Challenge 01: PLC App

rexroth
A Bosch Company

Let’s Start!

rexroth
A Bosch Company

Let‘s Start!

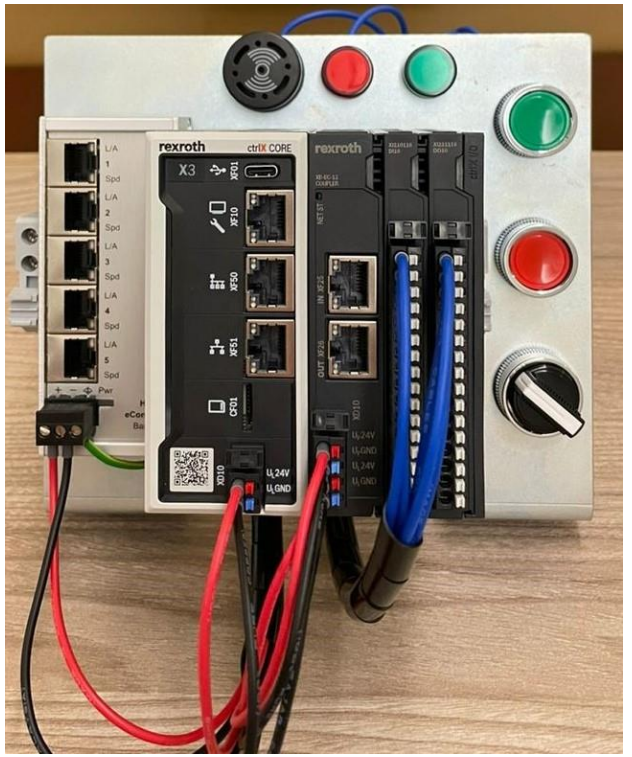
Inform

The setup of the ctrlX AUTOMATION Starter Kit consists of:

- ctrlX CORE X3 Controller
- ctrlX EtherCAT Bus Coupler
- ctrlX Digital Input (DI) 16-channels, 1-wire, 24VDC
- ctrlX Digital Output (DO), 16-channels, 1-wire, 24VDC
- Inputs: 2x Push Buttons and 1x Selector Switch
- Outputs: 2x Pilot Lamps and 1x Buzzer

The system is set up in the order shown in the adjacent image. They are already connected mechanically, and electrically. The installation allows the setup, operation and monitoring of a complete automation process.

ctrlX AUTOMATION Starter Kit



rexroth
A Bosch Company

Let‘s Start!

Inform

ctrlX AUTOMATION – PLC

ctrlX PLC is a versatile solution that combines classic PLC automation with IoT communication needs, making it ideal for future factories. It runs on Embedded Linux Ubuntu Core with real-time capabilities, and you can easily enhance its functionality with apps. You can tailor ctrlX PLC to specific tasks using apps from the ctrlX Store or third-party sources. Security is a top priority, with options for secure configuration and certified security apps.

Information about the ctrlX PLC App can be found online:

- ctrlX PLC App | ctrlX AUTOMATION Community
- ctrlX PLC App | Application Manual

Information about the ctrlX CORE platform can be found online:

- ctrlX CORE on YouTube
- ctrlX CORE Operating Instructions

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

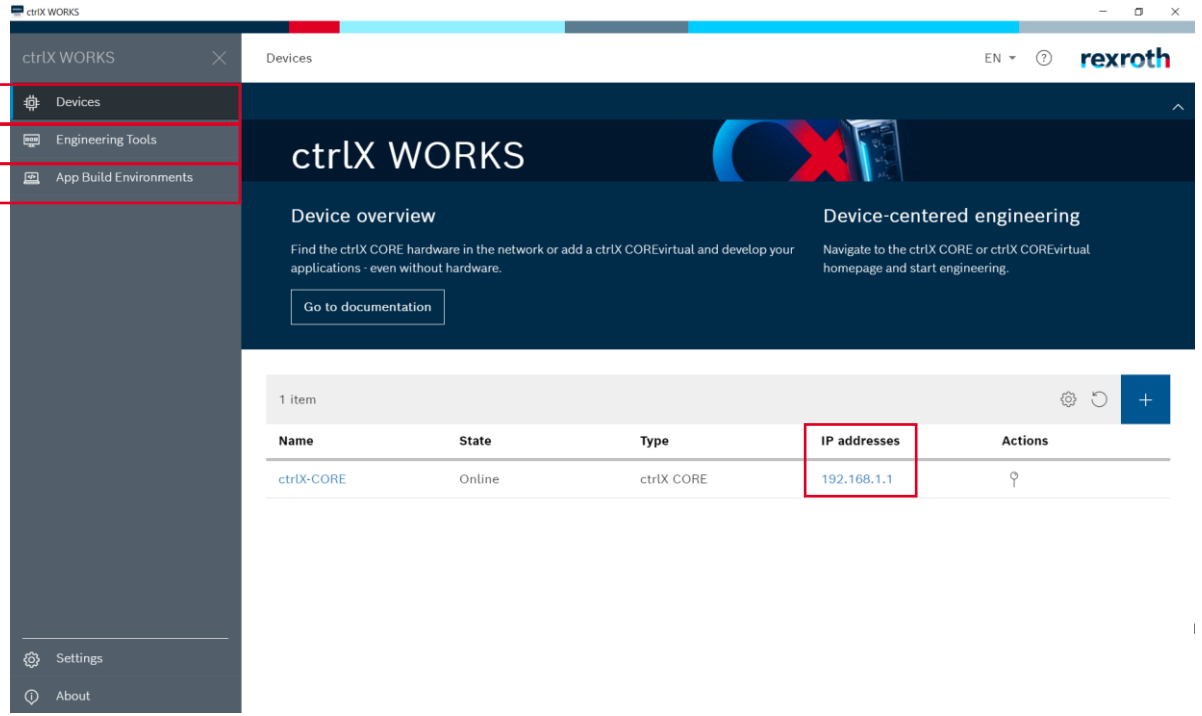
1. Open the software ctrlX WORKS on Windows. A ctrlX CORE is shown in the table “Devices” after it was identified in the connected network. To open the start page of the control, click on the device IP address (192.168.1.1).

ctrlX WORKS

Devices
Number of listed ctrlX CORE and ctrlX CORE Virtual controls

Engineering Tools
Provides an overview of all stand-alone Windows applications in the ctrlX AUTOMATION environment

App Build Environments
Provides the option to automatically create Linux build environments on a Windows PC to develop ctrlX CORE apps in the ctrlX AUTOMATION environment.



