

F-901 Controller Manual

AccuStore & AccuRipe

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1554 NE 3rd Ave, Camas, WA 98607, USA

Phone: (360) 833-8835

www.felixinstruments.com

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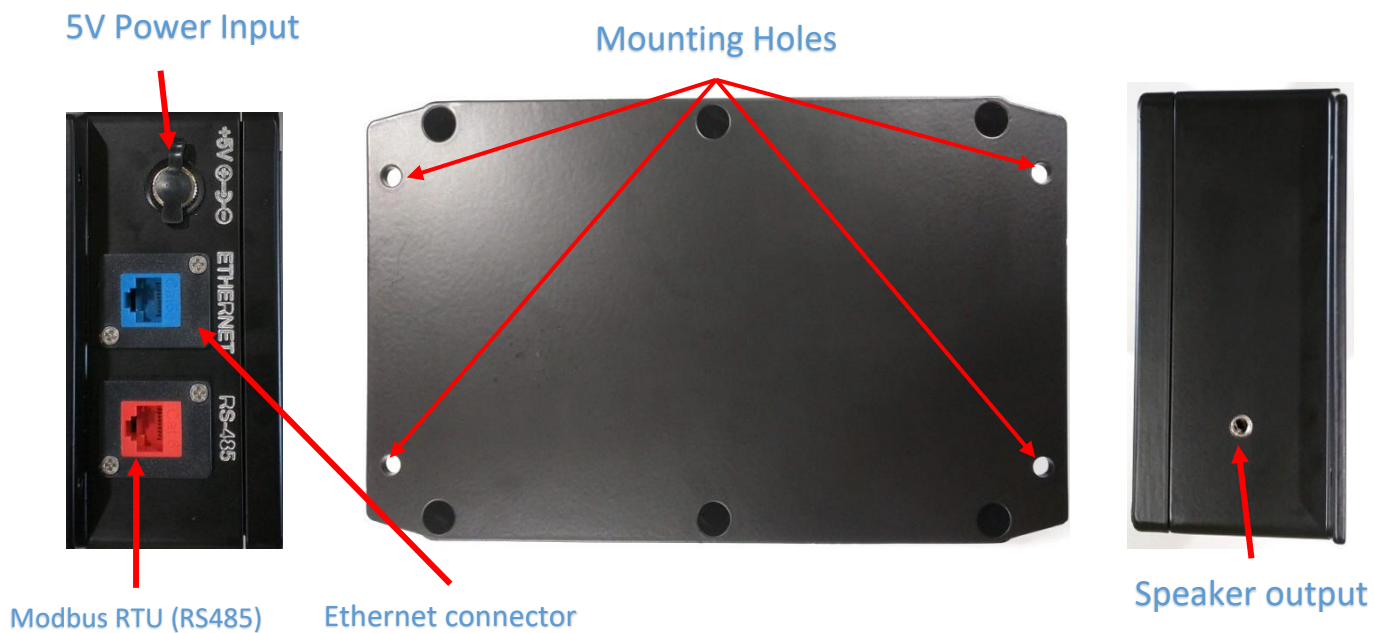
IMPORTANT SAFEGUARDS

To reduce the risk of fire, electrical shock, injury to persons or permanent damage to this device, these safety precautions should always be followed:

- Use the included 5VDC power supply when operating this device. Inappropriate voltage supply or power connector could cause irreparable damage to this device.
- Make sure power plug and Modbus cable are plugged in and secured before powering up the device.
- Do not expose this device to any liquids.

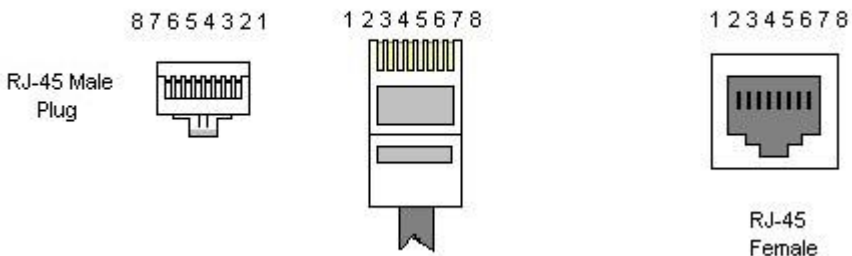
Specifications

Power Input	5VDC
Avg. Power Consumption	5W
Weight	0.88kg
Enclosure	Powder-coated aluminum
Dimensions	172mm x 103mm x 55mm
Communication	Modbus RTU (RS485) & TCPIP (Ethernet),
User interface	7" Touch Display, remote web browser, Desktop app
Software features	Configurable I/O for Modbus-compatible sensors/actuators Configurable control algorithm (PID, ON/OFF, Open-Loop) MQTT cloud API Sound and email alarms Control-event scheduler
Data storage	8GB



IMPORTANT: USE ONLY THE SPECIFIED POWER PLUG AND CABLES

MODBUS Connection (RS485)



Pin Description

Pin	Name	Type	Description
1	NC		No Connection
2	GND	Reference potential	Local device ground
3	NC		No Connection
4	B (D-)	Bus In/Out	Driver output and receiver input
5	A (D+)	Bus In/Out	Driver output and receiver input
6	NC		No Connection
7	NC		No Connection
8	NC		No Connection

Electrical Parameters

Parameter	Min	Max
Voltage range at A or B	-7V	12V
Differential Threshold Voltage (Receiver)	-0.2V	0.2V
Differential Output Voltage (Transmitter)	1.5V	5V
Input Current (12V)	-0.8mA	1mA
Input Resistance	12k Ω	
Electrostatic discharge at A and B		± 8 kV

Example Modbus Configuration

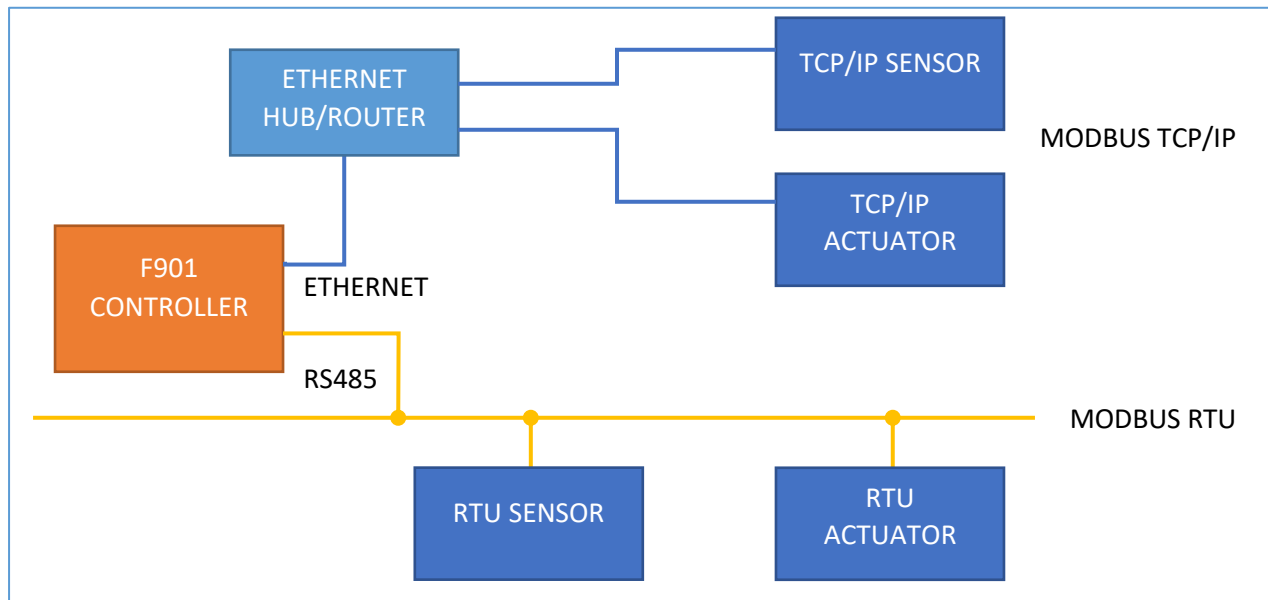


Figure 1: Hub connection configuration

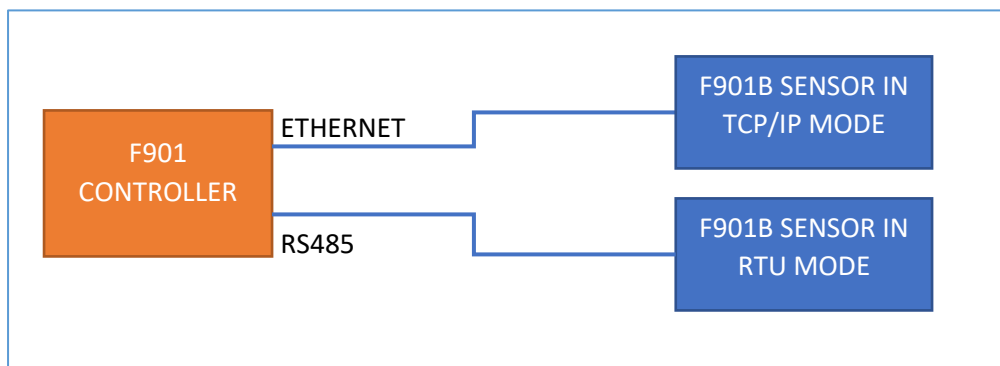


Figure 2 F901 Controller and Sensor direct connection

Note: see [Info Menu](#) for switching between Hub and Direct Ethernet connection

