongTime = T#0ms
  ⊟arrSequenceTable[5]
      .nTargetValue = 9000
      .tRampTime = T#1s0ms
      .tProlongTime = T#5s0ms
  ⊟arrSequenceTable[6]
      .nTargetValue = 27000
      .tRampTime = T#5s0ms
      .tProlongTime = T#1s0ms
  ⊟arrSequenceTable[7]
      .nTargetValue = 12000
      .tRampTime = T#1s0ms
      .tProlongTime = T#5s0ms
  ⊟arrSequenceTable[8]
      .nTargetValue = 0
      .tRampTime = T#0ms
      .tProlongTime = T#0ms
  ⊟arrSequenceTable[9]
      .nTargetValue = 15000
      .tRampTime = T#1s0ms
      .tProlongTime = T#5s0ms
  ⊟arrSequenceTable[10]
      .nTargetValue = 21000
      .tRampTime = T#5s0ms
      .tProlongTime = T#1s0ms
  ⊟arrSequenceTable[11]
      .nTargetValue = 0
      .tRampTime = T#0ms
      .tProlongTime = T#0ms
  ⊞arrSequenceTable[12]
  ⊞arrSequenceTable[13]
  ⊞arrSequenceTable[14]
  ⊞arrSequenceTable[15]
```

Over the course of time sequence 1, for example, looks like the following (*nStartIndex=1, nOptions.bit0=TRUE*, see below for explanation):



In addition, the function block can be switched on and off "normally" (On: *nLightLevel* = 32767, Off: *nLightLevel* = 0) or toggled between "On" and "Off" via the input *bToggle*. However, none of the command inputs is active unless the *bEnable* input is *TRUE*. If it is reset to *FALSE*, no more commands are accepted and the light value retains its current state – even from a ramp.

VAR_INPUT

```
bEnable             : BOOL;
bOn                 : BOOL;
bOff                : BOOL;
bToggle             : BOOL;
bStart              : BOOL;
nStartIndex         : USINT;
arrSequenceTable    : ARRAY[1..50] OF ST_SequenceTable;
nOptions            : DWORD;
```

bEnable: The *bOn*, *bOff*, *bToggle* and *bStart* inputs are active as long as this input is *TRUE*. A negative state deactivates the inputs and resets the function block.

bOn: A rising edge directly switches *nLightLevel* to the maximum value (*32767*).

bOff: A rising edge directly switches *nLightLevel* to "*0*".

bToggle: Switches the light state between On (*32767*) and Off (*0*).

bStart: A positive edge starts a light sequence from the beginning defined under *nStartIndex*.

nStartIndex: See *bStart.*

arrSequenceTable: Light value table with the corresponding ramp and dwell times (see ST_SequenceTable [▸ 95]).

nOptions: Parameterization input. The setting (or non-setting) of the individual bits of this variable of the type *DWORD* has the following effect:

Constant	Description
OPTION_INFINITE_LOOP	Following the expiry of a sequence, the function block automatically continues at the point defined at *nStartIndex*. If this option is not set, the sequence stops after it has elapsed. A new positive edge at *bStart* would be necessary to restart a sequence.

VAR_OUTPUT

```
nActualIndex        : USINT;
bLight              : BOOL;
bSequenceActive     : BOOL;
bBusy               : BOOL;
bError              : BOOL;
nErrorId            : UDINT;
```

nActualIndex: Reference to the current element in the sequence table. If a sequence has been completed (*bSequenceActive = FALSE*, see below), this output goes to "0".

bLight: This output is set as long as *nLightLevel* is greater than "*0*".

bSequenceActive: On processing a sequence this output is set to *TRUE*.

bBusy: This output is always active as long as the processing of a command (*bOn*, *bOff*, *bToggle* or ramp) is active.

bError: This output is switched to *TRUE* as soon as an error occurs during the execution of a command. The command-specific error code is contained in *nErrorId*. Is reset to *FALSE* by the execution of a command at the inputs.

nErrorId: Contains the specific error code of the most recently executed command. Is reset to "*0*" by the execution of a command at the inputs. See Error codes [▶ 93].

VAR_IN_OUT

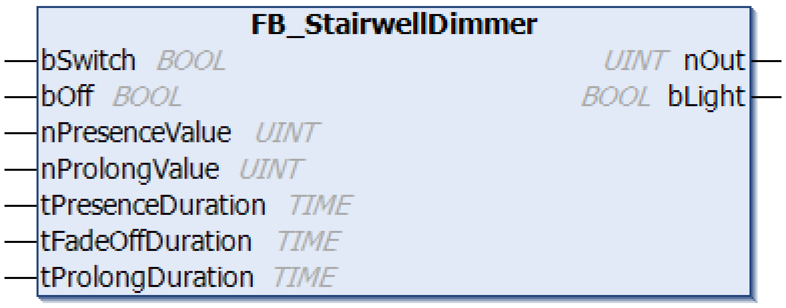
```
nLightLevel         : UINT;
```

nLightLevel: Output control value of the function block and reference to the light output value.

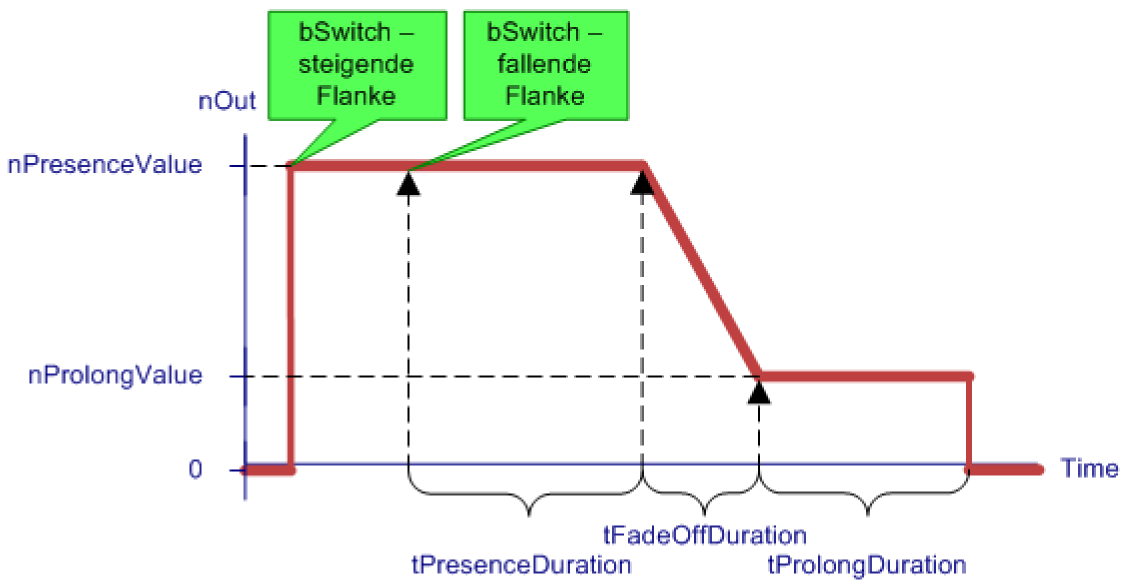
Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.11 FB_StairwellDimmer



A rising edge at the input *bSwitch* sets the analog output *nOut* to the value *nPresenceValue.* A falling edge on *bSwitch* starts or restarts a timer with the runtime *tPresenceDuration.* Following the expiry of this timer, *nOut* is dimmed to the value *nProlongValue* over the time period *tFadeOffDuration.* This value is maintained for the time period *tProlongDuration.* After that, *nOut* is set to 0. A positive edge at the input *bOff* switches the output *nOut* to 0 immediately. The digital output value *bLight* is always set when *nOut* is greater than 0.



VAR_INPUT

```
bSwitch              : BOOL;
bOff                 : BOOL;
nPresenceValue       : UINT := 32767;
nProlongValue        : UINT := 10000;
tPresenceDuration    : TIME := t#120s;
tFadeOffDuration     : TIME := t#10s;
tProlongDuration     : TIME := t#20s;
```

bSwitch: Upon a positive edge: *nOut* is set to *nPresenceValue*. Upon a negative edge: start of the presence time (see diagram).

bOff: Switches *nOut* off immediately.

nPresenceValue: Value to which *nOut* should be set during the presence time. (Preset value: 32767).

nProlongValue: Value to which *nOut* should be set during the dwell time. (Preset value: 10000).

tPresenceDuration: Duration of the presence time in which *nOut* is set to *nPresenceValue* following a falling edge on *bSwitch*. (Preset value: 120 seconds).

tFadeOffDuration: Duration over which *nOut* is faded down to the dwell time following the presence time. (Preset value: 10 seconds).

tProlongDuration: Duration of the dwell time. (Preset value: 20 seconds).

VAR_OUTPUT

```
nOut         : UINT;
bLight       : BOOL;
```

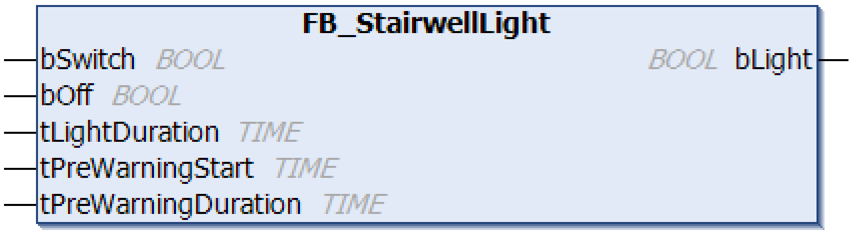
nOut: Output of the momentary light value.

bLight: This output is set as long as *nOut* is greater than 0.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.5.12 FB_StairwellLight



A positive edge at the *bSwitch* input sets the *bLight* output. The output is reset once the *tLightDuration* time has elapsed. If a signal is presented again to the *bSwitch* input before this time has elapsed, the timer is restarted. When *tPreWarningStart* has elapsed, the light is switched off (as a prewarning) for the period *tPreWarningDuration*. If this prewarning is not to be given, the parameter *tPreWarningStart* must be set to 0. A positive edge at the *bOff* input switches the output off immediately.

VAR_INPUT

```
bSwitch                 : BOOL;
bOff                    : BOOL;
tLightDuration          : TIME := t#120s;
tPreWarningStart        : TIME := t#110s;
tPreWarningDuration     : TIME := t#500ms;
```

bSwitch: Switches the output on for the period of time given by *tLightDuration*.

bOff: Switches the output off.

tLightDuration: Period of time for which the output is set.

tPreWarningStart: Warning time.

tPreWarningDuration: Duration of the prewarning.

VAR_OUTPUT

```
bLight            : BOOL;
```

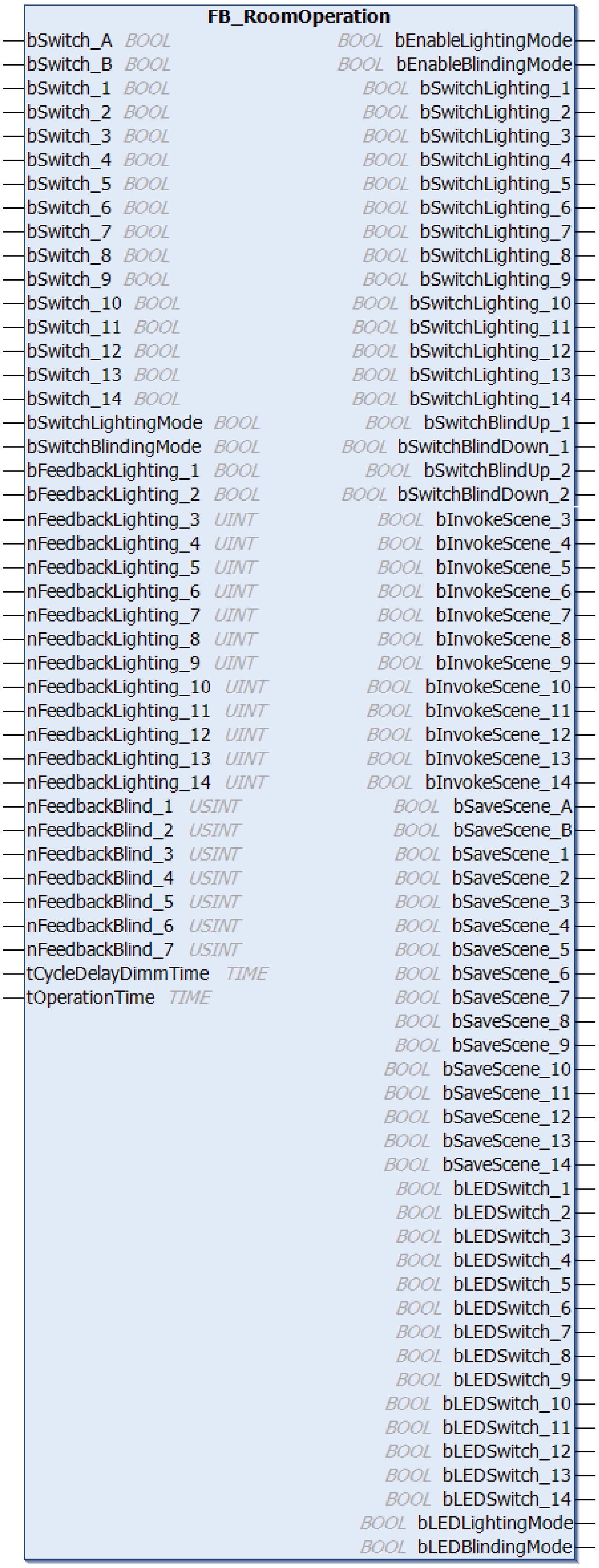
bLight: The output is set for the duration of *tLightDuration* with a positive edge at *bSwitch*.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.6 Scene management

4.1.6.1 FB_RoomOperation



FB_RoomOperation

bSwitch_A	BOOL	BOOL	bEnableLightingMode
bSwitch_B	BOOL	BOOL	bEnableBlindingMode
bSwitch_1	BOOL	BOOL	bSwitchLighting_1
bSwitch_2	BOOL	BOOL	bSwitchLighting_2
bSwitch_3	BOOL	BOOL	bSwitchLighting_3
bSwitch_4	BOOL	BOOL	bSwitchLighting_4
bSwitch_5	BOOL	BOOL	bSwitchLighting_5
bSwitch_6	BOOL	BOOL	bSwitchLighting_6
bSwitch_7	BOOL	BOOL	bSwitchLighting_7
bSwitch_8	BOOL	BOOL	bSwitchLighting_8
bSwitch_9	BOOL	BOOL	bSwitchLighting_9
bSwitch_10	BOOL	BOOL	bSwitchLighting_10
bSwitch_11	BOOL	BOOL	bSwitchLighting_11
bSwitch_12	BOOL	BOOL	bSwitchLighting_12
bSwitch_13	BOOL	BOOL	bSwitchLighting_13
bSwitch_14	BOOL	BOOL	bSwitchLighting_14
bSwitchLightingMode	BOOL	BOOL	bSwitchBlindUp_1
bSwitchBlindingMode	BOOL	BOOL	bSwitchBlindDown_1
bFeedbackLighting_1	BOOL	BOOL	bSwitchBlindUp_2
bFeedbackLighting_2	BOOL	BOOL	bSwitchBlindDown_2
nFeedbackLighting_3	UINT	BOOL	bInvokeScene_3
nFeedbackLighting_4	UINT	BOOL	bInvokeScene_4
nFeedbackLighting_5	UINT	BOOL	bInvokeScene_5
nFeedbackLighting_6	UINT	BOOL	bInvokeScene_6
nFeedbackLighting_7	UINT	BOOL	bInvokeScene_7
nFeedbackLighting_8	UINT	BOOL	bInvokeScene_8
nFeedbackLighting_9	UINT	BOOL	bInvokeScene_9
nFeedbackLighting_10	UINT	BOOL	bInvokeScene_10
nFeedbackLighting_11	UINT	BOOL	bInvokeScene_11
nFeedbackLighting_12	UINT	BOOL	bInvokeScene_12
nFeedbackLighting_13	UINT	BOOL	bInvokeScene_13
nFeedbackLighting_14	UINT	BOOL	bInvokeScene_14
nFeedbackBlind_1	USINT	BOOL	bSaveScene_A
nFeedbackBlind_2	USINT	BOOL	bSaveScene_B
nFeedbackBlind_3	USINT	BOOL	bSaveScene_1
nFeedbackBlind_4	USINT	BOOL	bSaveScene_2
nFeedbackBlind_5	USINT	BOOL	bSaveScene_3
nFeedbackBlind_6	USINT	BOOL	bSaveScene_4
nFeedbackBlind_7	USINT	BOOL	bSaveScene_5
tCycleDelayDimmTime	TIME	BOOL	bSaveScene_6
tOperationTime	TIME	BOOL	bSaveScene_7
		BOOL	bSaveScene_8
		BOOL	bSaveScene_9
		BOOL	bSaveScene_10
		BOOL	bSaveScene_11
		BOOL	bSaveScene_12
		BOOL	bSaveScene_13
		BOOL	bSaveScene_14
		BOOL	bLEDSwitch_1
		BOOL	bLEDSwitch_2
		BOOL	bLEDSwitch_3
		BOOL	bLEDSwitch_4
		BOOL	bLEDSwitch_5
		BOOL	bLEDSwitch_6
		BOOL	bLEDSwitch_7
		BOOL	bLEDSwitch_8
		BOOL	bLEDSwitch_9
		BOOL	bLEDSwitch_10
		BOOL	bLEDSwitch_11
		BOOL	bLEDSwitch_12
		BOOL	bLEDSwitch_13
		BOOL	bLEDSwitch_14
		BOOL	bLEDLightingMode
		BOOL	bLEDBlindingMode

The function block FB_RoomOperation () is conceived for the management of lighting and blinds. Scenes are called and dimmed in a state of rest. Lighting and blinds can be set and saved in the appropriate mode. This function block is intended for use with the function blocks FB_ScenesLighting() [▶ 63], FB_ScenesVenetianBlind() [▶ 66], FB_Dimmer1Switch() [▶ 37] and FB_VenetianBlindEx() [▶ 23].

Calling saved scenes:

A rising edge at the input *bSwitch_A, bSwitch_B or bSwitch_1..14* causes a pulse to be output at the output *bInvokeScene_A, bInvokeScene_B or bInvokeScene_1..14*.

Dimming saved scenes:

A scene is called and dimmed up by a signal that is applied to the input *bSwitch_A, bSwitch_B or bSwitch_1..14* for a time exceeding *tCycleDelayDimmTime*.

Setting blind and lighting values:

A signal at the input *bSwitchLightingMode* or *bSwitchBlindingMode* switches to the respective mode. The control values are changed by the inputs *bSwitch_1..14* via the outputs *bSwitchLighting_1..14* or *bSwitchBlindUp / bSwitchBlindDown_1..7*.

Saving the settings:

By means of setting the input *bSwitchLightingMode* or *bSwitchBlindingMode* and a signal at the input *bSwitch_A, bSwitch_B or bSwitch_1..14*, a pulse is output at the output *bSaveScene_A, bSaveScene_B or bSaveScene_1..14*. The values are saved in the function block FB_ScenesLighting() [▶ 63], FB_ScenesVenetianBlind() [▶ 66].

VAR_INPUT

