Application Note

FESTO

CPX-IOT with EtherCat

This document describes how to set up a CPX-IOT gateway and how to use all the performances of the device in EtherCAT environment.

CPX-IOT

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Author ..... Festo
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Table of contents

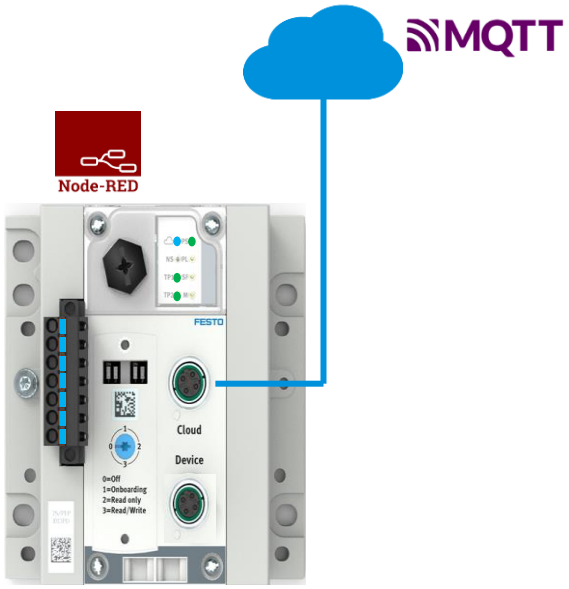
1 Components/Software used

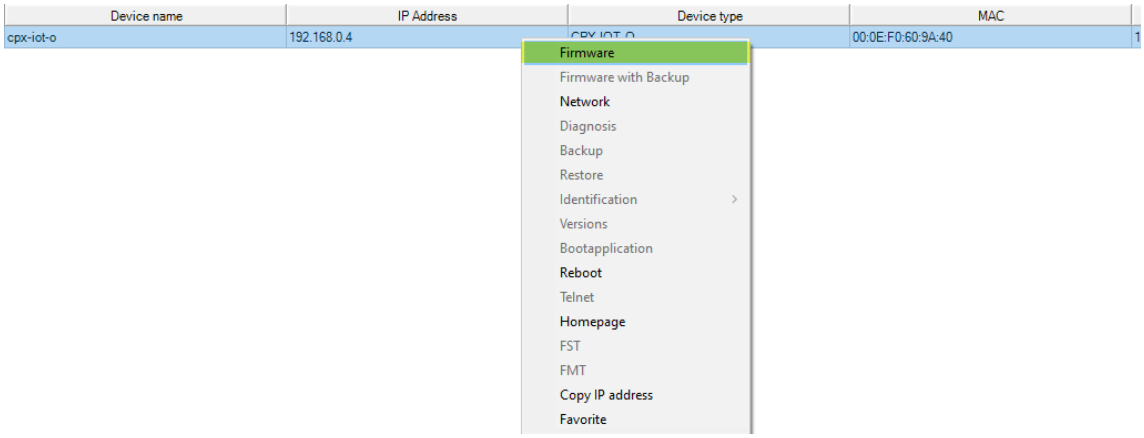
Type/Name	Version Software/Firmware	Date of manufacture
CPX-IOT-O	1.0.6-ac67942f6M.20210831	

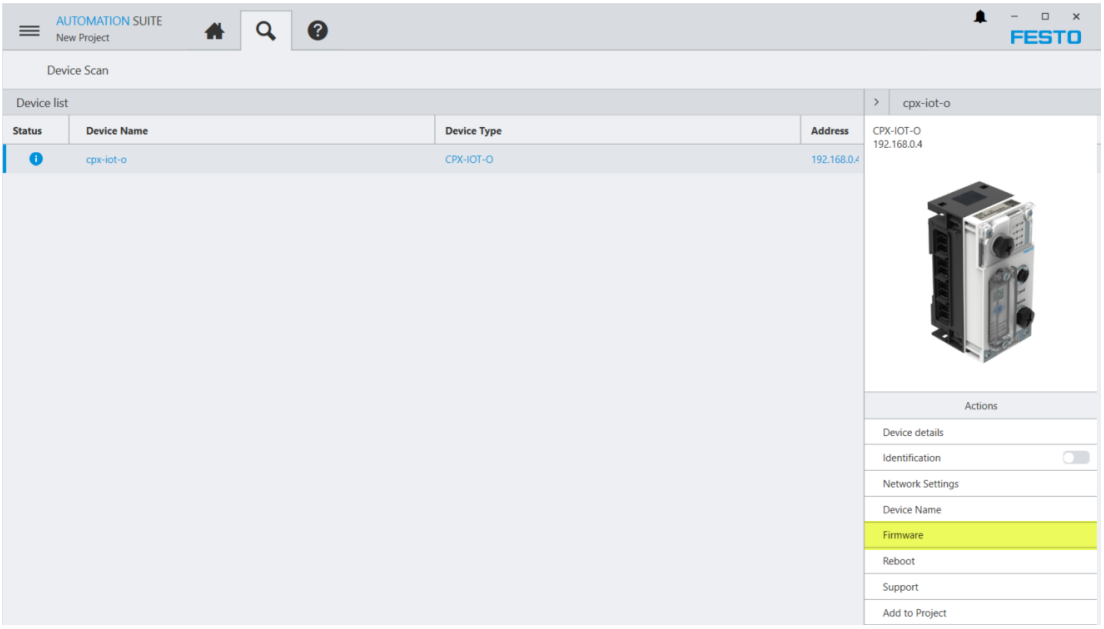
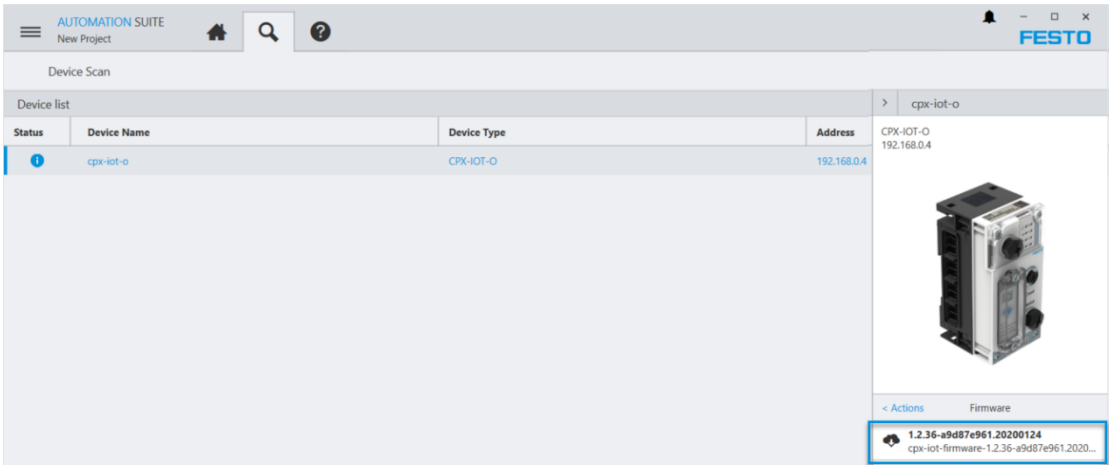
Table 1.1: 1 Components/Software used

1.1 Overview Connectivity

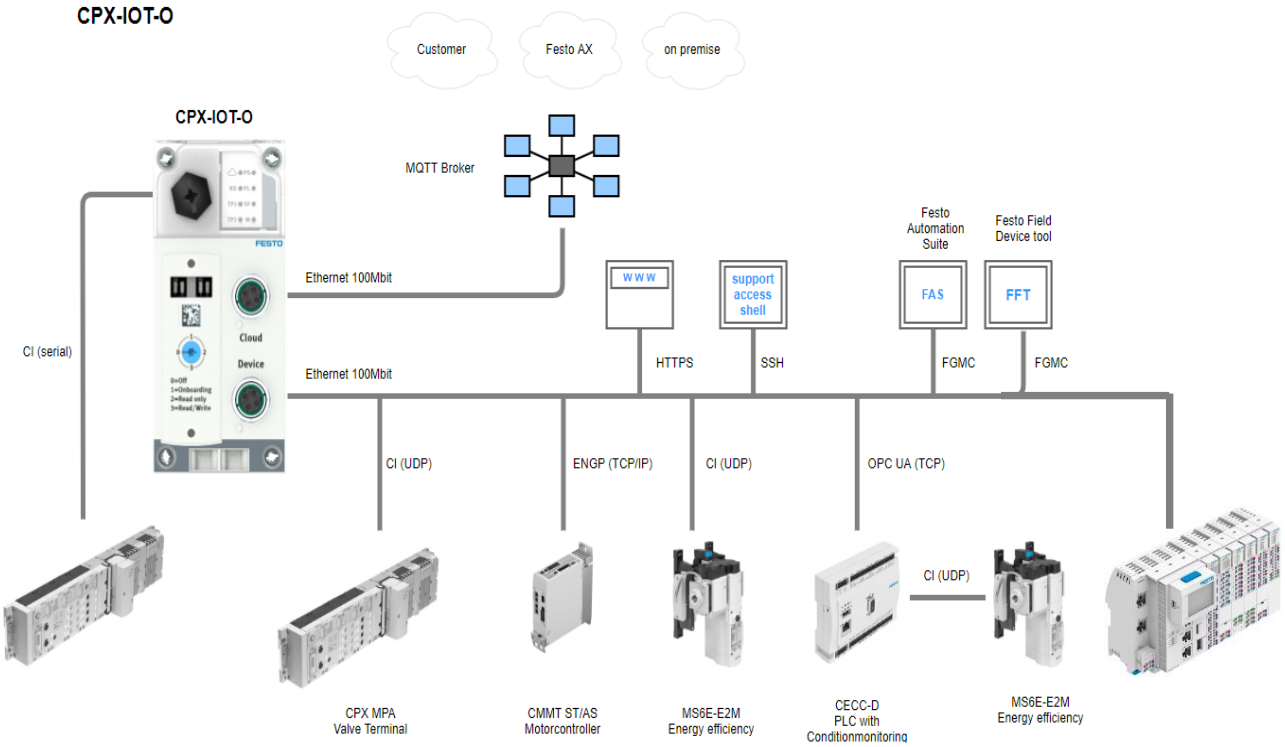
Node-RED is optional and must be installed separately. In order to get the latest security fixes, the correct procedure for updating the CPX-IOT is shown below.



No.	How to update CPX-IOT
1.	Update the bootloader file using Festo Field Device tool. Hint: Bootloader should be updated if there is a new version.
	

2	Via Festo Automation Suite
	
	
	cpx-iot-o-bootloader-1.3.0-6d08cb642.20211021.ffwu
2.	After updating the bootloader, do the same with firmware file. Use the same procedure as before.
	cpx-iot-o-firmware-1.0.7-6d08cb642.20211021.ffwu
3.	As optional, download the Node-RED file. Use the same procedure as before.
	cpx-iot-o-node-red-1.0.7-6d08cb642.20211021.ffwu

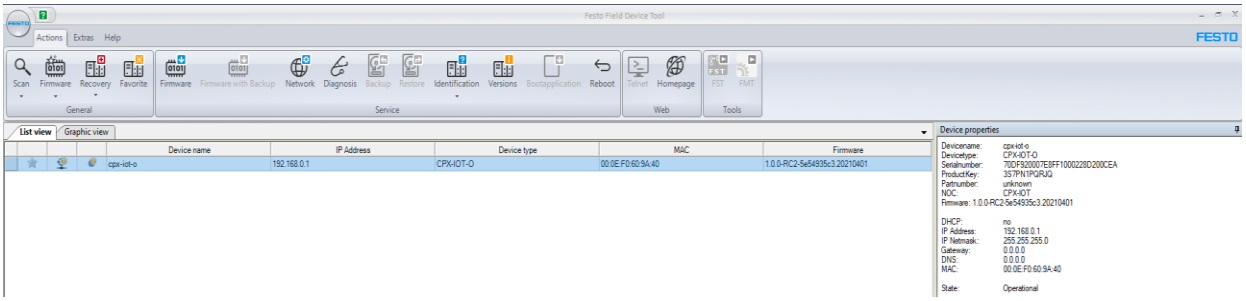
An overview of the connectivity of the CPX-IOT is shown in the following image. The MQTT broker could be also connected to the Device interface.



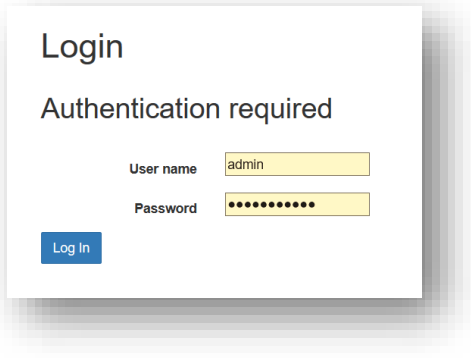
2 CPX_IOT

2.1 Login

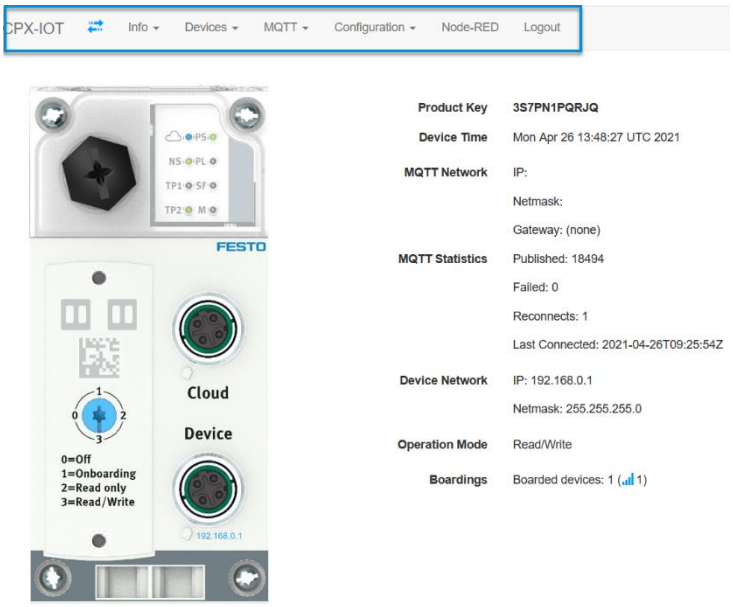
Default IP address: 192.168.0.1
Festo Field Device tool:



- Open a browser https://your-device-ip-address
- User name: admin
- Password: Festo Product Key



2.2 Webserver Toolbar.



MQTT  connection status.

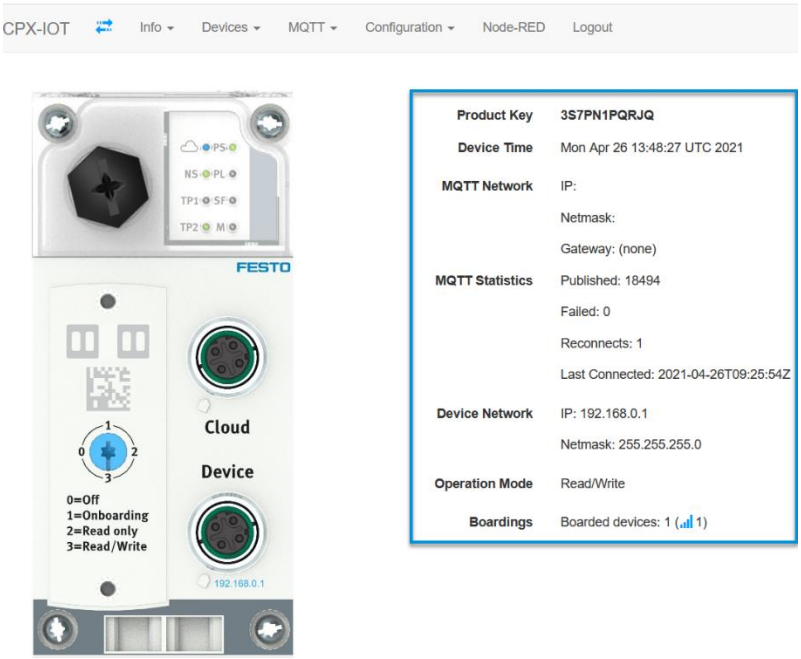
Red: MQTT disconnected.

Blue: MQTT connected.

Orange: Logout.

Info: General information and diagnosis.
Devices: Device boarding and configuration.
MQTT: MQTT configuration.
Configuration: MQTT and NTP configuration.
Node-Red: Node-Red for custom code.
User: Change user credentials.

2.3 Webserver home page



Product Key: Device Product Key.

Devices Time: Data and time from CPX-IOT.

MQTT Network: MQTT network configuration.

MQTT Network: Basic MQTT statistics.

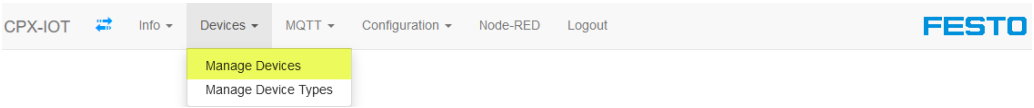
Device Network: Device network configuration.

Operation Mode: Should be on “Read/Write”.

Boardings: Count of boarded devices.

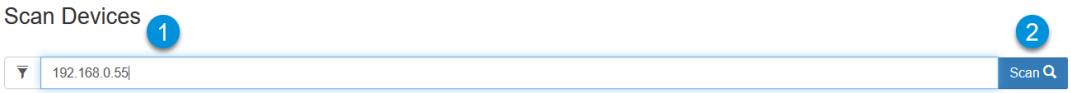
2.4 Manage Devices. Scan Devices

Plug devices to the device port as shown on the picture below. For scanning click on Manage Devices.

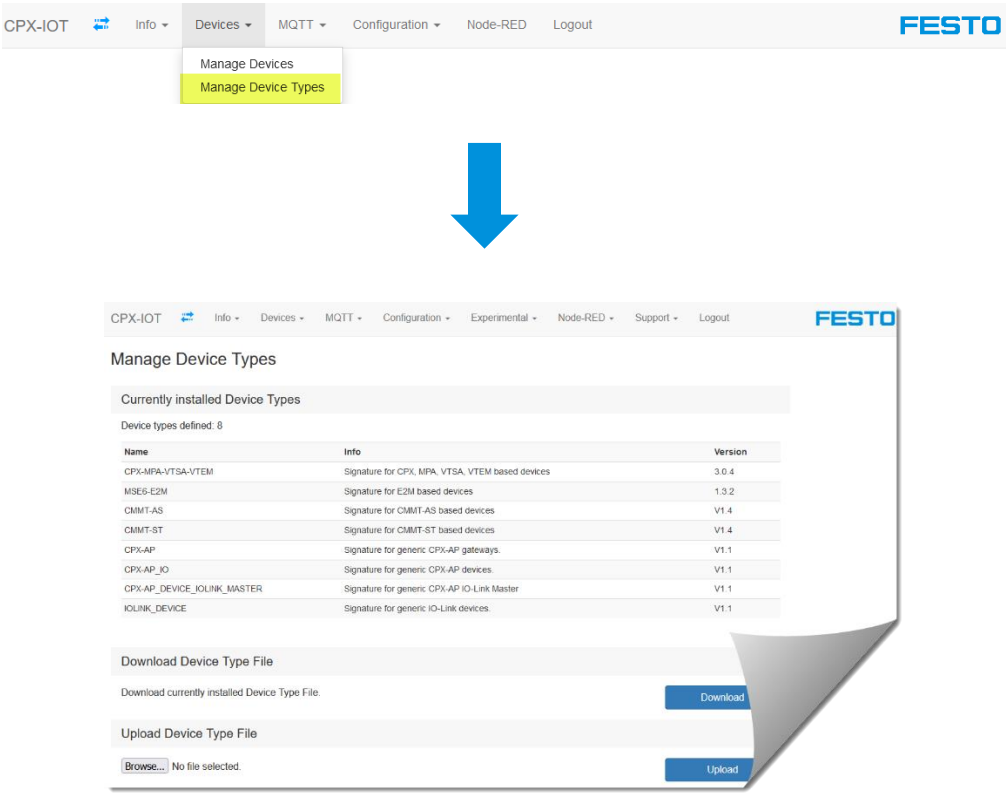


- Scan automatically.

- Write the device IP address.



