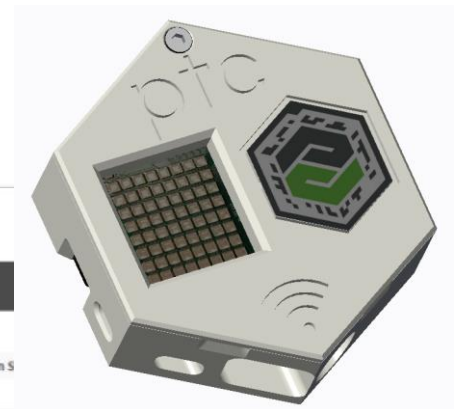




Sigma Tile Workshop Guide

This guide describes the initial configuration steps to get started with the Sigma Tile.



ptc Kinex for Manufacturing™ KEPServerEX Monitoring

DEVICE LIST: KepwareEX

Device Name	Channel	Device ID	Status	Alert	Time in Error (s)	Connection Type	Simulated	Demotion S
IQ-MT-L1D1	Channel1	<132.253.74.3>.0	✖	🔴	981	Ethernet	No	False
IQ-MT-L1D2	Channel1	<132.253.75.2>.0	✖	🔴	972	Ethernet	No	False
IQ-MT-L2D1	Channel1	<132.253.74.1>.0	✖	🔴	963	Ethernet	No	False
IQ-MT-L2D2	Channel1	<132.253.75.52>.0	✔	🟡	0	Ethernet	No	False
IQ-SR-L1D1	Channel1	<132.253.72.151>.0	⚠	🟡	0	Ethernet	No	False

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Chapter 1: System Requirements

The PTC Sigma Tile runs on a Raspberry Pi with a Sense HAT using several Python programs.

Hardware Requirements

Minimum Requirements:

- Raspberry Pi 3
- Sense HAT for Raspberry Pi
- Internet Connectivity
- Class 10 MicroSD card

Recommended:

- 3D printed enclosure and fasteners
- ThingMark

Software Requirements

- Win32DiskImager
- SDFormatter
- PuTTY or alternate SSH Client

Helpful Peripherals

- USB mouse and keyboard
- Monitor with HDMI input
- Micro USB power supply (5V, 2.4A)

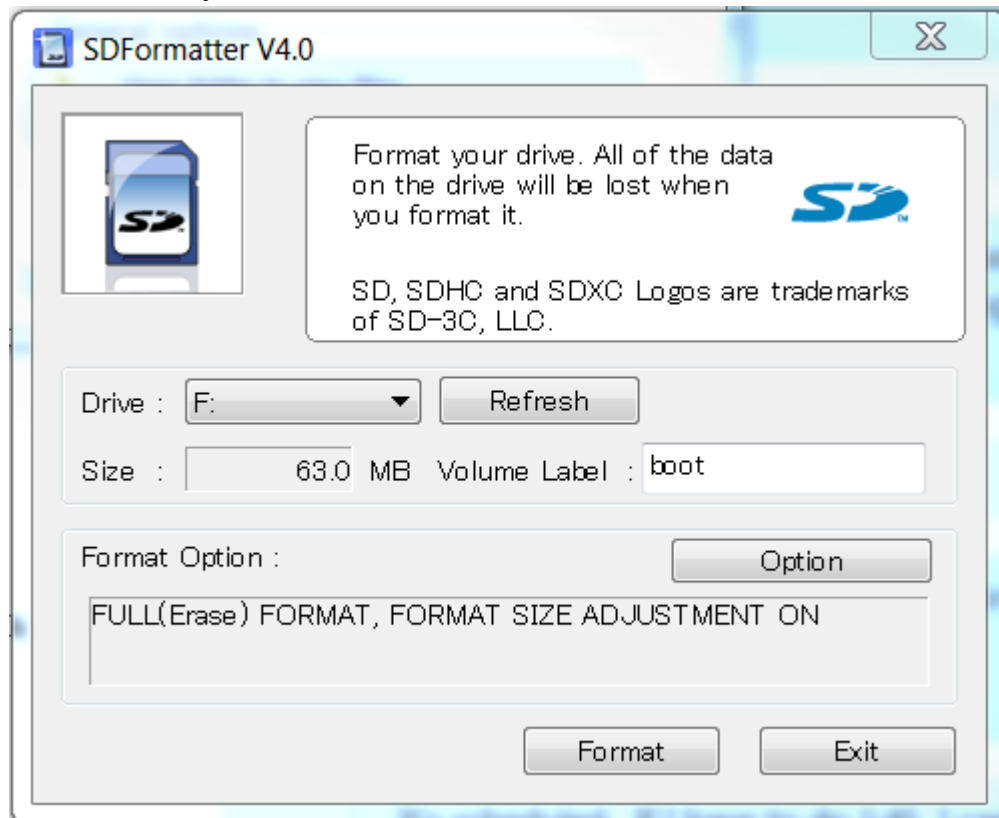
Chapter 2: Configure Your Raspberry Pi

Pi

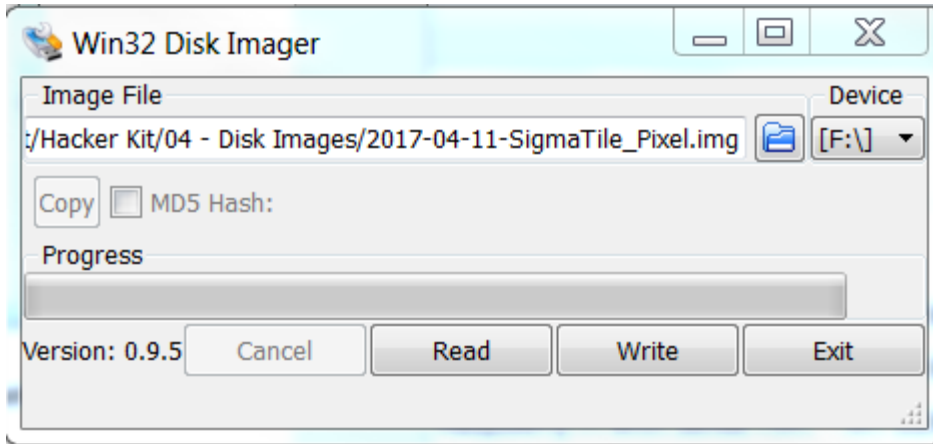
PTC recommends that you start with our premade disk image of the Raspberry Pi software with the proper scripts and configuration to run the Sigma Tile. If you want to create your own image, see Appendix A.

Using a Premade Disk Image

1. Download the SD card disk image for your Raspberry Pi from the webpage.
2. Insert your microSD card, and format it using [SDFormatter](#).
 - a. Format Type: Full (erase)
 - b. Format Size Adjustment: On

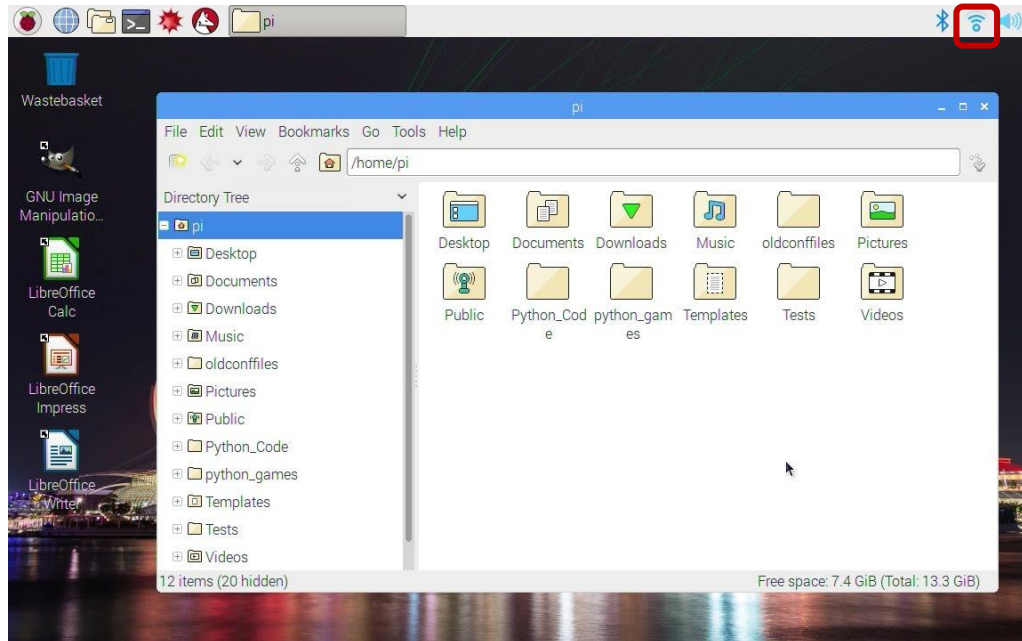


3. Write your disk image to the SD card using [Win32DiskImager](#).



4. Insert the microSD card into the Raspberry Pi and connect the Raspberry Pi to a **network with internet access** using one of the following options:

- Ethernet
 - a. Connect your ethernet cable, then power on the Raspberry Pi.
 - b. Watch the LED screen of the Sense HAT for its IP address. It will take approximately 15 seconds. Make note of the IP address.
- Wi-Fi
 - a. Connect a mouse, keyboard, and monitor to your Raspberry Pi.
 - b. Log in
 - user: **pi**
 - password: **raspberry**
 - c. Use the pixel GUI to configure the Raspberry Pi with your network.



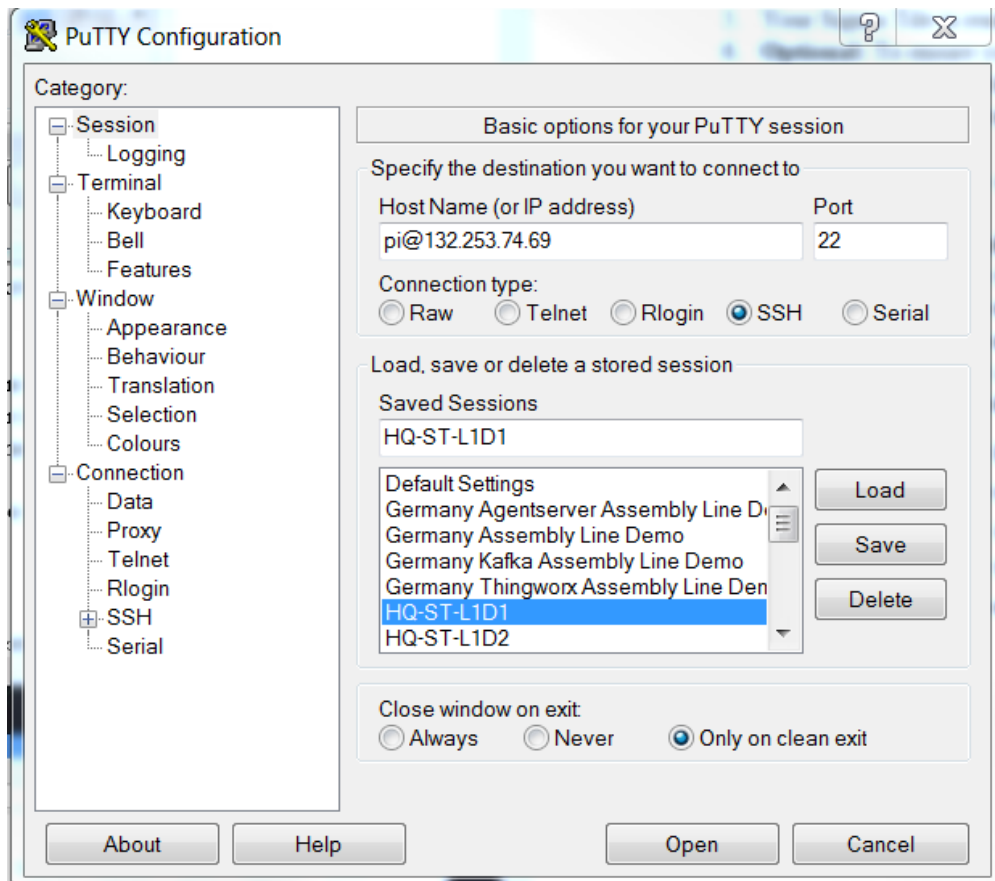
- d. Once you've confirmed you can connect to the internet, restart the pi.
Watch the LED screen of the Sense HAT for its IP address. Make note of the IP address.

5. Your Sigma Tile is ready to connect to Kepware.

Updating the Raspberry Pi from GitHub

Optional: To ensure you have the latest code, you can update the Raspberry Pi from the GitHub repository with these additional steps.

1. Use the IP address to SSH into the Pi.



or

Use the mouse and keyboard to access the command line of the Pi.

user: **pi**

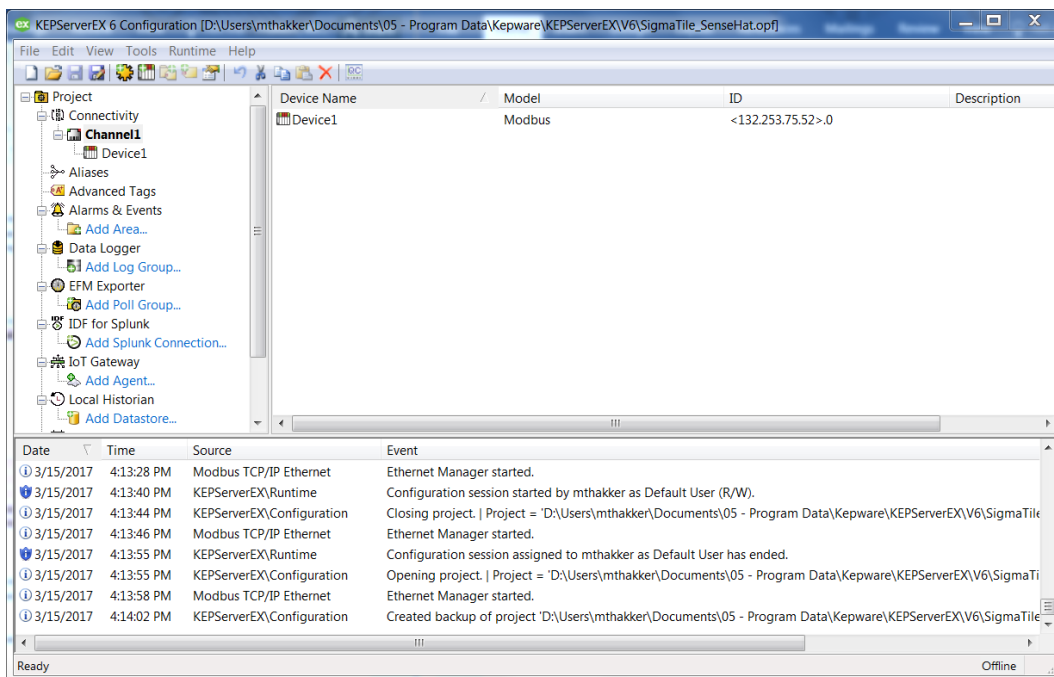
password: **raspberrypi**

2. In 15-30 seconds, you should see its IP address scroll across the screen.
3. Change to the directory that hosts all of the code: `cd mfg-tile/`
 - a. Pull down the latest code from the repository: `git pull`
 - b. Ensure that the launcher is executable: `chmod +x launcher.sh`
 - c. Add the cron job to start the script on boot: `crontab mycron.tab`
 - d. Reboot the Raspberry Pi: `sudo reboot now`

Chapter 3: Connect your Sigma Tile to Kepware







These steps show you how to connect Kepware to your Sigma Tile.