```
bSwitch_A              : BOOL;
bSwitch_B              : BOOL;
bSwitch_1              : BOOL;
bSwitch_2              : BOOL;
bSwitch_3              : BOOL;
bSwitch_4              : BOOL;
bSwitch_5              : BOOL;
bSwitch_6              : BOOL;
bSwitch_7              : BOOL;
bSwitch_8              : BOOL;
bSwitch_9              : BOOL;
bSwitch_10             : BOOL;
bSwitch_11             : BOOL;
bSwitch_12             : BOOL;
bSwitch_13             : BOOL;
bSwitch_14             : BOOL;
bSwitchLightingMode    : BOOL;
bSwitchBlindingMode    : BOOL;
bFeedbackLighting_1    : BOOL;
bFeedbackLighting_2    : BOOL;
bFeedbackLighting_3    : BOOL;
bFeedbackLighting_4    : BOOL;
bFeedbackLighting_5    : BOOL;
bFeedbackLighting_6    : BOOL;
bFeedbackLighting_7    : BOOL;
bFeedbackLighting_8    : BOOL;
bFeedbackLighting_9    : BOOL;
bFeedbackLighting_10   : BOOL;
bFeedbackLighting_11   : BOOL;
bFeedbackLighting_12   : BOOL;
bFeedbackLighting_13   : BOOL;
bFeedbackLighting_14   : BOOL;
nFeedbackLighting_1    : UINT;
nFeedbackLighting_2    : UINT;
nFeedbackLighting_3    : UINT;
nFeedbackLighting_4    : UINT;
nFeedbackLighting_5    : UINT;
nFeedbackLighting_6    : UINT;
nFeedbackLighting_7    : UINT;
nFeedbackLighting_8    : UINT;
nFeedbackLighting_9    : UINT;
```

```
nFeedbackLighting_10  : UINT;
nFeedbackLighting_11  : UINT;
nFeedbackLighting_12  : UINT;
nFeedbackLighting_13  : UINT;
nFeedbackLighting_14  : UINT;
nFeedbackBlind_1      : USINT;
nFeedbackBlind_2      : USINT;
nFeedbackBlind_3      : USINT;
nFeedbackBlind_4      : USINT;
nFeedbackBlind_5      : USINT;
nFeedbackBlind_6      : USINT;
nFeedbackBlind_7      : USINT;
tCycleDelayDimmTime   : TIME := t#500ms;
tOperationTime        : TIME := t#60s;
```

bSwitch_A, B: calls the saved Scene A or Scene B.

bSwitch_1..14: sets and calls the saved scenes.

bSwitchLightingMode: switches to the lighting mode.

bSwitchBlindingMode: switches to the blinding mode.

bFeedbackLighting_1..14: current status of the respective lamp. Return value from the dimmer function block FB_Dimmer1Switch() [▶ 37].

nFeedbackLighting_1..14: current control value of the respective lamp. Return value from the dimmer function block FB_Dimmer1Switch() [▶ 37].

nFeedbackBlind_1..7: current control value of the respective blind. Return value from the blind function block FB_VenetianBlindEx() [▶ 23].

tCycleDelayDimmTime: switching time between dimming and calling a scene.

tOperationTime: if the blinding or lighting mode is active and no operation takes place, the mode is automatically switched back to scene mode after the expiry of this time.

VAR_OUTPUT

```
bEnableLightingMode  : BOOL;
bEnableBlindingMode  : BOOL;
bSwitchLighting_1    : BOOL;
bSwitchLighting_2    : BOOL;
bSwitchLighting_3    : BOOL;
bSwitchLighting_4    : BOOL;
bSwitchLighting_5    : BOOL;
bSwitchLighting_6    : BOOL;
bSwitchLighting_7    : BOOL;
bSwitchLighting_8    : BOOL;
bSwitchLighting_9    : BOOL;
bSwitchLighting_10   : BOOL;
bSwitchLighting_11   : BOOL;
bSwitchLighting_12   : BOOL;
bSwitchLighting_13   : BOOL;
bSwitchLighting_14   : BOOL;
bSwitchBlindUp_1     : BOOL;
bSwitchBlindDown_1   : BOOL;
bSwitchBlindUp_2     : BOOL;
bSwitchBlindDown_2   : BOOL;
bSwitchBlindUp_3     : BOOL;
bSwitchBlindDown_3   : BOOL;
bSwitchBlindUp_4     : BOOL;
bSwitchBlindDown_4   : BOOL;
bSwitchBlindUp_5     : BOOL;
bSwitchBlindDown_5   : BOOL;
bSwitchBlindUp_6     : BOOL;
bSwitchBlindDown_6   : BOOL;
bSwitchBlindUp_7     : BOOL;
bSwitchBlindDown_7   : BOOL;
bInvokeScene_A       : BOOL;
bInvokeScene_B       : BOOL;
bInvokeScene_1       : BOOL;
bInvokeScene_2       : BOOL;
bInvokeScene_3       : BOOL;
bInvokeScene_4       : BOOL;
bInvokeScene_5       : BOOL;
```

```
bInvokeScene_6        : BOOL;
bInvokeScene_7        : BOOL;
bInvokeScene_8        : BOOL;
bInvokeScene_9        : BOOL;
bInvokeScene_10       : BOOL;
bInvokeScene_11       : BOOL;
bInvokeScene_12       : BOOL;
bInvokeScene_13       : BOOL;
bInvokeScene_14       : BOOL;
bSaveScene_A          : BOOL;
bSaveScene_B          : BOOL;
bSaveScene_1          : BOOL;
bSaveScene_2          : BOOL;
bSaveScene_3          : BOOL;
bSaveScene_4          : BOOL;
bSaveScene_5          : BOOL;
bSaveScene_6          : BOOL;
bSaveScene_7          : BOOL;
bSaveScene_8          : BOOL;
bSaveScene_9          : BOOL;
bSaveScene_10         : BOOL;
bSaveScene_11         : BOOL;
bSaveScene_12         : BOOL;
bSaveScene_13         : BOOL;
bSaveScene_14         : BOOL;
bLEDSwitch_1          : BOOL;
bLEDSwitch_2          : BOOL;
bLEDSwitch_3          : BOOL;
bLEDSwitch_4          : BOOL;
bLEDSwitch_5          : BOOL;
bLEDSwitch_6          : BOOL;
bLEDSwitch_7          : BOOL;
bLEDSwitch_8          : BOOL;
bLEDSwitch_9          : BOOL;
bLEDSwitch_10         : BOOL;
bLEDSwitch_11         : BOOL;
bLEDSwitch_12         : BOOL;
bLEDSwitch_13         : BOOL;
bLEDSwitch_14         : BOOL;
bLEDLightingMode      : BOOL;
bLEDBlindingMode      : BOOL;
```

bEnableLightingMode: enables the memory function block FB_ScenesLighting() [▸ 63].

bEnableBlindingMode: enables the memory function block FB_ScenesVenetianBlind() [▸ 66].

bSwitchLighting_1..14: output for operating the dimmer function block FB_Dimmer1Switch() [▸ 37] via the input *bSwitchDimm.*

bSwitchBlindUp_1..7: output for operating the blind function block FB_VenetianBlindEx() [▸ 23] via the input *bSwitchOverUp*.

bSwitchBlindDown_1..7: output for operating the blind function block FB_VenetianBlindEx() [▸ 23] via the input *bSwitchOverDown*.

bInvokeScene_A, B, 1..14: output signal for loading a scene. Is passed on to the function blocks FB_ScenesLighting() [▸ 63] und FB_ScenesVenetianBlind() [▸ 66].

bSaveScene_A, B, 1..14: output signal for saving a scene. Is passed on to the function blocks FB_ScenesLighting() [▸ 63] und FB_ScenesVenetianBlind() [▸ 66].

bLEDSwitch_1..14: these outputs indicate the status of the respective lighting (on/off) or shading (0%/100%). These outputs are always FALSE in scene mode.

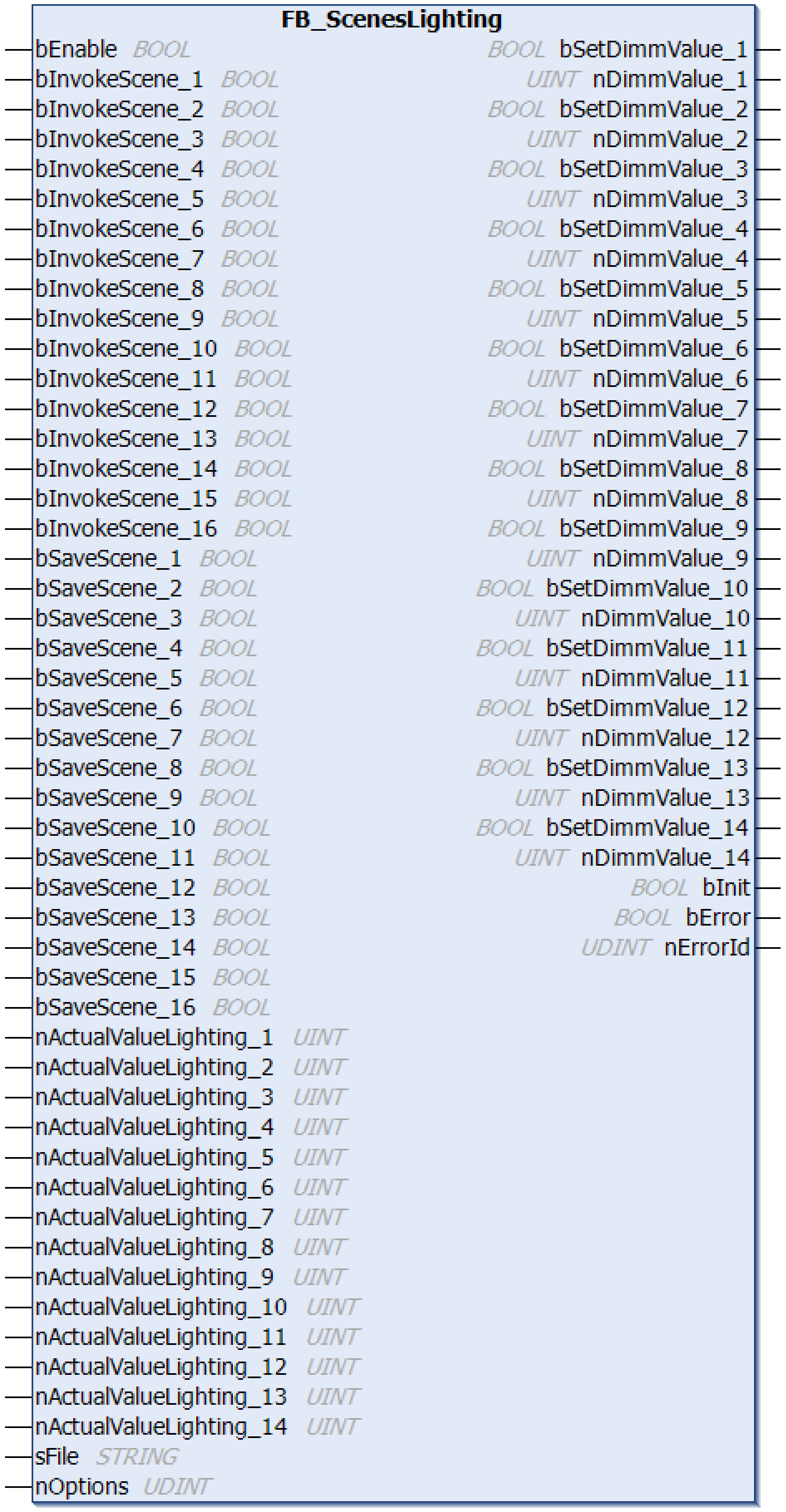
bLEDLightingMode: this output is TRUE if lighting mode is active.

bLEDBlindingMode: this output is TRUE if blinding mode is active.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.6.2 FB_ScenesLighting



This function block is intended for the management of lighting scenes. The function block is enabled via the *bEnable* input. The loading of the saved scenes is started by a positive edge at the *bEnable* input. The input must remain TRUE until the operation is completed. The values of the scenes are saved non-volatile in the TwinCAT Boot directory as a *.bin file. The last data status is saved in a *.bak file as a backup.

Save scene

The values of the inputs *nActualValueLighting_1..14* are saved in the respective scene by a rising edge at the input *bSaveScene_1...16*.

Load scenes

The saved values are output at the output *nDimmValue_1..14* by a rising edge at the input *bInvokeScene_1..16*. Furthermore, a positive edge is generated at output *bSetDimmValue_1..14* for a PLC cycle.

VAR_INPUT

