



**Weidmüller** 

## **Starter-Kit | u-control**

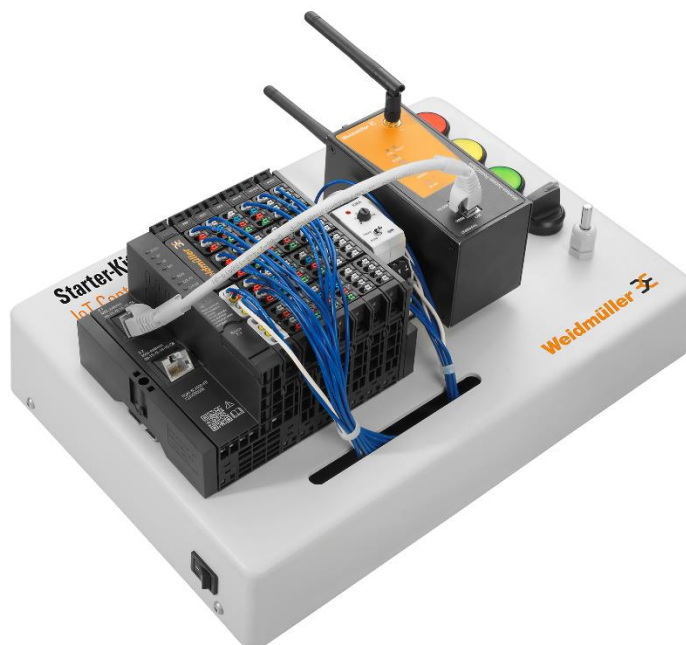
**Internet of Things with Node-RED (IoT)**

2666060000 | STARTERKIT-UC20-WL2000-IoT

## **Quick Start Guide for Starter-Kit IoT + Node-RED**

**Instructions for setup and usage of the Starter-Kit with u-create Web and Node-RED**

**QSG0033v01**



#### Revision history

Version	Date	Change log
01	01.2021	First release

#### Contact

Weidmüller Interface GmbH & Co. KG  
Klingenbergstraße 26  
32758 Detmold, Germany  
T +49 5231 14-0  
F +49 5231 14-292083  
[info@weidmueller.com](mailto:info@weidmueller.com)  
[www.weidmueller.com](http://www.weidmueller.com)

For further support please contact your local sales representative.

Author: w100141

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# 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 provide safety equipment/ electrical safety design or other redundant safety features that are independent from the automation system.

## Disclaimer

This Example / Application Note does not relieve you of the obligation to handle it safely during use, installation, operation and maintenance. Each user is responsible for the correct operation of his control system.

By using this program example / application note prepared by Weidmüller, you accept that Weidmüller cannot be held liable for any damage to property and / or personal injury that may occur because of the use.

## Note

The application examples do not represent customer-specific solutions, they are simply intended to help for typical tasks. The user is responsible for the proper operation of the described products. This application example does not relieve you of the obligation of safe use, installation, operation and maintenance. Application examples are not binding and do not claim to be complete in terms of configuration as well as any contingencies.

By using this Application Example, you acknowledge that we cannot be held liable for any damages beyond the described liability regime. We reserve the right to make changes to this sample application at any time without notice.

In case of discrepancies between the proposals in the application example and other Weidmüller publications, like manuals, such contents always have more priority to the examples.

We assume no liability for the information contained in this document. Our liability, for whatever legal reason, for damages caused by the use of the examples, instructions, programs, project planning and performance data, etc. described in this application example is excluded.

## 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. Abstract

This guide contains instructions on how to activate the starter kit and connect to the controller. Furthermore, it contains a guide how to setup the controller, setup an internet connection using the provided wireless access point and download a demo application to the controller. This demo application utilizes all key components of the starter kit to showcase the implementation of a simple temperature controller. Building on this temperature controller, the publishing of sensor values to a public MQTT broker as well as the reception of these values with a MQTT subscriber is shown.

## 3. Requirements

For certain parts of this Quick Start Guide you will need an internet connection, to push data to an IoT-service or to download software. Ideally, to complete every chapter of this guide, the internet connection is accessible via a simple WPA2-PSK encrypted WiFi (e.g. no corporate network or eduroam with EAP).

### 3.1. Hardware

Hardware	Order Nr. Weidmüller	Comments
STARTERKIT-UC20-SL2000-IOT	2666060000	
PC with Ethernet and full-size USB	-----	

### 3.2. Software

Software	Order Nr. Weidmüller	Comments
Recent web browser	-----	Microsoft Edge, Firefox, Chrome
u-control Demo Application	-----	Download from Weidmüller, Filetype .ucp
Node-RED Demo Application	-----	Download from Weidmüller, Filetype .json

## 4. 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).

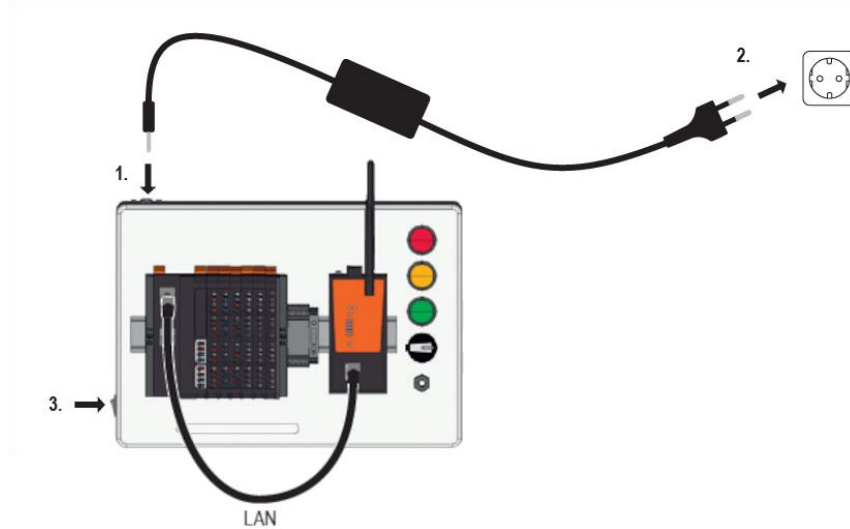


Figure 1: Starter kit and power supply

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.

Optional: max. 3 starter kits

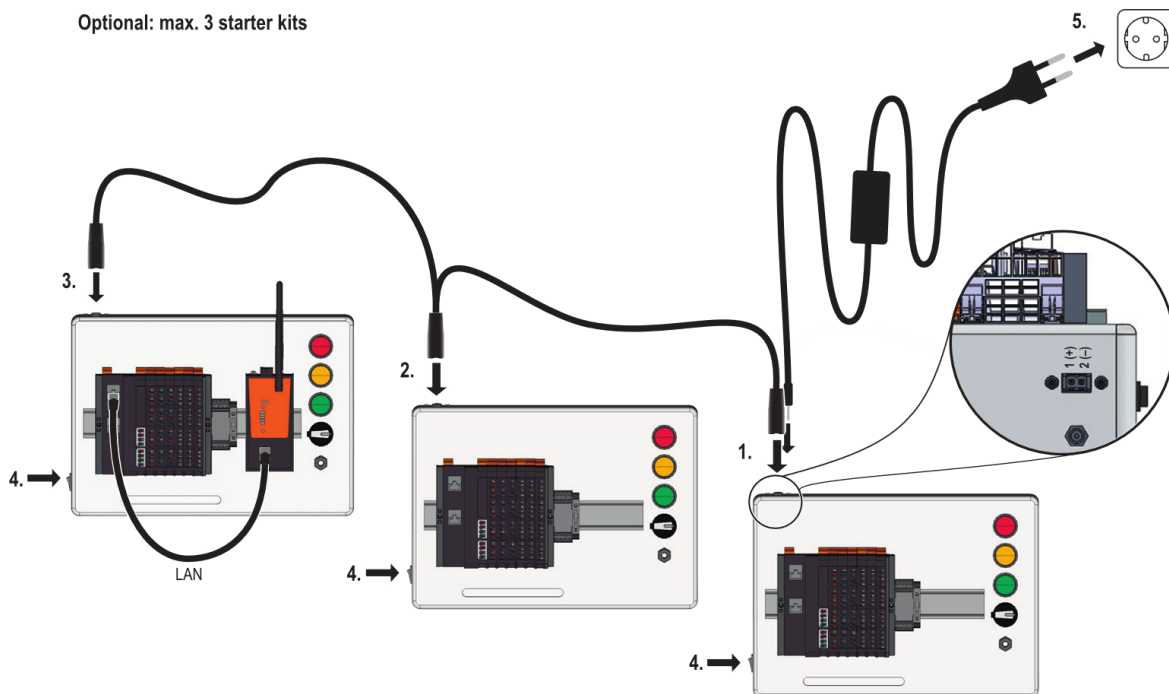


Figure 2: Daisy chaining of up to three starter kits

## 5. Network settings

The starter kit contains two networked devices, the u-control PLC and an WiFi Access Point (AP). The AP can also be used as an WiFi client to connect the u-control PLC to an existing WiFi network.