F901 Controller UI Overview

Main Toolbar

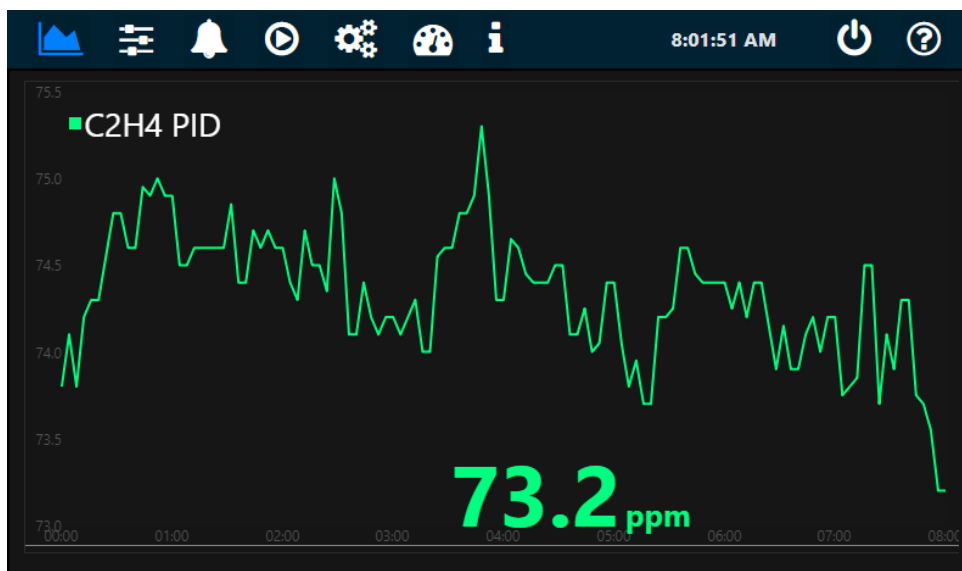


Menu buttons from left to right:

- [Sensor Measurements](#)
- [Control Panels](#)
- [Alarms](#)
- [Recipes](#)
- [Panel Configurations](#)
- [F901B sensor calibration](#)
- [Info](#)

Sensor Measurements Menu

This menu displays real-time data of sensor measurements. Measurement will only show in this menu if it is enabled in the [Control Panels menu](#).



To specify the length of displaying sensor data, see [Info Menu](#)

To download recorded sensor data, see Launcher app's [Download data](#)

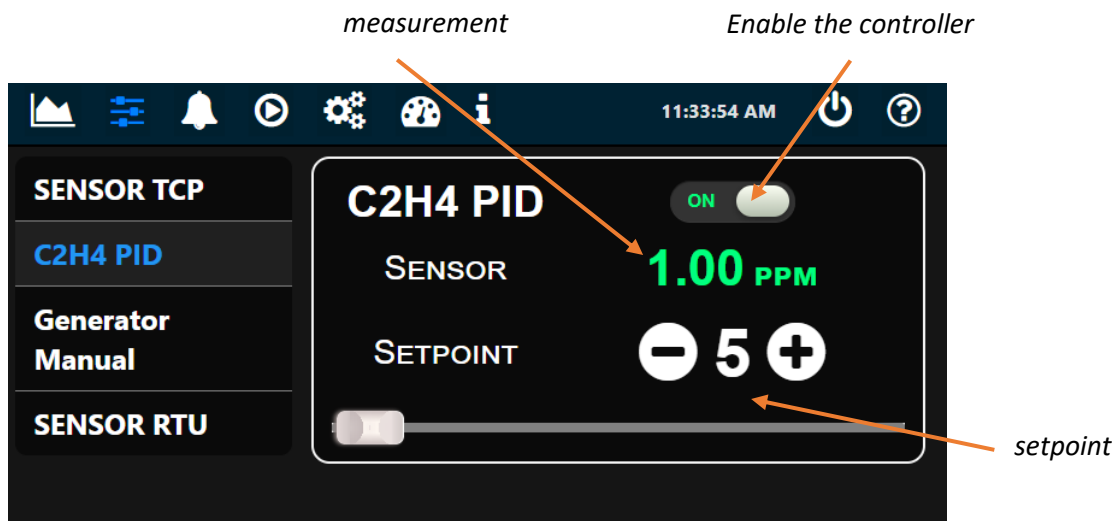
Control Panels Menu

This menu shows the available interactive panels that are configured by the [Panel Configuration menu](#). A panel is a control unit that allows a specific control task or acquisition of sensor data. There are 5 types of control panels:

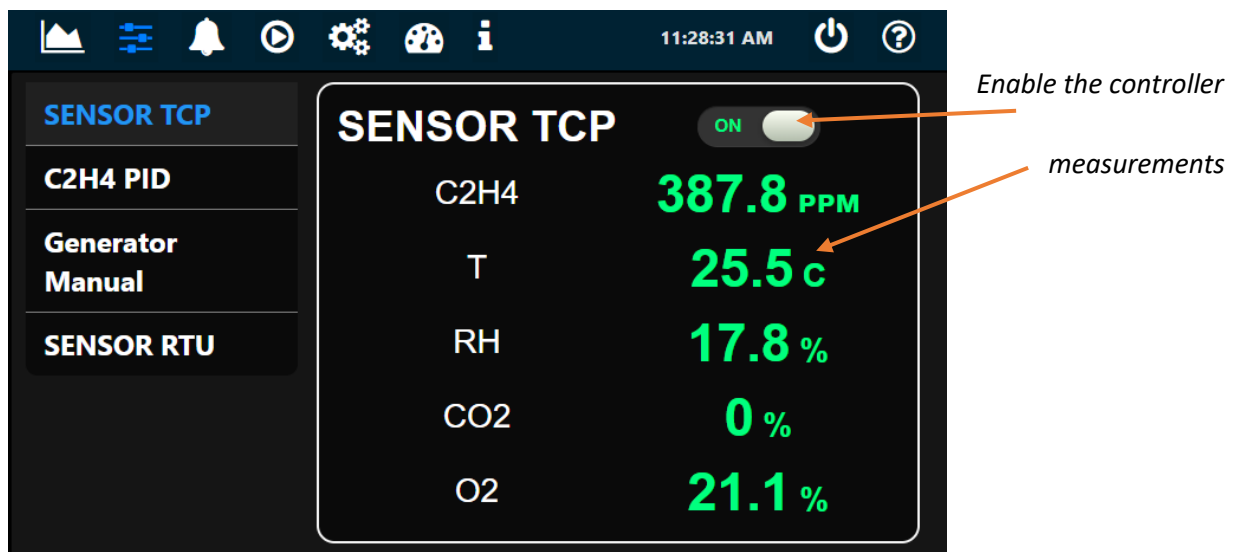
- **Single Stat:** an input-only controller for displaying sensor measurements
- **Switch:** an ON/OFF output-only (open-loop) controller
- **Slider:** a range output-only (open-loop) controller
- **ON-OFF controller:** a closed-loop controller with ON/OFF (bang-bang) control algorithm
- **PID Controller:** a closed-loop controller with PID control algorithm

In the example picture below:

The *C2H4 PID* panel is a **PID controller**. As a closed-loop controller, it requires sensors for input and actuators for driving output in the system. In this case, the sensor feedback is ethylene measurement from the F901B Sensor and the actuator is the ethylene generator.