CPX-IOT supports all the slaves shown below. As soon as the device is connected to CPX-IOT the data is automatically received on Node-RED. As mentioned in the section “Overview Connectivity” Node-RED is optional, the data is transmitted via MQTT. If Node-RED is installed the default MQTT setup is transferring the data to Node-RED.



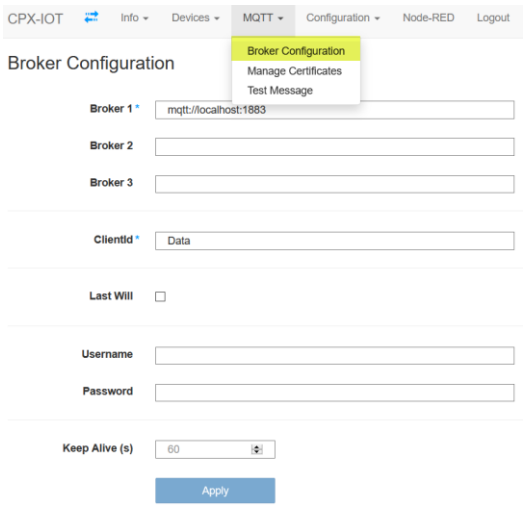
2.5 MQTT

MQTT is an OASIS standard messaging protocol for the Internet of Things (IoT). It is designed as an extremely lightweight publish/subscribe messaging transport that is ideal for connecting remote devices.

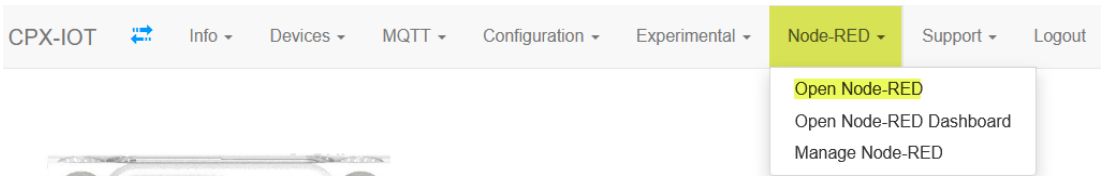
2.5.1 Configure localhost MQTT Broker

In order to read the data from the boarded devices. MQTT communication must be enabled otherwise the MQTT_IN function will be connected but no transmission is possible. How to make a Board of the devices will be explained in the next chapters. It is only detailed on this chapter the principle of localhost MQTT Broker.

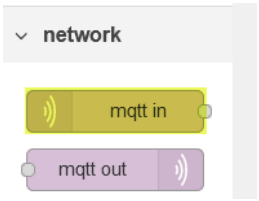
Local MQTT broker --› mqtt://localhost:1883



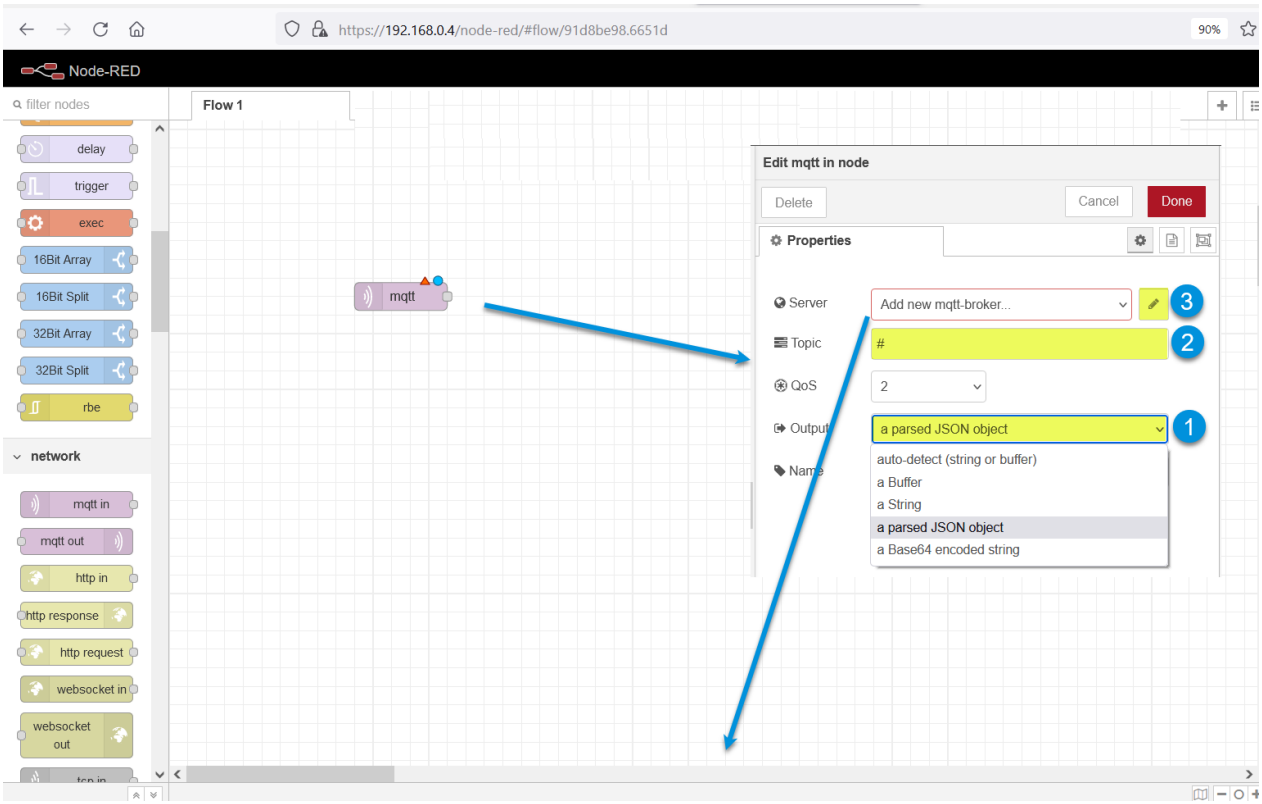
How to open Node-red in order to read the data published.

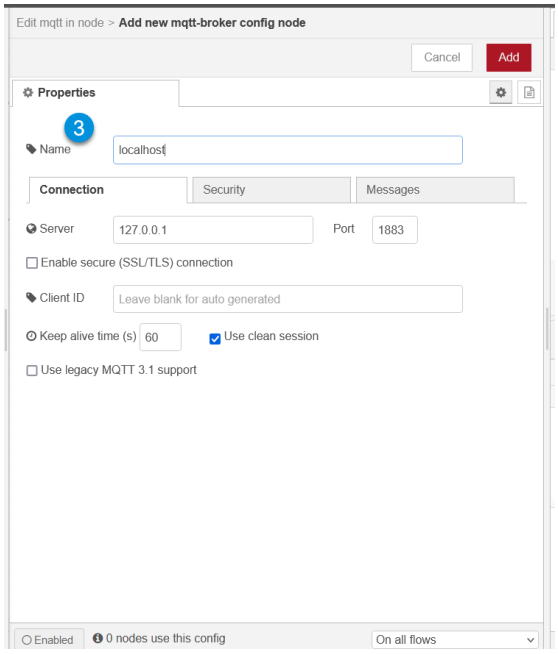


Go to the Node-red palette and choose MQTT in and drag & drop.

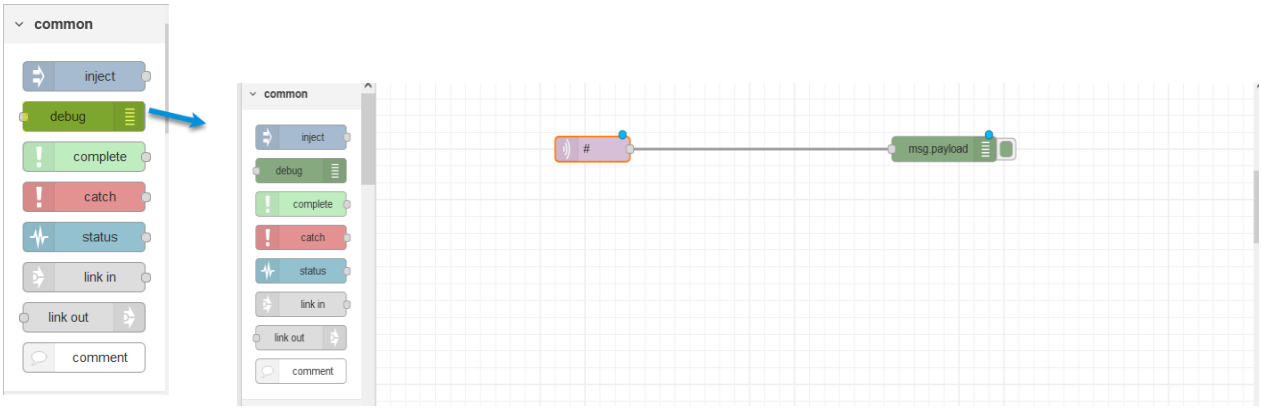


Configure the MQTT in:

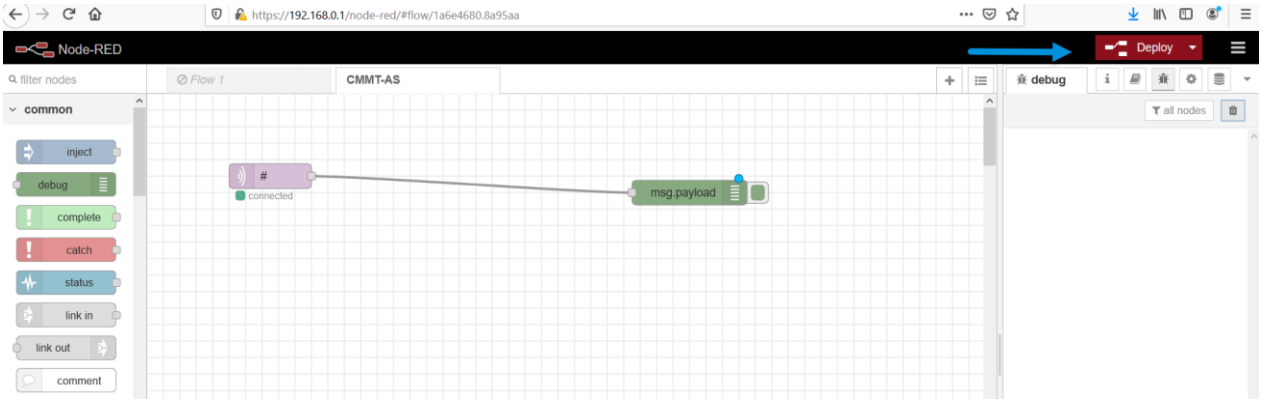




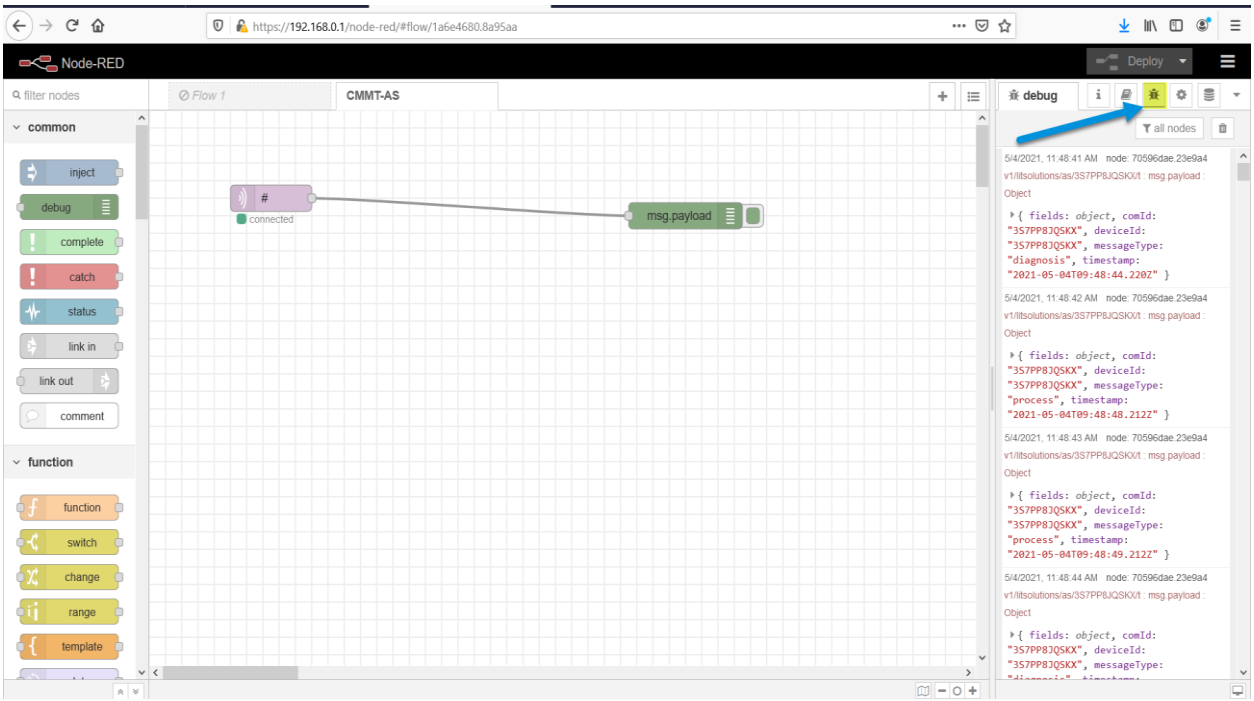
For reading the data coming, please connect a payload to the MQTT in



Finally click on deploy

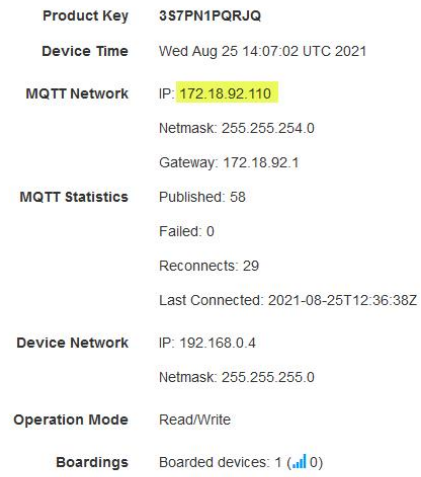


After deploying, please click on debug messages in order to check the data:


https://192.168.0.1/node-red/#flow/1a6e4680.8a95aa
Node-RED
Deploy
filter nodes
Flow 1
CMMT-AS
debug
common
inject
debug
complete
catch
status
link in
link out
comment
function
function
switch
change
range
template
#
connected
msg.payload
all nodes
5/4/2021, 11:48:41 AM node: 70596dae.23e9a4
v1/litsolutions/as/3S7PP8JQSKX/t : msg.payload : Object
{ fields: object, comId: "3S7PP8JQSKX", deviceId: "3S7PP8JQSKX", messageType: "diagnosis", timestamp: "2021-05-04T09:48:44.220Z" }
5/4/2021, 11:48:42 AM node: 70596dae.23e9a4
v1/litsolutions/as/3S7PP8JQSKX/t : msg.payload : Object
{ fields: object, comId: "3S7PP8JQSKX", deviceId: "3S7PP8JQSKX", messageType: "process", timestamp: "2021-05-04T09:48:48.212Z" }
5/4/2021, 11:48:43 AM node: 70596dae.23e9a4
v1/litsolutions/as/3S7PP8JQSKX/t : msg.payload : Object
{ fields: object, comId: "3S7PP8JQSKX", deviceId: "3S7PP8JQSKX", messageType: "process", timestamp: "2021-05-04T09:48:49.212Z" }
5/4/2021, 11:48:44 AM node: 70596dae.23e9a4
v1/litsolutions/as/3S7PP8JQSKX/t : msg.payload : Object
{ fields: object, comId: "3S7PP8JQSKX", deviceId: "3S7PP8JQSKX", messageType:

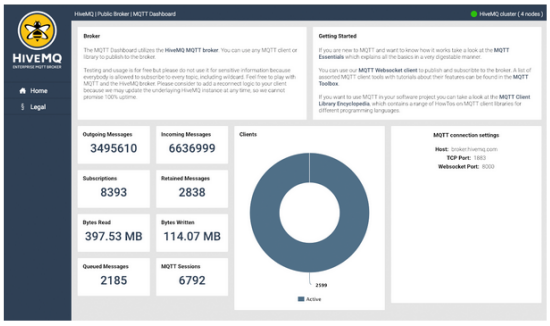
2.5.2 Broker Configuration HIVE MQ

This chapter shows and example how to setup a MQTT communication to a broker This section is not mandatory for the configuration of the CPX-IOT itself. The aim of this chapter is to show a practical example of a broker connection. A free public broker will be used and only the basic parameters will be configured.

No.	Action
1	Connect cloud port to the Internet. The Router via DCHP assign an IP to the CPX-IOT cloud port. The router assign to CPX_IOT **172.18.92.110**
	 

2	On this step, set up a MQTT communication to the public broker (HiveMQ), as an example. Open a browser and write the following URL: https://www.hivemq.com/public-mqtt-broker/

Public MQTT Broker



Our **Public HiveMQ MQTT broker** is open for anyone to use. Feel free to write an MQTT client that connects with this broker. We have a **dashboard** so you can see the amount of traffic on this broker. We also keep a list of **MQTT client libraries** that can be used to connect to HiveMQ.

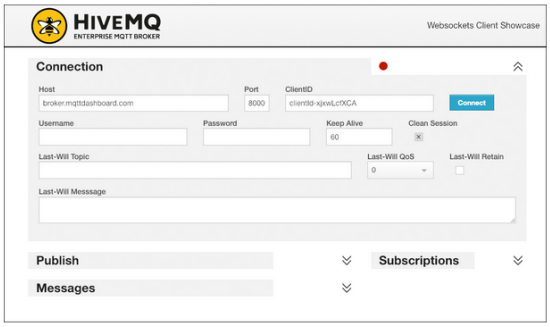
You can access the broker at:

Broker: `broker.hivemq.com`

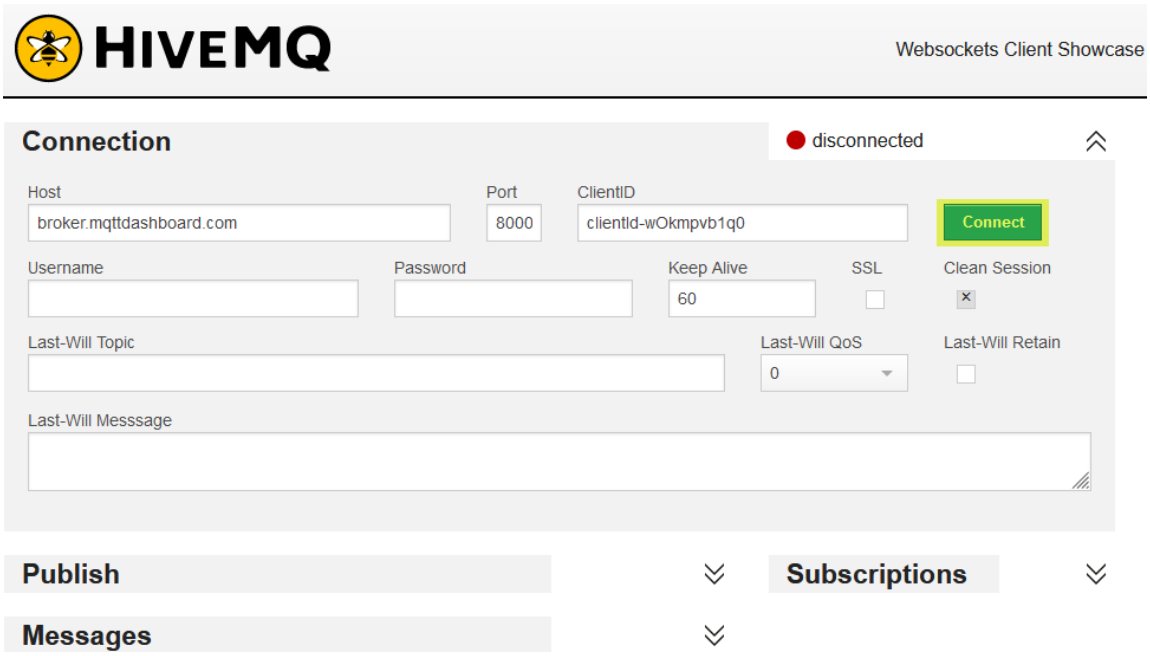
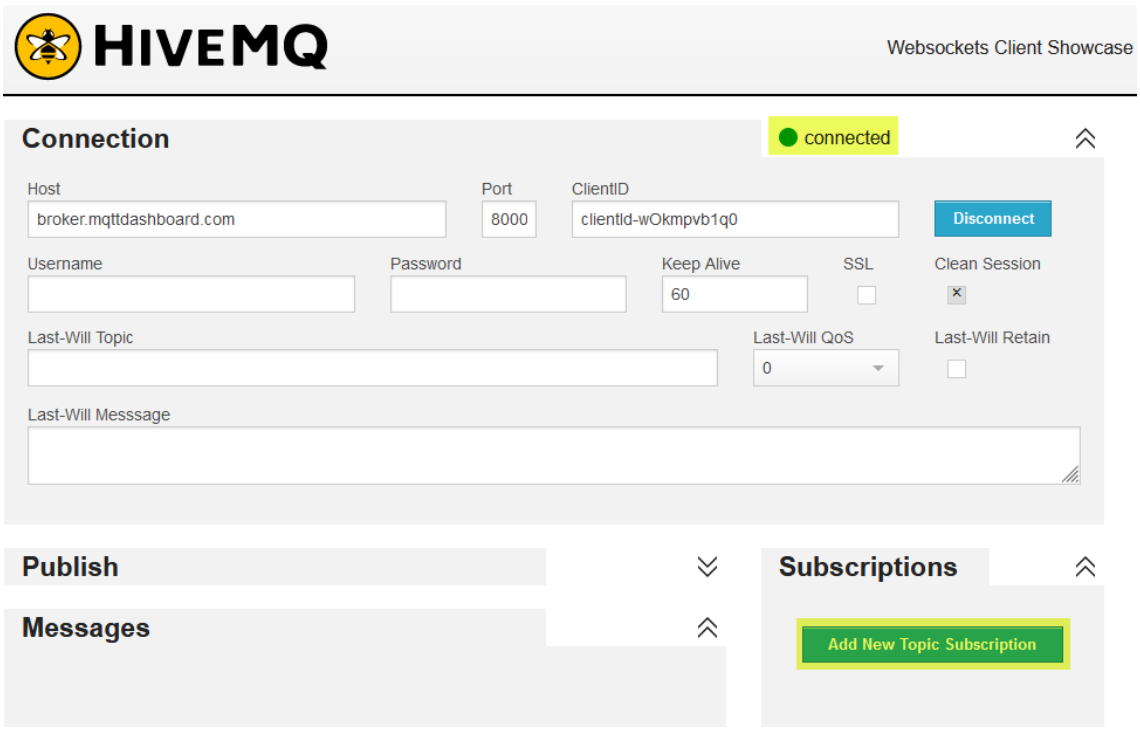
TCP Port: `1883`

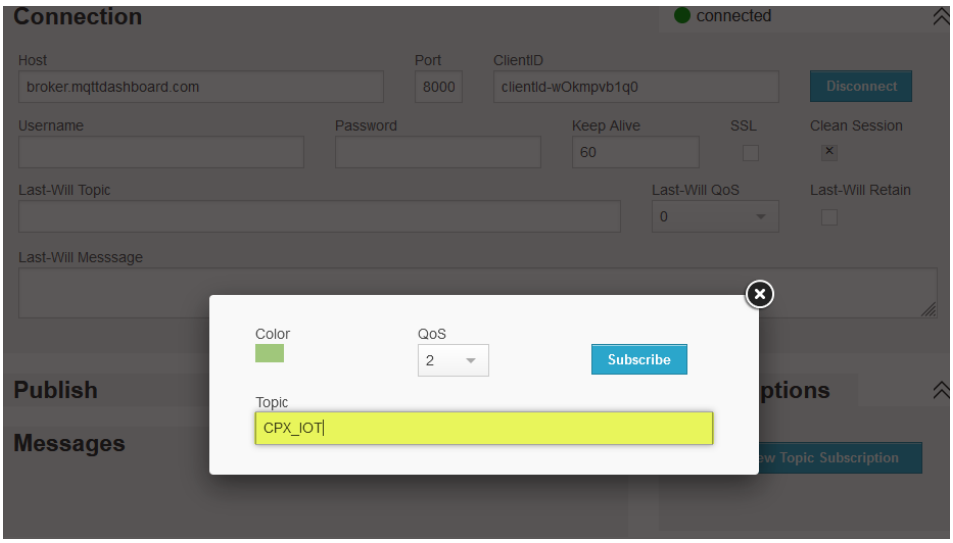
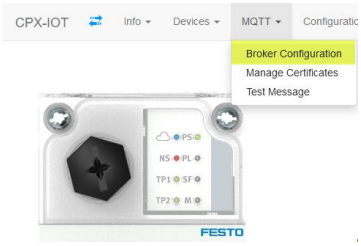
Websocket Port: `8000`

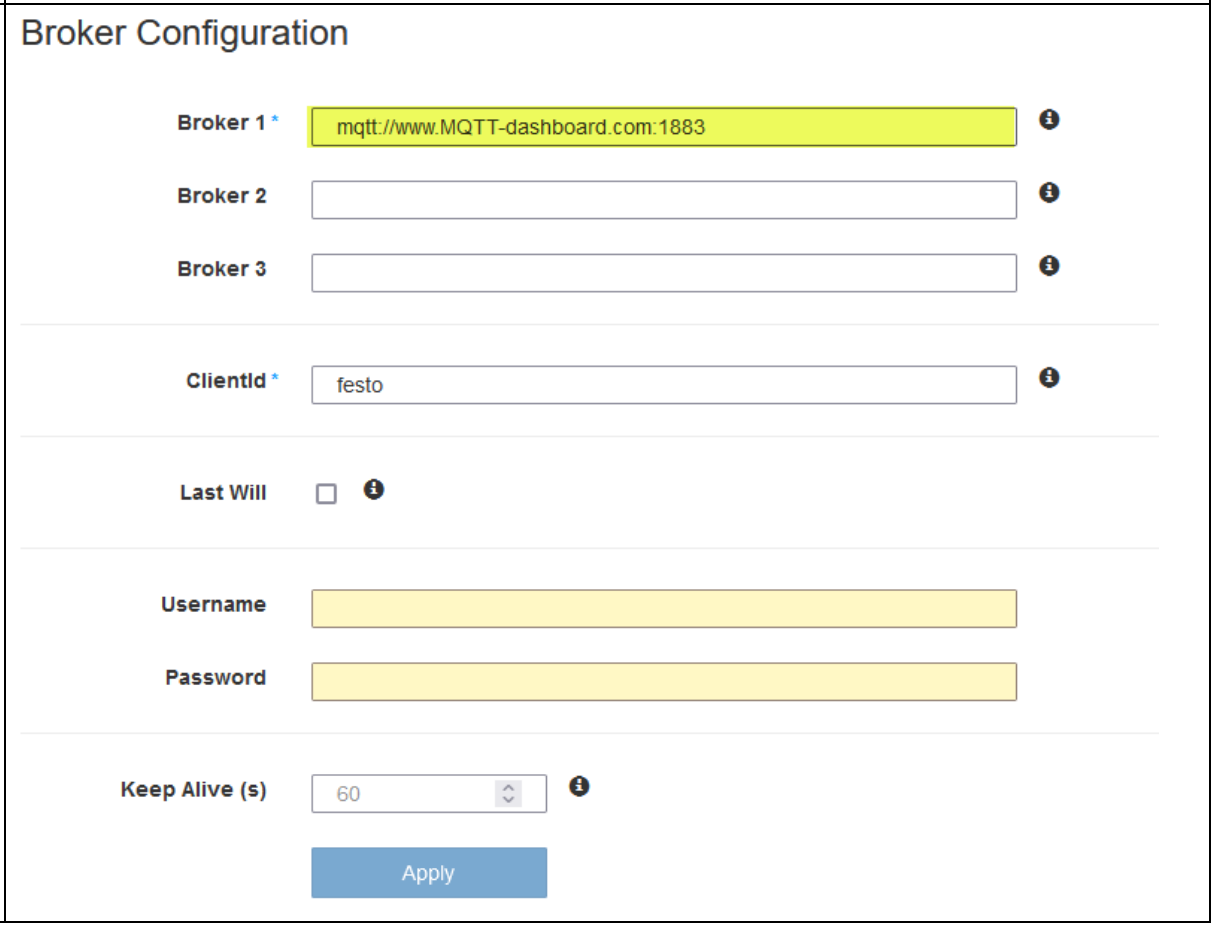
MQTT Browser Client

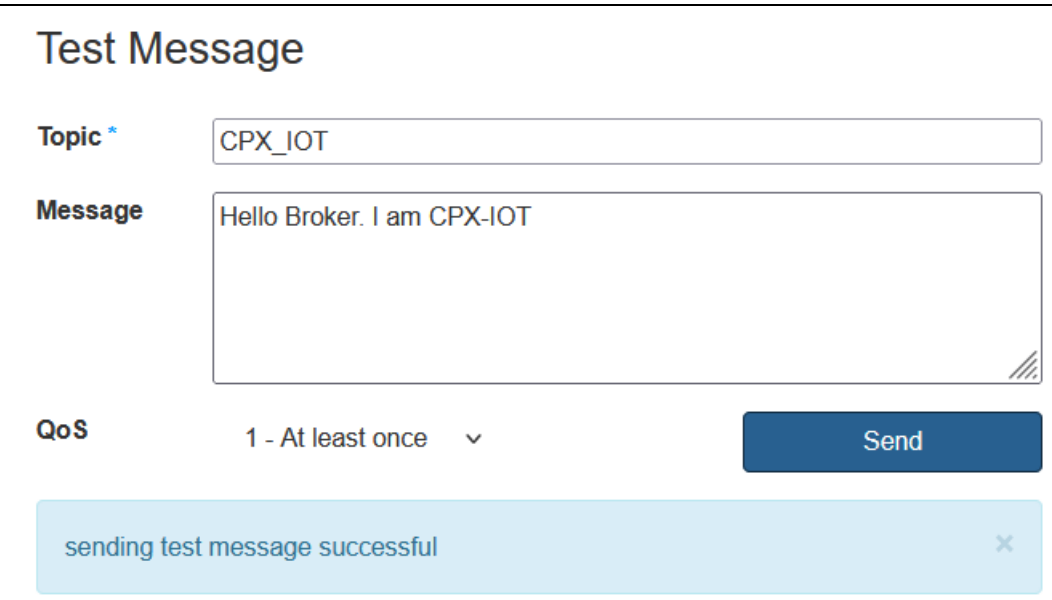
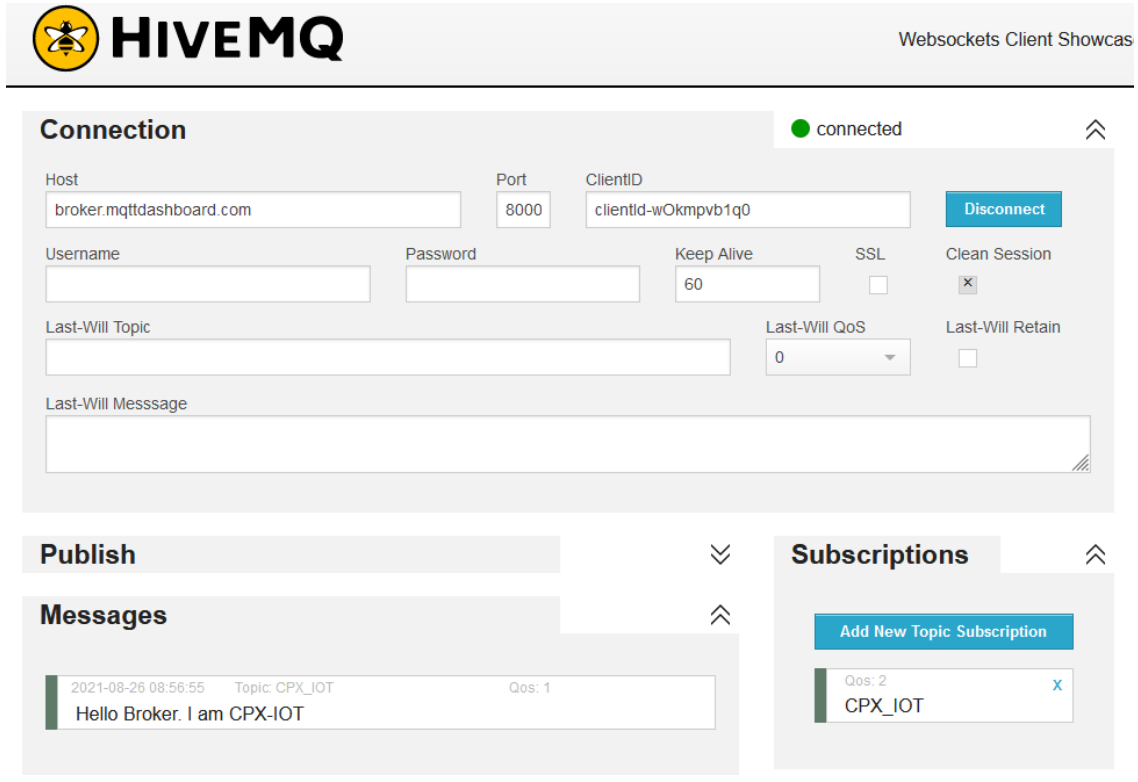


Try MQTT Browser Client

3	By default, the public broker provides a Host, Port and ClientID. Please keep the default values provided by HiveMQ. Click on “Connect”.
	
4	Now the Broker is connected successfully. Then please click on “Add New Topic Subscription”
	

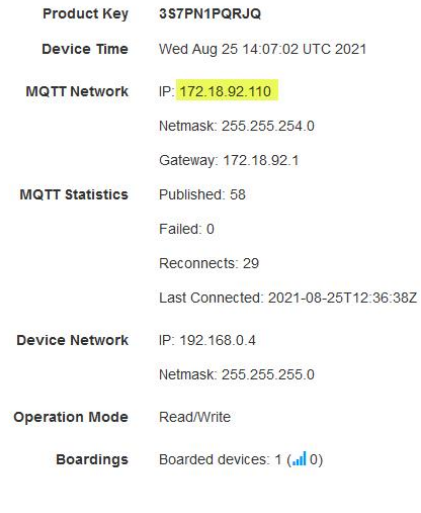
5	Create a subscription and write a topic name. For example CPX_IOT.
	
6	Go to CPX-IOT webserver and click con MQTT --› Broker configuration.
	

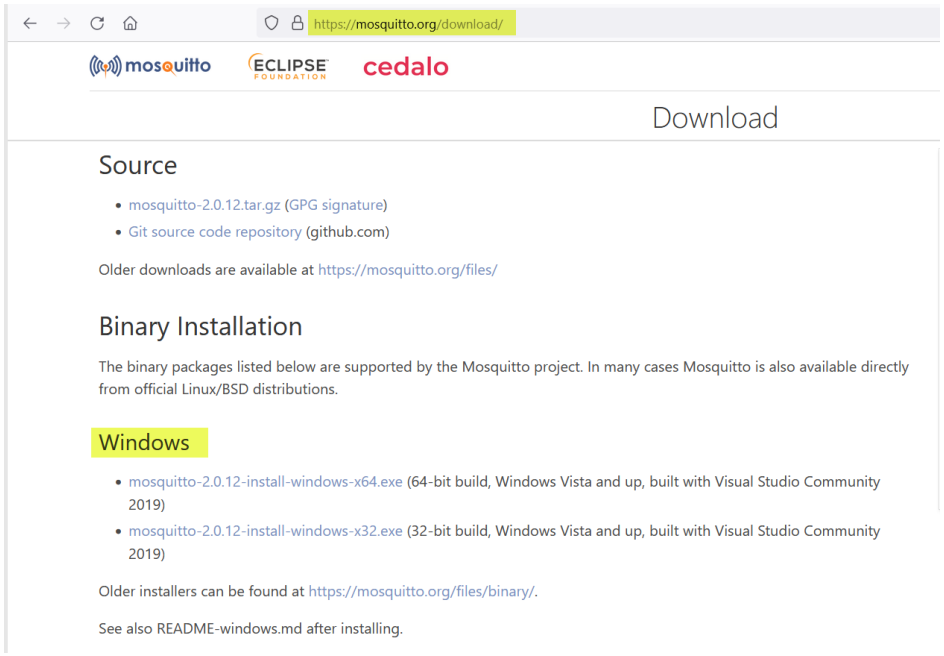
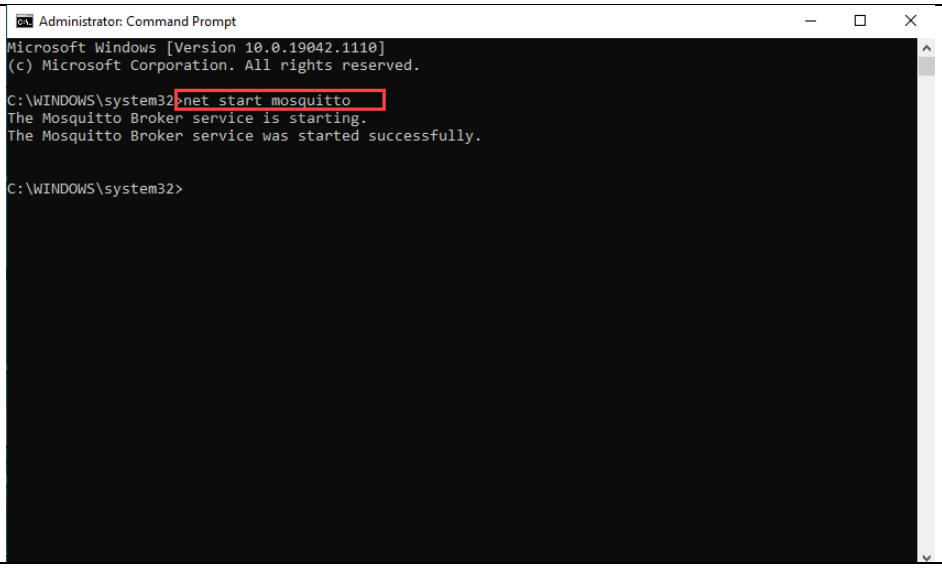
7	Write the URL: mqtt://www.MQTT-dashboard.com:1883 This URL allows CPX-IOT to connect to the borker
	

