
Getting started with the ST-PLC App for ladder logic programming

Introduction

The ST-PLC App allows drawing a ladder logic program for the X-NUCLEO-PLC01A1 expansion board, compile it and send the list of instructions to the PLC via Wi-Fi.

The ladder logic is the main programming language for industrial programmable logic controllers (PLC). It is a visual and graphical language which can generate low level code to drive ON/OFF utilities connected to the PLC outputs.

The ladder logic implemented in the ST-PLC App is based on primitive logic operators (AND, OR, NOT) and is regulated by the IEC 61131-3 standard.

The application is available for Windows 7, Android and iOS operating systems.

The application features:

- **Project design**
 - New project
 - Modify project
 - Duplicate project
 - Ladder design
- **PLC programming**
 - Ladder deploy
- **Diagnostics**
 - Device status
 - Connection settings

The ST-PLC App for mobiles uses Wi-Fi and tablet or smartphone storage space.

The application desktop version includes a self-hosted service that integrates the connection feature to the board via the TCP/IP protocol.

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1 Getting started

1.1 ST-PLC App startup

When the application starts, a splash screen and the following slides are shown.

Figure 1: ST-PLC App startup slide



Figure 2: ST-PLC App: expansion boards information window



To avoid the second slide appear at startup, the user can flag the "Don't show again" box, as indicated in the figure above.

1.2 ST-PLC App home page

The application home page contains a list of the most recent projects and commands to access other application features, such as **New Project** and **Connection settings**.

Figure 3: ST-PLC App New Project window

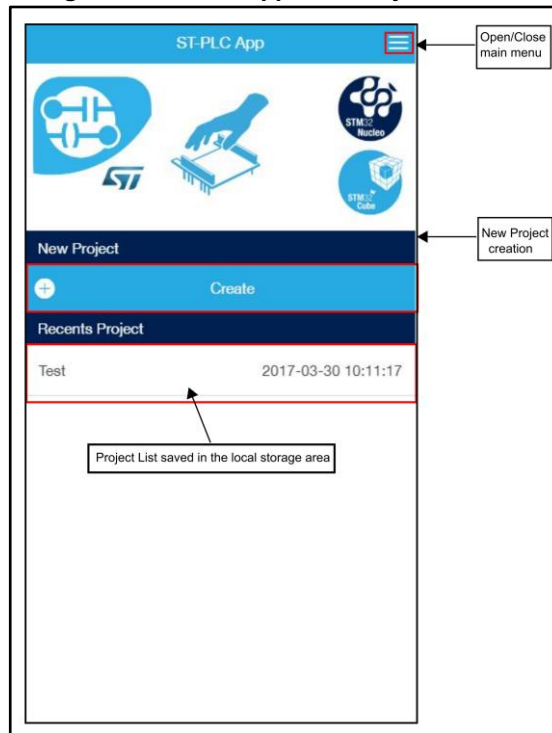
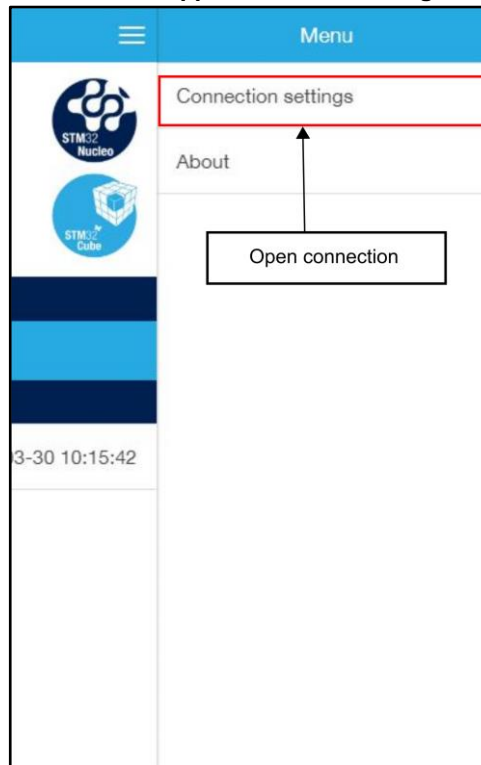


Figure 4: ST-PLC App Connection settings window



1.3 ST-PLC App project features

1.3.1 Create a new project

This feature is accessible from the application home page (**New Project** command).

Figure 5: ST-PLC App new project creation

To create a new project, the following information is required:

- **Project Name**
- Expansion board PLC configuration:
 - X-NUCLEO-PLC01A1
 - X-NUCLEO-PLC01A1+ X-NUCLEO-OUT01A1
 - X-NUCLEO-OUT01A1



To be valid, the project name must be unique.

After specifying the required parameters, the workspace for ladder design is arranged according to the selected configuration.

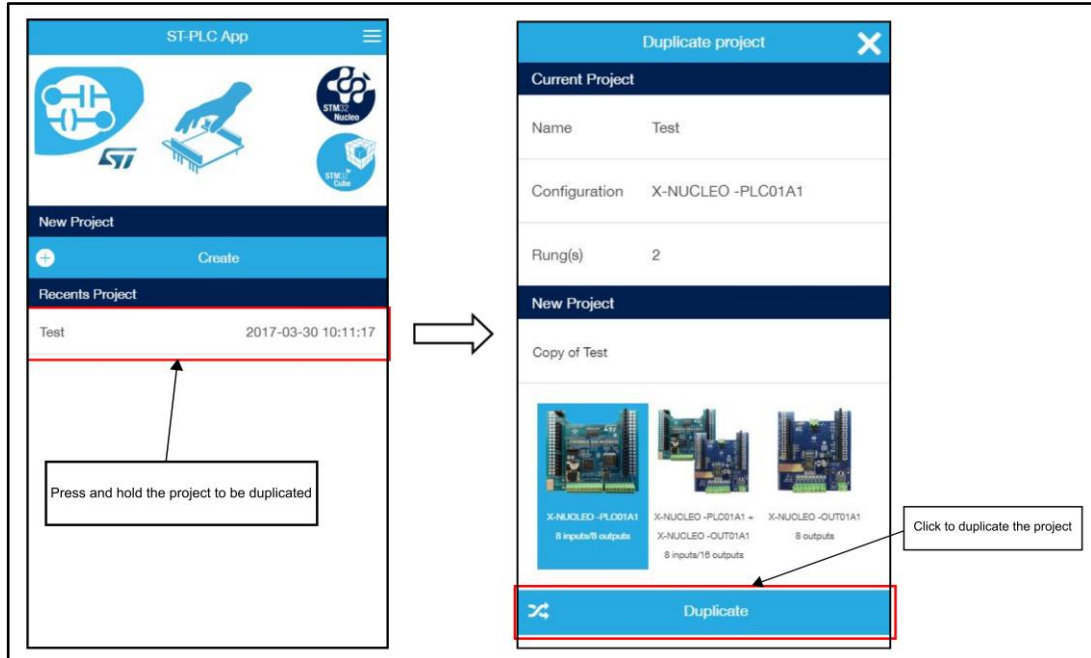
The **Confirm** command opens the project page.

1.3.2 Duplicate a project

This feature allows the user to copy the project into a new one.

To copy the project, press and hold the source project in the **Recent Project List** and click on the **Duplicate** command.

