

MS Series Multi-Stage Electronic Controls

The MS Series Controls are versatile, microprocessor-based, multifunction, programmable controls for humidity, pressure, or other applications that can provide a 0-10 VDC input. They are designed for single and multiple stage control applications.

Depending on the model selected, the MS Series Control can operate in one of several modes:

- *Direct mode*
- *Reverse mode*
- *Deadband mode*
- *Independent Setpoint mode*

The MS Series Controls have large, easy-to-read, red Light-Emitting Diode (LED) displays. These compact controls are available in Panel Mount and DIN Rail Mount models. They use 0-10 VDC transducers and powered sensors.



Figure 1: MS2 Panel Mount and DIN Rail Mount Multi-Stage Electronic Controls

Features and Benefits	
☐ Programmable Functions	Allows adjustment of control settings to meet application needs
☐ Alarm Management Functions	Provides visible alarm codes on the display
☐ Easily Readable LED Display	Displays status and functions quickly and clearly
☐ Programming Button Lockout	Allows user to disable programming buttons and deter accidental or unauthorized changes
☐ Self-Test Procedure	Checks control operation by cycling all outputs and testing all LEDs

Overview

IMPORTANT: All MS Series Controls are designed for use **only** as operating controls. Where an operating control failure would result in personal injury or loss of property, it is the responsibility of the installer to add devices (safety, limit controls) or systems (alarm, supervisory systems) that protect against, or warn of, control failure.

Refer to a specific model's installation bulletin for the necessary information on installation, use, and servicing.

Table 1: Typical Applications

MS1	MS2	Application
✓	✓	Rooftop humidifying and dehumidifying units
✓	✓	Boiler pressure or pump control
✓	✓	Space humidity control
✓		Pressure-based compressor pump-down control
✓	✓	Pressure-based condenser fan cycling
✓	✓	Suction pressure control for small refrigeration rack controllers
	✓	Compressor or chiller staging based on pressure
	✓	Humidity control for ripening rooms

Mode Selection

Mode Selection allows selection of one of several modes, depending on the model:

- Direct mode for applications requiring dehumidification or closing a circuit on a rise in input voltage
- Reverse mode for applications requiring humidification or closing a circuit on a drop in input voltage
- Deadband mode for applications requiring both Direct and Reverse modes with a common setpoint and deadband
- Independent Setpoint mode for applications requiring both Direct and Reverse modes with an independent setpoint for each mode

Stage Control Functions

Adjustable Setpoint Stops restrict setpoint adjustment to avoid extreme settings. The setpoint cannot be changed to a value outside of these stops.

Soft Start controls the rate at which the measured condition approaches the setpoint on power up, both initially and when the binary input is configured as a remote shutoff.

Anti-short Cycle Delay avoids situations where the equipment starts, stops, and restarts in a short period of time. This feature determines the minimum time between two subsequent On cycles of the equipment.

Binary Input Functions

The MS2 controls are equipped with a binary input that can perform one of the following functions:

- **Shutoff and Alarm Signaling:** When the binary input is open for a time longer than the binary input time delay, all outputs are shut off and an alarm message is displayed. Restart does not use the soft start function.
- **Setback:** When the binary input is open, the setpoints are shifted by a preset value in order to save energy.
- **Remote Shutoff:** When the binary input is open for a time longer than the binary input time delay, all outputs are shut off and an alarm message is displayed. Restart uses the soft start function.

Dimensions

Alarm Management Functions

High and Low Condition Alarms have setpoints relative to the main setpoint. If the condition reaches or exceeds the alarm values for a time longer than the alarm time delay, the display flashes a specific alarm message. On the MS1, an alarm output circuit is energized. The MS2 has no alarm output. Alarms are disabled for 20 minutes after startup in addition to the alarm time delay.

Alarm Time Delay is used to avoid short-duration events triggering the alarm.

Alarm Differential can be set to keep the alarm from cycling rapidly on and off.

Sensor Failure is indicated by an alarm message on the display.

