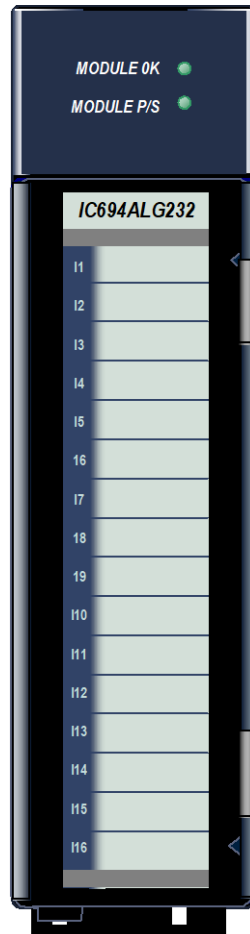# PACSystems™ RX3i

16-CHANNEL ANALOG INPUT VOLTAGE MODULE (IC694ALG232)

Warning Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury to exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Notes: Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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Introduction

The PACSystems RX3i 16-Channel Analog Voltage Input module provides 16 single-ended or 8 differential input channels. Each channel can be configured for either of two input ranges:

- 0 to 10 V (unipolar), default

- -10 to +10 V (bipolar).

High and Low alarm limits can be configured for both ranges.

This module can be installed in any I/O slot that has a serial connector in an RX3i system

Module Features

- Completely software-configurable, no module jumpers to set

- Configurable scaling and offsets per channel

- High alarm, low alarm, high-high alarm, low-low alarm detection and reporting selectable per channel

- Module fault reporting

- Supports diagnostic point fault contacts in the logic program

- Supports firmware upgrades.

- Positive and negative Rate of Change Alarms

- Display of module serial number, revision and date code in programming software.

- Supports hot insertion/removal

Isolated +24 VDC Power

If the module is in an RX3i Universal Backplane, an external source of isolated +24 VDC is required to provide power for the module. The external source must be connected via the TB1 connector on the left side of the backplane.

If this module is in an Expansion Backplane, the backplane's power supply provides the Isolated +24 VDC for the module.

LEDs

The MODULE OK LED provides module status information as follows:

- ON: status is OK, module configured

- OFF: no backplane power or software not running (watchdog timer timed out)

- Continuous rapid blinking: configuration data not received from CPU

- Slow blinking, then OFF: failed power-up diagnostics or encountered code execution error

The Module P/S LED indicates that the module's internally-generated +5 VDC supply is above a minimum designated level.

Specifications: ALG232

Specification	Description
Number of Channels	1 to 16 selectable, single-ended input mode 1 to 8 selectable, differential input mode
Input Ranges	0 V to +10 V (unipolar) or -10 V to +10 V (bipolar); selectable each channel
Calibration	Factory calibrated to: - 0.3125 mV per count on 0 V to +10 V (unipolar) range - 0.3125 mV per count on -10 to +10 V (bipolar) range
Update Rate for All Channels	Single Ended Input 5ms Differential Input 3ms
Resolution at 0V to +10V	1 LSB = 0.3125 mV
Resolution at -10V to +10V	1 LSB = 0.3125 mV
Absolute Accuracy 1,2	±0.25% of full scale @ 25°C (77°F) ±0.5% of full scale over specified operating temperature range
Linearity	< 4 LSB
Isolation, Field to Backplane (optical) and to frame ground	250VAC continuous; 1500 VAC for 1 minute
Common Mode Voltage (Differential)3	±11 V (bipolar range)
Cross-Channel Rejection	> 70dB from DC to 1 kHz
Input Impedance	>500K Ohms (single-ended mode) >1 Megohm (differential mode)
Input Filter Response	23 Hz (single-ended mode) 38 Hz (differential mode)
Internal Power Consumption	112 mA (maximum) from the backplane +5 VDC bus 110 mA (maximum) from the backplane isolated +24 VDC supply

1. In the presence of severe Radiated RF interference (IEC 61000-4-3, 10V/m), accuracy may be degraded to ±5% of full scale.

2. In the presence of severe Conducted RF interference (IEC 61000-4-6, 10Vrms), accuracy may be degraded to ±1% of full scale.

