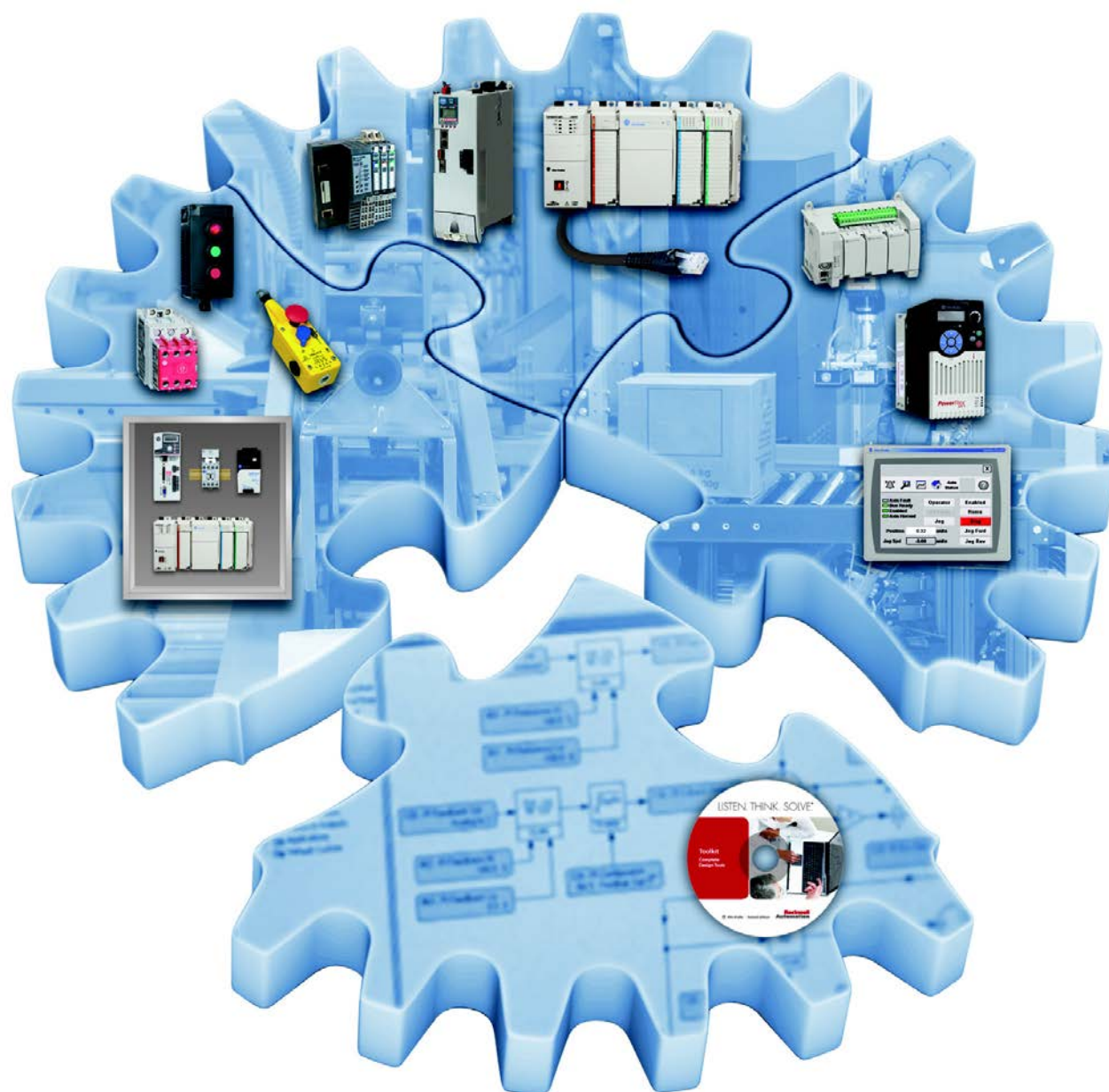


## Connected Components Accelerator Toolkit



# Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.



In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.




No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	<b>WARNING:</b> Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	<b>ATTENTION:</b> Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
<b>IMPORTANT</b>	Identifies information that is critical for successful application and understanding of the product.

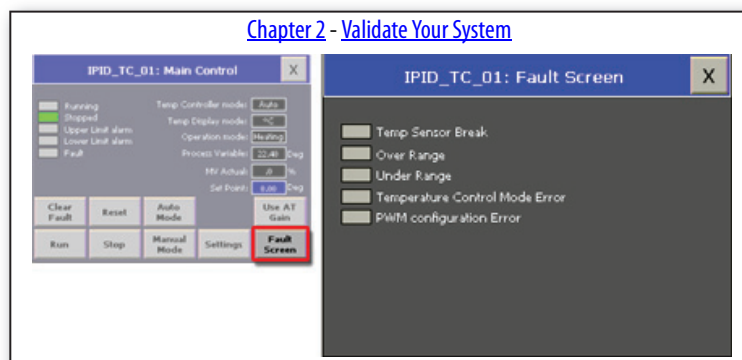
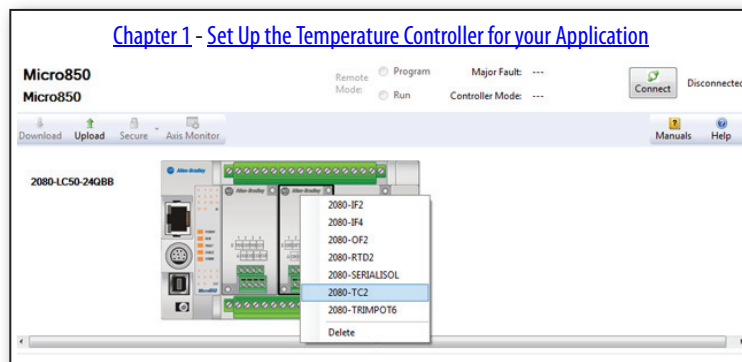
Labels may also be on or inside the equipment to provide specific precautions.

	<b>SHOCK HAZARD:</b> Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	<b>BURN HAZARD:</b> Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	<b>ARC FLASH HAZARD:</b> Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This Temperature Control Building Block is designed for slow applications such as ovens, autoclave machines, and chillers. These applications typically display a significantly slower passive rate than active rate. Active rate refers to the rate of temperature change from activating the heating or cooling element. Passive rate refers to the rate of temperature change by the environment.

Follow this path to complete your building block project.

Read the Getting Started CCAT with System Design Assistant Quick Start, publication [CC-QS035](#).



## Notes:

## **Preface**

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## **Chapter 1**

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## **Appendix A**

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## About This Publication

This quick start is designed to provide a way to implement common control tasks by aiding in the selection of products and providing access to panel and wiring information. Each section is designed with a different task as a standalone machine, or implemented in a larger system.

---

**IMPORTANT** Use this publication together with other Connected Components Accelerator Toolkit quick starts to aid in building your Micro800™ based application. Refer to [Available Connected Components Accelerator Toolkits](#) on page 9 for where to find other quick starts.

---

To help with the design and installation of your system, application files and other information are provided on the Connected Components Accelerator Toolkit (CCAT). The CCAT provides bills of materials (BOM), CAD drawings for panel layout and wiring, control programs, Human Machine Interface (HMI) screens, and more. With these tools and the built-in best-practices design, you are free to focus on the design of your machine control and not on design overhead tasks.

The CCAT is available on the Connected Components Accelerator Toolkit DVD, publication CC-QR002, or through the Rockwell Automation® Software Download and Registration System (SDRS) at <http://www.rockwellautomation.com/rockwellautomation/products-technologies/connected-components/tools/accelerator-toolkit.page>.

The beginning of each chapter contains the following information. Read these sections carefully before you begin work in each chapter:

- **Before You Begin** - The chapters in this quick start do not have to be completed in the order in which they appear. However, this section defines the minimum amount of preparation that is required before completing the current chapter.
- **What You Need** - This section lists the tools that are required to complete the steps in the current chapter, including, but not limited to, hardware and software.
- **Follow These Steps** - This section illustrates the steps in the current chapter and identifies the steps that are required to complete the examples.

## Terminology

Term (Abbreviation)	Definition
Application Sequence Programs	User-modified programs that work together with the standard state machine logic to control what the machine does while in the abort, clear, reset, run, and stop states.
Auto/manual operation	When the PanelView™ 800 terminal is in Auto mode, the controller logic controls the machine and monitors machine status. When the PanelView 800 terminal switches to Manual mode, the terminal takes over control. Command buttons and numeric entry fields are available only when the machine is in Manual mode.
Bill of Materials (BOM)	A list of components that are needed for your system.
Building block (BB)	Tools to accelerate and simplify the development of a Micro800 controller-based application. A typical building block includes a starting Bill of Material (BOM), Computer-Aided Design (CAD) drawings, Micro800 controller programs, PanelView 800 terminal applications, and a quick start document.
Computer-Aided Design (CAD)	A computer-based system that is developed to facilitate design of mechanical parts.
Connected Components Accelerator Toolkit (CCAT)	Software with application files and other information to speed the design and startup of component-based machines.
CCAT project	A project that consists of these items: <ul style="list-style-type: none"> <li>• A ProposalWorks™-based bill of materials</li> <li>• A set of CAD drawings (dimensions and schematics)</li> <li>• A Connected Components Workbench™ project</li> <li>• HMI displays</li> <li>• A set of Quick Start documents</li> <li>• A project document with information about the project components and links to reference materials</li> </ul>
Connected Components Workbench™ software	Software environment to configure or program Micro800 controllers, PanelView 800 terminals, PowerFlex® drives, and other component-level products.
Connected Components Workbench project	A project that consists of one or more of these items: <ul style="list-style-type: none"> <li>• Micro800 controller configuration</li> <li>• Up to 256 Micro800 programs, each with program local variables</li> <li>• Micro800 global variables</li> <li>• PanelView 800 terminal application</li> <li>• PowerFlex drive parameter lists</li> </ul>
Global variables	Project variables that any program can access, which includes all I/O and system variables.
State Machine control code	Machine logic to coordinate overall machine operation that is based on states. The state machine broadcasts commands and receives feedback information from each of the building blocks via user-modified application sequence programs.
Tags	A PanelView 800 term for variables.
User-defined Function Blocks (UDFBs)	Function block instructions that can be used like standard function block instructions within any Connected Components Workbench programming language. Anyone who uses Connected Components Workbench software can write these functions blocks. Many UDFBs are posted on the Rockwell Automation sample code website: <a href="http://samplecode.rockwellautomation.com/idc/groups/public/documents/webassets/sc_home_page.hcst">http://samplecode.rockwellautomation.com/idc/groups/public/documents/webassets/sc_home_page.hcst</a> .
User-defined Object (UDO)	A collection of PanelView 800 terminal screen objects that can be pasted into a new screen.



## Available Connected Components Accelerator Toolkits

For the most up-to-date listing of available Connected Components Accelerator Toolkits and related quick starts, refer to these resources:

- Rockwell Automation Connected Components Accelerator Toolkit website at <http://www.rockwellautomation.com/rockwellautomation/products-technologies/connected-components/tools/accelerator-toolkit.page>
- Connected Components Accelerator Toolkit Building Block Project Descriptions Quick Reference, publication [CC-QR003](#)

## Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	Description
Micro820™ 20-point Programmable Controllers User Manual, publication <a href="#">2080-UM005</a>	Provides a reference guide for Micro820 controller systems. It also contains procedures to install, wire, and troubleshoot your controller.
Micro830™ and Micro850™ Programmable Controllers User Manual, publication <a href="#">2080-UM002</a>	Provides information to install, wire, and troubleshoot the Micro830 and Micro850 programmable controllers.
Micro800 Digital and Analog Plug-in Modules and Accessories User Manual, publication <a href="#">2080-UM004</a>	Provides information to install, wire, and troubleshoot Micro800 plug-in modules and accessories.
PanelView 800 HMI Terminals Installation Instructions, publication <a href="#">2711R-IN001</a>	Provides information to install, wire, ground, and troubleshoot PanelView 800 HMI terminals.
PanelView 800 HMI Terminals User Manual, publication <a href="#">2711R-UM001</a>	Provides information to configure, operate, and troubleshoot the PanelView 800 HMI terminals.

