User Guide

Machine Monitor™

Powered by Factory-Relay™

A Guide for System Administrators

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Chapter 1: Introduction to Factory-Relay™ Machine Monitor™

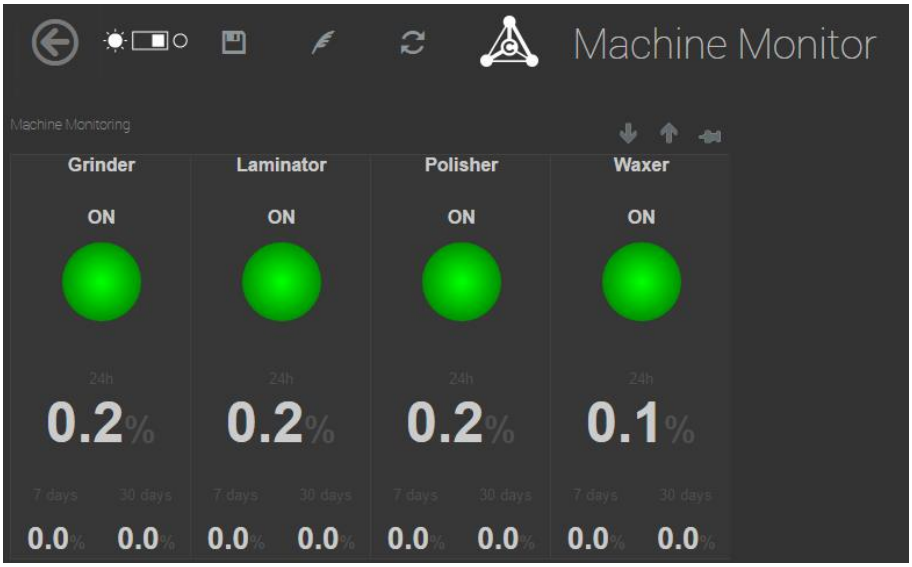
C-Labs created the Machine Monitor to help plant personnel answer an important question quickly and easily: Which machines are doing value-adding work? The answers that it provides are not the opinions of plant personnel, nor do they come from guesses and wishes of outside observers. They are, instead, grounded in the reality provided by sensors that provide a continuous, specific, objective reflection of how a specific machine is operating right now.

Three of the most unique features of the Factory-Relay Machine Monitor are

- Easy extensible with new plugins (machine and cloud connectors, services, and processors)
- Flexible API to write own extensions
- Support for mesh and other advanced network topologies

Machine Monitor Indicators

Machine Monitor indicators allow plant personnel to view equipment status in real-time. And not just one machine, but many machines at the same time. The Machine Monitor indicators provide real-time results to plant personnel. With one indicator per machine, plant personnel can see the status of multiple machines with a quick glance:



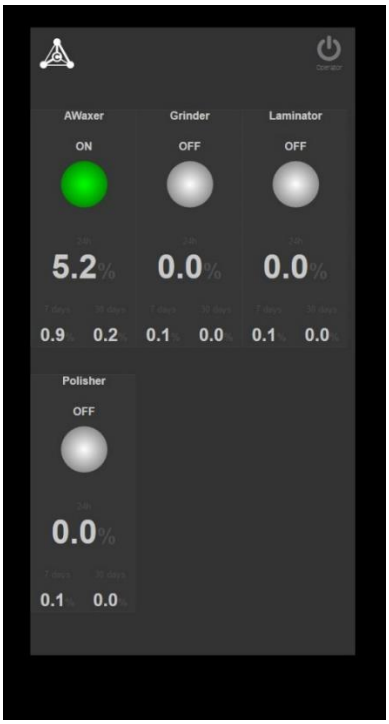
Machine Monitor showing the status of four machines

This display shows the status of four machines: a grinder, a laminator, a polisher, and a waxer. The indicator light for each of these machines is green. Not only is each of these machines powered and running, but each is also doing real work and being productive. C-Labs Machine Monitor comes equipped with four status indicators: green (meaning 'on'), gray (meaning 'off'), black (meaning 'unknown') and blue (for startup / maintenance mode). A set of extended states is optionally available which includes yellow (non-critical warning) and red (error – critical condition).

Note: "On" means being productive and doing work
Inside Machine Monitor (and in this document), we use the term "On" to mean more than that the machine has power. In Machine Monitor terminology, "On" means that a

machine has power, is operating, and is being productive. And so the term “Off” means a machine is not being productive (even though the power might, in fact, be on).

Using C-Labs exclusive IoT technology, this display can also be viewed beyond the plant boundaries so that support personnel, key vendors, and company executives can have the same visibility into operations whether they are around the corner or around the world. An authorized user can view the display in any web browser, such as Internet Explorer or Chrome, as well as in smart phone browsers as shown in this example:

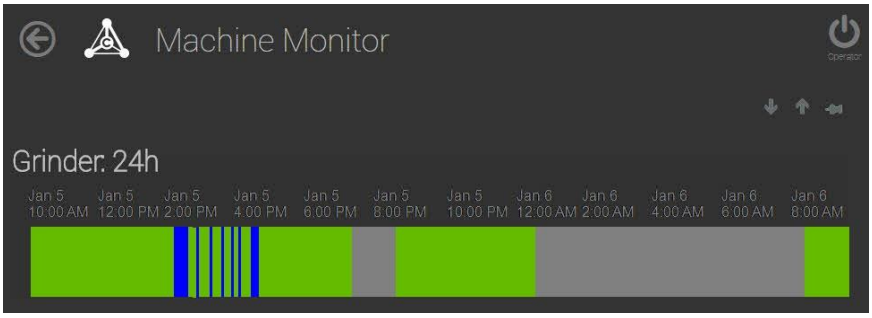


Machine Monitor status on a mobile phone

An “all green” display means that 100% of monitored equipment is not only up and running, but is doing real work and contributing to real production. When a machine has been briefly offline – perhaps for raw material loading or because of a shift change – that machine’s indicator changes to **gray**. When plant personnel see a gray ‘off’ display, they can decide whether additional attention is required or whether a normal pause is occurring.

Machine Monitor Strip Chart

Each indicator keeps a history, available to plant personnel as a strip chart.



Machine Monitor strip chart with 24-hour status summary

Strip charts provide a quick view into the historical status of a given machine. Strip charts are available for each machine indicator, showing 24-hour's worth of historic data at a glance.

General notes on this User Guide

The Machine Monitor Software will be constantly improved. The screenshots in this guide might not be the same as what you see in your browser.

If you see any differences we have not fixed, yet, please look for an updated guide on http://www.Factory-Relay.com/documentation

You can also send us an email at support@C-Labs.com

Thank you for your understanding

Chapter 2: Installation on Windows

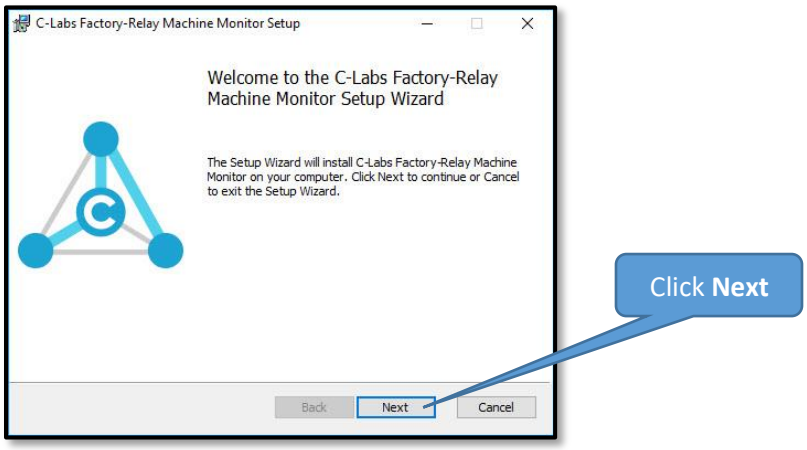
If you are running the Machine Monitor on a Deviceworx Gateway, you do not need to install it as it comes pre-installed on the gateway. You can skip to "Chapter 3 – Initial Configuration"

This chapter shows how to install the Machine Monitor onto a PC running Microsoft Windows. User accounts are created during the installation process, and so this chapter also covers the creation of user accounts.

Installation

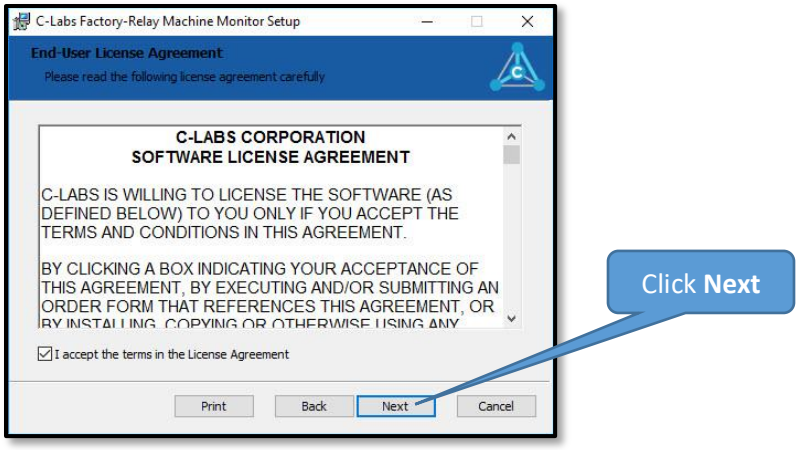
Install Machine Monitor by following the steps in the following sections.

1. On a system running Microsoft Windows, log in using an account that has Administrator privileges.
2. Navigate to the folder containing the MSI file for the Machine Monitor. Double-click on the Machine Monitor MSI file. A welcome message like the following appears:



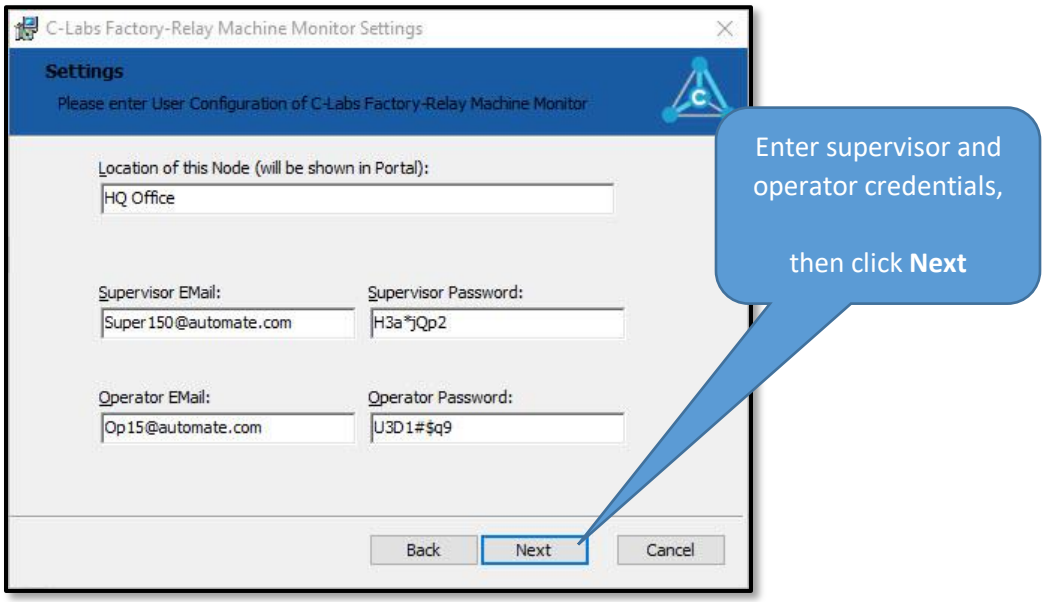
Welcome Screen for C-Labs Factory-Relay Machine Monitor Setup

3. Click the **Next** button. The end-user license agreement appears on the screen. Check the checkbox to indicate your acceptance of software license agreement.



End-User License Agreement

4. When you are ready, click **Next** to indicate your agreement with the license agreement. The **Settings** window appears. This window allows you to create Supervisor and Operator accounts.



Settings page for C-Labs Factory-Relay Machine Monitor Setup

Creating User Accounts

There are three type of user accounts in the Machine Monitor system.

- Administrator – The most privileged user account. Use to enable access to factory sensor data.
- Supervisor – Use this account type for users to pair specific machines to specific sensors for a given operator's console.
- Operator – Use this account to enable read-only access to a specific set of machines for a specific operator.

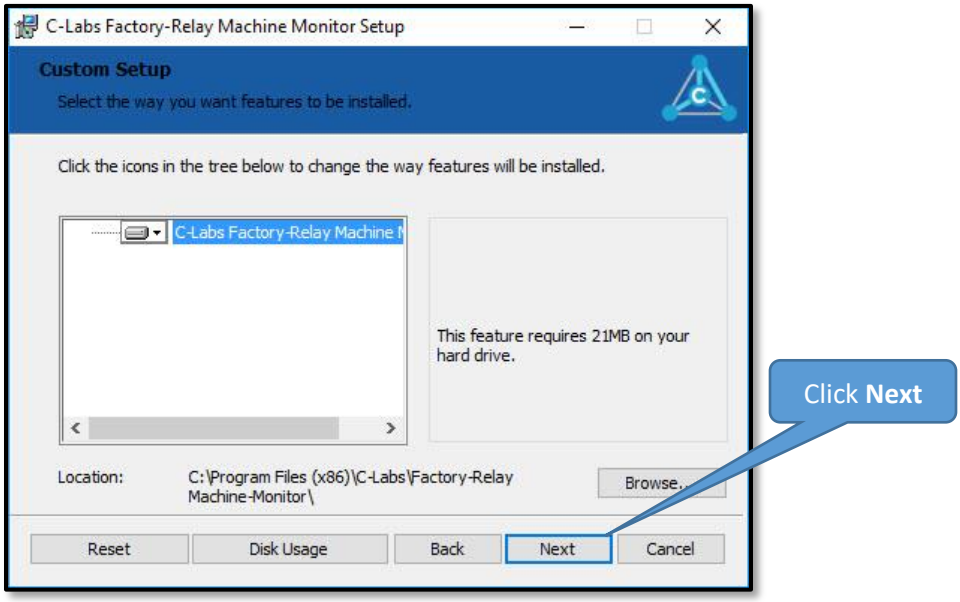
The Settings page is used to create a Supervisor account and an Operator account. The Administrator account will be created in a later step.

Important Note!
Use a **unique email address** for each user account. For example, do not use a single email address (for example, john@factory.com) for both a supervisor account and an operator account, or for a supervisor account and an administrator account.

The Settings page has five data entry fields, as summarized here:

- Location of this Node – Describes what machines are being monitored.
- Supervisor Email – A valid email address for supervisor account User ID.
- Supervisor Password – Supervisor password (minimum of 8 characters).
- Operator Email – A valid email address operator account User ID.
- Operator Password – Operator password (minimum of 8 characters).

1. For each user type, enter an Email address and a password.
2. When you are finished entering fields, click the **Next** button. The **Custom Setup** page appears



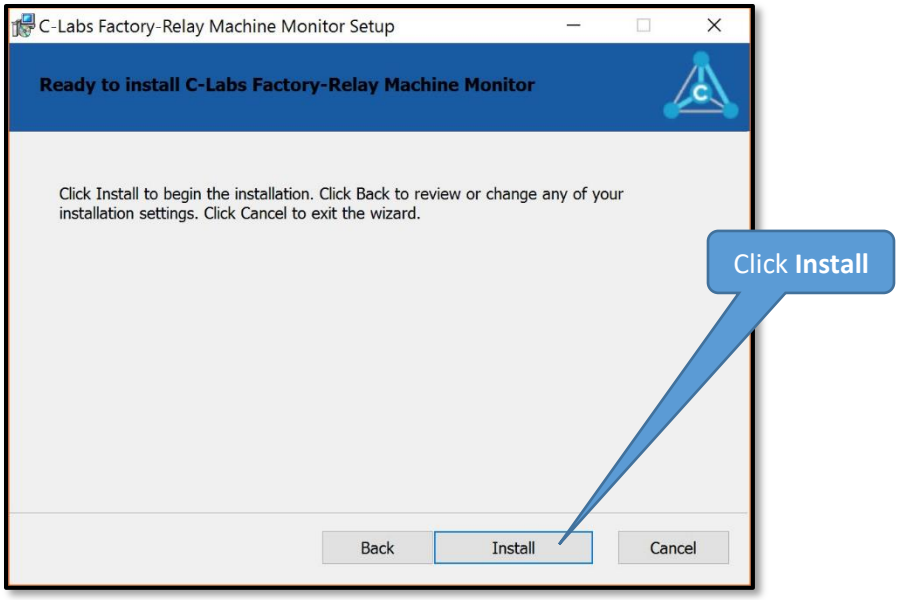
The Custom Setup page

Selecting an Install Location

Using the **Custom Setup** screen, indicate where to install the Machine Monitor on the system.