```
bEnable                   : BOOL;
bInvokeScene_1            : BOOL;
bInvokeScene_2            : BOOL;
bInvokeScene_3            : BOOL;
bInvokeScene_4            : BOOL;
bInvokeScene_5            : BOOL;
bInvokeScene_6            : BOOL;
bInvokeScene_7            : BOOL;
bInvokeScene_8            : BOOL;
bInvokeScene_9            : BOOL;
bInvokeScene_10           : BOOL;
bInvokeScene_11           : BOOL;
bInvokeScene_12           : BOOL;
bInvokeScene_13           : BOOL;
bInvokeScene_14           : BOOL;
bInvokeScene_15           : BOOL;
bInvokeScene_16           : BOOL;
bSaveScene_1              : BOOL;
bSaveScene_2              : BOOL;
bSaveScene_3              : BOOL;
bSaveScene_4              : BOOL;
bSaveScene_5              : BOOL;
bSaveScene_6              : BOOL;
bSaveScene_7              : BOOL;
bSaveScene_8              : BOOL;
bSaveScene_9              : BOOL;
bSaveScene_10             : BOOL;
bSaveScene_11             : BOOL;
bSaveScene_12             : BOOL;
bSaveScene_13             : BOOL;
bSaveScene_14             : BOOL;
bSaveScene_15             : BOOL;
bSaveScene_16             : BOOL;
nActualValueLighting_1    : UINT;
nActualValueLighting_2    : UINT;
nActualValueLighting_3    : UINT;
nActualValueLighting_4    : UINT;
nActualValueLighting_5    : UINT;
nActualValueLighting_6    : UINT;
nActualValueLighting_7    : UINT;
nActualValueLighting_8    : UINT;
nActualValueLighting_9    : UINT;
nActualValueLighting_10   : UINT;
nActualValueLighting_11   : UINT;
nActualValueLighting_12   : UINT;
nActualValueLighting_13   : UINT;
nActualValueLighting_14   : UINT;
sFile                     : STRING;
nOptions                  : UDINT;
```

bEnable: enables the function block.

bInvokeScene_1..16: calls the respective scene.

bSaveScene_1..16: saves the current analog value *nActualValueLighting_1..14* in the respective scene.

nActualValueLighting_1..14: current control value of the respective lamp. Return value from the dimmer function block FB_Dimmer1Switch() [▶ 37].

sFile: file name (without path and file extension) for saving the scenes. The file name must be unique in the entire project. If several instances of the function blocks FB_ScenesLighting() or FB_ScenesVenetianBlind() [▶ 66] are created, then each instance must use a different file name. The file is always saved to the TwinCAT Boot directory and is given the extension .bin. Example: 'ControlPanelA'.

nOptions: Reserved for future developments.

VAR_OUTPUT

```
bSetDimmValue_1     : BOOL;
nDimmValue_1        : UINT;
bSetDimmValue_2     : BOOL;
nDimmValue_2        : UINT;
bSetDimmValue_3     : BOOL;
nDimmValue_3        : UINT;
bSetDimmValue_4     : BOOL;
nDimmValue_4        : UINT;
bSetDimmValue_5     : BOOL;
nDimmValue_5        : UINT;
bSetDimmValue_6     : BOOL;
nDimmValue_6        : UINT;
bSetDimmValue_7     : BOOL;
nDimmValue_7        : UINT;
bSetDimmValue_8     : BOOL;
nDimmValue_8        : UINT;
bSetDimmValue_9     : BOOL;
nDimmValue_9        : UINT;
bSetDimmValue_10    : BOOL;
nDimmValue_10       : UINT;
bSetDimmValue_11    : BOOL;
nDimmValue_11       : UINT;
bSetDimmValue_12    : BOOL;
nDimmValue_12       : UINT;
bSetDimmValue_13    : BOOL;
nDimmValue_13       : UINT;
bSetDimmValue_14    : BOOL;
nDimmValue_14       : UINT;
bInit               : BOOL;
bError              : BOOL;
nErrorId            : UDINT;
```

bSetDimmValue_1..14: output with the edge for the input b*SetDimmValue* of the function block FB_Dimmer1Switch() [▶ 37].

nDimmValue_1..14: Output with the value for the input *nDimmValue* of the function block FB_Dimmer1Switch() [▶ 37].

bInit: this output goes TRUE as soon as the initialization of the function block is complete.

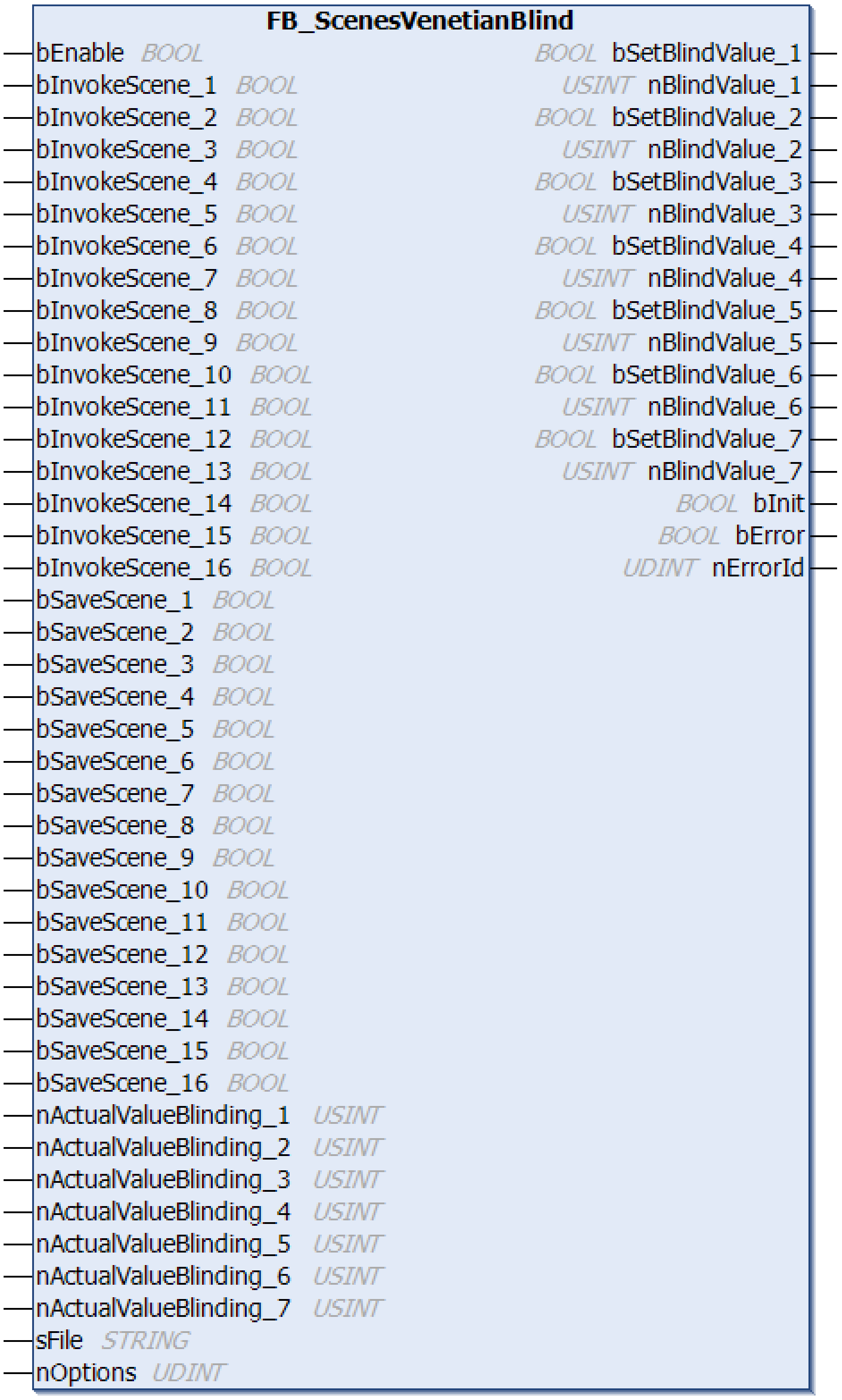
bError: this output is set to TRUE as soon as an error is detected during execution. The error code is contained in *nErrorId*.

nErrorId: *contains the error code as soon as* bError goes TRUE. See Error codes [▶ 93].

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.6.3 FB_ScenesVenetianBlind



This function block is intended for the management of blind scenes. The function block is enabled via the *bEnable* input. The loading of the saved scenes is started by a positive edge at the *bEnable* input. The input must remain TRUE until the operation is completed. The values of the scenes are saved non-volatile in the TwinCAT Boot directory as a *.bin file. The last data status is saved in a *.bak file as a backup.

Save scene

The values of the inputs *nActualValueBlinding_1..7* are saved in the respective scene by a rising edge at the input *bSaveScene_1...16*.

Load scenes

The saved values are output at the output *nBlindValue_1..7* by a rising edge at the input *bInvokeScene_1..16*. Furthermore, a positive edge is generated at the output *bSetBlindValue_1..7* for one PLC cycle.

VAR_INPUT

```
bEnable                  : BOOL;
bInvokeScene_1           : BOOL;
bInvokeScene_2           : BOOL;
bInvokeScene_4           : BOOL;
bInvokeScene_5           : BOOL;
bInvokeScene_6           : BOOL;
bInvokeScene_7           : BOOL;
bInvokeScene_8           : BOOL;
bInvokeScene_9           : BOOL;
bInvokeScene_10          : BOOL;
bInvokeScene_11          : BOOL;
bInvokeScene_12          : BOOL;
bInvokeScene_13          : BOOL;
bInvokeScene_14          : BOOL;
bInvokeScene_15          : BOOL;
bInvokeScene_16          : BOOL;
bSaveScene_1             : BOOL;
bSaveScene_2             : BOOL;
bSaveScene_3             : BOOL;
bSaveScene_4             : BOOL;
bSaveScene_5             : BOOL;
bSaveScene_6             : BOOL;
bSaveScene_7             : BOOL;
bSaveScene_8             : BOOL;
bSaveScene_9             : BOOL;
bSaveScene_10            : BOOL;
bSaveScene_11            : BOOL;
bSaveScene_12            : BOOL;
bSaveScene_13            : BOOL;
bSaveScene_14            : BOOL;
bSaveScene_15            : BOOL;
bSaveScene_16            : BOOL;
nActualValueBlinding_1   : UINT;
nActualValueBlinding_2   : USINT;
nActualValueBlinding_3   : USINT;
nActualValueBlinding_4   : USINT;
nActualValueBlinding_5   : USINT;
nActualValueBlinding_6   : USINT;
nActualValueBlinding_7   : USINT;
sFile                    : STRING;
nOptions                 : DWORD;
```

bEnable: enables the function block.

bInvokeScene_1..16: calls the respective scene.

bSaveScene_1..16: saves the current analog value *nActualValueBlinding_1..14* in the respective scene.

nActualValueBlinding_1..7: current control value of the respective blind. Return value from the blind function block FB_VenetianBlindEx() [▶ 23].

sFile: file name (without path and file extension) for saving the scenes. The file name must be unique in the entire project. If several instances of the function blocks FB_ScenesLighting() [▶ 63] or FB_ScenesVenetianBlind() are created, then each instance must use a different file name. The file is always saved to the TwinCAT Boot directory and is given the extension .bin. Example: 'ControlPanelA'.

nOptions: Reserved for future developments.

VAR_OUTPUT

```
bSetBlindValue_1    : BOOL;
nBlindValue_1       : USINT;
bSetBlindValue_2    : BOOL;
nBlindValue_2       : USINT;
bSetBlindValue_3    : BOOL;
nBlindValue_3       : USINT;
bSetBlindValue_4    : BOOL;
nBlindValue_4       : USINT;
bSetBlindValue_5    : BOOL;
nBlindValue_5       : USINT;
bSetBlindValue_6    : BOOL;
nBlindValue_6       : USINT;
bSetBlindValue_7    : BOOL;
nBlindValue_7       : USINT;
bInit               : BOOL;
bError              : BOOL;
nErrorId            : UDINT;
```

bSetBlindValue_1..7: output with the edge for the input *bPosition* of the function block FB_VenetianBlindEx() [▶ 23].

nBlindValue_1..7: output with the value for the input *nSetPosition* of the function block FB_VenetianBlindEx() [▶ 23].

bInit: this output goes TRUE as soon as the initialization of the function block is complete.

bError: this output is set to TRUE as soon as an error is detected during execution. The error code is contained in *nErrorId*.

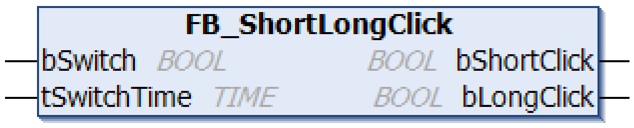
nErrorId: *contains the error code as soon as* bError goes TRUE. See Error codes [▶ 93].

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.7 Signal processing

4.1.7.1 FB_ShortLongClick



If the *bSwitch* input is longer than the *tSwitchTime*, the *bLongClick* output is set for one PLC cycle. Otherwise, the *bShortClick* output is set.

VAR_INPUT

```
bSwitch       : BOOL;
tSwitchTime   : TIME := t#50ms;
```

bSwitch: Input signal.

tSwitchTime: Duration above which the input signal is to be interpreted as a long button press.

VAR_OUTPUT

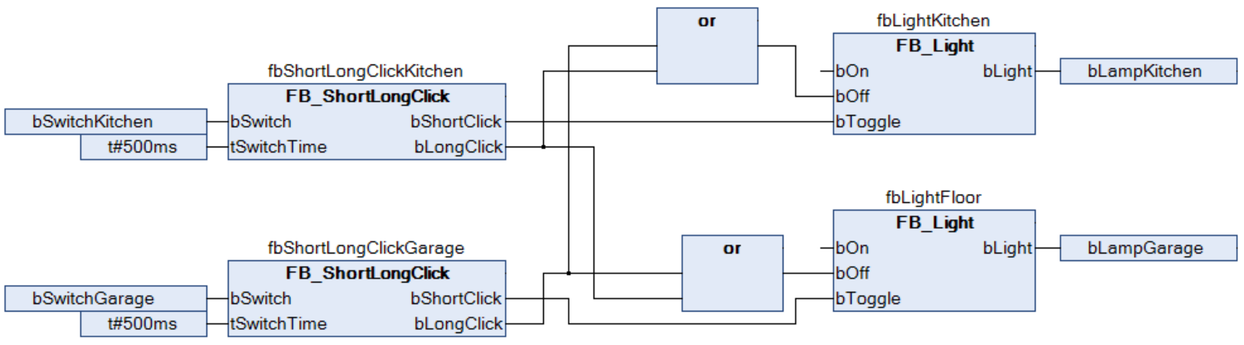
```
bShortClick       : BOOL;
bLongClick        : BOOL;
```

bShortClick: Indicates a short push of the button.

bLongClick: Indicates a long push of the button.

Example

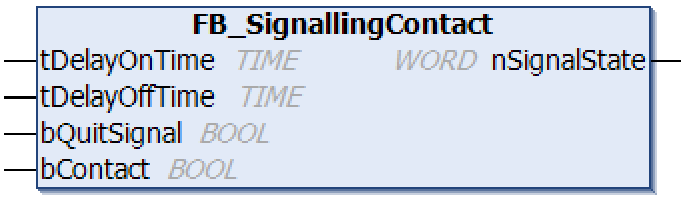
In the following example, two push buttons are used to control two different lamps. A switch is assigned to each lamp. If a button is pressed for longer than 500 ms, both lamps are switched off.



Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.7.2 FB_SignallingContact



The two inputs *tDelayOnTime* and *tDelayOffTime* allow slow operation and slow release delays to be set. If a message signal is to be acknowledged before this time can be ended, this is done by means of the *bQuitSignal* input. The state of the signaling contact is communicated to the function block via the *bContact* input.

The state of the message signal is indicated by the *nSignalState* output. A message signal can adopt one of altogether 6 different states. Corresponding constants are defined in the library:

Constant	Description
TCSIGNAL_INVALID	The message signal still does not have a defined state.
TCSIGNAL_SIGNALED	The message signal is active.
TCSIGNAL_RESET	The message signal has been reset.
TCSIGNAL_CONFIRMED	The message signal is confirmed, but has not yet been reset.
TCSIGNAL_SIGNALCON	The message signal is active and confirmed.
TCSIGNAL_RESETCON	The message signal is confirmed and reset.

VAR_INPUT

