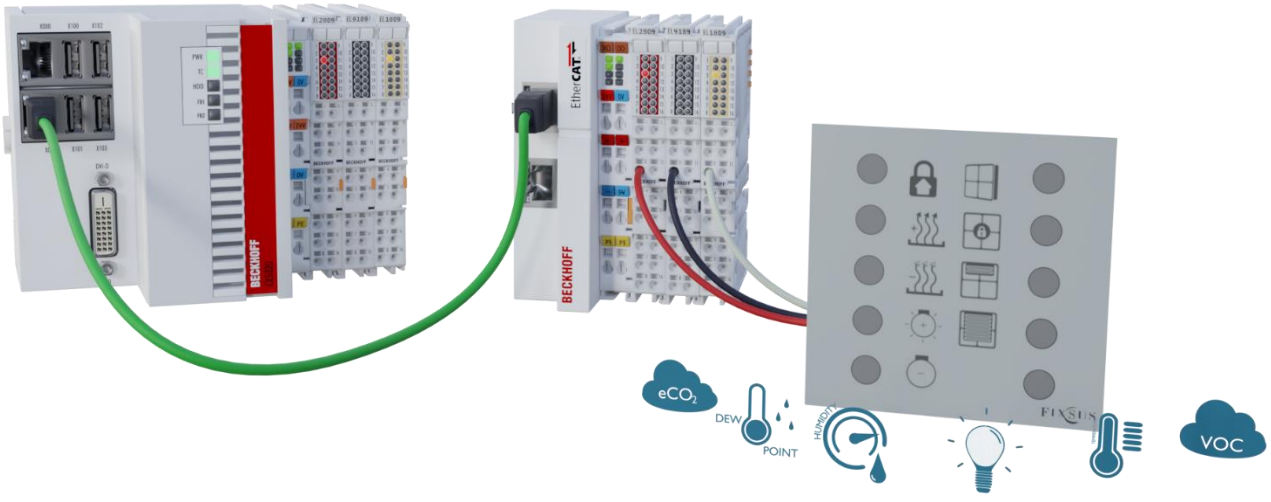
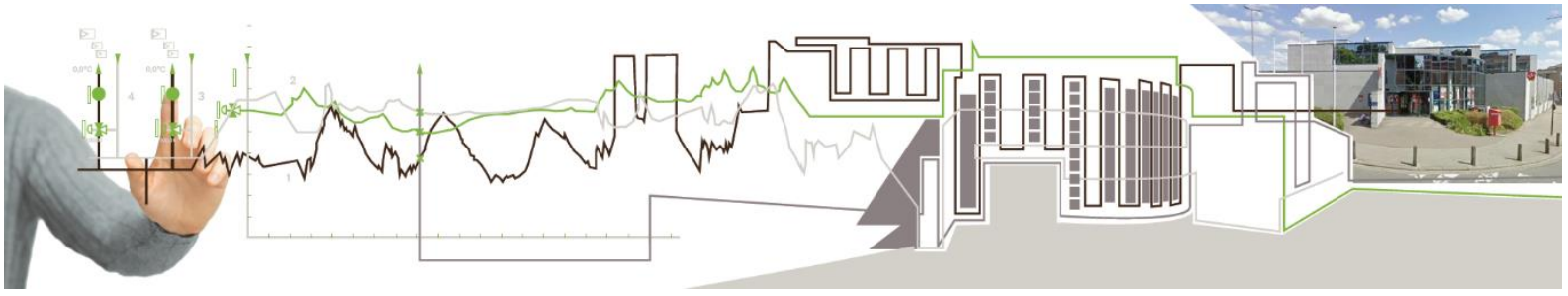
This document explains how to implement DIOC devices into a TwinCAT 3 project.

Manual TP10/RC/DIOC





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2. Introduction

This manual is provided to help people implement the TP10 into their own TwinCAT 3 projects. If required, you can visit our site, www.upzio.com.

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4. Detailed manual to implementing DIOC into TwinCAT 3

Step 1: Use E-bus digital input and output terminals

To implement the DIOC protocol, the E-bus must be used. To do this, E-bus digital input and output terminals must be used (e.g. EL1809, EL2809 or EL1859).

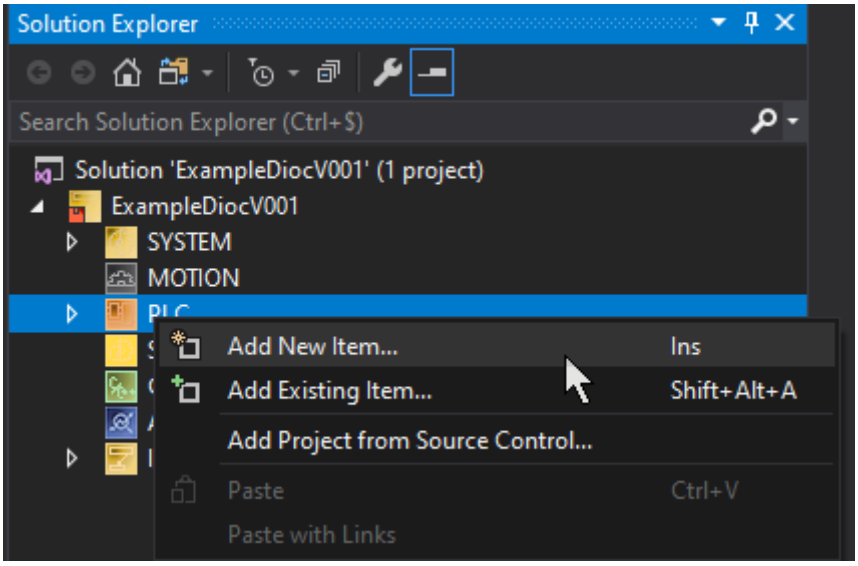
The DIOC protocol cannot be used on the K-bus. If the amount of inputs/outputs of the K-bus is too large, the I/O cycle time will get an offset causing the DIOC protocol to not function properly. Therefore, the K-bus is not officially supported.

Step 2: Download the DIOC library 'DIOC_Library' and install it

The first step of the implementation is to install the necessary libraries.
If the library is already installed continue to step 2.

Start by creating a new TwinCAT (not PLC) project.