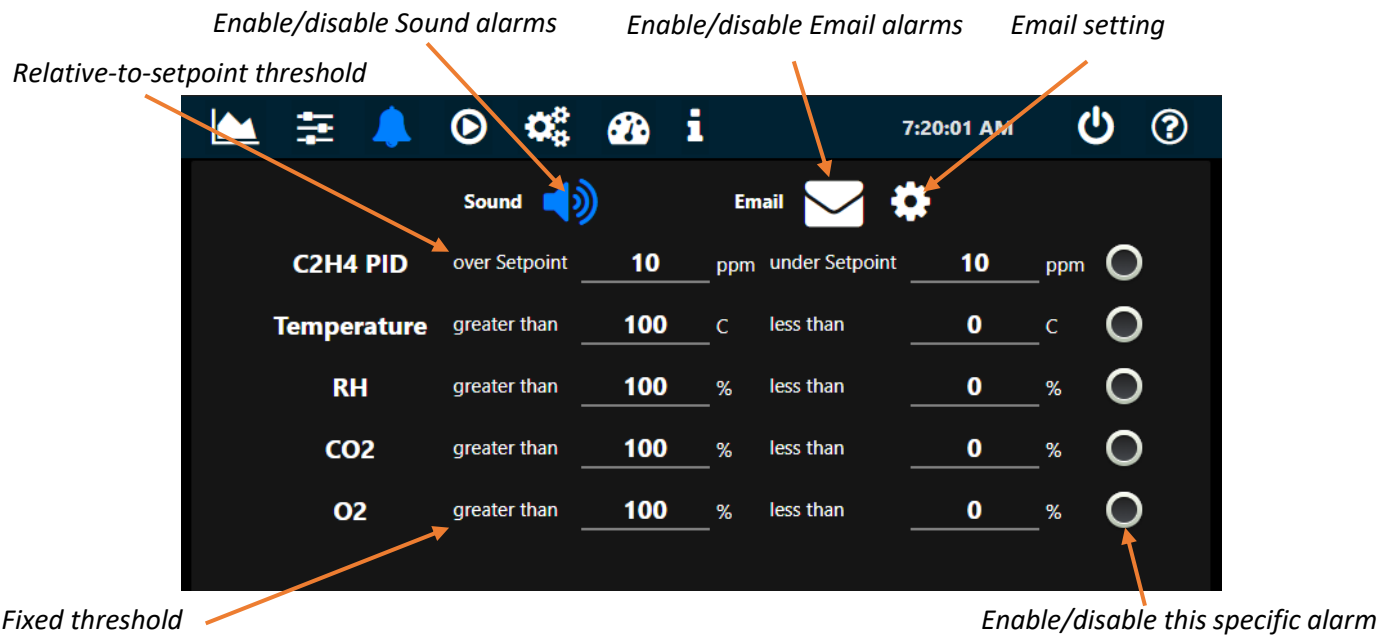


The *Environment* panel is a **Single-Stat** controller, which periodically acquires additional sensor data from the F901B sensor.



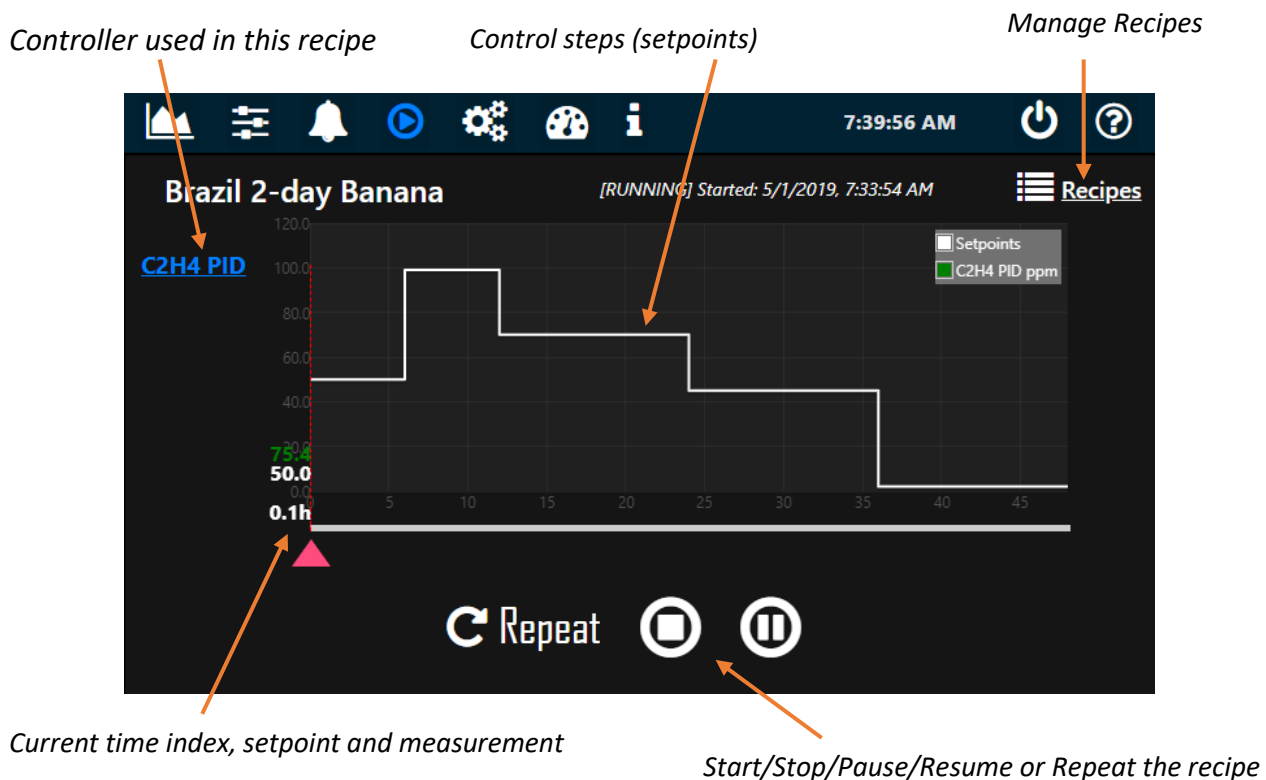
Alarms Menu

Use this menu to manage sensor alarms, via Sounds (beeper and speaker) or Emails.