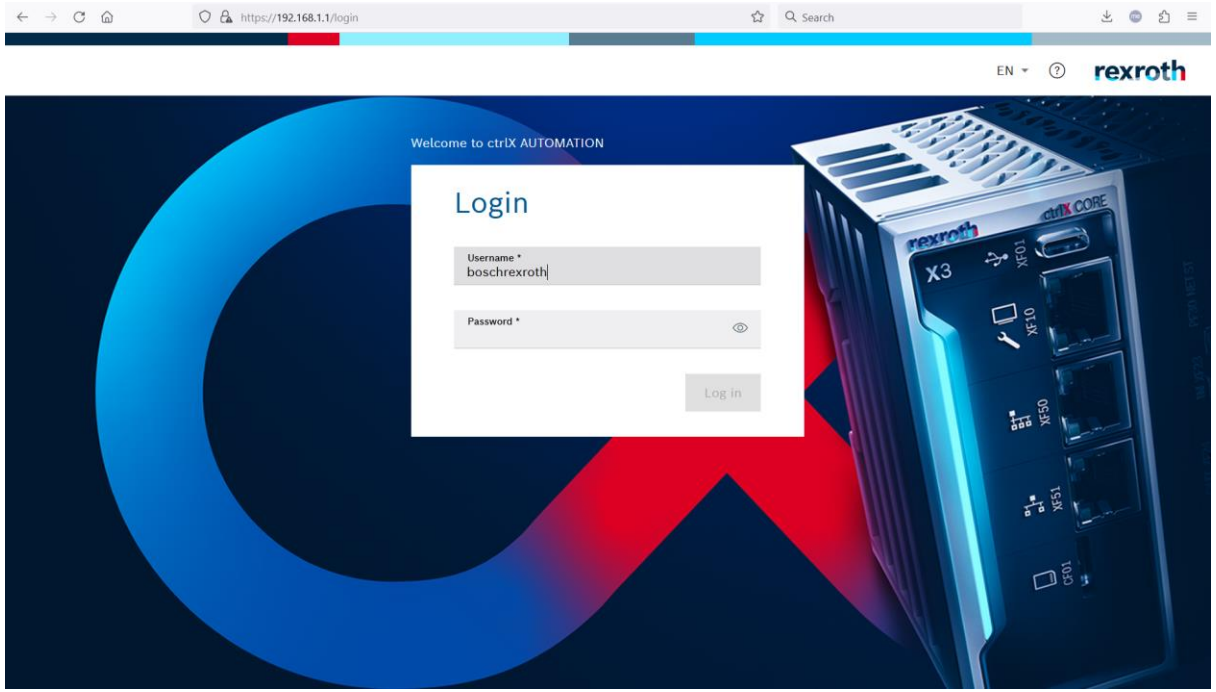
Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

2. A web browser will open the Login page of the ctrlX web-based user interface.

   Enter the Login details (Username: **boschrexroth**, Password: **B0schrexroth**).

ctrlX Web-Based User Interface – Login Page



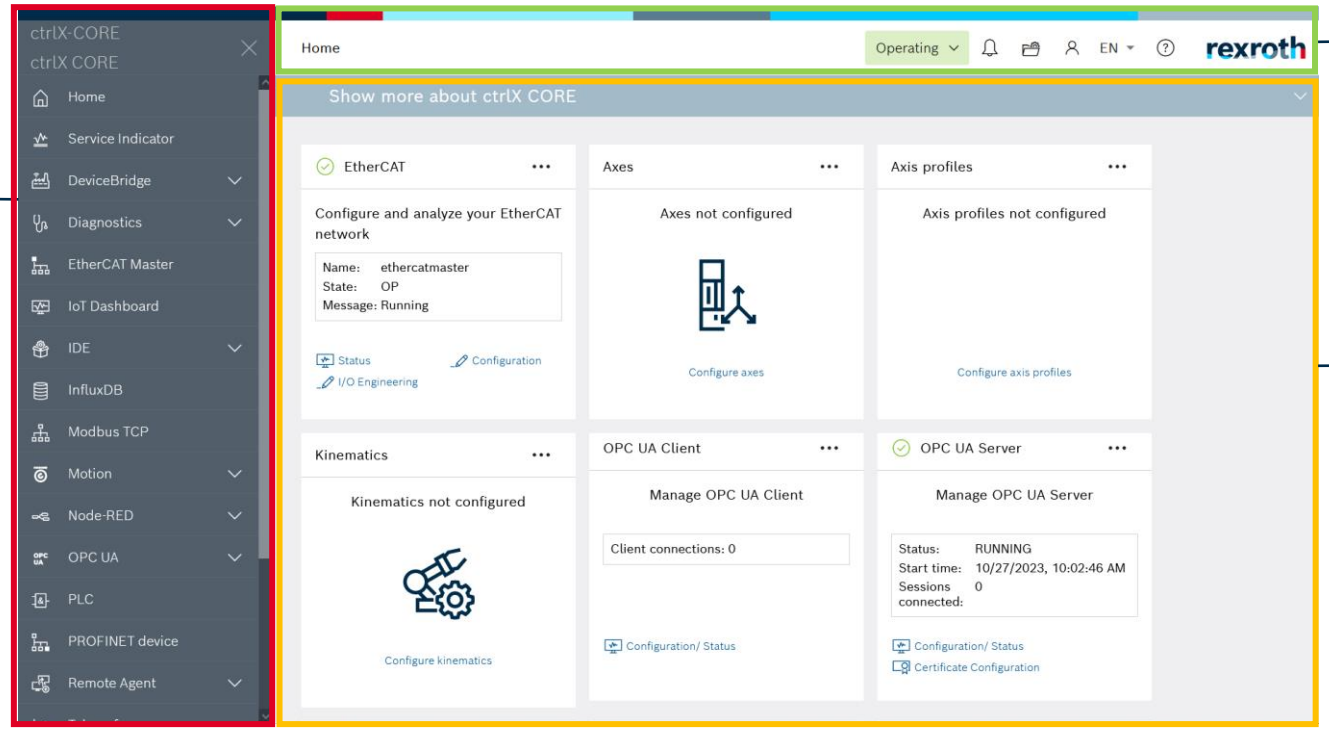
rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

3. After successfully logging in, you will be greeted with the Home Page of the ctrlX CORE Web Based User Interface.

ctrlX CORE Web-Based User Interface – Home Page



Side navigation/ sidebar
To navigate between Apps and General functions in the ctrlX CORE web interface

Header
To shows the status of the ctrlX CORE. manage the app data and other user settings

Workspace / Window
To configure the settings for the selected Apps or other functions

rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

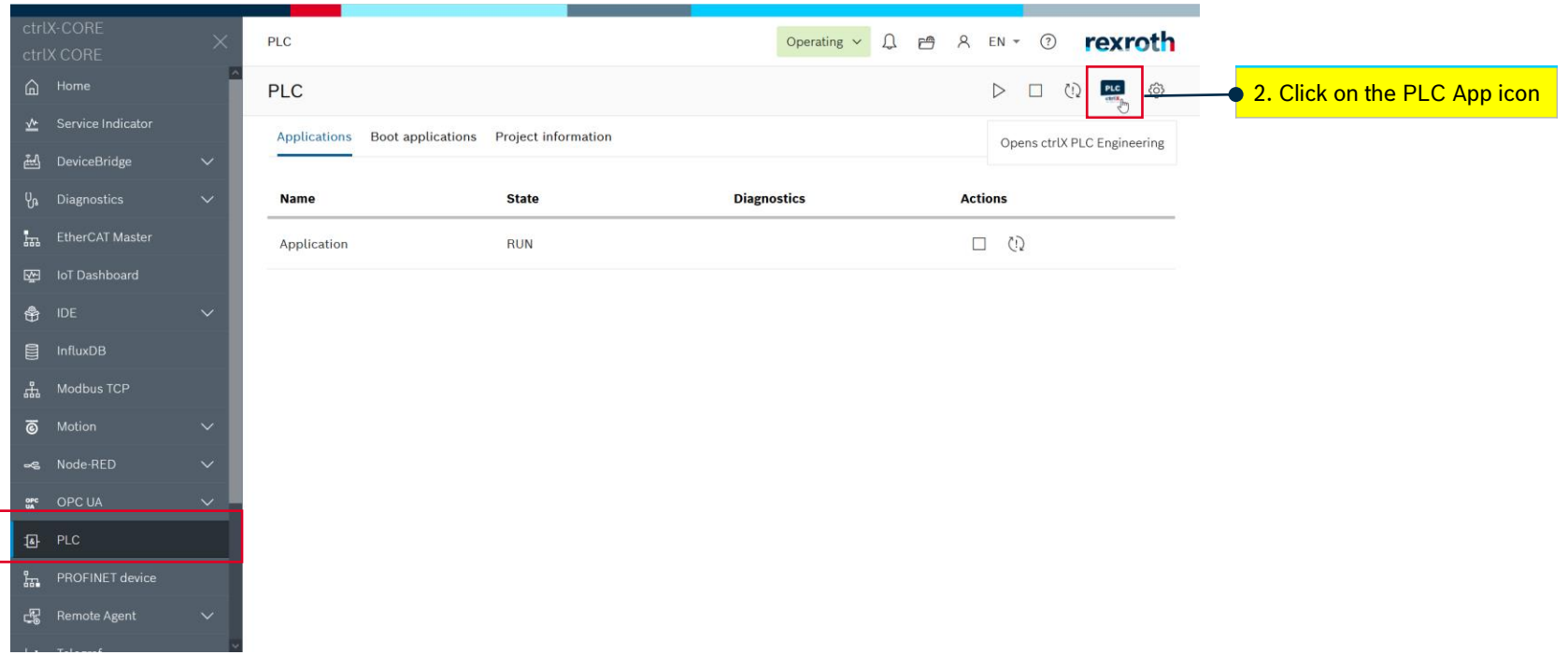
4. On the Sidebar, click on the PLC App, then click on the ctrlX PLC App icon.