Alarm codes are displayed by the LEDs and are used to help troubleshoot errors. Alarm codes exist for these conditions:

- sensor failure
- high condition alarm
- low condition alarm
- program failure
- binary input codes

Self-Test Procedure

The self-test procedure allows the user to verify that the LEDs and outputs of an MS control are operating correctly before the control is put into service.

Additional Features

Programming Button Lockout allows the programming buttons to be deactivated, which deters accidental or unauthorized modifications to the settings.

Display Updating Time provides an adjustable refresh rate to avoid displaying short duration fluctuations .

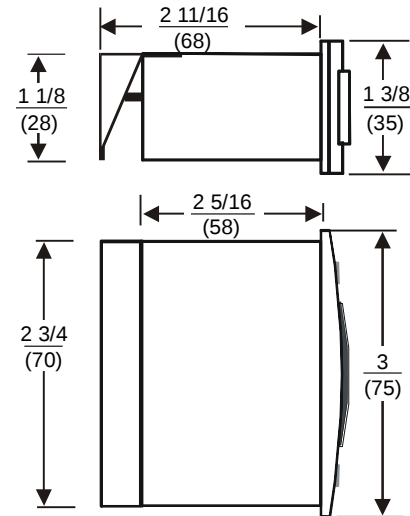


Figure 2: Panel Mount Control, in. (mm)

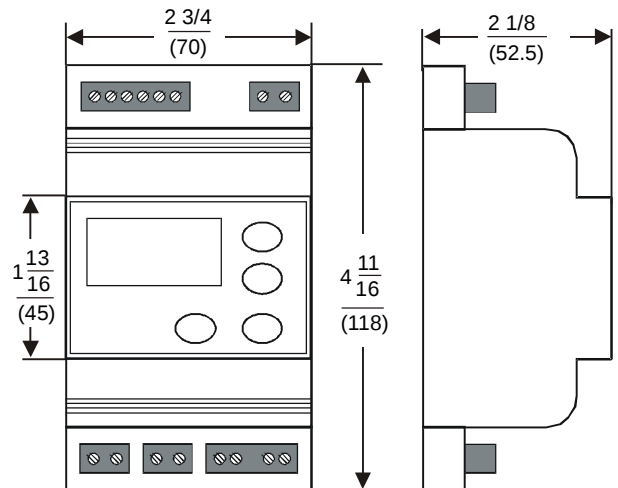


Figure 3: DIN Rail Mount Control in. (mm)

Display

The display has two 7-segment LEDs and a minus (-) indication to display conditions from -40 to 99. Two individual stage status LEDs display the relay status.

- LED * indicates Relay Output 1 is energized.
- LED * indicates Relay Output 2 is energized.

The MS1 has one stage status LED. The MS2 has two stage status LEDs.

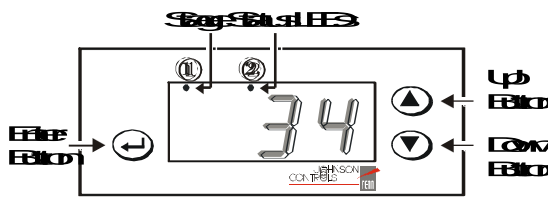


Figure 4: Panel Mount Front Panel and Display

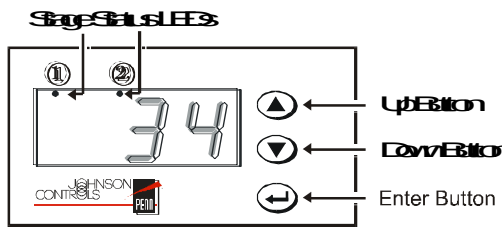


Figure 5: DIN Rail Mount Front Panel and Display

Modes of Operation

The MS1 Series Control performs condition (pressure, humidity, etc.) management and alarm management for single-stage applications. It operates in either Direct or Reverse modes.

The MS2 Series Control performs condition management for 2-stage applications. In addition to the MS1 modes, it has Deadband and Independent Setpoint modes for applications that require both direct and reverse modes.

Table 2: Modes of Operation

MS1	MS2	Modes of Operation
✓	✓	Direct
✓	✓	Reverse
	✓	Deadband
	✓	Independent Setpoint

The illustrations on the following pages show the modes that each MS Series Control is capable of using.

Direct Mode

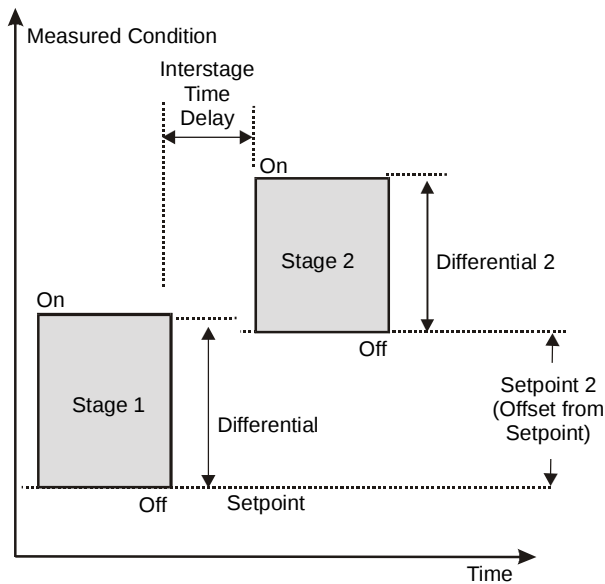


Figure 6: Direct Mode

Direct mode is used with humidity sensors for applications requiring dehumidification. This mode may also be used with other sensors for closing a circuit on rise in pressure (or input voltage).

The MS1 has one stage. The MS2 has two stages. Stages may overlap or have space between them.

Setpoint is the desired pressure or humidity (or voltage level) programmed by the user.

Differential is the operational range of Stage 1.

Setpoint 2 is the offset from setpoint that activates Stage 2.

Differential 2 is the operational range of Stage 2.

Interstage Time Delay is the minimum amount of time between two successive stages when multiple stages are called for in rapid sequence.

Reverse Mode

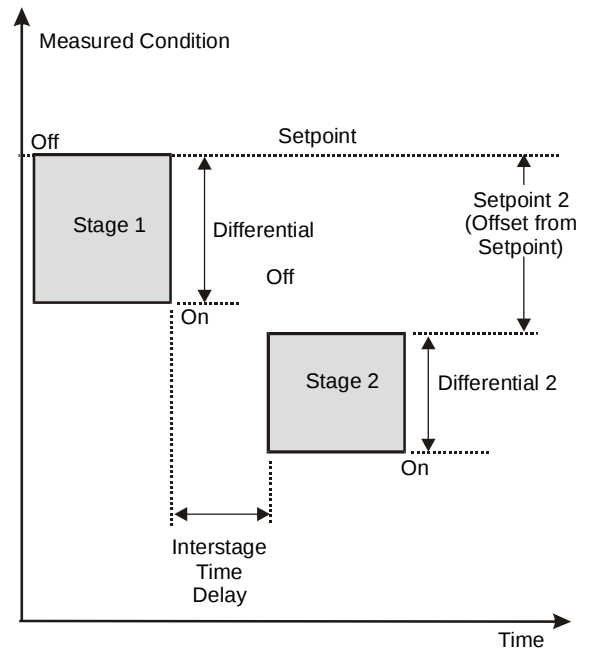


Figure 7: Reverse Mode

Reverse mode is used with humidity sensors for applications requiring humidification. This mode may also be used with other sensors for closing a circuit on drop in pressure (or input voltage).

The MS1 has one stage. The MS2 has two stages. Stages may overlap or have space between them.

Setpoint is the desired pressure or humidity (or voltage level) programmed by the user.

Differential is the operational range of Stage 1.

Setpoint 2 is the offset from setpoint that activates Stage 2.

Differential 2 is the operational range of Stage 2.

Interstage Time Delay is the minimum amount of time between two successive stages when multiple stages are called for in rapid sequence.

Deadband Mode (MS2 only)

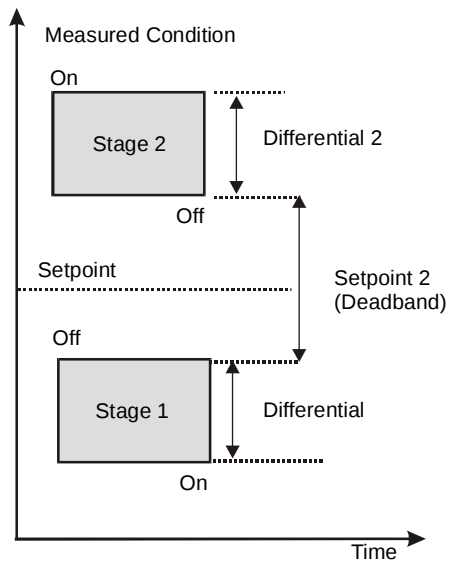


Figure 8: Deadband Mode

Deadband mode may be used with humidity sensors for applications requiring dehumidification and humidification. It may be used with other sensors for closing circuits on pressure (or input voltage) rise and on pressure (or input voltage) drop.

Setpoint is the desired pressure or humidity (or voltage level) programmed by the user.

Differential is the operational range of Stage 1.

Setpoint 2 is width of the deadband, which is centered on setpoint.

Differential 2 is the operational range of Stage 2.

Independent Setpoint Mode (MS2 only)

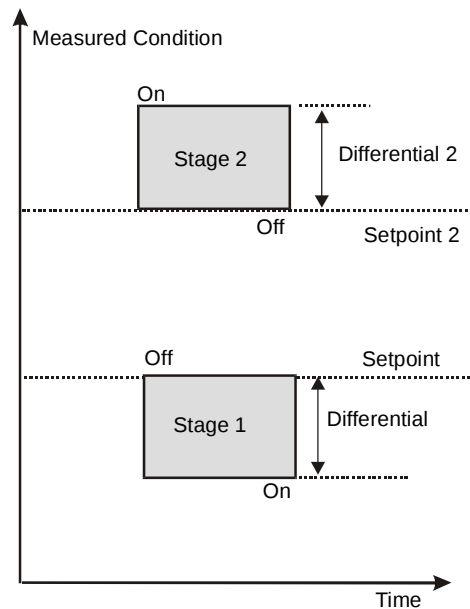


Figure 9: Independent Setpoint Mode

Independent Setpoint mode may be used with humidity sensors for applications requiring dehumidification and humidification. This mode may be used with other sensors for closing circuits on pressure (or input voltage) rise and on pressure (or input voltage) drop.

Setpoint is the desired pressure or humidity (or voltage level) programmed by the user. It is the basis for the reverse stage.

Differential is the operational range of Stage 1.

Setpoint 2 the desired pressure or humidity programmed by the user. It is the basis for the direct stage.

Differential 2 is the operational range of Stage 2.

Function Definitions

The MS Series Controls include a variety of condition (pressure, humidity, etc.) management functions, which are listed below. Not all of these functions are available on every model.

Refer to Table 3 for functions and setting ranges for specific models.

Control Function Management

Setpoint is the primary control point programmed by the user.

Setpoint 2 depends on the mode used. For information on function in each mode, see *Modes of Operation*.

Differentials (or hysteresis) establish the difference between the value at which the output is switched Off and the value at which the output is switched On. For further information, see *Modes of Operation*.

Example: In Direct mode, with the setpoint at 40 units, and the differential at 4 units, the load is switched On when the measured condition goes above 44 units, and is turned Off when the condition decreases to below 40 units.

High and Low Setpoint Stops are values that define how high and low the primary **setpoint** may be adjusted. **Setpoint stops** deter unauthorized or accidental overadjustment of **setpoint**.

Anti-short Cycle Timer, Direct establishes the minimum time in minutes between two subsequent On cycles of Direct stages.

Anti-short Cycle Timer, Reverse establishes the minimum time in minutes between two subsequent On cycles of Reverse stages.

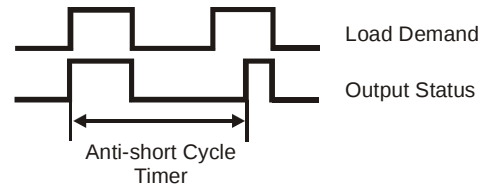


Figure 10: Anti-short Cycle Timer

Interstage Time Delay is the minimum amount of time between two successive stages when multiple stages are called for in rapid sequence.

Soft Start controls the rate at which the process condition is allowed to approach the **setpoint** on power up, both initially and when the binary input is configured as remote shutoff. The setting is minutes/unit.

Humidification Example:

Sensor reading = 20%
Setpoint = 30%
Soft start = 2 minutes

Rate of Increase =
Soft start x (**setpoint** – sensor reading)

Process setpoint increases 1% every two minutes.
To go from 20% to 30% takes 20 minutes.

Sensor Offset allows the user to compensate for differences between actual and displayed condition, such as those experienced when the location of the sensor results in inaccurate readings.

Low Range Analog Input defines the value of the lower control limit when the sensor input is at 0 VDC.

High Range Analog Input defines the value of the upper control limit when the sensor input is at 10 VDC.

Display Refresh Rate establishes the time delay (seconds) between updates of the display.

Alarm Management

High Alarm establishes the condition value relative to setpoint at which the control goes into a high condition alarm state.

Example: If setpoint is 40 and **high alarm** is 15, the alarm message will be displayed at 55.

Low Alarm establishes the condition relative to setpoint (units) at which the control goes into a low condition alarm state.

Example: If setpoint is 40 and **low alarm** is -10, an alarm message will be displayed at 30.

Alarm Differential establishes the difference between the measured condition at which the alarm is activated and the condition at which the alarm is deactivated. On the MS1, an alarm activation triggers an external alarm and displays an alarm message. On the MS2, an alarm message is displayed.

Example (dehumidifying):

Setpoint = 40%,

High Alarm = 15%

Alarm Differential = 2%.

When the measured condition exceeds 55% for a time greater than the **alarm time delay** setting, the alarm message is displayed; however, it will not reset until the condition drops below 53%.

Alarm Time Delay establishes the time delay (minutes) between reaching an alarm condition (high or low) and activating the alarm. This function reduces nuisance alarms caused by transient changes that temporarily exceed alarm setpoints. Conditions that would cause an alarm are disregarded during the first 20 minutes after power up.

Binary Input

Binary Input Function allows the user to select how the contacts of the binary input will activate the alarm. The user can select to disengage this function or set one of three actions:

- **Shutoff and Alarm Signaling** - If the binary input contact is open for a time longer than that set through the **binary input time delay**, the outputs are switched Off, an alarm message (A1) is displayed.
- **Setback** - If the binary input contact is open for a time longer than that set through **binary input time delay**, the setpoints are shifted by **setback**. Reverse setpoints decrease. Direct setpoints increase.
- **Remote Shutoff** of the outputs- If the binary input contact is open for a time longer than that set through the **binary input time delay**, the outputs are switched Off.

If a set of stage control contacts are used to control an external alarm, this function should be disabled.

Binary Input Time Delay establishes the time delay (minutes) between binary signal reaching the control and control's response to the binary signal.

Setback determines the value of the Setpoint shift when the binary input is open and the **binary input function** is set at **setback**.

Table 3: Functions and Settings

MS1	MS2	Setting	Setting Range
✓	✓	Mode Selection	D = Direct
✓	✓		R = Reverse
	✓		B = Deadband (Direct and Reverse)
	✓		I = Independent Setpoint (Direct and Reverse)
✓	✓	Setpoint	0 to 99
✓	✓	Differential 1	1 to 9
	✓	Setpoint 2	D, R modes 1 to 40
			B mode 2 to 40
			I mode Low to High Setpoint Stop
	✓	Differential 2	1 to 9
✓	✓	Low Setpoint Stop	0 to High Setpoint Stop
✓	✓	High Setpoint Stop	Low Setpoint Stop to 99
	✓	Interstage Time Delay	3 to 99 seconds
✓	✓	Anti-Short Cycle Timer, Direct	0 to 9 minutes
✓	✓	Anti-Short Cycle Timer, Reverse	0 to 9 minutes
✓	✓	Soft Start	0 to 99 minutes/(1% or 1 psi)
✓	✓	Low Range Analog Input	-40 to High Range Analog Input
✓	✓	High Range Analog Input	Low Range Analog Input to 100
✓	✓	Sensor Offset	-20 to +20
✓	✓	Display Refresh Rate	1 to 99 seconds
✓	✓	High Condition Alarm	0 to 50 above Setpoint
✓	✓	Low Condition Alarm	-50 to 0 below Setpoint
✓	✓	Alarm Differential	1 to 9
✓	✓	Alarm Time Delay	0 to 99 minutes
	✓	Binary Input Function	0 = No binary input 1 = Shutoff and alarm signaling 2 = Setback 3 = Remote shutoff
	✓	Setback	0 to 20
	✓	Binary Input Time Delay	0 to 99 minutes

MS1 – One Stage Electronic Control

The MS1 control is designed for 1-stage control applications. This model can use the P99V pressure transducers or the HE-6300 or HE-6310 humidity sensors. Other 0-10 VDC output transducers can also be used. All sensors or transducers are sold separately.

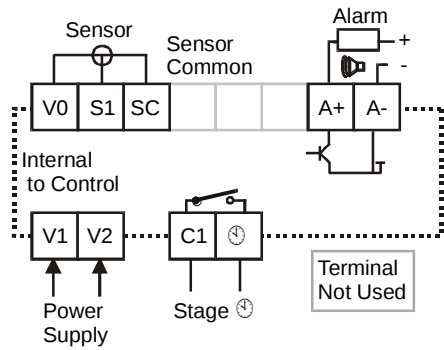


Figure 11: MS1 DIN Rail Mount Wiring

Table 4: Rating Table

Rating Category	120 VAC	240 VAC	24 VDC
Horsepower	1/4	1/2	-
Full Load Amperes	5.8	4.9	-
Locked Rotor Amperes	34.8	29.4	-
Inductive (non-motor) Amperes	8	8	8
Pilot Duty VA	275	450	-

Alarm circuit is rated at 40 VDC, 100 mA maximum.
Alarm requires additional power source.
Power supply is 24 VAC.
Terminal VO output is 12-17 VDC.

Modes of Operation

- Direct
- Reverse

Pressure/Humidity Management Settings

- Setpoint
- Differential (Hysteresis)
- Low Setpoint Stop
- High Setpoint Stop
- Anti-short Cycle Timer
- Soft Start
- Display Refresh Rate

Alarm Management Settings

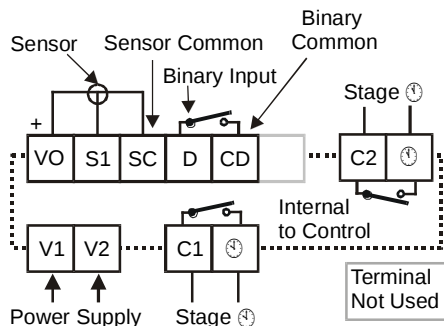
- High Condition Alarm
- Low Condition Alarm
- Alarm Differential
- Alarm Time Delay

Table 5: Ordering Information

Product Code Number	Description
MS1DR24V-11C	MS1 DIN Rail Mount Control; shipping weight 0.62 lb (280 g)
P99V-1C	Pressure transducer
HE-6300	Humidity sensor, wall mount
HE-6310	Humidity sensor, direct mount

MS2 – Two Stage Electronic Control

The MS2 control is designed for 2-stage control applications. These models can use the P99V pressure transducers or the HE-6300 or HE-6310 humidity sensors. Other 0-10 VDC output transducers can also be used. All sensors or transducers are sold separately.



Refer to Rating Table for more information.

Figure 12: MS2 DIN Rail Mount Wiring

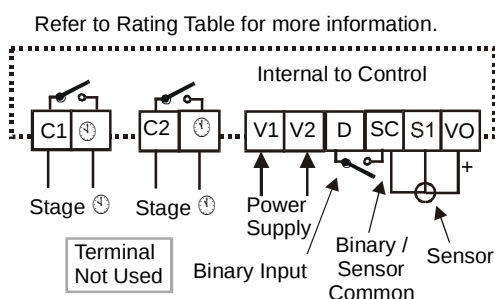


Figure 13: MS2 Panel Mount Wiring

Table 6: Rating Table

Rating Category	120 VAC	240 VAC	24 VDC
Horsepower	1/4	1/2	-
Full Load Amperes	5.8	4.9	-
Locked Rotor Amperes	34.8	29.4	-
Inductive (non-motor) Amperes	8	8	8
Pilot Duty VA	275	450	-

Power supply is 24 VAC.

Terminal VO output is 12-17 VDC.

Modes of Operation

- Direct
- Reverse
- Deadband (Direct and Reverse)
- Independent Setpoint (Direct and Reverse)

Condition Management Settings

- Multiple Setpoints
- Multiple Differentials (Hysteresis)
- Low Setpoint Stop
- High Setpoint Stop
- Interstage Time Delay
- Anti-short Cycle Timers
- Soft Start
- Display Refresh Rate

Alarm Management Settings

- High Condition Alarm
- Low Condition Alarm
- Alarm Differential
- Alarm Time Delay

Input Management Settings

- Binary Input Function Selection
- Binary Input Time Delay
- Setback

Table 7: Ordering Information

Product Code Number	Description
MS2DR24V-11C	MS2 DIN Rail Mount Control; shipping weight 0.62 lb (300 g)
MS2PM24V-11C	MS2 Panel Mount Control; shipping weight 0.40 lb (180 g)
P99V-1C	Pressure transducer
HE-6300	Humidity sensor, wall mount
HE-6310	Humidity sensor, direct mount

Table 8: Sensor Ordering Information

Product Code Number	Sensor Type	Operating Range	Cable
HE-6300-3	Humidity, Wall-mount	0 to 100% RH non-condensing, 20 to 140°F (-29 to 60°C)	None
HE-6310-3	Humidity, Duct-mount	0 to 100% RH non-condensing, 20 to 140°F (-29 to 60°C)	None
P99V-1C	Pressure	0 to 100 psig	6-1/2 ft (2 m)

Table 9: Electrical Ratings of Contacts

Rating Category	120 VAC	240 VAC	24 VDC
Horsepower	1/4	1/2	-
Full Load Amperes	5.8	4.9	-
Locked Rotor Amperes	34.8	29.4	-
Inductive (non-motor) Amperes	8	8	8
Pilot Duty VA	275	450	-

Open collector transistors on the MS1 alarm circuits have a maximum rating of 40 VDC, 100 mA. Alarm requires separate power source.

Specifications

Product	MS Series One and Two Stage Electronic Controls		
Power Requirements	3.7 VA @ 24 VAC, 50/60 Hz, Class 2 (20-30 VAC)		
Ambient Conditions	Operating:	+14 to +140°F (-10 to +60°C); 0 to 95 % RH (non-condensing)	
	Storage:	-22 to +176°F (-30 to +80°C); 0 to 95 % RH (non-condensing)	
Agency Listings	UL Recognized: File E194024, CCN XAPX2 Canadian UL Recognized: File E194024, CCN XAPX8 FCC Compliant per Class A Digital Device, Part 15 Canadian DOC Compliant per Class A, Radio Interference Regulations		
Dimensions (H x W x D)	Panel Mount:	1.38 x 2.95 x 2.68 in. (35 x 75 x 68 mm)	
	DIN Rail:	4.65 x 2.76 x 2.07 in. (118 x 70 x 52.5 mm)	
Shipping Weight	See ordering information in Tables 5 and 7.		

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult Johnson Controls/Penn Refrigeration Application Engineering at (414) 274-5535. Johnson Controls shall not be liable for damages resulting from misapplication or misuse of its products.



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