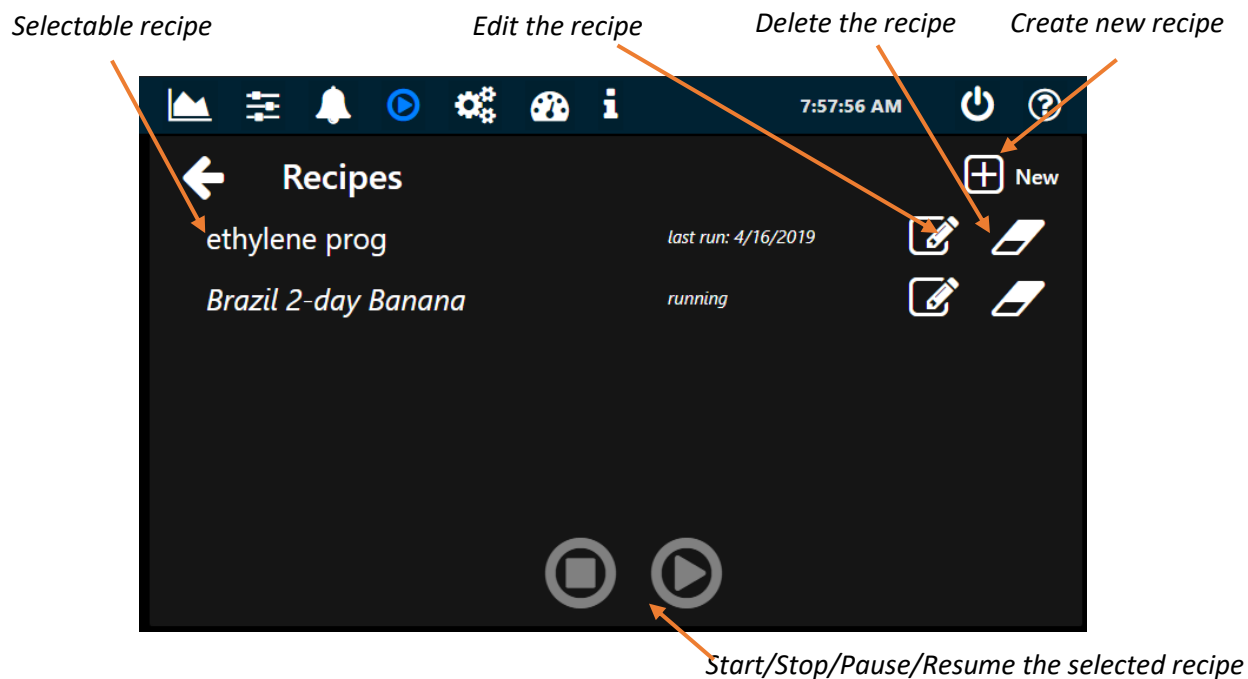


Recipes menu

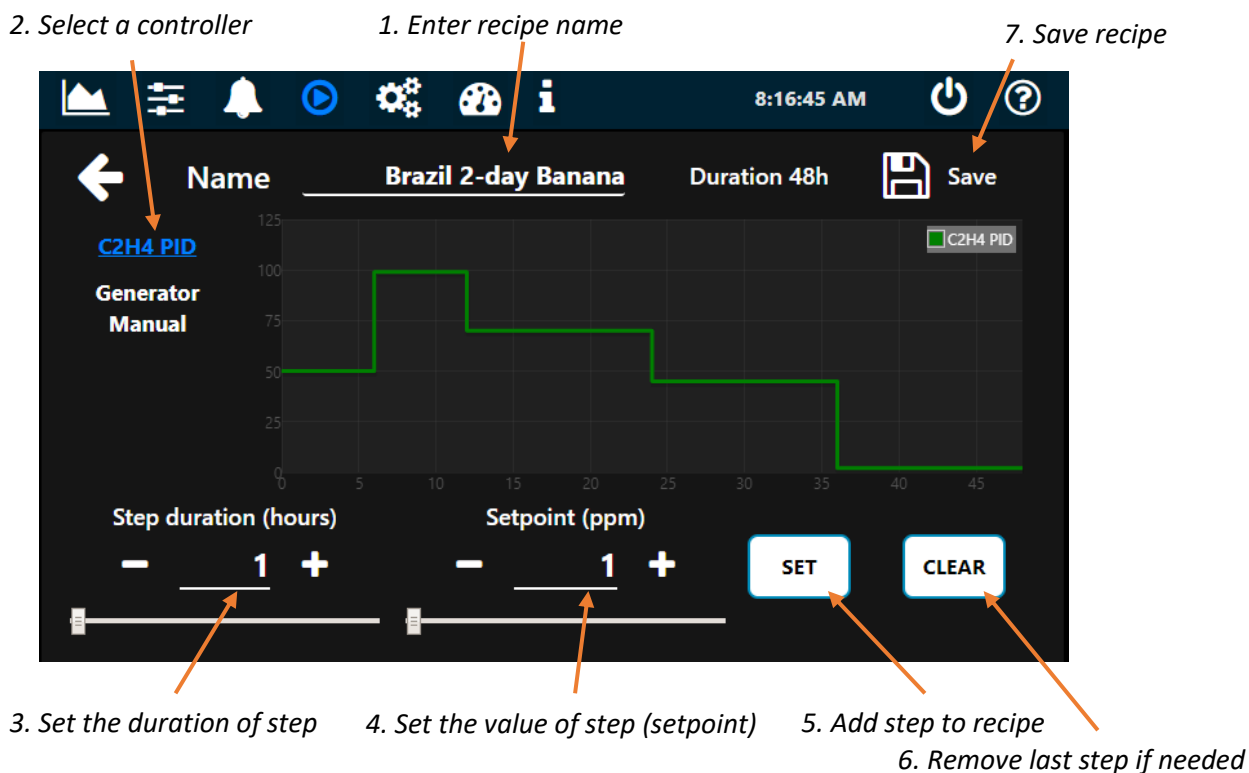
The F901 Controller provides programmable scheduler for the configured control panels. For example, in the screen below, a 48-hour ethylene PID-controller program is running with 5 different setpoint steps at specific time and duration.



In **Manage Recipes** menu:



To create a new recipe:



Note:

- You can add multiple controllers to your recipe by repeating from step 2.
- Once a recipe is started, it will override any manual setpoint of the corresponding panel in the [Control Panel menu](#)

Panel Configuration Menu

Note: Enter passcode 1111 to access this menu

A panel is a control unit that allows a specific control task or acquisition of sensor data. A panel (used interchangeably in this manual as a controller) contains one or many *devices* that are sensors or actuators.

With the Panel configuration menu, you can define your own controllers of the following categories:

- **Single Stat:** an input-only (no actuator) controller for displaying sensor measurements.
- **Switch:** an ON/OFF output-only (no sensor) controller.
- **Slider:** a range output-only (no sensor) controller.
- **ON-OFF controller:** a closed-loop controller with ON-OFF (bang-bang) control algorithm. The ON-OFF controller requires at least one sensor and one actuator.
- **PID Controller:** a closed-loop controller with PID control algorithm. PID controller requires at least one sensor and one actuator.

After the panels are configured, the F901 Controller will populate the corresponding panels in the [Control Panels Menu](#)

Currently selected panel

List of devices (sensors/actuators) in this panel

List of configured panels

Panel arrangement

Panel parameters

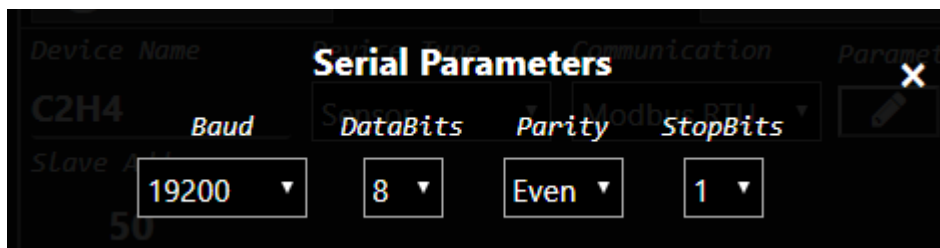
- **Interval:** control interval in seconds, specifies how frequently the controller should sample and produce new output
- **Setpoint Min/Max:** specifies the range of control setpoint. In the above example, the range of setpoint is 0-200ppm
- **Output Min/Max:** specifies the range of control output. In the above example, the range of output is 1-100
- **Sensor Unit:** a displayable unit of the sensor for this controller

To specify the input and output of your controller (devices in the panel):

- Click **New Device** button to create a new device
- Fill your device parameters
- Click **Save Device** button to add the device to the controller

Device parameters

- **Type:** specifies whether the device is a sensor or actuator. For example, the F901B C2H4 sensor can be specified as a sensor device and the Ethylene Generator can be specified as an actuator device.
- **Communication:** specifies the method of communication, Modbus RTU, TCP/IP or Virtual. If Modbus RTU select, you can also specify its serial parameters using the *Parameters* button



A Virtual communication method can be used to simulate a device without an actual physical connection. This is typically the case when you would like to apply a mapping function to your existing sensor outputs, specified in the *Virtual Function* input. For example, a virtual device with virtual function $10 \times \text{C2H4}$ produces 10x output of the actual C2H4 sensor device. Note that a virtual actuator will produce no effect.

- **Slave address/Ip Address:** specifies either the Modbus slave address (RTU) or IP address (TCP/IP) of the device.
- **Register Address:** specifies the Modbus register address of the device. For example, the F901B C2H4 reading can be accessed at address 0 (of the *Input Register* bank)
- **Register Type:** specify the type of Modbus register
- **Input Multiplier:** specify the multiplier for the input reading. For example, the F901B C2H4 reading is reported as ppmx10, therefore, we use 0.1 as a multiplier to modify this input as ppm
- **Output Modifier fx:** filter function applies on output value before sending to the actuator. Default function x (that is $fx = x$) implies no output modification.

Note: if multiple sensors are specified in a controller as feedbacks, the input will be the average of all sensor measurements. If multiple actuators are specified in a controller, the same output will be applied to all actuators.

F901B Sensor Calibration Menu

Use this menu to calibrate the F901B sensor. You can select between performing a span calibration or zero calibration.

Parameters:

- **Sensor:** select the sensor for calibration.
- **Sensor Slave Address:** F901B sensor slave address. The default address is 50 for RTU and 192.168.1.50 for TCP/IP.
- **Calibration duration:** specifies the duration of calibration.
- **Calibration concentration:** specifies the concentration of the calibration source.

F901B Sensor Calibration

Step 1 Calibration parameters Step 2 Setting up Step 3 Calibration

Sensor: C2H4 ☒ Span ☐ Zero

Sensor Slave Address: 50

Calibration Duration (minutes): 5

Calibration Concentration [PPM]: 200

Next Step Reset

Note:

- Span Calibration requires standard gas. A demand-flow regulator is also recommended.
- C2H4 Zero Calibration uses the F901B's internal KMnO4 filter as its reference source, no zero gas is required. For zeroing CO2 and O2, Zero gas source (e.g 100%N2) is required.
- Before calibration, in the [Control Panels](#) menu, disable any controller that has the F901B ethylene sensor as one of its devices to avoid control conflicts.

Info Menu

Controller IP: 192.168.1.192

Software version: 0.191

Storage usage: 40%

Preferences

Controller Name: F901 controller

Display Chart Length: 3 (h)

PID tuning: ☐

Enable MQTT: ☐

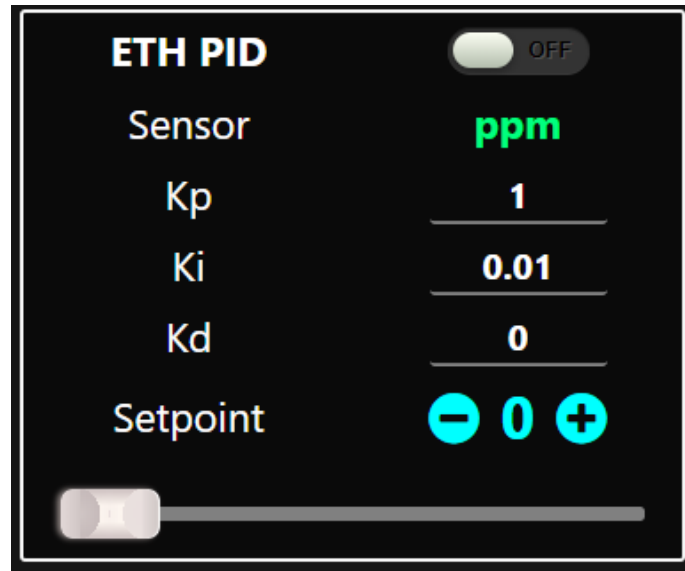
P2P Ethernet: ☐

SAVE

- **Controller IP:** displays the current local IP address of the F901 Controller
- **Software version:** current controller software version. To update controller software, see [Update software](#)
- **Storage usage:** current controller disk usage. The controller keeps all sensor data in its internal drive. If the storage is full, you have the option to clean up [recorded data](#).