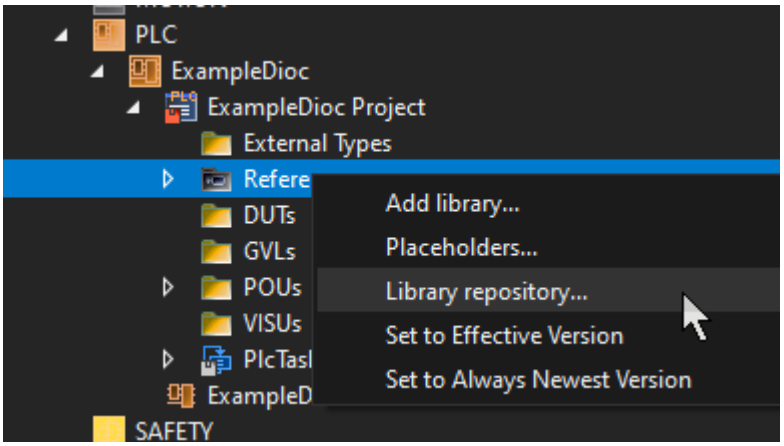
Add a TwinCAT PLC project by right clicking in the solution tree on item PLC



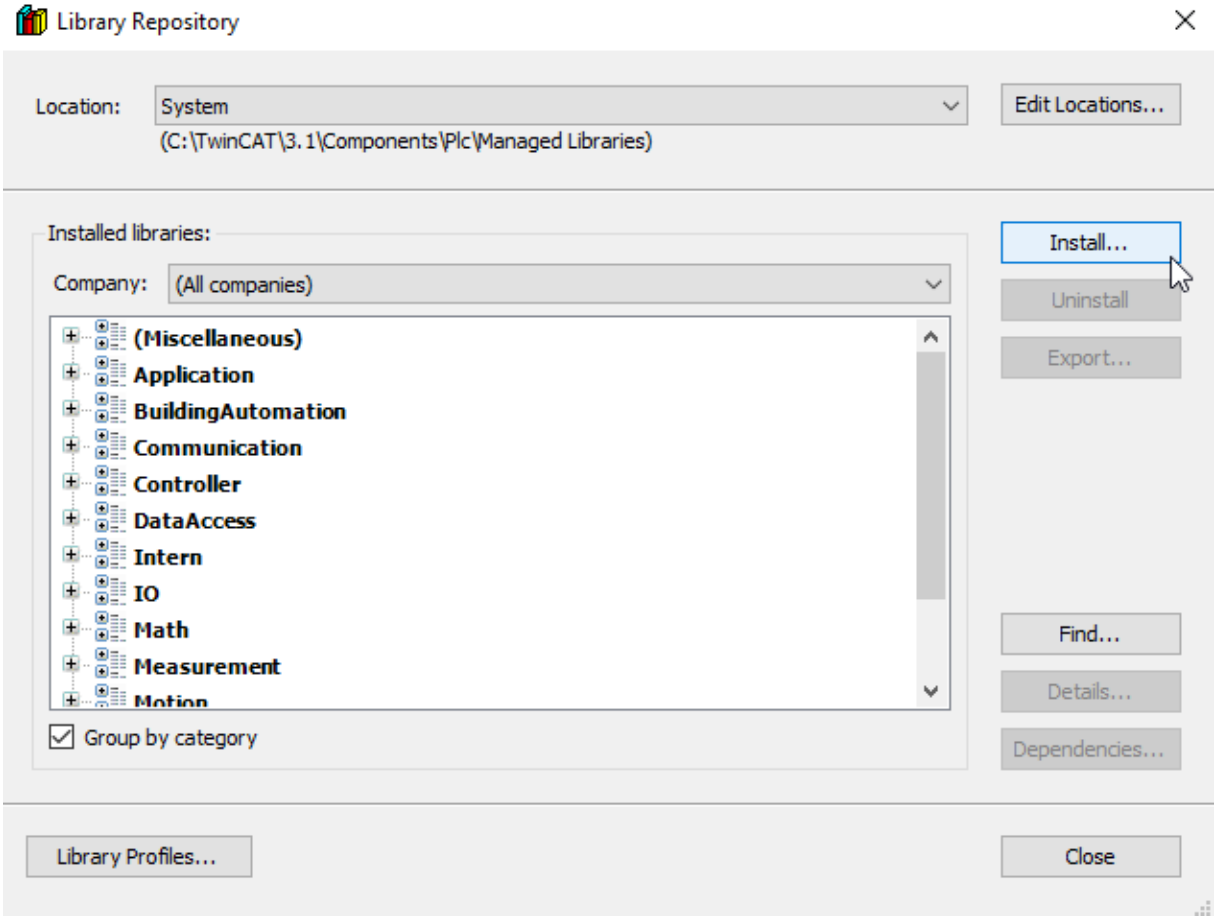
Download the latest TC3 library from our website. (https://www.upzio.com)

The library file 'TC3_Dioc_library.library' must be added to the TwinCAT library repository. This must only be done once, or every time there is a new library version.

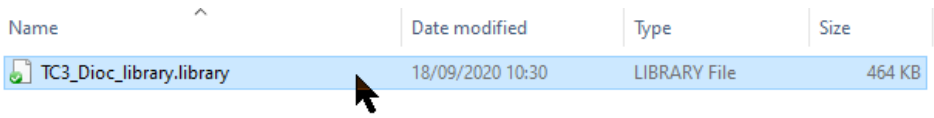
Do this by right clicking on ‘references’ in the plc, selecting library repository



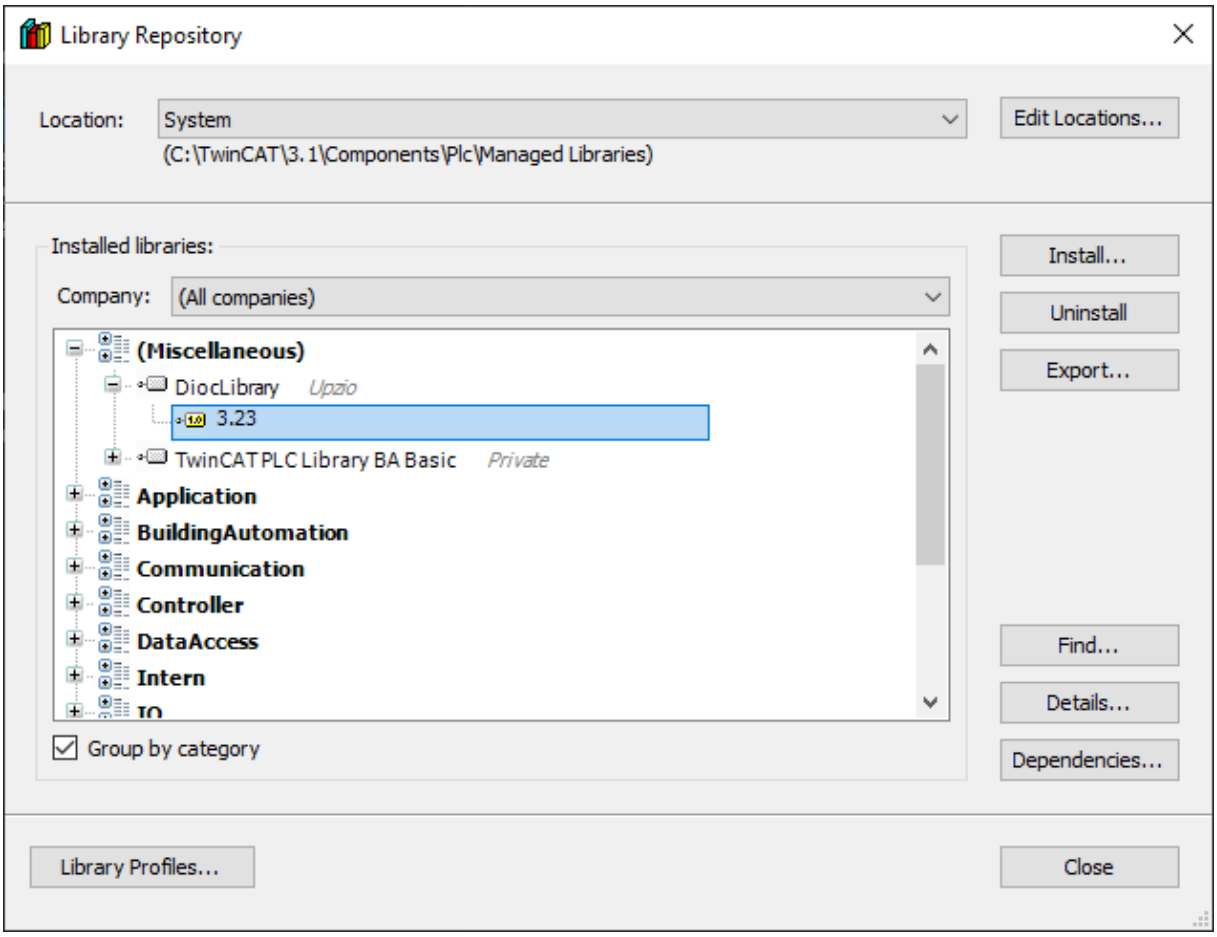
Press install



And install the downloaded library by double clicking it



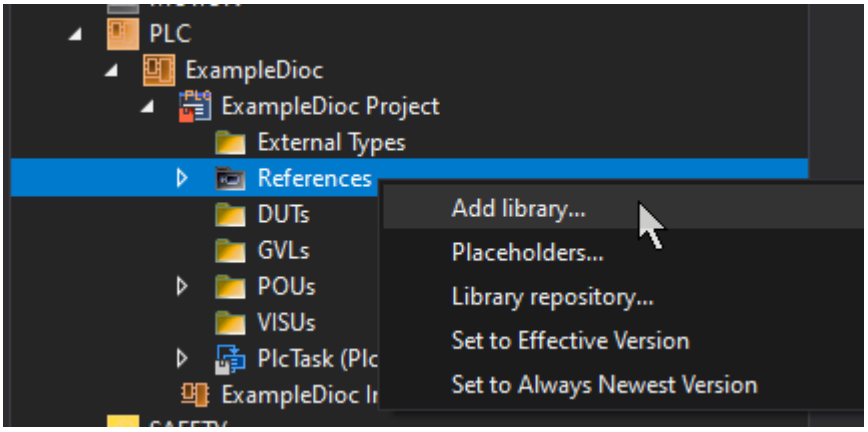
You should now find the (new) DIOC library under "Miscellaneous"



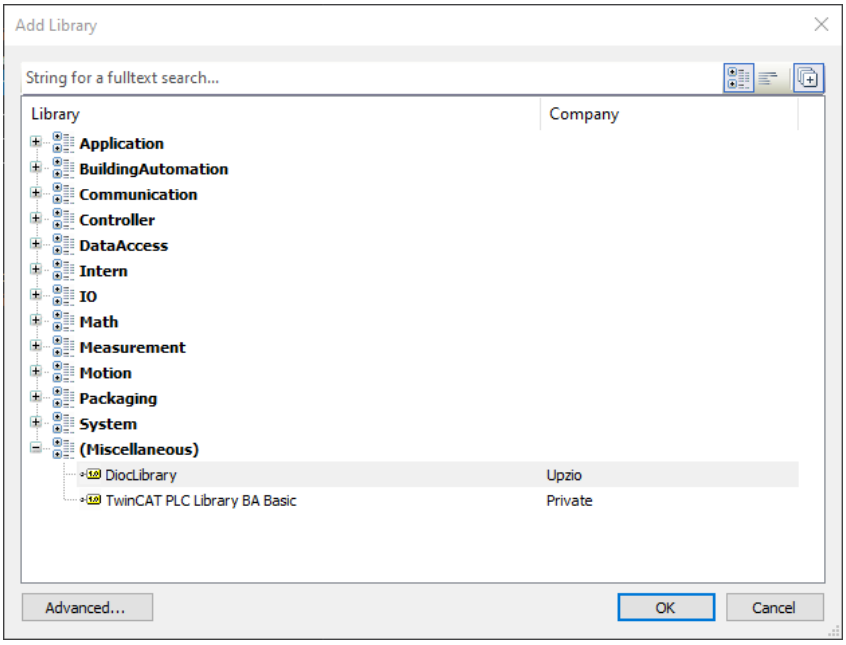
Step 3: Implement the library into a TwinCAT PLC project

If the 'DIOC_library' was installed, it needs to be implemented in every project using DIOC.

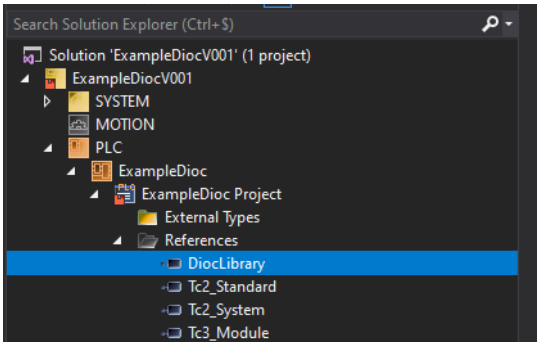
Do this by right clicking on 'references' in the plc and selecting 'add library'



Search for DiocLibrary or select the library under "Miscellaneous" and press ok



The library will now be imported into the PLC project



Step 4: Set the cycle time

To ensure a good communication with the TP10, RC and other DIOC devices, instances of the TP10, RC and other DIOC function blocks must be called with a fixed cycle time. This cycle time is currently 12ms.

There are two methods to do this:

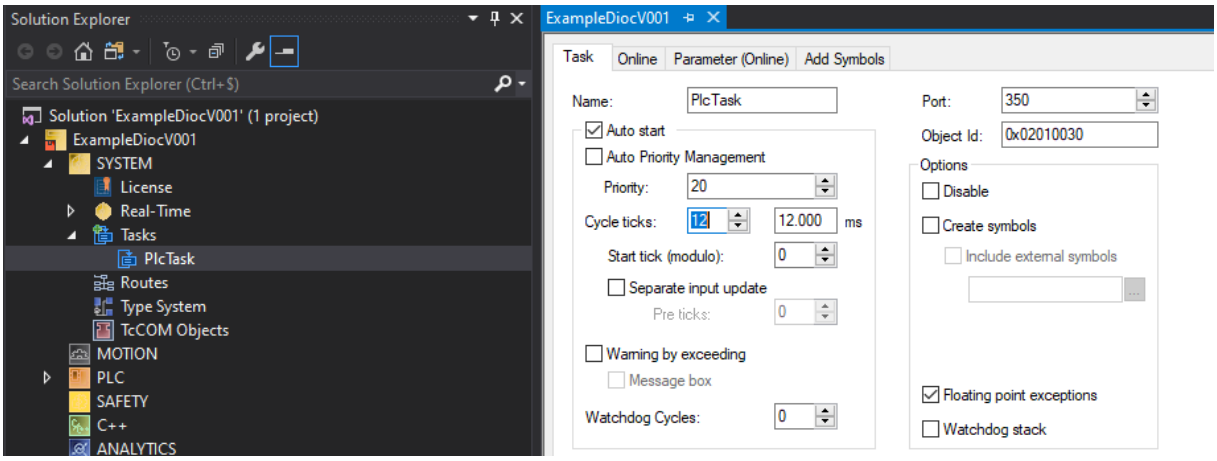
1. The standard cycle time can be set to 12ms, the DIOC instances should then be called in the standard program (the MAIN program)
2. A new task can be made with a cycle time of 12ms in which the DIOC instances can be called

Method 1: Change the standard cycle time

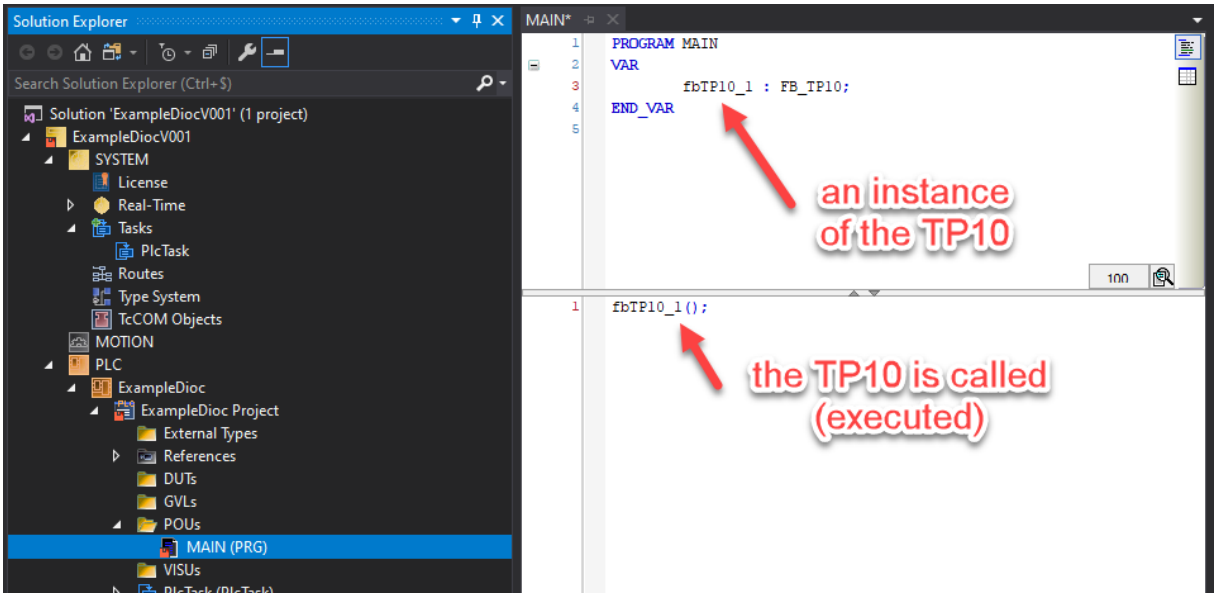
This is the least complicated method. However, when other components of the program need to run on a different cycle time or when the whole program is too large to run on a cycle time of 12ms, the second method should be used.

The cycle time can be changed under System/Tasks

Select the PLC task and change the default cycle time to 12ms by increasing the cycle ticks to 12.



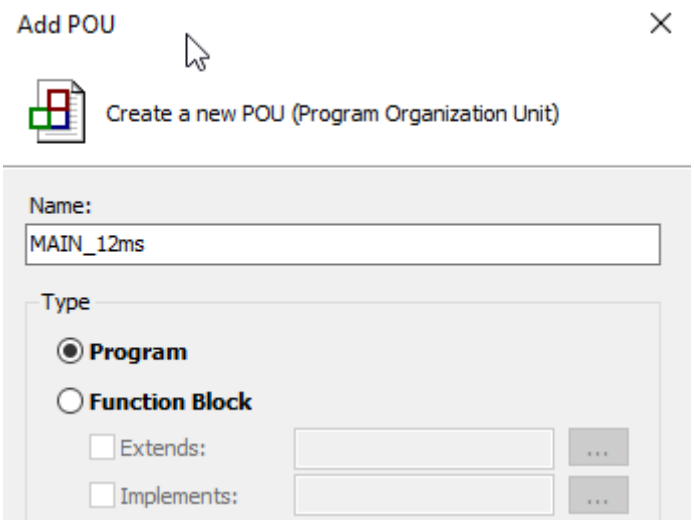
Now the DIOC instances must be called in the programs called by the PlcTask running at 12ms. For instance MAIN (PRG)



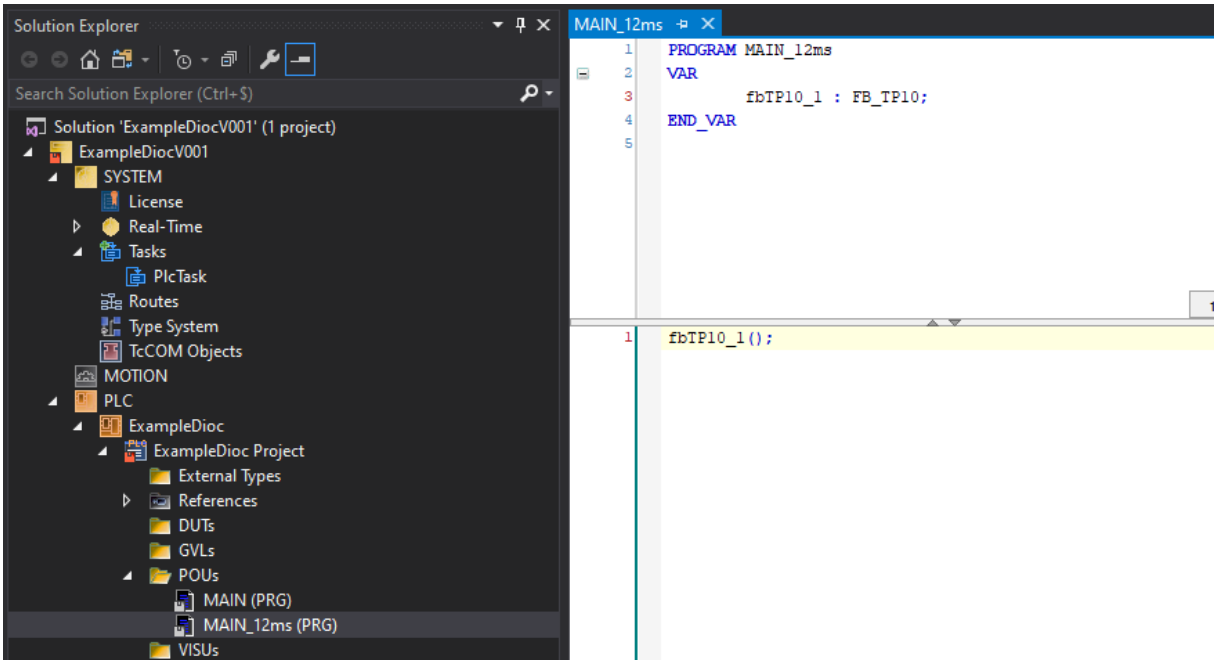
Make sure the instance is called every cycle to ensure a good communication.

Method 2: create a new task with a 12ms cycle time

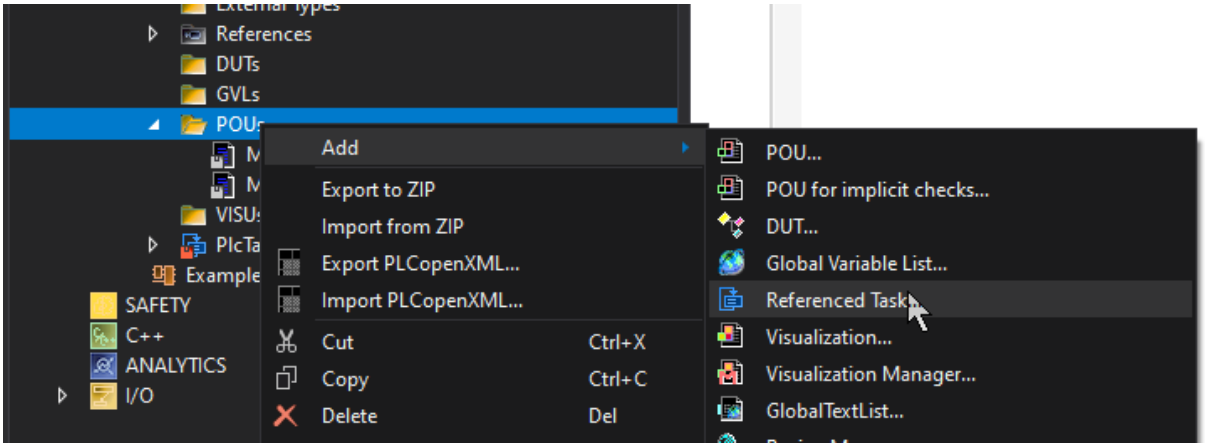
The first step is to make a new program that will be executed in the new task. Making a new program can be done by right-clicking under POU and adding a new object. The new program is named MAIN_12ms in the example.



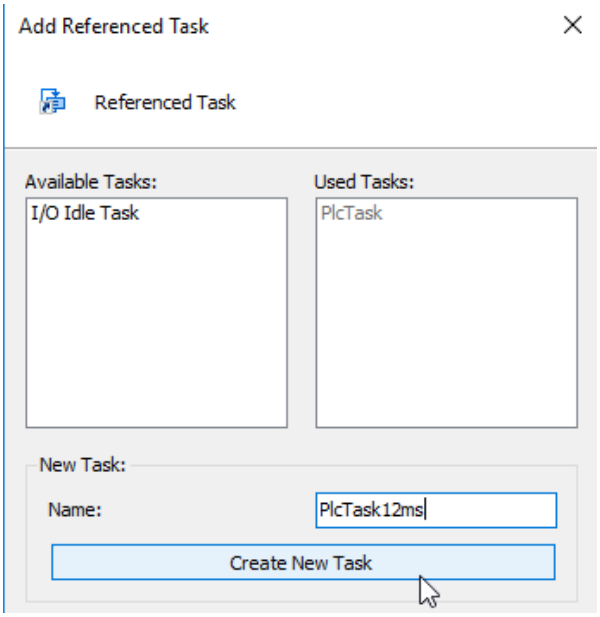
In this new program DIOC instances must be called, this means they will be executed.



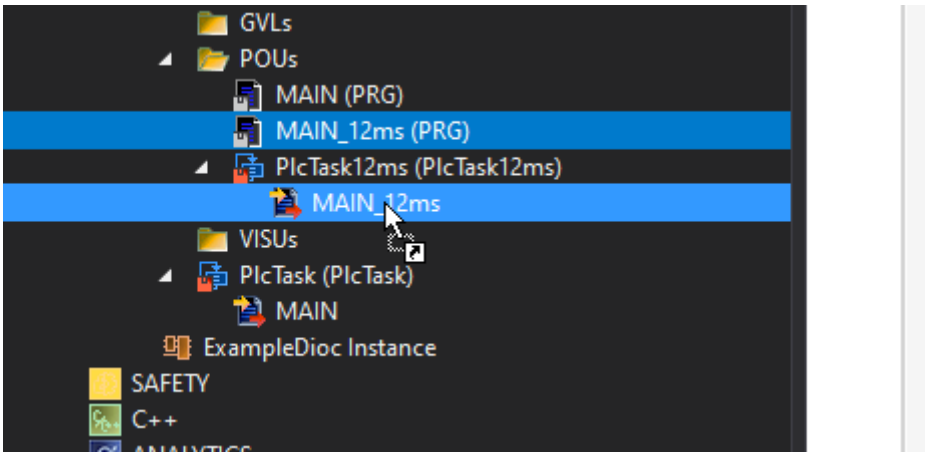
After the block is created we must create a referenced task in the plc.



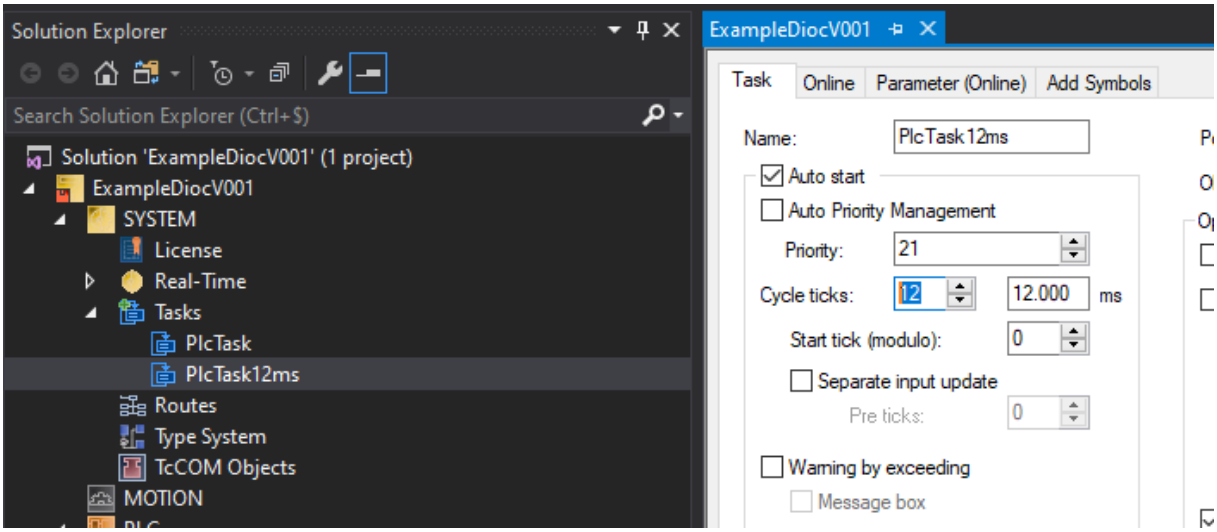
Give the name for the new task, press create new task and press open



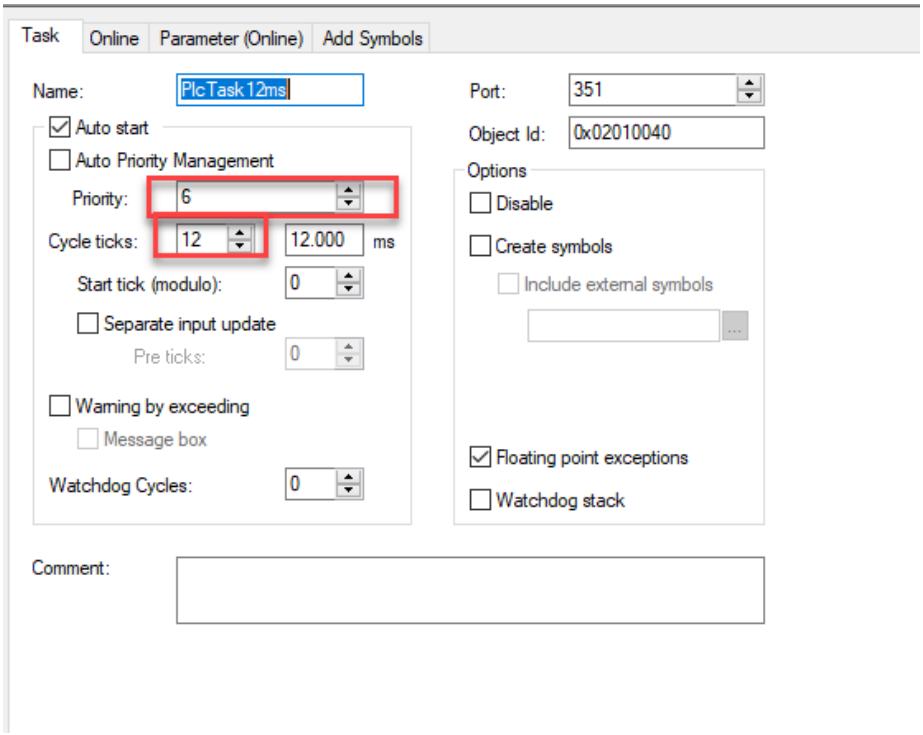
Once the task has been created drag and drop the program created before to the task

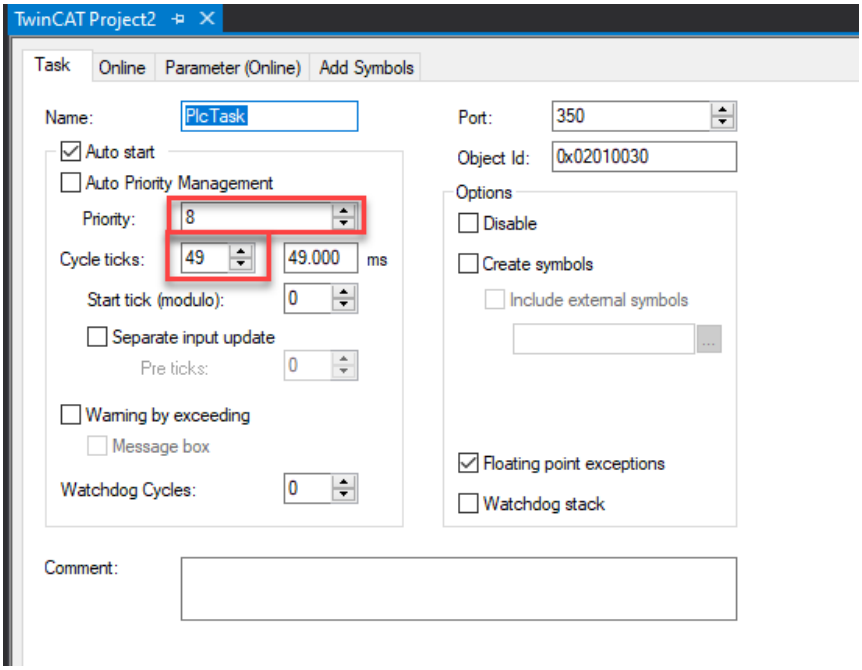


After linking set the cycle time of the new task to 12ms



The priorities of the tasks should also be set in order. The task with the lowest cycle time should always get the lowest priority number (lowest priority number means highest priority).




TwinCAT Project2
Task
Online
Parameter (Online)
Add Symbols
Name:
PlcTask
Port:
350
Object Id:
0x02010030
Auto start
Auto Priority Management
Priority:
8
Cycle ticks:
49
49.000
ms
Start tick (modulo):
0
Separate input update
Pre ticks:
0
Warning by exceeding
Message box
Watchdog Cycles:
0
Options
Disable
Create symbols
Include external symbols
Floating point exceptions
Watchdog stack
Comment:

Step 5: the program is to be executed after an output update

There are two VERY IMPORTANT things that have to be set to implement the TP10, RC and other DIOC devices

I/O at task begin

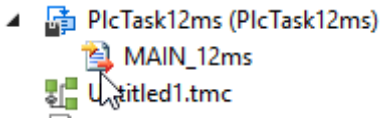
By means of a pragma we define whether a program is to be executed after an output update. This attribute replaces the TwinCAT 2 functionality of the option IO at Task begin.

The pragma must be placed in front of the PROGRAM calling the dioc blocks. In our example MAIN_12ms.

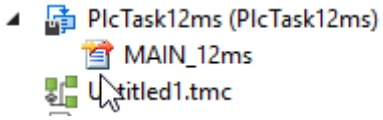
```
{attribute 'TcCallAfterOutputUpdate'}
PROGRAM MAIN_12ms
VAR
END_VAR
```

Once compiled this can be easily checked by looking at the two arrows on the task in the solution tree.

Before:



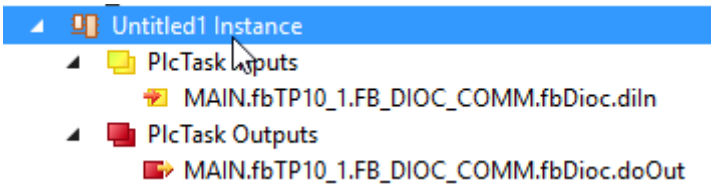
After:



Depending on the TwinCAT 3 version, it might be possible to disconnect and reconnect the program from the referenced task for the arrows to change.

Calling I/O in the correct task

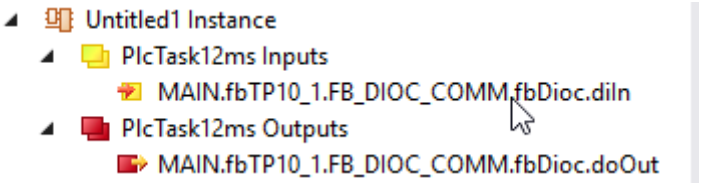
Depending on the size of the program and the situation, it can happen that the IO of the DIOC devices are not in the correct task IO. Like below, the IO is called in the task IO of MAIN and not MAIN_12ms as it should.



For this purpose as the pragma 'TcContextName' above the program where the instantiation of the dioc devices is done.

```
{attribute 'TcContextName':='PlcTask12ms'}
PROGRAM MAIN_12ms
VAR
    fbTP10_1        : FB_TP10;
END_VAR
```

After compilation it should look like



Sync unit assignment

For bigger projects, it might be a good idea to assign sync units to your I/Os. Without sync units the TP10's might not work if another I/O is missing or malfunctioning. Typically, a different sync unit should be assigned to every EtherCAT Coupler in your project. For more information on the sync units visit the Beckhoff information site.
https://infosys.beckhoff.com/english.php?content=../content/1033/tc3_io_intro/1468206859.html&id=6053821954081018594

5. Inputs and outputs of the TP10 block

Description usage of the inputs and outputs of the TP10

The TP10 block has a lot of inputs that can change the behaviour of the TP10.

As an example below the RGB leds of the TP10 are set to red. To do this, predefined colors can be used.

```
fbTP10_1.dwRgb := fixsus_dioc.Global_DIOC_Constants.RGB_RED;
```

Other colour constants available in the DIOC library are listed below in the description of the input.

The other variables of the TP10 can also be addressed this way. The table below shows a list of all the inputs, outputs and configuration variables the TP10 has.

The inputs and outputs of the TP10 are pretty straight forward. But for an even better understanding of a full implementation of a TP10, a very simple example is implemented in the sample project.

The code of the sample project is listed at the end of the document. The code is well documented so it should be comprehensible.

If you experience troubles while implementing, please post a note or a question in the forum.

Inputs

Name	Type	Description
bRoomAnalyser	BOOL	This boolean must be true of the connected device is a Room Analyser. If this boolean is true, all buttons are disabled, except button 10. Button 10 still be used to make the Room Analyser flash green. This can be used to test the DIOC communication with the PLC.
arr_bLeds	ARRAY [0..10] OF BOOL	Every button of the TP10 has it's own led. These can be controlled by changing the values in this array. True will make the led go on, false will make the led go off. arr_bLeds [1] = led 1, arr_bLeds [10] = led 10
iIntensityLeds	INT	Value between 0 and 100 that changes the intensity of the buttonleds.
iHapticIntensity	INT	Intensity of the sound when pressing a button (0..100)
iButtonSensitivity	DWORD	sensitivity of the buttons, only used if value > 0, (values from 1-99 are possible, 99 is the lowest sensitivity, 1 is the highest sensitivity, standard value is 55)
arr_bMasks	ARRAY [0..10] OF BOOL	Every button of the TP10 can be turned off, this can be done by changing the values in this array. False means the button is enabled, true means the button is disabled. arr_bMasks [1] = button 1, arr_bMasks [10] = button 10, bRoomAnalyser overrules these.
arr_sButtonComments	ARRAY [0..10] OF STRING(8)	Every button of the TP10 has a short description (maximum 8 characters) that will be displayed on the visualisation. arr_sButtonComments [1] = comment button 1, arr_sButtonComments [10] = comment button 10

bReset	BOOL	When the TP10 has to be reset, this boolean should be set to true briefly. Once bReset is false again, the reset time will count to restart the TP10.
bResetVOC	BOOL	if this input is true, the VOC/eCO2 sensor will be turned off for 1000 cycles
iIntervalCO	INT	Interval for the CO measurement in seconds. This determines how fast the measurements of the CO sensor must be checked. This is standard 7 (seconds). This variable must be changed before the start of the program. This value will not be sent to the TP10 once the TP10 program is running. After a restart or reset, this value will be sent again.
iIntervalCO2	INT	Interval for the CO2 measurements in seconds. This determines how fast the measurement of the CO2 sensor must be checked. This is standard 8 (seconds). The same conditions apply as iIntervalCO.
iIntervalIllumination	INT	Interval for the illumination measurement in seconds. This determines how fast the measurement of the illumination sensor must be checked. This is standard 13 (seconds). The same conditions apply as iIntervalCO.
iIntervalRoomHumidity	INT	Interval for the humidity measurement in seconds. This determines how fast the measurement of the humidity sensor must be checked. This is standard 11 (seconds). The same conditions apply as iIntervalCO.
iIntervalRoomtemp	INT	Interval for the roomtemperature measurement in seconds. This determines how fast the measurement of the roomtemperature sensor must be checked. This is standard 3 (seconds). The same conditions apply as iIntervalCO.

iIntervalVOC	INT	Interval for the VOC measurement in seconds. This determines how fast the measurement of the VOC sensor must be checked. This is standard 5 (seconds) The same conditions apply as iIntervalCO.
dwRgb	DWORD	The TP10 has a few RGB leds that can be used to light up the TP10. This value determines the intensity of each led. Predefined colors can be used for this input: RGB_BLACK , RGB_NAVY , RGB BLUE , RGB_GREEN , RGB_TEAL , RGB_LIME , RGB_AQUA , RGB_MAROON , RGB_PURPLE , RGB_OLIVE , RGB_GREY , RGB_ORANGE , RGB_FUCHSIA , RGB_YELLOW , RGB_WHITE You may also create your own color. To do this a DWORD has to be made. (eg. 16#1E8FE03F) In the example 1E is a hexadecimal value for the intensity, 8F is the red value, E0 is the green value and 3F is the blue value.
iRGBIntensity	INT	if intensity > -1 then use this value
bEn	BOOL	Enable bit.
bLocate	BOOL	IF TRUE: makes the TP10 flash green 3 times to know which one you are currently using.
bWallSurface	BOOL	Not relevant.

Outputs

Name	Type	Description
qarr_bButtons	ARRAY [0..12] OF BOOL	Every button of the TP10 can be read. This can be done by reading the values from this array. True means the button is operated, false means the button is unoperated. Qarr_bButtons [1] = button 1, qarr_bButtons [10] = button 10.
qfCO2	REAL	Value of the CO2 sensor in PPM (parts per million).
qfHumidity	REAL	Value of the humidity in percent.
qfLux	REAL	Value of the illumination sensor in lux.
qfRoomTemperature	REAL	Value of the temperature measurement in °C.
qfVOC	REAL	Value of the VOC sensor in PPB (parts per billion)
qfDewpoint	REAL	calculated dewpoint value, dependant on temperature and humidity measurements

Systeminfo

Name	Type	Description
qbDeviceActive	BOOL	Boolean that indicates if the TP10 is active. True = TP10 active False = TP10 not active
qdtVersionHw	DATE	Date of the hardware version of the TP10.
qdtVersionSw	DATE	Date of the software version of the TP10.
qdtVersionReg	DATE	Date of the register version of the TP10.
qrVoltageLevelA	REAL	Voltage level of the A line in Volt.
qrVoltageLevelB	REAL	Voltage level of the B line in Volt.
qsUniqueId	STRING	Unique ID of the TP10

Sample program listing TP10

MAIN_12ms

```
{attribute 'TcCallAfterOutputUpdate'}
{attribute 'TcContextName' := 'PlcTask12ms'}
PROGRAM MAIN_12ms
VAR
        fbTP10_1 : FB_TP10;

        fRoomTemperature : REAL;

        rtrigButton1  : R_TRIG;
        rtrigButton2  : R_TRIG;
END_VAR
```

```
fbTP10_1();

(*store the measured temperature in fRoomTemperature*)
fRoomTemperature := fbTP10_1.qfRoomTemperature;

(*turn on the red leds when button 1 is pressed*)
rtrigButton1(CLK:=fbTP10_1.qarr_bButtons[1]);
IF rtrigButton1.Q THEN
    fbTP10_1.dwRgb := RGB_RED;
END_IF

(*turn off the leds when button 2 is pressed*)
rtrigButton2(CLK:=fbTP10_1.qarr_bButtons[2]);
IF rtrigButton2.Q THEN
    fbTP10_1.dwRgb := RGB_BLACK;
END_IF

```

6. Inputs and outputs of the RC block

Description usage of the inputs and outputs of the RC

The RC block has a lot of inputs that can change the behaviour of the RC.

The table below shows a list of all the inputs, outputs and configuration variables the RC has.

Inputs:

Name	Type	Description
bEn	BOOL	This boolean must be true of the connected device is a Room Analyser. If this boolean is true, all buttons are disabled, except button 10. Button 10 still be used to make the Room Analyser flash green. This can be used to test the DIOC communication with the PLC.
bEnableFan	BOOL	enable fan bit (relay pin 41-42)
bHeating_3P_plus	BOOL	Heating plus signal (output pin 7)
bHeating_3P_min	BOOL	Heating min signal (output pin 8)
bCooling_3P_plus	BOOL	Cooling plus signal (output pin 20)
bCooling_3P_min	BOOL	Cooling min signal (output pin 21)
bFireDamper_OPN	BOOL	open signal fire damper (output pin 33)
bFireDamper_CLS	BOOL	close signal fire damper (output pin 34)
bRelais_45	BOOL	relay pin 45 (DO3)
bRelais_46	BOOL	relay pin 46 (DO2)
bRelais_47	BOOL	relay pin 47 (DO1)
iIntervalACVoltage	UDINT	retrieval time ac voltage (in seconds)
iIntervalTempHeatingWater	UDINT	retrieval time temperature heating water (in seconds)
iIntervalTempICEWater	UDINT	retrieval time temperature ice water (in seconds)
iInterval_FB_Pulsion	UDINT	retrieval time feedback pulsion (in seconds)
iIntervalTempAirPulsion	UDINT	retrieval time temperature pulsion air (in seconds)
iInterval_FB_Extraction	UDINT	retrieval time feedback extraction (in seconds)
iIntervalTempAirExtraction	UDINT	retrieval time temperature extraction (in seconds)
iIntervalDipswitches	UDINT	retrieval time dipswitches (in seconds)
iIntervalFBFiredamper	UDINT	retrieval time feedback firedamper (in seconds)
iIntervalFanFaultStatus	UDINT	retrieval time fan fault (in seconds)

iSendIntervalSpHeating	INT	send interval time for the heating set point in seconds*
iSendIntervalSpCooling	INT	send interval time for the cooling set point in seconds
iSendIntervalSpPulsion	INT	send interval time for the pulsion set point in seconds
iSendIntervalSpExtraction	INT	send interval time for the extraction set point in seconds
iSendIntervalSpFan	INT	send interval time for the fan set point in seconds
bForceSendSpHeating	BOOL	Set this to true to send the heating set point immediatly
bForceSendSpCooling	BOOL	Set this to true to send the cooling set point immediatly
bForceSendSpPulsion	BOOL	Set this to true to send the pulsion set point immediatly
bForceSendSpExtraction	BOOL	Set this to true to send the extraction set point immediatly
bForceSendSpFan	BOOL	Set this to true to send the fan set point immediatly
iSpHeating	INT	heating setpoint in % 0% = 0V, 100% = 10V
iSpCooling	INT	cooling setpoint in % 0% = 0V, 100% = 10V
iSpPulsion	INT	pulsion setpoint in % 0% = 0V, 100% = 10V
iSpExtraction	INT	extraction setpoint in % 0% = 0V, 100% = 10V
iSpFan	INT	fan setpoint in % 0% = 0V, 100% = 10V
bReset	BOOL	if true: resets the Room Controller
arr_sConnectionComments	ARRAY [1..41] OF STRING(8)	comments for every connection that is visible on the visualisation

Outputs:

Name	Type	Description
qbFiredamperFB_OPN	BOOL	feedback firedamper open (input pin 37)
qbFiredamperFB_CLS	BOOL	feedback firedamper closed (input pin 36)
qbFanFault	BOOL	fan fault (input pin 43)
qarr_bDipSwitches	ARRAY[1..12] OF BOOL	status dipswitches
qfACVoltageLevel	REAL	measured ac voltage
qfTempHeatingWater	REAL	temperature heating water in °C (PT1000 pin 12-13)
qfTempIceWater	REAL	temperature ice water in °C (PT 1000 pin 25-26)
qfPulsionFB	REAL	pulsion vav feedback in % (pin 17) 0% = 0V, 100% = 10V
qfTempAirPulsion	REAL	temperature pulsion in °C (PT1000 pin 18-19)
qfExtractionFB	REAL	extraction vav feedback in % (pin 30) 0% = 0V, 100% = 10V
qfTempAirExtraction	REAL	temperature extraction in °C (PT1000 pin 31-32)

Systeminfo:

Name	Type	Description
qbDeviceActive	BOOL	Boolean that indicates if the RC is active. True = RC active False = RC not active
qdtVersionHw	DATE	Date of the hardware version of the RC.
qdtVersionSw	DATE	Date of the software version of the RC.
qdtVersionReg	DATE	Date of the register version of the RC.
qrVoltageLevelA	REAL	Voltage level of the A line in Volt.
qrVoltageLevelB	REAL	Voltage level of the B line in Volt.
qsUniqueId	STRING	Unique ID of the RC