1. Accept the default installation location, or use the **Browse** button for a different location.

2. When finished making changes, click **Next**. The **Ready to Install** screen appears.



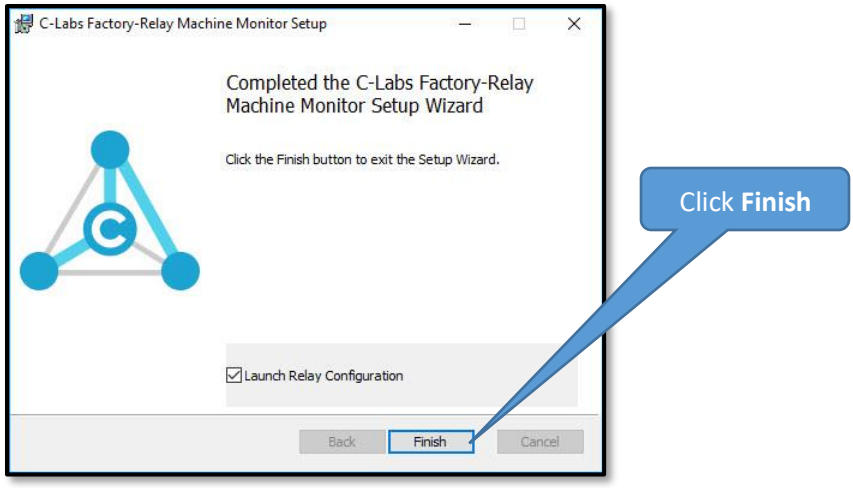
The Ready to Install page

Begin the Installation

1. To begin the installation, click the **Install** button.
2. At the start of the installation process, Microsoft Windows asks the user to confirm the installation with a User Account Control (UAC) message. A **User Account Control** confirmation page is displayed. Click **Yes** to confirm installation.

The User Account Control (UAC) Verification Request

3. After the Machine Monitor is installed, the setup completion page is displayed.



Setup Completion page

The Machine Monitor is installed on your system.

To complete the Installation without launching Machine Monitor

From here you can finish and exit the application or launch the Relay Configuration. To exit, clear the checkbox and click the **Finish** button.

Launch Relay Configuration

To launch the Relay Configuration:

1. Check the **Launch Relay Configuration** box (this is already checked).
2. Click the **Finish** button

When the checkbox marked “Launch Relay Configuration” is checked, the Machine Monitor launches in your system’s default Internet browser.

Chapter 3 – Initial Configuration

When the Machine Monitor starts for the first time, some initial configuration properties have to be set. This chapter goes of these steps.

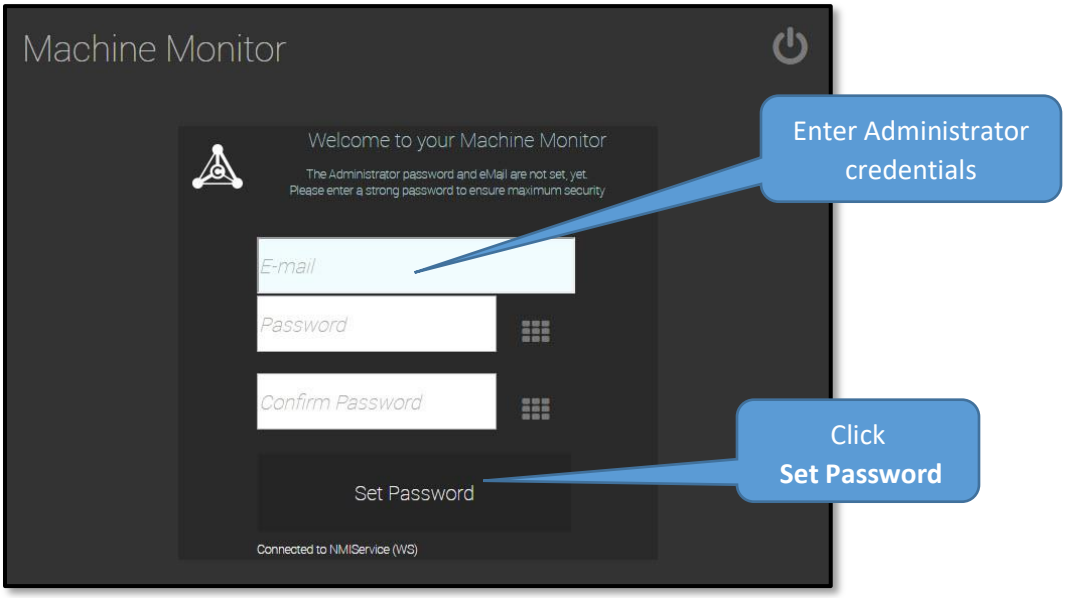
When you install the Machine Monitor on Windows, the default port used is 8704 on your local PC (localhost). You can get to the configuration at anytime using your browser and navigate to

http://localhost:8704/nmi

On a Deviceworx gateway, the default port is 80. Since you will connect to it from a different PC you need to know the IP Address of the gateway. You can then access the configuration using your browser and navigate to

http://<IP_of_Gateway>/nmi

When the page opens, you are asked to create a Machine Monitor Administrator account.



Create an Administrator user in the browser

Note: If this page does not show up in a browser window, refer to the troubleshooting tips in Appendix C of this document.

Creating the Administrator User

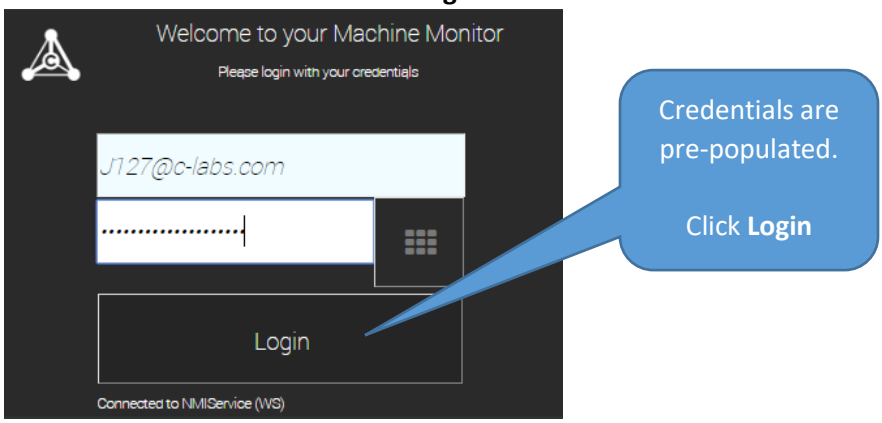
To create the Administrator user ID:

1. Enter a valid email address (including domain) in the email field.
2. Then enter the password (minimum length of 8 characters) twice,
   Important Note! Write the Administrator user-ID and password in a safe place. If lost, you must uninstall and reinstall Machine Monitor, which allows you to create a new Administrator account or follow the troubleshooting tips in Appendix C
3. Click the **Set Password** button.

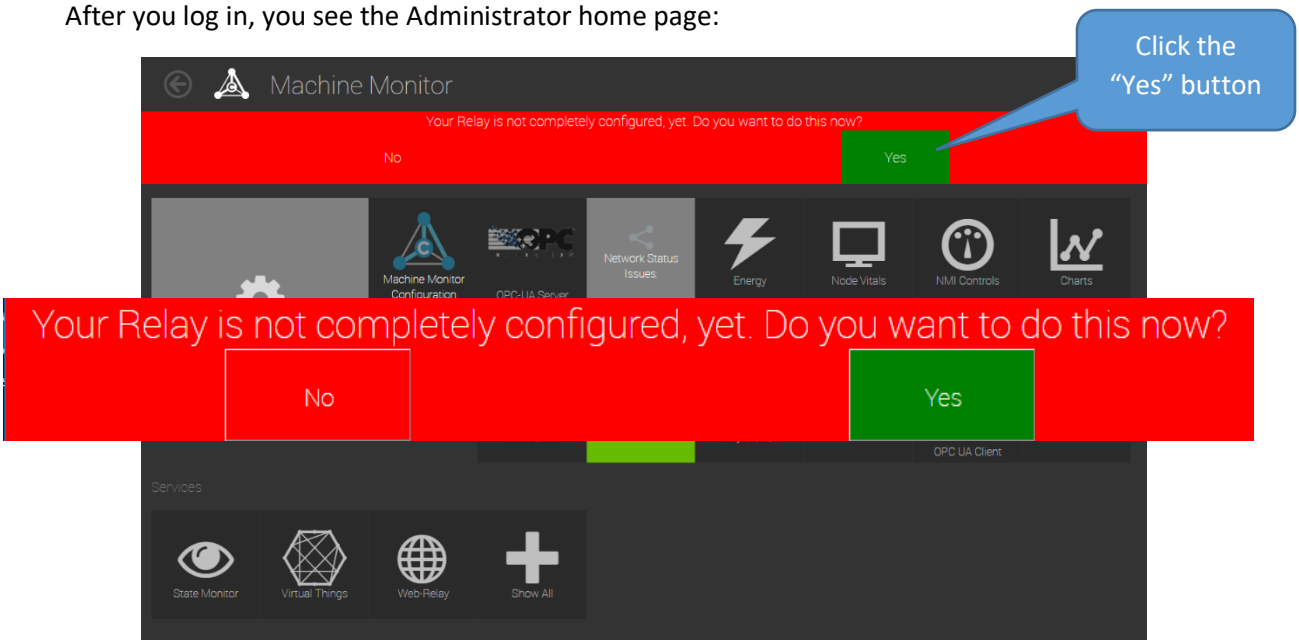
There is one more step to complete setting up of Machine Monitor. To take this last step, you need to log into Machine Monitor.

Login as Administrator

1. Immediately after you set the Administrator password, Machine Monitor displays its login page pre-populated with the administrator credentials. Click the **Login** button.



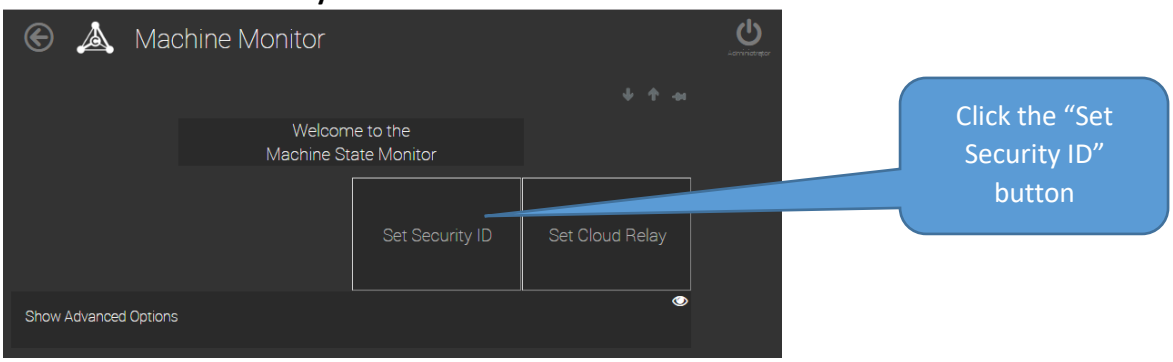
After you log in, you see the Administrator home page:



At the top of the screen is the message "Your Relay is not completely configured, yet. Do you want to do this now?"

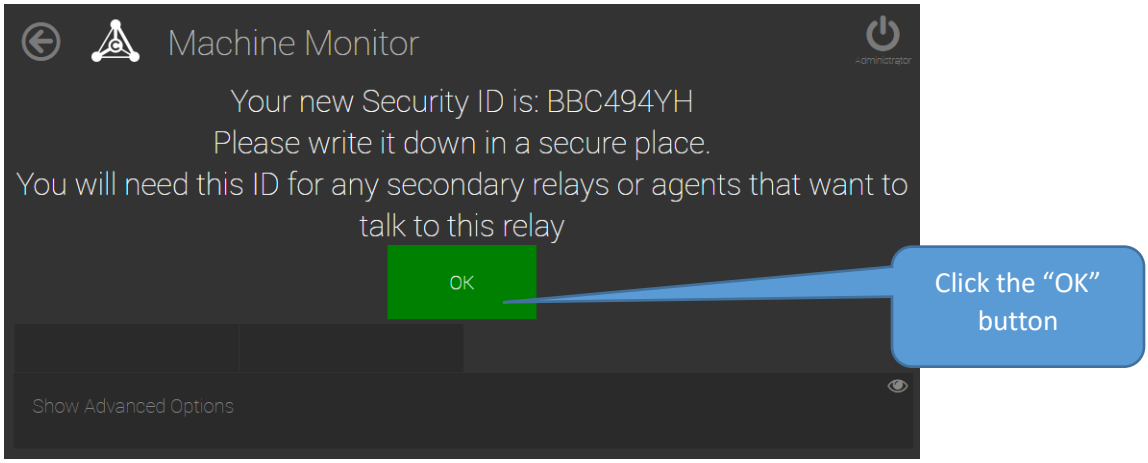
Click the **Yes** button. On the page that says "Welcome to the Machine State Monitor", click the

button labeled **Set Security ID**.



2. You are asked to confirm that you wish to set the Security ID. Click the **Yes** button.

3. You are presented with a message about the value of the security ID. Click the **OK** button.



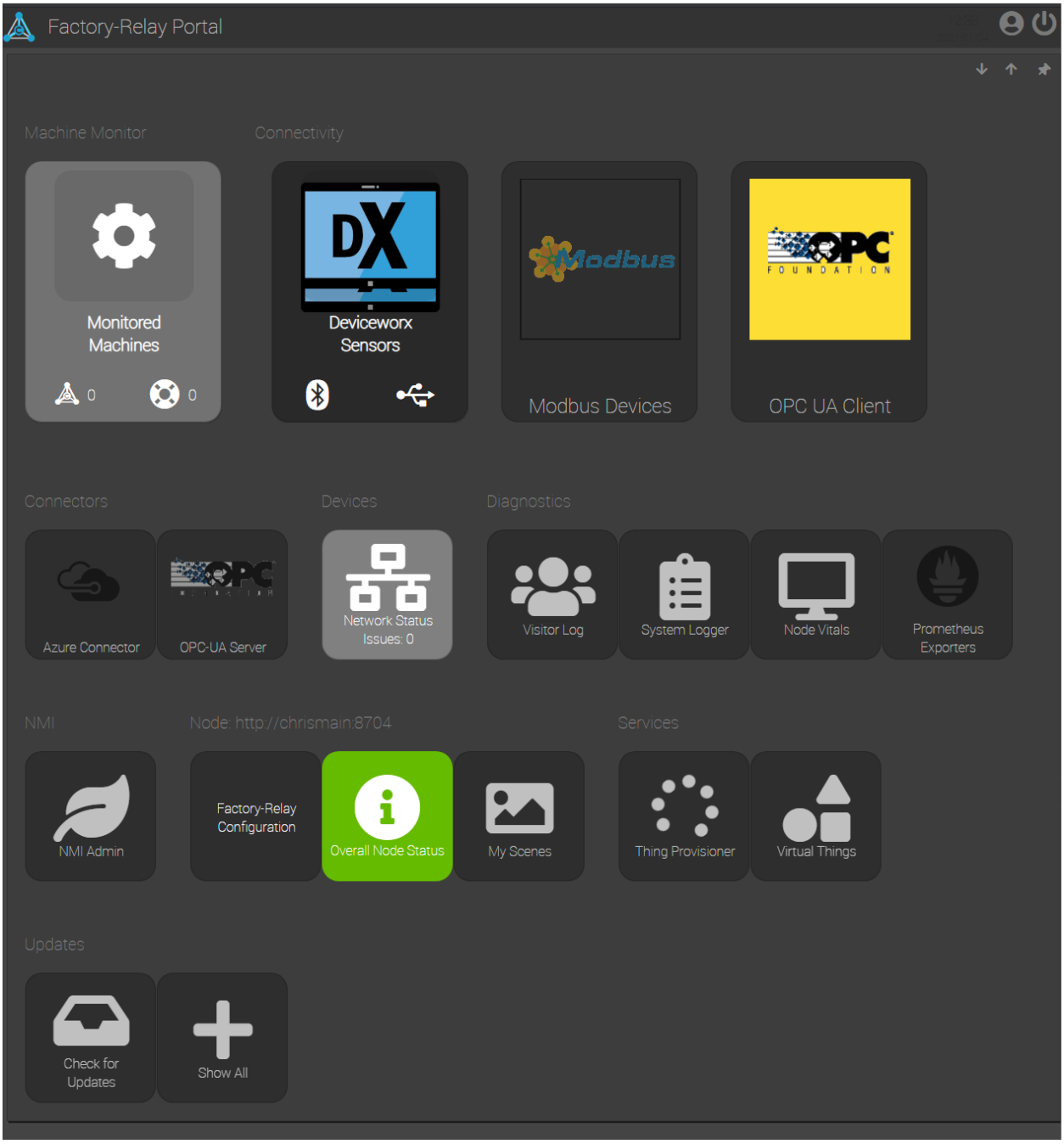
The Role of a Security ID in Machine Monitor
A security ID is a password that allows secure communication to your Machine Monitor installation. You are asked to set up a Security ID because it is a standard part of the installation and configuration of Machine Monitor.

Chapter 4: The Operator, Supervisor, and Administrator Views

To access the Machine Monitor, users first login using valid credentials. The set of available features depend on a user's assigned role, with operator accounts having the least privilege, supervisor accounts have a few additional privileges, and administrator having full privileges. In this chapter, we look at examples of what each of these user types might see when they log into the Machine Monitor.

