

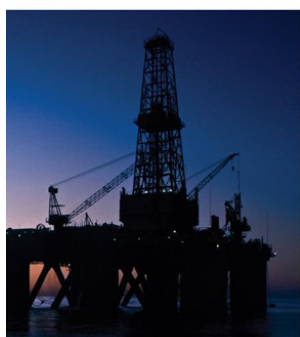
Reference Manual

Original Instructions

**PlantPAx**  
Distributed Control System

# Rockwell Automation Library of Steam Table Instructions

Version 4.0



## 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.



**WARNING:** 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.



**ATTENTION:** 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.

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### IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

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



**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.



**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.



**ARC FLASH HAZARD:** 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).

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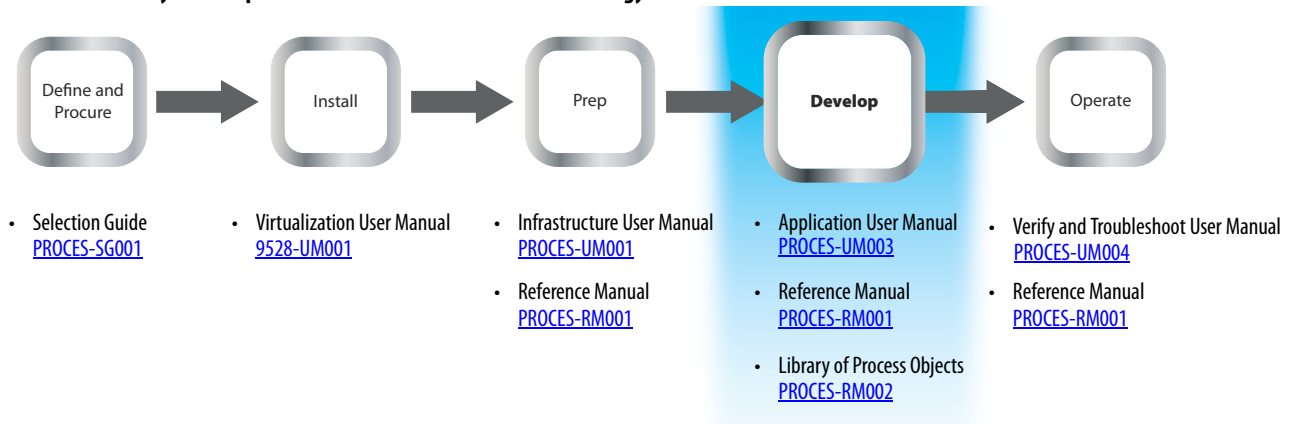
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The Rockwell Automation® Library of Steam Table Instructions is an extension of the Rockwell Automation Library of Process Instructions to provide steam table calculations. The Steam Table instructions can be used to calculate enthalpy, entropy, and specific volume for steam as well as temperature or pressure in saturated steam, in accordance with the International Association for the Properties of Water and Steam Industrial Formulation 1997 (IAPWS-IF97).

**Figure 1 - PlantPAx System Implementation and Documentation Strategy**



- **Define and Procure** – Helps you understand the elements of the PlantPAx system to make sure that you buy the proper components.
- **Install** – Provides direction on how to install the PlantPAx system.
- **Prep** – Provides guidance on how to get started and learn the best practices to follow before you develop your application.
- **Develop** – Describes the actions and libraries necessary to construct your application that resides on the PlantPAx system.
- **Operate** – Provides guidance on how to verify and maintain your systems for operation of your plant.

For the latest compatible software information and to download the Rockwell Automation Library of Logix Diagnostic Objects, see the Product Compatibility and Download Center at <http://www.rockwellautomation.com/rockwellautomation/support/pcdc.page>.

For general library considerations, see Rockwell Automation Library of Process Objects, publication [PROCES-RM002](#).

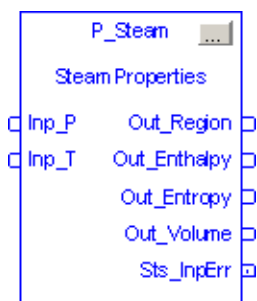
## Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
PlantPAx® Distributed Control System Selection Guide, publication <a href="#">PROCES-SG001</a>	Provides information to assist with equipment procurement for your PlantPAx system.
PlantPAx Distributed Control System Reference Manual, publication <a href="#">PROCES-RM001</a>	Provides characterized recommendations for implementing your PlantPAx system.
Logix5000™ Controllers Add-On Instructions Programming Manual, publication <a href="#">1756-PM010</a>	Provides information for designing, configuring, and programming Add-On Instructions.
Rockwell Automation Library of Process Objects: Basic Analog Input (P_Aln) Reference Manual, publication <a href="#">SYSLIB-RM001</a>	Provides details on the Basic Analog Input (P_Aln) instructions for a Logix-based controller.

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.

## General Steam Table (P\_Steam)



The P\_Steam (General Steam Table) Add-On Instruction calculates the enthalpy, entropy, and specific volume for steam (or water) at the given pressure and temperature.

Steam properties are calculated in accordance with the International Association for the Properties of Water and Steam Industrial Formulation 1997 (IAPWS-IF97).

The table shows the allowable input range.

Temperature		Pressure	
Min	Max	Min	Max
0.0 °C (32.0 °F)	800.0 °C (1472 °F)	0.0 MPa (0.0 psia)	100.0 MPa (14503.77 psia)
0.0 °C (32.0 °F)	2000 °C (3632 °F)	0.0 MPa (0.0 psia)	50 MPa (7251.885 psia)

### Guidelines

Use this instruction when you have measured or calculated the temperature and pressure of steam and you need to know the steam's enthalpy, entropy, or specific volume. (Specific volume is the inverse of density.)

Do **not** use this instruction in these situations:

- You are working with a substance other than liquid water or vapor (steam).
- You are working outside the range of validity for this instruction.

### Functional Description

The steam table instructions are **calculation functions only**, and no HMI components are provided. If a faceplate or graphic symbol (bar, trend, numeric display) or alarms are required for a calculated variable, send the variable to a P\_AIn (Analog Input) instruction for display and alarming.

## Controller Code

This section describes the parameter references for this Add-On Instruction.

### General Steam Table Input Structure

Input parameters include the following:

- Input data elements (Inp\_) are typically used to connect field inputs from I/O modules or signals from other objects.
- Configuration data elements (Cfg\_) are used to set configurable capabilities and features of the instruction.

**Table 1 - P\_Steam Input Parameters**

Input Parameter	Data Type	Default	Description
EnableIn	BOOL	1	<b>Ladder Diagram:</b> If the rung-in condition is true, the instruction's Logic routine executes. If the rung-in condition is false, the instruction's EnableInFalse routine executes. <b>Function Block Diagram:</b> If true, or not connected, the instruction's Logic routine executes. If the parameter is exposed as a pin and wired, and the pin is false, the instruction's EnableInFalse routine executes. <b>Structured Text:</b> No effect. The instruction's Logic routine executes.
Inp_P	REAL	14.696	Input steam pressure (absolute) (MPa or psia).
Inp_T	REAL	212	Input steam temperature (°C or °F).
Cfg_SI_Eng	BOOL	1	1 = English units (psia, °F, BTU, ft <sup>3</sup> , lbm). 0 = SI units (MPa, °C, kJ, m <sup>3</sup> , kg).

### General Steam Table Output Structure

Output parameters include the following:

- Output data elements (Out\_) are the primary outputs of the instruction, typically used by hardware output modules; however, they can be used by other application logic.
- Status data elements (Sts\_) are bit outputs of the instruction for use by the HMI. Status bits can also be used by other application logic.

**Table 2 - P\_Steam Output Parameters**

Output Parameter	Data Type	Description
EnableOut	BOOL	Enable output: System defined parameter.
Out_Region	DINT	1 = Liquid 2 = Superheated 3 = Supercritical 4 = Saturated 5 = HighTemp
Out_Enthalpy	REAL	Enthalpy (kJ/kg or BTU/lbm).
Out_Entropy	REAL	Entropy (kJ/kg K or BTU/lbm F).
Out_Volume	REAL	Specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm).
Sts_InpErr	BOOL	Error: Input pressure/temperature is outside of calculation range.



## Operations

The P\_Steam Add-On Instruction only performs calculations and does not have any modes or alarms.

To provide High-High, High, Low, and/or Low-Low threshold alarms for any of the variables (enthalpy, entropy, and specific volume), use a P\_AIn Input instruction for each such variable.

Refer to the Rockwell Automation® Library of Process Objects: Basic Analog Input (P\_AIn) Reference Manual, publication [SYSLIB-RM001](#), for more information.

## Execution

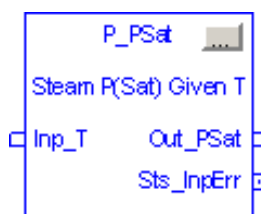
The following table explains the handling of instruction execution conditions.

Condition	Description
EnableIn False (false rung)	No EnableInFalse logic is provided. The instruction maintains its last state when EnableIn is false.
Powerup (prescan, first scan)	No Prescan or First Scan logic is provided. The P_Steam instruction performs its calculation every scan when EnableIn is true.
Postscan	No SFC Postscan logic is provided.

Refer to the Logix 5000™ Controllers Add-On Instructions Programming Manual, publication [1756-PM010](#), for more information.

## **Notes:**

## Saturated Steam Pressure (P\_PSat)



This instruction calculates the Absolute Pressure (in MPa or psia) of Saturated Steam given the temperature (in degrees Celsius or Fahrenheit). This instruction also reports the enthalpy, entropy, and specific volume for liquid and (saturated) vapor at the given temperature.

Saturation curve and properties are calculated in accordance with the International Association for the Properties of Water and Steam Industrial Formulation 1997 (IAPWS-IF97).

The table shows the allowable temperature range.

Temperature	
Min	Max
0.0 °C (32.0 °F)	373.946 °C (705.1028 °F)

### Guidelines

Use this instruction when you have measured or calculated the temperature of steam and you need to know the corresponding pressure of saturated steam. This instruction also provides the enthalpy, entropy, and specific volume of liquid water and of saturated steam vapor at the given temperature.

Do **not** use this instruction in these situations:

- You are working with a substance other than liquid water or vapor (steam).
- You are working outside the range of validity for this instruction.

### Functional Description

The P\_PSat instruction is a **calculation function only**, and no HMI components are provided. If a faceplate or graphic symbol (bar, trend, numeric display) or alarms are required for a calculated variable, send the variable to a P\_AIn (Analog Input) instruction for display and alarming.

## Controller Code

This section describes the parameter references for this Add-On Instruction.

### Saturated Steam Pressure Input Structure

Input parameters include the following:

- Input data elements (Inp\_) are typically used to connect field inputs from I/O modules or signals from other objects.
- Configuration data elements (Cfg\_) are used to set configurable capabilities and features of the instruction.

**Table 3 - P\_PSat Input Parameters**

Input Parameter	Data Type	Default	Description
EnableIn	BOOL	1	<b>Ladder Diagram:</b> If the rung-in condition is true, the instruction's Logic routine executes. If the rung-in condition is false, the instruction's EnableInFalse routine executes. <b>Function Block Diagram:</b> If true, or not connected, the instruction's Logic routine executes. If the parameter is exposed as a pin and wired, and the pin is false, the instruction's EnableInFalse routine executes. <b>Structured Text:</b> No effect. The instruction's Logic routine executes.
Inp_T	REAL	212	Input steam temperature (°C or °F).
Cfg_SI_Eng	BOOL	1	1 = English units (psia, °F, BTU, ft <sup>3</sup> , lbm). 0 = SI units (MPa, °C, kJ, m <sup>3</sup> , kg).

### Saturated Steam Pressure Output Structure

Output parameters include the following:

- Output data elements (Out\_) are the primary outputs of the instruction, typically used by hardware output modules; however, they can be used by other application logic.
- Status data elements (Sts\_) are bit outputs of the instruction for use by the HMI. Status bits also can be used by other application logic.

**Table 4 - P\_PSat Output Parameters**

Output Parameter	Data Type	Description
EnableOut	BOOL	Enable Output: system defined parameter.
Out_PSat	REAL	Calculated saturated steam pressure (absolute) (MPa or psia).
Out_Enthalpy_L	REAL	Liquid enthalpy (kJ/kg or BTU/lbm).
Out_Enthalpy_V	REAL	Vapor enthalpy (kJ/kg or BTU/lbm).
Out_Entropy_L	REAL	Liquid entropy (kJ/kg K or BTU/lbm F).
Out_Entropy_V	REAL	Vapor entropy (kJ/kg K or BTU/lbm F).
Out_Volume_L	REAL	Liquid specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm)
Out_Volume_V	REAL	Vapor-specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm)
Sts_InpErr	BOOL	Error: Input temperature is outside of calculation range.

## Operations

The P\_PSat Add-On Instruction only performs calculations and does not have any modes or alarms.

To provide High-High, High, Low, and/or Low-Low threshold alarms for any of the variables (pressure, enthalpy, entropy, or specific volume), use a P\_AIn Input instruction for each such variable.

Refer to the Rockwell Automation® Library of Process Objects: Basic Analog Input (P\_AIn) Reference Manual, publication [SYSLIB-RM001](#), for more information.

## Execution

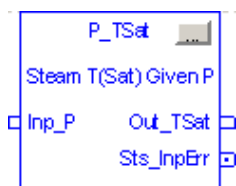
The following table explains the handling of instruction execution conditions.

Condition	Description
EnableIn False (false rung)	No EnableInFalse logic is provided. The instruction maintains its last state when EnableIn is false.
Powerup (prescan, first scan)	No Pre-scan or First Scan logic is provided. The P_PSat instruction performs its calculation every scan when EnableIn is true.
Postscan	No SFC Postscan logic is provided.

Refer to the Logix 5000™ Controllers Add-On Instructions Programming Manual, publication [1756-PM010](#), for more information.

## **Notes:**

## Saturated Steam Temperature (P\_TSat)



This instruction calculates the temperature (in degrees Celsius or Fahrenheit) of saturated steam given the absolute pressure (in MPa or psia). This instruction also reports the enthalpy, entropy, and specific volume for liquid and (saturated) vapor at the given pressure.

Saturation curve and properties are calculated in accordance with the International Association for the Properties of Water and Steam Industry Formulation 1977 (IAPWS-IF97).

The table shows the allowable pressure range.

Pressure	
Min	Max
0.000611213 MPa (0.08864893 psia)	22.064 MPa (3200.1118 psia)

### Guidelines

Use this instruction when you have measured or calculated the pressure of steam and you need to know the corresponding temperature of saturated steam. This instruction also provides the enthalpy, entropy, and specific volume of liquid water and of saturated steam vapor at the given pressure.

Do **not** use this instruction in these situations:

- You are working with a substance other than liquid water or vapor (steam).
- You are working outside the range of validity for this instruction.

### Functional Description

The P\_TSat instruction is a **calculation function only**, and no HMI components are provided. If you need a faceplate and/or alarms, send the calculated flow at standard conditions to a P\_AIn (Analog Input) instruction for alarming and display.

## Controller Code

This section describes the parameter references for this Add-On Instruction.

### Saturated Steam Temperature Input Structure

Input parameters include the following:

- Input data elements (Inp\_) are typically used to connect field inputs from I/O modules or signals from other objects.
- Configuration data elements (Cfg\_) are used to set configurable capabilities and features of the instruction.

**Table 5 - P\_TSat Input Parameters**

Input Parameter	Data Type	Default	Description
EnableIn	BOOL	1	<b>Ladder Diagram:</b> If the rung-in condition is true, the instruction's Logic routine executes. If the rung-in condition is false, the instruction's EnableInFalse routine executes. <b>Function Block Diagram:</b> If true, or not connected, the instruction's Logic routine executes. If the parameter is exposed as a pin and wired, and the pin is false, the instruction's EnableInFalse routine executes. <b>Structured Text:</b> No effect. The instruction's Logic routine executes.
Inp_P	REAL	14.696	Input steam pressure (absolute) (MPa or psia).
Cfg_SI_Eng	BOOL	1	1 = English units (psia, °F, BTU, ft <sup>3</sup> , lbm). 0 = SI units (MPa, °C, kJ, m <sup>3</sup> , kg).

### Saturated Steam Temperature Output Structure

Output parameters include the following:

- Output data elements (Out\_) are the primary outputs of the instruction, typically used by hardware output modules; however, they can be used by other application logic.
- Status data elements (Sts\_) are bit outputs of the instruction for use by the HMI. Status bits also can be used by other application logic.

**Table 6 - P\_TSat Output Parameters**

Output Parameter	Data Type	Description
EnableOut	BOOL	Enable Output: system defined parameter.
Out_TSat	REAL	Calculated saturated steam temperature (°C or °F)
Out_Enthalpy_L	REAL	Liquid enthalpy (kJ/kg or BTU/lbm).
Out_Enthalpy_V	REAL	Vapor enthalpy (kJ/kg or BTU/lbm).
Out_Entropy_L	REAL	Liquid entropy (kJ/kg K or BTU/lbm F).
Out_Entropy_V	REAL	Vapor entropy (kJ/kg K or BTU/lbm F).
Out_Volume_L	REAL	Liquid specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm).
Out_Volume_V	REAL	Vapor specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm).
Sts_InpErr	BOOL	Error: Input pressure is outside of calculation range.



## Operations

The P\_TSat Add-On Instruction only performs calculations and does not have any modes or alarms.

To provide High-High, High, Low, and/or Low-Low threshold alarms for any of the variables (temperature, enthalpy, entropy, and specific volume), use a P\_AIn Input instruction for each such variable.

Refer to the Rockwell Automation® Library of Process Objects: Basic Analog Input (P\_AIn) Reference Manual, publication [SYSLIB-RM001](#), for more information.

## Execution

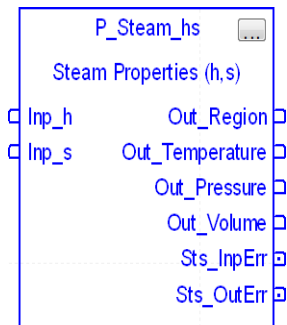
The following table explains the handling of instruction execution conditions.

Condition	Description
EnableIn False (false rung)	No EnableInFalse logic is provided. The instruction maintains its last state when EnableIn is false.
Powerup (prescan, first scan)	No Pre-scan or First Scan logic is provided. The P_TSat instruction performs its calculation every scan when EnableIn is true.
Postscan	No SFC Postscan logic is provided.

Refer to the Logix 5000™ Controllers Add-On Instructions Programming Manual, publication [1756-PM010](#), for more information.

## **Notes:**

## Steam Properties Given Enthalpy and Entropy (P\_Steam\_hs)



The P\_Steam\_hs (Steam Properties Given Enthalpy and Entropy) Add-On Instruction calculates the pressure, temperature, specific volume (Region 3), and vapor fraction (Region 4) at the given enthalpy and entropy.

Steam properties are calculated by using the steam table inverse equations in accordance with the International Association for the Properties of Water and Steam Industrial Formulation 1997 (IAPWS-IF97).

The table shows the allowable input range.

Enthalpy		Entropy	
Min	Max	Min	Max
-0.0416 kJ/kg (0.0179 BTU/lbm)	4160.66 kJ/kg (1789.95 BTU/lbm)	-0.0086 kJ/(kg.°K) (0.0 BTU/(lb.°K))	0.0021 kJ/(kg.°K) (2.85 BTU/(lb.°K))

### Guidelines

Use this instruction when you have measured or calculated the enthalpy and entropy of steam and you need to know the steam's temperature, pressure, specific volume, or vapor fraction.

Do **not** use this instruction in these situations:

- You are working with a substance other than liquid water or vapor (steam).
- You are working outside the range of validity for this instruction.

### Functional Description

The steam table instructions are **calculation functions only**, and no HMI components are provided. If a faceplate or graphic symbol (bar, trend, numeric display) or alarms are required for a calculated variable, send the variable to a P\_AIn (Analog Input) instruction for display and alarming.

## Controller Code

This section describes the parameter references for this Add-On Instruction.

### Steam Properties Given Enthalpy and Entropy Input Structure

Input parameters include the following:

- Input data elements (Inp\_) are typically used to connect field inputs from I/O modules or signals from other objects.
- Configuration data elements (Cfg\_) are used to set configurable capabilities and features of the instruction.

**Table 7 - P\_Steam\_hs Input Parameters**

Input Parameter	Data Type	Default	Description
EnableIn	BOOL	1	<b>Ladder Diagram:</b> If the rung-in condition is true, the instruction's Logic routine executes. If the rung-in condition is false, the instruction's EnableInFalse routine executes. <b>Function Block Diagram:</b> If true, or not connected, the instruction's Logic routine executes. If the parameter is exposed as a pin and wired, and the pin is false, the instruction's EnableInFalse routine executes. <b>Structured Text:</b> No effect. The instruction's Logic routine executes.
Inp_h	REAL	0.0	Input steam enthalpy (kJ/kg or BTU/lbm).
Inp_s	REAL	0.0	Input steam entropy (kJ/kg K or BTU/lbm F).
Cfg_SI_Eng	BOOL	1	1 = English units (psia, °F, BTU, ft <sup>3</sup> , lbm). 0 = SI units (°C, kJ, m <sup>3</sup> , kg).

### Steam Properties Given Enthalpy and Entropy Output Structure

Output parameters include the following:

- Output data elements (Out\_) are the primary outputs of the instruction, typically used by hardware output modules; however, they can be used by other application logic.
- Status data elements (Sts\_) are bit outputs of the instruction for use by the HMI. Status bits can also be used by other application logic.

**Table 8 - P\_Steam\_hs Output Parameters**

Output Parameter	Data Type	Description
EnableOut	BOOL	Enable output: system-defined parameter.
Out_Region	DINT	1 = Liquid 2 = Superheated 3 = Supercritical 4 = Saturated
Out_Temperature	REAL	Output steam temperature (°C or °F).
Out_Pressure	REAL	Output steam pressure (absolute) (MPa or PSIA).
Out_Volume	REAL	Output-specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm).

**Table 8 - P\_Steam\_hs Output Parameters**

Output Parameter	Data Type	Description
Out_VaporFrac	REAL	Output vapor fraction (mass fraction, dimensionless).
Sts_InpErr	BOOL	Error: Input pressure/temperature is outside of calculation range.
Sts_OutErr	BOOL	Error: Inp_h and Inp_s produce an invalid result (not in Regions 1...4 or not valid properties of water/steam).

## Operations

The P\_Steam\_hs Add-On Instruction only performs calculations and does not have any modes or alarms.

To provide High-High, High, Low, and/or Low-Low threshold alarms for any of the variables (temperature, pressure, and vapor fraction), use a P\_AIn Input instruction for each such variable.

Refer to the Rockwell Automation® Library of Process Objects: Basic Analog Input (P\_AIn) Reference Manual, publication [SYSLIB-RM001](#), for more information.

## Execution

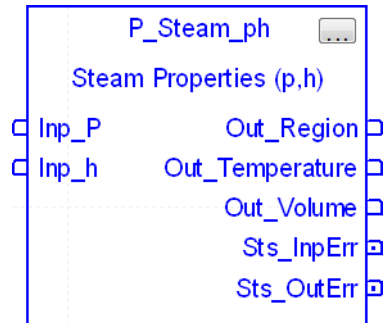
The following table explains the handling of instruction execution conditions.

Condition	Description
EnableIn False (false rung)	No EnableInFalse logic is provided. The instruction maintains its last state when EnableIn is false.
Powerup (prescan, first scan)	No Prescan or First Scan logic is provided. The P_Steam instruction performs its calculation every scan when EnableIn is true.
Postscan	No SFC Postscan logic is provided.

Refer to the Logix 5000™ Controllers Add-On Instructions Programming Manual, publication [1756-PM010](#), for more information.

## Notes:

## Steam Properties Given Pressure and Enthalpy (P\_Steam\_ph)



The P\_Steam\_ph (Steam Properties Given Pressure and Enthalpy) Add-On Instruction calculates the temperature and specific volume (Region 3) at the given pressure and enthalpy.

Steam properties are calculated by using the steam table inverse equations in accordance with the International Association for the Properties of Water and Steam Industrial Formulation 1997 (IAPWS-IF97).

The table shows the allowable input range.

Pressure		Enthalpy	
Min	Max	Min	Max
0.0 MPa absolute (0.0 psia)	100.0 MPa absolute (14503.77 psia)	-0.0416 kJ/kg (-0.0179 BTU/lbm)	4160.66 kJ/kg (1789.95 BTU/lbm)

### Guidelines

Use this instruction when you have measured or calculated the pressure and enthalpy of steam and you need to know the steam's temperature and specific volume.

Do **not** use this instruction in these situations:

- You are working with a substance other than liquid water or vapor (steam).
- You are working outside the range of validity for this instruction.

### Functional Description

The steam table instructions are **calculation functions only**, and no HMI components are provided. If a faceplate or graphic symbol (bar, trend, numeric display) or alarms are required for a calculated variable, send the variable to a P\_AIn (Analog Input) instruction for display and alarming.

## Controller Code

This section describes the parameter references for this Add-On Instruction.

### Steam Properties Given Pressure and Enthalpy Input Structure

Input parameters include the following:

- Input data elements (Inp\_) are typically used to connect field inputs from I/O modules or signals from other objects.
- Configuration data elements (Cfg\_) are used to set configurable capabilities and features of the instruction.

**Table 9 - P\_Steam\_ph Input Parameters**

Input Parameter	Data Type	Default	Description
EnableIn	BOOL	1	<b>Ladder Diagram:</b> If the rung-in condition is true, the instruction's Logic routine executes. If the rung-in condition is false, the instruction's EnableInFalse routine executes. <b>Function Block Diagram:</b> If true, or not connected, the instruction's Logic routine executes. If the parameter is exposed as a pin and wired, and the pin is false, the instruction's EnableInFalse routine executes. <b>Structured Text:</b> No effect. The instruction's Logic routine executes.
Inp_P	REAL	0.0	Input steam pressure (absolute) (MPa or psia).
Inp_h	REAL	0.0	Input steam enthalpy (kJ/kg or BTU/lbm)
Cfg_SI_Eng	BOOL	1	1 = English units (psia, °F, BTU, ft <sup>3</sup> , lbm). 0 = SI units (MPa, °C, kJ, m <sup>3</sup> , kg).

### Steam Properties Given Pressure and Enthalpy Output Structure

Output parameters include the following:

- Output data elements (Out\_) are the primary outputs of the instruction, typically used by hardware output modules; however, they can be used by other application logic.
- Status data elements (Sts\_) are bit outputs of the instruction for use by the HMI. Status bits can also be used by other application logic.

**Table 10 - P\_Steam\_ph Output Parameters**

Output Parameter	Data Type	Description
EnableOut	BOOL	Enable output: system-defined parameter.
Out_Region	DINT	1 = Liquid 2 = Superheated 3 = Supercritical 4 = Saturated
Out_Temperature	REAL	Output steam temperature (°C or °F).
Out_Volume	REAL	Output-specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm).
Sts_InpErr	BOOL	Error: Inp_p or Inp_h is outside of calculation range.
Sts_OutErr	BOOL	Error: Inp_p and Inp_h produce an invalid result (not in Regions 1 . . . 4 or not valid properties of water/steam).



## Operations

The P\_Steam\_ph Add-On Instruction only performs calculations and does not have any modes or alarms.

To provide High-High, High, Low, and/or Low-Low threshold alarms for any of the variables (temperature or specific volume), use a P\_AIn Input instruction for each such variable.

Refer to the Rockwell Automation® Library of Process Objects: Basic Analog Input (P\_AIn) Reference Manual, publication [SYSLIB-RM001](#), for more information.

## Execution

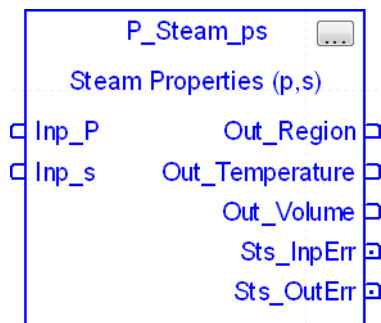
The following table explains the handling of instruction execution conditions.

Condition	Description
EnableIn False (false rung)	No EnableInFalse logic is provided. The instruction maintains its last state when EnableIn is false.
Powerup (prescan, first scan)	No Prescan or First Scan logic is provided. The P_Steam instruction performs its calculation every scan when EnableIn is true.
Postscan	No SFC Postscan logic is provided.

Refer to the Logix 5000™ Controllers Add-On Instructions Programming Manual, publication [1756-PM010](#), for more information.

## **Notes:**

## Steam Properties Given Pressure and Entropy (P\_Steam\_ps)



The P\_Steam\_ps (Steam Properties Given Pressure and Entropy) Add-On Instruction calculates the temperature and specific volume (Region 3) at the given pressure and entropy.

Steam properties are calculated by using the steam table inverse equations in accordance with the International Association for the Properties of Water and Steam Industrial Formulation 1997 (IAPWS-IF97).

The table shows the allowable input range.

Pressure		Entropy	
Min	Max	Min	Max
0.0 MPa (0.0 psia)	100.0 MPa (14503.77 psia)	-0.0086 kJ/(kg.°K) (-0.0021 BTU/(lb.°F))	11.92 kJ/(kg.°K) (2.85 BTU/(lb.°F))

### Guidelines

Use this instruction when you have measured or calculated the pressure and entropy of steam and you need to know the steam's temperature and specific volume.

Do **not** use this instruction in these situations:

- You are working with a substance other than liquid water or vapor (steam).
- You are working outside the range of validity for this instruction.

### Functional Description

The steam table instructions are **calculation functions only**, and no HMI components are provided. If a faceplate or graphic symbol (bar, trend, numeric display) or alarms are required for a calculated variable, send the variable to a P\_AIn (Analog Input) instruction for display and alarming.

## Controller Code

This section describes the parameter references for this Add-On Instruction.

### Steam Properties Given Pressure and Entropy Input Structure

Input parameters include the following:

- Input data elements (Inp\_) are typically used to connect field inputs from I/O modules or signals from other objects.
- Configuration data elements (Cfg\_) are used to set configurable capabilities and features of the instruction.

**Table 11 - P\_Steam Input Parameters**

Input Parameter	Data Type	Default	Description
EnableIn	BOOL	1	<b>Ladder Diagram:</b> If the rung-in condition is true, the instruction's Logic routine executes. If the rung-in condition is false, the instruction's EnableInFalse routine executes. <b>Function Block Diagram:</b> If true, or not connected, the instruction's Logic routine executes. If the parameter is exposed as a pin and wired, and the pin is false, the instruction's EnableInFalse routine executes. <b>Structured Text:</b> No effect. The instruction's Logic routine executes.
Inp_P	REAL	0.0	Input steam pressure (absolute) (MPa or psia).
Inp_s	REAL	0.0	Input steam entropy (kJ/kg K or BTU/lbm F).
Cfg_SI_Eng	BOOL	1	1 = English units (psia, °F, BTU, ft <sup>3</sup> , lbm). 0 = SI units (MPa, °C, kJ, m <sup>3</sup> , kg).

### Steam Properties Given Pressure and Entropy Output Structure

Output parameters include the following:

- Output data elements (Out\_) are the primary outputs of the instruction, typically used by hardware output modules; however, they can be used by other application logic.
- Status data elements (Sts\_) are bit outputs of the instruction for use by the HMI. Status bits can also be used by other application logic.

**Table 12 - P\_Steam\_ps Output Parameters**

Output Parameter	Data Type	Description
EnableOut	BOOL	Enable output: system defined parameter.
Out_Region	DINT	1 = Liquid 2 = Superheated 3 = Supercritical 4 = Saturated
Out_Temperature	REAL	Output steam temperature (°C or °F).
Out_Volume	REAL	Output-specific volume (m <sup>3</sup> /kg or ft <sup>3</sup> /lbm).
Sts_InpErr	BOOL	Error: Inp_p or Inp_s is outside of calculation range.
Sts_OutErr	BOOL	Error: Inp_p and Inp_s produce an invalid result (not in Regions 1...4 or not valid properties of water/steam).

## Operations

The P\_Steam\_ps Add-On Instruction only performs calculations and does not have any modes or alarms.

To provide High-High, High, Low, and/or Low-Low threshold alarms for any of the variables (temperature or specific volume), use a P\_AIn Input instruction for each such variable.

Refer to the Rockwell Automation® Library of Process Objects: Basic Analog Input (P\_AIn) Reference Manual, publication [SYSLIB-RM001](#), for more information.

## Execution

The following table explains the handling of instruction execution conditions.

Condition	Description
EnableIn False (false rung)	No EnableInFalse logic is provided. The instruction maintains its last state when EnableIn is false.
Powerup (prescan, first scan)	No Prescan or First Scan logic is provided. The P_Steam instruction performs its calculation every scan when EnableIn is true.
Postscan	No SFC Postscan logic is provided.

Refer to the Logix 5000™ Controllers Add-On Instructions Programming Manual, publication [1756-PM010](#), for more information.

## **Notes:**



## Rockwell Automation Support

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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