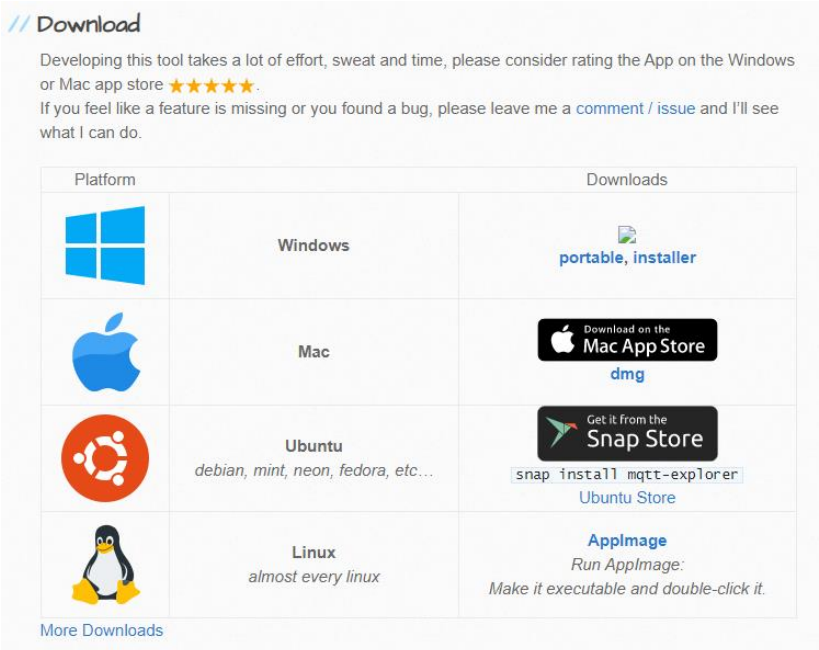
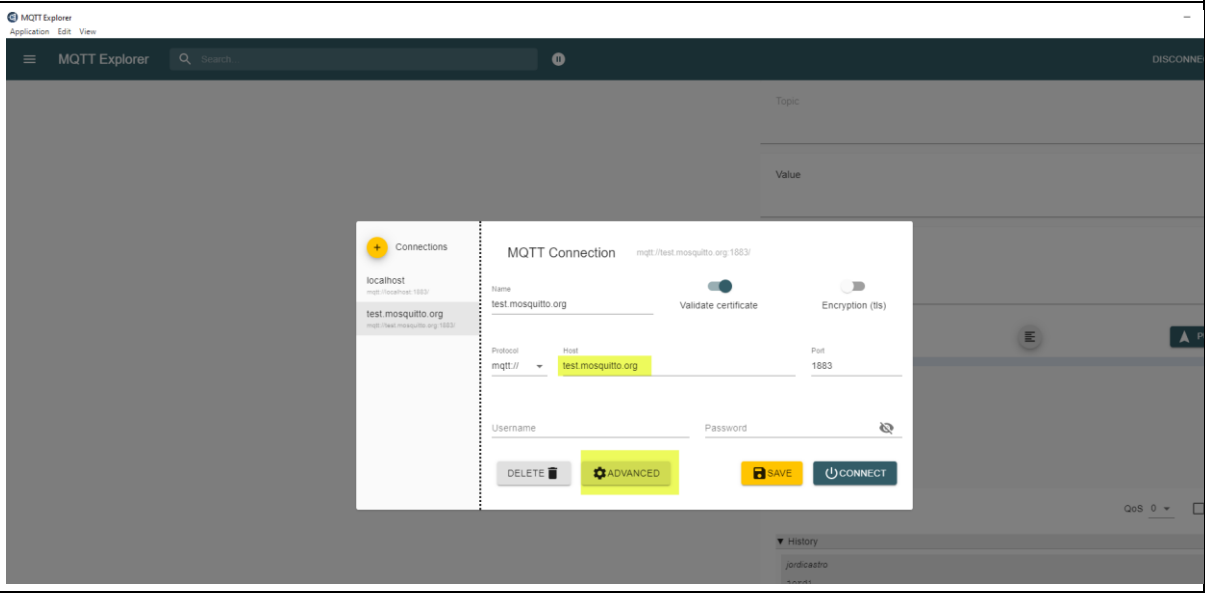
8	Write the topic: CPX_IOT
	
9	Receive the message on HIVEMQ MQTT Broker
	

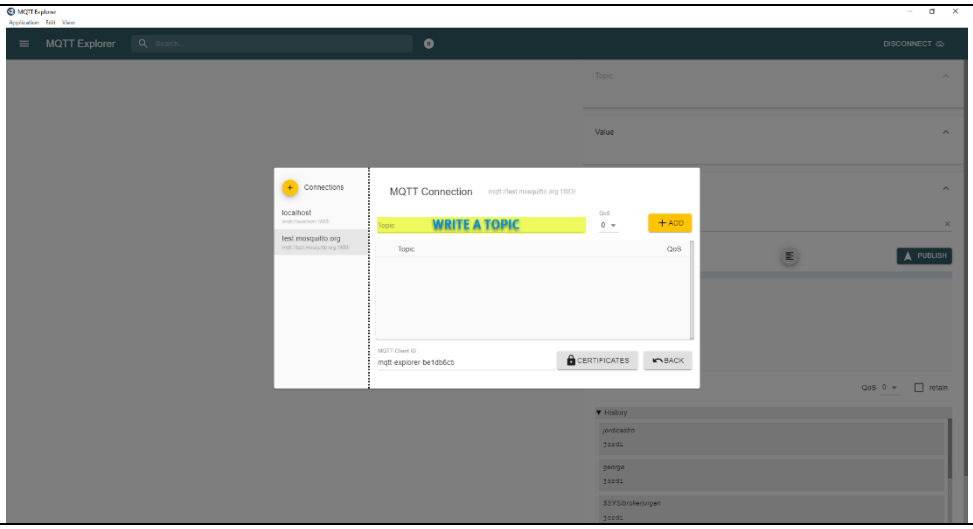
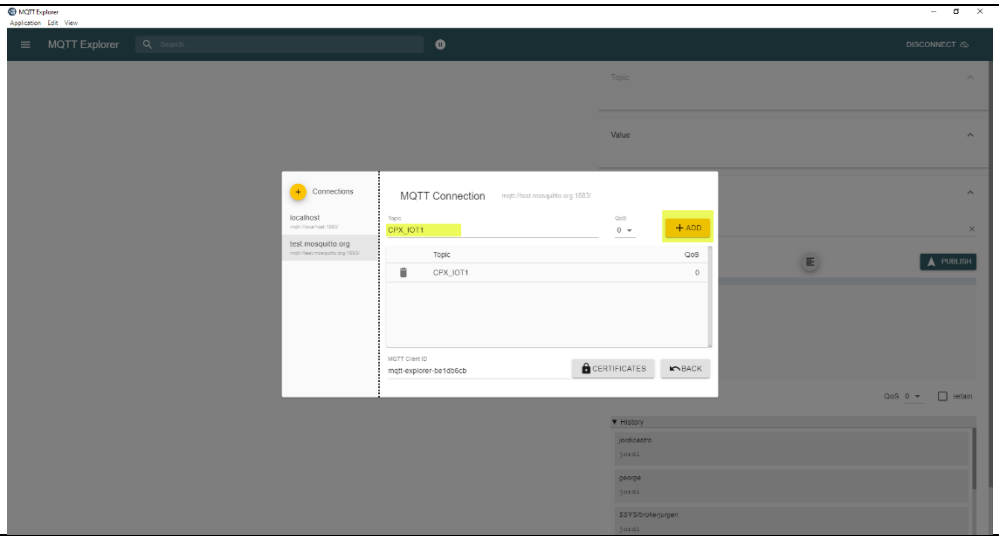
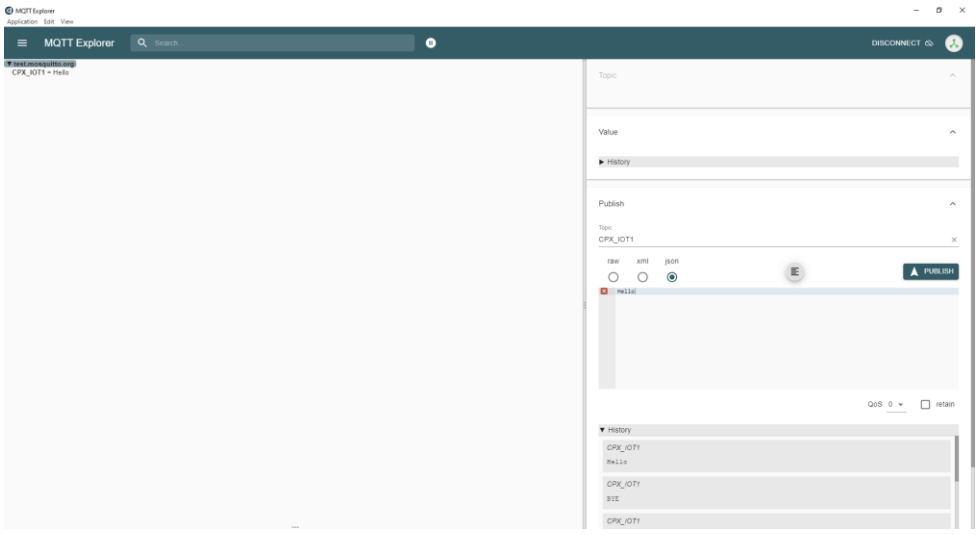
2.5.3 Broker Configuration Mosquitto

This chapter shows and example how to setup a MQTT communication to another broker well-known. This section is not mandatory for the configuration of the CPX-IOT itself. The aim of this chapter is to show a practical example of a broker connection. A free public broker will be used and only the basic parameters will be configured.

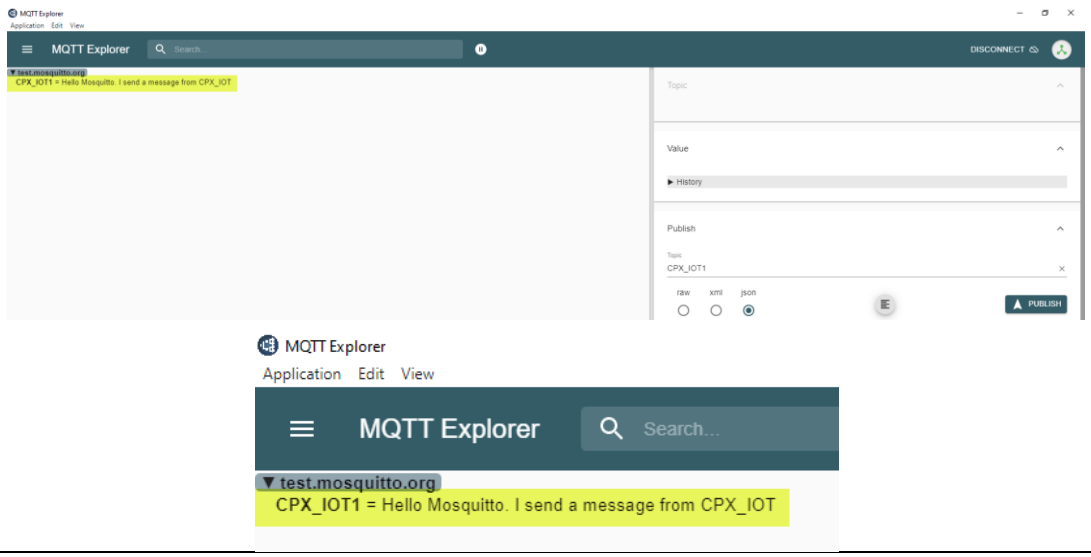
No.	Action
1	Connect the cloud port to the Internet. The Router via DCHP assign an IP to the CPX_IOT cloud port. The router assign to CPX_IOT **172.18.92.110**
	 

2	First of all, open a browser and write: https://mosquitto.org/download/ and choose correct package depending on your operating system.
	
3	Open a Command Prompt and write: net start mosquitto
	

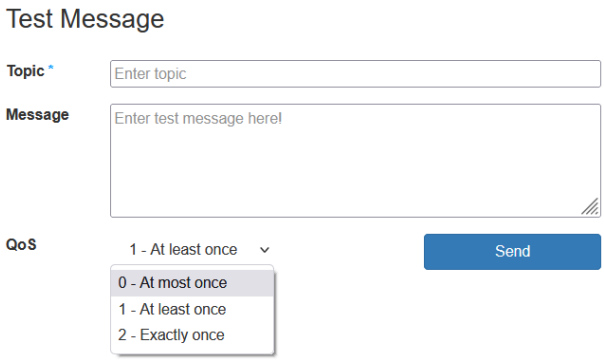
4	Open a Web Browser and please download MQTT Explorer. MQTT Explorer is a comprehensive MQTT client that provides a structured overview of your MQTT topics and makes working with devices/services on your broker dead-simple. http://mqtt-explorer.com Please select exe file according to your operating system.
	
5	Host: test.mosquitto.org Port: 1883 Please click on ADVANCED.
	

6	Create a **Topic.**
	
7	In this example the TOPIC is **CPX_IOT1** Then, please click on ADD.
	
8	On MQTT Explorer write an message using the topic that we created before (CPX_IOT1) in order to check that the communication is working.
	

9	Send a Test Message from CPX_IOT



2.5.4 Test Message



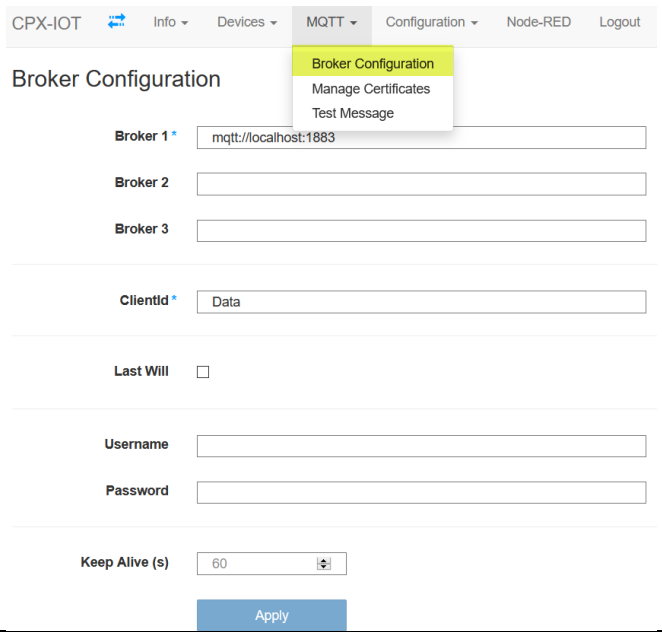
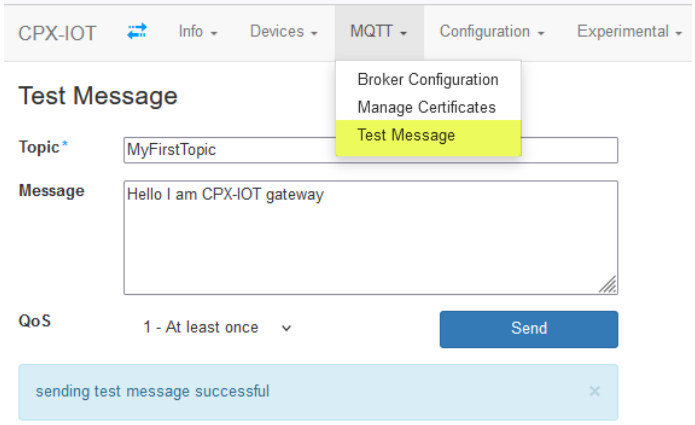
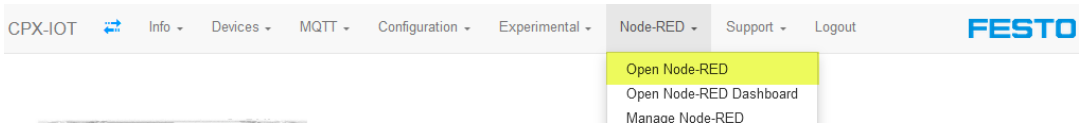
Topic : Topics are an alphanumeric identifier that is assigned to MQTT messages in order to MQTT messages to classify them according to a context.

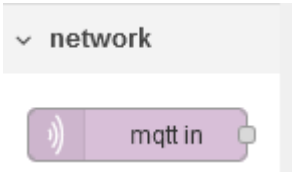
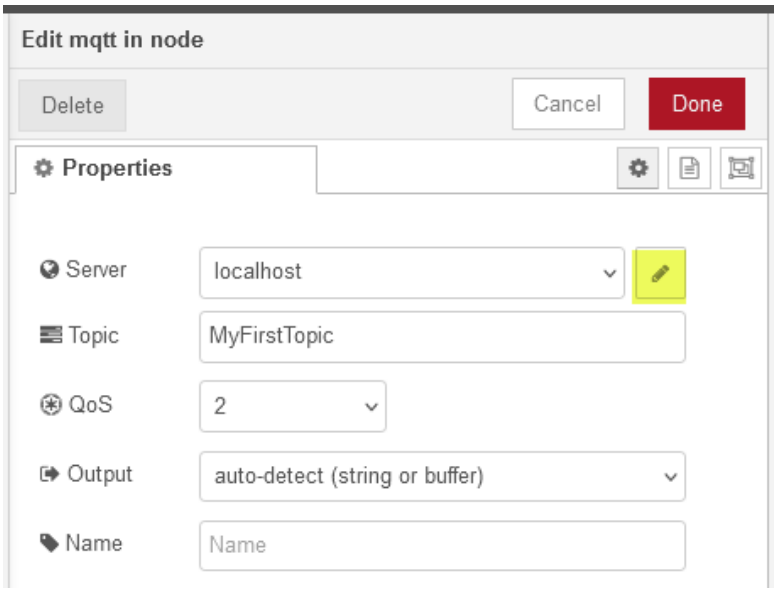
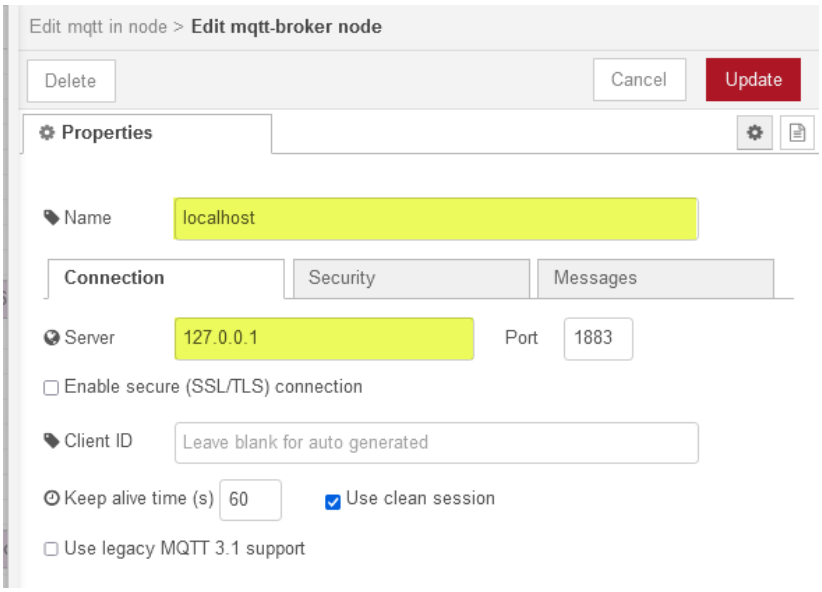
Message : Write the message to be sent here.

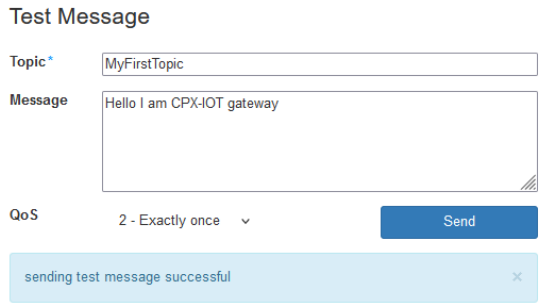
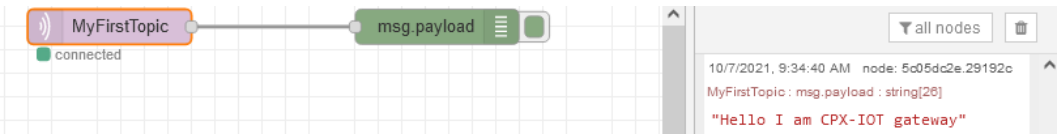
QoS (**Quality of Service) :** It is an agreement between the sender of a message and the receiver of a message that defines the guarantee of delivery for a specific message.

- QoS 0 – at most once : The minimal QoS level is zero. There is no guarantee of delivery. The receiver does not acknowledge receipt of the message and the message is not stored and retransmitted by the sender.
- QoS 1 – At least once: Level 1 guarantees that a message is delivered at least one time to the receiver. The sender stores the message until it gets a Puback packet form the receiver that acknowledges receipt of the message. It is possible for a message to be sent or delivered multiple times.
- QoS 2 – Exactly once : Qo2 is the highest level of service in MQTT protocol. This quality level guarantees that each message is received only once by the intended recipients. QoS 2 is the safest and slowest quality of service level. The guarantee is provided by at least two request/response flows (a four-part handshake) between the sender and the receiver. The sender and receiver use the packet identifier of the original PUBLISH message to coordinate delivery of the message.

There are 3 brokers. They are used for load distribution and fault tolerance. Data is distributed between them randomly. If there is only one broker, always configure broker 1.