Out of the box the following IP addresses are used:

u-control USB:	192.168.10.202
u-control Ethernet:	192.168.0.101
Access Point/Client:	192.168.1.110

First, we will configure the u-control PLC to acquire an IP address via DHCP, then we will use the AP to connect to your WiFi network and the internet.

### 5.1. u-control

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](http://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 one of the network interfaces X1 / X2 under the static IP [192.168.0.101](http://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.

For simplicity we will use the first option here. We will use the second approach to connect to the AP in the following section. 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.



The default credentials are:

User:	admin
Password:	Detmold

After login you are greeted by the following screen:

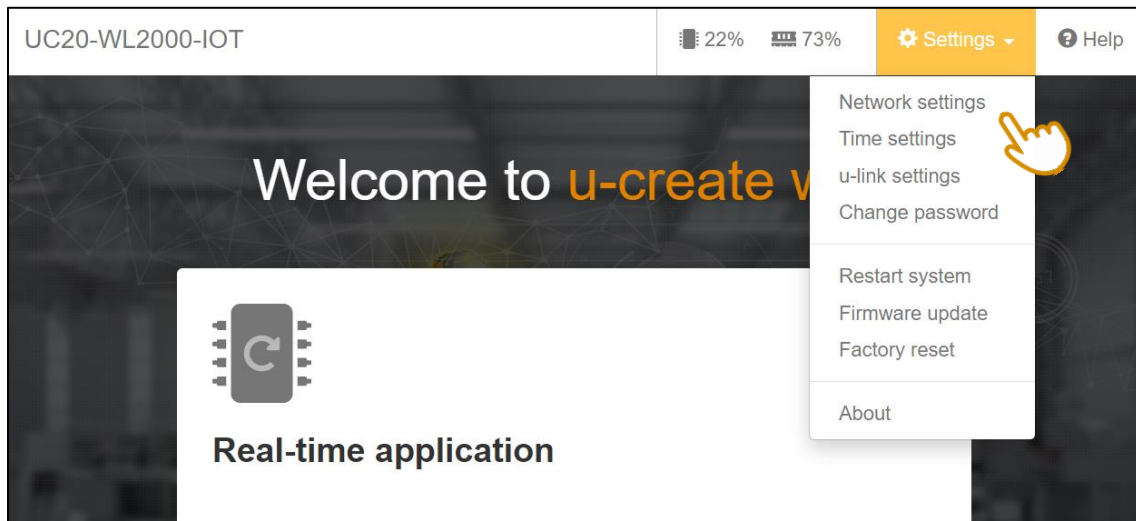


Figure 3: Welcome screen of u-create web, menu network settings

We will start by exploring the network settings of the u-control.

You can configure the network interfaces to either have their IP address assigned dynamically via DHCP or to have a static IP address. Configure X2 to use DHCP:

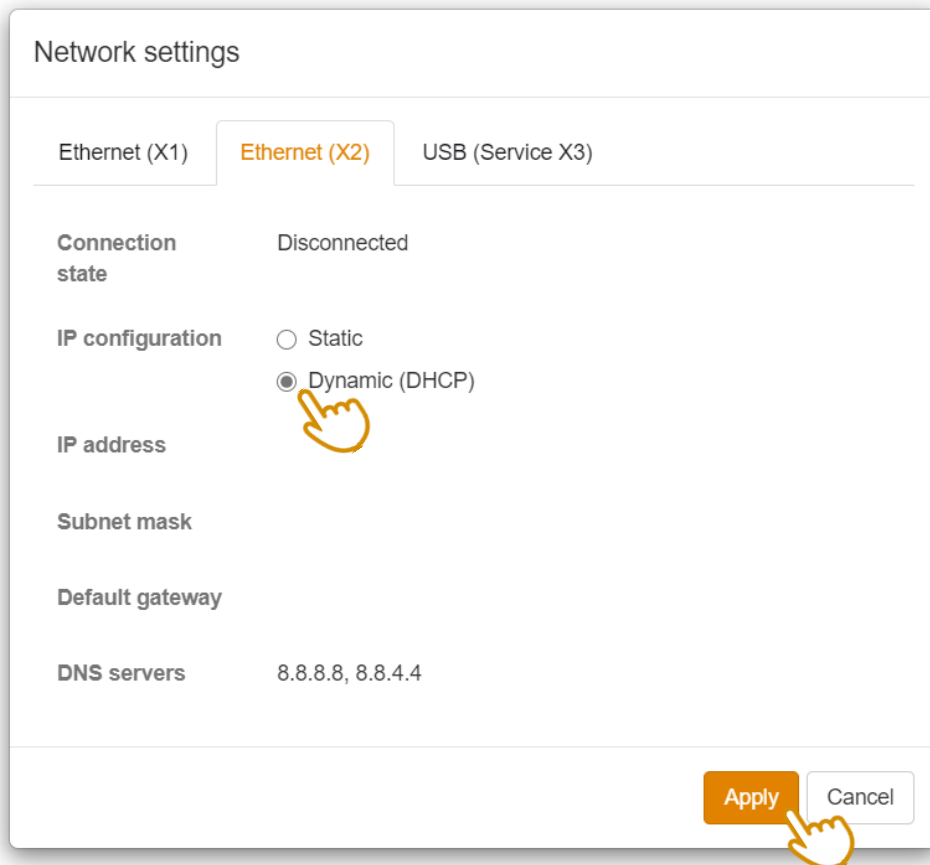


Figure 4: Network settings dialog of u-create web



## 5.2. WiFi access point as a client

Out of the box the AP is configured with the static IP 192.168.1.110 and can only be accessed using a wired connection. Connect an ethernet cable between the AP and your PC.

Configure the network adapter to use a static IP in the same subnet, e.g. 192.168.1.100:

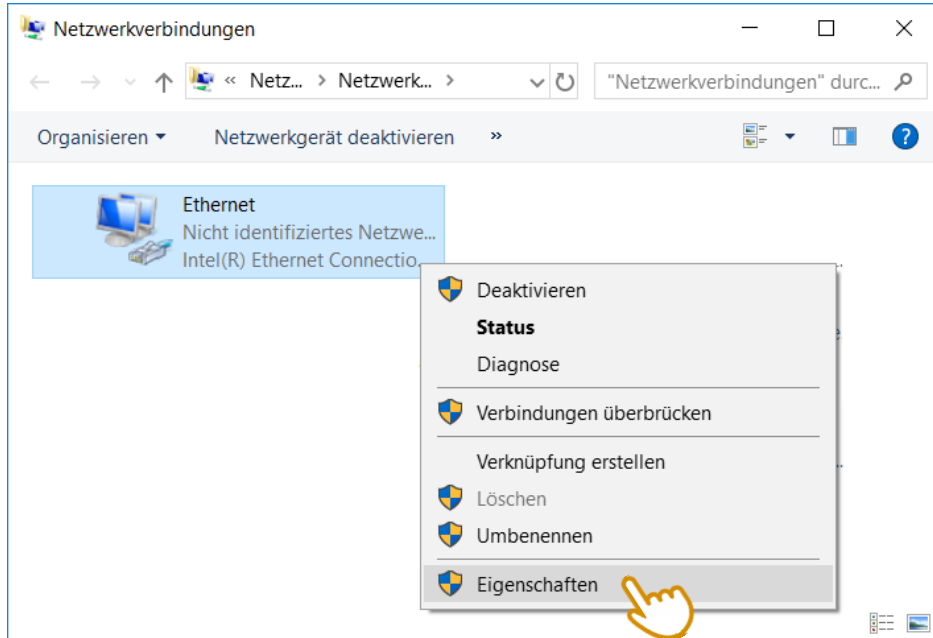


Figure 5: Windows network adapter settings

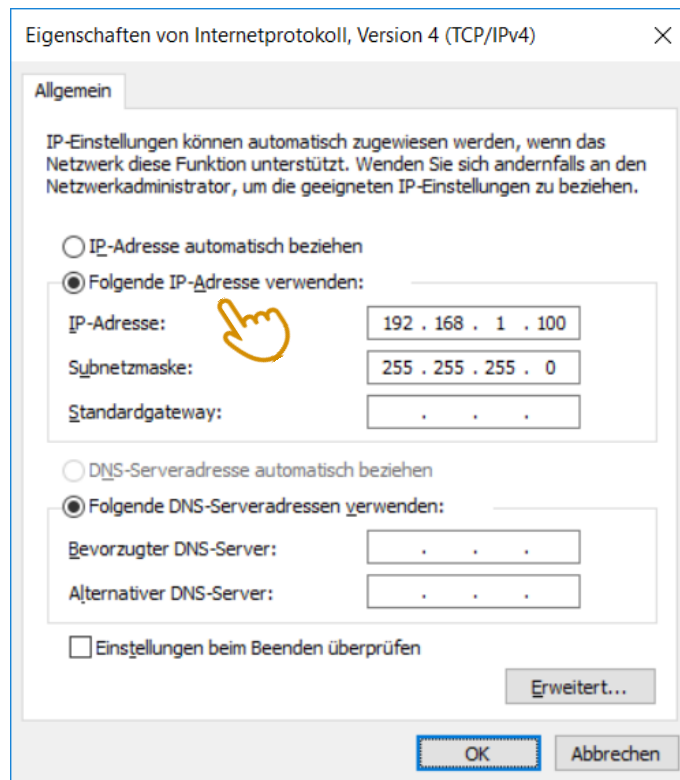


Figure 6: Windows network adapter with static IPv4 address

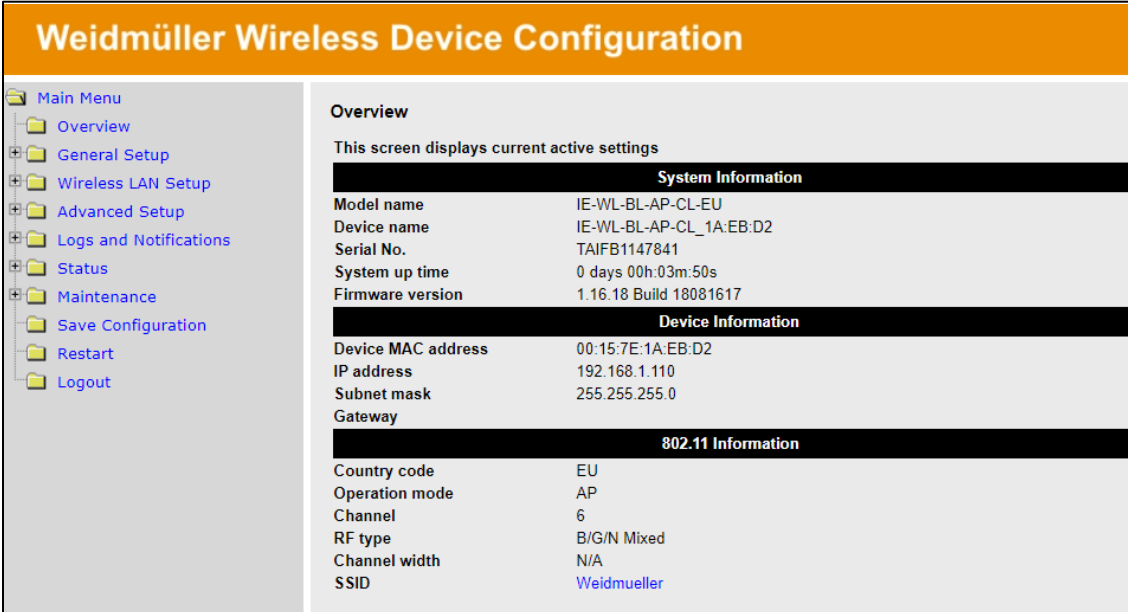
Enter the IP address [192.168.1.110](http://192.168.1.110) in your browser. The login page of the AP will open:



The login page features an orange header with the title 'Weidmüller Wireless Device Configuration' and the Weidmüller logo. The main content area is light gray and displays the device model 'Weidmüller IE-WL-BL-AP-CL-EU'. Below this, there are input fields for 'Username' (containing 'admin') and 'Password' (containing 'Detmold'). A 'Login' button is positioned below the password field, with a hand cursor icon pointing at it. At the bottom left, there is a 'goahead WEB SERVER' logo.

Figure 7: Login page of the wireless access point

Log in using the default credentials as shown in Figure 7. You will be greeted by an overview of the AP's configuration, as shown in Figure 8.



The configuration overview page has an orange header with the title 'Weidmüller Wireless Device Configuration'. On the left is a sidebar menu with options: Main Menu, Overview, General Setup, Wireless LAN Setup, Advanced Setup, Logs and Notifications, Status, Maintenance, Save Configuration, Restart, and Logout. The main content area is titled 'Overview' and contains a table of system and device information.

System Information	
Model name	IE-WL-BL-AP-CL-EU
Device name	IE-WL-BL-AP-CL_1A:EB:D2
Serial No.	TAIFB1147841
System up time	0 days 00h:03m:50s
Firmware version	1.16.18 Build 18081617

Device Information	
Device MAC address	00:15:7E:1A:EB:D2
IP address	192.168.1.110
Subnet mask	255.255.255.0
Gateway	

802.11 Information	
Country code	EU
Operation mode	AP
Channel	6
RF type	B/G/N Mixed
Channel width	N/A
SSID	Weidmueller

Figure 8: Configuration overview of the AP

Navigate to Wireless LAN Setup ► Operation Mode and select “Client”. Make sure the wireless interface is enabled. Make sure to submit your changes after each step.

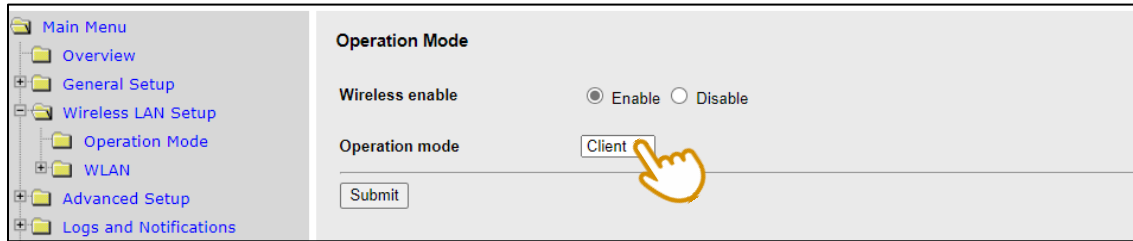


Figure 9: Operation mode selection "Client"

Navigate to Wireless LAN Setup ► WLAN ► Basic WLAN Setup. Enter the SSID (e.g. name) of the wireless network you want to connect to.