```
tDelayOnTime    : TIME := t#100ms;
tDelayOffTime   : TIME := t#100ms;
bQuitSignal     : BOOL;
bContact        : BOOL;
```

tDelayOnTime: Delay before setting the message signal.

tDelayOffTime: Delay before resetting the message signal.

bQuitSignal: Input to acknowledge message signal.

bContact: Input for the signaling contact.

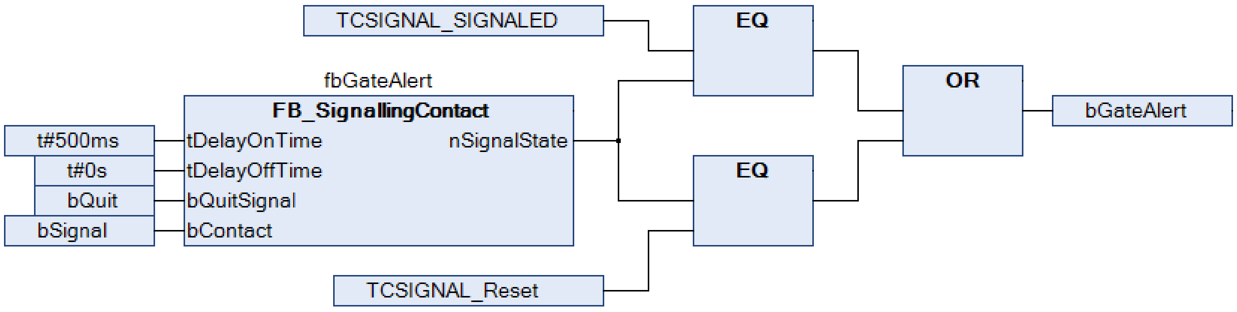
VAR_OUTPUT

```
nSignalState      : WORD;
```

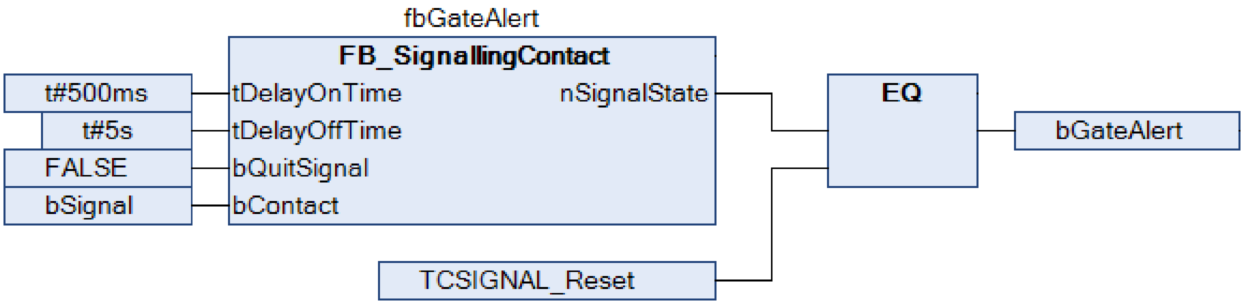
nSignalState: Message status.

Examples

A message signal requiring acknowledgement is implemented in the following example. The variable *bGateAlert* represents the state of the message signal. If the output *nSignalState* has the value *TCSIGNAL_SIGNALED* or *TCSIGNAL_RESET*, the message is active. A positive edge at the *bQuitSignal* input acknowledges the message signal.



The following example illustrates the simplest case. A message signal not requiring acknowledgement.

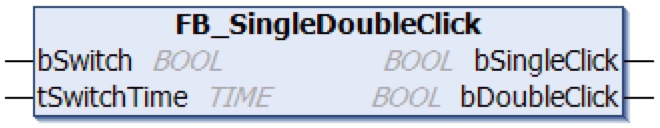


The slow release delay allows the message signal to remain active for a certain time. The slow operation delay can be used, for example, to suppress contact bounce.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.7.3 FB_SingleDoubleClick



If the input signal is presented twice within the time *tSwitchTime*, the *bDoubleClick* output is set for one PLC cycle. Otherwise, the *bSingleClick* output is set.

VAR_INPUT

```
bSwitch      : BOOL;
tSwitchTime  : TIME := t#500ms;
```

bSwitch: Input signal.

tSwitchTime: Duration above which the input signal is to be interpreted as a double button press.

VAR_OUTPUT

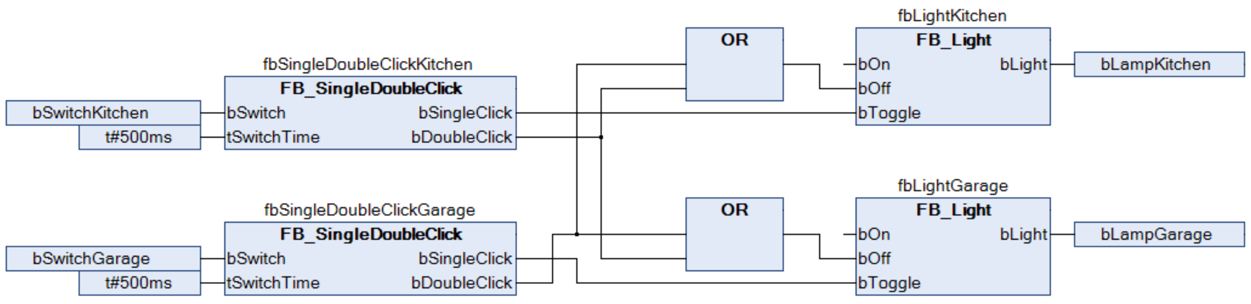
```
bSingleClick      : BOOL;
bDoublelick       : BOOL;
```

bSingleClick: Indicates a single push of the button.

bDoublelick: Indicates a double push of the button.

Example

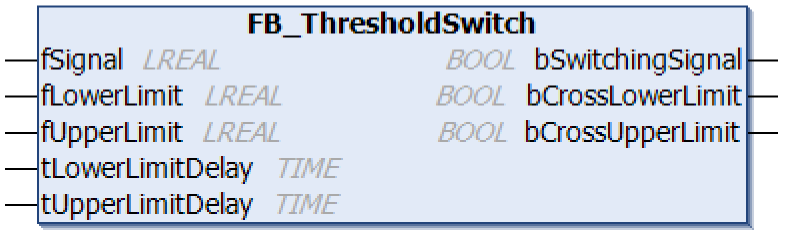
In the following example, two switches are used to control two different lamps. A switch is assigned to each lamp. If a switch is pressed twice in rapid succession, both lamps are switched off.



Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.7.4 FB_ThresholdSwitch



If the input signal exceeds the limit value *fUpperLimit* for the duration specified by *tUpperLimitDelay*, the output *bCrossUpperLimit* is set for one PLC cycle. The *bSwitchingSignal* output is also set. This remains set until the input signal passes below the value of *fLowerLimit* for the duration specified by *tLowerLimitDelay*. In this case, the output *fCrossLowerLimit* is set for one PLC cycle.

VAR_INPUT

```
fSignal           : LREAL;
fLowerLimit       : LREAL := 16000;
fUpperLimit       : LREAL := 17000;
tLowerLimitDelay  : TIME := t#100ms;
tUpperLimitDelay  : TIME := t#100ms;
```

fSignal: Input signal.

fLowerLimit: Lower limit value.

fUpperLimit: Upper limit value.

tLowerLimitDelay: Switching delay when passing beyond the lower limit.

tUpperLimitDelay: Switching delay when passing beyond the upper limit.

VAR_OUTPUT

```
bSwitchingSignal       : BOOL;
bCrossLowerLimit       : BOOL;
bCrossUpperLimit       : BOOL;
```

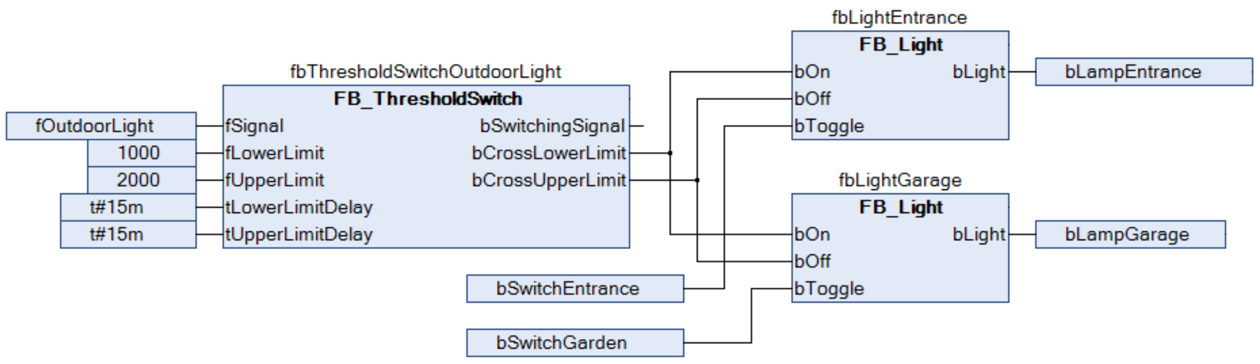
bSwitchingSignal: State depends on *bCrossLowerLimit* and *bCrossUpperLimit*.

bCrossLowerLimit: Becomes TRUE for a cycle if *fLowerLimit* has fallen below the time *tLowerLimitDelay*. At the same time *bSwitchingSignal* becomes FALSE.

bCrossUpperLimit: Becomes TRUE for a cycle if *fUpperLimit* is exceeded for the time *tUpperLimitDelay*. At the same time *bSwitchingSignal becomes* TRUE.

Example

In the following example, the two lamps can each be controlled with one switch. The two lamps are automatically switched in response to the outside brightness and the threshold switch. The lamps are switched on if the outside brightness is less than 1000 lux for 15 minutes. The lamps are switched off as soon as the brightness is greater than 2000 lux for more than 15 minutes.

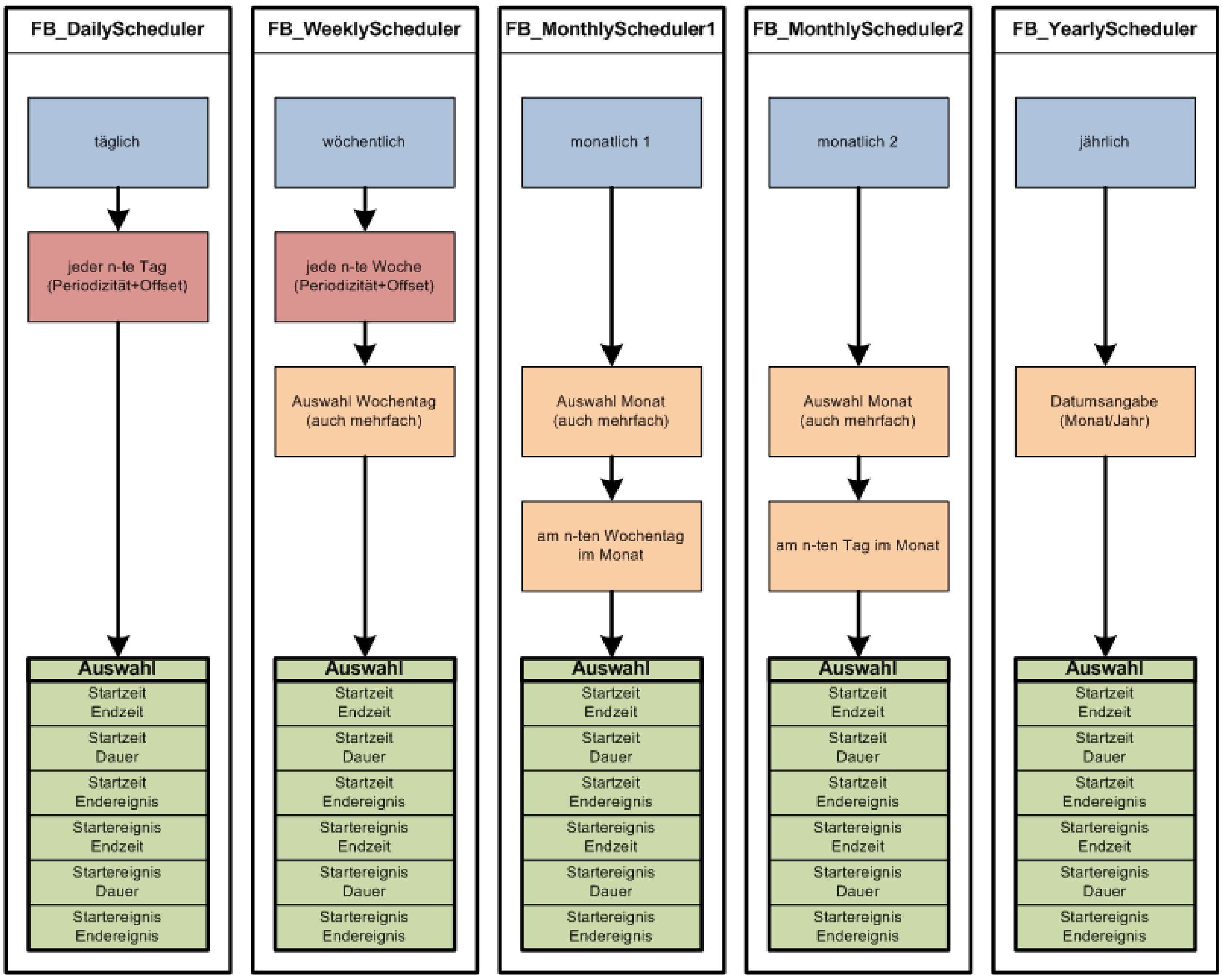


Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8 Timer functions

The timer function blocks are intended to trigger actions on certain days in the year/ month/ week. The action can be triggered via a start event or a start time and terminated via an end event, end time or duration. The following combinations are possible:



The grey-blue fields indicate the timer type. The day is determined by the periodicity (red fields) and further discretization (orange). A common feature of all function blocks is that they have the same start and end criteria (green). The start criterion relates to the selected day, the end criterion depends on the starting point. For each instance of a function block only one start and end criterion can be defined. To trigger several actions on the same day several instances of the function block are required.

Time overlaps

Time overlaps of two consecutive switch-on and switch-off criteria may occur in the same instance of the function block if the switching duration is not limited to less than 1 day. In this case a start event may be followed by another start event before the end of the preceding period. The following overlap scenarios are possible in the situation described above:

Starttime / Endtime (type TOD, TOD)

No overlap possible since for *Starttime<Endtime* the start and end point are on same day, and for Starttime>=Endtime the end point is assumed to be on the next day. This means that the duration is this limited to less than 1 day.

Starttime / Duration (type TOD, TIME)

Overlap is possible, since the duration is freely selectable and the TIME variable type can be up to 50 days. It would therefore be possible to trigger an action with a duration of 3 days on a daily basis. The action would never be completed since it would be constantly restarted.

Starttime / End event (type TOD, BOOL)

Overlap possible, since the end event is variable and **cannot** occur before the next start time.

Start event / Endtime (type BOOL, TOD)

Overlap may be possible. The end time is calculated when the start event occurs. If *Starttime<Endtime* the end time is on the same day. In this case no overlap is possible. On the other hand, if *Starttime>=Endtime* the end point is on the next day. An overlap occurs if the start is triggered on this day before the end of the previous action has been reached.

Start event / Duration (type BOOL, TIME)

Overlap is possible, since the duration is freely selectable and the TIME variable type can be up to 50 days. It would therefore be possible to trigger an action with a duration of 3 days on a daily basis. The action would never be completed since it would be constantly restarted.

Start event / End event (type BOOL, BOOL)

Overlap possible, since the end event is variable and **cannot** occur before the next start event.

An overlap means that the control output *bOut* for the respective function block does not change to FALSE. Instead, the system waits for the next period end. However, since the intention may also be that the function blocks merely trigger an action, the edge output *bTriggerOn* is also linked to the function blocks.

Further documentation

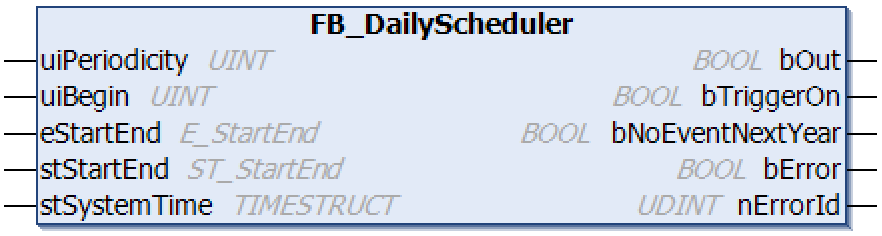
The following table contains an overview of the documentation for the individual function blocks:

FB_DailyScheduler() [▶ 74]	FB_WeeklyScheduler() [▶ 75]	FB_MonthlyScheduler1() [▶ 77]	FB_MonthlyScheduler2() [▶ 78]	FB_YearlyScheduler() [▶ 79]
switches every n-th day	switches every n-th week on certain weekdays (multiple selection possible)	switches in certain months (multiple selection possible) on a certain day of the week	switches in certain months (multiple selection possible) on a certain day of the month	switches on a certain day of the year

Sample program

A sample program [▶ 80] uses a daily switching function block (*FB_DailyScheduler*) to illustrate how the function blocks have to be parameterized.

4.1.8.1 FB_DailyScheduler



Function block for triggering actions every n-th day of the year.

The function block triggers switching when the switching time is passed. Subsequent modification of the switching events or the time is therefore not permitted.

VAR_INPUT

```
uiPeriodicity  : UINT;
uiBegin        : UINT;
eStartEnd      : E_StartEnd;
stStartEnd     : ST_StartEnd;
stSystemtime   : TIMESTRUCT;
```

uiPeriodicity: Periodicity or interval. May be within the range 1...365.

uiBegin: Starting value for the day counter. May be within the range 1...365.

Example1:
uiPeriodicity = 5,
uiBegin = 2: Switching events on 2 Jan., 7 Jan. 12 Jan. etc.

Example2:
uiPeriodicity = 3,
uiBegin = 1: Switching events on 1 Jan., 4 Jan. 7 Jan. etc.

eStartEnd: Selection of the start/end definition (see E_StartEnd [▶ 93]).

stStartEnd: Structure with the parameters defining the start and end. Unused variables, for example the duration for the selection of start/end time, are ignored internally (see ST_StartEnd [▶ 95]).

stSystemtime: current time in TIMESTRUCT format. It is important to count every second.

VAR_OUTPUT

```
bOut                 : BOOL;
bTriggerOn           : BOOL;
bNoEventNextYear     : BOOL;
bError               : BOOL;
nErrorId             : UDINT;
```

bOut: Control output that is switched on or off by the start and end event.

bTriggerOn: Trigger output for switch-on events. This output is intended for logging switch-on events. If two switch-on events occur consecutively they would not be detected via the control output *bOut*, since this output would remain TRUE. See also time overlaps in the overview.

bNoEventNextYear: No day matching the parameterization was found within the next 366 days.

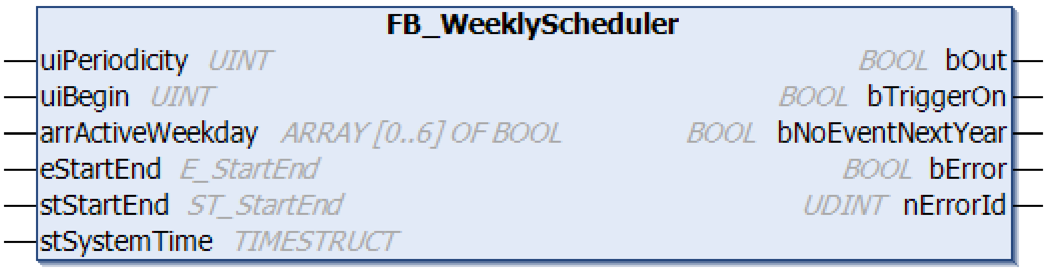
bError: This output is set to TRUE if the parameterization is faulty. The command-specific error code is contained in *nErrorId*. Reset to FALSE once the parameterization is correct.

nErrorId: Contains the command-specific error code. Reset to 0 once the parameterization is correct. See Error codes [▶ 93].

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.2 FB_WeeklyScheduler



Function block for triggering actions on certain weekdays in each n-th week of the year.

The function block triggers switching when the switching time is passed. Subsequent modification of the switching events or the time is therefore not permitted.

VAR_INPUT

```
uiPeriodicity      : UINT;
uiBegin            : UINT;
arrActiveWeekday   : ARRAY[0..6] OF BOOL;
eStartEnd          : E_StartEnd;
stStartEnd         : ST_StartEnd;
stSystemtime       : TIMESTRUCT;
```

uiPeriodicity: Periodicity or interval. May be within the range 1...52.

uiBegin: Starting value for the week. May be within the range 1...52.

Example1:
uiPeriodicity = 5,
uiBegin = 2: Switching events in week 2, week 7, week 12 etc.

Example 2:
uiPeriodicity = 3,

uiBegin = 1: Switching events in week 1, week 4, week 7 etc.

arrActiveWeekday: Day of the week on which switching is to take place - *arrActiveWeekday[0]* => Sunday .. *arrActiveWeekday[6]* => Saturday. Multiple selections are possible.

eStartEnd: Selection of the start/end definition (see E_StartEnd [▶ 93]).

stStartEnd: Structure with the parameters defining the start and end. Unused variables, for example the duration for the selection of start/end time, are ignored internally (see ST_StartEnd [▶ 95]).

stSystemtime: Current time in TIMESTRUCT format. It is important to count every second.

VAR_OUTPUT

```
bOut               : BOOL;
bTriggerOn         : BOOL;
bNoEventNextYear   : BOOL;
bError             : BOOL;
nErrorId           : UDINT;
```

bOut: Control output that is switched on or off by the start and end event.

bTriggerOn: Trigger output for switch-on events. This output is intended for logging switch-on events. If two switch-on events occur consecutively they would not be detected via the control output *bOut*, since this output would remain TRUE. See also time overlaps in the overview.

bNoEventNextYear: No day matching the parameterization was found within the next 366 days.

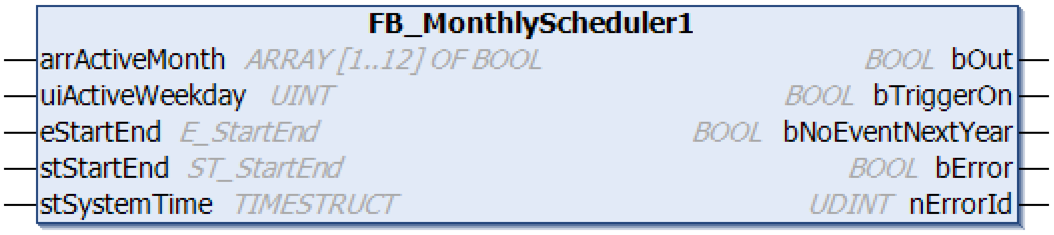
bError: This output is set to TRUE if the parameterization is faulty. The command-specific error code is contained in *nErrorId*. Reset to FALSE once the parameterization is correct.

nErrorId: Contains the command-specific error code. Reset to 0 once the parameterization is correct. See Error codes [▶ 93].

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.3 FB_MonthlyScheduler1



Function block for triggering actions on a certain day of the week in certain months.

The function block triggers switching when the switching time is passed. Subsequent modification of the switching events or the time is therefore not permitted.

VAR_INPUT

```
arrActiveMonth    : ARRAY[1..12] OF BOOL;
uiActiveWeekday   : UINT;
eStartEnd         : E_StartEnd;
stStartEnd        : ST_StartEnd;
stSystemtime      : TIMESTRUCT;
```

arrActiveMonth: Month in which an action is to be triggered - arrActiveMonth[1]=>January .. arrActiveMonth[12]=>December. Multiple selections are possible.

uiActiveWeekday: Day of the week on which an action is to be triggered in the selected months. 0=Sunday ... 6=Saturday. Multiple selections are not possible; the maximum value is 6

eStartEnd: Selection of the start/end definition (see E_StartEnd [▶ 93]).

stStartEnd: Structure with the parameters defining the start and end. Unused variables, for example the duration for the selection of start/end time, are ignored internally (see ST_StartEnd [▶ 95]).

stSystemtime: Current time in TIMESTRUCT format. It is important to count every second.

VAR_OUTPUT

```
bOut               : BOOL;
bTriggerOn         : BOOL;
bNoEventNextYear   : BOOL;
bError             : BOOL;
nErrorId           : UDINT;
```

bOut: Control output that is switched on or off by the start and end event.

bTriggerOn: Trigger output for switch-on events. This output is intended for logging switch-on events. If two switch-on events occur consecutively they would not be detected via the control output *bOut*, since this output would remain TRUE. See also time overlaps in the overview.

bNoEventNextYear: No day matching the parameterization was found within the next 366 days.

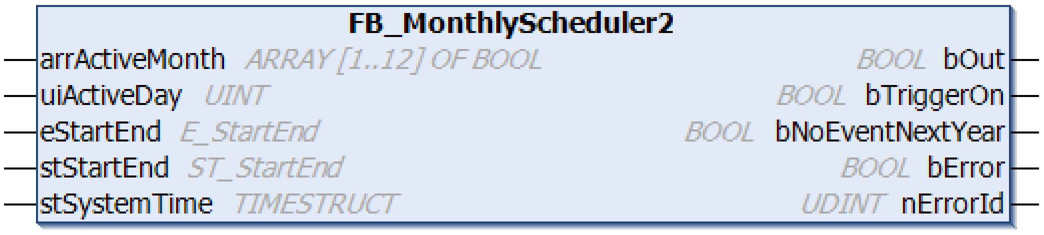
bError: This output is set to TRUE if the parameterization is faulty. The command-specific error code is contained in *nErrorId*. Reset to FALSE once the parameterization is correct.

nErrorId: Contains the command-specific error code. Reset to 0 once the parameterization is correct. See Error codes [▶ 93].

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.4 FB_MonthlyScheduler2



Function block for triggering actions on a certain day in certain months.

The function block triggers switching when the switching time is passed. Subsequent modification of the switching events or the time is therefore not permitted.

VAR_INPUT

```
arrActiveMonth    : ARRAY[1..12] OF BOOL;
uiActiveWeekday   : UINT;
eStartEnd         : E_StartEnd;
stStartEnd        : ST_StartEnd;
stSystemtime      : TIMESTRUCT;
```

arrActiveMonth: Month in which an action is to be triggered - arrActiveMonth[1]=>January ... arrActiveMonth[12]=>December. Multiple selections are possible.

uiActiveDay: Day of the month on which an action is to be triggered. Multiple selections are not possible.

eStartEnd: Selection of the start/end definition (see E_StartEnd [▸ 93]).

stStartEnd: Structure with the parameters defining the start and end. Unused variables, for example the duration for the selection of start/end time, are ignored internally (see ST_StartEnd [▸ 95]).

stSystemtime: Current time in TIMESTRUCT format. It is important to count every second.

VAR_OUTPUT

```
bOut              : BOOL;
bTriggerOn        : BOOL;
bNoEventNextYear  : BOOL;
bError            : BOOL;
nErrorId          : UDINT;
```

bOut: Control output that is switched on or off by the start and end event.

bTriggerOn: Trigger output for switch-on events. This output is intended for logging switch-on events. If two switch-on events occur consecutively they would not be detected via the control output *bOut*, since this output would remain TRUE. See also time overlaps in the overview.

bNoEventNextYear: No day matching the parameterization was found within the next 366 days.

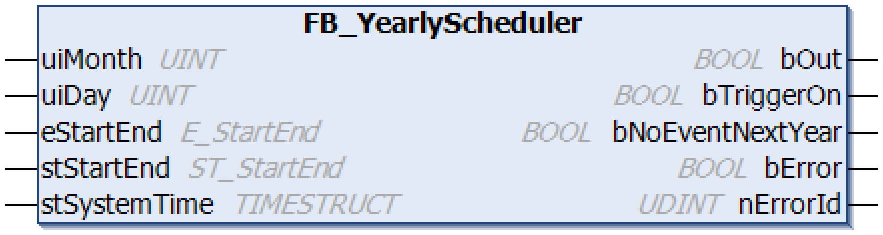
bError: This output is set to TRUE if the parameterization is faulty. The command-specific error code is contained in *nErrorId*. Reset to FALSE once the parameterization is correct.

nErrorId: Contains the command-specific error code. Reset to 0 once the parameterization is correct. See Error codes [▸ 93].

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.5 FB_YearlyScheduler



Function block for triggering actions on a certain day of the year.

The function block triggers switching when the switching time is passed. Subsequent modification of the switching events or the time is therefore not permitted.

VAR_INPUT

```
uiMonth         : UINT;
uiDay           : UINT;
eStartEnd       : E_StartEnd;
stStartEnd      : ST_StartEnd;
stSystemtime    : TIMESTRUCT;
```

uiMonth: Month in which an action is to be triggered. Multiple selections are not possible.

uiDay: Day on which an action is to be triggered. Multiple selections are not possible.

eStartEnd: Selection of the start/end definition (see E_StartEnd [▸ 93]).

stStartEnd: Structure with the parameters defining the start and end. Unused variables, for example the duration for the selection of start/end time, are ignored internally (see ST_StartEnd [▸ 95]).

stSystemtime: Current time in TIMESTRUCT format. It is important to count every second.

VAR_OUTPUT

```
bOut                : BOOL;
bTriggerOn          : BOOL;
bNoEventNextYear    : BOOL;
bError              : BOOL;
nErrorId            : UDINT;
```

bOut: Control output that is switched on or off by the start and end event.

bTriggerOn: Trigger output for switch-on events. This output is intended for logging switch-on events. If two switch-on events occur consecutively they would not be detected via the control output *bOut*, since this output would remain TRUE. See also time overlaps in the overview.

bNoEventNextYear: No day matching the parameterization was found within the next 366 days.

bError: This output is set to TRUE if the parameterization is faulty. The command-specific error code is contained in *nErrorId*. Reset to FALSE once the parameterization is correct.

nErrorId: Contains the command-specific error code. Reset to 0 once the parameterization is correct. See Error codes [▸ 93].

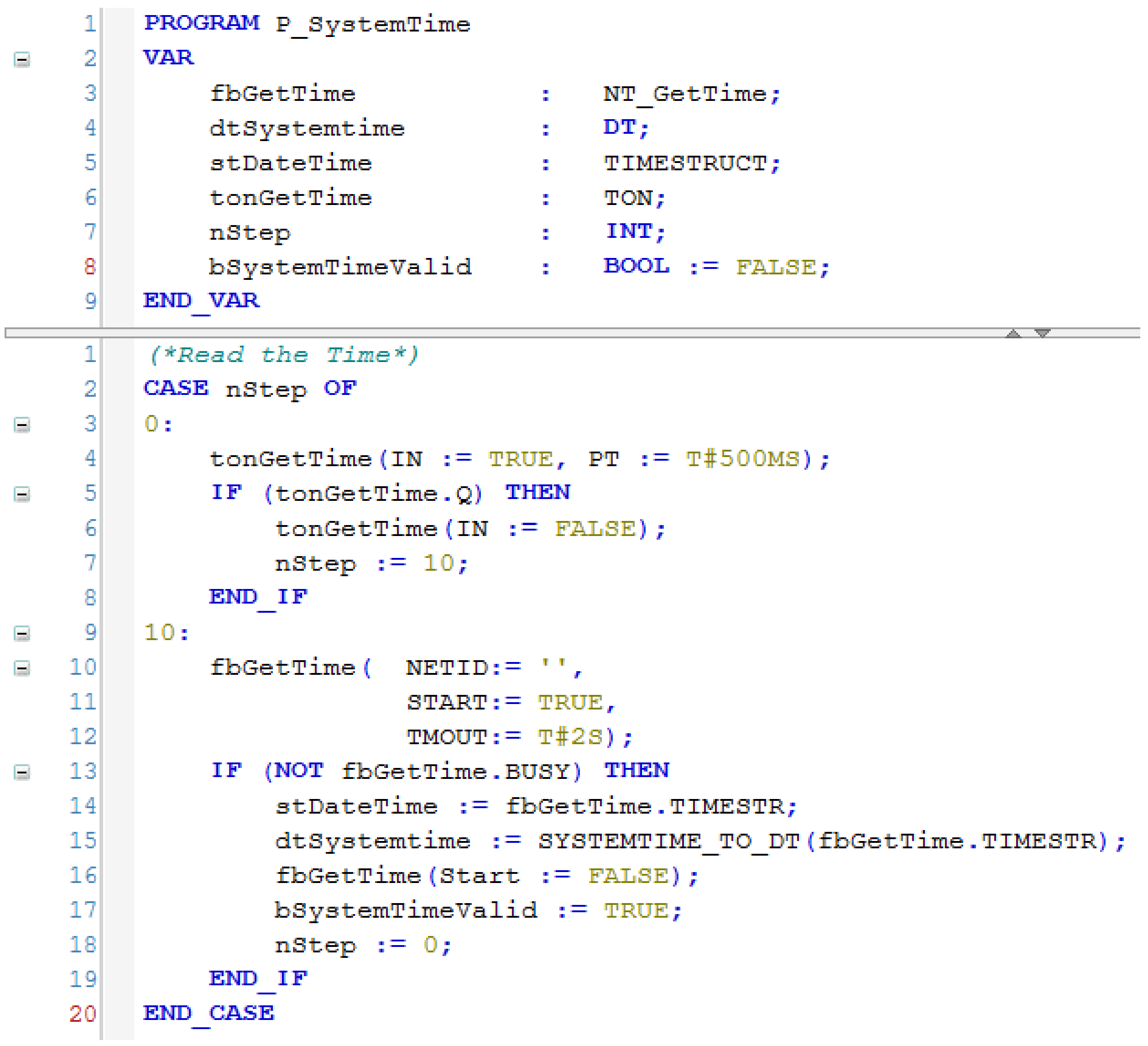
Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.6 Timer program example

The following program example uses a day timer to illustrate how the function blocks should be parameterized, particularly with regard to the inputs *eStartEnd*, *stStartEnd* and *stSystemTime*.

We recommend using the function block NT_GetTime, which is available in the library *Tc2_Utilities*, for reading the system time in PC- and CX-based systems. A program for reading might look as follows:



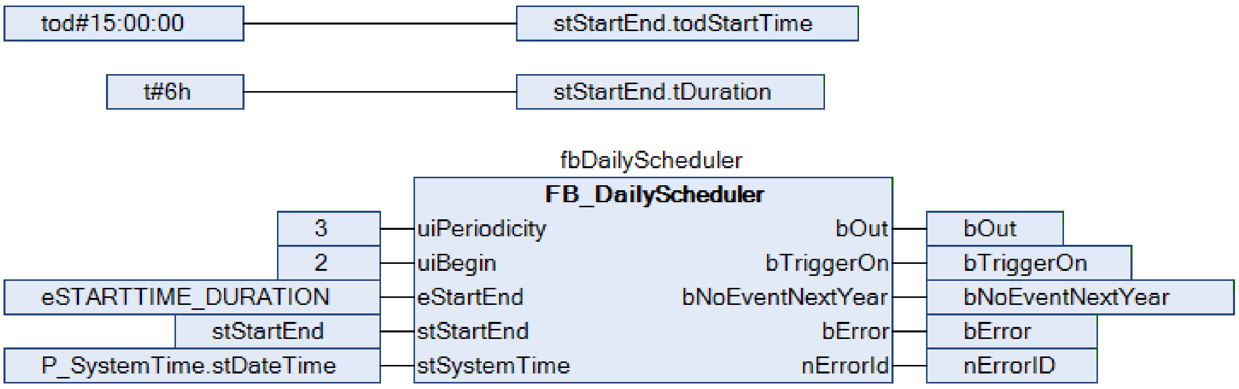
```
PROGRAM P_SystemTime
VAR
    fbGetTime           :   NT_GetTime;
    dtSystemtime        :   DT;
    stDateTime          :   TIMESTRUCT;
    tonGetTime          :   TON;
    nStep               :   INT;
    bSystemTimeValid    :   BOOL := FALSE;
END_VAR
```

```
(*Read the Time*)
CASE nStep OF
0:
    tonGetTime(IN := TRUE, PT := T#500MS);
    IF (tonGetTime.Q) THEN
        tonGetTime(IN := FALSE);
        nStep := 10;
    END_IF
10:
    fbGetTime(  NETID:= '',
                START:= TRUE,
                TMOUT:= T#2S);
    IF (NOT fbGetTime.BUSY) THEN
        stDateTime := fbGetTime.TIMESTR;
        dtSystemtime := SYSTEMTIME_TO_DT(fbGetTime.TIMESTR);
        fbGetTime(Start := FALSE);
        bSystemTimeValid := TRUE;
        nStep := 0;
    END_IF
END_CASE
```

It provides a timebase for parameterizing the scheduler function blocks with regard to the time input *stSystemTime*. The enumerator matching the required behavior is created at input *eStartEnd*:

eSTARTTIME_ENDTIME	Start criterion: Time - End criterion: Time
eSTARTTIME_DURATION	Start criterion: Time - End criterion: Duration
eSTARTTIME_ENDEVENT	Start criterion: Time - End criterion: Event (boolean input)
eSTARTEVENT_ENDTIME	Start criterion: Event (boolean input) - End criterion: Time
eSTARTEVENT_DURATION	Start criterion: Event (boolean input) - End criterion: Duration
eSTARTEVENT_ENDEVENT	Start criterion: Event (boolean input) - End criterion: Event (boolean input)

For the input *stStartEnd* a structure variable of the same type has to be declared that is referred to in the example as *stStartEnd*. The program then describes the subvariables of this structure, which are important for the function type. For the example shown, these are *todStartTime* and *tDuration*. All other variables are not read and therefore do not have to be described.

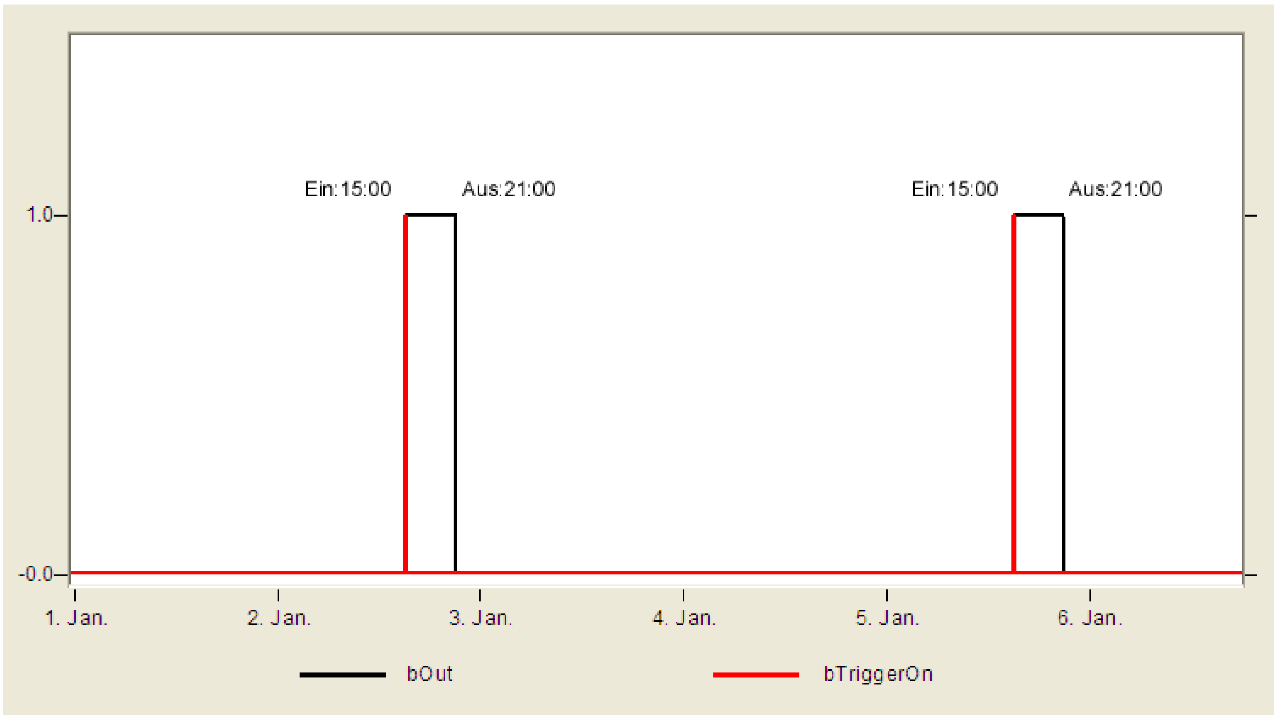


Both programs have to be called in the MAIN function block. The program part *P_SchedulerExample* may only be called once the program part P_SystemTime supplies valid data, i.e. once *P_SystemTimeValid* is TRUE. The reason for this protective logic is that reading the time takes several cycles which means that the time when the program starts is invalid and must not be used.

```
PROGRAM MAIN
VAR
END_VAR
```

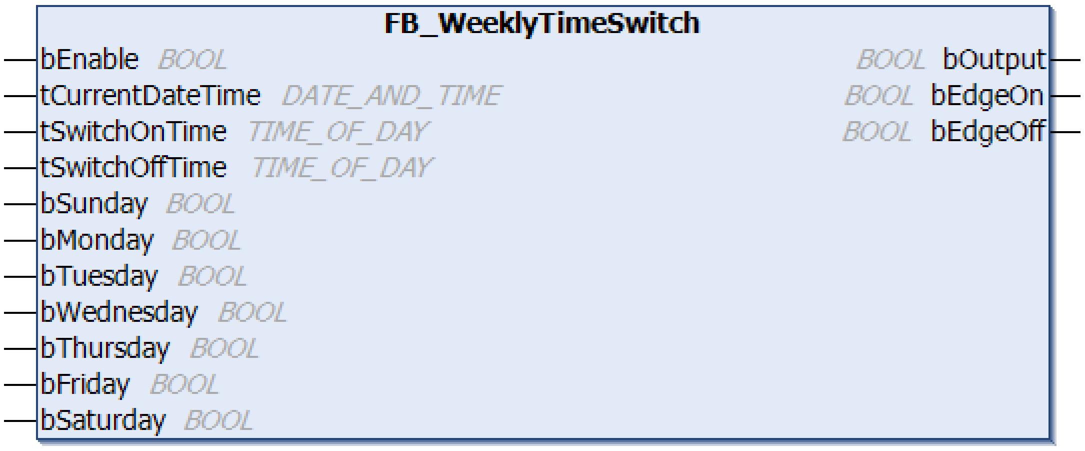
```
P_SystemTime();
IF NOT (P_SystemTime.bSystemTimeValid) THEN
    RETURN;
END_IF
P_SchedulerExample();
```

If the program starts on 1 January, the sequences is as follows:



The days on which actions are triggered start with the 2nd of the year (*uiBegin:=2*). The process is repeated every three days (*uiPeriodicity:=3*). The switch-on time is 15:00 (*stStartEnd.todStartTime:=tod#15:00:00*) and the switching duration is 6 hours (*stStartEnd.tDuration:=t#6h*).

4.1.8.7 FB_WeeklyTimeSwitch



The two parameters *tSwitchOnTime* and *tSwitchOffTime* define a time period during which the output *bOutput* is to be active. If the timer is only to apply on certain days of the week, this can be set via the inputs *bSunday*, *bMonday*, ..., *bSaturday*. Several time channels can be switched by creating several instances of the function block. Each instance is responsible for one time channel.

VAR_INPUT

```
bEnable              : BOOL;
tCurrentDateTime     : DATE_AND_TIME;
tSwitchOnTime        : TOD;
tSwitchOffTime       : TOD;
bSunday              : BOOL;
bMonday              : BOOL;
bTuesday             : BOOL;
bWednesday           : BOOL;
bThursday            : BOOL;
bFriday              : BOOL;
bSaturday            : BOOL;
```

bEnable: Function block enable.

tCurrentDateTime: current date and time.

tSwitchOnTime: switch-on time.

tSwitchOffTime: switch-off time.

bSunday: consider timer on Sundays.

bMonday: consider timer on Mondays.

bTuesday: consider timer on Tuesdays.

bWednesday: consider timer on Wednesdays.

bThursday: consider timer on Thursdays.

bFriday: consider timer on Fridays.

bSaturday: consider timer on Saturdays.

VAR_OUTPUT