Preferences Setting

- **Controller Name:** set controller name
- **Display Chart Length:** length (hours) of the data plot in the Sensor Measurement Menu
- **PID tuning:** enables PID tuning parameters in the Control Panels menu



- **Enable MQTT:** enables MQTT cloud API for remote access/control. For more details, see [MQTT Endpoints](#)
- **P2P Ethernet:** Switching between hub or direct (point to point) Ethernet connection between the controller and other Modbus TCP/IP devices

F901 Launcher app

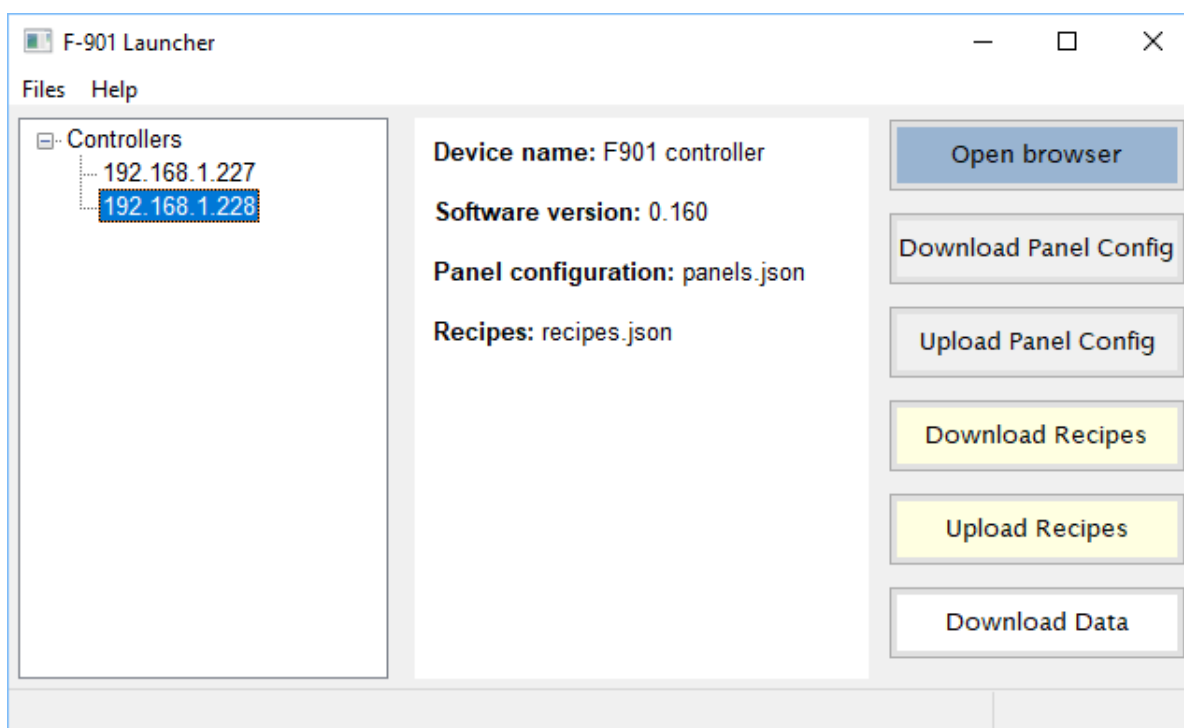
The F901 Launcher app allows managing multiple F901 controllers over your local Network connection, including:

- Search and view available F901 controllers in your network
- Update software
- Backup and restore Panel configurations
- Backup and restore Recipes
- Download recorded sensor data
- Configure MQTT settings

Download

Download the executable F901 Controller Launcher at <https://felixinstruments.com/support/F-901/software/>

Search and view controllers in your network



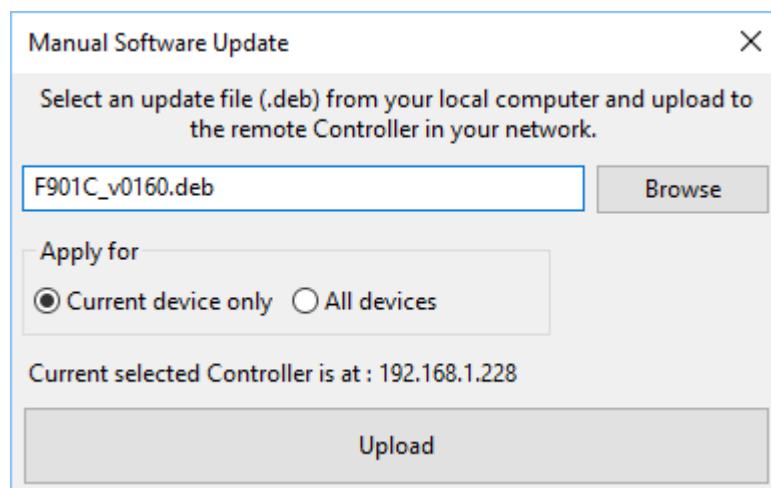
To search for available F901 controller in your network,

- Make sure the F901 controller is powered up and connected to the Local Network via ethernet (check your controller [Info menu](#) for Controller IP address)
- Select **Search for Controllers** in the **Files** menu.

You can also manually add a Controller using its IP address by selecting the **Add Controllers** option.

Once an F901 controller has been added to the app, double click the listing IP address or click **Open Browser** to launch the remote browser of your F901 Controller. The remote browser gives full UI access to the F901 Controller as its touch screen.

Update software



A screenshot of a 'Manual Software Update' dialog box. It has a title bar with a close button. The main text says 'Select an update file (.deb) from your local computer and upload to the remote Controller in your network.' Below this is a text input field containing 'F901C_v0160.deb' and a 'Browse' button. Underneath is a section 'Apply for' with two radio buttons: 'Current device only' (selected) and 'All devices'. Below that, it says 'Current selected Controller is at : 192.168.1.228'. At the bottom is a large 'Upload' button.

To update the F901 Controller software:

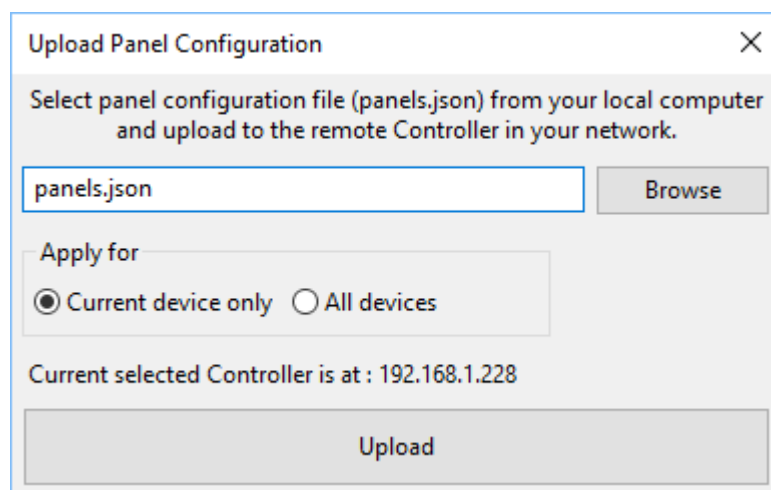
- Obtain the latest software update at <https://felixinstruments.com/support/F-901/software/>
- In the Launcher app, select **Files > Software update**
- Select the downloaded software
- Click Upload
- In your F901 Controller screen, confirm update request.
- The F901 Controller will automatically reboot after an update

Backup and restore Panel configuration

You can backup your customized [panel configuration](#) by:

- Select your controller on the left panel
- Click **Download Panel Config**
- Select location to save your panel config on your computer

To restore the panel configuration



A screenshot of an 'Upload Panel Configuration' dialog box. It has a title bar with a close button. The main text says 'Select panel configuration file (panels.json) from your local computer and upload to the remote Controller in your network.' Below this is a text input field containing 'panels.json' and a 'Browse' button. Underneath is a section 'Apply for' with two radio buttons: 'Current device only' (selected) and 'All devices'. Below that, it says 'Current selected Controller is at : 192.168.1.228'. At the bottom is a large 'Upload' button.

- Select your controller on the left panel
- Click **Upload Panel Config**

- Select panel config file on your computer for restoring
- Click upload

By the same process, you can upload your customized panel to other F901 Controllers.