You can view or download publications at <http://www.rockwellautomation.com/literature>. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

## Notes:

## Set Up the Temperature Controller for your Application

The temperature controller is located within the Micro800™ controller. Configuration is done through the ladder editor of the Connected Components Workbench™ software.

### Before You Begin

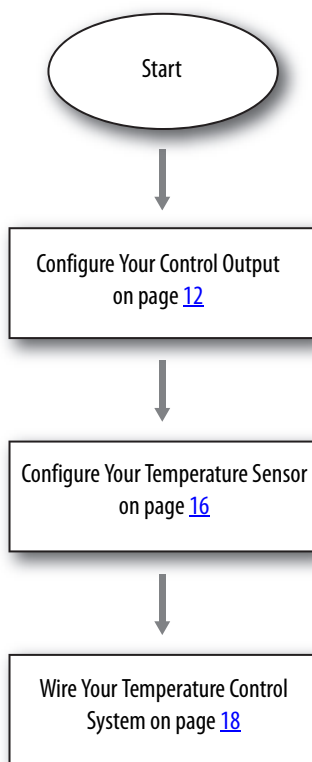
- Review the Getting Started Connected Components Accelerator Toolkit with System Design Assistant Quick Start, publication [CC-QS035](#).
- Apply power to your Micro800 controller.
- Ensure that the controller is wired according to the CAD diagram provided.

### What You Need

- Personal computer with an available USB port
- Connected Components Workbench software, version 9 or later
- Micro820™, Micro830®, or Micro850® controller
- Temperature sensor plug-in (2080- TC2™ or 2080-RTD2)
- Analog output plug-in (if the heating or cooling element is driven by analog output)
- Solid-state relay (if the heating or cooling element is driven by pulse-width modulation (PWM) output)
- Temperature sensor
- Heating or cooling element

## Follow These Steps

Follow these steps to configure your controller-based temperature control application building block



## Configure Your Control Output

Depending on your application, your heating or cooling element may be driven by analog or PWM output. The building block is designed for both, but is configured for PWM by default. It is recommended that you use a transistor-type output controller when you use PWM output.

### Analog Control Mode

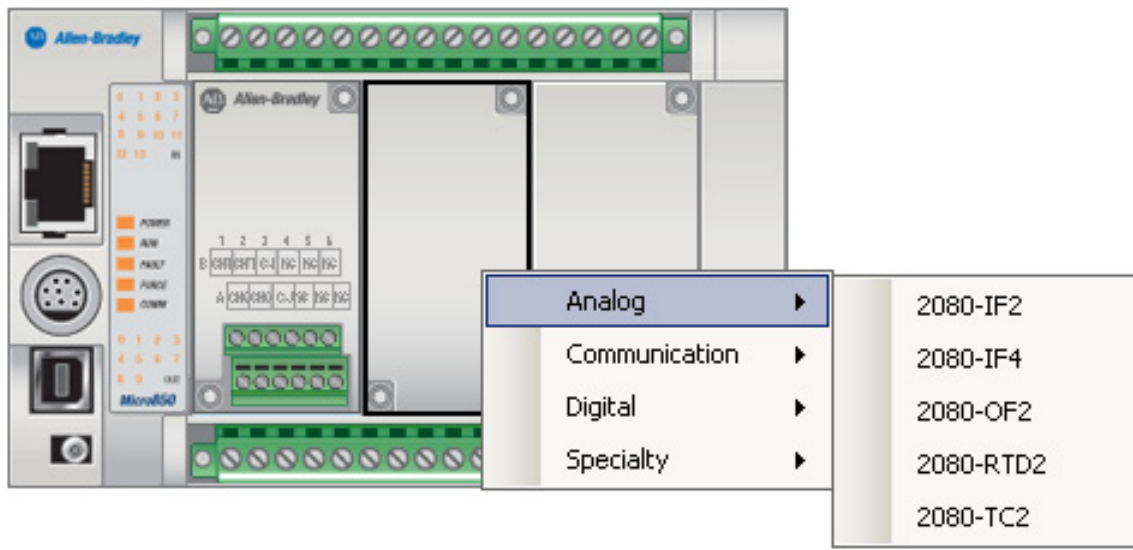
In this section, you configure the temperature control building block for analog output control. See [PWM Control Mode on page 15](#), if you are using PWM control mode.

1. Start the supplied Automated Tuning Temperature Control Building Block project for your specific Micro800 controller with Connected Components Workbench software.
2. To launch the controller configuration screen, double-click Micro850.



- By default, a Thermocouple plug-in (2080-TC2) is configured for you in slot 1. To add an analog output plug-in (2080-OF2), right-click slot 2.

**Note:** If your project is generated by CCAT, you must manually add your temperature sensor plug-in.



- Configure the analog output type according to your application need.

#### 2080-OF2 - Configuration

##### Channels

###### Channel 0

Output Type: **Voltage**

Output State: **Enabled**

###### Channel 1

Output Type: **Current**

Output State: **Disabled**

5. Enable the analog output state.

### 2080-OF2 - Configuration

#### Channels

##### Channel 0

Output Type:

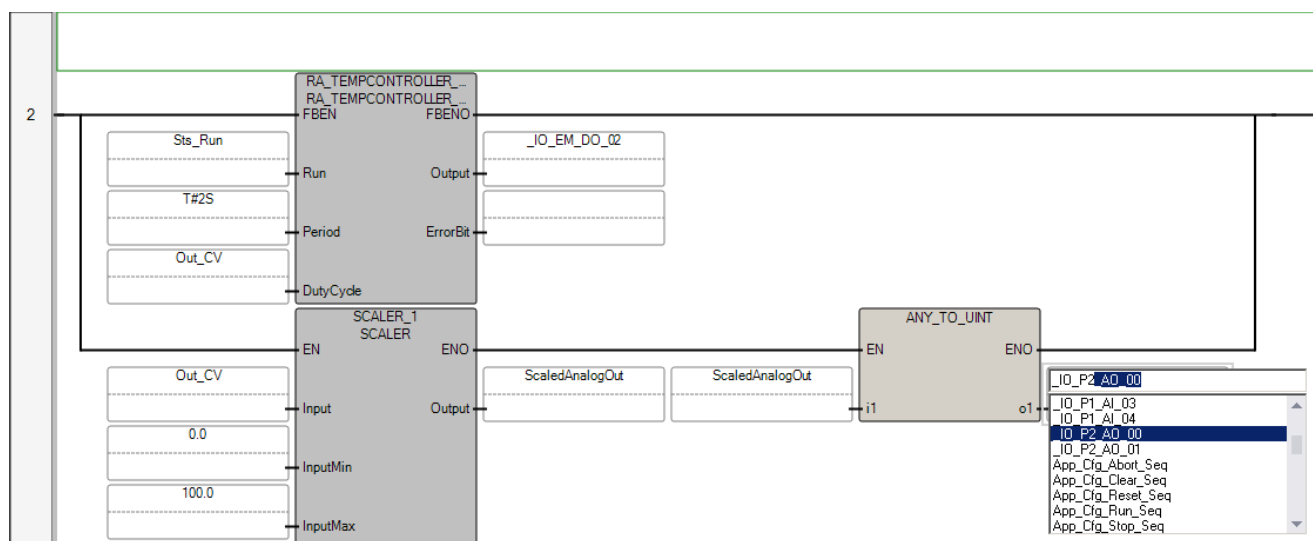
Output State:

##### Channel 1

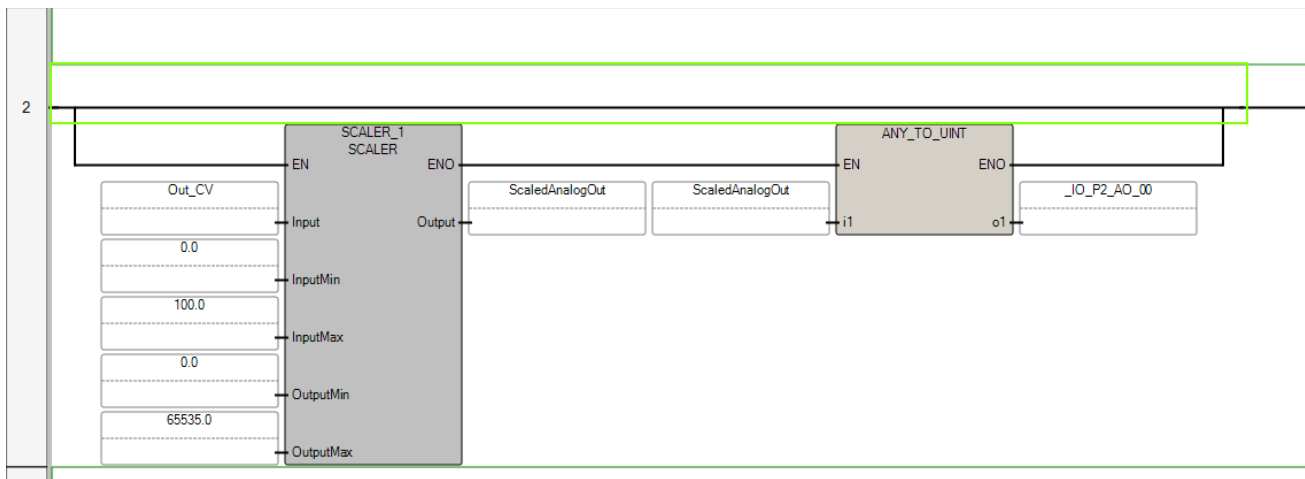
Output Type:

Output State:

6. Assign your analog output in the 'Analog Output Branch' of Rung 2 of the 'TC2\_01' program as shown in the diagram.



7. Delete the 'PWM Output Branch' because you are not using it.



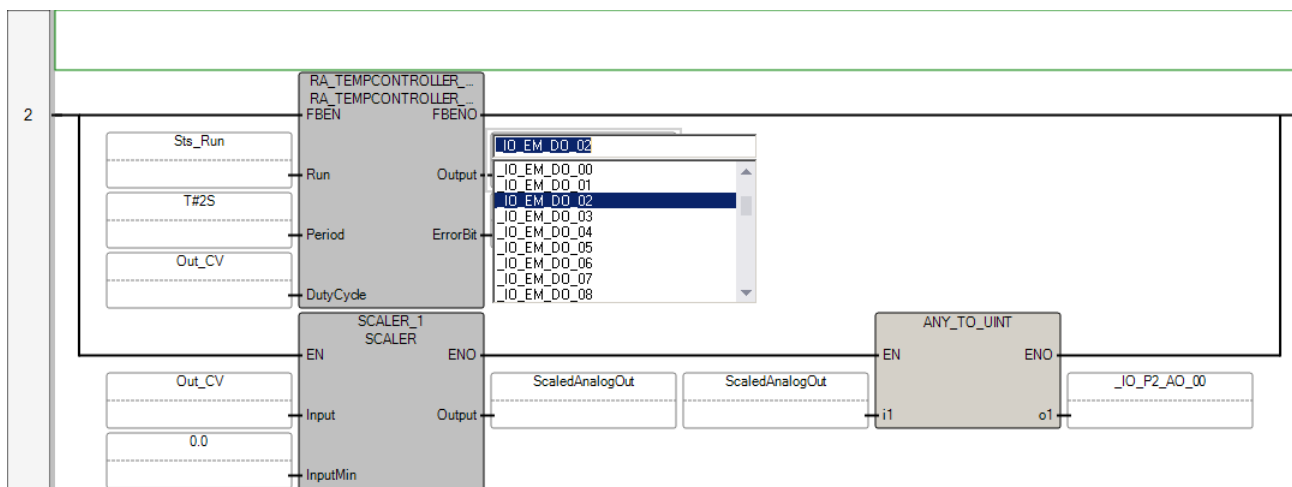
## PWM Control Mode

In this section, you configure the temperature control building block for PWM control. See [Analog Control Mode on page 12](#), if you are using analog control mode.

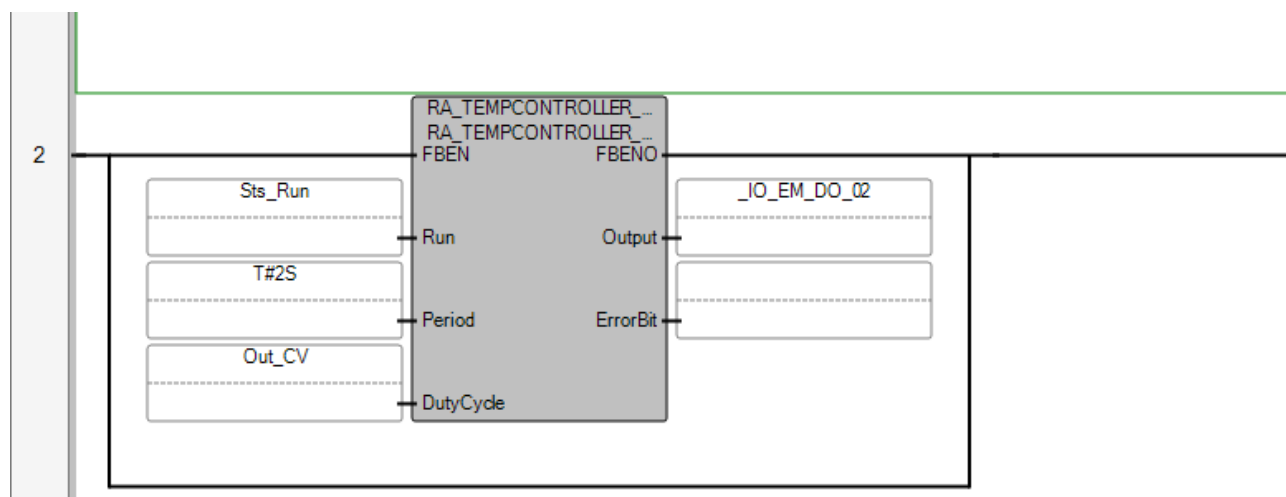
1. Start the supplied Automated Tuning Temperature Control Building Block project for your specific Micro800 controller with Connected Components Workbench software.
2. To launch the controller configuration screen, double-click Micro850.



3. Review your PWM output configuration in the 'PWM Output Branch' of Rung 2 of the 'TC2\_01' program. as shown in the diagram.



4. Delete the 'Analog Output Branch' because you are not using it.



## Configure Your Temperature Sensor

You are expected to have configured your control output from the previous section. There are two types of temperature sensor plug-ins available for Micro800 controllers: thermocouple (2080-TC2) and RTD (2080-RTD2). Select the plug-in based on the temperature sensor for your application.

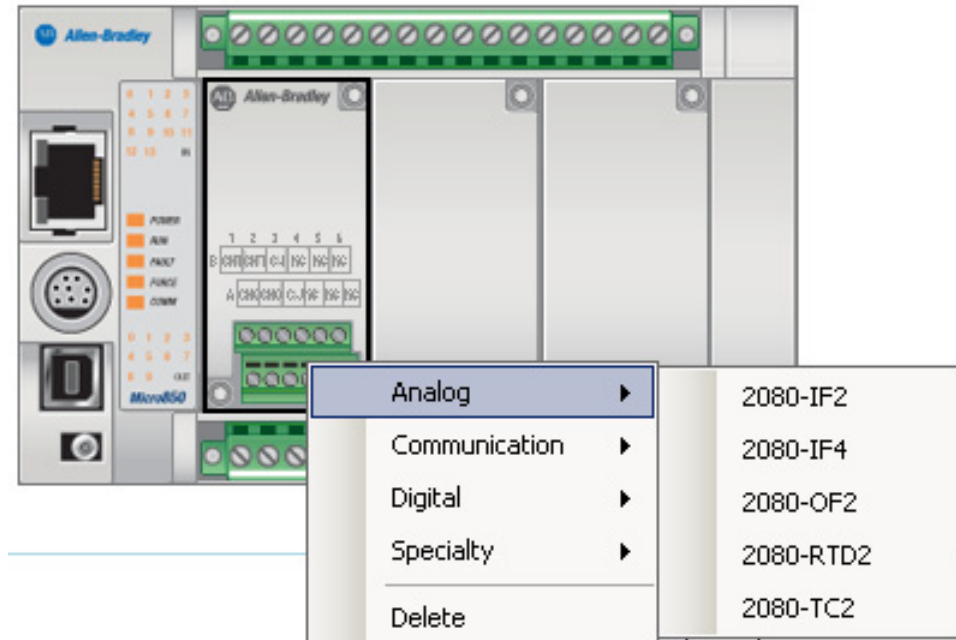
1. To launch the controller configuration screen, double-click Micro850.





- By default, a thermocouple sensor plug-in (2080-TC2) is configured for you in slot 1. Right-click and change the plug-in if you must replace it with an RTD type.

**Note:** If your project is generated by CCAT, you must manually add your temperature sensor plug-in.



- Configure the thermocouple or RTD type based on the temperature sensor you selected for your application.

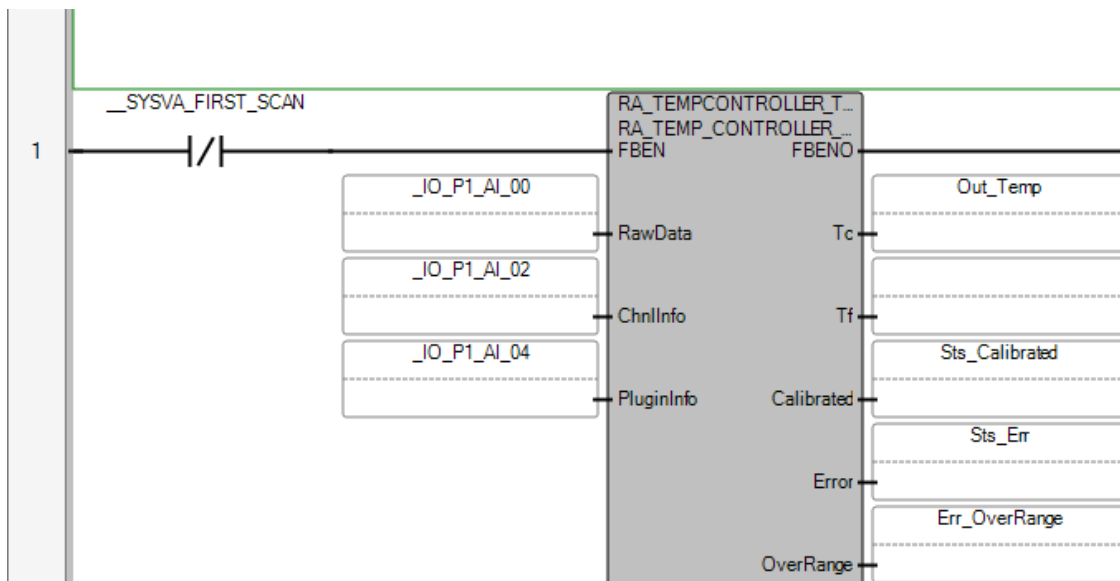
#### 2080-TC2 - Configuration

Channels	
Channel 0	
Thermocouple Type:	Type K
Data Update Rate:	16.7 Hz
Channel 1	
Thermocouple Type:	Type K
Data Update Rate:	16.7 Hz

#### 2080-RTD2 - Configuration

Channels	
Channel 0	
RTD Type:	100 Pt 385
Data Update Rate:	16.7 Hz
Channel 1	
RTD Type:	100 Pt 385
Data Update Rate:	16.7 Hz

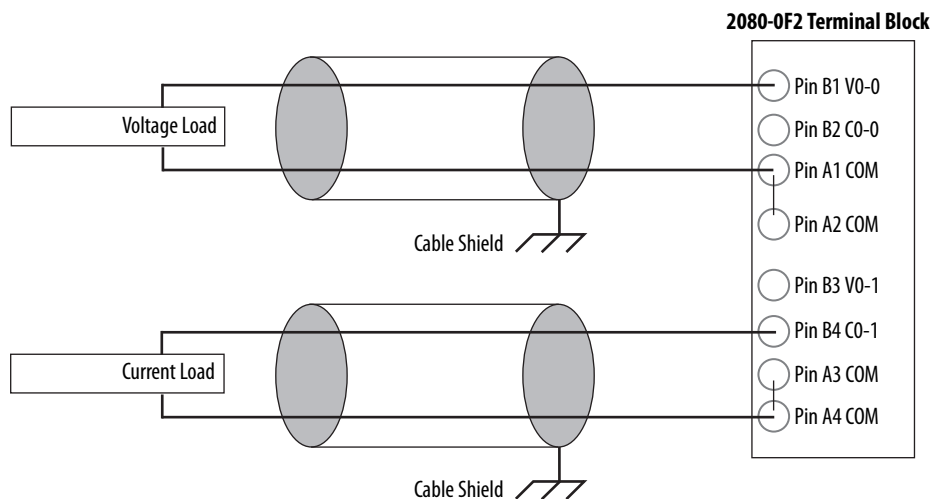
4. To assign your analog input in the program, complete the following steps:
  - a. Double-click the 'TC2\_01' ladder program.
  - b. In rung 1, assign the analog input to the appropriate UDFB input based on the channel information you want to read. For more information, see the Micro800 Plug-in Modules User Manual, publication [2080-UM004](#).



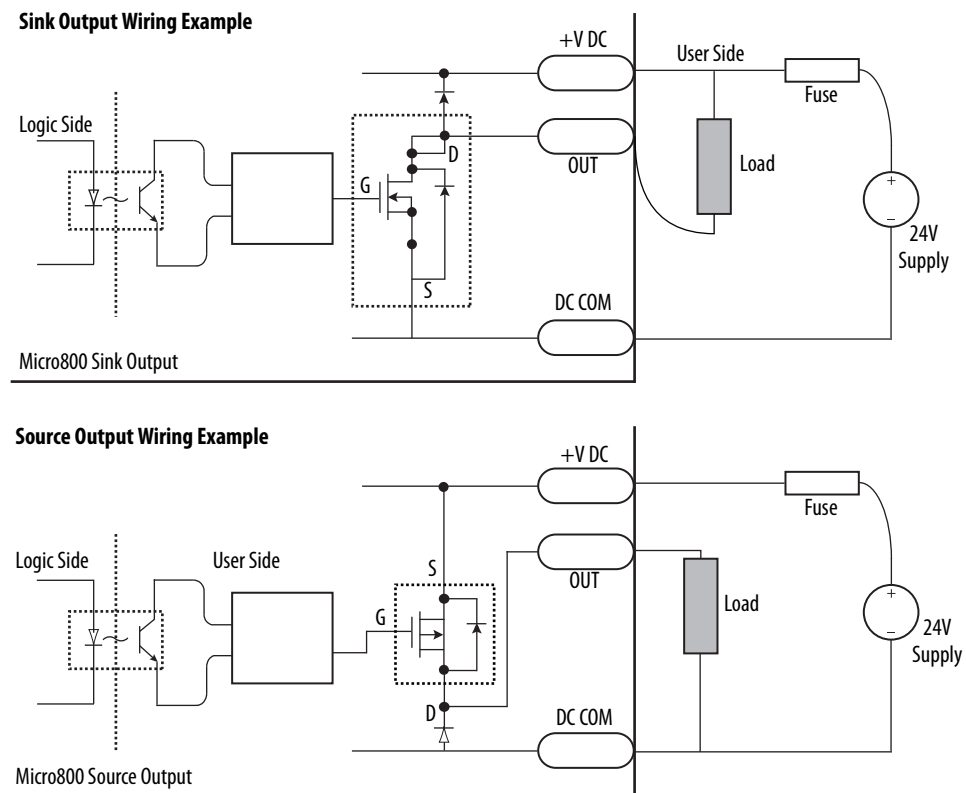
## Wire Your Temperature Control System

This section shows the wiring configuration for both controller output modes and both temperature sensors. This section also provides wiring diagrams for each of them.

**Figure 1 - Wiring Diagram for Analog Output**



Use only ungrounded thermocouples.

**Figure 2 - Wiring Diagram for PWM Output**

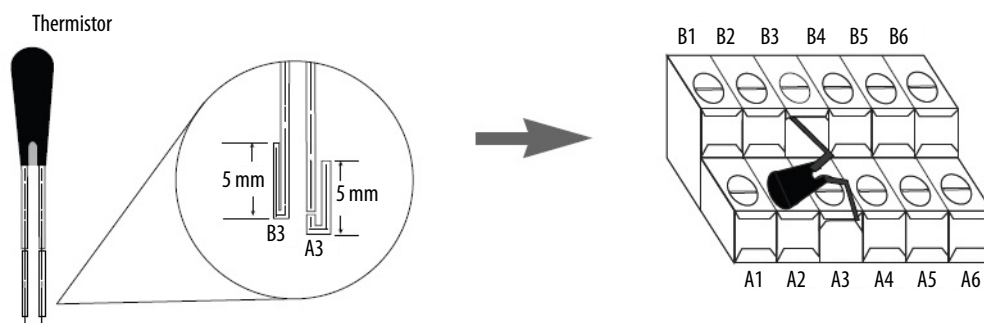
## Wiring Diagram for the 2080-TC2 Thermocouple

The 2080-TC2 thermocouple requires a cold junction compensation (CJC) sensor to function. This sensor is a non-polarized, passive negative temperature co-efficient thermistor (EPCOS B57869S0502F140). It is readily available through most third-party vendors. For further information, see the Micro830 and Micro850 Programmable Controllers User Manual, publication [2080-UM002](#).

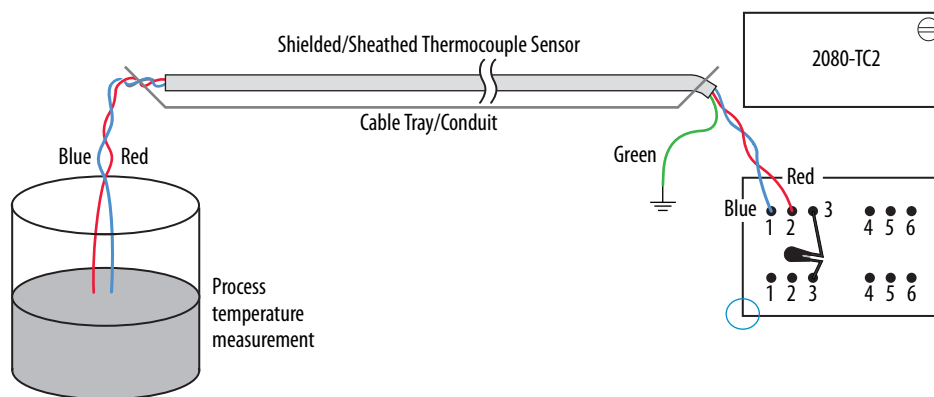
Follow these steps to connect the CJC sensor.

1. Connect the thermocouples to channels 0 and 1, respectively.
2. Connect and screw the thermistor to terminals A3 and B3.
3. Once fitted, bend the black bead of the thermistor so it makes a secure contact with the screw head of terminal A2.
4. With the CJC sensor connected, connect the thermocouple wires directly to the terminal block.

**Figure 3 - Wiring a CJC Thermistor on a 2080-TC2 Thermocouple**



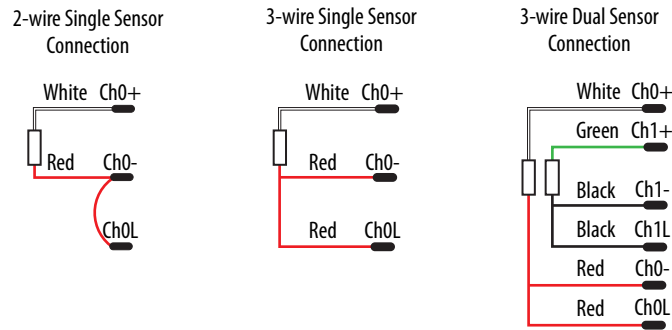
**Figure 4 - 2080-TC2 Direct Sensor Wiring**



## Wiring Diagram for the 2080-RTD Thermocouple

A 2080-RTD thermocouple does not require a CJC sensor. You can connect the RTD wire directly to the input terminal. For further information, see Micro830 and Micro850 Programmable Controllers User Manual, publication [2080-UM002](#).

**Figure 5 - 2080-RTD Sensor Wiring**



**IMPORTANT** The illustration shows channel 0 only for 2-wire and 3-wire single sensor connections. The wire colors illustrate a specific RTD sensor type available in the market.

## **Notes:**

# Validate Your System

This chapter shows you how to configure and connect the devices in your Automated AutoTune Temperature Control Building Block system, and validate that all devices communicate properly with each other.

## Before You Begin

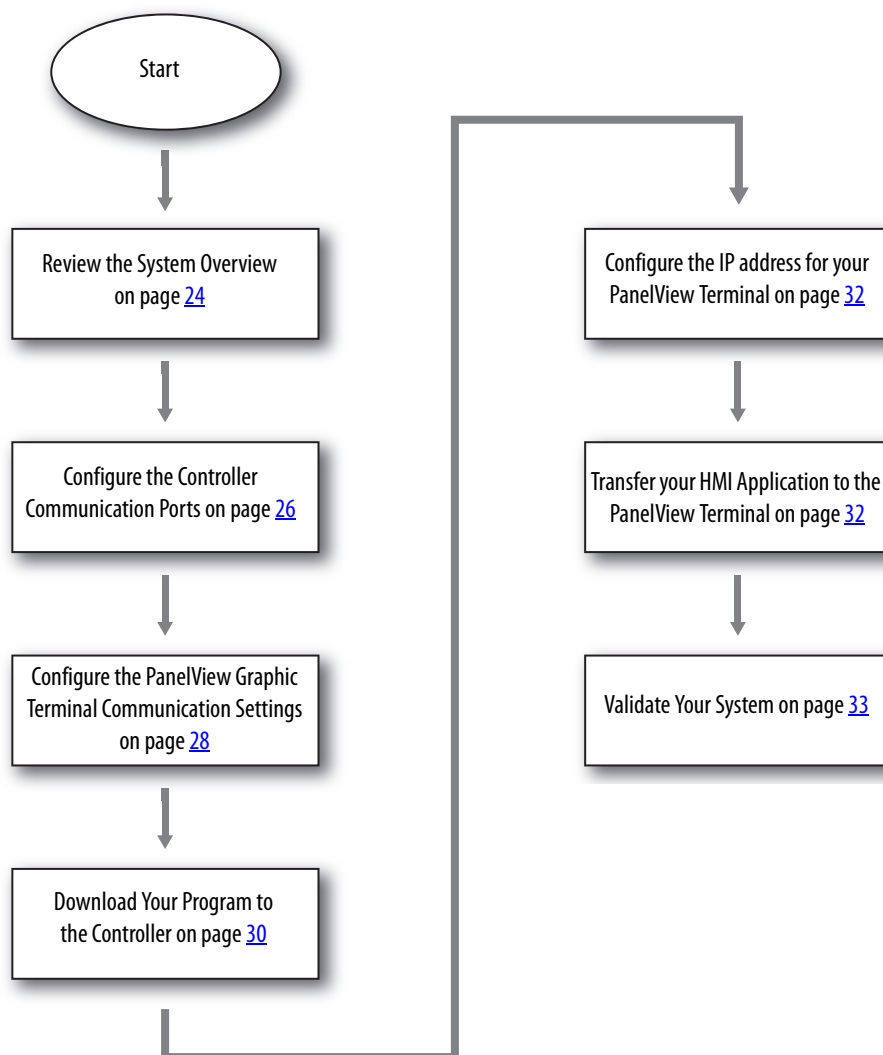
- Complete all steps in [Chapter 1](#).
- Connect the USB cable from your computer to the Micro800® controller.
- Connect the Ethernet cable from your computer to the PanelView™ 800 terminal.
- Set up the IP address of your computer to within the same subnet as your PanelView 800 terminal.
- Power up your Micro800 controller and PanelView 800 terminal.

## What You Need

- Micro800 controller
- 4-in. or larger PanelView 800 terminal
- 1761-CBL-PM02, 9-pin to 8-pin MINI-DIN RS-232 communication cable, if a CIP serial connection for the PanelView Component terminal is used
- USB programming cable (A to B) or Ethernet cable for personal computer to Micro800 controller communication
- Personal computer with available USB port and Ethernet connection with Connected Components Workbench™ software, version 9 or later, installed

## Follow These Steps

Follow these steps to validate your product selection.



## Review the System Overview

The PanelView graphic terminal can be connected to the Micro800 controller with a CIP serial or CIP on Ethernet connection:

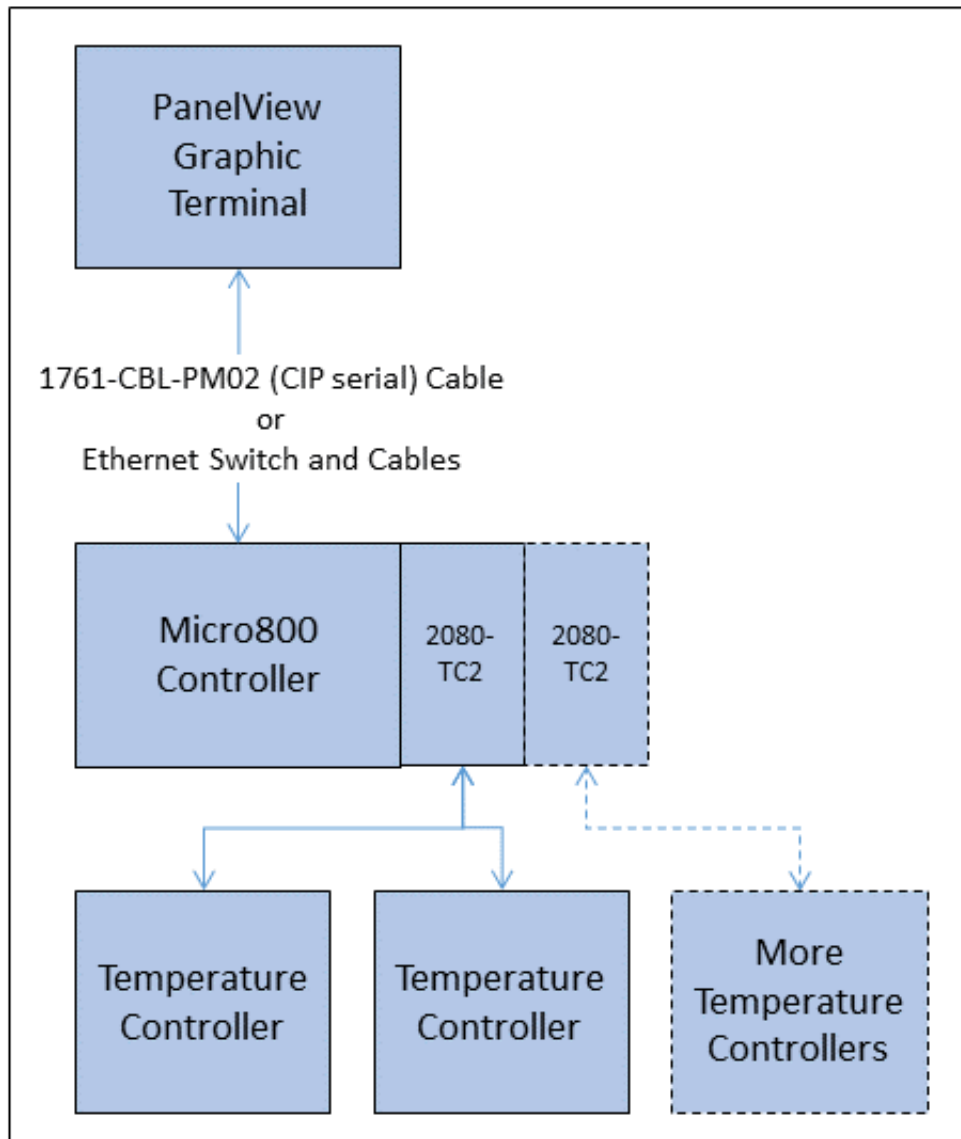
- When a CIP serial connection is used, connect the PanelView graphic terminal to the embedded serial port on the Micro800 controller by using a 1761-CBL-PM02 cable.
- When a CIP on Ethernet connection is used, connect the PanelView graphic terminal to the Stratix® switch and connect the Stratix switch to the embedded Ethernet port on the Micro800 controller by using Ethernet patch cords.

Both methods of connection are explained in this manual, but choose only one method for your project.



You can have multiple temperature-controller building blocks within a Micro800 controller. However, you have to ensure that the controller has the required hardware configuration and sufficient program memory. Typically, a temperature sensor has two identical sensor inputs and you can easily have another temperature control loop with the second sensor terminal.

**Figure 6 - Device Overview**



## Configure the Controller Communication Ports

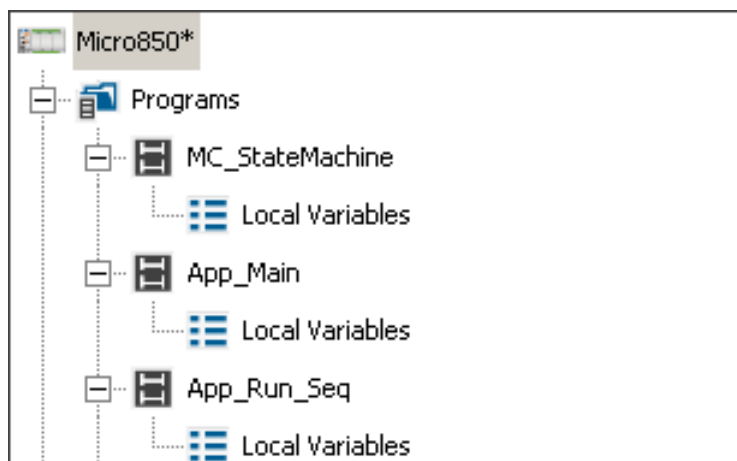
The following settings are used for CIP serial communication.

**Table 1 - CIP Serial Communication Settings**

<b>Embedded Serial Port (to PanelView Component Terminal)</b>	
<b>Setting</b>	<b>Value</b>
Driver	CIP Serial
Baud Rate	38400
Parity	None
Unit Address	1
<b>Advanced Settings</b>	
Error Detection	CRC
Embedded Responses	After One Received
Duplicate Packet Detection	Yes
Ack Timeout (x 20 ms)	50
NAK Retries	3
ENQ Retries	3
Transmit Retries	3
RTS Off Delay	0
RTS Send Delay	0

Follow these steps to modify these settings in the default Connected Components Workbench project:

1. Open the Automated AutoTune TempControl Building Block generated from CCAT or downloaded from the sample code website.
2. In the project Organizer, double-click the controller icon.



This example shows a Micro850® controller. The Controller Detail view appears in the main project window.

3. Configure the settings for your PanelView graphic terminal communication port:
  - a. If a CIP serial connection is used, select the embedded serial port in the controller configuration list and edit the required settings.

- [-] Controller
  - General
  - Memory
  - Startup
  - Serial Port**
  - USB Port
  - Ethernet
  - Interrupts
  - Modbus Mapping
  - Embedded I/O
- [-] Motion
  - < New Axis >
  - < New Axis >
- [-] Plug-in Modules
  - 2080-TC2
  - < Empty >
  - < Empty >
- [-] Expansion Modules
  - < Available >
  - < Available >
  - < Available >
  - < Available >

### Controller - Serial Port

---

**Common Settings**

Driver: CIP Serial ⓘ

Baud Rate: 38400

Parity: None

Station Address: 1

---

**Protocol Control**

DF1 Mode: DF1 Full-Duplex

Media: RS232 | No Handshake

Error Detection: CRC

Embedded Responses: After One Received

☒ Duplicate Packet Detection

ACK Timeout (x20ms): 50 ENQ Retries: 3

NAK Retries: 3 Transmit Retries: 3

- b. If a CIP on Ethernet connection is used, complete the following steps:
  - Select the Ethernet port in the controller configuration list.
  - Click Configure IP address and settings.
  - Edit the IP Address, Subnet Mask, and Gateway Address settings

- [-] Controller
  - General
  - Memory
  - Startup
  - Serial Port
  - USB Port
  - Ethernet**
  - Interrupts
  - Modbus Mapping
  - Embedded I/O
- [-] Motion
  - < New Axis >
  - < New Axis >
- [-] Plug-in Modules
  - 2080-TC2
  - < Empty >
  - < Empty >
- [-] Expansion Modules
  - < Available >
  - < Available >
  - < Available >
  - < Available >

### Controller - Ethernet

ⓘ Diagnose

---

**Internet Protocol (IP) Settings**

☐ Obtain IP address automatically using DHCP

☒ Configure IP address and settings

IP Address: 192 . 168 . 1 . 3

Subnet Mask: 255 . 255 . 255 . 0

Gateway Address: . . .

☒ Detect duplicate IP address

**Port Settings**

Port State: ☒ Enabled ☐ Disabled

☒ Auto-Negotiate Speed and Duplex Mode

## Configure the PanelView Graphic Terminal Communication Settings

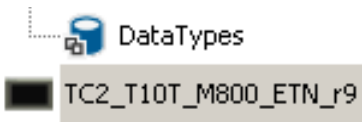
The following settings are used for CIP serial communication.

**Table 2 - Default CIP Serial Communication and Controller Settings**

Driver Configuration	
Protocol	CIP Serial
Port	RS-232
Baud Rate	38400
Data Format: 8-N-1	8-N-1
Flow Control	None
Controller Settings	
Name	PLC-1
Controller Type	Micro800
Address	1

Follow these steps to modify these settings in the default Connected Components Workbench project.

1. Double-click the PanelView terminal device icon



The PanelView Communication Settings pane appears in the main project window.

2. Configure the appropriate communication settings:
  - a. For CIP Serial communication, configure the settings that are shown below.

**Graphic Terminal - General**

Validity: False

Version: 3.011

**Communication**

Protocol: Serial | Allen-Bradley CIP

☐ Use Ethernet Encapsulation

**Controller Settings**

Add Controller Delete Selected Controller(s)

Name	Controller Type	Address	Timing	Auto-Demotion	Description
PLC-1	Micro800	1	...	...	

**PanelView Component Settings**

Write Optimization

- b. For CIP on Ethernet communication, configure the settings as shown in the graphic.

**Graphic Terminal - General**

Validity: True

Version: 3.011

**Communication**

Protocol: Ethernet | Allen-Bradley CIP

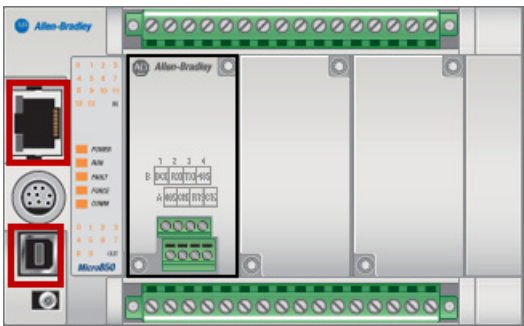
**Controller Settings**

Add Controller Delete Selected Controller(s)

Name	Controller Type	Address	Timing	Auto-Demotion	Description
PLC-1	Micro800	192.168.1.3	...	...	

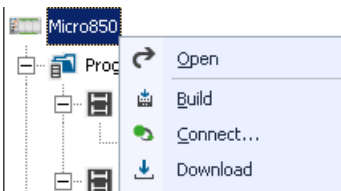
## Download Your Program to the Controller

1. Connect the computer to the controller by using either an Ethernet or USB connection.



If you are prompted to install any driver, use the recommended drivers.

2. In your Connected Components Workbench project, in the Project Organizer, right-click your controller icon and choose Download.



The software automatically builds the program before download. If the build is successful, the Output pane at the bottom of your project window displays a success message. Or, if the build was unsuccessful, an error list appears.

Figure 7 - Example Output Pane: Build Successful

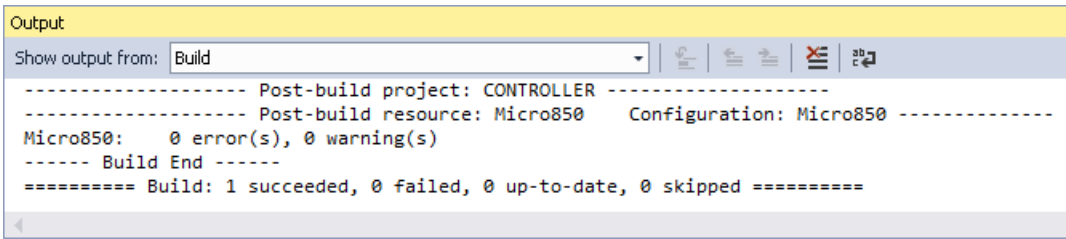
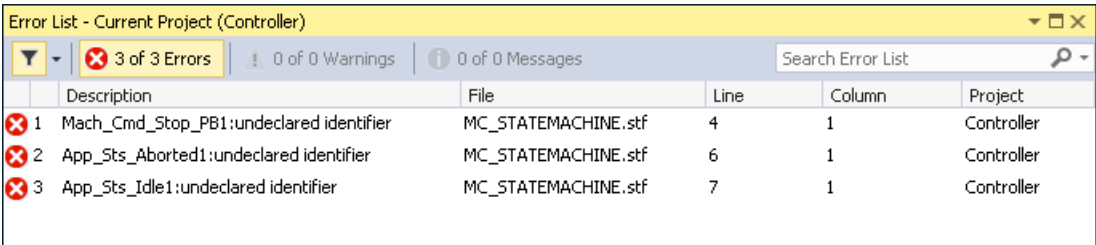
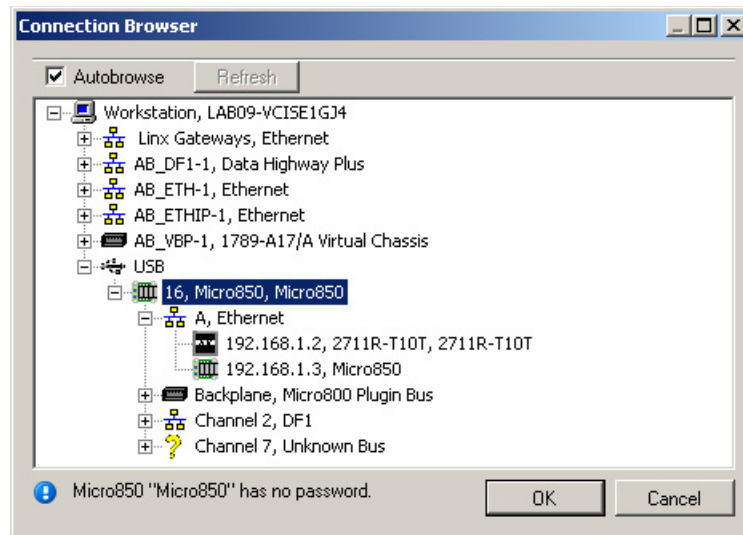


Figure 8 - Example Output Pane: Error List

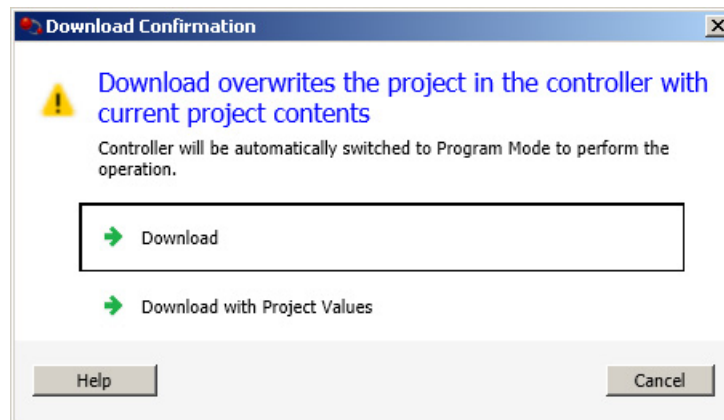


3. If the build is successful, continue to step 7.
4. If the build is unsuccessful, double-click an error description to go to that error.
5. Correct each error.
6. Repeat steps 4 and 5 until the build is successful and then continue to step 7.

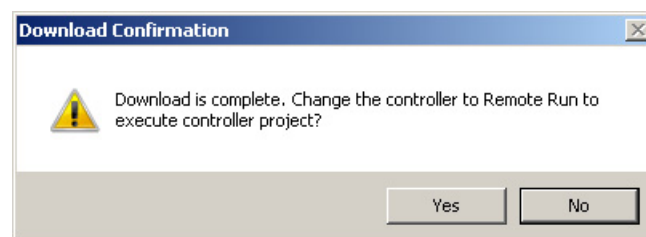
7. The Connection Browser window appears when the build is successful. Select your controller and click OK.



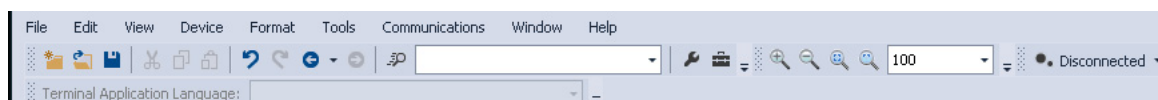
8. The software prompts you to select one of the following download options:
- Download: Download the project with initial values.
  - Download with Project Values: Download project the with project values previously uploaded.



9. If you are prompted to change the controller mode to Remote Program mode, click Yes.



10. When the download is completed, set the controller back to Remote Run mode.  
The controller automatically goes online.



11. Disconnect the controller.

## Configure the IP address for your PanelView Terminal

Follow these steps to configure a static IP address on the PanelView terminal.

1. To open the Communication screen, from the Main menu, press Communication.
2. Press Set Static IP Address.
3. Configure the IP Address and Mask values so they are in the same range as your Micro800 controller.
4. To return to the Main menu, press Main.

## Transfer your HMI Application to the PanelView Terminal

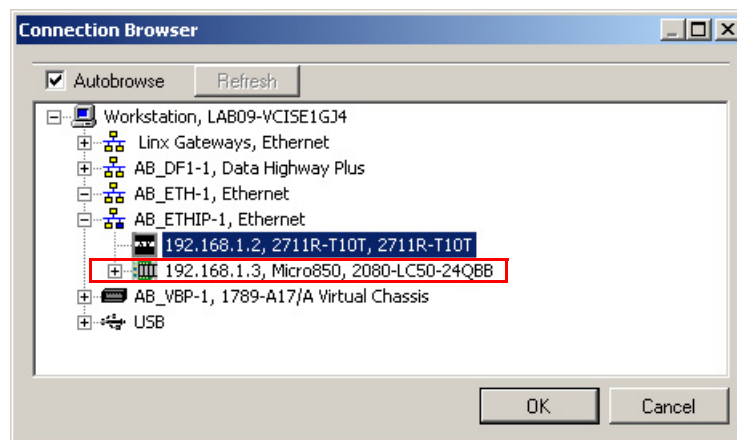
Follow these steps to transfer your HMI application to the PanelView terminal by using Connected Components Workbench software.

1. In the Project Organizer, right-click the PanelView 800 terminal icon and choose Download. If the project is not validated, choose validate before download.



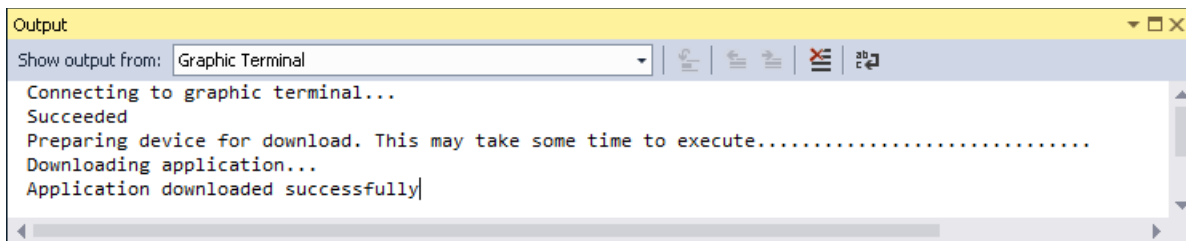
The software validates the application and thereafter, the Connection Browser window appears.

2. Select the PanelView 800 terminal and click OK.





3. Verify that the download completed successfully.



4. From the Main menu of your PanelView 800 terminal, press File Manager.
5. On the File Manager screen, select Internal as your Source.
6. Select your application 'TC2\_T10T\_M800\_ETN\_r9'.
7. Press Run.

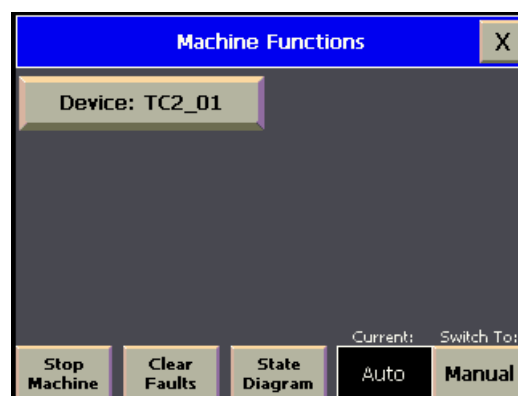
## Validate Your System

In this section, you review the Machine Functions screen and explore the Status and Command screens to test the manual control of the building block.

### Understand the Machine Functions Screen

The Machine Functions screen is the screen that links to all installed building blocks. When this screen is first loaded, you can complete the following tasks:

1. Return to the Machine Overview screen by pressing the 'X' in the upper right-hand corner of the screen.
2. View a device in detail by pressing its button.
3. View the current machine Auto/Manual state.
4. Change the current machine Auto/Manual state.
5. Clear machine faults, start/stop the machine (while in Auto mode) and go to the machine state diagram overview screen.

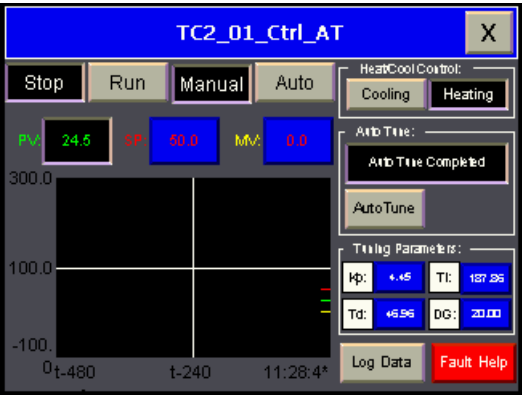


The border of the device button changes color to indicate a specific status. For the Pump Control Building Block, the button border colors indicate the following status:




- Green indicates that the drive is active and running
- Gray indicates that there is no alarm.
- Red indicates that there is a fault or an alarm is present.

Understand the Control and Auto Tune screen

This screen allows you to use the basic and advanced features of the temperate controller building block. Basic operations include, changing temperature controller mode or control direction, and adjusting setpoint or control output. Advanced operations include, auto tuning, manual tuning, and logging trend data onto the SD card.



Screen Element	Name	Description
	X	Back one screen
	Run	Press Run to run the temperature controller
	Stop	Press Stop to stop the temperature controller. When stopped, temperature controller is put into manual mode.
	Auto	Press Auto to set the temperature controller in auto mode. When temperature controller is in Auto mode, the PID loop controls the control value (CV)
	Manual	Press Manual to set the temperature controller in manual mode. When temperature controller is in manual mode, the operator control the control value via the manipulated value (MV)
	Cooling	Press to set to cooling operation
	Heating	Press to set to heating operation
	PV (Green line)	Process Value (Measured Temperature)
	SP (Red line)	Temperature Set Point
	MV	Manipulated value. The operator manually controls the output when the temperature controller is set to auto mode.
	CV (Yellow line)	Control value. This is the output of the PID loop when temperature controller is set to auto mode.

Screen Element	Name	Description
	AutoTune	Press to activate auto tune
	Cancel	Press to cancel auto tune
	Kp	Set Proportional Gain (P). This parameter can only be set when machine is in manual mode
	Ti	Set Time Integral (I). This parameter can only be set when machine is in manual mode
	Td	Set Time derivative (D). This parameter can only be set when machine is in manual mode
	DG	Set Derivative gain (Act as the effect for D). This parameter can only be set when machine is in manual mode
	Log Data	Press to log chart data
	Fault Help	Press to go to Fault Help screen

## Understand the Fault Help screen

This screen provides diagnostic status. If there is any issue with temperature sensors, it is reported here.

**TC2\_01: Fault Help** X

Fault #0 Unused	Fault #1 Unused	Fault #2 Unused	Fault #3 Unused	Fault #4 Data Not Rdy	Fault #5 Open Circuit
Fault #6 Temp Under Range	Fault #7 Temp Over Range	Fault #8 Unsueld	Fault #9 Unsueld	Fault #10 Calibration Failed	Fault #11 CJC Not Connected
Fault #12 Sys Under Temp	Fault #13 Sys Over Temp	Fault #14 Configuration Error	Fault #15 Unused		

Fault type:	Description	Action
No Fault	No Fault	No Fault

The top half of the screen displays indicators that turn red when the specific error occurs. The bottom half is the fault description and the possible action you can take to rectify the error. If there are multiple errors, tap the blue button to navigate through the fault messages. When the error is cleared, the indicator becomes gray again.

## Verify the Control and Auto Tune screen

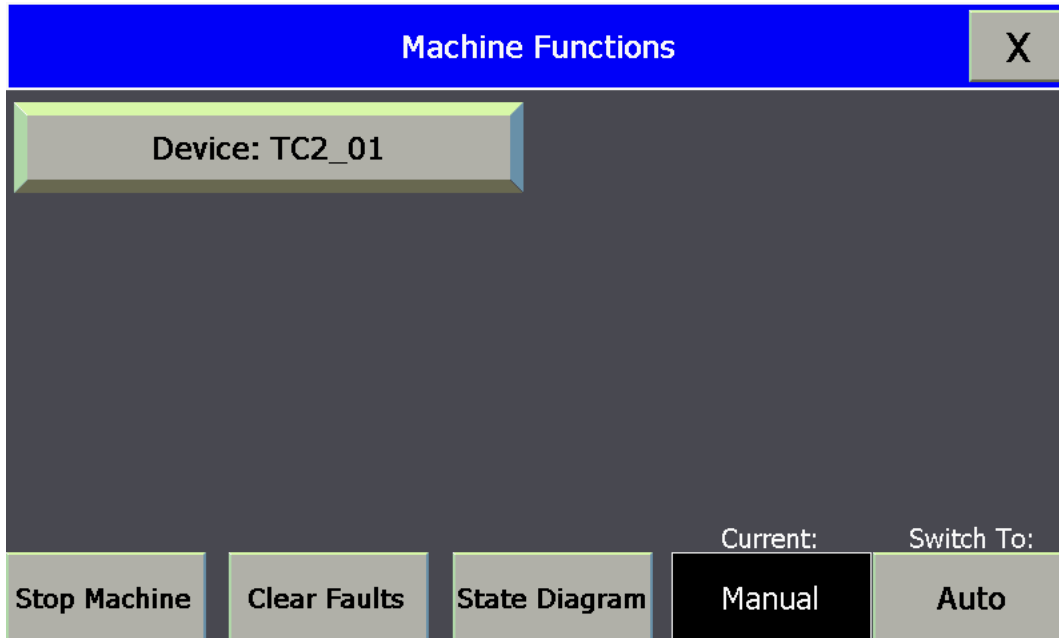
The building block has a machine auto mode/ machine manual mode and temperature controller auto mode/ temperature controller manual mode.

Machine auto/ manual mode switches between a fully automated program that uses the application sequences and manual control of the individual building block.

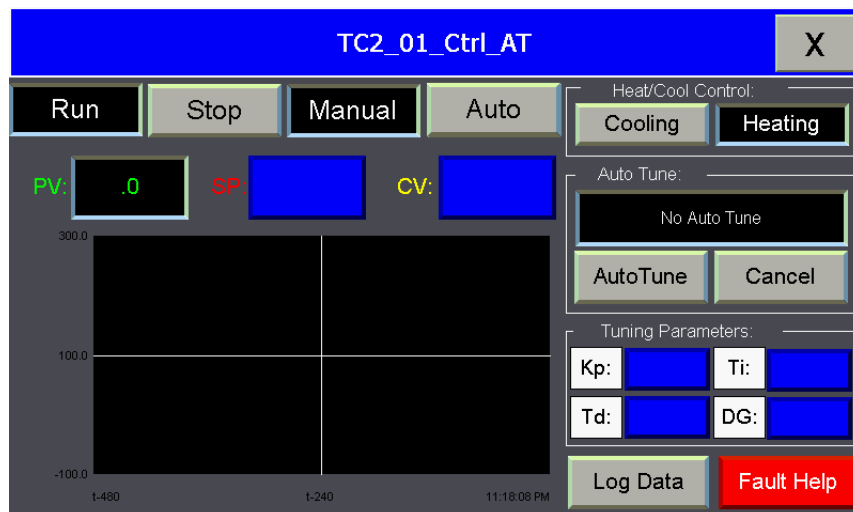
Temperature control auto/manual mode switches between the PID loop and the operator controlling the Control Value.

To auto tune with the temperature control building block:

1. Go to the Machine Functions screen

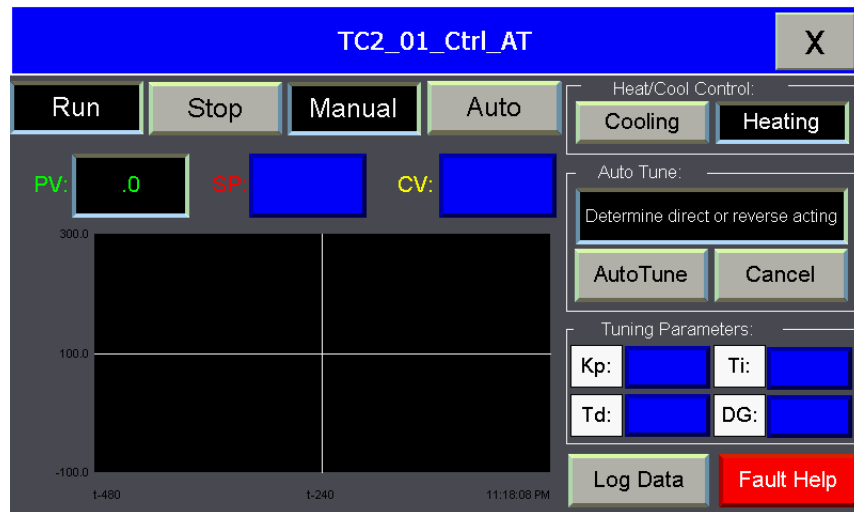


2. Set to Machine manual mode.
3. To access the Control and Auto Tune Screen, press the TC2\_01\_Ctrl\_AT button.
4. To enter the temperature control in Run mode, press Run.



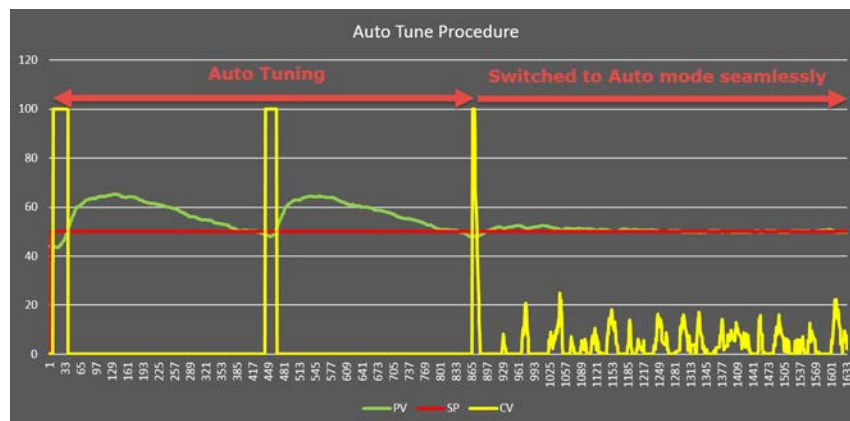
5. Ensure that the Temperature Controller is in Manual mode.
6. Enter a target Set Point for your auto tune.

- Press Auto Tune.



The auto tune status bar displays the state of auto tune. When auto tune is completed, you should get a set of PID parameters.

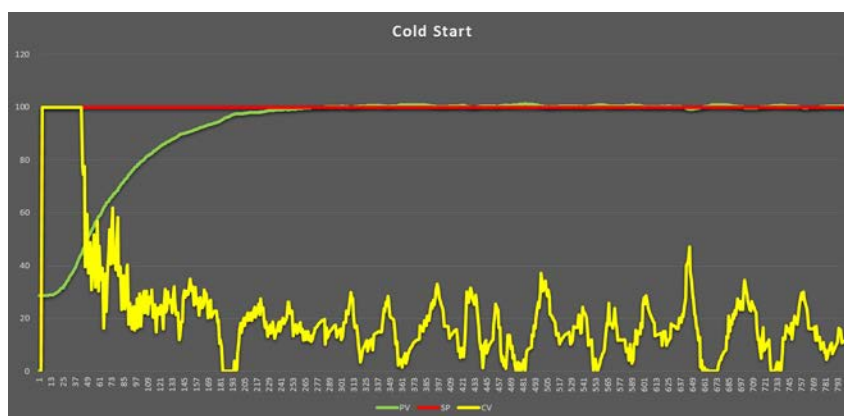
- The temperature controller is set to auto mode when auto tune is completed.



## Cold Start Your Temperature Control System

- Ensure that your temperature controller is running.
- Ensure that the temperature controller is in Auto mode.
- Ensure that the tuning parameters are proper.

4. Set a new temperature set point.



## User-defined Function Blocks for TempControl BB

This appendix describes the available user-defined function blocks and the associated inputs and outputs.

### RA\_TEMP\_CONTROLLER Function Block

Figure 9 - RA\_TEMP\_CONTROLLER Function Block

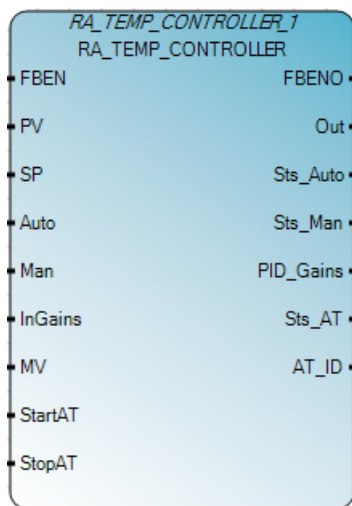


Table 3 - RA\_TEMP\_CONTROLLER Inputs

FB Input	Data Type	Description
FBEN	BOOL	Activate autotune process.
PV	REAL	Scaled temperature value.
SP	REAL	Scaled temperature setpoint. Setpoint is required in auto mode and during autotuning. Avoid autotuning at 0.0 degrees, the UDFB use this as an indication that user forgot to set SP for autotune. If you need to autotune at 0.0, set the next closest value that you can accept (for example, 0.001).
Auto	BOOL	Upon rising edge, set the UDFB to Auto mode. This bit is activated upon rising edge (FALSE -> TRUE).
Man	BOOL	This bit is activated upon rising edge (FALSE -> TRUE). Upon rising edge, set the UDFB to Manual mode.
InGains	GAIN	Manual input for gains parameter for manual tuning. For information about autotuning, see the section titled <a href="#">Autotune Procedure on page 40</a> .
MV	REAL	Manipulated value for 'Out' when in Manual mode.
StartAT	BOOL	This bit is activated upon rising edge (FALSE -> TRUE). Upon rising edge, start autotune.
StopAT	BOOL	This bit is activated upon rising edge (FALSE -> TRUE). Upon rising edge, stop autotune.

**Table 4 - RA\_TEMP\_CONTROLLER Outputs**

FB Output	Data Type	Description
FBENO	BOOL	This bit is TRUE when the function block is enabled.
Output	REAL	Control Value of the temperature controller. The value is between 0 – 100%.
Sts_Auto	BOOL	TRUE: Temperature controller is in Auto mode. FALSE: Temperature controller is not in Auto mode.
Sts_Man	BOOL	TRUE: Temperature controller is in Manual mode. FALSE: Temperature controller is not in Manual mode.
PID_Gains	GAIN	The gain parameters running in the PID loop. When autotune is successful, this is updated with the new gains value.
Sts_AT	BOOL	TRUE: Autotuning in process.
AT_ID	INT	-2: Autotune unable to continue because the Auto tune SP is 0.0. 0: No autotune. 1: Determine process direction. 10: Reverse process- Waiting for temperature > Setpoint. 11: Reverse process- Waiting for temperature < Setpoint. 12: Reverse process- Waiting for temperature > Setpoint. 13: Reverse process- Waiting for temperature < Lower Limit. 20: Direct process- Waiting for temperature < Setpoint. 21: Direct process- Waiting for temperature > Setpoint. 22: Direct process- Waiting for process value < Setpoint. 23: Direct process- Waiting for process value > Upper limit. 99: Autotune Completed.

## Autotune Procedure

It is important that you understand the autotune procedure before you use it. You must also verify that it is safe for your process to operate under the autotune procedures.

1. Check that SP is not '0.0'. If you must tune for 0.0 degrees Celsius, use the next closest value that you can accept (for example, 0.001).
2. Output is set to 100% when autotune is activated.
3. The direction of the process is determined.
4. When PV exceeds the targeted SP, Output is set to 0%.
5. When PV rebounds and passes the SP, Output is set to 100% again.
6. When PV exceeds the targeted SP, Output is set to 0%.
7. When PV rebounds and passes the SP again, autotune is completed.
8. The new gain is updated internally.
9. The controller switches to auto mode and the PID loop is in operation with the auto-tuned gains.



## How to Autotune with the RA\_Temp\_Controller

1. Enable the UDFB by setting 'FBEN' to TRUE.
2. Verify that the value in PV shows a reasonable temperature value.
3. Enter the targeted temperature that you want to tune for in SP.

**Note:** The autotune process does not work with  $SP = 0.0$ . If your targeted temperature is 0.0, use the next closest value that you can accept (for example, 0.001).

4. Verify the UDFB is in Manual mode by verifying Sts\_Man is TRUE.

If otherwise, set Man to TRUE.

5. Verify that the Output is connected to an actuator that provides heating or cooling to your process.

You can determine this by adjusting the MV upwards and observing the PV behavior. If the PV did not respond, or responded in an opposite manner, you have to check your configuration.

6. Activate autotune when your system is in place by setting StartAT to TRUE.
7. See [Table 4](#) for more information about the descriptions for AT\_ID.
8. When AT\_ID is 99 (Auto Tune Completed), the controller is switched to Auto with the updated gains parameter.
9. PID\_Gains shows the values that are used in the current PID loop.

## RA\_TEMP\_CONTROLLER\_TC\_RTD Function Block

Figure 10 - RA\_TEMP\_CONTROLLER\_TC\_RTD Function Block

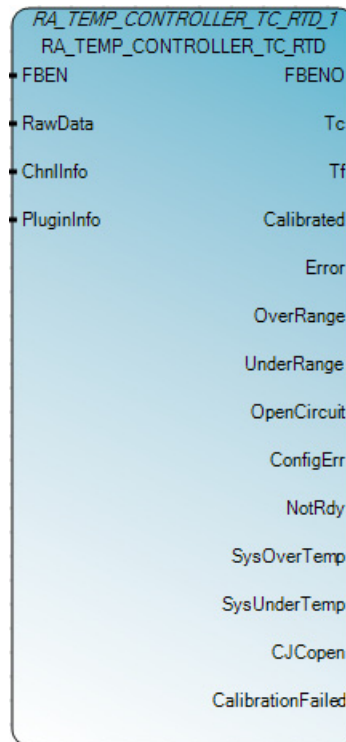


Table 5 - RA\_TEMP\_CONTROLLER\_TC\_RTD Inputs

FB Input	Data Type	Description
FBEN	BOOL	Set this bit TRUE to enable the function block.
RawData	UINT	Assign the raw data of the analog input that represents the temperature.
ChnlInfo	UINT	Assign the analog input that provides channel information.
PluginInfo	UINT	Assign the analog input that provides plugin or system information.

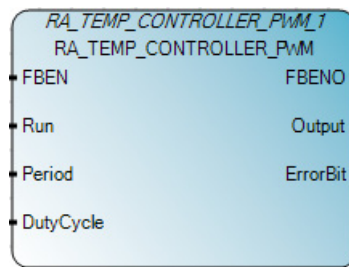
Table 6 - RA\_TEMP\_CONTROLLER\_TC\_RTD Outputs

FB Output	Data Type	Description
FBENO	BOOL	This bit is TRUE when the function block is enabled.
Tc	REAL	Scaled temperature value in Degree Celsius.
Tf	REAL	Scaled temperature value in Degree Fahrenheit.
Calibrated	BOOL	This bit is TRUE when temperature data is calibrated by the system calibration coefficient.
Error	BOOL	This bit is TRUE when the Plugin encounter error.
OverRange	BOOL	This bit is TRUE when there is an overrange on channel input. The Channel Temperature Data shows maximum temperature count for individual type of sensor that is used and the value does not change until overrange error is clear.
UnderRange	BOOL	This bit is TRUE when there is an underrange on channel input. The Channel Temperature Data shows minimum temperature count for individual type of sensor that is used and the value does not change until underrange error is clear.
OpenCircuit	BOOL	This bit is TRUE when there is an open-circuit on the channel input sensor.
ConfigErr	BOOL	This bit is TRUE when there is an unknown sensor type or rate error configured.
NotRdy	BOOL	This bit is TRUE when the channel data field is illegal and cannot be used. This bit is set when temperature data is not ready for use.

**Table 6 - RA\_TEMP\_CONTROLLER\_TC\_RTD Outputs (continued)**

FB Output	Data Type	Description
SysOverTemp	BOOL	This bit is TRUE when there is a system overrange error with environment temperature over 70 °C.
SysUnderTemp	BOOL	This bit is TRUE when there is a system underrange error with environment temperature under -20 °C.
CJCopen	BOOL	This bit is TRUE when the CJC sensor is not connected to thermocouple module, open circuit. This bit is for thermocouple module only.
CalibrationFailed	BOOL	This bit is TRUE when the module is not accurate. This bit is set to 0 by default and should remain as 0. Contact Technical Support when the value is otherwise.

## RA\_TEMP\_CONTROLLER\_PWM Function Block

**Figure 11 - RA\_TEMP\_CONTROLLER\_PWM Function Block****Table 7 - RA\_TEMP\_CONTROLLER\_PWM Inputs**

FB Input	Data Type	Description
FBEN	BOOL	Set this bit TRUE to enable the function block.
Run	BOOL	Set this bit TRUE to activate the PWM function.
Period	TIME	Set the duration for one cycle time.
DutyCycle	REAL	Set the duty cycle on-time.

**Table 8 - RA\_TEMP\_CONTROLLER\_PWM Outputs**

FB Output	Data Type	Description
FBENO	BOOL	This bit is TRUE when the function block is enabled.
Output	BOOL	This is the ON/Off output of the PWM module.
Errorbit	Bool	This bit is TRUE when there is an illegal setting in the input side of the UDFB.

## **Notes:**

## Global Variables

These global variables are for machine auto mode. The temperature controller operates based on the value in these variables.

**Table 9 - Global Variables Used for Machine Auto Mode**

Variable	Data Type	Description
TC2_01_Cmd_SP_Auto	REAL	Command Set Point.
TC2_01_Cmd_Auto_Auto	BOOL	Command input to set temperature controller to auto mode.
TC2_01_Cmd_Man_Auto	BOOL	Command input to set temperature controller to manual mode.
TC2_01_Cmd_MV_Auto	REAL	Command Manipulated Value for controlling the control value during temperature controller Auto mode.
TC2_01_Cmd_Run_Auto	BOOL	Trigger to run temperature controller .
TC2_01_Cmd_Stop_Auto	BOOL	Trigger to stop temperature controller.
TC2_01_Cmd_Abort_Auto	BOOL	Trigger to abort autotune.
TC2_01_Cfg_Gains	GAIN_PID	Gain setting for temperature controller.
TC2_01_Cfg_Datalog	BOOL	Set to TRUE to enable data logging.
TC2_01_Out_Temp	REAL	Scaled temperature value.
TC2_01_Out_CV	REAL	PID Control Value.
TC2_01_Sts_Man	BOOL	When TRUE indicates that the controller is in manual mode.
TC2_01_Sts_Auto	BOOL	When TRUE indicate that controller is in auto mode.
TC2_01_Sts_Stop	BOOL	When TRUE indicate that controller is stopped.
TC2_01_Sts_Run	BOOL	When TRUE indicate that controller is running.
TC2_01_Sts_AT	BOOL	When TRUE indicate that autotune is in progress.
TC2_01_Sts_AT_ID	INT	Indicate the autotune status.
TC2_01_Sts_Logging	BOOL	When TRUE indicate that trend data is being logged.

**Table 9 - Global Variables Used for Machine Auto Mode (continued)**

Variable	Data Type	Description
TC2_01_Sts_Err	BOOL	When TRUE indicates that a temperature control error occurred.
TC2_01_Sts_SP	REAL	Indicate the set point.
TC2_01_Err_Sts/ TC2_01_Err_Code	UINT	Bit fault. Bit 0: Unused. Bit 1: Unused. Bit 2: Unused. Bit 3: Unused. Bit 4: Data not ready. Bit 5: Open circuit. Bit 6: Temp Under Range. Bit 7: Temp Over Range. Bit 8: Unused. Bit 9: Unused. Bit 10: Calibration Fault. Bit 11: CJC not connected. Bit 12: Sys under -20 Degree Celsius. Bit 13: Sys over 70 Degree Celsius. Bit 14: Configuration Error. Bit 15: Unused.



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Use the following resources to access support information.

<b>Technical Support Center</b>	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	<a href="https://rockwellautomation.custhelp.com/">https://rockwellautomation.custhelp.com/</a>
<b>Local Technical Support Phone Numbers</b>	Locate the phone number for your country.	<a href="http://www.rockwellautomation.com/global/support/get-support-now.page">http://www.rockwellautomation.com/global/support/get-support-now.page</a>
<b>Direct Dial Codes</b>	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	<a href="http://www.rockwellautomation.com/global/support/direct-dial.page">http://www.rockwellautomation.com/global/support/direct-dial.page</a>
<b>Literature Library</b>	Installation Instructions, Manuals, Brochures, and Technical Data.	<a href="http://www.rockwellautomation.com/global/literature-library/overview.page">http://www.rockwellautomation.com/global/literature-library/overview.page</a>
<b>Product Compatibility and Download Center (PCDC)</b>	Get help determining how products interact, check features and capabilities, and find associated firmware.	<a href="http://www.rockwellautomation.com/global/support/pcdc.page">http://www.rockwellautomation.com/global/support/pcdc.page</a>

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

**[www.rockwellautomation.com](http://www.rockwellautomation.com)**

### Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444

Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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