3. The sum of the differential input, common-mode voltage, and noise must not exceed ±11 volts when referenced to COM

Refer to the PACSystems RX3i System Manual (GFK-2314), for product standards, general operating specifications, and installation requirements.

ALG232 Configuration

Configurable parameters for the ALG232 module are described in next page.

Module Parameters

Parameter	Choices	Description
Active Channels	1 to 16 for Single-ended Input Mode, or 1 to 8 for Differential Input Mode	The number of channels to be scanned. Channels are scanned in sequential, contiguous order.
Channel Value Reference Address	Valid memory types: %AI (default), %AQ, %R, %W, Symbolic Memory*	The starting address in memory for input data from the module. *Note: To support Symbolic Memories, the "Variable Mode" property should be enabled in PME.
Channel Value Reference Length	Read-only	Depends on the number of active channels. Each channel provides two words of analog input data to the Controller CPU.
Diagnostic Reference Address	Valid memory types: %I (default), %Q, %G, %M, %T, Symbolic Memory*	Starting address for the channel diagnostics data. Used only when Module Level Diagnostic Reporting is enabled. *Note: To support Symbolic Memories, the "Variable Mode" property should be enabled in PME.
Diagnostic Reference Length	Read-only	The amount of memory required for the channel diagnostics data. When Module Level Diagnostic Reporting is enabled, 32 bits (2 words) of diagnostic data are allocated for each active channel.
Module Status Reference Address	Valid memory types: %I (default), %Q, %G, %M, %T, Symbolic Memory*	The starting address in memory for status information from the module. *Note: To support Symbolic Memories, the "Variable Mode" property should be enabled in PME.
Module Status Reference Length	0, 32	The number of module status bits reported to the CPU. Data format is shown below. When set to 0, status reporting is disabled. To enable status reporting, set this parameter to a value other than 0.
I/O Scan Set	1 through 32	Assigns the module to an I/O Scan Set defined in the CPU configuration.
Inputs Default	Force Off (default) or Hold Last State	In the event of module failure or removal, this parameter specifies the state of all Channel Value References for the module. Force Off = Channel Values clear to 0. Hold Last State = Channels hold their last state.

Parameter	Choices	Description
Analog Input Mode	Single-Ended Input Mode (default), or Differential Input Mode	In Single-Ended Input Mode, 16 inputs are referenced to a single common. In Differential Input Mode, each of the 8 inputs has its own signal and common. This selection must match the input wiring to the module.
Module Level Diagnostic Reporting	Disabled (default) or Enabled	If enabled, 32 bits of data are allocated for each active channel. Diagnostic Reporting and Fault Reporting can be enabled separately for each channel.

Module Status Data Format

Bit	Description
0	0: Module has failed or is not present 1: Module OK
1	Reserved
2	0: Field power not present 1: Field power present
3 through 31	Reserved

Channel Data

Parameter	Choices	Description
Range	0 to 10 V (default) or -10 to 10 V	In the 0 to 10 V default range, input voltage values from 0 to 10 V report 0 to 32,000 integer values to the CPU. In the -10 to 10 V range, input voltage values from -10 to 10 V report -32000 to 32,000 integer values to the CPU.
Channel Value Format	32 Bit Floating Point (default) or 16 Bit Integer	32 Bit Floating Point: A real value, range 3.40282e+38 through 3.40282e+38 16 Bit Integer: The low word of the 32-bit channel data contains the 16-bit integer channel value. The high word contains the sign of the 16-bit integer. If the 16-bit integer result is negative, the upper word in the 32-bit channel data is set to 0xFFFF. If the 16-bit integer result is positive, the upper word is set to 0x0000. When the Channel Value Format parameter is set to 16 Bit Integer, 1000 Eng Units are equal to 1.0 A/D Unit.