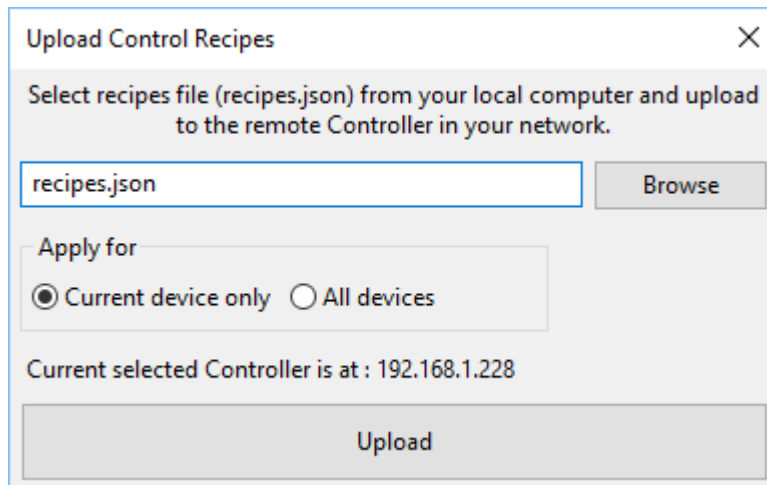
Backup and restore Recipes

You can backup your customized [Recipes](#) by:

- Select your controller on the left panel
- Click **Download Recipes**
- Select location to save your recipes on your computer

To restore the panel configuration

- Select your controller on the left panel
- Click **Upload Recipes**
- Select recipes file on your computer for restoring
- Click upload



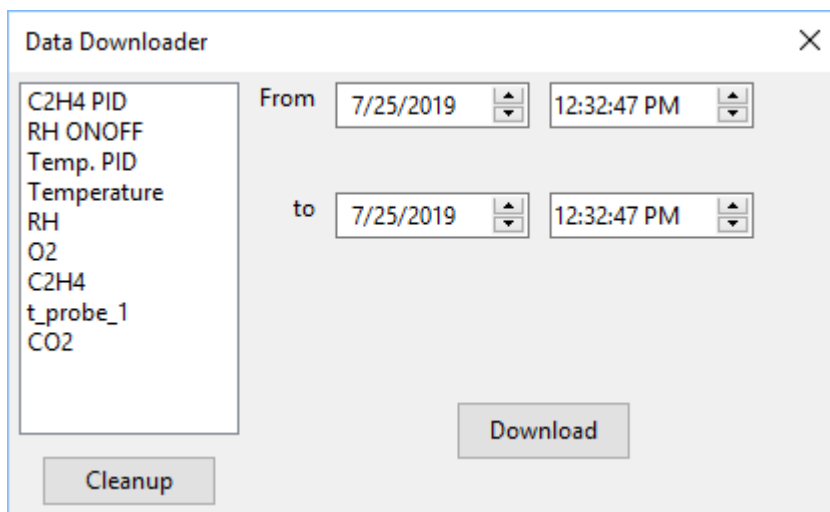
By the same process, you can upload your customized recipes to other F901 Controllers.

Download recorded sensor data

To download recorded sensor data on your F901 Controller:

- Select your controller on the left panel
- Click **Download data**
- Select the sensor data and DateTime range
- Click Download
- Select location to save data file (.csv) on your computer

To clean up all recorded data, click the Cleanup button. This will free up device internal storage.

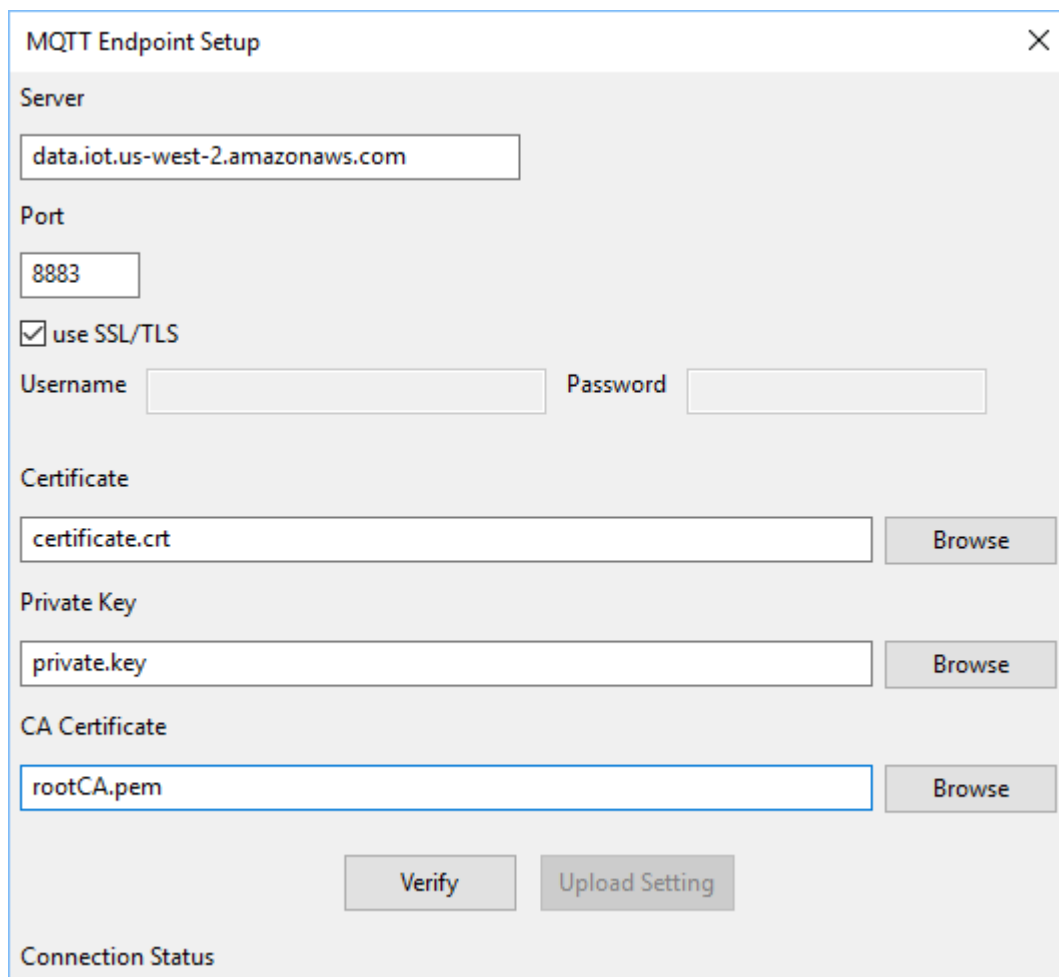


The Data Downloader dialog box features a list of data types on the left: C2H4 PID, RH ONOFF, Temp. PID, Temperature, RH, O2, C2H4, t_probe_1, and CO2. To the right, there are 'From' and 'to' time range selectors, each with date and time pickers. At the bottom, there are 'Cleanup' and 'Download' buttons.

Configure MQTT settings

The F901 Controller MQTT API allows remote access to your F901 Controller via secured cloud services. To configure your F901 controller MQTT settings, select **Files > MQTT Configuration**:

- Enter the Username/Password of your cloud service account. If your cloud service uses SSL/TLS connection, obtain and save the secure certificate, Private key, and CA Certificate files to your computer.
- Enter your cloud Server name.
- If using SSL/TLS connection, select your certificate, Private key, and CA Certificate files to be uploaded



The MQTT Endpoint Setup dialog box contains the following fields and controls:

- Server:** A text field containing 'data.iot.us-west-2.amazonaws.com'.
- Port:** A text field containing '8883'.
- use SSL/TLS:** A checked checkbox.
- Username:** An empty text field.
- Password:** An empty text field.
- Certificate:** A text field containing 'certificate.crt' and a 'Browse' button.
- Private Key:** A text field containing 'private.key' and a 'Browse' button.
- CA Certificate:** A text field containing 'rootCA.pem' and a 'Browse' button.
- Buttons:** 'Verify' and 'Upload Setting' buttons are located at the bottom.
- Connection Status:** A label at the very bottom of the dialog.

- Click **Verify** to verify the connection to your MQTT server
- Once the connection is successful, click **Upload**
- On your F901 Controller, enable the MQTT service under [Info menu](#) (must be done **after** successful Upload)
- Your F901 Controller MQTT API is now ready for remote access.

F901 Controller MQTT Endpoints

Subscribing

Topic: *[Controller name] EP0*

Return: Json object {topic, payload}

Note: default controller name is **F901 controller**. You can set controller name under [Info menu](#)

Example API call from paho-mqtt client:

```
Client.subscribe(topic="F901 controller EP0", qos=0)
```

Example return:

```
topic: F901 controller EP0

payload: {"id1556576356539": {"enable": false, "name": "Generator Manual",
"devices": {}}, "id1556575675503": {"enable": true, "name": "C2H4 PID",
"devices": {"C2H4": {"status": 0, "value": 75.0}, "Generator": {"status":
0, "value": 800}}}, "id1556575918560": {"enable": true, "name":
"Environment", "devices": {"CO2": {"status": 0, "value": 0.59}, "RH":
{"status": 0, "value": 34.2}, "Temperature": {"status": 0, "value": 26.0},
"O2": {"status": 0, "value": 19.5}}}}
```

Payload object hierarchy:

```
Payload {
  panel_id : {
    "enable": [true/false],
    "name": [string],
    "devices": {
      device_name: {"status": [number], "value": [number]},
      ...// other devices
    }
  }
  ...//other panels
}
```

Publishing

Topic: *[Controller name] EP1*

Payload: json object specifies control parameters of a panel/device

Control parameters:

panel_param: set a panel parameter.