No.	Action
1	Go to MQTT --› Broker Configuration. Configure the local Broker: mqtt://localhost:1883
	
2	Go to Test Message and write: Topic = *MyFirstTopic* and Message: *Hello I am CPX-IOT gateway*
	
3	Open NodeRed
	

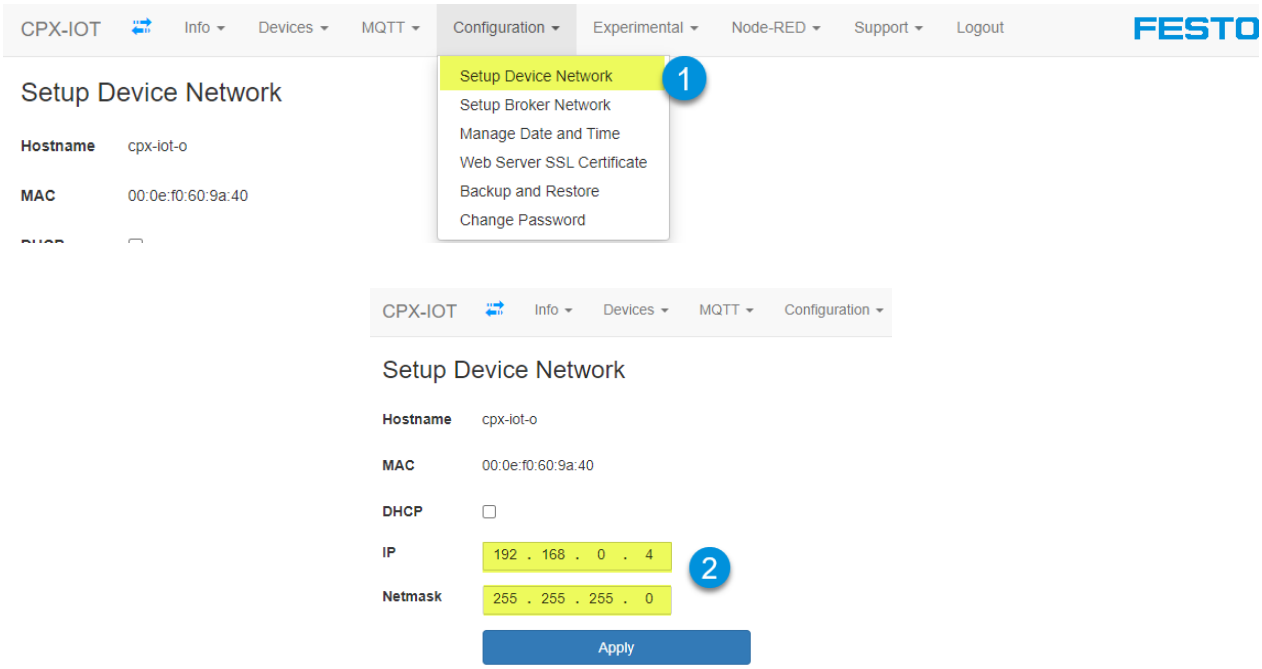
4	Select a MQTT in
	
5	Double click on MQTT in and configure the Server
	
6	Write a name to the server and configure localhost: 127.0.0.1
	

7	Connect a Payload to the MQTT in
	
	

2.6 Configuration

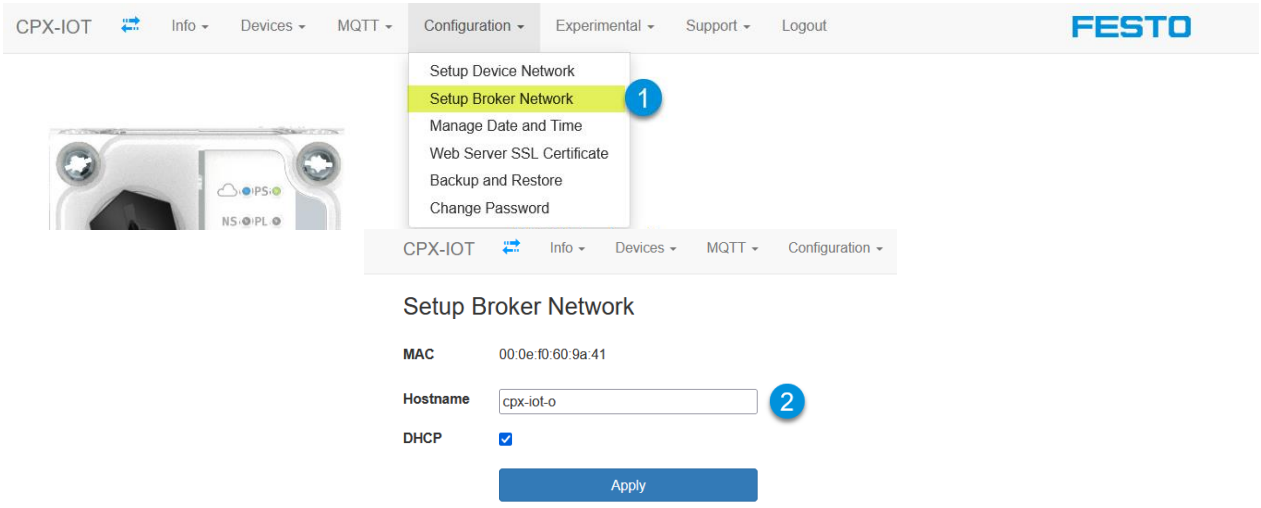
2.6.1 Setup Device Network

Configuration of the IP address and the subnet mask of the device port.

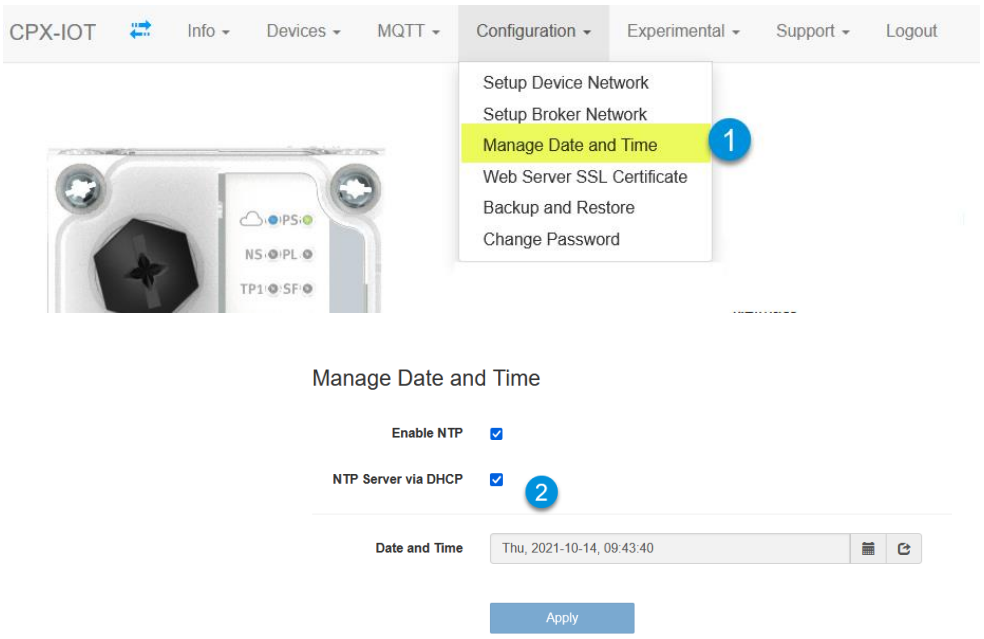


2.6.2 Setup Broker Network

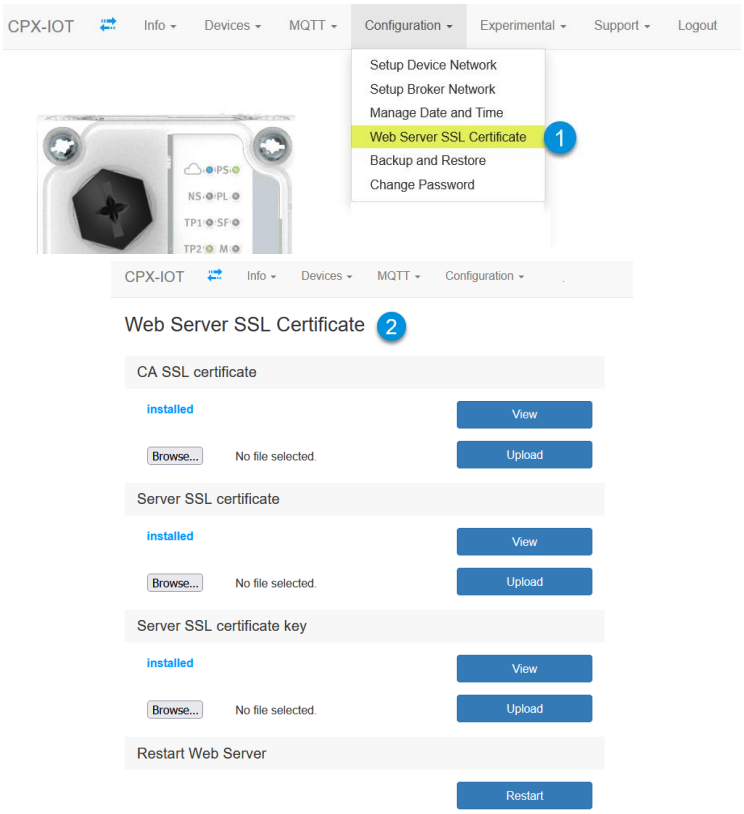
Configuration of the IP address and the subnet mask of the cloud port. It is possible to select DHCP.



2.6.3 Manage Date and Time



2.6.4 Web Server SSL Certificate

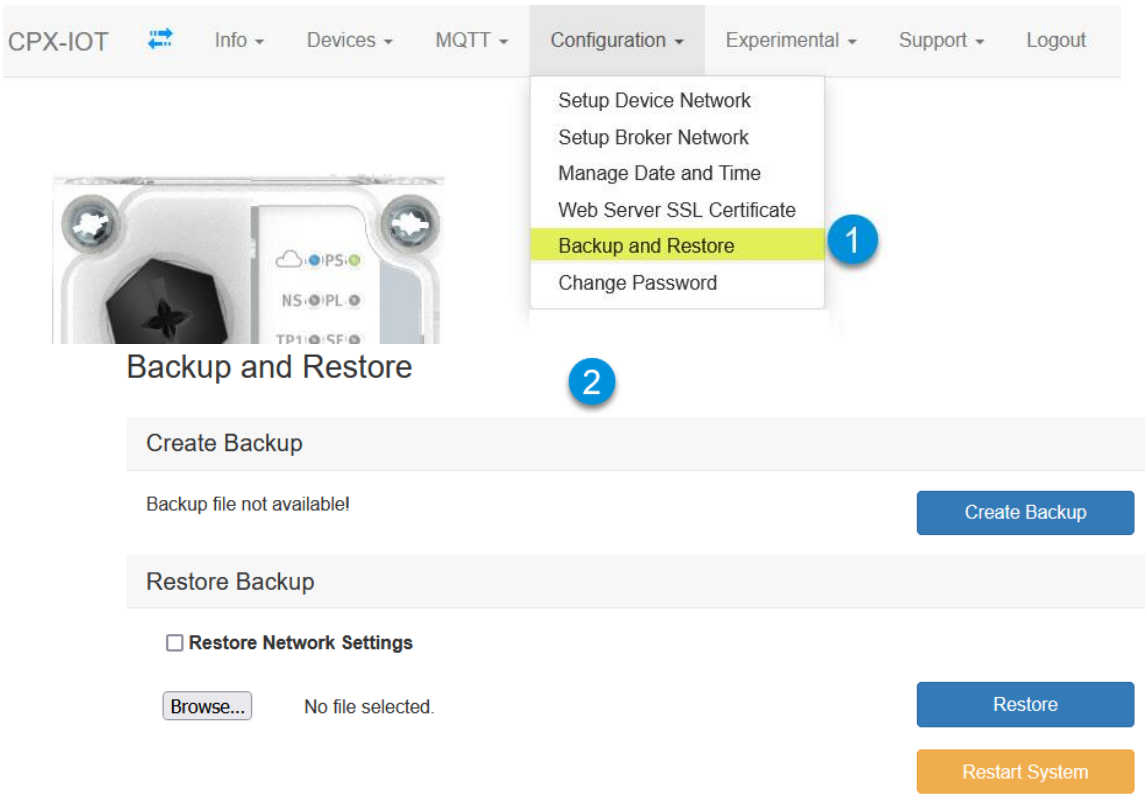


CA Certificate: This is used by the Gateway to verify the identity of the broker. It is needed to enable encryption It can be obtained from the administrator of the broker (e.g. cloud provider or IT department.

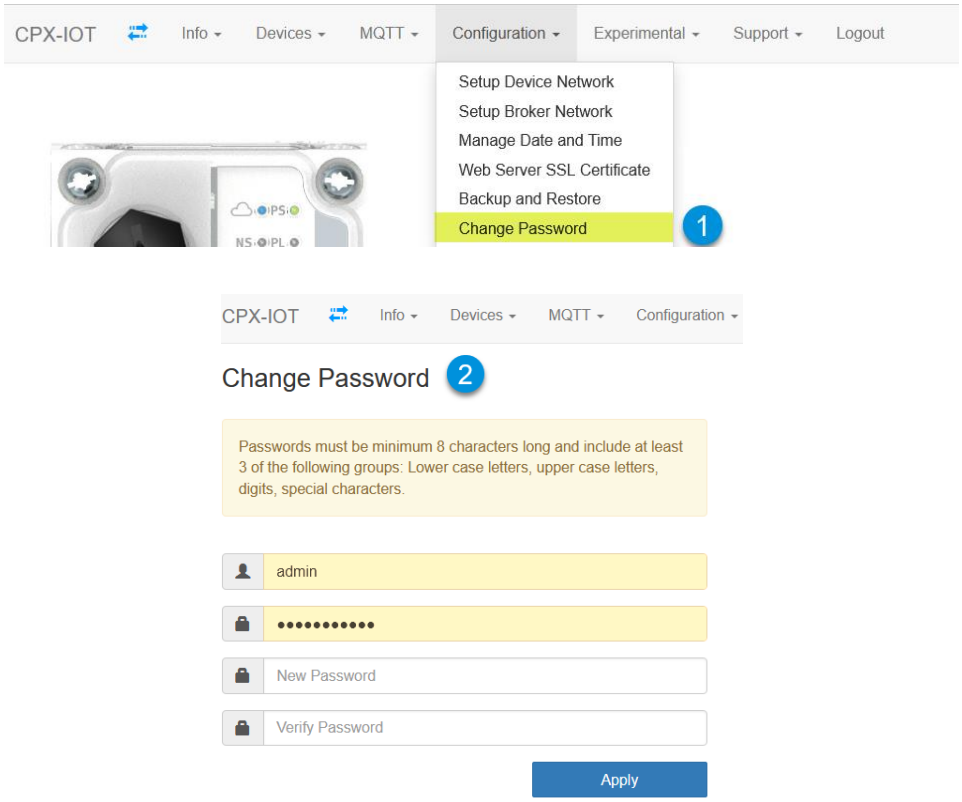
Client Certificate and Client Certificate Key: They belong together and are used to identify the Gateway at the broker. Using client certificate and key is optional, it is also possible to configure username and password instead.

Usually the client certificate and key is created by somebody who owns the CA certificate (e.g. the admin of the broker) and is created for a specific MQTT client.

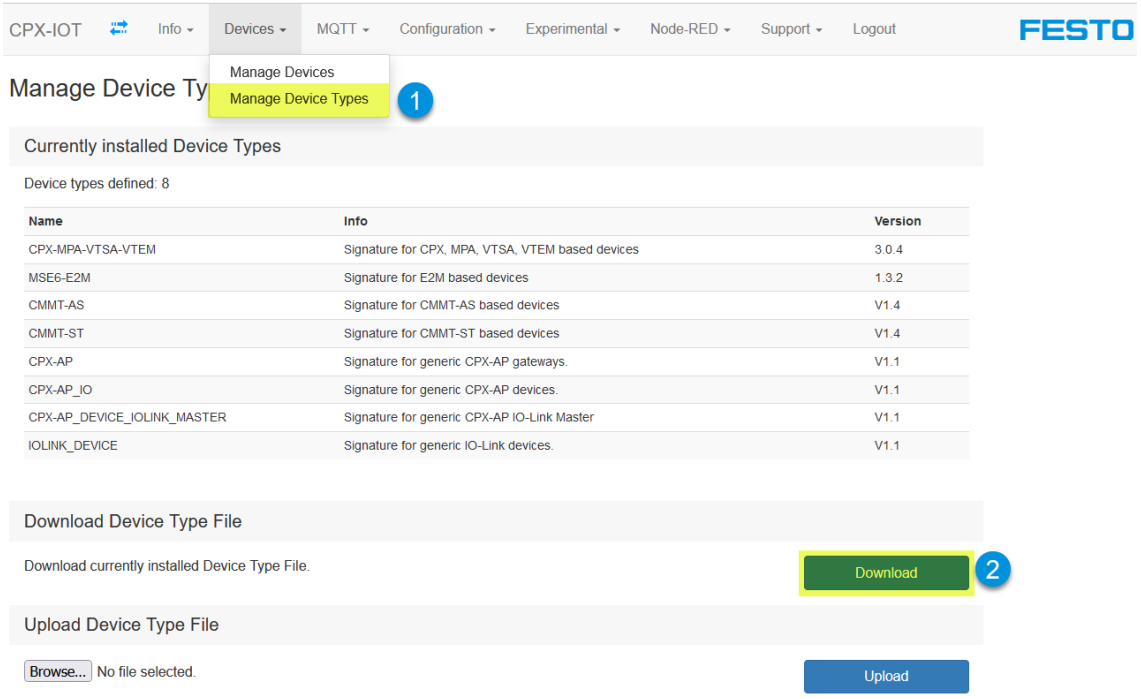
2.6.5 Backup and Restore



2.6.6 Change Password



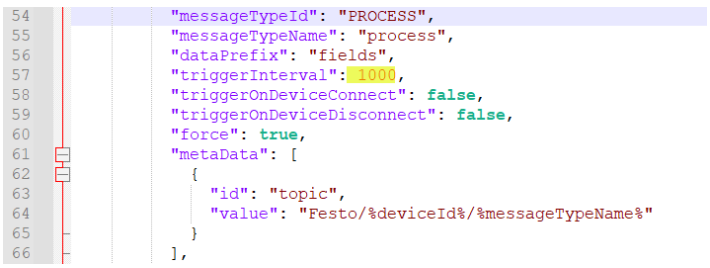
2.7 Configuration of “Signature.json”



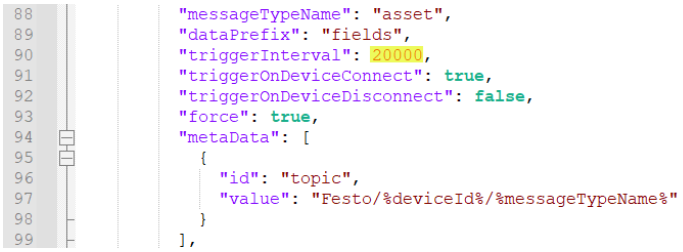
2.7.1 Trigger interval

Each device sends three messages with a preconfigure time. Diagnosis message payload is sent each 5 seconds. This time can be modified.

Process message payload is sent each 1 second. This parameter is configurable.



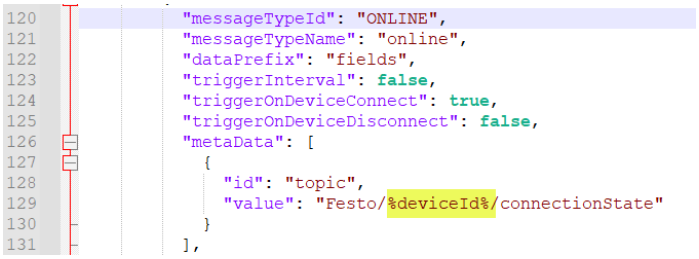
Asset message payload is sent each 20 seconds. This parameter is configurable.



```
"messageTypeName": "asset",
"dataPrefix": "fields",
"triggerInterval": 20000,
"triggerOnDeviceConnect": true,
"triggerOnDeviceDisconnect": false,
"force": true,
"metaData": [
  {
    "id": "topic",
    "value": "Festo/%deviceId%/%messageTypeName%"
  }
],
```

2.7.2 How to change MQTT topic.

The MQTT topic is defined in the metadata. In that example the topic is *“Festo/%deviceId%/connectionState”*



```
"messageTypeId": "ONLINE",
"messageTypeName": "online",
"dataPrefix": "fields",
"triggerInterval": false,
"triggerOnDeviceConnect": true,
"triggerOnDeviceDisconnect": false,
"metaData": [
  {
    "id": "topic",
    "value": "Festo/%deviceId%/connectionState"
  }
],
```

Note: You can use all variables from the section “Payload extension” as part of the MQTT topic.

2.7.3 How to change the content of the Device ID.

As a default, the DeviceID is the serial number of the valve terminal. In some case, it makes sense to change the DeviceID. Therefore, the tag “isDeviceID” must be relocate.

```
        "payloadExtension": [
          {
            "destKey": "messageType",
            "value": "%messageTypeName%"
          },
          {
            "destKey": "deviceId",
            "value": "%deviceId%"
          },
          {
            "destKey": "comId",
            "value": "%comId%"
          },
          {
            "destKey": "timestamp",
            "value": "%creationTime%"
          },
          {
            "destKey": "Publisher",
            "value": "%messageTypeName%"
          }
        ]
      }
    ],
```

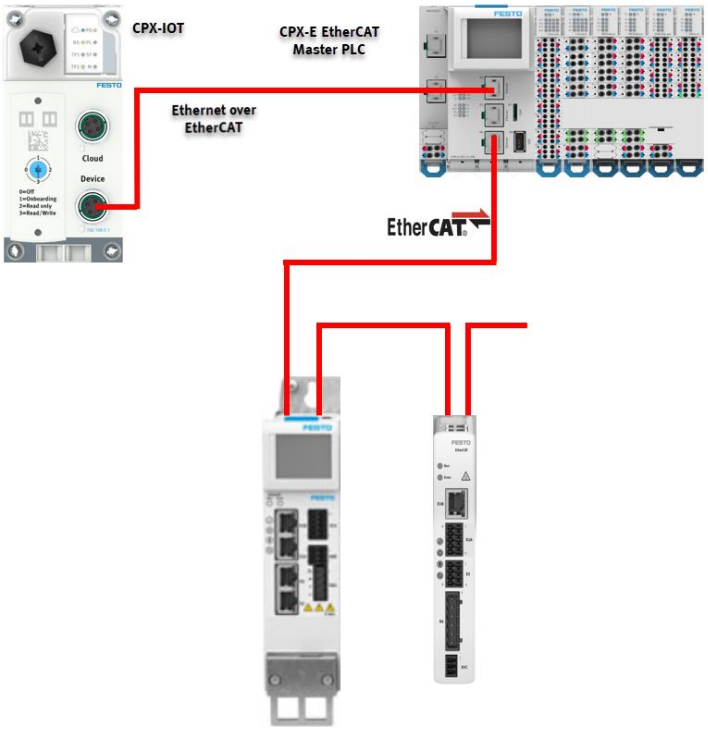
Finally, please delete the “isDeviceID”:1 as you can see in the image below.

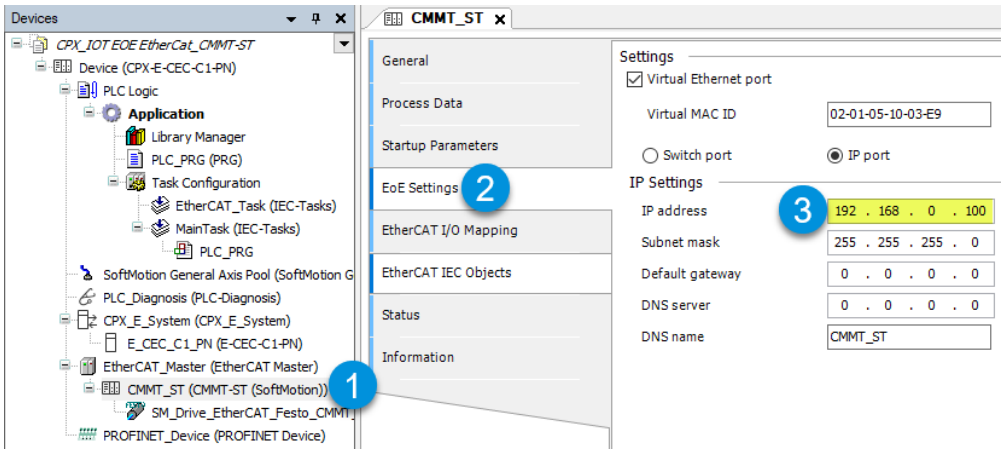
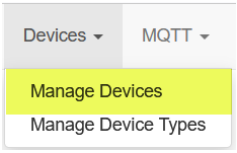
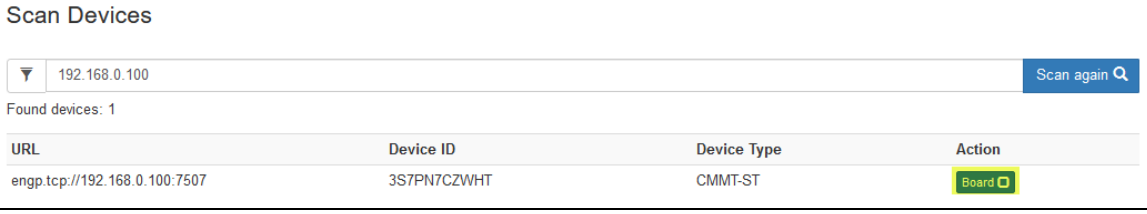
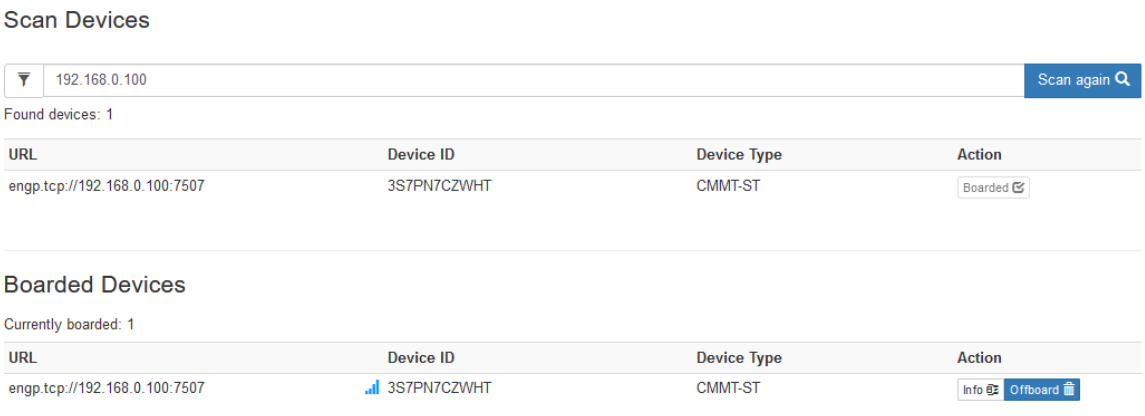
```
        {
          "srcKey": "%nspath%.Module00.SerialNumber",
          "destKey": "SERIAL00",
          "messageTypeIds": [
            "ASSET"
          ],
          "isDeviceID": 1
        },
        {
```

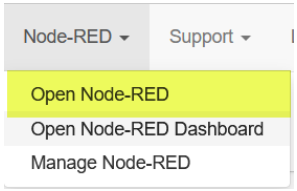
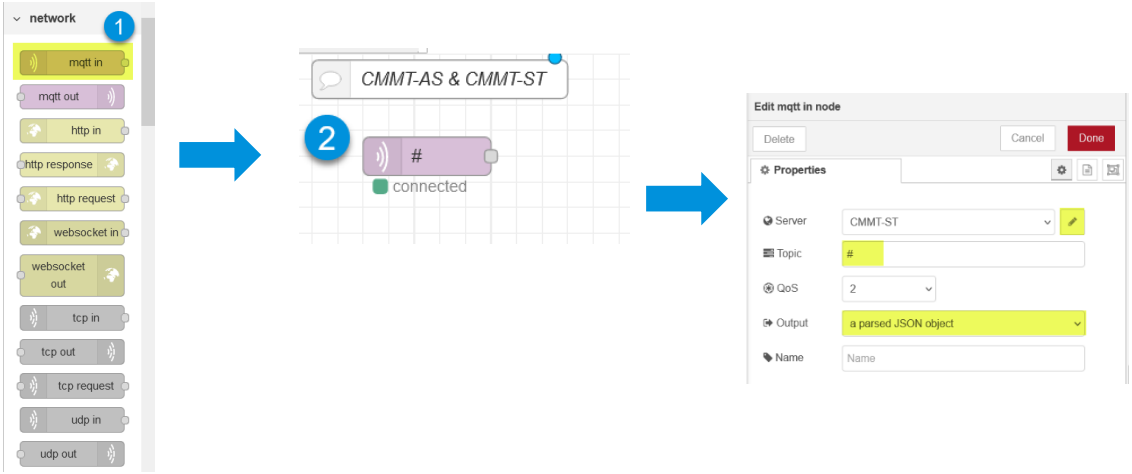
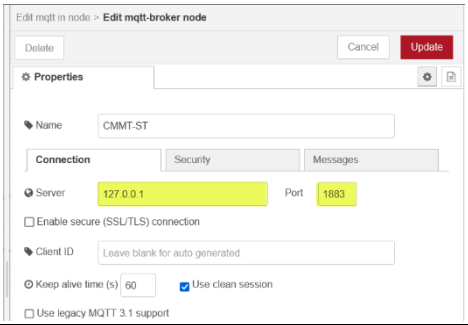
3 Integration CPX_IOT in EtherCAT environment

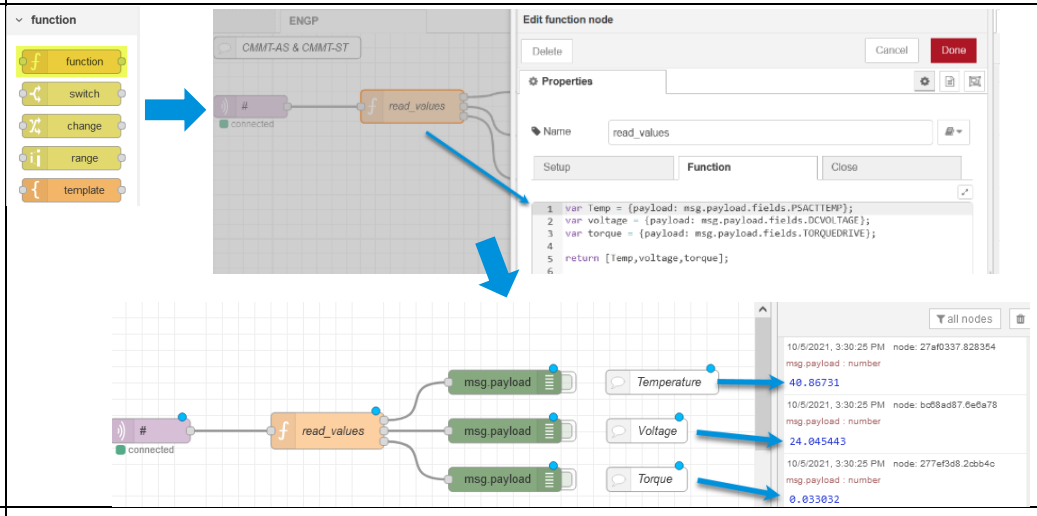
This chapter shows how to collect data from a CMMT-AS or CMMT-s via the CPX-IOT gateway connected on the EtherCAT network. In that case, it is a must to activate the Ethernet Over EtherCAT (EOE) on the PLC Master otherwise it is not possible to board the devices.

3.1 Manage Devices: Connecting CMMT-AS-xx-EC or CMMT-ST-xx-EC Data to CPX-IOT. Festo PLC CPX-E as EtherCAT master.

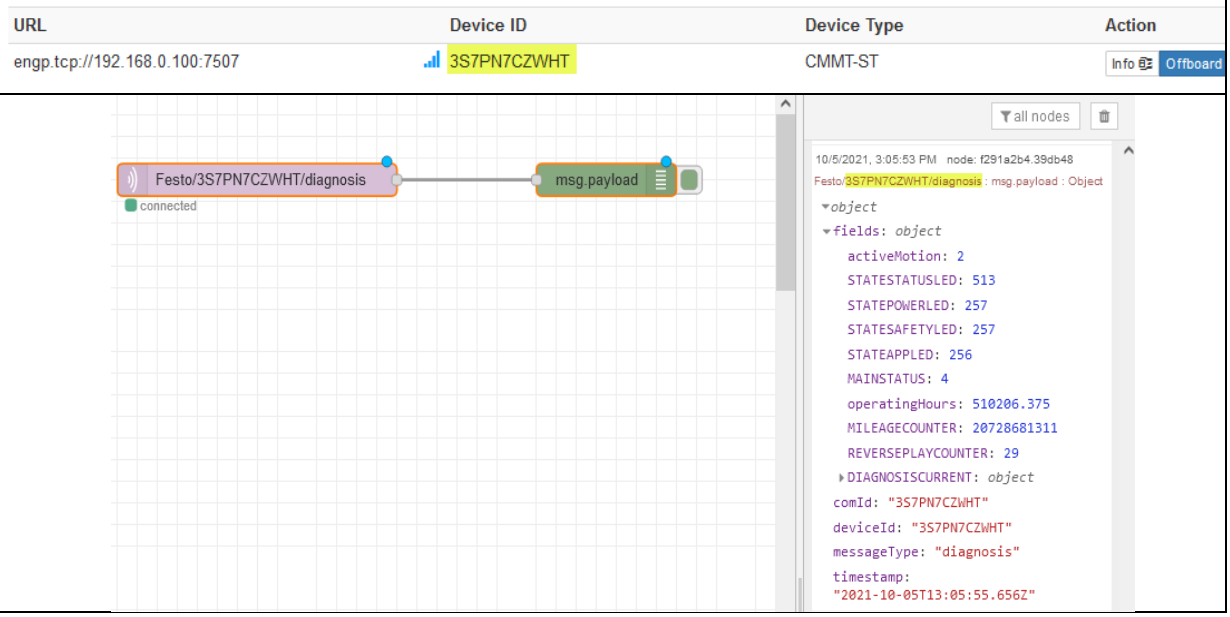


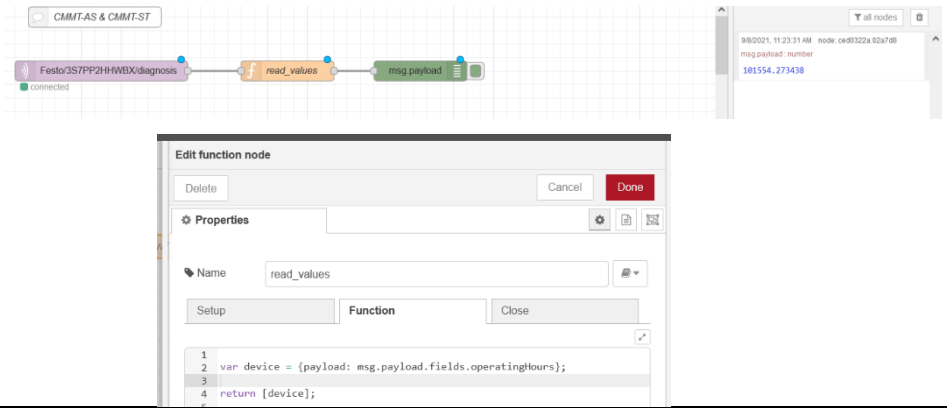
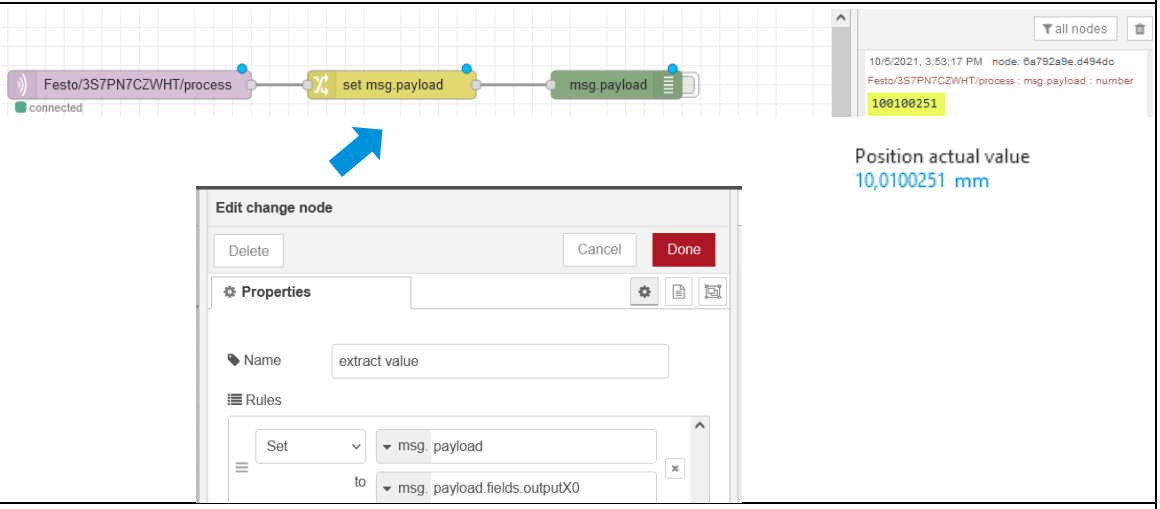
No.	Action
1	The Ethernet Over EtherCAT must be supported by the PLC. Enable Virtual Ethernet port and chose IP port. After this configuration, download the PLC program.
	
2	Go to CPX-IOT webserver and click on Devices --› Manage Devices
	
3	Write on Scan Devices the Ethernet Over EtherCAT Ip address. In that case, 192.168.0.100
	
4	The scan process has been completed successfully. Then click on “Board”
	
5	Boarding has been completed successfully. Connection OK  Connection Not OK  . After boarding the message are going out. Let’s read the data with Node Red but it is not mandatory for sending the data out.
	

6	Open Node-RED
	
7	On Network palette please drag and drop **MQTT in.** Then press double click on the object MQTT in. Topic = **#** The subscription can be explicit or use Wildcards (#) Output = choose “a parsed JSON object”.
	
8	Configure the server.
	
9	On Common Palette drag and drop a **debug.** There are 3 message payload: process, diagnosis and asset
	

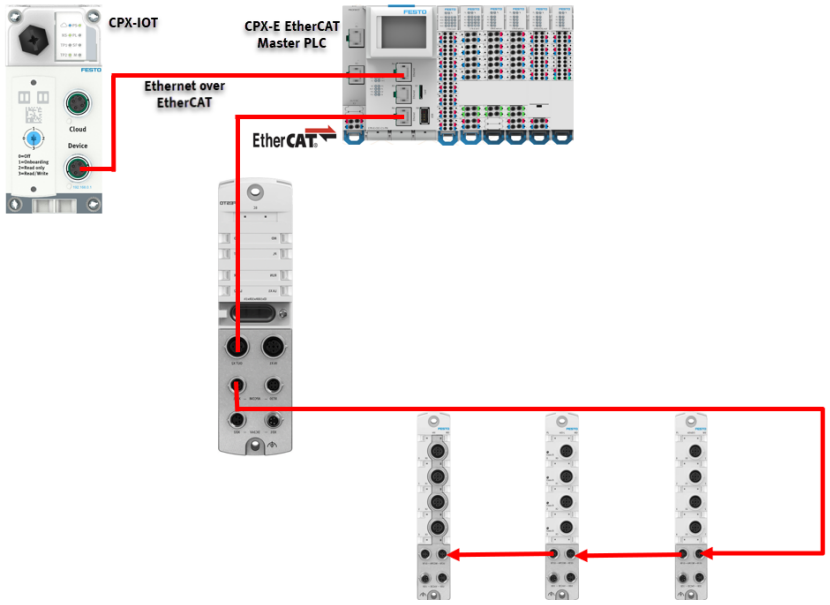
10	Flow for reading msg.payload process, diagnosis and asset.
	[{"id":"10de78c6.bffd2f","type":"mqtt in","z":"61f9dac7.db7b3c","name":"","topic":"#","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":150,"y":420,"wires":[["5c05dc2e.29192c"]]},{"id":"5c05dc2e.29192c","type":"debug","z":"61f9dac7.db7b3c","name":"","active":false,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":440,"y":440,"wires":[]},{"id":"14b2d5c8.45878a","type":"mqtt-broker","name":"CMMT-ST","broker":"127.0.0.1","port":"1883","clientid":"","usetls":false,"compatmode":false,"keepalive":"60","cleansession":true,"birthTopic":"","birthQos":"0","birthPayload":"","closeTopic":"","closeQos":"0","closePayload":"","willTopic":"","willQos":"0","willPayload":""}]
11	It is possible to split the data into different and store them in variables. This is done using the object function.
	