Figure 6: ST-PLC App new project creation

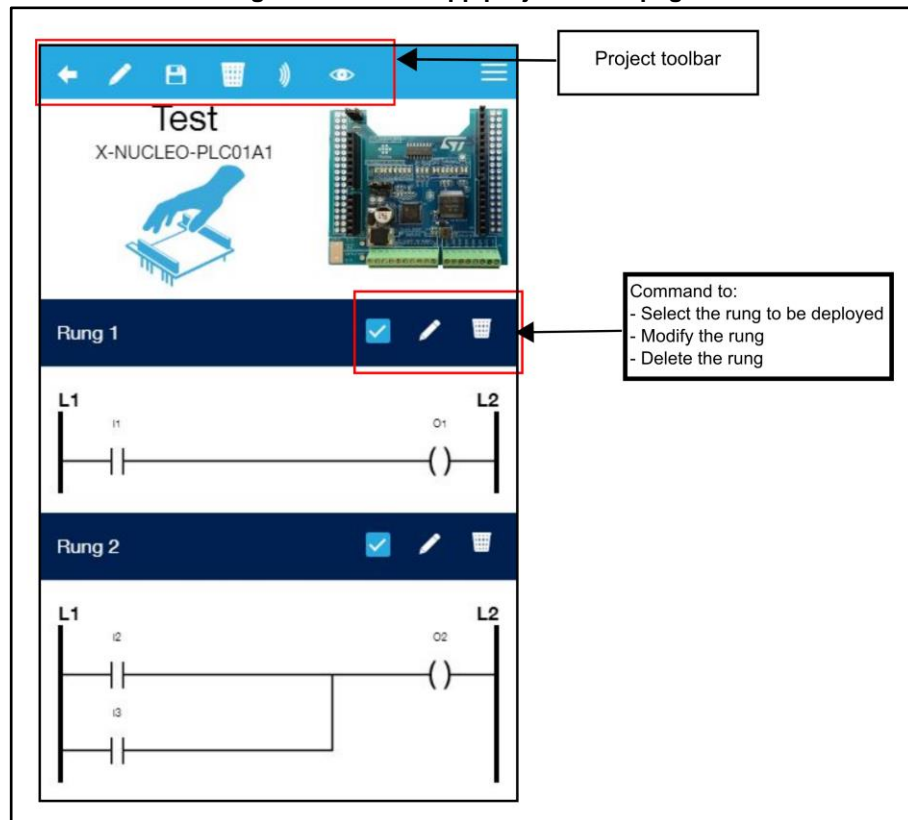


If the new project configuration has less inputs/outputs than the source project, a warning is shown to the user as some input/ outputs might not be available yet.

1.3.3 Project detail page

Once a project is selected or created in the home page, the application shows the project detail page.

Figure 7: ST-PLC App project detail page



The toolbar contains the following commands:



Close Project button to close the current project;



Modify Project Info button to allow the user to modify the project name;



Save button to confirm the project changes;



Delete Project button to delete the project from the local storage area;



Send to PLC button to perform ladder deployment to PLC;

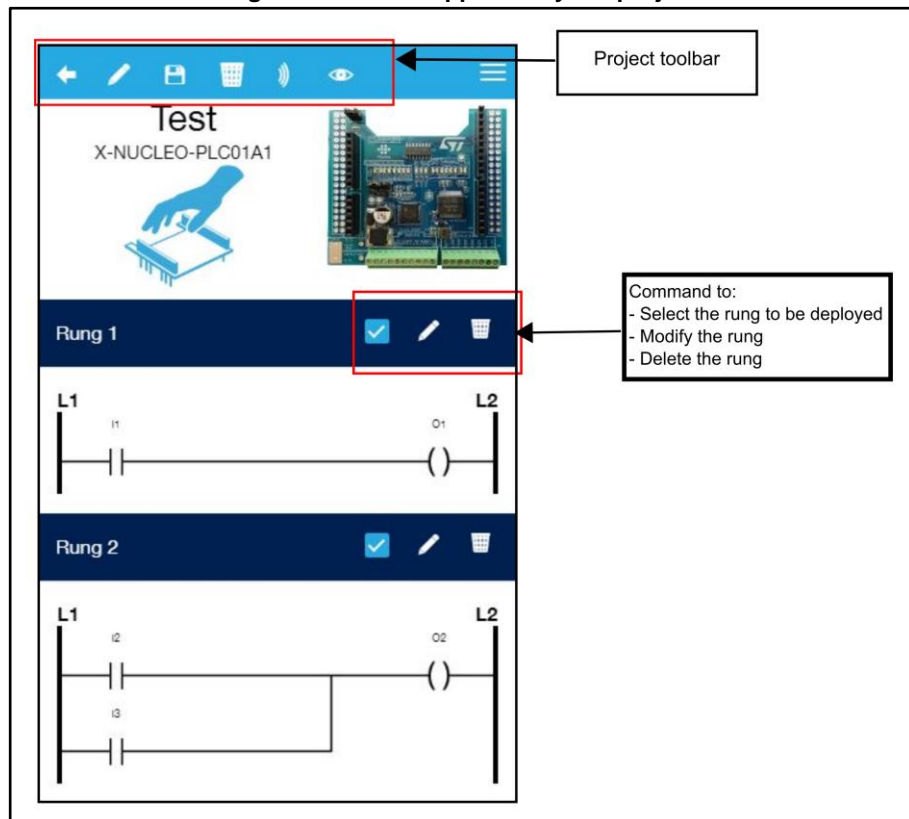


Show Summary Page button to show the summary page containing all the project rungs.

1.3.4 Modify a project

This function allows the user to modify the project name.

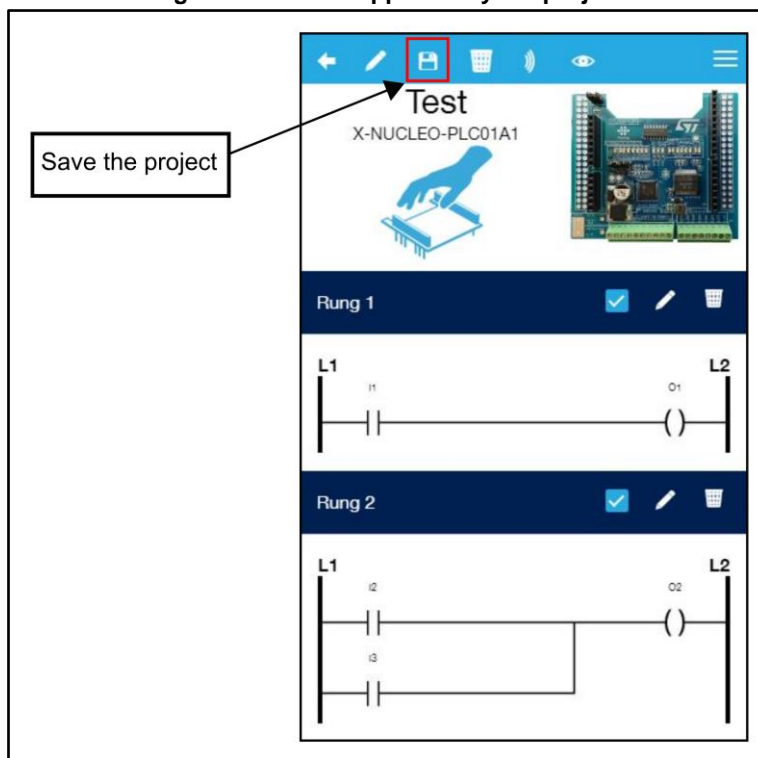
Figure 8: ST-PLC App: modify the project



1.3.5 Save a project

This function allows the user to save changes to the project.

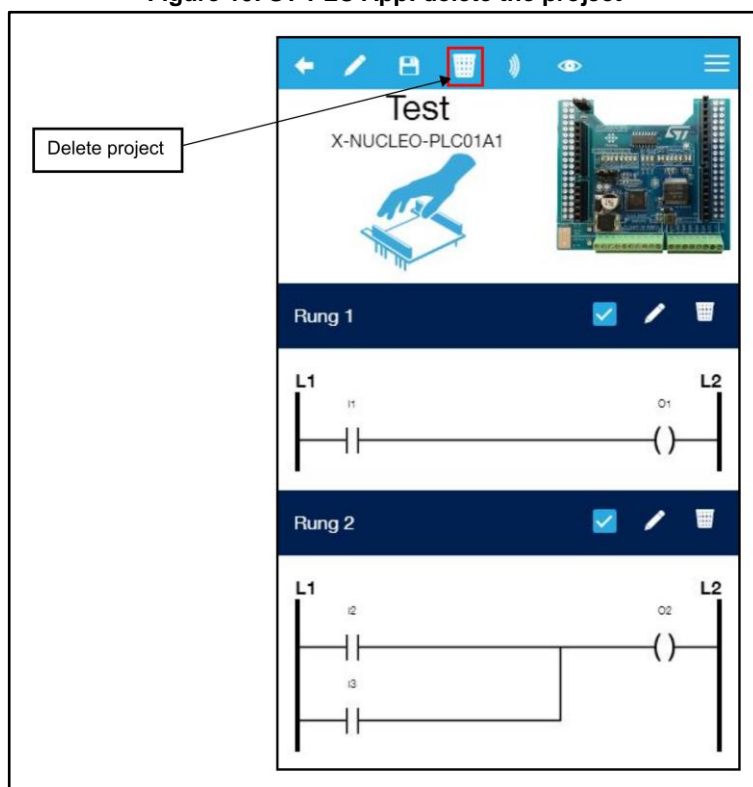
Figure 9: ST-PLC App: modify the project



1.3.6 Delete a project

This function allows the user to delete the current project.

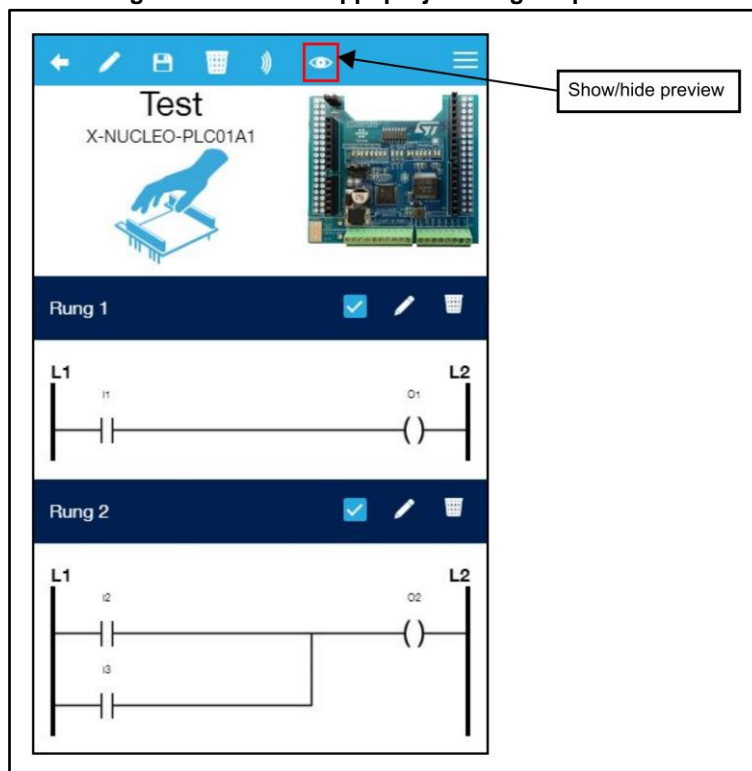
Figure 10: ST-PLC App: delete the project



1.3.7 Project preview

This function shows the overall project rung set.

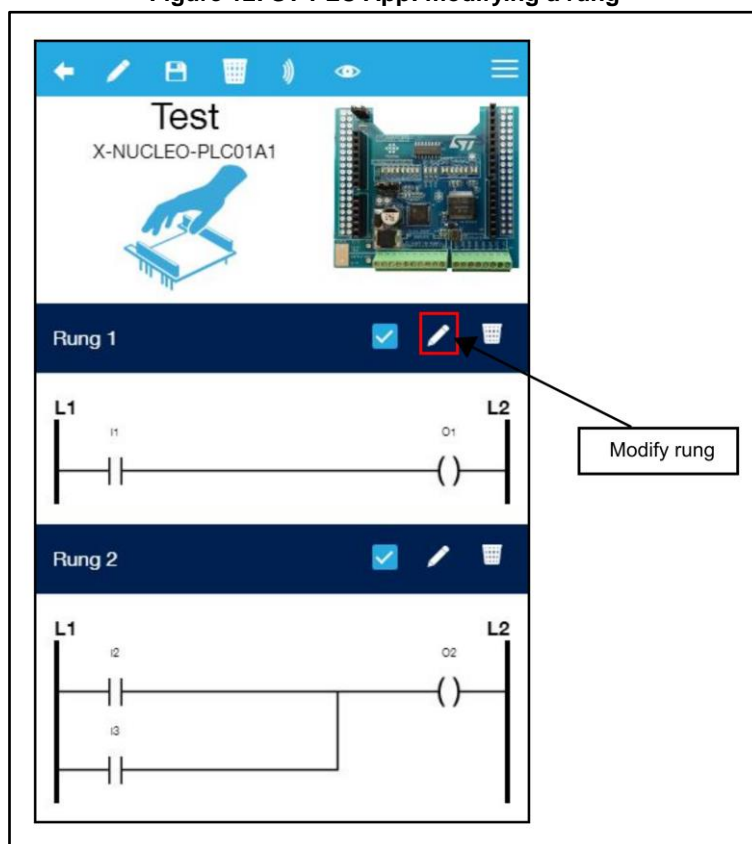
Figure 11: ST-PLC App: project rung set preview



1.3.8 Modify a rung

This function allows modifying an existing rung.

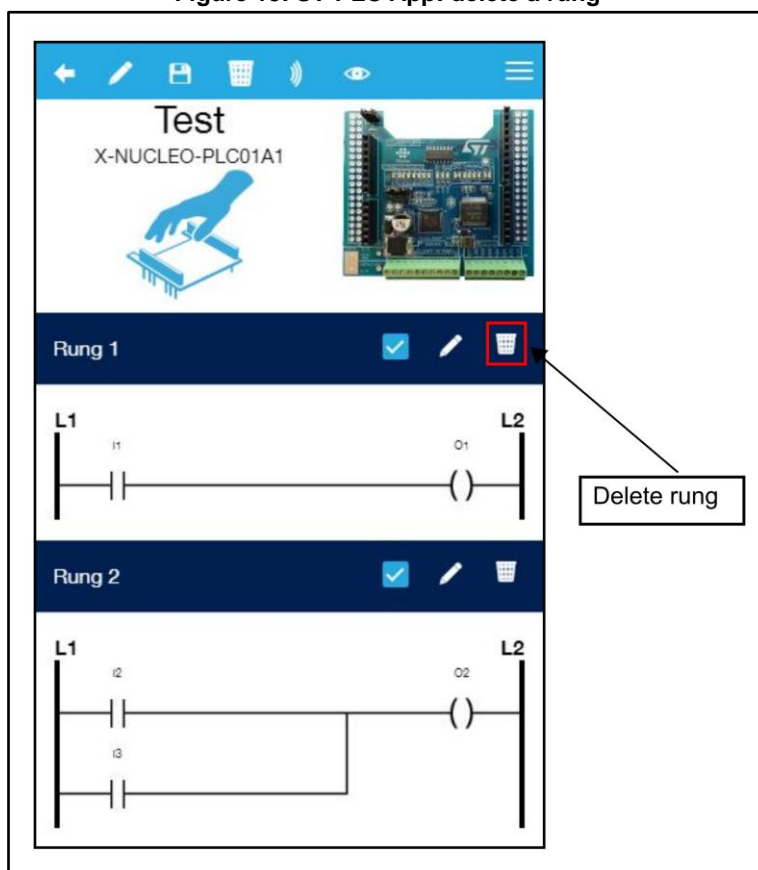
Figure 12: ST-PLC App: modifying a rung



1.3.9 Delete a rung

This function allows deleting an existing rung.

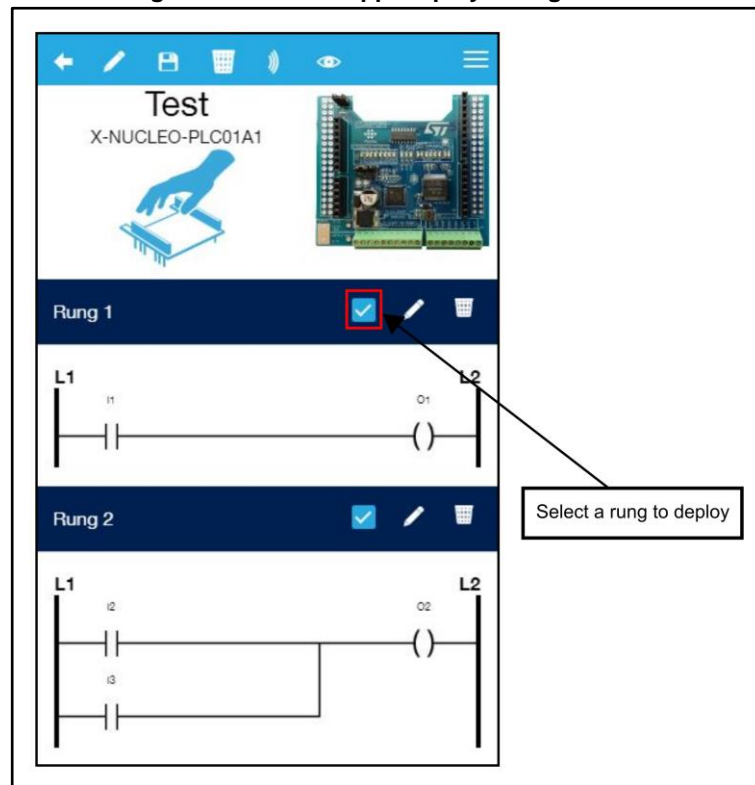
Figure 13: ST-PLC App: delete a rung



1.3.10 Deploy a rung

This feature allows flagging a rung to be deployed to PLC.

Figure 14: ST-PLC App: deploy a rung to PLC

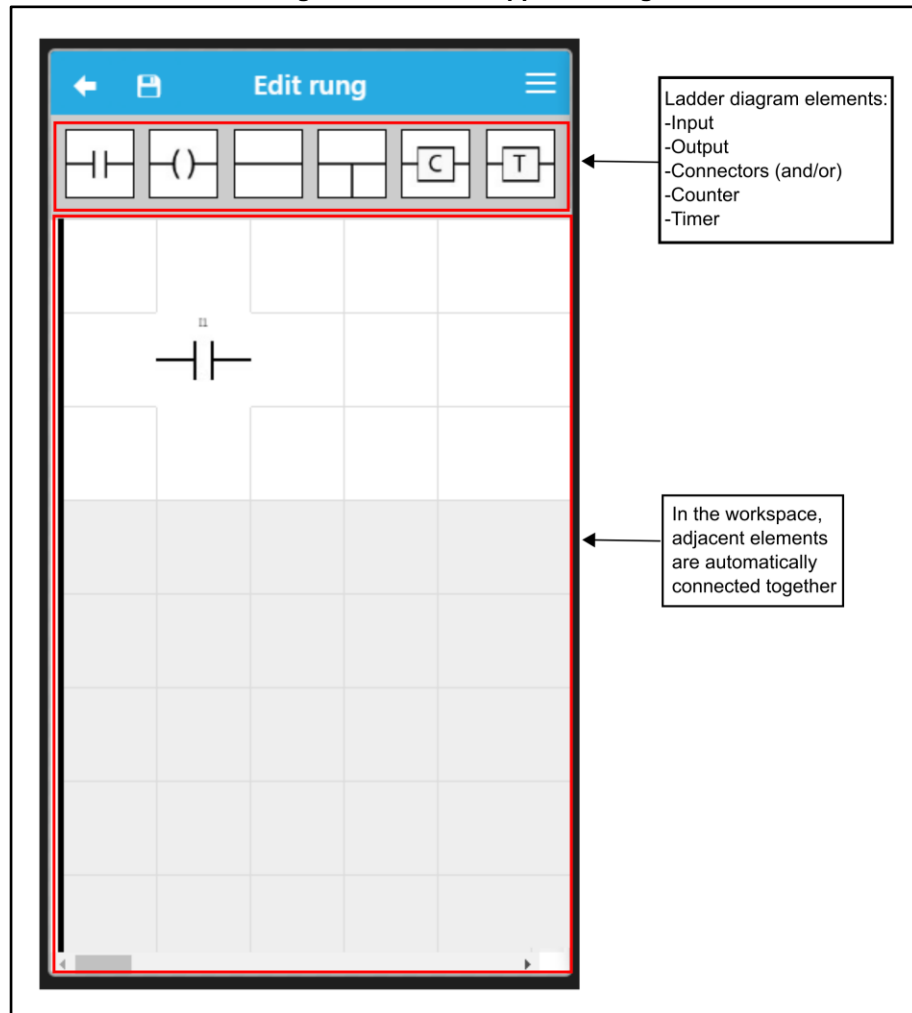


1.3.11 How to design a rung

This feature allows drawing rungs of the ladder diagram.

The user interface contains a toolbar with ladder elements and a workspace.

Figure 15: ST-PLC App: edit rung



To start rung editing, drag items on the workspace toolbar.

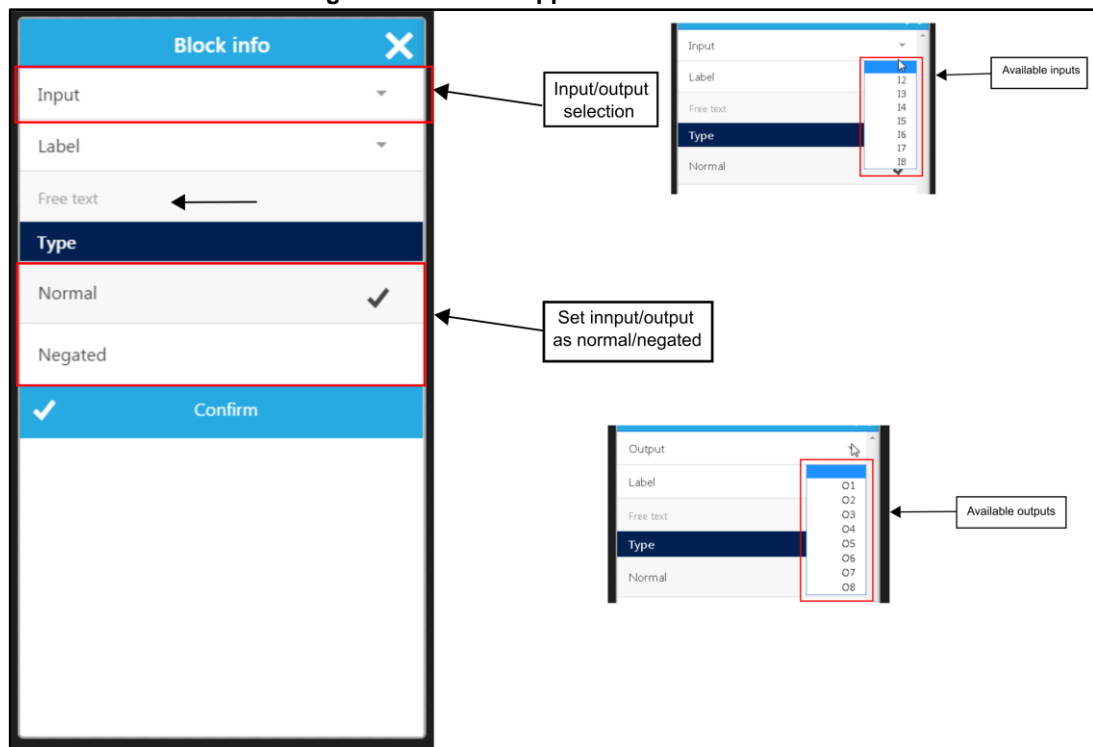
To insert a block in a specific cell, release it at the center of the cell.



If a block is released in a wrong position, it can be moved in edit mode.

For each element, some required parameters must be specified in the window that automatically opens up after the object is released on the workspace.

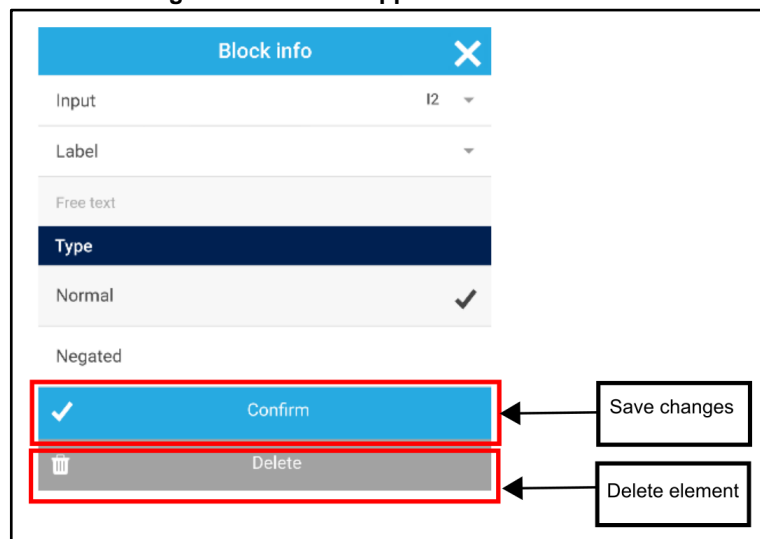
Figure 16: ST-PLC App: block info window



The **Block Info** window can also be opened double tapping the object on the workspace.

To delete or change any item, double tap the item and select "Delete" to remove the block or "Confirm" to save the changes.

Figure 17: ST-PLC App: block info window



To edit a block, just drag and drop it to the new location.

If a block is released on a busy location, the application gives an error message.

To move a counter or a timer; two adjacent free blocks are required.

To move a T-connection, two free blocks are required, one above the other.

The T-connection is automatically updated when a component is released on the left or on the right, to facilitate the branch creation the during the design phase.



This automatic update, in case of an user error in positioning a component adjacent to the T-connection, might cause an invalid link; in this case, you will be required to rebuild the affected part.