Parameter	Choices	Description
High Scale Value (Eng Units) Low Scale Value (Eng Units) High Scale Value (A/D Units) Low Scale Value (A/D Units)	The defaults and ranges for the four scaling parameters depend on the configured Range Type and Channel Value Format.	Scaling is disabled if : High Scale Eng. Units = High Scale A/D Units and Low Scale Eng. Units = Low Scale A/D Units. Default is High A/D Limit of selected range type. When Channel Value Format is set to 32 Bit Floating Point, range is -3.40282e+38 through 3.40282e+38. When set to 16 Bit Integer, range -32,768 through +32,767.
Positive Rate of Change Limit (Eng Units/Second)	Range: 0.0 (default) through 3.40282e+38	Rate of change in Engineering Units per Second that will trigger a Positive Rate of Change alarm. If set to 0, limit is disabled. Used with "Rate of Change Sampling Rate" parameter.
Negative Rate of Change Limit (Eng Units/Second)	Range: 0.0 (default) through 3.40282e+38	Rate of change in Engineering Units per Second that will trigger a Negative Rate of Change alarm. If set to 0, limit is disabled. Used with "Rate of Change Sampling Rate" parameter.
Rate of Change Sampling Rate (ms)	60.0 (default) through 300000.0	Time from 60 through 300000 milliseconds to wait between comparisons. If set to the default value of 60.0, the module checks after every input sample.
High-High Alarm (Eng Units) High Alarm (Eng Units) Low Alarm (Eng Units) Low-Low Alarm (Eng Units) High-High Alarm Deadband (Eng Units) High Alarm Deadband (Eng Units) Low Alarm Deadband (Eng Units)	The defaults and ranges for these parameters depend on the configured Range and Channel Value Format.	Alarms and Dead bands All the alarm parameters are specified in Engineering Units. To use alarming, Diagnostic Reporting or Fault Reporting must be enabled. High-High Alarm and Low-Low Alarm: When the configured value is reached or passed, a Low-Low Alarm or High-High Alarm is triggered. The configured values must be lower than/higher than the corresponding low/high alarm limits.

| Parameter	Choices	Description
Low-Low Alarm Deadband (Eng Units)		High Alarm and Low Alarm: When the configured value is reached or below (above), a Low (High) Alarm is triggered. High and Low Alarm Deadbands: A range in Engineering Units above the alarm condition (low deadband) or below the alarm condition (high deadband) where the alarm status bit can remain set even after the alarm condition goes away. For the alarm status to clear, the channel input must fall outside the deadband range. Alarm Deadbands should not cause the alarm clear condition to be outside the Engineering Unit User Limits range. For example, if the engineering unit range for a channel is -1000.0 to +1000.0 and a High Alarm is set at +100.0, the High Alarm Deadband value range is 0.0 to less than 1100.0. A deadband of 1100.0 or more would put the High Alarm clear condition below –1000.0 units making the alarm impossible to clear within the limits.
User Offset	16 Bit Integer range: -32768 through 32768 32 Bit Floating Point, range: -3.40282e+38 through 3.40282e+38. 0.0 (default) 0.0 (default)	Engineering Units offset to change the base of the input channel. This value is added to the scaled value on the channel prior to alarm checking.
Software Filtering	Disabled (default) or Enabled	Controls whether software filtering will be performed on the inputs.
Integration Time (ms)	0 (default) through 4294967295ms	Specifies the amount of time in milliseconds for the software filter to reach 63.2% of the input value. A value of 0 indicates software filter is disabled. A value of 100 indicates data will achieve 63.2% of its value in 100ms.
Diagnostic Reporting Enable	Disabled (default) or Enabled (Available only if Module Level Diagnostic Reporting is enabled on the Settings tab.)	If Diagnostic Reporting is enabled, the module reports channel alarms in the Diagnostic Reference memory. Channel alarms can be individually enabled.
Fault Reporting Enable		If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm. Fault reporting for channel alarms can be individually enabled.

Input Scaling

The default input mode is single-ended, and range is unipolar. In 0 to 10V mode, input data is scaled so that 0 volts corresponds to a count of 0 and 10 volts corresponds to a count of +32000.

The bipolar range and mode can be selected by changing the module's configuration parameters. In bipolar mode, -10 V corresponds to a count of -32000, 0 V corresponds to a count of 0, and +10 V corresponds to a count of +32000.

Factory calibration adjusts the analog value per bit (resolution) to a multiple of full scale (0.3125 mV/bit). The data is then scaled with the 32000 counts over the analog range. The data is scaled as shown below.