12	Flow of the reading values
	[{"id":"6a48101c.549fe","type":"function","z":"61f9dac7.db7b3c","name":"read_values","func":"var Temp = {payload: msg.payload.fields.PSACTTEMP};\nvar voltage = {payload: msg.payload.fields.DCVOLTAGE};\nvar torque = {payload: msg.payload.fields.TORQUEDRIVE};\n\nreturn [Temp,voltage, torque];","outputs":3,"noerr":0,"initialize":"","finalize":"","x":1070,"y":159,"wires":[["27af0337.828354"],["bc68ad87.6e6a78"],["277ef3d8.2cbb4c"]]},{"id":"e0330247.94ab88","type":"mqtt in","z":"61f9dac7.db7b3c","name":"","topic":"#","qos":"0","datatype":"json","broker":"14b2d5c8.45878a","x":850,"y":159,"wires":[["6a48101c.549fe"]]},{"id":"bc68ad87.6e6a78","type":"debug","z":"61f9dac7.db7b3c","name":"","active":false,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1290,"y":159,"wires":[]},{"id":"277ef3d8.2cbb4c","type":"debug","z":"61f9dac7.db7b3c","name":"","active":false,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1290,"y":219,"wires":[]},{"id":"27af0337.828354","type":"debug","z":"61f9dac7.db7b3c","name":"","active":false,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1290,"y":99,"wires":[]},{"id":"63a59ae0.ade394","type":"comment","z":"61f9dac7.db7b3c","name":"Temperature","info":"","x":1485,"y":99,"wires":[]},{"id":"962fbfd.9ed25c","type":"comment","z":"61f9dac7.db7b3c","name":"Voltage","info":"","x":1466,"y":159,"wires":[]},{"id":"989e2313.17d41","type":"comment","z":"61f9dac7.db7b3c","name":"Torque","info":"","x":1466,"y":219,"wires":[]},{"id":"14b2d5c8.45878a","type":"mqtt-broker","name":"CMMT-ST","broker":"127.0.0.1","port":"1883","clientid":"","usetls":false,"compatmode":false,"keepalive":"60","cleansession":true,"birthTopic":"","birthQos":"0","birthPayload":"","closeTopic":"","closeQos":"0","closePayload":"","willTopic":"","willQos":"0","willPayload":""}]

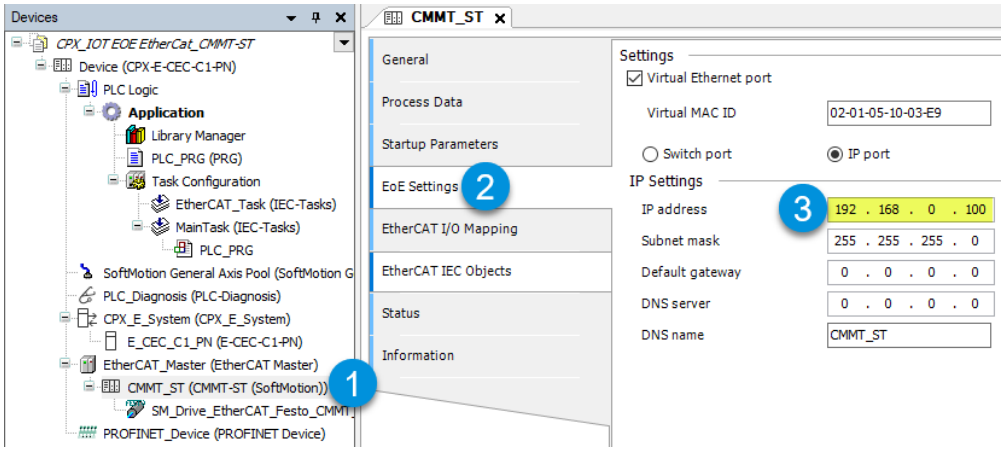
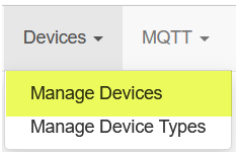
13 Another way is to subscribe to the topic using the DeviceId.

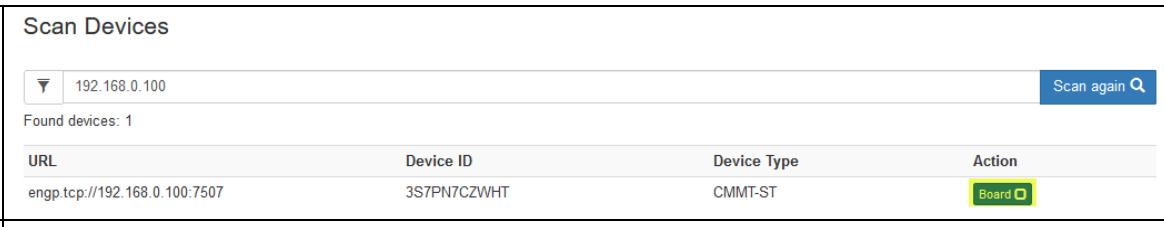


14	Flow for reading only the diagnosis message
	[{"id":"721e738a.b794bc","type":"mqtt in","z":"61f9dac7.db7b3c","name":"","topic":"Festo/3S7PN7CZWHT/diagnosis","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":860,"y":500,"wires":[["f291a2b4.39db48"]]},{"id":"f291a2b4.39db48","type":"debug","z":"61f9dac7.db7b3c","name":"","active":false,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1270,"y":500,"wires":[]},{"id":"14b2d5c8.45878a","type":"mqtt-broker","name":"CMMT-ST","broker":"127.0.0.1","port":"1883","clientid":"","usetls":false,"compatmode":false,"keepalive":"60","cleansession":true,"birthTopic":"","birthQos":"0","birthPayload":"","closeTopic":"","closeQos":"0","closePayload":"","willTopic":"","willQos":"0","willPayload":""}]
15	How to read the operating hours?
	
16	How to read the position of the drive?
	
17	Flow for reading the position of the drive.
	[{"id":"64e32d21.ff4dac","type":"mqtt in","z":"61f9dac7.db7b3c","name":"","topic":"Festo/3S7PN7CZWHT/process","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":850,"y":80,"wires":[["183a0c9e.3d3aab"]]},{"id":"6a792a9e.d494dc","type":"debug","z":"61f9dac7.db7b3c","name":"","active":false,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1370,"y":80,"wires":[]},{"id":"183a0c9e.3d3aab","type":"change","z":"61f9dac7.db7b3c","name":"","rules":[{"t":"set","p":"payload","pt":"msg","to":"payload.fields.outputX0","tot":"msg"}],"action":"","property":"","from":"","to":"","reg":false,"x":1130,"y":80,"wires":[["6a792a9e.d494dc"]]},{"id":"14b2d5c8.45878a","type":"mqtt-broker","name":"CMMT-ST","broker":"127.0.0.1","port":"1883","clientid":"","usetls":false,"compatmode":false,"keepalive":"60","cleansession":true,"birthTopic":"","birthQos":"0","birthPayload":"","closeTopic":"","closeQos":"0","closePayload":"","willTopic":"","willQos":"0","willPayload":""}]

3.2 Manage Devices: Connecting CPX_API-EC data to CPX-IOT. Festo PLC CPX_E as EtherCAT master

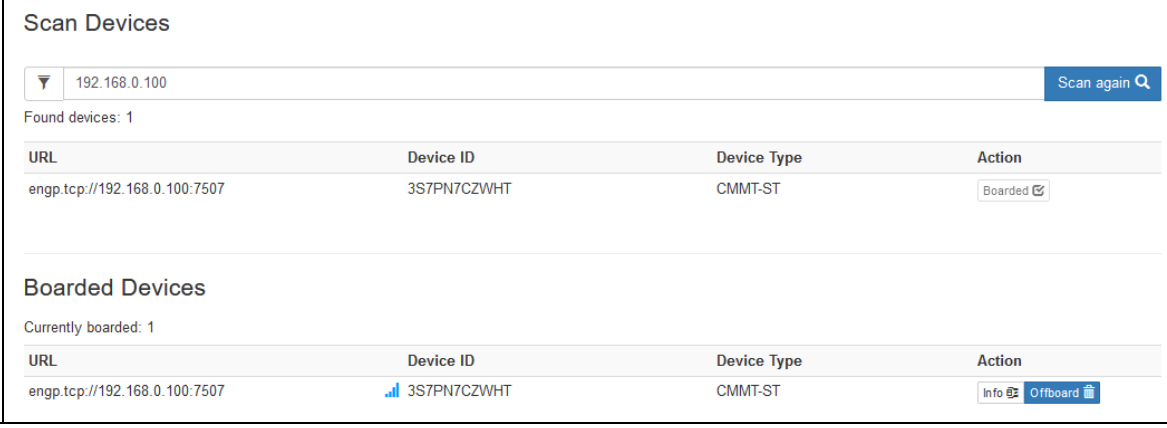


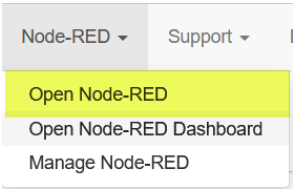
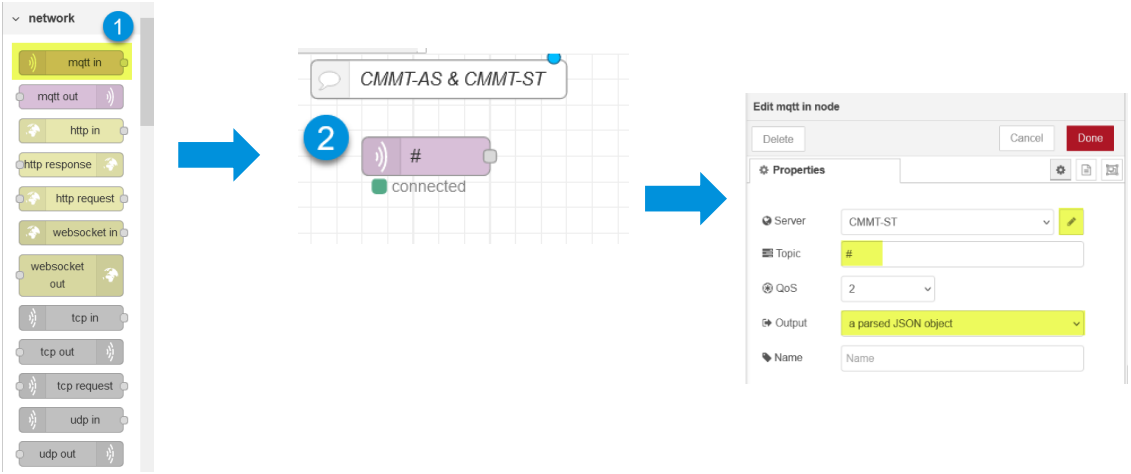
No.	Action
1	The Ethernet Over EtherCAT must be supported by the PLC. Enable Virtual Ethernet port and chose IP port. After this configuration, download the PLC program.
	
2	Go to CPX-IOT webserver and click on Devices --› Manage Devices
	
3	Write on Scan Devices the Ethernet Over EtherCAT Ip address. In that case, 192.168.0.100
	
4	The scan process has been completed successfully. Then click on “Board”

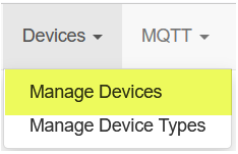
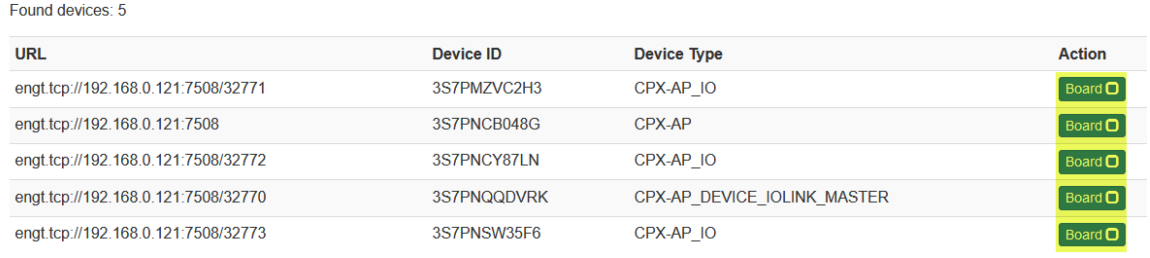


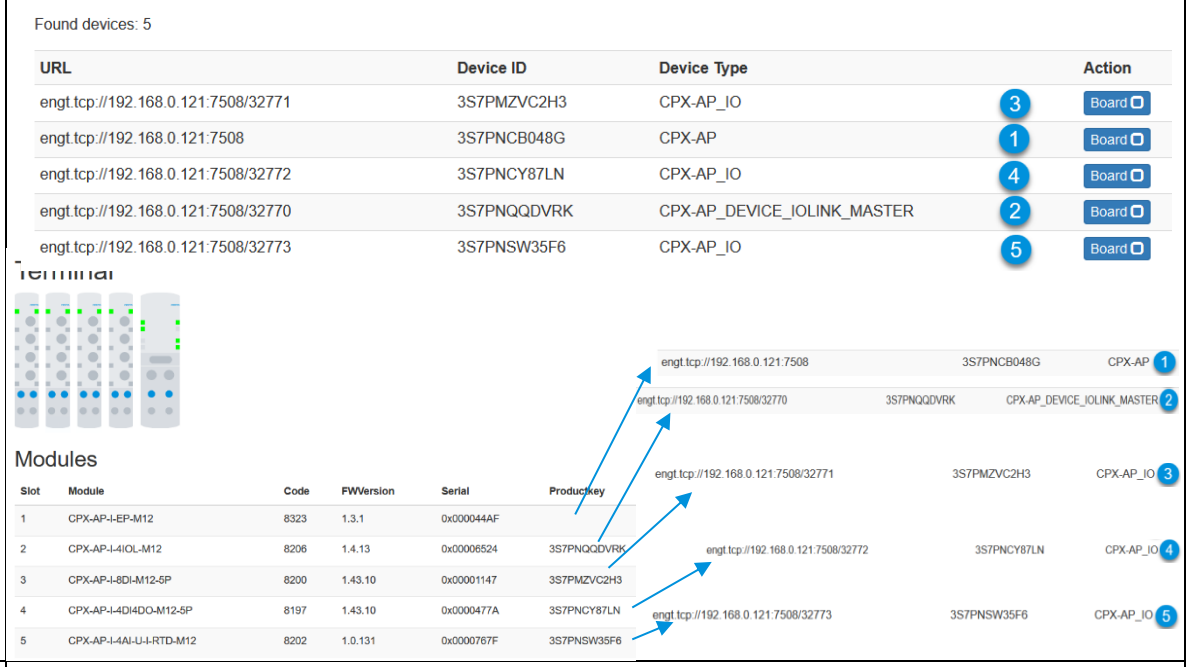
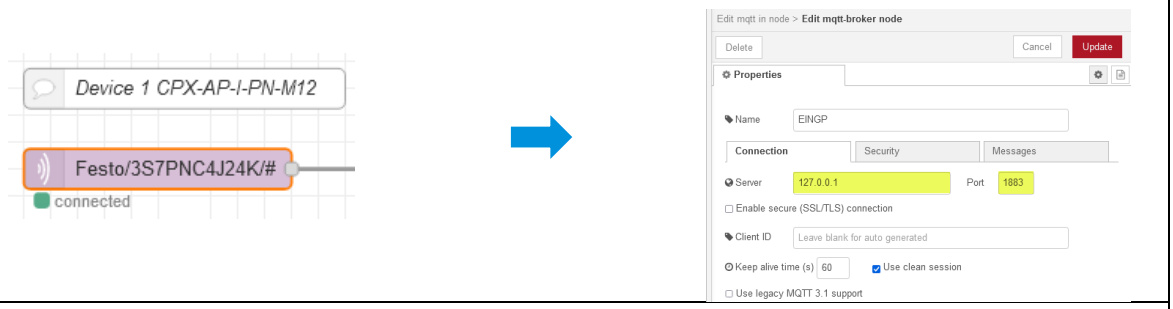
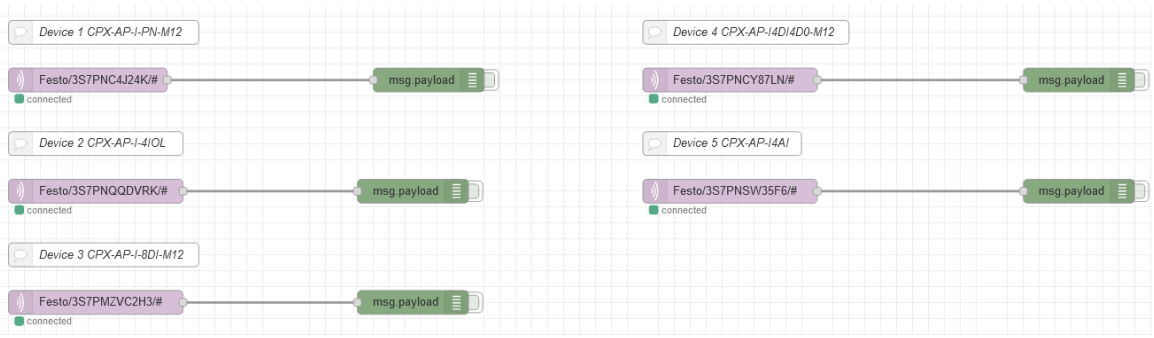
5

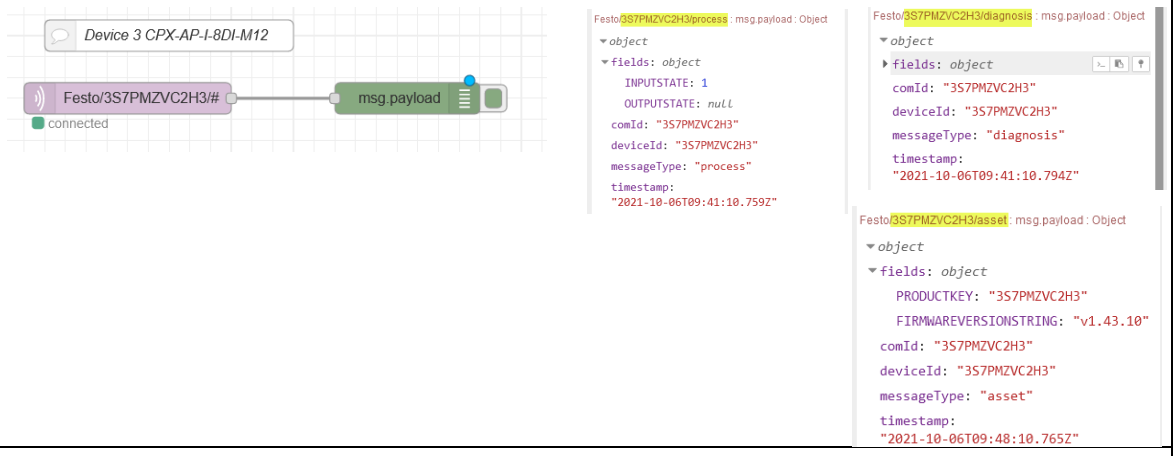
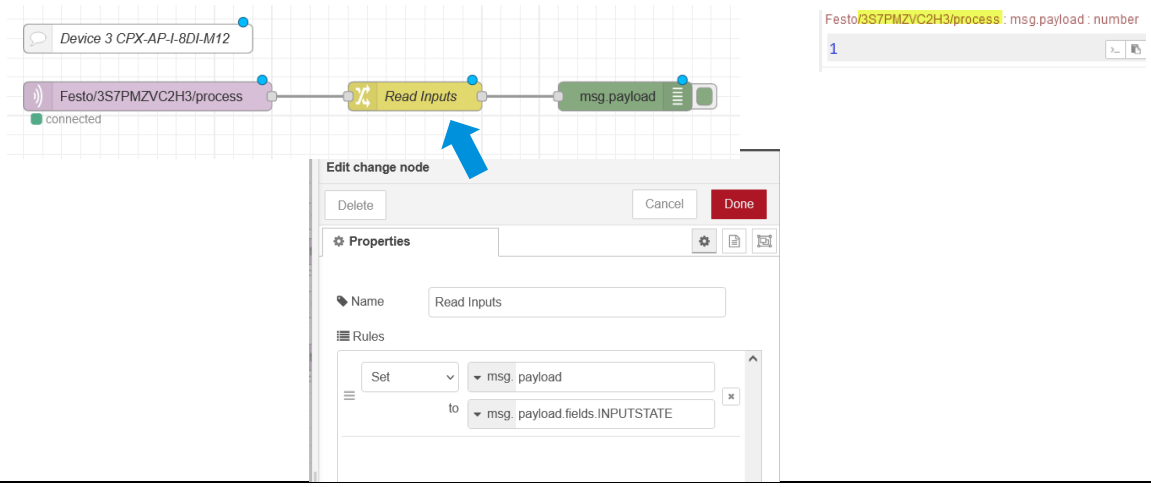
The board process has been completed successfully. Connection OK Connection Not OK .
After boarding the message are going out. Node-RED is optional and used here as a demo.