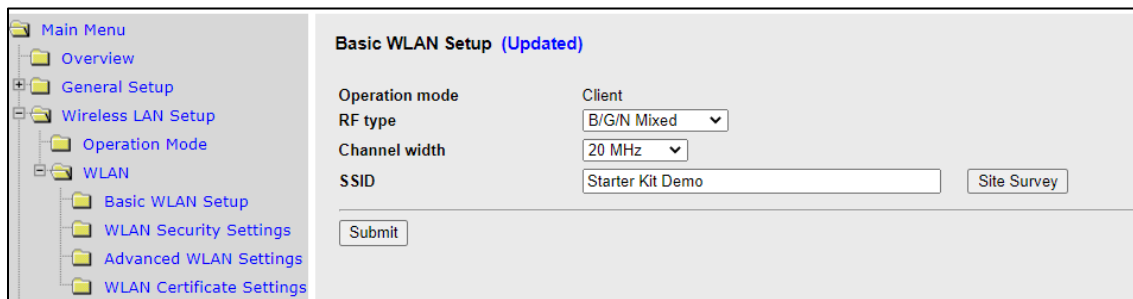


Figure 10: Basic configuration of the wireless connection

Under Wireless LAN Setup ► WLAN ► WLAN Security Settings configure the security mode, passphrase and other settings to match your wireless network.

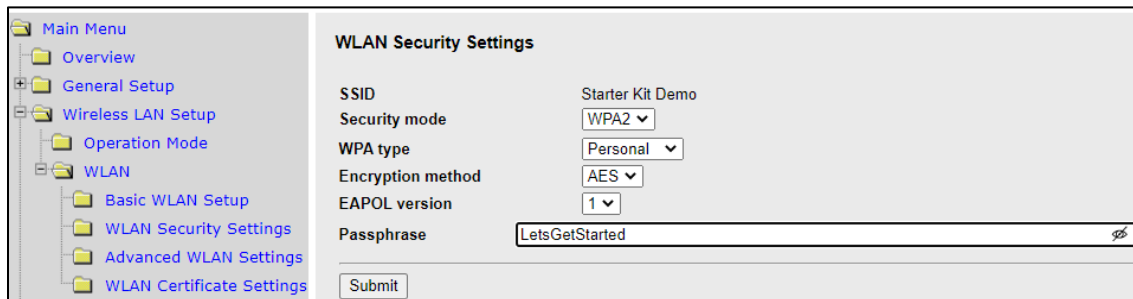


Figure 11: Security settings of the wireless connection

At last configure the AP to receive it's IP address dynamically using DHCP.

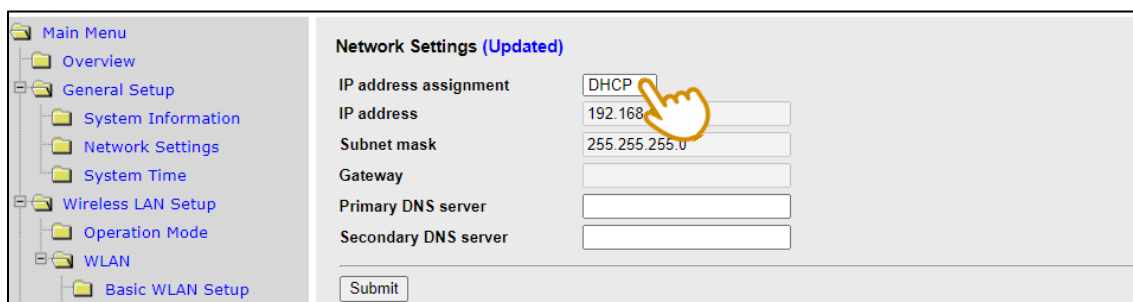


Figure 12: Network settings of the AP, dynamic IP address assignment (DHCP)

Navigate to Save Configuration and click on the “Save” button.

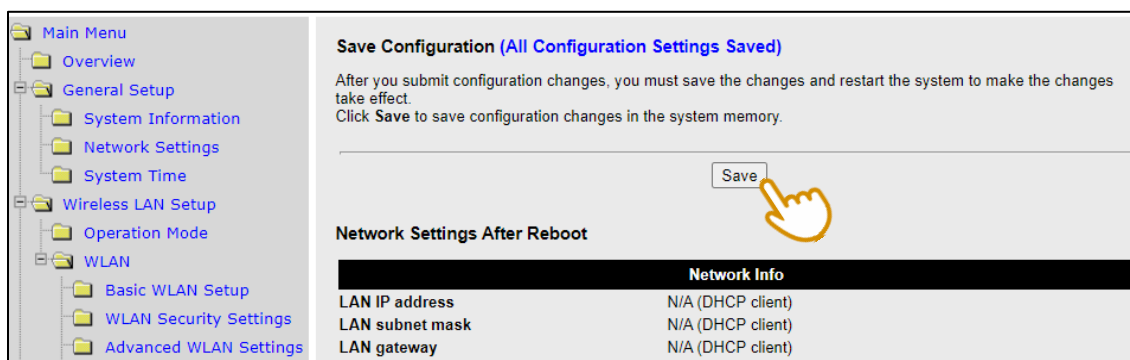


Figure 13: Save the configuration of the AP

Next navigate to Restart and click the “Restart” button. The AP will reboot, as shown in Figure 15.

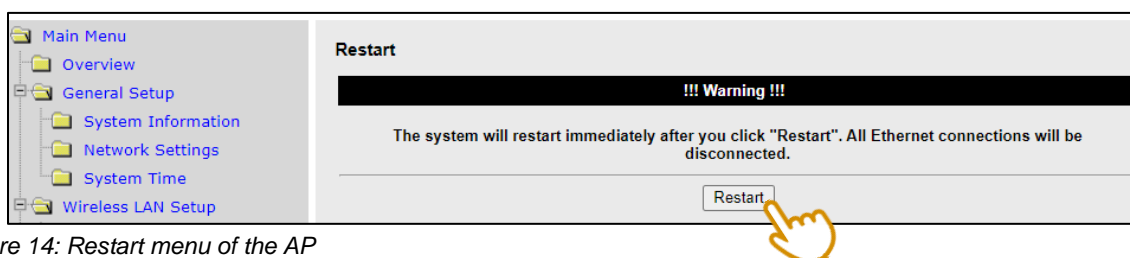


Figure 14: Restart menu of the AP

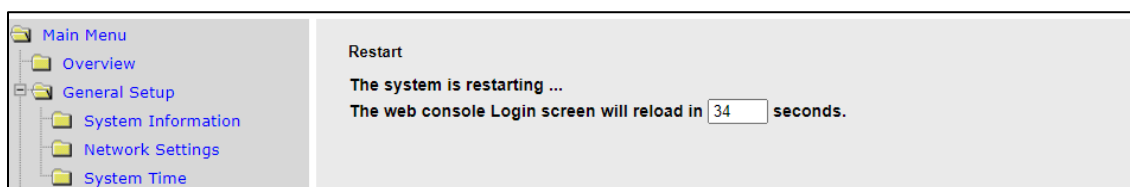


Figure 15: The AP is restarting

Since we’ve configured the AP to receive it’s IP address via DHCP, it will be assigned a new address and won’t be reachable under the default IP address anymore. To discover it’s new IP address, you can use the web interface of the wireless router or access point that’s hosting your wireless network.