The Administrator View

When you log in with an administrator account, you see the Machine Monitor administrator home page:



Machine Monitor administrator home page

From the Machine Monitor administrator home page, you can set up the operator display. The operator display (shown in the next section) shows a set of machines and the state of sensors that have been configured to show the state of the machines. (screen details may vary depending on installed plugins)

The Operator View

A user who logs in with an operator account can view a set of machines and the status of the sensors for those machines. However, an operator cannot change the configuration of machines or sensors. Changes can only be made from an administrator account or a supervisor account. An operator account provides read-only access to machine sensor details. Here is a sample operator display:

Machine Monitor operator home page

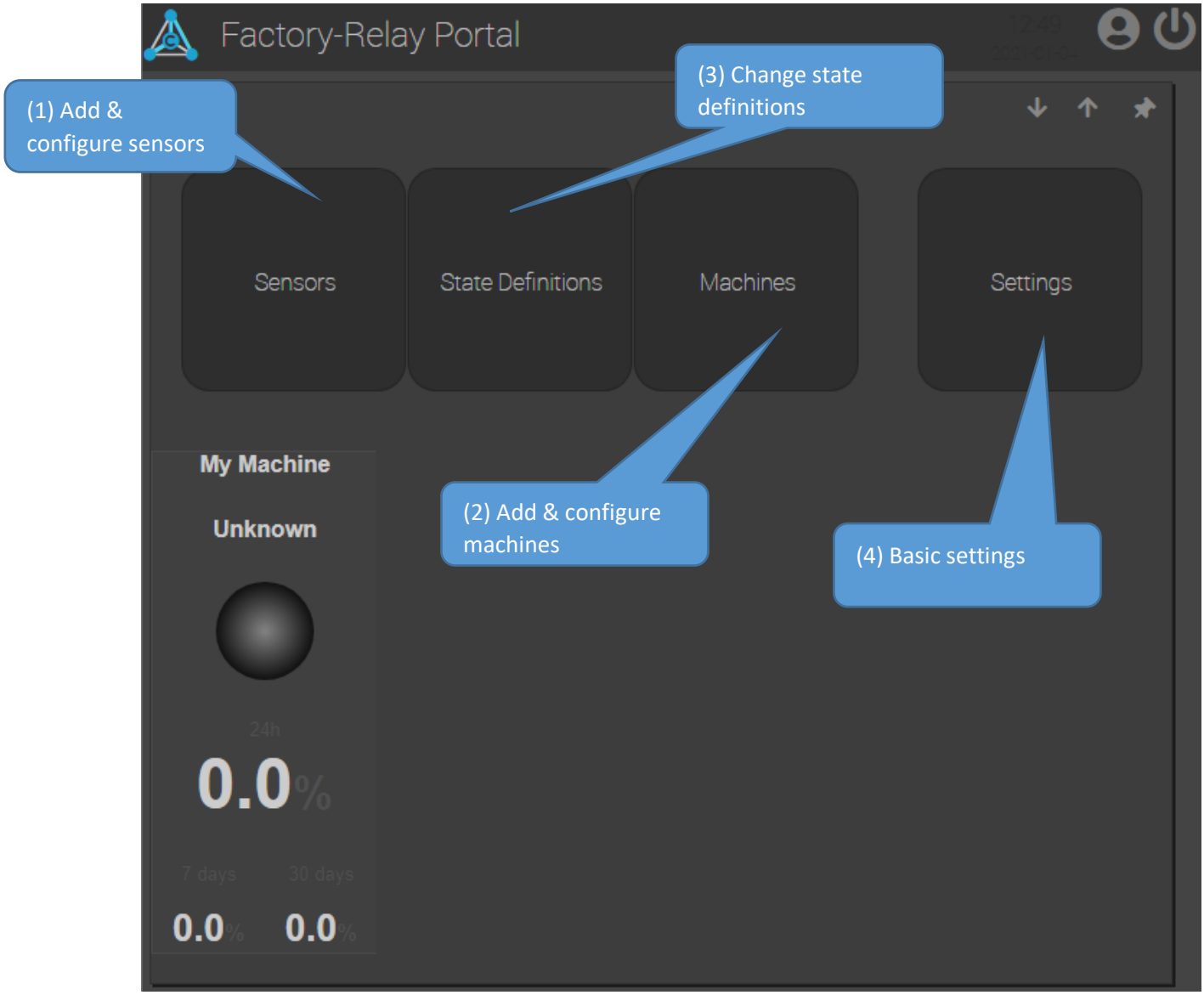
The above screen shot shows an example of an operator's view. When you log in to the Machine Monitor with a fresh installation, you will only see an empty screen. It is worth pointing out that this operator view shows the status of three machines, which are named "Input", "Process", and "Output". Inside display for each machine, the current values for the configured sensors appear.

Note: If you are using the Machine Monitor on a Deviceworx Gateway you need to create user accounts for operators manually. You can find a step-by-step guide in the "Appendix D – Creating User Accounts"

The Supervisor View

The view of a user who logs in with a supervisor account is the same as the operator, plus three buttons for system configuration. The Administrator will see the same screen by navigating on the "Monitored Machines" tile in the main portal.

A supervisor can (1) add new sensors and configure existing sensors, (2) add new machines and configure existing machines, (3) change the State definition or (4) change basic settings. Here is a sample supervisor display:



Machine Monitor supervisor home page

The above screen shot shows an example of how the display might appear when a user with a supervisor privileges logs in. When you log in to the Machine Monitor with a fresh installation, you will see the three buttons at the top of the screen. The items in the lower half of the screen appear because of configuring specific machines and specific sensors.

For this reason, the remainder of this guide focuses on setting up sensors. The purpose of this guide is to help you set up your first sensor. A separate set of documentation – the Machine Monitor Sensor Configuration Guides – provide detailed instructions on setting up a wide range of other types of sensors. (For a list of the guides that are available as of the printing of this guide, see Appendix B. For a complete set of guides, visit the C-Labs website: http://www.Factory-Relay.com/documentation.)

Chapter 5: Adding Machines to Machine Monitor

This chapter – along with the chapters 6 and 7 – provides the basics to set up Machine Monitor. This chapter covers adding machines to Machine Monitor. Chapter 6 covers adding sensors to Machine Monitor. Chapter 7 covers connecting sensors to machines. Machine Monitor supports creating machines first, or creating sensors first, whichever you prefer. If you prefer creating sensors first, you may skip ahead to chapter 5.

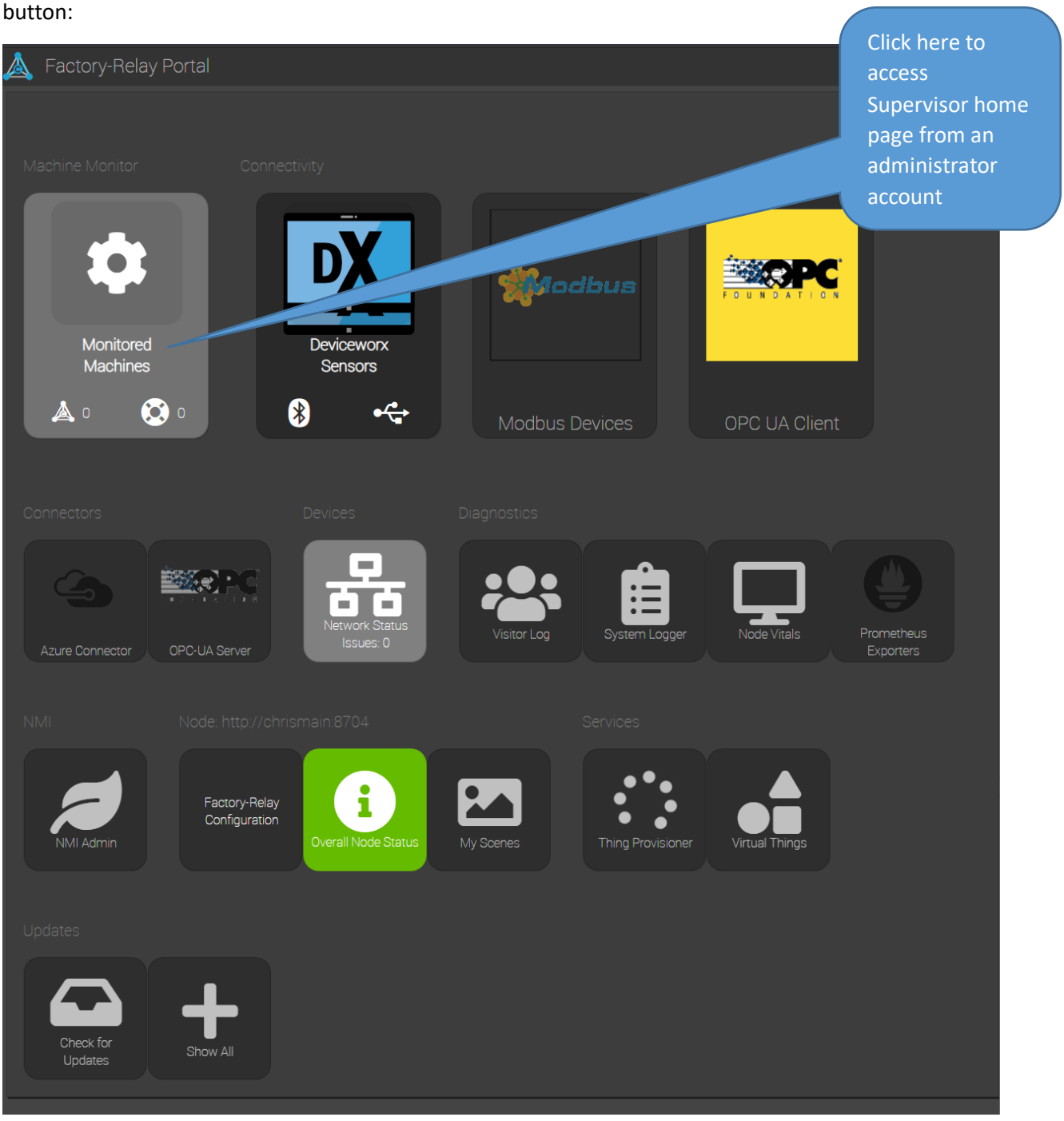
> Note: The instructions in this chapter assume that you have installed Machine Monitor and created user accounts. These topics are covered in chapter 2.

Supervisor Home Page

Create machines from the supervisor home page. A **supervisor account** has this home page:

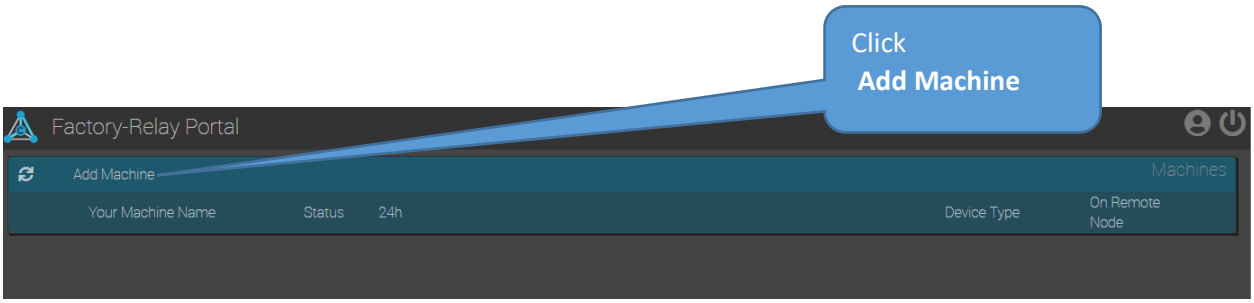
Machine Monitor supervisor home page with no machines configured

From an **administrator account**, access the supervisor home page by clicking the **Monitored Machines** button:

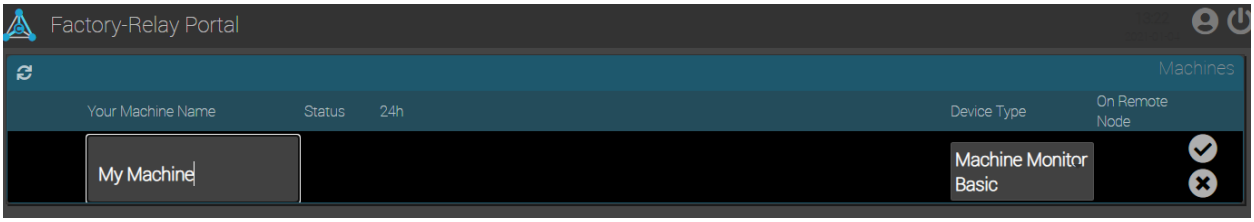


Accessing the Machines List

Click the **Machines** button on a supervisor's home page. After you do this, you are shown a list of all machines that have been added. At the start, this list is empty and looks like the following:



Click **Add Machine** to add an entry to the machine list. A blank row is added with space to enter values for a new machine:



You only need to enter two details: (a) machine name, and (b) Device Type. The Device Type can either be “Machine Monitor Basic” or “Machine Monitor Extended”.

The Basic Type uses only one Sensor and focuses only on “ON” and “OFF” states of a Machine.

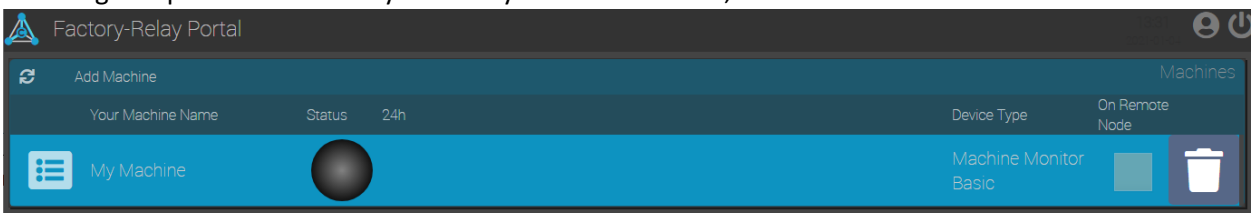
The Extended Type allows to combine multiple sensors into Machine States and can monitor up to 8 different states:

State	Value	Notes
OFF	0	Machine is OFF
RUNNING	1	Machine is ON
WARNING	2	Machine has a warning
ERROR	3	Machine is in Error state
RAMP UP / STARTUP	4	Machine is about to start
MAINTENANCE	5	Machine is in maintenance mode
SHUTDOWN	6	Machine is shutting down
UNKNOWN	7	Machine is in an unknown state (default with no sensor assigned or if the sensor value could not be read/used/is not available)

The table contains three columns that will be filled during runtime of the Machine Monitor. We recommend that you enter a machine name so that you can tell the different machines apart from each other.

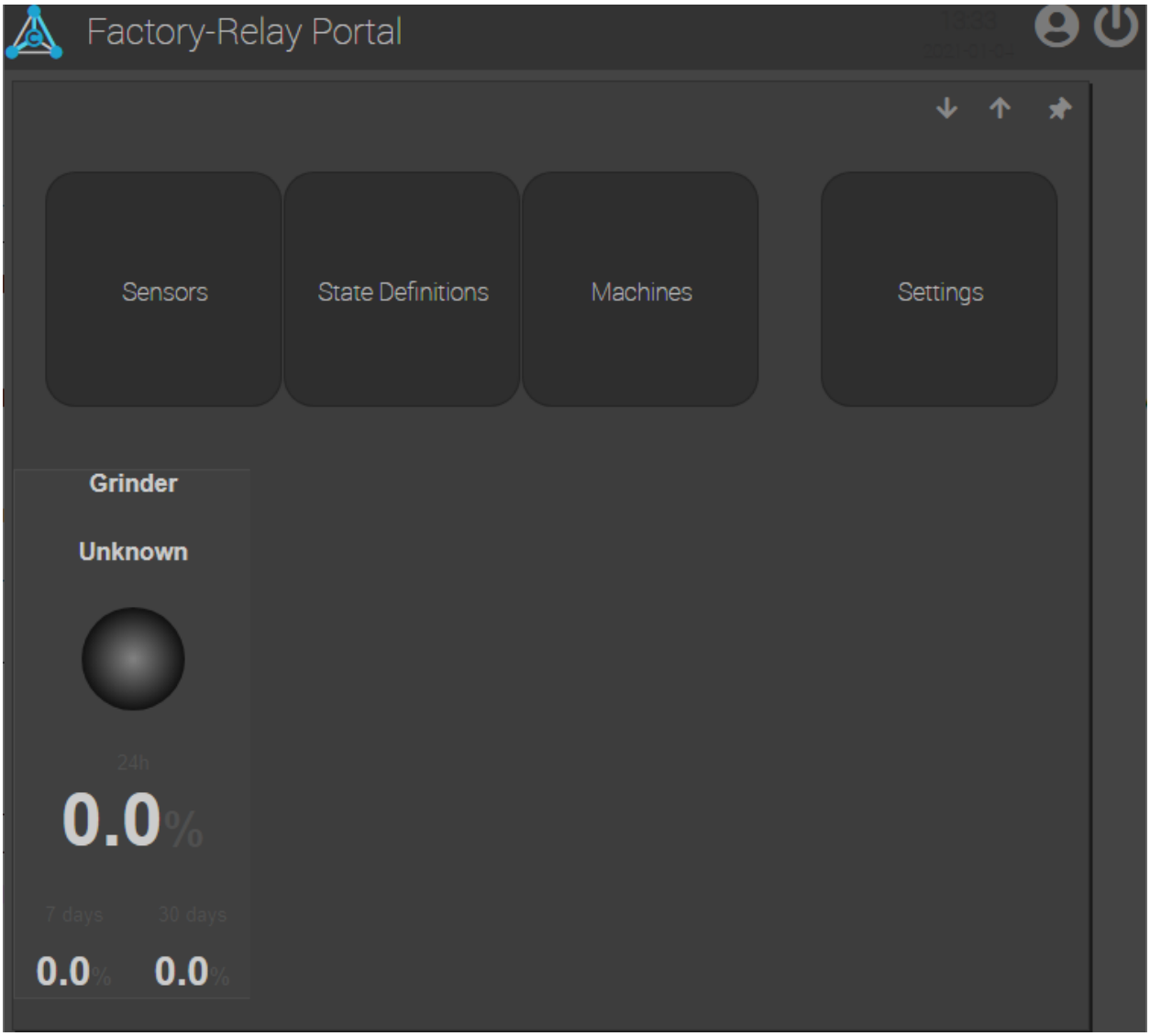
After entering values, confirm your entry by clicking the checkmark on the right side of the screen.

