Starter-Kit | u-control

Quick Start Guide for Starter-Kit Web - Three-state Temperature Controller

Abstract:
This guide contains instructions on how to activate the starter kit and connect to the controller. Furthermore, it contains a guide on how to setup the controller and download a demo application to the controller. This demo application utilizes the key components of the starter kit to showcase the implementation of a simple temperature controller.

Hardware reference

No.	Component name	Article No.	Hardware / Firmware version
1	STARTERKIT-UC20-WL2000-AC	2666080000	UC20-WL2000-AC FW 1.10.0 And Higher

Software reference

No.	Software name	Article No.	Software version
1	Recent web browser (Microsoft Edge, Firefox, Chrome)	-	-
2	u-control Demo Application	-	-

File reference

No.	Name	Description	Version
1	-	-	-

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https://www.weidmueller.com/countries

Content

1 Warning and Disclaimer

Warning
Controls may fail in unsafe operating conditions, causing uncontrolled operation of the controlled devices. Such hazardous events can result in death and / or serious injury and / or property damage. Therefore, there must be safety equipment provided / electrical safety design or other redundant safety features that are independent from the automation system.

Disclaimer
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Security notes
In order to protect equipment, systems, machines and networks against cyber threats, it is necessary to implement (and maintain) a complete state-of-the-art industrial security concept. The customer is responsible for preventing unauthorized access to his equipment, systems, machines and networks. Systems, machines and components should only be connected to the corporate network or the Internet if necessary and appropriate safeguards (such as firewalls and network segmentation) have been taken.

2 Requirements

The starter kit comes with everything you need to complete this guide. You only need a Computer or Tablet PC with a recent web browser to interact with the programming interface and visualisation. The demo application can be downloaded from www.weidmueller.com.

3 Installation of starter kit hardware

1.) Take the starter kit board and the power supply out of the box and connect the power supply with the board (1) and a power socket (2). Now the board can be activated by the switch on the left side (3).
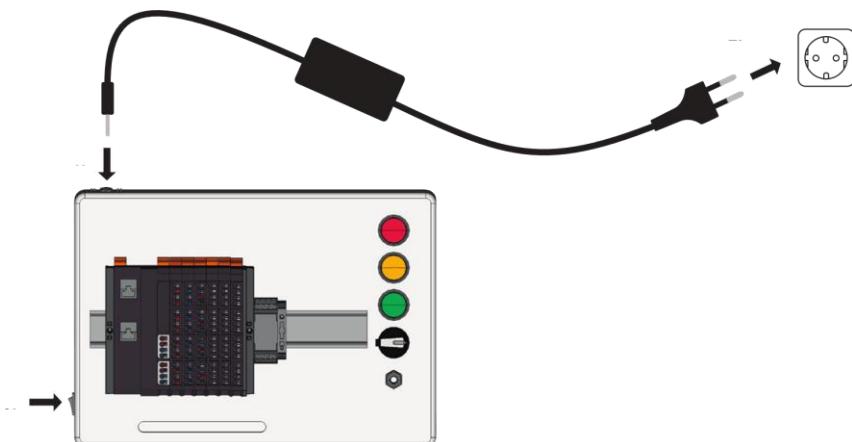
Figure 1: Starter kit and power supply

2.) It is possible to supply multiple starter kits with one 24V power supply. You can use the rear facing orange connector to daisy chain up to three starter kits. Use only the provided power supply or an equivalent.
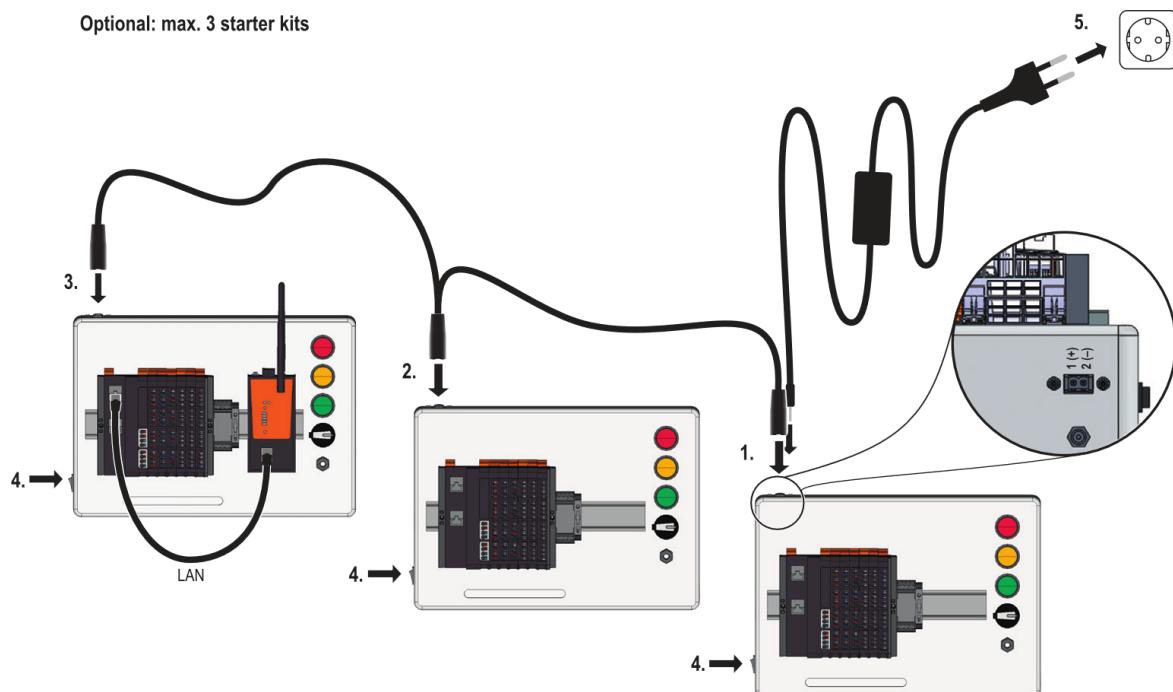
Figure 2: Daisy chaining of up to three starter kits

4 Network settings

You have two options to connect your PC to the u-control PLC:

1.) The easiest way of accessing the web interface of the u-control is via USB on the service interface X3. Make sure the board is powered up prior to connecting via USB. Enter the address 192.168.10.202 in a web browser of your choice to access the web interface.

2.) You can also access the u-control via the network interface X1 under the static IP 192.168.0.101. Make sure the network adapter of your Engineering PC which the u-control is connected to is configured with a static IP in the same subnet, e.g. 192.168.0.100.

> **i**   Out of the box the following IP addresses are used:
>
> u-control USB: 192.168.10.202
> u-control Ethernet: 192.168.0.101

For simplicity we will use the first option here. Once you have connected the u-control to your PC via USB and accessed its web interface with a browser, you will be asked to enter login credentials.

> **i**   The default credentials are:
>
> User: admin
> Password: Detmold

5 Getting started with u-create web

Now that your starter kit is up and running, we're ready to download and deploy the example application.

Note that your starter kit comes with simple, a pre-installed application project. It contains a program that simply maps the inputs and outputs of the various buttons and LEDs , as well as the analogue inputs and outputs. It also features a simple visualisation.

You can download this project from the support page and re-deploy it on your u-control, if needed.

In this Quick Start Guide, we will implement a simple temperature controller. It utilizes most of the starter kit hardware and demonstrates how to read and write I/O connected to the u-control PLC.

5.1 Online help and Firmware version

After logging in, you will see the starting page of your PLC ("Welcome to u-create web"), see Figure 3. When you need help with your PLC, you can access to the online manual by clicking on the "Help" on the upper right corner.

To make sure your u-control PLC is up to date, first check the Firmware version it is running. Click on "Settings" on the upper right, then on "About".
Make sure the installed Firmware ("Software Version") is equal or higher than the required version mentioned in the Hardware reference at the beginning of this document. If the Firmware needs to be updated, you will find the instructions in the online help ("Getting to know u-create web" → "Setting up u-create web" → "Updating the Firmware").

5.2 Importing the demo application

To download the demo application file for u-create web, navigate to the support page for Weidmüller's u-control starter kits. Scroll down to the downloads section for the starter kit web and download the temperature controller example program (Filetype .ucp).

Click on the "Edit" button of the u-create welcome page to enter the planning mode.
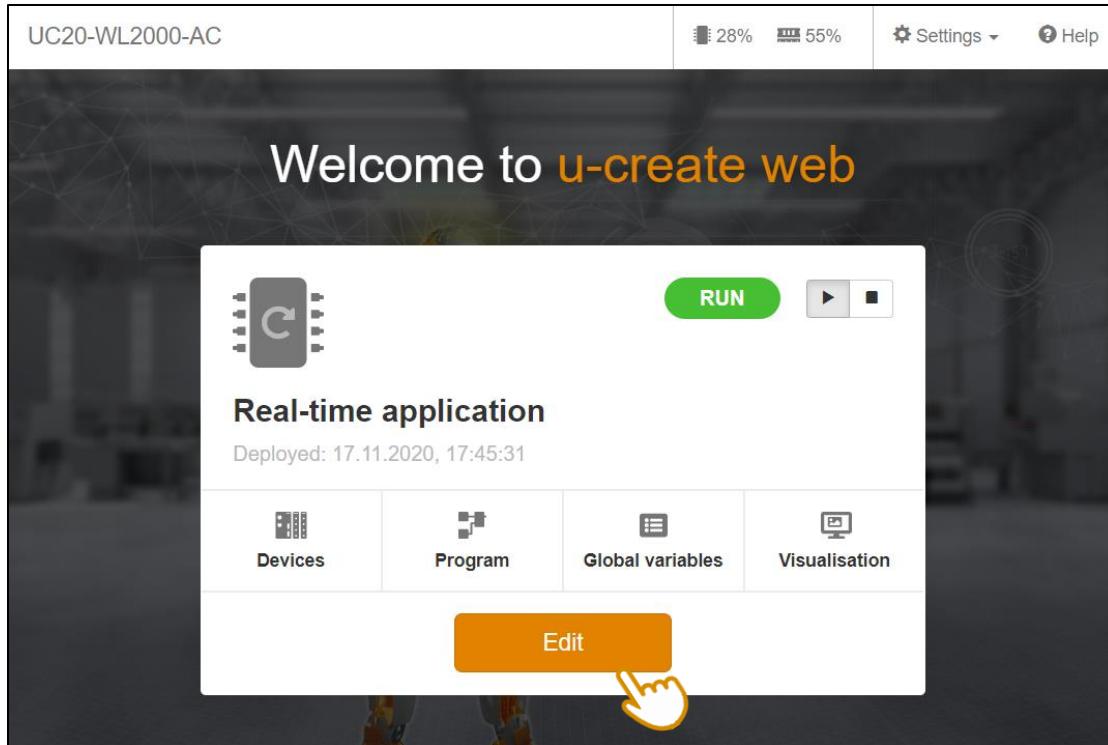
Figure 3: Welcome screen of u-create web, edit button highlighted

The menu button (three vertical dots) in the top-right hand corner of Figure 4 allows you to upload a project file to the u-control PLC.

1.) Select the .ucp file that you've downloaded from the support page.
2.) Once the upload is finished, click on deploy.

> If the deploy fails or if you made any changes to the IO-modules, click on "Autoscan Station" before trying to deploy again.

Don't worry if the devices tab still looks the same after the deploy. You'll explore the other tabs in the next sections.
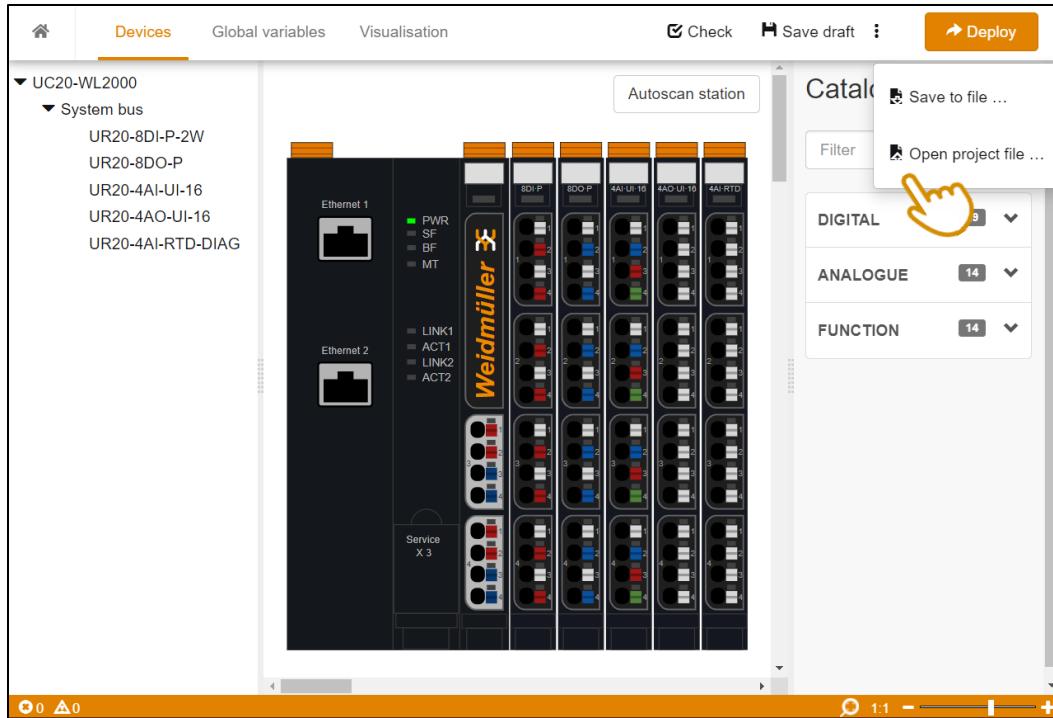
Figure 4: u-create web planning (e.g. edit) mode, devices tab, import/export menu

5.3   Devices and I/O

The starter kit comes fully assembled and ready to use.
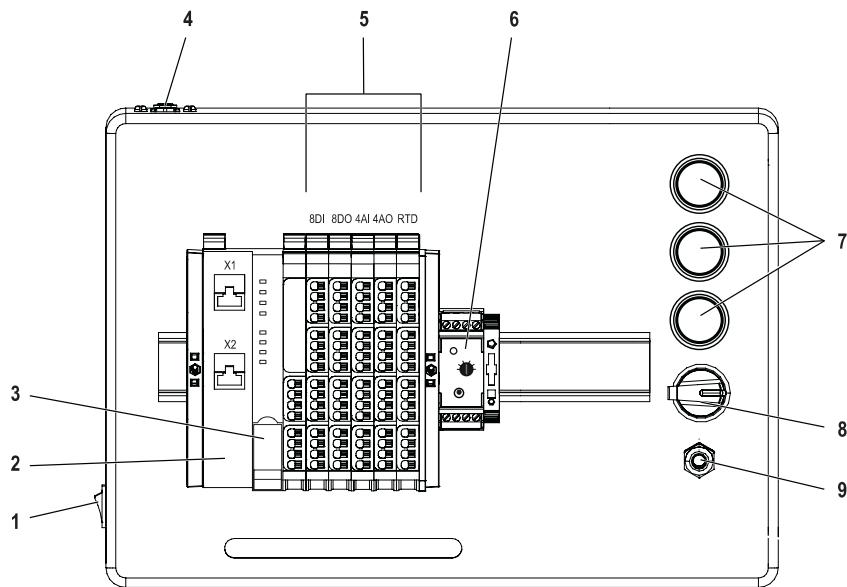
Figure 5: Overview of the starter kit hardware

The following devices are connected to the I/O modules and can be used to develop your first applications without making any changes to the starter kit's hardware:

Table 1: List of the starter kit hardware and connections

Pos		Hardware	I/O Module	Connection
7	🔴	Pushbutton red	UR20-8DI-P-2W	Channel 0 / DI 1.1
7	🟡	Pushbutton yellow	UR20-8DI-P-2W	Channel 1 / DI 1.3
7	🟢	Pushbutton green	UR20-8DI-P-2W	Channel 2 / DI 2.1
8		Rotary switch	UR20-8DI-P-2W	Channel 3 / DI 2.3
8		Rotary switch	UR20-8DI-P-2W	Channel 4 / DI 3.1
6	Hand/Auto	Analogue encoder	UR20-8DI-P-2W	Channel 5 / DI 3.3
7		LED red	UR20-8DO-P	Channel 0 / DO 1.1
7		LED yellow	UR20-8DO-P	Channel 1 / DO 1.3
7		LED green	UR20-8DO-P	Channel 2 / DO 2.1
8		LED white	UR20-8DO-P	Channel 3 / DO 2.3
6	OUT (Y)	Analogue encoder	UR20-4AI-UI-16	Channel 0 / AI 1.1
6	IN (YR)	Analogue encoder	UR20-4AO-UI-16	Channel 0 / AO 1.1
6	IN (YGND)	Analogue encoder	UR20-4AO-UI-16	Channel 0 / AO 1.4
9	Pt100 +	Temperature sensor	UR20-4AI-RTD-DIAG	Channel 0 / AI 1.1
9	Pt100 -	Temperature sensor	UR20-4AI-RTD-DIAG	Channel 0 / AI 1.4

We will use all four LEDs to signal the state of the temperature controller. The temperature set point will be given by the analogue encoder, while the Pt100 sensor is used to determine the actual temperature. The rotary switch is used to enable the temperature controller and to reset the alarm condition. The pushbuttons are not used.

5.4   Global variables

Navigate to the Global variables of the u-create web.

Figure 6: Planning view of Global variables in u-create web

Figure 6 shows the "Global variables" tab of the planning view with all required variables already configured. All but two variables are mapped to an I/O. The variables "rSetPoint" and "rTemperature" will be used to display data from the PLC program on the visualisation and therefore are not mapped to an I/O.

Note the naming convention used in this example:

1.) Variables are preceded by "I_"(or "O_") if they are mapped to an input (or Output).

2.) Next comes a lowercase letter indicating the data type of the variable:
- X: Bool
- i: Integer
- r: Real

3.) Next comes the name. It represents the function or the device the variable is mapped to.

This naming convention is by no means authoritative, it is a design decision meant to ease the use of these variables in the PLC program. The live view shown in Figure 7 allows to monitor the value of all variables.

To leave the planning mode go back to the welcome page, and then click on "Global Variables" again. The live mode does not allow you to make any changes but gives you live information about the value of the variables.

| Name ↑	Value	Data type
I_IPOTIVALUE	16418	INT
I_ITEMPERATURE	235	INT
I_XBUTTONGREEN	0	BOOL
I_XBUTTONRED	0	BOOL
I_XBUTTONYELLOW	0	BOOL
I_XROTATIONCCW	0	BOOL
I_XROTATIONCW	1	BOOL
I_XSWITCHAUTO	0	BOOL
O_XGREEN	1	BOOL
O_XRED	0	BOOL
O_XWHITE	1	BOOL
O_XYELLOW	0	BOOL
RSETPOINT	20.021667	REAL
RTEMPERATURE	23.500000	REAL

Figure 7: Live view of global variables in u-create web

Note that variables which are mapped to an input are preceded by an "I_", variables that are mapped to an output by an "O_". Next comes the type, "I" for integer, "X" for bool, "R" for real. This is a design decision, you can name variables as you prefer, using your own naming convention.

The Variables "RSETPOINT" and "RTEMPERATURE" are set by the PLC application, which we haven't uploaded to the u-control yet. Therefore, they will have a value of 0 at this point.

5.5 Visualisation

u-create web includes a powerful yet easy to use visualisation tool. You can create and display interactive visualisations like shown in Figure 8 using only a web browser. This is especially useful if you want to use mobile devices like tablets as an HMI.
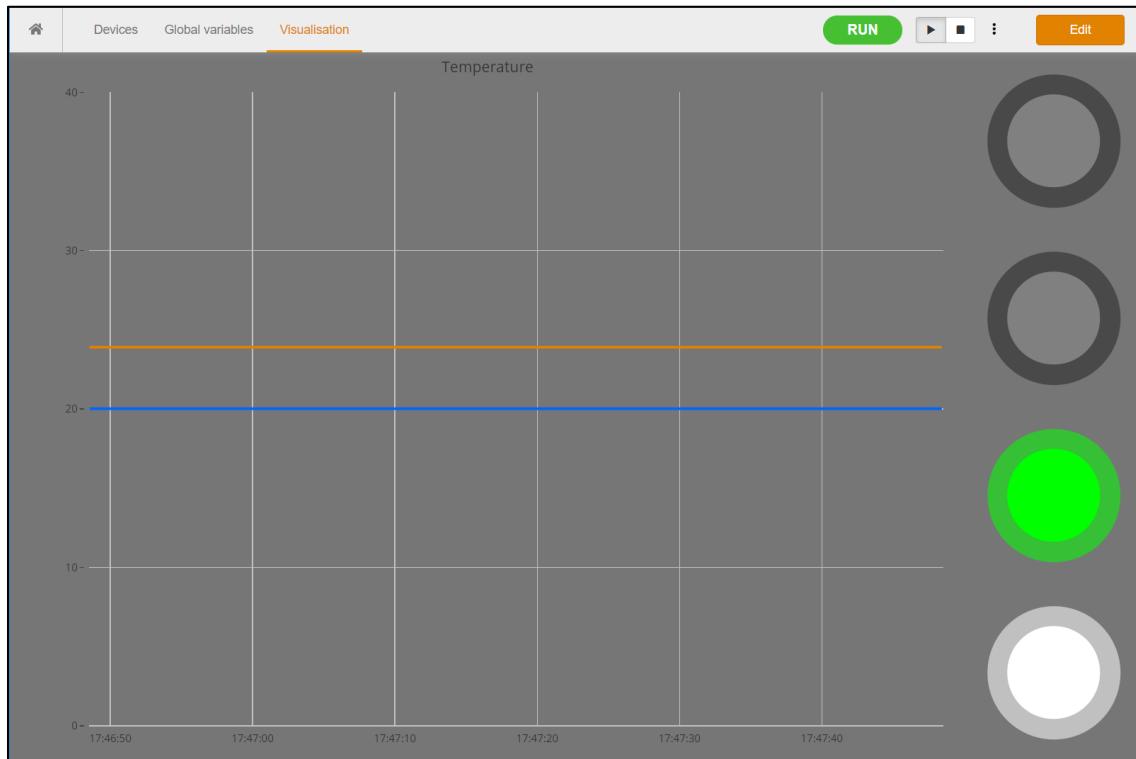
**Figure 8: Live view of the visualisation in u-create web**

While the creation of these visualisations is out of scope of this guide, feel free to explore the visualisation in the planning mode as shown in Figure 9.
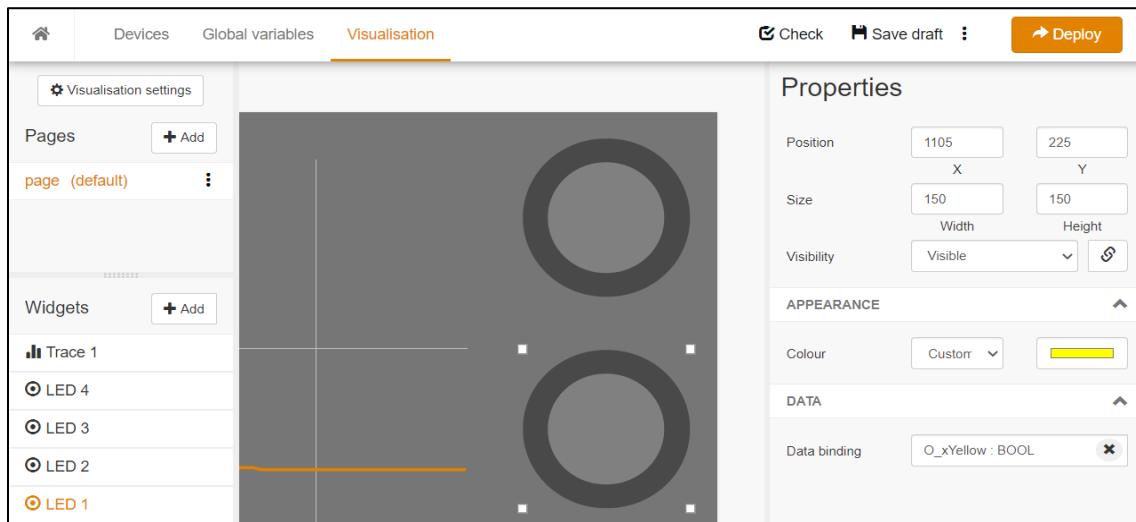
Figure 9: Planning view of the visualisation in u-create web

6 Exploring the PLC program

Now that the controller is up and running, the behavior of the program can be observed in u-create web's live view shown in Figure 10. In contrast to the planning mode, no changes to the program can be made here. Instead, the live state of the program is displayed.
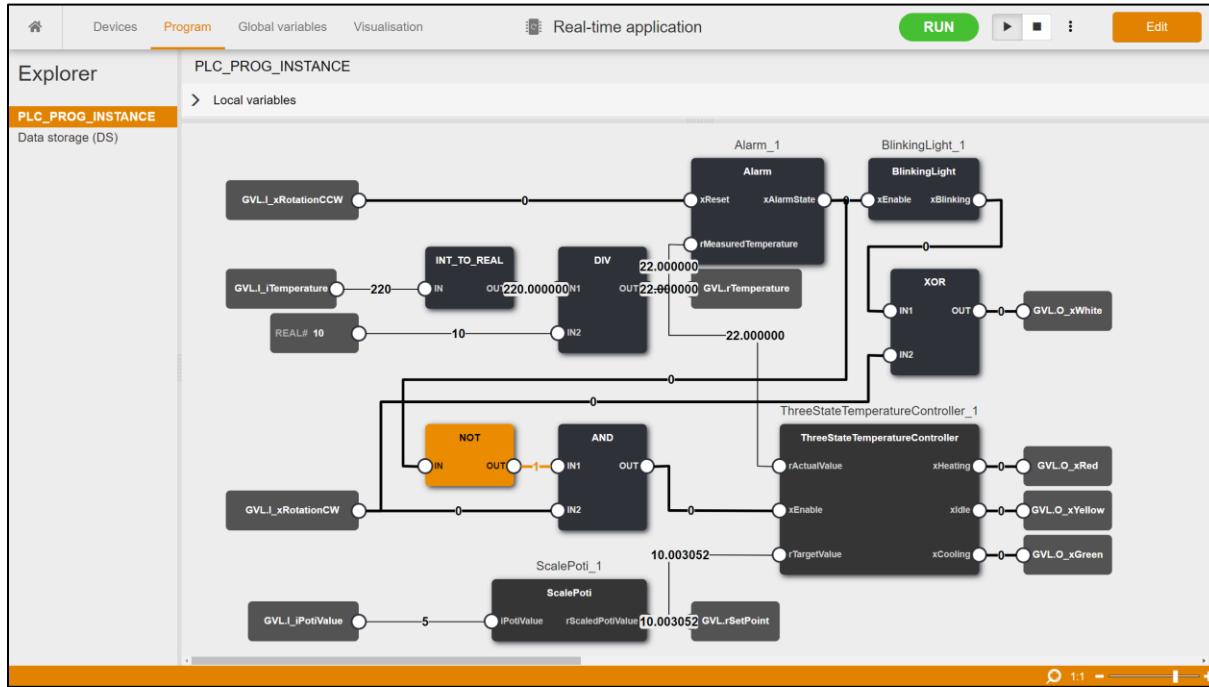
Figure 10: Live view of the PLC program in u-create web

You might notice some of the starter kit's LED being lit. If not, turn the rotary switch clockwise to 4:30. This enables the temperature controller. The following user inputs are available:

Reset Alarm Condition

Controller off

Controller on

Temperature set point [10°C, 30°C]

The controller's state is indicated by the LEDs of the starter kit:

	Heating
	Idle
	Cooling
	On: Controller active; Flashing: Alarm triggered
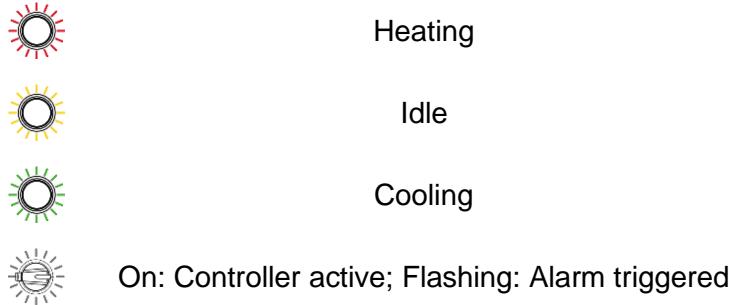
These status indicators are replicated on the u-create web HMI, in addition to a graph of the temperature set point and actual temperature. Navigate to the visualisation tab of the live view as shown previously in **Error! Reference source not found.**. The state of the controller can be observed on the program tab as well. This is especially helpful for troubleshooting or debugging of the program.
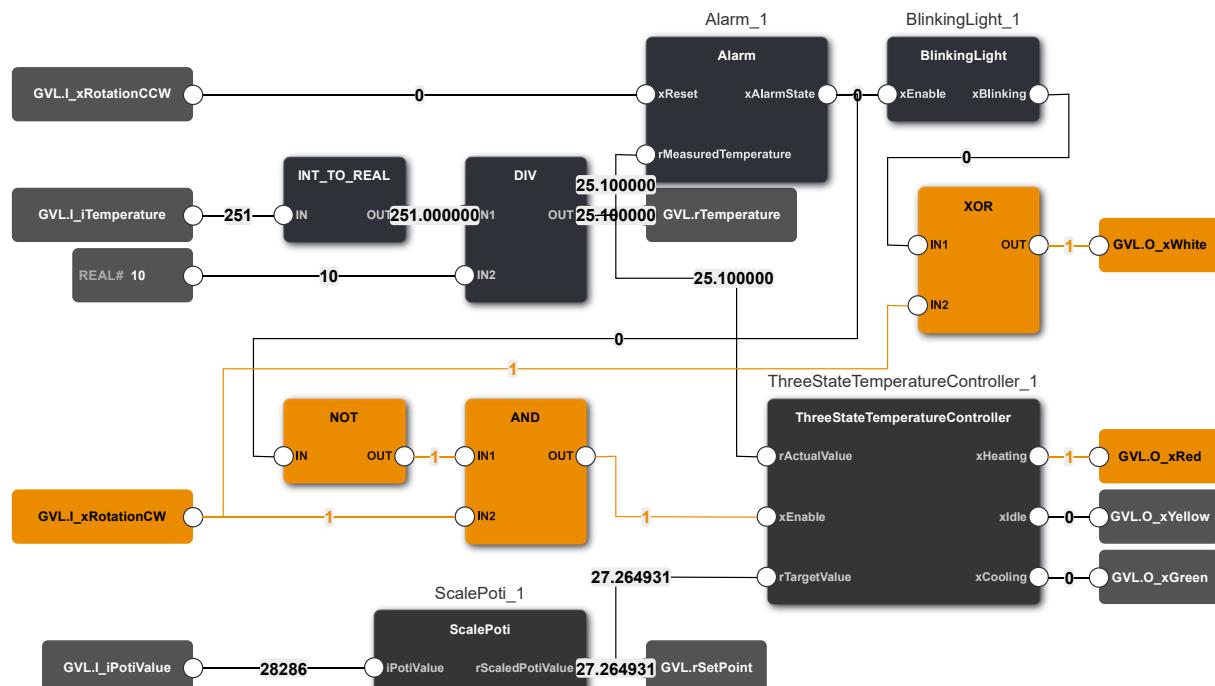
Figure 11: Live view of the main PLC program, temperature controller in state heating

All global variables mapped to the user input devices are connected as inputs on the left of the main PLC program, as shown in **Error! Reference source not found.**. The global variables mapped to the LEDs are connected as outputs on the right. The PLC program is split into four custom POUs, connected through a few standard blocks.

The ScalePoti POU is used to scale the integer value in the range of [0 .. 32,767] to a real value in the range of [10.0 .. 30.0], which is used as the temperature setpoint for the controller.
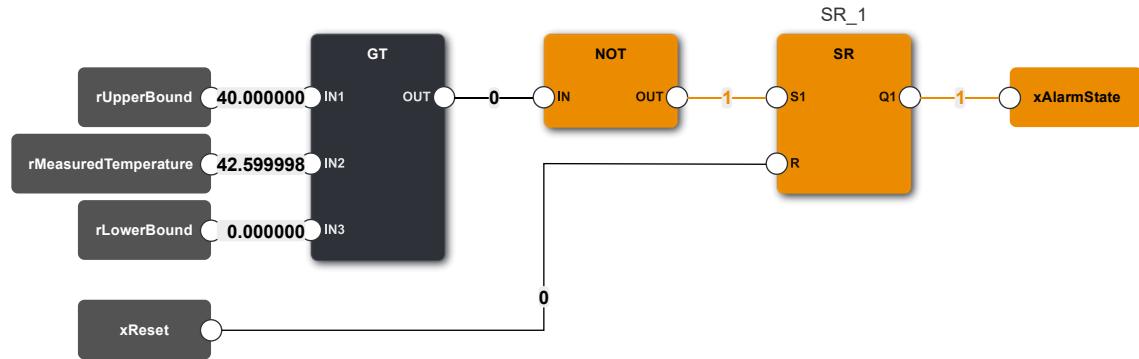

Figure 12: Live view of the Alarm POU, alarm triggered due to overtemperature

The Alarm POU monitors the measured temperature and checks if it lies within the allowed range of [0 .. 40] °C. If outside of these bounds, the alarm state is triggered, as shown in **Error! Reference source not found.**. This is done by using a GT and inverting its output. The output of GT is true if the value of IN2 is less than IN1 and greater than IN3. The alarm state can be reset, provided the temperature lies within the allowed range. This is achieved using a Set-Reset Flip-Flop whose set input is dominant.

Let's take a brief look at the ThreeStateTemperatureController, the heart of this example application. It monitors the measured temperature and compares it to the setpoint given by the analog encoder. If enabled, it can enable either a heater or a chiller to regulate the temperature. These are substituted by the LEDs of the starter kit. **Error! Reference source not found.** shows the main program with the temperature controller in state heating.
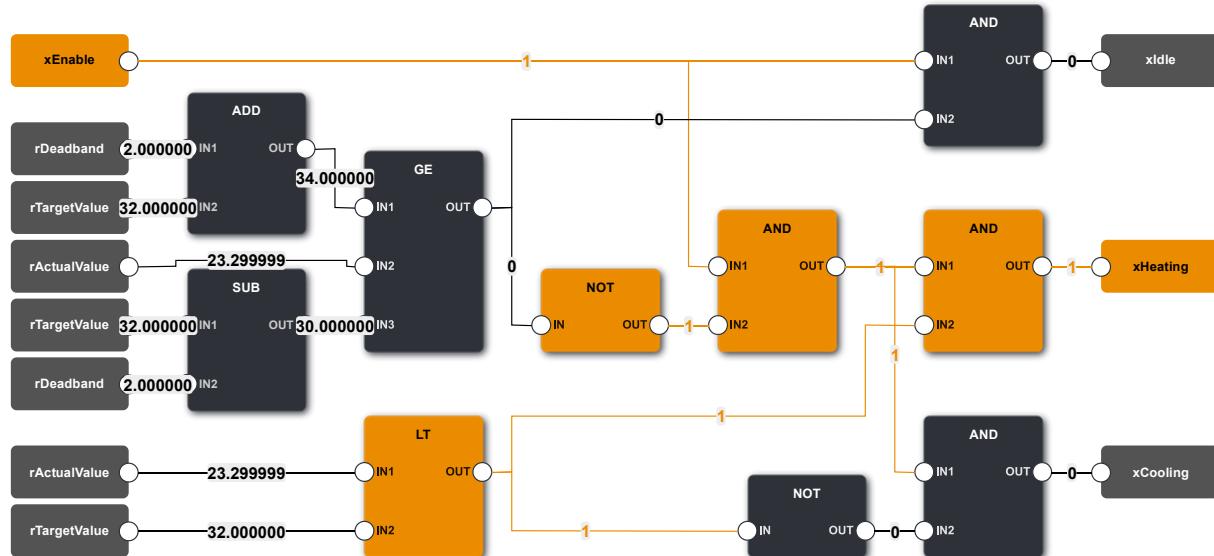

Figure 13: Live view of the Temperature Controller POU, heating

The implementation of the temperature controller is shown in **Error! Reference source not found.**. Note that each output is coupled to the "xEnable" input through an AND gate so that they can only be active if the controller is enabled. For the "xIdle" output this connection is straightforward. The output "xHeating" can only be active, if the following conditions are met:

- "xEnable" is true

- "rActualValue" is less than "rTargetValue" (implemented by the LT)

- "rActualValue" does not lie within the deadband around "rTargetValue" (ADD, SUB & GE)

The deadband is defined as a local variable "rDeadband" and is set to a constant value of 2.

To interact with the controller, use the analogue encoder (Pos 6 in **Error! Reference source not found.**). Note that the encoder has to be switched to "Hand" to have an effect. It is mapped to the temperature set point, in the range of 10°C to 30°C. You should see the controllers state changing from cooling over idle to heating, depending on the actual temperature. To change the actual temperature, either place your fingers or a damp piece of cloth on the Pt100 sensor to heat or cool it.

If you reach the limits of the allowed temperature range (<0°C or >40°C), the controller will go into an alarm state, indicated by the flashing white LED (see **Error! Reference source not found.**). To reset it, wait for the temperature sensor to recover to a value in the allowed range and then hold the rotary switch in the 1:30 position till the LED turns of. Now the controller can be activated again.
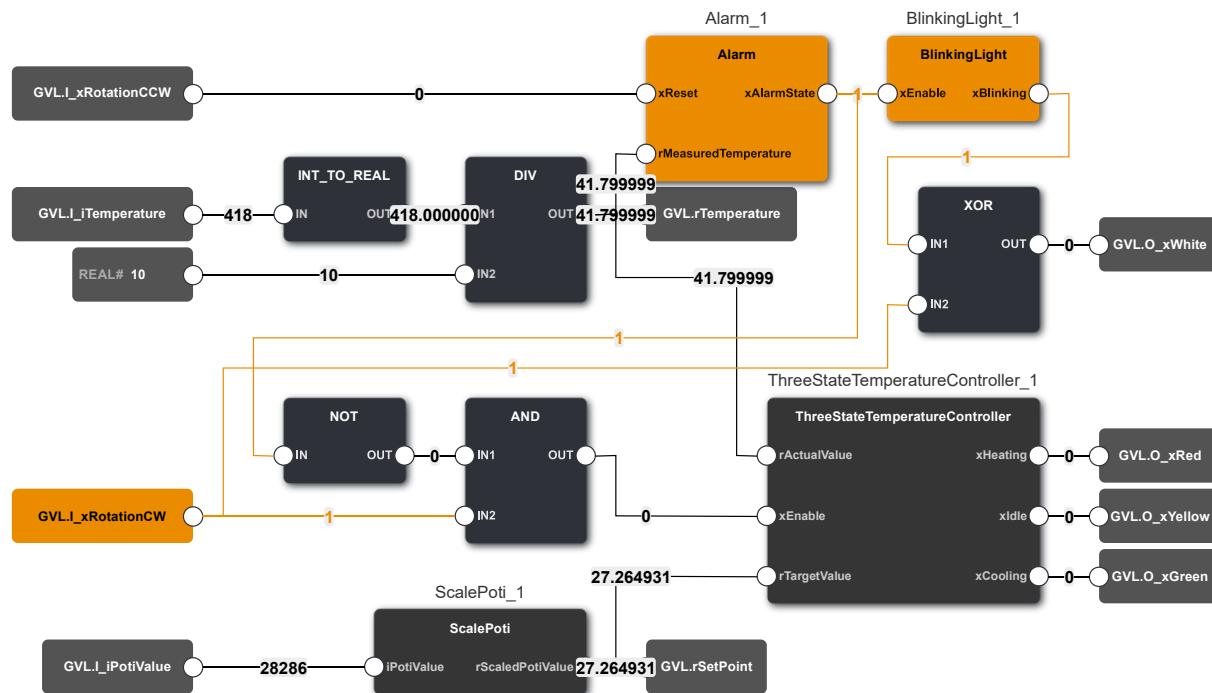
Figure 14: Live view of the main PLC program, alarm triggered

Error! Reference source not found. shows the main PLC program with the alarm triggered. The custom POU BlinkingLight makes the white LED flash at a rate of 1Hz when the alarm state is active. To light the white LED when the controller is enabled, the output of BlinkingLight and the "GVL.I_xRotationCW" are combined with a XOR.
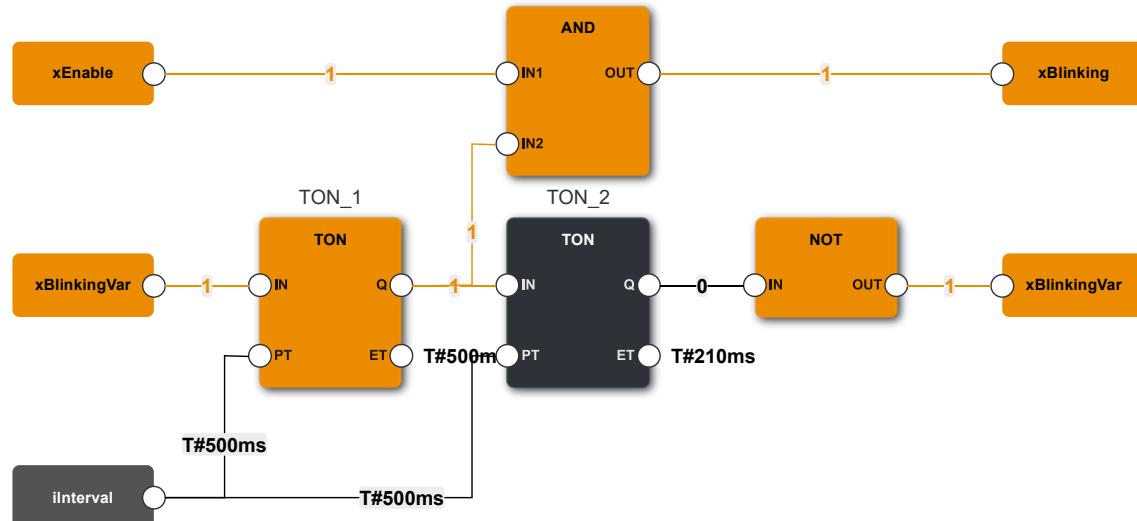

Figure 15: Live view of the BlinkingLight POU, state enabled

The alternating true/false signal used to make the LED flash is generated by the combination of the two TON blocks shown in **Error! Reference source not found.**.

7 Further information

Additional information, including manuals, example projects, Quick Start Guides, and Application Notes can be found on our website. The following resources provide a good starting point:

Support and Downloads for Starter Kits:
https://www.weidmueller.com/int/service/support_for_u_control_starter_kits.jsp