- **id** : panel id [string]
- **attr**: controllable panel attribute [string]
 - **controllerEnable**: enable/disable current panel
 - **setValue**: Panel setpoint . Applicable for *PID* and *ON-OFF controllers* only
- **value**: control value [true/false/number]

Example:

```
msg = {
    'panel_param': {
        "id": "id1556575675503",
        "attr": "controllerEnable",
        "value": False
    }
} // disable panel

client.publish(topic="F901 controller EP1", payload=json.dumps(msg))
```

device_param: set a device (in a panel) parameter. Applicable for actuator devices only

- **id** : panel id [string]
- **Index**: device index in the panel's devices list [number]
- **attr**: controllable panel attribute. Default attribute is "**value**"
- **value**: control value [number]

Example:

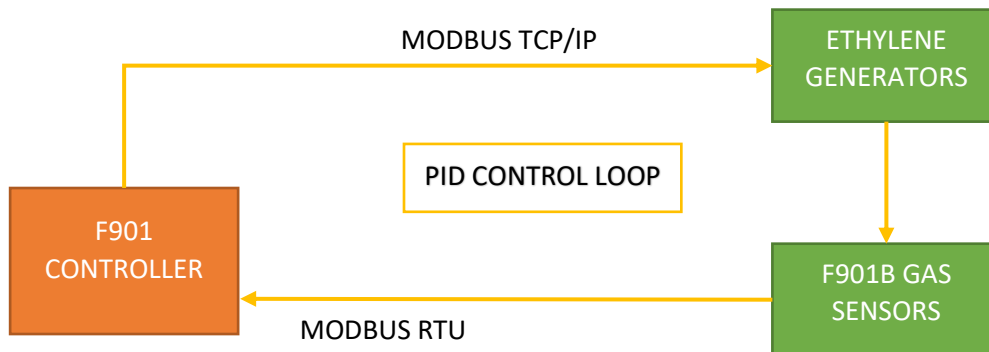
```
msg = {
    'device_param': {
        "id": "id1556575675503",
        "index": 0, // in the panel device list
        "attr": "value",
        "value": 40
    }
} // in a panel, set actuator output to 40

client.publish(topic="F901 controller EP1", payload=json.dumps(msg))
```

EXAMPLE PID CONTROLLER CONFIGURATION

Controller components

- Sensor (controller input): F901B Ethylene sensor, operating via Modbus RTU and sampling every 300 seconds
- Actuator (controller output): Ethylene Generator, operating via Modbus TCP/IP, accepting control output as the number of seconds between ethylene production peaks (short duration means higher production rate)



Create a new controller

In the Panel Configuration menu, press **New Panel**. Enter panel details:

- Panel Name: **ETH PID**
- Panel Type: **PID Controller**
- Sensor Unit: **ppm**
- Interval: **150**
- Setpoint Min **0**, Max **500**
- Output Min **1**, Max **100**

Panel Name	Panel Type	Interval(s)	Sensor Unit
ETH PID	PID Controller	150	ppm
Setpoint Min	0	Setpoint Max	500
Output Min	1	Output Max	100

Note:

- Control interval set to 150 seconds, as half of the sensor sampling interval (300 seconds)
- Output Max and Setpoint Max should be set correspondingly to each other for best controller performance.

Add a sensor device

In the same Panel Configuration menu, press **New Device**. Enter sensor details:

- Device Name: **Ethylene**
- Device Type: **Sensor**
- Communication: **Modbus RTU**
- Slave Addr: **50**
- Register Addr: **0**
- Register type: **Input**

- Input multiplier: **0.1**

Device Name	Device Type	Communication	Parameters
Ethylene	Sensor	Modbus RTU	
<i>Slave Addr.</i>			
50			
<i>Register Addr.</i>	<i>Register type</i>	<i>Input Multiplier</i>	
0	Input	0.1	

Press **Save Device** to add the sensor to our controller.

For more details on F901B sensor, please see [F901B manual](#)

Add an actuator device

In the same Panel Configuration menu, press **New Device**. Enter actuator details:

- Device Name: **Ethylene**
- Device Type: **Actuator**
- Communication: **Modbus TCP/IP**
- IP Addr: **192.168.1.165**
- Port: **502**
- Register Addr: **47**
- Register type: **Holding**
- Output Modifier: **800/x**

Panel configuration					New Panel	Save Panel
Environment Generator Manual ETH PID	<i>Panel Name</i>	<i>Panel Type</i>	<i>Interval(s)</i>	<i>Sensor Unit</i>	Ethylene	
	ETH PID	PID Controller	150	ppm	Generator	
	<i>Setpoint Min</i>	0	<i>Setpoint Max</i>	500		
	<i>Output Min</i>	1	<i>Output Max</i>	100		
	New Device		Save Device			
	<i>Device Name</i>	<i>Device Type</i>	<i>Communication</i>			
	Generator	Actuator	Modbus TCP/IP			
	<i>IP Addr.</i>	<i>Port (optional)</i>				
	192.168.1.165	502				
	<i>Register Addr.</i>	<i>Register type</i>	<i>Output Modifier fx</i>			
47	Holding	800/x				

Note:

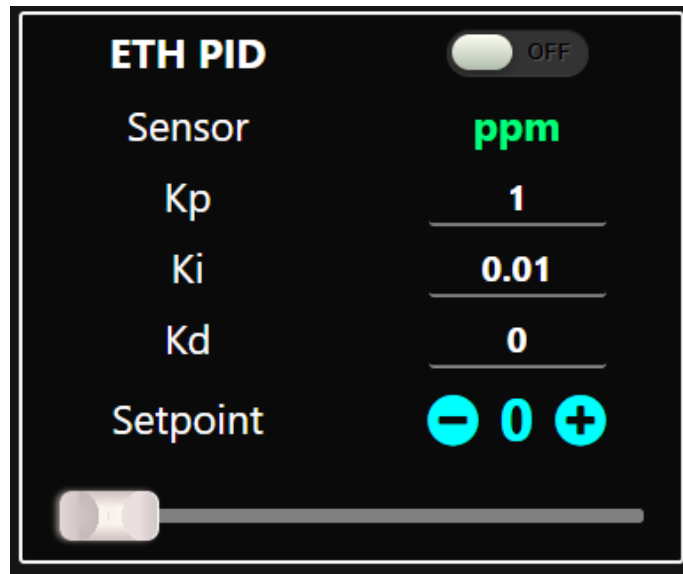
- Ethylene Generator may have a different IP address in the local Network

- The generator accepts a control value in Holding register 47 as the number of seconds between ethylene production peaks, with a minimum duration of 8 seconds. The output modifier remaps the linear controller output (1-100) to actual generator input (duration between peaks)

Press **Save Device** to add the generator to the controller.

Finally, press **Save Panel** to finish the controller configuration.

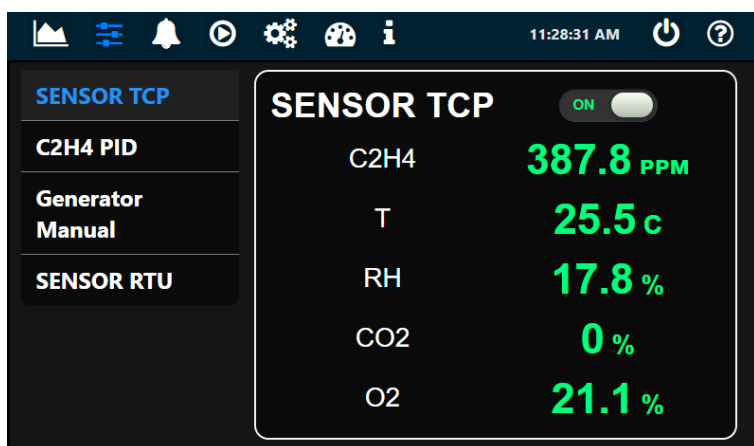
In the Control Panels menu, our new panel will appear after the configuration is saved:



F901 CONTROLLER AND SENSOR QUICKSTART



- Power up the F901 controller and sensor
- Connect the controller and sensor via a standard ethernet cable
- The controller should start to display current sensor measurement as below. See also [Example Modbus Configuration](#) and [Switching between Hub and Direct connection](#).