The list gets updated to include your newly-defined machine, as shown here:



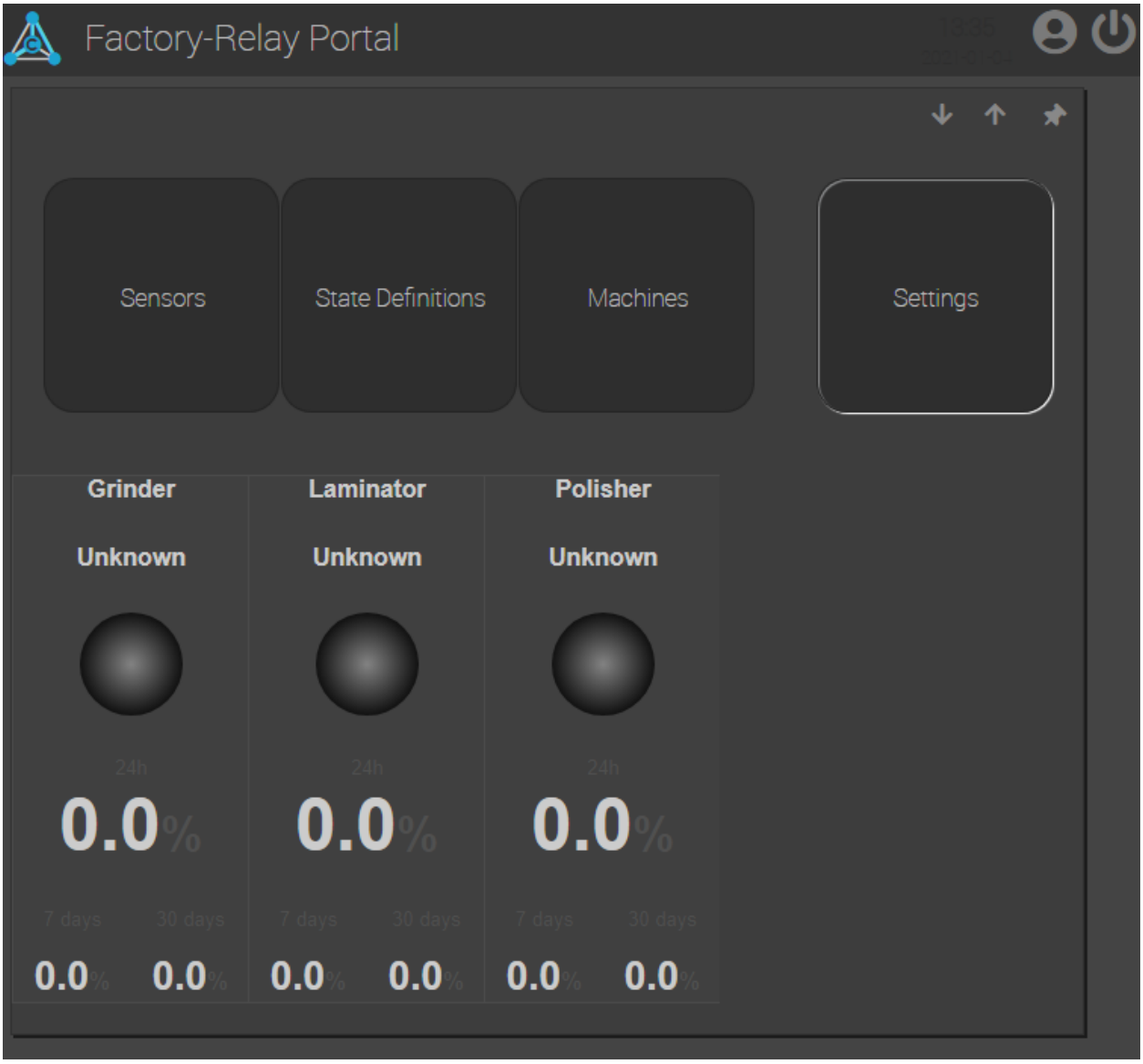
To view your newly created machine on the Machine Monitor display, click the back button of your browser.

Here is how our newly-created machine appears on the Machine Monitor display:



Adding More Machines

We can add additional machines by repeating the process. Here is how a supervisor's home screen appears after we add three more machines to the machine list:



Note: The order in which machines show up on this list is based on the friendly name, sorted alphabetically.

Chapter 6: Adding Sensors to Machine Monitor

This chapter has two parts. The first half covers virtual state sensors. A virtual state sensor enables you to fine-tune physical sensor input for Machine Monitor. The chapter's second half is a walk-through of creating a network ping sensor, using a plugin provided with Machine Monitor.

> Note: Sensors are a critical part of Machine Monitor's operation. This chapter provides the sensor setup basics. Since many sensors will require custom configuration, C-Labs has developed a sensor configuration library. (See appendix B of this document, or go to http://www.Factory-Relay.com/documentation , for the latest catalogue of this library.)

Overview

Sensors can generate signals to indicate change. The meaning of a change depends on the design of the system that the sensor is part of. For example, a temperature sensor might indicate an increase of one degree. How does that matter? In a freezer that holds frozen food, a change of one degree might not matter. Unless, of course, that one degree crosses the critical threshold between the proper storage temperature and the risk that the frozen food might thaw and perhaps spoil.

System designers can use Machine Monitor to monitor critical sensor state and communicate such changes to everyone who needs to know. Within Machine Monitor, the crossing of such thresholds indicates the difference between a machine operating properly and being productive and a machine not operating properly. When being productive, Machine Monitor shows that a system is "On". When not productive, we say that a machine is "Off". These two states do not simply reflect whether power has been provided to the machine and its indicator lights are on. Instead, when Machine Monitor says that a system is "On", it means that critical sensor signals indicate that a machine is operating as it should. Which sensors? That depends on choices made by system designers.

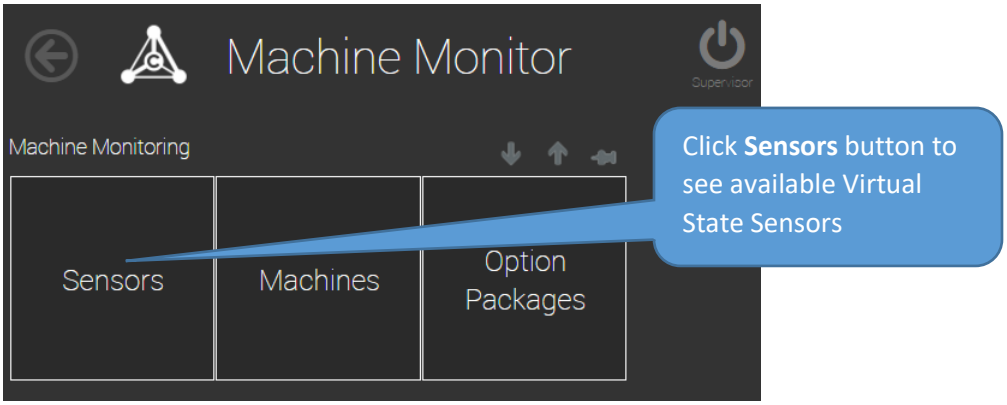
Machine Monitor recognizes three sensor types: **physical sensors**, **embedded sensors**, and **virtual sensors**. A physical sensor could be a temperature probe, a pressure plate, or a proximity sensor. An embedded sensor is integrated into a machine by its manufacturer, and its values are typically accessed through a software interface provided by the machine manufacturer. A virtual sensor is a feature provided by Machine Monitor to assist with mapping any process value type as sensor input. Some virtual sensors are stand-along data generators to provide signals to assist in testing. Taken together, these three sensor types provide a great deal of flexibility to help you implement and deploy the Machine Monitor.

Virtual State Sensors

Machine Monitor shows when machines are productive. Virtual state sensors provide the default sensor type in Machine Monitor. Virtual state sensors interpret input from any data source, including another sensor or any internal system state. When connected to a Machine (a subject we cover in Chapter 7), you'll see that you can define sensor input to indicate whether a specific machine is "productive" or "not productive". Inside Machine Monitor, you'll see that "ON" means productive and "OFF" means non-productive. For a first sensor, we create a virtual sensor to respond to a computer's CPU load.

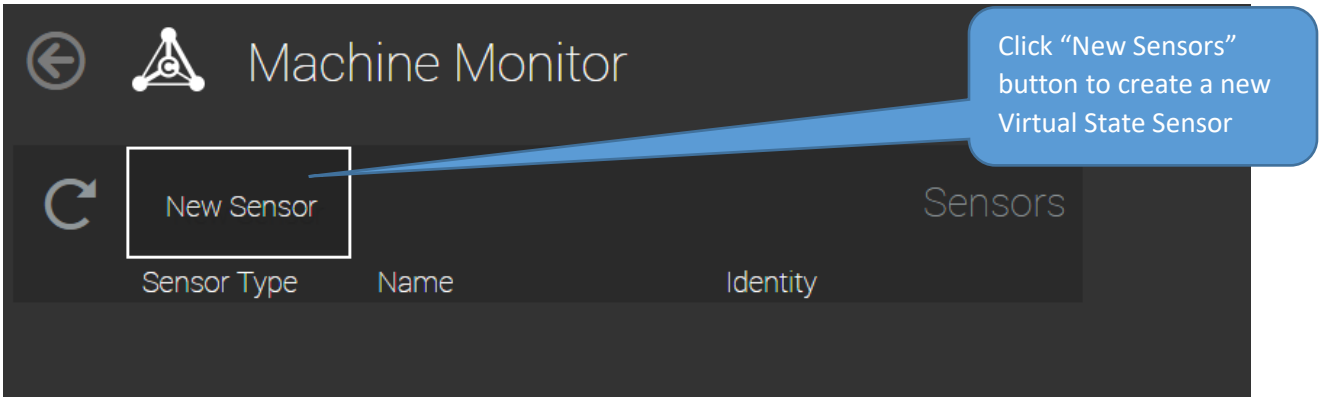
Creating a Virtual State Sensor

To create a new sensor, start at the supervisor home page and click the button labeled **Sensors**. (From the administrator home page, click the **Monitored Machines** button.)

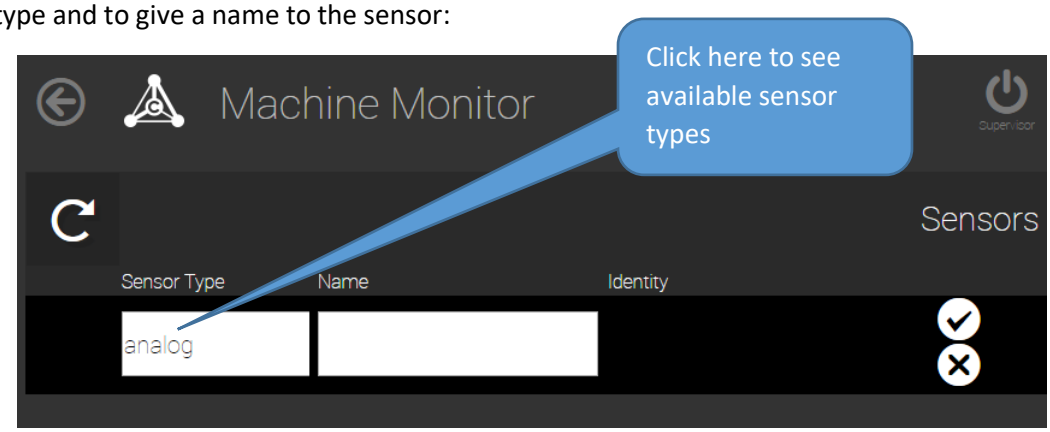


Machine Monitor supervisor home page with no machines configured

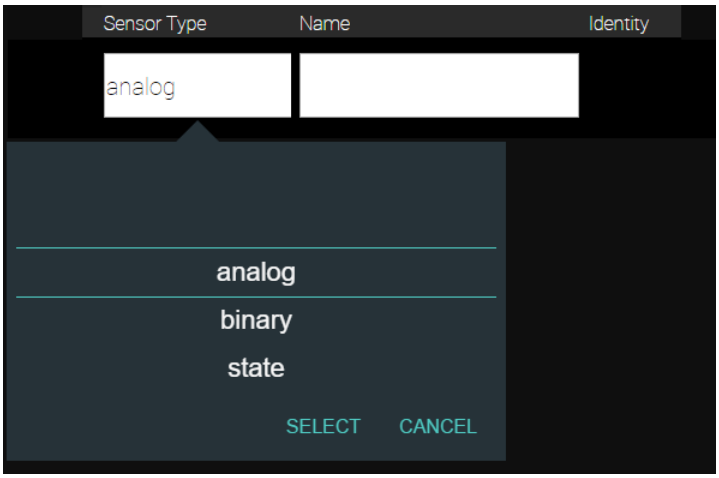
After you click the **Sensors** button, you are shown the list of available Virtual State Sensors. (In this example, the list happens to be empty.)



After you click on **New Sensor**, a new row is added to the sensor list. You have the chance to set the sensor type and to give a name to the sensor:



Click in the **Sensor Type** window to see a list of available sensors:



Types of Virtual State Sensors

As shown in the sensor type list, there are three types of virtual state sensors: analog, binary, and state. Figure 5.1 provides a summary of how Machine Monitor makes use of each virtual state sensor type.

Sensor Type	Data Type	Examples	Machine Monitor Usage	Machine Monitor Interpretation Examples
Analog	Numeric	1.245, 99, 123	Interpret from range of values	0 to 99 means "On", over 100 is "Off"
Boolean	Boolean logic	True, False	Interpret as two-state input	True means "On"
State	Integer	1, 2, 3, 4, 5	Search for integer state values	3 means "On", all other states are "Off"

Figure 5.1 Summary of Machine Monitor virtual state sensor by sensor type.

When to Use Analog Sensor Type. Select the analog sensor type when the input arrives as a numeric value. The values could be either integer values or floating point values. With the analog sensor type, Machine Monitor interprets the data based on a range of values that you define.

For example, later in this chapter we create a network ping sensor. For the ping sensor, we define the range of 0 to 200 as indicating that the machine is on and productive, and any value over 200 as our device being unavailable (e.g. “off” and “not productive”).

When to Use Boolean Sensor Type. Select the Boolean sensor type when the incoming data is two-state input. The values are either **true** or **false**, and nothing else.

For example, there might be an indicator light that is either ON or OFF. You would then use the state of the virtual state sensor to determine whether a given machine is productive or not productive. As you will see in the discussion on connecting sensors to machines, you can choose whether having the indicator light ON means that everything is working well and the machine is productive. As an alternative, you could also choose that having an indicator light ON means that the machine is not productive. This might be the case when the indicator light means that there is a problem in a machine’s input bin: perhaps the conveyor has stopped moving.

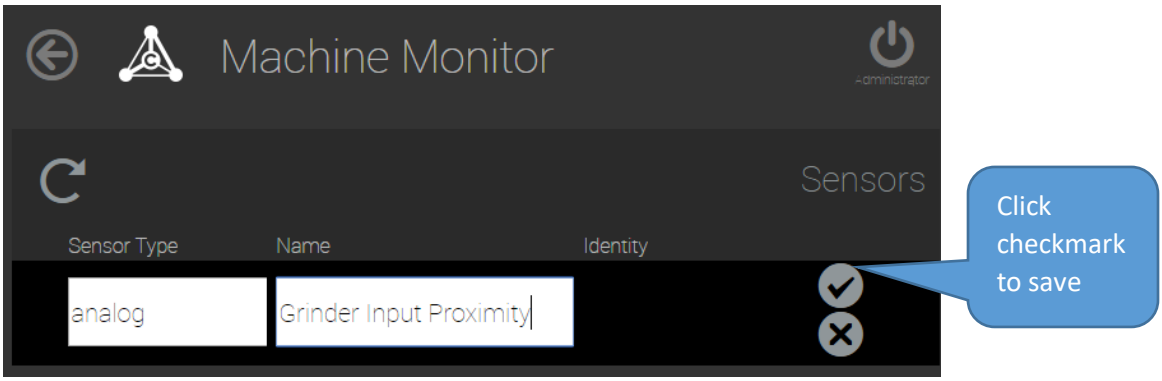
When to Use State Sensor Type. Select the State sensor type when input values are integer values that represent a fixed number of states. When you connect such a sensor to a machine, you define one state as representing the machine being productive and have all other states mean that the machine is not being productive.

For example, the input from a given machine might have the following state table: 0 = “power off”, 1 = “startup sequence underway”, 2 = “production underway”, 3 = “warning”, and 4 = “error”. In this case, the production underway value of 2 would be used to indicate that the machine is productive. All other states would indicate that the machine is not being productive.

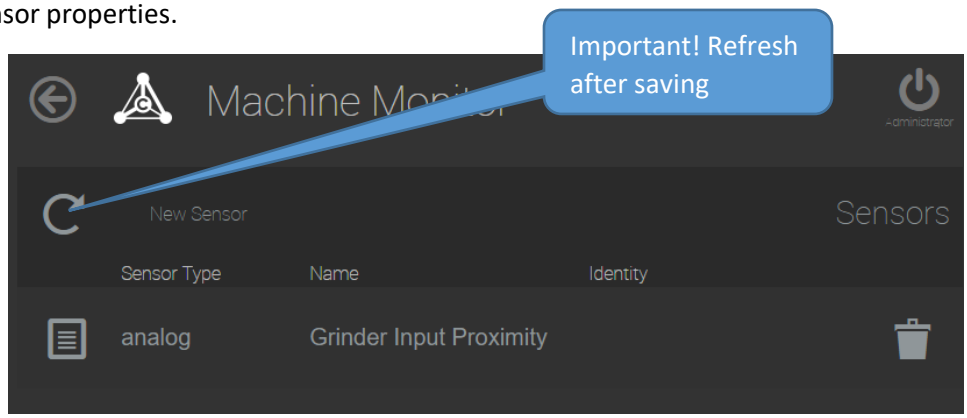
Setting the Virtual Sensor State Name

After you select the sensor type, set the name for the virtual state sensor. We suggest you give some thought to the name you use, because this name appears in lists of sensors used when connecting sensors to machines. Names like “Grinder Input Proximity” or “Laser Running State” are likely to be more useful than names like “My Sensor” or “XYZZY”.

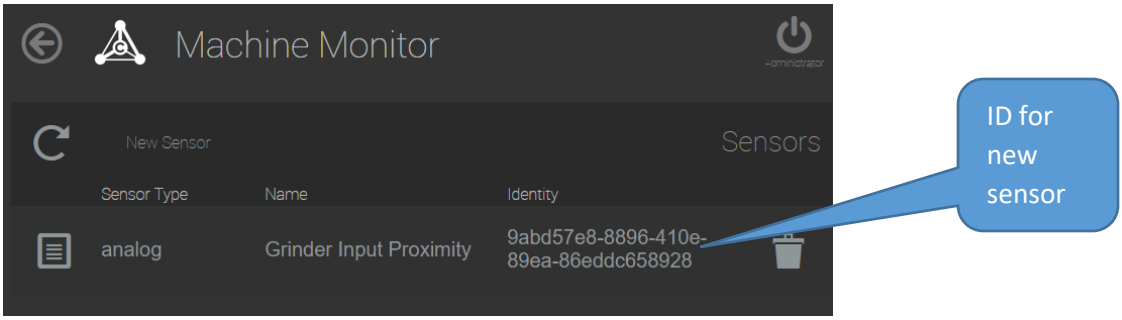
After entering the sensor name, click the checkmark to save your changes.



Important! After you save, click the **Refresh** button. The current version of Machine Monitor requires a page refresh to generate a sensor identifier. The sensor identifier needs to be defined before you can edit the sensor properties.

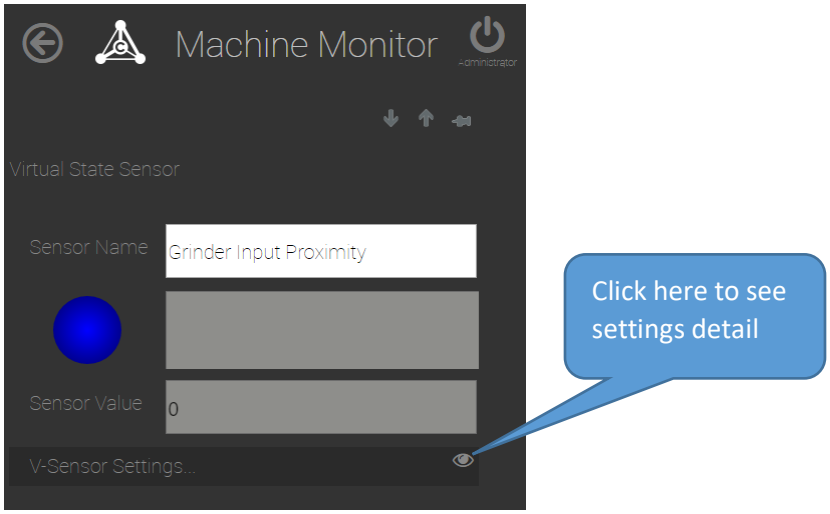


Here what a newly-created virtual state sensor looks like after the page has been refreshed: an identifier for the newly-created sensor appears.

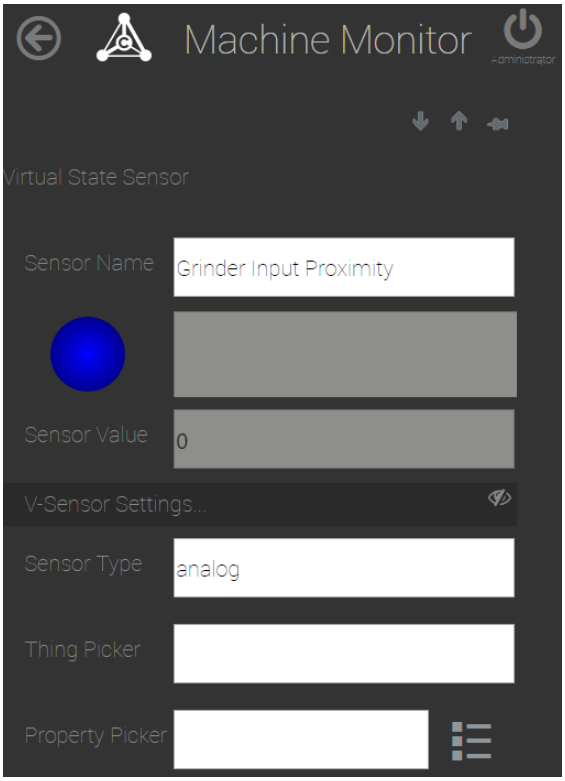


The Sensor Properties Page

Click the properties button ( ) to summon the sensor properties page.



On the sensor properties page, click the **Show More** icon ( ) for additional sensor settings.



The two most important settings for a sensor are: (1) **Thing Picker** and (2) **Property Picker**. We discuss these next.

About Things and Thing Properties

The Machine Monitor is built on the Factory-Relay engine. Factory-Relay is an Internet of Things (IoT) engine that enables secure communication channels between factory systems and office systems. Factory-Relay is built on an extensibility model that features plugins. Everything is a plugin, including the core Factory-Relay features. Anyone can customize Factory-Relay by creating custom plugins.

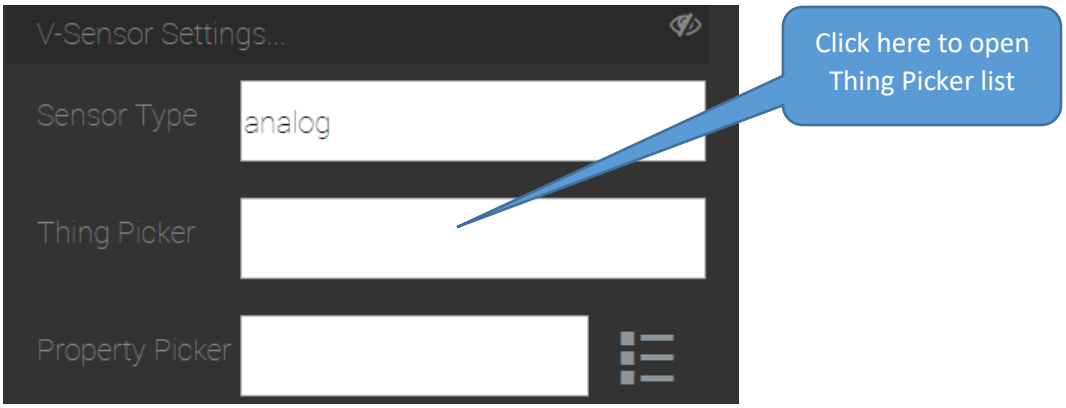
In keeping with the "Internet of Things" paradigm, every plugin within Factory-Relay enables one or more "Things". The word "Thing" is a placeholder for all possible objects that we connect to. A thermometer could be a thing, a robot arm could be a thing, and a laser could be a thing. Factory-Relay can communicate with any "Thing" that might provide useful input. The Thing Picker on the sensor properties page is important because it allows you to select what we are going to communicate with.

Each "Thing" has properties. A property might be a number, or it might be a name. A thermometer "thing" might have a property for the current temperature. It might also have another property with the average temperature for the last 24 hours. The thermometer might also provide a property to tell where it is located, such as "Temperature Sensor on Paint Robot's Left Arm". The Property Picker lets you select the specific input value that you are going to read in from the "Thing" that you are listening to.

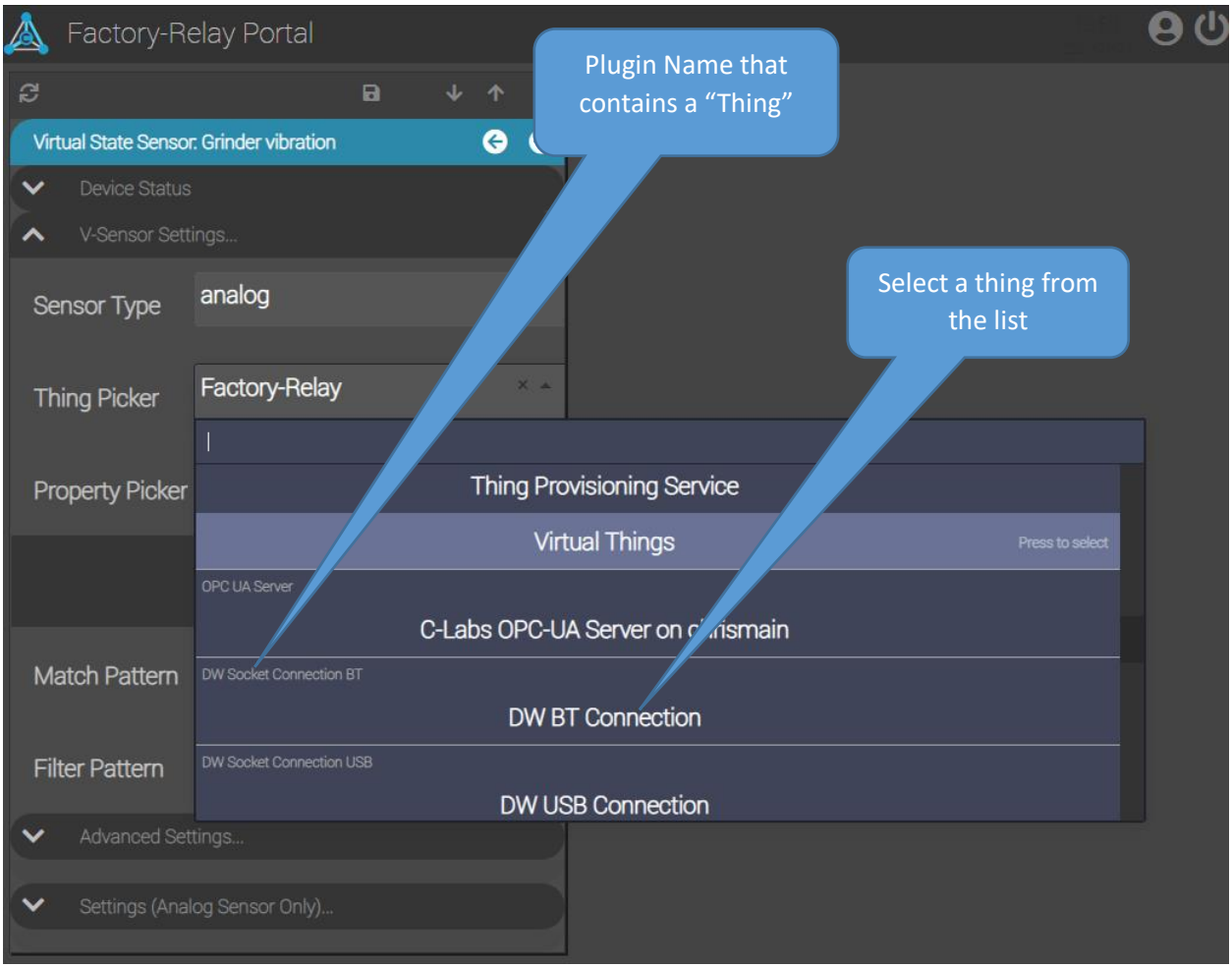
You use the Thing Picker and the Property Picker together. The order in which you make a choice is important. First you need to use the Thing Picker to select the data source. Second, you need to use the Property Picker to identify the specific data value that is of interest to you.

Using the Thing Picker

The Thing Picker lets you select a thing from a list. Open the list by clicking the white area to the right of the Thing Picker label.



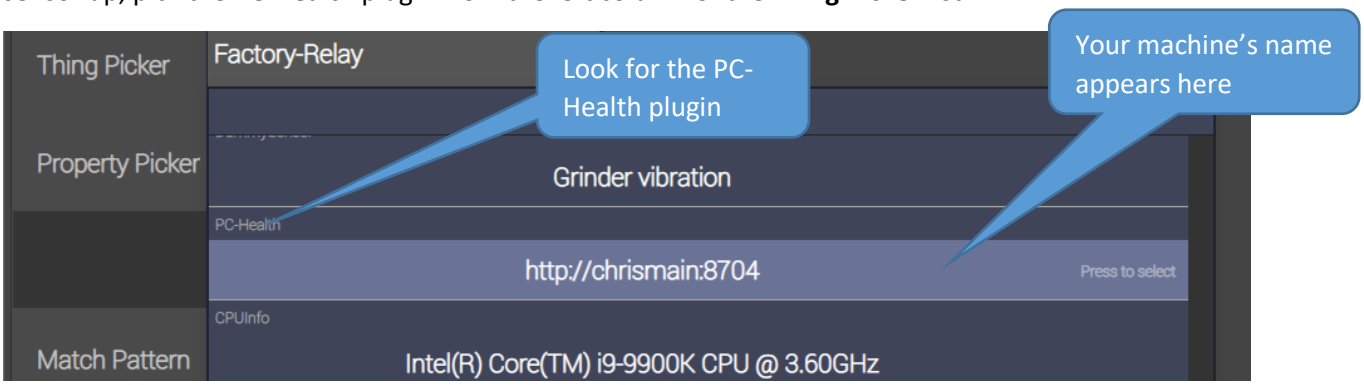
A portion of sensor properties page showing Thing Picker.



Thing Picker populated with available plugins and available things.

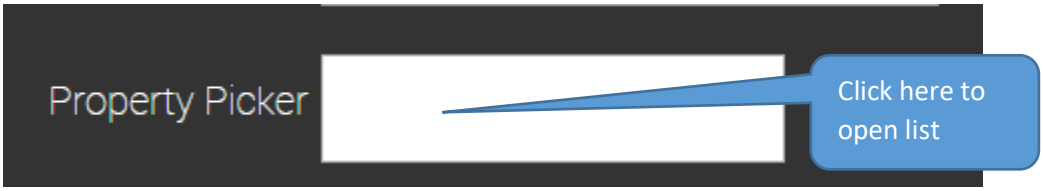
Creating a CPU Load Sensor

Machine Monitor ships with a PC-Health plug-in. This plugin provides data on some of the operating parameters of a Windows PC. The CPU load is one of the available operating parameters. To set this sensor up, pick the **PC-Health** plugin from the left column of the **Thing Picker** list.



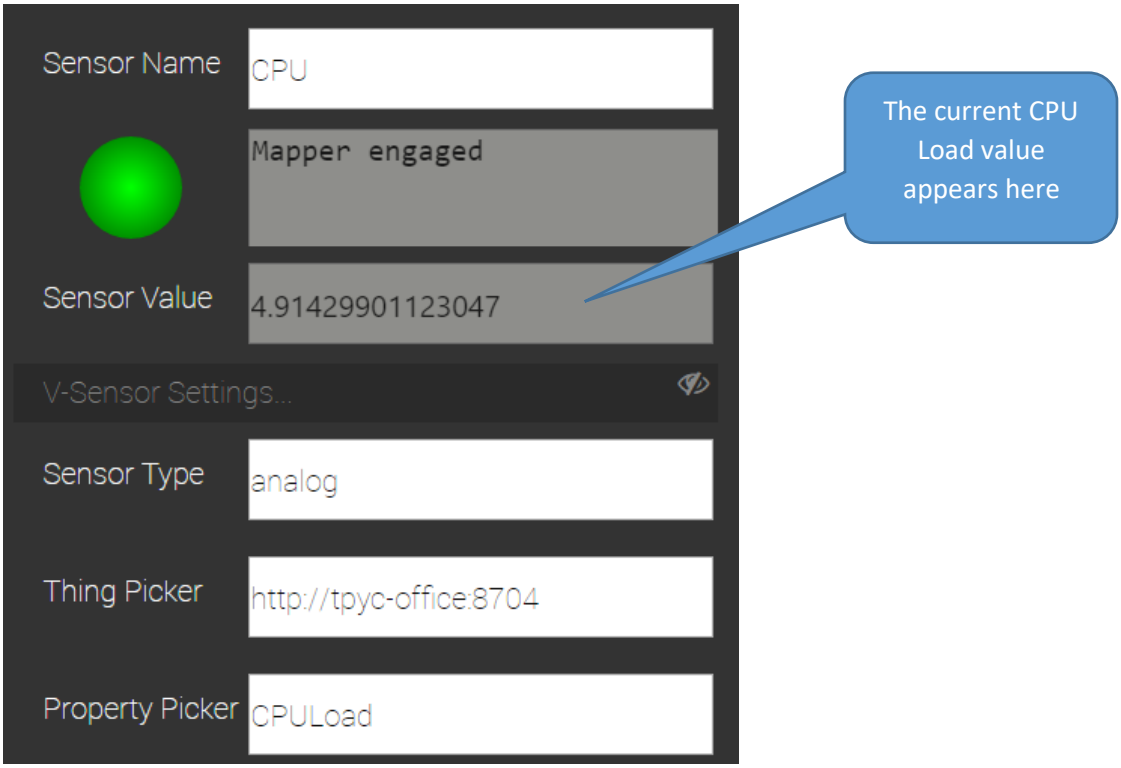
The name of your computer appears in the right column of the **Thing Picker** list. Click it, and click **SELECT**.

Now we select the CPU Load property from the **Property Picker**. Open the Property Picker list by clicking on the list icon on the right side of the Property Picker.



Select the **CPULoad** property.

After a moment, you should see values appear in the Sensor Value item on the sensor properties page.



At this point, you have created one type of sensor. In the next section, you get a chance to create a second sensor: a network ping.