Figure 1: Input Scaling
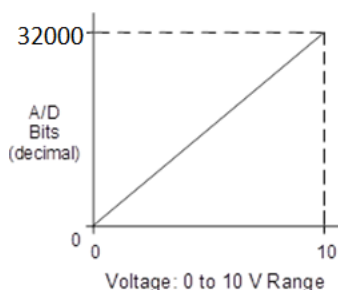
By default, the module converts a voltage input over the entire span of its configured Range into a floating-point value for the CPU. By modifying one or more of the four channel scaling parameters (Low/High Scale Value parameters) from their defaults, the scaled Engineering Unit range can be changed for a specific application. Scaling can provide inputs to the Controller that are already converted to their physical meaning or convert input values into a range that is easier for the application to interpret. Scaling is always linear and inverse scaling is possible. All alarm values apply to the scaled Engineering Units value, not to the A/D input value.

The scaling parameters only set up the linear relationship between two sets of corresponding values. They do not have to be the limits of the input.
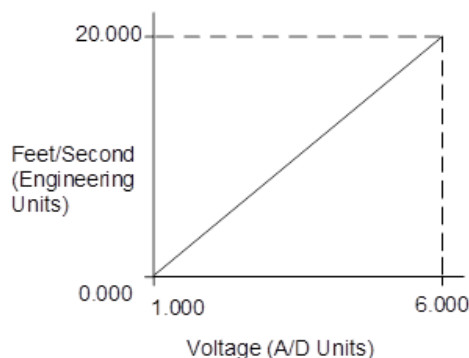
Example:

Figure 2: Scaling Example for ALG232

For a voltage input, 6.0 volts equals a speed of 20 feet per second, and 1.0 volt equals 0 feet per second. The relationship in this range is linear. For this example, the input values should represent speed rather than volts. The following channel configuration sets up this scaling:

High Scale Value (Eng. Units) = 20.000

Low Scale Value (Eng. Units) = 0.000

High Scale Value (A/D Units) = 6.000

Low Scale Value (A/D Units) = 1.000

For this example, 1.0V to 6.0V is the normal voltage range, but the module will attempt to scale the inputs for a voltage that lies outside the range. If a voltage of 10.0V were input to the channel, the module would return a scaled channel value of 36.000. The application should use alarms or other precautions for scaled inputs that are outside the acceptable range or otherwise invalid.

Rate of Change Alarms

ALG232 can detect both Negative Rate of Change and Positive Rate of Change in Engineering Units per Second. When either of the Rate of Change parameters is configured to be non-zero, the module takes the difference in Engineering Units between the previous sample and the current sample, then divides by the elapsed time between samples.

If the Engineering Unit change from the previous sample to current sample is negative, the module compares the rate change with the Negative Rate of Change parameter.

If the Engineering Unit change between samples is positive, the module compares the rate change with the Positive Rate of Change parameter value.

In either case, if the rate of change is greater than the configured rate, a rate of change alarm occurs. The actions taken by the module following the alarm depend on the enabled rate of change actions that have been set up in the Diagnostic Reporting Enable and Fault Reporting Enable parameters.

The Rate of Change Sampling Rate parameter determines how frequently the module compares the rate of change. The minimum value which can be used with this parameter is 60ms i.e., the module can compare the rate of change after every 60ms.

When the CPU transitions to RUN mode or the module field power is cycled, the ALG232 waits 100ms before starting Rate of Change detection. This is to ignore any glitches in the input signal.

Using Alarms

The Diagnostic Reporting Enable and Fault Reporting Enable configuration parameters can be used to enable different types of responses for individual channel alarms. By default, all responses are disabled on every channel. Any combination of alarms can be enabled for each channel.

- If Diagnostic Reporting is enabled, the module reports channel alarms in reference memory at the channel's Diagnostic Reference address.

- If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm
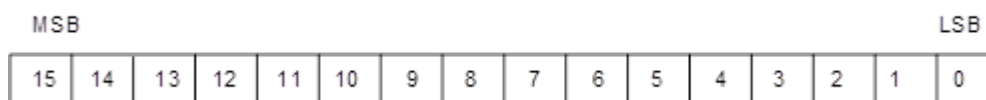
Channel Input Data

The module reports its channel input data in its configured input words, beginning at its assigned Channel Value Reference Address. Each channel occupies 2 words (whether the channel is used or not):

Depending on its configured Channel Value Format, each enabled channel reports a 32-bit floating point or 16-bit integer value to the CPU.