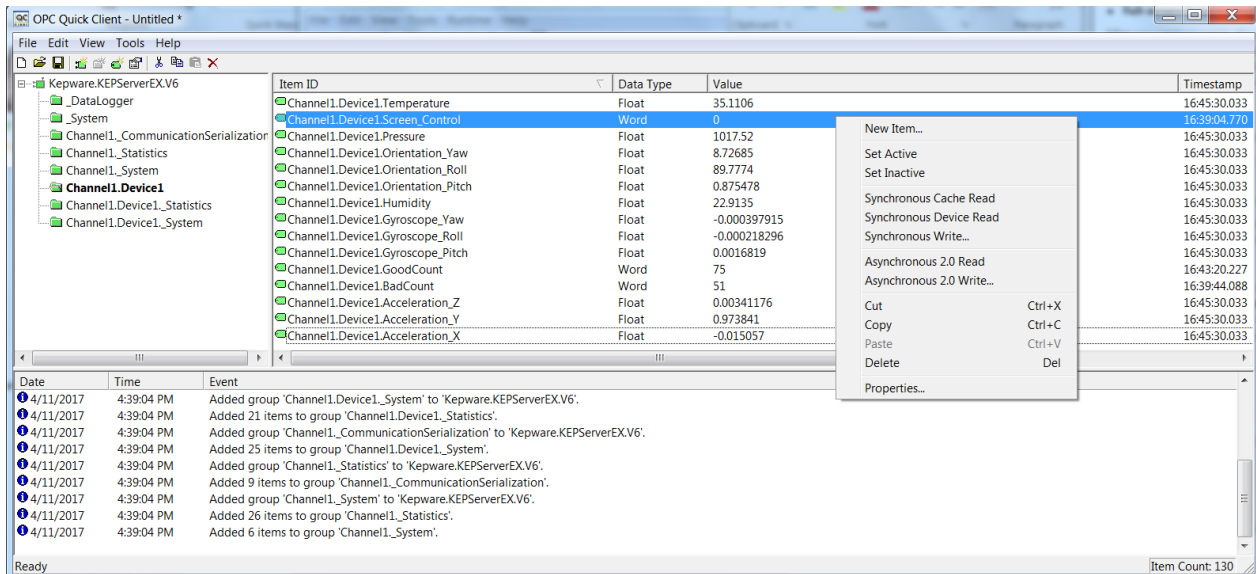
1. In Kepware, load the project **SigmaTile_SenseHat.opf**. If you have already created an instance of Kepware, go to appendix A for instructions on adding this device.
2. Select **Channel 1** in the left-hand menu, double click on the IP address, and change it to the one that scrolled across the Sigma Tile's screen.



3. Open up the quick client by selecting **Tools > Launch OPC Quick Client** and ensure data flow from the Sigma Tile.

4. Change the icon on the Sigma Tile’s screen. In the quick client, right-click on the tag labeled **Screen_Control**, and select **Asynchronous 2.0 Write**. Write any value between 0-4 into this, and observe what happens. Each icon corresponds to a different state detailed in table below:

Icon	Status Description	KepServerEX “Screen_Control” tag value
	Running	0
	Warning	1
	Planned Downtime	2
	Unplanned Downtime	3
	Device Error in the Last 24 hours	4
	Unavailable	5



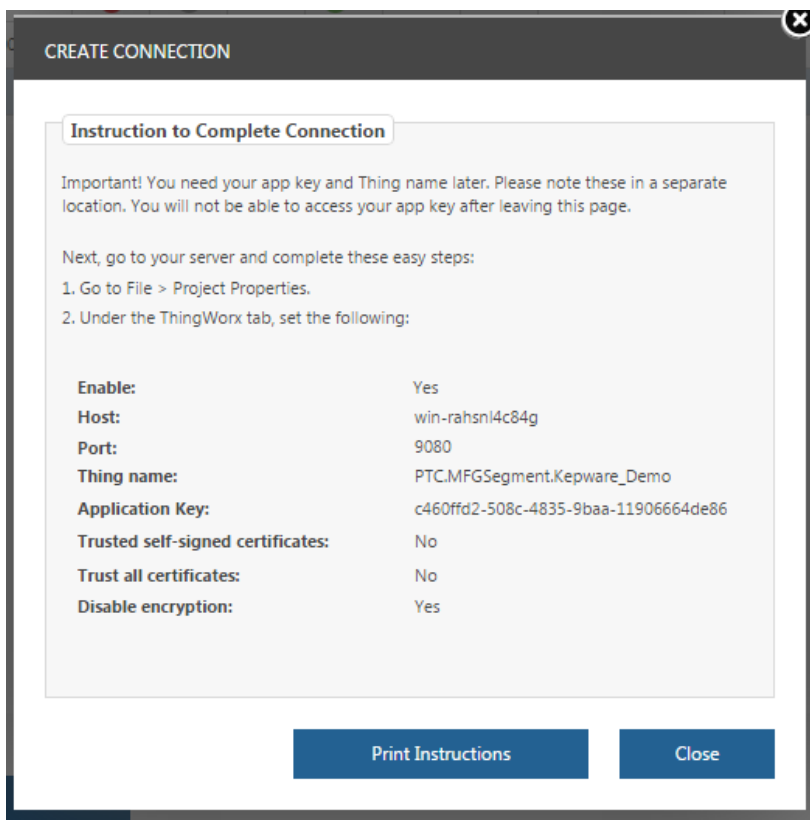
4. Follow the guidance in the ThingWorx Manufacturing Apps documentation to configure the connection with Thingworx.

Chapter 4: Configure Communication with Kepware

This connection with Kepware provides the data needed by the ThingWorx Manufacturing Apps. Kepware can be on the same server or a different server than ThingWorx. One or more KEPServerEX servers can be connected.

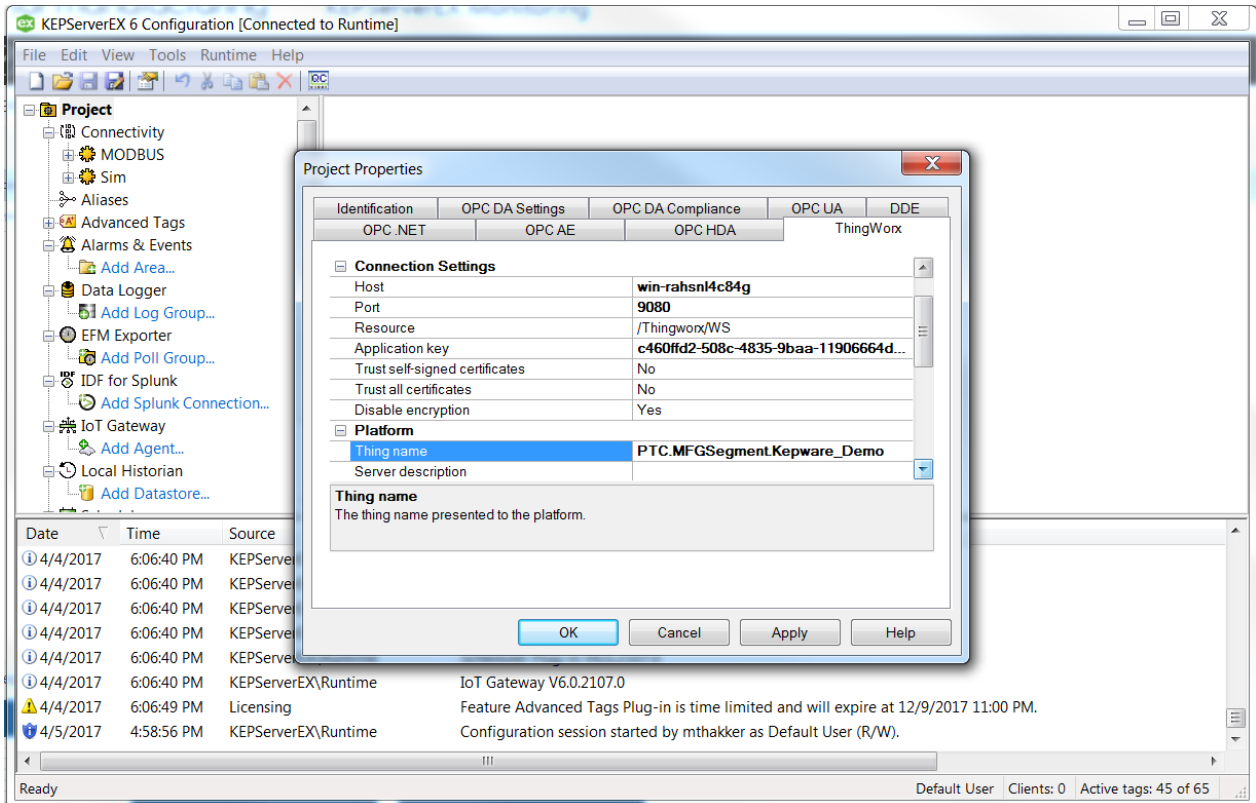
1. When using the ThingWorx Manufacturing Apps installer, the last page includes a link to the login page where you create your first Kepware server connection.

When you open the ThingWorx Manufacturing Apps for the first time, it will prompt you to enter a server or Thing name. Make this name something you can later use to identify this KEPServerEX instance. A list of configuration parameters will automatically be generated.



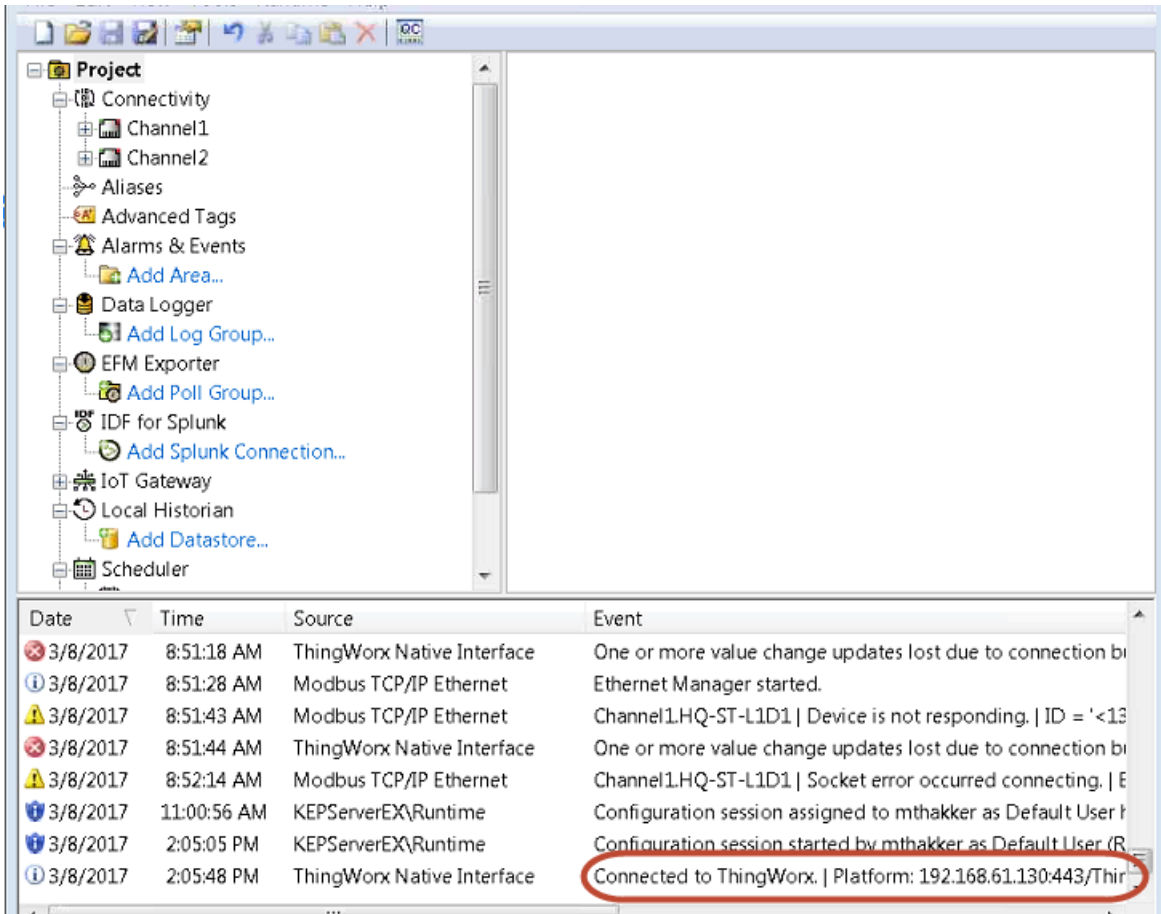
Input these configuration parameters into your instance of KEPServerEX.

1. Right-click **Project** and select **Properties**.
2. Select the **ThingWorx** tab. Kepware then solicits the connection with the ThingWorx Manufacturing Apps.




2. In KEPServerEX Configuration, confirm a connection to ThingWorx displays in the **Event** column. If you receive an error message similar to “Connection to ThingWorx platform <URL or Host>/Thingworx/WS failed: could not initialize a secure socket connection,” try the following steps:

- Verify the host, port, resource, and application key are all valid and correct
- Verify the host of KEPServerEX can reach the machine you’ve installed ThingWorx Manufacturing Apps on by pingging it’s (the ThingWorx Manufacturing Apps Host) hostname or IP address.
- Verify that the proper certificate settings are enabled



3. Launch the ThingWorx Manufacturing Apps from the icon on your desktop or the **Start** menu.
4. Click **KEPServerEX Monitoring**.



5. The server you connected displays in the Connected Servers list. Select it and click discover devices .

The action scans the server and creates the devices in the ThingWorx Manufacturing Apps. Repeat this action as devices are added and removed from KEPServerEX.

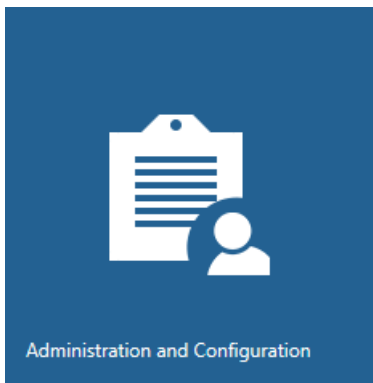
Chapter 5: Getting Started with the ThingWorx Manufacturing Apps


This is the suggested workflow for getting started with ThingWorx Manufacturing Apps.



Configure Users and Roles

1. Select **Administration and Configuration** ► **Users and Access Control**.



2. Click create user .
3. Enter information for the users. Each role is described below. Begin by creating a user for yourself in the Controls Engineer role.

Role	Access
Controls Engineer	All apps
Production Manager	<ul style="list-style-type: none">• Plant Viewer• Alert Monitoring
Quality Engineer	<ul style="list-style-type: none">• Plant Viewer• Trending and Troubleshooting• Alert Monitoring

Role	Access
Maintenance Manager	<ul style="list-style-type: none">• Manage Resources• Trending and Troubleshooting• Alert Management• Asset Performance
Maintenance Engineer	<ul style="list-style-type: none">• Manage Resources• Trending and Troubleshooting• Alert Management• Asset Performance

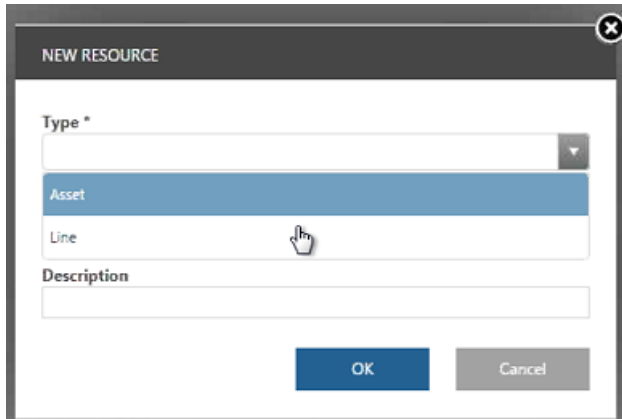
Create Lines and Assets (Resources)

1. Click **Administration and Configuration** ► **Manage Resources**.

2. Create a new line and a new asset.


a. Click new resource .

b. Create your line and asset. In this case, you'll create a single asset, whatever you'd like your Sigma Tile to simulate (e.g. a CNC Machine, Drill Press, bottle filler)

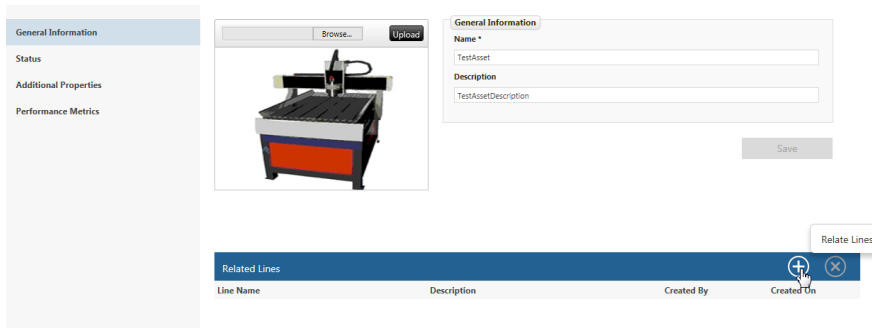


The screenshot shows a 'NEW RESOURCE' dialog box with a close button in the top right. It contains a 'Type *' dropdown menu with 'Asset' selected and 'Line' as an alternative option. Below the dropdown is a 'Description' text input field. At the bottom, there are 'OK' and 'Cancel' buttons.

3. Relate your Sigma Tile to the line.

a. Select it in Resources table and click configure resource .

b. In the **Related Lines** table on the **General Information** page, relate the line to the asset.



The screenshot shows the 'General Information' page for a resource. On the left, there are tabs for 'General Information', 'Status', 'Additional Properties', and 'Performance Metrics'. The main area shows a 'Browse...' button, an 'Upload' button, and a preview image of a CNC machine. To the right, there are input fields for 'Name *' (containing 'TestAsset') and 'Description' (containing 'TestAssetDescription'), with a 'Save' button below. At the bottom, there is a 'Related Lines' table with columns for 'Line Name', 'Description', 'Created By', and 'Created Tm'. A 'Relate Lines' button with a plus icon is positioned above the table.

4. **Optional Exercise:** If you finish this fairly quickly, you could work with a partner to connect their instance of Kepware to your instance of ThingWorx Manufacturing Apps, and relate their Sigma Tile as a second asset on your line. If you have trouble connecting, try the following:

- Ensure you can ping the ThingWorx Manufacturing Apps host from Kepware.
- Ensure the ThingWorx Manufacturing Apps host has the necessary port open. The default is 9080, but you could have changed it during configuration.

Configure Lines and Assets (Resources)

Once the line and asset is created, configure the properties, status, and performance metrics.

1. Click **Administration and Configuration** ► **Manage Resources**.

2. Select your asset or line from the Resources table and click configure resource .

3. From the details page of the asset or line, complete the actions on each page as described in the sections below. Here is the suggested workflow.

Note

This assumes you have related assets to your lines as described in [Create Lines and Assets \(Resources\)](#).


- Create properties on your Sigma Tile.
- Define the status for your Sigma Tile based on the tags selected from KEPServerEx.
- Define performance metrics for your Sigma Tile.
- Define the status for your line based on your Sigma Tile.
- Define performance metrics for your line.

Additional Properties

Add properties or tags from Kepware. You can add:

- static properties by specifying the name, type and value
- properties that pull the value from a Kepware tag

The following example pulls the temperature tag from Kepware.

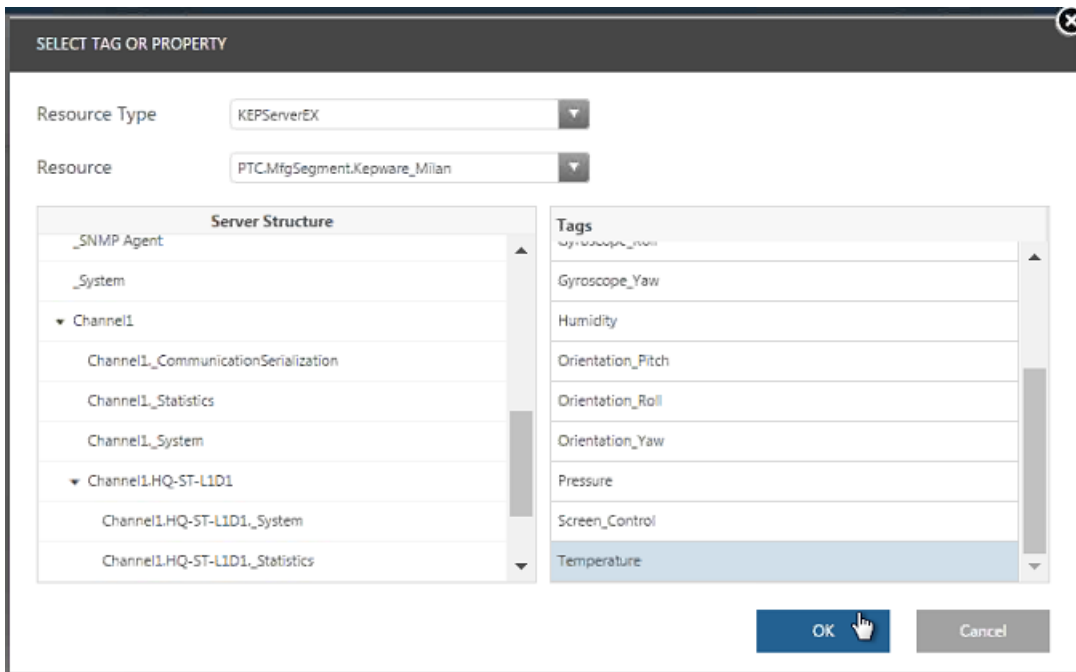
1. Click new property .

2. Enter information in related fields. For **Value**, click the icon to browse for a tag.



Name *	Type	Value *
Temperature	Number	

3. Locate and select the information from your Kepware server.



4. Try to add three or four different tags for ThingWorx Manufacturing Apps to keep track of. I recommend at least one acceleration tag, and one orientation tag, to allow for some variety in the types of data you're recording.

Status

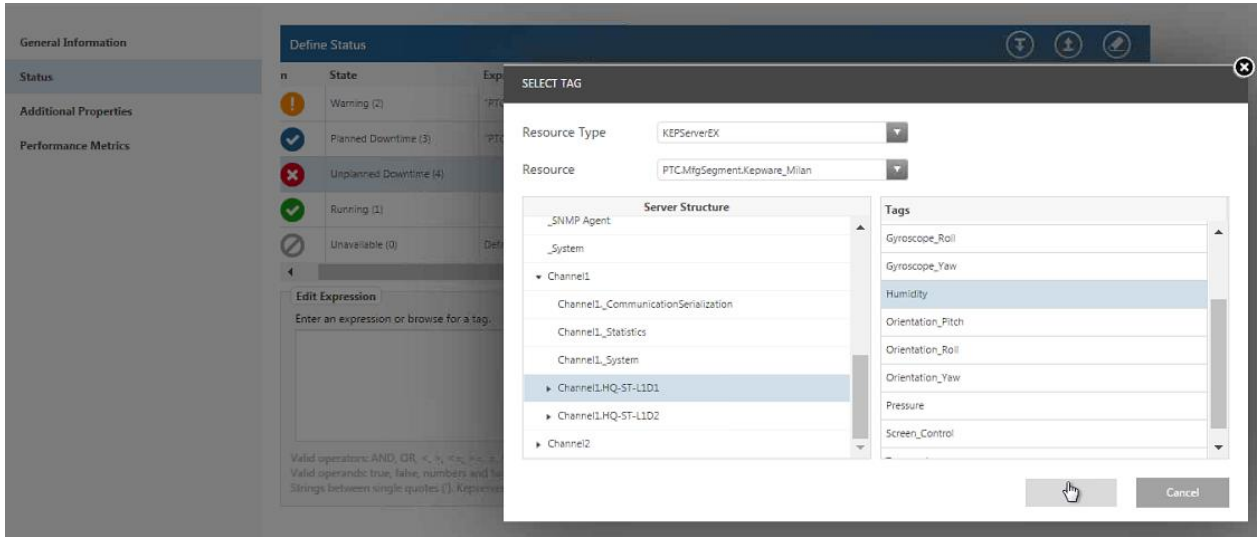
For an asset:

1. Use the arrows in the **Define Status** header to place the states in the order they are checked by the system.

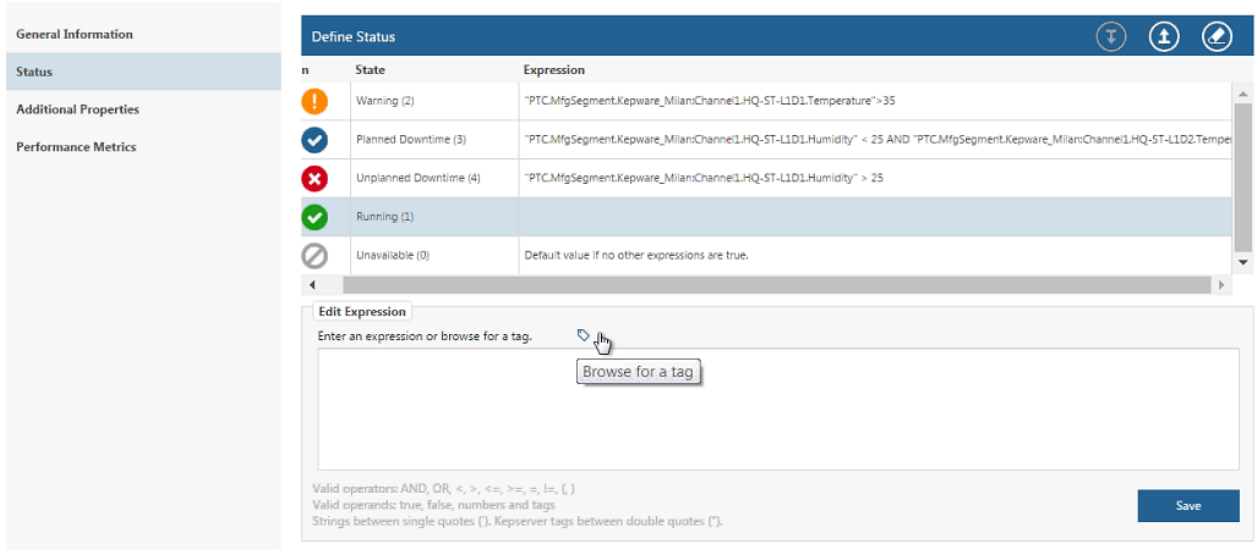
The numbers associated with the state name, for example **(1)**, do not apply to the order. They are used when you [create a new alert](#).

Define Status		
Icon	State	Expression
	Running (1)	
	Warning (2)	
	Planned Downtime (3)	

- For each state, enter an expression. You can manually enter the expression or browse to select tags from your Kepware server.



- This asset example shows the states set using the temperature and humidity properties. Experiment with the different properties that the Sigma Tile tracks to create an expression that relates to each line status. For example, if the machines got too hot (temperature > 38), the lines would be in a warning state. But but if the humidity was extremely high (Humidity > 25%), the machines end up in unplanned downtime.



- For lines, the expressions can relate to the children, or assets, of the line.

This line example shows that the line is in planned downtime if either of the two assets in the line are in planned downtime. The expressions were copied from the planned downtime expressions for each asset.

Give the lines similar definitions to what you gave to the asset. Or, if you completed the optional exercise with a partner, try to tie the status of the line to the status of both assets.

The screenshot shows a 'Define Status' window with a table of status definitions and an 'Edit Expression' dialog box.

Icon	State	Expression
	Running (1)	"ARE_ALL_CHILDREN_RUNNING;Line_3407af4a-1bee-4e5b-9627-f8369dc396af"
	Warning (2)	
	Planned Downtime (3)	("PTC.MfgSegment.Kepware_Milan:Channel2.HQ-ST-L2D2.Humidity" < 25 AND "PTC.MfgSegment.Kepware_Milan:Channel2.HQ-ST-L2D2.Te
	Unplanned Downtime (4)	
	Unavailable (0)	Default value if no other expressions are true.

The 'Edit Expression' dialog box contains the following text:

Enter an expression or browse for a tag.

```
("PTC.MfgSegment.Kepware_Milan:Channel2.HQ-ST-L2D2.Humidity" < 25 AND "PTC.MfgSegment.Kepware_Milan:Channel2.HQ-ST-L2D2.Temperature" > 40) OR ("PTC.MfgSegment.Kepware_Milan:Channel2.HQ-ST-L2D1.Humidity" < 25 AND "PTC.MfgSegment.Kepware_Milan:Channel2.HQ-ST-L2D1.Temperature" > 40)
```

Valid operators: AND, OR, <, >, <=, >=, !=, (,)
 Valid operands: true, false, numbers and tags
 Strings between single quotes ('), Kepserver tags between double quotes (").

A 'Save' button is visible at the bottom right of the dialog box.

3. Save the table.

Performance Metrics

The procedure below describes how to enter performance metrics for your lines and assets. The help icons in each field state the equations used.

General Information

Status

Additional Properties

Performance Metrics

Parameters for Performance Calculations

Enter an expression or browse for a tag.

Good Count ⓘ ⓘ

The following operators are valid: +, -, *, /
The following operands are valid: numbers and tags.
Strings between single quotes (''). Kepserver tags between double quotes ("").

Total Count ⓘ ⓘ

Ideal Run Rate ⓘ ⓘ

Performance Indicator Thresholds

Enter low and high threshold values for each metric.

Availability ⓘ	0%	Red →	30 %	Yellow →	70 %	Green →	100+ %
Quality ⓘ	0%	Red →	30 %	Yellow →	70 %	Green →	100+ %
Performance ⓘ	0%	Red →	30 %	Yellow →	70 %	Green →	100+ %
OEE ⓘ	0%	Red →	30 %	Yellow →	70 %	Green →	100+ %

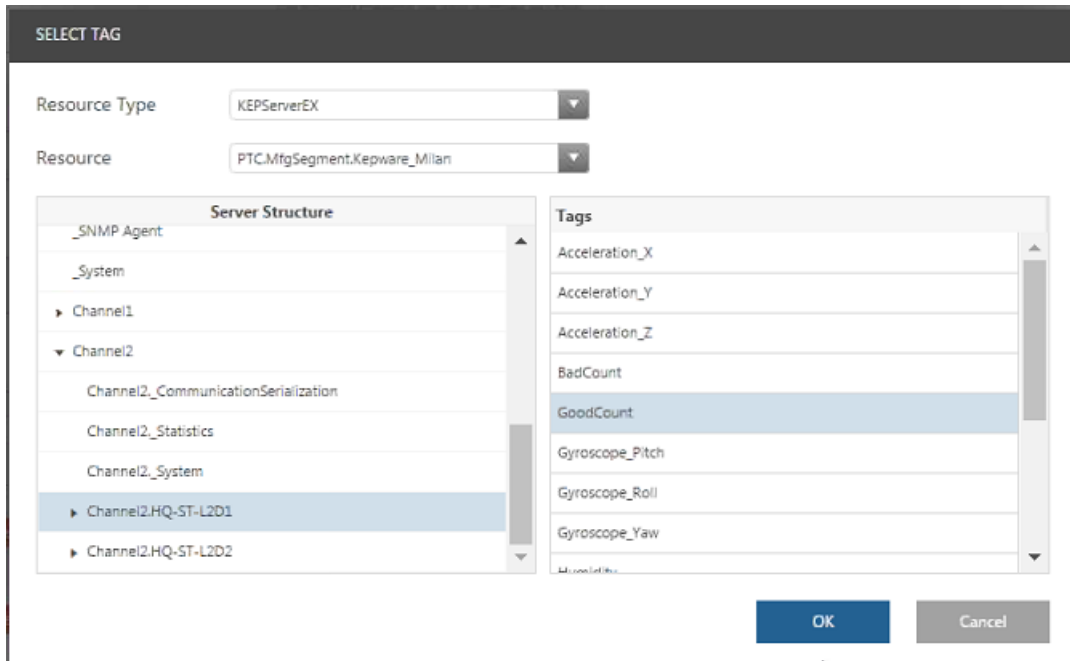
Save

Note

This procedure assumes you have a Kepware tag from which you can access the number of good parts and bad parts for the day.

1. Good Count

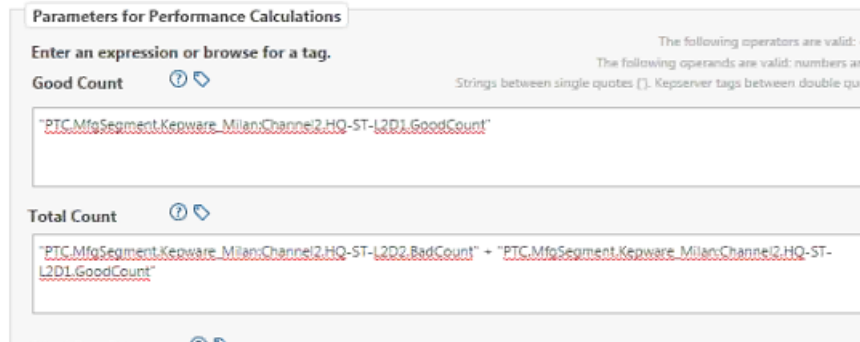
- a. Browse to the Kepware Tag labeled GoodCount for your Sigma Tile.



- b. For the line, enter the good count for each of the assets, or children. In this case it should be identical to that of child Sigma Tile.

2. Total Count

- For the Sigma Tile asset, browse for your bad count and then add your good count. You can copy and paste the good count from the previous field, as seen in the example below



- For the line, enter the good count and bad count for all assets, or children, of the line. In this case, the good count of the line will be identical to the

Parameters for Performance Calculations

Enter an expression or browse for a tag. The following operators are valid
The following operands are valid: numbers
Strings between single quotes []. Kepserver tags between double q

Good Count ⓘ ↻

`"PTC.MfgSegment.Keopware_Milan:Channel2.HQ-ST-L2D1.GoodCount" + "PTC.MfgSegment.Keopware_Milan:Channel2.HQ-ST-L2D2.GoodCount"`

Total Count ⓘ ↻

`"PTC.MfgSegment.Keopware_Milan:Channel2.HQ-ST-L2D1.GoodCount" + "PTC.MfgSegment.Keopware_Milan:Channel2.HQ-ST-L2D2.GoodCount" + "PTC.MfgSegment.Keopware_Milan:Channel2.HQ-ST-L2D1.BadCount" + "PTC.MfgSegment.Keopware_Milan:Channel2.HQ-ST-L2D2.BadCount"`

3. Ideal Run Rate

Identify how quickly your factory would be producing parts for the asset or line in an ideal situation. Enter parts per minute. For the Sigma Tile and this lab, that would be approximately 6 parts per minute

4. Click **Save**.
5. Go to **Plant Viewer** and **Asset Performance** to view the performance metrics you have defined for the lines and assets.

Note


Immediately after configuring performance metrics, low performance metrics are to be expected.

Configure Alerts

You can create alerts using the status expressions set when you [Configure Lines and Assets \(Resources\)](#). In this example follow these directions to create an alert whenever your asset is in a particular status.

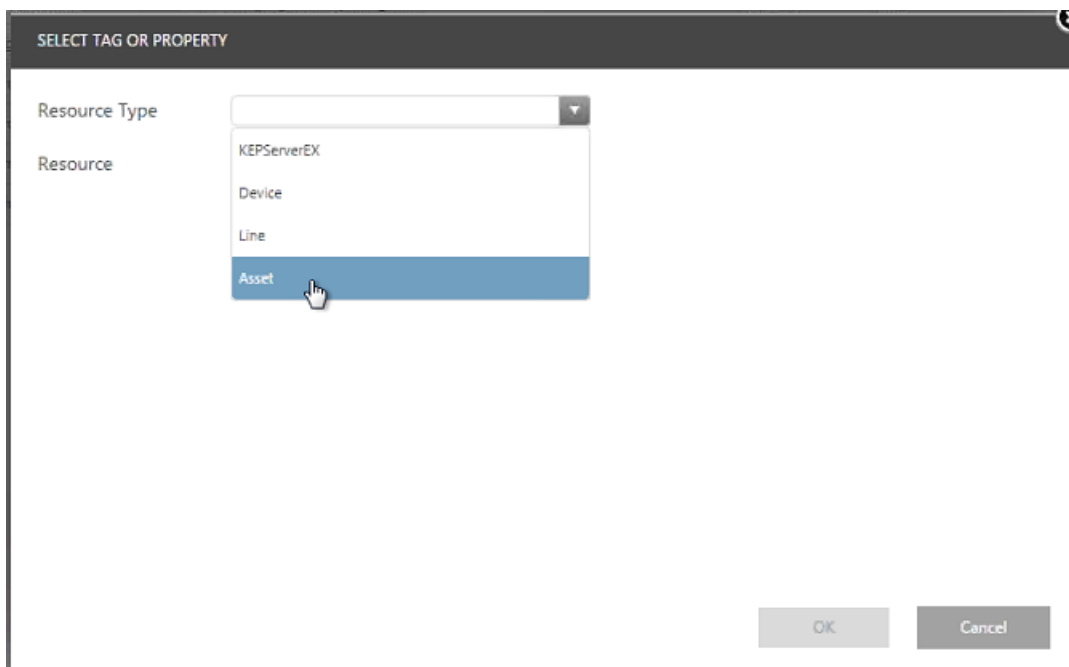
1. Go to **Alert Management** ► **Alert Editing**.



2. Click create .

3. Select the resource on which you want to create the alert. Choose from the following:

- a line or asset you created in ThingWorx Manufacturing Apps
- a device
- any KEPServerEx



4. Select the property used for the alert. This example uses status.
- For the Sigma Tile, tie the Alert to the KEPServerEX resource.

SELECT TAG OR PROPERTY

Resource Type: Asset

Resource: CNC - HQ - ST - L1D1

Properties:

- Humidity
- Temperature
- availability
- oee
- performance
- quality
- status

OK Cancel

5. Create the alert. For **Value**, use the numbers listed in the description.
 - For the Sigma Tile, use KEPServerEX as the resource and tie this to the humidity tag. Placing your finger over the sensor will cause it to increase, and trigger the Alert. You should see the screen on the Sigma Tile changing to signify that the device is in alert.

CREATE NEW ALERT

Tag or Property: status

Description: 1 = Running, 2 = Warning, 3 = Planned Downtime, 4 = Unplanned Downtime, 0 = Unavailable

Alert Definition

Alert Name * CNCLine1

Alert Type NotEqualTo

Value 1

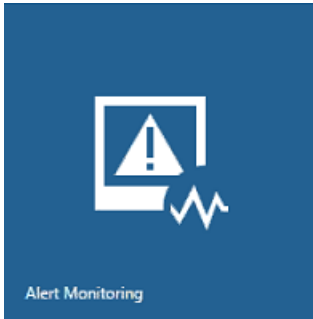
Alert Description

CNC Line 1 Not Running

Save Cancel

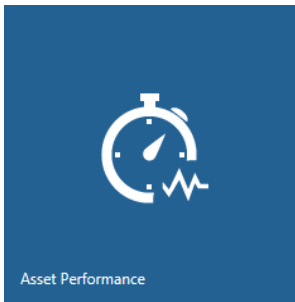
6. To view alerts:

a. Go to **Alert Monitoring**.



or

Go to **Asset Performance** and click the alert icon next to the asset with the alert.



b. The new alert appears in the Alert Monitor.

ptc Kinex for Manufacturing™ Alert Management MilanT

ALERT MONITOR: All Alerts 0 of 9 Active Filters | Add Filter

Refresh Now Summary History

Name	Source Property	Source	Time Stamp	Alert Type	Duration (ms)	Message	Description
CNCLine1	status	CNC - HQ - ST - L1D1	2017-03-08 14:43:00	NotEqualTo	19293.00	1	CNC Line 1 Not Running

Alert: CNCLine1

Details		History	
Priority	1	Event Name	Message
Time Stamp	Wed Mar 08, 2017 02:43:00 PM GMT-05:00	Time Stamp	Location
Acknowledged	false		
Acknowledged by			
Acknowledged Time Stamp			
Acknowledge Comment			

Note

After creating the alert, it may take a minute before the alert appears.

7. To acknowledge the alert, click

Once an alert has been acknowledged, a checkmark appears in the table and it no longer sends out emails and text messages.

ALERT MONITOR: All Alerts

Refresh Now

Name	Source Property	Source	Time Stamp
CNCLine1	status	CNC - HQ - ST - L1D1	2017-03-08 14:43:00

Configure Trends

Each trend you create in ThingWorx Manufacturing Apps tracks up to five tags or properties for a given resource (line or asset). Follow these directions and trend some acceleration and gyroscopic readings for the Sigma Tile.

To create a trend:

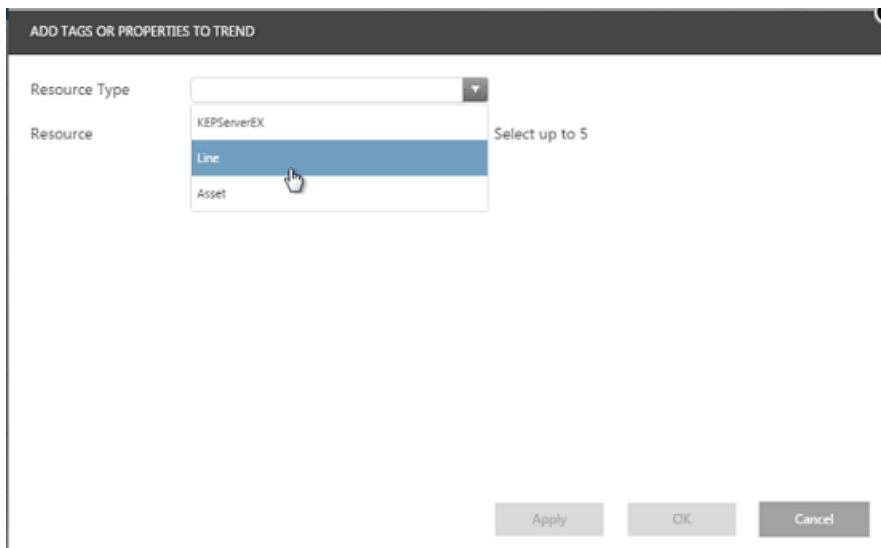
1. Click **Trending and Troubleshooting**.



2. Click new trend .

3. In the **New Trend** window, enter a name and optionally, a description.

4. Select the type and resource.



5. Select up to 5 properties or tags to trend for the selected resource. The following is recommended: one acceleration tag, one gyroscope tag, one orientation tag, and one of the environmental conditions tags.
6. Once the trend is created, you can view any of the selected properties over different lengths of time. Try shaking the Sigma Tile around, and watch what happens to the acceleration and gyroscope values that you trended.

Time filter: Last 15 Min | Last Hour | Last Day | Custom

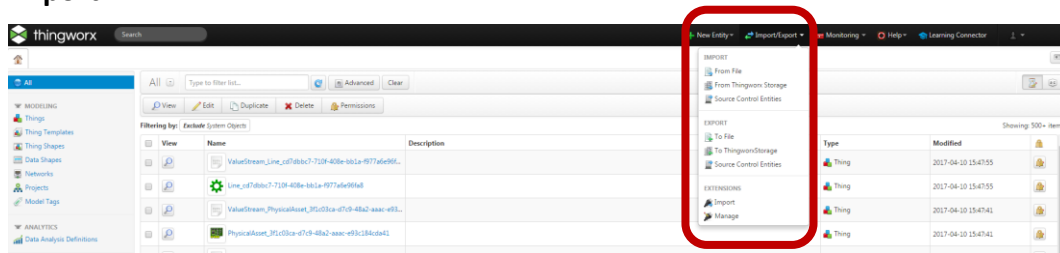
Tags Show Value Range +

<input checked="" type="checkbox"/>	CNC - HQ - ST - L1D1:Temperature	✗
<input checked="" type="checkbox"/>	CNC - HQ - ST - L1D1:availability	✗
<input checked="" type="checkbox"/>	CNC - HQ - ST - L1D1:oee	✗
<input checked="" type="checkbox"/>	CNC - HQ - ST - L1D1:performance	✗
<input checked="" type="checkbox"/>	CNC - HQ - ST - L1D1:quality	✗

Chapter 6: Extending your ThingWorx Manufacturing Apps

Now you will be extending your ThingWorx Manufacturing Apps software by installing a pre-built Extension. This extension contains services and logic to communicate with the Sigma Tile from ThingWorx and update the Screen Control values in Kepware based on an alert being triggered in ThingWorx Manufacturing Apps.

1. Download the Sigma Tile extension from the Sigma Tile webpage
2. Open up ThingWorx Core by navigating to:
<http://<yourhostname>:<yourport>/Thingworx/Composer>
3. To import the extension, select **Import/Export** ► **Import**. Select the extension file and click **Import**.



4. In Kepware, ensure the IoT Gateway plugin is on and running on the default network (127.0.0.1).
5. Check that your Sigma Tile LED display reflects an Alert status when an alert is triggered by ThingWorx Manufacturing Apps.

Appendix A – Building a Sigma Tile Software

Starting from a Clean Image of Raspbian

This advanced section of the guide assumes you have already connected your Raspberry Pi to a network and can SSH into the Raspberry Pi already.

1. Connect the Sense HAT to your Raspberry Pi.
2. Power on and SSH into your Raspberry Pi.
3. Install the following packages onto your Raspberry Pi:
 - Using `sudo apt-get install <package>`: python-dev, git-core, python-pip
 - Using `sudo pip install <package>`: pymodbus, pycrypto
 - Using `sudo apt-get install <package>`: libffi-dev, libssl-dev, sense-hat
 - Using `sudo pip install <package>`: cryptography
4. Reboot the Raspberry Pi: `sudo reboot now`
5. SSH into the Raspberry Pi again. Then copy the source code in from GitHub:
`git clone https://github.com/PTCInc/mfg-tile`
6. Set up the Modbus server to automatically run on startup.
 - Change to the directory that hosts all of the code: `cd mfg-tile/`
 - Ensure that the launcher is executable: `chmod +x launcher.sh`
 - Add the cron job to start the script on boot: `crontab mycron.tab`
 - Reboot the Raspberry Pi: `sudo reboot now`
7. When the Raspberry Pi boots, you should see its IP address scroll across the screen.

Appendix B – Supported Platforms and Technical Support

Supported Platforms and Prerequisites

Kepware

To use ThingWorx Manufacturing Apps with your Sigma Tile, you should have Kepware KepServerEX 6.0 (6.0.x) installed. If you don't have KepserverEX, you can sign up at myKepware and download the software: www.mykepware.com.

Kepware product downloads run for 2 hours at a time under a free demo license. The demo period can be repeated at any time by stopping and starting the application.

Note: To reset the KEPServerEX Runtime Service, right-click on the Administration tool, the green EX icon the Systray, and select **Stop Runtime Service**. If the service does not automatically reconnect, right-click on this icon again and select **Start Runtime Service**.

.Net

.Net Framework (version 3.5.1) needs to be installed and running.

VMWare

If you are going to install in a VMWare machine, ensure you have the latest VMWare tools installed. At least 2 cores and 5GB of RAM are required. The traditional 1 core, 2GB configuration is not sufficient.

Recommended Browsers

Browsers are listed in order of observed performance with the apps:

- Chrome 51 (recommended)
- Firefox ESR 47+
- Internet Explorer 11

Supported Platforms

Windows Server 2008 and 2012 are officially supported for the early access release. See the following information on previous Windows releases:

- Windows 7 – installer and applications work successfully
- Windows 10 – installer completes but very limited testing has been done
- Windows Vista and NT – not supported; the installer will not complete the installation

Support

For questions on the ThingWorx Manufacturing Apps apps (installation, configuration, capabilities) and Sigma Tile, see the links to our ThingWorx User Community pages below. You will be able to search and view posts from other participants of this Early Access program and from PTC subject matter experts. Ask questions, share your lessons learned, and provide feedback.

- ThingWorx Manufacturing Apps Apps: [https://community.thingworx.com/groups/ThingWorx Manufacturing Apps-for-manufacturing](https://community.thingworx.com/groups/ThingWorx_Manufacturing_Apps-for-manufacturing)
- Sigma Tile: <https://community.thingworx.com/groups/sigma-tile>

Tip: If you already a PTC customer, you probably already have an account. If you do not have an account, login on the top right end side of the page

For questions related to KepServerEX, see the Kepware Technical Support page: <https://www.kepware.com/en-us/support/technical-support/>