6	Open Node-RED
	
7	On Network palette please drag and drop **MQTT in.** Then press double click on the object MQTT in. Topic = **#** The subscription can be explicit or use Wildcards (#) Output = choose “a parsed JSON object”.
	

8	The PLC EthernetIP master assigns the IP address to the CPX-AP-I-EP module. In this example, the IP address is: 192.168.0.121
	
9	Please go to CPX-IOT webserver and click on Devices --› Manage Devices
	
10	Write on Scan Devices the Ethernet Over EtherCAT IP address of the CMMT an click on Scan again.
	
11	After doing a Scan, the I/O modules connected to the CPX_AP_I_PN are displayed. Board the devices.
	

12	Please check the order of the modules using the CPX_AP_I web server.
	
13	After boarding the devices, let's subscribe to the modules. To do this, the Product Key must be used to subscribe to the module.
	
14	The same procedure should be done for each module. As a hint: It is not necessary to board all the CPX-AP-I. Only the ones that we want to receive data.
15	
16	Flow example
	[{"id":"445cccb.f8b9534","type":"comment","z":"7a3e81eb.53df58","name":"Device 1 CPX-AP-I-EP-M12","info":"","x":180,"y":40,"wires":[]},{"id":"a3e396d4.c3a0a","type":"comment","z":"7a3e81eb.53df58","name":"Device 2 CPX-AP-I-4IOL","info":"","x":170,"y":160,"wires":[]},{"id":"5687b5fd.833c9c","type":"comment","z":"7a3e81eb.53df58","name":"Device 3 CPX-AP-I-8DI-M12","info":"","x":160,"y":280,"wires":[]},{"id":"687269a8.2b2e4","type":"comment","z":"7a3e81eb.53df58","name":"Device 4 CPX-AP-I-4DI4DO-M12","info":"","x":770,"y":40,"wires":[]},{"id":"e778f8e5.bde88","type":"comment","z":"7a3e81eb.53df58","name":"Device 5 CPX-AP-I-4AI","info":"","x":740,"y":140,"wires":[]},{"id":"bd76b67.0b5d8c8","type":"mqtt in","z":"7a3e81eb.53df58","name":"","topic":"Festo/3S7PNCB048G/#","qos":"2","datatype":"js

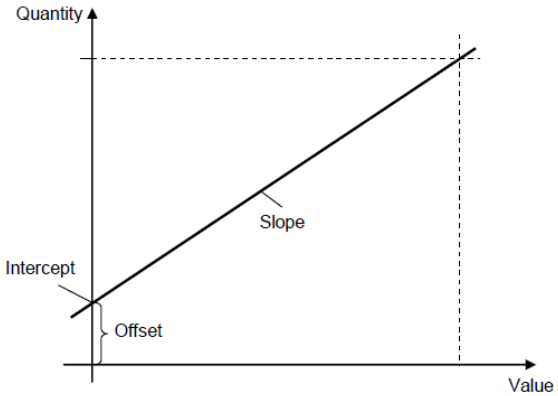
	on","broker":"14b2d5c8.45878a","x":120,"y":80,"wires":[["6aa6ed9f.6e4924"]]},{"id":"6aa6ed9f.6e4924","type":"debug","z":"7a3e81eb.53df58","name":"","active":true,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":390,"y":80,"wires":[]},{"id":"a90de56.a6d9918","type":"mqtt in","z":"7a3e81eb.53df58","name":"","topic":"Festo/3S7PNQQDVRK/#","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":130,"y":200,"wires":[["f1364836.e0a608"]]},{"id":"f1364836.e0a608","type":"debug","z":"7a3e81eb.53df58","name":"","active":true,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":390,"y":200,"wires":[]},{"id":"d3ed1b.44a242e8","type":"mqtt in","z":"7a3e81eb.53df58","name":"","topic":"Festo/3S7PMZVC2H3/#","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":120,"y":340,"wires":[["f9247fdb.98864"]]},{"id":"f9247fdb.98864","type":"debug","z":"7a3e81eb.53df58","name":"","active":true,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":390,"y":340,"wires":[]},{"id":"6c288eec.4a293","type":"mqtt in","z":"7a3e81eb.53df58","name":"","topic":"Festo/3S7PNCY87LN/#","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":700,"y":80,"wires":[["646c0a6a.88cd2c"]]},{"id":"646c0a6a.88cd2c","type":"debug","z":"7a3e81eb.53df58","name":"","active":true,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1010,"y":80,"wires":[]},{"id":"81e06257.410d4","type":"mqtt in","z":"7a3e81eb.53df58","name":"","topic":"Festo/3S7PNSW35F6/#","qos":"2","datatype":"json","broker":"14b2d5c8.45878a","x":700,"y":200,"wires":[["e9030e5a.e72db8"]]},{"id":"e9030e5a.e72db8","type":"debug","z":"7a3e81eb.53df58","name":"","active":true,"tosidebar":true,"console":false,"tostatus":false,"complete":"false","statusVal":"","statusType":"auto","x":1010,"y":200,"wires":[]},{"id":"14b2d5c8.45878a","type":"mqtt-broker","name":"CPX-AP-I","broker":"127.0.0.1","port":"1883","clientid":"","usetls":false,"compatmode":false,"keepalive":"60","cleansession":true,"birthTopic":"","birthQos":"0","birthPayload":"","closeTopic":"","closeQos":"0","closePayload":"","willTopic":"","willQos":"0","willPayload":""}]
17	Each module of CPX-AP-I system send three message payload: Process, diagnosis and asset. Let’s use CPX-AP-I-8DI-M12 to show an example.
	
18	Read the first input of the module CPX-AP-I-8DI-M12
	

3.2.1 CPX-AP-I-4IOL-M12.

This chapters show how to read data from a Io-Link device connected to a CPX-AP-I-4IOL-M12 module.
The example is carried out with a SPAW flow sensor.

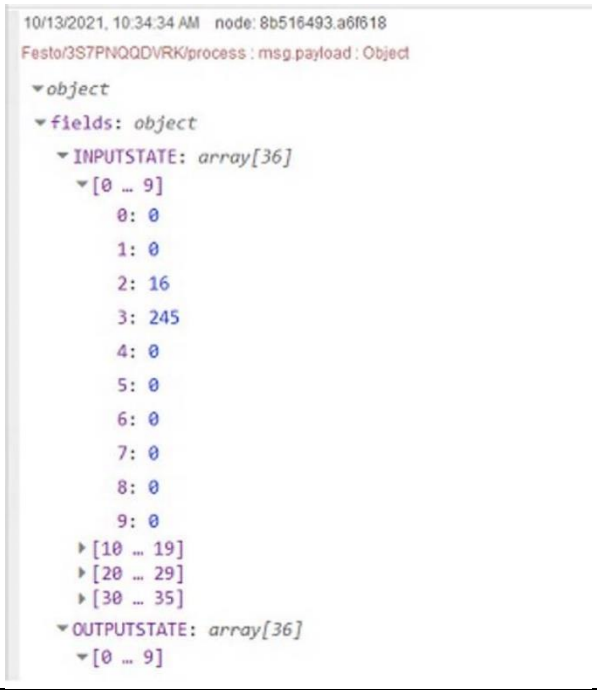
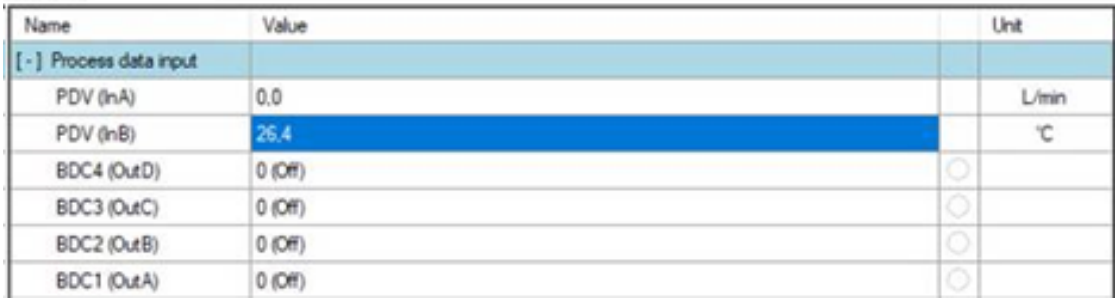
Please check the IO-Link Interface and system Specification: IO-Link Interface and System Specification

Value to quantity conversion via linear equation is taking from IO-Link Interface and System Specification.



$$Variable = Gradient\ x\ PDV + Offset$$

1	As an example this is the input process data for IO-Link device
	Process data input / Record 1 PDV (InA) 1 24 UIntegerT_14 0 to 16383 PDV (InB) 2 8 UIntegerT_14 0 to 16383 BDC4 (OutD) 3 3 BooleanT BDC3 (OutC) 4 2 BooleanT BDC2 (OutB) 5 1 BooleanT BDC1 (OutA) 6 0 BooleanT
2	Where InA is the flow, InB is the temperature. The IODD xml-File (can be obtained here: IODDfinder (io-link.com))
	‹ProcessDataRefCollection› ‹ProcessDataRef processDataId="PI_ProcessDataIn"› ‹ProcessDataRecordItemInfo subindex="1" gradient="0.001953244217" offset="0.000000000000" unitCode="1352" displayFormat="Dec.1" /› ‹ProcessDataRecordItemInfo subindex="2" gradient="**0.006103888177**" offset="0.000000000000" unitCode="1001" displayFormat="Dec.1" /› ‹ProcessDataRecordItemInfo subindex="3" /› ‹ProcessDataRecordItemInfo subindex="4" /› ‹ProcessDataRecordItemInfo subindex="5" /› ‹ProcessDataRecordItemInfo subindex="6" /› ‹/ProcessDataRef› ‹/ProcessDataRefCollection›

3	Data from the flow sensor on NodeRED.
	
4	Conversion to HEX
	▪ 16 = 0x10 ▪ 245 = 0xF5 The raw value is: 0x10F5 = 4341
5	$Variable = Gradient\ x\ PDV + Offset$
	$Variable$ = 0.006103888177 * 4341 + 0 = 26.4970 [°C]
	

4 Appendix

In this appendix section you will find the payload message of the devices.

4.1 CMMT-AS and CMMT-ST MQTT payloads.

Process message	Parameter number	Description
outputX0	1.128.0	Actual Position
PSACTTEMP	0.920.0	Temperature Powerstage
AIRACTTEMP	0.930.0	Temperature Air in Case
MOTORACTTEMP	1.940.0	Temperature Motor
DCVOLTAGE	0.480.0	DCLinkManagement "Actual value of the DC link voltage"
TORQUEMOTOR	1.150.0	Actual value of the torque (current * torque constant)
TORQUEDRIVE	1.151.0	Actual value of the torque (current*torque constant*gear ratio)
OUTPUTPOSITIONREF	1.90.0	Setpoint Position
OUTPUTVELOCITYREF	1.91.0	Setpoint Velocity
OUTPUTV0	1.1210.0	Actual Velocity
IQREF	1.86.0	Setpoint Current (Active Current)
IQ	1.814.0	Actual Current (Active Current)
INPUTVALUE	1.9912.0	AnalogIn
ID	1.813.0	Actual value of the reactive current
MOTOREACTREL	1.6331.0	Actual value of the relative I2T monitoring of the motor to the limit
ILIM	1.6334.0	Actual value of the I2T monitoring of the total current
STATE	1.460.0	Status of movement monitoring

The motor controller send 3 groups of message: asset message, process message and diagnosis message. The table below show the data received.

Process message	Parameter number	Description
OUTPUTX0	1.128.0	Actual Position
PSACTTEMP	0.920.0	Temperature Powerstage
AIRACTTEMP	0.930.0	Temperature Air in Case
MOTORACTTEMP	1.940.0	Temperature Motor
DCVOLTAGE	0.480.0	DCLinkManagement "Actual value of the DC link voltage"
TORQUEMOTOR	1.150.0	Actual value of the torque (current * torque constant)
TORQUEDRIVE	1.151.0	Actual value of the torque (current*torque constant*gear ratio)
OUTPUTPOSITIONREF	1.90.0	Setpoint Position
OUTPUTVELOCITYREF	1.91.0	Setpoint Velocity
OUTPUTV0	1.1210.0	Actual Velocity
IQREF	1.86.0	Setpoint Current (Active Current)
IQ	1.814.0	Actual Current (Active Current)

INPUTVALUE	1.9912.0	Analog Input
ID	1.813.0	Actual value of the reactive current
MOTOREACTREL	1.6331.0	Actual value of the relative I2T monitoring of the motor to the limit
ILIM	1.6334.0	Actual value of the I2T monitoring of the total current
STATE	1.460.0	Status of movement monitoring

Asset message	Parameter number	Description
DEVICENAME	0.902.0.0	name
PARTNUMBER	0.70.0	part number
NOCCODE	0.71.0	order code
PRODUCTKEY	0.791.0	Festo product key
IPADDRESS	0.12004.0	IP Address
IPADDRESSFB	0.12004.1	ipAddressFieldbusInterface (IP address for engp via tcp/ip over the fieldbus interface (currently either Ethernet coexistence in case of Profinet or EoE in case of EtherCAT, depending on the device type)
firmware	0.960.0	CMMT Firmware version in string representation
activeUserUnit	1.1150.0	Currently active user unit

4.2 CPX-AP-I-EC-M12 payloads.

Process message	Description
Inputstate	status of the inputs
Outputstate	status of the outputs
ComID	comID
DeviceID	DeviceId
MessageType	"process"
Timestamp	timestamp

Diagnosis message
Diagnosiscurrent
Uptime
Uloadvalue
Uelsenvalue
TempreatureValueAsic
ComID
MessageType
Timestamp

Asset message
Productkey
FirmwareVersionString
ComID
DeviceID
MessageType
Timestamp

4.2.1 CPX-AP-I-4IOL-M12 payloads.

Process message	Description
Inputstate	status of the inputs
Outputstate	status of the outputs
ComID	comID
DeviceID	DeviceId
MessageType	"process"
Timestamp	timestamp

Diagnosis message
Diagnosiscurrent
Uptime
Uloadvalue
Uelsenvalue
TempreatureValueAsic
IoLinkVariant
SensorSupplyCurrentDrain
SensorSupplyEnable
ComID
MessageType
Timestamp

Asset message
Productkey
FirmwareVersionString
ComID
DeviceID
MessageType
Timestamp

4.2.2 CPX-AP-I-8DI-M12 payloads.

Process message	Description
Inputstate	status of the inputs
Outputstate	*Null*
ComID	comID
DeviceID	DeviceId
MessageType	"process"
Timestamp	timestamp

Diagnosis message
Diagnosiscurrent
Uptime
Uloadvalue
Uelsenvalue
TempreatureValueAsic
IoLinkVariant
ComID
MessageType
Timestamp

Asset message
Productkey
FirmwareVersionString
ComID
DeviceID
MessageType
Timestamp

4.2.3 CPX-AP-I-4DI4DO-M12-5P payloads.

Process message	Description
Inputstate	status of the inputs
Outputstate	status of the outputs
ComID	comID
DeviceID	DeviceId
MessageType	"process"
Timestamp	timestamp

Diagnsosis message
Diagnosiscurrent
Uptime
Uloadvalue
Uelsenvalue
TempreatureValueAsic
ComID
MessageType
Timestamp

Asset message
Productkey
FirmwareVersionString
ComID
DeviceID
MessageType
Timestamp

4.2.4 CPX-AP-I-4AI-U-I-RTD-M12 payloads.

Process message	Description
Inputstate	status of the inputs
Outputstate	*Null*
ComID	comID
DeviceID	DeviceId
MessageType	"process"
Timestamp	timestamp

Diagnosis message
Diagnosiscurrent
Uptime
Uloadvalue
Uelsenvalue
TempreatureValueAsic
IoLinkVariant
ComID
MessageType
Timestamp

Asset message
Productkey
FirmwareVersionString
ComID
DeviceID
MessageType
Timestamp

4.3 MS6-E2M payloads.

Process message	Description
ShutoffValveClosed	State of the shut off valve
AutooffPrepared	Auto off function prepared
AutooffActivated	Auto off function active
FlowRawValue	Flow raw value
FlowAvgValue:	Average flow for the last aggregation period
FlowMinValue: 117	Minimum flow for the last aggregation period
FlowMaxValue: 119	Mmaximum flow for the last aggregation period
PressureRawValue: 4600	Pressure raw value
PressureAvgValue: 4563.200195	Average pressure for the last aggregation period
PressureMinValue: 4520	Minimum pressure for the last aggregation period
PressureMaxValue: 4600	Maximum pressure for the last aggregation period
ConsumptionRawValue: 65535	Consumption counter (absolute)
ConsumptionAvgValue: 0	Consumption for the last aggregation period (relative)
AirSavingLastPeriod	Fictional saving due to the shutdown function (in the last aggregation period)
Operation_Time	Overall operation time
Switching_Cy-cles_Shutoffvalve	Number of switching cycles (if available)
CycleProcessCounter	Internal counter for aggregation

Diagnosis message	Description
ErrorChannel	Channel
iErrorNumber	Error code number
sChanneltext	Error code description

Asset message	Description
ProductKey	Festo ProductKey
CMLibVersion	Software version preaggregation
ProcessTimePeriod	Aggregation period
PressureUnit	Pressure Unit
FlowUnit	Flow Unit
ConsumptionUnit	Consumption Unit
Flow_Standard	Flow Standard
Serial_No	Serialnumber

4.4 MS6-C2M payloads.

Process message	Description
ShutoffValveClosed	State of the shut off valve
AutooffPrepared	Auto off function prepared
AutooffActivated	Auto off function active
FlowRawValue	Flow raw value
FlowAvgValue:	Average flow for the last aggregation period
FlowMinValue: 117	Minimum flow for the last aggregation period
FlowMaxValue: 119	Mmaximum flow for the last aggregation period
PressureRawValue: 4600	Pressure raw value
PressureAvgValue: 4563.200195	Average pressure for the last aggregation period
PressureMinValue: 4520	Minimum pressure for the last aggregation period
PressureMaxValue: 4600	Maximum pressure for the last aggregation period
ConsumptionRawValue: 65535	Consumption counter (absolute)
ConsumptionAvgValue: 0	Consumption for the last aggregation period (relative)
ConsumptionExtRawValue: 65535	Consumption counter extended (absolute)
ConsumptionExtAvgValue: 0	Consumption extended for the last aggregation period (relative)
AirSavingLastPeriod	Fictional saving due to the shutdown function (in the last aggregation period)
Operation_Time	Overall operation time
Switching_Cycles_Shutoffvalve	Number of switching cycles (if available)
CycleProcessCounter	Internal counter for aggregation

Diagnosis message	Description
ErrorChannel	channel
iErrorNumber	error code number
sChanneltext	error code description

Asset message	Description
ProductKey	Festo ProductKey
CMLibVersion	Software Version preaggregation
ProcessTimePeriod	Aggregation period
PressureUnit	Pressure Unit
FlowUnit	Flow Unit
ConsumptionUnit	Consumption Unit
ConsumptionExtUnit	Consumption Extended Unit
Flow_Standard	Flow Standard
Serial_No	Serialnumber

Error Code No	Available Error Codes - Error Description
10	Upper limit exceeded
15	Module/ Channel failed
25	Fault in parametrizing upper limit
26	Fault in actuator supply
29	Fault in parametrizing

4.5 VTUG via CPX-AP payloads.

Process message	Description
Inputstate	status of the inputs
Outputstate	status of the outputs
ComID	comID
DeviceID	DeviceId
MessageType	"process"
Timestamp	timestamp

Diagnosis message
Diagnosiscurrent
Uptime
Uloadvalue
Uelsenvalue
TempreatureValueAsic
ComID
MessageType
Timestamp

Asset message
Productkey
FirmwareVersionString
ComID
DeviceID
MessageType
Timestamp