2 Ladder element

2.1 Input/output elements

Table 1: Required parameters for the input/output diagram element

PLC configuration	Input	Output	Description
X-NUCLEO-PLC01A1	I1,I2,...I8, O1,...O8 T/C (O17,O18,...)	O1,O2,...,O8	Enabled inputs: <ul style="list-style-type: none"> 8 physical inputs 8 virtual inputs (O1,...O8) 6 timers/counters (O17,O18...) Enabled outputs: 8 physical outputs
X-NUCLEO-PLC01A1 + X-NUCLEO-OUT01A1	I1,I2,...I8 O1,O2,...,O16 T/C (O17,O18,...)	O1,O2,...,O16	Enabled inputs: <ul style="list-style-type: none"> 8 physical inputs 16 virtual inputs 6 timers/counters (O17,O18...) Enabled outputs: 16 physical outputs
X-NUCLEO-OUT01A1	O1,O2,...,O8	O1,O2,...,O8	8 physical outputs 8 virtual inputs 6 timers/counters

To identify the inputs and the outputs across the configurations, the user can either insert a default label or a custom label.

For custom labels, the default values are:

- Inputs
 - Start motor
 - Enable alarm
 - Pressure sensor
 - Electric valve
 - Free text
- Output
 - Stop motor
 - Alarm ring
 - Close valve
 - Flush the tank
 - Free text

Alternatively, a 15-character maximum length free text string is allowed.

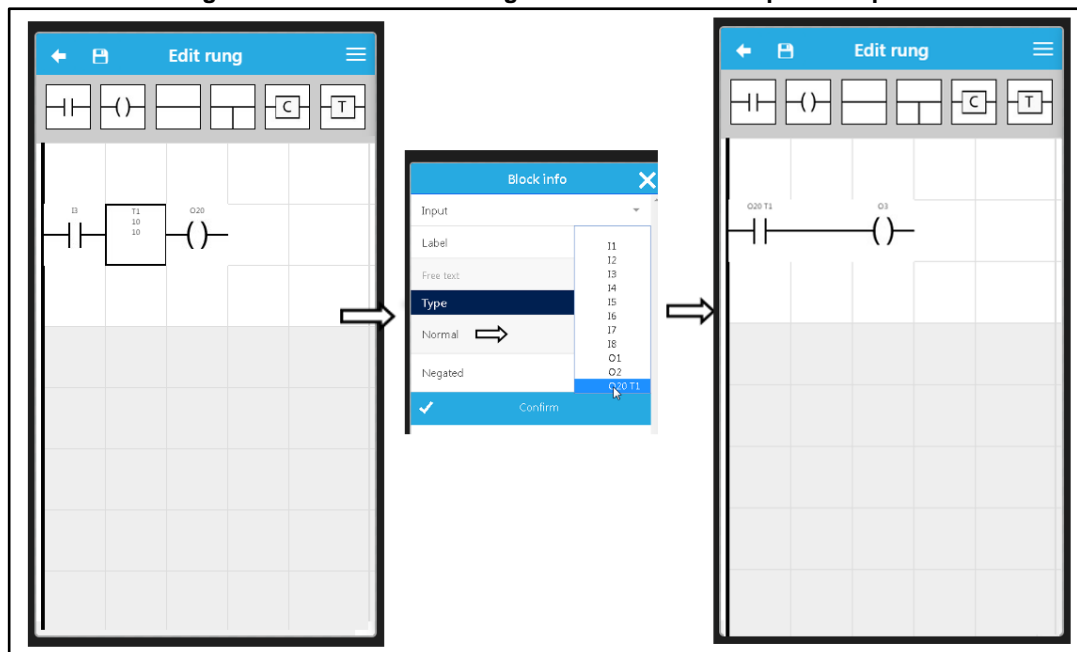
2.2 Timer/counter elements

Table 2: Required parameters for the timer/counter diagram element

Element	Parameter
Timer	N : a number identifying the counter, from 0 to 4095 T : time base P : preset value EN/DIS : a flag indicating the timer initial status (ON / OFF) if there is no specified input; otherwise, this parameter can be omitted Output : internal contact identified with a numbering higher than O16
Counter	N : counter number SV : set value U/D : up counter = 1, down counter = 0

The input list is populated with virtual inputs configured as outputs, as shown in the following figure.

Figure 18: Timer/counter diagram element virtual input example

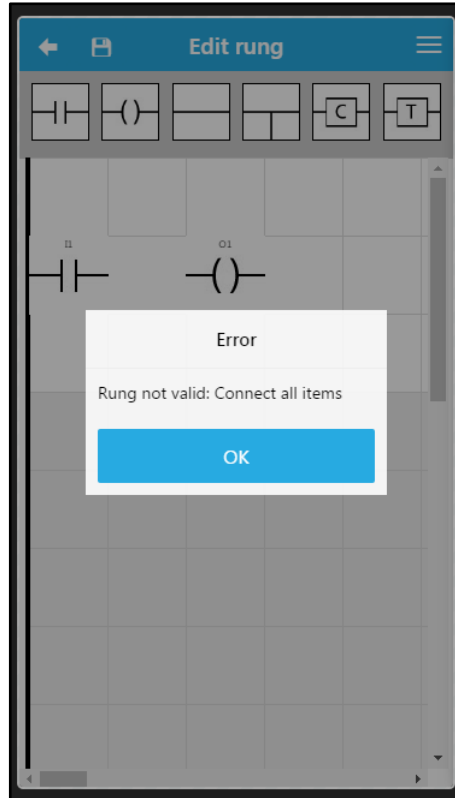


2.3 Validation rules

The rung cannot be saved if the following validation rules are not fulfilled:

- All elements must be connected

Figure 19: ST-PLC App validation rule 1: connection error

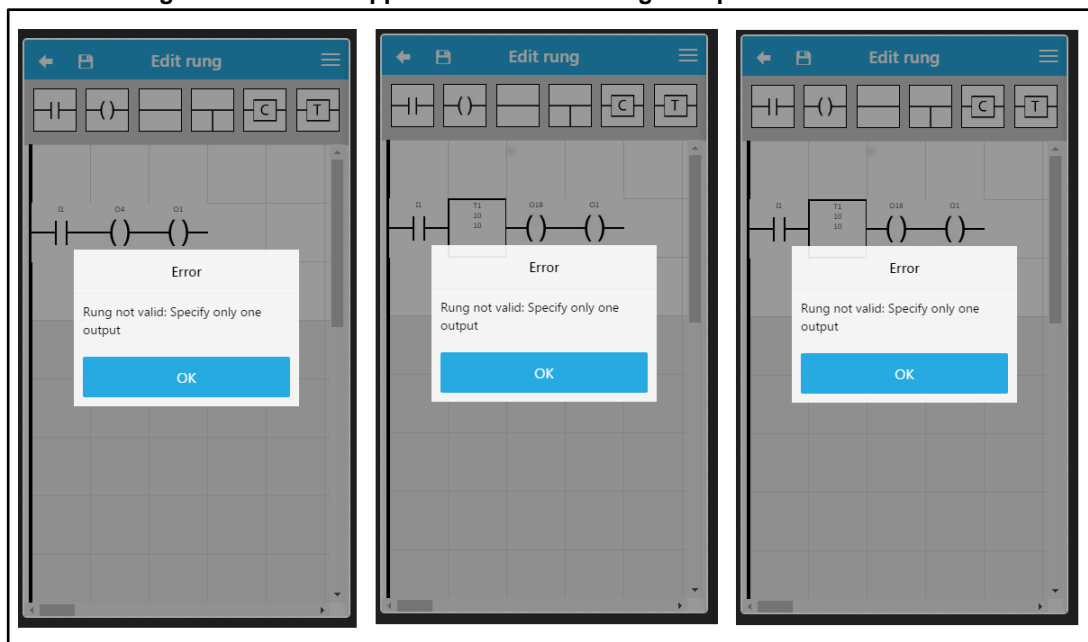


- Each rung must have a single output connected to the L2 power rail



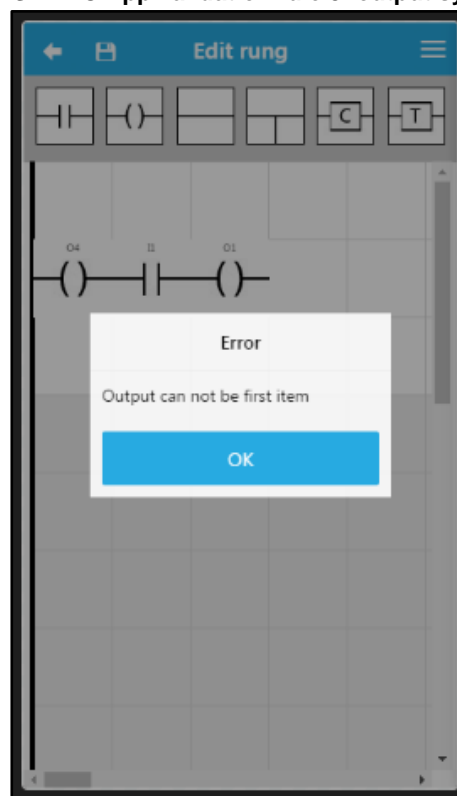
This rule also applies to the case of timer and counter

Figure 20: ST-PLC App validation rule 2: single output connection error



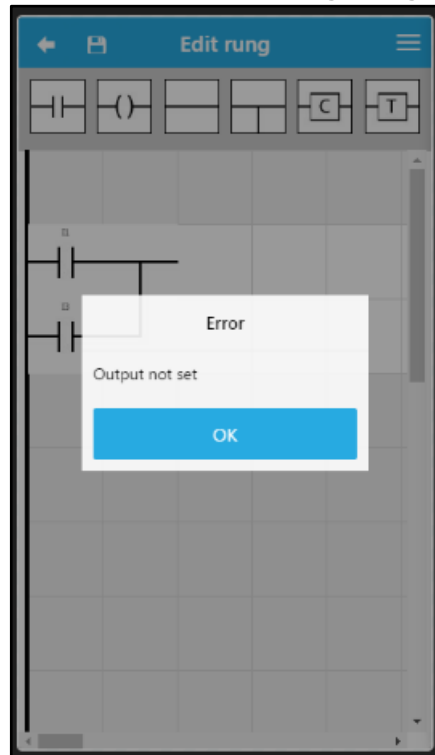
- It is not allowed to insert output symbols as inputs

Figure 21: ST-PLC App validation rule 3: output symbol error



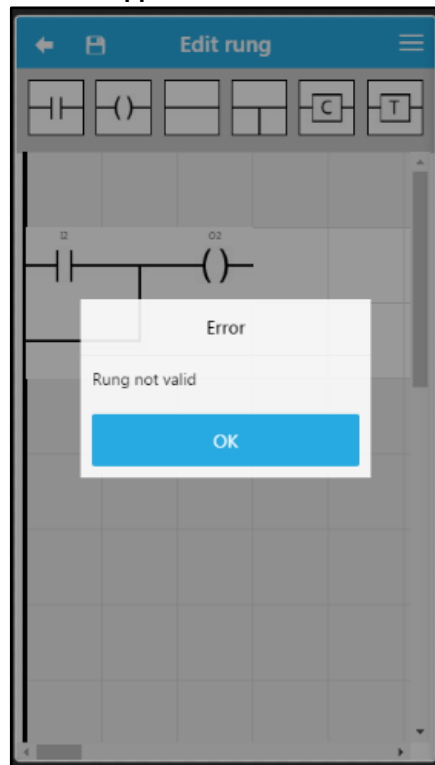
- It is not allowed to save a rung without output

Figure 22: ST-PLC App validation rule 4: saving a rung without output error



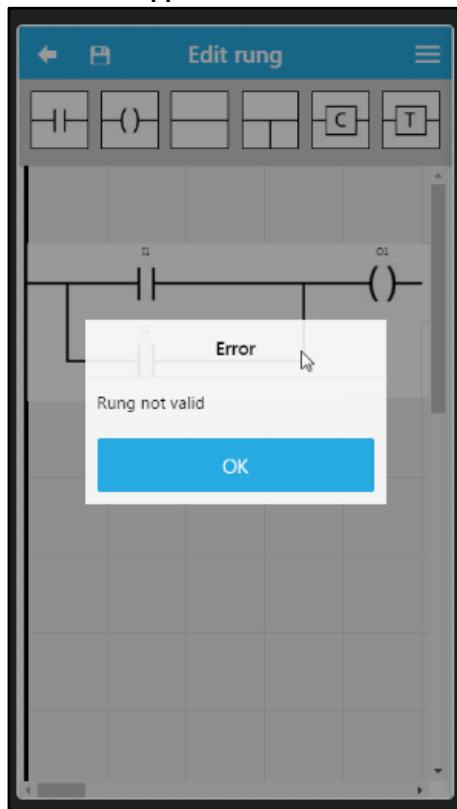
- It is not allowed to create a short-circuit

Figure 23: ST-PLC App validation rule 5: short-circuit error



- It is not allowed to create an OR block using the same component only

Figure 24: ST-PLC App validation rule 6: OR block error



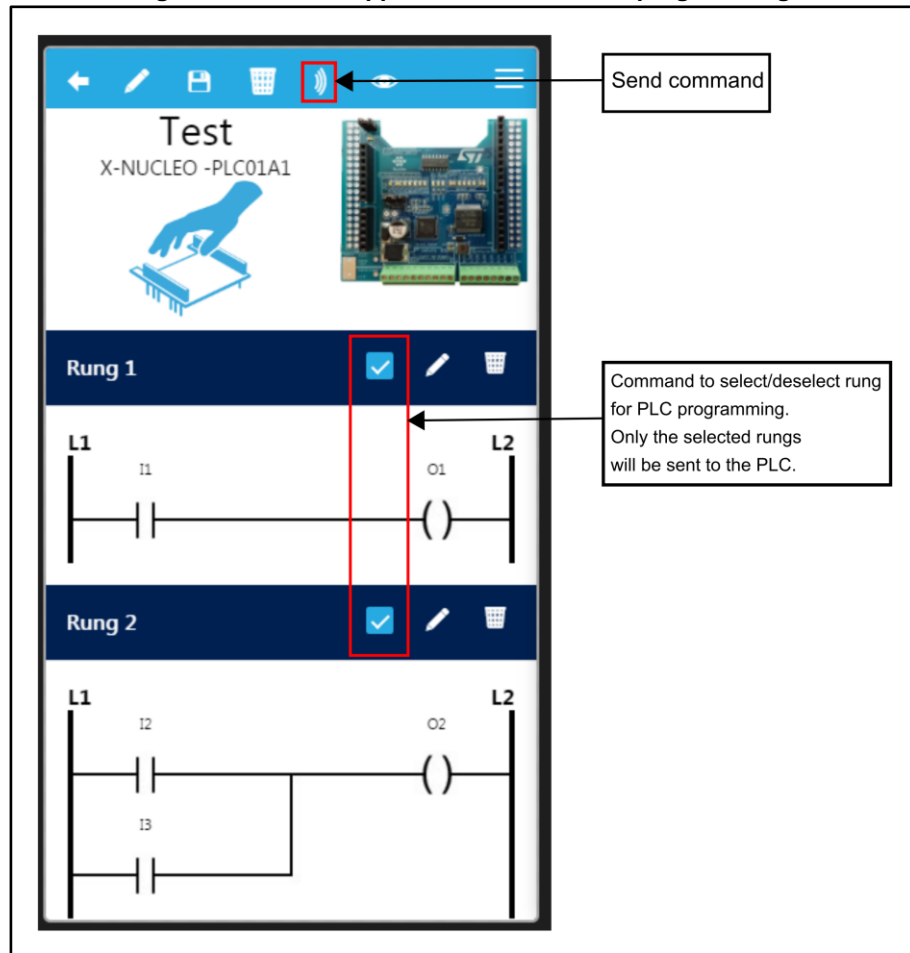
3 Ladder deployment

This feature allows compiling and transferring the ladder program to the PLC.



The device must be connected to perform PLC programming.

Figure 25: ST-PLC App: commands for PLC programming



A warning message is shown if the board is not connected or **Connection Settings** are not set.

Figure 26: ST-PLC App: PLC programming connection error

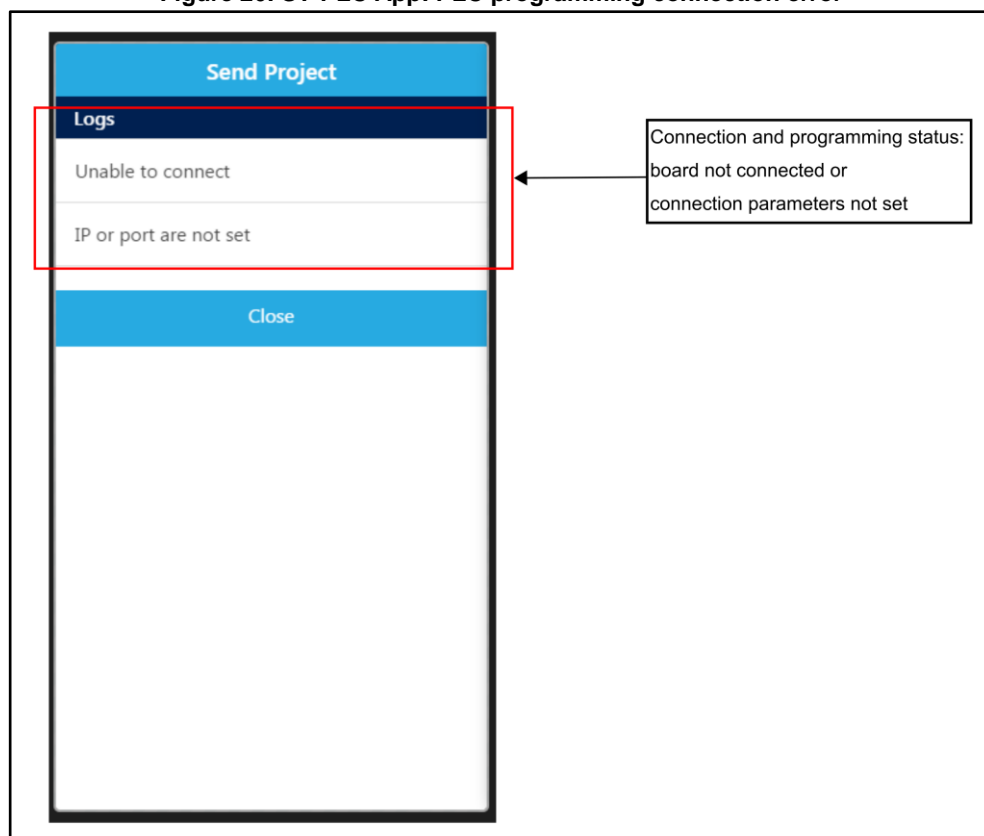
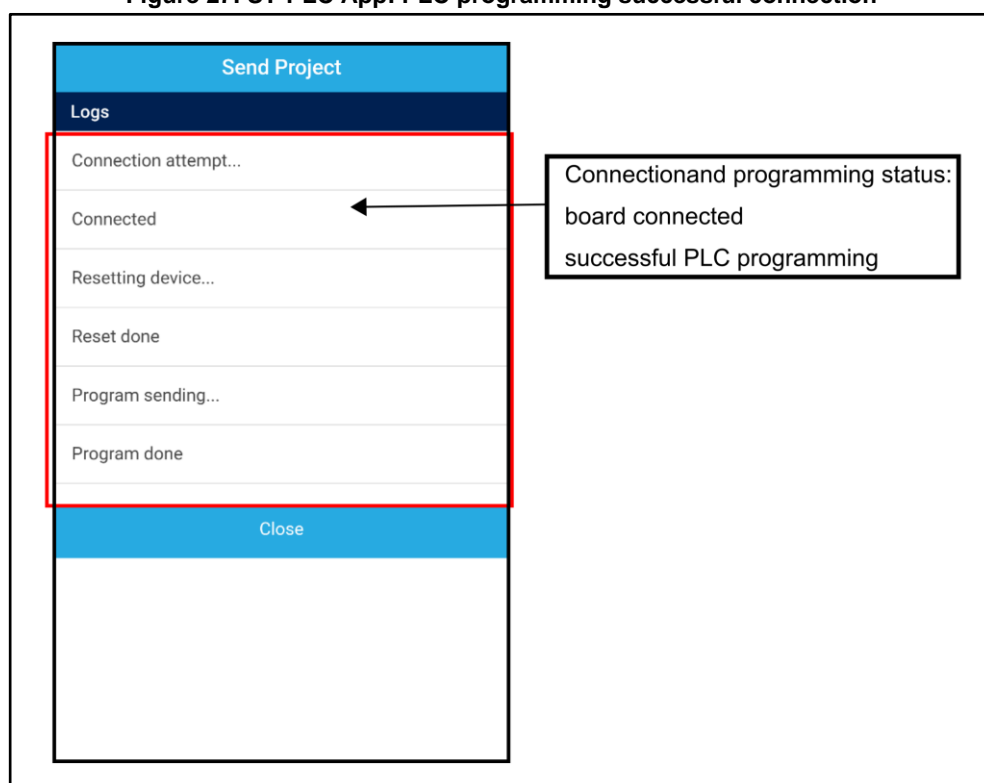


Figure 27: ST-PLC App: PLC programming successful connection

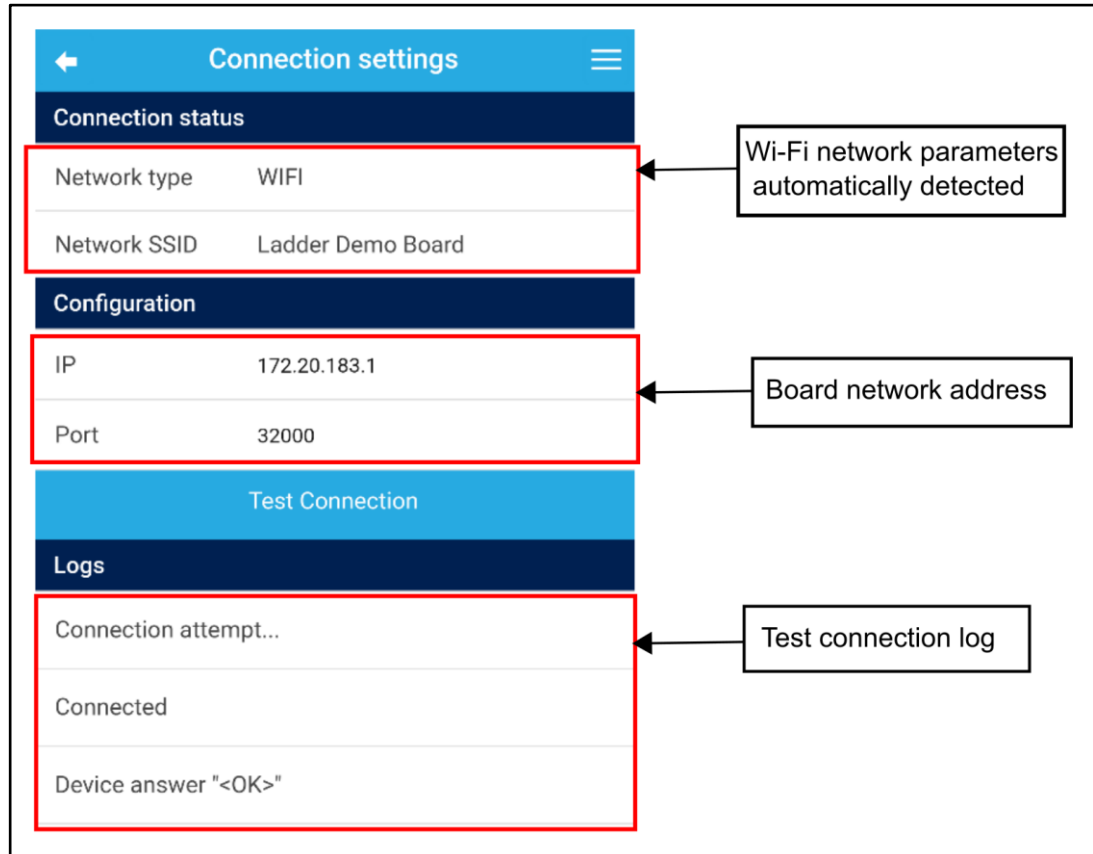


4 Diagnostics

4.1 Connection settings

This function allows configuring and testing the Wi-Fi connection with the X-NUCLEO expansion board used.