An Example Sensor: Network Ping

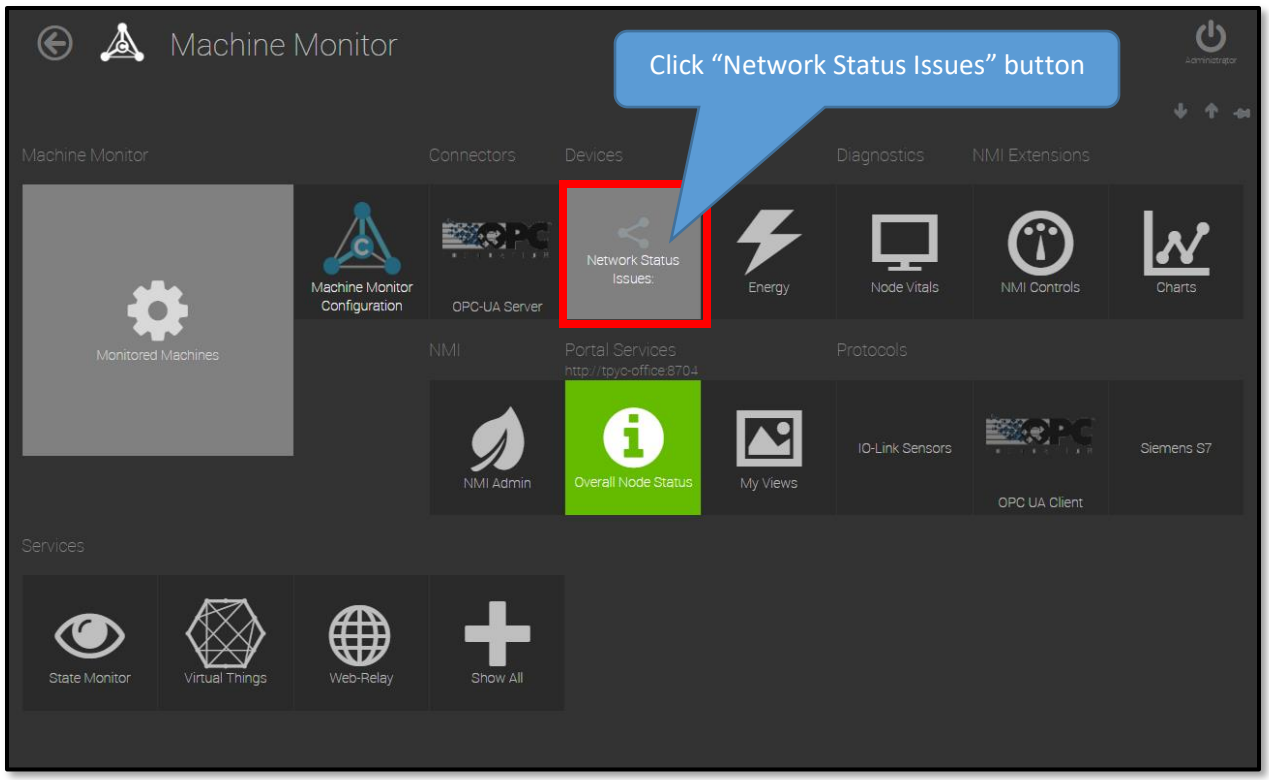
Like the common *ping* network utility, a network ping sensor checks whether two network-connected systems can establish a network connection. An ICMP echo request is sent. If the target machine receives the request, it sends an ICMP echo reply to the sender. If either request or reply does not reach the intended recipient, the sender has an indication that something might not be right. If after sending multiple ping requests there have been no replies, this indicates the need for some corrective action.

Another important aspect of a ping check involves the elapsed time between a ping request and a reply. In the C-Labs Machine Monitor, you can set up thresholds that allow the ping sensor to notify an operator when there is a persistent problem. The Machine Monitor can display a strip chart showing the results of queries over the last 24 hours, for example, so that a user can see just how reliable a service has been.

Creating a Network Ping Sensor

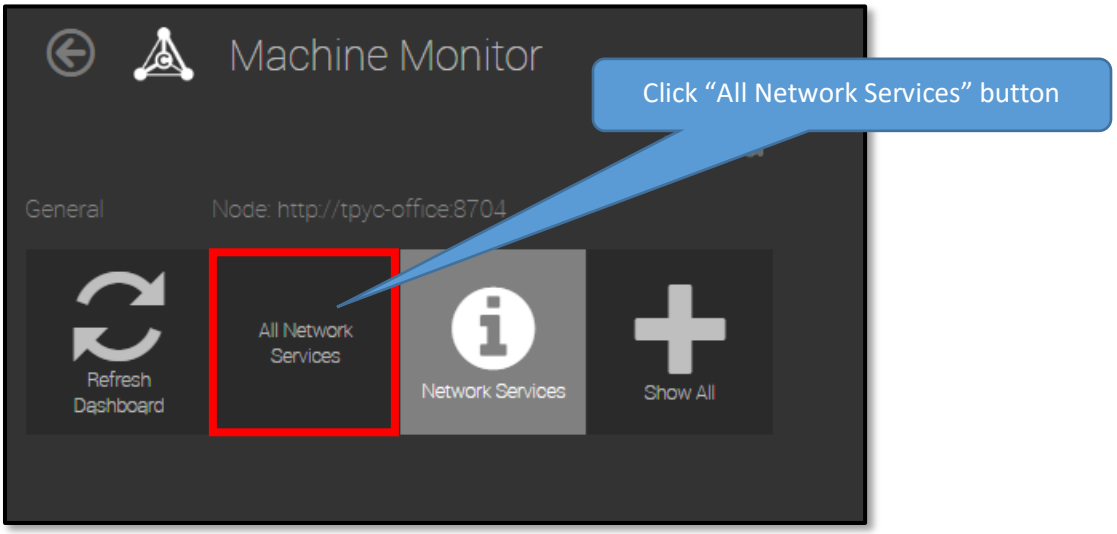
To create a network ping sensor:

1. Log into the Machine Monitor using an Administrator account.
2. When you have done this, you see the home dashboard as shown below.



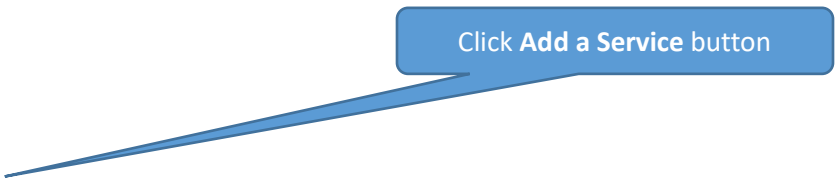
C-Labs Machine Monitor Home Dashboard

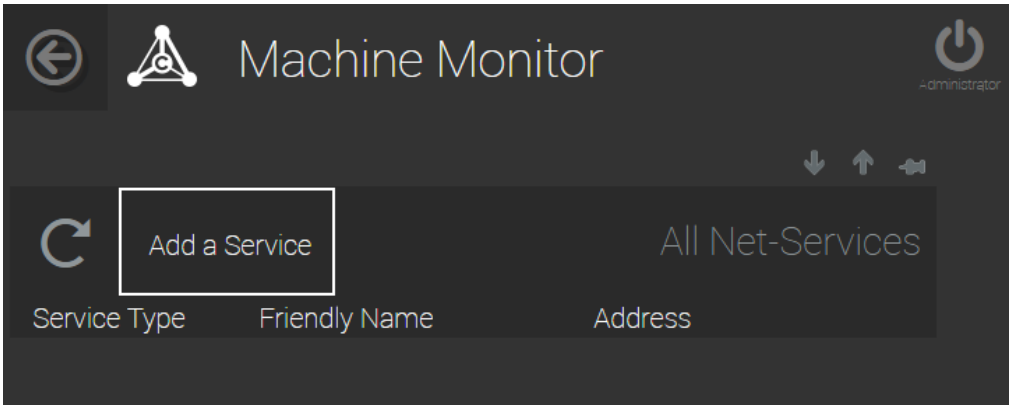
3. On the home dashboard, click the button labeled “**Network Status Issues**.”



The Dashboard for the Network Status Plugin

4. Click the button labeled “**All Network Services**”. You are shown a table display of any sensors that already exist. *Note:* Initially, the table will be empty until you create a sensor.

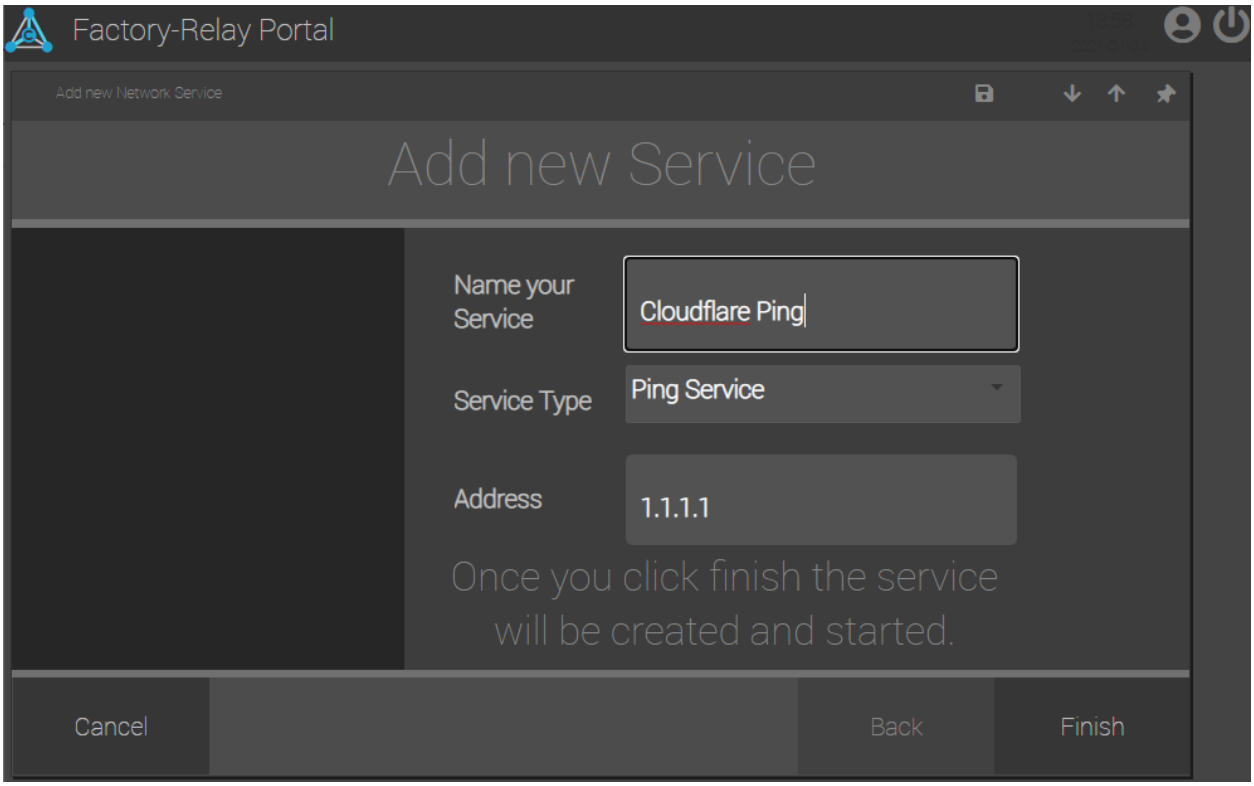




An Empty List of Network Sensors

In this screen, you can create a ping sensor:

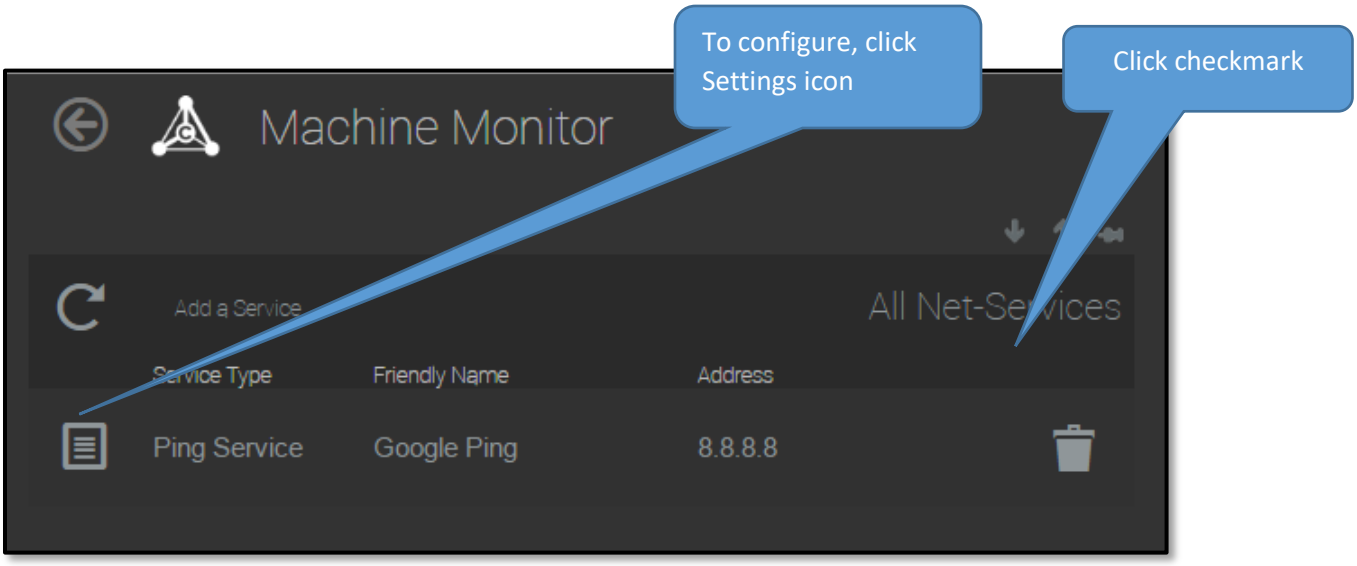
5. Click the link that says "**Add a Service**" located to the right of the refresh icon. A new, empty row is added to the table. It looks like the following:



The "Add new service Wizard"

- First give your sensor a name i.e. "Cloudflare Ping"
- Set the Service Type to "Ping Device".
- The third entry is for a network address, and can be either an IP address or the DNS Name of a machine. To check for access to the Internet, you could use the IP address of the Google DNS Servers (either 8.8.8.8 or 8.8.4.4). Alternatively, you could enter the machine name of another system on your local network and then this sensor would show whether the two machines can connect or not.

Here is the table filled in to create a Google Ping sensor:

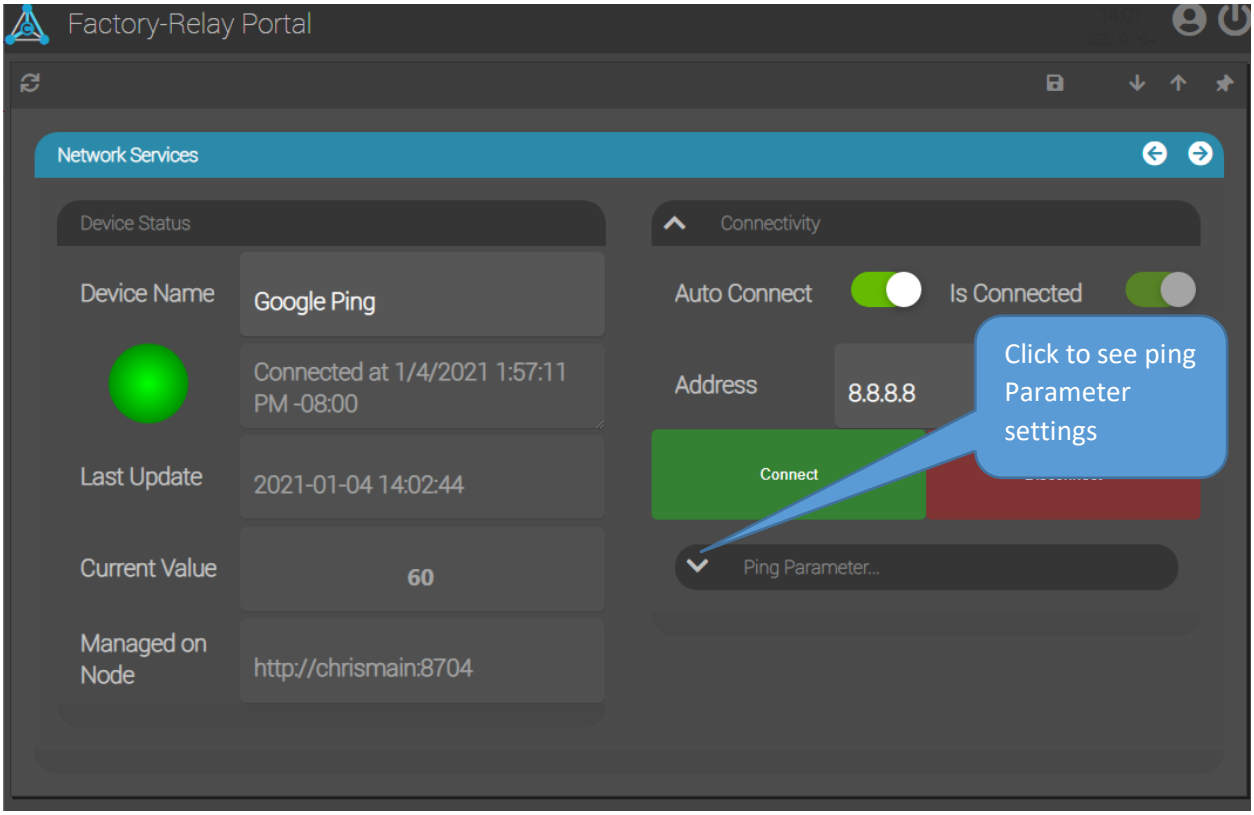


The Google Ping Service after creation

Although a network ping sensor is now defined, there are a few additional steps which need to be taken to make the sensor operational.