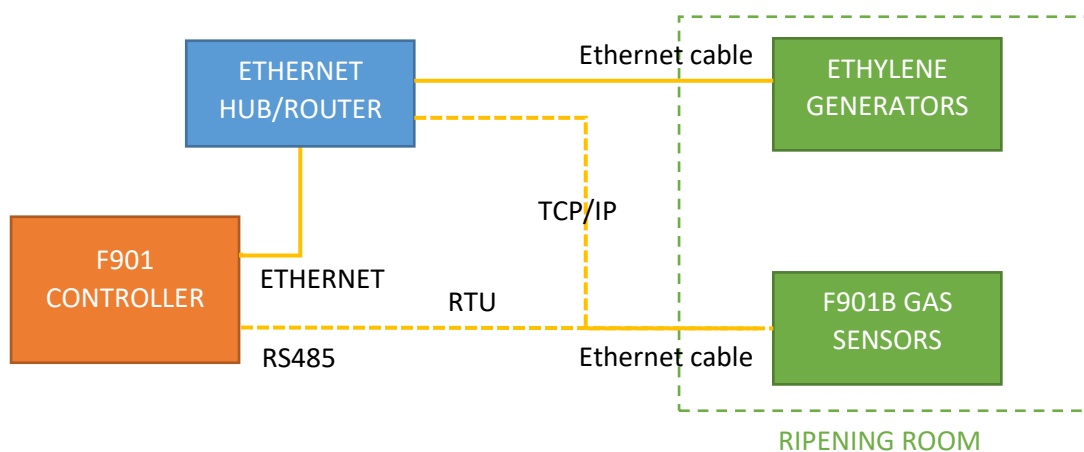


RIPENING ROOM QUICKSTART

Required equipment

- F901 Controller
- F901B Sensor
- Catalytic-Generators 's Ethylene Generator with Modbus TCP/IP configuration
- Ethernet Hub/Router
- Ethernet Cables

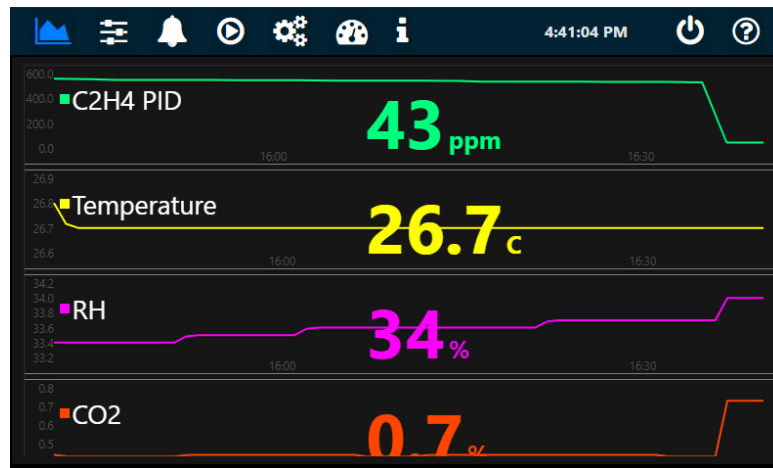
Setup Modbus Connections



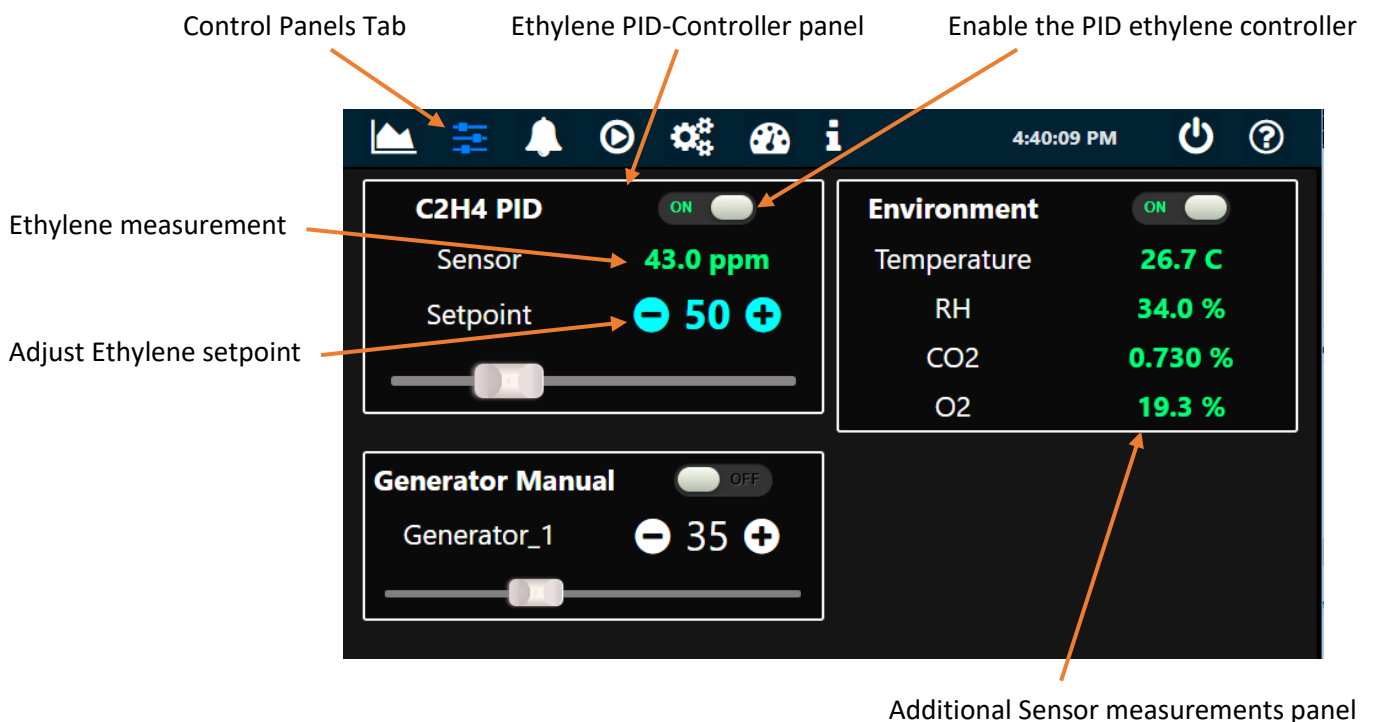
- Use either RTU or TCP/IP mode to connect the controller to sensor
- For more details on Modbus parameters, see [Device Parameters](#)

Power up the F901 controller, F901B Sensor and Ethylene Generator

- Power up the F901 Controller and the F901B sensor with the provided power adapters
- Turn Ethylene Generator on. The generator may take a few minutes of warm-up time before producing ethylene
- F901B sensor will automatically and periodically take measurements after startup. The default measurement interval is 5 minutes
- The F901 Controller display once successfully connected to the F901B sensor and Ethylene Generator:



- To manage the ethylene level of the ripening room, in the Control Panel tab:



Seller's Warranty and Liability

Felix Instruments- Applied Food Science warrants new equipment of its own manufacturing against defective workmanship and materials for a period of one year from date of sale. The results of ordinary wear and tear, neglect, misuse, accident and excessive deterioration due to corrosion from any cause are not to be considered a defect.

Felix Instruments' liability for repairing or replacing defective parts during the warranty period is contingent on examination by a Felix Instruments authorized representative. Felix Instruments liability will not extend beyond repairing or replacing parts from the factory where they were originally manufactured. Repair or alteration by an unauthorized technician voids warranty.

Material and equipment which is not manufactured by Felix Instruments are to be covered only by the warranty of its manufacturer. Felix Instruments will not be liable to the Buyer for loss, damage, or injury to persons or to property by the use of equipment manufactured by other companies.

Buyer accepts the terms of warranty through the use of this instrument and any accessory equipment. There are no understandings, representations, or warranties of any kind, express, implied, statutory, or otherwise (including, but without limitation, the implied warranties of merchantability and fitness for a particular purpose), not expressly set forth herein.

All instrument repairs or replacement covered under warranty require a Returned Material Authorization (RMA) number. Please contact Felix Instruments technical support department at support@felixinstruments.com to obtain an RMA number before shipping instrument to CID Bio-Science, Inc.

Buyer is responsible for shipping charges to Felix Instruments headquarters:

1554 NE 3rd Ave.
Camas, WA 98607
USA

Felix Instruments is responsible for return shipping charges on repairs and/or replacement covered by warranty.

Warranty Registration Card



1554 NE 3rd Ave, Camas, WA 98607, USA

Phone: (360) 833-8835 Fax: (360) 833-1914 e-mail: sales@felixinstruments.com Web: www.felixinstruments.com

PRODUCT REGISTRATION CARD

Please complete and return this form to Felix Instruments within 30 days to validate your Warranty on Parts & Labor.

Registration Information:

Your Name: _____ Title: _____

Company/University: _____

Address: _____

City: _____ State: _____ Zip: _____

Country: _____ Email: _____

Phone: _____ Fax: _____

Felix Instruments Serial Number(s): _____

Purchase Date: _____ Purchase Price: _____

Your opinions will help improve our service. Please answer the following questions.

1. What was the basis of your product selection?

- | | |
|--|---|
| <input type="checkbox"/> Representative Recommendation | <input type="checkbox"/> Price |
| <input type="checkbox"/> Product Features | <input type="checkbox"/> Product Design |
| <input type="checkbox"/> Technical Specifications | <input type="checkbox"/> Brand Name |
| <input type="checkbox"/> Warranty | <input type="checkbox"/> Service |
| <input type="checkbox"/> Other _____ | |

2. What other competing brands did you consider? _____

3. Where did you first learn of this product?

- | | |
|---|---|
| <input type="checkbox"/> Advertisement in _____ | <input type="checkbox"/> Representative |
| <input type="checkbox"/> Friend/Colleague | <input type="checkbox"/> Exhibit |
| <input type="checkbox"/> Other _____ | |

4. Who selected this product?

- | | |
|--|---|
| <input type="checkbox"/> I did | <input type="checkbox"/> Research Group |
| <input type="checkbox"/> University Department | <input type="checkbox"/> Purchasing |
| <input type="checkbox"/> Other _____ | |

5. Comments/Suggestions: