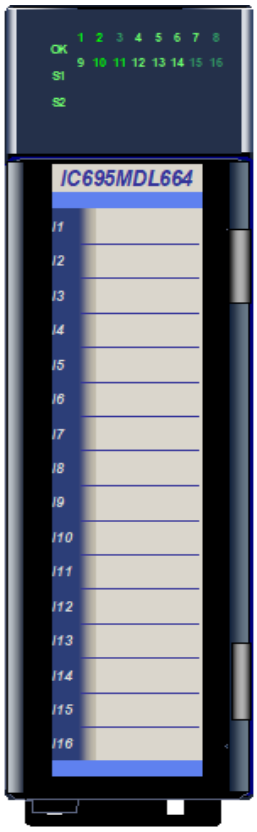
IMPORTANT PRODUCT INFORMATION
GFK-2590F
Nov 2023

PACSystems™ RX3i

16-CHANNEL DIGITAL INPUT MODULE WITH DIAGNOSTICS (IC695MDL664)



EMERSON

Warnings and Caution 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 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.

⚠ CAUTION

Caution notices are used where equipment might be damaged if care is not taken.

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

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Introduction

The Smart Digital Input module, IC695MDL664 provides sixteen positive logic input channels in two groups of eight. The module uses 24 Vdc field input power.

Each group of eight inputs is referenced to an isolated common connection. Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Current into an input point results in a logic 1 in the input status table (%I).

Power to operate field devices must by supplied by the user.

Sixteen dual LEDs indicate the ON/OFF/FAULT status of points 1 through 16. Two LEDs, S1 and S2 indicate whether field power is applied to each of the two input channel groups, and the status of the terminal block. The module also logs an Addition of Terminal Block or Loss of Terminal Block message to the I/O fault table to report the terminal block status.

The blue bands on the label indicate that MDL664 is a low-voltage module.

Features of the Smart Digital input module include:

- Selectable Input Filter Time from 0.5ms to 100ms.
- Open wire / Short to DC- (with external sense resistor).
- Short to DC + (with external sense resistor and external pull-up resistor).
- Input Pulse Test.

This module can be installed in any I/O slot in an RX3i system. Module supports insertion into and removal from an RX3i universal backplane which is under power. Refer to PACSystems RX3i System Manual, GFK-2314, Chapter 2.

This module can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth typically needed for field wiring to AC devices. Refer to PACSystems RX3i System Manual, GFK-2314 Chapter 17 for more information about Terminal Blocks. The Terminal Block is ordered separately.

Specifications: MDL664

Specification	Description
Inputs per Module	16 (two isolated groups of 8 inputs each)
Power Requirements	
Input Voltage (24V nominal), VIN	18 Vdc–32 Vdc
Ripple Voltage, maximum	10% Vpp
Backplane Power Consumption +3.3Vdc +5.1Vdc	 95 mA 225 mA (worst-case, i.e. with all channels on.)
Thermal derating	None required with input voltages in the 18 Vdc–24 Vdc range. For the 25 Vdc–32 Vdc range, see the Thermal Derating Curve for more details.