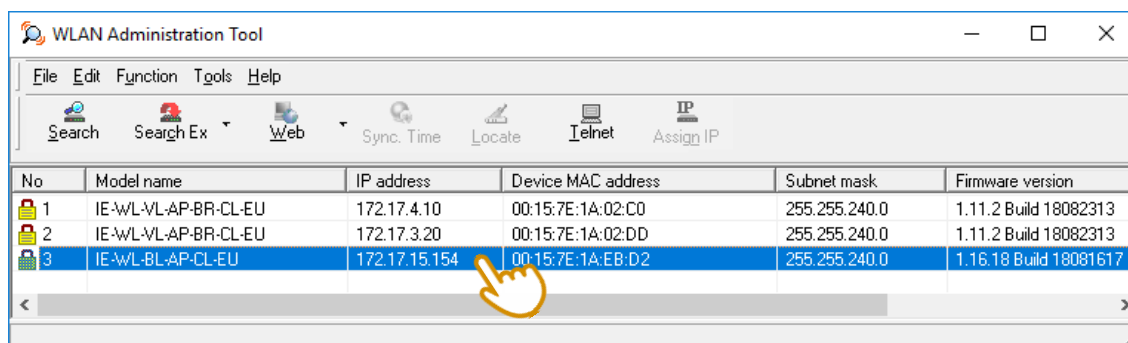
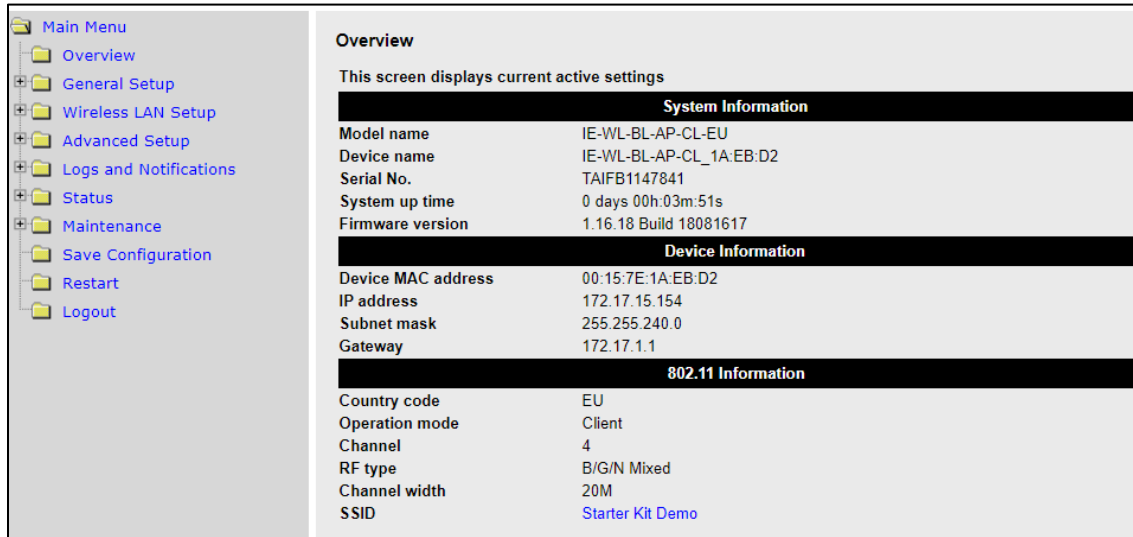


Figure 16: The WLAN Administration Tool allows quick discovery of the AP's new IP address

Alternatively, Weidmüller provides the “WLAN Administration Tool” for PC shown in Figure 16. It is available as a free download from the product catalogue page of the wireless AP. See Chapter 8

for further information. Click on the IP address of the discovered “IE-WL-BL-AP-CL-EU” to open the configuration overview as shown in Figure 17.



The screenshot shows a web interface with a left sidebar menu and a main content area. The sidebar menu includes: Main Menu, Overview, General Setup, Wireless LAN Setup, Advanced Setup, Logs and Notifications, Status, Maintenance, Save Configuration, Restart, and Logout. The main content area is titled 'Overview' and contains the following information:

This screen displays current active settings

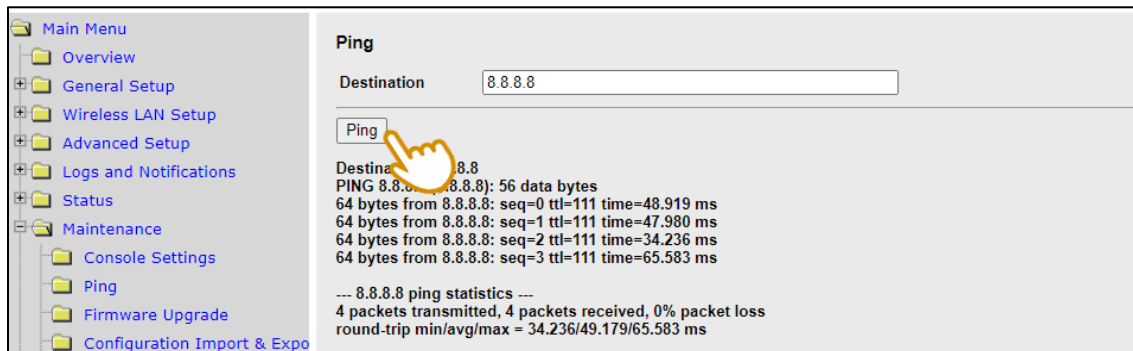
System Information	
Model name	IE-WL-BL-AP-CL-EU
Device name	IE-WL-BL-AP-CL_1A:EB:D2
Serial No.	TAIFB1147841
System up time	0 days 00h:03m:51s
Firmware version	1.16.18 Build 18081617

Device Information	
Device MAC address	00:15:7E:1A:EB:D2
IP address	172.17.15.154
Subnet mask	255.255.240.0
Gateway	172.17.1.1

802.11 Information	
Country code	EU
Operation mode	Client
Channel	4
RF type	B/G/N Mixed
Channel width	20M
SSID	Starter Kit Demo

Figure 17: Overview of the completed AP configuration

To test the internet connection, use the ping tool under Maintenance ► Ping. Google’s public DNS servers (8.8.8.8, 8.8.4.4) are a suitable ping destination. Note the 0% packet loss in the output of the ping tool shown in Figure 18. This means the internet connection is working.



The screenshot shows the 'Ping' tool interface. The 'Destination' field is set to '8.8.8.8'. A hand icon is pointing to the 'Ping' button. The output shows the following results:

```

Destination: 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: seq=0 ttl=111 time=48.919 ms
64 bytes from 8.8.8.8: seq=1 ttl=111 time=47.980 ms
64 bytes from 8.8.8.8: seq=2 ttl=111 time=34.236 ms
64 bytes from 8.8.8.8: seq=3 ttl=111 time=65.583 ms

--- 8.8.8.8 ping statistics ---
4 packets transmitted, 4 packets received, 0% packet loss
round-trip min/avg/max = 34.236/49.179/65.583 ms
    
```

Figure 18: Ping 8.8.8.8 (Google's public DNS server) confirms internet connectivity

## 6. Getting started with u-create web

Now that your starter kit is up and running, we're ready to download and deploy the first application. To make use of most of the provided components we will implement a simple temperature controller. It utilizes most of the starter kit hardware and demonstrates how to read and write global variables and I/O of the u-control PLC with Node-RED.

In this chapter you can familiarize yourself with the hardware of the starter kit and the online engineering tool u-create web. The next chapter shows the implementation of the temperature controller in Node-RED and how to connect it to an MQTT broker.

### 6.1. Importing the demo application

To download the demo application files for u-create web and Node-RED, navigate to the [support page](#) for Weidmüller's u-control starter kits. Scroll down to the downloads section for the u-control IoT starter kit and download the temperature controller example program. You need three files, one for u-create web (.ucp) and two for Node-RED (.json).

Access the u-create welcome page (see section 5.1). Click on the "Edit" button to enter the planning mode of u-create web.

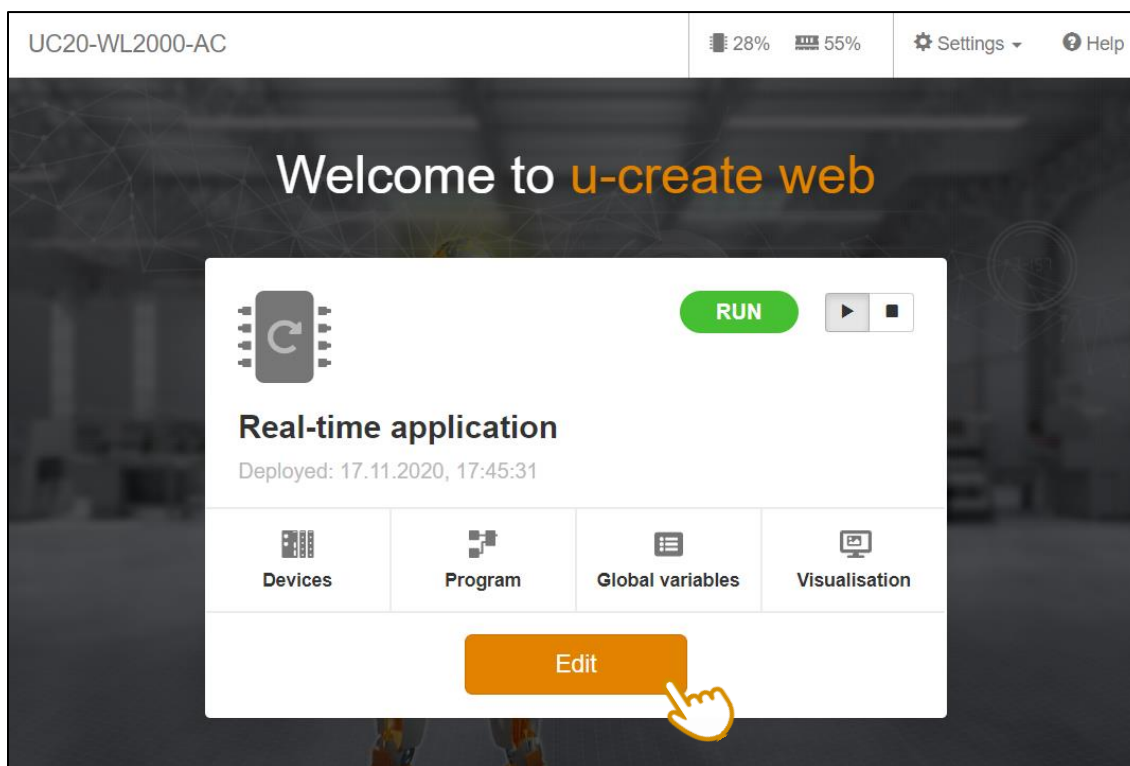


Figure 19: Welcome screen of u-create web, edit button highlighted

The kebab menu (three vertical dots) in the top right-hand corner allows you to upload a project file to the u-control PLC. Select the .ucp file that you've downloaded from the support page. Once the upload 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 that the devices tab still looks the same after the deploy. You'll explore the other tabs in the next sections.

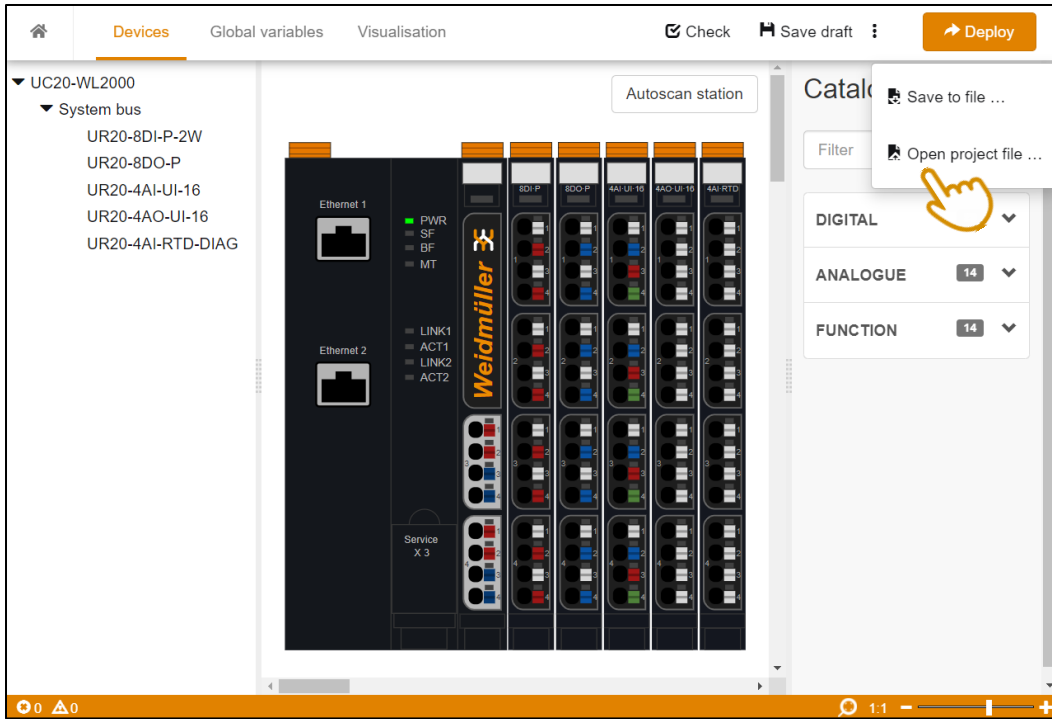


Figure 20: u-create web in planning (e.g. edit) mode, devices tab, import/export menu

## 6.2. Devices and I/O

The starter kit comes fully assembled and ready to use.

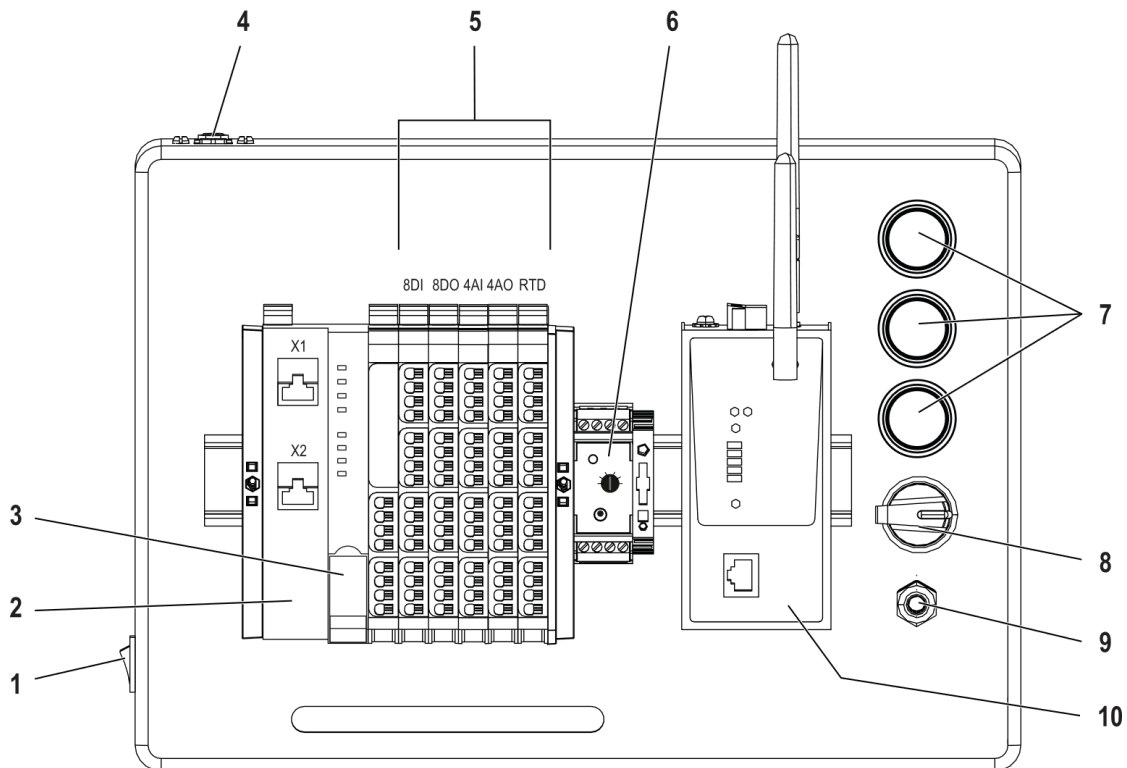


Figure 21: Overview of the starter kit hardware

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:










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

Table 1: List of the starter kit hardware and connections

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.

### 6.3. Global variables

Navigate to the global variables tab of u-create web's live view. To leave the planning mode go back to the welcome page. Then click on "Global Variables".

The live mode is different from the planning mode used in section 6.1, it does not allow you to make any changes but gives you live information about the value of the variables.