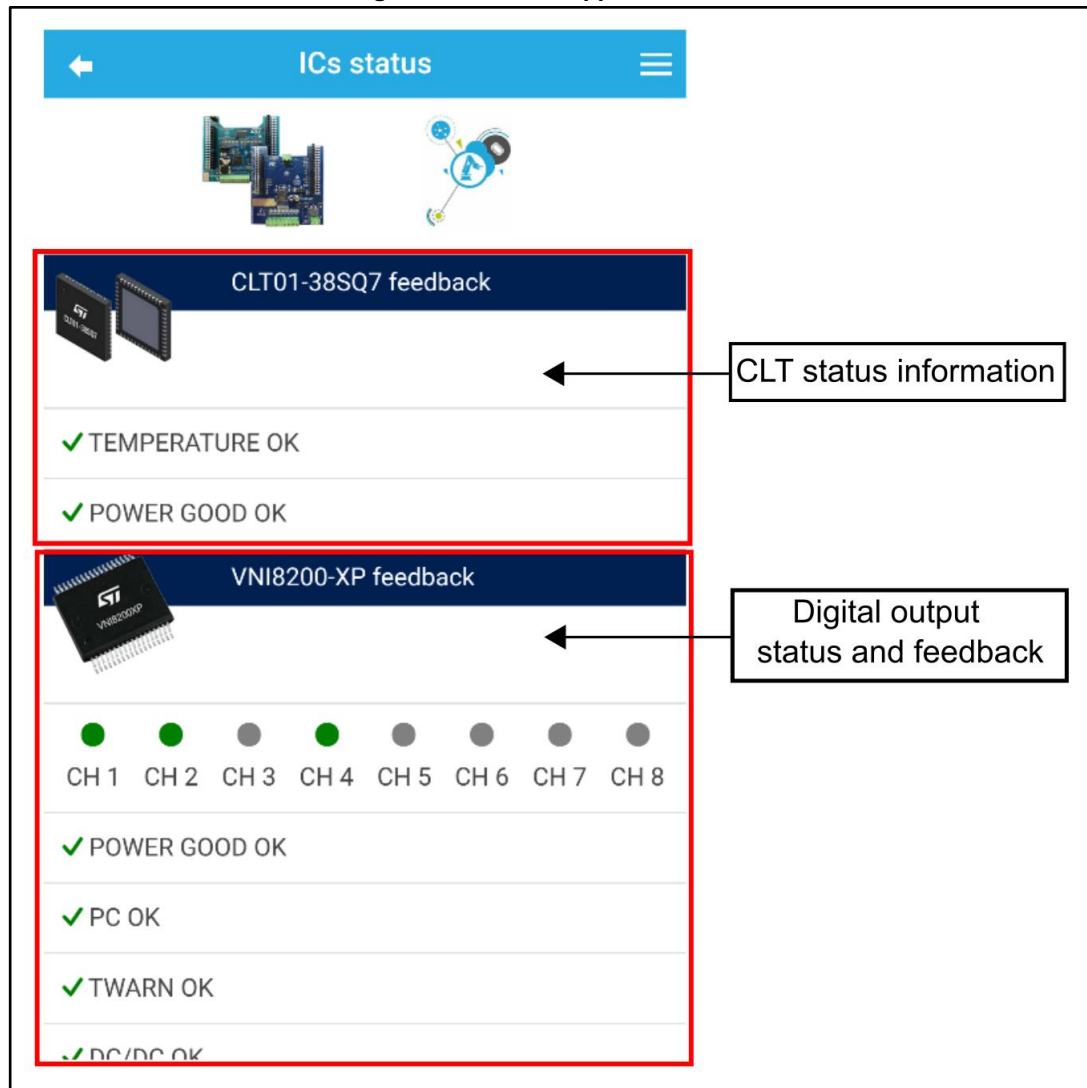
Figure 28: ST-PLC App: Wi-Fi connection



4.2 ICs status

This function allows displaying the board diagnostics information.

Figure 29: ST-PLC App: ICs status



The diagnostics information is about:

- VNI8200XP output diagnostics (ON/OFF and FAIL)
- VNI8200XP IC diagnostics (DC/DC, TWARN, PC, Power Good)
- CLT01-38SQ7 IC diagnostics (POWER GOOD, OK or FAIL, TEMPERATURE OK or FAIL)

The diagnostic information format is:

- **Digital output feedback**
 - CHANNEL (i) OFF or ON or FAIL
 - POWER GOOD OK or FAIL
 - PC OK or FAIL
 - TWARN OK or FAIL
 - DC/DC OK or FAIL

- **Digital input feedback**
 - TEMPERATURE OK or FAIL
 - POWER GOOD OK or FAIL

The channel status is shown in 3 different colors:

- Red: Channel Fault
- Green: On
- Gray: Off



The device must be connected to the X-NUCLEO expansion board to get **Device Status Information**.

5 ST-PLC App desktop version

The ST-PLC App desktop version includes a service window: at ST PLC app startup, the **X-NUCLEO PLC service** is launched too and the application is opened in the Internet browser.

Figure 30: ST-PLC App desktop version

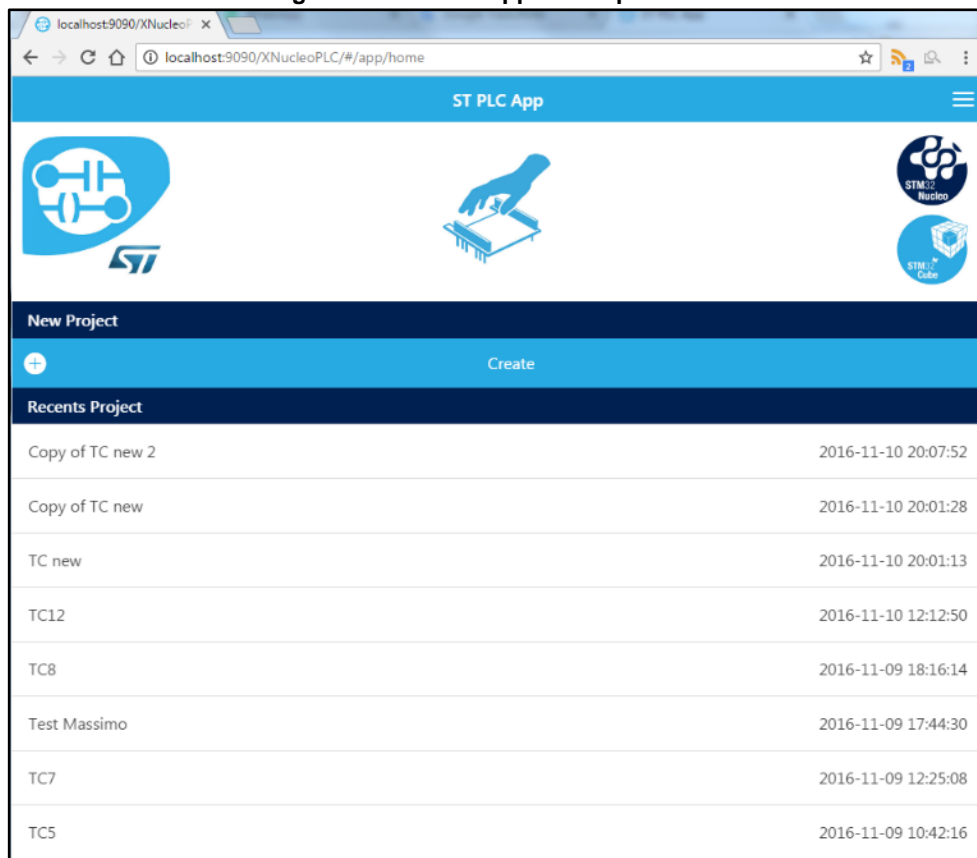
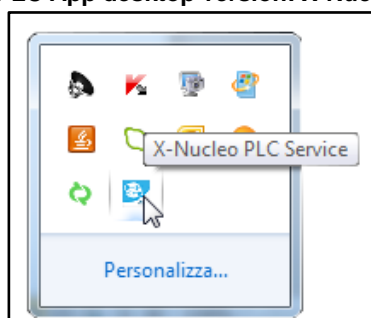


Figure 31: ST-PLC App desktop version: X-Nucleo PLC service



To use the application, the **X-NUCLEO PLC service** must be started; if it stops, the application must be restarted.



To use **X-NUCLEO PLC service** the user must have **Administrator** privileges.

Appendix A Known issues/troubleshooting

1. Issue: After "X-Nucleo-PLC.exe" execution, the message "An error occurred. Try to restart application with Administrator Privileges" is shown.
Solution: Start the application "X-Nucleo-PLC.exe" using administrator privileges.
2. Issue: The application does not correctly display images and other graphics.
Solution: Check if the "X-Nucleo Service" started properly in TryIcon; if not, restart the application.
3. Issue: In the desktop version, after connecting the PC to the "Ladder Demo Board" network via a joint connection to the PLC (Test Connection, ICs status, Send Project) a timeout error is displayed.
Solution: Try reinserting the wireless network password "Ladder Demo Board", wait for the reconnection and then retry.
4. Issue: The user is not able to connect via a mobile device to the PLC.
Solution: To successfully connect to the PLC via a mobile device, disable the data connection.

6 Revision history

Table 3: Document revision history

Date	Version	Changes
13-Sep-2017	1	Initial release.

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