In the 16-bit integer mode, the low word of the 32-bit channel data area contains the 16-bit integer channel value. The high word (upper 16-bits) of the 32-bit value is set with the sign extension of the 16-bit integer. This sign-extended upper word allows the 16-bit integer to be read as a 32-bit integer type in logic without losing the sign of the integer. If the 16-bit integer result is negative, the upper word in the 32-bit channel data has the value 0xFFFF. If the 16-bit integer result is positive, the upper word is 0x0000.

The 16-bit resolution module analog input data is stored in the CPU in 16-bit 2's complement format as shown below.

Figure 3: Channel Input Data Format

Channel Diagnostic Data

In addition to the input data from field devices, the module can be configured to report channel diagnostics status data to the CPU. The CPU stores this data at the module's configured Diagnostic Reference Address. Use of this feature is optional.

The diagnostics data for each channel occupies 2 words (whether the channel is used or not):

When a diagnostic bit equals 1, the alarm or fault condition is present on the channel. When a bit equals 0 the alarm or fault condition is either not present or detection is not enabled in the configuration for that channel.

For each channel, the format of this data is:

Bit	Description
0	Low Alarm
1	High Alarm
2	Under range
3	Overrange
4	Reserved (set to 0)
5 – 15	Reserved (set to 0)
16	Low-Low Alarm
17	High-High Alarm
18	Negative Rate of Change Alarm
19	Positive Rate of Change Alarm
20 - 31	Reserved (set to 0)

Field Wiring: ALG232

Terminal	Single-ended Mode	Differential Mode
1, 2	Not used	
3	Channel 1	Channel 1 +
4	Channel 2	Channel 1 -
5	Channel 3	Channel 2 +
6	Channel 4	Channel 2 -
7	Channel 5	Channel 3 +
8	Channel 6	Channel 3 -
9	Channel 7	Channel 4 +
10	Channel 8	Channel 4 -
11	Channel 9	Channel 5 +
12	Channel 10	Channel 5 -
13	Channel 11	Channel 6 +
14	Channel 12	Channel 6 -
15	Channel 13	Channel 7 +
16	Channel 14	Channel 7 -
17	Channel 15	Channel 8 +
18	Channel 16	Channel 8 -
19	Common	Common
20	Ground	Ground

Connections are shown below for 16-channel single-ended mode and 8-channel differential mode. Single-ended mode is the module's default operating mode. Differential mode must be selected by configuration.
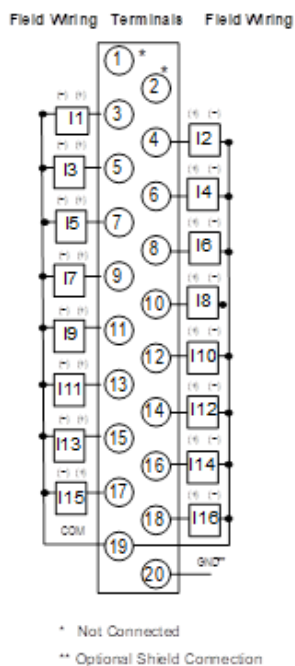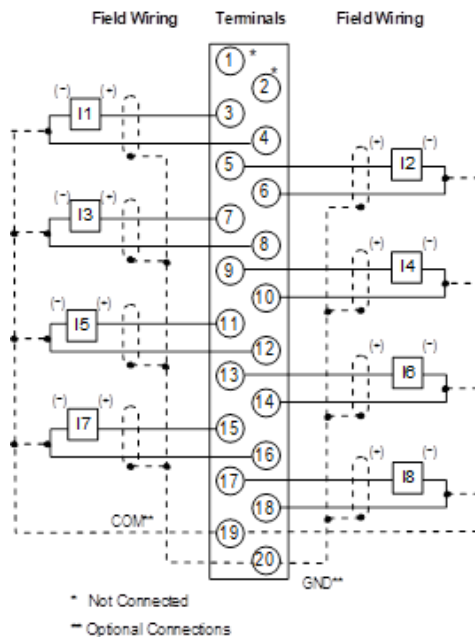
Figure 4: 16 Single Ended Channels	Figure 5: 8-Differential Channels