   It will open the software tool **ctrlX PLC Engineering** to create and manage your PLC project.

ctrlX PLC App

Information about the ctrlX PLC App can be found online:

- ctrlX PLC App, Application Manual



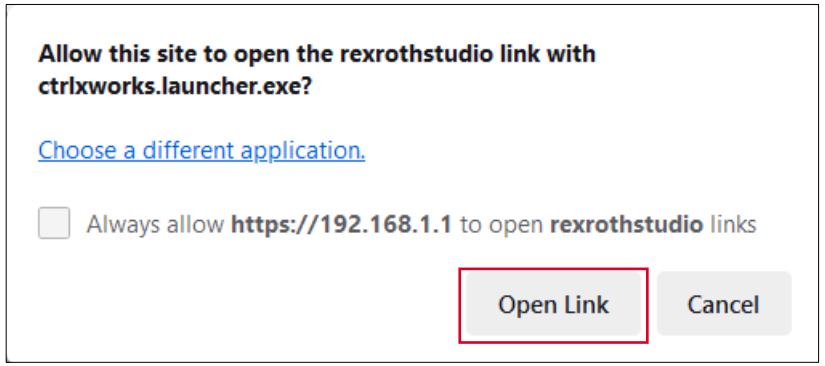
rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

5. Click on “Open Link“ in the popup message and ctrlX PLC Engineering will start to load.

ctrlX PLC Engineering



rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

6. Once ctrlX PLC Engineering have been loaded, you will view the PLC Engineering programming interface.

ctrlX PLC Engineering

In a “Standard project”, ctrlX PLC Engineering automatically creates the project with the project node in the device tree. The “PLC Logic” node contains the following objects and sub nodes:-

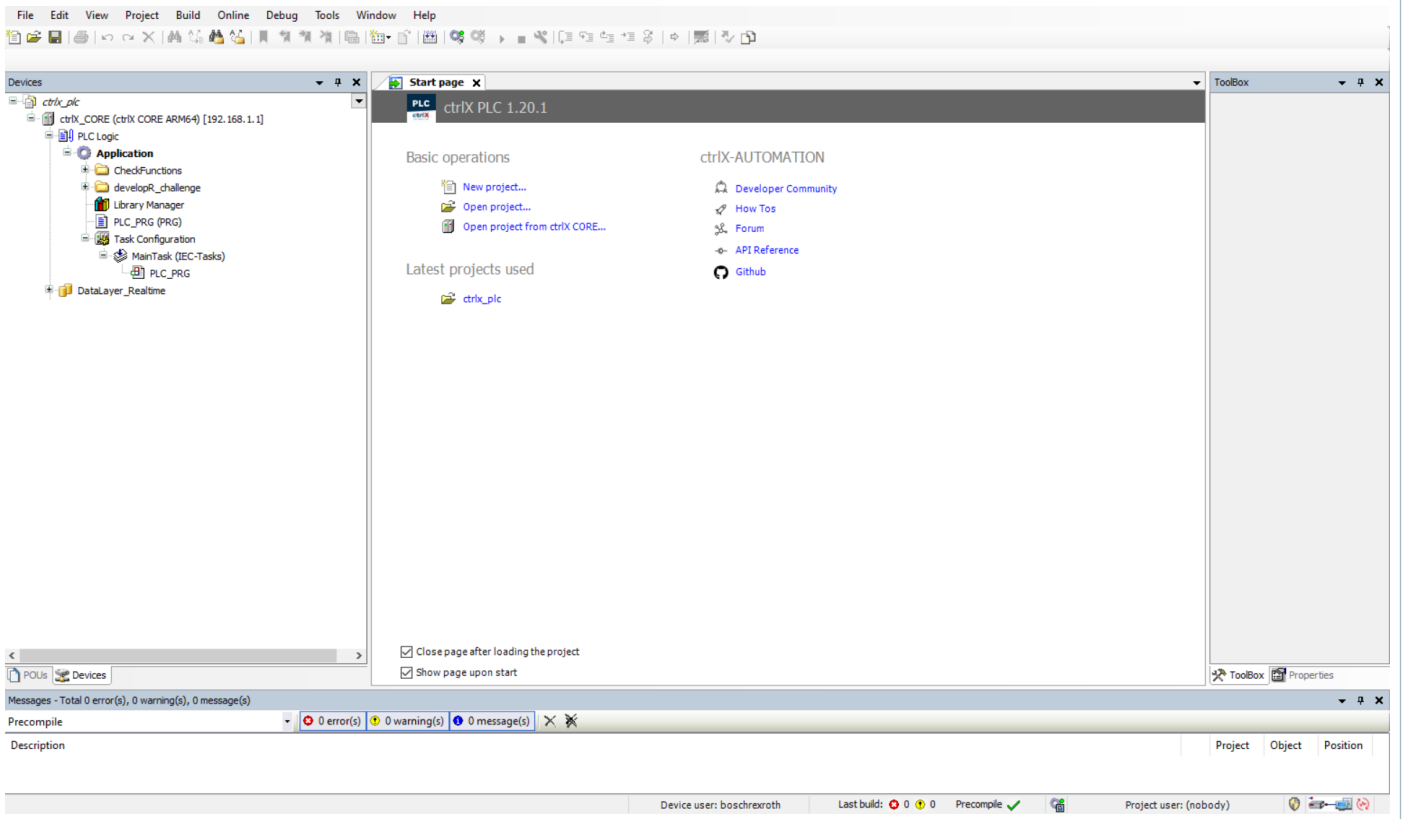
Application

Library Manager

- The library manager automatically receives the libraries, the selected device requires.

PLC_PRG (PRG)

- Standard POU (Program Organization Unit)
- If a correct code is added to the “PLC_PRG”, the POU can be loaded to the control and executed on the control without requiring other programming objects.



rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

6. Once ctrlX PLC Engineering have been loaded, you will view the PLC Engineering programming interface.

ctrlX PLC Engineering

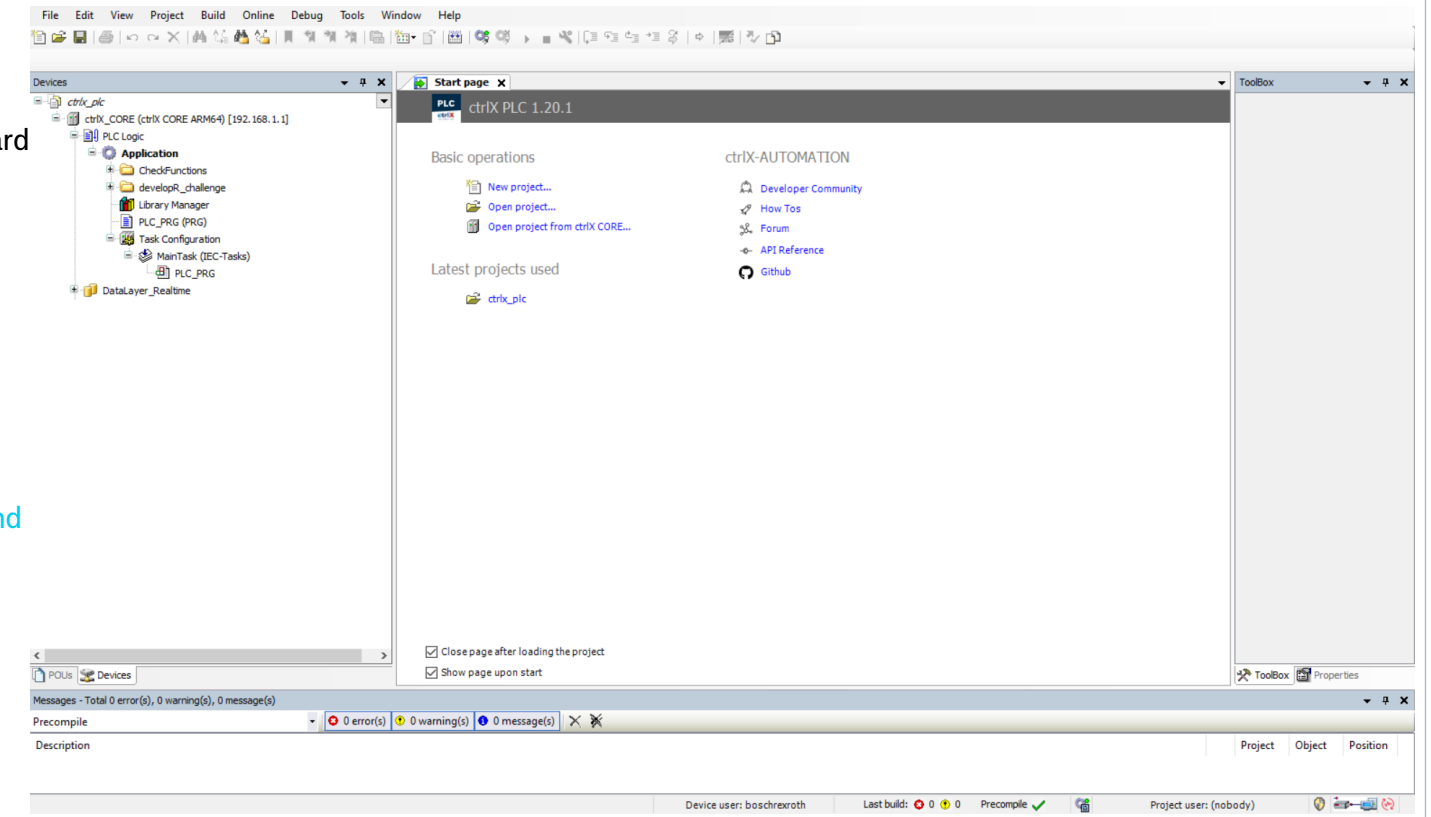
Task Configuration

- Defines the “MainTask” for processing of the standard POU “PLC_PRG”

DataLayer_Realtime

- The Data Layer on ctrlX devices facilitates the exchange of real-time data from EtherCAT I/O.

Information about the ctrlX PLC Engineering can be found online: ctrlX PLC Engineering, Application Manual



rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

Steps

7. The Data Layer exchanges real-time data from EtherCAT I/O and used by ctrlX PLC Engineering to include I/O points in the PLC project.

ctrlX I/O

EtherCAT Bus Coupler XB-EC-12

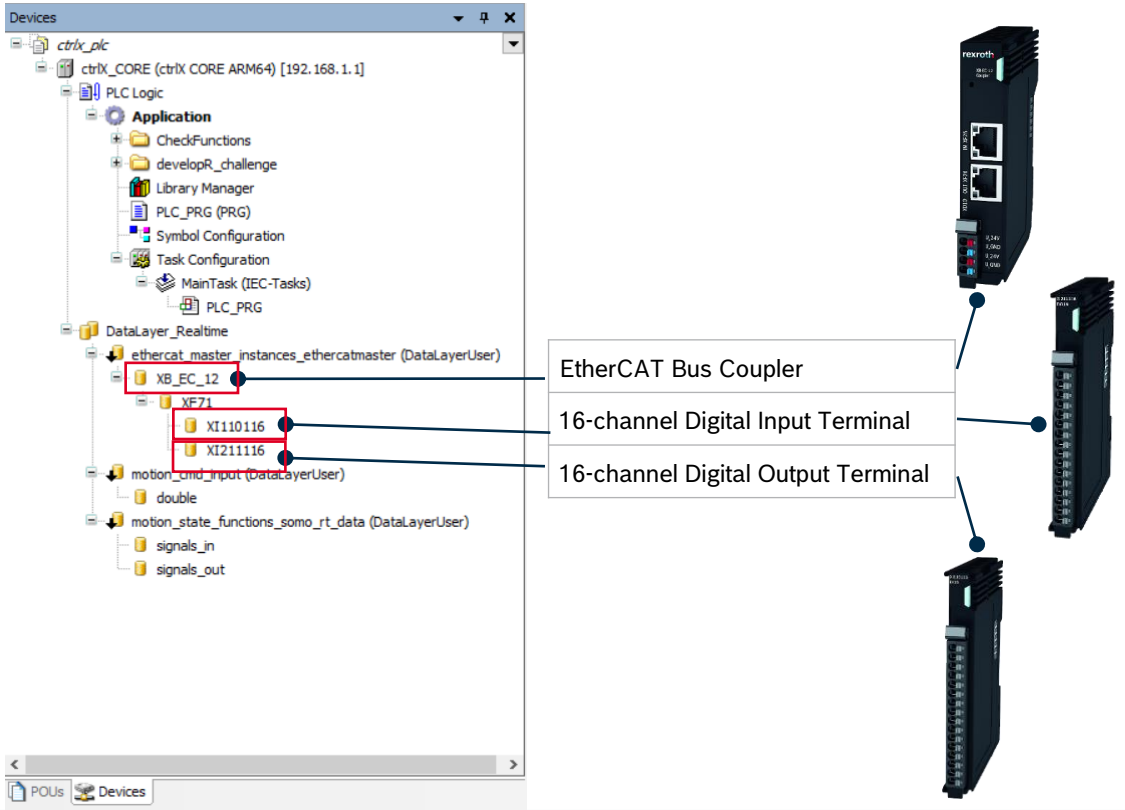
- The bus coupler connects the EtherCAT network and the ctrlX I/O system. The bus coupler supplies the connected I/O modules with the logic voltage UL and the peripheral voltage UP.

16-channel Digital Input Terminal XI110116

- The digital input terminal is used to detect binary 24 V control signals in a ctrlX I/O station. The terminal has 16 channels in a 1-wire technique.

16-channel Digital Output Terminal XI211116

- The digital output terminal is used to output binary 24 V control signals in a ctrlX I/O station. The terminal has 16 channels in a 1-wire technique.



rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

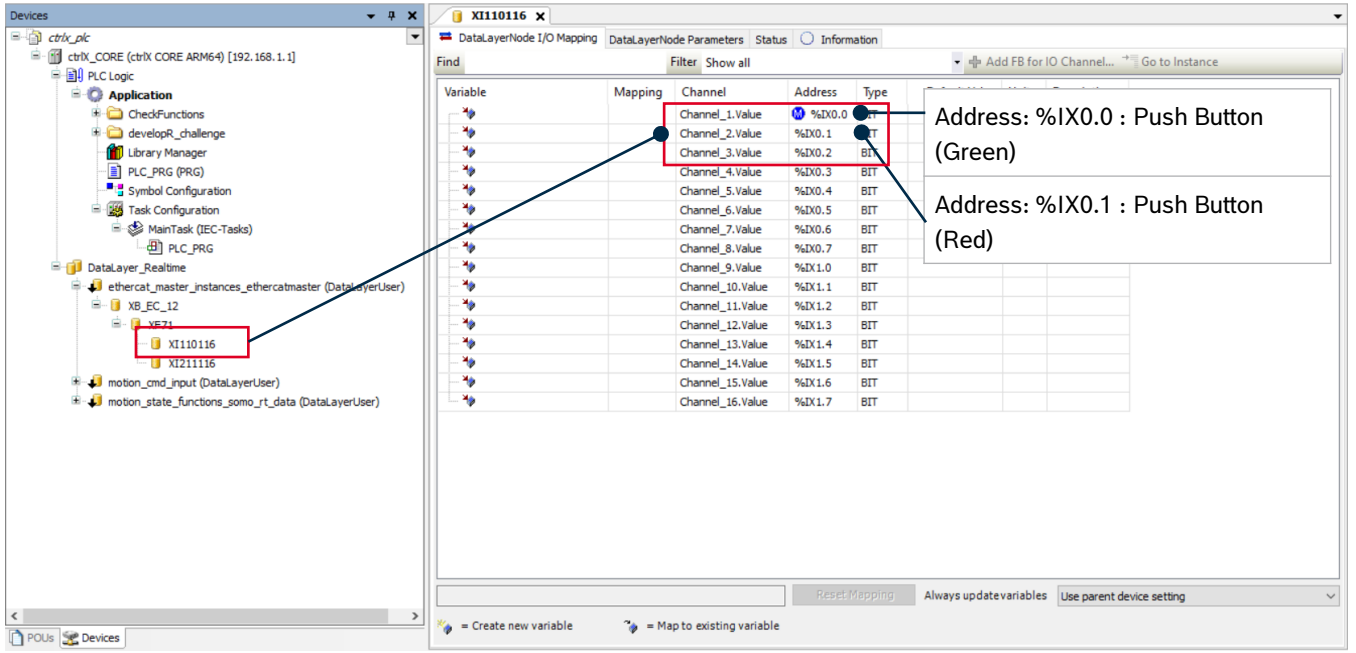
Steps

8. If data from the Data Layer real-time is to be processed in the PLC, they have to be mapped as input values (%I).

ctrlX I/O Digital Input

- The integration of PLC-specific data as real-time data into the PLC project is realized via Global Variable Lists (GVL), which contain the data to be exchanged.
- Channel 1 and 2 of the Digital Input terminal is pre-wired to 2 input elements:
  - Push Button (Green)
  - Push Button (Red)

Information about the ctrlX I/O Digital Input Terminal can be found online: ctrlX I/O, Digital Input Terminal, 16-channel



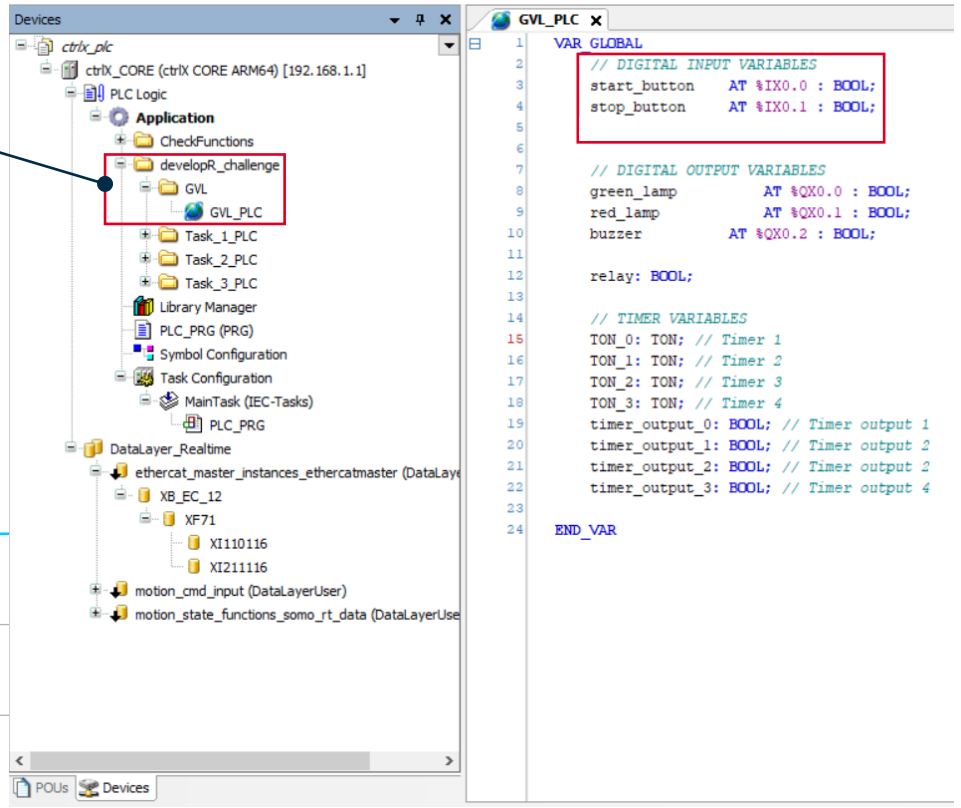
rexroth
A Bosch Company

Steps

8. If data from the Data Layer real-time is to be processed in the PLC, they have to be mapped as input values (%I).

ctrlX I/O Digital Input

- The GVL GVL_PLC is located within the "**developR_challenge**" folder
- The inputs are assigned with Variables via the Global Variable Lists (GVL), which contain the data to be exchanged.



Designation	Variable	Channel	Address	Type
Push Button (Green)	start_button	Channel_1.Value	%IX0.0	BOOL
Push Button (Red)	stop_button	Channel_2.Value	%IX0.1	BOOL

rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Setting up ctrlX PLC Engineering

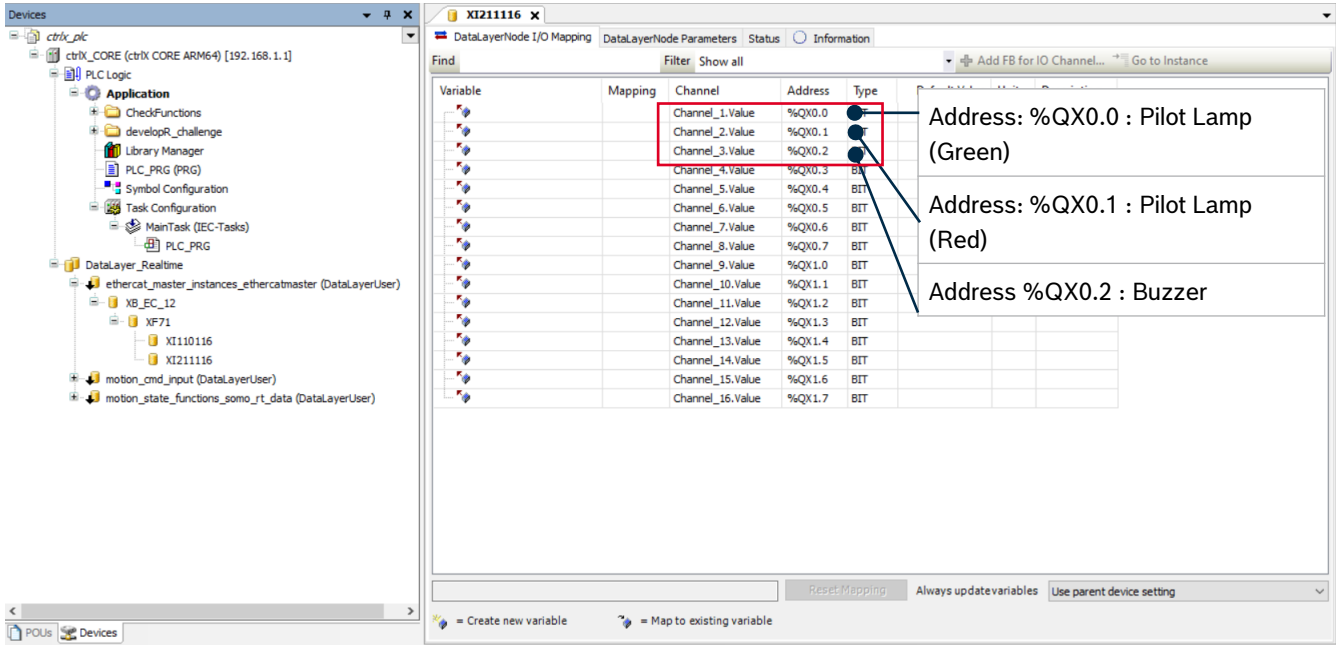
Steps

9. If PLC data is to be made known on the Data Layer real-time, the data is to be mapped to output values (%Q).

ctrlX I/O Digital Output

- The integration of PLC-specific data as real-time data into the PLC project is realized via Global Variable Lists (GVL), which contain the data to be exchanged.
- Channel 1, 2 and 3 of the Digital Output terminal is pre-wired to 3 output elements:
  - Pilot Lamp (Green)
  - Pilot Lamp (Red)
  - Buzzer