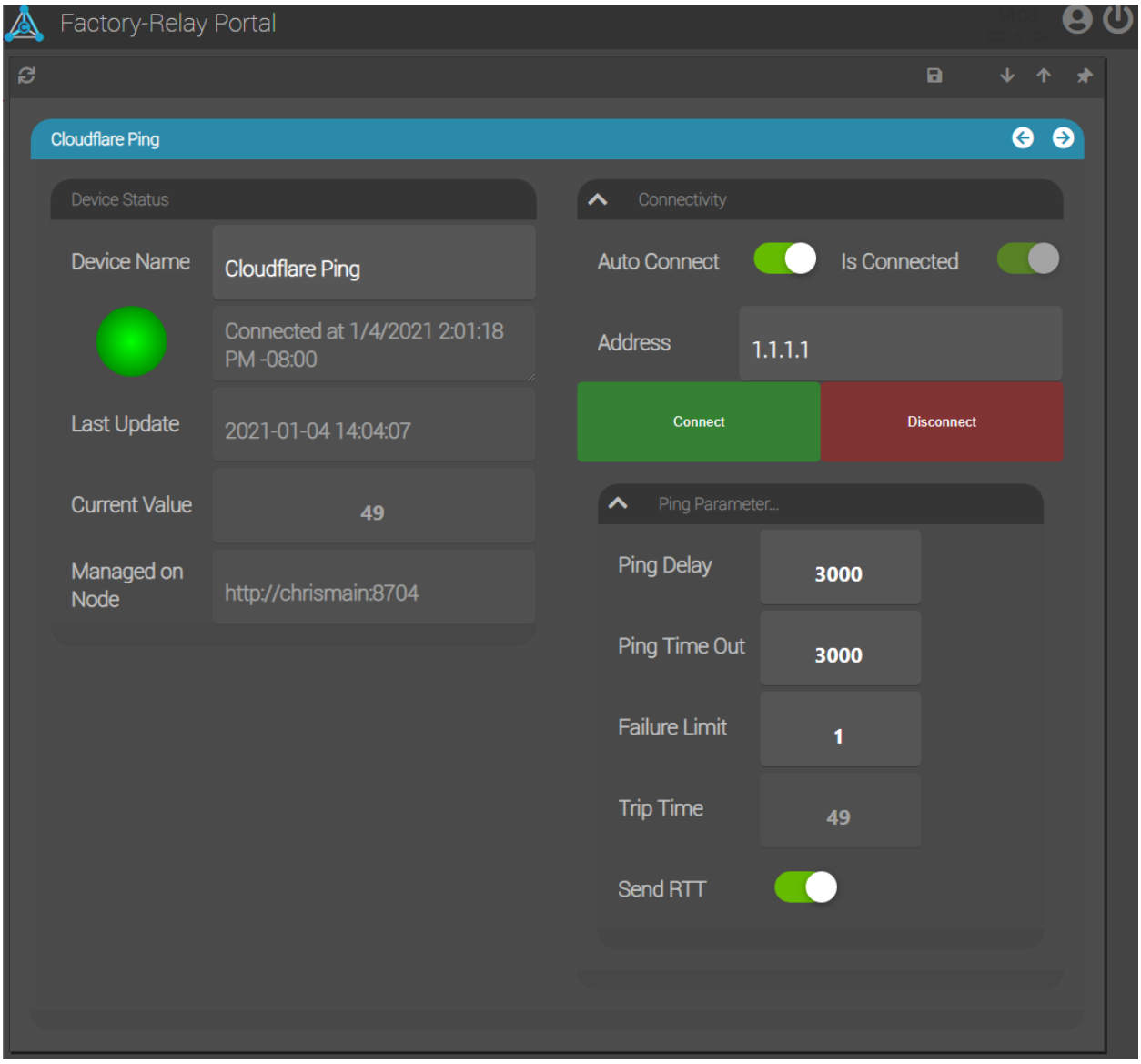
Configuring a Network Ping sensor

To enable the ping sensor, you must first configure the service by setting the target IP Address. To start configuring the ping sensor, click on the **Settings** icon, The configuration view will appear as shown here:



To the right of **Connectivity**, click the **Show More** icon, as indicated in the figure. When this is clicked, the **Connectivity Settings** area expands to show the available options, as shown below.

Click Show More icon to expand Ping Parameter. The complete configuration page is here:



Available Ping Service Parameters

The contents of the ping service settings are summarized in the following table:

Name	Description
Address	Network address to use.
Auto-Connect	Check this box to allow the ping service to auto-connect when the Machine Monitor starts.
Connect button	Click to start ping service.
Disconnect button	Click to stop ping service.
Failure Limit	Maximum number of failed attempts to allow.
Is Connected	Indicator with connection status.
Last-Msg	Last status message from ping service.
Ping Delay	Time in milliseconds between requests.

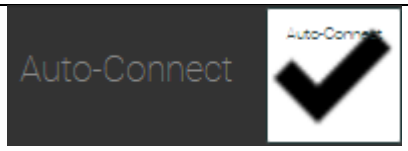
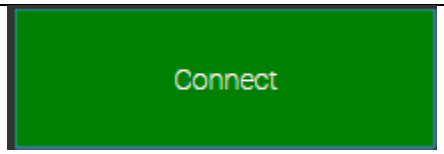
Name	Description
Ping Time Out	Time in milliseconds to failure.
Send RTT	Check this box for round-trip time to be used as the ping service result value.
Status Level	Status level of ping service.
Trip Time	Indicator with time for most recent round trip.

Recommended Settings

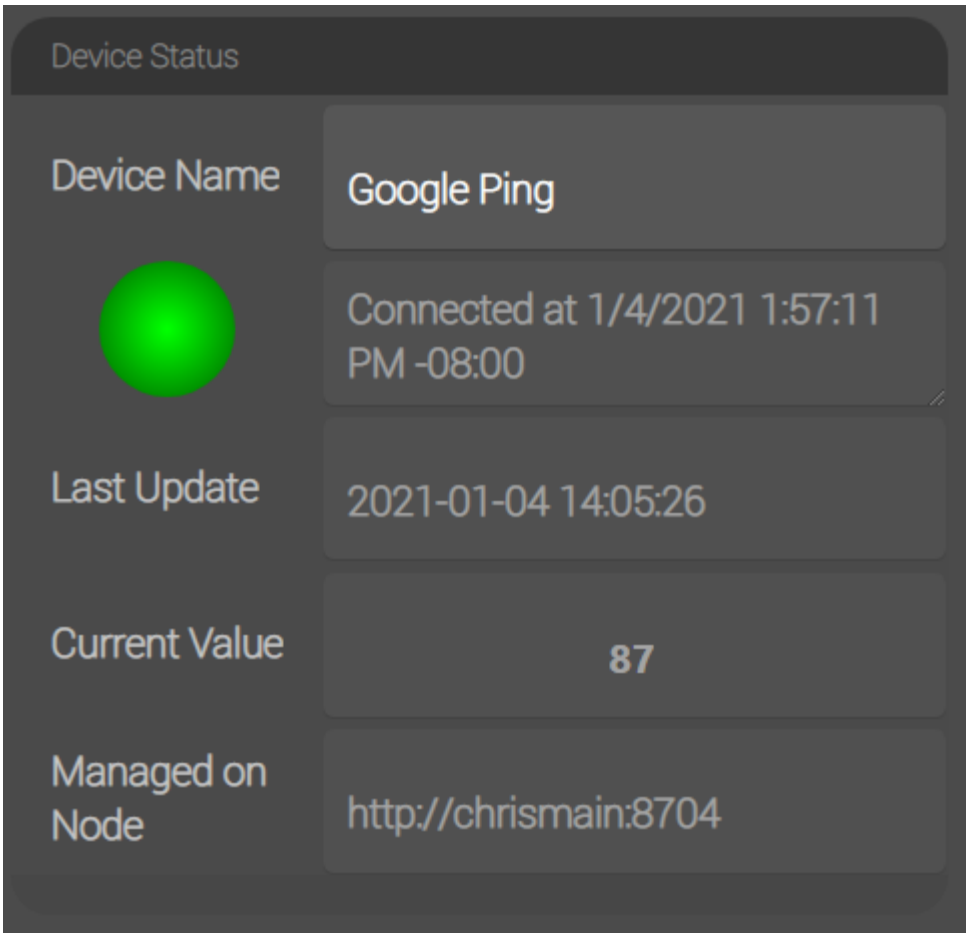
To ensure that the sensor connects the next time your run the Machine Monitor, configure the Auto-Connect turning Auto-connect on. To do this:

1. Click the box to the right of Auto-Connect. The box is checked when you see a dark check in the box.

We recommend these steps to start using the ping service:

Step 1 Set Auto-Connect on. When Machine Monitor starts, so will the ping service.	
Step 2 Request the round trip time be provided as the output value.	
Step 3 Click the connect button to test your settings and to start using the ping service right away.	

Here is what the ping service sensor looks like when it is running:


Device Status
Device Name
Google Ping
Connected at 1/4/2021 1:57:11 PM -08:00
Last Update
2021-01-04 14:05:26
Current Value
87
Managed on Node
http://chrismain:8704

Chapter 7: Connecting Sensors to Machines

This chapter covers connecting sensors to machines, which is the third and final step needed to set up Machine Monitor.

Prerequisites

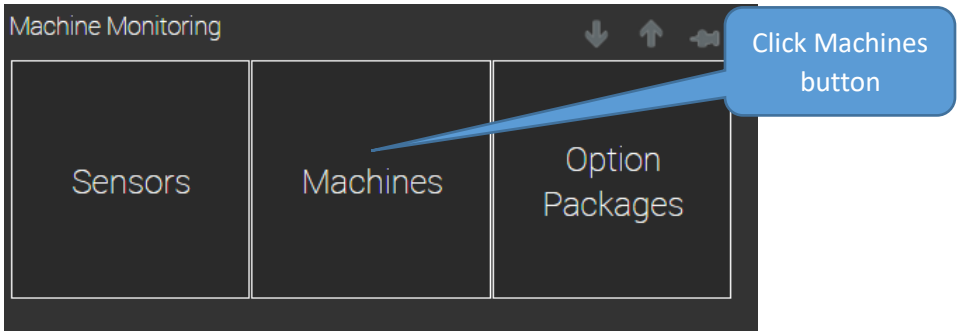
To follow the steps in this chapter, you must complete the steps covered in previous chapters:

(1) Added machines to Machine Monitor (covered in Chapter 5), and
(2) Added Sensors to Machine Monitor (covered in Chapter 6).

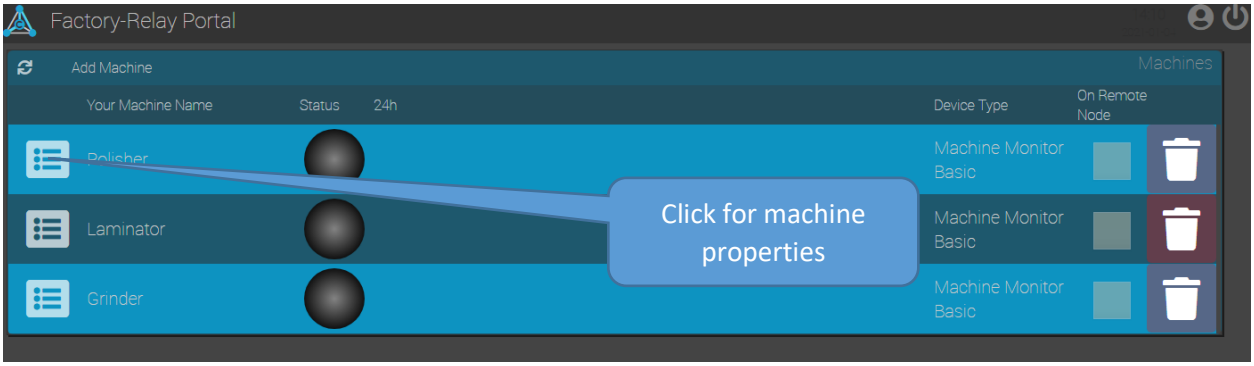
In addition, you need to log into a Machine Monitor account that has either supervisor access or administrator access.

Edit Machine Properties

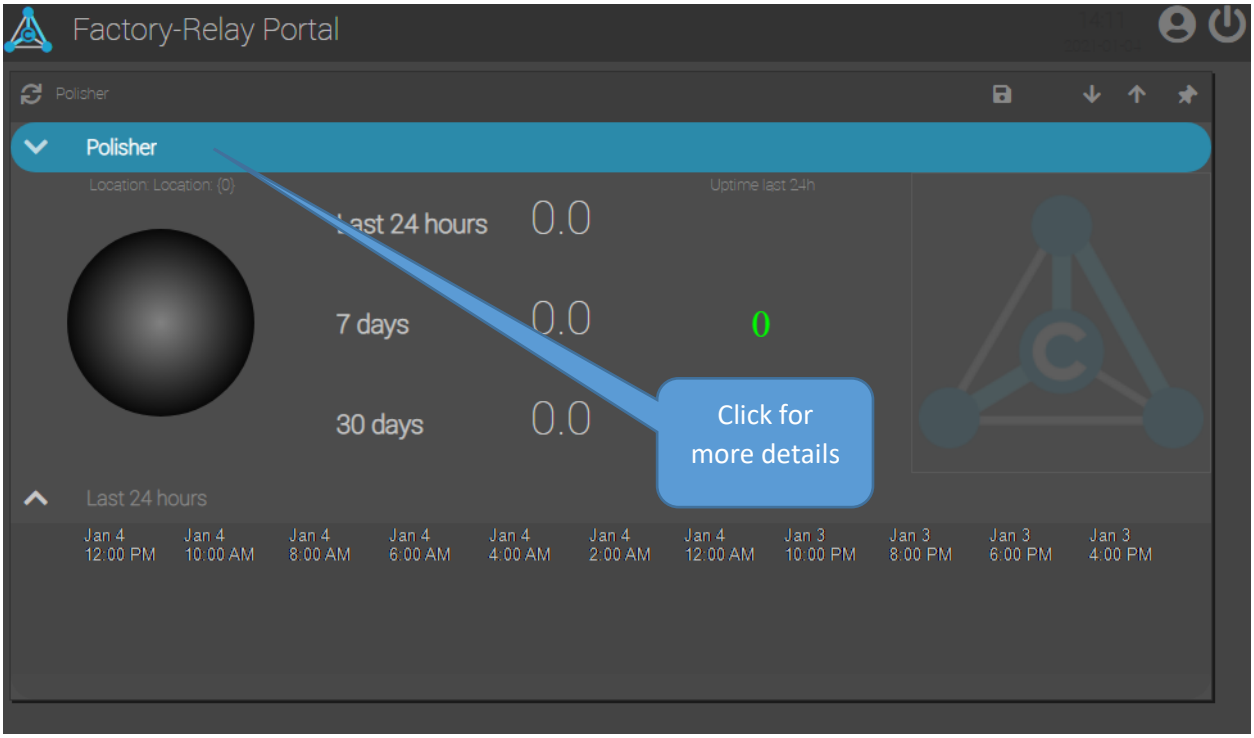
To connect sensors to machines, click the Machines button on the Supervisor home page:



Note: Click **Monitored Machines** button on administrator home page when logged in as administrator



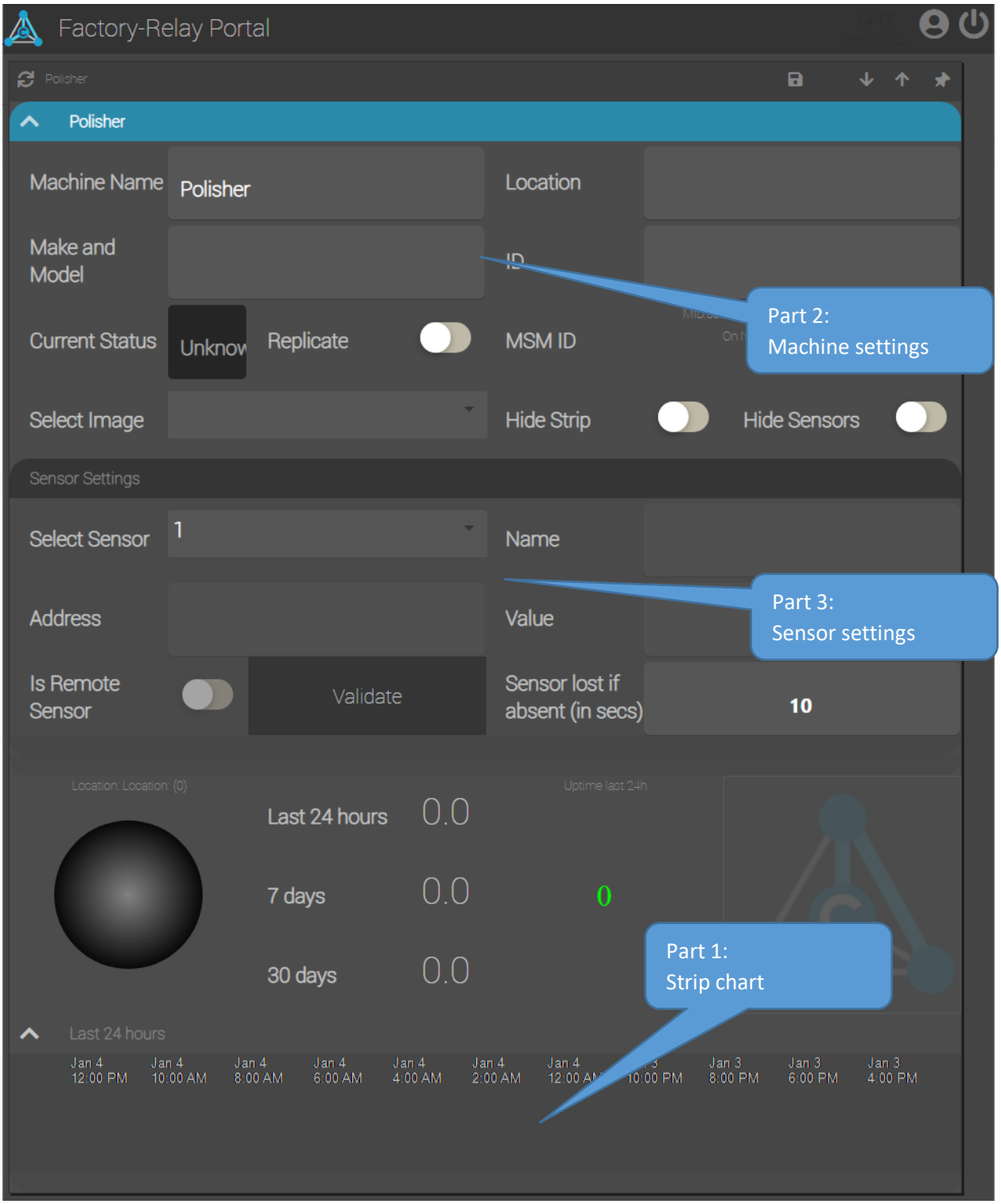
To connect a sensor to a machine, you need to edit the machine properties. Click on the properties icon (first column in the machine table) on the row corresponding to the machine that you wish to connect to a specific sensor. You should see a page like the following:



The Detail view shows you all you need to know about your machine state:

- A large status “bubble” indicating the current status according to the state table in Chapter 5
- Last 24 hours, 7 days and 30 days percentages in the ON state
- The Last 24 hours is also visualized as a radio gauge
- To the very right is a logo that can be replaced by an image of your choosing (requires the “Images” Plugin or the “Cameras” plugin)

If you click on the blue header bar you can expand the properties and settings of the machine:



The machine properties page has three parts: (1) a strip chart, (2) machine settings, and (3) sensor settings. All the changes for connecting a sensor to a machine are in the sensor settings portion of the machine properties page.