Release History

Version	Firmware Release	Date	Description
IC694ALG232-EC	2.00	Dec 2020	This release addresses the module hardware obsolescence.
IC694ALG232-DB	1.60	Sep 2019	Following Emerson's acquisition of this product, changes have been made to apply appropriate branding and registration of the product with required certification agencies. No changes to material, process, form, fit or functionality.
IC694ALG232-CB	1.60	Nov 2015	Documentation change only. Removed %AI, %AQ, %R, %W from the Diagnostic Reference Address and Module Status Reference Address module parameters.
IC694ALG232-CB	1.60	May 2012	Resolves several rarely occurring issues that were identified in field and factory testing.
IC694ALG232-BA	1.00	Feb 2012	Hardware revision to correct delayed detection of a disconnected input.
IC694ALG232-AA	1.00	Jul 2011	Initial release

Upgrades

An upgrade kit containing firmware version 2.00, 41G1485-MS10-001-A3, is available for download at https://www.emerson.com/Industrial-Automation-Controls/support.

Compatibility

Requirement	Description
Programmer version requirements	PAC Machine Edition version 7.00 SIM 2 or later is required to configure the ALG232 module.
CPU firmware requirements	RX3i CPU firmware version 6.70 or later is required to operate the ALG232 module.
Module firmware upgrade	The module revision IC694ALG232-DB or before cannot be upgraded with the firmware revision 2.00 or later as the firmware is not backward compatible. Similarly, module revision IC694ALG232-EC or later cannot be updated with any firmware revision earlier than 2.00.

Problems Resolved in this Revision

Subject	Description
Loss of I/O fault is logged for analog modules when a Clear All Memory command is sent through the RX3i CPU's serial port.	This release resolves the issue from IC694ALG232-EC, since the firmware is not compatible to revision IC694ALG232-DB or earlier. When the Rx3i CPU has more than three analog modules in a rack, PAC Machine Edition is communicating with serial port and sends a Clear All Memory command, then any module may unexpectedly log a Loss of I/O Module fault. To recover from this issue, power cycle the CPU and download configuration. Or while clearing, do not use Clear All, but select the configuration item checkboxes.

Restrictions and Open Issues

Subject	Description
Loss of I/O fault is logged for analog modules when a Clear All Memory command is sent through the RX3i CPU's serial port.	This is applicable from IC694ALG232-DB and earlier revisions When the Rx3i CPU has more than three analog modules in a rack, PME is communicating with serial port and sends a Clear All Memory command, then any module may unexpectedly log a Loss of I/O Module fault.
Constant Sweep Exceeded fault is logged when ALGxxx modules are in different racks, with at least one ALGxxx in a remote rack.	With the CPU in constant sweep mode, if two or more ALG modules are placed in a system such that one ALG module is in a remote expansion rack and the others are in a different rack, as soon the hardware configuration is downloaded, and the CPU is returned to run mode, the CPU logs a fault stating "Constant sweep exceeded" in the Controller fault table.

Operational Notes

Subject	Description
Restrictions on Hot Swap	ALG232 module should not be Hot swapped in any of the Expansion and Remote expansion Rx3i backplane racks. Doing so may damage the module or backplane hardware and disrupt the module operations.

Installation in Hazardous Areas

The following information is for products bearing the UL marking for Hazardous Areas or ATEX marking for explosive atmospheres:

> ⚠ **WARNING**
> - EQUIPMENT LABELED WITH REFERENCE TO CLASS I, GROUPS A, B, C & D, DIV. 2 HAZARDOUS LOCATIONS IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D OR NON-HAZARDOUS LOCATIONS ONLY
>
> - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2 or ATEX ZONE 2;
>
> - EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES; AND
>
> - EXPLOSION HAZARD - DO NOT CONNECT OR DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NONHAZARDOUS.

ATEX Marking

II 3 G   Ex nA IIC T4 X Ta: 0 - 60C

Technical Support & Contact Information

Home link: http://www.Emerson.com/Industrial-Automation-Controls

Knowledge Base: https://www.emerson.com/Industrial-Automation-Controls/support

Note: If the product is purchased through an Authorized Channel Partner, please contact the seller directly for any support.

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