FLEX I/O™ Very High Speed Counter

Cat. No. 1794-VHSC

IMPORTANT This module must be used with 1794-ACN15 or 1794-ACNR15 Series B or later ControlNet adapters in ControlNet systems.

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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 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.

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

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, or recognize the consequence

ATTENTION

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures

ATTENTION FLEX I/O is grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

ATTENTION

Prevent Electrostatic Discharge

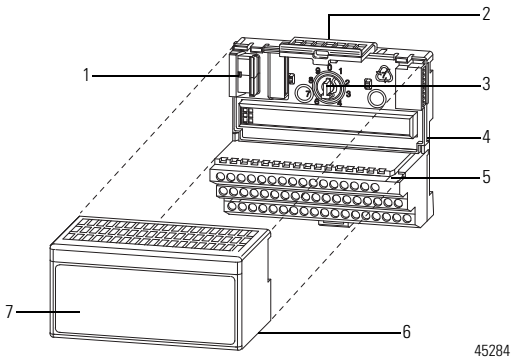
This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

ATTENTION If multiple power sources are used, do not exceed the specified isolation voltage.

ATTENTION Do not remove or replace a Terminal Base unit while power is applied. Interruption of the backplane can result in unintentional operation or machine motion.

Install Your Very High Speed Counter Module



ATTENTION During mounting of all devices, be sure that all debris (metal chips, wire strands, and so on) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

The module mounts on a 1794-TB3G or 1794-TB3GS terminal base.

1. Rotate the keyswitch (3) on the terminal base (4) clockwise to position 1 as required for this type of module.

2. Make certain the FlexBus connector (1) is pushed all the way to the left to connect with the neighboring terminal base/adapter. **You cannot install the module unless the connector is fully extended.**
3. Make sure the pins on the bottom of the module are straight so they will align properly with the connector in the terminal base.
4. Position the module (7) with its alignment bar (6) aligned with the groove (5) on the terminal base.
5. Press firmly and evenly to seat the module in the terminal base unit. The module is seated when the latching mechanism (2) is locked into the module.

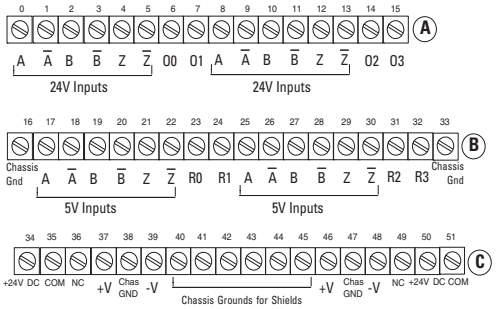
Connecting Wiring for the 1794-TB3G, and 1794-TB3GS

ATTENTION To reduce susceptibility to noise, power analog modules and digital modules from separate power supplies. Do not exceed a length of 3 m (9.8 ft) for DC power cabling.

ATTENTION Do not daisychain power or ground from this terminal base unit to any AC or DC digital module terminal base units.

ATTENTION Do not wire more than two conductors on any single terminal.

Wiring Connections Using 1794-TB3G and 1794-TB3GS



A, Ā = incremental encoder input A (+5 or +24V DC)
B, B̄ = incremental encoder input B (+5 or +24V DC)
Z, Z̄ = incremental encoder input Z (+5 or +24V DC)
O = sourcing outputs
Input power for Output O0 (A-6); Output O1 (A-7) - C-37 (+) and C-39 (-)
Input power for Output O2 (A-14); Output O3 (A-14) - C-46 (+) and C-48 (-)
R = returns for sourcing outputs
+V = +5 or +24V DC isolated power externally supplied for outputs (1A max)
-V = negative isolated power connection (1A max)
+24V DC= 24V DC terminal base power for module
COM = return for 24V DC terminal base power for module
Chassis Gnd = chassis ground for input or output cable shields
NC = No Connection

Wiring Connections

Encoder Inputs	Channel 0		Channel 1	
	24V Inputs	5V Inputs	24V Inputs	5V Inputs
A	A-0	B-17	A-8	B-25
A	A-1	B-18	A-9	B-26
B	A-2	B-19	A-10	B-27
B	A-3	B-20	A-11	B-28
Z	A-4	B-21	A-12	B-29
Z	A-5	B-22	A-13	B-30
Outputs	Source Out	Return		
O0	A-6	B-23		
O1	A-7	B-24		
O2	A-14	B-31		
O3	A-15	B-32		
24V DC		Terminals C-34 and C-50		
24V COM		Terminals C-35 and C-51		
5 or 24V output power		Terminals C-37 and C-46		
-V output power		Terminals C-39 and C-48		
Chassis Ground		Terminals B-16, B-33, C-38, C-40…C-45, C-47		

ATTENTION Do not connect 24V signals to the +5V input terminals. Permanent damage to the module will result.

Input Map

Dec.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct.	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
0	Channel 0 Current Count (least significant word)															
1	Channel 0 Current Count (most significant word)															
2	Channel 1 Current Count (least significant word)															
3	Channel 1 Current Count (most significant word)															
4	Channel 0 Stored/Accumulated Count (least significant word)															
5	Channel 0 Stored/Accumulated Count (most significant word)															
6	Channel 1 Stored/Accumulated Count (least significant word)															

Input Map

Dec.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct.	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
7	Channel 1 Stored/AccumulatedCount (most significant word)															
8	PE	FP	NR	TF	OS 3	OS 2	OS 1	OS 0	C1	C0	ZF	ZS	C1	C0	ZF	ZS

Where:PE = Programming error (error code in bits 11:0)
FP = Field power (24V DC power lost)
NR = Not ready (configuring field programmable array FPGA)
TF = Test fail flag = 1 (indicating failure during powerup) red indicator on.
Code in bits 2:0 indicate fail code (1 = RAM; 2 = ROM; 3 = EEPROM; 4 = FPGA)
Test flag = 1 with red indicator blinking, upper byte of counter control word in non-zero – in production test mode.
OS = Output status (current state of output)
C1, C0 = Stored data count
ZF = Zero frequency detected
ZS = Z input status

Output Map

Dec	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
0	Reserved for test								0	VR1	CP1	CR1	0	VR0	CP0	CR0
1	0	LC3	OE3	FO3	0	LC2	OE2	FO2	0	LC1	OE1	FO1	0	LC0	OE0	FO0
2	Channel 0 PWM Output Value (0-95.00%)															
3	Channel 1 PWM Output Value (0-95.00%)															

Where:VR = Value reset of stored/accumulated count (channel)
CP = Counter preset (channel)
CR = Counter reset (channel)
LC = Local control (channel) - outputs remain under control when FlexBus is unpowered - 1 = enabled
OE = Output enable (channel) - permitting output to be turned on from FO, compare match or PWM
- 1 = enabled
FO = Forced output (channel) - 1 = on
PWM = Pulse width modulation (0…9500 decimal)

Configuration Image

When a configuration is sent to the module, it is checked for consistency before being applied. If an error is found, the PE bit is asserted and the module locally retains its previous configuration. Your user application program should monitor the PE bit.

Configuration Map

Dec	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
0	Counter Configuration															
1	Filter Selection															
2	Time Base Value/PWM Period															
3	Channel 0 Gate Interval															
4	Channel 1 Gate Interval															
5	Reserved															
6	Channel 0 Rollover Value (least significant word)															
7	Channel 0 Rollover Value (most significant word)															
8	Channel 1 Rollover Value (least significant word)															
9	Channel 1 Rollover Value (most significant word)															
10	Channel 0 Preset Value (least significant word)															
11	Channel 0 Preset Value (most significant word)															
12	Channel 1 Preset Value (least significant word)															
13	Channel 1 Preset Value (most significant word)															
14	Channel 0 Scaler															
15	Channel 1 Scaler															
16	0	0	0	0	0	0	0	0	S4	S3	S2	S1	F4	F3	F2	F1
17	0	0	0	0	0	0	0	0	S4	S3	S2	S1	F4	F3	F2	F1
18	0	0	0	0	0	0	0	0	S4	S3	S2	S1	F4	F3	F2	F1
19	0	0	0	0	0	0	0	0	S4	S3	S2	S1	F4	F3	F2	F1
20	First Counter 1st ON Value (least significant word)															
21	First Counter 1st ON Value (most significant word)															

Configuration Map

Dec	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
22	First Counter 1st OFF Value (least significant word)															
23	First Counter 1st OFF Value (most significant word)															
24	First Counter 2nd ON Value (least significant word)															
25	First Counter 2nd ON Value (most significant word)															
26	First Counter 2nd OFF Value (least significant word)															
27	First Counter 2nd OFF Value (most significant word)															
28	First Counter 3rd ON Value (least significant word)															
29	First Counter 3rd ON Value (most significant word)															
30	First Counter 3rd OFF Value (least significant word)															
31	First Counter 3rd OFF Value (most significant word)															
32	First Counter 4th ON Value (least significant word)															
33	First Counter 4th ON Value (most significant word)															
34	First Counter 4th OFF Value (least significant word)															
35	First Counter 4th OFF Value (most significant word)															
36	Second Counter 1st ON Value (least significant word)															
37	Second Counter 1st ON Value (most significant word)															
38	Second Counter 1st OFF Value (least significant word)															
39	Second Counter 1st OFF Value (most significant word)															
40	Second Counter 2nd ON Value (least significant word)															
41	Second Counter 2nd ON Value (most significant word)															
42	Second Counter 2nd OFF Value (least significant word)															
43	Second Counter 2nd OFF Value (most significant word)															
44	Second Counter 3rd ON Value (least significant word)															
45	Second Counter 3rd ON Value (most significant word)															
46	Second Counter 3rd OFF Value (least significant word)															
47	Second Counter 3rd OFF Value (most significant word)															
48	Second Counter 4th ON Value (least significant word)															
49	Second Counter 4th ON Value (most significant word)															
50	Second Counter 4th OFF Value (least significant word)															
51	Second Counter 4th OFF Value (most significant word)															
52	Counter Control Safe State															
53	Output Control Safe State															
54	Channel 0 PWM Safe State															
55	Channel 1 PWM Safe State															

Counter Configuration/Mode (Configuration Word 0)

Bit	7	6	5	4	3	2	1	0	Counter 0
Bit	15	14	13	12	11	10	9	8	Counter 1
	Mode				Configuration				Description
					0	0	0	0	Counter
					0	0	0	1	Encoder X1
					0	0	1	0	PWM
					0	1	0	0	Encoder X4
					0	1	0	1	Period/Rate
					0	1	1	0	Continuous/Rate
					0	1	1	1	Rate Measurement
		0	0	0					Store Count Disabled
		0	0	1					Mode 1 – Store/Continue
		0	1	0					Mode 2 – Store; Reset/Resume
		0	1	1					Mode 3 – Store; Reset/Wait/Start
		1	0	0					Mode 4 – Store; Reset/start
	110 and 111								Reserved
	0								Z input not inverted
	1								Z input inverted

Filter Selection (Configuration Word 1)

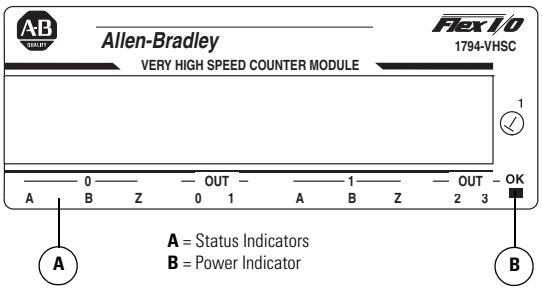
Bit	7	6	5	4	3	2	1	0	Counter 0
Bit	15	14	13	12	11	10	9	8	Counter 1

Filter Selection (Configuration Word 1)

	0	ZF	BF	AF	Filter				Description
					0	0	0	0	No filter
					0	0	0	1	50 kHz (10 µs + 0 µs/-1.6 µs)
					0	0	1	0	5k Hz (100 µs + 0 µs/-13.2 µs)
					0	1	0	0	500 Hz (1.0 ms + 0 ms/-125 µs)
					1	0	0	0	50 Hz (10.0 ms + 0 ms/-1.25 ms)
				0					A input not filtered
				1					A input filtered
			0						B input not filtered
			1						B input filtered
		0							Z input not filtered
		1							Z input filtered

Status Indicators

This module has one red/green power/status indicator (OK), and one yellow indicator for each input and output. The I/O status indicators are multiplexed in 2 groups (A0, B0, Z0, O0, O1); and (A1, B1, Z1, O2, O3) at a frequency of 488 Hz. If inputs or outputs change at or near that frequency, the indicators will vary in brightness.



Status Indicators

Indicator	Indication	Explanation
A (status of input A	Yellow	Input A active
	Off	Input A not active
B (status of input B	Yellow	Input B active
	Off	Input B not active
Z (status of input Z	Yellow	Input Z active
	Off	Input Z not active
Out 0, 1, 2, 3	Yellow	Output is on
	Off	Individual output is off

When an active indicator (yellow) is lighted, a valid signal (active high or active low) is present at the input terminals.

The module power/status indicator (OK) shows power applied to the module, and the status of the module.

Indicator	Indication	Explanation
OK	Solid red	• Hardware diagnostic error, TF set to 1 and module/channel status contains error code • Hardware runtime failure (that is, watchdog timeout), module communication ceases
	Flashing red	• Module is configuring hardware, NR is set to 1. • Module is in test mode (bits 8…15 of counter control word are nonzero), TF set to 1
	Flashing red (with occasional flashing green)	• Module 24V power is below minimum rating.
	Solid green	• Module is active and acting normally
	Flashing green	• Module is not configured • Programming error, PE is set to 1 and error code is supplied in bits 0…11 of module/channel status word • Field power fault, FP set to 1 • Adapter powered down, and module local power still active • ControlNet cable disconnected • PLC in PROG mode

Diagnostic Codes Returned by the Module

If an incomplete, incorrect or conflicting set of configuration parameters is sent to the module, the PE bit is asserted, the green module status indicator flashes, and an error code is displayed in bits 0…11 of the module/channel status word. The codes are identified below. Use a CIO instruction to access this information.

Diagnostics Reported by Input Data Word 8

Read Word	Bit	Indication
Word 8	00	A reserved configuration or mode was programmed.
	01	ZF/BF/AF were selected and no filter was programmed, or multiple filters were selected.
	02	A timebase was entered that was not a multiple of 10, or the timebase is out of range (>3000, that is 3 s).
	03	A configuration requiring a timebase was selected and no gate interval was set, or the gate interval is out of range (>3 s) or the product of timebase and gate interval is greater than 3 s.
	04	A rollover of zero was programmed through PWM was not selected; a rollover was programmed and PWM was selected; or the rolloveris out of range (1 < rollover < 16,777,216).
Word	05	The preset (1 < preset < 16,777,216) is out of range.
	06	A configuration was selected that requires a scalar, and no scalar was programmed or multiple scalars were selected.
	07	A tie has been connected to an unprogrammed window.
	08	Counter 0 window ON and OFF values are equal and not zero or counter 0 window ON and OFF value greater than16,777,215.
	09	Counter 1 window ON and OFF values are equal and not zero or counter 1 window ON and OFF value greater than16,777,215.
	10	Reserved
	11	

During hardware self-tests, when either FlexBus power or terminal base power is first applied and a fatal error occurs, the TF bit is asserted and the red module/power status indicator comes on. An error code is placed in the lower byte of the module/channel status word to indicate the failed resource. Use a CIO instruction to access this information. When using the CIO instruction, this would be word 10.

Word 9 Bit Description

Read Word	Bit	02	01	00	Dec.	Definition
Word 8	00…07	0	0	1	1	RAM test failed
		0	1	0	2	ROM checksum test failed
		0	1	1	3	EEPROM test failed
		1	0	0	4	Programmable Gate Array loading failed
		All other combinations not used				

Specifications

Input Specifications

Attribute	Value
Number of input channels	2
Number of inputs per counter	2 groups of A/$\overline{A}$, B/$\overline{B}$, and Z/$\overline{Z}$ pairs with 5V DC or 15…24V DC terminations
Input voltage	5V DC or 15…24V DC (Determined by terminal base terminations)
Input current	5V DC terminations: 19.1 mA @ 5V DC 25.7 mA @ 6V DC 15…24V DC terminations: 6.1 mA @ 15V DC 10.2 mA @ 24V DC
Voltage, input, off-state	5V DC terminations: ≤1.25V DC 15…24V DC terminations: ≤1.8V DC
Current, input, off-state	≤0.25 mA
Voltage, input, on-state	5V DC terminations: ≥2.6V DC 15…24V DC terminations: ≥12.5V DC
Current, input, on-state	≥5 mA
Voltage, on-state, max	5V DC terminations: ±6V 15…24V DC terminations (Refer to Derating Curve)
Input frequency, max	1.0 MHz counter and encoder X1 (no filters) 500 kHz encoder X2 (no filters) 250 kHz endocer X4 (no filters)
Input filter selections	Off, 10µs, 100µs, 1.0ms, 10.0ms per A/B/Z group

Output Specifications

Attribute	Value
Number of outputs	2 isolated groups of 2: (0.5A @ 5V DC, max; 1.0A @ 12…24V DC, max)
Output control	Outputs can be tied to 8 compare windows
Voltage range, output supply	5…7V DC; 10…31V DC
Leakage current, off-state	Less than 300 µA
Voltage drop, on-state	5V DC terminations: 0.9V DC @ 0.5 A 12…24V DC terminations: 0.9V DC @ 1.0 A
Current, on-state, max	5V DC terminations: 0.5 A 12…24V DC terminations: 1.0 A
Current per output pair, max	5V DC terminations: 0.5 A 12…24V DC terminations: 1.0 A
Short circuit current	5V DC terminations: 0.9A 12…24V DC terminations: 4.0A Outputs are short-circuit protected and turned off until power is cycled.
Surge current	2A for 50 ms, repeatable every 2 s
Delay TimeOff to On On to Off	25 µs (load dependent) 150 µs (load dependent)

General Specifications

Attribute	Value
Module location	1794-TB3G and 1794-TB3GS
External DC power supply voltage Voltage range, nom Supply voltage Supply current	 24V DC 19.2…31.2V DC (includes 5% AC ripple) 100 mA @ 24V DC

General Specifications

Attribute	Value
Dimensions, HxWxD (with module installed on terminal base)	94 x 94 x 69 mm (3.7 x 3.7 x 2.7 in.)
Isolation voltage	50V (continuous), Basic Insulation Type, between six isolated areas including: Flexbus Module 24V DC power A0/B0/Z0 inputs A1/B1/Z1 inputs 00/01 and output power supply 1 02/03 and output power supply 2 Tested @ 850V DC for 1 s
FlexBus current	75 mA @ 5V DC (with terminal base power off)
Power dissipation, max	5.0 W @ 31.2V DC
Thermal dissipation, max	17.1 BTU/hr @ 31.2V DC
Indicators (field side driven, logic side indication)	1 green/red power/status indicator 6 yellow input status indicators – logic side 4 yellow output tatus indicators – logic side
Keyswitch position	1

Environmental Specifications

Attribute	Value
Temperature, operating	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0…55 °C (32…131 °F)
Temperature, nonoperating	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40…85 °C (-40…185 °F)
Relative humidity	IEC 60068-2-30 (Test Db, Unpackaged Damp Heat): 5…95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 5g @ 10…500 Hz
Shock, operating	IEC60068-2-27 (Test Ea, Unpackaged shock): 30 g
Shock, nonoperating	EC60068-2-27 (Test Ea, Unpackaged shock): 50 g
Emissions	CISPR 11: Group 1, Class A (with appropriate enclosure)
ESD Immunity	IEC 61000-4-2: 6 kV contact discharges 8 kV air discharges
Radiated RF immunity	IEC 61000-4-3: 10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 10V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz
EFT/B immunity	IEC 61000-4-4: ±2 kV @ 5 kHz on power ports ±2 kV @ 5 kHz on signal ports
Surge transient immunity	IEC 61000-4-5: ±1 kV line-line(DM) and ±2 kV line-earth(CM) on power ports ±1 kV line-line(DM) and ±2 kV line-earth(CM) on signal ports ±2 kV line-earth(CM) on shielded ports
Conducted RF immunity	IEC 61000-4-6: 10V rms with 1 kHz sine-wave 80%AM from 150 kHz…80 MHz
Enclosure type rating	None (open-style)
Wire size	Determined by installed terminal base
Wiring category[1]	2 – on signal ports 2 – on power ports
Terminal base screw torque	Determined by installed terminal base

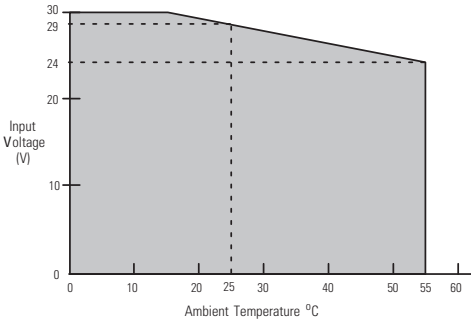
(1) Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications

Certification (when product is marked)[1]	Description
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3

(1) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Derating Curve



The area within the curve represents the safe operating range for the module under various conditions of user supplied 24V DC supply voltages and ambient temperatures.
This includes all possible mounting positions, including inverted horizontal.

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

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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