Information about the ctrlX I/O Digital Output Terminal can be found online: ctrlX I/O, Digital Output Terminal, 16-channel



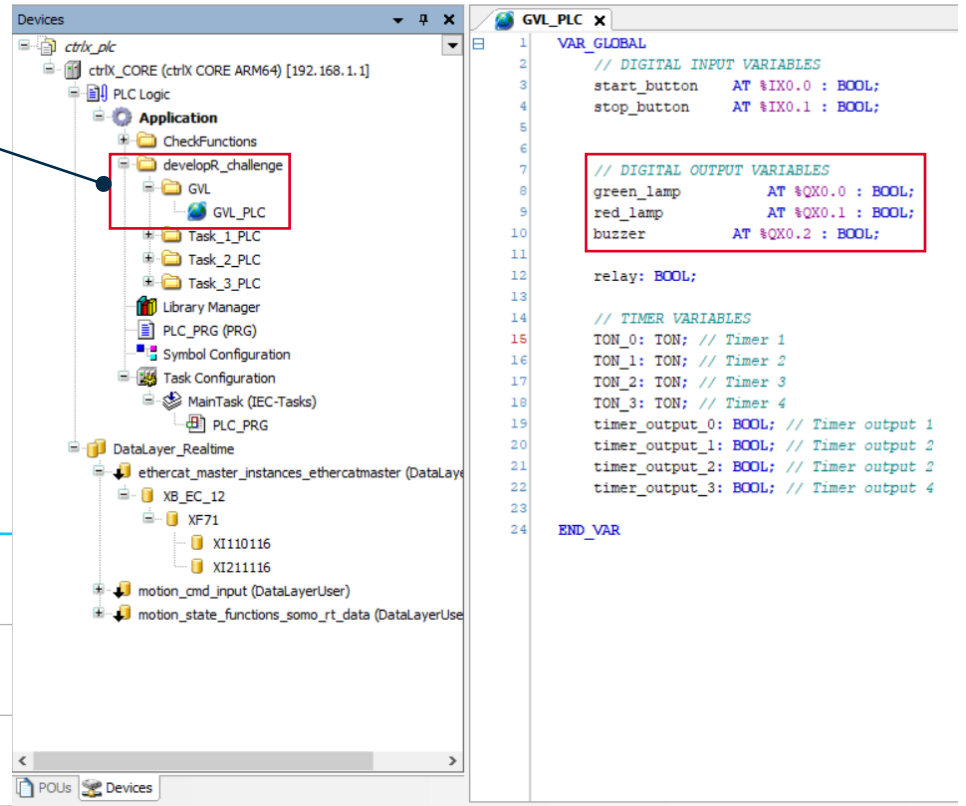
rexroth
A Bosch Company

Steps

9. If PLC data is to be made known on the Data Layer real-time, the data is to be mapped to output values (%Q).

ctrlX I/O Digital Output

- The GVL GVL_PLC is located within the "**developR_challenge**" folder
- The outputs are assigned with Variables via the Global Variable Lists (GVL), which contain the data to be exchanged.



Designation	Variable	Channel	Address	Type
Pilot Lamp (Green)	green_lamp	Channel_1.Value	%QX0.0	BOOL
Pilot Lamp (Red)	red_lamp	Channel_2.Value	%QX0.1	BOOL
Buzzer	buzzer	Channel_3.Value	%QX0.2	BOOL

rexroth
A Bosch Company

Challenge 01: PLC App

Task 01

rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Task 01

Description

You're given a simple control task. A conveyor system needs to be turned on when a Start button is pressed, and the conveyor stops when a Stop button is pressed. When the system is on, a green light and a buzzer audible sound should indicate its status. When the system is off, a red light should indicate its status.

Task

This task will test your understanding on latching circuits in PLC programming. Solve the problem in the Ladder Logic Diagram (LD) PLC Program in the CtrlX Core PLC Engineering to accomplish this task. Use appropriate symbols and connections.

rexroth
A Bosch Company

Safety instructions for the project exercise

In order to ensure the operational capability and to identify the possible hazards of machines and systems, the safety regulations must be observed before and during the order execution.

The ctrlX CORE may only be operated in technically perfect condition. The intended use, performance data and operating conditions may not be changed. No protective devices/components may be deactivated.

In case of emergency, failure or other irregularities:

- Before connecting or disconnecting any electrical components, ensure that the power to the ctrlX CORE unit and associated equipment is turned off.

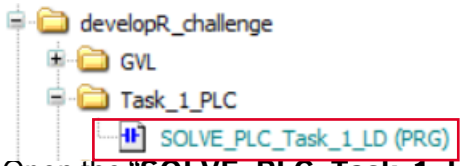
Challenge 01: ctrlX PLC App | Task 01

Steps

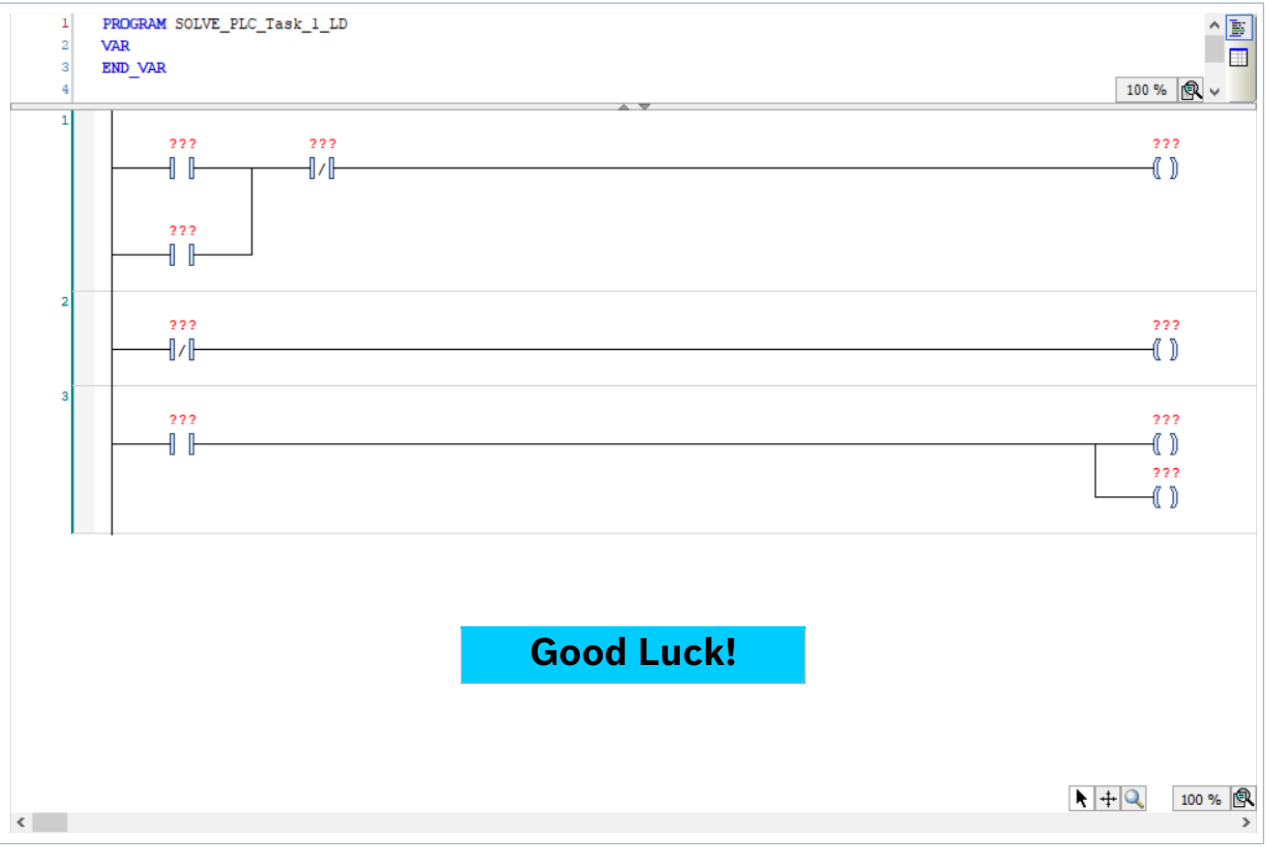
1. The task to be completed is located inside the “**developR_challenge**” folder in the Device tree.