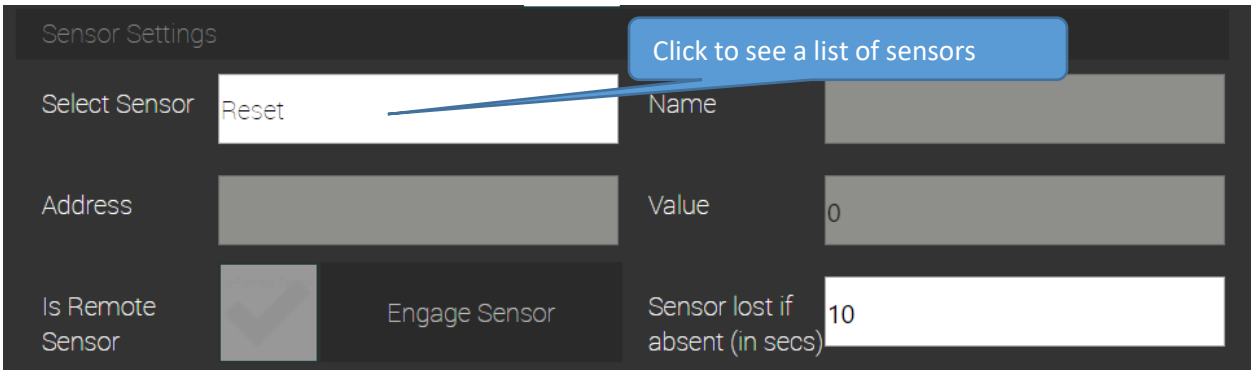
Machine Settings

This section allows you to describe your machine in more detail.

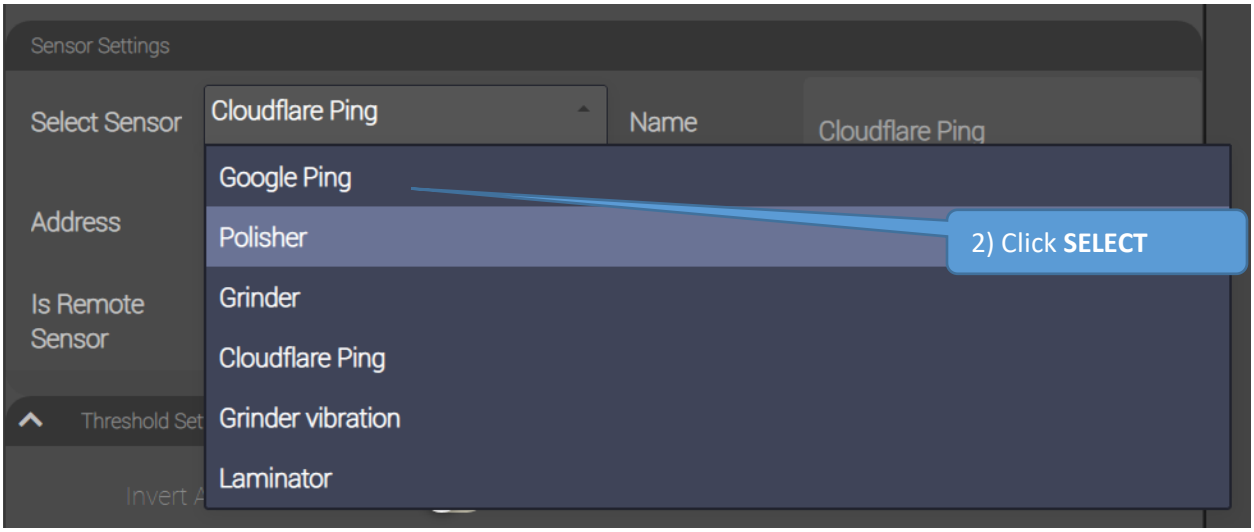
Setting	Default	Notes
Replicate	No	In a mesh of Machine Monitor nodes this Machine gets replicated to other nodes. The more nodes you have in a mesh the more expensive replication can become.
Hide Strip	No	Hides the Strip Chart
Hide Sensors	No	Hides the list of Sensors (only for extended Machines)
Select Image	Not selected	You can upload images with the “Images” plugin and then select an uploaded image here. If you have the Cameras plugin you can even have a live image of a camera showing (where the C-Labs Logo is displayed by default)

Sensor Settings

The sensor settings part of the machine properties page is shown here:



Click within the box to see the list of sensors. In the current version of Machine Monitor, the list is empty the first time it is selected. To refresh the list, select the **Refresh** button on the form.



This list shows both sensors that were created in Chapter 6 and the Machines you created. A Machine is also automatically a sensor. That way you can combine multiple machines into a bigger machine or even a production line and therefore monitor multiple machines with one compound machine.

> Note: Do not select the Machine you are configuring as the sensor of itself! If you do so, you create a machine that flips between ON and OFF very fast because you have created a feedback loop to itself. In a later version of the Machine Monitor we will prevent this from happening.

Select one of the sensors that you created earlier. When you do so, several changes may occur in the machine properties page:

- The **Current Status** field may change (located in the machine properties portion of the page).
- In the **Sensor Settings** section of the page, various values are now populated.
- A new section named **Threshold Settings** is added to the page.

Here is an example of the changes that appear on the machine properties page:

Grinder
Grinder
Current Status might change
Machine Name
Grinder
Make and Model
ID
Current Status
ON
Replicate
MSM ID
Select Image
Hide Strip
Hide Sensors
Sensor Settings
Select Sensor
Cloudflare Ping
Name
Address might update
Address
1.1.1.1
Value
1
Value might update
Is Remote Sensor
Validate
Sensor lost if absent (in secs)
10
Threshold Settings
Invert Analog Value
When sensor is below
,machine is
OF
Threshold Settings section appears
When sensor is, or reaches
,machine is
ON
Location: Location: (0)
Uptime last 24h
Last 24 hours
2.5
7 days
0.4
2
30 days
0.1
Last 24 hours
Jan 4 2:00 PM
Jan 4 12:00 PM
Jan 4 10:00 AM
Jan 4 8:00 AM
Jan 4 6:00 AM
Jan 4 4:00 AM
Jan 4 2:00 AM
Jan 4 12:00 AM
Jan 3 10:00 PM
Jan 3 8:00 PM
Jan 3 6:00 PM
Jan 3 4:00 PM

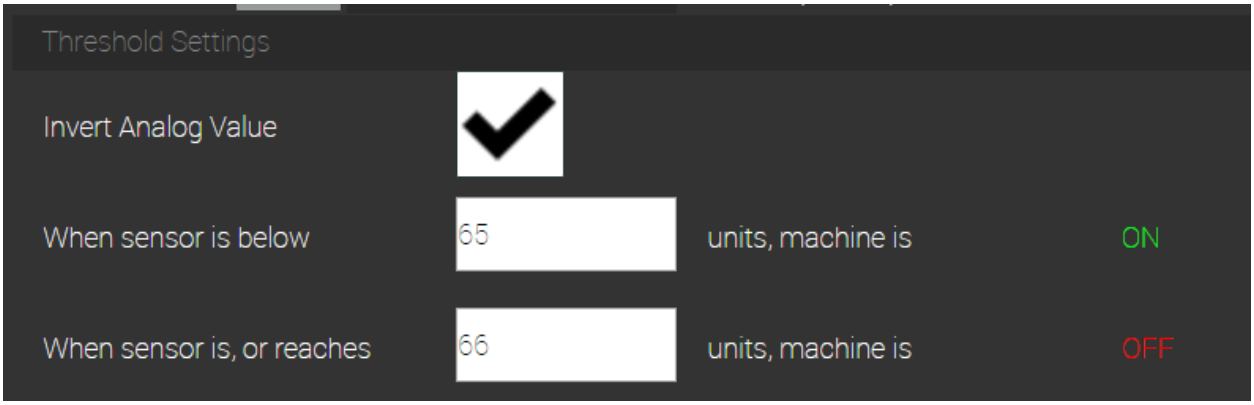
Setting Sensor Thresholds

The Machine Monitor shows when a machine is *productive*. The meaning of "being productive" depends on what the sensors tell us. By setting the sensor threshold, we enable Machine Monitor to tell from the sensor input whether the machine is, in fact, productive or not. The exact threshold that you select depends on the specific machine and on the specific sensor.

What is more important, however, is to learn from experience to be able to determine how to convert sensor input into a meaningful indicator of overall productivity. Consider the two sensors that we created in Chapter 5: the CPU Load and the Google Ping.

CPU Load Sensor Threshold

The value for CPU Load from the PC-Health plugin provides the percent of the system's total CPU throughput that is currently in use. When a system is idle, the CPU load might run from 2 to 10 percent. Let's say, for the purposes of this example, that we have learned from experience that our computer runs find when the CPU Load is at 65% or lower, but at 65% or higher the system is not able to do the work that it needs to do in the time available. Here is how we might set the sensor thresholds:



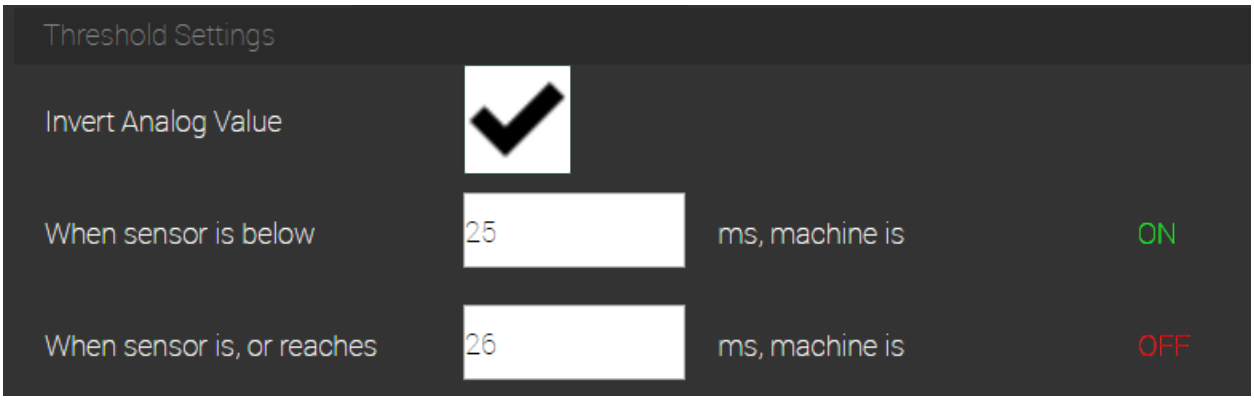
The first things worth noting is that the **Invert Analog Value** setting is checked. Analog sensors produce numeric values, and by default Machine Monitor assumes that "non-productive" numbers are lower than "productive" numbers. That might be the case, for example, with the rotating speed of a drill that must reach 1,500 before the drill will work correctly on the material that is being drilled. In this case, rotating speeds from 0-1,499 are said to be non-productive and speeds of 1,500 or over are productive.

We use the **Invert Analog Value** setting to indicate to Machine Monitor that we are working with a sensor for which lower numbers are "productive" and higher numbers are "non-productive". We indicated earlier that lower CPU Load values are "productive" and higher CPU Load values are non-productive. On the right side of the Threshold Settings area, you see the words "ON" and "OFF". This is often a source of confusion with Machine Monitor. We use "ON" as a shorthand for "productive" and "OFF" as a shorthand for "non-productive". Keep in mind that a "non-productive" machine may be receiving power and might be "running", but Machine Monitor will still show it as "OFF".

Google Ping Sensor Threshold

A network ping measures the time in milliseconds to establish a rudimentary connection from one computer to another computer. Our Google ping sensor measures the time from a local computer to the

Google DNS servers. Quicker response time is better response time. As such, just like the CPU Load sensor that was covered earlier, our Google Ping sensor needs to have the Invert Analog Value flag set. Based on our experience with internet access at our location, we set the threshold between being productive and not being productive at 25 milliseconds. Here is how we would set the Threshold settings to reflect that:



Appendix A: Machine Monitor Navigation Icons

To help navigate the Machine Monitor configuration pages, we start with a summary of the navigation icons which are used on these configuration pages. The icons are summarized in the following table:

Icon	Name	Comments
	Home	Navigate to main dashboard
	Refresh	Some screens or menus allow to refresh their content. NOTE: If you click the refresh button of your browser, your user session might get terminated and you have to login again!
	Properties	Click to view properties
	Trash Can	Delete an item
	Show More	Click to view expanded settings
	Show Less	Click to hide expanded settings

Appendix B: Machine Monitor Sensor Configuration Guides

Order Number	Topic
2101-066	Virtual Things
2101-149	Rules Engine (trigger events on actions)
2101-079	Messaging (sending email on events)
2101-123	Modbus
2101-078	OPC / UA Client
2101-160	Image Management (for Machine Pictures)
2101-093	Networking (Ping Service)
2101-095	Cloud Services (Azure IoT Hub, Event Hub etc)

Appendix C: Troubleshooting Tips

Here are some solutions for problems that you may encounter when installing the C-Labs Factory-Relay Machine Monitor.

Symptom	Solution
Immediately after installation, Machine Monitor does not launch.	**Solution 1: Check for an internet browser.** Reason: The Machine Monitor user-interface appears in an internet browser. If your computer does not have an internet browser, then you need to install one. **Solutions 2: Launch Machine Monitor manually.** Reason: Sometimes, Microsoft Windows cannot launch an internet browser even though one is installed. When this happens: A) Manually launch an internet browser B) Enter this URL into the address line: http://localhost:8704/nmiportal C) On a Deviceworx Gateway use http://<IP_OF_GATEWAY>/nmiportal **Solution 3: Change the network port address.** Reason: Another software program might be using the default port address that Machine Monitor uses. A) Find the configuration (*.config) file for the Machine Monitor. This file is in the installation folder. It is named **MachineMonitorServer.exe.Config**. B) Within this file, locate the line with the key value "STATIONPORT". This value sets the network port C) Change this value. D) When you change the network port address, you may need to change your firewall setting to make Machine Monitor available from other computer systems. E) After making this change and saving the file, and restart the Machine Monitor service. (Find the Windows Services, locate the service named "C-Labs – Factory-Relay Machine Monitor", then right-click on the service name and select "Restart.") Note: On Windows Vista and higher, you might need to copy the config file to another directory, edit it, then copy it back. Direct editing violates the Microsoft Windows User Access Control (UAC).
You forgot your administrator email/password	**Solution 1: Reinstall the Machine Monitor**

Symptom	Solution
	Solution 2: Delete the "ClientBin/cache" folder under your Machine Monitors installation directory. On the Deviceworx Gateway the installation Folder is "FR" under the root home directory. **IMPORTANT:** **If you delete the cache folder or reinstall the relay you lose all your configuration!** **Unfortunately, this is necessary to avoid illegal reset of the administrator password by unauthorized personal.**

Appendix D: Creating User Accounts

If you use a preinstalled version of the Machine Monitor, for example on the Deviceworx xGATEWAY, you need to create the Operator and Supervisor accounts manually. You might also decide not to have these accounts depending on your use case.

Creating the Operator Account:

1. In the main Portal click on the “NMI Admin” to get to the NMI Administration.

In here you find the “Admin Users” tile

2. If you click on it, you can see a list of existing users
3. To add a new user, click on “Add new User” and fill out the form

If you want to see the Machine Monitor Dashboard when the user logs in, select “Monitored Machines” in the “Home Screen” dropdown

Important is the “User Access Level” – select “OT User” here to create an operator. “OT User” can only see status information but not change any values or settings on any devices, sensors, or machines.

A supervisor is a “OT Admin”, supervisors can edit some parameter and configuration settings but still have only limited access.

The administrator you created during the first boot (Chapter 2) can modify and configure everything.