Name ↑	Value	Data type
I_IPOTVALUE	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 22: Live view of global variables in u-create web

Note that variables that 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 Node-RED application, which we haven’t uploaded to the u-control yet. Therefore, they will have a value of 0 at this point.

## 6.4. Visualisation

u-create web includes a powerful yet easy to use visualisation tool. You can create and display interactive visualisations like shown in Figure 23 using only a web browser. This is especially useful if you want to use mobile devices like tablets as an HMI. While the creation of these visualisations is out of the scope of this guide, feel free to explore the visualisation in the planning mode. The application note that accompanies this quick start guide goes into more detail, see chapter 8 for further information.



Figure 23: Live view of the visualisation in u-create web

## 7. Getting started with Node-RED

Now that you've explored the integrated features of u-create web, let's see how Node-RED builds on these features and allows you to create automation applications using web technologies. To open Node-RED, click on the respective button on the welcome page of u-create web.

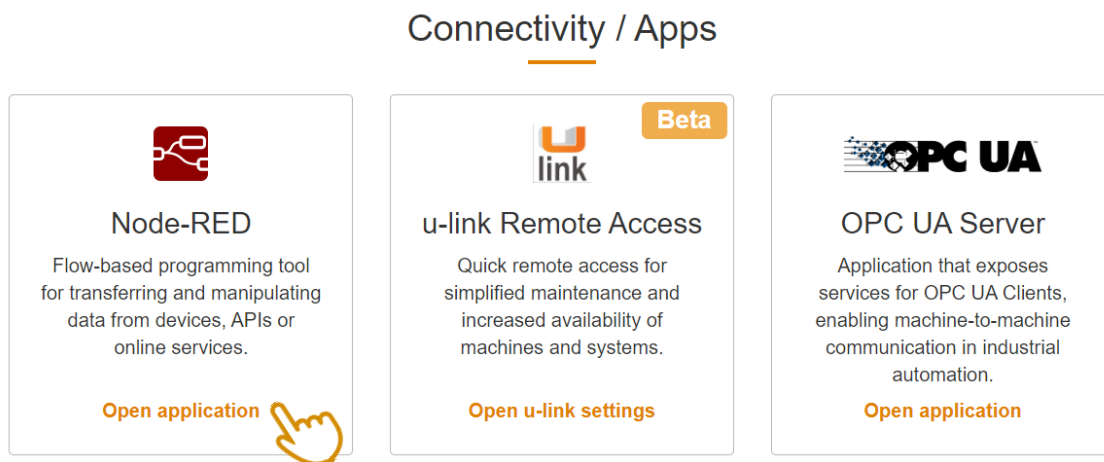


Figure 24: Application menu in u-create web

## 7.1. Importing and running the demo application

Now that you've opened the Node-RED application, you will be greeted by an empty flow canvas.

To import the demo application into Node-RED, click on the hamburger menu in the top right-hand corner and select "Import". Upload the .json file that you've downloaded previously. Make sure to select the file without "mqtt" in its name.

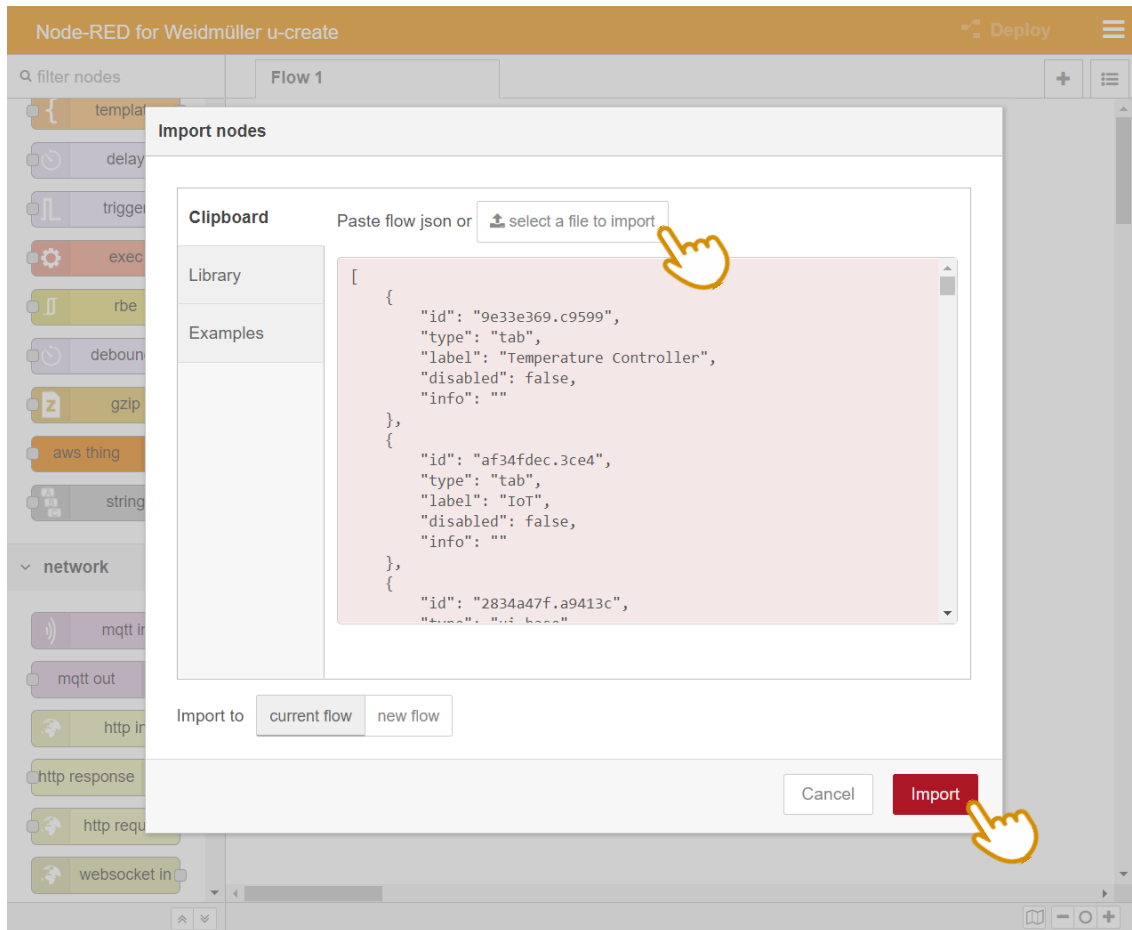


Figure 25: Import dialog in Node-RED, accessible via the hamburger menu in the top right-hand corner

A new tab will be created, containing the temperature controller.

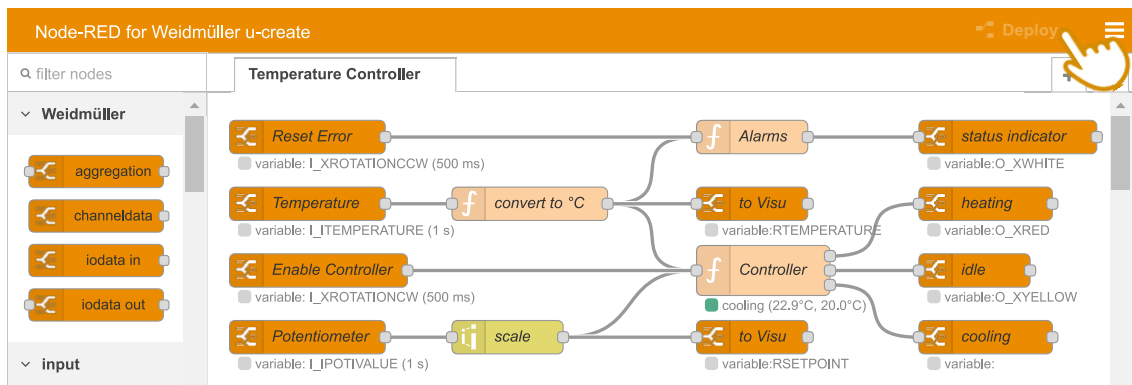










Figure 26: The imported flow in Node-RED, a simple temperature controller that lights the LEDs of the starter kit

Hit “Deploy” to run the program. Any changes made to the program must be deployed as well to take effect. Look at the starter kit. You might notice some LEDs being lit. If not, turn the rotary switch to the South-East / 4:30 position. This enables the temperature controller. You can use the following user inputs to interact with it:

-  Reset Alarm Condition
-  Controller off
-  Controller on
-  Temperature set point [10°C, 30°C]

The controller’s state is shown as a status notice in the Node-RED application on screen. Physically it 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 u-create live view as shown previously in Figure 23.