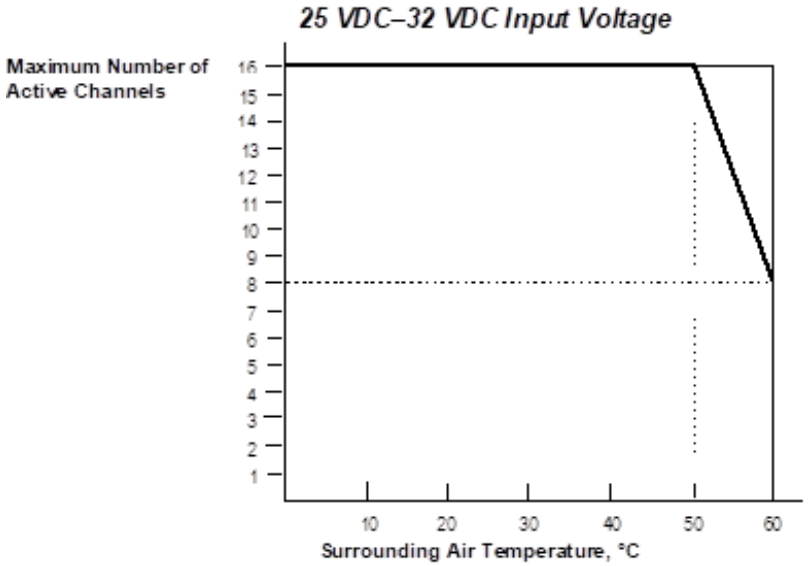
Specification	Description
Input Characteristics	
DC Characteristics	
Input Resistance	1966 Ω
Input Capacitance	0.05µf
Input Current (at 24Vdc)	12.2 mA
Input Voltage ON (Logic 1)	0.5 × VIN Vdc
Input Voltage OFF (Logic 0)	0.3 × VIN Vdc
AC Characteristics	
Turn On Delay, typical	20.6ms
Turn Off Delay, typical	20.6ms
Digital Input Filter Time	0.5–100ms, 20ms default
Isolation	
Field to Backplane Continuous For 1 minute	 250 Vac 1500 Vac
Group to Group Continuous For 1 minute	 250 Vac 1500 Vac

Refer to the PACSystems RX3i System Manual, GFK-2314, for product standards, and general operating specifications, and installation requirements. Manuals can be downloaded from https://www.emerson.com/Industrial-Automation-Controls/support.

Thermal Derating: MDL664

With input voltage in the 18 Vdc to 24 Vdc range, no temperature derating is required, and all input channels can operate within the entire Surrounding Air temperature range. With input voltage greater than 24 Vdc, the number of active channels must be reduced as temperature increases, according to the following derating curve.

Figure 1: Thermal Derating

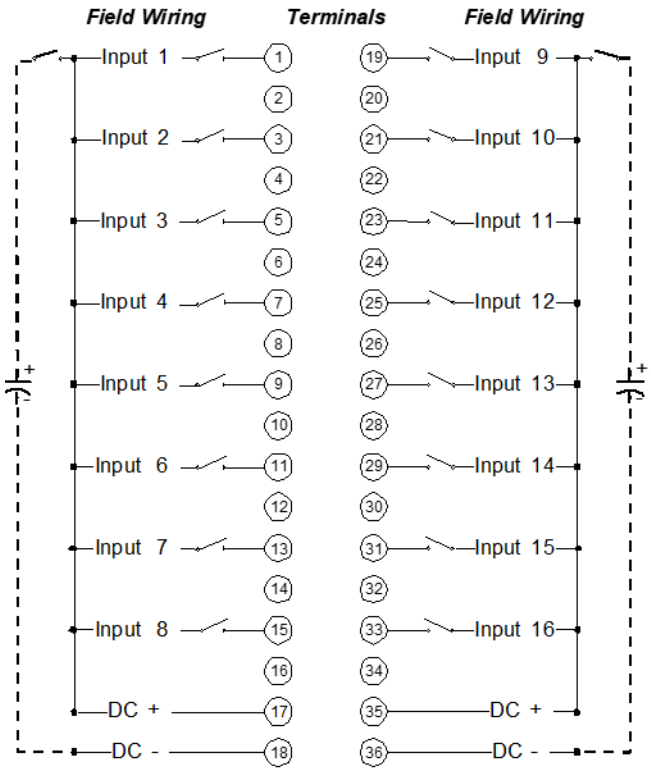


Field Wiring: MDL664

Field wiring connections to the module are made to the removable terminal assembly, as described in the PACSystems RX3i System Manual, GFK-2314.