Where to find Task 1 PLC Program (POU)

- The POU for Task 1 is located inside “**Task_1_PLC**” folder



- Open the “**SOLVE_PLC_Task_1_LD (PRG)**”
- This will open a POU editor (right photo)
- The PLC program is created with Ladder Logic Diagram (LD) language based on IEC 61131-3 standard developed by the International Electrotechnical Commission (IEC).
- The PLC program however is not in working condition and requires your help to solve it.
- Hint: Use the correct Input and Output variables from **GVL_PLC** global variables list
- From time to time, make sure to Save your program (with Ctrl + S)



rexroth
A Bosch Company

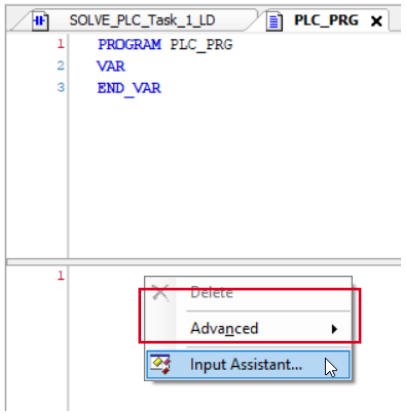
Challenge 01: ctrlX PLC App | Task 01

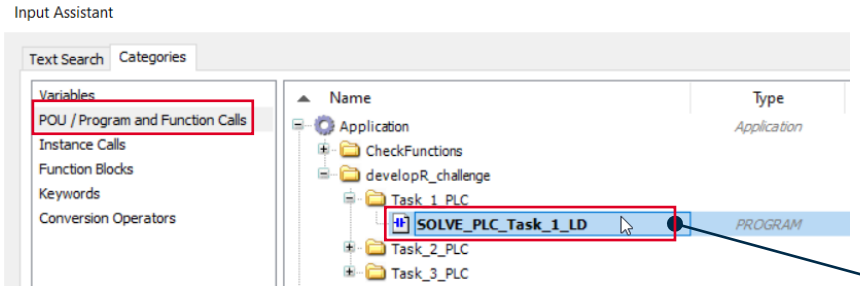
Steps

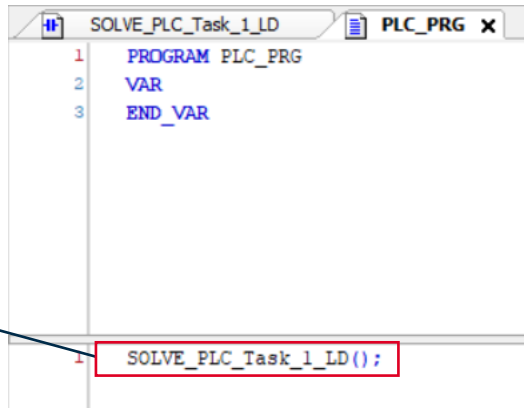
2. Once you have completed Task 1 and ready to download the PLC Program to the ctrlX CORE, follow the steps below.

How to insert Task 1 PLC Program (POU) into PLC_PRG

- Open “**PLC_PRG**” PLC_PRG (PRG) in the Device tree
- Right click on the empty page of the POU editor
- Select “**Input Assistant…**”
- Under the POU / Program and Function Calls Categories, select the PLC Program **“SOLVE_PLC_Task_1_LD”** and click **OK**
- **Important!** In the POU editor of PLC_PRG, there should be the name of the program which you selected. This means that the selected program will be uploaded to the controller. The name of the program has to match with the name of the POU including **();**







rexroth
A Bosch Company

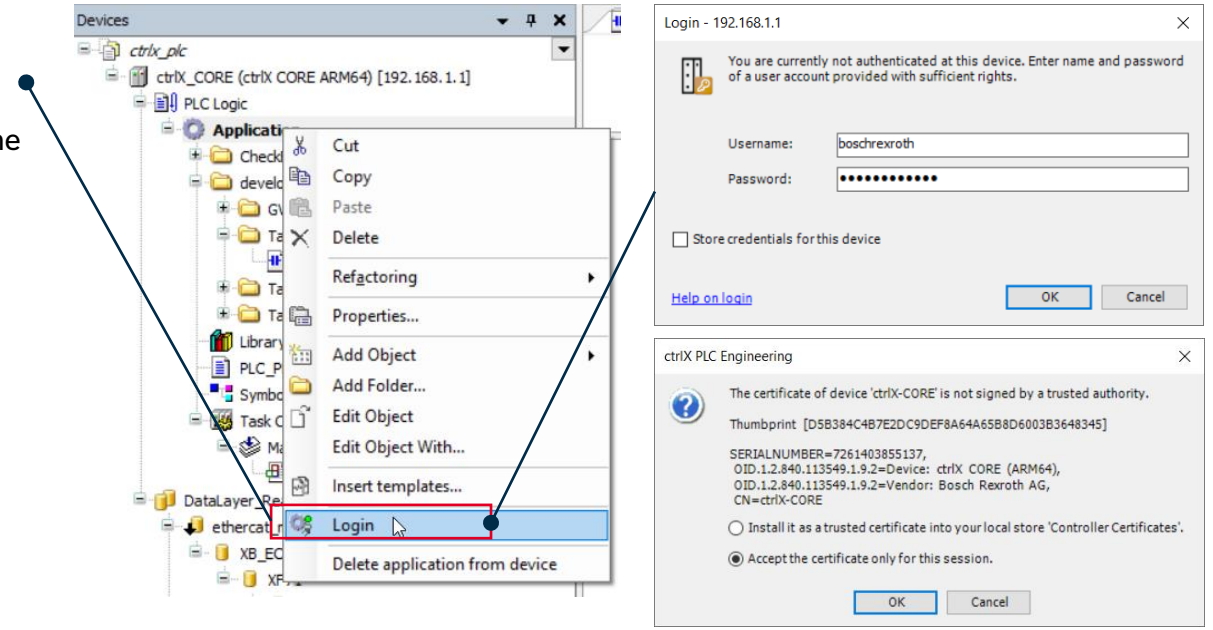
Challenge 01: ctrlX PLC App | Task 01

Steps

2. Once you have completed Task 1 and ready to download the PLC Program to the ctrlX CORE, follow the steps below.

How to download Task 1 PLC Program (POU) to the ctrlX CORE

- In the Device tree, right click on the “**Application**” object
- Click on **“Login”**
- This will open a popup message requesting to Login to the control. Enter the **Username: boschrexroth** and **Password: B0schrexroth**
- Another popup message will open requesting to trust the Certificate of the device, click **OK**



rexroth
A Bosch Company

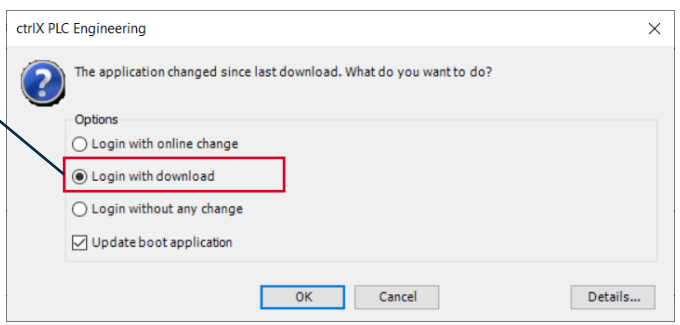
Challenge 01: ctrlX PLC App | Task 01

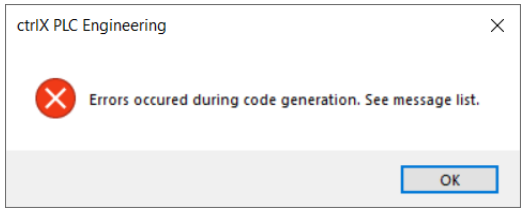
Steps

2. Once you have completed Task 1 and ready to download the PLC Program to the ctrlX CORE, follow the steps below.

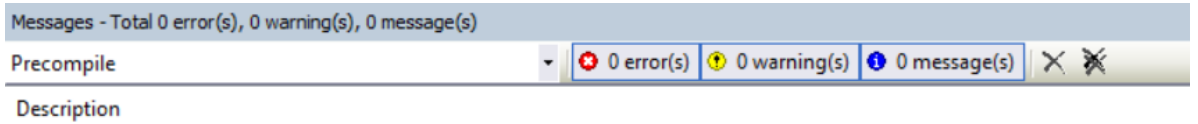
How to download Task 1 PLC Program (POU) to the ctrlX CORE

- In the next popup message, select the option: **Login with download** and click **OK**
- The PLC program will be compiled and build. Only when there are no errors that the download will start.
- If there are any errors, you will see a popup message below





- Look at the bottom section of PLC Engineering window for the error messages



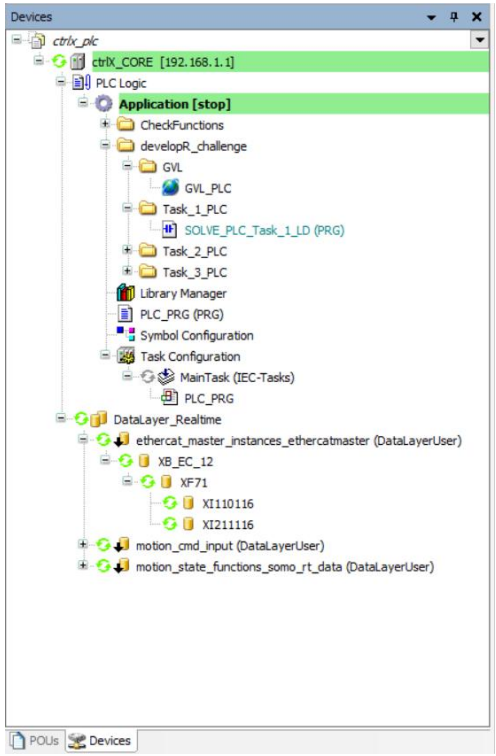
rexroth
A Bosch Company

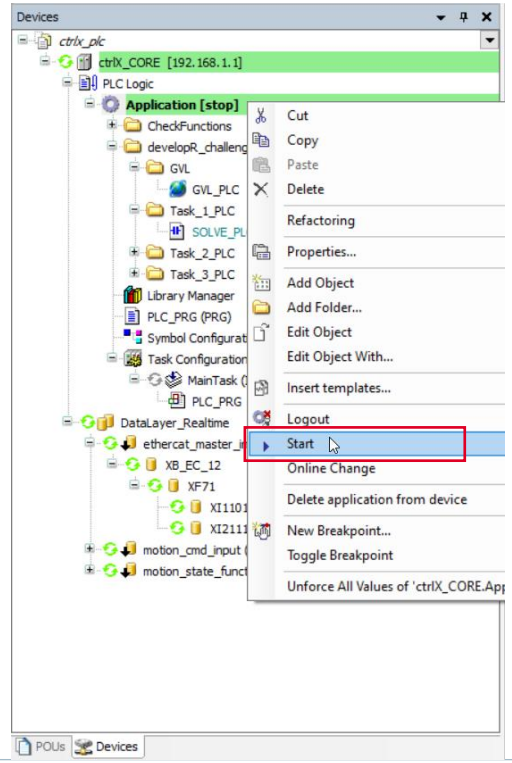
Steps

2. Once you have completed Task 1 and ready to download the PLC Program to the ctrlX CORE, follow the steps below.

How to download Task 1 PLC Program (POU) to the ctrlX CORE

- If the download is successful, your Application object will be highlighted in Green and a **[stop]** status will be displayed.
- This means that the PLC is in Stop mode and no PLC program is running in this mode.
- To change the mode, you can right click on the "**Application**" object again and Click on "**Start**"





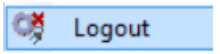
rexroth
A Bosch Company

Challenge 01: ctrlX PLC App | Task 01

Steps

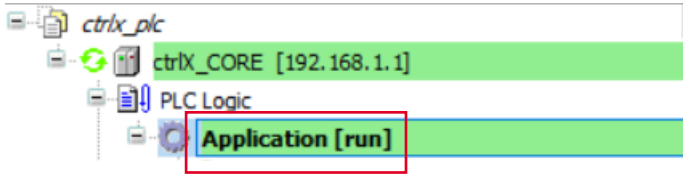
2. Once you have completed Task 1 and ready to download the PLC Program to the ctrlX CORE, follow the steps below.

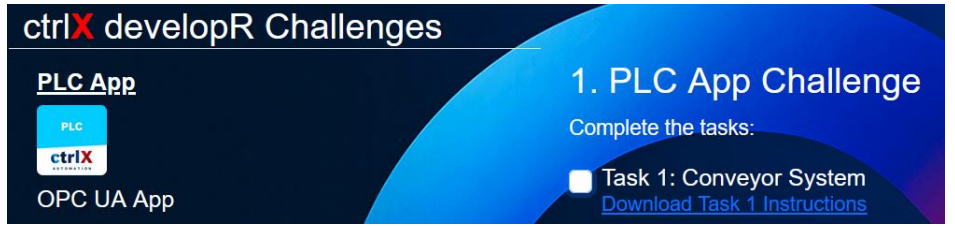
How to download Task 1 PLC Program (POU) to the ctrlX CORE

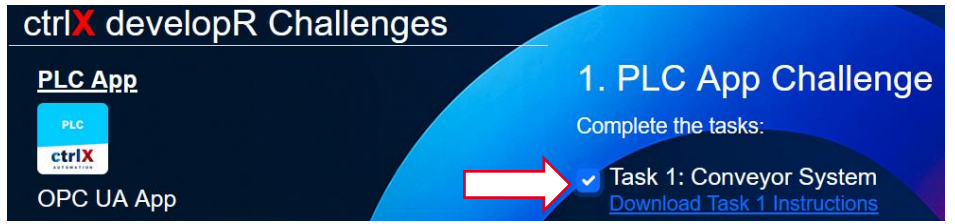
- This will change the mode from **[stop]** to **[run]**
- You can test your program against the Task description
- Once it satisfies the task requirements, confirm that you have completed the task by informing the available instructor for verification
- In the ctrlX developR challenge website, under the PLC App challenge section, tick [✓] the Task 1 checkbox
- If you are done with testing, you can logout by right clicking the Application object and select Logout 

Congratulations on completing Task 1!

Proceed to Task 2!







rexroth
A Bosch Company