To interact with the controller, use the analogue encoder (Pos 6 in Figure 21). 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 (<10°C or >30°C) the controller will go into an alarm state, indicated by the flashing white LED. To reset it, wait for the temperature sensor to recover to the allowed range and then hold the rotary switch in the north-east position till the LED turns of. Now the controller can be activated again.

While the implementation of this example application is out of the scope of this guide, feel free to explore the Node-RED flow and the source code in the function nodes on your own. The application note that accompanies this quick start guide describes the implementation in detail, see chapter 8 for further information.

## 7.2. Turning the temperature controller into an IoT-device

Now that the temperature controller is running on the u-control PLC, let's connect it to an MQTT broker to turn it into an IoT-device. We will use the free test broker of mosquitto.org for this guide.

First, we need to install the string node via the Node-RED palette. The palette is accessible via the hamburger menu.

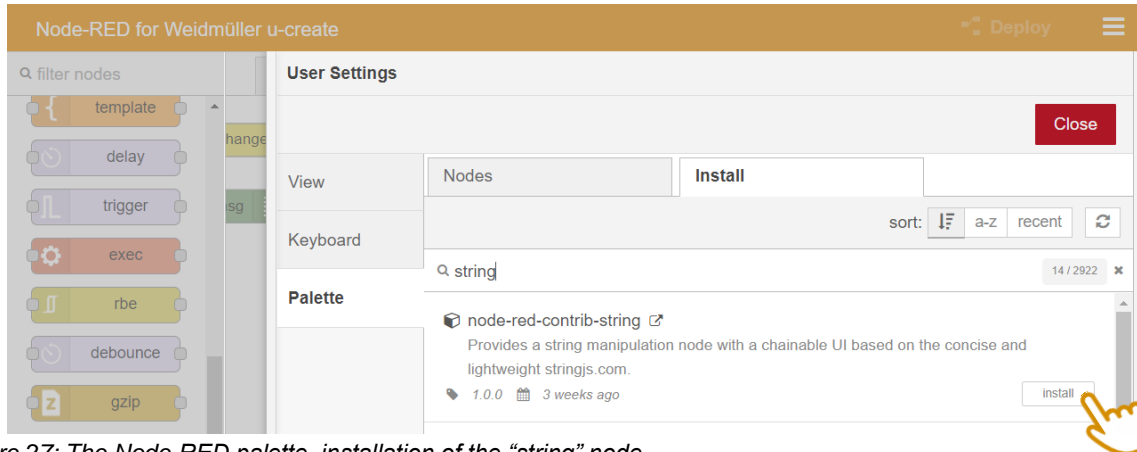


Figure 27: The Node-RED palette, installation of the "string" node

Once the install has finished, indicated by the "install" button changing to "installed", you can import the extended demo application.

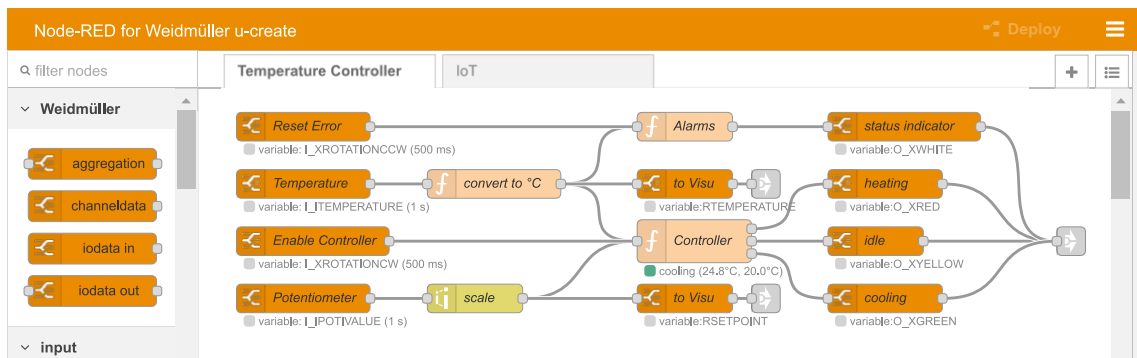


Figure 28: The temperature controller flow with three "out" nodes connecting to the IoT flow

It comes with a preconfigured MQTT publisher node that sends the controllers state to the mosquitto.org broker. This node can be found on the new tab named "IoT".

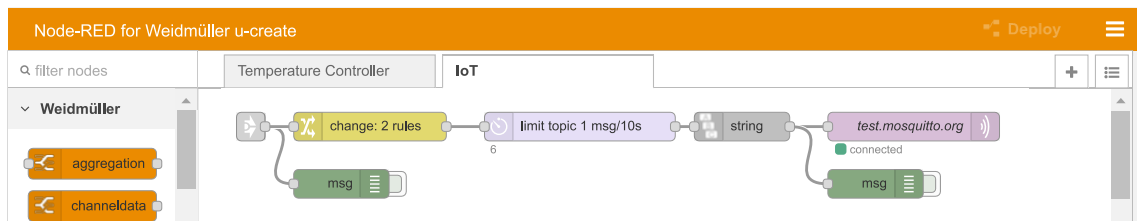
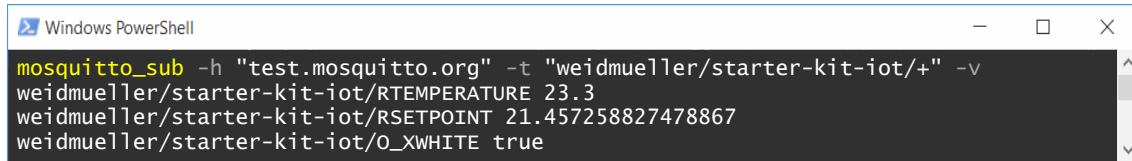


Figure 29: The IoT flow with an MQTT publisher node

The status "connected" beneath the MQTT node indicates that the MQTT publisher is up and running and connected to the broker.

To see which values the controller is publishing via MQTT you need to subscribe to the topic “weidmueller/starter-kit-iot/+” using an MQTT subscriber of your choice. The free command line utility `mosquitto_sub` is shown below.



```
Windows PowerShell
mosquitto_sub -h "test.mosquitto.org" -t "weidmueller/starter-kit-iot/+" -v
weidmueller/starter-kit-iot/RTEMPERATURE 23.3
weidmueller/starter-kit-iot/RSETPOINT 21.457258827478867
weidmueller/starter-kit-iot/O_XWHITE true
```

Figure 30: The Mosquitto MQTT subscriber command line utility (command can be copied)

## 8. Further information

More information, manuals, example projects, Quick start guides, application notes you can find on our website. The following resources provide a good starting point.

**AN0055:** Application Note for a simple temperature controller with MQTT publisher in Node-RED

### Support and Downloads for Starter Kits

[https://www.weidmueller.com/int/service/support\\_for\\_u\\_control\\_starter\\_kits.jsp](https://www.weidmueller.com/int/service/support_for_u_control_starter_kits.jsp)

### UC20-WL2000-IOT

[https://catalog.weidmueller.com/procat/Product.jsp?productId=\(%5b1334990000%5d\)](https://catalog.weidmueller.com/procat/Product.jsp?productId=(%5b1334990000%5d))

### WiFi Access Point IE-WL-BL-AP-CL-EU

[https://catalog.weidmueller.com/procat/Product.jsp?productId=\(%5b2536600000%5d\)](https://catalog.weidmueller.com/procat/Product.jsp?productId=(%5b2536600000%5d))

### MQTT General Information

<https://mqtt.org/>

### Eclipse Mosquitto™ MQTT tools

<https://mosquitto.org/>