Figure 2: Field Wiring

Connections	Terminals
Input 1	1
NC	2
Input 2	3
NC	4
Input 3	5
NC	6
Input 4	7
NC	8
Input 5	9
NC	10
Input 6	11
NC	12
Input 7	13
NC	14
Input 8	15
NC	16
DC +	17
DC -	18



Terminals	Connections
1	Input 9
2	NC
2	Input 10
2	NC
2	Input 11
2	NC
2	Input 12
2	NC
2	Input 13
2	NC
2	Input 14
3	NC
3	Input 15
3	NC
3	Input 16
3	NC
3 5	DC+
3	DC-

Installation Location

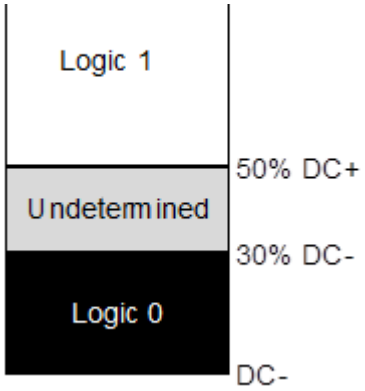
This product is intended for use with the RX3i system. Its components are considered open equipment (having live electrical parts that may be accessible to users) and must be installed in an ultimate enclosure that is manufactured to provide safety. At a minimum, the enclosure shall provide a degree of protection against solid objects as small as 12mm (fingers, for example). This equates to a NEMA/UL Type 1 enclosure or an IEC60529 IP20 rating providing at least a pollution degree 2 environment. For details about installing RX3i rack systems, refer to PACSystems RX3i System Manual, GFK-2314.

For complete installation information, please refer to RX3i Installation and Maintenance Requirements document, GFK-2975.

Circuit Operation

The input circuit references the input to the common (DC -) on the field side of the module. An ON condition for the input device is read as a logic 1, and an OFF condition for the input device is read as a logic 0.

Figure 3: Normal Thresholds



Tri-state Operation (Open Wire / Short to DC- Detection)

Figure 4: Tri-State Operation

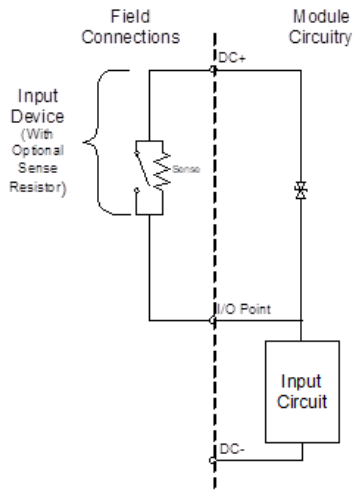
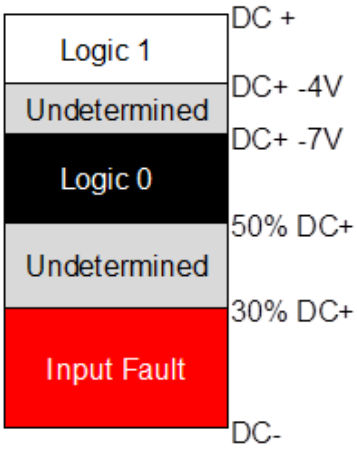


Figure 5: Tri-State Operation



The Open Wire / Short to Ground diagnostic can be enabled on any circuit configured as a tri-state input. In addition to being configured as a tri-state input, the circuit must have a non-inductive sense resistor placed as close as practical to the actual dry contacts (such as across the field device terminals).

Quad-state Operation (Open Wire / Short to DC- and Short to DC+ Detection)

Figure 6: Quad State Thresholds

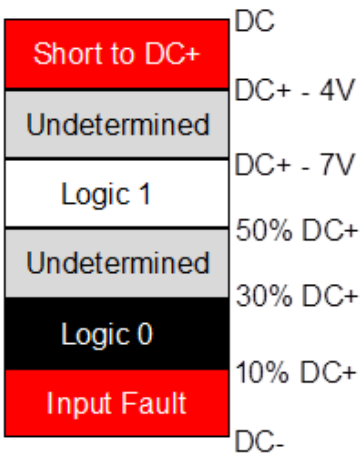
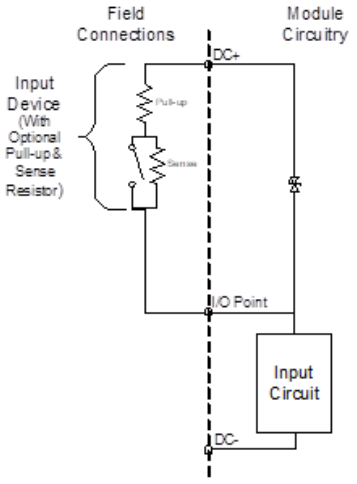


Figure 7: Quad State Input Diagram



The Open Wire / Short to DC- diagnostic and the Short to DC+ diagnostic can be enabled on any circuit configured as a quad-state input. In addition to being configured as a quad-state input, the circuit must have a non-inductive sense resistor placed as close as practical to the actual dry contacts (such as across the field device terminals) and a pull-up resistor between the high side of the Input Device and DC+.

External Resistor Selection

For Tri-state and Quad-state, the external resistor values must be calculated to allow the logic levels to fall within the ranges for the selected Input mode when driven by the expected voltage of the device connected to the input point.

For example, consider an ideal situation with an input configured for Quad-state, a DC+ reference of 24V, and the input point connected to normally open contact that is driven by a voltage between 22V and 24V. A sense resistor is placed across the contact and a pull-up resistor connects the contact to the voltage source.

The pull-up resistor is selected first, using the logic 1 voltage levels. For Quad-state logic 1, the voltage at the input point must be between 12Vdc (50% of DC+) and 17Vdc (DC+ -7V.) The closed contact shorts the sense resistor, so the voltage at the input point is determined by a divider between the internal resistance and the external pull-up resistor. To achieve the best margin across the range of input voltages, two resistances are determined to complete the divider from the maximum and minimum device voltage to the midpoint of the logic 1 range (14.5 Vdc.) From these two results, a standard resistor value that lies between the limits is chosen, such as 1100Ω.

Figure 8: Pull-up Resistor Selection

$$14.5 = 22 * \left(\frac{1966}{1966+\mathrm{Rp}}\right) \qquad \mathrm{Rp} = 1017\Omega$$

$$14.5 = 24 * \left(\frac{1966}{1966+\mathrm{Rp}}\right) \qquad \mathrm{Rp} = 1288\Omega$$

The sense resistor across the contact is solved next, using the logic 0 voltage levels. For Quad-state logic 0, the voltage at the input point must be between 2.4Vdc (10% of DC+) and 7.2Vdc (30% of DC+.) The voltage at the input point is determined by a voltage divider between the internal resistance and the two external resistors. To achieve the best margin across the range of input voltages, two resistances are determined to complete the divider from the maximum and minimum device voltage to the midpoint of the logic 0 range (4.8 Vdc.) From these two results, a standard resistor value that lies between the limits is chosen, such as 6200Ω.

Figure 9: Sense Resistor Selection

$$4.8 = 22 * \left(\frac{1966}{1966+1100+\mathrm{Rs}}\right) \qquad \mathrm{Rs} = 5945\Omega$$

$$4.8 = 24 * \left(\frac{1966}{1966+1100+\mathrm{Rs}}\right) \qquad \mathrm{Rs} = 6764\Omega$$

LED Operation

Figure 10: LEDs

The 16 green/amber channel status LEDs on the module indicate the ON/OFF/Fault status of points 1 through 16.

The Module OK LED indicates module status.

The field status LEDs (S1 and S2) indicate whether the external +24 Vdc power supply is present and is above the minimum level, whether faults are present, and whether the terminal block is locked into place. The module also logs an Addition of Terminal Block or Loss of Terminal Block message to the I/O fault table to report the Terminal Block connection status.

LED	Function	LED Indications
OK	Module status	Off: Module is not receiving power from the RX3i backplane or the module has failed self-test.
		Solid green: Module OK and configured.
		Blinking green: The module has not received configuration from the CPU. If configuration is not successful, the module will continue to blink in this mode.
		Amber: Module hardware watchdog timeout Blinking amber: Module internal error. Record the blink pattern and contact technical support.
1–16	Channel status	Off: Input is off
		Green: Input is on
		Amber: Input fault
S1, S2	Terminal block and field power status	Off: Terminal present and field power not present
		Green: Terminal and field power present
		Red: Terminal not present or field power over-voltage

Note: *The OK, S1 and S2 LEDs blink green in unison when the module is in firmware update mode.*

Input and Output Data Formats

Channel Value Data

The module reports its input channel data in one bit per input, beginning at the configured Channel Value Reference Address.

Channel Diagnostic and Status Data

The module can be configured to report channel diagnostic and 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 data for each channel occupies two words whether the channel is used.

Note: At least two sweeps must occur to clear the diagnostic bits: one scan to send the %Q data to the module and one scan to return the %I data to the CPU. Because module processing is asynchronous to the controller sweep, more than two sweeps may be needed to clear the bits, depending on the sweep rate and the point at which the data is made available to the module.

Bit Offset	Description
0–3	Reserved
4	Set on when open wire is detected.
5	Set on when short to power is detected.
6–8	Reserved
9	Set on when pulse test has failed.
10–14	Reserved
15	Set on when channel communication failure between backplane and field side channel circuits.
16	Set on when pulse test is complete. Note: This bit remains set until the corresponding pulse test command bit is cleared.
17–30	Reserved
31	Set on when any channel fault is detected.

Module Status Data

The module can be configured to return two words of module status data to the CPU. The CPU stores this data in the module's 32-bit configured Module Status Data reference area.

Bit Offset	Description
0	When on, indicates module I/O data is ready.
1	Set on when Terminal block is present.
2	Set on when loss of field power for one or more groups is detected.
3	Set on when module over temperature is detected.
4	Set on when pulse test has failed on any channel.
5	Reserved
6	Set on when loss of group 1 field power is detected.
7	Set on when loss of group 2 field power is detected.
8	Set on when channel fault is reported on any channel.
9–31	Reserved

Pulse Test Command Output Data

The module uses these bits (one bit per input), beginning at the configured Pulse Command Output Reference Address to command an on-demand pulse test. To command an on-demand pulse test, the Pulse Test Enable parameter for the channel must be set to Enabled – Manual.

Diagnostics

The module always performs a set of standard diagnostic checks. Individual circuits can be configured not to log a fault to the CPU if a fault occurs. The module returns current diagnostics for all circuits to %I bits.

Input Pulse Test

The Input Pulse Test is an optional diagnostic feature that exercises the input points to confirm they can detect and respond to changes in the actual input state. Pulse testing verifies the ability of a module's inputs to detect a change in state. Pulse Testing should be enabled if the module has loads that hold state for long periods of time. The application must be capable of withstanding the loss of the input feedback for up to 16ms.

When the pulse test occurs, the input point power is removed, and then the input is connected internally to DC+. This verifies the ability of the input to detect a change in state. Each of the input points is tested individually to ensure there are no shorts between inputs. If a change in state is not detected, a fault is logged with the CPU. Valid field power must be present for the pulse test to run successfully.

On Demand Pulse Test

To use this feature, the channel's Pulse Test Enable parameter must be set to Enabled-Manual. To command a pulse test, set the Pulse Test Command bit for the channel(s) to be pulse tested.

The module will perform one or more pulse tests for each channel selected. Since this will take many sweeps, you should keep the Pulse Test Command bit set until the Pulse Test Complete bit is set for that channel in the Channel Diagnostic and Status Data.

The module will keep the Pulse Test Complete bit set if the Pulse Test Command bit is set. One output scan with the Pulse Test Command bit cleared clears the Pulse Test Complete status bit and the Pulse Test Failure diagnostic bit.

Automatic Pulse Test

To use this feature, the channel's Pulse Test Enable parameter must be set to Enabled-Auto.

The Input Pulse Test occurs at a frequency selected in the Hardware Configuration, with no intervention from the CPU. The pulse test execution is based on the Time of Day clock set in the CPU, and the frequency is relative to 12:00am. For example, a frequency of 12 hours will result in a pulse test run at 12:00am and 12:00pm.

If the pulse test fails, the Pulse Test Failed bit is set.

Configuration

Module Settings

Parameter	Function
Channel Value Reference Address Channel Value Reference Length	Specifies the memory location where the module reports 16 bits of channel values.
Diagnostic Reference Address	Specifies the starting address for reporting channel diagnostics data.
Diagnostic Reference Length	Provides 32 bits of diagnostic data per channel. Setting this value to 0 disables channel diagnostics reporting.
Module Status Reference Address	Specifies the starting address for reporting module status data.
Module Status Reference Length	Provides 32 bits of module status data. Setting this value to 0 disables channel diagnostics reporting.
Pulse Test Command Output Reference Address/ Pulse Test Command Output Reference Length	Specifies the memory location for manual pulse test command data.
Channel Faults w/o Terminal Block	Enables or disables generation of channel faults and alarms after a Terminal Block has been removed.
Inputs Default w/o Terminal Block	Enables or disables defaulting inputs when the terminal block is removed.
Loss of Terminal Block Detection	Enables or disables logging of a fault to indicate a Terminal Block has been removed.
Loss of Field Power Group 1 Detection/ Loss of Field Power Group 2 Detection	Enables or disables loss of field power detection for the specified group.
Inputs Default	Specifies whether inputs will go to Force Off or Hold Last State if module loses communication with the CPU.
I/O Scan Set	Assigns the module I/O status data to a scan set defined in the CPU configuration. Determines how often the RX3i polls the data.

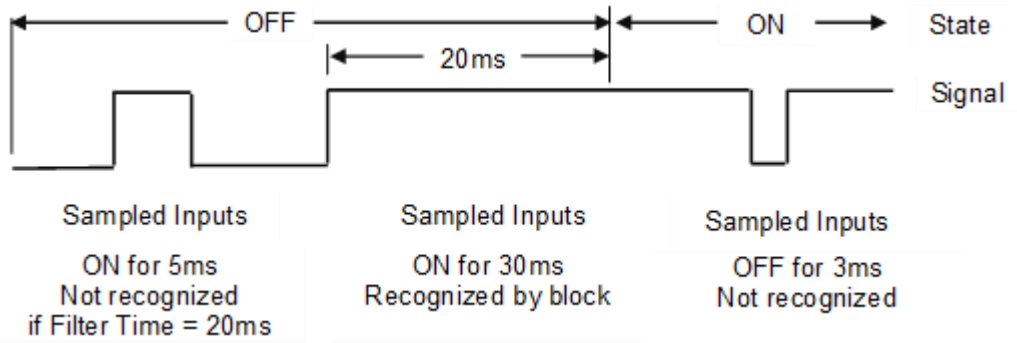
Channel Settings

Parameter	Function	Input Type
Input Type	Selects the input operation, along with enabling the corresponding fault logging. Choices are: Dual state, Tri-state or Quad-state.	
Digital Filter	Enables or disables the digital filter for the input.	All
Digital Filter Frequency	Selects the digital filter frequency in 0.5ms increments. For details, see Input Filter Time.	All
Pulse Test Enable	Enables or disables pulse testing of input. Allows you to select Manual or Automatic pulse testing. For details about this feature, refer to Diagnostics above.	All
Pulse Test Frequency	If Pulse Test Enable is set to Auto, allows you to select the frequency of pulse testing.	All
Diagnostic Reporting Enable	Enables or disables channel diagnostics. If enabled, channel diagnostic data is written to the Channel Diagnostic and Status Data.	All
Open Wire Reporting Enable	If enabled, an open wire condition is reported in the Channel Diagnostic and Status Data.	Tri-State Quad-State
Short to Power Reporting Enable	If enabled, a short to power is reported in the Channel Diagnostic and Status Data.	Quad-State
Pulse Test Failed Enable	If enabled, the results of manual or automatic pulse testing are reported in the Channel Diagnostic and Status Data.	All
Fault Reporting Enable	If enabled, channel faults are reported to the I/O fault table.	All
Open Wire Reporting Enable	If enabled and the corresponding diagnostic reporting is enabled, an open wire condition is reported in the I/O fault table.	Tri-State Quad-State
Short to Power Reporting Enable	If enabled and the corresponding diagnostic reporting is enabled, a short to power is reported in the I/O fault table.	Quad State
Pulse Test Failed Enable	If enabled and the corresponding diagnostic reporting is enabled, a failed pulse test is reported in the I/O fault table.	All

Input Filter Time

An input filter time of 0.5ms to 100ms can be selected for the module, in 0.5ms increments. The default filter time is 20ms. The input filter can be disabled.

Figure 11: Filter Timing



The filter is a digital low-pass filter. The module continuously samples an input for the length of the filter time. The input must remain at a constant state for the length of the Filter Time for the module to recognize the state.

An input filter helps reject spurious noise spikes and multiple inputs generated by the bounce of mechanical devices. In controlled, noise-free environments, signals generated by clean, solid state electronics may be unnecessarily slowed by a filter, delaying system response. In such an environment, no additional filter time is needed. In noisy environments, use a longer filter time to prevent noise from possibly causing erratic or unsafe system operations.

Important Product Information for this Release

Release History

Part Number	Date	Comments
IC695MDL664-EB IC695MDL664CA-EB	Nov 2023	The product's labels have been updated to show compliance with IECEx and ECAS(UAE). For updated certifications, please refer to https://emerson-mas.my.site.com/communities/en_US/Article/Certifications-and-Agency-Approvals-Landing-Page.
IC695MDL664-CB	Feb 2022	Documentation update to provide clarity on channel diagnostic and status data.
IC695MDL664-CB	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.
IC695MDL664-BB	May 2015	Change in packaging of Modules. No change in form-fit-functionality.
IC695MDL664-AB	Aug 2011	Resolves a problem with some modules failing to power up properly under elevated temperature conditions.
IC695MDL664-AA		Initial Release

Upgrades

If a module containing firmware version 1.00 exhibits the symptoms described in Restrictions and Open Issues, contact Emerson for corrective actions.

Functional Compatibility

Programming Software	PAC Machine Edition Logic Developer PLC, version 6.00, SIM 21 or later is required to configure the MDL664.
RX3i CPU Firmware	The MDL664 requires CPU firmware version 6.70 or later.

Restrictions and Open Issues

Subject	Description
At elevated ambient temperature conditions, some modules fail to power up properly.	At elevated ambient temperatures, some IC695MDL664 modules containing firmware version 1.00 fail to power up successfully. Whenever this happens, all the module LEDs are off, and a Loss of Module fault is logged to the I/O fault table. Additionally, all module point faults are correctly set provided point faults are enabled. If this behavior is encountered, contact Emerson for corrective actions. Firmware version 1.01 or later corrects this problem but cannot be installed with Boot version 1.00.

New Features and Enhancements in this Release

This release adds IECEx and ECAS (UAE) certification to the product.

General Contact Information

Home link: http://www.emerson.com/industrial-automation-controls

Knowledge Base: https://www.emerson.com/industrial-automation-controls/support

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+39-0362-228-5555 (from Italy - if toll-free 800 option is unavailable or dialing from a mobile telephone)

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Technical Support: support.mas.apac@emerson.com

Any escalation request should be sent to: mas.sfdcescalation@emerson.com

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

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