```
bOutput              : BOOL;
bEdgeOn              : BOOL;
bEdgeOff             : BOOL;
```

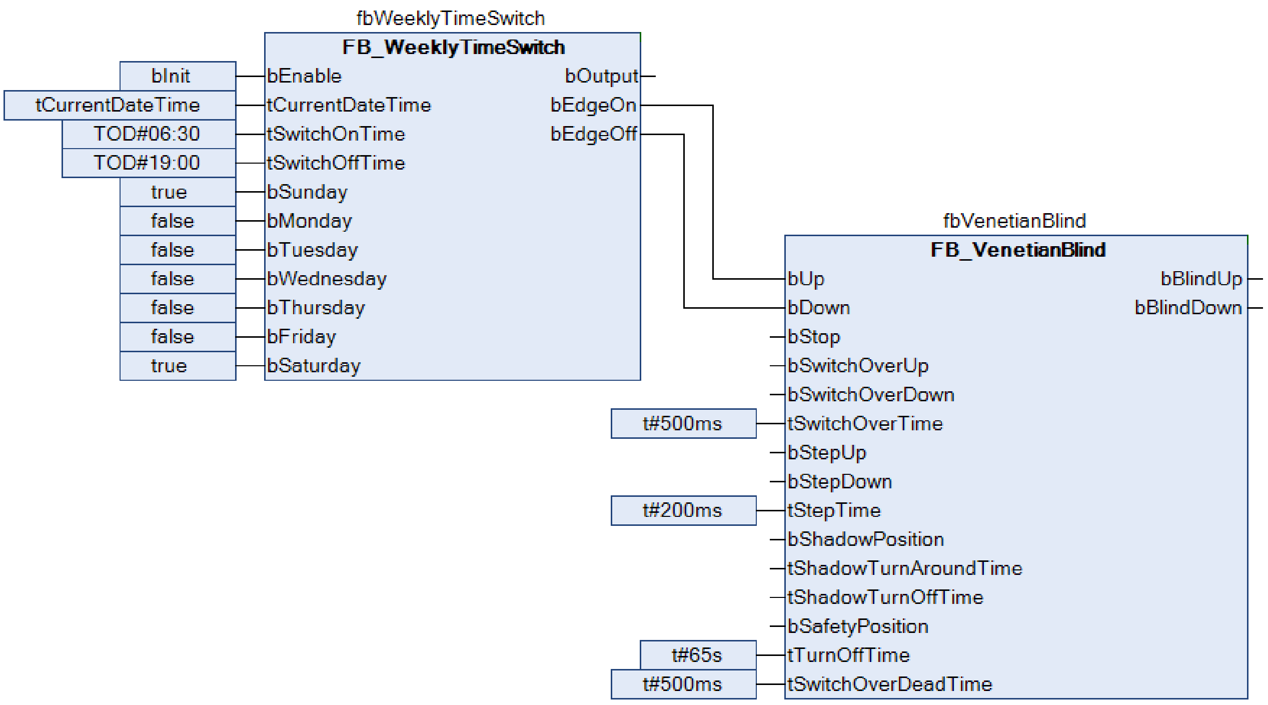
bOutput: output becomes TRUE if the current time is between the switch-on time and the switch-off time.

bEdgeOn: the output is set to TRUE for one PLC cycle when the time channel becomes active.

bEdgeOff: the output is set to TRUE for one PLC cycle when the time channel becomes deactivated.

Example

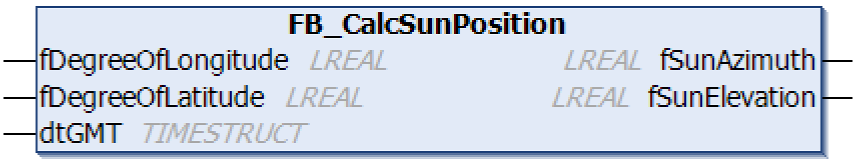
In the following example, the blinds are to be raised at 6.30 a.m. at weekends and lowered at 7.00 p.m. The two timer outputs *bEdgeOn* and *bEdgeOff* are linked to the inputs *bUp* and *bDown* of the blind function block. The pulses from the outputs then trigger raising or lowering of the blinds at the specified time.



Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.8 FB_CalcSunPosition



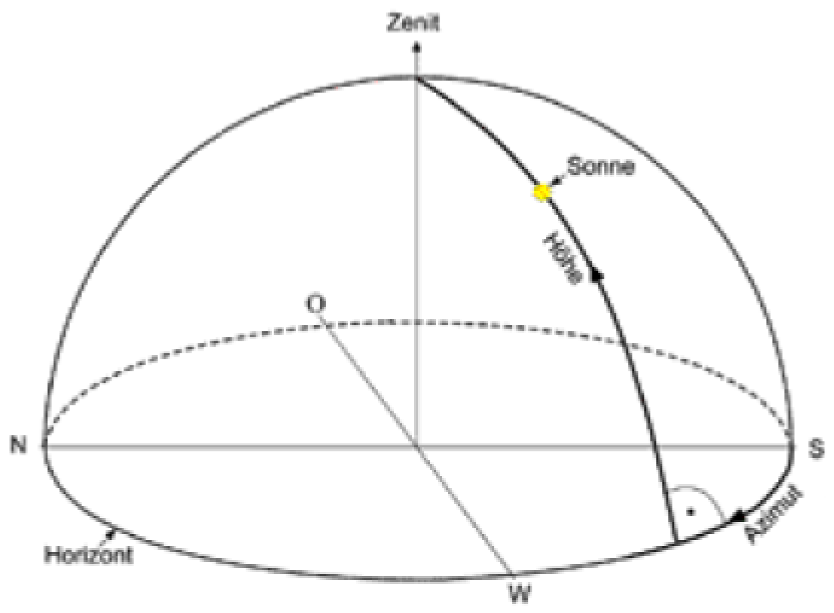
Calculation of sun position based on the date, time, longitude and latitude.

Description

The position of the sun for a given point in time can be calculated according to common methods with a defined accuracy. For applications with moderate requirements, the present function block is sufficient. As the basis for this, the SUNAE algorithm was used, which represents a favorable compromise between accuracy and computing effort.

The position of the sun at a fixed observation point is normally determined by specifying two angles. One angle indicates the height above the horizon, where 0° means that the sun is in the horizontal plane of the observation site and 90° means that the sun is directly over the observer's head. The other angle indicates the direction in which the sun is standing. The SUNAE algorithm is used to distinguish whether the observer is standing on the northern hemisphere (longitude > 0 degrees) or on the southern hemisphere (longitude <

0 degrees) of the earth. If the observation point is in the northern hemisphere, a value of 0° is assigned for the northern direction of the sun and then moves clockwise around the compass, i.e. 90° is east, 180° is south, 270° west, etc. If the observation point is in the southern hemisphere, 0° corresponds to the southern direction and moves counterclockwise, i.e. 90° is east, 180° is north, 270° is west, etc.



In specifying the time, the time according to Greenwich Mean Time (GMT) must be given.

The latitude is specified as the distance of a place on the surface of the earth from the equator to the north or to the south in degrees. The latitude can assume a value from 0° (at the equator) to ±90° (at the poles). A positive sign thereby indicates a northern direction and a negative sign a southern direction. The longitude is an angle that can assume values up to ±180° starting from the prime meridian 0° (an artificially determined North-South line). A positive sign indicates a longitude in an eastern direction and a negative sign in a western direction. Examples:

Location	Longitude	Latitude
Sydney, Australia	151.2°	-33.9°
New York, USA	74.0°	40.7°
London, England	-0.1°	51.5°
Moscow, Russia	37.6°	55.7°
Beijing, China	116.3°	39.9°
Dubai, United Arab Emirates	55.3°	25.4°
Rio de Janeiro, Brazil	-43.2°	-22.9°
Hawaii, USA	-155.8°	20.2°
Verl, Germany	8.5°	51.9°

If the function block *FB_CalcSunPosition()* returns a negative value for the height of the sun (*fSunElevation*), then the sun is not visible. This can be used to determine sunrise and sunset.

VAR_INPUT

```
fDegreeOfLongitude   : LREAL := 8.5;
fDegreeOfLatitude    : LREAL := 51.9;
dtGMT                : TIMESTRUCT;
```

fDegreeOfLongitude: Longitude in degrees.

fDegreeofLatitude: Latitude in degrees.

dtGMT: Current time as Greenwich Mean Time (GMT).

VAR_OUTPUT

```
fSunAzimuth      : LREAL;
fSunElevation    : LREAL;
```

fSunAzimuth: Direction of the sun (northern hemisphere: 0° north ... 90° east ... 180° south ... 270° west ... / southern hemisphere: 0° south ... 90° east ... 180° north ... 270° west ...).

fSunElevation: Height of the sun (0° horizontal ... 90° vertical).

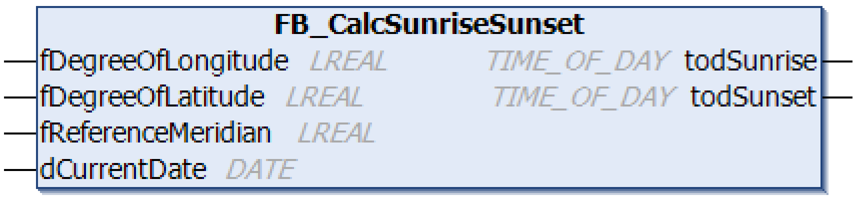
Example

```
PROGRAM MAIN
VAR
  fbCalcSunPosition   : FB_CalcSunPosition;
  fSunAzimuth         : LREAL;
  fSunElevation       : LREAL;
  fbGetSystemTime     : GETSYSTEMTIME;
  fileTime            : T_FILETIME;
END_VAR

fbGetSystemTime(timeLoDW=>fileTime.dwLowDateTime,
        timeHiDW=>fileTime.dwHighDateTime);

fbCalcSunPosition( fDegreeOfLongitude := 8.5,
           fDegreeOfLatitude := 51.9,
           dtGMT := FILETIME_TO_SYSTEMTIME(fileTime));
fSunAzimuth := fbCalcSunPosition.fSunAzimuth;
fSunElevation := fbCalcSunPosition.fSunElevation;
```

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.9 FB_CalcSunriseSunset



Function block for calculating sunrise and sunset based on the longitude, latitude, reference meridian and time.

The earth is divided into several time zones. Each time zone is associated with a reference meridian. Reference meridian for some of the time zones:

Time zone	Reference meridian
GMT (Greenwich Mean Time)	λ_{GMT} = 0°
CET (Central European Time)	λ_{CET} = 15°
CEST (Central European Summer Time)	λ_{CEST} = 30°

In specifying the time, the time according to Greenwich Mean Time (GMT) must be given.

This function block is only available in the PC version of the library.

VAR_INPUT

```
fDegreeOfLongitude    : LREAL := 8.5;
fDegreeOfLatitude     : LREAL := 51.9;
fReferenceMeridian    : LREAL;
dCurrentDate          : DATE;
```

fDegreeOfLongitude: Longitude in degrees.

fDegreeofLatitude: Latitude in degrees.

fReferenceMeridian: Reference meridian of the time zone.

dCurrentDate: current date.

VAR_OUTPUT

```
todSunrise        : TOD;
todSunset         : TOD;
```

todSunrise: Sunrise. Output of hour and minute.

todSunset: Sunset. Output of hour and minute.

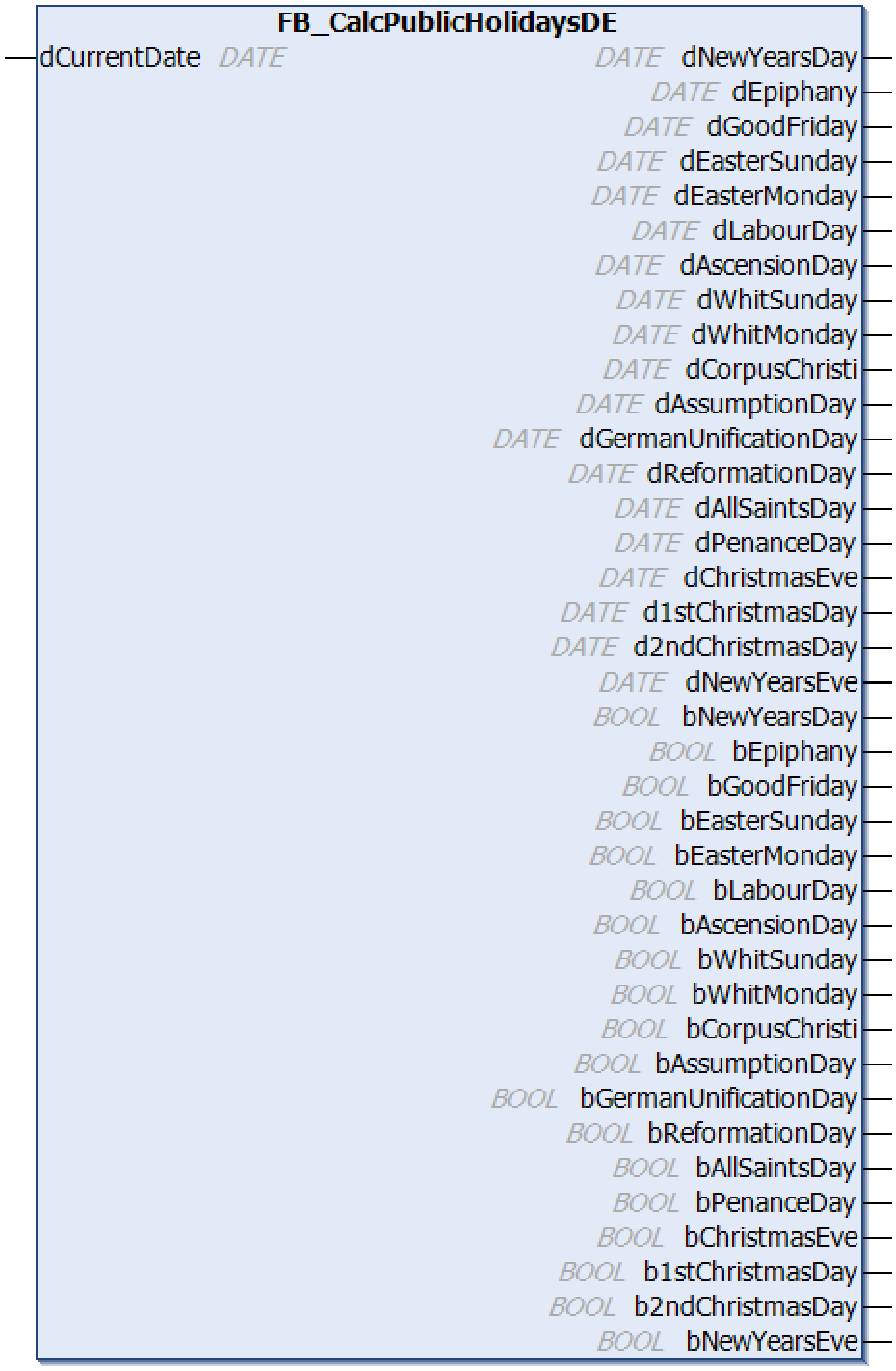
Example

```
PROGRAM MAIN
VAR
   fbCalcSunriseSunset    : FB_CalcSunriseSunset;
   todSunrise             : TOD;
   todSunset              : TOD;
   fbGetSystemTime        : GETSYSTEMTIME;
   fileTime               : T_FILETIME;
   dtCurrentDate          : DT;END_VAR

fbGetSystemTime(timeLoDW =>fileTime.dwLowDateTime,
        timeHiDW =>fileTime.dwHighDateTime);
dtCurrentDate := FILETIME_TO_DT(fileTime);

fbCalcSunriseSunset( fDegreeOfLongitude := 8.5,   (* Longitude of Verl *)
             fDegreeOfLatitude := 51.9,   (* Latitude of Verl *)
             fReferenceMeridian := 30.0,  (* Central European Summer Time *)
             dCurrentDate := DT_TO_DATE(dtCurrentDate),
             todSunrise => todSunrise,
             todSunset => todSunset);
```

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.10 FB_CalcPublicHolidaysDE



German holidays for the current year are calculated based on the date entered. A boolean output indicates whether the entered date matches one of the calculated holidays. To ensure international readability the function block was translated into English. The parameters have the following meaning:

English name	German name
NewYears Day	Neujahr
Epiphany	Heilige Drei Könige
Good Friday	Karfreitag
Easter Sunday	Ostersonntag
Easter Monday	Ostermontag
Labor Day	Maifeiertag
Ascension Day	Christi Himmelfahrt
Whit Sunday	Pfingstsonntag
Whit Monday	Pfingstmontag
Corpus Christi	Fronleichnam
Assumption Day	Mariä Himmelfahrt
German Unification Day	Tag Der Deutschen Einheit
Reformation Day	Reformationstag
All Saints Day	Allerheiligen
Penance Day	Buß- und Bettag
Christmas Eve	Heiligabend
1st ChristmasDay	1. Weihnachtstag
2nd ChristmasDay	2. Weihnachtstag
New Years Eve	Silvester

VAR_INPUT

```
dCurrentDate      : DATE;
```

dCurrentDate: current date.

VAR_OUTPUT

```
dNewYearsDay             : DATE;
dEpiphany                : DATE;
dGoodFriday              : DATE;
dEasterSunday            : DATE;
dEasterMonday            : DATE;
dLabourDay               : DATE;
dAscensionDay            : DATE;
dWhitSunday              : DATE;
dWhitMonday              : DATE;
dCorpusChristi           : DATE;
dAssumptionDay           : DATE;
dGermanUnificationDay    : DATE;
dReformationDay          : DATE;
dAllSaintsDay            : DATE;
dPenanceDay              : DATE;
dChristmasEve            : DATE;
d1stChristmasDay         : DATE;
d2ndChristmasDay         : DATE;
dNewYearsEve             : DATE;
bNewYearsDay             : BOOL;
bEpiphany                : BOOL;
bGoodFriday              : BOOL;
bEasterSunday            : BOOL;
bEasterMonday            : BOOL;
bLabourDay               : BOOL;
bAscensionDay            : BOOL;
bWhitSunday              : BOOL;
bWhitMonday              : BOOL;
bCorpusChristi           : BOOL;
bAssumptionDay           : BOOL;
bGermanUnificationDay    : BOOL;
bReformationDay          : BOOL;
bAllSaintsDay            : BOOL;
bPenanceDay              : BOOL;
bChristmasEve            : BOOL;
```

```
b1stChristmasDay        : BOOL;
b2ndChristmasDay        : BOOL;
bNewYearsEve            : BOOL;
```

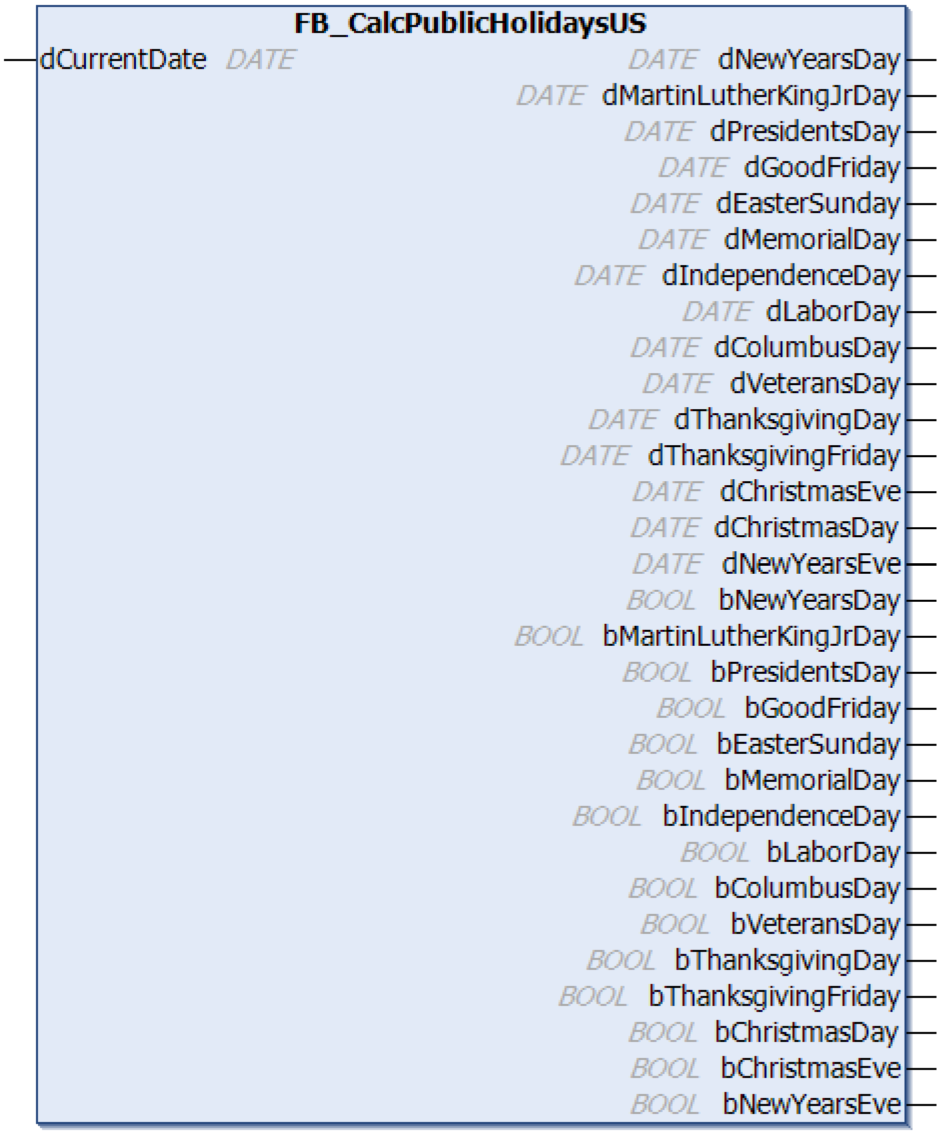
dxxxxxx: Date of the respective holiday.

bxxxxxx: Boolean statement indicating whether today is the respective holiday.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.11 FB_CalcPublicHolidaysUS



Calculation of the United States public holidays.

US public holidays for the current year are calculated based on the date entered. A boolean output indicates whether the entered date matches one of the calculated holidays. To ensure international readability the function block was translated into English. The parameters have the following meaning:

English name	German
New Year's Day	Neujahr
Martin Luther King "JR" Day	Martin Luther King Tag
Presidents Day	Tag der Präsidenten
Good Friday	Karfreitag
Easter Sunday	Ostersonntag
Memorial Day	Gedenktag
Independence Day	Unabhängigkeitstag
Labor Day	Maifeiertag
Columbus Day	Kolumbus-Tag
Veterans Day	Veteranentag
Thanksgiving Day	Erntedank
Thanksgiving Friday	Schwarzer Friday (Freitag nach Erntedank)
Christmas Eve	Heiligabend
Christmas Day	Weihnachtstag
New Years Eve	Silvester

VAR_INPUT

```
dCurrentDate      : DATE;
```

dCurrentDate: current date.

VAR_OUTPUT

```
dNewYearsDay              : DATE;
dEpiphany                 : DATE;
dGoodFriday               : DATE;
dEasterSunday             : DATE;
dEasterMonday             : DATE;
dLabourDay                : DATE;
dAscensionDay             : DATE;
dWhitSunday               : DATE;
dWhitMonday               : DATE;
dCorpusChristi            : DATE;
dAssumptionDay            : DATE;
dGermanUnificationDay     : DATE;
dReformationDay           : DATE;
dAllSaintsDay             : DATE;
dPenanceDay               : DATE;
dChristmasEve             : DATE;
d1stChristmasDay          : DATE;
d2ndChristmasDay          : DATE;
dNewYearsEve              : DATE;
bNewYearsDay              : BOOL;
bEpiphany                 : BOOL;
bGoodFriday               : BOOL;
bEasterSunday             : BOOL;
bEasterMonday             : BOOL;
bLabourDay                : BOOL;
bAscensionDay             : BOOL;
bWhitSunday               : BOOL;
bWhitMonday               : BOOL;
bCorpusChristi            : BOOL;
bAssumptionDay            : BOOL;
bGermanUnificationDay     : BOOL;
bReformationDay           : BOOL;
bAllSaintsDay             : BOOL;
bPenanceDay               : BOOL;
bChristmasEve             : BOOL;
b1stChristmasDay          : BOOL;
b2ndChristmasDay          : BOOL;
bNewYearsEve              : BOOL;
```

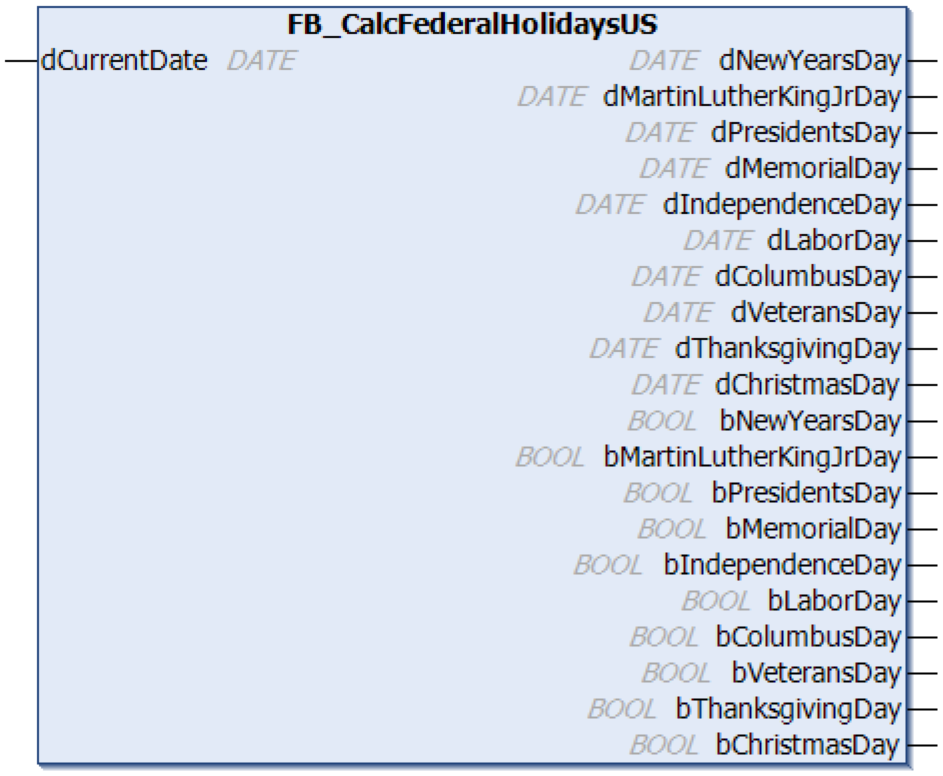
dxxxxxx: Date of the respective holiday.

bxxxxxx: Boolean statement indicating whether today is the respective holiday.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.8.12 FB_CalcFederalHolidaysUS



US federal holidays for the current year are calculated based on the date entered. A boolean output indicates whether the entered date matches one of the calculated holidays. To ensure international readability the function block was translated into English. The parameters have the following meaning:

English name	German name
NewYears Day	Neujahr
Martin Luther King "JR" Day	Martin Luther King Tag
Presidents Day	Tag der Präsidenten
Memorial Day	Gedenktag
Independence Day	Unabhängigkeitstag
Labor Day	Labor Day
Columbus Day	Kolumbus-Tag
Veterans Day	Veteranentag
Thanksgiving Day	Erntedank
Christmas Day	Weihnachtstag

VAR_INPUT

```
dCurrentDate        : DATE;
```

dCurrentDate: current date.

VAR_OUTPUT

```
dNewYearsDay            : DATE;
dMartinLutherKingJrDay : DATE;
dPresidentsDay          : DATE;
dMemorialDay            : DATE;
dIndependenceDay        : DATE;
dLaborDay               : DATE;
dColumbusDay            : DATE;
dVeteransDay            : DATE;
dThanksgivingDay        : DATE;
dChristmasDay           : DATE;
dNewYearsDay            : BOOL;
dMartinLutherKingJrDay : BOOL;
dPresidentsDay          : BOOL;
dMemorialDay            : BOOL;
dIndependenceDay        : BOOL;
dLaborDay               : BOOL;
dColumbusDay            : BOOL;
dVeteransDay            : BOOL;
dThanksgivingDay        : BOOL;
dChristmasDay           : BOOL;;
```

dxxxxxx: Date of the respective holiday.

bxxxxxx: Boolean statement indicating whether today is the respective holiday.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.1.9 Error Codes

Value (hex)	Value (dec)	Description
0x0000	0	No error.
0x0001	1	FB_MaximumDemandController() [▶ 16]: -- reserved error code --
0x0002	2	FB_MaximumDemandController() [▶ 16]: The input parameter *fMeterConstant* is "0".
0x0003	3	FB_LightControl() [▶ 49] *:* The switch range *(nSwitchRange)* in the first or second element of the value table *arrControlTable* is 0. It is thus assumed that the table has only one value set or none at all.
0x0004	4	FB_LightControl() [▶ 49] *:* 2 neighboring input values *nActualValue* in the value table *arrControlTable* lie too close together i.e. each in the switching range of the other.
0x0005	5	FB_Sequencer() [▶ 52] *:* The start index *nStartIndex* is outside of the valid range [1..50].
0x0006	6	FB_Sequencer() [▶ 52] *:* The start index *nStartIndex* refers to a point that, for its part, marks the end of a sequence (zero entries).
0x0007	7	Scheduler function blocks: An input parameter is not in the valid range.
0x0008	8	Scheduler function blocks: None is set for the selection parameters (weekly time clock: selection of weekdays, monthly time clocks: selection of months).
0x0009	9	Scheduler function blocks: A day in the month was selected that is not valid.
0x000A	10	FB_ConstantLightControlEco() [▶ 33] *:* Input parameter *nMinLevel* is greater than or equal to *nMaxLevel.*
0x000B	11	FB_ScenesLighting() [▶ 63], FB_ScenesVenetianBlind() [▶ 66]: Input parameter *sFile* is invalid (empty).
0x000C	12	FB_ScenesLighting() [▶ 63], FB_ScenesVenetianBlind() [▶ 66]: Internal error. File with the scene values was not found.
0x000D	13	FB_ScenesLighting() [▶ 63], FB_ScenesVenetianBlind() [▶ 66]: Internal error: No further free file handles available.

4.2 DUTs

4.2.1 Enumerations

4.2.1.1 E_StartEnd

```
TYPE E_StartEnd :
(
  eSTARTTIME_ENDTIME     := 1,
  eSTARTTIME_DURATION    := 2,
  eSTARTTIME_ENDEVENT    := 3,
  eSTARTEVENT_ENDTIME    := 4,
  eSTARTEVENT_DURATION   := 5,
  eSTARTEVENT_ENDEVENT   := 6
) INT := Undefined;
END_TYPE
```

eSTARTTIME_ENDTIME: Selection of start/end time. If the start time is equal or greater the end time, the end is allocated to the next day.

eSTARTTIME_DURATION: Selection of start time/duration.

eSTARTTIME_ENDEVENT: Selection of start time/end event.

eSTARTEVENT_ENDTIME: Selection of start event/end time. If the start time is equal or greater the end time, the end is allocated to the next day.

eSTARTEVENT_DURATION: Selection of start event/duration.

eSTARTEVENT_ENDEVENT: Selection of start event/end event.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.2.2 Structures

4.2.2.1 ST_ControlTable

```
TYPE ST_ControlTable :
STRUCT
  nActualValue     : UINT;
  nControlValue    : UINT;
  nSwitchRange     : UINT;
END_STRUCT
END_TYPE
```

nActualValue: Current brightness.

nControlValue: Corresponding switch point (control value).

nSwitchRange: Threshold value around the input value interpolation point at which switching takes place. The entry “0” marks the beginning of the unused area of the table.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.2.2.2 ST_MDCInDataKL1501

```
TYPE ST_MDCInDataKL1501 :
STRUCT
  nStatus     : USINT;
  nDummy1     : USINT;
  nDummy2     : USINT;
  nDummy3     : USINT;
  nData       : DWORD;
END_STRUCT
END_TYPE
```

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.2.2.3 ST_MDCLoadParameters

```
TYPE ST_MDCLoadParameters :
STRUCT
  bConnected          : BOOL;
  nDegreeOfPriority   : INT;
  tMINPowerOnTime     : TIME;
  tMAXPowerOffTime    : TIME;
END_STRUCT
END_TYPE
```

bConnected: TRUE = consumer connected; FALSE = consumer not connected.

nDegreeOfPriority: Indicates the switch-off priority; consumers with a low priority will be switched off first. (1 => low; ... 8 => high priority)

tMINPowerOnTime: The minimum power-on time (minimum ramp-up time) during which the consumer may not be switched off.

tMINPowerOffTime: The minimum power-off time (recovery time) during which the consumer may not be switched on again.

tMAXPowerOffTime: The maximum power-off time after which the consumer must be switched on again.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.2.2.4 ST_MDCOutDataKL1502

```
TYPE ST_MDCOutDataKL1501 :
STRUCT
  nCtrl       : USINT;
  nDummy1     : USINT;
  nDummy2     : USINT;
  nDummy3     : USINT;
  nData       : DWORD;
END_STRUCT
END_TYPE
```

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.2.2.5 ST_SequenceTable

```
TYPE ST_SequenceTable :
STRUCT
  nTargetValue     : UINT;
  tRampTime        : TIME;
  tProlongTime     : TIME;
END_STRUCT
END_TYPE
```

nTargetValue: Target value.

tRampTime: Time to reach the target value.

tProlongTime: Dwell time at the target value.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.2.2.6 ST_StartEnd

```
TYPE ST_StartEnd :
STRUCT
  todStartTime     : TOD;
  bStartEvent      : BOOL;
  tDuration        : TIME;
  todEndTime       : TOD;
  bEndEvent       : BOOL;
END_STRUCT
END_TYPE
```

todStartTime: Start time.

bStartEvent: Start event

tDuration: Switching duration.

todEndTime: End time.

bEndEvent: End event.

Requirements

Development environment	Required PLC library
TwinCAT from v3.1.4020.32	Tc2_BABasic from v3.1.0.0

4.3 GVLs

4.3.1 Constants

```
VAR_GLOBAL CONSTANT
    TCSIGNAL_INVALID        : WORD := 16#0000;
    TCSIGNAL_SIGNALED       : WORD := 16#0001;
    TCSIGNAL_RESET          : WORD := 16#0002;
    TCSIGNAL_CONFIRMED      : WORD := 16#0010;
    TCSIGNAL_SIGNALCON      : WORD := 16#0011;
    TCSIGNAL_RESETCON       : WORD := 16#0012;

    OPTION_INIFINITE_LOOP   : DWORD := 16#0000_0001;
END_VAR
```

5 Appendix

5.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages: https://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline:	+49 5246 963 157
Fax:	+49 5246 963 9157
e-mail:	support@beckhoff.com

Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

Hotline:	+49 5246 963 460
Fax:	+49 5246 963 479
e-mail:	service@beckhoff.com

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone:	+49 5246 963 0
Fax:	+49 5246 963 198
e-mail:	info@beckhoff.com
web:	https://www.beckhoff.com

More Information:
www.beckhoff.com/tf8010

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com